

Biological Sciences

Department Website: <http://bscd.uchicago.edu>

PROGRAM OF STUDY

Biology is the study of life, past and present. The faculty of the College believe that a sound knowledge of biology is essential for understanding the world in which we live, engaging many pressing problems facing humanity, and becoming a part of their eventual solution. The Biological Sciences Collegiate Division, therefore, provides a variety of general education courses for all College students—prospective biologists and non-biologists alike. Although most of the course offerings beyond the introductory year are designed to serve the needs of students majoring in biological sciences, many of these courses are well suited to students in other areas who wish to study some aspect of modern biology in greater detail. Courses on the ethical and societal implications of the biological sciences, for example, are of interest to many non-majors. For prospective biologists and medical professionals, our curriculum offers in-depth course work at all scales of life, from complex ecosystems to organisms to the molecular mechanisms operating in subcellular compartments.

Academic Honesty

Academic dishonesty is a matter of grave concern to the faculty of the Biological Sciences Collegiate Division and will not be tolerated. Students should become familiar with the guidelines presented in *Doing Honest Work in College* by Charles Lipson and consult with each of their instructors to make sure they understand the specific expectations of each course. Consequences of academic dishonesty (including plagiarism) may result in suspension or expulsion from the University.

The General Education Requirement in the Biological Sciences

Students choose one of the following options to meet the general education requirement in the Biological Sciences:

1. a two-quarter general education sequence for non-majors; or
2. The Pre-Med Sequence for non-science majors; or
3. BIOS 20153 Fundamentals of Ecology and Ev and BIOS 20151 Introduction to Quantitative Modeling in Biology (Basic) or BIOS 20152 Introduction to Quantitative Modeling in Biology (Advanced).

Advanced Placement Credit

For students who do not plan to major in the Biological Sciences or prepare for the health professions, a score of 4 or 5 on the AP biology test confers credit for BIOS 10130 Core Biology. These students meet the general education requirement with either one or two topics courses in the Biological Sciences, depending on how the requirements in the mathematical and physical sciences are met; consult your College adviser for details.

Students with a score of 4 or 5 on the AP biology test who complete the first three quarters of an Advanced Biology Fundamentals Sequence will be awarded a total of two quarters of credit to be counted toward the general education requirement for the Biological Sciences. This option is especially appropriate for students who plan to major in the Biological Sciences or prepare for the health professions, but it is open to all qualified students.

REQUIREMENTS FOR THE BACHELOR OF ARTS DEGREE IN THE BIOLOGICAL SCIENCES

The goals of the Biological Sciences program are to give students (1) an understanding of currently accepted concepts in biology and the experimental support for these concepts and (2) an appreciation of the gaps in our current understanding and the opportunities for new research in this field. Emphasis is placed on introducing students to the diversity of subject matter and methods of investigation in the Biological Sciences. The program prepares students for graduate or professional study in the Biological Sciences and for careers in the Biological Sciences. The following sections describe the requirements for a BA in the Biological Sciences. Sequences in the first year of the program are referred to as the Fundamentals and include the following: (1) The Advanced Biology sequence—designed for first-year students who have achieved a score of 4 or 5 on the Advanced Placement Biology test. (2) Molecules to Organisms (Sections 1 and 2) sequence—begins in the Winter Quarter of the first year and is structured to provide students with a broad-based understanding of contemporary biology. (3) Life, Ecosystems, and Evolution (formerly Track C)—designed for students interested in pursuing careers in ecology and evolution or environmental science. At the completion of the first three quarters of a Fundamentals sequence students begin taking the upper-level advanced elective courses and may start a specialization.

General Education Courses for Biological Sciences Majors

To prepare for more advanced work in the Biological Sciences, students must take the following to satisfy general education requirements:

PHYSICAL SCIENCES. One of the following sequences: 200

CHEM 10100 & CHEM 10200	Introductory General Chemistry I and Introductory General Chemistry II (or equivalent)
CHEM 11100-11200	Comprehensive General Chemistry I-II

MATHEMATICAL SCIENCES. One of the following sequences: 200

MATH 13100-13200	Elementary Functions and Calculus I-II (or higher)
MATH 15100-15200	Calculus I-II
MATH 16100-16200	Honors Calculus I-II

BIOLOGICAL SCIENCES. One of the following:		200
BIOS 20153 & BIOS 20151	Fundamentals of Ecology and Ev and Introduction to Quantitative Modeling in Biology (Basic)	
BIOS 20153 & BIOS 20152	Fundamentals of Ecology and Ev and Introduction to Quantitative Modeling in Biology (Advanced)	
BIOS 20234-20235-20236	Molecular Biology of the Cell; Biological Systems; Biological Dynamics *	
Total Units		600

* Students with a score of 4 or 5 on the AP Biology test may use their AP credit to meet the general education requirement in the Biological Sciences if the first three quarters of the Advanced Biology sequence are completed.

Courses Required for the Biological Sciences Major*

Natural Science excluding Biology

In addition to the general education requirements, all students majoring in Biological Sciences must complete the third quarter of general chemistry (CHEM 11300 Comprehensive General Chemistry III, or equivalent).

(Biological Sciences majors following the Molecules to Organisms or Advanced Biology Fundamentals sequences also take two quarters of organic chemistry (CHEM 22000 Organic Chemistry I and CHEM 22100 Organic Chemistry II/CHEM 23100 Honors Organic Chemistry II)**; two quarters of physics (PHYS 12100-12200 General Physics I-II, or higher); and one general quantitative course (BIOS 26210 Mathematical Methods for Biological Sciences I, PHYS 12300 General Physics III (or higher), or STAT 22000 Statistical Methods and Applications (or higher)).

Biological Sciences majors following the Life, Ecosystems, and Evolution Fundamentals sequence take either two quarters of organic chemistry (CHEM 22000 Organic Chemistry I and CHEM 22100 Organic Chemistry II/CHEM 23100 Honors Organic Chemistry II) OR two quarters of physics (PHYS 12100-12200 General Physics I-II, or higher), one general quantitative course (BIOS 26210 Mathematical Methods for Biological Sciences I, PHYS 12300 General Physics III (or higher), or STAT 22000 Statistical Methods and Applications (or higher)), and three additional quantitative courses (<http://bscd.uchicago.edu/page/quantitative-courses>).

Biological Sciences Fundamentals Sequences

Students register for four quarters of Biological Sciences Fundamentals courses associated with one of three sequences.

Molecules to Organisms: BIOS 20186 Fundamentals of Cell and Molecular Biology, BIOS 20187 Fundamentals of Genetics, BIOS 20188 Fundamentals of Physiology or BIOS 20191 Integrative Physiology, and BIOS 20189 Fundamentals of Developmental Biology or BIOS 20190 Principles of Developmental Biology

Life, Ecosystems, and Evolution (formerly Track C): BIOS 20186 Fundamentals of Cell and Molecular Biology, BIOS 20187 Fundamentals of Genetics, BIOS 20198 Biodiversity, and BIOS 20196 Ecology and Conservation

Advanced Biology Fundamentals (open only to first-year students who have scored a 4 or 5 on the AP Biology exam): BIOS 20234 Molecular Biology of the Cell, BIOS 20235 Biological Systems, BIOS 20236 Biological Dynamics, and BIOS 20242 Principles of Physiology.

Students who do not enter the Advanced Biology sequence must complete BIOS 20153 Fundamentals of Ecology and Ev in Winter Quarter and BIOS 20151 Introduction to Quantitative Modeling in Biology (Basic) (Spring) or BIOS 20152 Introduction to Quantitative Modeling in Biology (Advanced) (Winter) their first year. (These two courses fulfill the general education requirement.)

* Students planning to apply to medical school should be aware of individual medical school admissions requirements and should tailor their program accordingly with the help of UChicago Careers in Health Professions (<http://cchp.uchicago.edu>) (UCIHP).

** The first two quarters of organic chemistry are required for all Biological Sciences majors except for those completing Life, Ecosystems, and Evolution, who may take either two quarters of Organic Chemistry or two quarters of General Physics.

NOTE: Biological Sciences does NOT require the third quarter of calculus in any of the sequences. Students entering the Molecules to Organisms or the Life, Ecosystems, and Evolution sequence MUST take BIOS 20151 Introduction to Quantitative Modeling in Biology (Basic) or BIOS 20152 Introduction to Quantitative Modeling in Biology (Advanced), and students in the Advanced Biology sequence MUST take BIOS 20236 Biological Dynamics. NO MATH courses may be substituted for these requirements.

20200-Level and Above Courses in Biological Sciences

Students taking the Molecules to Organisms or Advanced Biology sequence also register for BIOS 20200 Introduction to Biochemistry plus five additional 21000- to 28999-level courses in Biological Sciences. The Life, Ecosystems, and Evolution sequence also requires five additional 21000- to 28999-level courses in the Biological Sciences, but not BIOS 20200 Introduction to Biochemistry. These courses may be selected by the student or in consultation with the BSCD Senior Advisers (Megan McNulty, mmcnulty@uchicago.edu and Christine Andrews, candrews@uchicago.edu). If the

student chooses to complete a “specialization” (see sections that follow), courses should be chosen in consultation with the Specialization Adviser (listed below).

NOTE: BIOS 00199 Undergraduate Research, BIOS 00206 Readings: Biology, and BIOS 00299 Advanced Research: Biological Sciences may not be used to meet requirements for the Biological Sciences major. Courses listed under the heading Specialized Courses (numbered in the 29000 range) may not be used to meet requirements for the Biological Sciences major.

Summary of General Education Requirements for Molecules to Organisms; Advanced Biology; and Life, Ecosystems, and Evolution

GENERAL EDUCATION

One of the following CHEM sequences (or equivalent): §		200
CHEM 10100 & CHEM 10200	Introductory General Chemistry I and Introductory General Chemistry II	
CHEM 11100-11200	Comprehensive General Chemistry I-II	
One of the following MATH sequences: §		200
MATH 13100-13200	Elementary Functions and Calculus I-II	
MATH 15100-15200	Calculus I-II	
MATH 16100-16200	Honors Calculus I-II	
One of the following BIOS sequences:		200
Completion of the three-quarter Advanced Biology sequence *		
BIOS 20153 & BIOS 20151	Fundamentals of Ecology and Ev and Introduction to Quantitative Modeling in Biology (Basic)	
BIOS 20153 & BIOS 20152	Fundamentals of Ecology and Ev and Introduction to Quantitative Modeling in Biology (Advanced)	
Total Units		600

* Open only to students with a 4 or 5 on the AP Biology test. Upon completion of the first three quarters of the sequence, students will be awarded a total of 200 units to be counted toward the general education requirement in the Biological Sciences.

§ Credit may be granted by examination.

Summary of Major Requirements: Molecules to Organisms

MAJOR

CHEM 11300	Comprehensive General Chemistry III (or equivalent) §	100
PHYS 12100-12200	General Physics I-II (or higher) §	200
One of the following:		100
BIOS 26210	Mathematical Methods for Biological Sciences I	
PHYS 12300	General Physics III (or higher) §	
STAT 22000	Statistical Methods and Applications (or higher) §	
All of the following:		
BIOS 20186	Fundamentals of Cell and Molecular Biology	100
BIOS 20187	Fundamentals of Genetics	100
BIOS 20188	Fundamentals of Physiology	100
or BIOS 20191	Integrative Physiology	
BIOS 20189	Fundamentals of Developmental Biology	100
or BIOS 20190	Principles of Developmental Biology	
BIOS 20200	Introduction to Biochemistry	100
Five courses above BIOS 20242 in Biological Sciences		500
One of the following sequences:		200
CHEM 22000 & CHEM 22100	Organic Chemistry I and Organic Chemistry II	
CHEM 23000 & CHEM 23100	Honors Organic Chemistry I and Honors Organic Chemistry II	
Total Units		1600

§ Credit may be granted by examination.

Summary of Major Requirements: Life, Ecosystems, and Environment

MAJOR

CHEM 11300	Comprehensive General Chemistry III (or equivalent) §	100
One of the following two-quarter sequences:		200
CHEM 22000 & CHEM 22100	Organic Chemistry I and Organic Chemistry II	
CHEM 23000 & CHEM 23100	Honors Organic Chemistry I and Honors Organic Chemistry II	
PHYS 12100-12200	General Physics I-II (or higher) §	
One of the following:		100
BIOS 26210	Mathematical Methods for Biological Sciences I	
PHYS 12300	General Physics III (or higher) §	
STAT 22000	Statistical Methods and Applications (or higher) §	
All of the following:		
BIOS 20186	Fundamentals of Cell and Molecular Biology	100
BIOS 20187	Fundamentals of Genetics	100
BIOS 20198	Biodiversity	100
BIOS 20196	Ecology and Conservation	100
Three additional quantitative courses (http://bscd.uchicago.edu/page/quantitative-courses)		300
Five courses above BIOS 20242 in Biological Sciences		500
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Total Units		1600

§ Credit may be granted by examination.

Summary of Major Requirements: Advanced Biology*

MAJOR

CHEM 11300	Comprehensive General Chemistry III (or equivalent) §	100
PHYS 12100-12200	General Physics I-II (or higher) §	200
One of the following:		100
BIOS 26210	Mathematical Methods for Biological Sciences I	
PHYS 12300	General Physics III (or higher) §	
STAT 22000	Statistical Methods and Applications (or higher, or petition BSCD for replacement) §	
All of the following:		
BIOS 20234	Molecular Biology of the Cell	100
BIOS 20235	Biological Systems	100
BIOS 20236	Biological Dynamics	100
BIOS 20200	Introduction to Biochemistry	100
BIOS 20242	Principles of Physiology	100
Five courses above BIOS 20242 in Biological Sciences		500
One of the following sequences:		200
CHEM 22000 & CHEM 22100	Organic Chemistry I and Organic Chemistry II	
CHEM 23000 & CHEM 23100	Honors Organic Chemistry I and Honors Organic Chemistry II	
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Total Units		1600

* Open only to students with a 4 or 5 on the AP Biology test. Upon completion of the first three quarters of the sequence, students will be awarded a total of 200 units to be counted toward the general education requirement in the Biological Sciences.

§ Credit may be granted by examination.

Grading

Students must receive quality grades in all courses that meet requirements for the Biological Sciences major.

Research Opportunities

Students are encouraged to carry out individual guided research in an area of their interest. A student may propose an arrangement with any faculty member in the Division of the Biological Sciences to sponsor and supervise research on an individual tutorial basis. Students may register for BIOS 00199 Undergraduate Research or BIOS 00299 Advanced

Research: Biological Sciences if they want to receive general elective credit for their research work. Consult the following course description section for information about procedures, grading, and requirements for registration in BIOS 00199 Undergraduate Research and BIOS 00299 Advanced Research: Biological Sciences. For more information, see bscd.uchicago.edu/content/undergrad-research or contact John Kennedy (jmkennedy@uchicago.edu). NOTE: Course credit cannot be given for work that is compensated by a salary.

Some financial support may be available to students for summer research through their research supervisors or through fellowships awarded competitively by the Biological Sciences Collegiate Division. Application deadlines for various fellowships range from mid-February to early April. Please see bscd.uchicago.edu/content/undergrad-research for more information about fellowship opportunities.

Honors

Honors in Biological Sciences can be earned via one of two tracks. Scholar Honors: This track recognizes exceptional academic performance (minimum cumulative GPA of 3.75 or above), including submission and acceptance of a scholarly thesis. Research Honors: This track emphasizes exceptional achievement in a program of original research (minimum cumulative GPA of 3.30 or above) plus submission and acceptance of an in-depth research thesis. Both programs require formal declarations of intent to seek Honors by the candidates. The details of each program are provided on the BSCD Website (<http://bscd.uchicago.edu/page/honors-biology>). Candidates must apply for either program no later than the beginning of Spring quarter of their third year in the College.

SPECIALIZATION PROGRAMS IN THE BIOLOGICAL SCIENCES

Students who wish to complete a "specialization" should discuss their plans with the specialization director by Spring Quarter of their second year. Students may complete only one specialization. All courses must be taken for a quality grade in order to count towards a specialization.

Specialization in Cancer Biology

Students who complete the requirements detailed below will be recognized as having completed a specialization in cancer biology.

To be eligible to carry out a specialization in cancer biology, students must average a B grade in the first three quarters of a Biological Sciences Fundamentals Sequence.

Students who plan to specialize in cancer biology are advised to begin the required specialization courses below in their third year. Students who elect to specialize should consult Dr. Kay F. Macleod, Ben May Department for Cancer Research and the Committee on Cancer Biology (kmacleod@uchicago.edu), who is available to advise on the objectives of the specialization and the importance of each of the classes, and to identify labs in which individual research projects can be carried out.

The following two courses are required for a specialization in cancer biology. To continue in the specialization, students must achieve an A or B grade in both courses.

BIOS 25108	Cancer Biology	100
BIOS 25308	Heterogeneity in Human Cancer: Etiology and Treatment	100

To complete the specialization in cancer biology, students should also take one of the following two courses in either their third or fourth year, having successfully completed BIOS 25108 and BIOS 25308 above, and started work in their chosen research laboratory.

BIOS 25326	Tumor Microenvironment and Metastasis	100
BIOS 25327	Health Disparities in Breast Cancer	100

Laboratory Research

To complete the specialization in cancer biology, students will also carry out an individual guided cancer research project that is written up as an honors thesis and evaluated by an honors thesis committee, and attend cancer biology-related seminars. Participation in the research component of the specialization in cancer biology is by invitation only and is based on: (1) performance in the above-mentioned courses, (2) identification of a research project and mentor, (3) submission of a research abstract for consideration by the end of the Winter Quarter of their junior year to the Director of the Specialization in Cancer Biology (Dr. Kay Macleod).

Independent research projects performed by students in the specialization in cancer biology must be approved by the Director of the Specialization (Dr. Macleod) and be of sufficiently high standard to qualify as a senior honors project and ideally to produce data that contributes to peer-reviewed publication.

Students are encouraged to begin their research project no later than the Spring/Summer Quarter of their junior year.

Specialization in Cellular and Molecular Biology

Students majoring in Biological Sciences who meet the following requirements will be recognized as having completed a specialization in the area of cellular and molecular biology.

The following requirements must be met:

Courses

One of the following:		100
CHEM 22200	Organic Chemistry III	
CHEM 23200	Honors Organic Chemistry III	
Three of the following:*		300
BIOS 21236	Genetics of Model Organisms	
BIOS 21237	Developmental Mechanisms	
BIOS 21238	Cell Biology II	
BIOS 23299	Plant Development and Molecular Genetics	
BIOS 21208	Fundamentals of Molecular Biology	
BIOS 21360	Advanced Molecular Biology	
Total Units		400

* If students choose a developmental course, they must choose between BIOS 21237 or BIOS 23299.

Laboratory Research

Completion of an independent research project is required under the guidance of a faculty mentor/adviser that either:

1. Qualifies as a senior honors project; or
2. Is approved by the Director of the Specialization and the student's Research Adviser.

The specialization in cellular and molecular biology is administered by the Department of Molecular Genetics and Cell Biology. The director of this specialization is TBA.

Specialization in Ecology and Evolution

Students majoring in Biological Sciences who complete the course work indicated below and write a research-based senior thesis will be recognized as having completed a specialization in ecology and evolution. This specialization is recommended for students who are interested in pursuing graduate work in the field or in laboratory sciences of ecology, evolution, population genetics, or behavior. Based on the student's particular interest, he or she will select a Faculty Adviser, who then may recommend specific courses necessary to meet the specialization requirements (see following section). The Faculty Advisers may also help the student find an appropriate research lab in which to conduct an individual research project.

The following requirements must be met:

Courses

1. Students intending to pursue the Ecology and Evolution specialization are strongly encouraged to follow Life, Ecosystems, and Evolution (formerly Track C) for the BIOS Fundamentals sequence. Students who take the Advanced Biology sequence are also eligible for the specialization and should consult with Chris Andrews (candrews@uchicago.edu) to plan their course work.

2. Students in the Ecology and Evolution specialization must take three courses in statistics (STAT 22000 Statistical Methods and Applications or higher) or other quantitative approaches relevant to their research plans (BIOS 26210 Mathematical Methods for Biological Sciences I and BIOS 26211 Mathematical Methods for Biological Sciences II recommended). These courses can count toward the quantitative requirements for the Life, Ecosystems, and Environment sequence. See bscd.uchicago.edu/page/quantitative-courses.

3. Three of the upper-level courses required for completion of the BIOS major must be chosen from a menu of courses in behavior, ecology, evolution, and genetics.

Students must select the courses required for the Ecology and Evolution specialization in consultation with the Faculty Research Adviser, the director of the specialization (Cathy Pfister, 773.834.0071, cpfister@uchicago.edu) or the BSCD Ecology and Evolution Adviser (Chris Andrews, 773.702.1214, candrews@uchicago.edu).

Laboratory or Field Research

Students specializing in Ecology and Evolution must perform original research under the guidance of a member of the ecology and evolution faculty and write a senior thesis based on this research. The research paper draft should be submitted before the end of fifth week in Spring Quarter, with the final thesis due in eighth week. NOTE: Students must complete field research by the end of the growing season (summer) of their third year.

The specialization in ecology and evolution is administered by the Department of Ecology and Evolution. For more information, please consult the director of the specialization, Cathy Pfister (773.834.0071, cpfister@uchicago.edu).

Specialization in Endocrinology

After taking the following three courses, students majoring in Biological Sciences will be recognized as having completed a specialization in endocrinology. Students who complete the specialization will be well versed in all aspects of endocrinology, ranging from basic cell signaling to the integration of endocrine systems and their dysregulation in human disease. Students will also have the option of participating in a hands-on research component in an endocrinology lab. The prerequisite for these courses is completion of the Fundamentals Sequence. It is strongly recommended that students complete a Biochemistry course before enrolling; however, the specialization can be completed as Endocrinology I–II–III or Endocrinology II–III–I.

Introductory Courses

BIOS 25226	Endocrinology I: Cell Signaling (Autumn)	100
BIOS 25227	Endocrinology II: Systems and Physiology (Winter)	100
BIOS 25228	Endocrinology III: Human Disease (Spring)	100

The specialization in endocrinology is administered by the Section of Endocrinology, Diabetes and Metabolism, the Committee on Molecular Metabolism & Nutrition, and the NIH funded Diabetes Research & Training Center. For more information, consult Matthew Brady (mbrady@medicine.bsd.uchicago.edu).

Specialization in Genetics

Biological Sciences majors who obtain a B or better in the five courses from the categories listed below and complete an independent research project will be recognized as having fulfilled the requirements for a specialization in the area of genetics. Please consult Vincent Lynch (vjlynch@uchicago.edu) if you would like to request approval for any non-listed course with significant genetics content to satisfy this requirement.

One of the following:		100
BIOS 20187	Fundamentals of Genetics	
BIOS 20235	Biological Systems	
STAT 22000	Statistical Methods and Applications (or higher)	100
BIOS 21306	Human Genetics and Evolution	100
One of the following:		100
BIOS 21236	Genetics of Model Organisms (Autumn)	
BIOS 23258	Molecular Evolution I: Fundamentals and Principles (Winter)	
One of the following:		100
BIOS 21216	Intro Statistical Genetics (Winter)	
BIOS 21229	Genome Informatics: How Cells Reorganize Genomes (Winter)	
BIOS 21237	Developmental Mechanisms (Winter)	
BIOS 23299	Plant Development and Molecular Genetics (Spring)	
BIOS 25216	Molecular Basis of Bacterial Disease (Winter)	
BIOS 25287	Introduction to Virology (Spring)	
BIOS 28407	Genomics and Systems Biology (Spring)	

Total Units

500

Laboratory Research

completion of an independent research project.

The project must either:

qualify as a senior honors project

or

be approved by the director of the specialization.

The specialization in genetics is administered by the Committee on Genetics. Consult Vincent Lynch (773.834.1326, vjlynch@uchicago.edu) for more information.

Specialization in Global Health Sciences

Students majoring in Biological Sciences who complete the following requirements will be recognized as having completed a specialization in global health sciences. Note that this specialization fulfills two upper-level elective requirements in the Biological Sciences major, and students must take three additional upper-level electives to complete the major.

Students register for the three required courses listed below. BIOS 27810 and BIOS 27811 qualify as upper-level electives in the Biological Sciences major, and BIOS 29812 qualifies as a general elective in the College. There are two ways to complete this specialization:

1. On campus: Offered every other year, as a yearlong sequence beginning Autumn 2016, or
2. At the University of Chicago Center in Paris: Offered every year in Winter Quarter. See study-abroad.uchicago.edu/programs/paris-global-health.

Additional courses may be available but are not required. These courses should be identified in consultation with the director of the specialization, Dr. Sola Olopade (solopade@bsd.uchicago.edu (solopade@bsd.uchicago.edu)).

Courses

Students are required to take the following three courses:

BIOS 27810	Epidemiology and Population Health: Global Health Sciences I	100
Offered Autumn Quarter every year on campus; Winter Quarter in Paris as part of Study Abroad, beginning 2018 and every other year thereafter		
BIOS 27811	Global Health Sciences II: Microbiology	100
Offered Winter Quarter on campus beginning 2017 and every other year thereafter; Winter Quarter in Paris as part of Study Abroad, beginning 2018 and every other year thereafter		
BIOS 29812	Global Health Sciences III: Topics in Global Health	100
Offered Spring Quarter every other year on campus beginning 2017; Winter Quarter in Paris as part of Study Abroad, beginning 2018 and every other year thereafter. This course may not be counted toward the Biological Sciences major.		
Total Units		300

Thesis Option

For students interested in a career in the area of Global Health, a thesis is recommended and should be arranged with the director of the specialization during the Spring Quarter of their third year. The thesis may be either a report on an original research project conducted under the direction of a faculty mentor or an original review of a current area of interest in the literature and must be approved by the director of the specialization.

For more information, students should consult with Dr. Sola Olopade (solopade@bsd.uchicago.edu).

Specialization in Immunology

After taking three of the four courses listed below, students majoring in Biological Sciences will be recognized as having completed a specialization in immunology. The fourth course is available to students who wish further study.

Students are required to take the following three courses:

BIOS 25256	Immunobiology (Autumn)	100
BIOS 25258	Immunopathology (Winter)	100
BIOS 25266	Molecular Immunology (Spring)	100
The following is an elective course:		
BIOS 25260	Host Pathogen Interactions (Autumn)	100

For more information, students should consult with Bana Jabri, Department of Pathology and the Committee on Immunobiology (773.834.8670, bjabri@bsd.uchicago.edu).

Accelerated Program in Immunology

The University of Chicago Graduate Program in Immunology permits undergraduate students who have demonstrated outstanding potential for graduate studies in biology to begin graduate school during their fourth year in the College. This is a competitive merit-award program.

Because of the accelerated nature of the curriculum, applicants must have outstanding academic credentials (i.e., GPA typically in the range of 3.7 and GRE scores typically not less than 1400). Eligible students also have a clear understanding of their motivation for immunology. Laboratory experience is not mandatory but highly encouraged.

Candidates will apply to the Graduate Program in Immunology at the University of Chicago during their third year in the College. Eligible students must have completed thirty-three credits (of the forty-two required for a degree in the College) by the end of their third year. These thirty-three credits must include all fifteen general education requirements and one-half of the requirements for their major.

For further information, contact Bana Jabri, Department of Pathology and the Committee on Immunobiology (773.834.8670, bjabri@bsd.uchicago.edu).

Specialization in Microbiology

Students majoring in Biological Sciences who complete three courses on the list that follows will be recognized as having completed a specialization in microbiology.

Students should preferentially register for BIOS 25206 Fundamentals of Bacterial Physiology, BIOS 25216 Molecular Basis of Bacterial Disease, and BIOS 25287 Introduction to Virology.

With prior approval from the specialization chair, Dominique Missiakas (dmissiak@bsd.uchicago.edu) (dmissiak@bsd.uchicago.edu), students may substitute BIOS 25206 and BIOS 25216 for the two elective courses GEOS 26650 Environmental Microbiology and BIOS 27811 Global Health Sciences II: Microbiology respectively. The elective courses are also available to students who wish to pursue additional studies in microbiology.

Students are encouraged to begin this sequence in Autumn Quarter of their third year, carry out individual guided research, participate in the honors research program, and attend the Microbiology Seminar series (<https://biomedsciences.uchicago.edu/page/committee-microbiology-activities>). Students who elect to specialize should consult Dominique Missiakas (dmissiak@bsd.uchicago.edu) (dmissiak@bsd.uchicago.edu) for advice on the choice of courses and identification of a laboratory to carry out research projects in microbiology.

Students are required to take the following three courses:

BIOS 25206	Fundamentals of Bacterial Physiology (Autumn)	100
BIOS 25216	Molecular Basis of Bacterial Disease (Winter)	100
BIOS 25287	Introduction to Virology (Spring)	100

Total Units		300
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ELECTIVES

BIOS 27811	Global Health Sciences II: Microbiology (Winter)	100
GEOS 26650	Environmental Microbiology (Autumn)	100

Specialization in Neuroscience

The specialization in Neuroscience is no longer available starting with the entering class of Autumn Quarter 2017. Students who matriculated before Autumn Quarter 2017 who wish to complete the specialization should contact Megan McNulty (mmcnulty@uchicago.edu) for guidance regarding course selection.

Specialization in Quantitative Biology

Quantitative biology is a burgeoning interdisciplinary field that encompasses questions ranging across all scales of biology, from populations to molecules, and uses quantitative methods drawn from computer science, statistics, and mathematics. Students will acquire skills necessary for cutting-edge biological research: to program in a high-level language, to extract information from data sets, and to analyze mathematical models of dynamic and stochastic systems. Students majoring in Biological Sciences who complete the course work indicated below and complete a research-based senior thesis will be recognized as having completed a specialization in quantitative biology.

For additional information, please contact the Director of Specialization, Dmitry Kondrashov, at dkon@uchicago.edu.

Foundational Courses

BIOS 26210	Mathematical Methods for Biological Sciences I (fulfills one of the major course requirements)	100
BIOS 26212	Mathematical Methods for Biological Sciences III	100

Students are required to take two BIOS courses chosen from the following options:

BIOS 21216	Intro Statistical Genetics	100
BIOS 21249	Organization, Expression, and Transmission of Genome Information	100
BIOS 21328	Biophysics of Biomolecules	100
BIOS 21349	Protein Structure and Functions in Medicine	100
BIOS 21358	Simulation, Modeling, and Computation in Biophysics	100
BIOS 21407	Image Processing in Biology	100
BIOS 21417	Systems Biology: Molecular Regulatory Logic of Networks	100
BIOS 21507	The Engineering and Biology of Tissue Repair	100
BIOS 23258	Molecular Evolution I: Fundamentals and Principles	100
BIOS 23365	Evolutionary and Genomic Medicine I	100
BIOS 23404	Reconstructing the Tree of Life: An Introduction to Phylogenetics	100
BIOS 23409	The Ecology and Evolution of Infectious Diseases	100
BIOS 26120	An Introduction to Bioinformatics and Proteomics	100
BIOS 26318	Fundamentals of Biological Data Analysis	100

BIOS 28407	Genomics and Systems Biology	100
Students are required to take two courses from quantitative programs, including the following options:		
MATH 19620	Linear Algebra	100
MATH 21100	Basic Numerical Analysis	100
MATH 21200	Advanced Numerical Analysis	100
MATH 23500	Markov Chains, Martingales, and Brownian Motion	100
MATH 27300	Basic Theory of Ordinary Differential Equations	100
MATH 27500	Basic Theory of Partial Differential Equations	100
STAT 22000	Statistical Methods and Applications	100
or STAT 23400	Statistical Models and Methods	
STAT 22200	Linear Models And Experimental Design	100
STAT 22400	Applied Regression Analysis	100
STAT 22700	Biostatistical Methods	100
STAT 22810	Epidemiology and Population Health	100
STAT 24300	Numerical Linear Algebra	100
STAT 24400-24500	Statistical Theory and Methods I-II	200
STAT 25100	Introduction to Mathematical Probability	100
STAT 25300	Introduction to Probability Models	100
STAT 27725	Machine Learning	100
CMSC 12100-12200-12300	Computer Science with Applications I-II-III	300
CMSC 23900	Data Visualization	100
CMSC 25025	Machine Learning and Large-Scale Data Analysis	100
CMSC 27200	Theory of Algorithms	100
CMSC 27610	Digital Biology	100
MENG 21400	Introduction to Applications of Quantum Mechanical Methods to Materials Design	100
MENG 21600	Bioengineering Kinetics	100
MENG 24100-24200	Selected Topics in Molecular Engineering: Molecular/Materials Modelling I-II	100
MENG 24300	The Engineering and Biology of Tissue Repair	100
MENG 24310	Cellular Engineering	100

Other courses from quantitative programs may be counted by consent of the director of the specialization.

Research Component

Students will develop the skills necessary for quantitative biology research, which is expected to be primarily, though not exclusively, computational in nature. They will work on mini-research projects starting in the foundational BIOS 26210-26211 sequence and in the third year develop a research proposal under the direction of a faculty advisor, which has to be approved by the director of the specialization by the Spring Quarter. In their last year students will complete either (1) a senior honors project based on original research or (2) a senior thesis project approved by the director of the specialization. Students are expected to communicate and share their research with their peers through participation in the Quantitative Biology discussion club and by presenting their research in the annual Quantitative Biology undergraduate research conference. Opportunities to further their quantitative biology training and to work on their research project over the summer exist through summer quantitative biology fellowships.

REQUIREMENTS FOR THE BACHELOR OF SCIENCE DEGREE IN THE BIOLOGICAL SCIENCES

Students can earn a BS in the Biological Sciences by (1) completing three upper-level BIOS courses beyond those required for the BA degree, and (2) writing a BS thesis (research paper or literature review) under the supervision of an Adviser who is on the BSD research faculty. The BA is designed for students who wish to gain extensive training in modern biology but also retain the flexibility to take elective courses outside the major. The BS is suitable for students who wish to take more courses within the major and to write a senior thesis. Students completing the honors program or a specialization that requires a senior thesis can submit the same thesis for the BS degree. If you have any questions, please contact BSCD Senior Adviser Chris Andrews (candrews@uchicago.edu) or Megan McNulty (mmcnulty@uchicago.edu)@uchicago.edu (nich@uchicago.edu)). Details of the BS degree and a timeline for completion of requirements are provided on the BSCD website at <https://bscd.uchicago.edu/page/bs-biological-sciences>.

MINOR PROGRAM IN THE BIOLOGICAL SCIENCES

Students who elect the minor program must meet with one of the Senior Advisers of the Biological Sciences Collegiate Division by the Spring Quarter of their second year in order to obtain consent to pursue the minor and to plan out the appropriate curriculum (Chris Andrews [candrews@uchicago.edu] or Megan McNulty [mmcnulty@uchicago.edu)@uchicago.edu (nich@uchicago.edu)]).

The minor in Biological Sciences requires a total of seven BIOS courses beyond the general education requirement. Courses in the minor may be selected from a specific area of the Biological Sciences (e.g., molecular and cell biology, genetics, evolutionary biology, developmental biology, organismal biology, ecology, neurobiology, immunobiology, microbiology). Alternatively, courses may be selected from related areas to construct a program that gives a more inclusive account of how different disciplines of biology interact. These areas could comprise, for instance, immunology and microbiology, organismal biology and evolution, genetics and genomics, developmental biology and evolution, or ecology and evolution. Other combinations are also possible.

Students must meet general education requirements in the Biological Sciences and the physical sciences before entering the program. Biological Sciences courses at the 10000 level or above and MATH 13100 Elementary Functions and Calculus I and MATH 13200 Elementary Functions and Calculus II are the minimal general education requirements for the minor. Students interested in completing the minor are strongly encouraged to take BIOS 20153 Fundamentals of Ecology and Ev and BIOS 20151 Introduction to Quantitative Modeling in Biology (Basic) or BIOS 20152 Introduction to Quantitative Modeling in Biology (Advanced) to complete the general education requirement in the Biological Sciences, as these courses also serve as prerequisites to the Fundamentals courses (BIOS 20186-20198), three of which are required for the minor. Students who fulfill their general education requirement in the Biological Sciences via other paths may also request approval to pursue the minor. General Chemistry and Organic Chemistry are not specifically required. These courses would, however, allow for a greater variety of upper-level Biological Sciences courses, especially those in the areas of molecular and cellular biology; chemistry and/or biochemistry are usually prerequisites for those courses.

Following completion of the general education requirements, the minor can then be completed by taking three Fundamentals courses and at least four upper level electives to be chosen in consultation with one of the Senior Advisers in the Biological Sciences Collegiate Division.

Students who complete the pre-med sequence for non-majors (BIOS 20170s) are also eligible for the Biological Sciences minor. BIOS 20170 Microbial and Human Cell Biology and BIOS 20171 Human Genetics and Developmental Biology satisfy the general education requirement in biology; BIOS 20172 Mathematical Modeling for Pre-Med Students, BIOS 20173 Perspectives of Human Physiology and BIOS 20175 Biochemistry and Metabolism satisfy the fundamentals requirement. These students must follow up the 20170s with at least four upper-level electives to be chosen in consultation with one of the Senior Advisers in the Biological Sciences Collegiate Division.

No course in the minor can be double counted with the student's major(s) or with other minors, nor can they be counted toward general education requirements. More than half of the requirements for the minor must be met by registering for courses with University of Chicago course numbers. All courses for the minor must be taken for quality grades.

Prior to beginning the minor program, students must obtain formal approval from one of the Senior Advisers in the Biological Sciences on a form obtained from their College adviser and returned to the adviser by the deadline. To schedule an appointment with one of the Senior Advisers, contact Christine Andrews (candrews@uchicago.edu) or Megan McNulty (mmcnulty@uchicago.edu).

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MINOR PROGRAM IN COMPUTATIONAL NEUROSCIENCE

The minor in computational neuroscience is offered by the Biological Sciences Collegiate Division. Information regarding the program and its requirements can be found on the Computational Neuroscience page of this catalog.

COURSES: Biological Sciences (BIOS)

Students must confirm their registration with their instructors by the second class meeting or their registration may be canceled.

In the following course descriptions, L indicates courses with a laboratory.

Courses at Marine Biological Laboratory

Semester in Environmental Science Sequence

Courses BIOS 27710 to BIOS 27715 are the College designations for the Semester in Environmental Science that is taught at the Marine Biological Laboratory in Woods Hole, Massachusetts. Registration in BIOS 27710 Ecology - Marine Biological Laboratory, BIOS 27711 Biogeochemical Analysis in Terrestrial and Aquatic Ecosystems # Marine Biological Laboratory, and BIOS 27712 Independent Undergraduate Research in Environmental Sciences # Marine Biological Laboratory, plus one of BIOS 27713 Quantitative Environmental Analyses # Marine Biological Laboratory, BIOS 27714 Methods in Microbial Ecology - Marine Biological Laboratory, or BIOS 27715 Roles of Animals in Ecosystems # Marine Biological Laboratory are required. Admission to the Semester in Environmental Science program is by application, which must be received by the Marine Biological Laboratory in March of the year preceding the start of the semester. Admissions decisions will be mailed in April. Note that these courses start at the beginning of September, typically four weeks prior to the start of the College's Autumn Quarter and are completed by the end of Autumn Quarter. More information on the course content and the application process can be found at www.mbl.edu/ses (<http://www.mbl.edu/ses>).

September Courses (Autumn Quarter)

The College offers three courses at the Marine Biological Laboratory (MBL) in Woods Hole, Massachusetts. These intensive, three-week-long courses are designed for students with a strong interest in research in the sciences. All are taught by University of Chicago and MBL faculty, and take advantage of both the unique research strengths and the natural

environmental resources found at MBL. The courses will each meet 5–6 days/week, 8 hours per day, with lecture in the mornings and lab or fieldwork in the afternoons. Students may only enroll in one course. Classes are small (12–15 students maximum), and the teaching environment will allow extensive contact with the instructors. The course topics cross several disciplines; students in such majors as Biological Sciences, Neuroscience, Computer Science, Physics, Mathematics, Molecular Engineering, Geophysical Sciences, Environmental Science, and Chemistry are particularly encouraged to consider these opportunities.

Each course carries 100 units of credit. All courses count as upper-level electives for Biological Sciences majors; for students in other majors, the courses can be used as courses to fulfill the second quarter of the general education requirement in the Biological Sciences. Descriptions for BIOS 27720 Microbiomes Across Environments, BIOS 27721 Observing Proteins in Action: How to Design and Build Your Own, and BIOS 27723 Biodiversity and Genomics: Exploring the Marine Animal Diversity of Woods Hole Using Molecular Tools can be found in the General Courses section of this page.

Students register for a September MBL course as part of their Autumn Quarter course load. The courses will take place from September 1 through September 21, 2018. This will allow students to return to campus in time for the remainder of the Autumn Quarter. Since the courses at MBL are considered part of Autumn Quarter, students who participate in the program will take either 200 or 300 units of credit for the rest of the quarter. This is something applicants should consider carefully when looking at major and general education requirements.

In addition to tuition, each course has a program fee of \$2,750, which covers three weeks' dorm-style housing and meals at MBL, as well as all supplies and excursions. A limited number of need-based scholarships are available. Students seeking financial assistance are encouraged to apply early. Because of the small course sizes, the MBL program will be admissions-based. An application form can be found at college.uchicago.edu/academics/mbl-september-courses.

For questions about the program, contact Jocelyn Malamy at jmalamy@bsd.uchicago.edu. (jmalamy@bsd.uchicago.edu)

Biological Sciences Sequences for Non-Majors

All students must take at least two courses in the Biological Sciences to fulfill the general education requirement. The requirement should be completed by the end of the second year. Information regarding course and sequence options for non-majors can be found on the Biological Sciences Curriculum page in this catalog.

Biological Sciences Sequences for Majors and Students Preparing for the Health Professions Fundamentals Sequences

All first-year students who wish to major in Biological Sciences must take BIOS 20153 Fundamentals of Ecology and Ev and either BIOS 20151 Introduction to Quantitative Modeling in Biology (Basic) or BIOS 20152 Introduction to Quantitative Modeling in Biology (Advanced) during their first year as prerequisites for the Fundamentals courses. Beginning in 2017, BIOS 20151 Introduction to Quantitative Modeling in Biology (Basic) can be taken together with the first course of the Fundamentals sequence. (Chemistry, Biological Chemistry, and Neuroscience majors can take the Fundamentals Sequences without the Biological Sciences prerequisites (BIOS 20153-20151/20152) unless they pursue a double major in Biological Sciences. They are expected to show competency in mathematical modeling of biological phenomena covered in BIOS 20151 or BIOS 20152.)

BIOS 20151. Introduction to Quantitative Modeling in Biology (Basic) 100 Units.

The goal for this course is to give future biologists the quantitative tools to fully participate in modern biological research. These include descriptive statistics, linear regression, stochastic independence and hypothesis testing, Markov models and stationary probability distributions, solutions of linear differential equations, equilibria and stability analysis of nonlinear differential equations. The ideas are applied to different areas of biology, e.g. molecular evolution, allometry, epidemiology, and biochemistry, and implemented by students in computer assignments using the R computational platform.

Instructor(s): D. Kondrashov Terms Offered: Spring, L.

Prerequisite(s): Two quarters of calculus of any sequence (MATH 13200 or 15200 or 16200) AND CHEM 10100-10200 or CHEM 11100-11200 or CHEM 12100-12200. First-year Biology Major standing only.

BIOS 20152. Introduction to Quantitative Modeling in Biology (Advanced) 100 Units.

This is a more advanced version of 20151, intended for students with greater mathematical maturity. In addition to the topics covered in the regular version, students will learn about nonlinear least-squares fitting, eigenvalues and eigenvectors, bifurcations and bistability in differential equations. Additional applications will include phylogenetic distance and systems biology.

Instructor(s): D. Kondrashov Terms Offered: Winter, L.

Prerequisite(s): MATH placement of 15200 or higher OR completion of MATH 16200 AND CHEM 10100-10200 or CHEM 11100-11200 or CHEM 12100-12200. First-year Biology Major standing only.

BIOS 20153. Fundamentals of Ecology and Ev. 100 Units.

This course surveys the basic principles of ecology and evolutionary biology to lay the foundation for further study in all fields of biology. Broad ecological concepts, such as population growth, disease dynamics, and species interactions, will be explored through a combination of published data, simulations, and mathematical models. The emphasis is on "ecological thinking" rather than specific notions. Essential topics in the modern study of evolutionary biology will be covered with a focus on both theory and empirical examples. Examples of topics include history of evolutionary thought, evidence for evolution, mechanisms of microevolution, phylogenetics, molecular evolution, and speciation. This course requires a weekly 120-minute discussion period.

Instructor(s): T. Price, M. Kronforst, C. Andrews, A. Hunter. Terms Offered: Winter. L.

Prerequisite(s): Concurrent enrollment in CHEM 10100--10200 or CHEM 11100-11200 or CHEM 12100

BIOS 20170 through BIOS 20175

This integrated sequence explores the molecular, cellular, organismal, and biochemical properties of living systems. It is designed to prepare students who do not intend to major in Biological Sciences for graduate study in the health professions. This five-course sequence begins with BIOS 20170 Microbial and Human Cell Biology in the Winter Quarter and both BIOS 20171 Human Genetics and Developmental Biology and BIOS 20172 Mathematical Modeling for Pre-Med Students in the Spring Quarter. The second year of the sequence continues with BIOS 20173 Perspectives of Human Physiology in the Autumn Quarter and concludes with BIOS 20175 Biochemistry and Metabolism in the Winter Quarter. BIOS 20172 must be taken concurrently with BIOS 20171 in the Spring Quarter of the first year. The Fundamentals sequence for Biological Sciences majors is also open to non-majors completing their pre-med biology requirements and provides comparable topical coverage. *This sequence is open only to first- and second-year non-Biological Sciences majors except by consent of instructor and cannot be applied toward a major in Biological Sciences. It can be applied toward a minor in Biological Sciences.*

For students taking the Pre-Med sequence for non-biology majors, BIOS 20170 and 20171 satisfy the general education requirement. Please note that students in the second quarter of the sequence are required to take both 20171 and 20172 in the same quarter. Students leaving the sequence after completion of BIOS 20170 can complete their general education requirement with a topics course.

BIOS 20170. Microbial and Human Cell Biology. 100 Units.

This course is the entry point into an integrated biology sequence designed to prepare non-biology majors for application to medical school. We explore topics in human cell biology within the context of evolutionary biology, chemistry, microbiology, and medicine. We pay special attention to the influence of prokaryotes on the history of life and to the ecological interactions between humans and their microbiota, which have major implications for human health and disease. Students read and discuss papers from the scientific literature, attend discussions led by physicians, researchers, and other medical professionals, and gain experience with microbiological basic microscopy techniques in lab.

Instructor(s): C. Andrews, R. Zaragoza, E. Kovar Terms Offered: Winter. L.

Prerequisite(s): First or second-year standing, or consent of instructors.

BIOS 20171. Human Genetics and Developmental Biology. 100 Units.

This course covers the fundamentals of genetics, with an emphasis on human traits and diseases. Topics include Mendelian genetics, simple and complex traits, genetic diseases, the human genome, and testing for human traits and diseases. After establishing a foundation in genetics, we will discuss mechanisms underlying differentiation and development in humans. We will focus on events that lead to gastrulation and the establishment of the body plan (how humans develop from an unpatterned egg into a recognizable human form). Other topics may include limb development and stem cell biology.

Instructor(s): O. Pineda-Catalan, R. Zaragoza Terms Offered: Spring. L.

Prerequisite(s): BIOS 20170

BIOS 20172. Mathematical Modeling for Pre-Med Students. 100 Units.

This course covers mathematical approaches in biology and medicine, including basic statistics and hypothesis testing, mathematical modeling of biological systems, and an introduction to bioinformatics. Students will apply what they learn as they analyze data and interpret primary papers in the biological and clinical literature. BIOS 20172 lays the foundation for biomathematical approaches explored during subsequent courses in the BIOS 20170s sequence.

Instructor(s): E. Haddadian Terms Offered: Spring. L.

Prerequisite(s): BIOS 20170, concurrent enrollment in BIOS 20171

BIOS 20173. Perspectives of Human Physiology. 100 Units.

This course will explore the structure and function of the human body as a set of integrated, interdependent systems. We will continue the cellular, genetic, and developmental themes of the previous courses to explore the emergent functions of the human body, from cells to systems. The laboratory exercises will allow the students to experience the concepts discussed in lecture in a way that introduces them to the methods of academic research, including the application of mathematical models to physiological questions. Students will be asked to serve as test subjects in several of the laboratory exercises. In required weekly discussions, students will present on papers from the scientific literature and attend talks by physicians, researchers, and other medical professionals.

Instructor(s): C. Andrews, E. Kovar Terms Offered: Autumn. L.

Prerequisite(s): BIOS 20170, BIOS 20171, BIOS 20172

BIOS 20175. Biochemistry and Metabolism. 100 Units.

The course introduces cellular biochemical metabolism. The chemical characteristics, biochemical properties, and function of carbohydrates, proteins, and lipids are introduced. Basic protein structure and enzyme kinetics including basic allosteric interactions are considered. The integration of carbohydrates, proteins, and lipids in cellular intermediary metabolism is examined including pathway regulation and bioenergetics. Adaptation of the pathways to changes in nutritional or disease state is used to highlight interrelationships in cellular metabolism.

Instructor(s): P. Strieleman Terms Offered: Winter

Prerequisite(s): BIOS 20170, BIOS 20171, BIOS 20172, BIOS 20173

BIOS 20186 through 20191

This sequence is an introduction to the breadth of biology as a modern scientific discipline. It is designed for students who are preparing for a career in the Biological Sciences. Topics include cell and molecular biology, genetics, physiology, and developmental biology. Students registering for this sequence must have completed or placed out of general or honors chemistry or be enrolled concurrently in general or honors chemistry.

BIOS 20186. Fundamentals of Cell and Molecular Biology. 100 Units.

This course is an introduction to molecular and cellular biology that emphasizes the unity of cellular processes amongst all living organisms. Topics are the structure, function, and synthesis of nucleic acids and protein; structure and function of cell organelles and extracellular matrices; energetics; cell cycle; cells in tissues and cell-signaling; temporal organization and regulation of metabolism; regulation of gene expression; and altered cell functions in disease states.

Instructor(s): Section 1: D. Kovar, B. Glick, E. Kovar, Staff. Section 2: R. Fehon, D. Arac, C. Schonbaum, E. Kovar. Terms Offered: Spring, L.

Prerequisite(s): An average grade of C or higher in, and completion of, CHEM 10100-10200 or CHEM 11100-11200 or CHEM 12100-12200, a 5 on the AP Chemistry exam, or consent of the department.

Note(s): NSCI majors and other students, through petition BSCD, may take BIO20186 without BIOS 20151/20152, 20153 unless they plan to pursue a double major in Biological Sciences. All students in BIOS20186 will be expected to possess the competency in mathematical modeling of biological phenomena covered in BIOS 20151 or BIOS 20152. Contact BSCD Advisers, Megan McNulty (mmcnulty@uchicago.edu) or Chris Andrews (candrews@uchicago.edu) to petition.

BIOS 20187. Fundamentals of Genetics. 100 Units.

The goal of this course is to integrate recent developments in molecular genetics into the structure of classical genetics with an emphasis on recent advances in genetics and genomics. Topics include Mendelian inheritance, genotype-phenotype relationships, linkage analysis, modern gene mapping techniques, gene expression, model systems genetics and analysis of genetic pathways.

Instructor(s): Section 1: L. Mets, A. Imamoto, E. Kovar, Staff. Section 2: J. Malamy, C. Schonbaum, E. Kovar. Terms Offered: Autumn, L.

Prerequisite(s): BIOS 20186

BIOS 20188. Fundamentals of Physiology. 100 Units.

This course focuses on the physiological problems that animals (including humans) face in natural environments; solutions to these problems that the genome encodes; and the emergent physiological properties of the molecular, cellular, tissue, organ, and organismal levels of organization. Lectures and labs emphasize physiological reasoning, problem solving, and current research.

Instructor(s): D. McGehee, J. Kennedy. Terms Offered: Spring, L.

Prerequisite(s): BIOS 20187. Credit can NOT be earned for both BIOS 20188 and BIOS 20191.

BIOS 20189. Fundamentals of Developmental Biology. 100 Units.

This course covers both the classical experiments that contributed to our understanding of developmental biology and the recent explosion of information about development made possible by a combination of genetic and molecular approaches. Examples from both vertebrate and invertebrate systems are used to illustrate underlying principles of animal development.

Instructor(s): R. Ho, S. Horne-Badovinac, C. Schonbaum, E. Kovar Terms Offered: Winter, L.

Prerequisite(s): BIOS 20187. Credit can NOT be earned for both BIOS 20189 and BIOS 20190.

BIOS 20190. Principles of Developmental Biology. 100 Units.

This course will cover important concepts of developmental biology including differentiation, lineage, fate, pattern formation, and morphogenesis. We will review developmental processes and experimental evidence used to uncover underlying mechanisms. We will focus on a few model organisms-vertebrates (chicken and mice) and non-vertebrates (*Drosophila*).

Instructor(s): A. Imamoto, W. Du Terms Offered: Spring, L.

Prerequisite(s): BIOS 20187. Credit may not be earned for both BIOS 20190 and BIOS 20189.

BIOS 20191. Integrative Physiology. 100 Units.

This course investigates body function in animals (including humans) at times of rest and under various environmental stresses such as temperature, salinity, altitude, fasting, activity, and others. The lectures and labs of this course will draw together concepts of physics, chemistry, and quantitative biology to explore the interactions of molecules, cells, tissues, and organs in living organisms. Students will be asked to serve as test subjects in the various laboratory exercises of this course.

Instructor(s): J. Kennedy, E. Kovar. Terms Offered: Winter, L.

Prerequisite(s): BIOS 20187. Credit CANNOT be earned for both BIOS 20188 and BIOS 20191.

BIOS 20196 through 20198

Life, Ecosystems, and Evolution

This sequence is designed for students majoring in Biological Sciences and interested in pursuing a course of study in ecology and evolution or environmental science. Students will begin the sequence with BIOS 20186 Fundamentals of Cell and Molecular Biology and BIOS 20187 Fundamentals of Genetics, and continue with courses that emphasize biological diversity, conservation biology, principles of ecology, and mechanisms of evolution (BIOS 20198 Biodiversity and BIOS 20196 Ecology and Conservation).

BIOS 20196. Ecology and Conservation. 100 Units.

This course focuses on the contribution of ecological theory to the understanding of current issues in conservation biology. We emphasize quantitative methods and their use for applied problems in ecology (e.g., risk of extinction, impact of harvesting, role of species interaction, analysis of global change). Course material is drawn mostly from current primary literature; lab and field components complement concepts taught through lecture. Overnight field trip required. Prerequisite(s): BIOS 20150, BIOS 20151 or BIOS 20152 Note(s): BIOS 20196 is identical to the previously offered BIOS 23251. Students who have taken BIOS 23251 should not enroll in BIOS 20196. Equivalent Course(s): ENSC 24400 Instructor(s): C. Pfister, E. Larsen Terms Offered: Autumn, L. Prerequisite(s): BIOS 20150, BIOS 20151 or BIOS 20152 Note(s): BIOS 20196 is identical to the previously offered BIOS 23251. Students who have taken BIOS 23251 should not enroll in BIOS 20196. Equivalent Course(s): ENSC 24400

BIOS 20198. Biodiversity. 100 Units.

An overview of the diversity of living organisms, both prokaryotes and eukaryotes, is presented. We emphasize the major groups of organisms, their evolutionary histories and relationships, and the biological and evolutionary implications of the characteristic features of each group. We discuss how the biosphere transformed to its present state over the past four billion years. Instructor(s): M. LaBarbera, C. Andrews Terms Offered: Spring, L. Prerequisite(s): BIOS 20150 except for Geophysical Sciences majors Note(s): BIOS 20198 is identical to the previously offered BIOS 20184. Students who have taken BIOS 20184 should not enroll in BIOS 20198.

Four-Quarter Advanced Biology Fundamentals Sequence

Advanced Biology is an accelerated four-quarter Fundamentals sequence designed for motivated first-year students with exceptionally strong science and mathematics backgrounds and an intense interest in examining and understanding biological mechanisms. Successful students are those motivated to learn about biological processes and mechanisms through learning how to interpret the primary evidence that supports modern understanding. The courses emphasize experimental design and interpretation, together with quantitative and theoretical approaches to understanding biological mechanisms. This sequence is most appropriate for students considering careers in biomedical sciences. Students are expected to devote significant time to this sequence (minimum four to eight hours/week for reading primary literature and background information and for working problem sets, in addition to attendance at lectures and participation in laboratory exercises and discussion sections). A score of 4 or 5 on the Biology AP exam is required and successful students usually also have strong preparation in chemistry and calculus as well as some experience in computer programming.

Upon completion of the first three quarters of the Advanced Biology sequence, students will have three credits in the major and they will have met the general education requirement in the Biological Sciences. Beginning with the graduating Class of 2015, all students must register for BIOS 20234 Molecular Biology of the Cell (Autumn Quarter), BIOS 20235 Biological Systems (Winter Quarter), and BIOS 20236 Biological Dynamics (Spring Quarter). Students complete the sequence by taking BIOS 20242 Principles of Physiology.* During their second year, Advanced Biology students are required to take BIOS 20242 Principles of Physiology (Autumn Quarter).

* BIOS majors unable to complete the sequence after the first quarter must then complete BIOS 20151/BIOS 20152 which will be applied to their Biological Sciences general education requirement along with their AP Biology credit. BIOS 20234 Molecular Biology of the Cell would then be applied toward their major which they complete by following the requirements for either the Molecules to Organisms sequence or the Life, Ecosystems, and Evolution sequence.

BIOS 20234. Molecular Biology of the Cell. 100 Units.

This course covers the fundamentals of molecular and cellular biology. Topics include protein structure and function; DNA replication, repair, and recombination; transcription, translation, control of gene expression; cytoskeletal dynamics; protein modification and stability; cellular signaling; cell cycle control; mitosis; and meiosis. Prerequisite(s): Score of 4 or 5 on the AP biology test Instructor(s): M. Glotzer, A. Ruthenburg, N. Bhasin, L. Terms Offered: Autumn Prerequisite(s): Score of 4 or 5 on the AP biology test Note(s): To continue in the sequence, students must receive a minimum grade of B- in BIOS 20234

BIOS 20235. Biological Systems. 100 Units.

Students preparing for the health professions must take BIOS 20235 and 20242 in sequence. This course builds upon molecular cell biology foundations to explore how biological systems function. Topics include classical and molecular genetics, developmental signaling networks, genomics, proteomics, transcriptomics, and biological networks.

Instructor(s): I. Rebay, M. Pascual, N. Bhasin. L. Terms Offered: Winter

Prerequisite(s): A grade of B- or above in BIOS 20234

BIOS 20236. Biological Dynamics. 100 Units.

This class introduces the use of quantitative approaches to study biological dynamics. Deeper exploration of cellular and developmental processes introduced in BIOS 20234 and BIOS 20235 will emphasize the use of quantitative analysis and mathematical modeling to infer biological mechanisms from molecular interactions. The lab portion of the class will introduce basic approaches for simulating biological dynamics using examples drawn from the lectures.

Instructor(s): E. Munro, M. Rust, E. Kovar. Terms Offered: Spring, L.

Prerequisite(s): BIOS 20234 and BIOS 20235 with a minimum grade of B- in each course.

BIOS 20242. Principles of Physiology. 100 Units.

This course focuses on the physiological problems that animals (including humans) face in natural environments; solutions to these problems that the genome encodes; and the emergent physiological properties of the molecular, cellular, tissue, organ, and organismal levels of organization. We emphasize physiological reasoning, problem solving, and current research.

Instructor(s): M. Feder, E. Kovar. Terms Offered: Autumn, L.

Prerequisite(s): BIOS 20236 or BIOS 20189 or consent of instructor

Course Summary

The following list provides information for students who are planning programs of study. Letters after course titles refer to the subject matter presented in the course: (C) Cell and Molecular, Genetics, Developmental Biology, or Biochemistry; (CI) Computer Intensive; (E&E) Ecology and Evolution; (F) Fundamentals Sequence; (MIV) Microbiology, Immunology, or Virology; (N) Neuroscience; (O) Organismal; (SB) Systems Biology; and (S) Specialized. L indicates courses with laboratory.

Autumn Quarter

20173. Human Physiology. L. (F)

20187. Fundamentals of Genetics. L. (F)

20190. Principles of Developmental Biology. (F)

20196. Ecology and Conservation. L. (F)

20200. Introduction to Biochemistry. L. (F)

20234. Molecular Biology of the Cell. L. (F)

20242. Principles of Physiology. L. (F)

21236. Genetics of Model Organisms. (C)

21416. Stem Cells and Regeneration. (C)

22249. Principles of Toxicology. (O)

22265. Human Origins: Milestones in Human Evolution and the Fossil Record. (E&E)

22306. Evolution and Development. (O)

23261. Invertebrate Paleobiology and Evolution. (E&E)

23262. Mammalian Evolutionary Biology. L. (E&E)

23266. Evolutionary Adaptation. (E&E)

23404. Reconstructing the Tree of Life: An Introduction to Phylogenetics. (E&E)

24208. Survey of Systems Neuroscience. (N)

24226. Gazing into the Black Box: Neocortex. (N)

24248. Biological Clocks and Behavior. (N)

25206. Fundamentals of Bacterial Physiology. (MIV)

25226. Endocrinology I: Cell Signaling. (MIV)

25256. Immunobiology. (MIV)

25260. Host Pathogen Interactions. (MIV)

- 25308. Heterogeneity in Human Cancer: Etiology and Treatment. (MIV)
- 26120. An Introduction to Bioinformatics and Proteomics. L. (CI)
- 26210. Mathematical Models for Biological Sciences I. (CI)
- 26318. Fundamentals of Biological Data Analysis. (CI)
- 27810. Epidemiology and Population Health: Global Health Sciences I
- 29265. Evolution and Economics of Human Behavior. (S)
- 29271. The Psychology and Neurobiology of Stress. (S)
- 29313. Medical Ethics: Central Topics. (S)

Winter Quarter

- 20152. Introduction to Quantitative Modeling in Biology. L. (Advanced) (F)
- 20153. Fundamentals of Ecology and Evolution. (F)
- 20170. Microbial and Human Cell Biology. L. (F)
- 20175. Biochemistry and Nutrition. (F)
- 20189. Fundamentals of Developmental Biology. L. (F)
- 20191. Integrative Physiology. L. (F)
- 20235. Biological Systems. L. (F)
- 21216. Introductory Statistical Genetics. (C)
- 21229. Genome Informatics: How Cells Reorganize Genomes. (C)
- 21237. Developmental Mechanisms. (C)
- 21238. Cell Biology. (C)
- 21306. Human Genetics and Evolution. (C)
- 21358. Simulation, Modeling, and Computation in Biophysics. (C)
- 21360. Advanced Molecular Biology. (C)
- 21418. Historical and Conceptual Foundations of Evolutionary Development. (C)
- 21506. Biological Physics. (C)
- 21508. Cellular Engineering. (C)
- 22250. Chordates: Evolution and Comparative Anatomy. (O)
- 23247. Bioarchaeology and the Human Skeleton. (E&E)
- 23249. Animal Behavior. (E&E)
- 23258. Molecular Evolution I: Fundamentals and Principles. (E&E)
- 23289. Marine Ecology. (E&E)
- 23365. Evolutionary and Genomic Medicine I. (E&E)
- 23406. Biogeography. (E&E)
- 24209. Photons to Consciousness. (N)
- 24217. Conquest of Pain. (N)
- 24231. Methods in Computational Neuroscience. L. (N)
- 24249. Neurobiology of Seeing. (N)
- 25108. Cancer Biology. (MIV)
- 25216. Molecular Basis of Bacterial Disease. (MIV)
- 25227. Endocrinology II: Systems and Physiology. (MIV)
- 25258. Immunopathology. (MIV)

25327. Health Disparities in Breast Cancer. (MIV)
 25407. Organ Transplantation. (MIV)
 26211. Mathematical Models for Biological Sciences II. (CI)
 27811. Microbiology: Global Health Sciences II. (MIV)
 29294. Introduction to Global Health. (S)
 29300. Biological Psychology. (S)
 29323. Health Care and the Limits of State Action. (S)

Spring Quarter

20151. Introduction to Quantitative Modeling in Biology. L. (Basic) (F)
 20171. Human Genetics and Developmental Biology. L. (F)
 20172. Mathematical Modeling for Pre-Med Students I. L. (F)
 20186. Fundamentals of Cell and Molecular Biology. L. (F)
 20188. Fundamentals of Physiology. L. (F)
 20190. Principles of Developmental Biology. L. (F)
 20198. Biodiversity. L. (F)
 20200. Introduction to Biochemistry. L. (F)
 20236. Biological Dynamics. L. (F)
 21249. Organization, Expression, and Transmission of Genome Information. (C)
 21317. Topics in Biological Chemistry. (C)
 21328. Biophysics of Biomolecules. (C)
 21349. Protein Structure and Functions in Medicine. (C)
 21356. Vertebrate Development. (O)
 21407. Image Processing In Biology. (C)
 21415. Stem Cells in Development and Diseases. (C)
 21417. Systems Biology: Molecular Regulatory Logic of Networks. (C)
 21507. Selected Topics in Molecular Engineering. (C)
 22233. Comparative Vertebrate Anatomy. (O)
 22236. Reproductive Biology of Primates. (O)
 22260. Vertebrate Structure and Function. (O)
 23100. Dinosaur Science. (O)
 23232. Ecology and Evolution in the Southwest. (E&E)
 23233. Ecology and Evolution in the Southwest: Field School. (E&E)
 23242. Primate Evolution and the Roots of Human Biology. (E&E)
 23252. Field Ecology. L. (E&E)
 23254. Mammalian Ecology. L. (E&E)
 23299. Plant Development and Molecular Genetics. (E&E)
 23409. The Ecology and Evolution of Infectious Diseases. (E&E)
 23410. Complex Interactions: Coevolution, Parasites, Mutualists, and Cheaters. (E&E)
 24131. Molecular Neuroscience. (N)
 24232. Computational Approaches to Cognitive Neuroscience. (N)
 24408. Signal Analysis and Modeling for Neuroscientists. L. (N)

25109. Topics in Reproductive Biology and Cancer. (MIV)
 25126. Animal Models of Human Disease. (MIV)
 25228. Endocrinology III: Human Disease. (MIV)
 25266. Molecular Immunology. (MIV)
 25267. Mucosal Immunology. (MIV)
 25287. Introduction to Virology. (MIV)
 25326. Tumor Microenvironment and Metastasis. (MIV)
 28407. Genomics and Systems Biology. (SB)
 29326. Introduction to Medical Physics and Medical Imaging. (S)
 29327. Topics in Clinical Research. (S)
 29328. Biological Materials. (S)
 29812. Biological and Social Determinants of Health: Global Health Sciences III. (S)

Advanced-Level Courses

There are three types of advanced courses. In courses listed under the heading *General Courses*, instructors present the general principles and recent developments for broad areas within the Biological Sciences. Such courses are usually offered on a regular basis, either annually or biennially. In courses listed under the heading *Specialized Courses*, the focus is on either a topic of particular interest to the instructor or on topics that are examined at a more advanced level than in *General Courses*. Such courses are offered less regularly, as warranted by student and faculty interest. Unless otherwise stated, most *General Courses* assume mastery of the material covered in the *Fundamentals Sequences*. Courses listed under the headings *Specialized Courses* and *Independent Study and Research* may not be counted toward the courses required for the major with the exception of BIOS 00296 Undergraduate Honors Research.

General Courses

Most general and specialized courses that are at the 20000-level and above assume mastery of the material covered in the *Fundamentals Sequences*. Students who have not yet completed the *Fundamentals Sequence* should consult with the individual instructor and the BSCD Senior Advisers before registering for the following courses. Students must confirm their registration with their instructors by the second class meeting or their registration may be canceled.

BIOS 20200. Introduction to Biochemistry. 100 Units.

This course meets the biochemistry requirement in the Biological Sciences major. This course examines the chemical nature of cellular components, enzymes, and mechanisms of enzyme activity, energy interconversion, and biosynthetic reactions. Strong emphasis is given to control and regulation of metabolism through macromolecular interactions.
 Instructor(s): M. Makinen, E. Özkan, P. Strieleman, L. Terms Offered: Autumn Spring Summer, L.
 Prerequisite(s): Completion of a Biological Sciences fundamentals sequence with an average grade of C and CHEM 22000-22100/23100 with an average grade of C.

BIOS 21216. Intro Statistical Genetics. 100 Units.

This course focuses on genetic models for complex human disorders and quantitative traits. Topics covered also include linkage and linkage disequilibrium mapping and genetic models for complex traits, and the explicit and implicit assumptions of such models.
 Instructor(s): Xin He, Hae Kyung Im Terms Offered: Winter
 Equivalent Course(s): GENE 47100, HGEN 47100

BIOS 21229. Genome Informatics: How Cells Reorganize Genomes. 100 Units.

This course deals with the molecular and cellular basis of genetic change. We discuss DNA repair functions, mutator loci, induced mutation, mechanisms of homologous recombination and gene conversion, site-specific recombination, transposable elements and DNA rearrangements, reverse transcription and retrotransposons, transposable vector systems for making transgenic organisms, and genetic engineering of DNA sequences in antibody formation. Discussion section required.
 Instructor(s): J. Shapiro Terms Offered: Winter
 Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence.

BIOS 21236. Genetics of Model Organisms. 100 Units.

A small number of organisms have been chosen for extensive study by biologists. The popularity of these organisms derives largely from the fact that their genomes can be easily manipulated, allowing sophisticated characterization of biological function. This course covers modern methods for genetic analysis in budding yeast (*Saccharomyces cerevisiae*), fruit flies (*Drosophila melanogaster*), plants (*Arabidopsis thaliana*), and mice (*Mus musculus*). Case studies demonstrate how particular strengths of each system have been exploited to understand such processes as genetic recombination, pattern formation, and epigenetic regulation of gene expression.
 Instructor(s): D. Bishop, H-C Lee, E. Ferguson, I. Moskowitz Terms Offered: Autumn
 Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence including BIOS 20187.

BIOS 21237. Developmental Mechanisms. 100 Units.

This course provides an overview of the fundamental questions of developmental biology, with particular emphasis on the genetic, molecular and cell biological experiments that have been employed to reach mechanistic answers to these questions. Topics covered will include formation of the primary body axes, the role of local signaling interactions in regulating cell fate and proliferation, the cellular basis of morphogenesis, and stem cells.

Instructor(s): E. Ferguson, R. Fehon Terms Offered: Winter

Prerequisite(s): For undergraduates only: Three quarters of a Biological Sciences Fundamentals sequence including BIOS 20189, BIOS 20190, or BIOS 20235.

Equivalent Course(s): DVBI 36400, MGCB 36400

BIOS 21238. Cell Biology II. 100 Units.

This course covers the mechanisms with which cells execute fundamental behaviors. Topics include signal transduction, cell cycle progression, cell growth, cell death, cancer biology, cytoskeletal polymers and motors, cell motility, cytoskeletal diseases, and cell polarity. Each lecture will conclude with a dissection of primary literature with input from the students. Students will write and present a short research proposal, providing excellent preparation for preliminary exams.

Instructor(s): M. Glotzer, D. Kovar Terms Offered: Winter

Prerequisite(s): For undergraduates: Three quarters of a Biological Sciences Fundamentals sequence.

Equivalent Course(s): DVBI 31700, BCMB 31700, MGCB 31700

BIOS 21249. Organization, Expression, and Transmission of Genome Information. 100 Units.

This seminar course examines how genomes are organized for coding sequence expression and transmission to progeny cells. The class discusses a series of key papers in the following areas: bacterial responses to external stimuli and genome damage, control of eukaryotic cell differentiation, complex loci regulating developmental expression in animals, centromere structure and function, position effect variegation, chromatin domains, chromatin remodeling, RNAi, and chromatin formatting.

Instructor(s): J. Shapiro Terms Offered: Spring

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence. Recommended for Advanced Biology students

BIOS 21306. Human Genetics and Evolution. 100 Units.

The goal of this course is to provide an evolutionary perspective on the molecular genetic bases of human diseases and non-clinical human traits. The course covers fundamental concepts and recent progress in Mendelian and complex trait mapping as well as evolutionary principles as they apply to genomics analyses of DNA sequence variation in human populations. These topics will be introduced through lectures and will be complemented by discussion and student presentations of original research papers.

Instructor(s): V. Lynch, A Di Rienzo. Terms Offered: Autumn

Prerequisite(s): Three quarters of a Biological Fundamentals Sequence including BIOS 20187 or BIOS 20235.

BIOS 21317. Topics in Biological Chemistry. 100 Units.

Required of students who are majoring in biological chemistry. This course examines a variety of biological problems from a chemical and structural perspective, with an emphasis on molecular machines. Topics include macromolecular structure-function relationships, DNA synthesis and repair, RNA folding and function, protein synthesis, targeting and translocation, molecular motors, membrane proteins, photosynthesis, and mechanisms of signal transduction. Computer graphics exercises and in-class journal clubs complement the lecture topics.

Instructor(s): P. Rice, R. Keenan Terms Offered: Spring

Prerequisite(s): BIOS 20200

BIOS 21328. Biophysics of Biomolecules. 100 Units.

This course covers the properties of proteins, RNA, and DNA, as well as their interactions. We emphasize the interplay between structure, thermodynamics, folding, and function at the molecular level. Topics include cooperativity, linked equilibrium, hydrogen exchange, electrostatics, diffusion, and binding.

Instructor(s): T. Sosnick Terms Offered: Spring

Prerequisite(s): Consent of instructor

Equivalent Course(s): BCMB 32200, BPHS 31000

BIOS 21349. Protein Structure and Functions in Medicine. 100 Units.

This course explores how molecular machinery works in the context of medicine (vision, fight or flight, cancer, and action of drugs). We first explore the physical and biochemical properties of proteins in the context of cellular signaling. We then examine how proteins and other cellular components make up the signal transduction pathway of humans and conduct their biological functions. The course engages students to strengthen their scientific communication and teaching skills via the in-class podcast, oral examinations, computer-aided structural presentations, student lectures, and discussions.

Instructor(s): W-J. Tang Terms Offered: Spring

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence. Biochemistry strongly recommended.

Equivalent Course(s): CABI 31900, NURB 33500

BIOS 21356. Vertebrate Development. 100 Units.

This advanced-level course combines lectures, student presentations, and discussion sessions. It covers major topics on the developmental biology of embryos (e.g. formation of the germ line, gastrulation, segmentation, nervous system development, limb patterning, organogenesis). We make extensive use of the primary literature and emphasize experimental approaches including embryology, genetics, and molecular genetics.

Instructor(s): V. Prince, C. Ragsdale. Terms Offered: Spring

Prerequisite(s): For College students: Three quarters of a Biological Sciences Fundamentals sequence.

Equivalent Course(s): MGCB 35600, ORGB 33600, DVBI 35600

BIOS 21358. Simulation, Modeling, and Computation in Biophysics. 100 Units.

This course develops skills for modeling biomolecular systems. Fundamental knowledge covers basic statistical mechanics, free energy, and kinetic concepts. Tools include molecular dynamics and Monte Carlo simulations, random walk and diffusion equations, and methods to generate random Gaussian and Poisson distributors. A term project involves writing a small program that simulates a process. Familiarity with a programming language or Matlab would be valuable.

Instructor(s): B. Roux Terms Offered: Winter

Prerequisite(s): BIOS 20200 and BIOS 26210-26211, or consent from instructor

Equivalent Course(s): CPNS 31358, BCMB 31358

BIOS 21360. Advanced Molecular Biology. 100 Units.

This course covers genome structures, transcription of DNA to RNA, messenger RNA splicing, translation of RNA to protein, transcriptional and post-transcriptional gene regulations, non-coding RNA functions, epigenetics and epitranscriptomics. Basic methods in molecular biology will also be covered. The course also includes special, current topics on genomics, single molecule studies of gene expression, epitranscriptomics, and others.

Instructor(s): J. Fei, T. Pan. Terms Offered: Winter

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and Organic Chemistry, or consent of instructor.

BIOS 21407. Image Processing in Biology. 100 Units.

Whether one is trying to read radio signals from faraway galaxies or to understand molecular structures, it is necessary to understand how to read, interpret, and process the data that contain the desired information. In this course, we learn how to process the information contained in images of molecules as seen in the electron microscope. We also deal with the principles involved in processing electron microscope images, including the underlying analytical methods and their computer implementation.

Instructor(s): R. Josephs Terms Offered: Spring

Prerequisite(s): For College students: Three quarters of a Biological Sciences Fundamentals sequence and one year of calculus

Equivalent Course(s): MGCB 34300

BIOS 21415. Stem Cells in Development and Diseases. 100 Units.

This course will provide a survey of concepts and biology of stem cells based on experimental evidence for their involvement in developmental processes and human diseases. Topics will discuss classic models as well as recent advance made in the biomedical research community.

Instructor(s): A. Imamoto, X. Wu Terms Offered: Spring

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence, including BIOS 20186 and BIOS 20187

BIOS 21416. Stem Cells and Regeneration. 100 Units.

The course will focus on the basic biology of stem cells and regeneration, highlighting biomedically relevant findings that have the potential to translate to the clinic. We will cover embryonic and induced pluripotent stem cells, as well as adult stem cells from a variety of systems, both invertebrate and vertebrates.

Instructor(s): E. Ferguson, V. Prince, J. Cunningham, J. De Jong, X. Wu Terms Offered: Autumn

Prerequisite(s): For undergraduates only: completion of a Biological Sciences fundamentals sequence

Equivalent Course(s): DVBI 36200

BIOS 21417. Systems Biology: Molecular Regulatory Logic of Networks. 100 Units.

Systems biologists investigate networks of genes and model how they function. They do this to better understand the nature of systems-based mechanisms that control development, physiology, evolution, and disease resistance. Quantitative techniques and computational tools help investigators analyze heterogeneous data about molecular networks to uncover meaningful relationships about key components. These studies inspire a framework for understanding the molecular regulatory logic of living states. Related principles about dynamic biological systems are the focus of the course.

Instructor(s): B. Aprison, E. Kovar. Terms Offered: Spring

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and consent of Instructor

BIOS 21418. Historical and Conceptual Foundations of DevoEvo. 100 Units.

The goal of this course is to explore the historical and conceptual foundations of Developmental Evolution (DevoEvo) through readings and group discussions of historical and philosophical literature on evolutionary and developmental biology, in particular the role developmental biology played in the formulation of evolutionary theory and its subsequent banishment from the Modern Synthesis. The course begins with a review of nineteenth-century scientific and evolutionary thought, including an examination of competing theories of evolution (Theistic Evolutionism, Lamarckism, Orthogenesis, and Mutation Theory) and their contribution (or lack thereof) to modern evolutionary biology. We then explore how (and why) developmental biology was excluded from the formulation of the Synthesis and Neo-Darwinian thought, and examine the source of continued conflicts between Neo-Darwinism and DevoEvo. The course concludes with a discussion of what (if anything) DevoEvo can contribute to evolutionary theory that other research programs cannot (for example, what kinds of phenomena do developmental mechanisms contribute more to the explanation of evolutionary processes than population genetic mechanisms?).

Instructor(s): V. Lynch. Terms Offered: Winter

Prerequisite(s): For Biology Majors: Three quarters of a Biological Sciences Fundamentals sequence.

Equivalent Course(s): ORGB 39500, HGEN 39500

BIOS 21506. Biological Physics. 100 Units.

This course is an introduction to the physics of living matter. Its goal is to understand the design principles from physics that characterize the condensed and organized matter of living systems. Topics include: basic structures of proteins, nucleotides, and biological membranes; application of statistical mechanics to diffusion and transport; hydrodynamics of low Reynolds number fluids; thermodynamics and chemical equilibrium; physical chemistry of binding affinity and kinetics; solution electrostatics and depletion effect; biopolymer mechanics; cellular mechanics and motions; molecular motors.

Instructor(s): A. Murugan Terms Offered: Spring

Prerequisite(s): PHYS 13300 or PHYS 14300

Note(s): Students majoring in Physics may use this course either as a Physics elective OR as a upper level elective in the Biological Sciences major.

Equivalent Course(s): PHYS 25500, MENG 21900

BIOS 21507. The Engineering and Biology of Tissue Repair. 100 Units.

In this course, students will gain an understanding of the science and application of tissue engineering, a field that seeks to develop technologies for restoring lost function in diseased or damaged tissues and organs. The course will first introduce the underlying cellular and molecular components and processes relevant to tissue engineering: extracellular matrices, cell/matrix interactions such as adhesion and migration, growth factor biology, stem cell biology, inflammation, and innate immunity. The course will then discuss current approaches for engineering a variety of tissues, including bone and musculoskeletal tissues, vascular tissues, skin, nerve, and pancreas. Students will be assessed through in-class discussions, take-home assignments and exams, and an end-of-term project on a topic of the student's choice.

Instructor(s): Jeffrey Hubbell Terms Offered: Spring

Prerequisite(s): BIOS 20186 or BIOS 20234

Equivalent Course(s): MENG 34300, MENG 24300, MPMM 34300

BIOS 22226. Human Developmental Biology. 100 Units.

This course covers the anatomic and physiologic development of the human from conception to birth, on an organ-by-organ basis. Special attention is paid to the profound physiologic events that take place in the transition from intra-uterine to extra-uterine life. Examples of clinical conditions due to specific errors in development are presented in context. Genetic regulation of organogenesis with reference to mouse models are discussed where the data are available.

Instructor(s): J. Marks Terms Offered: Winter

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence

BIOS 22233. Comparative Vertebrate Anatomy. 100 Units.

This course covers the structure and function of major anatomical systems of vertebrates. Lectures focus on vertebrate diversity, biomechanics, and behavior (from swimming and feeding to running, flying, seeing, and hearing). Labs involve detailed dissection of animals (muscles, organs, brains) and a focus on skull bones in a broad comparative context from fishes to frogs, turtles, alligators, mammals, birds, and humans. Field trip to Field Museum and visit to medical school lab for human dissection required.

Instructor(s): M. Westneat. L. Terms Offered: Spring

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence.

Equivalent Course(s): ORGB 32233

BIOS 22236. Reproductive Biology of Primates. 100 Units.

The aim of this advanced-level course is to provide a comparative overview of adaptations for reproduction in primates as a background to human reproductive biology. Where appropriate, reference will be made to other mammals and some comparisons will be even wider. Ultimately, the aim of all comparisons is to arrive at concrete lessons for human reproduction, notably in the realm of obstetrics and gynecology. For this reason, the course will be of interest for medical students as well as for those studying anthropology, biology or psychology.

Instructor(s): R. Martin Terms Offered: Spring

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence.

BIOS 22249. Principles of Toxicology. 100 Units.

This course covers basic concepts of toxicology including routes of exposure and uptake, metabolic conversion, and elimination of toxic agents, as well as fundamental laws governing the interaction of external chemicals with biological systems. In addition to toxins of biological origin, we also consider a set of physical and chemical toxicants in the environment, including air pollution, radiation, manufactured chemicals, metals, and pesticides. Methods of risk assessment will also be considered.

Instructor(s): Y-Y He Terms Offered: Autumn

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and BIOS 20200

BIOS 22250. Chordates: Evolution and Comparative Anatomy. 100 Units.

Chordate biology emphasizes the diversity and evolution of modern vertebrate life, drawing on a range of sources (from comparative anatomy and embryology to paleontology, biomechanics, and developmental genetics). Much of the work is lab-based, with ample opportunity to gain firsthand experience of the repeated themes of vertebrate body plans, as well as some of the extraordinary specializations manifest in living forms. The instructors, who are both actively engaged in vertebrate-centered research, take this course beyond the boundaries of standard textbook content.

Instructor(s): M. Coates Terms Offered: Winter, L.

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence. Recommended for Advanced Biology students.

Equivalent Course(s): EVOL 30200, ORGB 30250

BIOS 22260. Vertebrate Structure and Function. 100 Units.

This course is devoted to vertebrate bones and muscles, with a focus on some remarkable functions they perform. The first part takes a comparative look at the vertebrate skeleton via development and evolution, from lamprey to human. The major functional changes are examined as vertebrates adapted to life in the water, on land, and in the air. The second part looks at muscles and how they work in specific situations, including gape-feeding, swimming, leaping, digging, flying, and walking on two legs. Dissection of preserved vertebrate specimens required.

Instructor(s): P. Sereno, L. Terms Offered: Spring

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and consent of instructor. See also http://paulsereno.uchicago.edu/fossil_lab/classes/vertebrate_structure_and_function for more information.

BIOS 22265. Human Origins: Milestones in Human Evolution and the Fossil Record. 100 Units.

This course aims at exploring the fundamentals of human origins by tracking the major events during the course of human evolution. Starting with a laboratory based general introduction to human osteology and muscle function, the latest on morphological and behavioral evidence for what makes *Homo sapiens* and their fossil ancestors unique among primates will be presented. Our knowledge of the last common ancestor will be explored using the late Miocene fossil record followed by a series of lectures on comparative and functional morphology, adaptation and biogeography of fossil human species. With focus on the human fossil record, the emergence of bipedalism, advent of stone tool use and making, abandonment of arboreality, advent of endurance walking and running, dawn of encephalization and associated novel life histories, language and symbolism will be explored. While taxonomic identities and phylogenetic relationships will be briefly presented, the focus will be on investigating major adaptive transitions and how that understanding helps us to unravel the ecological selective factors that ultimately led to the emergence of our species. The course will be supported by fresh data coming from active field research conducted by Prof. Alemseged and state of the art visualization methods that help explore internal structures. By tracing the path followed by our ancestors over time, this course is directly relevant to reconnoitering the human condition today and our place in nature.

Instructor(s): Z. Alemseged Terms Offered: Autumn

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence, or consent of Instructor.

BIOS 22306. Evolution and Development. 100 Units.

The course will provide a developmental perspective on animal body plans in phylogenetic context. The course will start with a few lectures, accompanied by reading assignments. Students will be required to present a selected research topic that fits the broader goal of the course and will be asked to submit a referenced written version of it after their oral presentation. Grading will be based on their presentation (oral and written) as well as their contributions to class discussions.

Prerequisite(s): Advanced undergraduates may enroll with the consent of the instructor.

Instructor(s): U. Schmidt-Ott Terms Offered: Autumn

Prerequisite(s): Advanced undergraduates may enroll with the consent of the instructor.

Equivalent Course(s): ORGB 33850, DVBI 33850, EVOL 33850

BIOS 23100. Dinosaur Science. 100 Units.

This introductory-level (but intensive) class includes a ten-day expedition to South Dakota and Wyoming (departing just after graduation). We study basic geology (e.g., rocks and minerals, stratigraphy, Earth history, mapping skills) and basic evolutionary biology (e.g., vertebrate and especially skeletal anatomy, systematics and large-scale evolutionary patterns). This course provides the knowledge needed to discover and understand the meaning of fossils as they are preserved in the field, which is applied to actual paleontological sites. Participants fly from Chicago to Rapid City, and then travel by van to field sites. There they camp, prospect for, and excavate fossils from the Cretaceous and Jurassic Periods. Field trip required. Instructor(s): P. Sereno. L. Terms Offered: Spring

Prerequisite(s): Consent of instructor, three quarters of a Biological Sciences Fundamentals sequence and a prior course in general science, preferably geology. See also http://paulsereno.uchicago.edu/fossil_lab/classes/dinosaur_science for more information.

Note(s): Need based financial assistance for field trip may be available. Apply to the Master of BSCD (jmalamy@bsd.uchicago.edu)

BIOS 23232. Ecology and Evolution in the Southwest. 100 Units.

This lecture course focuses on the ecological communities of the Southwest, primarily on the four subdivisions of the North American Desert, the Chihuahuan, Sonoran, Mohave, and Great Basin Deserts. Lecture topics include climate change and the impact on the flora and fauna of the region; adaptations to arid landscapes; evolutionary, ecological, and conservation issues in the arid Southwest, especially relating to isolated mountain ranges; human impacts on the biota, land, and water; and how geological and climatic forces shape deserts.

Instructor(s): E. Larsen Terms Offered: Spring

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence, or consent of instructor

BIOS 23233. Ecology and Evolution in the Southwest:Field School. 100 Units.

This lecture/lab course is the same course as BIOS 13111, but includes a lab section preparatory to a two-week field trip at end of Spring Quarter, specific dates to be announced. Our goal in the lab is to prepare proposals for research projects to conduct in the field portion of this course. Field conditions are rugged. Travel is by twelve-passenger van. Lodging during most of this course is tent camping on developed campsites.

Instructor(s): E. Larsen Terms Offered: Spring

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and consent of instructor

Note(s): Need based financial assistance for field trip may be available. Apply to the Master of BSCD (jmalamy@bsd.uchicago.edu)

BIOS 23242. Primate Evolution and the Roots of Human Biology. 100 Units.

The course is designed to achieve a state-of-the-art synthesis of primate evolution and human origins. An overview of the biology and evolution of the mammalian order Primates provides a broad foundation for considering the special case human evolution. Across primates as a group, the course explores and integrates comparative evidence from anatomy, physiology, behavior, chromosomal studies, and molecular genetics. Both living primates and their fossil relatives are covered, with due reference to theoretical aspects. Particular emphasis is given to evaluation of characters for inference of evolutionary relationships and to explicit examination of scaling effects of body size in between-species comparisons. Within the general framework of origins and adaptations of primates, human evolution is examined with respect to all features covered. Special features of humans are identified and related to an overview of the hominid fossil record. A specific goal of this course is to guide students to read, interpret, and synthesize scientific literature, and exercise critical thinking with respect to selected topics. As shown by examples, the course is directly relevant to the field of Darwinian medicine, which considers health and disease in relation to the evolutionary background of human biology.

Instructor(s): R. Martin Terms Offered: Spring

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence, or consent of instructor.

BIOS 23247. Bioarchaeology and the Human Skeleton. 100 Units.

This course is intended to provide students in archaeology with a thorough understanding of bioanthropological and osteological methods used in the interpretation of prehistoric societies by introducing bioanthropological methods and theory. In particular, lab instruction stresses hands-on experience in analyzing the human skeleton, whereas seminar classes integrate bioanthropological theory and application to specific cases throughout the world. Lab and seminar-format class meet weekly.

Instructor(s): M. C. Lozada Terms Offered: Winter

Note(s): This course qualifies as a Methodology selection for Anthropology majors.

Equivalent Course(s): ANTH 28400, ANTH 38800

BIOS 23249. Animal Behavior. 100 Units.

This course introduces the mechanism, ecology, and evolution of behavior, primarily in nonhuman species, at the individual and group level. Topics include the genetic basis of behavior, developmental pathways, communication, physiology and behavior, foraging behavior, kin selection, mating systems and sexual selection, and the ecological and social context of behavior. A major emphasis is placed on understanding and evaluating scientific studies and their field and lab techniques.

Instructor(s): S. Pruett-Jones (even years), J. Mateo (odd years) Terms Offered: Winter

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence.

Note(s): CHDV Distribution: A

Equivalent Course(s): PSYC 23249, CHDV 23249

BIOS 23252. Field Ecology. 100 Units.

Open only to students who are planning to pursue graduate research. This course introduces habitats and biomes in North America and the methods of organizing and carrying out field research projects in ecology and behavior, focusing on questions of evolutionary significance. A two-week field trip to southern Florida during the Winter/Spring Quarter break consists of informal lectures and discussions, individual study, and group research projects. During Spring Quarter, there are lectures on the ecology of the areas visited and on techniques and methods of field research. Field trip required.

Instructor(s): S. Pruett-Jones Terms Offered: Spring. This course is offered in alternate (odd) years.

Prerequisite(s): Consent of instructor

BIOS 23254. Mammalian Ecology. 100 Units.

This course introduces the diversity and classification of mammals and their ecological relationships. Lectures cover natural history, evolution, and functional morphology of major taxonomic groups. Lab sessions focus on skeletal morphology, identifying traits of major taxonomic groups, and methods of conducting research in the field. Participation in field trips, occasionally on Saturday, is required.

Instructor(s): E. Larsen Terms Offered: Spring, L. Offered every other year in odd years.

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and third-year standing or consent of instructor.

BIOS 23258. Molecular Evolution I: Fundamentals and Principles. 100 Units.

The comparative analysis of DNA sequence variation has become an important tool in molecular biology, genetics, and evolutionary biology. This course covers major theories that form the foundation for understanding evolutionary forces that govern molecular variation, divergence, and genome organization. Particular attention is given to selectively neutral models of variation and evolution, and to alternative models of natural selection. The course provides practical information on accessing genome databases, searching for homologous sequences, aligning DNA and protein sequences, calculating sequence divergence, producing sequence phylogenies, and estimating evolutionary parameters.

Instructor(s): M. Kreitman Terms Offered: Winter

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and two quarters of calculus, or consent of instructor.

Equivalent Course(s): ECEV 44001, EVOL 44001

BIOS 23261. Invertebrate Paleobiology and Evolution. 100 Units.

This course provides a detailed overview of the morphology, paleobiology, evolutionary history, and practical uses of the invertebrate and microfossil groups commonly found in the fossil record. Emphasis is placed on understanding key anatomical and ecological innovations within each group and interactions among groups responsible for producing the observed changes in diversity, dominance, and ecological community structure through evolutionary time. Labs supplement lecture material with specimen-based and practical application sections. An optional field trip offers experience in the collection of specimens and raw paleontological data. Several "Hot Topics" lectures introduce important, exciting, and often controversial aspects of current paleontological research linked to particular invertebrate groups. (L)

Instructor(s): M. Webster Terms Offered: Autumn

Prerequisite(s): GEOS 13100 and 13200, or equivalent. Students majoring in Biological Sciences only; Completion of the general education requirement in the Biological Sciences, or consent of instructor.

Equivalent Course(s): EVOL 32400, GEOS 36300, GEOS 26300

BIOS 23262. Mammalian Evolutionary Biology. 100 Units.

This course examines mammalian evolution—the rise of living mammals from ancient fossil ancestors stretching back over 300 million years. Lectures focus on the evolutionary diversification of mammals, including anatomical structure, evolutionary adaptations, life history, and developmental patterns. Labs involve detailed comparative study of mammalian skeletons, dissection of muscular and other systems, trips to the Field Museum to study fossil collections, and studies of human anatomy at the Pritzker School of Medicine. Students will learn mammalian evolution, functional morphology, and development, and will gain hands-on experience in dissection. Taught by instructors who are active in scientific research on mammalian evolution, the course is aimed to convey new insights and the latest progress in mammalian paleontology, functional morphology, and evolution. Prerequisite(s): Second-year standing and completion of a Biological Sciences Fundamentals sequence; or GEOS 13100-13200 or GEOS 22300, or consent of instructors.

Instructor(s): Z. Luo, K. Angielczyk Terms Offered: Autumn, L.

Prerequisite(s): Second-year standing and three quarters of a Biological Sciences Fundamentals sequence; or GEOS 13100-13200 or GEOS 22300, or consent of instructors.

Equivalent Course(s): ORGB 31201, EVOL 31201

BIOS 23266. Evolutionary Adaptation. 100 Units.

This course deals with the adaptation of organisms to their environments and focuses on methods for studying adaptation. Topics include definitions and examples of adaptation, the notion of optimization, adaptive radiations, the comparative method in evolutionary biology, and the genetic architecture of adaptive traits. Students will draw on the logical frameworks covered in lecture as they evaluate primary papers and prepare two writing assignments on an adaptive question of their choice.

Instructor(s): C. Andrews Terms Offered: Autumn

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence or consent of instructor.

BIOS 23289. Marine Ecology. 100 Units.

This course provides an introduction into the physical, chemical, and biological forces controlling the function of marine ecosystems and how marine communities are organized. The structures of various types of marine ecosystems are described and contrasted, and the lectures highlight aspects of marine ecology relevant to applied issues such as conservation and harvesting.

Instructor(s): T. Wootton Terms Offered: Winter

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and prior introductory course in ecology or consent of instructor.

Equivalent Course(s): ENST 23289

BIOS 23299. Plant Development and Molecular Genetics. 100 Units.

Genetic approaches to central problems in plant development will be discussed. Emphasis will be placed on embryonic pattern formation, meristem structure and function, reproduction, and the role of hormones and environmental signals in development. Lectures will be drawn from the current literature; experimental approaches (genetic, cell biological, biochemical) used to discern developmental mechanisms will be emphasized. Graduate students will present a research proposal in oral and written form; undergraduate students will present and analyze data from the primary literature, and will be responsible for a final paper.

Instructor(s): J. Greenberg Terms Offered: Spring

Prerequisite(s): For undergraduates only: Three quarters of a Biological Sciences Fundamentals sequence.

Equivalent Course(s): ECEV 32900, MGCB 36100, DVBI 36100

BIOS 23365. Evolutionary and Genomic Medicine I. 100 Units.

Evolution is regularly investigated in free-living organisms, but some of its most fascinating and important examples occur in the interface between free-living and non-free-living states. In this course, we will use evolutionary and ecological principles to study the dynamics of viruses, unicellular organisms and cells in multi-cellular organisms relevant to human medicine. In EGM I, the emphasis will be on the evolution of pathogens, the evolution of cells of the immune system in response to pathogen invasion, the basis of autoimmune disorders, and the population genetics of cancerous cells in light of recent cancer genomic studies. EGM II will cover more general topics including Darwinian medicine, aging, and systems biology/medicine.

Instructor(s): S. Cobey, C-I. Wu Terms Offered: Winter

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence. Background in evolution and population genetics.

Equivalent Course(s): ECEV 33365

BIOS 23404. Reconstructing the Tree of Life: An Introduction to Phylogenetics. 100 Units.

This course is an introduction to the tree of life (phylogeny): its conceptual origins, methods for discovering its structure, and its importance in evolutionary biology and other areas of science. Topics include history and concepts, sources of data, methods of phylogenetic analysis, and the use of phylogenies to study the tempo and mode of lineage diversification, coevolution, biogeography, conservation, molecular biology, development, and epidemiology. One Saturday field trip and weekly computer labs required in addition to scheduled class time. This course is offered in alternate (odd) years.

Instructor(s): R. Ree. Terms Offered: Autumn. L.

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence or consent of instructor

Note(s): This course is offered in alternate (odd) years.

Equivalent Course(s): EVOL 35401

BIOS 23406. Biogeography. 100 Units.

This course examines factors governing the distribution and abundance of animals and plants. Topics include patterns and processes in historical biogeography, island biogeography, geographical ecology, areography, and conservation biology (e.g., design and effectiveness of nature reserves).

Instructor(s): B. Patterson (odd years, lab). L., Heaney (even years, discussion) Terms Offered: Winter

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and a course in either ecology, evolution, or earth history; or consent of instructor

Equivalent Course(s): EVOL 45500, GEOG 35500, GEOG 25500, ENST 25500

BIOS 23409. The Ecology and Evolution of Infectious Diseases. 100 Units.

Understanding the ecology and evolution of infectious diseases is crucial for both human health and for preservation of the natural environment. In this course, we combine mathematical modeling with ecological and evolutionary analyses to understand how fundamental mechanisms of host-pathogen interactions are translated into disease dynamics and host-pathogen co-evolution.

Instructor(s): G. Dwyer Terms Offered: Spring. L.

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and Integral calculus.

BIOS 23410. Complex Interactions: Coevolution, Parasites, Mutualists, and Cheaters. 100 Units.

This course emphasizes the enormous diversity of interactions between organisms. It is an introduction to the biology and ecology of parasitic and mutualistic symbiotic associations and their evolution. Topics include endosymbioses and their impact on the evolution of photosynthetic organisms, bacterial symbioses (e.g., nitrogen fixation), symbioses that fungi evolved with plants and animals (e.g., endophytes, mycorrhizae, lichens), pollination biology, insect-plant associations, and associations of algae with animals. Methods to elucidate the evolution of these associations are discussed with a focus on coevolutionary events and the origin of cheaters.

Instructor(s): T. Lumbsch Terms Offered: Spring

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence.

BIOS 24110. Fundamental Neuroscience. 100 Units.

This course is a rigorous introduction to the study of neurons, nervous systems and brains. The systems anatomy and physiology of the vertebrate brain will be covered in depth. Common features of neural circuits, such as those subserving the stretch reflex, will be examined. The biology of brain evolution and development will be introduced. A highlight of this course will be student dissections of sheep brains and the laboratory presentation of human brain dissections by the instructors.

Instructor(s): C. Ragsdale, P. Mason Terms Offered: Autumn

Prerequisite(s): At least two quarters of Biological Sciences instruction (including courses taken concurrently) or consent of instructor

Equivalent Course(s): NSCI 20110

BIOS 24120. Cellular Neuroscience. 100 Units.

This course describes the cellular and subcellular properties of neurons, including passive and active electrophysiological properties, and their synaptic interactions. Readings are assigned from a general neuroscience textbook.

Instructor(s): R.A. Eatock, W. Wei Terms Offered: Winter

Prerequisite(s): NSCI 20110, along with completion of MATH 13100, or MATH 15100, or MATH 16100, or consent of instructor

Equivalent Course(s): NSCI 20120

BIOS 24130. Systems Neuroscience. 100 Units.

This course covers vertebrate and invertebrate systems neuroscience with a focus on the anatomy, physiology, and development of sensory and motor control systems. The neural bases of form and motion perception, locomotion, memory, and other forms of neural plasticity are examined in detail. We also discuss clinical aspects of neurological disorders.

Instructor(s): D. Freedman Terms Offered: Spring

Prerequisite(s): NSCI 20110, NSCI 20120 or consent of instructors

Equivalent Course(s): NSCI 20130

BIOS 24131. Molecular Neuroscience. 100 Units.

This lecture/seminar course explores the application of modern cellular and molecular techniques to clarify basic questions in neurobiology. Topics include mechanisms of synaptic transmission, protein trafficking, exo- and endo-cytosis, and development and mechanisms of neurological diseases.

Instructor(s): S. Sisodia Terms Offered: Spring

Prerequisite(s): NSCI 20110, NSCI 20120 and BIOS 20200, or consent of instructor

Equivalent Course(s): NSCI 22100

BIOS 24208. Survey of Systems Neuroscience. 100 Units.

This lab-centered course teaches students the fundamental principles of vertebrate nervous system organization. Students learn the major structures and the basic circuitry of the brain, spinal cord and peripheral nervous system. Somatic, visual, auditory, vestibular and olfactory sensory systems are presented in particular depth. A highlight of this course is that students become practiced at recognizing the nuclear organization and cellular architecture of many regions of brain in rodents, cats and primates.

Instructor(s): S. Bensmaia

Prerequisite(s): NSCI 20130. For Biological Sciences majors: Three quarters of a Biological Sciences fundamentals sequence

Equivalent Course(s): NURB 31600, ORGB 32500, CPNS 30116

BIOS 24217. Conquest of Pain. 100 Units.

This course examines the biology of pain and the mechanisms by which anesthetics alter the perception of pain. The approach is to examine the anatomy of pain pathways both centrally and peripherally, and to define electrophysiological, biophysical, and biochemical explanations underlying the action of general and local anesthetics. We discuss the role of opiates and enkephalins. Central theories of anesthesia, including the relevance of sleep proteins, are also examined.

Instructor(s): K. Ruskin Terms Offered: Winter

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence, CHEM 2200-22100-22200 or BIOS 20200 and prior course in neurobiology or physiology is recommended.

BIOS 24231. Methods in Computational Neuroscience. 100 Units.

Topics include (but are not limited to): Hodgkin-Huxley equations, Cable theory, Single neuron models, Information theory, Signal Detection theory, Reverse correlation, Relating neural responses to behavior, and Rate vs. temporal codes.

Instructor(s): S. Bensmaia Terms Offered: Winter. L.

Prerequisite(s): BIOS 26210 and BIOS 26211 which must be taken concurrently, or consent of instructor.

Equivalent Course(s): PSYC 24231, CPNS 34231

BIOS 24232. Computational Approaches to Cognitive Neuroscience. 100 Units.

This course is concerned with the relationship of the nervous system to higher order behaviors (e.g., perception, object recognition, action, attention, learning, memory, and decision making). Psychophysical, functional imaging, and electrophysiological methods are introduced. Mathematical and statistical methods (e.g. neural networks and algorithms for studying neural encoding in individual neurons and decoding in populations of neurons) are discussed. Weekly lab sections allow students to program cognitive neuroscientific experiments and simulations.

Instructor(s): N. Hatsopoulos Terms Offered: Spring. L.

Prerequisite(s): BIOS 26210, a course in systems neuroscience, and knowledge using Matlab, or consent of instructor.

Equivalent Course(s): ORGB 34650, PSYC 34410, CPNS 33200

BIOS 24248. Biological Clocks and Behavior. 100 Units.

This course will address physiological and molecular biological aspects of circadian and seasonal rhythms in biology and behavior. The course will primarily emphasize biological and molecular mechanisms of CNS function, and will be taught at a molecular level of analysis from the beginning of the quarter. Those students without a strong biology background are unlikely to resonate with the course material.

Instructor(s): B. Prendergast Terms Offered: Spring

Prerequisite(s): A quality grade in PSYC 20300 Introduction to Biological Psychology. Additional biology courses are desirable. Completion of Core biology will not suffice as a prerequisite.

Equivalent Course(s): PSYC 21750

BIOS 24408. Modeling and Signal Analysis for Neuroscientists. 100 Units.

The course provides an introduction into signal analysis and modeling for neuroscientists. We cover linear and nonlinear techniques and model both single neurons and neuronal networks. The goal is to provide students with the mathematical background to understand the literature in this field, the principles of analysis and simulation software, and allow them to construct their own tools. Several of the 90-minute lectures include demonstrations and/or exercises in Matlab.

Instructor(s): W. van Drongelen Terms Offered: Spring. L.

Prerequisite(s): Undergraduates: Biology Major - BIOS 26210 and 26211, or consent of instructor. Neuroscience Major - NSCI 20130

Equivalent Course(s): CPNS 32111, NSCI 24000

BIOS 25108. Cancer Biology. 100 Units.

This course covers the fundamentals of cancer biology with a focus on the story of how scientists identified the genes that cause cancer. The emphasis is on "doing" science rather than "done" science: How do scientists think, how do they design experiments, where do these ideas come from, what can go wrong, and what is it like when things go right? We stress the role that cellular subsystems (e.g., signal transduction, cell cycle) play in cancer biology, as well as evolving themes in cancer research (e.g., ongoing development of modern molecular therapeutics).

Instructor(s): M. Rosner, W. Du Terms Offered: Winter

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence.

BIOS 25109. Topics in Reproduction and Cancer. 100 Units.

This course focuses on several aspects of the molecular and cellular biology of human reproduction. We also discuss the basis of chemical/viral carcinogenesis and the progression, treatment, and prevention of cancer. The role of steroid hormones and their receptors in the control of growth, development, and specialized cell function is discussed in the context of normal and abnormal gene expression in human development and disease. Key historical events, research approaches, utilization of knowledge, recent advances in drug design and herbal medicines, and philosophies of scientific research are also covered.

Instructor(s): G. Greene, D. Vander Griend Terms Offered: Spring

Prerequisite(s): For Biology majors: Three quarters of a Biological Sciences Fundamentals sequence and Biochemistry, or consent of Instructor.

BIOS 25126. Animal Models of Human Disease. 100 Units.

This course introduces the use of animals in biomedical research for the purposes of understanding, treating, and curing human disease. Particular emphasis is placed on rodent models in the context of genetic, molecular, and immunologic manipulations, as well as on the use of large animal surgical models. University veterinarians also provide information regarding humane animal care.

Instructor(s): K. Luchins Terms Offered: Spring

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence, or consent of instructor

BIOS 25206. Fundamentals of Bacterial Physiology. 100 Units.

This course meets one of the requirements of the microbiology specialization. This course introduces bacterial diversity, physiology, ultra-structure, envelope assembly, metabolism, and genetics. In the discussion section, students review recent original experimental work in the field of bacterial physiology.

Instructor(s): D. Missiakas Terms Offered: Autumn

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence, or consent of instructor

Equivalent Course(s): MICR 30600

BIOS 25216. Molecular Basis of Bacterial Disease. 100 Units.

This course meets one of the requirements of the microbiology specialization. This lecture/discussion course involves a comprehensive analysis of bacterial pathogens, the diseases that they cause, and the molecular mechanisms involved during pathogenesis. Students discuss recent original experimental work in the field of bacterial pathogenesis.

Instructor(s): H. Shuman Terms Offered: Winter

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence.

Equivalent Course(s): MICR 31600

BIOS 25226. Endocrinology I: Cell Signaling. 100 Units.

The subject matter of this course considers the wide variety of intracellular mechanisms that, when activated, change cell behavior. We cover aspects of intracellular signaling, the latter including detailed discussions of receptors, G-proteins, cyclic nucleotides, calcium and calcium-binding proteins, phosphoinositides, protein kinases, and phosphatases.

Instructor(s): M. Brady, R. Cohen Terms Offered: Autumn

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and BIOS 20200.

Equivalent Course(s): NPHP 33600

BIOS 25227. Endocrinology II: Systems and Physiology. 100 Units.

Endocrinology is the study of hormones, which are chemical messengers released by tissues that regulate the activity of other cells in the body. This course covers the classical hormone systems, including hormones regulating metabolism, energy mobilization and storage, calcium and phosphate metabolism, reproduction, growth, "fight or flight," and circadian rhythms. We focus on historical perspective, the mechanisms of action, homeostatic regulation, and relevant human diseases for each system.

Instructor(s): M. Brady, R. Cohen Terms Offered: Winter

Prerequisite(s): Completion of the first three quarters of a Biological Fundamentals Sequence.

BIOS 25228. Endocrinology III: Human Disease. 100 Units.

A Fundamentals Sequence (BIOS 20180s or 20190s, or AP 5 sequence) and BIOS 25227 recommended but not required.

This course is a modern overview of the patho-physiologic, genetic, and molecular basis of human diseases with nutritional perspectives. We discuss human diseases (e.g., hypertension, cardiovascular diseases, obesity, diabetes, osteoporosis, alopecia).

Instructor(s): Y. C. Li Terms Offered: Spring

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence is required and BIOS 25227 is strongly recommended.

BIOS 25256. Immunobiology. 100 Units.

This comprehensive survey course presents an integrated coverage of the tactics and logistics of innate and adaptive immunity in mammalian organisms. It conveys the elegance and complexity of immune responses against infectious agents. It introduces their implications in autoimmune diseases, cancer and organ transplantation and presents some of the emerging immunotherapeutics that are transforming health care. Prior knowledge of microbiology (e.g., BIOS 25206) will be advantageous. Prerequisite(s): Completion of a Biological Sciences Fundamentals Sequence which includes, Cell, Genetics, Developmental Biology, and Physiology

Instructor(s): A. Bendelac Terms Offered: Autumn

Prerequisite(s): BIOS 20186, BIOS 20187, BIOS 20189 and BIOS 20188 or BIOS 20191.

BIOS 25258. Immunopathology. 100 Units.

Five examples of diseases are selected each year among the following categories: autoimmune diseases, inflammatory bowel diseases, infection immunity, immunodeficiencies and gene therapy, and transplantation and tumor immunology. Each disease is studied in depth with general lectures that include, where applicable, histological analysis of diseased tissue samples and discussions of primary research papers on experimental disease models. Special emphasis is placed on understanding immunopathology within the framework of general immunological concepts and on experimental approaches to the study of immunopathological models.

Instructor(s): B. Jabri Terms Offered: Winter

Prerequisite(s): BIOS 25256 with a grade of B or higher.

Equivalent Course(s): IMMU 30010, PATH 30010

BIOS 25260. Host Pathogen Interactions. 100 Units.

This course explores the basic principles of host defense against pathogens, including evolutionary aspects of innate and adaptive immunity and immune evasion strategies. Specific examples of viral and bacterial interactions with their hosts are studied in depth. A review of immunological mechanisms involved in specific cases is incorporated in the course.

Instructor(s): A. Chervonsky Terms Offered: Autumn

Prerequisite(s): BIOS 25206 and BIOS 25256

Equivalent Course(s): IMMU 31200, MICR 31200

BIOS 25266. Molecular Immunology. 100 Units.

This discussion-oriented course examines the molecular principles of immune recognition. We explore the roles of protein modification, protein-protein and protein-DNA interactions in the discrimination between self and non-self, and study the molecular fundamentals of cell stimulation and signaling. Primary literature focused on molecular research of the immune system is integrated with lectures on commonly used biochemical, structural and immunological techniques used in the research papers examined.

Instructor(s): E. Adams Terms Offered: Spring. Offered in odd years

Prerequisite(s): BIOS 20200 or 25256, or consent of instructor

Equivalent Course(s): IMMU 30266

BIOS 25267. Mucosal Immunology. 100 Units.

This course addresses how the gut associated lymphoid tissue distinguishes innocuous dietary antigens and commensal bacteria from pathogenic microbes and mounts an appropriate response. The realization that we live in a dynamic relationship with the trillions of bacteria that form the commensal microbiome has added additional complexity to our understanding of this conundrum. In this course a topic will be introduced with a lecture and review article for the first class of each week. In the second class each week students will lead the discussion of the primary articles assigned. The course will be graded on class participation and a final essay-based exam. Although intended primarily for graduate students in the Immunology, Microbiology, MPMM and CMMN programs, undergraduates may enroll with the permission of the instructor.

Instructor(s): C. Nagler Terms Offered: Spring. Offered every other year in even years.

Prerequisite(s): BIOS 25266

Equivalent Course(s): IMMU 37000

BIOS 25287. Introduction to Virology. 100 Units.

This class on animal viruses considers the major families of the viral kingdom with an emphasis on the molecular aspects of genome expression and virus-host interactions. Our goal is to provide students with solid appreciation of basic knowledge, as well as instruction on the frontiers of virus research.

Instructor(s): B. Manicassamy Terms Offered: Spring

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and third- or fourth-year standing

Equivalent Course(s): MICR 34600

BIOS 25308. Heterogeneity in Human Cancer: Etiology and Treatment. 100 Units.

This course addresses the importance of understanding human tumor heterogeneity (organ site by organ site) in terms of predicting whether tumors will progress to malignancy and how tumors will respond to standard treatments or require tailored molecular therapeutics. Alternating lecture and discussion lectures will explore and tease apart the controversies in the field that limit progress in cancer prevention, diagnosis and treatment. At the end of the course, students should have an in-depth understanding of the complexities, challenges and opportunities facing modern cancer researchers and clinical oncologists and be able to discuss novel scientific approaches to solving these issues.

Instructor(s): K. MacLeod Terms Offered: Autumn 2018

Prerequisite(s): A grade of B or better in BIOS 25108

Equivalent Course(s): CABI 30500

BIOS 25326. Tumor Microenvironment and Metastasis. 100 Units.

The tumor microenvironment regulates disease progression and chemoresistance in most cancers. This course addresses the functional contribution of the different cellular and non-cellular constituents of the tumor that surround the malignant cancer cells in cancer progression and metastasis. We will thoroughly discuss the function of stroma, inflammation, tumor senescence, immunity and the interactions in cancer progression and metastasis. Moreover, we will evaluate the translational impact of targeting the tumor microenvironment. Laboratory studies will introduce key techniques and organotypic model systems to elucidate these functions. At the end of the course, students should be able to understand the biology behind cancer metastasis and to evaluate manuscripts reporting novel findings in cancer biology. Prerequisite(s): BIOS 25108 and BIOS 25308

Instructor(s): H. Kenny, E. Lengyel Terms Offered: Spring

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence.

Note(s): Three optional weekend, one-day workshops will be offered during the quarter. This course qualifies in the Cancer Specialization.

BIOS 25327. Health Disparities in Breast Cancer. 100 Units.

Across the globe, breast cancer is the most common women's cancer. In the last two decades, there have been significant advances in breast cancer detection and treatment that have resulted in improved survival rates. Yet, not all populations have benefited equally from these improvements, and there continues to be a disproportionate burden of breast cancer felt by different populations. In the U.S., for example, white women have the highest incidence of breast cancer but African-American women have the highest breast cancer mortality overall. The socioeconomic, environmental, biological, and cultural factors that collectively contribute to these disparities are being identified with a growing emphasis on health disparities research efforts. In this 10-week discussion-based course students will meet twice weekly and cover major aspects of breast cancer disparities.

Instructor(s): Eileen Dolan, Suzanne Conzen Terms Offered: Winter

Prerequisite(s): BIOS 25108

Equivalent Course(s): CCTS 40400, CCTS 20400

BIOS 25407. Organ Transplantation. 100 Units.

This course presents biological, technical, ethical, and economic issues associated with organ transplantation. We sharply focus the immunologic knowledge from BIOS 25256 onto the biologic barriers to organ acceptance and the ultimate goal of immunologic tolerance. We also address principles of organ preservation and the mechanisms of ischemia/reperfusion injury. The technical aspects and physiology of organ transplantation (i.e., kidney, liver, heart, lung, pancreas, islet, intestinal) are covered. The social, economic, and ethical issues raised in transplantation (i.e., allografts, xenografts, living donation) are also discussed. This course is offered in alternate years.

Instructor(s): A. Chong Terms Offered: Winter. Every other year in odd years.

Prerequisite(s): BIOS 25256

BIOS 26120. An Introduction to Bioinformatics and Proteomics. 100 Units.

Modern biology generates massive amounts of data; this course is devoted to biological information and the models and techniques used to make sense of it. Students learn about biological databases, algorithms for sequence alignment, phylogenetic tree building, and systems biology. They will also learn about the basics of large-scale study of proteins, particularly their structures and functions. Students will be introduced to basics of high performance computation (HPC) and its application to the field of bioinformatics. They will learn how to use our in-house Super Computer to process and analyze next generation sequencing data. Using state of the art tools, students will align and genotype a group of genes in order to identify disease-relevant variants. The course will be taught as a hands on computer approach (a computation background would be helpful, but not needed).

Instructor(s): E. Haddadian Terms Offered: Autumn. L.

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence or BIOS 20172 or consent of Instructor. No computation background required.

BIOS 26210-26211. Mathematical Methods for Biological Sciences I-II.**BIOS 26210. Mathematical Methods for Biological Sciences I. 100 Units.**

This course builds on the introduction to modeling course biology students take in the first year (BIOS 20151 or 152). It begins with a review of one-variable ordinary differential equations as models for biological processes changing with time, and proceeds to develop basic dynamical systems theory. Analytic skills include stability analysis, phase portraits, limit cycles, and bifurcations. Linear algebra concepts are introduced and developed, and Fourier methods are applied to data analysis. The methods are applied to diverse areas of biology, such as ecology, neuroscience, regulatory networks, and molecular structure. The students learn computations methods to implement the models in MATLAB.

Instructor(s): D. Kondrashov Terms Offered: Autumn. L.

Prerequisite(s): BIOS 20151 or BIOS 20152 and three quarters of a Biological Sciences Fundamentals sequence or consent of the instructor

Equivalent Course(s): CPNS 31000, PSYC 36210

BIOS 26211. Mathematical Methods for Biological Sciences II. 100 Units.

This course is a continuation of BIOS 26210. The topics start with optimization problems, such as nonlinear least squares fitting, principal component analysis and sequence alignment. Stochastic models are introduced, such as Markov chains, birth-death processes, and diffusion processes, with applications including hidden Markov models, tumor population modeling, and networks of chemical reactions. In computer labs, students learn optimization methods and stochastic algorithms, e.g., Markov Chain, Monte Carlo, and Gillespie algorithm. Students complete an independent project on a topic of their interest.

Instructor(s): D. Kondrashov Terms Offered: Winter. L.

Prerequisite(s): BIOS 26210 or equivalent.

Equivalent Course(s): PSYC 36211, CPNS 31100

BIOS 26211. Mathematical Methods for Biological Sciences II. 100 Units.

This course is a continuation of BIOS 26210. The topics start with optimization problems, such as nonlinear least squares fitting, principal component analysis and sequence alignment. Stochastic models are introduced, such as Markov chains, birth-death processes, and diffusion processes, with applications including hidden Markov models, tumor population modeling, and networks of chemical reactions. In computer labs, students learn optimization methods and stochastic algorithms, e.g., Markov Chain, Monte Carlo, and Gillespie algorithm. Students complete an independent project on a topic of their interest.

Instructor(s): D. Kondrashov Terms Offered: Winter. L.

Prerequisite(s): BIOS 26210 or equivalent.

Equivalent Course(s): PSYC 36211, CPNS 31100

BIOS 26318. Fundamentals of Biological Data Analysis. 100 Units.

This course is intended for students who have original data from a research project and are looking to produce a thesis or publication. Students will learn to organize, process, visualize, and make inferences from biological data sets using the data processing tools of R. We will review statistics concepts, such as probability distributions, linear and nonlinear fitting, estimation and hypothesis testing, and introduce new concepts relevant for the specific research questions identified by the students. The end result will be a written report that can function as a methods and results section of a research publication and contains high-quality graphics.

Instructor(s): D. Kondrashov, S. Allesina Terms Offered: Autumn. L.

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence, STAT 22000 or higher, and fourth-year standing, or consent of Instructor. Primarily intended for students that have a data set from original research.

BIOS 27710-27711-27712-27713-27714-27715. Ecology – Marine Biological Laboratory; Biogeochemical Analysis in Terrestrial and Aquatic Ecosystems – Marine Biological Laboratory.; Independent Undergraduate Research in Environmental Sciences – Marine Biological Laboratory; Quantitative Environmental Analyses – Marine Biological Laboratory; Methods in Microbial Ecology – Marine Biological Laboratory.; Roles of Animals in Ecosystems – Marine Biological Laboratory.

Marine Biological Laboratory Semester in Environmental Science Sequence (SES). Courses BIOS 27710-27715 are the College designations for the Semester in Environmental Science that is taught at the Marine Biological Laboratory (MBL) in Woods Hole, Massachusetts. Registration in BIOS 27710, 27711, and 27712, plus one of BIOS 27713, 27714, or 27715 is required. Admission to the Semester in Environmental Science program is by application, which must be received by the MBL in March of the year preceding the start of the semester. Admissions decisions will be mailed in April. Note that these courses start at the beginning of September, typically four weeks prior to the start of the College's Autumn Quarter and are completed by the end of Autumn Quarter. More information on the course content and the application process can be found at www.mbl.edu/ses.

BIOS 27710. Ecology - Marine Biological Laboratory. 100 Units.

This course examines the structure and functioning of terrestrial and aquatic ecosystems including the application of basic principles of community and ecosystem ecology. The course also examines contemporary environmental problems such as the impacts of global and local environmental change on community composition and food webs within forest, grassland, marsh and nearshore coastal ecosystems on Cape Cod. This course examines the structure and functioning of terrestrial and aquatic ecosystems including the application of basic principles of community and ecosystem ecology. The course also examines contemporary environmental problems such as the impacts of global and local environmental change on community composition and food webs within forest, grassland, marsh and nearshore coastal ecosystems on Cape Cod.

Instructor(s): Marine Biological Laboratory Staff Terms Offered: Autumn. L.

Prerequisite(s): Consent only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA; concurrent registration in BIOS 27711 and BIOS 27712 along with one of BIOS 27713, BIOS 27714 or BIOS 27715.

Equivalent Course(s): ENSC 24100

BIOS 27711. Biogeochemical Analysis in Terrestrial and Aquatic Ecosystems # Marine Biological Laboratory. 100 Units.

This course examines the interface of biological processes with chemical processes in ecological systems. Course content emphasizes aquatic chemistry and the role of microbes in the cycling of nitrogen, carbon, and other elements. Effects of global changes on chemical cycling are emphasized.

Instructor(s): Marine Biological Laboratory Staff. Terms Offered: Autumn. L.

Prerequisite(s): Consent only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA; concurrent registration in BIOS 27710 and BIOS 27712 along with one of BIOS 27713, BIOS 27714 or BIOS 27715.

Equivalent Course(s): ENSC 23820

BIOS 27712. Independent Undergraduate Research in Environmental Sciences # Marine Biological Laboratory. 100 Units.

This course is the culmination of the Semester in Environmental Science at the Marine Biological Laboratory. An independent research project, on a topic in aquatic or terrestrial ecosystem ecology, is required. Students will participate in a seminar for scientific communication as well as submit a final paper on their project.

Instructor(s): Marine Biological Laboratory Staff Terms Offered: Autumn. L.

Prerequisite(s): Consent only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA; concurrent registration in BIOS 27710 and BIOS 27711 along with one of BIOS 27713, BIOS 27714 or BIOS 27715.

Equivalent Course(s): ENSC 29800

BIOS 27713. Quantitative Environmental Analyses # Marine Biological Laboratory. 100 Units.

This course emphasizes the application of quantitative methods to answering ecological questions. Students apply mathematical modeling approaches to simulating biological and chemical phenomena in terrestrial and marine ecosystems.

Instructor(s): Marine Biological Laboratory Staff Terms Offered: Autumn. L.

Prerequisite(s): Consent Only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA; concurrent registration in BIOS 27710, BIOS 27711 and BIOS 27712.

Equivalent Course(s): ENSC 28100

BIOS 27714. Methods in Microbial Ecology - Marine Biological Laboratory. 100 Units.

This course explores the biology of microbes found in the environment, including relationships with the physical, chemical, and biotic elements of their environment. Emphasis is placed on understanding the science underlying the various methodologies used in the study of these organisms and systems. In the laboratory, students will work with the latest techniques to measure microbial biomass, activity, extracellular enzymes, and biogeochemical processes. Students are also introduced to molecular methods for assessing microbial genomic diversity.

Instructor(s): Marine Biological Laboratory Staff Terms Offered: Autumn. L.

Prerequisite(s): Consent only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA; concurrent registration in BIOS 27710, BIOS 27711 and BIOS 27712.

Equivalent Course(s): ENSC 24200

BIOS 27715. Roles of Animals in Ecosystems # Marine Biological Laboratory. 100 Units.

This course addresses the question, How do animals, including man, affect the structure and function of ecosystems. The course takes an interdisciplinary approach focused on the interactions of animal diversity, migration patterns, population dynamics, and behavior with biogeochemical cycles, productivity, and transport of materials across ecosystems. This course is an elective option within the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA.

Instructor(s): Marine Biological Laboratory Staff Terms Offered: Autumn

Prerequisite(s): Consent only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA; concurrent registration in BIOS 27710, BIOS 27711, and BIOS 27712.

Equivalent Course(s): ENSC 24300

BIOS 27711. Biogeochemical Analysis in Terrestrial and Aquatic Ecosystems # Marine Biological Laboratory. 100 Units.

This course examines the interface of biological processes with chemical processes in ecological systems. Course content emphasizes aquatic chemistry and the role of microbes in the cycling of nitrogen, carbon, and other elements. Effects of global changes on chemical cycling are emphasized.

Instructor(s): Marine Biological Laboratory Staff Terms Offered: Autumn. L.

Prerequisite(s): Consent only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA; concurrent registration in BIOS 27710 and BIOS 27712 along with one of BIOS 27713, BIOS 27714 or BIOS 27715.

Equivalent Course(s): ENSC 23820

BIOS 27712. Independent Undergraduate Research in Environmental Sciences # Marine Biological Laboratory. 100 Units.

This course is the culmination of the Semester in Environmental Science at the Marine Biological Laboratory. An independent research project, on a topic in aquatic or terrestrial ecosystem ecology, is required. Students will participate in a seminar for scientific communication as well as submit a final paper on their project.

Instructor(s): Marine Biological Laboratory Staff Terms Offered: Autumn. L.

Prerequisite(s): Consent only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA; concurrent registration in BIOS 27710 and BIOS 27711 along with one of BIOS 27713, BIOS 27714 or BIOS 27715.

Equivalent Course(s): ENSC 29800

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This course emphasizes the application of quantitative methods to answering ecological questions. Students apply mathematical modeling approaches to simulating biological and chemical phenomena in terrestrial and marine ecosystems.

Instructor(s): Marine Biological Laboratory Staff Terms Offered: Autumn. L.

Prerequisite(s): Consent Only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA; concurrent registration in BIOS 27710, BIOS 27711 and BIOS 27712.

Equivalent Course(s): ENSC 28100

BIOS 27714. Methods in Microbial Ecology - Marine Biological Laboratory. 100 Units.

This course explores the biology of microbes found in the environment, including relationships with the physical, chemical, and biotic elements of their environment. Emphasis is placed on understanding the science underlying the various methodologies used in the study of these organisms and systems. In the laboratory, students will work with the latest techniques to measure microbial biomass, activity, extracellular enzymes, and biogeochemical processes. Students are also introduced to molecular methods for assessing microbial genomic diversity.

Instructor(s): Marine Biological Laboratory Staff Terms Offered: Autumn. L.

Prerequisite(s): Consent only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA; concurrent registration in BIOS 27710, BIOS 27711 and BIOS 27712.

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Instructor(s): Marine Biological Laboratory Staff Terms Offered: Autumn

Prerequisite(s): Consent only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA; concurrent registration in BIOS 27710, BIOS 27711, and BIOS 27712.

Equivalent Course(s): ENSC 24300

BIOS 27720. Microbiomes Across Environments. 100 Units.

Microbiomes Across Environments provides a comprehensive introduction to microbiome research, tools and approaches for investigation, and a lexicon for biological understanding of the role of microbial communities in environmental and host environments. Microbiome science is an emerging field that bridges disciplines, merging microbiology with genomics, ecosystem science, computation, biogeochemistry, modeling, medicine, surgery, immunology, molecular engineering, and many others, including architecture, social science, chemistry and even economics. In this course we will uncover the vast biochemical and metabolic diversity of the microbial world by examining life in ocean and marine systems, terrestrial ecosystems, and animal (including human) host-associated contexts. Students will develop or strengthen biological field/lab techniques, analyze and compare data prepared from student-collected samples, and will integrate fundamental knowledge, modeling, and theory as it pertains to microbiome research.

Instructor(s): J. Gilbert, D. Mark-Welch, M. Sogin, T. Flynn Terms Offered: Autumn. L. September 2018.

Note(s): This course will be given at Marine Biological Laboratory, Woods Hole, Massachusetts.

BIOS 27721. Observing Proteins in Action: How to Design and Build Your Own. 100 Units.

New insights into cell function are now possible using technologies that resolve single molecules. However, as devices become more complicated, we are often faced with three questions: What is it that our instruments actually measure; how can we change the instrument to see a new behavior; and, how do we analyze the data to get the greatest insight? We will learn how to answer these questions by designing, building, and using our own electrical and optical instruments, making measurements, and then analyzing the results. Membrane proteins play an essential role in the behavior of all cells. We will study membrane protein channels in synthetic membranes, host cells, and giant axons from squid collected in the waters surrounding the MBL. The movement of electrical charge produced by conformational changes will be correlated with both the current passing thru single channels and structural information obtained from light and electron microscopy. The course will proceed from simple measurements to student-designed projects.

Instructor(s): E. Schwartz, F. Bezanilla, E. Perozo Terms Offered: Autumn. L. September 2018.

Note(s): This course will be given at Marine Biological Laboratory, Woods Hole, Massachusetts

BIOS 27723. Biodiversity and Genomics: Exploring the Marine Animal Diversity of Woods Hole Using Molecular Tools. 100 Units.

In this course, student will have the opportunity to explore the large diversity of marine animal species in Woods Hole, Massachusetts and its surroundings. We will combine fieldwork with genomic and bioinformatic approaches to study different aspects of the evolution, ecology, taxonomy, physiology, and biogeography of marine animals in this unique location. Student will integrate knowledge and analytical tools from different biological disciplines to develop short research projects. During the three weeks of the course, student will have access to the Marine Biological Laboratory's collection of living marine animals, participate in ongoing research projects at MBL, and contribute data that will advance our understanding of marine biodiversity.

Instructor(s): O. Pineda-Catalan Terms Offered: Autumn. L. September 2018

Note(s): This course will be given at Marine Biological Laboratories, Woods Hole, Massachusetts.

BIOS 27810. Epidemiology and Population Health: Global Health Sciences I. 100 Units.

Epidemiology is the basic science of public health. It is the study of how diseases are distributed across populations and how one designs population-based studies to learn about disease causes, with the object of identifying preventive strategies. Epidemiology is a quantitative field and draws on biostatistical methods. Historically, epidemiology's roots were in the investigation of infectious disease outbreaks and epidemics. Since the mid-twentieth century, the scope of epidemiologic investigations has expanded to a fuller range non-infectious diseases and health problems. This course will introduce classic studies, study designs and analytic methods, with a focus on global health problems. Prerequisite(s): Completion of the first three quarters of a Biological Sciences Fundamentals Sequence or consent of the Master of BSCD, Laurens Mets (mets@uchicago.edu). STAT 220 or other introductory statistics highly desirable.

Instructor(s): D. Lauderdale. Terms Offered: Autumn, Winter. This course is offered Autumn Quarter every year on campus and Winter Quarter every other year in Paris as part of Study Abroad beginning Winter 2018.

Prerequisite(s): Completion of the three quarters of a Biological Sciences Fundamentals Sequence and completion of the quantitative requirements for the biological sciences major. STAT 22000 or other introductory statistics highly desirable.

BIOS 27811. Global Health Sciences II: Microbiology. 100 Units.

This course will examine infectious diseases with global health impact, analyzing their historic and projected impact, their biological foundations, treatment, and preventative control. Course topics include gastrointestinal infections (e.g., cholera, bacillary dysentery, typhoid fever, rotavirus infections), sexually transmitted diseases (HIV), infections transmitted via aerosol droplets (tuberculosis, meningitis), and vector borne diseases (e.g., malaria, typhus, dengue fever, plague). Special emphasis will be placed on emerging infectious diseases (Ebola, Lassa, Rift Valley fever) and either completed or ongoing studies for infectious disease elimination (smallpox, polio, diphtheria, river blindness). The course encompasses lectures, student presentations, and the preparation of a capstone essay.

Instructor(s): D. Missiakas, O. Schneewind Terms Offered: Winter. This course is offered on campus in alternate years beginning Winter Quarter 2017 and in Paris in alternate years beginning Winter Quarter 2018

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence, or consent of Instructor.

BIOS 28407. Genomics and Systems Biology. 100 Units.

This lecture course explores technologies for high-throughput collection of genomic-scale data, including sequencing, genotyping, gene expression profiling, and assays of copy number variation, protein expression and protein-protein interaction. In addition, the course will cover study design and statistical analysis of large data sets, as well as how data from different sources can be used to understand regulatory networks, i.e., systems. Statistical tools that will be introduced include linear models, likelihood-based inference, supervised and unsupervised learning techniques, methods for assessing quality of data, hidden Markov models, and controlling for false discovery rates in large data sets. Readings will be drawn from the primary literature. Evaluation will be based primarily on problem sets.

Instructor(s): Y. Gilad Terms Offered: Spring

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and STAT 23400 or BIOS 26210 and BIOS 26211

Equivalent Course(s): HGEN 47300, CABI 47300, BPHS 47300, IMMU 47300

Big Problems Courses

These courses may not be used towards the general education requirement in the Biological Sciences unless approved through petition to the BSCD Senior Advisers.

BIOS 02280. Drinking Alcohol: Social Problem or Normal Cultural Practice? 100 Units.

Alcohol is the most widely used psychoactive agent in the world, and, as archaeologists have recently demonstrated, it has a very long history dating back at least 9,000 years. This course will explore the issue of alcohol and drinking from a trans-disciplinary perspective. It will be co-taught by an anthropologist/archaeologist with experience in alcohol research and a neurobiologist who has experience with addiction research. Students will be confronted with literature on alcohol research from anthropology, sociology, history, biology, medicine, psychology, and public health and asked to think through the conflicts and contradictions. Selected case studies will be used to focus the discussion of broader theoretical concepts and competing perspectives introduced in the first part of the course. Topics for lectures and discussion include: What is alcohol? The early history of alcohol; Histories of drinking in ancient, medieval, and modern times; Alcohol and the political economy; Alcohol as a cultural artifact; Styles of drinking and intoxication; Alcohol, addiction, and social problems; Alcohol and religion; Alcohol and health benefits; Comparative case studies of drinking.

Instructor(s): M. Dietler, W. Green Terms Offered: Not offered in 2018-2019

Prerequisite(s): Third or fourth-year standing.

Note(s): This course does not meet requirements for the biological sciences major.

Equivalent Course(s): BPRO 22800, ANTH 25310

BIOS 02490. Biology and Sociology of AIDS. 100 Units.

This interdisciplinary course deals with current issues of the AIDS epidemic.

Instructor(s): H. Pollack, J. Schneider Terms Offered: Not offered in 2018-2019; May be offered in 2019-2020

Prerequisite(s): Third- or fourth-year standing

Note(s): This course does not meet requirements for the biological sciences major.

Equivalent Course(s): BPRO 24900, SSAD 65100

Specialized Courses

These courses may not be counted toward the courses required for the Biological Sciences major.

BIOS 29100. Biology of Toxoplasma. 100 Units.

This course is suitable for undergraduates with a good background in biology and molecular genetics. This course does not meet requirements for the biological sciences major. This course undertakes a study of *Toxoplasma gondii* and toxoplasmosis: a model system to study the cellular and molecular biology, biochemistry, and genetics of an obligate intracellular protozoan parasite; the immune responses it elicits; its interactions with host cells; and the pathogenesis of the diseases it causes. This information is also applied to consideration of public health measures for prevention of infection, for vaccines, and for development of new antimicrobial treatments. General principles applicable to the study of other microorganisms are emphasized.

Instructor(s): R. McLeod Terms Offered: Autumn, Spring

Prerequisite(s): Consent of instructor. This course does not meet the requirements for the Biological Sciences Major.

BIOS 29265. Evolution and Economics of Human Behavior. 100 Units.

This course explores how evolutionary biology and behavioral economics explain many different aspects of human behavior. Specific topics include evolutionary theory, natural and sexual selection, game theory, cost-benefit analyses of behavior from an evolutionary and a behavioral economics perspective, aggression, power and dominance, cooperation and competition, biological markets, parental investment, life history and risk-taking, love and mating, physical attractiveness and the market, emotion and motivation, sex and consumer behavior, cognitive biases in decision-making, and personality and psychopathology. Note(s): CHDV Distribution, A*; 1* Equivalent Course(s): CHDV 37950, PSYC 27950, PSYC 37950, BIOS 29265, ECON 14810

Instructor(s): D. Maestriperi Terms Offered: Winter

Note(s): CHDV Distribution, A

Equivalent Course(s): CHDV 27950, ECON 14810, PSYC 37950, PSYC 27950, CHDV 37950

BIOS 29271. The Psychology and Neurobiology of Stress. 100 Units.

This course explores the topic of stress and its influence on behavior and neurobiology. Specifically, the course will discuss how factors such as age, gender, and social context interact to influence how we respond to stressors both physiologically and behaviorally. The course will also explore how stress influences mental and physical health.

Instructor(s): G. Norman Terms Offered: Spring

Equivalent Course(s): PSYC 25750

BIOS 29294. Introduction to Global Health. 100 Units.

This course provides an overview of global health from the historical perspective to the current state of global health. The course features weekly guest lecturers with a broad range of expertise in the field: topics include the social and economic determinants of health, the economics of global health, global burden of disease, and globalization of health risks, as well as the importance of ethics, human rights, and diplomacy in promoting a healthier world. The course is designed for graduate-level students and senior undergraduates with an interest in global health work in resource-limited settings.

Instructor(s): C. Babcock, N. Fenny Terms Offered: Winter

Prerequisite(s): This course does not meet requirements for the Biological Sciences major

Equivalent Course(s): CCTS 43000, PBPL 29294

BIOS 29300. Biological Psychology. 100 Units.

What are the relations between mind and brain? How do brains regulate mental, behavioral, and hormonal processes; and how do these influence brain organization and activity? This course introduces the anatomy, physiology, and chemistry of the brain; their changes in response to the experiential and sociocultural environment; and their relation to perception, attention, behavioral action, motivation, and emotion.

Instructor(s): L. Kay, B. Prendergast Terms Offered: Winter

Prerequisite(s): Some background in biology and psychology.

Note(s): This course does not meet requirements for the Biological Sciences Major.

Equivalent Course(s): PSYC 20300, CHDV 20300

BIOS 29314. Medical Ethics: Central Topics. 100 Units.

Decisions about medical treatment, medical research, and medical policy often have profound moral implications. Taught by a philosopher, two physicians, and a medical lawyer, this course will examine such issues as paternalism, autonomy, assisted suicide, kidney markets, abortion, and research ethics.

Instructor(s): D. Brudney; Staff Terms Offered: TBD. May be offered in 2019-2020

Prerequisite(s): Third or fourth year standing. This course does not meet requirements for the Biological Sciences major.

Note(s): Undergrads enroll in section 01 and 02. Graduates enroll in section 03. For Philosophy majors: this course fulfills the practical philosophy (A) requirement.

Equivalent Course(s): BPRO 22612, PHIL 21609, PHIL 31609, HIPS 21609

BIOS 29323. Health Care and the Limits of State Action. 100 Units.

In a time of great human mobility and weakening state frontiers, epidemic disease is able to travel fast and far, mutate in response to treatment, and defy the institutions invented to keep it under control: quarantine, the cordon sanitaire, immunization, and the management of populations. Public health services in many countries find themselves at a loss in dealing with these outbreaks of disease, a deficiency to which NGOs emerge as a response (an imperfect one to be sure). Through a series of readings in anthropology, sociology, ethics, medicine, and political science, we will attempt to reach an understanding of this crisis of both epidemiological technique and state legitimacy, and to sketch out options.

Instructor(s): E. Lyon, H. Saussy Terms Offered: Not offered in 2018-2019; may be offered in 2019-2010

Prerequisite(s): Third- or fourth-year standing. This course does not meet requirements for the biological sciences major.

Equivalent Course(s): CMLT 28900, BPRO 28600, HMRT 28602

BIOS 29326. Introduction to Medical Physics and Medical Imaging. 100 Units.

This course covers the interaction of radiation with matter and the exploitation of such interactions for medical imaging and cancer treatment. Topics in medical imaging include X-ray imaging and radionuclide imaging, as well as advanced technologies that provide three-dimensional images, including X-ray computed tomography (CT), single photon emission computed tomography (SPECT), positron emission tomography (PET), magnetic resonance imaging (MRI), and ultrasonic imaging.

Instructor(s): S. Armato, P. La Riviere, C. Pelizzari Terms Offered: Spring

Prerequisite(s): PHYS 23500. This course does not meet requirements for the Biological Sciences major. Students majoring in physics may use this course either as an elective or as one of the topics courses to meet the general education requirement in the Biological Sciences.

Equivalent Course(s): MPHY 29326

BIOS 29327. Topics in Clinical Research. 100 Units.

This course provides an overview of clinical research subject matter from the history and ethics of clinical research to the types and practice of contemporary clinical research. How does clinical research differ from other research traditions? What is special about clinical research? What types of questions can be answered by clinical research (what questions not)? What types of ethical oversight over the responsible conduct of research have arisen over the years? We will learn how to read and critique clinical research, survey the major types of clinical research designs, and the differences between hypothesis generation and hypothesis testing. Finally, we provide an overview of the mechanics of developing and implementing clinical research, including grant writing, regulatory issues, and quality assurance. Along the way, we will be teaching core statistical concepts including prevalence, risk ratios, and sensitivity and validation techniques. The objectives are for students to obtain an understanding of how and why to perform clinical research and to do so in an ethical and responsible manner.

Instructor(s): Valerie Press Terms Offered: Spring. Last offered 2017

Prerequisite(s): Completed general education requirement in the social sciences. This course does not meet requirements for the Biological Sciences major.

Equivalent Course(s): CCTS 21003

BIOS 29812. Global Health Sciences III: Topics in Global Health. 100 Units.

This course will review the major factors that influence the health of individuals and communities worldwide and seek to gain a better understanding of the complexities of global health. Students will study both broad and disease-specific global health challenges (e.g., cancer, diabetes, and cardiopulmonary disease) and strategies for responding to them; key institutions and stakeholders; environmental impacts on health; ethical considerations in research and interventions; maternal and child health; health and human rights; and international legal frameworks within global health diplomacy. The course encompasses lectures, student presentations, and the preparation of a proposal addressing a significant global health problem with major impact.

Instructor(s): C. Olopade, O. Olopade Terms Offered: Spring Winter. This course is offered in alternate years on campus beginning Spring Quarter 2017 and in alternate years in Paris beginning Winter Quarter 2018.

Prerequisite(s): This course does not meet the requirements for the Biological Sciences major.

Independent Study and Research**BIOS 00199. Undergraduate Research. 100 Units.**

This course may be elected for up to three quarters. Before Friday of fifth week of the quarter in which they register, students must submit a one-page summary of the research that they are planning to their research sponsor and to the director of undergraduate research and honors. A detailed two to three page summary on the completed work must be submitted to the research sponsor and the Master of BSCD before Friday of examination week.

Instructor(s): BSCD Master Terms Offered: Autumn, Spring, Summer, Winter

Prerequisite(s): Consent of research sponsor and the Master of BSCD.

Note(s): Students are required to submit the College Reading and Research Course Form. This course is graded P/F. This course does not meet requirements for the biological sciences major.

BIOS 00206. Readings: Biology. 100 Units.

Students may register for only one BIOS 00206 tutorial per quarter. Enrollment must be completed by the end of the second week of the quarter. This tutorial offers individually designed readings.

Terms Offered: Summer, Autumn, Winter, Spring

Prerequisite(s): Consent of faculty sponsor

Note(s): Students are required to submit the College Reading and Research Course Form. This course is graded P/F. This course does not meet requirements for the biological sciences major.

BIOS 00296. Undergraduate Honors Research. 100 Units.

This course is required for students accepted into the BSCD Research Honors program. Students must register for this course both Autumn and Winter Quarters of their fourth year. This course can be counted toward the Biological Sciences major and may be counted among the three upper-level courses required for the BS. See also bscd.uchicago.edu/page/honors-biology. Quality grade. Prerequisite(s): Consent Only. Acceptance in BSCD Honors Research Program.

Instructor(s): S. Kron Terms Offered: Autumn, Winter

Prerequisite(s): Consent Only. Acceptance in BSCD Honors Research Program.

BIOS 00299. Advanced Research: Biological Sciences. 100 Units.

Before Friday of fifth week of the quarter in which they register, students must submit a one-page summary of the research that they are planning to their research sponsor and to the director of undergraduate research and honors. A detailed two to three page summary on the completed work must be submitted to the research sponsor and the Master of BSCD before Friday of examination week. This course does may be counted as a general elective but does not meet requirements for the Biological Sciences major. In the first quarter of registration, students must submit College Reading and Research form to their research sponsor and the director of undergraduate research and honors.

Instructor(s): BSCD Master Terms Offered: Autumn, Spring, Summer, Winter

Prerequisite(s): Fourth-year standing and consent of research sponsor and Master of BSCD.

Note(s): Students are required to submit the College Reading and Research Course Form. This course is graded P/F.

Graduate-Level Courses

Many graduate-level courses in the Division of the Biological Sciences are open to qualified College students. Students should consult their Advisers, the BSCD office, or the various departments and committees in the division to identify appropriate courses.



Font Notice

This document should contain certain fonts with restrictive licenses. For this draft, substitutions were made using less legally restrictive fonts. Specifically:

Times was used instead of Trajan.

Times was used instead of Palatino.

The editor may contact Leepfrog for a draft with the correct fonts in place.