Biological Sciences

Department Website: https://college.uchicago.edu/academics/biological-sciences-collegiate-division (https://college.uchicago.edu/academics/biological-sciences-collegiate-division/)

Program of Study

Biology is the study of life, past and present. Our curriculum offers courses in many fields, from theoretical to experimental biology, and from molecular and genetic mechanisms underlying life to the complex interactions of organisms in ecosystems. As a major research institution, the University of Chicago focuses all courses in the Biological Sciences Collegiate Division on scientific reasoning, research, and discovery. The goals of the Biological Sciences curriculum 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 and tools available for new discoveries. A major in Biological Sciences can prepare students for careers in a wide range of areas, including health professions, basic or applied research in academia or industry, education, and policy related to human, animal, and planetary health.

Students can choose from multiple tracks to complete the Major in Biological Sciences:

Biology Track (BA and BS): Majors in the Biology Track take a series of foundational courses that span biological knowledge across fields and scales. They may then explore the breadth of biology with free electives to complete the major OR they may specialize in one area of biology through a focused selection of electives. Specializations are listed below and will be recognized on student transcripts (e.g., Biological Sciences – Specialization: Immunology). Research opportunities (https://college.uchicago.edu/academics/bscd-undergraduate-research-opportunities/), internships (https://careeradvancement.uchicago.edu/careers-in/biological-sciences/), and courses at the Marine Biological Laboratory (https://college.uchicago.edu/academics/college-marine-biological-laboratory/) and Paris (https://study-abroad.uchicago.edu/paris-global-health/) campuses are available for students in this track. See bscd.uchicago.edu (https://bscd.uchicago.edu) for more information about research opportunities.

Paths through the Biology Track:

1. *Biological Sciences – No Specialization (free choice of BIOS electives)*
2. *Biological Sciences – Cancer Biology Specialization*
3. *Biological Sciences – Cellular and Molecular Biology Specialization*
4. *Biological Sciences – Developmental Biology Specialization*
5. *Biological Sciences – Endocrinology Specialization*
6. *Biological Sciences – Genetics Specialization*
7. *Biological Sciences – Immunology Specialization*
8. *Biological Sciences – Microbiology Specialization*

Interdisciplinary Biology Tracks (BA and BS): Increasingly, the biological sciences are incorporating knowledge and tools from physics, chemistry, computer science, statistics, public health, technological sciences, and the study of culture and society. Each Interdisciplinary Biology Track requires unique foundational courses that reflect these intersections. These tracks also allow students to choose electives from multiple departments to complete the major. Research opportunities (https://college.uchicago.edu/academics/bscd-undergraduate-research-opportunities/), internships, (https://careeradvancement.uchicago.edu/careers-in/biological-sciences/) and courses at the MBL (https://college.uchicago.edu/academics/college-marine-biological-laboratory/) and Paris (https://study-abroad.uchicago.edu/paris-global-health/)campuses are available for students in these tracks. Interdisciplinary tracks are available in the following areas and will be recognized on student transcripts (e.g., Biological Sciences – Interdisciplinary Focus: Global and Public Health). Specializations are not available within the Interdisciplinary Biology Tracks.

Interdisciplinary Biology Tracks:

1. *Biological Sciences – Ecology and Evolution*
2. *Biological Sciences – Global and Public Health*
3. *Biological Sciences – Computational Biology*

BA and BS Degrees and Honors

Several types of degrees can be earned in all tracks:

Bachelor of Arts (BA): The BA is designed for students who wish to gain extensive training in the field of biology but also retain the flexibility to take elective courses outside the major. Scientific research is required for some tracks, but a thesis is not required to obtain a BA (although a thesis is required for some specializations; see details below).

Bachelor of Science (BS): The BS is designed for students who wish to delve more deeply into the field of their major through additional electives and completion of a BS thesis. Successful BS students will (1) learn how scientists design and conduct scientific experiments; (2) collect data as part of a research effort; (3) evaluate the strengths and weaknesses of that data; (4) interpret the data in the context of a specific scientific discipline; and (5) describe their work in a BS Thesis.

Bachelor of Arts/Bachelor of Science with Research Honors (Research Honors): Biology Research Honors is reserved for students who excel in the coursework of the major and have completed original research of high quality suitable for inclusion in a professional publication. Successful Research Honors students will (1) gain a scholarly understanding of a specific area of biology; (2) conduct scientific experiments, collect original data, analyze that data using appropriate statistics, and evaluate the strengths and weaknesses of the data; (3) interpret their findings in the context of their field; (4) describe their work in an Honors Thesis; and (5) present and defend their work in an oral presentation.

Bachelor of Arts/Bachelor of Science with Scholar Honors (Scholar Honors): Scholar Honors recognizes exceptional academic performance including submission and acceptance of a scholarly thesis.

General Education Requirements for the Biological Sciences

Students in all tracks must take 200 units of Biological Sciences, 200 units of Mathematics, and 200 units of Chemistry from the selected list described below.

Biological Sciences General Education Courses

Students majoring in Biological Sciences choose one of the following options:

BIOS 20153	Fundamentals of Ecology and Evolutionary Biology	100
AND		
BIOS 20151	Introduction to Quantitative Modeling in Biology	100

OR

A qualifying score on the AP, IB, or A-Level Biology exam AND three quarters of the Advanced Biology Fundamentals Sequence (BIOS 20234-20236).

BIOS 20234	Molecular Biology of the Cell	100
BIOS 20235	Biological Systems	100
BIOS 20236	Biological Dynamics	100

Note: There are two additional options for completing the general education requirement for students who are NOT Biological Sciences majors:

1. A two-quarter general education sequence for non-majors (http://collegecatalog.uchicago.edu/thecollege/biologicalsciencescore/)

2. The Health Professions Preparation Sequence for Non-Majors (BIOS 20170 Microbial and Human Cell Biology and BIOS 20171 *Human Genetics and Developmental Biology)*

Mathematics General Education Courses

Students majoring in Biological Sciences choose one of the following options:

MATH 13100-13200	Elementary Functions and Calculus I-II	200
MATH 15100-15200	Calculus I-II	200
MATH 16100-16200	Honors Calculus I-II	200

Chemistry General Education Courses

Students majoring in Biological Sciences choose one of the following options:

CHEM 10100 & CHEM 10200	Introductory General Chemistry I and Introductory General Chemistry II	200
CHEM 11100-11200	Comprehensive General Chemistry I-II	200
CHEM 12100 & CHEM 12200	Honors General Chemistry I and Honors General Chemistry II	200

AP, IB, or A-Level Exam Credit

Upon enrollment in the College, students with select scores from the AP, IB, or A-Level exam (http://collegecatalog.uchicago.edu/thecollege/apibalevelexams/)s (http://collegecatalog.uchicago.edu/thecollege/biologicalsciencescore/#apibora-levelexamcredit) will be awarded credit for BIOS 10130 Principles of Biology. For students who do not plan to prepare for the health professions or pursue a major that requires specific courses for the general education requirement (http://collegecatalog.uchicago.edu/thecollege/biologicalsciencescore/#Specific%20Gen%20Ed%20Req), this credit will apply toward the general education sequence for non-Biological Science majors articulated above. These students should complete the general education requirement in the Biological Sciences with either one or two Topics courses for non-majors (http://collegecatalog.uchicago.edu/thecollege/biologicalsciencescore/#topicscoursesfornon-majors), depending on how the requirements in the mathematical and physical sciences are met; students should contact their academic adviser for details.

Students granted credit for BIOS 10130 due to their AP, IB, or A-Level exam scores have the option to enroll in the Advanced Biology Fundamentals Sequence. Students who complete the first three quarters of an Advanced Biology Fundamentals Sequence (BIOS 20234 Molecular Biology of the Cell through BIOS 20236 Biological Dynamics) will be awarded an additional 100 units to be counted toward the general education requirement in the biological sciences and three quarters of credit for Biological Sciences Fundamentals courses. This option is especially appropriate for students who plan to major in Biological Sciences and prepare for a career in research, but it is open to all qualified students including those planning a career in the health professions.

Bachelor of Arts Degree in Biological Sciences

All Tracks require students to take 1600 units.

The basic degree in Biological Sciences is the BA. Students can qualify for a BA by following one of several tracks:

1) **Biology Track** – Provides a comprehensive education in biology across scales, focusing on the research that leads to discovery. Students may explore the breadth of biological science or choose to specialize in a particular area.

2) **Interdisciplinary Track – Ecology and Evolution** – Provides an in-depth education in ecology and evolution through course work, field work, advanced statistical skills, and research. Coursework opportunities at the Marine Biological Laboratory (https://college.uchicago.edu/academics/college-marine-biological-laboratory/) are particularly suited for this track.

3) **Interdisciplinary Track – Global and Public Health** – Provides a cross-cutting education through coursework and research in the biology of disease, as well as economic and social factors influencing health outcomes worldwide. Coursework offered in Paris (https://study-abroad.uchicago.edu/paris-global-health/) is particularly suited for this track.

4) **Interdisciplinary Track – Computational Biology** – Provides an interdisciplinary education in biology and the design and use of computational tools that can be used to address biological questions.

To qualify for a BA in one of these tracks, students must satisfy the general education requirements in biology, chemistry, and mathematics as described above AND:

1) complete the required foundational courses, termed “Fundamentals Sequence,” for the track chosen;

2) complete the required physical and mathematical sciences courses for the track chosen;

3) complete appropriate upper-level electives for the track chosen.

Biology Track

Fundamentals Sequence Requirement

Students completing the major in the Biology Track will choose one of the following Fundamentals sequences:

1. **Fundamentals of Biological Science sequence**—begins in the Winter Quarter of the first year and is structured to provide students with a broad-based understanding of contemporary biology. Note that BIOS 20151 Introduction to Quantitative Modeling in Biology and BIOS 20153 Fundamentals of Ecology and Evolutionary Biology fulfill the general education requirement in biological sciences (http://collegecatalog.uchicago.edu/thecollege/biologicalsciencescore/) and are not counted towards the major.

BIOS 20151	Introduction to Quantitative Modeling in Biology *	100
BIOS 20153	Fundamentals of Ecology and Evolutionary Biology *	100
BIOS 20186	Fundamentals of Cell and Molecular Biology *#	100
BIOS 20187	Fundamentals of Genetics	100
BIOS 20188	Fundamentals of Physiology	100

BIOS 20189	Fundamentals of Developmental Biology	100
BIOS 20200	Introduction to Biochemistry	100

2. **Advanced Biology sequence**—begins in the Autumn Quarter of first year and requires a high level of preparedness in Biology as well as a deep interest in research. The sequence is open to students who have been granted credit for BIOS 10130 due to their AP, IB, or A-Level exam scores (http://collegecatalog.uchicago.edu/thecollege/biologicalsciencescore/#apibora-levelexamcredit) or otherwise been granted permission to enroll in the course sequence by consent.[+] Students seeking consent should contact Michael Glotzer (mglotzer@uchicago.edu).

BIOS 20234	Molecular Biology of the Cell	100
BIOS 20235	Biological Systems	100
BIOS 20236	Biological Dynamics	100
BIOS 20188	Fundamentals of Physiology	100
BIOS 20200	Introduction to Biochemistry	100

* BIOS 20151 and BIOS 20153 fulfill the general education requirement in the biological sciences. BIOS 20151 is typically taken simultaneously with BIOS 20186.

\# Non–Biological Sciences majors can take the Fundamentals of Biological Science sequence without BIOS 20151 unless they pursue a double major in Biological Sciences. Students opting not to take it should be aware that subsequent courses in the sequence expect competency in mathematical modeling of biological phenomena and basic coding in R.

\+ Students who complete the Advanced Biology sequence but do not have credit granted for BIOS 10130 Principles of Biology will need to take one additional course to fulfill the general education requirement in the Biological Sciences. Students should consult with the BSCD Senior Advisers (Megan McNulty, mmcnulty@uchicago.edu; Chris Andrews, candrews@uchicago.edu) to select an appropriate course.

After completion of three quarters of a Fundamentals Sequence, students begin taking upper-level elective courses in the biological sciences and may start a specialization.

Physical and Mathematical Sciences Requirement

Students completing the major in the Biology Track are required to take courses in mathematical and physical sciences as follows:

PHYSICAL SCIENCES. All of the following:		
CHEM 11300	Comprehensive General Chemistry III (or equivalent)	100
CHEM 22000 & CHEM 22100	Organic Chemistry I and Organic Chemistry II (or higher)	200
PHYS 12100-12200	General Physics I-II (or higher)	200
MATHEMATICAL SCIENCES. One of the following:		
BIOS 26210	Mathematical Methods for Biological Sciences I	100
PHYS 12300	General Physics III (or higher)	100
STAT 22000	Statistical Methods and Applications (or higher)	100

NOTE 1: The Biology Track does NOT require the third quarter of calculus. Students MUST take BIOS 20151 Introduction to Quantitative Modeling in Biology, and students in the Advanced Biology sequence MUST take BIOS 20236 Biological Dynamics. NO Mathematics courses may be substituted for these requirements.

NOTE 2: Students planning to apply to medical school or other schools in the health professions should be aware of individual medical school admissions requirements and should tailor their program accordingly with the help of UChicago Careers in Healthcare (https://careeradvancement.uchicago.edu/careers-in/healthcare/).

Upper-Level Elective Requirements

Students completing the major in the Biology Track must take five upper-level courses (course numbers BIOS 21000 to 28999) to complete the Bachelor of Arts degree. These courses may be selected by the student or in consultation with the BSCD Senior Advisers (Megan McNulty, mmcnulty@uchicago.edu; Chris Andrews, candrews@uchicago.edu).

If the student following the Biology Track chooses to focus their coursework in a specific area, they can complete a specialization. In this case, 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 degree.

Summary of Requirements for a BA in Biological Sciences: Biology Track

CHEM 11300	Comprehensive General Chemistry III (or equivalent)	100
CHEM 22000 & CHEM 22100	Organic Chemistry I and Organic Chemistry II (or higher)	200
PHYS 12100-12200	General Physics I-II (or higher)	200
One of the following general quantitative courses:		100
BIOS 26210	Mathematical Methods for Biological Sciences I	
PHYS 12300	General Physics III (or higher)	
STAT 22000	Statistical Methods and Applications (or higher)	
Fundamentals of Biological Science Sequence or Advanced Biology Sequence		500
Five upper-level electives in Biological Sciences, BIOS 21000-28999		500
Total Units		1600

Specialization Programs in the Biological Sciences

Specializations represent recommended programs of study for students interested in one particular field within 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 toward a specialization. Electives taken for a specialization count towards the upper-level electives (BIOS 21000-28999) required for a BA or BS (unless otherwise noted).

- Specialization in Cancer Biology
- Specialization in Cellular and Molecular Biology
- Specialization in Developmental Biology
- Specialization in Endocrinology
- Specialization in Genetics
- Specialization in Immunology
- Specialization in Microbiology

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 one of the Fundamentals Sequences.

Students who plan to specialize in cancer biology are advised to begin the required specialization courses in their second or third year in the College. Students who elect to specialize should email the Director of the Specialization, Dr. Kay F. Macleod (kmacleod@uchicago.edu), providing the details outlinedhere.

Course Work. *The following courses are required for a Specialization in Cancer Biology. To continue in the specialization, students must achieve an A or a 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 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 and Other Cancers	100
BIOS 25329	Tissue Immunity and Cancer	100
BIOS 25426	From Diagnostics to Therapy: The Application of Translational Research in Cancer	100

Laboratory Research and Thesis Requirement:

To complete the Specialization in Cancer Biology, students will also carry out individual guided research in a cancer research laboratory and are also encouraged to attend cancer biology–related seminars. Independent research projects performed by students in the Specialization in Cancer Biology must be of sufficiently high standard to qualify as a senior honors project and ideally to produce data that contributes to peer-reviewed publication. Participation in the research component of the Specialization in Cancer Biology requires the student to identify a research project and mentor, participate in an original research project for at least one year, and submit a research thesis. This project must be approved by the director of the specialization, no later than Spring Quarter of the third year.

The completed thesis must be reviewed and approved first by the student's faculty research mentor and then by an expert faculty thesis committee, selected by the student. If the thesis will be counted toward the requirements for the BS or Honors in Biological Sciences, it must also be approved by the directors of those programs. More detailed information can be found on the Cancer SpecializationPage. For questions, contact Dr. Kay F. Macleod (kmacleod@uchicago.edu).

Specialization in Cellular and Molecular Biology

Biological Sciences majors can complete the Specialization in Cellular and Molecular Biology by either:

1. Successful completion of CHEM 22200 Organic Chemistry III or CHEM 23200 Honors Organic Chemistry III plus four upper-level BIOS courses selected from the list below.

NOTE: The third quarter of organic chemistry is required for the specialization but does not count towards the major.

OR

2. Successful completion of CHEM 22200 Organic Chemistry III or CHEM 23200 Honors Organic Chemistry III plus three upper-level BIOS courses selected from the list below and completion of a senior thesis on an independent research project. This project must be approved by the directors of the specialization no later than Spring Quarter of the third year. If the thesis will be counted toward the requirements for the BS or Honors in Biological Sciences, it must also be approved by the directors of those programs.

Please consult Chris Andrews (candrews@uchicago.edu) or Megan McNulty (mmcnulty@uchicago.edu) for approval of research projects or to request approval for any non-listed course with significant content in cellular and molecular biology.

Courses

BIOS 21236	Genetics of Model Organisms	100
BIOS 21237	Developmental Mechanisms *	100
BIOS 21238	Cell Biology II	100
BIOS 21360	Advanced Molecular Biology	100
BIOS 21416	Stem Cells and Regeneration	100
BIOS 21510	Chromatin & Epigenetics	100
BIOS 23299	Plant Development and Molecular Genetics *	100
BIOS 25226	Endocrinology I: Cell Signaling	100
BIOS 25266	Molecular Immunology	100
BIOS 27750	Stem Cells and Regeneration: from aquatic research organisms to mammals	100

* Students may choose only one of these courses: BIOS 21237 Developmental Mechanisms or BIOS 23299 Plant Development and Molecular Genetics.

Specialization in Developmental Biology

Students majoring in Biological Sciences who complete the requirements detailed below will be recognized as having completed a Specialization in Developmental Biology.

The following requirements must be met:

1. Successful completion of BIOS 20189 Fundamentals of Developmental Biology or BIOS 20236 Biological Dynamics plus five upper-level courses selected from the list below.

OR

2. Successful completion of BIOS 20189 Fundamentals of Developmental Biology or BIOS 20236 Biological Dynamics plus three upper-level courses selected from the list below and completion of a senior thesis on an independent research project. This project must be approved by the director of the specialization no later than Spring Quarter of the third year. If the thesis will be counted toward the requirements for the BS or Honors in Biological Sciences, it must also be approved by the directors of those programs.

Please consult Victoria Prince (vprince@uchicago.edu) for approval of research projects or to request approval for any non-listed course with significant content in developmental biology.

Courses

Three of the following (with research thesis) or five of the following (without research thesis):

BIOS 20198	Biodiversity	100
BIOS 21236	Genetics of Model Organisms	100
BIOS 21237	Developmental Mechanisms	100

BIOS 21415	Stem Cells in Development and Diseases	100
BIOS 21416	Stem Cells and Regeneration	100
BIOS 21507	Stem Cell Biology, Regeneration, and Disease Modeling	100
BIOS 21510	Chromatin & Epigenetics	100
BIOS 22250	Chordates: Evolution and Comparative Anatomy	100
BIOS 22306	Evolution and Development	100
BIOS 23299	Plant Development and Molecular Genetics	100
BIOS 27724	Introduction to Imaging for Biological Research	100
BIOS 27750	Stem Cells and Regeneration: from aquatic research organisms to mammals	100
BIOS 27761	Embryology	100
NSCI 22300	Molecular Principles of Nervous System Development	100

Specialization in Endocrinology

Students majoring in Biological Sciences who complete the requirements detailed below 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 must take three introductory courses listed below plus two additional courses from the elective list. 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 introductory courses can be completed as Endocrinology I–II-III or Endocrinology II-III-I.

Introductory Courses

BIOS 25226	Endocrinology I: Cell Signaling	100
BIOS 25227	Endocrinology II: Systems and Physiology	100
BIOS 25228	Endocrinology III: Human Disease	100

Elective Courses

BIOS 23249	Animal Behavior	100
BIOS 24140	Neuropharmacology	100
BIOS 24248	Biological Clocks and Behavior	100
BIOS 25108	Cancer Biology	100
BIOS 27720	Microbiomes Across Environments	100
BIOS 27810	Epidemiology and Population Health	100
BIOS 25126	Animal Models of Human Disease	100

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

Specialization in Genetics

Students majoring in Biological Sciences who complete the requirements below will be recognized as having completed a Specialization in Genetics.

Students must successfully complete a Fundamentals Sequence for Biological Sciences majors and STAT 22000 Statistical Methods and Applications (or higher).

Students must take BIOS 21236 Genetics of Model Organisms and either:

1. Four additional courses from the categories listed below, including at least one from each category.

OR

2. Complete two courses chosen from the categories listed below, including one course in each category, and complete a senior thesis or an independent research project. This project must be approved by the directors of the specialization no later than Spring Quarter of the third year. If the thesis will be counted toward the requirements for the BS or Honors in Biological Sciences, it must also be approved by the directors of those programs.

Please consult Chris Andrews (candrews@uchicago.edu) or Megan McNulty (mmcnulty@uchicago.edu) for approval of research projects or to request approval for any non-listed course with significant genetics content.

One of the following:		
BIOS 21306	Human Genetics and Evolution	100
BIOS 21216	Introduction to Statistical Genetics	100

BIOS 22306	Evolution and Development	100
BIOS 25328	Cancer Genetics and Genomics	100
One of the following:		
BIOS 21229	Genome Informatics: How Cells Reorganize Genomes	100
BIOS 21237	Developmental Mechanisms	100
BIOS 21360	Advanced Molecular Biology	100
BIOS 21510	Chromatin & Epigenetics	100
BIOS 23299	Plant Development and Molecular Genetics	100
BIOS 25216	Molecular Basis of Bacterial Disease	100
BIOS 25287	Introduction to Virology	100
BIOS 28407	Genomics and Systems Biology	100

Please consult Megan McNulty (mmcnulty@uchicago.edu) or Chris Andrews (candrews@uchicago.edu) for more information.

Specialization in Immunology

Students majoring in Biological Sciences will be recognized as having completed a Specialization in Immunology if they complete the following: (1) three of the courses listed below, and (2) either two additional elective courses or a research project approved by the director of the specialization. "Core" immunology courses may also be chosen as further electives. Electives other than those listed below need to be approved by the Director of the Specialization, Daria Esterhazy (desterhazy@bsd.uchicago.edu).

BIOS 25256	Immunobiology	100
BIOS 25258	Immunopathology	100
One of the following: *		
BIOS 25260	Host Pathogen Interactions	100
BIOS 25266	Molecular Immunology	100
BIOS 25268	Barrier Immunity (offered during odd years)	100
BIOS 25329	Tissue Immunity and Cancer	100
BIOS 26403	Quantitative Immunobiology	100
Elective Courses:		
BIOS 21507	Stem Cell Biology, Regeneration, and Disease Modeling	100
BIOS 21510	Chromatin & Epigenetics	100
BIOS 23410	Complex Interactions: Coevolution, Parasites, Mutualists, and Cheaters	100
BIOS 23413	Quantitative Microbial Ecology	100
BIOS 25126	Animal Models of Human Disease	100
BIOS 25206	Fundamentals of Bacteriology	100
BIOS 25207	Fundamentals and Applications of the Human Microbiota	100
BIOS 25216	Molecular Basis of Bacterial Disease	100
BIOS 25260	Host Pathogen Interactions	100
BIOS 25287	Introduction to Virology	100
BIOS 25326	Tumor Microenvironment and Metastasis	100
BIOS 26120	An Introduction to Bioinformatics and Proteomics	100
BIOS 26121	Introduction to Transcriptomics	100
BIOS 26318	Fundamentals of Biological Data Analysis	100
BIOS 27714	Methods in Microbial Ecology - Marine Biological Laboratory	100
BIOS 27720	Microbiomes Across Environments	100
BIOS 27724	Introduction to Imaging for Biological Research	100
BIOS 27810	Epidemiology and Population Health	100
BIOS 27815	Infectious Diseases	100
BIOS 28407	Genomics and Systems Biology	100

* These courses may also be taken as electives.

For more information, including advice on focuses within immunology (e.g., genetics/genomics, evolution/development, tumor immunology, host-microbiome/pathogen interface, human immunology), students should consult with the Director of the Specialization, Daria Esterhazy (desterhazy@bsd.uchicago.edu). Note: If you intend to study abroad in Autumn Quarter of your 3rd year, please reach out to Dr. Esterhazy by May 1 of your 2nd year at the latest to discuss your options.

Specialization in Microbiology

Students majoring in Biological Sciences who complete the requirements detailed below will be recognized as having completed a Specialization in Microbiology. Students must take the three courses listed below and either two additional courses or a research project. This project must be approved by the director of the specialization no later than Spring Quarter of the third year. If the thesis will be counted toward the requirements for the BS or Honors in Biological Sciences, it must also be approved by the directors of those programs. With prior approval from the director of the specialization, students may substitute a required course with an elective.

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://micro.uchicago.edu/page/events-2/).

For additional information, please contact the director of the specialization, Tatyana Golovkina (tgolovki@uchicago.edu).

REQUIRED COURSES

BIOS 25206	Fundamentals of Bacteriology	100
BIOS 25216	Molecular Basis of Bacterial Disease	100
BIOS 25287	Introduction to Virology	100
Total Units		300

ELECTIVE COURSES

Two of the following:		
BIOS 25207	Fundamentals and Applications of the Human Microbiota	100
BIOS 25256	Immunobiology	100
BIOS 25260	Host Pathogen Interactions	100
GEOS 26650	Environmental Microbiology (Autumn)	100
BIOS 27720	Microbiomes Across Environments	100
CHEM 22200	Organic Chemistry III *	100

* CHEM 22200 does not count as a course in the major, even if taken to satisfy specialization requirements.

Interdisciplinary Biology Tracks

Ecology and Evolution Track

Fundamentals Sequence Requirement

Students completing the Biological Sciences major in the Ecology and Evolution Track must choose one of the following Fundamentals sequences:

1. **Fundamentals of Ecology and Evolution sequence**—begins in the Winter Quarter of the first year and is structured to provide students with a foundation for interdisciplinary study in this field. Note that BIOS 20151 Introduction to Quantitative Modeling in Biology and BIOS 20153 Fundamentals of Ecology and Evolutionary Biology fulfill the general education requirement in biological sciences and are not counted towards the major.

BIOS 20151	Introduction to Quantitative Modeling in Biology #	100
BIOS 20153	Fundamentals of Ecology and Evolutionary Biology #	100
BIOS 20186	Fundamentals of Cell and Molecular Biology	100
BIOS 20187	Fundamentals of Genetics	100
BIOS 20198	Biodiversity *#	100

\# BIOS 20151 and BIOS 20153 fulfill the general education requirement in the biological sciences. BIOS 20151 is typically taken simultaneously with BIOS 20186.

*# BIOS 20198 Biodiversity is offered both in Chicago and at MBL in the Spring Quarter at MBL program (https://college.uchicago.edu/academics/mbl-spring-quarter-biology/).

OR

2. Advanced Fundamentals of Ecology and Evolution sequence—begins in the Autumn Quarter of first year and requires a high level of preparedness in Biology as well as a deep interest in research. The sequence is open to students who have been granted credit for BIOS 10130 due to their AP, IB, or A-Level exam scores (http://collegecatalog.uchicago.edu/thecollege/biologicalsciencescore/#apibora-levelexamcredit) or otherwise been granted permission to enroll in the course sequence by consent.[+] Students seeking consent should contact Michael Glotzer (mglotzer@uchicago.edu).

BIOS 20234	Molecular Biology of the Cell	100
BIOS 20235	Biological Systems	100
BIOS 20236	Biological Dynamics	100
BIOS 20198	Biodiversity	100

+ Students who complete the Advanced Biology sequence but do not have credit granted for BIOS 10130 Principles of Biology will need to take one additional course to fulfill the general education requirement in the Biological Sciences. Students should consult with the BSCD Senior Advisers (Megan McNulty, mmcnulty@uchicago.edu; Chris Andrews, candrews@uchicago.edu) to select an appropriate course.

Field Ecology Requirement

In addition, students following either the Fundamentals of Ecology and Evolution sequence or the Advanced Biology Ecology and Evolution Fundamentals sequence must complete the sequence with one of the following field ecology courses:

BIOS 20196	Ecology and Conservation	100
BIOS 27710	Ecology - Marine Biological Laboratory (offered in the Semester in Environmental Science program at MBL) *	100
BIOS 27716	Methods and Concepts in Oceanography- at Marine Biological Laboratory (offered in the Semester in Environmental Science program at MBL) *	100
BIOS 27723	Biodiversity and Genomics: Exploring the Marine Animal Diversity of Woods Hole Using Molecular Tools (offered in the September Term at MBL) *	100
BIOS 27725	Biogeography and Distribution of Species	100
BIOS 27726	Marine Ecosystems: From Microbiomes, to Conservation, Climate & Beyond (offered in the September Term at MBL) *	100
BIOS 27727	Light and Color in the Ocean (offered in the September Term at MBL) *	100

* More information on the experiences and opportunities at MBL can be found on the College's MBL page. (https://college.uchicago.edu/academics/college-marine-biological-laboratory/)

Physical and Mathematical Sciences Requirement

Students completing the Biological Sciences major in the Ecology and Evolution track must take:

CHEM 11300	Comprehensive General Chemistry III (or equivalent)	100
STAT 22000	Statistical Methods and Applications	100
One of the following:		
CHEM 22000 & CHEM 22100	Organic Chemistry I and Organic Chemistry II (or higher)	200
PHYS 12100-12200	General Physics I-II (or higher)	200
Three additional quantitative courses *		300

*Students can satisfy this requirement with quantitative upper-level BIOS courses or courses from other departments (e.g., MATH, PHYS, STAT, GISC, DATA or CMSC). Biological Sciences majors pursuing this track should confirm their quantitative course selections with Senior Biology Advisor Chris Andrews (candrews@uchicago.edu).

NOTE 1: The Ecology and Evolution Track does NOT require the third quarter of calculus. Students MUST take BIOS 20151 Introduction to Quantitative Modeling in Biology, and students in the Advanced Biology sequence MUST take BIOS 20236 Biological Dynamics. NO Mathematics courses may be substituted for these requirements.

NOTE 2: Students planning to apply to medical school or other school in the health professions should be aware of individual school admissions requirements and should tailor their program accordingly with the help of UChicago Careers in Healthcare (https://careeradvancement.uchicago.edu/careers-in/healthcare/).

Upper-Level Elective Requirements

Students completing the Biological Sciences major in the Ecology and Evolution Track must take **five upper-level courses** (BIOS 21000 to 28999) after the **Fundamentals of Ecology and Evolution sequence** to complete the Bachelor of Arts degree; three of these electives must be in the area of ecology, evolution, genetics, or behavior (notated with an E after the course title in the catalog).

Four upper-level electives are required for students who have completed the ***Advanced Biology Ecology and Evolution Fundamentals sequence****; three of these electives must be in the area of ecology, evolution, genetics or behavior (notated with an E after the course title in the catalog).*

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 degree.

Additional Requirements: Completion of the major through this track requires one quarter of independent field or research work in the area of Ecology and Evolution. Approval of the Ecology and Evolution Track Directors Cathy Pfister (cpfister@uchicago.edu) and Chris Andrews (candrews@uchicago.edu) is required.

Research opportunities of particular interest to students in this track can be found on the Interdisciplinary Biology Ecology and Evolution page. (https://college.uchicago.edu/academics/interdisciplinary-biology-track-ecology-and-evolution/)

Summary of Requirements: Ecology and Evolution Track

CHEM 11300	Comprehensive General Chemistry III (or equivalent)	100
STAT 22000	Statistical Methods and Applications (or higher)	100
One of the following:		200
CHEM 22000 & CHEM 22100	Organic Chemistry I and Organic Chemistry II (or higher)	
PHYS 12100-12200	General Physics I-II (or higher)	
Three additional quantitative courses *		300
Fundamentals of Ecology and Evolution Sequence or Advanced Biology Ecology and Evolution Sequence +		300
Field Ecology Course		100
Five courses, BIOS 21000-28999 in Biological Sciences (at least 3 notated E) +		500
One quarter of approved research		
Total Units		1600

* Students can satisfy this requirement with quantitative upper-level BIOS courses or courses from other departments (e.g., MATH, PHYS, STAT, GISC, DATA or CMSC). Biological Sciences majors pursuing this track should confirm their quantitative course selections with Senior Biology Advisor Chris Andrews (candrews@uchicago.edu).

\+ Students completing the Advanced Biology Sequence take four additional upper-level electives, at least three notated E.

For further questions about this track please contact Ecology and Evolution Track Directors Cathy Pfister (cpfister@uchicago.edu) and Chris Andrews (candrews@uchicago.edu).

Global and Public Health Track

Fundamentals Sequence Requirement

Students completing the Biological Sciences major in the Global and Public Health Track must choose one of the following Fundamentals sequences:

1. Fundamentals of Global and Public Health sequence—begins in the Winter Quarter of the first year and is structured to provide students with a foundation for interdisciplinary study in this field. Note that BIOS 20151 Introduction to Quantitative Modeling in Biology and BIOS 20153 Fundamentals of Ecology and Evolutionary Biology fulfill the general education requirement in the biological sciences and are not counted towards the major.

BIOS 20151	Introduction to Quantitative Modeling in Biology *#	100
BIOS 20153	Fundamentals of Ecology and Evolutionary Biology *#	100
BIOS 20186	Fundamentals of Cell and Molecular Biology	100
BIOS 20187	Fundamentals of Genetics	100
BIOS 20188	Fundamentals of Physiology	100
BIOS 27810	Epidemiology and Population Health **	100

*# BIOS 20151 and BIOS 20153 fulfill the general education requirement in the biological sciences. BIOS 20151 is typically taken simultaneously with BIOS 20186.

OR

2. Advanced Biology Global and Public Health Fundamentals sequence— begins in the Autumn Quarter of first year and requires a high level of preparedness in Biology as well as a deep interest in research. The sequence is open to students who have been granted credit for BIOS 10130 due to their AP, IB, or A-Level exam scores (http://collegecatalog.uchicago.edu/thecollege/biologicalsciencescore/#apibora-levelexamcredit) or otherwise been granted permission to enroll in the course sequence by consent.+ Students seeking consent should contact Michael Glotzer (mglotzer@uchicago.edu).

BIOS 20234	Molecular Biology of the Cell	100
BIOS 20235	Biological Systems	100
BIOS 20236	Biological Dynamics	100
BIOS 20188	Fundamentals of Physiology	100
BIOS 27810	Epidemiology and Population Health **	100

* Students who complete the Advanced Biology sequence but do not have credit granted for BIOS 10130 Principles of Biology will need to take one additional course to fulfill the general education requirement in the Biological Sciences. Students should consult with the BSCD Senior Advisers (Megan McNulty, mmcnulty@uchicago.edu; Chris Andrews, candrews@uchicago.edu) to select an appropriate course.

In addition, students following either the Fundamentals of Global and Public Health Sequence or the Advanced Biology Global and Public Health Sequence must complete the sequence with the following courses:

The Chicago series of foundational courses in Global and Public Health:

BIOS 25216	Molecular Basis of Bacterial Disease	100
or BIOS 25287	Introduction to Virology	
HLTH 17000	Introduction to Health and Society	100

OR

The Paris series of foundational courses in Global and Public Health (offered during Winter Quarter)†:

BIOS 27815	Infectious Diseases	100
BIOS 29814	Biological and Social Determinants of Health	100
SSAD 25006	Global Health Initiatives: An Interdisciplinary Approach	100

** BIOS 27810 should be taken before the Paris series

† More information on the Global Health in Paris Program can be found on the Study Abroad page for Paris: Global Health (https://study-abroad.uchicago.edu/paris-global-health/).
Note: BIOS 27815 and BIOS 29814 will complete the foundational course requirements in this track, and the final course in the Paris Quarter, SSAD 25006, will count as one upper-level non-BIOS elective.

Physical and Mathematical Sciences Requirement

Students pursuing the major in the Global and Public Health Track will complete the following:

CHEM 11300	Comprehensive General Chemistry III	100
One of the following quantitative courses:		
BIOS 26210	Mathematical Methods for Biological Sciences I	100
PHYS 12300	General Physics III (or higher)	100
STAT 22000	Statistical Methods and Applications (or higher)	100

NOTE 1: The third quarter of Calculus is NOT required for the Global and Public Health Track. Students MUST take BIOS 20151 Introduction to Quantitative Modeling in Biology and students in the Advanced Biology sequence MUST take BIOS 20236 Biological Dynamics. NO Mathematics courses may be substituted for these requirements.

NOTE 2: Students planning to apply to medical school or other schools in the health professions should be aware of individual school admissions requirements and should tailor their program accordingly with the help of UChicago Careers in Healthcare (https://careeradvancement.uchicago.edu/uchicago-careers-in/health-professions/).

Upper-Level Elective Requirements

Students completing the major in the Global and Public Health Track must take **eight upper-level electives** distributed as follows: **Four** upper-level BIOS courses (BIOS 21000 to 28999) and **four courses from the approved non-BIOS course list** (see list below). **Two of the BIOS electives must be in the area of global and public health** (notated with a GP after the course title in the catalog).

Students who have completed the Advanced Biology Global and Public Health sequence must take ***three BIOS upper-level electives*****,** ***two of which must be in the area of global and public health*** *(notated with a GP after the course title in the catalog)* ***in addition to four courses from the approved non-BIOS course list*** *(see below)*

Note: Students in this track can use BIOS 20200 Introduction to Biochemistry as one of the GP BIOS upper-level electives and CHEM 22000 Organic Chemistry I as one of the non-BIOS upper-level electives.

Non-BIOS upper-level electives:

ANTH 21420	Ethnographic Methods	100
ANTH 25215	Human Rights: An Anthropological Perspective	100
BPRO 22800	Drinking Alcohol: Social Problem or Normal Cultural Practice?	100
BUSN 42300	Global Health and Social Policy	100
CCTS 21009	Justice, Solidarity, and Global Health	100
CCTS 22006	Decision Modeling for Health Economic Evaluation	100
CEGU 21720	Climate Change and Human Health	100
CEGU 22100	Disease, Health, and the Environment in Global Context	100
CHDV 21000	Cultural Psychology	100
CHEM 22000	Organic Chemistry I	100
ECON 11850	Behavioral Economics and Welfare Analysis	100
ECON 17700	Introduction to Health Economics	100
ENGL 10620	Literature, Medicine, and Embodiment	100
FREN 28888	Mosquitos and Morphine: A Seminar in the Global Medical Humanities	100
GLST 23101	Global Studies I	100
GLST 25701	Anthropology of Borders	100
HIST 27810	Histories of Abortion and Forced Sterilization in the United States	100
HLTH 22133	Consent in American Life	100
HLTH 22700	Abortion: Morality, Politics, Philosophy	100
HMRT 24823	International Human Rights Law and Practice	100
HLTH 25600	Money, Medicine, and Markets: The Financialization of the US Health System	100
HLTH 27450	Social Inequalities in Health: Race/Ethnicity & Class	100
HLTH 28010	Economic Analysis of Health Policies	100
HMRT 21006	International Human Rights Law	100
HMRT 21400	Health and Human Rights	100
LACS 25132	Covid-19 and other epidemics in Latin American History	100
PBHS 22710	Environmental Health	100
PBHS 23700	Sexual Health	100
PBHS 24700	Community Health Promotion	100
PBHS 31831	Genetic & Molecular Epidemiology	100
PBPL 21011	Clinical Research Design and Interpretation of Health Data	100
PBPL 25500	Introduction to U.S. Health Policy and Politics	100
PBPL 25510	Evidence in Health Policy	100
PBPL 26260	Environmental Justice in Principle and Practice I	100
PBPL 27000	International Economics	100
PBPL 27905	Global Health Metrics	100
PBPL 28925	Health Impacts of Transportation Policies	100
PHIL 21609	Topics in Medical Ethics	100
PPHA 47400	Patriarchy and Public Policy	100
PSYC 20600	Social Psychology	100
PSYC 25750	The Psychology and Neurobiology of Stress	100
PSYC 28791	Behavioral Science and Public Policy	100
SSAD 21300	Global Mental Health	100
SSAD 25006	Global Health Initiatives: An Interdisciplinary Approach	100
SOCI 20558	Digital Ethnography	100
SOCI 20582	Death & Dying	100

Additional Requirements: One quarter of independent field or research work in the area of Global and Public Health (approval of the Track Director Kathleen Beavis is required kbeavis@bsd.uchicago.edu (kbeavis@uchicago.edu)).

Research opportunities of particular interest to students in this track can be found on the Interdisciplinary Biology Track Global and Public Health page. (https://college.uchicago.edu/academics/interdisciplinary-biology-track-global-and-public-health/)

Summary of Requirements: Global and Public Health Track

CHEM 11300	Comprehensive General Chemistry III	100
One of the following quantitative courses:		100
STAT 22000	Statistical Methods and Applications (or higher)	
BIOS 26210	Mathematical Methods for Biological Sciences I	
PHYS 12300	General Physics III (or above)	
Global and Public Health Fundamentals Sequence or Advanced Biology Global and Public Health Fundamentals Sequence		600
Four upper-level electives in Biological Sciences, BIOS 21000-28999 (at least two annotated GP) +		400
Four upper-level non-BIOS electives in Global and Public Health		400
One quarter of approved research		
Total Units		1600

\+ Students completing the Advanced Biology Global and Public Health Sequence take three BIOS upper-level electives, at least two notated GP.

Honors for the Global and Public Health Track

Students wishing to complete an honors thesis should see Honors. When appropriate for their research topic and methods, students in this track may instead enroll in SOCI 29998 Sociology BA Thesis Seminar with approval.

For questions about this track, please contact Global and Public Health Track Director Kathleen Beavis (kbeavis@bsd.uchicago.edu) or the Senior Biology Advisors (https://college.uchicago.edu/academics/biological-sciences-collegiate-division/).

Computational Biology Track

Fundamentals Sequence Requirement

Students completing the Biological Sciences major in the Computational Biology Track must choose one of the following Fundamentals sequences:

1. Fundamentals of Computational Biology sequence—begins in the Winter Quarter of the first year and is structured to provide students with a foundation for interdisciplinary study in this field. Note that BIOS 20151 Introduction to Quantitative Modeling in Biology and BIOS 20153 Fundamentals of Ecology and Evolutionary Biology fulfill the general education requirement in the biological sciences and are not counted towards the major.

BIOS 20151	Introduction to Quantitative Modeling in Biology *#	100
BIOS 20153	Fundamentals of Ecology and Evolutionary Biology *#	100
BIOS 20186	Fundamentals of Cell and Molecular Biology	100
BIOS 20187	Fundamentals of Genetics	100
BIOS 26210	Mathematical Methods for Biological Sciences I	100

*# BIOS 20151 and BIOS 20153 fulfill the general education requirement in the biological sciences. BIOS 20151 is typically taken simultaneously with BIOS 20186.

OR

2. Advanced Computational Biology Fundamentals sequence— begins in the Autumn Quarter of first year and requires a high level of preparedness in Biology as well as a deep interest in research. The sequence is open to students who have been granted credit for BIOS 10130 due to their AP, IB, or A-Level exam scores (http://collegecatalog.uchicago.edu/thecollege/biologicalsciencescore/#apibora-levelexamcredit) or otherwise been granted permission to enroll in the course sequence by consent.+ Students seeking consent should contact Michael Glotzer (mglotzer@uchicago.edu).

BIOS 20234	Molecular Biology of the Cell	100
BIOS 20235	Biological Systems	100
BIOS 20236	Biological Dynamics	100
BIOS 26210	Mathematical Methods for Biological Sciences I	100

* Students who complete the Advanced Biology sequence but do not have credit granted for BIOS 10130 Principles of Biology will need to take one additional course to fulfill the general education requirement in the Biological Sciences. Students should consult with the BSCD Senior Advisers (Megan McNulty, mmcnulty@uchicago.edu; Chris Andrews, candrews@uchicago.edu) to select an appropriate course.

In addition, students following either the Fundamentals of Computational Biology Sequence or the Advanced Computational Biology Sequence must complete the sequence with the following courses in computer programming:

Two courses in computer programming:

DATA 11800 & DATA 11900	Introduction to Data Science I and Introduction to Data Science II	200
OR		
CMSC 14100 & CMSC 14200	Introduction to Computer Science I and Introduction to Computer Science II	200
OR		
CMSC 14200 & CMSC 14300	Introduction to Computer Science II and Systems Programming I	200
OR		
CMSC 14300 & CMSC 14400	Systems Programming I and Systems Programming II +	200

\+ CMSC back credit not permitted. Students who place into CMSC 14400 may fulfill this requirement with CMSC 14400 and an additional course from the approved non-BIOS list.

AND

One course in Computational Approaches to Biological Problems†:

BIOS 26211	Mathematical Methods for Biological Sciences II	100
BIOS 26318	Fundamentals of Biological Data Analysis	100
BIOS 26120	An Introduction to Bioinformatics and Proteomics	100
BIOS 26121	Introduction to Transcriptomics	100
BIOS 26403	Quantitative Immunobiology	100
BIOS 26404	Quantitative Genetics for the 21st Century	100
BIOS 26405	Predictive Biology: Learning from Data in Microbiomes	100

† These courses can count as either a Computational Approaches to Biological Problems course or an upper-level elective.

Physical Sciences Requirements

CHEM 11300	Comprehensive General Chemistry III (or higher)	100
AND		
CHEM 22000 & CHEM 22100	Organic Chemistry I and Organic Chemistry II (or higher)	200
or PHYS 12100 & PHYS 12200	General Physics I and General Physics II	
AND		
STAT 22000	Statistical Methods and Applications (or higher)	100
AND		
STAT 24300	Numerical Linear Algebra	100
or MATH 19620	Linear Algebra	
or DATA 21200	Mathematical Methods for Data Science II	

Upper-Level Elective Requirements

Students completing the major in the Computational Biology Track must take **five upper-level electives** distributed as follows: **Three upper-level BIOS courses in the area of computational biology** (annotated **CB**) and **two courses from the approved non-BIOS course list** (see list below).

Students who have completed the Advanced Computational Biology Fundamentals sequence must take **two BIOS upper-level courses in the area of computational biology** (annotated **CB).**

Non-BIOS Electives:

CMSC 14300	Systems Programming I (if not used to fulfill programming requirement)	100
CMSC 14400	Systems Programming II (if not used to fulfill programming requirement)	100
CMSC 21800	Data Science for Computer Scientists	100
CMSC 23900	Data Visualization ***	100
CMSC 25025	Machine Learning and Large-Scale Data Analysis	100
CMSC 25300/STAT 27700	Mathematical Foundations of Machine Learning **	100
CMSC 25400/STAT 27725	Machine Learning **	100
CMSC 25440	Machine Learning in Medicine **	100
DATA 22100	Introduction to Machine Learning: Concepts and Applications **	100
DATA 27100-27200	Data Science Clinic I-II (also fulfills research requirement)	200
DATA 22700	Data Visualization and Communication ***	100
STAT 22810	Epidemiology and Population Health	100
MENG 21400	Molecular Engineering Thermodynamics	100

** only one of these courses may be counted:
DATA 22100, CMSC 25300, CMSC 25400, CMSC 25440

*** Only one of these courses may be counted:
(DATA 22700, CMSC 23900)

Other courses from quantitative programs may be counted by consent of one of the Track Directors Anindita Basu (onibasu@uchicago.edu) or Dmitry Kondrashov (dkon@uchicago.edu).

Additional Requirements: One quarter of independent field or research work in the area of Computational Biology is required. This requirement can be fulfilled by approved independent research with a faculty mentor or by completion of DATA 27100 Data Science Clinic I or DATA 27200 Data Science Clinic II. More information on track-specific opportunities can be found on the Interdisciplinary Biology Computational Biology page. (https://college.uchicago.edu/academics/interdisciplinary-biology-track-computational-biology/) For approval of independent research, contact one of the Track Directors Dmitry Kondrashov (dkon@uchicago.edu) or Anindita Basu (onibasu@uchicago.edu).

Summary of Requirements: Computational Biology Track

CHEM 11300	Comprehensive General Chemistry III (or higher)	100
CHEM 22000 & CHEM 22100	Organic Chemistry I and Organic Chemistry II (or higher)	200
or PHYS 12100 & PHYS 12200	General Physics I and General Physics II	
STAT 22000	Statistical Methods and Applications (or higher)	100
STAT 24300	Numerical Linear Algebra	100
or MATH 19620	Linear Algebra	
or DATA 21200	Mathematical Methods for Data Science II	
Computational Biology Fundamentals Sequence or Advanced Computational Biology Fundamentals Sequence +		300
Two courses in computer programming		200
One course in Computational Applications to Biological Problems		100
Three upper-level (BIOS 21000-28999) electives (annotated CB) +		300
Two upper-level non-BIOS electives from the approved list		200
One quarter of approved research		
Total Units		1600

+ Students completing the Advanced Computational Biology Fundamentals Sequence take two BIOS upper-level electives (annotated CB).

For questions about this track, please contact one of the Track Directors Dmitry Kondrashov (dkon@uchicago.edu) and Anindita Basu (onibasu@uchicago.edu) or the Senior Biology Advisors (https://college.uchicago.edu/academics/biological-sciences-collegiate-division/).

Program Requirements for the Bachelor of Science in Biological Sciences

Students can earn a Bachelor of Science (BS) degree in Biological Sciences in any of the tracks by:

(1) completing three upper-level elective courses in Biological Sciences beyond those required for the BA degree, including BIOS 28900 Undergraduate Bachelor of Science Research (or both quarters of BIOS 00296 Undergraduate Honors Research if also pursuing Biology Research Honors)

AND

(2) writing a BS thesis under the supervision of an adviser who is a member of the Biological Sciences Division research faculty. The topic of the BS thesis must be appropriate for the track chosen.

Students completing the honors program or a specialization in the Biology Track that requires a senior thesis can submit the same thesis for the BS degree. Candidates must declare their intent by submitting a faculty consent form no later than the end of the Spring Quarter of their third year in the College. Details of the BS degree and a timeline for completion of requirements are provided on the BSCD BS Thesis Guidelines and Timeline Page (https://college.uchicago.edu/academics/bs-guidelines-and-timeline/).

Honors

Honors in Biological Sciences can be earned via one of two ways.

Research Honors: 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.

Scholar Honors: Recognizes exceptional academic performance (minimum cumulative GPA of 3.75 or above), including submission and acceptance of a scholarly thesis.

Both programs require formal declarations of intent to seek honors by the candidates. The details of each program are provided on the BSCD Honors website (https://college.uchicago.edu/academics/honors-biology/). Candidates must apply for either program no later than Spring Quarter of their third year in the College.

Research Opportunities

Students in all tracks 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 Biological Sciences Division to sponsor and supervise research. Students may register for BIOS 00199 Undergraduate Research or BIOS 00299 Advanced Research: Biological Sciences at any time if they want to receive course credit for their research work, but this is not required. (Please note that there are required research courses for the BS and Research Honors programs.) For more information, see The BSCD Student Resources Research Page (https://bscduchi.squarespace.com/research/) or contact Alison Hunter (ahunter@uchicago.edu) (ahunter@uchicago.edu). NOTE: Course credit cannot be given for work that is compensated by a salary. BIOS 00199 and BIOS 00299 may not be used to meet the requirements of the Biological Sciences degree.

Students interested in research are also encouraged to work in a research lab over the summer. In addition to individual arrangements with faculty, students may take advantage of fellowship programs. Application deadlines for fellowships range from mid-February to early April. Please see The BSCD Student Resources Research Page (https://bscduchi.squarespace.com/research/) for more information about fellowship opportunities and funding for research in the Biological Sciences at the University of Chicago, or the College Center for Research and Fellowships (ccrf.uchicago.edu (https://ccrf.uchicago.edu/)), and Career Advancement (https://careeradvancement.uchicago.edu/careers-in/biological-sciences/) for a searchable database of internal and external research and fellowship opportunities.

Prospective biology majors interested in learning more about the variety of labs conducting biological research on campus can attend one or more quarters of BIOS 10098 Pizza with the PIs: Introduction to Biology Research at The University of Chicago.

BIOS 10098. Pizza with the PIs: Introduction to Biology Research at The University of Chicago. 000 Units.
This is an optional, non-credit course for students interested in carrying out research at the University of Chicago. It provides students with an opportunity to get to know the research faculty, identify potential labs to join, and be inspired by the research advances happening on our campus. Each week, a different faculty member from any of the various departments in the Biological Sciences Division (BSD) will present their own research work in a 50 minute, lunch-time seminar. Registration for the course is required to be able to attend these seminars. Pizza will be served.
Instructor(s): N. Bhasin Terms Offered: Winter
Prerequisite(s): This course is for prospective biology majors only. Students should have attended, or be enrolled in, at least one quarter of any Fundamentals sequence in biology.

Minor in Biological Sciences

Students who wish to complete a Minor in Biological Sciences should meet with one of the BSCD Senior Advisers, Chris Andrews (candrews@uchicago.edu) or Megan McNulty (mmcnulty@uchicago.edu), by the Spring Quarter of their second year in order to obtain formal consent (https://humanities-web.s3.us-east-2.amazonaws.com/college-prod/s3fs-public/documents/Consent_Minor_Program.pdf) and to plan out the appropriate program of study.

A student may earn a Minor in Biological Sciences by completing:

The General Education Requirements in Biological Sciences (see below);

The General Education Requirement in Physical Sciences (MATH 13100-13200 or higher);

Three quarters of a Fundamentals Sequence;

Four upper-level Biology electives.

Students satisfy the General Education Requirement in the Mathematical Sciences for the Biological Sciences Minor with the following coursework:

MATH 13100-13200	Elementary Functions and Calculus I-II (or higher)	200

There are multiple options for fulfilling the Biological Sciences Requirements (see options below):

Option 1: Fundamentals in Biological Sciences Sequence

Students planning to take the Fundamentals in Biological Sciences Sequence complete their General Education Requirement by taking either

BIOS 20153	Fundamentals of Ecology and Evolutionary Biology	100
BIOS 20151	Introduction to Quantitative Modeling in Biology	100

OR

BIOS 10130	Principles of Biology	100
or BIOS 10140	Inquiry-based Exploration of Biology	
AND		
One biology Topics course (BIOS 11000-19999) #		100

\# See Topics Courses for Non-Majors (http://collegecatalog.uchicago.edu/thecollege/biologicalsciencescore/#topicscoursesfornon-majors)

OR A Two-Quarter General Education Sequence:

BIOS 10501 & BIOS 10500	Systems of the Human Body and Metabolism and Exercise	200
OR		
BIOS 10602 & BIOS 10603	Multiscale Modeling of Biological Systems I and Multiscale Modeling of Biological Systems II	200

Students who select Option 1 follow their General Education courses with three courses from the Fundamentals in Biological Sciences Sequence:

BIOS 20186	Fundamentals of Cell and Molecular Biology	100
BIOS 20187	Fundamentals of Genetics	100
AND one of the following:		
BIOS 20188	Fundamentals of Physiology	100
BIOS 20189	Fundamentals of Developmental Biology	100
BIOS 20196	Ecology and Conservation	100
BIOS 20198	Biodiversity	100

Option 2: Health Professions Preparation Sequence

Students completing Health Professions Preparation Sequence satisfy the General Education Requirement by taking:

BIOS 20170	Microbial and Human Cell Biology	100
BIOS 20171	Human Genetics and Developmental Biology (must be taken concurrently with BIOS 20172)	100

Students who select Option 2 follow their General Education Courses with:

BIOS 20172	Mathematical Modeling for Pre-Med Students (must be taken concurrently with BIOS 20171)	100
BIOS 20173	Perspectives of Human Physiology	100

AND		
BIOS 20175	Biochemistry and Metabolism	100

Option 3: The Advanced Biology Fundamentals Sequence

Students with credit for BIOS 10130 Principles of Biology due to the results of their AP, IB, or A-Level Biology exam may complete both the General Education Requirement and the Minor Fundamentals Sequence Requirement by taking:

BIOS 20234	Molecular Biology of the Cell (General Education Requirement)	100
BIOS 20235	Biological Systems	100
BIOS 20236	Biological Dynamics	100

Upper-Level Electives Requirement

After following one of the three options above to complete the General Education and Fundamentals Requirements, students complete the Minor by taking four upper-level electives (BIOS 21000-28999).

None of the seven courses 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.

Summary of Requirements- Minor in Biological Sciences

General Education Requirement in Mathematical Sciences (MATH 13100-MATH 13200 or higher)	
General Education Requirement in Biological Sciences	
Fundamentals Sequence Requirement	300
Choice of four upper-level BIOS electives	400
Total Units	700

Back To Top (http://collegecatalog.uchicago.edu/thecollege/biologicalsciences/#top/#top)

Grading and Academic Honesty

Students must receive quality grades in all courses that fulfill requirements for the BA or BS degree in Biological Sciences.

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 include suspension or expulsion from the University.

Biological Sciences (BIOS) Courses

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.

E indicates a course that can be counted towards a degree in Biological Sciences through the Ecology and Evolution Track.

GP indicates a course that can be counted towards a degree in Biological Sciences through the Global and Public Health Track.

CB indicates a course that can be counted towards a degree in Biological Sciences through the Computational Biology Track.

Health Professions Preparation Sequence for Non-Majors

This sequence (BIOS 20170- BIOS 20175) is an integrated set of biology courses designed to prepare non-biological sciences majors for application to medical school or other schools in the health professions. This sequence cannot substitute for the Fundamentals Sequence in any of the tracks in the Biological Sciences major but students who complete the sequence qualify to take upper-level BIOS elective courses can use the BIOS 20170s courses to fulfill requirements in the Biological Sciences minor. Students who are not Biological Sciences majors may also complete their pre-health biological sciences requirements in the Fundamentals Sequence or the Advanced Biology Sequence.

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 schools in the health professions. 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 and gain experience with microbiological basic microscopy techniques in lab.
Instructor(s): F. Salas-Lucia, C. Andrews, R. Bednarczyk Terms Offered: Winter. L.
Prerequisite(s): This sequence is open only to students who are not planning to major in Biological Sciences or Biological Chemistry and cannot be applied to either of these majors. It is recommended that students start the sequence in their first or second year.

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 un-patterned egg into a recognizable human form). Other topics may include limb development and stem cell biology.
Instructor(s): S. Mukherjee, O. Pineda-Catalan, J. Gifford Terms Offered: Spring. L.
Prerequisite(s): Not open to students who have not completed BIOS 20170. Must be taken concurrently with BIOS 20172.

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): Not open to students who have not completed BIOS 20170. Must be taken concurrently with 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. Required weekly discussions include student presentations on papers from the scientific literature.
Instructor(s): C. Andrews Terms Offered: Autumn. L.
Prerequisite(s): Not open to students who have not completed all previous courses in this sequence: 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): Wen Yi Low Terms Offered: Winter
Prerequisite(s): This course is not open to students who have not completed all previous courses in this sequence (BIOS 20170, BIOS 20171, BIOS 20172 & BIOS 20173).

Fundamentals Sequence Courses for Biological Sciences Majors

It is recommended that students registering for Fundamentals Sequence courses in the Biological Sciences major have completed or placed out of general or honors chemistry or be enrolled concurrently in general or honors chemistry. These courses are also open to non-majors completing the minor in Biological Sciences or satisfying pre-health biological sciences requirements.

BIOS 20151. Introduction to Quantitative Modeling in Biology. 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): Section 1: D. Kondrashov; Section 2: A. Basu, K. Bader. Terms Offered: Spring. L.

Prerequisite(s): Two quarters of calculus of any sequence (MATH 13200 or 15200 or 16200). First-year Biology Major standing only.
Note(s): This course is required to partially fulfill the general education requirement in biology for Biological Sciences majors in all tracks except for students in the Advanced Biology sequence. This course cannot be used as a Topics course for the general education requirement for non-Biological Sciences majors.

BIOS 20153. Fundamentals of Ecology and Evolutionary Biology. 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 placed on "ecological thinking". 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.
Instructor(s): Section 1: G. Dwyer, P. Muralidhar, Section 2: S. Allesina, J. Kreiner. C. Andrews, A. Hunter. Terms Offered: Winter. L.

BIOS 10053. Collaborative Learning in Biology: Ecology & Evolution. 000 Units.
Optional, limited enrollment workshop for students concurrently enrolled in BIOS 20153. An Instructional Professor or Team Leader will guide small groups of students in weekly workshops. Students will analyze problem sets designed to complement, but not duplicate, assignments and material in Ecology & Evolution. Students will work collaboratively in small groups on assigned problems, with reference to course materials such as lecture notes and assigned texts. These workshops are also designed to develop communication skills and teamwork. Collaborative learning requires being present and engaged, so this zero-credit course is graded P/F based on student's participation and attendance.
Instructor(s): K. Butler Terms Offered: Winter
Prerequisite(s): Concurrent enrollment in BIOS 20153: Fundamentals of Ecology & Evolution.

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: B. Glick, D. Kovar, C. Schonbaum; Section 2: R. Fehon, D. Pincus, P. Smith Terms Offered: Spring. L.
Prerequisite(s): Concurrent registration in BIOS 20151 or similar math prep. Reg. by lab sec.
Note(s): All students in BIOS 20186 will be expected to possess the competency in mathematical modeling of biological phenomena covered concurrently in BIOS 20151.

BIOS 10086. Collaborative Learning in Biology- Cell & Molecular Biology. 000 Units.
Optional, limited enrollment workshop for students concurrently enrolled in BIOS 20186 Fundamentals of Cell and Molecular Biology. An instructional professor will guide small groups of students in weekly workshops. Students will analyze problem sets designed to complement, but not duplicate, assignments and material in Cell and Molecular Biology. Students will work collaboratively in small groups on assigned problems, with reference to course materials such as lecture notes and assigned texts. These workshops are also designed to develop communication skills and teamwork. Collaborative learning requires being present and engaged, so this zero-credit course is graded P/F based on student's participation and attendance.
Instructor(s): K. Butler Terms Offered: Spring
Prerequisite(s): Concurrent enrollment in BIOS 20186.

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: J. Malamy, R O'Malley, C. Schonbaum. Section 2: E. Ferguson, E.Green, P. Smith. Terms Offered: Autumn. L.
Prerequisite(s): BIOS 20186

BIOS 10087. Collaborative Learning in Biology- Genetics. 000 Units.
Optional, limited enrollment workshop for students concurrently enrolled in BIOS 20187. An instructional professor will guide small groups of students in weekly workshops. Students will analyze problem sets designed to complement, but not duplicate, assignments and material in Genetics. Students will work collaboratively in small groups on assigned problems, with reference to course materials such as lecture notes and assigned texts. These workshops are also designed to develop communication skills and teamwork. Collaborative learning requires being present and engaged, so this zero-credit course is graded P/F based on student's participation and attendance.
Instructor(s): K. Butler Terms Offered: Autumn

Prerequisite(s): Concurrent enrollment in BIOS 20187.

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): Winter: staff; Spring: D. McGehee, staff Terms Offered: Spring Winter. L.
Prerequisite(s): BIOS 20186 & 20187, or BIOS 20234 & 20235.

BIOS 10088. Collaborative Learning in Biology- Physiology. 000 Units.
Optional, limited enrollment workshop for students concurrently enrolled in BIOS 20188. An Instructional Professor or Team Leader will guide small groups of students in weekly workshops. Students will analyze problem sets designed to complement, but not duplicate, assignments and material in Physiology. Students will work collaboratively in small groups on assigned problems, with reference to course materials such as lecture notes and assigned texts. These workshops are also designed to develop communication skills and teamwork. Collaborative learning requires being present and engaged, so this zero-credit course is graded P/F based on student's participation and attendance.
Instructor(s): K. Butler Terms Offered: Spring Winter
Prerequisite(s): Concurrent enrollment in BIOS 20188.

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): Winter: V. Prince, S. Horne-Badovinac, C. Schonbaum. Spring: W. Du, Staff. Terms Offered: Spring Winter. L.
Prerequisite(s): BOIS 20186 & 20187.

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, M. Zhao, E. Özkan, W.Y. Low. 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 10020. Collaborative Learning in Biology: Biochemistry. 000 Units.
Optional, limited enrollment workshop for students concurrently enrolled in BIOS 20200. An instructional professor will guide small groups of students in weekly workshops. Students will analyze problem sets designed to complement, but not duplicate, assignments and material in Biochemistry. Students will work collaboratively in small groups on assigned problems, with reference to course materials such as lecture notes and assigned texts. These workshops are also designed to develop communication skills and teamwork. Collaborative learning requires being present and engaged, so this zero-credit course is graded P/F based on student's participation and attendance.
Instructor(s): K. Butler Terms Offered: Spring
Prerequisite(s): Concurrent enrollment in BIOS 20200 Biochemistry

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.
Instructor(s): Autumn: C. Pfister, E. Larsen. Spring: L. Carley, E. Larsen Terms Offered: Autumn Spring. L.
Prerequisite(s): Overnight field trip required.
Equivalent Course(s): ENSC 24400

BIOS 20198. Biodiversity. 100 Units.
Section 1. Students will review the three biodiversity levels, i.e., genetic, species, and ecosystem, using a systemic approach to appraise the complex network of interactions among living organisms on our planet. During the course, students will survey the main taxonomic groups, such as archaea, bacteria, single-celled eukaryotes, fungi, plants, and animals, to identify their defining characteristics, describe their evolutionary origin, and evaluate their role in ecosystems. Students will integrate knowledge and analytical tools to assess the biodiversity in their neighborhoods, as well as differentiate parameters that impact distribution and abundance of organisms in their local ecosystems. Section 2. This course presents an overview of the diversity of living organisms, including archaea, bacteria, single-celled eukaryotes, fungi, plants, and animals, with an emphasis on their evolutionary histories, relationships, and the biological and evolutionary implications of the characteristic

features of each group. We will explore how these different lineages have evolved remarkable solutions to challenges in locomotion, metabolism, and life in extreme environments. Work in the lab will take advantage of the diversity of organisms that live around, or are maintained at, the Marine Biological Laboratory at Woods Hole, MA.
Instructor(s): Section 1: O. Pineda, C. Andrews; Section 2: A. Gillis. Terms Offered: Spring. L. Section 1 will be taught on the Chicago campus. Section 2 will be taught during Spring Quarter at MBL in Woods Hole, MA (https://college.uchicago.edu/academics/mbl-spring-quarter-biology)
Prerequisite(s): BIOS 20153 for Biological Sciences majors; not required for GeoSci majors or students taking BIOS 20198 as part of a general education sequence.
Equivalent Course(s): CEGU 20198

Advanced Biology Fundamentals Sequence

This is an accelerated four-quarter Fundamentals sequence (BIOS 20234-20236 and BIOS 20188) designed for motivated first-year students with exceptionally strong science and mathematics backgrounds and an intense interest in research in the biological sciences. Credit awarded for BIOS 10130 Principles of Biology as a result of a student's AP, IB, or A-Level Biology exam scores is required; students seeking consent should contact Michael Glotzer (mglotzer@uchicago.edu (glotzer@uchicago.edu)). Successful students usually also have strong preparation in biology, chemistry, and calculus as well as some experience in computer programming. 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). Upon completion of the first three quarters of the Advanced Biology sequence, students will have three credits towards the Biological Sciences major and they will have met the general education requirement in the biological sciences.

Note: Biological Sciences majors who opt not to complete the sequence after the first quarter (BIOS 20234) should take BIOS 20151, which will be applied to their general education requirement in the biological sciences along with their AP Biology credit. BIOS 20234 will be counted as a credit towards the Biological Sciences major. Students will then complete the major by following the requirements for either the Biology Track or an Interdisciplinary Biology Track starting with BIOS 20187.

Note: Students who complete the Advanced Biology sequence without having been awarded credit for BIOS 10130 Principles of Biology from their AP, IB, or A-Level Biology exam *scores will need to take one additional course to fulfill the general education requirement in the Biological Sciences. Students should consult with BSCD Senior Advisers (Megan McNulty, mmcnulty@uchicago.edu, and Chris Andrews, candrews@uchicago.edu) to select an appropriate course.*

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.
Instructor(s): M. Glotzer, A. Ruthenburg, N. Bhasin. L. Terms Offered: Autumn
Prerequisite(s): Score of 4 or 5 on the AP biology test or consent.
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 20188 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, J. Novembre, 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. Terms Offered: Spring. L.
Prerequisite(s): BIOS 20234 and BIOS 20235 with a minimum grade of B- in each course.

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): Winter: staff; Spring: D. McGehee, staff Terms Offered: Spring Winter. L.
Prerequisite(s): BIOS 20186 & 20187, or BIOS 20234 & 20235.

Upper-level Elective Courses

Course numbers 21000-28999

These courses assume mastery of the material covered in the Fundamentals Sequences and explore specific areas of biology at an advanced level. In most cases, students will be reading primary scientific literature. Students who have not yet completed a Fundamentals Sequence, including at least cell biology and genetics, should consult with the course instructor and the BSCD Senior Advisers before registering for an upper-level elective course. Students must confirm their registration with their instructors by the second class meeting or their registration may be canceled.

BIOS 21216. Introduction to Statistical Genetics. 100 Units.
In this course, we will cover the core concepts and statistical procedures that are used in the mapping of genetic traits from observational data. We will cover statistical techniques used in genome-wide association studies and tools for "post-GWAS" analysis. Proficiency in R programming and the command line needs to be achieved early on to keep up with the course's demanding homework problems.
Instructor(s): Xin He, Hae Kyung Im Terms Offered: Winter
Prerequisite(s): Students are expected to have had: • Strong statistics foundation from taking HGEN 47400 Introduction to Probability and Statistics for Geneticists, or STAT 24400 Statistical Theory and Methods I, or equivalent. Note that STAT 22000 or 24300 Statistical Models and Methods, are not sufficient. • An introductory course in genetics: BIOS 20187 Fundamental of Genetics or equivalent. • Knowledge of programming (R) and Unix command lines. Computational labs will quickly move towards using unix-command-line tools, file and data management, and the software package R. The course can be challenging for students unfamiliar with the Unix command line This course is catered toward graduate students in Genetics, Genomics, and Systems Biology. It is not an introductory course for undergrads who will need consent from the instructors.
Note(s): E. GP. CB.
Equivalent Course(s): HGEN 47100

BIOS 21226. Gene Regulation: Concepts and Mechanisms. 100 Units.
This upper-level undergraduate course explores the molecular mechanisms and systems-level principles of gene regulation in both prokaryotes and eukaryotes. Students examine transcriptional control, chromatin structure and epigenetic modifications, post-transcriptional regulation, and gene regulatory networks (GRNs) in development, disease, and evolution. The course blends lectures with student-led discussion of classical and modern primary research. Students will gain knowledge of different gene regulatory mechanisms and their effects in development and disease. At the end of this course, students will be able to use the learned concepts to critically read and assess primary research in the field.
Instructor(s): H-C. Lee and S. Pott Terms Offered: Winter
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence or consent of the instructor.

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): H-C. Lee, E. Ferguson, D. Pincus, X. Zhang. Terms Offered: Autumn
Prerequisite(s): The first three quarters of a fundamentals sequence including a course in genetics (BIOS 20187, BIOS 20235, or BIOS 20171).
Note(s): E.

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, or BIOS 20235. AND CONSENT OF INSTRUCTOR
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: Spring
Prerequisite(s): For undergraduates: Three quarters of a Biological Sciences Fundamentals Sequence.
Equivalent Course(s): DVBI 31700, MGCB 31700, BCMB 31700

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): Y. Li and R. Blekhman Terms Offered: Autumn
Prerequisite(s): Three quarters of a Biological Fundamentals Sequence including BIOS 20171, BIOS 20187, or BIOS 20235.
Note(s): E. GP.

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): C. Hayes, R. Keenan Terms Offered: Spring
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and BIOS 20200 or BIOS 20175.

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
Equivalent Course(s): BPHS 31000, BCMB 32200

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 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 Mathlab would be valuable.
Instructor(s): B. Roux Terms Offered: Winter
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence, BIOS 20200 or BIOS 20175 and BIOS 26210-26211, or consent from instructor
Note(s): CB
Equivalent Course(s): CPNS 31358, CHEM 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 epi-transcriptomics. Basic methods in molecular biology will also be covered. The course also includes special, current topics on genomics, single molecule studies of gene expression, epi-transcriptomics, and others.
Instructor(s): J. Fei, T. Pan. Terms Offered: Winter
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence including BIOS 20171, BIOS 20187 or BIOS 20235 and Organic Chemistry, or consent of instructor.

BIOS 21402-21403. Multi-scale Imaging and Quantitative Analysis.
The ability to visualize biological structures and processes across multiple scales is a cornerstone of modern medicine and biological research. By mastering imaging modalities, scientists can understand biological processes, diagnose disease with precision, track cellular dynamics in real-time, and derive quantitative insights from complex visual data. In this three-course sequence, students will explore the physics, application, and use of Python programming on biological imaging data. These courses may be taken in any order. Students can take a single course or the entire sequence. Throughout these courses, students will explore recent primary literature to identify cutting-edge applications and computational tools for both clinical use and biological research. Students

will also gain hands-on experience using Python programming to visualize, process, and classify biological images.

BIOS 21402. Biomedical Imaging. 100 Units.
Medical Imaging has revolutionized the healthcare system due to its ability to diagnose and guide treatment for many different human diseases such as cancer, cardiovascular disease and neurodegenerative diseases. Medical imaging continues to advance with new technologies, innovative applications and advanced computational tools that will lead to earlier diagnoses, better treatment guidance and improved prediction of patient outcome. This course will introduce students to the key concepts and applications of medical imaging systems for biology research and medical applications. After covering the key concepts of image formation and image quality, the course will cover the principles and applications of the major modalities: radiographic imaging, Computer Tomography (CT), Magnetic Resonance Imaging (MRI), Nuclear Medicine Imaging and Ultrasound. The course will cover medical imaging safety, ethics, developing tissue phantoms to reduce animal models and the integration of imaging systems in the current healthcare profession. Additionally, Python programming-based projects will be used in the discussion sections for hands-on experience with real medical imaging data sets and to reinforce concepts covered in the lectures.
Instructor(s): M. Walsh and H. Whitney. CB. Terms Offered: Winter
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence and a quarter of calculus. Familiarity with coding in R/Python recommended.

BIOS 21403. Quantitative Bioimaging. 100 Units.
How do you count thousands of different cell types in seconds, reconstruct a 3D heart from 2D slices, identify patterns in tumors to diagnose deadly cancers, or track neurons firing in real-time? This course equips students with the computational tools to solve these problems using Python. This course builds a practical approach to developing computational data pipelines including data handling, visualization, image preprocessing and classification from a range of imaging modalities, including microscopy and medical imaging techniques. Using Python programming, this course will explore how we can move beyond simple observation and qualitative analysis of images to quantitative analysis and automated classification on a wide range of biological images.
Instructor(s): J. Weinstein and M. Walsh Terms Offered: Spring. CB.
Prerequisite(s): Three quarters of a biological sciences fundamentals sequence. Two quarters of calculus and Python proficiency recommended. Or consent of the instructor.

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): X. Wu, Y. Miao Terms Offered: Winter
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence, including cell and molecuar biology and genetics.

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): H. Marlow, E. Ferguson, V. Prince, J. Cunningham, Terms Offered: Spring
Prerequisite(s): For undergraduates only: Three quarters of a Biological Sciences fundamentals Sequence
Equivalent Course(s): DVBI 36200

BIOS 21506. Biological Physics. 100 Units.
This course will focus on unifying problems and themes found across biology that benefit from a quantitative approach. Questions covered include: How do evolved non-equilibrium mechanisms get around the constraints of equilibrium thermodynamics? What are the minimal requirements for matter to become life by replicating and evolving? How do living systems partition limited resources (energy, matter) acquired from the environment? How do living systems exploit dynamical systems behaviors to store and retrieve memories of past environments on different timescales? No specialized biological knowledge assumed.
Terms Offered: Winter
Prerequisite(s): PHYS 13300 or PHYS 14300, or permission of Instructor.
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

BIOS 21507. Stem Cell Biology, Regeneration, and Disease Modeling. 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): Huanhuan Chen Terms Offered: Autumn
Prerequisite(s): BIOS 20186 or BIOS 20234
Equivalent Course(s): MENG 33110, MENG 23110, MPMM 34300

BIOS 21508. Cellular Engineering. 100 Units.
Cellular engineering is a field that studies cell and molecule structure-function relationships. It is the development and application of engineering approaches and technologies to biological molecules and cells. This course provides a bridge between engineers and biologists that quantitatively study cells and molecules and develop future clinical applications. Topics include fundamental cell and molecular biology; immunology and biochemistry; receptors, ligands, and their interactions; nanotechnology/biomechanics; enzyme kinetics; molecular probes; cellular and molecular imaging; single-cell genomics and proteomics; genetic and protein engineering; and drug delivery and gene delivery.
Instructor(s): Jun Huang Terms Offered: Autumn
Prerequisite(s): Completion of the first two quarters of a Biological Sciences Fundamentals Sequence including cell and molecular biology and genetics.
Equivalent Course(s): MENG 32200, MOMN 34310, MENG 22200

BIOS 21510. Chromatin & Epigenetics. 100 Units.
This course presents the dynamic nature of the physiological genome - an exquisitely regulated macromolecular polymer termed chromatin - that gives rise to hundreds of cellular identities, each adaptable to various environmental milieu. Students will explore the mechanisms and determinants that shape distinct chromatin conformations and their influences on gene expression and cell fate. Topics include histone modifications, ATP-dependent chromatin remodeling, DNA methylation, Polycomb, heterochromatin, topologically associating domains, phase transition, and non-coding RNA. Students will apply their knowledge to understand the role of chromatin structure in development (e.g. lineage specification), disease (e.g. cancer) and potential therapeutics (e.g. cellular reprogramming). Students will leave the course with an in-depth knowledge of cutting-edge epigenetic methodologies as well as the ability to critically evaluate primary literature and propose original scientific research.
Instructor(s): A. Koh Terms Offered: Spring
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence
Equivalent Course(s): IMMU 33000

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: Winter
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence.
Note(s): Offered Winter during odd years. E.
Equivalent Course(s): ORGB 32233

BIOS 22245. Biomechanics: How Life Works. 100 Units.
This course will explore form and function in a diversity of organisms, using the principles of physics and evolutionary theory to understand why living things are shaped as they are and behave in such a diversity of ways. Biomechanics is at the interface of biology, physics, art, and engineering. We will study the impact of size on biological systems, address the implications of solid and fluid mechanics for organismal design, learn fundamental principles of animal locomotion, and survey biomechanical approaches. Understanding the mechanics of biological organisms can help us gain insight into their behavior, ecology and evolution.
Instructor(s): M. Westneat Terms Offered: Spring. L.
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence. Physics useful.
Note(s): E.
Equivalent Course(s): ORGB 32245, EVOL 32245

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. Offered Winter during even years.
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence, including BIOS 20171, BIOS 20187, or BIOS 20235
Note(s): E.
Equivalent Course(s): EVOL 30200, ORGB 30250

BIOS 22258. Physics of Behavior. 100 Units.
From stochastic firing of ion channels in single cells to ordered flight paths of birds in a flock, much of what fascinates us about life emerges from the collective behavior of many smaller units. This course introduces mathematical frameworks used to describe, quantify, and predict behavior across scales, emphasizing tools from statistical physics and dynamical systems. Topics will include noise and stochasticity in gene expression and ion channels, neural dynamics from single cells to circuits, random walks and swarming in microorganisms, and movement ecology in larger animals. A central theme will be connecting microscopic variability to macroscopic behavioral patterns. Students will gain hands-on experience with mathematical modeling and simulation in Python and R.
Instructor(s): J. Nirody Terms Offered: Spring. E.CB.
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence or BIOS 26210 & 26211.

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.
Note(s): E.

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. L. Terms Offered: Autumn. Will be offered Autumn 2025. Offered every other year.
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence, or consent of Instructor.
Note(s): E.
Equivalent Course(s): ANTH 28110, ORGB 33265

BIOS 22270. Bones and Genes: The Story of Homo Sapiens. 100 Units.
The primary aim of this course is to explore the biological and behavioral makings of our species, anatomically modern Homo sapiens, by considering hypotheses, models, evidence, and the latest consensus from the complementary fields of paleoanthropology and genetics. The course is divided into two blocks, one focusing on our origins and the other on migrations across the globe. After a brief introduction to the human skeleton, students will learn about the pool of potential direct ancestors that lived before Homo sapiens emerged 300,000 year ago, as well as the environmental and cultural environments that may have led to the arrival of our species. This will be complemented by an evaluation of competing genetic models for the origin of our species and evidence for genetic intermixing with archaic humans such as Neanderthals and Denisovans. We will, then, follow modern humans out of Africa and study the fossil, archaeological, and genetic evidence for the peopling of the planet and adaptations to novel environments. Finally, the contributions of paleoanthropology and genetics to our understanding of behavior, cognition, physical traits/phenotypes, diet, and disease evolution will be explored. Complementary laboratory and discussion sessions will expose students to state-of-the-art methods and current research endeavors in these fields.
Instructor(s): M. Raghavan, Z. Alemseged. Terms Offered: Spring. L. This course will be taught during even years.
Prerequisite(s): BIOS Majors: Three quarters of a Biological Sciences Fundamentals Sequence. Also open to students in Anthropology and Genetics with an interest in human evolution, or consent of instructors.
Note(s): E.

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: Spring
Prerequisite(s): Advanced undergraduates may enroll with the consent of the instructor.
Note(s): E.
Equivalent Course(s): EVOL 33850, ORGB 33850, DVBI 33850

BIOS 23132. Ecology in the Anthropocene (Advanced) 100 Units.
This course is designed to introduce students to human impacts on the natural world, and the costs to us. The course is in 3 parts. The first part introduces basic principles of ecology. We discuss models of population growth, focusing on examples from human disease and agriculture. Species interactions (predation, parasitism, mutualism and competition) are covered in the context of novel pressures imposed by anthropogenic change. The second part covers six major impacts on species in detail: Climate change, Over-harvesting, Pollution, Habitat loss, Invasive species and Disease ("COPHID"). We consider economic approaches to the valuation of nature and discuss difficulties of prediction, in the light of past and projected human population growth, income, and greenhouse gases. The last section is on conservation biology: we evaluate the current state of nature, how to conserve species, and what are the benefits to us for doing so. This course differs from BIOS 13132 in having separate discussion sections, with emphasis on data analysis and requiring a term paper.
Instructor(s): T. Price & A. Hunter Terms Offered: Autumn
Prerequisite(s): BIOS 20153

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
Note(s): E.

BIOS 23233. Ecology and Evolution in the Southwest:Field School. 100 Units.
This lecture/lab course is the same course as BIOS 23232, but includes a lab section preparatory to a three-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 fifteen-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): E.

BIOS 23247. Bioarchaeology and Forensic Anthropology: Approaches to the Past. 100 Units.
This course is intended to provide students with a thorough understanding of bioanthropological, osteological and forensic methods used in the interpretation of past and present behavior by introducing osteological methods and anthropological theory. In particular, lab instruction stresses hands-on experience in analyzing human remains, whereas seminar classes integrate bioanthropological theory and its application to specific archaeological and forensic cases throughout the world. At the end of this course, students will be able to identify, document, and interpret human remains from archaeological and forensic contexts. Lab and seminar-format classes each meet weekly.
Note(s): This course qualifies as a Methodology selection for Anthropology majors.
Equivalent Course(s): ANTH 28400, LACS 38400, LACS 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): J. Mateo Terms Offered: Winter
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence.
Note(s): CHDV Distribution: A E.
Equivalent Course(s): CHDV 23249, PSYC 23249

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.

Note(s): E.

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. 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; completion of the general education requirement in the Biological Sciences, or consent of instructor.
Equivalent Course(s): GEOS 36300, EVOL 32400, 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): Three quarters of a Biological Sciences Fundamentals Sequence or consent of instructors.
Note(s): E.
Equivalent Course(s): ORGB 31201, EVOL 31201

BIOS 23263. Primate Evolution. 100 Units.
This course explores the diverse primate radiation throughout 65 million years of their evolutionary history. This includes a focus on primate origins and adaptive changes across different primate groups, as well as an emphasis on the biomechanics of the locomotor and feeding systems. Through a combination of lectures and readings, students will gain opportunities to deepen their understanding of key topics in primate evolution. A field trip to the Lincoln Park Zoo is also required.
Instructor(s): Zewdi Tsegai Terms Offered: Spring. TTh 11:00am-12:20pm, Culver 403 E.
Equivalent Course(s): ORGB 30400

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 a writing assignment on an adaptive question of their choice.
Instructor(s): C. Andrews Terms Offered: Autumn
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence including BIOS 20153 and BIOS 20187 or BIOS 20234 and 20235 or BIOS 20170 and 20171 or consent of instructor.
Note(s): E.

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.
Note(s): E.

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 including BIOS 20171, BIOS 20187, or BIOS 20235.
Note(s): E.
Equivalent Course(s): DVBI 36100, MGCB 36100, ECEV 32900

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.; A. Hipp Terms Offered: Autumn. This course is offered in alternate (odd) years. L.
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence or consent of instructor
Note(s): E. CB.
Equivalent Course(s): EVOL 35401

BIOS 23406. Biogeography. 100 Units.
In this course, we examine the uneven distribution of life on Earth and how ecology, evolution, and Earth sciences help us understand its past, present, and future. Topics include diversity gradients and hotspots, islands, methods for inferring the boundaries and histories of biotas, models and laws in biogeography, and the relevance of biogeography in the Anthropocene.
Instructor(s): J. Bates Terms Offered: Autumn
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 25500, GEOG 35500

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.
Note(s): E.

BIOS 23413. Quantitative Microbial Ecology. 100 Units.
Microbes live in nearly every niche on the planet from our bodies to the soil beneath our feet. In all of these habitats, microbes live in communities that harbor staggering complexity with thousands of species possessing almost unimaginable variation in traits and interactions. From all of this complexity emerge global nutrient cycles, the functional microbiota within higher organisms, and many industrial processes upon which life depends. In recent years ecologists and microbiologists have joined forces with physicists, engineers, chemists, and computer scientists to try and build quantitative and predictive formalisms to understand these systems. This course gives students a front-row seat to this emerging field through a "physics-style approach" to understand the structure, dynamics, and function of complex communities of microbes. We engage with the general principles of microbial physiology. These considerations connect our inquiry to consumer-resource models and computational studies of resource-mediated interactions in microbial communities.
Instructor(s): Seppe Kuehn Terms Offered: Spring
Prerequisite(s): Calculus. Basic familiarity with programming in Python, Matlab or R is beneficial but not required. Biology majors: Completion of three quarters of a Biological Sciences Fundamentals sequence.
Equivalent Course(s): ECEV 36500

BIOS 23414. Theoretical Ecology. 100 Units.
An introduction to mathematical modeling in ecology. The first half of the course will cover models of competition, predation and disease. The second half will cover stochastic models and fitting models to data. The course will emphasize numerical computation in the R programming language.
Instructor(s): G. Dwyer, S. Cobey Terms Offered: Autumn
Prerequisite(s): For undergraduates: Three quarters of a Biological Sciences Fundamentals Sequence and one quarter of calculus.
Equivalent Course(s): ECEV 42900

BIOS 24101. Foundations of Neuroscience. 100 Units.
This course is an introduction to the broad field of neuroscience. This is a lecture-based course that aims to introduce undergraduate students to concepts and principles that explain how the nervous system is built and how it functions. Examples of thematic areas covered in lectures include: (a) cellular anatomy of the nervous system, (b) development and evolution of the nervous system, (c) sensory systems, (d) motor systems, (e) cognition and behavior.
Instructor(s): D. Freedman, P. Kratsios, M. McNulty Terms Offered: Autumn

Equivalent Course(s): NSCI 20101, PSYC 24450

BIOS 24111. Cellular Neurophysiology. 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): M. Sheffield Terms Offered: Winter
Prerequisite(s): NSCI 20101 AND MATH 13100, MATH 15100, or MATH 16100 or consent of instructor
Equivalent Course(s): NSCI 20111, PSYC 24470

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): J. MacLean Terms Offered: Spring
Prerequisite(s): NSCI 20101, NSCI 20111 or consent of instructors
Equivalent Course(s): NSCI 20130, PSYC 24010

BIOS 24136. Photons to Consciousness: Cellular and Integrative Brain Functions. 100 Units.
This course uses the visual system as a model to explore how the brain works. We begin by considering the physical properties of light. We then proceed to consider the mechanism of sensory transduction, cellular mechanisms of neuron to neuron communication, the operation of small neural networks, strategies of signal detection in neuron networks, and the hierarchical organization of cortical function. We conclude with visually guided behavior and consciousness.
Instructor(s): E. Schwartz Terms Offered: Winter
Prerequisite(s): Recommended: NSCI 20101
Equivalent Course(s): NSCI 21100

BIOS 24140. Neuropharmacology. 100 Units.
This is a one quarter course that will explore neuronal pharmacology. Both the autonomic and central nervous system will be examined. The course has a clinical orientation. The course starts with an overview of the nervous system. In this section, we will explore the cellular aspects of neurons and their basic membrane and electrophysiological properties as will cellular and molecular aspects of synaptic transmission. The majority of the course will explore different neurotransmitter systems and drugs that interact with these systems.
Instructor(s): A. Fox Terms Offered: Spring
Prerequisite(s): NSCI 20101, NSCI 20111
Equivalent Course(s): NSCI 21900

BIOS 24143. Molecular and Translational Neuroscience. 100 Units.
This lecture/seminar course explores the application of modern cellular and molecular techniques to clarify basic mechanisms that underlie neural development , synaptic transmission, protein trafficking, and circuit function and the dysfunction of these fundamental processes that results in neurodevelopmental disorders and age-associated neurological diseases.
Instructor(s): S. Sisodia Terms Offered: Winter
Prerequisite(s): Neuroscience Fundamental Series (NSCI 20101-20130)
Equivalent Course(s): NSCI 22110

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): HLTH 21750, PSYC 21750, NSCI 21400

BIOS 24251. Neurons and Glia: A Cellular and Molecular Perspective. 100 Units.
This course will be an interactive, in-depth analysis of the cell biology of neurons and glia. We will learn and discuss the latest techniques used, for example, to study the structure and function of neuronal proteins. In this way we will illuminate the central concepts that define our understanding of the cell and molecular biology of neurons and glia. The course will consist of lectures and critical reading of contemporary literature.
Instructor(s): R. Carrillo; W. Green Terms Offered: Spring
Prerequisite(s): Neuroscience Majors: NSCI 20101-20130 (Fundamental Neuroscience Sequence) Biological Sciences Majors: NSCI 20101-20130, or three quarters of a Biological Sciences Fundamentals Sequence
Equivalent Course(s): NSCI 23810, NURB 34810

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, BIOS 26210 and 26211, or consent of instructor.
Note(s): CB.
Equivalent Course(s): NSCI 24000, CPNS 32111

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): A. Muir, S. Challa Terms Offered: Autumn
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence.
Note(s): GP.

BIOS 25109. Topics in Cancer. 100 Units.
This course focuses on several aspects of the molecular and cellular biology of hormone dependent cancers. 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. An additional goal is to provide an understanding of the contributions of tumor associated macrophages (TAMs) to breast cancer tumorigenesis, and to discuss emerging approaches to target TAMs for therapeutic benefit.
Instructor(s): G. Greene, L. Becker Terms Offered: Spring
Prerequisite(s): For Biology majors: Three quarters of a Biological Sciences Fundamentals Sequence including BIOS 20187 or BIOS 20235 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, A. Ostdiek Terms Offered: Spring
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence including a course in genetics, or consent of instructor
Note(s): GP.

BIOS 25206. Fundamentals of Bacteriology. 100 Units.
This course meets one of the requirements of the microbiology specialization. This course introduces bacterial diversity, metabolism, ultra-structure, envelope assembly, genetics, bacterial communities, interbacterial interactions, and symbioses. In the discussion section, students review recent original experimental work in the field of bacteriology.
Instructor(s): L. Comstock Terms Offered: Autumn
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence, or consent of instructor
Note(s): GP.
Equivalent Course(s): MICR 30600

BIOS 25207. Fundamentals and Applications of the Human Microbiota. 100 Units.
Thousands of microbes colonize the human body to collectively establish the human microbiota. Research findings over the past two decades have led to a growing appreciation of the importance of the microbiota in various facets of human health. This course will explore the human microbiota through a critical review of the primary scientific literature. The first portion of the course will cover distinct ways by which the human microbiota impacts mammalian health. The second part of the course will focus on established and developing microbiota-targeting biotechnologies. Students will leave the course with a general understanding of the current state of human microbiota research and its therapeutic and diagnostic applications.
Instructor(s): S. Light, M. Mimee Terms Offered: Winter
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence. Third or fourth year standing or consent of instructor.
Note(s): GP.
Equivalent Course(s): MENG 33210, MENG 23210, MICR 38000

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): J. Chen Terms Offered: Winter
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence.
Note(s): GP.
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. 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.
Note(s): GP.

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.
Note(s): GP.

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 Sceinces Fundamentals Sequence which includes, Cell, Genetics, Developmental Biology, and Physiology
Instructor(s): M. Alegre Terms Offered: Autumn
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence including BIOS 20187 or BIOS 20235, and BIOS 20188 and BIOS 20189
Note(s): GP.

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): D. Esterhazy; RR. Chowdhury Terms Offered: Winter
Prerequisite(s): BIOS 25256 with a grade of B+ or higher.
Note(s): GP.
Equivalent Course(s): PATH 30010, IMMU 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
Note(s): GP.
Equivalent Course(s): MICR 31200, IMMU 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): J.S. Park; A. Concepcion Terms Offered: Spring
Prerequisite(s): The first three quarters of a bioliogical sciences Fundamentals Sequence and BIOS 25256, or consent of instructor.
Equivalent Course(s): IMMU 30266

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): T. Golovkina Terms Offered: Spring
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence and third- or fourth-year standing
Note(s): GP.
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: Winter
Prerequisite(s): A grade of B or better in BIOS 25108
Note(s): GP.

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 interactome 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.

BIOS 25327. Health Disparities In Breast Cancer and Other Cancers. 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 9-week discussion-based course students will meet twice weekly and cover major aspects of disparities in breast cancer and other cancers.
Instructor(s): E. Dolan, S. Conzen Terms Offered: Winter
Prerequisite(s): BIOS 25108
Note(s): GP.
Equivalent Course(s): GNSE 20408, CCTS 40400, CCTS 20400, GNSE 30408, HLTH 20400

BIOS 25328. Cancer Genetics and Genomics. 100 Units.
Unprecedented technological progress over the last decade, especially high throughput sequencing technologies, has transformed the basic and translational research of cancer as well as other diseases. In this course, we will introduce the current state of the field, discuss how germline and somatic factors drive cancer initiation and progression, and demonstrate how to use omics data to advance our understanding of cancer. We will review recent literature in cancer genetics and genomics, learn about the standing questions in the field, and practice the analytical techniques to address these questions. Computational exercises will be an integral part of the course and provide you with a hand-on experience of state-of-the-art techniques.
Instructor(s): H.K. Im, L. Yang Terms Offered: Spring
Prerequisite(s): A course in genetics (BIOS 20187, BIOS 20235 or 20171)

Note(s): CB. GP.

BIOS 25329. Tissue Immunity and Cancer. 100 Units.
This course explores classical and contemporary cancer immunology and immunotherapy concepts. It covers fundamental knowledge in cancer immunity, immune evasion, and immunotherapy design through lectures and primary literature reviews. The unique aspect of this course is its focus on tissue-specific immunity and how it impacts tumor surveillance or aids cancer progression. This perspective leads students to the forefront of cancer research, investigating why tumors vary in aggressiveness across different tissues and why treatments differ in effectiveness. Students will also learn about the principles of adaptive and innate immune system coordination against tumorigenesis and how these systems can be manipulated to facilitate or hinder tumor progression. The course uses colon, skin, and pancreas as examples to illustrate how various tissues establish distinct immune-cancer interactions, leading to diverse responses against primary or metastatic tumors and promoting cancer immune evasion. Additionally, the course discusses advancements in cancer immunotherapy, spanning pre-clinical and clinical testing stages, with an emphasis on using tissue-specific immunity to design optimal treatments. Students will be assessed through in-class discussions, take-home assignments, exams, and an end-of-term project on a topic of their choice.
Instructor(s): D. Esterhazy and Y. Miao Terms Offered: Autumn
Prerequisite(s): Three quarters of a biology fundamentals sequence and one of the following: BIOS 25108 Cancer Biology, BIOS 25256 Immunobiology, or BIOS 25258 Immunopathology.
Note(s): This course counts as a required course in the Immunology Specialization for biology majors. GP.
Equivalent Course(s): IMMU 35300

BIOS 25426. From Diagnostics to Therapy: The Application of Translational Research in Cancer. 100 Units.
With the tremendous strides in medicine and healthcare, cancer is still a leading cause of mortality worldwide. Why is this? Cancer is a complex disease, which ultimately makes treatment challenging. Reasons for this disease complexity include the cancer origin/type; impact of cancer heterogeneity; complex interactions between cell types within the tumor microenvironment; tendency of disease to recur; and whether metastasis has occurred. Although cancer is still a major problem, there is hope founded on the recent advancements in technology/methodology in cancer diagnosis/treatments, which translational research has a significant role. In this course, students will learn about what cancer is and the characteristics that make it a complex disease. Translational research and its role in increasing the cure rate/prolonging survival will be defined. The course will cover the advancements in cancer diagnostics from imaging, sequencing, body fluids, and digital pathology using machine learning. The course will also include introducing methods of long-term monitoring of cancer progression/relapse and dynamic evaluation of the treatment effectiveness. Novel cancer treatments based on successes in translational research will be presented. Guest speakers that are experts in fields of cancer diagnostics, clinical pathology, and immunology will provide lectures on relevant topics pertaining to application of translational research to improve cancer patient outcomes.
Instructor(s): E. Izumchenko and R. Bednarczyk Terms Offered: Spring
Prerequisite(s): Three quarters of a biology fundamentals sequence.
Note(s): GP.

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

BIOS 26121. Introduction to Transcriptomics. 100 Units.
Transcriptomics is the study of the transcriptome -the complete set of RNA or transcripts that are produced by the genome, using high-throughput methods. In this course, students will learn about modern techniques used to capture and analyze mRNA and the connections of transcriptomics to epi-genomics (study of the epi-genome) and proteomics (study of proteins). The course will be divided into three parts: 1) Introduction of technologies that generate transcriptomics data, 2) Statistical analysis of the data, and 3) Case studies and applications. A range of topics relevant to the current practices in the field will be discussed, including introduction to microarrays, Next-Generation Sequencing (NGS), bulk and single-cell RNA processing, machine learning techniques used in data analyses, data pre-processing, differential expression analysis, and correcting batch effects and other experimental artifacts. Students will obtain hands-on experience in downloading public-domain data and performing analyses using different packages written in R and Python. After taking the class, students will have a working knowledge of the field and acquire experience in RNA-seq data analyses that are currently used in research labs. We will also organize visits to research laboratories and sequencing facility for the students to observe experimental workflows used in cutting-edge research.

Instructor(s): A. Basu, M. Chen Terms Offered: Winter. Not offered Winter 2026
Prerequisite(s): BIOS 20151, 20172, or 20236
Note(s): CB.

BIOS 26122. Introduction to Machine Learning for Biology. 100 Units.
Machine learning techniques are essential in many fields of biology that rely on large amounts of data. This course is intended to introduce key concepts in this field and illustrate their applications to biological questions. Students will learn about methods for supervised and unsupervised learning; regression and classification algorithms, and dimensionality reduction approaches. With every method we will emphasize model selection and validation on real data sets. Computational labs are an integral part of the course for students to work on applying these methods using R in the Quarto document system.
Instructor(s): D. Kondrashov Terms Offered: Winter
Prerequisite(s): BIOS 20151, BIOS 20172 or BIOS 20236. STAT 22000 or equivalent.
Note(s): L. CB.
Equivalent Course(s): NSCI 21710

BIOS 26123. Introduction to Python for Biologists & Neuroscientists. 100 Units.
This course is an introduction to Python for biology and neuroscience students. The objective of this course is to teach you the building blocks of Python in a fun and interactive way. You will learn the core python concepts and fundamentals to start applying them to various research problems in biology and neurology. We will step through problems drawn from biology and neurology using interactive JupyterLab notebooks. By the end of the course, you will be able to i) think through different data structures and know when to apply what, ii) develop comfort in utilizing key Python libraries for biological and/or neuroscience datasets, iii) design a basic Python framework to tackle a specific research problem and execute it, and iv) develop a good foundation to learn more advanced Python. No prior knowledge of Python is expected or required. You will use your own laptop for this class.
Instructor(s): Autumn: M. Walsh, Spring: A. Venkat Terms Offered: Autumn Spring
Note(s): CB. Students who have taken introductory computer science courses (CMSC 13100, 14200, 14300 OR 14400) cannot also count BIOS 26123 in the Biological Sciences major.
Equivalent Course(s): NSCI 21820

BIOS 26210-26211. Mathematical Methods for Biological Sciences I-II.
The following two courses are intended to be taken as a sequence.

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 to implement the models using Python in the Jupyter notebook platform.
Instructor(s): D. Kondrashov Terms Offered: Autumn. L.
Prerequisite(s): BIOS 20151 or equivalent quantitative experience by consent of instructor, and three courses 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.
Note(s): CB.
Equivalent Course(s): PSYC 36211, CPNS 31100

BIOS 26311. Introduction to Mathematical Modeling in Public Health. 100 Units.
Modeling is a simplified representation of reality that aims to capture essential features of a real-life object or process. Mathematical modeling in public health encompasses a wide array of methodologies offering a powerful toolkit to approach questions that would otherwise be extremely difficult or impossible to answer. This course will introduce students to the conceptual framework of mechanistic modeling and cover the most widely used mathematical modeling approaches in public health, including Markov models, queuing models, models of contagion, and a brief overview of network models and systems dynamic models. The course will explore differences, trade-offs and applications of discrete and continuous time models, deterministic and stochastic models, and compartmental and agent-based models, and will cover the basics of computational techniques used to calibrate models to data. The course will combine lectures and interactive computer / discussion sessions

aimed to provide students with an opportunity to practice quantitative techniques covered in lectures and apply these methods to real-world problems.
Instructor(s): O. Morozova Terms Offered: Spring
Prerequisite(s): The course assumes that students have prior coursework in basic probability and statistics and have basic coding skills. Familiarity with R statistical computing environment is recommended but not required. Courses that would provide the appropriate background include BIOS 20151, STAT 22000, STAT 25100 and PBHS 32100. Undergraduates: First 3 quarters of a Biology Fundamentals Sequence.
Note(s): E. CB. GP.
Equivalent Course(s): HLTH 21100, PBHS 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.
Note(s): CB.

BIOS 26403. Quantitative Immunobiology. 100 Units.
The science of immunology was born at the end of the 19th century as a discipline focused on the body's defenses against infection. The following 120+ years has led to the discovery of a myriad of cellular and molecular players in immunity, placing the immune system alongside the most complex systems such as Earth's global climate and the human brain. The functions and malfunctions of the immune system have been implicated in virtually all human diseases. It is thought that cracking the complexity of the immune system will help manipulate and engineer it against some of the most vexing diseases of our times such as AIDS and cancer. To tackle this complexity, immunology in the 21st century - similar to much of the biological sciences - is growing closer to mathematics and data sciences, physics, chemistry and engineering. A central challenge is to use the wealth of large datasets generated by modern day measurement tools in biology to create knowledge, and ultimately predictive models of how the immune system works and can be manipulated. The goal of this course is to introduce motivated students to the quantitative approaches and reasoning applied to fundamental questions in immunology.
Instructor(s): Nicolas Chevrier Terms Offered: Winter
Prerequisite(s): Completion of the first two quarters of a Biological Sciences Fundamentals Sequence. Knowledge of R is recommended but not required. Courses in immunology and microbiology are an advantage but not required (e.g., BIOS 25256 Immunobiology; BIOS 25206 Fundamentals of Bacterial Physiology).
Note(s): CB. GP.
Equivalent Course(s): IMMU 34800, MENG 33300, MENG 23300

BIOS 26404. Quantitative Genetics for the 21st Century. 100 Units.
This course has three parts. In the first four weeks, we take a deep look at some fundamentals of quantitative genetics, focusing on underlying mathematical theory and causal interpretations of basic quantitative genetic models. These include the breeder's equation and related descriptions of the response to natural selection, various methods of estimating heritability, GWAS methods accounting for environmental effects, and explicit causal inference methods like Mendelian randomization. In the next three weeks of the course, we discuss the scientific opportunities and pitfalls of applying these fundamental quantitative genetic tools in challenging settings. This section covers phenotypic prediction with polygenic scores, inferences about quantitative trait evolution, and the application of quantitative genetic tools to complex social traits like educational attainment. Finally, in the third section we examine the relationship between race, genetics, and complex traits. In this section we discuss definitions of race and how they are (or are not) related to genetics, as well as ongoing legitimate scientific debates over how racial classifications are used in medicine. We will also critique pseudoscientific arguments about the relationship between race, genetics and complex traits.
Instructor(s): Jeremy Berg, Andrew Dahl Terms Offered: Spring
Prerequisite(s): R/Python proficiency. Undergraduates: Completion of the first two quarters of a Biological Sciences Fundamentals Sequence.
Note(s): E.
Equivalent Course(s): HGEN 47800

BIOS 26405. Predictive Biology: Learning from Data in Microbiomes. 100 Units.
In the 21st century, biology is completing its transition from a descriptive discipline to a predictive science. At the heart of this transformation is an essential craft: the ability to translate massive datasets into biological understanding. This course prepares advanced undergraduates to lead this shift, mastering the computational tools required to decode the logic of complex biological systems. We will bridge the gap between measurements and models by coarse-graining biological complexity-leveraging neural networks and non-linear dimension reduction to distill simplified descriptions from high-dimensional data. Rather than getting lost in microscopic

detail, you will learn to construct effective models that capture the core principles governing biological dynamics. We will utilize AI-assisted coding to bypass syntax hurdles, allowing us to focus on the principled evaluation and critical interpretation of our results. While these methods apply across all scales-from proteins to ecosystems-we will master them in the context of the microbiome. From the human gut to the soil, microbes form communities of staggering complexity that drive global nutrient cycles and human health. By exploiting high-dimensional sequencing and metabolite measurements, you will join a multidisciplinary frontier, learning to distill clear, predictive insight from the beautiful chaos of data.
Instructor(s): S. Kuehn Terms Offered: Spring. Spring quarter in even years. E.
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence AND 2 quarters of calculus, statistics, or physics, or BIOS 26210-26211 and any course that includes programming in Python (e.g. Intro to Data Science I (DATA11800), II (DATA11900), Introduction to Computer Programming I (CMSC 14100).

BIOS 26406. Machine Learning for Healthcare. 100 Units.
This course introduces machine learning in healthcare by covering the characteristics of clinical data and the application of machine learning techniques addressing challenges in healthcare and biology. The course will cover tasks such as precision medicine, diagnosis, subtype identification, biomarker identification, risk stratification, disease progression / outcome modeling. To do this, techniques beginning with basic classification and regression and working towards time-series analyses, deep learning, transfer learning, interpretability, causality, and unsupervised learning will be introduced. The first half of the course is problem set focused, and the second half of the course consists of each student proposing and completing a project using real world data (provided), focusing on the complexities of learning from these data and/or using machine learning to improve healthcare. The course will include a couple of guest lectures from Chicago-area clinicians.
Instructor(s): B. Beaulieu-Jones Terms Offered: Spring
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and prior coursework in statistics and Python programming, or consent of the instructor.
Note(s): GP.

BIOS 26420. Statistical Inference in Biology: Intuition from a Historical Perspective. 100 Units.
Biology is undergoing a substantial transition. With the advent of new technologies that enable the collection of massive amounts of data coupled with advances in computational frameworks and hardware, Biology is squarely in the era of statistical learning-inferring models of how Biology works from statistics rather than a deep understanding of complex mechanism. How did this shift come about? Why did this shift come about? How can we really understand how to deal with 'complexity' in Biology? This course is meant to provide students with an intuition regarding statistical inference as an emerging philosophy for studying Biology. As such, this course is centered around key papers that thematically frame (i) each week and (ii) several consecutive lectures of the course. We begin by introducing the concept of reductionism in Biology and its limitations. We move on to describing complexity and how the scientific need for statistical inference frameworks follows from this description. We discuss how these statistical inference frameworks have been implemented and how results from these frameworks have shaped our understanding of complex biological systems through extensive validation efforts and cutting-edge design strategies geared toward engineering synthetic biological systems. Finally, we discuss what key mathematical aspects define statistical inference, including a very short discussion regarding machine-learning and artificial intelligence applications in Biology.
Instructor(s): A. S. Raman Terms Offered: Spring
Prerequisite(s): BIOS 26120 and three quarters of a Biological Sciences Fundamentals sequence, or consent of the instructor.
Equivalent Course(s): GENE 36420

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.
Note(s): E.
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.
Note(s): E.
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 or BIOS 27714.
Note(s): E.
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.
Note(s): E.
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.
Note(s): E.
Equivalent Course(s): ENSC 24200

BIOS 27716. Methods and Concepts in Oceanography- at Marine Biological Laboratory. 100 Units.
This immersive course provides students with a thorough introduction to the core methodologies and concepts in oceanographic research. Over a 10-week period, with 3 hours of class each week, students will explore the dynamic systems that shape our oceans and the cutting-edge techniques used to study them. The course combines engaging lectures, hands-on laboratory work, and field work aboard a coastal research vessel to offer a comprehensive introduction to biological oceanography, physical oceanography, biogeochemistry, marine ecology, and the ever-changing nature of our oceans. Students will gain practical experience in key laboratory, field, and ship-board oceanographic techniques, including microscopy, molecular methods like PCR and sequencing, ocean sampling methods such as water column profiling using CTD casts and Niskin bottle grabs, and sediment grabs. Additionally, they will delve into the physical processes that drive ocean circulation, major oceanographic features, the role of primary and secondary production and the microbial loop in marine ecosystems, and the impact of climate change and human activities on ocean health. Throughout the course, students will actively participate in discussions, lab work, and field activities. They will be evaluated based on their engagement, performance in practical sessions, quizzes, and a final project report that synthesizes their learning and research findings.
Instructor(s): Marine Biological Laboratory Staff Terms Offered: Autumn. Offered as part of the Semester in Environmental Science (SES) at MBL in Woods Hole, MA. E.
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 25100

BIOS 27720. Microbiomes Across Environments. 100 Units.
This course provides a comprehensive introduction to the theory and techniques of microbiome science, an emerging field that bridges disciplines, merging microbiology with genomics, ecology, population and evolutionary biology, phylogenetics, ecosystem science, and biogeochemistry, and has broad applications in

medicine, agriculture, and ecosystem health. Through a combination of faculty and guest lectures and student-led discussion of primary literature we will explore the vast biochemical and metabolic diversity of the microbial world and its relationships with multicellular life. The major component of the course is an independent research project investigating the microbiomes of marine organisms collected by the students or resident in the MBL's Marine Resources Center, or of a salt marsh ecosystem in Woods Hole. Students develop their own hypotheses and sampling strategies, carry our sampling, extract DNA, and perform PCR for sequencing. The last third of the course is devoted to data analysis, where students learn to use the Unix-based bioinformatic tools necessary to find patterns in the hundreds of thousands of DNA sequences their project produced, a skill broadly applicable to any discipline in modern biology.
Instructor(s): D. Mark-Welch and B. Paul Terms Offered: Spring. L. Offered as part of the Spring Semester of Biological Discovery at MBL

BIOS 27723-27726-27727-27728. SEPTEMBER COURSES AT MARINE BIOLOGICAL LABORATORY, WOODS HOLE.
The September courses combine lecture with hands-on learning and development of independent research ideas and projects. All are taught by University of Chicago or MBL faculty, and take advantage of the unique research strengths and the natural environmental resources found at MBL. These are intensive, three-week-long courses that meet for up to eight hours per day for 5–6 days per week, combining morning lectures with afternoon labs and fieldwork. Each student can only enroll in one course at a time. The September courses at MBL have no prerequisites, and can count either to fulfill the general education requirement in Biology OR as an upper-level elective. More information, including application details and program fees, can be found at https://college.uchicago.edu/academics/mbl-september-courses. The MBL September courses end before classes commence in Chicago.

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: Summer. L. September term.
Note(s): This course will be given at Marine Biological Laboratories, Woods Hole, Massachusetts. E.

BIOS 27726. Marine Ecosystems: From Microbiomes, to Conservation, Climate & Beyond. 100 Units.
This course is designed for rising 2nd years with interests in microbiology, the environment, and society. More specifically, the course is designed for students considering a science major, as well as non-majors, who are looking for broad exposure to geosciences, environmental and climate science, microbiology, molecular biology, and the intersection between society and science. Students will study coastal marine habitats, connectivity to ocean and climate, dynamics of microbial community structure, and marine conservation alongside gaining experience on laboratory microbiome science and environmental field work. Students will gain firsthand experience with the types of microbes that that influence climate and that impact health through laboratory experiments on culturing and analyzing microbes in 'pristine' and highly impacted coastal ecosystems. Methods to be learned include plating, epifluorescence microscopy, flow cytometry, DNA extraction, and sequencing. Lectures will cover marine microbiology, CO_2 sequestration (natural and engineered), geochemistry, coastal and open ocean habitat structure, and links to climate and the climate crisis. We will also address equity issues in marine conservation and the climate crisis. While all field work will be coastal, students will also learn about the open ocean due to the key linkages of water masses as well as climate feedback.
Instructor(s): A. Worden Terms Offered: Summer. L. September term. This course will be given at Marine Biological Laboratories, Woods Hole, Massachusetts. E.
Equivalent Course(s): ENSC 24600

BIOS 27727. Light and Color in the Ocean. 100 Units.
Spectacular optical adaptations shape marine life, from sunlit shallows to the deep sea. We will explore how ocean creatures manipulate light-becoming transparent, ultra-black, iridescent, vividly colored, or bioluminescent-through the lens of physics, photosynthesis, and visual systems. With morning lectures, afternoon hands-on work, local outings, and a final research project, students will learn the physics and biology of light in the ocean. We encourage students to develop publishable original research projects using the fantastic resources of the MBL.
Instructor(s): D. McCoy Terms Offered: Summer. September Term at MBL. L.
Prerequisite(s): This course will be given at Marine Biological Laboratories, Woods Hole, Massachusetts. E.

BIOS 27728. The Meaning of Life: Experimenting with the History of Biology in Woods Hole. 100 Units.
This course, taught on-site at the Marine Biological Laboratory (MBL) in Woods Hole Massachusetts, examines early twentieth century biology through hands-on recreations of classic experiments. Course

undertakings include working with organisms like sea urchins, starfish, hydras, slipper snails, and plankton; fieldwork in local beaches, ponds, and marshes; laboratory experimentation using early twentieth century equipment; and close readings of historical sources in early twentieth-century experimental biology. By the end of this course, students will have gained experiences collecting, identifying, caring for, and working with classic invertebrate model organisms; they will be able to identify and explain key concepts and techniques in biology between 1900 and today; and they will be able to parse historical sources and recreate the knowledge-making strategies that shaped early twentieth century biology.
Instructor(s): M. Rossi Terms Offered: Summer. September Term at MBL
Prerequisite(s): This course can be counted as a biology topics course or as an upper-level elective for biology majors.
Equivalent Course(s): CEGU 27728

BIOS 27724. Introduction to Imaging for Biological Research. 100 Units.
Many breakthroughs in science have been made possible by revolutionary advances in our ability to visualize biological processes, and recent progress in microscopy has led to important breakthroughs in understanding life at the molecular, cellular, and organismal level. In this course, we will introduce the students to basic techniques in microscopy, starting with an opportunity for students to build their own simple microscopes, and then proceeding all the way to using state-of-the-art confocal, light sheet, and electron microscopes. Students will explore the challenges of sample preparation, of imaging processes in living cells, and in the computational analysis of imaging data. Throughout the course, students will be able to design their own experiments, and undertake a student-designed research project.
Instructor(s): Wolff, C., Kerr, L. Terms Offered: Spring
Prerequisite(s): Second-year standing or greater (or by consent) and acceptance into the Spring Quarter Program at MBL.
Equivalent Course(s): NSCI 21515

BIOS 27750. Stem Cells and Regeneration: from aquatic research organisms to mammals. 100 Units.
This course will focus on contemporary stem cell biology and regeneration with emphasis on molecular mechanisms and applications. The course will cover the history of stem cell discoveries through the latest advances, including genome-wide profiling, targeted gene editing, and other techniques used in stem cell and regeneration research. A portion of the course will consist of modules where specific stem cell types will be discussed together with relevant diseases they could impact (i.e. stem cells and neurodegeneration). A focus of the course will be around how discoveries in aquatic research organisms have driven the progress in regeneration biology. In this classroom and lab based course, students will have the opportunity to work on an independent research project under the supervision of a Resident Faculty at MBL. The lab portion of the course will introduce and provide hands-on experience on experimental approaches and techniques used in cell biology, development, and regeneration research. There will be a focus on microscopy (brightfield, fluorescence, high-resolution microscopy) and use of open source software to analyze images. There will be an introduction into the use of stains, antibodies, and genetically-encoded fluorescent markers to analyze cellular structures in aquatic organisms that include axolotls, Nematostella, worms, cephalopods and zebrafish. In addition, this course will provide hands-on experience through labs.
Instructor(s): K. Echeverri Terms Offered: Spring
Prerequisite(s): Second-year standing or greater (or by consent) and acceptance into the Spring Quarter Program at MBL.

BIOS 27751. Biological Oceanography. 100 Units.
This intensive four-week course addresses fundamental oceanographic processes that maintain and structure marine biodiversity and productivity, including physical oceanographic processes of dispersal and upwelling, environmental selection, biogeography, nutrient dynamics, primary production, and food web dynamics. Students will design an original research project during an initial week-long shore component at Marine Biological Laboratory (MBL) in Woods Hole, MA, and then address their own questions by collecting samples and data aboard Sea Education Association (SEA)'s oceanographic research sailing vessel, the SSV Corwith Cramer, on a 10-day offshore voyage. At sea students will deploy oceanographic instruments, interpret various data streams, and work as research teams and watch members as they navigate and sail the vessel. During a final week-long shore component at MBL, students will analyze and interpret the data they collected and present their results in written and oral reports.
Instructor(s): SEA Staff. Terms Offered: Spring. MBL Spring Quarter- Biology. L.
Prerequisite(s): Second-year standing or greater (or by consent).
Note(s): Course meets for three weeks (5-6 days/week, 8 hours per day) at Marine Biological Laboratories, in Woods Hole Massachusetts as part of the Spring Quarter at MBL. For more information see https://college.uchicago.edu/academics/mbl-spring-quarter-biology E.
Equivalent Course(s): ENSC 25000

BIOS 27752. Dynamic Camouflage: Behavior, Visual Perception and Neural Skin Patterning in Cephalopods. 100 Units.
This course takes an integrative approach to understanding a neurally controlled system of dynamic defense against visual predators. Camouflage is a widespread form of defense throughout the animal kingdom in every known habitat - land or sea. In the oceans, cephalopods (cuttlefish, octopus, squid) have evolved a sophisticated sensorimotor system called Rapid Adaptive Coloration, which can instantaneously change their total body

appearance within a fraction of a second to range from highly camouflaged to startlingly conspicuous for a wide range of behaviors. The forms and functions of this dynamic system will be teased apart in integrative fashion in a top-down approach from ecology to organismal biology to organs, tissues and cells. The course touches on neural anatomy, sensation, visual perception (including psychophysics) and animal behavior. There are also applied biology aspects of this system that will be presented as well.
Instructor(s): R. Hanlon Terms Offered: Spring
Prerequisite(s): Second-year standing or greater (or by consent) and acceptance into the Spring Quarter Program at MBL.
Note(s): E.
Equivalent Course(s): NSCI 21530

BIOS 27753. Fundamentals of Synapses. 100 Units.
In this course, students will learn about the fundamentals of synapses, from molecular analysis to structure and function. Marine and aquatic models have historically provided a unique opportunity to investigate synaptic function due to the large size of their neurons, including the synaptic connections. Today, these synapse models are used to study basic principles of neuron-to-neuron communication (synaptic transmission), as well as disease mechanisms. In addition to lectures and discussions of key literature, this course will feature hands-on laboratory-based exercises in molecular genetics, imaging and physiology of synapses, as well as independent "discovery" projects to explore new topics in synapse biology.
Instructor(s): J. Morgan, J. Rosenthal Terms Offered: Spring
Prerequisite(s): Second-year standing or greater (or by consent) and acceptance into the Spring Quarter Program at MBL.
Equivalent Course(s): NSCI 21510

BIOS 27760. An Introduction to Parasitology. 100 Units.
This course introduces the diversity of parasitic organisms, both protozoan and metazoan, and explores the life cycles, morphology, genomics, pathology, immunology, epidemiology, and treatment and control of major parasite groups. The focus will be on aquatic species, including those that cause disease in humans and livestock. The course will involve lectures, a journal club and lab work including carrying out a research project. The lab work and research project will include working on parasitic flatworms; in particular investigating the molecular and cellular biology of a tropical species, Schistosoma mansoni, that is medically important. Here, in this research-led institute, you will contribute novel data and information to ongoing research at MBL that will advance our understanding of parasites. The lab portion will introduce the morphological and molecular techniques that form part of the toolkit used by parasitologists to understand the biology of these organisms, an essential step in the search and development of novel control strategies and therapeutics.
Instructor(s): K. Rawlinson Terms Offered: TBD
Note(s): Offered at The Marine Biological Laboratory in Woods Hole, MA.

BIOS 27761. Embryology. 100 Units.
How do animals make eggs, and how to eggs make animals? How will a changing climate affect these processes? The most diverse group of animals in our oceans is the invertebrates. In this course, students will learn broad concepts in animal reproduction and development, from a biomedical, evolutionary, and climate perspective. Topics will include oogenesis, meiosis, fertilization, early development, and germ line specification, covered through morning lectures and journal club discussions of research papers. We will approach these topics through a cell biological and gene regulatory lens. In the lab, we will primarily work with the bat star Patiria miniata, but also with local sea urchin species that we will collect locally from Vineyard Sound (weather and spawning season permitting). Students will learn essential cell biological and embryological techniques including gamete and embryo/larval culture, staining, microinjection, live imaging, and cutting-edge approaches in CRISPR-Cas9 gene editing. Students will conduct independent embryology projects focusing on marine invertebrate reproduction and embryogenesis.
Instructor(s): Z. Swartz; MBL staff. Terms Offered: Spring. Spring Semester in Biological Discovery at Marine Biological Laboratory
Prerequisite(s): Second-year standing or greater (or by consent) and acceptance into the Spring Semester in Biological Discovery at MBL.

BIOS 27810. Epidemiology and Population Health. 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.
Instructor(s): D. Lauderdale Terms Offered: Autumn
Prerequisite(s): STAT 22000 or other introductory statistics highly desirable. For BIOS students-completion of the first three quarters of a Biological Sciences Fundamentals sequence.
Equivalent Course(s): HLTH 20910, STAT 22810, PPHA 36410, PBHS 30910

BIOS 27815. Infectious Diseases. 100 Units.
This course will examine infectious diseases with global health impact, analyzing their historic and projected impact, biological foundations, and preventive 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, Coronavirus) and the role of vaccines and other strategies for infectious disease elimination (smallpox, polio, malaria, river blindness). The course encompasses lectures and student presentations. Students have the option to write a paper in lieu of a final exam
Instructor(s): K. Beavis Terms Offered: Winter
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals Sequence or consent of instructor.
Note(s): This course is offered in Paris. For more information see: https://study-abroad.uchicago.edu/paris-global-health

BIOS 28101-28102. Science Communication.
The ability to communicate the importance, excitement, and rigor of science to the general public is a critical skill for scientists. By translating scientific research scientists can, among other things, shape public policy, create an informed voting population, and encourage funding for research. In these two courses, open to third- and fourth-year undergraduates, students will critically analyze different communication strategies and practice communicating science through assignments and interactive skill-building sessions. In BIOS 28101, students will translate primary research into written story form and publish their work on a digital platform. In BIOS 28102, students will communicate primary research by creating a video. Students can take a single course or both courses. Either BIOS 28101 or BIOS 28102 (but not both) can be applied toward a major in Biological Sciences. Students who would like to explore science communications in greater detail are encouraged to consider the minor in science communications and public discourse (http://collegecatalog.uchicago.edu/thecollege/sciencecommunicationpublicdiscourse).

BIOS 28101. Science Communication: Writing a Digital Science Story. 100 Units.
Students will gain skills in written and digital communication, focusing on translating primary scientific research to a general audience. Students will learn what makes an engaging written article and how to write for the public without sacrificing scientific accuracy or complexity. We will explore platforms such as newspapers, magazines, blogs and social media. Students will work with faculty mentors to complete two written pieces that communicate research findings and their significance to a general audience. Student articles may be disseminated on the websites of the Illinois Science Council, Marine Biology Laboratory, the Institute for Translational Medicine, or the National Institutes of Health. Students will walk away with a polished, published work.
Instructor(s): S. Serritella; S. Kron Terms Offered: Autumn
Prerequisite(s): Three quarters of physical or biological (including neuroscience) sciences. Third- or fourth-year standing. This course does not satisfy the general education requirement in the physical sciences.
Equivalent Course(s): SCPD 11100, PHSC 28101

BIOS 28102. Science Communication: Producing a Science Video Story. 100 Units.
Students will gain skills in oral communication and will apply these skills to produce a video communicating primary research in a scientific area of the student's choice. The goal is effective, engaging communication of science to a general audience without sacrificing scientific accuracy or complexity. Students will work with faculty to write scripts and design visual and audio elements. The talks will be filmed and edited in collaboration with UChicago Creative, who will assist with visual aids and animation. Students will leave the course with a professionally produced video that they can use to advance their career and promote their topic. While this course naturally follows BIOS 28101, that course is not a pre-requisite.
Instructor(s): S. Serritella; S. Kron. Terms Offered: Spring
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence. Third- or fourth-year standing. This course does not satisfy the general education requirement in the physical sciences.
Equivalent Course(s): PHSC 28102, SCPD 11200

BIOS 28105. Ethics through a Neurobiological Lens. 100 Units.
This class surveys a range of ethical dilemmas as viewed from a neurobiological perspective. Using their working knowledge of functional neuroanatomy, students will be expected to understand and articulate the reasoning behind multiple viewpoints for each topic. Then, students will be asked to discuss a particular case study that revolves around the week's topic, and write a one-page summary of what they learned from the week's discussion. For a final project, students will study one of the dilemmas presented or one of their own choosing.
Instructor(s): P. Mason Terms Offered: Spring
Prerequisite(s): At least one course in the Neuroscience Major Fundamental Sequence (NSCI 20101, OR NSCI 20111, OR NSCI 20130)
Equivalent Course(s): NSCI 21750

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 statistic 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): Yang Li Sebastian Pott Joshua A. Weinstein Terms Offered: Spring
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence including BIOS 20171, BIOS 20187 or BIOS 20235 and STAT 23400 or BIOS 26210 and BIOS 26211
Note(s): CB.
Equivalent Course(s): IMMU 47300, BPHS 47300, HGEN 47300, CABI 47300

BIOS 28411. Quantitative Systems Biology. 100 Units.
This course aims to provide students with knowledge on the use of modern methods for the analysis, manipulation, and modeling of complex biological systems, and to introduce them to some of the most important applications in quantitative and systems biology. We will first survey theoretical concepts and tools for analysis and modeling of biological systems like biomolecules, gene networks, single cells, and multicellular systems. Concepts from information theory, biochemical networks, control theory, and linear systems will be introduced. Mathematical modeling of biological interactions will be discussed. We will then survey quantitative experimental methods currently used in systems biology. These methods include single cell genomic, transcriptomic, and proteomic analysis techniques, in vivo and in vitro quantitative analysis of cellular and molecular interactions, single molecule methods, live cell imaging, high throughput microfluidic analysis, and gene editing. Finally, we will focus on case studies where the quantitative systems approach made a significant difference in the understanding of fundamental phenomena like signaling, immunity, development, and diseases like infection, autoimmunity, and cancer.
Instructor(s): Savas Tay Terms Offered: Winter
Prerequisite(s): Completion of three quarters of a Biological Sciences Fundamentals Sequence
Equivalent Course(s): MENG 32300, MENG 22300

BIOS 28900. Undergraduate Bachelor of Science Research. 100 Units.
Students who are completing the Biological Sciences major with a BS degree must register for this course in the autumn of the fourth year (see guidelines at https://college.uchicago.edu/academics/bs-guidelines-and-timeline) unless they are enrolled in the research course for the BSCD Honors program (BIOS 00296. Undergraduate Honors Research.) Students register in the Autumn Quarter but the course meets in both Autumn and Winter Quarters. Participants will give short presentations on their thesis research during these sessions. Students will receive a quality grade for the course upon submission of an approved BS thesis in Spring Quarter. BIOS 28900 can be counted as one upper-level elective toward the Biological Sciences major and may be counted among the three upper-level courses required for the BS.
Instructor(s): J. Malamy; C. Andrews Terms Offered: Autumn
Prerequisite(s): Students must be Biological Sciences majors pursuing the BS degree. This course is not open to students in the BSCD Honors program who are enrolled in BIOS 00296. (Undergraduate Honors Research).

Big Problems Courses

The following two courses are part of the Big Problems Curriculum franke.uchicago.edu/big-problems-courses (https://franke.uchicago.edu/big-problems-courses/). These courses may not be used as upper-level electives in the Biological Sciences major, nor can they be used to satisfy the general education requirement in the biological sciences, unless approved through petition to the BSCD Senior Advisors. They may count as upper-level electives in certain Interdisciplinary Biology Tracks.

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: fermentation and the chemistry and pharmacology of 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; how is alcohol metabolized; addiction; how does alcohol affect sensations; social problems; alcohol and religion; alcohol and health benefits; comparative case studies of drinking.
Instructor(s): M. Dietler, W. Green Terms Offered: May be offered in 2027-2028
Prerequisite(s): Third or fourth-year standing.
Equivalent Course(s): ANTH 25310, BPRO 22800, HLTH 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 2026-2027
Prerequisite(s): Third- or fourth-year standing

Equivalent Course(s): SSAD 65100, BPRO 24900

Specialized Courses

These courses may not be used as upper-level electives in the Biological Sciences major, nor can they be used to satisfy the general education requirement in the biological sciences, unless otherwise indicated in the course description or approved through petition to the BSCD Senior Advisors. They may count as upper-level electives in certain Interdisciplinary Biology Tracks.

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): P. La Riviere, S. Armato. Terms Offered: Winter
Prerequisite(s): This course does not meet requirements for the Biological Sciences major.
Equivalent Course(s): MPHY 29326

BIOS 29814. Biological and Social Determinants of Health. 100 Units.
Global health is an interdisciplinary and empirical field, requiring holistic and innovative approaches to navigate an ever-changing environment in the pursuit of health equity. This course will emphasize specific health challenges facing vulnerable populations in low resource settings including in the United States and the large scale social, political, and economic forces that contribute to them through topical events and case studies. Students will study the importance of science and technology, key institutions and stakeholders; environmental impacts on health; ethical considerations in research and interventions; maternal and child health; health and human rights; international legal frameworks and global health diplomacy. Students will gain skills in technical writing as they construct position statements and policy briefs on global health issues of interest. Career opportunities in global health will be explored throughout the course.
Instructor(s): C. Olopade and F. Olopade Terms Offered: Winter. This course is offered every Winter quarter in Paris.
Prerequisite(s): BIOS 27810 or consent of instructor.
Note(s): This course counts towards the Biological Sciences major ONLY for students in the Global & Public Health Track.
Equivalent Course(s): CCTS 22003, CCTS 42003

Independent Study and Research Courses

BIOS 00199-00299

Students pursuing independent research in the lab of a Biological Sciences Division faculty member may obtain credit by enrolling in the following courses. These courses cannot be counted toward the major in Biological Sciences. The College Reading and Research Form (https://college.uchicago.edu/advising/tools-forms/) is available from College Advising.

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.