BIOPHYSICS

Departmental Office: 600 Fairchild, 212-854-4581; mes2314@columbia.edu; biology@columbia.edu

Director of Undergraduate Studies, Undergraduate Programs and Laboratories:
Prof. Alice Heicklen, 744B Mudd; 212-854-5952; ah2289@columbia.edu

On-Line Resources:
Checklist of major requirements: http://biology.columbia.edu/programs/major-requirements
Additional course information: http://biology.columbia.edu/courses

For the first term of their introductory biology sequence, students may take either BIOL UN2005 INTRO BIO I: BIOCHEM,GEN,MOLEC, which has a prerequisite of chemistry, or EEBB UN2001 Environmental Biology I: Elements to Organisms, which does not require chemistry. EEBB UN2001 Environmental Biology I: Elements to Organisms may be taken in the first year.

BIOL UN2005 INTRO BIO I: BIOCHEM,GEN,MOLEC should be taken later, after general chemistry. For more details, see Introductory Courses under Requirements—Major in Biology. All students interested in biology are encouraged to take BIOL UN1908 First Year Seminar in Biology in the fall semester of their first year.

Non-science majors who wish to take a biology course to fulfill the science requirement are encouraged to take BIOL UN1130 Genes and Development. Interested students should consult listings in other departments for courses related to biology.

Advanced Placement

Transfer Credit

Transfer credits granted toward the degree are not automatically counted toward the major. The department determines which transfer credits can be counted toward the major. For most majors, at least four biology or biochemistry courses and at least 18 credits of the total (biology, biochemistry, math, physics, and chemistry) must be taken at Columbia. Barnard courses may not be substituted for the required Columbia courses without advance permission from the adviser. For neuroscience and behavior, one of the five biology course and one of the psychology courses may be transferred. Students who wish to count a course from outside Columbia toward their major must receive written approval from their adviser or the director of undergraduate studies. Students must supply a syllabus and/or course description to receive approval.

Advising

Biology Major and Concentration Advisers:
For a list of current biology, biochemistry, biophysics, and neuroscience and behavior advisers, please visit http://biology.columbia.edu/programs/advisors

• A-F: Prof. Alice Heicklen, 744B Mudd; ah2289@columbia.edu
• G-O: Prof. Mary Ann Price, 744A Mudd; map2293@columbia.edu
• P-Z: Prof. Tulle Hazelrigg, 753A Mudd; tih1@columbia.edu

Biochemistry Advisers:
Biology: Prof. Brent Stockwell, 1208 Northwest Corner Building; 212-854-2948; stockwell@columbia.edu
Chemistry: Prof. Virginia Cornish, 1209 Northwest Corner Building; 212-854-5209; vc114@columbia.edu

Biophysics Adviser: Prof. Ozgur Sahin, 908 Northwest Corner Building; os2246@columbia.edu

Neuroscience and Behavior Advisers:
Biology: Prof. Stuart Firestein, 1011B Fairchild; sjf24@columbia.edu
Psychology: Prof. Alfredo Spagna, 315 Schermerhorn; as5559@columbia.edu (Students with last names beginning A-L)
Psychology: Prof. Caroline Marvin, 317 Schermerhorn; cbm2118@columbia.edu (Students with last names beginning M-Z)

Summer Undergraduate Research Fellowship (SURF) Program

First-year students, sophomores, and juniors are eligible for the department’s paid internship program (SURF). This program is competitive; the department cannot assure every eligible student a place in any given summer.

Students apply to the program early in the spring term. A faculty committee headed by Dr. Alice Heicklen then matches selected students to appropriate labs. The deadline for SURF applications is at the beginning of the spring semester.

SURF students must submit a report on their work at the end of the summer session and participate in the following year’s annual Undergraduate Research Symposium. Although it does not carry any academic credit, SURF can be used toward the lab requirement for majors and toward graduation with honors. For detailed information on all summer research programs and how to apply, please visit the SURF website.

Current detailed descriptions of the SURF program and the application procedure are available at SURF's website, https://www.biology.columbia.edu/programs/surf. For more information on the Amgen Scholarship Program, please visit https://www.biology.columbia.edu/programs/amgen-scholars-program. Applications to all of these programs are through SURF.

Departmental Honors

Students must apply for departmental honors. Applications are due no later than one day before spring break of their senior year. For details, please visit the departmental website at http://biology.columbia.edu/programs/honors-biological-sciences.

Professors

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
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<tbody>
<tr>
<td>Peter Andolfatto</td>
<td>Departmental Honors Professor</td>
</tr>
<tr>
<td>Harmen Bussemaker</td>
<td>Biochemistry Adviser</td>
</tr>
</tbody>
</table>

• A-F: Prof. Alice Heicklen, 744B Mudd; ah2289@columbia.edu
• G-O: Prof. Mary Ann Price, 744A Mudd; map2293@columbia.edu
• P-Z: Prof. Tulle Hazelrigg, 753A Mudd; tih1@columbia.edu
Associate Professors

Lawrence Chasin
Stuart Firestein
Joachim Frank
Iva Greenwald
Tulle Hazelrigg
Oliver Hobert
John Hunt
Songtao Jia
Daniel Kalderon
Darcy Kelley
Laura Landweber
James Manley
Robert Pollack
Carol Prives
Ronald Prywes
Molly Przeworski
Michael Sheetz
Brent Stockwell
Simon Tavare
Saeed Tavazoie
Liang Tong
Jian Yang
Rafael Yuste
Guy Sella

Assistant Professors

Erin Barnhart
Laura Duvall
Jellert Gaublomme
Marko Jovanovic
Raju Tomer
Maria Tosches

Lecturers

Claire Elise Hazen
Alice Heicklen
Mary Ann Price
Lili Yamasaki

Adjunct Faculty

Lewis Brown
Ronald Guido
Jay Hammel
Danny Nam Ho
John Loike
Alan Morrison
Deborah Mowshowitz
Solomon Mowshowitz
Dana Pe'er
Vincent Racaniello
David Sable
Christian Schindler

Guidelines for all Biological Sciences Majors, Concentrators, and Interdepartmental Majors

Returning students should check the departmental website for any last-minute changes and/or additional information. See especially undergraduate updates and list of department courses. All major and...
concentration requirements are detailed on the website and links provided below.

Exceptions to Requirements
Students must get written permission in advance for any exceptions to the requirements listed below. For the exceptions to be applied toward graduation, the student must notify the biology department in one of the following two ways:

1. The student can file a completed paper planning form, signed by a faculty adviser, in the biology department office at 600 Fairchild; or
2. The faculty member approving the exception can send an e-mail explaining the exceptions to mes2314@columbia.edu.

Grade Requirements for the Major
A grade of C- or higher must be earned and revealed on your transcript for any course – including the first – to be counted toward the major or concentration requirements. The grade of P is not acceptable. A course that was taken Pass/D/Fail may be counted if and only if the P is uncovered by the Registrar’s deadline.

Courses
Courses with the subject code HPSC or SCNC do not count toward the majors or concentrations.

Major in Biology
General Information
The requirements for the biology major include courses in biology, chemistry, physics, and mathematics.

The required biology courses are one year of introductory biology, two core courses in biology or biochemistry, two 3-point electives in biology or biochemistry, and an appropriate lab experience. See below for details.

The required courses outside the biology department are chemistry through organic (plus labs), one year of college-level physics (plus lab), and the completion of one year of college-level mathematics (usually calculus).

Alternative sequences to the above may be arranged in special circumstances, but only with the permission of the director of undergraduate studies or a departmental adviser obtained in advance; for example, certain courses listed in the Summer Term Bulletin, the School of General Studies Bulletin, and the Barnard College Bulletin may be applied toward the major. In addition, selected courses at the Columbia-Presbyterian Medical Center are open to advanced undergraduates. Credit toward the major for courses not listed in the Columbia College Bulletin must be discussed in advance with the director of undergraduate studies or a departmental adviser. Students are responsible for notifying the department of all exceptions either in writing or by e-mail as explained above.

Alternative programs must be arranged in advance with the director of undergraduate studies. Students planning graduate work in biology should keep in mind that physical chemistry and statistics are important for many graduate programs.

Introductory Courses
The usual one-year introductory biology sequence is BIOL UN2005 INTRO BIO I: BIOCHEM,GEN,MOLEC-BIOL UN2006 INTRO BIO II:CELL BIO,DEV/PHYS, taken in the sophomore year, or EEBB UN2001 Environmental Biology I: Elements to Organisms-BIOL UN2006 INTRO BIO II:CELL BIO,DEV/PHYS, which may be taken in the first year.

Other sequences require permission in advance from the director of undergraduate studies or departmental advisers. Students with a strong background in chemistry or molecular biology may take BIOL UN2005 INTRO BIO I: BIOCHEM,GEN,MOLEC-BIOL UN2006 INTRO BIO II:CELL BIO,DEV/PHYS in their first year; the permission of one of the instructors is required.

Premedical students usually take BIOL UN2005 INTRO BIO I: BIOCHEM,GEN,MOLEC-BIOL UN2006 INTRO BIO II:CELL BIO,DEV/PHYS after a year of general chemistry; premedical students interested in the environmental sciences may take EEBB UN2001 Environmental Biology I: Elements to Organisms followed by BIOL UN2006 INTRO BIO II:CELL BIO,DEV/PHYS.

Students with advanced placement in biology are expected but not required to take EEBB UN2001 Environmental Biology I: Elements to Organisms or BIOL UN2005 INTRO BIO I: BIOCHEM,GEN,MOLEC as their initial biology course, because BIOL UN2005 INTRO BIO I: BIOCHEM,GEN,MOLEC-BIOL UN2006 INTRO BIO II:CELL BIO,DEV/PHYS is taught at a level of detail and depth not found in most advanced placement courses.

Students who wish to skip BIOL UN2005 INTRO BIO I: BIOCHEM,GEN,MOLEC and start with a higher-level biology course may do so, but they must obtain permission in advance from the director of undergraduate studies. For additional information, see FAQs for first-year students at http://www.columbia.edu/cu/biology/ug/advice/faqs/firstyr.html.

Core Courses
Two out of the following five departmental core courses are required:

<table>
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<tr>
<th>Course</th>
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<tbody>
<tr>
<td>BIOL UN3022</td>
<td>Developmental Biology</td>
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<tr>
<td>BIOL UN3031</td>
<td>GENETICS</td>
</tr>
<tr>
<td>BIOL UN3041</td>
<td>Cell Biology</td>
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<tr>
<td>BIOC GU4501 or BIOC UN3300</td>
<td>Biochemistry: Structure and Metabolism</td>
</tr>
<tr>
<td>BIOC GU4512</td>
<td>Molecular Biology</td>
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</tbody>
</table>

Laboratory Courses
A laboratory experience in biology is required. It may be fulfilled by completing any one of the following options:

Option 1:
Select one of the following 5-point laboratory courses:
- BIOL UN3058 Project Laboratory in Microbiology

Option 2:
Select an additional 3-point lab such as BIOL UN3040 or a Barnard lab.

Option 3:
Two terms of BIOL UN3500 taken for a letter grade, including the submission of a satisfactory research report at the end of each semester

Option 4:
Completion of all the requirements for one session of the Summer Undergraduate Research Fellowship (SURF). An additional semester of BIOL UN3500 in the same research lab is recommended but not required. Summer lab work under other auspices may not be substituted for the SURF Program.

The laboratory fee ($150) partially covers the cost of nonreturnable items. This fee is charged for all lab courses, including BIOL UN3500 Independent Biological Research.

**Upper-Level Elective Courses**

Select two additional courses, carrying at least 3 points each, from any of the 3000- or 4000- level lecture courses. BIOL UN3500 Independent Biological Research cannot be used as one of the courses to satisfy the upper-level elective course requirement.

**Chemistry**

All majors must take chemistry through organic including labs. One of the following three groups of chemistry courses is required:

**Option 1:**
- CHEM UN1403 GENERAL CHEMISTRY I-LECTURES
- CHEM UN1404 GENERAL CHEMISTRY II-LECTURES
- CHEM UN1500 GENERAL CHEMISTRY LABORATORY
- CHEM UN1501 GENERAL CHEMISTRY LAB-Lecture
- CHEM UN2443 Organic Chemistry I (Lecture) and ORGANIC CHEMISTRY II-LECTURES
- CHEM UN2493 Organic Chemistry Laboratory I (Techniques) and ORGANIC CHEM. LAB II SYNTHESIS

**Option 2:**
For students who qualify for intensive chemistry
- CHEM UN1604 2ND TERM GEN CHEM (INTENSIVE)
- CHEM UN1507 Intensive General Chemistry Laboratory
- CHEM UN2444 ORGANIC CHEMISTRY II-LECTURES and Organic Chemistry I (Lecture)
- CHEM UN2495 Organic Chem. Laboratory I and Organic Chem. Laboratory II

**Option 3:**
For students who qualify for first year organic chemistry
- CHEM UN1507 Intensive General Chemistry Laboratory
- CHEM UN2045 INTENSIVE ORGANIC CHEMISTRY and INTENSIVE ORG CHEM-FOR 1ST YEAR
- CHEM UN2495 Organic Chem. Laboratory I and Organic Chem. Laboratory II
- CHEM UN2545 Intensive Organic Chemistry Laboratory

**Physics**

Students must take two terms of physics including the accompanying labs. The usual choices are PHYS UN1201-PHYS UN1202 General Physics II and PHYS UN1201-PHYS UN1292 General Physics Laboratory II. Higher-level physics sequences are also acceptable. The 1400-level sequence is recommended for students who plan to take three terms of physics.

**Mathematics**

Two semesters of calculus or honors mathematics are required. Students may substitute one semester of statistics for one semester of calculus with an adviser's permission. For students with AP credit, completion of MATH UN1102 CALCULUS II, MATH UN1201 Calculus III, or MATH UN1207 Honors Mathematics A is sufficient. However, students with AP credit are encouraged to take additional courses in mathematics or statistics at Columbia.


**Major in Biochemistry**

The required basic courses for the biochemistry major are chemistry through organic, including laboratory, and one year each of physical chemistry, physics, calculus, biology, and biochemistry/molecular biology. The required additional courses are three lecture courses chosen from mathematics, chemistry, and biology, and two upper-level laboratory courses.


**Major in Biophysics**

The requirements for the biophysics major are as follows:

One year of introductory biology:
- BIOL UN2005 INTRO BIO I: BIOCHEM,GEN,MOLEC
- BIOL UN2006 and INTRO BIO II:CELL BIODEV/PHY

Select at least one of the following laboratory courses:
- BIOL UN3050 Project Laboratory In Protein Biochemistry
- BIOL UN3052 PROJECT LAB-MOLECULAR GENETICS
- BIOL UN3058 Project Laboratory in Microbiology
- BIOL UN3500 Independent Biological Research

One course in biochemistry or molecular biology:
- BCHM GU4501 BIOCHEM I-STRUCTURE/METABOLISM
  or BIOC UN3512 Molecular Biology
  or BIOC UN3310 Biochemistry

Select one of the following options:

**Option 1 - Genetics:**
- BIOL UN3031 GENETICS

**Option 2 - Neurobiology:**
- BIOL UN3004 Neurobiology I: Cellular and Molecular Neurobiology
  or BIOL UN3005 Neurobiology II: Development & Systems

**Option 3 - Developmental Biology:**
- BIOL UN3022 Developmental Biology

Select one of the following sequences to be completed at the end of sophomore year:

**PHYS UN1401:**
- PHYS UN1402 Introduction To Mechanics and Thermodynamics
- PHYS UN1403 and INTRO ELEC/MAGNETSM # OPTCS
- PHYS UN1494 and Introduction to Classical and Quantum Waves
  and Introduction to Experimental Physics

**PHYS UN1601:**
- PHYS UN1602 Physics, I: Mechanics and Relativity
- PHYS UN2601 and Physics, II: Thermodynamics,
- PHYS UN2699 Electricity, and Magnetism
  and Physics, III: Classical and Quantum Waves
  and Experiments in Classical and Modern Physics
PHYS UN2801 - PHYS UN2802 - PHYS UN3081

Accelerated Physics I and Accelerated Physics II
and INTERMEDIATE LABORATORY WORK

Select any two physics courses at the 3000-level or above, chosen in consultation with the adviser.

Calculus through MATH UN1202 or MATH UN1208

MATH UN3027

Ordinary Differential Equations

Chemistry through organic including labs; see biology major for options

Select one additional course at the 3000- or 4000-level, including BIOL GU4002, BIOC GU4323, and BIOC GU4324, in either physics or biology.

Major in Neuroscience and Behavior

In addition to one year of college general chemistry, ten courses are required to complete the major in neuroscience and behavior—five in biology and five in psychology.

CHEMISTRY COURSES

One year of college chemistry is required prior to taking Introductory Biology.

Biology Courses

One year of introductory biology.

BIOL UN2005 - BIOL UN2006

INTRO BIO I: BIOCHEM,GEN,MOLEC
and INTRO BIO II:CELL BIO,DEV/PHYS

One year of Neurobiology

BIOL UN3004 - BIOL UN3005

Neurobiology I: Cellular and Molecular Neurobiology
and Neurobiology II: Development & Systems

One additional 3000 or 4000 level biology lecture course from the following:

BIOL UN3006

PHYSIOLOGY

BIOL UN3019

Brain Evolution

BIOL UN3022

Developmental Biology

BIOL UN3025

Neurogenetics

BIOL UN3031

GENETICS

BIOL UN3799

Molecular Biology of Cancer

BIOL UN3041

Cell Biology

BIOL UN3073

Cellular and Molecular Immunology

BIOL UN3193

Stem Cell Biology and Applications

BIOC UN3300

Biochemistry

BIOL UN3404

The Global Threat of Antimicrobial Resistance

BIOL GU4034

(or BIOL UN3404)

BIOL GU4035

Seminar in Epigenetics

BIOL GU4075

Biology at Physical Extremes

BIOL GU4080

ANCIENT AND MODERN RNA WORLDS

BIOL GU4082

Theoretical Foundations and Applications of Biophysical Methods

BIOL GU4260

Proteomics Laboratory

BIOL GU4290

Biological Microscopy

BIOL GU4300

Drugs and Disease

BIOL GU4305

Seminar in Biotechnology

BIOC GU4323

Biophysical Chemistry I

BIOC GU4324

Biophysical Chemistry II

BCHM GU4501

BIOCHEM I-STRUCTURE/METABOLISM
(or BIOL UN3501)

BIOC GU4512

Molecular Biology (or BIOL UN3512)

BIOL GU4510

Genomics of Gene Regulation

BIOL GU4560

Evolution in the age of genomics

Psychology Courses

Each of the following courses:

PSYC UN1001
or PSYC UN1021

The Science of Psychology
Science of Psychology: Explorations and Applications

PSYC UN2430

COGNITIVE NEUROSCIENCE (Students who have previously taken PSYC UN1010 Mind, Brain and Behavior (no longer offered) may use that course to fulfill this requirement.)

or PSYC UN2450

Behavioral Neuroscience

or PSYC UN2470

Fundamentals of Human Neuropsychology

One statistics or research methods course from the following:

PSYC UN1420

RESEARCH METHODS - HUMAN BEHAVIOR

PSYC UN1450

RESEARCH METHODS - SOCIAL COGNITION # EMOTION

PSYC UN1455

RESEARCH METHODS: SOCIAL/PERSONALITY

PSYC UN1490

RESEARCH METHODS - COGNITION/DECISION MAKING

PSYC UN1610

Introductory Statistics for Behavioral Scientists

PSYC UN1660

Advanced Statistical Inference

STAT UN1101

Introduction to Statistics

STAT UN1201

Calculus-Based Introduction to Statistics
(Note, STAT UN1001 does not count towards the N&B major.)

One additional 2000- or 3000-level psychology lecture course from a list approved by the psychology advisor:

PSYC S2210Q

Cognition: Basic Processes

PSYC UN2215

Cognition and the Brain

or PSYC S2215D

Cognition and the Brain

PSYC UN2220

Cognition: Memory and Stress

PSYC W2225

Attention and Perception

PSYC W2330

Perception and Sensory Processes

PSYC UN2235

THINKING AND DECISION MAKING

or PSYC S2235Q

Thinking and Decision Making

PSYC UN2250

Evolution of Cognition

PSYC UN2280

Developmental Psychology

PSYC UN2420

Animal Behavior

PSYC UN2440

Language and the Brain

PSYC UN2450

Behavioral Neuroscience

or PSYC S2450Q

Behavioral Neuroscience

PSYC UN2460

Drugs and Behavior

PSYC UN2470

Fundamentals of Human Neuropsychology

PSYC UN2480

The Developing Brain

PSYC UN2481

Developmental Cognitive Neuroscience

PSYC S2490D

Evolutionary Psychology

PSYC UN2620

Abnormal Behavior

or PSYC S2620Q

Abnormal Behavior

PSYC UN2690

Frontiers of Justice
One advanced psychology seminar from a list approved by the psychology advisor:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>PSYC W3265</td>
<td>Auditory Perception (Seminar)</td>
</tr>
<tr>
<td>PSYC UN3270</td>
<td>Computational Approaches to Human Vision (Seminar)</td>
</tr>
<tr>
<td>PSYC UN3280 or PSYC S3280D</td>
<td>Seminar In Infant Development (Seminar)</td>
</tr>
<tr>
<td>PSYC S3285D</td>
<td>The Psychology of Disaster Preparedness</td>
</tr>
<tr>
<td>PSYC UN3290</td>
<td>Self: A Cognitive Exploration (Seminar)</td>
</tr>
<tr>
<td>PSYC GU4202</td>
<td>Theories of Change in Human Development</td>
</tr>
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<td>PSYC GU4222</td>
<td>The Cognitive Neuroscience of Aging (Seminar)</td>
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<td>PSYC GU4223</td>
<td>Memory and Executive Function Thru the Lifespan</td>
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<td>PSYC GU4242</td>
<td>Evolution of Language (Seminar)</td>
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<td>PSYC GU4244</td>
<td>Language and Mind</td>
</tr>
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<td>PSYC GU4250</td>
<td>Evolution of Intelligence, Cognition, and Language (Seminar)</td>
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<tr>
<td>PSYC GU4265</td>
<td>Auditory Perception</td>
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<tr>
<td>PSYC GU4270</td>
<td>COGNITIVE PROCESSES</td>
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<tr>
<td>PSYC GU4280</td>
<td>Core Knowledge (Seminar)</td>
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<tr>
<td>PSYC GU4281</td>
<td>The Psychology of Curiosity</td>
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<td>PSYC GU4282</td>
<td>The Neurobiology and Psychology of Play</td>
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<td>PSYC GU4285</td>
<td>Multidisciplinary Approaches to Human Decision Making (Seminar)</td>
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<td>PSYC GU4287</td>
<td>Decision Architecture</td>
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<tr>
<td>PSYC GU4289</td>
<td>THE GAMES PEOPLE PLAY:PSYCH OF STRAT DEC</td>
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<tr>
<td>PSYC S3410Q</td>
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<tr>
<td>PSYC W3435</td>
<td>Neurobiology of Reproductive Behavior (Seminar)</td>
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<td>PSYC UN3445</td>
<td>The Brain &amp; Memory</td>
</tr>
<tr>
<td>PSYC UN3450 or PSYC GU4450</td>
<td>Evolution of Intelligence, Animal Communication, # Language</td>
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<tr>
<td>PSYC UN3481</td>
<td>Critical Periods in Brain Development and Behavior</td>
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<td>PSYC W3484</td>
<td>Life Span Development: Theory and Methods</td>
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<td>PSYC UN3496 or PSYC S3490Q</td>
<td>Neuroscience and Society</td>
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<tr>
<td>PSYC W4415</td>
<td>Methods and Issues in Cognitive Neuroscience (Seminar)</td>
</tr>
<tr>
<td>PSYC GU4420</td>
<td>Animal Cognition (Seminar)</td>
</tr>
<tr>
<td>PSYC GU4430</td>
<td>Learning and the Brain (Seminar)</td>
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<td>PSYC GU4435</td>
<td>Non-Mnemonic Functions of Memory Systems</td>
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<tr>
<td>PSYC GU4440 or PSYC S4440Q</td>
<td>TOPICS-NEUROBIOLOGY &amp; BEH</td>
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<td>PSYC G4460</td>
<td>Cognitive Neuroscience and the Media (Seminar)</td>
</tr>
<tr>
<td>PSYC GU4470</td>
<td>Psychology &amp; Neuropsychology of Language (Seminar)</td>
</tr>
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<td>PSYC GU4480</td>
<td>Psychobiology of Infant Development (Seminar)</td>
</tr>
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<td>PSYC GU4482</td>
<td>Neural Plasticity</td>
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<tr>
<td>PSYC G4485</td>
<td>Affective Neuroscience (Seminar)</td>
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<td>PSYC GU4486</td>
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<tr>
<td>PSYC GU4493</td>
<td>Stress and the Brain</td>
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<tr>
<td>PSYC G4495</td>
<td>Ethics, Genetics, and the Brain</td>
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<tr>
<td>PSYC GU4496</td>
<td>Behavioral Neuroimmunology</td>
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<tr>
<td>PSYC GU4498</td>
<td>Behavioral Epigenetics</td>
</tr>
<tr>
<td>PSYC S3610D</td>
<td>The Psychology of Stereotyping &amp; Prejudice</td>
</tr>
<tr>
<td>PSYC UN3615</td>
<td>Children at Risk (Lecture)</td>
</tr>
<tr>
<td>PSYC UN3620</td>
<td>Seminar in Developmental Psychopathology</td>
</tr>
<tr>
<td>PSYC UN3623</td>
<td>Topics in Clinical Psychology</td>
</tr>
<tr>
<td>PSYC UN3624</td>
<td>Adolescent Mental Health: Causes, Correlates, Consequences</td>
</tr>
<tr>
<td>PSYC UN3625 or PSYC S3625Q</td>
<td>Clinical Neuropsychology (Seminar)</td>
</tr>
<tr>
<td>PSYC UN3655</td>
<td>Field Experimentation Methods for Social Psychology</td>
</tr>
<tr>
<td>PSYC UN3661</td>
<td>Happiness Studies Seminar</td>
</tr>
<tr>
<td>PSYC UN3671</td>
<td>Motivation Science</td>
</tr>
<tr>
<td>PSYC UN3680 or GU4685</td>
<td>Social Cognitive Neuroscience (Seminar)</td>
</tr>
<tr>
<td>PSYC UN3691</td>
<td>Interpersonal Cognition Seminar: Close Relationships, Identity, and Memory</td>
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<td>PSYC UN3693</td>
<td>Stress in an Interpersonal Context</td>
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<tr>
<td>PSYC GU4612</td>
<td>Frontiers of Justice</td>
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<tr>
<td>PSYC GU4615</td>
<td>PSYCH OF CULTURE &amp; DIVERS</td>
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<tr>
<td>PSYC GU4627</td>
<td>Seminar in Anxiety, Obsessive-Compulsive, and Related Disorders</td>
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<tr>
<td>PSYC GU4630</td>
<td>Advanced Seminar in Current Personality Theory and Research (Seminar)</td>
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<tr>
<td>PSYC GU4635</td>
<td>The Unconscious Mind (Seminar)</td>
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<tr>
<td>PSYC GU4645</td>
<td>Culture, Motivation, and Prosocial Behavior</td>
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<td>Socio-Ecological Psychology</td>
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<td>PSYC GU4682</td>
<td>FAQs about Life: Applications of Psychological Research to Everyday Experiences</td>
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<tr>
<td>PSYC GU4690</td>
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Concentration in Biology

Students who wish to concentrate in biology must design their programs in advance with the director of undergraduate studies or a departmental adviser.

The requirement for the concentration is 22 points in biology or biochemistry, with at least five courses chosen from the courses listed in the Biological Sciences section of the Bulletin. Additional courses in physics, chemistry, and mathematics are required as detailed below.

A project laboratory and BIOL UN2501 Contemporary Biology Laboratory may not both be counted toward the 22-point total. See the biology major requirements for additional information.

The requirements for the concentration in biology are as follows:

BIOL UN2005 INTRO BIO I: BIOCHEM, GEN, MOLEC
or EEB UN2001 Environmental Biology I: Elements to Organisms
BIOL UN2006 INTRO BIO II: CELL, BIO, DEV/PHYS

Select at least one of the following core courses:

- BIOL UN3022 Developmental Biology
- BIOL UN3031 GENETICS
- BIOL UN3041 Cell Biology
- BIOL GU4501 Biochemistry: Structure and Metabolism
  or BIOC UN3300 Biochemistry
- BIOC GU4512 Molecular Biology

Plus additional biology elective courses (see electives listed under biology major) to reach a total of 22 points in biology courses.

Beginning Fall 2018, no biology lab is required for the concentration. All other requirements remain the same, including enough electives to reach at least 22 points. Either UN2501 or a five-point lab course, but not both, may count towards the 22 point total.

All Courses

BIOC UN3300 Biochemistry. 3 points.
Prerequisites: one year each of Introductory Biology and General Chemistry. Corequisites: Organic Chemistry. Primarily aimed at nontraditional students and undergraduates who have course conflicts with BIOC UN3501.
Biochemistry is the study of the chemical processes within organisms that give rise to the immense complexity of life. This complexity emerges from a highly regulated and coordinated flow of chemical energy from one biomolecule to another. This course serves to familiarize students with the spectrum of biomolecules (carbohydrates, lipids, amino acids, nucleic acids, etc.) as well as the fundamental chemical processes (glycolysis, citric acid cycle, fatty acid metabolism, etc.) that allow life to happen. In particular, this course will employ active learning techniques and critical thinking problem-solving to engage students in answering the question: how is the complexity of life possible? NOTE: While Organic Chemistry is listed as a corequisite, it is highly recommended that you take Organic Chemistry beforehand.

BIOC UN3501 Biochemistry: Structure and Metabolism. 4 points.
Prerequisites: one year of BIOL UN2005 and BIOL UN2006 and one year of organic chemistry.
Lecture and recitation. Students wishing to cover the full range of modern biochemistry should take both BIOC UN3501 and BIOC UN3512. UN3501 covers subject matters in modern biochemistry, including chemical biology and structural biology, discussing the structure and function of both proteins and small molecules in biological systems. Proteins are the primary class of biological macromolecules and serve to carry out most cellular functions. Small organic molecules function in energy production and creating building blocks for the components of cells and can also be used to perturb the functions of proteins directly. The first half of the course covers protein structure, enzyme kinetics and enzyme mechanism. The second half of the course explores how small molecules are used endogenously by living systems in metabolic and catabolic pathways; this part of the course focuses on mechanistic organic chemistry involved in metabolic pathways.

BIOC UN3512 Molecular Biology. 3 points.
Prerequisites: one year of biology. Recommended but not required: BIOC UN3501.
This is a lecture course designed for advanced undergraduates and graduate students. The focus is on understanding at the molecular level how genetic information is stored within the cell and how it is regulated. Topics covered include genome organization, DNA replication, transcription, RNA processing, and translation. This course will also emphasize the critical analysis of the scientific literature and help students understand how to identify important biological problems and how to address them experimentally. SPS and TC students may register for this course, but they must first obtain the written permission of the instructor, by filling out a paper Registration Adjustment Form (Add/Drop form). The form can be downloaded at the URL below, but must be signed by the instructor and returned to the office of the registrar. http://registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf

BIOC GU4323 Biophysical Chemistry I. 4 points.
This course provides a rigorous introduction to the theory underlying widely used biophysical methods, which will be illustrated by practical applications to contemporary biomedical research problems. The course has two equally important goals. The first goal is to explicate the fundamental approaches used by physical chemists to understand the behavior of molecules and to develop related analytical tools. The second goal is to prepare students to apply these methods themselves to their own research projects. The course will be divided into seven modules: (i) solution thermodynamics; (ii) hydrodynamic methods; (iii) statistical analysis of experimental data; (iv) basic quantum mechanics; (v) optical spectroscopy with an emphasis on fluorescence; (vi) nuclear magnetic resonance spectroscopy; and (vii) light-scattering and diffraction methods. The first three modules will be covered during the fall term. In each module, the underlying physical theories and models with be presented and used to derive the mathematical equations applied to the analysis of experimental data. Weekly recitations will emphasize the analysis of real experimental data and understanding the applications of biophysical experimentation in published research papers.

BIOC GU4324 Biophysical Chemistry II. 4 points.
This course provides a rigorous introduction to the theory underlying widely used biophysical methods, which will be illustrated by practical applications to contemporary biomedical research problems. The course has two equally important goals. The first goal is to explicate the fundamental approaches used by physical chemists to understand the behavior of molecules and to develop related analytical tools. The second goal is to prepare students to apply these methods themselves to their own research projects. The course will be divided into seven modules: (i) solution thermodynamics; (ii) hydrodynamic methods; (iii) statistical analysis of experimental data; (iv) basic quantum mechanics; (v) optical spectroscopy with an emphasis on fluorescence; (vi) nuclear magnetic resonance spectroscopy; and (vii) light-scattering and diffraction methods. In each module, the underlying physical theories and models with be presented and used to derive the mathematical equations applied to the analysis of experimental data. Weekly recitations will emphasize the analysis of real experimental data and understanding the applications of biophysical experimentation in published research papers.
BIOC 4501 Biochemistry: Structure and Metabolism. 4 points.
Undergraduates should register for BIOC C3501.

Prerequisites: one year of BIOL C2005 and BIOL C2006 and one year of organic chemistry.
Lecture and recitation. Students wishing to cover the full range of modern biochemistry should take both BIOC C3501 and C3512. C3501 covers subject matters in modern biochemistry, including chemical biology and structural biology, discussing the structure and function of both proteins and small molecules in biological systems. Proteins are the primary class of biological macromolecules and serve to carry out most cellular functions. Small organic molecules function in energy production and creating building blocks for the components of cells and can also be used to perturb the functions of proteins directly. The first half of the course covers protein structure, enzyme kinetics and enzyme mechanism. The second half of the course explores how small molecules are used endogenously by living systems in metabolic and catabolic pathways; this part of the course focuses on mechanistic organic chemistry involved in metabolic pathways.

Fall 2022: BIOC 4501

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<td>4</td>
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BIOC GU4512 Molecular Biology. 3 points.
Prerequisites: one year of biology. Recommended but not required: BIOC UN3501
This is a lecture course designed for advanced undergraduates and graduate students. The focus is on understanding at the molecular level how genetic information is stored within the cell and how it is regulated. Topics covered include genome organization, DNA replication, transcription, RNA processing, and translation. This course will also emphasize the critical analysis of the scientific literature and help students understand how to identify important biological problems and how to address them experimentally. SCE and TC students may register for this course, but they must first obtain the written permission of the instructor, by filling out a paper Registration Adjustment Form (Add/Drop form). The form can be downloaded at the URL below, but must be signed by the instructor and returned to the office of the registrar. [http://registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf](http://registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf)

Spring 2022: BIOC GU4512

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BIOL UN1004 Foundations of Biology. 1.50 point.
In this course, we will introduce basic terminology, important concepts, and basic problem-solving skills in order to prepare biology and pre-health students for the challenging Biology courses they will take at Columbia. We will do a deep dive into a small number of topics and use these as access points to teaching skills that will aid them in future STEM courses. Classes will include time for problem solving, and there will be an optional recitation

Spring 2022: BIOL UN1004

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<th>Course Number</th>
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<td>Mary Ann Price</td>
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BIOL UN1130 Genes and Development. 3 points.
CC/GS: Partial Fulfillment of Science Requirement
Prerequisites: one year of high school or college biology.
This course covers selected topics in genetics and developmental biology, with special emphasis on issues that are relevant to contemporary society. Lectures and readings will cover the basic principles of genetics, how genes are expressed and regulated, the role of genes in normal development, and how alterations in genes lead to abnormal development and disease. We will also examine how genes can be manipulated in the laboratory, and look at the contributions of these manipulations to basic science and medicine, as well as some practical applications of these technologies. Interspersed student-run workshops will allow students to research and discuss the ethical and societal impacts of specific topics (e.g. in vitro fertilization, uses and misuses of genetic information, genetically modified organisms, steroid use, and cloning). SCE and TC students may register for this course, but they must first obtain the written permission of the instructor, by filling out a paper Registration Adjustment Form (Add/Drop form). The form can be downloaded at the URL below, but must be signed by the instructor and returned to the office of the registrar. [http://registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf](http://registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf)

Spring 2022: BIOL UN1130

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<td>Tulle Hazelrigg</td>
<td>3</td>
<td>20/22</td>
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</table>

BIOL UN1002 Theory and Practice of Science: Biology. 4 points.
CC/GS: Partial Fulfillment of Science Requirement
Prerequisites: either BIOL UN1015 or AP biology, or the instructor’s permission.
Lecture and recitation. By analysis and example from the primary literature of evolution and genetics, examines how scientific theories are invented and how they come to be accepted, verified, and in some cases rejected. Papers begin with Darwin and Mendel and end with Watson. Ordinarily does not fulfill biology major or concentration requirements. Normally may not be taken for credit by any student who has previously completed any biology course numbered 2000 or above. BIOL UN1015 should be taken first then BIOL UN1002 for non-science majors.
BIOL UN1360 Science and Society. 3.00 points.
This course, which has been given at another institution for the past five years, uses a seminar discussion format to examine the relationship between science and society from numerous perspectives, using examples from many fields of science, mostly biology and medicine, including the Covid-19 pandemic. We welcome undergraduates from all classes who are concentrating in any field of sciences, humanities, or the arts; there are no prerequisites, other than an interest in how the scientific enterprise works. The course addresses a wide array of topics: why do people choose a scientific career; why do governments and other funders support scientific work; how does science fail; why is there widespread skepticism about science; how is it represented in the arts; how are results disseminated, evaluated, and legally protected; and many other subjects. Assignments—mainly short articles (from newspapers and journals) and book chapters, but also a few films and novels—will be provided for each class, and every student will undertake a term project of their own choosing, after consultations with the instructor.

BIOL UN1908 First Year Seminar in Biology. 1.00 point.
If you are interested in doing biology-related research at Columbia University this is the course for you. Each week a different Columbia University professor's discusses their biology-related research giving you an idea of what kind of research is happening at Columbia. Come ask questions and find out how the body works, the latest therapies for disease and maybe even find a lab to do research in. http://www.columbia.edu/cu/biology/courses/UN1908/index.html

BIOL UN2006 INTRO BIO II: CELL BIO, DEV/PHYS. 4.00 points.
Prerequisites: EEBE UN2001 or BIOL UN2005, or the instructor's permission.
Prerequisites: EEBE UN2001 or BIOL UN2005, or the instructors permission. Lecture and recitation. Recommended second term of biology for majors in biology and related majors, and for premedical students. Cellular biology and development; physiology of cells and organisms. Website: http://www.columbia.edu/cu/biology/courses/c2006/ SPS, Barnard, and TC students may register for this course, but they must first obtain the written permission of the instructor, by filling out a paper Registration Adjustment Form (Add/Drop form). The form can be downloaded at the URL below, but must be signed by the instructor and returned to the office of the registrar. http://registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf Students must register for a recitation section BIOL UN2016

BIOL UN2005 INTRO BIO I: BIOCHEM, GEN, MOLEC. 4.00 points.
Prerequisites: one year of college chemistry, or a strong high school chemistry background.
Prerequisites: one year of college chemistry is required. Lecture and recitation. Recommended as the introductory biology course for biology and related majors, and for premedical students. Fundamental principles of biochemistry, molecular biology, and genetics. Website: http://www.columbia.edu/cu/biology/courses/cc2005/index.html. SPS, Barnard, and TC students may register for this course, but they must first obtain the written permission of the instructor, by filling out a paper Registration Adjustment Form (Add/Drop form). The form can be downloaded at the URL below, but must be signed by the instructor and returned to the office of the registrar. registrar. http://registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf
**BIOL UN2015 INTRO BIO I: BIOCHEM, GEN, MOLEC. 0.00 points.**
Lecture and recitation. Recommended as the introductory biology course for biology and related majors, and for premedical students. Fundamental principles of biochemistry, molecular biology, and genetics. SPS, Barnard, and TC students may register for this course, but they must first obtain the written permission of the instructor, by filling out a paper Registration Adjustment Form (Add/Drop form). The form can be downloaded at the URL below, but must be signed by the instructor and returned to the office of the registrar. http://registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf

### Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
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### BIOL UN2016 INTRO BIO II: CELL BIO, DEV/PHYS. 0 points.
Prerequisites: Course does not fulfill Biology major requirements or premedical requirements. Enrollment in laboratory limited to 16 students per section.
Corequisites: BIOL UN2006
Prerequisites: Course does not fulfill Biology major requirements or premedical requirements. Enrollment in laboratory limited to 16 students per section. Exploration of the major discoveries and ideas that have revolutionized the way we view organisms and understand life. The basic concepts of cell biology, anatomy and physiology, genetics, evolution, and ecology will be traced from seminal discoveries to the modern era. The laboratory will develop these concepts and analyze biological diversity through a combined experimental and observational approach.

### Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
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<td>Th 12:10pm - 2:00pm 253 Engineering Terrace</td>
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BIOL UN2401 Contemporary Biology Laboratory. 3 points.
Enrollment per section limited to 28. Lab Fee: $150.
Fee: Lab Fee - 150.00

Prerequisites: Strongly recommended prerequisite or corequisite: BIOL UN2005 or BIOL UN2401.
Experiments focus on genetics and molecular biology, with an emphasis on data analysis and experimental techniques. The class also includes a study of mammalian anatomy and histology. SPS and TC students may register for this course, but they must first obtain the written permission of the instructor, by filling out a paper Registration Adjustment Form (Add/Drop form). The form can be downloaded at the URL below, but must be signed by the instructor and returned to the office of the registrar. http://registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf

BIOL UN2402 Contemporary Biology II: Cell Biology, Development & Physiology. 3 points.
Prerequisites: a course in college chemistry and BIOL UN2005 or BIOL UN2401, or the written permission of either the instructor or the premedical adviser.
Cellular biology and development, physiology of cells and organisms. Same lectures as BIOL UN2006, but recitation is optional. For a detailed description of the differences between the two courses, see the course web site or http://www.columbia.edu/cu/biology/courses/c2006/index.html. Website: http://www.columbia.edu/cu/biology/courses/c2006/.
SPS, Barnard, and TC students may register for this course, but they must first obtain the written permission of the instructor, by filling out a paper Registration Adjustment Form (Add/Drop form). The form can be downloaded at the URL below, but must be signed by the instructor and returned to the office of the registrar. http://registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf

BIOL UN2501 Foundations for Lab Biology. 3.00 points.
Due to COVID-19 related restrictions on in-person laboratory work, this course acts as a replacement for BIOL UN2501. This course will act as a virtual introduction to the practice of contemporary biology, with an emphasis on common laboratory methods, online tools, statistical analysis, styles of scientific reasoning, and science communication. Students will be expected to watch a weekly lecture, either in-person or via recording. Lab activities are designed to be highly interactive and collaborative to reflect the realities of biological research. Small groups of students will work together on in-class activities, as well as on a long-term student-designed biological research project

Fall 2022: BIOL UN2401

<table>
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<tr>
<th>Course</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
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Spring 2022: BIOL UN2501

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Fall 2022: BIOL UN2501

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Spring 2022: BIOL UN2402

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<th>Course</th>
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<td>BIOL 2402</td>
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<td>T Th 4:10pm - 5:25pm</td>
<td>309 Havemeyer Hall</td>
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</table>
BIOL UN2700 Past and future of the human genome. 3 points.
CC/GS: Partial Fulfillment of Science Requirement

We can now determine the genetic makeup of any person in a matter of days and at a cost already within reach for many millions of people. For the past few years a movement has emerged to provide detailed genetic information directly to ordinary people, in some cases with the explicit aim of helping prospective parents to “eliminate preventable genetic disease” or, as one newspaper put it, to promote “genetically flawless babies.”

But our technical capacity to both interrogate and manipulate the human genome has raced far ahead of serious consideration of the societal implications of doing so. This course will provide students with the background necessary to understand what has and will be done with the human genome and ultimately to help society formulate appropriate policies for wise stewardship of the human genome.

To help illustrate the information available in the human genome and how it may influence individuals’ lives, the instructors’ will share and discuss their own and other public genomes in ways both molecular and personal.

BIOL UN3004 Neurobiology I: Cellular and Molecular Neurobiology. 4 points.
Discussion Section Required

Prerequisites: one year of biology; a course in physics is highly recommended.

Lecture and recitation. This is an advanced course intended for majors pursuing careers in medicine as well as those that will pursue careers in biomedical research. This course will also be of interest to graduate students desiring an introduction to the cellular physiology of nerve and muscle.

This course will present a quantitative description of the cellular physiology of excitable cells (mostly nerve and muscle). While the course will focus on examining basic mechanisms in cell physiology, there will be a thread of discussion of disease mechanisms throughout. The end of each lecture will include a discussion of the molecular mechanisms of selected diseases that relate to the topics covered in the lecture. The course will consist of two lectures per week. This course will be of interest to advanced (3000-4000 level) undergraduates that aim to pursue careers in medicine as well as those that will pursue careers in biomedical research. This course will also be of interest to graduate students desiring an introduction to the cellular physiology of nerve and muscle.

BIOL UN3005 Neurobiology II: Development & Systems. 4 points.
Prerequisites: BIOL UN3004, one year of biology, or the instructor’s permission.

This course is the “capstone” course for the Neurobiology and Behavior undergraduate major at Columbia University and will be taught by the faculty of the Kavli Institute of Brain Science: http://www.kavli.columbia.edu/Science: http://www.kavli.columbia.edu/.

It is designed for advanced undergraduate and graduate students. Knowledge of Cellular Neuroscience (how an action potential is generated and how a synapse works) will be assumed. It is strongly recommended that students take BIOL UN3004 Neurobiology I: Molecular and Cellular Neuroscience, or a similar course, before enrolling in BIOL UN3005. Students unsure about their backgrounds should check a representative syllabus of BIOL UN3004 on the BIOL UN3004 website (http://www.columbia.edu/cu/biology/courses/w3004/). Website for BIOL UN3005: http://www.columbia.edu/cu/biology/courses/w3005/index.html

Spring 2022: BIOL UN3005

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<th>Course Number</th>
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BIOL UN3006 PHYSIOLOGY. 3.00 points.
Prerequisites: (BIOL UN2005 and BIOL UN2006) or (BIOL UN2401 and BIOL UN2402) or the instructor’s permission.

Major physiological systems of vertebrates (circularatory, digestive, hormonal, etc.) with emphasis on cellular and molecular mechanisms and regulation. Readings include research articles from the scientific literature. SCE and TC students may register for this course, but they must first obtain the written permission of the instructor, by filling out a paper Registration Adjustment Form (Add/Drop form). The form can be downloaded at the URL below, but must be signed by the instructor and returned to the office of the registrar. http://registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf

Fall 2022: BIOL UN3006

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BIOL UN3008 The Cellular Physiology of Disease. 3 points.
Prerequisites: one 3000-level course in Cell Biology or Biochemistry, or the instructor’s permission.

This course will present a quantitative description of the cellular physiology of excitable cells (mostly nerve and muscle). While the course will focus on examining basic mechanisms in cell physiology, there will be a thread of discussion of disease mechanisms throughout. The end of each lecture will include a discussion of the molecular mechanisms of selected diseases that relate to the topics covered in the lecture. The course will consist of two lectures per week. This course will be of interest to advanced (3000-4000 level) undergraduates that aim to pursue careers in medicine as well as those that will pursue careers in biomedical research. This course will also be of interest to graduate students desiring an introduction to the cellular physiology of nerve and muscle.
BIOL UN3015 Neurobiology II Recitation. 0.00 points.
Discussion/recitation section for BIOL UN3005 Neurobiology II
Spring 2022: BIOL UN3015

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BIOL UN3019 Brain Evolution. 3.00 points.
If an engineer were to build "the brain", they would not be able to reproduce any of the brains that exist on Earth. Our brains were not designed to be perfect, but are a result of millions of years of evolution and adaptation. The goal of this course is to provide an overview of brain evolution, ranging from the evolution of the first neurons to the origin of the human brain. Specifically, the course will focus on recent insights emerging from studies of development, gene expression, and neural circuit architecture. The evolutionary perspective on commonly used terms, such as "neuron" and "brain", and general principles of brain organization and function emerging from comparative studies will be discussed

Spring 2022: BIOL UN3019

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<th>Course</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
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<td>707 Hamilton Hall</td>
<td>Maria Tosches</td>
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BIOL UN3022 Developmental Biology. 3 points.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: BIOL UN2005 and BIOL UN2006 or equivalent.
Come discover how the union of egg and sperm triggers the complex cellular interactions that specify the diverse variety of cells present in multicellular organisms. Cellular and molecular aspects of sex determination, gametogenesis, genomic imprinting, X-chromosome inactivation, telomerase as the biological clock, stem cells, cloning, the pill and cell interactions will be explored, with an emphasis on humans. Original research articles will be discussed to further examine current research in developmental biology. SPS and TC students may register for this course, but they must first obtain the written permission of the instructor, by filling out a paper Registration Adjustment Form (Add/ Drop form). The form can be downloaded at the URL below, but must be signed by the instructor and returned to the office of the registrar. http://registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf

Fall 2022: BIOL UN3022

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<td>601 Fairchild Life Sciences Bldg</td>
<td>Alice Heicklen</td>
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BIOL UN3025 Neurogenetics. 3 points.
Prerequisites: (BIOL UN2005 and BIOL UN2006)
This course provides an introduction to Neurogenetics, which studies the role of genetics in the development and function of the nervous system (https://en.wikipedia.org/wiki/Neurogenetics). The course will be focused on teaching classic and contemporary concepts in genetics and neuroscience, rather than cataloguing mere facts. The course will emphasize the discovery processes, historical figures involved in these processes and methodologies of discovery. Primary research papers will be discussed in detail. A central organizational theme of the course is the presence of a common thread and narrative throughout the course. The common thread is an invertebrate model system, the roundworm Caenorhabditis elegans, which serves as a paradigm to show how simple genetic model systems have informed our view on the genetics of nervous system development and function. The ultimate goal of this course is to gain an understanding of the underlying principles of how the nervous system of one specific animal species forms, from beginning to end. The course is intended for neuroscience-inclined students (e.g. neuroscience majors) who want to learn about how genetic approaches have informed our understanding of brain development and function and, vice versa, for students with an interest in molecular biology and genetics, who want to learn about key problems in neuroscience and how genetic approaches can address them.

Fall 2022: BIOL UN3025

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<td>Oliver Hobert</td>
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BIOL UN3031 GENETICS. 3.00 points.
Students may receive credit for BIOL W3031 or BIOL C3032, but not both due to overlap in course content.

Prerequisites: BIOL UN2005 and BIOL UN2006 or the equivalent.
Prerequisites: BIOL UN2005 and BIOL UN2006. General genetics course focused on basic principles of transmission genetics and the application of genetic approaches to the study of biological function. Principles will be illustrated using classical and contemporary examples from prokaryote and eukaryote organisms, and the experimental discoveries at their foundation will be featured. Applications will include genetic approaches to studying animal development and human diseases. SPS and TC students must obtain the written permission from the instructor, by filling out a Registration Adjustment Form (Add/ Drop form). https://www.registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf

Spring 2022: BIOL UN3031

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Fall 2022: BIOL UN3032

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<td>Alice Heicklen</td>
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BIOL UN3034 Biotechnology. 3 points.
CC/GS: Partial Fulfillment of Science Requirement
For upper-level undergraduates.

Prerequisites: genetics or molecular biology.
The course covers techniques currently used to explore and manipulate
gene function and their applications in medicine and the environment.
Part I covers key laboratory manipulations, including DNA cloning,
gene characterization, association of genes with disease, and methods
for studying gene regulation and activities of gene products. Part II
also covers commercial applications, and includes animal cell culture,
production of recombinant proteins, novel diagnostics, high throughput
screening, and environmental biosensors. SCE and TC students may
register for this course, but they must first obtain the written permission
of the instructor, by filling out a paper Registration Adjustment Form
(Add/Drop form). The form can be downloaded at the URL below, but
must be signed by the instructor and returned to the office of the
registrar. http://registrar.columbia.edu/sites/default/files/content/reg-
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BIOL UN3040 Lab in Molecular Biology. 3 points.
Enrollment limited to 12. Lab fee: $150.

Prerequisites: one year of biology (BIOL UN2005 and BIOL UN2006) and
Contemporary Biology Laboratory (BIOL UN2501).
Prerequisites: one year of biology (UN2005-UN2006) and Contemporary
Biology Laboratory (UN2501). This lab will explore various molecular
biology techniques frequently utilized in modern molecular biology
laboratories. The lab will consist of four modules: 1) Molecular
verification of genetically modified organisms (GMOS); 2) Site-directed
mutagenesis; 3) gDNA extraction, PCR amplification, sequencing
and GenBank analysis of the COI genes from diverse fish species
and 4) protein gel analysis of fish muscle components. SPS and TC
students may register for this course, but they must first obtain the
written permission of the instructor, by filling out a paper Registration
Adjustment Form (Add/Drop form). The form can be downloaded at:
http://registrar.columbia.edu/sites/default/files/content/reg-
adjustment.pdf

BIOL UN3041 Cell Biology. 3 points.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: one year of biology, normally BIOL UN2005-BIOL UN2006,
or the equivalent.
Cell Biology 3041/4041 is an upper-division course that covers in depth
all organelles of cells, how they make up tissues, secrete substances
important for the organism, generate and adapt to their working
environment in the body, move throughout development, and signal
to each other. Because these topics were introduced in the Intro Course
(taught by Mowshowitz and Chasin), this course or its equivalent is a
pre-requisite for W3041/4041. Students for whom this course is useful
include biology, biochem or biomedical engineering majors, those
preparing to apply for medical school or graduate school, and those doing
or planning to start doing research in a biology or biomedical lab. SCE
and TC students may register for this course, but they must first obtain
the written permission of the instructor, by filling out a paper Registration
Adjustment Form (Add/Drop form). The form can be downloaded at the
URL below, but must be signed by the instructor and returned to the office of
the registrar. http://registrar.columbia.edu/sites/default/files/content/
reg-adjustment.pdf

BIOL UN3050 Project Laboratory In Protein Biochemistry. 5 points.
Prerequisites: one year of biology (UN2005-UN2006) plus one upper-level
course recommended. Enrollment is not restricted as long as total is no
more than 14. Seniors will be given preference in the unlikely event that
restriction is necessary. Students with specific questions should e-mail
the instructor (jfh21@columbia.edu).
This course provides an intensive introduction to professional
biomedical laboratory research. Students conduct a portion of an
ongoing biochemical research project and write-up their results in a
format suitable for publication in a peer-reviewed scientific research
journal. Techniques in molecular biology and protein biochemistry are
used to address a problem in mechanistic biochemistry or molecular
pharmacology. Students are exposed to the full spectrum of techniques
used in contemporary protein biochemistry, including molecular
sequence analysis of genomic databases, molecular cloning and
manipulation of recombinant DNA, protein expression in E. coli, protein
purification, and biophysical characterization (typically including
crystallization for x-ray structure determination). The course emphasizes
the use of critical thinking skills in scientific research while giving
students the opportunity to apply the basic knowledge learned in a
wide variety of biology and chemistry lecture courses to a real research
project. Examples of past projects can be found on the course website:
https://www1.columbia.edu/sec/cu/biology/courses/w3050/class/index.html (cunix account required to login).
BIOL UN3052 PROJECT LAB-MOLECULAR GENETICS. 5.00 points.
Enrollment limited to approximately 12. Fee: $150.

Prerequisites: one year of introductory biology and the instructor's permission.
Multicellular animals contain a diverse array of cell types, yet start from a single cell. How do cells decide what kind of cell to be? In this lab course, we will use the tools of molecular biology and genetics to explore this fascinating question. We will use the nematode Caenorhabditis elegans, a powerful model organism used in hundreds of research labs. The course will be divided into three modules: C. elegans genetics, molecular cloning, and genetic screening. Laboratory techniques will include PCR, gel electrophoresis, restriction digest, ligation, transformation, RNAi, and C. elegans maintenance. Students will pursue original projects; emphasis will be placed on scientific thinking and scientific communication. SPS and TC students may register for this course, but they must first obtain the written permission of the instructor, by filling out a paper Registration Adjustment Form (Add/Drop form). Prerequisites: UN2005/UN2401 and UN2006/UN2402, or the equivalent at a different institution.

BIOL UN3058 Project Laboratory in Microbiology. 5 points.
Lab fee: $150.

Prerequisites: one year of Intro Bio. An introductory biology or chemistry lab is recommended.
Bacteria are not just unicellular germs. This lab course will broaden your awareness of the amazing world of microbiology and the diverse capabilities of microbes. The focus will be on bacterial multicellularity, pigment production, and intercellular signaling. Pigment-producing bacteria will be isolated from the wild (i.e. Morningside Campus or your skin), and characterized using standard genetic tools (PCR, DNA gel electrophoresis, transformation, screen) and microbiology techniques (isolation of bacteria and growth of bacterial colonies, media preparation, enrichment techniques for pigments). These techniques will also be applied in the study of bacterial multicellularity and signaling in the standard lab strain Pseudomonas aeruginosa. SCE and TC students may register for this course, but they must first obtain the written permission of the instructor, by filling out a paper Registration Adjustment Form (Add/Drop form). The form can be downloaded at the URL below, but must be signed by the instructor and returned to the office of the registrar. http://registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf

BIOL UN3073 Cellular and Molecular Immunology. 3 points.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: two semesters of a rigorous, molecularly-oriented introductory biology course (such as UN2005 and UN2006), or the instructor’s permission.
This course will cover the basic concepts underlying the mechanisms of innate and adaptive immunity, as well as key experimental methods currently used in the field. To keep it real, the course will include clinical correlates in such areas as infectious diseases, autoimmune diseases, cancer immunotherapy and transplantation. Taking this course won’t turn you into an immunologist, but it may make you want to become one, as was the case for several students last year. After taking the course, you should be able to read the literature intelligently in this rapidly advancing field. SCE and TC students may register for this course, but they must first obtain the written permission of the instructor, by filling out a paper Registration Adjustment Form (Add/Drop form). The form can be downloaded at the URL below, but must be signed by the instructor and returned to the office of the registrar. http://registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf

BIOL UN3190 STEM CELLS: BIOL,ETHICS,APPLIC. 3.00 points.

BIOL UN3193 Stem Cell Biology and Applications. 3 points.

Prerequisites: three semesters of Biology or the instructor's permission.
The course examines current knowledge and potential medical applications of pluripotent stem cells (embryonic stem cells and induced pluripotent stem cells), direct conversions between cell types and adult, tissue-specific stem cells (concentrating mainly on hematopoietic and gut stem cells as leading paradigms). A basic lecture format will be supplemented by presentations and discussions of research papers. Recent reviews and research papers, together with extensive instructor notes, will be used in place of a textbook. SCE and TC students may register for this course, but they must first obtain the written permission of the instructor, by filling out a paper Registration Adjustment Form (Add/Drop form). The form can be downloaded at the URL below, but must be signed by the instructor and returned to the office of the registrar. http://registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf

BIOL UN3208 Introduction to Evolutionary Biology. 3 points.

Prerequisites: recommended preparation: an introductory course in college biology.
Introduction to principles of general evolutionary theory, both nomological and historical; causes and processes of evolution; phylogenetic evolution; species concept and speciation; adaptation and macroevolution; concepts of phylogeny and classification.

BIOL UN3310 Virology. 3 points.

Prerequisites: two semesters of a rigorous, molecularly-oriented introductory biology course (such as BIOL UN2005), or the instructor’s permission.
The course will emphasize the common reactions that must be completed by all viruses for successful reproduction within a host cell and survival and spread within a host population. The molecular basis of alternative reproductive cycles, the interactions of viruses with host organisms, and how these lead to disease are presented with examples drawn from a set of representative animal and human viruses.
BIOL UN3320 Regulation of Behaviors for Survival. 4.00 points.
To maximize their survival animals must regulate their behavior in response to external environmental cues and their own internal state. A fundamental goal of neuroscience is to understand how neural circuits in the brain function to influence behavior. The aim of this course is to highlight the neural basis of neuropeptide regulation of innate behaviors that are critical for survival and discuss modern approaches to study the neuronal control of classically studied aspects of behavior. We will explore motor control (escape responses), sensory systems (vision, taste, and olfaction), and survival behaviors (feeding, drinking, mating, and aggression). Focus will be on recent and current research, the diversity of approaches for studying it, and how this knowledge can be applied to solve scientific questions. Students will read primary scientific literature and a significant portion of the course will be presentation and discussion-based.

BIOL UN3387 BIOLOGY TEST. 3 points.

BIOL UN3404 The Global Threat of Antimicrobial Resistance. 3.00 points.
Prerequisites: (biol un2005 and biol un2006) or (biol un2401 and biol un2402)
Antimicrobial resistant bacterial infections were estimated to account for 1.27 million deaths worldwide in 2019. The goal of the seminar is to provide an in-depth analysis of this ongoing threat. Discussions will include the molecular mechanisms, epidemiology of transmission and the consequences of antimicrobial resistant infections. It will also cover current efforts to reduce the spread and emergence of these difficult to treat pathogens, both in the community and the healthcare setting.

BIOL UN3500 Independent Biological Research. 2 points.
Fee: $150. Students must register for a recitation section, BIOL W3510. Fee: Lab Fee - 150
Prerequisites: Concurrent with registering for this course, a student must register with the department and provide a written invitation from a mentor; details of this procedure are available at http://www.columbia.edu/cu/biology/courses/w3500/index.htm. Students must register for recitations UN3510 or consult the instructor.
Corequisites: BIOL UN3510
The course involves independent study, faculty-supervised laboratory projects in contemporary biology. Concurrent with registering for this course, a student must register with the department, provide a written invitation from a mentor and submit a research proposal; details of this procedure are available at http://www.columbia.edu/cu/biology/courses/w3500/index.htm. A paper summarizing results of the work is required by the last day of finals for a letter grade; no late papers will be accepted. See the course web site (above) for more details. Students can take anywhere from 2-4 points for this course.

BIOL UN3560 Evolution in the age of genomics. 4 points.
Prerequisites: Introductory Biology I and II, or the instructors permission. This course introduces basic concepts in evolutionary biology, from speciation to natural selection. While the lectures incorporate a historical perspective, the main goal of the class is to familiarize students with topics and tools of evolutionary genetics as practiced today, in the era of genomics. Thus, the focus will be on evidence from molecular evolution and genetics and exercises will assume a basic background in genetics. Examples will be drawn from across the tree of life, but with a primary focus on humans.

BIOL UN3700 Independent Clinical Research. 2-4 points.
Prerequisites: concurrent with registering for this course, a student must register with the department, provide a written invitation from a mentor, and submit a research proposal. BIOL 3700 will provide an opportunity for students interested in independent research work in a hospital or hospice setting. In these settings, where patients and their needs are paramount, and where IRB rules and basic medical ethics make "wet-lab biology research" inappropriate, undergraduates may well find a way nevertheless, to assist and participate in ongoing clinical research. Such students, once they have identified a mentor willing to provide support, participation, and advising, may apply to the faculty member in charge of the course for 2-4 points/semester in BIOL W3700. This course will closely follow procedures already in place for BIOL 3500, but will ask potential mentors to provide evidence that students will gain hands-on experience in a clinical setting, while participating in a hospital- or hospice-based research agenda. A paper summarizing results of the work is required by the last day of finals for a letter grade; no late papers will be accepted.
BIOL UN3799 Molecular Biology of Cancer. 3 points.
Prerequisites: three terms of biology (genetics and cell biology recommended).
Cancer is one of the most dreaded common diseases. Yet it is also one of the great intellectual challenges in biology today. How does a cell become cancerous? What are the agents that cause this to occur? How do current findings about genes, cells, and organisms ranging from yeast cells to humans inform us about cancer? How do findings about cancer teach us new biological concepts? Over the past few years there have been great inroads into answering these questions which have led to new ways to diagnose and treat cancer. This course will discuss cancer from the point of view of basic biological research. We will cover topics in genetics, molecular and cell biology that are relevant to understanding the differences between normal and cancer cells. These will include tumor viruses, oncogenes, tumor suppressor genes, cell cycle regulation, programmed cell death and cell senescence. We will also study some current physiological concepts related to cancer including angiogenesis, tumor immunology, cancer stem cells, metastasis and new approaches to treatment that are built on recent discoveries in cancer biology. The text book for this course is "The Biology of Cancer Second Edition by Robert A Weinberg (Garland Science). Additional and complementary readings will be assigned. SCE and TC students may register for this course, but they must first obtain the written permission of the instructor, by filling out a paper Registration Adjustment Form (Add/Drop form). The form can be downloaded at the URL below, but must be signed by the instructor and returned to the office of the registrar. http://registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf

BIOL UN3995 Topics in Biology. 1 point.
Enrollment limited to 18.
Prerequisites: Introductory Biology or equivalent.
Topics in Biology: Radiographic Anatomy and Select Pathology (Section 007 Fall semester)
Radiographic Anatomy and Selective Pathology is a survey course intended for undergraduate students. This course is not limited to science majors and would be of value to any student that may have an interest in studying the anatomy of the human body.
The course is a systematic approach to the study of the human body utilizing medical imaging. We will be studying neuro-anatomy, anatomy of the thorax, abdomen, and pelvis. Vascular and musculoskeletal imaging will be addressed as well. Modalities will include CT, MRI, PET/CT, and Ultrasound. Cross sectional imaging will be supplemented with pathology demonstrated on appropriate cross sectional imaging.
The class size will be limited to 15 students. The lecture will be offered Wednesday evenings from 6:10-7:00 pm. This will be a 1 credit course offered only during the fall semesters.
Topics in Biology: Crossroads in Bioethics (Section 001 Spring semester)
This two credit multidisciplinary and interactive course will focus on contemporary issues in bioethics and medical ethics. Each topic will cover both the underlying science of new biotechnologies and the subsequent bioethical issues that emerge from these technologies. Each topic will introduce a bioethical principle that will be explored using case studies. Students are expected to prepare for each class based on the assignment so that classroom time will be devoted to discussion, case presentations, and role playing rather than merely lectures. Topics include stem cell research, human reproductive cloning, bioterrorism, neuroethics, genetic screening, medical stem cell tourism, patents and science, forensic science and the interface of science and culture/religion.
Prerequisites: for undergraduates: Introductory Genetics (W3031) and the instructor’s permission.

This seminar course provides a detailed presentation of areas in classical and molecular genetics for advanced undergraduates and beginning graduate students. Topics include transmission genetics, gain and loss of function mutations, genetic redundancy, suppressors, enhancers, epistasis, expression patterns, using transposons, and genome analysis. The course is a mixture of lectures, student presentations, seminar discussions, and readings from the original literature.

Prerequisites: one year of biology; a course in physics is highly recommended. Lecture and recitation. This is an advanced course intended for majors providing an in depth survey of the cellular and molecular aspects of nerve cell function. Topics include the cell biology and biochemistry of neurons, ionic and molecular basis of electrical signals, synaptic transmission and its modulation, function of sensory receptors. Although not required, it is intended to be followed by Neurobiology II (see below). The recitation meets once per week in smaller groups and emphasizes readings from the primary literature.

This course has three interrelated goals: (i) to develop an intuitive understanding of the thermodynamic forces that control the structure of biological macromolecules and the evolution of life, (ii) to learn how to apply that understanding to experimental analyses of macromolecular interactions, and (iii) to master the use of molecular graphics software for understanding and interpreting macromolecular structures and interactions. The lectures develop the essential thermodynamic theory from the ground up, starting from a review of the relevant physical forces (Newton’s and Coulomb’s Laws) and culminating with an intuitive explanation of how complex biological organisms can evolve spontaneously, in a universe in which all natural processes are driven by increasing randomness or entropy, as specified by the 2nd Law of Thermodynamics. Subsequent lectures elaborate how these thermodynamic principles govern the formation and interaction of macromolecular structures, which represent the physical foundation for the evolution of life, and how the same principles are applied to analyze related experimental data. The problem sets for the course focus on practical applications of these principles to the analysis of data from common experiments used by molecular biologists to characterize macromolecular interactions. Extensive use is made of molecular graphics software throughout the semester, including in the problem sets, based on instruction provided in both the lectures and recitation sections. The course is designed to develop a deep understanding of the physical mechanisms controlling macromolecular interactions while simultaneously empowering students to critically read related literature and rigorously design and analyze related experiments themselves.
BIOL GU4035 Seminar in Epigenetics. 3 points.
Prerequisites: Genetics (3032/4032) or Molecular Biology (3512/4512),
and the instructor's permission.
This is a combined lecture/seminar course designed for advanced
undergraduates and graduate students. The focus is on understanding
the mechanisms underlying epigenetic phenomena: the heritable
inheritance of genetic states without change in DNA sequence.
Epigenetic mechanisms play important roles during normal animal
development and oncogenesis. It is an area under intensive scientific
investigation and the course will focus on recent advances in
understanding these phenomena. In each class, students will present
and discuss in detail recent papers and background material concerning
each individual topic, followed by an introductory lecture on the following
week's topic. This course will emphasize critical analysis of the scientific
literature and help students understand how to identify important
biological problems and how to address them experimentally.

BIOL GU4036 Transformative Concepts in Systems Biology. 3.00 points.
Systems biology approaches are rapidly transforming the technological
and conceptual foundations of research across diverse areas
of biomedicine. In this course we will discuss the fundamental
developments in systems biology with a focus on two important
dimensions: (1) the unique conceptual frameworks that have emerged
to study systems-level phenomena and (2) how these approaches are
revealing fundamentally new principles that govern the organization
and behavior of cellular systems. Although there will be much discussion of
technologies and computational approaches, the course will emphasize
the conceptual contributions of the field and the big questions that
lie ahead. Lectures and discussions of primary literature will enable
students to scrutinize research in the field and to internalize systems
biology thinking in their own research. To make this a concrete endeavor,
the students will develop mini-NIH-style grant proposals that aims
to study a fundamental problem/question using systems biology
approaches. The students will then convene an in-class NIH-style
review panel that will assess the strengths and weaknesses of these
proposals. In addition, the students will have the opportunity to defend
their proposals in a live presentation to the class. The course is open
to graduate students in Biological Sciences. Advanced undergraduates
in biological sciences, and other graduate students with background in
biology from other disciplines, including physics, chemistry, computer
science, and engineering may also attend after consulting with the
instructor.

BIOL GU4065 Molecular Biology of Disease. 3 points.
Enrollment limited to 30.
Prerequisites: open to advanced undergraduates with the instructor's
permission. Completion of a 3000-level course in at least one of
the following, with completion of two or more preferred: genetics,
biochemistry, cell biology.
Molecular and cellular basis of infectious diseases and inherited
propensities. Mechanisms of disease examined in discussions based
on current research papers. Lectures, discussions, and student
presentations. Essay required in lieu of final examination.

BIOL GU4070 The Biology and Physics of Single Molecules. 3 points.
CC/GS: Partial Fulfillment of Science Requirement
Prerequisites: calculus, chemistry, physics, one year of biology, or the
instructor’s permission.
This course will examine the fundamental mechanisms underlying
the behavior of biological molecules, at the single molecule level. The
course will cover the methods used to track single molecules: optical
tweezers, single molecule AFM, Magnetic tweezers, Optical techniques
and Fluorescence energy transfer (FRET) probes. The course will
cover the mechanism of action of mechanical motors, such as myosin
dynein, kinesin. It will cover the action of DNA binding enzymes such
as topoisomerases, helicases, etc. We will also discuss the function of
large motors such as the ATP Synthase and the bacterial AAA ATPases.
We will discuss the mechanical properties of DNA, RNA, and proteins.
The course will consist mainly of reviewing classical experiments in each
category, and developing the background physical theories to promote a
deep understanding of biological mechanisms at the mesoscopic level.

BIOL GU4075 Biology at Physical Extremes. 3 points.
Prerequisites: one year each of biology and physics, or the instructor’s
permission.
This is a combined lecture/seminar course designed for graduate
students and advanced undergraduates. The course will cover a series of
cases where biological systems take advantage of physical phenomena
in counter intuitive and surprising ways to accomplish their functions.
In each of these cases, we will discuss different physical mechanisms
at work. We will limit our discussions to simple, qualitative arguments.
We will also discuss experimental methods enabling the study of these
biological systems. Overall, the course will expose students to a wide
range of physical concepts involved in biological processes.
BIOL GU4080 ANCIENT AND MODERN RNA WORLDS. 3.00 points.
Prerequisites: BIOL UN3512
RNA has recently taken center stage with the discovery that RNA molecules sculpt the landscape and information contained within our genomes. Furthermore, some ancient RNA molecules combine the roles of both genotype and phenotype into a single molecule. These multi-tasking RNAs offering a possible solution to the paradox of which came first: DNA or proteins. This seminar explores the link between modern RNA, metabolism, and insights into a prebiotic RNA world that existed some 3.8 billion years ago. Topics include the origin of life, replication, and the origin of the genetic code; conventional, new, and bizarre forms of RNA processing; structure, function and evolution of key RNA molecules, including the ribosome, and RNA therapeutics including vaccines. The format will be weekly seminar discussions with presentations. Readings will be taken from the primary literature, emphasizing seminal and recent literature. Requirements will be student presentations, class participation, and a final paper.

BIOL GU4082 Theoretical Foundations and Applications of Biophysical Methods. 4 points.
Prerequisites: at least one year of coursework in single-variable calculus and not being freaked-out by multivariable calculus. Physics coursework through a calculus-based treatment of classical mechanics and electromagnetism. One year of general chemistry (either AP Chemistry or a college course). One year of college coursework in molecular/cellular biology and biochemistry equivalent to Biology C2005-2006 at Columbia. Rigorous introduction to the theory underlying biophysical methods, which are illustrated by practical applications to biomedical research. Emphasizes the approach used by physical chemists to understand and analyze the behavior of molecules, while also preparing students to apply these methods in their own research. Course modules cover: (i) statistical analysis of data; (ii) solution thermodynamics; (iii) hydrodynamic methods; (iv) light-scattering methods; and (v) spectroscopic methods, especially fluorescence. Recitations focus on curve-fitting analyses of experimental data.

BIOL GU4193 Stem Cell Biology and Applications. 3 points.
Prerequisites: Three semesters of Biology or instructor permission.
The course examines current knowledge and potential medical applications of pluripotent stem cells (embryonic stem cells and induced pluripotent stem cells), direct conversions between cell types and adult, tissue-specific stem cells (concentrating mainly on hematopoietic and gut stem cells as leading paradigms). A basic lecture format will be supplemented by presentations and discussions of research papers. Recent reviews and research papers together with extensive instructor notes will be used in place of a textbook.

BIOL GU4260 Proteomics Laboratory. 3 points.
Lab Fee: $150.
This course deals with the proteome: the expressed protein complement of a cell, organelle, matrix, tissue, organ or organism. The study of the proteome (proteomics) is broadly applicable to life sciences research, and is increasingly important in academic, government and industrial research through extension of the impact of advances in genomics. These techniques are being applied to basic research, exploratory studies of cancer and other diseases, drug discovery and many other topics. Emphasis will be on mastery of practical techniques of sample preparation, liquid chromatography/ mass spectrometry (LC/MS) with electrospray ionization. Database searching and interpretation for identification of proteins will be intensively studied, and practiced supported by background tutorials and exercises covering other techniques used in proteomics. Open to students in M.A. in Biotechnology Program (points can be counted against laboratory requirement for that program), Ph.D. and advanced undergraduate students with background in genetics or molecular biology. Students should be comfortable with basic biotechnology laboratory techniques as well as being interested in doing computational work in a Windows environment.

BIOL GU4290 Biological Microscopy. 3 points.
Prerequisites: (biol un2005 or biol un2401) or BIOL UN2005 or BIOL UN2401 or equivalent
This is an advanced microscopy course aimed at graduates and advanced undergraduate students, who are interested in learning about the foundational principles of microscopy approaches and their applications in life sciences. The course will introduce the fundamentals of optics, light-matter interaction and in-depth view of most commonly used advanced microscopy methods, explore important practical imaging parameters, and also introduce digital images and their analysis.
BIOL GU4300 Drugs and Disease. 3 points.
Prerequisites: Four semesters of biology with a firm foundation in molecular and cellular biology.
Introduces students to the current understanding of human diseases, novel therapeutic approaches and drug development process. Selected topics will be covered in order to give students a feeling of the field of biotechnology in health science. This course also aims to strengthen students’ skills in literature comprehension and critical thinking.

BIOL GU4305 Seminar in Biotechnology. 3 points.
Prerequisites: BIOL W4300 or the instructor’s permission.
A weekly seminar and discussion course focusing on the most recent development in biotechnology. Professionals of the pharmaceutical, biotechnology, and related industries will be invited to present and lead discussions.

BIOL GU4310 Virology. 3 points.
The basic thesis of the course is that all viruses adopt a common strategy. The strategy is simple:
1. Viral genomes are contained in metastable particles.
2. Genomes encode gene products that promote an infectious cycle (mechanisms for genomes to enter cells, replicate, and exit in particles).
3. Infection patterns range from benign to lethal; infections can overcome or co-exist with host defenses.

Despite the apparent simplicity, the tactics evolved by particular virus families to survive and prosper are remarkable. This rich set of solutions to common problems in host/parasite interactions provides significant insight and powerful research tools. Virology has enabled a more detailed understanding of the structure and function of molecules, cells and organisms and has provided fundamental understanding of disease and virus evolution.

The course will emphasize the common reactions that must be completed by all viruses for successful reproduction within a host cell and survival and spread within a host population. The molecular basis of alternative reproductive cycles, the interactions of viruses with host organisms, and how these lead to disease are presented with examples drawn from a set of representative animal and human viruses, although selected bacterial viruses will be discussed.

BIOL GU4510 Genomics of Gene Regulation. 4 points.
Prerequisites: one year of Biology, Chemistry, and Physics. Courses taken at CU are recommended, but AP courses may be sufficient with the instructor’s permission.
This course will provide students with a quantitative understanding of the ways in which molecular interactions between nucleotides and proteins give rise to the behavior of gene regulatory networks. The key high-throughput genomics technologies for probing the cell at different levels using microarrays and next-generation sequencing will be discussed. Strategies for interpreting and integrating these data using statistics, biophysics, and genetics will be introduced. In computer exercises, student will learn the basics of the R language, and use it to perform analyses of genomics data sets. No prior computer programming experience is assumed. This highly interdisciplinary course is intended for advanced undergraduates as well as beginning graduate students in Biology, Chemistry, Physics, Engineering, and Computer Science. Offered in previous years as CHBC W4510.

BIOL GU4560 Evolution in the age of genomics. 4 points.
Prerequisites: introductory genetics or the instructor’s permission.
This course introduces basic concepts in evolutionary biology, from speciation to natural selection. While the lectures incorporate a historical perspective, the main goal of the class is to familiarize students with topics and tools of evolutionary genetics as practiced today, in the era of genomics. Thus, the focus will be on evidence from molecular evolution and genetics and exercises will assume a basic background in genetics. Examples will be drawn from across the tree of life, but with a primary focus on humans.

BIOL GU4600 Cell Signaling. 3 points.
Prerequisites: A strong background in molecular and cellular biology. Generally students with four or more courses are accepted. Cell Signaling is a graduate course for Ph.D. students open to advanced undergraduate and masters students. The basic molecular mechanism of signal transduction pathways will be discussed related to cell growth and stress systems. There will be an emphasis on specific categories of signaling components. Students will read the literature and give presentations. Topics include the pathways by which cells respond to extracellular signals such as growth factors and the mechanisms by which extracellular signals are translated into alterations in the cell cycle, morphology, differentiation state, and motility of the responding cells. For stress pathways we will discuss how cells respond to survive the stress or induce their own death. In many cases these pathways will be related to human diseases.
BIOT GU4160 Biotechnology Law. 3 points.
Priority given to Biotechnology Program students.

Prerequisites: at least 4 college-level biology or biotechnology courses. This course will introduce students to the interrelated fields of patent law, regulatory law, and contract law that are vital to the biotech and biopharmaceutical sectors. The course will present core concepts in a way that permits students to use them throughout their corporate, academic, and government careers. SCE and TC students may register for this course, but they must first obtain the written permission of the instructor, by filling out a paper Registration Adjustment Form (Add/Drop form). The form can be downloaded at the URL below, but must be signed by the instructor and returned to the office of the registrar. http://registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf

BIOT GU4161 ETHICS IN BIOPHARM PAT/REG LAW. 3.00 points.
Prerequisites: BIOT GU4160 BIOTECHNOLOGY LAW (BIOT W4160) This course -- the first of its kind at Columbia -- introduces students to a vital subfield of ethics focusing on patent and regulatory law in the biotech and pharmaceutical sectors. The course combines lectures, structured debate, and research to best present this fascinating and nuanced subject. Properly exploring this branch of bioethics requires an in-depth understanding of biotech and pharmaceutical patent and regulatory law. Students can gain this understanding by first completing Biotechnology Law (BIOT GU4160), formerly the prerequisite for this course. Now, they can also gain it by reading the appropriate chapters of Biotechnology Law: A Primer for Scientists (the textbook for BIOT GU4160 published earlier this year) prior to each class. A number of students in the biotechnology fields (such as those in biotechnology, biomedical engineering, and bioethics programs) have shown a keen interest over the years in taking this course, yet were unable to do so because they hadn’t taken BIOT GU4160. Given the recent publication of Biotechnology Law and the desirability of making BIOT GU4161 accessible to more students having the appropriate science background, BIOT GU4160 has been removed as a prerequisite.

Of Related Interest

Biomedical Engineering
BMEN E4150 THE CELL AS A MACHINE
Chemistry
BIOC UN3501 Biochemistry: Structure and Metabolism
BIOC UN3512 Molecular Biology
Ecology, Evolution, and Environmental Biology
EEEB UN2001 Environmental Biology I: Elements to Organisms
EEEB GU4321 Human Nature: DNA, Race & Identity
History and Philosophy of Science
HPSC W3201 Philosophy and History of Evolutionary Biology
Physics
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