Biology (Undergraduate)

Associate Dean of Biology and Chair
Edward Hawrot

Director of Undergraduate Affairs
Katherine F. Smith

The Undergraduate Program in Biology offers courses at all levels of biological organization: molecular, cellular, organismal, and population, and concentration programs with varying degrees of multidisciplinary or specialty foci.

There is a vast range of collaborative opportunities for independent study and research under the mentorship of the faculty. Faculty maintain research programs at the cutting edge of their fields including biochemistry, biophysics, cell biology, developmental biology, ecology, evolution, genetics, immunology, molecular biology, neurobiology, physiology, anatomy, artificial organs, microbiology, virology, experimental pathology, and pharmacology. The close administrative relationship with the Alpert Medical School offers additional opportunities for blending fundamental biology and clinical sciences in research projects at the Brown-affiliated hospitals.

The Office of Biology Undergraduate Education is a full service academic resource center, serving a key role for students of the life sciences here. The Office provides individualized advising for students at all levels; oversees student-faculty research collaborations, holds special events and maintains a variety of programs that support and enrich student life. For further information, please visit: http://www.brown.edu/academics/biology/undergraduate-education/

Biology Concentration Requirements

The Biology concentration invites students to study, in depth and in breadth, the science of life and living matter. Whether pursuing the Bachelor of Arts (A.B.) or Science (Sc.B.) in biology, students can expect to learn broadly in the discipline through a selection of courses in three areas: cell and molecular biology, structure and function, and organismal biology. In addition, students pursuing the Sc.B. complete a thematic track through which they gain an in-depth understanding of a particular subfield such as, Immunopathology, Ecology and Evolutionary Biology, Physiology/Biotechnology, Cell and Molecular Biology, Physical Sciences. The concentration also emphasizes practical skills and experimental design. Concentrators are required to take at least 3 courses with a laboratory or fieldwork component. Within all of these requirements, students have a high degree of flexibility and choice. Broad research opportunities are also available across several departments within the basic sciences as well.

Standard program for the A.B. Biology

The concentration program for the A.B. in Biology consists of four prerequisite courses in math, chemistry, and a statistics course as well as ten courses in biological sciences, including at least one course in each of the following three areas: Area 1: Cell/Molecular Biology, Area 2: Structure/Function, and Area 3: Organismal Biology.


Prerequisites:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 0330</td>
<td>Equilibrium, Rate, and Structure</td>
</tr>
<tr>
<td>CHEM 0350</td>
<td>Organic Chemistry</td>
</tr>
<tr>
<td>MATH 0090</td>
<td>Introductory Calculus, Part I (or placement. MATH 0050/MATH 0060 may be substituted for MATH 0090.)</td>
</tr>
</tbody>
</table>

One of the following:

MATH 0100  Introductory Calculus, Part II (or placement)
MATH 0170  Advanced Placement Calculus (or equivalent placement)

Or a statistics course, to be approved by the concentration advisor.

Ten Core Courses: 2,3,4

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 0200</td>
<td>The Foundation of Living Systems (Required course; AP credit or similar IB or A-levels accepted, placement test available.)</td>
</tr>
</tbody>
</table>

Area 1 (Cell/Molecular Biology)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 0280</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>BIOL 0470</td>
<td>Genetics</td>
</tr>
<tr>
<td>BIOL 0500</td>
<td>Cell and Molecular Biology</td>
</tr>
<tr>
<td>BIOL 0510</td>
<td>Introductory Microbiology</td>
</tr>
<tr>
<td>BIOL 0530</td>
<td>Principles of Immunology</td>
</tr>
<tr>
<td>BIOL 1050</td>
<td>Biology of the Eukaryotic Cell</td>
</tr>
<tr>
<td>BIOL 1310</td>
<td>Developmental Biology</td>
</tr>
<tr>
<td>BIOL 1515</td>
<td>Conservation in the Genomics Age</td>
</tr>
<tr>
<td>BIOL 1810</td>
<td>21st Century Applications in Cell and Molecular Biology</td>
</tr>
<tr>
<td>BIOL 1865</td>
<td>Toxicology</td>
</tr>
<tr>
<td>NEUR 1020</td>
<td>Principles of Neurobiology</td>
</tr>
</tbody>
</table>

Area 2 (Structure/Function)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 0400</td>
<td>Biological Design: Structural Architecture of Organisms</td>
</tr>
<tr>
<td>BIOL 0410</td>
<td>Invertebrate Zoology</td>
</tr>
<tr>
<td>BIOL 0440</td>
<td>Inquiry in Plant Biology: Analysis of Plant Growth, Reproduction and Adaptive Responses</td>
</tr>
<tr>
<td>BIOL 0800</td>
<td>Principles of Physiology</td>
</tr>
<tr>
<td>BIOL 1120</td>
<td>Biomaterials</td>
</tr>
<tr>
<td>BIOL 1155</td>
<td>Hormones and Behavior</td>
</tr>
<tr>
<td>BIOL 1310</td>
<td>Developmental Biology</td>
</tr>
<tr>
<td>BIOL 1330</td>
<td>Biology of Reproduction</td>
</tr>
<tr>
<td>BIOL 1800</td>
<td>Animal Locomotion</td>
</tr>
<tr>
<td>BIOL 1865</td>
<td>Toxicology</td>
</tr>
<tr>
<td>BIOL 1880</td>
<td>Comparative Biology of the Vertebrates</td>
</tr>
<tr>
<td>NEUR 0010</td>
<td>The Brain: An Introduction to Neuroscience</td>
</tr>
</tbody>
</table>

Area 3 (Organismal Biology)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 0210</td>
<td>Diversity of Life</td>
</tr>
<tr>
<td>BIOL 0350</td>
<td>The Fossil Record: Life through Time on Earth</td>
</tr>
<tr>
<td>BIOL 0380</td>
<td>The Ecology and Evolution of Infectious Disease</td>
</tr>
<tr>
<td>BIOL 0410</td>
<td>Invertebrate Zoology</td>
</tr>
<tr>
<td>BIOL 0420</td>
<td>Principles of Ecology</td>
</tr>
<tr>
<td>BIOL 0430</td>
<td>The Evolution of Plant Diversity</td>
</tr>
<tr>
<td>BIOL 0480</td>
<td>Evolutionary Biology</td>
</tr>
<tr>
<td>BIOL 1480</td>
<td>Terrestrial Biogeochemistry and the Functioning of Ecosystems</td>
</tr>
<tr>
<td>BIOL 1515</td>
<td>Conservation in the Genomics Age</td>
</tr>
<tr>
<td>BIOL 1800</td>
<td>Animal Locomotion</td>
</tr>
<tr>
<td>BIOL 1880</td>
<td>Comparative Biology of the Vertebrates</td>
</tr>
<tr>
<td>ENVS 0490</td>
<td>Environmental Science in a Changing World</td>
</tr>
</tbody>
</table>

Six additional courses chosen from BIOL and/or NEUR offerings for concentrators. The Core may include up to two related sciences, with advisor approval. The Core must also include a Senior Capstone.
SENIOR CAPSTONE: "Only applies to students who have declared in Fall 2019 or later." To be fulfilled via one of the following:

1. One of the following approved courses: BIOL 1100, 1250, 1515, 1555, 1565, 1575, 1600, 1820, 1970A.
2. One semester of independent research/independent study (BIOL 1950 or BIOL 1960).
3. A senior Honors thesis in Biology: Students can register for BIOL 1950 or BIOL 1960 or both.

Please visit the BUE webpage for more information.

Total Credits: 10

1. AP scores of 4 or 5 may substitute Math courses.
2. Biology courses for concentration credit include those numbered between 0100 - 2999. Exclusions: BIOL 1070, 1920 series courses, and BIOL 1980 can only be used as related sciences with advisor approval and do not fulfill advanced course requirements.
3. At least two biology and/or neuroscience courses must be at the advanced level (between 1000-2999). Senior Capstone can be used towards one advanced requirement. At least three of the Biology and/or Neuroscience courses must include laboratory or fieldwork. BIOL 1950/BIOL 1960, (Directed Research) may be included, but is not required. If a lab project, this can count for one of the three lab course requirements, and one advanced course.
4. No substitutions per above Area list. If a course is listed in more than one area, it may be used to fulfill one area only; the other area must be fulfilled by a different course.

Honors: Honors in biology requires a thesis and presentation based on a research project (conducted via BIOL 1950/BIOL 1960), and quality grades in the concentration. Guidelines and information on faculty research are available in the Office of Biology Undergraduate Education or found at http://www.brown.edu/academics/biology/undergraduate-education/.

Standard Program for the Sc.B. Biology

The concentration program for the Sc.B. in Biology consists of seven prerequisite courses in math, chemistry, and physics as well as thirteen to fourteen courses in biological sciences, including courses in each of the following three areas: Area 1: Cell/Molecular Biology, Area 2: Structure/Function, and Area 3: Organismal Biology, and the three-course Track. The biological sciences requirement also requires research (BIOL 1950/BIOL 1960), which should reflect the advanced cluster.

Students pursuing a ScB in Biology have the option to substitute a course for CHEM 0360 (Organic Chemistry) in their background core. For students pursuing the Marine Biology track, an upper level course in Geological Sciences may replace CHEM 0360. For students pursuing all other tracks, BIOL 0280 (Introductory Biochemistry) may serve as the replacement course. Please note that approval from the concentration advisor is required for these background course substitutions. If the student has already declared, then a revised concentration plan must be submitted and approved via the ASK system. If BIOL 0280 is used as a substitute for CHEM 0360, it cannot be counted as a core course or as an Area 1 course. Students planning to apply to medical or graduate school should seek additional advising (such as from the Health Careers Office) in crafting their course plan.


Prerequisites:

MATH 0090 Introductory Calculus, Part I (or placement. MATH 0050/MATH 0060 may be substituted for MATH 0090)

One of the following:

MATH 0100 Introductory Calculus, Part II (or placement)

MATH 0170 Advanced Placement Calculus (or an equivalent placement)

Or a statistics course, to be approved by the concentration advisor.

CHEM 0330 Equilibrium, Rate, and Structure (or IB credit)

CHEM 0350 Organic Chemistry

CHEM 0360 Organic Chemistry or BIOL 0280 Biochemistry

PHYS 0030 Basic Physics A (or equivalent. PHYS 0050 PHYS 0070, or ENGN 0030 may be substituted for PHYS 0030.)

PHYS 0040 Basic Physics B (or equivalent. PHYS 0060 or ENGN 0040 may be substituted for PHYS 0040.)

Core Courses:

BIOL 0200 The Foundation of Living Systems (or placement)

Area 1 (Cell/Molecular Biology)

BIOL 0280 Biochemistry

BIOL 0470 Genetics

BIOL 0500 Cell and Molecular Biology

BIOL 0510 Introductory Microbiology

BIOL 0530 Principles of Immunology

BIOL 1050 Biology of the Eukaryotic Cell

BIOL 1310 Developmental Biology

BIOL 1515 Conservation in the Genomics Age

BIOL 1810 21st Century Applications in Cell and Molecular Biology

BIOL 1865 Toxicology

NEUR 1020 Principles of Neurobiology

Area 2 (Structure/Function)

BIOL 0400 Biological Design: Structural Architecture of Organisms

BIOL 0410 Invertebrate Zoology

BIOL 0440 Inquiry in Plant Biology: Analysis of Plant Growth, Reproduction and Adaptive Responses

BIOL 0800 Principles of Physiology

BIOL 1120 Biomaterials

BIOL 1155 Hormones and Behavior

BIOL 1310 Developmental Biology

BIOL 1330 Biology of Reproduction

BIOL 1800 Animal Locomotion

BIOL 1865 Toxicology

BIOL 1880 Comparative Biology of the Vertebrates

NEUR 0010 The Brain: An Introduction to Neuroscience

Area 3 (Organismal Biology)

BIOL 0210 Diversity of Life

BIOL 0350 The Fossil Record: Life through Time on Earth

BIOL 0380 The Ecology and Evolution of Infectious Disease

BIOL 0410 Invertebrate Zoology

BIOL 0420 Principles of Ecology

BIOL 0430 The Evolution of Plant Diversity

BIOL 0480 Evolutionary Biology

BIOL 1480 Terrestrial Biogeochemistry and the Functioning of Ecosystems

BIOL 1515 Conservation in the Genomics Age
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 1800</td>
<td>Animal Locomotion</td>
</tr>
<tr>
<td>BIOL 1880</td>
<td>Comparative Biology of the Vertebrates</td>
</tr>
<tr>
<td>ENVS 0490</td>
<td>Environmental Science in a Changing World</td>
</tr>
</tbody>
</table>

Six additional courses chosen from BIOL and/or NEUR offerings for concentrators. The Core may include up to two related sciences, with advisor approval. The Core must also include research.

### RESEARCH:

Typically, two courses in Core are advanced level research (BIOL 1950, 1960).

### TRACK:
The advanced thematic track consists of three additional biological sciences courses (not including BIOL 1950/1960 research) that form a Track. Tracks include: Immuno/Pathobiology; Ecology and Evolutionary Biology; Physiology and Biotechnology; Neurobiology; Physical Sciences; Marine Biology; Cell and Molecular Biology; Biomedical Informatics. At least two track courses, and preferably all three, must be above 1000-level. Track courses should form a cohesive grouping approved by an advisor and/or Associate Dean of Biology, Katherine Smith.

### Biomedical Informatics - BIOL 1565 is required for this track along with 2 additional courses from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>BIOL 1555</td>
<td>Methods in Informatics and Data Science for Health</td>
</tr>
<tr>
<td>BIOL 1575</td>
<td>Evaluation of Health Information Systems</td>
</tr>
<tr>
<td>BIOL 1595</td>
<td>Artificial Intelligence in Biomedicine</td>
</tr>
</tbody>
</table>

### Cell and Molecular Biology

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 1050</td>
<td>Biology of the Eukaryotic Cell</td>
</tr>
<tr>
<td>BIOL 1270</td>
<td>Advanced Biochemistry</td>
</tr>
<tr>
<td>BIOL 1300</td>
<td>Biomolecular Interactions: Health, Disease  and Drug Design</td>
</tr>
<tr>
<td>BIOL 1310</td>
<td>Developmental Biology</td>
</tr>
<tr>
<td>BIOL 1330</td>
<td>Biology of Reproduction</td>
</tr>
<tr>
<td>BIOL 1540</td>
<td>Molecular Genetics</td>
</tr>
<tr>
<td>BIOL 1545</td>
<td>Human Genetics and Genomics</td>
</tr>
<tr>
<td>BIOL 1810</td>
<td>21st Century Applications in Cell and Molecular Biology</td>
</tr>
<tr>
<td>BIOL 1970A</td>
<td>Stem Cell Biology</td>
</tr>
</tbody>
</table>

### Ecology and Evolutionary Biology

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 1420</td>
<td>Experimental Design in Ecology</td>
</tr>
<tr>
<td>BIOL 1430</td>
<td>Population Genetics</td>
</tr>
<tr>
<td>BIOL 1435</td>
<td>Computational Methods for Studying Demographic History with Molecular Data</td>
</tr>
<tr>
<td>BIOL 1440</td>
<td>Marine Biology</td>
</tr>
<tr>
<td>BIOL 1450</td>
<td>Community Ecology</td>
</tr>
<tr>
<td>BIOL 1465</td>
<td>Human Population Genomics</td>
</tr>
<tr>
<td>BIOL 1470</td>
<td>Conservation Biology</td>
</tr>
<tr>
<td>BIOL 1475</td>
<td>Biogeography</td>
</tr>
<tr>
<td>BIOL 1480</td>
<td>Terrestrial Biogeochemistry and the Functioning of Ecosystems</td>
</tr>
<tr>
<td>BIOL 1495</td>
<td>500 Million Years of Land Plants</td>
</tr>
<tr>
<td>BIOL 1515</td>
<td>Conservation in the Genomics Age</td>
</tr>
<tr>
<td>BIOL 1800</td>
<td>Animal Locomotion</td>
</tr>
<tr>
<td>BIOL 1880</td>
<td>Comparative Biology of the Vertebrates</td>
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</tbody>
</table>

### Immunobiology

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>BIOL 1250</td>
<td>Host-microbiome Interactions in Health and Disease</td>
</tr>
<tr>
<td>BIOL 1290</td>
<td>Cancer Biology</td>
</tr>
<tr>
<td>BIOL 1520</td>
<td>Innate Immunity</td>
</tr>
<tr>
<td>BIOL 1550</td>
<td>Biology of Emerging Microbial Diseases</td>
</tr>
<tr>
<td>BIOL 1560</td>
<td>Virology</td>
</tr>
<tr>
<td>BIOL 1600</td>
<td>Development of Vaccines to Infectious Diseases</td>
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</tbody>
</table>

### Marine Biology

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>BIOL 1440</td>
<td>Marine Biology</td>
</tr>
<tr>
<td>GEOL (EEPS) listings 1000 level or above. Must be a coherent set of courses that are above the introductory level and approved by advisor.</td>
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</tbody>
</table>

### Neurobiology

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>BIOL 1100</td>
<td>Cell Physiology and Biophysics</td>
</tr>
<tr>
<td>BIOL 1110</td>
<td>Topics in Signal Transduction</td>
</tr>
<tr>
<td>BIOL 1190</td>
<td>Synaptic Transmission and Plasticity</td>
</tr>
<tr>
<td>BIOL 1260</td>
<td>Physiological Pharmacology</td>
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<tr>
<td>NEUR listings 1000 level or above</td>
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</tbody>
</table>

### Physiology and Biotechnology

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>BIOL 1090</td>
<td>Polymer Science for Biomaterials</td>
</tr>
<tr>
<td>BIOL 1100</td>
<td>Cell Physiology and Biophysics</td>
</tr>
<tr>
<td>BIOL 1110</td>
<td>Topics in Signal Transduction</td>
</tr>
<tr>
<td>BIOL 1120</td>
<td>Biomaterials</td>
</tr>
<tr>
<td>BIOL 1140</td>
<td>Tissue Engineering</td>
</tr>
<tr>
<td>BIOL 1150</td>
<td>Stem Cell Engineering</td>
</tr>
<tr>
<td>BIOL 1190</td>
<td>Synaptic Transmission and Plasticity</td>
</tr>
<tr>
<td>BIOL 1300</td>
<td>Biomolecular Interactions: Health, Disease and Drug Design</td>
</tr>
</tbody>
</table>

### Physical Sciences

Must be a coherent set of courses drawn from the Physical Sciences; courses must be above the introductory level and approved by advisor.

Total Credits: 13

1. AP scores of 4 or 5 may substitute Math courses.
2. Biology courses for concentration credit include those numbered between 0100-2999. Exclusions: BIOL 1070, 1920 series courses, and BIOL 1980 can only be used as related sciences with advisor approval and do not fulfill advanced course requirements.
3. At least two biology and/or neuroscience courses must be at the advanced level (between 1000-2999). At least three of the biology and/or neuroscience courses must include laboratory or fieldwork. BIOL 1950/BIOL 1960 can count for one of the three lab course requirements and one advanced course.
4. No substitutions per above Area list. If a course is listed in more than one area, it may be used to fulfill one area only; the other area must be fulfilled by a different course.
5. If substantial research is carried out away from Brown, it must be approved by an appropriate Brown BioMed faculty member but does not carry course credit toward the Core program.

**Honors:** Honors in biology requires a thesis and presentation based on a research project (usually conducted via BIOL 1950/BIOL 1960), and quality grades in the concentration. Guidelines and information on faculty research are available in the Office of Biology Undergraduate Education or at [http://www.brown.edu/academics/biology/undergraduate-education/](http://www.brown.edu/academics/biology/undergraduate-education/).

**Stipulations for Biology Programs:**

1. For double concentrations, no more than two courses may overlap (i.e., be used to meet requirements of both programs). This includes prerequisite courses.
2. No more than two semesters of directed research may be used as concentration credits. Each does count as an individual core towards the program, but only carry one lab credit towards the three required.
3. A limited number of transfer or study abroad courses may be used within the program, subject to approval of advisor, and Associate Dean of Biology, Katherine Smith.
Health & Human Biology Concentration Requirements

Health and Human Biology is an interdisciplinary concentration that provides a rigorous foundation in the biological sciences with substantive course work in humanities and social sciences within a subfield of Human Health and Disease. The program includes: background courses, biology core courses, a set of theme courses, and a Senior Capstone activity. Background courses provide the essential foundations in chemistry, mathematics, methods, and basic biology. These support the Biology core, which is comprised of a flexible menu of intermediate and advanced courses. A required portion of the Biology core is Genetics, a cornerstone of human biology and its interface with other fields. The Biology core underscores the related coursework within the Health and Disease Theme. The Theme courses are social science and humanities courses that form a cohesive, thoughtful grouping. Theme groupings must be approved by the advisor. A required senior capstone course or activity builds on the program’s focus.

Program Requirements

REQUIRED BACKGROUND:

Four (4) courses including:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 090</td>
<td>Introductory Calculus, Part I (or equivalent placement)</td>
<td>1</td>
</tr>
<tr>
<td>OR</td>
<td>MATH 0050 Analytic Geometry and Calculus &amp; MATH 0060 and Analytic Geometry and Calculus</td>
<td>1</td>
</tr>
<tr>
<td>OR</td>
<td>MATH 0100 Introductory Calculus, Part II or MATH 0170 Advanced Placement Calculus</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 0330</td>
<td>Equilibrium, Rate, and Structure</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 0200</td>
<td>The Foundation of Living Systems</td>
<td>1</td>
</tr>
<tr>
<td>Statistics course chosen with advisor’s help.</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

CORE PROGRAM:

In addition to the stated background in Chemistry, Math, Biology and Statistics, five (5) Biology plus four (4) coherently-grouped Theme courses, plus a Senior-Year Capstone course or project. (See description of Capstone at link below this table).

BIOLOGY:

Five (5) courses, including:

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>BIOL 0470</td>
<td>Genetics</td>
<td>5</td>
</tr>
<tr>
<td>OR</td>
<td>BIOL 0480 Evolutionary Biology &amp; BIOL 0500 Cell and Molecular Biology</td>
<td>1</td>
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<td>OR</td>
<td>BIOL 0480 Evolutionary Biology &amp; BIOL 0510 Introductory Microbiology</td>
<td>1</td>
</tr>
<tr>
<td>OR</td>
<td>BIOL 0480 Evolutionary Biology &amp; BIOL 0280 Biochemistry</td>
<td>1</td>
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</table>

Select one course in structure/function/development such as:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 0400</td>
<td>Biological Design: Structural Architecture of Organisms</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 0800</td>
<td>Principles of Physiology</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 1310</td>
<td>Developmental Biology</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 1800</td>
<td>Animal Locomotion</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 1880</td>
<td>Comparative Biology of the Vertebrates</td>
<td>1</td>
</tr>
<tr>
<td>NEUR 0010</td>
<td>The Brain: An Introduction to Neuroscience</td>
<td>1</td>
</tr>
</tbody>
</table>

Select one course in organismal/population biology such as:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 0380</td>
<td>The Ecology and Evolution of Infectious Disease</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 0410</td>
<td>Invertebrate Zoology</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 0420</td>
<td>Principles of Ecology</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 0480</td>
<td>Evolutionary Biology</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 1470</td>
<td>Conservation Biology</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 1880</td>
<td>Comparative Biology of the Vertebrates</td>
<td>1</td>
</tr>
<tr>
<td>ENVS 0490</td>
<td>Environmental Science in a Changing World</td>
<td>1</td>
</tr>
</tbody>
</table>

Or a course from the NEUR 1940 series

Two Biology or Neuroscience courses. At least one must be at the advanced level.

THEME: With the advisor’s assistance, a theme is selected and a cohesive set of courses are selected from outside of Biology and Neuroscience. See Notes below:

SENIOR CAPSTONE ACTIVITY: Must be conducted during the senior year, fulfilled by one of the following, and related to the students learning goals in the concentration:

1) Advisor approved senior seminar or advanced course related to the theme
2) One semester of independent research/independent study (BIOL 1950 or BIOL 1960); in the case of a senior honors thesis, both BIOL 1950 and BIOL 1960 can be used as the capstone.
3) An appropriate internship with a scholarly context can be used if coupled with a semester of independent study mentored by a Brown faculty member.

Total Credits 14

THEME:

• Approved courses must be above the introductory level and at least one must be 1000-level or above.
• No more than TWO courses from a given department may be included in the theme portion.
• Students will then select from FOUR theme options: 1) Health Behavior, 2) Environmental Health, 3) Global/International Health, 4) Social Context of Health and Disease.


HONORS: See more information about Honors at https://www.brown.edu/academics/biology/undergraduate-education/honors-biological-sciences/.

Applied Mathematics-Biology Concentration Requirements

The Applied Math - Biology concentration recognizes that mathematics is essential to address many modern biological problems in the post genomic era. Specifically, high throughput technologies have rendered vast new biological data sets that require novel analytical skills for the most basic analyses. These technologies are spawning a new “data-driven” paradigm in the biological sciences and the fields of bioinformatics and systems biology. The foundations of these new fields are inherently mathematical, with a focus on probability, statistical inference, and systems dynamics. These mathematical methods apply very broadly in many biological fields including some like population growth, spread of disease, that predate the genomics revolution. Nevertheless, the application of these methods in areas of biology from molecular genetics to evolutionary biology has grown very rapidly in the availability of vast amounts of genomic sequence data. Required coursework in this program aims at ensuring expertise in mathematical and statistical sciences, and their application in biology. The students will focus in particular areas of biology. The program culminates in a senior
capstone experience that pairs student and faculty in creative research collaborations.

**Standard program for the Sc.B. degree**

Required coursework in this program aims at ensuring expertise in mathematical and statistical sciences, and their application in biology. The students will focus in particular areas of biology. The program culminates in a senior capstone experience that pairs student and faculty in creative research collaborations. Applied Math – Biology concentrators are prepared for careers in medicine, public health, industry and academic research.

**Required Courses:**

*Students are required to take all of the following courses.*

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 0090</td>
<td>Introductory Calculus, Part I</td>
<td>1</td>
</tr>
<tr>
<td>MATH 0100</td>
<td>Introductory Calculus, Part II</td>
<td>1</td>
</tr>
<tr>
<td>or MATH 0170</td>
<td>Advanced Placement Calculus</td>
<td></td>
</tr>
<tr>
<td>MATH 0180</td>
<td>Intermediate Calculus (or equivalent placement)</td>
<td>1</td>
</tr>
<tr>
<td>MATH 0520</td>
<td>Linear Algebra</td>
<td>1</td>
</tr>
<tr>
<td>or MATH 0540</td>
<td>Honors Linear Algebra</td>
<td></td>
</tr>
<tr>
<td>CHEM 0330</td>
<td>Equilibrium, Rate, and Structure</td>
<td>1</td>
</tr>
<tr>
<td>PHYS 0030</td>
<td>Basic Physics A</td>
<td>1</td>
</tr>
<tr>
<td>or PHYS 0050</td>
<td>Foundations of Mechanics</td>
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</tr>
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</table>

Select one of the following sequences:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>APMA 0350 &amp; APMA 0360</td>
<td>Applied Ordinary Differential Equations I</td>
<td></td>
</tr>
<tr>
<td>APMA 0330 &amp; APMA 0340</td>
<td>Methods of Applied Mathematics I, II</td>
<td></td>
</tr>
<tr>
<td>APMA 1650</td>
<td>Statistical Inference I</td>
<td>1</td>
</tr>
<tr>
<td>or APMA 1655</td>
<td>Statistical Inference I</td>
<td></td>
</tr>
<tr>
<td>APMA 1070</td>
<td>Quantitative Models of Biological Systems</td>
<td>1</td>
</tr>
<tr>
<td>APMA 1080</td>
<td>Inference in Genomics and Molecular Biology</td>
<td>1</td>
</tr>
<tr>
<td>or NEUR 2110</td>
<td>Statistical Neuroscience</td>
<td></td>
</tr>
<tr>
<td>BIOL 0200</td>
<td>The Foundation of Living Systems (or equivalent)</td>
<td>1</td>
</tr>
</tbody>
</table>

**Additional Courses**

One additional course in Applied Math or Biology

We strongly recommend that Applied Mathematics-Biology concentrators take one of the programming courses on or before their first semester as a concentrator. Those who do can use it to satisfy this requirement:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>APMA 0160</td>
<td>Introduction to Scientific Computing</td>
<td></td>
</tr>
<tr>
<td>CSCI 0040</td>
<td>Introduction to Scientific Computing and Problem Solving</td>
<td></td>
</tr>
<tr>
<td>CSCI 0111</td>
<td>Computing Foundations: Data</td>
<td></td>
</tr>
<tr>
<td>CSCI 0150</td>
<td>Introduction to Object-Oriented Programming and Computer Science</td>
<td></td>
</tr>
<tr>
<td>CSCI 0170</td>
<td>Computer Science: An Integrated Introduction</td>
<td></td>
</tr>
<tr>
<td>CSCI 0190</td>
<td>Accelerated Introduction to Computer Science</td>
<td></td>
</tr>
<tr>
<td>CLPS 0950</td>
<td>Introduction to programming</td>
<td></td>
</tr>
</tbody>
</table>

One research-related course in Applied Math or Biology. For example:

A senior seminar course from the APMA 193X, 194X series

A directed research/independent study course from the APMA 1970, 1971, or BIOL 1950, 1960, or NEUR 1970 series

A directed research/independent study course in a related discipline (i.e. STEM disciplines, ENVS, PHP, etc.) if the project is relevant to the student's learning goals in the concentration and with approval from the concentration advisor.

A pre-approved course that satisfies the Biology AB capstone requirement: BIOL 1100, 1250, 1515, 1555, 1565, 1575, 1600, 1820, 1970.

A relevant CURE (Course-based Undergraduate Research Experience) course: BIOL 0190R, 0190S, 0285, 0440, 0600, 0940G, 1515, 1555; NEUR 1630, CLPS 1195.

A non-research course related to the concentration along with a research experience equivalent in scope and scale to work the student would pursue in an Applied Math or Biology independent study course. Examples include UTRAs, LINK awards, research programs at other institutions, etc. This requires approval from the concentration advisor and appropriate documentation.

Other equivalent opportunities not listed - with approval from the concentration advisor.

Four classes in the biological sciences agreed upon by the student and advisor. These four courses should form a cohesive grouping in a specific area of emphasis, at least two of which should be at the 1000-level. Some example groupings are below:

**Areas of Emphasis and Suggested Courses:**

Some areas of possible emphasis for focusing of elective courses are listed below. Given the large number of course offerings in the biosciences and neuroscience, students are free to explore classes in these areas that are not listed below. However, all classes must be approved by the concentration advisor. APMA 1910 cannot be used as an elective.

**Biochemistry**

BIOL 0280  Biochemistry
BIOL 1270  Advanced Biochemistry
CHEM 0350/0360  Organic Chemistry
CHEM 1230  Chemical Biology

**Biotechnology and Physiology**

BIOL 0800  Principles of Physiology
BIOL 1100  Cell Physiology and Biophysics
and/or appropriate bioengineering courses, such as:

BIOL 1090  Polymer Science for Biomaterials
BIOL 1120  Biomaterials
BIOL 1140  Tissue Engineering
BIOL 1150  Stem Cell Engineering
BIOL 1210  Synthetic Biological Systems

**Ecology, Evolution, and Genetics**

BIOL 0410  Invertebrate Zoology
& BIOL 0480  and Evolutionary Biology
BIOL 0420  Principles of Ecology
& BIOL 0430  and The Evolution of Plant Diversity
BIOL 0470  Genetics
BIOL 1420  Experimental Design in Ecology
BIOL 1430  Population Genetics
BIOL 1465  Human Population Genomics
BIOL 1540  Molecular Genetics

**Neuroscience**

APMA 0410  Mathematical Methods in the Brain Sciences

Neurosciences courses: See https://www.brown.edu/academics/neuroscience/undergraduate/neuroscience-concentration-requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 1100</td>
<td>Cell Physiology and Biophysics</td>
<td></td>
</tr>
<tr>
<td>BIOL 1110</td>
<td>Topics in Signal Transduction</td>
<td></td>
</tr>
<tr>
<td>BIOL 1190</td>
<td>Synaptic Transmission and Plasticity</td>
<td></td>
</tr>
</tbody>
</table>

Total Credits 18
Students whose independent study is expected to be in an experimental field are strongly encouraged to take APMA 1660, which covers experimental design and the analysis of variance (ANOVA), a method commonly used in the analysis of experimental data.

Professional Tracks
The requirements for the professional tracks include all those of each of the standard tracks, as well as the following:
Students must complete full-time professional experiences doing work that is related to their concentration programs, totaling 2-6 months, whereby each internship must be at least one month in duration in cases where students choose to do more than one internship experience. Such work is normally done at a company, but may also be at a university under the supervision of a faculty member. Internships that take place between the end of the fall and the start of the spring semesters cannot be used to fulfill this requirement. On completion of each professional experience, the student must write and upload to ASK a reflective essay about the experience, to be approved by the student's concentration advisor.

On completion of each professional experience, the student must write and upload to ASK a reflective essay about the experience, to be approved by the student's concentration advisor:
• Which courses were put to use in your summer's work? Which topics, in particular, were important?
• In retrospect, which courses should you have taken before embarking on your summer experience? What are the topics from these courses that would have helped you over the summer if you had been more familiar with them?
• Are there topics you should have been familiar with in preparation for your summer experience, but are not taught at Brown? What are these topics?
• What did you learn from the experience that probably could not have been picked up from course work?
• Is the sort of work you did over the summer something you would like to continue doing once you graduate? Explain.
• Would you recommend your summer experience to other Brown students? Explain.

Honors
Requirements and Process: Honors in the Applied Math-Biology concentration is based primarily upon an in-depth, original research project carried out under the guidance of a Brown (and usually Applied Math or BioMed) affiliated faculty advisor. Projects must be conducted for no less than two full semesters, and students must register for two semesters of credit for the project via APMA 1970 or BIOL 1950/BIOL 1960 or similar independent study courses. One of these courses can be used to fulfill the research-related course requirement, but the other cannot be used elsewhere in the concentration. The project culminates in the writing of a thesis which is reviewed by the thesis advisor and a second reader. It is essential that the student have one advisor from the biological sciences and one in Applied Mathematics. The thesis work must be presented in the form of an oral presentation (arranged with the primary thesis advisor) or posted at the annual Undergraduate Research Day in either Applied Mathematics or Biology. For information on registering for BIOL 1950/BIOL 1960, please see https://www.brown.edu/academics/biology/undergraduate-education/undergraduate-research (https://www.brown.edu/academics/biology/undergraduate-education/undergraduate-research/)
The concentrations in Applied Math (including joint concentrations) require that honors students demonstrate excellence in grades for courses in the concentration. Students must have earned grades of A or S-with-distinction in at least 70% of the courses used for concentration credit, excluding calculus and linear algebra, or be in the upper 20% of the student's cohort (as measured by the fraction of grades of A or S-with-distinction among courses used for concentration credit, excluding calculus and linear algebra). Since S with distinctions do not appear on the internal academic record or the official transcript, the department will consult directly with the Registrar's Office to confirm a student's grades in concentration courses. Additional guidelines and requirements for honors are published on the department website (https://www.brown.edu/academics/applied-mathematics/undergraduate-program/honors/)
The deadline for applying to graduate with honors in the concentration are the same as those of the biology concentrations. However, students in the joint concentration must inform the undergraduate chair in Applied Mathematics of their intention to apply for honors by these dates.

Biochemistry & Molecular Biology Concentration Requirements
How does life work at the molecular level? This question is at the core of the concentration program Biochemistry and Molecular Biology. In earlier years of this discipline, the focus was on structure and function of proteins, nucleic acids, lipids, carbohydrates and small molecules such as vitamins. Today the logical approach and tools of biochemical science are being expanded to new areas in neuroscience, developmental biology, immunology, pharmacology and synthetic biology (the design of analogs of biological systems). Training in biochemistry begins with a foundation in mathematics, physics, chemistry and biology. Some courses offered in other departments, including engineering, geology and computer science, are also useful. A key component of this program is the year of hands-on research carried out in collaboration with a faculty member here at Brown. Faculty sponsors are drawn from both the Chemistry Department and the Division of Biology and Medicine, and include basic science and clinical faculty.

Standard program for the Sc.B. degree
Students must take twenty courses in biology, chemistry, mathematics, and physics, including the following core requirements, some of these may be fulfilled with AP credits.

Three courses in mathematics including two courses in MATH 0090/0100 or MATH 0170/0180 with a third in statistics, math, or computer science

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 0030</td>
<td>Basic Physics A</td>
</tr>
<tr>
<td>or PHYS 0050</td>
<td>Foundations of Mechanics</td>
</tr>
<tr>
<td>or ENGN 0030</td>
<td>Introduction to Engineering</td>
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</tbody>
</table>

Three courses in physical and organic chemistry:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 0330</td>
<td>Equilibrium, Rate, and Structure</td>
</tr>
<tr>
<td>CHEM 0350/0360</td>
<td>Organic Chemistry</td>
</tr>
<tr>
<td>One course in biophysical or related chemistry, such as:</td>
<td></td>
</tr>
<tr>
<td>CHEM 0500</td>
<td>Inorganic Chemistry</td>
</tr>
</tbody>
</table>

Four courses in biochemistry:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 0280</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>BIOL 0285</td>
<td>Inquiry in Biochemistry: From Gene to Protein Function</td>
</tr>
<tr>
<td>Plus two of three upper level biochemistry courses:</td>
<td></td>
</tr>
<tr>
<td>BIOL 1270</td>
<td>Advanced Biochemistry</td>
</tr>
<tr>
<td>or CHEM 1230</td>
<td>Chemical Biology</td>
</tr>
<tr>
<td>or CHEM 1240</td>
<td>Biochemistry</td>
</tr>
</tbody>
</table>

Select two semester courses of independent research approved by a concentration advisor:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 1950/1960</td>
<td>Directed Research/Independent Study</td>
</tr>
<tr>
<td>or CHEM 0970/0980</td>
<td>Undergraduate Research</td>
</tr>
</tbody>
</table>

Suggested Elective Courses:

Students are required to take five courses from the chart below or, with approval from a concentration advisor, from any science or mathematics course relevant to biochemistry, cell and molecular biology.
### Applied Mathematics Electives:
- APMA 0330: Methods of Applied Mathematics I, II
- APMA 0410: Mathematical Methods in the Brain Sciences
- APMA 0650: Essential Statistics

### Chemistry Electives:
- CHEM 1450
- CHEM 1240
- CHEM 1230
- CHEM 1220
- CHEM 1150
- CHEM 1140
- CHEM 0500
- CHEM 1140S
- CHEM 1130
- CHEM 1120
- CHEM 1110
- CHEM 1090
- CHEM 1080
- CHEM 1070
- CHEM 1060
- CHEM 1050
- CHEM 0510
- CHEM 0500
- CHEM 0470
- CHEM 0440
- CHEM 0415
- CHEM 0380
- CHEM 0190S
- CHEM 0190R
- CHEM 0170
- CHEM 0160
- CHEM 0150D
- CHEM 0030
- APMA 0650
- APMA 0410
- APMA 0330
- APMA 0180
- APMA 0170
- APMA 0160
- APMA 0150

### Biology Electives:
- BIOL 0030: Principles of Nutrition
- BIOL 0150D: Techniques in Regenerative Medicine: Cells, Scaffolds and Staining
- BIOL 0170: Biotechnology in Medicine
- BIOL 0190R: Phage Hunters, Part I
- BIOL 0190S: Phage Hunters, Part II
- BIOL 0200: The Foundation of Living Systems
- BIOL 0380: The Ecology and Evolution of Infectious Disease
- BIOL 0415: Microbes in the Environment
- BIOL 0440: Inquiry in Plant Biology: Analysis of Plant Growth, Reproduction and Adaptive Responses
- BIOL 0470: Genetics
- BIOL 0500: Cell and Molecular Biology
- BIOL 0510: Introductory Microbiology
- BIOL 0530: Principles of Immunology
- BIOL 0800: Principles of Physiology
- BIOL 1050: Biology of the Eukaryotic Cell
- BIOL 1090: Polymer Science for Biomaterials
- BIOL 1100: Cell Physiology and Biophysics
- BIOL 1110: Topics in Signal Transduction
- BIOL 1120: Biomaterials
- BIOL 1150: Stem Cell Engineering
- BIOL 1200: Protein Biophysics and Structure
- BIOL 1210: Synthetic Biological Systems
- BIOL 1260: Physiological Pharmacology
- BIOL 1290: Cancer Biology
- BIOL 1300: Biomolecular Interactions: Health, Disease and Drug Design
- BIOL 1310: Developmental Biology
- BIOL 1330: Biology of Reproduction
- BIOL 1520: Innate Immunity
- BIOL 1540: Molecular Genetics
- BIOL 1560: Virology
- BIOL 1600: Development of Vaccines to Infectious Diseases
- BIOL 2110: Drug and Gene Delivery
- BIOL 2350: The Biology of Aging

### Computer Science Electives:
- CSCI 0080: A First Byte of Computer Science
- CSCI 0150: Introduction to Object-Oriented Programming and Computer Science
- CSCI 0160: Introduction to Algorithms and Data Structures
- CSCI 0170: Computer Science: An Integrated Introduction
- CSCI 0180: Computer Science: An Integrated Introduction
- CSCI 1810: Computational Molecular Biology

### Education Electives:
- EDUC 1110: Introductory Statistics for Education Research and Policy Analysis

### Engineering Electives:
- ENGN 0410: Materials Science

### Neuroscience Electives:
- BIOL 0285
- BIOL 0286
- BIOL 0287
- BIOL 0288
- BIOL 0289

### Public Health Electives:
- PHP 1501: Essentials of Data Analysis

### Engineering Accreditation Commission of ABET:
- The Sc.B. program in Biomedical Engineering is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org/. It is

### Honors Requirements for Biochemistry

All ScB Biochemistry concentrators are candidates for Honors; no separate application is necessary. The requirements for Honors in Biochemistry are:

* Students in the class of 2021: A strong grade record in concentration courses. This means a grade point average for the concentration that is higher than 3.25. For students in the classes of 2022 and after:

  * Two semesters of Independent Study (CHEM 0970, CHEM 0980 or equivalent). Guidelines and requirements associated with Independent Study are in the Undergraduate Concentration Handbook which can be found at the department website (http://www.brown.edu/academics/chemistry/undergraduate/).

  * A Thesis in a form approved by the research advisor, and recommended by the research advisor. Additional information about thesis guidelines will be provided by the Concentration Advisor in the first half of the fall semester.

### Biomedical Engineering Concentration Requirements

The Sc.B. program in Biomedical Engineering is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org/. It is
The Biomedical Engineering concentration shares much of the core with the other engineering programs, but is structured to include more courses in biology and chemistry, and a somewhat different emphasis in mathematics.

The requirements regarding Mathematics, Advanced Placement, Transfer Credit, Substitutions for Required Courses, and Humanities and Social Science Courses are identical to those of the Sc.B. degree programs in Engineering. Please refer to the Engineering section of the University Bulletin for explicit guidelines.

The Biomedical Engineering concentration shares much of the core with the other engineering programs, but is structured to include more courses in biology and chemistry, and a somewhat different emphasis in mathematics.

**Standard program for the Sc.B. degree**

1. **Core Courses**
   - ENGN 0030 Introduction to Engineering 1
   - or ENGN 0031 Honors Introduction to Engineering 1
   - ENGN 0040 Dynamics and Vibrations 1
   - ENGN 0510 Electricity and Magnetism 1
   - or ENGN 0520 Electrical Circuits and Signals 1
   - ENGN 0720 Thermodynamics 1
   - ENGN 0810 Fluid Mechanics 1
   - CHEM 0330 Equilibrium, Rate, and Structure 1
   - CHEM 0350 Organic Chemistry 1
   - MATH 0190 Advanced Placement Calculus (Physics/Engineering) 1
   - or MATH 0170 Advanced Placement Calculus 1
   - or MATH 0100 Introductory Calculus, Part II 1
   - MATH 0200 Intermediate Calculus (Physics/Engineering) 1
   - or MATH 0180 Intermediate Calculus 1
   - or MATH 0350 Honors Calculus 1
   - APMA 0330 Methods of Applied Mathematics I, II 1
   - or APMA 0350 Applied Ordinary Differential Equations 1
   - APMA 1650 Statistical Inference I 1
   - or BIOL 0495 Statistical Analysis of Biological Data 1
   - or PHP 1510 Principles of Biostatistics and Data Analysis 1
   - or APMA 1655 Statistical Inference I 1

2. **Upper Level Biomedical Engineering Curriculum**
   - ENGN 1110 Transport and Biotransport Processes 1
   - ENGN 1210 Biomechanics 1
   - ENGN 1230 Instrumentation Design 1
   - ENGN 1490 Biomaterials 1
   - BIOL 0800 Principles of Physiology 1

3. **Additional Biomedical Engineering Electives (Complete at least 3 courses from the following groups):**
   - Select one or two of the following:

**Biophysics Concentration Requirements**

Biophysics is a quantitative science that requires a significant level of competence in physics, chemistry, mathematics, and biology. These areas therefore form the required background coursework for this program, and serve as a springboard to an advanced focus, developed in consultation with a concentration advisor. Advanced foci may include structure-function relations of macromolecules, biomechanics of cell cytoskeleton, biotechnology for drug and gene delivery, molecular mechanisms of membrane transport, sensory signal transduction, for examples. The program also requires a capstone research project that reflects this focus.
and may be drawn from collaborative research opportunities offered by faculty in biology, chemistry, or physics departments.

Additional detailed information about the field of Biophysics may be found at: http://www.biophysics.org/AboutUs/Biophysics/tabid/517/Default.aspx.

**Standard program for the Sc.B. degree**

**Requirements**

Select one of the following Series: 2

<table>
<thead>
<tr>
<th>Series</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 0050 &amp; PHYS 0060</td>
<td>Foundations of Mechanics and Introduction to Electromagnetism and Modern Physics</td>
</tr>
<tr>
<td>PHYS 0070 &amp; PHYS 0160</td>
<td>Analytical Mechanics and Introduction to Relativity, Waves and Quantum Physics</td>
</tr>
<tr>
<td>PHYS 0470</td>
<td>Electricity and Magnetism</td>
</tr>
<tr>
<td>CHEM 0330</td>
<td>Equilibrium, Rate, and Structure</td>
</tr>
<tr>
<td>CHEM 0350</td>
<td>Organic Chemistry</td>
</tr>
<tr>
<td>CHEM 0360</td>
<td>Organic Chemistry</td>
</tr>
</tbody>
</table>

Select one of the following: 1

<table>
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<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 0400</td>
<td>Biophysical and Bioinorganic Chemistry</td>
</tr>
<tr>
<td>CHEM 1140</td>
<td>Physical Chemistry: Quantum Chemistry</td>
</tr>
<tr>
<td>PHYS 1530</td>
<td>Thermodynamics and Statistical Mechanics</td>
</tr>
<tr>
<td>PHYS 1610</td>
<td>Biological Physics</td>
</tr>
<tr>
<td>MATH 0100</td>
<td>Introductory Calculus, Part II (or equivalent)</td>
</tr>
<tr>
<td>MATH 0180</td>
<td>Intermediate Calculus (or equivalent)</td>
</tr>
<tr>
<td>BIOL 0200</td>
<td>The Foundation of Living Systems</td>
</tr>
</tbody>
</table>

Select two additional biology courses chosen with approval of the advisor. Examples include courses in: 2

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 0200</td>
<td>Cell and Molecular Biology</td>
</tr>
<tr>
<td>BIOL 0250</td>
<td>Biology of the Eukaryotic Cell</td>
</tr>
<tr>
<td>BIOL 1200</td>
<td>Protein Biophysics and Structure</td>
</tr>
<tr>
<td>BIOL 0800</td>
<td>Principles of Physiology</td>
</tr>
<tr>
<td>BIOL 1100</td>
<td>Cell Physiology and Biophysics</td>
</tr>
<tr>
<td>BIOL 1190</td>
<td>Synaptic Transmission and Plasticity</td>
</tr>
<tr>
<td>NEUR 1020</td>
<td>Principles of Neurobiology</td>
</tr>
<tr>
<td>BIOL 1260</td>
<td>Physiological Pharmacology</td>
</tr>
<tr>
<td>BIOL 1090</td>
<td>Polymer Science for Biomaterials</td>
</tr>
<tr>
<td>BIOL 1120</td>
<td>Biomaterials</td>
</tr>
<tr>
<td>BIOL 1140</td>
<td>Tissue Engineering</td>
</tr>
</tbody>
</table>

Select six additional intermediate or advanced level courses, chosen from biology (e.g., biochemistry, genetics, physiology, physics, chemistry, and/or computer sciences and mathematics). Examples include: 6

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 0280</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>BIOL 0470</td>
<td>Genetics</td>
</tr>
<tr>
<td>BIOL 0800</td>
<td>Principles of Physiology</td>
</tr>
<tr>
<td>BIOL 1190</td>
<td>Synaptic Transmission and Plasticity</td>
</tr>
<tr>
<td>PHYS 0500</td>
<td>Advanced Classical Mechanics</td>
</tr>
<tr>
<td>PHYS 0560</td>
<td>Experiments in Modern Physics</td>
</tr>
<tr>
<td>PHYS 1410</td>
<td>Quantum Mechanics A</td>
</tr>
<tr>
<td>PHYS 1420</td>
<td>Quantum Mechanics B</td>
</tr>
<tr>
<td>PHYS 1610</td>
<td>Biological Physics</td>
</tr>
</tbody>
</table>

**Computational Biology Concentration Requirements**

Computational biology involves the analysis and discovery of biological phenomena using computational tools, and the algorithmic design and analysis of such tools. The field is widely defined and includes foundations in computer science, applied mathematics, statistics, biochemistry, molecular biology, genetics, ecology, evolution, anatomy, neuroscience, and visualization.

Students may pursue a Bachelor of Arts or a Bachelor of Science. Students pursuing the ScB have the option of electing a concentration in Computational Biology with one of three focus areas: Computer Sciences, Biological Sciences, or Applied Mathematics & Statistics. Both programs require a senior capstone experience that pairs students and faculty in creative research collaborations.

**Standard program for the A.B. degree**

**Prerequisites:** 2

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 0100</td>
<td>Introductory Calculus, Part II</td>
</tr>
<tr>
<td>or MATH 0170</td>
<td>Advanced Placement Calculus</td>
</tr>
<tr>
<td>BIOL 0200</td>
<td>The Foundation of Living Systems</td>
</tr>
</tbody>
</table>

**General Core Requirements: Biology** 2

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 0470</td>
<td>Genetics</td>
</tr>
<tr>
<td>BIOL 0280</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>or BIOL 0500</td>
<td>Cell and Molecular Biology</td>
</tr>
</tbody>
</table>

**General Core Requirements: Chemistry** 1

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 0330</td>
<td>Equilibrium, Rate, and Structure</td>
</tr>
<tr>
<td>or CHEM 0350</td>
<td>Organic Chemistry</td>
</tr>
</tbody>
</table>

**General Core Requirements: Computer Science** 2

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCI 0150</td>
<td>Introduction to Object-Oriented Programming and Computer Science</td>
</tr>
<tr>
<td>or CSCI 0160</td>
<td>and Introduction to Algorithms and Data Structures</td>
</tr>
<tr>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>CSCI 0170 &amp; CSCI 0180</td>
<td>Computer Science: An Integrated Introduction</td>
</tr>
<tr>
<td>OR</td>
<td></td>
</tr>
</tbody>
</table>
CSCI 0190 & CSCI 0180 & CSCI 0320 & CSCI 1010 
Accelerated Introduction to Computer Science and Computer Science: An Integrated Introduction to Software Engineering and Introduction to Computer Systems and Theory of Computation

General Core Course Requirements: Probability & Statistics 1
APMA 1650 Statistical Inference I
OR
CSCI 1450 Probability for Computing and Data Analysis
OR
MATH 1610 Probability

Comp Bio Core Course Requirements 4
CSCI 1810 Computational Molecular Biology
APMA 1080 Inference in Genomics and Molecular Biology
AND two of the following:
CSCI 1820 Algorithmic Foundations of Computational Biology
BIOL 1430 Population Genetics
BIOL 1465 Human Population Genomics
CSCI 1420 Machine Learning
APMA 1690 Computational Probability and Statistics
APMA 1660 Statistical Inference II
Additional course with Director approval

Total Credits 12

University Writing Requirement:
As part of Brown’s writing requirement, all students must demonstrate that they have worked on their writing both in their general studies and their concentration. There are a number of ways for Computational Biology concentrators to fulfill these requirements:
• Enrolling in an independent study: CSCI 1970, BIOL 1950, APMA 1970
• Writing an Honors Thesis
• Taking a “WRIT” course in the final two years

Capstone Experience
Students enrolled in the computational biology concentration will complete a research project in their senior year under faculty supervision. The themes of such projects evolve with the field and the technology, but should represent a synthesis of the various specialties of the program. The requirements are either one semester of reading and research with a CCMB Faculty member or approved advisor, or a 2000-level Computational Biology course.

Standard program for the Sc.B. degree

Prerequisites
MATH 0100 Introductory Calculus, Part II (or equivalent) 1
or MATH 0170 Advanced Placement Calculus
BIOL 0200 The Foundation of Living Systems (or equivalent) 1

General Core Course Requirements: Biology
BIOL 0470 Genetics (prerequisite BIOL 0200 or equivalent) 1
BIOL 0280 Biochemistry 1
or BIOL 0500 Cell and Molecular Biology

General Core Requirements: Chemistry
CHEM 0330 Equilibrium, Rate, and Structure 1
or CHEM 0350 Organic Chemistry

General Core Requirements: Computer Science 2-4
CSCI 0150 & CSCI 0160 Introduction to Object-Oriented Programming and Computer Science and Introduction to Algorithms and Data Structures
OR
CSCI 0170 & CSCI 0180 Computer Science: An Integrated Introduction and Computer Science: An Integrated Introduction
OR
CSCI 0190 & CSCI 0320 & CSCI 0330 Accelerated Introduction to Computer Science and Computer Science: An Integrated Introduction and Introduction to Software Engineering and Introduction to Computer Systems
CSCI 0220 Introduction to Discrete Structures and Probability

General Core Requirements: Probability & Statistics
APMA 1650 Statistical Inference I
or CSCI 1450 Probability for Computing and Data Analysis
or MATH 1610 Probability

General Core Requirements: Computational Biology
CSCI 1810 Computational Molecular Biology 1
APMA 1080 Inference in Genomics and Molecular Biology 1

Capstone Experience 1
BIOL 1950/1960 Directed Research/Independent Study
CSCI 1970 Individual Independent Study

Six courses in one of the following three tracks: 6

Computer Science Track:
Three of the following:
CSCI 1230 Introduction to Computer Graphics
CSCI 1270 Database Management Systems
CSCI 1410 Artificial Intelligence
CSCI 1550 Probabilistic Methods in Computer Science
CSCI 1570 Design and Analysis of Algorithms
or other Computer Science courses approved by the concentration advisor
Three of the following:
CSCI 0330 Introduction to Computer Systems
or CSCI 0320 Introduction to Software Engineering
CSCI 1820 Algorithmic Foundations of Computational Biology
PHP 2620 Statistical Methods in Bioinformatics, I
APMA 1660 Statistical Inference II
BIOL 1430 Population Genetics
BIOL 1465 Human Population Genomics
APMA 1690 Computational Probability and Statistics

Biological Sciences track
At least four courses comprising a coherent theme in one of the following areas: Biochemistry, Ecology, Evolution, or Neurobiology.

AND select two courses from the following:
CSCI 1820 Algorithmic Foundations of Computational Biology
PHP 2620 Statistical Methods in Bioinformatics, I
APMA 1660 Statistical Inference II
BIOL 1430 Population Genetics
BIOL 1465 Human Population Genomics
APMA 1690 Computational Probability and Statistics

Standard program for the Sc.B. degree

Prerequisites
MATH 0100 Introductory Calculus, Part II (or equivalent) 1
or MATH 0170 Advanced Placement Calculus
BIOL 0200 The Foundation of Living Systems (or equivalent) 1

General Core Course Requirements: Biology
BIOL 0470 Genetics (prerequisite BIOL 0200 or equivalent) 1
BIOL 0280 Biochemistry 1
or BIOL 0500 Cell and Molecular Biology

General Core Requirements: Chemistry
CHEM 0330 Equilibrium, Rate, and Structure 1
or CHEM 0350 Organic Chemistry

General Core Requirements: Computer Science 2-4
CSCI 0150 & CSCI 0160 Introduction to Object-Oriented Programming and Computer Science and Introduction to Algorithms and Data Structures
OR
CSCI 0170 & CSCI 0180 Computer Science: An Integrated Introduction and Computer Science: An Integrated Introduction
OR
CSCI 0190 & CSCI 0320 & CSCI 0330 Accelerated Introduction to Computer Science and Computer Science: An Integrated Introduction and Introduction to Software Engineering and Introduction to Computer Systems
CSCI 0220 Introduction to Discrete Structures and Probability

General Core Requirements: Probability & Statistics
APMA 1650 Statistical Inference I
or CSCI 1450 Probability for Computing and Data Analysis
or MATH 1610 Probability

General Core Requirements: Computational Biology
CSCI 1810 Computational Molecular Biology 1
APMA 1080 Inference in Genomics and Molecular Biology 1

Capstone Experience 1
BIOL 1950/1960 Directed Research/Independent Study
CSCI 1970 Individual Independent Study

Six courses in one of the following three tracks: 6

Computer Science Track:
Three of the following:
CSCI 1230 Introduction to Computer Graphics
CSCI 1270 Database Management Systems
CSCI 1410 Artificial Intelligence
CSCI 1550 Probabilistic Methods in Computer Science
CSCI 1570 Design and Analysis of Algorithms
or other Computer Science courses approved by the concentration advisor
Three of the following:
CSCI 0330 Introduction to Computer Systems
or CSCI 0320 Introduction to Software Engineering
CSCI 1820 Algorithmic Foundations of Computational Biology
PHP 2620 Statistical Methods in Bioinformatics, I
APMA 1660 Statistical Inference II
BIOL 1430 Population Genetics
BIOL 1465 Human Population Genomics
APMA 1690 Computational Probability and Statistics

Biological Sciences track
At least four courses comprising a coherent theme in one of the following areas: Biochemistry, Ecology, Evolution, or Neurobiology.

AND select two courses from the following:
CSCI 1820 Algorithmic Foundations of Computational Biology
PHP 2620 Statistical Methods in Bioinformatics, I
APMA 1660 Statistical Inference II
BIOL 1430 Population Genetics
BIOL 1465 Human Population Genomics
APMA 1690 Computational Probability and Statistics
**Biology (Undergraduate)**

**Applied Mathematics & Statistics Track:**

At least three courses from the following:

- APMA 1660 Statistical Inference II
- APMA 1690 Computational Probability and Statistics
- CSCI 1410 Artificial Intelligence
- APMA 0340 Methods of Applied Mathematics I, II
- APMA 0330 and Methods of Applied Mathematics I, II

**OR**

- APMA 0360 Applied Partial Differential Equations I
- APMA 0350 and Applied Ordinary Differential Equations

At least three of the following:

- BIOL 1430 Population Genetics
- CSCI 1820 Algorithmic Foundations of Computational Biology
- PHP 2620 Statistical Methods in Bioinformatics, I
- APMA 1070 Quantitative Models of Biological Systems
- BIOL 1465 Human Population Genomics

Total Credits: 18-20

**Honors:**

In order to be considered a candidate for honors, students will be expected to maintain an outstanding record, with no "C"s in concentration courses and with a minimum of an "A-" average in concentration courses. In addition, students should take at least one semester, of reading and research with a CCMB faculty member or approved advisor. Students must submit to a public defense of their theses to be open to the CCMB community.

- Students seeking honors are advised to choose a Thesis Advisor prior to the end of their Junior year
- Students must complete the Registration form for Comp Bio and submit it to CCMB@BROWN.EDU

Any deviation from these rules must be approved by the director of undergraduate studies, in consultation with the student's advisor.

**Courses**

**BIOL 0030. Principles of Nutrition.**

Introduces the basic principles of human nutrition, and the application of these principles to the specific needs of humans, and the role of nutrition in chronic diseases. Provides an overview of the nutrients and their use by the human body. Also examines the role of nutrients in specific functions and disease states of the body. Not for biology concentration credit. Enrollment limited to 100.

Fall BIOL0030 S01 15557 Arranged (M. Flynn)

**BIOL 0040. Nutrition for Fitness and Physical Activity.**

Reviews the role of nutrition in physical activity and health. It is designed to provide the student with the information and skills needed to translate nutrition and physical activity recommendations into guidelines for both the athlete for maximal performance and the non-athlete to improve both health and body weight. Students will learn the use of the energy yielding nutrition in physical activity and how food choices can influence both athletic performance and long-term health through the effect on risk factors for chronic diseases. Prerequisite: BIOL 0030. Enrollment limited to 20. Instructor permission required.

**BIOL 0060. Introduction to Human Physiology.**

An introduction to human physiology aimed primarily at undergraduates who have minimal to no Biology background or who are not concentrating in biology. Acquire a basic understanding of the physiological mechanisms that allow for the running of each major organ systems. Topics include basic cardiovascular, respiratory, urinary, digestive, endocrine, and neuromuscular function, as well as aspects of reproduction and exercise physiology. Not for biology concentration credit. Lab.

**BIOL 0080. Biotechnology Management.**

An examination of the pharmaceutical, biotechnology, and medical product industries: what they are, how they function, whence they originate, and various perspectives on why some succeed and others fail. Pathways from lab-bench to marketplace are described as are the pervasive influences of the FDA, patent office, and courts. Extensive reading; emphasis on oral presentation. Primarily intended for students planning a career in biomedical industry. Not for biology concentration credit. Students MUST register for the lecture section and the conference. Enrollment limited to 20.

**BIOL 0100. Living Biology at Brown and Beyond.**

BIOL 0100 is a unique first year seminar tailored to students from historically underrepresented groups who aim to study in the biological sciences. By successfully completing this course, students will be able to: 1) Apply a deeper understanding of opportunities in Biology at Brown to the development of personal academic goals. 2) Articulate goals for personal and professional growth during college and apply specific skills to achieve them. 3) Apply specific techniques to effectively engage with STEM primary literature, lectures, and research talks. 4) Draw on science from various sub-disciplines of biology to articulate how human-animal interactions in the 21st century can cause infectious disease emergence events that lead to global pandemics such as COVID-19.

Fall BIOL0100 S01 15571 Arranged (K. Smith)

**BIOL 0110. Fake Math: Analyzing the Misuse of Quantitative Concepts.**

From the Scarecrow in the Wizard of Oz to the White House, quantitative errors are made and put forth. This course will present, discuss, and challenge students to analyze misused quantitative concepts. These errors will be taken from misapplied logic; inappropriate use of numbers; graphical inaccuracies and manipulations; cognitive illusions; self-fulfilling prophecies; the wrong-but-often-relied-upon Law of Small Numbers; conditional probability; correlation, confounding, and causality; hazards of data mining; circular reasoning; and basic misuses of statistics. Introductory concepts of classical logic, probability, and statistics will be presented and reviewed, and examples of their misuse will be discussed and evaluated.

**BIOL 0140A. Topics in Science Communications: Science Journalism Practicum.**

Participants will understand how to read scientific research papers to interpret their findings and communicate these to a broader lay audience; analyze and understand best practices in science writing and the challenges of covering science for mass media; interviewing; fair and balanced coverage in reporting; give and receive peer feedback. Not for concentration credit in Biological Sciences programs. Enrollment limited to 10. Instructor permission required. S/NC

**BIOL 0140B. Communicating Science: Biological Illustration.**

This Sophomore Seminar is an immersion practicum that conjoins art and science. By successfully completing this course, students will be able to: 1) Apply a deeper understanding of opportunities in Biology at Brown to the development of personal academic goals. 2) Articulate goals for personal and professional growth during college and apply specific skills to achieve them. 3) Apply specific techniques to effectively engage with STEM primary literature, lectures, and research talks. 4) Draw on science from various sub-disciplines of biology to articulate how human-animal interactions in the 21st century can cause infectious disease emergence events that lead to global pandemics such as COVID-19.

**BIOL 0140C. Communicating Science: Animating Science.**

Taught by RISD/Brown professors with the Science Ctr and Creative Mind Initiative, this course explores the pedagogy of using visual media to convey scientific concepts. The goal is to assess the quality of existing material and design new material that fill an educational need and makes science engaging and accessible. Lectures, labs, discussions, critiques and speakers. Teams collaborate on a series of short exercises leading to the creation of videos/animations explaining scientific concepts. Projects evaluated on accuracy, clarity of explanation, educational value, viewer engagement and creativity. Not for concentration credit in Biological Sciences programs. Enrollment limited to 12; instructor permission.

**BIOL 0150. Biotechnology Management.**

An examination of the pharmaceutical, biotechnology, and medical product industries: what they are, how they function, whence they originate, and various perspectives on why some succeed and others fail. Pathways from lab-bench to marketplace are described as are the pervasive influences of the FDA, patent office, and courts. Extensive reading; emphasis on oral presentation. Primarily intended for students planning a career in biomedical industry. Not for biology concentration credit. Students MUST register for the lecture section and the conference. Enrollment limited to 20.

**Fall BIOL0100 S01 15571 Arranged (K. Smith)**
**BIOL 0140K. Conservation Medicine.**
How have fruit bats contributed to the emergence of Nipah virus in Malaysia? Is an infectious cancer going to drive the Tasmanian Devil to extinction? Will a warmer world be a sicker world? We will consider these and additional topics at the intersection of global change biology and infectious disease emergence in this course. The course should be of interest to pre-med, general biology and environmental studies concentrators seeking interdisciplinary learning classroom experience. This will satisfy “Area 3” organismal biology concentration requirement for Biology/Health-Human Biology. Expected background: BIOL 0200 or equivalent placement. Enrollment limited to 12 sophomores. Instructor permission required.

**BIOL 0140T. Communicating Science Through Visual Media.**
This class, offered jointly by professors at RISD and Brown, will explore the pedagogy and practice of using visual media to convey scientific concepts. The goal of this course will be to assess examples of existing material and create new animations/video that fill an educational need and make science engaging and accessible. Class time will be comprised of lectures, labs, screenings, discussions, critiques and exercises. After an introduction to teaching pedagogy and the basics of animation and visual design, small student teams will be paired with science faculty mentors to create videos and animations that explain scientific concepts. Fall BIOL0140T S01 18021 W 1:10-6:10(06) (J. Stein)
Fall BIOL0140T L01 18463 M 7:00-10:00PM (J. Stein)

**BIOL 0150A. Techniques and Analyses using DNA-Based Biotechnology.**
Students will study and practice a range of methods used in molecular biology while examining the ways in which those tools are used in research and in the development of medical treatments. This experience, combined with the reading and discussion of selected papers from the primary literature, fosters development of a skill set critically important for the modern day biology student. Expected background: high school Biology course. Enrollment limited to 10 first year students. Instructor permission required. Half-credit course. S/NC.

**BIOL 0150B. Statistical Computing for Biology.**
Modern biological research is a data rich endeavor, necessitating strong quantitative and computational skills to interpret the results of experimental and observational studies. In this course we will explore the application of statistics and modeling in biological research and environmental science. Topics covered will include basic probability, experimental design, sampling, hypothesis testing and mathematical models for prediction. No prior statistics knowledge is assumed. Enrollment limited to 10 first year and sophomore students. Instructor permission, based on a portfolio review. This is a half-credit course. S/NC.

**BIOL 0150C. Introduction to Ethnopharmacology.**
Plant secondary metabolites are currently the subject of much research interest when investigating new target compounds for potential medicine from natural products. New leads for drugs and phytomedicines from plants and plant parts have been increasing at a rapid rate especially by the pharmaceutical industry. Many plants have been selected and collected for their specific secondary compounds and healing powers by ethnobotanists in the field. Students will gain hands on experience identifying medicinal plants, laboratory equipment, sampling procedures, field tests and extraction techniques of secondary metabolites by high throughput screening methods. Enrollment limited to 10 FYS. Instructor permission required.

**BIOL 0150D. Techniques in Regenerative Medicine: Cells, Scaffolds and Staining.**
Regenerative Medicine, also known as Tissue Engineering, is the process of creating living, functional tissues to repair or replace native tissue or organ functions that have been lost due to disease or congenital defects. As such, it is a prominent scientific discipline that can either “stand alone” or complement material-based research efforts in the areas of device design, drug delivery, diagnostics and pharmaceuticals. Students will develop proficiencies in basic cell culture techniques, early stage tissue regeneration strategies and histochemical characterization of mammalian cell constructs. Enrollment limited to 10 first year students. Instructor permission required. Half-credit course. S/NC.

**BIOL 0160. Plants, Food, and People.**
Examines the selection, breeding, cultivation and uses of food plants. Discusses the effects on agriculture of pathogens, climate change, and loss of biodiversity. Considers whether enough food can be produced for a world population of potentially 10 billion, while sustaining biodiversity and environmental quality. Enrollment limited to 50. Spr BIOL0160 S01 24362 Arranged (P. Heywood)

**BIOL 0170. Biotechnology in Medicine.**
Introduces undergraduates to the main technological advances currently dominating the practice of medicine. Provides an overview of the objectives, techniques, and problems related to the application of biomedical technology to the diagnosis and treatment of disease and the contemporary health care industry. Topics include: pharmaceutical development and formulation; organ replacement by prosthesis and transplantation; medical imaging; tissue engineering, therapeutic cloning, regenerative medicine; stem cells; societal, economic, and ethical issues. This course does carry Biology concentration credit. Fall BIOL0170 S01 15680 MWF 1:00-1:50(06) (T. Achilli)

**BIOL 0180. The Biology of AIDS.**
AIDS represents an example of the vulnerability of humans to new infectious agents. We will review some human infectious diseases including small pox yellow fever and influenza, and then explore AIDS/HIV. First characterized in 1981, AIDS became the leading cause of death in U.S. males aged 25-44 within a decade. We will examine what factors make HIV such a potent pathogen. The course is intended for students beginning in biology. Expected: BIOL 0200, or equivalent placement. This course does carry Biology concentration credit.

**BIOL 0190E. Botanical Roots of Modern Medicine.**
This course will explore a variety of medicinal plants found throughout the world, the diverse cultures that use them in their daily lives and how these and additional topics at the intersection of global change biology and infectious disease emergence in this course. The course should be of interest to pre-med, general biology and environmental studies concentrators seeking interdisciplinary learning classroom experience. This will satisfy “Area 3” organismal biology concentration requirement for Biology/Health-Human Biology. Expected background: BIOL 0200 or equivalent placement. Enrollment limited to 10 first year and sophomore students. Instructor permission required. Half-credit course. S/NC.

**BIOL 0190F. Darwinian Medicine.**
Explores evolutionary explanations of why we get sick, and how this can shape, or misshape, our interpretations of medicine. Draws on evolutionary genetics, population biology, molecular biology and physiology. This course will build on evolutionary biology and then focus on disease processes such as infection, aging, cancer, allergy, diabetes, and obesity. Enrollment limited to 19 first year students.

**BIOL 0190P. Pride and Prejudice in the Development of Scientific Theories.**
We will examine how the pace and shape of scientific progress is affected by the social/cultural context and the “personality” of the individual. We will look into how the interplay between society and the individual affects how scientific theories arise, are presented, are debated and are accepted. The course will initially focus on Charles Darwin and his theory of Natural Selection using the biography of Adrian Desmond and James Moore, "Darwin: The Life of a Tormented Evolutionist." Enrollment limited to 19 first year students.
Biology (Undergraduate) 13

BIOL 0190Q. Climate Change and Species Extinction.
In this course students will go beyond the headlines and delve into the science to explore the impact of climate change on species extinction. Students will explore the integration of science and technology through traditional textbooks, primary literature, open source databases, simulations, and discussions. Students will investigate the impact of climate change on species distribution, ecology, and behavior through interactive, inquiry-based, collaborative classroom investigations. Students will learn to integrate information from a variety of sources and disciplines and share their ideas through classroom discussion, written assignments, and oral presentations. Enrollment limited to 19 first year students.

BIOL 0190R. Phage Hunters, Part I.
A research-based lab class for freshmen; both semesters are required in the sequence. Students will isolate and characterize a bacteriophage viruses found in the soil. Lab work includes isolation and purification of your own phage, DNA isolation and restriction mapping, and EM characterization of your phage. Several phages will be selected for genome sequencing, and will be annotated during the second semester. Instructor permission required. Admittance based on review of applications in the first class. Limited to 19 freshmen.

BIOL 0190S. Phage Hunters, Part II.
A research-based laboratory/class for freshmen; both semesters are required. Students will isolate and characterize a bacteriophage viruses found in the soil. Lab work includes isolation and purification of your own phage, DNA isolation and restriction mapping, and EM characterization of your phage. Several phages will be selected for genome sequencing over Winter Recess, and annotated in the spring. One hour of lecture/discussion, and 3 hours lab per week. Expected: AP Biology or equivalent, HS chemistry, and permission of the instructor. Students are expected to take fall and spring courses in the sequence. Enrollment limited to 19 first-year students. Instructor permission.

BIOL 0190T. Bioinformatics: A Practical Introduction.
The amount of biological sequence data has grown at an exponential pace and spurred the development of computational tools that allow biologists to use this information. Students will become familiar with useful bioinformatics tools used by researchers. The course will introduce concepts of information transfer in biological molecules, storage in public databases, and how to use tools to access this information and organize it meaningfully. We will explore tools for studying whole genomes, including high-throughput sequencing data to assemble genomes and mapping subsets. Students will gain hands-on experience using these tools. Expected: AP credit or equivalent placement for BIOL 0200.

BIOL 0190U. The Lives of Plants.
This course examines the lives of plants through their development, structure, function, reproduction, and responses to environmental conditions. Enrollment limited to 19 first year students.

BIOL 0200. The Foundation of Living Systems.
A broad overview of biological systems, emphasizing patterns and processes that form the basis of life. Explores essentials of biochemistry, molecular, and cellular biology and their relationship to the larger issues of ecology, evolution, and development. Examines current research trends in biology and their influence on culture. Appropriate for all students interested in biology. Serves as a gateway course to much of the intermediate and advanced curriculum. Placement tests are offered (contact Jody_Hall@brown.edu). AP scores of 4 or 5 are equivalent to BIOL 0200, and place a student out of this course. Students will be assigned to a lab time during the second week of class.

Biology (Undergraduate) 13

Fall BIOL0190U S01 15636 MW 3:00-4:20(10) (P. Heywood)
BIOI 0280. Biochemistry
Lectures and recitation sections explore the mechanisms involved in the principles of macromolecular structure and function, the organization and regulation of pathways for intermediary metabolism, and the transfer of information from genes to proteins. It is expected that students have taken CHEM 0350 or are taking it concurrently.
Spr BIOI0280 S01 24374 TTh 1:00-2:20(08) (A. Salomon)
Spr BIOI0280 C01 24375 M 5:30-7:00 (A. Salomon)
Spr BIOI0280 C02 24376 M 7:00-8:30PM (A. Salomon)
Spr BIOI0280 C03 24377 M 8:30PM-10:00PM (A. Salomon)
Spr BIOI0280 C04 24378 T 8:00PM-9:30PM (A. Salomon)
Spr BIOI0280 C05 24379 W 5:30-7:00 (A. Salomon)
Spr BIOI0280 C06 24380 W 7:00-8:30PM (A. Salomon)
Spr BIOI0280 C07 24381 W 8:30PM-10:00PM (A. Salomon)
Spr BIOI0280 C08 24382 Th 8:00PM-9:30PM (A. Salomon)
Spr BIOI0280 C09 24383 F 5:30-7:00 (A. Salomon)
Spr BIOI0280 C10 24384 S 11:00-12:30 (A. Salomon)
Spr BIOI0280 C11 24385 S 3:00-4:30 (A. Salomon)
Spr BIOI0280 C12 26592 Su 11:00-12:30 (A. Salomon)
Spr BIOI0280 C13 26593 Su 3:00-4:30 (A. Salomon)
Spr BIOI0280 C14 26594 Su 6:00-7:30 (A. Salomon)
Spr BIOI0280 C15 26595 Th 4:00-6:00 (A. Salomon)

BIOI 0285. Inquiry in Biochemistry: From Gene to Protein Function.
In this inquiry-based research course, students work in teams to formulate and test a hypothesis about how a change in genetic sequence affects enzyme function. Students will cultivate skills in scientific visualization, experimental design, data analysis, and laboratory techniques in molecular biology and biochemistry. In discussion, students will learn scientific writing through peer editing and iterative revisions to write a full scientific paper. This course is WRIT designated and will prepare students for writing an honors thesis. Expected: Students have previously taken or be concurrently enrolled in BIOI 0280. Enrollment in one lab section and one discussion section is required.
Spr BIOI0285 S01 24386 M 1:00-5:00(10) (M. Ray)
Spr BIOI0285 S01 24386 Th 2:30-6:30(10) (M. Ray)
Spr BIOI0285 C01 24387 T 4:00-5:00 (M. Ray)

BIOI 0300. Endocrinology.
A basic examination of endocrinology with emphasis on hormone biosynthesis, mechanism of action, physiological roles, and endocrine pathology. Topics include: mechanism of action of steroid, amine, and peptide hormones; neuroendoendocrinology; reproductive endocrinology; and endocrinology of metabolism and calcium homeostasis. It is expected that students have taken BIOI 0200 (or equivalent) and CHEM 0350.

BIOI 0320. Vertebrate Embryology.
Introduction to the developmental anatomy of vertebrate embryos, including humans, in an evolutionary context, through lecture, discussion and microscope slide study. Gametogenesis through germ layers and their organ system derivatives. Expected: BIOI 0200, or equivalent placement, or AP Biology score of 4 or 5. Limited to 18 freshmen and 18 sophomores. Students MUST register for the lecture section and the lab.

BIOI 0350. The Fossil Record: Life through Time on Earth.
The course is designed for students with prior background in geology or evolutionary biology and who want to learn more about the fossil record, the origins of modern biodiversity and ecosystem structure, and interaction between organisms, and the geological and chemical cycles on the Earth. Lectures will cover major time periods during which animals and plants lived, as well as focusing on major transitions in the evolution of life on Earth. This course will fulfill requirements in both the geology/biology and evolutionary biology concentrations. Expected: BIOI 0210, GEOL 0240 or equivalent. Instructor permission, enrollment limited to 20 sophomores/juniors; register for course/lab.

BIOI 0380. The Ecology and Evolution of Infectious Disease.
Infectious diseases remain among the leading causes of death worldwide, and this burden is disproportionately borne by children living in low- and middle-income countries. Thus management of infectious disease remains a critical intellectual challenge in the 21st century. This course will develop and apply ecological and evolutionary theory to infectious microbes (and their hosts) via the detailed examination of a number of case studies. This will be accomplished by a combination of lectures, discussions, and readings drawn mainly from the primary literature. Assessment will be based on biweekly problem sets, two midterms and one final exam.
Expected: BIOI 0200, BIOI 0210 or equivalent.
Fall BIOI0380 S01 15576 Arranged (D. Weinreich)
Fall BIOI0380 C01 17935 M 6:00-6:50 (D. Weinreich)
Fall BIOI0380 C02 17936 M 7:00-7:50 (D. Weinreich)
Fall BIOI0380 C03 17932 T 8:00PM-8:50PM (D. Weinreich)
Fall BIOI0380 C04 18094 W 7:00-7:50 (D. Weinreich)
Fall BIOI0380 C05 18095 Th 8:00PM-8:50PM (D. Weinreich)
Fall BIOI0380 C06 18908 W 9:00-9:50 (D. Weinreich)

BIOI 0390. Vertebrate Evolution and Diversity.
An overview of vertebrate evolution that not only covers historical events, but also introduces various scientific concepts and modes of thought. Topics include past and present biodiversity, convergent evolution, biogeography, competition, continental drift, climatic change over time, the notion of evolution as progress, and a whole-animal approach to understanding evolutionary events. Enrollment limited to 50.

Many questions about the workings of living creatures can be answered by joining math, physics, and biology. We will identify basic physical science concepts that help biologists understand the structure and function of animals, plants, and microorganisms, and use these to study how the physical world constrains and facilitates the evolution of the extraordinary design and diversity of organisms. For first and second year students; others by permission. Recommended background: BIOI 0200, or equivalent. Enrollment limited to 40. Instructor permission required.

BIOI 0410. Invertebrate Zoology.
A survey of invertebrate animals emphasizing evolutionary patterns and ecological relationships. Functional morphology, physiology, reproduction, development, and behavior of invertebrates will be examined. Laboratory exercises and two separate day-long field trips provide firsthand experience with the animals. Expected: BIOI 0200 or equivalent. Enrollment limited to 44. Students MUST register for the lecture section and a lab.

Fall BIOI0410 S01 15577 TTh 9:00-10:20(02) (P. Ewanchuk)
Fall BIOI0410 L01 15578 W 1:00-4:00 (P. Ewanchuk)
Fall BIOI0410 L02 18288 W 1:00-4:00 (P. Ewanchuk)
Fall BIOI0410 L03 18289 W 1:00-4:00 (P. Ewanchuk)
Fall BIOI0410 L04 18290 W 1:00-4:00 (P. Ewanchuk)

Examines the diversity of microbial life in the environment. Surveys key services that microbes perform on land and sea, including biodegradation of contaminants in the environment and ecosystem processes related to climate change. Examines biological interactions of symbioses, quorum sensing, and antibiotic production in an ecological context. Explores the genomic mechanisms explaining phylogeny and life history strategies in microbes. Demonstrate knowledge of the diversity of microbes in the environment and benefits in an ecological/evolutionary context. Lecture based, two fieldtrips to expand appreciation for microbial ecology. BIOI 0200 or equivalent placement; CHEM 0330. Enrollment limited to 20 sophomores, juniors and seniors.
The principles, concepts, and controversies involved in the study of the distribution and abundance of plant and animal populations and their integration into natural communities. Emphasizes interactions among organisms and the hierarchical nature of ecological processes affecting individuals, populations, and communities. Expected: BIOL 0200 (or equivalent) and MATH 0900. Lectures and weekly discussion.
Spr BIOL0420 S01 24353 TTh 9:00-10:20(01) (J. Witman)
Spr BIOL0420 C01 24354 M 5:40-7:10 (J. Witman)
Spr BIOL0420 C02 26671 T 8:10PM-9:40PM (J. Witman)
Spr BIOL0420 C03 26672 W 5:40-7:10 (J. Witman)
Spr BIOL0420 C04 26673 Th 8:10PM-9:40PM (J. Witman)

BIOL 0430. The Evolution of Plant Diversity.
Examines the evolutionary history of plants from a phylogenetic perspective. Introduces the science of phylogenetics - how to infer phylogenies and how to use them to understand organismal evolution. Highlights major trends in plant evolution over the past 400 million years. Lectures survey major plant lineages, with special focus on flowering plants. Weekly labs, field trips, and assignments stress basic plant anatomy and morphology, identification, and learning the local flora. Expected: BIOL 0200 (or equivalent placement).
Spr BIOL0430 S01 24355 Arranged (R. Kartzinel)
Spr BIOL0430 L01 24356 T 1:00-4:00 (R. Kartzinel)
Spr BIOL0430 L02 26873 Th 1:00-4:00 (R. Kartzinel)

This course focuses on what plants do and how they do it. Introduces the biology of plants, their growth and development, structural features, and their cellular and organismal responses to key stimuli. Examines physiological, reproductive and developmental strategies throughout the plant life cycle and in relation to environmental challenges. During laboratory section meetings, students pursue inquiry-based group research projects addressing novel questions about mechanisms that control plant growth and development. Laboratory section is required. Prerequisites: One Brown course with laboratory section in either Biology or Chemistry. Enrollment limited to 24 students.
Spr BIOL0440 S01 26487 MW 8:30-9:50(02) (M. Fuxjager)

BIOL 0450. Evolutionary Behavioral Ecology.
An exploration of the ecological and evolutionary principles that define animal behavior in the natural world. We will focus mostly on the field of behavioral ecology, including important phenomena like avoiding predators, obtaining food, finding mates, producing offspring, living in groups, and solving problems. In doing so, we will combine ideas and principles from the disciplines of ecology, systematics, physiology, and economics.
Spr BIOL0450 S01 26487 MW 8:30-9:50(02) (M. Fuxjager)

Will enable students to master fundamental ecological concepts and understand how this knowledge can be used to inform coastal conservation and management. Case studies from New England and elsewhere, field trips to rocky shores, salt marshes and coastal ecosystems enable students to develop scientific skills and experience the challenges of coastal conservation science. The course is aimed at freshmen and sophomores. Expected background: BIOL 0200 or equivalent placement. Enrollment limited to 10 students, and written permission required. (Mark_Bertness@brown.edu) to receive course application (due May 1). Admitted students register for the course in September.

BIOL 0460. Insect Biology.
Focuses on characteristics that make insects unique and why more insect species have been described than all other organisms combined; the opportunity to investigate diversity and adaptation; their abundance, small size, and short lifespans; their importance as agents of biocontrol, pollination, agricultural pests, and disease vectors. Expected: BIOL 0200 or equivalent. Enrollment limited to 20. Students MUST register for lecture AND lab. Primarily for freshmen and sophomores.

BIOL 0470. Genetics.
Genetic phenomena at the molecular, cellular, organismal, and population levels. Topics include transmission of genes and chromosomes, mutation, structure and regulation of the expression of the genetic material, elements of genetic engineering, and evolutionary genetics. One laboratory session and one discussion session per week. (Students should not plan to take BIOL 0470 after 1540.) Expected: BIOL 0200 (or equivalent placement). Students will be assigned to Lab sections the first week of class.
Fall BIOL0470 S01 15637 Arranged (M. Johnson)

BIOL 0480. Evolutionary Biology.
A broad introduction to the patterns and processes of evolution at diverse levels of biological organization. Topics covered include natural selection, adaptation, speciation, systematics, macroevolution, mass extinction events, and human evolution. Students will be given the opportunity to do their 23andMe ancestry analyses as a means of integrating the topics that span genomics to human variation. Weekly discussion sections involve active learning simulations and discussions of papers from the primary literature. Occasional problem sets involve computer exercises with population genetics and phylogeny reconstruction. Expected: BIOL 0200 (or equivalent placement).
Fall BIOL0480 S01 15579 MWF 9:00-9:50(01) (D. Rand)
Fall BIOL0480 C01 15580 T 8:10PM-9:10PM (D. Rand)
Fall BIOL0480 C02 18455 W 5:40-6:40 (D. Rand)
Fall BIOL0480 C03 18456 W 7:00-8:00PM (D. Rand)
Fall BIOL0480 C04 18457 W 8:10PM-9:10PM (D. Rand)
Fall BIOL0480 C05 18458 Th 8:10PM-9:10PM (D. Rand)
Fall BIOL0480 C06 18459 S 11:00-12:00 (D. Rand)

BIOL 0495. Statistical Analysis of Biological Data.
A first course in probability distributions and the use of statistical methods for biological data. Topics covered will include describing data, statistical inference (hypothesis tests and confidence intervals), analyzing associations, and methods for categorical data (contingency tables and odds ratios). Methods will be applied to data drawn from areas of biological inquiry. For statistics or related science credit in Biology programs. Expected background: BIOL 0200 or equivalent, math equivalent to MATH 0100. This course is for related science credit only in Biological Sciences concentration programs. Enrollment limited: 35 undergraduates-17 juniors and 18 sophomores. Registration for seniors requires permission from the instructor.
Spr BIOL0495 S01 24345 TTh 2:30-3:50(10) 'To Be Arranged'
Spr BIOL0495 C01 24346 M 6:00-8:00PM 'To Be Arranged'
Spr BIOL0495 C02 26695 W 6:00-8:00PM 'To Be Arranged'

BIOL 0500. Cell and Molecular Biology.
This course examines the structure and function of the basic unit of an organism, the cell. An experimental approach is used to examine cellular functions, ranging from gene transcription, cell division and protein secretion, to cell motility, and signal transduction. Relevance to health and disease will be considered. Expected: BIOL 0200 (or equivalent placement).
Spr BIOL0500 S01 24391 Arranged (P. Heywood)
Spr BIOL0500 C01 26490 M 5:40-6:50 (P. Heywood)
Spr BIOL0500 C02 26491 W 5:40-6:50 (P. Heywood)
Spr BIOL0500 C03 26492 T 8:00PM-9:20PM (P. Heywood)
Spr BIOL0500 C04 26493 Th 8:00PM-9:20PM (P. Heywood)

BIOL 0510. Introductory Microbiology.
Introduces role of microbes in our understanding of biology at the cellular and molecular level. Focuses on microbial significance for infectious disease, public health, genetics, biotechnology, and biogeochemical cycles. Expected: BIOL 0200 (or equivalent placement). For spring 2021 only, this course will be limited to sophomores, juniors, and seniors. In spring 2022 and beyond, enrollment will once again be open to first-year students.
Spr BIOL0510 S01 24336 MW 1:00-2:20(06) (R. Bennett)
Biology (Undergraduate)

BIOI 0530. Principles of Immunology.
Introduction to experimental and theoretical foundations of immunology. Focuses on concepts, landmark experiments and recent advances. Topics include innate and adaptive immunity; structure/function of antibody molecules and T cell receptors; regulation of immune responses through cellular interactions. Applications of concepts to medically significant issues (vaccines, transplantation, inflammation, autoimmunity, cancer, HIV/AIDS) are discussed. Interpretative analysis of experimental data is emphasized. Expected background: BIOL 0200 or equivalent placement credit.

Fall BIOL0530 S01 15560 Th 2:30-3:50(12) (R. Bungiro)
Fall BIOL0530 C01 18413 Su 2:00-2:50 (R. Bungiro)
Fall BIOL0530 C02 18414 Su 5:00-5:50 (R. Bungiro)
Fall BIOL0530 C03 18415 Su 6:00-6:50 (R. Bungiro)
Fall BIOL0530 C04 18416 M 6:00-6:50 (R. Bungiro)
Fall BIOL0530 C05 18417 M 7:00-7:50 (R. Bungiro)
Fall BIOL0530 C06 18418 M 8:00PM-8:50PM (R. Bungiro)
Fall BIOL0530 C07 18419 T 8:30PM-9:20PM (R. Bungiro)
Fall BIOL0530 C08 18420 W 6:00-6:50 (R. Bungiro)
Fall BIOL0530 C09 18421 W 7:00-7:50 (R. Bungiro)
Fall BIOL0530 C10 18422 W 8:00PM-8:50PM (R. Bungiro)
Fall BIOL0530 C11 18423 Th 8:30PM-9:20PM (R. Bungiro)
Fall BIOL0530 C12 18424 F 6:00-6:50 (R. Bungiro)
Fall BIOL0530 C13 18425 S 2:00-2:50 (R. Bungiro)
Fall BIOL0530 C14 18426 S 3:00-3:50 (R. Bungiro)
Fall BIOL0530 C15 18427 S 5:00-5:50 (R. Bungiro)

BIOI 0600. Genetic Screening in Model Organisms.
Using gene silencing (RNAi) in the nematode C. elegans, students will identify genetic modifiers of proteins with roles in aging by reverse genetics. Analyzing the effect of knocking down genes on the level of aging-related proteins tagged with fluorophores (GFP, RFP, etc.). Students will use function-specific RNAi libraries (transcription factors, kinases, etc) established in our lab. Students will evaluate the effect of genetic modifiers on proteostasis and lifespan, also familiarize C. elegans work and appreciating the use of model organisms, the students will master microscopy, genetic crosses, gene silencing, and molecular and biochemical readout assays such as qPCR and immunoblotting.

Fall BIOL0600 S01 15710 T 12:00-2:00(08) (L. Lapierre)
Fall BIOL0600 L01 15711 F 12:00-4:00 (L. Lapierre)

BIOI 0800. Principles of Physiology.
Introduction to the function and integration of organ systems with an emphasis on human physiology. Includes basic concepts in cell and organ system physiology as well as fundamentals of modern trends in physiological science. Emphasizes the application of physical and chemical principles to organ function at both the cellular and systemic levels. Expected: BIOL 0200 or equivalent.

Fall BIOL0800 S01 15681 Arranged (J. Stein)

BIOI 0860. Diet and Chronic Disease.
This course addresses the relationship of food to the development and treatment of chronic diseases. Chronic diseases discussed are obesity, dyslipidemia/heart disease, diabetes mellitus, cancers and osteoporosis. Dietary recommendations for these diseases are critically assessed. Geared toward students interested in nutrition, medicine, and public health. Prerequisites: BIOL 0030, plus permission of the instructor. Enrollment limited to 20.

Spr BIOL0860 S01 24333 T 4:00-6:30 (M. Flynn)

BIOI 0920A. Controversies in Medicine.
Why and how do controversies in medicine emerge at specific moments in time? Why do scientists come to different conclusions based on the same data? Does it matter how we interpret controversies? This sophomore-level seminar critically analyzes contemporary controversies in medicine and public health. Using a case study approach, we will examine the social and political assumptions that inform important controversies. Questions related to the relationship between science, media, activism, and health inequality will be woven into the case studies. Enrollment limited to 20 sophomores. (For theme, not biology, credit in Health and Human Health and Biology only.)

BIOI 0940A. Viral Epidemics.
This sophomore seminar will examine epidemics (outbreaks) of viral infections from a historical perspective. We will also cover current literature and up to the minute news accounts of infectious disease related outbreaks occurring around the globe. The major focus will be on virus related diseases but any microbial outbreak in the news will be explored. The seminar will cover basic aspects of microbial pathogenesis so students can gain an appreciation of microbial host interactions. Essential writing skills will also be developed. Enrollment limited to 20 sophomore students.

Fall BIOL0940A S01 15648 Th 4:00-6:30 (W. Atwood)

BIOI 0940B. Sophomore Seminars in Biology: Life in a Shell.
This Sophomore Seminar is an examination of broad themes in whole animal physiology with an emphasis on environmental adaptations. The foundation of the course will be the instructor’s recent book “Life in a Shell: A Physiologist’s View of Turtle.” A consideration of this iconic animal’s novel biological traits will lead into comparisons with our own biology and that of other animals. Topics: respiration, circulation, metabolic rate, buoyancy control, overwintering, migration, reproduction, and bone structure and function. Relevant original research papers will be used. Mandatory S/NC; enrollment of 20 students; override required. Expected: BIOL 0200 or equivalent placement credit.

BIOI 0940C. Sophomore Seminar: Insect Biology.
Focuses on characteristics that make insects unique and why more insect species have been described than all other organisms combined; the opportunity to investigate diversity and adaptation; their abundance, small size, and short lifespans; their importance as agents of biocontrol pollination, agricultural pests, and disease vectors. Expected: BIOL 0200 or equivalent. Enrollment limited to 12 sophomores only. Students MUST register for lecture AND lab.

BIOI 0940D. Rhode Island Flora: Understanding and Documenting Local Plant Diversity.
This Sophomore Seminar focuses on species level identification of plants in Rhode Island and will cover the dominant plant species in each of the state’s main habitats including coastal wetlands and uplands, freshwater wetlands, peatlands, upland forests, and disturbed areas. Students will learn to identify plants using online interactive keys as well as more technical dichotomous keys and will also cover basic ecological processes in each habitat including the interaction of soils, geology, and hydrology. Materials related to plant morphology, plant taxonomy, plant evolution, understanding phylogenetic trees, and botanical illustration. Instructor permission required.

BIOI 0940E. Precision Medicine or Privileged Medicine? Addressing Disparities in Biomedical Research.
This course examines the biomedical research behind precision medicine, disparities in the inclusiveness of this research, and implications of these disparities for the relevance of precision medicine innovations for people and places in Rhode Island. We will focus on these four questions: What new knowledge is making precision medicine possible? Who has been the focus of the biomedical research generating this knowledge, and why? How might inclusiveness of this research impact healthcare disparities in Rhode Island? What is needed to improve the design and outcomes of precision medicine research so that it provides benefits and mitigates harms for all?

This is a Course-based Undergraduate Research Experience (CURE) class that will provide students with the chance to propose, design and conduct their own research projects. Antibiotic resistance is a major global health threat. Pharmaceutical companies are less likely to fund research and development of new antibiotics due to their relative low profitability. As bacteria become more resistant to antibiotics, it is critical that we have a robust pipeline ready to combat these pathogens. The main focus of the course will be for students to discover new antibiotics in soil bacteria that can be used to treat infectious diseases.

Spr BIOL0940G S01 24968 Arranged (T. Achilli)
Spr BIOL0940G L01 24969 M 12:00-2:50 (T. Achilli)
Spr BIOL0940G L02 26626 F 12:00-2:50 (T. Achilli)
Biology (Undergraduate)

BIO 0945. Toolbox for Scientific Research.
Why is scientific research important? What is the scientific method? What are hypotheses and theories? How do scientists identify research questions, design experiments, fund research, and communicate results?
This sophomore seminar is designed for students who want to understand and engage in scientific research in biology. Through active learning seminars, group discussions, and meetings with scientists, students will gain a deeper understanding and an appreciation for the principles, practice, and culture of scientific research. The course will also help develop practical and transferable skills to succeed in research and give students an opportunity to connect with research groups at Brown.

BIO 0960. Independent Study in Science Writing.
BIO 0960 (fall/spring) is a half credit Independent Study in Science Writing course incorporating a nontechnical science journalism component into the Biology curriculum. Assignments may include investigative or analytical reviews, or feature articles on ethical or social impacts of new discoveries in the biological sciences. BIO 0960 requires the submission of a formal project proposal completed collaboratively by the student and faculty mentor (see the Biology Undergraduate Education research page for details). BIO 0960 is not for concentration credit in the biological sciences program.

BIO 1040. Ultrastructure/Bioimaging.
This course examines microscopy and image analysis in the life sciences. Theoretical and practical aspects of microscopy will be discussed. Students will obtain hands-on experience with electron microscopy, light microscopy, fluorescence microscopy, and confocal microscopy. Students will learn to display images in 3D. Advanced undergraduates. Instructor permission required.

Examines organelles and macromolecular complexes of eukaryotic cells with respect to structural and functional roles in major cellular activities. Emphasizes experimental basis for knowledge in modern cell biology using original literature, and discusses validity of current concepts. For advanced undergraduates and beginning graduate students. Complementary to BIO 1270 and 1540. Prerequisites: BIO 0280 or 0470 or 0500, or instructor permission. Graduate students register for BIO 2050.

This course examines contemporary biotechnologies used to combat the predominant, worldwide problems in human health. Global health will be addressed from the scientific and engineering perspectives while integrating public health policy, health systems and economics, medical and research ethics, and technology regulation and management. This course is intended for graduate and advanced undergraduate students in biology, engineering, or related fields who have an interest in global health initiatives. Expected background: BIO 0200 and BIO 0800, or equivalents. Preference will be granted to graduate students in the Biotechnology and Biomedical Engineering programs. Only for related course credit in Biology. Enrollment limited to 20. Instructor permission required.

BIO 1090. Polymer Science for Biologists.
Basic principles of polymer science and its application in medicine. Topics include basic polymerization chemistry, kinetics of polymerization and depolymerization with emphasis on bioerodible polymers, characterization of polymers by physical methods, bulk and surface properties, behavior of polymers in solutions, crystallization, gelation, and liquid crystals. Hands-on experience with polymer characterization. Expected: CHEM 0350. Enrollment limited to 25.

BIO 1100. Cell Physiology and Biophysics.
Current topics in cell physiology, with an emphasis on membrane-mediated interactions between cells and their environment. Topics may include: ion channel structure, function and regulation; intracellular regulatory molecules; mechanisms of sensory transduction; membrane receptors and second messenger systems; vesicle secretion; and cytoskeletal regulation of cell function. Lectures, discussion, and student presentations of the current literature. Expected: BIO 0800 or NEUR 0210. Instructor permission required. Registration overrides will not be given until after the first one or two classes. Enrollment limited to 30, and admission is based on seniority -- graduate students, seniors, then juniors. (Not for first and second-year undergraduates.)

BIO 1110. Topics in Signal Transduction.
Signal transduction is one of the most rapidly developing fields in biomedical sciences. Defects in signaling pathways can be responsible for diseases such as cancer, diabetes, cardiovascular disorders and psychoses. This course offers students an overview of the molecular pathways that allow cells to receive and process signals from their external environment, with an emphasis on the emerging state-of-the-art techniques used in their study. Expected background: BIO 0200, 0280, 0470, or 0500. Enrollment limited to 20 juniors and seniors.

BIO 1120. Biomaterials.
A biomaterial is defined as a material suitable for use in medical implants that come in direct contact with patients’ tissues. These include polymers, metals, and ceramics, and materials obtained from biological sources or through recombinant biotechnology. Goal: to provide comprehensive coverage of biomaterial science and technology. Emphasizes the transition from replacement to repair strategies. For advanced undergraduates and graduate students. Prerequisite: BIO 0800 or instructor permission.

BIO 1140. Tissue Engineering.
Tissue engineering is an interdisciplinary field that incorporates progress in cellular and molecular biology, materials science, and engineering, to advance the goal of replacing or regenerating compromised tissue function. Using an integrative approach, we will examine tissue design and development, manipulation of the tissue microenvironment, and current strategies for functional reconstruction of injured tissues. Expected: CHEM 0330, plus BIO 0500 or 0800. Enrollment limited to 20. Instructor permission required.

BIO 1150. Stem Cell Engineering.
Stem cell engineering focuses on using adult, embryonic, and induced pluripotent stem cells to repair damaged or diseased tissues. This course will examine the role of stem cells in development, tissue homeostasis, and wound healing, as well as how they can be used for tissue engineering and cell-based regenerative therapies. We will also discuss the ethical, legal, and regulatory issues that accompany current and emerging stem cell engineering endeavors. The course will use an inverted lecture and classroom discussion format to effectively deliver relevant information. Emphasis is placed on oral and written communication skills applied to assignments, tests, and individual projects. As an additional part of this course, students will receive hands-on training in how to culture cells and assess samples for stemness characteristics in a group laboratory setting.

BIO 1155. Hormones and Behavior.
This class will explore the hormonal basis of animal behavior. We will assess this relationship at the molecular, cellular, physiological, and evolutionary levels, focusing on a wide range of species beyond humans. Our goal is to understand the diverse mechanisms by which hormones act throughout the animal body to mediate what individuals do in their natural environment. We will explore how selective forces shape these mechanisms in a way to not only arise at common behavior traits, but also unique and unusual traits that allow species to thrive in harsh or extreme environments.
BIOL 1160. Principles of Exercise Physiology.
Application of the basic principles of physiology to the study of the response mechanisms of the human body during exercise. Topics include muscle and neural control, energy metabolism, cardiovascular and respiratory effects, endocrinology, principles of training, and special topics (e.g., diving, high altitude, and microgravity). Student presentations based on scientific articles are included. Expected: BIOL 0800 or written permission of the instructor.
Fall BIOL1160 S01 15689 MWF 1:00-1:50(06) (C. Hai)

BIOL 1180. Comparative Animal Physiology.
Comparative approach to the function and regulation of animal systems with an emphasis on vertebrates. Topics include circulation, gas exchange, neuromuscular function, excretion, acid-base and ion regulation, and temperature regulation. Considers the unity and diversity of physiological processes in animals differing in phylogeny and environmental adaptation. Original papers are discussed. Expected: BIOL 0800 or equivalent.

BIOL 1190. Synaptic Transmission and Plasticity.
Synapses are the means by which the nervous system communicates. In this seminar-style course, we will explore the molecular and physiological underpinnings of synaptic transmission. We will then examine ways in which synapses can modulate their strength during development, learning, after addictive drugs, and other adaptive processes. Readings are ONLY from primary literature. Course recommended for juniors and seniors. Required: NEUR 1020. Enrollment limited to 20. Instructor’s permission required, attendance at class on the first day is mandatory.

BIOL 1200. Protein Biophysics and Structure.
Structural Biology is the science to determine 3-dimensional structures of biomacromolecules (i.e. proteins, RNA, and DNA). These structures enable biologists to understand and explore their function. Since proteins, RNA, and DNA are the primary molecules of life, structural biology enables us to understand and influence these molecular machineries which form the basis of all biological processes. Throughout the class, the students will see examples of biologically important proteins and protein complexes that will allow them to correlate structure and biological function. Prerequisite: BIOL 0280.

BIOL 1210. Synthetic Biological Systems.
A multidisciplinary course that combines science and engineering providing a solid foundation in a cutting edge field of biological engineering. Synthetic biology is a mixture of biology, chemistry, engineering, genetic engineering and biophysics. It builds on recent work in systems biology which involves the modeling of biological systems, but goes further in that it involves the construction and standardization of biological parts that fit together to form more complex systems. Expected: at least four courses beyond BIOL 0200, CHEM 0330, PHYS 0300, ENGN 0300, MATH 0900, or CSCI 0040.

BIOL 1220. Synthetic Biological Systems in Theory and Practice.
A multidisciplinary laboratory, lecture, and discussion based course that combines several areas of science and engineering providing a foundation in the cutting edge field of synthetic biological engineering. The field of synthetic biology is centered around trying to make biology easier to engineer. It builds on recent work in systems biology which involves the modeling of biological systems, but goes further in that it involves the construction and standardization of biological parts that fit together making complex systems. This course will combine classes, guest lectures and discussion lab visits to give students the best possible tools for understanding and applying research in synthetic biology. Expected: at least two courses in any of the key disciplines (biology, chemistry, physics, math, engineering, computer science) beyond the introductory level, and permission of the instructor.

BIOL 1222A. Current Topics in Functional Genomics.
A technological revolution in genomics has exponentially increased our ability to gather biological data. A host of new methods and types of analysis has arisen to accommodate this dramatic shift in data collection. The broad scope of inquiry has ushered in an era of “system-wide” approaches and brute-force strategies where rare signals can be detected and studied. In this seminar we will cover papers that embody this new approach. Students typically have taken an advanced undergraduate-level course in biology.
Spr BIOL1222A S01 24710 Arranged (W. Fairbrother)

BIOL 1250. Host-microbiome Interactions in Health and Disease.
Will focus on current understanding of how various microbes interact and communicate with the host and the factors that influence these interactions. We will discuss how the new technologies such as metagenomics and metabolomics have enhanced our understanding of host-microbiome interactions in health and disease. Students will have the opportunity to participate in discussions on how to apply recent discoveries to disease processes, health restoration and maintenance. The course will help students develop skills in critical thinking and in reading and evaluating original scientific literature. Expected: students with a background in basic microbiology (BIOL 0530 or its equivalent), 20 enrollment.
Spr BIOL1250 S01 24340 Th 4:30-6:30 (P. Belenky)

BIOL 1260. Physiological Pharmacology.
Covers the physiology of human disease (e.g., Heart failure and arrhythmia; cancer signaling pathways with a focus on breast cancer; neurological disorders such as schizophrenia and Parkinson’s disease) and discusses the pharmacology of the drugs used to treat disease. A group of the most commonly prescribed drugs is discussed in terms of their fundamental modes of action and clinical importance. Expected: BIOL 0800.
Fall BIOL1260 S01 15718 TTh 10:30-11:50(13) (J. Marshall)

BIOL 1270. Advanced Biochemistry.
An advanced course in biochemistry, biochemical methods, and reading of the primary literature, featuring systematic coverage of the biochemistry of the central dogma, including DNA (replication, repair, recombination), RNA (regulation and mechanism of transcription, processing, turnover), and proteins structure, synthesis, modification, degradation, mechanisms of action, function). Expected: BIOL 0280, CHEM 0350, 0360. Graduate students register for BIOL 2270.
Fall BIOL1270 S01 15656 TTh 2:30-3:50(12) (G. Lisi)

Provides a conceptual understanding of molecular events underlying development of human cancer. Focused on genetic changes leading to malignant transformation of cells. Covers cell cycle control, DNA damage, mutagenesis, cancer predisposition syndromes, oncogenic viruses, tumor immunology, metastasis, cancer chemotherapy and drug resistance. Lecture plus discussion of primary literature. Prerequisites: BIOL 0280 OR BIOL 0470 OR BIOL 0500.
Fall BIOL1290 S01 15670 MW 3:00-4:20(10) (A. Zhitkovich)

BIOL 1300. Biomolecular Interactions: Health, Disease and Drug Design.
Interactions between the molecules of life-proteins, RNA, DNA, membrane components-underlie all functions necessary for life. This course focuses on how nature controls these interactions, how these interactions can go awry in disease, and how we can learn the rules of these interactions to design drugs to treat disease. Students will review the physical basis of molecular interactions, learn classic and state-of-the-art high-resolution and high-throughput tools used to measure interaction, and survey the experimental and computational strategies to harness these interactions using a case study in rational drug design. Prerequisite: Introductory Biochemistry (BIOL 0280). Enrollment limited to 20; instructor permission.
Fall BIOL1300 S01 15720 M 3:00-5:30 (N. Fawzi)
BIOL 1310. Developmental Biology.  
Covers the molecular and cellular events of development from fertilized egg to adult. Genetic basis of body form, cell fate specification and differentiation, processes controlling morphogenesis, growth, stem cells and regeneration will be examined. Differential gene regulation, intercellular signaling and their evolutionary conservation will be central to discussion of mechanisms governing developmental processes. Additional topics: developmental plasticity, impact of epigenetic and environmental factors, and basis of disease gleaned from developmental biology research. Live embryos will complement and reinforce concepts covered in class. Enrollment limited to 36. Expected: BIOL 0200 (or equivalent), and one course in genetics, cell biology or embryology.

Fall BIOL1310  S01  18128  TTh  10:30-11:50(13) (K. Wharton)  
Fall BIOL1310  L01  18201  W  1:00-4:00 (K. Wharton)

This course is an advanced, seminar-based course. Primary literature is emphasized to complement the format of extensive student seminar presentations. It is essential that students have a strong background in biology in order to gain the most from this course. The emphasis of the course is student seminar presentation and extensive discussion on the material. This is often the first opportunity for students to present/discuss science in a seminar format. Expected background: a course in Cell Biology (e.g., BIOL 0500 or 0505), and two additional Biology courses above the introductory (BIOL 0200) level. Enrollment limited to 20.  
Spr BIOL1330  S01  24421  Arranged (G. Wessel)  
Spr BIOL1330  C01  26564  M  3:00-5:30 (G. Wessel)

BIOL 1410. Evolutionary Genetics.  
This course will focus on selected topics in molecular population genetics, molecular evolution, and comparative genomics. Classic and current primary literature at the interface of evolution and genetics will be discussed in a seminar format. The laboratory involves wet-lab exercises (allozymes, PCR-RFLP, sequencing), plus computer labs using DNA analysis packages. Students will prepare a final grant proposal on specific research interests. Expected: BIOL 0470 or 0480. Students MUST register for the lecture section and the lab. Enrollment limited to 20.

BIOL 1420. Experimental Design in Ecology.  
An overview and discussion of the basic principles used to design lab and field experiments in ecology and environmental science. Topics include: replication and statistical power, appropriate use of factorial designs, nonparametric methods, post hoc tests, natural versus manipulative experiments, experimental artifacts and impact study design. Discussions based on primary literature and a new text. Expected: BIOL 0420.

BIOL 1425. Phylogenetic Biology.  
This course is the study of the evolutionary relationships between organisms, and the use of evolutionary relationships to understand other aspects of organism biology. This course will provide a detailed picture of the statistical, mathematical, and computational tools for building phylogenies and using them to study evolution. Enrollment is by instructor permission. Students will present scientific papers in class and complete a final project consisting of their own phylogenetic analysis. Expected Background: Evolutionary Biology and quantitative methods (such as statistics, computation, or math). Open to juniors, seniors, and graduate students. Enrollment limited to 16.

Population genetics considers the genetic basis of evolution: temporal changes in the genetic composition of populations in response to processes such as mutation, natural selection and random sampling effects. Starting from first principles, this course will develop a theoretical understanding of these dynamics. We will also explore the application of these tools to genomic-scale data in order to quantify the influence of various evolutionary processes at work in natural populations. Assessments will be based on problem sets, two midterm exams and one final exam. Prerequisites: MATH 0100 and one of BIOL 0470 or 0480, or permission.

BIOL 1435. Computational Methods for Studying Demographic History with Molecular Data.  
This course broadly covers the field of population genetics and genomics, and focuses on how inferences about demographic history can be made from genetic variation observed across populations today. The main question we will endeavor to answer in class is “How can we infer demographic history in a population using next-generation sequencing data?” Students will also learn how to apply computational tools/methods to infer demographic history using both simulated and real DNA sequencing data.  
Spr BIOL1435  S01  26974  TTh  10:30-11:50(09) (E. Huerta-Sanchez)

BIOL 1440. Marine Biology.  
An examination of current topics in the ecology of marine organisms and communities. Current literature and ideas are analyzed in a seminar format (5hr/week). A class research project provides hands-on experience with designing and interpreting experimental field work. Prerequisites: BIOL 0410 and 0420. Instructor’s permission required.

This course will explore foundational concepts in community ecology, and will draw on examples and case studies from marine and terrestrial ecosystems, including species-rich tropical rain forests and coral reefs, the marine intertidal and benthic environments, and species-poor forests and grasslands of the temperate zone. Overarching themes will emphasize theoretical frameworks to understand the evolutionary origins and maintenance of this biological diversity. This will be accomplished using traditional lectures, weekly student-led discussions, readings of the primary literature, and class activities. Expected background: BIOL 200 or equivalent placement; and BIOL 0420; OR instructor permission.

BIOL 1465. Human Population Genomics.  
An introduction to human genomics and the evolutionary forces that shape observed genetic variation across humans today. Topics will include the relationship among humans and other primates, human population genetics and genomics, and examples of the concomitant evolution of both cultural traits and domesticated organisms. Assignments include a class presentation and reviewing papers on a selected topic. Expected background: BIOL 0470 or 0480, and BIOL 0495, PHP 2500, or equivalent. Enrollment limited to 25. Instructor permission required.

BIOL 1470. Conservation Biology.  
Conservation Biology is the scientific study of the phenomena that affect the maintenance, loss, and restoration of biological diversity. Topics covered include: 1) the impacts of global warming, species invasions, and habitat destruction on biodiversity, 2) strategies developed to combat these threats, and 3) a consideration of key economic and ethical tradeoffs. Special attention will be paid to current debate and controversy within this rapidly emerging field of study. Readings will include the primary literature. Prerequisite: BIOL 0420 or instructor permission. Enrollment limited to 30.

Fall BIOL1470  S01  15584  TTh  9:30-10:20(02) (D. Sax)

BIOL 1475. Biogeography.  
Will provide an overview of the field of biogeography—the study of geography of living organisms. Class meetings will be split between lectures and discussions. Each discussion will expose students to foundational papers, which set the context for the field’s development, and more recent papers, which show where the field is headed. Each student will conduct a short (but time consuming) original research project on some topic in biogeography. Prerequisites: BIOL 0420 and 0480. Expected: one taxonomy-based course (e.g., BIOL 0410, 0430, or 0460). Enrollment limited to 15 juniors, seniors, and graduate students. Instructor permission required.
Biology (Undergraduate)

Three fundamental multidisciplinary questions will be addressed: How do ecosystems work? What limits the growth of life on Earth? How are humans altering the framework in which all life exists? Earth is basically a closed chemical system, and the reactions that support life are fueled by sunlight. But added to this chemistry and physics is the tremendous influence of life. Life created an oxygen atmosphere; the evolution of biological nitrogen fixation exponentially increased how many organisms could exist, and the soils that support human food production developed only by biologically-mediated processes. Throughout Earth's 4.5 billion-year history changes in Earth's basic biogeochemical processes have been fairly slow. Under our inattentive stewardship, we have almost instantaneously altered all of the major element cycles. We will focus heavily on what these changes mean for life on Earth. Instructor permission required.

Explore the linkages between climate change and health. Students will come to appreciate the topic through the foundations of the primary disciplines relevant to the field including global health, environmental change, disease ecology, and others. Climate-health linkages will be learned through weekly case studies addressed collectively through student-centered lectures, discussion of the primary literature, groups activities and guest lectures from campus faculty on topics ranging from climate migration to infectious disease range shifts. Expected background: BIOL 0475, or BIOL 1470, or PHP 1070, or PHP 1920, or equivalent experience with instructor's permission. Enrollment limited to 12 juniors and seniors.

Biol 1495. 500 Million Years of Land Plants.
Explores the evolution of terrestrial plants and the ecosystems they structure. Introduces the fossil record of plants and basic patterns of plant diversification on land. Highlights major trends in the evolution of plant morphology, anatomy, and ecology. Lectures survey the diversity and community structure of different geological time periods. Weekly discussion sections, field trips, and assignments examine major evolutionary trends, particularly with regard to climatic changes over time. Expected: BIOL 0400, BIOL 0430, (or equivalent placement). Enrollment limited to 15 students; instructor permission; register for section and conference.

An in-depth look at plant ecological strategy, focusing on the anatomical and physiological adaptations of plants to particular environments. Additional topics include plant-animal interactions, historical biogeography, and community assembly processes. A comparative, phylogenetic approach is emphasized. Lectures present a broad overview of topics, and discussions focus on current outstanding problems. Lab exercises provide hands-on experience in designing experiments, measuring plant performance, and scientific writing. Required laboratory hours to be arranged by the instructor. Expected: BIOL 0430 or BIOL 0440. Enrollment limited to 15.

The course will introduce students to the rapidly developing field of molecular ecology, emphasizing its importance for conservation biology. Students will explore key principles in evolutionary ecology based on readings, lectures, and discussions. Participants will also gain practical experience with ecological, genomic, and computational methods in the lab. This course is intended for advanced undergraduate and graduate students. Suggested prerequisites include Principles of Ecology (0420); Evolutionary Biology (0480) or Genetics (0470); the Lab Techniques Workshop for Biology Students provided by MDL; or similar with permission. Students will obtain permission from the professor to enroll.

Fall Biol 1515 S01 15589 Arranged (T. Kartzinel)
Fall Biol 1515 C01 18355 M 10:00-10:50 (T. Kartzinel)
Fall Biol 1515 C02 18356 W 10:00-10:50 (T. Kartzinel)
Fall Biol 1515 C03 18357 F 10:00-10:50 (T. Kartzinel)
Fall Biol 1515 L01 15591 W 1:00-4:00 (T. Kartzinel)

Innate immunity is the initial response to microbes that prevents infection of the host. It acts within minutes to hours, allowing the development of the adaptive response in vertebrates. It is the sole mechanism of defense in invertebrates such as insects. The components and mechanisms dictating this response are explored. Prerequisite: BIOL 0530. Enrollment limited to 30. Graduate students must obtain instructor permission.

Fall Biol 1520 S01 15561 Arranged (L. Brossay)
Fall Biol 1520 C01 18407 Th 9:00-10:20 (L. Brossay)
Fall Biol 1520 C02 18408 Th 9:00-10:20 (L. Brossay)

Biol 1540. Molecular Genetics.
Even in this era when whole genome DNA sequencing has become routine, there are still thousands of eukaryotic genes with unknown functions. Genetic screens for mutations that alter pathways of interest remain the primary approach to understanding gene function in the context of the organism. In Molecular Genetics students will learn the key concepts involved in designing and interpreting genetic screens using the powerful tools available in model animal, plant, and fungal organisms. Students will also learn how to understand and analyze results presented in the primary scientific literature. Furthermore, students will gain an appreciation of how the field of genetics has changed through discoveries and technological advances made over the past 50 years. Graduate students should register for BIOL 2540.

Spr Biol 1540 S01 24422 Arranged (E. Larschan)
Spr Biol 1540 C01 26509 T 2:30-3:50 (E. Larschan)
Spr Biol 1540 C02 26663 Th 2:30-3:50 (E. Larschan)

This course will exemplify the power of genetically informed approaches to understanding human biology. It is intended for advanced undergraduate students and graduate students; prerequisites include BIOL0470 or equivalent. The course is based in lectures, reading material (textbook and primary literature), and in-class discussions. Course topics include: medical genetics and genomics; methods to study human genotypes and related phenotypes; industry-related topics; and ethical and societal implications of genome science. It will benefit students with career interests in basic science, medicine, biotechnology, or science policy. Enrollment is limited to 20 students; selection will be based on seniority, prerequisites, and registration order.

Emerging diseases influence the health of human populations in less developed countries and are expected to have similar effects worldwide. Rising incidence of “new” diseases underscores the need for knowledge of infection mechanisms and their outcomes. Focuses on biochemical, genetic, cell and immunological events of emerging pathogens and host responses. Expected: BIOL 0470 or BIOL 0530.

Spr Biol 1550 S01 24341 MWF 11:00-11:50(04) (C. de Graffenried)
Spr Biol 1550 C01 26696 M 5:40-7:00 (C. de Graffenried)
Spr Biol 1550 C02 26697 W 5:40-7:00 (C. de Graffenried)
Spr Biol 1550 C03 26698 F 5:40-7:00 (C. de Graffenried)

The goal of this course is for students to develop a solution that uses data science and informatics approaches to address a biomedical or health challenge. This course will teach informatics and data science skills needed for public health and biomedicine research. Emphasis will be given to algorithms used within the context of biomedical research and health care, including those used in biomolecular sequence analysis, electronic health records, clinical decision support, and public health surveillance. This course has been developed as a Course-based Undergraduate Research Experience (CURE), where students will gain experience with the scientific method, its application, and presentation.

Spr Biol 1555 S01 24347 M 3:00-5:30 (N. Sarkar)
BIOL 1560. Virology.
Emphasizes the understanding of molecular mechanisms of viral pathogenesis. Begins with a general introduction to the field of virology and then focuses on the molecular biology of specific viruses that are associated with human disease. Lectures based on current literature. Prerequisite: BIOL 0280, 0470, or 0530, or instructor permission.

Fall BIOL1560 S01 15562 MWF 9:00-9:50(01) (A. Jamieson)
Fall BIOL1560 C01 18233 M 6:00-6:50 (A. Jamieson)
Fall BIOL1560 C02 18234 W 6:00-6:50 (A. Jamieson)
Fall BIOL1560 C03 18235 Th 8:00PM-8:50PM (A. Jamieson)
Fall BIOL1560 C04 18236 Su 5:00-5:50 (A. Jamieson)

BIOL 1565. Survey of Biomedical Informatics.
Survey course provides overview of field of biomedical informatics. Topics include computer science, healthcare, biology, social science. This course is designed to be complementary to BIOL 1555. Emphasis is given to understanding the role of biomedical informatics, effective management of information using computer technology, impact of such technology on biomedical research, education, patient care. Major aim is to explore the process of developing and applying computational and information science techniques for assessing current information practices, determining information needs of health care providers and patients, developing interventions or supporting clinical practice using informatics, and evaluating the impact of informatics solutions from a biomedial perspective.

Fall BIOL1565 S01 15566 TTh 10:00-11:15(02) (N. Sarkar)
Fall BIOL1565 C01 17958 M 3:00-3:50 (N. Sarkar)

This course covers the field of evaluation of health information systems (HIS) in a range of roles and environments, in the US and worldwide. It includes topics in health information system (HIS) design and deployment, healthcare workflow, quantitative and qualitative evaluation methods and socio-technical environment for HIS. Emphasis is given to understanding the range of evaluation questions that can be asked, identifying the key stakeholders, understanding available evaluation techniques, and designing rigorous but achievable studies. Examples will include Open Source systems, medical Apps, and economic evaluation, the role of evaluation frameworks and theories, and notable HIS successes and failures. Recommended: past or concurrent enrollment BIOL 1565 or a public health course covering clinical research.

Fall BIOL1575 S01 15567 MWF 10:30-11:50(13) (H. Fraser)
Fall BIOL1575 C01 18353 Th 10:30-11:50 (H. Fraser)

BIOL 1595. Artificial Intelligence in Biomedicine.
This course will teach the fundamental theory and methods of artificial intelligence (AI) alongside their application to the biomedical domain. It will give a representative overview of traditional methods as well as modern developments in the areas of (deep) machine learning, natural language processing and information retrieval. The course is designed to be accessible to non-computer science audiences and will not require extensive prior programming experience. The course will be accompanied by practical assignments applying the discussed techniques in a biomedical context. Understanding of formal theoretical knowledge will be assessed in a final exam. The course is designed for students concentrating in domains such as Computational Biology and Applied Mathematics-Biology; or Neuroscience concentrators who have completed a course in introductory statistics (e.g., BIOL 0495).

Spr BIOL1595 S01 24348 TTh 1:00-2:20(08) (C. Eickhoff)

BIOL 1600. Development of Vaccines to Infectious Diseases.
Provides background steps involved in vaccine development, from conceptualization to production to deployment. Considers infectious diseases and associated vaccines in context of community health. Appropriate for students wanting to gain an understanding of vaccine science. Provides a foundation for advanced courses in immunology and infectious disease, biomedical research, or medical/graduate studies. Activities include a weekly section meeting for discussion of relevant primary literature, and a final project of the student's choice in the form of an in-class presentation, a research paper or an approved alternative format. Expected: BIOL 0200 or equivalent placement; BIOL 0530, and at least one additional biology course.

Spr BIOL1600 S01 24342 MW 3:00-4:20 (S. Vaishnava)

BIOL 1610. Experimental Neurobiology.
Intensive laboratory experience in neuroscience appropriate for students with basic background in Neurobiology. Learn and employ the classical neurophysiological techniques of extracellular recording, intracellular recording and receptive field mapping using a variety of animal species. Experiments will include recording of sensory signals in the cockroach leg; frog sciatic nerve and sciatic nerve/muscle preparation; intracellular recording of neurons in Aplysia; receptive field mapping in frog skin; and visual field mapping in the frog tectum. Instruction on and practice of effective science writing is another component to this course. Labs are supplemented by informal lectures. Enrollment limited to 18. Please request override through C@B. Overrides will not be given until after the first course meeting.

Spr BIOL1610 S01 26670 W 1:00-5:00(07) (J. Stein)
Spr BIOL1610 S02 26767 Th 1:00-5:00(10) (J. Stein)

BIOL 1630. Big Data Neuroscience Lab.
Recent technological developments have transformed neuroscience research, enabling us to generate comprehensive 'big data' sets that are often shared freely amongst the neuroscience community. This lab course will explore strategies to effectively use such open-sourced neuroscience data sets. Students will identify fundamental open questions in brain science and develop strategies to mine open-source sequencing, imaging and connectivity data to address their research questions.

Fall BIOL1630 S01 18604 TTh 9:00-10:20(02) (A. Fleischmann)

BIOL 1650. Structure of the Nervous System.
Combined lecture and laboratory course on the anatomy of the central nervous system. Lectures survey the circuitry of the major neural systems for sensation, movement, cognition, and emotion. Laboratory exercises (Mon. 10:30-12:30) include brain dissections, microscopy of neural tissue, and discussion of clinical cases. Prerequisites: NEUR 0010, NEUR 1020, and NEUR 1030. Please request an override through C@B. Please keep in mind that decisions on overrides may not be made until the first meeting of the course.

Fall BIOL1650 S01 18605 Arranged (D. Berson)
Fall BIOL1650 L01 18606 Arranged "To Be Arranged"
Fall BIOL1650 L02 18607 Arranged "To Be Arranged"

How and why do animals run, jump, swim and fly? Physiology, anatomy, ecology, and evolutionary history all influence, and are influenced by, the way animals move around. We will integrate analyses from many levels of biological organization - from molecular motors, through bone-muscle systems, to biogeography - with methods and approaches from mechanics, fluid dynamics, and robotics. Expected: BIOL 0800 and PHYS 0030. Instructor permission required.
Biology (Undergraduate)

BIOL 1810. 21st Century Applications in Cell and Molecular Biology. Twenty-first century applications in cell and molecular biology focuses on the structure and function of macromolecules and cells and how they are altered in disease and therapy. This course will explore physical principles underlying cell function, along with biophysical approaches for solving problems of cell and molecular biology. Cutting-edge molecular and cellular-based therapeutics will be discussed throughout this course; this includes viral gene delivery constructs, novel platforms for tissue engineering, CRISPR genome editing, and immune checkpoint therapy. This course is particularly suitable for undergraduate students interested in basic medical research, graduate school, or research-based careers in biotechnology or pharmaceutical industry.

Spr BIOL1810 S01 24967 Arranged  (M. Dawson)
Spr BIOL1810 C01 26511 T 9:00-10:20  (M. Dawson)
Spr BIOL1810 C02 26512 Th 9:00-10:20  (M. Dawson)
Spr BIOL1810 C03 26513 Arranged  (M. Dawson)

BIOL 1820. Environmental Health and Disease. Humans live, work, and play in complex chemical environments. BIOL1820 examines how environmental exposures impact human health and contribute to disease. The course covers basic concepts in toxicology, epidemiology, and safety assessment, and is divided into 4 sections: radiation, lead, perfluorinated chemicals, and endocrine disruptors. For each section, students will examine the molecular mechanisms that mediate toxicity, learn how toxicant exposure impacts physiology, evaluate exposure risk, and discuss issues of environmental justice. Prerequisites: introductory level biology and chemistry. BIOL 1820 is designed for junior and senior undergraduates, and is open to others with permission.

Spr BIOL1820 S01 24448 Arranged  (J. Plavicki)
Spr BIOL1820 C01 26567 T 10:30-11:50  (J. Plavicki)
Spr BIOL1820 C02 26568 Th 10:30-11:50  (J. Plavicki)

BIOL 1850. Environmental and Genetic Toxicology. Human disease is produced by complex interactions between inherited genetic predisposition and environmental exposures. These interactions will be explored at the molecular, cellular, and systemic levels. Prototype diseases will include hereditary disorders of hemoglobin, hypercholesterolemia, birth defects, and cancer. Expected: Cell Biology.

BIOL 1865. Toxicology. Toxicology is the science that describes the adverse biological effects of exogenous chemical and physical stressors, including environmental, industrial, and agricultural chemicals and pharmaceuticals. This course will introduce the principal biological processes that determine an organism’s response to a toxicant, including absorption, distribution through a biological system, metabolism, elimination, and effects at the site(s) of action. We will discuss modern challenges in toxicology, such as assessing toxicity of mixtures and testing some of the thousands of untested chemicals in commerce. The material will be presented in lecture and student-led discussions, with readings from the toxicology literature.

BIOL 1870. Techniques and Clinical Applications in Pathobiology. A methodology course featuring laboratory and lecture instruction in established and leading-edge technologies. Examples: flow cytometry (multi-parameter analysis, cell sorting); molecular biology (PCR, real time PCR, in situ hybridization, microarrays, DNA sequencing, bioinformatics); digital imaging (image acquisition, processing and analysis); confocal microscopy; histology and immunohistochemistry (confocal, immuno-histochemistry).

BIOL 1880. Comparative Biology of the Vertebrates. The biology, structure, and evolutionary history of the vertebrates considered phylogenetically, emphasizing evolution of the major body systems. Stresses an evolutionary approach to the correlation of structure and function with environment and mode of life. Labs include dissection of several different vertebrates and comparative osteological material. Emphasis of course is on critical thinking rather than memorization of material. Recommended: BIOL 0320 or 0800. First year students must obtain instructor permission to register. Enrollment limited to 32. Students MUST register for the lecture section and lab.

BIOL 1885. Human Structure and Function. Human Structure and Function examines the structure of the human body from the perspectives of biomechanics, evolution, and development. The course considers biological form and function at multiple levels of organization and in diverse contexts, and offers students opportunities to critically synthesize, question, and write about ideas presented in class. The integrative approach to understanding human structure that this course employs will provide understanding of the mechanistic basis of human movement by demonstrating how constituent elements of musculoskeletal systems function together. At the same time, students will learn to recognize and interpret the roles of development and evolution in shaping the structure and function of the musculoskeletal system of the limbs and locomotion, human sensory systems, and the complex, multifunctional organ of the human skin.

Spr BIOL1885 S01 26949 Th 2:30-3:50(10)  (S. Swartz)

BIOL 1890. Human Histology. This course will provide an in-depth treatment of the “stuff we are made of” and the wonderful logic of its organization. This course focuses first on the biology of the four basic tissues (epithelium, connective tissue, muscle and nerve) and second, how they contribute to the functional anatomy of all organs and systems. For Pfizer students only.

Fall BIOL1890 S01 18491 Arranged  (S. Chen)

BIOL 1920C. Social Contexts of Disease. What shapes our understandings of disease, and what makes a disease real? How might we explain the demise of formerly prevalent diseases and the arrival of others? How do politics, technologies, and institutions affect conceptions of disease and structure their treatment? Will examine the impact of social context on patients’ experiences of disease, including clinical, scientific, and public health approaches. Will consider disease in relation to social relationships, power of the state to regulate disease, and cultural care of the body. Enrollment limited to 20 students; instructor permission required; serves as Capstone in Health and Human Biology. Not for concentration credit.

BIOL 1941A. Plants in a Changing Planet. Plants are the foundation of Earth’s ecosystems and essential to human survival and civilization. This seminar will examine the physiological, ecological, and evolutionary responses of plants to rapid environmental change, and the consequences for agriculture and the structure and function of natural systems. Expected background: at least one of the following courses - BIOL 0420, 0430, 0440, 0480, or ENVS 0490.

BIOL 1950. Directed Research/Independent Study. Directed research/independent study in biological sciences: basic science, social studies of biomedical science, and clinically-oriented projects, mentored by individual faculty members in the Division of Biology and Medicine. Sites include campus and hospital based facilities. Projects can serve as the basis for Honors theses, or to fulfill research requirements in a Bio-Med concentration program. Students planning to use 1950/1960 to fulfill a concentration requirement must receive approval from the concentration advisor. No more than two (2) semesters of BIOL 1950/1960 may be used toward a concentration program in the biological sciences. Faculty from outside the Division may supervise projects for bio-med program concentrators, but should do so using their Department’s own Independent Study course number.

BIOL 1960. Directed Research/Independent Study. Directed research/independent study in biological sciences: basic science, social studies of biomedical science, and clinically-oriented projects, mentored by individual faculty members in the Division of Biology and Medicine. Sites include campus and hospital based facilities. Projects can serve as the basis for Honors theses, or to fulfill research requirements in a Bio-Med concentration program. Students planning to use 1950/1960 to fulfill a concentration requirement must receive approval from the concentration advisor. No more than two (2) semesters of BIOL 1950/1960 may be used toward a concentration program in the biological sciences. Faculty from outside the Division may supervise projects for bio-med program concentrators, but should do so using their Department’s own Independent Study course number.
BIOL 1970A. Stem Cell Biology.
Senior seminar course will provide an interactive forum by which up to twenty seniors (and qualified juniors with permission) will explore the biology of stem cells from their humble beginnings in the embryo to their potential use in regenerative medicine. The potency and regulation of embryonic and adult stem cell populations derived from diverse organisms will be contrasted with laboratory-derived human stem-like cells for biomedical applications. Critical reading of classical and modern literature in the field of stem cell biology will form the basis of student-led presentations, papers and ethical forums. Expected: biochemistry, genetics and/or cell biology. Instructor permission; 20 students.

BIOL 1980. HIV/AIDS in Diverse Settings: Focus on Israel.
Participants in this winter session course will explore HIV/AIDS within the context of Israel’s diverse society, unique demographics and universal healthcare. While in Israel, students will visit clinics, hospitals, and universities, engage with health care providers, experts in the field and populations with HIV. By the end of the course students will gain research skills and an understanding of this pandemic, its management and challenges in Israel, and how this important disease is modulated through risk factors, healthcare systems, medical innovations, and socio-economic factors. There is no need for prior experience in any associated discipline or any knowledge of Hebrew.
Course is by Application only. Application deadline is OCT 2, 2019.
Course schedule: January 2-4, 2020 - daily seminars at Brown (including student and guest lectures); January 4-13 - tour in Israel; January 14 - rest day; January 15-17 - daily seminars at Brown.

BIOL XLIST. Courses of Interest to Biology Concentrators.
Fall 2020
The following courses may be taken for concentration credit. Please see the sponsoring department for the time and location of each course.

 Africana Studies
AFRI 1920 Health Inequality in Historical Perspective

Cognitive, Linguistics, Psychological Sciences
CLPS 1195 Life Under Water in the Anthropocene

Neuroscience
NEUR 1530 Communication In the Brain: What We Know and How We Know It
Font Notice

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

- Helvetica was used instead of Arial.

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