**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, Immunopatology, 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 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:**

- **CHEM 0330** Equilibrium, Rate, and Structure
- **CHEM 0350** Organic Chemistry
- **MATH 0900** Introductory Calculus, Part I (or placement. MATH 0960 may be substituted for MATH 0900.)

One of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 0100</td>
<td>Introductory Calculus, Part II (or placement)</td>
</tr>
<tr>
<td>MATH 0170</td>
<td>Advanced Placement Calculus (or equivalent placement)</td>
</tr>
</tbody>
</table>

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

**Ten Core Courses:**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 0200</td>
<td>The Foundation of Living Systems</td>
</tr>
<tr>
<td></td>
<td>(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.

**Prerequisites: 1**

- **CHEM 0330** Equilibrium, Rate, and Structure
- **CHEM 0350** Organic Chemistry
- **MATH 0900** Introductory Calculus, Part I (or placement. MATH 0950/MATH 0960 may be substituted for MATH 0900.)
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 1890 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) 1

Area 1 (Cell/Molecular Biology) 1

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) 1

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) 1

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
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:

| BIOL 1555 | Methods in Informatics and Data Science for Health |
| BIOL 1575 | Evaluation of Health Information Systems |
| BIOL 1595 | Artificial Intelligence in Biomedicine |

Cell and Molecular Biology

| BIOL 1050 | Biology of the Eukaryotic Cell |
| BIOL 1270 | Advanced Biochemistry |
| BIOL 1300 | Biomolecular Interactions: Health, Disease and Drug Design |
| BIOL 1310 | Developmental Biology |
| BIOL 1330 | Biology of Reproduction |
| BIOL 1540 | Molecular Genetics |
| BIOL 1545 | Human Genetics and Genomics |
| BIOL 1810 | 21st Century Applications in Cell and Molecular Biology |
| BIOL 1970A | Stem Cell Biology |

Ecology and Evolutionary Biology

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

Immunobiology

| BIOL 1250 | Host-microbiome Interactions in Health and Disease |
| BIOL 1290 | Cancer Biology |
| BIOL 1520 | Innate Immunity |
| BIOL 1550 | Biology of Emerging Microbial Diseases |
| BIOL 1560 | Virology |
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:

- MATH 0090 Introductory Calculus, Part I (or equivalent placement) 1
- MATH 0050 Analytic Geometry and Calculus & MATH 0060 and Analytic Geometry and Calculus OR
- MATH 0100 Introductory Calculus, Part II or MATH 0170 Advanced Placement Calculus
- CHEM 0330 Equilibrium, Rate, and Structure 1
- BIOL 0200 The Foundation of Living Systems 1
- Statistics course chosen with advisor's help. 1

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: 5

Genetics, which can be fulfilled in the following ways:

- BIOL 0470 Genetics
- BIOL 0480 Evolutionary Biology & BIOL 0500 and Cell and Molecular Biology
- BIOL 0480 Evolutionary Biology & BIOL 0510 and Introductory Microbiology
- BIOL 0480 Evolutionary Biology & BIOL 0280 and Biochemistry

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

- BIOL 0400 Biological Design: Structural Architecture of Organisms
- BIOL 0800 Principles of Physiology
- BIOL 1310 Developmental Biology
- BIOL 1800 Animal Locomotion
- BIOL 1880 Comparative Biology of the Vertebrates
- NEUR 0010 The Brain: An Introduction to Neuroscience

One course in organismal/population biology such as:

- BIOL 0380 The Ecology and Evolution of Infectious Disease

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 with 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.

**MATH 0090**  Introductory Calculus, Part I  1
**MATH 0100**  Introductory Calculus, Part II  1
**or MATH 0170**  Advanced Placement Calculus
**MATH 0180**  Intermediate Calculus (or equivalent placement)  1
**MATH 0520**  Linear Algebra  1
**or MATH 0540**  Honors Linear Algebra
**CHEM 0330**  Equilibrium, Rate, and Structure  1
**PHYS 0030**  Basic Physics A  1
**or PHYS 0050**  Foundations of Mechanics

Select one of the following sequences:

- **APMA 0350 & APMA 0360**  Applied Ordinary Differential Equations and Applied Partial Differential Equations I  2
- **APMA 0330 & APMA 0340**  Methods of Applied Mathematics I, II and Methods of Applied Mathematics I, II  2
- **APMA 1650**  Statistical Inference I  1
**or APMA 1655**  Statistical Inference I  1
- **APMA 1070**  Quantitative Models of Biological Systems  1
**or NEUR 2110**  Statistical Neuroscience  1
- **BIOL 0200**  The Foundation of Living Systems (or equivalent)  1

Additional Courses

In addition to required courses listed above, students must take the following:

Two additional courses in Applied Math or Biology. At least one of these must be a directed research course, e.g. a senior seminar or independent study in Applied Math or a directed research/independent study in Biology. For example:

- A course from the APMA 1930 series
- A course from the APMA 1940 series.
- **APMA 1970**  Independent Study
- **BIOL 1950**  Directed Research/Independent Study
- **BIOL 1960**  Directed Research/Independent Study

We strongly recommend that Applied Mathematics-Biology concentrators take one of the following programming courses on or before their first semester as a concentrator:

- **APMA 0160, CSCI 0040, CSCI 0150, CSCI 0170, CSCI 0190, CLPS 0950**. Those who do can use it as their second Applied Math or Biology course.

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**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 0280</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>BIOL 1270</td>
<td>Advanced Biochemistry</td>
</tr>
<tr>
<td>CHEM 0350/0360</td>
<td>Organic Chemistry</td>
</tr>
<tr>
<td>CHEM 1230</td>
<td>Chemical Biology</td>
</tr>
</tbody>
</table>

**Biotechnology and Physiology**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<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 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>
<tr>
<td>BIOL 1150</td>
<td>Stem Cell Engineering</td>
</tr>
<tr>
<td>BIOL 1210</td>
<td>Synthetic Biological Systems</td>
</tr>
</tbody>
</table>

**Ecology, Evolution, and Genetics**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 0410</td>
<td>Invertebrate Zoology</td>
</tr>
<tr>
<td>&amp; BIOL 0480</td>
<td>and Evolutionary Biology</td>
</tr>
<tr>
<td>BIOL 0420</td>
<td>Principles of Ecology</td>
</tr>
<tr>
<td>&amp; BIOL 0430</td>
<td>and The Evolution of Plant Diversity</td>
</tr>
<tr>
<td>BIOL 0470</td>
<td>Genetics</td>
</tr>
<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 1465</td>
<td>Human Population Genomics</td>
</tr>
<tr>
<td>BIOL 1540</td>
<td>Molecular Genetics</td>
</tr>
</tbody>
</table>

**Neuroscience**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>APMA 0410</td>
<td>Mathematical Methods in the Brain Sciences</td>
</tr>
<tr>
<td>Neurosciences courses:</td>
<td>See <a href="https://www.brown.edu/academics/neuroscience/undergraduate/neuroscience-concentration-requirements">https://www.brown.edu/academics/neuroscience/undergraduate/neuroscience-concentration-requirements</a></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 1190</td>
<td>Synaptic Transmission and Plasticity</td>
</tr>
</tbody>
</table>

| Total Credits | 18 |

1 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.

**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 student must register for credit for the project via APMA 1970 or BIOL 1950/BIOL 1960 or similar independent study courses. 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)

Excellence in grades within the concentration as well as a satisfactory evaluation by the advisors are also required for Honors. The student’s grades must place them within the upper 20% of their cohort, in accordance with the university policy on honors. Honors recipients typically maintain a Grade Point Average of 3.4 or higher in the concentration. However, in the case of outstanding independent research as demonstrated in the thesis and supported by the Thesis Committee, candidates with a GPA between 3.0 and 3.4 will be considered and are encouraged to apply.
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. Students are expected to take courses that will count toward the concentration ABC/NC. Students should discuss the S/NC option with their concentration advisor if circumstances warrant consideration. Students should not register S/NC for a concentration course without advisor pre-approval.

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

Two courses in physics, typically:

- PHYS 0030 Basic Physics A
- or PHYS 0050 Foundations of Mechanics
- or ENGN 0030 Introduction to Engineering

Three courses in physical and organic chemistry:

- CHEM 0330 Equilibrium, Rate, and Structure
- CHEM 0350/0360 Organic Chemistry

One course in biophysical or related chemistry, such as:

- CHEM 0500 Inorganic Chemistry

Four courses in biochemistry:

- BIOL 0280 Biochemistry
- BIOL 0285 Inquiry in Biochemistry: From Gene to Protein Function
- BIOL 1270 Advanced Biochemistry
- or CHEM 1230 Chemical Biology
- or CHEM 1240 Biochemistry

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

- BIOL 1950/1960 Directed Research/Independent Study
- CHEM 0970/0980 Undergraduate Research

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

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

Chemistry Electives:

- CHEM 0500 Inorganic Chemistry
- CHEM 1140 Physical Chemistry: Quantum Chemistry
- CHEM 1150 Physical Chemistry: Thermodynamics and Statistical Mechanics
- CHEM 1220 Computational Tools in Biochemistry and Chemical Biology
- CHEM 1230 Chemical Biology
- CHEM 1240 Biochemistry
- CHEM 1450 Advanced Organic Chemistry
- CHEM 2420 Organic Reactions
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 jointly offered by the School of Engineering and the Division of Biology and Medicine as an interdisciplinary concentration designed for students interested in applying the methods and tools of engineering to the subject matter of biology and the life sciences. The education objectives of the Biomedical Engineering program are to prepare graduates: (1) to be employed in careers of useful service to society, including scientific and technical areas within medicine, industry, and health care delivery; (2) to demonstrate the ability to apply the basic principles of engineering and science, as well as problem solving skills and critical thinking, to a broad spectrum of biomedical engineering problems; (3) to demonstrate their ability to work in teams, and to effectively communicate and understand the broad social, ethical, economic and environmental consequences of their lifelong education. The student outcomes of this program are the ABET (1) - (7) Student Outcomes as defined by the "ABET Criteria for Accrediting Engineering Programs (available online at http://www.abet.org/accreditation-criteria-policies-documents/)." 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

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2. Upper Level Biomedical Engineering Curriculum

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<tr>
<td>ENGN 1490</td>
<td>Biomaterials</td>
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**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:
- PHYS 0050 & PHYS 0060: Foundations of Mechanics and Foundations of Electromagnetism and Modern Physics
- PHYS 0070 & PHYS 0160: Analytical Mechanics and Introduction to Relativity, Waves and Quantum Physics
- PHYS 0470: Electricity and Magnetism
- CHEM 0330: Equilibrium, Rate, and Structure
- CHEM 0350: Organic Chemistry
- CHEM 0360: Organic Chemistry

Select one of the following:
- CHEM 0400: Biophysical and Bioinorganic Chemistry
- CHEM 1140: Physical Chemistry: Quantum Chemistry
- PHYS 1530: Thermodynamics and Statistical Mechanics
- PHYS 1610: Biological Physics
- MATH 0100: Introductory Calculus, Part II (or equivalent)
- MATH 0180: Intermediate Calculus (or equivalent)
- BIOL 0200: The Foundation of Living Systems

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

**Cell Biology**
- BIOL 0500: Cell and Molecular Biology
- BIOL 1050: Biology of the Eukaryotic Cell
- BIOL 1200: Protein Biophysics and Structure

**Physiology**
- BIOL 0800: Principles of Physiology
- BIOL 1100: Cell Physiology and Biophysics
- BIOL 1190: Synaptic Transmission and Plasticity
- NEUR 1020: Principles of Neurobiology

**Pharmacology**
- BIOL 1260: Physiological Pharmacology

**Biotechnology**
- BIOL 1090: Polymer Science for Biomaterials
- BIOL 1120: Biomaterials
- BIOL 1140: Tissue Engineering

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:

**Biology**
- BIOL 0280: Biochemistry
- BIOL 0470: Genetics
- BIOL 0800: Principles of Physiology
- BIOL 1190: Synaptic Transmission and Plasticity

**Physics**
- PHYS 0500: Advanced Classical Mechanics
- PHYS 0560: Experiments in Modern Physics
- PHYS 1410: Quantum Mechanics A
- PHYS 1420: Quantum Mechanics B
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:

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General Core Requirements: Biology

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General Core Requirements: Computer Science

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Total Credits: 19

Comp Bio Core Course Requirements

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General Core Requirements: Probability & Statistics

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OR

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OR

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Comp Bio Core Course Requirements

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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:

- 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

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General Core Requirements: Biology

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General Core Requirements: Chemistry

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General Core Requirements: Computer Science

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General Core Requirements: Computer Science

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General Core Requirements: Probability & Statistics

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OR

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OR

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Total Credits: 19

Biology (Undergraduate) 9

Standard program for the A.B. degree

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General Core Requirements: Mathematics

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Chemistry

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A course from the CHEM 1560 series.

Select at least one semester (two are recommended) of Directed Research:

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Chemistry

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General Core Requirements: Biology

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General Core Course Requirements:

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APMA 0330

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APMA 0340

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APMA 0360

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Chemistry

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Additional course with Director approval

Total Credits: 19

Biology (Undergraduate) 9

Standard program for the Sc.B. degree

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General Core Requirements: Biology

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General Core Requirements: Computer Science

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<tbody>
<tr>
<td>CSCI 0150 &amp; CSCI 0160</td>
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OR

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<tr>
<th>Course</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CSCI 0170 &amp; CSCI 0180</td>
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Total Credits: 19

Biology (Undergraduate) 9
### Biological Sciences track
- 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 0180 & CSCI 0320 & CSCI 0330: Accelerated Introduction to Computer Science and Computer Science: An Integrated Introduction and 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
- APMA 1080: Inference in Genomics and Molecular Biology

### Capstone Experience
- BIOL 1950/1960: Directed Research/Independent Study
- CSCI 1970: 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

### 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 & APMA 0330: Methods of Applied Mathematics I, II
- OR

### 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, and are strongly encouraged to take 2 semesters, 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

### Courses

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 9:00-10:20 (5) (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.
This unique first-year seminar taught by Dean Smith has 3 goals: 1) introduce students to the people, projects, and opportunities in Biology at Brown, 2) foster and cultivate student STEM identities and interests, 3) arm students with personal, professional and academic skills to help them succeed in Biology at Brown (and beyond). Students will visit faculty research labs, learn novel lab skills, engage in active research talks from Professors, read and discuss timely books like 'The Immortal Life of Henrietta Lacks', and more. LivBio is especially tailored to students from historically underrepresented groups, but open to all.

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. Employing a series of techniques, students will learn the protocols of scientific rendering in an intensive hands-on approach. Field trips will include the RISD Nature Lab, the Brown Greenhouse, and John Hay collection of biomedical and botanical folia. Media will include graphite/ carbon dust; pen and ink (stipple, line); coquille board; scratch-board, colored pencil, watercolor and polymer clay. Course will be driven by project presentations focused on communicating science through illustration. Not for concentration credit in Biological Sciences programs. Instructor permission required; enrollment 10 students. 1/2 credit.

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 required.

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 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. Course will include two papers and assistance from Writing Fellows; feedback from first paper will be available when writing second paper. Enrollment limited to 50.

BIOL 0160K. Conservation Biology.

BIOL 0160L. Evolutionary Genomics for Medicine.

BIOL 0170. Life Sciences Laboratory

BIOL 0180. Introduction to Biotechnology.

BIOL 0190. Introduction to Biologically Based Problem Solving.

BIOL 0200. Discrete Structures for Biology.

BIOL 0250. Modern Biological Research: Data Analysis and Critical Thinking.

BIOL 0300. Evolution and Conservation at the Molecular Level.

BIOL 0350. Biophysics and Molecular Biology.
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 prosthetics 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.
Fall BIOL0180 S01 24690 MW 8:30-9:50(02) (P. Shank)

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 the scientific underpinnings of their medicinal uses. In conjunction with readings, students will gain a hands-on approach in lab, observing, identifying and growing these plants. Enrollment limited to 19. Students MUST register for the lecture section and the lab.
Fall BIOL0190E S01 15572 MW 3:00-4:20(17) (F. Jackson)
Fall BIOL0190E L01 15573 W 4:30-5-50 (F. Jackson)

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.
Fall BIOL0190F S01 15574 TTh 1:00-2:20(08) (M. Tatar)

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.
Fall BIOL0190P S01 15635 TTh 2:30-3:50(12) (S. Helfand)

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 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 over Winter Recess, and annotated in the spring. One hour of lecture/ discussion, and 3 hours lab per week. Expected: AP Biology or equivalent, and HS chemistry. Instructor permission required. Admission based on review of applications in the first class. Limited to 19 freshmen.
Fall BIOL0190R S01 15558 M 3:00-5:30(05) (S. Taylor)
Fall BIOL0190R L01 15559 Arranged (S. Taylor)

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 required.
Spr BIOL0190S S01 24334 W 3:00-5:30(10) (S. Taylor)
Spr BIOL0190S L01 24334 Arranged (S. Taylor)
Spr BIOL0190S L01 24335 Arranged (S. Taylor)

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.
Fall BIOL0190U S01 15636 TTh 10:30-11:30(13) (P. Heywood)

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.
Spr BIOL0200 S01 24363 MWF 11:00-11:50(04) (K. Miller)
Spr BIOL0200 L01 24364 Arranged (J. Hall)
Spr BIOL0200 L02 24365 Arranged (J. Hall)
Spr BIOL0200 L03 24366 Arranged (J. Hall)
Spr BIOL0200 L04 24367 Arranged (J. Hall)
Spr BIOL0200 L05 24368 Arranged (J. Hall)
BIOL 0210. Diversity of Life.
This course will explore biological diversity – the number of taxa, and the functions, and processes that support life – from the perspectives of ecology and evolutionary biology. It will draw on examples and case studies from the geological record, functional morphology, the evolution of organ systems in vertebrates, genomics, behavior and sexual selection in birds and invertebrates. Overarching themes will emphasize that taxonomic diversity is an emergent property of complex life on Earth, and the importance of diversity of biological functions and processes in generating and maintaining taxonomic diversity. The course is open to all students.
Fall BIOL0210 S01 15575 MWF 11:00-11:50(16) (J. Kellner)

BIOL 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 0390 or are taking it concurrently.
Spr BIOL0280 S01 24374 TTh 1:00-2:20(08) (A. Salomon)
Spr BIOL0280 C01 24375 M 4:00-5:30 (A. Salomon)
Spr BIOL0280 C02 24376 M 7:00-8:30PM (A. Salomon)
Spr BIOL0280 C03 24377 T 4:00-5:30 (A. Salomon)
Spr BIOL0280 C04 24378 T 7:00-8:30PM (A. Salomon)
Spr BIOL0280 C05 24379 W 4:00-5:30 (A. Salomon)
Spr BIOL0280 C06 24380 W 7:00-8:30PM (A. Salomon)
Spr BIOL0280 C07 24381 Th 4:00-5:30 (A. Salomon)
Spr BIOL0280 C08 24382 Th 7:00-8:30PM (A. Salomon)
Spr BIOL0280 C09 24383 F 1:00-3:00 (A. Salomon)
Spr BIOL0280 C10 24384 Su 4:00-5:30 (A. Salomon)
Spr BIOL0280 C11 24385 Su 7:00-8:30PM (A. Salomon)

BIOL 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 BIOL 0280. Enrollment in one lab section and one discussion section is required.
Spr BIOL0285 S01 24386 M 1:00-5:00 (K. Cohen)
Spr BIOL0285 S02 24387 Th 2:30-6:30 (K. Cohen)
Spr BIOL0285 C01 24387 T 4:00-5:00 (K. Cohen)

BIOL 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; neuroendocrinology; reproductive endocrinology; and endocrinology of metabolism and calcium homeostasis. It is expected that students have taken BIOL 0200 (or equivalent) and CHEM 0350.

BIOL 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: BIOL 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.

BIOL 0350. The Fossil Record: Life through Time on Earth.
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 biology/geology and evolutionary biology concentrations. Expected: BIOL 0210, GEOL 0240 or equivalent. Instructor permission, enrollment limited to 20 sophomores/juniors; register for course/lab.
Fall BIOL0350 S01 15576 MWF 10:00-10:50(14) 'To Be Arranged'

BIOL 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: BIOL 0200 or equivalent.

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: BIOL 0200, or equivalent. Enrollment limited to 40. Instructor permission required.
Spr BIOL0400 S01 24352 MWF 2:00-2:50(07) (S. Swartz)

BIOL 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: BIOL 0200 or equivalent. Enrollment limited to 44. Students MUST register for the lecture section and a lab.
Fall BIOL0410 S01 15577 TTh 9:00-10:20(02) (P. Ewanchuk)
Fall BIOL0410 L01 15578 Arranged (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 a 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. BIOL 0200 or equivalent placement; CHEM 0330. Enrollment limited to 20 sophomores, juniors and seniors.
Biology (Undergraduate)

BIOI 0420. Principles of Ecology
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: BIOI 0200 (or equivalent) and MATH 0090. Lectures and weekly discussion.
Spr BIOI0420 S01 24353 TTh 9:00-10:20(01) (J. Witman)
Spr BIOI0420 C01 24354 Arranged (J. Witman)

BIOI 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: BIOI 0200 (or equivalent placement). Enrollment limited to 10 students, and written permission required. Email (Mark_Bertness@brown.edu) to receive course application (due May 1). Admitted students register for the course the first week of class.
Fall BIOI0430 L01 15637 TTh 10:30-11:50(13) (M. Johnson)
Fall BIOI0430 L01 15638 Arranged (J. Hall)

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

BIOI 0455. Coastal Ecology and Conservation
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: BIOI 0200 or equivalent placement. Enrollment limited to 10 students, and written permission required. Email (Mark_Bertness@brown.edu) to receive course application (due May 1). Admitted students register for the course in September.

BIOI 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: BIOI 0200 or equivalent. Enrollment limited to 20. Students MUST register for lecture AND lab. Primarily for freshmen and sophomores.

BIOI 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 BIOI 0470 after 1540.) Expected: BIOI 0200 (or equivalent placement). Students will be assigned to Lab sections the first week of class.
Fall BIOI0470 S01 15637 TTh 10:30-11:50(13) (M. Johnson)
Fall BIOI0470 L01 15638 Arranged (J. Hall)

BIOI 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. Weekly discussion sections involve debates on original research papers. Occasional problem sets involve computer exercises with population genetics and phylogeny reconstruction. Expected: BIOI 0200 (or equivalent placement).
Fall BIOI0480 S01 15579 MWF 9:30-9:50(01) (D. Rand)
Fall BIOI0480 C01 15580 Arranged (D. Rand)

BIOI 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: BIOI 0200 or equivalent, math equivalent to MATH 0100. This course is for related science credit only in Biological Sciences concentration programs. Enrollment limited: 40 undergraduates-20 juniors and 20 sophomores. Registration for seniors requires permission from the instructor.
Spr BIOI0495 S01 24345 TTh 10:30-11:50(09) (S. Ramachandran)
Spr BIOI0495 C01 24346 Arranged (S. Ramachandran)

BIOI 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: BIOI 0200 (or equivalent placement).
Spr BIOI0500 S01 24391 MW 3:30-4:20(10) (P. Heywood)

BIOI 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. Laboratory involves basic microbiological techniques and selection and manipulation of microbes. Expected: BIOI 0200 (or equivalent placement). Students MUST register for the lecture section, conference, and the lab. 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 BIOI0510 S01 24336 MW 2:00-2:50(07) (R. Bennett)
Spr BIOI0510 C01 24337 MW 2:00-2:50 (R. Bennett)
Spr BIOI0510 L01 24338 Arranged 'To Be Arranged'
BIOL 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 TTh 2:30-3:50(12) (R. Bungiro)

BIOL 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 appreciate 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 Arranged (L. Lapierre)
Fall BIOL0600 L01 15711 Arranged (L. Lapierre)

BIOL 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 TTh 10:30-11:50(13) (J. Stein)
Fall BIOL0800 L01 15682 Arranged (A. Sobieraj)
Fall BIOL0800 L02 15683 Arranged (A. Sobieraj)
Fall BIOL0800 L03 15684 Arranged (A. Sobieraj)
Spr BIOL0800 S01 24457 MWF 10:00-10:50(03) (G. Hai)
Spr BIOL0800 L01 24458 Arranged (A. Sobieraj)
Spr BIOL0800 L02 24459 Arranged (A. Sobieraj)
Spr BIOL0800 L03 24460 Arranged (A. Sobieraj)
Spr BIOL0800 L04 24461 Arranged (A. Sobieraj)
Spr BIOL0800 L05 24462 Arranged (A. Sobieraj)

BIOL 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(16) (M. Flynn)

BIOL 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.)

BIOL 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(04) (W. Atwood)

BIOL 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.

BIOL 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.

BIOL 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.
Fall BIOL0940D S01 16602 F 1:00-5:00 (R. Kartzinel)

BIOL 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 disease.
Spr BIOL0940G S01 24968 M 12:00-2:50 (T. Achilli)
Spr BIOL0940G L01 24969 F 12:00-2:50 (T. Achilli)
BIOL 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.
Fall BIOL0945 S01 15709 TTh 10:30-11:50(13) (Y. Raynes)

BIOL 0960. Independent Study in Science Writing.
BIOL 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. BIOL 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). BIOL 0960 is not for concentration credit in the biological sciences programs.
BIOL 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.
Spr BIOL1040 S01 24413 M 2:00-5:00 (G. Williams)

BIOL 1050. Biology of the Eukaryotic Cell.
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 BIOL 1270 and 1540. Prerequisites: BIOL 0280 or 0470 or 0500, or instructor permission. Graduate students register for BIOL 2050.
Fall BIOL1050 S01 15649 TTh 1:00-2:20(08) (K. Miller)
Fall BIOL1050 C01 15650 Arranged (K. Miller)

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: BIOL 0200 and BIOL 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.
Fall BIOL1070 S01 15686 MTh 2:00-3:20 (J. Schell)

BIOL 1090. Polymer Science for Biomaterials.
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.
Fall BIOL1090 S01 16494 T 1:00-3:50 (E. Mathiowitz)
Fall BIOL1090 L01 16496 Arranged (E. Mathiowitz)

BIOL 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: BIOL 0800 or NEUR 0910. Instructor permission required. Registration overrides will not be given out 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.)
Spr BIOL1100 S01 24464 M 3:00-5:30(13) (D. Horrigan)

BIOL 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: BIOL 0200, 0280, 0470, or 0500. Enrollment limited to 20 juniors and seniors. Instructor permission required.
Fall BIOL1110 S01 15687 W 3:00-5:30(17) (E. Oancea)

BIOL 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: BIOL 0800 or instructor permission.
Spr BIOL1120 S01 24465 TTh 6:40-8:00PM(18) (J. Scott)

BIOL 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 0350, plus BIOL 0500 or 0800. Enrollment limited to 20. Instructor permission required.
Fall BIOL1140 S01 15688 Th 3:00-5:50 (D. Hoffman-Kim)

BIOL 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.
Spr BIOL1150 S01 24970 Th 3:00-5:20 (E. Darling)
Spr BIOL1150 L01 24971 F 9:00-12:50 (E. Darling)
BIOL 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 to not only arrive 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.

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 both 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 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.

BIOL 1250. Host-microbiome Interactions in Health and Disease.
Will focus on current understanding of how various microbiomes communicate and interact 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.

BIOL 1250. 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.

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.

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(17) (A. Zhilkovich)
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(05) (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. BIOL 1330. Biology of Reproduction.
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 1050), and two additional Biology courses above the introductory (BIOL 0200) level. Enrollment limited to 20. Spr BIOL1330 S01 24421 M 3:00-5:30(13) (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.

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. A term-paper will be required. Prerequisite: BIOL 0420 or instructor permission. Enrollment limited to 30.

Fall BIOL1470 S01 15584 Th 9:00-10:20(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.

BIOL 1480. Terrestrial Biogeochemistry and the Functioning of Ecosystems. 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.

BIOL 1485. Climate Change Health and Ecology. 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.

BIOL 1500. Plant Physiological Ecology. 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.

BIOL 1515. Conservation in the Genomics Age. 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 BIOL1515 S01 15589 MWF 9:00-9:50(01) (T. Kartzinell)
Fall BIOL1515 L01 15591 W 1:00-4:00 (T. Kartzinell)

BIOL 1520. Innate Immunity. Immune defense is the initial response to microbes that prevent 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 BIOL1520 S01 15561 TTh 9:00-10:20(02) (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 premier 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 BIOL1540 S01 24422 TTh 2:30-3:50(11) (E. Larschan)

BIOL 1545. Human Genetics and Genomics. 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.

BIOL 1550. Biology of Emerging Microbial Diseases. 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, cellular and immunological events of emerging pathogens and host responses. Expected: BIOL 0470 or BIOL 0530.

Spr BIOL1550 S01 24341 MWF 11:00-11:50(04) (C. de Graffenried)

BIOL 1555. Methods in Informatics and Data Science for Health. 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 molecular 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 BIOL1555 S01 24347 TTh 10:30-11:50(09) (N. Sarkar)
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)

B I O L 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 given to understanding the organization of biomedical information, effective management of information using computer technology, impact of such technology on biomedical research, education, patient care. Major aim explores 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 biomedical perspective.
Fall BIOL1565 S01 15566 M 3:00-5:30(05) (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 TTh 1:00-2:20(08) (H. Fraser)

B I O L 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 0455). Spr BIOL1595 S01 24348 TTh 1:00-2:20(08) (C. Eickhoff)

B I O L 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(10) (S. Vaishnavav)

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 biomegography - with methods and approaches from mechanics, fluid dynamics, and robotics. Expected: BIOL 0800 and PHYS 0030. Instructor permission required.

B I O L 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 TTh 9:00-10:20(01) (M. Dawson)

B I O L 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 TTh 10:30-11:50(09) (J. Plawiicki)

B I O L 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.

B I O L 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, immunohistochemistry).
Spr BIOL1870 S01 24453 TTh 1:00-3:50 (C. Jackson)

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 the lab.
Spr BIOL1880 S01 24358 MWF 11:00-11:50(04) 'To Be Arranged'
Spr BIOL1880 L01 24359 W 1:00-4:50 'To Be Arranged'

B I O L 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.
Biology (Undergraduate)

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 consider 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.

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.

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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.
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 Leefrog for a draft with the correct fonts in place.