Department of Biological Sciences

Veronica Hinman, Department Head
Amanda Willard, Director of Undergraduate Studies
Location: Doherty Hall 1321
www.cmu.edu/bio (http://www.cmu.edu/bio/)

A major revolution is occurring in the field of biological sciences. Biology is undergoing unprecedented technological advances in biochemistry, biophysics, cell biology, genetics, molecular biology, developmental biology, neuroscience and computational biology. Carnegie Mellon's Department of Biological Sciences is nationally recognized as one of the outstanding departments in these areas. Advances in basic research are already being used to solve problems, not only in medicine and public health, but also in areas such as agriculture, forestry, mining, energy, and in industrial and pharmaceutical manufacturing processes. The department provides its students with an education that has both intellectual breadth and depth of exposure to modern research biology. This education can be used to gain employment immediately after graduation in government, industry or academic research laboratories, or to pursue graduate studies in a variety of areas such as science, medicine, public health, law, or business. A degree in biological sciences provides excellent preparation for many careers or graduate programs in the health professions. These students are aided by the Carnegie Mellon Health Professions Program (HPP), an advisory and resource service for all Carnegie Mellon students who are considering careers in the health care field. (See the HPP (http://coursecatalog.web.cmu.edu/servicesandadoptions/undergraduateservices/#healthprofessionssprogram) section in this catalog or www.cmu.edu/hpp (http://www.cmu.edu/hpp) for more information.)

The department offers a Bachelor of Science (B.S.) degree in Biological Sciences. This program has a distinctive core curriculum that provides a foundation in biology, chemistry, computer science, mathematics, and physics. In addition to the core courses, the program includes six biology electives, free electives as well as humanities, social science and fine arts electives. With these electives, students can shape a degree program according to their own interests and career goals. For students who have an interest in a particular field of biology and wish to have a specialized focus, the department offers options in biochemistry, biophysics, cell biology, computational biology, developmental biology, genetics, molecular biology, and neuroscience that provide the relevant training in each area. The options are especially recommended for students who are considering graduate school in one of these areas.

In this exciting era that includes the influence of biology and the life sciences on many fields from medicine to law, the in-depth exposure to multiple disciplines provides opportunities for students to prepare for involved at the forefront of emerging new fields, markets, and policy changes. The Department of Biological Sciences at Carnegie Mellon is working at these new interfaces through interdisciplinary research and educational programs. Innovative interdisciplinary degrees which are offered by the department include the inter-college B.S. degree in Neuroscience as well as the unified B.S. degree in Biological Sciences and Psychology. Students also pursue interests at the interface between the arts and sciences through the Bachelor of Science and Arts (B.S.A.) degree program combining biological sciences with a discipline in the College of Fine Arts. A stand-alone Bachelor of Arts (B.A.) degree is available for students who wish to expand their educational training into other fields. Many students choose to broaden their education by pursuing minors and additional majors in disciplines throughout the university, not just within the Mellon College of Science.

One of the most important features of the Department of Biological Sciences is the opportunity for undergraduate students to interact with faculty. Providing a solid foundation to scientific practice is critical; therefore, the department offers first-year students a variety of inquiry-based, hands-on courses that incorporate a wide range of topics and interests within Biological Sciences. These courses kick-start the transformation of science students to scientists. We encourage our students to get to know their faculty through one of these courses, or through mentored, independent research projects in the faculty laboratories. Our faculty members are prominent research scientists who also teach beginning and advanced courses. The upper level teaching laboratories are located in the same building as the faculty research laboratories and share scientific equipment. We encourage students to make themselves aware of the research areas of the faculty and to develop research projects with faculty. While such research is usually most important in the senior year, it may begin earlier in a student's undergraduate training. The department has an Honors Program in research Biology to facilitate a more intensive involvement in research for eligible students. During the past four years, more than 85 percent of the undergraduate biology majors have worked with faculty on their research and, in some cases, have been co-authors of research papers and have given presentations at national meetings.

Since the fall of 2011, the Department of Biological Sciences has offered a B.S. degree in Biological Sciences at Carnegie Mellon University in Doha, Qatar. Students enrolled in either of these degree programs will also complete the requirements outlined below. One of the required courses for the CMU-Qatar program is offered through a collaboration with the Weill Cornell Medical College in Qatar. For a listing of how the degree requirements are fulfilled for students enrolled in Doha, please consult the CMU-Qatar website (www.qatar.cmu.edu/curriculum-bs (https://www.qatar.cmu.edu/curriculum-bs/)).

Program Outcomes

Upon graduation recipients of the B.S. or B.A. degree in Biological Sciences will:

• Use the basic concepts and experimental, computational, and theoretical methods of the core fields of science, mathematics and technology.
• Use foundational knowledge from the natural sciences and mathematics for advanced work in the discipline.
• Understand and apply the scientific method.
• Apply disciplinary knowledge toward solving problems.
• Use modern methods for finding and sharing current scientific information and primary literature.
• Convey information including scientific content in written and oral formats within Biological Sciences.
• Work in multidisciplinary and culturally diverse teams.
• Demonstrate proper values and ethics within Biological Sciences, the University, and the larger scientific community.

B.S. Biological Sciences

The Bachelor of Science (B.S.) in Biological Sciences is built around a core program and elective units as detailed in the following section.

Degree Requirements:

Biological Sciences

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-151</td>
<td>Honors Modern Biology</td>
<td>10</td>
</tr>
<tr>
<td>or 03-121</td>
<td>Modern Biology</td>
<td></td>
</tr>
<tr>
<td>03-201</td>
<td>Undergraduate Colloquium for Sophomores</td>
<td>2</td>
</tr>
<tr>
<td>03-220</td>
<td>Genetics</td>
<td>9</td>
</tr>
<tr>
<td>or 03-221</td>
<td>Genomes, Evolution, and Disease: Introduction to Quantitative Genetic Analysis</td>
<td></td>
</tr>
<tr>
<td>03-231</td>
<td>Honors Biochemistry</td>
<td>9</td>
</tr>
<tr>
<td>or 03-232</td>
<td>Biochemistry I</td>
<td></td>
</tr>
<tr>
<td>02-250</td>
<td>Introduction to Computational Biology</td>
<td>12</td>
</tr>
<tr>
<td>03-320</td>
<td>Cell Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-343</td>
<td>Experimental Techniques in Molecular Biology</td>
<td>12</td>
</tr>
<tr>
<td>03-344</td>
<td>Experimental Biochemistry</td>
<td>12</td>
</tr>
<tr>
<td>or 03-345</td>
<td>Experimental Cell and Developmental Biology</td>
<td></td>
</tr>
<tr>
<td>or 03-346</td>
<td>Experimental Neuroscience</td>
<td></td>
</tr>
<tr>
<td>03-411</td>
<td>Topics in Research</td>
<td>1</td>
</tr>
<tr>
<td>03-412</td>
<td>Topics in Research</td>
<td>1</td>
</tr>
<tr>
<td>03-xxx</td>
<td>Biological Sciences Electives</td>
<td>54</td>
</tr>
</tbody>
</table>

Total Biology units 131

1 Details on electives can be found in the "Biological Sciences Electives" section (see below).

Mathematics, Physics and Computer Science

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-110</td>
<td>Principles of Computing</td>
<td>10</td>
</tr>
<tr>
<td>or 15-112</td>
<td>Fundamentals of Programming and Computer Science</td>
<td></td>
</tr>
<tr>
<td>or 02-201</td>
<td>Programming for Scientists</td>
<td></td>
</tr>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-124</td>
<td>Calculus II for Biologists and Chemists</td>
<td>10</td>
</tr>
<tr>
<td>or 21-122</td>
<td>Integration and Approximation</td>
<td></td>
</tr>
<tr>
<td>33-121</td>
<td>Physics I for Science Students</td>
<td>12</td>
</tr>
<tr>
<td>or 33-141</td>
<td>Physics I for Engineering Students</td>
<td></td>
</tr>
</tbody>
</table>

Department of Biological Sciences
The following specifications apply to Biological Sciences electives:

- Majors entering CMU and majoring in Biological Sciences (or affiliated majors) in the Fall of 2015 or beyond will fulfill the MCS Technical Breadth requirements as follows:
  1. Life Sciences: any courses in this category except for the 03-xxx courses.
  2. Physical Sciences: 09-105, 09-106, 33-121 and 33-122
  3. Math/CS/Stats: 21-120 and (21-122 or 21-124)
  4. STEM Elective: will be filled by courses above or any STEM course from the approved list.

### Biological Sciences Electives

The following specifications apply to Biological Sciences electives:

- At least 18 units must be at the 03-3xx level or above, exclusive of 03-445 and 03-545.
- Up to three interdisciplinary electives may count as biology electives.
- Up to 18 units of 03-445 Undergraduate Research and/or 03-545 Honors Research may count as general biology electives; a maximum of 36 units can count for the minimum units required for graduation.
- Courses in biology taken through cross-registration or study abroad at another university may count as electives if prior permission is obtained from the Carnegie Mellon Department of Biological Sciences advisor.

### Departmental Electives Group

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-117</td>
<td>Frontiers, Analysis, and Discovery in Biological Sciences</td>
<td>6</td>
</tr>
<tr>
<td>03-118</td>
<td>Beer: A Yeast’s Perspective</td>
<td>6</td>
</tr>
<tr>
<td>03-120</td>
<td>Biology for Life Special Topics Mini</td>
<td>Var.</td>
</tr>
<tr>
<td>03-124</td>
<td>Modern Biology Laboratory</td>
<td>9</td>
</tr>
<tr>
<td>03-125</td>
<td>Evolution</td>
<td>9</td>
</tr>
<tr>
<td>03-132</td>
<td>Basic Science to Modern Medicine</td>
<td>9</td>
</tr>
<tr>
<td>03-133</td>
<td>Neurobiology of Disease</td>
<td>9</td>
</tr>
<tr>
<td>03-140</td>
<td>Ecology and Environmental Science</td>
<td>9</td>
</tr>
<tr>
<td>03-161</td>
<td>Molecules to Mind</td>
<td>9</td>
</tr>
<tr>
<td>03-327</td>
<td>Evolutionary Bioinformatics: Trees, Sequences and the Comparative Method</td>
<td>9</td>
</tr>
<tr>
<td>03-350</td>
<td>Developmental Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-360/02-319</td>
<td>Genomics and Epigenetics of the Brain</td>
<td>9</td>
</tr>
<tr>
<td>03-362</td>
<td>Cellular Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>03-363</td>
<td>Systems Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>03-365</td>
<td>Neural Correlates of Learning and Memory</td>
<td>9</td>
</tr>
<tr>
<td>03-366</td>
<td>Neuroparmacology: Drugs, Brain and Behavior</td>
<td>9</td>
</tr>
<tr>
<td>03-390</td>
<td>Molecular and Cellular Immunology</td>
<td>9</td>
</tr>
<tr>
<td>03-391</td>
<td>Microbiology</td>
<td>9</td>
</tr>
<tr>
<td>03-410</td>
<td>Special Topics in Biological Sciences</td>
<td>Var.</td>
</tr>
<tr>
<td>03-428</td>
<td>Genome Editing</td>
<td>6</td>
</tr>
<tr>
<td>03-435</td>
<td>Cancer Biology</td>
<td>9</td>
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<tr>
<td>03-439</td>
<td>Introduction to Biophysics</td>
<td>10</td>
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<tr>
<td>03-442</td>
<td>Molecular Biology</td>
<td>9</td>
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<tr>
<td>03-445</td>
<td>Undergraduate Research</td>
<td>Var.</td>
</tr>
<tr>
<td>03-451</td>
<td>Advanced Developmental Biology and Human Health</td>
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<tr>
<td>03-511</td>
<td>Computational Molecular Biology and Genomics</td>
<td>9</td>
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<tr>
<td>03-534</td>
<td>Biological Imaging and Fluorescence</td>
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<tr>
<td>03-545</td>
<td>Honors Research</td>
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<tr>
<td>03-620</td>
<td>Techniques in Electron Microscopy</td>
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</tr>
<tr>
<td>03-711</td>
<td>Computational Molecular Biology and Genomics</td>
<td>12</td>
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<tr>
<td>03-713</td>
<td>Bioinformatics Data Integration Practicum</td>
<td>6</td>
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<tr>
<td>03-726</td>
<td>Evolution of Regulatory Genomics</td>
<td>6</td>
</tr>
<tr>
<td>03-727</td>
<td>Evolutionary Bioinformatics: Trees, Sequences and the Comparative Method</td>
<td>12</td>
</tr>
<tr>
<td>03-728</td>
<td>Genome Editing Biotechnology</td>
<td>6</td>
</tr>
<tr>
<td>03-730</td>
<td>Advanced Genetics</td>
<td>12</td>
</tr>
<tr>
<td>03-740</td>
<td>Advanced Biochemistry</td>
<td>12</td>
</tr>
<tr>
<td>03-741</td>
<td>Advanced Cell Biology</td>
<td>12</td>
</tr>
<tr>
<td>03-742</td>
<td>Advanced Molecular Biology</td>
<td>12</td>
</tr>
<tr>
<td>03-744</td>
<td>Membrane Trafficking</td>
<td>9</td>
</tr>
<tr>
<td>03-751</td>
<td>Advanced Developmental Biology and Human Health</td>
<td>12</td>
</tr>
<tr>
<td>03-758</td>
<td>Special Topics</td>
<td>6</td>
</tr>
<tr>
<td>03-762</td>
<td>Advanced Cellular Neuroscience</td>
<td>12</td>
</tr>
<tr>
<td>03-763</td>
<td>Advanced Systems Neuroscience</td>
<td>12</td>
</tr>
<tr>
<td>03-765</td>
<td>Advanced Neural Correlates of Learning and Memory</td>
<td>12</td>
</tr>
<tr>
<td>03-791</td>
<td>Advanced Microbiology</td>
<td>12</td>
</tr>
<tr>
<td>03-871</td>
<td>Structural Biophysics</td>
<td>12</td>
</tr>
</tbody>
</table>

### Interdisciplinary Electives Group

Up to three of the following courses may count as biology electives:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-518</td>
<td>Bioorganic Chemistry: Nucleic Acids and Carbohydrates</td>
<td>9</td>
</tr>
<tr>
<td>09-519</td>
<td>Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry</td>
<td>9</td>
</tr>
<tr>
<td>09-521</td>
<td>Metals in Biology: Function and Reactivity</td>
<td>6</td>
</tr>
<tr>
<td>09-535</td>
<td>Applied topics in Macromolecular and Biophysical Techniques</td>
<td>9</td>
</tr>
<tr>
<td>09-803</td>
<td>Chemistry of Gene Expression</td>
<td>12</td>
</tr>
<tr>
<td>21-127</td>
<td>Concepts of Mathematics</td>
<td>10</td>
</tr>
<tr>
<td>21-259</td>
<td>Calculus in Three Dimensions</td>
<td>9</td>
</tr>
<tr>
<td>21-260</td>
<td>Differential Equations</td>
<td>9</td>
</tr>
<tr>
<td>36-200</td>
<td>Reasoning with Data</td>
<td>9</td>
</tr>
<tr>
<td>36-247</td>
<td>Statistics for Lab Sciences</td>
<td>9</td>
</tr>
<tr>
<td>42-202</td>
<td>Physiology</td>
<td>9</td>
</tr>
<tr>
<td>85-219</td>
<td>Biological Foundations of Behavior</td>
<td>9</td>
</tr>
</tbody>
</table>

### Options for the B.S. in Biological Sciences

Students who wish to specialize in a particular area of biology can do so through a set of departmentally defined options. A student who completes the required biology electives for any option can have up to two noted on his or her transcript. Options need not be declared. The elective courses required for each of the options are listed below.

### Biochemistry Option

Required Biology Electives:
Required Biology Electives:

- Genetics Option
- Developmental Biology Option
- Computational Biology Option
- Cell Biology Option
- Biophysics Option
- Neuroscience Option
- Molecular Biology Option

Recommended Biology Electives:

- Any ONE of the following courses:
  - 03-740 Advanced Biochemistry
  - 03-442 Molecular Biology
  - 03-350 Biological Imaging and Fluorescence Spectroscopy
  - 03-871 Structural Biophysics

Biophysics Option

Required Biology Electives:

- 03-740 Advanced Biochemistry
- 03-439 Introduction to Biophysics
- 21-259 Calculus in Three Dimensions or 21-260 Differential Equations

Recommended Biology Electives:

- 03-534 Biological Imaging and Fluorescence Spectroscopy
- 03-871 Structural Biophysics

Cell Biology Option

Required Biology Electives:

- 03-350 Developmental Biology
- 03-741 Advanced Cell Biology

Recommended Biology Electives:

- 03-362 Cellular Neuroscience
- 03-390 Molecular and Cellular Immunology

Computational Biology Option

Required Biology Electives:

- 03-711 Computational Molecular Biology and Genomics
- 15-210 Parallel and Sequential Data Structures and Algorithms

Recommended Biology Electives:

- 03-512 Computational Methods for Biological Modeling and Simulation
- 15-451 Algorithm Design and Analysis
- 09-560 Computational Chemistry

Developmental Biology Option

Required Biology Electives:

- 03-350 Developmental Biology
- 03-442 Molecular Biology
- 03-751 Advanced Developmental Biology and Human Health

Recommended Biology Electives:

- 03-326 Evolution of Regulatory Genomics
- 03-741 Advanced Cell Biology

Genetics Option

Required Biology Electives:

- 03-326 Evolution of Regulatory Genomics
- 03-327 Evolutionary Bioinformatics: Trees, Sequences and the Comparative Method
- 03-442 Molecular Biology
- 03-730 Advanced Genetics

Recommended Biology Electives:

- 03-391 Microbiology

Molecular Biology Option

Required Biology Electives:

- 03-442 Molecular Biology
- 09-518 Bioorganic Chemistry: Nucleic Acids and Carbohydrates
- 03-726 Evolution of Regulatory Genomics
- 03-727 Evolutionary Bioinformatics: Trees, Sequences and the Comparative Method

Recommended Biology Electives:

- 03-390 Molecular and Cellular Immunology
- 03-391 Microbiology
- 03-730 Advanced Genetics

Neuroscience Option

Required Biology Electives:

- 03-362 Cellular Neuroscience
- 03-363 Systems Neuroscience

Any ONE of the following courses:

- 03-133 Neurobiology of Disease
- 03-350 Developmental Biology
- 03-364 Developmental Neuroscience
- 03-365 Neural Correlates of Learning and Memory
- 03-366 Neuropharmacology: Drugs, Brain and Behavior
- 03-534 Biological Imaging and Fluorescence Spectroscopy
- 42-202 Physiology
- 85-219 Biological Foundations of Behavior

B.S. Biological Sciences/Neuroscience Track

The Bachelor of Science in Biological Sciences/Neuroscience Track provides an option for those Biological Sciences majors who are interested in an intensive curricular focus in neuroscience. The requirements of the Track are the same as those listed for the B.S. in Biological Sciences with the following changes to the biological sciences elective requirements:

Degree Requirements:

- 03-362 Cellular Neuroscience
- 03-363 Systems Neuroscience
- 03-765 Advanced Neural Correlates of Learning and Memory

Plus three of the following electives:

- 03-133 Neurobiology of Disease
- 03-350 Developmental Biology
- 03-360/02-319 Genomics and Epigenetics of the Brain
- 03-364 Developmental Neuroscience
- 03-366 Neuropharmacology: Drugs, Brain and Behavior
- 03-534 Biological Imaging and Fluorescence Spectroscopy
- 15-385 Introduction to Computer Vision
- 15-386 Neural Computation
- 42-202 Physiology
- 85-211 Cognitive Psychology
B.S. Neuroscience

The Bachelor of Science in Neuroscience is listed in the Intercollege Programs (http://coursecatalog.web.cmu.edu/servicesandoptions/intercollegeprograms/#bachelorofscienceneurosciencetext) section of this catalog. It is a joint degree program offered between the Mellon College of Science and the Dietrich College of Humanities and Social Sciences. Current MCS students interested in pursuing this degree should contact the Biological Sciences Undergraduate Programs Office (bio-ungrad@andrew.cmu.edu).

B.S. Biological Sciences and Psychology

Veronica Hinman, Department Head, Biological Sciences

Michael Tarr, Department Head, Psychology

This major is intended to reflect the interdisciplinary nature of current research in the fields of biology and psychology, as well as the national trend in some professions to seek individuals broadly trained in both the social and natural sciences.

Note: Students entering from the Dietrich College of Humanities and Social Sciences will earn a Bachelor of Science in Psychology and Biological Sciences. Students in the Mellon College of Science will earn a Bachelor of Science in Biological Sciences and Psychology.

Depending on a student's home college (DC or MCS), General Education (GenEd) requirements will be different. GenEd requirements for DC are found on their respective Catalog pages.

Degree Requirements:

<table>
<thead>
<tr>
<th>Units</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Human Information Processing and Artificial Intelligence</td>
</tr>
<tr>
<td>9</td>
<td>Biological Foundations of Behavior</td>
</tr>
</tbody>
</table>

Total Science units 99-101

Total Math units 33-121

Total Stat units 10-12

B.S. Biological Sciences

85-213 Human Information Processing and Artificial Intelligence 9
85-219 Biological Foundations of Behavior 9

B.S. Neuroscience

The Bachelor of Science in Neuroscience is listed in the Intercollege Programs (http://coursecatalog.web.cmu.edu/servicesandoptions/intercollegeprograms/#bachelorofscienceneurosciencetext) section of this catalog. It is a joint degree program offered between the Mellon College of Science and the Dietrich College of Humanities and Social Sciences. Current MCS students interested in pursuing this degree should contact the Biological Sciences Undergraduate Programs Office (bio-ungrad@andrew.cmu.edu).

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<tbody>
<tr>
<td>9</td>
<td>Human Information Processing and Artificial Intelligence</td>
</tr>
<tr>
<td>9</td>
<td>Biological Foundations of Behavior</td>
</tr>
</tbody>
</table>

Total Science units 99-101

Total Math units 33-121

Total Stat units 10-12

B.S. Biology courses

85-219 Biological Foundations of Behavior 9
85-220 Survey Psychology Courses 16
85-310 Research Methods in Cognitive Psychology 9
or 85-340 Research Methods in Social Psychology 12
or 85-320 Research Methods in Developmental Psychology 9
or 85-314 Cognitive Neuroscience Research Methods 9
or 85-330 Analytic Research Methods 18

Total Psychology units 63

Additional Advanced Elective 9 units

(Choose one of the following courses)
85-3xx Advanced Psychology Elective 9
or 03-3xx Advanced Biology Elective 9

Additional Laboratory or Research Methods 9-12 units

(Choose one of the following courses)
03-344 Experimental Biochemistry 12
03-345 Experimental Cell and Developmental Biology 12
03-346 Experimental Neuroscience 12
85-310 Research Methods in Cognitive Psychology 9
85-314 Cognitive Neuroscience Research Methods 9
85-320 Research Methods in Developmental Psychology 9
85-340 Research Methods in Social Psychology 9

Elective Units 36-48

MCS Nontechnical Breadth or DC General Education requirements 36-48

Total Elective units 69-84

Minimum number of units required for degree: 360

B.A. Biological Sciences

The Department of Biological Sciences offers a Bachelor of Arts (B.A.) degree that is intended for students who wish to combine their interest in science with their interest(s) in other discipline(s) across campus. The requirements for the B.A. degree are distributed as follows:

Degree Requirements:

<table>
<thead>
<tr>
<th>Units</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Honors Modern Biology</td>
</tr>
<tr>
<td>9</td>
<td>Modern Biology</td>
</tr>
<tr>
<td>9</td>
<td>Modern Organic Chemistry</td>
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<tr>
<td>9</td>
<td>Organic Chemistry II</td>
</tr>
<tr>
<td>9</td>
<td>Organic Chemistry II</td>
</tr>
<tr>
<td>12</td>
<td>Research Methods in Cognitive Psychology</td>
</tr>
<tr>
<td>12</td>
<td>Research Methods in Social Psychology</td>
</tr>
<tr>
<td>9</td>
<td>Cognitive Neuroscience Research Methods</td>
</tr>
<tr>
<td>9</td>
<td>Analytic Research Methods</td>
</tr>
<tr>
<td>9</td>
<td>Advanced Psychology Electives</td>
</tr>
</tbody>
</table>

Total Chemistry units 56-62

Total Psychology units 63

Additional Advanced Elective 9 units

(Choose one of the following courses)
85-3xx Advanced Psychology Elective 9
or 03-3xx Advanced Biology Elective 9

Additional Laboratory or Research Methods 9-12 units

(Choose one of the following courses)
03-344 Experimental Biochemistry 12
03-345 Experimental Cell and Developmental Biology 12
03-346 Experimental Neuroscience 12
85-310 Research Methods in Cognitive Psychology 9
85-314 Cognitive Neuroscience Research Methods 9
85-320 Research Methods in Developmental Psychology 9
85-340 Research Methods in Social Psychology 9

Elective Units 36-48

Free Electives 33-36

MCS Nontechnical Breadth or DC General Education requirements 36-48

Total Elective units 69-84

Minimum number of units required for degree: 360
Courses for the Minor in Biological Sciences will be considered on an individual basis. Units awarded for undergraduate research are not applicable to elective courses. Courses taken in other departments or as specified below. The curriculum includes four required courses and two elective courses (prerequisites) must be completed to fulfill the minor in biological sciences.

All university students are eligible to pursue a minor in biological sciences in conjunction with a major in any other department in the university. A minimum of six biological sciences courses (and two chemistry prerequisites) must be completed to fulfill the minor in biological sciences. The curriculum includes four required courses and two elective courses as specified below. Units awarded for undergraduate research are not applicable to elective courses. Courses taken in other departments or colleges will be considered on an individual basis.

### Courses for the Minor in Biological Sciences

**Prerequisites:**
- 09-105 Introduction to Modern Chemistry I or 9
- 09-217 Organic Chemistry I or 9

**Required courses:**
- 03-320 Cell Biology or 9
- 03-343 Experimental Techniques in Molecular Biology or 9-12
- 03-124 Modern Biology Laboratory or 1

**Elective courses**
- 03-xxx General Biology Electives or 8
- 03-3xx Advanced Biology Electives or 8

**Total Biology units** 86-89

*Please see description and requirements for electives under the B.S. in Biological Sciences section of this Catalog.*

### Minor in Neuroscience

The curriculum within the Neuroscience minor will allow students from various disciplines to gain fundamental knowledge of neuroscience concepts. The interdisciplinary nature of the coursework echoes the nature of the field itself; students will select courses from the natural, social, and computer sciences. Neuroscientists not only require foundational knowledge of molecular, cellular, and systems neuroscience, but they should also understand the behavioral significance and appreciate how computational work and imaging techniques can aid in clarifying normal and abnormal functioning of these fundamental processes.

Students pursuing the minor in Neuroscience will:
- Acquire foundational knowledge of the basic biological foundations of the nervous system, from the cellular through systems levels.
- Understand the effects of basic neurological function on behavior, including cognition.
- Gain an appreciation of the interdisciplinary nature of the field of neuroscience.

**NOTE:** Because the curriculum within this minor may overlap with some degree requirements, no more than 2 courses fulfilling Neuroscience Minor requirements may count towards the requirements of a student's major or other minor.

### Course Requirements

**Minimum units required for Neuroscience minor**
- 63

**Required courses (4):**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121 Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>or 03-151 Honors Modern Biology</td>
<td></td>
</tr>
<tr>
<td>03-362 Cellular Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>03-363 Systems Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>85-219 Biological Foundations of Behavior</td>
<td>9</td>
</tr>
<tr>
<td>or 03-161 Molecules to Mind</td>
<td></td>
</tr>
</tbody>
</table>

**Distribution Requirements:**

Three courses, including at least 1 from each of the following categories:

<table>
<thead>
<tr>
<th>Approaches to Neuroscience Category</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-386 Neural Computation</td>
<td>9</td>
</tr>
<tr>
<td>15-883 Computational Models of Neural Systems</td>
<td>12</td>
</tr>
<tr>
<td>85-412 Cognitive Modeling</td>
<td>9</td>
</tr>
<tr>
<td>85-414 Cognitive Neuropsychology</td>
<td>9</td>
</tr>
<tr>
<td>85-419 Introduction to Parallel Distributed Processing</td>
<td>9</td>
</tr>
<tr>
<td>85-429 Cognitive Brain Imaging</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cognitive Neuroscience Category</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-133 Neurobiology of Disease</td>
<td>9</td>
</tr>
<tr>
<td>03-364 Developmental Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>85-211 Cognitive Psychology*</td>
<td>9</td>
</tr>
<tr>
<td>85-356 Music and Mind: The Cognitive Neuroscience of Sound</td>
<td>9</td>
</tr>
<tr>
<td>85-370 Perception</td>
<td>9</td>
</tr>
<tr>
<td>85-406 Autism: Psychological and Neuroscience Perspectives</td>
<td>9</td>
</tr>
</tbody>
</table>

*NOTE: 85-213 may be used instead of 85-211 when offered*

### Masters Degree in Computational Biology

Students who are interested in more advanced training in this emerging field may want to consider the Master of Science Program in Computational
Honors Program in Research Biology

The departmental Honors Program offers an opportunity to become extensively involved in research. The program requires students to conduct an independent project and to prepare a formal thesis that is written and defended in the senior year. This program does not preclude a student from completing any of the options within the department nor is it the only way in which students can participate in undergraduate research, although it is excellent preparation for graduate studies.

Transfer credit for Modern Biology

Students wishing to transfer credit for 03-121 Modern Biology from another institution must meet the following requirements:

1. The course in question should have at least an 80% match in topics with 03-121. Topics in 03-121 cover the genetic, molecular, cellular, developmental, and evolutionary mechanisms that underlie biological processes and include: Cell theory; Cell chemistry; Cell structure; Function and structure of proteins, DNA, RNA, lipids and carbohydrates; Cell respiration and fermentation; The cell cycle; Cell-cell interactions and communication; Transcription; Translation; RNA processing in Eukaryotes; DNA replication; DNA mutation and repair; Meiosis; Mitosis; and Regulation of Gene Expression.


3. Introductory level courses that focus on other biology areas (i.e. anatomy, physiology, ecology, evolution, and/or development) will not be accepted for 03-121 credit. These courses may receive credit for a general biology elective.

4. Students should contact their departmental academic advisor for the transfer credit approval process in their college.

Faculty


ALISON L. BARTH, Professor – Ph.D., University of California, Berkeley; Carnegie Mellon, 2002.

MOHAMED BOUAOUINA, Associate Teaching Professor, Carnegie Mellon-Qatar – Ph.D., Pierre and Marie Curie University; Carnegie Mellon, 2013.

DANIEL BRASIER, Associate Teaching Professor and Assistant Department Head for Graduate Affairs – Ph.D., University of California, San Diego; Carnegie Mellon, 2012.

MAGGIE BRAUN, Teaching Professor and Associate Dean of Undergraduate Affairs for MCS – Ph.D., University of Pittsburgh; Carnegie Mellon, 2008.

MARCEL BRUCHEZ, Professor in Biological Sciences and Chemistry, Director of MBIC – Ph.D., University of California, Berkeley; Carnegie Mellon, 2006.


EN CAI, Assistant Professor – Ph.D., University of Illinois at Urbana-Champaign; Carnegie Mellon, 2021.

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CARRIE B. DOONAN, Teaching Professor and Director of Undergraduate Laboratories – Ph.D., University of Connecticut; Carnegie Mellon, 1993.

LYNLEY DOONAN, Special Lecturer – Ph.D., University of Pittsburgh; Carnegie Mellon, 2018.

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VERONICA F. HINMAN, Professor and Department Head – Ph.D., University of Queensland; Carnegie Mellon, 2006.

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ROBERT F. MURPHY, Ray and Stephanie Lane Professor of Computational Biology – Ph.D., California Institute of Technology; Carnegie Mellon, 1983.


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Affiliated Faculty

BRUCE A. ARMITAGE, Professor of Chemistry and Co-Director of CNAST – Ph.D., University of Arizona; Carnegie Mellon, 1997.

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gopher: Advanced Associate Professor of Computational Biology – Ph.D., Dartmouth College; Carnegie Mellon, 2004–

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D. LANSING TAYLOR, President and Chief Executive Officer of Cellumen, Inc. – Ph.D., State University of New York at Albany; Carnegie Mellon, 1982–

MASSIMO TRUCCO, Adjunct Associate Professor and Principal Investigator at Institute of Cellular Therapeutics - Allegheny Health Network – M.D., University of Turino School of Medicine;

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