Department of Biological Sciences

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 other fields 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 medical school or other 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/servicesandoptions/undergraduateoptions/#healthprofessionsprogram) section in this catalog or 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. The B.S. degrees in Biological Sciences/Neuroscience Track and Neuroscience are available to those students who wish to pursue an in-depth study of neuroscience.

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 involvement 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. degrees in Computational Biology and Neuroscience as well as the unified B.S. degree in Biological Sciences and Psychology. Students also explore interdisciplinary studies through the Science and Humanities Scholars program, or 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 interest areas 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 mentorship, 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 80 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 B.S. degrees in Biological Sciences as well as Computational Biology at Carnegie Mellon University in Doha, Qatar. Students enrolled in either of these degree programs will also complete the requirements outlined below. A limited number of required courses for the CMU-Qatar program are 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 (https://www.qatar.cmu.edu/curriculum-bs).

Program Outcomes

Upon graduation recipients of the BS or BA 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:

<table>
<thead>
<tr>
<th>Biological Sciences</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>03-201 Undergraduate Colloquium for Sophomores</td>
<td>2</td>
</tr>
<tr>
<td>03-220 Genetics</td>
<td>9</td>
</tr>
<tr>
<td>03-231/232 Biochemistry I</td>
<td>9</td>
</tr>
<tr>
<td>03-250 Introduction to Computational Biology</td>
<td>12</td>
</tr>
<tr>
<td>or 03-251 AND 03-252</td>
<td></td>
</tr>
<tr>
<td>03-320 Cell Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-343 Experimental Techniques in Molecular Biology</td>
<td>12</td>
</tr>
<tr>
<td>03-344 Experimental Biochemistry</td>
<td>12</td>
</tr>
<tr>
<td>or 03-345 Experimental Cell and Developmental Biology</td>
<td></td>
</tr>
<tr>
<td>or 03-346 Experimental Neuroscience</td>
<td></td>
</tr>
<tr>
<td>03-411 Topics in Research</td>
<td>1</td>
</tr>
<tr>
<td>03-412 Topics in Research</td>
<td>1</td>
</tr>
<tr>
<td>03-xxx Biological Sciences Electives</td>
<td>54</td>
</tr>
<tr>
<td>Total Biology units</td>
<td>130</td>
</tr>
</tbody>
</table>

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

Mathematics, Physics and Computer Science

<table>
<thead>
<tr>
<th>Mathematics, Physics and Computer Science</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>02-201 Programming for Scientists</td>
<td>2</td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-122 Integration and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>33-124 Calculus II for Biologists and Chemists</td>
<td></td>
</tr>
<tr>
<td>33-121 Physics I for Science Students</td>
<td>3</td>
</tr>
<tr>
<td>33-122 Physics II for Biological Sciences &amp; Chemistry Students</td>
<td>9</td>
</tr>
</tbody>
</table>
Departmental Electives Group

Total Science units: 54

1. Life Sciences: any courses in this category except for the 03-XXX courses (these can be counted as general bio electives towards your degree).
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.

Elective Units: 120

Minimum number of units required for degree: 360

MCS Technical Breadth Requirements

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 the 03-XXX courses (these can be counted as general bio electives towards your degree).
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.

Elective Units: 48

MCS Nontechnical Breadth Requirements: 72

Elective Units: 56

Elective Units: 120

Minimum number of units required for degree: 360

Interdisciplinary Electives Group

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

09-512 Computational Methods for Biological Modeling and Simulation
09-534 Biological Imaging and Fluorescence Spectroscopy
03-454 Honors Research
03-620 Techniques in Electron Microscopy
03-709 Applied Cell and Molecular Biology
03-711 Computational Molecular Biology and Genomics
03-712 Computational Methods for Biological Modeling and Simulation
03-726 Evolution of Regulatory Genomics
03-727 Phylogenetics
03-728 Genome Editing Biotechnology
03-730 Advanced Genetics
03-740 Advanced Biochemistry
03-741 Advanced Cell Biology
03-742 Molecular Biology
03-744 Membrane Trafficking
03-751 Advanced Developmental Biology and Human Health
03-762 Advanced Cellular Neuroscience
03-763 Advanced Systems Neuroscience
03-765 Advanced Neural Correlates of Learning and Memory
03-770 Principles of Biotechnology
03-791 Advanced Microbiology
03-871 Structural Biophysics

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 03-370.
- Up to three interdisciplinary electives may count as biology electives.
- Up to 18 units of 03-445 Undergraduate 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.

03-115/116 Phage Genomics Research
03-116 Phage Genomics Research
03-124 Modern Biology Laboratory
03-125 Evolution
03-126 Cellular Response to the Environment
03-127 How Biological Experiments Work - A Project Course
03-133 Neurobiology of Disease
03-161 Molecules to Mind
03-326 Evolution of Regulatory Genomics
03-327 Phylogenetics
03-350 Developmental Biology
03-362 Cellular Neuroscience
03-363 Systems Neuroscience
03-364 Developmental Neuroscience
03-365 Neural Correlates of Learning and Memory
03-366 Biochemistry of the Brain
03-370 Principles of Biotechnology
03-390 Molecular and Cellular Immunology
03-391 Microbiology
03-392 Microbiology Laboratory
03-428 Genome Editing Biotechnology
03-435 Cancer Biology
03-439 Introduction to Biophysics
03-442 Molecular Biology
03-445 Undergraduate Research
03-451 Advanced Developmental Biology and Human Health
03-511 Computational Molecular Biology and Genomics
03-512 Computational Methods for Biological Modeling and Simulation
03-534 Biological Imaging and Fluorescence Spectroscopy
03-545 Honors Research
03-620 Techniques in Electron Microscopy
03-709 Applied Cell and Molecular Biology
03-711 Computational Molecular Biology and Genomics
03-712 Computational Methods for Biological Modeling and Simulation
03-726 Evolution of Regulatory Genomics
03-727 Phylogenetics
03-728 Genome Editing Biotechnology
03-730 Advanced Genetics
03-740 Advanced Biochemistry
03-741 Advanced Cell Biology
03-742 Molecular Biology
03-744 Membrane Trafficking
03-751 Advanced Developmental Biology and Human Health
03-762 Advanced Cellular Neuroscience
03-763 Advanced Systems Neuroscience
03-765 Advanced Neural Correlates of Learning and Memory
03-770 Principles of Biotechnology
03-791 Advanced Microbiology
03-871 Structural Biophysics

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 the 03-XXX courses (these can be counted as general bio electives towards your degree).
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.

Elective Units: 48

MCS Nontechnical Breadth Requirements: 72

Elective Units: 56

Elective Units: 120

Minimum number of units required for degree: 360

Interdisciplinary Electives Group

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

09-518 Bioorganic Chemistry: Nucleic Acids and Carbohydrates
09-519 Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry
09-521 Metals in Biology: Function and Reactivity
09-535 Applied topics in Macromolecular and Biophysical Techniques
21-127 Concepts of Mathematics
21-259 Calculus in Three Dimensions
21-260 Differential Equations
36-201 Statistical Reasoning and Practice
36-247 Statistics for Lab Sciences
42-202 Physiology
85-219 Biological Foundations of Behavior
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:
- 03-740 Advanced Biochemistry 12
- 21-259 Calculus in Three Dimensions 9
  or 21-260 Differential Equations

Any ONE of the following courses:
- 09-518 Bioorganic Chemistry: Nucleic Acids and Carbohydrates 9
- 09-519 Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry 9
- 09-521 Metals in Biology: Function and Reactivity 6

Recommended Biology Electives:
- 03-442 Molecular Biology 9
- 03-534 Biological Imaging and Fluorescence Spectroscopy 9
- 03-439 Introduction to Biophysics 9
- 03-871 Structural Biophysics 12

**Biophysics Option**
Required Biology Electives:
- 03-740 Advanced Biochemistry 12
- 03-439 Introduction to Biophysics 9
- 21-259 Calculus in Three Dimensions 9
  or 21-260 Differential Equations

Recommended Biology Electives:
- 03-534 Biological Imaging and Fluorescence Spectroscopy 9
- 03-871 Structural Biophysics 12

**Cell Biology Option**
Required Biology Electives:
- 03-350 Developmental Biology 9
- 03-741 Advanced Cell Biology 12

Any ONE of the following courses:
- 03-362 Cellular Neuroscience 9
- 03-390 Molecular and Cellular Immunology 9

**Computational Biology Option**
Required Biology Electives:
- 03-711 Computational Molecular Biology and Genomics 12
- 15-210 Parallel and Sequential Data Structures and Algorithms 12

Any ONE of the following courses:
- 36-247 Statistics for Lab Sciences 9
- 21-260 Differential Equations 9
- 21-241 Matrices and Linear Transformations 10

Recommended Biology Electives:
- 03-512 Computational Methods for Biological Modeling and Simulation 9
- 15-451 Algorithm Design and Analysis 12
- 09-560 Computational Chemistry 12

**Developmental Biology Option**
Required Biology Electives:
- 03-350 Developmental Biology 9
- 03-442 Molecular Biology 9
- 03-751 Advanced Developmental Biology and Human Health 12

Recommended Biology Electives:
- 03-326 Evolution of Regulatory Genomics 4.5
- 03-741 Advanced Cell Biology 12

**Genetics Option**
Required Biology Electives:
- 03-326 Evolution of Regulatory Genomics 4.5
- 03-327 Phylogenetics 9
- 03-442 Molecular Biology 9
- 03-730 Advanced Genetics 6

6 Minimum grade of B in 03-330 or 03-220 required.

Recommended Biology Electives:
- 03-391 Microbiology 9

**Molecular Biology Option**
Required Biology Electives:
- 03-442 Molecular Biology 9
- 09-518 Bioorganic Chemistry: Nucleic Acids and Carbohydrates 9
- 03-726 Evolution of Regulatory Genomics 6
- 03-727 Phylogenetics 12

Recommended Biology Electives:
- 03-390 Molecular and Cellular Immunology 9
- 03-391 Microbiology 9
- 03-730 Advanced Genetics 12

**Neuroscience Option**
Required Biology Electives:
- 03-362 Cellular Neuroscience 7
- 03-363 Systems Neuroscience 7

Any ONE of the following courses:
- 03-133 Neurobiology of Disease 9
- 03-350 Developmental Biology 9
- 03-364 Developmental Neuroscience 9
- 03-365 Neural Correlates of Learning and Memory 9
- 03-366 Biochemistry of the Brain 9
- 03-534 Biological Imaging and Fluorescence Spectroscopy 9
- 42-202 Physiology 9
- 85-219 Biological Foundations of Behavior 9

7 One of these courses must be completed at the Graduate Level (Complete either 03-762 or 03-763).

**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 9
- 03-363 Systems Neuroscience 9
- 03-765 Advanced Neural Correlates of Learning and Memory 12

Plus three of the following electives:
- 03-133 Neurobiology of Disease 9
- 03-350 Developmental Biology 9
Degree Requirements:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-364</td>
<td>Developmental Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>03-366</td>
<td>Biochemistry of the Brain</td>
<td>9</td>
</tr>
<tr>
<td>03-534</td>
<td>Biological Imaging and Fluorescence Spectroscopy</td>
<td>9</td>
</tr>
<tr>
<td>15-385</td>
<td>Introduction to Computer Vision</td>
<td>6</td>
</tr>
<tr>
<td>15-386</td>
<td>Neural Computation</td>
<td>9</td>
</tr>
<tr>
<td>42-202</td>
<td>Physiology</td>
<td>9</td>
</tr>
<tr>
<td>85-211</td>
<td>Cognitive Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-213</td>
<td>Human Information Processing and Artificial Intelligence</td>
<td>9</td>
</tr>
<tr>
<td>85-219</td>
<td>Biological Foundations of Behavior</td>
<td>9</td>
</tr>
</tbody>
</table>

B.S. Neuroscience

The Bachelor of Science in Neuroscience is listed in the Intercollege 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. Students entering from the Dietrich College of Humanities and Social Sciences will earn a Bachelor of Arts (B.A.) degree 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 entering from the Mellon College of Science will earn a Bachelor of Science in Psychology and Biological Sciences. Students in the joint Science and Humanities Scholars (SHS) program can complete the SHS educational requirements in science with their interest(s) in other discipline(s) across campus. The 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:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-105</td>
<td>Introduction to Modern Chemistry I</td>
<td>10</td>
</tr>
<tr>
<td>09-106</td>
<td>Modern Chemistry II</td>
<td>10</td>
</tr>
<tr>
<td>09-217</td>
<td>Organic Chemistry I</td>
<td>9</td>
</tr>
<tr>
<td>09-218</td>
<td>Organic Chemistry II</td>
<td>9</td>
</tr>
<tr>
<td>09-207</td>
<td>Techniques in Quantitative Analysis</td>
<td>9-12</td>
</tr>
<tr>
<td>09-221</td>
<td>Laboratory I: Introduction to Chemical Analysis</td>
<td>9-12</td>
</tr>
<tr>
<td>09-208</td>
<td>Techniques for Organic Synthesis and Analysis</td>
<td>9</td>
</tr>
</tbody>
</table>

Total Chemistry units: 56-62

**Additional Advanced Elective** 9 units

(Choose one of the following courses)

- 85-3xx Advanced Psychology Elective 9
- 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
- 08-310 Research Methods in Cognitive Psychology 9
- 08-314 Cognitive Neuroscience Research Methods 9
- 08-320 Research Methods in Developmental Psychology 9
- 08-340 Research Methods in Social Psychology 9

Elective Units 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

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:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-151</td>
<td>Honors Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-201</td>
<td>Undergraduate Colloquium for Sophomores</td>
<td>2</td>
</tr>
</tbody>
</table>
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:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-106</td>
<td>Introduction to Modern Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>or 09-219</td>
<td>Modern Organic Chemistry</td>
<td>9</td>
</tr>
<tr>
<td>or 09-220</td>
<td>Modern Organic Chemistry II</td>
<td>9</td>
</tr>
<tr>
<td>or 09-217</td>
<td>Organic Chemistry I</td>
<td>10</td>
</tr>
</tbody>
</table>

Required courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-105</td>
<td>Introduction to Modern Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>09-217</td>
<td>Organic Chemistry I</td>
<td>9</td>
</tr>
</tbody>
</table>

Total Biology units: 360

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 Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>or 03-151</td>
<td>Honors Modern Biology</td>
<td></td>
</tr>
<tr>
<td>03-220</td>
<td>Genetics</td>
<td>9</td>
</tr>
<tr>
<td>03-231/232</td>
<td>Biochemistry I</td>
<td>9</td>
</tr>
<tr>
<td>03-320</td>
<td>Cell Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-xxx</td>
<td>General Biology Elective</td>
<td>9</td>
</tr>
<tr>
<td>03-3xx</td>
<td>Advanced Biology Elective</td>
<td>9</td>
</tr>
</tbody>
</table>

Total Science units: 360

Distribution Requirements:

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

- Cognitive Psychology Category: 03-151, 03-161
- Musical Psychology Category: 85-211
- Developmental Neuroscience: 03-364
- Cognitive Psychology: 85-211
- Perception: 85-370
- Human Memory: 85-390
- Autism: Psychological and Neuroscience Perspectives: 85-406

*NOTE: 85-213 may be used instead of 85-211 when offered.
B.S. in Computational Biology

Students who entered CMU in Fall 2016 and earlier may pursue the Intercollege Bachelor of Science in Computational Biology joint program between the Mellon College of Sciences and the School of Computer Science. Degree requirements for this program can be found in the 2016-2017 catalog (http://coursecatalog.web.cmu.edu/previous). Interested students should contact Dr. Becki Campanaro (bcampana@andrew.cmu.edu) for more information.

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 Biology. For more information about this program, contact the Biological Sciences Graduate Programs Office (bio-gradoffice@andrew.cmu.edu).

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. This information is sometimes available in the course description, but more detail is often found in a course syllabus.


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.

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