

Department of Biological Sciences

Aaron P. Mitchell, Department Head
 Becki Campanaro, Assistant Department Head for Undergraduate Affairs
 Undergraduate Office: Doherty Hall 1321
<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 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.

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. degree in 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 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 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.

However, 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:

Biological Sciences		Units
03-151	Honors Modern Biology	10
or 03-121	Modern Biology	
03-201	Undergraduate Colloquium for Sophomores	2
03-220	Genetics	9
or 03-221	Genomes, Evolution, and Disease: Introduction to Quantitative Genetic Analysis	
03-231	Honors Biochemistry	9
03-250	Introduction to Computational Biology	12
03-320	Cell Biology	9
03-343	Experimental Techniques in Molecular Biology	12
03-344	Experimental Biochemistry	12
or 03-345	Experimental Cell and Developmental Biology	
or 03-346	Experimental Neuroscience	
03-411	Topics in Research	1
03-412	Topics in Research	1
03-xxx	Biological Sciences Electives ¹	54
Total Biology units		131

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

Mathematics, Physics and Computer Science		Units
02-201	Programming for Scientists	10
or 15-110	Principles of Computing	
or 15-112	Fundamentals of Programming and Computer Science	
21-120	Differential and Integral Calculus	10
21-124	Calculus II for Biologists and Chemists	10
or 21-122	Integration and Approximation	
33-121	Physics I for Science Students	12
or 33-141	Physics I for Engineering Students	
33-122	Physics II for Biological Sciences and Chemistry Students	9
or 33-142	Physics II for Engineering and Physics Students	

99-10x	Computing at Carnegie Mellon	3
Total Science units		54
Chemistry		Units
09-105	Introduction to Modern Chemistry I ²	10
or 09-107	Honors Chemistry: Fundamentals, Concepts and Applications	
09-106	Modern Chemistry II	10
09-217	Organic Chemistry I	9
or 09-219	Modern Organic Chemistry	
09-218	Organic Chemistry II	9
or 09-220	Modern Organic Chemistry II	
09-207	Techniques in Quantitative Analysis	9
or 09-221	Laboratory I: Introduction to Chemical Analysis	
09-208	Techniques for Organic Synthesis and Analysis	9
or 09-222	Laboratory II: Organic Synthesis and Analysis	
Total Chemistry units		56
Elective Units		Units
Free Electives		48
MCS Nontechnical Breadth Requirements		72
Total 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 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.

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.

Departmental Electives Group

03-117	Frontiers, Analysis, and Discovery in Biological Sciences	6
03-124	Modern Biology Laboratory	9
03-125	Evolution	9
03-126	Cellular Response to the Environment	4
03-127	How Biological Experiments Work - A Project Course	9
03-133	Neurobiology of Disease	9
03-161	Molecules to Mind	9
03-326	Evolution of Regulatory Genomics	4.5
03-327	Phylogenetics	9
03-350	Developmental Biology	9
03-362	Cellular Neuroscience	9
03-363	Systems Neuroscience	9
03-364	Developmental Neuroscience	9
03-365	Neural Correlates of Learning and Memory	9
03-366	Biochemistry of the Brain	9
03-370	Principles of Biotechnology	9

03-390	Molecular and Cellular Immunology	9
03-391	Microbiology	9
03-392	Microbiology Laboratory	6
03-428	Genome Editing Biotechnology	4.5
03-435	Cancer Biology	9
03-439	Introduction to Biophysics	9
03-442	Molecular Biology	9
03-445	Undergraduate Research	Var.
03-451	Advanced Developmental Biology and Human Health	9
03-511	Computational Molecular Biology and Genomics	9
03-512	Computational Methods for Biological Modeling and Simulation	9
03-534	Biological Imaging and Fluorescence Spectroscopy	9
03-545	Honors Research	9
03-620	Techniques in Electron Microscopy	9
03-711	Computational Molecular Biology and Genomics	12
03-712	Computational Methods for Biological Modeling and Simulation	12
03-713	Bioinformatics Data Integration Practicum	6
03-726	Evolution of Regulatory Genomics	6
03-727	Phylogenetics	12
03-728	Genome Editing Biotechnology	6
03-730	Advanced Genetics	12
03-740	Advanced Biochemistry	12
03-741	Advanced Cell Biology	12
03-742	Advanced Molecular Biology	12
03-744	Membrane Trafficking	9
03-751	Advanced Developmental Biology and Human Health	12
03-762	Advanced Cellular Neuroscience	12
03-763	Advanced Systems Neuroscience	12
03-765	Advanced Neural Correlates of Learning and Memory	12
03-770	Principles of Biotechnology	12
03-791	Advanced Microbiology	12
03-871	Structural Biophysics	12

Interdisciplinary Electives Group

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

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
09-535	Applied topics in Macromolecular and Biophysical Techniques	9
21-127	Concepts of Mathematics	10
21-259	Calculus in Three Dimensions	9
21-260	Differential Equations	9
36-200	Reasoning with Data	9
36-247	Statistics for Lab Sciences	9
42-202	Physiology	9
85-219	Biological Foundations of Behavior	9

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	12

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	9
03-363	Systems Neuroscience ⁷	9

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
03-364	Developmental Neuroscience	9
03-366	Biochemistry of the Brain	9
03-534	Biological Imaging and Fluorescence Spectroscopy	9
15-385	Introduction to Computer Vision	6
15-386	Neural Computation	9
42-202	Physiology	9
85-211	Cognitive Psychology	9
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/#bachelorofscienceinneurosciencetext>) 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 Dr. Becki Campanaro (DH 1320). More information can also be found on the CMU Neuroscience website (<http://www.cmu.edu/neuro>).

B.S. Biological Sciences and 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. Students in the joint Science and Humanities Scholars (SHS) program can complete the SHS educational core and choose either departmental order for their diploma.

Depending on a student's home college (DC or MCS), General Education (GenEd) requirements will be different. GenEd requirements for DC (<http://coursecatalog.web.cmu.edu/dietrichcollegeofhumanitiesandsocialsciences/#hampssgeneraleducationprogram160>) and MCS (<http://coursecatalog.web.cmu.edu/melloncollegeofscience>) are found on their respective Catalog pages.

Degree Requirements:

Biological Sciences	Units
03-151 Honors Modern Biology or 03-121 Modern Biology	10
03-220 Genetics or 03-221 Genomes, Evolution, and Disease: Introduction to Quantitative Genetic Analysis	9
03-231 Honors Biochemistry	9
03-320 Cell Biology	9
03-343 Experimental Techniques in Molecular Biology	12
03-411 Topics in Research	1
03-412 Topics in Research	1
03-xxx General Biology Elective ¹	9
03-3xx Advanced Biology Elective ¹	18
Total Biology units	78

¹ Please see description and requirements for electives under the B.S. in Biological Sciences section of this Catalog.

Mathematics, Statistics, Physics and Computer Science	Units
21-120 Differential and Integral Calculus	10
21-124 Calculus II for Biologists and Chemists or 21-122 Integration and Approximation	10
36-247 Statistics for Lab Sciences or 36-200 Reasoning with Data	9
36-309 Experimental Design for Behavioral & Social Sciences	9
33-121 Physics I for Science Students ² or 33-141 Physics I for Engineering Students	12
15-110 Principles of Computing or 15-112 Fundamentals of Programming and Computer Science or 02-201 Programming for Scientists	10-12
99-10x Computing at Carnegie Mellon	3
Total Science units	63-65

² MCS students must also complete 33-122 Physics II for Biological Sciences and Chemistry Students.

Chemistry	Units
09-105 Introduction to Modern Chemistry I	10
09-106 Modern Chemistry II	10
09-217 Organic Chemistry I	9

or 09-219 Modern Organic Chemistry	
09-218 Organic Chemistry II	9
or 09-220 Modern Organic Chemistry II	
09-207 Techniques in Quantitative Analysis	9-12
or 09-221 Laboratory I: Introduction to Chemical Analysis	
09-208 Techniques for Organic Synthesis and Analysis	9-12
or 09-222 Laboratory II: Organic Synthesis and Analysis	

Total Chemistry units 56-62

Psychology Courses	Units
85-102 Introduction to Psychology	9
85-219 Biological Foundations of Behavior	9
85-2xx Survey Psychology Courses *	18
85-310 Research Methods in Cognitive Psychology or 85-340 Research Methods in Social Psychology or 85-320 Research Methods in Developmental Psychology or 85-314 Cognitive Neuroscience Research Methods or 85-330 Analytic Research Methods	9
85-3xx Advanced Psychology Electives	18
Total Psychology units	63

* Excluding 85-261 Abnormal Psychology

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	Units
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

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:

Biological Sciences	Units
03-151 Honors Modern Biology or 03-121 Modern Biology	10
03-201 Undergraduate Colloquium for Sophomores	2
03-220 Genetics or 03-221 Genomes, Evolution, and Disease: Introduction to Quantitative Genetic Analysis	9
03-231 Honors Biochemistry	9
03-320 Cell Biology	9
03-343 Experimental Techniques in Molecular Biology or 03-124 Modern Biology Laboratory	9-12
03-411 Topics in Research	1
03-412 Topics in Research	1
03-xxx General Biology Electives ⁸	18

03-3xx	Advanced Biology Electives ⁸	18
Total Biology units		86-89

⁸ Please see description and requirements for electives under the B.S. in Biological Sciences section of this Catalog.

Chemistry	Units	
09-105 Introduction to Modern Chemistry I ⁹	10	
or 09-107 Honors Chemistry: Fundamentals, Concepts and Applications		
09-106 Modern Chemistry II	10	
09-217 Organic Chemistry I	9	
or 09-219 Modern Organic Chemistry		
09-218 Organic Chemistry II	9	
or 09-220 Modern Organic Chemistry II		
09-207 Techniques in Quantitative Analysis	9-12	
or 09-221 Laboratory I: Introduction to Chemical Analysis		
Total Chemistry units		47-50

⁹ Students who complete 09-107 with an A grade will be exempted from the requirement to take 09-106 Modern Chemistry II.

Mathematics, Physics, and Computer Science	Units	
02-201 Programming for Scientists	10	
or 15-110 Principles of Computing		
or 15-112 Fundamentals of Programming and Computer Science		
21-120 Differential and Integral Calculus	10	
21-124 Calculus II for Biologists and Chemists	10	
or 21-122 Integration and Approximation		
33-121 Physics I for Science Students	12	
or 33-141 Physics I for Engineering Students		
33-122 Physics II for Biological Sciences and Chemistry Students	9	
or 33-142 Physics II for Engineering and Physics Students		
99-10x Computing at Carnegie Mellon	3	
Total Science units		54
Elective courses		Units
MCS Nontechnical Breadth Requirements		72
Free Electives		96-99
Total Elective units		168-171

360 Minimum number of units required for degree:

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:	Units
09-105 Introduction to Modern Chemistry I	10
09-217 Organic Chemistry I	9
Required courses:	
03-121 Modern Biology	9
or 03-151 Honors Modern Biology	
03-220 Genetics	9
or 03-221 Genomes, Evolution, and Disease: Introduction to Quantitative Genetic Analysis	
03-231 Honors Biochemistry	9
or 03-232 Biochemistry I	
03-320 Cell Biology	9
03-xxx General Biology Elective	9
03-3xx Advanced Biology Elective	9

73 Minimum number of units required for the Minor in Biological Sciences:

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):

	Units
03-121 Modern Biology	9
or 03-151 Honors Modern Biology	
03-362 Cellular Neuroscience	9
03-363 Systems Neuroscience	9
85-219 Biological Foundations of Behavior	9
or 03-161 Molecules to Mind	

Distribution Requirements:

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

Approaches to Neuroscience Category	Units
15-386 Neural Computation	9
15-883 Computational Models of Neural Systems	12
85-412 Cognitive Modeling	9
85-414 Cognitive Neuropsychology	9
85-419 Introduction to Parallel Distributed Processing	9
85-429 Cognitive Brain Imaging	9
Cognitive Neuroscience Category	
03-133 Neurobiology of Disease	9
03-364 Developmental Neuroscience	9
85-211 Cognitive Psychology*	9
85-356 Music and Mind: The Cognitive Neuroscience of Sound	9
85-370 Perception	9
85-390 Human Memory	9
85-406 Autism: Psychological and Neuroscience Perspectives	9

*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.
2. The textbook used in the transfer course should be at a comparable level to S. Freeman (2010) "Biological Science, Vol. 1 (The Cell, Genetics, and Development)," Fourth Edition, Pearson Benjamin Cummings, ISBN 0-321-61347-3.
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

NESRINE AFFARA, Assistant Teaching Professor, Carnegie Mellon-Qatar – Ph.D., The Ohio State University; Carnegie Mellon, 2006–

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

MOHAMED BOUAOUINA, Assistant Teaching Professor, Carnegie Mellon-Qatar – Ph.D., Carnegie Mellon, 2013–

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

MAGGIE BRAUN, Associate 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–

AMY L. BURKERT, Teaching Professor and Vice Provost for Education – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1997–

BECKI M. CAMPANARO, Assistant Teaching Professor and Assistant Department Head for Undergraduate Affairs – Ph.D., Arizona State University; Carnegie Mellon, 2015–

JASON M. D'ANTONIO, Assistant Teaching Professor and Director of the Health Professions Program – Ph.D., University of Pittsburgh School of Medicine; Carnegie Mellon, 2013–

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

EMILY DRILL, Assistant Teaching Professor – Ph.D., University of Pittsburgh; Carnegie Mellon, 2012–

M. DANNIE DURAND, Associate Professor – Ph.D., Columbia University; Carnegie Mellon, 2000–

CHARLES A. ETTENSOHN, Professor – Ph.D., Yale University; Carnegie Mellon, 1987–

ARYN GITTIS, Associate Professor – Ph.D., University of California, San Diego; Carnegie Mellon, 2012–

N. LUISA HILLER, Associate Professor – Ph.D., Northwestern University Medical School; Carnegie Mellon, 2012–

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

KENNETH HOVIS, Associate Teaching Professor and Assistant Dean for Educational Initiatives for MCS – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2011–

VALENTIN ILYIN, Associate Teaching Professor of Computational Biology at CMU-Qatar – Ph.D., Carnegie Mellon, 2012–

JONATHAN W. JARVIK, Associate Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1978–

SANDRA KUHLMAN, Associate Professor – Ph.D., University of Kentucky; Carnegie Mellon, 2012–

FREDERICK LANNI, Associate Professor – Ph.D., Harvard University; Carnegie Mellon, 1982–

CHRISTINA H. LEE, Associate Professor – Ph.D., University of California, San Francisco; Carnegie Mellon, 2000–

ADAM D. LINSTEDT, Professor – Ph.D., University of California, San Francisco; Carnegie Mellon, 1995–

A. JAVIER LOPEZ, Associate Professor – Ph.D., Duke University; Carnegie Mellon, 1989–

BROOKE M. MCCARTNEY, Associate Professor – Ph.D., Duke University; Carnegie Mellon, 2003–

NATALIE M. MCGUIER, Assistant Teaching Professor – Ph.D., Medical University of South Carolina; Carnegie Mellon, 2015–

C. JOEL MCMANUS, Associate Professor – Ph.D., University of Wisconsin-Madison; Carnegie Mellon, 2011–

JONATHAN S. MINDEN, Professor – Ph.D., Albert Einstein College of Medicine; Carnegie Mellon, 1990–

AARON P. MITCHELL, Professor and Department Head – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2008–

ROBERT F. MURPHY, Professor of Biological Sciences and Department Head of Computational Biology – Ph.D., California Institute of Technology; Carnegie Mellon, 1983–

GORDON S. RULE, Professor and Associate Dean for Research, Carnegie Mellon-Qatar – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1996–

RUSSELL S. SCHWARTZ, Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2002–

ANNETTE VINCENT, Assistant Teaching Professor, Carnegie Mellon-Qatar – Ph.D., National University of Singapore; Carnegie Mellon, 2012–

JOHN L. WOOLFORD JR., Professor and Co-Director of CNASt – Ph.D., Duke University; Carnegie Mellon, 1979–

STEPHANIE WONG-NOONAN, Assistant Teaching Professor – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2016–

IHAB YOUNIS, Assistant Teaching Professor, Carnegie Mellon-Qatar – Ph.D., The Ohio State University; Carnegie Mellon, 2005–

ERIC YTTRI, Assistant Professor – Ph.D., Washington University in St. Louis; Carnegie Mellon, 2017–

YONGXIN ZHAO, Assistant Professor – Ph.D., University of Alberta; Carnegie Mellon, 2017–

Affiliated Faculty

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

ZIV BAR-JOSEPH, Associate Professor of Computer Science and Machine Learning – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2003–

PHIL G. CAMPBELL, Research Professor at the Institute for Complex Engineering Systems – Ph.D., Pennsylvania State University; Carnegie Mellon, 1999–

PHILLIP COMPEAU, Assistant Teaching Professor – Ph.D., University of California-San Diego; Carnegie Mellon, 2015–

KRIS DAHL, Associate Professor of Biomedical Engineering – Ph.D., University of Pennsylvania; Carnegie Mellon, 2006–

WILLIAM F. EDDY, Professor of Statistics – Ph.D., Yale University; Carnegie Mellon, 1976–

ALEX EVILEVITCH, Associate Professor of Physics – Ph.D., Lund University; Carnegie Mellon, 2009–

YONG FAN, Adjunct Associate Professor and Principal Investigator at Institute of Cellular Therapeutics - Allegheny Health Network – Ph.D., University of Pittsburgh; Carnegie Mellon, 1999–

NICK GIANNOUKAKIS, Adjunct Associate Professor and Principal Investigator at Institute of Cellular Therapeutics - Allegheny Health Network – Ph.D., McGill University in Montreal; Carnegie Mellon, 1997–

T.D. JACOBSEN, Assistant Director and Principal Research Scientist at the Hunt Institute for Botanical Documentation – Ph.D., Washington State University; Carnegie Mellon, 1979–

ROBERT W. KIGER, Distinguished Service Professor and Botany Professor and the History of Science Director and Principal Research Scientist for the Hunt Institute for Botanical Documentation – Ph.D., University of Maryland; Carnegie Mellon, 1974–

CARLETON L. KINGSFORD, Associate Professor of Computational Biology – Ph.D., Princeton University; Carnegie Mellon, 2005–

CHRISTOPHER J. LANGMEAD, Associate Assistant Professor of Computational Biology – Ph.D., Dartmouth College; Carnegie Mellon, 2004–

PHILIP R. LEDUC, Professor of Mechanical Engineering – Ph.D., The Johns Hopkins University; Carnegie Mellon, 2002–

CARL R. OLSON, Professor of the CNBC – Ph.D., University of California, Berkeley; Carnegie Mellon, 1996–

ANDREAS R PFENNING, Assistant Professor of Computational Biology – Ph.D., Duke University ; Carnegie Mellon, 2016–

ALAN J. RUSSELL, Professor of Chemical Engineering and Director of Disruptive Health Technology Institute – Ph.D., Imperial College of Science and Technology, University of London; Carnegie Mellon, 1987–

FREDERICK H. UTECH, Principal Research Scientist at the Hunt Institute for Botanical Documentation – Ph.D., Washington University; Carnegie Mellon, 1977–

ERIC P. XING, Associate Professor of Computer Science, Language Technologies Institute, and Machine Learning – Ph.D., University of California, Berkeley; Carnegie Mellon, 2004–

GE YANG, Assistant Professor of Biomedical Engineering and the Lane Center for Computational Biology – Ph.D., University of Minnesota, Twin Cities; Carnegie Mellon, 2010–

Adjunct Faculty

RITA BOTTINO, Adjunct Associate Professor and Principal Investigator at Institute of Cellular Therapeutics - Allegheny Health Network – Ph.D. , University of Genova; Carnegie Mellon, 1990–

JON W. JOHNSON, Professor of Neuroscience at the University of Pittsburgh – Ph.D., Stanford University; Carnegie Mellon, 2006–

KARL KANDLER, Professor of Otolaryngology and Neurobiology at the University of Pittsburgh – Ph.D., University of Tübingen, Germany; Carnegie Mellon, 2006–

CYNTHIA LANCE-JONES, Associate Professor of Neurobiology at the University of Pittsburgh – Ph.D., University of Massachusetts; Carnegie Mellon, 2006–

CYNTHIA M. MORTON, Associate Curator and Head of Botany at the Carnegie Museum of Natural History – Ph.D., New York Botanical Garden/CUNY; Carnegie Mellon, 2002–

PETER L. STRICK, Co-Director of CNBC and Distinguished Professor of Neurobiology at the University of Pittsburgh – Ph.D., University of Pennsylvania; Carnegie Mellon, 2000–

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

EDDA THIELS, Assistant Professor of Neurobiology at the University of Pittsburgh – Ph.D., Indiana University; Carnegie Mellon, 2006–

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

NATHAN URBAN, Professor and Vice Chair, Neurobiology, University of Pittsburgh – Ph.D., University of Pittsburgh ; Carnegie Mellon, 1998–

KARL WILLIAMS, Adjunct Professor of Otolaryngology and Neurobiology - University of Pittsburgh – M.D., University of Pittsburgh School of Medicine ; Carnegie Mellon, 1974–

Emeriti Faculty

PETER B. BERGET, Professor Emeritus – Ph.D., University of Minnesota; Carnegie Mellon, 1986–

ERIC W. GROTZINGER, Teaching Professor Emeritus – Ph.D., University of Pittsburgh; Carnegie Mellon, 1979–

DAVID D. HACKNEY, Professor Emeritus – Ph.D., University of California, Berkeley; Carnegie Mellon, 1978–

CHIEN HO, Professor Emeritus – Ph.D., Yale University; Carnegie Mellon, 1979–

LINDA R. KAUFFMAN, Teaching Professor Emeritus – Ph.D., University of Pittsburgh; Carnegie Mellon, 1977–

WILLIAM R. MCCLURE, Professor Emeritus – Ph.D., University of Wisconsin; Carnegie Mellon, 1981–

JOHN F. NAGLE, Professor Emeritus – Ph.D., Yale University; Carnegie Mellon, 1967–

ALAN S. WAGGONER, Professor Emeritus – Ph.D., University of Oregon; Carnegie Mellon, 1999–

JAMES F. WILLIAMS, Professor Emeritus – Ph.D., University of Toronto; Carnegie Mellon, 1976–

C. ROY WORTHINGTON, Professor Emeritus – Ph.D., Adelaide University; Carnegie Mellon, 1969–