

Computational Biology

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

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

Standard program for the A.B. degree

Please see the bottom of the page for more information regarding the University Writing Requirement, the Capstone Experience, and the Computational Biology Honors Program.

Standard program for the A.B. degree

Please review the footnotes for clarifying details and see the bottom of the page for more information regarding the Capstone Experience and the Computational Biology Honors Program.

Prerequisites (0-3 courses)

Students must complete or place out of these prerequisites.

MATH 0100	Single Variable Calculus, Part II
or MATH 0170	Single Variable Calculus, Part II (Accelerated)
APMA 0260	Linear Algebra and Multivariable Calculus for Applied Mathematicians ¹
or MATH 0180	Multivariable Calculus
or MATH 0200	Multivariable Calculus (Physics/Engineering)
or MATH 0350	Multivariable Calculus With Theory
BIOL 0200	The Foundation of Living Systems

General Core Requirements: Biology 2

BIOL 0470	Genetics
BIOL 0280	Biochemistry
or BIOL 0500	Cell and Molecular Biology

General Core Requirements: Chemistry 1

CHEM 0330	Equilibrium, Rate, and Structure
or CHEM 0350	Organic Chemistry I

General Core Requirements: Computer Science 2

Choose one of the following groupings of introductory courses:

Group A	
CSCI 0111 & CSCI 0200	Computing Foundations: Data and Program Design with Data Structures and Algorithms

Group B	
CSCI 0150 & CSCI 0200	Introduction to Object-Oriented Programming and Computer Science and Program Design with Data Structures and Algorithms

Group C	
CSCI 0170 & CSCI 0200	Computer Science: An Integrated Introduction and Program Design with Data Structures and Algorithms

Group D	
CSCI 0190 & CSCI 0200	Accelerated Introduction to Computer Science and Program Design with Data Structures and Algorithms (or any full-credit computer science course above CSCI 0190)

General Core Requirements: Probability & Statistics² 1

APMA 1650	Introduction to Probability and Statistics with Calculus
or APMA 1655	Introduction to Probability and Statistics with Theory
or CSCI 1450	Advanced Introduction to Probability for Computing and Data Science
or MATH 1210	Probability

Comp Bio Core Course Requirements 4

CSCI 1810	Computational Molecular Biology
APMA 1080	Inference in Genomics and Molecular Biology ²

AND two of the following:

APMA 1070	Quantitative Models of Biological Systems
APMA 1660	Statistical Inference II
APMA 1690	Computational Probability and Statistics
BIOL 1222A	Current Topics in Functional Genomics
BIOL 1430	Foundations of Population Genetics
BIOL 1435	Computational Methods for Studying Demographic History with Molecular Data
BIOL 1525	Pathogenomics: Analysis, interpretation and applications of microbial genomes
BIOL 1545	Human Genetics and Genomics
BIOL 1555	Methods in Informatics and Data Science for Health

BIOL 1575	Evaluation of Health Information Systems
CSCI 1420	Machine Learning
CSCI 1470	Deep Learning
CSCI 1820	Algorithmic Foundations of Computational Biology

PHP 1510	Principles of Biostatistics and Data Analysis
PHP 1560	Using R for Data Analysis

Additional 1000+ level course with concentration advisor approval

Capstone Experience 1

Students enrolled in the computational biology concentration will complete a research project in their senior year under faculty supervision (i.e: BIOL 1950/1960, CSCI 1970, APMA 1970). The themes of such projects evolve with the field and the technology, but should represent a synthesis of the various specialties of the program. The requirements are either one semester of reading and research with a CCMB Faculty member or approved advisor resulting in an advanced research project or a 2000-level Computational Biology course that covers an advanced topic within the Computational Biology field and includes an advanced research component.³

Total Credits 11

¹ These courses are prerequisites for APMA 1655. Students who matriculate in or after Fall 2025 will be required to take APMA 1655 as a prerequisite for APMA 1080 and will therefore need to complete or place out of one of these courses.

² APMA 1655 will be a prerequisite for APMA 1080 starting in Fall 2025. Current concentrators (as of Spring 2025) may still take APMA 1080 with APMA 1650 as their prerequisite but APMA 1655 is encouraged. Students matriculating in Fall 2025 or later will need to take APMA 1655 before taking APMA 1080.

³ Some 2000-level courses are not available to undergraduate students due to department restrictions but have 1000-level equivalents (such as BIOL 1545/2545) that can count for capstone credit with approval from

the instructor and the student's faculty advisor. Please reach out to the CCMB Academic Programs Coordinator for more information.

Capstone Experience:

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Honors:

In order to be considered a candidate for honors, students will be expected to maintain an outstanding record. Students must have a majority of either As or S with distinction grades in concentration courses. In addition, students should take at least one semester, and are strongly encouraged to take 2 semesters semesters, of reading and research with a CCMB faculty member or approved advisor. In addition, students should take at least one semester, and are strongly encouraged to take 2 semesters of reading and research with a CCMB faculty member or approved advisor.

Students seeking honors are advised to choose a Thesis Advisor prior to the end of their Junior year. Students must complete the Comp Bio Honors Registration form (<https://docs.google.com/forms/d/e/1FAIpQLSe5jZSIwNdZqCFOWTPVQN7PQUM1aMmrZOOdLxox9DVuCjkDz/viewform/>) and submit their honors proposal to ccmb@brown.edu by the first Friday in October of their senior year. Students must submit a honors thesis in April of their senior year and present a public defense of their theses to the CCMB community. More information about the honors guidelines and deadlines can be found here: <https://ccmb.brown.edu/academics/undergraduate-program/honors-designation>. Any deviation from these rules must be approved by the director of undergraduate studies, in consultation with the student's advisor.

Standard program for the Sc.B. degree

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Prerequisites (0-3 courses)

Students must complete or place out of these prerequisites.

MATH 0100	Single Variable Calculus, Part II (or equivalent)
or MATH 0170	Single Variable Calculus, Part II (Accelerated)
APMA 0260	Linear Algebra and Multivariable Calculus for Applied Mathematicians ¹
or MATH 0180	Multivariable Calculus
or MATH 0200	Multivariable Calculus (Physics/Engineering)
or MATH 0350	Multivariable Calculus With Theory
BIOL 0200	The Foundation of Living Systems (or equivalent)

General Core Course Requirements: Biology		2
BIOL 0470	Genetics (prerequisite BIOL 0200 or equivalent)	
BIOL 0280	Biochemistry	
or BIOL 0500	Cell and Molecular Biology	

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

General Core Requirements: Computer Science		3
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CSCI 0220	Introduction to Discrete Structures and Probability	
AND complete one of the following groupings of introductory courses:		
Group A		
CSCI 0111 & CSCI 0200	Computing Foundations: Data and Program Design with Data Structures and Algorithms	
Group B		
CSCI 0150 & CSCI 0200	Introduction to Object-Oriented Programming and Computer Science and Program Design with Data Structures and Algorithms	
Group C		
CSCI 0170 & CSCI 0200	Computer Science: An Integrated Introduction and Program Design with Data Structures and Algorithms	
Group D		
CSCI 0190 & CSCI 0200	Accelerated Introduction to Computer Science and Program Design with Data Structures and Algorithms (or any full-credit computer science course above CSCI 0190)	
General Core Requirements: Probability & Statistics ²		1
APMA 1650	Introduction to Probability and Statistics with Calculus	
or APMA 1655	Introduction to Probability and Statistics with Theory	
or CSCI 1450	Advanced Introduction to Probability for Computing and Data Science	
or MATH 1210	Probability	
General Core Requirements: Computational Biology		2
APMA 1080	Inference in Genomics and Molecular Biology ²	
CSCI 1810	Computational Molecular Biology	
Six Courses in One Track		6
Choose one of 3 tracks: Computer Science, Biological Sciences, or Applied Mathematics and Statistics. See track requirements below.		
Capstone Experience		1
Students enrolled in the computational biology concentration will complete a research project in their senior year under faculty supervision (i.e: BIOL 1950/1960, CSCI 1970, APMA 1970). The themes of such projects evolve with the field and the technology, but should represent a synthesis of the various specialties of the program. The requirements are either one semester of reading and research with a CCMB Faculty member or approved advisor resulting in an advanced research project or a 2000-level Computational Biology course that covers an advanced topic within the Computational Biology field and includes an advanced research component. ³		
Total Credits		16

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³ Some 2000-level courses are not available to undergraduate students due to department restrictions but have 1000-level equivalents (such as

BIOL 1545/2545) that can count for capstone credit with approval from the instructor and the student's faculty advisor. Please reach out to the CCMB Academic Programs Coordinator for more information.

Tracks

Please review the prerequisites required for the courses below in CAB. Students should also be aware of the requirements for enrolling in a given CSCI course, which can be found on the Computer Science website.

Computer Science Track:

Three of the following: 3

CSCI 1230	Introduction to Computer Graphics
CSCI 1270	Database Management Systems
CSCI 1411	Foundations of AI
CSCI 1420	Machine Learning
CSCI 1430	Computer Vision
CSCI 1470	Deep Learning
CSCI 1820	Algorithmic Foundations of Computational Biology
CSCI 2952G	Deep Learning in Genomics
or other 1000+ level Computer Science course approved by the concentration advisor.	

Three of the following: 3

APMA 1070	Quantitative Models of Biological Systems
APMA 1660	Statistical Inference II
APMA 1690	Computational Probability and Statistics
BIOL 1430	Foundations of Population Genetics
BIOL 1435	Computational Methods for Studying Demographic History with Molecular Data
BIOL 1555	Methods in Informatics and Data Science for Health
CPSY 1492	Computational Cognitive Neuroscience
CSCI 0320 & CSCI 0330	Introduction to Software Engineering and Introduction to Computer Systems ¹
CSCI 1550	Probabilistic Methods in Computer Science
CSCI 1570	Design and Analysis of Algorithms
PHP 1510	Principles of Biostatistics and Data Analysis
PHP 1560	Using R for Data Analysis
or another 1000+ level computational course approved by the concentration advisor.	

Total Credits 6

¹ Both CSCI 0320 and CSCI 0330 need to be taken to fulfill one of the six course requirements in this track.

Biological Sciences track

At least four 1000+ level courses comprising a coherent theme related to Computational Biology. Examples of themes include: Biochemistry, Ecology, Evolution, Genomics, Immunology, or Neurobiology. Other themes can be approved by your concentration advisor. 4

AND two courses from the following: 2

APMA 1660	Statistical Inference II
APMA 1690	Computational Probability and Statistics
BIOL 1222A	Current Topics in Functional Genomics
BIOL 1250	Host-microbiome Interactions in Health and Disease
BIOL 1430	Foundations of Population Genetics
BIOL 1435	Computational Methods for Studying Demographic History with Molecular Data

BIOL 1525	Pathogenomics: Analysis, interpretation and applications of microbial genomes
CSCI 1420	Machine Learning
CSCI 1470	Deep Learning
CSCI 1820	Algorithmic Foundations of Computational Biology
PHP 1560	Using R for Data Analysis
or other 1000+ level Computational Biology course approved by concentration advisor.	

Total Credits 6

Applied Mathematics & Statistics Track:

At least three courses from the following: 3

APMA 0350 & APMA 0360	Applied Ordinary Differential Equations and Applied Partial Differential Equations ¹
APMA 1070	Quantitative Models of Biological Systems
APMA 1660	Statistical Inference II
APMA 1690	Computational Probability and Statistics
APMA 1740	Recent Applications of Probability and Statistics
PHP 1510	Principles of Biostatistics and Data Analysis
PHP 1560	Using R for Data Analysis

At least three of the following: 3

BIOL 1222A	Current Topics in Functional Genomics
BIOL 1430	Foundations of Population Genetics
BIOL 1435	Computational Methods for Studying Demographic History with Molecular Data
BIOL 1555	Methods in Informatics and Data Science for Health
CSCI 1411	Foundations of AI
CSCI 1420	Machine Learning
CSCI 1470	Deep Learning
CSCI 1820	Algorithmic Foundations of Computational Biology
PHP 1855	Infectious Disease Modeling
or other 1000+ level Computational Biology course approved by concentration advisor.	

Total Credits 6

¹ Students must take both courses in this set (APMA 0350 & APMA 0360) to fulfill one of the six course requirements.

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