## 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

**Prerequisites:**
- MATH 0100   Introductory Calculus, Part II  
  or MATH 0170 Advanced Placement Calculus  
  or MATH 0170  
- BIOL 0200  The Foundation of Living Systems  

**General Core Requirements: Biology**
- BIOL 0470  Genetics
- BIOL 0280 Introductory Biochemistry
  or BIOL 0500  Cell and Molecular Biology

**General Core Requirements: Chemistry**
- CHEM 0330  Equilibrium, Rate, and Structure
  or CHEM 0350  Organic Chemistry

**General Core Requirements: Computer Science**
- CSCI 0150  Introduction to Object-Oriented Programming and
  & CSCI 0160  Computer Science
  and Introduction to Algorithms and Data Structures  
  OR
- CSCI 0170  Computer Science: An Integrated Introduction
  & CSCI 0180  Computer Science: An Integrated Introduction
  OR
- CSCI 0190  Accelerated Introduction to Computer Science
  & CSCI 0180  Computing Science: An Integrated Introduction
  & CSCI 0320  Introduction to Software Engineering
  & CSCI 0330  Introduction to Computer Systems
  & CSCI 0510  Models of Computation

**General Core Requirements: Probability & Statistics**
- APMA 1650  Statistical Inference I
  OR
- CSCI 1450  Probability and Computing
  OR
- MATH 1610  Probability

**Comp Bio Core Course Requirements**
- CSCI 1810  Computational Molecular Biology
- APMA 1080  Inference in Genomics and Molecular Biology

AND two of the following:
- CSCI 1820  Algorithmic Foundations of Computational Biology
- BIOL 1430  Computational Theory of Molecular Evolution and Population Genetics
- BIOL 1465  Human Population Genomics
- CSCI 1420  Machine Learning
- APMA 1690  Computational Probability and Statistics
- APMA 1660  Statistical Inference II

**University Writing Requirement:**
- Taking a "WRIT" course in the final two years
- Writing an Honors Thesis
- Taking a "WRIT" course in the final two years

**Capstone Experience**

Students enrolled in the computational biology concentration will complete a research project in their senior year under faculty supervision. The themes of such projects evolve with the field and the technology, but should represent a synthesis of the various specialties of the program. The requirements are either one semester of reading and research with a CCMB Faculty member or approved advisor, or a 2000-level Computational Biology course.

**Total Credits**

### Standard program for the Sc.B. degree

**Prerequisites**
- MATH 0100  Introductory Calculus, Part II  
  or MATH 0170 Advanced Placement Calculus
- BIOL 0200  The Foundation of Living Systems  

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

**General Core Requirements: Chemistry**
- CHEM 0330  Equilibrium, Rate, and Structure
  or CHEM 0350  Organic Chemistry

**General Core Requirements: Computer Science**
- CSCI 0150  Introduction to Object-Oriented Programming and
  & CSCI 0160  Computer Science
  and Introduction to Algorithms and Data Structures  
  OR
- CSCI 0170  Computer Science: An Integrated Introduction
  & CSCI 0180  Computer Science: An Integrated Introduction
  OR
- CSCI 0190  Accelerated Introduction to Computer Science
  & CSCI 0180  Computing Science: An Integrated Introduction
  & CSCI 0320  Introduction to Software Engineering
  & CSCI 0330  Introduction to Computer Systems
  & CSCI 0220  Introduction to Discrete Structures and Probability

**General Core Requirements: Probability & Statistics**
- APMA 1650  Statistical Inference I
  or CSCI 1450  Probability and Computing
  or MATH 1610  Probability

**General Core Requirements: Computational Biology**
- CSCI 1810  Computational Molecular Biology
- APMA 1080  Inference in Genomics and Molecular Biology

**Capstone Experience**
- BIOL 1950/1960  Directed Research/Independent Study
- CSCI 1970  Individual Independent Study

**Six courses in one of the following three tracks:**

### Computer Science Track:

Three of the following:
- CSCI 1230  Introduction to Computer Graphics
- CSCI 1270  Database Management Systems
- CSCI 1410  Applied Artificial Intelligence
- CSCI 1550  Probability and Computing: Randomized Algorithms and Probabilistic Analysis
- CSCI 1570  Design and Analysis of Algorithms

As part of Brown’s writing requirement, all students must demonstrate that they have worked on their writing both in their general studies and their concentration. There are a number of ways for Computational Biology concentrators to fulfill these requirements:

- Writing an Honors Thesis
- Taking a “WRIT” course in the final two years

### Total Credits

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 0100 Introductory Calculus, Part II</td>
<td>2</td>
</tr>
<tr>
<td>or MATH 0170 Advanced Placement Calculus</td>
<td></td>
</tr>
<tr>
<td>BIOL 0200 The Foundation of Living Systems</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td>12</td>
</tr>
</tbody>
</table>
or other Computer Science courses approved by the concentration advisor.

Three of the following:

- CSCI 0330 Introduction to Computer Systems
- or CSCI 0320 Introduction to Software Engineering
- CSCI 1820 Algorithmic Foundations of Computational Biology
- PHP 2620 Statistical Methods in Bioinformatics, I
- APMA 1660 Statistical Inference II
- BIOL 1430 Computational Theory of Molecular Evolution and Population Genetics
- BIOL 1465 Human Population Genomics
- APMA 1690 Computational Probability and Statistics

**Biological Sciences track**

At least four courses comprising a coherent theme in one of the following areas: Biochemistry, Ecology, Evolution, or Neurobiology.

AND select two courses from the following:

- CSCI 1820 Algorithmic Foundations of Computational Biology
- PHP 2620 Statistical Methods in Bioinformatics, I
- APMA 1660 Statistical Inference II
- BIOL 1430 Computational Theory of Molecular Evolution and Population Genetics
- BIOL 1465 Human Population Genomics
- APMA 1690 Computational Probability and Statistics

**Applied Mathematics & Statistics Track:**

At least three courses from the following:

- APMA 1660 Statistical Inference II
- APMA 1690 Computational Probability and Statistics
- CSCI 1410 Applied Artificial Intelligence
- APMA 0340 Methods of Applied Mathematics I, II
  & APMA 0330 and Methods of Applied Mathematics I, II

OR

- APMA 0360 Applied Partial Differential Equations I
  & APMA 0350 and Applied Ordinary Differential Equations

At least three of the following:

- BIOL 1430 Computational Theory of Molecular Evolution and Population Genetics
- CSCI 1820 Algorithmic Foundations of Computational Biology
- PHP 2620 Statistical Methods in Bioinformatics, I
- APMA 1070 Quantitative Models of Biological Systems
- BIOL 1465 Human Population Genomics

**Total Credits** 18-20

**Honors:**

In order to be considered a candidate for honors, students will be expected to maintain an outstanding record, with no "C's" in concentration courses and with a minimum of an "A-" average in concentration courses. In addition, students should take at least one semester, and are strongly encouraged to take 2 semesters, of reading and research with a CCMB faculty member or approved advisor. Students must submit to a public defense of their theses to be open to the CCMB community.

- Students seeking honors are advised to choose a Thesis Advisor prior to the end of their Junior year
- Students must complete the Registration form for Comp Bio and submit it to CCMB@BROWN.EDU

Any deviation from these rules must be approved by the director of undergraduate studies, in consultation with the student's advisor.
Font Notice

This document should contain certain fonts with restrictive licenses. For this draft, substitutions were made using less legally restrictive fonts. Specifically:

Helvetica was used instead of Arial.

The editor may contact Leepfrog for a draft with the correct fonts in place.