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
- 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 Computer Science
- & CSCI 0160 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 Computer Science: An Integrated Introduction
- & CSCI 0320 and Introduction to Software Engineering
- & CSCI 0330 and Introduction to Computer Systems
- & CSCI 0510 and 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
- Additional course with Director approval

Total Credits: 12

University Writing Requirement:
- 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

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.

Standard program for the Sc.B. degree

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

General Core Course Requirements: Biology
- CSCI 0150 Introduction to Object-Oriented Programming and Computer Science
- & CSCI 0160 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 Computer Science: An Integrated Introduction
- & CSCI 0320 and Introduction to Software Engineering
- & CSCI 0330 and Introduction to Computer Systems
- & CSCI 0510 and Models of Computation

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

General Core Requirements: Computer Science
- CSCI 0150 Introduction to Object-Oriented Programming and 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 Computer Science: An Integrated Introduction
- & CSCI 0320 and Introduction to Software Engineering
- & CSCI 0330 and Introduction to Computer Systems
- & CSCI 0510 and Models of Computation

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 Directed Research/Independent Study
- 1950/1960
- 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
or other Computer Science courses approved by the concentration advisor.

Three of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>CSCI 0330</td>
<td>Introduction to Computer Systems</td>
</tr>
<tr>
<td>or CSCI 0320</td>
<td>Introduction to Software Engineering</td>
</tr>
<tr>
<td>CSCI 1820</td>
<td>Algorithmic Foundations of Computational Biology</td>
</tr>
<tr>
<td>PHP 2620</td>
<td>Statistical Methods in Bioinformatics, I</td>
</tr>
<tr>
<td>APMA 1660</td>
<td>Statistical Inference II</td>
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<td>BIOL 1430</td>
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<td>Human Population Genomics</td>
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<td>APMA 1690</td>
<td>Computational Probability and Statistics</td>
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**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:

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**Applied Mathematics & Statistics Track:**

At least three courses from the following:

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<tr>
<td>APMA 1690</td>
<td>Computational Probability and Statistics</td>
</tr>
<tr>
<td>CSCI 1410</td>
<td>Applied Artificial Intelligence</td>
</tr>
<tr>
<td>APMA 0340</td>
<td>Methods of Applied Mathematics I, II</td>
</tr>
<tr>
<td>&amp; APMA 0330</td>
<td>and Methods of Applied Mathematics I, II</td>
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<td>OR</td>
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<tr>
<td>APMA 0360</td>
<td>Methods of Applied Mathematics I, II</td>
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<tr>
<td>&amp; APMA 0350</td>
<td>and Applied Ordinary Differential Equations</td>
</tr>
</tbody>
</table>

At least three of the following:

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

**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.