Requirements for Ph.D. Program(s) in Computational Molecular Biology

Updated: May 2015

1. Prerequisites for Admission:
The program will have the following prerequisites: mathematics through intermediate calculus, linear algebra and discrete mathematics, demonstrated programming skill, and at least one undergraduate course in chemistry and in molecular biology.

2. Foundations
Students in this program must achieve mastery in three areas — computational science, molecular biology, and probability and statistical inference — through a common core of studies that spans and integrates these areas. Admitted students are expected to have an academic background commensurate with that of our Computational Biology undergraduate degree, established in 1996 and widely recognized in the computational biology community. Table 2 details the core requirements for our undergraduate degree.

Because the program is interdisciplinary, admitted students may enter with diverse backgrounds. All incoming Ph.D. students will will be individually interviewed by a committee of CCMB faculty so as to recommend a personalized training program consisting largely of undergraduate offerings. The committee will determine which part of this training, if any, can be undertaken for graduate credit.

Table 1

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<tbody>
<tr>
<td></td>
<td>Introductory Biology (BIOL 0200)</td>
<td>Discrete Structures (CSCI 0220)</td>
<td>Intermediate Calculus (MATH 0180)</td>
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<td>Genetics (BIOL 0470) or Biochemistry (BIOL 0280)</td>
<td>Design and Analysis of Algorithms (CSCI 1570)</td>
<td>Linear Algebra (MATH 0520)</td>
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<td>Computational Molecular Biology (CSCI 1810)</td>
<td>Statistical Inference (APMA 1650)</td>
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<td>Inference in Genomics and Molecular Biology (APMA 1080)</td>
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3. Course Requirements
Each student should complete six courses by the end of their second year. These six courses are subject to the following criteria.

(1) Four computational biology courses from the table below. These courses must include at least one from each of the three areas: Biology, Computer Science, and Applied Mathematics & Biostatistics.
(2) Two additional graduate courses selected by the student in consultation with his/her advisor.

Additional stipulations for the CSCB degree. The two additional courses in (2) must be graduate-level courses in computer science, outside of computational biology, and selected from a list of pre-approved courses. CS courses should cover at least three different areas. At least six 2000-level courses must be completed.

**Computational Biology Courses**

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<th>Biology</th>
<th>Computer Science</th>
<th>Applied Mathematics &amp; Biostatistics</th>
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<td>BIOL 1410: Evolutionary Genetics</td>
<td>Computational Molecular Biology: CSCI 1810</td>
<td>Inference in Genomics and Molecular Biology: APMA 2080 or APMA 1080</td>
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<td>BIOL 1430: Computational Theory of Molecular Evolution.</td>
<td>Medical Bioinformatics: CSCI 2820</td>
<td>PHP 2620: Statistical Methods in Bioinformatics</td>
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<td>BIOL 2030: Foundations for Advanced Study in the Life Sciences (double credit course)</td>
<td>Topics in Computational Biology: CSCI 2950-C</td>
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<td>Other 2000-level course in MCB, EEB, or MPPB</td>
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Student will also be expected to meet qualifying requirements comparable to those of his or her home department as specified and agreed upon by CCMB and the home department.

4. Additional Requirements

In addition to coursework, students will enhance their interdisciplinary training through additional requirements:

- Students will complete eight-week rotations in two laboratories within 24 months of admission to the program. One of these rotations must take place with an advisor outside the student’s home department.
• Students will complete a project during their rotations and present its results in a public seminar to members of the Center and all others who may be interested.

• Students will prepare a preliminary research presentation and defend it under the evaluation of a committee by the beginning of the third academic year (usually within 24 months of entering). For the CSCB degree, this preliminary research presentation should follow the same rules as the research part of the comprehensive exam. For the AM degree, students will be required to present and defend a thesis proposal under the evaluation of a committee by the beginning of the third academic year, instead of the preliminary research presentation.

Admission to candidacy will be conditioned on positive evaluation of coursework, laboratory rotations, and the research presentation. For the CSCB degree, students must pass the programming part of the CS comprehensive exam. For the AM degree, students must pass the oral exams in their major, minor and CCMB areas of study.

In addition,

• Students will obtain teaching experience. Typically, this experience will include serving as graduate teaching assistants for 1-2 semesters during the course of study. Alternative teaching experiences require approval from the Director of Graduate Studies.

• Students will be expected to organize and participate in the student-run colloquia. For the CSCB degree, students must attend 90% of the CCMB colloquia and 25% of the Computer Science colloquia.

• Ph.D. dissertation committees must have at least one CCMB faculty member from biological sciences and one CCMB faculty member from applied mathematics/statistics/computer science, as well as at least two members from the home department (Applied Mathematics, Computer Science, or Biological sciences departments).

After admission to candidacy, students will conduct supervised research to be presented to a thesis committee no earlier than six months before the planned date for the defense of the doctoral dissertation.

• Students will prepare a dissertation and defend it in a formal presentation to CCMB faculty and the home department.

Upon successful completion of these requirements, students will be awarded a PhD in Computational Molecular Biology.

2 Advancement to Candidacy and Thesis Research

The specific requirements for the advancement to candidacy and for the completion of the doctoral dissertation are detailed under the rubrics of the distinct Ph.D. programs listed below. Note that the requirements of the two Biology Ph.D. programs are identical:
Ph.D. in Applied Mathematics (with Computational Biology Annotation):
Requirements for Admission include the prescribed coursework and meeting the requirements for a Ph.D. in Applied Mathematics as described in the handbook.

The student’s thesis research will normally be done under the supervision of a member of the faculty of the CCMB, and proceeds through the following steps:

A thesis proposal, demonstrating the student’s knowledge of the area, outlining the proposed research problem and its solution, and demonstrating the student is capable of successfully completing a Ph.D., is required.

The thesis itself will be read by the thesis supervisor and two readers appointed by the CCMB and the Division of Applied Mathematics upon the recommendation of the thesis supervisor.

The thesis (defense) will be presented at a meeting open to students, faculty, and the public. Its adequacy will be judged by the thesis supervisor, and the readers.

Ph.D. in Computer Science and Computational Biology:
Requirements for Admission include the prescribed coursework, a programming assignment that tests programming ability, and a research project that tests ability to perform research. The research projects must be proposed after the selection of a research advisor and its result must be presented to an appointed faculty committee by the end of the second year.

The student’s thesis research will normally be done under the supervision of a member of the faculty of the CCMB, and proceeds through the following steps:

A thesis proposal, demonstrating the student’s knowledge of the area, outlining the proposed research problem and its solution, and demonstrating that the student has done substantial work in the area and is capable of successfully completing a Ph.D. is required.

The thesis itself will be read by the thesis supervisor and two readers appointed by the CCMB upon the recommendation of the thesis supervisor.

The thesis (defense) will be presented at a meeting open to students, faculty, and the public. Its adequacy will be judged by the thesis supervisor, the readers, and the faculty of the CCMB and the Department of Computer Science attending the oral presentation. The defense is expected to occur no earlier than six months after the presentation of the proposal.

Ph.D. in Biology and Computational Biology:
Requirements for Admission include the required coursework as well as satisfactory completion of an oral qualifying exam by the end of the fourth semester. The student will form a qualifying committee of no fewer than four faculty by the end of the summer following the first year of the program. A written thesis proposal shall be submitted by the student not less than two weeks prior to the examination. This will
determine whether the student has the motivation, intellectual capacity, curiosity, educational background and technical skill to pursue the Ph.D. successfully.

The student’s thesis research will normally be done under the supervision of a member of the faculty of the CCMB, and proceeds through the following steps:

Shortly after advancing to candidacy, the student will constitute a thesis committee consisting of not fewer than four faculty advisors, at least one of whom must not be a member of the Brown University faculty.

The student will meet with this committee at least annually.

Upon completion, the thesis will be presented at a meeting open to students, faculty, and the public followed by a thesis defense to members of the thesis committee and other faculty members who choose to participate. The thesis must be submitted to the committee at least two weeks before the defense.