Learning Assessment in Computational Biology

1. Overview

Computational Biology (CB) is a growing young graduate field at Cornell, launched in 2006 and now home to 22 graduate students. The field is highly interdisciplinary, and includes 34 faculty members from more than a dozen departments. The CB graduate field currently has only one degree program: the Ph.D. program in Computational Biology.

The CB graduate field is closely associated with the Tri-Institutional Program in Computational Molecular Biology (CBM; http://www.triiprograms.org/cbm/), which is run jointly by Cornell-Ithaca, Weill Cornell Medical College (WCMC), and Memorial Sloan-Kettering Cancer Center (MSKCC). All CBM students spend their first academic year taking courses in Ithaca, and during this time they are officially enrolled in the CB field. Starting in their second year, CBM students join laboratories either in Ithaca or in New York City. If they choose to stay in Ithaca, they remain enrolled in the CB field; otherwise they are administratively accommodated by graduate programs at WCMC or MSKCC. CBM students who remain in Ithaca must meet all requirements of the CB field, as well as some additional requirements of the CBM program. At present, the majority of CB students (all but 5) are enrolled via the CBM program.

2. Learning Objectives

Upon completion of the Ph.D. in Computational Biology, students should have:

1. (Fundamentals) Demonstrated mastery of fundamental concepts, theory, and methodology in areas of biology, computer science, and mathematics relevant to the chosen specialty.

2. (Breadth) Demonstrated broad knowledge of theory and research across several sub-disciplines in computational biology.

3. (Originality) Demonstrated the ability to independently conduct, document, and defend original research having the potential to produce new biological insights and/or improved computational methods.

4. (Communication) Demonstrated proficiency in oral and written presentation of results appropriate for a career in advanced research in government or industry, or advanced research and/or teaching at a college or university.

5. (Literacy and Outreach) Demonstrated broad knowledge of the scientific literature relevant to the specialty area, including awareness of recent advances, active areas of research, and open questions. Students should also have demonstrated the ability to participate in the broader research community outside of Cornell, through meetings, conferences, individual collaborations, or other interactions.

6. (Ethics) Demonstrated the ability to follow established ethical standards for the field, pertaining to topics such as (but not limited to) recognition of prior scholarship, acknowledgment of intellectual and material contributions to research, falsification of data, appropriate handling of human and animal subjects and of hazardous materials, and respectful and fair treatment of students and co-workers of diverse backgrounds.

7. (Teaching, for those entering a teaching profession) Demonstrated the ability to communicate complex ideas and methods in terms students can understand, to grade and comment effectively on student work, to lead discussions effectively, and to plan an effective course in the field.

8. (Career progress) Demonstrated significant progress toward future career goals, or found employment, if desired.
3. Methods of Assessment

Measure #1: The A examination

Description: The A examination consists of a written proposal, an oral presentation, and an oral examination by the Special Committee. Committee members will also evaluate students for progress in meeting course requirements at this time. Broadly speaking, the goal of this examination is to ensure that a student has finished his or her academic preparation and is prepared to begin focused work on the dissertation. Committee members will formulate questions to assess fundamental concepts theory, and methodology, breadth across subdisciplines, knowledge of the relevant literature, and the promise of the student’s proposed research agenda.

Criteria for success: Students in the program are strongly encouraged to take this examination by the end of their second year, although the graduate school requires only that it is taken before beginning the seventh semester of registration. Students must pass the A examination in order to proceed with their dissertation work. The Special Committee will specifically address progress toward Learning Objectives using a scoring rubric (attached). Students must have a rating of Proficient, or higher, on all relevant categories to pass the exam. The rate at which students pass the exam will be tracked by the program. The program will aim to have at least 85% of matriculated students progress to and pass the A exam (evaluated as a four-year average).

Relevant learning objectives: All objectives are relevant. The main emphasis is on objectives 1 (Fundamentals), 2 (Breadth), and 4 (Communication). Students should also show progress on objectives 3 (Originality), 5 (Literacy and Outreach), and, if appropriate, 7 (Teaching). Any concerns about objective 6 (Ethics) should also be discussed at this time.

Measure #2: The B examination

Description: The B examination consists of the written dissertation, a public presentation, and a (closed) oral examination by the Special Committee. The dissertation is critically reviewed by the Special Committee and evaluated for quality and originality. The committee also critically reviews the quality of the public presentation, and, in the oral examination, probes the student’s mastery of the chosen specialty area, as well as breadth of knowledge and plans for future research. More broadly, the committee will evaluate whether the student has met the complete list of learning objectives.

Criteria for success: Students must pass this examination to graduate from the program and obtain a Ph.D. The Special Committee will specifically address progress toward Learning Objectives using a scoring rubric (attached). Students must have a rating of Proficient, or higher, on all relevant categories to pass the exam. The program will aim to have at least 70% of matriculated students pass the B exam within 7 years, and will aim to maintain a median completion time of 5 years or less (evaluated over four years).

Relevant learning objectives: All learning objectives are relevant, with particular emphasis on 3 (Originality), 4 (Communication), and 5 (Literacy and Outreach).

Measure #3: Annual survey of current students and recent graduates

Description: A few weeks prior to the annual Field Meeting (near the end of the Spring Semester), the Graduate Field Assistant (GFA) will ask all current students to fill out a simple form listing their major accomplishments from the last year. These will include progress toward meeting degree requirements, laboratory rotations (for first-year students), publications, major presentations, major meetings attended, grants or fellowships obtained, collaborative projects, and teaching activities (including TA-ships). Students will also be invited to offer comments about strengths of the program, areas for improvement, and possible changes to its organization or structure. In parallel, the GFA will informally survey recent graduates of the program (within the last 5 years) by email and invite them to send a short update on their career progress, recent accomplishments, and contact information (for use in subsequent correspondences), as well as any new thoughts they might have about strengths or weakness of the program. This survey
will be designed to be minimally time-consuming (requiring no more than 5–10 minutes), in order to maximize the response rate. The GFA will assemble this feedback into a concise summary document and distribute it to all faculty members prior to the Field Meeting. Faculty members will also be encouraged to fill in missing or incomplete data for students with whom they are in contact.

**Criteria for success:** Statistics will be collected to summarize student publications, presentations, fellowships, meeting attendance, teaching, collaboration, and other activities. These statistics will be examined in a biennial review. This review will consider trends over time in the program, and where possible, similar statistics from competing programs. Problem areas will be identified and means for improvement will be proposed (see “Use and Dissemination of Assessment Information,” below).

**Relevant learning objectives:** 1 (Fundamentals), 2 (Breadth), 4 (Communication), 5 (Literacy and Outreach), and 7 (Teaching).

**Measure #4:** Annual review of active students by graduate field faculty

**Description:** At the annual Field Meeting (shortly after the end of the Spring Semester), faculty members will review progress by all current students in the program. There will be a special focus on first- and second-year students, and students who have been in the program six years or longer. Advisors of active students will be strongly encouraged to attend the meeting. If they are unable to do so, they will be asked to report on their advisees’ progress in writing. Field members in New York City will be invited to participate by Video Conference (this can be done using facilities in Weill Hall).

**Criteria for success:** First- and second-year students will be evaluated for progress in meeting the academic requirements of the program and advancing to their A exams in a timely manner. Grades in courses and performance in laboratory rotations will be considered for these students. More senior students will be evaluated for progress in Originality, Communication, Literacy and Outreach, and timely movement toward the B exam. Performance in teaching will also be considered where relevant. Any ethical concerns will also be discussed at this meeting, as will concerns about physical, mental, or emotional health, excessive absence, student/advisor relationships, or other issues.

**Relevant learning objectives:** All objectives are relevant.

**Measure #5:** Exit interview with graduating students

**Description:** The Director of Graduate Studies will conduct a short exit interview with graduating students, to collect information and solicit feedback about the program. This will be an opportunity to ensure all records of publications, presentation, collaborations, fellowships, grants, teaching activities, and other accomplishments are complete and accurate. Students will be asked about their future career plans and new contact information, and encouraged to keep the program informed of their future activities and accomplishments, either through annual surveys or informal email updates. They will be invited to offer their perspective on strengths and weaknesses of the program at the time of graduation. This information will be summarized in a short report by the DGS.

**Criteria for success:** Information from this survey will be considered in the biennial review, together with the other information described above.

**Relevant learning objectives:** All objectives are relevant, with a particular emphasis on objective 8 (Career progress).

4. **Use and Dissemination of Assessment Information**

Every second year, a portion of the annual Field Meeting will be devoted to a review of the program. In preparation for this review, the GFA and DGS will prepare a short report summarizing various measures of success, including rates of A-exam passage and graduation, the distribution of times to graduation, job placement rates, and statistics
describing student publications, presentations, fellowships, meeting attendance, teaching, and collaboration. General feedback from current and former students will also be summarized. Because the program admits only 6–8 students per year, on average, most statistics will be evaluated cumulatively over multiple years (for example, in 4–5 year windows). This summary will also address other more difficult-to-quantify issues, such as ethical concerns, or signs of stress or depression among students.

After reviewing and discussing this summary and identifying problem areas, the faculty will discuss possible means for improvement. These may include changes to the curriculum, reporting methods, or surveys; changes in the structure of the A- or B-exams; improvements in dissemination of information to students; programs to encourage and/or provide funds for particular types of activities (such as meeting attendance or outreach); more active mentoring in particular areas of deficiency (such as writing, oral presentation, or teaching); or other changes. The DGS will summarize these discussions in a report to the Graduate School, together with a plan for implementing changes that have been approved by the faculty.
**Fundamentals**: Mastery of fundamental concepts, theory, and methodology in areas of biology, computer science, and mathematics relevant to the chosen specialty

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<th>Rating (1–5)</th>
<th>1 (Unacceptable)</th>
<th>3 (Proficient)</th>
<th>5 (Outstanding)</th>
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<td>Demonstrates major gaps in knowledge of fundamental concepts, theory, and methodology.</td>
<td>Displays a clear understanding of essential concepts and methods, and demonstrates the ability to effectively apply existing methods to research problems.</td>
<td>Demonstrates a comprehensive understanding of fundamental concepts, theory, and methodology, and the ability to combine and extend existing concepts in novel ways.</td>
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**Breadth**: Broad knowledge of theory and research across several sub-disciplines in computational biology

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<td>Shows limited knowledge of topics outside of specialty area</td>
<td>Displays an appropriate level of awareness and depth of understanding of multiple sub-disciplines</td>
<td>Demonstrates broad knowledge of the field, and significant depth of understanding in multiple sub-disciplines.</td>
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**Originality**: Ability to independently conduct, document, and defend original research having the potential to produce new biological insights and/or improved computational methods

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<td>Research agenda lacks originality and/or compelling motivation, or represents a trivial extension of existing theory or methodology</td>
<td>Research agenda is substantive and well-motivated, and requires creative solutions from the student</td>
<td>Research agenda is highly novel, requiring an entirely new theory or methodology in order to resolve open research questions in a rigorous manner.</td>
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**Communication (oral)**: Proficiency in oral presentation

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<td>Uses weak, flawed, or unsubstantiated arguments in motivating research or answering questions. Visual aids fail to convey information in a clear, concise fashion.</td>
<td>Uses clear, logical reasoning to motivate research or respond to questions. Employs clear, concise, and organized visual aids.</td>
<td>Beyond meeting the proficiency standard, the student is articulate, persuasive, and insightful in motivating research and responding to questions.</td>
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**Communication (written)**: Proficiency in written presentation

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<tr>
<td>Writing lacks clarity, with consistent errors and/or poor organization. Inadequate review and explanation of literature. Key mathematical results are incorrect, or unclearly described.</td>
<td>Writing is clear, concise, and organized, with few grammatical errors. Appropriate review and explanation of literature. Logical development and presentation of technical results supported with adequate mathematical detail.</td>
<td>Elegant writing and organization with fully developed literature review and correct grammar. Logical development and presentation of technical results supported with clear, convincing, and insightful arguments.</td>
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**Literacy**: Broad knowledge of scientific literature relevant to specialty area, including awareness of recent advances, active areas of research, and open questions

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<td>Shows limited awareness of current research in the field</td>
<td>Demonstrates broad, deep, and current knowledge of the relevant scientific literature and research currently underway.</td>
<td>Demonstrates exceptional knowledge of specialty area and related literature, on par with leading researchers in the field.</td>
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**Overall Rating** (on the whole, not necessarily an average)

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Annual survey of current students

Please take a few minutes to summarize your accomplishments from the past year, using the form below. The information that you provide will help us to evaluate your individual progress and the performance of the graduate program as a whole. It may also be used for training grant applications, student recruitment efforts, and other purposes.

(All questions pertain to the past year only. You need not list items you have previously reported, unless you have new information to report, such as an updated citation for a journal article, or a renewal of a grant.)

1. Journal articles you co-authored (submitted or published in past year; provide complete citations):

2. Major conferences, workshops, or meetings you attended:

3. Major research presentations you delivered (ones outside Cornell, unless they were particularly notable events on campus):

4. Grants or fellowships you were awarded:

5. Major collaborative projects in which you played a key role (for example, genome sequencing projects):

6. Teaching activities (TAships, guest lectures, workshop contributions):

7. Outreach/broader impact activities (e.g., recruitment of underrepresented minorities, dissemination of scientific information to the broader public):
8. Learning accomplishments (e.g., particularly useful or illuminating courses, conceptual breakthroughs or major new ideas, new skills or techniques):

9. Any other major accomplishments you feel are worth reporting:

Finally, in the space below, we invite you to provide feedback on the Ph.D. program in Computational Biology, including your current thoughts on its strengths and weaknesses, and any suggestions you may have for possible changes in its organization or structure.