**Program Outcomes Assessment Report**

**2018-2019 Academic Year**

**Date:** 26 July 2019

**Name of Program:** M.S. Biology and Ph.D. in Integrative and Systems Biology (ISB)

**Program Director:** Alan Vajda, Ph.D.

**Program Assistant:** Virginia Ware, M.S.

**Person Completing Assessment Plan:** Michael B. Wunder, Ph.D. (Assessment Committee) and Alan Vajda (Graduate Program Coordinator)

1. **Core Concepts and Competencies:**

“Biology is evidence based and grounded in the formal practices of observation, experimentation, and hypothesis testing.”

From the American Association for the Advancement of Science Vision and Change Core Competency of “Ability to Apply the Process of Science” and the American Association of Colleges and Universities Essential Learning Outcome of “Inquiry and Analysis.

1. **Specialized knowledge and skills within sub-discipline:**

Students must:

* 1. demonstrate specialized knowledge of content and methodology within their chosen subfield; and,
  2. demonstrate an ability to acquire new knowledge and skills as the field changes.

1. **Apply the process of science through inquiry and analysis:**

Students must:

* 1. characterize the state of the field and identify critical gaps in knowledge or ability;
     1. identify a testable/doable question(s) that could contribute the gaps in the state of the field;
  2. evaluate reliability of sources of information and evidence;
  3. locate, summarize and explain how a study contributes to the field;
  4. develop and critique scientific hypotheses;
  5. design and conduct observational and experimental studies with attention to replication and statistical design constraints;
  6. analyze and interpret data to form conclusions;
  7. articulate variables and assumptions required by a study; and,
  8. place scientific findings into a larger intellectual/contextual framework.

1. **Use abstract/quantitative reasoning:**

**“**Biology relies on applications of quantitative analysis and mathematical reasoning.”

**“**Biology focuses on the study of complex systems. All students should understand how mathematical and computational tools describe living systems.”

From the American Association for the Advancement of Science Vision and Change Core Competency of “Ability to Use Quantitative Reasoning” and the American Association of Colleges and Universities Essential Learning Outcome of “Quantitative Literacy”.

Students must:

1. manage and organize data sets;
2. create and interpret data visualizations (e.g. graphs, tables);
3. apply descriptive and inferential statistical methods of design and analysis for diverse study questions;
4. use data as evidence to draw conclusions about biological processes;
5. use mathematical formulas to reason about biological processes and understand the underlying probability in the calculations;
6. describe the assumptions used to make a model and evaluate alternate models;
7. explain the effects of probability and uncertainty in biological models;
8. interpret models given changing variables­­;
9. create a conceptual model to represent related components and processes of biological systems;
10. create a quantitative model to represent related components and processes of biological systems; and,
11. interpret quantitative and conceptual models.
12. **Communicate and collaborate**

**“**Biology is a collaborative scientific discipline. Biological research increasingly involves teams of scientists who contribute diverse skills to tackling large and complex biological problems.”

From the American Association for the Advancement of Science Vision and Change Core Competency of “Ability to Communicate and Collaborate with Other Disciplines” and the American Association of Colleges and Universities Essential Learning Outcomes of “Oral Communication “, “Written Communication”, and “Teamwork”.­

Students must:

* 1. Participate in the dialogue in your discipline using the appropriate formats;
  2. demonstrate an understanding of context, audience, and purpose in writing and other communications;
  3. use appropriate conventions of organization, content, formatting, presentation, and style in writing and other communications;
  4. correctly cite high-quality, relevant sources to support arguments; and,
  5. communicate scientific understanding to both scientific and general audiences.

1. **Context of Science**

**“**Biology is conducted in a societal context. Biologists have an increasing opportunity to address critical issues affecting human society by advocating for the growing value of science in society, by educating all students about the need for biology to address pressing global problems.”

From the American Association for the Advancement of Science Vision and Change Core Competency of “Ability to understand the relationship between science and society” and the American Association of Colleges and Universities Essential Learning Outcomes of “Ethical Reasoning” and “Civic Engagement”.

Students must:

* 1. Explain the implications of their research for society;
  2. Explain relationships between biological principles and global, economic, environmental and societal issues;
  3. Describe how the history of scientific thought has shaped the development of scientific principles;
  4. Understand the philosophy of science.

1. **Assessment Data Collection and Analysis:**

Assessment data were collected at two time points: 1. A student’s thesis proposal defense (M.S.) or comprehensive examination (Ph.D.) in which a dissertation proposal was defended; and, 2. At a student’s thesis/dissertation defense.

Each rubric was completed by student advisory committee members and the data were collected by the Graduate Program Director. The data were analyzed and visualized by the Program Director in collaboration with the Program Assistant.

1. **Summary of Assessment Data:**

Below, in the table, we summarize the outcomes assessment data we collected in the Fall 2018 (4 students) and Spring 2019 (6 students) terms. Of the 10 students evaluated, 5 were at M.S. thesis defenses, 3 were at Ph.D. comprehensive exams, and 2 at Ph.D. dissertation defenses. The data below represent the percentage of faculty (n= 25) that rated our students in each level of proficiency for each learning objective. Note: in some cases, faculty did not rate a student for one or more of the outcomes. For this reason, not all percentages sum to 100.

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| --- | --- | --- | --- |
| **PROGRAM LEARNING OUTCOMES:** | **Below Proficient** | **Proficient** | **Above Proficient** |
| 1. **Specialized knowledge and skills within sub-discipline**   Students must:   * 1. demonstrate specialized knowledge of content and methodology within their chosen subfield; and,   2. demonstrate an ability to acquire new knowledge and skills as the field changes. |  | 48% | 48% |
| 1. **Process of science through inquiry and analysis**   Students must:   * 1. characterize the state of the field and identify critical gaps in knowledge or ability;   2. identify a testable/doable question(s) that could contribute the gaps in the state of the field;   3. evaluate reliability of sources of information and evidence;   4. locate, summarize and explain how a study contributes to the field;   5. develop and critique scientific hypotheses;   6. design and conduct observational and experimental studies with attention to replication and statistical design constraints;   7. analyze and interpret data to form conclusions;   8. articulate variables and assumptions required by a study; and,   9. place scientific findings into a larger intellectual and contextual framework. |  | 64% | 36% |
| 1. **Abstract/quantitative reasoning**   Students must:   1. manage and organize data sets; 2. create and interpret data visualizations (e.g. graphs, tables); 3. apply descriptive and inferential statistical methods of design and analysis for diverse study questions; 4. use data as evidence to draw conclusions about biological processes; 5. apply mathematical formulas to reason about biological processes and understand the underlying probability in the calculations; 6. describe the assumptions used to make a model and evaluate alternate models; 7. explain the effects of probability and uncertainty in biological models; 8. interpret models given changing variables­­; 9. create a conceptual model to represent related components and processes of biological systems; 10. create a quantitative model to represent related components and processes of biological systems; and, 11. interpret quantitative and conceptual models. |  | 80% | 20% |
| 1. **Communication and collaboration**   Students must:   * 1. Engage in a dialogue with other scientists about content, design, analysis, and techniques in an appropriate manner;   2. demonstrate an understanding of context, audience, and purpose in writing and other communications;   3. display appropriate conventions of organization, content, formatting, presentation, and style in writing and other communications;   4. correctly cite high-quality, relevant sources to support arguments; and,   5. communicate scientific understanding to both scientific and general audiences; |  | 60% | 40% |
| 1. **Context of Science**   Students must:   * 1. Explain the implications of their research for society;   2. Explain relationships between biological principles and global, economic, environmental and societal issues;   3. Describe how the history of scientific thought has shaped the development of scientific principles;   4. Understand the philosophy of science; |  | 52% | 36% |

1. **Interpretation of Assessment Data:**

This report summarizes results for the first full academic year using our updated outcomes assessment plan which was approved by the Department of Integrative Biology’s Graduate Advisory Committee in the spring of 2018. Based on projections from 2018-2019, we expected to collect data on about 12 to 18 students during this academic year; we collected data for 10 this academic year.

We combine data from our two degree programs because of philosophy. Both degree tracks have the same learning objectives and we do not have different expectations for student performance other than the amount of content expected for completion of a thesis versus a dissertation.

Overall, we are pleased with the outcomes reported here based upon data collected by our assessment rubrics. Each committee member was expected to complete the assessment rubric, while considering our program learning objectives, for each student at the stated time points. Data from AY 2018-2019 demonstrate that no graduate student was deficient (below proficient) in any learning outcome by the time s/he reached key benchmarks in academic programs. Faculty predominantly consider our students as proficient by the time they reach programmatic benchmarks.

1. **Feedback and Use of Information:**

Based on the 2017-2018 outcomes assessment, the Integrative Biology graduate program provided financial support for a student-initiated seminar series that provided additional opportunity for students to interact with other scientists, and to practice discussing and debating the merits of their own research. This seminar series in spring 2019 was supplemented by a drop-in forum/lab (HackR lab) for students to collaborate specifically on quantitative aspects of their research, especially as related to support for abstracting questions and writing computer code to organize, analyze and display data.