Student Learning Assessment Report, Academic

Report Year

2022-2023

Program

Biology (BA/BS) Major

Department Head

Greg Byrnes

Submitted By

Tom Giarla

Previously Submitted Reports

2021-2022 Biology (BA/BS) Major

Mission

The Biology Department seeks to develop in each student an appreciation of the science of biology at all levels of study (molecular, cell, whole organism, and populations), which is understood and integrated in terms of Darwinian evolution. This is accomplished through a rigorous, broadly based, laboratory-intensive curriculum taught by faculty who are dedicated, first and foremost, to enriching the learning experience of their students. In addition to a biology core curriculum, all students take additional courses in the areas of cell/molecular biology, physiology, morphology, and organismic/population biology. A major emphasis of our program is to encourage critical thinking and an active engagement in the biological sciences. We do this by keeping class sizes small and including a laboratory experience as an integral component of most courses. Many laboratories incorporate independent research projects where students creatively build on fundamental concepts and techniques to address interesting biological questions. The program further encourages and reinforces independent research skills by offering credit for on-campus Independent Research courses mentored by departmental faculty or off-campus Science internships in Biology. In order to accomplish these pedagogical goals, the department hires only broadly-trained faculty who also possess expertise in a particular biological discipline. Faculty members are encouraged to establish and maintain active research programs in order to remain current in their disciplines, enthusiastic about their courses, and to provide independent study opportunities for students.

Assessment

1. Major/Program Student Learning Outcomes

Student will be able to...

Explain key biology concepts within an evolutionary framework and across different levels of biological organization, from molecules to ecosystems.

2. Phase

Check all that apply

- [x] **Planning/ determining procedure**
- [x] **Planning/ Redesigning based on past assessment**
- [x] **Collecting/ analyzing assessment data**
- [ ] **Discussing/ using result**
- [ ] **Determining if Changes had an Impact on Student Learning**
- [ ] **Objective not assessed this year**

3. Assessment Procedures (Planning/ determining)

Method: (ex. tests, presentations, research paper, describe the assessment course and student sample when it is applicable, etc.)

This outcome will be assessed in multiple upper-division biology courses (BIOL225 and above) that emphasize learning facts and theories. Student learning will be assessed through projects, exams, and/or quizzes.

When does assessment occur?

Once per course selected by the assessment coordinator.

How often does assessment occur?

Every other year

Criteria (How do you know students are achieving learning outcome?)

At least 80% of students earning a C- or better on the quiz or exam.

4. Assessment Results (Collecting/ analyzing, please identify the samplle size and course number when appropriate)

We collected data from three courses to evaluate this SLO for the 2022-2023 academic year: Ecology (BIOL225), Biology of the Vertebrates (BIOL 230), and Comparative Anatomy (BIOL255).

Ecology (Spring 2023, n = 32 students)
Type of assessment: weekly open-book, online multiple-choice quizzes challenging students with mostly higher-level (e.g., application, problem-solving) questions related to the material discussed in the textbook.
Results: 28/32 (88%) of students met the criteria

Ecology (Spring 2023, n = 32 students)
Type of assessment: Final exam.
Results: 20/32 (63%) of students met the criteria

Biology of the Vertebrates (Fall 2022, n = 16 students)
Type of assessment: Final Exam that tested students ability to explain key concepts in vertebrate biology.
Results: 14/16 (88%) of students met the criteria

Comparative Anatomy (Spring 2023, n = 31 students)
Type of assessment: Final Exam that tested students ability to explain key concepts in vertebrate anatomy
Results: 30/31 (97%) of students met the criteria

Learning Outcome Met? (Based on Criteria)

Yes

Assessment

1. Major/Program Student Learning Outcomes

Student will be able to...

Evaluate scientific literature to engage in scientific discussion, debate competing ideas, and formulate arguments.

2. Phase

Check all that apply

- [x] **Planning/ determining procedure**
- [x] **Planning/ Redesigning based on past assessment**
- [x] **Collecting/ analyzing assessment data**
- [ ] **Discussing/ using result**
- [ ] **Determining if Changes had an Impact on Student Learning**
- [ ] **Objective not assessed this year**

3. Assessment Procedures (Planning/ determining)

Method: (ex. tests, presentations, research paper, describe the assessment course and student sample when it is applicable, etc.)

This outcome will be assessed in courses where students are required to read and synthesize multiple primary literature articles. The assessment coordinator will identify at least two courses from which to gather data for a given cycle. Faculty members will teaching those courses will provide a rubric and report to the assessment coordinator explaining their assessment procedure and results. Student learning will be assessed via in-class debates, literature reviews, annotated bibliographies, and/or oral presentations.

When does assessment occur?

Once per course selected by the assessment coordinator.

How often does assessment occur?

Every other year.

Criteria (How do you know students are achieving learning outcome?)

At least 80% of students earning a C- or better on the assignment.

4. Assessment Results (Collecting/ analyzing, please identify the samplle size and course number when appropriate)

We collected data from three courses to evaluate this SLO for the 2022-2023 academic year: Molecular Genetics (BIOL265), Microbiology (BIOL320) and Biochemistry (BIOL420).

Molecular Genetics (Spring 2023, n = 50)
Type of assessment: Students had two "journal article assignments" over the course of the semester (a guided review of a paper). The assignment guides students through the article and assesses how students process individual components from a scientific paper.
Results: 46/50 (92%) of students met the criteria

Microbiology (Spring 2023, n = 14)
Type of assessment: Pathogen report. Students write a paper using extensive literature review to understand one pathogen from several different perspectives: the biology of that microbe and how it compares to other closely related species, the pathogenesis of the microbe and how it causes disease in one individual, and then the epidemiology of that pathogen and how it does or does not spread through communities and how outbreaks could be prevented if it is a disease that can cause outbreaks. I think this addresses SLO 1 by forcing students to make connections between multiple levels of science; the cell biology of a single bacterium or virus, the interactions between a pathogen and a whole organism, and then on a community level. It also engages with the evolutionary framework as students have to compare their organism to close relatives to see how species can be similar but different. Rubric attached ("Pathogen report rubric - Anna McLoon.pdf").
Results: 13/14 (93%) of students met the criteria

Biochemistry (Fall 2022 and Spring 2023, n = 52)
Type of assessment: Small groups of students 1) identified a primary research article relevant to a metabolic disorder, 2) presented a slideshow with background information on the disorder and to discuss some of the results from the article, and 3) developed discussion questions to lead the class in a discussion of the article and its value/impact on treating or diagnosing the disorder. Rubric attached (Metabolic Disorder Project S22 - Patrick Maxwell.pdf)
Results: 52/52 (100%) of students met the criteria

Learning Outcome Met? (Based on Criteria)

Yes

Assessment

1. Major/Program Student Learning Outcomes

Student will be able to...

Apply scientific inquiry to address biological questions, including hypothesis formulation and experimental design.

2. Phase

Check all that apply

- [x] **Planning/ determining procedure**
- [x] **Planning/ Redesigning based on past assessment**
- [x] **Collecting/ analyzing assessment data**
- [ ] **Discussing/ using result**
- [ ] **Determining if Changes had an Impact on Student Learning**
- [ ] **Objective not assessed this year**

3. Assessment Procedures (Planning/ determining)

Method: (ex. tests, presentations, research paper, describe the assessment course and student sample when it is applicable, etc.)

This outcome will be assessed in courses with independent projects where students design experiments with appropriate strategies, controls, and alternative approaches. The assessment coordinator will identify at least two courses from which to gather data for a given cycle. Student learning will be assessed via experimental planning worksheets, written proposals, lab journals, and portions of formal lab reports or posters.

When does assessment occur?

Once per course selected by the assessment coordinator.

How often does assessment occur?

Every other year.

Criteria (How do you know students are achieving learning outcome?)

At least 80% of students earning a C- or better on the assignment.

4. Assessment Results (Collecting/ analyzing, please identify the samplle size and course number when appropriate)

We collected data from three courses to evaluate this SLO for the 2022-2023 academic year: Ornithology (BIOL 270), Microbiology (BIOL320), and Biochemistry (BIOL420).

Ornithology (n = 30 students)
Type of assessment: Students worked in groups of 2-3 to design then carried out a study of a local bird population. This involved hypothesis building, data collection and analysis, literature reviews and the creation of a well-researched manuscript including figures/tables. Rubric attached ("Ornithology Final Paper Rubric and Guidelines - Christopher Harbison.pdf")
Results: 30/30 (100%) of students met the criteria

Microbiology (Spring 2023, n = 13)
Type of assessment: Poster with presentation. Students worked in teams of 3-4 to ask a question, develop controlled experiments, carry out experiments, collect and analyze data, refine methods and repeat experiments if necessary, and then designed and presented posters of their work. Some years I have given students "example" questions, but I didn't this year, but I did meet with each group at multiple points to help steer them to a successful topic/project. Rubric attached ("Micro poster rubric 2023 blank - Anna McLoon.pdf")
Results: 13/13 (100%) of students met the criteria

Biochemistry (Spring 2023, n = 21)
Type of assessment: In the lab section of this course, students work in small groups over the semester to try to make baker's yeast cells overproduce an amino acid that has value in medicine and biotechnology. They are given access to mutant yeast strains, strains overexpressing metabolic enzymes, and different media components. They are then asked to come up with hypotheses to test, collect data, and use their results to either refine their hypotheses or come up with new hypotheses to test. They go through multiple rounds of designing experiments, collecting data, and designing new experiments based on their results. They write a paper and present a poster for the project. ("Report Guidelines - Ornithine Project - Patrick Maxwell.docx" and "Poster Guidelines - Ornithine Project - Patrick Maxwell.docx").
Results: 21/21 (100%) of students met the criteria

Learning Outcome Met? (Based on Criteria)

Yes

Assessment

1. Major/Program Student Learning Outcomes

Student will be able to...

Operate equipment and use experimental techniques competently in lab and field settings.

2. Phase

Check all that apply

- [x] **Planning/ determining procedure**
- [ ] **Planning/ Redesigning based on past assessment**
- [x] **Collecting/ analyzing assessment data**
- [ ] **Discussing/ using result**
- [ ] **Determining if Changes had an Impact on Student Learning**
- [ ] **Objective not assessed this year**

3. Assessment Procedures (Planning/ determining)

Method: (ex. tests, presentations, research paper, describe the assessment course and student sample when it is applicable, etc.)

This outcome will be assessed in courses with lab or field components that demand safe handling of scientific equipment and chemicals to make observations and generate data of sufficient quality as to be useful for addressing biological questions. The assessment coordinator will identify at least two courses from which to gather data for a given cycle. Student learning will be assessed via lab practicals and portions of formal lab reports.

When does assessment occur?

Once per course selected by the assessment coordinator.

How often does assessment occur?

Every other year.

Criteria (How do you know students are achieving learning outcome?)

At least 80% of students earning a C- or better on the assignment.

4. Assessment Results (Collecting/ analyzing, please identify the samplle size and course number when appropriate)

We collected data from three courses to evaluate this SLO for the 2021-2022 academic year: Ecology (BIOL225), Biochemistry (BIOL 420) and Animal Physiology (BIOL430).

Ecology (n = 32 students)
Students conducted a multiweek environmental microbiology project that entailed using both field- and wet-lab techniques. Students had to practice sterile techniques to obtain soil samples in the field and then process the samples back in the lab. Students were asked to use various pieces of equipment in the lab, including a multi-channel pipettor, vortex, and other small instruments. Studenrs were assessed via a short lab report.
Results: 29/32 (90%) of students met the criteria

Biochemistry (n = 18 students)
Students had to determine normalized measurements of an amino acid from cultures of yeast cells for an independent project. This involved 1) correctly assembling and heating an assay solution prior to reading absorbance with a spectrophotometer, 2) obtaining a standard curve for known amounts of the amino acid in the same assay conditions to convert absorbances to amounts of amino acid, and 3) separately obtaining absorbance readings for the cultures from which they prepared their samples in order to normalize amounts of the amino acid to cell density. Proficiency in this basic procedure was required for students to consistently obtain usable data for their independent project. The grade for this was a component of their independent project and lab performance grades.
Results: 16/18 (89%) of students met the criteria

Animal Physiology (n = 25)
Students completed a lab practical exam that included questions that specifically evaluated their ability to operate key physiology instrumentation and software.
Results: 25/26 (96%) of students met the criteria

Learning Outcome Met? (Based on Criteria)

Yes

Assessment

1. Major/Program Student Learning Outcomes

Student will be able to...

Apply quantitative reasoning to problems in biology, including analyzing data and modeling biological phenomena.

2. Phase

Check all that apply

- [x] **Planning/ determining procedure**
- [ ] **Planning/ Redesigning based on past assessment**
- [x] **Collecting/ analyzing assessment data**
- [ ] **Discussing/ using result**
- [ ] **Determining if Changes had an Impact on Student Learning**
- [ ] **Objective not assessed this year**

3. Assessment Procedures (Planning/ determining)

Method: (ex. tests, presentations, research paper, describe the assessment course and student sample when it is applicable, etc.)

This outcome will be assessed in courses that include data collection and/or analysis and in courses where mathematical modeling is applied to biological phenomena. The assessment coordinator will identify at least two courses from which to gather data for a given cycle. Student learning will be assessed via data analysis exercises in the lab, relevant exam/assignment questions, and data analysis portions of formal lab reports.

When does assessment occur?

Once per course selected by the assessment coordinator.

How often does assessment occur?

Every other year.

Criteria (How do you know students are achieving learning outcome?)

At least 80% of students earning a C- or better on the assignment.

4. Assessment Results (Collecting/ analyzing, please identify the samplle size and course number when appropriate)

We collected data from five courses to evaluate this SLO for the 2021-2022 academic year: BIOL 225 (Ecology), BIOL 320 (Microbiology), BIOL 420 (Biochemistry), BIOL 430 (Animal Phys), and BIOL 440 (Neurobiology). Four out of the five assessments shown below meet the criteria for success. The only assessment that did not was the Lab Quiz in Neurobiology, and it very nearly met the criteria for success. so, overall, we believe this SLO meets the criterion and will continue to monitor for Neurobiology in case it slips further.

Ecology (n = 32 students)
Students conducted an experiment with two species of parasitoid wasps and then used a mathematical model (the Lotka-Volterra competition) to predict the outcome of the competition. Students then answered a series of homework questions assessing their understanding of the model, including the construction of graphs and calculation of model parameters.
Results: 28/32 (88%) of students met the criteria

Microbiology (n = 14 students)
Students built SIR models of outbreaks, then modified the model to predict how different types of diseases or different rates of transmission or immunity alter outbreak dynamics. Students completed a homework assignment, then I tested their comprehension with an exam question on midterm 2 and on the final exam. This applies to SLO 5 because it required students to use a quantitative model built using an excel spreadsheet, and they had to look at the graphical outputs to interpret the data, and then had to predict how new input changes would change the model.
Results: 13/14 (93%) of students met the criteria

Biochemistry (n = 18 students)
Students carried out an independent research project in small groups over the course of most of the semester during the lab sessions. The project involved using baker's yeast to try to overproduce a particular amino acid. Students had access to the yeast deletion collection, a small sublibrary of strains with plasmids to overexpress particular metabolic enzymes, and could choose to supplement growth medium with various chemicals/nutrients or change the composition of the medium. Students obtained data for levels of the amino acid in samples from yeast cultures during multiple lab periods and were expected to analyze and prepare figures from the data. The project is described more in a file submitted for a different learning outcome. While students worked in a group to obtain data and for the initial analysis, each student had to individually write a paper in the format of a research article to present the data. The grade for this assessment is based on the Results portion of the paper and parts of the Discussion that related to analysis and interpretation of the data.
Results: 15/18 (83%) of students met the criteria

Animal Physiology (n = 24 students)
Lab Short Report: In Animal Physiology labs, students learn how to use physiology instrumentation, software, and techniques to collect data. They then complete short "data summary" assignments where they are asked to use the appropriate type of graph to visually present their results, and include the appropriate statistical calculations and scientific conclusions in the accompanying figure legend. Full credit on the assignment requires selection of the appropriate graph type, statistic, and logical/accurate conclusions.
Results: 23/24 (96%) of students met the criteria

Neurobiology (n = 18 students)
Lab quiz. This quiz covers understanding of how to use key instrumentation as well as electrophysiology concepts. This includes how to interpret the data we collect in lab. Several of the quiz questions require quantitative reasoning.
Results: 14/18 (78%) of students met the criteria

Learning Outcome Met? (Based on Criteria)

Yes

Assessment

1. Major/Program Student Learning Outcomes

Student will be able to...

Effectively communicate current knowledge of biology orally and in writing to varied audiences, including faculty, peers, community members, and/or other professionals.

2. Phase

Check all that apply

- [x] **Planning/ determining procedure**
- [ ] **Planning/ Redesigning based on past assessment**
- [x] **Collecting/ analyzing assessment data**
- [ ] **Discussing/ using result**
- [ ] **Determining if Changes had an Impact on Student Learning**
- [ ] **Objective not assessed this year**

3. Assessment Procedures (Planning/ determining)

Method: (ex. tests, presentations, research paper, describe the assessment course and student sample when it is applicable, etc.)

This outcome will be assessed in courses that include a major writing assignment or presentation. The assessment coordinator will identify at least two courses from which to gather data for a given cycle. Student learning will be assessed via formal scientific reports, poster presentations, and oral presentations.

When does assessment occur?

Once per course selected by the assessment coordinator.

How often does assessment occur?

Every other year.

Criteria (How do you know students are achieving learning outcome?)

At least 80% of students earning a C- or better on the assignment.

4. Assessment Results (Collecting/ analyzing, please identify the samplle size and course number when appropriate)

We collected data from five courses to evaluate this SLO for the 2021-2022 academic year: BIOL 250 (Biology of the Invertebrates), BIOL 260 (Molecular Genetics), BIOL 320 (Microbiology), BIOL 420 (Biochemistry), BIOL 430 (Animal Physiology).

Biology of the Invertebrates (n = 23 students)
Students read a paper about invertebrate ecology and taught the class about it in a presentation. See attached rubric.
Results: 22/23 (96%) of students met the criteria

Molecular Genetics (n = 44 students)
From the assignment handout: "This semester we will cover topics ranging from the mechanisms of cellular processes like DNA replication and epigenetic regulation of gene expression to molecular pathways involved in sex determination and cancer and even modern genetics-based technologies like CRISPR/Cas-mediated gene editing. This is your chance to dig into the literature and learn what kind of current research informs our understanding of these phenomena and techniques. Students will choose a paper based on their own interest and write a 3-5 page summary/analysis of the paper."
Results: 44/44 (100%) of students met the criteria." See attached rubric.

Microbiology (n = 14 students)
Students carried out independent research projects in teams of 2-3 (Designed by students with support), then presented the data as posters at the academic showcase. They were assessed on the scientific content of their poster, the clarity of their visual presentation, and their oral presentation to me.
Results: 14/14 (100%) of students met the criteria. See attached rubric.

Biochemistry (n = 18 students)
Students worked in small groups on an independent research project during most lab sessions for the course. The project involved trying to make baker's yeast cells overproduce an amino acid that has value for health and commercial applications. Students were shown how to carry out basic procedures to grow yeast and to assay cells or culture medium for levels of the amino acid. They were expected to learn on their own about relevant metabolic pathways and develop hypotheses about how to increase levels of the amino acid by manipulating different pathways. Students could request strains from the yeast deletion collection, a small sublibrary of strains with plasmids to overexpress particular metabolic enzymes, or could choose to supplement growth medium with various chemicals/nutrients or change the composition of the medium. As they began to collect data, they revised or made new hypotheses, and carried out new experimental manipulations to test those new ideas. One of the final assignments for the project was then to write a research paper in the format of a primary research article to summarize the outcome of their work. Students worked as a group on the project, but wrote the paper individually (though they could share figures). The attached file provides the guidelines and evaluation criteria for the paper.
Results: 17/18 (94%) of students met the criteria

Biochemistry (n = 18 students)
Students had to present as a small group during a class session on a metabolic disorder. This involved researching basic aspects of the disorder (causes, symptoms, prevalence, treatments), connecting it to aspects of metabolism we discussed, finding a primary research article reporting a protein structure/function connection to the disorder, and presenting what they found. The presentation involved a short slideshow about the disorder and some experiments from the article (10-15 minutes), followed by the group leading a class discussion of questions about the disorder and the research article that they submitted ahead of their presentation (so other students could see questions in advance). In total, presentations usually were 25-30 minutes (half slides and half discussion).
Results: 18/18 (100%) of students met the criteria

Learning Outcome Met? (Based on Criteria)

Yes

Assessment

1. Major/Program Student Learning Outcomes

Student will be able to...

Evaluate information related to global challenges in biology and society, including climate change, habitat destruction, biodiversity loss, sustainable resource use, and disease outbreaks.

2. Phase

Check all that apply

- [x] **Planning/ determining procedure**
- [ ] **Planning/ Redesigning based on past assessment**
- [x] **Collecting/ analyzing assessment data**
- [ ] **Discussing/ using result**
- [ ] **Determining if Changes had an Impact on Student Learning**
- [ ] **Objective not assessed this year**

3. Assessment Procedures (Planning/ determining)

Method: (ex. tests, presentations, research paper, describe the assessment course and student sample when it is applicable, etc.)

This outcome will be assessed in courses that address one or more of these issues. The assessment coordinator will identify at least two courses from which to gather data for a given cycle. Student learning will be assessed via reflection papers (where students examine their own thinking about a global challenge and potential solutions) and via literature reviews (where students synthesize information from multiple sources to provide a holistic overview of a challenge).

When does assessment occur?

Once per course selected by the assessment coordinator.

How often does assessment occur?

Every other year.

Criteria (How do you know students are achieving learning outcome?)

At least 80% of students earning a C- or better on the assignment.

4. Assessment Results (Collecting/ analyzing, please identify the samplle size and course number when appropriate)

We collected data from two courses to evaluate this SLO for the 2021-2022 academic year: BIOL 225 (Ecology) and BIOL 320 (Microbiology).

Ecology (n = 32 students)
We held two "symposia" over the course of the semester. These are reading/discussion-based activities that ask students to critically evaluate and discuss how humans are impacting the environment. The first symposium is about climate change, and the second symposium is about indigenous ecology. Students are assessed via low-stakes in-class presentations and a pre-discussion homework assignment.
Results: 31/32 (97%) of students met the criteria

Microbiology (n = 14 students)
During the semester, we discussed antibiotic resistance and drug discovery, diagnosing microbial diseases (focusing primarily on those with the largest burden of disease globally), and the environmental effects of problems related to microbial processes in the soil and water (carbon cycles, plastic degradation by microbes, how microbes react with soil runoff to create ocean dead zones). Students engaged with this material by reading peer-reviewed articles, by answering in-class questions, and I then assessed student learning through homework and relevant questions on exams.
Results: 14/14 (100%) of students met the criteria. See attached rubric.

Learning Outcome Met? (Based on Criteria)

Yes

Package History

Date	User	Action	
7/18/2023 10:34:13 AM	Tom Giarla		Submitted 'Student Learning Assessment Report'
7/18/2023 10:35:04 AM	School of Science - Asst. Dean		Received
7/18/2023 10:35:04 AM	School of Science - Dean		Received
7/18/2023 10:35:04 AM	Tom Giarla		Received
7/18/2023 10:35:05 AM	Institutional Effectiveness		Received
7/18/2023 10:35:05 AM	Gregory Byrnes		Received
7/18/2023 10:35:05 AM	Provost and Senior Vice President		Received
7/18/2023 10:40:00 AM	Gregory Byrnes		Decision Approved
7/18/2023 10:41:04 AM	Margaret Madden		Decision Approved
7/18/2023 11:58:31 AM	John Cummings		Decision Approved