Program Student Learning Outcome (PSLO) Assessment Reporting Template 2016-2017
[For further guidance on this process, see the PSLO Assessment How-To Guide on the TLC website]

Program: Biology **Data Collected:** 2016-2017 **Submitted:** December 7, 2017

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Part 1: Assessment Goals

What do you want to learn about your students and their learning from this process?

- **What is/are your research question(s)? Why is this research question significant to your program?**
    - To what extent are our Biology major students meeting proficiency in the program student learning outcomes we have specified?
    - Specifically in terms of PSLO #3, to what extent are we supporting students in utilizing evidence to grapple with the relationship between structure and function after Bio 20 (Cell and Molecular Biology), and to what extent are we developing students' capacity to utilize an evolutionary framework in Bio 21 (Organismal Biology)?

Part 2: Assessment Plan

PSLO	Method of Assessment	Proficiency Criteria	Student Population Assessed
Enter all the PSLOs for your program below. (Additional rows may be needed)	**Identify and describe the assessment activity** (capstone project, portfolio, interview, pre/post survey, analysis of success rates, etc) used to assess the students' proficiency of the PSLO. Explicitly state which part of the assessment activity assessed a particular PSLO.	**List the criteria you used to determine proficiency levels for each of your PSLOs.** How did you determine "needs improvement," "meets proficiency," or "exceeds proficiency" criteria?	**Describe which student populations you assessed and how you chose those populations.** To what extent did the sample adequately represent all students in the program? Why did you choose this particular group for this particular PSLO? Explain.
PSLO #1: *Utilize the scientific method to develop hypotheses, conduct scientific experiments, critically analyze experimental data, and communicate results through written reports and oral presentations.*	Analysis of Bio 20's **CSLO #1** (*Apply biological principles through the process of making observations..*) and Bio 21's **CSLO #2** *(Formulate a scientific hypothesis, design experiments…)* assessment data from 2014 and 2015, respectively. Both of these CSLOs are mapped to PSLO #1. We summarized trends in these two datasets and reported overall program findings. For Bio 20's CSLO #1, we utilized **lab reports** as tools to assess the capacity to develop hypotheses and address with experimental data. For Bio 21's CSLO #2, we utilized the **ecology research presentations + research notebooks** and associated rubric as assessment tools to look for proficiency in conducting experiments and communicating results.	For each of the categories above, we utilized the same criteria from the CSLO assessment analysis for each respective CSLO. **Bio 20 CSLO #1 - Lab Report:** **High Proficiency**: A score of 9 -10/10 (90 - 100%) **Meets Proficiency**: A score of 7–8/10 (70 - 80%) **Below Proficiency**: A score of 6 / 10 or less **Bio 21 CSLO #2 - Research Project:** **High Proficiency**: score of 90% or higher (45/50) **Meets Proficiency:** score of 70% or higher (35-44/50)	Across 4 sections of Bio 20 and 2 sections of Bio 21, we assessed a total of **169 students**. We chose to analyze data from **multiple sections of both Bio 20 and Bio 21 from Fall 2014 & Fall 2015**. The sample student population reflects students at varying stages of our program, including students halfway through the program (Bio20 Fall 2014) and students nearing the end of the program (Bio21 Fall 2015). We felt this sample population was meaningful, as we want our students to exhibit proficiency in utilizing the process of science at all stages of their biology program journey. Note: As of Fall 2014, the Bio 20 pre-requisite for Bio 21 was still in place, meaning all Bio 20 students in the assessed sections had not yet taken Bio 21. In Fall 2015, Bio 21 students represented a mix of students who had and had not taken Bio 20 first.

PSLO #2: *Identify and/or describe the correlation between structure and function in living organisms, including the functional roles of the internal and external structures of cells, the basic relationship between DNA, proteins, and the transmission of traits, and the similarities and differences between metabolic processes and structures of diverse living organisms that allow them to exhibit distinctive characteristics of life.*	Analysis of Bio 20's **CSLOs #2 & 3** (2 - *Explain how molecular & cellular form and function are correlated… , 3 - evaluate the role of nucleic acids DNA & RNA…*) and Bio 21's **CSLO #1** *(Apply various biological classification schemes…)* assessment data from 2014 and 2015, respectively. All of these CSLOs are mapped to PSLO #2. We summarized trends in these three datasets and reported overall program findings. For Bio 20's CSLO #2, we utilized **10 lab practical exam questions** focused on form/function, and for CSLO #3, we utilized a **written exam question on the final exam** focused on gene expression. For Bio21's CSLO #1, we utilized **Lab Practical 2 total exam scores**, as this exam primarily focused on form/function of animal and plant systems.	For each of the categories above, we utilized the same criteria from the CSLO assessment analysis for each respective CSLO. **Bio20 CSLO #2 Lab Practical Questions:** **High Proficiency**: Correctly answers 9 / 10 questions (90 – 100 %) **Meets Proficiency**: Correctly answers 7 – 8 / 10 questions (70 – 80%) **Below Proficiency:** Correctly answers 6 or less 60% or below) **Bio20 CSLO #3 Written Exam Question:** **High Proficiency**: 90% based on points allotted for questions **Meets Proficiency**: 70% (based on points) **Below Proficiency**: Less than 70% (based on points) **Bio21 CSLO #1 Lab Practical:** **High Proficiency**: score of 90% or higher (45/50) **Meets Proficiency:** score of 70% - 89% (35-44/50)	Across four sections of Bio20 (assessed on two total CSLOs) and two sections, we analyzed 296 assessments and a total of **~183 students**. We chose to analyze data from multiple sections of both Bio 20 and Bio 21 from Fall 2014 and Fall 2015. The sample student population reflects students at varying stages of our program, including Biology majors halfway through the program (Bio20 Fall 2014), as well as some students nearing the end of the program (Bio21 Fall 2015). We felt this sample population was meaningful, as we aim for student proficiency in correlating structure to function at multiple stages in the program. In Bio20, we expect that form and function relate strongly to cellular structures and related processes, and in Bio21, to anatomical structures and adaptations and related processes. Note: As of Fall 2014, the Bio20 pre-requisite for Bio21 was still in place, meaning all Bio20 students in the assessed sections had not yet taken Bio21. In Fall 2015, Bio21 students represented a mix of students who had and had not taken Bio20 first.
PSLO #3: *Explain how evolution provides a framework for understanding the unity, diversity, and interdependency of living organisms.*	Analysis of **pre/post written responses** was used to assess PSLO #3. The pre survey was given to all students enrolled in Bio 21 in Spring 2017 (3 sections) in the first week of classes, and the post-instruction survey was given during the last two weeks of classes in Spring 2017. Students were encouraged to participate in the assessment to inform Biology program effectiveness and were assured that their performance would not affect their grade. The prompt asked students to consider functions shared across life forms, and how those functions can be accomplished using different structures. Students were then asked to propose an evolutionary mechanism that potentially led to the variation in structure.	**Bio21 Pre/Post Conceptual Rubric:** We utilized an 8-point conceptual rubric with high/medium/low point categories for each of the 3 conceptual subcategories. We determined proficiency levels based on post-scores. **High Proficiency**: 87.5% or higher (7-8/8) **Meets Proficiency:** 62.5% - 75% (5-6/8) **Below Proficiency:** score of 0-50% (0-4/8)	By assessing all students enrolled in Spring 2017 Bio 21 (3 sections, ~83 students), we hope to have captured a representative sample of students (we randomly scored **40** of the 60 **students** across 3 sections who completed Bio20 and both the pre- and post- assessment). We removed every 5th paired response from the sample of 60 to arrive at our final 40. We chose Bio21 as our target course, as it is generally taken second in the Biology majors' sequence, and we are specifically looking to assess students who have taken Bio20 before Bio21, such that we are capturing data from those who are advanced in the program. We expect these students during the pre-survey to provide thorough examples of unity and diversity (from Bio20 – with cell and

	We also asked students if they had taken Bio 20 prior to Bio 21 at LMC and how recently they had taken in (within last year or in the more distant past).		molecular focus) and during the post-survey to use mechanisms of evolution to explain the prevalence of similar functions, yet different structures in living things (evolutionary framework developed in Bio21).
PSLO #4: *Evaluate aspects of ecology and the interactions among the life forms on Earth – including the implications of human economic and cultural practices on the Earth's natural resources. Ultimately, students will comprehend the numerous ethical implications and applications of bioscience concepts in their everyday lives.*	Analysis of **ecology research presentations** was used to assess knowledge of ecological interactions, as well as the application of ecology research to human practices and ecosystem health. The ecology research project, which is the capstone experience of students in Bio21, requires that students reflect on implications of independent ecology research that they have designed and engaged in throughout the semester. These presentations were used as an assessment tool for PSLO #4, looking specifically at the rubric category "*Significance and application of research to California's ecology and/or personal life.*"	**Bio 21 Mini Rubric for Ecology Research Presentations:** **Exceeds proficiency**: 3/3 **Meets proficiency**: 2/3 **Needs improvement:** 0-1/3 See attached rubric for more specific information.	By assessing all students enrolled in Fall 2016 Bio 21 (2 sections), we aimed to capture a representative sample of students (at least 40). Though we had hoped to assess this PSLO for individual students, Bio21 students give project presentations in groups of 3-5, thus we chose to evaluate student groups instead, of which there were only **11**. Bio21 was chosen as the target course, as it is through this course's curriculum and research experience that we emphasize the interactions among living things. Given that students engage in independently designed and run ecology research projects through the semester, we hope that their proficiency level in explaining the relevance of their research to ecological issues is high.

Parts 3 & 4: Assessment Findings + Next Steps

Self-Perceived Proficiency on all PSLOs

In order to provide students an opportunity to reflect on their learning experiences and to collect students' perceptions on achieved proficiency of PSLOs, we asked students who had completed both Bio 20 and 21 to strongly agree (1), agree (2), neither agree/disagree (3), disagree (4), or strongly disagree (5) with statements about achieving proficiency on each individual PSLO (see appendix). There was no significant difference in self-perceived proficiency among PSLOs 1, 2, 3, and 4 ($x=1.65, 1.79, 1.56, 1.66$; $p=.202$ [$p>.05$]). However, students did provide examples of the learning experiences that most supported their achievement of each PSLO. That information is shared below under each PSLO.

PSLO #1 Scientific Method CSLO Aggregation Summary			
Below	Meets	Exceeds	Total
6	49	114	169
3.55%	**28.99%**	**67.46%**	

Findings: Most students (96.45 %) successfully demonstrated an understanding of the scientific method through written lab reports and / or oral presentations. Using verbal directions from their instructors as well as written guidelines, students could develop reasonable hypotheses, design scientific experiments, gather and interpret experimental data and report their findings in lab reports that include prose and graphic form and /or in an oral presentation.

Students Self-Assessment of this PSLO: In the self-assessment given to students who had completed Bio20 and 21 (n=40 students across 3 sections), students gave an average Likert scale score of 1.73 (scale of 1-4, 1 being highly proficient) to their perceived competence in this PSLO and cited lab reports, ecology research projects, labs, and in-class lecture activities as contributing to their competence.

Recent Curricular Changes: Recently in Biology 20, in an effort to raise all students to a level of competency in the scientific endeavor, we reduced the number of full lab reports assigned and replaced a few with just sub-sections of a report, i.e. Purpose with hypothesis, Table and graph, Discussion with Conclusion. In doing so, we give students an opportunity to focus on each section independently and receive feedback before submitting a full report. This piece-meal approach could help some students understand the meaning and importance of each section while also seeing how a whole report represents every aspect of the scientific method. Additionally, in Biology 21, we now provide specific guidance on each piece of the scientific process as they become necessary to conduct independent research projects. For example, we spend one hour on an activity designed to help students learn how to ask scientific questions and form those into testable questions, capable of being researched in a scientific setting.

Future Curricular Changes: Since nearly all students were successful, we do not see a need to make changes to our approach to PSLO #1. The PSLO itself was very straightforward to assess, given that the scientific process is deeply embedded in both Bio20 and 21 and the process components point to specific deliverables, such as sections of lab reports.

Changes to Language/Inclusion of PSLO #1 in Program: None

Professional Development & Next Steps: N/A

PSLO #2 Structure/Function CSLO Aggregation Summary			
Below	Meets	Exceeds	Total
115	116	65	296
38.85%	**39.19%**	**21.96%**	

Findings: The relationship between structure/function is a core theme in biology. Students are taught to decipher this relationship for biochemicals, cellular structures, and whole biological systems. Just over 61% of students met or excelled at recognizing and deciphering the structure/function relationship prevalent in biological systems. 39% of students did not recognize and explain relationships between structure and function, which could be due to:

- Vaguely written exam essay questions and lab practical questions
- Misinterpretation of exam questions
- Lack of familiarity with lab practical mechanics
- Difficulty recalling and articulating information (the exam is not multiple choice)
- Difficulty reaching higher order thinking to connect structure with function
- Student expectation of depth and breadth of course material does not align with instructor expectation
- Improper application of study techniques and/or time management

Students Self-Assessment of this PSLO: In the self-assessment given to students who had completed Bio 20 and 21 (n=40 students across 3 sections), students gave an average Likert scale score of 1.8 (scale of 1-4, 1 being highly proficient) to their perceived competence in this PSLO and cited emphasis of transcription/translation in lecture and discussions, field trips in which we compare forms found in the field and discuss varied functions, dissections, homology, BLAST, fruit fly labs, and videos shown in class. Students primarily mentioned hands-on experiences.

Recent Curricular Changes: After CSLO assessment in Cycle 1, we ramped up focus on structure/function, particularly on lab practical exams. We hope this will continue to give students opportunities to practice articulating the connection between the biological forms and functions.

Future Curricular Changes: To improve student competency, when the compressed calendar begins, we are considering breaking out the current two lab practical system into smaller quiz-like practicals that occur more regularly throughout the semester. This will give students more practice at taking this type of timed exam, lessen the amount of information per practical, and students will get feedback more often which should increase performance. We are also always working on editing the essay prompts to help direct students to focusing on targeted concepts in their responses. Potentially, giving students opportunities to reflect on the strategies they are using to study and sharing those strategies among peers will also provide all students with a clear path moving forward in the testing cycle in our program and beyond.

Changes to Language/Inclusion of PSLO #2 in Program: We agreed to change PSLO #2 to the following: *Describe the relationship of structure & function at and between molecular, cellular, and organismal levels*

Professional Development & Next Steps: Training in how to write clear exam questions, as well as departmentt-wide discussions on how to best accommodate students as we transition to compressed calendar would both be helpful. In terms of our next rounds of CSLO assessment, we might consider field-testing our assessment questions with each other and former students to ensure we are asking what we think we are asking. As mentioned above, providing students with more opportunities to practice the test-taking process in lower stakes environments and allowing for some class time to share best practices in studying will both benefit our students, their scientific explanations, and their performance on exams. Providing examples of model responses might be a concrete strategy to explore in class. Course leads (Jancy Rickman and Briana McCarthy/Jill Bouchard) will facilitate these next steps, drawing out these practices during FLEX sessions at the beginning of each semester with instructors teaching these courses.

PSLO #3 Unity/Diversity Post Rubric Scores			
Below	Meets	Exceeds	Total
12	18	10	40
30.00%	**45.00%**	**25.00%**	

PSLO #3 Comparison of Pre-Post Scores (out of 8)				
Mean Pre	Mean Post	Mean Gain	t value	p value
4.52	5.32	0.8	2.788	0.00407

Findings: In the sample population of students, the average age was 22 and the gender distribution was male 46%, female 54%. Students self-identified as Hispanic 42.5%, African American 22%, White 17.5%, and Asian/Filipino 12.5%. In terms of financial aid, 79% were receiving the BOG waiver and only 18% (7 students) were a first generation college student.

In terms of post rubric scores, 70% of students met or exceeded proficiency (greater than a 5 on the 8-point conceptual rubric). The mean pre-score was 4.52, the post- was 5.32, with a mean gain score of 0.8. The difference between the pre- and post-scores was statistically significant ($p<0.05$). We hoped that students would give structure/function examples in both pre- and post-responses since all 40 students took Cell and Molecular Biology (Bio 20) prior to taking Organismal Biology (Bio 21).

We largely found students gave both cellular/molecular and body system examples of how structure supports function; however, we expected larger gains on the post- explanations. Although the 0.8 mean rubric score gain was statistically significant, we saw that Part C had the lowest subcategory score with lots of evolutionary knowledge present, just not the specific content we had intended to prompt (we were looking for evolutionary mechanisms, such as genetic drift, sexual selection, etc, and students were instead speaking to specific aspects of cellular reproduction). Overall, we did not see students bringing specific conceptual knowledge to the table on evolution after a whole semester of a course focused on evolution. Potential reasons could include:

- We did not use the word "evolution" in Part C of the prompt
- We did not provide specific prompting in the question in order to elicit evolutionary mechanisms
- Students are energetic and eager to make conceptual connections from past courses (such as Bio20) at the beginning of the semester
- Students are fatigued at the end of the semester and less likely to strive to make connections
- We do too much at the end of the long semester to allow for space to make conceptual connections

Analysis of demographic groups was difficult with small numbers, but we found no significant differences in mean gains by gender, race, financial aid status, or first generation status. Although older students had higher gains and higher pre- scores than younger students, there was no statistically significant difference (at $p<0.10$ level) between the two groups (21 or older, 20 or younger). This is interesting because it suggests we may want to explore some specific strategies for engaging younger students, or consider reconstructing the major's educational plan so students are encouraged to take Bio 20 and Bio 21 in their second year at Los Medanos versus their first year.

Students Self-Assessment of this PSLO: In the self-assessment given to students who had completed Bio 20 and 21 (n=40 students across 3 sections), students gave an average Likert scale score of 1.56 (scale of 1-4, 1 being highly proficient) to their perceived competence in this PSLO and cited dissections, discussions, lectures, and the Tree of Life lab. Students recognized that this was a theme in Biology 21; some even noticed that while the theme was present in Biology 20, Biology 21 drew it out and named it. This seems ideal!

Recent Curricular Changes: In Bio21, we shifted the introduction of the course along with each unit to emphasize the concept of unity (living things share common ancestors and life functions) and diversity (the environment has selected for/against particular structures that have allowed organisms to survive and reproduce). This is a liminal concept in Biology: it draws the boundary between students who are stuck in a very novice understanding of evolution and a more developed understanding. This emphasis was recently implemented in the last two years (after the CSLO assessment was done), but before the PSLO assessment was done.

Future Curricular Changes: We did see gains in student understanding of this concept, yet would like to guide students towards using more of the developed language of evolution in both lecture and lab. This would include emphasizing mechanisms of evolution throughout the semester in Biology 21, not just halfway through when we name the mechanisms. Also by not "leaving the concept behind" when we move onto animal body systems, we could guide students' thinking in pondering what mechanisms are responsible for the varying structures we see in the diverse plants and animals we focus on during field trips and dissections. By challenging students to think about which mechanisms apply to which settings, we could facilitate higher order thinking on the connection between env pressures and evolutionary directions.

We also came up with more specific pre/post prompts for next CSLO/PSLO assessment (see example below). We would like to give the pre-assessments during the first week, hold onto these pre-assessments, and then distribute them during the final exam so that students can reflect back on their preliminary thinking around these concepts. We believe this would facilitate deeper reflection and metacognition around why their thinking has potentially changed. We suggest the following

> ***Pre:*** *Pick a function that is shared among organisms – draw on your cell and molecular knowledge from Biology 20 or a previous biology class/experience. Ex: using oxygen to produce ATP.*
> ***Post:*** *Look back at your response from the beginning of the semester and reflect on how your ideas have changed. Name some organisms that exhibit functions, discuss their different structures, and from an evolutionary perspective, how it is that these organisms accomplish the same function with different structures. (Ex response: Plants have stomata for gas exchange to support respiration and photosynthesis. Fish have gills for gas exchange through water to support respiration. Humans have lungs for gas exchange through air to support respiration. Mutations likely led to these variations and were selected for/against by different environments (like dry v. wet))*

Changes to Language/Inclusion of PSLO #3 in Program: We agreed to change PSLO #3 to:
Describe how evolutionary processes explain the similarities and differences among organisms.

Professional Development & Next Steps:
We first need to determine where in our PSLOs to cut concepts and/or represent the concepts in a different manner or with reduced language. In both Biology 20 and 21, it may be productive to think about how to engage our younger learners. Understanding generations that are not our own could entail attending professional development sessions on intergenerational communication, as well as talking to our younger students to find out how they learn best and ways they consume information. This in general is a good practice.

To further support and improve upon our students' learning, Bio 21 instructors should make a game plan of how to draw out evolutionary mechanisms across the curriculum, not just in one discrete place. We can also strategize on how to thoughtfully distribute the course workload so that more is happening early/mid semester and less at the end. For example, we can hold the last lab practical earlier in the semester and administer the final exam before the final research presentations. By doing this, students have more time to reflect on making connections of their research to course concepts. Another option is to hold the presentations well before the final exam and final ecology unit, which would give instructors a chance to address students ecology research topics in ecology-focused lectures. Next steps will be discussed in Spring 2018 FLEX (Leads: Briana McCarthy, Jill Bouchard).

PSLO #4 Ecology Rubric Subcategory Scores			
Below	Meets	Exceeds	Total
0	4	7	11
0.00%	**36.36%**	**63.64%**	

Findings: All student groups (100%) demonstrated an understanding of how their chosen ecology research topic benefits humans. Given that students spend an entire semester thinking about their ecology research concepts and are asked to explain applications at multiple points during the semester (on proposal, during research update presentations, and during final presentations), this finding is perhaps not surprising. We did not assess students individually on this PSLO, which may have yielded very different results.

Students Self-Assessment of this PSLO: In the self-assessment given to students who had completed Bio 20 and 21 (n=40 students across 3 sections), students gave an average Likert scale score of 1.66 (scale of 1-4, 1 being highly proficient) to their perceived competence in this PSLO. In their responses, students cited lectures on deforestation and defaunation, as well as readings and discussions on ecosystem goods and services as contributing to their understanding. They did not mention the ecology research topics as much, despite working on them for most of the semester. These data provide further evidence that we need to explore ecology-related concepts more in depth at the beginning of the semester when research projects are being developed, emphasize that starting with what we know is how we figure out what we don't know and what needs research attention. Alternatively, the emphasis on students citing ecology-related lecture/lab material instead of the research project could also be a function of the material being fresh in their heads since these concepts are covered at the end of the semester.

Recent Curricular Changes: Recently in Biology 21, we also brought ecology to the forefront by starting the semester with biodiversity. We have also discussed focusing on more ecological concepts at the beginning of the semester to inform selection of ecology research topics, but this has not been fully implemented.

Future Curricular Changes: Given that student groups scored well on this PSLO, we do not have concrete steps linked to our findings for this particular round of assessment. However, in Biology 21, we would like to flesh out ecology principles earlier on in the semester, as well as provide students opportunities to connect their particular research topic to course ecology concepts and beyond in their final presentations. Co-evolution and the ecological implications of removing one partner of a pair or a system may also allow students to make more distinct connections between evolution and ecology. By making some of the shifts described in PSLO #3 curricular changes above (shifting final exams to two weeks before the semester ends and focusing entirely on projects in last couple weeks), we may find students make more meaning out of their projects and make more connections between their project topics and course concepts.

Changes to Language/Inclusion of PSLO #4 in Program: New format:
Explain the interdependency among living and non-living things in diverse and changing ecosystems.

Professional Development & Next Steps:
Biology 21 instructors will sit down at the beginning of the Spring 2018 semester and discuss concrete strategies for bringing in ecology-related readings, discussions, and lectures, to begin developing a deeper understanding and interest in topics for research projects. Additionally, Briana will share best practices from recent professional development workshop on CUREs (Course-embedded Undergraduate Research Experiences).

Closing Thoughts: Some general observations about the types of skills our students struggle with that may have an impact on PSLO assessment performance:

- Time commitment and attendance
- Comprehension of challenging course material
    - Course advisories include High School Biology and Chemistry but most took H.S. Biology freshman year.
    - Recently we changed this advisory to AP H.S. Bio and Chemistry starting in the Fall 2018 -19 catalogue.
- Reading comprehension, which impacts following lab manual directions, interpreting exam questions, and utilizing the text book for in-depth study.

Summary of Changes to PSLO Language:

- **PSLO #1** (no change): Utilize the scientific method to develop hypotheses, conduct scientific experiments, critically analyze experimental data, and communicate results through written reports and oral presentations.
- **PSLO #2**: Analyze the relationship of structure & function at and across molecular, cellular, and organismal levels.
- **PSLO #3**: Describe how evolutionary processes explain the similarities and differences among organisms.
- **PSLO #4:** Explain the interdependency among living and non-living things in diverse and changing ecosystems.

Part 5: Report Summary

Lastly, sum up your PSLO assessment in 400 words or less. This summary, along with all program assessment summaries, will be made public on the LMC website's Program Assessment page and used to inform our accreditation self-evaluation.

The Biological Sciences program sought to determine the extent to which Biology major students meet proficiency in the program student learning outcomes (PSLO). Specifically, we determined to what extent we are supporting students in: understanding the scientific process (PSLO #1), utilizing evidence to explain the relationship between structure and function (PSLO #2), utilizing an evolutionary framework in explaining unity and diversity (PSLO #3), and evaluating aspects of ecology and interactions among living organisms (PSLO #4).

We utilized a variety of assessments, including evaluating parts of students' capstone ecology research projects and lab reports, administering pre/post in-class written assessments, and scoring lab practical/exam questions. Overall the general theme was that students are meeting proficiency (70% and above) in all but one of the outlined PSLOs (#1, 3, 4, but not #2). The details of what we found, and what we plan to do, are outlined below.

For **PSLO 1**, we found that students (~100%) showed evidence of understanding the scientific process. Distributing lab report sections throughout the semester (vs. submitting a final report) with feedback supported students in developing scientific analysis and writing skills. We will continue to provide feedback, give students opportunities to incorporate feedback, and share examples of excellent student work.

For **PSLO 2**, 60% of students met expectations in demonstrating an understanding of structure and function. This may be in part due to the PSLO itself being too wordy for instructors and students to make meaning of

it. We plan to clarify and simplify this PSLO. To further support instructors we will create and share a list of structure/function examples to help ensure they are embedded in all of our curricula. Finally, we will incorporate more low stakes assessment opportunities (e.g., quizzes, practice questions) leading up to lab practical and/or lecture exams.

For **PSLO 3**, 70% of students met expectations in demonstrating understanding of unity/diversity: pre-to-post gains of the assessments were not as high as expected. Students did not bring up specific concepts (e.g., mechanisms of evolution), likely because they were not prompted to and the question was at the end of a long assessment. We will further revise and clarify our prompts on this assessment and more deeply embed evolutionary processes through all aspects of curriculum.

For **PSLO 4**, although students met proficiency, students need support connecting ecology concepts to their research projects. We propose more explicit connection between ecology research topics and lecture content. Mid-point research check-ins will incorporate course ecological concepts. Ecological concepts will also be introduced earlier so students have guidance on what project topics are possible.

** If available, please include the assessment collection or analysis tools you used, such as exam questions, essay prompts, or rubrics, at the end of your report [*copy and paste into this same document to limit your report to one file*].**

Appendix:

Post-Assessment for PSLO #3:

Biology 21: PSLO Post-Assessment - Spring 2017

You will once again be participating in our program assessment process, which will help us think about how to more thoroughly support you and your learning. This short assessment activity will not affect your grade or performance in the class. Please do your best!

1. Have you taken Biology 20 (Cell & Molecular Biology) or equivalent course?
Yes **No**

2. If you answered yes above, where did you take Biology 20 or equivalent course?

_____

3. If you answered yes above, when did you take Biology 20 or equivalent? Indicate term and year.

_____

4. "I have heard of PSLOs (Program-Level Student Outcomes) before."
Circle a number below.

1	2	3	4
Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**

Question 5

Please read **ALL** parts of the question carefully before you choose an example and begin writing. Make sure to respond specifically and thoughtfully to each question.

Thinking about all the organisms on Earth and the unity and diversity of structures and functions across these organisms, consider the following questions:

Part A. Describe a specific function that is shared by many organisms.
(Non-biological example: *Functionally, all shoes protect the bottom of feet. This function is needed because...*)

Part B: Now, discuss a specific example of how TWO different organisms accomplish this function using different structures.
(Ex: *High heels and running shoes structurally accomplish the above task in very different ways…*)

Part C: Propose an explanation for how these structures came about or developed.
(Ex: *High heels and running shoes likely came about in the following way(s)…)*

Instructions for Questions 6-9: For each of the below statements, circle a number AND respond to the questions under each statement.

Question 6

"I feel proficient utilizing the scientific method to develop hypotheses, conduct scientific experiments, critically analyze experimental data, and communicate results through written reports and oral presentations."

1	2	3	4	5
Strongly Agree	**Agree**	**Neither Agree/Disagree**	**Disagree**	**Strongly Disagree**

What about this statement do you agree with? What do you disagree with? How did you gain proficiency? What specific Bio21 and/or Bio20 activities, lectures, labs, or experiences helped you gain proficiency in the above outcome?

Question 7

"I feel proficient identifying and/or describing the correlation between structure and function in living organisms, including the functional roles of the internal and external structures of cells, the basic relationship between DNA, proteins, and the transmission of traits, and the similarities and differences between metabolic processes and structures of diverse living organisms that allow them to exhibit distinctive characteristics of life."

1	2	3	4	5
Strongly Agree	**Agree**	**Neither Agree/Disagree**	**Disagree**	**Strongly Disagree**

What about this statement do you agree with? What do you disagree with? How did you gain proficiency? What specific Bio21 and/or Bio20 activities, lectures, labs, or experiences helped you gain proficiency in the above outcome?

Question 8

"I feel proficient explaining how evolution provides a framework for understanding the unity, diversity, and interdependency of living organisms."

1	2	3	4	5
Strongly Agree	**Agree**	**Neither Agree/Disagree**	**Disagree**	**Strongly Disagree**

What about this statement do you agree with? What do you disagree with? How did you gain proficiency? What specific Bio21 and/or Bio20 activities, lectures, labs, or experiences helped you gain proficiency in the above outcome?

Question 9

"I feel proficient evaluating aspects of ecology and interactions among the life forms on Earth – including the implications of human economic and cultural practices on the Earth's natural resources. I comprehend the numerous ethical implications and applications of bioscience concepts to my everyday life."

1	2	3	4	5
Strongly Agree	**Agree**	**Neither Agree/Disagree**	**Disagree**	**Strongly Disagree**

What about this statement do you agree with? What do you disagree with? How did you gain proficiency? What specific Bio21 and/or Bio20 activities, lectures, labs, or experiences helped you gain proficiency in the above outcome?

Rubric for PSLO #3: Total possible points +8

Response Components	3 points	2 points	1 point	0 points
Part A. Describes purpose of identified function shared by two organisms	N/A	1) Identifies shared function (ex: gas exchange) 2) Indicates purpose of function (ex: gas exchange processes inputs/outputs for ATP production)	Only discusses 1 item from left	Discusses none of these items
Part B. Describes variation in structures that accomplish shared function	1) Discusses one structure/method (ex: air sacs in bird respiratory system) 2) Discusses another different structure/method (ex: spiracles & tracheoles in insects) 3) Explains how variation relates to function (ex: air sacs hold addl air to maximize ATP production; spiracles intake oxygen and deliver directly to cells for ATP prod)	Only discusses two items from left	Only discusses 1 item from left	Discusses none of these items
Part C. Provides mechanism of evolution & explains how mechanism led to diversity in structure	Provides mechanism(s) of evolution (ex: mutation, natural selection, genetic drift, sexual selection, migration, or crossing over) & reasoned explanation for how mechanism led to diversity (ex: random mutations led to air sacs in birds and spiracles in insects – variations gave selective advantage and passed on to offspring)	Provides mechanism(s) & limited explanation (ex: mutations selected for/against through natural selection)	Provides mechanism (s) (ex: mutation)	Discusses none of these items

PSLO #4 Ecology Research Group Presentation Rubric Subcategory: Total Possible Points +3

0	1	2	3
Presenters do not address application of research to ecological issues	Presenters do not address application of research to ecological issues/ Presenters acknowledge that research is ecological in nature.	Presenters make a general connection to a local ecological issue (investigating water loss in plants can inform drought management efforts)	Presenters make a specific connection to local ecological issue (Understanding how plants respond to drought allows us to select and manage drought-tolerant plants in food production, landscaping, and restoration contexts such that we maximize ecological health and productivity)