

Lincoln University  
School of Natural Sciences and Mathematics

## Biology Program Assessment Report for 2010-2011

Submitted by the Faculty of the Biology Department

5/6/11

David Royer, PhD, Co-Chair  
Susan Safford, PhD, Co-Chair  
Anna Hull, PhD, Co-Chair  
Karen Baskerville, PhD  
James Gallagher, PhD  
Dianne York, MS  
Nancy Smith, MS

## Table of Contents

I.	Mission.....	page 3
II.	Program Goals.....	page 3
III.	Student Learning Outcomes (SLOs) and Matrix of Program Major Courses .....	page 4
IV.	Assessment Methods and Sources of Data .....	page 4
V.	Summary Analysis of Assessment Results.....	page 6
	a. Executive Summary.....	page 6
	b. Program Level Assessment.....	page 10
	c. Assessment of SLO 2.....	page 10
	d. Assessment of SLO 4.....	page 11
	e. Assessment of SLO 5.....	page 12
	f. Assessment of SLO 6.....	page 13
VI.	Using Assessment Results for Program Improvement	
	a. Improving Teaching and Learning.....	page 14
	b. Improving the Assessment Process.....	page 14
VII.	Planned Actions for the Next Assessment Cycle.....	page 15
VIII.	Showcasing Best Practices.....	page 16
IX.	Appendices.....	page 17

## **I. Mission**

The mission of the Department of Biology is to provide a challenging and supportive educational experience for our students so that each student can achieve his or her educational goals. Our Biology curriculum is sufficiently diverse to prepare our students for the broad variety of postgraduate opportunities that exist in biology; it is unified so that each student experiences all the relevant areas of biology, and it is current and reflective of the new information and methodology in the field. The Biology major provides a strong grounding in biology, chemistry, physics and mathematics, and then allows flexibility in the selection of electives. Recommendations for electives are offered for students interested in pursuing interests in medicine, specialized graduate study, the many careers in the allied health professions, and the teaching of biology in secondary schools.

## **II. Program Goals**

1. To prepare students to conduct and communicate original scientific investigations
2. To provide a curriculum that cultivates the students' knowledge base of the foundational areas of biology at the molecular, cellular, organismal and ecosystem levels of organization
3. To prepare and graduate students who enter graduate school or professional school or who obtain employment in biology-related fields

## **III. Program Student Learning Outcomes (SLOs)**

Upon completion of the program, students will be able to:

1. Apply the scientific method and complete an independent research project.
2. Communicate effectively biological concepts through written, spoken and visual means.
3. Explain the processes that lead to evolutionary change and recognize biological structures and functions as products of evolutionary change.
4. Relate energy flow to nutrient cycling at multiple levels of biological organization.
5. Correlate structure and function at multiple levels of biological organization.
6. Describe how genetic information is stored, expressed and transmitted from one generation to the next.

Table 1 summarizes the courses in which each Program SLO is assessed. Each Program SLO is assessed in at least nine courses of the twenty-one courses offered as part of the major, and at least two of the program SLOs are measured in each course. The links between course and program SLOs are in Appendix 1, Table 1 and the course SLOs are listed in Appendix 1, pg 19.

**Table 1:** Program SLO Assessment by Course for the Biology Curriculum

Course Name	Course ID	Program SLO assessed					
		1	2	3	4	5	6
<b>Introductory courses:</b>							
General Biology I	103	x	x	x	x	x	
General Biology II	104	x	x	x	x		x
<b>Core courses:</b>							
Plant and Animal Systems	209		x	x	x	x	x
Genetics	208	x	x	x			x
<b>Electives:</b>							
Vertebrate Physiology	302		x		x	x	
Biological Techniques	305	x	x				
Histology	308		x			x	
Botany	309	x	x	x	x	x	x
Invertebrate Zoology	310		x	x	x	x	x
Conservation Biology	311		x	x			x
General Ecology	312		x	x	x		
Microbial Ecology	316		x	x	x	x	
Cancer Biology	319		x				x
Microbiology	401	x	x		x	x	x
Immunology	402		x			x	
Developmental Biology	404		x	x		x	x
Comparative Vertebrate Anatomy	405		x	x		x	x
Cell Biology	407		x		x	x	x
Molecular Biology	408	x	x				x
Neuroscience	412	x	x			x	
Senior Seminar	420	x	x				

#### IV. Assessment Methods and Sources of Data

##### *Standards for Student Learning*

The Biology Program has set **75% as the minimal acceptable score (MAS)** for student learning. Seventy-five percent was chosen because it equals a grade of C, and students must have a C average to graduate. The score is calculated by the direct measures listed below and determined by (1) the value earned based on a rubric, or (2) the score of the specific questions being used for assessment from a particular direct measure (e.g. if eight multiple choice questions from a final examination are being used for assessment, then the student would need to get six correct (75%) to reach the MAS).

The **standard for each direct measure**, which is the desired percentage of students who should reach the MAS of 75%, is listed below after each measure. The standards are generally set higher for assignments that allow students to collaborate and use outside resources because more students generally meet the MAS of 75% on these types of

measures, while the standard is set lower for more difficult direct measures. Standards are determined based on previous years' assessment results and will be reviewed on an annual basis as more assessment data are collected.

***Direct Measures:***

1. **Laboratory reports**
  - Measured by rubrics that calculate the students' competency in effectively communicating the hypothesis, purpose, methods, results and analysis of an experiment.
  - Standard: 75% of the students should reach the MAS of 75%.
2. **Laboratory notebooks**
  - Assessed by rubrics to measure effective communication of primary research methods, results and conclusions.
  - Standard: 50% of the students should reach the MAS of 75%.
3. **Essays**
  - Assessed by rubrics to measure effective communication of biological concepts.
  - Standard: 50% of the students should reach the MAS of 75%.
4. **Oral presentations**
  - Assessed by rubrics to measure effective communication of biological concepts.
  - Standard: 100% of the students should reach the MAS of 75%.
5. **Research papers**
  - Assessed by rubrics to measure the students' ability to use the scientific literature to research a topic and to use that research to write a grammatically-correct, coherent and well supported paper.
  - Standard: 75% of the students should reach the MAS of 75%.
6. **Pre- and post-tests**
  - Using select, course and program SLO-specific questions that are usually multiple choice, to assess learning.
  - Standard: 100% of the students should demonstrate learning gains on the post-test and 50% of students should reach the MAS of 75%.
7. **In-class assignments**
  - Designed to measure a specific SLO and assessed by rubrics.
  - Standard: 75% of the students should reach the MAS of 75%.
8. **Homework questions**
  - Designed to measure a specific SLO and assessed using rubrics.
  - Standard: 80% of the students should reach the MAS of 75%.
9. **Quizzes**
  - Entire quizzes or select quiz questions that measure a specific SLO.
  - Standard: 75% of the students should reach the MAS of 75%.
10. **Multiple-choice (MC) questions on hour and final exams**
  - Select MC questions designed to measure a specific SLO on exams.
  - Standard: 75% of the students should reach the MAS of 75%.
11. **Short answer questions on hour and final exams**
  - Select short answer and problem solving questions designed to measure a specific SLO on exams.

- Standard: 75% of the students should reach the MAS of 75%.
12. **Essay questions on hour and final exams**
- Select essay questions designed to measure a specific SLO on exams.
  - Standard: 50% of the students should reach the MAS of 75%.

**V. Summary Analysis of Assessment Results**

**a. Executive Summary**

Program SLOs 2, 4, 5, and 6 were assessed in the current cycle. The report is organized by SLO; for each SLO there is a summary analysis. The tables that show the percentage of students achieving the MAS and the analysis and planned actions for each SLO are in the Appendix. Tables 2 and 3 summarize the assessment methods that were used in each course for each SLO assessed in the fall and spring respectively. The italicized assessment methods are the ones that are discussed in this report and are summarized in individual tables in appendix I.

**Table 2:** Assessment of Program SLOs in Biology, Fall 2010

Course Name	Course ID	Program SLO and assessment methods					
		1	2	3	4	5	6
<b>Introductory Courses:</b>							
General Biology I	BIO 103				<i>Pre-post-test</i>	<i>Pre-post-test</i>	
General Biology II	BIO 104						<i>Homework Essay on exam</i>
<b>Core Courses:</b>							
Plant and Animal Systems	BIO 209					<i>Homework Quiz</i>	
<b>Elective Courses</b>							
Vertebrate Physiology	BIO 302		<i>Essays</i>			<i>In-class assignment</i>	
Botany	BIO 309		<i>Oral Presentation</i>	Essay on exam	<i>Homework Essay on exam</i>	<i>Homework</i>	
Invertebrate Zoology	BIO 310	Research paper	<i>Oral Presentation</i>			<i>Essay on exams</i>	
Cell Biology	BIO 406				<i>Pre-post-test</i>	<i>Pre-post-test</i>	<i>Pre-post-test</i>

*The italicized direct measures are the ones that are discussed in this report and are summarized in individual tables in the appendix.*

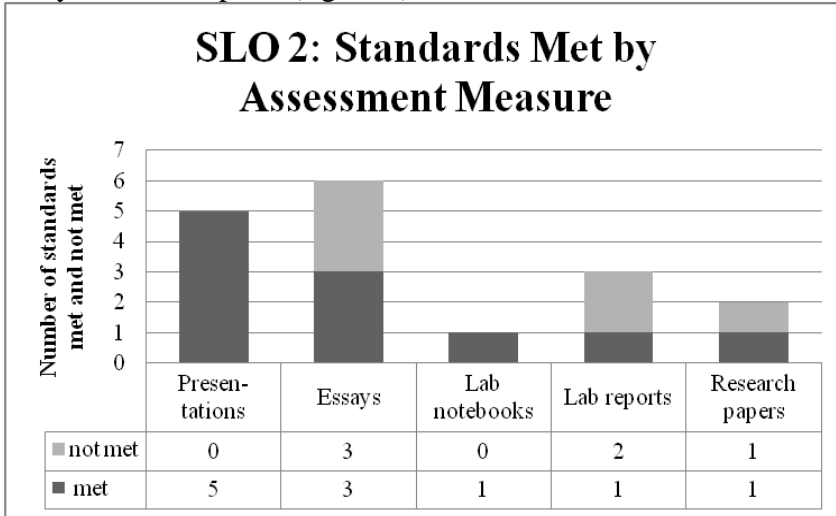
**Table 3:** Assessment of Program SLOs in Biology, Spring 2011

		Program SLO and direct measure					
Course Name	Course ID	1	2	3	4	5	6
<b>Introductory Courses:</b>							
General Biology I	BIO 103				<i>Pre-post-test Essay on exam</i>	<i>Pre-post-test Essay on exam</i>	
General Biology II	BIO 104		<i>Lab report</i>	Pre-post-test Homework Quiz Short answer on exam			<i>Pre-post-test Homework Quiz Short answer on exam</i>
<b>Core Courses:</b>							
Genetics	BIO 208		<i>Lab report</i>				<i>Pre-post-test Homework MC and short answer on exam</i>
<b>Elective Courses</b>							
Biological Techniques	BIO 305		<i>Lab notebook</i>				
Conservation Biology	BIO 311		<i>Presentation Research paper</i>				
Cancer Biology	BIO 319		<i>Essays</i>				<i>MC and essay on exams</i>
Comparative Anatomy	BIO 405		<i>Essays</i>	Pre-post-test		<i>Pre-post-test</i>	
Neuroscience	BIO 412	In-class assignment Homework	<i>Lab report</i>			<i>Pre-post-test MC on exam</i>	
Senior Seminar	BIO 420	Research paper	<i>Presentation Research paper</i>				

*The italicized direct measures are the ones that are discussed in this report and are summarized in individual tables in the appendix.*

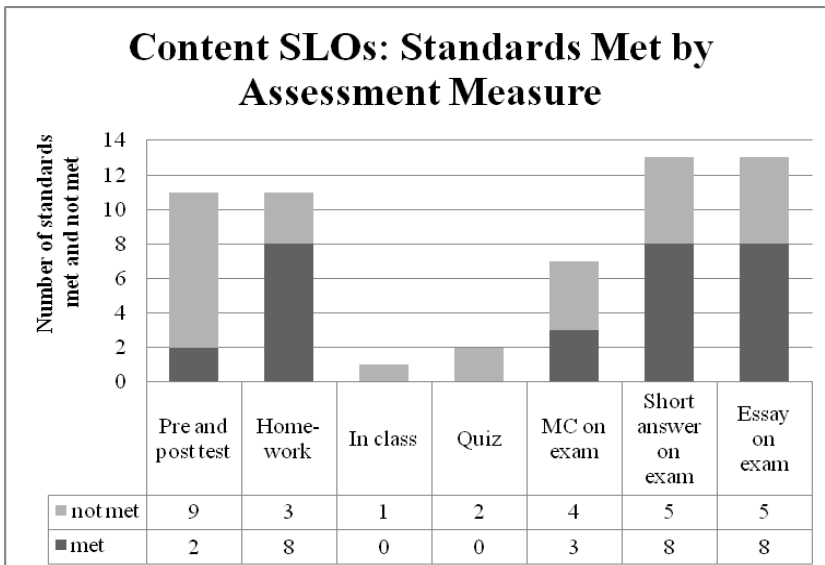
In total, 75 assessment measures were administered and the standard was met on 40 (or 53%) of these measures. For the purpose of analysis, the communication SLO (2) was separated from the content SLOs (4, 5, and 6). The communication SLO (2) had 17 measures and the standard was met on 11. Significantly, students met the communications SLO on oral presentations every time it was assessed, but they did not

meet the standard for the same SLO as measured by writing assessment tools, especially essays and lab reports (figure 1).



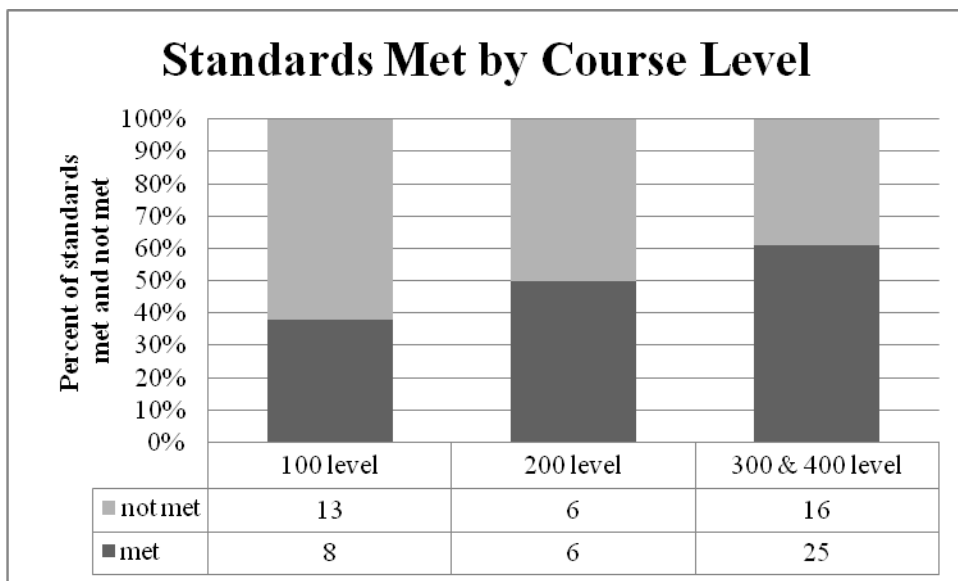
**Figure 1. SLO 2: Standards met by assessment measure.** The table below the graph summarizes the number of assessments that were met and not met for each measure.

For the content SLOs, there were a total of 58 individual measures; the standards were met on 29 of these measures, or 50% of the time (figure 2). The standard was met more than 50% of the time for three direct measures – homework, short answers on exams and essays on exams, and less than 50% of the time for the remaining measures. The standard was not met at all for in class assignments and quizzes, but there were only three reports of these two direct measures. Although most students display learning gains within a class as measured by pre and post-tests, the standard of everybody improving or 50% of the class meeting the MAS of 75% on the post-test was only met in two out of 11 classes.



**Figure 2. Content SLOs: Standards met by Assessment Measure.** The table below the graph summarizes the number of assessments that were met and not met for each measure.

When the data is analyzed by course level (figure 3), we find improvement in meeting the standard from 100 level to 300/400 level courses. In this analysis, the 300 and 400 level courses are combined because they are taken by a mix of juniors and seniors; the 100 level courses are taken exclusively by freshmen, and the 200 level courses are taken almost exclusively by sophomores. More assessment measures are administered in the 300 and 400 level courses because we offer more courses at that level.



**Figure 3. Standards met by course level.** The table below the graph summarizes the number of assessments that were met and not met for each course level.

In examining reasons why students are not meeting the various standards, several common issues appear repeatedly in faculty reports. These include:

- Students are underprepared coming into the introductory level courses.
- Students do not retain information.
- Students cannot integrate information from several sources when they are writing essays, research papers and other assignments that require this skill.
- Students cannot solve problems that require a multi-step process and/or quantitative skills.

We plan to address these issues through the following actions:

- Begin courses with a brief review of concepts and content that students are expected to have retained from previous classes at the beginning of each course.
- Provide more learning opportunities to help retention of knowledge.
- Provide more in class assignments that require writing and analysis of concepts.
- Spend more time in class on how to access multiple sources and collate the material into a coherent document.
- Remind students of the writing support services that exist on campus and encourage peer proof-reading of papers.
- Divide challenging concepts into step-wise problems that guide problem solving.

- Require students to analyze why each possible answer to a multiple choice question is or is not correct.
- Spend more instructional time on approaches to solving complex problems.
- Incorporate more assessment measure that allow students to work collaboratively, have access to unlimited resources with relaxed time constraints.

**b. *Program Level Assessment***

Assessment at the program level was conducted under program SLO 1 in senior seminar (BIO 420) this assessment cycle; students were assessed on a capstone research paper using the department research paper rubric (Appendix I, Table 2 and Appendix II, pg 44). Of the sixteen students assessed, 56% met the MAS of 75%. Our standard of 75% of the students meeting the MAS was not met. This year, students who conducted other types of capstone research (summer internship, study abroad, and/or research in the department) are not included in the analysis. These students will be included in future cycles as program SLO 2 is assessed.

**c. *Assessment of SLO 2***

Program Student Learning Outcome 2, students' ability to communicate biological concepts effectively through written, spoken and visual means, was assessed in eleven courses during the 2010-2011 academic year. The direct assessment tools included essays, lab notebooks, lab reports, presentations and research papers. The data are reported in Appendix I, Table 2 as the percentage of students reaching the MAS (75%) for each direct measure; Appendix I, Table 3 shows the data analysis and proposed actions for this SLO. The data in Table 3 can be divided into two categories, oral presentations and written assignments; because of the disparity in students achieving the MAS of 75% on these two types of assignments, they are considered separately.

*Oral Presentations* – In all five assessments using this measure, 100% of the students achieved the MAS. In the fall (two assessments), each faculty member used a different rubric for scoring the presentations; in the spring, a common department rubric was developed and used to score the presentations. In interpreting the achievement rate, the following points were viewed as significant:

- Students had a full semester to develop familiarity with the subject matter for the report.
- Since students chose their topic, it can be assumed that they chose a topic for which they already had an interest or some knowledge.
- Students enjoy preparing PowerPoint presentations.
- Students are motivated to do well in front of their peers.
- Peer evaluations, which were used in one course, may produce generous scores.

Because of the high achievement rate, we will continue to have students choose topics early in the semester and establish transition steps e.g. a required outline of the presentation at the midpoint of the semester. If time permits within the structure of the course, students could be required to do a shorter presentation earlier in the semester.

*Written Assignments* – Because of the diversity of written assignments, the range of the percent of students achieving the MAS was wide (27% to 100%). Two of the direct measures, lab reports and research papers, were scored using a common department rubric. The students exhibited the most difficulty in achieving the MAS when writing essays, either as part of an exam or as an assignment. In interpreting student performance, we have identified the following issues:

- It is difficult for students to gather data from multiple sources and collate it into a single document.
- Students lack confidence in their ability to perform well on written assignments even when they can choose the topic, have opportunities for revision, etc.
- Students have deficiencies in grammar and spelling.
- Students do not take advantage of the opportunity to submit rough drafts for review and feedback.
- The lab report is a new type of assignment for many students in the freshman and sophomore years.

Actions that may improve performance in written assignments include:

- more time spent in class on how to access multiple sources and collate the material into a coherent document
- instruction on how to write a lab report with emphasis on discussion of results
- encourage students to meet deadlines
- remind students of the writing support services that exist on campus
- encourage students to ask their peers to proof read their papers

**d. *Assessment of SLO 4***

Program Student Learning Outcome 4, students are able to connect nutrient cycling and energy flow at multiple levels of biological organization, was assessed four times in three different courses (two semesters of BIO 103) spanning entry level freshman to senior students during the 2010-2011 academic year. The direct assessment tools included pre- and post-tests, homework assignments and essay questions on exams. The data are reported in Appendix I, Table 4 as the percentage of students reaching the MAS (75%) for each direct measure; Appendix I, Table 5 shows the data analysis and proposed actions for this SLO.

The few data points make strong generalizations difficult, but generally, over half the students reached the 75% MAS. In interpreting the achievement rate, the following points were viewed as significant:

- Post-test scores were higher than pre-test scores, but the 50% standard for post-tests was not met in any class; the largest increase was 20%.
- Students perform best under conditions of no time constraints and availability of multiple resources, as evidenced by the score (84%; exceeded the MAS of 75%) on the one homework assignment assessed.
- Students have difficulty writing about biological concepts, especially under time constraints and when they have to rely upon retained knowledge.

- A significant portion of our students struggle to answer questions or solve problems when they are required to work independently and to rely only on retained knowledge under time restriction.

Actions that may improve performance in all assessment measures include:

- more in class assignments that require writing and analysis of concepts and that closely resemble the questions asked on exams
- more homework assignments that rely on analysis and not rote memorization and that closely resemble the questions asked on exams
- a brief review of concepts and content that students are expected to have retained from previous classes at the beginning of each course

Actions that may improve our ability to assess student performance include:

- assessing this SLO in more classes
- assessing this SLO using a wider range of assessment measures
- using the same type of assessment measure in a range of courses
- designing select questions to embed in various assignments across different levels of the curriculum to better measure changes in student's performance with repeated exposure

**e. *Assessment of SLO 5***

Program Student Learning Outcome 5, students' ability to correlate structure and function at multiple levels of biological organization, was assessed in nine courses spanning entry level freshman to senior students during the 2010-2011 academic year. The assessment measures included pre- and post-tests, homework assignments, in class assignments, quiz questions, and multiple choice questions, short answer and essay questions on exams. The data are reported in Appendix I, Table 6 as the percentage of students reaching the MAS (75%) for each direct measure; Appendix I, Table 7 shows the data analysis and proposed actions for this SLO. This SLO has been measured at all levels of the curriculum.

The range of students achieving the MAS of 75% was large (0-100%) at all course levels and with all assessment measures, although homework assignments and essays exhibited more narrow ranges. Generally, about half the students reached the 75% MAS. In interpreting the achievement rate, the following points were viewed as significant:

- Post-test scores were higher than pre-test scores, but the 50% standard for post-tests was met in only two classes.
- Students perform best under conditions of no time constraints and availability of multiple resources, as evidenced by scores on homework assignments.
- Students have difficulty writing about biological concepts, especially under time constraints and when they have to rely upon retained knowledge.
- A significant portion of our students struggle to answer questions or solve problems when they are required to work independently and to rely only on retained knowledge under time restriction.

Actions that may improve performance in all assessment measures include:

- more in-class assignments that work through difficult problems on a step-by-step basis and that closely resemble the questions asked on exams
- more homework assignments that rely on analysis and not rote memorization and that closely resemble the questions asked on exams
- a brief review of concepts and content that students are expected to have retained from previous classes at the beginning of each course
- require students to analyze why each possible answer to a multiple choice question is or is not correct

Actions that may improve our ability to assess student performance include:

- using the same type of assessment measures for the same SLO in a range of courses
- designing select questions to embed in various assignments across different levels of the curriculum to better measure changes in student's performance with repeated exposure

**f. *Assessment of SLO 6***

Program Student Learning Outcome 6, students' ability to describe how genetic information is stored, expressed and transmitted from one generation to the next, was assessed in six courses during the 2010-2011 academic year. The direct assessment tools included pre- and post-tests, homework assignments, multiple choice questions on exams, short answers on exams, and essays on exams. The data are reported in Appendix I, Table 8 as the percentage of students reaching the MAS (75%) for each direct measure; Appendix I, Table 9 shows the data analysis and proposed actions for this SLO.

In total, there were 13 assessment instruments, four in the fall and nine in the spring. For the spring semester, the nine assessment instruments can be broken down into 15 separate scores since some measures include two or more elements (e.g. the BIO 104 and 208 homework instruments measured performance on two separate genetics problems). The standard was achieved on 10 of the 15 separate measures.

An innovation for the spring was using two different courses (BIO 140 and 208) for the assessment of student performance on the same two genetics problems, and within the courses, the problems were assigned as homework and appeared on at least one exam. The first problem was based on a fundamental concept (monohybrid cross) and requires relatively simple analysis; the MAS was achieved on all six instances for this assessment measure. The second problem required more sophisticated analysis (dihybrid cross); the MAS was not met in any of the five assessments by this measure. The conclusion is that more class time needs to be devoted to more complex genetic analysis in future semesters and that more assignments with complex analysis requirements should be developed.

For the academic year, students achieving the MAS for this SLO ranged from 0% to 96%. The lowest percentages were on pre-tests, and the higher percentages occurred in courses that included significant genetics content – BIO 104 and 208. This suggests that students can do well with genetics concepts when they are actively studying genetics, but they have difficulty applying the principles in courses where genetics is not the primary focus.

The collective interpretation of the assessment for this SLO includes the following observations:

- Tests do not always reflect the classroom instruction.
- Students do not retain course information.
- Students are not given enough learning opportunities to master course content.
- Learning gains in genetics are evident from freshman year to sophomore year.
- Both freshman and sophomore students master simple genetic analysis, but not complex genetic analysis.
- Learning gains are observed within the BIO 208 class for the dihybrid cross.

Actions that can improve performance with respect to SLO 6 include:

- improve tests to better reflect what is being taught in the classroom
- provide more learning opportunities to help retention
- divide challenging concepts into step-wise problems that guide problem solving
- assign additional and more challenging homework assignments for this SLO
- spend more instructional time on complex genetic analysis
- continue to assess the dihybrid cross, as a type of complex analysis in the future for both BIO 104 and 208 so that cohort data will be available

## **VI. Using Assessment Results for Program Improvement**

### **a. *Improving Teaching and Learning***

- We need to find ways to get students, particularly underprepared students, to take advantage of the tutoring opportunities that are available to them.
- The types of questions asked on exams should better mimic those given to students in class through in-class assignments and homework assignments. This process was begun in the spring semester and will be expanded in the future.
- Class time should be used to train students in using multiple sources and in integrating the information from those sources to produce a coherent and well structured document. It is also important to show students that the skills they so successfully exhibit in preparing oral presentations can be adapted for written assignments.
- Provide more opportunities for students to learn collaboratively.
- To stimulate retention of material, an effort should be made to structure some questions on exams so that they require incorporation of material from previous parts of the course (or even previous courses).

### **b. *Improving the Assessment Process***

- SLO 5 was the only SLO measured using the same type of direct measure in several classes during the fall semester (Table 2). A slight trend towards more students reaching the MAS as they move through the curriculum was observed on homework and different types of test questions. In the spring, the same types of direct measures were used for SLOs 2, 3, 5 and 6 which gave us a better assessment of how our students are doing as they move through the curriculum. As in the fall, there was a

slight trend towards more students achieving the MAS as they moved through the curriculum.

- In the fall we recognized that using different direct measures for the same SLO gives widely varying numbers for percentage of student that meet the MAS. For the spring, we set standards for each direct measure. These standards will be improved to enhance assessment of student learning in the Biology Program based on the data that is collected in this and future assessment cycles.
- We have begun to collect assessment data to follow cohorts.
- In the fall, we decided that it would be useful to have standardized assessment tools that can be administered at different times in the curriculum to measure student improvement over time. In the spring, we used selected genetics problems as assessment tools in two courses – General Biology and Genetics. The data collected will be used to make changes in how genetics problems are taught in these courses in future assessment cycles.
- Common department rubrics were developed for research papers, lab reports and oral presentations; this was done after assessing the fall results in which we discovered that it was difficult to assess student improvement if we all used different rubrics. Department rubrics (Appendix II, pp 41-44) were developed and used in the spring semester.

## **VII. Planned Actions for the next Assessment Cycle**

### *Assessment of Specific SLOs*

In the next cycle we plan to report on the assessment of SLOs 1, 2, 4, and 6 for the following reasons:

- SLO 1, because it was not assessed in the current cycle. This SLO will be assessed through lab reports graded using the department rubric (Appendix II, pg 41).
- SLO 2, because student writing as measured by essays is weak and in most cases, has not met our standard in the current cycle. A department essay rubric will be developed for this purpose.
- SLO 4, because it is the least assessed content SLO in the current cycle.
- SLO 6, because we would like to continue to collect assessment data on student solving complex problems and to continue to collect cohort data.

### *Improving Assessment and Instruction*

Based on previous and current assessment analyses, we are planning the following actions to improve student learning and assessment:

- We have begun to and will continue to collect assessment data to follow cohorts.
- The standards set for each assessment measure will be reviewed and possibly modified to enhance assessment of student learning based on the data that is collected in future assessment cycles.
- The types of questions asked on exams should better mimic those given to students in class through in-class assignments and homework assignments. This process was begun in the spring semester and will be expanded in the future.
- Class time should be used to train students in using multiple sources and in integrating the information from those sources to produce a coherent and well structured document.

- We will provide more opportunities for students to learn collaboratively.
- To stimulate retention of knowledge by our students, we will structure some questions on exams so that the answers will require incorporation of knowledge from previous parts of the course (or even previous courses).

### **VIII. Showcasing Best Practices**

- *Standardization of Rubrics* – We used common rubrics in the spring of 2011 for grading oral presentations, research papers and lab reports. This allows us to compare the performances of our students longitudinally from freshman to senior years. In future years, the common rubrics will also allow us to review the performance of cohorts as they progress through the curriculum.
- *MAS and Standards* – A minimal acceptable score (MAS) of 75%, corresponding to a C grade, was established, and standards were identified for each type of direct measure based on the level of difficulty of the measure. This has given us a tool to measure student performance within courses and to compare performance between courses and between assessment methods.
- *Pair-wise Comparisons* – Two identical genetics problems were used multiple times in two courses, General Biology and Genetics, to allow for a pair-wise comparison; in every case, the same rubric was used to score the problems. This provided the opportunity to measure student retention of information within these two courses and between the courses. While this type of pair-wise comparison may not be feasible for many of our courses, it provides a unique perspective when it can be used.

## **Appendices Content**

### **Appendix I**

#### **2010-2011 Results and Analysis**

<b>Table 1:</b> Course and program SLO links	<b>18</b>
<b>List of course SLOs</b>	<b>19</b>
<b>Table 2:</b> Program SLO 2: Percentage of students reaching the minimally acceptable score (75%) for each direct measure	<b>24</b>
<b>Table 3:</b> Program SLO 2 Analysis and Proposed Actions	<b>24</b>
<b>Table 4:</b> Program SLO 4: Percentage of students reaching the minimally acceptable score (75%) for each direct measure	<b>27</b>
<b>Table 5:</b> Program SLO 4 Analysis and Proposed Actions	<b>27</b>
<b>Table 6:</b> Program SLO 5: Percentage of students reaching the minimally acceptable score (75%) for each direct measure	<b>29</b>
<b>Table 7:</b> Program SLO 5 Analysis and Proposed Actions	<b>29</b>
<b>Table 8:</b> Program SLO 6: Percentage of students reaching the minimally acceptable score (75%) for each direct measure	<b>33</b>
<b>Table 9:</b> Program SLO 6 Analysis and Proposed Actions	<b>33</b>

### **Appendix II**

#### **Sample Assignments, Direct Measures and Rubrics**

Direct Measure for BIO 103 with Rubrics	<b>37</b>
Direct Measure for BIO 104 and 208 with Rubrics	<b>38</b>
Research Assignment for BIO 311	<b>40</b>
Biology Program Common Rubric for Laboratory Reports	<b>41</b>
Biology Program Common Rubric for Research Papers	<b>43</b>
Biology Program Common Rubric for Oral Presentations	<b>44</b>

**Table 1:** Course and program SLO links

Course Name	Course ID	Course SLO linked to program SLO					
		pSLO 1	pSLO 2	pSLO 3	pSLO 4	pSLO 5	pSLO 6
<b>Introductory Courses:</b>							
General Biology I	BIO 103	cSLO 4	cSLO1, 28-31	cSLO 3	cSLO19-27	cSLO2, 5-18	
General Biology II	BIO 104			cSLO 8,9	cSLO 10	cSLO 7,8,9	cSLO 1-6
<b>Core Courses:</b>							
Genetics	BIO 208		cSLOlab				cSLO 1-8
Plant and Animal Systems	BIO 209		cSLO 1		cSLO 2, 10-12	cSLO 3,4,6-9, 13-17	cSLO 5
<b>Elective Courses</b>							
Vertebrate Physiology	BIO 302	Skill cSLO 1, 2, 4	Skill SLO 3, 5			cSLO 1, 2	
Biological Techniques	BIO 305	cSLO 1, 5-8	cSLO 2				cSLO 4
Botany	BIO 309		cSLO 2, 9	cSLO 1	cSLO 3, 4, 7, 8	cSLO 5, 6	
Invertebrate Zoology	BIO 310		cSLO 4	cSLO 1,2		cSLO 3	
Conservation Biology	BIO 311			cSLO 1, 2	cSLO 3	5	cSLO 2, 4
Cancer Biology	BIO 319		cSLO 1, 11-13			cSLO 6-10	cSLO 2-5
Comparative Anatomy	BIO 405		Skill SLO 1-3	cSLO 3		cSLO 1, 2	
Cell Biology	BIO 406	cSLO 13	cSLO14,15		cSLO 6	cSLO 1, 2, 7-11	cSLO 3-6, 12
Neuroscience	BIO 412		cSLO 4, 7			cSLO 1-3, 5	
Senior Seminar	BIO 420	cSLO 2	cSLO 1, 3				

## List of course SLOs

### BIO 103, General Biology I, course SLOs:

#### Content Outcomes:

1. Learn new vocabulary necessary to read and write well about biology
2. Be able to distinguish between prokaryotic and eukaryotic cells
3. Understand the basic classification system used for living organisms
4. Use and describe hypothesis-based science
5. Distinguish between elements and compounds
6. Name and define subatomic particles
7. Draw atoms based on atomic number and weight
8. Name and describe the different types of chemical bonds
9. Discuss the importance of hydrogen bonding to the properties of water
10. Describe the emergent properties of water and how they contribute to life on earth
11. Understand the relationship between pH and the structure of a water molecule
12. Draw and identify the structures of the basic organic molecules
13. Draw and identify the variations in the carbon skeleton that contribute to molecular diversity
14. Draw and identify the six basic functional groups associated with organic molecules
15. Distinguish between monomers and polymers
16. Learn the names and identify the structures of the different types of basic organic molecules
17. Learn the names and functions of the main cellular organelles, and identify them in drawings of cells
18. Learn the main components of cell membranes
19. Name and describe the three main types of transport across and through cell membranes
20. Describe the structure and function of ATP
21. Describe how enzymes work and discuss factors that influence enzyme function
22. Describe in detail the biochemical processes of glycolysis, citric acid cycle, and electron transport
23. Describe the light and dark cycles of photosynthesis
24. Describe the main steps in cell signaling
25. Describe in detail two different cell signaling systems – G-coupled protein receptors and tyrosine kinase receptors
26. Name and describe the two main phases of the cell cycle
27. Name and describe the phases of each the two main phases of the cell cycle

#### Skill Outcomes:

28. Learn to use a science textbook effectively
29. Navigate through course specific courseware and use it to help you learn on your own
30. Apply time management principles to complete assignments on time
31. Write well-constructed paragraphs on scientific subjects

### BIO 104, General Biology II, course SLOs:

1. describe the process by which cells divide to produce gametes
2. explain how meiosis and sexual reproduction lead to genetic diversity
3. explain the Mendelian rules of inheritance and non-Mendelian patterns of inheritance
4. be able to solve genetics problems involving monohybrid and dihybrid crosses involving incomplete dominance, codominance, epistasis and sex linked inheritance
5. describe the structure of DNA and the chromosomal basis of inheritance
6. explain, in a stepwise fashion, the processes of transcription and translation
7. describe how viruses infect cells
8. explain evolution and natural selection
9. evaluate the evidence for evolution
10. describe the structure and functions of ecosystems

### BIO 208, Genetics, course SLOs:

1. Describe in words and illustrations the progression of two pairs of chromosomes through all the stages of mitosis and meiosis.
2. Perform monohybrid, dihybrid and testcrosses and identify the genotypes and phenotypes of all possible first and second generation offspring in monohybrid and dihybrid crosses, including crosses containing epistatic interactions.
3. Perform chi-square analysis on genetic data and be able to determine the statistical significance of genetic outcomes.
4. Compare and contrast sex-linked and sex-influenced inheritance
5. Perform pedigree analysis of genetic traits; you will be required to analyze a family of your choice for a particular genetic trait.
6. Describe the structure and function of DNA and RNA
7. Draw and describe a replication fork and replicate a short DNA sequence.
8. With the aid of the genetic code, transcribe a gene and translate the transcript into a protein.

### BIO 209, Plant and Animal Systems, course SLOs:

By the end of the **Plant Systems** section, you will be able to:

1. Reflect on and discuss the role of plants on earth and in your life
2. Describe the role of photosynthetic organisms in evolution.
3. Describe the function of the three basic plant tissue types and identify them in each organ.
4. Describe how water and nutrients are transported in plants
5. Define alternation of generations and correctly identify meiotic and mitotic divisions in the life cycle of the plant.

By the end of the **Animal Systems** section, you will be able to:

6. Discuss how physical laws and the environment affect animal form.

7. Correlate animal form and function with the hierarchical levels of organization from molecules to the organism, with emphasis on the tissue, organ, and organ system levels.
8. Describe the structures in and functions of the digestive, circulatory, respiratory, immune, urinary, endocrine, nervous, skeletal, muscular, and reproductive systems.
9. Understand metabolism and discuss how animals use chemical energy to maintain form and function.
10. Describe the regulation of the internal environment of an animal by homeostasis and diagram homeostatic mechanisms.
11. Reflect on how carbon and essential nutrients are extracted from an animal's diet.
12. Describe the processes of ingestion, digestion, absorption, and elimination.
13. Discuss and illustrate gas exchange across a respiratory membrane.
14. Describe the excretory functions of the kidney.
15. Discuss neural and hormonal control.
16. Describe how an animal senses and carries out motor functions.
17. Distinguish between asexual and sexual reproduction.

**BIO 302, Vertebrate Physiology, course SLOs:**

1. be able to describe mechanisms of action of various physiological actions
2. be able to discuss special physiology cases

**Skill SLOs:**

1. be able to read and critique scientific articles on physiology
2. be able to use search engines and databases to find articles on specific physiological topics
3. be able to write grammatically and scientifically accurate essays on various topics in physiology
4. be able to interpret graphs and tables
5. be able to orally present a topic in physiology to a group of peers

**BIO 305, Biological Techniques, course SLOs:**

1. Enhance your experience in laboratory techniques in biology.
2. Keep an appropriate research notebook
3. Do basic laboratory techniques, such as preparing solutions and pipetting correctly.
4. Understand recombinant DNA concepts.
5. Isolate genomic DNA.
6. Analyze DNA by agarose gel electrophoresis, restriction digests, and PCR.
7. Do southern blotting and hybridization of PCR products.
8. Become familiar with western blotting techniques.

**BIO 309, Botany, course SLOs:**

1. Describe in writing how the evolution of photosynthesis enabled to the move of life from the oceans to land.
2. Discuss in writing how the modern world depends on plants.
3. Detail how energy is harvested from sunlight during photosynthesis.
4. Describe the different adaptations that plants have made to reduce photorespiration.
5. Identify ground, vascular and dermal tissues in all organs of both monocots and eudicots.
6. Identify and describe in words and illustrations the organs of the plant body.
7. Know the essential elements required for plant growth.
8. Describe in writing the transport of water and nutrients in plants during changing environmental conditions.
9. Communicate, in writing and through a presentation about a plant of your choice.

**BIO 310, Invertebrate Zoology, course SLOs:**

1. Students will be able to describe the evolutionary relationships of the major invertebrate phyla.
2. Students will be able explain the taxonomy of the invertebrates.
3. Students will be able to compare and contrast the characteristics of the major invertebrate phyla including anatomy, physiology of principal systems, distribution and ecology.
4. Students will be able to illustrate the relationships of selected invertebrates to humans.

**BIO 311, Conservation Biology, course SLOs:**

1. Students can chart the history of extinctions on Earth.
2. Students can explain the processes that lead to speciation and increases in biodiversity.
3. Students can analyze the balance between human needs and the needs of other species.
4. Students can describe common methods used to prevent extinction and assess the effectiveness of these methods.
5. Students can identify the geographic areas that are most likely to be used for human needs and the species that are at risk if these areas are utilized for humans.

**BIO 319, Cancer Biology, course SLOs:**

1. Describe the hallmarks of cancer.
2. Learn the types of gene mutation possible and how these mutations can contribute to cancer formation
3. Describe an oncogene and why it is important in cancer development
4. Describe the cell cycle, its regulation, and how cell cycle dysfunction can lead to cancer
5. Describe the function of tumor suppressor genes.
6. Describe how external or internal stimuli can lead to apoptosis.
7. Describe how cancer cells escape cell death.
8. List and describe the steps that lead to metastasis
9. Describe how chronic inflammation and infectious agents can lead to cancer

10. Explain the role of diet in cancer development and cancer prevention

Skill Outcomes

11. Expand scientific comprehension
  - a. Learn major components of scientific journal articles
  - b. Learn to interpret data published in scientific journal articles
  - c. Analyze and critique, in written and oral form, published cancer biology articles.
12. Learn to Organize data and information for presentation
13. Develop public speaking skills

**BIO 405, Comparative Anatomy, course SLOs:**

1. Analyze the concept of the complementarity of structure and function as exemplified by the effect of body size and shape on function
2. Compare and contrast systems (skeletal, muscular, digestive, respiratory, urinary, circulatory, and reproductive) among vertebrate classes.
3. Analyze the relationship between evolutionary concepts and our current understanding of modern morphology

Skill SLOs:

1. Draw accurately various structures in a wide variety of animals
2. Construct well written essays on the relationship between different structures and their functions
3. Orally present concepts of anatomy through reporting out in class on group problems

**BIO 406, Cell Biology, course SLOs:**

1. Cellular polymer biosynthesis
2. Protein Structure and function
3. How chromosomal DNA code is converted into protein
4. Gene Expression Control
5. Genetic Manipulation
6. DNA replication
7. Cellular energy generation
8. Membrane structure and transport
9. How cells communicate with each other
10. Apoptosis/necrosis
11. Cellular structure proteins
12. Eukaryotic Cell Meiosis and mitosis
13. Expand scientific comprehension
  - a. Learn major components of scientific journal articles
  - b. Learn to interpret data published in scientific journal articles
  - c. Analyze and critique, in written and oral form, published cancer biology articles.
14. Learn to Organize data and information for presentation
15. Develop public speaking skills

**BIO 412, Neuroscience, course SLOs:**

1. To differentiate the structure and function of neurons (nerve cells) and glia.
2. To discuss how and where sensory, motor, and integrative functions are processed in the brain and spinal cord, thus gaining a deeper understanding of the correlation of the anatomy and physiology of the brain and spinal cord.
3. To calculate an equilibrium potential, using the Nernst equation, and describe the events in an action potential.
4. To outline in written and visual form how neurotransmitters are released at a synapse.
5. To demonstrate familiarity with the anatomical, physiological, neurochemical, and genetic bases of brain diseases, behavior, and learning and memory.
6. To describe how the brain is wired, i.e. developed, how plastic changes can occur in the brain, and how aging affects the brain.
7. To read, evaluate, analyze, and discuss journal articles in the neuroscience literature.

**Lab:**

1. To identify the anatomical parts of the brain.
2. To correlate structure and function of the neuron and the brain as a whole.
3. To discuss how genes influence brain function.
4. To design an experiment, write a research paper based on the experiment, and present data like a neuroscientist.

**BIO 420, Senior Seminar, course SLOs:**

1. Prepare a 40 minute class lecture with a group on a textbook topic (SLO 2)
2. Construct a well written research paper following guidelines and a grading rubric on a biology issue, presenting multiple viewpoints in its ethical considerations, backed up by biological evidence (SLO 1)
3. Orally present the research paper and lead a classroom discussion on the issue (SLO 2)

**Appendix I, Table 2:** Program SLO 2: Percentage of students reaching the minimal acceptable score (75%) for each direct measure

Course	Course ID	Semester	Percentage of students meeting the minimal acceptable score of 75% per direct measure				
			Essays	Lab notebook	Lab report	Presentation	Research paper
Gen Bio II	BIO 104	Spring			70%		
Genetics	BIO 208	Spring			70%		
Vertebrate Physiology	BIO 302	Fall	47%-71%				
Bio techniques	BIO 305	Spring		82%			
Botany	BIO 309	Fall				100%	
Invertebrate Zoology	BIO 310	Fall				100%	
Conservation bio	BIO 311	Spring				100%	100%
Cancer Bio	BIO 319	Spring	73%				
Comp. Anatomy	BIO 405	Spring	27% - 54%				
Neuroscience	BIO 412	Spring			80%		
Senior Seminar	BIO 420	Spring				100%	56%

**Appendix I, Table 3:** Program SLO 2 Analysis and Proposed Actions

Direct Measure	Results	Interpretation	Proposed Actions
Three essays in BIO 302	<ul style="list-style-type: none"> <li>In BIO 302, 7 students were assessed</li> <li>47%, 71% and 52% achieved the MAS on the three exams</li> <li>The standard of 50% was achieved on 2 out of 3 assignments.</li> </ul>	<ul style="list-style-type: none"> <li>Students struggle when they have to collate data from several sources but do much better when the information can be found in one source</li> </ul>	<ul style="list-style-type: none"> <li>Expose students to more in-class examples on how to gather, analyze and collate data from several sources</li> <li>In the fall, the program considered raising the standard for essays as most measures show that we meet the low standard of 50%</li> <li>Based on the fall and spring data, it is prudent to keep the standard at 50%</li> </ul>
One essay in BIO 319	<ul style="list-style-type: none"> <li>In BIO 319, 23 students were assessed.</li> <li>The average score was 86%, with a range of 67-100%</li> <li>73% met the MAS</li> <li>The standard was met</li> </ul>		
Two essays in BIO 405	<ul style="list-style-type: none"> <li>In BIO 405, the first essay was answered by 13 students and the second essay by 11 students.</li> <li>The average score on the first essay was 76% and 62% on the second essay.</li> <li>54% met the MAS on the first essay and 7% met the MAS on the</li> </ul>		

	<p>second essay.</p> <ul style="list-style-type: none"> <li>• The standard was met on the first assessment, but not on the second assessment measure.</li> </ul>		
Lab notebook in BIO 305	<ul style="list-style-type: none"> <li>• 11 students were assessed in BIO 305</li> <li>• The average score was 90%, with a range of 75-100%</li> <li>• 82% of the students met the MAS</li> <li>• The standard of 75% was met</li> </ul>	<ul style="list-style-type: none"> <li>• By the end of the semester, when the assessment measure was administered, the students had mastered the skill of lab-notebook keeping through access to ample examples and one mid-semester submission with feedback.</li> </ul>	<ul style="list-style-type: none"> <li>• Access to example notebooks and early feedback will be continued; this approach is a result of assessment data from previous year and the approach has effectively lead to mastery of the SLO.</li> </ul>
Lab report in BIO 104, measured using a rubric	<ul style="list-style-type: none"> <li>• 33 students were assessed in BIO 104</li> <li>• The average score was 81%, with a range of 51%-99%</li> <li>• 70% if the students met the MAS</li> <li>• The standard of 75% was not met</li> </ul>	<ul style="list-style-type: none"> <li>• In the freshman and sophomore years students do not meet the standard because they are inexperienced in writing lab reports, however, the average and range for both years indicate that the standard will be achieved in the junior or senior year.</li> </ul>	<ul style="list-style-type: none"> <li>• Continue to require lab-reports throughout the curriculum so that students have plenty of learning opportunities to gain mastery of this skill.</li> </ul>
Lab report in BIO 208, measured using a rubric	<ul style="list-style-type: none"> <li>• 27 students were assessed on BIO 208</li> <li>• The average score was 80%, with a range of 70%-93%</li> <li>• 70% if the students met the MAS</li> <li>• The standard of 75% was not met</li> </ul>	<ul style="list-style-type: none"> <li>• In the upper-level class the standard is met</li> </ul>	
Lab report in BIO 412, measured using a rubric	<ul style="list-style-type: none"> <li>• 14 students were assessed in Bio 412</li> <li>• The average score was 81%, with a range of 68%-98%.</li> <li>• 80% of the students met the MAS</li> <li>• The standard of 75% was met</li> </ul>		
One oral presentation in BIO 309 measured by a rubric and graded by the professor and the students.	<ul style="list-style-type: none"> <li>• 21 students were assessed</li> <li>• The average score was 92%, with a range of 78%-99%</li> <li>• 100% achieved the MAS</li> <li>• The standard of 100% was met.</li> </ul>	<ul style="list-style-type: none"> <li>• The high percentage achieving the MASs is likely due to student's familiarity and/or interest in the topic because they were required to research the same topic all semester</li> </ul>	<ul style="list-style-type: none"> <li>• Continue with oral presentations for semester-long topic at the end of the semester</li> <li>• Introduce a presentation early in the semester to measure progress within the class</li> </ul>
One oral presentation in BIO 310 measured by a rubric and graded by the professor.	<ul style="list-style-type: none"> <li>• 12 student were assessed in BIO 310</li> <li>• The average was 83% with a range of 75% to 91%</li> <li>• 100% achieved the MAS.</li> <li>• The standard of 100% was met.</li> </ul>	<ul style="list-style-type: none"> <li>• Students are motivated to do a good job in front of their peers</li> <li>• Students find the preparation of PowerPoint presentations an enjoyable task</li> </ul>	<ul style="list-style-type: none"> <li>• Use new rubric designed by the Biology program to measure improvement across classes and follow cohorts</li> <li>• Have the students</li> </ul>

<p>One oral presentation in BIO 311</p> <p>Two oral presentations in BIO 420. The first was a group presentation.</p> <p>The second was an individual presentation</p>	<ul style="list-style-type: none"> <li>• 20 students were assessed in BIO 311</li> <li>• The average score was 86% with a range of 80-90%</li> <li>• 100% achieved the MAS</li> <li>• The standard of 100% was met.</li> </ul> <ul style="list-style-type: none"> <li>• 17 students were assessed in BIO 420 on the first presentation</li> <li>• The average score was 90% with a range of 80-95%</li> <li>• 100% achieved the MAS</li> <li>• The standard of 100% was met.</li> </ul> <ul style="list-style-type: none"> <li>• 15 students were assessed in BIO 420 on the second presentation</li> <li>• The average score was 85% with a range of 78-91%</li> <li>• 100% achieved the MAS</li> <li>• The standard of 100% was met.</li> </ul>	<ul style="list-style-type: none"> <li>• Peer-evaluation may have lead to relaxed evaluations</li> <li>• Subjective rubric allowed students to give each other inflated scores</li> <li>• In Bio 310 , some students had to change their topics late in the semester as they learned there was insufficient research material to support the topic.</li> </ul>	<p>choose their topics earlier in the semester.</p> <ul style="list-style-type: none"> <li>• Develop assignments and a calendar that force the students to complete certain steps in the preparation of their presentation according to the calendar.</li> </ul>
<p>Research Paper in BIO 311 graded on the department research paper rubric</p> <p>Research Paper in BIO 420 graded on the department research paper rubric</p>	<ul style="list-style-type: none"> <li>• 20 students were assessed in BIO 311</li> <li>• The average score was 93%, with a range of 85%-96%</li> <li>• 100% achieved the MAS</li> <li>• The standard of 75% was met.</li> </ul> <ul style="list-style-type: none"> <li>• 16 students were assessed in BIO 420</li> <li>• The average score was 77%, with a range of 50%-90%</li> <li>• 56% achieved the MAS</li> <li>• The standard of 75% was not met.</li> </ul>	<ul style="list-style-type: none"> <li>• Students who did well were engaged with the topic.</li> <li>• The assignment was clearly defined with submission dates for topic, outline, references and rough drafts.</li> <li>• Students had the opportunity to submit drafts and do multiple revisions.</li> <li>• Students who took the opportunity to submit rough drafts did well.</li> <li>• Students who did poorly had not turned in drafts and did therefore not have time for revisions.</li> <li>• Grammar and spelling is a common weakness.</li> <li>• BIO 420 is only required for students who have not completed summer internships, research internships at LU or study abroad programs. Such opportunities are usually only available for the top half of the class. Therefore, the students attending BIO 420 mostly</li> </ul>	<ul style="list-style-type: none"> <li>• Research papers with specific guidelines and several deadlines for different components will continue to be used in upper-level classes.</li> <li>• The importance of handing in all components of the research paper on time will be emphasized.</li> </ul>

		belong to the bottom half of the class	
--	--	--	--

**Appendix I Table 4:** Program SLO 4: Percentage of students reaching the minimal acceptable score (75%) for each direct measure

Course	Course ID	Fall, Spring	Percentage of students meeting the MAS of 75% per direct measure		
			Pre-post-test	Homework	Essay on exam
Gen Bio I	BIO 103	Fall	Increased from 3% to 21%		
Gen Bio I	BIO 103	Spring	Increased from 4% to 24%		34%
Botany	BIO 309	Fall		84%	60%-75% (3 questions)
Cell Biology	BIO 406	Fall	Increased from 0% to 10%		

**Appendix I Table 5:** Program SLO 4 Analysis and Proposed Actions

Direct Measure	Results	Interpretation	Proposed Actions
Pre and post-tests in BIO 103 (fall) and BIO 406	<ul style="list-style-type: none"> <li>29 students were assessed in BIO 103 and 21 in BIO 406</li> <li>The percentage achieving the MAS increased from 3% to 21% in BIO 103 and from 0% to 10% in BIO 406.</li> <li>The standard of reaching overall improvement was met, but the standard of 50% reaching the MAS was not met.</li> </ul>	<ul style="list-style-type: none"> <li>No improvement was seen from fall to spring in the same class (BIO 103).</li> <li>Tests do not reflect course contents, or the questions are too difficult</li> <li>Students are having difficulty answering multiple choice questions</li> <li>Students do not retain course information</li> <li>Students are not given enough learning opportunities to master course content</li> </ul>	<ul style="list-style-type: none"> <li>Improve test to better reflect course content</li> <li>Provide more learning opportunities to allow the students to master and retain the SLO</li> </ul>
Pre and Post Test in BIO 103 (spring), 10 MC questions	<ul style="list-style-type: none"> <li>25 students assessed were assessed in BIO 103 (spring)</li> <li>The average was 27% with the range of 0-80%</li> <li>4% met the MAS of 75% on the pre-test</li> <li>29 students were assessed with a post test containing the same 10 questions.</li> <li>The average was 63% with a range of 20-100%</li> <li><b>24% met expectations by reaching the MAS.</b></li> <li>The standard of 50% was not met for this class, neither was the standard of 100% of the students improving.</li> </ul>	<ul style="list-style-type: none"> <li>Professor was not clear enough of their expectations for student knowledge in this subject matter</li> <li>Students did not put necessary time into studying the material</li> <li>Students were not prepared sufficiently prior to entering the class</li> </ul>	<ul style="list-style-type: none"> <li>Questions will be reviewed to make sure they are clear for students</li> <li>More challenging homework will be assigned to ensure students are rigorously keeping up with their studies. Allow more time to review material in the classes before exams are given</li> </ul>
Homework about photosynthesis in the form of multiple choice	<ul style="list-style-type: none"> <li>20 students were assessed</li> <li>84% of the students achieved the MAS on the homework assignment.</li> </ul>	<ul style="list-style-type: none"> <li>The high percentage of students achieving the MAS on homework is likely due to students' ability to</li> </ul>	<ul style="list-style-type: none"> <li>Assign more challenging homework assignments</li> <li>Design more in-class</li> </ul>

questions on WebCT in BIO 309	<ul style="list-style-type: none"> <li>• The standard of 80% was met.</li> </ul>	collaborate with peers, consult outside references and take time to finish the work	<p>and homework assignments to measure the SLO</p> <ul style="list-style-type: none"> <li>• Design rubrics to grade consistently the newly designed assignments</li> </ul>
<p>Essay on exam in BIO 103 (spring)</p> <p>Essays on exams in BIO 309</p>	<ul style="list-style-type: none"> <li>• 29 students assessed on a multipart essay question</li> <li>• The average for the class was 55% with a range of 14%-100%</li> <li>• 10 out of 29 (34%) of the students achieved the MAS on the essay.</li> <li>• The standard of 50% was not met.</li> <li>• 16 students were assessed in BIO 309</li> <li>• 60-75% of the students achieved the MAS on three separate test questions.</li> <li>• The standard of 50% was met.</li> </ul>	<ul style="list-style-type: none"> <li>• Improvement was observed from freshmen to juniors</li> <li>• In BIO 309, the high percentage of students achieving the MAS on essay test questions indicates that students master the SLO</li> <li>• In BIO 103, the low percentage of students achieving the MAS could be due to: <ul style="list-style-type: none"> <li>• Students have difficulty answering essay questions</li> <li>• Essay question was too difficult for the students to achieve</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Continue to use test questions to measure the SLO because proficiency should include the ability to retrieve knowledge without collaboration with peers or external sources under time-constraints</li> <li>• More challenging homework will be assigned to ensure students are rigorously keeping up with their studies.</li> <li>• More time will be spent in recitation practicing essay writing and how to formulate proper outlines of information for essays</li> </ul>

**Appendix I Table 6:** Program SLO 5: Percentage of students reaching the minimal acceptable score (75%) for each direct measure

Course	Course ID	Semester	Percentage of students meeting the MAS of 75% per direct measure							
			Pre-post-test	HW	In class assignment	Quiz	MC on exam	Short answer on exam	Essay on exam	
Gen Bio I	BIO 103	Fall	Increased from 6% to 40%						43%	
Gen Bio I	BIO 103	Spring	Increased from 0% to 26%						43%	
Plant Animal Systems	BIO 209	Fall		78%-94%		56%				
Vertebrate Physiology	BIO 302	Fall			14%		17%-83%	17%-50%	33%	
Botany	BIO 309	Fall		84%-100%				67%-90%	25%-50%	
Invertebrate Zoology	BIO 310	Fall							30%-58%	
Comp. Anatomy	BIO 405	Spring	Increased from 0% to 14%							
Cell Biology	BIO 406	Fall	Increased from 5% to 23%							
Neuroscience	BIO 412	Spring	Increased from 0-50%						64%	16-100%

**Appendix I Table 7:** Program SLO 5 Analysis and Proposed Actions

Direct Measure	Results	Interpretation	Proposed Actions
Pre and post-tests in BIO 103 (fall) and BIO 406	<ul style="list-style-type: none"> <li>29 students were assessed in BIO 103 and 21 students in BIO 406</li> <li>The percentage of students achieving the MAS increased from 6% to 40% in BIO 103 and from 5% to 23% in BIO 406</li> <li>The standard of reaching overall improvement was met, but the standard of 50% reaching the MAS was not met.</li> </ul>	<ul style="list-style-type: none"> <li>Student learning gains are achieved, but they are not sufficient to meet the standard</li> <li>Tests do not reflect course contents</li> <li>Students do not retain course information</li> <li>Students are not given enough learning opportunities to master course content</li> </ul>	<ul style="list-style-type: none"> <li>Improve test to better reflect course content</li> <li>Provide more learning opportunities to allow the students to master and retain the SLO</li> </ul>
Pre and post-test in BIO 103 (spring)	<ul style="list-style-type: none"> <li>25 students were assessed in BIO 103 (spring)</li> <li>The average score on the pretest was 28%, with a range of 0-60%.</li> <li>The average score on the post-test was 45%, with a range of 0-100%</li> <li>None of the students met the MAS of 50% on the pre-test, while 26%</li> </ul>	<ul style="list-style-type: none"> <li>Students do best on knowledge-based questions, but have difficulties with questions requiring analysis, synthesis and evaluation.</li> <li>Students exposed to the</li> </ul>	

<p>Pre and post-test in BIO 405 (spring)</p> <p>Pre and post-test in BIO 412 (spring)</p>	<p>of the students met the MAS on the post test</p> <ul style="list-style-type: none"> <li>• The standard of 50% for the post-test was not achieved.</li> <li>• The standard of every student improving was not met</li> </ul> <ul style="list-style-type: none"> <li>• 12 students were assessed in BIO 405</li> <li>• The average on the pretest was 20%, with a range of 0-40%</li> <li>• The average on the post-test was 44%, with a range of 0-100%</li> <li>• The standard of 50% meeting the MAS on the post-test was not achieved, neither was the standard of all students improving from the pre-test to the post-test</li> </ul> <ul style="list-style-type: none"> <li>• 11 students were assessed in BIO 412</li> <li>• The average on the pre-test was 41% with a range of 20-67%</li> <li>• The average on the post-test was 73% with a range of 45-100%</li> <li>• The standard of 50% for the post test was met and the standard for 100% improvement was met.</li> </ul>	<p>subject matter through research perform better on the pre and post tests.</p>	
<p>Two homework assignments on the urinary system and immunology in BIO 209 and homework about the structure and function of roots, stems and leaves using 30 multiple choice questions on WebCT in BIO 309</p>	<ul style="list-style-type: none"> <li>• 18 students were assessed in BIO 209 and 20 students were assessed in BIO 309</li> <li>• 78-94% of the students in BIO 209 achieved the MAS on the two homework assignments.</li> <li>• 84-100% of the students in BIO 309 achieved the MAS.</li> <li>• The standard of 80% meeting the MAS was almost met in both classes.</li> </ul>	<ul style="list-style-type: none"> <li>• High percentages of students achieving the MAS on homework is likely due to students' ability to collaborate with peers, consult outside references and take time to finish the work</li> </ul>	<ul style="list-style-type: none"> <li>• Give more challenging homework assignments.</li> <li>• Design more in-class and homework assignments to measure the SLO</li> <li>• Design rubrics to grade consistently the newly designed assignments</li> </ul>
<p>In-class assignment on the digestive system in BIO 302</p>	<ul style="list-style-type: none"> <li>• 7 students were assessed</li> <li>• The average was 36% with a range of 0-100%</li> <li>• 14% of the students achieved the MAS.</li> <li>• The standard of 75% was not met on this one assignment.</li> </ul>	<ul style="list-style-type: none"> <li>• This particular assignment was very difficult</li> <li>• Professor felt that she did not have enough time in class to support the students during the in-class assignment</li> </ul>	<ul style="list-style-type: none"> <li>• Give in-class assignments that step-wise increases the difficulty level</li> </ul>
<p>Quiz on the circulatory system in BIO 209</p>	<ul style="list-style-type: none"> <li>• 18 students were assessed in BIO 209</li> <li>• The average was 74% with a range of 0-92%</li> <li>• 56% of the students achieved the</li> </ul>	<ul style="list-style-type: none"> <li>• This quiz was the first in the animal portion of the course, students were uncertain of what to expect</li> </ul>	<ul style="list-style-type: none"> <li>• In the future, student will be given more learning opportunities to master the material before quizzes.</li> </ul>

<p>Quizzes in BIO 412</p>	<p>MAS.</p> <ul style="list-style-type: none"> <li>• The standard of 75% was not met.</li> <li>• 14 students were assessed in BIO 412</li> <li>• The average was 69% with a range of 0-100%</li> <li>• 64% of the students met the MAS</li> <li>• The standard of 75% was not met</li> </ul>	<ul style="list-style-type: none"> <li>• Student had limited time solving in-class assignments with this professor before the quiz</li> </ul>	<ul style="list-style-type: none"> <li>• Keep the standard at 75% and work on improving student learning in and out of class to reach the standard.</li> </ul>
<p>MC questions on a unit exam and a final exam in BIO 302</p> <p>MC questions on three unit exams in BIO 412. The third exam was on WebCT</p>	<ul style="list-style-type: none"> <li>• 7 students were assessed in BIO 302</li> <li>• The percentage achieving the MAS was 83% on the unit exam, but when the same questions were asked on the final exam the percentage was only 17%</li> <li>• While the standard of 75% was met directly after learning took place, it was not met at the end of the semester.</li> <li>• 14 students were assessed in BIO 412</li> <li>• The average (range) on the three exams were: 65% (40-100%), 62% (21-94%) and 94% (85-100%).</li> <li>• The percentage of students that met the MAS was 43%, 16% and 100%.</li> <li>• The standard of 75% was only met on the WebCT exam</li> </ul>	<ul style="list-style-type: none"> <li>• Students do not retain information</li> <li>• Students do not study old exams for the final</li> <li>• Faculty do not emphasize the importance of studying old exams prior to the final exam</li> <li>• Not enough time is spend on review in the class</li> <li>• Students do much better when they can answer the questions at their leisure and are allowed to collaborate and use outside resources.</li> </ul>	<ul style="list-style-type: none"> <li>• Emphasize importance of studying old exams for the final.</li> <li>• Increase opportunity for review in the classes, especially before the final exam.</li> <li>• Provide more feed-back on MS questions, for example, students may be allowed to gain points by explaining why answers are correct or incorrect on their exams.</li> </ul>
<p>Short answer questions on hour exams in BIO 302 about the immune system and the urinary system and in BIO 309 about plant organs</p>	<ul style="list-style-type: none"> <li>• 7 students were assessed in BIO 302, while 21 students were assessed in BIO 309</li> <li>• 17% - 50% achieved the MAS in BIO 302, while the percentage in BIO 309 was 67% - 90%.</li> <li>• The standard of 50% was met in BIO309, but only on one short answer question in BIO 302.</li> </ul>	<ul style="list-style-type: none"> <li>• Low percentages of students achieving the MAS may be due to students inability to retrieve information under time-pressure</li> <li>• Students often seem to have a difficult time drawing or articulate learned information – or apply learned information to solve new problems.</li> <li>• Short answer questions on exams may be too different from assignments that students have access to</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce time pressure on exams by making shorter exams</li> <li>• Practice phrasing answers and drawing structures in class or on homework assignments</li> <li>• Write questions that mimic more precisely the other learning opportunities that the students have been given access to</li> </ul>

<p>Essay test questions on exams in BIO 302, 309 and 310</p>	<ul style="list-style-type: none"> <li>• 7 students were assessed in BIO 302, 21 in 309 and 12 in 310</li> <li>• 25%-58% of the students achieved the minimal acceptable score on numerous essay test questions in three separate classes.</li> <li>• The standard of 50% of the students reaching the MAS was only observed for one test question in one class.</li> </ul>	<ul style="list-style-type: none"> <li>• The SLO is difficult to master and therefore the essay test results are low</li> </ul>	<ul style="list-style-type: none"> <li>• Continue to use essay test questions to measure the SLO because proficiency should include the ability to retrieve knowledge without collaboration with peers or external sources under time-constraints</li> </ul>
--	---	---	--

**Appendix I Table 8:** Program SLO 6: Percentage of students reaching the minimal acceptable score (75%) for each direct measure

Course	Course ID	Semester	Percentage of students meeting the MAS of 75% per direct measure				
			Pre-post-test	Homework	MC on exam	Short answer on exam	Essay on Exam
Gen Bio II	BIO 104	Fall	Increased from 0% to 27%	23% - 86%			36% - 91%
Gen Bio II	BIO 104	Spring	Increased from 13% to 72%	71% - 94%		65% - 91%	
Genetics	BIO 208	Spring	Increased from 0% to 70%	48%-96%	70%	52%-95%	
Cancer biology	BIO 319	Spring			75%		78%
Cell biology	BIO 406	Fall	Increased from 5% to 14%				

**Appendix I Table 9:** Program SLO 6 Analysis and Proposed Actions

Direct Measure	Results	Interpretation	Proposed Actions
Pre and post-tests in BIO 104 and BIO 406 (fall)	<ul style="list-style-type: none"> <li>23 students were assessed in BIO 104 and 21 in BIO 406</li> <li>The percentage of students who achieved the MAS increased from 0% to 27% in BIO 104 and from 5% to 14% in BIO 406</li> <li>The standard of reaching overall improvement was met, but the standard of 50% reaching the MAS was not met.</li> </ul>	<ul style="list-style-type: none"> <li>Tests do not always reflect learning opportunities</li> <li>Students do not retain course information</li> <li>Students are not given enough learning opportunities to master course content</li> <li>Students do better on this SLO in their sophomore year, because they were exposed to it as 2<sup>nd</sup> semester freshmen and some of the information is retained from the freshman year and then emphasized in a semester-long course (BIO 208) in the sophomore year</li> <li>Learning gains are observed from freshman to sophomore year in genetics content.</li> </ul>	<ul style="list-style-type: none"> <li>Improve test to better reflect learning opportunities</li> <li>Provide more learning opportunities to allow the students to master and retain the SLO</li> </ul>
Pre and post-tests in BIO 104 and BIO 208 (spring)	<ul style="list-style-type: none"> <li>32 students were assessed in BIO 104</li> <li>The average on the pre-test was 53%</li> <li>The average on the post test was 82%</li> <li>13% achieved the MAS on the pre-test. This increased to 72% on the post-test.</li> <li>The standard of 75% on the post test was not met, neither was the standard of 100% of the students improving</li> <li>28 students were assessed in BIO 208</li> <li>The average on the pre-test was 50%</li> <li>The average on the post-test was 84%</li> </ul>		

	<ul style="list-style-type: none"> <li>• None of the students achieved the MAS on the pre-test, while 70% met the MAS on the post-test.</li> <li>• Both the standards of 50% meeting the MAS on the post test and 100% of the students improving were met.</li> </ul>		
<p>Homework on genetics problems in BIO 104 (fall)</p> <p>Homework on identical genetics problems in BIO 104 and BIO 208 (spring)</p>	<ul style="list-style-type: none"> <li>• 23 students were assessed in BIO 104</li> <li>• The percentage of students achieving the MAS ranged from 23% to 86% on three separate genetics homework assignments</li> <li>• The standard of 75% is met on all assignments except for on the most challenging problem-solving homework</li> <li>• 36 student were assessed in BIO 104 (spring) on the monohybrid cross</li> <li>• The average was 87%, with a range of 10-100%</li> <li>• 94% of the students met the MAS of 75%</li> <li>• The standard was met</li> <li>• 38 students were assessed in BIO 104 (spring) on the dihybrid cross</li> <li>• The average was 73% with a range of 0-100%</li> <li>• 71% of the students met the MAS</li> <li>• The standard was not met</li> <li>• 27 students were assessed in BIO 208 on the monohybrid cross</li> <li>• The average was 96% with a range of 40-100%</li> <li>• The 75% MAS was met by 96% of the students</li> <li>• The standard of 75% was met</li> <li>• 25 students were assessed in BIO 208 on the dihybrid cross.</li> <li>• The average was 75%, with a range of 18-100%</li> <li>• 48% of the students met the MAS.</li> <li>• The standard of 75% was not met</li> </ul>	<ul style="list-style-type: none"> <li>• The low percentage of students achieving the MAS on the most challenging genetics homework is consistent with results from previous years</li> <li>• The higher percentages on other homework assignments are likely due to students' ability to collaborate with peers, consult outside references and take time to finish the work</li> <li>• Slight learning gains are observed from the freshman to sophomore year on the monohybrid cross</li> <li>• For the dihybrid cross, fewer students met the MAS in the sophomore class, however the average was slightly increased and the range was more narrow in the sophomore year.</li> </ul>	<ul style="list-style-type: none"> <li>• Divide challenging concepts into step-wise problems that guide problem solving – especially on homework</li> <li>• Assign more challenging homework assignments</li> <li>• Design more in-class and homework assignments to measure the SLO</li> <li>• Design rubrics to grade consistently the newly designed assignments</li> </ul>

<p>Five MC questions on final exam in BIO 208</p> <p>MC questions on unit exams in BIO 319</p>	<ul style="list-style-type: none"> <li>• 30 students were assessed</li> <li>• The average was 80% with a range of 20-100%</li> <li>• 70% met the MAS of 75%</li> <li>• The standard of 75% was not met</li> </ul> <ul style="list-style-type: none"> <li>• 24 students were assessed</li> <li>• The average was 79%, with a range of 40-100%</li> <li>• 75% met the MAS of 75%</li> <li>• The standard of 75% was met</li> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>• Students are retaining this information from previous classes</li> </ul>	<ul style="list-style-type: none"> <li>• The subject matter will be expanded upon to give students a stronger foundation for advanced degrees</li> </ul>
<p>Short answer or problem solving on exams in BIO 104 and BIO 208 (spring)</p>	<ul style="list-style-type: none"> <li>• 39 students were assessed on the monohybrid cross in BIO 104 on a unit exam</li> <li>• The average was 94% with a range of 0-100%</li> <li>• 92% of the students met the MAS of 75%</li> <li>• The standard of 75% was met</li> </ul> <ul style="list-style-type: none"> <li>• 40 students were assessed on the monohybrid cross in BIO 104 on the final exam</li> <li>• The average was 90% with a range of 20-100%</li> <li>• 90% of the students met the MAS</li> <li>• The standard of 75% was met</li> </ul> <ul style="list-style-type: none"> <li>• 29 students were assessed on the monohybrid cross in BIO 208 on a unit exam</li> <li>• the average was 95%, with a range of 20-100%</li> <li>• 93% of the students met the MAS</li> <li>• The standards was met</li> </ul> <ul style="list-style-type: none"> <li>• 30 students were assessed on the monohybrid cross in BIO 208 on the final exam</li> <li>• The average was 95%, with a range of 40-100%</li> <li>• 95% of the students me the MAS</li> <li>• The 75% standard was met</li> </ul> <ul style="list-style-type: none"> <li>• 40 students were assessed on the dihybrid cross in BIO 104 on the final</li> <li>• The average was 71%, with a range of 0-100%</li> <li>• 65% of the students reached the MAS</li> <li>• The 75% standard was not met</li> </ul>	<ul style="list-style-type: none"> <li>• Both freshmen and sophomore students master the monohybrid, but not the dihybrid cross.</li> <li>• Students show minimal learning gains from freshman to sophomore year on both monohybrid and dihybrid crosses.</li> <li>• Learning gains are observed within the sophomore course for the dihybrid cross.</li> </ul>	<ul style="list-style-type: none"> <li>• Spend less class-time on the monohybrid cross and more on the dihybrid cross.</li> <li>• Increase the hands-on learning opportunities for students to master the dihybrid cross</li> <li>• Continue to assess only the dihybrid cross in the future in both BIO 140 and BIO 208 so that cohort data will be available; it may be more informative of actual learning gains since it would follow the same students.</li> </ul>

	<ul style="list-style-type: none"> <li>• 29 students were assessed on the dihybrid cross in BIO 208 on a unit exam</li> <li>• The average was 68% with a range of 10-100%</li> <li>• 54% students met the MAS</li> <li>• The 75% standard was not met</li> <li>•</li> <li>• 30 students were assessed on the dihybrid cross in BIO 208 on the final exam</li> <li>• the average was 75% with a range of 20-100%</li> <li>• 67% of the students met the MAS</li> <li>• The 75% standard was not met</li> </ul>		
<p>Essay test questions on exams in BIO 104</p> <p>Essay test questions on exams in BIO 319</p>	<ul style="list-style-type: none"> <li>• 23 students were assessed in BIO 104</li> <li>• 46%-64% of the students achieved the MAS on five separate genetics questions on the final exam.</li> <li>• The standard of 50% was met on 3 out of the 5 questions</li> <li>•</li> <li>• 23 students were assessed</li> <li>• The average was 87% with a range of 53-100%</li> <li>• 78% met the MAS</li> <li>• The 50% standard was met</li> </ul>	<ul style="list-style-type: none"> <li>• The problem on which the lowest percentage of students achieved the MAS (36%) was a dihybrid cross, a type of problem with which the students consistently struggle.</li> <li>• Relatively high percentages on essay test questions are indicative of student mastery of the SLO</li> </ul>	<ul style="list-style-type: none"> <li>• Provide more learning opportunities for dihybrid cross problems to allow student mastery</li> <li>• Continue to use test questions to measure the SLO because proficiency should include the ability to retrieve knowledge without collaboration with peers or external sources under time-constraints</li> </ul>

## Appendix II. Direct Measure for BIO 103 with Rubrics

### BIO 103 Assessment Plan

#### SLO 4

A pre-post-test will be administered. Further, the students will be assessed via MC questions on sectional exams as well as an essay. The essay being used for assessment is below followed by the appropriate grading rubric:

#### **Question:**

Please explain how the electron transport chain works. Follow the process from NADH up to and including to the creation of ATP. Also please state how the process is different with FADH<sub>2</sub> instead of NADH.

#### **Rubric:**

The question is worth a total of 7 points which will be 25% of the exam. Each student will receive points for including:

- 1 pt for mentioning NADH donating its electrons to Complex 1
- 1 pt for explaining how electrons are passed from complexes and electron carriers down a chain.
- 1 pt for explaining how Complexes I, III and IV push H<sup>+</sup> across the inner mitochondrial membrane.
- 1 pt for discussing how this forms an electrochemical gradient.
- 1pt for discussing how H<sup>+</sup> are permitted to come back across the membrane through ATP- synthase creating ATP.
- 2 pts for using proper essay format

#### SLO 5

A pre-post-test will be administered. Further, the students will be assessed via MC questions on sectional exams as well as an essay. The essay being used for assessment is below followed by the appropriate grading rubric.

#### **Question:**

**Cell cycle.** Please tell me the process of the cell cycle. In particular, tell me the names of the phases as well as what happens in each phase with particular reference to the nucleus, DNA, centrosomes and microtubules.

#### **Rubric:**

The question is worth a total of 8 points which will be 25% of the exam. Each student will receive points for including:

- 1 pt Prophase - Chromosomes condense, Centrosomes begin to move to poles
- 1 pt Prometaphase - Nuclear envelope dissolves, centrosomes align on the poles, microtubules form attached to the centrosomes.
- 1 pt Metaphase—Chromosomes line up along the metaphase plate.
- 1 pt Anaphase—Chromosomes start to move along the microtubules to the poles
- 1 pt Telophase—Nuclear envelopes reform and chromosomes start to decondense.
- 1 pt Cytokinesis—Cell Membranes reform
- 2 pts for using proper essay format

## Appendix II. Direct Measure for BIO 104 and 208 with Rubrics

The ability to solve genetics problems is an important proficiency in biology majors as it requires critical thinking and quantitative skills, but it is an ability that develops slowly in many students. Because of its importance, we are planning to assess this ability in the spring, 2011 semester in two courses, General Biology II (Biology 104) and Genetics (Biology 208). We will use the two problems shown below for assessment. The problems will be explained in class, among other examples, then assigned on homeworks, and included on an hour exam and on the final exam. In all cases, the problems will be worth 10 points and graded using the rubrics that appears below. At the end of the semester, student performance on these two problems will be assessed to determine (1) proficiency rates based on earning at least 7.5 points of the 10 possible points and (2) improvement rates with each opportunity to solve the problems.

### Problem 1 (monohybrid cross):

In pea plants, the gene for tall plants is dominant to the gene for dwarf plants. I cross a heterozygous plant with a homozygous recessive plant.

- Do the Punnett square for this cross using a one-letter abbreviation for each trait
- What is the genotypic ratio that results from this cross? Give both the ratio and the genotypes.
- What is the phenotypic ratio that results from this cross? Give both the ratio and the phenotypes.

### Rubric for Problem 1:

- 4 points for the correct construction of the Punnett square
  - 2 points for the correct gamete genotypes
  - 2 points for the correct offspring genotypes
- 3 points for the correct genotypic ratio
  - 2 points for the correct ratio numbers
  - 1 point for the inclusion of the correct genotypes
- 3 points for the correct phenotypic ratio
  - 2 points for the correct ratio numbers
  - 1 point for the inclusion of the correct phenotypes

### Problem 2 (dihybrid cross):

In watermelons, bitter fruit ( $B$ ) is dominant over sweet fruit ( $b$ ), and yellow spots ( $E$ ) are dominant over no spots ( $e$ ). The genes for these two characteristics assort independently. A homozygous plant that has bitter fruit and yellow spots is crossed with a homozygous plant that has sweet fruit and no spots. The  $F_1$  offspring are crossed to produce the  $F_2$  generation.

- Draw out the parent cross using the letters for the genes given above and give the genotype(s) of the  $F_1$  offspring.

- b. Using the same letters as in a, draw out the  $F_1$  cross and give the  $F_2$  offspring.
- c. What will be the phenotypic ratio in the  $F_2$  generation? (Show both the genotypes and phenotypes with the ratio)

**Rubric for Problem 2:**

- a. 3 points for the correct parent cross with the  $F_1$  offspring  
- 1 point for each correct genotype ( $BBEE$ ,  $bbee$  and  $BbEe$ )
- b. 4 points for the correct  $F_2$  cross (most students will use a Punnett square for this)  
- 1 point for each major correct genotype ( $B\_E\_$ ,  $bbE\_$ ,  $B\_ee$ ,  $bbee$ )
- c. 3 points for the correct phenotypic ratio  
- 1 point for the correct ratio numbers  
- 1 point for the inclusion of the correct phenotypes  
- 1 point for the inclusion of the correct genotypes

## **Appendix II. Sample of assignment to be assessed in BIO 311**

### Biology 311 – Conservation Biology Research Paper/Presentation Timeline

The assignment is to research and report on a single species that is classified as vulnerable, endangered, critically endangered on the IUCN Red List.

For each of the submissions below, I will review your submitted materials and return your submission with comments and suggestions.

1. Choose a species from the listing at <http://www.iucnredlist.org>. Instructions will be given in class on how to use this website.

- **Deadline: Friday, January 28**

2. Identify five references for the species that you have chosen. The website above should be one of those references.

- **Deadline: Friday, February 11**

3. Submit an outline of what you plan to cover in your paper/presentation.

- **Deadline: Friday, February 25**

4. Submit a rough draft of your research paper.

- **Deadline: Friday, March 11**

5. Submit a rough draft of your presentation.

- **Deadline: Friday, March 25**

**Class presentations will be on Friday, April 8<sup>th</sup>, Monday, April 11<sup>th</sup> and Wednesday, April 13<sup>th</sup>**

**Papers will be due on Thursday, April 14<sup>th</sup>**

## Appendix II. Biology Program Common Rubric for Laboratory Reports

Lab Report Rubric, Pg 1	Exceeds Expectations	Meets Expectations	Approaches Expectations	Does Not Meet Expectations
	90-100%	75-89%	55-74%	Below 55%
<b>TITLE (5%)</b> Describes the lab experiments concisely and accurately	Describes the lab experiments concisely and accurately	Basic experiment is described but description is slightly incomplete	Average - basics covered, but incomplete description of the lab.	Substantially incomplete and/or inaccurate
<b>ABSTRACT (15%)</b> Significance, hypothesis, purpose, methodological approach, results, conclusion	Clearly stated purpose/question, method, results, conclusion and related to big picture	Contains all directives but is slightly lacking in clarity and conciseness	Major errors, lacking 1-2 directives or most are not stated clearly or concisely	Missing several directives, unclear, major errors
<b>INTRODUCTION (10%)</b> Background including references, hypothesis, justification for experiments (tie background to rest of report)	Clearly stated background with references. The background is tied into a clearly and accurately stated hypothesis.	Minor errors in the background (like lack of references or no connection between background and hypothesis.	Major errors. Lacking either background with references or an outline/hypothesis.	Unclear. Major errors and omissions.
<b>RESULTS (20%)</b> Results should be presented in tables, figures and graphs that have legends and are easy to understand. All tables, figures and graphs MUST have paragraph format text that supports and references the material in the figure.	All results are presented in a clearly stated fashion. All figures and tables labeled and supported by paragraph format text.	Mostly accurate, no omissions, all figures and tables supported by paragraph format text. Minor errors in one or two areas. No major error.	Multiple major errors or missing 1-2 directives. Tables and figures not supported by text in paragraph format.	Unclear, major errors and omissions.
<b>Totals for columns</b>				

**Lab Report  
Rubric, Pg 2**

	<b>Exceeds Expectations</b>	<b>Meets Expectations</b>	<b>Approaches Expectations</b>	<b>Does Not Meet Expectations</b>
	<b>90-100%</b>	<b>75-89%</b>	<b>55-74%</b>	<b>Below 55%</b>
<p><b>DISCUSSION (20%)</b> Summary of results. Re-visit hypothesis, did your results support the hypothesis? Discussion of major concepts, significance and techniques. Relation to background with references. Suggestions for improvement.</p>	Clearly stated summary and conclusions. Critical thinking applied to discussion of principles, significance and techniques. All directives met.	Clearly stated summary and conclusions. Critical thinking applied to discussion. Minor omissions/errors in discussion.	Conclusions are unclear and disorganized. Lack of in-depth analysis. Lacking 1-2 directives in discussion.	Conclusions unclear and disorganized. Critical thinking skills not applied. Major omissions in discussion.
<p><b>REFERENCES (10%)</b> References cited correctly in the text and formatted correctly in the reference list at the end of the document.</p>	Perfect in fulfilling all directives appropriately.	Contains all required fields but minor errors, references used appear sufficient.	Minor Errors or omissions. A few references missing or not proper references.	Major errors or omissions, did not follow directives, lacking references, lack of or poor paraphrasing.
<p><b>WRITING (10%)</b> Cohesion and organization (logic and flow) Grammar, spelling. Format followed.</p>	Cohesive, Concise, Organization enhances presentation. Guidelines met. Proper grammar and spelling.	Average organization, some areas could be better organized. Minor errors in both guidelines and grammar and spelling.	Language usage not proper. Major errors in grammar and spelling. Little to no Cohesion	Chaotic. Detracts from presentation. Guidelines not met. Major errors in language usage.
<b>Totals for columns</b>				

## Appendix II. Biology Program Common Rubric for Research Papers

Research Paper Rubric	Exceeds Expectations	Meets Expectations	Approaches Expectations	Does Not Meet Expectations
	90-100%	75-89%	55-74%	Below 55%
<b>CONTENT (65%)</b> Clear thesis statement (main idea), logical and systematic development of thesis, supporting details and examples, strong conclusion, factual accuracy, originality, content organization - introductory paragraph, body of paper, summary paragraph, and conclusion	The thesis is stated clearly in one sentence in a strong introductory paragraph and well developed with supporting details throughout the body. Concise summary and strong conclusion are given. The content is logical, original, and accurate.	The thesis is stated clearly in a good introductory paragraph; more supporting details could be presented. Content is accurate and logical for the most part. Content organization is adequate.	The thesis needs to be stated more clearly and developed more systematically in the body of the paper. More supporting details and examples are needed. The introductory paragraph and conclusion are not strong.	The thesis is unclear and not developed. The content is not logically or systematically presented. Most content is inaccurate or not supported with details. Major problems with content organization. No originality.
<b>REFERENCES (15%)</b> References cited correctly in text and formatted correctly in reference list; adherence to guidelines regarding format of references and number of references	Perfect in fulfilling all directives appropriately. All references used are of scholarly quality and are important to the researched topic.	Contains all required elements but minor errors in formatting. References used appear sufficient.	Minor errors and omissions. A few references are missing and/or cited/formatted incorrectly. Some references used are not important to the topic or not good quality.	Major errors in citations and formatting and omissions. Did not follow guidelines. Most references used are not important and poor quality or completely lacking references.
<b>MECHANICS OF WRITING (20%)</b> Adherence to guidelines regarding page length, fonts, spacing, margins, cover page; correct grammar, punctuation, and spelling; sentence structure (well-structured and varied); transitions (logical flow and connection of ideas); sequencing (logical order); proper language	Paper is clear and well written. Guidelines met completely. Correct grammar, punctuation, and spelling. Well-structured, clear, concise, and varied sentences. Logical and cohesive organization.	Minor errors in guidelines, grammar, punctuation, and spelling. Average organization, some areas could be better organized.	Several elements in guidelines not met. Major grammatical and spelling errors. Improper use of language. Several areas could be better organized. Little to no cohesion.	Guidelines not met. Unclear. Poor organization. Not cohesive. Major errors in grammar, punctuation, spelling, and language usage.
<b>Totals for columns</b>				

## Appendix II. Biology Program Common Rubric for Oral Presentations

Presentation Rubric, Pg 1	Exceeds Expectations	Meets Expectations	Approaches Expectations	Does Not Meet Expectations
	90-100%	75-89%	55-74%	Below 55%
<b>Content (60% of total points)</b>				
Objectives/hypothesis/purpose (15%)	Testable hypothesis with objectives or purpose is clearly stated	Testable hypothesis clearly stated; objectives or purpose incomplete	Hypothesis not testable and/or objectives incomplete or poorly described	Hypothesis missing or not testable as written and/or objectives poorly written or missing
Main Ideas (15%)	The main ideas that will be discussed are presented with supporting documentation and linked to hypothesis	Main ideas discussed with inadequate supporting documentation and inadequate connection to hypothesis	Main ideas poorly discussed, supporting documentation incomplete and/or linkage to hypothesis or purpose tenuous or missing	Main ideas are missing or listed with no supporting documentation; no connection to hypothesis, purpose, or objectives
Introduction (10%)	Well researched background material discussed that support hypothesis and main ideas, and any contradictory evidence is discussed	An adequate amount of material is presented that supports the hypothesis and main idea, but contradictory information not presented and/or background material not adequately linked to hypothesis or main idea	Insufficient background material, but what is presented supports the hypothesis and main ideas; material may not be well linked to hypothesis and main idea	Background information is inadequate and/or not linked to hypothesis and main ideas; contradictory ideas not presented
Conclusion (10%)	A clear trajectory from hypothesis or purpose, main ideas of research, and background information is made to derive well-stated and reasoned conclusions	Well stated conclusions, but connection to hypothesis and background information unclear, or conclusions may not be complete	Inadequate or incomplete conclusions due to poor trajectory from hypothesis to conclusions, with no clear role of background or main ideas	The trajectory from hypothesis through ideas and background material is not clear, leading to poorly worded and reasoned conclusions or conclusions not stated
References (10%)	Correct number and types of references in accordance with guidelines and they were well chosen to support hypothesis and main ideas	Correct number and types if references in accordance with guidelines (or only 1 missing), but the references don't completely support hypothesis and main ideas	Number and/or types of references not in accordance with guidelines <b>OR</b> quality of references insufficient to support hypothesis and main ideas	Number and/or types of references not in accordance with guidelines; insufficient to support hypothesis and main ideas
Totals for columns:				

<b>Presentation Rubric, Pg 2</b>	<b>Exceeds Expectations</b>	<b>Meets Expectations</b>	<b>Approaches Expectations</b>	<b>Does Not Meet Expectations</b>
	<b>90-100%</b>	<b>75-89%</b>	<b>55-74%</b>	<b>Below 55%</b>
<b>Presentation (40% of total points)</b>				
Organization (10%)	Well organized with hypothesis/ purpose/objectives clearly stated up front; arguments and supporting evidence for hypothesis logically organized with sufficient information, but not too much; acknowledgements and references included	Organization allows the logic of the idea and supporting evidence to be followed, but some information may be presented out of order, or some is missing	Major gaps in the order of presentation of information; difficult to follow arguments and supporting evidence for hypothesis	The order of information is not logical; ideas and supporting information jump around; important information lacking
Preparation (10%)	All deadlines were met; hypothesis and main ideas well thought out with excellent supporting figures; graphics appropriate but not overwhelming; answers all or most questions well	Most or all deadlines met; hypothesis and main ideas adequate, but lack evidence of long, deep thought; supporting figures adequate, but could be improved; graphics inappropriate – either too much, too little, or not relevant; answers most questions adequately	Missed some deadlines; hypothesis and main ideas inadequate and show evidence of being put together with little thought; lacks appropriate supporting figures; graphics either insufficient, irrelevant or overwhelming; answers only some questions adequately	Met deadlines late; hypothesis and main ideas poorly presented with little or no supporting figures; graphics either completely missing or overwhelm the message; can't answer questions
Delivery (10%)	Student dressed appropriately; arrives on time; poised; makes eye contact; doesn't read from notes or screen; introduces each topic before slide comes up; answers questions with confidence	Most of the following apply and student lacking in no more than two areas: Student dressed appropriately; arrives on time; poised; makes eye contact; doesn't read from notes or screen; introduces each topic before slide comes up; answers questions with confidence	Student's appearance is acceptable, but interaction with audience, and confidence in discussing material is lacking	Most of the following apply: Inappropriate dress, late arrival, eye contact lacking, reads from notes or slides, can't introduce each topic; lack of confidence apparent in answering questions
Totals for columns:				

**Presentation Rubric, Pg 3**

	<b>Exceeds Expectations</b>	<b>Meets Expectations</b>	<b>Approaches Expectations</b>	<b>Does Not Meet Expectations</b>
	<b>90-100%</b>	<b>75-89%</b>	<b>55-74%</b>	<b>Below 55%</b>
Visuals (10%)	Presentation is pleasing to look at; slides aren't too crowded; information on each slide is limited to one aspect of the topic; fonts large enough to read; sharp contrast between background and font color; appropriate figures, such as pictures, molecular structures, etc. available from internet are used to illustrate main topic, ideas, and data; number of slides is sufficient to length of presentation (about 1/minute)	Presentation has most of the qualities of an exemplary presentation, but one or two may be missing or inadequate	The presentation is not pleasing to look at; some of the slides are difficult to read due to color or font choice, or arrangement or amount of material on slide; figures and pictures to illustrate topic and ideas are lacking or inadequate	Overall presentation does not visually pull in audience; most or all slides are crowded or lack important or exciting material; Topics on slides aren't logically organized; colors and/or font sizes make reading all or most slides difficult; pictures to illustrate topic and ideas are missing or inadequate
Totals for columns:				