

## STUDENT LEARNING ASSESSMENT REPORT

**PROGRAM:** Biochemistry (B.S.)  
**SUBMITTED BY:** Amanda Wright  
**DATE:** 9/2019

### Executive Summary: Description of Assessment Process

List *all* of the program's learning outcomes, as of the assessment year's catalog: (regardless of whether or not they are being assessed this year)

Goals	Learning Outcomes	Year of Last Assessment	Assessed This Year	Year of Next Planned Assessment
1. Students will be able to independently conduct and evaluate scientific research.	1. Students can formulate scientifically sound hypotheses	17-18	No	2019-2020
	2. Students can design and implement a research project	17-18	No	2019-2020
	3. Students can analyze data and draw conclusions	17-18	No	2019-2020
	4. Students can critically evaluate scientific literature	17-18	No	2019-2020
2. Students will be able to demonstrate effective oral and written scientific communication skills.	1. Students can develop coherent written arguments.	17-18	No	2019-2020
	2. Students can write using current scientific styles.	17-18	No	2019-2020
	3. Students can deliver effective oral scientific presentations	17-18	No	2019-2020
3. Students will understand the moral and ethical impact of sciences on their communities, both local and global.	1. Students will identify ethical dilemmas associated with current scientific innovations	new	Yes	2020-2021
	2. Students will follow ethical norms of scientific communication the final outcomes	new	Yes	2020-2021
4. Students will be able to integrate a range of scientific concepts and ideas.	1. Students can make connections between similar content ideas from different courses	new	Yes	2020-2021
<b>Biochemistry specific:</b> Students will demonstrate an understanding of fundamental biochemistry principles.	1. Students can compare and contrast structure and function of biomolecules.	17-18	yes	2019-2020
	2. Students can apply knowledge of metabolic pathways to medical applications.	17-18	yes	2019-2020
	3. Students can apply knowledge of biochemical process regulation to predict changes in metabolic outcomes.	17-18	yes	2019-2020

Provide a **brief** description of the assessment process used including how results are shared and discussed and strengths, challenges, and planned improvements to the **process**, providing evidence of a culture of continuous improvement based on assessment. If there is something that is impeding your ability to implement improvements, please comment on those issues (generally not more than two paragraphs, may use bullet points):

We have had many changes to our assessment process in the past year and have plans for additional changes in the coming year. Our assessment results are shared and discussed in our first department meeting in September. Each faculty member is sent a copy of the report and the assessment coordinator shares a short presentation with the faculty during this meeting. Ideas for changes or improvements are discussed and assigned.

**Strength:** The new learning goals and outcomes are closely aligned with our mission as a department and we expose students to these topics are various points in our curriculum (introductory, intermediate, and capstone levels).

**Challenges:** Our major challenges remain to be sifting through a tremendous amount of data in an efficient, organized way. Specifically, we currently use the DAT rubric to assess many of our outcomes. We acknowledge some problems with consistency with this tool that we would like to address. In addition, the data collection and analysis from this tool is cumbersome and time-consuming.

**Planned Improvements:** For the upcoming year, we plan to put different measures in place for many of our outcomes that are simpler and more accurately reflective of our students' abilities. Our intention is to replace the DAT with an entrance exam or other metrics that would be appropriately reflective of students' abilities and easier to analyze. In addition, we plan to devise assessment tools for our undergraduate research experience. Several faculty have recently attended workshops on this topic and we believe we can receive grant support to develop these tools and, once they are in place, we could receive more external funding for our on-campus research experiences.

We are working as a department to make assessment more meaningful and less burdensome. This started with the overhauling of our goals and outcomes last year, and the re-writing of the exit exam and implementation of a new way to administer the exam using Socrative software that makes analysis easier. This academic year, we plan to continue to improve the process. Although we recognize there are still deficiencies and areas we need to improve upon, we believe we are consistently making the process better each year. With regards to curriculum development, we carefully analyzed our results from last year and decided to focus on reading of scientific literature to draw conclusions and analyze data. Many faculty have implemented assignments or modules within their classes to specifically help address these outcomes. In addition, in response to feedback from alums and our current students, we added 11 new minors to our program this past year to help better prepare students for graduate and/or professional schools.

### Closing the Loop: Progress on Planned Improvements from Prior Year

Describe how the program implemented its planned improvements from last year:

Outcome	Planned Improvement	Update <i>(Indicate when, where, and how planned improvement was completed. If planned improvement was not completed, please provide explanation.)</i>
<b>Students can formulate scientifically sound hypotheses.</b>	We feel that students in Bio 441 Lab receive excellent instruction and practice in developing hypotheses. We will be working to incorporate this skill in lower level courses (Bio 151, Bio 260, and Bio 262) to target all of our students and at earlier points in the curriculum.	We implemented a specific activity in Bio 151 that focuses on formulating and evaluating hypotheses. There is a renewed department wide commitment to ensure that all laboratory exercises and independent research is hypothesis-driven.
<b>Students can design and implement a research project.</b>	We feel very encouraged by the results of this assessment with our senior students in particular. We will purposefully and intentionally implement	We added an exercise in Bio 151 and a module in Bio 151L to specifically address designing a research plan. The idea is to

Outcome	Planned Improvement	<b>Update</b> <i>(Indicate when, where, and how planned improvement was completed. If planned improvement was not completed, please provide explanation.)</i>
	<p>new approaches for our freshmen and sophomore students to begin to acquire these skills at earlier points during the curriculum. It is our intention to increase continuity and provide consistent language and skill development across the curriculum. In addition, we hope to involve more students in independent research projects with both faculty and upperclassmen mentors. These experiences will expose students to the skill of designing their own research projects and allow them the opportunity to carry out these projects under supervision.</p>	<p>engage students in research design early on their academic careers and build upon that as they progress. We are working to add build upon this skill in mid-level classes and will also be working to assess this during independent research projects. Developing the assessment tool for independent research has given us some challenges that we are working through.</p>
<p><b>Students can analyze data and draw conclusions.</b></p>	<p>We feel that students in Bio 441 Lab receive excellent instruction and practice in analyzing data and drawing conclusions. We will be working to incorporate these skills in lower level courses (Bio 151, Bio 260, and Bio 262) to target all of our students and at earlier points in the curriculum.</p>	<p>Expectations for lab reports are laid out clearly in BIO151L. As students progress, BIO262L (all sections) has implemented vigorous standards for lab reports and we provide the students with guidelines and detailed grading rubrics as feedback. Clear presentation of data is a critical skill, and we cover what makes good tables and figures in detail in BIO300.</p>
<p><b>Students can critically evaluate scientific literature.</b></p>	<p>Based on the data presented here, we see that our students are somewhat struggling to meet our expectations in regards to evaluating and analyzing scientific literature. However, we are encouraged by the data from the review paper rubric and will continue to give students instruction and practice in these skills, especially focusing on our sophomore and junior students.</p>	<p>In BIO300, one of our mid-level WI courses, we have implemented the use the retracted MMR-autism paper as a case study throughout the semester. First, students learn about the peer-review and editorial process, and then the power of the scientific method to test hypotheses and correct false associations. We also spend a lot of time teaching students about primary versus secondary sources. We are also in the process of developing a seminar class designed, among other things, to address evaluating scientific literature.</p>
<p><b>Students can develop coherent written arguments.</b></p>	<p>Writing will continue to be an integral part of our curriculum and we will continue to emphasis scientific writing in all of our courses, especially working to ensure that freshmen and sophomores receive training in these skills.</p>	<p>We continue to emphasize writing in all courses and are working on developing department-wide rubrics at all levels to better assess writing.</p>
<p><b>Students can write using current scientific styles.</b></p>	<p>Writing will continue to be an integral part of our curriculum and we will continue to emphasis scientific writing in all of our courses, particularly at the freshmen and sophomore level. We spend quite a bit of time discussing scientific writing styles in our Bio 300 course but we will work to emphasize this in other courses as well.</p>	<p>In BIO300, we cover the complete range of scientific styles. For research articles, we follow the style guidelines of the top publications. We have also implemented the use the MMR-autism case study to practice effective communication with a non-specialized audience. There has also been an increased emphasis on this in our introductory classes where we</p>

Outcome	Planned Improvement	<b>Update</b> <i>(Indicate when, where, and how planned improvement was completed. If planned improvement was not completed, please provide explanation.)</i>
		are designing workshops for lab report writing to teach good habits from the beginning.
<b>Students can deliver effective oral scientific presentations.</b>	We have students give oral presentations throughout our curriculum and we will continue to emphasize this skill with our students. We will work to provide more immediate and useful feedback and provide opportunities for students to present their independent research as well as classroom research projects.	We already discuss poster presentations in BIO300, but we have added guidelines on oral presentations. A grading rubric for oral presentations was implemented in BIO272, which provided students with immediate, constructive feedback. We will be working this year to incorporate use of this rubric in other classes as well.
<b>Students can compare and contrast structure and function of biomolecules.</b>	With the implementation of these new outcomes, I will be working to design a project for Bio 441 specifically tied to this goal. Additionally, I will design a rubric that can be used as an additional tool to assess student's understanding of structure and function of biomolecules.	We did implement a project designed to enhance understanding of structure and function of biomolecules. In collaboration with Dr. Bubar and his students, we designed a 3D printed model of a protein that students must assemble and analyze based on structure/function relationships. The assessment tool for this activity is still underway and requires revision.
<b>Students can apply knowledge of metabolic pathways to medical applications.</b>	We feel we do a nice job of applying learned principles to medical applications. We will be working to expand this application to other classes so students get experience applying these ideas in other courses.	This is something we are still working toward but did not achieve significant success on during this year. With all the other work being done to improve assessment and enhance learning outcomes, this planned improvement was not a priority.
<b>Students can apply knowledge of biochemical process regulation to predict changes in metabolic outcomes.</b>	We feel we do a good job of providing student's the tool they need to apply knowledge of metabolic changes to predict outcomes. We will be working to provide students more opportunities to practice these skills in the form of assignments or exam questions where we can assess their abilities and skills.	This is something we are still working toward but did not achieve significant success on during this year. With all the other work being done to improve assessment and enhance learning outcomes, this planned improvement was not a priority. We will be working in the coming year to develop better metrics in this area.

**Provide a response to last year's University Assessment Committee review of the program's learning assessment report:**

Comment: Needs minor revision in the catalog changes proposed in language on outcomes (last outcome needs deletion of "Students will") on page #1.

Response: During this process we discovered the program outcomes are incorrect in the 2019-2020 catalog and we are currently working to correct this problem.

Comment: Perhaps an example or explanation of how the exit exam was rewritten to overlap with outcomes would have made that point clearer.

Response: The previous exit exam was very content based. There was a physics section, a biology section, a genetics section, a chemistry section, etc. No specific question was directly linked with a programmatic outcome. In rewriting the exam in 2018, we specifically wrote questions that directly measured the learning outcomes we wanted our students to achieve. For example, we want our students to be able to identify ethical dilemmas, thus; we wrote several questions that present scenarios in which they are asked to identify ethical dilemmas.

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Comment: Goal #2 (oral and written skills) has corresponding outcomes for written skills, but none for the oral communications skills. Was that an oversight?

Response: This was an oversight. There is a corresponding outcome regarding oral presentations (Outcome #3: Students can deliver effective oral presentations). It was assessed in the report but inadvertently omitted from the table in the beginning of the document.

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Comment: A very onerous task, but done very well. This could become Exemplary if the following can be achieved in the next assessment cycle:- (1) when the number of seniors in the course are very few, the target may not be achieved if it is expressed as a %. For example, when 2 out 3 students meet the desired level of achievement, and the target is set at 70%, the target cannot be mathematically achieved. It might be necessary to set the target in both formats (# and %) to make it easy to discuss the results and plan improvements for the next year; and (2) figure out alternative indirect measures or how to increase participation from graduating students/alumni.

Response: Targets and the way in which the data is presented have been adjusted this year based on this recommendation. We did receive data from our graduating student survey (n=9) that we feel will serve as a valid indirect measure. However, our response rate was still too low from our alumni survey to be valid. However, we feel that as we graduate more students in this program, the alumni survey will become more valuable. We have also recently developed a set of questions that address student's confidence levels in areas that will be directly related to our assessment. We are administering these questions for first time in 2019-2020 and will have this data next year to serve as an alternative indirect measure.

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## Outcomes Assessment 2018-2019

**Goal 3: Students will understand the moral and ethical impact of science on their communities, both local and global.**

**Learning Outcome 1: Students will identify ethical dilemmas associated with current scientific innovations.**

<b>Outcome Measures</b> <i>Explain how student learning will be measured and indicate whether it is direct or indirect.</i>	<b>Performance Standard</b> <i>Define the acceptable level of student performance.</i>	<b>Data Collection</b> <i>Discuss the process for collecting this data: who conducted the assessment, when, and how?</i>	<b>Result</b> <i>Did you meet your target? What was the result?</i>
Direct: Exit exam questions 41-45 (see appendix 1)	70% (or at least 7 of the 11 students tested) of students will achieve a score of 60% or more on the pertinent questions corresponding to each learning outcome of the exit exam.	The exit exam was given to 11 biochemistry students (graduating seniors) in Fall 2018 or Spring 2019 during their Senior Seminar exam time. The instructor for this course administered the exam using <i>Socrative</i> software and data was analyzed using Excel.	On average, 93% of biochemistry majors (10 of 11) scored at least 60% on this section (86% or 6 of 7 students in Fall 2018 and 100% or 4 of 4 students in Spring 2019). <b>The performance standard was met.</b>
Direct: Literature review paper grading rubric: conclusion section (see Appendix 2)	70% of students will score at least 30 out of 50 points.	1) All biochemistry majors are required to take Bio 442: Nucleic Acids and Metabolism. As a requirement of this course, students write a comprehensive literature review where they analyze 8 primary research papers and write their own literature review based on the evidence submitted in these papers. Review paper grading rubrics were collected from all students who participated in Bio 442 during Fall 2018 (n=8). The points earned for the conclusion section of the grading rubric were assessed and the percentage of students who scored at least a 30/50 was calculated. Students are asked to identify ethical dilemmas as part of this section.	For Fall 2018, the average score on the conclusions section combined was 38.3 out of 50. Seven of the eight students assessed scored at least 30/50 on this section of the literature review rubric. This corresponds to 88% of students achieving the performance standard. <b>The performance standard was met.</b>

### Interpretation of Results

**Analysis and Implications:** *What does this result tell you about the extent to which your students achieved this outcome? What are the strengths and weaknesses that this result highlights, and what are the implications for your curriculum or your program?*

In general, our students performed well on this learning outcome and we believe this is a testament to the effectiveness of the ethical modules we have implemented in many of our classes. We will continue to emphasize ethical awareness via specific modules in our classes ranging from freshmen to senior students. Specifically, we will address more ethical practices around genomic medicine. From an assessment perspective, I will work to separate the ethical component of the assignment to more accurately reflect students' mastery of this concept.

**Discuss planned curricular or program improvements for this year based on assessment of outcome:**

We will continue to emphasize ethical relevance and understanding in our classes. We will work to emphasize ethical implications of genomic medicine through specific modules. The Center for Case Study Teaching in Science has case studies that will be added to the curriculum to address these issues.

**Goal 3: Students will understand the moral and ethical impact of science on their communities, both local and global**  
**Learning Outcome 2: Students will follow ethical norms of scientific communication.**

<b>Outcome Measures</b> <i>Explain how student learning will be measured and indicate whether it is direct or indirect.</i>	<b>Performance Standard</b> <i>Define the acceptable level of student performance.</i>	<b>Data Collection</b> <i>Discuss the process for collecting this data: who conducted the assessment, when, and how?</i>	<b>Result</b> <i>Did you meet your target? What was the result?</i>
Direct: Exit exam questions 46-50 (see appendix 1)	70% (or at least 7 of the 11 students tested) of students will achieve a score of 60% or more on the pertinent questions corresponding to each learning outcome of the exit exam.	The exit exam was given to 11 biochemistry students (graduating seniors) in Fall 2018 or Spring 2019 during their Senior Seminar exam time. The instructor for this course administered the exam using <i>Socrative</i> software and data was analyzed using Excel.	On average, 73% of biochemistry majors (8 of 11) scored at least 60% on this section (71% or 5 of 7 students in Fall 2018 and 75% or 3 of 4 students in Spring 2019). <b>The performance standard was met.</b>
Direct: Literature review paper grading rubric: formatting section (see Appendix 2)	70% of students will score at least 9 out of 15 points.	2) All biochemistry majors are required to take Bio 442: Nucleic Acids and Metabolism. As a requirement of this course, students write a comprehensive literature review where they analyze 8 primary research papers and write their own literature review based on the evidence submitted in these papers. Review paper grading rubrics were collected from all students who participated in Bio 442 during Fall 2018 (n=8). The points earned for the formatting section of the grading rubric were assessed and the percentage of students who scored at least a 9/15 was calculated.	For Fall 2018, the average score on the formatting section combined was 11.1 out of 15. Six of the eight students assessed scored at least 9/15 points on this section of the literature review rubric. This corresponds to 75% of students achieving the performance standard. <b>The performance standard was met.</b>

**Interpretation of Results**

**Analysis and Implications:** *What does this result tell you about the extent to which your students achieved this outcome? What are the strengths and weaknesses that this result highlights, and what are the implications for your curriculum or your program?*

Overall, this goal was met for biochemistry students. The exit exam questions assesses students' knowledge of publication ethics (for example, authorship and ethics of data presentation). We believe this may be a factor of the student's involvement in undergraduate research, although this is an idea that we would like to investigate further. Anecdotally, we believe that, based on percentages, more biochemistry students are involved in research and thus are exposed to these ethical situations. This is an area

that we will continue to emphasize in our writing course and with those students who conduct independent research. We will also strive to provide more research opportunities for our students so they can acquire direct experiences with ethical dilemmas surrounding publication.

**Discuss planned curricular or program improvements for this year based on assessment of outcome:**

We will continue to emphasize ethical balance, presenting, clarifying, and supporting varying viewpoints in our classes. We will work to specifically implement an assignment or module regarding this topic in our mid-level writing class. In addition, we will design curriculum around authorship and ethics of data presentation at every level of our curriculum. As more students become involved in independent research (and as we develop assessment tools for our independent research objectives) we will work specifically to make sure students are receiving training on these important topics.

**Goal 4: Students will be able to integrate a range of scientific concepts and ideas.**

**Learning Outcome 1: Students can make connections between similar content ideas from different courses.**

<b>Outcome Measures</b> <i>Explain how student learning will be measured and indicate whether it is direct or indirect.</i>	<b>Performance Standard</b> <i>Define the acceptable level of student performance.</i>	<b>Data Collection</b> <i>Discuss the process for collecting this data: who conducted the assessment, when, and how?</i>	<b>Result</b> <i>Did you meet your target? What was the result?</i>
Direct: Exit exam questions 22-26	70% (or at least 7 of the 11 students tested) of students will achieve a score of 60% or more on the pertinent questions corresponding to each learning outcome of the exit exam.	The exit exam was given to 11 biochemistry students (graduating seniors) in Fall 2018 or Spring 2019 during their Senior Seminar exam time. The instructor for this course administered the exam using <i>Socrative</i> software and data was analyzed using Excel.	On average, only 52% of biochemistry majors (~6 of 11) scored at least 60% on this section (29% or 2 of 7 students in Fall 2018 and 75% or 3 of 4 students in Spring 2019). The spring data is taken less seriously here given the small number of students. <b>The performance standard was not met.</b>
Direct: Literature review paper grading rubric: evidence section (see Appendix 2)	70% of students will score at least 30 out of 50 points.	All biochemistry majors are required to take Bio 442: Nucleic Acids and Metabolism. As a requirement of this course, students write a comprehensive literature review where they analyze 8 primary research papers and write their own literature review based on the evidence submitted in these papers. Review paper grading rubrics were collected from all students who participated in Bio 442 during Fall 2018 (n=8). The points earned for the evidence section of the grading rubric were assessed and the percentage of students who scored at least a 30/50 was calculated. Students are specifically asked to integrate information from all sources in this section of the paper.	For Fall 2018, the average score on the evidence section combined was 34.3 out of 50. Only four of the eight students assessed scored at least 30/50 points on this section of the literature review rubric. This corresponds to 50% of students achieving the performance standard. <b>The performance standard was met.</b>



**Interpretation of Results**

**Analysis and Implications:** *What does this result tell you about the extent to which your students achieved this outcome? What are the strengths and weaknesses that this result highlights, and what are the implications for your curriculum or your program?*

Overall, this goal was not met. Given how poorly our students performed on the exit exam and the struggles students had integrating information in the literature review, we see this as a real growth opportunity for our department and this program specifically. Clearly, our students are struggling to perform as we would like them to in this area. We believe, based on previous assessment reports, that students are successful at mastering subject areas individually but this result highlights that students are clearly having difficulty merging ideas from related disciplines, a skill we consider to be a hallmark of a Marymount Biochemistry education. Integration of ideas will become a focus of our curriculum development in the upcoming academic year.

**Discuss planned curricular or program improvements for this year based on assessment of outcome:**

We will be working to integrate ideas across classes to better help students see how topics relate to one another. For example, we will be working to redesign the introductory biology curriculum so that students will see applications for chemistry and physics, implementing specific modules where students are asked to utilize knowledge from other classes to carry out an assignment. Within biochemistry classes specifically, the aspects of the curriculum will be redesigned to have a specific focus on integration. In addition, case studies that require students to draw from several other disciplines to solve medical questions will be added to the curriculum. This will be a significant undertaking and require extensive redesign to our curriculum and perhaps addition of new courses. We will start small and expand based upon success and effectiveness of our strategy.

**Biochemistry specific: Students will demonstrate an understanding of fundamental biochemistry principles.**

**Learning Outcome 1: Students can compare and contrast structure and function of biomolecules.**

<b>Outcome Measures</b> <i>Explain how student learning will be measured and indicate whether it is direct or indirect.</i>	<b>Performance Standard</b> <i>Define the acceptable level of student performance.</i>	<b>Data Collection</b> <i>Discuss the process for collecting this data: who conducted the assessment, when, and how?</i>	<b>Result</b> <i>Did you meet your target? What was the result?</i>
Direct: exam question: "Compare and contrast the following three proteins: alpha-keratin, collagen, and fibroin. Be sure to include a thorough discussion of how each structure relates to the specific function of each protein."	70% of students will achieve a score of 60% or more on this question specifically (overall worth 10 points).	Senior students in Bio 441 were given an exam mid-term which included the question to be assessed. Student exams were graded by the instructor and scores on this question were recorded. Individual student scores on this specific question were recorded using excel during Spring 2019 (n=21). The percentage of students who earn at least a 6/10 (60%) was calculated.	After examining the analysis for individual scores, 81% of biochemistry majors scored at least 60% on this section. The average score for this question was 8.17/10. <b>The performance standard was met.</b>
Direct: exam question: "Describe 3 possible biological functions of polysaccharides, 3 functions for nucleotides, and 4 possible functions for nucleic acids. Give examples of each!"	70% of students will achieve a score of 60% or more on this question specifically (overall worth 10 points).	Senior students in Bio 441 were given an exam at the end of the term which included the question to be assessed. Student exams were graded by the instructor and scores on this question were recorded. Individual student scores on this specific question were recorded using excel during Spring 2019 (n=21). The percentage of students who earn at least a 6/10 (60%) was calculated.	1) After examining the analysis for individual scores, 95% of biochemistry majors scored at least 60% on this section. The average score of this question was 8.52/10. <b>The performance standard was met.</b>

**Interpretation of Results**

**Analysis and Implications:** *What does this result tell you about the extent to which your students achieved this outcome? What are the strengths and weaknesses that this result highlights, and what are the implications for your curriculum or your program?*

This performance standard was met in both areas in which it was assessed. Although we did not set up the assessment to accurately reflect improvement throughout the semester, we were pleased to see that average student scores were higher on the question given at the end of the term than on the question given at mid-term. We recognize that this comparison is not entirely valid since the two questions are different. We feel these are questions are strong direct indicators of our student’s ability to compare and contrast structure and function of biological molecules.

**Discuss planned curricular or program improvements for this year based on assessment of outcome:**

We will continue to emphasize structure/function relationships with our biochemistry students. The assignment involving the 3D printed model worked really well and we will work to do more of this modeling, in collaboration with Dr. Bubar, in biochemistry and other classes. We are currently working to do more modeling in our introductory course to demonstrate structure/function relationships of DNA.

**Biochemistry specific: Students will demonstrate an understanding of fundamental biochemistry principles.**

**Learning Outcome 2: Students can apply knowledge of metabolic pathways to medical applications.**

<p><b>Outcome Measures</b> <i>Explain how student learning will be measured and indicate whether it is direct or indirect.</i></p>	<p><b>Performance Standard</b> <i>Define the acceptable level of student performance.</i></p>	<p><b>Data Collection</b> <i>Discuss the process for collecting this data: who conducted the assessment, when, and how?</i></p>	<p><b>Result</b> <i>Did you meet your target? What was the result?</i></p>
<p>Direct: exam question: “Methotrexate is a drug used to treat many cancers and autoimmune disorders. Describe the pathway effected by this drug and explain how it works to effectively treat these such diseases.”</p>	<p>70% of students will achieve a score of 60% or more on this question specifically (overall worth 10 points).</p>	<p>Senior students in Bio 442 were given an exam mid-term which included the question to be assessed. Student exams were graded by the instructor and scores on this question were recorded. Individual student scores on this specific question were recorded using excel during Fall 2018 (n=8). The percentage of students who earn at least a 6/10 (60%) was calculated.</p>	<p>After examining the analysis for individual scores, 75% (6 of 8 students) of biochemistry majors scored at least 60% on this section. The average score for this question was 7.61/10. <b>The performance standard was met.</b></p>
<p>Direct: exam question: It’s your first patient of the day – an infant with excessive sleepiness, irritability, jaundice, poor feeding, and vomiting, especially after eating fruits or high fructose foods. Your boss orders you to do a blood analysis. The following table represents the results. Based on this analysis, what, if any, defects in glycolysis is this infant experiencing? What other possible explanations exists to explain the symptoms this infant is experiencing. What additional tests would you run to confirm your diagnosis? <b>see appendix 2 for full question</b></p>	<p>70% of students will achieve a score of 60% or more on this question specifically (overall worth 10 points).</p>	<p>Senior students in Bio 442 were given an exam at the end of the term which included the question to be assessed. Student exams were graded by the instructor and scores on this question were recorded. Individual student scores on this specific question were recorded using excel during Fall 2018 (n=8). The percentage of students who earn at least a 6/10 (60%) was calculated.</p>	<p>2) After examining the analysis for individual scores, 100% of biochemistry majors scored at least 60% on this section. The average score of this question was 9.12/10. <b>The performance standard was met.</b></p>

**Interpretation of Results**

**Analysis and Implications:** *What does this result tell you about the extent to which your students achieved this outcome? What are the strengths and weaknesses that this result highlights, and what are the implications for your curriculum or your program?*

This performance standard was met in both areas in which it was assessed. Although we did not set up the assessment to accurately reflect improvement throughout the semester, we were pleased to see that average student scores were higher on the question given at the end of the term than on the question given at mid-term. We recognize that this comparison is not entirely valid since the two questions are different. We feel these are questions are strong direct indicators of our student’s ability to apply knowledge of metabolic pathways to medical applications. We have an additional assignment in place where students solve medical mysteries based on case studies.

**Discuss planned curricular or program improvements for this year based on assessment of outcome:**

We will continue to emphasize the application of learned principles to medical situations. We will be working to expand this application to other classes so students get experience applying these ideas in other courses. In the coming academic year, we will be collaborating to implement case studies or other assignments to increase the relevance of metabolic pathways, specifically to our pre-med students. We will be implementing confidence assessments to current students to serve as an indirect measure of this outcome.

**Biochemistry specific: Students will demonstrate an understanding of fundamental biochemistry principles.**

**Learning Outcome 3: Students can apply knowledge of biochemical process regulation to predict changes in metabolic outcomes.**

<b>Outcome Measures</b> <i>Explain how student learning will be measured and indicate whether it is direct or indirect.</i>	<b>Performance Standard</b> <i>Define the acceptable level of student performance.</i>	<b>Data Collection</b> <i>Discuss the process for collecting this data: who conducted the assessment, when, and how?</i>	<b>Result</b> <i>Did you meet your target? What was the result?</i>
Direct: exam question: “ <i>E. coli</i> cells are placed in a growth medium containing lactose. Indicate how the following circumstances would affect the expression of the lactose operon (increase/decrease/no change) and explain your answers. --Addition of high levels of glucose --A Lac repressor mutation that prevents dissociation of Lac repressor from the operator --A mutation that inactivates Beta-galactosidase --A mutation that inactivates galactoside permease --A mutation that prevents binding of CRP to its binding site near the <i>lac</i> promoter	70% of students will achieve a score of 60% or more on this question specifically (overall worth 15 points).	Senior students in Bio 442 were given an exam mid-term which included the question to be assessed. Student exams were graded by the instructor and scores on this question were recorded. Individual student scores on this specific question were recorded using excel during Fall 2018 (n=8). The percentage of students who earn at least a 9/15 (60%) was calculated.	After examining the analysis for individual scores, 75% of biochemistry majors (6 of 8 students) scored at least 60% on this section. The average score for this question was 10.63/15. <b>The performance standard was met.</b>
Indirect: Graduating Student Survey, "Apply knowledge and skills to new situations" and "Solve problems in your field using your knowledge and skills"	70% of GSS respondents perceive their preparation to be good or excellent.	Individual graduating undergraduate seniors answered questions pertaining to their perceptions of their academic preparation and learning outcomes. The	For both questions examined, 100% of the 9 respondents perceived their preparation as good or excellent. <b>The performance standard was met.</b>

<b>Outcome Measures</b> <i>Explain how student learning will be measured and indicate whether it is direct or indirect.</i>	<b>Performance Standard</b> <i>Define the acceptable level of student performance.</i>	<b>Data Collection</b> <i>Discuss the process for collecting this data: who conducted the assessment, when, and how?</i>	<b>Result</b> <i>Did you meet your target? What was the result?</i>
		University administered and collected the surveys and analyzed the results.	

**Interpretation of Results**

**Analysis and Implications:** *What does this result tell you about the extent to which your students achieved this outcome? What are the strengths and weaknesses that this result highlights, and what are the implications for your curriculum or your program?*

This performance standard was met using the tool we had in place for this outcome. The indirect measure of the GSS was used to assess students’ perception of their preparedness. Although we recognize the limitations of this tool, the department does value students feeling confident in their abilities to solve problems and apply knowledge.

**Discuss planned curricular or program improvements for this year based on assessment of outcome:** We will continue to emphasize application of knowledge of metabolic changes to predict outcomes. We will be working to provide students more opportunities to practice these skills in the form of assignments or exam questions where we can assess their abilities and skills. This is something that will become a priority in the current academic year. We will be implementing confidence assessments to current students to serve as an indirect measure of this outcome.

### Appendix 1: Senior Exit Exam

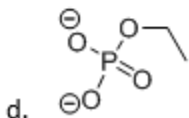
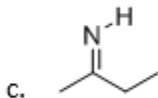
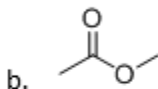
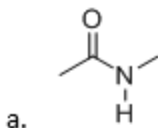
We have only included the portions of the exit exam that we analyzed in the outcomes addressed here. If the committee wishes to see the entire exit exam, we are happy to provide that.

#### SENIOR COMPREHENSIVE EXAM – BIOLOGY & PHYSICAL SCIENCES

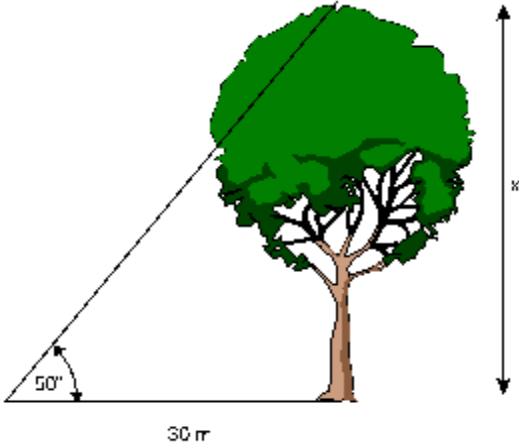
22) Which of the following is eliminated in the reaction which joins two monomers in polymer synthesis?

- a.  $\text{NH}_4$
- b.  $\text{H}_2\text{O}$**
- c. NO
- d.  $\text{CO}_2$

23) The secondary structure of proteins results from hydrogen bonding between two of which of the following functional groups? (answer A)



24) How would you determine the height of the tree in the figure below? You stand 30 feet from the tree. The angle between the tree and the ground is  $90^\circ$ . The angle to the top of the tree is  $50^\circ$ .



- a) Height = 30 feet  $\times$  sin (50°)
- b) **Height = 30 feet  $\times$  tan (50°)**
- c) Height = 30 feet  $\times$  cos (50°)
- d) Height = 30 feet / tan (50°)

- 25) Following which checkpoint might you detect elevated levels of topoisomerase, DNA polymerase, and DNA ligase activity?
- a) **G1 checkpoint**
  - b) G2 checkpoint
  - c) M checkpoint
  - d) any of the listed checkpoints are equally likely
- 26) Your boss gives you a sample of bacterial culture medium and asks you to determine the number of **living** bacteria in the sample. Which technique would give you the most accurate result?
- a) streak plate colony cultures
  - b) growth cultures on selective-differential media
  - c) turbidimetric method with a spectrophotometer
  - d) **serial dilutions and colony plate counts**

Written communication in science follows standards of technical writing. Such communication provides a platform to describe context for why an experiment is performed, give details of the experiment so it can be repeated, show a thorough analysis and provide conclusions that place your work in a broader scientific context. Oral presentations in science, however, are typically shorter and are intended to convey the high points of a result and publicize a particularly novel or exciting result. For the following statements, decide if it belongs in a written lab report or an oral presentation. If it belongs more in a written report, answer “a”, if it belongs more in an oral presentation answer “b”, if it should be done in both answer “c”

- 31) Convey **ALL** the details of your experimental design answer: A
- 32) Describe the **details** of what you did to analyze your data answer: A
- 33) **Briefly** describe your experimental design answer: B
- 34) Focus **PRIMARILY** on describing your results and conclusions answer: B
- 35) Reference all sources and previous studies answer: C

- 41) As scientists become adept at deciphering a person's genetic composition, we may be able to predict that a child will develop a serious illness by the age of 30. What is the best way to handle this situation?
- Inform prospective employers of the person's genetic trait
  - Inform prospective insurance carriers of the person's genetic trait
  - Develop rules for ethical practice as to how and to whom genetic information is revealed**
  - Inform relatives so that they may be aware of the trait
  - The best way is to do all of the above.
- 42) Mary and John are working in a research lab together. Mary observed John entered data that was not accurate. She questioned John when she noticed that the numbers were not accurate. John proceeded to utilize the data and, after statistical analysis, he reported that his data was significant. Mary should:
- Ignore what she observed since she had made an attempt to correct the situation.
  - Speak to John's mentor and tell him/her what she observed**
  - Tell other students what she observed so that they will support her concern.
  - Publish a comment about the inaccuracy of John's data on Facebook
  - None of the above are correct.
- 43) What ethical principle is supported by conservation biology?
- Biodiversity is desirable for all living things, including humans**
  - Extinctions due to human action are to be expected
  - Biodiversity has no value unto itself
  - Survival of the fittest
  - Nature is not guided by ethical principles, only biological, so no principles apply
- 44) A course in Ethics
- Provides guidance for students to make thoughtful decisions**
  - Provides rules for making decisions
  - Creates ethical individuals
  - Requires that students have the same religious beliefs in order to make ethical decisions
  - All of the above are correct
- 45) The IRB, the Institutional Review Board, at Marymount University is established to protect human subjects in research situations. The committee works to:
- Assure University compliance with federal regulations
  - Create an institutional culture where responsible conduct is understood, supported and followed by Marymount students, faculty, staff and administration.
  - Provide guidance for the method of selection of human subjects and to assure that selection is equitable
  - Assure that informed consent is obtained and properly documented to protect human subjects
  - All of the above are roles of the IRB**
- 46) An author of a scientific paper should
- have provided substantial intellectual contributions to the study**
  - have completed all of the work for the paper him or herself
  - take no responsibility for coauthor's integrity or ability
  - both a and b are correct
  - all of the above

- 47) When writing a scientific paper for publication, it is permissible to quote from an article you have previously published because it is your original work.
- True
  - False**
- 48) Which of the following should be included for publication in a scientific journal article?
- The principle investigator who is overseeing the project
  - The lab technician who prepared all the solutions for the project
  - The lab manager who typed the paper
  - The undergraduate student who performed two experiments that were included in the paper.
  - all of the above
  - A & D only**
  - B & C only
  - A, C, and D only
- 49) When preparing data for publication, it is permissible to ignore data that is inconsistent with or does not support your hypothesis without discussing your reasons for doing so.
- True
  - False**
- 50) Which of the following scenarios would be classified as deviations from ethical norms in scientific communication?
- Submitting the same paper to two different journals without informing the editors
  - Including a colleague as an author in return for a favor
  - Assigning a project to two students to see who finishes the project the fastest
  - Both A and B are correct
  - all of the above**



**Appendix 2: Bio 442 Review Paper Rubric**

<b>Deadlines:</b>	_____ pts out of 30 for meeting all deadlines.
<b>Reflection paper:</b>	_____ pts out of 20 for including a thoughtful reflection statement.
<b>INTRODUCTION:</b>	_____ pts out of 25 for a brief introduction to the topic, highlighting its importance.
<b>Evidence:</b>	_____ pts out of 50 for a detailed presentation of evidence supporting your topic, paying particular attention to integrating information from all your sources.
<b>CONCLUSIONS:</b>	_____ pts out of 50 for a well thought out conclusion highlighting gaps in the field, remaining questions, and current research being done, and identifying ethical dilemmas associated with innovations in this field.
<b>REFERENCE LIST:</b>	_____ pts out of 10 for a correctly formatted list of references including at least 8 primary research articles not older than 2009.
<b>FORMATTING:</b>	_____ pts out of 15 for detailed, organized, clear, concise, professional article.
<b>SPELLING/GRAMMAR:</b>	_____ number of mistakes

**Appendix 3: Biochemistry Specific Goal, Outcome 2 Exam Question**

It's your first patient of the day – an infant with excessive sleepiness, irritability, jaundice, poor feeding, and vomiting, especially after eating fruits or high fructose foods. Your boss orders you to do a blood analysis. The following table represents the results:

Compound	Results (+, normal ; - ,decreased levels)
Blood glucose	-
Glucose 6-phosphate	+
Fructose 6-phosphate	+
Fructose 1,6-bisphosphate	+
Glyceraldehyde 3-phosphate	+
1,3 bisphosphoglycerate	+
Phosphoenolpyruvate	+
Pyruvate	+
Red blood cell concentration	+

Based on this analysis, what, if any, defects in glycolysis is this infant experiencing? What other possible explanations exists to explain the symptoms this infant is experiencing. What additional tests would you run to confirm your diagnosis? (10 points)