

STUDENT LEARNING ASSESSMENT REPORT (2017 – 2018)

PROGRAM: Biochemistry (BS)

SUBMITTED BY: Amanda Wright

DATE:

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EXECUTIVE SUMMARY

Program description from the Course Catalog: Please copy and paste the current year's catalog description of this program. This is generally a one-two paragraph description immediately following the name of the program. Please be sure to include the listing of program outcomes as printed.

Currently, the 2017-2018 course description for Biochemistry (BS) states:

Biochemistry is the study of biological molecules and chemical processes that make up all living systems, which in turn relates to the study and understanding of whole organisms. To fully interact with known biochemical information and make future contributions to our molecular understanding of life, students must obtain a broad background in biology and a firm foundation in chemistry, mathematics, and physics.

The program prepares students for professional school (medicine, dentistry, or veterinary medicine) and graduate school in biochemistry, molecular biology, or another biological science discipline. Graduates will find employment opportunities in the research programs of universities or industrial and government laboratories.

Upon successful completion of the biochemistry program, students will be able to

- comprehend the breadth of current concepts in biochemistry and molecular genetics;
- read and critically evaluate scientific literature;
- formulate hypotheses and develop, conduct, and interpret a research plan; and
- demonstrate the ability to apply knowledge gained.

During Spring 2018, the department wrote and implemented revised program learning outcomes. These changes have been submitted to our assistant dean, the office of planning and institutional effectiveness, and the registrar's office. At the time of the drafting of this report (Summer 2018) the program learning outcomes have not been updated in the catalog. However, upon the recommendation of the Office of Planning and Institutional Effectiveness, we used these newly written outcomes to conduct assessment for this report. Once catalog changes have been put into place, it will read as stated below:

Upon successful completion of the biology program, students will be able to

- formulate scientifically sound hypotheses;
- demonstrate effective oral and written scientific communication skills;
- understand the moral and ethical impact of science on their communities, both local and global;
- integrate a range of scientific concepts and ideas
- Students will demonstrate an understanding of fundamental biochemistry principles.

Please note: After much deliberation, research, and communication with the PIE, the department agreed upon these overall goals for our students. We held several departmental workshops to establish major goals that we want our students to accomplish during their Marymount careers. We decided that these outcomes were appropriate for all our

students – both biology and biochemistry. We did implement an additional biochemistry specific goal to assess these students from a content perspective. We thoroughly researched other institutions and found that it is the norm for biology and biochemistry programs to have similar – if not identical – learning outcomes.

Goal 1: Students will be able to independently conduct and evaluate scientific research.

Outcomes: Students can formulate scientifically sound hypotheses

Students can design and implement a research project

Students can analyze data and draw conclusions

Students can critically evaluate scientific literature

Goal 2: Students will be able to demonstrate effective oral and written scientific communication skills.

Outcomes: Students can write clear, concise, and accurate papers that follow logical reasoning

Students can write using current scientific styles

Students can deliver effective oral scientific presentations

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

Outcomes: Students will identify ethical dilemmas associated with current scientific innovations

Students will follow ethical norms of scientific communication

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

Outcomes: Students can make connections between similar content ideas from different courses

Biochemistry specific Goal 5: Students will demonstrate an understanding of fundamental biochemistry principles.

Outcomes: Students can compare and contrast structure and function of biomolecules.

Students can apply knowledge of metabolic pathways to medical applications.

Students can apply knowledge of biochemical process regulation to predict changes in metabolic outcomes.

List all of the program's learning outcomes: (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	new	yes	2019-2020
	2. Students can design and implement a research project	new	yes	2019-2020
	3. Students can analyze data and draw conclusions	new	yes	2019-2020
	4. Students can critically evaluate scientific literature	new	yes	2019-2020
2. Students will be able to demonstrate effective oral and written scientific communication skills.	1. Students can develop coherent written arguments.	new	yes	2019-2020
	2. Students can write using current scientific styles.	new	yes	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	no	2018-2019
	2. Students will follow ethical norms of scientific communication the final outcomes	new	no	2018-2019
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	no	2018-2019

Biochemistry specific: Students will demonstrate an understanding of fundamental biochemistry principles.	1. Students can compare and contrast structure and function of biomolecules.	new	yes	2018-2019
	2. Students can apply knowledge of metabolic pathways to medical applications.	new	yes	2018-2019
	3. Students can apply knowledge of biochemical process regulation to predict changes in metabolic outcomes.	new	yes	2018-2019

Describe briefly how the program's outcomes support Marymount's mission, strategic plan, and relevant school plan (*generally not more than two paragraphs, may use bullet points*):

During the past academic year, our department updated and revised our program learning outcomes based on major overall goals that we felt were important for our graduates to be successful as scientists in their careers and in their communities. We compiled these goals and outcomes with great care and consideration of Marymount's mission, vision, and strategic plan. It is evident in our curriculum that we have a strong commitment to intellectual curiosity and this is something we emphasize throughout a student's academic career at Marymount. We demonstrate this in a variety of ways, most prominently through our active undergraduate research programs. We have a strong record of success in training undergraduates to do effective, relevant, impactful research that has been presented at national and international meetings and/or published in scientific research journals. The level of engagement we have with one-on-one student-faculty training is unique in a scientific undergraduate environment and something we feel strengthens our department and is an effective recruitment and retention tool. We will be working during the next academic year to develop tools to better assess these experiences.

Our department has a strong commitment to promoting career preparation within a liberal arts framework. Our first two goals and associated outcomes are a direct result of this commitment. Through the process of building a solid foundation of knowledge in the current fields of biology and biochemistry, developing the student's ability to conduct and evaluate scientific research, and promoting effective oral and written scientific communication skills, we give them not only an excellent education but also the tools to become effective members of society in any field they chose. Our required departmental internship is a cap-stone experience which provides an opportunity for personal and professional growth of our students and provides a stepping-stone to jobs after graduation. Many of the projects in our introductory through advanced level courses require interpretation of primary research, group work and classroom presentations and our departmental writing intensive course, Bio 300, hones the students' technical writing skills.

Our third goal and associated outcomes demonstrate our level of commitment to education of the whole person and guiding the ethical development of our students. Many of our courses contain modules, which focus on ethical and social issues designed to help students identify ethical dilemmas and follow ethical norms. In addition, we have several research projects within the department that center around service to others and provide our students with true global experiences.

Our programs have consistently demonstrated a strong commitment to academic excellence and we continue to emphasize a rigorous, cohesive, integrated curriculum that enables our graduates to succeed in careers or pursuits of advanced degrees. The content of our introductory through advanced science courses provide the foundational knowledge and spark their interest in general biology, chemistry, physics, genetics, microbiology, botany, parasitology, endocrinology, immunology, virology, biochemistry, and environmental topics. Our last general goal and outcome is a measure of our student's ability to make connections and integrate information from the various courses they take during their scientific careers at Marymount.

The biochemistry specific goal and associated outcomes speak directly to the rigorous program we have developed for these students. While biochemistry students are expected to achieve many of the same learning outcomes as biology students, there is specific content that biochemistry majors must master in order to distinguish themselves.

Provide a **brief** description of the assessment process used including strengths, challenges and planned improvements to the process, and provide evidence of the existence of a culture of continuous improvement based on assessment (*generally not more than two paragraphs, may use bullet points*):

Brief description of the assessment process used including strengths, challenges and planned improvement

As described above, we spent the previous academic year (2017-2018) reevaluating our learning outcomes and exit exam, which is used as a primary direct measure of many of our outcomes. In light of program objectives and Marymount's mission, vision, and strategic plan, we wrote new program goals and measurable outcomes. In addition, we wrote an entirely new exit exam to better coordinate with these goals and outcomes. We hope that the implementation of this new exit exam will improve the value of the data and information we obtain and provide a more accurate assessment of our outcomes. In addition to this strong direct measure, we also use rubrics and information from courses as our majors move through the program to assess our learning outcomes. Specifically, for biochemistry majors, we use Bio 441 Biochemistry, and Bio 442 Nucleic Acids and Metabolism.

Unfortunately, we lack data from our usual indirect measures, the Graduating Senior Survey (GSS) and the University and Biology Department Alumni Surveys. There were not enough responses from our biochemistry students to warrant data analysis from these surveys. We see this as a challenge and something we hope to improve upon in the coming years with more departmental outreach to our seniors and alums.

This year, we implemented an assessment workshop where several faculty met at the end of May to evaluate and compile assessment data so reports could be written during the remainder of the summer. This process seemed to work pretty well and helped to encourage cooperation and participation from several faculty in the assessment process. Currently, our challenges include sifting through a tremendous amount of data in an efficient, organized way so that the assessment process is not too demanding on any faculty subset. Additionally, we discovered the immediate need to develop a way to distinguish our majors when compiling and deciphering assessment data. For example, we discovered that the feedback we receive from our faculty regarding the DAT analysis did not reflect Biology BS majors from Biochemistry majors. Thus, for the purposes of this report, we were unable to use the DAT as a valid assessment tool. Going further, we will be working to devise a way to fully distinguish all the majors within our department. For the upcoming year, we also 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. Once they are in place, we could receive more external funding for our on-campus research experiences.

Evidence of the existence of a culture of continuous improvement based on assessment

The strongest evidence of this continuous improvement is the work done this past academic year to reevaluate our learning goals and outcomes and better align our exit exam with these learning objectives. This is based on feedback we have received from the committee for several years and we believe that this new way of assessing our students will be more useful to us as individual faculty and as a department as a whole. In addition, we are continually tweaking curriculum to better support our students and their learning needs, as well as support the goals of the university. For example, we have implemented several new research topics that involve service to others (3D printing of prosthetics hands and a community garden and other efforts to help food insecure populations). We had evidence to suggest that our students desire these types of experiences and both of these projects have been successful at drawing in not only biology and biochemistry students, but also students from across the university.

Specifically in the biochemistry program, we have redesigned the biochemistry lab to reflect a true inquiry-driven experience. We have replaced the "cookbook" style labs with inquiry-based labs where students design their own experiments based on relevant literature and background knowledge. Dr. Wright, along with two colleagues outside of Marymount, wrote the lab manual that supports this type of laboratory experience.

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>
read and critically evaluate scientific literature	More improvements will be made in CHM 441 to include more interpretation of research papers.	In addition to modules and improvements made in the CHM441 course, improvements were made to the Bio 441Lab course. Students are now required to read primary literature in order to

Outcome	Planned Improvement	Update <i>(Indicate when, where, and how planned improvement was completed. If planned improvement was not completed, please provide explanation.)</i>
		design their own experiences, replacing the cookbook style labs that we did have. Much time is spent in that laboratory discussing interpretation of primary research papers.
demonstrate the ability to apply knowledge gained	More activities in upper division coursework for integration of learning from a variety of previous course will be developed and implemented.	This is an area where we have made some progress, but hope to make more in the coming years. Particularly within the biochemistry program, we have focused more on coursework integration within the required biochemistry classes. We address this often in lecture course but perhaps the best evidence comes from the laboratory. Students are asked to draw on previous knowledge to design their own labs from drafting questions and hypotheses to designing their experiments to analyzing their data and drawing conclusions. It is an absolute requirement that students use and integrate knowledge from other courses to be successful at this type of exercise.

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

Comment: There was no update on outcome 1 because it relates to foundational courses and the planned program improvements are in the advanced course work. Outcome 2 was addressed in a general way.

Response: Goals and outcomes have all been revised and improvements were made or planned all at levels of the curriculum.

Comment: Two, measurable outcomes were identified. From your list of outcomes, "comprehend" is not measurable. You should revise that verb. Also, "read" is probably superfluous -- you could start with "critically evaluate." For the third outcome, "formulate hypotheses...". You need to make sure you measure all parts of this outcome; otherwise revise to be clear what it is you are looking for. The fourth outcome is also a little vague.

Response: Goals and outcomes have been revised through an inclusive departmental process and with feedback from the Office of Planning and Institutional Effectiveness.

Comment: Strengths and limitations of program were identified. What do the faculty think the problem is that only half of students in the exit exam achieve the desired performance level?

Response: We believe the low performance rate on the previous exit exam was a caveat of the exam itself. We spent the last year re-writing the exit exam to better correlate with our goals and outcomes.

Outcomes Assessment 2017-2018

Goal 1: Students will be able to independently conduct and evaluate scientific research.

Learning Outcome 1: Students can formulate scientifically sound hypotheses

Assessment Activity

Outcome Measures <i>Explain how student learning will be measured and indicate whether it is direct or indirect.</i>	Performance Standard <i>Define and explain acceptable level of student performance.</i>	Data Collection <i>Discuss how the data was collected and describe the student population</i>	Analysis <i>1) Describe the analysis process. 2) Present the findings of the analysis including the numbers participating and deemed acceptable.</i>
Direct: Exit exam questions 1-3, 13, 21	70% of students will achieve a score of 60% or more on the pertinent questions corresponding to each learning outcome of the exit exam.	The newly written exit exam was given to 3 biochemistry students (graduating seniors) in Spring 2018.	1) We administered a newly written exit exam to senior students as part of their Senior Seminar course. The results were analyzed by the Office of Planning and Institutional Effectiveness. The percentage of students who scored at least 60% on each section was calculated. 2) After examining the analysis for individual questions, 66.7% of biochemistry majors scored at least 60% on this section. (2 of the 3 students assessed). The performance standard was not met.
Direct: Lab report grading rubric: hypothesis (see Appendix 2)	70% of students will score at least a 4 out of 5 on the "hypothesis" portion of the lab report grading rubric.	All biochemistry majors are required to take biochemistry laboratory (Bio 441L). As a requirement of this lab, students complete 4 lab reports on research projects that they design from start to finish. Within the introduction of the lab report, students must develop and state a sound, testable hypothesis	1) Lab report grading rubrics were collected from all students who participated in Bio 441L during Spring 2018. The points earned for the "hypothesis" section of the grading rubric were assessed and the percentage of students who scored at least a 4/5 were calculated. Forty-eight lab report rubrics were analyzed (12 students, 4 lab reports per student). 2) For Spring 2018, the average score on the hypothesis section across all 48 lab reports was 4.31 out of 5. Ten of the twelve students assessed scored at least an average of 4/5 on this section across all four lab reports. This corresponds to 83.3% of students achieving the performance standard. The performance standard was met.

Interpretation of Results

Describe the extent to which this learning outcome has been achieved by students (Use both direct and indirect measure results): Overall, the performance standard for this outcome was met in one area and not met in the other. The exit exam was newly written for Spring 2018 and will be undergoing revisions prior to Fall or Spring 2019 administration. In general, we feel good about the extent to which our biochemistry students develop sound hypotheses.

Briefly describe program strengths and opportunities for improvement relative to assessment of outcome: We feel the lab report grading rubric is a strong tool for assessing this outcome and with some tweaks and revision, the exit exam will also serve as a valuable tool. We realize the need to address some concerns or issues with the exam, primarily regarding question wording and questions with multiple correct answers (choose all that apply). I believe there was a glitch in the system where these questions were not scored correctly. We will be working to correct that error before administering the exam this year.

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

Learning Outcome 2. Students can design and implement a research project.

Assessment Activity

Outcome Measures <i>Explain how student learning will be measured and indicate whether it is direct or indirect.</i>	Performance Standard <i>Define and explain acceptable level of student performance.</i>	Data Collection <i>Discuss how the data was collected and describe the student population</i>	Analysis <i>1) Describe the analysis process. 2) Present the findings of the analysis including the numbers participating and deemed acceptable.</i>
Direct: Exit exam questions 4-7, 9, and 14-17.	70% of students will achieve a score of 60% or more on the pertinent questions corresponding to each learning outcome of the exit exam.	The newly written exit exam was given to 3 biochemistry students (graduating seniors) in Spring 2018.	1) We administered a newly written exit exam to senior students as part of their Senior Seminar course. The results were analyzed by the Office of Planning and Institutional Effectiveness. The percentage of students who scored at least 60% on each section was calculated. 2) After examining the analysis for individual questions corresponding to this outcome (Q4-7, 9, 14-17), 100% of biochemistry majors scored at least 60% on this section. The performance standard was met.
Direct: Lab report grading rubric (see Appendix 2)	70% of students will score at least 80% on the lab report grading rubric for the SEEK project in Bio 441L.	All biochemistry majors are required to take biochemistry laboratory (Bio 441L). As a requirement of this lab, students complete an independent research project, which we call SEEK. Students design their own question, develop a hypothesis, design experimental protocols, carry out experiments, analyze results, and present those results in a lab report.	1) Lab report grading rubrics were collected from all students (n=12) who participated in Bio 441L during Spring 2018. The scores for the SEEK project lab report were analyzed and the percent of students who scored at least a 70% was calculated. 2) For Spring 2018, the average score on the SEEK project lab report was 87.5 out of 100. Of the twelve of the students assessed, nine scored at least 80% on this lab report. That corresponds to 75% of the students achieving the performance standard. The performance standard was met.

Describe the extent to which this learning outcome has been achieved by students (Use both direct and indirect measure results): This performance standard was met in all areas assessed. We recognize the low number of biochemistry students who participated in the exit exam and realize that we may see different results with increasing numbers.

Briefly describe program strengths and opportunities for improvement relative to assessment of outcome: We feel the newly written exit exam questions are strong assessment tool for this outcome and good measure of our student's understanding of research design. As this exam undergoes tweaking and revision, we will likely take a look at these questions to ensure they meet the rigorous expectations that we have of our students. We also feel strongly that the SEEK project is an excellent assessment tool for our biochemistry students.

Discuss planned curricular or program improvements for this year based on assessment of outcome: We feel very encouraged by the results of this assessment with our senior students in particular. We will purposefully and intentionally implement 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.

Learning Outcome 3. Students can analyze data and draw conclusions.

Assessment Activity

Outcome Measures <i>Explain how student learning will be measured and indicate whether it is direct or indirect.</i>	Performance Standard <i>Define and explain acceptable level of student performance.</i>	Data Collection <i>Discuss how the data was collected and describe the student population</i>	Analysis <i>1) Describe the analysis process. 2) Present the findings of the analysis including the numbers participating and deemed acceptable.</i>
Direct: Exit exam questions 8, 10, 12, 18-20	70% of students will achieve a score of 60% or more on the pertinent questions corresponding to each learning outcome of the exit exam.	The newly written exit exam was given to 3 biochemistry students (graduating seniors) in Spring 2018.	1) We administered a newly written exit exam to senior students as part of their Senior Seminar course. The results were analyzed by the Office of Planning and Institutional Effectiveness. The percentage of students who scored at least 60% on each section was calculated. 2) After examining the analysis for individual questions corresponding to this outcome (Q8,10,12,18-20), 66.67% of biochemistry majors scored at least 60% on this section. The performance standard was not met.
Direct: Lab report grading rubric: data and conclusions sections (see Appendix 2)	70% of students will score at least a 32 out of 40 points on the two sections combined.	All biochemistry majors are required to take biochemistry laboratory (Bio 441L). As a requirement of this lab, students complete 4 lab reports on research projects that they design from start to finish. As a part of each lab report, students must analyze their data and draw conclusions.	1) Lab report grading rubrics were collected from all students who participated in Bio 441L during Spring 2018 (n=12). The points earned for the data and conclusions sections of the grading rubric were assessed and the percentage of students who scored at least a 32/40 on the two sections combined were calculated. Forty-eight lab report rubrics were analyzed (12 students, 4 lab reports per student). 2) For Spring 2018, the average score on the data and conclusions sections combined was 34.48 out of 50. Ten of the twelve students assessed scored at least an average of 32/40 on this section across all four lab reports. This corresponds to 83.3% of students achieving the performance standard. The performance standard was met.

Describe the extent to which this learning outcome has been achieved by students (Use both direct and indirect measure results): Overall, the performance standard for this outcome was met in one area and not met in the other. The exit exam was newly written for Spring 2018 and will be undergoing revisions prior to Fall or Spring 2019 administration. In general, we feel good about the extent to which our biochemistry students were able to analyze their data and draw conclusions.

Briefly describe program strengths and opportunities for improvement relative to assessment of outcome: We feel the lab report grading rubric is a strong tool for assessing this outcome and with some tweaks and revision, the exit exam will also serve as a valuable tool. We realize the need to address some concerns or issues with the exam. It was recently brought to our attention that there may have been some problems visualizing portions of the exam corresponding to these questions. We will be revising this exam, looking all at questions, before the next administration.

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

Learning Outcome 4. Students can critically evaluate scientific literature

Assessment Activity

Outcome Measures <i>Explain how student learning will be measured and indicate whether it is direct or indirect.</i>	Performance Standard <i>Define and explain acceptable level of student performance.</i>	Data Collection <i>Discuss how the data was collected and describe the student population</i>	Analysis <i>1) Describe the analysis process. 2) Present the findings of the analysis including the numbers participating and deemed acceptable.</i>
Direct: Exit exam questions 11,27-30	70% of students will achieve a score of 60% or more on the pertinent questions corresponding to each learning outcome of the exit exam.	The newly written exit exam was given to 3 biochemistry students (graduating seniors) in Spring 2018.	1) We administered a newly written exit exam to senior students as part of their Senior Seminar course. The results were analyzed by the Office of Planning and Institutional Effectiveness. The percentage of students who scored at least 60% on each section was calculated. 2) After examining the analysis for individual questions corresponding to this outcome (Q11,27-30), only 33.3% of biochemistry majors scored at least 60% on this section. The performance standard was not met.
Direct: Literature review paper grading rubric: evidence and conclusion sections (see Appendix 3)	70% of students will score at least a 68 out of 85 points on the two sections combined.	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.	1) Review paper grading rubrics were collected from all students who participated in Bio 442 during Spring 2018 (n=6). The points earned for the evidence and conclusions sections of the grading rubric were assessed and the percentage of students who scored at least a 60/85 on the two sections combined were calculated. 2) For Spring 2018, the average score on the evidence and conclusions sections combined was 78.01 out of 85. Five of the six students assessed scored at least an average of 68/85 on this section of the literature review rubric. This corresponds to 83.3% of students achieving the performance standard. The performance standard was met.

Describe the extent to which this learning outcome has been achieved by students (Use both direct and indirect measure results): This performance standard was met in one of the two areas in which it was assessed. We recognize the low number of students taking the exit exam but only 1 of the 3 students met the performance standard on this section, which brings us some concern.

Briefly describe program strengths and opportunities for improvement relative to assessment of outcome: We will be focusing our efforts in two main areas in regards to this outcome. First, we will be revising the exit exam questions pertinent to this outcome to clarify the questions and remove ambiguity and/or questions with multiple answers. In addition, it was brought to our attention that there may have been some problems viewing portions of the exam, which we will work to fix. We feel the literature review paper is a strong tool for assessing the outcome and will continue to use this tool.

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

Overall analysis of goal 1:

Taking all measurable outcomes together for the goal of independently conducting and evaluating scientific research, we were encouraged by our student's achievements. Upon analysis of this section on the exit exam (questions 1-21, 27-30), 100% of the three biochemistry students scored 60% or better. We recognized the small sample group, but we are still encouraged by student's performance on this exam.

We were also encouraged by the data from the lab report grading rubric and the literature review rubric in that we met all performance standards as they relate to this objective.

Unfortunately, we do not have data from the GSS or the alumni surveys to report on student's perception of their preparation, which we see as valuable data. We will be reaching out to alum directly to encourage them to complete the survey and will hopefully have more GSS survey analysis as the program grows.

Given that our exit exam was newly re-written and administered for the first time this Spring, we knew there would be areas that required revision. We will work to revise exit exam questions to more directly assess the desired components and we will continue to incorporate instruction and assignments related to the skills needed for our students to be successful. In addition, we will be working to develop assessment tools for our independent research experiences, which will give us valuable information regarding this goal.

Goal 2: Students will be able to demonstrate effective oral and written scientific communication.

Learning Outcome 1: Students can develop coherent written arguments.

Assessment Activity

Outcome Measures <i>Explain how student learning will be measured and indicate whether it is direct or indirect.</i>	Performance Standard <i>Define and explain acceptable level of student performance.</i>	Data Collection <i>Discuss how the data was collected and describe the student population</i>	Analysis <i>1) Describe the analysis process. 2) Present the findings of the analysis including the numbers participating and deemed acceptable.</i>
Direct: Lab report grading rubric: entire rubric (all 4 lab reports) (see Appendix 2)	70% of students will score at least an average of 80% on the four required lab reports.	All biochemistry majors are required to take biochemistry laboratory (Bio 441L). As a requirement of this lab, students complete 4 lab reports on research projects that they design from start to finish. This is a professional document where students must coherently, concisely, and accurately represent their experimental details.	1) Lab report grading rubrics were collected from all students who participated in Bio 441L during Spring 2018 (n=12). The scores for each lab report were averaged and the percentage of students who scored at least an average of 70% on the four combined lab reports was calculated. Forty-eight lab report rubrics were analyzed (12 students, 4 lab reports per student). 2) For Spring 2018, ten of the twelve students assessed scored at least an average of 80% across all four lab reports. This corresponds to 83.3% of students achieving the performance standard. The performance standard was met.
Direct: Literature review paper grading rubric: entire rubric (see Appendix 3)	70% of students will score at least an 80% on this assignment.	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.	1) Review paper grading rubrics were collected from all students who participated in Bio 442 during Spring 2018 (n=6). The percentage of students who scored at least an 80% on the assignment was calculated. 2) For Spring 2018, five of the six students assessed scored at least an 80% on the literature review rubric. This corresponds to 83.3% of students achieving the performance standard. The performance standard was met.

Interpretation of Results

Describe the extent to which this learning outcome has been achieved by students (Use both direct and indirect measure results): This performance standard was met in both areas in which it was assessed. Out students exceeded performance standards on both grading rubrics.

Briefly describe program strengths and opportunities for improvement relative to assessment of outcome: We feel that both of these rubrics are good tools to measure out student's ability to write coherent arguments. Students must process a great deal of information and draw conclusions in both of these assignments. Going further, we would like to ensure that we have data from the GSS or the alumni surveys so that we can assess student's perception of their preparedness in this area.

Discuss planned curricular or program improvements for this year based on assessment of outcome: Writing will continue to be an integral part of our curriculum and we will continue to emphasize scientific writing in all of our courses, especially working to ensure that freshmen and sophomores receive training in these skills.

Learning Outcome 2: Students can write using current scientific styles.

Assessment Activity

Outcome Measures <i>Explain how student learning will be measured and indicate whether it is direct or indirect.</i>	Performance Standard <i>Define and explain acceptable level of student performance.</i>	Data Collection <i>Discuss how the data was collected and describe the student population</i>	Analysis <i>1) Describe the analysis process. 2) Present the findings of the analysis including the numbers participating and deemed acceptable.</i>
Direct: Exit exam questions 36-40	70% of students will achieve a score of 60% or more on the pertinent questions corresponding to each learning outcome of the exit exam.	The newly written exit exam was given to 3 biochemistry students (graduating seniors) in Spring 2018.	1) We administered a newly written exit exam to senior students as part of their Senior Seminar course. The results were analyzed by the Office of Planning and Institutional Effectiveness. The percentage of students who scored at least 60% on each section was calculated. 2) After examining the analysis for individual questions, 100% of biochemistry majors scored at least 60% on this section. (all 3 of the students who participated in the exam). The performance standard was met.
Direct: Lab report grading rubric: reference list and formatting sections (see Appendix 2)	70% of students will score at least a 12 out of 15 points on the two sections combined.	All biochemistry majors are required to take biochemistry laboratory (Bio 441L). As a requirement of this lab, students complete 4 lab reports on research projects that they design from start to finish. As a part of each lab report, students must correctly site sources and use current scientific writing styles.	1) Lab report grading rubrics were collected from all students who participated in Bio 441L during Spring 2018 (n=12). The points earned for the reference and formatting sections of the grading rubric were assessed and the percentage of students who scored at least a 12/15 on the two sections combined were calculated. Forty-eight lab report rubrics were analyzed (12 students, 4 lab reports per student). 2) For Spring 2018, the average score on the reference and formatting sections combined was 12.9 out of 15. Ten of the twelve students assessed scored at least an average of 12/15 on these sections across all four lab reports. This corresponds to 83.3% of students achieving the performance standard. The performance standard was met.

Interpretation of Results

Describe the extent to which this learning outcome has been achieved by students (Use both direct and indirect measure results): We used two direct methods to analyze this outcome. The performance standard was met in both areas assessed. We are encouraged by student's ability to recognize and write using current styles. We realize the small sample size, particularly for the exit exam, but we look forward to larger sample sizes as the program grows.

Briefly describe program strengths and opportunities for improvement relative to assessment of outcome: We feel that both of these measures (the exit exam and the lab report grading rubric) are strong tools to assess this outcome. We will be working to revise the exit exam to clear up any confusion and eliminate questions with multiple correct answers.

Discuss planned curricular or program improvements for this year based on assessment of outcome: Writing will continue to be an integral part of our curriculum and we will continue to emphasize 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.

Learning Outcome 3: Students can deliver effective oral scientific presentations.

Assessment Activity

Outcome Measures <i>Explain how student learning will be measured and indicate whether it is direct or indirect.</i>	Performance Standard <i>Define and explain acceptable level of student performance.</i>	Data Collection <i>Discuss how the data was collected and describe the student population</i>	Analysis <i>1) Describe the analysis process. 2) Present the findings of the analysis including the numbers participating and deemed acceptable.</i>
Direct: Exit exam questions 31-35	70% of students will achieve a score of 60% or more on the pertinent questions corresponding to each learning outcome of the exit exam.	The newly written exit exam was given to 3 biochemistry students (graduating seniors) in Spring 2018.	1) We administered a newly written exit exam to senior students as part of their Senior Seminar course. The results were analyzed by the Office of Planning and Institutional Effectiveness. The percentage of students who scored at least 60% on each section was calculated. 2) After examining the analysis for individual questions corresponding to this outcome (Q31-35), 100% of biochemistry majors scored at least 60% on this section. The performance standard was met.
Direct: Metabolic disease presentation rubric (see Appendix 4)	70% of students will score at least an 80% on this assignment.	In Bio 442, biochemistry students research a metabolic disease of their choice and present their findings to the class.	1) Presentation grading rubrics were collected from all students who participated in Bio 442 during Spring 2018 (n=6). The percentage of students who scored at least an 80% on the assignment was calculated. 2) For Spring 2018, the average score on this assignment was a 97 and all 6 students scored at least an 80%. The performance standard was met.

Interpretation of Results

Describe the extent to which this learning outcome has been achieved by students (Use both direct and indirect measure results): This performance standard was met in both areas in which it was assessed. Out students exceeded expectations with both tools.

Briefly describe program strengths and opportunities for improvement relative to assessment of outcome: We feel these are strong tools to assess our student's ability to deliver effective scientific presentations. We plan to tweak the presentation rubric a bit in the coming year to reflect more scientific styles and we will be tweaking the exit exam to ensure that it reflects accurately what we want to measure and meets our rigorous standards.

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

Overall analysis of goal 2:

Taking all measurable outcomes together for the goal of demonstrating effective oral and written communication, we were greatly encouraged but our student's performance in this area. This is an area we focus on strongly in the biochemistry curriculum. We recognize that we have low sample sizes but we expect these results to be maintained as the program grows.

Given that our exit exam was newly re-written and administered for the first time this Spring, we knew there would be areas that required revision. We will work to revise exit exam questions to more directly assess the desired components and we will continue to incorporate instruction and assignments related to the skills needed for our students to be successful. In addition, we will be working to develop assessment tools for our independent research experiences, which will give us valuable information regarding this goal.

Biochemistry Specific Goal: Students will demonstrate an understanding of fundamental Biochemistry principles

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

Assessment Activity

Outcome Measures <i>Explain how student learning will be measured and indicate whether it is direct or indirect.</i>	Performance Standard <i>Define and explain acceptable level of student performance.</i>	Data Collection <i>Discuss how the data was collected and describe the student population</i>	Analysis <i>1) Describe the analysis process. 2) Present the findings of the analysis including the numbers participating and deemed acceptable.</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.	1) Individual student scores on this specific question were recorded using excel during Spring 2018 (n=15). The percentage of students who earn at least a 6/10 (60%) was calculated. 2) After examining the analysis for individual scores, 80% of biochemistry majors scored at least 60% on this section. The average score for this question was 7.5/10. The performance standard was met.
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.	1) Individual student scores on this specific question were recorded using excel during Spring 2018 (n=15). The percentage of students who earn at least a 6/10 (60%) was calculated. 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 8.64/10. The performance standard was met.

Interpretation of Results

Describe the extent to which this learning outcome has been achieved by students (*Use both direct and indirect measure results*): 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.

Briefly describe program strengths and opportunities for improvement relative to assessment of outcome: We feel these are questions are strong direct indicators of our student's ability to compare and contrast structure and function of biological molecules. We will be working in the coming year to design additional questions that can be used to measure student improvement as they progress through the program.

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

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

Assessment Activity

Outcome Measures <i>Explain how student learning will be measured and indicate whether it is direct or indirect.</i>	Performance Standard <i>Define and explain acceptable level of student performance.</i>	Data Collection <i>Discuss how the data was collected and describe the student population</i>	Analysis <i>1) Describe the analysis process. 2) Present the findings of the analysis including the numbers participating and deemed acceptable.</i>
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."	70% of students will achieve a score of 60% or more on this question specifically (overall worth 10 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.	3) Individual student scores on this specific question were recorded using excel during Spring 2018 (n=6). The percentage of students who earn at least a 6/10 (60%) was calculated. 4) After examining the analysis for individual scores, 83% of biochemistry majors scored at least 60% on this section. The average score for this question was 8.35/10. The performance standard was met.
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? see appendix 5 for full question	70% of students will achieve a score of 60% or more on this question specifically (overall worth 10 points).	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.	3) Individual student scores on this specific question were recorded using excel during Spring 2018 (n=6). The percentage of students who earn at least a 6/10 (60%) was calculated. 4) 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 9.1/10. The performance standard was met.

Interpretation of Results

Describe the extent to which this learning outcome has been achieved by students (*Use both direct and indirect measure results*): 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.

Briefly describe program strengths and opportunities for improvement relative to assessment of outcome: 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. We will be working in the coming year to tweak this assignment and create a rubric so that it can be included in our assessment.

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

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

Assessment Activity

Outcome Measures <i>Explain how student learning will be measured and indicate whether it is direct or indirect.</i>	Performance Standard <i>Define and explain acceptable level of student performance.</i>	Data Collection <i>Discuss how the data was collected and describe the student population</i>	Analysis <i>1) Describe the analysis process. 2) Present the findings of the analysis including the numbers participating and deemed acceptable.</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.	5) Individual student scores on this specific question were recorded using excel during Spring 2018 (n=6). The percentage of students who earn at least a 6/10 (60%) was calculated. 6) After examining the analysis for individual scores, 100% of biochemistry majors scored at least 60% on this section. The average score for this question was 13.07/15. The performance standard was met.

Interpretation of Results

Describe the extent to which this learning outcome has been achieved by students (*Use both direct and indirect measure results*): This performance standard was met using the tool we had in place for this outcome. We recognize we only had one tool for the assessment of this outcome and we will be working in the coming year to design a second.

Briefly describe program strengths and opportunities for improvement relative to assessment of outcome: We feel the question we have in place is a strong indicator tool for assessment of this outcome. I will be working in the coming year to design a second tool specifically designed to assess this outcome.

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

Overall analysis of Biochemistry Specific Goal:

Taking all measurable outcomes together for the goal of demonstrating an understanding of fundamental biochemical principles, we were greatly encouraged but our student's performance in this area. All performance standards were met. We will be working in the coming year to add additional tools and assessment measures, including student's own perceptions of their preparation in these areas.