Microbiology, BS

Program Description

The degree program in Microbiology is designed to provide a comprehensive education in the biology of microorganisms. A BS graduate of this program will have a thorough grounding in the classical areas of microbial physiology and biochemistry, microbial genetics and molecular biology. The curriculum provides excellent training toward a career in any one of many areas of industrial microbiology and public health services. It is also an ideal preparation for advanced study or professional school in medicine, dentistry and other related fields, especially medical technology and biotechnology.

Outcome 1 – Scientific Thinking

Microbiology students will be able use the scientific method to identify research questions, formulate hypotheses and interpret scientific results.

Measure 1.1 – Independent Research Summaries

Data Collection: All students participating in independent research are required to write a summary or poster of their work at the end of the semester. These summaries will be scored by the undergraduate research coordinator using the attached rubric for the student's ability to employ the scientific method in describing their research.

Methodology or data analysis strategy: Based on the last 5 years, the number of students completing summaries each year gives a large enough sample so that we do not need to aggregate data to complete the analysis: [See relevant rubric under *Supporting Documentation*.]

Target 1.1

75% of all students will score at least 6 out of a total possible of 9 when the three rubric criteria are added together. This target reflects the differences in academic level (U1 versus U4) of students participating in undergraduate research.

Finding 1.1: Not Met

Eleven microbiology students enrolled in independent research submitted written summaries at the end of the spring 2024 semester. Summaries were read and scored according to the rubrics. When the scores for the three categories were added together, 8 of the 11 students (72%) scored 6 or more out of a possible 9 points. Thus, the target was not met.

The past several years, roughly 60% of microbiology students scored a 6 or better on this assessment. Thus, this past year has seen students improve on their ability to apply the scientific method to their research. Looking more closely at the data, all students scored a 2 or 3 (meets or exceeds expectations) in the ability to identify the scientific question, and 9 of 11 (81%) met or exceeded expectations in critical thinking. These results are improved from previous years. In contrast, only 4 of 11 (36%) of students met or exceeded expectations in formulating hypotheses or models, which is not changed from previous years.

Use of Results

A breakdown of our data shows that students continue to have difficulty in formulating a hypothesis or model driving their research even though they do a much better job of interpreting their results and placing them in a larger context. To help students focus on forming hypotheses or models, select faculty will write 3-5 questions that will be sent to all students registered for BIOL 291 and BIOL 491: Independent Research at the midterm of semester- roughly 1 week before midterm grades are due. These questions will specifically ask students to think about the hypotheses/models being tested and ask them to provide alternatives.

A small committee of biology faculty will be formed by the Undergraduate Research Coordinator to develop the questions in the Fall 2024 semester. Questions will be sent to students at the midterm of Spring 2025. We will collect responses in a Google form, which is the same mechanism by which they submit their research summaries.

We believe this directed approach will work because students are already used to providing summaries at the end of the semester and having students score their own summaries using the rubric before submission increased student learning in 2 of the 3 areas assessed. By having the students directly focus on formulating hypotheses at the midterm, we expect that this area will be more clearly addressed in the final summary.

The undergraduate research coordinator asked a small number of faculty who have undergraduate students performing research in their labs about their willingness to have their students complete a short assignment as outlined. No objections were found.

The plan was discussed with the associate head.

Status Update on a Previous Action

Microbiology students have repeatedly fallen short of learning goals related to scientific thinking as measured by written research summaries. In previous assessment cycles, we had decided to provide students with a copy of the rubric used to score their summaries for their ability to apply the scientific method in their independent research. Despite providing rubrics when the call for final summaries was sent, we saw no change in scores. We hypothesized that this was due to students not actually looking at the rubrics. Therefore, in the previous assessment cycle we continued to provide the rubrics ahead of time, but we also required students to score their own summaries. For each of the three rubrics categories, a prompt followed by the descriptions corresponding to the four different competency levels (mastery-completing lacking) were shown, and students were required to check the box corresponding to how they scored their work. This assessment was done at the same time and in the same Google form in which they submitted their summaries. This new student self-assessment was done for the first time in Spring 2024.

In this short time, we have seen gains in the ability of students to identify the scientific question they are researching and in their critical thinking skills as they are able to place their work in context and draw appropriate conclusions. We have not seen improvement in their ability to formulate hypotheses or propose alternative models. It is interesting to note that most students thought their summaries showed mastery level (top) in each category, while faculty scored the summaries lower. Despite this difference, requiring the students to perform self-assessment on their work appears to have helped

students be more intentional in completing their summaries and has led to improvement in PLO achievement.

Supporting Documentation

Undergraduate Research Rubric

	Mastery (3)	Meets Expectations (2)	Needs Development (1)	Completely Lacking (0)
Critical thinking *	Interprets data, draws reasonable conclusions, and proposes the next experiment.	Demonstrates some understanding of experimental methods and theoretical outcome, but not always able to draw conclusions or propose the next experiment.	Shows little understanding of what the results mean. Unable to propose the next experiment.	Only describes the result with no attempt to interpret.
Identifying scientific questions	Provides background, clearly identifies the scientific question and places their work in this context	Provides some background, identifies the overall lab focus or aim of project but does not directly tie their work to the larger question.	Provides minimal background and a description of what they did, does not identify the aim of the project.	No background, simple description of what was done
Formulating hypotheses or alternative models.	Defines a clear hypothesis or models for the project, explains how their work/results either support or refute the hypothesis/model	Includes a hypothesis or expectation, either not as clear or fails to directly link their work back to the hypothesis	Expected outcome(s) of individual experiments mentioned but not placed in larger context.	No hypothesis or expectation of outcomes

This measure adapted from a rubric developed by 2010 Waypoint Outcomes