Assessment Report for BCMB Program
2022-2023 Academic Year

The BCMB Program faculty met on May 11, 2023 from 1:00 to 2:15 in DW Reynolds (Room 12).

The following members were present: Andrew Schurko (chair), Jennifer Dearolf, Richard Murray, Andres Caro, David Hales.

The following faculty members were absent: Andrea Duina, Julie Gunderson

In the meeting, our goal was to assess the success of the program in meeting the following BCMB Learning Goals:

- *Learning Goal 1: Describe, interpret, and integrate foundational and core concepts in the discipline.*
- *Learning Goal 2: Conduct appropriate scientific literature and database searches.*
- *Learning Goal 3: Develop hypotheses and propose appropriate experiments to test them.*

These learning goals were last assessed in 2019-20. In this report, data from the last four years (when available) is presented to demonstrate whether the learning goal is being achieved.

We used the following assessment tools:

I. Direct assessment:

- Grades on BCMB Senior Capstone Exam
- Rubric of final research report and oral presentation (in Senior Seminar)
- Literature search assignments in *Genetics* and *Biochemistry* courses
- Sequence database search assignment in *Genetics* course

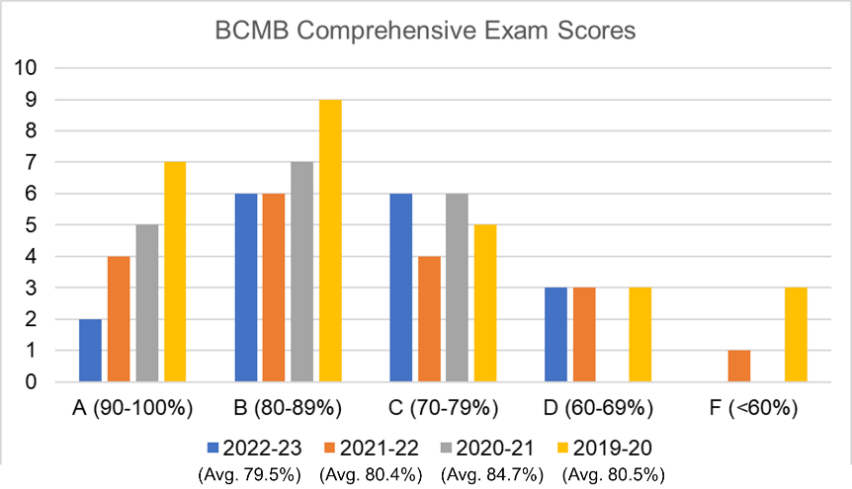
II. Indirect assessment:

- Senior exit survey (provided as a separate attached document)

I. Direct assessment of learning goals

Learning goal 1: *Describe, interpret, and integrate foundational and core concepts in the discipline.*

a) Grades on BCMB Senior Capstone Exam: This exam is a comprehensive exam that assesses knowledge across the BCMB curriculum. The exam was written by BCMB faculty in 2017 and is comprised of 120 multiple choice questions. The grade distribution on the exams for the past four years is shown below.



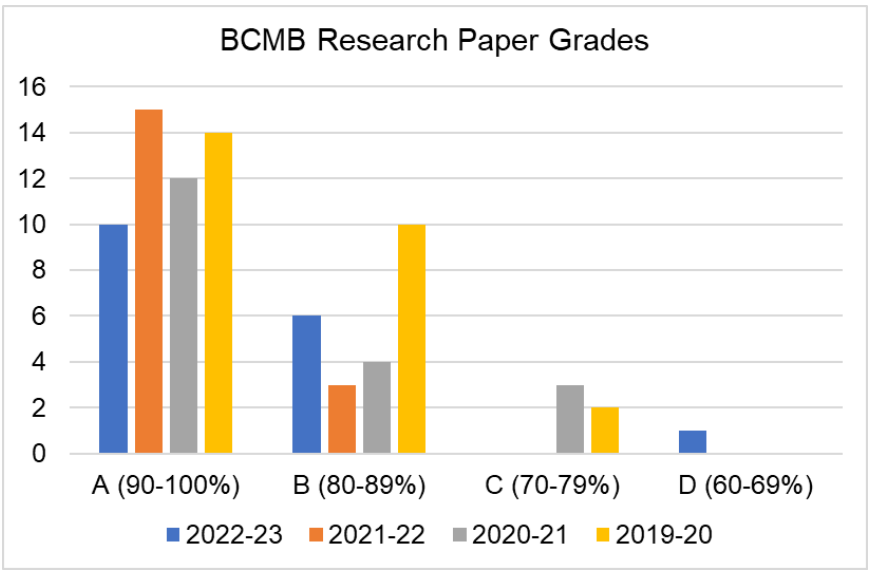
Each year (except for 2022-23) most students achieved a grade of B or higher. This demonstrates that the ability to "*describe*" and "*interpret*" concepts in the discipline is being achieved. However, at our assessment meeting we noted that this exam has been administered since 2017 but we have never re-evaluated the exam. Two points of concern about the exam were:

- Do the questions accurately reflect content currently being taught by all instructors?
- Do students score low on certain questions each year? If so, should the question be re-written/omitted, or does this reflect the need to place more emphasis on the topic in courses?

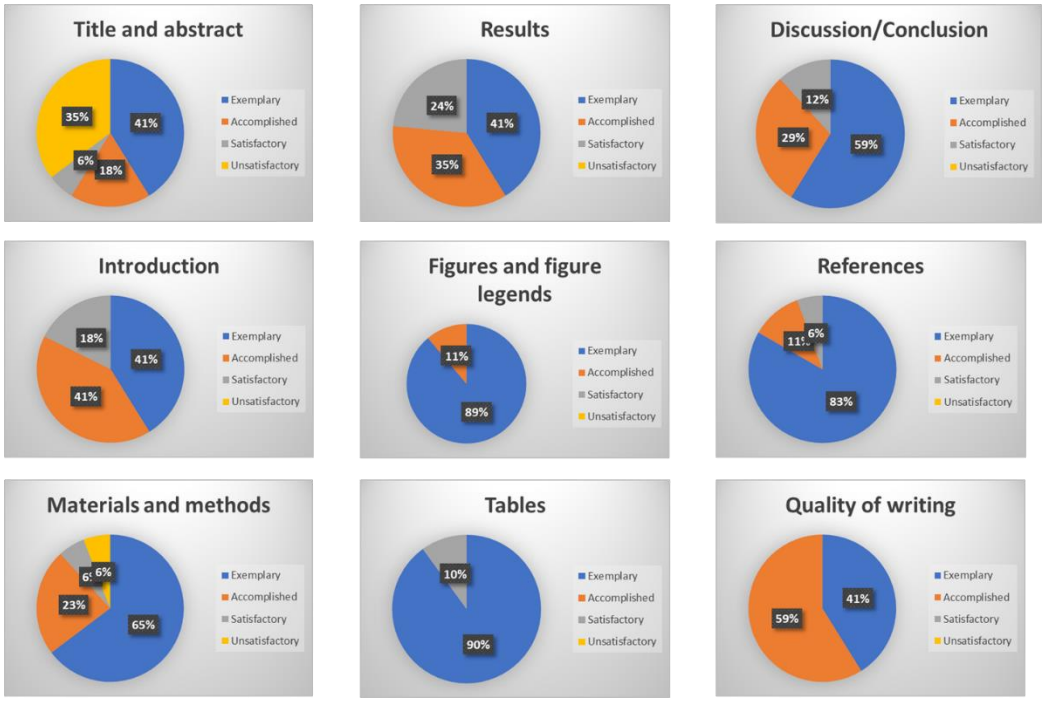
To address these concerns, the BCMB faculty will re-evaluate the exam questions next fall. In addition, scores for each questions from each year will be summarized to identify questions that consistently score low among students so that we can evaluate how to address these questions.

b) Grades on Final Research Report and Oral Presentation: As part of the BCMB research requirement, students write a research paper and give an oral presentation (during *Senior Seminar BCMB497*) that summarizes their independent research project.

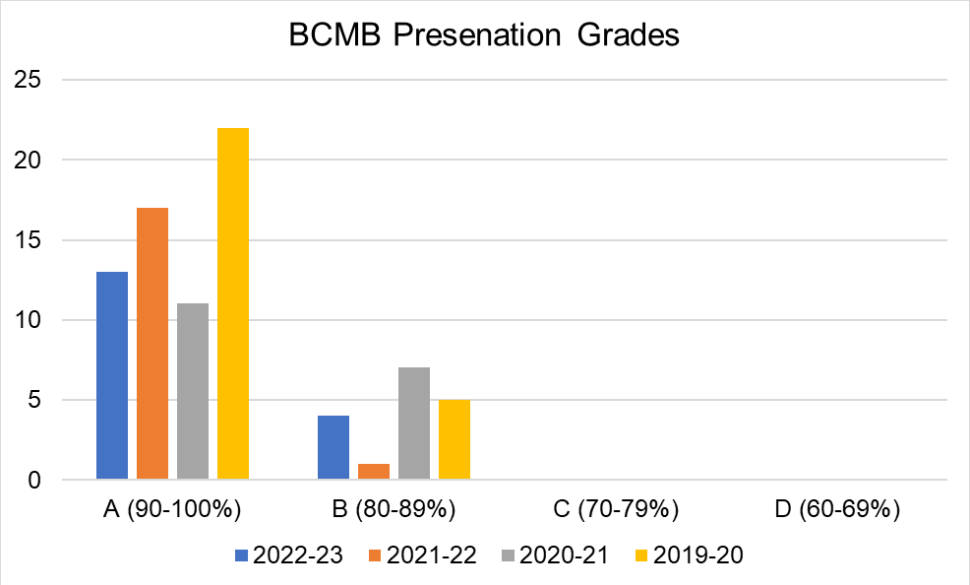
The paper is written in the style of a scientific article under the mentorship of a BCMB faculty member, and with writing guidance during *Senior Seminar*. There is an expectation that students will provide at least one draft to their faculty mentor for feedback, which should be incorporated into the final draft. The paper is graded by the mentor using a rubric developed by the BCMB faculty (provided as an attachment). The grades for the paper from the past four years are shown below.



The rubric for the paper addresses nine different categories of evaluation. The charts below show the distribution of the proficiency levels for each category (for a total of 17 students in 2022-23). The levels of achievement for the previous three years are also provided as an attachment.



For the oral presentation, grading was done using a rubric developed by the instructor for Senior Seminar (the rubric is provided as an attachment) and by student peer evaluation. The grade distribution on these presentations for the past four years is shown below:



The high level of academic achievement in the final grades from the paper and presentation, (including and nine categories for the paper) demonstrates that this learning goal (in particular, the ability to "*Describe, interpret, and integrate"* core concepts in the disciple summarize is being fulfilled. Grades for presentations have been consistent over the past four years, with most students receiving an "A" grade. Research paper grades have also been consistent (with most students scoring an A). This past year students worked on writing in *Senior Seminar,* assignments on preparing the introduction, methods, figures, etc. gave class time to work on the paper and also get feedback from the instructor. To ensure more uniform grading across all students (an issue that was raised in last year's assessment report), students were given a firm deadline (the last day of classes) to turn in their final papers to their mentors to avoid problems with students turning in drafts too late.

Summary of Learning Goal 1: Levels of achievement on the comprehensive exam are similar from year to year. BCMB faculty are overdue for a re-evaluation of exam questions and are also planning to include Physics questions. The summaries of grades for presentations and research papers also show consistently high levels of achievement. Anecdotally, peer grading was very generous and might contribute to high levels of achievement, and this will be discussed in the fall. In addition, the rubrics for presentations and papers will also be re-evaluated this fall to ensure they are optimized for evaluating this learning goal.

<u>Learning Goal 2: Conduct appropriate scientific literature and database searches.</u>

The rubrics from the research report and presentation were the original direct assessment tools for this learning goal. However, in previous assessment reports plans were proposed to include assignments in *General Chemistry (CHEM 110)* and *Genetics (BIOL 250)* dedicated to literature and database searches. These would provide a scaffolded approach in developing these skills. However, further discussion determined that *Genetics* and *Biochemistry (CHEM 330)* were more appropriate courses for these assignments. In addition, we agreed to no longer use the rubrics from the research paper and oral presentation since students are not being assessed on whether they are searching databases with these assignments.

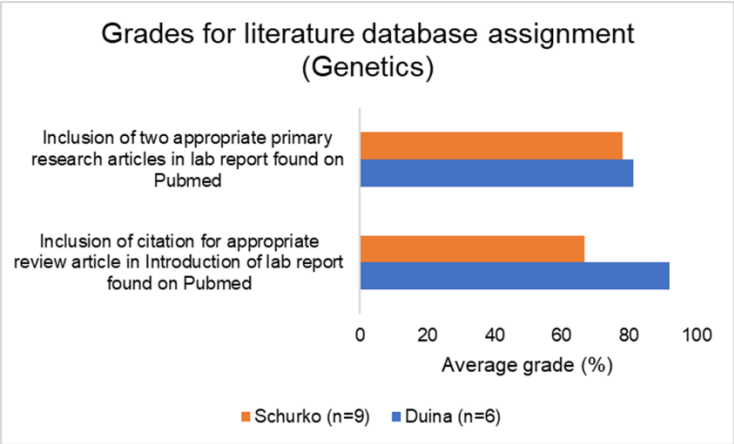
Therefore, the following two direct assessment tools are now used to assess Learning Goal 2.

a) Grade on scientific literature search assignments *Genetics (BIOL 250)* and *Biochemistry (CHEM 330)*

i) Genetics lab assignment: *Genetics* labs are taught by Drs. Duina, Murray and Schurko. In each lab, students write either a lab report that summarizes a multi-week project or a grant proposal related to the project. Although lab projects differ between instructors and from year-to-year, the three faculty agreed on a set of criteria for a laboratory assignment as part of the final lab report or grant proposal to assess this learning goal. Each semester, the *Genetics* lab will incorporate the following assignment in the lab report or grant proposal that requires students to search literature databases to:

- Distinguish primary and secondary research.
- Use database to search for and find scientific literature (*e.g.* Pubmed).
- Include citations for three articles in lab report/proposal (at least two primary research articles and one review article, and these must be in addition to any articles read/introduced during the lab). Formatting citations of articles can be determined by the instructor.

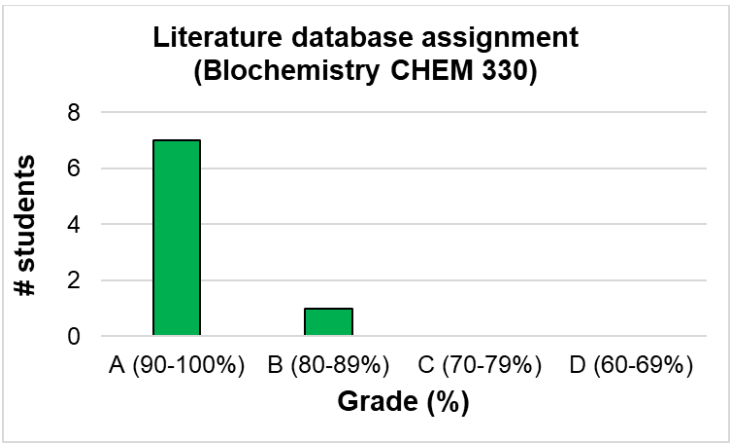
This past spring, labs taught by Drs. Duina and Schurko were used for this assessment (assignments and grading rubrics provided as attachment). The rubrics for the final lab reports or grant proposal for each lab included a section to assess whether students achieved the above goals, and the grades from each section are reported as a percent grade below:

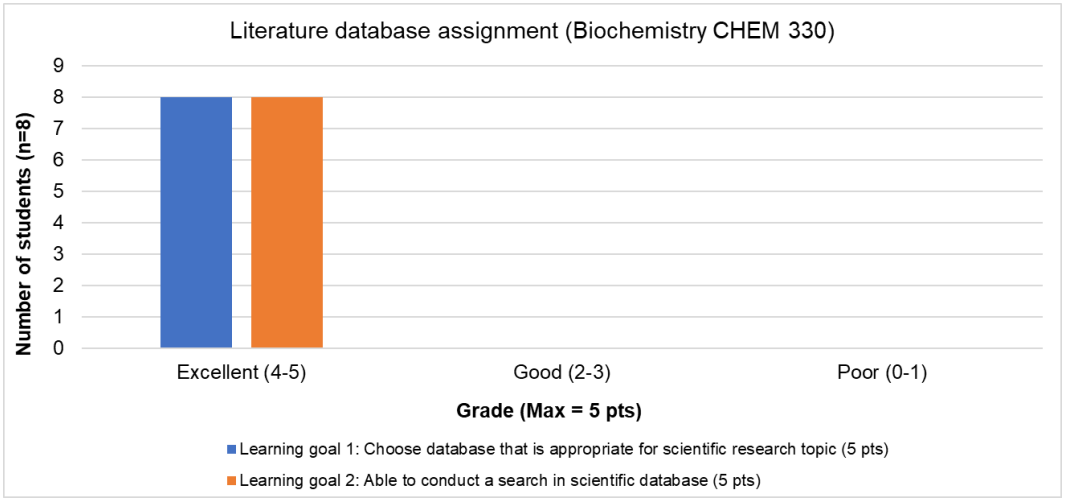


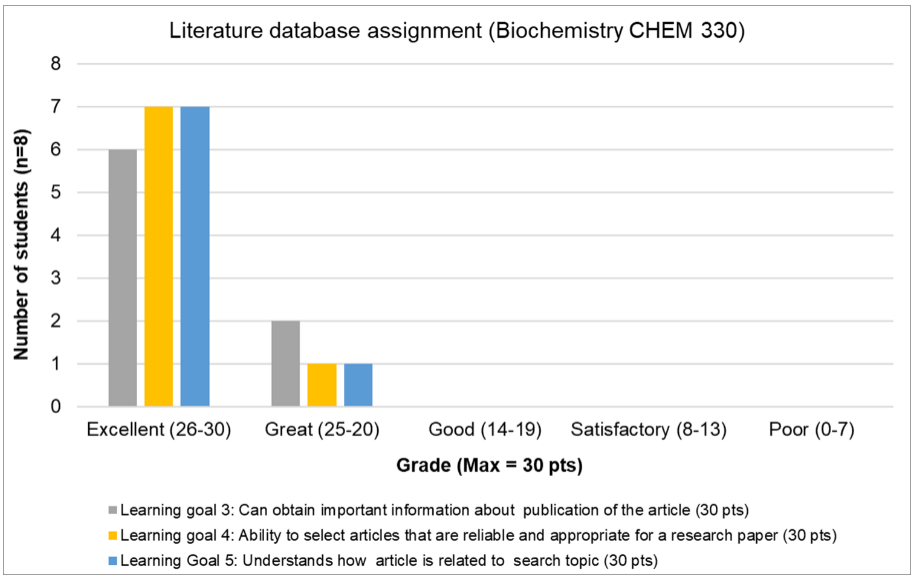
However, in Dr. Schurko's section each student wrote an individual report, while in Dr. Duina's section proposals were done in pairs of students. In addition, the grading rubric of each assignment was different for each instructor. In subsequent years, a common rubric will be developed for this assignment so that a common grading method can be used by all instructors (even if projects and final assignments are different) for more reliable assessment.

i) Biochemistry lab assignment: In *Biochemistry,* Drs. Scott and Caro developed an assignment in which each group of students is assigned a topic. Then, each group follows a series of steps to search appropriate databases for different types of articles and then responds to questions about the articles found (see two attachments for the assignment and rubric/assessment of related learning

goals). Last fall, 32 students participated in this activity and the grades (for 8 groups of 4 students) and assessment of the corresponding learning goals for the assignment are summarized below:







b) Grade on sequence database assignment (*Genetics BIOL 250).*

The objectives were for students to use the Basic Local Alignment Search Tool (BLAST) tool to search online DNA and protein databases at the National Center for Biotechnology Information (NCBI). Drs. Duina, Murray and Schurko each designed assignments for their lab sections that met the following criteria:

- Use the BLAST tool to search for sequence homologs. Any BLAST tool(s) and questions are fine, as long as students learn to use at least one.
- Understand how to interpret the list of hits (e.g. sequences are a ranked list, % identity between query and subject)

This was done as a standalone assignment (individual or group work) and was included in the syllabus. The final grades for the assignment from each section are reported below:

	Average grade
BLAST Assignment (Duina) - Groups	97.70%
BLAST Assignment (Schurko) - individual	86.70%
BLAST Assignment (Murray) - individual	82.50%

While each lab had a unique assignment that was tailored for the respective lab project, the goals were the same (assignments are included here as attachments). However, variation in how the assignment was administered (groups vs individuals) varied. In subsequent years, a common rubric will be developed for this assignment so that a common method for grading can be used by all instructors for more reliable assessment.

Summary for Learning Goal 2: Based on grades for assignments above in *Genetics* and *Biochemistry,* this learning goal is being achieved by these courses. These are important skills so that students can work independently on searching for literature and citations for their Senior research paper. However, this was the first year these assignments were used to assess this learning goal, and the plan for subsequent years is to:

- Continue with literature and database assignments in *Genetics,* but to develop a common rubric to be used by all instructors and sections, and
- Continue using the literature search assignment in *Biochemistry* without modifications in subsequent years.
- Exclude the rubrics for the research paper and oral presentation for assessment.

Learning Goal 3: *Develop hypotheses and propose appropriate experiments to test them.*

The rubrics from the final research paper and oral presentation are the direct assessment tools for this learning goal. These findings and levels for achievement are summarized above for Learning Goal 1.

Summary for Learning Goal 3: At our assessment meeting this year, BCMB faculty determined that direct assessment of this learning goal was not necessarily being achieved by relying solely on

the senior research project and presentation. During independent research, most students gain experience with hypothesis testing, but it is unclear to what extent hypothesis development is practiced since many projects are developed by faculty mentors.

The last time this learning goal was assessed, the need to assess hypothesis testing and development in the core courses was agreed upon. Two years ago, BCMB faculty summarized the BCMB *laboratory courses* that involve either hypothesis development and/or testing with the following results:

- Hypothesis development and testing: BIOL150, BIOL340, BIOL470, BIOL320, PHYS235
- Hypothesis testing only: BIOL250, CHEM330

However, laboratory courses can be challenging to assess this learning goal since projects and instructors change from year to year. At our assessment meeting this year, faculty agreed that *Advanced Biochemistry CHEM 335* and *Eukaryotic Cell Biology BIOL 355* (neither of which has a laboratory seciton0 will be used for direct assessment of this learning goal, and we came up with the following plan:

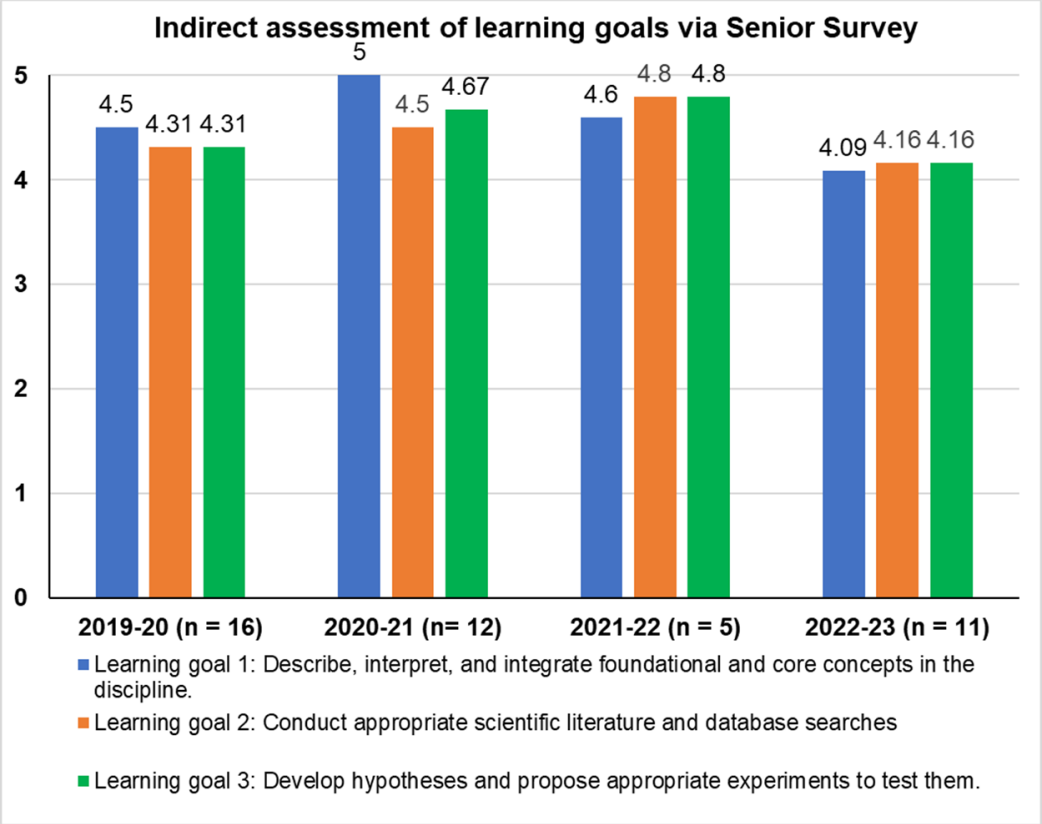
a) For several years, Dr. Caro has included a final exam question in *Advanced Biochemistry CHEM 335* (which is taken by all BCMB majors) for which students are given a set of data or a problem/question for which they need to proposed hypotheses to explain their observations. For subsequent years, we will use the grade from this question on the final exam to assess *hypothesis development.*

b) In *Eukaryotic Cell Biology BIOL 355* (also taken by all BCMB majors), Dr. Duina will develop a similar assessment tool (*e.g.* an assignment during discussions of primary literature) that will focus on *hypothesis development* and this will be implemented in Fall 2023.

c) The rubric from the final research report will still be used as a direct assessment tool for hypothesis testing, since testing hypothesis is the basis of research projects even if the students have not been involved their development.

II. Indirect assessment of learning goals

The Senior Survey was completed by 11 out of 17 BCMB majors and the feedback is included here as an attachment. The scores from the last four years are shown below with the mean for each learning goal (1 = strongly disagree, 2 = disagree, 3 = neither agree/disagree, 4 = agree, 5 = strongly agree).



Scores for learning goals 1, 2 and 3 and 8 remain high (with scores >4), although the average scores for each learning goal are the lowest, they have been during this time. From student comments, the research experience is valuable, and students appreciate the time to work with faculty. The integration of the paper and presentation in Senior Seminar is worthwhile. However, some comments were critical about using a comprehensive exam to assess achievement in the major is flawed and unnecessary, and better communication among faculty and between faculty and students during the entire course of the major is needed at times.

III. Reflections on assessment data for learning goals 1, 2 and 3:

BCMB program faculty reflected on the assessment data and our discussions from the meeting, and our thoughts are discussed above in greater detail but also summarized below with future planning for assessment included:

Learning Goal 1: Describe, interpret, and integrate foundational and core concepts in the discipline. Students continue to have high achievement in the category based on grades from the comprehensive exam, research papers and oral presentation. This fall, we will re-evaluate the questions on the exam, as well as rubrics for presentations and papers.

Learning Goal 2: Conduct appropriate scientific literature and database searches. This was the first year implementing assignments in *Genetics* and *Biochemistry* to evaluate this learning goal, and these courses showed high levels of achievement. In subsequent years common rubrics will be developed for all

Genetics instructors to use. The *Biochemistry* assignment will continue to be implemented each year in its current form.

Learning Goal 3: Develop hypotheses and propose appropriate experiments to test them. We agreed that senior research may not be an accurate assessment tool on its own. Therefore, in subsequent years exam questions and assignments in *Biochemistry* and *Eukaryotic Cell Biology* will also be used as an assessment tool for *hypothesis development*. The grade for the senior research paper will continue to be used to assess *hypothesis testing*.

Other thoughts: Although Learning Goal 7 (*Analyze and interpret experimental results using appropriate quantitative tools*) will not be assessed until 2024-25, this fall with be the first year of including a new direct assessment tool in the *Biochemistry* laboratory section, for which a rubric for a lysozyme isolation lab assignment will be used for direct assessment. In addition, at last year's assessment meeting we discussed developing a rubric for lab notebooks that students keep during their independent research and to use this as a direct assessment tool. This will also be discussed and developed in 2023-24.