# CHM 461 Assessment Report Spring 2017 Caitlin Miller May 23, 2017

## What was examined: Exam 3 (complete) and Exam 4 (partial)

**Exam 3:** Questions and scores were examined for exam 3 of CHM 461 Biochemistry II. The exam consisted of 17 multiple choice questions (2 points each) and 7 short answer questions (varied points) and was scored out of 100 points. The exam content was not cumulative, however, exam 3 was the last exam of the metabolism unit, which spanned a total of four exams (one in Biochemistry I and three in Biochemistry II). In order to master the new material for each exam, students were required to draw on previous material. Although exam questions were not explicitly cumulative, the content was. The exam can be found in the file CHM 461\_Spring 2017\_Exam 3.docx. A spreadsheet containing scores of each question and statistical analyses are found in the file CHM 461\_2017\_SLA\_Data.xlsx.

**Exam 4:** Select questions and scores were examined for exam 4 of CHM 461 Biochemistry II. The exam consisted of 9 multiple choice questions (3 points each) and 8 short answer questions (varied points) and was scored out of 100 points. The exam content was not cumulative and was unrelated to the material covered in exam 3. Only select questions that correlate with the assessed student learning outcome were analyzed. The exam can be found in the file CHM 461\_Spring 2017\_Exam 4.docx. A spreadsheet containing scores of each question and statistical analyses are found in the file CHM 461\_2017\_SLA\_Data.xlsx.

CHM 461 ran as one section of 15 students, all of whom had completed Biochemistry I immediately prior, under my instruction.

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The multiple choice component of exam 3 was analyzed with respect to the frequency of incorrect/correct responses to individual questions. The average for each question was used to categorize student learning of the content as mastery (A/A-), satisfactory (B+/B/B-), minimally adequate (C+/C/C-), or deficient (D/f), with letter grade cutoffs outlined in the course syllabus and in the data. Additionally, the percentage of students that demonstrated the varying degrees of performance was tabulated. The short answer component of exam 3 and selected short answer questions from exam 4 were analyzed with respect to the number of points earned per question. The average for each question was used to determine overall mastery, satisfactory, minimally adequate, or deficient performance with respect to the specific question content. Additionally, the percentage of students that demonstrated the varying degrees of performance was tabulated for each question and for the complete short answer component. Finally, students’ overall performance on exam 3 was categorized as mastery, satisfactory, minimally adequate, or deficient by the sum of the multiple choice and short answer questions. Extra credit questions were excluded from the content analysis as they were optional.

## What was found for **Outcome 1:**

The program-level learning outcome that was assessed using exam 3 reflects comprehensive knowledge of subject matter for the course: s*killfully applied key concepts in biological chemistry and molecular biology to systems at the interface of chemistry and biology.*

All of the multiple choice and short answer questions on exam 3 were analyzed in order to address this learning outcome. A summary of categorized student performance on exam 3 (overall), and subdivided multiple choice and short answer components can be found in the table below:

Table 1: Exam 3 Performance

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Percentage of students** | | |
| **Achievement level** | **Multiple Choice** | **Short Answer** | **Overall** |
| Mastery | 6.7 % | 26.7 % | 20.0 % |
| Satisfactory | 53.3 % | 33.3 % | 33.3 % |
| Minimally adequate | 13.3 % | 13.3 % | 33.3 % |
| Deficient | 26.7 % | 26.7 % | 13.3 % |

The summarized data reveals that approximately 53.3% of students achieved satisfactory or mastery performance on exam 3. Itemized analysis of exam questions reveals that minimally adequate or deficient performance was observed in seven of the 17 multiple choice questions. Of the five deficient questions, three questions required application of knowledge of chemical structures to chemical reactions. The difficulty with these questions is that there were no images provided. The students were required to know the structures of various metabolic intermediates and the reactions they participate in. When the content was introduced in class, images accompanied the material. Providing images on the exam would likely boost student performance on these types of questions, however, requiring students to know the structures of common metabolic intermediates is important. The remaining two deficient questions required understanding the role of specific enzymes or organs in metabolic pathways, but did not require in-depth application of concepts. The two questions that were minimally adequate required identification of molecules involved in a pathway and identification of a common reaction. Neither question required in-depth application of concepts. It is unclear why these questions that did not require in-depth analysis were commonly missed. It is likely that they were topics that were overlooked by students in favor or more complicated material.

In the short answer component, multi-part questions were subdivided for a more accurate analysis. Of the 11 subdivided questions, two were categorized as deficient and four were categorized as minimally adequate based on the average number of points awarded. Question 3B was deficient by the largest margin. This question required an understanding of enzyme kinetics, a topic that was covered in-depth in Biochemistry I. Students were specifically instructed to review the content independently. The specific knowledge required to answer this question was covered this semester, but it was clear that the students were lacking the basics. It is not feasible to review an entire previously learned chapter in class; however, giving the students a more structured review would have helped performance on this question. Questions 4B was also deficient, and required students to explain the significance of a relationship found in the regulation of a metabolic pathway. It was very surprising that performance on this question was deficient. This specific relationship was discussed in-depth a total of four times in lecture, as requested by many students. My assumption is that the students who performed deficiently on this question never had a firm grasp of the concept and did not study it until immediately prior to the exam. If they had studied ahead of time, they would have asked questions to clarify during any of the four times it was discussed. To boost performance on questions related to this topic, more relevant practice questions would be beneficial. Of the four minimally adequate questions, one (4A) required providing the definition of a term and another (6) was listing order of events and naming chemical reactions. Neither required in-depth application of knowledge, rather, recognition of the significance of the processes while studying the material. The remaining two minimally adequate questions (5A and 5B) required students to explain the significance of an enzyme’s structure and state the outcome under certain environmental conditions. The topic addressed in question 5 was discussed in class a total of three times and justifying structure-function relationships is something that is stressed during lecture, so it is unclear why approximately half of the class performed poorly on this question. My assumption that student did not have a firm grasp of the material as it was being discussed in class applies to question 5 as well.

## What was found for **Outcome 4:**

The program-level learning outcome that was assessed using exam 4 reflects a student’s facility with experimental design and the scientific method: *constructed or critiqued the design of an experiment in biochemistry or molecular biology.*

Due to schedule conflicts, the content for exam 4 was limited to approximately 1/3 of what was anticipated, covering only DNA replication *(in vivo and in vitro*) and DNA repair. A number of relevant questions from exam 4 that reflected learning outcome 4 were selected for analysis. A summary of student performance on the selected questions can be found in the table below:

Table 1: Exam 4 Performance, Selected questions

|  |  |
| --- | --- |
| **Achievement level** | **Percentage of students** |
| Mastery | 60.0 % |
| Satisfactory | 33.3 % |
| Minimally adequate | 6.7 % |
| Deficient | 0.0 % |

The summarized data reveals that approximately 93.3% of the students achieved satisfactory or mastery performance on the selected exam 4 questions. A total of eight subdivided questions were analyzed, for which mastery was achieved on five and satisfactory performance was achieved for the remaining three. Question 1 required students to provide a list of reaction components necessary for an enzymatic process to occur. The question did not require explanation of the list, which is an addition I will make in the future to demonstrate understanding of why each component is needed. Question 2 required students to explain the purpose of each step in a biochemical technique as well as provide and explain hypothetical reaction temperatures. Although most students were successful in answering this question, minor errors that resulted in only a half or one point deduction illustrated that many students lacked the most important component of the question: that melting temperature is dependent on the annealing temperature of the *primer,* not the whole template molecule*.* The question required nine separate answers, so only 1 point was allotted for this fact. A different grading scheme for question 2 would have resulted in minimally adequate or deficient performance for at least half of the population. Question 3 (A, B, C and D) required students to analyze sample experimental data, predict and explain the results of subsequent steps. Most errors in question 3 were on part D and I believe this was a reading comprehension issue. The question asks students to assume that an enzyme catalyzes *a single reaction per molecule* and identify what the structure would look like following the reaction. Many students either missed this statement, or did not thoroughly understand its meaning, and answered as if the enzyme catalyzed an arbitrary number of reactions. This illustrates that some students may have difficulty in following experimental procedures and predicting outcomes based on their knowledge of the chemistry. This type of question is not one that was practiced in class and additional questions of this nature would have aided in students’ understanding. Question 5 (A and B) required students to design nucleic acid primers for amplification of a single-stranded DNA template molecule and then analyze their chemical properties. Although most students were successful, those that lost credit were lacking fundamental understanding of the experiment. Practice problems of this nature were done in class, however, the template molecule was double-stranded. By provided the students with a single-stranded template on the exam, they needed to identify an additional step in the experiment, which was production of the double-stranded template before they could proceed as done in class. This illustrates that some students may have difficulty outlining procedures and do not have the foresight to anticipate results.

## Conclusions

**Outcome 1**

Analysis of exam 3 scores as a measure of student achievement for the assessed learning outcome: s*killfully applied key concepts in biological chemistry and molecular biology to systems at the interface of chemistry and biology*, revealed that approximately 53.3% of the total population achieved satisfactory or mastery performance on the final exam. The average exam score was approximately 79.9%, which is significantly lower that than the course average of 93%. The overall course average takes into account 4 equally weighted exams, an in-class group literature activity, individual literature presentation and a participation score. The non-exam component of the course inflated the average. I believe that the nature of the content, being the final and most difficult exam in the metabolism unit, drove the score much below the course average. A course average of 93% is very high, however, the majority of enrollees in CHM 461 are there by choice, taking the course as an elective, and were some of the top students in CHM 460. Overall, student performance on the multiple choice component of the exam is still lacking, with only 6.7% of students achieving mastery. This is likely due to the use of in-class problem sets that were formatted similarly to short answer questions, not multiple choice. Implementing practice multiple choice questions is difficult, but I believe this is something that could be introduced in the future as I develop a catalogue of exam material. An activity I began to incorporate this semester was discussion of strategies for answering multiple choice questions as appropriate opportunities arose in class.

**Outcome 4**

Analysis of select exam 4 questions as a measure of student achievement for the assessed learning outcome: *constructed or critiqued the design of an experiment in biochemistry or molecular biology,* revealed that approximately 93.3% of the total population achieved satisfactory or mastery performance. The average score for the questions selected for analysis was 89%. The average exam score including all questions was 92%, indicating that the questions involving facility with experimental design and the scientific method were more difficult, albeit minimally. The high percentage of mastery and satisfactory performances is in part due to the limited exam content which allowed student to focus their attention in greater detail on the topic, and the fact that all students are either Biology or Biochemistry majors and have learned some aspects of this material in other courses. Additionally, the question format and grading schemes facilitated high scores. Questions that required lengthy explanations of experimental procedures resulted in minor deductions when only 1 or 2 of several key ideas were missed. A weighted grading scheme that allotted more points for the most critical information would have resulted in a different distribution of performance outcomes. Although a few common mistakes were made that demonstrated some students’ lack of ability to think critically regarding an experimental procedure, the grading scheme facilitated high scores. This combined with limited exam content, resulted in excellent student performance on the selected questions from exam 4. In the future, I hope to allocate more class time to discussions of experimental design to determine what exactly these students are lacking in understanding and/or application of knowledge.