

# Supplemental Material

*CBE—Life Sciences Education*

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**Supplemental Materials Table 1: Comparison of Course Contexts**

<b>Feature</b>	<b>Introductory Biology Course</b>	<b>Senior-level Biology Course</b>
<b>Course</b>	BIOL1107 Introductory Biology, an introduction to key concepts in cell biology and genetics, 4 credit hours	CBIO3400 Cell Biology, an examination of cell biology structures, processes, and mechanisms, 4 credit hours
<b>Number of students</b>	261 in one section	229 in three sections (79+76+74=229)
<b>Course components</b>	Lecture (3 x 50 min/week) Lab (1 x 115 min/week)	Lecture (3 x 50 min/week) Breakout session (1 x 75 min/week)
<b>Lecture style and features</b>	Interactive lecture <ul style="list-style-type: none"> <li>• Daily clicker questions, 10% of course grade</li> <li>• Weekly formal group work (e.g., completing worksheets)</li> </ul>	Interactive lecture <ul style="list-style-type: none"> <li>• Daily written questions, 5.7% of course grade</li> <li>• Daily informal group work (e.g., think-pair-share, “talk through” exercises)</li> </ul>
<b>Formal group work</b>	Occurs in lecture <ul style="list-style-type: none"> <li>• Groups assigned for the entire semester</li> <li>• Groups collaborated on worksheets</li> <li>• Students did not receive points for participating</li> </ul>	Occurs in breakout session <ul style="list-style-type: none"> <li>• Groups assigned and change two times during the semester</li> <li>• Groups collaborated on POGIL-style problem sets</li> <li>• Students received points for participating</li> </ul>
<b>Exams</b>	Three section exams and a cumulative final exam	Three section exams and a cumulative final exam
<b>Exam style</b>	Multiplechoice and short answer questions	Short essay questions
<b>Percentage of course grade from exams</b>	75.0% of course grade came from exams	77.2% of course grade came from exams
<b>Textbook</b>	Online textbook, free	Published textbook, not free
<b>Homework</b>	Weekly online homework through learning management system, 10% of course grade	Infrequent online homework through learning management system, 2.2% of course grade

**Supplemental Materials Table 2: Metacognition Codebook**

<b>Evaluating Effectiveness of Individual Learning Strategies</b>	<b>Questions from Exam Self-Evaluation Assignment:</b> <i>Which study strategies (from your list above) worked well for you?</i> <i>Why did these study strategies work well for you?</i>	
<b>Code</b>	<b>Description and coding notes</b>	<b>Examples</b>
<b>Sufficient evidence</b>	<ul style="list-style-type: none"> <li>• Student lists one or more strategies that worked well and explains why each strategy they listed was effective for their learning</li> </ul> <p><i>Notes:</i></p> <ul style="list-style-type: none"> <li>• If they write that all their strategies were effective, and they explain the effectiveness of each strategy they listed, then code as “sufficient”</li> </ul>	<p>“Answering the study questions worked well. It helped with applying what I learned and being able to write answers in my own words.”</p> <p>“Writing down everything in my own words on blank paper worked well. I forced myself to write things down to make sure I knew them. It’s easy to think you know something without actually knowing it, so writing helps.”</p>
<b>Partial evidence</b>	<ul style="list-style-type: none"> <li>• Student lists one or more strategies that worked well but provides little explanation as to why</li> </ul> <p><i>Notes:</i></p> <ul style="list-style-type: none"> <li>• If they write that all their strategies were effective but only explain the effectiveness of the strategies in general, then code as “partial”</li> <li>• If they write about “liking” a strategy or their preferences (e.g., “I’m a visual learner”) instead of explaining why a strategy helped them learn, then code as “partial”</li> </ul>	<p>“Reading the book worked well. I am more comfortable when I read all the info provided on a topic.”</p> <p>“All my strategies worked well (reading the book, taking notes, doing the worksheets). I learned the most and got practice from them.”</p>
<b>Insufficient evidence</b>	<ul style="list-style-type: none"> <li>• Student lists one or more strategies that worked well but does not reasonably explain why a strategy was effective</li> </ul> <p><i>Notes:</i></p> <ul style="list-style-type: none"> <li>• If they write that all their strategies were effective, but their explanation is very general, then code is “insufficient”</li> </ul>	<p>“I think all my strategies worked well. I’ve used these same techniques on other tests I’ve done well on.”</p> <p>“All my strategies worked well. I got a better understanding of broad information.”</p>

Evaluating Ineffectiveness of Individual Learning Strategies	<p align="center"><b>Questions from Exam Self-Evaluation Assignment:</b>  <i>Which study strategies (from your list above) did <u>not</u> work well for you?  Why didn't these study strategies work well for you?</i></p>	
Code	Description and coding notes	Examples
<p><b>Sufficient evidence</b></p>	<ul style="list-style-type: none"> <li>• Student lists one or more strategies that did not work well and explains why each strategy was ineffective for their learning</li> </ul> <p><i>Notes:</i></p> <ul style="list-style-type: none"> <li>• If they write that none of their strategies did not work well, but explained why each study strategy was effective (in response to previous question), code as "sufficient"</li> </ul>	<p>"Typing class notes didn't work well. I don't really think through the information I type. I don't think I was really absorbing the information, and I was unable to recall the information on the test."</p> <p>"The practice test did not work well. Not timing myself while answering questions was not a realistic approach because it is not reflective of true testing conditions."</p>
<p><b>Partial evidence</b></p>	<ul style="list-style-type: none"> <li>• Student lists one or more strategies that did not work well but provides little explanation as to why</li> </ul> <p><i>Notes:</i></p> <ul style="list-style-type: none"> <li>• If they list one or more strategies that did not work well but their explanation of ineffectiveness focuses on how much time they spent using the strategy or how early they started using the strategy, then code as "partial"</li> </ul>	<p>"Not completing and reviewing the study questions sooner did not work. I feel like I didn't understand some concepts in depth enough."</p> <p>"Reading the textbook questions did not work. The questions were confusing, and I was overthinking things."</p>
<p><b>Insufficient evidence</b></p>	<ul style="list-style-type: none"> <li>• Student lists one or more strategies that did not work well but does not reasonably explain why a strategy was ineffective</li> <li>• Student lists a strategy they did not use but think they should have used</li> </ul> <p><i>Notes:</i></p> <ul style="list-style-type: none"> <li>• If they list a general reflection rather than evaluating a strategy's effectiveness, then code as "insufficient"</li> <li>• If they do not list anything that did not work but go on to say their plan was not effective, then code as "insufficient"</li> </ul>	<p>"I should have been reviewing every day after lecture."</p> <p>"Cramming does not work." (<i>Note: cramming was not a strategy they planned to use.</i>)</p>

Evaluating Effectiveness of Overall Study Plan	<b>Question and Prompt from Exam Self-Evaluation Assignment:</b> <i>How effective was your study plan for Exam One?</i> <i>Please explain you answer.</i>	
Code	Description and coding notes	Examples
<b>Sufficient evidence</b>	<ul style="list-style-type: none"> <li>• Student writes about how effective their plan was and explains why their overall plan was effective or ineffective</li> </ul> <p><i>Notes:</i></p> <ul style="list-style-type: none"> <li>• If they write about realizations they have about how to take the test or realizations about what the test is like, this is not an evaluation of their plan unless they write about how their plan did not prepare them for these aspects of the test</li> </ul>	<p>“My plan was not effective at all. I think it would have been better if I went through notes and tried to understand each concept instead of memorizing.”</p> <p>“My plan worked well enough to put me close to the class average, but not well enough to score as high as I wanted. I studied in a way that gave me a brief pass over the major points, but I should have better understood individual concepts and how they relate to each other.”</p>
<b>Partial Evidence</b>	<ul style="list-style-type: none"> <li>• Student writes about how effective their plan was but gives little explanation as to why it was effective or ineffective</li> </ul> <p><i>Notes:</i></p> <ul style="list-style-type: none"> <li>• If they write about their use of time as what was ineffective about their plan (they crammed or started studying late), then the code can be “<i>partial</i>”, but if they write about time as something that happened to them (out of their control), then code as “<i>insufficient</i>”</li> <li>• If they write that their study plan made them feel prepared or confident as their explanation of effectiveness code as partial</li> </ul>	<p>“My plan was moderately effective. I did alright (on the exam), but definitely could have done better by studying more efficiently.”</p> <p>“My study plan was very effective. I started studying a week before and I felt confident.”</p>
<b>Insufficient evidence</b>	<ul style="list-style-type: none"> <li>• Student does not write about why their plan was effective or ineffective</li> </ul> <p><i>Notes:</i></p> <ul style="list-style-type: none"> <li>• If they only write about their performance without any other explanation of effectiveness, then code as “<i>insufficient</i>”</li> </ul>	<p>“I did not implement as much time into my studying as I wanted to, and having my time stretched thin, I was unprepared.”</p> <p>“My plan was relatively effective. I did better on the exam than I expected to compared to the average.”</p>