Supplemental Material

CBE—Life Sciences Education

Bailey ***et al.***

Supplemental Materials for

Weekly Formative Midterms and Creative Grading Enhance Student Learning in an Introductory Science Course

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Questions Asked During Student Interviews

1. What study techniques did you perform on your own that helped you to improve on weekly assessments and in class? Did these techniques change throughout the semester at all?

2. What did instructors do that were most beneficial to your learning and success in the class?

3. Do you feel like knowing what you missed on exams helped you have a better idea of what you needed to study?

4. At one point in the semester, you switched from consistently missing these problems to consistently getting them right. What were the most significant factors in helping you make that switch?

5. Is there anything that would have helped you to master this type of problem earlier in the semester?

6. Overall how do you feel about weekly midterms?

7. Do you feel like having weekly midterms prepared you for what was going to be on the final?

8. Did your opinion about weekly midterms change throughout the semester?

9. How would you feel if other classes adopted the weekly midterm format?

10. How much biology did you have prior to taking this class?

11. Are you enrolled in any biology classes this semester? If so, do you feel that the weekly practice from PDBIO 120 helps you remember concepts when they are needed?

12. What was the biggest challenge to your success in the class?

13. Did the amount of time you spent studying for the class change throughout the semester?

14. Is there anything else you can tell us about that helped you to learn throughout the course that you haven't already mentioned?

Full transcripts of interviews are available upon request.

Scientists hypothesized that the gene for a protein called Rb was inhibited as part of the signal to initiate DNA replication. Thus, they predicted that cellular levels of this protein would decrease during the early part of replication. A fluorescent antibody was prepared as a probe to detect the level of Rb in cells. The table below describes the various samples tested and the amount of fluorescence measured in each after incubation with the antibody.

Group	Condition	Fluorescence Intensity		
		mean	standard deviation	n
A	Cells in early G_1 phase	27.3	4.8	9
B	Cells in early S phase	17.5	5.6	9
C	Cells in early G_2 phase	29.8	4.1	9
D	Cells injected with purified Rb	55.2	9.2	9

What is an appropriate conclusion based on the data?

a. Fluorescence does not detect the presence of Rb.
b. Rb levels decrease during mitosis.
c. The amount of Rb in the cell decreases at the onset of replication.
d. Replication occurs during the S phase.
e. Rb levels do not really change. The data observed are only random fluctuations.

Fig. S1.

Example of an“Evaluate Experimental Data” item found on exams. Correct answer is italicized.This type of problem is included in the “Apply/Evaluate” category in Fig. 2A and requires processes found at the evaluation level of the revised Bloom’s taxonomy. All problems used in Fig. 3B are of this type.

Part of the template strand of a DNA molecule has the sequence 5'TCTCGC3'. This codes for amino acids #76 and 77. What is the sequence of the anti-codon for amino acid #77?

a. *5'UCU3'*
b. 5'CGC3'
c. 5'AGA3'
d. 5'GCG3'

Fig. S2

Example of a "Sequence" problem found on exams. Correct answer is italicized.This type of item is included in Fig. 2A ("Apply/Evaluate") and requires processes found at the application level of the revised Bloom's taxonomy. All problems used in Fig. 3C are of this type.

The weight of a protein is 13,920 g/mol. The average weight of an amino acid is 120 g/mol, and the average weight of a nucleotide is 310 g/mol. What is the weight of the coding region of the gene coding for this protein?

a. 10,777 g/mol
b. 16,165 g/mol
c. 23,973 g/mol
d. 32,330 g/mol
e. 35,960 g/mol
f. 71,920 g/mol
g. 107,880 g/mol
h. 215,760 g/mol
i. 12,945,600 g/mol
j. 25,891,200 g/mol

Fig. S3

Example of a "Central Dogma" problem found on exams. Correct answer is italicized.This type of item is included in Fig. 2A ("Apply/Evaluate") and requires processes found at the application level of the revised Bloom's taxonomy. All problems used in Fig. 3D are of this type.

In 1966, André Jagendorf and Ernest Uribe published a paper on experiments to study hydrogen ions and ATP production during photosynthesis. The investigators isolated chloroplasts from spinach leaves and disrupted them so that chemical reagents added during the experiment would have access to the thylakoids. These broken chloroplasts were equilibrated in a "first solution" with a high hydrogen ion concentration and then transferred quickly to a fresh "second solution" at low hydrogen ion concentration in order to establish a gradient. This second solution also contained ADP and inorganic phosphate. The rate of ATP production was measured from the second solution. The following table summarizes Jagendorf and Uribe's results.

	Hydrogen Ion Concentration (nmol/liter)		
Test #	First Solution	Second Solution	Rate of ATP synthesis (mean ± S.D., n = 16 for all)
1	10,000	5.0	5 ± 7 nmol/mg
2	25,000	5.0	11 ± 6 nmol/mg
3	159,000	5.0	28 ± 10 nmol/mg
4	63.0	63.0	0 ± 0 nmol/mg
5	10,000	63.0	1 ± 0 nmol/mg
6	25,000	63.0	2 ± 1 nmol/mg
7	159,000	63.0	8 ± 2 nmol/mg

What is a reasonable conclusion based on these data?

a. Hydrogen ion gradients are unrelated to ATP synthesis.
b. The difference in hydrogen ion concentration is zero.
c. ATP does not affect the hydrogen ion concentration gradient.
d. Hydrogen ion gradients stimulate ATP synthesis.
e. The difference in hydrogen ion concentration grows as ATP is made.
f. The greater the number of hydrogen ions outside the thylakoids, the faster the ATP synthesis.

Fig. S4.

Additional example of an "Evaluate Experimental Data" item found on exams, included to illustrate the unique contexts of these items. Correct answer is italicized.This type of problem is included in the "Apply/Evaluate" category in Fig. 2A and requires processes found at the evaluation level of the revised Bloom's taxonomy. All problems used in Fig. 3B are of this type.

Pea plants with the genotype RrYy are crossed with others that have the genotype Rryy. The resulting phenotypes were observed in 32 offspring: 20 round (R) and yellow (Y), 6 round and green (y), 1 wrinkled (r) and yellow, and 5 wrinkled and green. What is the most probable conclusion to account for these results?

a. *These genes are linked and crossing over occurred.*
b. These genes are linked but crossing over did not occur.
c. The inheritance of these genes occurs by independent assortment.
d. Dual inheritance of the round and green phenotypes is harmful to the plant.

Fig. S5.

Additional example of an "Evaluate Experimental Data" item found on exams, included to illustrate the unique contexts of these items. Correct answer is italicized.This type of problem is included in the "Apply/Evaluate" category in Fig. 2A and requires processes found at the evaluation level of the revised Bloom's taxonomy. All problems used in Fig. 3B are of this type.