

# Supplemental Material

*CBE—Life Sciences Education*

*Mynlieff et al.*

## Supplement A Post-exam Quiz Example

Approximately two weeks after exams 1, 2, and 3, students were given a 5 question quiz covering the most difficult concepts on each exam. The quizzes were administered in class using iclickers®. All three sections were given the identical quiz on the same day regardless of whether they participated in written corrections, discussion of corrections, or no corrections.

1. Upon strenuous exercise, oxygen availability in the muscles is reduced and the muscles switch from aerobic to anaerobic processes. Which of the following is correct?
  - a. Without oxygen, NADH can be oxidized to NAD with the formation of lactic acid allowing glycolysis to continue (with the production of reduced levels of ATP?)
  - b. Reduction-oxidation of NADH and NAD can work equally well with or without oxygen so you can continue to function (at reduced capacity?)
  - c. Glucose is produced and stored until there is sufficient oxygen to carry out oxidative phosphorylation again
  - d. The muscles convert to using oxidation of FADH and FAD to produce ATP so you continue to function (at a reduced capacity?)
2. Membrane fluidity can be predicted based on the composition of specific components in the membrane. Warming membranes causes them to become more fluid. To make a membrane that had the same degree of fluidity at 40 degrees as the original one at 20 degrees, one could change the composition of the membrane
  - a. to incorporate peripheral proteins
  - b. to incorporate long unsaturated fatty acid tails
  - c. to incorporate long saturated fatty acid tails
  - d. one cannot do the impossible
3. Kidney dialysis is used for people who have renal failure or kidney injury. Blood and the dialyzing solution are run past each other, separated by a semipermeable membrane that allows ions and small molecules to exchange. In order for this to be the most effective, one would
  - a. use pure water as the dialyzing solution
  - b. use a dialyzing solution that has all the components that you want the person to keep, but does not have the waste products that you are trying to remove
  - c. use a dialyzing solution that is the same as the person's blood so you don't remove anything that is important for them
  - d. use a dialyzing solution that is green so you can tell if it is working

4. A cell is active producing proteins for secretion. The proteins are translated in the rough ER and carbohydrates are added in the golgi. When the cell is done, you would find
  - a. the phospholipid membrane in the plasma membrane and the protein in the extracellular space
  - b. the phospholipid membrane in the plasma membrane and the protein in the cytoplasm
  - c. the phospholipid membrane and the protein in the nucleus
  - d. the phospholipid membrane and the protein in the extracellular space
  - e. the phospholipid membrane in a vesicle membrane with the protein inside the vesicle
  
5. If one were to make the inner mitochondrial matrix permeable to small ions, the result on ATP production would be
  - a. no change as this membrane does not play a role in the generation of ATP
  - b. a reduction in ATP production because the integral membrane ATP synthase would be damaged
  - c. a reduction in ATP production because the H<sup>+</sup> gradient would be destroyed
  - d. an increase in ATP production because H<sup>+</sup> could now pass more quickly from the inner mitochondrial space into the matrix producing more ATP
  - e. A reduction in ATP production because the oxidation of NADH to NAD<sup>+</sup> would no longer occur

Answers:

1. A
2. C
3. B
4. A
5. C

## Supplement B

### Essay short term assessment example

Below is an example of a post-essay quiz that was administered to assess the students after completing the carbonic acid buffering activities (essay assignment, discussion activity, or traditional lecture). All students received lecture and reading material on pH and respiration. The quiz was administered through the online course management system, D2L<sup>®</sup>, within a 24 hour period. Students were given a maximum of 15 minutes to complete the quiz. Multiple versions of the quiz were administered, all of which contained similar question content, to minimize the sharing of answers among students.

#### **Case study:**

A small child ingests a large number of pills from a bottle of salicylate (aspirin) and is rushed to the hospital. She arrives at the emergency room in a nearly comatose condition, breathing rapidly and deeply. Her blood pH is measured and reveals a startlingly low value of 6.8 (normal blood pH is 7.4). The emergency room doctor immediately orders treatment with intravenous bicarbonate, hydration and hemodialysis to remove dissolved salicylate from her bloodstream. The child's breathing begins to return to normal and the emergency room staff declares that the child is no longer in life threatening danger.

Q1. From reading this case study, we can assume that salicylate (aspirin) is:

- a. An acid
- b. A base
- c. A buffer

Q2. If the pH of a solution is decreased from pH 7 to pH 5, what does this say about the change in hydrogen ( $H^+$ ) and hydroxide ( $OH^-$ ) ion concentrations?

- a. concentration of  $H^+$  is one-hundredth (0.01X) what it was at pH 7
- b. concentration of  $OH^-$  is 100 times greater than what it was at pH 7
- c. concentration of  $H^+$  is twice (2X) what it was at pH 7
- d. concentration of  $H^+$  is half (1/2) what it was at pH 7
- e. concentration of  $H^+$  is 100 times greater what it was at pH 7

Q3. Why does the child's breathing become deep and rapid in response to this condition?

- a. The body is trying to raise blood pH by lowering the  $CO_2$  concentration
- b. The body is trying to lower blood pH by lowering the  $CO_2$  concentration
- c. The body is trying to raise blood pH by raising the  $CO_2$  concentration
- d. The body is trying to lower blood pH by raising the  $CO_2$  concentration

Q4. Respiring cells release CO<sub>2</sub> which dissolves into the bloodstream. What prediction can we make about the pH of blood as that blood first comes in contact with respiring cells?

- a. Blood pH will increase slightly (by less than 1 pH unit)
- b. Blood pH will remain unchanged
- c. Blood pH will decrease significantly (by more than 3 pH units)
- d. Blood pH will decrease slightly (by less than 1 pH unit)
- e. Blood pH will increase significantly (by more than 3 pH units)

Q5. Like the child's blood in the case study, the world's oceans have become acidified. Listed below are a several theoretical remedies to this problem. Identify ALL of those remedies which would serve to reduce ocean acidity:

- a. Add bicarbonate to the oceans
- b. Add calcium carbonate to the oceans
- c. Add CO<sub>2</sub> to the oceans
- d. Remove bicarbonate from the oceans
- e. Remove carbonate from the oceans
- f. Remove CO<sub>2</sub> from the oceans

Answers:

- 1. A
- 2. E
- 3. A
- 4. D
- 5. A, B, and F

### Supplement C

#### Essay long-term assessment example

Below is an example of the carbonic acid buffering long-term assessment administered at the end of the semester on the cumulative final exam.

- 1. Carbonic anhydrase is an enzyme found in many cells. What does carbonic anhydrase do?
  - a) convert  $\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{HCO}_3^- + \text{H}^+$  when CO<sub>2</sub> levels are high
  - b) convert  $\text{HCO}_3^- + \text{H}^+ \rightarrow \text{CO}_2 + \text{H}_2\text{O}$  when HCO<sub>3</sub><sup>-</sup> levels are high
  - c) convert  $\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{HCO}_3^- + \text{H}^+$  when CO<sub>2</sub> levels are low
  - d) A and B
  - e) B and C

2. A chemical plant off the coast of Australia accidentally spilled large amounts of hydrochloric acid into local reef area. Which of the following would you expect to happen?
- a) The increase in hydrogen concentration binds with available carbonate to form bicarbonate
  - b) There will be more available calcium carbonate to build shells of marine animals
  - c) The hydrochloric acid allows the water to take up more  $\text{CO}_2$
  - d) Carbonic anhydrase freely floating in the environment will be inactivated, and  $\text{CO}_2$  will not be converted to bicarbonate.

Answers

- 1. D
- 2. A