Unit 3 Progress Check: FRQ

1. Read each question carefully. Write your response in the space provided for each part of each question. Answers must be written out in paragraph form. Outlines, bulleted lists, or diagrams alone are not acceptable and will not be scored.

Researchers studied the relationship between glucose concentration, oxygen level, and ATP production in one type of mammalian cell. Cells were isolated and cultured in growth medium containing either 1.5 mM glucose or 25 mM glucose and at oxygen levels that varied from 0% to 21%. The researchers determined the concentration of ATP per cell under the different conditions. The ATP concentrations are shown as relative to the maximum ATP concentration obtained when cells were cultured in the presence of 25 mM glucose and 21% oxygen, standard culture conditions. The data are shown in Table 1.

Table 1. Relative concentration of ATP per cell under different growth conditions

Concentration of Glucose in Growth Medium	Percent of Oxygen	Relative Concentration of ATP per Cell
1.5 mM	0	0.3
1.5 mM	5	0.65
1.5 mM	10	0.75
1.5 mM	21	0.85
25 mM	0	0.4
25 mM	5	0.7
25 mM	10	0.8
25 mM	21	1.0

(a) **Describe** the role of oxygen in cellular respiration.

(b) Using the template, **construct** an appropriately labeled graph to represent the data in Table 1.

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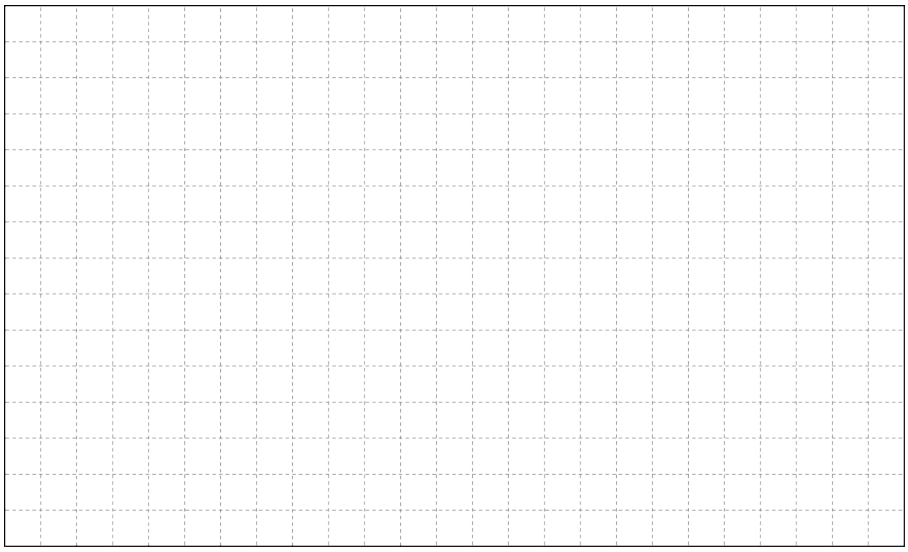

(c) **Describe** the relationship between the concentration of glucose in the culture medium and the ATP concentration in the cells.

(d) In a further experiment, the researchers add a compound to the cell growth medium that both binds and releases protons (H^+) and also passes through lipid membranes. **Predict** the effect of this added compound on ATP production by the cells. **Justify** your prediction.

Part A

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that oxygen is the terminal acceptor of electrons that have passed through the electron transport chain.

Part B

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1	2	3 ✓

The sketched bars / curve meet(s) all of the criteria below.

- ☐ Correct axis labeling

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- [ ] Correct scale and unit
- [ ] Correctly plotted line graph

Part C

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that the concentration of glucose appears to have little or no effect on the ATP concentration in the cells.

Part D (i)

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that the amount of ATP produced will decrease OR that no ATP will be produced.

Part D (ii)

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that the compound is more likely to bind protons where the protons are in greater concentration, in the intermembrane space. It also indicates that if the compound then carries the protons across the inner membrane to the matrix, there will no longer be a proton concentration/pH/electrochemical gradient across the inner membrane, and protons will not flow through and power the ATP synthase enzymes.

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2. Read each question carefully. Write your response in the space provided for each part of each question. Answers must be written out in paragraph form. Outlines, bulleted lists, or diagrams alone are not acceptable and will not be scored.

Enolase is an enzyme that catalyzes one reaction in glycolysis in all organisms that carry out this process. The amino acid sequence of enolase is similar but not identical in the organisms. Researchers purified enolase from *Saccharomyces cerevisiae*, a single-celled eukaryotic yeast that grows best at 37°C, and from *Chloroflexus aurantiacus*, a bacterium that grows best at the much higher temperature of 55°C. The researchers compared the activity of purified enolase from the two organisms by measuring the rate of the reaction in the presence of varying concentrations of substrate and a constant amount of each enzyme at both 37°C and 55°C.

(a) Depending on the organism, the optimal pH for enolase to catalyze its reaction is between 6.5 and 8.0. **Describe** how a pH below or above this range is likely to affect enolase and its catalytic ability.

(b) **Identify** the appropriate negative control the researchers most likely used when measuring the reaction rate in the presence of each organism's enolase.

(c) The researchers predict that for any particular concentration of substrate, the *C. aurantiacus* enolase-catalyzed reaction is more rapid at 55°C than at 37°C. Provide reasoning to **justify** the researchers' prediction.

Part A

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that a pH below or above this range will most likely cause enolase to denature/change its shape and be less efficient or unable to catalyze the reaction.

Part B

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1 ✓

The response indicates that the appropriate negative control is to measure the reaction rate (at the varying substrate concentrations) without any enzyme present.

Part C

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

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0	1 ✓

The response indicates that the enolase has a more stable/functional/correct/normal protein structure at the higher temperature of 55°C than at 37°C because the enzyme is from an organism that is adapted to growth at 55°C.