Cell Respiration

**** IMPORTANT: These test questions must remain secure. The questions are for projection on to a screen only. Students may not have a hard copy of these questions.

Multiple Choice

Identify the choice that best completes the statement or answers the question.

For the next three quesiton use the information below.

An experiment to measure the rate of respiration in crickets and mice at 10° C and 25° C was performed using a respirometer, an apparatus that measures changes in gas volume. Respiration was measured in mL of 0_2 consumed per gram of organism over several five-minute trials and the following data were obtained.

Organism	Temperature (°C)	Average respiration (mL O ₂ /g/min)		
Mouse	10	0.0518		
Mouse	25	0.0321		
Cricket	10	0.0013		
Cricket	25	0.0038		

1. During aerobic cellular respiration, oxygen gas is consumed at the same rate as carbon dioxide gas is produced. In order o provide accurate volumetric measurements of oxygen gas consumption, the experimental setup should include which of the following?

- a. A substance that removes carbon dioxide c. A glucose reserve gas
- b. A plant to produce oxygen d. A valve to release excess water
- 2.

According to the data, the mice at 10°C demonstrated greater oxygen consumption per gram of tissue than did the mice at 25°C. This is most likely explained by which of the following statements?

- a. The mice at 10°C had a higher rate of ATP
- c. The mice at 25°C weighed less than the mice at 10°C.
- b. The mice at 10°C had a lower metabolic rate than the mice at 25°C.
- d. The mice at 25° C were more active than the mice at 10° C.

- 3. According to the data, the crickets at 25°C have greater oxygen consumption per gram of tissue than do the crickets at 10°C. This trend in oxygen consumption is the opposite of that in the mice. The difference in trends in oxygen consumption among crickets and mice is due to their
 - a. relative size c. mode of internal temperature regulation
 - b. mode of nutrition d. mode of ATP production
- 4. Which of the following statements most directly supports the claim that different species of organisms use different metabolic strategies to meet their energy requirements for growth, reproduction, and homeostasis?
 - a. During cold periods pond-dwelling animals can increase the number of unsaturated fatty acids in their cell membranes while some plants make antifreeze proteins to prevent ice crystal formation in tissues
- c. Carnivores have more teeth that are specialized for ripping food while herbivores have more teeth that are specialized for grinding food.
- Bacteria lack introns while many
eukaryotic genes contain many of these
intervening sequences.d.Plants generally use starch molecules for
storage while animals use glycogen and
fats for storage.

5.

b.

Experimental evidence shows that the process of glycolysis is present and virtually identical in organisms from all three domains, Archaea, Bacteria, and Eukarya. Which of the following hypotheses could be best supported by this evidence?

- a. All organisms carry out glycolysis in mitochondria.
- b. Glycolysis is a universal energy-releasing process and therefore suggests a common ancestor for all forms of life.
- c. Across the three domains, all organisms depend solely on the process of anaerobic respiration for ATP production.
 - d. The presence of glycolysis as an energyreleasing process in all organisms suggests that convergent evolution occurred.



6. The figures below illustrate the similarities between ATP synthesis in mitochondria and chloroplasts.

The figures can best assist in answering which of the following questions?

- a. Do electron transport chains create a gradient so that ATP synthase can generate ATP molecules?
- b. What are the sources of energy that drive mitochondrial and chloroplast electron transport systems?
- c. What is the optimal temperature at which ATP synthase chemically converts ADP and a phosphate group into one molecule of ATP?
- d. What is the evolutionary relationship between the ATP synthase in mitochondria and the ATP synthase in chloroplasts?

- 7. Two nutrient solutions are maintained at the same pH. Actively respiring mitochondria are isolated and placed into each of the two solutions. Oxygen gas is bubbled into one solution. The other solution is depleted of available oxygen. Which of the following best explains why ATP production is greater in the tube with oxygen than in the tube without oxygen?
 - a. The rate of proton pumping across the inner mitochondrial membrane is lower in the sample without oxygen.
 - b. Electron transport is reduced in the absence of a plasma membrane.
 - c. In the absence of oxygen, oxidative phosphorylation produces more ATP than does fermentation.
 - d. In the presence of oxygen, glycolysis produces more ATP than in the absence of oxygen.

Cell Respiration Answer Section

MULTIPLE CHOICE

1. ANS: A

(A) This option is correct. There is no change in gas volume measured by the respirometer unless carbon dioxide is removed, because oxygen is consumed at the same rate that carbon dioxide is produced during cellular respiration.

(B) This option is incorrect because the production of oxygen by plants is by the process of photosynthesis, which is not the focus of this experiment. The focus of this experiment is the consumption of oxygen during aerobic cellular respiration, not the production of oxygen gas during photosynthesis.

(C) This option is incorrect because a glucose reserve would have no effect on the measurement of oxygen gas consumption because the oxidation of glucose via aerobic cellular respiration would still consume oxygen gas at the same rate asarbon dioxide production.

(D) This option is incorrect because the release of excess water would have no effect n the relative volumes of oxygen or carbon dioxide gas. There would not be enough water produced in this experiment to affect gas volume due to differences in solubility.

PTS: 1

DIF: EK 2.A.2: Organisms capture and store free energy for use in biological processes

REF: SP 2.D.1: All biological systems from cells and organisms to populations, communities, and

ecosystems are affected by complex biotic and abiotic interactions involving matter and free energy. OBJ: 6.2: The student can construct explanations of phenomena produced on evidence produced through scienctific practices. TOP: cell respiration | scientific method

2. ANS: A

(A) This option is correct. Mice are endotherms and at cold temperatures will increase their rate of ATP production in order to shiver. This increase in metabolism will produce heat according to the second law of thermodynamics. This heat production will help the mouse maintain a constant internal environment.

(B) This option is incorrect because a lower metabolic rate would mean a lower consumption of oxygen. The data do not support this claim. The mouse consumed more oxygen at IO'C than at 25C.

(C) This option is incorrect because the data for oxygen consumption were controlled for by mass *l* weight. All numbers are mUg.

(D) This option is incorrect because the data do not support this claim. If the mice were more active at the higher temperature, then they would have consumed more oxygen. More activity would require more ATP, which is produced by aerobic cellular respiration in mice.

PTS: 1

DIF: EK 2.A.2: Organisms capture and store free energy for use in biological processes

REF: SP 6.2: The student can construct explanations of phenomena based on evidence produced through scientific practices.

OBJ: 2.5: The student is able to construct explanations of the mechanisms and structural features of cells that allow organisms to capture, store, or use free energy. TOP: cell respiration | scientific method

3. ANS: C

(A) This option is incorrect because the rate of oxygen consumption is due to metabolic rates since oxygen is necessary for ATP production. Though size does affect heat gain and loss due to surface area to volume ratios, this physical trait would have the same effect in both organisms, not the opposite.

(B) This option is incorrect because both crickets and mice are chemoheterotrophs.
(C) This option is correct because crickets are ectotherms. Ectotherms have very low metabolic rates, so they depend on the environment to help regulate their internal temperature. Therefore, crickets would have a higher metabolic rate at the higher temperature due to kinetics or more frequent molecular collisions.
(D) This option is incorrect because both organisms produce ATP via aerobic cellular respiration when oxygen is not a limiting reactant.

PTS: 1 DIF: EK 2.A.1: All living systems require constant input of free energy
REF: SP 2.A.2: Organisms capture and store free energy for use in biological practices.
OBJ: 6.2: The student can construct explanations of phenomena based on evidence produced through scientific practices. TOP: cell respiration | scientific method

4. ANS: D

(A) This option is incorrect despite being a correct statement. These strategies help the different organisms to survive cold periods but are not metabolic strategies for meeting their energy needs.

(B) This option is incorrect because this fact comparing bacterial and eukaryotic genomes and the presence of introns has nothing to do with these organisms meeting their energy needs by varying metabolic strategies.

(C) This option is incorrect. Metabolism is defined as the totality of an organism's chemical reactions. The type of teeth organisms have would not be considered a metabolic strategy but rather a structural strategy.

(D) This option is correct. Starch, glycogen, and fat are all molecules used for energy storage, yet plants have evolved to use starch while animals have evolved to use fat for long-term energy storage and glycogen for short-term energy storage.

PTS: 1 DIF: EK 2.A.1: All living systems require constant input of free energy.

REF: SB 6.1: The student can justify claims with evidence.

OBJ: 2.2: The student is able to justify a scientific claim that free energy is required for living systems to maintain organization, to grow, or to reproduce, but that multiple strategies exist in different living systems.s. LOC: 2012 TOP: cell respiration | biochemistry

5. ANS: B

(A) This option is incorrect. Glycolysis does not occur in the mitochondria. Archaea and Bacteria do not contain mitochondria.

(B) This option is correct Because it demonstrates understanding of the processes of evolution and glycolysis, which is common to Both aerobic and anaerobic respiration.

(C) This option is incorrect. Many organisms rely on aerobic respiration for ATP production.

(D) This option is incorrect. There is no evidence for any other energy-producing process that substitutes for and predates glycolysis.

PTS: 1

DIF: EK 1.B.1: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today

REF: SP 7.2: The student can connect concepts in and across domain(s) to generalize or extrapolate in and/or across enduring understandings and/or big ideas

OBJ: 1.15: The student is able to describe specific examples of conserved core biological processes and features shared by all domains or vvithin one domain oflife, and how these shared, conserved core processes and features support the concept of common ancestry for all organisms.

LOC: 2012 TOP: evolution | cells | cell respiration

6. ANS: A

(A) This option is correct because both diagrams indicate that hydrogen ions are flowing back down their gradient through a channel in the transmembrane protein (ATP synthase) to phosphorylate ADP, forming ATP.(B) This option is incorrect because neither diagram shows the changes of energy to drive the electron transport chain in both processes.

(C) This option is incorrect because neither diagram indicates temperature data needed to pose this scientific question.(D) This option is incorrect because neither diagram indicates data regarding evolutionary relationships needed to pose this scientific question.

PTS:	1	OBJ:	LO 2.4	NAT:	ΕK	2.A.2:	STA:	SP 3.1
LOC:	2012	TOP:	photosynthesis	s cellul	lar re	spiration		

7. ANS: A

This question requires understanding of chemiosmosis and the electron transport chain found in the mitochondrion, and its role in aerobic respiration. The electron transport chain pumps hydrogen ions H^+ or protons across the cristae. The ultimate electron acceptor is oxygen. The increased concentration of H^+ in the outer compartment is the force causing the phosphorylation of ADP resulting in ATP.

b. Electron transport is reduced or stopped if the cristae is destroyed, not the plasma membrane (in eukaryotes).

c. In the absence of oxygen, there is not oxidative phosphorylation.

d. The glycolytic pathway will net two molecules of ATP whether oxygen is present or not.

PTS: 1 OBJ: LO2.4 NAT: EK 2.A.2.g STA: SP 1.4 | SP 3.1