***Campbell's Biology: Concepts and Connections, 7e* (Reece et al.)**
Chapter 6 How Cells Harvest Chemical Energy

6.1 Multiple-Choice Questions

1) Which of the following statements regarding photosynthesis and cellular respiration is *true*?
A) Photosynthesis occurs in chloroplasts, and cellular respiration occurs in mitochondria.
B) Photosynthesis occurs in mitochondria, and cellular respiration occurs in chloroplasts.
C) Photosynthesis occurs in mitochondria and in chloroplasts.
D) Cellular respiration occurs in mitochondria and in chloroplasts.
Answer: A
Topic: 6.1
Skill: Knowledge/Comprehension

2) How do cells capture the energy released by cellular respiration?
A) They produce ATP.
B) They produce glucose.
C) They store it in molecules of carbon dioxide.
D) The energy is coupled to oxygen.
Answer: A
Topic: 6.1
Skill: Knowledge/Comprehension

3) The processes of photosynthesis and cellular respiration are complementary. During these energy conversions, some energy is
A) lost in the form of heat.
B) used to create light.
C) destroyed when the chemical bonds of glucose are made.
D) saved in the chemical bonds of water, CO_2 and O_2.
Answer: A
Topic: 6.1
Skill: Knowledge/Comprehension

4) Respiration _____, and cellular respiration _____.
A) produces ATP . . . is gas exchange
B) is gas exchange . . . produces ATP
C) produces glucose . . . produces oxygen
D) uses glucose . . . produces glucose
Answer: B
Topic: 6.2
Skill: Knowledge/Comprehension

5) Which of the following are products of cellular respiration?
A) oxygen and carbon dioxide
B) energy to make ATP and carbon dioxide
C) oxygen and glucose
D) oxygen and energy to make ATP
Answer: B
Topic: 6.3
Skill: Knowledge/Comprehension

6) Which of the following statements regarding cellular respiration is *false*?
A) Cellular respiration is a single chemical reaction with just one step.
B) Cellular respiration produces water.
C) Cellular respiration produces carbon dioxide.
D) Cellular respiration releases heat.
Answer: A
Topic: 6.3
Skill: Knowledge/Comprehension

7) The overall equation for the cellular respiration of glucose is
A) $C_5H_{12}O_6 + 6\ O_2 \rightarrow 5\ CO_2 + 6\ H_2O$ + energy.
B) $5\ CO_2 + 6\ H_2O \rightarrow C_5H_{12}O_6 + 6\ O_2$ + energy.
C) $C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$ + energy.
D) $C_6H_{12}O_6$ + energy $\rightarrow 6\ CO_2 + 6\ H_2O + 6\ O_2$.
Answer: C
Topic: 6.3
Skill: Knowledge/Comprehension

8) Which of the following statements about the energy yields from cellular respiration is *true*?
A) Cellular respiration is more efficient at harnessing energy from glucose than car engines are at harnessing energy from gasoline.
B) Cellular respiration converts all of the energy in glucose into high-energy ATP bonds.
C) Cellular respiration converts the kinetic energy of glucose into chemical energy.
D) The heat produced during cellular respiration is only a tiny fraction of the chemical energy available in a glucose molecule.
Answer: A
Topic: 6.3
Skill: Knowledge/Comprehension

9) Humans use the calories they obtain from _____ as their source of energy.
A) food
B) water
C) sunlight
D) minerals
Answer: A
Topic: 6.4
Skill: Knowledge/Comprehension

10) Humans use about _____ of their daily calories to maintain brain cells and power other life-sustaining activities.
A) 25%
B) 50%
C) 75%
D) 90%
Answer: C
Topic: 6.4
Skill: Knowledge/Comprehension

11) A kilocalorie is defined as
A) the quantity of glucose needed to increase the body temperature by 1°C.
B) the quantity of heat needed to raise the temperature of 1 kg of water by 1°C.
C) the quantity of food used to maintain normal bodily functions.
D) the quantity of food consumed during a given type of exercise.
Answer: B
Topic: 6.4
Skill: Knowledge/Comprehension

12) The label on the box of breakfast cereal lists one serving as containing "200 Calories" per serving. How many calories are actually in one serving?
A) 20
B) 2,000
C) 200,000
D) 2,000,000
Answer: C
Topic: 6.4
Skill: Application/Analysis

13) During cellular respiration, the energy in glucose
A) becomes stored in molecules of ammonia.
B) is used to manufacture glucose.
C) is released all at once.
D) is carried by electrons.
Answer: D
Topic: 6.5
Skill: Knowledge/Comprehension

14) During redox reactions,
A) the loss of electrons from one substance is called reduction.
B) a substance that gains electrons is said to be oxidized.
C) electrons are lost from one substance and added to another substance.
D) protons from one molecule replace the electrons lost from another molecule.
Answer: C
Topic: 6.5
Skill: Knowledge/Comprehension

15) Oxidation is the _____, and reduction is the _____.
A) gain of electrons . . . loss of electrons
B) loss of electrons . . . gain of electrons
C) gain of oxygen . . . loss of oxygen
D) gain of protons . . . loss of protons
Answer: B
Topic: 6.5
Skill: Knowledge/Comprehension

16) In biological systems, an important enzyme involved in the regulation of redox reactions is
A) glucose.
B) dehydrogenase.
C) oxygen.
D) ATP.
Answer: B
Topic: 6.5
Skill: Knowledge/Comprehension

17) During cellular respiration, NADH
A) is chemically converted into ATP.
B) is reduced to form NAD^+.
C) delivers its electron load to the first electron carrier molecule.
D) is the final electron acceptor.
Answer: C
Topic: 6.5
Skill: Knowledge/Comprehension

18) During cellular respiration, electrons move through a series of electron carrier molecules. Which of the following statements about this process is *true*?
A) The electrons move from carriers that have more affinity for them to carriers that have less affinity for them.
B) Molecular oxygen is eventually oxidized by the electrons to form water.
C) The electrons release large amounts of energy each time they are transferred from one carrier to another.
D) Molecular oxygen is reduced when it accepts electrons and forms water.
Answer: D
Topic: 6.5
Skill: Knowledge/Comprehension

19) The functioning of an electron transport chain is analogous to
A) a Slinky toy going down a flight of stairs.
B) a canoe going over a waterfall.
C) a person climbing a flight of stairs one step at a time.
D) a person leaping from the top to the bottom of a flight of stairs in one jump.
Answer: A
Topic: 6.5
Skill: Application/Analysis

20) Which of the following options lists the stages in cellular respiration in the correct order?
A) glycolysis, the citric acid cycle, and oxidative phosphorylation
B) glycolysis, oxidative phosphorylation, and the citric acid cycle
C) the citric acid cycle, oxidative phosphorylation, and glycolysis
D) oxidative phosphorylation, glycolysis, and the citric acid cycle
Answer: A
Topic: 6.6
Skill: Knowledge/Comprehension

21) A drug is tested in the laboratory and is found to create holes in both mitochondrial membranes. Scientists suspect that the drug will be harmful to human cells because it will inhibit
A) the citric acid cycle.
B) oxidative phosphorylation.
C) glycolysis.
D) the citric acid cycle and oxidative phosphorylation.
Answer: D
Topic: 6.6
Skill: Application/Analysis

22) During which of the following phases of cellular respiration does substrate-level phosphorylation take place?
A) glycolysis
B) the citric acid cycle
C) oxidative phosphorylation
D) glycolysis and the citric acid cycle
Answer: D
Topic: 6.6
Skill: Knowledge/Comprehension

23) Which of the following metabolic pathways is common in aerobic and anaerobic metabolism?
A) the citric acid cycle
B) oxidative phosphorylation
C) glycolysis
D) electron transport chain
Answer: C
Topic: 6.7
Skill: Knowledge/Comprehension

24) As a result of glycolysis there is a net gain of _____ ATPs.
A) 0
B) 1
C) 2
D) 36
Answer: C
Topic: 6.7
Skill: Knowledge/Comprehension

25) How many molecules of NADH are produced during glycolysis?
A) 2
B) 4
C) 6
D) 8
Answer: A
Topic: 6.7
Skill: Knowledge/Comprehension

26) Which of the following is a result of glycolysis?
A) production of CO_2
B) conversion of glucose to two three-carbon compounds
C) a net loss of two ATPs per glucose molecule
D) conversion of NADH to NAD^+
Answer: B
Topic: 6.7
Skill: Knowledge/Comprehension

27) A culture of bacteria growing aerobically is fed glucose containing radioactive carbon and is then examined. As the bacteria metabolize the glucose, radioactivity will appear first in
A) carbon dioxide.
B) glucose-6-phosphate.
C) pyruvate.
D) ATP.
Answer: B
Topic: 6.7
Skill: Application/Analysis

28) The end products of glycolysis include
A) NADH.
B) acetyl CoA.
C) citric acid.
D) O_2.
Answer: A
Topic: 6.7
Skill: Knowledge/Comprehension

29) Pyruvate
A) forms at the end of glycolysis.
B) is the molecule that starts the citric acid cycle.
C) is the end product of oxidative phosphorylation.
D) is a six-carbon molecule.
Answer: A
Topic: 6.8
Skill: Knowledge/Comprehension

30) After glycolysis but before the citric acid cycle,
A) pyruvate is oxidized.
B) a carbon atom is added to pyruvate to make a four-carbon compound.
C) coenzyme A is cleaved off pyruvate.
D) glucose is split, producing two molecules of pyruvate.
Answer: A
Topic: 6.8
Skill: Knowledge/Comprehension

31) Which of the following statements regarding the chemical grooming of pyruvate is *false*?
A) Two molecules of pyruvate are each converted into two-carbon molecules joined to a coenzyme A molecule.
B) Each pyruvate loses a carbon atom, which is released as CO_2.
C) Two pyruvate molecules together contain less chemical energy than was found in the original glucose molecule.
D) Each pyruvate molecule has a CO_2 added and then joins with an NADH.
Answer: D
Topic: 6.8
Skill: Knowledge/Comprehension

32) The enzymes of the citric acid cycle are located in the
A) cytoplasm.
B) outer mitochondrial membrane.
C) nucleus.
D) matrix and inner mitochondrial membrane.
Answer: D
Topic: 6.9
Skill: Knowledge/Comprehension

33) The end products of the citric acid cycle include all of the following *except*
A) CO_2.
B) pyruvate.
C) ATP.
D) $FADH_2$.
Answer: B
Topic: 6.9
Skill: Knowledge/Comprehension

34) The function of coenzyme A in the citric acid cycle is most like
A) a limousine driver dropping off a couple at the school prom.
B) a frog that turns into a prince.
C) a kid jumping up and down on a trampoline.
D) throwing a baited hook into a lake and catching a fish.
Answer: A
Topic: 6.9
Skill: Application/Analysis

35) A culture of bacteria growing aerobically is fed glucose containing radioactive carbon and is then examined. During the citric acid cycle, radioactivity would first appear in
A) NADH.
B) citrate.
C) oxaloacetic acid.
D) CoA.
Answer: B
Topic: 6.9
Skill: Application/Analysis

36) At the end of the citric acid cycle, most of the energy remaining from the original glucose is stored in
A) CO_2.
B) pyruvate.
C) ATP.
D) NADH.
Answer: D
Topic: 6.9
Skill: Knowledge/Comprehension

37) During chemiosmosis,
A) energy is released as H^+ ions move freely across mitochondrial membranes.
B) ATP is synthesized when H^+ ions move through a channel in ATP synthase.
C) a concentration gradient is generated when large numbers of H^+ ions are passively transported from the matrix of the mitochondrion to the mitochondrion's intermembrane space.
D) H^+ ions serve as the final electron acceptor.
Answer: B
Topic: 6.10
Skill: Knowledge/Comprehension

38) Which of the following statements about the inner mitochondrial membrane is *false*?
A) ATP synthase is found in the inner mitochondrial membrane.
B) The inner mitochondrial membrane plays a role in the production of pyruvate.
C) Electron carriers are found in the inner mitochondrial membrane.
D) A gradient of H^+ exists across the inner mitochondrial membrane.
Answer: B
Topic: 6.10
Skill: Knowledge/Comprehension

39) The mitochondrial cristae are an adaptation that
A) permits the expansion of mitochondria as oxygen accumulates in the mitochondrial matrix.
B) helps mitochondria divide during times of greatest cellular respiration.
C) increases the space for more copies of the electron transport chain and ATP synthase complexes.
D) carefully encloses the DNA housed within the mitochondrial matrix.
Answer: C
Topic: 6.10
Skill: Knowledge/Comprehension

40) A mutant protist is found in which some mitochondria lack an inner mitochondrial membrane. Which of the following pathways would be completely disrupted in these mitochondria?
A) oxidative phosphorylation
B) alcoholic fermentation
C) glycolysis
D) biosynthesis
Answer: A
Topic: 6.10
Skill: Application/Analysis

41) If you were able to stop the process of cellular respiration after completing electron transport but prior to chemiosmosis, you would find the pH of a mitochondrion to be at its lowest
A) on the outer membrane.
B) on the inner membrane.
C) in the mitochondrial matrix.
D) in the intermembrane space.
Answer: D
Topic: 6.10
Skill: Application/Analysis

42) By-products of cellular respiration include
A) oxygen and heat.
B) carbon dioxide and water.
C) $FADH_2$ and NADH.
D) NADH and ATP.
Answer: B
Topic: 6.10
Skill: Knowledge/Comprehension

43) In the electron transport chain, the final electron acceptor is
A) an oxygen atom.
B) a molecule of carbon dioxide.
C) a molecule of water.
D) ADP.
Answer: A
Topic: 6.10
Skill: Knowledge/Comprehension

44) Rotenone is a poison commonly added to insecticides. Insects exposed to rotenone will die because
A) they will no longer be able to perform anaerobic respiration.
B) high levels of fermentation products will build up in their bodies.
C) they will no longer be able to produce adequate amounts of ATP.
D) they will no longer be able to absorb water and will become dehydrated.
Answer: C
Topic: 6.11
Skill: Application/Analysis

45) Cyanide differs from dinitrophenol in that
A) cyanide is highly toxic to human cells, while dinitrophenol is nontoxic.
B) cyanide is an electron transport blocker, while dinitrophenol makes the membrane of the mitochondrion leaky to H^+ ions.
C) cyanide makes the membrane of mitochondria leaky to H^+ ions and prevents a concentration gradient from building up, while dinitrophenol blocks the passage of electrons through electron carriers.
D) cyanide inhibits the production of ATP by inhibiting ATP synthase, while dinitrophenol causes mitochondrial membranes to become less permeable to H^+ ions.
Answer: B
Topic: 6.11
Skill: Knowledge/Comprehension

46) Which of the following statements about the energy yield of aerobic respiration is *false*?
A) Less than 50% of the chemical energy available in glucose is converted to ATP energy.
B) Most of the ATP derived during aerobic respiration results from oxidative phosphorylation.
C) Oxidative phosphorylation resulting from 1 glucose molecule yields about 12 ATP molecules.
D) The total yield of ATP molecules per glucose molecule is about 32.
Answer: C
Topic: 6.12
Skill: Knowledge/Comprehension

47) The energy yield from the complete aerobic breakdown of a single molecule of glucose
A) is always 32 ATP.
B) increases as the supply of oxygen increases.
C) can vary depending on whether NADH passes its electrons to NAD^+ or FAD.
D) is less than the yield from anaerobic respiration.
Answer: C
Topic: 6.12
Skill: Knowledge/Comprehension

48) Which of the following processes produces the most ATP per molecule of glucose oxidized?
A) aerobic respiration
B) alcoholic fermentation
C) lactic acid fermentation
D) All produce approximately the same amount of ATP per molecule of glucose.
Answer: A
Topic: 6.13
Skill: Knowledge/Comprehension

49) In fermentation, _____ is _____.
A) NADH . . . reduced
B) NAD^+ . . . oxidized
C) NADH . . . oxidized
D) ethanol . . . oxidized
Answer: C
Topic: 6.13
Skill: Knowledge/Comprehension

50) When an organism such as a yeast lives by fermentation, it converts the pyruvate from glycolysis into a different compound, such as alcohol. Why doesn't it secrete the pyruvate directly?
A) The conversion yields 32 ATP per pyruvate molecule.
B) The conversion yields one NADH per pyruvate molecule.
C) The conversion is needed to regenerate the molecules needed for glycolysis.
D) A buildup of pyruvate in the surrounding environment would be too toxic.
Answer: C
Topic: 6.13
Skill: Knowledge/Comprehension

51) A child is born with a rare disease in which mitochondria are missing from skeletal muscle cells. However, the muscles still function. Physicians find that
A) the muscles contain large amounts of lactate following even mild physical exercise.
B) the muscles contain large amounts of carbon dioxide following even mild physical exercise.
C) the muscles require extremely high levels of oxygen to function.
D) the muscle cells cannot split glucose to pyruvate.
Answer: A
Topic: 6.13
Skill: Application/Analysis

52) Some friends are trying to make wine in their basement. They've added yeast to a sweet grape juice mixture and have allowed the yeast to grow. After several days they find that sugar levels in the grape juice have dropped, but there's no alcohol in the mixture. The most likely explanation is that
A) the mixture needs more sugar, because yeast need a lot of energy before they can begin to produce alcohol.
B) the mixture needs less oxygen, because yeast only produce alcohol in the absence of oxygen.
C) the mixture needs more oxygen, because yeast need oxygen to break down sugar and get enough energy to produce alcohol.
D) the yeast used the alcohol as a carbon source.
Answer: B
Topic: 6.13
Skill: Application/Analysis

53) In yeast cells,
A) lactic acid is produced during anaerobic respiration.
B) lactic acid is produced during glycolysis.
C) alcohol is produced during the citric acid cycle.
D) alcohol is produced after glycolysis.
Answer: D
Topic: 6.13
Skill: Knowledge/Comprehension

54) Bacteria that are unable to survive in the presence of oxygen are called
A) obligate anaerobes.
B) obligate aerobes.
C) facultative anaerobes.
D) aerotolerant anaerobes.
Answer: A
Topic: 6.13
Skill: Knowledge/Comprehension

55) Yeasts can produce ATP by either fermentation or oxidative phosphorylation; thus, they are
A) strict anaerobes.
B) strict aerobes.
C) facultative anaerobes.
D) facultative aerobes.
Answer: C
Topic: 6.13
Skill: Knowledge/Comprehension

56) When did the level of oxygen in Earth's atmosphere become high enough to sustain aerobic respiration?
A) 1.0 billion years ago
B) 1.5 billion years ago
C) 2.7 billion years ago
D) 3.5 billion years ago
Answer: C
Topic: 6.14
Skill: Knowledge/Comprehension

57) Which of the following statements regarding glycolysis is *false*?
A) Glycolysis is considered to be an ancient metabolic process because it does not require oxygen.
B) Glycolysis is considered to be an ancient metabolic process because it is not located in a membrane-bound organelle.
C) Glycolysis is considered to be an ancient metabolic system because it occurs universally.
D) Glycolysis is considered to be an ancient metabolic system because it is the most efficient metabolic pathway for ATP synthesis.
Answer: D
Topic: 6.14
Skill: Knowledge/Comprehension

58) To obtain energy from starch and glycogen, the body must begin by
A) hydrolyzing the starch to glucose and the glycogen to amino acids.
B) hydrolyzing both starch and glycogen to glucose.
C) converting both starch and glycogen to fatty acids.
D) removing one glucose at a time with a condensation reaction.
Answer: B
Topic: 6.15
Skill: Knowledge/Comprehension

59) When proteins are used as a source of energy for the body, the proteins
A) are converted into glucose molecules, which are fed into glycolysis.
B) are converted mainly into intermediates of glycolysis or the citric acid cycle.
C) are hydrolyzed to their constituent amino acids; electrons are stripped from the amino acids and passed to the electron transport chain.
D) are hydrolyzed to glucose and converted to acetyl CoA, which enters the citric acid cycle.
Answer: B
Topic: 6.15
Skill: Knowledge/Comprehension

60) When a cell uses fatty acid for aerobic respiration, it first hydrolyzes fats to
A) glycerol and amino acids.
B) glycerol and fatty acids.
C) fatty acids and sugars.
D) sugars and glycerol.
Answer: B
Topic: 6.15
Skill: Knowledge/Comprehension

61) If you consume 1 g of each of the following, which will yield the most ATP?
A) fat
B) glucose
C) protein
D) starch
Answer: A
Topic: 6.15
Skill: Knowledge/Comprehension

62) Which of the following statements regarding food is *false*?
A) Food provides the raw materials for biosynthetic pathways that make molecules for cellular repair and growth.
B) Food provides the raw materials for biosynthetic pathways that can produce molecules that are not actually present in the original food.
C) Food provides the raw materials for biosynthetic pathways that can produce sugar by a process that is the exact opposite of glycolysis.
D) Food provides the raw materials for biosynthetic pathways that consume ATP.
Answer: C
Topic: 6.16
Skill: Knowledge/Comprehension

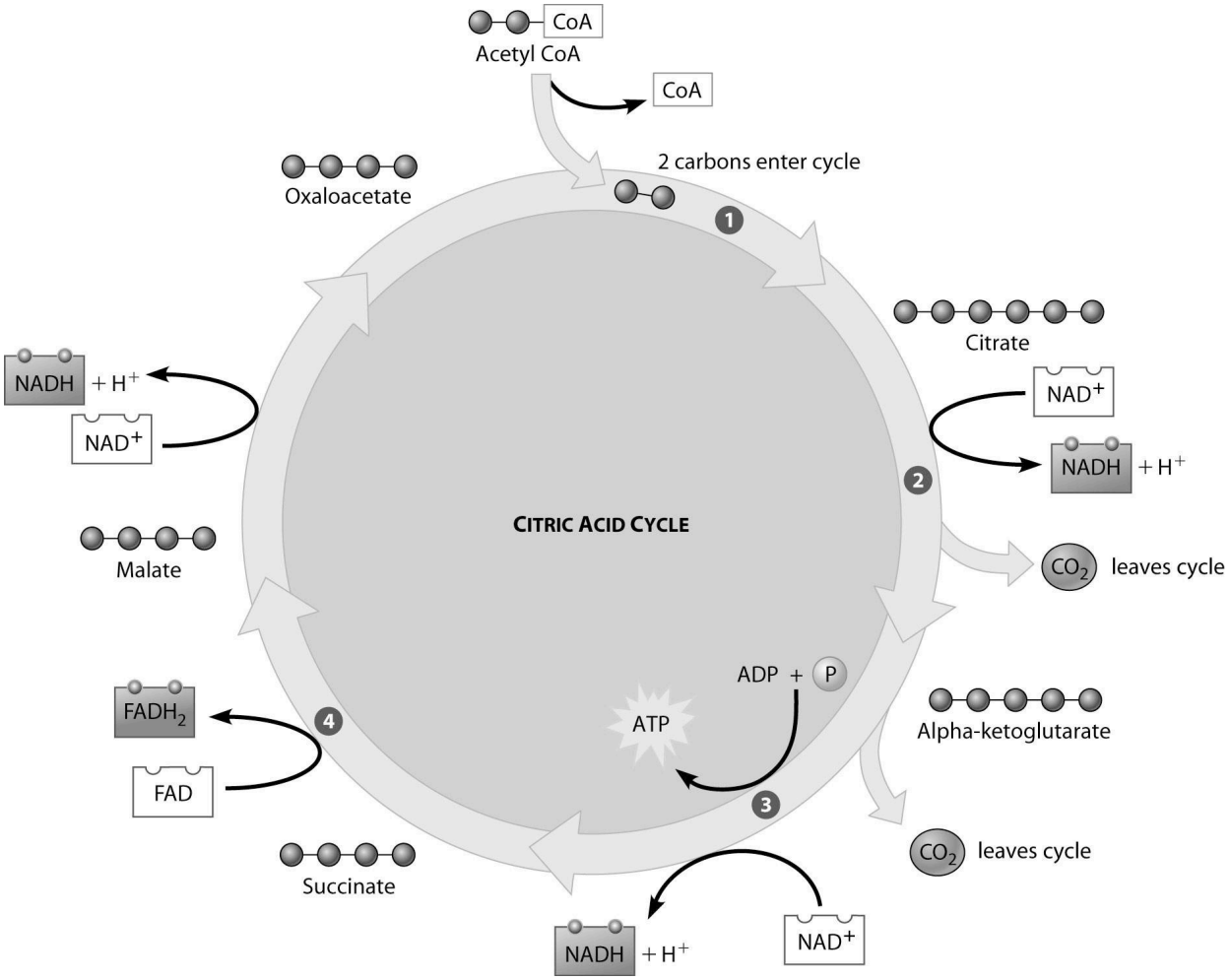
63) Which of the following organisms can make organic molecules from water and carbon dioxide?
A) bear
B) mushroom
C) wheat
D) crayfish
Answer: C
Topic: 6.16
Skill: Application/Analysis

64) The conversion of CO_2 and H_2O into organic compounds using energy from light is called
A) glycolysis.
B) photosynthesis.
C) fermentation.
D) cellular respiration.
Answer: B
Topic: 6.16
Skill: Knowledge/Comprehension

65) If ATP accumulates in a cell
A) the cell receives a signal that there is a need for more energy.
B) feedback inhibition speeds up cellular respiration.
C) feedback inhibition slows down cellular respiration.
D) the rate of cellular respiration does not change.
Answer: C
Topic: 6.16
Skill: Knowledge/Comprehension

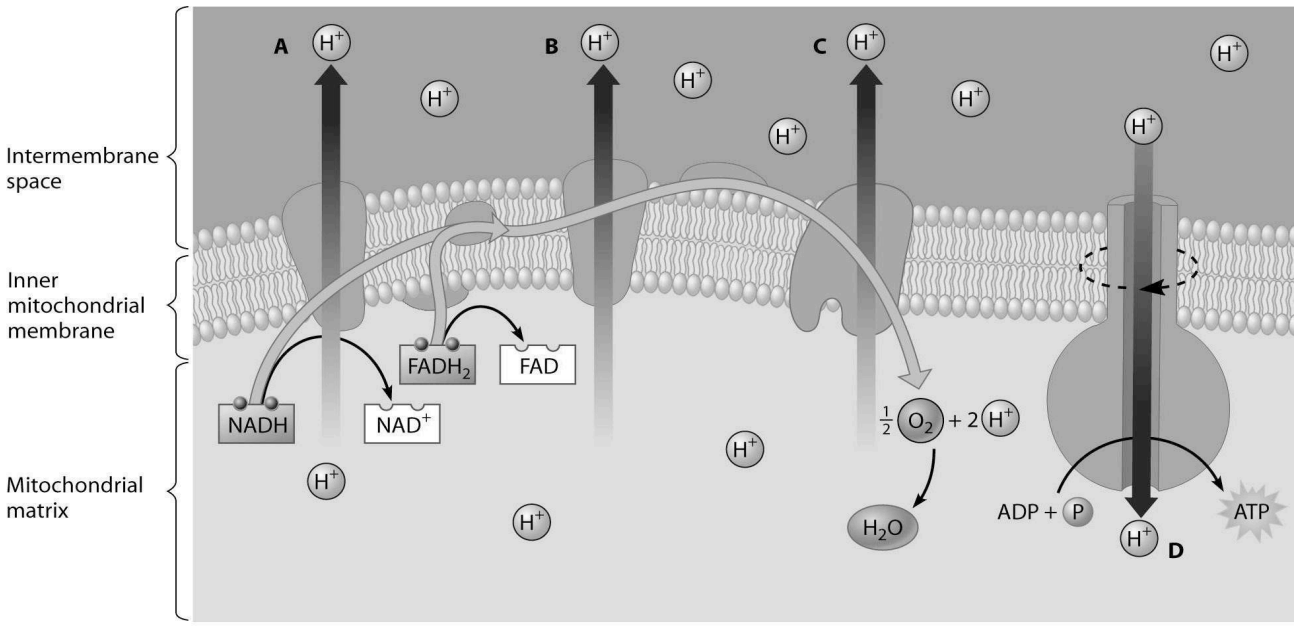
6.2 Art Questions

1) Which step of the citric acid cycle requires both NAD^+ and ADP as reactants?



A) step 1
B) step 2
C) step 3
D) step 4
Answer: C
Topic: 6.9
Skill: Application/Analysis

2) Which H^+ ion has just passed through the inner mitochondrial membrane by diffusion?



A) hydrogen ion A
B) hydrogen ion B
C) hydrogen ion C
D) hydrogen ion D
Answer: D
Topic: 6.10
Skill: Application/Analysis

6.3 Scenario Questions

After reading the paragraph, answer the question(s) that follow.

As a scientist employed by the FDA, you've been asked to sit on a panel to evaluate a pharmaceutical company's application for approval of a new weight loss drug called Fat Away. The company has submitted a report summarizing the results of their animal and human testing. In the report, it was noted that Fat Away works by affecting the electron transport chain. It decreases the synthesis of ATP by making the mitochondrial membrane permeable to H^+, which allows H^+ to leak from the intermembrane space to the mitochondrial matrix. This effect leads to weight loss.

1) The method of weight loss described for Fat Away shows that the drug is acting as a metabolic
A) feedback inhibitor.
B) oxygen carrier.
C) redox promoter.
D) uncoupler.
Answer: D
Topic: 6.11
Skill: Application/Analysis

2) Fat Away prevents ATP from being made by
A) destroying the H^+ gradient that allows ATP synthase to work.
B) preventing glycolysis from occurring.
C) preventing the conversion of NADH to NAD^+.
D) slowing down the citric acid cycle.
Answer: A
Topic: 6.10, 6.11
Skill: Application/Analysis