Name: _____ Class: _____ Date: _____ ID: A

AP Biology Cellular Respiration Test(Collaborative)

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

____ 1. What is the term for metabolic pathways that release stored energy by breaking down complex molecules?
a. anabolic pathways
b. catabolic pathways
c. fermentation pathways
d. thermodynamic pathways
e. bioenergetic pathways

____ 2. The molecule that functions as the reducing agent (electron donor) in a redox or oxidation-reduction reaction
a. gains electrons and gains potential energy.
b. loses electrons and loses potential energy.
c. gains electrons and loses potential energy.
d. loses electrons and gains potential energy.
e. neither gains nor loses electrons, but gains or loses potential energy.

____ 3. When electrons move closer to a more electronegative atom, what happens?
a. The more electronegative atom is reduced, and energy is released.
b. The more electronegative atom is reduced, and energy is consumed.
c. The more electronegative atom is oxidized, and energy is consumed.
d. The more electronegative atom is oxidized, and energy is released.
e. The more electronegative atom is reduced, and entropy decreases.

____ 4. Why does the oxidation of organic compounds by molecular oxygen to produce CO_2 and water release free energy?
a. The covalent bonds in organic molecules and molecular oxygen have more kinetic energy than the covalent bonds in water and carbon dioxide.
b. Electrons are being moved from atoms that have a lower affinity for electrons (such as C) to atoms with a higher affinity for electrons (such as O).
c. The oxidation of organic compounds can be used to make ATP.
d. The electrons have a higher potential energy when associated with water and CO_2 than they do in organic compounds.
e. The covalent bond in O_2 is unstable and easily broken by electrons from organic molecules.

____ 5. When a glucose molecule loses a hydrogen atom as the result of an oxidation-reduction reaction, the molecule becomes
a. hydrolyzed.
b. hydrogenated.
c. oxidized.
d. reduced.
e. an oxidizing agent.

____ 6. When a molecule of NAD^+ (nicotinamide adenine dinucleotide) gains a hydrogen atom (not a proton), the molecule becomes
a. dehydrogenated.
b. oxidized.
c. reduced.
d. redoxed.
e. hydrolyzed.

____ 7. Which of the following statements describes NAD^+?
a. NAD^+ is reduced to NADH during glycolysis, pyruvate oxidation, and the citric acid cycle.
b. NAD^+ has more chemical energy than NADH.
c. NAD^+ is oxidized by the action of hydrogenases.
d. NAD^+ can donate electrons for use in oxidative phosphorylation.
e. In the absence of NAD^+, glycolysis can still function.

____ 8. Where does glycolysis take place in eukaryotic cells?
a. mitochondrial matrix
b. mitochondrial outer membrane
c. mitochondrial inner membrane
d. mitochondrial intermembrane space
e. cytosol

____ 9. The ATP made during glycolysis is generated by
a. substrate-level phosphorylation.
b. electron transport.
c. photophosphorylation.
d. chemiosmosis.
e. oxidation of NADH to NAD^+.

____ 10. The oxygen consumed during cellular respiration is involved directly in which process or event?
a. glycolysis
b. accepting electrons at the end of the electron transport chain
c. the citric acid cycle
d. the oxidation of pyruvate to acetyl CoA
e. the phosphorylation of ADP to form ATP

____ 11. An electron loses potential energy when it
a. shifts to a less electronegative atom.
b. shifts to a more electronegative atom.
c. increases its kinetic energy.
d. increases its activity as an oxidizing agent.
e. moves further away from the nucleus of the atom.

____ 12. Why are carbohydrates and fats considered high-energy foods?
a. They have a lot of oxygen atoms.
b. They have no nitrogen in their makeup.
c. They can have very long carbon skeletons.
d. They have a lot of electrons associated with hydrogen.
e. They are easily reduced.

____ 13. During aerobic respiration, electrons travel downhill in which sequence?
a. food → citric acid cycle → ATP → NAD^+
b. food → NADH → electron transport chain → oxygen
c. glucose → pyruvate → ATP → oxygen
d. glucose → ATP → electron transport chain → NADH
e. food → glycolysis → citric acid cycle → NADH → ATP

____ 14. In prokaryotes, the respiratory electron transport chain is located
a. in the mitochondrial inner membrane.
b. in the mitochondrial outer membrane.
c. in the plasma membrane.
d. in the cytoplasm.
e. in the bacterial outer membrane.

____ 15. Which process in eukaryotic cells will proceed normally whether oxygen (O_2) is present or absent?
a. electron transport
b. glycolysis
c. the citric acid cycle
d. oxidative phosphorylation
e. chemiosmosis

____ 16. Substrate-level phosphorylation accounts for approximately what percentage of the ATP formed by the reactions of glycolysis?
a. 0%
b. 2%
c. 10%
d. 38%
e. 100%

____ 17. In addition to ATP, what are the end products of glycolysis?
a. CO_2 and H_2O
b. CO_2 and pyruvate
c. NADH and pyruvate
d. CO_2 and NADH
e. H_2O, $FADH_2$, and citrate

____ 18. The free energy for the oxidation of glucose to CO_2 and water is -686 kcal/mol and the free energy for the reduction of NAD^+ to NADH is +53 kcal/mol. Why are only two molecules of NADH formed during glycolysis when it appears that as many as a dozen could be formed?
a. Most of the free energy available from the oxidation of glucose is used in the production of ATP in glycolysis.
b. Glycolysis is a very inefficient reaction, with much of the energy of glucose released as heat.
c. Most of the free energy available from the oxidation of glucose remains in pyruvate, one of the products of glycolysis.
d. There is no CO_2 or water produced as products of glycolysis.
e. Glycolysis consists of many enzymatic reactions, each of which extracts some energy from the glucose molecule.

____ 19. Starting with one molecule of glucose, the energy-containing products of glycolysis are
a. 2 NAD^+, 2 pyruvate, and 2 ATP.
b. 2 NADH, 2 pyruvate, and 2 ATP.
c. 2 $FADH_2$, 2 pyruvate, and 4 ATP.
d. 6 CO_2, 2 pyruvate, and 2 ATP.
e. 6 CO_2, 2 pyruvate, and 30 ATP.

____ 20. In glycolysis, for each molecule of glucose oxidized to pyruvate
a. two molecules of ATP are used and two molecules of ATP are produced.
b. two molecules of ATP are used and four molecules of ATP are produced.
c. four molecules of ATP are used and two molecules of ATP are produced.
d. two molecules of ATP are used and six molecules of ATP are produced.
e. six molecules of ATP are used and six molecules of ATP are produced.

____ 21. Carbon dioxide (CO_2) is released during which of the following stages of cellular respiration?
a. glycolysis and the oxidation of pyruvate to acetyl CoA
b. oxidation of pyruvate to acetyl CoA and the citric acid cycle
c. the citric acid cycle and oxidative phosphorylation
d. oxidative phosphorylation and fermentation
e. fermentation and glycolysis

____ 22. Where are the proteins of the electron transport chain located?
a. cytosol
b. mitochondrial outer membrane
c. mitochondrial inner membrane
d. mitochondrial intermembrane space
e. mitochondrial matrix

____ 23. In cellular respiration, the energy for most ATP synthesis is supplied by
a. high-energy phosphate bonds in organic molecules.
b. a proton gradient across a membrane.
c. converting oxygen to ATP.
d. transferring electrons from organic molecules to pyruvate.
e. generating carbon dioxide and oxygen in the electron transport chain.

____ 24. The primary role of oxygen in cellular respiration is to
a. yield energy in the form of ATP as it is passed down the respiratory chain.
b. act as an acceptor for electrons and hydrogen, forming water.
c. combine with carbon, forming CO_2.
d. combine with lactate, forming pyruvate.
e. catalyze the reactions of glycolysis.

____ 25. Inside an active mitochondrion, most electrons follow which pathway?
a. glycolysis → NADH → oxidative phosphorylation → ATP → oxygen
b. citric acid cycle → $FADH_2$ → electron transport chain → ATP
c. electron transport chain → citric acid cycle → ATP → oxygen
d. pyruvate → citric acid cycle → ATP → NADH → oxygen
e. citric acid cycle → NADH → electron transport chain → oxygen

____ 26. During aerobic respiration, H_2O is formed. Where does the oxygen atom for the formation of the water come from?
a. carbon dioxide (CO_2)
b. glucose ($C_6H_{12}O_6$)
c. molecular oxygen (O_2)
d. pyruvate ($C_3H_3O_3^-$)
e. lactate ($C_3H_5O_3^-$)

____ 27. In chemiosmosis, what is the most direct source of energy that is used to convert ADP + $\textcircled{P}_i$ to ATP?
a. energy released as electrons flow through the electron transport system
b. energy released from substrate-level phosphorylation
c. energy released from dehydration synthesis reactions
d. energy released from movement of protons through ATP synthase, down their electrochemical gradient
e. No external source of energy is required because the reaction is exergonic.

____ 28. Energy released by the electron transport chain is used to pump H^+ into which location in eukaryotic cells?
a. cytosol
b. mitochondrial outer membrane
c. mitochondrial inner membrane
d. mitochondrial intermembrane space
e. mitochondrial matrix

____ 29. The direct energy source that drives ATP synthesis during respiratory oxidative phosphorylation in eukaryotic cells is
a. oxidation of glucose to CO_2 and water.
b. the thermodynamically favorable flow of electrons from NADH to the mitochondrial electron transport carriers.
c. the final transfer of electrons to oxygen.
d. the proton-motive force across the inner mitochondrial membrane.
e. the thermodynamically favorable transfer of phosphate from glycolysis and the citric acid cycle intermediate molecules of ADP.

____ 30. When hydrogen ions are pumped from the mitochondrial matrix across the inner membrane and into the intermembrane space, the result is
a. the formation of ATP.
b. the reduction of NAD^+.
c. the restoration of the Na^+/K^+ balance across the membrane.
d. the creation of a proton-motive force.
e. the lowering of pH in the mitochondrial matrix.

____ 31. Where is ATP synthase located in the mitochondrion?
a. cytosol
b. electron transport chain
c. outer membrane
d. inner membrane
e. mitochondrial matrix

____ 32. Which of the following produces the most ATP when glucose ($C_6H_{12}O_6$) is completely oxidized to carbon dioxide (CO_2) and water?
a. glycolysis
b. fermentation
c. oxidation of pyruvate to acetyl CoA
d. citric acid cycle
e. oxidative phosphorylation (chemiosmosis)

____ 33. Approximately how many molecules of ATP are produced from the complete oxidation of two molecules of glucose ($C_6H_{12}O_6$) in aerobic cellular respiration?
a. 2
b. 4
c. 15
d. 30-32
e. 60-64

____ 34. The synthesis of ATP by oxidative phosphorylation, using the energy released by movement of protons across the membrane down their electrochemical gradient, is an example of
a. active transport.
b. an endergonic reaction coupled to an exergonic reaction.
c. a reaction with a positive ΔG .
d. osmosis.
e. allosteric regulation.

____ 35. In liver cells, the inner mitochondrial membranes are about five times the area of the outer mitochondrial membranes. What purpose must this serve?
a. It allows for an increased rate of glycolysis.
b. It allows for an increased rate of the citric acid cycle.
c. It increases the surface for oxidative phosphorylation.
d. It increases the surface for substrate-level phosphorylation.
e. It allows the liver cell to have fewer mitochondria.

____ 36. Chemiosmotic ATP synthesis (oxidative phosphorylation) occurs in
a. all cells, but only in the presence of oxygen.
b. only eukaryotic cells, in the presence of oxygen.
c. only in mitochondria, using either oxygen or other electron acceptors.
d. all respiring cells, both prokaryotic and eukaryotic, using either oxygen or other electron acceptors.
e. all cells, in the absence of respiration.

____ 37. In vertebrate animals, brown fat tissue's color is due to abundant blood vessels and capillaries. White fat tissue, on the other hand, is specialized for fat storage and contains relatively few blood vessels or capillaries. Brown fat cells have a specialized protein that dissipates the proton-motive force across the mitochondrial membranes. Which of the following might be the function of the brown fat tissue?
a. to increase the rate of oxidative phosphorylation from its few mitochondria
b. to allow the animals to regulate their metabolic rate when it is especially hot
c. to increase the production of ATP
d. to allow other membranes of the cell to perform mitochondrial functions
e. to regulate temperature by converting most of the energy from NADH oxidation to heat

____ 38. What carbon sources can yeast cells metabolize to make ATP from ADP under anaerobic conditions?
a. glucose
b. ethanol
c. pyruvate
d. lactic acid
e. either ethanol or lactic acid

____ 39. Which of the following normally occurs regardless of whether or not oxygen (O_2) is present?
a. glycolysis
b. fermentation
c. oxidation of pyruvate to acetyl CoA
d. citric acid cycle
e. oxidative phosphorylation (chemiosmosis)

____ 40. Which of the following occur(s) in the cytosol of a eukaryotic cell?
a. glycolysis and fermentation
b. fermentation and chemiosmosis
c. oxidation of pyruvate to acetyl CoA
d. citric acid cycle
e. oxidative phosphorylation

____ 41. Which metabolic pathway is common to both cellular respiration and fermentation?
a. the oxidation of pyruvate to acetyl CoA
b. the citric acid cycle
c. oxidative phosphorylation
d. glycolysis
e. chemiosmosis

____ 42. The ATP made during fermentation is generated by which of the following?
a. the electron transport chain
b. substrate-level phosphorylation
c. chemiosmosis
d. oxidative phosphorylation
e. aerobic respiration

____ 43. In the absence of oxygen, yeast cells can obtain energy by fermentation, resulting in the production of
a. ATP, CO_2, and ethanol (ethyl alcohol).
b. ATP, CO_2, and lactate.
c. ATP, NADH, and pyruvate.
d. ATP, pyruvate, and oxygen.
e. ATP, pyruvate, and acetyl CoA.

____ 44. An organism is discovered that thrives both in the presence and absence of oxygen in the air. Curiously, the consumption of sugar increases as oxygen is removed from the organism's environment, even though the organism does not gain much weight. This organism
a. must use a molecule other than oxygen to accept electrons from the electron transport chain.
b. is a normal eukaryotic organism.
c. is photosynthetic.
d. is an anaerobic organism.
e. is a facultative anaerobe.

____ 45. Which statement best supports the hypothesis that glycolysis is an ancient metabolic pathway that originated before the last universal common ancestor of life on Earth?
a. Glycolysis is widespread and is found in the domains Bacteria, Archaea, and Eukarya.
b. Glycolysis neither uses nor needs O_2.
c. Glycolysis is found in all eukaryotic cells.
d. The enzymes of glycolysis are found in the cytosol rather than in a membrane-enclosed organelle.
e. Ancient prokaryotic cells, the most primitive of cells, made extensive use of glycolysis long before oxygen was present in Earth's atmosphere.

____ 46. Why is glycolysis considered to be one of the first metabolic pathways to have evolved?
a. It produces much less ATP than does oxidative phosphorylation.
b. It does not involve organelles or specialized structures, does not require oxygen, and is present in most organisms.
c. It is found in prokaryotic cells but not in eukaryotic cells.
d. It relies on chemiosmosis, which is a metabolic mechanism present only in the first cells' prokaryotic cells.
e. It requires the presence of membrane-enclosed cell organelles found only in eukaryotic cells.

____ 47. When an individual is exercising heavily and when the muscle becomes oxygen-deprived, muscle cells convert pyruvate to lactate. What happens to the lactate in skeletal muscle cells?
a. It is converted to NAD^+.
b. It produces CO_2 and water.
c. It is taken to the liver and converted back to pyruvate.
d. It reduces $FADH_2$ to FAD^+.
e. It is converted to alcohol.

____ 48. What is the purpose of beta oxidation in respiration?
a. oxidation of glucose
b. oxidation of pyruvate
c. feedback regulation
d. control of ATP accumulation
e. breakdown of fatty acids

____ 49. Where do the catabolic products of fatty acid breakdown enter into the citric acid cycle?
a. pyruvate
b. malate or fumarate
c. acetyl CoA
d. α-ketoglutarate
e. succinyl CoA

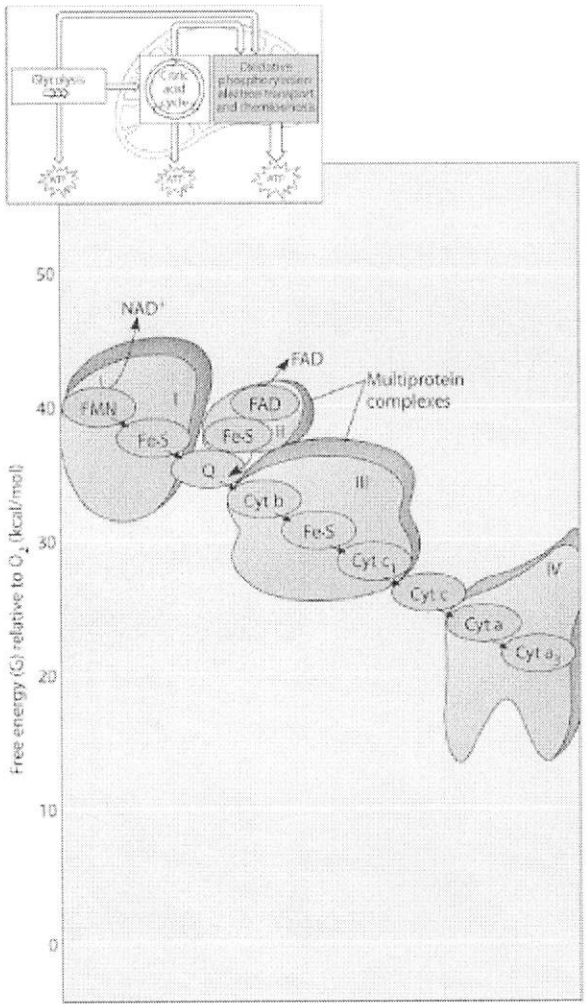

Figure 7.2

____ 50. Figure 7.2 shows the electron transport chain. Which of the following is the combination of substances that is initially added to the chain?
a. oxygen, carbon dioxide, and water
b. NAD^+, FAD, and electrons
c. NADH, $FADH_2$, and protons
d. NADH, $FADH_2$, and O_2
e. oxygen and protons

____ 51. Which of the protein complexes labeled with Roman numerals in Figure 7.2 will transfer electrons to O_2?
a. complex I
b. complex II
c. complex III
d. complex IV
e. All of the complexes can transfer electrons to O_2.

In the presence of oxygen, the three-carbon compound pyruvate can be catabolized in the citric acid cycle. First, however, the pyruvate (1) loses a carbon, which is given off as a molecule of CO_2, (2) is oxidized to form a two-carbon compound called acetate, and (3) is bonded to coenzyme A.

____ 52. These three steps result in the formation of
a. acetyl CoA, O_2, and ATP.
b. acetyl CoA, $FADH_2$, and CO_2.
c. acetyl CoA, FAD, H_2, and CO_2.
d. acetyl CoA, NADH, H^+, and CO_2.
e. acetyl CoA, NAD^+, ATP, and CO_2.

____ 53. Which one of the following is formed by the removal of a carbon (as CO_2) from a molecule of pyruvate?
a. lactate
b. glyceraldehyde-3-phosphate
c. oxaloacetate
d. acetyl CoA
e. citrate