

Sample Questions Chapters 9-10

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?
- anabolic pathways
 - catabolic pathways
 - fermentation pathways
 - thermodynamic pathways
 - bioenergetic pathways
- ___ 2. The molecule that functions as the reducing agent (electron donor) in a redox or oxidation-reduction reaction
- gains electrons and gains energy.
 - loses electrons and loses energy.
 - gains electrons and loses energy.
 - loses electrons and gains energy.
 - neither gains nor loses electrons, but gains or loses energy.
- ___ 3. When electrons move closer to a more electronegative atom, what happens?
- Energy is released.
 - Energy is consumed.
 - The more electronegative atom is reduced.
 - The more electronegative atom is oxidized.
 - A and C are correct.
- ___ 4. Why does the oxidation of organic compounds by molecular oxygen to produce CO_2 and water release free energy?
- The covalent bonds in organic molecules are higher energy bonds than those in water and carbon dioxide.
 - 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).
 - The oxidation of organic compounds can be used to make ATP.
 - The electrons have a higher potential energy when associated with water and CO_2 than they do in organic compounds.
 - The covalent bond in O_2 is unstable and easily broken by electrons from organic molecules.
- ___ 5. Which of the following statements describes the results of this reaction?
- $$\text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2 \rightarrow 6 \text{CO}_2 + 6 \text{H}_2\text{O} + \text{Energy}$$
- $\text{C}_6\text{H}_{12}\text{O}_6$ is oxidized and O_2 is reduced.
 - O_2 is oxidized and H_2O is reduced.
 - CO_2 is reduced and O_2 is oxidized.
 - $\text{C}_6\text{H}_{12}\text{O}_6$ is reduced and CO_2 is oxidized.

- e. O_2 is reduced and CO_2 is oxidized.
- ___ 6. When a glucose molecule loses a hydrogen atom as the result of an oxidation-reduction reaction, the molecule becomes
- dehydrogenated.
 - hydrogenated.
 - oxidized.
 - reduced.
 - an oxidizing agent.
- ___ 7. When a molecule of NAD^+ (nicotinamide adenine dinucleotide) gains a hydrogen atom (not a hydrogen ion) the molecule becomes
- hydrogenated.
 - oxidized.
 - reduced.
 - redoxed.
 - a reducing agent.
- ___ 8. Which of the following statements describes NAD^+ ?
- NAD^+ is reduced to NADH during both glycolysis and the citric acid cycle.
 - NAD^+ has more chemical energy than NADH.
 - NAD^+ is reduced by the action of hydrogenases.
 - NAD^+ can donate electrons for use in oxidative phosphorylation.
 - In the absence of NAD^+ , glycolysis can still function.
- ___ 9. Where does glycolysis takes place?
- mitochondrial matrix
 - mitochondrial outer membrane
 - mitochondrial inner membrane
 - mitochondrial intermembrane space
 - cytosol
- ___ 10. The ATP made during glycolysis is generated by
- substrate-level phosphorylation.
 - electron transport.
 - photophosphorylation.
 - chemiosmosis.
 - oxidation of NADH to NAD^+ .
- ___ 11. The oxygen consumed during cellular respiration is involved directly in which process or event?
- glycolysis
 - accepting electrons at the end of the electron transport chain
 - the citric acid cycle
 - the oxidation of pyruvate to acetyl CoA
 - the phosphorylation of ADP to form ATP

- ___ 12. Which process in eukaryotic cells will proceed normally whether oxygen (O_2) is present or absent?
- electron transport
 - glycolysis
 - the citric acid cycle
 - oxidative phosphorylation
 - chemiosmosis
- ___ 13. An electron loses potential energy when it
- shifts to a less electronegative atom.
 - shifts to a more electronegative atom.
 - increases its kinetic energy.
 - increases its activity as an oxidizing agent.
 - attaches itself to NAD^+ .
- ___ 14. Why are carbohydrates and fats considered high energy foods?
- They have a lot of oxygen atoms.
 - They have no nitrogen in their makeup.
 - They can have very long carbon skeletons.
 - They have a lot of electrons associated with hydrogen.
 - They are easily reduced.
- ___ 15. Substrate-level phosphorylation accounts for approximately what percentage of the ATP formed during glycolysis?
- 0%
 - 2%
 - 10%
 - 38%
 - 100%
- ___ 16. During glycolysis, when glucose is catabolized to pyruvate, most of the energy of glucose is
- transferred to ADP, forming ATP.
 - transferred directly to ATP.
 - retained in the pyruvate.
 - stored in the NADH produced.
 - used to phosphorylate fructose to form fructose-6-phosphate.
- ___ 17. In addition to ATP, what are the end products of glycolysis?
- CO_2 and H_2O
 - CO_2 and pyruvate
 - NADH and pyruvate
 - CO_2 and NADH
 - H_2O , $FADH_2$, and citrate
- ___ 18. The free energy for the oxidation of glucose to CO_2 and water is -686 kcal/mole and the free energy for the reduction of NAD^+ to NADH is +53 kcal/mole. Why are only two molecules of NADH formed during glycolysis when it appears that as many as a dozen could be formed?
- 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 "net" products of glycolysis are
- a. 2 NAD^+ , 2 H^+ , 2 pyruvate, 2 ATP, and 2 H_2O .
 - b. 2 NADH, 2 H^+ , 2 pyruvate, 2 ATP, and 2 H_2O .
 - c. 2 FADH_2 , 2 pyruvate, 4 ATP, and 2 H_2O .
 - d. 6 CO_2 , 6 H_2O , 2 ATP, and 2 pyruvate.
 - e. 6 CO_2 , 6 H_2O , 36 ATP, and 2 citrate.
- ___ 20. In glycolysis, for each molecule of glucose oxidized to pyruvate
- a. 2 molecules of ATP are used and 2 molecules of ATP are produced.
 - b. 2 molecules of ATP are used and 4 molecules of ATP are produced.
 - c. 4 molecules of ATP are used and 2 molecules of ATP are produced.
 - d. 2 molecules of ATP are used and 6 molecules of ATP are produced.
 - e. 6 molecules of ATP are used and 6 molecules of ATP are produced.
- ___ 21. A molecule that is phosphorylated
- a. has been reduced as a result of a redox reaction involving the loss of an inorganic phosphate.
 - b. has a decreased chemical reactivity; it is less likely to provide energy for cellular work.
 - c. has been oxidized as a result of a redox reaction involving the gain of an inorganic phosphate.
 - d. has an increased chemical reactivity; it is primed to do cellular work.
 - e. has less energy than before its phosphorylation and therefore less energy for cellular work.
- ___ 22. Which kind of metabolic poison would most directly interfere with glycolysis?
- a. an agent that reacts with oxygen and depletes its concentration in the cell
 - b. an agent that binds to pyruvate and inactivates it
 - c. an agent that closely mimics the structure of glucose but is not metabolized
 - d. an agent that reacts with NADH and oxidizes it to NAD^+
 - e. an agent that blocks the passage of electrons along the electron transport chain
- ___ 23. Why is glycolysis described as having an investment phase and a payoff phase?
- a. It both splits molecules and assembles molecules.
 - b. It attaches and detaches phosphate groups.
 - c. It uses glucose and generates pyruvate.
 - d. It shifts molecules from cytosol to mitochondrion.

- e. It uses stored ATP and then forms a net increase in ATP.

Use the following information to answer the next questions.

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.

- ___ 24. These three steps result in the formation of
- acetyl CoA, O_2 , and ATP.
 - acetyl CoA, FADH_2 , and CO_2 .
 - acetyl CoA, FAD, H_2 , and CO_2 .
 - acetyl CoA, NADH, H^+ , and CO_2 .
 - acetyl CoA, NAD^+ , ATP, and CO_2 .
- ___ 25. Why is coenzyme A, a sulfur containing molecule derived from a B vitamin, added?
- because sulfur is needed for the molecule to enter the mitochondrion
 - in order to utilize this portion of a B vitamin which would otherwise be a waste product from another pathway
 - to provide a relatively unstable molecule whose acetyl portion can readily bind to oxaloacetate
 - because it drives the reaction that regenerates NAD^+
 - in order to remove one molecule of CO_2
- ___ 26. How does pyruvate enter the mitochondrion?
- active transport
 - diffusion
 - facilitated diffusion
 - through a channel
 - through a pore
- ___ 27. Which of the following intermediary metabolites enters the citric acid cycle and is formed, in part, by the removal of a carbon (CO_2) from one molecule of pyruvate?
- lactate
 - glyceraldehydes-3-phosphate
 - oxaloacetate
 - acetyl CoA
 - citrate
- ___ 28. During cellular respiration, acetyl CoA accumulates in which location?
- cytosol
 - mitochondrial outer membrane
 - mitochondrial inner membrane
 - mitochondrial intermembrane space
 - mitochondrial matrix

- ___ 29. How many carbon atoms are fed into the citric acid cycle as a result of the oxidation of one molecule of pyruvate?
- 2
 - 4
 - 6
 - 8
 - 10

Refer to Figure 9.2, showing the citric acid cycle, as a guide to answer the following questions.

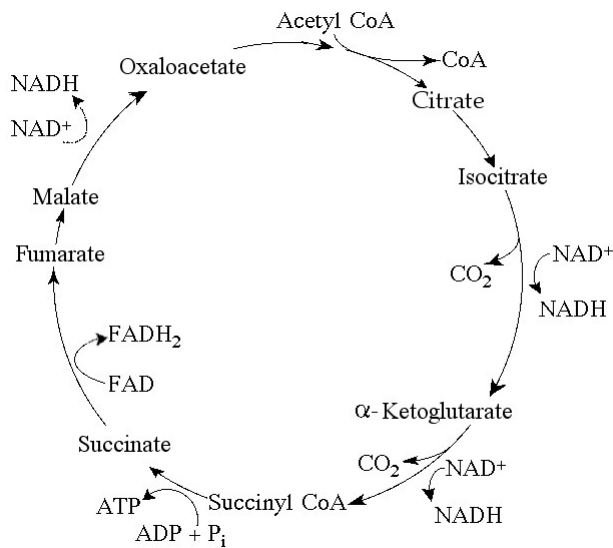


Figure 9.2

- ___ 30. Starting with one molecule of isocitrate and ending with fumarate, what is the maximum number of ATP molecules that could be made through substrate-level phosphorylation?
- 1
 - 2
 - 11
 - 12
 - 24
- ___ 31. Carbon skeletons for amino acid biosynthesis are supplied by intermediates of the citric acid cycle. Which intermediate would supply the carbon skeleton for synthesis of a five-carbon amino acid?
- succinate
 - malate
 - citrate
 - α-ketoglutarate**
 - isocitrate
- ___ 32. How many molecules of carbon dioxide (CO₂) would be produced by five turns of the citric acid cycle?

- a. 2
- b. 5
- c. 10
- d. 12
- e. 60

- ___ 33. How many reduced dinucleotides would be produced with four turns of the citric acid cycle?
- a. 1 FADH_2 and 4 NADH
 - b. 2 FADH_2 and 8 NADH
 - c. 4 FADH_2 and 12 NADH
 - d. 1 FAD and 4 NAD^+
 - e. 4 FAD^+ and 12 NAD^+
- ___ 34. Starting with citrate, which of the following combinations of products would result from three turns of the citric acid cycle?
- a. 1 ATP, 2 CO_2 , 3 NADH, and 1 FADH_2
 - b. 2 ATP, 2 CO_2 , 1 NADH, and 3 FADH_2
 - c. 3 ATP, 3 CO_2 , 3 NADH, and 3 FADH_2
 - d. 3 ATP, 6 CO_2 , 9 NADH, and 3 FADH_2
 - e. 38 ATP, 6 CO_2 , 3 NADH, and 12 FADH_2
- ___ 35. 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
- ___ 36. For each molecule of glucose that is metabolized by glycolysis and the citric acid cycle, what is the total number of NADH + FADH_2 molecules produced?
- a. 4
 - b. 5
 - c. 6
 - d. 10
 - e. 12
- ___ 37. A young animal has never had much energy. He is brought to a veterinarian for help and is sent to the animal hospital for some tests. There they discover his mitochondria can use only fatty acids and amino acids for respiration, and his cells produce more lactate than normal. Of the following, which is the best explanation of his condition?
- a. His mitochondria lack the transport protein that moves pyruvate across the outer mitochondrial membrane.
 - b. His cells cannot move NADH from glycolysis into the mitochondria.
 - c. His cells contain something that inhibits oxygen use in his mitochondria.
 - d. His cells lack the enzyme in glycolysis that forms pyruvate.

- e. His cells have a defective electron transport chain, so glucose goes to lactate instead of to acetyl CoA.
- ___ 38. Cellular respiration harvests the most chemical energy from which of the following?
- substrate-level phosphorylation
 - chemiosmotic phosphorylation
 - converting oxygen to ATP
 - transferring electrons from organic molecules to pyruvate
 - generating carbon dioxide and oxygen in the electron transport chain
- ___ 39. During aerobic respiration, electrons travel downhill in which sequence?
- food → citric acid cycle → ATP → NAD⁺
 - food → NADH → electron transport chain → oxygen
 - glucose → pyruvate → ATP → oxygen
 - glucose → ATP → electron transport chain → NADH
 - food → glycolysis → citric acid cycle → NADH → ATP
- ___ 40. Where are the proteins of the electron transport chain located?
- cytosol
 - mitochondrial outer membrane
 - mitochondrial inner membrane
 - mitochondrial intermembrane space
 - mitochondrial matrix
- ___ 41. Which of the following describes the sequence of electron carriers in the electron transport chain, starting with the least electronegative?
- ubiquinone (Q), cytochromes (Cyt), FMN, Fe•S
 - cytochromes (Cyt), FMN, ubiquinone, Fe•S
 - Fe•S, FMN, cytochromes (Cyt), ubiquinone
 - FMN, Fe•S, ubiquinone, cytochromes (Cyt)
 - cytochromes (Cyt), Fe•S, ubiquinone, FMN
- ___ 42. During aerobic respiration, which of the following directly donates electrons to the electron transport chain at the lowest energy level?
- NAD⁺
 - NADH
 - ATP
 - ADP + P_i
 - FADH₂
- ___ 43. The primary role of oxygen in cellular respiration is to
- yield energy in the form of ATP as it is passed down the respiratory chain.
 - act as an acceptor for electrons and hydrogen, forming water.
 - combine with carbon, forming CO₂.
 - combine with lactate, forming pyruvate.
 - catalyze the reactions of glycolysis.
- ___ 44. Inside an active mitochondrion, most electrons follow which pathway?

- a. glycolysis → NADH → oxidative phosphorylation → ATP → oxygen
- b. citric acid cycle → FADH₂ → 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

- ___ 45. During oxidative phosphorylation, H₂O is formed. Where does the oxygen for the synthesis of the water come from?
- a. carbon dioxide (CO₂)
 - b. glucose (C₆H₁₂O₆)
 - c. molecular oxygen (O₂)
 - d. pyruvate (C₃H₃O₃⁻)
 - e. lactate (C₃H₅O₃⁻)
- ___ 46. In chemiosmotic phosphorylation, what is the most direct source of energy that is used to convert ADP + 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 ATP synthase pumping hydrogen ions from the mitochondrial matrix
 - d. energy released from movement of protons through ATP synthase
 - e. No external source of energy is required because the reaction is exergonic.
- ___ 47. Energy released by the electron transport chain is used to pump H⁺ ions into which location?
- a. cytosol
 - b. mitochondrial outer membrane
 - c. mitochondrial inner membrane
 - d. mitochondrial intermembrane space
 - e. mitochondrial matrix
- ___ 48. The direct energy source that drives ATP synthesis during respiratory oxidative phosphorylation is
- a. oxidation of glucose to CO₂ 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 difference in H⁺ concentrations on opposite sides of the inner mitochondrial membrane.
 - e. the thermodynamically favorable transfer of phosphate from glycolysis and the citric acid cycle intermediate molecules of ADP.
- ___ 49. When hydrogen ions are pumped from the mitochondrial matrix across the inner membrane and into the intermembrane space, the result is the
- a. formation of ATP.
 - b. reduction of NAD⁺.
 - c. restoration of the Na⁺/K⁺ balance across the membrane.

- d. creation of a proton gradient.
- e. lowering of pH in the mitochondrial matrix.

- ___ 50. Where is ATP synthase located in the mitochondrion?
- a. cytosol
 - b. electron transport chain
 - c. outer membrane
 - d. inner membrane
 - e. mitochondrial matrix
- ___ 51. It is possible to prepare vesicles from portions of the inner membrane of the mitochondrial components. Which one of the following processes could still be carried on by this isolated inner membrane?
- a. the citric acid cycle
 - b. oxidative phosphorylation
 - c. glycolysis and fermentation
 - d. reduction of NAD^+
 - e. both the citric acid cycle and oxidative phosphorylation
- ___ 52. Each time a molecule of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) is completely oxidized via aerobic respiration, how many oxygen molecules (O_2) are required?
- a. 1
 - b. 2
 - c. 6
 - d. 12
 - e. 38
- ___ 53. Which of the following produces the most ATP when glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) 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)
- ___ 54. Approximately how many molecules of ATP are produced from the complete oxidation of two molecules of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) in cellular respiration?
- a. 2
 - b. 4
 - c. 15
 - d. 38
 - e. 76
- ___ 55. Assume a mitochondrion contains 58 NADH and 19 FADH_2 . If each of the 77 dinucleotides were used, approximately how many ATP molecules could be generated as a result of oxidative phosphorylation (chemiosmosis)?
- a. 36

- b. 77
- c. 173
- d. 212
- e. 1102

- _____ 56. Approximately what percentage of the energy of glucose ($C_6H_{12}O_6$) is transferred to storage in ATP as a result of the complete oxidation of glucose to CO_2 and water in cellular respiration?
- a. 2%
 - b. 4%
 - c. 10%
 - d. 25%
 - e. 40%
- _____ 57. Recall that the complete oxidation of a mole of glucose releases 686 kcal of energy ($\Delta G = -686$ kcal/mol). The phosphorylation of ADP to form ATP stores approximately 7.3 kcal per mole of ATP. What is the approximate efficiency of cellular respiration for a "mutant" organism that produces only 29 moles of ATP for every mole of glucose oxidized, rather than the usual 36-38 moles of ATP?
- a. 0.4%
 - b. 25%
 - c. 30%
 - d. 40%
 - e. 60%
- _____ 58. What is proton-motive force?
- a. the force required to remove an electron from hydrogen
 - b. the transmembrane proton concentration gradient
 - c. movement of hydrogen into the intermembrane space
 - d. movement of hydrogen into the mitochondrion
 - e. the addition of hydrogen to NAD^+
- _____ 59. In liver cells, the inner mitochondrial membranes are about 5 X the area of the outer mitochondrial membranes, and about 17 X that of the cell's plasma membrane. What purpose must this serve?
- a. It allows for increased rate of glycolysis.
 - b. It allows for 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.

Use the following to answer the following questions.

Exposing inner mitochondrial membranes to ultrasonic vibrations will disrupt the membranes. However, the fragments will reseal "inside out." These little vesicles that result can still transfer electrons from NADH to oxygen and synthesize ATP. If the membranes are agitated still further however, the ability to synthesize ATP is lost.

- ___ 60. After the first disruption, when electron transfer and ATP synthesis still occur, what must be present?
- all of the electron transport proteins as well as ATP synthase
 - all of the electron transport system and the ability to add CoA to acetyl groups
 - the ATP synthase system is sufficient
 - the electron transport system is sufficient
 - plasma membranes like those bacteria use for respiration
- ___ 61. After the second agitation of the membrane vesicles, what must be lost from the membrane?
- the ability of NADH to transfer electrons to the first acceptor in the electron transport chain
 - the prosthetic groups like heme from the transport system
 - cytochromes
 - ATP synthase, in whole or in part
 - the contact required between inner and outer membrane surfaces
- ___ 62. It should be possible to reconstitute the abilities of the vesicles if which of the following is added?
- cytochromes
 - extra NADH
 - a second membrane surface
 - more electrons
 - intact ATP synthase

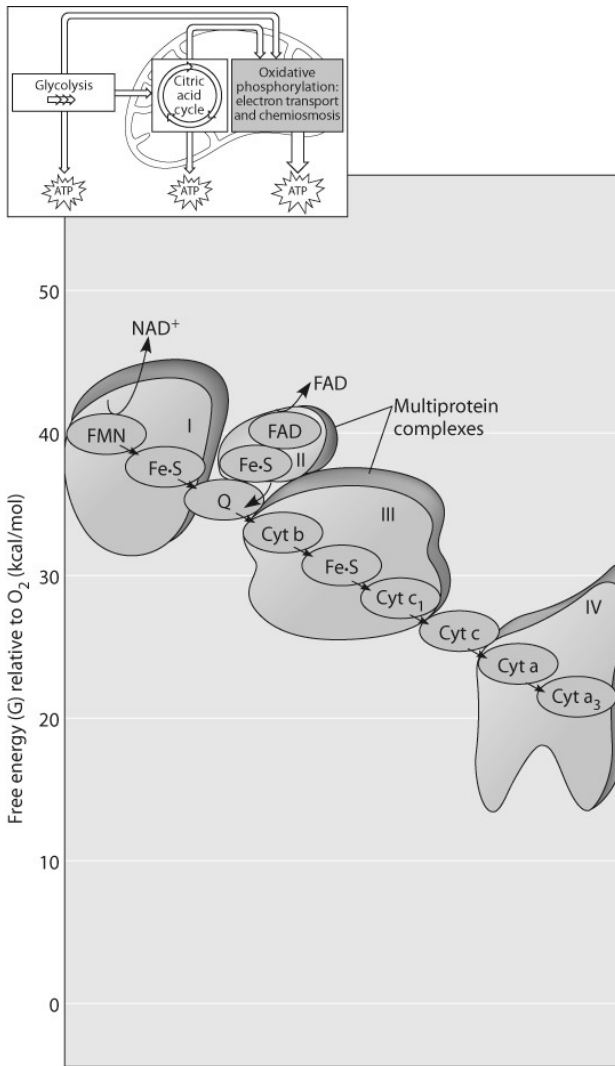


Figure 9.3

- ___ 63. The accompanying figure shows the electron transport chain. Which of the following is the combination of substances that is initially added to the chain?
- oxygen, carbon dioxide, and water
 - NAD⁺, FAD, and electrons
 - NADH, FADH₂, and protons
 - NADH, FADH₂, and electrons
 - Oxygen and electrons
- ___ 64. Which of the following most accurately describes what is happening along this chain?
- Chemiosmosis is coupled with electron transfer.
 - Each electron carrier alternates between being reduced and being oxidized.
 - ATP is generated at each step.
 - Energy of the electrons increases at each step.
 - Molecules in the chain give up some of their potential energy.

- ___ 65. The parts of the figure labeled with Roman numerals symbolize what concept?
- different inner mitochondrial membranes
 - different mitochondria functioning together
 - molecules with different attached metal ions
 - carbohydrate framework holding the molecules in place
 - multimeric groups of proteins in 4 complexes
- ___ 66. What happens at the end of the chain?
- The 2 original electrons combine with NAD^+ .
 - The 2 original electrons combine with oxygen.
 - 4 electrons combine with oxygen and protons.
 - 4 electrons combine with hydrogen and oxygen atoms.
 - 1 electron combines with oxygen and hydrogen.
- ___ 67. Which of the following couples chemiosmosis to energy storage?
- NADH
 - FADH_2
 - cytochromes
 - electron transport
 - ATP synthase
- ___ 68. Which of the following describes ubiquinone?
- a protein in the electron transport chain
 - a small hydrophobic coenzyme
 - a substrate for synthesis of FADH
 - a vitamin needed for efficient glycolysis
 - an essential amino acid
- ___ 69. Which of the following normally occurs whether or not oxygen (O_2) is present?
- glycolysis
 - fermentation
 - oxidation of pyruvate to acetyl CoA
 - citric acid cycle
 - oxidative phosphorylation (chemiosmosis)
- ___ 70. Which of the following occurs in the cytosol of a eukaryotic cell?
- glycolysis and fermentation
 - fermentation and chemiosmosis
 - oxidation of pyruvate to acetyl CoA
 - citric acid cycle
 - oxidative phosphorylation
- ___ 71. Which metabolic pathway is common to both cellular respiration and fermentation?
- the oxidation of pyruvate to acetyl CoA
 - the citric acid cycle
 - oxidative phosphorylation
 - glycolysis
 - chemiosmosis

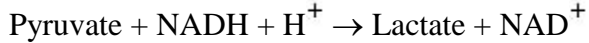
- ___ 72. The ATP made during fermentation is generated by which of the following?
- the electron transport chain
 - substrate-level phosphorylation
 - chemiosmosis
 - oxidative phosphorylation
 - aerobic respiration
- ___ 73. In the absence of oxygen, yeast cells can obtain energy by fermentation, resulting in the production of
- ATP, CO_2 , and ethanol (ethyl alcohol).
 - ATP, CO_2 , and lactate.
 - ATP, NADH, and pyruvate.
 - ATP, pyruvate, and oxygen.
 - ATP, pyruvate, and acetyl CoA.
- ___ 74. In alcohol fermentation, NAD^+ is regenerated from NADH during which of the following?
- reduction of acetaldehyde to ethanol (ethyl alcohol)
 - oxidation of pyruvate to acetyl CoA
 - reduction of pyruvate to form lactate
 - oxidation of NAD^+ in the citric acid cycle
 - phosphorylation of ADP to form ATP
- ___ 75. One function of both alcohol fermentation and lactic acid fermentation is to
- reduce NAD^+ to NADH.
 - reduce FAD^+ to FADH_2 .
 - oxidize NADH to NAD^+ .
 - reduce FADH_2 to FAD^+ .
 - none of the above
- ___ 76. An organism is discovered that consumes a considerable amount of sugar, yet does not gain much weight when denied air. Curiously, the consumption of sugar increases as air is removed from the organism's environment, but the organism seems to thrive even in the absence of air. When returned to normal air, the organism does fine. Which of the following best describes the organism?
- It must use a molecule other than oxygen to accept electrons from the electron transport chain.
 - It is a normal eukaryotic organism.
 - The organism obviously lacks the citric acid cycle and electron transport chain.
 - It is an anaerobic organism.
 - It is a facultative anaerobe.
- ___ 77. Glycolysis is thought to be one of the most ancient of metabolic processes. Which statement supports this idea?
- Glycolysis is the most widespread metabolic pathway.
 - Glycolysis neither uses nor needs O_2 .
 - 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.
- ___ 78. 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 is found in the cytosol, does not involve 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.
- ___ 79. Muscle cells, when an individual is exercising heavily and when the muscle becomes oxygen deprived, 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.
- ___ 80. When muscle cells are oxygen deprived, the heart still pumps. What must the heart cells be able to do?
- a. derive sufficient energy from fermentation
 - b. continue aerobic metabolism when skeletal muscle cannot
 - c. transform lactate to pyruvate again
 - d. remove lactate from the blood
 - e. remove oxygen from lactate
- ___ 81. When muscle cells undergo anaerobic respiration, they become fatigued and painful. This is now known to be caused by
- a. buildup of pyruvate.
 - b. buildup of lactate.
 - c. increase in sodium ions.
 - d. increase in potassium ions.
 - e. increase in ethanol.
- ___ 82. You have a friend who lost 7 kg (about 15 pounds) of fat on a "low carb" diet. How did the fat leave her body?
- a. It was released as CO_2 and H_2O .
 - b. Chemical energy was converted to heat and then released.
 - c. It was converted to ATP, which weighs much less than fat.
 - d. It was broken down to amino acids and eliminated from the body.
 - e. It was converted to urine and eliminated from the body.

- ___ 83. Phosphofructokinase is an important control enzyme in the regulation of cellular respiration. Which of the following statements describes a function of phosphofructokinase?
- It is activated by AMP (derived from ADP).
 - It is activated by ATP.
 - It is inhibited by citrate, an intermediate of the citric acid cycle.
 - It catalyzes the conversion of fructose-1,6-bisphosphate to fructose-6-phosphate, an early step of glycolysis.
 - It is an allosteric enzyme.
- ___ 84. Phosphofructokinase is an allosteric enzyme that catalyzes the conversion of fructose-6-phosphate to fructose-1,6-bisphosphate, an early step of glycolysis. In the presence of oxygen, an increase in the amount ATP in a cell would be expected to
- inhibit the enzyme and thus slow the rates of glycolysis and the citric acid cycle.
 - activate the enzyme and thus slow the rates of glycolysis and the citric acid cycle.
 - inhibit the enzyme and thus increase the rates of glycolysis and the citric acid cycle.
 - activate the enzyme and increase the rates of glycolysis and the citric acid cycle.
 - inhibit the enzyme and thus increase the rate of glycolysis and the concentration of citrate.
- ___ 85. Even though plants carry on photosynthesis, plant cells still use their mitochondria for oxidation of pyruvate. When and where will this occur?
- in photosynthetic cells in the light, while photosynthesis occurs concurrently
 - in non-photosynthesizing cells only
 - in cells that are storing glucose only
 - in photosynthesizing cells in dark periods and in other tissues all the time
 - in photosynthesizing cells in the light and in other tissues in the dark
- ___ 86. In vertebrate animals, brown fat tissue's color is due to abundant mitochondria. White fat tissue, on the other hand, is specialized for fat storage and contains relatively few mitochondria. 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?
- to increase the rate of oxidative phosphorylation from its few mitochondria
 - to allow the animals to regulate their metabolic rate when it is especially hot
 - to increase the production of ATP synthase
 - to allow other membranes of the cell to perform mitochondrial function
 - to regulate temperature by converting energy from NADH oxidation to heat
- ___ 87. What is the purpose of beta oxidation in respiration?
- oxidation of glucose
 - oxidation of pyruvate
 - feedback regulation
 - control of ATP accumulation
 - breakdown of fatty acids
- ___ 88. Where do the catabolic products of fatty acid breakdown enter into the citric acid cycle?
- pyruvate
 - malate or fumarate

- c. acetyl CoA
- d. α -ketoglutarate
- e. succinyl CoA

___ 89. What is the reducing agent in the following reaction?



- a. oxygen
- b. NADH
- c. NAD^+
- d. lactate
- e. pyruvate

___ 90. The immediate energy source that drives ATP synthesis by ATP synthase during oxidative phosphorylation is

- a. the oxidation of glucose and other organic compounds.
- b. the flow of electrons down the electron transport chain.
- c. the affinity of oxygen for electrons.
- d. the H^+ concentration gradient across the inner mitochondrial membrane.
- e. the transfer of phosphate to ADP.

___ 91. Which metabolic pathway is common to both fermentation and cellular respiration of a glucose molecule?

- a. the citric acid cycle
- b. the electron transport chain
- c. glycolysis
- d. synthesis of acetyl CoA from pyruvate
- e. reduction of pyruvate to lactate

___ 92. In mitochondria, exergonic redox reactions

- a. are the source of energy driving prokaryotic ATP synthesis.
- b. are directly coupled to substrate-level phosphorylation.
- c. provide the energy that establishes the proton gradient.
- d. reduce carbon atoms to carbon dioxide.
- e. are coupled via phosphorylated intermediates to endergonic processes.

___ 93. The final electron acceptor of the electron transport chain that functions in aerobic oxidative phosphorylation is

- a. oxygen.
- b. water.
- c. NAD^+ .
- d. pyruvate.
- e. ADP.

___ 94. When electrons flow along the electron transport chains of mitochondria, which of the following changes occurs?

- a. The pH of the matrix increases.
- b. ATP synthase pumps protons by active transport.

- c. The electrons gain free energy.
 - d. The cytochromes phosphorylate ADP to form ATP.
 - e. NAD^+ is oxidized.
- ___ 95. Cells do not catabolize carbon dioxide because
- a. its double bonds are too stable to be broken.
 - b. CO_2 has fewer bonding electrons than other organic compounds.
 - c. CO_2 is already completely reduced.
 - d. CO_2 is already completely oxidized.
 - e. the molecule has too few atoms.
- ___ 96. Which of the following is a true distinction between fermentation and cellular respiration?
- a. Only respiration oxidizes glucose.
 - b. NADH is oxidized by the electron transport chain in respiration only.
 - c. Fermentation, but not respiration, is an example of a catabolic pathway.
 - d. Substrate-level phosphorylation is unique to fermentation.
 - e. NAD^+ functions as an oxidizing agent only in respiration.
- ___ 97. Most CO_2 from catabolism is released during
- a. glycolysis.
 - b. the citric acid cycle.
 - c. lactate fermentation.
 - d. electron transport.
 - e. oxidative phosphorylation.
- ___ 98. If photosynthesizing green algae are provided with CO_2 synthesized with heavy oxygen (^{18}O), later analysis will show that all but one of the following compounds produced by the algae contain the ^{18}O label. That one is
- a. PGA.
 - b. PGAL.
 - c. glucose.
 - d. RuBP.
 - e. O_2 .
- ___ 99. Which of the following are products of the light reactions of photosynthesis that are utilized in the Calvin cycle?
- a. CO_2 and glucose
 - b. H_2O and O_2
 - c. ADP, P_i , and NADP^+
 - d. electrons and H^+
 - e. ATP and NADPH
- ___ 100. What are the products of the light reactions that are subsequently used by the Calvin cycle?
- a. oxygen and carbon dioxide

- b. carbon dioxide and RuBP
 - c. water and carbon
 - d. electrons and photons
 - e. ATP and NADPH
- ___ 101. Where does the Calvin cycle take place?
- a. stroma of the chloroplast
 - b. thylakoid membrane
 - c. cytoplasm surrounding the chloroplast
 - d. chlorophyll molecule
 - e. outer membrane of the chloroplast
- ___ 102. In any ecosystem, terrestrial or aquatic, what group(s) is (are) always necessary?
- a. autotrophs and heterotrophs
 - b. producers and primary consumers
 - c. photosynthesizers
 - d. autotrophs
 - e. green plants
- ___ 103. In autotrophic bacteria, where are the enzymes located that can carry on organic synthesis?
- a. chloroplast membranes
 - b. nuclear membranes
 - c. free in the cytosol
 - d. along the outer edge of the nucleoid
 - e. along the inner surface of the plasma membrane
- ___ 104. When oxygen is released as a result of photosynthesis, it is a by-product of which of the following?
- a. reducing NADP^+
 - b. splitting the water molecules
 - c. chemiosmosis
 - d. the electron transfer system of photosystem I
 - e. the electron transfer system of photosystem II
- ___ 105. A plant has a unique photosynthetic pigment. The leaves of this plant appear to be reddish yellow. What wavelengths of visible light are being absorbed by this pigment?
- a. red and yellow
 - b. blue and violet
 - c. green and yellow
 - d. blue, green, and red
 - e. green, blue, and yellow

Use the following information to answer the questions below.

Theodor W. Engelmann illuminated a filament of algae with light that passed through a prism, thus exposing different segments of algae to different wavelengths of light. He added aerobic bacteria and then noted in which areas the bacteria congregated. He noted that the largest groups were found in the areas illuminated by the red and blue light.

- ___ 106. What did Engelmann conclude about the congregation of bacteria in the red and blue areas?
- Bacteria released excess carbon dioxide in these areas.
 - Bacteria congregated in these areas due to an increase in the temperature of the red and blue light.
 - Bacteria congregated in these areas because these areas had the most oxygen being released.
 - Bacteria are attracted to red and blue light and thus these wavelengths are more reactive than other wavelengths.
 - Bacteria congregated in these areas due to an increase in the temperature caused by an increase in photosynthesis.
- ___ 107. An outcome of this experiment was to help determine
- the relationship between heterotrophic and autotrophic organisms.
 - the relationship between wavelengths of light and the rate of aerobic respiration.
 - the relationship between wavelengths of light and the amount of heat released.
 - the relationship between wavelengths of light and the oxygen released during photosynthesis.
 - the relationship between the concentration of carbon dioxide and the rate of photosynthesis.
- ___ 108. If you ran the same experiment without passing light through a prism, what would you predict?
- There would be no difference in results.
 - The bacteria would be relatively evenly distributed along the algal filaments.
 - The number of bacteria present would decrease due to an increase in the carbon dioxide concentration.
 - The number of bacteria present would increase due to an increase in the carbon dioxide concentration.
 - The number of bacteria would decrease due to a decrease in the temperature of the water.

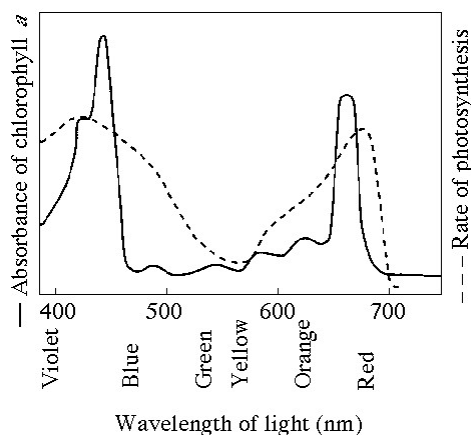


Figure 10.1

- ___ 109. Figure 10.1 shows the absorption spectrum for chlorophyll *a* and the action spectrum for photosynthesis. Why are they different?

- a. Green and yellow wavelengths inhibit the absorption of red and blue wavelengths.
- b. Bright sunlight destroys photosynthetic pigments.
- c. Oxygen given off during photosynthesis interferes with the absorption of light.
- d. Other pigments absorb light in addition to chlorophyll *a*.
- e. Aerobic bacteria take up oxygen which changes the measurement of the rate of photosynthesis.

- ___ 110. What wavelength of light in the figure is *most* effective in driving photosynthesis?
- a. 420 nm
 - b. 475 nm
 - c. 575 nm
 - d. 625 nm
 - e. 730 nm
- ___ 111. Compared with the lines for chlorophyll *a* in the figure, where would you expect to find the lines to differ for chlorophyll *b*?
- a. The absorption spectrum line would be lowest for chlorophyll *b* somewhat to the right of that for chlorophyll *a* (500—600).
 - b. The rate of photosynthesis line for chlorophyll *b* would be lowest from 600—700 nm.
 - c. The lines for the two types of chlorophyll would be almost completely opposite.
 - d. The lines for the two types of chlorophyll would be almost completely identical.
 - e. The peaks of the line for absorbance of *b* would be shifted to the left, and for rate of photosynthesis would be shifted to the right.
- ___ 112. In the thylakoid membranes, what is the main role of the antenna pigment molecules?
- a. split water and release oxygen to the reaction-center chlorophyll
 - b. harvest photons and transfer light energy to the reaction-center chlorophyll
 - c. synthesize ATP from ADP and Pi
 - d. transfer electrons to ferredoxin and then NADPH
 - e. concentrate photons within the stroma
- ___ 113. The reaction-center chlorophyll of photosystem I is known as P700 because
- a. there are 700 chlorophyll molecules in the center.
 - b. this pigment is best at absorbing light with a wavelength of 700 nm.
 - c. there are 700 photosystem I components to each chloroplast.
 - d. it absorbs 700 photons per microsecond.
 - e. the plastoquinone reflects light with a wavelength of 700 nm.
- ___ 114. Which of the events listed below occur in the light reactions of photosynthesis?
- a. NADP is produced.
 - b. NADP^{H} is reduced to NADP^+ .
 - c. carbon dioxide is incorporated into PGA.
 - d. ATP is phosphorylated to yield ADP.
 - e. light is absorbed and funneled to reaction-center chlorophyll *a*.
- ___ 115. Which statement describes the functioning of photosystem II?
- a. Light energy excites electrons in the electron transport chain in a photosynthetic

unit.

- b. The excitation is passed along to a molecule of P700 chlorophyll in the photosynthetic unit.
- c. The P680 chlorophyll donates a pair of protons to NADPH, which is thus converted to NADP^+ .
- d. The electron vacancies in P680 are filled by electrons derived from water.
- e. The splitting of water yields molecular carbon dioxide as a by-product.

- ___ 116. Which of the following are directly associated with photosystem I?
- a. harvesting of light energy by ATP
 - b. receiving electrons from plastocyanin
 - c. P680 reaction-center chlorophyll
 - d. extraction of hydrogen electrons from the splitting of water
 - e. passing electrons to plastoquinone
- ___ 117. Some photosynthetic organisms contain chloroplasts that lack photosystem II, yet are able to survive. The best way to detect the lack of photosystem II in these organisms would be
- a. to determine if they have thylakoids in the chloroplasts.
 - b. to test for liberation of O_2 in the light.
 - c. to test for CO_2 fixation in the dark.
 - d. to do experiments to generate an action spectrum.
 - e. to test for production of either sucrose or starch.
- ___ 118. What are the products of linear photophosphorylation?
- a. heat and fluorescence
 - b. ATP and P700
 - c. ATP and NADPH
 - d. ADP and NADP
 - e. P700 and P680
- ___ 119. As a research scientist, you measure the amount of ATP and NADPH consumed by the Calvin cycle in 1 hour. You find 30,000 molecules of ATP consumed, but only 20,000 molecules of NADPH. Where did the extra ATP molecules come from?
- a. photosystem II
 - b. photosystem I
 - c. cyclic electron flow
 - d. linear electron flow
 - e. chlorophyll
- ___ 120. Assume a thylakoid is somehow punctured so that the interior of the thylakoid is no longer separated from the stroma. This damage will have the most direct effect on which of the following processes?
- a. the splitting of water
 - b. the absorption of light energy by chlorophyll
 - c. the flow of electrons from photosystem II to photosystem I
 - d. the synthesis of ATP
 - e. the reduction of NADP^+

- ___ 121. What does the chemiosmotic process in chloroplasts involve?
- establishment of a proton gradient
 - diffusion of electrons through the thylakoid membrane
 - reduction of water to produce ATP energy
 - movement of water by osmosis into the thylakoid space from the stroma
 - formation of glucose, using carbon dioxide, NADPH, and ATP
- ___ 122. Suppose the interior of the thylakoids of isolated chloroplasts were made acidic and then transferred in the dark to a pH-8 solution. What would be likely to happen?
- The isolated chloroplasts will make ATP.
 - The Calvin cycle will be activated.
 - Cyclic photophosphorylation will occur.
 - Only A and B will occur.
 - A, B, and C will occur.
- ___ 123. In a plant cell, where are the ATP synthase complexes located?
- thylakoid membrane
 - plasma membrane
 - inner mitochondrial membrane
 - A and C
 - A, B, and C
- ___ 124. In mitochondria, chemiosmosis translocates protons from the matrix into the intermembrane space, whereas in chloroplasts, chemiosmosis translocates protons from
- the stroma to the photosystem II.
 - the matrix to the stroma.
 - the stroma to the thylakoid space.
 - the intermembrane space to the matrix.
 - ATP synthase to NADP⁺ reductase.
- ___ 125. Which of the following statements *best* describes the relationship between photosynthesis and respiration?
- Respiration is the reversal of the biochemical pathways of photosynthesis.
 - Photosynthesis stores energy in complex organic molecules, while respiration releases it.
 - Photosynthesis occurs only in plants and respiration occurs only in animals.
 - ATP molecules are produced in photosynthesis and used up in respiration.
 - Respiration is anabolic and photosynthesis is catabolic.
- ___ 126. Where are the molecules of the electron transport chain found in plant cells?
- thylakoid membranes of chloroplasts
 - stroma of chloroplasts
 - outer membrane of mitochondria
 - matrix of mitochondria
 - cytoplasm
- ___ 127. Synthesis of ATP by the chemiosmotic mechanism occurs during
- photosynthesis.

- b. respiration.
 - c. both photosynthesis and respiration.
 - d. neither photosynthesis nor respiration.
 - e. photorespiration.
- ___ 128. Reduction of oxygen which forms water occurs during
- a. photosynthesis.
 - b. respiration.
 - c. both photosynthesis and respiration.
 - d. neither photosynthesis nor respiration.
 - e. photorespiration.
- ___ 129. Reduction of NADP^+ occurs during
- a. photosynthesis.
 - b. respiration.
 - c. both photosynthesis and respiration.
 - d. neither photosynthesis nor respiration.
 - e. photorespiration.
- ___ 130. The splitting of carbon dioxide to form oxygen gas and carbon compounds occurs during
- a. photosynthesis.
 - b. respiration.
 - c. both photosynthesis and respiration.
 - d. neither photosynthesis nor respiration.
 - e. photorespiration.
- ___ 131. Generation of proton gradients across membranes occurs during
- a. photosynthesis.
 - b. respiration.
 - c. both photosynthesis and respiration.
 - d. neither photosynthesis nor respiration.
 - e. photorespiration.
- ___ 132. What is the relationship between wavelength of light and the quantity of energy per photon?
- a. They have a direct, linear relationship.
 - b. They are inversely related.
 - c. They are logarithmically related.
 - d. They are separate phenomena.
 - e. They are only related in certain parts of the spectrum.
- ___ 133. In a protein complex for the light reaction (a reaction center), energy is transferred from pigment molecule to pigment molecule, to a special chlorophyll a molecule, and eventually to the primary electron acceptor. Why does this occur?
- a. The action spectrum of that molecule is such that it is different from other molecules of chlorophyll.
 - b. The potential energy of the electron has to go back to the ground state.
 - c. The molecular environment lets it boost an electron to a higher energy level and also to transfer the electron to another molecule.

- d. Each pigment molecule has to be able to act independently to excite electrons.
- e. These chlorophyll a molecules are associated with higher concentrations of ATP.

- ___ 134. P680⁺ is said to be the strongest biological oxidizing agent. Why?
- a. It is the receptor for the most excited electron in either photosystem.
 - b. It is the molecule that transfers electrons to plastoquinone (Pq) of the electron transfer system.
 - c. NADP reductase will then catalyze the shift of the electron from Fd to NADP⁺ to reduce it to NADPH.
 - d. This molecule results from the transfer of an electron to the primary electron acceptor of photosystem II and strongly attracts another electron.
 - e. This molecule is found far more frequently among bacteria as well as in plants and plantlike Protists.
- ___ 135. Some photosynthetic bacteria (e.g., purple sulfur bacteria) have photosystem I but not II, while others (e.g. cyanobacteria) have both PSI and PSII. Which of the following might this observation imply?
- a. Photosystem II must have been selected against in some species.
 - b. Photosystem I must be more ancestral.
 - c. Photosystem II may have evolved to be more photoprotective.
 - d. Cyclic flow must be more primitive than linear flow of electrons.
 - e. Cyclic flow must be the most necessary of the two processes.
- ___ 136. Cyclic electron flow may be photoprotective (protective to light-induced damage). Which of the following experiments could provide information on this phenomenon?
- a. using mutated organisms that can grow but that cannot carry out cyclic flow of electrons and compare their abilities to photosynthesize in different light intensities
 - b. using plants that can carry out both linear and cyclic electron flow, or only one or another of these processes, and measuring their light absorbance
 - c. using bacteria that have only cyclic flow and look for their frequency of mutation damage
 - d. using bacteria with only cyclic flow and measuring the number and types of photosynthetic pigments they have in their membranes
 - e. using plants with only photosystem I operative and measure how much damage occurs at different wavelengths.
- ___ 137. Carotenoids are often found in foods that are considered to have antioxidant properties in human nutrition. What related function do they have in plants?
- a. They serve as accessory pigments.
 - b. They dissipate excessive light energy.
 - c. They cover the sensitive chromosomes of the plant.
 - d. They reflect orange light.
 - e. They take up toxins from the water.
- ___ 138. In thylakoids, protons travel through ATP synthase from the stroma to the thylakoid space. Therefore the catalytic "knobs" of ATP synthase would be located
- a. on the side facing the thylakoid space.
 - b. on the ATP molecules themselves.

- c. on the pigment molecules of PSI and PSII.
- d. on the stroma side of the membrane.
- e. built into the center of the thylakoid stack (granum).

- ___ 139. Which of the following statements best represents the relationships between the light reactions and the Calvin cycle?
- a. The light reactions provide ATP and NADPH to the Calvin cycle, and the cycle returns ADP, P_i , and $NADP^+$ to the light reactions.
 - b. The light reactions provide ATP and NADPH to the carbon fixation step of the Calvin cycle, and the cycle provides water and electrons to the light reactions.
 - c. The light reactions supply the Calvin cycle with CO_2 to produce sugars, and the Calvin cycle supplies the light reactions with sugars to produce ATP.
 - d. The light reactions provide the Calvin cycle with oxygen for electron flow, and the Calvin cycle provides the light reactions with water to split.
 - e. There is no relationship between the light reactions and the Calvin cycle.
- ___ 140. Where do the enzymatic reactions of the Calvin cycle take place?
- a. stroma of the chloroplast
 - b. thylakoid membranes
 - c. outer membrane of the chloroplast
 - d. electron transport chain
 - e. thylakoid space
- ___ 141. What is the primary function of the Calvin cycle?
- a. use ATP to release carbon dioxide
 - b. use NADPH to release carbon dioxide
 - c. split water and release oxygen
 - d. transport RuBP out of the chloroplast
 - e. synthesize simple sugars from carbon dioxide

For the following questions, compare the light reactions with the Calvin cycle of photosynthesis in plants.

- ___ 142. Produces molecular oxygen (O_2)
- a. light reactions alone
 - b. the Calvin cycle alone
 - c. both the light reactions and the Calvin cycle
 - d. neither the light reactions nor the Calvin cycle
 - e. occurs in the chloroplast but is not part of photosynthesis
- ___ 143. Requires ATP
- a. light reactions alone
 - b. the Calvin cycle alone
 - c. both the light reactions and the Calvin cycle
 - d. neither the light reactions nor the Calvin cycle
 - e. occurs in the chloroplast but is not part of photosynthesis

- ___ 144. Produces NADH
- light reactions alone
 - the Calvin cycle alone
 - both the light reactions and the Calvin cycle
 - neither the light reactions nor the Calvin cycle
 - occurs in the chloroplast but is not part of photosynthesis
- ___ 145. Produces NADPH
- light reactions alone
 - the Calvin cycle alone
 - both the light reactions and the Calvin cycle
 - neither the light reactions nor the Calvin cycle
 - occurs in the chloroplast but is not part of photosynthesis
- ___ 146. Produces three-carbon sugars
- light reactions alone
 - the Calvin cycle alone
 - both the light reactions and the Calvin cycle
 - neither the light reactions nor the Calvin cycle
 - occurs in the chloroplast but is not part of photosynthesis
- ___ 147. Requires CO_2
- light reactions alone
 - the Calvin cycle alone
 - both the light reactions and the Calvin cycle
 - neither the light reactions nor the Calvin cycle
 - occurs in the chloroplast but is not part of photosynthesis
- ___ 148. Requires glucose
- light reactions alone
 - the Calvin cycle alone
 - both the light reactions and the Calvin cycle
 - neither the light reactions nor the Calvin cycle
 - occurs in the chloroplast but is not part of photosynthesis
- ___ 149. The sugar that results from three "turns" of the Calvin cycle is glyceraldehyde-3-phosphate (G3P). Which of the following is a consequence of this?
- Formation of a molecule of glucose would require 9 "turns."
 - G3P more readily forms sucrose and other disaccharides than it does monosaccharides.
 - Some plants would not taste sweet to us.
 - The formation of starch in plants involves assembling many G3P molecules, with or without further rearrangements.
 - G3P is easier for a plant to store.
- ___ 150. In the process of carbon fixation, RuBP attaches a CO_2 to produce a 6 carbon molecule, which is then split in two. After phosphorylation and reduction, what more needs to happen in the Calvin cycle?

- addition of a pair of electrons from NADPH
- inactivation of RuBP carboxylase enzyme
- regeneration of ATP from ADP
- regeneration of RuBP
- a gain of NADPH

Use the following figure and the stages labeled A, B, C, D, and E to answer the following questions.

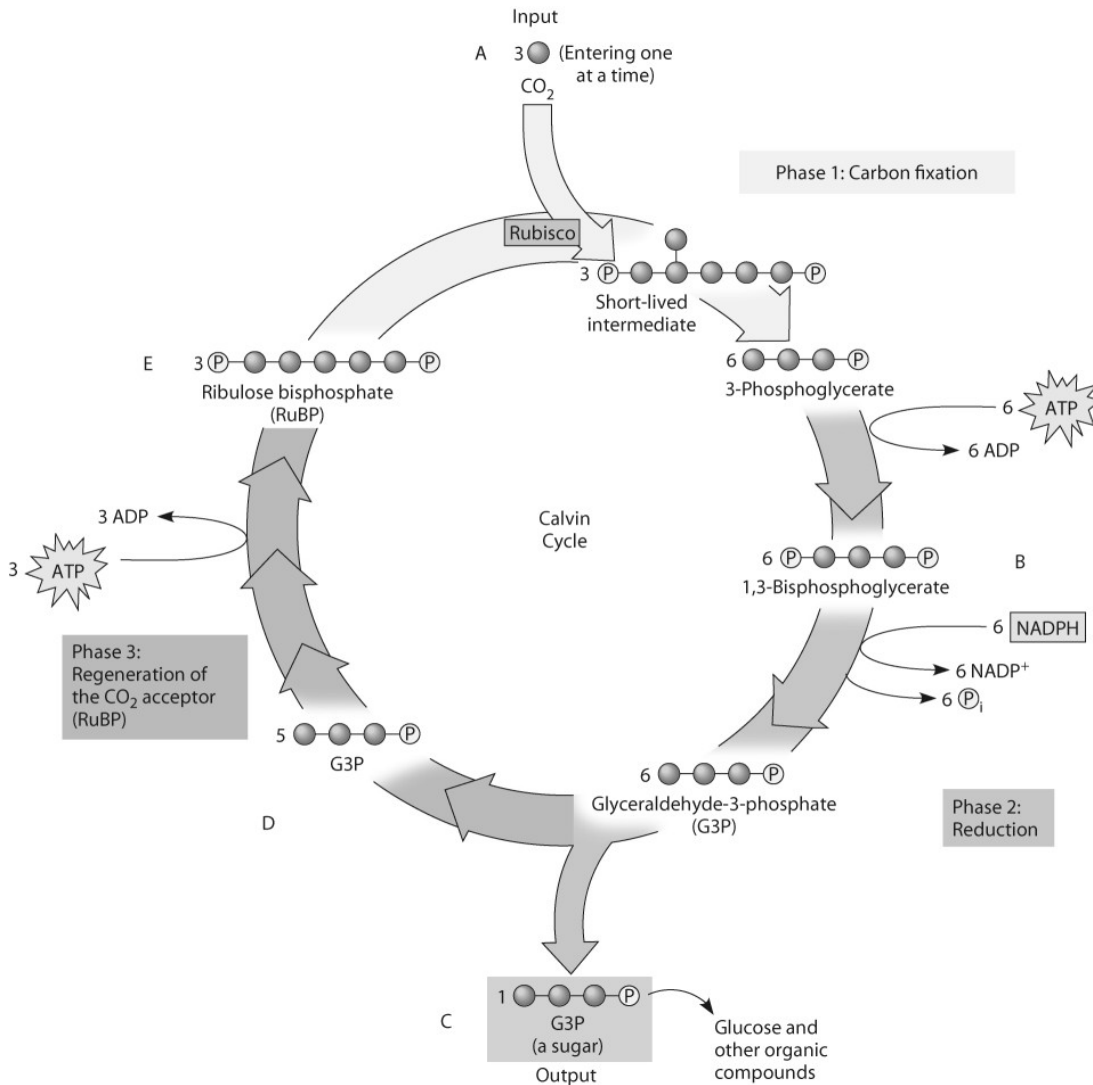


Figure 10.2

151. If ATP used by this plant is labeled with radioactive phosphorus, in which molecules will the radioactivity be measurable after one "turn" of the cycle?
- in B only
 - in B and C only
 - in B, C, and D only
 - in B and E only

e. in B, C, D, and E

- ___ 152. If the carbon atom of the incoming CO_2 molecule is labeled with a radioactive isotope of carbon, where will the radioactivity be measurable after one cycle?
- a. in C only
 - b. in B, D, and E only
 - c. in C, D, and E
 - d. in A, B, and C
 - e. in B and C
- ___ 153. Which molecule(s) of the Calvin cycle is/are most like molecules found in glycolysis?
- a. A, B, C, and E
 - b. B, C, and E
 - c. A only
 - d. C and D only
 - e. E only
- ___ 154. In metabolic processes of cell respiration and photosynthesis, prosthetic groups such as heme and iron-sulfur complexes are encountered. What do they do?
- a. donate electrons
 - b. act as reducing agents
 - c. act as oxidizing agents
 - d. transport protons within the mitochondria and chloroplasts
 - e. both oxidize and reduce during electron transport
- ___ 155. The pH of the inner thylakoid space has been measured, as have the pH of the stroma and of the cytosol of a particular plant cell. Which, if any, relationship would you expect to find?
- a. The pH within the thylakoid is less than that of the stroma.
 - b. The pH of the stroma is higher than that of the other two measurements.
 - c. The pH of the stroma is higher than that of the thylakoid space but lower than that of the cytosol.
 - d. The pH of the thylakoid space is higher than that anywhere else in the cell.
 - e. There is no consistent relationship.

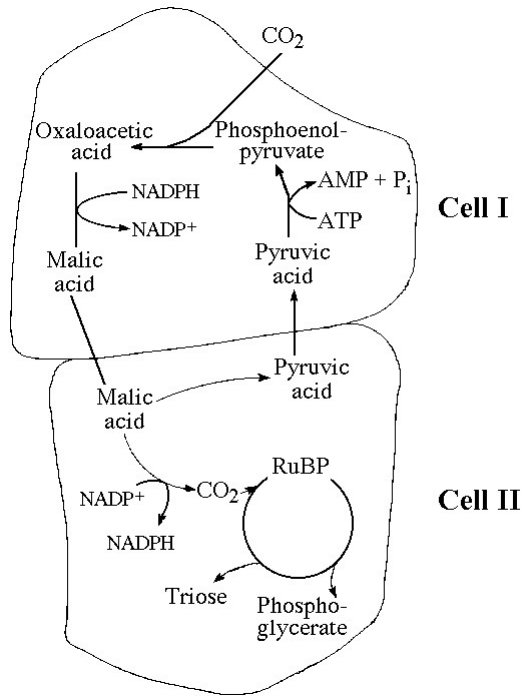


Figure 10.3

- ___ 156. Which of the following statements is *true* concerning Figure 10.3?
- It represents cell processes involved in C₄ photosynthesis.
 - It represents the type of cell structures found in CAM plants.
 - It represents an adaptation that maximizes photorespiration.
 - It represents a C₃ photosynthetic system.
 - It represents a relationship between plant cells that photosynthesize and those that cannot.
- ___ 157. Referring to Figure 10.3, oxygen would inhibit the CO₂ fixation reactions in
- cell I only.
 - cell II only.
 - neither cell I nor cell II.
 - both cell I and cell II.
 - cell I during the night and cell II during the day.
- ___ 158. In which cell would you expect photorespiration?
- Cell I
 - Cell II
 - Cell I at night
 - Cell II at night
 - neither Cell I nor Cell II

- ___ 159. In an experiment studying photosynthesis performed during the day, you provide a plant with radioactive carbon (^{14}C) dioxide as a metabolic tracer. The ^{14}C is incorporated first into oxaloacetate. The plant is best characterized as a
- C_4 plant.
 - C_3 plant.
 - CAM plant.
 - heterotroph.
 - chemoautotroph.
- ___ 160. Why are C_4 plants able to photosynthesize with no apparent photorespiration?
- They do not participate in the Calvin cycle.
 - They use PEP carboxylase to initially fix CO_2 .
 - They are adapted to cold, wet climates.
 - They conserve water more efficiently.
 - They exclude oxygen from their tissues.
- ___ 161. CAM plants keep stomata closed in daytime, thus reducing loss of water. They can do this because they
- fix CO_2 into organic acids during the night.
 - fix CO_2 into sugars in the bundle-sheath cells.
 - fix CO_2 into pyruvate in the mesophyll cells.
 - use the enzyme phosphofructokinase, which outcompetes rubisco for CO_2 .
 - use photosystems I and II at night.
- ___ 162. Photorespiration lowers the efficiency of photosynthesis by preventing the formation of
- carbon dioxide molecules.
 - 3-phosphoglycerate molecules
 - ATP molecules.
 - ribulose biphosphate molecules.
 - RuBP carboxylase molecules.
- ___ 163. The alternative pathways of photosynthesis using the C_4 or CAM systems are said to be compromises. Why?
- Each one minimizes both water loss and rate of photosynthesis.
 - C_4 compromises on water loss and CAM compromises on photorespiration.
 - Each one both minimizes photorespiration and optimizes the Calvin cycle.
 - CAM plants allow more water loss, while C_4 plants allow less CO_2 into the plant.
 - C_4 plants allow less water loss but Cam plants but allow more water loss.
- ___ 164. If plant gene alterations cause the plants to be deficient in photorespiration, what would most probably occur?
- Cells would carry on more photosynthesis.
 - Cells would carry on the Calvin cycle at a much slower rate.
 - Less ATP would be generated.
 - There would be more light-induced damage to the cells.

- e. More sugars would be produced.
- ___ 165. The light reactions of photosynthesis supply the Calvin cycle with
- light energy.
 - CO_2 and ATP.
 - H_2O and NADPH.
 - ATP and NADPH.
 - sugar and O_2 .
- ___ 166. Which of the following sequences correctly represents the flow of electrons during photosynthesis?
- $\text{NADPH} \rightarrow \text{O}_2 \rightarrow \text{CO}_2$
 - $\text{H}_2\text{O} \rightarrow \text{NADPH} \rightarrow \text{Calvin cycle}$
 - $\text{NADPH} \rightarrow \text{chlorophyll} \rightarrow \text{Calvin cycle}$
 - $\text{H}_2\text{O} \rightarrow \text{photosystem I} \rightarrow \text{photosystem II}$
 - $\text{NADPH} \rightarrow \text{electron transport chain} \rightarrow \text{O}_2$
- ___ 167. In *mechanism*, photophosphorylation is most similar to
- substrate-level phosphorylation in glycolysis.
 - oxidative phosphorylation in cellular respiration.
 - the Calvin cycle.
 - carbon fixation.
 - reduction of NADP^+ .
- ___ 168. How is photosynthesis similar in C_4 and CAM plants?
- In both cases, only photosystem I is used.
 - Both types of plants make sugar without the Calvin cycle.
 - In both cases, rubisco is not used to fix carbon initially.
 - Both types of plants make most of their sugar in the dark.
 - In both cases, thylakoids are not involved in photosynthesis.
- ___ 169. Which process is most directly driven by light energy?
- creation of a pH gradient by pumping protons across the thylakoid membrane
 - carbon fixation in the stroma
 - reduction of NADP^+ molecules
 - removal of electrons from chlorophyll molecules
 - ATP synthesis
- ___ 170. Which of the following statements is a correct distinction between autotrophs and heterotrophs?
- Only heterotrophs require chemical compounds from the environment.
 - Cellular respiration is unique to heterotrophs.
 - Only heterotrophs have mitochondria.
 - Autotrophs, but not heterotrophs, can nourish themselves beginning with CO_2 and other nutrients that are inorganic.
 - Only heterotrophs require oxygen.
- ___ 171. Which of the following *does not occur* during the Calvin cycle?

- carbon fixation
- oxidation of NADPH
- release of oxygen
- regeneration of the CO_2 acceptor
- consumption of ATP

Short Answer

Refer to Figure 9.1 to answer the following questions.

Figure 9.1 illustrates some of the steps (reactions) of glycolysis in their proper sequence. Each step is lettered. Use these letters to answer the questions.

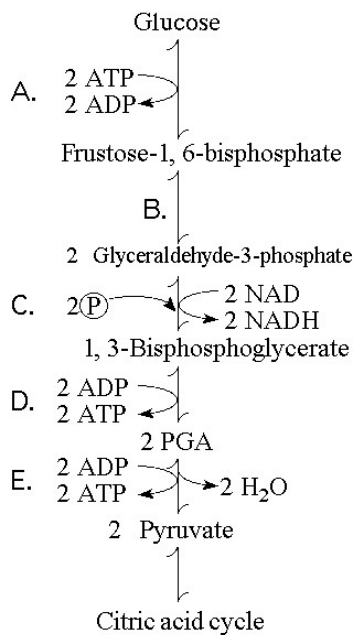


Figure 9.1

- Which step shows a split of one molecule into two smaller molecules?
- In which step is an inorganic phosphate added to the reactant?
- In which reaction does an intermediate pathway become oxidized?
- Which step involves an endergonic reaction?
- Which step consists of a phosphorylation reaction in which ATP is the phosphate source?

177. The graph here shows the pH difference across the inner mitochondrial membrane over time in an actively respiring cell. At the time indicated by the vertical arrow, a metabolic poison is added that specifically and completely inhibits all function of mitochondrial ATP synthase. Draw what you would expect to see for the rest of the graphed line.

