GRADE 12 BIOLOGY UNIT 3 ENERGY TRANSFORMATION

1. Which of the following statements best describes the primary difference between anabolism and catabolism?
   A. Anabolism releases energy by breaking down molecules, while catabolism uses energy to build molecules.
   B. Anabolism is a constructive process that requires energy, while catabolism is a destructive process that releases energy.
   C. Anabolism occurs only during photosynthesis, while catabolism occurs only during cellular respiration.
   D. Anabolism involves exergonic reactions, while catabolism involves endergonic reactions.
2. What is the ultimate source of energy that drives the process of photosynthesis in plants?
   A. The chemical energy stored in ATP.
   B. The absorption of heat from the environment.
   C. The splitting of water molecules.
   D. The electromagnetic energy from sunlight.
3. The oxygen gas (O_2) released as a byproduct of photosynthesis originates from which of the following molecules?
   A. The breakdown of carbon dioxide. B. The splitting of water molecules.
   C. The degradation of glucose. D. The reduction of NADP+.
4. Which tissue layer in a plant leaf contains the highest density of chloroplasts and is the primary site of photosynthesis?
   A. The upper epidermis. B. The spongy mesophyll.
   C. The palisade mesophyll. D. The vascular bundle sheath.
5. In the structure of a chloroplast, the light-dependent reactions occur in the _____, while the light-independent reactions (Calvin cycle) occur in the _____.
   A. stroma; thylakoid membranes B. thylakoid membranes; stroma
   C. intermembrane space; stroma D. outer membrane; inner membrane
6. Which of the following metabolic processes is an example of a catabolic pathway?
   A. The synthesis of proteins from amino acids.
   B. The conversion of glucose to pyruvate during glycolysis.

C. The formation of starch from glucose molecules.

D. The fixation of CO_2 into organic molecules.

7. A pigment appears green to the human eye because it:

A. absorbs green wavelengths of light.

B. absorbs all wavelengths of light except green.

C. reflects or transmits green wavelengths of light.

D. converts blue and red light into green light.

8. What is the primary role of accessory pigments like carotenoids in photosynthesis?

A. To directly participate in the Calvin cycle.

B. To absorb light energy and transfer it to chlorophyll a.

C. To produce the oxygen byproduct of photosynthesis.

D. To serve as the primary reaction-center chlorophyll.

9. An analysis of the absorption spectrum for chlorophyll a and chlorophyll b would show that they absorb light most effectively in which regions of the visible spectrum?

A. Green and yellow. B. Blue-violet and red.

C. Orange and yellow. D. Green and red.

10. What are the three main products of the light-dependent reactions that are used in the Calvin cycle? A. Oxygen, ATP, and NADPH. B. Carbon dioxide, ATP, and NADPH.

C. Water, ATP, and NADPH. D. ATP, NADPH, and G3P.

11. The process of splitting water using light energy during photosynthesis is known as:

A. hydrolysis. B. photolysis. C. chemiosmosis. D. photophosphorylation.

12. In non-cyclic photophosphorylation, where do the electrons that replace those lost from photosystem II originate?

A. From photosystem I. B. From the splitting of water.

C. From the reduction of NADP+. D. From the stroma of the chloroplast.

13. Which of the following is a key difference between cyclic and non-cyclic photophosphorylation?

A. Only non-cyclic photophosphorylation produces ATP.

B. Only cyclic photophosphorylation produces NADPH.

C. Non-cyclic photophosphorylation involves both Photosystem I and II, while cyclic involves only Photosystem I.

D. Cyclic photophosphorylation releases oxygen, while non-cyclic does not.

14. What is the name of the enzyme that catalyzes the initial fixation of carbon dioxide in the Calvin cycle?
A. PEP carboxylase. B. ATP synthase. C. NADP+ reductase. D. RuBisCO.
15. The Calvin cycle is often referred to as the C3 pathway because:
A. it requires three molecules of ATP to proceed.
B. the first stable product of carbon fixation is a three-carbon compound.
C. it takes place in a three-stage process.
D. it uses three molecules of CO_2 to produce one molecule of glucose.
16. What is the primary function of the Calvin cycle?
A. To convert light energy into chemical energy.
B. To produce ATP and NADPH.
C. To synthesize simple sugars from carbon dioxide.
D. To release oxygen into the atmosphere.
17. How do C4 plants minimize photorespiration?
A. By opening their stomata only at night.
B. By using RuBisCO, which has a low affinity for oxygen.
C. By spatially separating initial CO_2 fixation from the Calvin cycle.
D. By fixing CO_2 directly into a three-carbon compound.
18. A plant that opens its stomata to fix CO_2 into organic acids during the night and then closes its stomata to run the Calvin cycle during the day is best described as a:
A. C3 plant. B. C4 plant. C. CAM plant. D. nitrogen-fixing plant.
19. Photorespiration is considered a wasteful process because it:
A. produces ATP but consumes oxygen.
B. consumes ATP and releases CO_2 without producing sugar.
C. fixes carbon dioxide but does not produce oxygen.
D. produces excess sugar that the plant cannot store.
20. Which of the following is the correct overall equation for cellular respiration?
A. $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$
B. $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$
C. $C_6H_{12}O_6 + 6H_2O \rightarrow 6CO_2 + 6O_2 + ATP$
D. $6O_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6CO_2$
21. The term "**endergonic reaction**" refers to a chemical reaction that:
A. releases energy into the surroundings.
B. absorbs energy from the surroundings.

C. occurs spontaneously without energy input.

D. breaks down complex molecules into simpler ones.

22. What molecule is known as the "**energy currency**" of the cell, directly powering most cellular work?

A. Glucose. B. NADH.

C. Adenosine triphosphate (ATP). D. Adenosine monophosphate (AMP).

23. The breakdown of ATP to ADP and inorganic phosphate is an example of what type of reaction? A. Hydrolysis. B. Dehydration synthesis. C. Oxidation. D. Reduction.

24. Glycolysis, the first stage of cellular respiration, takes place in which part of the cell?

A. Mitochondrial matrix. B. Inner mitochondrial membrane.

C. Cytosol. D. Chloroplast stroma.

25. What is the net production of **ATP** and **NADH** from one molecule of glucose during glycolysis? A. 2 ATP and 0 NADH. B. 4 ATP and 2 NADH.

C. 2 ATP and 2 NADH. D. 0 ATP and 2 NADH.

26. The end product of glycolysis is:

A. acetyl CoA. B. pyruvate. C. citric acid. D. glucose-6-phosphate.

27. Before entering the Krebs cycle, pyruvate is converted into:

A. oxaloacetate.

B. citrate.

C. lactic acid.

D. acetyl CoA.

28. The Krebs cycle (citric acid cycle) occurs in which cellular compartment?

A. Cytosol.

B. Intermembrane space of the mitochondria.

C. Mitochondrial matrix.

D. Inner mitochondrial membrane.

29. For each molecule of glucose that is completely respired, how many turns of the Krebs cycle are required?

A. One.

B. Two.

C. Three.

D. Four.

30. What are the main energy-carrying molecules produced during the Krebs cycle?

A. ATP and NADP+.

B. NADH and $FADH_2$.

C. ADP and FAD.

D. Pyruvate and CO_2.

31. The process that generates the most ATP during cellular respiration is:

A. glycolysis.

B. the Krebs cycle.

C. oxidative phosphorylation.

D. fermentation.

32. What is the role of oxygen in aerobic respiration?

A. It combines with pyruvate to form acetyl CoA.

B. It is the final electron acceptor in the electron transport chain.

C. It directly powers the synthesis of ATP by ATP synthase.

D. It donates electrons to the beginning of the electron transport chain.

33. The electron transport chain in cellular respiration is located on the:

A. outer mitochondrial membrane.

B. cytosolic side of the plasma membrane.

C. inner mitochondrial membrane.

D. matrix of the mitochondria.

34. The movement of H+ ions across the inner mitochondrial membrane, down their concentration gradient, through ATP synthase is known as:

A. active transport.

B. chemiosmosis.

C. substrate-level phosphorylation.

D. glycolysis.

35. The purpose of fermentation is to:

A. produce a large amount of ATP in the absence of oxygen.

B. regenerate NAD+ from NADH to allow glycolysis to continue.

C. produce alcohol and carbon dioxide for energy storage.

D. convert pyruvate into a less toxic substance.

36. In human muscle cells, under anaerobic conditions, pyruvate is converted into:

A. ethanol and CO_2.

B. acetyl CoA.

C. lactic acid.

D. citric acid.

37. Which process is common to both aerobic respiration and fermentation?

A. The Krebs cycle.

B. Oxidative phosphorylation.

C. The conversion of pyruvate to acetyl CoA.

D. Glycolysis.

38. Yeast cells carry out which type of fermentation?

A. Lactic acid fermentation.

B. Alcoholic fermentation.

C. Acetic acid fermentation.

D. Propionic fermentation.

39. The synthesis of complex molecules like proteins and polysaccharides from simpler subunits is an example of:

A. catabolism.

B. anabolism.

C. an exergonic process.

D. hydrolysis.

40. In C4 plants like maize, the initial fixation of CO_2 occurs in the _____ cells, and the Calvin cycle occurs in the _____ cells.

A. bundle-sheath; mesophyll

B. mesophyll; bundle-sheath

C. epidermal; palisade

D. palisade; spongy mesophyll

41. Which molecule serves as the electron donor in the Calvin cycle?

A. Water.

B. ATP.

C. NADPH.

D. Oxygen.

42. The "**regeneration**" phase of the Calvin cycle involves:

A. the fixation of additional CO_2 molecules.

B. the formation of glucose from G3P.

C. the use of ATP to reform the CO_2 acceptor molecule, RuBP.

D. the reduction of 3-PGA to G3P.

43. A scientist is studying a photosynthetic organism that contains chlorophylls a and b, as well as carotenoids. This organism is most likely a:

A. cyanobacterium.

B. red alga.

C. plant or green alga.

D. brown alga.

44. Which step in cellular respiration produces carbon dioxide?

A. Glycolysis.

B. The link reaction (pyruvate oxidation) and the Krebs cycle.

C. The electron transport chain.

D. Lactic acid fermentation.

45. The energy stored in the proton gradient (H+ gradient) across the inner mitochondrial membrane is a form of:

A. chemical energy.

B. potential energy.

C. kinetic energy.

D. thermal energy.

46. When fats are used as an energy source, the fatty acid chains are broken down into two-carbon units that enter the respiratory pathway as:

A. pyruvate.

B. glucose.

C. acetyl CoA.

D. glyceraldehyde-3-phosphate.

47. The process of removing an amino group from an amino acid before it can enter the cellular respiration pathway is called:

A. decarboxylation.

B. dehydrogenation.

C. deamination.

D. beta-oxidation.

48. The waxy, waterproof layer secreted by the epidermis of a leaf that helps prevent water loss is the:

A. stoma.

B. cuticle.

C. mesophyll.

D. grana.

49. Which of the following correctly describes the flow of energy in photosynthesis?

A. Chemical energy → Light energy → Chemical energy

B. Light energy → Chemical energy (ATP/NADPH) → Chemical energy (Sugar)

C. Chemical energy (Sugar) → Light energy → Chemical energy (ATP)

D. Light energy → Thermal energy → Chemical energy

50. Which of the following is an input for the light-independent reactions of photosynthesis?

A. Water.

B. Light.

C. Oxygen.

D. Carbon dioxide.

51. Substrate-level phosphorylation is a method of **ATP** synthesis that occurs during:

A. the electron transport chain only.

B. chemiosmosis only.

C. glycolysis and the Krebs cycle.

D. the light reactions of photosynthesis only.

52. The function of the stomata on the underside of a leaf is to:

A. absorb sunlight.

B. transport water and nutrients.

C. allow for gas exchange.

D. protect the leaf from insects.

53. If the thylakoid membrane of a chloroplast were made permeable to protons (H+), what would be the most direct consequence?

A. The synthesis of ATP would cease.

B. The rate of water splitting would increase.

C. The production of NADPH would stop.

D. The absorption of light by chlorophyll would be inhibited.

54. The final products of the complete oxidation of glucose in aerobic respiration are:

A. pyruvate, ATP, and NADH.

B. acetyl CoA, $FADH_2$, and CO_2.

C. lactic acid, NAD+, and ATP.

D. ATP, CO_2, and H_2O.

55. Which compound is regenerated at the end of the Krebs cycle?

A. Citrate.

B. Acetyl CoA.

C. Pyruvate.

D. Oxaloacetate.

56. In the overall process of photosynthesis, CO_2 is _____ and H_2O is _____.

A. oxidized; reduced

B. reduced; oxidized

C. phosphorylated; hydrolyzed

D. hydrolyzed; phosphorylated

57. The main structural difference between ATP and ADP is the:

A. type of sugar.

B. type of nitrogenous base.

C. number of phosphate groups.

D. number of carbon atoms.

58. Which of the following metabolic pathways is exergonic?

A. The synthesis of starch from glucose.

B. The light-independent reactions (Calvin cycle).

C. Cellular respiration.

D. The formation of proteins from amino acids.

59. In CAM plants, malate is stored in the _____ of the cell during the night.

A. chloroplasts

B. mitochondria

C. cytoplasm

D. vacuoles

60. The primary electron acceptor in Photosystem II receives an excited electron directly from:

A. the P680 chlorophyll a molecule.

B. the splitting of water.

C. the electron transport chain.

D. ATP synthase.

61. Which of the following correctly pairs a cellular process with its description of oxygen requirement?

A. Krebs cycle: anaerobic

B. Glycolysis: aerobic

C. Electron Transport Chain: aerobic

D. Alcoholic fermentation: aerobic

62. The carbon atoms that are used to build glucose during photosynthesis originate from:

A. ribulose-1,5-bisphosphate (RuBP).

B. carbon dioxide (CO_2).

C. glyceraldehyde-3-phosphate (G3P).

D. water (H_2O).

63. If a plant's stomata are closed during a hot, dry day, how will this most likely affect the rate of photosynthesis?

A. It will increase because less water is lost through transpiration.

B. It will decrease because the availability of CO_2 will be limited.

C. It will remain unchanged as photosynthesis is dependent on light, not CO_2.

D. It will increase because the internal temperature of the leaf rises.

64. During the energy investment phase of glycolysis:

A. ATP is produced.

B. ATP is consumed.

C. NADH is produced.

D. pyruvate is formed.

65. What would happen if the enzyme PEP carboxylase was inhibited in a C4 plant?

A. The plant would not be able to carry out the Calvin cycle.

B. The initial fixation of CO_2 into a four-carbon compound would stop.

C. The rate of photorespiration would increase dramatically.

D. The plant would switch to CAM metabolism.

66. What is the fundamental role of the light-dependent reactions in photosynthesis?

A. To synthesize carbohydrates using CO_2.

B. To capture and convert light energy into the chemical energy of ATP and NADPH.

C. To release the oxygen from carbon dioxide.

D. To regenerate the RuBP needed for the Calvin cycle.

67. During oxidative phosphorylation, the energy released by the flow of electrons down the electron transport chain is used to:

A. directly phosphorylate ADP.

B. pump protons (H+) into the mitochondrial matrix.

C. pump protons (H+) into the intermembrane space.

D. split water molecules to release oxygen.

68. The reactions of the Calvin cycle are considered "light-independent" because:

A. they can occur in complete darkness for an extended period.

B. they do not directly use photons of light.

C. they occur in the stroma, which is shielded from light.

D. they are less important to the overall process of photosynthesis than the light reactions.

69. In an experiment, a plant is provided with water containing a radioactive isotope of oxygen, $H_2{}^{18}O$. The ^{18}O isotope will be found in which product of photosynthesis?

A. In the glucose ($C_6H_{12}O_6$) molecule.

B. In the oxygen gas (O_2) released.

C. In the carbon dioxide (CO_2) used.

D. It will not be incorporated into any product.

70. The "link reaction" in cellular respiration connects which two major stages?

A. Glycolysis and the Krebs cycle.

B. The Krebs cycle and the electron transport chain.

C. The light and dark reactions of photosynthesis.

D. Glycolysis and fermentation.

71. Which statement accurately describes a key feature of CAM photosynthesis?

A. It separates carbon fixation and the Calvin cycle spatially between two different cell types.

B. It is less water-efficient than C3 photosynthesis.

C. It involves fixing CO_2 at night to minimize water loss.

D. It does not use the enzyme RuBisCO.

72. The final destination of electrons that pass through the electron transport chain during non-cyclic photophosphorylation is:

A. Photosystem I.

B. water.

C. NADP+.

D. ATP.

73. How many molecules of CO_2 are released for each molecule of pyruvate that is oxidized through the Krebs cycle?

A. One.

B. Two.

C. Three.

D. Six.

74. A coupled reaction in metabolism involves:

A. two anabolic reactions occurring simultaneously.

B. two catabolic reactions occurring simultaneously.

C. an exergonic reaction driving an endergonic reaction.

D. an endergonic reaction driving an exergonic reaction.

75. The stacks of thylakoids found within a chloroplast are called:

A. stroma.

B. grana.

C. lamellae.

D. cristae.

76. Which of the following is **NOT** a product of the Krebs cycle per turn (from one acetyl CoA)?

A. ATP (or GTP).

B. CO_2.

C. Pyruvate.

D. $FADH_2$.

77. Which sequence correctly represents the flow of electrons during photosynthesis?

A. NADPH → O_2 → CO_2

B. H_2O → NADPH → Calvin cycle

C. NADPH → electron transport chain → O_2

D. H_2O → Photosystem II → Photosystem I → NADP+

78. The synthesis of ATP via a proton gradient is a process known as:

A. chemiosmosis.

B. hydrolysis.

C. dehydrogenation.

D. glycolysis.

79. What distinguishes photorespiration from cellular respiration?

A. Photorespiration produces ATP, whereas cellular respiration consumes it.

B. Photorespiration occurs in the light and does not produce ATP, unlike cellular respiration.

C. Photorespiration consumes CO_2 and releases O_2, the opposite of cellular respiration.

D. Photorespiration occurs in the mitochondria, while cellular respiration occurs in the chloroplasts.

80. The first phase of glycolysis, involving the phosphorylation of glucose, is often called the:

A. energy liberation phase.

B. cleavage phase.

C. energy investment phase.

D. oxidation phase.

81. Which of these processes contributes to the maintenance of the O_2 and CO_2 balance in the atmosphere?

A. Photosynthesis consumes O_2 and releases CO_2.

B. Cellular respiration consumes CO_2 and releases O_2.

C. Photosynthesis consumes CO_2 and releases O_2.

D. Both processes consume CO_2 and release O_2.

82. Which molecule enters the Krebs cycle by combining with oxaloacetate?

A. Pyruvate.

B. Citrate.

C. Malate.

D. Acetyl CoA.

83. The light-independent reactions of photosynthesis require which of the following from the light-dependent reactions?

A. CO_2 and glucose.

B. O_2 and H_2O.

C. Light and chlorophyll.

D. ATP and NADPH.

84. Compared to a gram of carbohydrate, a gram of fat oxidized by respiration produces:

A. less than half the amount of ATP.

B. approximately the same amount of ATP.

C. slightly more ATP.

D. more than twice as much ATP.

85. A key difference in the structure of the mitochondria and chloroplast is that:

A. mitochondria have a double membrane, whereas chloroplasts have a single membrane.

B. chloroplasts contain their own genetic material, but mitochondria do not.

C. mitochondria have inner folds called cristae, while chloroplasts have disc-like sacs called thylakoids.

D. mitochondria are found in animal cells, while chloroplasts are found in plant and bacterial cells.

86. Which of the following statements about glycolysis is true?

A. It requires oxygen to proceed.

B. It is the most efficient stage of cellular respiration in terms of ATP

production.

C. It occurs in the mitochondrial matrix.

D. It breaks down a six-carbon sugar into two three-carbon molecules.

87. What is the role of NADH and $FADH_2$ in cellular respiration?

A. To directly provide energy for substrate-level phosphorylation.

B. To act as the final electron acceptors in the electron transport chain.

C. To carry high-energy electrons to the electron transport chain.

D. To catalyze the reactions of the Krebs cycle.

88. If the enzyme RuBisCO were to be completely inhibited, which process would immediately stop?

A. The splitting of water in the light reactions.

B. The absorption of light by chlorophyll.

C. The synthesis of ATP via chemiosmosis.

D. The fixation of carbon in the Calvin cycle.

89. The sour taste of yogurt is due to the production of _____ by bacteria.

A. ethanol

B. lactic acid

C. acetic acid

D. carbon dioxide

90. In the equation for aerobic respiration, $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$, the glucose molecule is:

A. reduced.

B. oxidized.

C. phosphorylated.

D. hydrolyzed.

91. The primary function of the porphyrin ring in a chlorophyll molecule is to:

A. anchor the pigment to the thylakoid membrane.

B. absorb light energy and lose or gain electrons easily.

C. reflect green light, giving the leaf its color.

D. transfer energy to carotenoid pigments.

92. In which of the following organisms would you expect to find the highest rate of CAM photosynthesis?

A. A sugarcane plant in a tropical field.

B. A cactus in a hot, dry desert.

C. An oak tree in a temperate forest.

D. Rice in a flooded paddy.

93. The protein complexes of the electron transport chain in mitochondria are found in the:

A. cytosol.

B. outer mitochondrial membrane.

C. mitochondrial matrix.

D. inner mitochondrial membrane.

94. Which of the following correctly orders the main stages of aerobic cellular respiration?

A. Krebs Cycle → Glycolysis → Oxidative Phosphorylation

B. Glycolysis → Oxidative Phosphorylation → Krebs Cycle

C. Oxidative Phosphorylation → Krebs Cycle → Glycolysis

D. Glycolysis → Krebs Cycle → Oxidative Phosphorylation

95. In the absence of oxygen, the net ATP gain for a cell from the breakdown of one glucose molecule is primarily from which process?

A. The Krebs cycle.

B. Oxidative phosphorylation.

C. Glycolysis.

D. The link reaction.

96. Which environmental condition would most favor photorespiration?

A. A cool, moist environment with high CO_2 levels.

B. A hot, dry environment with low CO_2 levels.

C. A dark environment with high O_2 levels.

D. A warm, humid environment with low O_2 levels.

97. The three main stages of the Calvin cycle, in the correct order, are:

A. Reduction, Fixation, Regeneration.

B. Fixation, Regeneration, Reduction.

C. Fixation, Reduction, Regeneration.

D. Regeneration, Fixation, Reduction.

98. Which of the following processes requires a net input of energy from another source?

A. $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

B. $ADP + Pi \rightarrow ATP + H_2O$

C. The breakdown of proteins to amino acids.

D. $ATP + H_2O \rightarrow ADP + Pi$

99. The energy for the formation of ATP by ATP synthase in both mitochondria and chloroplasts is directly supplied by:

A. the breakdown of glucose.

B. the absorption of light.

C. the flow of protons (H+) down an electrochemical gradient.

D. the transfer of phosphate from a substrate molecule.

100. The continuity of life on Earth is fundamentally dependent on energy transformations. Which two processes are most directly responsible for the flow of energy from the sun to the metabolic activities of animals?

A. Fermentation and Glycolysis.

B. Photosynthesis and Cellular Respiration.

C. Krebs Cycle and Calvin Cycle.

D. Light Reactions and Chemiosmosis.

1. **Answer:** B

   Explanation: The text explicitly defines anabolism as a constructive (building up) process that requires energy (endergonic), and catabolism as a destructive (breaking down) process that releases energy (exergonic).

   Competency: Explain anabolic and catabolic pathways in cellular metabolism.

   Page: 115-116

2. **Answer:** D

   Explanation: The definition of photosynthesis on page 118 clearly states that it is a series of chemical reactions that "use light energy" to assemble CO_2 into glucose. This light energy comes from the sun.

   Competency: Discuss the process of energy transformation in cells.

   Page: 118

3. **Answer:** B

   Explanation: The text explains that during the light-dependent reactions, water is split in a process called photolysis. This reaction provides electrons and protons (H+) and releases oxygen gas (O_2) as a byproduct.

   Competency: Explain the process of dark and light reaction of photosynthesis.

   Page: 118, 125

4. **Answer:** C

   Explanation: The text describes the palisade mesophyll cells as being located near the upper surface of the leaf where they receive more sunlight and consequently contain more chloroplasts, making them the

primary site for photosynthesis.

Competency: Describe the external and internal structure of a leaf.

Page: 119

5. **Answer:** B

Explanation: Page 120 states that the light-dependent stage of photosynthesis takes place in the thylakoids (which are stacked into grana), while the light-independent stage (Calvin cycle) occurs in the fluid-filled matrix called the stroma.

Competency: Explain the roles of grana and stroma in the process of photosynthesis.

Page: 120

6. **Answer:** B

Explanation: Catabolism is the breakdown of complex molecules. Glycolysis is the process of breaking down a complex six-carbon glucose molecule into two simpler three-carbon pyruvate molecules, which fits the definition of a catabolic pathway.

Competency: Explain anabolic and catabolic pathways in cellular metabolism.

Page: 115, 140

7. **Answer:** C

Explanation: Pigments appear a certain color because they reflect or transmit the wavelengths of light corresponding to that color, while absorbing other wavelengths. A green pigment absorbs blue and red light but reflects green light.

Competency: Describe the different chlorophyll pigments involved in the

absorption of light energy.

Page: 121-122

8. **Answer:** B

Explanation: The text describes carotenoids as accessory pigments that cannot transfer sunlight energy directly to the photosynthetic pathway but must pass their absorbed energy to chlorophyll. They expand the range of light that can be used for photosynthesis.

Competency: Describe the different chlorophyll pigments involved in the absorption of light energy.

Page: 121

9. **Answer:** B

Explanation: The absorption spectrum graph on page 122 clearly shows that both chlorophyll a and chlorophyll b have major absorption peaks in the blue-violet range (around 400-450 nm) and the red range (around 650-700 nm), with very little absorption in the green-yellow range.

Competency: Analyze an absorption spectra of chlorophyll a and chlorophyll b using graph.

Page: 122

10. **Answer:** D

Explanation: The light-dependent reactions convert solar energy into chemical energy in the form of ATP and NADPH. These two molecules are then used to power the synthesis of sugars in the Calvin cycle. Oxygen is a byproduct released, not used in the Calvin cycle.

Competency: Explain the process of dark and light reaction of

photosynthesis.

Page: 123, 125

11. **Answer:** B

Explanation: The light-dependent splitting of water is specifically termed photolysis. This process is crucial as it releases electrons, protons, and oxygen.

Competency: Explain the process of dark and light reaction of photosynthesis.

Page: 125

12. **Answer:** B

Explanation: In non-cyclic photophosphorylation, the electrons lost from the reaction center of photosystem II (P680) are replaced by electrons derived from the photolysis (splitting) of water molecules.

Competency: Describe cyclic and non-cyclic photophosphorylation.

Page: 125

13. **Answer:** C

Explanation: The key distinction is the involvement of photosystems. Non-cyclic photophosphorylation uses both Photosystem II and I to produce both ATP and NADPH. Cyclic photophosphorylation uses only Photosystem I and produces only ATP.

Competency: Compare cyclic and non-cyclic photophosphorylation.

Page: 124

14. **Answer:** D

Explanation: The text identifies the enzyme RuBP carboxylase, commonly known as RuBisCO, as the catalyst for the reaction where CO_2

is combined with the five-carbon acceptor molecule, RuBP, in the first step of the Calvin cycle.

Competency: Explain the process of Calvin cycle.

Page: 126

15. **Answer:** B

Explanation: The Calvin cycle is called the C3 pathway because the first stable product formed after carbon dioxide fixation is a three-carbon compound called 3-phosphoglycerate (3-PGA).

Competency: Discuss the mechanism as to how CO_2 is fixed in C_3,C_4 plants, and CAM Plants.

Page: 126

16. **Answer:** C

Explanation: The primary function of the Calvin cycle (the light-independent reactions) is to use the ATP and NADPH produced during the light-dependent reactions to convert carbon dioxide into simple sugars like glyceraldehyde-3-phosphate (G3P), which is then used to synthesize glucose.

Competency: Explain the process of Calvin cycle.

Page: 126

17. **Answer:** C

Explanation: C4 plants minimize photorespiration by using the enzyme PEP carboxylase to fix CO_2 initially in mesophyll cells. This fixed carbon is then transported to bundle-sheath cells, where CO_2 is released, creating a high concentration that favors the carboxylase activity of RuBisCO over its oxygenase activity.

Competency: Justify the reason why the rate of photorespiration is less in C4 plants as compared to C3 plants.

Page: 127

18. **Answer:** C

Explanation: Crassulacean acid metabolism (CAM) plants are adapted to arid conditions. They open their stomata at night to fix CO_2 into organic acids (temporal separation) and close them during the day to conserve water while using the stored CO_2 for the Calvin cycle.

Competency: Differentiate between C3, C4 plants, and CAM Plants.

Page: 129

19. **Answer:** B

Explanation: Photorespiration is considered wasteful because RuBisCO fixes O_2 instead of CO_2. This process consumes ATP and releases previously fixed carbon as CO_2, resulting in a net loss of energy and carbon from the Calvin cycle without producing any sugar.

Competency: Justify the reason why the rate of photorespiration is less in C4 plants as compared to C3 plants.

Page: 130

20. **Answer:** B

Explanation: This equation correctly shows the reactants (glucose and oxygen) and the products (carbon dioxide, water, and ATP) of aerobic cellular respiration.

Competency: write the chemical equation of aerobic respiration.

Page: 140

21. **Answer:** B

Explanation: An endergonic reaction is a non-spontaneous reaction that requires a net input of energy from its surroundings to proceed. An example is anabolism.

Competency: Define cellular metabolism.

Page: 116

22. **Answer:** C

Explanation: ATP (Adenosine Triphosphate) is referred to as the "energy currency of the cell." The energy released from the hydrolysis of ATP to ADP is used to power the vast majority of cellular activities.

Competency: Define cellular respiration.

Page: 137

23. **Answer:** A

Explanation: The breaking of the phosphoanhydride bond in ATP to release a phosphate group and form ADP is a hydrolysis reaction, meaning it involves the addition of a water molecule to break a bond.

Competency: Apply the concept of cellular respiration to calculate amount of energy yield from a given molecule of glucose.

Page: 137

24. **Answer:** C

Explanation: The text explicitly states that glycolysis occurs in the cytosol (or cytoplasm) of the cell and does not require oxygen.

Competency: describe the process of glycolysis.

Page: 139, 140

25. **Answer:** C

Explanation: During glycolysis, there is an initial investment of 2 ATP, but a total of 4 ATP are produced via substrate-level phosphorylation, resulting in a net gain of 2 ATP. Additionally, 2 molecules of NAD+ are reduced to form 2 NADH.

Competency: list the products formed at the end of glycolysis.

Page: 142

26. **Answer:** B

Explanation: Glycolysis is the metabolic pathway that breaks down one molecule of glucose into two molecules of pyruvate.

Competency: describe the process of glycolysis.

Page: 140

27. **Answer:** D

Explanation: Before the Krebs cycle, pyruvate undergoes pyruvate oxidation (the link reaction), where it is decarboxylated and oxidized to form a two-carbon acetyl group, which then attaches to Coenzyme A to form acetyl CoA.

Competency: describe the different stages of aerobic respiration.

Page: 142

28. **Answer:** C

Explanation: After being formed in the link reaction, acetyl CoA enters the mitochondrial matrix, which is the specific location where all the enzymes of the Krebs cycle are found.

Competency: describe the structure of mitochondria.

Page: 143

29. **Answer:** B

Explanation: Glycolysis produces two molecules of pyruvate from one molecule of glucose. Each pyruvate is converted into one acetyl CoA. Therefore, two turns of the Krebs cycle are needed to completely process the products of one glucose molecule.

Competency: describe the different stages of aerobic respiration.

Page: 143

30. **Answer:** B

Explanation: The primary purpose of the Krebs cycle is to complete the oxidation of the acetyl group and capture the high-energy electrons in the form of reduced coenzymes, specifically NADH and $FADH_2$.

Competency: describe the different stages of aerobic respiration.

Page: 143-144

31. **Answer:** C

Explanation: Oxidative phosphorylation, which includes the electron transport chain and chemiosmosis, generates the vast majority of ATP (about 30-34 molecules) from each glucose molecule, far more than the net 2 ATP from glycolysis or the 2 ATP from the Krebs cycle.

Competency: Differentiate between substrate-level phosphorylation and oxidative phosphorylation.

Page: 144

32. **Answer:** B

Explanation: Oxygen's critical role in aerobic respiration is to act as the terminal (final) electron acceptor at the end of the electron transport chain. By accepting electrons, it is reduced to form water, which allows

the chain to continue operating.

Competency: show the mechanism electron transport system in mitochondria.

Page: 145

33. **Answer:** C

Explanation: The protein complexes and electron carriers that constitute the electron transport chain are embedded within the inner mitochondrial membrane (cristae).

Competency: describe the structure of mitochondria.

Page: 144

34. **Answer:** B

Explanation: Chemiosmosis is the specific process where the potential energy stored in the form of a proton (H+) gradient across a membrane is used to drive cellular work, such as the synthesis of ATP by ATP synthase.

Competency: show the mechanism electron transport system in mitochondria.

Page: 146

35. **Answer:** B

Explanation: In the absence of oxygen, the electron transport chain stops, and NADH cannot be reoxidized to NAD+. Fermentation is an anaerobic pathway that oxidizes NADH back to NAD+, which is required for glycolysis to continue producing a small amount of ATP.

Competency: Discuss the significances of fermentation by

microorganisms in our daily life.

Page: 152

36. **Answer:** C

Explanation: During strenuous exercise when oxygen supply is insufficient, human muscle cells undergo lactic acid fermentation. Pyruvate accepts electrons from NADH, regenerating NAD+ and forming lactate (lactic acid) as the end product.

Competency: compare and contrast aerobic and anaerobic respiration.

Page: 153

37. **Answer:** D

Explanation: Glycolysis is the initial pathway for breaking down glucose and occurs in the cytosol. It is a universal process that precedes both aerobic respiration (if oxygen is present) and fermentation (if oxygen is absent).

Competency: compare and contrast aerobic and anaerobic respiration.

Page: 140

38. **Answer:** B

Explanation: Yeast is a facultative anaerobe that, in the absence of oxygen, carries out alcoholic fermentation. It converts pyruvate first to acetaldehyde (releasing CO_2) and then to ethanol, oxidizing NADH to NAD+ in the process.

Competency: state the products of alcoholic fermentation by yeast.

Page: 153

39. **Answer:** B

Explanation: Anabolism is the set of metabolic pathways that construct

complex molecules from simpler units. The synthesis of proteins from amino acids and polysaccharides from monosaccharides are classic examples of anabolic processes.

Competency: Explain anabolic and catabolic pathways in cellular metabolism.

Page: 115

40. **Answer:** B

Explanation: This spatial separation is the hallmark of C4 photosynthesis. CO_2 is first fixed into a four-carbon acid in the mesophyll cells. This acid is then shuttled to the bundle-sheath cells, where the CO_2 is released to enter the Calvin cycle.

Competency: Differentiate between C3, C4 plants, and CAM Plants.

Page: 128

41. **Answer:** C

Explanation: The reduction phase of the Calvin cycle involves the conversion of 3-PGA to G3P. This is a reduction reaction because 3-PGA gains electrons, which are donated by NADPH. ATP provides the necessary energy for this process.

Competency: Explain the process of Calvin cycle.

Page: 126

42. **Answer:** C

Explanation: In the final phase of the Calvin cycle, some of the G3P molecules produced are used in a complex series of reactions, powered by ATP, to regenerate the initial CO_2 acceptor molecule, ribulose-1,5-bisphosphate (RuBP), allowing the cycle to continue.

Competency: Explain the process of Calvin cycle.

Page: 126

43. **Answer:** C

Explanation: The text states that chlorophyll "a" is found in all plants, algae, and cyanobacteria, while chlorophyll "b" occurs only in "green algae" and in plants. The presence of both indicates the organism is a plant or green alga.

Competency: Describe the different chlorophyll pigments involved in the absorption of light energy.

Page: 121

44. **Answer:** B

Explanation: Carbon dioxide is produced when a carboxyl group is removed from a molecule. This happens during the conversion of the three-carbon pyruvate to the two-carbon acetyl CoA (link reaction) and at two separate steps within the Krebs cycle.

Competency: describe the different stages of aerobic respiration.

Page: 142-144

45. **Answer:** B

Explanation: The proton gradient is a form of stored energy due to the difference in concentration and electrical charge across the membrane. This stored energy, based on position or configuration, is defined as potential energy.

Competency: explain how energy is harvested in aerobic respiration.

Page: 147

46. **Answer:** C

Explanation: Through a process called beta-oxidation, fatty acid chains are broken down into two-carbon acetyl groups. These acetyl groups then attach to Coenzyme A to form acetyl CoA, which can then enter the Krebs cycle.

Competency: Appreciate the mechanism of energy transformation in cells.

Page: 149

47. **Answer:** C

Explanation: Before the carbon skeletons of amino acids can be used as fuel in glycolysis or the Krebs cycle, their amino groups must be removed. This process is called deamination.

Competency: Appreciate the mechanism of energy transformation in cells.

Page: 149

48. **Answer:** B

Explanation: The epidermis of the leaf secretes a waxy coating called the cuticle, which is waterproof and helps the plant retain water by preventing evaporation.

Competency: Describe the external and internal structure of a leaf.

Page: 118

49. **Answer:** B

Explanation: Photosynthesis begins with the capture of light energy. This energy is first converted into temporary chemical energy carriers (ATP and NADPH) during the light-dependent reactions. This chemical energy

is then used to synthesize stable chemical energy in the form of sugar during the Calvin cycle.

Competency: Discuss the process of energy transformation in cells.

Page: 113

50. **Answer:** D

Explanation: The light-independent reactions (Calvin cycle) use the products of the light-dependent reactions (ATP and NADPH) along with carbon dioxide from the atmosphere to synthesize sugars.

Competency: Explain the process of dark and light reaction of photosynthesis.

Page: 126

51. **Answer:** C

Explanation: Substrate-level phosphorylation is the direct transfer of a phosphate group from a substrate molecule to ADP to form ATP. This mechanism is used to generate ATP during both glycolysis and the Krebs cycle.

Competency: Differentiate between substrate-level phosphorylation and oxidative phosphorylation.

Page: 140

52. **Answer:** C

Explanation: Stomata are pores, typically on the leaf's underside, that can open and close. Their primary function is to allow for gas exchange: the entry of CO_2 for photosynthesis and the exit of O_2 and water vapor.

Competency: Describe the external and internal structure of a leaf.

Page: 118

53. **Answer:** A

Explanation: The synthesis of ATP by ATP synthase is powered by the flow of protons down their concentration gradient (chemiosmosis). If the membrane were permeable to protons, the gradient would dissipate, and ATP synthesis would stop.

Competency: Explain the process of dark and light reaction of photosynthesis.

Page: 123

54. **Answer:** D

Explanation: The complete oxidation of glucose through glycolysis, the link reaction, the Krebs cycle, and oxidative phosphorylation consumes glucose and oxygen and produces ATP, carbon dioxide, and water.

Competency: write the chemical equation of aerobic respiration.

Page: 140

55. **Answer:** D

Explanation: The Krebs cycle begins when acetyl CoA combines with the four-carbon molecule oxaloacetate. After a series of reactions that release CO_2 and generate ATP, NADH, and $FADH_2$, oxaloacetate is regenerated at the end of the cycle, ready to accept another acetyl CoA.

Competency: describe the different stages of aerobic respiration.

Page: 143

56. **Answer:** B

Explanation: In photosynthesis, carbon dioxide gains electrons and hydrogen ions to become glucose, so it is reduced. Water loses electrons when it is split to release oxygen, so it is oxidized.

Competency: Summarize the process of photosynthesis using chemical equation.

Page: 118

57. **Answer:** C

Explanation: The names themselves indicate the difference. ATP is Adenosine Tri-Phosphate (three phosphate groups), while ADP is Adenosine Di-Phosphate (two phosphate groups).

Competency: Define cellular respiration.

Page: 137

58. **Answer:** C

Explanation: An exergonic pathway is one that releases energy. Cellular respiration breaks down glucose, a high-energy molecule, into lower-energy molecules (CO_2 and H_2O), releasing a large amount of free energy that is captured in ATP.

Competency: Explain anabolic and catabolic pathways in cellular metabolism.

Page: 116

59. **Answer:** D

Explanation: A key feature of CAM plants is the storage of malic acid (an organic acid derived from CO_2 fixation) in the large central vacuoles of their leaf cells overnight. This stored acid provides the CO_2 for the Calvin cycle during the day.

Competency: Differentiate between C3, C4 plants, and CAM Plants.

Page: 129

60. **Answer:** A

Explanation: When the reaction-center chlorophyll a molecule of Photosystem II, known as P680, absorbs light energy, one of its electrons is boosted to a higher energy level and captured by the primary electron acceptor.

Competency: Describe cyclic and non-cyclic photophosphorylation.

Page: 123

61. **Answer:** C

Explanation: The Electron Transport Chain is strictly aerobic because oxygen is the final electron acceptor. Glycolysis and fermentation are anaerobic. The Krebs cycle is indirectly aerobic as it requires the NAD+ regenerated by the aerobic ETC.

Competency: compare and contrast aerobic and anaerobic respiration.

Page: 145

62. **Answer:** B

Explanation: The process of photosynthesis is fundamentally about "carbon fixation," which is the incorporation of inorganic carbon from atmospheric carbon dioxide (CO_2) into organic molecules, which are then used to build glucose.

Competency: Explain the process of Calvin cycle.

Page: 126

63. **Answer:** B

Explanation: Stomata are the pores through which CO_2, a necessary reactant for photosynthesis, enters the leaf. If the stomata are closed to conserve water, the CO_2 supply inside the leaf will be depleted, thus

limiting and decreasing the rate of photosynthesis.

Competency: Discuss the mechanism as to how CO_2 is fixed in C_3,C_4 plants, and CAM Plants.

Page: 118

64. **Answer:** B

Explanation: The first few steps of glycolysis are known as the energy investment phase because two molecules of ATP are consumed to phosphorylate the glucose molecule, making it more reactive and preparing it for cleavage.

Competency: list the products formed at the end of glycolysis.

Page: 142

65. **Answer:** B

Explanation: PEP carboxylase is the enzyme in C4 plants responsible for the initial fixation of CO_2 into a four-carbon compound in the mesophyll cells. Inhibiting this enzyme would halt this crucial first step, preventing CO_2 from being shuttled to the bundle-sheath cells.

Competency: Differentiate between C3, C4 plants, and CAM Plants.

Page: 128

66. **Answer:** B

Explanation: The entire purpose of the light-dependent reactions is to absorb solar energy and convert it into a usable chemical form. This is accomplished by producing the energy-rich molecules ATP and NADPH, which then power the synthesis of sugars in the next stage.

Competency: Explain the process of dark and light reaction of

photosynthesis.

Page: 123

67. **Answer:** C

Explanation: The protein complexes in the electron transport chain act as proton pumps. As high-energy electrons are passed from one complex to another, the energy released is used to actively transport protons (H+) from the mitochondrial matrix into the intermembrane space, creating a proton gradient.

Competency: show the mechanism electron transport system in mitochondria.

Page: 146

68. **Answer:** B

Explanation: While they depend on the products of the light reactions (ATP and NADPH), the enzymatic reactions of the Calvin cycle themselves do not directly use photons of light as an energy source. They can proceed as long as ATP and NADPH are available.

Competency: Explain the process of dark and light reaction of photosynthesis.

Page: 126

69. **Answer:** B

Explanation: Experiments using isotopic tracers have confirmed that the oxygen gas released during photosynthesis comes from the splitting (oxidation) of water molecules, not from the carbon dioxide molecules.

Competency: Summarize the process of photosynthesis using chemical

equation.

Page: 118

70. **Answer:** A

Explanation: The link reaction, or pyruvate oxidation, is the intermediate step that processes the product of glycolysis (pyruvate) into the reactant for the Krebs cycle (acetyl CoA).

Competency: describe the different stages of aerobic respiration.

Page: 142

71. **Answer:** C

Explanation: CAM photosynthesis is a temporal (time-based) separation of processes. To minimize water loss (transpiration), CAM plants open their stomata and fix CO_2 into organic acids at night when it is cooler, then process these acids to release CO_2 for the Calvin cycle during the day when the stomata are closed.

Competency: Differentiate between C3, C4 plants, and CAM Plants.

Page: 129

72. **Answer:** C

Explanation: In non-cyclic photophosphorylation, electrons flow from water through PSII, down an ETC, through PSI, and then down a second ETC to the final electron acceptor, NADP+, which is reduced to NADPH.

Competency: Describe cyclic and non-cyclic photophosphorylation.

Page: 123

73. **Answer:** C

Explanation: One molecule of pyruvate (a 3-carbon molecule) is converted to acetyl CoA (a 2-carbon molecule), releasing one CO_2. The 2-

carbon acetyl CoA then enters the Krebs cycle, where its two carbons are released as two more CO_2 molecules. Total = 1 + 2 = 3.

Competency: describe the different stages of aerobic respiration.

Page: 142-144

74. **Answer:** C

Explanation: Coupled reactions are a fundamental concept in bioenergetics. The energy released by an exergonic (energy-releasing) reaction, like ATP hydrolysis, is used to drive an endergonic (energy-requiring) reaction, like muscle contraction or active transport.

Competency: Discuss the process of energy transformation in cells.

Page: 138

75. **Answer:** B

Explanation: The text describes thylakoids as disk-shaped compartments. It states that in most plants, thylakoids are interconnected to form stacks called grana.

Competency: Explain the the roles of grana and and stroma in the process of photosynthesis.

Page: 120

76. **Answer:** C

Explanation: Pyruvate is the reactant for the link reaction that produces acetyl CoA; it is not a product of the Krebs cycle. The Krebs cycle takes acetyl CoA and produces ATP (or GTP), CO_2, NADH, and $FADH_2$.

Competency: describe the different stages of aerobic respiration.

Page: 144

77. **Answer:** D

Explanation: This sequence traces the path of electrons in the light-dependent reactions. Electrons originate from the splitting of water, are excited in Photosystem II, pass down an electron transport chain, are re-excited in Photosystem I, and are finally transferred to NADP+ to form NADPH.

Competency: Describe cyclic and non-cyclic photophosphorylation.

Page: 123

78. **Answer:** A

Explanation: Chemiosmosis is the specific term for the process in which energy stored in a hydrogen ion (proton) gradient across a membrane is used to drive the synthesis of ATP.

Competency: show the mechanism electron transport system in mitochondria.

Page: 146

79. **Answer:** B

Explanation: Photorespiration occurs in the light, consumes oxygen and ATP, and releases CO_2, but it does not produce any usable energy (ATP) for the cell. Cellular respiration, on the other hand, is the primary process for producing ATP.

Competency: Justify the reason why the rate of photorespiration is less in C4 plants as compared to C3 plants.

Page: 130

80. **Answer:** C

Explanation: The initial steps of glycolysis (steps 1-3) require the cell to

use two ATP molecules to phosphorylate glucose and its intermediate. This is an investment of energy that is paid back with a net gain of ATP in the later energy liberation phase.

Competency: describe the process of glycolysis.

Page: 142

81. **Answer:** C

Explanation: Photosynthesis removes carbon dioxide from the atmosphere and releases oxygen. Cellular respiration does the opposite, consuming oxygen and releasing carbon dioxide. Together, these processes maintain the balance of these crucial gases.

Competency: Justify how energy transformations in cells contribute for the maintenance CO_2 and O_2 balance in the atomosphere.

Page: 134

82. **Answer:** D

Explanation: The Krebs cycle begins when the two-carbon acetyl group from acetyl CoA joins with the four-carbon acceptor molecule, oxaloacetate, to form the six-carbon molecule, citrate.

Competency: describe the different stages of aerobic respiration.

Page: 143

83. **Answer:** D

Explanation: The light-independent reactions (Calvin Cycle) are dependent on the light-dependent reactions for a constant supply of chemical energy (ATP) and reducing power (NADPH) to fix CO_2 and synthesize sugars.

Competency: Explain the process of dark and light reaction of

photosynthesis.

Page: 126

84. **Answer:** D

Explanation: The text states, "A gram of fat oxidized by respiration produces more than twice as much ATP as a gram of carbohydrate." This is due to the highly reduced state of the carbon atoms in the long hydrocarbon tails of fatty acids.

Competency: Appreciate the mechanism of energy transformation in cells.

Page: 149

85. **Answer:** C

Explanation: A key structural difference is their internal membrane systems. Mitochondria have an inner membrane that is folded into cristae to increase surface area for the ETC. Chloroplasts have an internal system of flattened, interconnected sacs called thylakoids.

Competency: describe the structure of mitochondria.

Page: 120, 136

86. **Answer:** D

Explanation: Glycolysis is the initial stage where the six-carbon sugar, glucose, is split into two molecules of the three-carbon compound, pyruvate. It is an anaerobic process occurring in the cytosol.

Competency: describe the process of glycolysis.

Page: 140

87. **Answer:** C

Explanation: NADH and $FADH_2$ are high-energy electron carriers. They are

produced during glycolysis and the Krebs cycle and their primary role is to transport these electrons to the electron transport chain, where their energy is used to generate a proton gradient for ATP synthesis.

Competency: explain how energy is harvested in aerobic respiration.

Page: 145

88. **Answer:** D

Explanation: RuBisCO is the enzyme that catalyzes the very first step of the Calvin cycle: the fixation of atmospheric CO_2 to RuBP. If this enzyme is inhibited, the entire cycle cannot begin.

Competency: Explain the process of Calvin cycle.

Page: 126

89. **Answer:** B

Explanation: Certain bacteria used in the production of yogurt carry out lactic acid fermentation. The lactic acid they produce causes milk proteins to coagulate (forming the yogurt texture) and contributes the characteristic sour taste.

Competency: Discuss the significances of fermentation by microorganisms in our daily life.

Page: 153

90. **Answer:** B

Explanation: In this redox reaction, glucose ($C_6H_{12}O_6$) loses electrons (and hydrogen atoms) as it is converted to carbon dioxide (CO_2). The loss of electrons is the definition of oxidation. Oxygen is reduced.

Competency: Compare the process of photosynthesis and cellular

respiration.

Page: 140

91. **Answer:** B

Explanation: The porphyrin ring is the light-absorbing "head" of the chlorophyll molecule. Its structure allows it to easily gain or lose electrons, which is essential for capturing light energy and passing energized electrons to other molecules.

Competency: Describe the different chlorophyll pigments involved in the absorption of light energy.

Page: 121

92. **Answer:** B

Explanation: CAM photosynthesis is an adaptation to extremely hot and dry (arid) environments. Cacti and other succulent plants in deserts use CAM to minimize water loss by opening their stomata only at night.

Competency: Differentiate between C3, C4 plants, and CAM Plants.

Page: 129

93. **Answer:** D

Explanation: The electron transport chain consists of a series of protein complexes embedded within the inner mitochondrial membrane. This location is critical for their function of pumping protons from the matrix to the intermembrane space.

Competency: show the mechanism electron transport system in mitochondria.

Page: 144

94. **Answer:** D

Explanation: Aerobic respiration begins with Glycolysis in the cytosol. The product, pyruvate, is processed and enters the Krebs Cycle in the mitochondrial matrix. The electron carriers from both stages then fuel Oxidative Phosphorylation on the inner mitochondrial membrane.

Competency: describe the different stages of aerobic respiration.

Page: 140

95. **Answer:** C

Explanation: In the absence of oxygen, the Krebs cycle and oxidative phosphorylation cannot occur. The only source of ATP is the net gain of 2 ATP molecules produced during glycolysis through substrate-level phosphorylation.

Competency: compare and contrast aerobic and anaerobic respiration.

Page: 152

96. **Answer:** B

Explanation: Photorespiration is favored when the concentration of O_2 is high relative to CO_2 inside the leaf. Hot, dry conditions cause plants to close their stomata to conserve water. This traps O_2 (from light reactions) inside and prevents new CO_2 from entering, creating the ideal conditions for photorespiration.

Competency: Justify the reason why the rate of photorespiration is less in C4 plants as compared to C3 plants.

Page: 130

97. **Answer:** C

Explanation: The Calvin cycle proceeds in three distinct stages: 1. Carbon

Fixation (capturing CO_2), 2. Reduction (using ATP and NADPH to convert 3-PGA to G3P), and 3. Regeneration (using ATP to reform the starting molecule, RuBP).

Competency: Explain the process of Calvin cycle.

Page: 126

98. **Answer:** B

Explanation: The reaction that forms ATP from ADP and inorganic phosphate is an endergonic process. It requires a net influx of energy, which in cells is supplied by catabolism (cellular respiration) or light energy (photosynthesis), to create the high-energy phosphate bond.

Competency: Explain anabolic and catabolic pathways in cellular metabolism.

Page: 138

99. **Answer:** C

Explanation: This is the core principle of chemiosmosis. The enzyme ATP synthase acts like a molecular turbine. The flow of protons (H+) through it, down their electrochemical gradient, provides the energy to drive the phosphorylation of ADP to ATP.

Competency: show the mechanism electron transport system in mitochondria.

Page: 146

100. **Answer:** B

Explanation: Photosynthesis is the process that captures the sun's energy and stores it in the chemical bonds of organic molecules (like glucose). Cellular respiration is the process by which organisms

(including animals that eat plants) break down these organic molecules to release the stored energy and produce ATP for their own metabolic activities.

Competency: Appreciate the role of photosynthesis and cellular respiration for continuity of life.

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