INDIAN SCHOOL AL WADI AL KABIR

Class: XI	**DEPARTMENT OF SCIENCE: 2025 – 2026** **SUBJECT: BIOLOGY**	**Date: 01.02.2026**
Worksheet: 19	**UNIT- IV- PLANT PHYSIOLOGY** **CHAPTER 12 Respiration in plants**	**Note:** **A4 FILE FORMAT**
NAME OF THE STUDENT	**CLASS & SEC:**	**ROLL NO.**

I.**MULTIPLE CHOICE QUESTIONS (1M)**

1. Which of the following processes occurs in both aerobic and anaerobic respiration?
   A. Krebs cycle
   B. Oxidative phosphorylation
   C. Glycolysis
   D. Fermentation
2. The Respiratory Quotient (RQ) value for carbohydrates is typically:
   A. 0.7
   B. 0.9
   C. 1
   D. More than 1
3. Which molecule acts as the terminal electron acceptor in aerobic respiration?
   A. Hydrogen
   B. Oxygen
   C. Cytochrome
   D. Glucose
4. During one turn of the Krebs cycle, how many molecules of NADH are produced?
   A. 1
   B. 2
   C. 3
   D. 4
5. Anaerobic respiration differs from aerobic respiration because it:
   A. Produces more ATP
   B. Requires oxygen
   C. Produces less ATP
   D. Occurs in mitochondria only

Two statements are given - one labelled as **Assertion (A)** and the other labelled as **Reason (R)**. Select the correct answer to these questions from the codes (A), (B), (C), and (D) as given below.

A. Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of the Assertion (A).
B. Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
C. Assertion (A) is true, Reason (R) is false.

D. Assertion (A) is false, Reason (R) is true.

6. **Assertion (A):** ATP synthesis occurs through chemiosmosis.
   Reason (R): The electron transport chain pumps protons into the intermembrane space.
7. **Assertion (A):** Plants do not have specialised respiratory organs.
   Reason (R): There is very little transport of gases from one plant part to another.
8. **Assertion (A):** The metabolic pathway through which the electron passes from one carrier to another is called the electron transport system (ETS).
   Reason (R): ETS is present in the inner mitochondrial membrane.

II. <u>VERY SHORT ANSWER TYPE QUESTIONS(2M)</u>

9. What are the assumptions made during the calculation of the net gain of ATP?
10. Differentiate between aerobic and anaerobic respiration in terms of oxygen requirement and energy yield.
11. Define respiratory substrate. Name the most common respiratory substrate and a substance that can be used under specific conditions.
12. What are the main steps in aerobic respiration? Where does it take place?
13. Discuss, "The respiratory pathway is an amphibolic pathway."
14. What is the significance of the step-wise release of energy in respiration?

III. <u>SHORT ANSWER TYPE QUESTIONS (3M)</u>

15. Explain the process of oxidative phosphorylation. Where does it occur?
16. Give the schematic representation of an overall view of the Krebs' cycle.
17. Explain alcoholic fermentation in plants. Why does anaerobic respiration yield less ATP than aerobic respiration?

IV. <u>CASE STUDY BASED QUESTIONS (4M)</u>

18. A student is observing two plants: Plant A, grown in normal oxygen conditions, and Plant B, grown in waterlogged soil where oxygen is limited. Both plants receive the same amount of sunlight and water. After some time, the student measures their energy production.

Observations:

- Plant A produces a large amount of ATP, grows well, and has healthy leaves.
- Plant B produces very little ATP, shows stunted growth, and some leaves start turning yellow.

A. Why is ATP production lower in Plant B compared to Plant A?
B. Explain the fate of the $NADH+H^+$ molecules produced during glycolysis in Plant A versus Plant B.
C. Write a short note on the importance of oxygen in aerobic respiration.

OR

D. Which process occurs identically in both Plant A and Plant B cells?

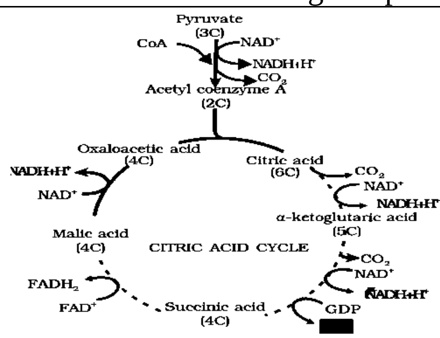
V. <u>LONG ANSWER TYPE QUESTIONS (5M)</u>

19. A. Where does glycolysis occur in a plant cell?
    B. What are the end products of glycolysis?
    C. Support your answer with a neat labelled diagram.
20. Explain ETS with a neat labelled diagram.

Answer Key

Q. No.	Answer
I.	**MULTIPLE CHOICE QUESTIONS (1M)**
1	C. Glycolysis
2	C. 1

3	A. Hydrogen
4	C. 3
5	C. Produces less ATP
	ASSERTION & REASONING
6	A. Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of the Assertion (A).
7	A. Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of the Assertion (A).
8	B. Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
II	**VERY SHORT ANSWER TYPE QUESTIONS(2M)**
9	Assumptions made during the calculation of the net gain of ATP are as follows: • NADH generated inside the mitochondria synthesises 3 ATP molecules during its oxidation. • NADH formed during glycolysis sends its reducing power into mitochondria via the shuttle system. • During oxidation of $FADH_2$, 2 molecules of ATP are produced inside mitochondria. • Formation of 3 ATP in the malate-aspartate shuttle (heart, liver, and kidney) and 2 ATP in the glycerol phosphate shuttle (muscles and nerve cells).
10	Oxygen Requirement: Aerobic respiration occurs in the presence of molecular oxygen, which acts as the terminal electron acceptor. Anaerobic respiration occurs in the absence of oxygen. Energy Yield: Aerobic respiration is a high-energy yielding process, producing around 36 to 38 ATP molecules per glucose molecule due to complete oxidation. Anaerobic respiration yields much less energy, with a net gain of only 2 ATP molecules, because the breakdown of the substrate is incomplete.
11	Definition: Respiratory substrates are the organic substances that are oxidized during respiration to release energy within living cells. Common Substrate: The most common respiratory substrate is glucose (a carbohydrate). Alternative Substrates: Under certain conditions (e.g., starvation), other substances like fats, proteins, and organic acids can also be broken down to produce energy.
12	The main steps in aerobic respiration are as follows: • Glycolysis: Occurs in the cytoplasm(cytosol), where glucose is broken down to pyruvic acid. • Oxidative decarboxylation of pyruvic acid to acetyl coenzyme-A: Takes place inside the mitochondrial matrix. • TCA, or the Krebs cycle, takes place in the Mitochondrial matrix, where pyruvic acid is oxidised to transform the energy contained in these molecules into ATP. • The electron transport chain occurs in the mitochondrial membrane, involves the ATP synthase complex.
13	Organic substances such as fats, carbohydrates, proteins, etc., liberate energy when they are disintegrated in the respiratory pathway. This phenomenon is said to be catabolic in nature. The respiratory process that serves as a catabolic pathway for the respiratory substrates also serves as an anabolic pathway to produce different metabolic products and secondary metabolites. Thus, the respiratory pathway serves as a catabolic and anabolic pathway. Therefore, the respiratory pathway is amphibolic.
14	During respiration single molecule of glucose is disintegrated to generate carbon dioxide and water along with the formation of ATP molecules. If the energy gets released at one go, then

	most of the energy will be lost as heat. In order to synthesise new compounds, the cell should be able to utilise the energy. Hence, the step-wise release of energy in respiration is most efficient in the conservation of energy.
III	**SHORT ANSWER TYPE QUESTIONS (3M)**
15	Oxidative phosphorylation is the metabolic pathway that synthesizes a large amount of ATP using the energy released from the oxidation of electron carriers (NADH and $FADH_2$) produced during cellular respiration. It occurs in two main steps within the inner mitochondrial membrane. 1. Electron Transport System (ETS): Electrons are passed sequentially along a chain of protein carriers. The energy released during this transfer is used to pump protons (H^+) from the matrix into the intermembrane space, generating a steep electrochemical gradient. Oxygen acts as the final electron acceptor at the end of the chain, forming water. 2. Chemiosmosis: The accumulated protons flow back across the membrane, moving down their gradient through a channel in the enzyme called ATP synthase. This flow drives the rotation of the enzyme's components, providing the energy required to catalyse the synthesis of ATP from ADP and inorganic phosphate (Pi).
16	 Figure 12.3 The Citric acid cycle
17	Alcoholic fermentation occurs in the cytoplasm under anaerobic conditions. Pyruvate produced during glycolysis is first decarboxylated to acetaldehyde, and then reduced by NADH to ethanol, regenerating NAD^+ for continued glycolysis. Carbon dioxide is released as a by-product. This process allows the plant cell to produce 2 ATP per glucose molecule, which is far less than the 36–38 ATP produced in aerobic respiration. Fermentation is important in energy production under low oxygen conditions and in industrial applications like brewing and baking. Anaerobic respiration yields less ATP because it does not use the electron transport chain or oxygen. Only glycolysis occurs, producing a net gain of 2 ATP molecules per glucose, compared to 36–38 ATP in aerobic respiration, where NADH and $FADH_2$ generate ATP through oxidative phosphorylation. FIG.12.2 FROM NCERT TEXTBOOK
IV	**CASE STUDY BASED QUESTIONS (4M)**
18. A	ATP production is lower in Plant B because oxygen is limited, preventing aerobic respiration. As a result, the plant relies on anaerobic respiration, which produces only 2 ATP per glucose compared to 36–38 ATP in aerobic respiration.
B	In Plant A, $NADH+H^+$ is fully oxidized via the electron transport system within the mitochondria, using oxygen as the final acceptor to produce lots of ATP.

	In Plant B, $NADH+H^+$ is oxidized in the cytoplasm during fermentation (converting acetaldehyde to ethanol) to regenerate NAD^+, which keeps glycolysis running and produces very little ATP.
C	Oxygen is the final electron acceptor in the electron transport chain. It combines with electrons and protons to form water, allowing electron flow, proton gradient formation, and ATP synthesis. Without oxygen, aerobic respiration cannot continue.
D	Glycolysis occurs identically in both Plant A (aerobic) and Plant B (anaerobic) cells. This process takes place in the cytoplasm and breaks down glucose into two molecules of pyruvate, two molecules of ATP, and two molecules of NADH, without requiring oxygen. The subsequent fate of the pyruvate and NADH is where the pathways diverge.
V	**LONG ANSWER TYPE QUESTIONS (5M)**
19	A. Glycolysis occurs in the cell's cytoplasm. It is the first step of respiration where one molecule of glucose (6C) is broken down into two molecules of pyruvate (3C each). This process does not require oxygen and yields a net gain of 2 ATP molecules and 2 NADH molecules, which carry electrons for further steps of respiration. B. The end products of glycolysis are: • 2 molecules of pyruvate, which enter the mitochondria for the Krebs cycle. • 2 ATP molecules (net gain), formed after using 2 ATP in the energy investment phase. • 2 molecules of NADH, which will donate electrons to the electron transport chain for ATP production. Refer to Figure 12.1 FROM the NCERT TEXTBOOK
20.	• The electron transport system (ETS) is found in the inner mitochondrial membrane and aids in liberating and using the energy stored in the $NADH+H^+$ and $FADH_2$ • $NADH+ H^+$, formed while the citric acid cycle and glycolysis occur, is oxidised by NADH dehydrogenase or complex I. • Electrons hence produced are conveyed to ubiquinone via FMN. • Similarly, the complex II or $FADH_2$ synthesised during the citric acid cycle is conveyed to ubiquinone. • From ubiquinone, electrons are accepted by the complex III or cytochrome bc_1, which is furthermore conveyed to cytochrome c, which serves as a mobile carrier between the cytochrome c oxidase complex and complex III, comprising cytochrome a and a_3 with copper centres (complex IV) additionally. • When electrons are transferred from each complex, simultaneously other processes occur, such as the production of ATP from ADP and the inorganic phosphate through the action of ATP synthase (complex V). • This amount of ATP production is dependent on the molecule that has been oxidised. 3 ATP molecules are generated by the oxidation of 1 molecule of NADH, while 1 $FADH_2$ molecule, upon oxidation, produces 2 ATP molecules. REF. FIG. 12.4 FROM NCERT TEXTBOOK

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