Chapter - 14 Respiration in Plants

Question-1

Give two types of cellular respiration.

Solution:

The two types of cellular respiration are (i) Aerobic respiration and (ii) Anaerobic respiration.

Question-2

What is respiratory quotient (RQ)? Give the RQ for carbohydrates.

Solution:

The ratio of the volume of carbon dioxide produced to the volume of oxygen consumed in respiration over a period of time is called respiratory quotient (RQ).

$$RQ = \frac{\text{Volume of } CO_2 \text{ evolved}}{\text{Volume of } O_2 \text{ absorbed}}$$

The value of RQ for carbohydrates is

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$$

$$RQ = \frac{6CO_2}{6O_2} = 1$$

Question-3

Name the energy currency of the cells.

Solution:

ATP is the energy currency of the cells.

Question-4

What is compensation point?

Solution:

The light intensity, at which the rate of photosynthesis is just equal to the rate of respiration, is called compensation point.

Question-5

What is significance of $F_0 - F_1$ combination in mitochondria?

Solution:

$F_0 - F_1$ combination in mitochondria maintains the proton gradient on the two sides of the membrane.

Question-6

How does respiration differ from combustion?

Solution:

Respiration	Combustion
(i) Respiration is a biochemical process and occurs in living cells.	(i) Combustion is a physiochemical and non cellular process.
(ii) It is under biological control.	(ii) It is an uncontrolled process.
(iii) Energy is released in stages as chemical bonds are broken in steps.	(iii) Energy is released in a single step as most of the chemical bonds break simultaneously.
(iv) Only a part of energy is lost as heat.	(iv) Most of the energy is liberated as heat.
(v) Expect in a few cases, light is not emitted during respiration.	(v) Light is often emitted during combustion.
(vi) Temperature is not allowed to rise.	(vi) Temperature becomes very high.
(vii) Most of the energy is trapped in ATP molecules.	(vii) No ATP is formed during combustion.
(viii) Each step in respiration is catalysed by an enzyme.	(viii) Enzymes are not involved in combustion.
(ix) A number of intermediates are formed for the synthesis of different organic compounds.	(ix) No intermediates are produced in combustion.
(x) The oxidation of substrate occurs by the loss of hydrogen or electrons. Molecular oxygen is involved only in the last step.	(x) The substrate is directly oxidised in combustion.

Question-7

Write the importance of anaerobic respiration.

Solution:

(i) Anaerobic respiration is important during periods of oxygen deficiency.

(ii) Various types of wines, beers and whiskeys are prepared through alcoholic fermentation of sugary solutions with yeast.

(iii) Carbon dioxide, released by yeast cells in alcoholic fermentation is used in baking industry for making bread light and spongy.

(iv) Dairy industry depends upon the action of lactic acid bacteria, which converts milk sugar, lactose to lactic acid. Lactic acid coagulates the milk protein casein and fuses droplets of milk fat.

(v) Vinegar is obtained by the fermentation activity of acetic acid bacteria.

(vi) Tea and tobacco leaves are cured by fermentation with certain bacteria.

(vii) Fermentation is also employed in the preparation of ensilage, cleaning of hides, retting of stem fibres and production of industrial alcohols and organic acids.

(viii) Decomposition of dead bodies of organisms is carried out by fermentation.

Question-8

A total of 38 ATP molecules are produced per glucose molecule oxidized but net gain is 36 ATP molecules. What happens to 2 ATP molecules?

Solution:

Two molecules of ATP are lost as heat.

Question-9

Discuss the external factors influencing respiration.

Solution:

The external factors, which influence respiration are,

(i) Temperature: Most of the plants respire normally between 5°C and 25° C. Further rise in temperature causes decrease and finally inhibition of respiration due to denaturation of enzymes. The actual range of temperature at which respiration occurs varies considerably in different plants. Some temperate and arctic plants can respire well near or below 0°C. Similar hardiness is observed in dormant seeds, which do not lose viability even at -40° C.

(ii) Light: The effect of light on the rate of respiration is indirect. Under suitable light, the rate of photosynthesis is optimum, which supplies respiratory substrates at a moderate rate. Active input of respiratory substrates ultimately increases the respiration rate.

(iii) Oxygen: Oxygen is the most important factor, affecting the rate of aerobic respiration. In absence of O_2, plants continue to respire anaerobically. Absence of O_2 does not affect anaerobic organisms. However, higher plants fail to survive for long under anaerobic conditions, due to accumulation of toxic alcohol and carbon dioxide.

(iv) Carbon dioxide: The concentration of carbon dioxide in the atmosphere is almost constant. Therefore, it does not affect the rate of respiration. Under controlled conditions, a higher concentration of carbon dioxide decreases the rate of respiration.

(v) Water: The rate of respiration is decreased, when the amount of available water becomes low, because the respiratory enzymes become inactive in the absence of this medium.

(vi) Inorganic salts: The rate of respiration increases when a plant or tissue is transferred from water to a salt solution. The amount by which respiration is increased over normal is called ' salt respiration'.

(vii) Organic substances: Within limits, plant hormones, auxins and gibberellins and many herbicides enhance the rate of respiration. Certain organic substances such as cyanides, azides, carbon monoxide, etc. inhibit respiration, because they act as enzyme inhibitors. Small quantities of anesthetics such as chloroform, ether, etc. increase the rate of respiration. But in higher doses they function as inhibitors of respiration.

(viii) Injuries: Injuries initiate meristematic activity in the area of wound, which enhances the rate of respiration to supply more energy for the healing of the injury.

Question-10

Name the phenomenon by which carbohydrates are oxidized to release CO_2, H_2O and energy.

Solution:

The phenomenon by which carbohydrates are oxidized to release CO_2, H_2O and energy is called aerobic respiration.

Question-11

What is the significance of pentose phosphate pathway?

Solution:

Pentose phosphate pathway is significant in the following ways:

(i) Pentose phosphate pathway constitutes an alternate pathway for the breakdown of carbohydrates in respiration.

(ii) It produces NADPH + H^+ for some synthetic processes.

(iii) It produces ribose 5-phosphate, which is used in the synthesis of nucleic acid.

(iv) Erythrose 4-phosphate produced in pentose phosphate pathway is required for the synthesis of lignin, anthocyanin, IAA and a number of other compounds.

Question-12

In which organelle does Kreb's cycle occur in a living cell?

Solution:

Mitochondria is the organelle where Kreb's cycle occurs in a living cell.

Question-13

What are the internal factors influencing respiration?

Solution:

The internal factors influencing respiration have been listed below:

(i) Protoplasmic factors: The rate of respiration is influenced by the amount and state of protoplasm. Young growing cells show higher rate of respiration than mature cells. Dormant tissues have very low rate of respiration.

(ii) Respiratory substrate: Within limit, the rate of respiration shows a linear relation with the concentration of available respiratory substrate, particularly sugars.

Question-14

Where does glycolysis take place in a cell?

Solution:

Glycolysis takes place in the cytoplasm of the cell.

Question-15

What is the unit of oxidative phosphorylation?

Solution:

Oxysomes is the unit of oxidative phosphorylation.

Question-16

What is electron transport chain?

Solution:

The inner mitochondrial membrane contains some proteins, which act as H^+ ions and electron transporting enzymes. The enzymes are arranged in an ordered manner in a specific series called electron transport chain. An electron transport chain is a series of enzymes and cytochromes in the inner mitochondrial membrane that take part in the passage of electrons from a substance to its ultimate acceptor. The electron carriers include flavins, iron-sulphur complexes, quinines and cytochromes. Most of them are prosthetic groups of proteins.

reduced prosthetic groups. The electrons are then transported successively from one enzyme or cytochrome to the next in a down hill journey with a loss of energy at each step. At the end of the chain, the electrons and the accompanying protons combine with oxygen to form water. Oxygen is thus, the terminal electron acceptor of the mitochondrial respiratory chain.

At each step of electron transport, the electron acceptor has a higher electron affinity than the electron donor. The energy from such electron transport is utilized in transporting protons from the matrix, across the inner membrane to its outer end. There are three such sites in the electron transport chain. This creates a higher proton concentration outside the inner membrane than in the matrix.

Question-17

What is the full form of EMP pathway?

Solution:

EMP - Embden – Mayerhof – Parnas pathway.

Question-18

Why does strenuous exercise cause muscular fatigue?

Solution:

Skeletal muscles usually derive their energy by anaerobic respiration. After vigorous exercise, lactic acid accumulates, leading to muscular fatigue. During rest, however, the lactic acid is reconverted to pyruvic acid and this is channeled back into the aerobic respiration pathway.

Question-19

What is oxidative phosphorylation and substrate level phosphorylation?

Solution:

Oxidative phosphorylation is the synthesis of ATP with the help of energy released by the oxidation of reduced co-enzymes during terminal oxidation.

Substrate level phosphorylation is the phosphorylation of ATP or some other nucleoside diphosphate directly from a metabolite.

Question-20

What is the final acceptor of electrons in electron transport chain?

Solution:

Oxygen is the final acceptor of electrons in electron transport chain.

Question-21

Why is less energy produced during anaerobic respiration?

Solution:

Less energy is produced during anaerobic respiration because

(i) Incomplete breakdown of respiratory substrate takes place.

(ii) Some of the products of anaerobic respiration can be oxidised further to release energy, which shows that anaerobic respiration does not liberate the whole of energy contained on the respiratory substrate.

(iii) ATP as electron transport is absent hence, $NADH_2$ is not produced.

(iv) Oxygen is not utilized for securing electrons and protons.

Question-22

What is the common step in aerobic and anaerobic pathway?

Solution:

Glycolysis is the common step in aerobic and anaerobic pathway.

Question-23

Out of the following substances, carbohydrates, fats and proteins, which gets easily oxidised by oxygen to produce energy during respiration?

Solution:

The carbohydrates – glucose and fructose are broken down during respiration very easily to produce energy. The carbohydrate gets hydrolysed to glucose and fructose for respiration. When fats are used as respiratory substrate they are first hydrolysed to fatty acids and glycerol by the action of enzymes and are then oxidised in respiration. Proteins are rarely used as respiratory substrates. But when they are used, they are first broken down to amino acids.

Question-24

Name the enzyme, which is represented by oxysomes.

Solution:
ATPase is the enzyme, which represents oxysomes.

Question-25

What role is played by ATPase?

Solution:
ATPase helps in the formation of ATP from ADP, Pi and energy by downward flow of protons.

Question-26

Write the mechanism of respiration.

Solution:
During both aerobic and anaerobic respiration the glucose molecule gets broken down into an intermediate pivotal compound the pyruvic acid by a process known as glycolysis. But further breakdown of this pivotal compound differs in two types of respiration.

(a) Breakdown of pyruvic acid in anaerobic respiration - In this process, in the absence of oxygen the pyruvic acid is incompletely reduced to ethyl alcohol.

(b) Breakdown of pyruvic acid in aerobic respiration – In this process, the pyruvic acid is completely oxidised into carbon dioxide and water in the presence of oxygen. This process occurs in the mitochondria of the cell and is known as Kreb's cycle.

Question-27

In which part of the mitochondria is the electron transport chain located?

Solution:

The electron transport chain is located on the cristae of inner mitochondrial membrane.

Question-28

Where do TCA cycle enzymes occur?

Solution:

TCA cycle enzymes occur in the matrix of mitochondria.

Question-29

Point out the differences between cellular respiration and alcoholic fermentation.

Solution:

Cellular respiration	Alcoholic fermentation
Glucose ↓ Pyruvic acid ↓ Carbon dioxide + Water + 38 molecules of ATP	Glucose ↓ Pyruvic acid ↓ Carbon dioxide + Alcohol + 2 molecules of ATP

Question-30

What is the common substrate of cellular respiration?

Solution:

Glucose is the common substrate of cellular respiration.

Question-31

Where is ETS found?

Solution:

Electron Transmitter System (ETS) is found in the inner membrane of mitochondria.

Question-32

Explain the role of NAD in glycolysis.

Solution:

NAD plays an important role during glycolysis, where 3-phosphoglyceraldehyde is converted into 1,3 disphosphoglycerate in the presence of inorganic phosphate and the enzyme – glyceraldehydes phosphate dehydrogenase. In this reaction NAD is reduced to $NADH_2$.

Question-33

Give the site of glycolysis in cells.

Solution:

Cytoplasm is the site of glycolysis in cells.

Question-34

Name the final acceptor of electrons in electron transmitter system.

Solution:

Oxygen is the final acceptor of electrons in electron transmitter system.

Question-35

What is the unit of oxidation photophorylation?

Solution:

Oxysome is the unit of oxidation photophorylation.

Question-36

What are the four parts of cellular respiration?

Solution:

The four parts of cellular respiration are,

(i) Glycolysis

(ii) Decarboxylation

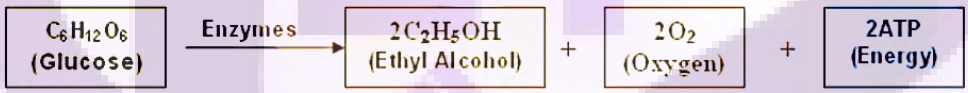
(iii) TCA

(iv) Electron transport chain

Question-37

Give the chemical equation for respiration.

Solution:



Question-38

Name the three end products of glycolysis.

Solution:

The three end products of glycolysis are,

(i) Two molecules of pyruvic acid,

(ii) 2ATP, and

(iii) $2NADPH_2$.

Question-39

Write the differences between respiration and combustion.

Solution:

Respiration	Combustion
Occurs in the cells of living organisms.	Does not occur in living things.
Energy is liberated in small quantities during each step of a series of reactions.	Unlimited energy is liberated once during combustion.
The liberated energy is stored in ATP molecules.	No energy is stored during combustion.

Question-40

What is the main source of energy for endergonic activity in living cells?

Solution:

The main source of energy for endergonic activity in living cells is cellular respiration.