Respiration in Plants

Case Study Based Questions

Read the following passages and answer the questions that follow:

1. Schools are an important food environment to cultivate and promote healthy food choices and practices among children and adolescents. The school food environment has a potentially significant impact on a child's dietary practices as they spend more time in school than in any other environment away from home and consume almost half of their total daily energy in the school setting.

(A) What will be the possible substrate mentioned in the question?

(a) Fat

(b) Protein

(c) Both (a) and (b)

(d) Vitamin

(B) Formula for RQ:

(a) $\frac{\text{Volume of } CO_2 \text{ released}}{\text{Volume of } O_2 \text{ absorbed}}$

(b) $\frac{\text{Volume of } O_2 \text{ absorbed}}{\text{Volume of } CO_2 \text{ released}}$

(c) $\frac{\text{Volume of } CO_2 \text{ absorbed}}{\text{Volume of } O_2 \text{ released}}$

(d) $\frac{\text{Volume of } O_2 \text{ released}}{\text{Volume of } CO_2 \text{ absorbed}}$

(C) The respiratory quotient in succulent plants is always less than one. The reason is:

(a) complete reduction

(b) complete oxidation
(c) incomplete reduction
(d) incomplete oxidation

(D) In germinating seeds of castor, respiratory quotient is:
(a) zero
(b) less than one
(c) greater than one
(d) one

Ans. (A) (c) Both (a) and (b)

Explanation: Respiratory quotient or respiratory ratio for different substrates are the following: For carbohydrates RQ= 1, they are completely oxidised and equal amounts of oxygen and carbon dioxide are produced. For proteins R.Q=0.9 approximately. For fats and proteins, R.Q is less than 1.

(B) (a) $RQ = \frac{Volume\ of\ CO_2\ released}{Volume\ of\ O_2\ absorbed}$

Explanation: The respiratory quotient is the actual ratio of the volume of carbon dioxide expelled to the volume of oxygen consumed during cellular respiration. The respiratory ratio is another name for it. RQ is the abbreviation for it.

(C) (d) incomplete oxidation

Explanation: The respiratory quotient is the actual ratio of the volume of carbon dioxide expelled to the volume of oxygen consumed during cellular respiration. The respiratory quotient is less than one in succulent plants
at night. This is due to the incomplete oxidation of carbohydrates which leads to the production of acids (malic acid, oxalic acid) and in extreme cases; no CO_2 is evolved at all. This makes the RQ less than 1.

(D) (b) less than one

Explanation: The respiratory substrate produced during the germination of the castor seed is fat. The respiratory quotient value of fats is always less than one. It means, when fat is consumed during respiration, the volume of CO_2 evolved is less than the volume of O_2 consumed.

2. It refers to the final process while the organism is respiring in the presence of oxygen. It requires the transfer of electrons to produce ATP. Different molecules produce

different numbers of ATP while we proceed through this process. The process takes place within the membrane of some important organelle of the cell. Many complexes are involved in the transport of electrons, they pass via complex
I to V. Small proteins are attached to its outer membrane that acts as a mobile carrier for transfer of electrons from complex III to IV.
(A) Identify the above event.
(B) Where does this event occur in the cell? Give another name for this organelle and also give a reason why it is called so.
(C) Identify the protein involved and name it.

Ans. (A) The event is the electron transport chain. It is a set of four protein complexes that link redox processes to create an electrochemical gradient that results in the production of ATP in a process known as oxidative phosphorylation. In both cellular respiration and photosynthesis, it occurs in mitochondria.
(B) It occurs in the inner mitochondrial membrane of the cell. Mitochondria is also known as the "powerhouse of the cell" because it is in charge of cellular respiration which is the process of obtaining energy from oxidation of food. Adenosine triphosphate is used to release the energy (ATP). It is called energy currency of the cell.
(C) Protein involved is cytochrome c. It is a small protein acting as a mobile carrier for transfer of electrons between complex III and complex IV, it is found attached to the outer surface of the inner mitochondrial membrane.

3. Electron transport chain is the final stage of aerobic respiration which is located on the mitochondrial membrane. There are two mitochondrial membranes, outer and inner. All proton pumps are located on the inner mitochondrial membrane which is arranged into folds called cristae. These folds increase the surface area available for the transport chain. Electron transport chain is the series of redox reactions in which there is transfer of electrons from electron donors to electron acceptors. The energy is released and stored within the reduced hydrogen carriers which are then used to synthesise ATP. This is called oxidative phosphorylation. Oxidative phosphorylation occurs in distinct steps. First, the proton pumps create an electrochemical gradient called as proton motive force, second, ATP synthase uses the subsequent diffusions of protons, this step is called chemiosmosis. ATP is synthesised in this step. Third and final, oxygen accepts electrons and protons to form water.
(A) The correct series of electron acceptors present in mitochondrial membrane

is:

(a) Cyt-c, b, a, a_3

(b) Cyt-b, c, a, a_3

(c) Cyt-a, a, b, c

(d) Cyt-b, c, a_3, a

(B) How many ATPs will be produced from three molecules of NADPH and two molecules of $FADH_2$?

(a) 5

(b) 9

(c) 13

(d) 18

(C) In amphibolic pathway, fatty acids will produce:

(a) Glucose-6-phosphate

(b) Glucose-1-6-phosphate

(c) Pyruvate

(d) Acetyl-CoA

(D) The Fo-F1 complex acts as a site for ATP synthesis when protons enter inner membrane space.

(a) True

(b) False

(c) Cannot say

(d) Protons are not involved.

(E) Ubiquinone (UQ) transfers its electrons to:

(a) Cytochrome b in complex III

(b) Cytochrome a in complex IV

(c) FAD in Complex II

(d) Mitochondrial matrix

Ans. (A) (b) Cyt-b, c, a, a_3

Explanation: Cytochromes are the electron carriers in the different electron transport complexes in the membrane of the mitochondria which helps in the formation of ATP by the process of oxidative phosphorylation. The sequence of the movement of the electrons includes cytochromes b, cytochrome c, cytochrome a, and cytochrome a3.

(B) (c) 13

Explanation: Three molecules of NADH will produce 9 ATP molecules and two molecules of $FADH_2$ will produce 4 ATP.

Total ATP produced is 9 + 4 = 13.

(C) (d) Acetyl-CoA

Explanation: In amphobolic pathway, fatty acids are converted to acetyl-CoA by beta oxidation.

(D) (a) True

Explanation: The ATP synthase is also sometimes referred to as complex V of the electron transport system. It consists of two components:

(1) A transmembrane protein complex is known as Fo.

(2) A peripheral protein complex is known as F_1.

The F_1 headpiece present peripherally contains the site of ATP synthesis. Fo is a channel protein and allows the diffusion of protons through it, down the electrochemical gradient.

(E) (a) Cytochrome b in complex III

Explanation: Ubiquinone receives reducing equivalents via $FADH_2$(complex II) that is generated during the oxidation of succinate in the citric acid cycle.

The reduced ubiquinone (ubiquinol) is then oxidised with the transfer of electrons to cytochrome c via cytochrome bc_1 complex (complex III).