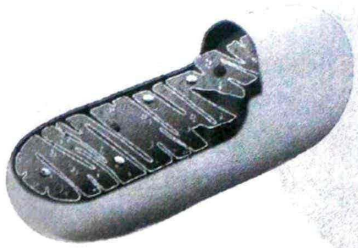
CHAPTER



12 Respiration in Plants

12.1. Do Plants Breathe?

1. The bacterium (*Clostridium botulinum*) that causes botulism is:
(A) an obligate anaerobe (B) a facultative aerobe
(C) an obligate aerobe (D) a facultative anaerobe
[AIPMT 2006]

2. Site of respiration in bacteria is:
(A) episome (B) ribosome
(C) mesosome (D) microsome **[AIPMT 1997]**

3. Maximum amount of energy/ATP is liberated on oxidation of:
(A) fats (B) proteins
(C) starch (D) vitamins **[AIPMT 1994]**

4. Respiratory substrate yielding maximum number of ATP molecule is:
(A) ketogenic amino acids
(B) glucose
(C) amylose
(D) glycogen **[AIPMT 1994]**

5. Life without air would be:
(A) reductional
(B) free from oxidative damage
(C) impossible
(D) anaerobic. **[AIPMT 1993]**

12.2. Glycolysis

6. Which of the following are correct about cellular respiration?
(I) Cellular respiration is the breaking of C — C bonds of complex organic molecules by oxidation.
(II) The entire cellular respiration takes place in Mitochondria.
(III) Fermentation takes place under anaerobic condition in germinating seeds.
(IV) The fate of pyruvate formed during glycolysis depends on the type of organism also.
(V) Water is formed during respiration as a result of O_2 accepting electrons and getting reduced.
Choose the correct answer from the options given:
(A) (I), (III), (IV), (V) only
(B) (I), (II), (V) only
(C) (I), (II), (III), (V) only
(D) (II), (III), (IV), (V) only **[Re-NEET 2024]**

7. Given below are two statements. One is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A): ATP is used at two steps in glycolysis.
Reason (R): First ATP is used in converting glucose into glucose-6-phosphate and second ATP is used in conversion of fructose-6-phosphate into fructose-1, 6-diphosphate.
In the light of the above statements, choose the correct answer from the options given:
(A) A is true but R is false.
(B) A is false but R is true.
(C) Both A and R are true and R is the correct explanation of A.
(D) Both A and R are true but R is NOT the correct explanation of A. **[NEET 2023]**

8. What is the net gain of ATP when each molecule of glucose is converted to two molecules of pyruvic acid?
(A) Six (B) Two
(C) Eight (D) Four **[NEET 2022]**

9. In glycolysis, during oxidation electrons are removed by:
(A) ATP
(B) glyceraldehyde-3-phosphate
(C) NAD^+
(D) molecular oxygen. **[AIPMT 2004]**

12.3. Fermentation

10. What amount of energy is released from glucose during lactic acid fermentation?
(A) More than 18% (B) About 10%
(C) Less than 7% (D) Approximately 15%
[NEET 2022]

11. The energy-releasing metabolic process in which substrate is oxidised without an external electron acceptor is called:

(A) glycolysis (B) fermentation

(C) aerobic respiration (D) photorespiration.

[AIPMT Screening 2010, 08]

12. In which one of the following processes CO_2 is not released?

(A) Aerobic respiration in plants

(B) Aerobic respiration in animals

(C) Alcoholic fermentation

(D) Lactate fermentation **[AIPMT 2014]**

12.4. Aerobic Respiration

13. Identify the step in tricarboxylic acid cycle, which does not involve oxidation of substrate.

(A) Succinic acid → Malic acid

(B) Succinyl-CoA → Succinic acid

(C) Isocitrate → α-ketoglutaric acid

(D) Malic acid → Oxaloacetic acid **[NEET 2024]**

14. Match List-I with List-II.

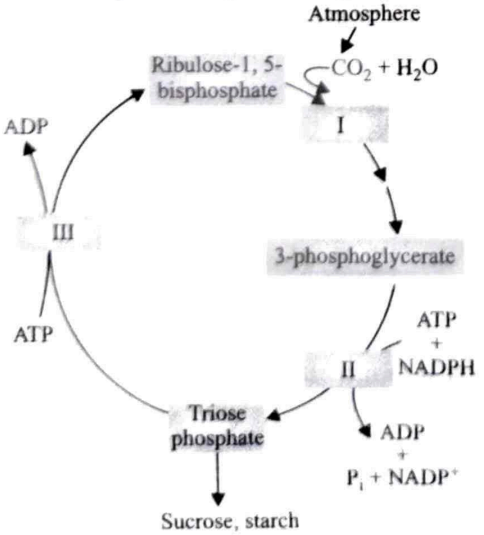
List-I	List-II
(a) ETS Complex I	(i) NADH Dehydrogenase
(b) ETS Complex II	(ii) Cytochrome bC_1
(c) ETS Complex III	(iii)Cytochrome C oxidase
(d) ETS Complex IV	(iv)Succinate Dehydrogenase

Choose the correct answer from the options given below:

	(a)	(b)	(c)	(d)
(A)	(iv)	(i)	(iii)	(ii)
(B)	(i)	(iv)	(ii)	(iii)
(C)	(iii)	(i)	(iv)	(ii)
(D)	(i)	(ii)	(iv)	(iii)

[Re-NEET 2024]

15. Observe the given figure. Identify the different stages labelled with alphabets by selecting the correct option.



(A) I-Carboxylation, II-Regeneration, III-Reduction

(B) I-Reduction, II-Decarboxylation, III-Regeneration

(C) I-Carboxylation, II-Reduction, III-Regeneration

(D) I-Reduction, II-Carboxylation, III-Regeneration

[Re-NEET 2024]

16. Match List I with List II:

List I	List II
(a) Citric acid cycle	(i) Cytoplasm
(b) Glycolysis	(ii) Mitochondrial matrix
(c) Electron transport system	(iii) Intermembrane space of mitochondria
(d) Proton gradient	(iv) Inner mitochondrial membrane

Choose the correct answer from the options given below:

	(a)	(b)	(c)	(d)
(A)	(ii)	(i)	(iv)	(iii)
(B)	(iii)	(iv)	(i)	(ii)
(C)	(iv)	(iii)	(ii)	(i)
(D)	(i)	(ii)	(iii)	(iv)

[NEET 2024]

17. Match List I with List II:

List I	List II
(a) Oxidative decarboxylation	(i) Citrate synthase
(b) Glycolysis	(ii) Pyruvate dehydrogenase
(c) Oxidative phosphorylation	(iii) Electron transport system
(d) Tricarboxylic acid cycle	(iv) EMP pathway

Choose the correct answer from the options given below:

	(a)	(b)	(c)	(d)
(A)	(iii)	(i)	(ii)	(iv)
(B)	(ii)	(iv)	(iii)	(i)
(C)	(iii)	(iv)	(ii)	(i)
(D)	(ii)	(iv)	(i)	(iii)

[NEET 2023]

18. Which of the following statements is incorrect?

(A) During aerobic respiration, role of oxygen is limited to the terminal stage.

(B) In ETC (Electron Transport Chain), one molecule of $NADH + H^+$ gives rise to 2 ATP molecules, and one $FADH_2$ gives rise to 3 ATP molecules.

(C) ATP is synthesised through complex V.

(D) Oxidation-reduction reactions produce proton gradient in respiration. **[NEET 2021]**

19. What is the role of NAD^+ in cellular respiration?

(A) It is a nucleotide source of ATP synthesis.

(B) It functions as an electron carrier.

(C) It functions as an enzyme.

(D) It is the final electron acceptor for anaerobic respiration. **[NEET 2018]**

20. Which one of these statements is incorrect?

(A) Glycolysis operates as long as it is supplied with NAD that can pick up hydrogen atoms.

(B) Glycolysis occurs in cytosol.

(C) Enzymes of TCA cycle are present in mitochondrial matrix.

(D) Oxidative phosphorylation takes place in outer mitochondrial membrane. **[NEET 2018]**

21. Which statement is wrong for Kreb, cycle?

(A) There are three points in the cycle where NAD^+ is reduced to $NADH + H^+$.

(B) There is one point in the cycle where FAD^+ is reduced to $FADH_2$.

(C) During conversion of succinyl CoA to succinic acid, a molecule of GTP is synthesised.

(D) The cycle starts with condensation of acetyl group (acetyl CoA) with pyruvic acid to yield citric acid.

[NEET 2018]

22. Oxidative phosphorylation is:

(A) formation of ATP by transfer of phosphate group from a substrate to ADP

(B) oxidation of phosphate group in ATP

(C) addition of phosphate group to ATP

(D) formation of ATP by energy released from electrons removed during substrate oxidation.

[NEET Phase-II 2016]

23. The chemiosmotic coupling hypothesis of oxidative phosphorylation proposes that Adenosine Triphosphate (ATP) is formed because:

(A) high energy bonds are formed in mitochondrial proteins.

(B) ADP is pumped out of the matrix into the intermembrane space.

(C) a proton gradient forms across the inner membrane.

(D) there is a change in the permeability of the inner mitochondrial membrane toward Adenosine Diphosphate (ADP). **[AIPMT Screening 2008]**

24. Identify the biochemical difference between anaerobic respiration and fermentation.

	Aerobic Respiration	Fermentation
(A)	It is an extracellular biochemical reaction.	It is an intracellular biochemical reaction.
(B)	This is induced by endoenzymes.	This is induced by exoenzymes.
(C)	It does not produce ATP.	It produces ATP.
(D)	End products are ethanol and CO_2.	End products are CO_2 and H_2O.

[AIPMT Mains 2008 (Mod.)]

25. All enzymes of TCA cycle are located in the mitochondrial matrix except one which is located in inner mitochondrial membrane in eukaryotes and in cytosol in prokaryotes. This enzyme is:

(A) isocitrate dehydrogenase

(B) malate dehydrogenase

(C) succinate dehydrogenase

(D) lactate dehydrogenase. **[AIPMT 2007]**

26. The overall goal of glycolysis, Krebs' cycle and the electron transport system is the formation of:

(A) ATP in one large oxidation reaction

(B) sugars

(C) nucleic acids

(D) ATP in small stepwise units. **[AIPMT 2007]**

27. During which stage in the complete oxidation of glucose are the greatest number of ATP molecules formed from ADP?

(A) Glycolysis

(B) Krebs' cycle

(C) Conversion of pyruvic acid to acetyl CoA

(D) Electron transport chain. **[AIPMT 2005]**

28. In which one of the following do the two names refer to one and the same thing?

(A) Krebs' cycle and Calvin cycle

(B) Tricarboxylic acid cycle and citric acid cycle

(C) Citric acid cycle and Calvin cycle

(D) Tricarboxylic acid cycle and urea cycle

[AIPMT 2003]

29. In Krebs' cycle, FAD participates as electron acceptor during the conversion of:

(A) succinyl-CoA to succinic acid

(B) α-ketoglutarate to succinyl-CoA

(C) succinic acid to fumaric acid

(D) fumaric acid to malic acid. **[AIPMT 1997]**

30. The correct sequence of electron acceptor in ATP synthesis is:

(A) Cyt b, c, a_3, a (B) Cyt c, b, a, a_3

(C) Cyt a, a, b, c (D) Cyt b, c, a, a_3.

[AIPMT 1997]

31. EMP can produce a total of:

(A) 6 ATP (B) 8 ATP

(C) 24 ATP (D) 38 ATP. **[AIPMT 1990]**

12.5. The Respiratory Balance Sheet

32. How many ATP molecules could maximally be generated from one molecule of glucose, if the complete oxidation of one mole of glucose to CO_2 and H_2O yields 686 kcal

and the useful chemical energy available in the high energy phosphate bond of one mole of ATP is 12 kcal?

(A) 1 (B) 2

(C) 30 (D) 57 **[AIPMT 2006]**

33. How many ATP molecules are produced by aerobic oxidation of one molecule of glucose?

(A) 2 (B) 4

(C) 38 (D) 34 **[AIPMT 2003]**

12.6. Amphibolic Pathway

34. Which of the metabolite is common to respiration mediated breakdown of fats, carbohydrates and proteins?

(A) Glucose-6-phosphate

(B) Fructose 1, 6-bisphosphate

(C) Pyruvic acid

(D) Acetyl CoA **[NEET 2013]**

35. Aerobic respiratory pathway is appropriately termed as:

(A) catabolic (B) parabolic

(C) amphibolic (D) anabolic.

[AIPMT Screening 2009]

12.7. Respiratory Quotient

36. R.Q. is ratio of:

(A) CO_2 produced to substrate consumed

(B) CO_2 produced to O_2 consumed

(C) oxygen consumed to water produced

(D) oxygen consumed to CO_2 produced. **[AIPMT 1990]**

SOLUTIONS

1. (A) The bacterium *Clostridium botulinum* is an obligate anaerobe, which means it normally lives in the absence of oxygen. It is responsible for botulism. It attacks the nervous system of our body.

2. (C) Bacteria lack mitochondria in their cytoplasm. So, their respiratory activities are done by plasma membrane. Mesosomes (folded invaginations of the plasma membrane) increase the surface area of the plasma membrane, which aids in increased respiratory rate. Enzymes linked with bacterial aerobic respiration are found on these infoldings.

3. (A) Although fats provide energy slowly, fats are the most energy-efficient type of food. The body gets about 9 grams of energy per gram of fat.

4. (B) Glucose must be oxidised as the principal substrate in the glycolysis step of respiration. Before entering glycolysis, any other substrate must first be converted into glucose. Certain substrates, including amylose, glycogen, and ketogenic amino acids, must first be converted to glucose at a cost of ATP energy. Due to this, their net ATP production is lower than that of glucose as a substrate.

5. (D) In absence of air or oxygen, many organisms are capable of respiring using anaerobic respiration. Hence, life without air is considered as anaerobic.

6. (A) The entire cellular respiration takes place in cytoplasm and mitochondria. The process of Glycolysis occurs inside the cytoplasm and whereas the Krebs' cycle occurs inside the mitochondrial matrix.

7. (C) First ATP is used in converting glucose into glucose-6-phosphate and the second ATP is used in the conversion of fructose-6-phosphate into fructose-1,6-bisphosphate.

8. (B) During glycolysis, glucose is broken down into 2 molecules of pyruvic acid with the simultaneous production of 2 molecules of ATP by substrate level phosphorylation.

9. (C) When 3-phosphoglyceraldehyde is converted into 1, 3-biphosphoglyceric acid, two electrons and two protons are released, which are utilised to convert NAD^+ to NADH.

$$NAD^+ + 2H^+ + 2e^- \rightarrow NADH + H^+$$

Related Theory

Glycolysis is the partial breakdown of a 6C glucose molecule into 3C molecules of pyruvate. 2NADH, $2H^+$, and 2 net ATP are a result of substrate-level phosphorylation. Glycolysis occurs in the cytoplasm of the cell.

10. (C) A significant amount of energy is not released throughout the fermentation process. Less than 7% of the energy from glucose is released in this situation. Additionally, not all of it is included in ATP's high energy bonds.

11. (B) In the absence of oxygen (external electron acceptor), fermentation is incomplete oxidation of food substances into alcohol or lactic acid, with a small amount of energy being released. Aerobic respiration uses oxygen as an electron acceptor for oxidation of substrates. Glycolysis is the first common stage of both fermentation and aerobic respiration. Photorespiration is oxidation of RuBP by enzyme RuBisCO and does not produce energy.

12. (D) During lactic acid fermentation, fructose and sucrose are converted into lactic acid. It is an anaerobic fermentation reaction, that allows glycolysis to continue by ensuring that NADH is converted to NAD^+.

$$\underset{\text{Pyruvate}}{C_3H_3O_3} + NADH \rightarrow \underset{\text{Lactic acid}}{C_3H_6O_3} + NAD^+$$

Related Theory

➥ *Lactic acid accumulates in muscle cells as fermentation proceeds during strenuous exercise. During these times, the respiratory and cardiovascular systems are unable to meet the needs of muscle cells efficiently, especially in legs, as they are not fast enough to maintain aerobic respiration. Hence, to allow the continuous production of some ATP, muscle cells use lactic acid fermentation, but this also causes cramps due to inefficient ATP availability.*

13. (B) During the conversion of succinyl-CoA to succinic acid, a molecule of GTP is synthesised. This is a substrate level phosphorylation. In a coupled reaction GTP is converted to GDP with the simultaneous synthesis of ATP from ADP. It does not involve oxidation of substrate.

14. (B) NADH dehydrogenase is the ETS complex I, Succinate dehydrogenase is ETS complex II, Cytochrome bC_1 is the ETS complex III and Cytochrome C oxidase is ETS complex IV.

15. (C) Given figure is of Calvin cycle, it proceeds in three stages.

(I) Carboxylation, during which carbon dioxide combines with ribulose-1,5-bisphosphate, reaction catalyzed by the RuBisCO.

(II) Reduction, during which glyceraldehyde-3-phosphate is formed by ATP and NADPH.

(III) Regeneration during which the ribulose-1, 5-bisphosphate is recycled again.

16. (A) (a) Citric acid cycle or Krebs' cycle that involves complete oxidation of pyruvate takes place in the matrix of the mitochondria.

(b) Glycolysis that involves partial oxidation of glucose to two molecules of pyruvate occurs in the cytoplasm of the cell and is present in all living organisms.

(c) Electron transport system involving passing on of the electrons removed as part of the hydrogen atoms to molecular O_2 with simultaneous synthesis of ATP occurs in the inner membrane of the mitochondria.

(d) Proton gradient occurs in the intermembrane space of mitochondria.

17. (B) List I refers to the different metabolic pathways in the cell, while list II contains specific enzymes or processes associated with those pathways.

(a) Oxidative decarboxylation is the process by which pyruvate is converted into acetyl-CoA. This conversion is catalysed by pyruvate dehydrogenase enzyme.

(b) Glycolysis is the metabolic pathway that converts glucose into pyruvate. This process occurs in the cytoplasm of cells and is facilitated by a series of enzymes and is also known as the Embden-Meyerhof-Parnas (EMP) pathway.

(c) Oxidative phosphorylation is the metabolic pathway that involves the transfer of electrons from NADH and $FADH_2$ to molecular oxygen through a series of electron carriers. This process takes place in the inner mitochondrial membrane and is facilitated by a series of enzymes collectively known as the electron transport system.

(d) The tricarboxylic acid cycle (also known as the Krebs' cycle) is a metabolic pathway that oxidises acetyl-CoA to carbon dioxide and water. Citrate synthase is the enzyme that catalyses the first step in the cycle, in which acetyl-CoA combines with oxaloacetate to form citrate.

18. (B) Oxidation of one molecule of NADH gives rise to 3 molecules of ATP, while that of one molecule of $FADH_2$ produces 2 molecules of ATP.

Related Theory

➥ *NADH generated in the cytoplasm during glycolysis must be transported across the mitochondrial membrane before it can transfer electrons to the electron transport chain and this requires energy.*

Caution

➥ *Students should remember that $FADH_2$ produces less ATP than NADH because the electrons for $FADH_2$ are dropped off at the second protein of the electron transport chain.*

19. (B) NAD^+ functions as an electron carrier during cellular respiration. It acts as an oxidising agent, which accepts electron and then transfers them to electron transport system. As a result, three ATP molecules are formed.

Related Theory

➥ *Oxidative phosphorylation, is the phosphorylation of ADP to ATP is dependent on the oxidative reactions occurring in the mitochondria. The three major steps in oxidative phosphorylation are:*

(1) Oxidation-reduction reactions involving electron transfer between specialised proteins embedded in the inner mitochondrial membranes;

(2) The generation of a proton (H^+) gradient across the inner mitochondrial membrane; and,

(3) The synthesis of ATP using energy from the spontaneous diffusion of electrons down the proton gradient generated.

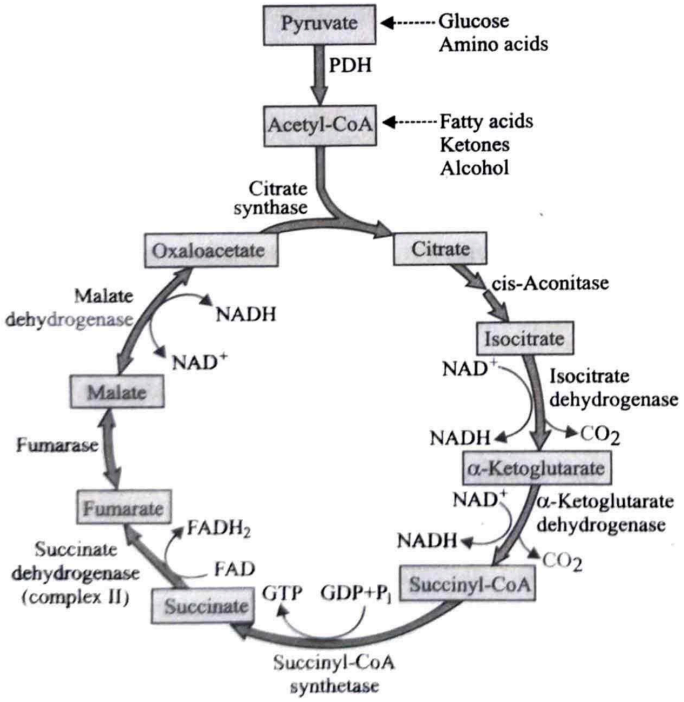
20. (D) Oxidative phosphorylation is the process in which ATP is formed as a result of the transfer of electrons from NADH or $FADH_2$ to O_2 by a series of electron carriers. This process takes place in the inner

mitochondrial membrane. Glycolysis is the process in which one glucose molecule is broken down to form two molecules of pyruvic acid (also called pyruvate). It is a multi-step metabolic pathway that occurs in the cytoplasm of animal cells, plant cells, and the cells of microorganisms. NADH contributes to oxidation in glycolysis to help with the oxidation of glucose. Enzymes involved in Krebs, cycle are present in mitochondrial matrix.

Related Theory

Oxidative phosphorylation is linked to a electron transport system (ETS). The ETS is located in the inner mitochondrial membrane, and transfers electrons donated by the reduced electron carriers NADH and $FADH_2$ (obtained from glycolysis, the citric acid cycle or fatty acid oxidation) through a series of electrons acceptors, to oxygen. The movement of electrons through complexes of the electron transport system essentially charges a battery that is used to make ATP in oxidative phosphorylation. In this way, the oxidation of sugars and fatty acids is coupled to the synthesis of ATP, effectively extracting energy from food.

21. (D) The Krebs' cycle starts with condensation of acetyl-CoA with oxalo acetic acid and water to yield citric acid. Each turn of the cycle forms three NADH molecules and one $FADH_2$ molecule. One GTP molecule is synthesised during conversion of succinyl CoA to succinic acid.



Krebs' cycle

Related Theory

Glucose and amino acids enter Krebs' cycle, in the form of pyruvate, while fatty acids, ketone and alcohol enters via acetyl CoA.

Mnemonics

The sequence of the compounds formed in Krebs' cycle can be learned as:

Can I keep Some Sweets For My Office?

- ***Can*** - *Citrate*
- ***I*** - *Iso-citrate*
- ***Keep*** - *α-ketoglutarate*
- ***Some*** - *Succinyl CoA*
- ***Sweets*** - *Succinate*
- ***For*** - *Fumarate*
- ***My*** - *Malate*
- ***Office*** - *Oxalo acetate*

22. (D) Oxidative phosphorylation is the process in which ATP is formed as a result of the transfer of electrons from NADH or $FADH_2$ to O_2 by a series of electron carriers.

23. (C) The chemiosmotic coupling hypothesis of oxidative phosphorylation explains the process of ATP formation and states that it is linked to development of a proton gradient across the mitochondrial membrane. ATP synthase, required for ATP synthesis is located in F_1 particles present in the inner mitochondrial membrane and becomes active only when there is high concentration of proton on F_0 side, as compared to F_1 side. The flow of proton through F_0 channel induces F_1 particles to function as ATP synthase and the energy of proton gradient produces ATP by attaching a phosphate radical to ADP.

Related Theory

ATP synthase then uses the energy stored in this gradient to make ATP. This process is called oxidative phosphorylation because it uses energy released by the oxidation of NADH and $FADH_2$ to phosporylate ADP into ATP.

24. (B)

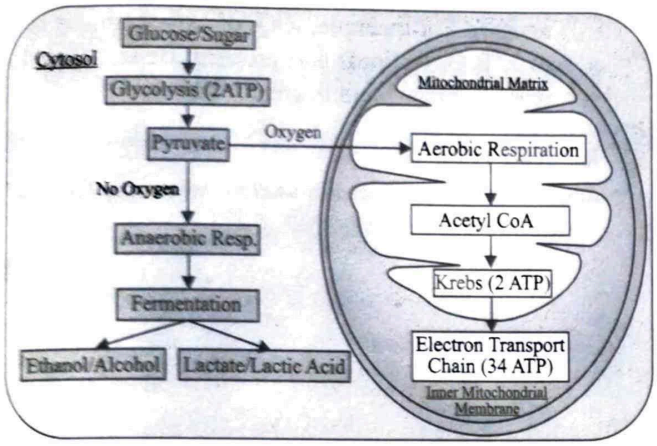
	Aerobic Respiration	Fermentation
(A)	It is an intracellular biochemical reaction.	It is an extracellular biochemical reaction.
(B)	This is induced by endoenzymes.	This is induced by exoenzymes.
(C)	It produces ATP.	It does not produce ATP.
(D)	End products are CO_2 and H_2O.	End products are CO_2 and ethanol.

25. (C) Succinate dehydrogenase is tightly bound to the inner mitochondrial membrane in eukaryotes and to crytosol in prokaryotes. Succinate dehydrogenase provides a link between the citric acid cycle and the membrane-bound electron transport system.

Related Theory

The major significance of the citric acid cycle is to act as the final common pathway for the oxidation of carbohydrates, lipids and proteins since glucose, fatty acids and many amino acids are all metabolised to acetyl-CoA.

26. (D) Glycolysis, Krebs' cycle and electron transport system, all gives ATP, which is the main energy currency of our body. Glycolysis takes place in cytoplasm, Krebs' cycle occurs in mitochondrial matrix and ETS takes place in the inner membrane of mitochondria.



Cellular Respiration

27. (D) The electron transport chain is primarily used to send protons across the membrane into the intermembrane space. This creates a proton-motive force, which drive ATP synthase in the final step of cellular respiration to create ATP from ADP and a phosphate group.

Related Theory

➥ *In chemiosmosis, the free energy from the series of redox reactions just described is used to pump hydrogen ions across the membrane. The uneven distribution of H^+ ions across the membrane establishes both concentration and electrical gradients, owing to the hydrogen ions' positive charge and their aggregation on one side of the membrane. If the membrane were open to diffusion by the hydrogen ions, the ions would tend to diffuse back across into the matrix, driven by their electrochemical gradient. Similarly, hydrogen ions in the matrix space can only pass through the inner mitochondrial membrane through an integral membrane protein called ATP synthase.*

28. (B) The citric acid cycle, also known as the TCA cycle (tricarboxylic acid cycle) or the Krebs' cycle is a series of chemical reactions used by all aerobic organisms to release stored energy through the oxidation of acetyl-CoA derived from carbohydrates, fats, and proteins. The Krebs' cycle (discovered by Hans Krebs) is also known as the citric acid cycle or TCA (tricarboxylic acid) cycle because the citric acid has 3-COOH groups and is the first product of the Krebs' cycle.

Related Theory

➥ *The link between glycolysis and the citric acid cycle is the oxidative decarboxylation of pyruvate to form acetyl-CoA.*

29. (C) Succinic acid undergoes dehydrogenation to form fumaric acid with the help of a membrane based enzyme succinate dehydrogenase. During the process, FAD participates as an electron acceptor and gets converted into $FADH_2$.

30. (D) Cytochromes are the 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 cytochrome b, cytochrome c, cytochrome a, and cytochrome a_3.

31. (B) EMP (Embden-Meyerhof-Parnas) pathway is another name of glycolysis. Here, one molecule of glucose is broken down to two molecules of pyruvic acid. In this process, there is a gain of total 2NADH (2×3 ATP) and 2ATP, *i.e.*, a total of 8 ATP.

Related Theory

➥ *The first step in cellular respiration is glycolysis. During glycolysis, there is a net production of 2 ATP and 2 NADH molecules after oxidation of 2 glyceraldehyde 3-phosphate to 1, 3-bisphosphoglycerate. This 2 NADH produces 6 ATP molecules in the respiratory chain, and hence, a total of 8 ATP molecules are produced by the EMP pathway.*

32. (D) Complete oxidation of one mole of glucose yields

= 686 kcal.

Chemical energy available in high energy phosphate bonds of one mole of ATP = 12 kcal.

ATP molecules maximally generated from one molecule of glucose = $\frac{686}{12}$ = 57.16 ≈ 57 ATP molecules.

33. (C) A total of 38 molecules of ATP are produced during aerobic respiration of one molecule of glucose.

Summary of ATP synthesis:

8 ATP from glycolysis.

6 ATP from acetyl-CoA.

24 ATP from Krebs' cycle.

Related Theory

➥ *One molecule of NADH yields 3 ATP, each $FADH_2$ yields 2 ATP and each GTP yields 1 ATP in the ETS.*

34. (D) Acetyl CoA is common to respiration mediated breakdown of fats, carbohydrates and proteins. Glucose and amino acids enter Krebs', cycle, in the form of pyruvate, while fatty acids, ketone and alcohol enters *via* acetyl CoA.

Related Theory

➥ *The Krebs' cycle starts with condensation of acety CoA with oxalo acetic acid and water to yield citric acid. Each turn of the cycle forms three NADH molecules and one $FADH_2$ molecule. One GTP molecule is synthesised during conversion of succinyl CoA to succinic acid.*

35. (C) An amphibolic pathway involves both anabolic and catabolic processes. For example, Krebs' cycle, which involves both the catabolism of carbohydrates and fatty acids and the synthesis of anabolic precursors for amino acid synthesis, *e.g.*, ketoglutarate and oxaloacetate.

Related Theory

➥ *Catabolic process is the process, which break down large molecules into smaller units, that are either oxidised to release energy or used in other metabolic reaction. Anabolic process is the process that construct large molecules from smaller units.*

36. (B) Respiratory quotient (R.Q.) is the ratio of the volume of CO_2 released to volume of O_2 absorbed during the respiration.

$$\text{R.Q.} = \frac{\text{Volume of } CO_2 \text{ produced}}{\text{Volume of } O_2 \text{ consumed}}$$

Value of R.Q. varies from one respiratory substrate to another. For example, R.Q. of carbohydrates is equal to 1, R.Q. of lipids and proteins are less than 1, and that of organic acid is greater than 1.

Related Theory

➥ *Respirometer is an apparatus used for measuring R.Q. and rate of respiration.*