Chapter 14. Respiration In Plants

1. Which statement is wrong for Krebs' cycle?
(a) There is one point in the cycle where FAD^+ is reduced to $FADH_2$.
(b) During conversion of succinyl CoA to succinic acid, a molecule of GTP is synthesised.
(c) The cycle starts with condensation of acetyl group (acetyl CoA) with pyruvic acid to yield citric acid.
(d) There are three points in the cycle where NAD^+ is reduced to $NADH + H^+$.
(NEET 2017)

2. Which of the following biomolecules 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-II 2016)*

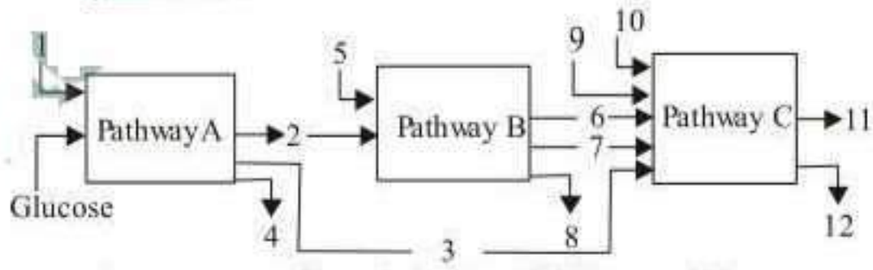
3. Oxidative phosphorylation is
(a) formation of ATP by transfer of phosphate group from a substrate to ADP
(b) oxidation of phosphate group in ATP
(c) addition of phosphate group to ATP
(d) formation of ATP by energy released from electrons removed during substrate oxidation. *(NEET-II 2016)*

4. Cytochromes are found in
(a) cristae of mitochondria
(b) lysosomes
(c) matrix of mitochondria
(d) outer wall of mitochondria.
(2015 Cancelled)

5. 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 *(2014)*

6. Which of the metabolites is common to respiration-mediated breakdown of fats, carbohydrates and proteins?
(a) Pyruvic acid
(b) Acetyl CoA
(c) Glucose - 6 - phosphate
(d) Fructose 1, 6 - bisphosphate *(NEET 2013)*

7. The three boxes in this diagram represent the three major biosynthetic pathways in aerobic respiration. Arrows represent net reactants or products.



Arrows numbered 4, 8 and 12 can all be
(a) H_2O (b) FAD^+ or $FADH_2$
(c) NADH (d) ATP.
(NEET 2013)

8. In mitochondria, protons accumulate in the
(a) outer membrane
(b) inner membrane
(c) intermembrane space
(d) matrix. *(Mains 2011)*

9. 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. *(2010, 2008)*

10. Aerobic respiratory pathway is appropriately termed
(a) parabolic (b) amphibolic
(c) anabolic (d) catabolic. *(2009)*

11. The chemiosmotic coupling hypothesis of oxidative phosphorylation proposes that adenosine triphosphate (ATP) is formed because

(a) a proton gradient forms across the inner membrane
(b) there is a change in the permeability of the inner mitochondrial membrane toward adenosine diphosphate (ADP)
(c) high energy bonds are formed in mitochondrial proteins
(d) ADP is pumped out of the matrix into the intermembrane space. *(2008)*

12. 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. *(2007)*

13. All enzymes of TCA cycle are located in the mitochondrial matrix except one which is located in inner mitochondrial membranes in eukaryotes and in cytosol in prokaryotes. This enzyme is
(a) isocitrate dehydrogenase
(b) malate dehydrogenase
(c) succinate dehydrogenase
(d) lactate dehydrogenase. *(2007)*

14. 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 *(2006)*

15. 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 *(2005)*

16. In glycolysis, during oxidation electrons are removed by
(a) ATP
(b) glyceraldehyde-3-phosphate
(c) NAD^+
(d) molecular oxygen. *(2004)*

17. In alcohol fermentation
(a) triose phosphate is the electron donor while acetaldehyde is the electron acceptor
(b) triose phosphate is the electron donor while pyruvic acid is the electron acceptor
(c) there is no electron donor
(d) oxygen is the electron acceptor. *(2003)*

18. 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 *(2003)*

19. How many ATP molecules are produced by aerobic oxidation of one molecule of glucose?
(a) 2 (b) 4
(c) 38 (d) 34 *(2002)*

20. Organisms which obtain energy by the oxidation of reduced inorganic compounds are called
(a) photoautotrophs
(b) chemoautotrophs
(c) saprozoic
(d) coproheterotrophs. *(2002)*

21. Cytochrome is
(a) metallo flavo protein
(b) Fe containing porphyrin pigment
(c) glycoprotein
(d) lipid. *(2001)*

22. Net gain of ATP molecules, during aerobic respiration, is
(a) 40 molecules (b) 48 molecules
(c) 36 molecules (d) 38 molecules. *(1999)*

23. Which one of the following statements about cytochrome P_{450} is wrong?
(a) It is a coloured cell.
(b) It is an enzyme involved in oxidation reactions.
(c) It has an important role in metabolism.
(d) It contains iron. *(1998)*

24. Which of the following is the key intermediate compound linking glycolysis to the Krebs' cycle?
(a) Malic acid (b) Acetyl CoA
(c) NADH (d) ATP *(1997)*

25. In Krebs' cycle, the FAD precipitates as electron acceptor during the conversion of
(a) fumaric acid to malic acid
(b) succinic acid to fumaric acid
(c) succinyl CoA to succinic acid
(d) □-ketoglutarate to succinyl CoA. *(1997)*

26. The end product of fermentation are
(a) O_2 and C_2H_5OH
(b) CO_2 and acetaldehyde
(c) CO_2 and O_2
(d) CO_2 and C_2H_5OH. *(1997)*

27. 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. *(1997)*

28. Which of the following products are obtained by anaerobic respiration from yeast?
(a) Beer and wine (b) Alcohols
(c) CO_2 (d) All of these *(1996)*

29. At the end of glycolysis, six carbon compound ultimately changes into
(a) ethyl alcohol (b) acetyl Co-A
(c) pyruvic acid (d) ATP. *(1996)*

30. When one molecule of ATP is disintegrated, what amount of energy is liberated?
(a) 8 kcal (b) 38 kcal
(c) 7 kcal (d) 4.5 kcal *(1996)*

31. Poisons like cyanide inhibit Na^+ efflux and K^+ influx during cellular transport. This inhibitory effect is reversed by an injection of ATP. This demonstrates that
(a) ATP is the carrier protein in the transport system
(b) energy for Na^+-K^+ exchange pump comes from ATP
(c) ATP is hydrolysed by ATPase to release energy
(d) Na^+-K^+ exchange pump operates in the cell. *(1994)*

32. The ultimate respiratory substrate, yielding maximum number of ATP molecules, is
(a) glycogen
(b) ketogenic amino acid
(c) glucose
(d) amylose. *(1994)*

33. When yeast ferments glucose, the products obtained are
(a) ethanol and CO_2
(b) methanol and CO_2
(c) ethanol and water
(d) water and CO_2. *(1994)*

34. The 1992 Nobel Prize for medicine was awarded to Edmond H. Fischer and Edwin J. Krebs for their work concerning
(a) reversible protein phosphorylation as a biological regulation mechanism
(b) isolation of the gene for a human disease
(c) human genome project
(d) drug designing involving inhibition of DNA synthesis of the pathogen. *(1994)*

35. The first phase in the breakdown of glucose, in animal cell, is
(a) fermentation (b) Krebs' cycle
(c) glycolysis (d) E.T.S. *(1994)*

36. Plants, but not animals, can convert fatty acids to sugars by a series of reactions called
(a) photosynthesis (b) Kreb's cycle
(c) glycolysis (d) glyoxylate cycle. *(1994)*

37. Life without air would be
(a) reductional
(b) free from oxidative damage
(c) impossible
(d) anaerobic. *(1993)*

38. Out of 38 ATP molecules produced per glucose, 32 ATP molecules are formed from NADH/ $FADH_2$ in
(a) respiratory chain
(b) Krebs' cycle
(c) oxidative decarboxylation
(d) EMP. *(1993)*

39. End product of citric acid cycle/Krebs' cycle is
(a) citric acid (b) lactic acid
(c) pyruvic acid (d) $CO_2 + H_2O$. *(1993)*

40. Apparatus to measure rate of respiration and R.Q. is
(a) auxanometer (b) potometer
(c) respirometer (d) manometer. *(1992)*

41. When one glucose molecule is completely oxidised, it changes
(a) 36 ADP molecules into 36 ATP molecules
(b) 38 ADP molecules into 38 ATP molecules
(c) 30 ADP molecules into 30 ATP molecules
(d) 32 ADP molecules into 32 ATP molecules. *(1992)*

42. Oxidative phosphorylation is production of
(a) ATP in photosynthesis
(b) NADPH in photosynthesis
(c) ATP in respiration
(d) NADH in respiration. *(1992)*

43. At a temperature above 35°C
(a) rate of photosynthesis will decline earlier than that of respiration
(b) rate of respiration will decline earlier than that of photosynthesis
(c) there is no fixed pattern
(d) both decline simultaneously. *(1992)*

44. End products of aerobic respiration are
(a) sugar and oxygen
(b) water and energy
(c) carbon dioxide, water and energy
(d) carbon dioxide and energy. *(1992)*

45. Link between glycolysis, Krebs' cycle and □-oxidation of fatty acid or carbohydrate and fat metabolism is
(a) oxaloacetic acid (b) succinic acid
(c) citric acid (d) acetyl CoA. *(1992)*

46. Out of 36 ATP molecules produced per glucose molecule during respiration
(a) 2 are produced outside glycolysis and 34 during respiratory chain
(b) 2 are produced outside mitochondria and 34 inside mitochondria
(c) 2 during glycolysis and 34 during Krebs cycle
(d) all are formed inside mitochondria. *(1992)*

47. Terminal cytochrome of respiratory chain which donates electrons to oxygen is
(a) Cyt *b* (b) Cyt *c*
(c) Cyt a_1 (d) Cyt a_3. *(1992)*

48. Connecting link between glycolysis and Krebs' cycle before pyruvate entering Krebs' cycle is changed to
(a) oxaloacetate (b) PEP
(c) pyruvate (d) acetyl CoA. *(1990)*

49. EMP can produce a total of
(a) 6 ATP (b) 8 ATP
(c) 24 ATP (d) 38 ATP. *(1990)*

50. 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. *(1990)*

51. End product of glycolysis is
(a) acetyl CoA
(b) pyruvic acid
(c) glucose 1-phosphate
(d) fructose 1-phosphate. *(1990)*

52. R.Q. is
(a) C/N (b) N/C
(c) CO_2/O_2 (d) O_2/CO_2. *(1988)*

53. $NADP^+$ is reduced to NADPH in
(a) HMP (b) Calvin Cycle
(c) glycolysis (d) EMP. *(1988)*

Answer Key

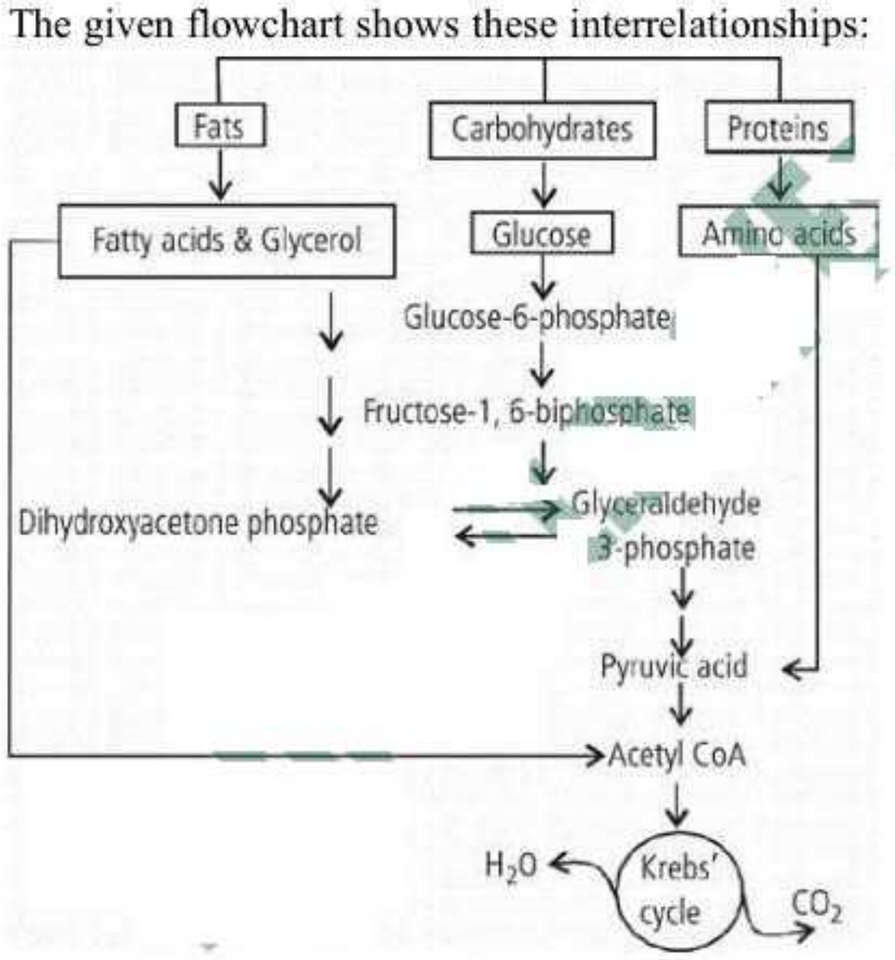
1.	(c)	**2.**	(d)	**3.**	(d)	**4.**	(a)	**5.**	(d)	**6.**	(b)	**7.**	(d)	**8.**	(c)	**9.**	(b)	**10.**	(b)
11.	(a)	**12.**	(d)	**13.**	(c)	**14.**	(d)	**15.**	(d)	**16.**	(c)	**17.**	(a)	**18.**	(b)	**19.**	(c)	**20.**	(b)
21.	(b)	**22.**	(c)	**23.**	(a)	**24.**	(b)	**25.**	(b)	**26.**	(d)	**27.**	(d)	**28.**	(d)	**29.**	(c)	**30.**	(c)
31.	(b)	**32.**	(c)	**33.**	(a)	**34.**	(a)	**35.**	(c)	**36.**	(d)	**37.**	(d)	**38.**	(a)	**39.**	(d)	**40.**	(c)
41.	(b)	**42.**	(c)	**43.**	(a)	**44.**	(c)	**45.**	(d)	**46.**	(b)	**47.**	(d)	**48.**	(d)	**49.**	(b)	**50.**	(b)
51.	(b)	**52.**	(c)	**53.**	(a)														

EXPLANATIONS

1. (c) : Krebs' cycle starts with condensation of acetyl group (acetyl CoA) with oxaloacetate to form a tricarboxylic, 6-carbon compound called citric acid.

2. (d) : Carbohydrates are usually first converted into glucose before they are used for respiration. Fats are broken down into glycerol and fatty acids first. If fatty acids were to be respired they would first be degraded to acetyl CoA and enter the pathway. Glycerol would enter the pathway after being converted to 3-phosphoglyceraldehyde (PGAL). The proteins are degraded by proteases to individual amino acids (after deamination) and depending on their structure enter the pathway within the Krebs' cycle or as pyruvate or acetyl CoA. Thus, acetyl CoA is the common metabolite of all the three (carbohydrates, proteins and fats).

The given flowchart shows these interrelationships:



3. (d) : Oxidative phosphorylation is the synthesis of energy rich ATP molecules with the help of energy liberated during oxidation of reduced co-enzymes ($NADH$, $FADH_2$) produced in respiration.

The enzyme required for this synthesis is called ATP synthase. It is located in F_1 or head piece of $F_0 - F_1$ or elementary particles present in the inner mitochondrial membrane. F_1 particle is capable of ATP synthesis.

ATP synthase becomes active in ATP formation only when there is a proton gradient having higher concentration of H^+ or protons on the F_0 side as compared to F_1 side.

This higher concentration creates an electric potential across the mitochondrial membrane. The proton gradient and membrane electric potential together form proton motive force (PMF). The flow of protons through the F_0 channel which induces F_1 particle to function as ATP synthase. The energy of the proton gradient is used in attaching a phosphate radicle to ADP by high-energy bond. This produces ATP.

4. (a) : Cytochrome is a group of proteins, each with an iron containing haeme group. They are a part of electron transport chain in mitochondria (present in cristae) and chloroplasts (in thylakoids).

5. (d) : Anaerobic respiration or fermentation can be of two types, *i.e.*, lactate fermentation and ethanol fermentation. Lactate fermentation produces lactic acid only as pyruvic acid produced in glycolysis is directly reduced by NADH to form lactic acid and no CO_2 is produced. Alcoholic (ethanol) fermentation involves conversion of pyruvate to acetaldehyde, hence, CO_2 is released.

6. (b) : *Refer to answer 2.*

7. (d) : In the given diagram, pathway A represents glycolysis, pathway B represents Krebs' cycle and pathway C represents oxidative phosphorylation. Arrows numbered 4, 8 and 12 can all be ATP.

8. (c) : In respiration, protons accumulate in the intermembrane space of the mitochondria when electrons move through the ETS.

9. (b) : Fermentation is the process of deriving energy from the oxidation of organic compounds such as carbohydrates and using an endogenous electron acceptor not external or exogenous, which is usually an organic compound, as opposed to respiration where electrons are donated to an exogenous electron acceptor, such as oxygen *via* an electron transport chain.

10. (b) : A biochemical pathway that serves both anabolic and catabolic process is known as amphibolic pathway. The aerobic respiration involves both catabolism of carbohydrates and fatty acids and the synthesis of anabolic precursors for amino acid synthesis, various intermediatory metabolic products and secondary metabolites. Thus it is called as amphibolic pathway rather than a catabolic pathway.

11. (a) : The chemiosmotic coupling hypothesis of oxidative phosphorylation proposed by Mitchell, explains the process of ATP formation and states that

it is linked to development of a proton gradient across a 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 particle to function as ATP synthase and the energy of proton gradient produces ATP by attaching a phosphate radical to ADP.

12. (d) : Respiration is an energy liberating enzymatically controlled multistep catabolic process of step wise breakdown of organic substances (hexose sugar) inside the living cells. Aerobic respiration includes the 3 major process, glycolysis, Krebs' cycle and electrons transport chain. The substrate is completely broken down to form CO_2 and water. A large amount of energy is released stepwise in the form of ATP.

13. (c) : Mitochondrion is the organelle which bears various enzymes participating in Krebs' cycle. Each mitochondrion is covered by double membrane. The inner membrane is selectively permeable and forms foldings called cristae. The inner membrane bears oxysomes, enzymes of fatty acids, succinate dehydrogenase (of Krebs' cycle) and electron transport system. All other enzymes of Krebs' cycle are present in the mitochondrial matrix.

14. (d) : One mole of ATP liberates 12 kcal of energy. So 686 kcal will be liberated by 686/12 = 57.1 ATP molecules.

15. (d) : The last step of aerobic respiration is the oxidation of reduced coenzymes, *i.e.*, $NADH_2$ and $FADH_2$ by molecular oxygen through FAD, ubiquinone, Cyt *b*, Cyt *c*, Cyt c_1, Cyt *a* and Cyt a_3. By oxidation of 1 molecule of $NADH_2$, 3ATP molecules are produced and by oxidation of 1 molecule of $FADH_2$, 2 ATP molecules are produced.

In glycolysis 2 ATP molecules are produced from ADP. Further $2NADH_2$ produced, give $2 \times 3 = 6$ ATP, on oxidative phosphorylation. Similarly in Krebs' cycle 2 ATP molecules are produced. So the greatest number of ATP molecules are produced in the electron transport chain.

16. (c) : During glycolysis, NAD (Nicotinamide adenine dinucleotide) removes electrons from 1, 3-diphosphoglyceric acid using diphospho-glyceraldehyde dehydrogenase. NAD changes to $NADH_2$ and this is either utilized as such in anaerobic respiration or in the presence of oxygen.

17. (a) : When oxygen is not available (anaerobic condition) yeast and some other microbes convert pyruvic acid into ethyl alcohol. It is a two step process. In the first step pyruvic acid is decarboxylated to yield acetaldehyde and CO_2.

Pyruvic acid is a 3-C compound and acts as electron donor while acetaldehyde is the electron acceptor.

$$CH_3COCOOH \xrightarrow[\text{carboxylase}]{\text{pyruvic}} CH_3CHO + CO_2$$

In the second step acetaldehyde is reduced to ethyl alcohol by $NADH_2$ formed in the glycolysis.

$$CH_3CHO + NADH_2 \xrightarrow[\text{dehydrogenase}]{\text{Alcoholic}} C_2H_5OH + NAD$$

18. (b) : The reactions of Krebs' cycle were worked out by Sir Hans Kreb, hence the name Krebs' cycle. It involves many 3-C compounds such as citric acid, cis-aconitic acid and iso-citric acid etc., so it is also called TCA cycle or tricarboxylic acid cycle. It involves formation of citric acid as its first product so it is called citric acid cycle. It involves production of 24 ATP molecules.

19. (c) : Energy gain in one complete cycle of aerobic respiration is :

Glycolysis (or EMP) $\rightarrow$ $2\,ATP + 2NADH_2 = 8\,ATP$ $\xrightarrow{ETS}$ $6\,ATP$

Intermediate step $= 2\,NADH_2 \xrightarrow{ETS} = 6\,ATP$

Krebs' cycle $= 6\,NADH_2 + 2\,FADH_2 + 2\,ATP = 24\,ATP$

ETS $\rightarrow$ 18 ATP; ETS $\rightarrow$ 4 ATP

Total = 38 ATP

In aerobic respiration complete oxidation of one glucose molecule produces 38 ATP molecules. But the number of ATP molecules so produced may vary depending upon the mode of entry of $NADH_2$ in the mitochondria.

If the electrons of $NADH_2$ are accepted by malate then each molecule of $NADH_2$ yields 3 ATP molecules and the total would be 38 ATP molecules. But if the electrons of $NADH_2$ are accepted by FAD it yields only 2 ATP molecules making the total of 36 ATP molecules. This type of shuttle occurs in most of the eukaryotic cells.

20. (b) : Chemoautotrophs are organisms that are capable of manufacturing their organic food utilizing chemical energy released in oxidation of some inorganic substances. The process of manufacture of food in such organisms is called chemosynthesis. It includes some aerobic bacteria. Photoautotroph obtain energy for their synthesis of food from light.

Fungi living on dead or decaying plant or animal remains and also growing on dung of herbivores are saprophytes.

21. (b) : Cytochromes are electron transferring proteins often regarded as enzymes. They contain iron porphyrin or copper porphyrin as prosthetic groups. Cytochrome *a*, *b* and *c* are harmo-chromogens widely occurring in cells and acting as oxygen carriers during cellular respiration.

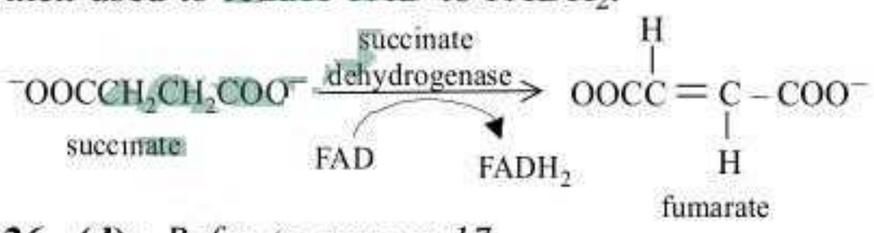
22. (c) : *Refer to answer 19.*

23. (a) : Cytochrome P_{450} is a host of enzymes that use iron to oxidise, often as part of the body's strategy to dispose of potentially harmful substances making them more water soluble. These are found in plants, animals and microbes and are involved in a variety of oxidative reaction in cells. These catalyse a variety of reactions including epoxidation, *N*-dialkylation,*o*-dialkylation,*s*-oxidation and hydroxylation. A typical cytochrome P_{450} catalysed reactions is

$$NADPH + H^+ + O_2 + RH \rightarrow NADP^+ + H_2O + R - OH$$

24. (b) : During glycolysis pyruvic acid is produced from glucose and is oxidatively decarboxylated to form acetyl CoA. This formation of acetyl CoA from pyruvic acid needs a multienzyme complex and 5 essential cofactors, *i.e.* lipoic acid, CoA, Mg^{2+}, NAD and TPP (thiamine pyrophosphate). It results in production of 2 molecules of CO_2 and 2 molecules of $NADH_2$. This acetyl CoA enters mitochondria and is completely oxidised during Krebs' cycle. Thus acetyl CoA acts as the linker of glycolysis and Krebs' cycle.

25. (b) : During Krebs' cycle when succinic acid is oxidised to fumaric acid then the precipitation of FAD as electron acceptor occurs. It is the only Krebs' cycle oxidation that does not employ a pyridine nucleotide. In this, succinate is dehydrogenated by succinate dehydrogenase. This enzyme removes two hydrogen ions and two electrons from succinate and these are then used to reduce FAD to $FADH_2$.



26. (d) : *Refer to answer 17.*

27. (d) : Last step of aerobic respiration is oxidation of reduced co-enzymes, *i.e.*, $NADH_2$ and $FADH_2$ by molecular oxygen through FAD, CoQ (ubiquinone), Cyt. *b*, Cyt. c_1, Cyt. *c*, Cyt. *a* and Cyt a_3. Two hydrogen atoms or electrons move from $NADH_2$ and travel through this ETS chain and finally combine with half molecule of O_2 to form water.

During this electron transport FAD and Fe of different cytochromes are successively reduced and oxidised and at certain points, enough energy is released which is used to bind ADP with Pi to form ATP.

28. (d) : In the absence of O_2, fermentation or anaerobic respiration occurs. In this process pyruvic acid forms ethyl alcohol and CO_2.

29. (c) : Glycolysis or EMP pathway is the breakdown of glucose to two molecules of pyruvic acid through a series of enzyme mediated reaction releasing energy. Pyruvic acid is a 3-carbon compound. In glycolysis net gain of 2ATP and 2 $NADH_2$ molecules occurs.

It can be represented in equation form as –

$$C_6H_{12}O_6 + 2ADP + 2Pi + 2NAD \rightarrow 2CH_3COCOOH + 2\,ATP + 2\,NADH_2$$

30. (c) : ATP is adenosine triphosphate. It was discovered by Lohmann in 1929. It consists of a purine, adenine, a pentose sugar (ribose) and a row of three phosphates out of which the last two are attached by high energy bonds. The last phosphate bond yields an energy equivalent of 7 kcal.

31. (b) : Active transport is uphill movement of materials across the membrane where the solute particles move against their chemical concentration or electrochemical gradient. Hence the transport requires energy in the form of ATP. Metabolic inhibitors like cyanide inhibit absorption of solutes by lowering the rate of respiration. Consequently less ATP are formed. However, by adding ATP, active transport is facilitated.

It occurs in plants as in climacteric fruits and under cold stress. ATP synthesis does not occur. Reducing power present in reduced coenzymes is oxidised to produce heat energy. Therefore, the heat liberation pathway of terminal oxidation is cyanide resistant.

In normal aerobic respiration, the effect of cyanide poisoning can be minimised by immediate supply of ATP.

32. (c) : Glucose is the chief respiratory substrate which fields maximum number of ATP molecules. Glucose is the most common substate in glycolysis. Any other carbohydrate is first converted into glucose. During glycolysis it changes to pyruvic acid and net gain is of 2 ATP and 2 $NADH_2$ molecules. And later on during Krebs cycle 30 molecules of ATP are produced. So a total of 38 ATP molecules are produced from 1 mol of glucose during aerobic respiration.

33. (a) : *Refer to answer 17.*

34. (a) : The 1992 Nobel prize for medicine was awarded to Edmond H. Fischer and Edwin J. Krebs for their work concerning reversible protein phosphorylation as biological regulation mechanism.

The winners of 1992 Noble prize in Physiology and Medicine discovered a 'life switch" that turns on and off a variety of biological functions of the cell, including the breakdown of fats and the generation of chemical energy. The prize - winning discovery is known as "reversible protein phosphorylation".

35. (c) : Glycolysis is the first step of glucose breakdown in both animals and plants. During glycolysis 6-carbon glucose molecule is converted into 2 molecules of 2 carbon pyruvic acid. In this process net gain of 2 ATP and 2 $NADH_2$ occurs. It is a common pathway for both aerobic and anaerobic modes of respiration.

36. (d) : Kornberg and Krebs (1957) gave glyoxylate cycle in *Pseudomonas* bacteria. It involves conversion of insoluble fats into soluble sugars. This occurs in germinating fatty seeds because plants are not able to transport fats from the endosperm to the root and shoot tissues of the germinating seedling, so they must convert stored lipids to a more mobile form of carbon, generally sucrose.

37. (d) : Anaerobic respiration (absence of oxygen) takes place in anaerobic bacteria and in plant seeds. Anaerobic respiration occurs in the organism which can live without oxygen. In this respiration, only glycolysis takes place due to the absence of oxygen.

38. (a) : During respiratory chain, complete degradation of one glucose molecule produced 38 ATP molecules. NAD and FAD is reduced to $NADH/FADH_2$.

39. (d) : The end product of glycolysis is pyruvic acid whereas acetyl CoA is the connecting link between glycolysis and Krebs' cycle. The TCA cycle was first described by Krebs, 1937 as a cyclic process in which acetyl coA is oxidised to CO_2 and water. Acetyl CoA combines with oxalo acetic acid to form citric acid. After a series of cyclic reactions OAA is recycled back.

40. (c) : Respirometer is an instrument used for measuring R.Q. and rate of respiration. The apparatus consists of a graduated tube attached at right angles to a bulbous respiratory chamber in its upper end. Desired plant material whose R.Q. is to be determined is placed in the respiratory chamber.

41. (b) : *Refer to answer 19.*

42. (c) : In electron transport system the hydrogen donated by succinate is accepted by FAD which is reduced to $FADH_2$. This hydrogen dissociate into electrons and protons and then passes through a series of carriers involving the phenomenon of oxidation and reduction. During this flow, ATP synthesis occurs at different steps and the phenomenon is called as oxidative phosphorylation.

43. (a) : The plants can perform photosynthesis on a range of temperature, while some cryophytes can do photosynthesis at 35°C. Usually the plants can perform photosynthesis between 10°C - 40°C. The optimum temperature ranges between 25°C - 30°C. At high temperature the enzymes are denatured and hence the photosynthetic rate declines.

44. (c) : *Refer to answer 12.*

45. (d) : Krebs' cycle is intimately related with fat metabolism. Dihydroxy acetone phosphate produced in glycolysis may be converted into glycerol *via* glycerol - 3 - phosphate and vice-versa. Glycerol is important constituents of fats. After □-oxidation, fatty acids give rise to active 2-C units, the acetyl-CoA which may enter the Krebs' cycle. Thus, Acetyl-CoA is a link between glycolysis, Krebs' cycle and □-oxidation of fatty acid or carbohydrate and fat metabolism.

46. (b) : During respiration, 36 ATP molecules are produced per glucose molecule. 2 molecules of ATP are produced outside mitochondria *i.e.*, during glycolysis and other 34 molecules of ATP are produced inside mitochondria from Krebs' cycle.

47. (d) : Cytochrome a_3 helps in transfer of electron to oxygen. The oxygen has great affinity to accept the electrons and in presence of protons a water molecule is formed.

48. (d) : *Refer to answer 39.*

49. (b) : *Refer to answer 19.*

50. (b) : The ratio of the volume of CO_2 released to volume of O_2 absorbed in the respiratory process is termed as the respiratory ratio or Respiratory Quotient.

$$\text{R. Q.} = \frac{\text{Volume of } CO_2 \text{ evolved}}{\text{Volume of } O_2 \text{ absorbed}}$$

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

51. (b) : *Refer to answer 29.*

52. (c) : *Refer to answer 50.*

53. (a) : HMP pathway generates NADPH molecules which are used as reductants in biosynthetic process under conditions when NADPH molecules are not generated by photosynthesis. It is, therefore, important in non-photosynthetic tissues such as in differentiating tissues, generating seeds and during periods of darkness. Production of NADPH is not linked to ATP generation in pentose phosphate pathway.