14.RESPIRATION IN PLANTS

Biology Smart Booklet

Theory + NCERT MCQs + NEET PYQs

RESPIRATION IN PLANTS

Glycolysis

- Partial breakdown of Glucose into Pyruvic Acid in the presence of oxygen.

Preparatory phase

Glucose (6C) → (ATP → ADP, Hexokinase) → Glucose-6-phosphate (6C) → (Phospho hexose isomerase) → Fructose-6-phosphate (6C) → (ATP → ADP, Phospho fructo kinase) → Fructose1, 6-bisphosphate (6C) → (Aldolase) → Triose phosphate (glyceraldehyde-3-phosphate) (3C) ⇌ (Isomerase) ⇌ Triose phosphate (Dihydroxy acetone phosphate) (3C)

Pay off phase

Triose phosphate (glyceraldehyde-3-phosphate) (3C) → (Glyceraldehyde-3-phosphate dehydrogenase; NAD⁺ → NADH+H) → 2 × Triose bisphosphate (1,3 bisphosphoglyceric acid) (3C) → (1st ATP formation (substrate level phosphorylation); ADP → ATP, Phosphoglycerate kinase) → 2 × Triose phosphate (3-phosphoglyceric acid) (3C) → (Phosphoglyceromutase) → 2 × 2-phosphoglycerate → (H_2O, Enolase) → 2 × phosphoenolpyruvate → (2nd ATP formation (substrate level phosphorylation); ADP → ATP, Pyruvate kinase) → 2 × Pyruvic acid (3C)

Triose phosphate (Dihydroxy acetone phosphate) (3C) → NAD → NADH+H → 2 × Triose bisphosphate (1,3 bisphosphoglyceric acid) (3C) → ADP → ATP → 2 × Triose phosphate (3-phosphoglyceric acid) (3C) → 2 × 2-phosphoglycerate → 2 × phosphoenolpyruvate → ADP → ATP → 2 × Pyruvic acid (3C)

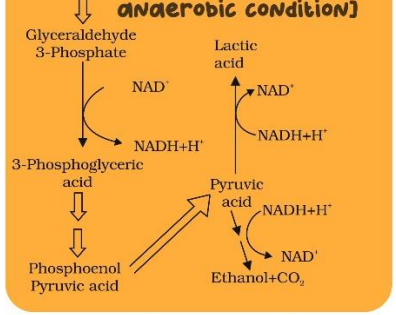
Anaerobic Respiration

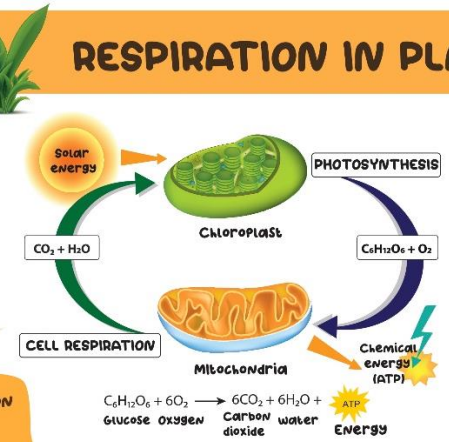
Pyruvic Acid

in absence of O_2

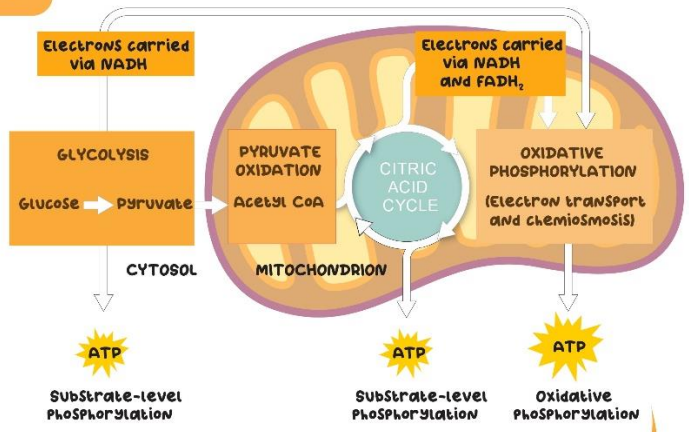
Fermentation

Glucose (Incomplete oxidation of glucose under anaerobic condition)



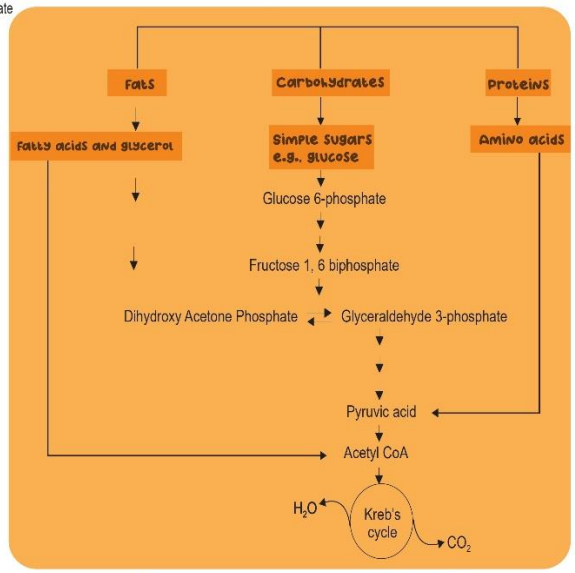


Process of oxidation of food material within cell to release energy for ATP synthesis



Amphibolic Pathway

- Respiration is referred as amphibolic pathway because it involves both anabolism and catabolism



Inner mitochondrial membrane is the site of

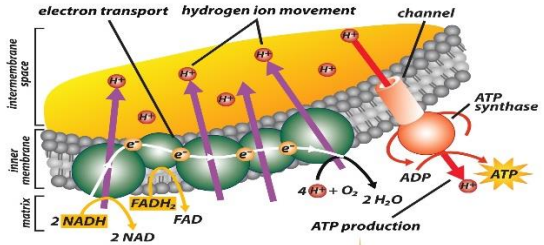
ELECTRON TRANSPORT SYSTEM

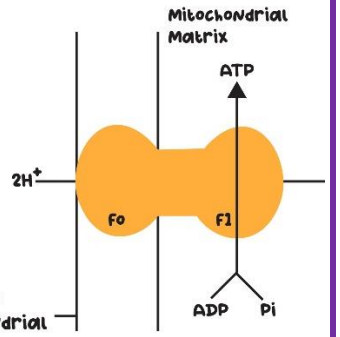
Metabolic Pathway through which electron passes from one carrier to another

OXIDATIVE PHOSPHORYCATION

- Electrons are passed from electron donors to electron acceptors
- Proton gradient is generated across the inner mitochondrial membrane

Electron Transport Chain





F_1 headpiece (peripheral membrane protein complex)
F_O (integral membrane protein complex)

Respiratory Quotient

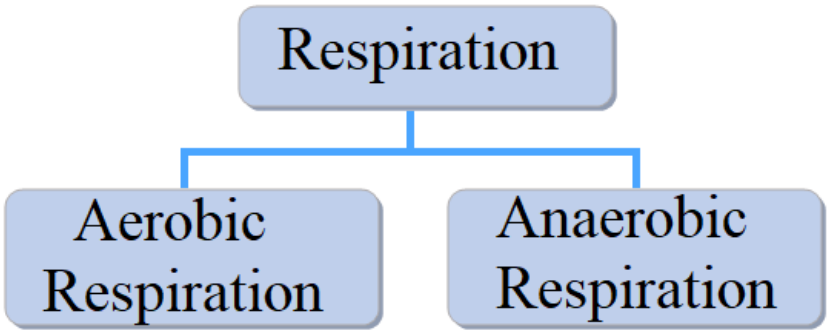
$$RQ = \frac{\text{Volume of } CO_2 \text{ envolved}}{\text{Volume of } O_2 \text{ Consumed}}$$

- RQ for Carbohydrates = $\frac{6CO_2}{6O_2} = 1$
- C6H1206 + 602 -6C02 + 6H20 + Energy
- RQ for fats is less than 1
- RQ for proteins is usually 0.9

RESPIRATION IN PLANTS

Respiration

Respiration is an energy releasing, enzymatically controlled catabolic process which involves a step-wise oxidative breakdown of food substance inside living cells.



Aerobic Respiration: Aerobic Respiration is an enzymatically controlled release of energy in a stepwise catabolic process of complete oxidation of organic food into carbon dioxide and water with oxygen acting as terminal oxidant.

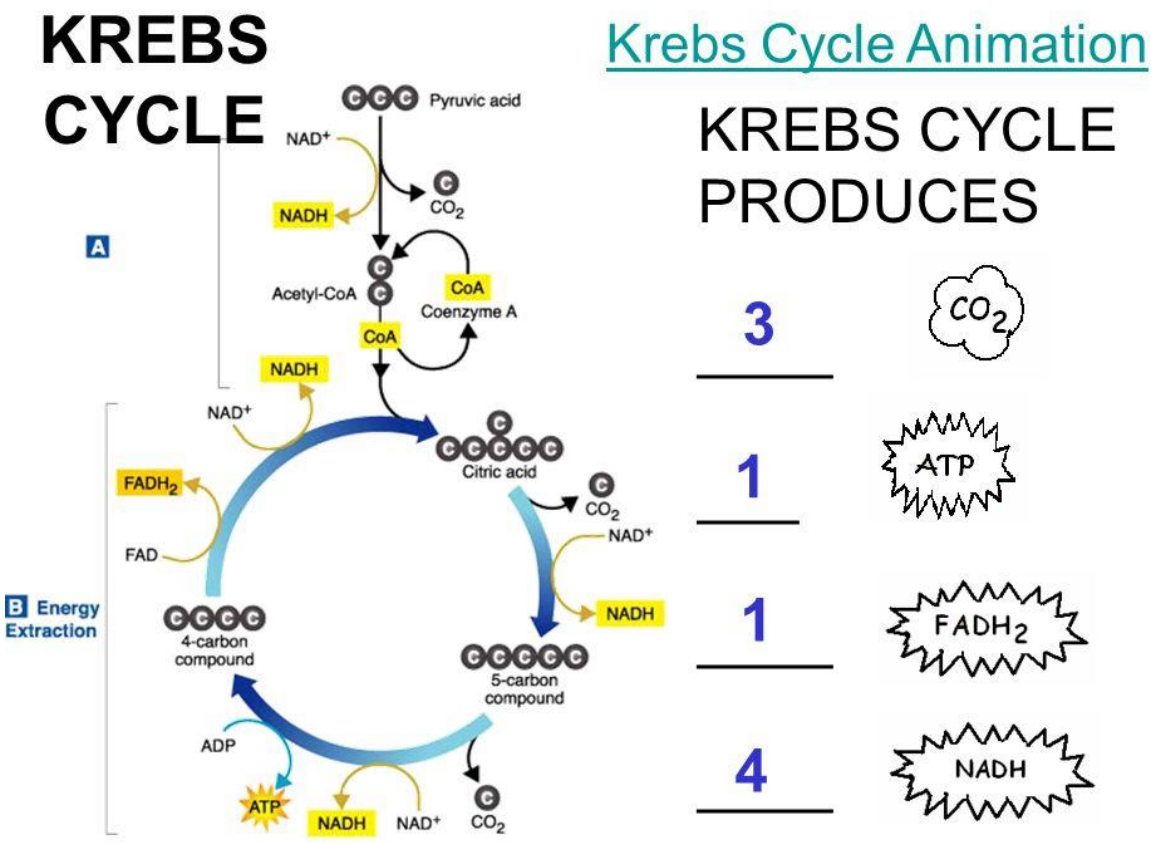
Anaerobic Respiration: Anaerobic respiration is the type of respiration through which cells can break down sugars to generate energy in the absence of oxygen. This is in contrast to the highly efficient process of aerobic respiration, which relies on oxygen to produce energy.

Aerobic Respiration

- Glycolysis
- Kreb's Cycle
- Terminal Oxidation

Glycolysis

- The scheme of glycolysis is given by Gustav Embden, Otto Meyerhof, and J. Parnas. It is also called as EMP pathway.
- Glycolysis is the partial oxidation of glucose or similar hexose sugar into two molecules of pyruvic acid through a series of enzyme mediated reaction releasing some ATP and NADH2. It occurs in cytoplasm.
- In plants glucose is derived from sucrose or from storage carbohydrates. Sucrose is converted into glucose and fructose by enzyme invertase.
- Glycolysis starts with phosphorylation of glucose in presence of enzyme hexokinase to form Glucose-6-phosphate. One molecules of ATP is used in this process.
- In next steps Glucose-6-phosphate is converted into fructose-6-phosphate, catalyzed by enzyme phosphohexose isomerase.
- Fructose-6-phosphate uses another molecule of ATP to form Fructose-1-6 biphosphate in presence of enzyme phosphofructokinase.



Tricarboxylic Acid Cycle/ Kreb's Cycle

- The Acetyl CoA enters a cyclic pathway called TCA cycle or Kreb's cycle.
- TCA cycle was discovered by Hans Krebs in 1940. This cycle is called TCA cycle because initial product is citric acid.
- Acetyl CoA combine with OAA (Oxaloacetic acid) and water to yield citric acid in presence of enzyme citrate synthase to release CoA.
- Citrate is then isomerized to isocitrate. It is followed by two successive steps of decarboxylation, leading to the formation of a-ketoglutaric acid and then succinyl-CoA.
- In the remaining steps, succinyl-CoA is oxidized to OAA allowing the cycle to continue.
- There are three points in the cycle where NAD + is reduced to $NADH_2$ and one point where FAD + is reduced to $FADH_2$.
- A molecule of glucose produces two molecules of $NADH_2$, 2ATP and two pyruvate while undergoing glycolysis. The two molecules of pyruvate are completely degraded in Krebs cycle to form two molecules of ATP, $8NADH_2$ and $2FADH_2$.

$$\text{Pyruvic} + 4NAD^+ + FAD^+ + 2H_2O + ADP + Pi \xrightarrow[\text{Matrix}]{\text{Mitochondrial}} 3CO_2 \underset{FADH_2}{+4NADH} + \underset{ATP}{4H^+}$$

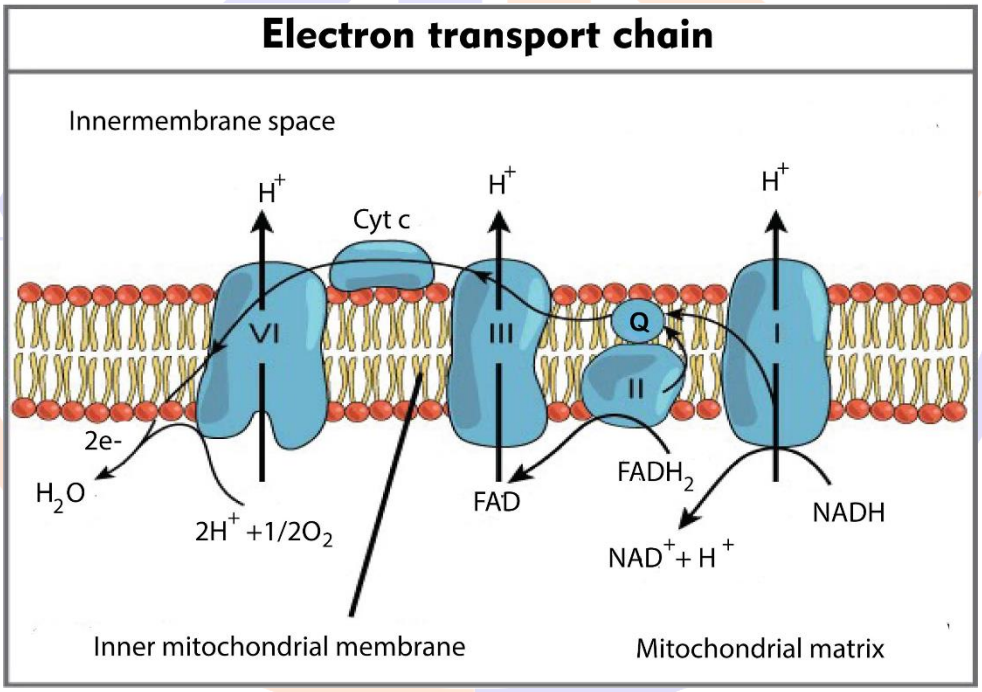
Terminal Oxidation

Terminal Oxidation is the name of oxidation found in aerobic respiration that

occurs towards end of catabolic process and involves the passage of both electrons and protons of reduced coenzyme to oxygen to produce water.

Electron Transport Chain

- The metabolic pathway through which the electron passes from one carrier to another inside the inner mitochondrial membrane is called ETC or mitochondrial respiratory chain.
- Electrons from NADH produced during citric acid cycle are oxidized by NADH dehydrogenase and electrons are transferred to ubiquinone located within the inner membrane. Ubiquinone also receives electrons from $FADH_2$ which is transferred to cytochrome c via cytochrome bc_1 complex.
- When the electrons pass from one carrier to another via electron transport chain, they produce ATP from ADP and inorganic phosphate. The number of ATP molecules synthesized depends upon electron donor.
- Oxidation of one molecule of NADH gives rise to 3 molecules of ATP, while oxidation of one molecule of FAD_2 produce two molecules of ATP.



Oxidative phosphorylation

It occurs in respiration process. Energy of oxidation-reduction is used for production of proton gradient required for phosphorylation.

Photophosphorylation

It occurs in photosynthesis. Light energy is utilized for production of proton gradient for phosphorylation.

Fermentation

- It accounts for incomplete oxidation of glucose.

- In fermentation, there is net gain of only two molecules of ATP.
- NADH is oxidized to NAD+ very slowly.

Aerobic Respiration

- It accounts for complete oxidation of glucose.
- In aerobic respiration, there is more net gain of ATP.
- NADH is oxidized to NAD+ very fast.

Amphibolic Pathway

- Glucose is the favored substrate for respiration. All carbohydrates are usually converted into glucose before used for respiration.
- Fats needs to be broken down into glycerol and fatty acid, which is further broken converted into Acetyl CoA and enter the respiratory pathway.
- Proteins are broken into amino acids and further enter Krebs cycle.
- Breaking down process within living organism is called catabolism and synthesis process is called anabolism process. So, respiration is an Amphibolic pathway.

NCERT LINE BY LINE QUESTIONS

13.1 What do we know?

1. Respiration is defined as – **(Pg. 227, E)**
   A) Formation of C – C bonds of complex compound
   B) Breaking of C – C bonds of complex compound
   C) Breaking of C – N bonds of complex compound
   D) All of the above
2. Respiration results finally to a formation and release of which among the following? **(Pg. 227, E)**
   A) NADPH B) Glucose C) ATP D) Both A & C
3. The C – C bond of complex compound in broken by which process in respiration? **(Pg. 227, E)**
   A) Oxidation B) Reduction
   C) Hydrogenation D) None of the above
4. Assertion – ATP act as energy currency of cell.
   Reason – Energy released through respiration is trapped as bio-chemical energy in the form of ATP. **(Pg. 227, H)**
   A) Only Assertion is correct
   B) Only Reason is correct
   C) Both Assertion and Reason is correct
   D) Both Assertion and Reason is wrong
5. Which among the following is wrong? **(Pg. 227, E)**
   i) Only carbohydrates are oxidised to release energy in the process of respiration.
   ii) Energy produced in respiration is not released in a single step.
   iii) ATP can be broken down, as and when energy needs to be utilised.
   A) Only ii B) Only iii
   C) Only i D) None of the above
6. ATP stands for? **(Pg. 227, E)**
   A) Adenosine 3' – triphosphate
   B) Adenosine – 3' – trio phosphite
   C) Adenosine 5' – triphosphate
   D) Adenosine 5' – triophosphite
7. Compounds that are oxidised during the process of respiration is called? **(Pg. 227, E)**
   A) Respiratory index B) Reductory substrate
   C) Respiratory quotient D) Respiratory substrate
8. Statement I – Only green plants and cyanabacteria can prepare their own food by photosynthesis.
   Statement II – Only green plants and cyanobacteria can prepare their own food by converting chemical energy to light energy
   Which of the statements is/are true? **(Pg. 227, M)**
   A) Only I B) Only II
   C) Both of these D) None of these
9. "Ultimately all the food that is respired for life processes comes from photosynthesis."
   The above statement is – **(Pg. 227, M)**
   A) correct B) incorrect
   C) partially correct D) can't be said as it is incomplete

10. Which of the following cannot be used as respiratory substances in plants under any conditions? **(Pg. 227, E)**
A) fat B) protein
C) carbohydrate D) none of these

14.1 Do Plants Breathe?

11. What are the byproducts of Respiration process? **(Pg. 227, E)**
A) Oxygen B) Water
C) Carbon dioxide D) Both B and C
12. Respiration is a _____ process. **(Pg. 227, E)**
A) Anabolic B) Catabolic
C) Both Anabolic as well as catabolic D) None of the above
13. Choose the correct equation- **(Pg. 228, E)**
A) $C_6H_{12}O_6 + 12O_2 \rightarrow 6H_2O + 6H_2O + Energy$
B) $C_6H_{12}O_6 + 3O_2 \rightarrow 2CO_2 + 3H_2O + Energy$
C) $C_6H_{12}O_6 + 6CO_2 + 6H_2O + Energy$
D) $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + Energy$
14. Respiration organs for plants are- **(Pg. 228, E)**
A) Lenticels B) Stomata
C) Woody Bark D) Both of the above A and B
15. Which among the following is wrong? **(Pg. 228, M)**
A) Roots, Leaves and Stem respire a for lower than animal do
B) For plants to respire, availability of O_2 is a problem as O_2 is not released within the cell during photosynthesis
C) There is very little transport of gases from one plant part to another
D) None of the above

14.2 'Glycolysis'

16. Glycolysis is originated from- **(Pg. 228, E)**
A) Latin word B) French word
C) Italian word D) Greek word
17. Meaning of glycolysis is-
A) Splitting of water B) Splitting of sugar
C) Splitting of fat D) Splitting of protein
18. Glycolysis is also known as _____ pathway.
A) ETS B) EMP C) ENP D) ELP
19. The scheme of glycolysis was given by-
A) Gustav Embden B) Otto Meyerhof
C) J. Parnas D) All of the above
20. The scheme of glycolysis was given by-
A) Gustav Embden B) Alto Meyerhof
C) J. Parnas D) All of the above
21. Glycolysis occurs in which among the following?
A) Aerobic organism B) Anaerobic organism
C) Eukaryotes D) All of the above
22. Sucrose is converted to __(i)__ and __(ii)__ using enzyme __(iii)__

(i)	(ii)	(iii)
A) Glucose	Glucose	Hexokinase
B) Glucose	Fructose	Hexokinase
C) Glucose	Glucose	Invertase

D) Glucose	Fructose	Invertase

23. What is the isomerised produce of glucose – 6 – phosphate in the steps of glycolysis? **(Pg 229, E)**
A) Fructose 1, 6 – bisphosphate B) Fructose –6 – phosphate
C) Fructose –1, 3, 6 – triphosphate D) Fructose –3 – phosphate

24. Glycolysis is a how many steps of process? **(Pg 229, E)**
A) Ten B) Eight C) Eleven D) Five

25. End product of glycolysis is? **(Pg 229, E)**
A) Pyruvate B) Phenol C) Prusic acid D) Phosphoenolpyruvate

26. ATP is utilised in which steps of glycolysis. **(Pg 229, E)**
i) Conversion of BPGA to PGA
ii) Conversion of glucose into glucose – 6– phosphate
iii) Conversion fructose 6 – phosphate to fructose 1, 6 – bisphosphate
iv) Conversion of PEP to pyruvate
A) Only i B) Only iii
C) Both ii and iii D) Only ii, iii, iv

27. One molecule of glucose is converted into how many molecules of pyruvic acid? **(Pg 229, E)**
A) 1 B) 2 C) 3 D) 4

28. When PGAL is converted into BPGA in process of respiration there is formation of? **(Pg 229, E)**
A) 1 molecule of ATP B) 1 molecule of H2O
C) 1 molecule of NADH + H+ D) 1 molecule of ADP

29. PGAL get _____ and get converted to BPGA? **(Pg 229, E)**
A) reduced B) hydrolysed
C) oxidized D) all of these

30. Conversion of 2-phosphoglycerate to phosphoenolpyruvate leads of formation of? **(Pg 229, E)**
A) ATP B) $NADH_2$ C) H_2O D) ADP

31. What does PGAL stands for? **(Pg 229, E)**
A) 3 – Phosphoglyceraldehyde
B) 5 – Phosphoglyceraldehyde
C) 3 – Phosphoglyceric acid
D) 5 – Phosphoglyceric acid

32. What is the full form of PEP? **(Pg 229, E)**
A) Pyroenol pyruvate B) Pyruvic pyruvate
C) Phosphoenolpyruvate D) None of the above

33. Pyruvic acid is composed of how many carbon atom? **(Pg 229, E)**
A) Two B) Three C) Four D) Five

34. Which among the following step in glycolysis yields energy? **(Pg 229, E)**
i) Conversion of BPGA to PGA
ii) Conversion of fructose – 6 –phosphate to fructose 1, 6 –bisphosphate
iii) Conversion of PEP to pyruvic acid
iv) Conversion of glucose – 6 –phosphate to fructose – 6 – phosphate
A) Both ii and iv B) i, ii, iii C) Both i and iii D) All of the above

35. In glycolysis, fructose 1, 6 – bisphosphate get split into which of the following? **(Pg 229, E)**
A) PGAL and BPGA

B) Glyceraldehyde – 3 – phosphate and 3 – phosphoglyceric acid
C) Glyceraldehyde – 3 – phosphate and Dihydroxy acetone phosphate
D) None of the above

36. What is the net gain of ATP from one molecule of glucose in one complete glycolysis? **(Pg 229, M)**
A) 4 B) 3 C) 5 D) 2

37. How many ATP are utilized in complete process of glycolysis of one glucose molecule? **(Pg 229, M)**
A) 2 B) 1 C) 3 D) 4

38. How many molecules of NADH are produced in one complete process of glycolysis of one glucose molecule? **(Pg 229, M)**
A) 1 B) 2 C) 3 D) 4

39. How many molecules of ATP are directly produced in one complete glycolysis of one glucose molecule? **(Pg 229, E)**
A) 1 B) 2 C) 3 D) 4

40. Which among the following are correct about Glycolysis? **(Pg 229, E)**
i) It is the only process that occurs in anaerobes for oxidation of glucose.
ii) Glucose undergoes complete oxidation to form pyruvic acid.
iii) At the end, there is a net gain of 4 ATP and 2 NADH.
A) Only ii B) Both ii and iii
C) Only i D) all of the above

41. For further complete oxidation of glucose, pyruvic acid enters to which among the following? **(Pg 229, E)**
A) ETS B) Kreb's cycle
C) EMP pathway D) None of the above

42. Fermentation occurs when there is **(Pg 230, E)**
A) Complete supply of oxygen B) No supply of oxygen
C) Complete supply of water D) No supply of water

43. In alcoholic fermentation, pyruvate is converted to which among the following?
A) Ethanol, CO_2, NADH **(Pg 230, E)**
B) CO_2 and Methanol
C) CO_2 and Ethanol only
D) CO_2 and Carboxylic acid

44. Which enzyme is responsible for alcoholic fermentation? **(Pg 230, E)**
A) Pyruvic acid decarboxylase
B) Lactate dehydrogenase
C) Alcohol dehydrogenase
D) More than one option is correct

45. Which enzyme is involved in lactic acid fermentation? **(Pg 230, E)**
A) Pyruvic acid decarboxylase
B) Lactate dehydrogenase
C) Alcohol dehydrogenase
D) More than one option is correct

46. Choose the correct option **(Pg 230, M)**
In the fermentation process:-
i) Oxidation of ADP to ATP takes place
ii) Reduction of ATP to ADP takes place
iii) Reducing agent NADH + H+ is reoxidised to NAD+
iv) Formation of NADH + H+ takes place by oxidation
A) ii and iv B) ii and iii C) Both i and iii D) Only iii

47. How many statements are correct about fermentation? **(Pg 230, M)**
i) Very low amount of energy is released, < 7% of energy in glucose is released in fermentation
ii) In animal cells, when oxygen is inadequate acetic acid is formed during respiration
iii) It is dangerous process as it leads to acid and alcohol formation.
A) 0 B) 1 C) 2 D) 3

48. The range beyond which yeasts poison themselves to death in alcohol fermentation when the concentration of alcohol reaches to? **(Pg 230, E)**
A) 13% B) 15% C) 12% D) 17%

49. Which among the following is the processes steps in, complete cellular respiration which don't need oxygen molecule (O_2)? **(Pg 231, E)**
A) Glycolysis B) Tricarboxylic acid cycle
C) ETC D) Both A and B

14.4 Aerobic Respiration

50. Complete the following reaction- **(Pg 231, E)**
Pyruvic acid + (i) + NAD+ $\xrightarrow[\text{Enzyme}]{\text{(ii)}}$ Acetyl COA +(iii) + NAD + H+
A) (i) O_2 (ii) Mg^{2+} (iii) CO_2 B) (i) O_2 (ii) Na+ (iii) H_2O
C) (i) CoA (ii) Na^+ (iii) CO_2 D) (i) CoA (ii) Mg^{2+} (iii) CO_2

51. Pyruvate enters to the mitochondrial matrix and undergoes. **(Pg 231, E)**
A) Reductive decarboxylation B) Oxidative carboxylation
C) Reductive carboxylation D) Oxidative decarboxylation

52. Which enzyme catalyse the reaction going on in mitochondrial matrix in respiration? **(Pg 231, E)**
A) Pyruvate carboxylase B) Lactate dehydrogenase
C) Alcohol dehydrogenase D) Pyruvate dehydrogenase

53. Who elucidated Tricarboxylic Acid cycle? **(Pg 231, E)**
A) Johns Elen B) Hans Krebs
C) Meyerhoff D) Elena Parker

54. Formation of Acetyl coenzyme A from Pyruvate in mitochondrial matrix yields which among the following? **(Pg 231, E)**
A) CO_2 B) H_2O
C) NADPH + H+ D) Both A and C

55. How many molecules of NADH + H^+ are produced when pyruvate converts to Acetyl CoA in TCA cycle? **(Pg 231, E)**
A) 0 B) 1 C) 2 D) 3

14.4.1 'Tricarboxylic Acid Cycle'

56. Where does TCA cycle occurs? **(Pg 231, E)**
A) Cytoplasm B) Mitochondria cell wall
C) Mitochondrial matrix D) Chloroplast

57. What is the first product of TCA cycle? **(Pg 231, E)**
A) Acetyl CoA B) Citric acid
C) Isocitric acid D) OAA

58. What is the 1st step of TCA cycle? **(Pg 231, E)**
A) Formation of citrate from isocitrate
B) Formation of citrate from the acetyl coenzyme A
C) Formation of citrate from decarboxylation of succinic acid
D) None of the above

59. Which enzyme catalyses the first step of TCA cycle? **(Pg 231, E)**
A) Citrate Synthase B) Citrate Reductase

C) Citrate Oxidase D) None of the above

60. What is the first member of TCA cycle that accepts Acetyl CoA? **(Pg 231, E)**
A) Citrate B) CoA
C) Oxaloacetic acid D) Both A and C

61. Which among the following is synthesized during the conversion of succinyl – CoA to succinic acid in TCA cycle? **(Pg 232, E)**
A) $FADH_2$ B) GTP C) $NADH_2$ D) ATP

62. How many total CO_2 molecule are released from Pyruvate to completion of TCA cycle? **(Pg 232, E)**
A) 0 B) 1 C) 2 D) 3

63. How many total $NADH_2$ are produced from pyruvate to completion of TCA cycle? **(Pg 232, E)**
A) 2 B) 3 C) 4 D) 5

64. How many $FADH_2$ are produced in TCA cycle? **(Pg 232, E)**
A) 1 B) 2 C) 3 D) 4

65. One molecule of glucose synthesizes how many molecules of NADH + H+ at the end of TCA cycle? **(Pg 232, E)**
A) 6 B) 7 C) 8 D) 10

66. How many molecules of $FADH_2$ are yielded from one glucose molecule at the end of TCA cycle? **(Pg 232, E)**
A) 1 B) 2 C) 3 D) 4

67. How many net ATP molecules are directly yielded from complete oxidation of one glucose (including ATP of TCA)? **(Pg 232, E)**
A) 4 B) 2 C) 3 D) 8

68. Which among the following is wrong? **(Pg 232, E)**
(i) Glycolysis occurs in all living organism.
(ii) TCA cycle and ETS only occurs in aerobes.
(iii) Complete oxidation of pyruvate occurs by removal of all hydrogen atom in TCA cycle.
A) (i) B) (ii) C) (iii) D) None of the above

14.4.2 Electron Transport System (ETS) and Oxidative Phosphorylation

69. ETS occurs in which place? **(Pg 232, E)**
A) Outer membrane of mitochondria
B) Cytoplasm
C) Inner membrane of mitochondria
D) Matrix of mitochondria

70. Energy stored in NADH + H^+ $FADH_2$ are released in ETS through _____. **(Pg 232, E)**
A) Reduction of these molecules B) Oxidation of these molecules
C) Hydrolysis of these molecules D) Both A & B

71. ETS stands for **(Pg 232, E)**
A) Electrical Transport System B) Electron Transmission System
C) Electron Transport System D) None of the above

72. When the electrons are passed onto O_2 in ETS it leads to formation of what? **(Pg 232, E)**
A) CO_2 B) ATP C) H_2O D) NADH + H+

73. Ubiquinone is located at _____. **(Pg 233, E)**
A) inner membrane of mitochondria
B) outer membrane of mitochondria
C) inner membrane of nucleus

D) outer membrane of nucleus

74. Ubiquinone receives electrons from which of the following? **(Pg 233, E)**
i) From NADH produced in mitochondrial matrix during TCA.
ii) From $FADH_2$ produced during oxidation of succinate in TCA.
A) Only i B) Only ii
C) Both i and ii D) None of the above

75. Electrons from NADH produced during TCA are oxidised by which enzyme? **(Pg 233, E)**
A) NAD^+ hydrogenase B) NADH dehydrogenase
C) NAD^+ hydroxylase D) NADH dehydroxylase

76. The reduced ubiquinone are also called what? **(Pg 233, E)**
A) Ubiquinate B) Ubiquinase
C) Ubiquinal D) Ubiquinol

77. Cytochrome c is _____? **(Pg 233, E)**
A) Lipid B) Carbohydrate
C) Protein D) Fat

78. What is the function of cytochrome c? **(Pg 233, E)**
A) Act as donor of electron
B) Passage for movement of e-
C) Act as a receptor of e- between complex II and III
D) Act as a mobile carrier for e- transfer between complex III and IV

79. What does cytochrome c oxidase complex contains? **(Pg 233, E)**
A) Cytochrome a B) Cytochrome a3
C) Two copper centres D) All of the above

80. When e- passes from complex I to IV in ETS they are coupled to _____ for ATP production from ADP. **(Pg 233, E)**
A) Cytochrome c B) Cytochrome bc1
C) ATP synthase D) Both A and B

81. Oxidation of one molecule of $NADH_2$ produces how many molecules of ATP? **(Pg 233, E)**
A) 1 B) 2 C) 3 D) 4

82. Oxidation of 2 molecule of $FADH_2$ produces how many molecules of ATP? **(Pg 233, E)**
A) 1 B) 2 C) 3 D) 4

83. Which among the following is the role of O_2 in whole respiration process? **(Pg 233, M)**
i) Act as hydrogen removal from the system.
ii) Act as final hydrogen acceptor.
iii) It bond with C atom and released CO_2, one of the byproduct of respiration.
A) ii and iii B) iii only
C) Both i and ii D) All of the above

84. ETS of respiration process is called **(Pg 233, E)**
A) Reductive phosphorylation
B) Oxidative phosphorylation
C) Oxidative photophosphorylation
D) Both B and C

85. Which among the following is wrong about ATP synthase? **(Pg 234, E)**
i) It is also called complex V.
ii) This is used to synthesis ATP by utilising the energy released during ETS.
iii) It works on the basis of proton gradient.
iv) It consist of two major components, F_1 and F_0.
A) Only ii B) Both i and iii

C) i and iv D) None of the above

86. What is F1 in ATP synthase? **(Pg 234, E)**
A) It contain a site for protein synthesis.
B) It contain a site for ADP synthesis from ATP.
C) It contain a site for ATP production from ADP.
D) It act as a channel through which proton cross the inner membrane.

87. What is the role of F0 in ATP synthase? **(Pg 234, E)**
A) It act as a channel through which ecrosses the inner membrane.
B) It act as a channel through which proton crosses the inner membrane.
C) It act as a mobile protein carrier of electron across the inner membrane.
D) Acts as site for ATP synthesis

88. For each ATP produced, _____ passes through F0 from intermembrane space to the matrix down the electrochemical proton gradient. **(Pg 234, E)**
A) H+ B) 2H+ C) 3H+ D) $4H^+$

14.5 The Respiratory Balance Sheet

89. What is the net gain of ATP molecules during aerobic respiration of one glucose molecule? **(Pg 234, E)**
A) 40 ATP B) 38 ATP C) 36 ATP D) 34 ATP

90. Match the following **(Pg 234, H)**

1 Glycolysis	i Mitochondrial matrix
2 TCA	ii Cytoplasm
3 ETC	iii Inner membrane of mitochondria

A) 1-i, 2-ii, 3-iii B) 1-ii, 2-i, 3-iii
C) 1-iii, 2-ii, 3-I D) 1-ii, 2-iii, 3-i

91. The respiratory balance sheet is calculated on some assumptions. Which of the following assumption is correct? **(Pg 234, M)**
A) The pathway is sequential, with series of glycolysis, ETS and TCA cycle in the same order for a given molecule.
B) NADH is transferred to chloroplast where oxidative phosphorylation occurs, leading to formation of 3 ATP
C) Only glucose is the substrate and none other substrate or intermediate enters or leaves the pathway
D) None of these

92. In the balance sheet of fermentation, net gain is – **(Pg 234, M)**
A) 12 ATP molecules B) 38 ATP molecules
C) 2 ATP molecules D) 8 ATP molecules

93. Oxidation of NADH to NAD+ is – **(Pg 235, M)**
A) Slower in fermentation than aerobic respiration
B) Faster in fermentation than aerobic respiration
C) Equal in fermentation and aerobic respiration
D) Cannot be compared

14.6 Amphibolic Pathway

94. Which among the following is wrong? **Pg 235, M)**
i) Other than glucose, no other substrates can be used in respiratory process.
ii) Respiratory pathway is an amphibolic pathway.
iii) Different substrates enters at different stage in respiratory pathway.
A) Only i B) Only iii C) Only ii D) Both i and ii

95. Which among the following is wrong? **Pg 235, M)**
i) Other than glucose, no other substrates can be used in respiratory process.
ii) Respiratory pathway is an amphibolic pathway.

iii) Different substrates enters at different stage in respiratory pathway.
A) Only i B) Only iii C) Only ii D) Both i and ii

96. Fats as a respiratory substrate converts to which compound first? **Pg 235, M)**
A) Dihydroxy Aceton Phosphate B) Glycerol
C) Fatty acid D) Both B and C

97. Match the following- **Pg 235, H)**

1 Amino acids	i Pyruvic acid
2 Fatty acid	ii Dihyroxy Acetone Phosphate
3 Glycerol	iii Acetyl CoA

A) 1-i, 2-iii, 3-ii B) 1-ii, 2-i, 3-iii C) 1-iii, 2-i, 3-ii D) 1-ii, 2-iii, 3-i

98. Choose the correct according to the correct sequence (from substrate to end product) **(Pg 235, M)**
i) Glucose 6 – phosphate ii) Pyruvic acid
iii) Carbohydrate iv) Fructose–1, 6-bisphosphate
v) Glucose
vi) Dihydroxy Acetone Phosphate ⇄ Glyceraldehyde 3 – phosphate
A) i, iii, iv, v, vi, ii B) iii, iv, v, ii, i, vi
C) iii, v, i, ii, iv, vi D) iii, v, i, iv, vi, ii

14.7 Respiratory Quotient

99. Which statement is true about RQ? **(Pg 236, M)**
i) It is also called respiratory ratio.
ii) It is the volume of O2 released over the volume of CO_2 evolved during respiration.
iii) RQ of diff. substrate is different.
A) Only i B) Only iii C) Both i and iii D) All of the above

100. Choose the correct. **(Pg 236, M)**
A) RQ = volume of CO_2 evolved/volume of O_2 consumed
B) RQ = volume of O_2 consumed/volume of CO_2 evolved
C) RQ = volume of O_2 evolved/volume of CO_2 consumed
D) None of the above

101. What will be the RQ for the following equation **(Pg 236, M)**
$2(C_{31}H_{28}O_6) + 145\ O_2 \rightarrow 102\ CO_2 + 98\ H_2O$ + Energy
A) 0.9 B) 1 C) 0.8 D) 0.7

102. What is RQ if proteins are used as a respiratory substrate? **(Pg 236, E)**
A) 1 B) 0.8 C) 0.9 D) 0.7

103. What is RQ if carbohydrates are used as a respiratory substrate? **(Pg 236, E)**
A) 1 B) 0.8 C) 0.7 D) 0.9

104. Match the following- **(Pg 236, E)**

1) NADH + H^+	i) 1 ATP
2) FADH2	ii) 2 ATP
3) GTP	iii) 3 ATP

A) 1-i, 2-ii, 3-iii B) 1-i, 2-iii, 3-ii
C) 1-iii, 2-ii, 3-i D) 1-ii, 2-i, 3-iii

105. In ETS O_2 accept the electrons and get reduced to which of the following? **(Pg 236, E)**
A) Water B) Carbon dioxide
C) Palmitic acid D) None of the above

106. What is the final end product of TCA cycle? **(Pg 236, E)**
A) 3 NADH + H^+ B) 1 ATP
C) 1 $FADH_2$ D) All of the above

107. How many ATPs are produced through ETS only from 1 molecule of 3-phosphoglycerate in aerobic respiration **(Pg 236, E)**

A) 12 B) 14 C) 16 D) 15

NEET PREVIOUS YEARS QUESTIONS

1. What is the role of NAD+ in cellular respiration? **[2018]**

(a) It functions as an enzyme.

(b) It functions as an electron carrier.

(c) It is the final electron acceptor for anaerobic respiration.

(d) It is a nucleotide source for ATP synthesis.

2. Which of these statements is **incorrect**? **[2018]**

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

(b) Glycolysis occurs in cytosol.

(c) Oxidative phosphorylation takes place in outer mitochondrial membrane.

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

3. Phosphoenol Pyruvate (PEP) is the primary CO2 acceptor in _____. **[2017]**

(a) C_4 plants (b) C_2 plants (c) C_3 and C_4 plants (d) C_3 plants

4. Which statement is wrong for Krebs' cycle? **[2017]**

(a) There is one point in the cycle where FAD+ is reduced to FADH2.

(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+.

5. In which one of the following processes CO2 in not released? **[2014]**

(a) Aerobic respiration in plants. (b) Aerobic respiration in animals.

(c) Alcoholic fermentation. (d) Lactate fermentation.

6. Respiratory Quotient (RQ) value of tripalmitin is : **[NEET-2019]**

(1) 0.9 (2) 0.7 (3) 0.07 (4) 0.09

7. Conversion of glucose to glucose-6-phosphate, the first irreversible reaction of glycolysis, is catalyzed by : **[NEET-2019]**

(1) Aldolase (2) Hexokinase

(3) Enolase (4) Phosphofructokinase

8. Where is respiratory electron transport system (ETS) located in plants ? **[NEET-2019 ODISSA]**

(1) Mitochondrial matrix (2) Outer mitochondrial membrane

(3) Inner mitochondrial membrane (4) Intermembrane space

9. Pyruvate dehydrogenase activity during aerobic respiration requires **[NEET-2020 COVID]**

(1) Calcium (2) Iron (3) Cobalt (4) Magnesium

10. The number of substrate level phosphorylations in one turn of citric acid cycle is **[NEET-2020]**

1) Three 2) Zero 3) One 4) Two

11. Which of the following statements is **incorrect**? **[NEET-2021]**

1) 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.

2) ATP is synthesized through complex V.

3) Oxidation-reduction reactions produce proton gradient in respiration.

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

12. What amount of energy is released from glucose during lactic acid fermentation?

1) Approximately 15% 2) More than 18%

3) About 10% 4) Less than 7%

13. What is the net gain of ATP when each molecule of glucose is converted to two molecules of pyruvic acid?

1) Four 2) Six 3) Two 4) Eight

NCERT LINE BY LINE QUESTIONS – ANSWERS

1	2	3	4	5	6	7	8	9	10
B	C	A	C	C	C	D	A	A	D
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
D	B	D	D	B	D	B	B	D	D
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
D	D	B	A	A	C	B	C	C	A
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
A	C	B	C	C	D	A	D	B	C
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
B	B	C	D	B	D	C	A	A	D
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
D	D	B	A	B	C	B	B	A	C
61	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**
B	D	C	A	C	B	A	D	C	B
71	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
C	C	A	C	B	D	C	D	D	C
81	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**
C	B	C	B	D	C	B	B	B	B
91	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
C	C	A	A	B	D	A	D	C	A
101	**102**	**103**	**104**	**105**	**106**	**107**			
D	C	A	C	A	D	B			

NEET PREVIOUS YEARS QUESTIONS-ANSWERS

1 (b) **2** (c) **3** (a) **4** (c) **5** (d) **6** (2) **7** (2) 8 (3) **9** (4) **10** (3)

11 (1) 12 (4) 13 (3)

NEET PREVIOUS YEARS QUESTIONS-EXPLANATIONS

1. (b) In cellular respiration, NAD+ act as an electron carrier.

2. (c) Oxidative phosphorylation takes place in inner mitochondrial membrane.

3. (a) In the mesophyll cells cytoplasm of C4 plants like sugarcane, maize, sorghum etc. PEP is 3C Compound which serves as primary CO2 acceptor.

4. (c) Krebs cycle begins with condensation of acetyl CoA (2C) with oxaloacetic acid (4C) to form citric acid (6C).

5. (d) **Lactic acid fermentation:** It occurs in lactic acid bacteria (*Lactobacillus*) and muscles (Human). Pyruvic acid produced in glycolysis is reduced by $NADH_2$ to form lactic acid without producing carbon dioxide.

$$\underset{\text{Pyruvic acid}}{CH_3COCOOH} + NADH_2 \xrightarrow[FMN,Zn^{2+}]{\textit{Lactate dehydrogenase}} \underset{\text{Lactic acid}}{CH_3CHOHCOOH} + NAD$$

10. In citric acid cycle during conversation of succinyl CO.A ⟶ succinic acid, one ATP molecule is synthesized by substrate level phosphorylations

11. In ETC –

1 NADH – 3 ATP ; 1 $FADH_2$ – 2 ATP

12. Lactic acid fermentation – less than 7%

13. In glycolysis the net gain of ATP is 2