Respiration

1) Explain how does aerobic respiration differ from anaerobic respirations? Discuss the cycle that involves break down of two carbon compound Acetyl CoA in aerobic respiration with necessary schematic chart. (2080, 2079) (3+5=8) marks.

Aerobic Respiration	Anaerobic Respiration
i) Takes place in the presence of oxygen.	i) Takes place in the absence of oxygen
ii) Takes place in cytoplasm and mitochondria.	ii) Takes place in cytoplasm
iii) Releases large amount of energy (686 Kcal)	iii) Releases less amount of energy (56 Kcal).

iv) Large number of CO_2 is evolved	iv) Less number of CO_2 is evolved or no evolution of CO_2.

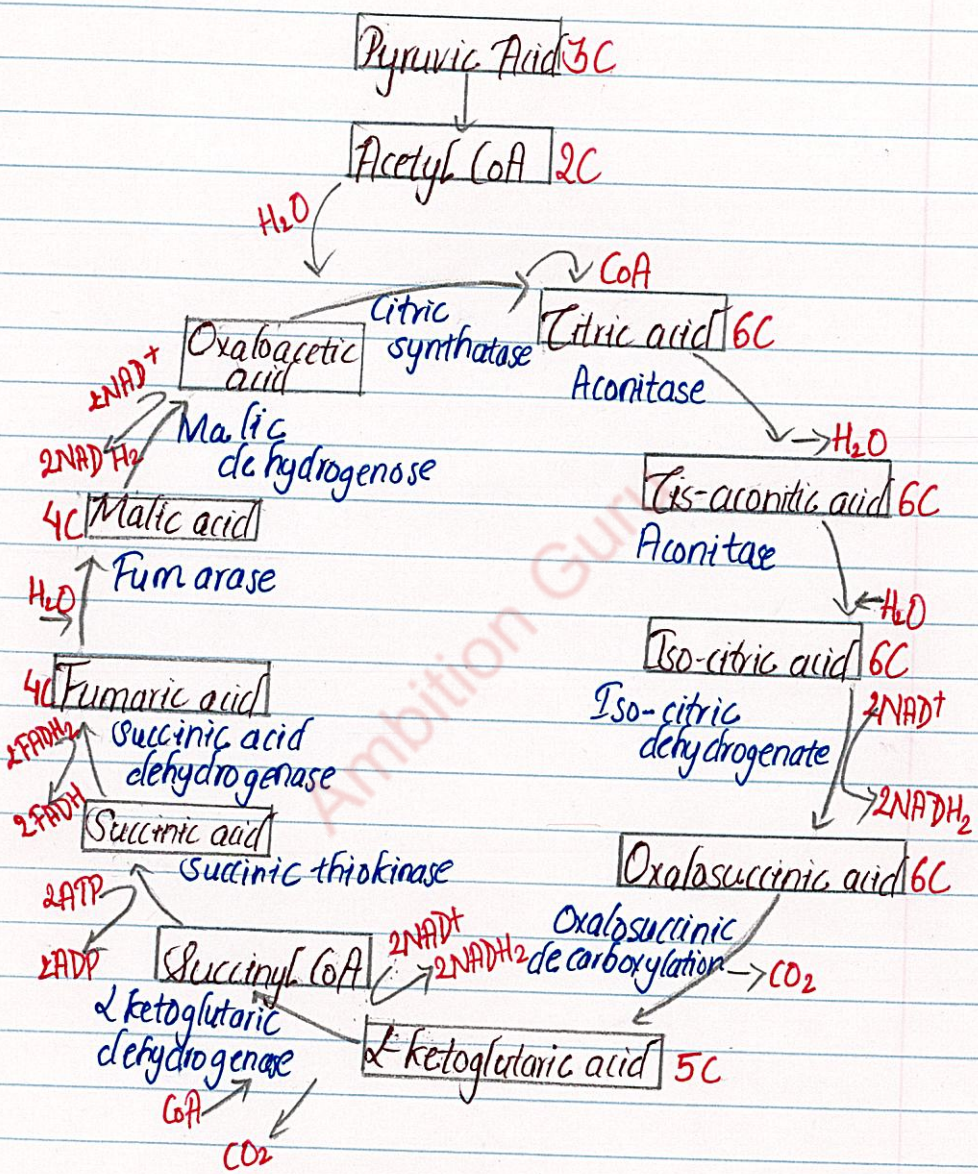
The cycle that involves breakdown of two carbon compound Acetyl CoA in aerobic respiration is as follows:

The whole reaction of Kreb's cycle occurs in Mitochondria in the following steps.

1) Acetyl CoA:

- Acts as connecting link between Glycolysis and Kreb's cycle.
- Acetyl CoA reacts with Oxaloacetic acid with the use of 1 molecule of water to form citric acid (6C) in the presence of citric synthetase and CoA is liberated in this step.

Oxaloacetic acid + Acetyl CoA + H_2O → Citric acid + CoA.


Pyruvic Acid 3C
Acetyl CoA 2C
H_2O
CoA
Citric synthatase
Oxaloacetic acid
Citric acid 6C
Aconitase
$2NAD^+$
$2NADH_2$
Malic dehydrogenose
4C Malic acid
H_2O
Fumarase
4C Fumaric acid
$2FADH_2$
2FADH
Succinic acid dehydrogenase
Succinic acid
Succinic thiokinase
2ATP
2ADP
Succinyl CoA
$2NAD^+$
$2NADH_2$
α ketoglutaric dehydrogenase
CoA
CO_2
α ketoglutaric acid 5C
Oxalosuccinic decarboxylation
CO_2
Oxalosuccinic acid 6C
Iso-citric dehydrogenate
$2NAD^+$
$2NADH_2$
Iso-citric acid 6C
H_2O
Cis-aconitic acid 6C
Aconitase
H_2O

Kreb's cycle

2) Citric Acid:
Loses one molecule of water to form Cis-aconitic acid in the presence of Aconitase enzyme.
Citric acid → Cis-aconitic acid + H_2O

3) Cis-aconitic acid:
- Hydrated with 1 molecule of water to form Iso-citric acid in the presence of Aconitase.
Cis-aconitic acid + H_2O → Iso-citric acid.

4) Iso-citric acid:
Converted into oxalosuccinic acid and $NADH_2$ in the presence of Iso citric dehydrogenase.
Iso-citric acid + 2NAD → Oxalosuccinic acid + $2NADH_2$

5) Oxalosuccinic acid (6C):
Decarboxylated to form α-keto-glutaric acid (5C) in the presence of oxalosuccinic decarboxylase.
Oxalosuccinic acid → α-ketoglutaric acid + CO_2

6) α-Ketoglutaric acid:
- Undergoes oxidative decarboxylation to form Succenyl CoA, $NADH_2$ and CO_2 in the presence of α-ketoglutaric dehydrogenase.

α-ketoglutaric acid $\longrightarrow$ Succenyl CoA + CO_2 + $2NADH_2$
+ 2NAD + CoA

7) Succenyl CoA:
- Converted into Succinic acid by removal of CoA in the presence of Succinic thiokinase. During this process, GTP reacts with ADP and ATP is formed.

Succenyl CoA + $\longrightarrow$ Succinic acid + GTP + CoA.
H_2O + GDP

$GTP + 2ADP \longrightarrow 2ATP + GDP$

8) Succinic acid:
Converted into fumaric acid in the presence of Succinic acid dehydrogenase. During this process FAD (Flavin Adenine Dinucleotide) is converted into $FADH_2$.

Succinic acid + 2FAD → Fumaric acid + 2FADH$_2$.

9) Fumaric acid:
Reacts with water to form Malic acid in the presence of enzyme Fumarase
Fumaric acid + H_2O → Malic acid.

10) Malic acid:
Oxidized into Oxaloacetic acid and $NADH_2$ in the presence of Malic dehydrogenase.
Malic acid + 2NAD → Oxaloacetic acid + 2NADH$_2$.

2) Oxygen is an essential requirement for aerobic respiration but it enters the respiratory process at the end. Why? Draw a detailed flow chart showing the important series of events of aerobic respiration that occurs in the matrix of mitochondria. (2+6=8) marks (2079)

- Oxygen enters the respiratory process at the end as oxygen is required only as a terminal electron acceptor that accepts electrons.
- Electrons are donated from $NADH + H^+$ and $FADH_2$ during the last step of aerobic respiration called Electron Transport System (ETS).
- In ETS, the movement of electrons occur in the sequence $NADH + H^+$ to $FADH_2$ and then to co-enzyme Q_1 Cytochrome b, Cytochrome c, Cytochrome a and then to Cytochrome a_3.
- Finally to molecular oxygen which gets permanently reduced to water molecule.

Flow chart of Kreb's cycle.

3) Describe the process of Glycolysis. (8 marks) (2010).

Glycolysis is:

- Common in both aerobic and anaerobic respiration.
- Glucose molecule break into 2 molecules of Pyruvic acid.
- Occurs in the cytoplasm of cell.
- Does not require oxygen.
- Also known as EMP pathway.

Process of Glycolysis:

a) First phosphorylation:

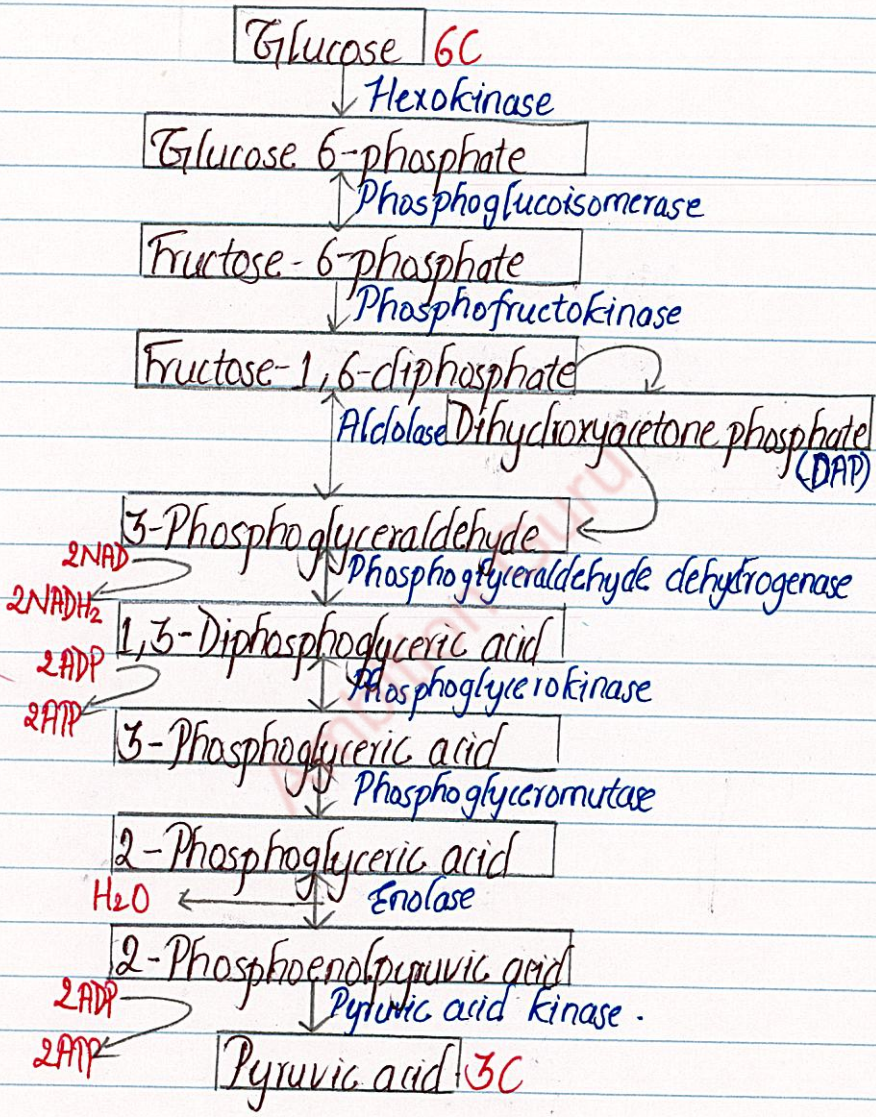
Glucose + ATP $\longrightarrow$ Glucose-6-phosphate + ADP

b) 1st Isomerisation:

Glucose-6-phosphate $\longleftrightarrow$ Fructose-6-phosphate.

c) Second Phosphorylation:

Fructose-6-phosphate + ATP $\longrightarrow$ Fructose-1,6-diphosphate + ADP.



Glycolysis Pathway.

d) Cleavage:

Fructose-1,6-diphosphate ⟷ 3-Phosphoglyceraldehyde + DAP.

Dihydroxyacetone ⟷ 3-Phosphoglyceraldehyde phosphate

e) Phosphorylation:

3-Phosphoglyceraldehyde + 2NAD ⟷ 1,3-diphospho glyceric acid + 2NADH$_2$

f) ATP Generation:

1,3-Diphosphoglyceric acid + 2ADP ⟷ 3-PGA + 2ATP

g) 2nd Isomerisation:

3-Phosphoglyceric acid ⟷ 2-Phosphoglyceric acid.

h) Dehydration:

2-Phosphoglyceric acid ⟷ 2-Phosphoenol pyruvic acid + H_2O

2-Phosphoenol pyruvic acid + 2ADP ⟶ Pyruvic acid + 2ATP

4). Difference between Glycolysis and Kreb's cycle. (4 marks).

Glycolysis	Kreb's Cycle
i) Occurs in both in aerobic and anaerobic respiration.	i) Occurs only in aerobic respiration
ii) Non-cyclic (linear) pathway.	ii) Cyclic pathway
iii) Takes place in cytoplasm	iii) Takes place in mitochondria.
iv) Consums 2 molecules of ATP.	iv) Does not consume ATP