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ASSIGNMENT

MECHANISM OF AEROBIC RESPIRATION

Aerobic respiration begins with glycolysis. Also called EMP pathway, it is the breakdown of glucose or similar hexose sugar to molecules of pyruvic acid through a series of enzyme meditated reactions releasing some energy as ATP and reducing power as NADH2. It occurs in the cytoplasm and takes place in the following sub steps;

* Phosphorylation: Glucose is phosphorylated to glucose-6-phosphate by ATP in the presence of enzyme hexokinase or glucokinase and Mg2+.
* Isomerism: Glucose-6-phosphate is changed to its isomer fructose-6-phosphate with the help of enzyme fructokinase. Fructose-6-phosphate can also be produced directly by phosphorylation of fructose with the help of enzyme fructokinase.
* Phosphorylation: Fructose-6-phosphate is further phosphorylated by means of enzyme phosphofructokinase and Mg2+. The product is Fructose-1,6 diphosphate.
* Splitting: Fructose-1,6-diphosphate splits up enzymatically to form one molecule each of 3- carbon compounds, glyceraldehyde 3- phosphate (= GAP or 3- phosphoglyceraldehyde =PGAL) and dihydroxy acetone 3- phosphate (DIHAP). The latter is further changed to glyceraldehyde 3- phosphate isomerase (= phosphotriose isomerase).
* Dehydration and Phosphorylation: In the presence of enzyme glyceraldehyde phosphate dehydrogenase, glyceraldehyde 3- phosphate loses hydrogen to NAD to form NADH2 and accepts inorganic phosphate to form 1,3-diphosphoglyceric acid.
* Formation of ATP: One of the two phosphates of diphosphoglyeerie acid in linked by high energy bond. It can synthesize ATP and form 3- phosphoglyceric acid. The enzyme is phosphoglyceryl inase. The direct synthesis of ATP from metabolites is called substrate level phosphorylation.
* Isomerization: 3- phosphoglyceric acid is changed to its isomer 2-phosphoglyceric acid by zyme phosphoglyceromutase.
* Dehydration: Through the agency of enzyme enolase, 2-phosphoglyceride acid is converted to phosphoenol pyruvate (PEP). A molecule of water is removed in the process. Mg2+ is required.
* Formation of ATP: During formation of phospohoenol pyruvate the phosphate radical picks up energy. It helps in the production of ATP by substrate level phosphorylation. The enzyme is pyruvic kinase. It produces pyruvate from phosphoenol pyruvate.

In glycolysis two molecules of ATP are consumed during double phosphorylation of glucose to form fructose-1,6 diphosphate. In return four molecules of ATP are produced by substrate level phosphorylation (conversion of 1,3 diphosphoglyceric acid to 3-phosphoglyceric acid and phosphenol pyruvate to pyruvate). Two molecules of NADH2 are formed at the time of oxidation of glyceraldehyde 3-phosphate to 1,3- diphosphoglyceric acid.

The next step is the kerb’s or citric acid cycle. It occurs in the mitochondria and is stepwise oxidative and cyclic degradation of activated acetate derived from pyruvate. Pyruvate enters mitochondria. It is decarboxylated oxidatively to produce CO2 and NADH. The product combines with Sulphur containing coenzyme A to form acetyl CoA or activated acetate. The reaction occurs in the presence of an enzyme complex pyruvate dehydrogenase (made of a decarboxylase, lipoic acid, TTP, transacetylase and Mg2+). Acetyl CoA functions as substrate entrant for Kerbs cycle. The acceptor molecule of Kerbs cycle is a 4-carbon compound oxaloacetate. Kerbs cycle involves two decarboxylations and four dehydrogenations. The various components of the Kerbs cycle are as follows;

1. Condensation: Acetyl CoA (2-carbon compound) combines with oxalo-acetate (4-carbon compound) in the presence of condensing enzyme citrate synthetase to form a tricarboxylic 6-carbon compound called citric acid. It is the first product of Kerbs cycle. CoA is liberated.
2. Dehydration: Citrate undergoes reorganization in the presence of aconitase forming cis aconitate releasing water.
3. Hydration: Cis-aconitate is converted into isocitrate with the addition of water in the presence of iron containing enzyme aconitase.
4. Dehydrogenation: Isocitrate is dehydrogenated to oxalosuccinate in the presence of enzyme isocitrate dehydrogenases and Mg2+.NADH2 is produced.
5. Decarboxylation: Oxalosuccinate is decarboxylated to form alpha ketoglutarate through enzyme decarboxylase. Carbon dioxide is released.
6. Dehydrogenation and Decarboxylation: Alpha ketoglutarate is both dehydrogenated (with the help of NAD+) and decarboxylated by an enzyme complex alpha ketoglutarate dehydrogenase. The enzyme complex contains TPP and lipoic acid. The product combines with CoA to form succinyl CoA.
7. Formation of ATP/GTP: Succinyl CoA is acted upon by enzyme succinyl thiokinase to form succinate. The reaction releases sufficient energy to form ATP (in plants) or GTP (in animals).
8. Dehydrogenation: Succinate undergoes dehydrogenation to form fumarate with the help of a dehydrogenase. FADH2(reduced flavin adenine dinucleotide) is produced. Succinate +FAD Succinate= Dehydrogenase, Fumarate+ FADH2.
9. Hydration: A molecule of water gets added to fumarate to form malate. The enzyme is called fumarase.
10. Dehydrogenation: Malate is dehydrogenated or oxidized through the agency of malate dehydrogenase to produce oxaloacetate. Hydrogen is accepted by NADP+ and NAD+.

Other terms related to aerobic respiration include:

* Terminal Oxidation
* Electron Transport Chain
* Oxidative Phosphorylation