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General Microbiology: MICROBIAL METABOLISM: MOB 202

Medicine Laboratory Science

Describe the mechanism of 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.

The common aerobic respiration consists of three steps - glycolysis, Krebs cycle and terminal oxidation.

Glycolysis:

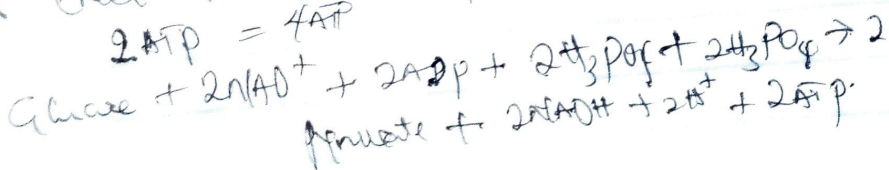
also called (EMP) Embden-Meyerhof-Parnas pathway which does not require  $O_2$  although it can take place in the presence of oxygen. Glycolysis is the process of breakdown of glucose or similar to those sugar to molecules of pyruvic acid through a series of enzymes mediated reactions releasing some energy (as ATP) and reducing power (as  $NADH_2$ ).

Glycolysis occurs in the cytoplasm.

Steps involved in Glycolysis

- 1) Phosphorylation - Glucose -> Glucose-6-phosphate (Hexokinase)
- 2) Isomerization - Glucose-6-phosphate -> Fructose-6-phosphate
- 3) Phosphorylation: Fructose-6-phosphate -> Fructose-1,6-bisphosphate
- 4) Cleavage: Fructose-1,6-bisphosphate -> Glyceraldehyde-3-phosphate
- 5) Dehydrogenation and phosphorylation: Glyceraldehyde-3-phosphate -> 1,3-bisphosphoglyceric acid
- 6) Formation of ATP: 1,3-bisphosphoglyceric acid -> 3-phosphoglyceric acid
- 7) Isomerization: 3-phosphoglyceric acid -> 2-phosphoglyceric acid
- 8) Dehydration: 2-phosphoglyceric acid -> Phosphoenolpyruvate
- 9) Formation of ATP: Phosphoenolpyruvate -> Pyruvate

Total net product of Glycolysis =



Krebs - cycle! This process occurs in Mitochondria, also called Citric acid cycle; Krebs cycle is stepwise oxidative and cyclic degradation of activated acetate derived from pyruvate

- Oxidation of Pyruvate

Pyruvate Enters → Mitochondria - It is decarboxylated oxidatively to produce  $\text{CO}_2$  and  $\text{NADH}$ , the product combines with Sulphur containing Coenzyme A to form Acetyl CoA (this ~~step~~ occurs in the presence of an enzyme complex Pyruvate dehydrogenase, lipoic acid, TPP, transacetylase and  $\text{Mg}^{2+}$ ).

Component of Krebs-cycle

(1) Condensation - Acetyl CoA + Oxaloacetate = Tricarboxylic CoA  
Enzyme: Citrate Synthase

(2) Dehydration: Citrate  $\xrightarrow[\text{Synthetase}]{\text{Aconitase}}$  Cis-aconitate +  $\text{H}_2\text{O}$

(3) Hydration: Cis-aconitate +  $\text{H}_2\text{O} \xrightarrow{\text{Aconitase}}$  Isocitrate

4 Dehydrogenation: Isocitrate +  $\text{NAD}^+$   $\xrightarrow[\text{dehydrogenase}]{\text{Isocitrate}}$  Oxalosuccinate +  $\text{NADH} + \text{H}^+$   
(TPP, lipoic acid,  $\text{Mg}^{2+}$ )

5) De Carboxylation: Oxalosuccinate  $\xrightarrow{\text{Decarboxylase}}$   $\alpha$ -Ketoglutarate +  $\text{CO}_2$

(6) Dehydrogenation and Decarboxylation  $\Rightarrow$

$\alpha$ -Ketoglutarate + CoA +  $\text{NAD}^+$   $\xrightarrow[\text{dehydrogenase}]{\text{Ketoglutarate}}$  Succinyl CoA +  $\text{NADH} + \text{H}^+$  +  $\text{CO}_2$   
(TPP, lipoic acid)

7) Formation of ATP/GTP

Succinyl CoA +  $\text{GDP/ADP} + \text{H}_2\text{PO}_4^- \xrightarrow[\text{thiokinase}]{\text{Succinyl}}$  Succinate + CoA + GTP/ATP

(8) Dehydration

Succinate +  $\text{FAD}$  Succinate  $\xrightarrow{\text{Dehydrogenase}}$  Fumarate +  $\text{FADH}_2$

(9) Hydration:

Fumarate +  $\text{H}_2\text{O} \xrightarrow{\text{Fumarate}}$  Malate

(10) Dehydration

Malate +  $\text{NAD(P)}^+ \xrightarrow[\text{Dehydrogenase}]{\text{Malate}}$  Oxaloacetate +  $\text{NAD(P)H} + \text{H}^+$

Terminal Oxidation

This process occurs towards the end of Citric Acid process and involves the passage of both electrons and protons of reduced coenzyme to oxygen

