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Assignment on Introduction to Microbiology

Answer

Mechanism in aerobic respiration

Aerobic respiration is an energy efficient catabolic process which involves the breaking down of glucose with oxygen as its final electron acceptor to produce CO2, H2O and ATP.

The catabolism begins with one or more pathways that yield pyruvate. These pathways also produce NADH, FADH2, or both. Next the partially oxidized carbon is fed into the TCA cycle and oxidized completely to C02 with the production of some GTP or ATP, NADH, and FADH2. The NADH and FADH2 formed by glycolysis and the TCA cycle are oxidized by an electron transport chain, using 02 as the terminal electron acceptor.

So generally, it involves three stages:

1) Glycolysis

2) Kerb cycle

3) Electron transport chain

Glycolysis

Glycolysis is the breaking down of **one molecule of glucose** (6 carbon) in the body to generate energy and yield **two molecules of Pyruvate** (3 carbon). In this process, 4ATP are generated, 2ATP are used up and 2NADH (2 x 3 = 6ATP) are generated giving a total of 8ATP in the glycolytic cycle. Glycolysis occurs in the cytoplasm.

**Glycolytic cycle**

**Glucose**

Phosphorylation (hexokinase) ATP ADP

**Glucose 6 phosphate**

Isomerization (Isomerase)

**Fructose 6-phosphate**

Phosphofructokinase ATP ADP

**Fructose 1,6 bisphosphate**

Aldolase (6C phase)

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**Fructose 1, 6-bisphosphate is split into two** (3C phase)

**Dihydroxyacetone phosphate(DHAP)**

**(2)** **Glyceraldehyde 3 phosphate** Isomerizes

Glyceraldehyde-3- NAD+ 2NADH +H+

Phosphate dehydrogenase

**(2) 1,3 – bisphosphoglycerate**

Phosphoglycerate kinase ADP 2ATP

**(2) 3 – phosphoglycerate**

Phosphogycerate mutase

**(2) 2 – phosphoglycerate**

Enolase H2O

**(2) Phosphoenolpyruvate**

Pyruvate kinaseADP 2ATP

**(2) Pyruvate**

The Oxidative breakdown of one glucose result in the formation of two pyruvate molecules. Pyruvate is one of the most important precursor metabolites.

Glucose+ 2ADP + 2P; + 2NAD+ 2 pyruvate+ 2ATP + 2NADH + 2H+

**Kreb cycle**

During aerobic respiration, the catabolic process continues by oxidizing pyruvate to three C02. The first step of this process employs a multienzyme system called the pyruvate dehydrogenase complex. It oxidizes and cleaves **pyruvate** to release one C02 and the 2-carbon molecule **acetyl-coenzyme A (acetyl-CoA)** yielding **2NADH**.

Acetyl-CoA then enters the tricarboxylic add (TCA) cycle, which is also called the citric add cycle or the Krebs cycle. In the first reaction, acetyl-CoA is condensed with the 4-carbon intermediate **oxaloacetate** to form **citrate**, a molecule with six carbons. Citrate is rearranged to give **isocitrate**, a more readily oxidized alcohol yielding **2NADH**. Isocitrate is subsequently oxidized and decarboxylated twice to yield **alpha-ketoglutarate** (five carbons) which is then converted to **succinyl-CoA** (four carbons) yielding **2NADH**.

At this point, two NADH molecules have been formed and two carbons lost from the cycle as C02. The cycle continues when succinyl-CoA is converted to **succinate**. This involves hydrolysis of the thioester bond in succinyl-CoA and using the large amount of energy released to form either **one ATP** or **one GTP** by substrate level phosphorylation. GTP is also a high-energy molecule, and it is functionally equivalent to ATP. It is used in protein synthesis and to make other nucleoside triphosphates, including ATP. Two oxidation steps follow converting succinate to **fumarate** yielding **one FADH2** and then with addition of H2O to fumarate, fumarate is converted to **malate** and then the last oxidation step regenerates **oxaloacetate** yielding **2NADH**.

As long as there is a supply of acetyl-CoA, the cycle can repeat itself. In this process, 1GTP is generated (1ATP), 2FADH is generated (2 x 2= 4ATP) and 8NADH is generated (8 x 3= 18ATP) giving in total 30ATP generated in kerb cycle. Kreb cycle occurs in the mitochondrion.

So in total, 8ATP is gotten from glycolysis cycle and 30ATP from kreb cycle giving a total of 38ATP produced in aerobic respiration.

**Electron transport chain**

The mitochondrial electron transport chain (ETC) is composed of a series of electron carriers found on cell membrane that operate together to transfer electrons from donors, such as NADH and FADH2, to 02. The electrons flow from carriers with more negative reduction potentials to those with more positive potentials and eventually combine with 02 and H+ to form water.