MECHANISMS OF AEROBIC RESPIRATION

Aerobic respiration involves several important catabolic pathways which may be divided into three stages. In the first stage with is the glycolysis stage, larger nutrient molecules (proteins, polysaccharides, and lipids) are hydrolyzed or otherwise broken down into their constituent parts. The chemical reactions occurring during this stage do not release much energy. Various microorganisms make use of different types of glycolysis and the most common been **the Embden-Meyerhof pathway.**

Amino acids, monosaccharides, fatty acids, glycerol and other products of the first stage are degraded to a few simpler molecules in the second stage. In this stage called the Krebs cycle, metabolites like acetyl coenzyme A and pyruvate are formed. In addition, the second stage produces some ATP as well as NADH and/or FADH2.

Finally during the third stage (which is the electron transport chain stage) of catabolism, partially oxidized carbon is fed into the tricarboxylic acid cycle and oxidized completely to CO2 with the production of ATP, NADH, and FADH2. Most of the ATP derived from aerobic respiration comes from the oxidation of NADH and FADH2 by the electron transport chain, which uses oxygen as the terminal electron acceptor.

STAGE 1: GLYCOLYSIS

THE EMBDEN-MEYERHOF PATHWAY

This is the most common pathway for glucose degradation to pyruvate,it is found in all major groups of microorganisms. The pathway occurs in the cytoplasmic matrix of procaryotes and eucaryotes. The pathway as a whole may be divided into two parts. In the initial 6 carbon phase:

-Glucose is phosphorylated at the expense of one ATP, creating glucose 6-phospate.

-Glucose 6-phosphate undergoes isomerization to fructose 6-phosphate .

-Fructose 6-phosphate is phosphorylated to fructose 1,6-bisphosphate which begins the 3C phase.

-Fructose 1,6-bisphosphate is split into two 3-carbon molecules. Glyceraldehyde 3-phosphate and Dihydroxacetone phosphate. Dihydroxacetone phosphate undergoes isomerization to glyceraldehyde 3-phosphate.

-The 2 molecules of glyceraldehyde 3-phosphate is oxidized and simultaneously phosphorylated, creating a high-energy molecule,1,3-bisphosphate. The electrons released reduce NAD+ to NADH.

-ATP is made by substrate -level phosphorylation and 3-phosphoglycerate is formed. One phosphate is lost forming 2-phosphoglycerate from which one molecule of water is lost to give phosphoenolpyruvate. ATP and pyruvate. This pathway degrades one glucose to two pyruvates by the above sequence of reactions.

THE TRICARBOXYLIC ACID CYCLE

Ih the glycolytic pathways, the energy captured by the oxidation of glucose to pyruvate is limited to no more than two ATP generated by substrate -level phosphorylation. During aerobic respiration, the cataboic process continues by oxidizing pyruvate to three CO2. Pyruvate is acted upon by pyruvate dehydrogenase, it oxidizes and cleaves pyruvate to form acetyl-coenzyme A (acetyl CoA) and one carbon is lost in the form of CO2.

-Acetyl CoA then enters the TCA cycle (also called citric acid cycle or Krebs cycle). In the first reaction, acetyl-CoA is condensed with a 4 carbon intermediate, oxaloacetate, to form citrate, a molecule with6 carbons.

-Citrate is rearranged to give isocitrate,a more readily oxidized secondary alcohol.

-Another carbon is removed ,creating the 5-carbon metabolite, alpha ketoglutarate. In the process, NADH is formed.

-The last carbon of glucose is released as carbon dioxide. More NADH is formed for use in ETS and the 4-carbon precursor metabolite succinyl-CoA is formed.

-CoA is cleaves from succinyl-CoA to form succinate. The energy released is used to form GTP, which can be used to make ATP or used directly to supply energy to processes such as translation.

-Succinate is oxidized to fumarate. FAD serves as electron acceptor.

-Fumarate reacts with H2O to form malate.

-Malate is oxidized, generating more NADH and regenerating oxaloacetate, which is needed to accept the two carbons from acetyl-CoA and continue the cycle. Ocaloacetate is also a precursor metabolite.

TCA cycle generates two CO2 molecules, 3 NADH molecules, one FADH2 and one GTP for each each acetyl-CoA molecule oxidized.

ELECTRON TRANSPORT CHAIN.

The mitochondrial electron transport chain is composed of a series of electron carriers that operate together to transfer electrons from donors, like nadh And FADH2, to acceptors such as oxygen. The electrons flow from carriers with more negative reduction potentials to those with more positive potential and eventually combine with oxygen and hydrogen to form water. The electrons move down this potential gradient. The difference in reduction potentials between O2 and nadh is large, about 1.14 volts, which makes possible the release of a great deal of energy. The ETC breaks up the large overall energy release into small steps .Electron transport at these points generate proton and electrical gradients. These gradients can drive Apt synthesis and perform other work. In eucaryotes, theATC carriersvreside within the inner membrane ofbthe mitochondrion. In procaryotes they are located w it thin the plasma membrane.