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NAAC ACCREDITED 'A' GRADE



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FATE OF PYRUVIC ACIDS IN AEROBIC AND ANAEROBIC RESPIRATION

Anaerobic respiration: In absence of Oxygen, plants carry out fermentation forming either ethanol or lactic acid. So fermentation can be defined as a sequential series of reactions which occurs in absence of oxygen and in which pyruvate is converted to ethanol and CO₂ (alcoholic fermentation) or lactic acid (lactic acid fermentation).

Anaerobic organisms which lack TCA cycle and respiratory chain are unable to regenerate NAD from NADH₂ in the way aerobic organisms do. They have to reduce pyruvic acid to either lactic acid or ethanol with the help of NADH₂ which is thereby oxidized to NAD. NAD so produced is then utilized for running glycolysis. Moreover, anaerobic organisms have to depend on substrate-level phosphorylation for generation of ATP.

- A. **ALCOHOLIC FERMENTATION:**- some plants and unicellular organisms (like yeast) convert pyruvic acid to ethyl alcohol and CO₂. it is used to make bread, wine, biofuels etc.

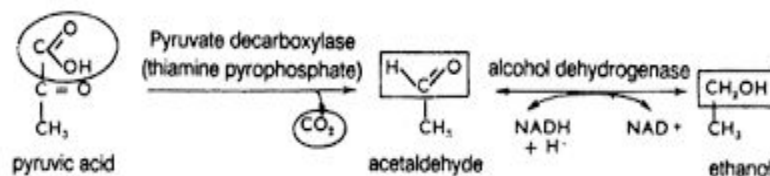
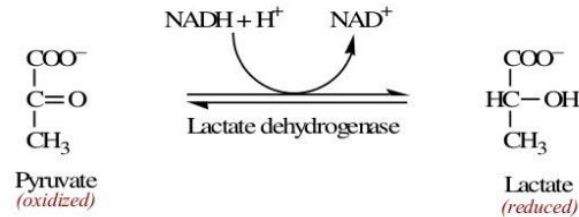


FIG. 4-31. — Transformation of pyruvic acid into ethanol.

- B. **LACTIC ACID FERMENTATION:** This type of fermentation is carried out by the bacteria in yogurt. It is also used by our own muscle cells when we work hard and fast. Here pyruvic acid changes to lactic acid by a special type of an enzyme i.e lactate dehydrogenase.



Aerobic respiration: In aerobic organisms carrying out oxygen respiration, pyruvic acid is further degraded via tricarboxylic acid cycle (TCA cycle or Krebs' cycle) where carbon atoms of pyruvic acid are oxidized to CO_2 and the H-atom are transferred to specific coenzymes, like NAD and FAD. The hydrogen from these coenzymes are fed into the electron transport chain for generation of ATP and finally transferred to oxygen-producing water.

NADH_2 is in the process oxidized back to NAD and can be used in the oxidation-reduction step of glycolysis. Thus, a continuous supply of NAD for running glycolysis is assured.

In presence of O_2 , plants carry out aerobic respiration which takes place in the following two steps-

- a. Formation of acetyl CoA from pyruvic acid produced by glycolysis.
- b. Conversion of acetyl CoA to CO_2 and H_2O and production of energy.(TCA cycle)

a. Formation of Acetyl CoA (LINK REACTION):- In presence of sufficient O_2 , oxidative decarboxylation of pyruvate takes place to form acetyl Coenzyme A in presence of five cofactors and a complex of enzyme as mentioned below-

A. Co- factors:-

- a. Thiamine pyrophosphate (TPP)
- b. Mg²⁺
- c. FAD, NAD⁺
- d. Co-enzyme A
- e. Lipoic acid.

B. Enzymes:- Pyruvate dehydrogenase complex or PDH (E1, E2, E3)

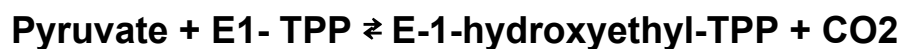
- a. E1= Pyruvate dehydrogenase
- b. E2= Dihydrolipoyl transacetylase
- c. E3= Dihydrolipoyl dehydrogenase.

These factors and enzymes are present in the mitochondria of the eukaryotic cell and in cytoplasm of prokaryotic cells.

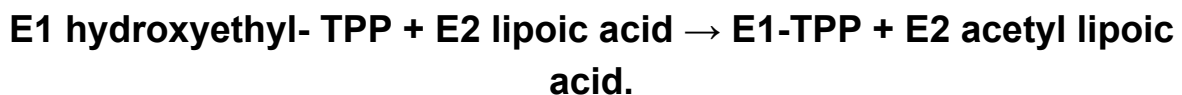
It occurs through the following steps-

1. Pyruvate reacts with TPP bound with E1 and loses its carboxyl group to form the hydroxyl derivative of TPP.

Mg²⁺

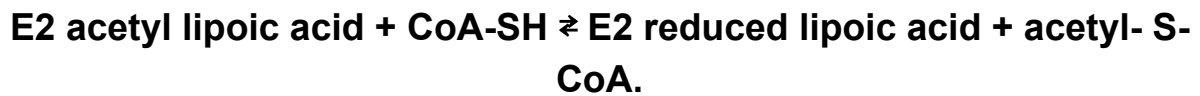


2. The acetyl group from TPP is transferred to the oxidised form of lipoic acid, a prosthetic group of E2, in presence of E1 to form acetyl lipoic acid enzyme complex.



[A high energy thioester reduced lipoic acid is formed and thus oxidised lipoic acid is reduced]

- The acetyl group of acetyl lipoic acid complex is transferred to a molecule of coenzyme A (CoA~SH) to form acetyl ~ S- CoA and the fully reduced form of lipoic acid- enzyme complex.



- Dihydrolipoyl dehydrogenase transfers hydrogen atoms from reduced lipoyl group to FAD to reduce it.



- The reduced FADH₂ is reoxidised by transferring hydrogen atoms to NAD and thereby NADH + H⁺ is formed.

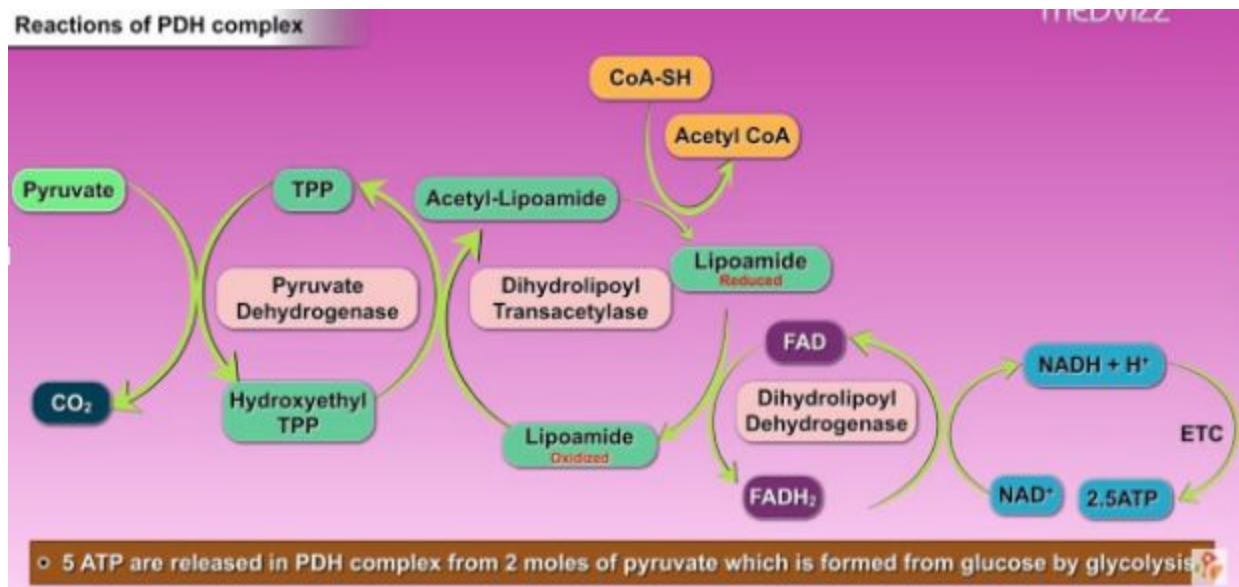


Fig: Schematic representation of link reaction

Overall reaction is given below:-

