Propionic acid fermentation

- Propionic acid fermentation: is a metabolic process includes production of propionic acid (CH_3-CH_2-COOH) from either glucose or lactate by using anaerobic bacteria such as *Propionibacterium, Veillonella, Clostridium,* and *Selenomonas*.
- This acid is an organic and colorless liquid at room temperature with a very pungent odor.
- Lactate, a fermentation product of the lactic acid bacteria, is probably the major substrate for propionic acid bacteria. in nature, where these two groups live in close association.
- Biotechnological methods by using inexpensive organic waste materials such as apple pomace (as a sole carbon source) for propionic acid synthesis can significantly reduce environmental pollution.

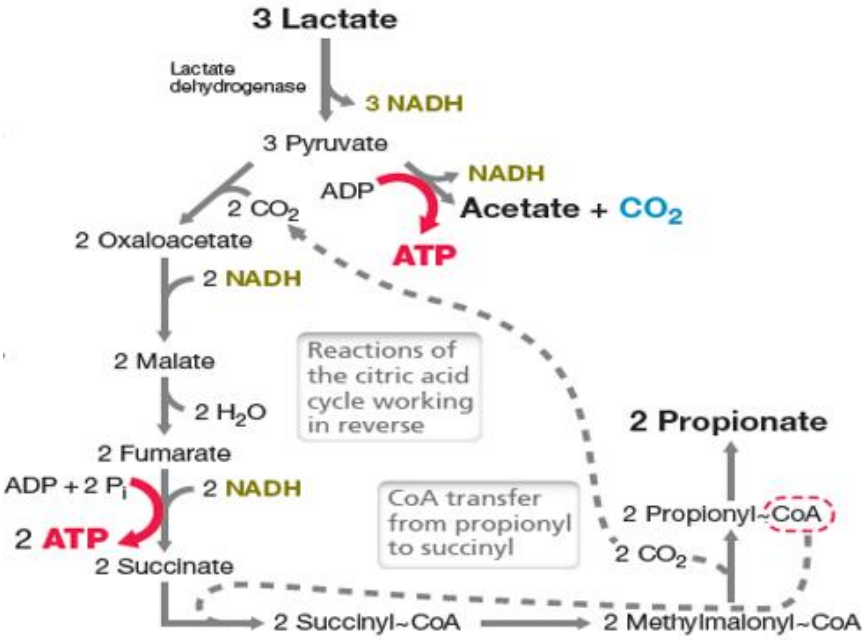
Propionibacterium

- Gram-positive, facultative anaerobic and rod-shaped bacterium.
- Facultative parasites and commensals of human and other animals.
- Living in and around the sweat glands, sebaceous glands and other areas of the skin.
- They may cause acne.
- Selective media for their growth is Sodium Lactate.
- Members of the Genus *Propionibacterium* are widely used in: production of vitamin B12, probiotic and cheese industries, and propionic acid production.

Propionic acid fermentation pathway

- Pyruvate produced either from glucose or from the oxidation of lactate, is converted to acetate plus CO_2 or carboxylated by methyl malonyl-CoA to form propionyl-CoA and oxaloacetate.
- Oxaloacetate reduced to malate, fumarate and succinate by reverse TCA cycle.
- The reduction of fumarate to succinate yields one ATP molecule.
- Propionyl-CoA reacts with succinate in a step catalyzed by the enzyme CoA transferase, producing succinyl-CoA.
- The succinyl-CoA is then isomerized to methyl malonyl-CoA and the cycle is complete when propionate is formed and CO_2 regenerated
- When the glucose is initial substrate, propionic acid fermentation results in the formulation of the following: 3 mol glucose → 4 mol propionic acid + 2 mol acetic acid + 2 mol CO_2 + 2 mol H_2O + 12 mol ATP.

- When the lactate is initial substrate, propionic acid fermentation results in the formulation of the following: 3 mol lactate →2 mol propionic acid + 1 mol acetic acid + 1 mol CO_2 + 1 mol H_2O + 3 mol ATP.



Uses of propionic acid

In Food Industry: propionic acid is safe for human and animal consumption by Food and Drug Administration (FDA) regulations.

- Propionic acid and its sodium, calcium and potassium salts are incorporated to suppress the growth of mold in breads and cakes, on the surface of cheese, malt, fruits, vegetables and tobacco.
- The association of propionic acid with lactic and acetic acids for the preservative of foods has been recommended by the works which demonstrated the synergistic effect of these acids on the inhibition of *Listeria monocytogenes* growth in foods.

In Animal Therapy:

- Sodium propionate has been used in:
  - Wound infections
  - Antifungal agents to treat dermatoses
  - Anti-arthritic drugs
  - Conjunctivitis

Other Uses: propionic acid used in the manufacture of

- Cellulose plastics
- Herbicides
- Rubber chemicals
- Artificial fruit flavors