Lactic acid fermentation

-Dr. Ekta Khare
Department of Microbiology
Institute of Biosciences & Biotechnology,
CSJM University, Kanpur

Lactic acid fermenters

- **The essential feature of lactic acid bacteria (LAB) metabolism is efficient carbohydrate fermentation coupled to substrate-level phosphorylation.**
- **Adenosine triphosphate (ATP) generated is subsequently used for biosynthesis.**
- **LAB as a group exhibit an enormous capacity to degrade different carbohydrates and related compounds.**
- **Generally, the predominant end product is lactic acid (>50% of sugar carbon).**
- **However, LAB adapt to various conditions and change their metabolism accordingly. This may lead to significantly different end-product patterns.**
- **Lactic acid fermenters are of two types:**
  - **Homolactic fermenters**
  - **Heterolactic fermenters**

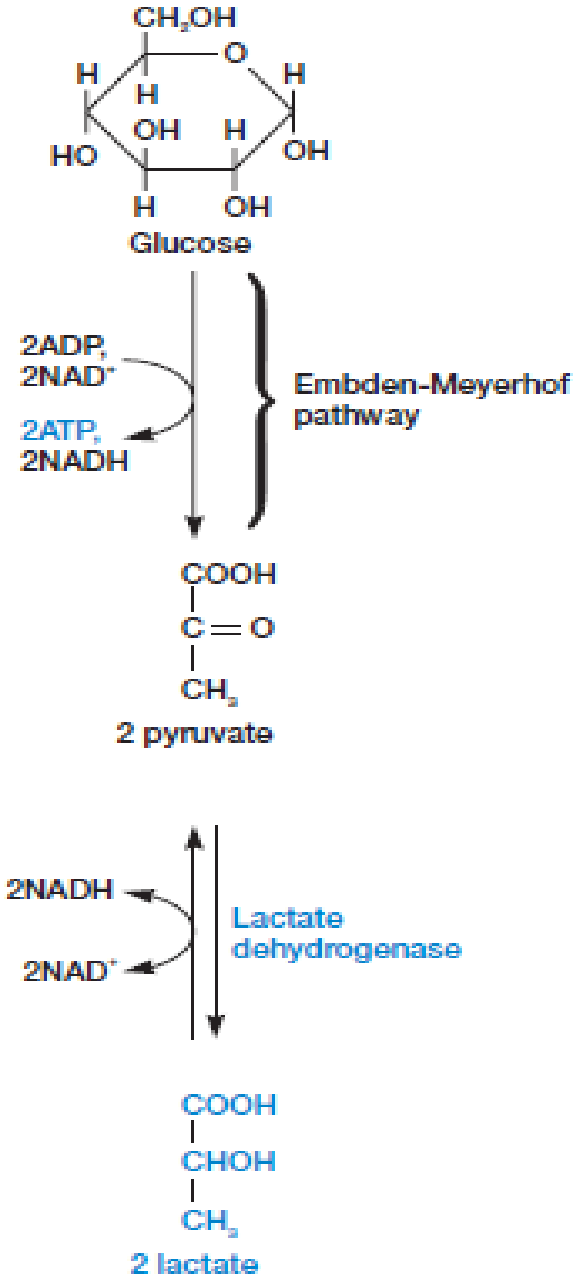
Homolactic acid fermenters

- **Homolactic fermenters** use the glycolytic pathway and directly reduce almost all their pyruvate to lactate with the enzyme lactate dehydrogenase.
- Homolactic fermentative bacteria convert glucose to two molecules of lactate and use this reaction to perform substrate-level phosphorylation to make two molecules of ATP:

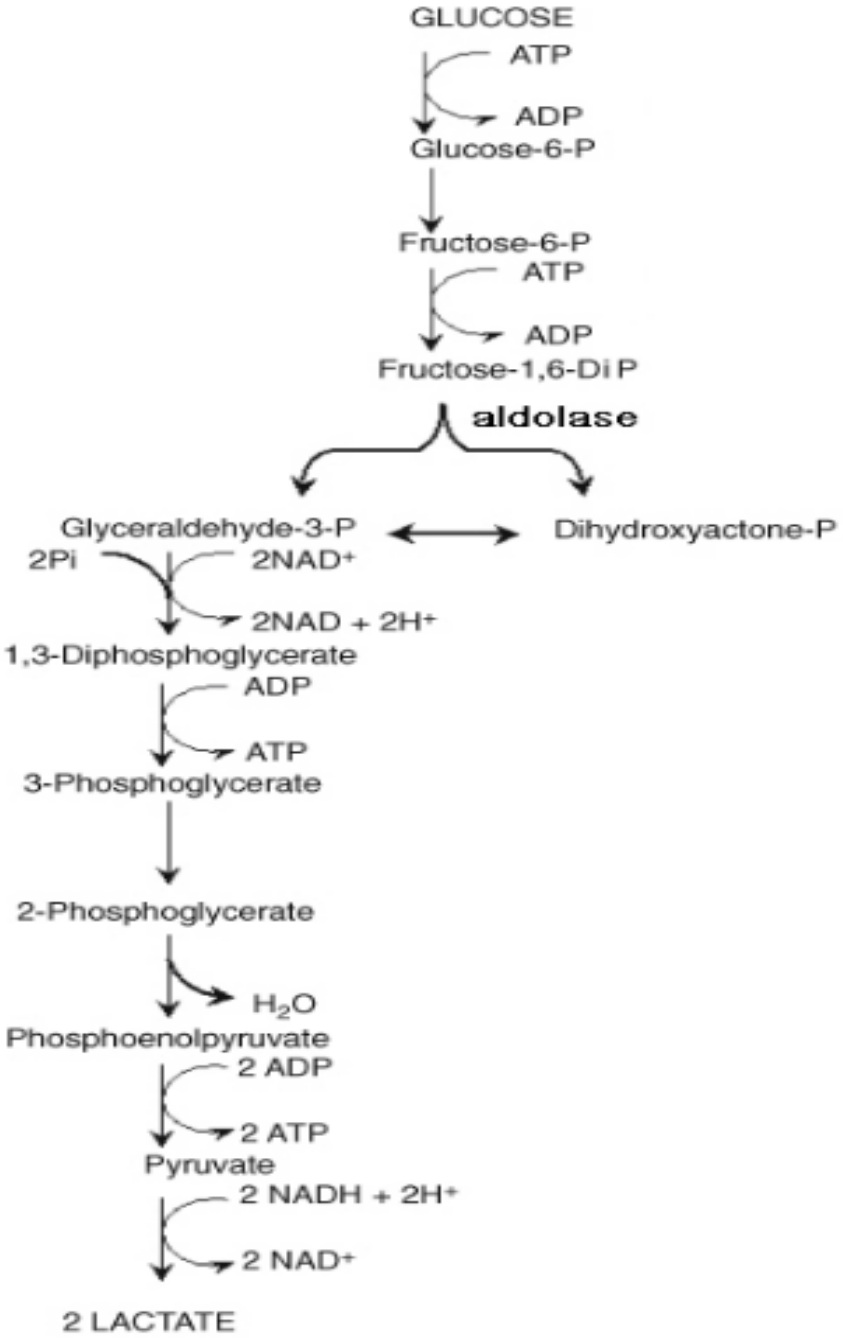
$$\text{Glucose} + 2\ \text{ADP} + 2\ P_i \rightarrow 2\ \text{lactate} + 2\ \text{ATP}$$

- (oxidation of glucose to 2 molecues of pyruvate produces 2ATP and 2NADH. During reduction of two pyruvate to lactate two NADH consumed)
- Example includes some lactobacilli and most species of enterococci, lactococci, pediococci, streptococci, tetragenococci, and vagococci

Homolactic fermentation



Homolactic fermentation



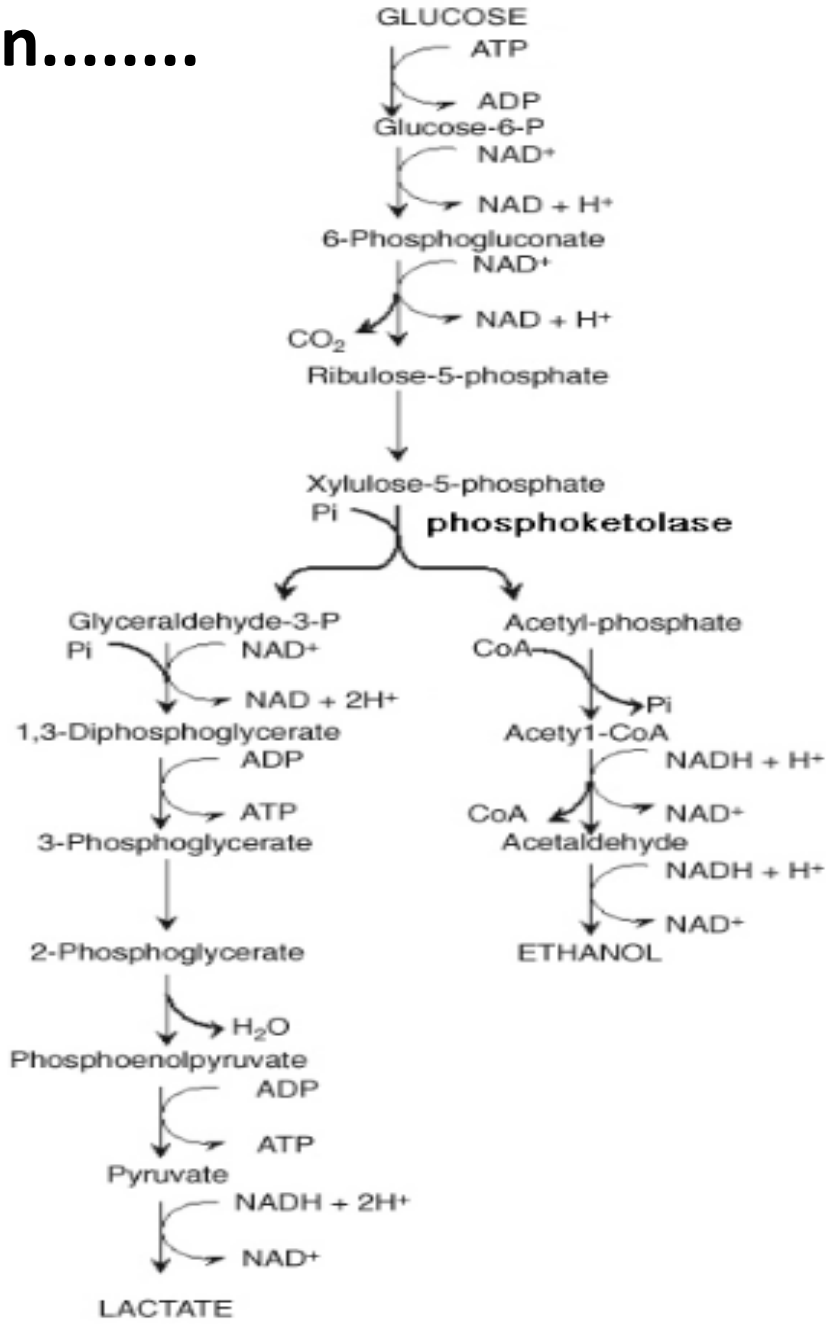
Heterolactic acid fermenters

- **Heterolactic fermenters** form substantial amounts of products other than lactate; many produce lactate, ethanol, and CO_2 by way of the phosphoketolase pathway.
- One mole of glucose-6-phosphate is initially dehydrogenated to 6-phosphogluconate and subsequently decarboxylated to yield one mole of CO_2.
- The resulting pentose-5-phosphate is cleaved into one mole glyceraldehyde phosphate (GAP) and one mole acetyl phosphate.
- GAP is further metabolized to lactate as in homofermentation, with the acetyl phosphate reduced to ethanol via acetyl-CoA and acetaldehyde intermediates.
- Theoretically, end- products (CO_2, lactate and ethanol) are produced in equimolar quantities from the catabolism of one mole of glucose.
- Heterolactic fermentative bacteria produce less lactate and less ATP, but produce several other end products:

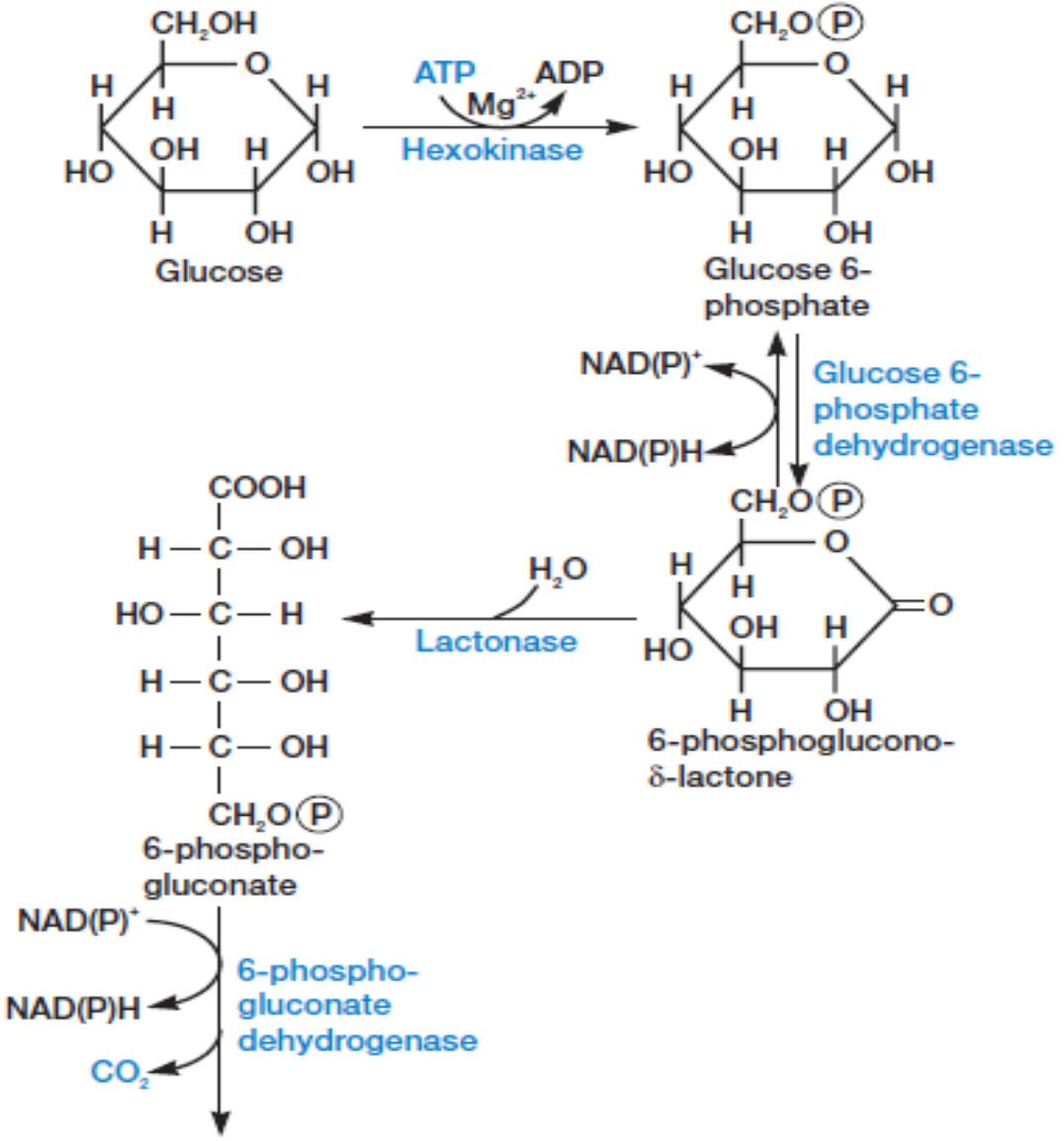
$$\text{Glucose} + \text{ADP} + P_i \rightarrow \text{lactate} + \text{ethanol} + CO_2 + \text{ATP}$$

- Examples: *Leuconostoc, Oenococcus, Weissella*, and certain lactobacilli

Heterolactic fermentation.....

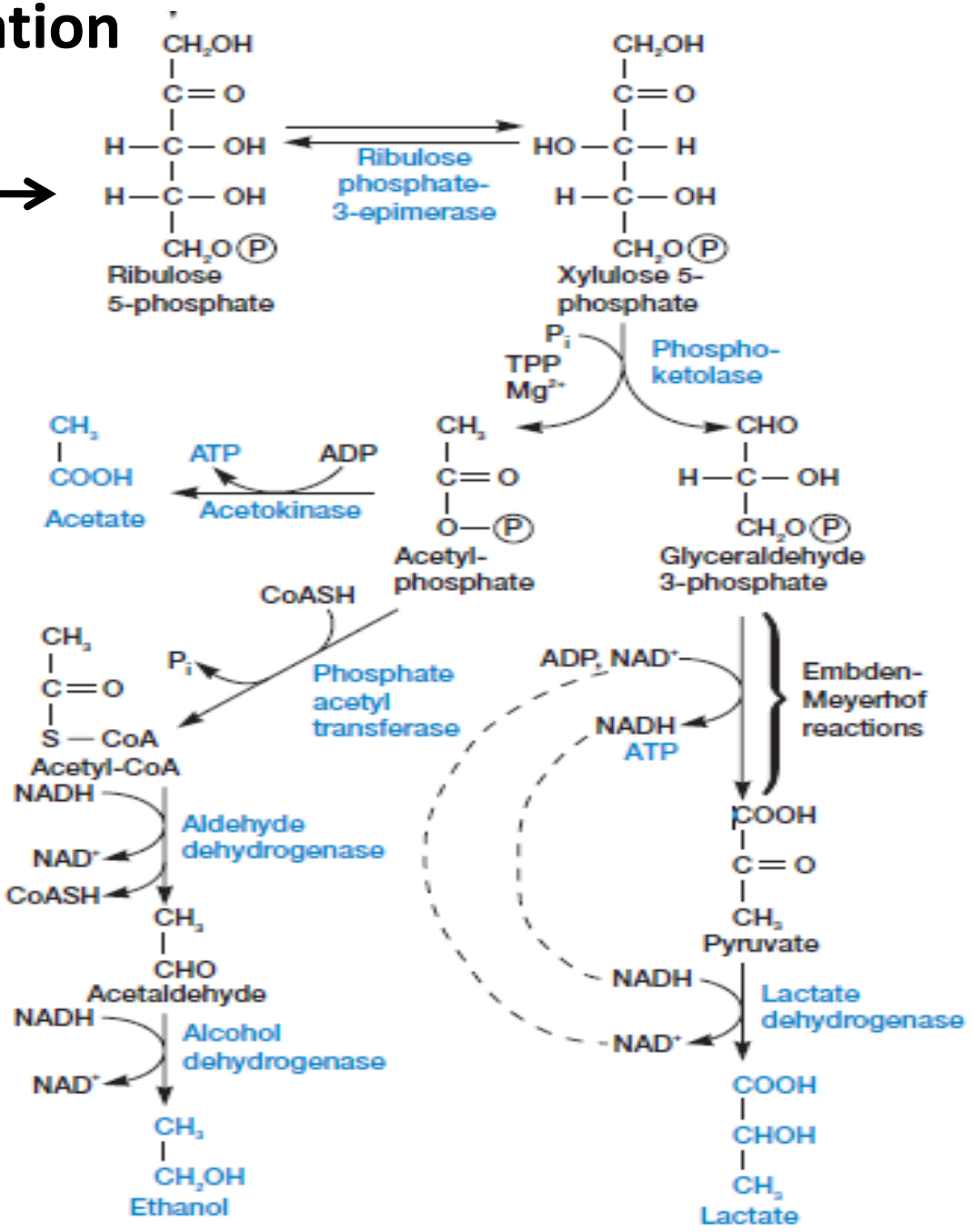


Heterolactic fermentation.....



.....Heterolactic fermentation

6-phospho gluconate →



Questions

- Write an essay on lactic acid fermenters.

- Difference between homo lactic and heterolactic bacteria.