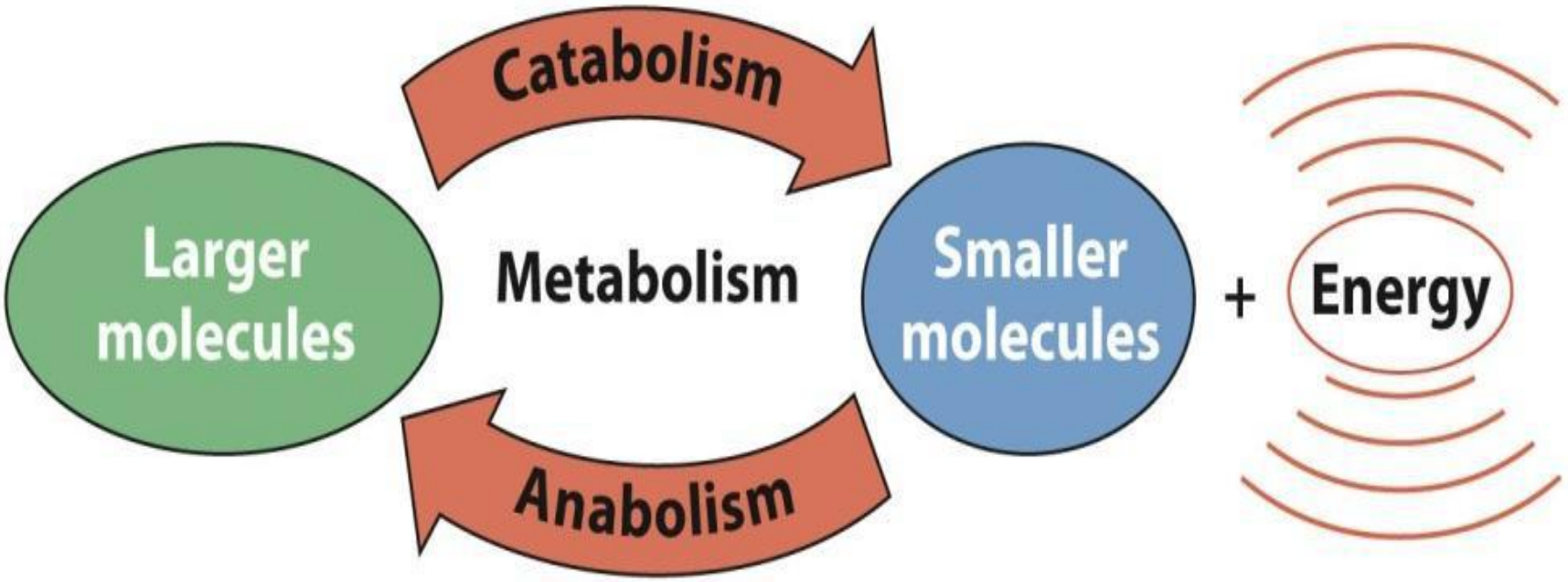
Chemoheterotrph

These organism can derive energy from chemical compound.

Metabolism

- **Metabolism**, the sum of the chemical reactions that take place within each cell of a living organism and that provide energy for vital processes and for synthesizing new organic material.

Classification of Metabolism



- What is the relation between respiration and metabolism ?

Condition for mtabolism

- Availability of the substrate
- Presence of enzyme
- Presence of cofactor, energy currency
- Negative Δ G

Regulation of Metabolic reaction

- Inhibition of enzyme activity
- Inhibition of transcription of enzyme production

Respiration

The biochemical process in which the cells of an organism obtain energy from oxidation of glucose, resulting in the release of carbon di oxide, water and energy.

Phases of respiration

- External respiration
- Internal respiration

Internal respiration	External Respiration
Biochemical procedure	Mechanical process i.e exchange of CO2 and O2 gasses
Occurs in living cell	Occurs outside the cell
Requires Enzyme	Does not require enzyme
Steps are Glycolysis, TCA cycle	Steps are exhalation and inhalation
In this process living cell participates	Respiratory organs participate in this process

Types of Internal respiration

- Aerobic respiration:
- Anaerobic respiration
- Fermentation

Aerobic	Anaerobic
Occurs in presence of O2	Occurs in absence of O2
Complete oxidation of food occurs	Partial oxidation of food occurs
More ATP are produced in this system	Less ATP are produced
Occurs in mostly plant and animal	Occurs mostly in microorganism, parasite and sometimes in higher animal due to lack of O2
Terminal electron carrier is O2	Terminal electron carrier is not O2

Aerobic respiration

- Steps:
- Glycolysis
- Pyruvate Oxidation
- TCA Cycle
- Electron transport chain

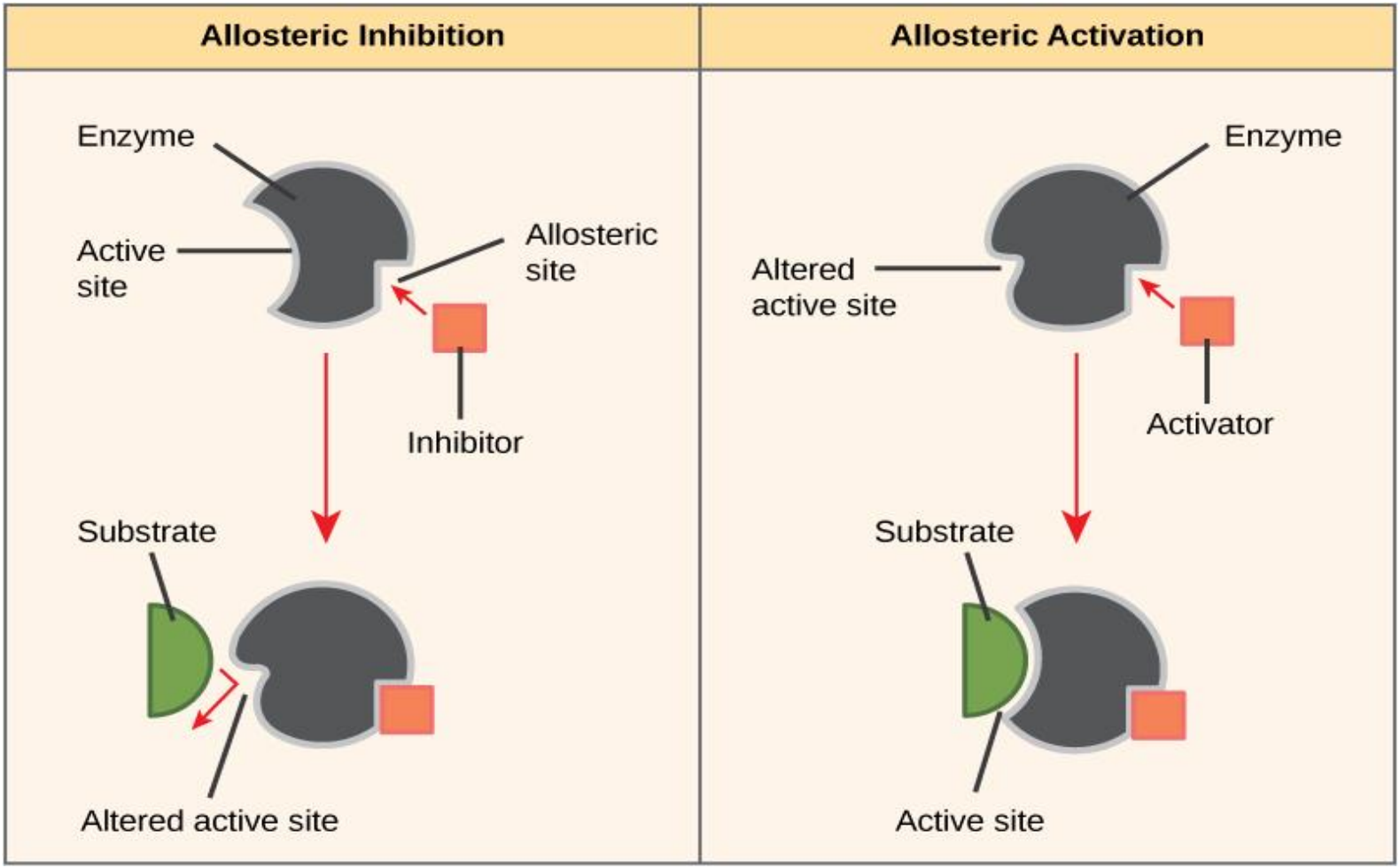
Anaerobic Respiration

- Steps:
- Glycolysis
- Electron transport chain with nitrate ion, sulphate ion and carbonate ion

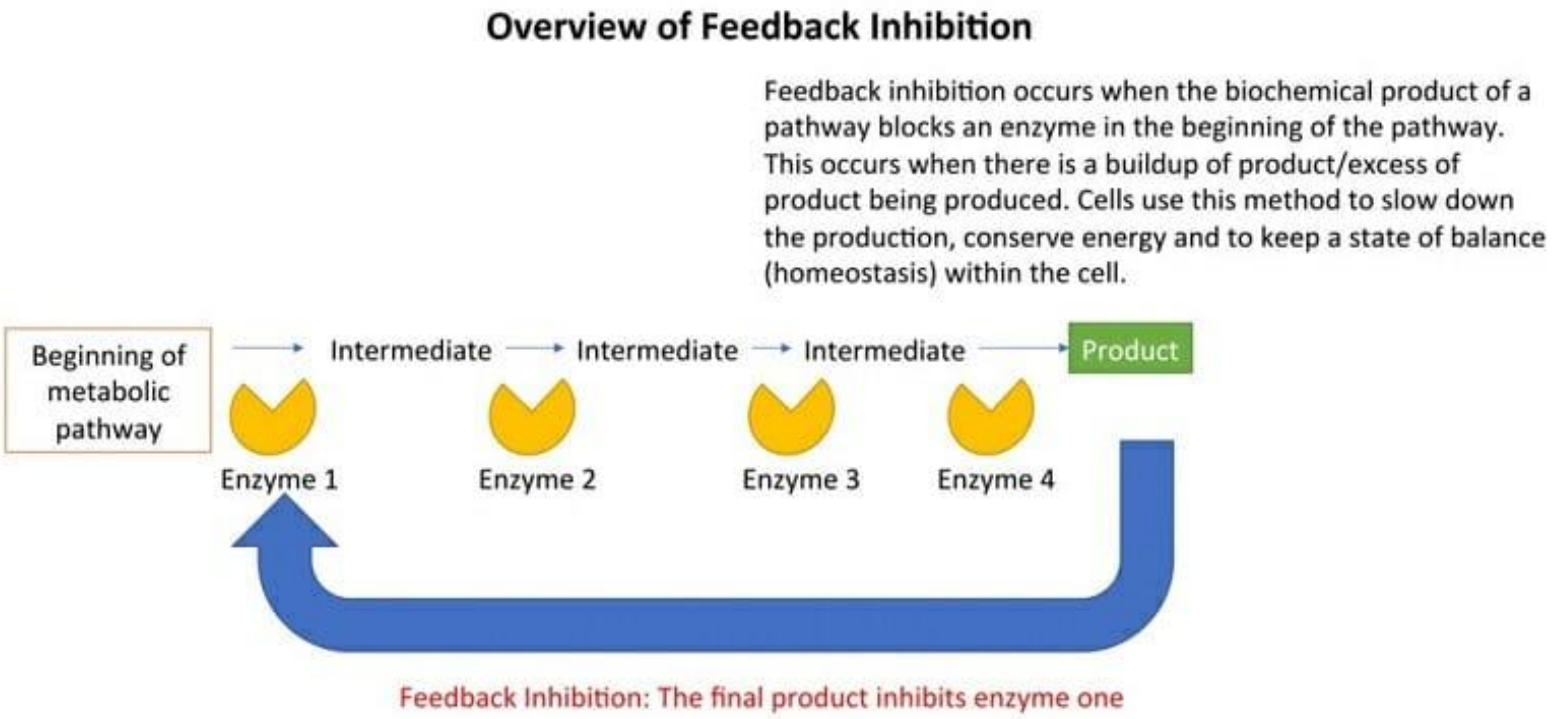
Fermentation

- Steps:
- Glycolysis
- Production of ethyl alcohol, lactic acid, formic acid from pyruvate

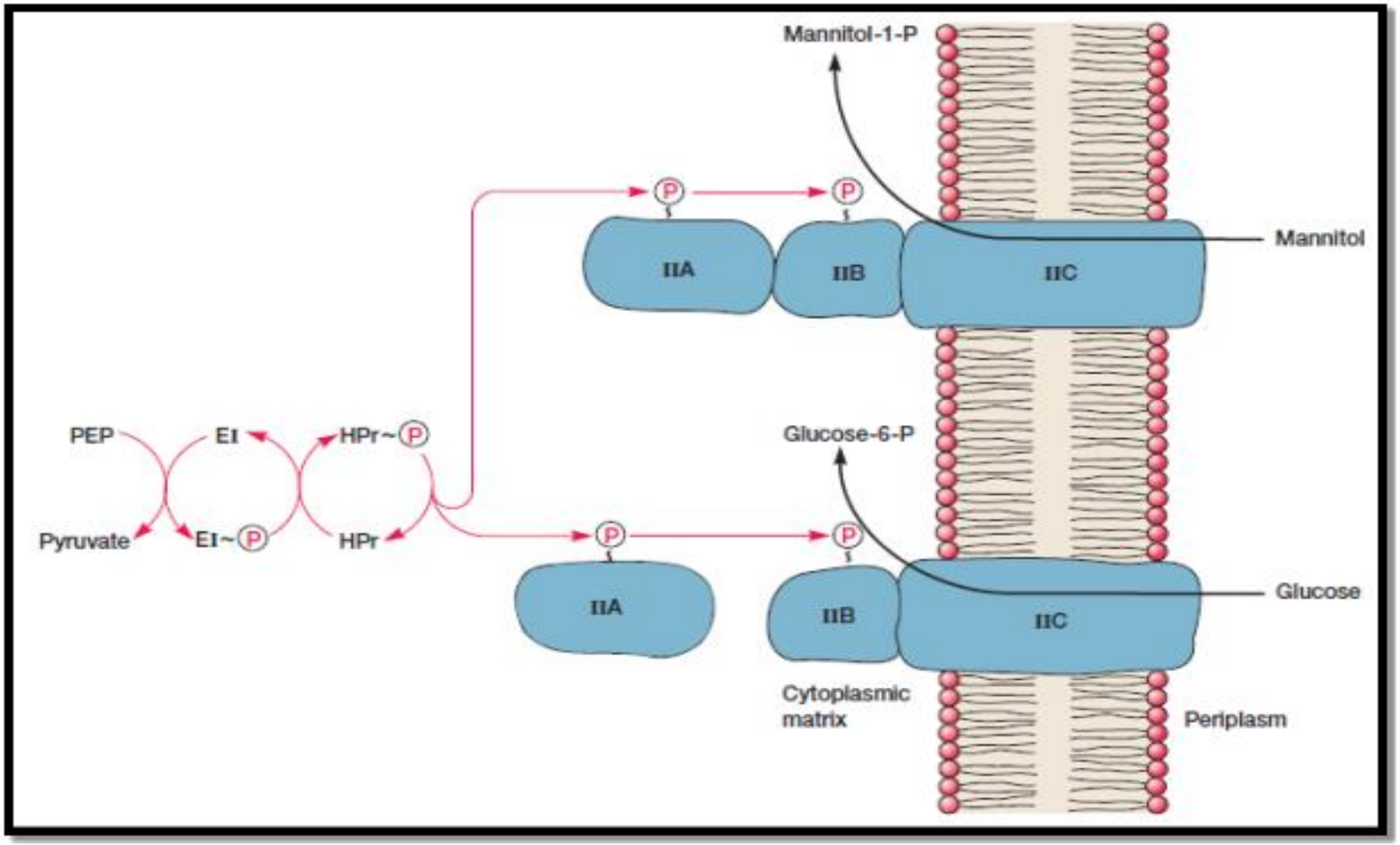
Allosteric inhibition



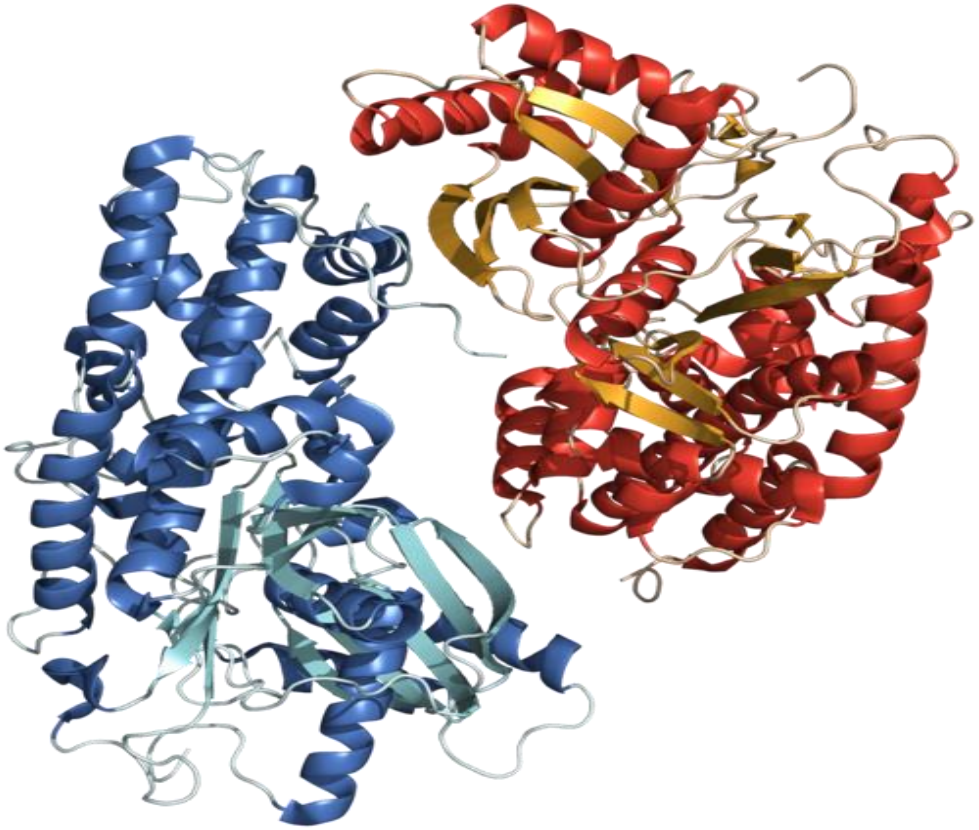
Feedback inhibition



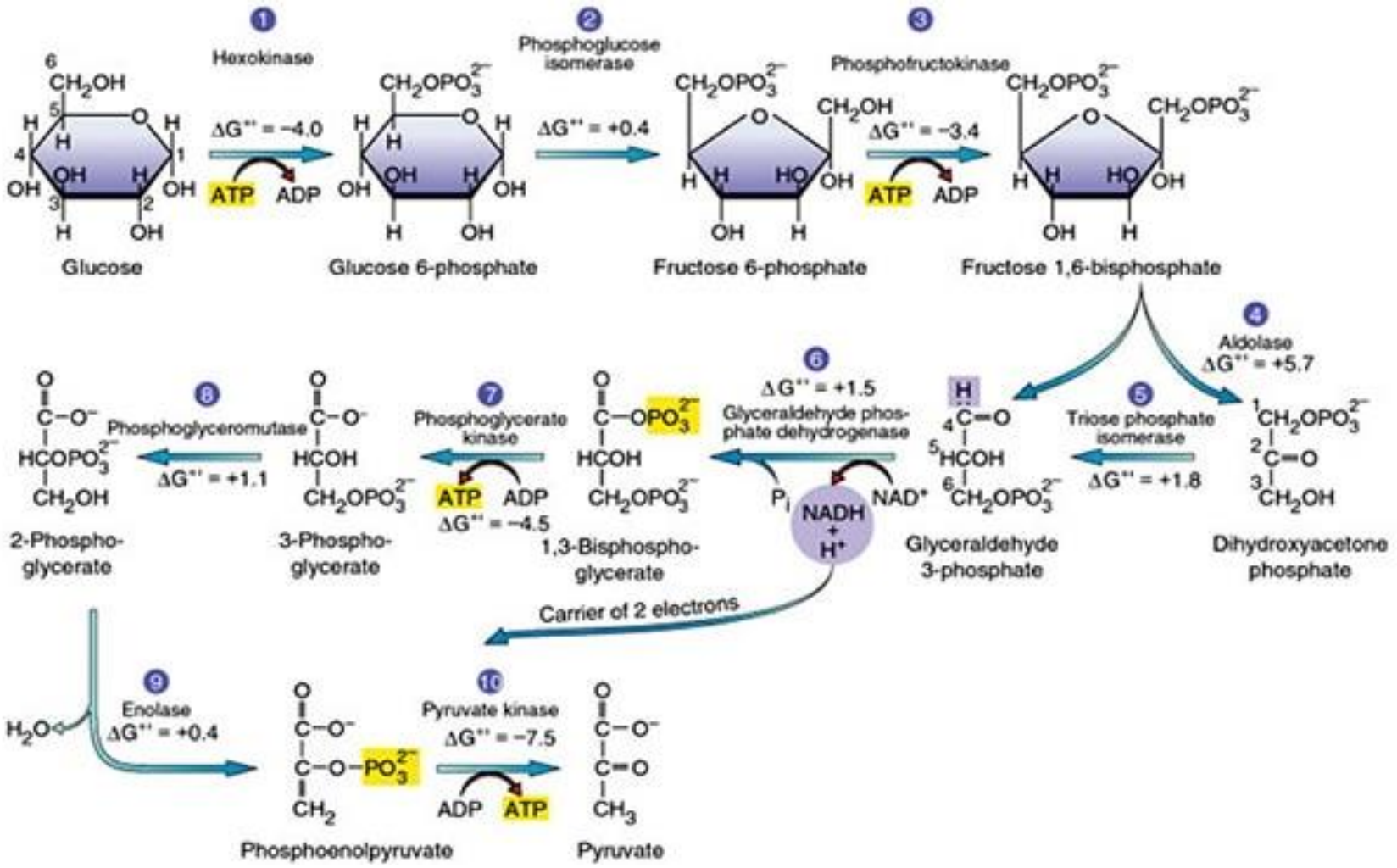
Phosphoenolpyruvate:sugar phosphotransferase system



Hexokinase



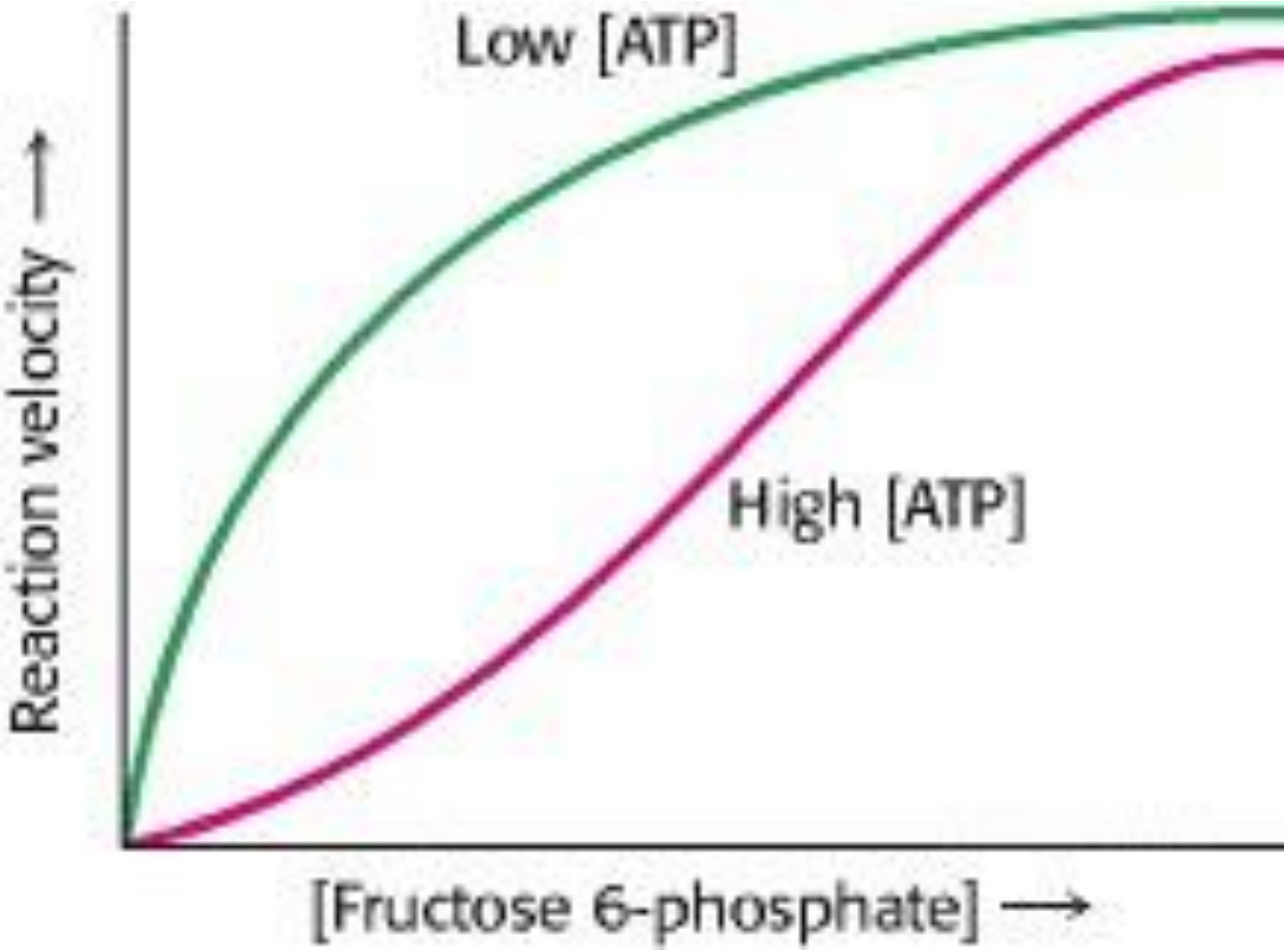
Glycolysis or Embden-Meyerhof pathway



Regulation of hexokinase enzyme

- Hexokinase enzyme is inhibited by its product Glucose -6 Phosphate

Regulation of PFK1



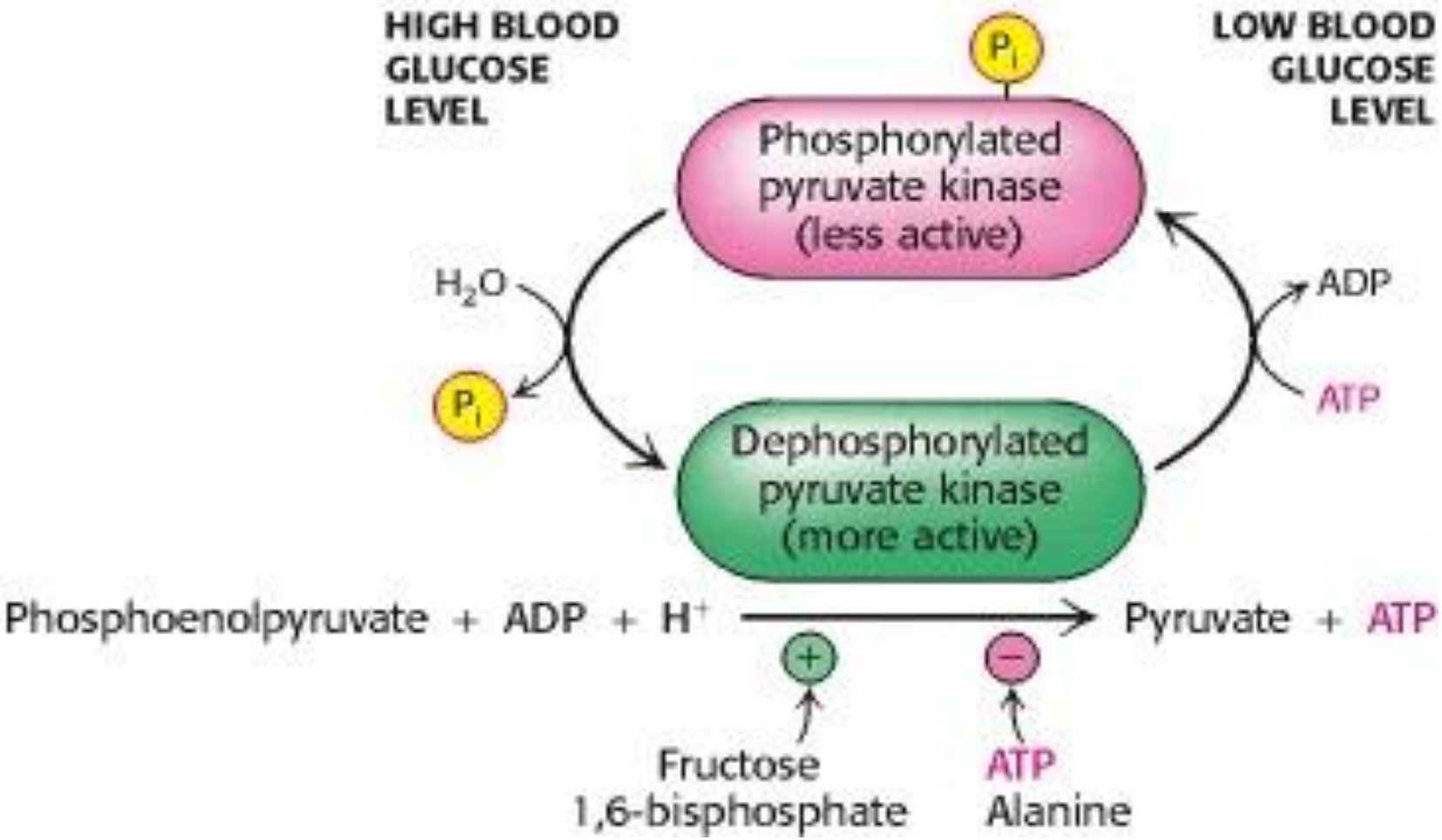
Regulation of PFK1

- PFK1 enzyme is activated by Fructose 2,6 bis phosphate
- Fructose 6 P  Fructose 2,6 bis P

Regulation of PFK1

- Inhibited at high concentration of H^+
- Inhibited at high concentration of citrate ion

Regulation of Pyruvate kinase



Account the number of ATP gained in glycolysis

- No of ATP gained :2

Related Questions

- Compare Gluco kinase and hexokinase
- Explain the effect of ATP, Fructose 2,6 bis P, H^{+} on phosphofructokinase I (PFKI).
- Name NAD^{+}/NADH requiring enzyme, Mg^{+2} requiring enzyme, Zn^{+2} requiring enzyme.
- What do you mean by positive regulator and negative regulator of an enzyme?

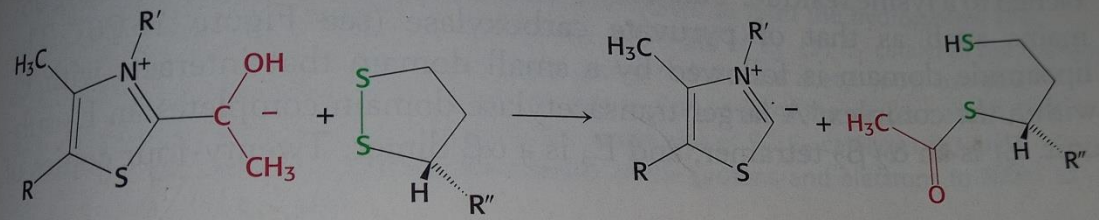
TCA cycle

- In TCA cycle a series of enzymatic reactions takes place and these steps replenish the pools of intermediates or metabolites.

TABLE 17.1 **Pyruvate dehydrogenase complex of *E. coli***

Enzyme	Abbreviation	Number of chains	Prosthetic group	Reaction catalyzed
Pyruvate dehydrogenase component	E_1	24	TPP	Oxidative decarboxylation of pyruvate
Dihydrolipoyl transacetylase	E_2	24	Lipoamide	Transfer of the acetyl group to CoA
Dihydrolipoyl dehydrogenase	E_3	12	FAD	Regeneration of the oxidized form of lipoamide

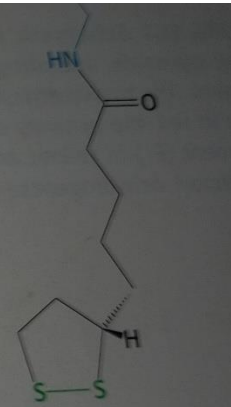
linkage.



Hydroxyethyl-TPP (ionized form) **Lipoamide** **Carbanion of TPP** **Acetyllipoamide**

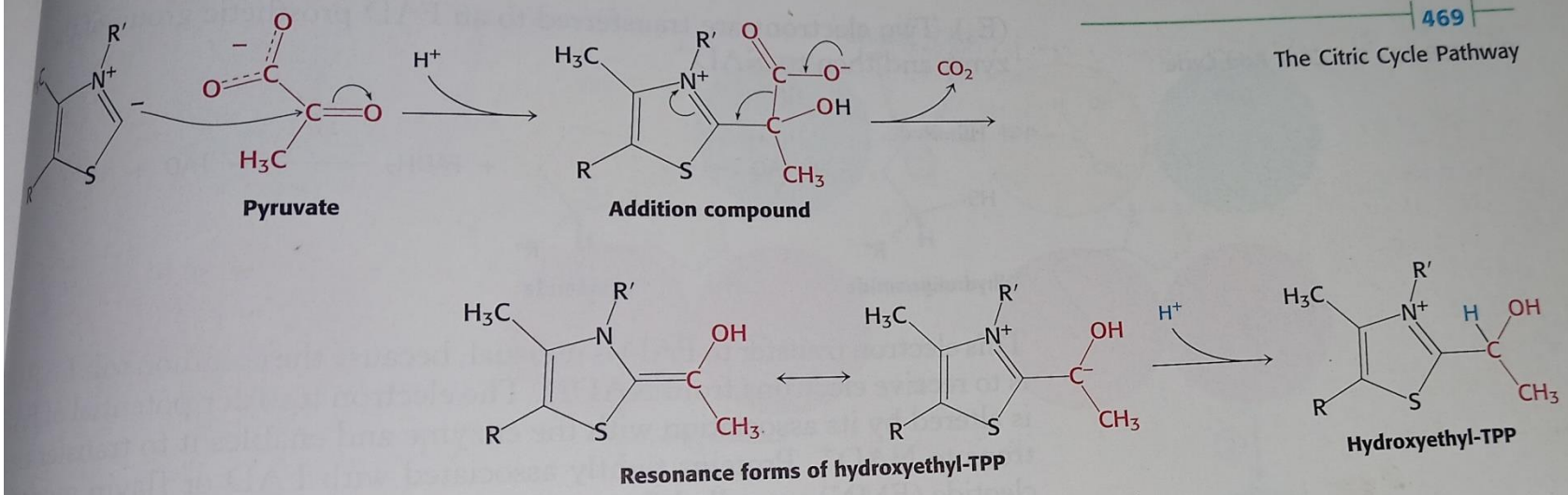
The oxidant in this reaction is the disulfide group of lipoamide, which is reduced to its disulfhydryl form. This reaction, also catalyzed by the pyruvate dehydrogenase component E_1, yields *acetyllipoamide*.

Third, *the acetyl group is transferred from acetyllipoamide to CoA to form acetyl CoA.*

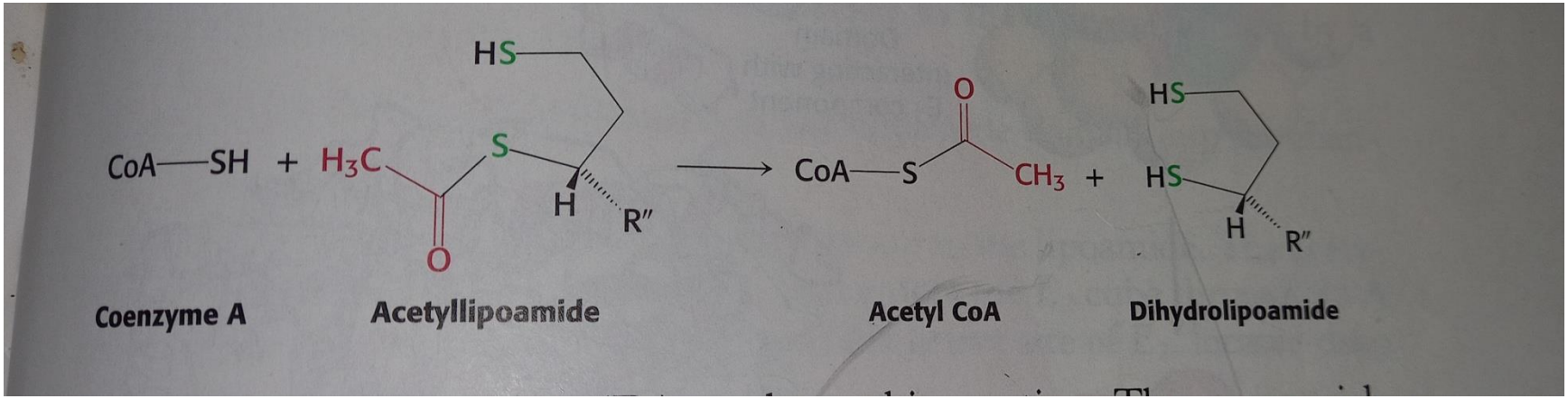


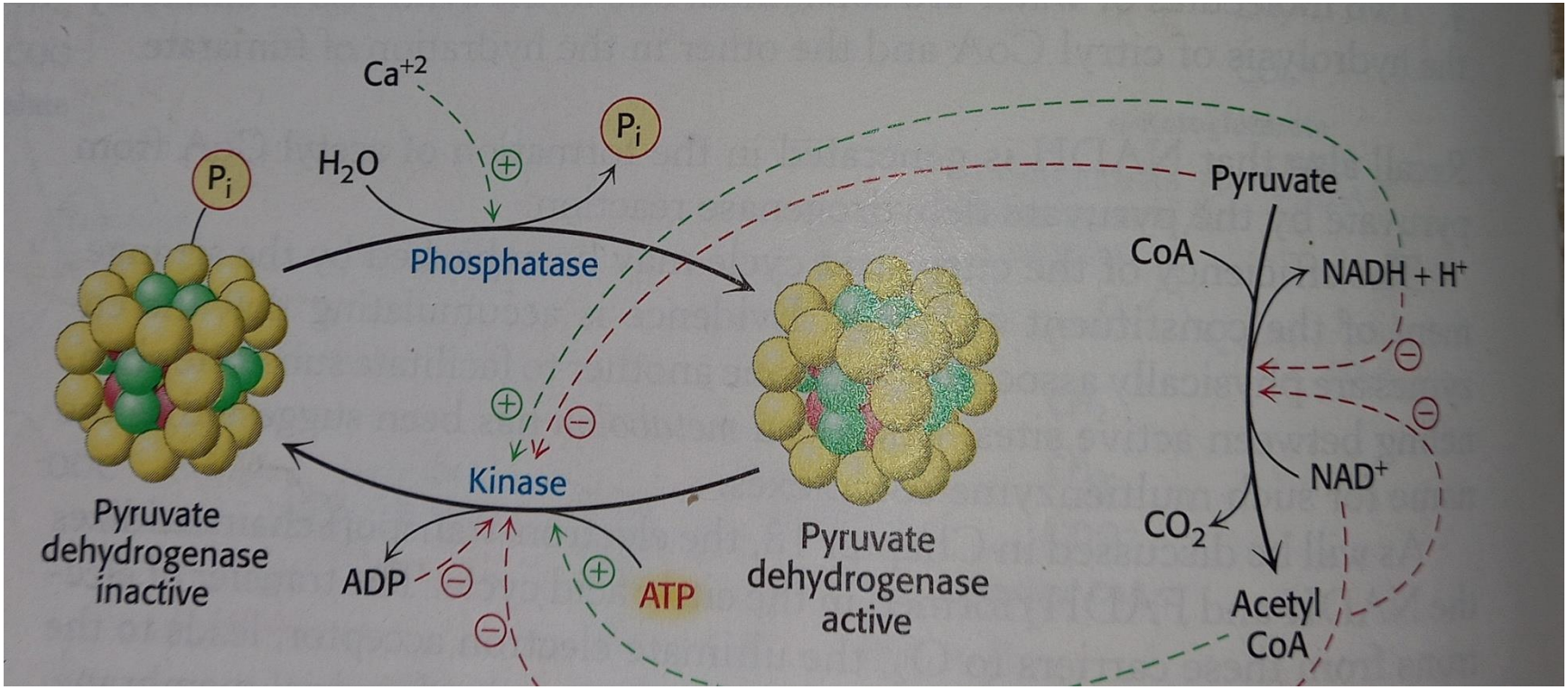
Reactive disulfide bond

Lipoamide

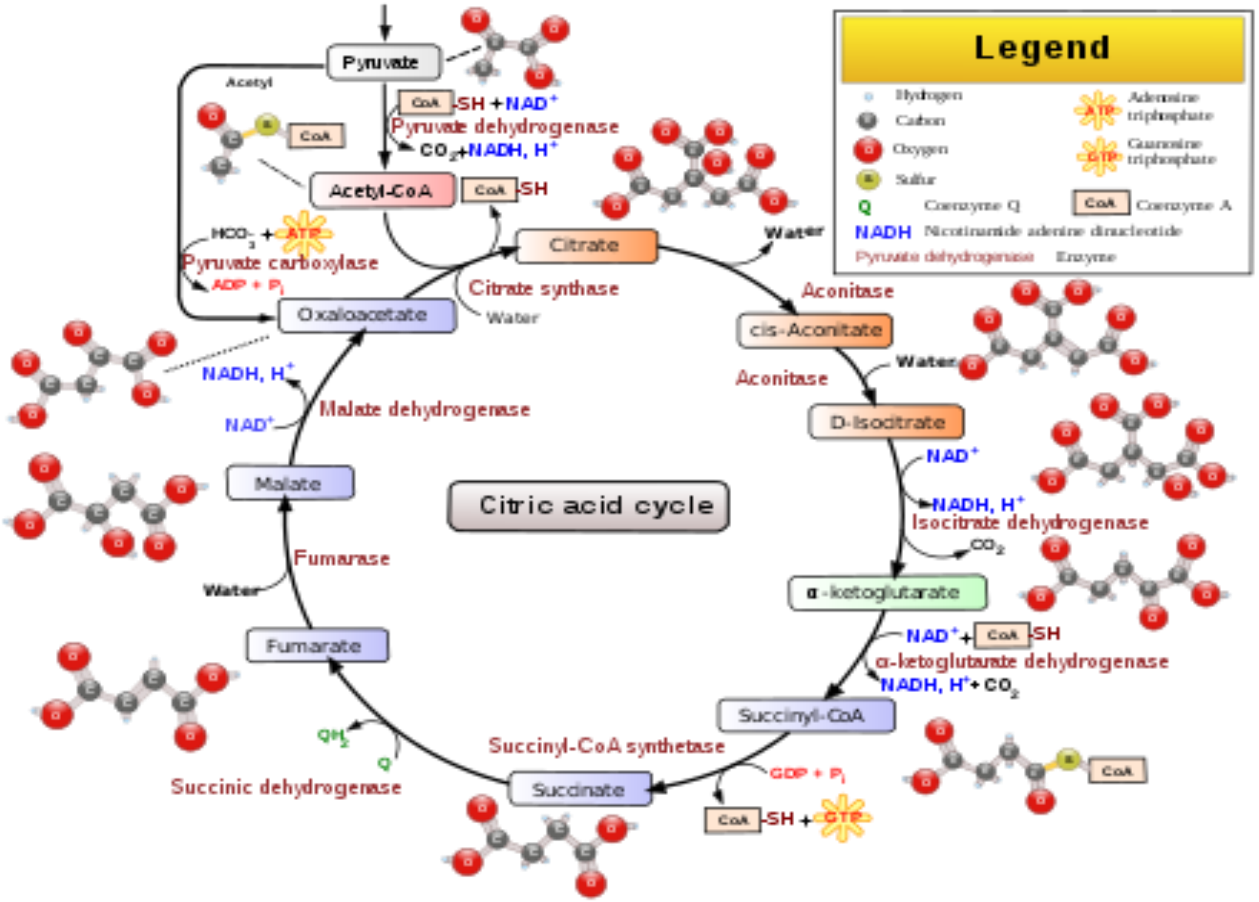


GURE 17.6 Mechanism of the decarboxylation reaction of E_1, the pyruvate
hydrogenase component of the pyruvate dehydrogenese complex.


CoA—SH
+
H3C
HS
S
H
R″
O
CoA—S
O
CH3
+
HS
HS
H
R″
Coenzyme A
Acetyllipoamide
Acetyl CoA
Dihydrolipoamide


Ca+2
Pi
H2O
Pi
Phosphatase
Pyruvate
CoA
NADH + H+
Kinase
NAD+
CO2
Pyruvate dehydrogenase inactive
ADP
ATP
Pyruvate dehydrogenase active
Acetyl CoA

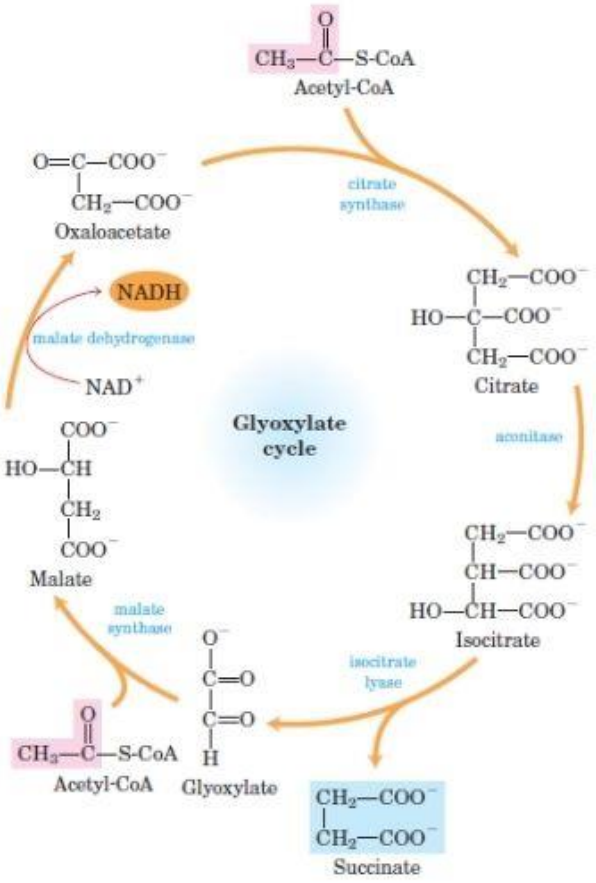
Tri carboylic Acid Cycle (TCA Cycle)

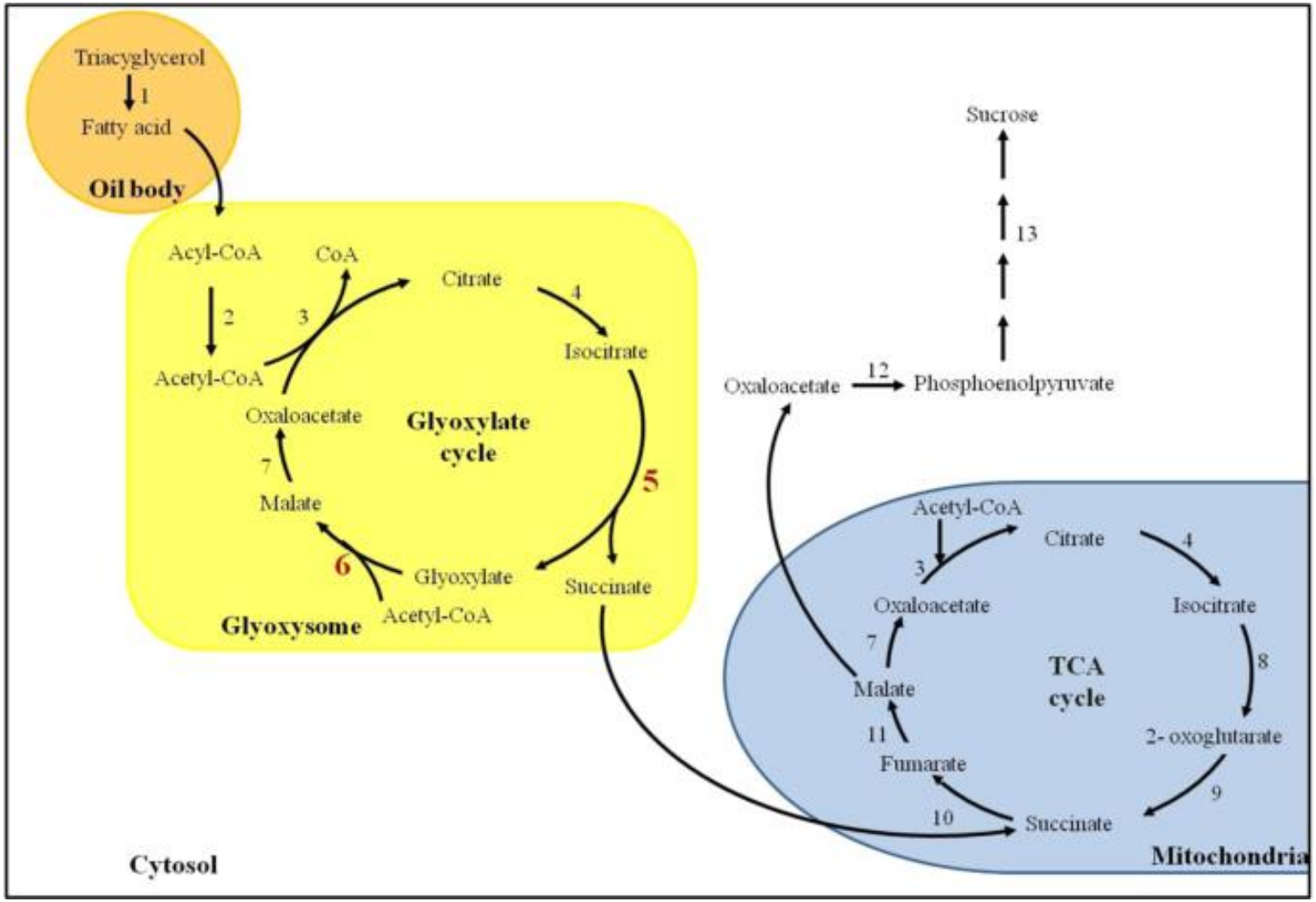


Glyoxylate cycle

- **an anabolic pathway occurring in plants, bacteria, protists, and fungi**

Glyoxylate Cycle




Triacyglycerol
1
Fatty acid
Oil body
Acyl-CoA
CoA
2
3
Citrate
4
Isocitrate
Acetyl-CoA
Oxaloacetate
Glyoxylate cycle
7
5
Malate
6
Glyoxylate
Succinate
Acetyl-CoA
Glyoxysome
Sucrose
13
Oxaloacetate
12
Phosphoenolpyruvate
Acetyl-CoA
Citrate
4
3
Oxaloacetate
Isocitrate
7
8
TCA cycle
Malate
11
2- oxoglutarate
Fumarate
9
10
Succinate
Mitochondria
Cytosol

Coordinated Regulation of Glyoxylate Cycle and TCA Cycle

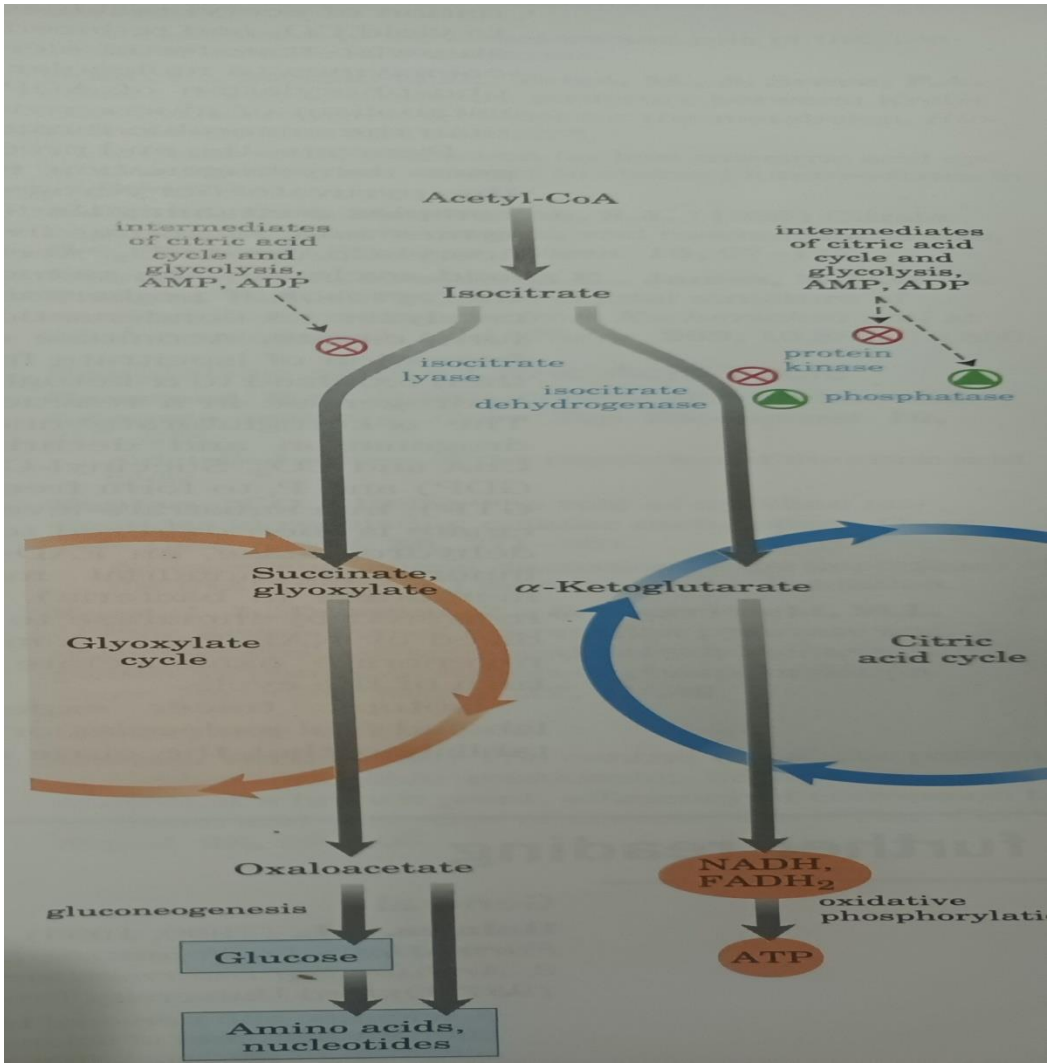


figure 16–19

Regulation of isocitrate dehydrogenase activity that determines partitioning of isocitrate between the glyoxylate and citric acid cycles. When isocitrate dehydrogenase is inactivated by phosphorylation (by a specific protein kinase), isocitrate is directed into biosynthetic reactions via the glyoxylate cycle. When the enzyme is activated by dephosphorylation (by a specific phosphatase), isocitrate enters the citric acid cycle and ATP is produced.

Pentose Phosphate pathway

- Location: Cell cytosol
- Importance:
- It is important to provide precursors for nucleotide and amino acid biosynthesis, to provide reducing moecule for steroid biosynthesis, to reduce toxicity or to defeat oxidative stress.

Oxidative phase reaction

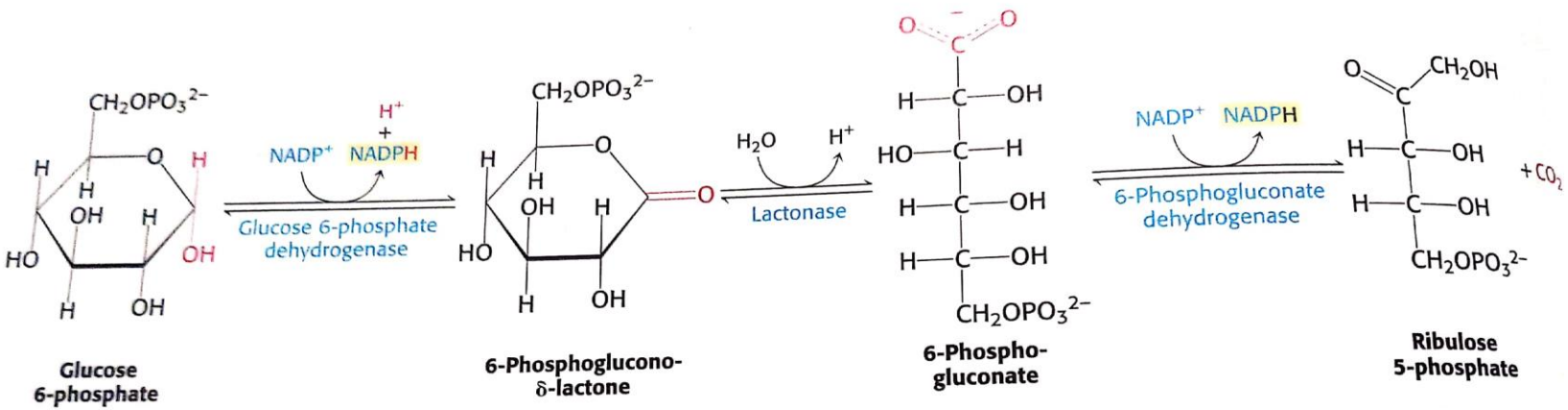
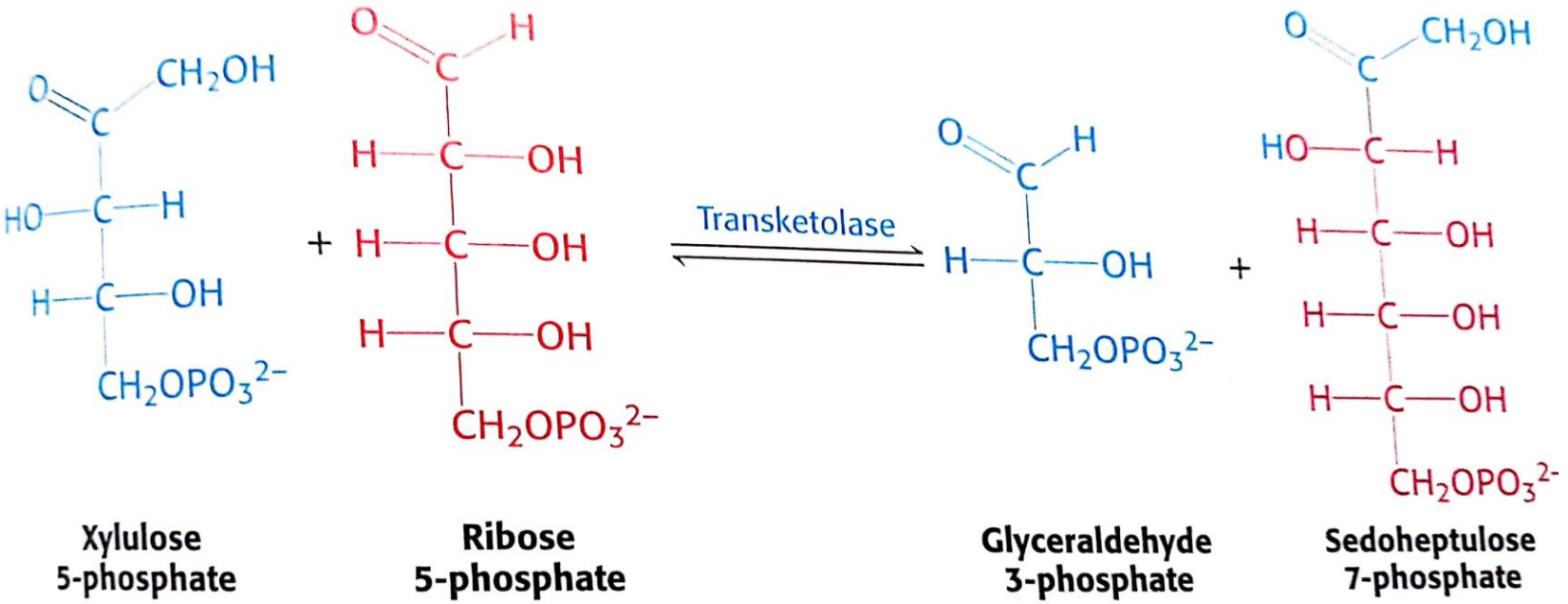


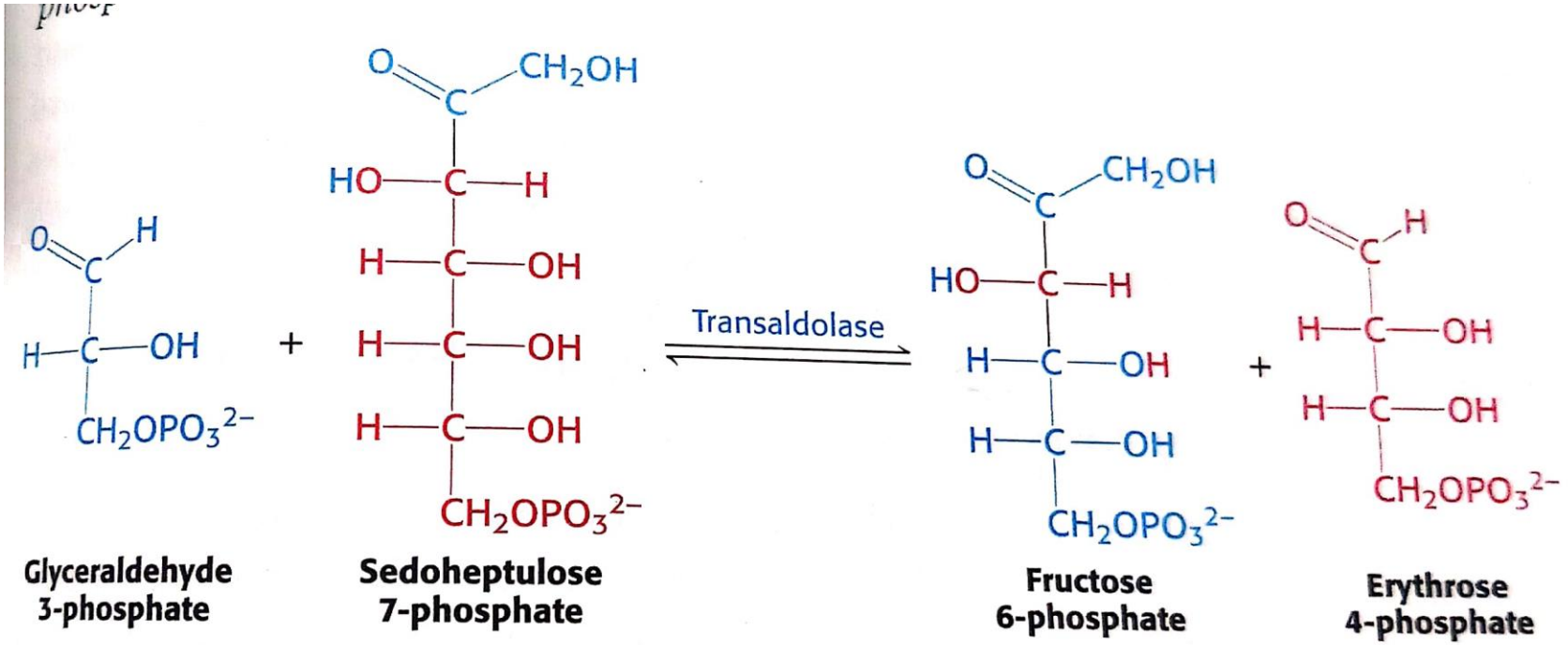
FIGURE 20.20 Oxidative phase of the pentose phosphate pathway. Glucose 6-ph phate is oxidized to 6-phosphoglucono-δ-lactone to generate one molecule of NADPH. lactone product is hydrolyzed to 6-phosphogluconate, which is oxidatively decarboxylat ribulose 5-phosphate with the generation of a second molecule of NADPH.

Non oxidative phase reaction

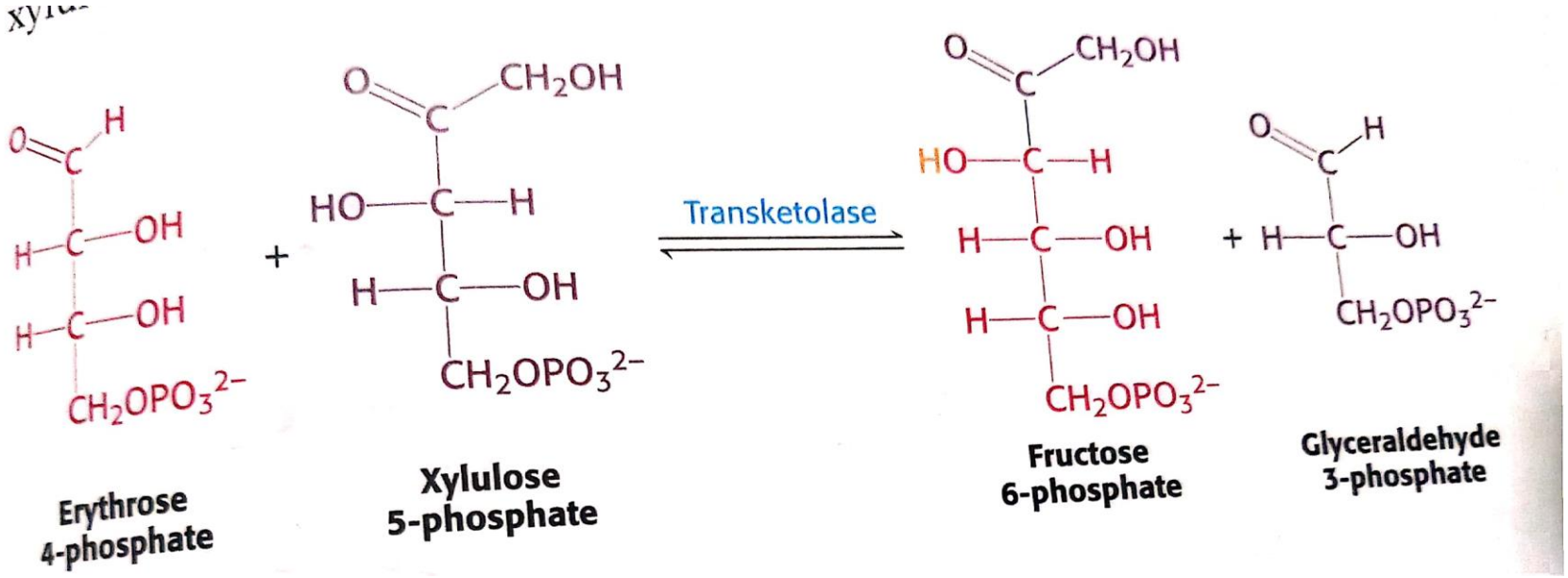


The donor of the two-carbon unit in this reaction is xylulose 5-phospha

Non oxidative phase reaction



Non oxidative phase reaction



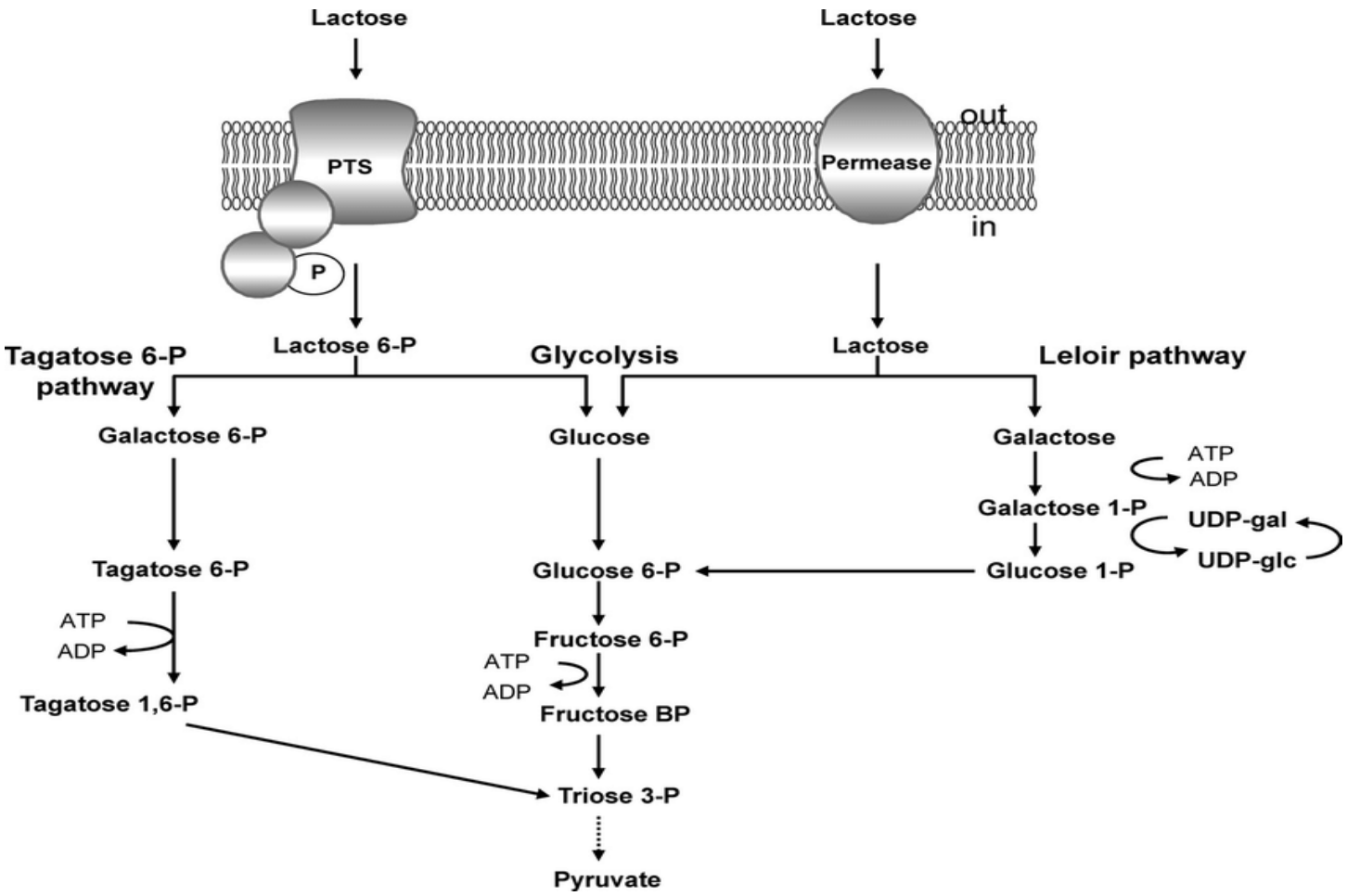
Feeder pathway in glycolysis

Fructose metabolism in microorganism

- Fructose 

Fructose 6P

Metabolism of lactose

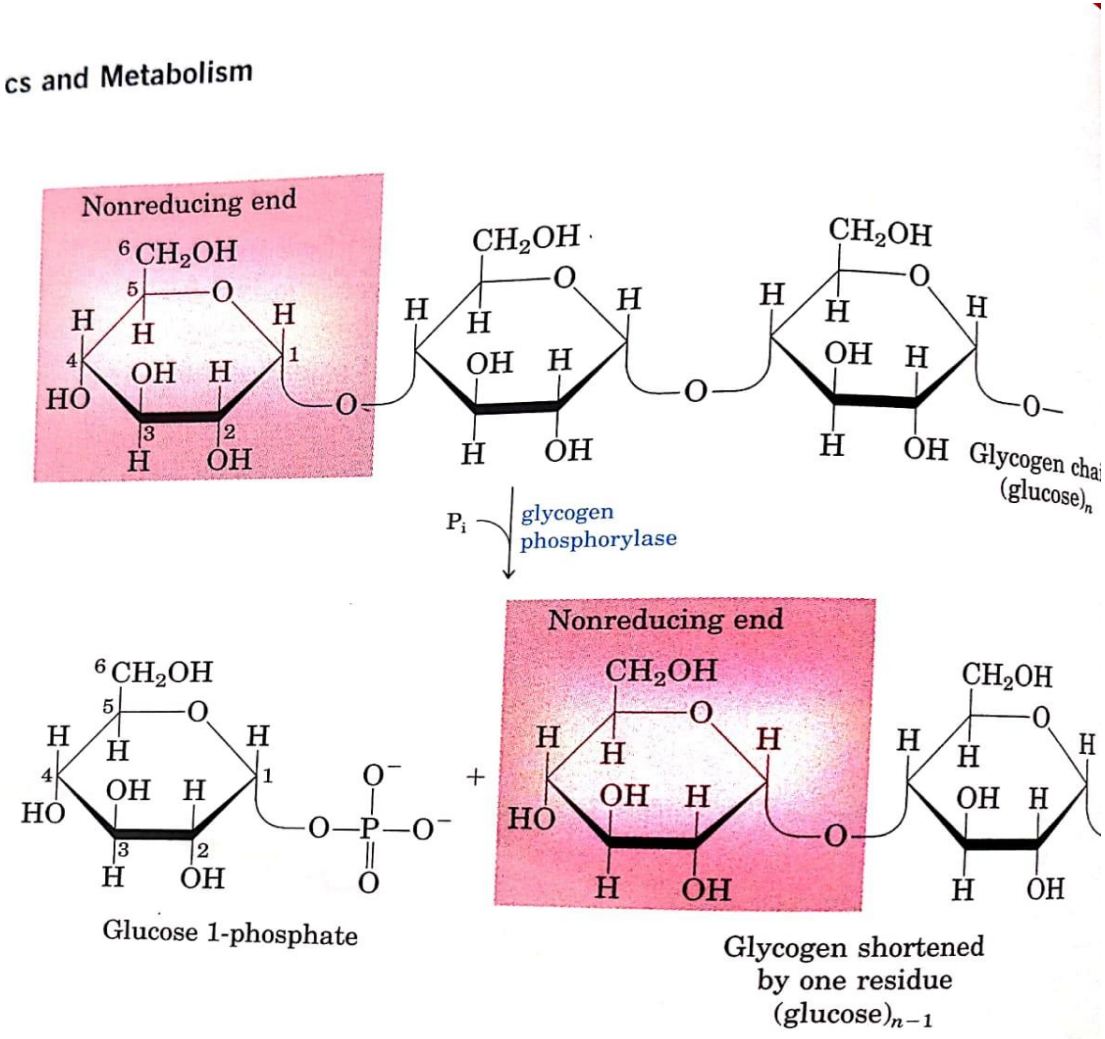


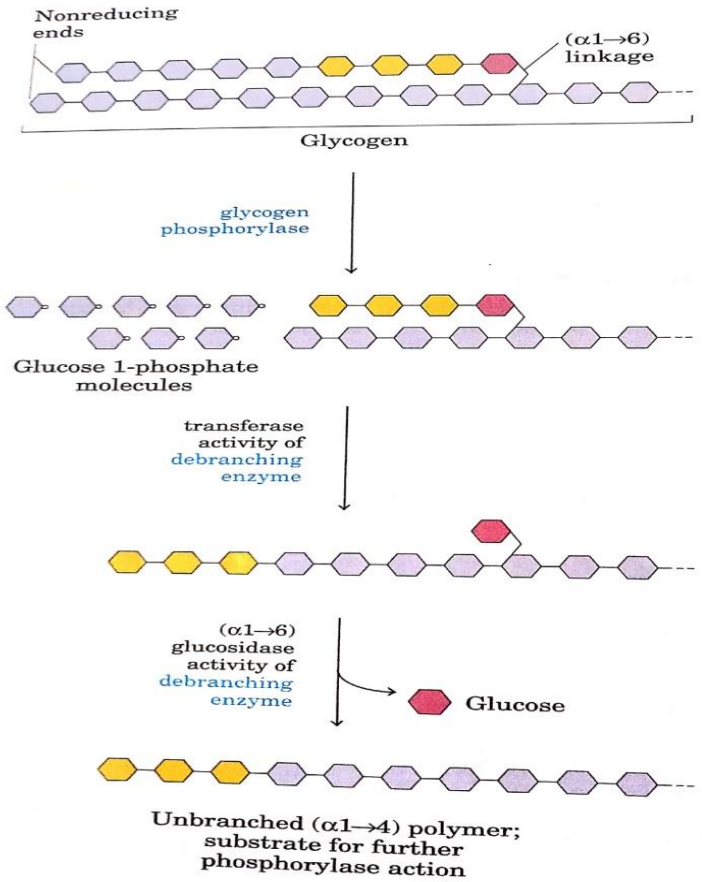
Metabolism of fructose in mammalian system

- **In muscle:**
- **Fructose → Fructose 6P**
- **In liver:**
- **Fructose → Fructose 1P**
- **Fructose 1P → Glyceraldehyde+ Dihydroxy acetone P**

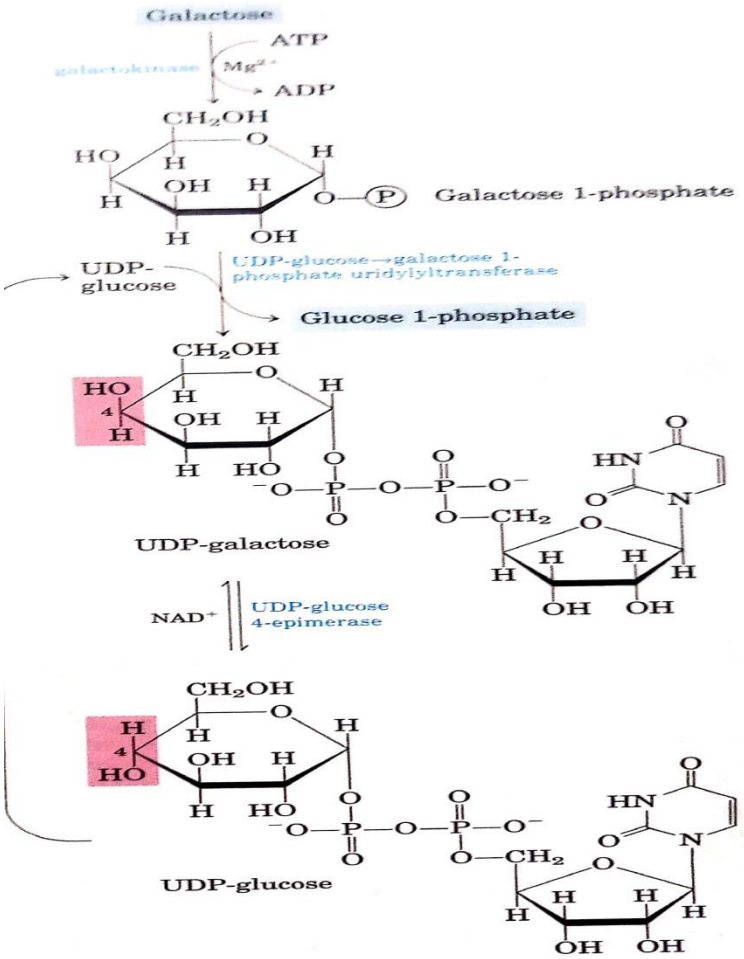
Glyceraldehyde → Glyceraldehyde 3P

Glycogenolysis / glycogen metabolism

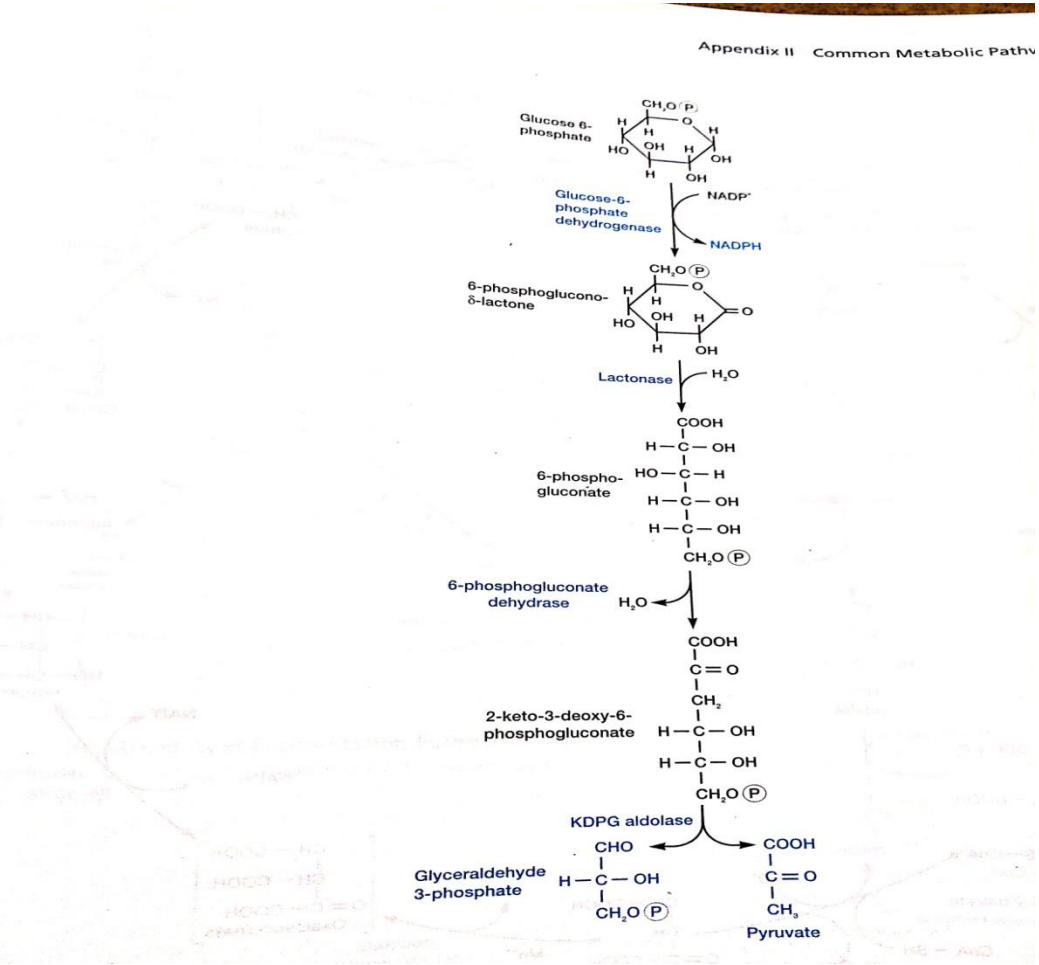



Nonreducing ends
(α1→6) linkage
Glycogen
glycogen phosphorylase
Glucose 1-phosphate molecules
transferase activity of debranching enzyme
(α1→6) glucosidase activity of debranching enzyme
Glucose
Unbranched (α1→4) polymer; substrate for further phosphorylase action

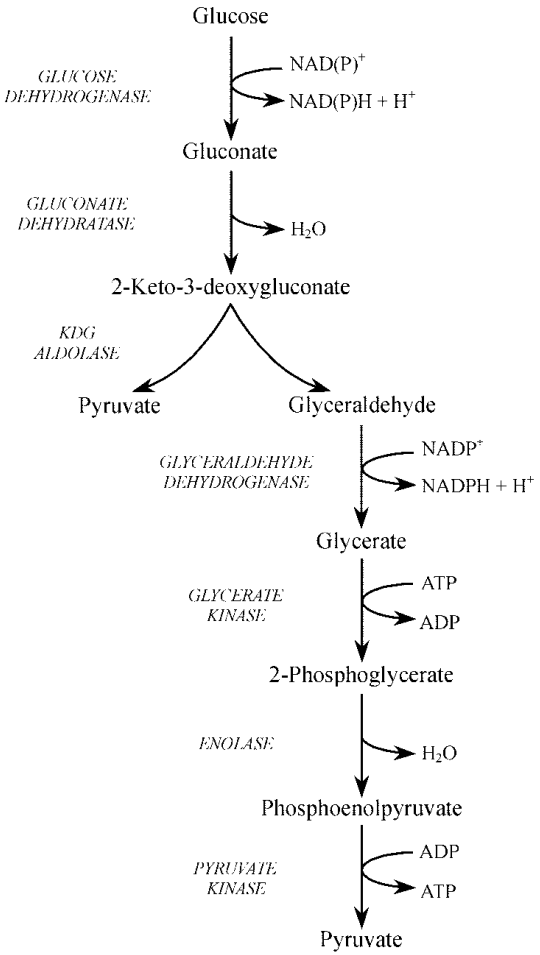
Galactose metabolism



Entner dowdoroff pathway



Modified entner doudoroff Pathway



Alcohol fermentation

- GlucosePyruvate → Acetaldehyde → Alcohol

Mixed Acid Fermentation (Escherichia, Salmonella)

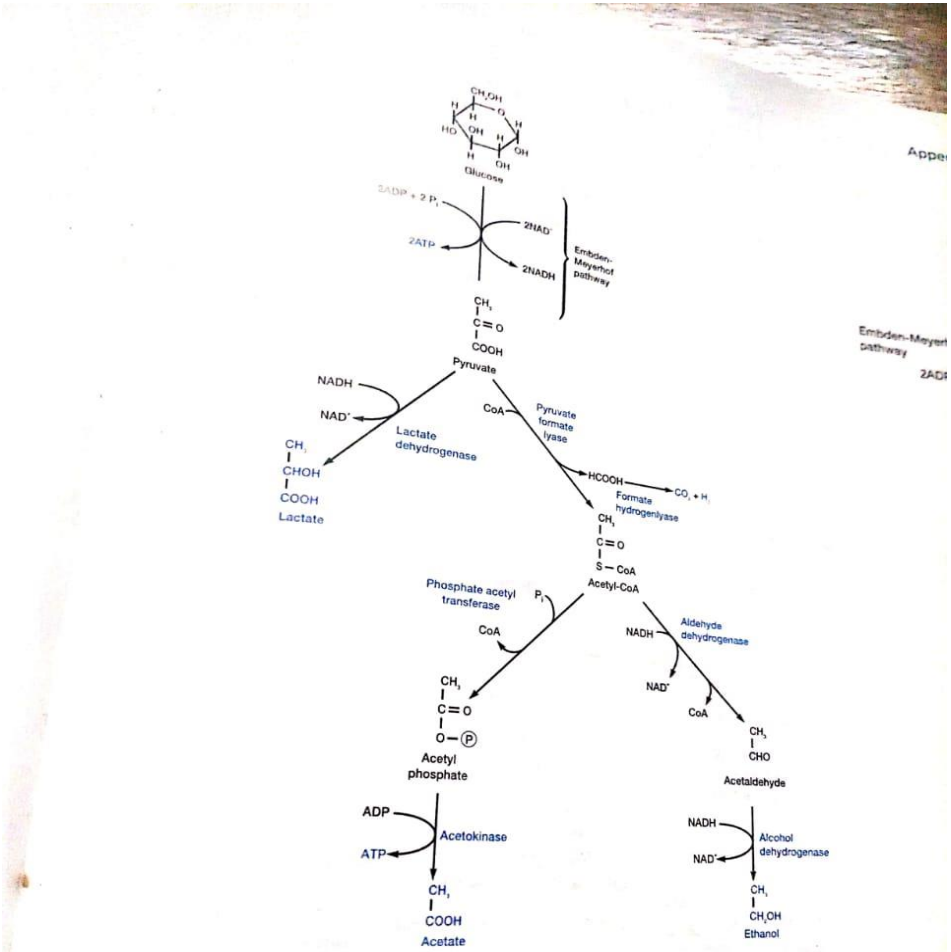
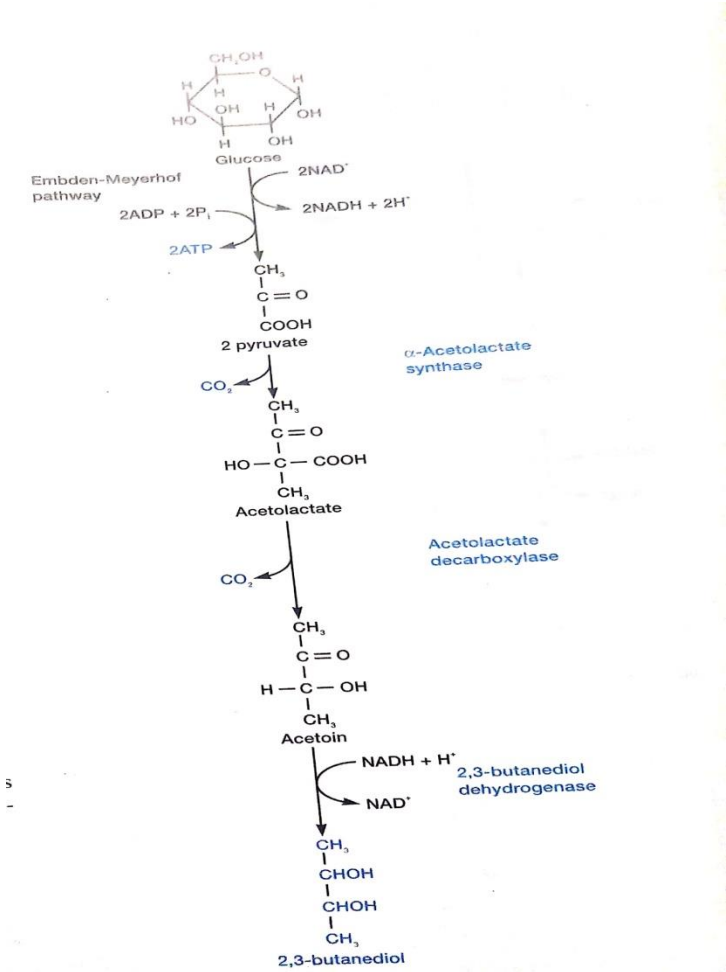
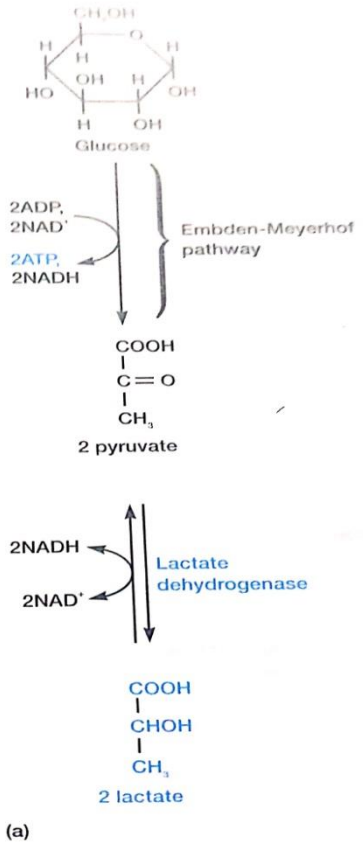


Figure AII.5 The Mixed Acid Fermentation Pathway. This pathway is characteristic of many members of the *Enterobacteriaceae* such as *E. coli.*

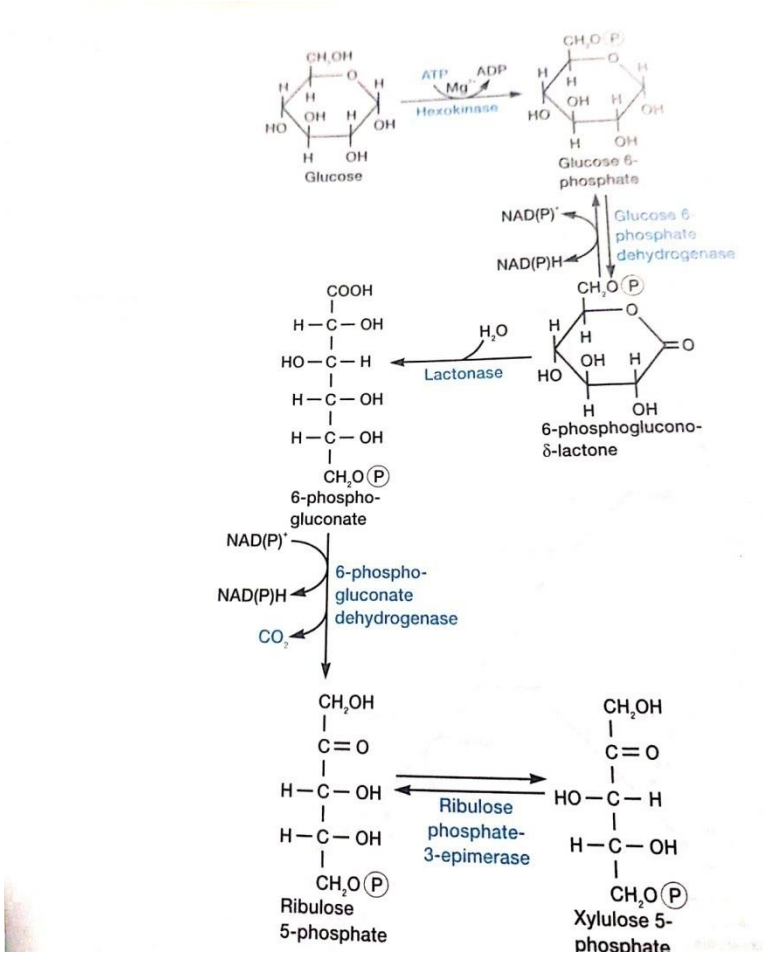
Butanediol fermentation (Enterobacter, Serratia)



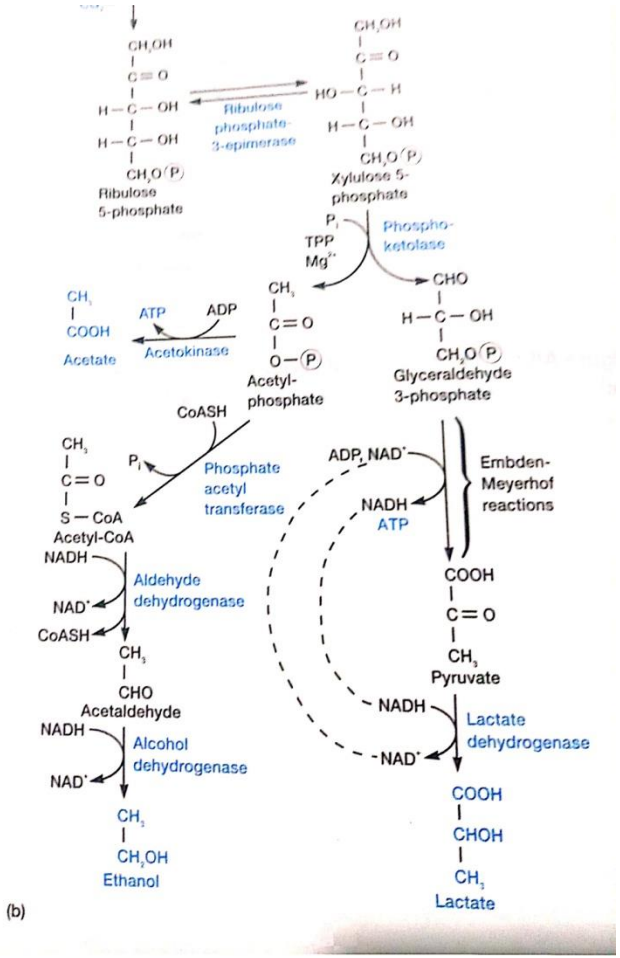
Homo lactic Fermentation



Hetero Lactic Fermentation((Enterobacteriaceae)



Heterolactic fermentation



Stickland reaction(Genus: Clostridium)