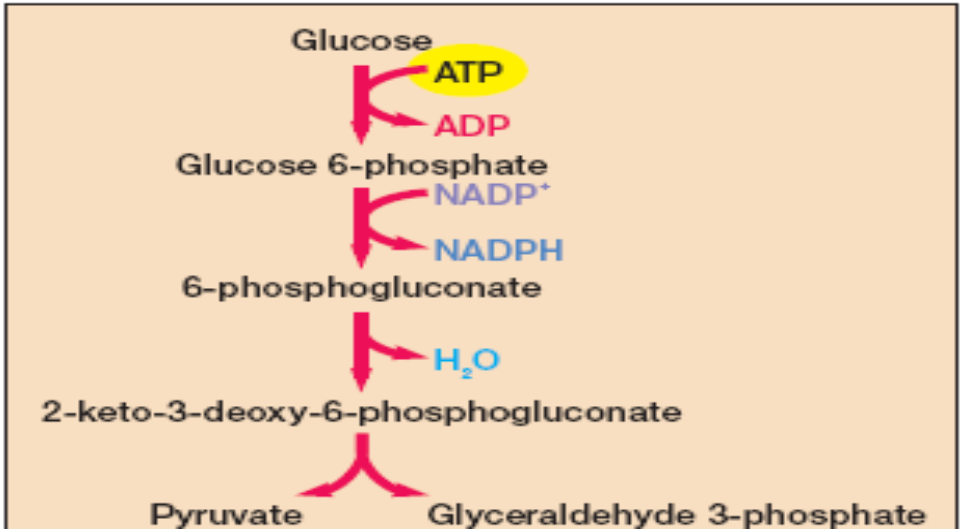
The Entner–Doudoroff Pathway

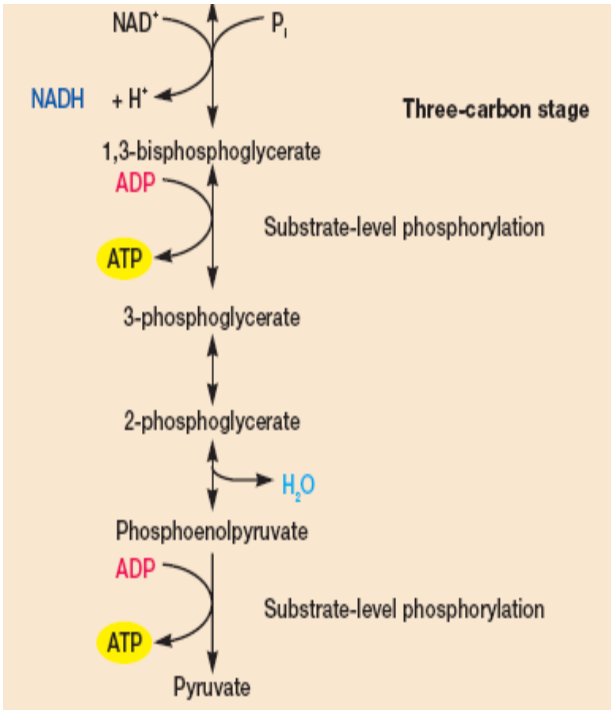
Although the glycolytic pathway is the most common route for the conversion of hexoses to pyruvate, another pathway with a similar role has been discovered.

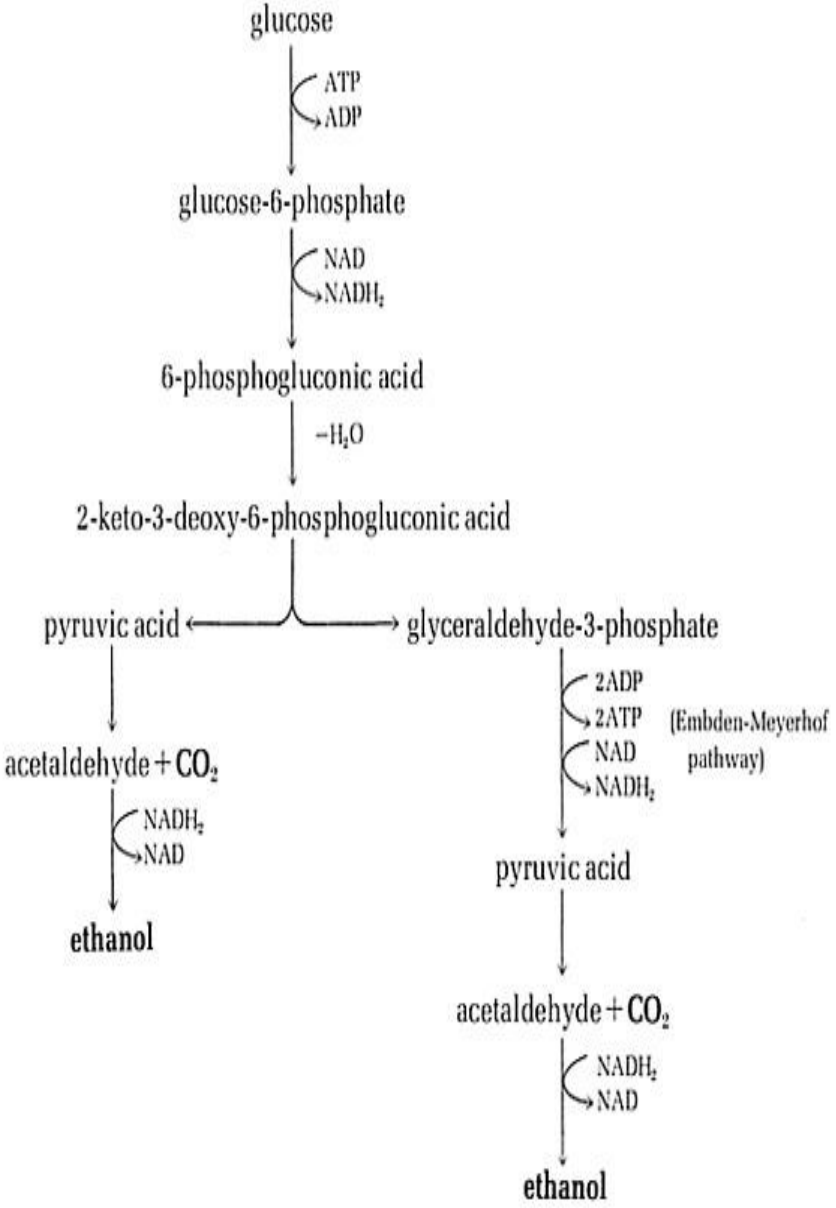
6-phosphogluconate is dehydrated to form 2-keto-3-deoxy-6-phosphogluconate or KDPG, the key intermediate in this pathway. KDPG is then cleaved by KDPG aldolase to pyruvate and glyceraldehyde 3-phosphate. The glyceraldehyde 3-phosphate is converted to pyruvate in the bottom portion of the glycolytic pathway.

If the Entner–Doudoroff pathway degrades glucose to pyruvate in this way, it yields one ATP, one NADPH, and one NADH per glucose metabolized.

Most bacteria have the glycolytic and pentose phosphate pathways, but some substitute the Entner–Doudoroff pathway for glycolysis. The Entner–Doudoroff pathway is generally found in *Pseudomonas, Rhizobium, Azotobacter, Agrobacterium, and a few* other gram-negative genera. Very few Gram-positive bacteria have this pathway, with *Enterococcus faecalis* being a rare exception.


Glucose
ATP
ADP
Glucose 6-phosphate
NADP+
NADPH
6-phosphogluconate
H2O
2-keto-3-deoxy-6-phosphogluconate
Pyruvate
Glyceraldehyde 3-phosphate


NAD+
Pi
NADH + H+
Three-carbon stage
1,3-bisphosphoglycerate
ADP
ATP
Substrate-level phosphorylation
3-phosphoglycerate
2-phosphoglycerate
H2O
Phosphoenolpyruvate
ADP
ATP
Substrate-level phosphorylation
Pyruvate


glucose
ATP
ADP
glucose-6-phosphate
NAD
NADH2
6-phosphogluconic acid
−H2O
2-keto-3-deoxy-6-phosphogluconic acid
pyruvic acid
glyceraldehyde-3-phosphate
acetaldehyde + CO2
NADH2
NAD
ethanol
2ADP
2ATP
NAD
NADH2
(Embden-Meyerhof pathway)
pyruvic acid
acetaldehyde + CO2
NADH2
NAD
ethanol

Entner–Doudoroff (ED) pathway

4.4.1 Glycolytic pathways in some G(–) bacteria (continued)

Table 4.2. *Major glycolytic pathways in prokaryotes*

Organism	EMP	ED
Arthrobacter species	+	+/−[a]
Azotobacter chroococcum	+	−
Ralstonia eutropha (*Alcaligenes eutrophus*)	−	+
Bacillus subtilis	+	−
Cellulomonas flavigena	+	+/−[a]
Escherichia coli and enteric bacteria	+	+/−[a]
Pseudomonas saccharophila	−	+
Rhizobium japonicum	−	+
Thiobacillus ferrooxidans	−	+
Xanthomonas phaseoli	−	+
Thermotoga maritima	+	+[b]
Thermoproteus tenax	+[c]	+[b,d]
Halococcus saccharolyticus	+[c,e]	+[b,d,f]
Halobacterium saccharovorum	−	+[d]
Clostridium aceticum	−	+[d]
Sulfolobus acidocaldarius	−	+[d]

+, present; −, absent.
[a] When gluconate is used as energy and carbon source.
[b] Enzymes for EMP and ED pathways are expressed simultaneously.
[c] Modified EMP pathway.
[d] Modified ED pathway.
[e] Fructose.
[f] Glucose.

Entner–Doudoroff (ED) pathway

4.4.2 Key enzymes of the ED pathway

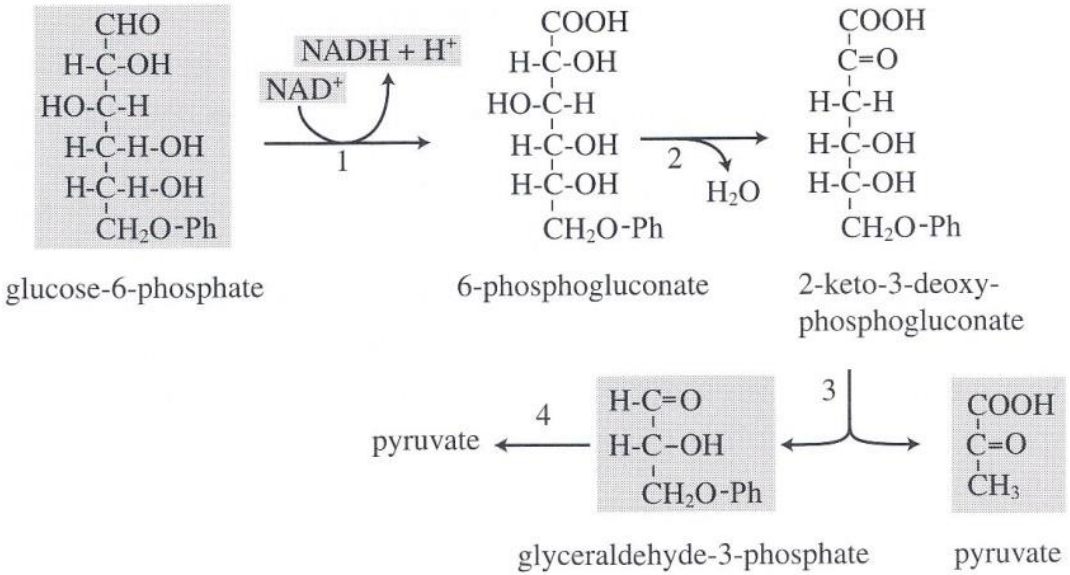


Figure 4.6 The Entner–Doudoroff (ED) pathway.

This metabolism is known only in prokaryotes, mainly Gram-negative bacteria, that do not possess the EMP pathway.

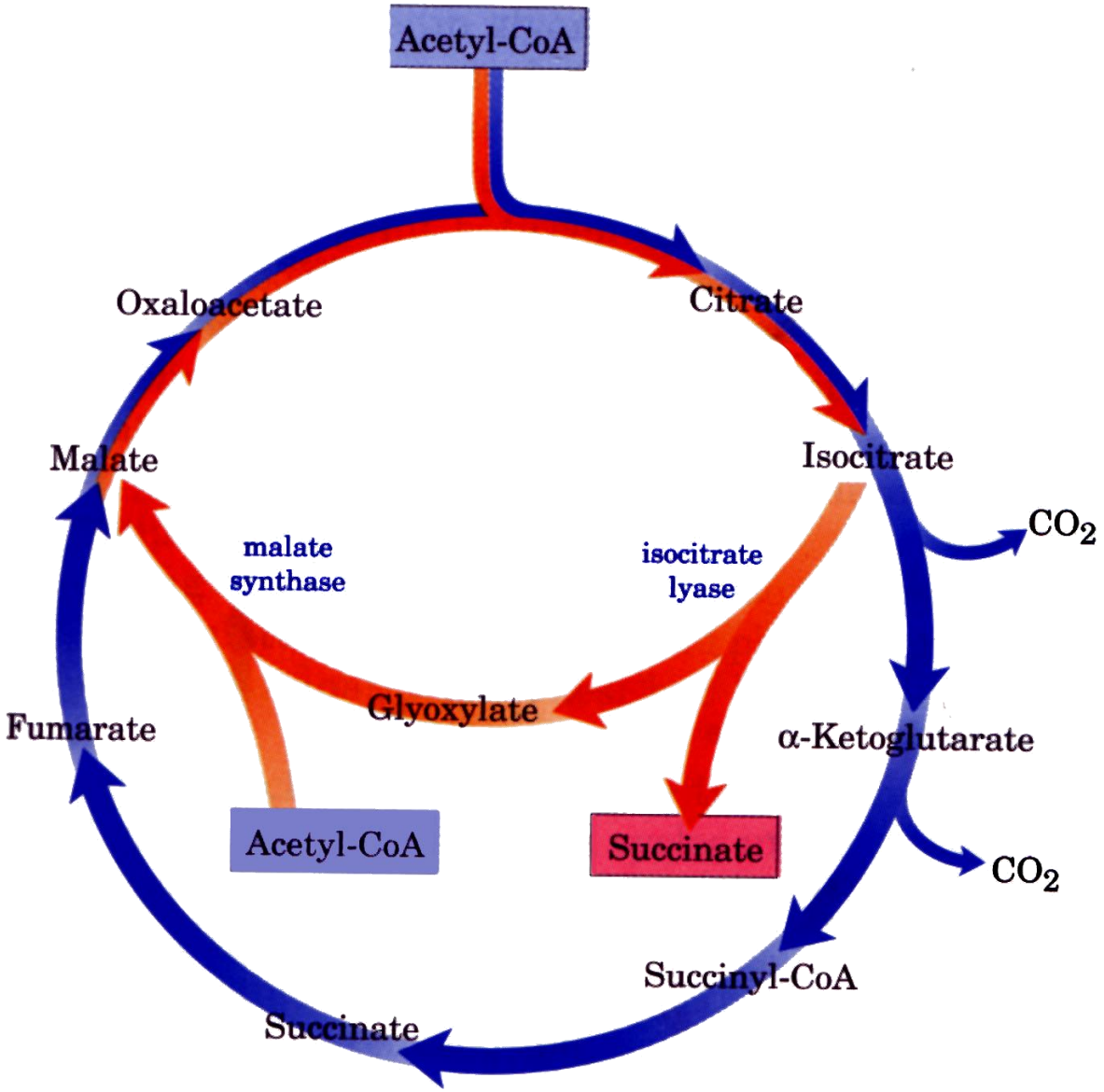
1, glucose-6-phosphate dehydrogenase; 2, 6-phosphogluconate dehydratase; 3, 2-keto-3-deoxy-6-phosphogluconate aldolase; 4, as in the EMP pathway.

- NAD(P)$^+$–dependent glucose–6–phosphate dehydrogenase converts glucose–6–phosphate to 6–phosphogluconolactone that is converted to 6–phosphogluconate.
- 6–Phosphogluconate dehydratase removes water molecule from 6–phosphogluconate and produces 2–keto–3–deoxy–phosphogluconate (KDPG).
- KDPG aldolases splits KDPG into pyruvate and glyceraldehyde–3–phosphate.
- The key enzymes in the ED pathway are 6–phosphogluconate dehydrogenase and KDPG aldolase.

Glyoxalate cycle

- **Anaplerotic reaction** – to meet out the demand of carbon requirement.
- This cycle operates for **gluconeogenesis**.
- Modified TCA cycle Found in plants and some microbes
- Utilizes **fattyacids as the source of energy** in the form of acetyl coA.
- In this cycle Co2 evolving steps of TCA cycle were by –passed and instead of acetyl coA is utilized(which condenses gloxalate to form malate).
- Succinate is a by product, used for biosynthesis , particularly in gluconeogenesis.

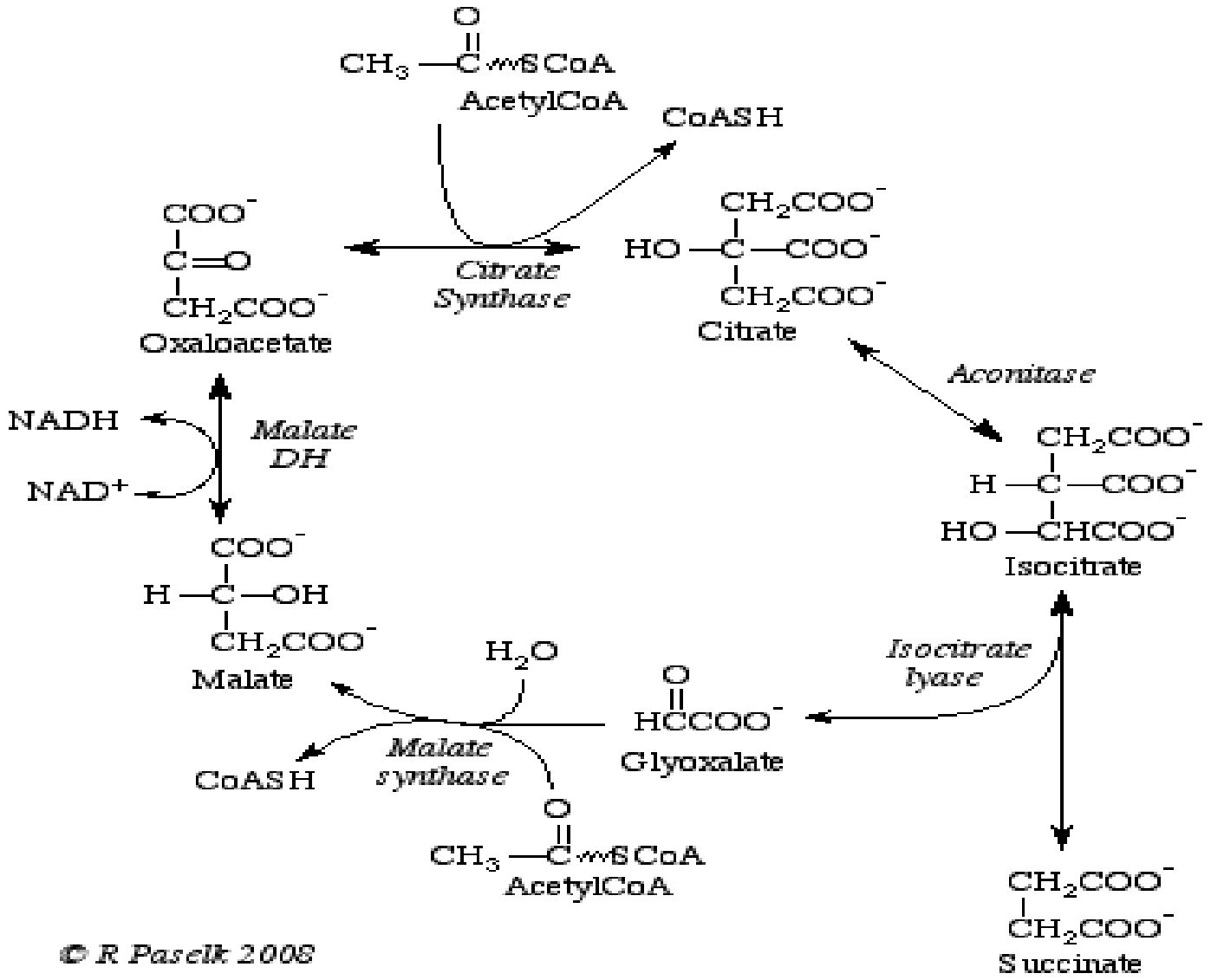
- Key enzymes.
- Isocitrate lyase and malate synthtase present in glyoxysomes.
- Glyoxysomes import fatty acids and aspartate, which provide acetyl-CoA to the shunt.
- *Aspartate transaminase* (*aspartate aminotransferase*) converts aspartate into oxaloacetate, permitting incorporation of acetyl CoA into citrate via *citrate synthase.*
- Glyoxalate cyle goes on simultaneously with TCA cycle, while TCA provides energy, glyoxalate cycle provides succinate for the formation of new CHO from fats.



The glyoxylate cycle and its relationship to **the citric acid cycle.** The orange reaction arrows represent the **glyoxylate cycle**, and the **blue arrows**, the **citric acid cycle**. Notice that the glyoxylate cycle **bypasses the two decarboxylation** steps of the citric acid cycle, and that **two molecules of acetyl-CoA enter the glyoxylate cycle** during each turn, but only **one enters the citric acid cycle**. The **glyoxylate cycle** was elucidated by **Hans Kornberg** and **Neil Madsen** in the laboratory of Hans Krebs.

!!!

Glyoxylate Cycle



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