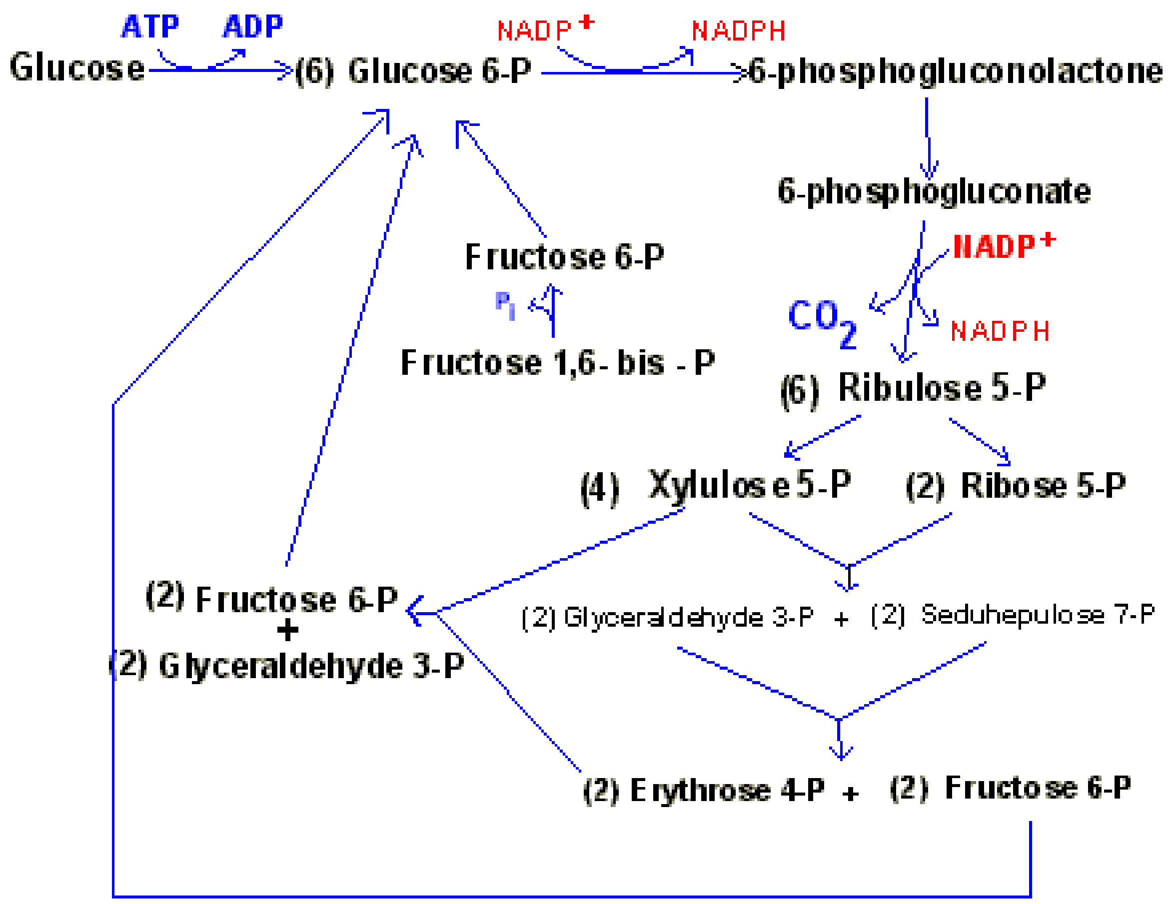
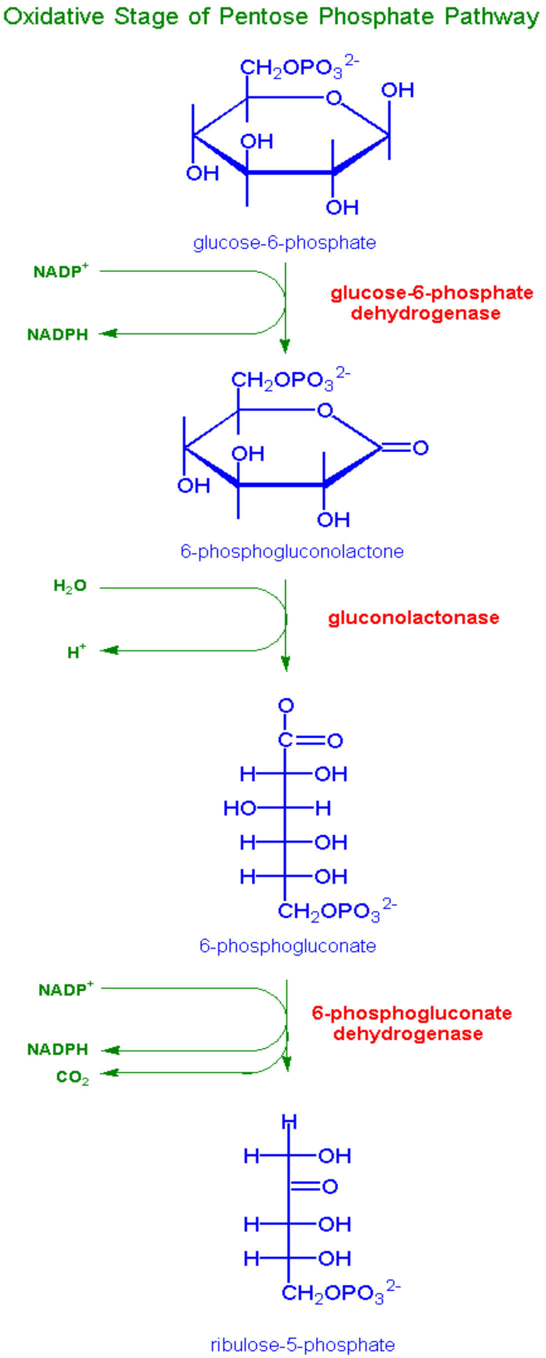
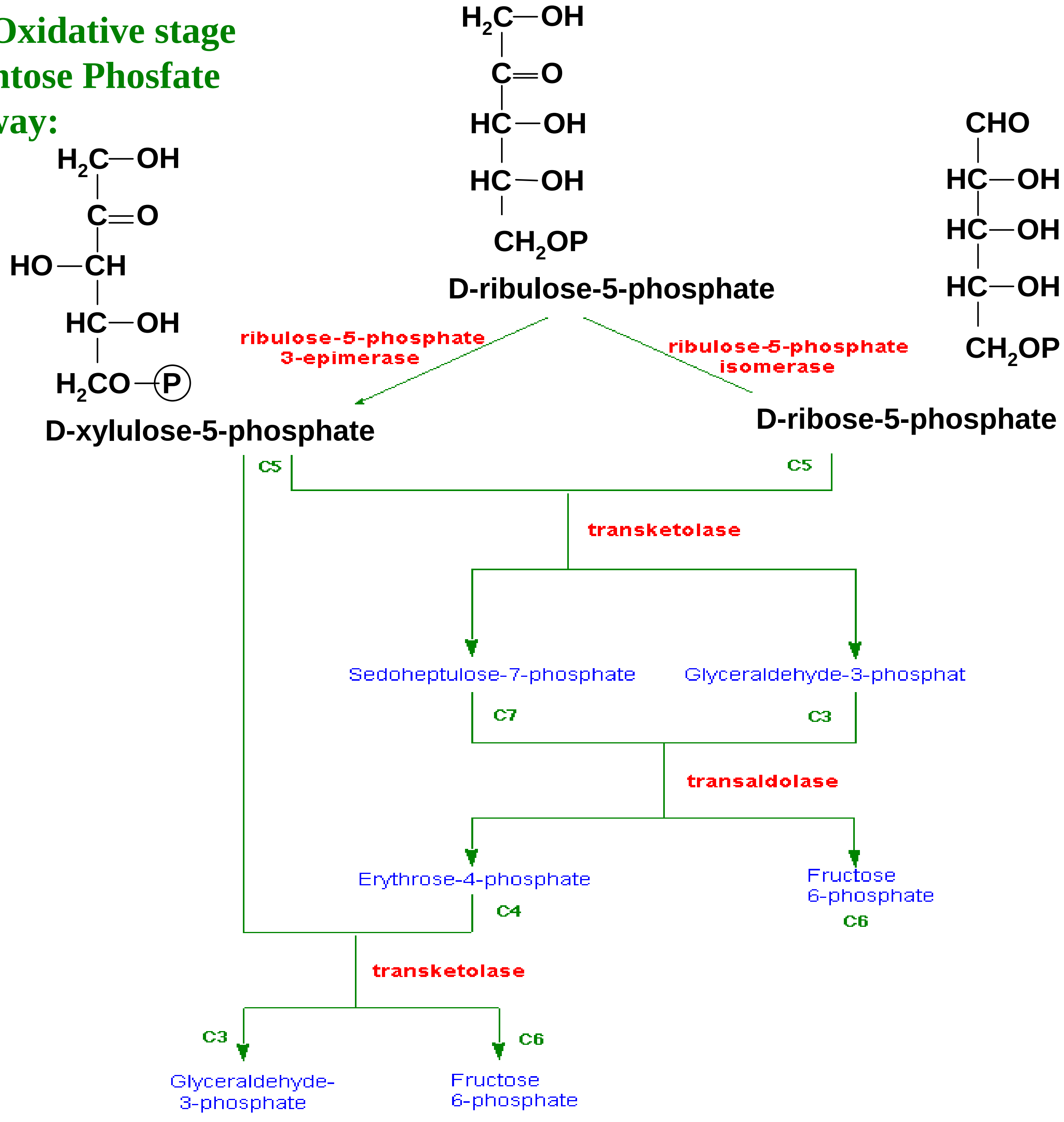
Pentose Phosphate pathway



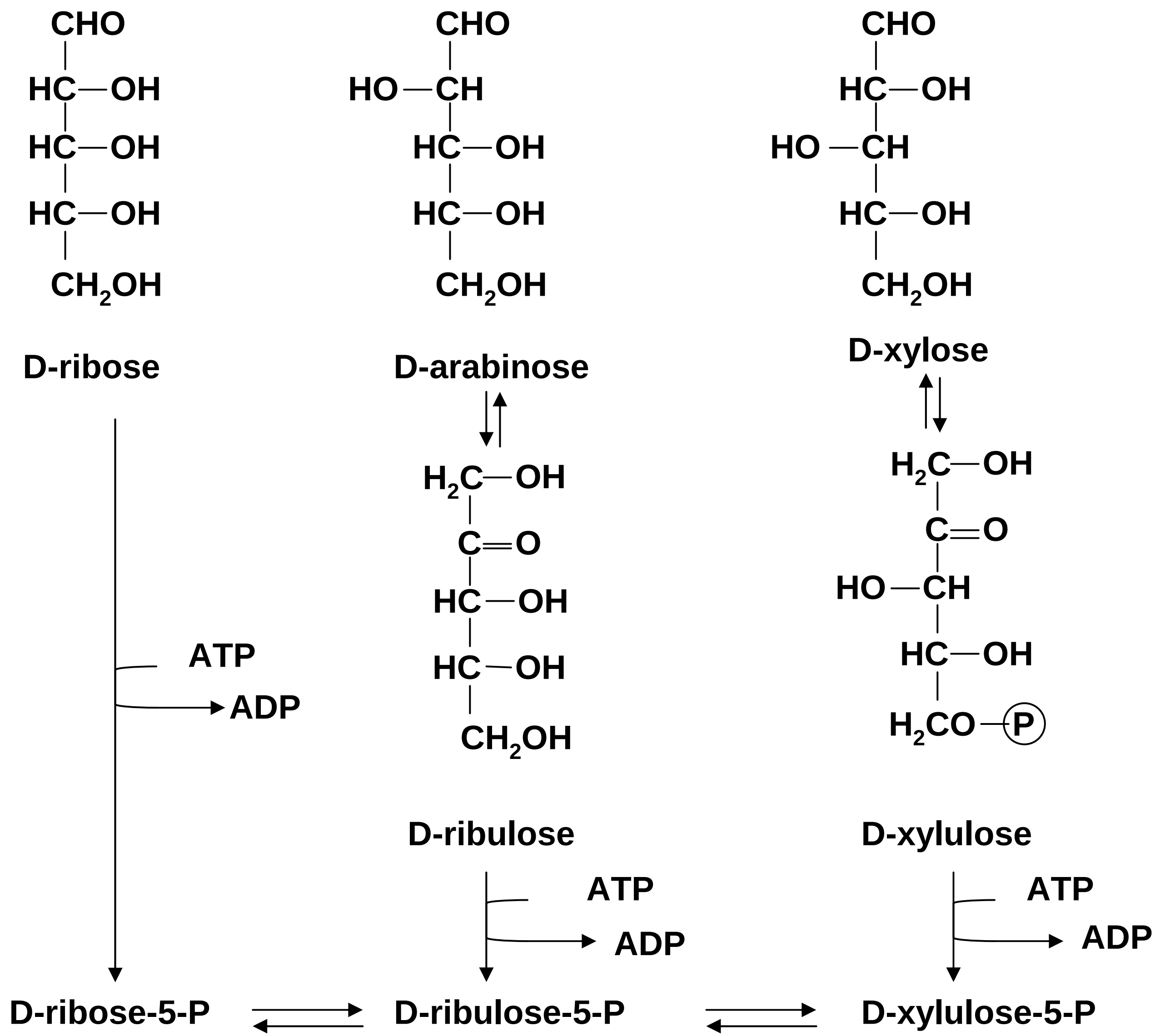
Oxidative stage of Pentose Phosfate pathway:



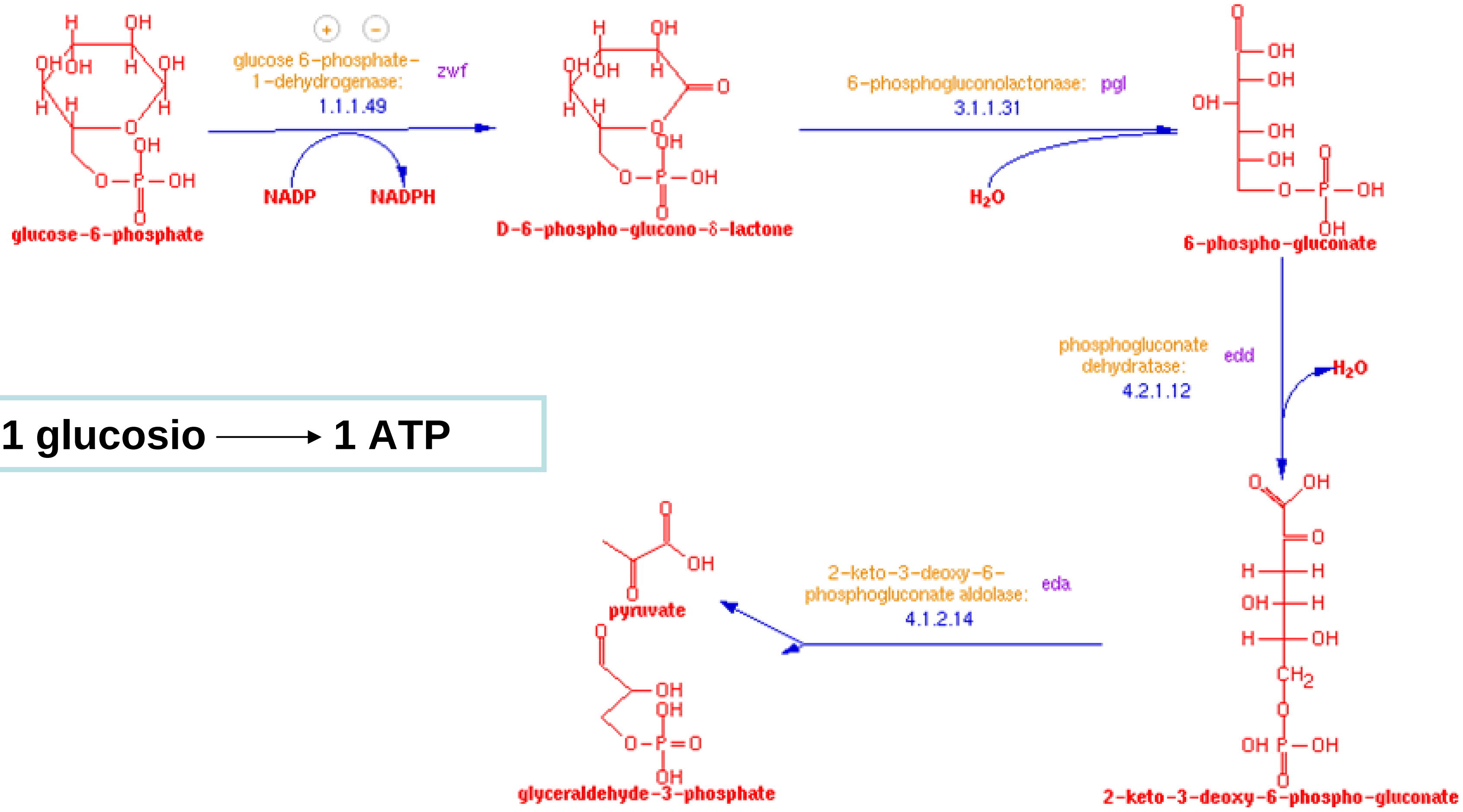
Non-Oxidative stage of Pentose Phosfate pathway:



REACTIONS IN *E. coli* LEADING FROM PENTOSES TO D-RIBOSE-5-PHOSPHATE AND D-XYLULOSE-5-PHOSPHATE



E. coli K-12 Pathway: Entner-Doudoroff pathway



1 glucosio ⟶ 1 ATP

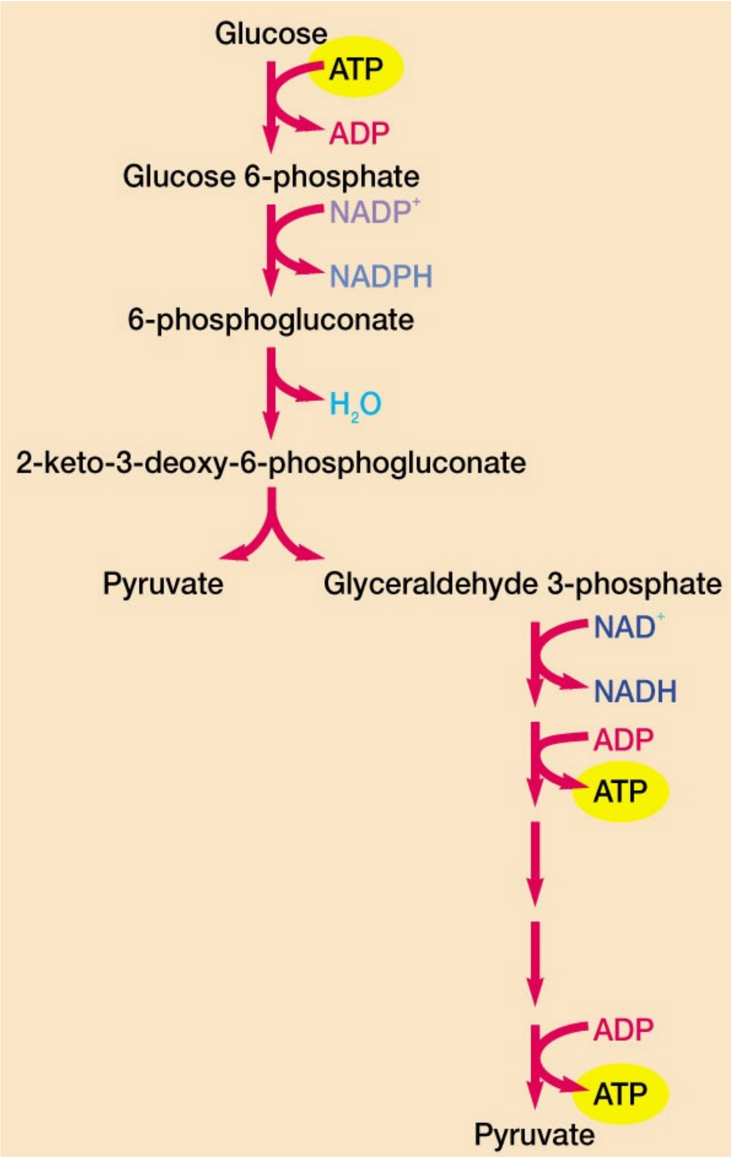
Net Reaction Equation:

glucose-6-phosphate + NADP = pyruvate + glyceraldehyde 3-P + NADPH + H^+

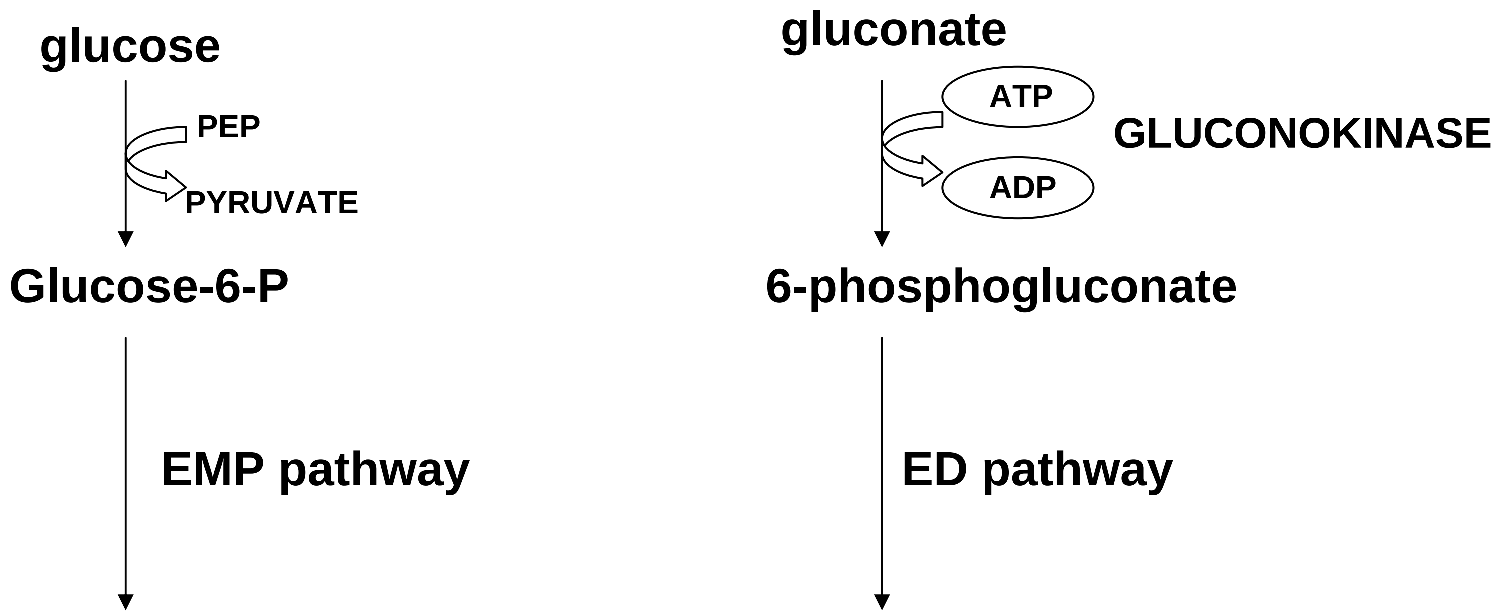
Entner-Doudoroff pathway

yield:

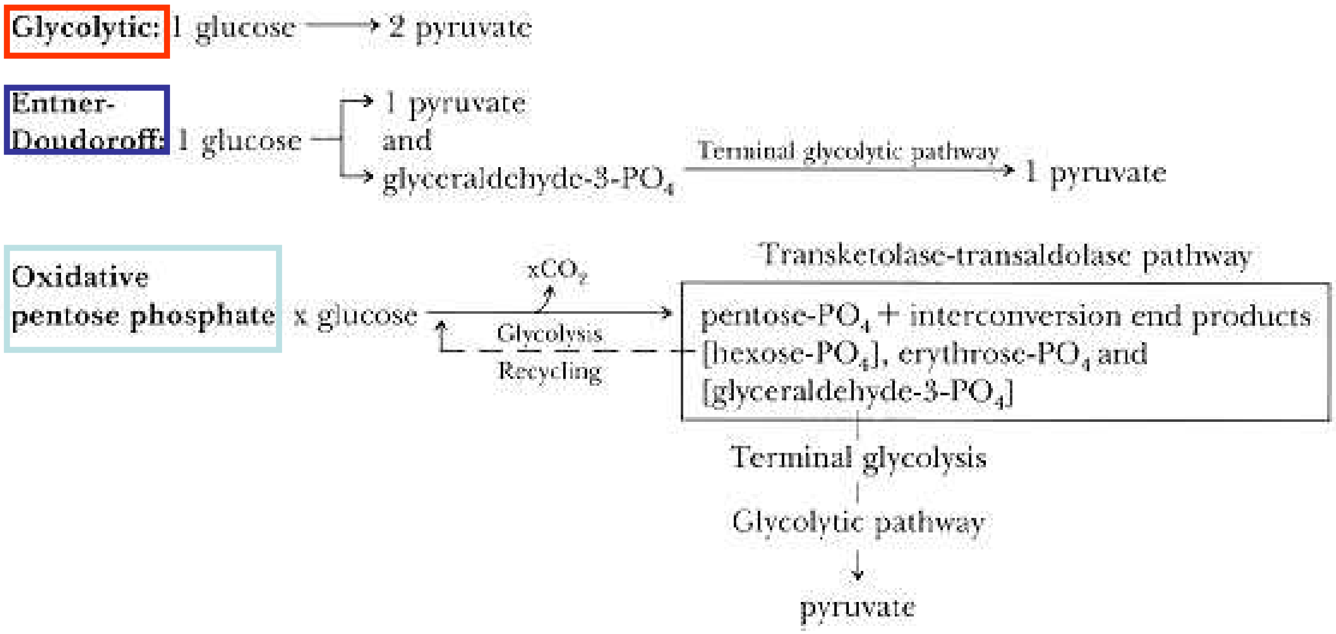
2 pyruvate
1 ATP
2 NADH + H^+



DEGRADATION OF GLUCOSE AND GLUCONATE BY *E. coli*



End products of glucose dissimilatory pathways



The glycolytic pathway may be the major one existing concomitantly with the minor oxidative pentose phosphate pathway; the Entner-Doudoroff pathway also may function as a major pathway with a minor hexose monophosphate shunt. A few bacteria possess only one pathway. All cyanobacteria, *Acetobacter suboxydans*, and *A. xylinum* possess only the pentose phosphate pathway; *Pseudomonas sacch.* and *Z. mobilis* possess solely the Entner-Doudoroff pathway.

TABLE 4-2 Glucose Dissimilation Pathways Utilized by Bacteria, Cyanobacteria, and Yeasts

Bacteria	Glycolytic Pathway	Oxidative Pentose Phosphate Pathway	Entner-Doudoroff Pathway
Acetobacter suboxydans		Sole	
Acetobacter xylinum		Sole	
Agrobacterium spp			Major
Azotobacter vinelandii[a]			Major
Bacillus subtilis	Major	Minor	
Caulobacter spp			Major
Escherichia coli	Major		Minor
Lactobacillus delbrueckii	Major		
Leuconostoc mesenteroides		Major	
Neisseria gonorrhoeae		Minor	Major
Neisseria meningitides		Minor	Major
Neisseria perflava		Major	
Neisseria sicca		Major	
Pseudomonas aeruginosa[a]			Major
Pseudomonas saccharophilia			Sole
Rhizobium spp			Major
Sarcina lutea	Major	Minor	
Spirillum spp			Major
Streptococcus faecalis			(Major)[b]
Streptomyces griseus	Major	Minor	
Zymomonas anaerobia			Sole
Zymomonas mobilis			Sole
All cyanobacteria			Sole
All yeasts	Major	Minor	

[a] Most species utilize the Enter-Doudoroff pathway as major pathway.
[b] Induced by growth on gluconate.

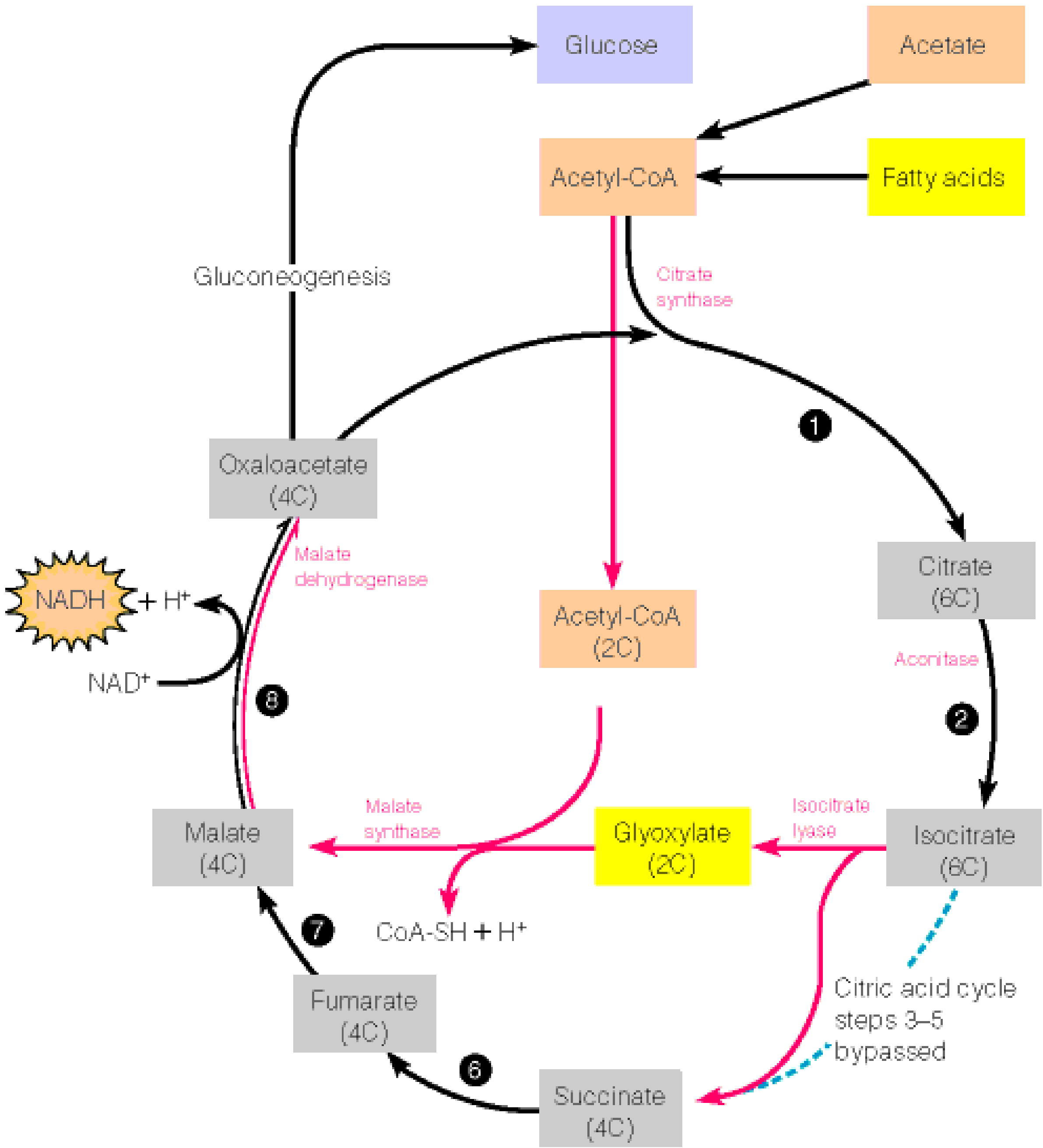
The Glyoxylate Cycle

A variant of TCA for plants and bacteria

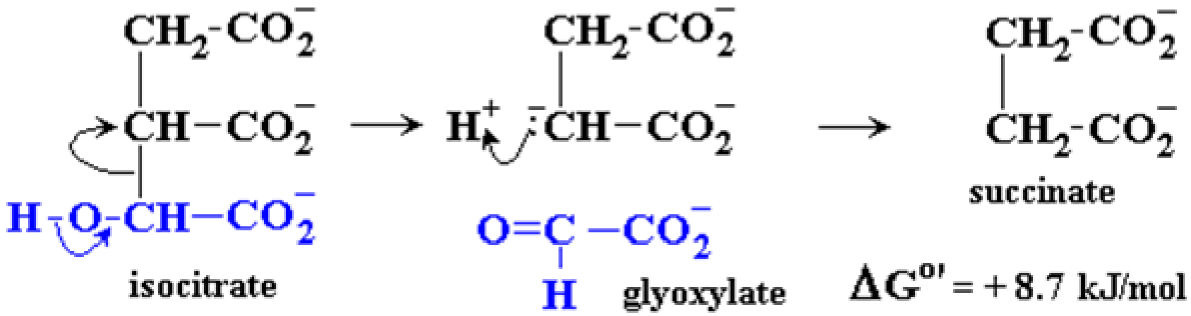
- Acetate-based growth - net synthesis of carbohydrates and other intermediates from acetate - is not possible with TCA
- Glyoxylate cycle offers a solution for plants and some bacteria and algae
- The CO_2-evolving steps are bypassed and an extra acetate is utilized
- Isocitrate lyase and malate synthase are the short-circuiting enzymes

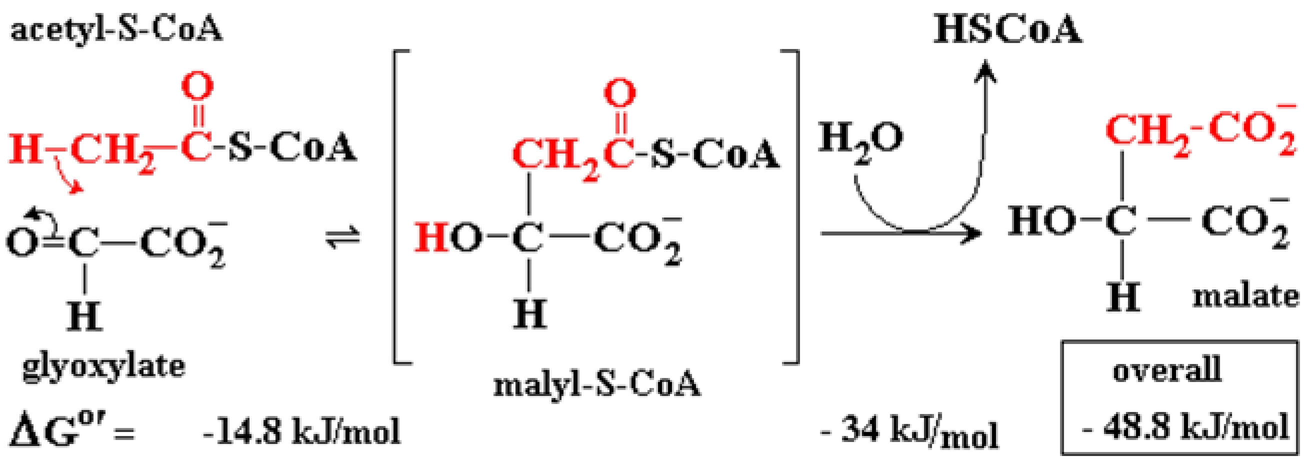
Glyoxylate cycle

- Shunts C2 units from Ethanol or Fat catabolism to dicarboxylic acid Malate
- Malate/OAA is a substrate for gluconeogenesis
- Restricted to plants, fungi, some bacteria
  - Animals cannot make glucose from C2 units!!

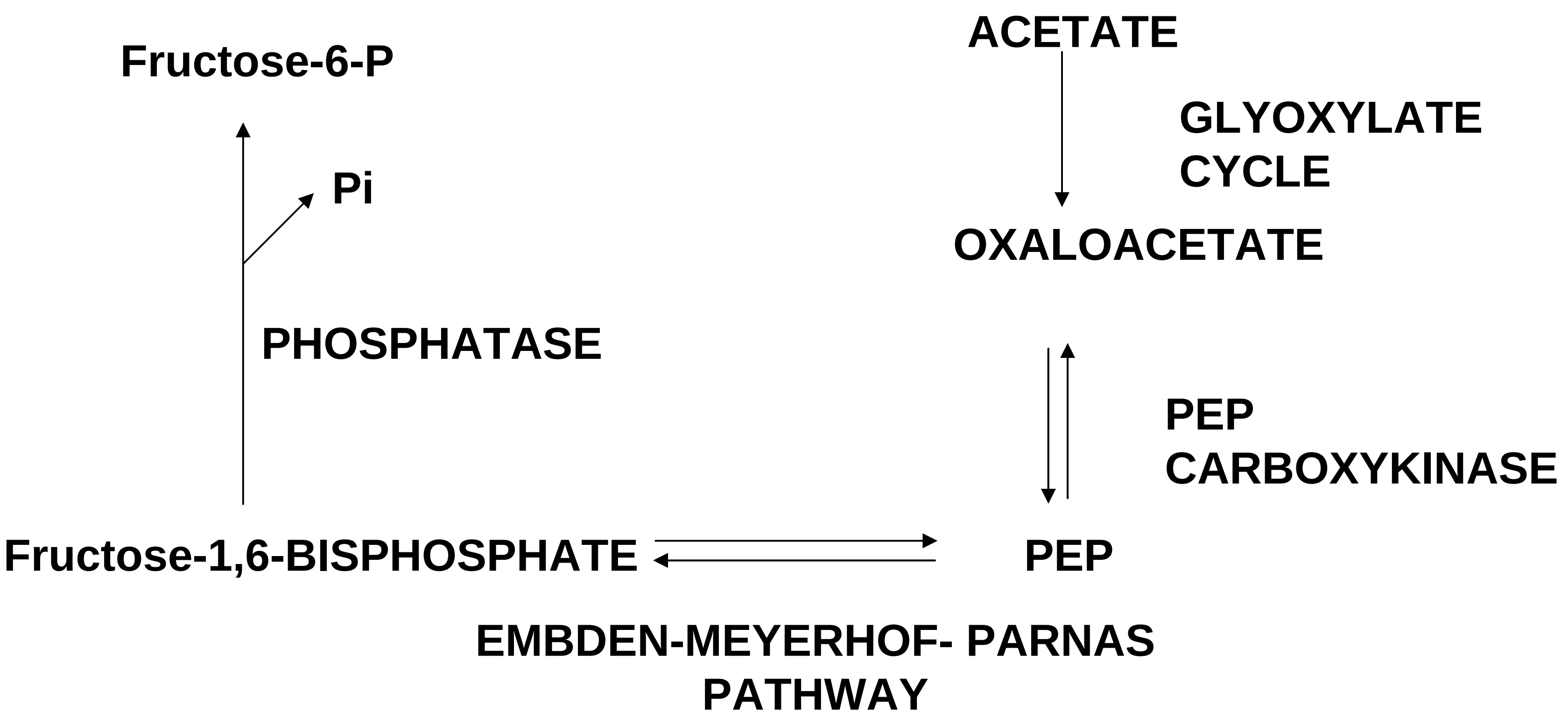


Glucose
Acetate
Acetyl-CoA
Fatty acids
Gluconeogenesis
Citrate synthase
1
Oxaloacetate (4C)
Citrate (6C)
Malate dehydrogenase
NADH
+ H+
NAD+
Acetyl-CoA (2C)
Aconitase
8
2
Malate (4C)
Malate synthase
Glyoxylate (2C)
Isocitrate lyase
Isocitrate (6C)
7
CoA-SH + H+
Citric acid cycle steps 3–5 bypassed
Fumarate (4C)
6
Succinate (4C)

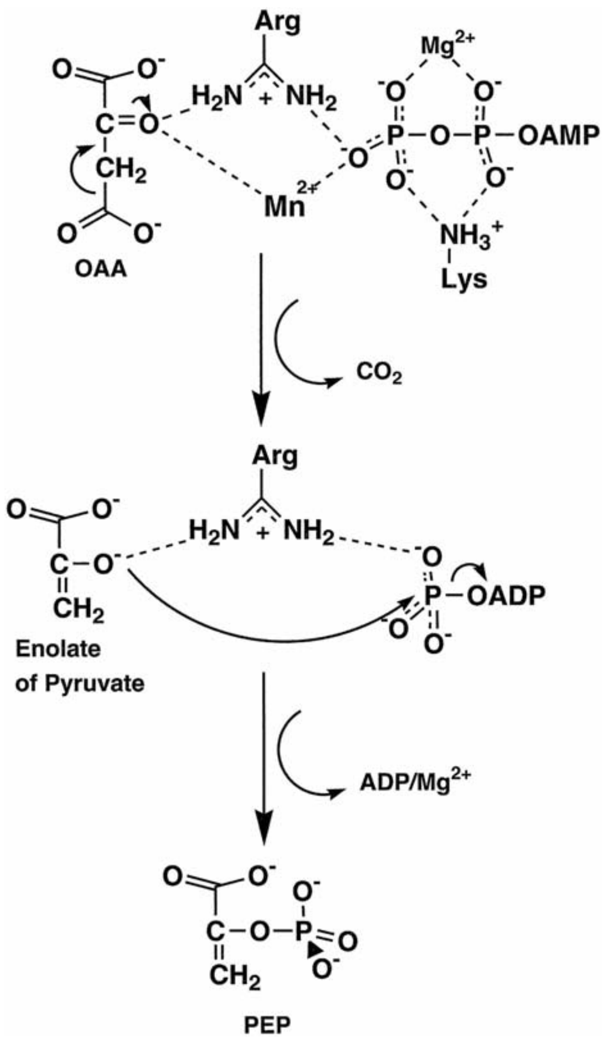

isocitrate
glyoxylate
succinate
ΔG°' = + 8.7 kJ/mol


acetyl-S-CoA
glyoxylate
malyl-S-CoA
HSCoA
H2O
malate
ΔG°' = -14.8 kJ/mol
- 34 kJ/mol
overall
- 48.8 kJ/mol

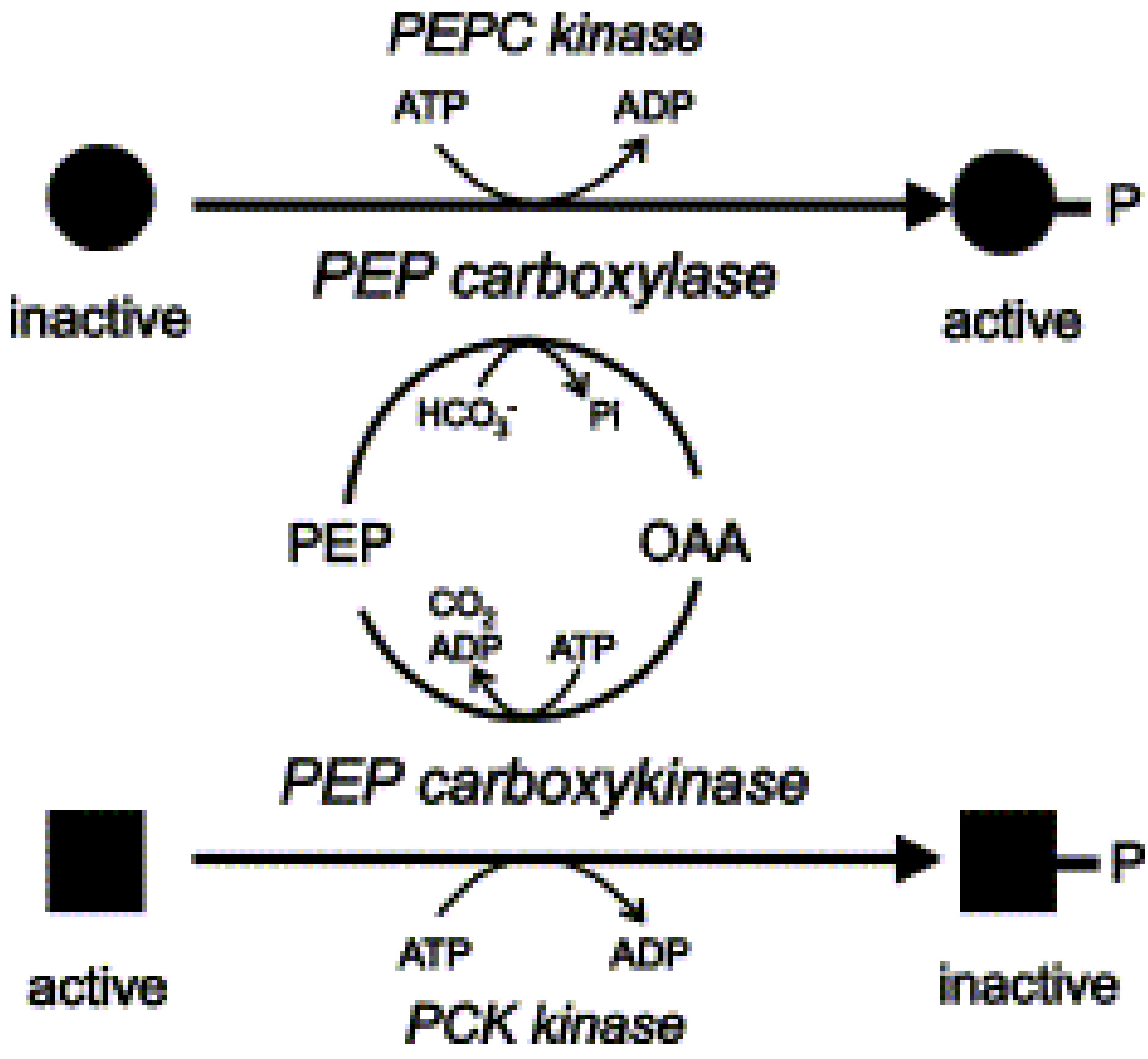
REACTION SEQUENCE LEADING FROM ACETATE TO HEXOSEMONOPHOSPHATE



Phosphoenolpyruvate carboxykinase mechanism



Matte, A. et al. J. Biol. Chem. 1997;272:8105-8108


PEPC kinase
ATP
ADP
P
inactive
PEP carboxylase
active
HCO3-
Pi
PEP
OAA
CO2
ADP
ATP
PEP carboxykinase
P
ATP
ADP
active
inactive
PCK kinase

Carbon flux in *E. coli* ML308 during growth on acetate as the sole carbon and energy source in batch culture at 37 °C