Microbial Metabolism

- Sum of all biochemical reactions
- Catabolic and anabolic
- Enzymes:
  - Catalyze reactions
  - Lower energy of activation
  - Do not change equilibrium
  - Specific
  - Cofactors or coenzymes
- Oxidation reduction reactions

Patterns of Energy Production

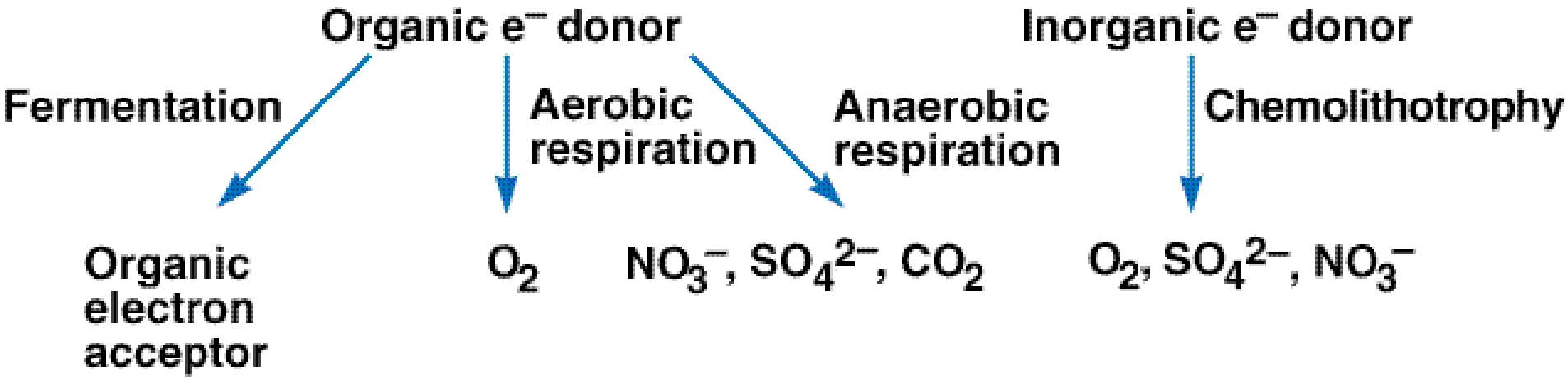


Fig. 9.2

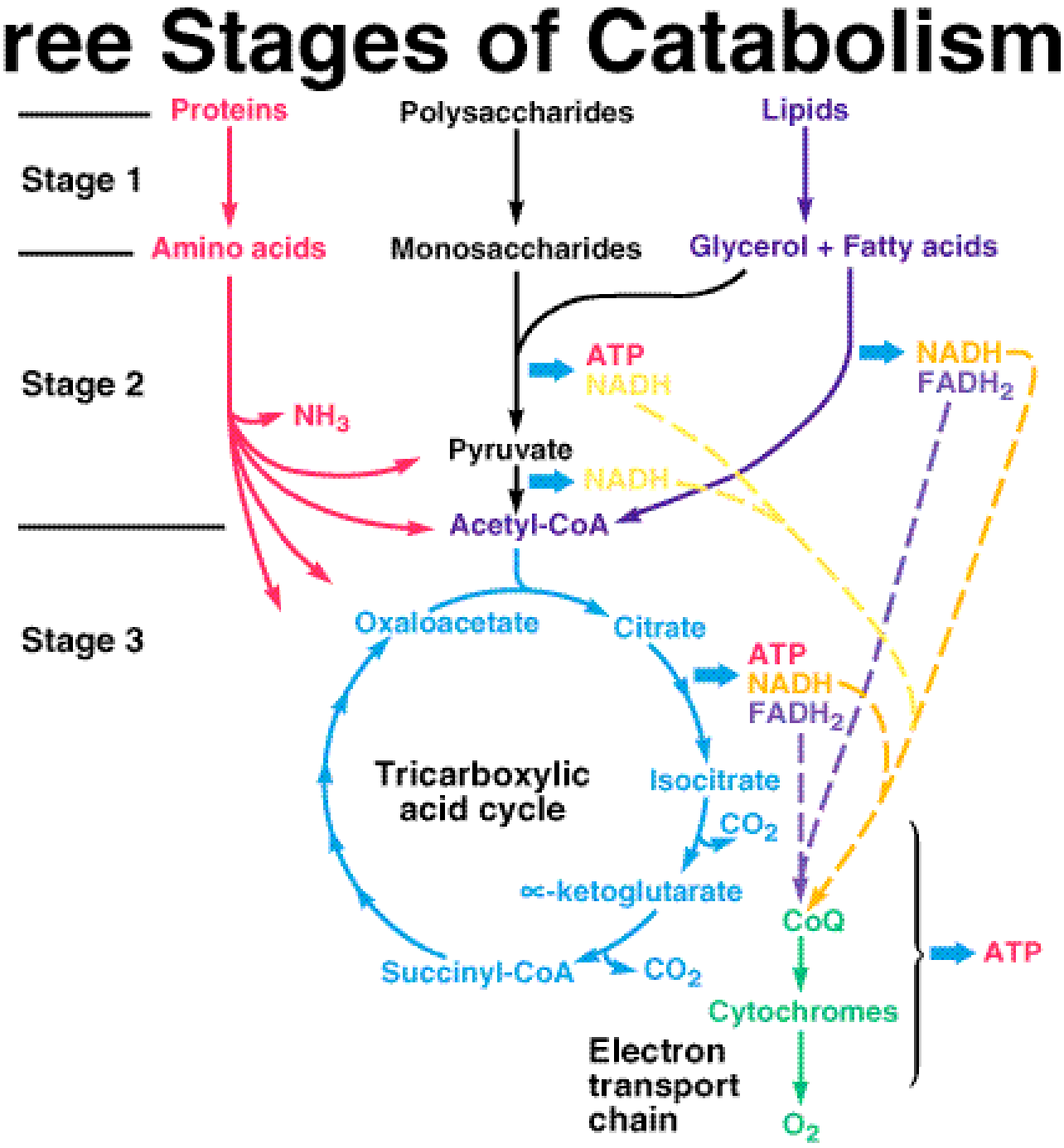


Fig. 9.3

Glycolysis

4 ATPs
-2 ATPs
2 ATPs

2 NADH
2 Pyruvates

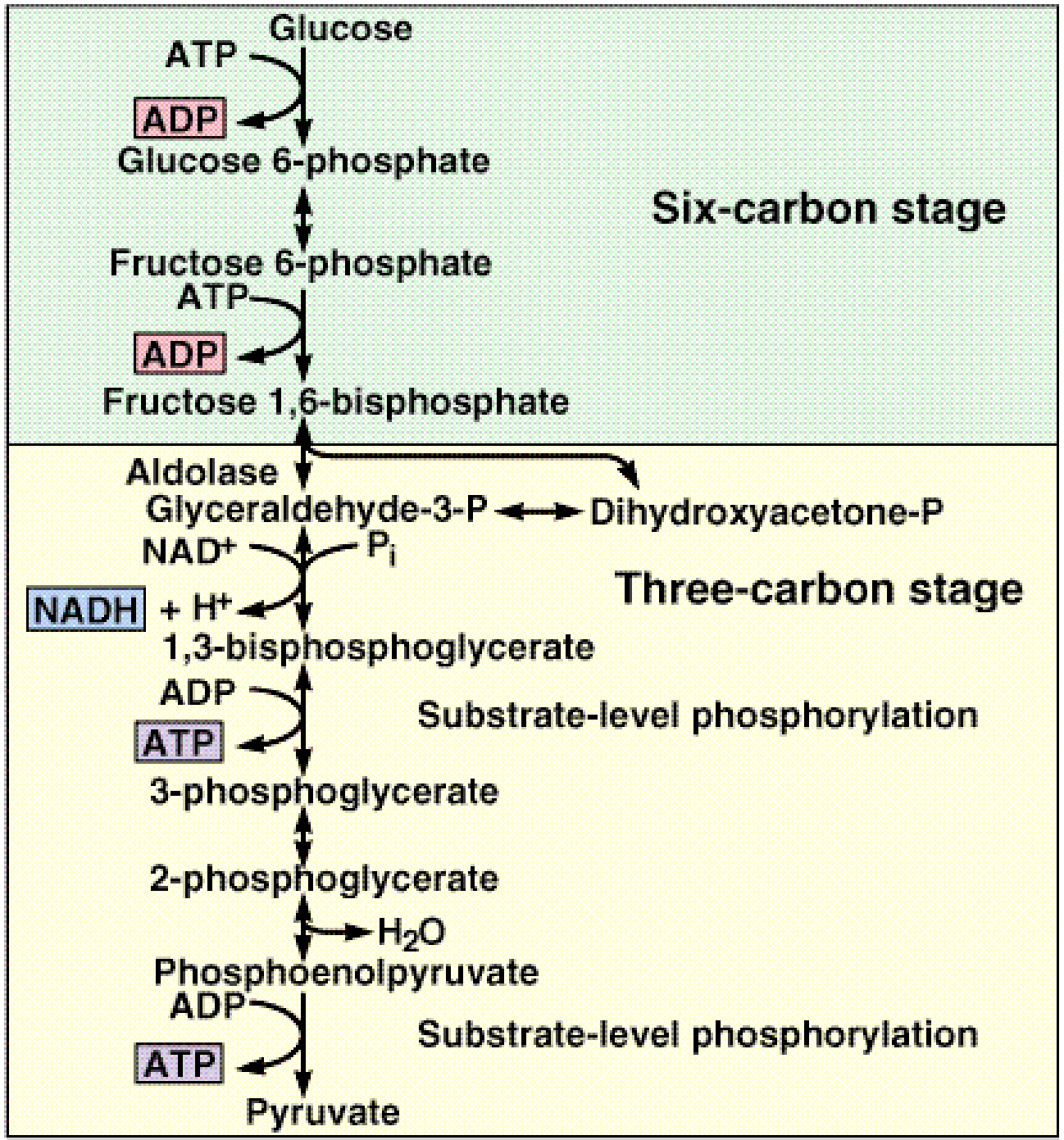
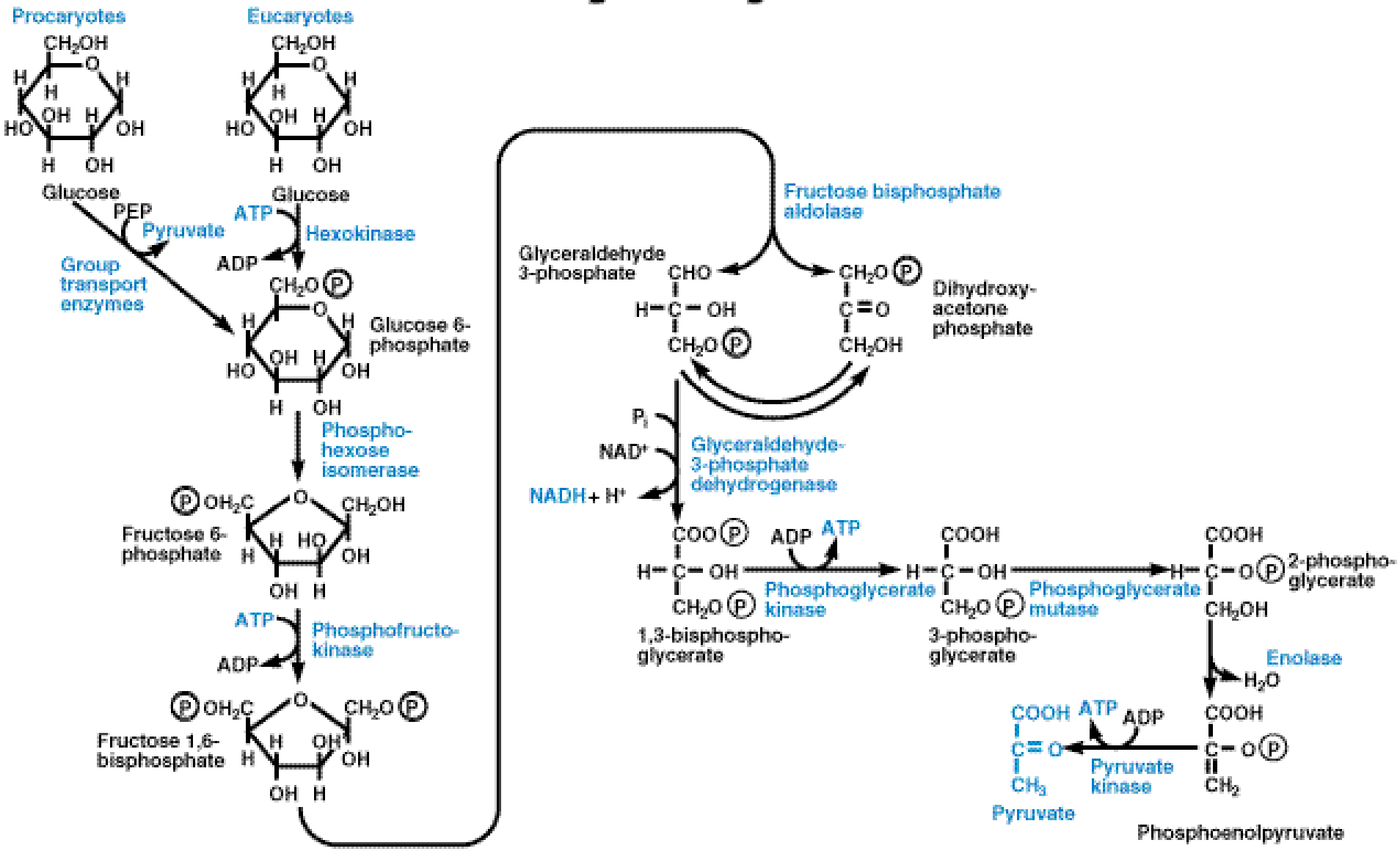


Fig. 9.5

Glycolysis



Bacterial PTS Transport

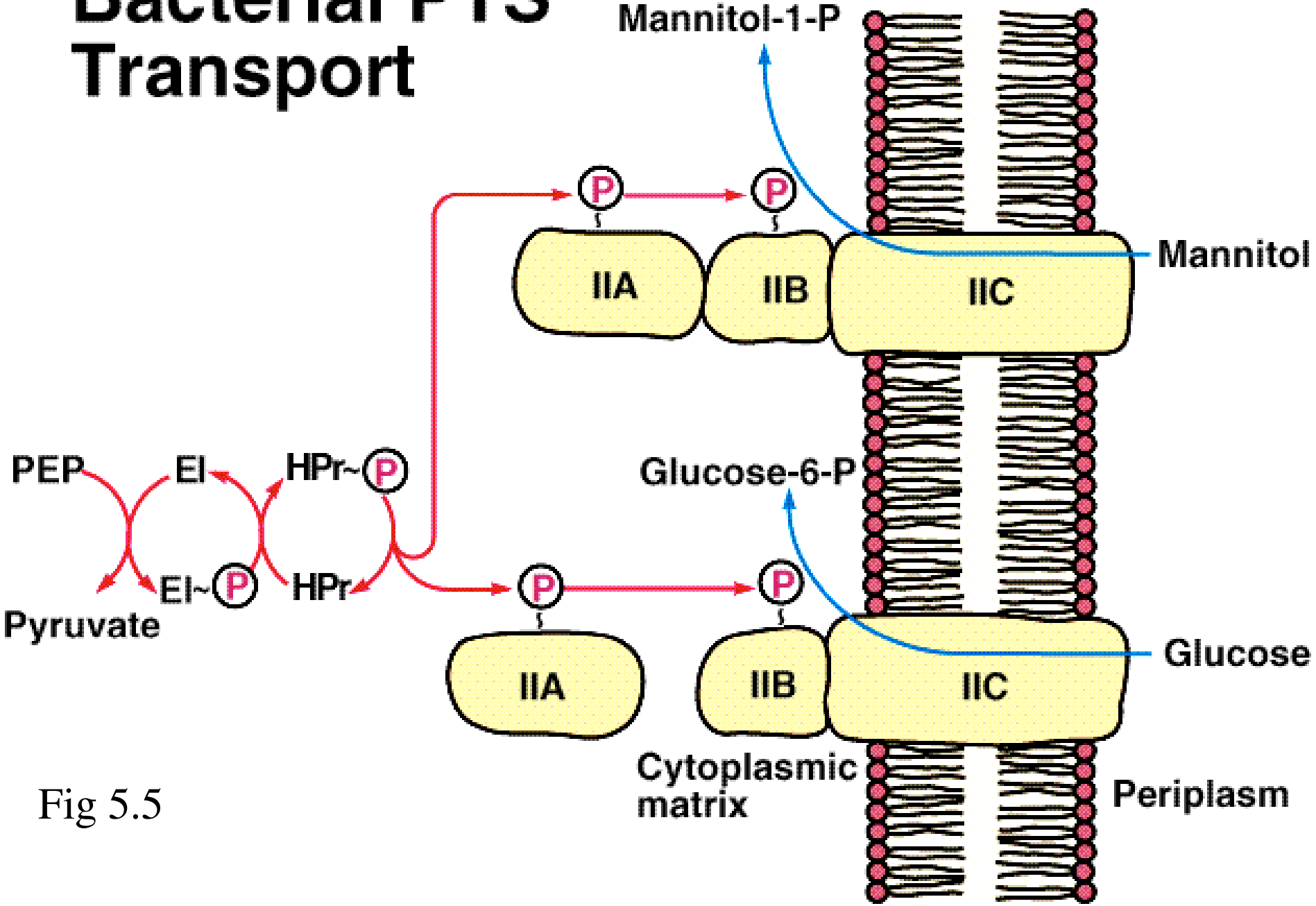


Fig 5.5

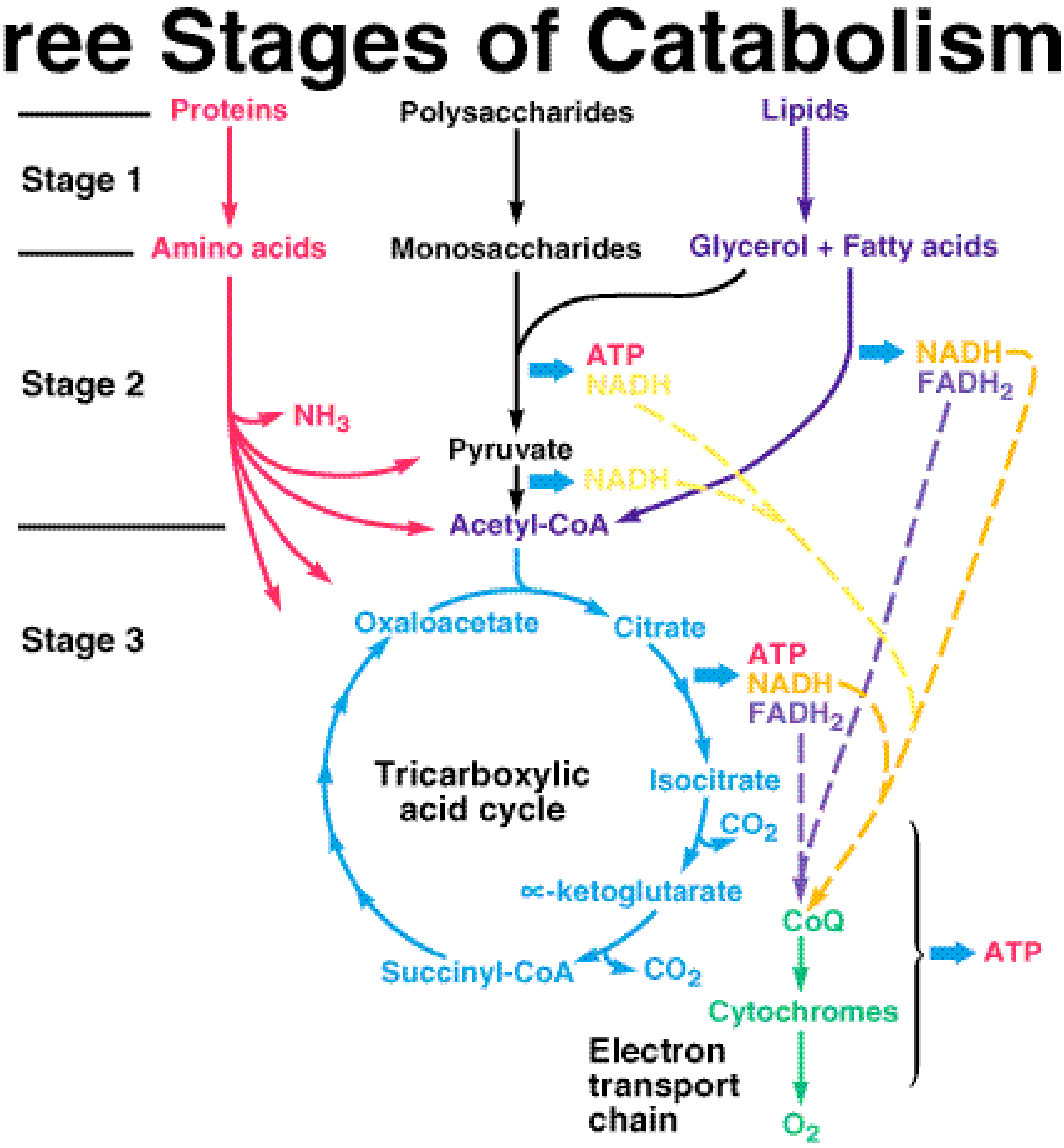


Fig. 9.3

Entner-Doudoroff Pathway

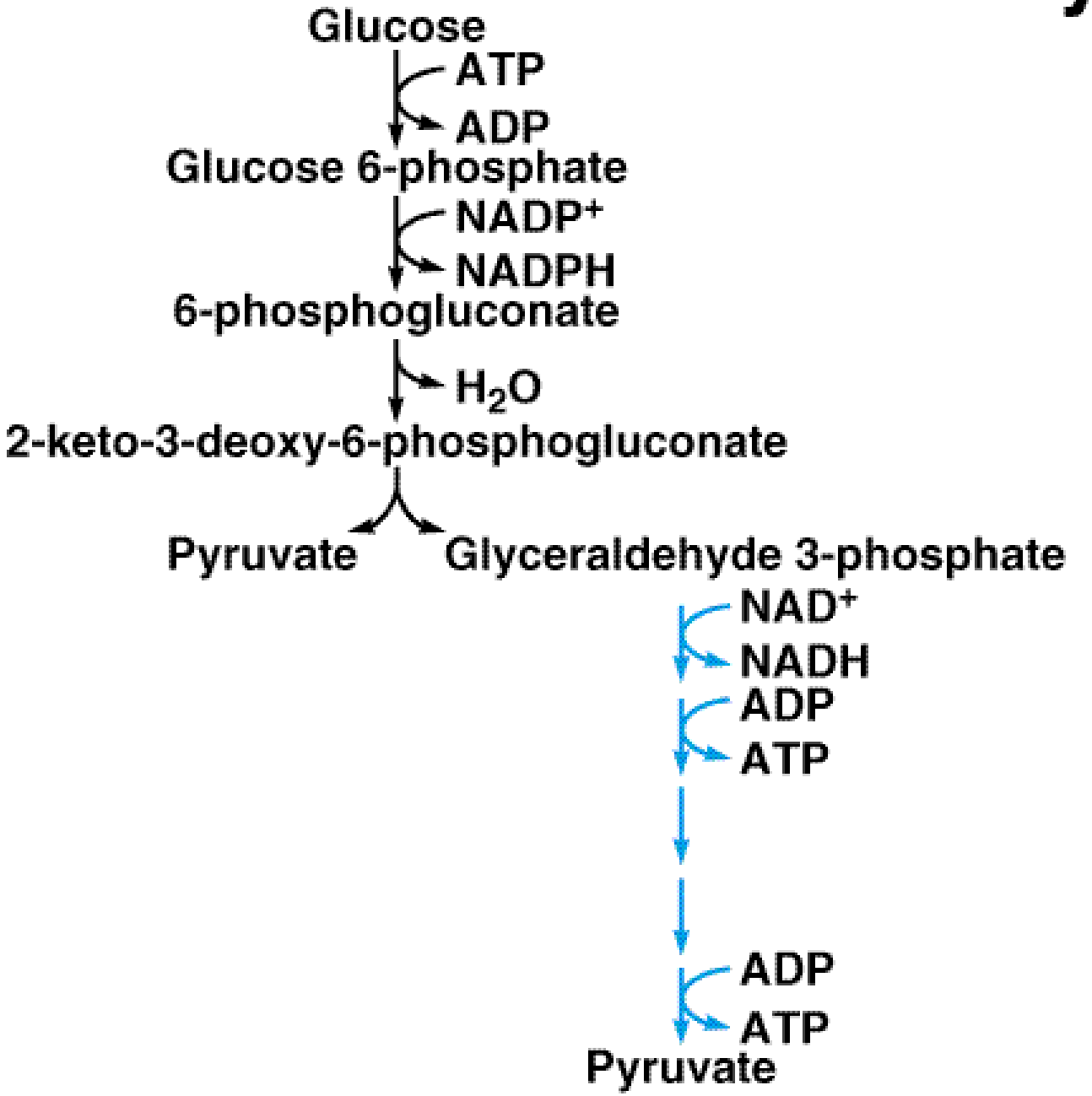


Fig 9.8

Pentose Phosphate Pathway

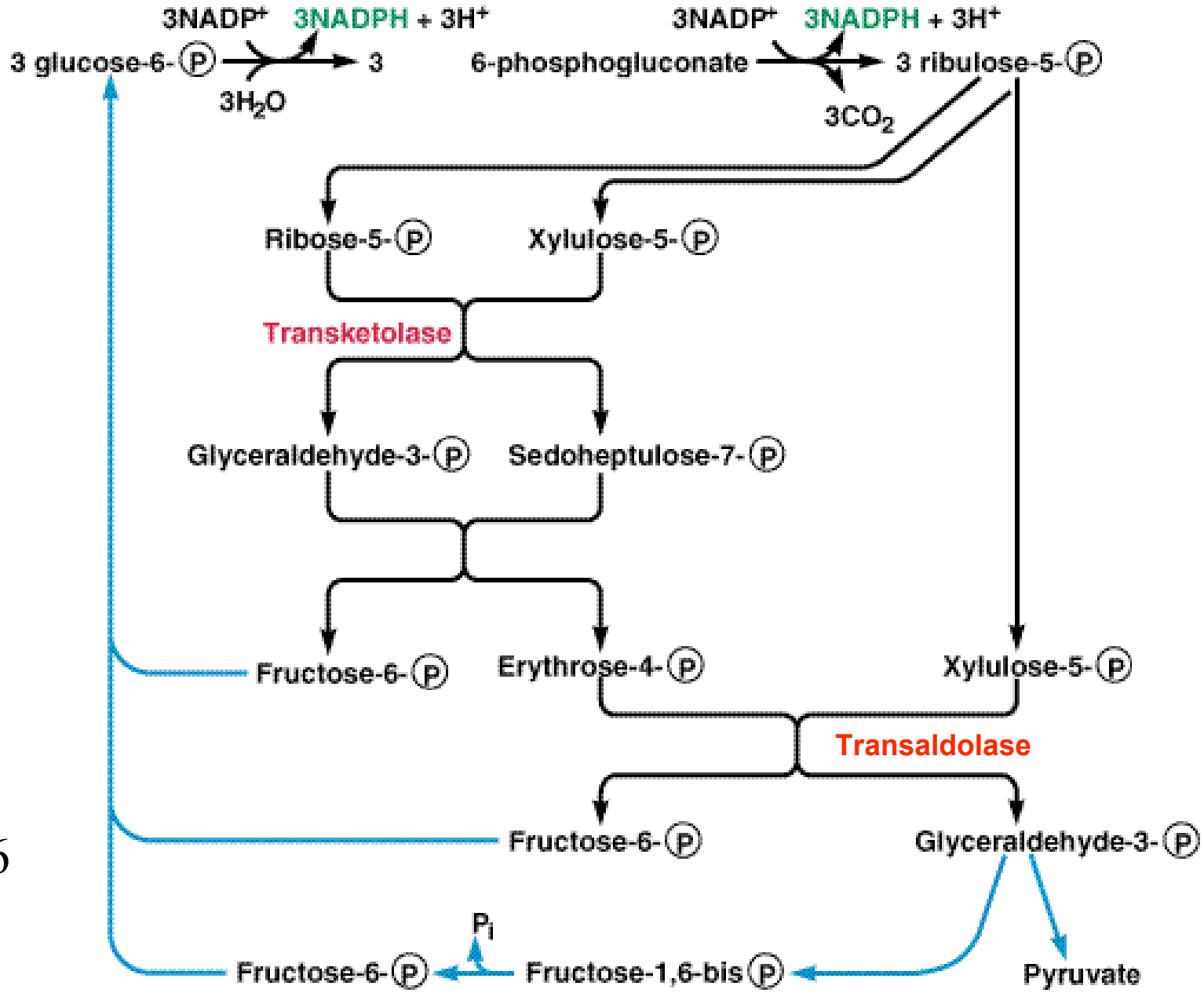


Fig 9.6

Transketolase & Transaldolase

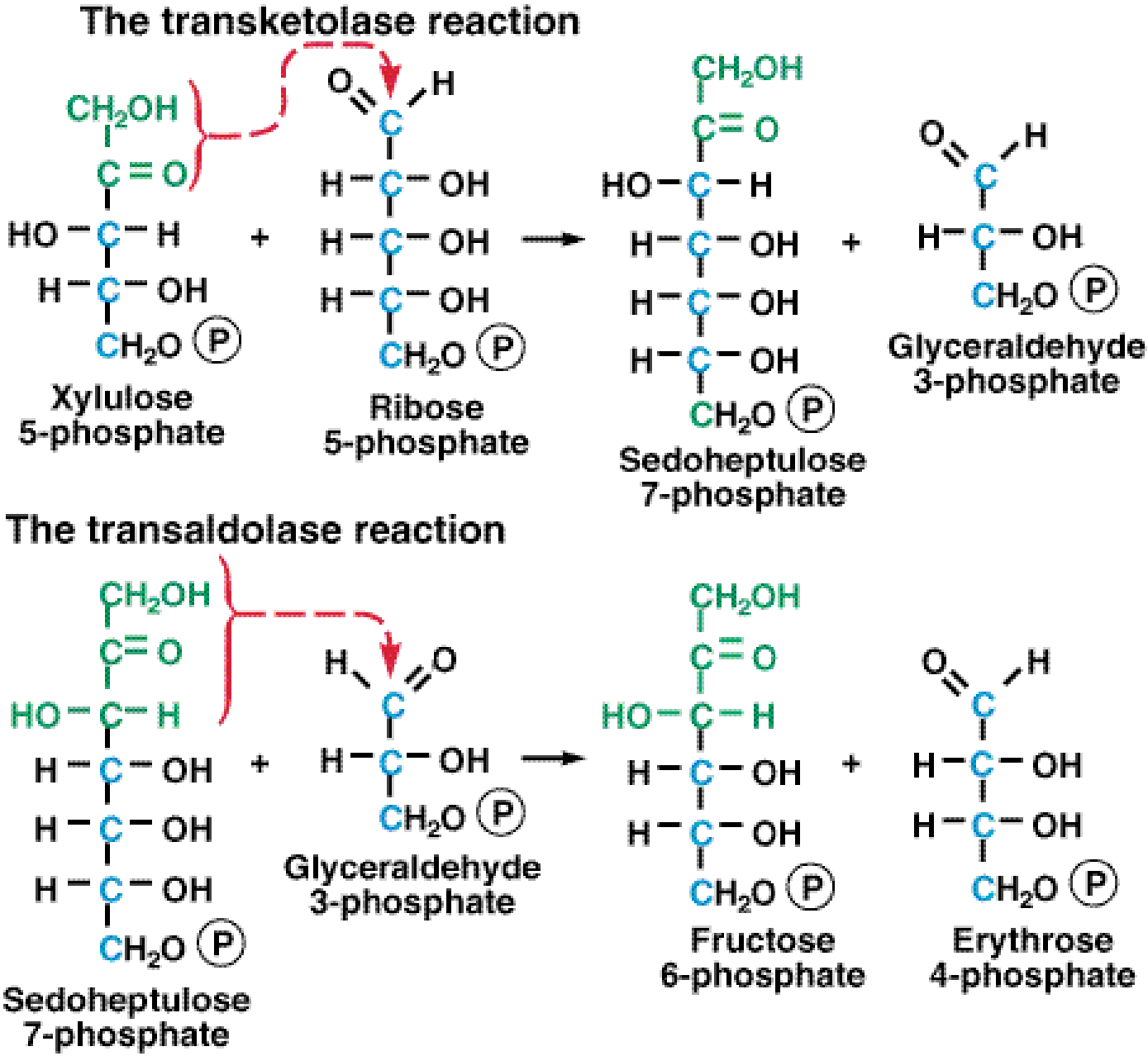


Fig. 9.7

Three Stages of Catabolism

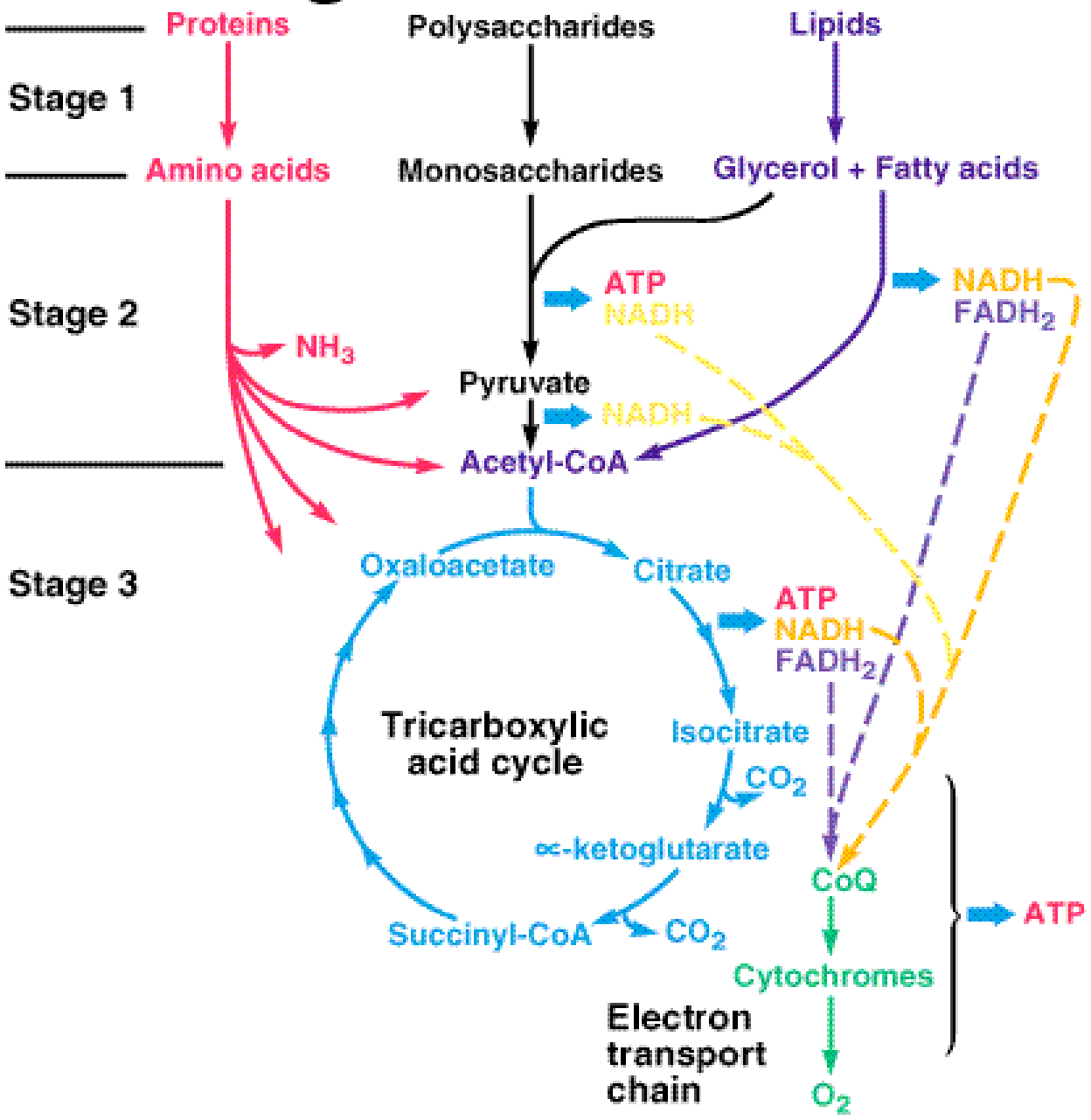


Fig 9.3

Fatty Acid β-oxidation

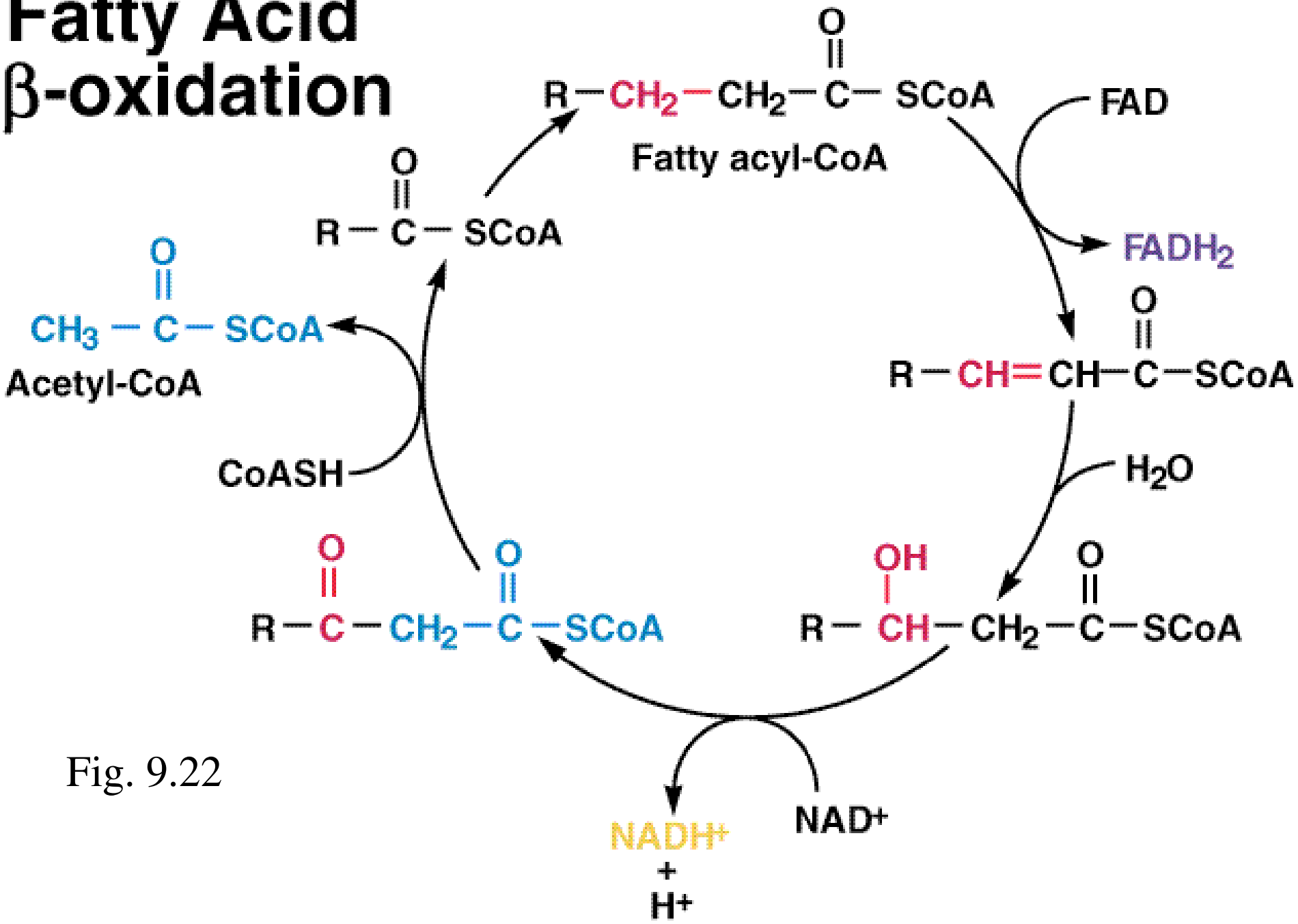


Fig. 9.22

Tricarboxylic Acid Cycle

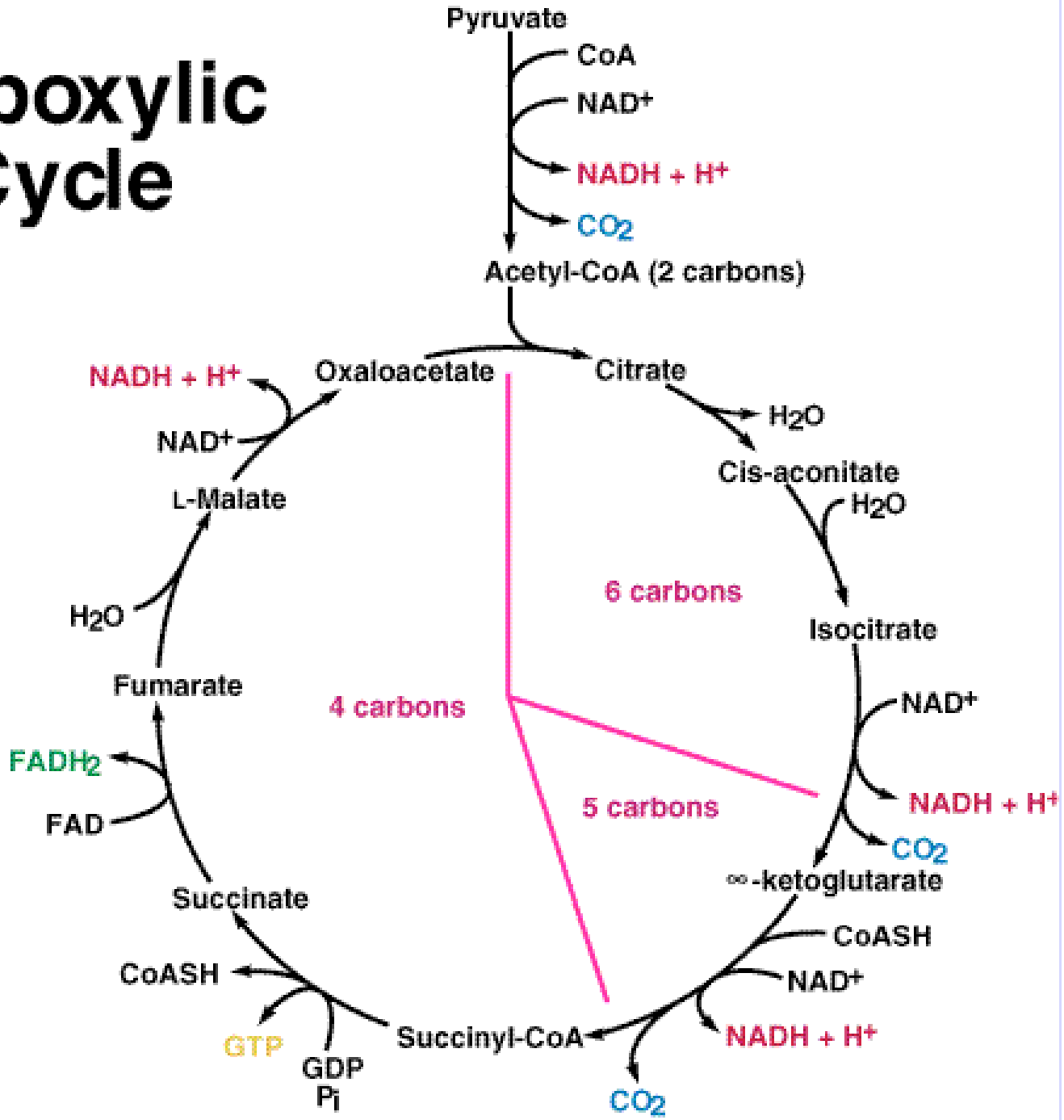
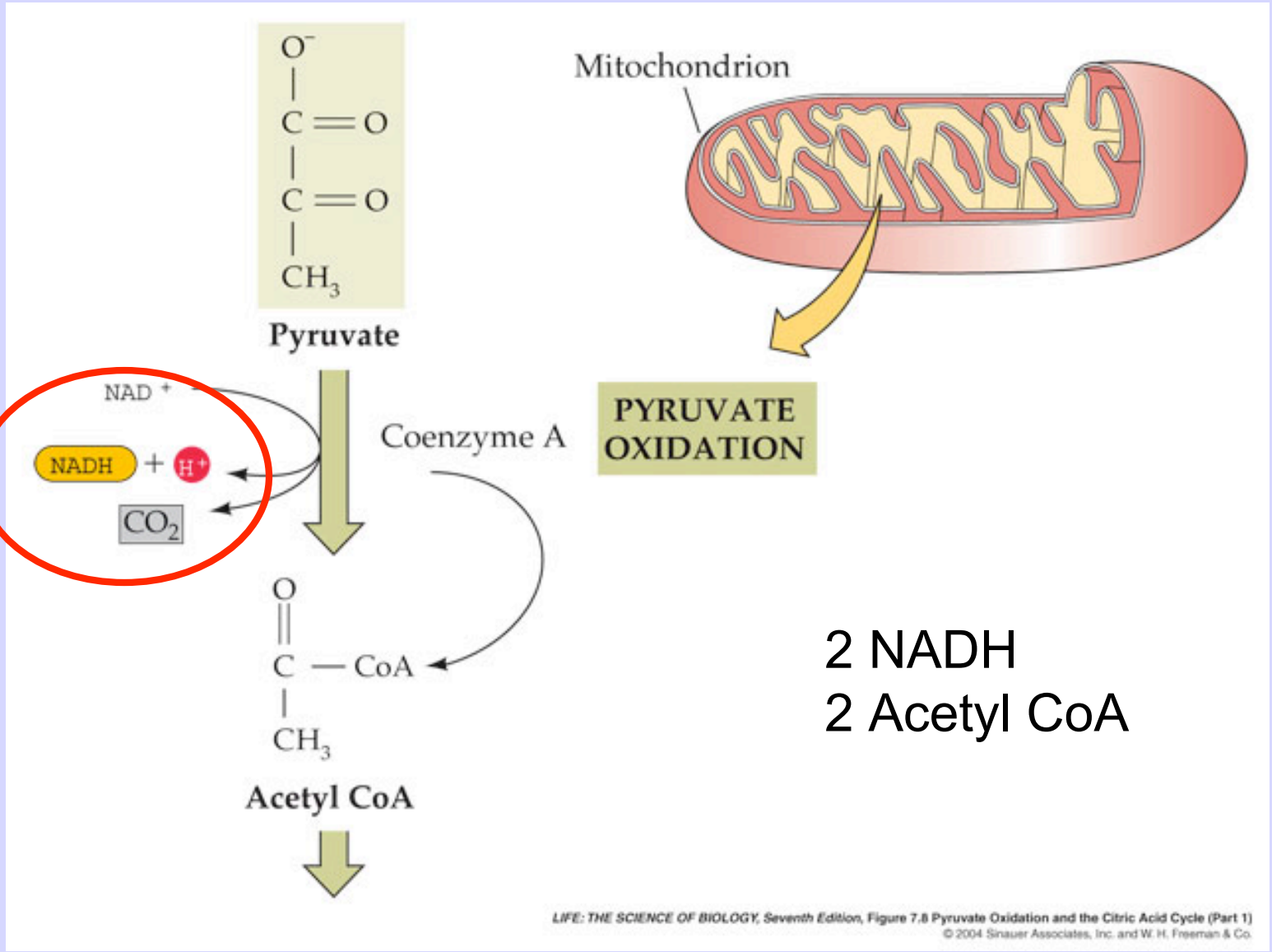


Fig. 9.12



2 NADH
2 Acetyl CoA

Tricarboxylic Acid Cycle

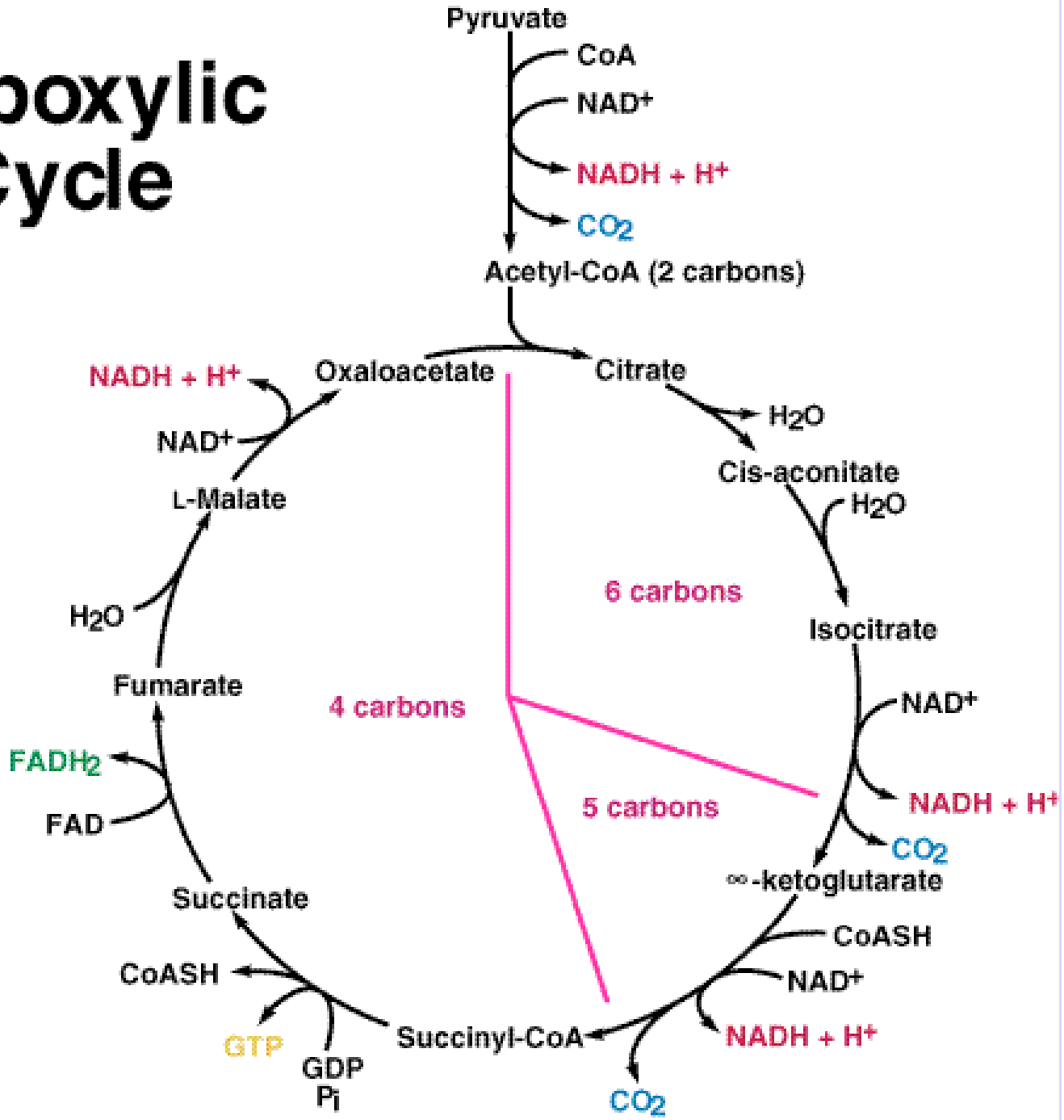
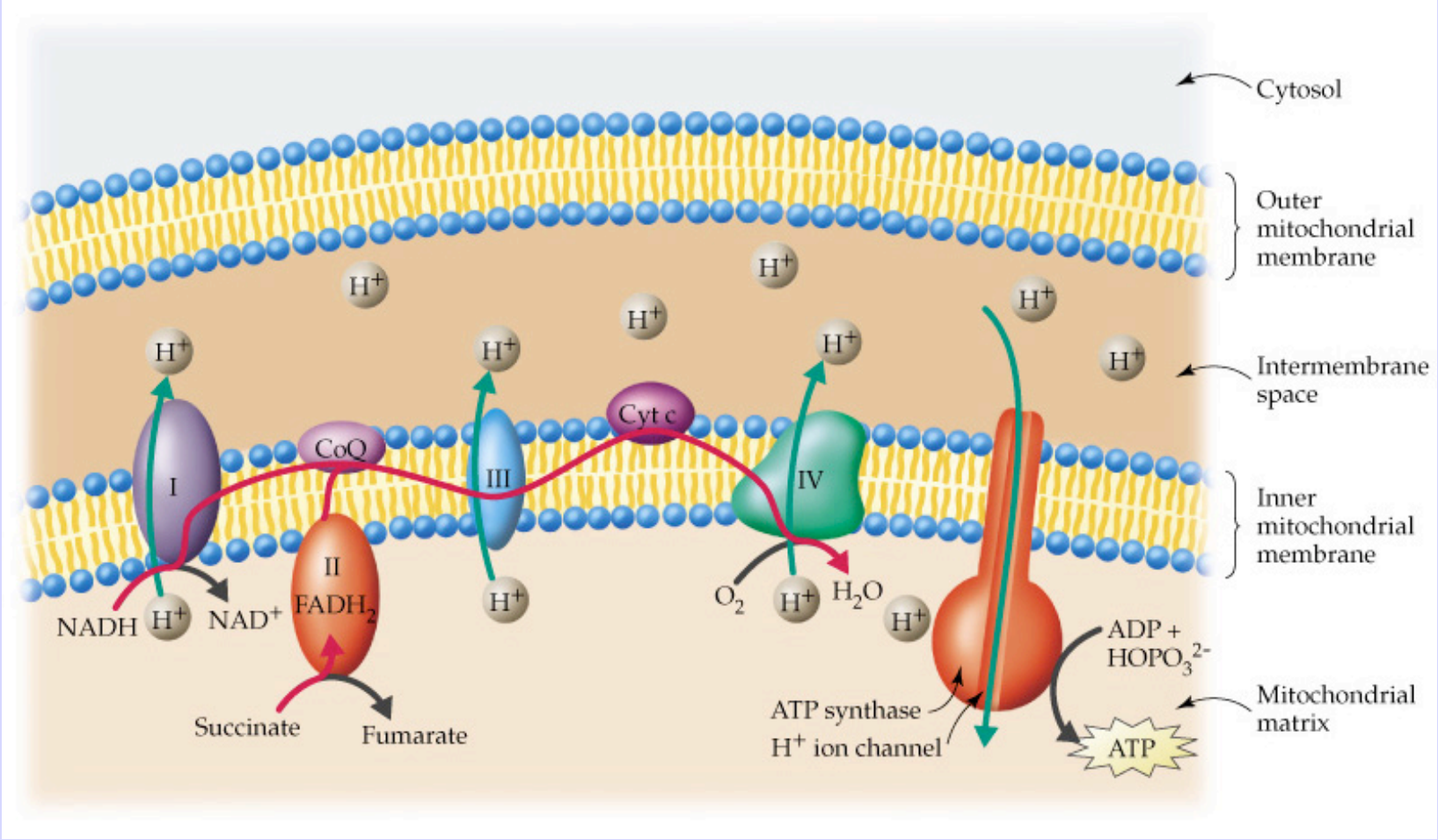
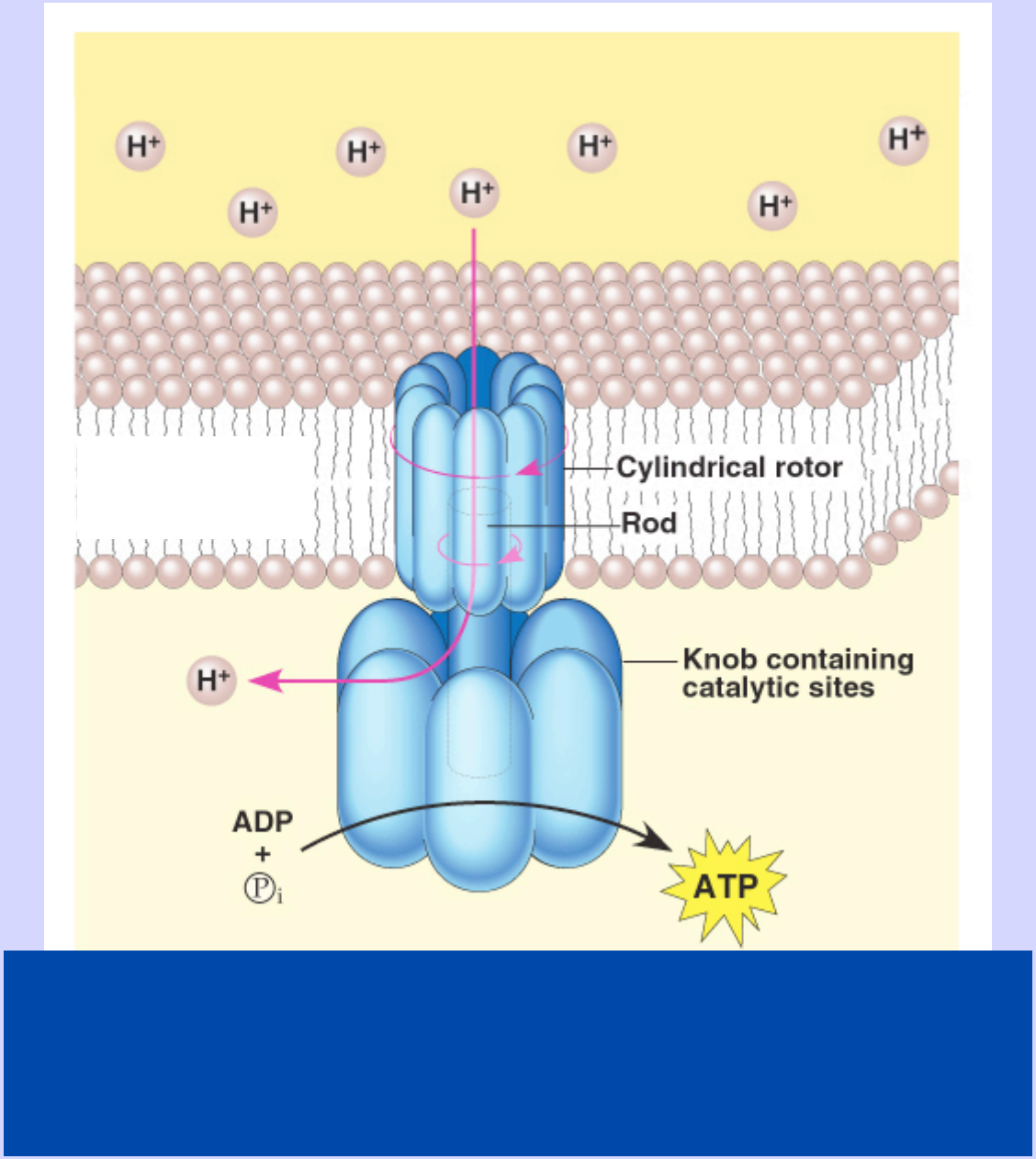
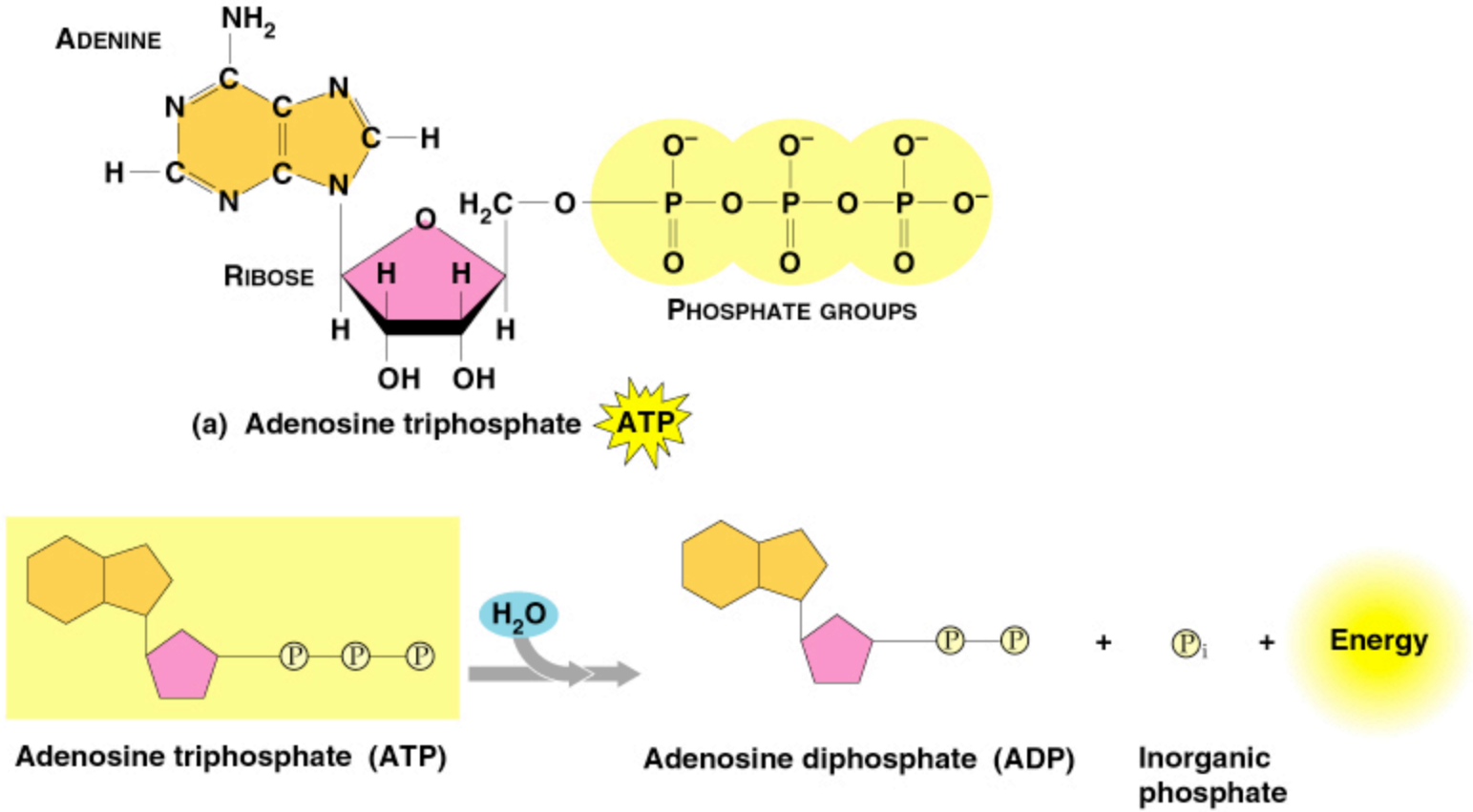


Fig. 9.12

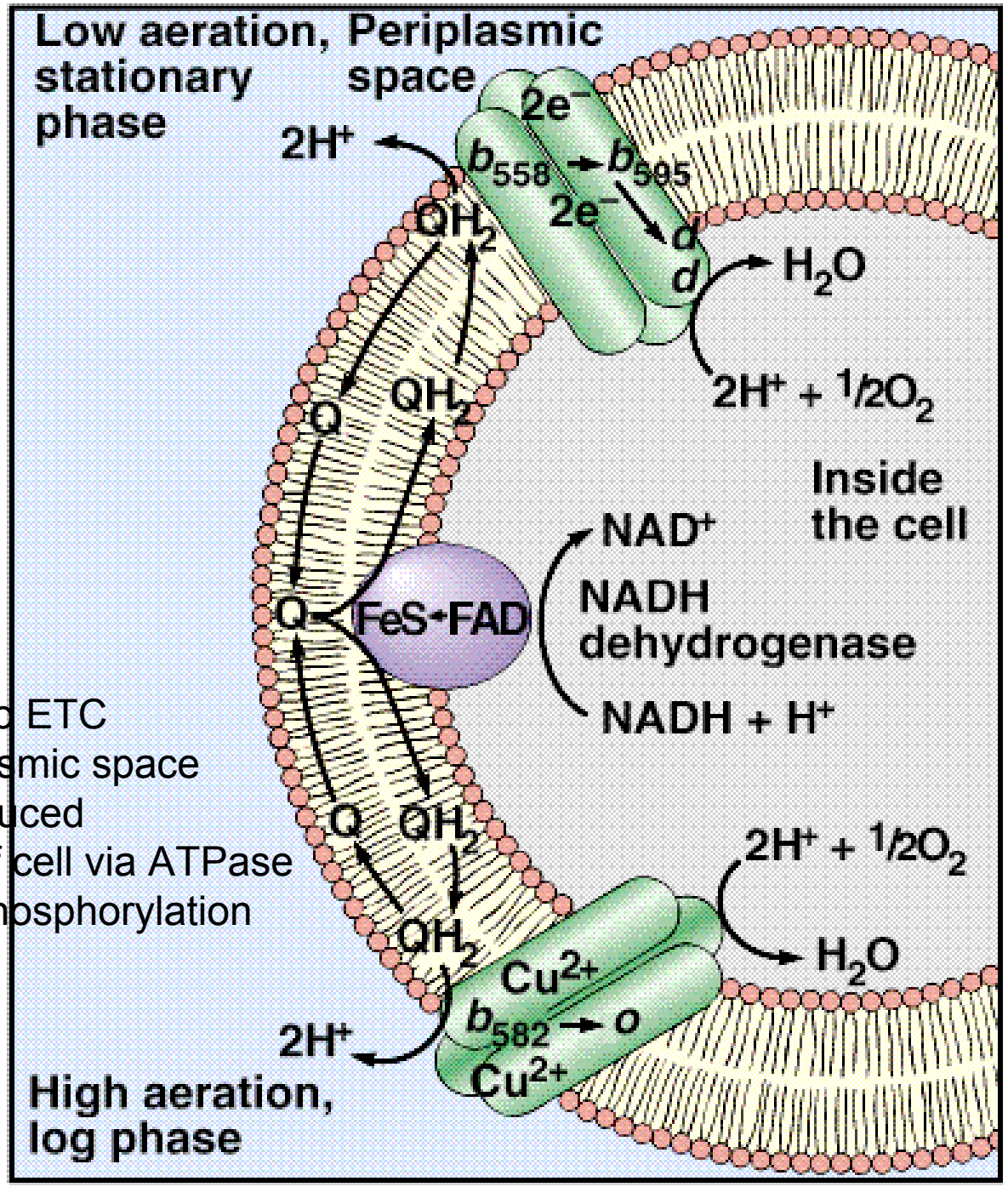
Electron Transport Chain




H+
H+
H+
H+
H+
H+
Cylindrical rotor
Rod
Knob containing
catalytic sites
H+
ADP
+
Pi
ATP

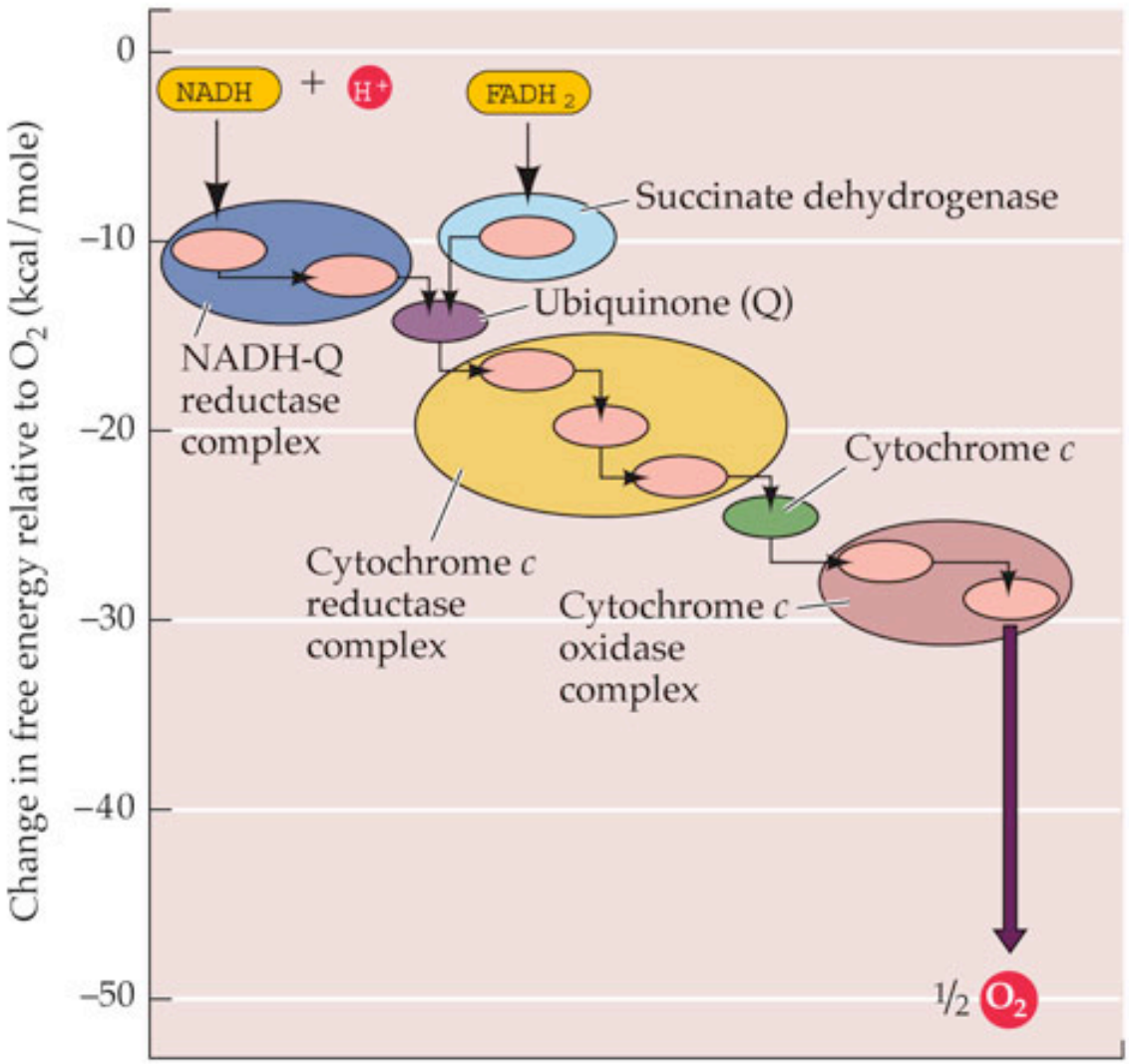


Respiratory Chain of *E. coli*

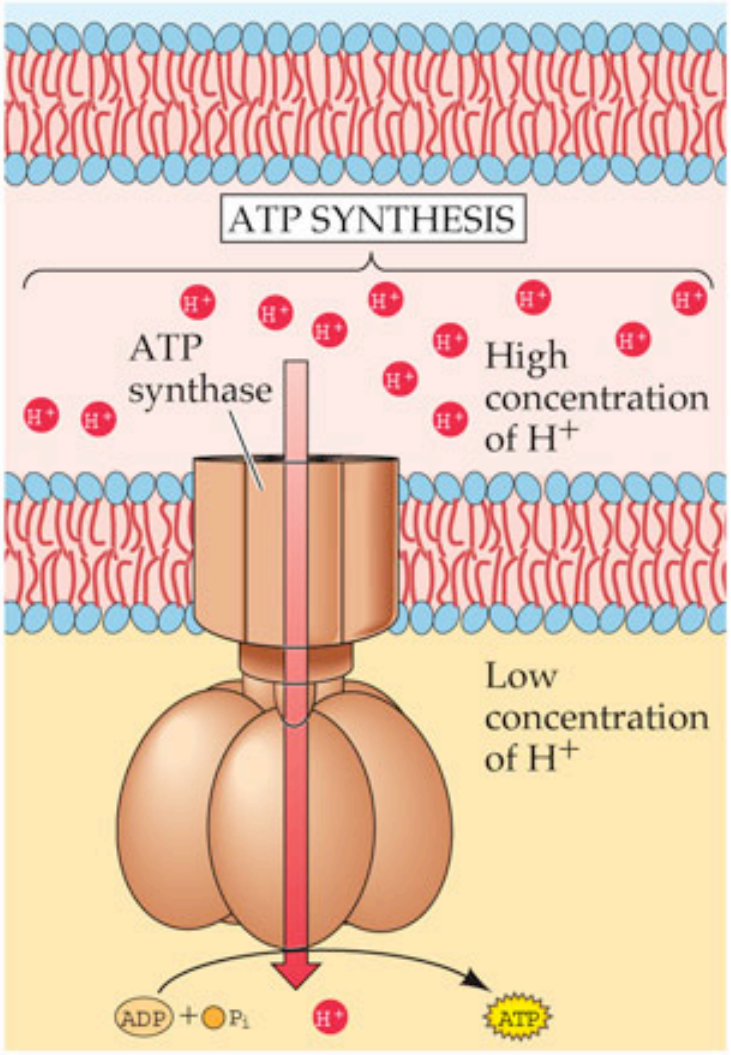


- Electron carrier transfer e^- (H^+) to ETC
- Protons are pumped into periplasmic space
- Electrochemical gradient is produced
- Protons "travel back" to inside of cell via ATPase
- ATP is produced via oxidative phosphorylation
- O_2 is reduced to H_2O

Fig. 9.15



LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 7.11 The Complete Respiratory Chain



LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 7.12 A Chemiosmotic Mechanism Produces ATP (Part 2)

Animations

TABLE 9.3 Some Electron Acceptors Used in Respiration

	Electron Acceptor	Reduced Products	Examples of Microorganisms
Aerobic	O_2	H_2O	All aerobic bacteria, fungi, protozoa, and algae
Anaerobic	NO_3^-	NO_2^-	Enteric bacteria
	NO_3^-	NO_2^-, N_2O, N_2	*Pseudomonas* and *Bacillus*
	SO_4^{2-}	H_2S	*Desulfovibrio* and *Desulfotomaculum*
	CO_2	CH_4	All methanogens
	S^0	H_2S	*Desulfuromonas* and *Thermoproteus*
	Fe^{3+}	Fe^{2+}	*Pseudomonas* and *Bacillus*

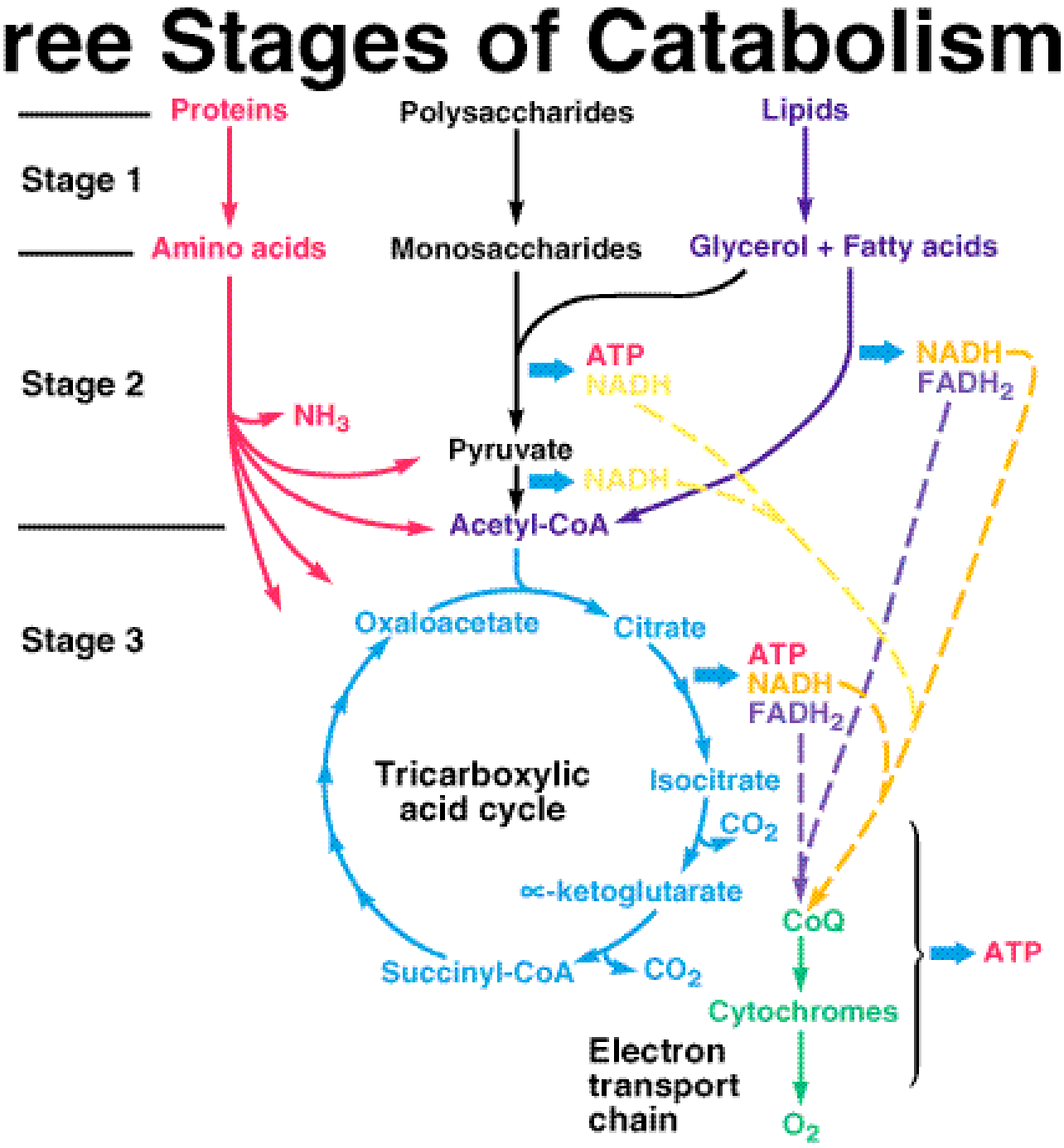
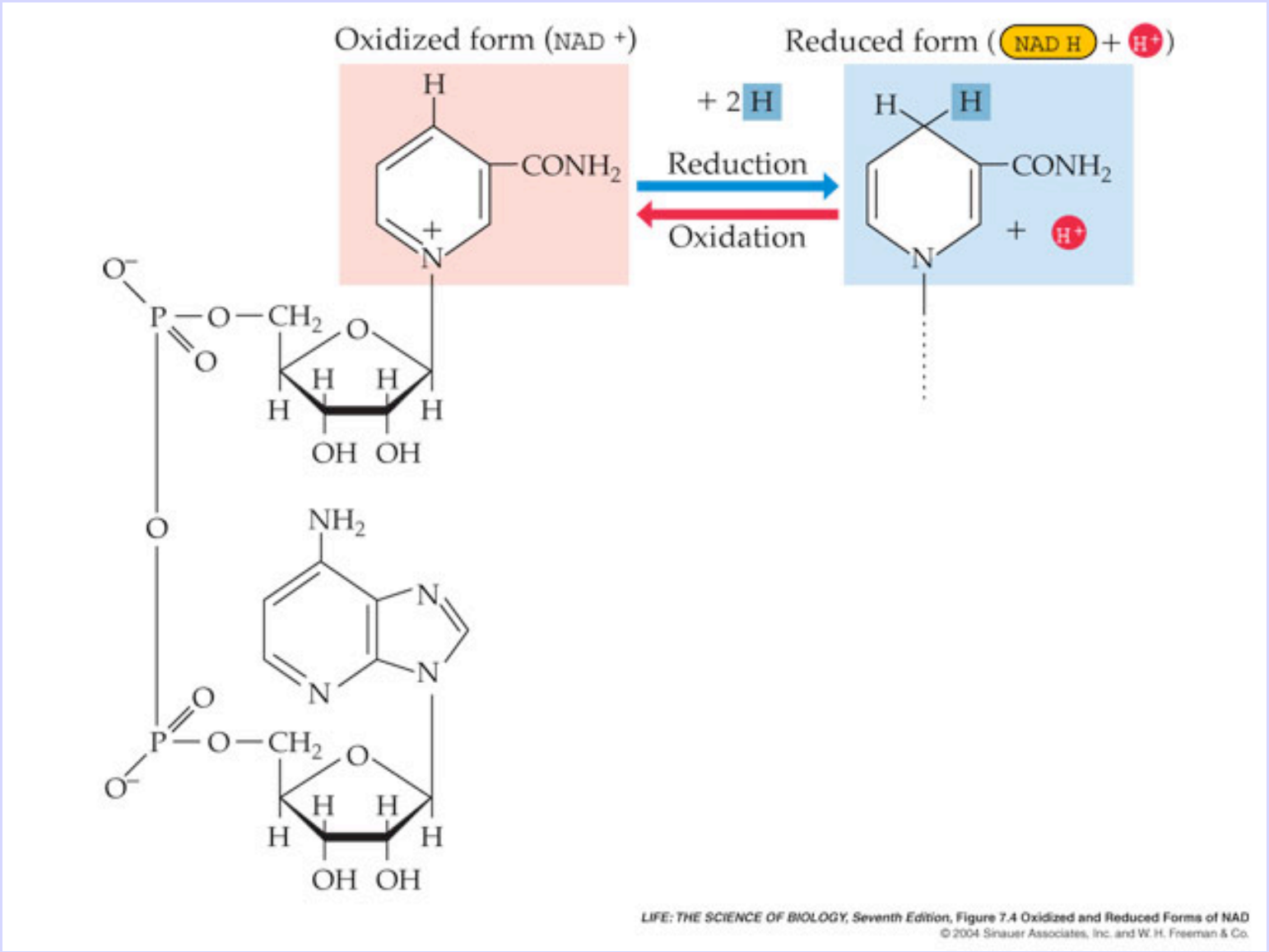


Fig. 9.3



LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 7.4 Oxidized and Reduced Forms of NAD

NADH Oxidation in Fermentation

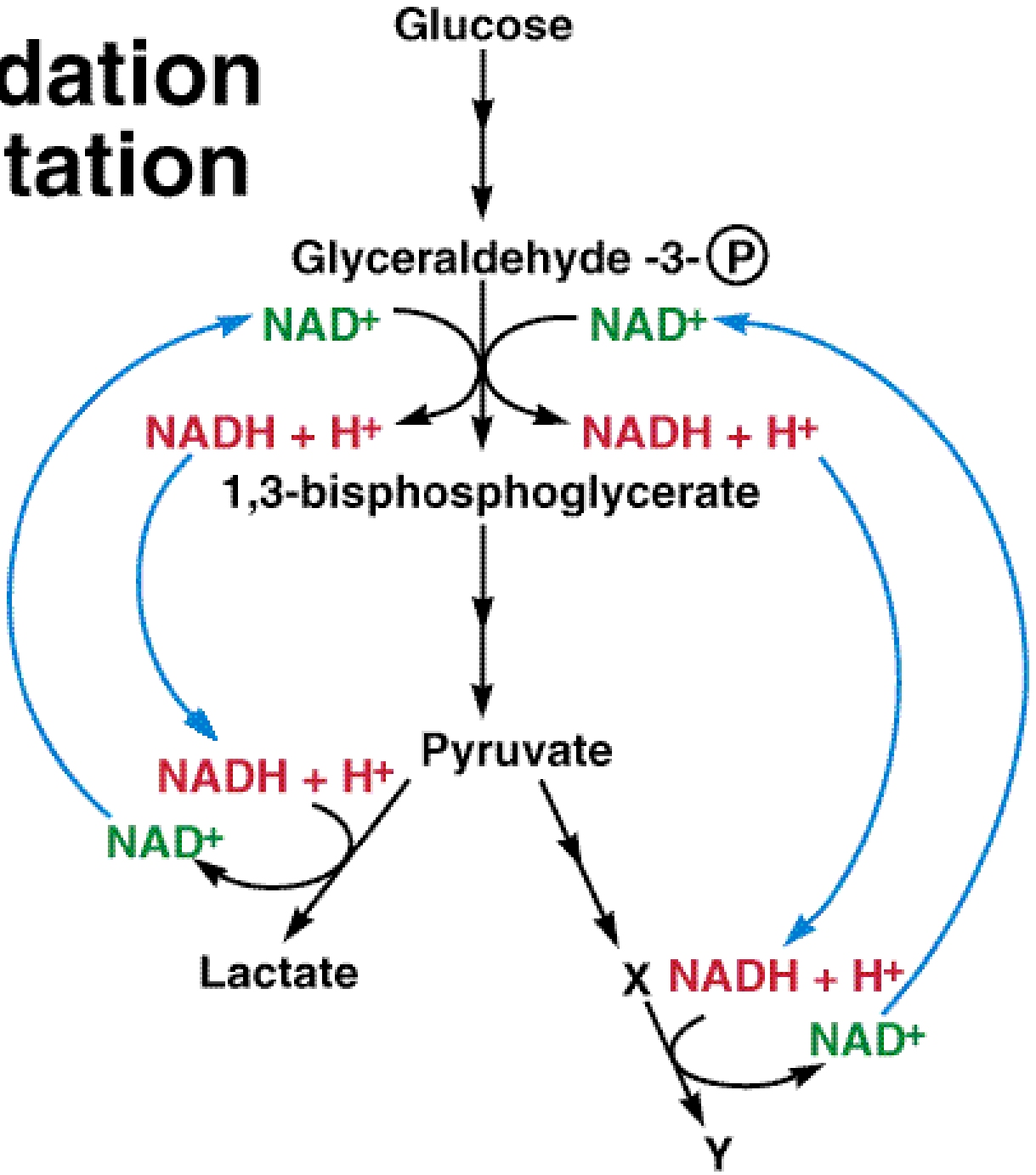
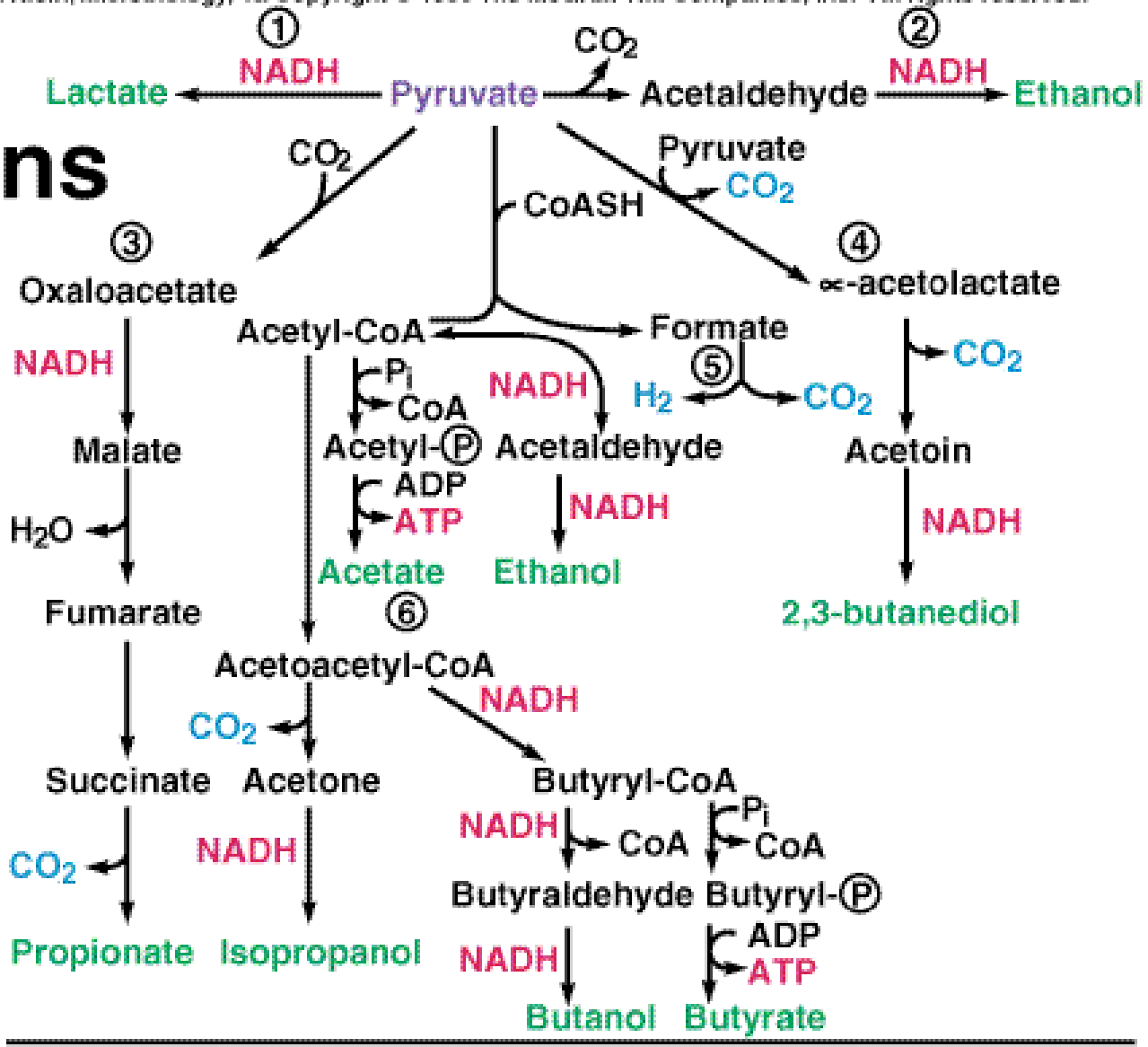


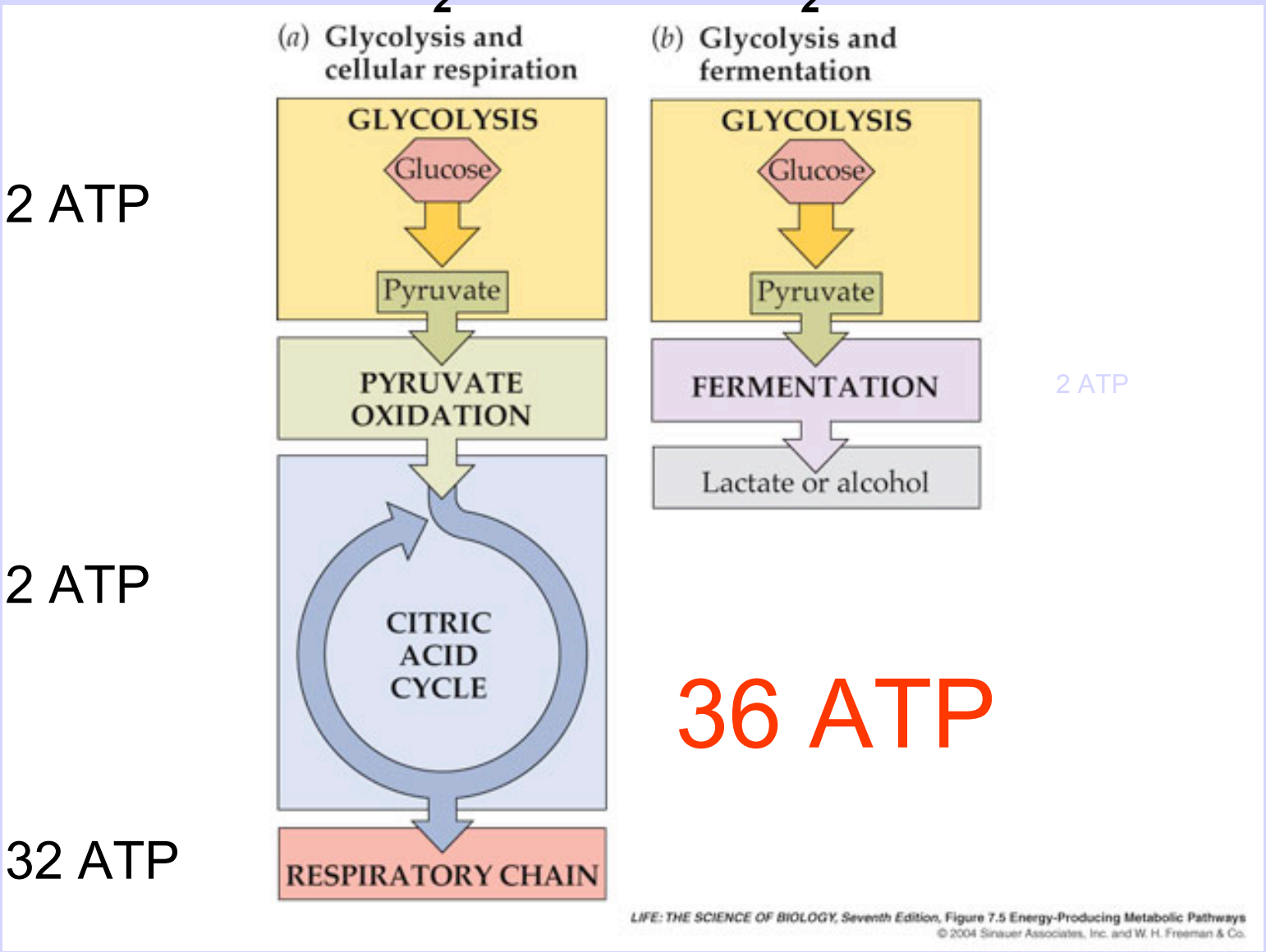
Fig. 9.9

Microbial Fermentations



1. Lactic acid bacteria (*Streptococcus, Lactobacillus*), *Bacillus*
2. Yeast, *Zymomonas*
3. Propionic acid bacteria (*Propionibacterium*)
4. *Enterobacter, Serratia, Bacillus*
5. Enteric bacteria (*Escherichia, Enterobacter, Salmonella, Proteus*)
6. *Clostridium*

Fig. 9.10


+ O2
- O2
(a) Glycolysis and cellular respiration
(b) Glycolysis and fermentation
GLYCOLYSIS
Glucose
Pyruvate
PYRUVATE OXIDATION
CITRIC ACID CYCLE
RESPIRATORY CHAIN
FERMENTATION
Lactate or alcohol
2 ATP
2 ATP
32 ATP
2 ATP
36 ATP
LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 7.5 Energy-Producing Metabolic Pathways
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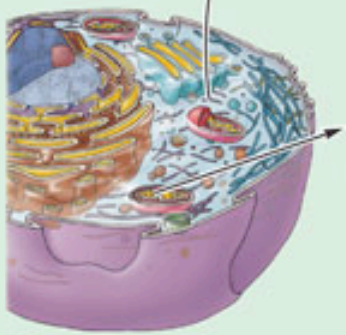
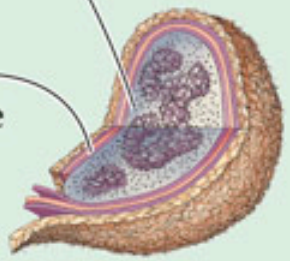
7.1 Cellular Locations for Energy Pathways in Eukaryotes and Prokaryotes

EUKARYOTES	PROKARYOTES
External to mitochondrion Glycolysis Fermentation	**In cytoplasm** Glycolysis Fermentation Citric acid cycle
Inside mitochondrion Inner membrane Pyruvate oxidation Respiratory chain Matrix Citric acid cycle	**On inner face of plasma membrane** Pyruvate oxidation Respiratory chain





LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Table 7.1

Patterns of Energy Production

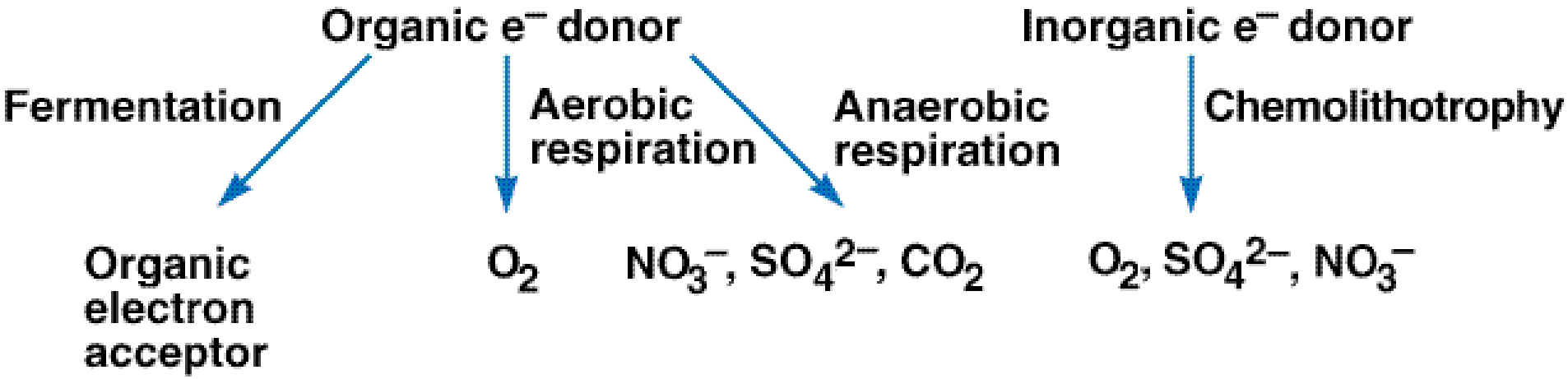


Fig. 9.2