Concept 6.2 Carbohydrate Catabolism in the Presence of Oxygen Releases a Large Amount of Energy

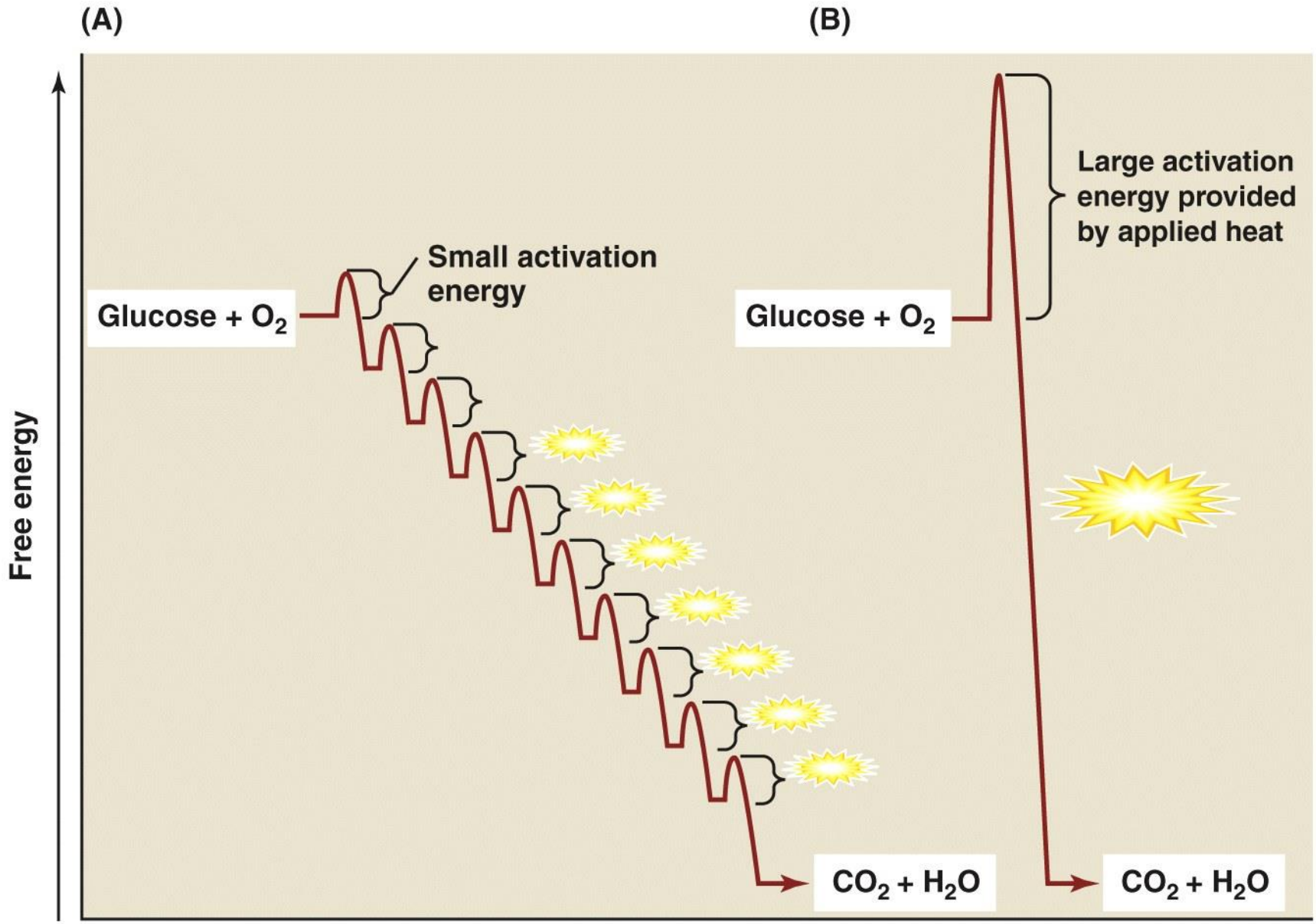
Cellular Respiration

A lot of energy is released when reduced molecules with many C—C and C—H bonds are fully oxidized to CO_2.

Oxidation occurs in a series of small steps in three pathways:

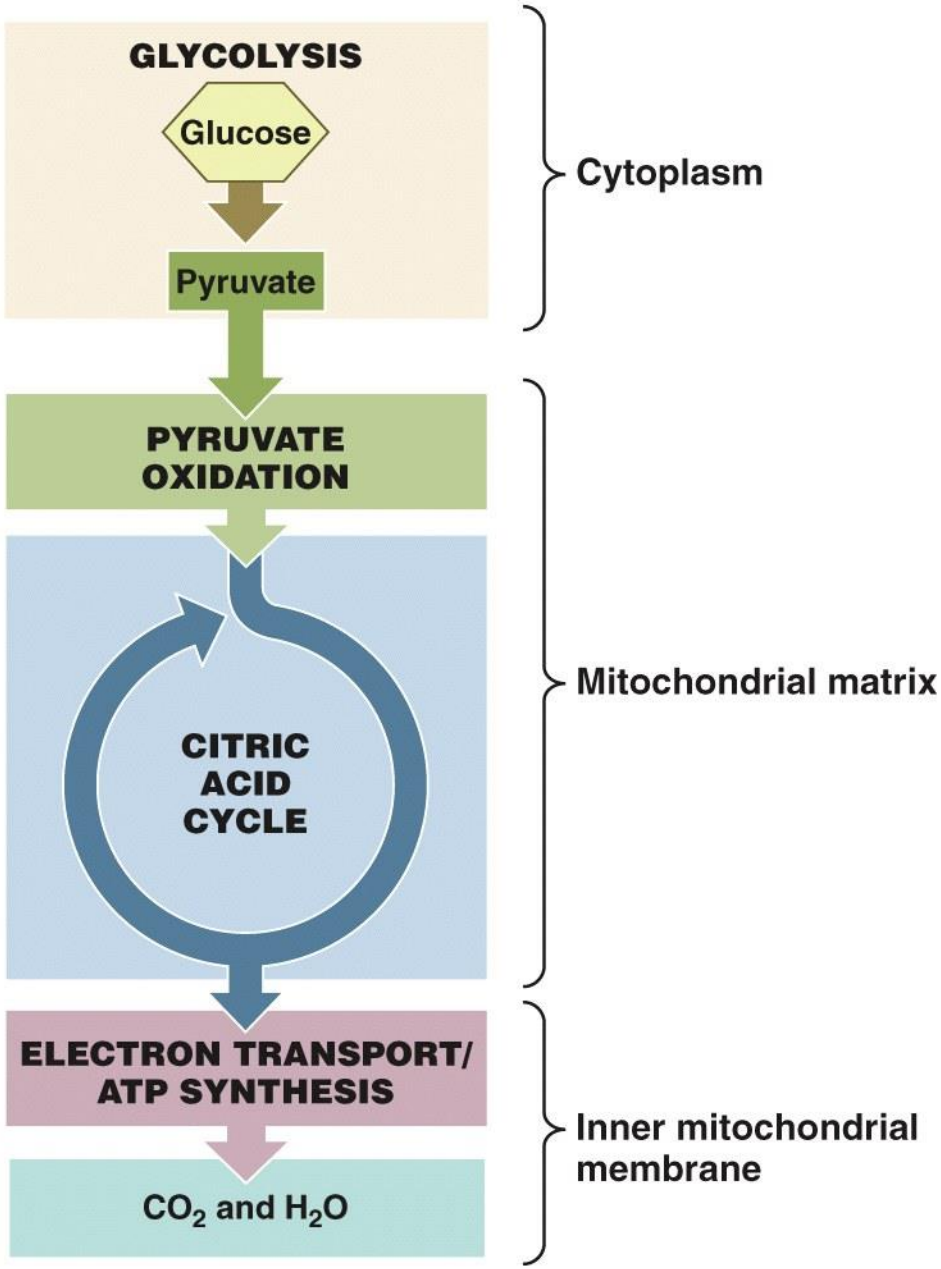
1. glycolysis
2. pyruvate oxidation
3. citric acid cycle

Figure 6.8 Energy Metabolism Occurs in Small Steps



***PRINCIPLES OF LIFE,* Figure 6.8**

Figure 6.9 Energy-Releasing Metabolic Pathways



***PRINCIPLES OF LIFE*, Figure 6.9**

Concept 6.2 Carbohydrate Catabolism in the Presence of Oxygen Releases a Large Amount of Energy

Glycolysis: ten reactions.

Takes place in the cytosol.

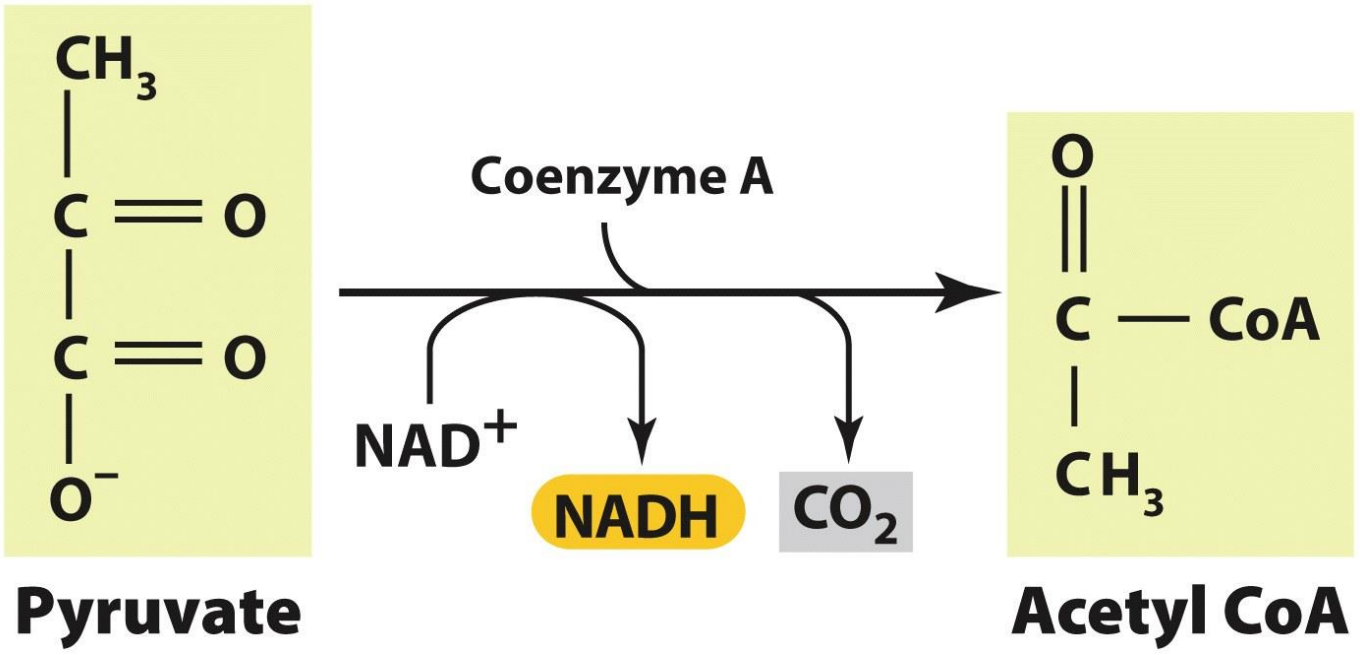
Final products:

- 2 molecules of pyruvate (pyruvic acid)
- 2 molecules of ATP
- 2 molecules of NADH

Concept 6.2 Carbohydrate Catabolism in the Presence of Oxygen Releases a Large Amount of Energy

Pyruvate Oxidation:

Products: CO_2 and acetate; acetate is then bound to **coenzyme A** (**CoA**)



PRINCIPLES OF LIFE, In-Text Art, Ch. 6, p.108 (1)

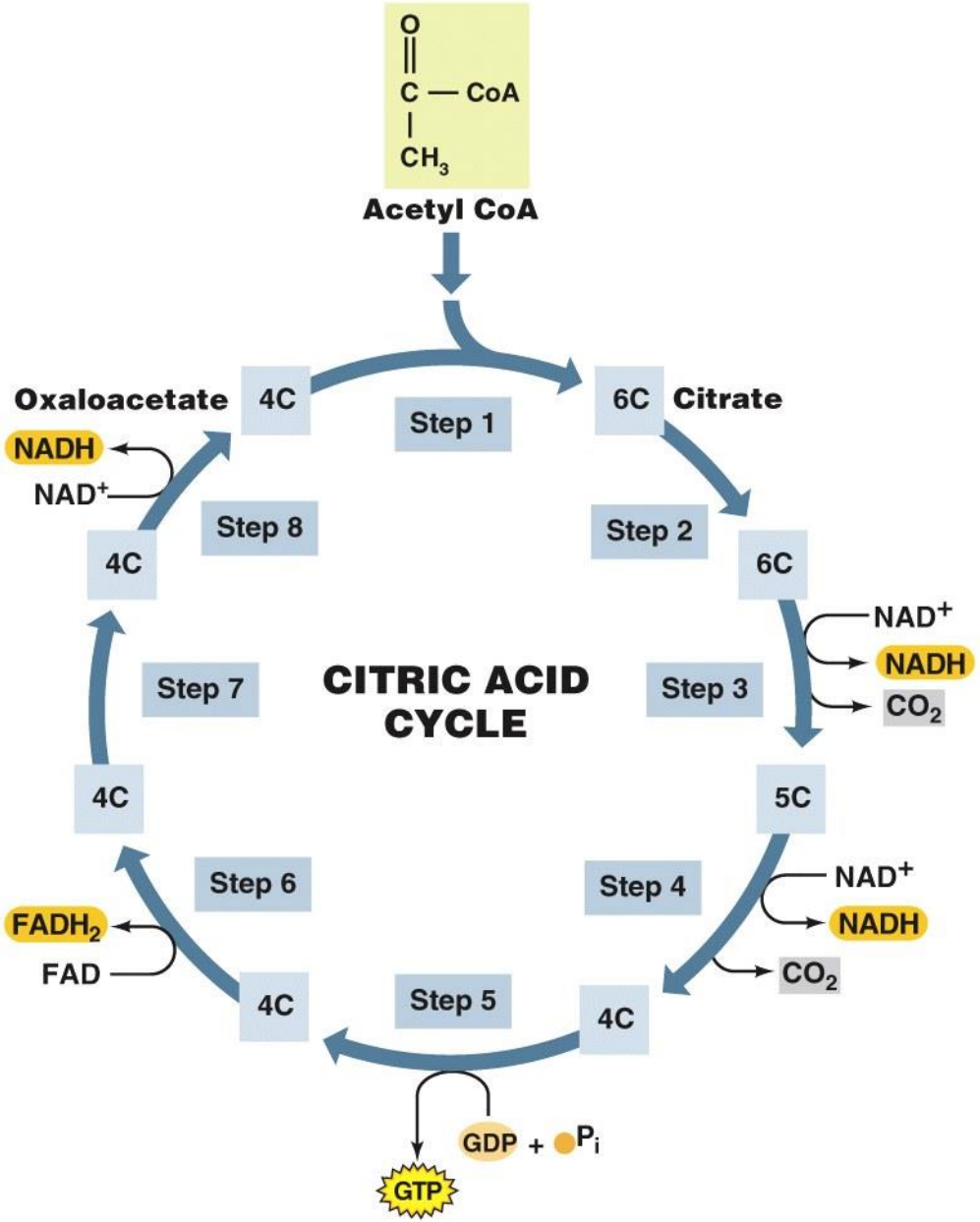
Concept 6.2 Carbohydrate Catabolism in the Presence of Oxygen Releases a Large Amount of Energy

Citric Acid Cycle: 8 reactions, operates twice for every glucose molecule that enters glycolysis.

Starts with Acetyl CoA; acetyl group is oxidized to two CO_2.

Oxaloacetate is regenerated in the last step.

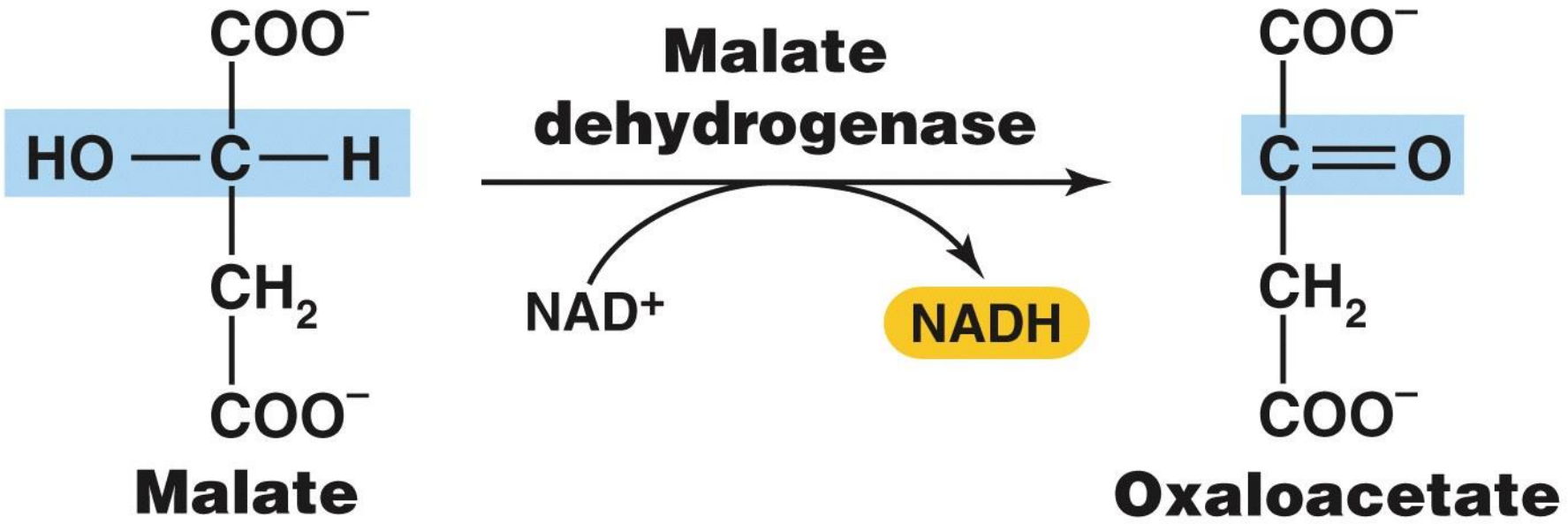
Figure 6.11 The Citric Acid Cycle



***PRINCIPLES OF LIFE*, Figure 6.11**

Concept 6.2 Carbohydrate Catabolism in the Presence of Oxygen Releases a Large Amount of Energy

Final reaction of citric acid cycle:



PRINCIPLES OF LIFE, In-Text Art, Ch. 6, p.108 (2)

Concept 6.2 Carbohydrate Catabolism in the Presence of Oxygen Releases a Large Amount of Energy

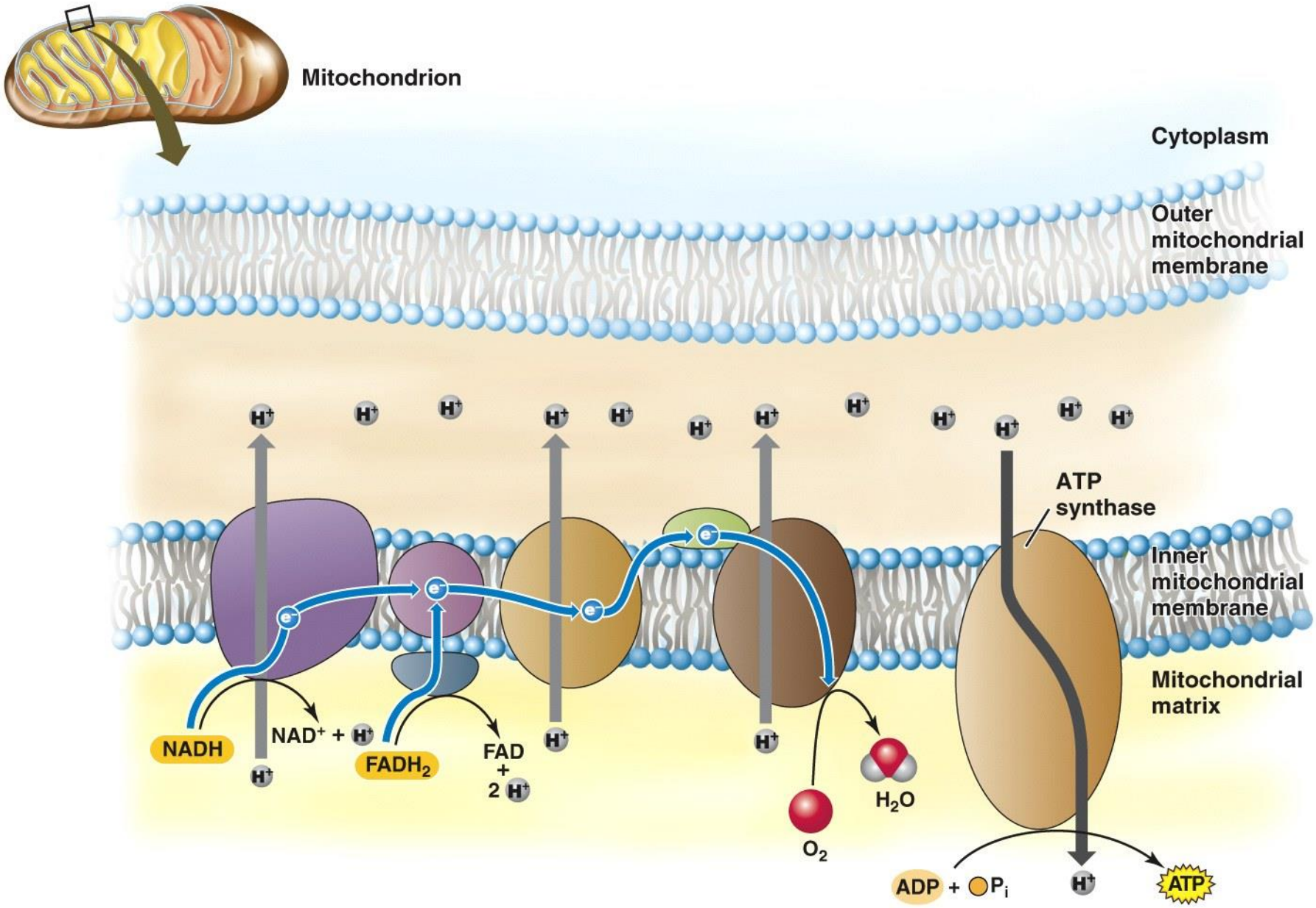
Electron transport/ATP Synthesis:

NADH is reoxidized to NAD^+ and O_2 is reduced to H_2O in a series of steps.

Respiratory chain—series of redox carrier proteins embedded in the inner mitochondrial membrane.

Electron transport—electrons from the oxidation of NADH and $FADH_2$ pass from one carrier to the next in the chain.

Figure 6.12 Electron Transport and ATP Synthesis in Mitochondria



***PRINCIPLES OF LIFE,* Figure 6.12**

Concept 6.2 Carbohydrate Catabolism in the Presence of Oxygen Releases a Large Amount of Energy

The oxidation reactions are exergonic; the energy is used to actively transport H^+ ions out of the mitochondrial matrix, setting up a proton gradient.

ATP synthase in the membrane uses the H^+ gradient to synthesize ATP by chemiosmosis.

Concept 6.2 Carbohydrate Catabolism in the Presence of Oxygen Releases a Large Amount of Energy

About 32 molecules of ATP are produced for each fully oxidized glucose.

The role of O_2: most of the ATP produced is formed by oxidative phosphorylation, which is due to the reoxidation of NADH.