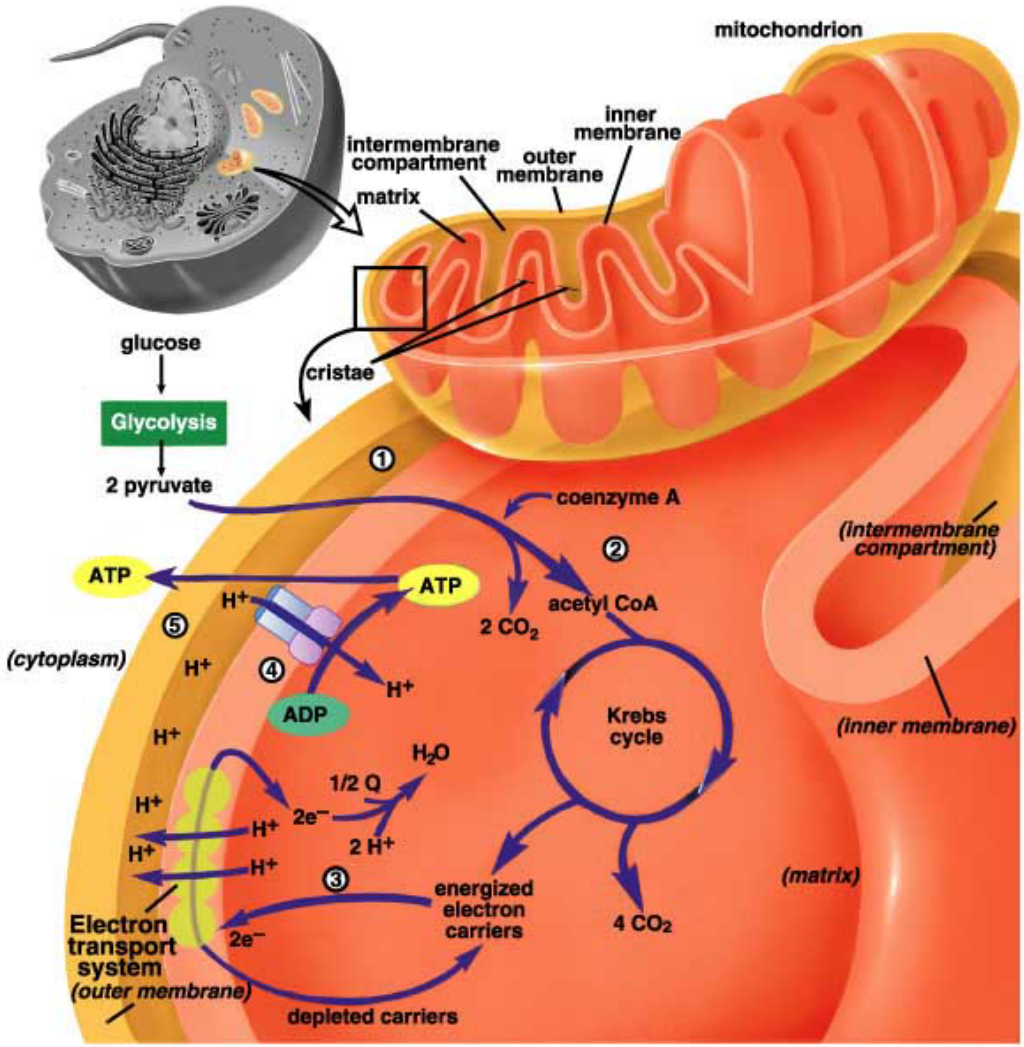
Chapter 8

Harvesting Energy: Glycolysis and Cellular Respiration



What is Glucose Metabolism?

Answer: The breakdown of glucose to release energy from its chemical bonds

Photosynthesis:

$$6\ CO_2 + 6\ H_2O + \text{Light Energy} = C_6H_{12}O_6 + 6\ O_2$$

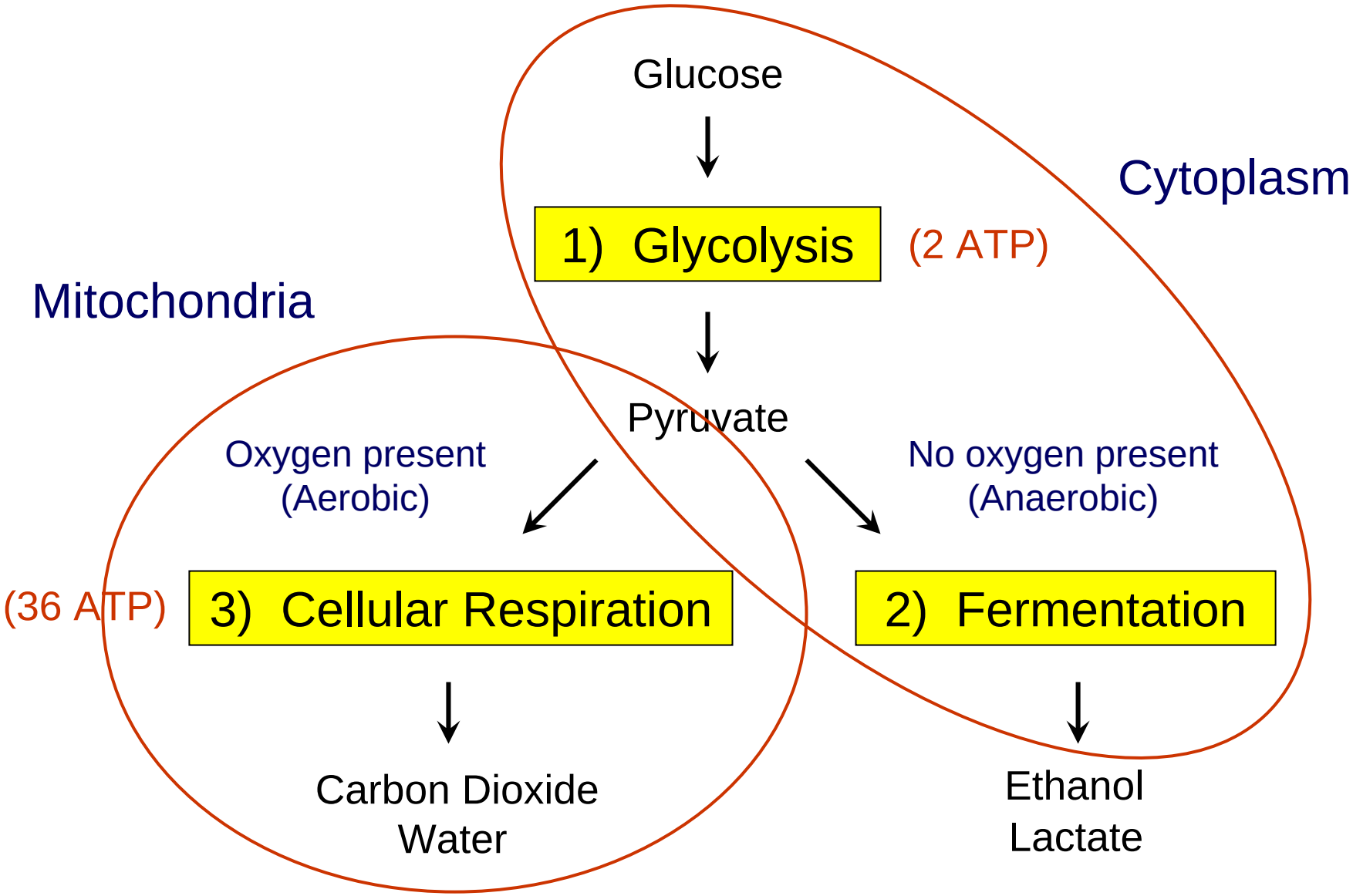
Carbon Dioxide | Water | Glucose | Oxygen

Glucose Metabolism:

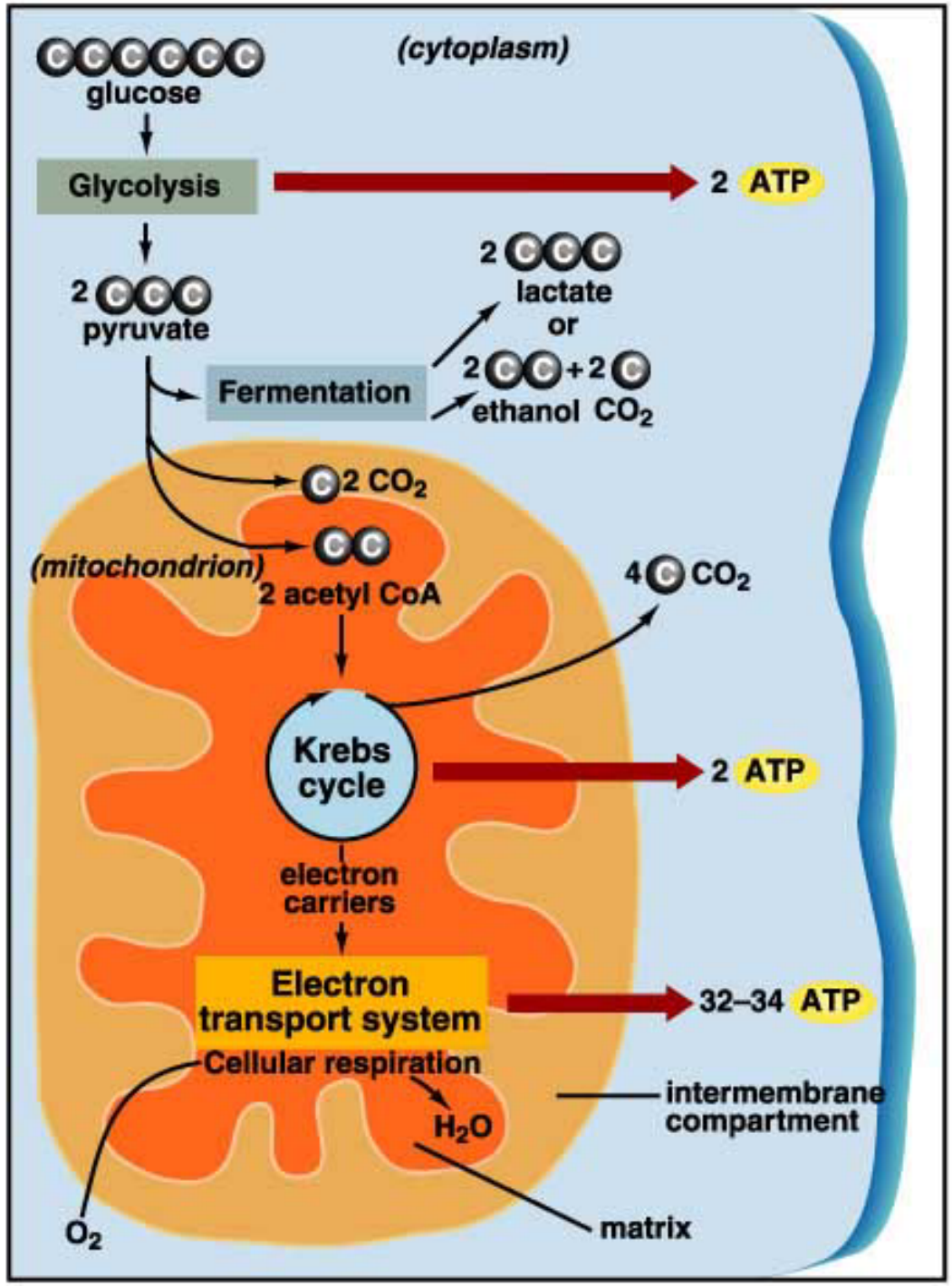
$$C_6H_{12}O_6 + 6\ O_2 = 6\ CO_2 + 6\ H_2O + \text{Energy}$$

Glucose | Oxygen | Carbon Dioxide | Water | Chemical Heat

Major Steps of Glucose Metabolism



Major Steps in Glucose Metabolism:



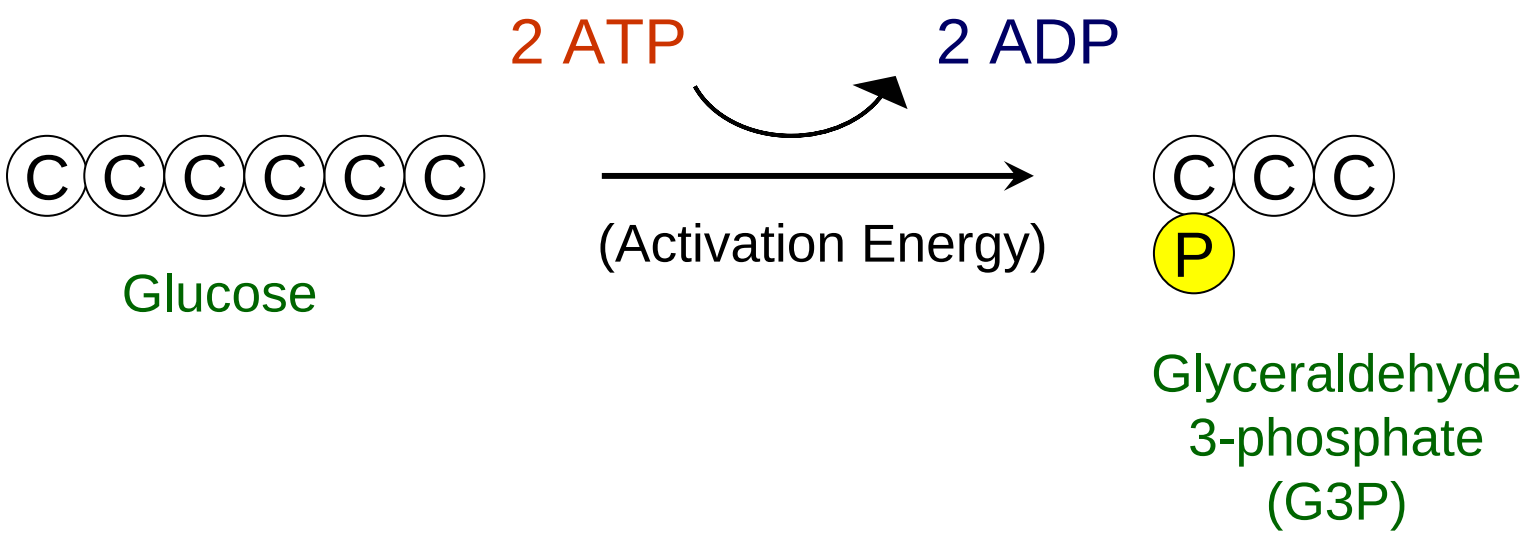
(Figure 8.1)

1) Glycolysis (Greek: “To break down a sweet”)

- Ancient biochemical pathway (all organisms do it...)
- Occurs in the cytoplasm; Does not require oxygen

Two Major Components:

A) Glucose Activation: Initiate the reaction (takes energy)

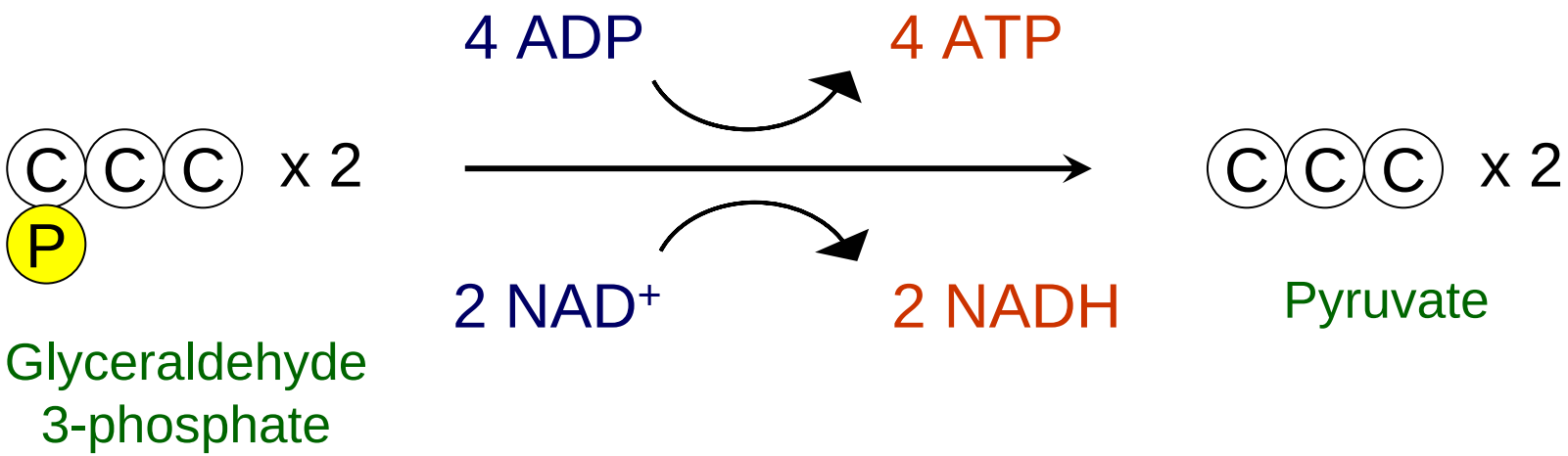


1) Glycolysis (Greek: “To break down a sweet”)
   - Ancient biochemical pathway (all organisms do it...)
   - Occurs in the cytoplasm; Does not require oxygen

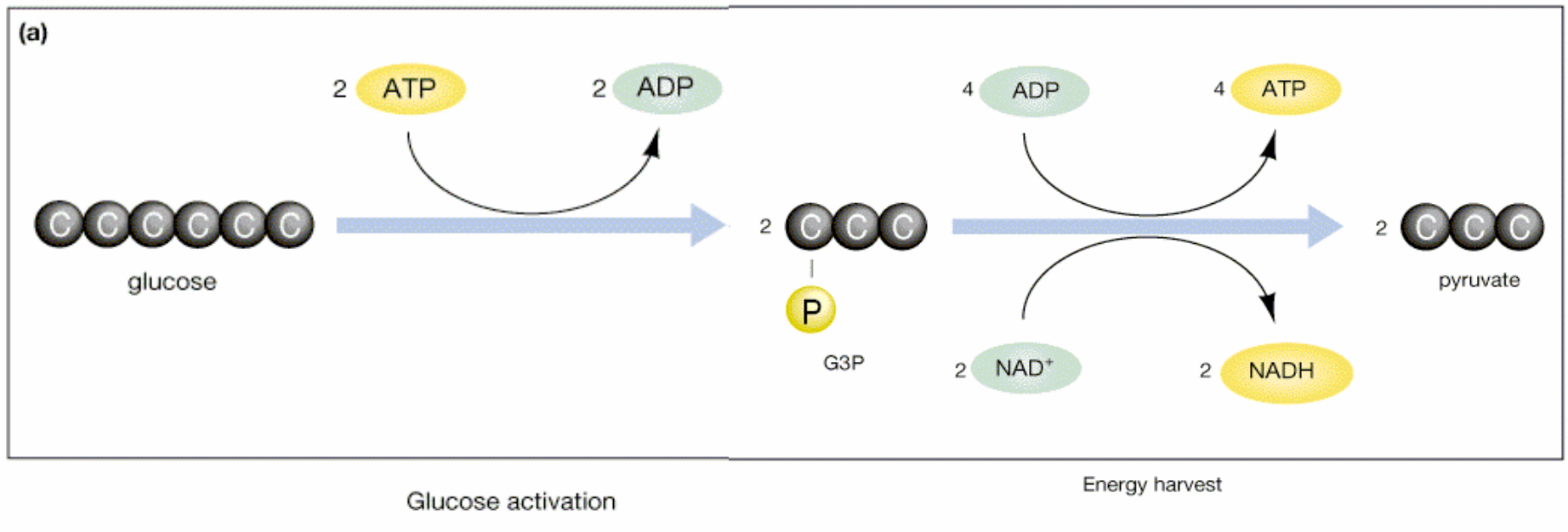
Two Major Components:

A) Glucose Activation: Initiate the reaction (takes energy)

B) Energy Harvesting: Complete the reaction (makes energy)



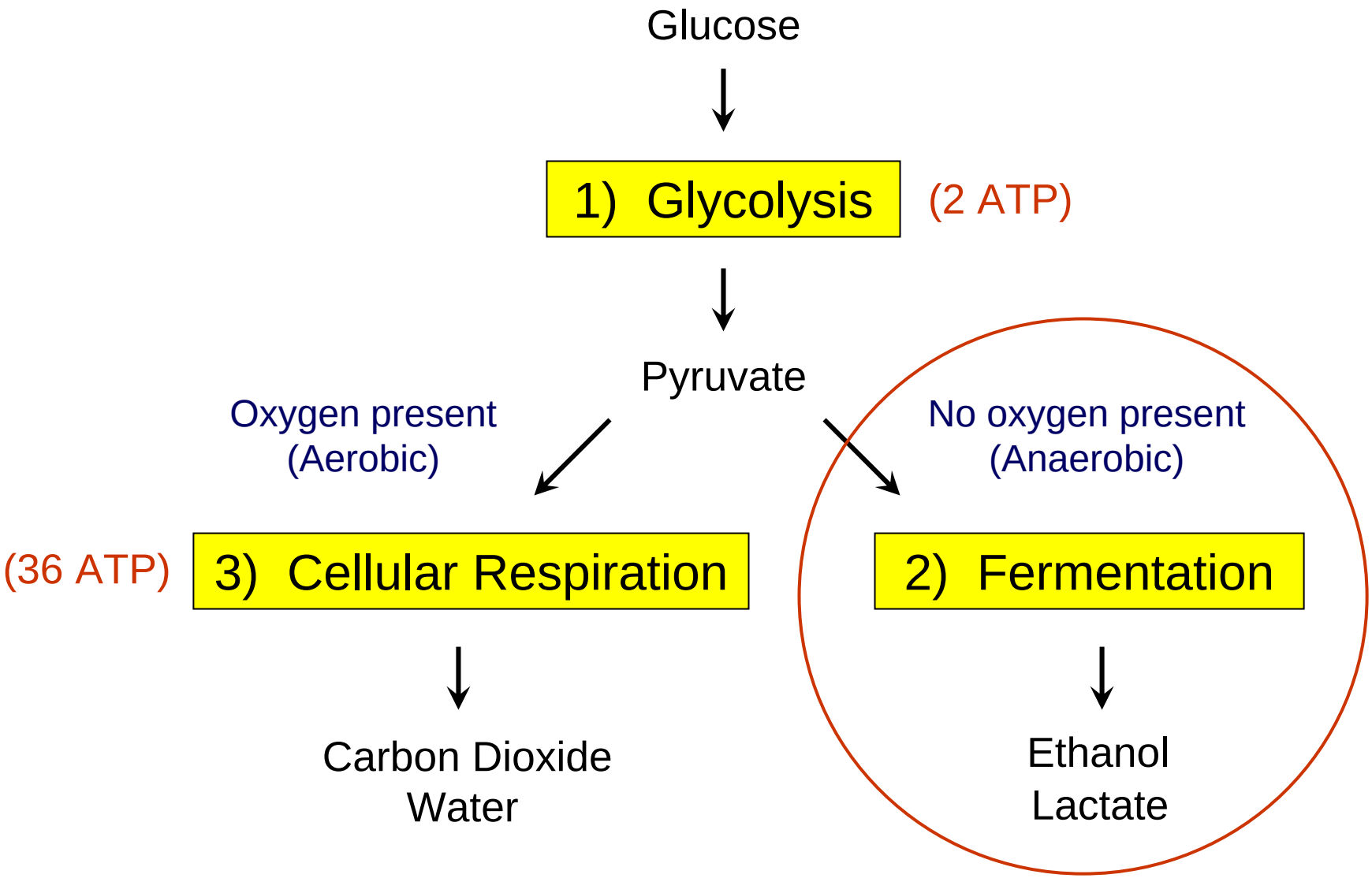
Glycolysis in Review:



Net ATP Gain = 2 ATP

(Figure 8.2)

Major Steps of Glucose Metabolism

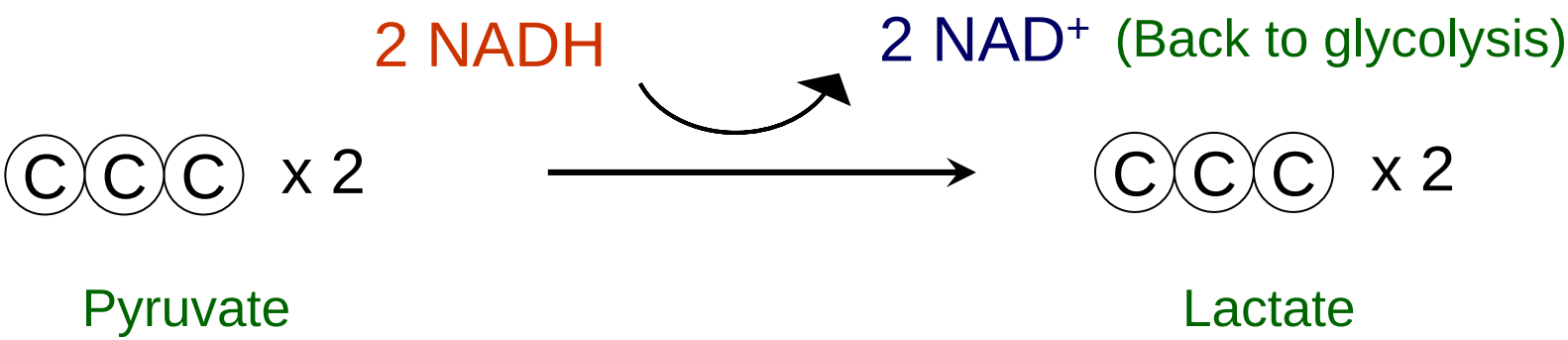


2) Fermentation: Process for regenerating NAD^+ for glycolysis

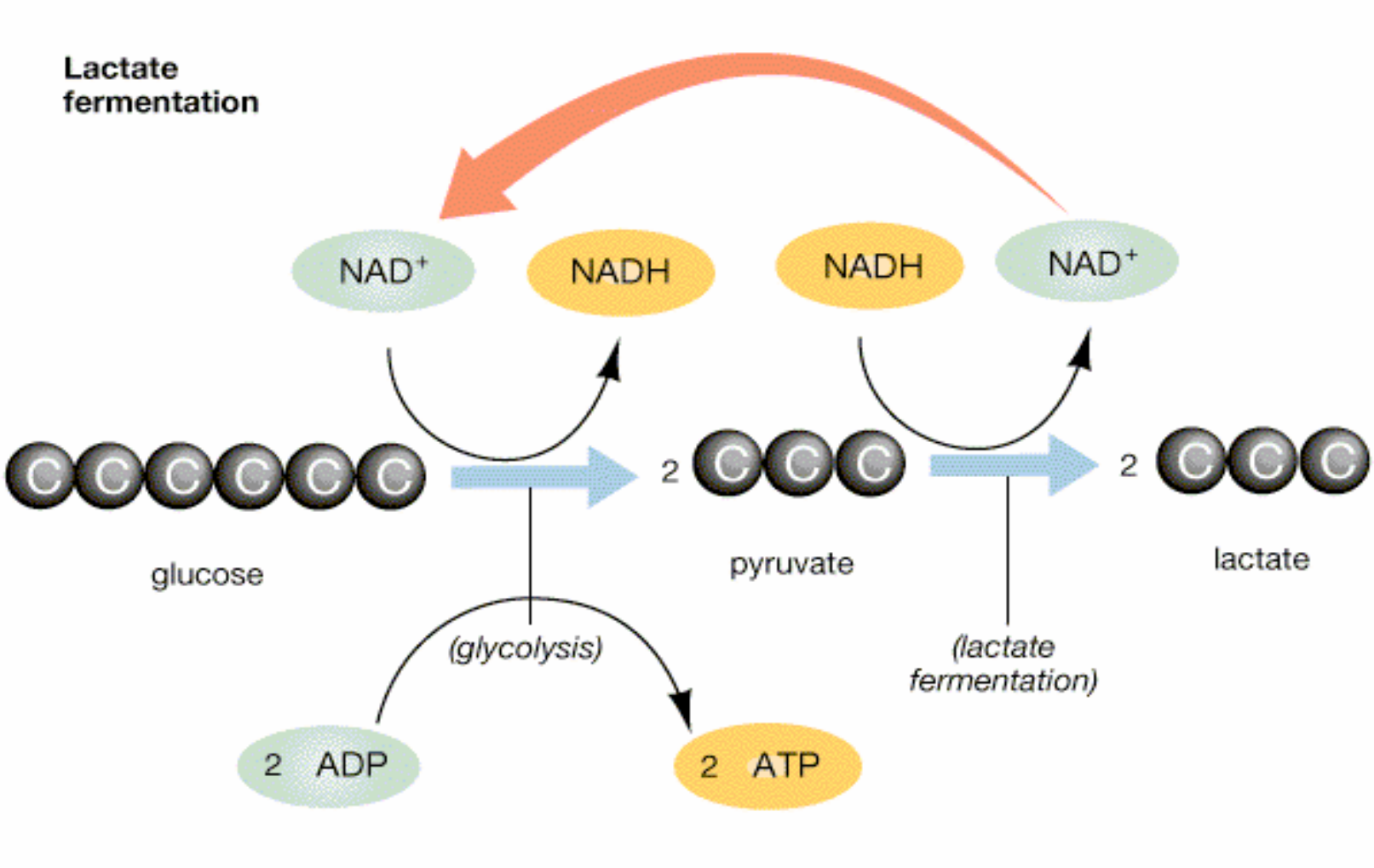
- Occurs in organisms which live where oxygen is rare
  - Intestines / stomach; soils / sediments / bogs

Two Types of Fermentation:

A) Lactate Fermentation: Pyruvate converted to lactate (lactic acid)



Lactate Fermentation:



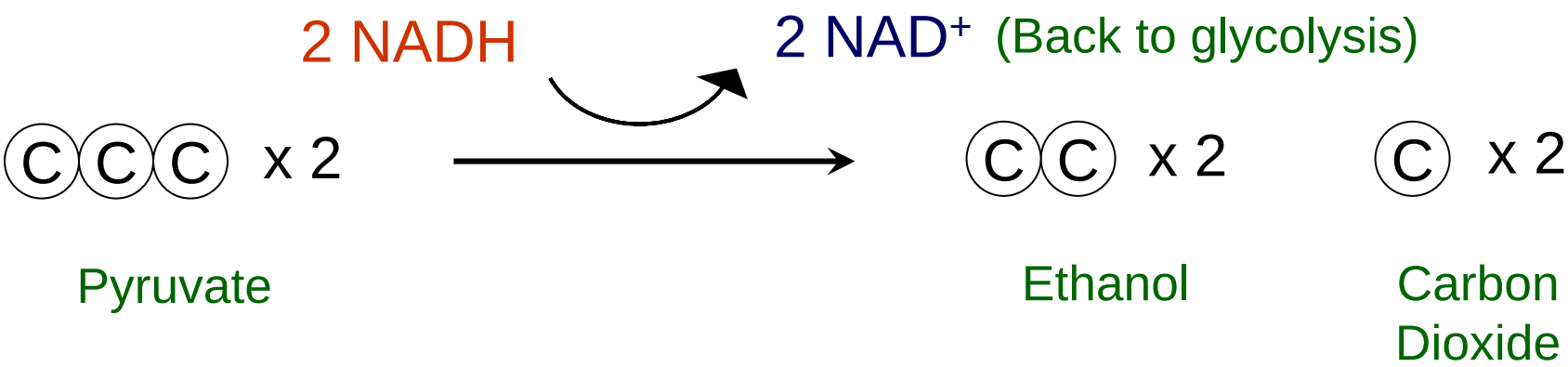
2) Fermentation: Process for regenerating NAD^+ for glycolysis

- Occurs in organisms which live where oxygen is rare
  - Intestines / stomach; soils / sediments / bogs

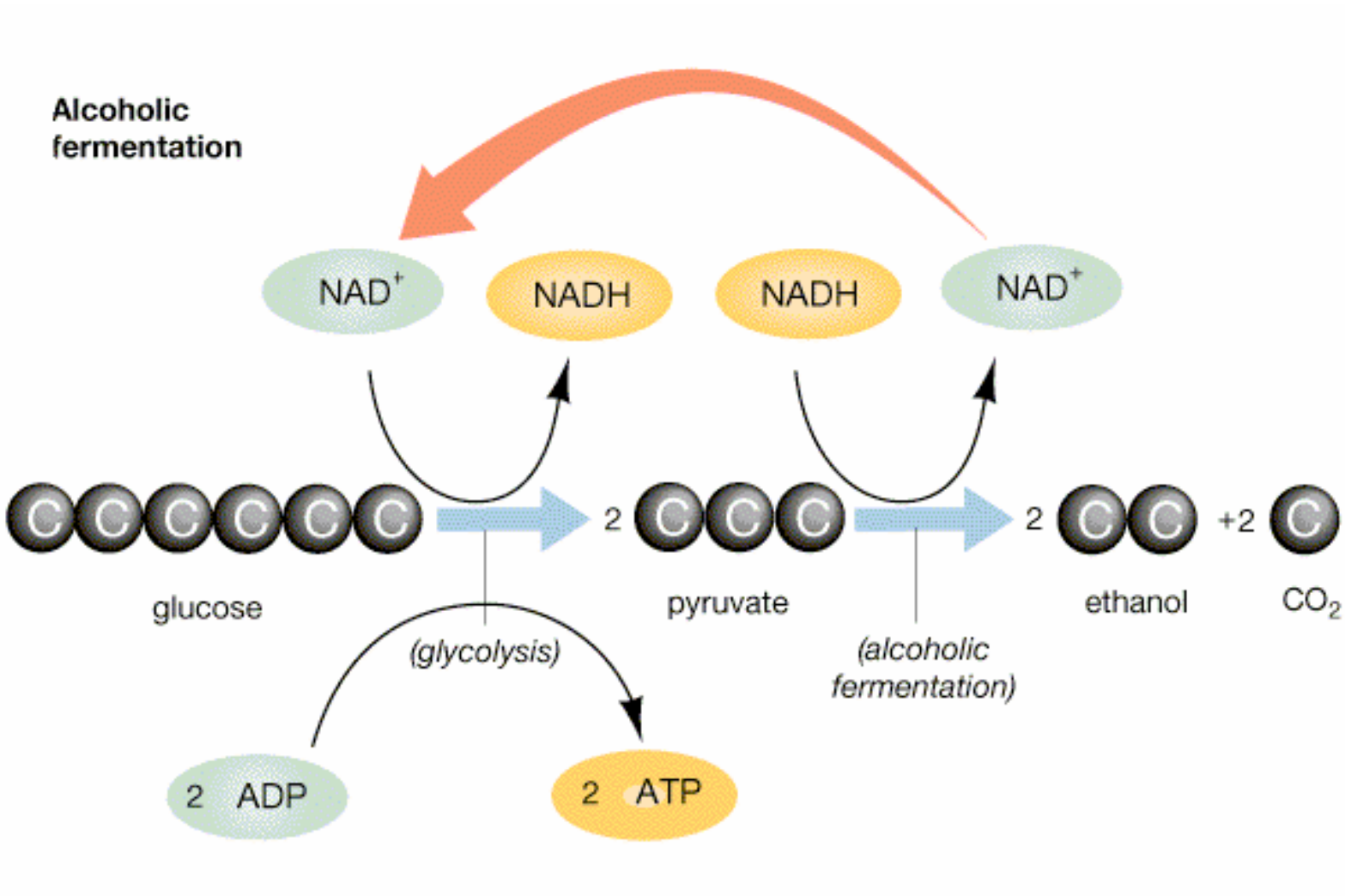
Two Types of Fermentation:

A) Lactate Fermentation: Pyruvate converted to lactate (lactic acid)

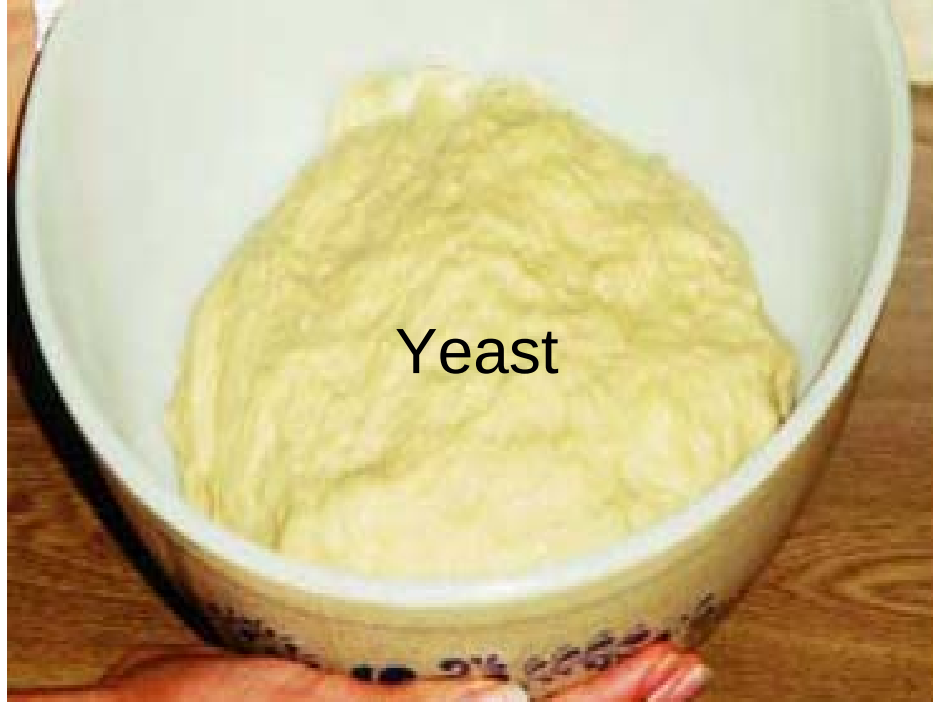
B) Alcoholic Fermentation: Pyruvate converted to ethanol and CO_2



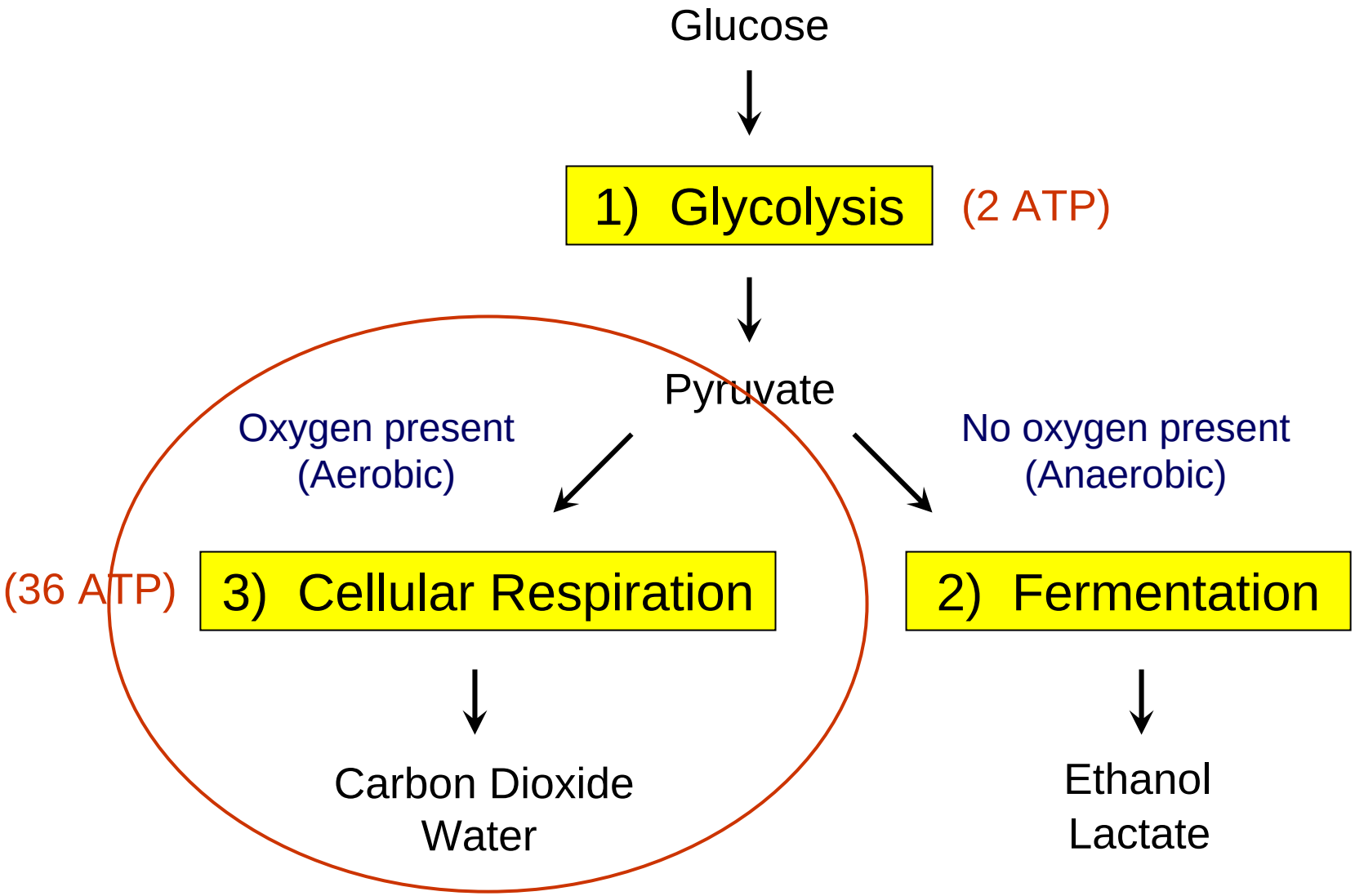
Alcohol Fermentation:




CHAMPAGNE


Yeast

Major Steps of Glucose Metabolism



3) Cellular Respiration: Series of reactions producing ATP

- Occurs in mitochondria / requires oxygen

$$\text{Pyruvate} + O_2 = CO_2 + H_2O + \text{ATP}$$

Oxygen

Carbon Dioxide

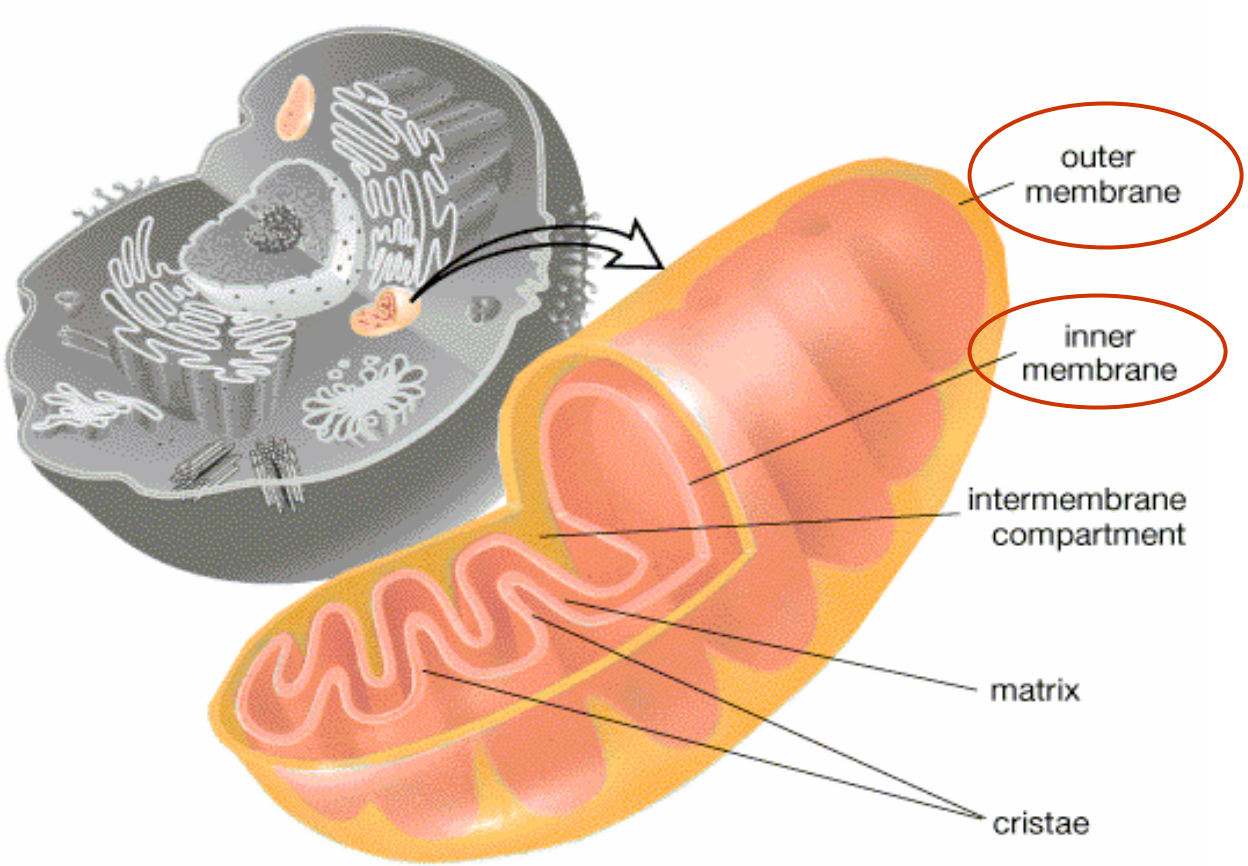
Water

Chemical Energy

Recall from Chapter 5:

Mitochondria has two membranes:

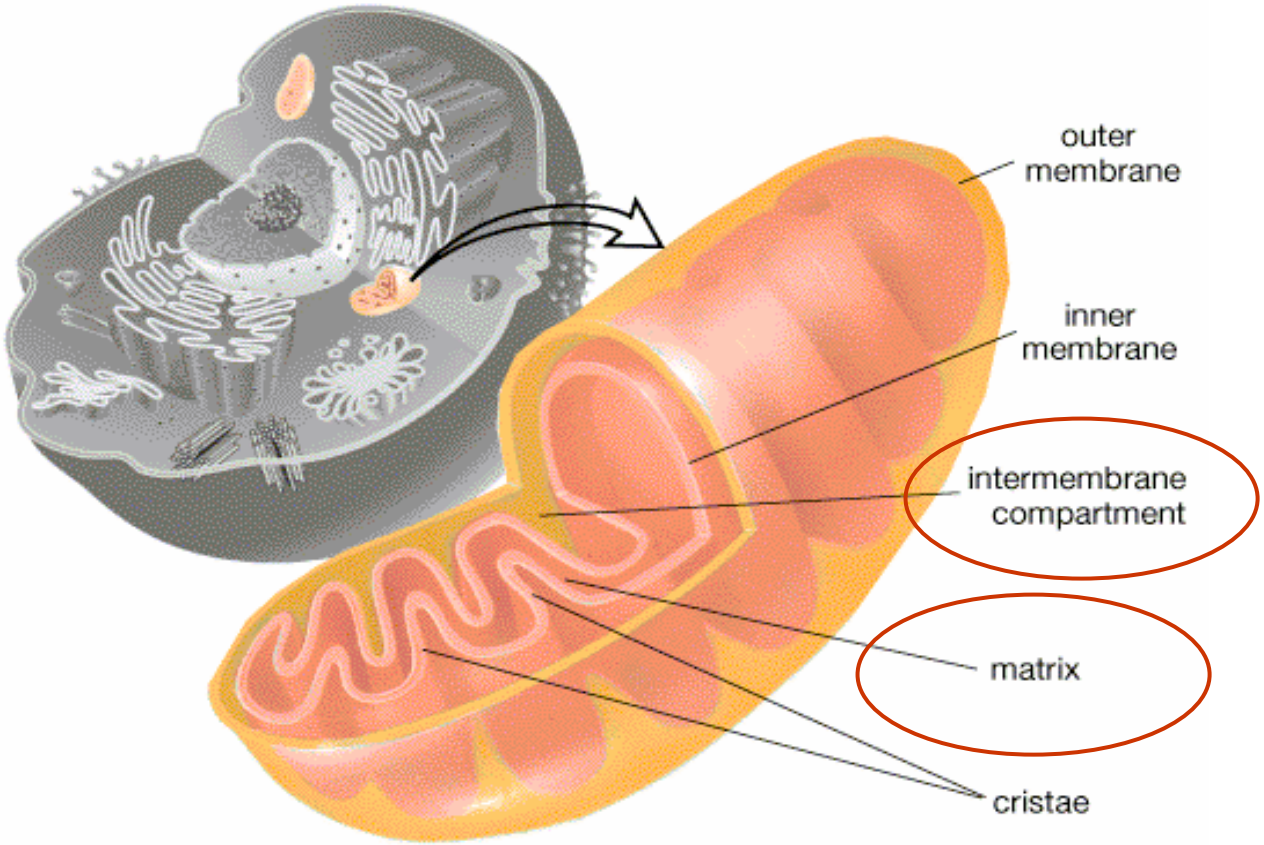
1) Outer Membrane (smooth)
2) Inner Membrane (folded - cristae)



Recall from Chapter 5:

The two membranes provide two separate compartments:

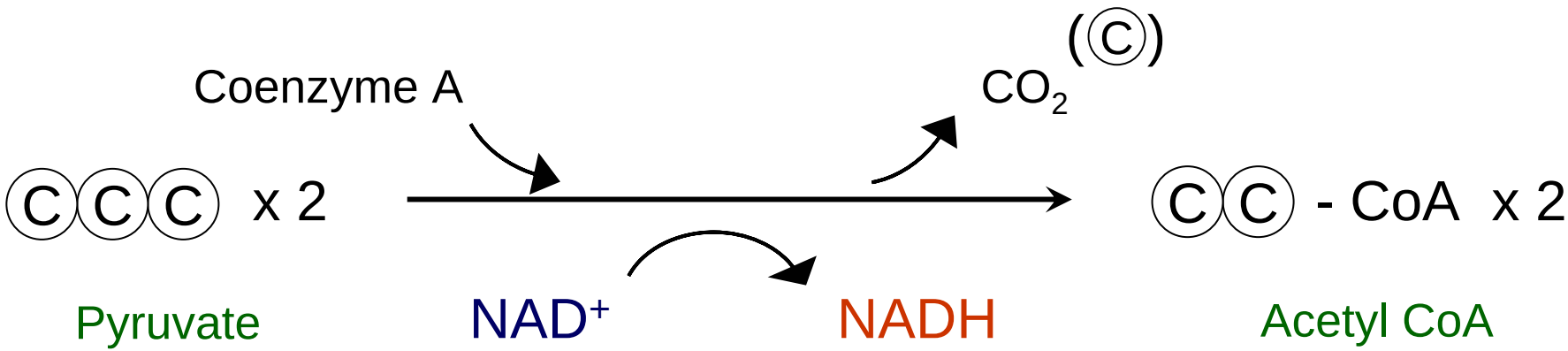
1) Intermembrane Compartment
   - Lies between inner and outer membrane
2) Matrix (lies within inner membrane)



3) Cellular Respiration - Sequence of Events:

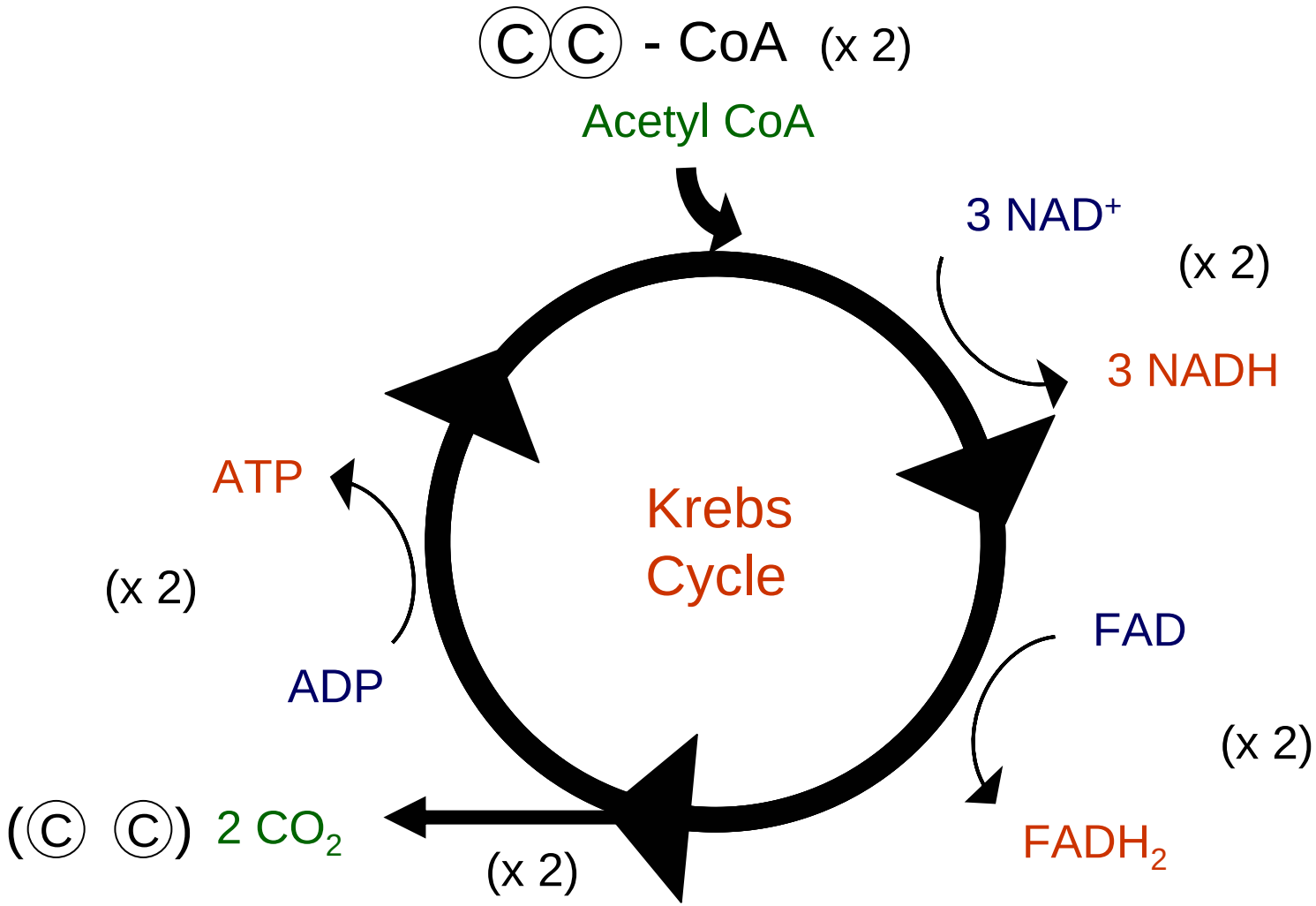
A) Formation of Acetyl CoA:

- Pyruvate diffuses into mitochondrial matrix
  - Down concentration gradient (via pores)



3) Cellular Respiration - Sequence of Events:

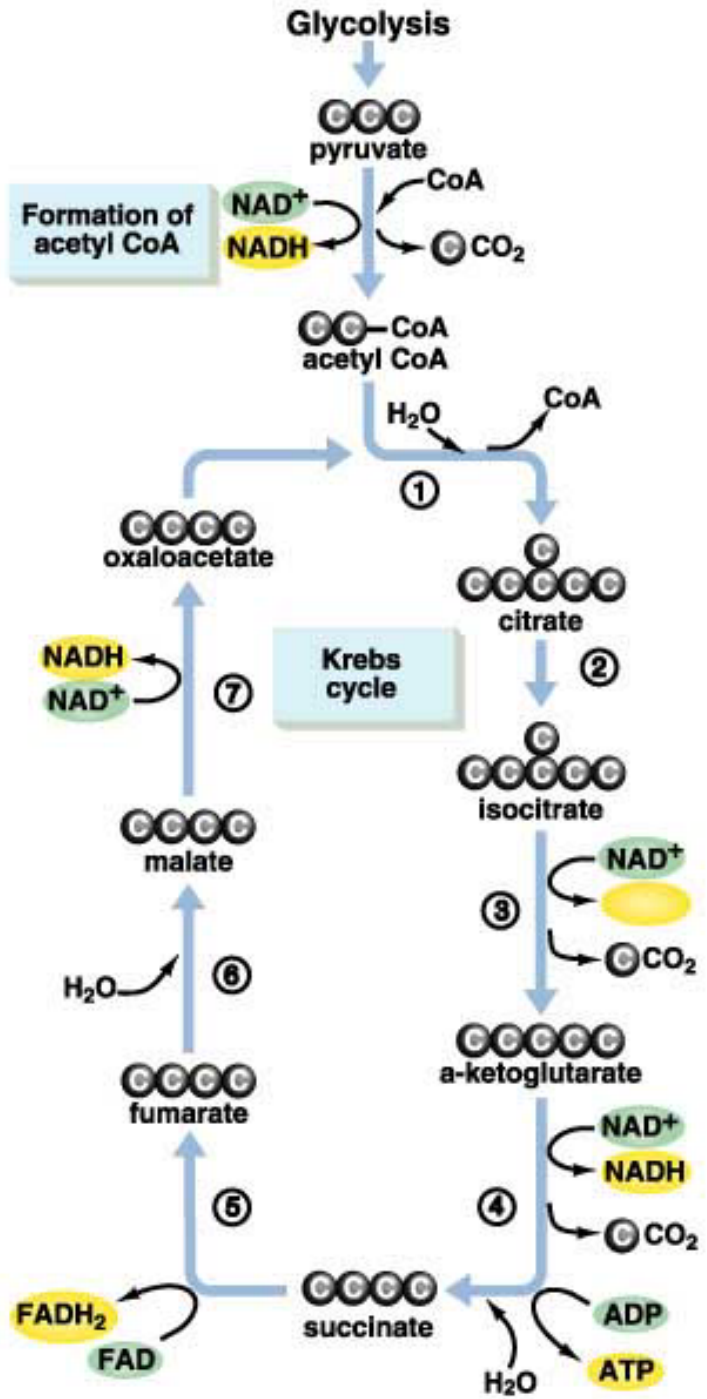
B) Krebs Cycle (Citric Acid Cycle):



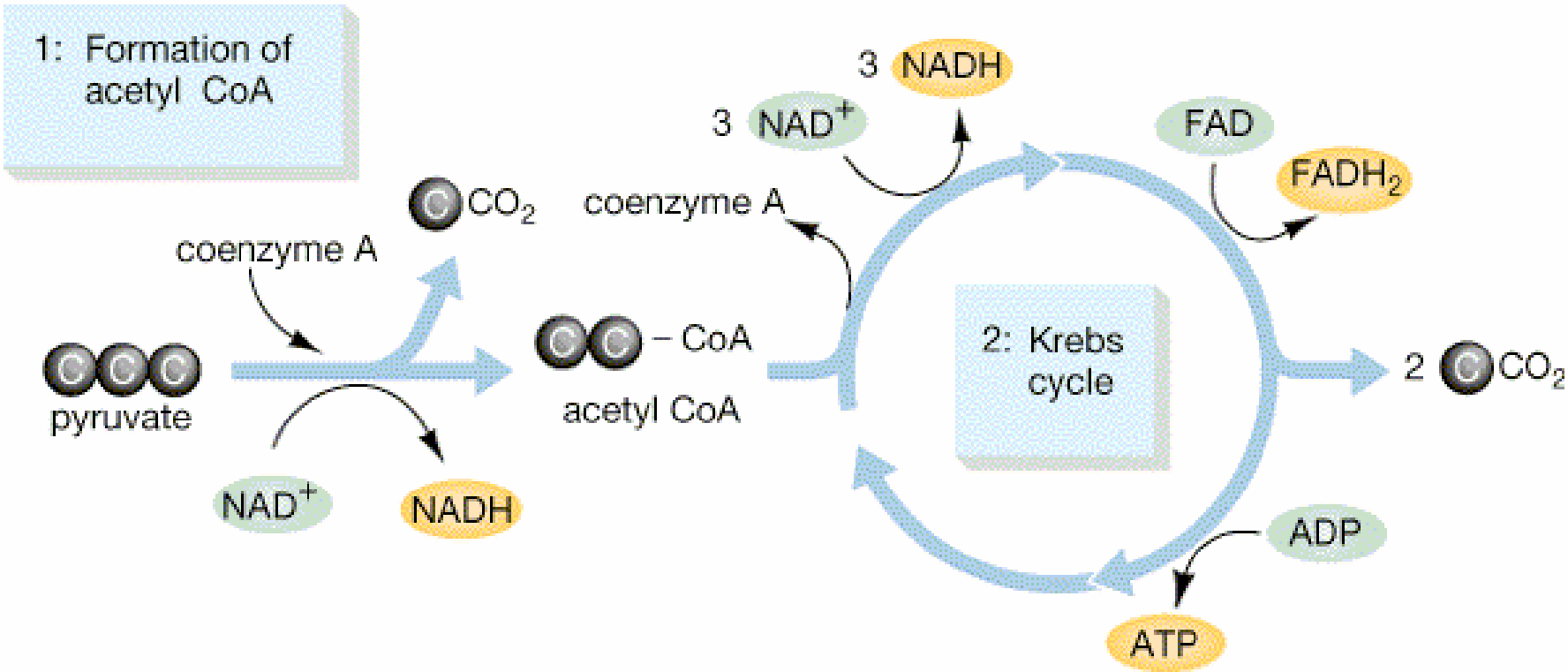
Chapter 8: Glycolysis and Cellular Respiration

The True Story:

DO NOT COPY!



Review:

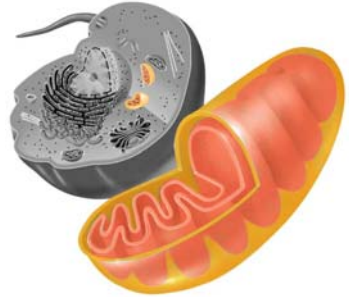


(Figure 8.5)

3) Cellular Respiration - Energy Checklist:

What energy molecules have we produced so far:

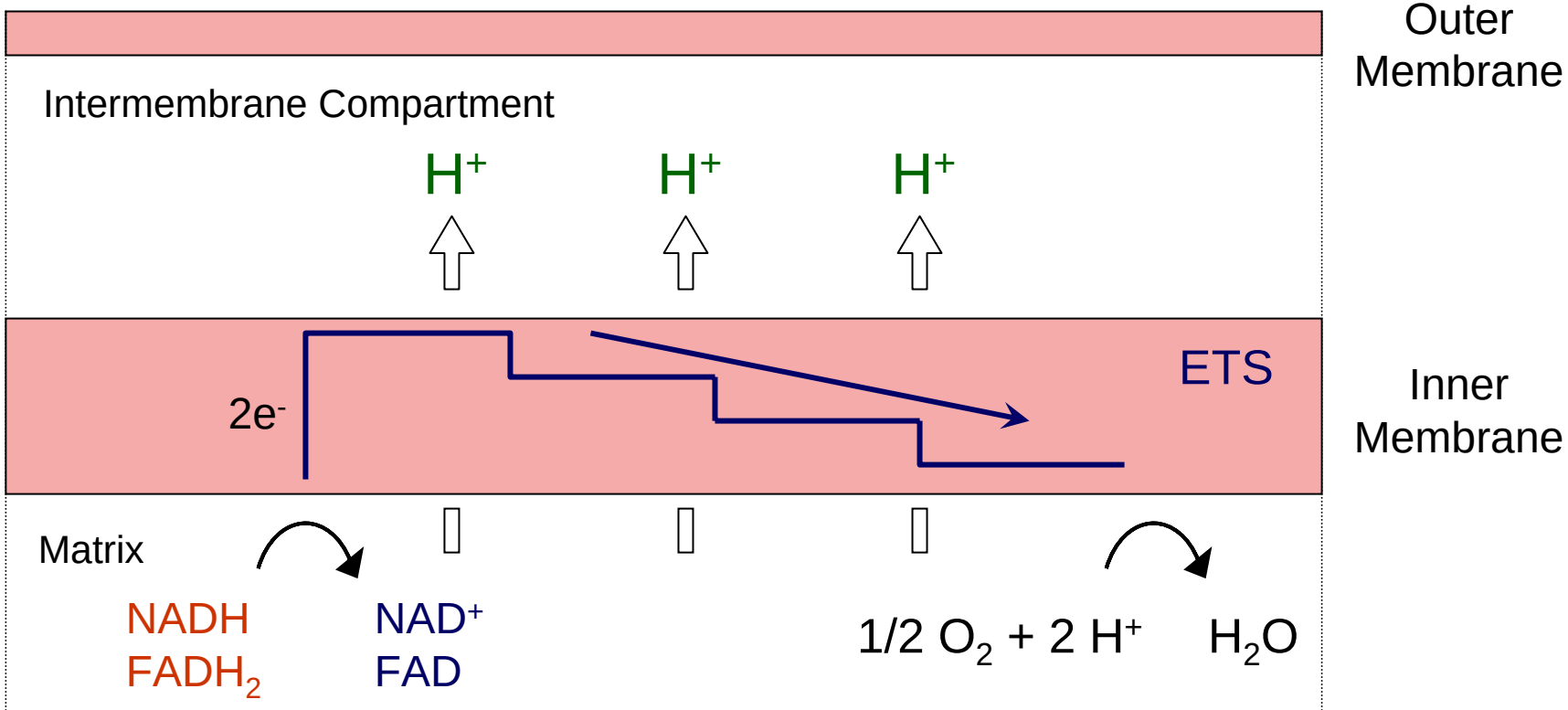
1) 2 ATP (from glycolysis)
2) 2 ATP (from Krebs cycle)
3) Multiple Electron-carrier Molecules:
    - 2 NADH (from glycolysis)
    - 8 NADH (from Krebs cycle)
    - 2 $FADH_2$ (from Krebs cycle)



3) Cellular Respiration - Sequence of Events:

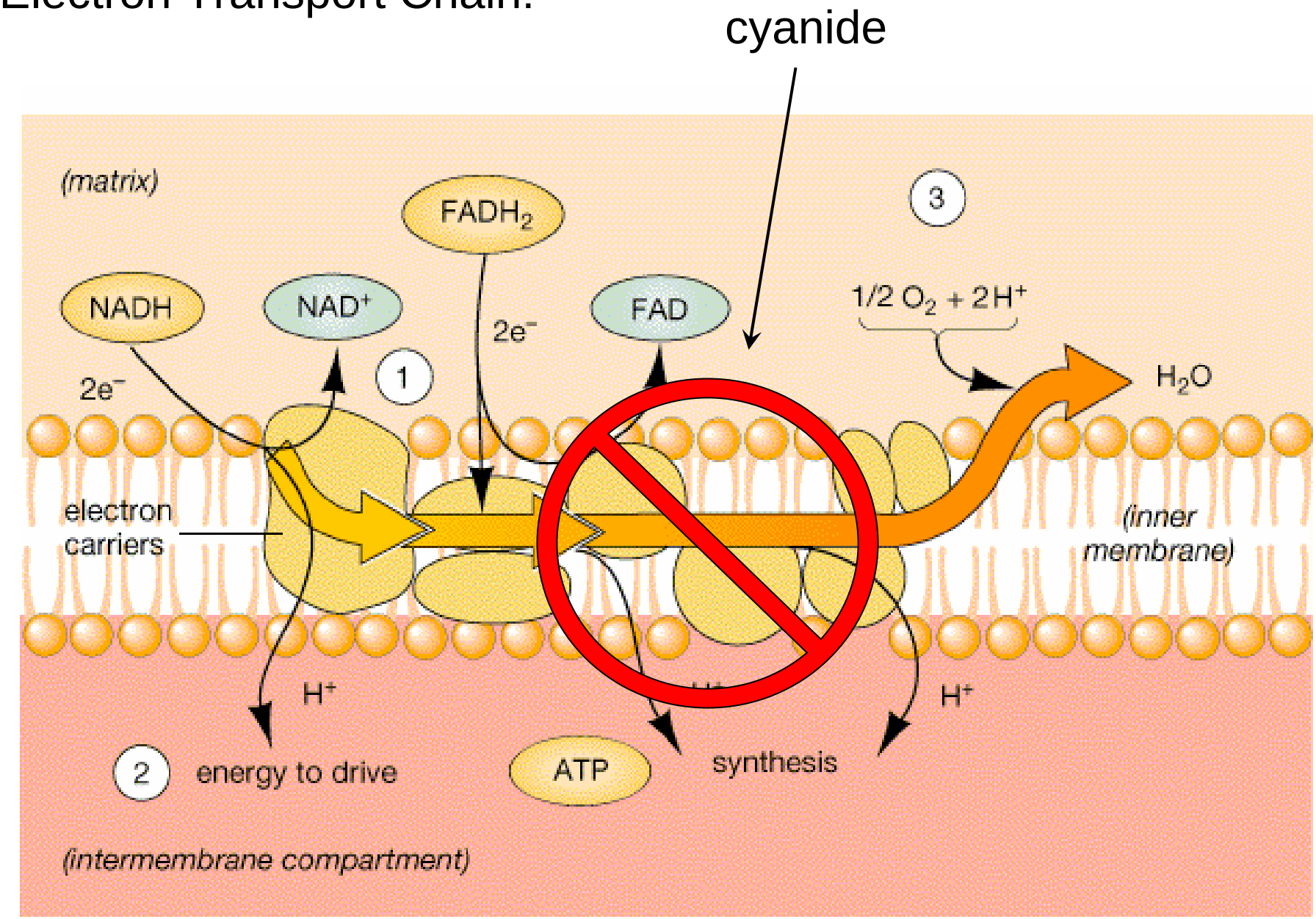
C) Electron Transport System

- Place where electron-carrier molecules unload their electrons
- Located in inner mitochondrial membrane



(Figure 8.6)

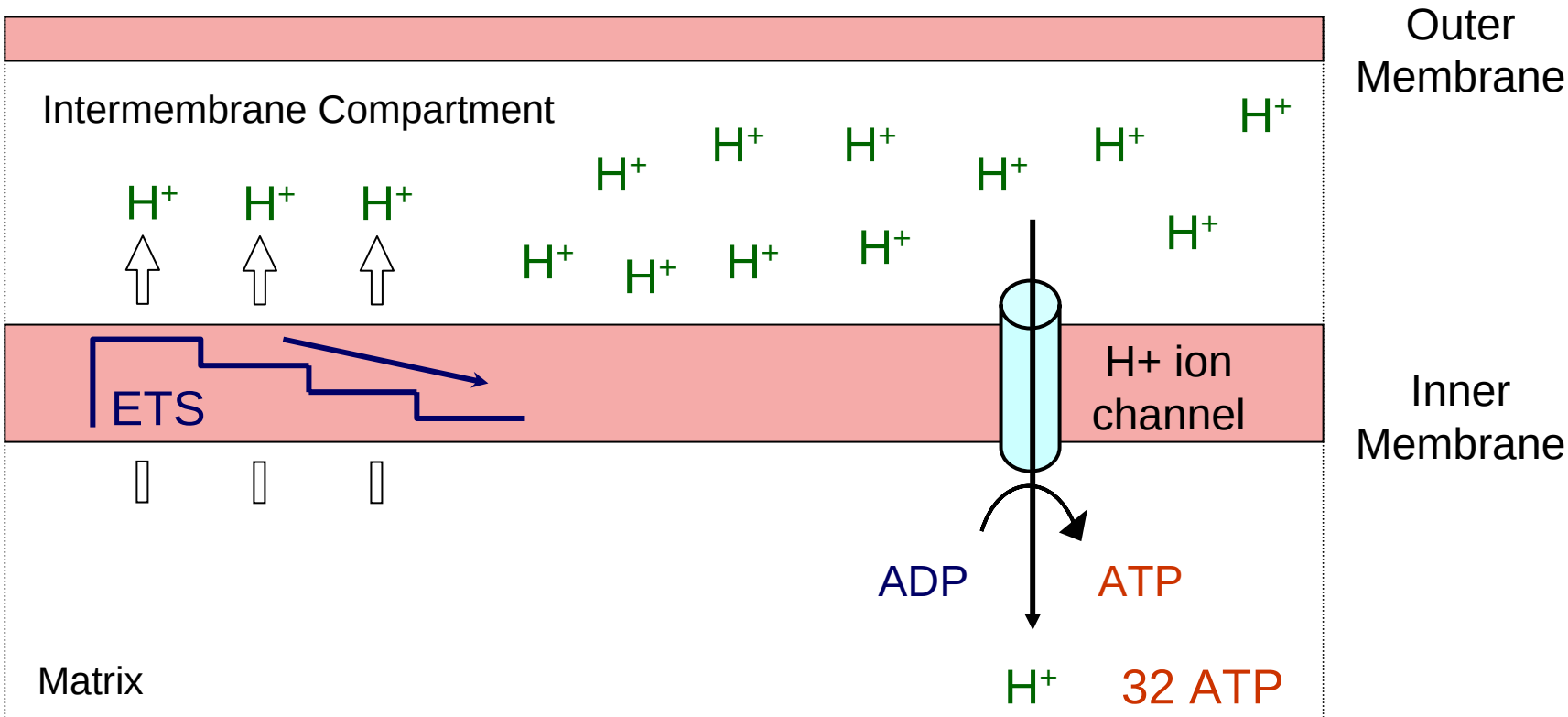
Electron Transport Chain:



Sequence of Events in Cellular Respiration:

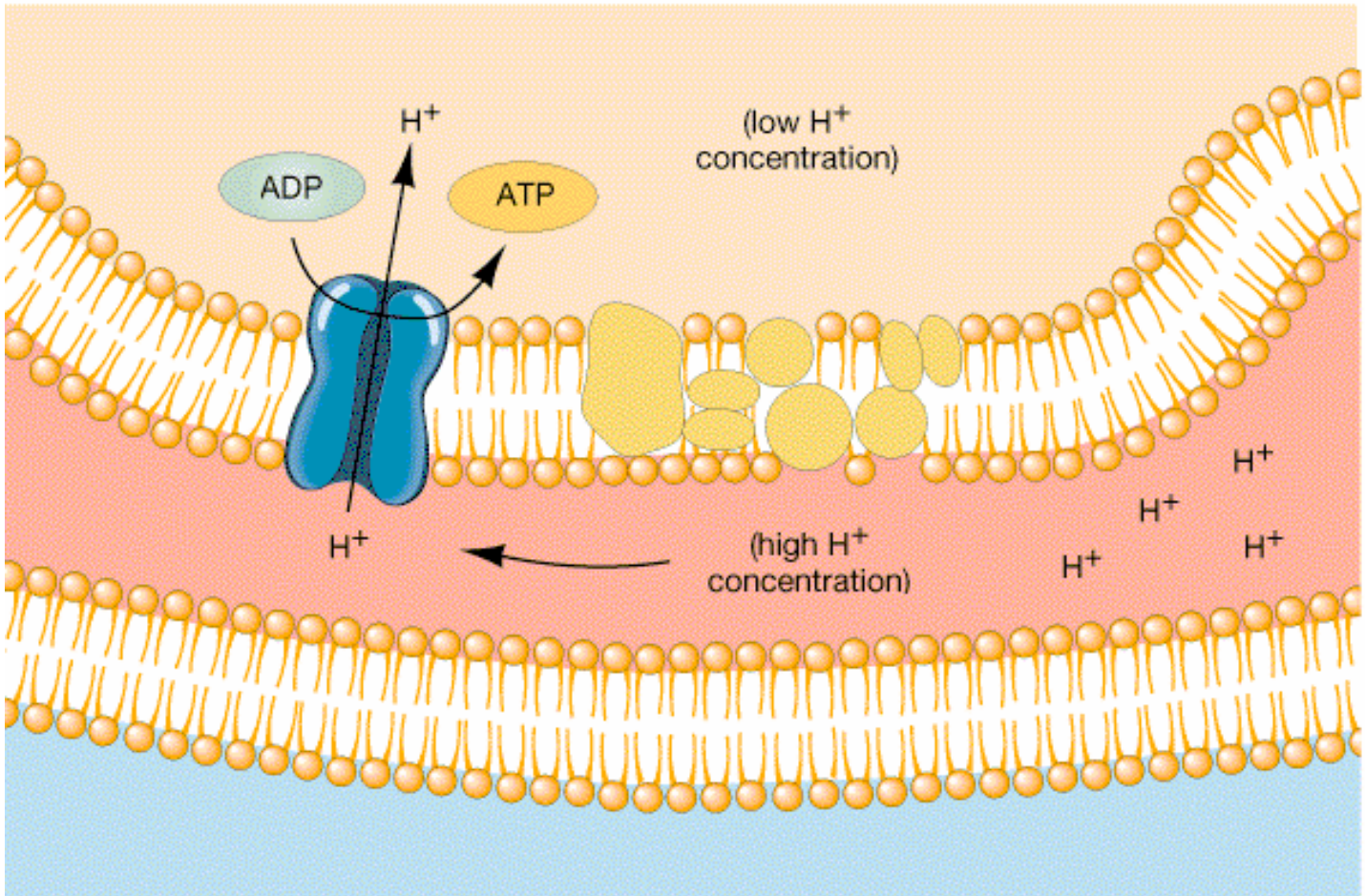
4) Chemiosmosis:

- Captures energy stored in hydrogen ion gradient and produces ATP
- Located in inner mitochondrial membrane



Chemiosmosis:

- ATP diffuses out of mitochondria to provide energy for cellular processes

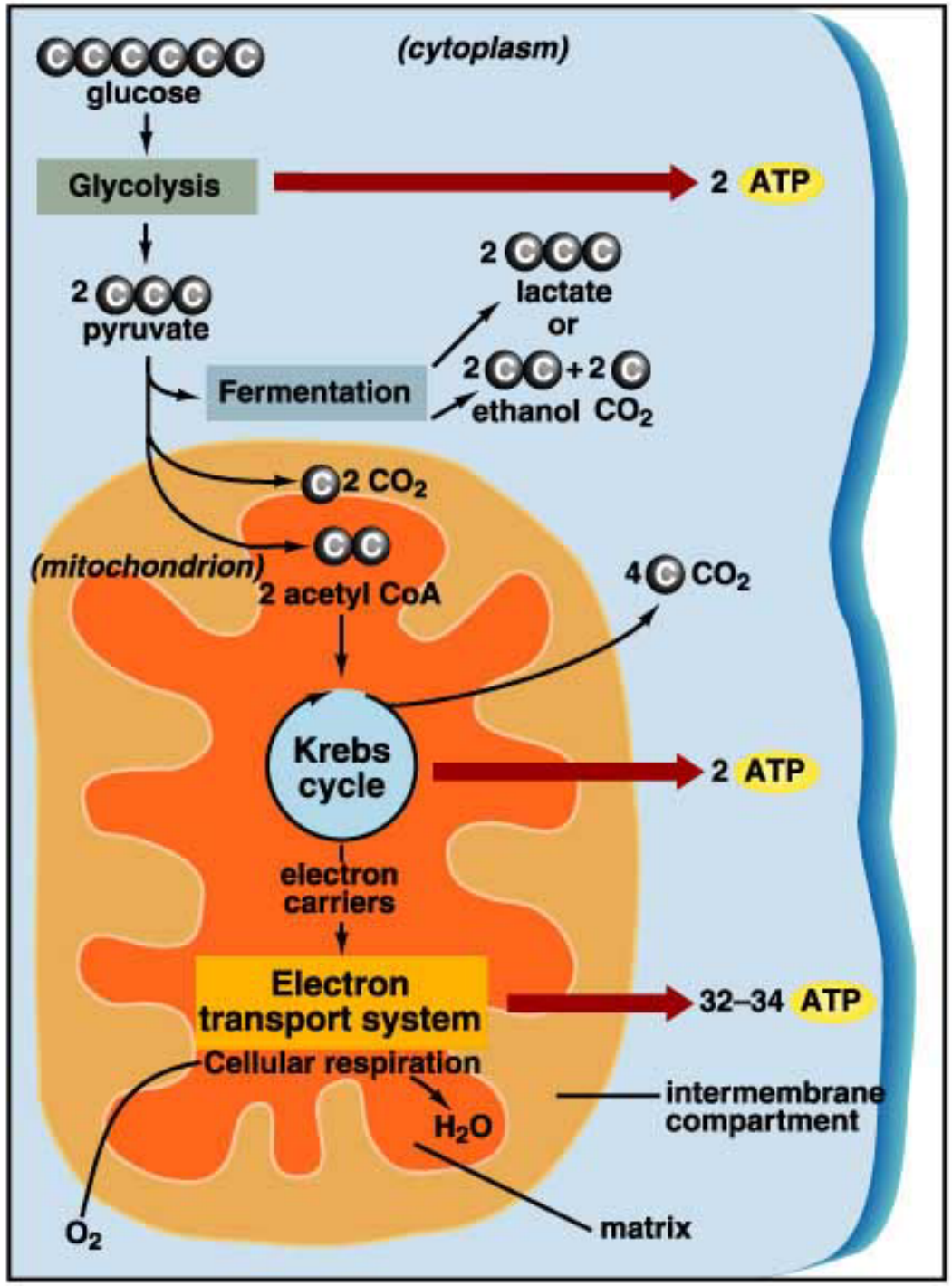


(See “A Closer Look - Chemiosmosis: Pg. 142)

Final Tally of Energy Production:

One Molecule of Glucose Yields 36 - 38 ATP

Yippee!



(Figure 8.1)

How Various Biomolecules Yield Energy:

Fats:

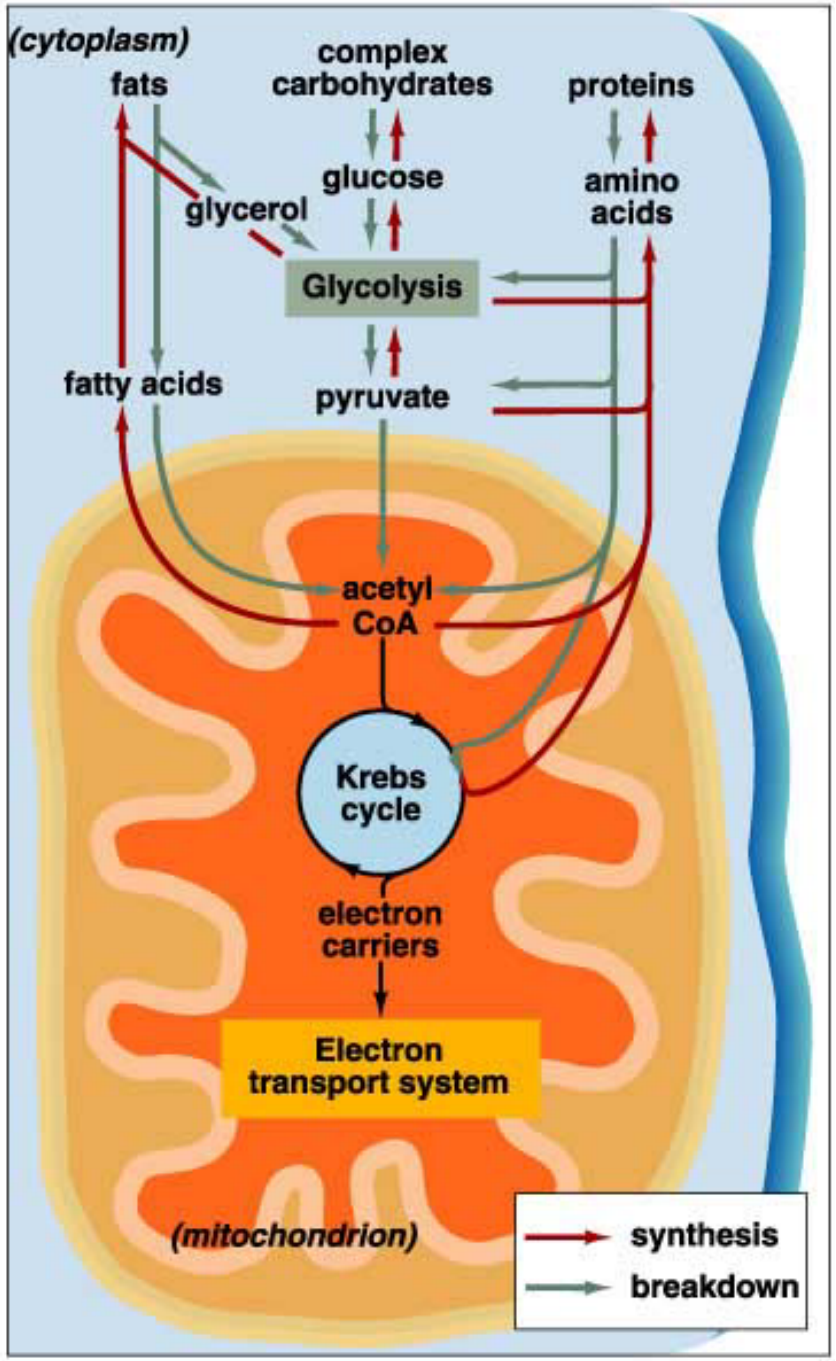
- Glycerol → glycolysis
- Fatty Acids → Krebs cycle

Proteins:

- Enter at multiple stages

Reversal true as well:

Glucose → Fats



(See Health Watch - Pg. 134)