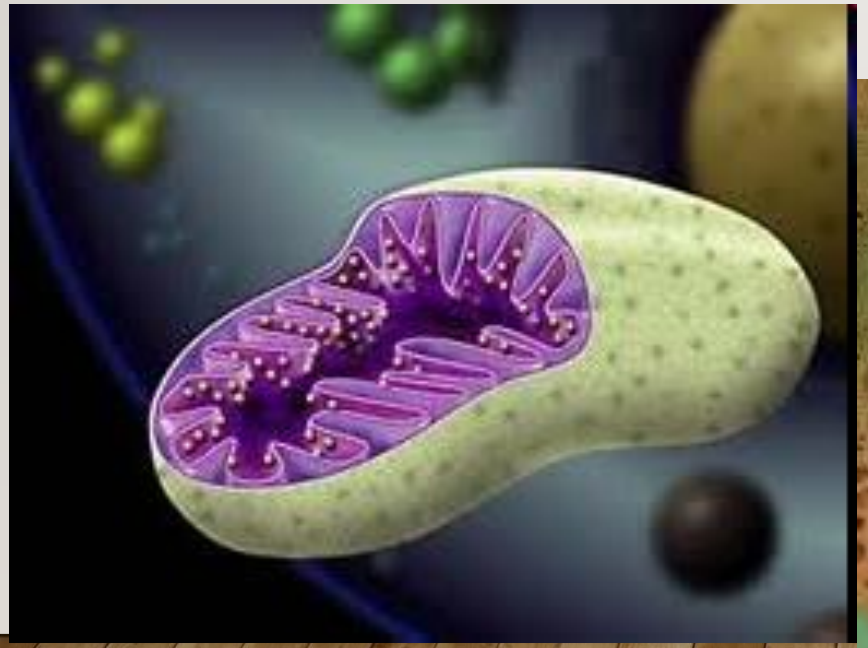
CELLULAR RESPIRATION! THE PROCESS THROUGH WHICH YOUR CELLS OBTAIN USABLE ENERGY



EQUATION

Glucose + Oxygen → Energy + Carbon Dioxide + Water

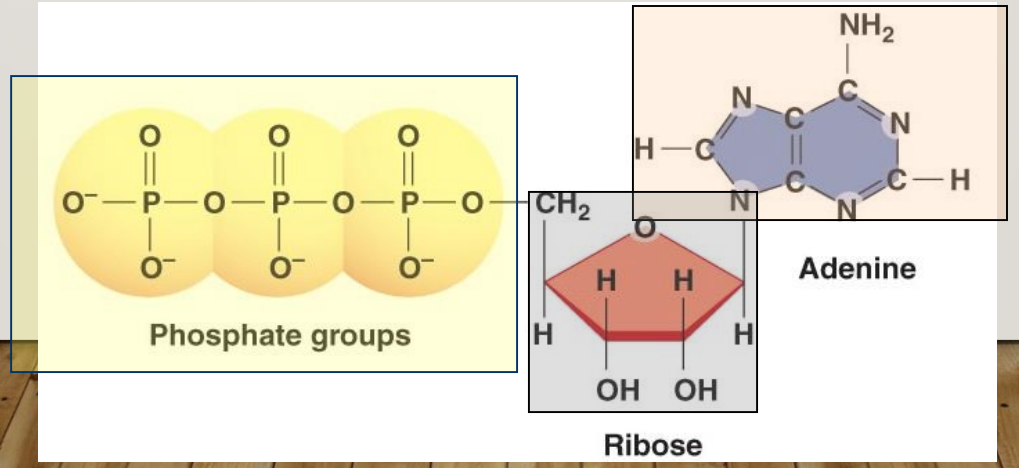
$C_6H_{12}O_6 + 6\ O_2 \rightarrow ATP + 6\ CO_2 + 6\ H_2O$

CELLULAR RESPIRATION SUMMARY

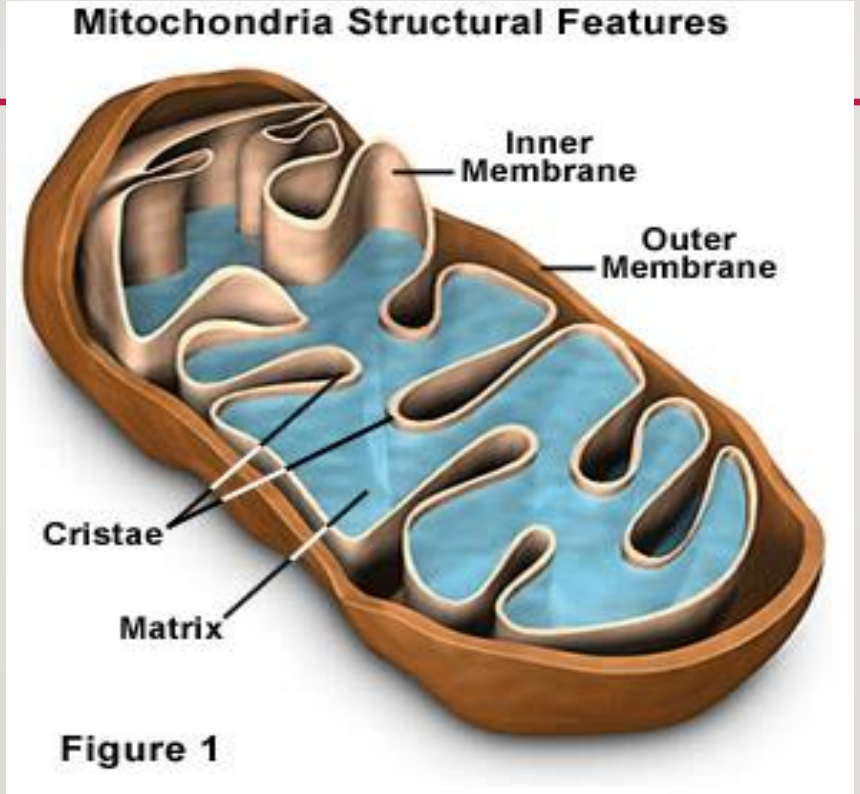
- Location: Mitochondria (Eukaryotes), Cell Membrane/Cytoplasm (Prokaryotes)
- Goal: Produce ATP from Glucose
- Main Processes:
    1) Glycolysis
    2) Kreb's Cycle
    3) Electron Transport Chain

RECALL: WHAT IS ATP?

- It is a molecule that "stores" energy in its bonds
- When used, the energy in ATP can act on other compounds like an enzyme, and either break their chemical bonds, or form them
- ATP stands for "Adenosine Triphosphate"



STRUCTURE OF A MITOCHONDRION



1. Glycolysis occurs in cytoplasm of cell
2. Kreb's Cycle occurs in matrix
3. ETC occurs in inner membrane

TWO TYPES OF RESPIRATION

- Aerobic
- With oxygen
- Makes a lot of ATP
- Includes all 3 steps

- **Anaerobic**
- **Without oxygen**
- **Makes a little ATP**
- **Only glycolysis**

PART 1: GLYCOLYSIS

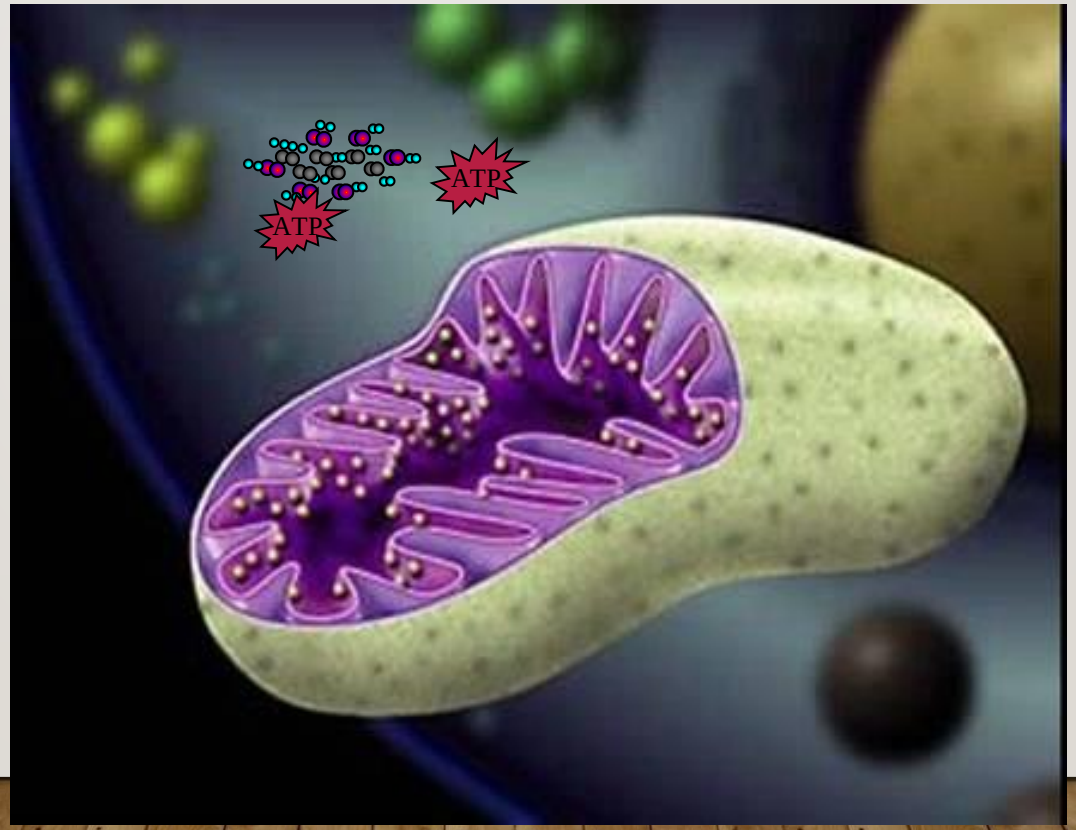
- **Purpose:** Glucose is broken down into two smaller molecules (pyruvate – 3 carbons), send electrons to ETC
- **Type:** Aerobic AND Anaerobic
- **Location:** cytoplasm

- **Reactants:** Glucose
- **Products:** Pyruvate, NADH, ATP

GLYCOLYSIS

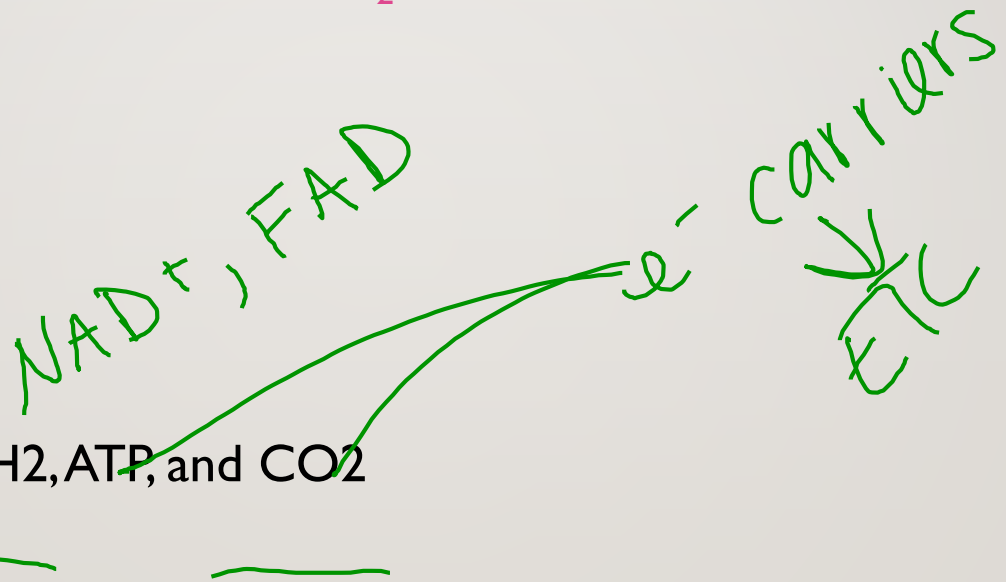
An enzyme splits the glucose into 2 pieces, called "**Pyruvate**". The process is called "**Glycolysis**".

The split also produces **2 ATP** Molecules



PART 2: KREB'S CYCLE

- **Purpose:** Pyruvate broken down into CO_2, send electrons to ETC
- **Type:** Aerobic ONLY
- **Location:** matrix



- **Reactants:** pyruvate
- **Products:** NADH, FADH2, ATP, and CO2

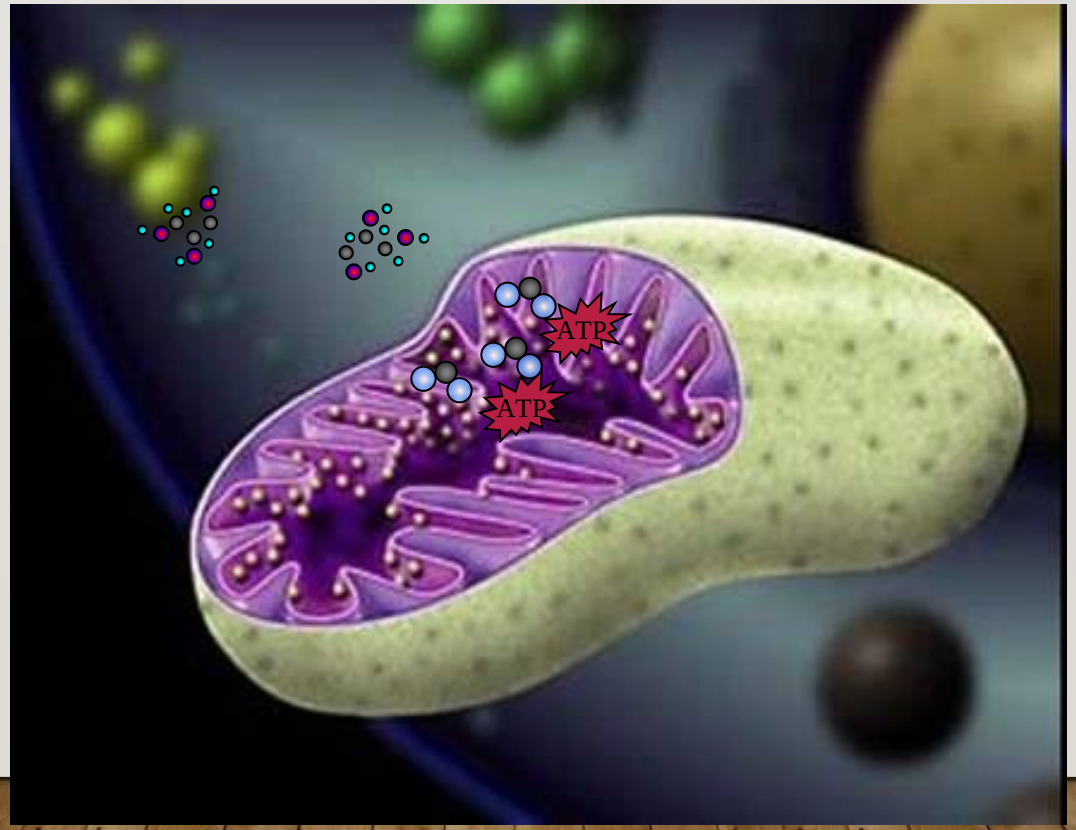
KREBS/CITRIC ACID CYCLE

The two Pyruvate molecules enter the **mitochondria** and undergo reactions which produce **2 more ATP** Molecules, plus CO_2 molecules as waste

The CO_2 leaves the cell

The ATP is available for use by the cell for energy

CO_2



PART 3: ELECTRON TRANSPORT CHAIN

- **Purpose:** Electrons from NADH and FADH2 are passed to oxygen → Water
- *ATP is made using ATP Synthase*
- **Type:** Aerobic ONLY
- **Location:** Inner Membrane

- **Reactants:** Oxygen
- **Products:** Water, ATP

, NADH, $FADH_2$
, NADH, FAD

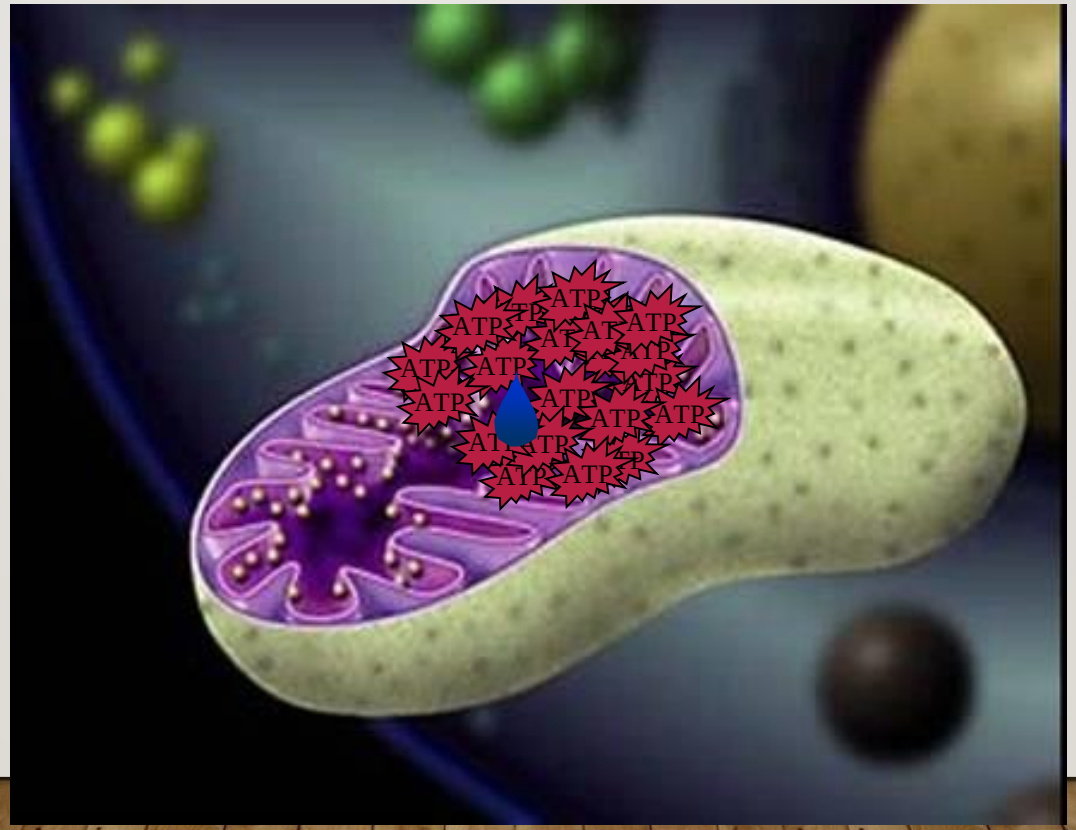
ELECTRON TRANSPORT CHAIN

Inside the Mitochondria, oxygen (O_2), the final e- acceptor, is used to drive additional reactions that produce 32 more ATP molecules

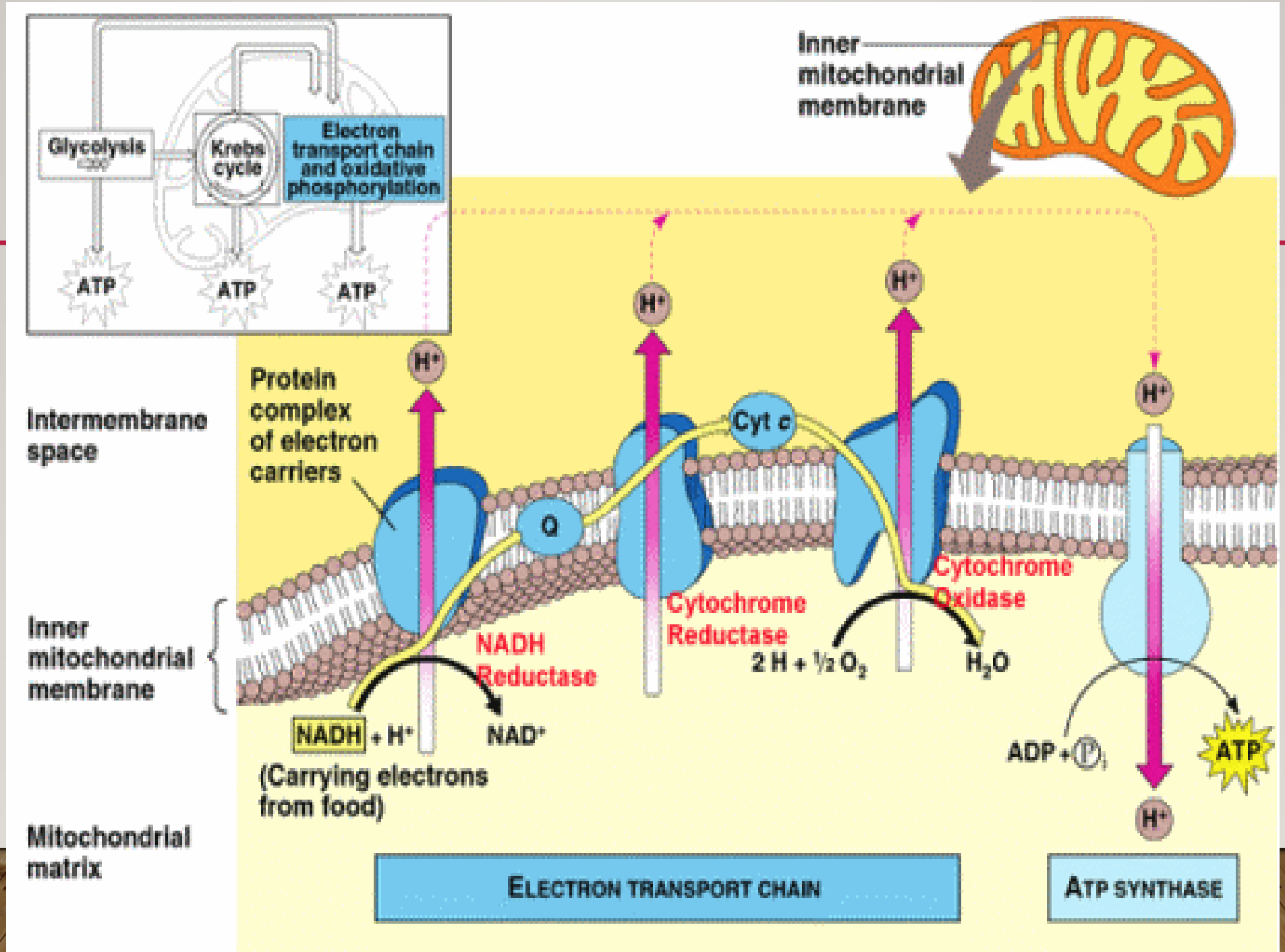
The process is called Electron Transport

Water (H_2O) is also produced, and exits the cell

O_2



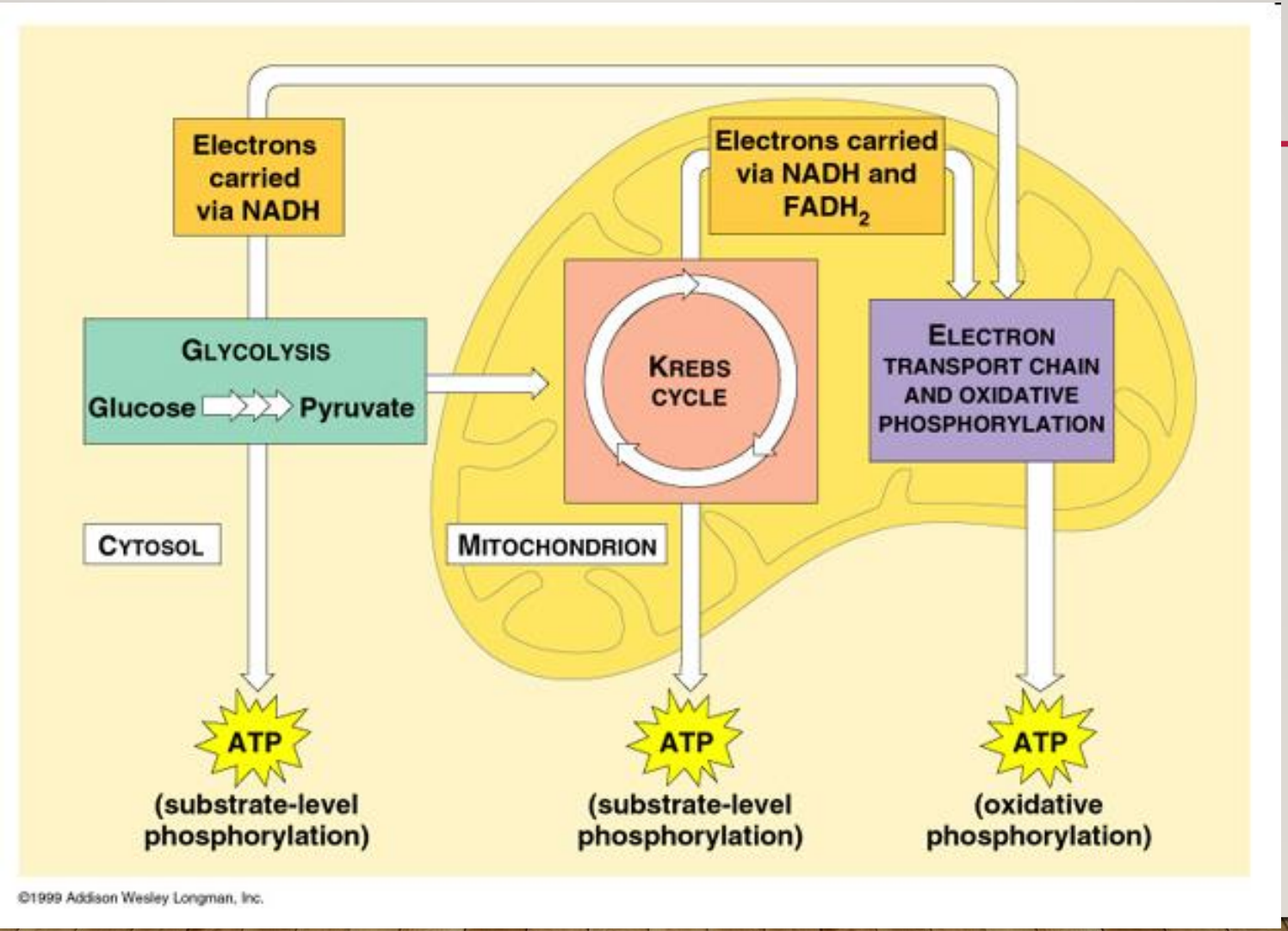
H_2O


Glycolysis
Krebs cycle
Electron transport chain and oxidative phosphorylation
ATP
ATP
ATP
Inner mitochondrial membrane
Intermembrane space
Protein complex of electron carriers
Inner mitochondrial membrane
Mitochondrial matrix
H+
Q
Cyt c
NADH Reductase
Cytochrome Reductase
Cytochrome Oxidase
2 H + ½ O2
H2O
NADH + H+
NAD+
(Carrying electrons from food)
ADP + P
ATP
ELECTRON TRANSPORT CHAIN
ATP SYNTHASE

ENERGY YIELD

- 2 ATP from Glycolysis
- 2 ATP from Kreb's Cycle
- 32-34 ATP from Electron Transport Chain

36-38 Total ATP!!!



ANAEROBIC RESPIRATION (FERMENTATION)

- ~~Glycolysis~~ only
- Occurs in the absence of oxygen
- Goal: break down glucose
  - Produce 34-36 ATP *fewer* than aerobic cell resp
- Two Types: Lactic Acid and Alcoholic

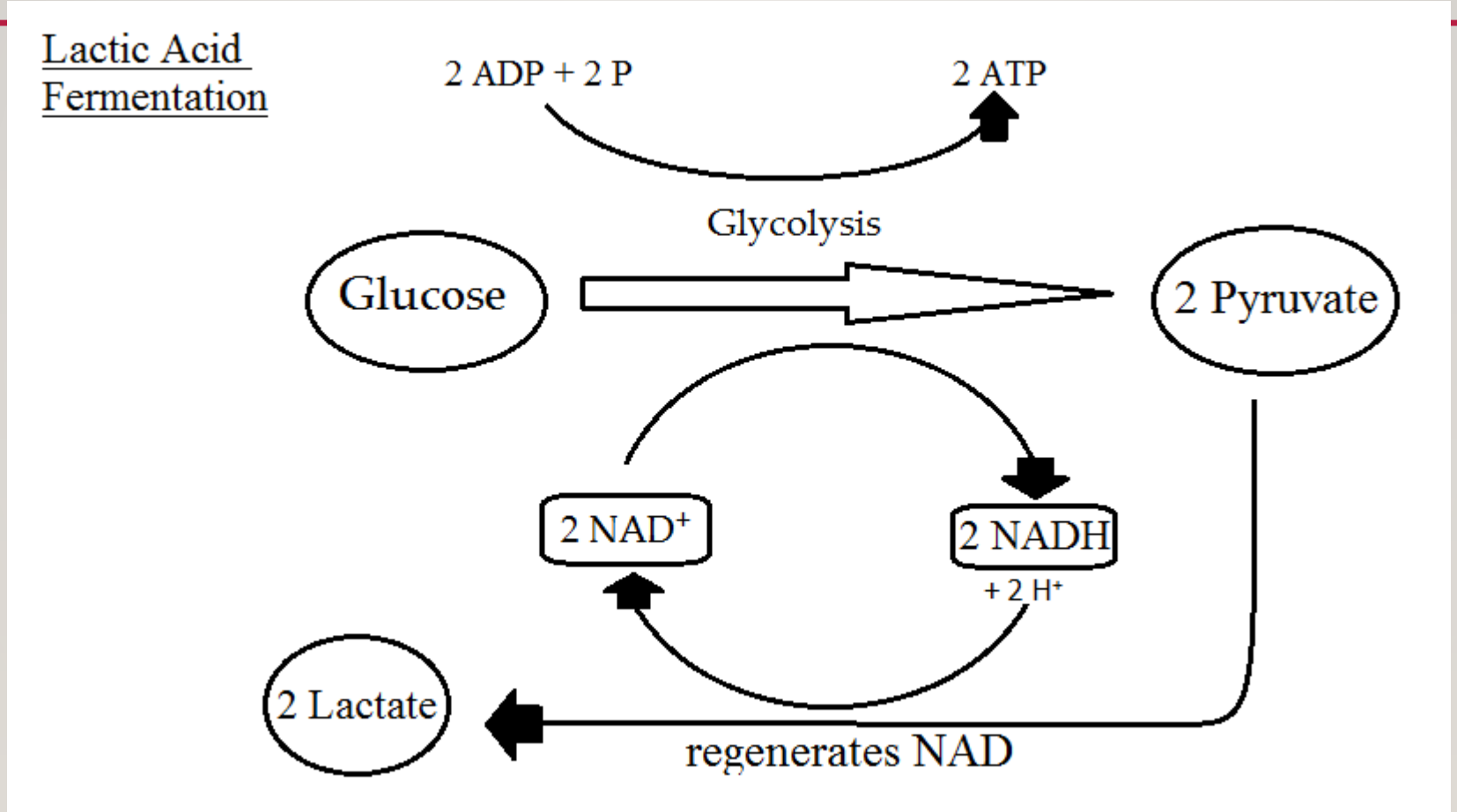
LACTIC ACID FERMENTATION

Equation: Gives us lactic acid and ATP

Happens in: Animals, prokaryotes

Examples in Everyday Life: Muscle cells during exercise, yogurt, pickles, etc.

LACTIC ACID FERMENTATION



ALCOHOLIC FERMENTATION

Equation: Gives us alcohol (ethanol), CO_2 and ATP

Happens in: Yeast and other microorganisms

Examples in Everyday Life: Yeast causes bread to rise!

ALCOHOLIC FERMENTATION