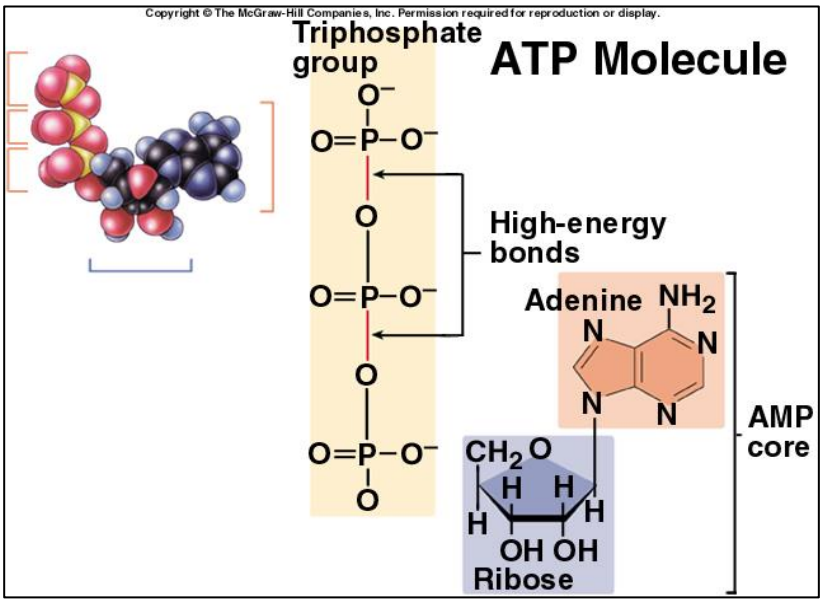
Plant Physiology 4th Biology Lecture 9
Respiration

- **Respiration:** is Breaking down sugars to chemical energy (ATP) for Growth, Development and Reproduction. Occurs in Mitochondria of Cells. Mitochondria are membrane-enclosed organelles distributed through the cytosol of most eukaryotic cells. Their main function is the conversion of the potential energy of food molecules into ATP.



Aerobic Respiration

- Requires Oxygen
- Main Type of Respiration that Occurs in most Plants and Animals.
- Involves Complete Breakdown of Glucose back to CO_2 and Water.
- Not all of the Energy in Glucose Is Converted to ATP Formation
  - Only about 40% Efficient
  - Extra Energy Is Given off as Heat
    - In Plants, Heat Quickly Dissipates

Three Main Steps:

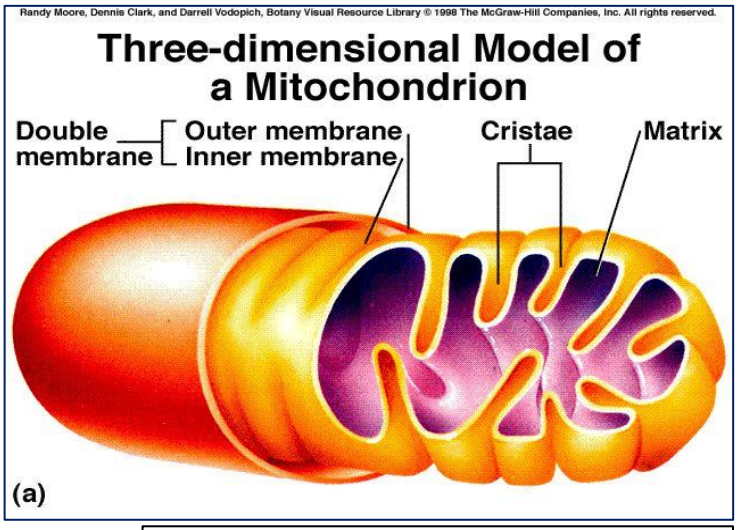
1. Glycolysis

- Breakdown of Glucose (6C) → 2 pyruvate (3C each)
- Pyruvate molecules move to the mitochondria

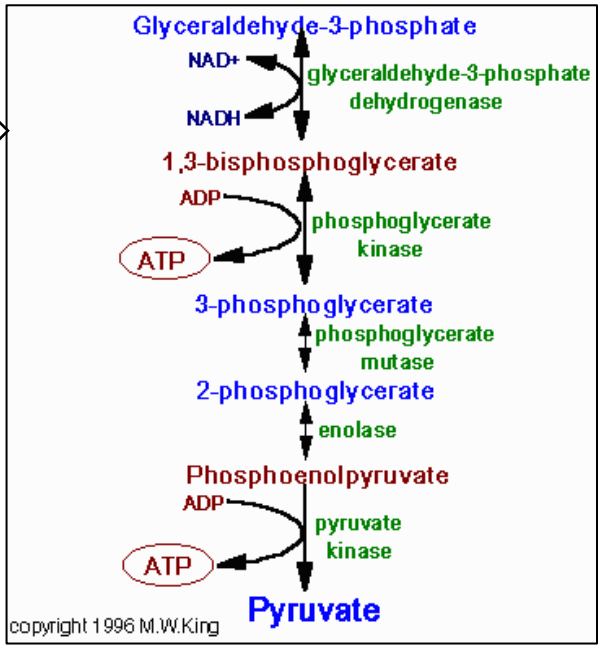
Glucose + 2 ATP $\rightarrow$ 2 NADH + 4 ATP + 2 pyruvate

Net energy outcome 2 NADH and 2 ATP

Mitochondria



Glycolysis



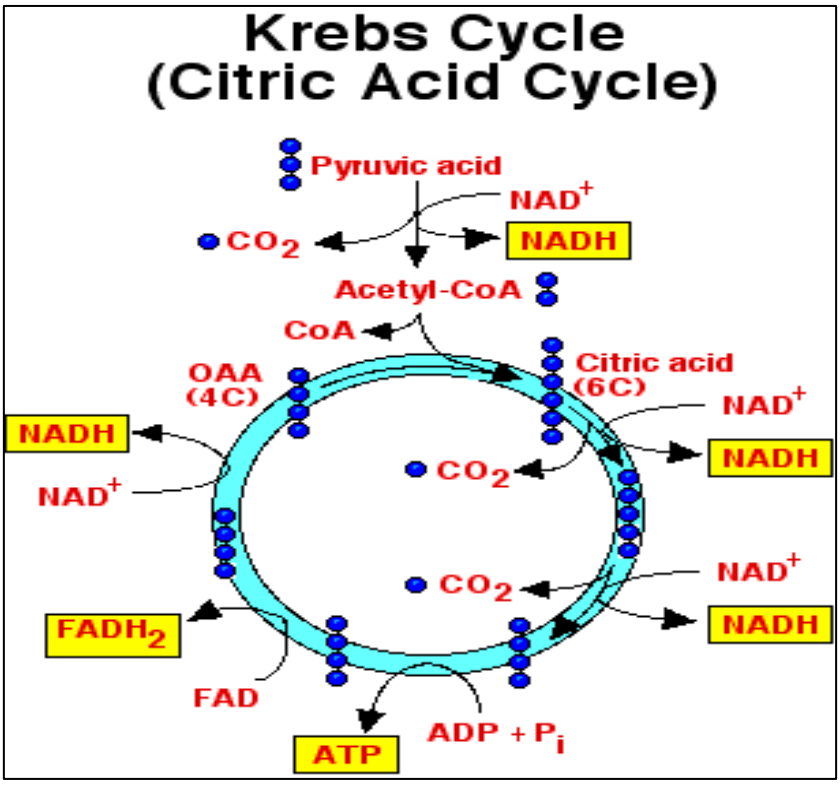
2- Krebs Cycle

Tricarboxylic acid Cycle (TCA Cycle)' or 'Citric Acid Cycle'

- Occurs in Mitochondrial Matrix
- Pyruvate broken down to CO_2 and the remaining 2 Cs (acetyl group) are added to Coenzyme A, Also can get Acetyl CoA from fats

- A Cyclic Series are used in other metabolic pathways to make various compounds

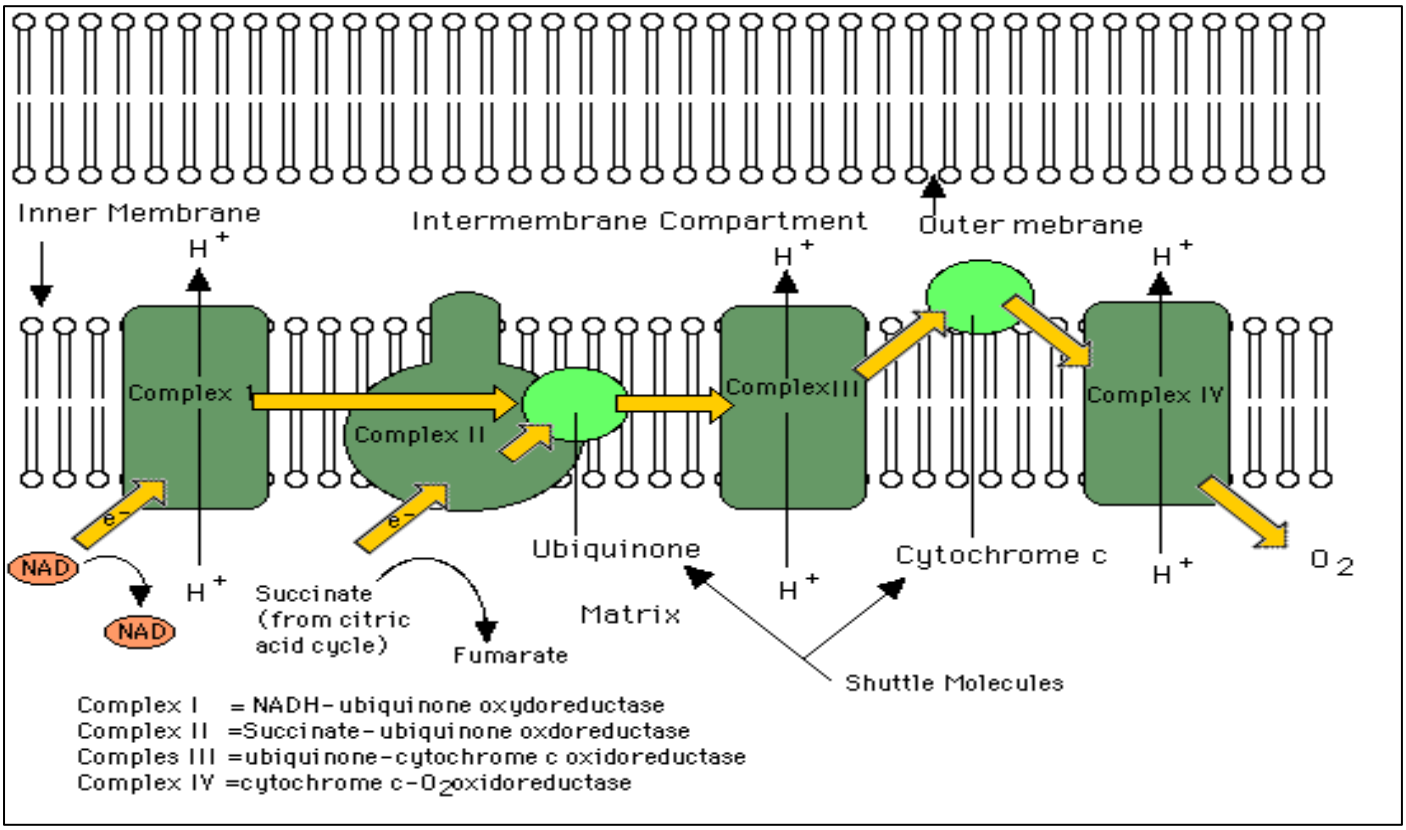
-Proteins, Lipids, Cell Wall Carbohydrates, DNA, Plant Hormones, Plant Pigments and many other Biochemical Compounds



3- Electron-Transport Chain

'Oxidative Phosphorylation'

- Final step in energy generation – most energy released here
- e^- of NADH and $FADH_2$ move through the chain, moving to lower energy level
- Occurs in the inner membrane of the mitochondria
- Specialized molecules accept and donate e^- as they move down chain
- Create an electrochemical gradient
  - As e^- move down chain, H^+ move across the membrane, altering the concentration of H^+ on either side = gradient
  - Gradient used to generate ATP.
  - Oxygen Is Required for this Step
  - Water Is Produced



Electron-Transport Chain

Review of the Energy Yield:

Glycolysis, Pyruvate Dehydrogenase and the TCA Cycle

- Glycolysis:

glucose (2pyruvate + 2NADH+2ATP 6-8 ATPs

- Pyruvate Dehydrogenase:

pyruvate (acetyl CoA + NADH 6 ATPs

TCA cycle:

- acetyl CoA(2CO2+3NADH+FADH2+GTP 2x12ATPs

OVERALL yield from glucose **36-38 ATPs**

Because NADH from cytosol to ETC within mitochondria carried by the dihydoxyacetone phosphate shuttle yields 2 ATP/NADH while the malate shuttle yields 3 ATP/NADH.

Anaerobic Respiration:

- **'Fermentation'**
- Occurs in Low-Oxygen Environments
  - Wet or Compacted Soils for Plants
- ATP Is still Produced from Glucose but not as Efficiently as with Aerobic Respiration

- Aerobic (with oxygen)

36 ATP molecules per glucose molecule

- Anaerobic (without oxygen)

2 ATP molecules per glucose molecule