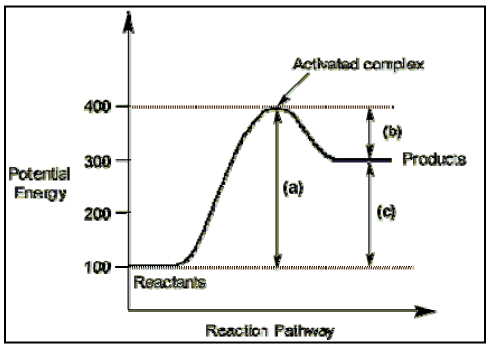
Cellular Respiration (8%)

I. Reactions

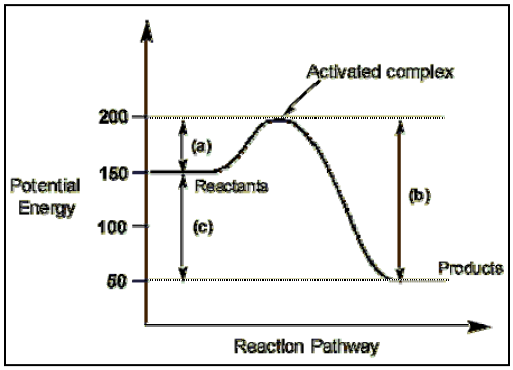
a. Endothermic



Endothermic

Endothermic: Heat energy taken in from surroundings → turned into potential energy in the products
Enthalpy: Products > Reactants
(a): The activation energy (Ea) for the forward reaction
(b): The activation energy (Ea) for the reverse reaction

b. Exothermic



Exothermic

Exothermic: Reactant's potential energy or enthalpy is released into the surroundings, usually in the form of heat
Enthalpy: Products < Reactants
(a): The activation energy (Ea) for the forward reaction
(b): The activation energy (Ea) for the reverse reaction

c. Enzymes (Covered in Week 1)

II. Organism Synthesization

i. Autotrophs
    1. synthesize their own organize molecules
    2. use sunlight to perform chemical reactions
ii. Heterorophs
    1. ingest organic molecules created by an outside source
    2. humans

III. Cellular Respiration (4-step process)

a. Glycolysis (1)
    i. Anaerobic (No Oxygen)
    ii. Glucose → Pyruvate
    iii. Result: 2 ATP, 2 NADH
        1. No Oxygen Present
            a. Fermentation
                i. Changes Pyruvate
                ii. Converts NADH → NAD^+
                iii. Allows Glycolysis to continue
                iv. Output comparison

Anaerobic (Fermentation)	Aerobic
2 ATP	32-36 ATP

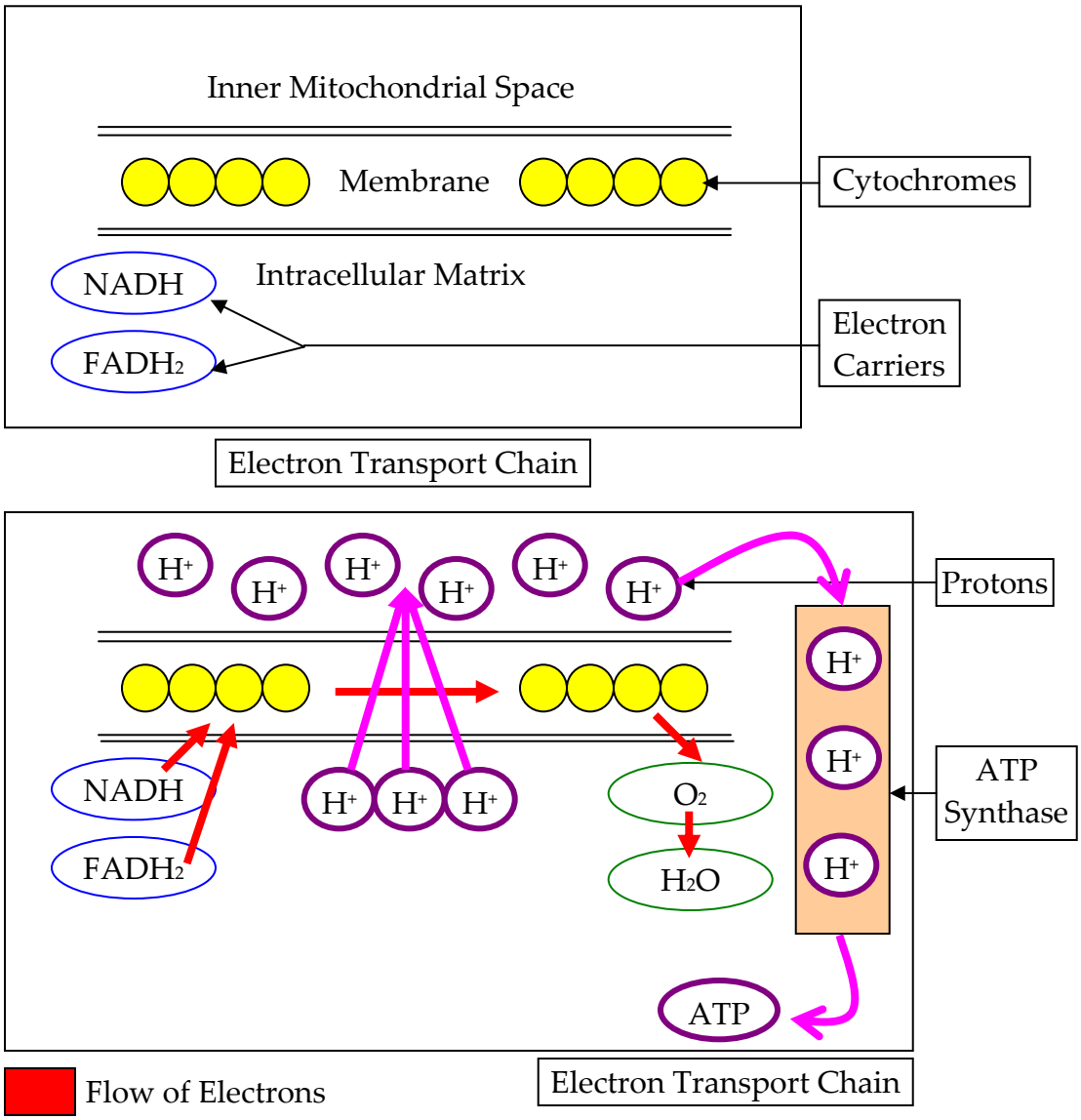
                v. Yeast and some bacteria
                    1. CO_2 and Ethanol
                vi. Animals
                    1. Lactic Acid

FOR EUKARYOTIC CELLS → ENTER MITOCHONDRIA

FOR PROKARYOTIC CELLS → CONTINUE IN CYTOPLASM

b. Pyruvate Oxidation (2)
    i. Pyruvate → Acetyl CoA
    ii. Result: 1 CO_2, 1 NADH
        1. Proteins, Nucleic Acids, and Lipids CAN be broken down to form Acetyl CoA
c. Citric Acid Cycle (Krebs Cycle) (3)
    i. Acetyl CoA goes through molecular changes
    ii. Result: NADH, $FADH_2$, CO_2

d. Electron Transport Chain (Oxidative Phosphorylation) (4)



i. Flow of Electrons
   1. Electron carriers transfer electrons to cytochromes in membrane
   2. Cytochromes transfer electrons to O_2
   3. O_2 transfers electrons to H_2O

ii. Flow of Protons
   1. Energy released by electrons pumps protons (H^+) from the intracellular matrix into the inner mitochondrial space
   2. Protons are pumped through the ATP synthase from low to high concentration

3. Protons are released from the ATP synthase in the form of ATP

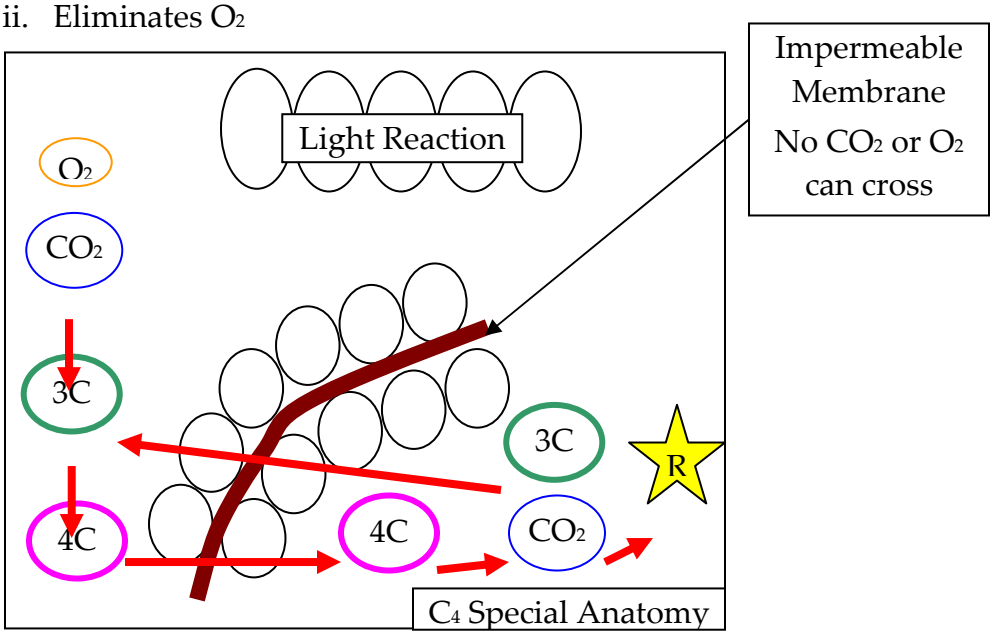
IV. Photosynthesis (2-Step Process)

a. Light Dependent Reaction (Light Reaction)
   i. Sunlight hits chlorophyll
   ii. Chlorophyll excites an electron
      1. Path 1
         a. Electron loses energy
         b. Electron energy pumps protons (H^+) through the membrane
         c. Protons (H^+) are pumped through the ATP synthase from low to high concentration
         d. Protons (H^+) are released from the ATP synthase in the form of ATP
      2. Path 2
         a. Electrons passed to $NADP^+$
         b. $NADP^+$ and electrons form NADPH
   iii. Photolysis
      1. "Breaking water by light"
      2. $H_2O \rightarrow H^+ + e^- + O_2$
      3. Replaces electrons lost by reactions
      4. Donates O_2 to reactions

b. Light In-dependent Reaction (Dark Reaction; Calvin-Benson Cycle)
   i. Uses energy in ATP + NADPH from Light Reaction to form "food"
   ii. CO_2 (1 carbon molecule) + RuBP (5 carbon molecule) + RUBISCO → Temporary (6 carbon molecule) → 2 (3 carbon molecules)
      1. Rubisco: Enzyme that catalyzes the reaction
         a. RuBP Carboxylase
      2. Product
         a. PGAL (3 carbon molecule)
         b. PGALs form Glucose and other polysaccarides such as starch.

V. Forms of Carbon

a. In a hot environment, Rubisco does not function properly
   i. Grabs O_2 instead of CO_2
b. C_3 Photosynthesis:
   i. Normal Way
c. C_4 Photosynthesis:
   i. Solves Rubisco problem in hot environments
   ii. Eliminates O_2



   iii. Process
      1. CO_2 combines with 3C to form 4C
      2. 4C travels over the impermeable membrane
      3. 4C breaks into 3C and CO_2
      4. Rubisco only finds CO_2 → No O_2
      5. Rubisco catalyzses reaction with CO_2 to form 6C
      6. 6C breaks into 2 - 3C
      7. 3C travels back over membrane to attach to more O_2
d. CAM Photosynthesis:
   i. Stomates are open during the night when it is cool
      1. CO_2 enters
      2. CO_2 → 4C for storage
   ii. Stomates are closed during the day when it is hot
      1. No H_2O loss
      2. 4C slowly broken down into CO_2 during the course of the day
   iii. CAM Plant has a normal leaf anatomy