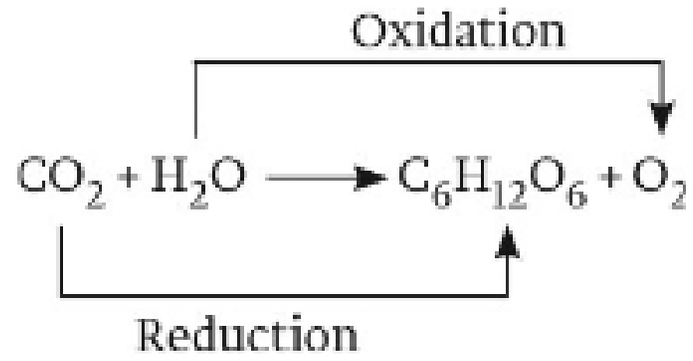
Chapter 8 – Photosynthesis

Part 1: Introduction



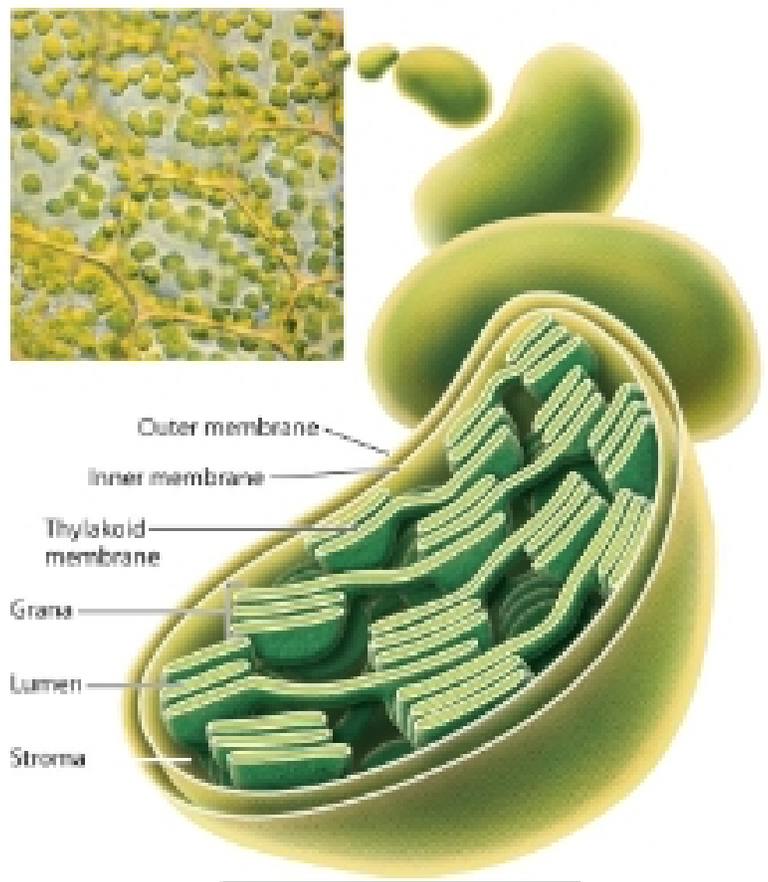
Redox Reaction

I. ***Redox reaction***
   - ***A.*** **Needs a source of electrons (H_2O)**
     - ***1.*** Product of oxidation of H_2O is O_2
   - ***B.*** Endergonic reaction (needs energy to proceed)
     - ***1.*** Energy comes in the form of **light**

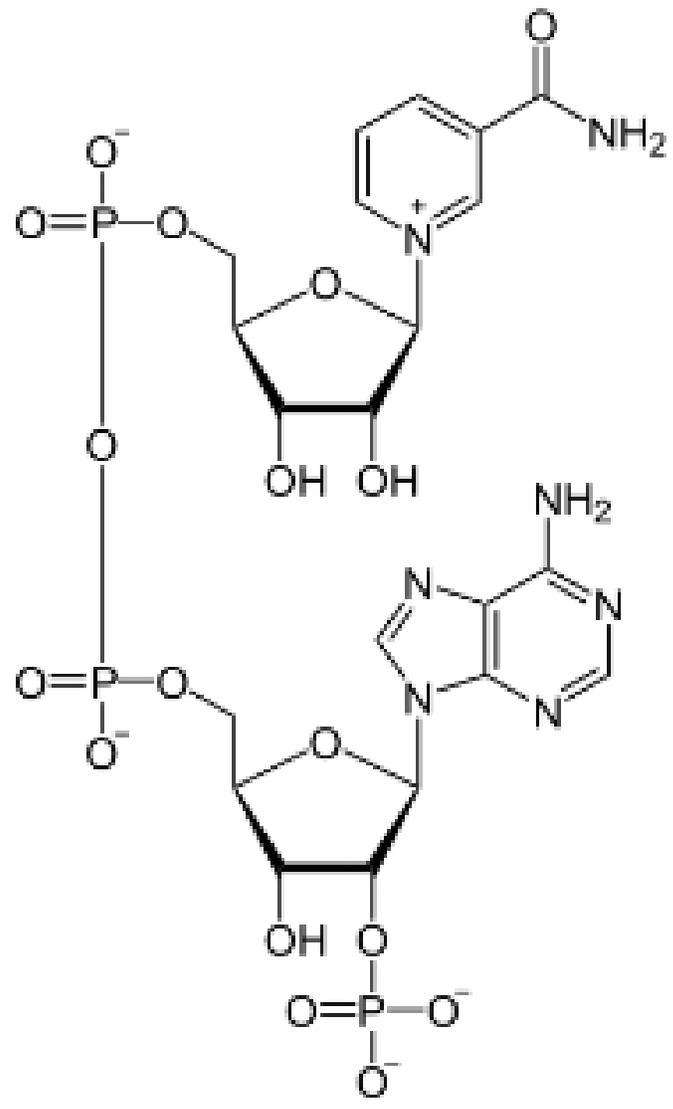
II. ***Chloroplast Structure:***
   - ***A.*** **Thylakoid**
     - ***1.*** Sub-divides a single space (like E.R.)
   - ***B.*** **Lumen**
     - ***1.*** Space inside the membrane of the thylakoid
   - ***C.*** **Stroma**
     - ***1.*** Fluid filled space inside the inner membrane but outside the thylakoid membrane

III. ***2 Sets of Reactions in the Chloroplast***
   - ***A.*** **Light Reactions:** use **water & light** to make **ATP & NADPH**
   - ***B.*** **Calvin cycle/Dark reactions**: use **ATP, NADPH, CO_2** to make **carbohydrates**
     - ***1.*** Can occur both in the light & in dark

IV. **NADPH –** primary electron donor of photosynthesis
   - ***A.*** NADH + Phosphate
   - ***B.*** Electron-rich
   - ***C.*** In the form of a di-nucleotide with an extra phosphate group:



Chloroplast



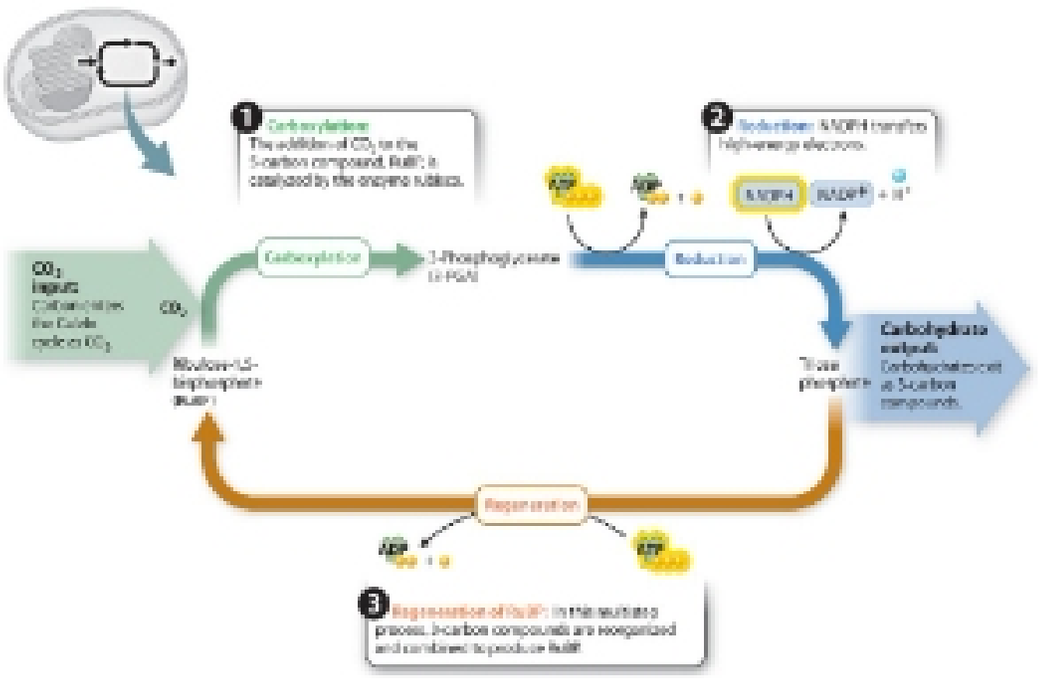
NADPH

Part 2: Calvin/Benson Cycle ("Dark Reaction")

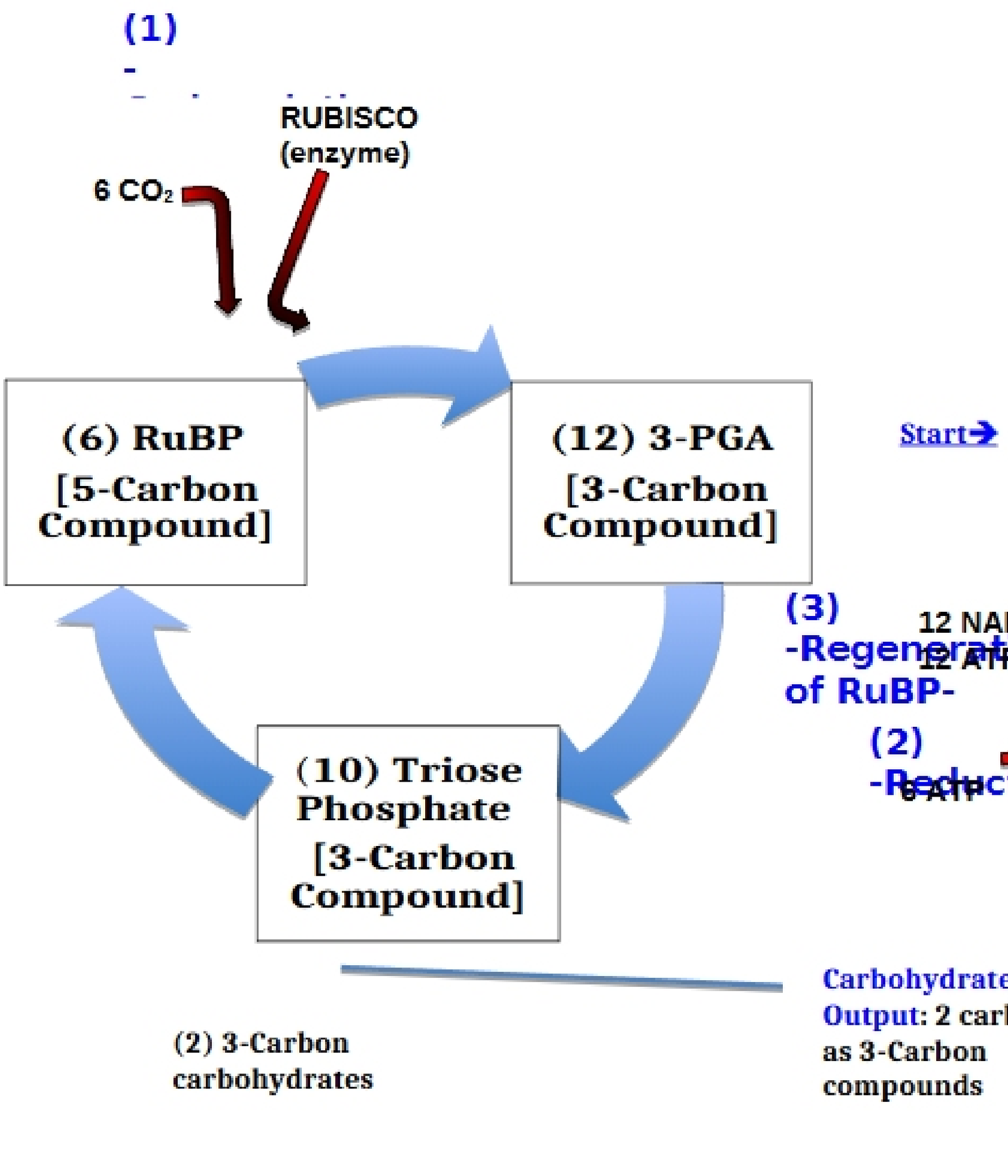
I. **Introduction**
   - ***A.*** In **stroma**
   - ***B.*** Uses **ATP & NADPH** to reduce **CO_2** to make **carbs**

II. **3 Steps of Calvin Cycle**
   - ***A.*** **Carbon Fixation (Carboxylation of RuBP)**
     - ***1.*** CO_2 absorbed from the air is added to RuBP
       - ***a.*** This reaction is catalyzed by **rubisco**
         - ***i.*** Most abundant enzyme on earth
   - ***B.*** **Reduction (of 3-PGA)**
     - ***1.*** Uses NADPH & ATP
     - ***2.*** NADPH➔$NAD^+ + H^+ + e^-$
     - ***3.*** NADPH transfers electrons to 3-PGA
   - ***C.*** **Regeneration (of RuBP)**
     - ***1.*** 10 Triose Phosphates are rearranged to produce 6 RuBP
       - ***a.*** Requires energy (6 ATP)

III. In total, **18 ATP** & **12 NADPH** are needed for every **6 CO_2** incorporated



Calvin Cycle



Part 3: Light Reactions

I. Occur in Thylakoid Membrane
II. Uses an electron transport chain
III. Relies on **Photosystems**: complexes of proteins & pigments that convert light energy to chemical energy
- ***A.*** Not found in mitochondria
- ***B.*** This is the part of photosynthesis that is light-dependent
- ***C.*** **Light Energy➔ Chemical Energy in 4 steps (Photosystem II – p680)**
  1. Light hits pigment molecules & is transferred through each one
  2. Energy (now in the form of a high energy electron) reaches p680 & turns it into p680*
  3. P680* transfers high-energy electron to primary electron acceptor (i.e., p680* is oxidized to $p680^{+}$)
  4. Oxidation of H_2O via Mn^{+2} complex gives $p680^{+}$ a low energy electron
     - ***a.*** This step also produces O_2 & H^{+}
     - ***b.*** p680 is the only protein system that can oxidize H_2O
  5. *Diagram*