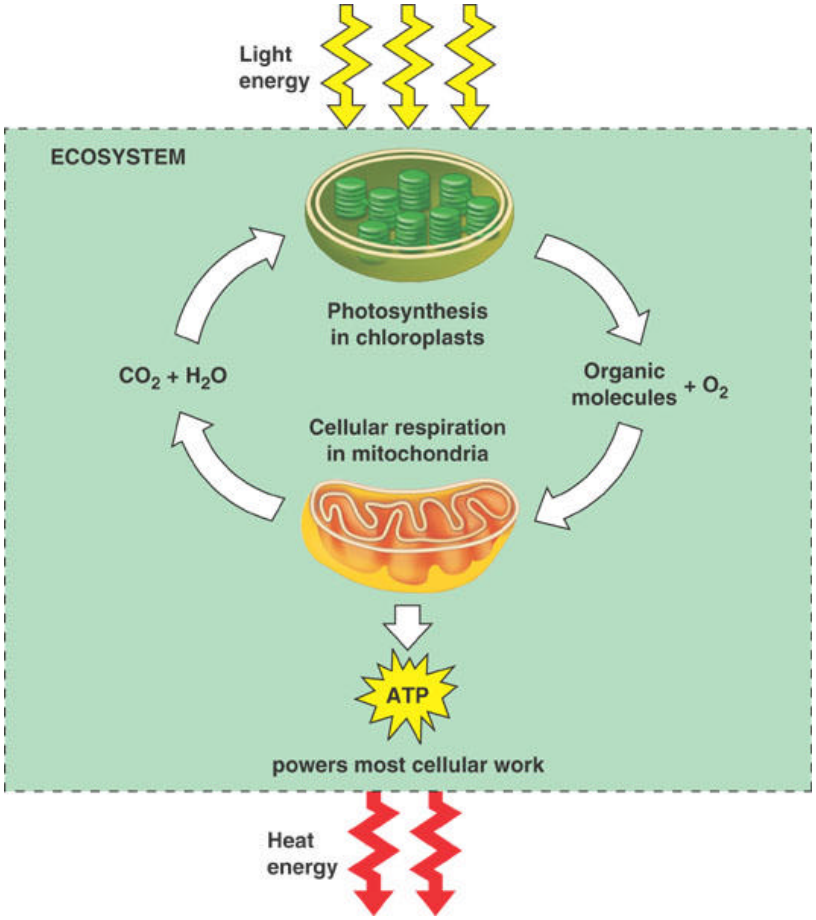
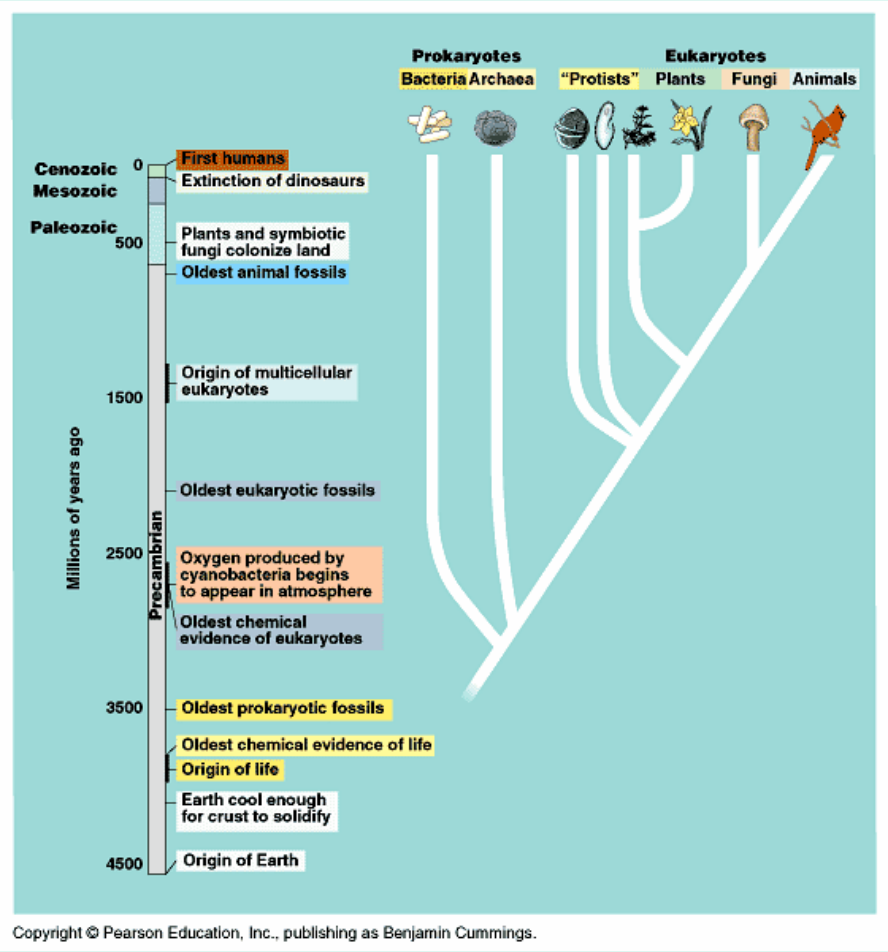
Photosynthesis

Photosynthesis: What is it?

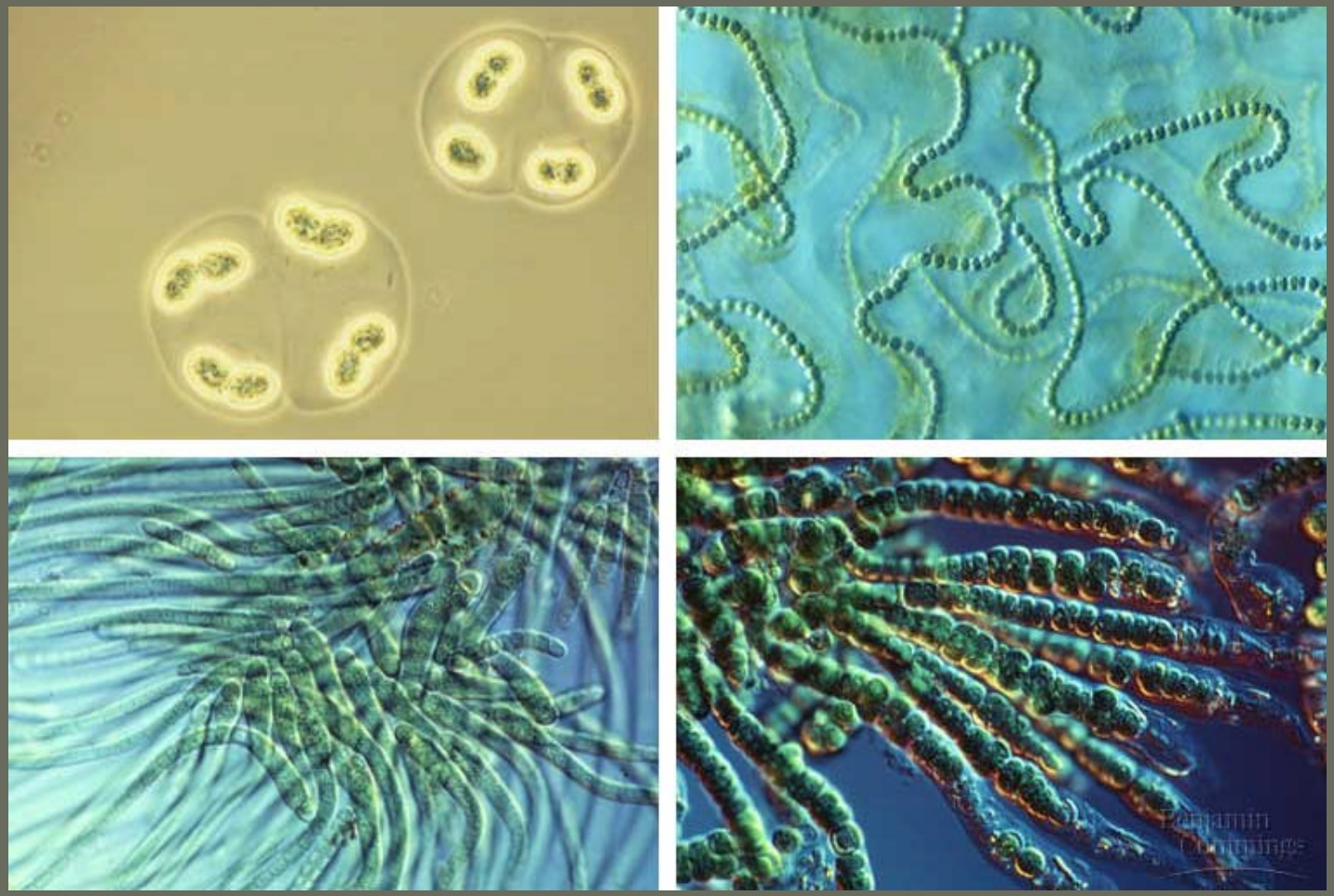
- Photosynthesis is the production of organic molecules utilizing light energy
- Photoautotroph organisms do photosynthesis



Photosynthesis: When Did It Start?



What Organisms First Did Photosynthesis?



Photosynthetic Bacteria:

http://www-micro.msb.le.ac.uk/video/Cyanobacteria.html

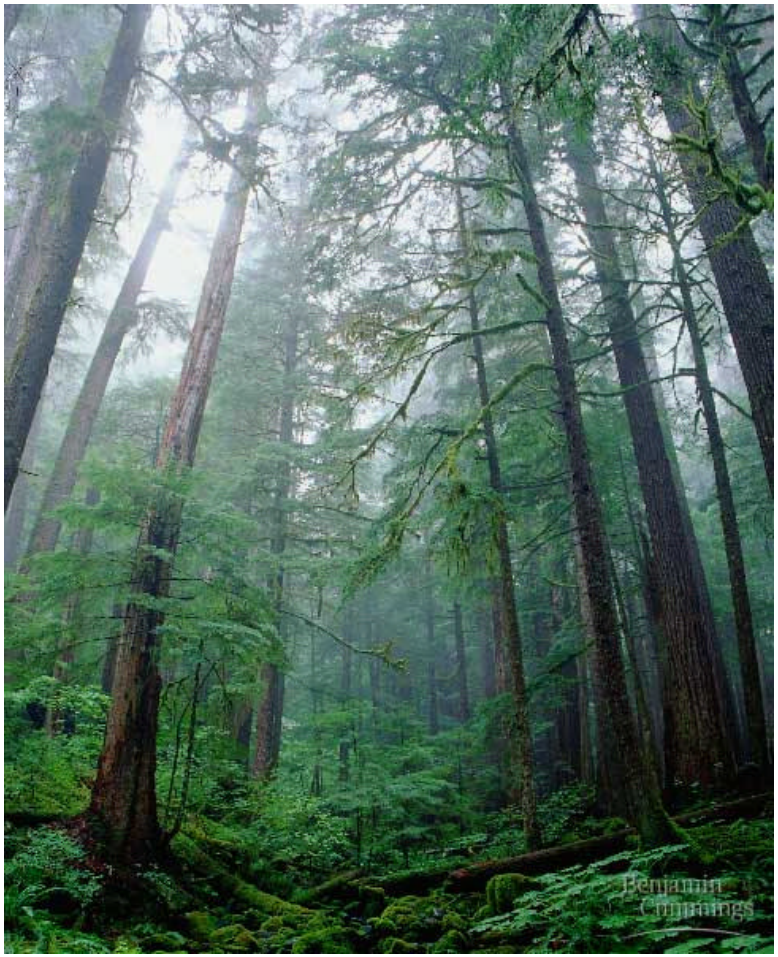
What Organisms Do Photosynthesis?

Plants

Photosynthetic Bacteria

Algae

The Flow of Energy or How Organisms Relate



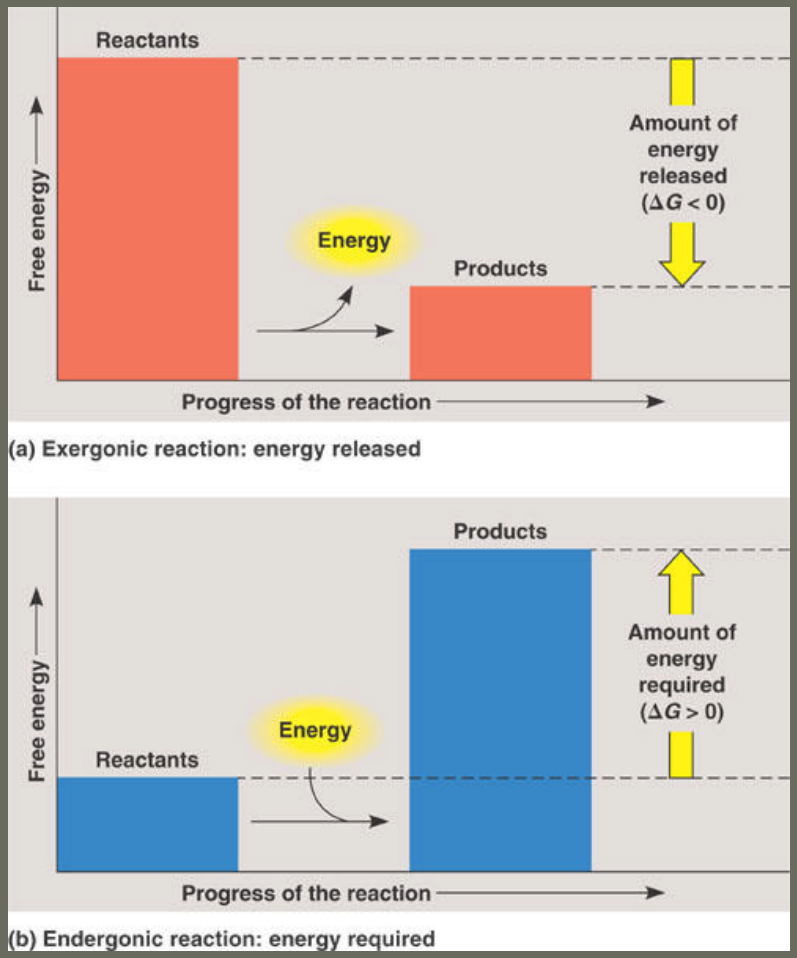
Producers or Autotrophs (Photoautotrophs)

Consumers or Heterotrophs

Decomposers

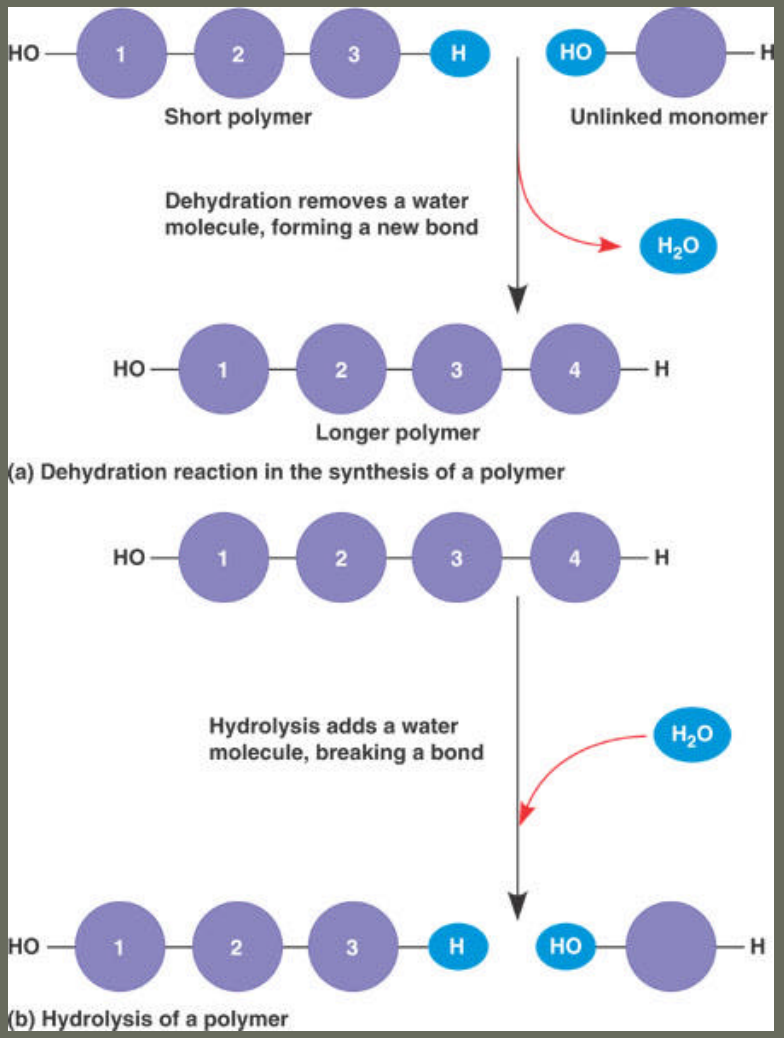
Energy and Metabolism
Endergonic and Exergonic Reactions

- When do our cells perform exergonic reactions?
- When do our cell perform endergonic reactions?



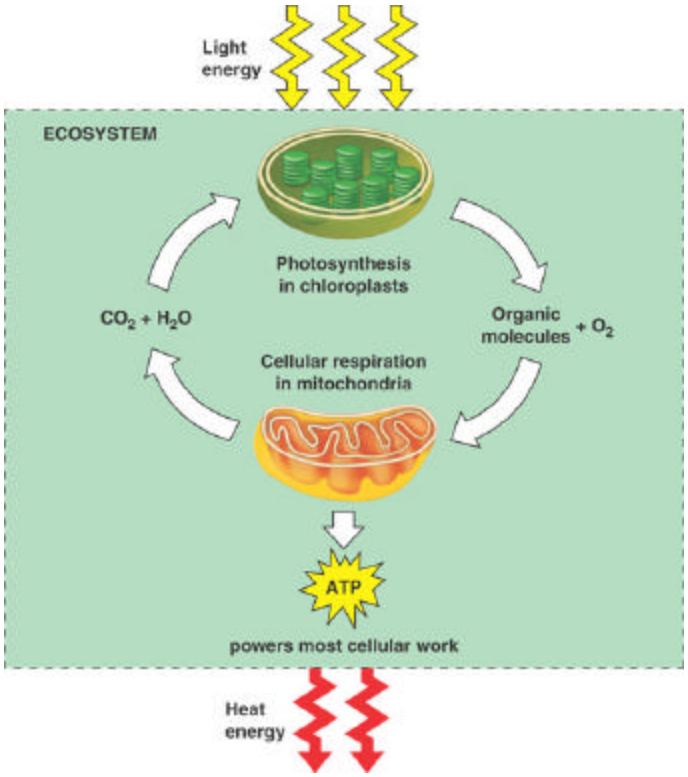
Energy and Metabolism
Biosynthetic and Degradative Pathways

- Biosynthetic Pathway: Anabolism
- Degradative Pathway: Catabolism

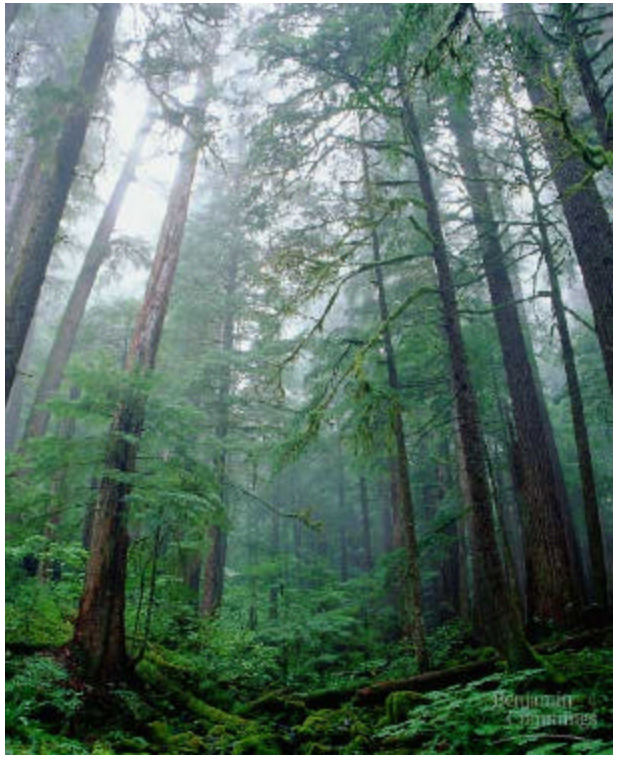


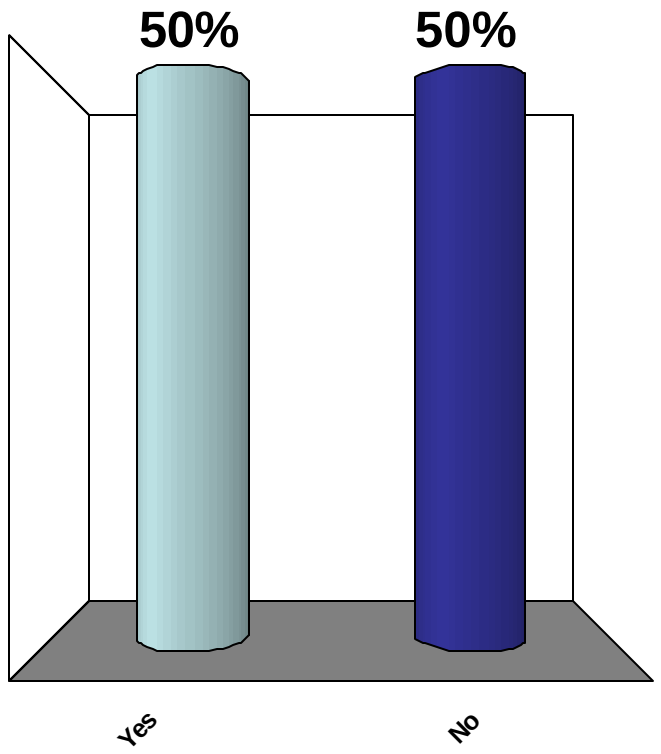
The Flow of Energy or How Organisms Relate

- Photoautotrophs synthesize high energy organic molecules during photosynthesis
- Both photoautotrophs and heterotrophs use such organic molecules to obtain energy (ATP) through cellular respiration for fueling cellular work



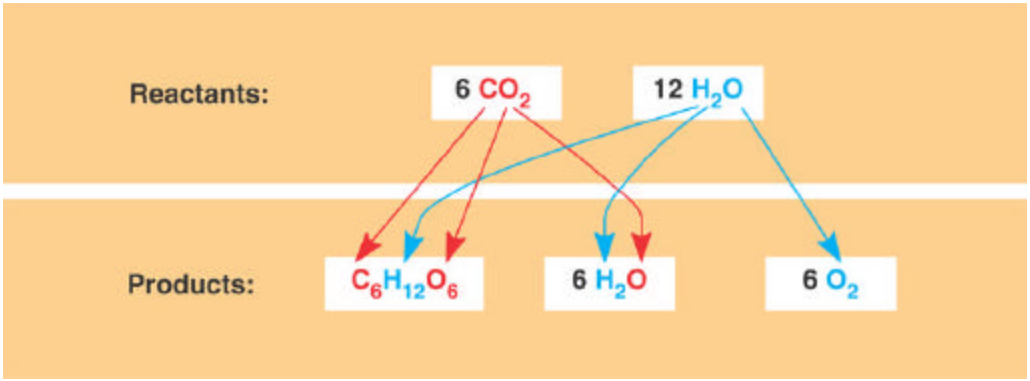
Plants need to burn sugars and fats to obtain ATP. Do you agree?





1. Yes
2. No

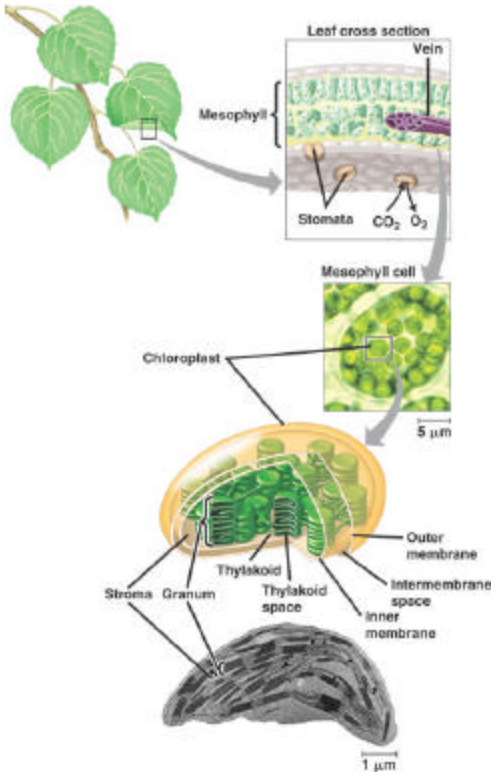
What is Photosynthesis?



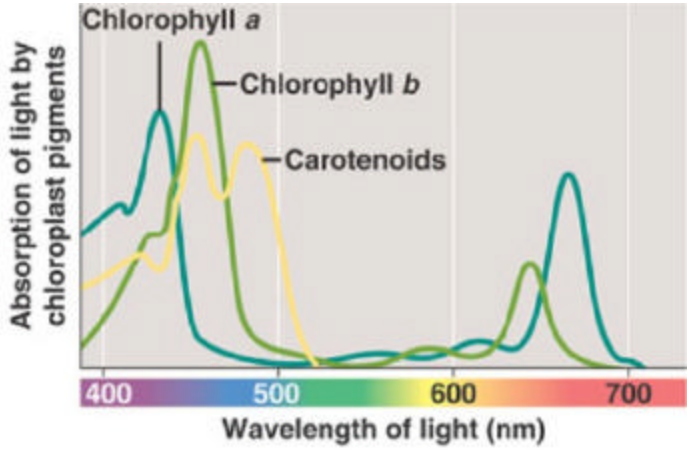
- Photosynthesis is:

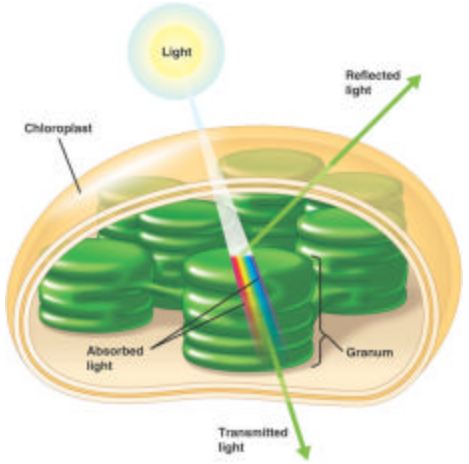
Where Does Photosynthesis Occur?

- Photosynthesis is carried out by pigments located in the thylakoid membranes of chloroplasts
- The plant organs that contain the largest amount of chloroplasts are the leaves



What Molecules Perform Photosynthesis?

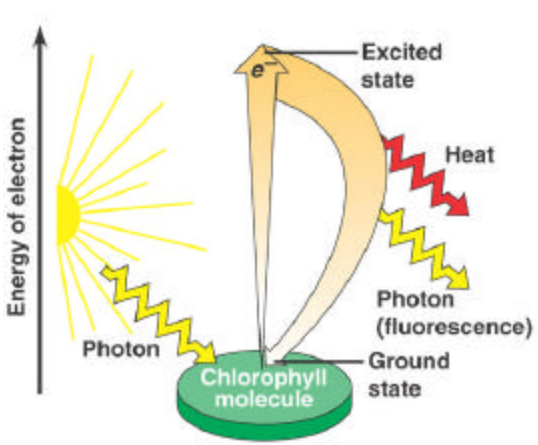




- Photosynthetic pigments (chlorophyll *a,* chlorophyll *b,* and several different types of carotenoids) are the molecules that transform light energy into chemical energy. Chlorophyll *a* is the most efficient photosynthetic pigment
- Pigments absorb different wavelengths. The amount of energy absorbed is inversely related to the wavelength of light; the shorter the wavelength is, the greater the energy of each photon in that wavelength

Photosynthetic Pigments: How Do They Work?

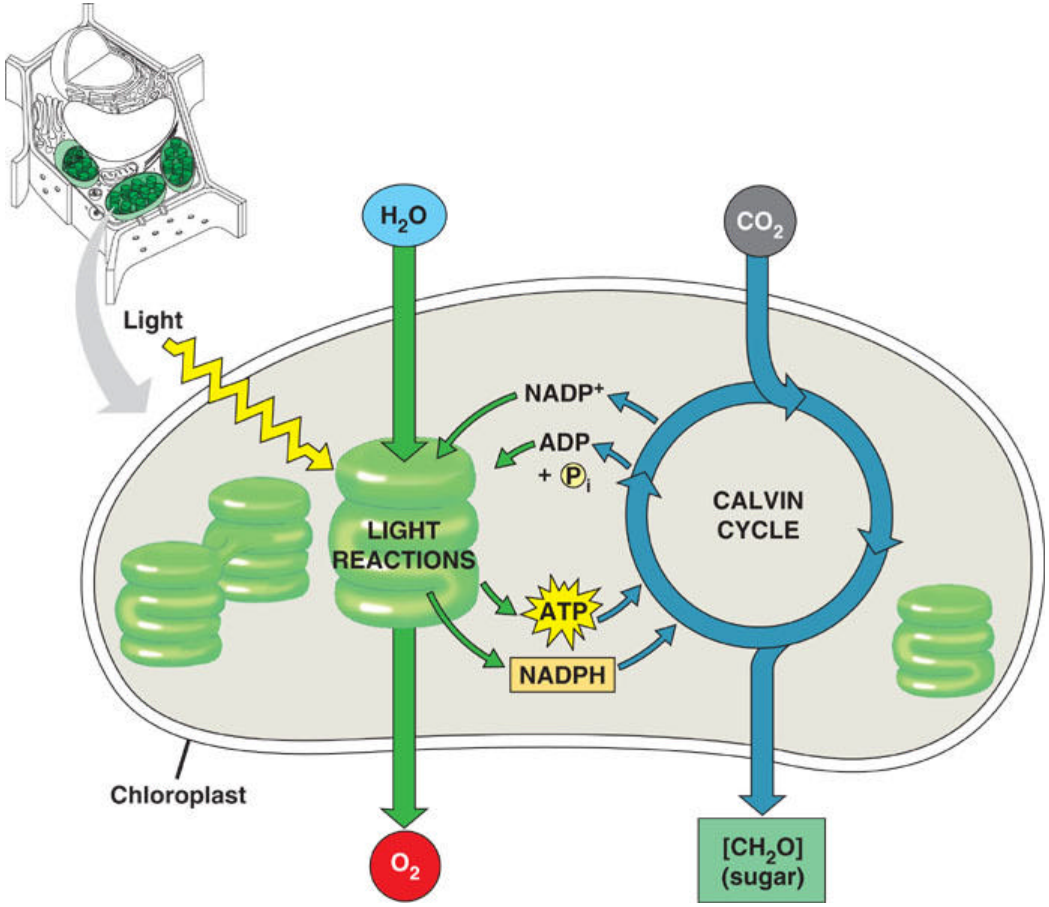
- When a molecule absorbs a *photon* (unit of energy light), one of the molecule's electrons is pushed from its *ground state* to an orbital more distant from the nucleus – to the *excited state*. As the electron goes back to its original orbital, it releases energy that can be used to turn on photosynthesis



(a) Excitation of isolated chlorophyll molecule

(b) Fluorescence

Reactions in Photosynthesis: Light Reactions and Dark Reactions

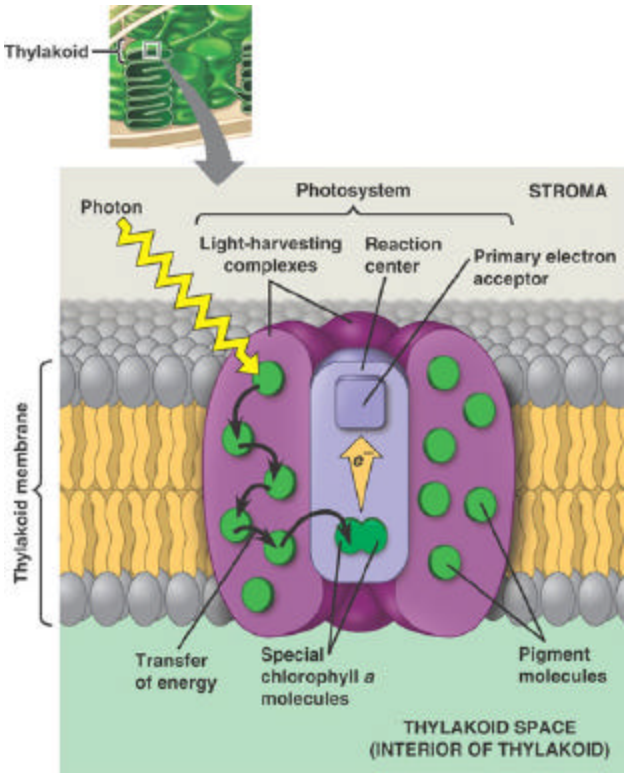


Light Reactions are also referred to as Light Dependent Reactions

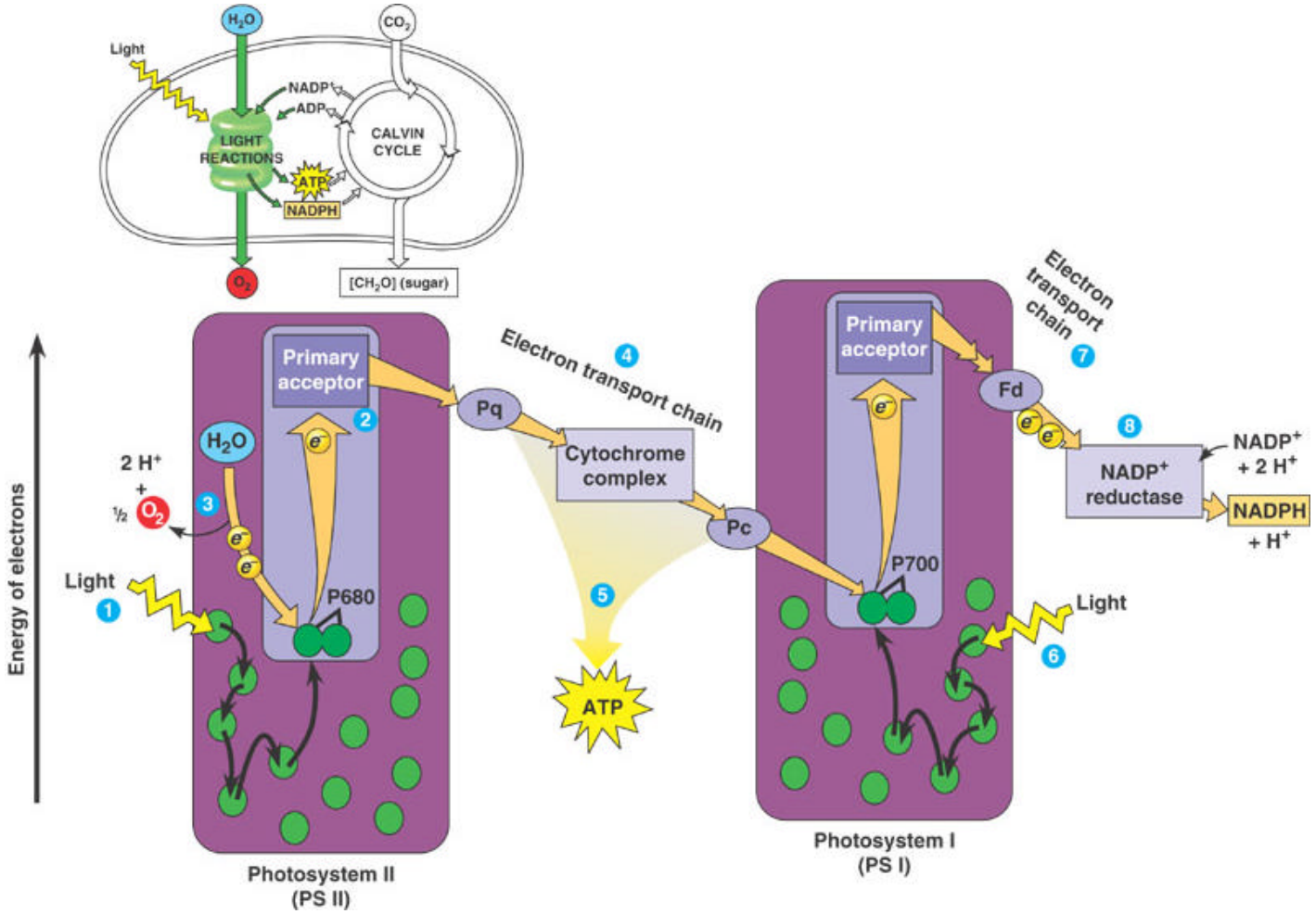
Dark Reactions are also referred to as Light Independent Reactions

Light Dependent Reactions: Photoexcitation of Chlorophyll *a*

- Light harvesting complexes consist of many pigments that function together to transfer light energy and excited electrons to chlorophyll *a,* located in the **reaction center**
- A **primary acceptor** receives the electron and turns on the light reactions of photosynthesis
- Photolysis of water molecules also release excited electrons that contribute to the light reactions

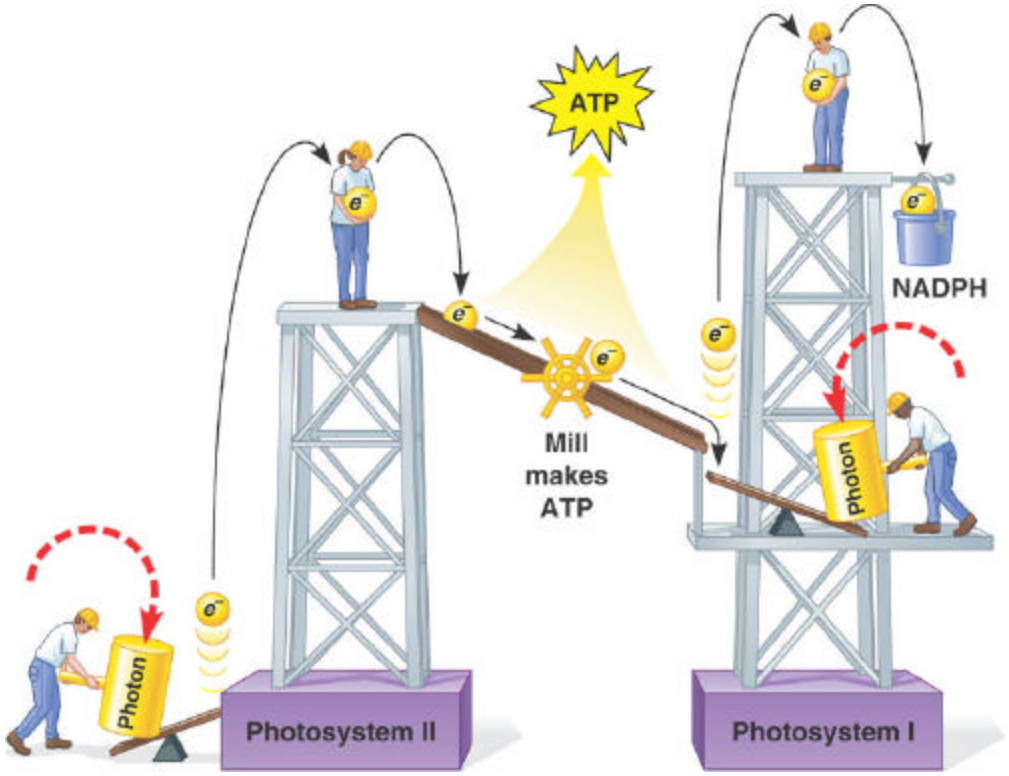


Light Dependent Reactions: Production of ATP and NADPH

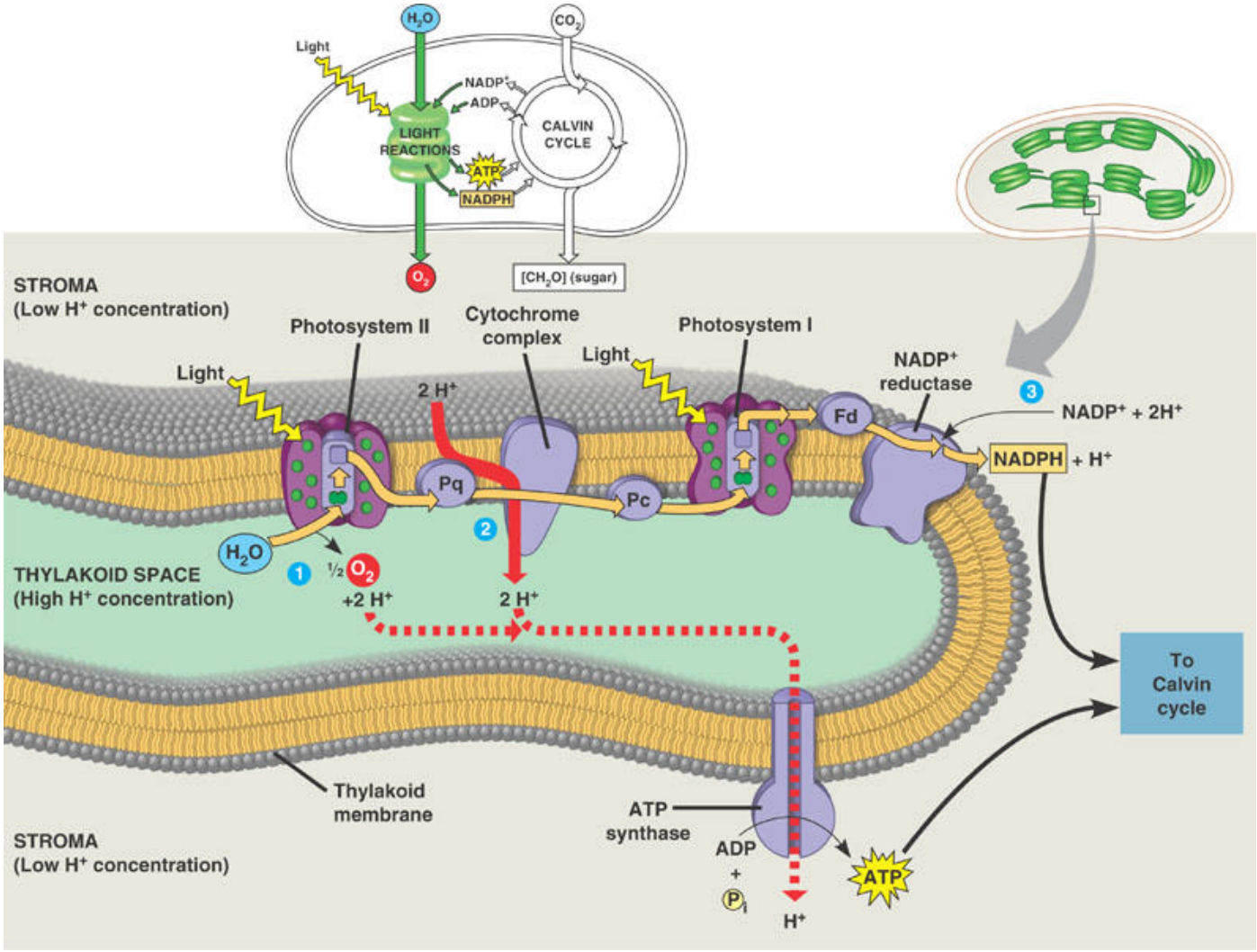


Pq: Plastoquinone; Pc: Plastocyanin; Fd: Ferredoxin

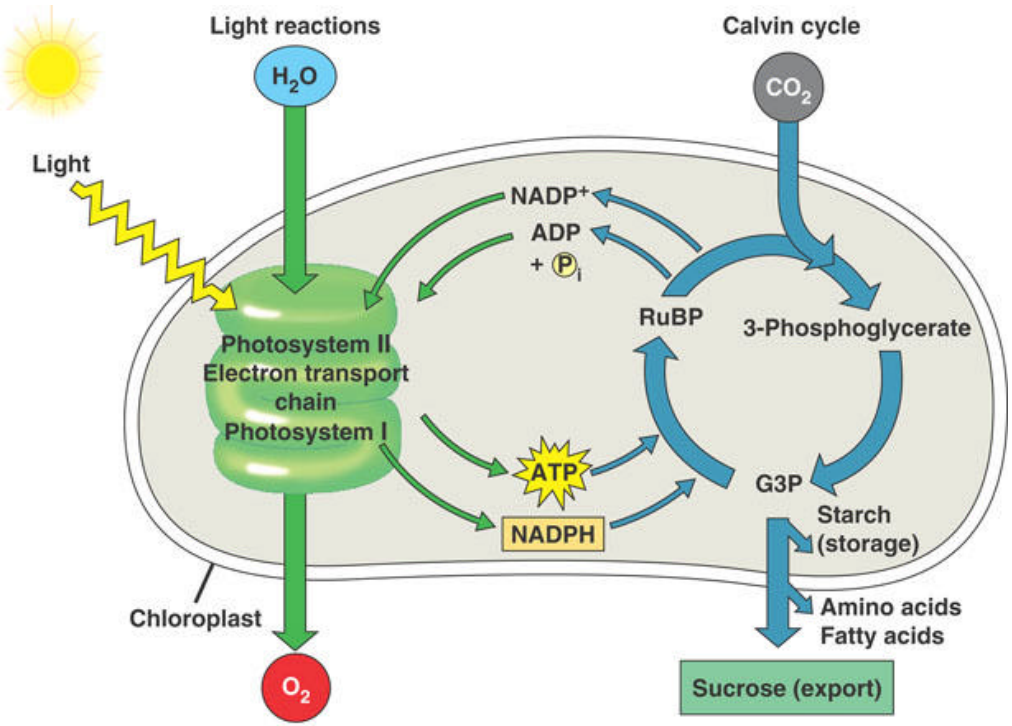
Light Dependent Reactions: Production of ATP and NADPH



Light Dependent Reactions: Production of ATP and NADPH



Light Independent Reactions: Production of Glucose



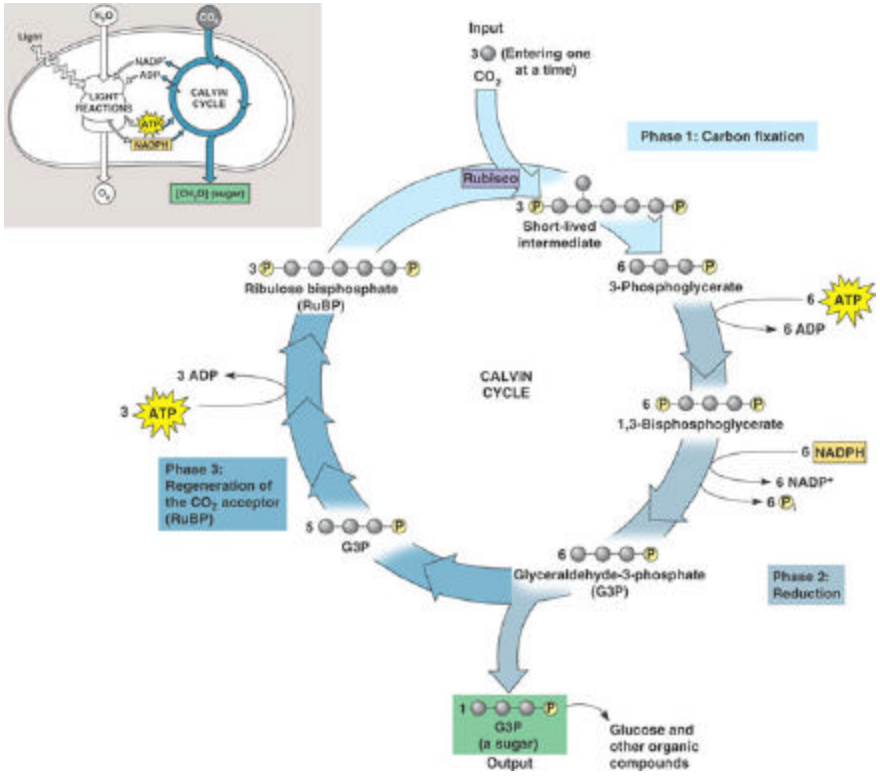
Light reactions:

- Are carried out by molecules in the thylakoid membranes
- Convert light energy to the chemical energy of ATP and NADPH
- Split H_2O and release O_2 to the atmosphere

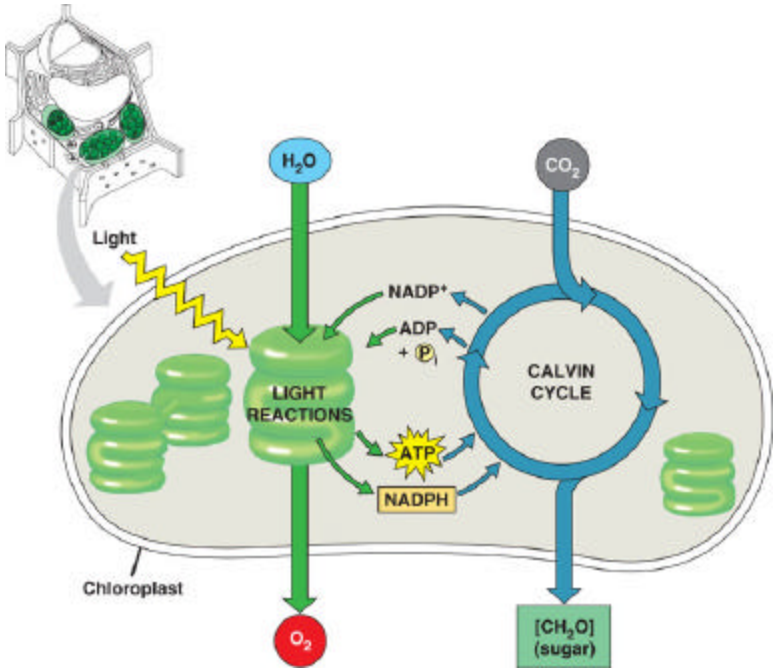
Calvin cycle reactions:

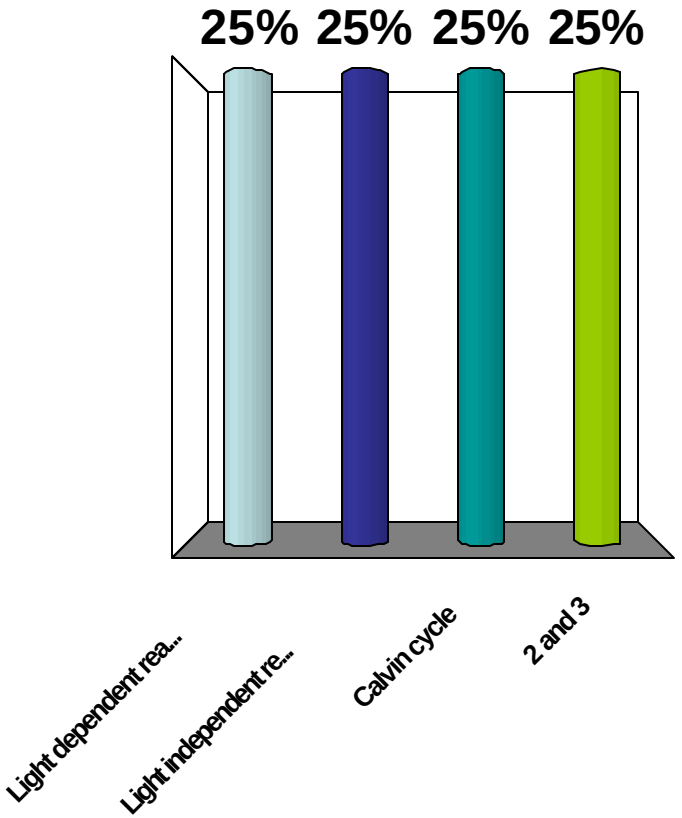
- Take place in the stroma
- Use ATP and NADPH to convert CO_2 to the sugar G3P
- Return ADP, inorganic phosphate, and $NADP^+$ to the light reactions

Production of Glucose: The Calvin Cycle



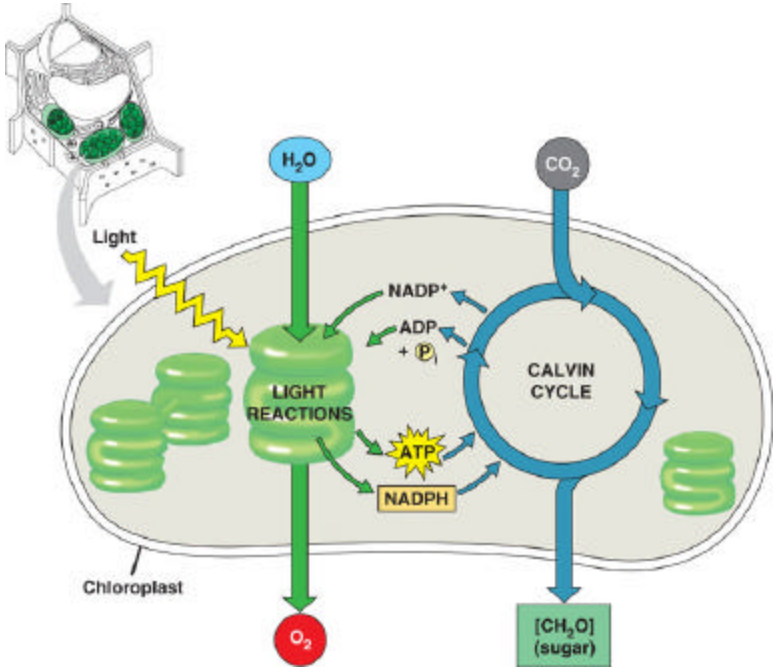
During photosynthesis, ATP is produced in:

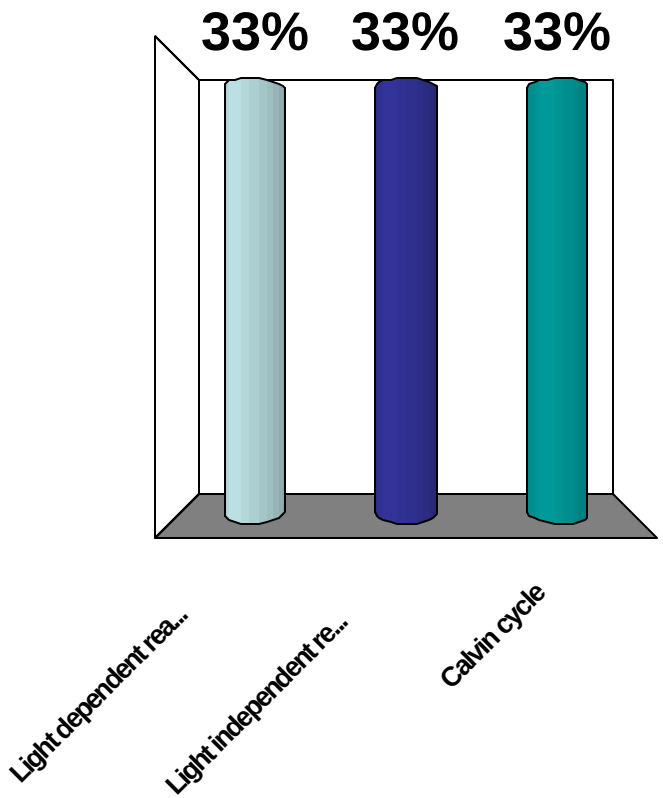




1. Light dependent reactions
2. Light independent reactions
3. Calvin cycle
4. 2 and 3

During photosynthesis, glucose is produced in:





1. Light dependent reactions
2. Light independent reactions
3. Calvin cycle