8-2 Photosynthesis: An Overview

A. The Photosynthesis Equation

1. The equation for photosynthesis is:

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

carbon dioxide + water → sugars + oxygen

- Photosynthesis uses the energy of sunlight to convert water and carbon dioxide into high-energy sugars and oxygen.

B. Light and Pigments

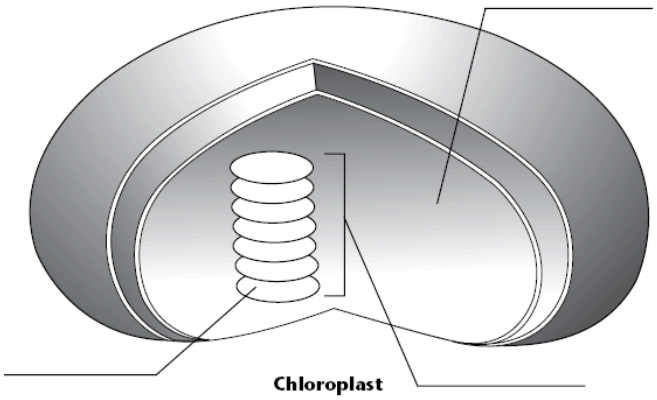
1. In addition to water and carbon dioxide, photosynthesis requires light and chlorophyll.
2. Plants gather the sun's energy with light-absorbing molecules called pigments.
3. The main pigment in plants is chlorophyll.
4. There are 2 main types of chlorophyll: chlorophyll *a* and chlorophyll *b*
5. Visible spectrum- the wavelengths of sunlight you can see which contain all the colors
    a. ROYGBIV- red, orange, yellow, green, blue, indigo, violet
6. Chlorophyll absorbs light well in the blue-violet and red regions of the visible spectrum.
7. Chlorophyll does not absorb light well in the green region of the spectrum.
8. Green light is reflected by leaves, which is why plants look green.

9. Light is a form of energy, so any compound that absorbs light also absorbs energy from that light.
10. When chlorophyll absorbs light, much of the energy is transferred directly to electrons in the chlorophyll molecule, raising the energy levels of these electrons.
11. These high-energy electrons are what make photosynthesis work.

8-3 The Reactions of Photosynthesis

A. Inside a Chloroplast

1. In plants, photosynthesis takes place inside chloroplasts.
2. Chloroplasts have saclike photosynthetic membranes called thylakoids
3. Thylakoids are arranged in stacks known as grana. A singular stack is called a granum.
4. Proteins in the thylakoid membrane organize chlorophyll and other pigments into clusters called photosystems, which are the light-collecting units of the chloroplast.



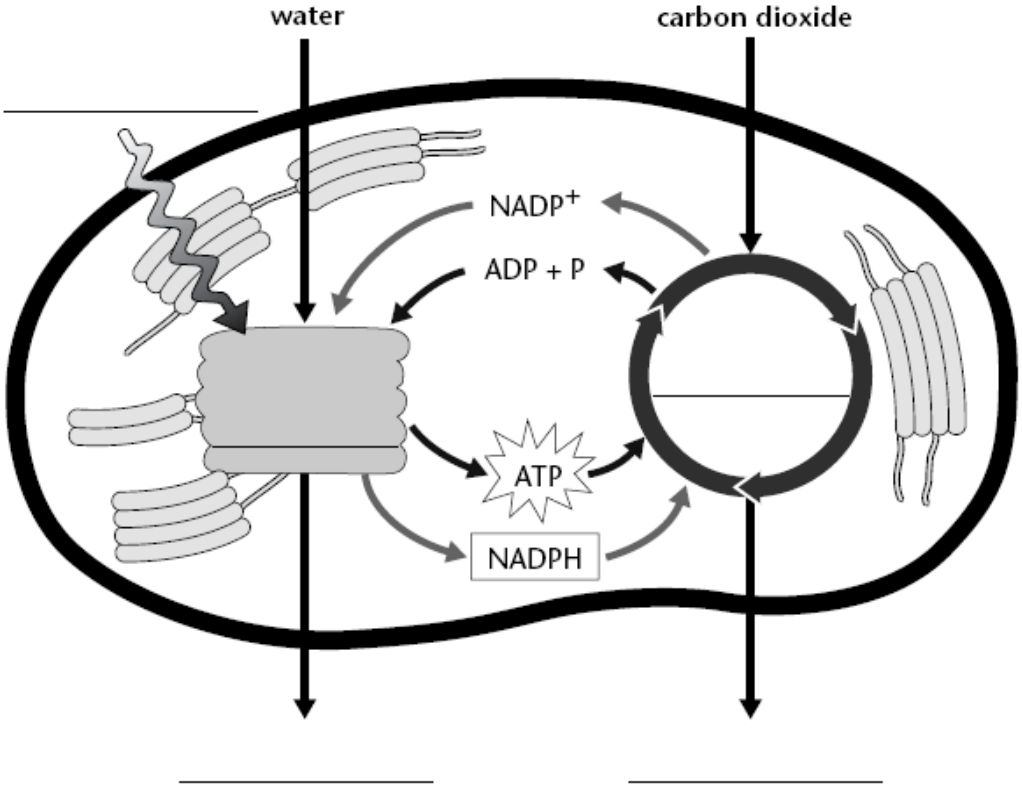
In the diagram of the chloroplast label… thylakoid, stroma, and gramum.

B. Electron Carriers

1. When sunlight excites

electrons in chlorophyll, the electrons gain energy.
2. The electrons transfers its energy to another molecule
3. The energy continues to move from molecule to molecule until it gets to the end of the chain
4. There are 2 parts to this reaction:
    a. The light dependent reactions- produce oxygen gas and convert ADP and $NADP^+$ into ATP and NADPH.

Use the following words to label the diagram: Calvin cycle, light-dependent reaction, light energy, oxygen, sugars.



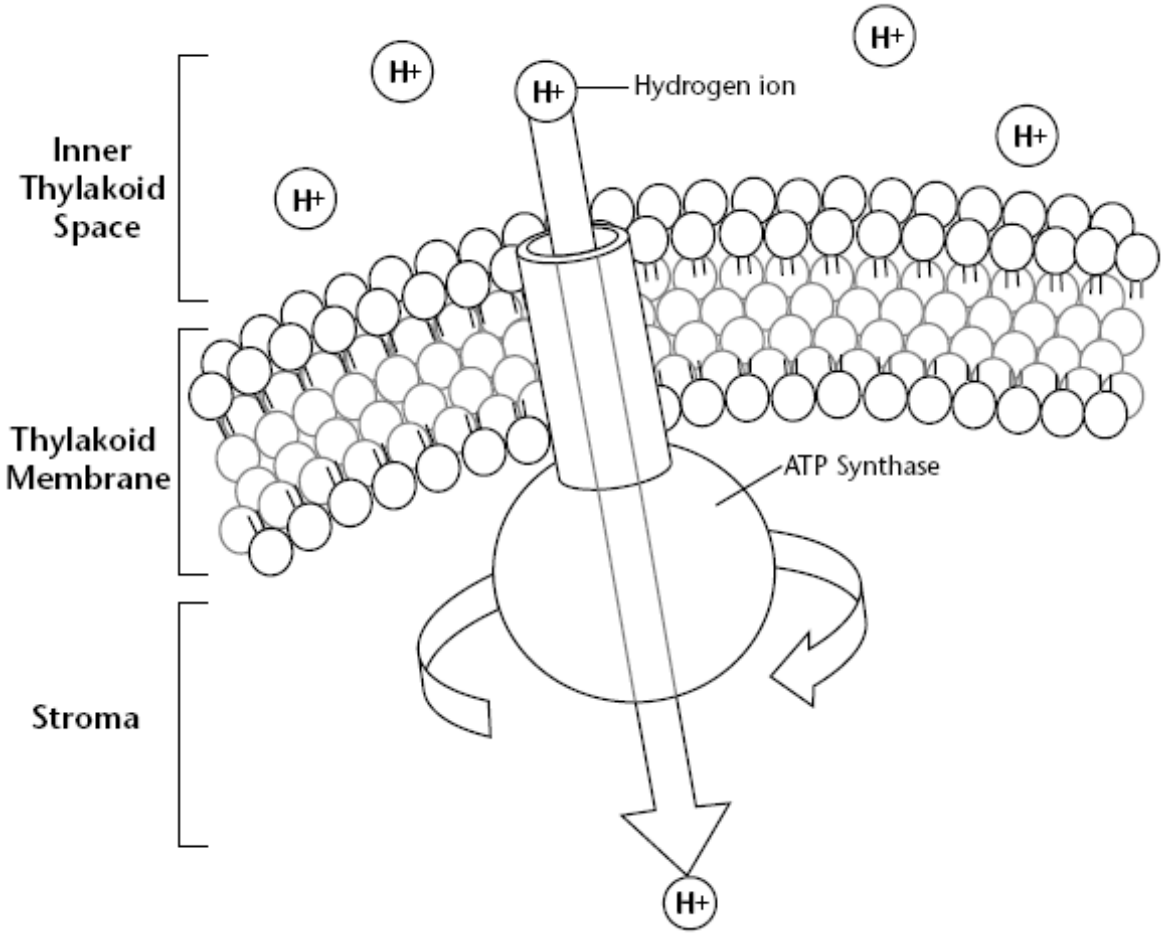
i. These reactions need light and occur in the thylakoid membranes
ii. Reactions can be divided into 4 processes: light absorption, oxygen production, electron transport, and ATP formation.
iii. The light dependent reactions use water, ADP, and $NADP^+$

ATP formation in the light-dependent reactions of photosynthesis

Color the arrow that shows how ATP synthase spins. Then draw in the formation of ATP from ADP.

Q: Where does the formation of ATP take place?

A: stroma



iv. They produce oxygen, ATP and NADPH

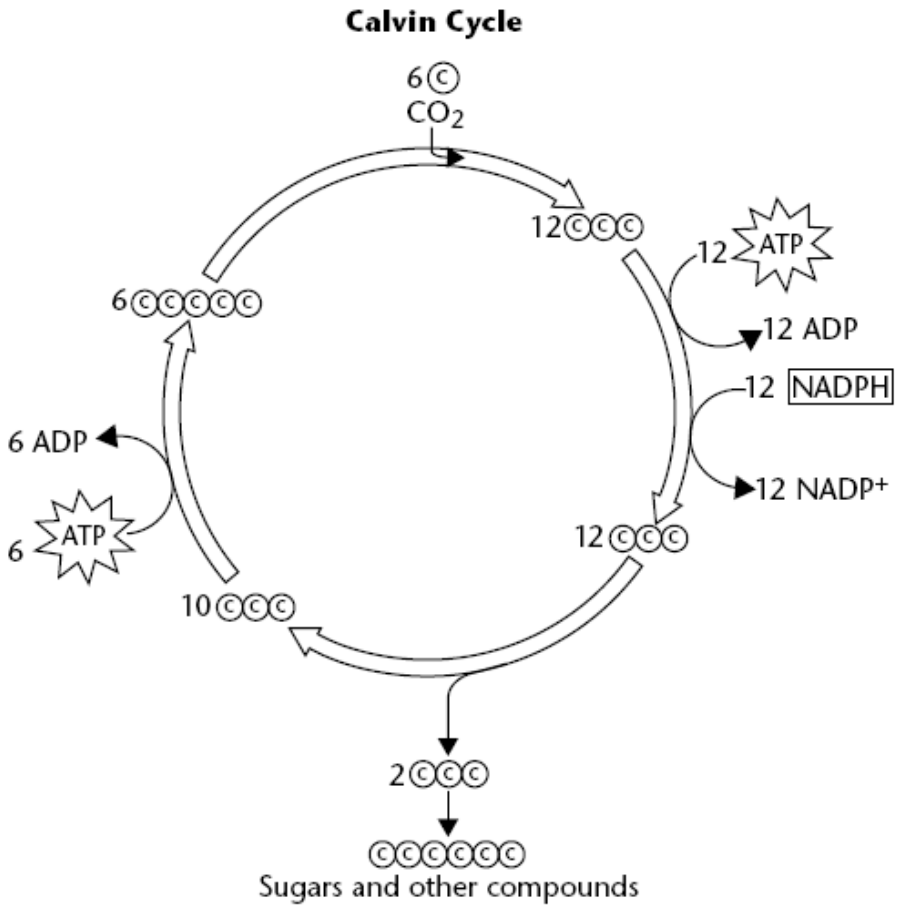
b. The light-independent reactions (Calvin Cycle)- uses ATP and NADPH from the light-dependent reaction to produce high-energy sugars.
   i. Does not require light
   ii. Calvin Cycle takes place in the stroma

iii. Uses carbon dioxide in its reactions and works steadily to remove carbon dioxide from the atmosphere
iv. Produces energy-rich sugars
v. 6 carbon dioxide molecules are needed to produce a single 6-carbon sugar

The Calvin Cycle

Circle the places where ATP and NADPH are used.
Then, draw an X over the 6-carbon high energy sugar produced by the Calvin Cycle

Q: How many molecules of CO_2 are used to produce one 6-carbon sugar molecule?
A: six



5. Many factors affect the rate of photosynthesis like: water availability, temperature, and intensity of light.

In your text book on p. 213….

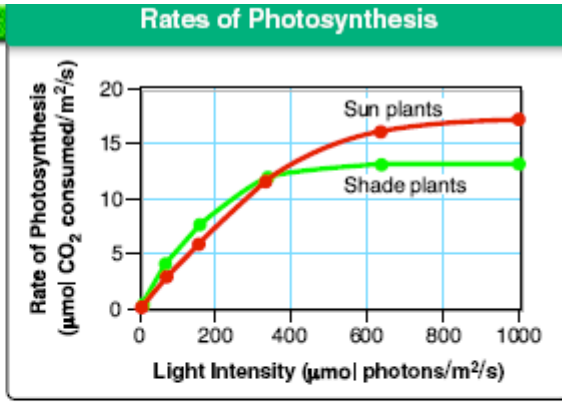
Analyzing Data

Rates of Photosynthesis

The rate at which a plant carries out photosynthesis depends in part on its environment. Plants that grow in the shade, for example, carry out photosynthesis at low levels of light. Plants that grow in the sun, such as desert plants, typically carry out photosynthesis at much higher levels of light.

The graph compares the rates of photosynthesis between plants that grow in the shade and plants that grow in the sun. It shows how the rate of photosynthesis changes with the number of micromoles of photons per square meter per second (µmol photons/m²/s), a standard unit of light intensity.

1. **Using Tables and Graphs** When light intensity is below 200 µmol photons/m²/s, do sun plants or shade plants have a higher rate of photosynthesis?
2. **Drawing Conclusions** Does the relationship in question 1 change when light intensity increases above 400 µmol photons/m²/s? Explain your answer.



3. **Inferring** The average light intensity in the Sonoran Desert is about 400 µmol photons/m²/s. According to the graph, what would be the approximate rate of photosynthesis for sun plants that grow in this environment?
4. **Going Further** Suppose you transplant a sun plant to a shaded forest floor that receives about 100 µmol photons/m²/s. Do you think this plant will grow and thrive? Why or why not? How does the graph help you answer this question?