Photosynthesis:

Ultimately, almost all life is dependent on plants (or algae, etc.):

Plants take sunlight and convert it into energy (sugar molecules).

\[
\text{sunlight} \quad 6 \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2
\]

Before we tackle photosynthesis, some background:

Autotroph - means “self feeder” Plants get their food from sunlight (above equation).

Heterotrophs - get energy by feeding on something else (almost everything eventually derives from plants). We are heterotrophs.

Chloroplasts:

Found in plants and eukaryotic algae.

Are green and are the parts that actually carry out photosynthesis [OVERHEAD, fig. 7.2, p. 109].

Within the chloroplast there are membranous sacs called thylakoids.

The fluid between the thylakoids and the inside membrane is known as the stroma.

Two stages to photosynthesis [OVERHEAD, fig. 7.5, p. 111]:

Light reactions - take place within the thylakoid membranes.

Convert light energy into chemical energy. Also produce \( \text{O}_2 \) as a waste product.

This energy is stored as ATP and NADPH. NADPH stores energy in by attaching to electrons. Remember this from respiration (NADPH is similar to NADH).

Calvin cycle - takes place within the stroma.

This is where \( \text{CO}_2 \) is converted into sugars, using the energy provided by the light reactions.

Does not require light, though usually only active if light reactions are going.

Source of energy:

Electromagnetic radiation (light). All light has energy in it (this should be obvious).

Chlorophyll can absorb visible light, particularly in the blue-violet ranges and red ranges.
Light that is reflected is not used. Green is reflected, so plants look green.

See [OVERHEAD, fig. 7.6B, p. 112].

Other pigments (caroten, xanthophyll) can help with this. These are the pigments that become visible when leaves change color (chlorophyll falls apart quickly, and what we see is these other pigments).

**Photons and electrons:**

Light waves consist in part of photons (we're glossing over a lot of physics here).

These photons hit the chlorophyll, and cause the chlorophyll to donate a high energy electron to other molecules.

Using electrons [OVERHEAD, simplified from figs. 7.8 and 7.9, pp. 114 - 115]:

There exist two photosystems. Each uses light to put energy into electrons.

Photosystem II uses light energy to energize electrons.

These are donated to photosystem I. In the process photosystem II uses up water and makes O\(_2\) (it replaces it’s electrons from water) and Hydrogen ions.

Photosystem I gets its electrons from photosystem II

Via an electron transport chain that makes ATP

Photosystem I gives this electron a boost (from light) and then makes NADPH.

The end result is that ATP and NADPH are made from the light reactions.

**Calvin cycle (summary only - details in text):**

The Calvin cycle uses the energy made in the light reactions (ATP & NADPH) to convert CO\(_2\) into sugar.

Essentially, one molecule of CO\(_2\) is used at a time. Thus to make glucose (a 6 carbon sugar), we need to go through the cycle 6 times.

**Energy usage:**

The sugars made through these processes power everything that the plant needs (incl. cellular respiration & the Krebs cycle), as well as all animal life on the planet (eating meat only means eating something that ultimately eats plants if one goes down the food chain far enough).