

Photosynthesis

Photosynthesis is executed in 2 reactions:

1) Light reactions: Produce the energy ^{and molecules} needed for the calvin cycle to function. This energy ^{the resultants} and molecules are presented as ATP and NADPH.

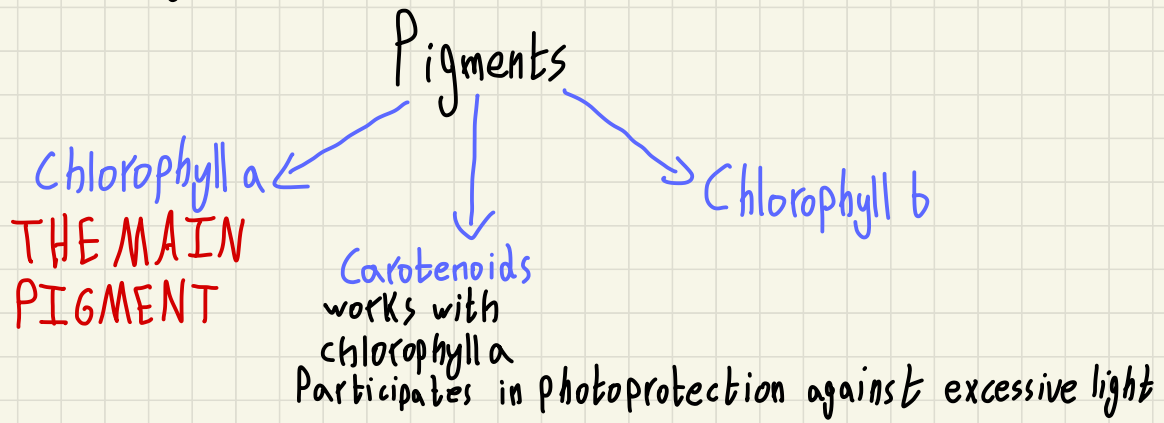
Sun → Light energy → Chemical energy

* Light dependent reactions. For this reason, they take place in the Thylakoids. (There, they oxidize H_2O to $\frac{1}{2}O_2 + 2H^+$)

2) Calvin cycle: Converts CO_2 to sugar. Consumes ATP and NADPH to ADP and $NADP^+$. It takes place in the Stroma of the plant cell.

* Green light is either reflected or transmitted by the pigments, but never absorbed. (The light we gain from in photosynthesis is the absorbed light.)

* Pigments are responsible for the absorption of lights



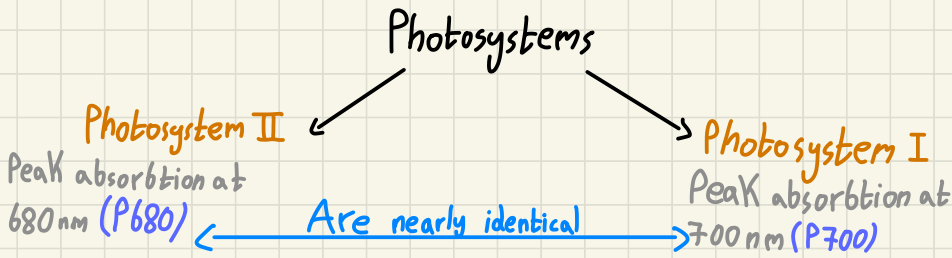
Pigments absorb light and dissipate excessive light that can interact with oxygen to form reactive oxidative molecules that could damage the cell, or directly the chloroplast.

✘ Chlorophyll absorbs best in the red and violet blue wave lengths

✘ The chlorophyll isn't attached to the phospholipid bilayer of the thylakoid membrane, rather with proteins embedded in the thylakoid (The protein and the chloroplast together make the photosystem.)

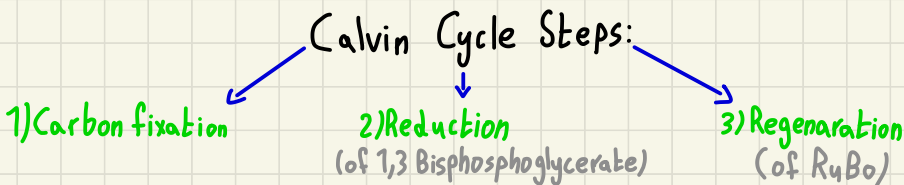
✘ Chlorophyll "a" pigments are the only pigments in the reaction center of the photosystem

✘ In the reaction center of a photosystem a redox reaction happens

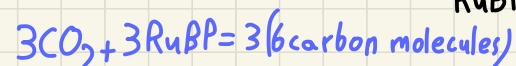


Photosystems I and II function sequentially, with photosystem II first.

✘ Calvin cycle: Inputs: 1) 3CO_2
2) 6NADPH
3) 9ATP | Output: 1G3P (Glyceraldehyde 3-phosphate)



1) Carbon fixation: → Keep in mind carbon dioxide has 1 carbon, and RuBP has 5 carbons



→ 1 CO₂ binds with 1 RuBP, making a 6 carbon molecule (With a helping hand of the enzyme Rubisco)

This 6 carbon molecule is unstable, and thus breaking into 2 (3 carbon molecules) called 3-PGA (3 Phosphoglyceric acid) Phosphoglycerate

~~→~~ The total:
3 CO₂ + 3 RuBP → 3, 6 carbon molecules
→ 6, 3-PGA

2) Reduction:

→ A 3-PGA molecule needs to be converted to 3-G3P We do that by:

- 1) Phosphorylating the 3-PGA using 1 ATP, making 1,3 Biphosphoglycerate
- 2) Reducing 1,3 Biphosphoglycerate to G3P using 1 NADPH

Overall:

From the light dependent reactions



→ 1 G3P is taken as the output of the Calvin Cycle, leaving us with 5 G3P

3) Regeneration:

$$5 \cdot 3 = 15 \text{ carbons} = 3 \cdot 5 = 15 \text{ carbons}$$

The 5 G3P are converted to 3 RuBP by a series of reactions using 3 ATPs.

Side notes

accessory pigments

I) Chlorophyll b and carotenoids **don't** participate in the direct energy transfer and synthesis that chlorophyll a does (But they do absorb and transfer energy to chlorophyll a).

II) The products of the light dependent reaction are: 1) NADPH 2) ATP 3) Oxygen

III) In the cyclic e^- path, the **only** product is ATP.

IV) H^+ concentration in the **thylakoid space** is higher than in the **stroma**

V) H^+ need a transporting agent that ^{can} help it **diffuse** from **higher** concentration ^(Thylakoid space) to **lower** concentration, which is the **ATP synthase**.
(Stroma)

VI) The **light reactions** happen in the **thylakoid space**.
The **Calvin cycle** happens in the **stroma**.

VII) The CO_2 acceptor in the calvin cycle is **RuBP**

VIII) The regeneration of **1 RuBP** requires **1 ATP**

IX) Light harvesting complexes **only** transfer energy (We can differentiate them by being on both sides of the photosystem).

X) P680 gets back its $2e^-$ from H_2O

XI) P700 gets back its $2e^-$ from the $2e^-$ passed from photosystem II

XII) The **Stomata** is responsible for the entrance of CO_2 molecules.