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 absorbtion of lights

Pigments

- Chlorophyll a – THE MAIN PIGMENT
- Carotenoids – works with chlorophyll a. Participates in photoprotection against excessive light
- Chlorophyll b

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.

* 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 aborbs best in the red and violet blue wave lengths

* 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

- Photosystem II — Peak absorbtion at 680 nm (P680)
- Photosystem I — Peak absorbtion at 700 nm (P700)

Photosystem II ⟷ Photosystem I: Are nearly identical

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

* Calvin cycle: Inputs: 1) 3 CO_2
  2) 6 NADPH
  3) 9 ATP

  Output: 1 G3P (Glyceraldehyde 3-phosphate)

Calvin Cycle Steps:

1) Carbon fixation
2) Reduction (of 1,3 Bisphosphoglycerate)
3) Regenaration (of RuBo)

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

$3CO_2 + 3RuBP = 3$ (6 carbon molecules)

- 1 CO_2 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:
> $3CO_2 + 3RuBP \rightarrow 3$, 6 carbon molecules $\rightarrow$ 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

(NADPH: from the light dependent reactions)

Overall:

6(3-PGA) —6 ATP→ 6(1,3 Biphosphoglycerate) —6 NADPH→ 6 G3P

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

3) Regeneration:

5.3 = 15 carbons = 3.5 = 15 carbons

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

Side notes

I) Chlorophyll b and carotenoids (accessory pigments) 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 ē 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 (Thylakoid space) concentration to lower (Stroma) concentration, which is the ATP synthase.

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 2ē from H_2O

XI) P700 gets back its 2ē from the 2ē passed from photosystem II

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