

4.3 Photosynthesis in Detail

KEY CONCEPT

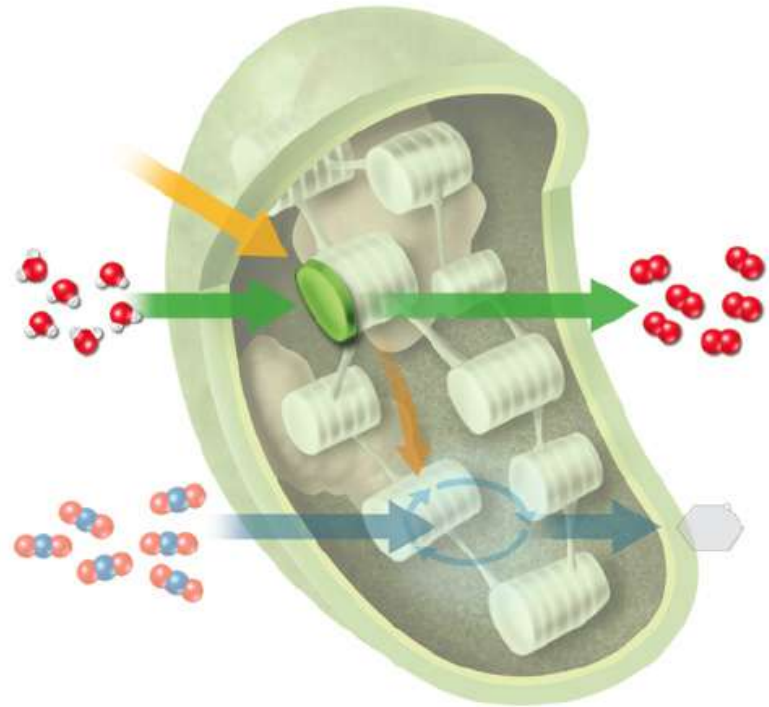
Photosynthesis requires a series of chemical reactions.



4.3 Photosynthesis in Detail

The first stage of photosynthesis captures and transfers energy.

- The light-dependent reactions include 2 groups of molecules called photosystems.

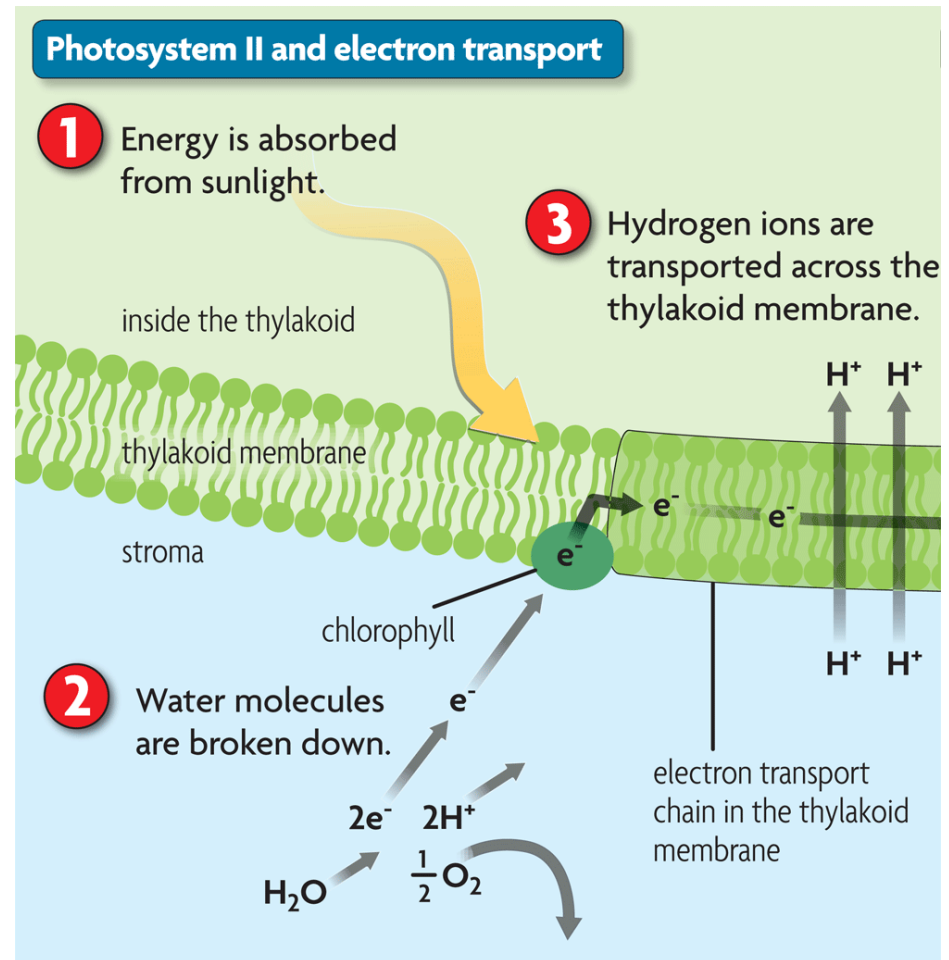


Light-dependent reactions take place in and across the thylakoid membrane.

4.3 Photosynthesis in Detail

- Photosystem II captures and transfers energy.

1. chlorophyll absorbs energy from sunlight (**photo-part of photosynthesis**)
—energized electrons enter electron transport chain
2. water molecules are split
—oxygen is released as waste
3. hydrogen ions are transported across thylakoid membrane



4.3 Photosynthesis in Detail

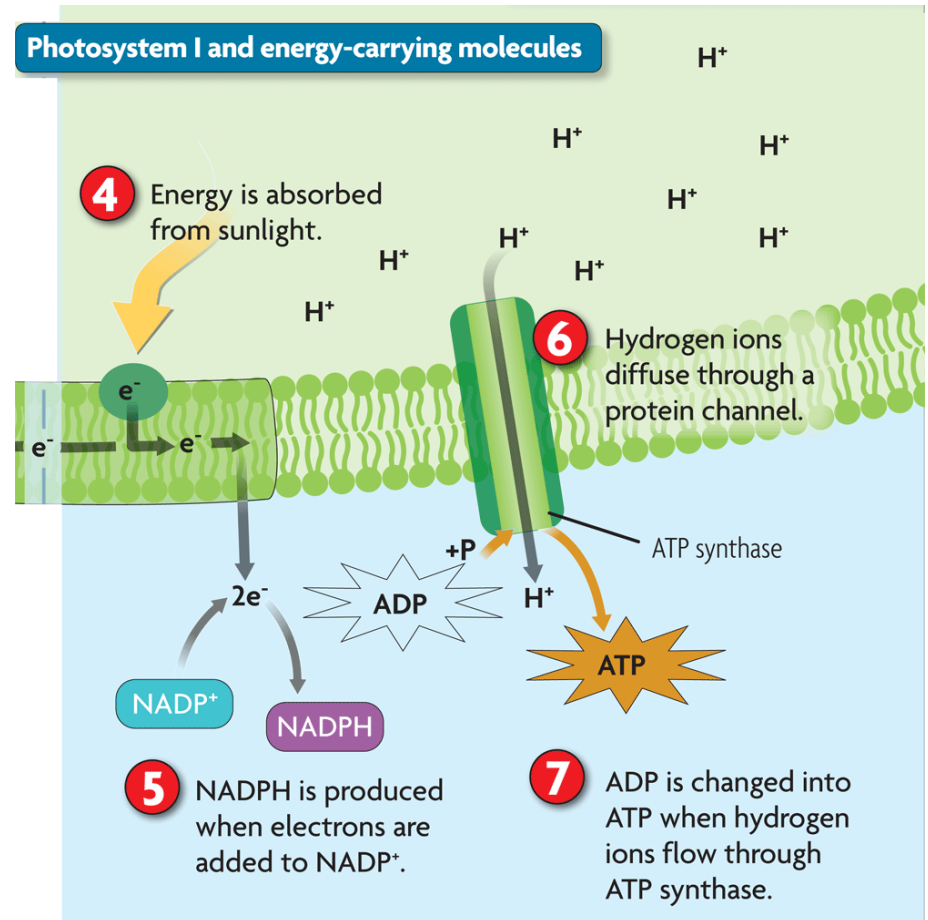
- Photosystem I captures energy and produces energy-carrying molecules.

4. chlorophyll absorbs energy from sunlight

–energized electrons leave the molecules

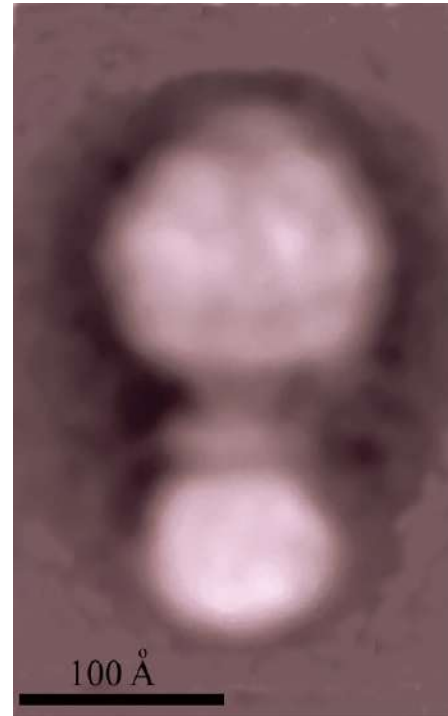
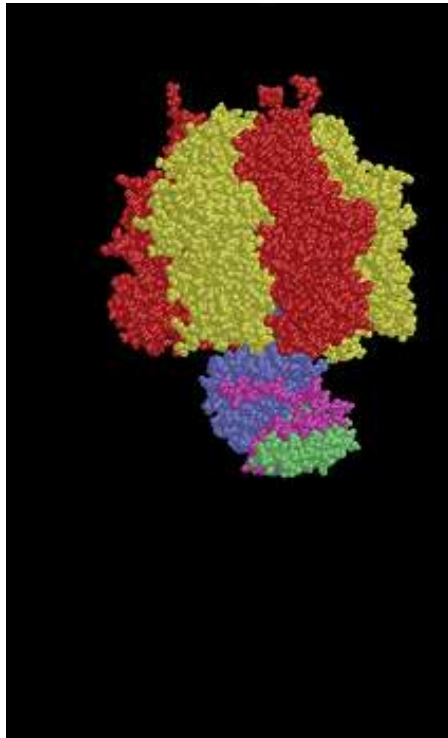
5. Energized electrons are added to NADP^+ (functions like ADP) to form NADPH (functions like ATP)

–NADPH molecules are transferred to light-independent reactions



4.3 Photosynthesis in Detail

- The light-dependent reactions produce ATP.
6. hydrogen ions flow through a protein channel in the thylakoid membrane (diffusion)
 7. ATP synthase attached to the channel makes ATP (adds a phosphate group to ADP)



4.3 Photosynthesis in Detail

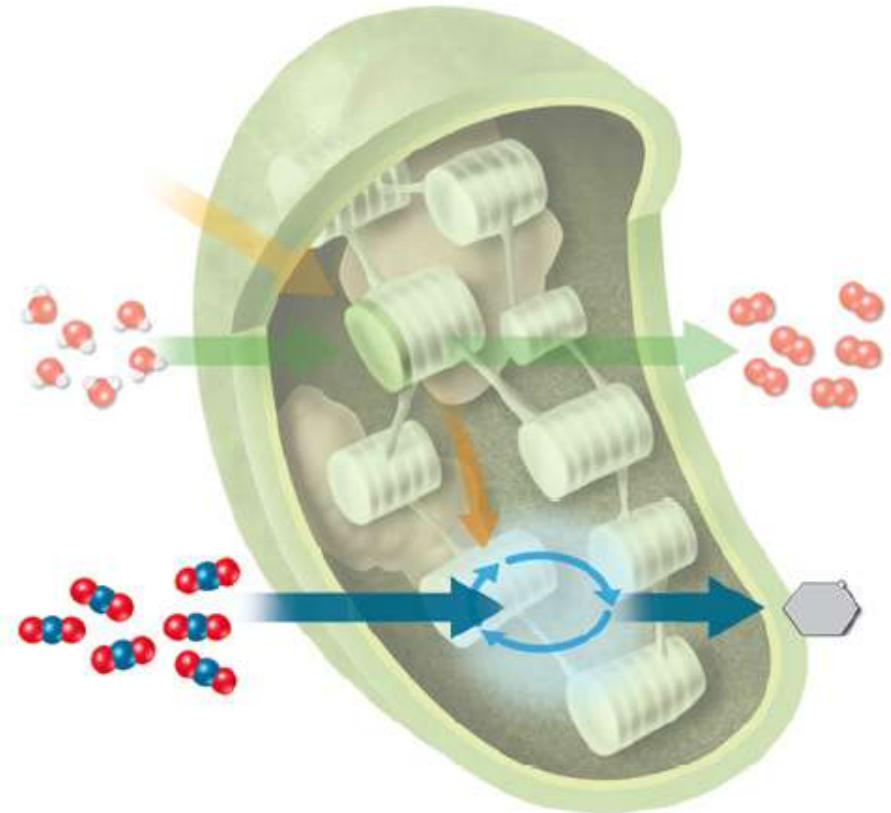
Light-Dependent Reactions Summary

1. Energy is captured from sunlight by light-absorbing molecules. This energy is transferred to electrons that enter an electron transport chain.
2. Water molecules are broken down into H^+ ions, electrons, and oxygen molecules. (H^+ ions and electrons needed for light-dependent reactions)
3. Energized electrons provide energy for H^+ ion transport and they change $NADP^+$ to NADPH.
4. The flow of H^+ ions through ATP synthase makes ATP.
5. The products are oxygen, NADPH, and ATP. Oxygen is given off as a waste product. Energy from ATP and NADPH is used later to make sugars.

4.3 Photosynthesis in Detail

The second stage of photosynthesis uses energy from the first stage to make sugars.

- Light-independent reactions occur inside the chloroplasts (stroma) and use CO_2 molecules.
- Do not need sunlight – just available energy (ATP and NADPH formed during the L-D reactions).



Light-independent reactions take place in the stroma.

4.3 Photosynthesis in Detail

Calvin Cycle

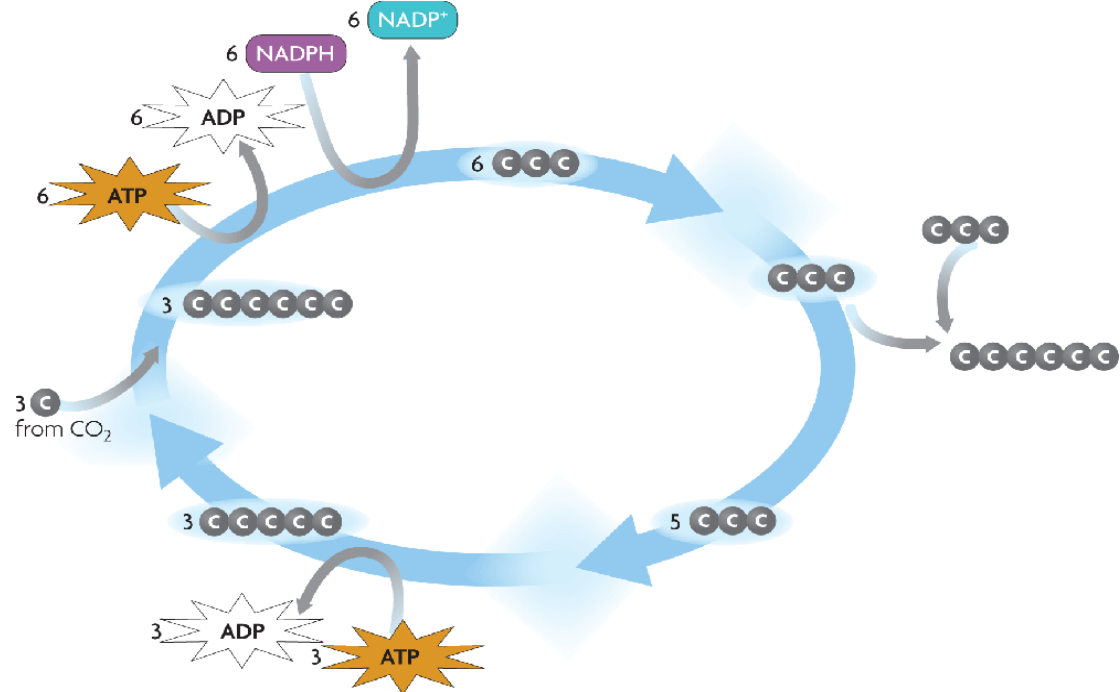
The Calvin Cycle is a series of chemical reactions that use the energy (ATP) from the light-dependent reactions.

It uses carbon dioxide gas from the atmosphere and the energy carried by ATP and NADPH to make simple sugars.
(synthesis part of photosynthesis)

4.3 Photosynthesis in Detail

1. Carbon dioxide molecules enter the Calvin cycle and are added to 5-carbon molecules that are already in the Calvin cycle to produce 6-carbon molecules

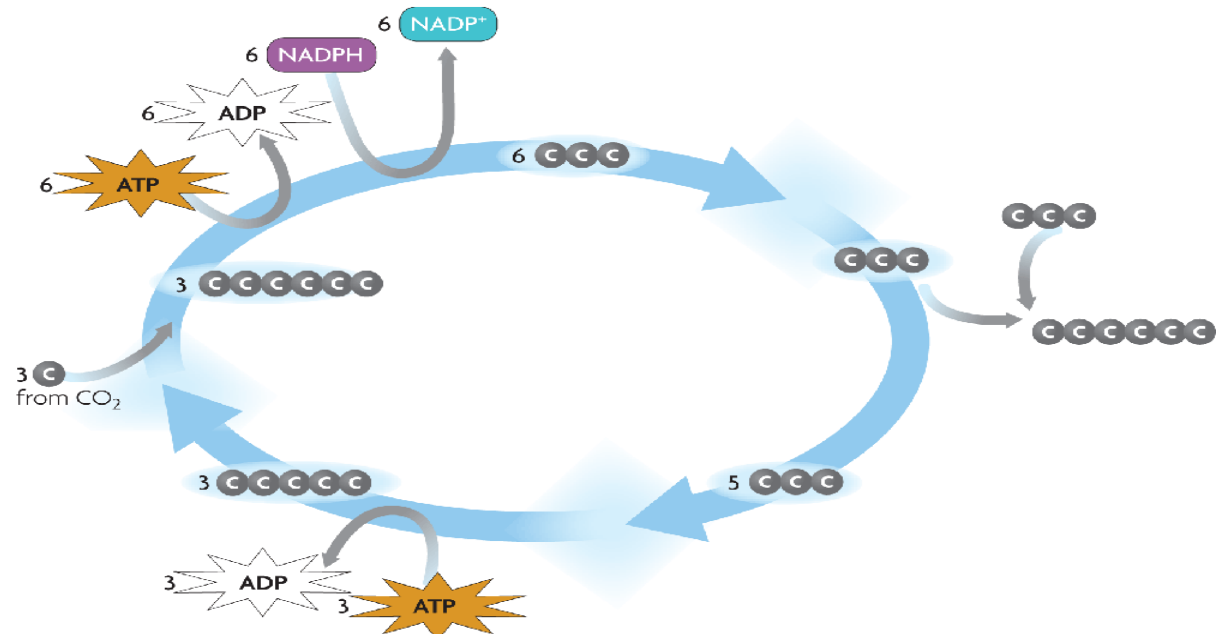
2. Energy (ATP and NADPH) is used by enzymes to split the 6-carbon molecules. 3-carbon molecules are formed and rearranged



4.3 Photosynthesis in Detail

3. One high-energy 3-carbon molecule leaves the cycle. After two 3-carbon molecules leave the cycle, they are bonded together to form a 6-carbon sugar molecule.

4. The remaining 3-carbon molecules stay in the cycle and are changed back into 5-carbon molecules by energy from ATP. These stay in the cycle and are added to new carbon dioxide molecules that enter the cycle.



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Light-Independent Reactions Summary

1. Carbon dioxide enters the Calvin cycle.
2. ATP and NADPH from the L-D reactions transfer energy to the Calvin cycle and keep the cycle going.
3. One high-energy 3-carbon molecule is made for every 3 molecules of carbon dioxide that enter the cycle.
4. Two high-energy 3-carbon molecules are bonded together to make a sugar. (6 molecules of carbon dioxide must be added to the Calvin cycle to make one 6-carbon sugar)
5. The products are a 6-carbon sugar (glucose), NADP^+ , and ADP. The NADP^+ and the ADP molecules return to the L-D reactions.

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Function of Photosynthesis

- Make sugars

- Provides materials for plant growth and development (starch and cellulose)

- Helps regulate Earth's environment