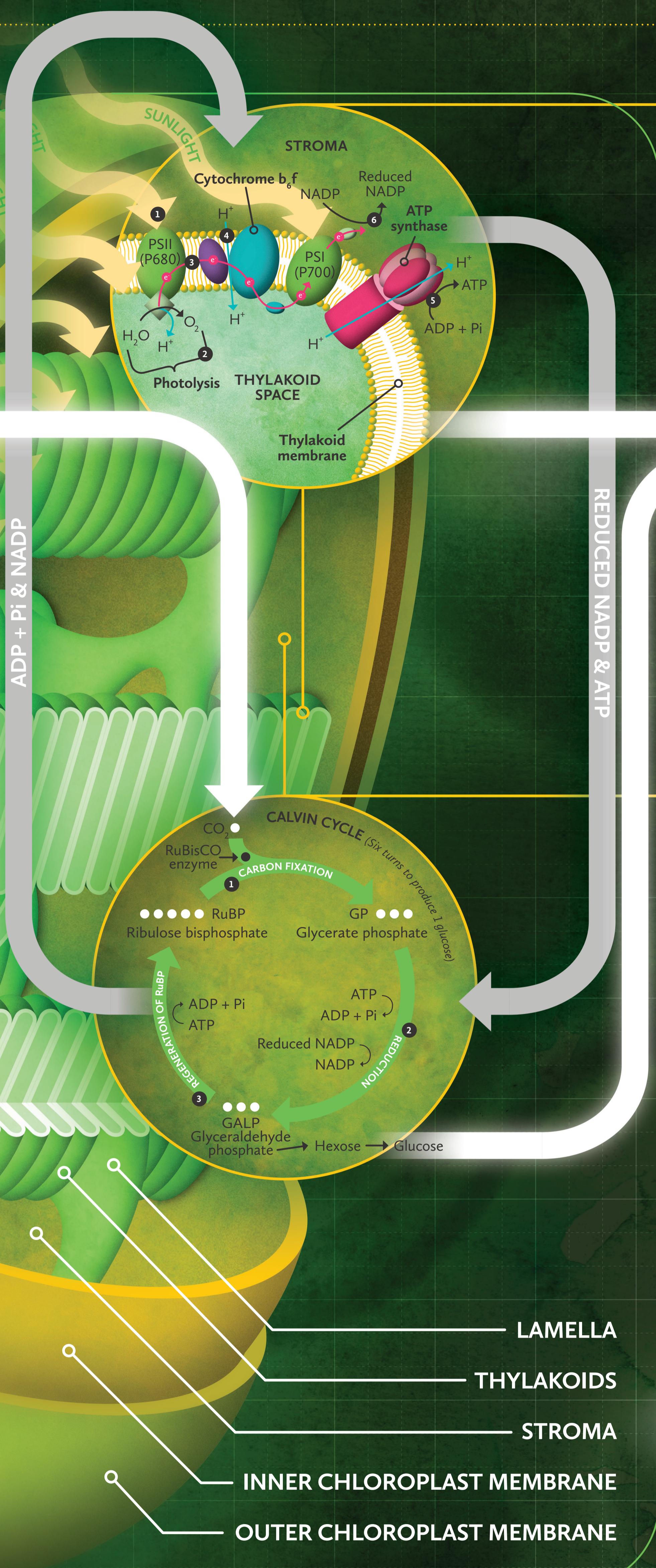


# Photosynthesis

# BigPicture

Photosynthesis is the process by which plants use sunlight (light energy) to produce glucose from carbon dioxide and water, with oxygen as a byproduct. This process occurs in the chloroplasts in a plant cell and has two stages – the light-dependent reactions and the light-independent reactions. It all starts with the sunlight hitting the first photocentre (PSII).



## LIGHT-DEPENDENT REACTIONS

1. Light activation of photocentres
2. Photolysis of water
3. Electron transport
4. Pumping H<sup>+</sup> into the thylakoid space
5. Synthesis of ATP
6. Reduction of NADP

OXYGEN  
GLUCOSE

Glucose is used in respiration for energy.

- Glucose is converted to:
1. Cellulose for cell walls
  2. Sucrose for transport
  3. Starch for storage

## CHLOROPLAST

## LIGHT-INDEPENDENT REACTIONS

- Calvin cycle
1. Carbon fixation
  2. Reduction
  3. Regeneration of RuBP

## GLOSSARY

**ATP synthase:** An enzyme that catalyses the synthesis of ATP from ADP and inorganic phosphate (Pi).

**Carbon fixation:** The first stage of the Calvin cycle. The enzyme RubisCO catalyses a reaction between ribulose bisphosphate (RuBP) and carbon dioxide, producing glyceraldehyde phosphate (GP), thus fixing inorganic carbon into an organic compound.

**Chlorophyll:** A family of green pigments found in and around the photosystems of chloroplasts.

**Chloroplasts:** The pigment-rich organelles where photosynthesis takes place in plant cells.

**Cytochrome b<sub>6</sub>f:** An enzyme in the thylakoid membrane that acts as an electron carrier.

**Ferredoxin:** An electron carrier sitting just outside the thylakoid in the chloroplast stroma. In the poster, this is the small light green oval.

**Glucose:** A hexose sugar and the product of photosynthesis. It is one of the main sources of chemical energy used in cellular respiration.

**Hexose:** A six-carbon sugar formed as the product of six turns of the Calvin cycle.

**Inorganic phosphate (Pi):** A molecule that plays a key role in respiration and photosynthesis and which, among its functions, combines with ADP to create ATP.

**Lamella:** An extension connecting two thylakoid discs arranged in different stacks within a chloroplast.

**Light-dependent reactions:** The first stage of photosynthesis. These reactions take place in the thylakoid membrane, forming an electron transport chain that creates ATP and reduced NADP.

**Light-independent reactions:** Also known as the Calvin cycle, these three reactions – carbon fixation, reduction and regeneration of ribulose bisphosphate (RuBP) – form the second stage of photosynthesis, in which glucose is produced. They occur in the chloroplast stroma.

**NADP (nicotinamide adenine dinucleotide phosphate):** A coenzyme that acts as an electron acceptor in photosynthesis.

**Photolysis:** A chemical reaction in which a compound is broken down using light energy. Photosystem II uses water photolysis to replace the electrons emitted from its reaction centre.

**Photosystem I (PSI):** The second photosystem in the electron transport chain of the light-dependent reactions (but named because it was discovered first).

**Photosystem II (PSII):** The first photosystem in the electron transport chain of the light-dependent reactions (but named because it was discovered second). It uses light energy to emit excited electrons sourced via photolysis of water.

**Plastocyanin (PC):** An electron carrier in the thylakoid membrane, sitting between photosystem II and cytochrome b<sub>6</sub>f. In the poster, this is the medium-sized purple oval.

**Reduction:** The donation of an electron to a molecule.

**Plastoquinone:** A molecule that is reduced by taking two electrons from photosystem II, before picking up two hydrogen ions from the chloroplast stroma and passing the electrons and protons to cytochrome b<sub>6</sub>f.

**Reaction centres:** Complexes of proteins, each containing a special pair of chlorophyll molecules, that sit at the heart of photosystems. Regular chlorophyll molecules channel light energy to these special chlorophyll pairs (called P680 in photosystem II, P700 in photosystem I), which then, when sufficiently excited, shed a highly energised electron.

**Regeneration of RuBP:** The third stage of the Calvin cycle. Glyceraldehyde phosphate molecules are converted into ribulose monophosphate (which has five carbon atoms and one phosphate), which are then converted into ribulose bisphosphate (RuBP) by reacting with ATP. This RuBP then relaunches the cycle with new carbon dioxide molecules.

**Ribulose bisphosphate (RuBP):** A molecule with five carbon atoms and two phosphates that reacts with carbon dioxide to fix carbon in the Calvin cycle.

**RubisCO:** Ribulose bisphosphate carboxylase oxidase; an enzyme that catalyses a reaction between carbon dioxide and ribulose bisphosphate (RuBP).

**Stroma:** The aqueous solution that fills the inner chloroplast membrane, suspending the chloroplast's contents. The light-independent reactions of photosynthesis take place here.

**Sucrose:** A disaccharide sugar composed of two monosaccharide sugars: glucose and fructose.

**Thylakoids:** Disc-shaped compartments, enclosed by their own membranes, present inside the chloroplast. Much of the light-dependent reactions of photosynthesis take place in the membranes of thylakoids.

**Thylakoid space:** The compartment enclosed by the thylakoid membrane. Hydrogen ions concentrate inside this space, creating an electrochemical gradient across the thylakoid membrane that powers ATP synthase. A stack of thylakoid discs is known as a grana (plural: grana).