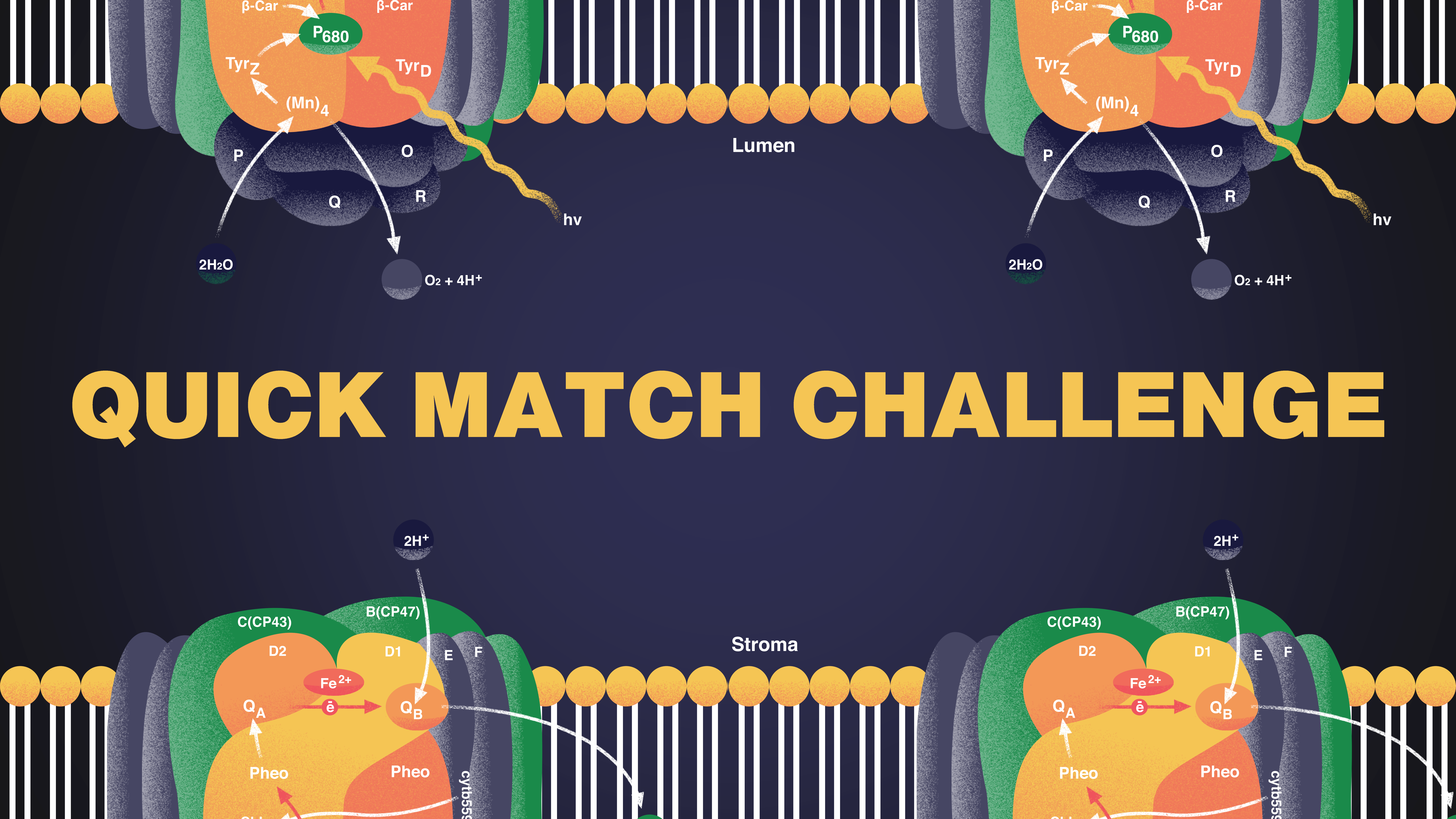
QUICK MATCH CHALLENGE



CELL MEMBRANE

CELL MEMBRANE

Controls movement of substances in and out of the cell.

Provides support and protection; maintains cell shape.

CELL WALL

Provides support and protection; maintains cell shape.

CYTOPLASM

CYTOPLASM

Holds organelles and allows movement of materials within the cell.

Controls cell activities; stores genetic material (DNA).

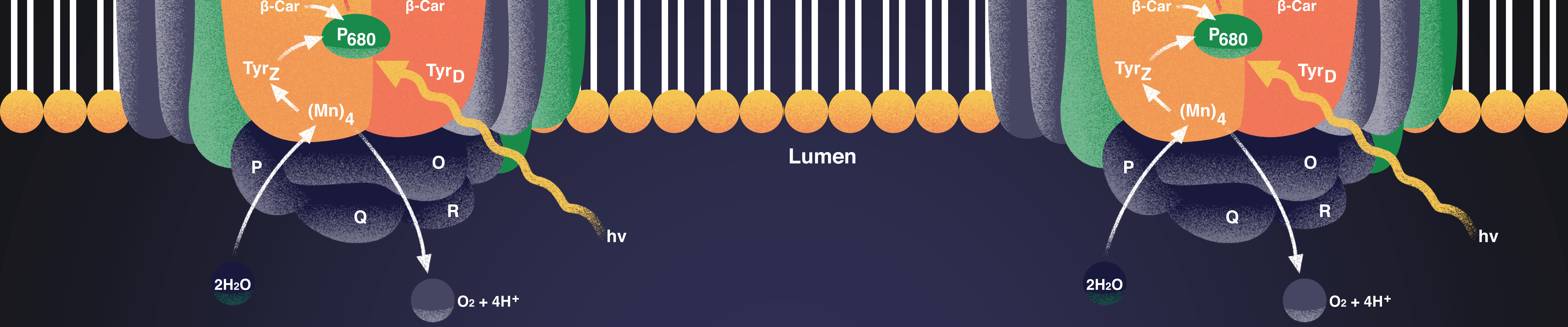
NUCLEUS

Controls cell activities; stores genetic material (DNA).

CHLOROPLAST

CHLOROPLAST

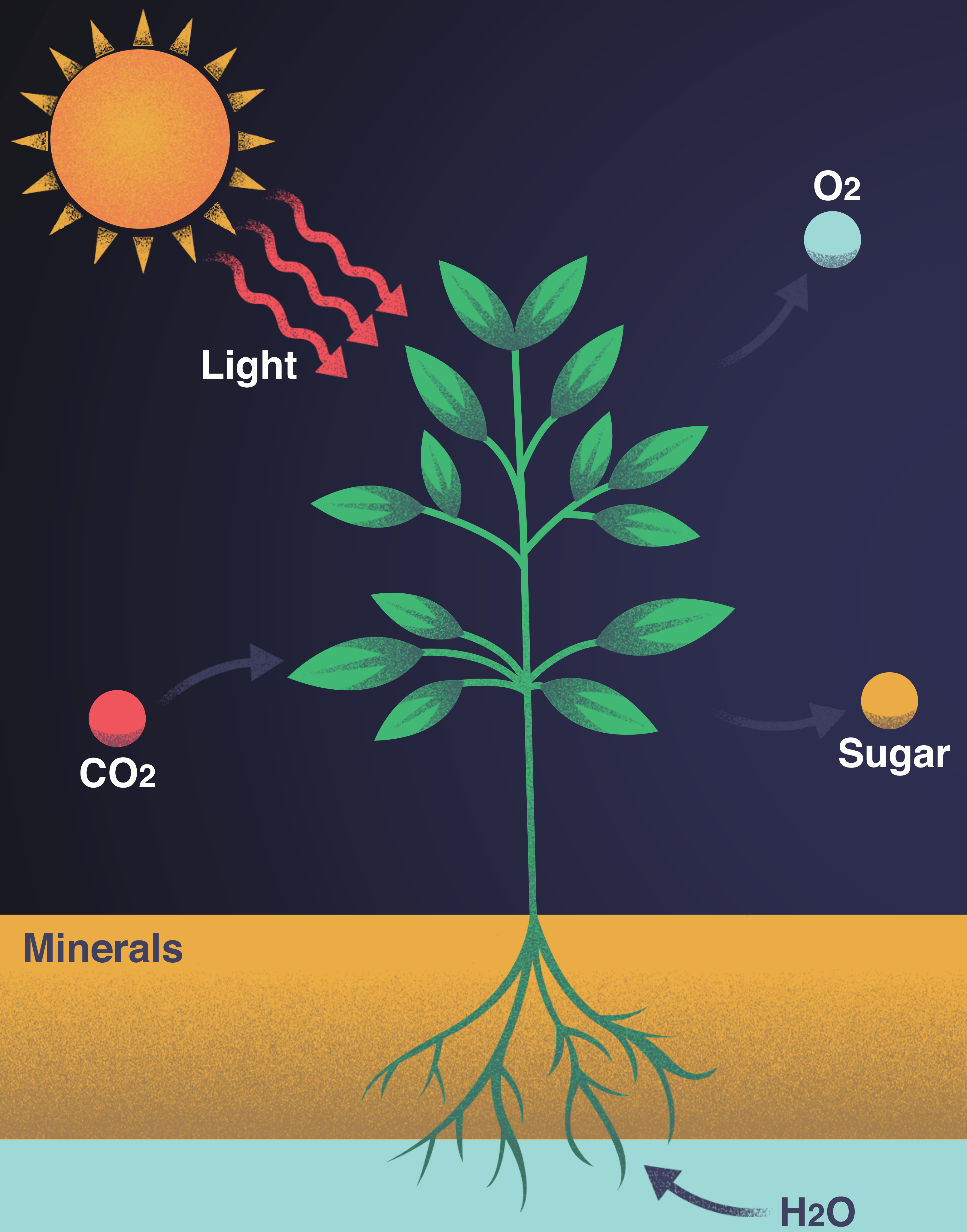
Site of photosynthesis; converts light energy into chemical energy.



Biology I

PHOTOSYNTHESIS

Prepared by: Marjorie Jane G. Badilla



Competencies:

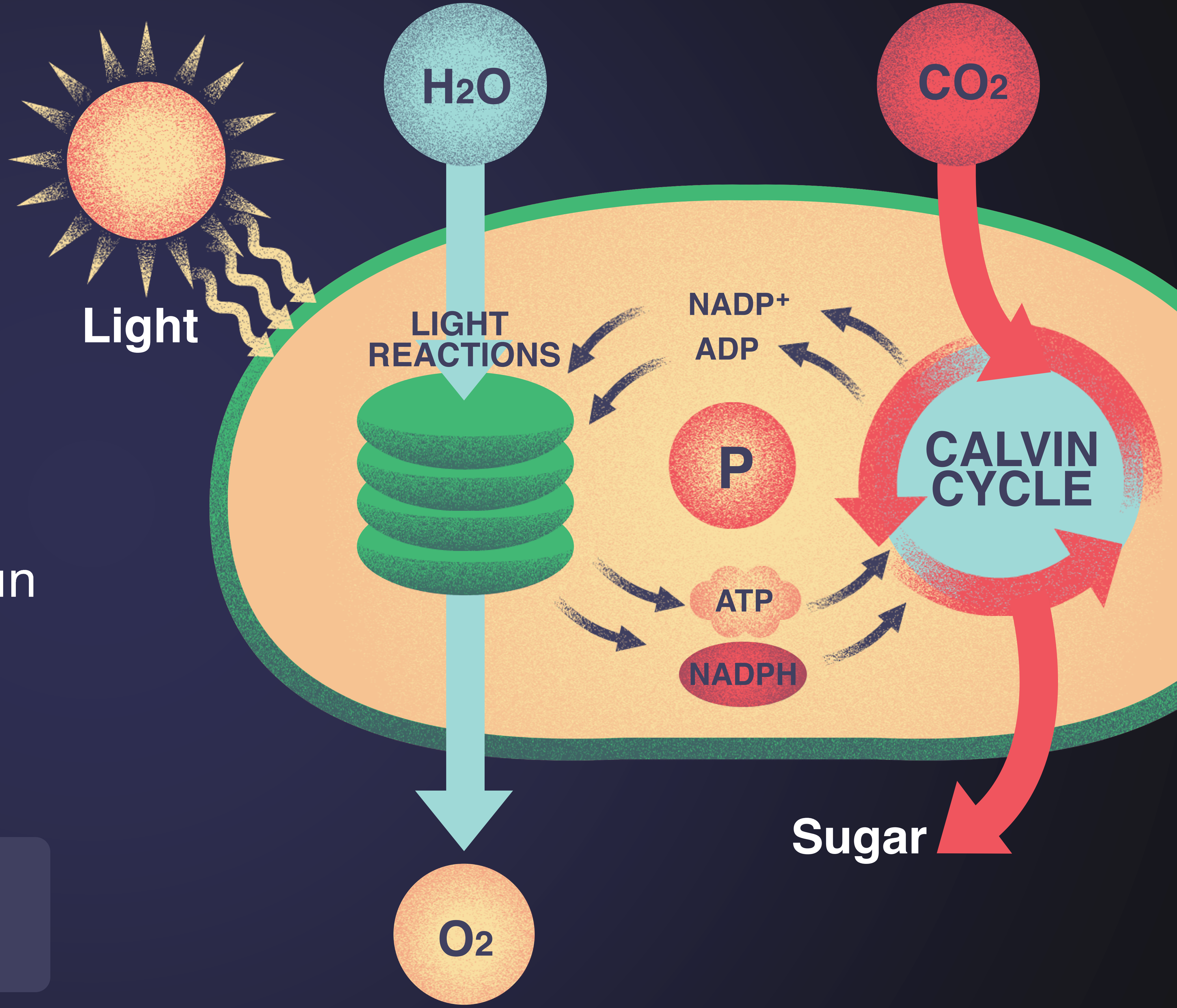
- Identify that photosynthesis takes place within the cells of autotrophs with the aid of chloroplasts.
- Describe the role of chlorophyll and other pigments in capturing light energy in plants required for the photosynthesis reaction to take place.

Every leaf is like a tiny solar panel, converting sunlight into chemical energy that fuels life on Earth.

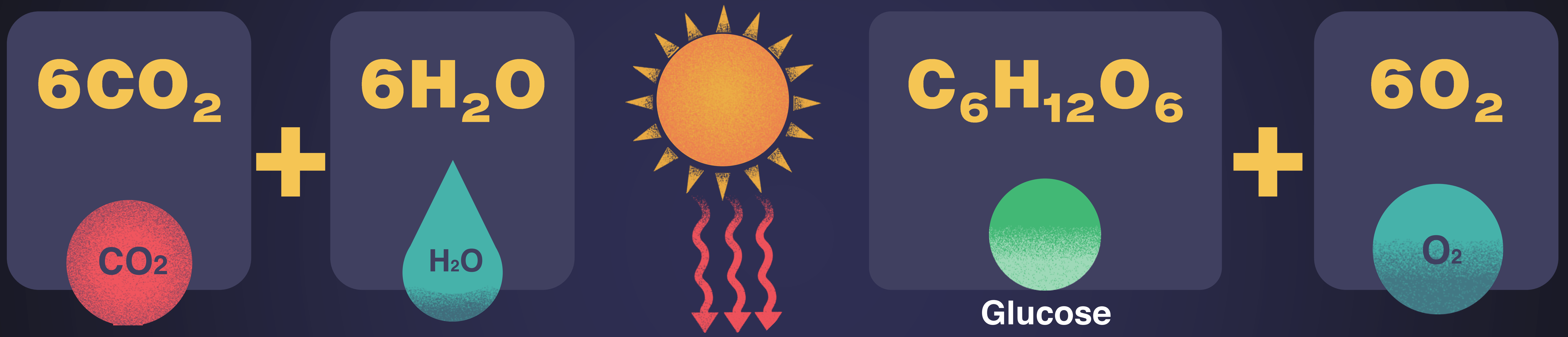
Photo-synthesis

Photosynthesis is the process by which plants, algae, and some bacteria use light energy from the sun to convert carbon dioxide and water into glucose (a sugar) and oxygen.

How do plants capture sunlight and turn it into the food and oxygen we depend on?



Photosynthesis Equation



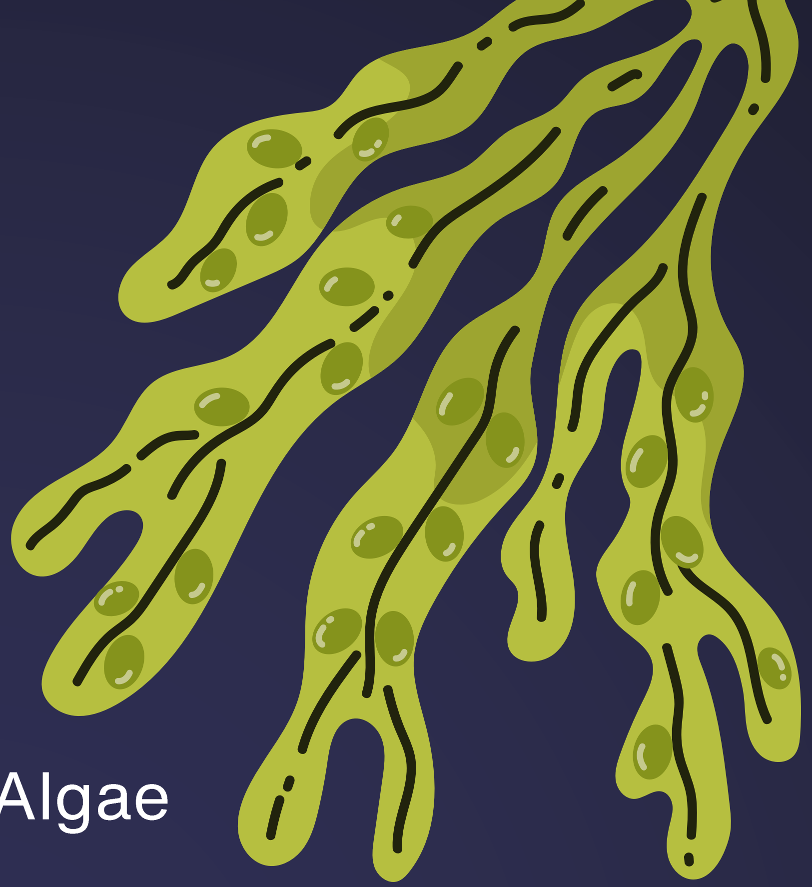
$$6CO_2 + 6H_2O + \text{light} \rightarrow C_6H_{12}O_6 + 6O_2$$

The photosynthesis equation, $6CO_2 + 6H_2O + \text{light} \rightarrow C_6H_{12}O_6 + 6O_2$, shows how plants use sunlight to transform carbon dioxide from the air and water from the soil into glucose, a sugar that stores chemical energy, and oxygen, which is released as a byproduct.

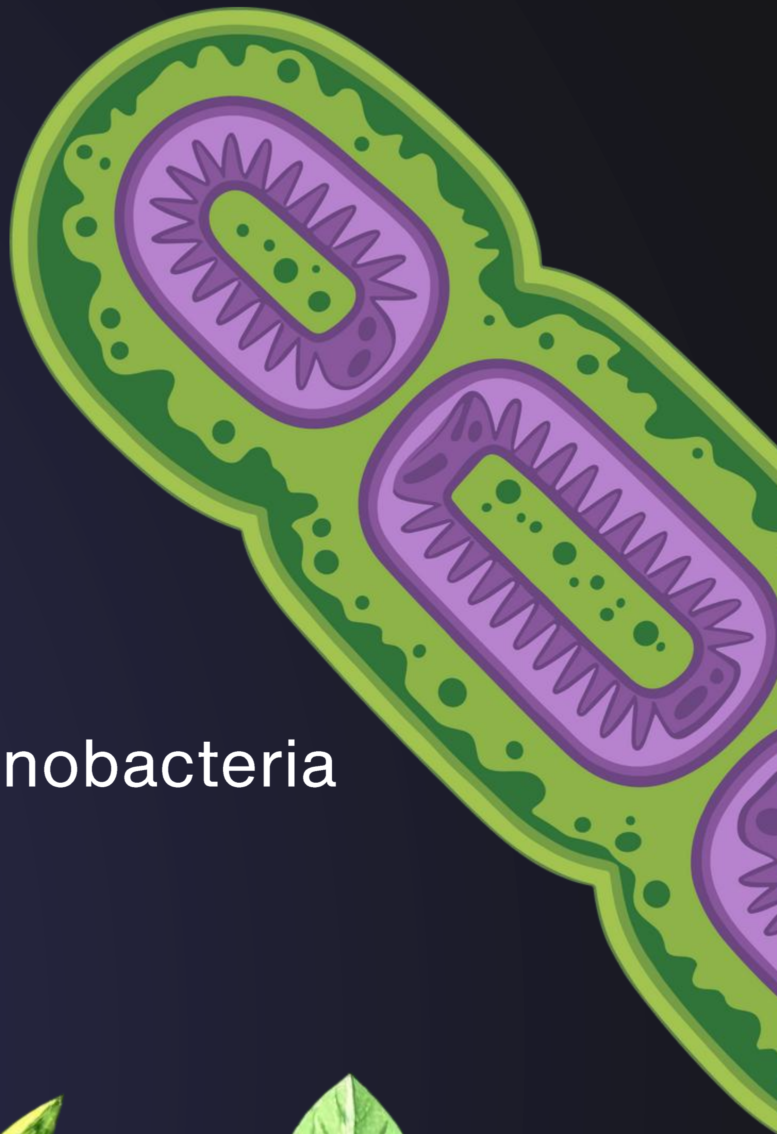
Autotrophs

Autotrophs are organisms that can make their own food using simple substances from their environment. They produce organic food (like glucose) from inorganic materials, such as **Carbon dioxide (CO_2)** and **Water (H_2O)** using energy from **Sunlight** (*photoautotrophs*) and **Chemical energy** (*chemoautotrophs*).

How do plants capture sunlight and turn it into the food and oxygen we depend on?



Algae



Cyanobacteria

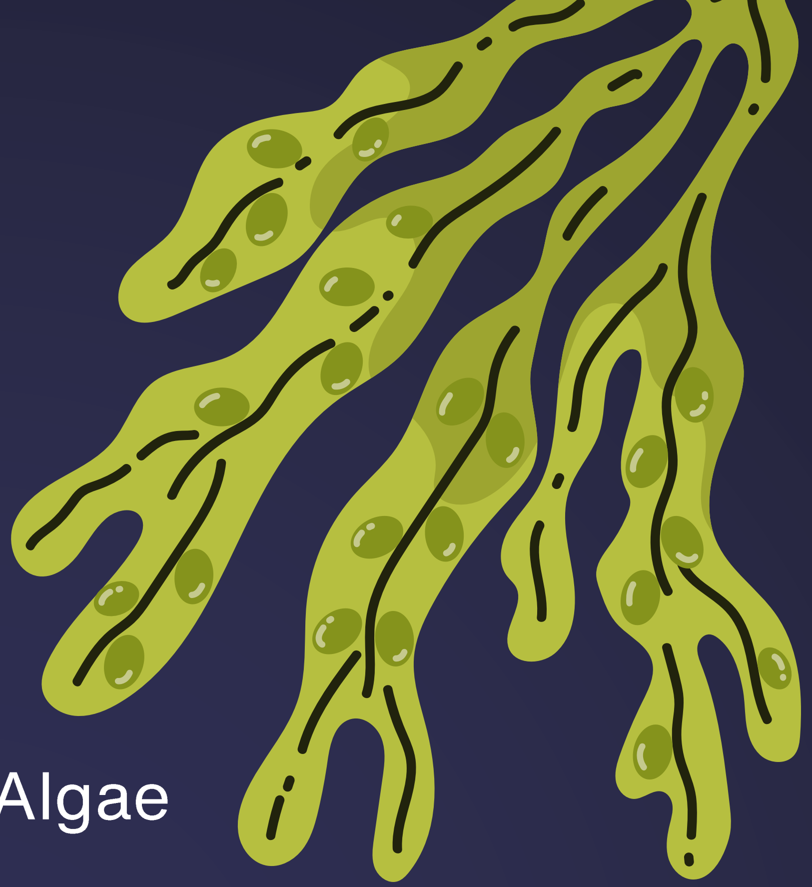
Green Plants

Autotrophs

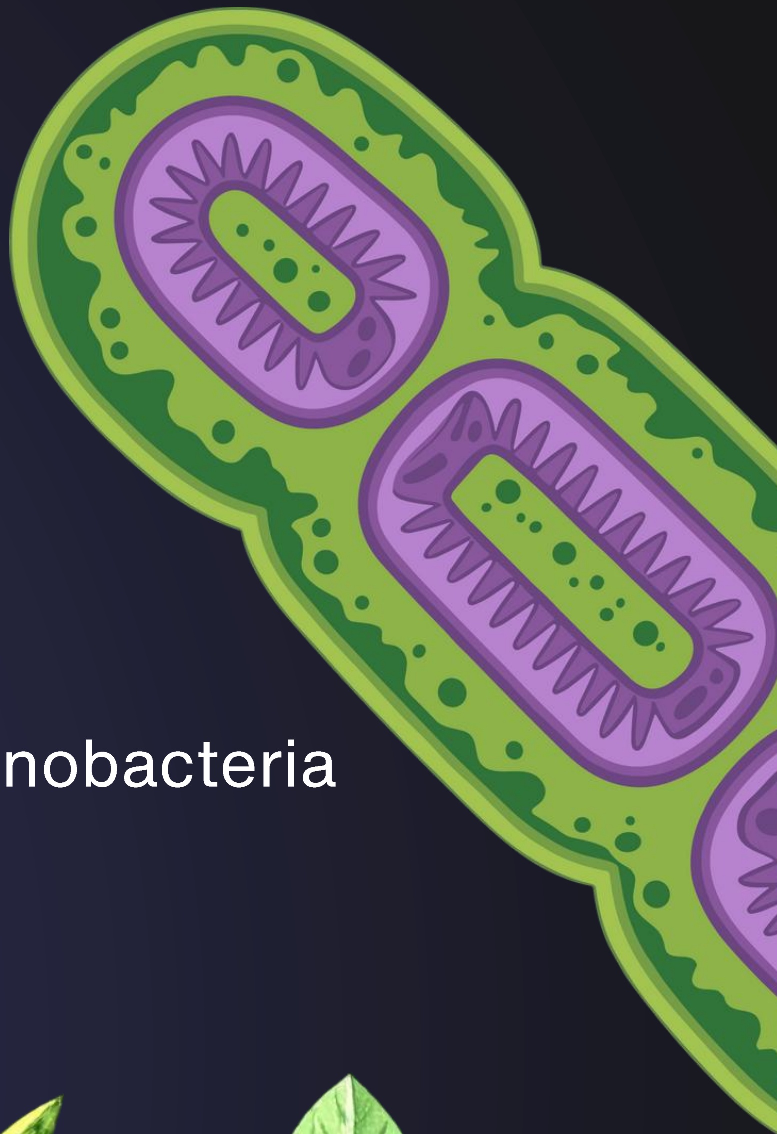
Autotrophs are important because:

- They are the base of the food chain.
- They provide food and oxygen for other organisms.

How do plants capture sunlight and turn it into the food and oxygen we depend on?



Algae



Cyanobacteria

Green Plants

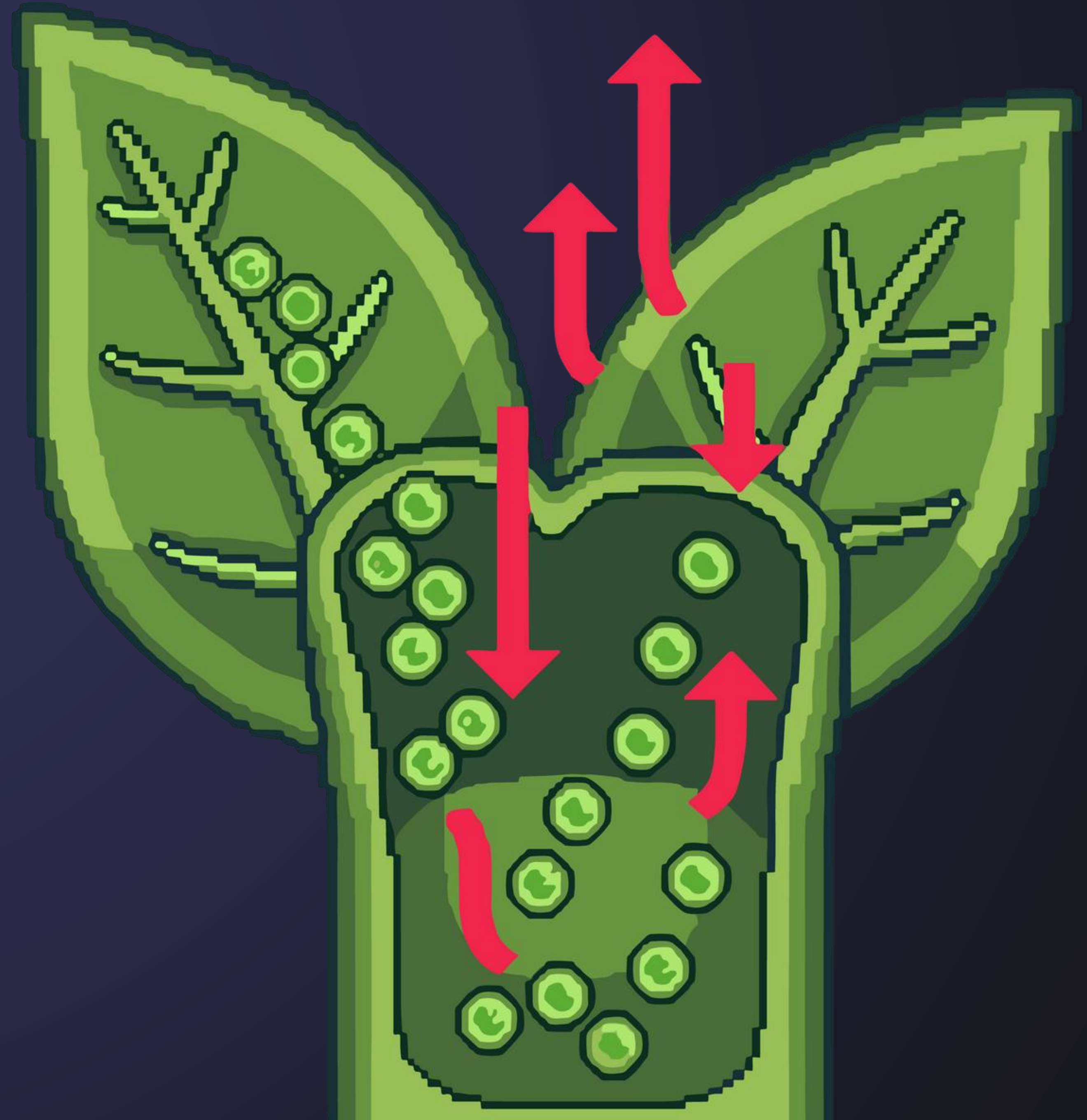
Plant Cells as the Site of Photosynthesis

Plant cells have special structures that make photosynthesis possible.

- Chloroplast
- Thylakoid Membrane
- Grana (singular: Granum)
- Stroma
- Chlorophyll

Chloroplast:
The Photosynthetic Organelle

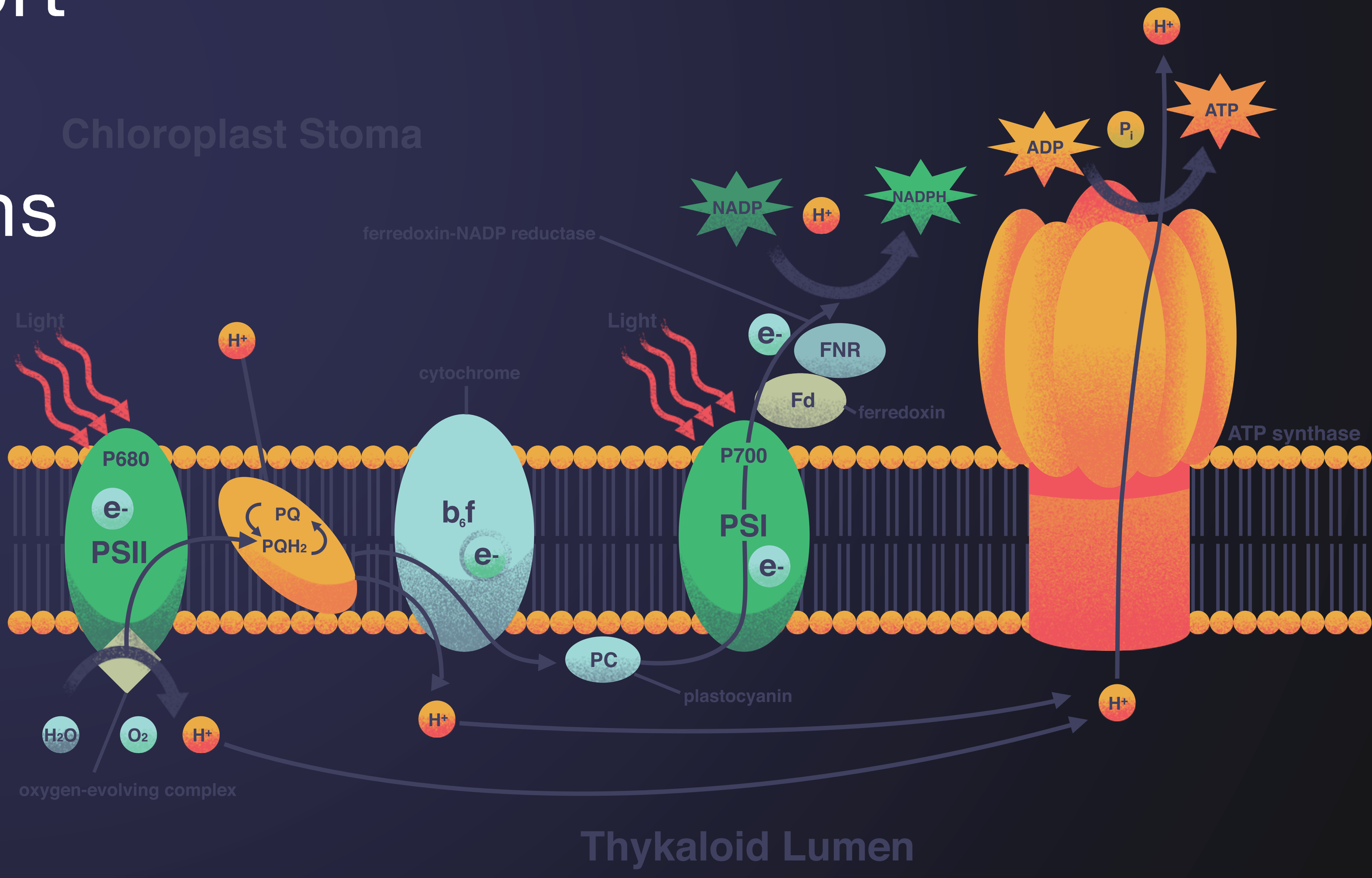
- Main site of Photosynthesis
- Contains chlorophyll that absorbs light energy
- Found only in plant cells (and some algae)



A chloroplast is an organelle in plant cells where photosynthesis occurs, converting light energy into chemical energy (glucose).

Thylakoid Membrane

- Located inside the chloroplast
- Contains chlorophyll, photosystems, electron transport chains, and ATP synthase
- Site of light-dependent reactions (ATP and NADPH production)



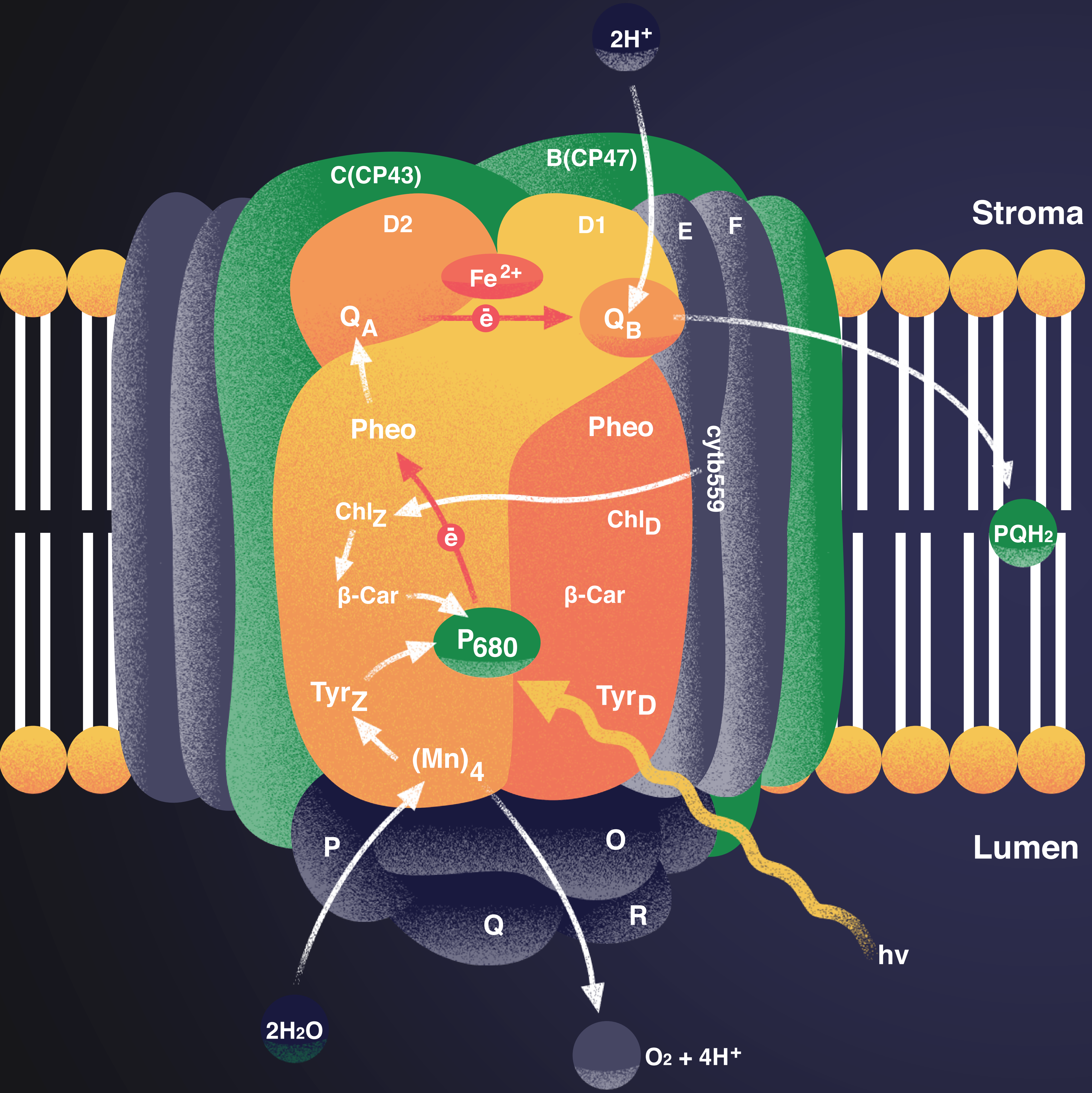


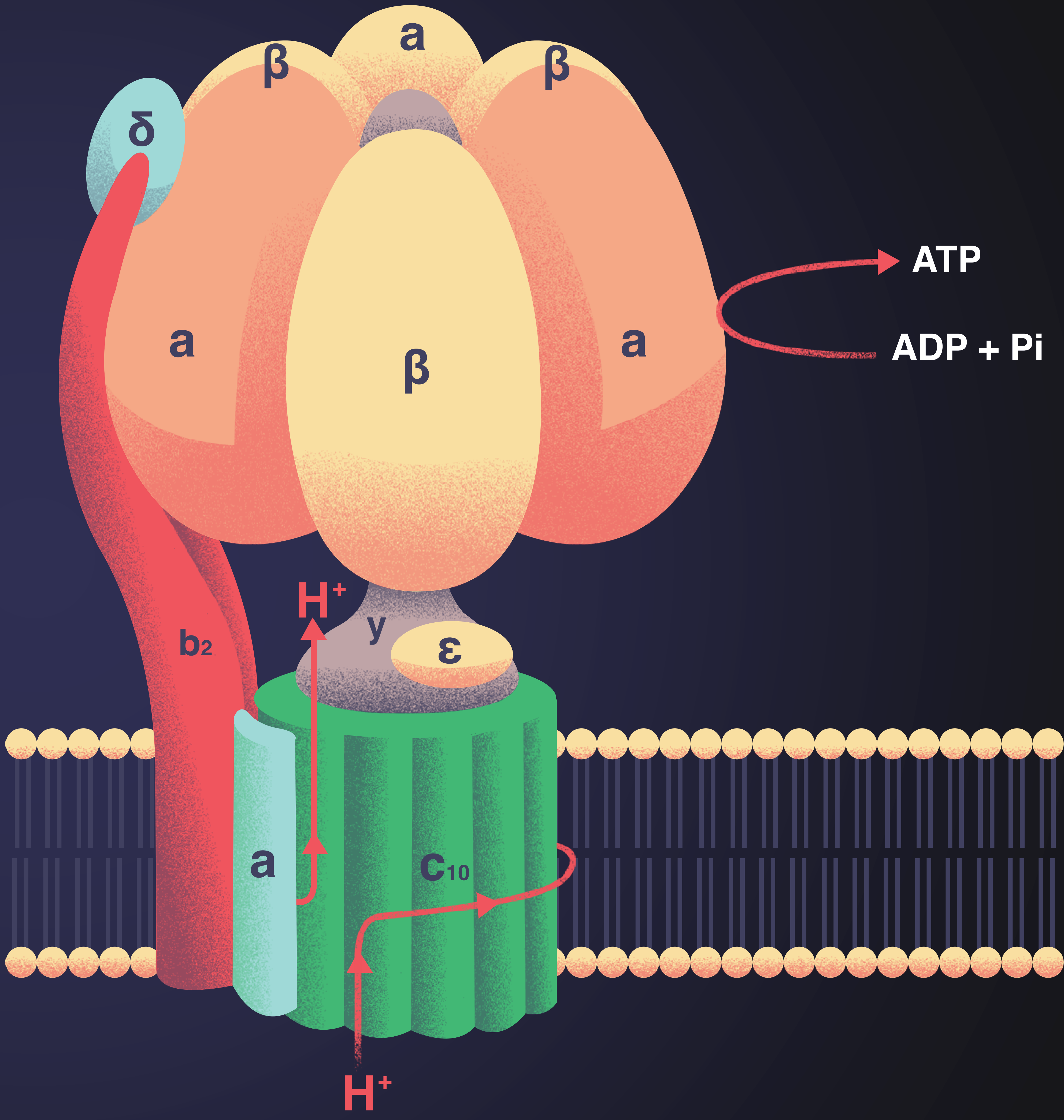
Photo-systems

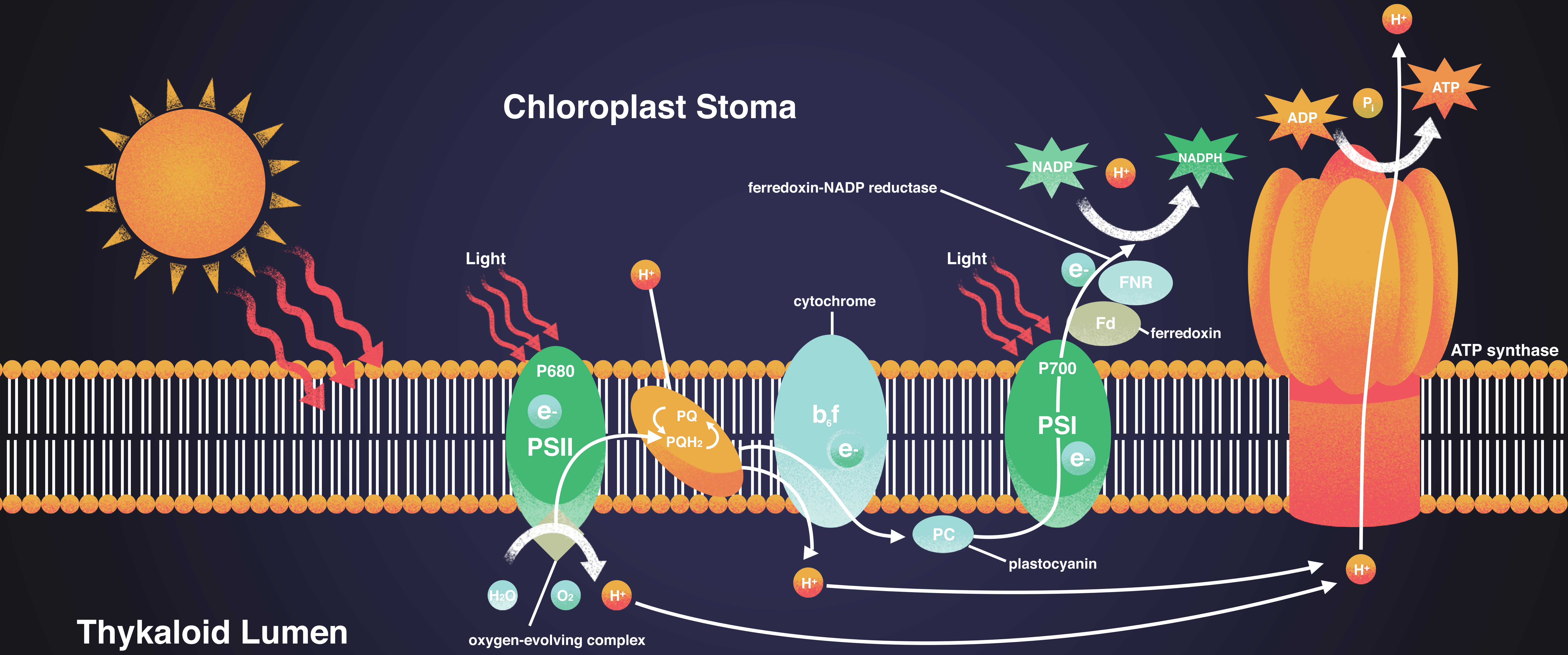
- Photosystems are protein-pigment complexes embedded in the thylakoid membrane.
- Contain chlorophyll and accessory pigments that absorb light energy.
- Light energy excites electrons, starting the flow through the electron transport chain (ETC).
- PSII splits water into electrons, protons, and oxygen (photolysis).

ATP Synthase

How It Works:

- Light reactions pump protons into the thylakoid lumen, creating a high concentration inside.
- Protons flow back into the stroma through ATP synthase — like water turning a turbine.
- This flow powers ATP synthase to bind ADP and phosphate, forming ATP.

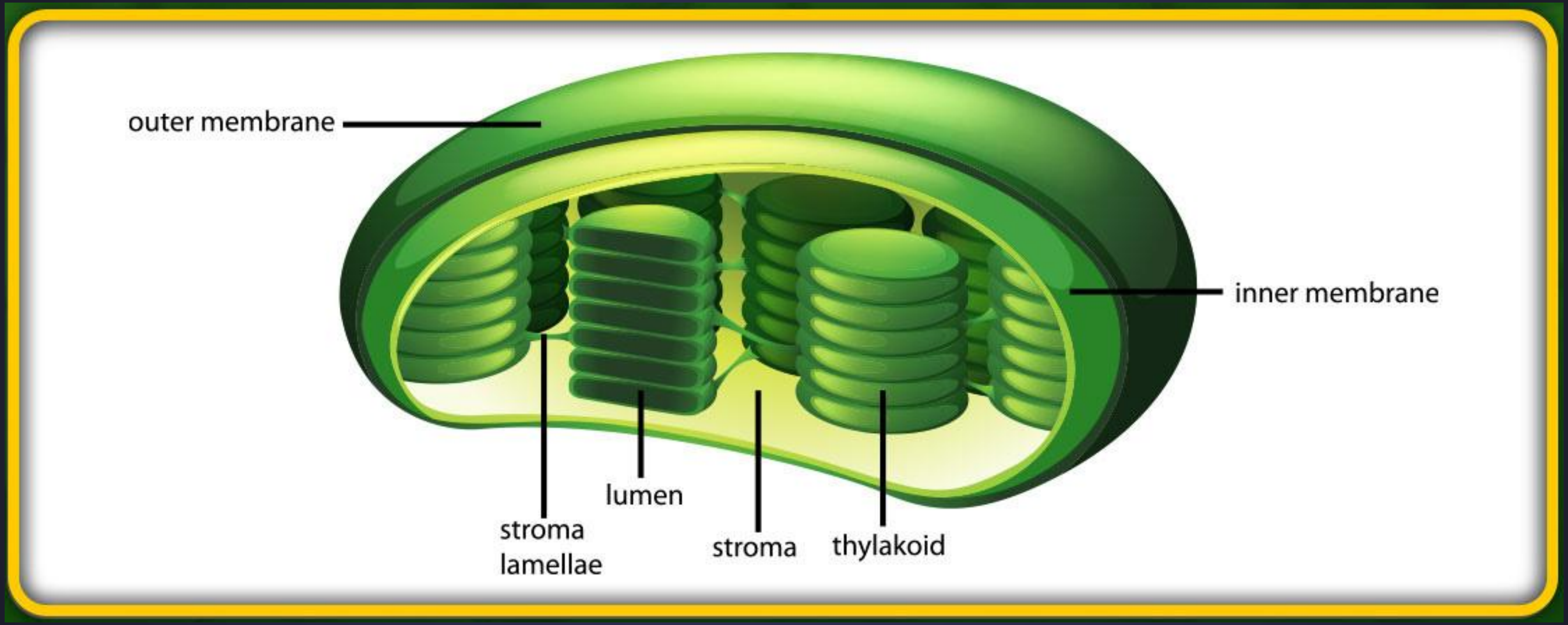



Chloroplast Stoma
Light
H+
P680
e-
PSII
PQ
PQH2
H2O
O2
H+
oxygen-evolving complex
cytochrome
b6f
e-
H+
Light
P700
PSI
e-
PC
plastocyanin
ferredoxin-NADP reductase
e-
FNR
Fd
ferredoxin
NADP
H+
NADPH
ADP
Pi
ATP
H+
ATP synthase
H+
Thykaloid Lumen

Grana (singular: Granum)

- Stacks of thylakoids
- Increase surface area for light absorption
- Improve efficiency of the light reactions

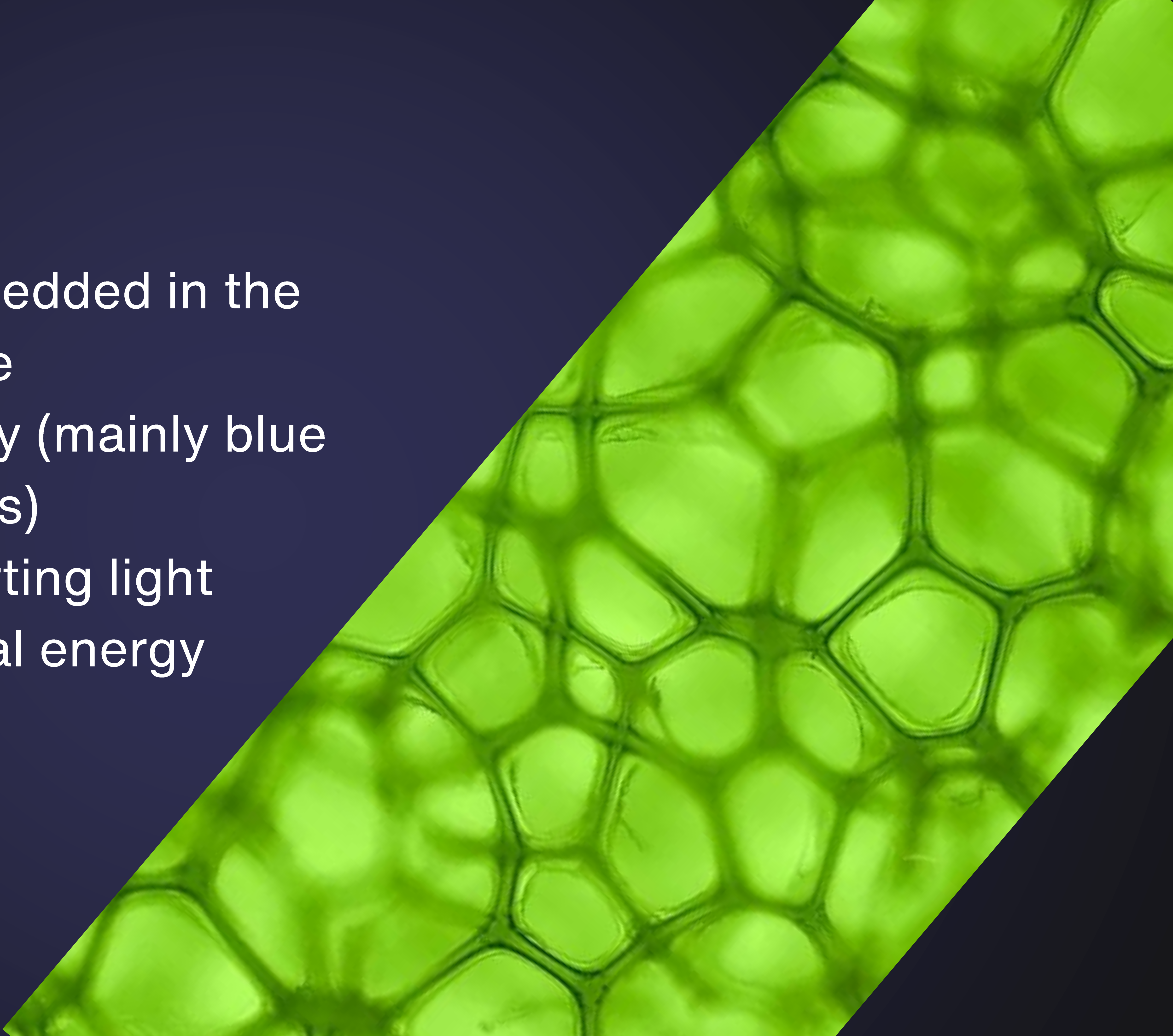
Stroma



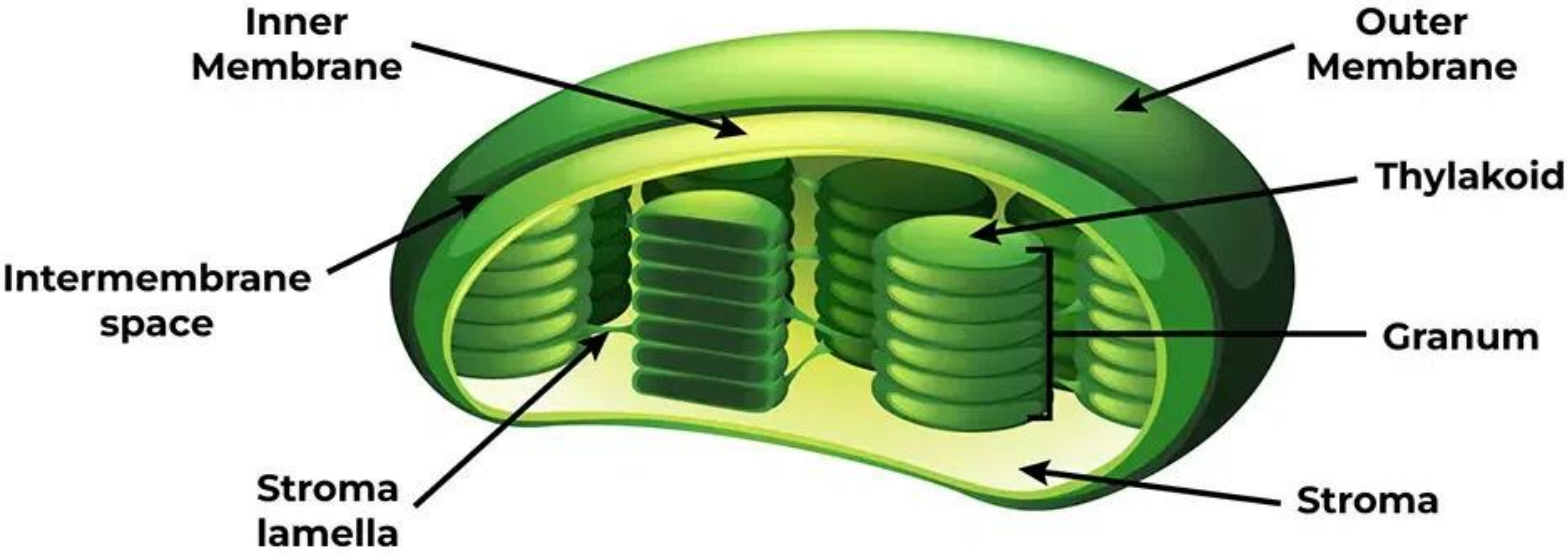
- Fluid-filled space surrounding the thylakoids
- Site of the Calvin cycle (light-independent reactions)
- Contains enzymes like Rubisco

Chlorophyll

- Green pigment embedded in the thylakoid membrane
- Absorbs light energy (mainly blue and red wavelengths)
- Essential for converting light energy into chemical energy

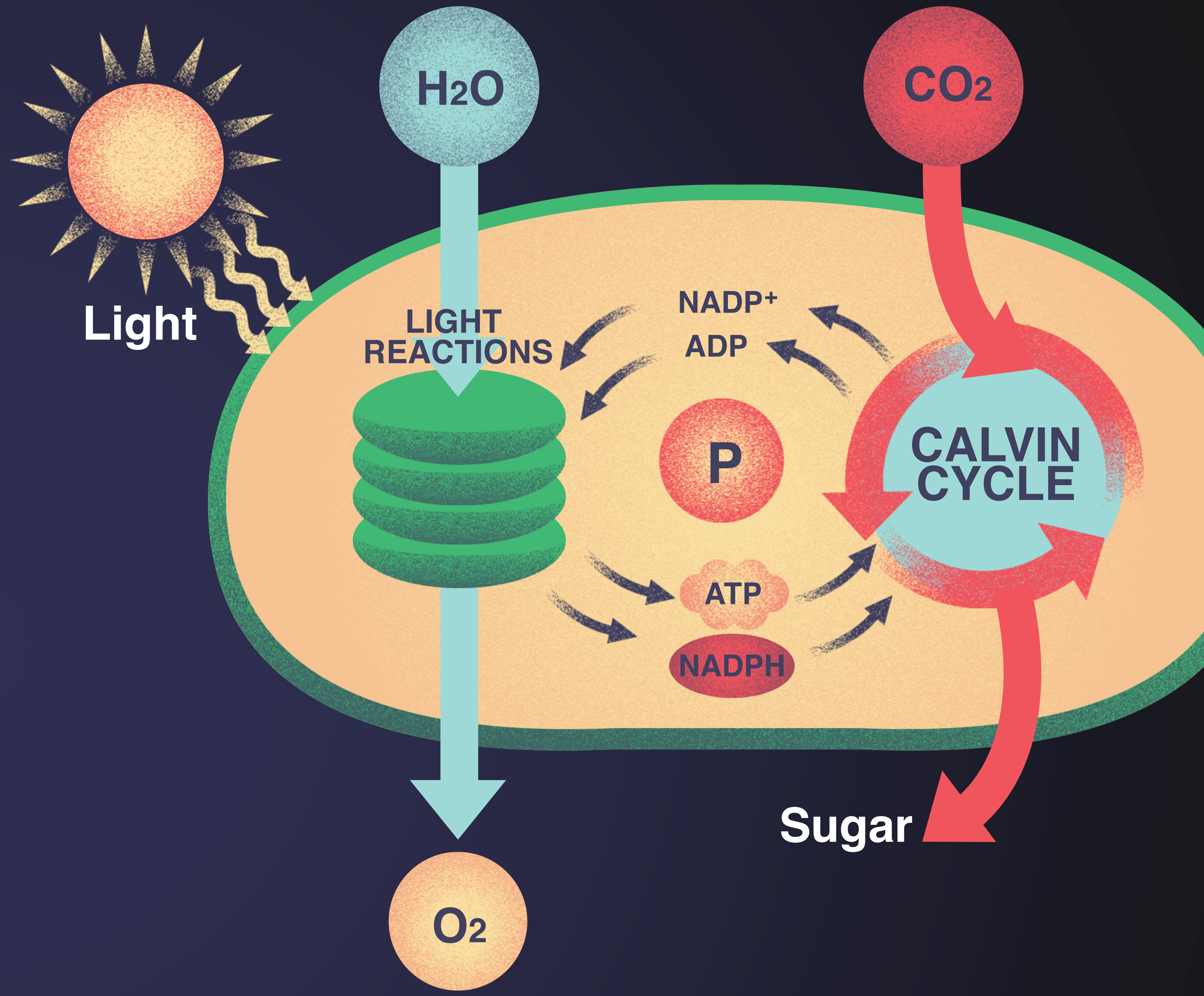


Chloroplast

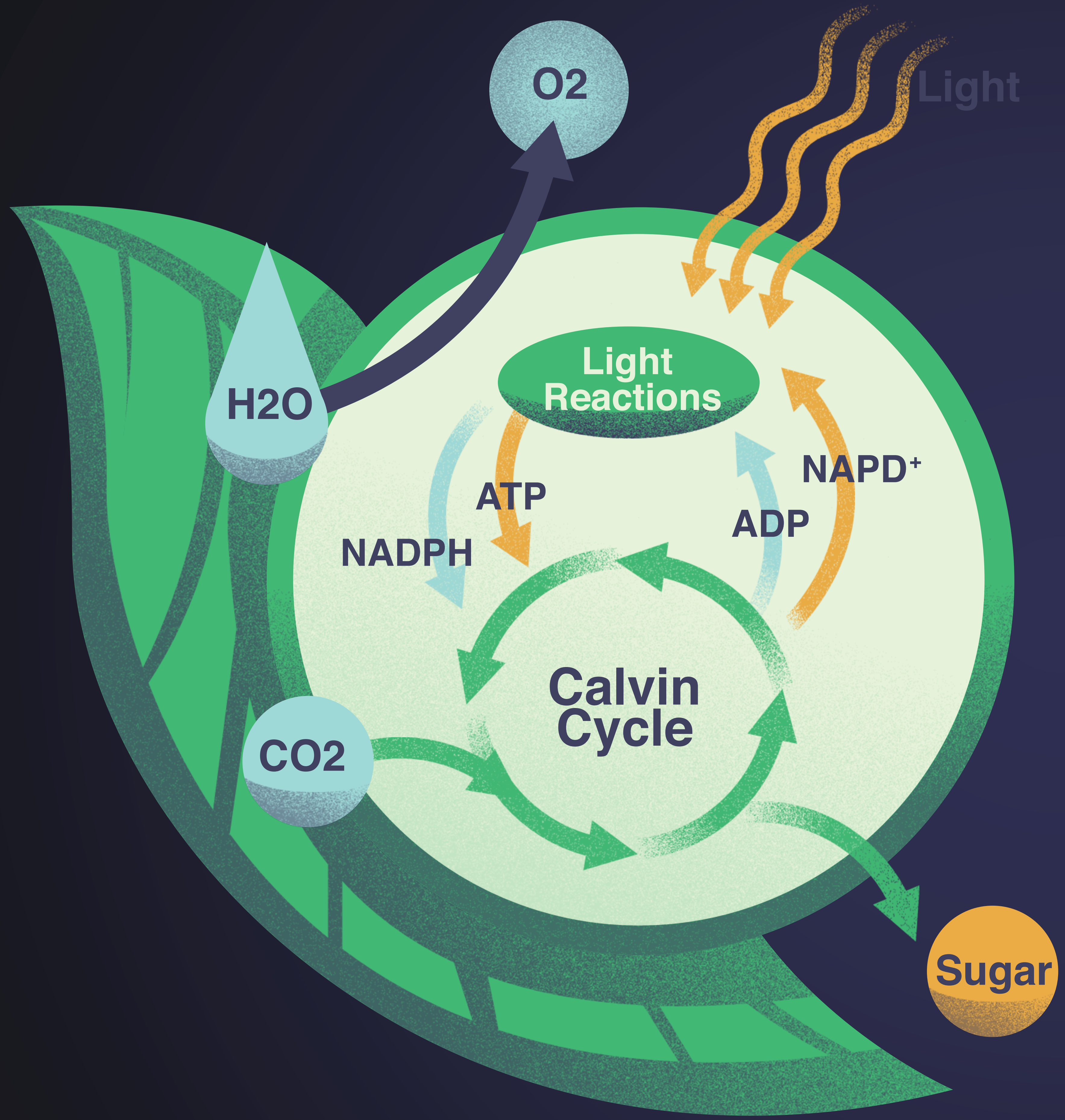


Chloroplast Structure	Function	How Structure Supports Function
Outer & inner membranes	Protect chloroplast and control movement of molecules	Semi-permeable membranes regulate transport of materials needed for photosynthesis
Thylakoid membrane	Site of light-dependent reactions (ATP & NADPH production)	Membrane houses **chlorophyll, photosystems, electron transport chains, ATP synthase**
Thylakoid lumen	Provides space for proton accumulation	Proton gradient forms here to drive **ATP synthesis**
Grana (stacks of thylakoids)	Increase surface area for light absorption	More membrane surface → more **chlorophyll and electron transport chains** → more light energy captured
Stroma	Site of Calvin cycle (light-independent reactions)	Fluid contains **enzymes, Rubisco, DNA, ribosomes** for carbon fixation and sugar synthesis
Chlorophyll & accessory pigments	Capture light energy	Embedded in thylakoid membrane, absorb specific light wavelengths efficiently

Where Photosynthesis Happens Inside the Chloroplast

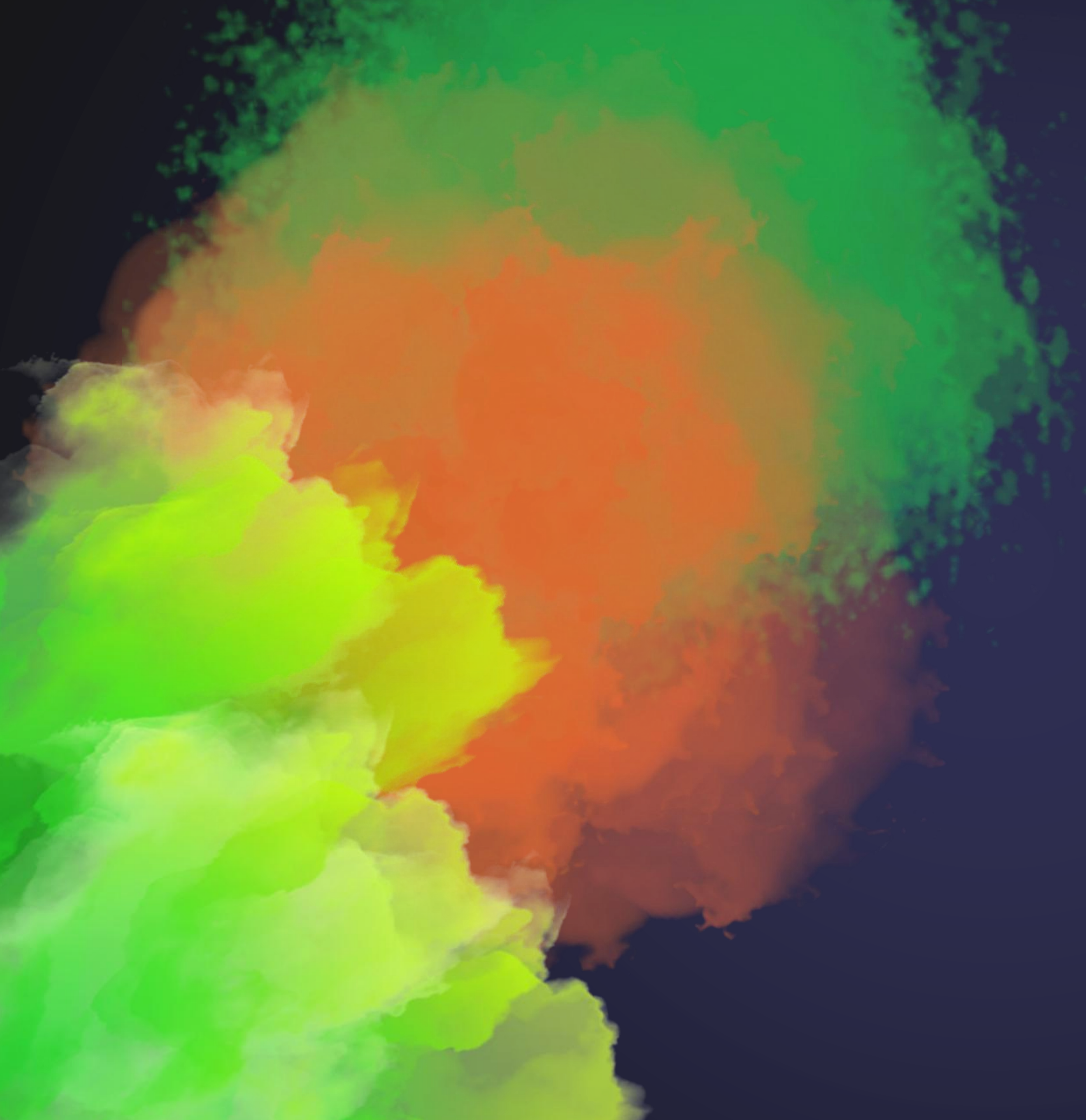


- Light reactions → thylakoid membranes
- Calvin cycle → stroma



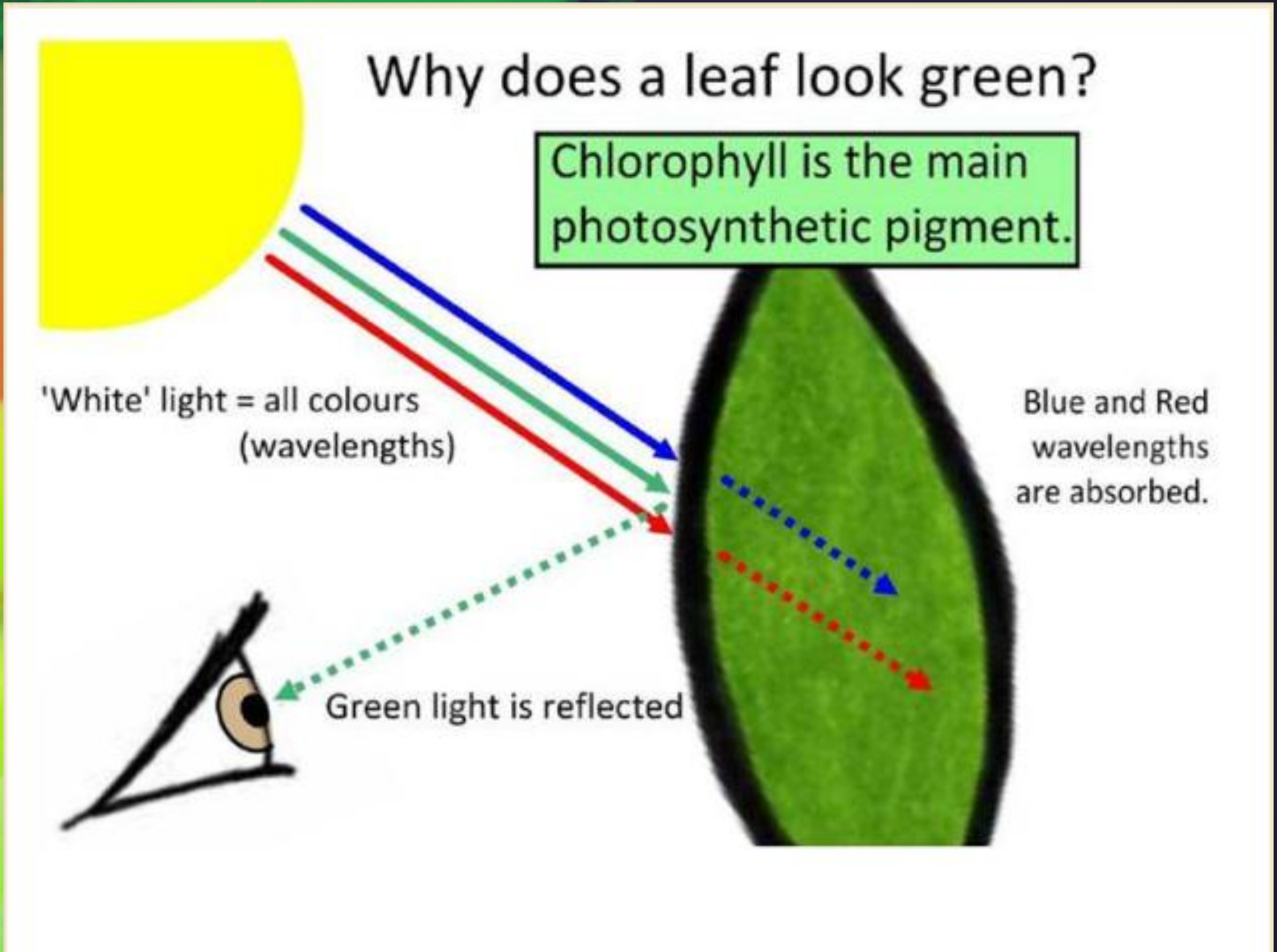
Light as Energy for Photosynthesis

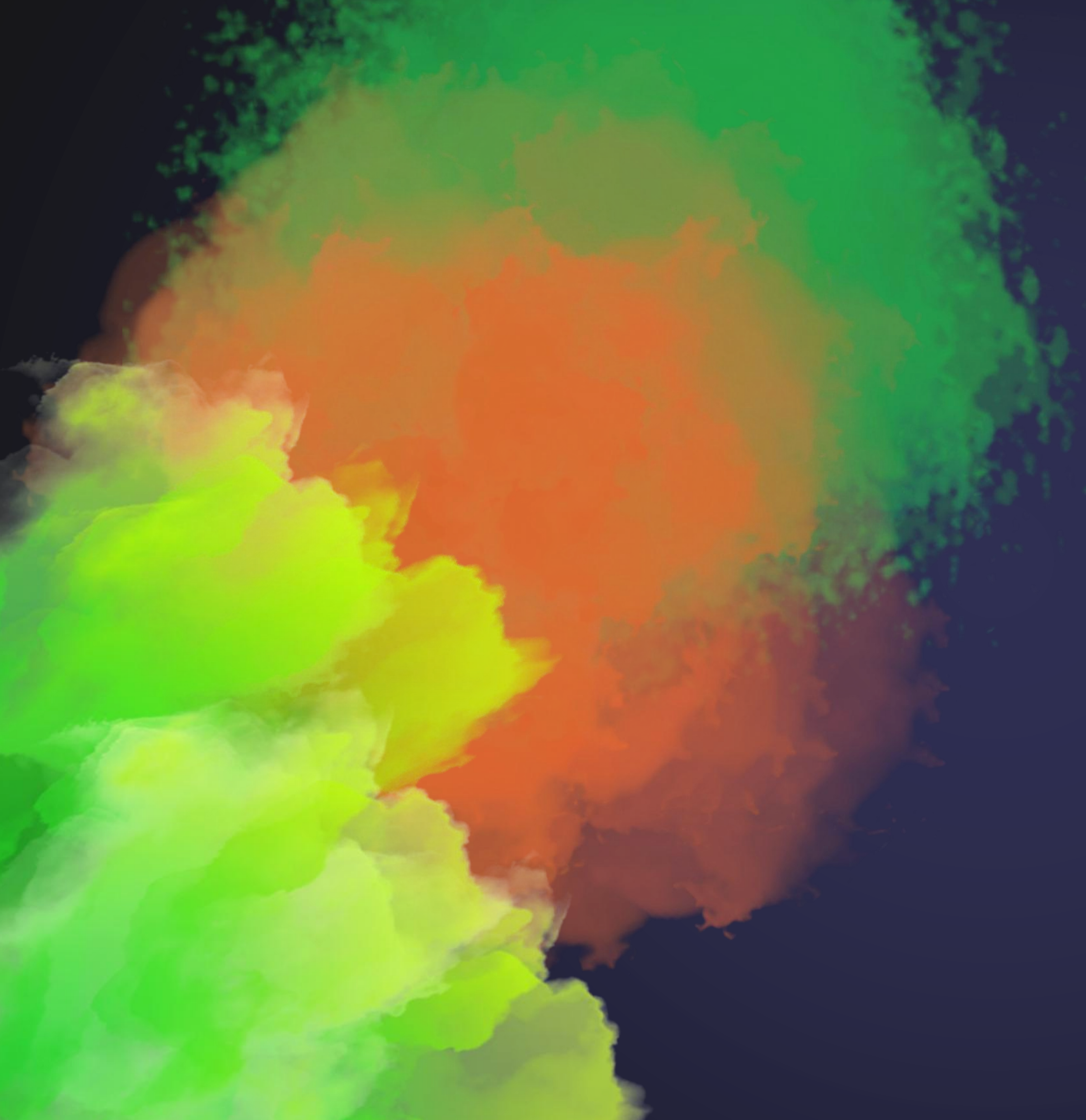
- Light provides energy to drive the reactions of photosynthesis.
- Specifically, it excites electrons in chlorophyll, which start the electron transport chain.
- This energy is ultimately stored in ATP and NADPH, which are used in the Calvin cycle.



Photosynthetic Pigments

- Photosynthetic pigments are molecules that capture light energy of specific wavelengths and transfer it to the photosystems to drive the light-dependent reactions of photosynthesis.


Why does a leaf look green?
Chlorophyll is the main photosynthetic pigment.
'White' light = all colours (wavelengths)
Blue and Red wavelengths are absorbed.
Green light is reflected



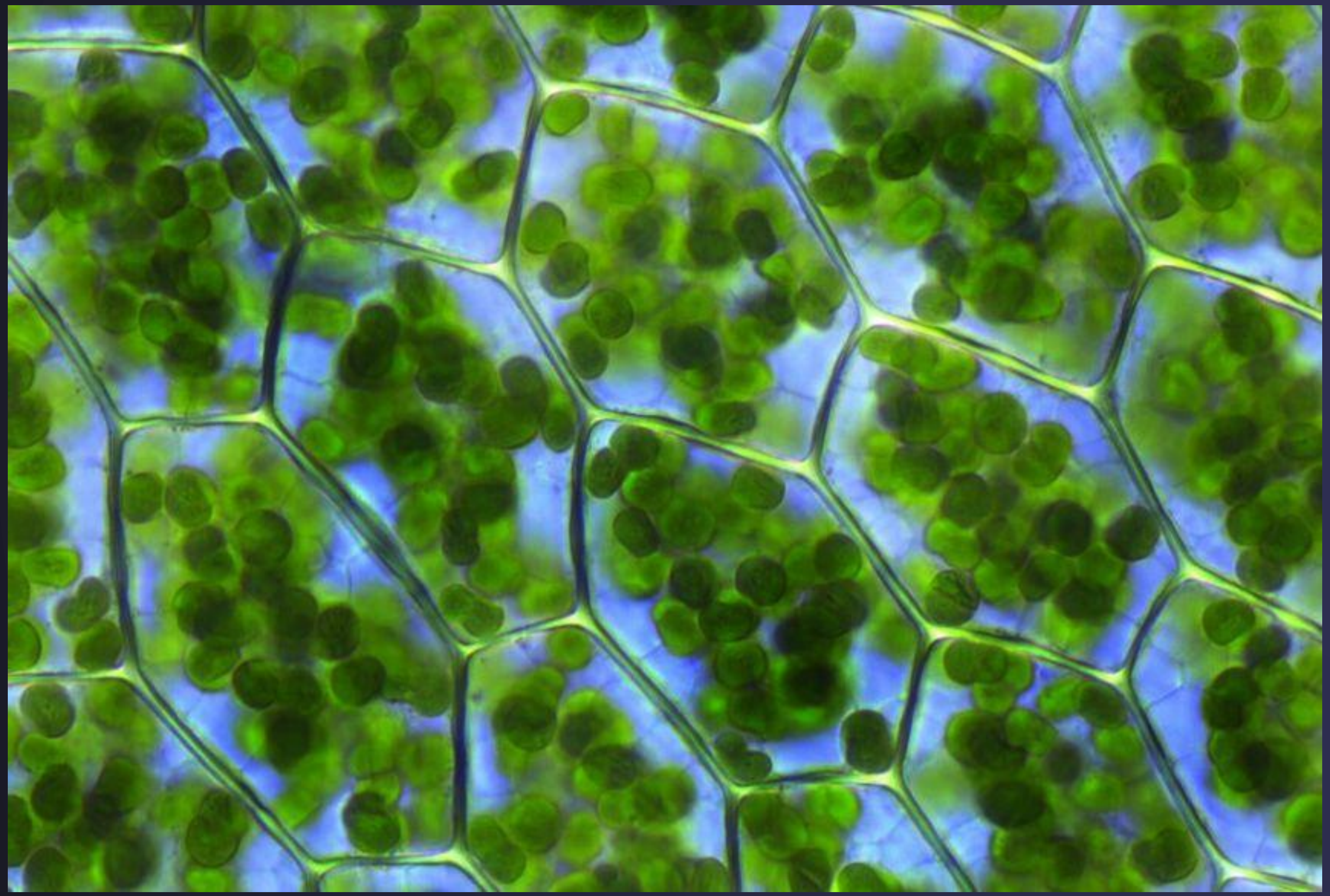
Role of Pigments

- Pigments absorb light energy of specific wavelengths.
- This energy excites electrons in the pigment molecule, which is the first step in the light-dependent reactions.
- Without pigments, plants cannot capture sunlight efficiently.

Location of Pigments

- Photosynthetic pigments (chlorophyll a, chlorophyll b, carotenoids) are embedded in the thylakoid membranes of chloroplasts.
- They are organized into protein-pigment complexes called photosystems (Photosystem I and II).

Primary Pigment



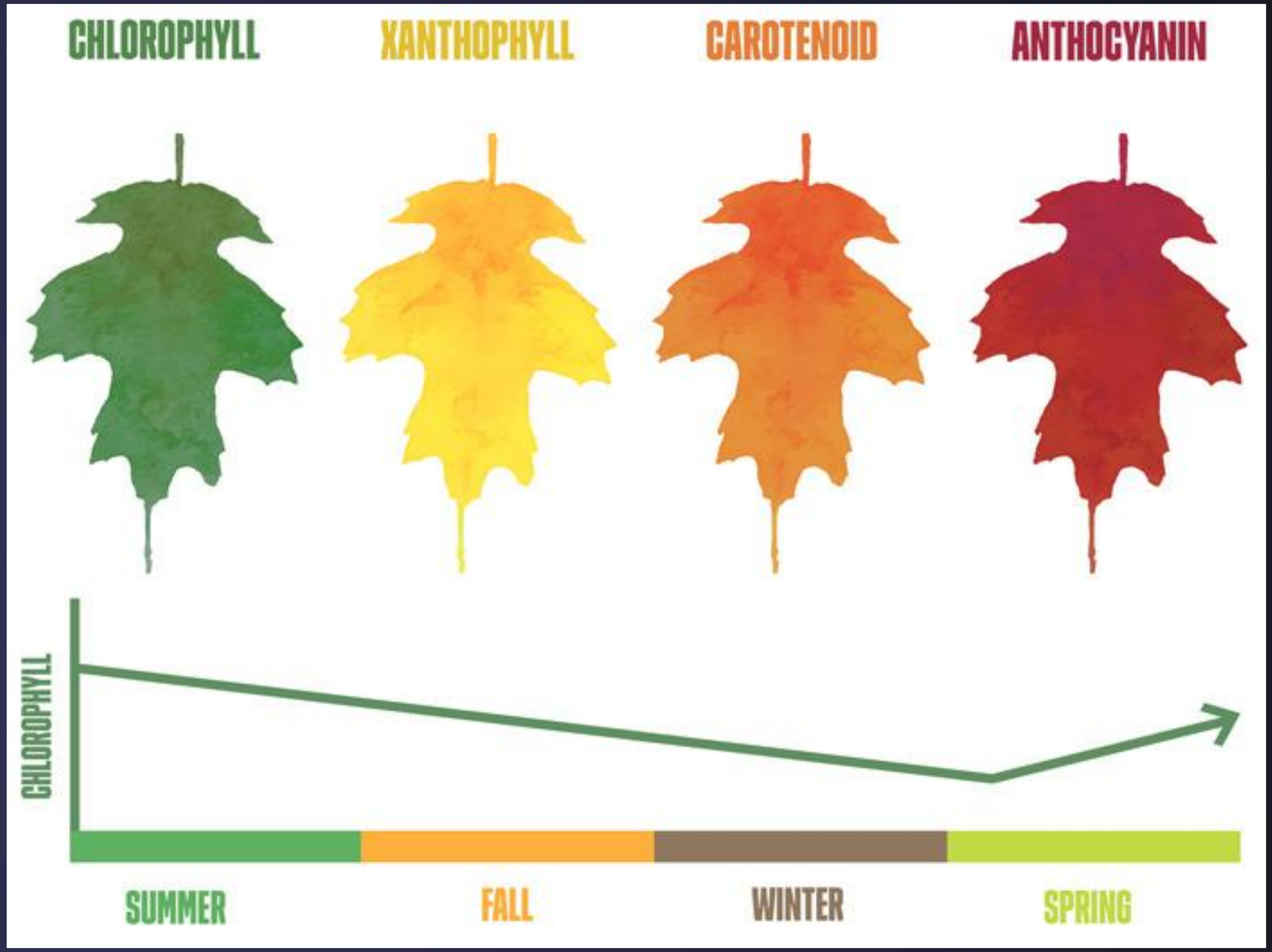
Chlorophyll

Accessory Pigments

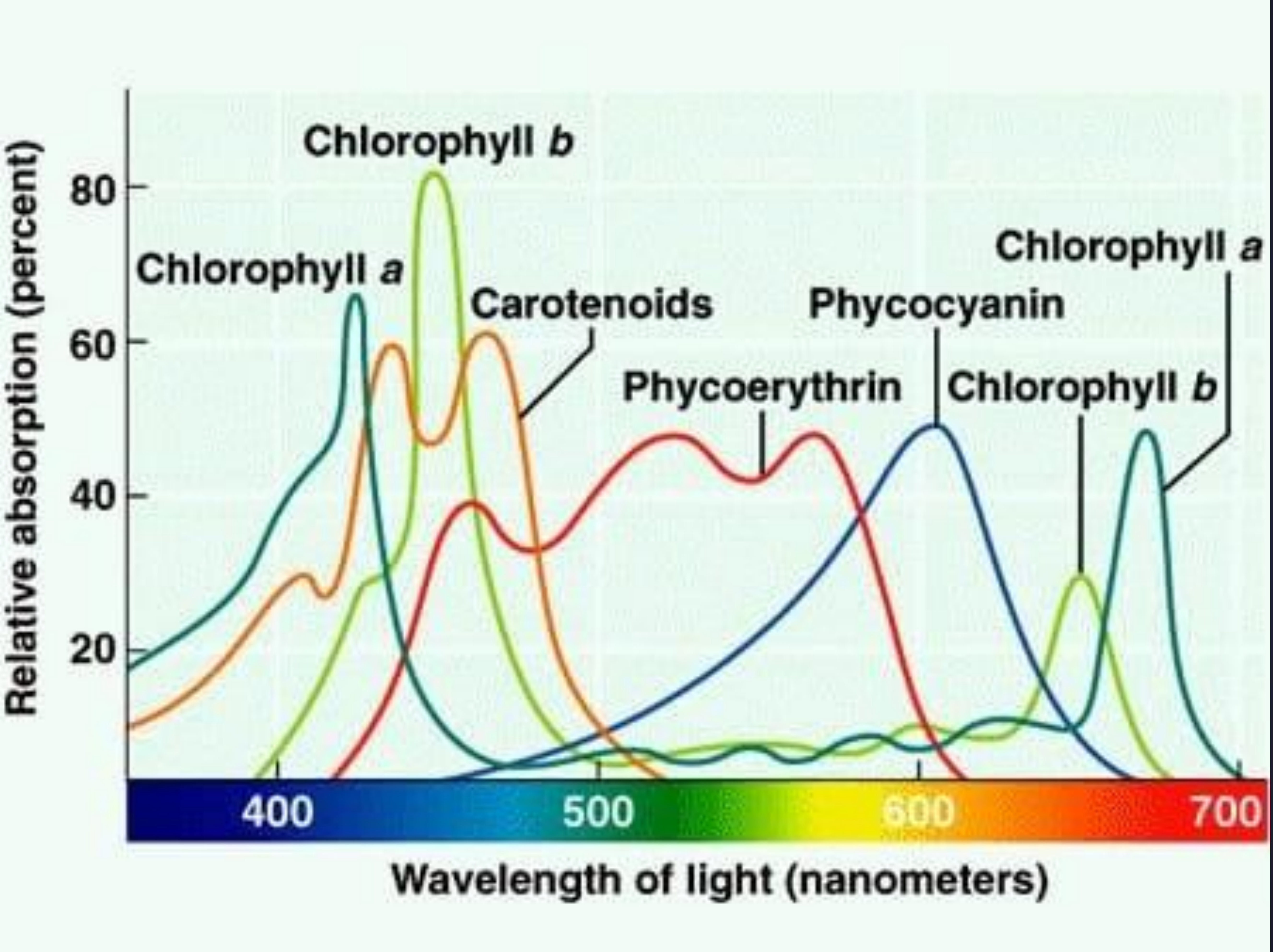
Carotene and Xanthophyll

Table 1. Photosynthetic Pigments in Plants and Other Phototrophic Organisms

Photosynthetic Pigments			Light Absorbed and Reflected	Found in
Principal Pigments	Chlorophyll a		Absorbs blue-violet and red lights; Reflects green light	all plants
	Bacteriochlorophyll		Absorbs the lights in the infrared region (red light to violet); Reflects reddish - purple lights	phototrophic bacteria
Accessory Pigments	Chlorophyll b		Absorbs blue and orange lights; Reflects yellow -green lights	plants, multi-celled algae and single-celled algae (diatoms)
	Chlorophyll c and d		Absorbs red and blue lights; Reflects yellow -green lights	
	Carotenoids	Carotene	Absorbs blue, violet lights; Reflects red, orange lights	all plants
		Xanthophyll	Absorbs blue, violet lights; Reflects brown, yellow lights	
	Phycobilins	Phycoerethrin	Absorbs dim and blue lights; Reflects red light	red algae and cyanobacteria
		Phycocyanin	Absorbs orange and red lights; Reflects blue light	

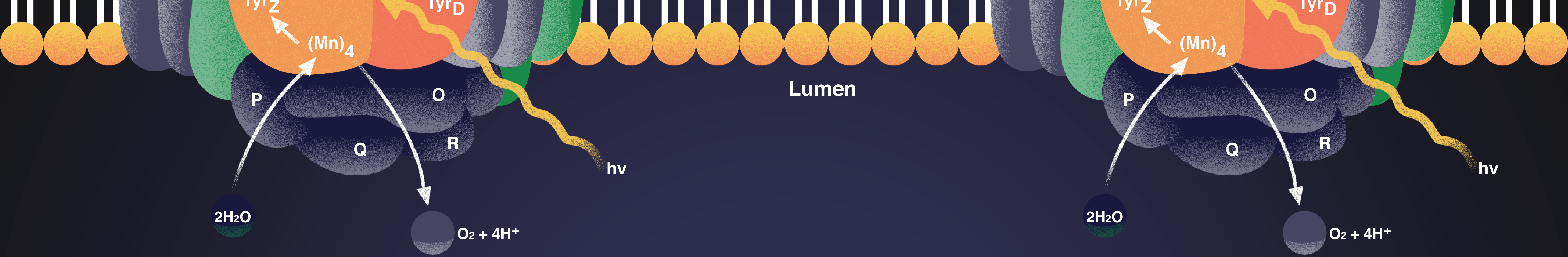


In countries that has 4 seasons, winter, spring, summer, and fall, the leaves in the trees change color as fall or autumn comes.


Chlorophyll b
Chlorophyll a
Carotenoids
Phycocyanin
Chlorophyll a
Phycoerythrin
Chlorophyll b
80
60
40
20
Relative absorption (percent)
400
500
600
700
Wavelength of light (nanometers)

Importance of Pigments in Photosynthesis

- Increased efficiency of photosynthesis.
- Adaptation to different light environments
- Effect of pigment loss (e.g., leaf color changes).



Activity 1

MY HOME-MADE CHLOROPHYLL POWDER

Activity 1: My Home-Made Chlorophyll Powder

In this part of the lesson, you will be producing home-made chlorophyll powder. Extracted chlorophyll powder from leaves of plants is usually used as organic alternatives for coloring of food, cosmetic products or in soaps. Chlorophyll is a great natural colorant that can be utilized to give hues to different products.

Activity 1:
My Home-Made Chlorophyll Powder

Activity 1:
My Home-Made Chlorophyll Powder

Materials Needed:

✓ 3 full cups of picked out / sorted out malunggay (*Moringa olifera*) or very finely chopped/shredded alugbati (*Basella alba Linn.*) leaves *Important Note:* *a. Use only one kind of plant leaves – meaning, if you decide to use malunggay then use only malunggay leaves, and if you decide to use alugbati, use only alugbati leaves.* *b. Choose leaves that are fully developed and that are found from the middle section of the plant because they contain the highest amount of chlorophyll.* *c. Plants that grow in semi-shaded areas contain more chlorophyll than the ones highly exposed to full sun.* *d. Avoid using stems, very young or old leaves, spotted and damaged leaves.*	✓ 4 to 5 cups of clean cold water ✓ Strainer (sala-an) ✓ small basin or bowl (plangganita) ✓ Clean cloth to be used for squeezing out liquid from blended or pounded leaves ✓ cooking pot and cooking stove ✓ Clean container or pitcher ✓ Blender or Mortar and pestle ✓ Tray or pan for drying your extracted chlorophyll powder and wax paper or bond paper

Activity 1: My Home-Made Chlorophyll Powder

Directions:

1. Prepare all the materials and lay and arrange them in a clean table for easy and quick reach.
2. Sort or pick out (hagpaton) the leaves. Wash them well and drain.
3. Measure 3 full cups.
4. If you have a blender at home, blend the leaves thoroughly to make a puree. Blend them in small portion, depending on the capacity of your blender. Add cold water to the leaves for easy blending. However, if you do not have blender at home, you can chop the leaves very finely using knife and chopping board. Be extra careful when using knife. You can also use mortar and pestle to crush the leaves. Just add cold water when crushing the leaves to prevent heating as you do the grinding or pounding.

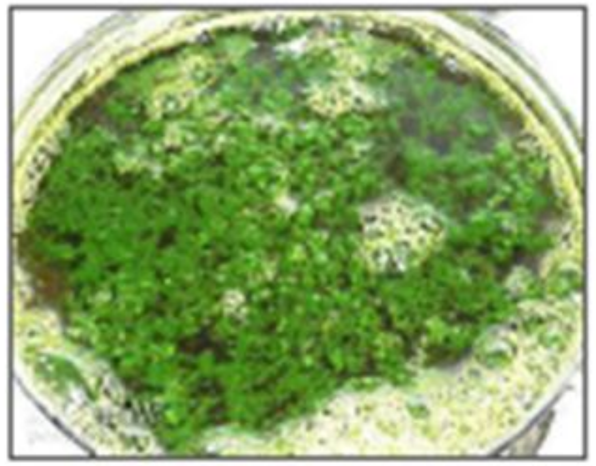
Photo Source:
https://st2.depositphotos.com/1009329/6462/i/950/depositphotosleaves-with-mortar-and.jpg

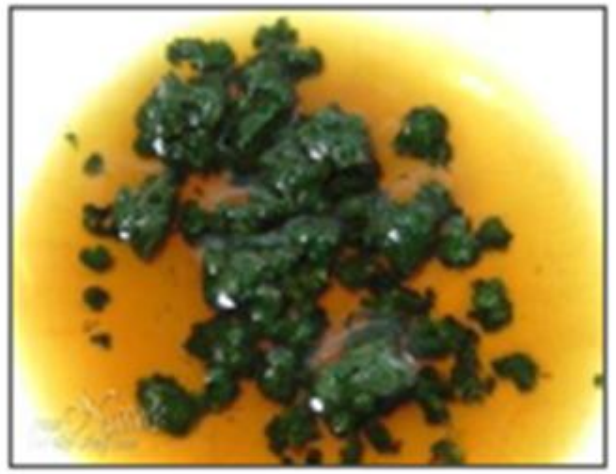
Activity 1: My Home-Made Chlorophyll Powder

6. After blending or grinding, strain the puree through a clean cloth and collect the liquid extract. The strained extract contains chlorophyll, so tightly press the cloth containing the puree with your hands to collect as much extract as possible. The collected liquid should be deep green in color and turbid. When done, the solid particles left on the cloth can be discarded. You can use them as chicken or pig feeds or as fertilizer to your garden.

Photo Source: http://www.natureontheshelf.com/natural-ingredients/homemade-chlorophyll-powder.html

7. Boil the collected liquid extract in a pot over **medium heat** for 1 to 2 minutes until curdles form. The chlorophyll-holding proteins in the extract will curdle. Green curdles containing chlorophyll will appear on top of the clarified reddish or brownish liquid. See the photos below as guide.





Photos' Source: http://www.natureontheshelf.com/natural-ingredients/homemade-chlorophyll-powder.html

Activity 1: My Home-Made Chlorophyll Powder

8. Strain the chlorophyll curdles. Use your hand to squeeze to remove the excess liquid. Discard the reddish-brown liquid.
9. Gently wash the chlorophyll curdles in clean cold water and strain them again through a clean cloth. Squeeze excess liquid by hand. This process will make the color of the chlorophyll powder bright green, since washing will remove the water-soluble red pigments.
10. Lay a wax paper or bond paper over a tray or a pan. Spread the wet green curdles over the paper to form a very thin layer. Dry them under direct heat of the sun for 4 to 5 hours or until they are very dry. Repeat sun drying if needed. You will know if your chlorophyll extract is completely dry when the granules are **'rock hard'** and **dark or almost black in color.**
11. Crush the dried extract using mortar and pestle to turn them into fine powder. When your chlorophyll powder is ready, you can store them in a clean clear glass jar with cover.

Activity 1:
My Home-Made Chlorophyll Powder

12. Finished products to be submitted will be one teaspoon chlorophyll powder only which will be stored in a small decanter/jar (garapa) with cover or in clean clear ice candy cellophane wrapper. Make sure you label it or tag it as follows:

    A. *Title: My Home-made Chlorophyll Powder*
    B. *Your Name:* ______________________
    C. *Grade and Section:* ________________

Photo Source: https://en.wikipedia.org/wiki/Matcha

Activity 1: My Home-Made Chlorophyll Powder

1) Package it as if you were to sell it.
2) Duration: 1 week
3) Deadline: February 06, 2026
4) Credit: 50 points

Biology I

Thank you for listening!

Prepared by: Marjorie Jane G. Badilla