MAMMOTH

SCIENCE

Unit 6 - P[illegible]

Cellular Energy

- *Understand that cellular energy is temporarily stored in the nucleotide ATP (adenosine triphosphate)*
- *Describe how energy is released by ATP*

Photosynthesis

- *Know that autotrophs or producers use sunlight to make their own food through the process of photosynthesis*
- *Identify the reactants & products in photosynthesis as CO_2 and H_2O + energy*
- *Explain the energy conversions in a cell during photosynthesis; light energy is converted to chemical energy*

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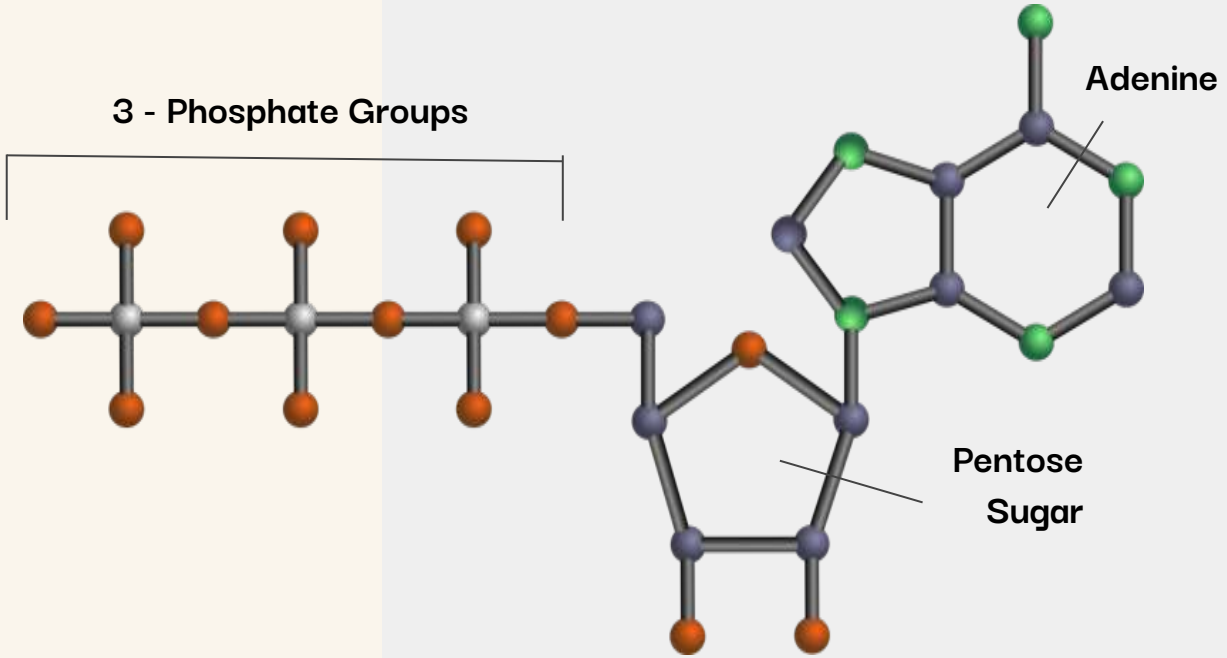
Menu

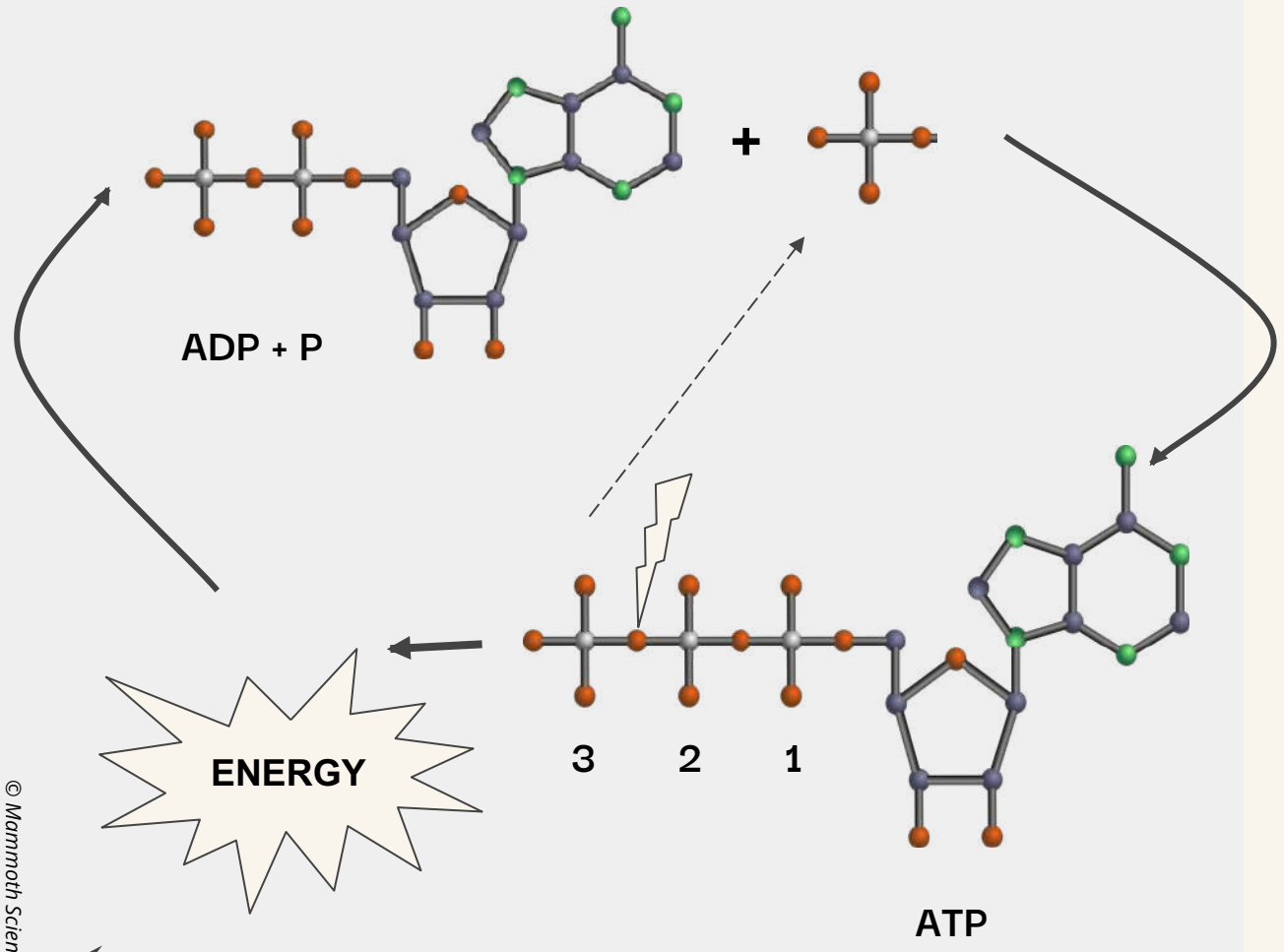
Cellular Energy - ATP

All organisms require energy for:

- Movement
- Active transport
- Production of proteins
- Cell division
- Photosynthesis
- Cellular respiration
- All other cellular reactions
- Cellular energy is stored in the ATP Molecule: **Adenosine Triphosphate**



ADP → ATP



ADP Molecule or Adenosine Diphosphate:

- Cells recycle the ADP to make new ATP to store more energy for future use.
- Many proteins have spots where ATP attaches to provide energy for the protein to do its job, and then the ADP is released for recycling.

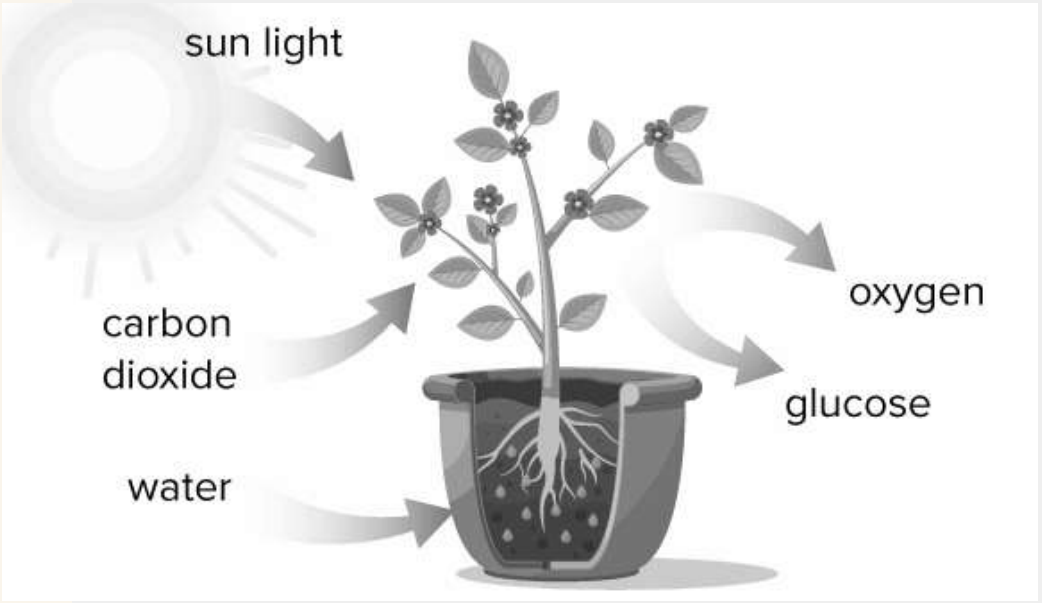
ATP Molecule or Adenosine Triphosphate:

- Cells have enough ATP to last for a few seconds.
- ATP must constantly be made.
- ATP transfers energy very well.
- ATP is NOT good at energy storage.

The What

Photosynthesis Summary

- **The What:** Is the process that uses the sun's energy to make chemical energy - **Glucose**
- Purpose is to trap sun's energy and store it in glucose (food for the plant).
- Carried out by green plants and some bacteria known as autotrophic – can make their own food.
- Reaction: **$6\ CO_2 + 6\ H_2O \quad C_6H_{12}O_6 + 6\ O_2$**
- This process is known as a biochemical pathway: when products of one reaction are used as the reactants for the next.



The Where

01

The Where

Mainly occurs in the leaves:

- **Stoma** - pores
- **Mesophyll cells**
  - ➔Occurs in the **Chloroplasts** inside the Mesophyll Cell
- Inside the **Chloroplast**
  - ➔**Thylakoids** are green because they contain **chlorophyll**.

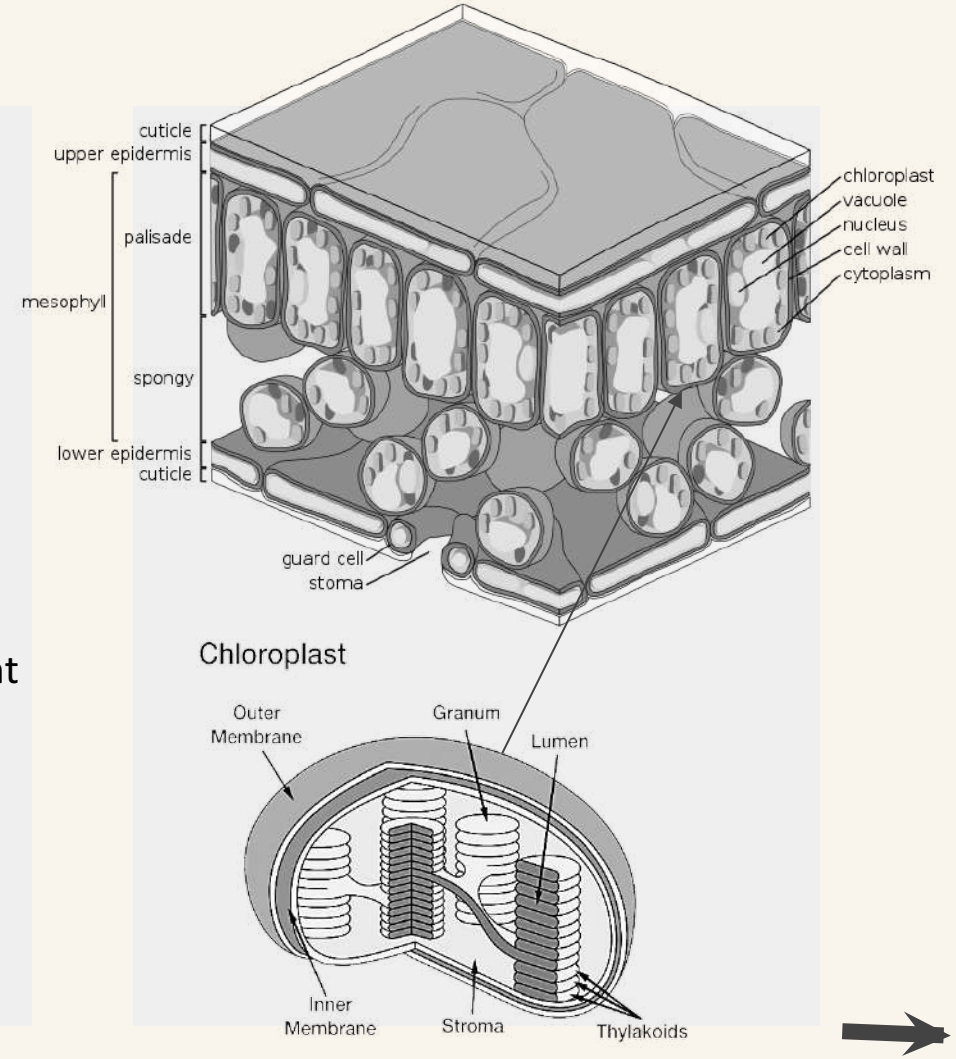
02

The Where - Continued

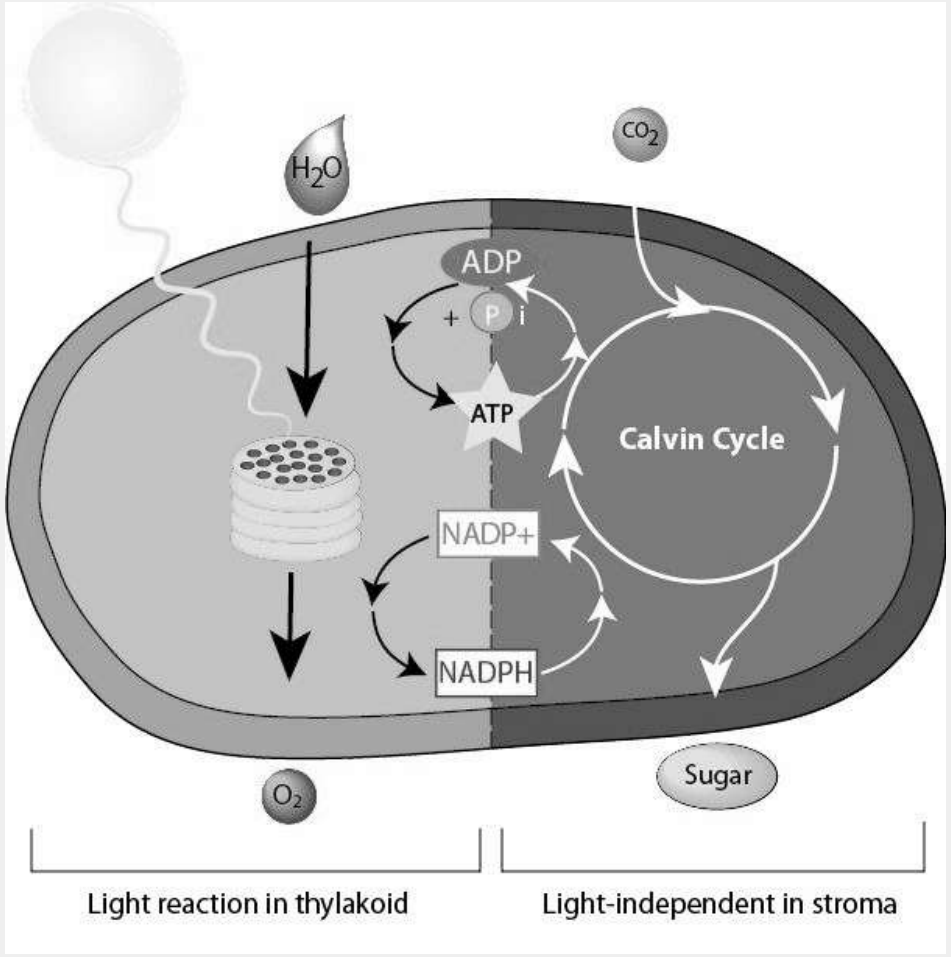
➔**Chlorophyll** a is the green pigment in plants that absorbs light energy. Absorbs light in the violet-blue and orange-red wavelengths

➔**Chlorophyll B** is a yellow pigment that absorbs blue wavelengths

➔Pigment is a light-**absorbing** compound.



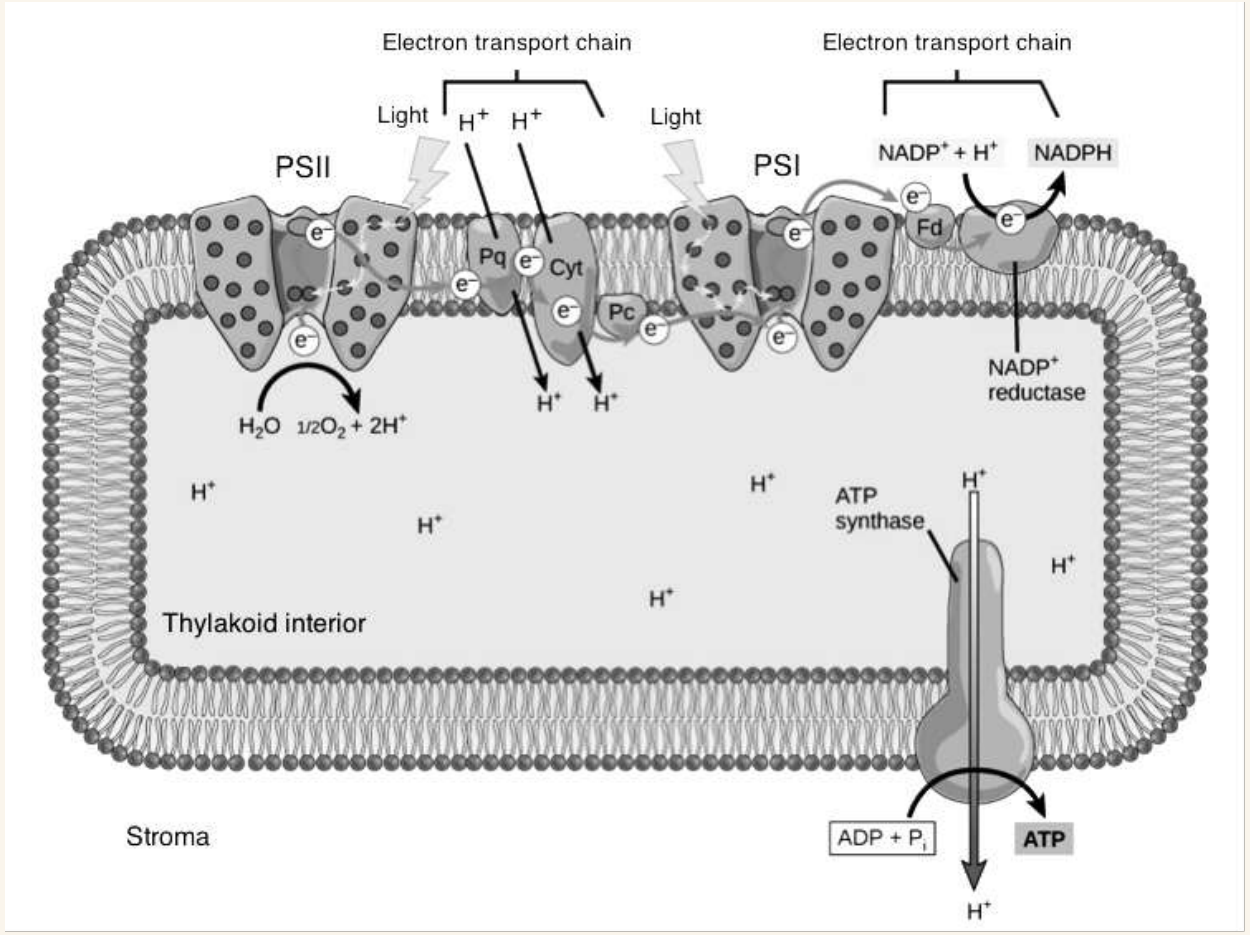
The How



A Look inside Photosynthesis

- There are two separate reactions that occur inside the process of Photosynthesis:
- **Light (Dependent) Reaction**
- **Dark (Light Independent) Reaction / Calvin Cycle**

Light Dependent Reaction



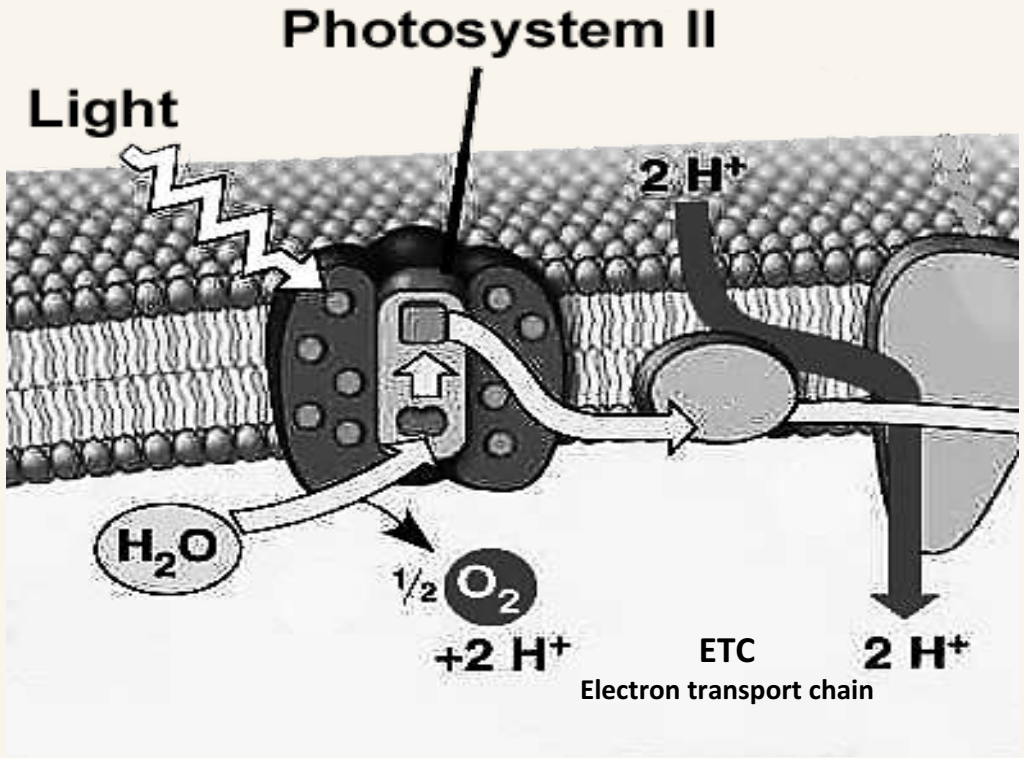
Photosynthesis - The Specifics

- **The LIGHT Dependent Reaction -** First step of photosynthesis that traps sunlight and makes electrons and ATP to run the dark reaction.
  - ➔ Occurs **inside** the **thylakoid** membranes.
  - ➔ Uses **light** energy.
  - ➔ Produce **Oxygen** from water.
  - ➔ Converts **ADP** to **ATP**.
  - ➔ Also converts **NADP+** into the energy carrier **NADPH**.

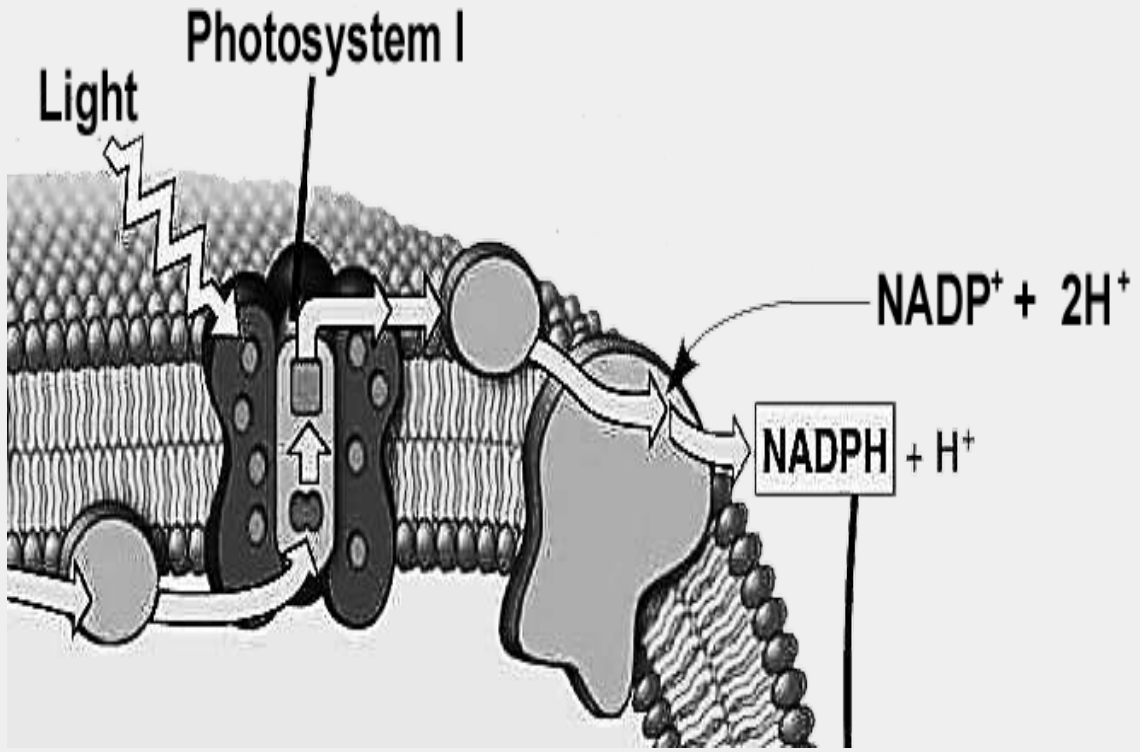
Light Dependent - Stage 1

Stage 1:

- **Photosystem II** absorbs light energy.
- Electrons are energized and passed to the **Electron Transport Chain (ETC).**
- Lost electrons are replaced from the splitting of water into 2H+, free electrons, and oxygen.
- 2H+ pumped across thylakoid membrane.



Light Dependent - Stage 2



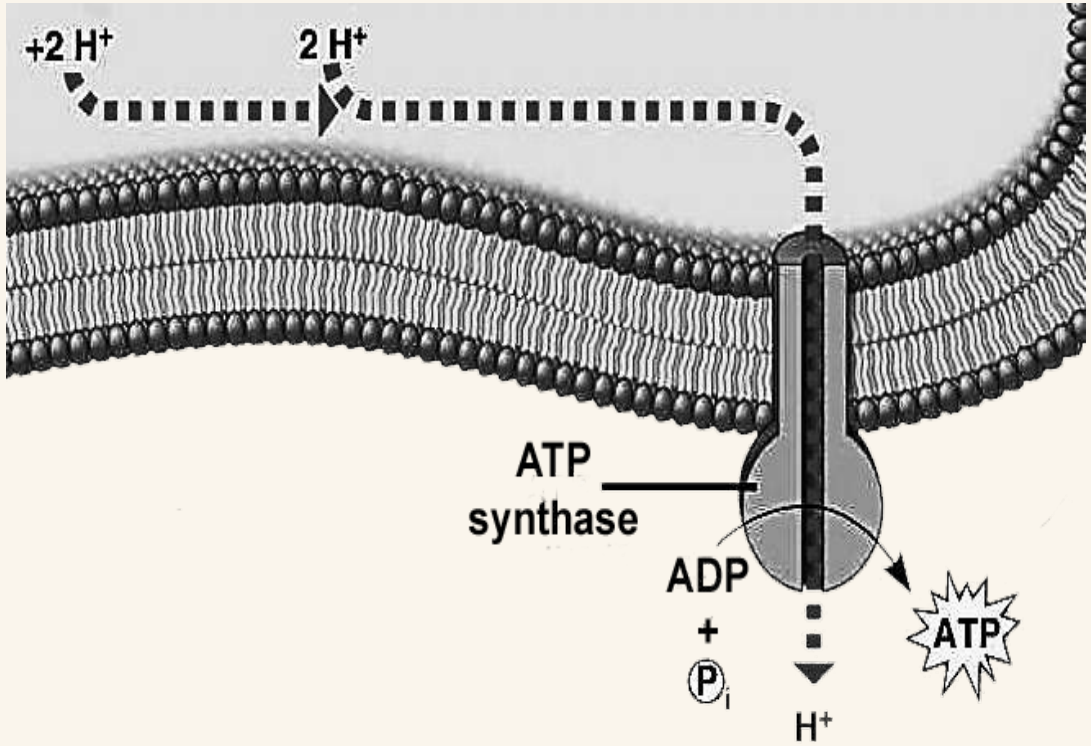
Stage 2:

- High-energy electrons are moved to photosystem I through the **Electron Transport Chain** (ETC).
- Energy is used to transport H+ from the stoma to the inner thylakoid membrane.
- **NADP+** is converted to 2 molecules of **NADPH** when it picks up 2 electrons & H+.

Light Dependent - Stage 3

Stage 3:

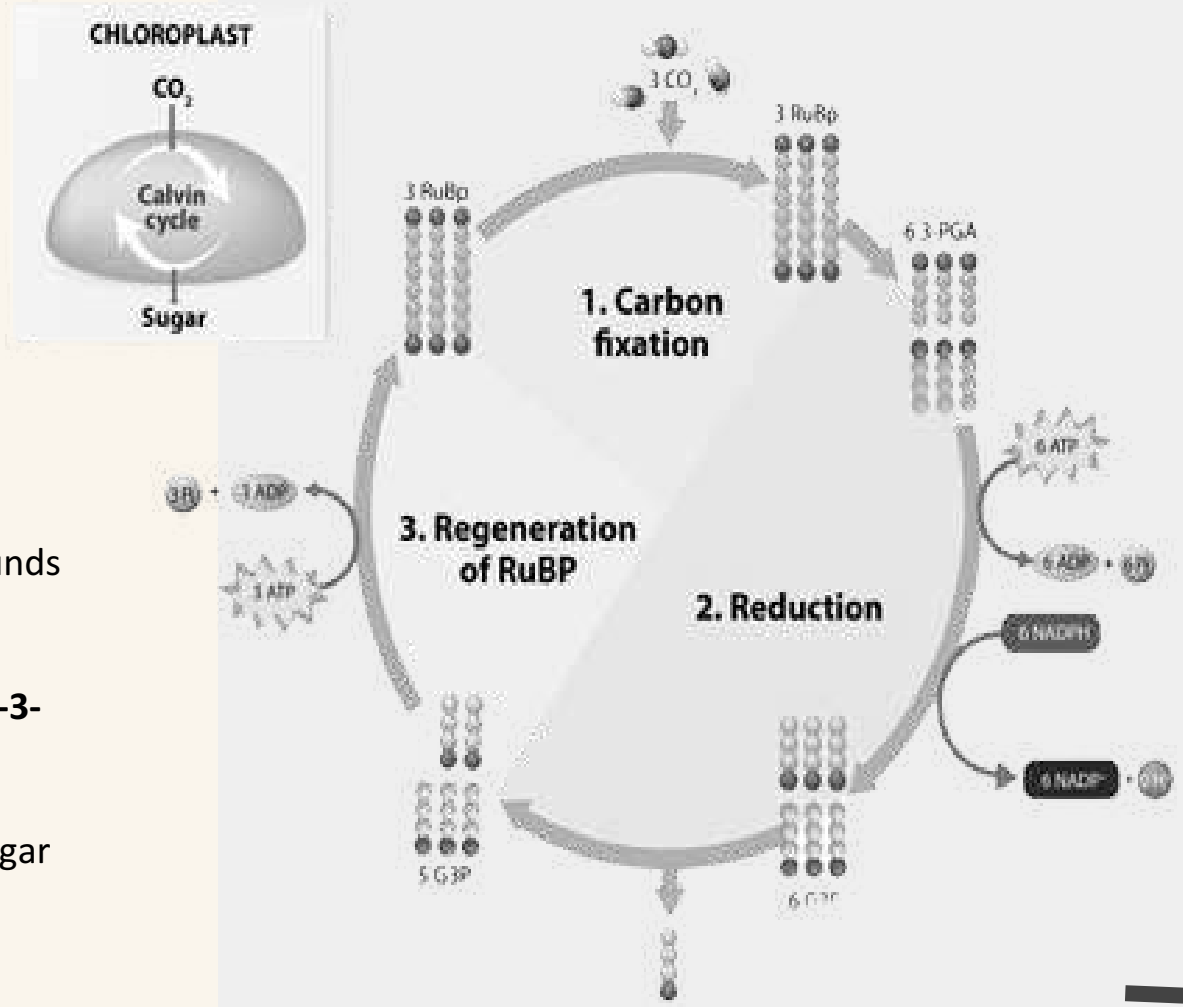
- Powers ATP synthesis.
- In the thylakoid membrane is an enzyme called ATP Synthase.
- As H+ ions pass through the thylakoid membrane, down their concentration gradient, the enzyme binds them to a molecule of ADP (hydrolysis).
- Forms 3 molecules of ATP that is used to fuel cellular activities.



Light Independent Reaction / Calvin Cycle

The DARK Reaction / Calvin Cycle:

- Sunlight is not necessary for this reaction to occur.
- Occurs in the **stroma**
- Uses **ATP** and **NADPH** from light reaction as energy.
  - ➔ Atmospheric C02 is used to make sugars like glucose and fructose.
  - ➔ A 3-carbon molecule called Ribulose Biphosphate (**RuBP**) is used to regenerate the Calvin cycle. (**Carbon Fixation**)
  - ➔ 3-CO_2 molecules enter the cycle to form several intermediate compounds (**PGA**). (**Reduction**)
  - ➔ The 3 carbon molecule used to make glucose is PGAL (**Glyceraldehyde-3-phosphate**). (**Regeneration**)
  - ➔ Two turns of the Calvin Cycle are required to make one molecule of sugar and other compounds.



Light Independent Stages

Stage 1:

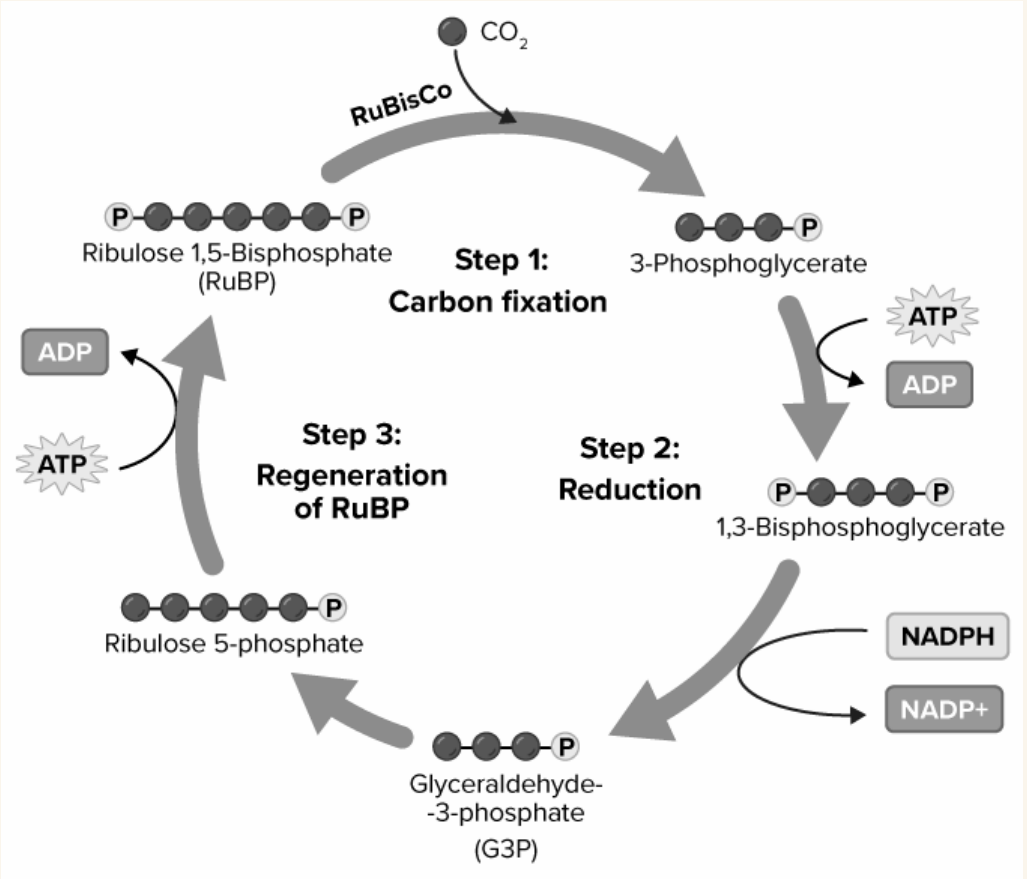
- CO2 from the atmosphere undergoes fixation and creates 6 copies of an intermediate molecule called: 3-Phosphoglycerate (3-PGA)

Stage 2:

- ATP and NADPH lose a phosphate group to become ADP and NADH.
- 3-PGA converts to G3P – Glyceraldehyde 3-phosphate and ultimately Glucose

Stage 3:

- 5 of the G3P molecules use 3 ATP molecules to regenerate Ribulose bisphosphate in order to go through the Calvin Cycle again.



Photosynthesis Chemical Summary

Photosynthesis Biochemical Summary

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

	Consumed	Produced
Light Reaction	12 H_2O	12 - NADPH 18 – ATP 6 – O_2
Dark Reaction	6– CO_2 18 – ATP 12 - NADPH	1 – Sugar (Glucose) 6 – H_2O

Thank you!

Do you have any questions?

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