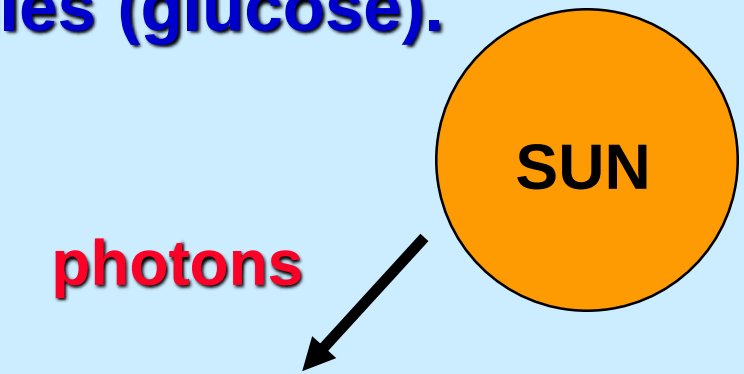
PHOTOSYNTHESIS

Botany Department
B.N.D. College

Photosynthesis

- An **anabolic, endergonic, carbon dioxide (CO_2)** requiring process that uses **light energy (photons)** and **water (H_2O)** to produce **organic macromolecules (glucose).**

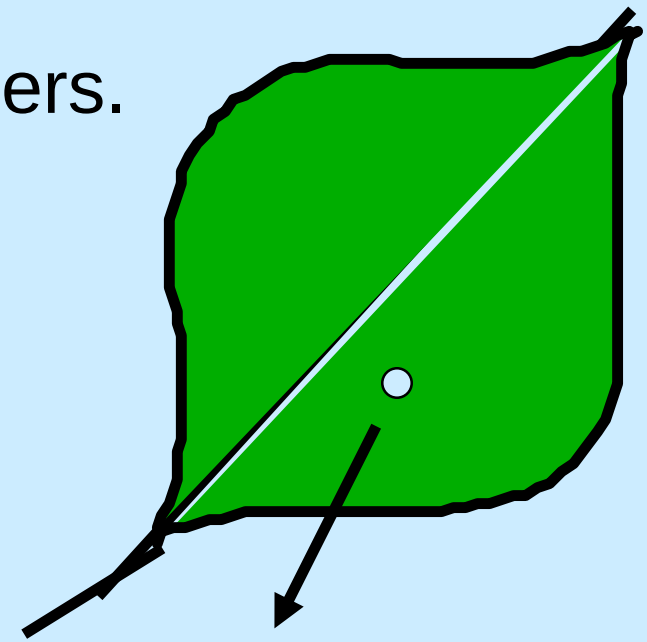


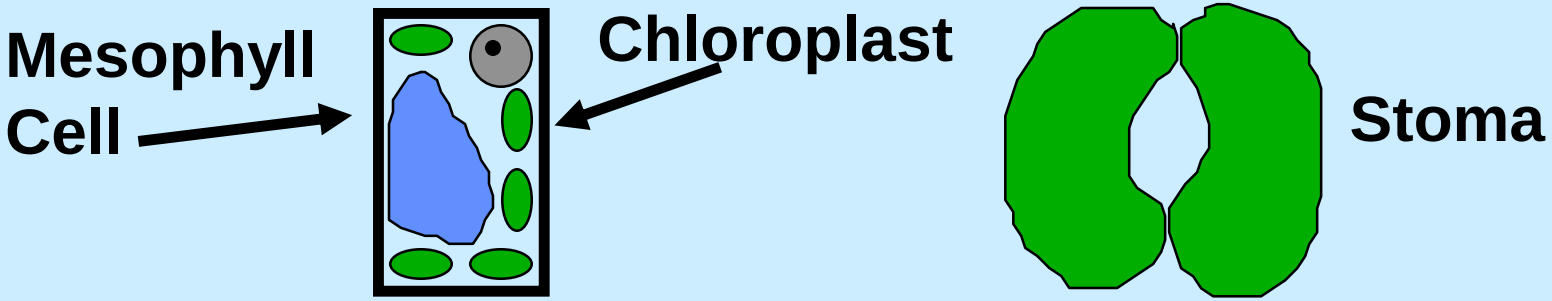
$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

glucose

Plants

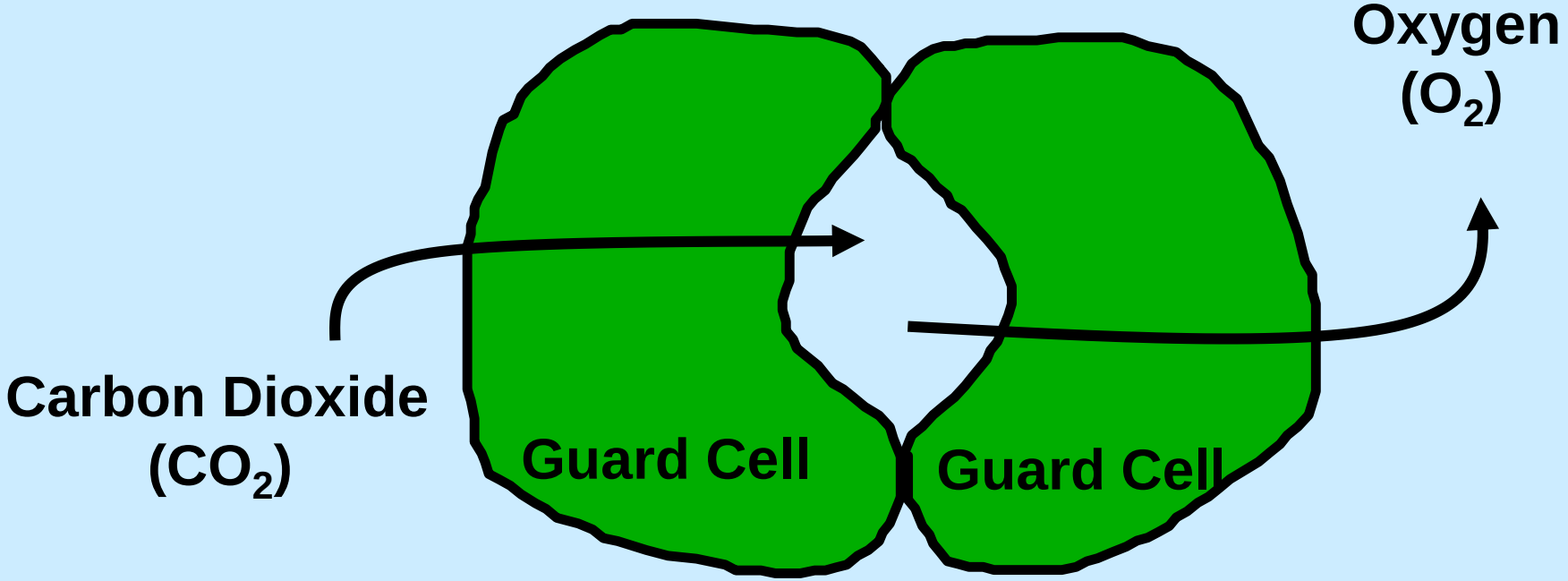
- **Autotrophs:** self-producers.
- Location:
  1. Leaves
     a. **stoma**
     b. **mesophyll cells**



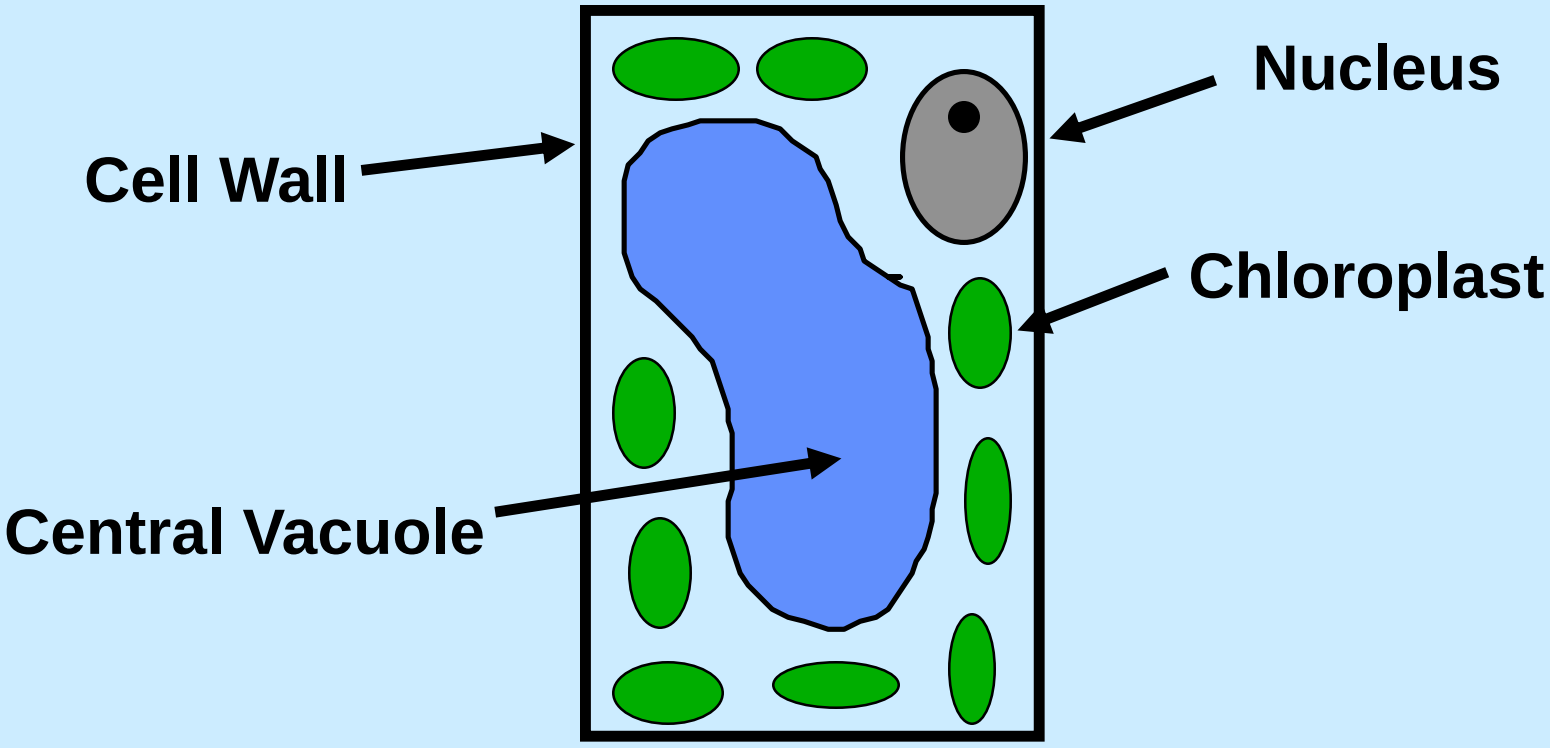


Stomata (stoma)

- **Pores** in a plant's cuticle through which **water** and **gases** are exchanged between the plant and the atmosphere.

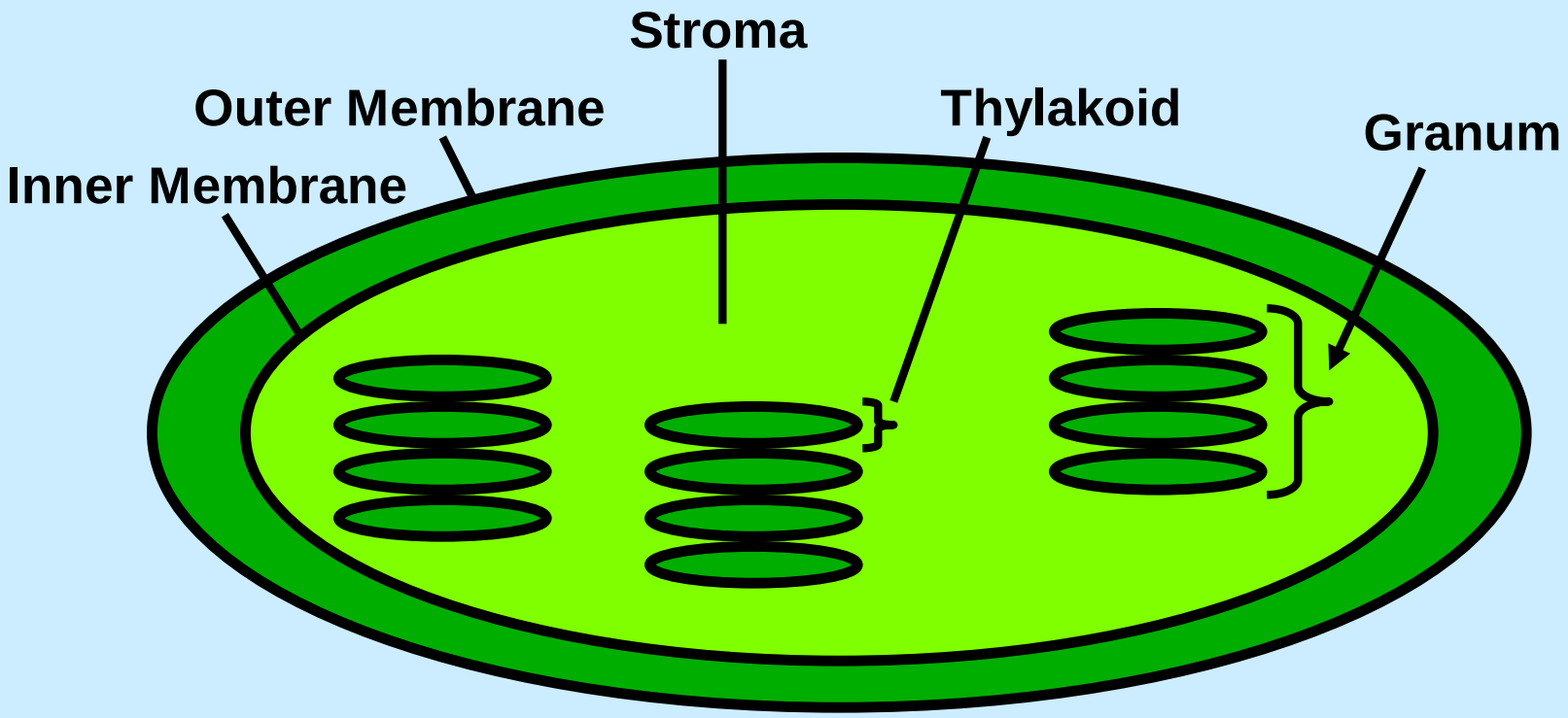


Mesophyll Cell

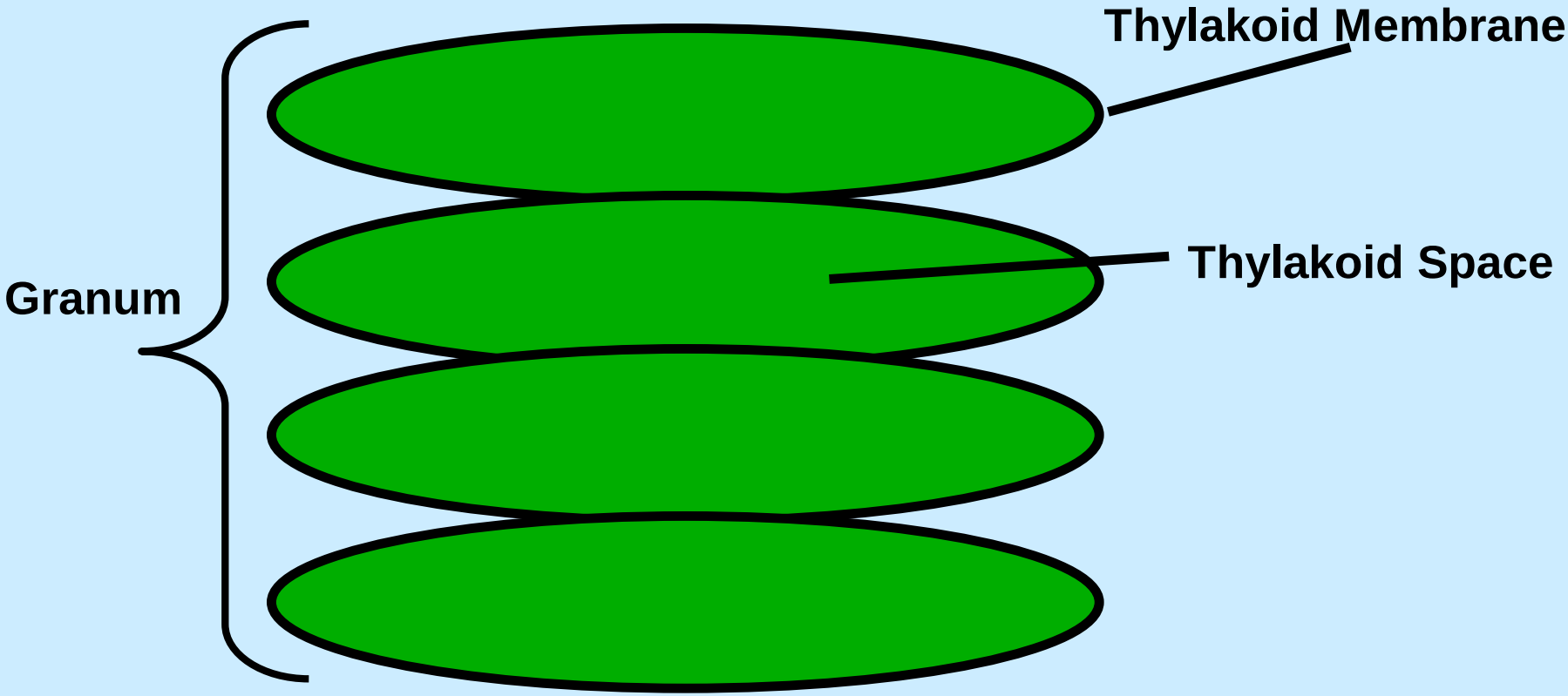


Chloroplast

- **Organelle** where **photosynthesis** takes place.



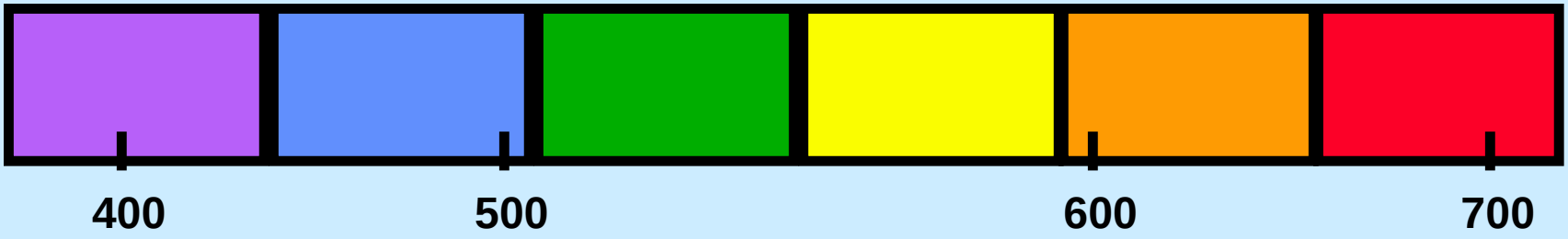
Thylakoid



Chlorophyll Molecules

- Located in the **thylakoid membranes**.
- Chlorophyll have **Mg^{+}** in the center.
- **Chlorophyll pigments** harvest energy (photons) by **absorbing** certain **wavelengths** (**blue-420 nm** and **red-660 nm** are most important).
- **Plants** are **green** because the **green wavelength** is **reflected**, **not absorbed**.

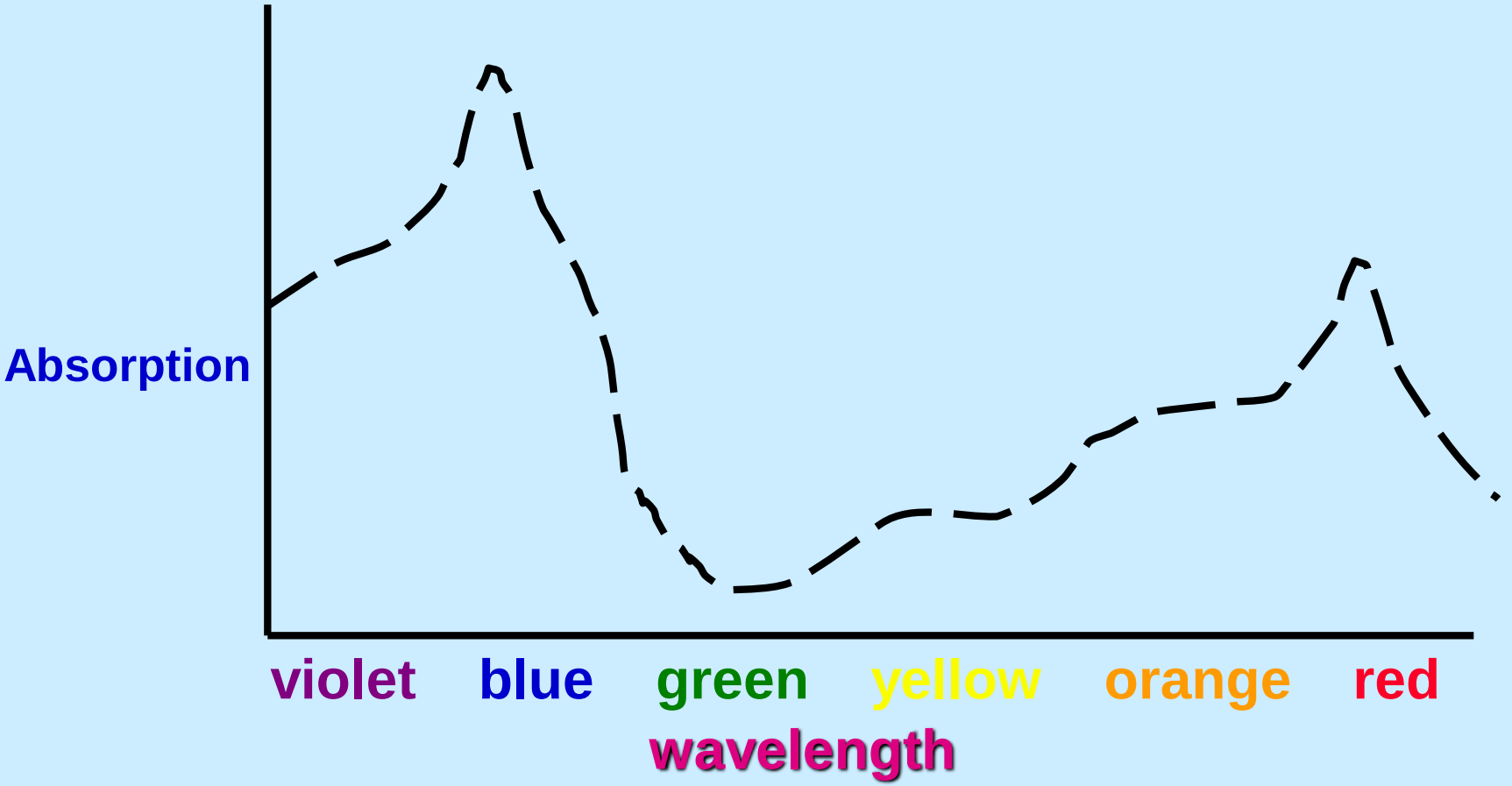
Wavelength of Light (nm)



Short wave
(more energy)

Long wave
(less energy)

Absorption of Chlorophyll



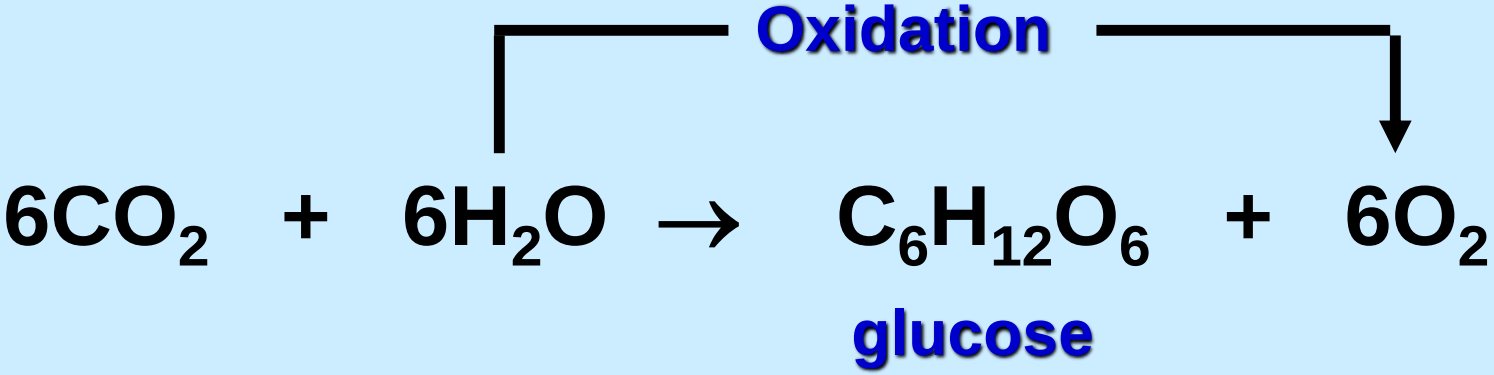
Redox Reaction

- The **transfer** of **one** or **more electrons** from **one reactant** to **another**.

- **Two types:**
  1. **Oxidation**
  2. **Reduction**

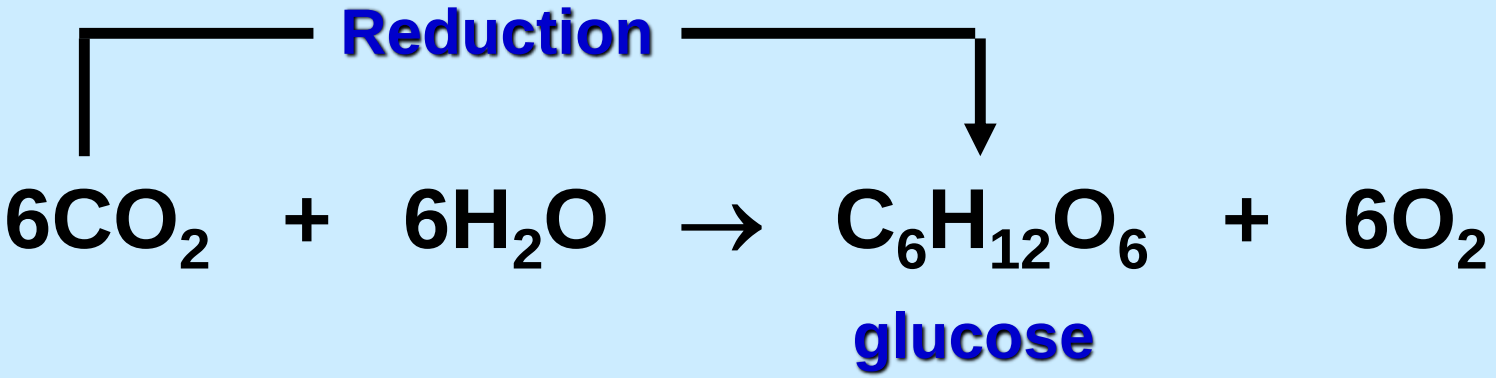
Oxidation Reaction

- The **loss** of **electrons** from a **substance**.
- Or the **gain** of **oxygen**.



Reduction Reaction

- The **gain** of **electrons** to a **substance**.
- Or the **loss** of **oxygen**.



Breakdown of Photosynthesis

- **Two main parts (reactions).**

1. **Light Reaction or**
   Light Dependent Reaction

Produces **energy** from **solar power (photons)** in the form of **ATP** and **NADPH**.

Breakdown of Photosynthesis

2. **Calvin Cycle or**
   Light Independent Reaction or
   Carbon Fixation or
   C_3 Fixation

Uses **energy (ATP and NADPH)** from **light rxn** to make **sugar (glucose).**

1. Light Reaction (Electron Flow)

- Occurs in the **Thylakoid membranes**
- During the **light reaction**, there are **two possible** routes for **electron flow**.

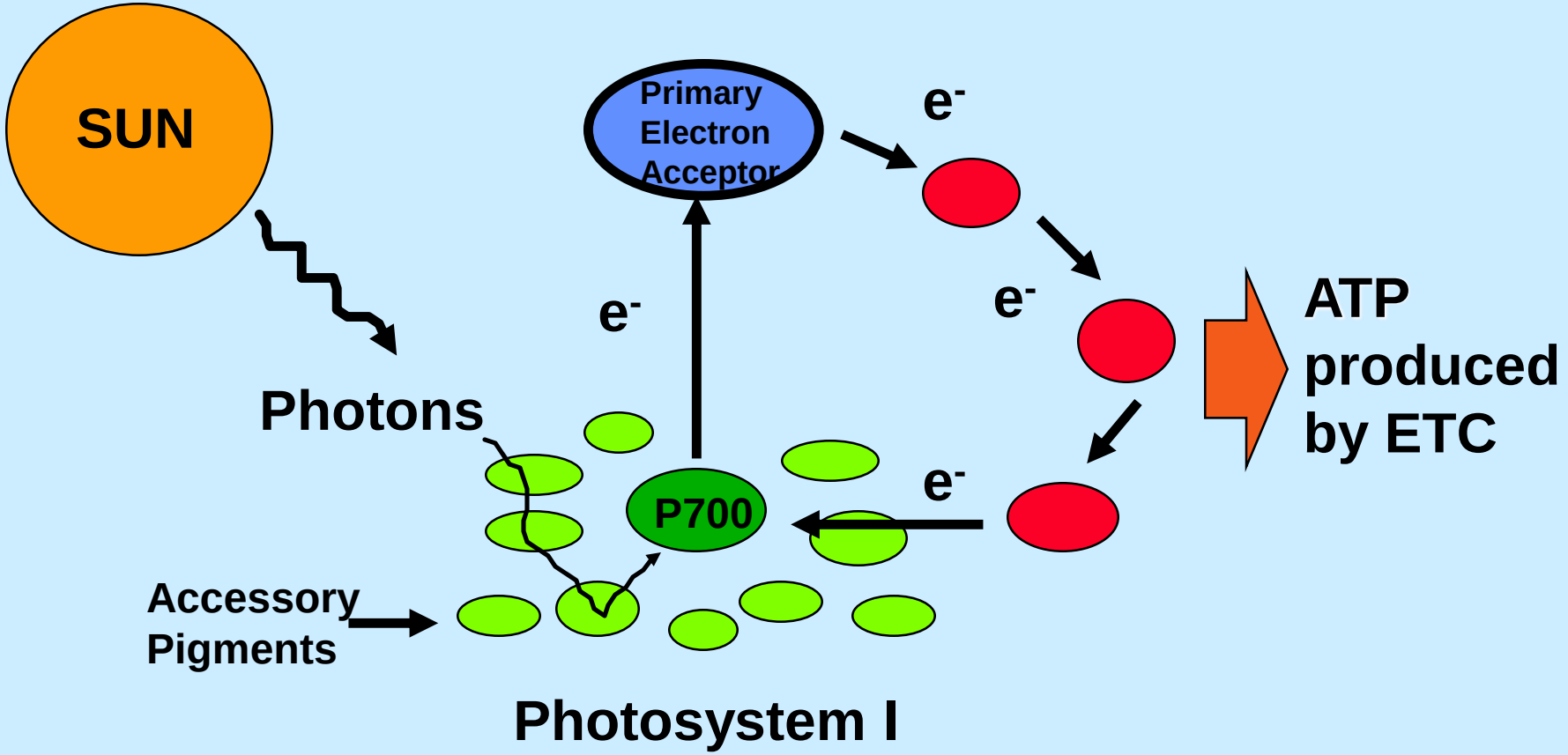
A. Cyclic Electron Flow

B. Noncyclic Electron Flow

A. Cyclic Electron Flow

- Occurs in the **thylakoid membrane**.
- Uses **Photosystem I only**
- P700 reaction center- chlorophyll a
- Uses **Electron Transport Chain (ETC)**
- **Generates ATP only**

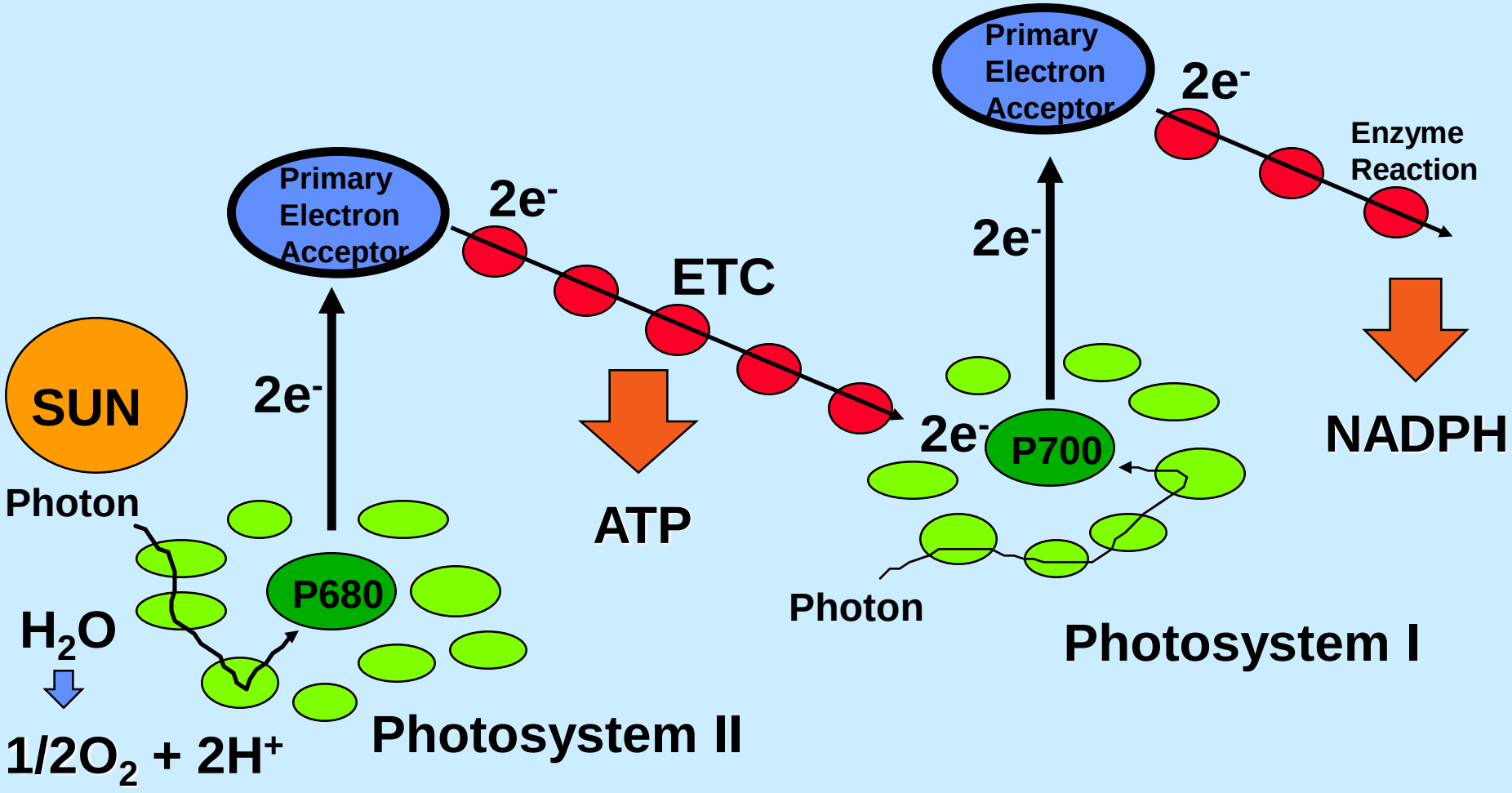
A. Cyclic Electron Flow



B. Noncyclic Electron Flow

- Occurs in the **thylakoid membrane**
- Uses **PS II** and **PS I**
- P680 rxn center (PSII) - chlorophyll a
- P700 rxn center (PS I) - chlorophyll a
- Uses **Electron Transport Chain (ETC)**
- **Generates O_2, ATP and NADPH**

B. Noncyclic Electron Flow



B. Noncyclic Electron Flow

- ADP + P → ATP
  (Reduced)
- $NADP^+$ + H → NADPH
  (Reduced)

- Oxygen comes from the splitting of H_2O, not CO_2

$$H_2O \rightarrow 1/2\ O_2 + 2H^+$$

(Oxidized)

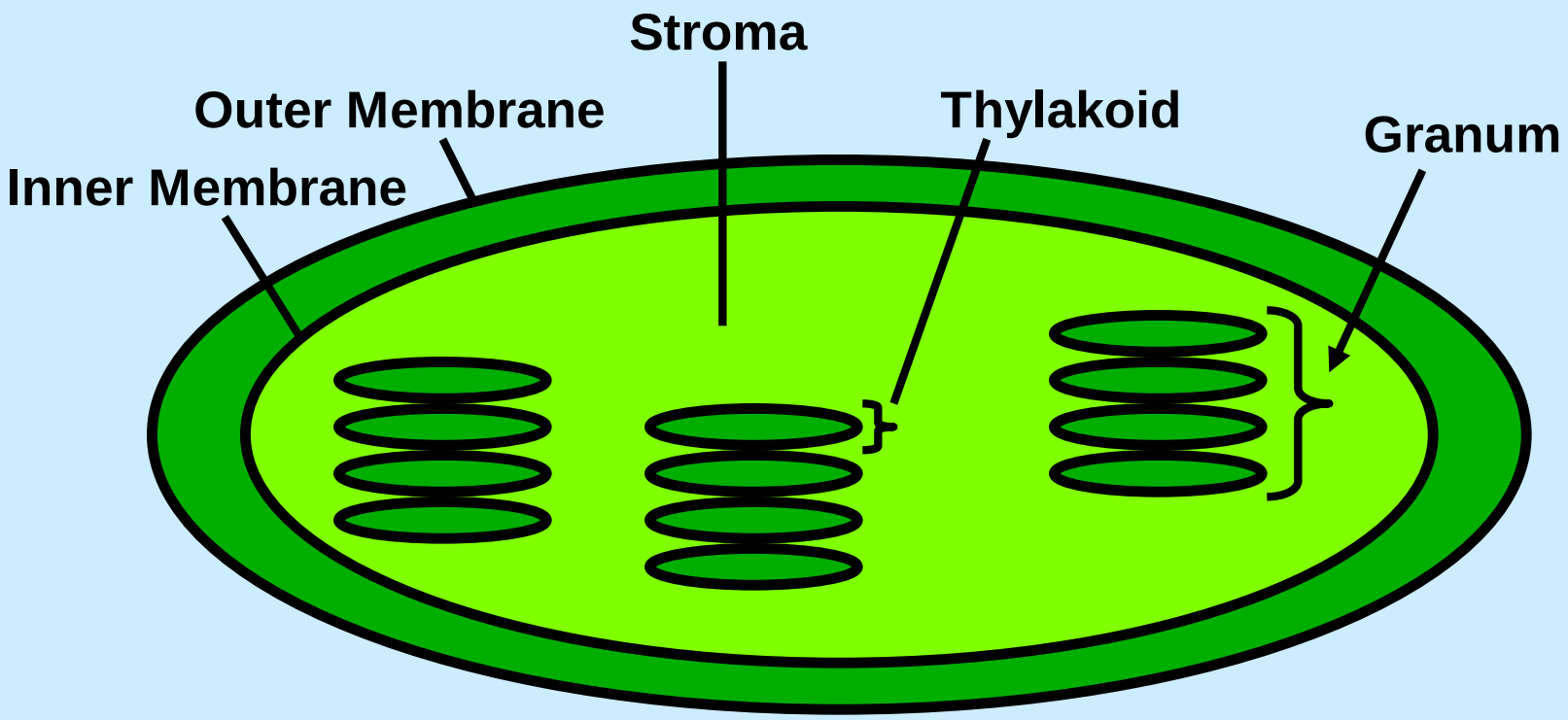
Chemiosmosis

- **Powers ATP synthesis.**
- Located in the **thylakoid membranes**.
- Uses **ETC** and **ATP synthase (enzyme)** to **make ATP**.
- **Photophosphorylation:** addition of **phosphate** to **ADP** to make **ATP**.

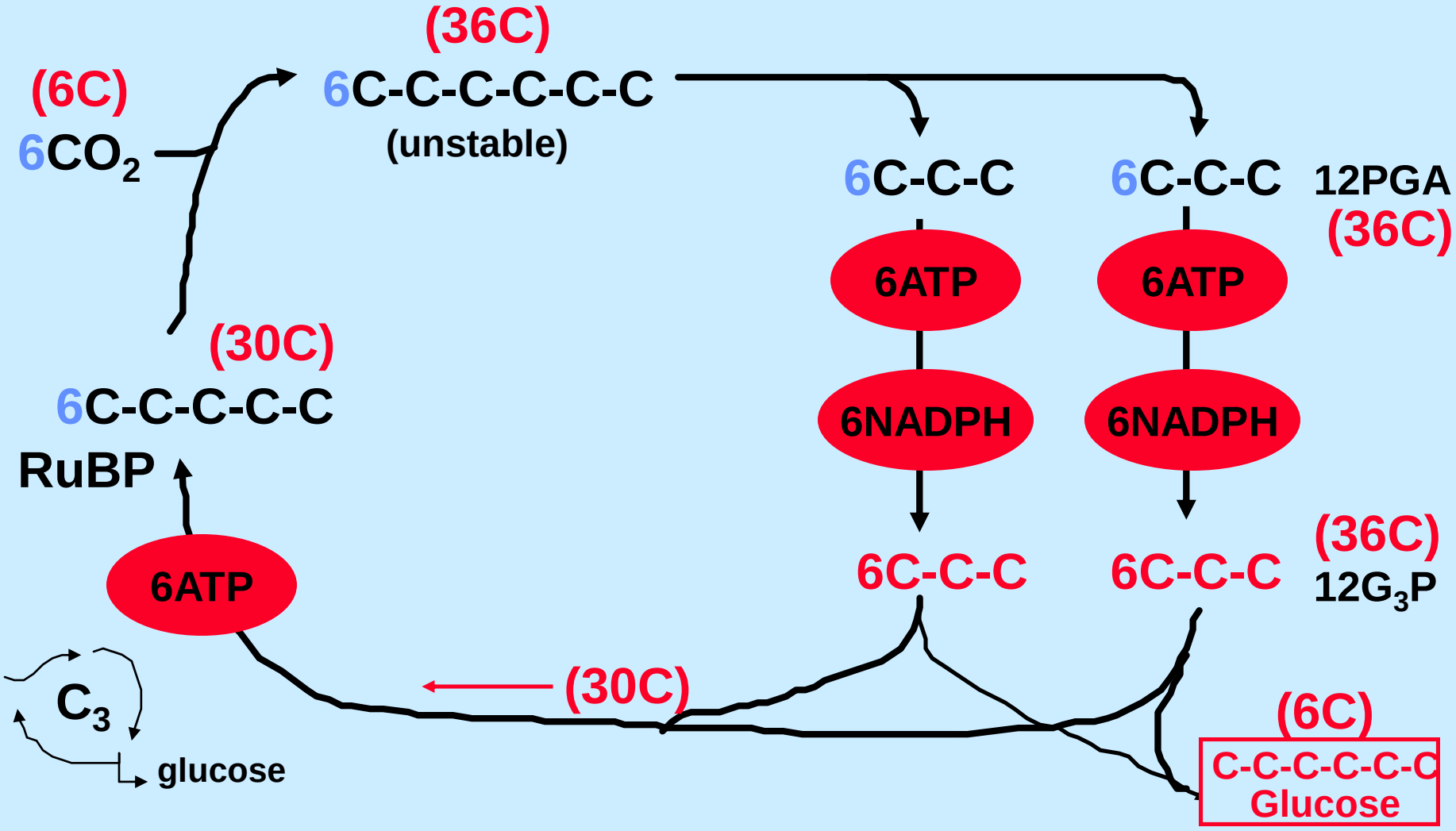
Calvin Cycle

- **Carbon Fixation (light independent rxn).**
- **C_3 plants** (80% of plants on earth).
- Occurs in the **stroma**.
- Uses **ATP** and **NADPH** from light rxn.
- Uses **CO_2**.
- To produce **glucose**: it takes **6 turns** and **uses 18 ATP and 12 NADPH**.

Chloroplast

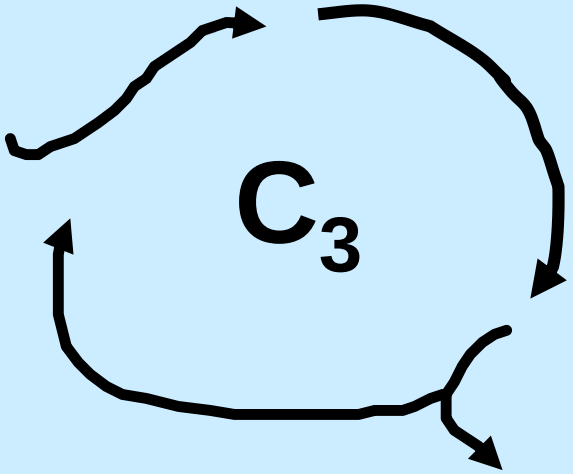


Calvin Cycle (C_3 fixation)



Calvin Cycle

- **Remember: C3 = Calvin Cycle**



Glucose

Photorespiration

- Occurs on **hot, dry, bright days**.
- **Stomates close.**
- Fixation of **O_2 instead of CO_2**.
- Produces **2-C molecules** instead of **3-C sugar molecules**.
- Produces **no sugar molecules or no ATP.**

Photorespiration

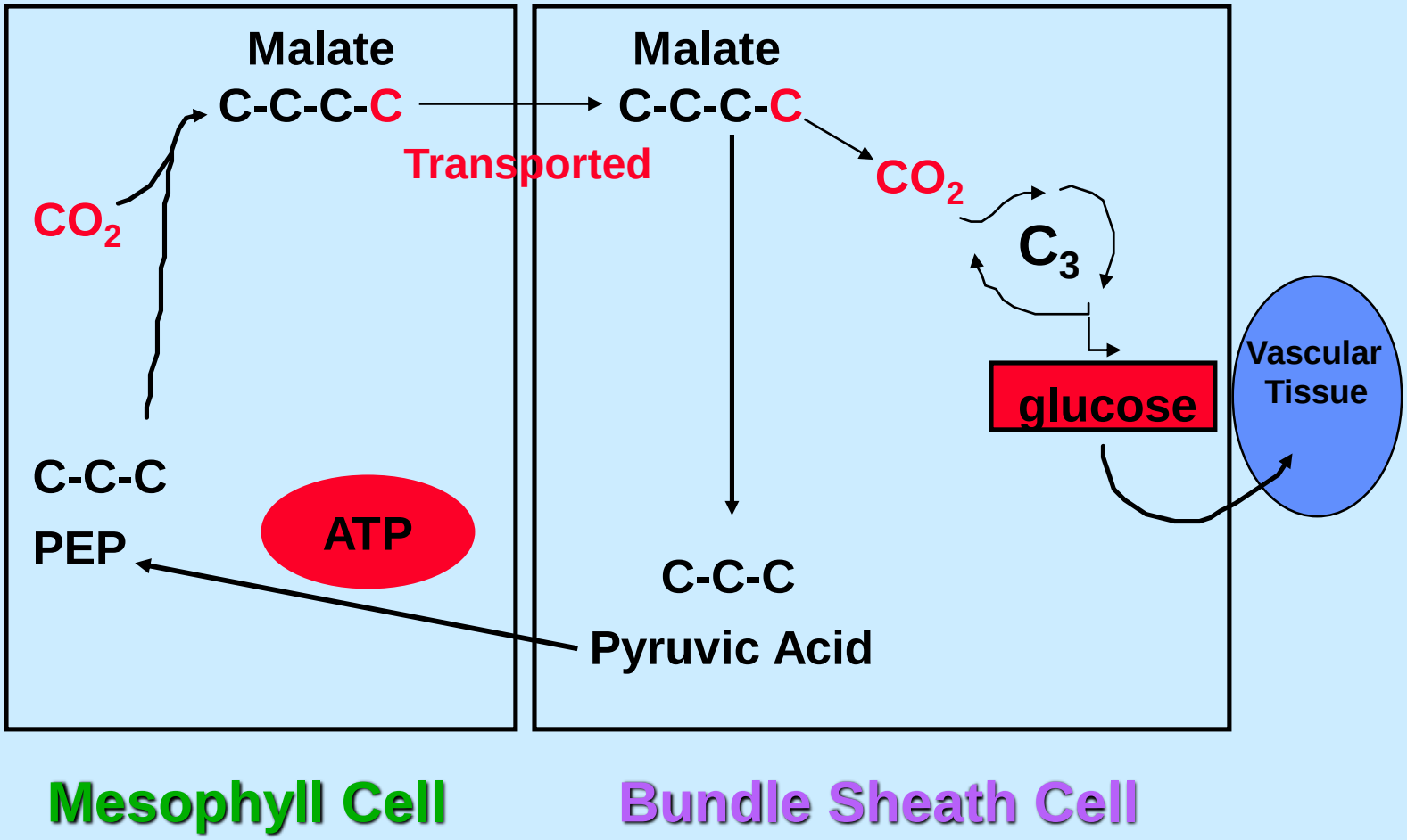
- **Because of photorespiration**: **Plants** have **special adaptations** to limit the effect of **photorespiration**.

1. **C4 plants**
2. **CAM plants**

C4 Plants

- **Hot, moist environments**.
- **15% of plants (grasses, corn, sugarcane).**
- **Divides photosynthesis spatially.**
- Light rxn - mesophyll cells.
- Calvin cycle - bundle sheath cells.

C4 Plants


Malate
C-C-C-C
Transported
Malate
C-C-C-C
CO_2
CO_2
C_3
glucose
Vascular Tissue
C-C-C
PEP
ATP
C-C-C
Pyruvic Acid
Mesophyll Cell
Bundle Sheath Cell

THANK YOU