محاضرة عن
البناء الضوئى

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«النباتات» طعام ودواء ومصدر للأوكسجين

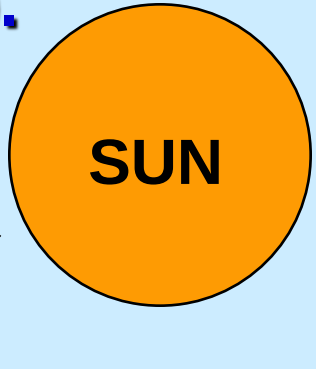
- النباتات غداء للإنسان والحيوان، تحتوي على الكربوهيدرات والفيتامينات والأملاح والدهون والألياف والأحماض ويحتوي بعضها على البروتين، كما تشكل مصدر رزق للمزارعين، وهي مصدر رئيسي للأدوية والعطور ومجالات صناعية وحرفية عديدة، ومنها يتم الحصول على الأخشاب والورق والأصباغ والزيوت والأنسجة. فالنبات، طعام للإنسان والحيوان والطير وغيره يقول الله تعالى: (فلينظر الإنسان إلى طعامه * أنا صببنا الماء صبا * ثم شققنا الأرض شقا * فأنبتنا فيها حبا * وعنبا وقضبا * وزيتونا ونخلا * وحدائق غلبا * وفاكهة وأبا * متاعا لكم ولأنعامكم)، «عبس: الآيات 24 - 32»، فالطعام ضرورة من ضرورات الحياة، ولازمة من لوازمها

- وقد قدر الله سبحانه وتعالى أن يعتمد الناس والحيوانات في غذائهم على ما ينتجه النبات في مصانعه الخضراء، وهذه المصانع يخرجها النبات بأمر ربه، عند بداية نموه، ويدلنا القرآن الكريم على هذه الحقائق في قوله تعالى: (وهو الذي أنزل من السماء ماء فأخرجنا به نبات كل شيء فأخرجنا منه خضرا نخرج منه حبا متراكبا ومن النخل من طلعها قنوان دانية وجنات من أعناب والزيتون والرمان مشتبها وغير متشابه انظروا إلى ثمره إذا أثمر وينعه إن في ذلكم لآيات لقوم يؤمنون)، «الأنعام: الآية 99

PHOTOSYNTHESIS

Photosynthesis

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



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

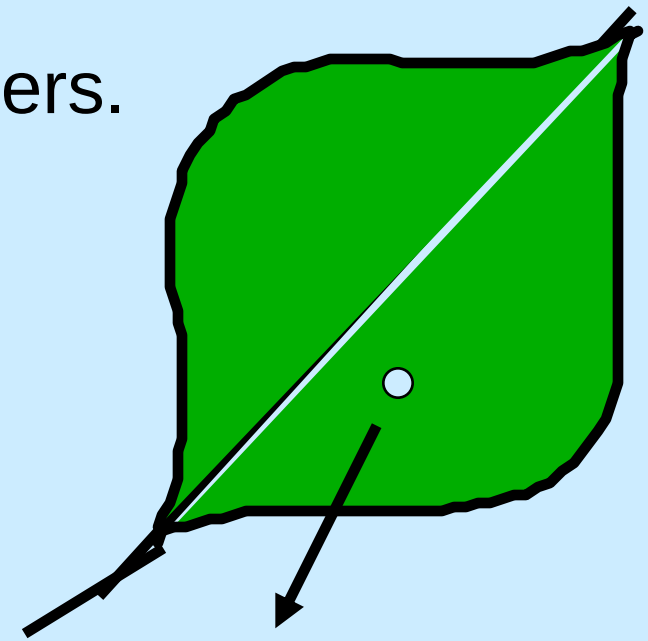
glucose

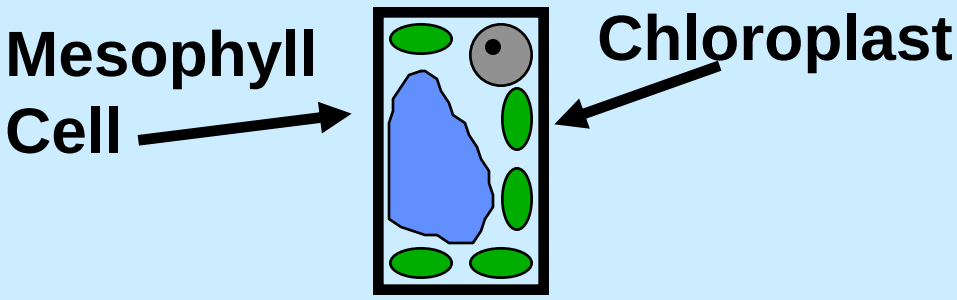
Question:

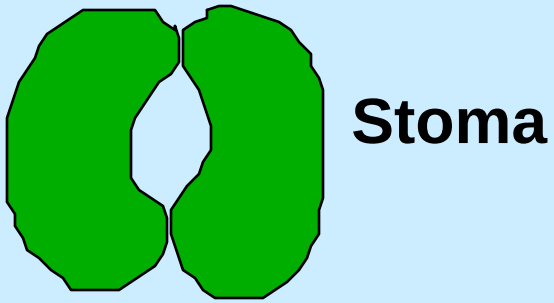
- **Where does photosynthesis take place?**

Plants

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

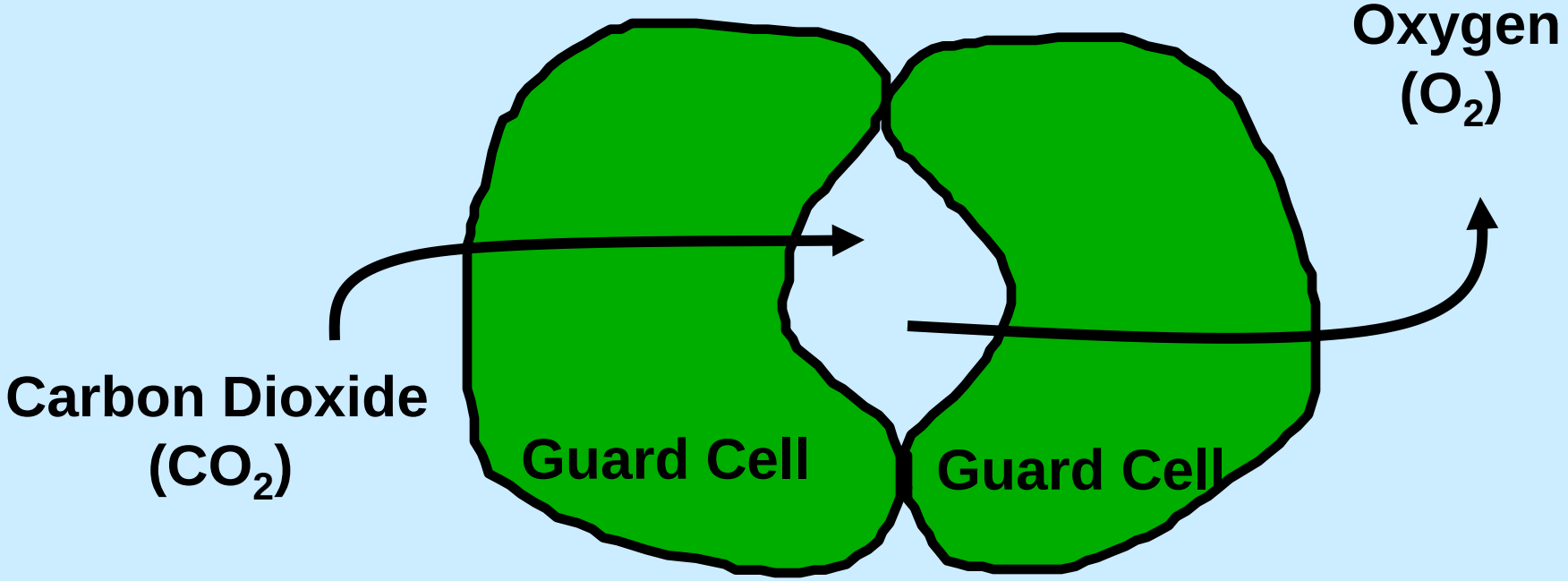




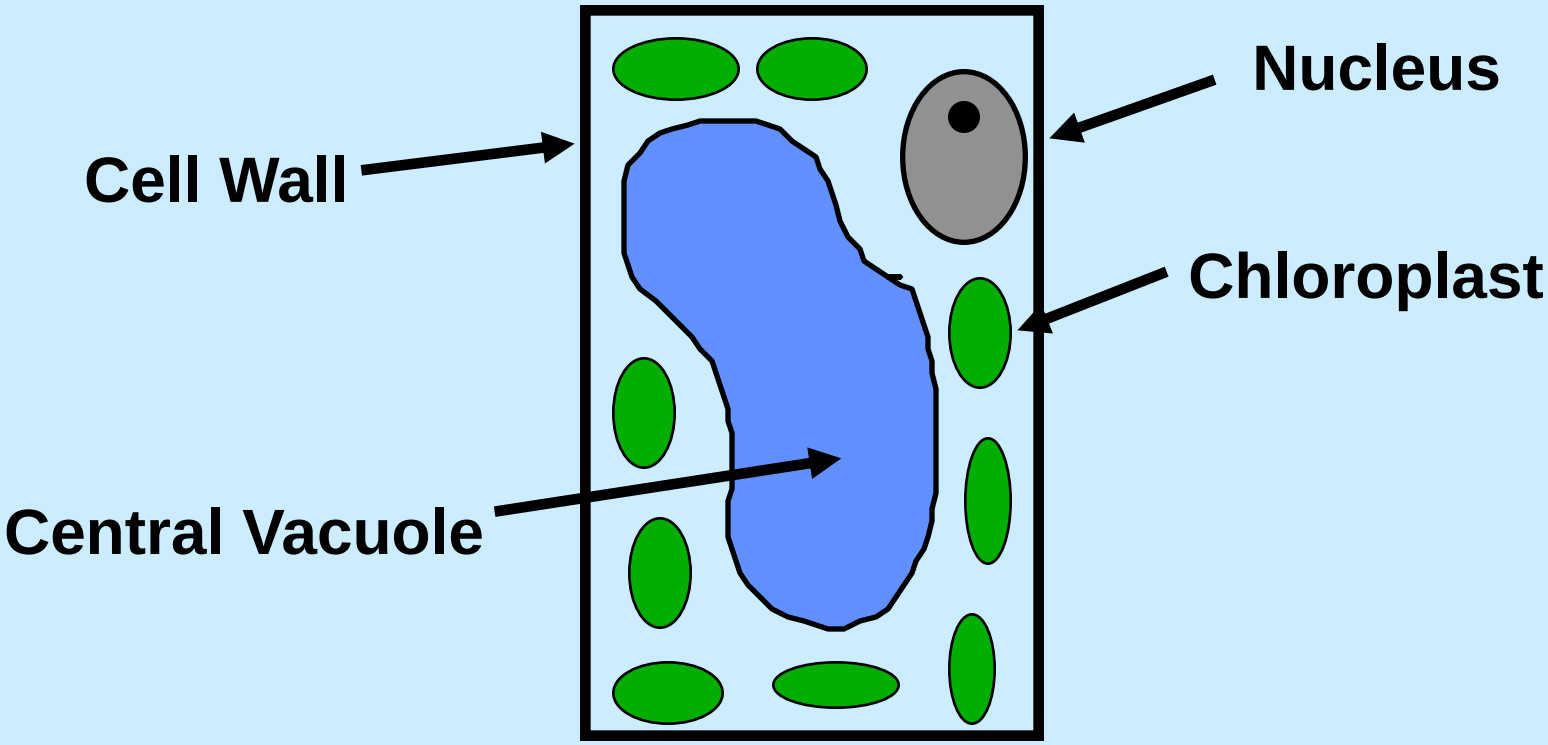


Stomata (stoma)

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

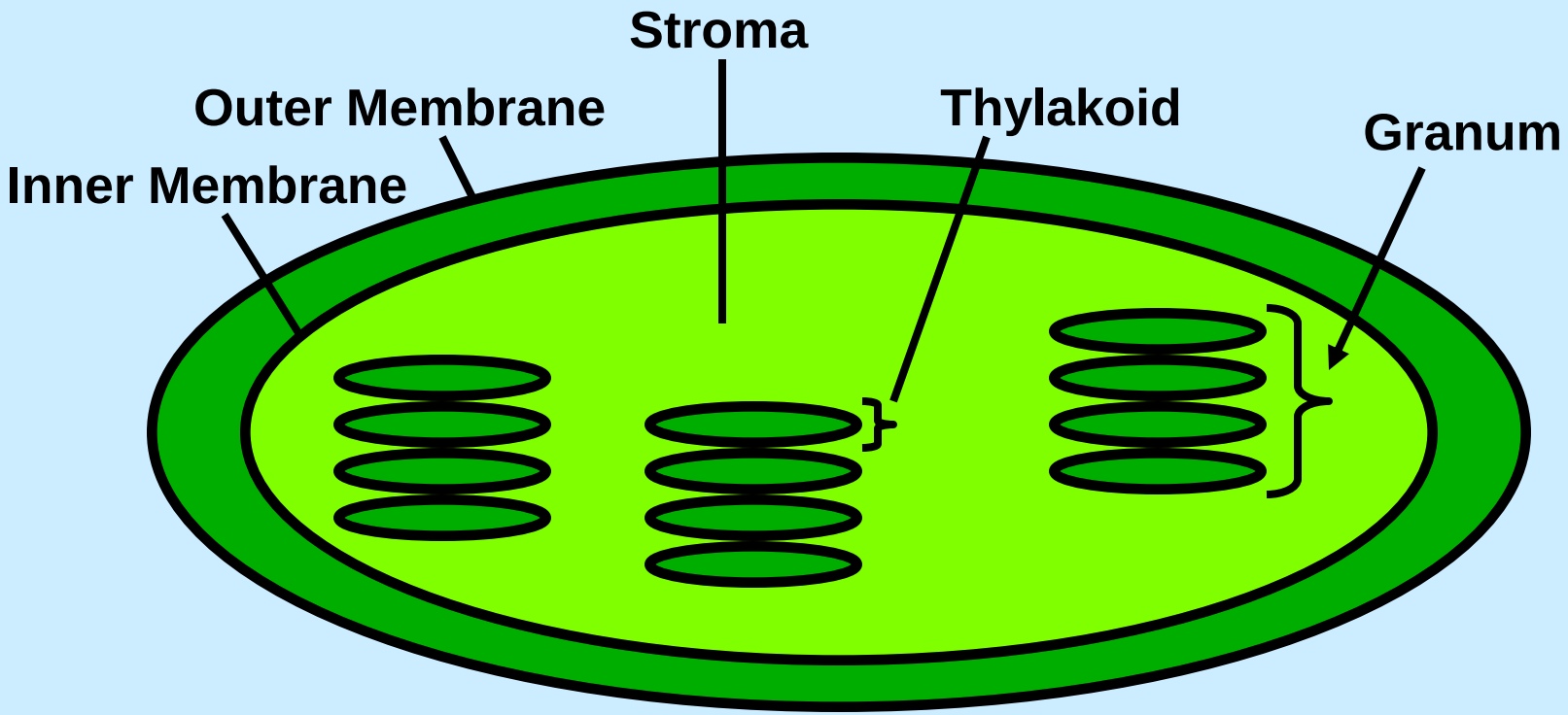


Mesophyll Cell

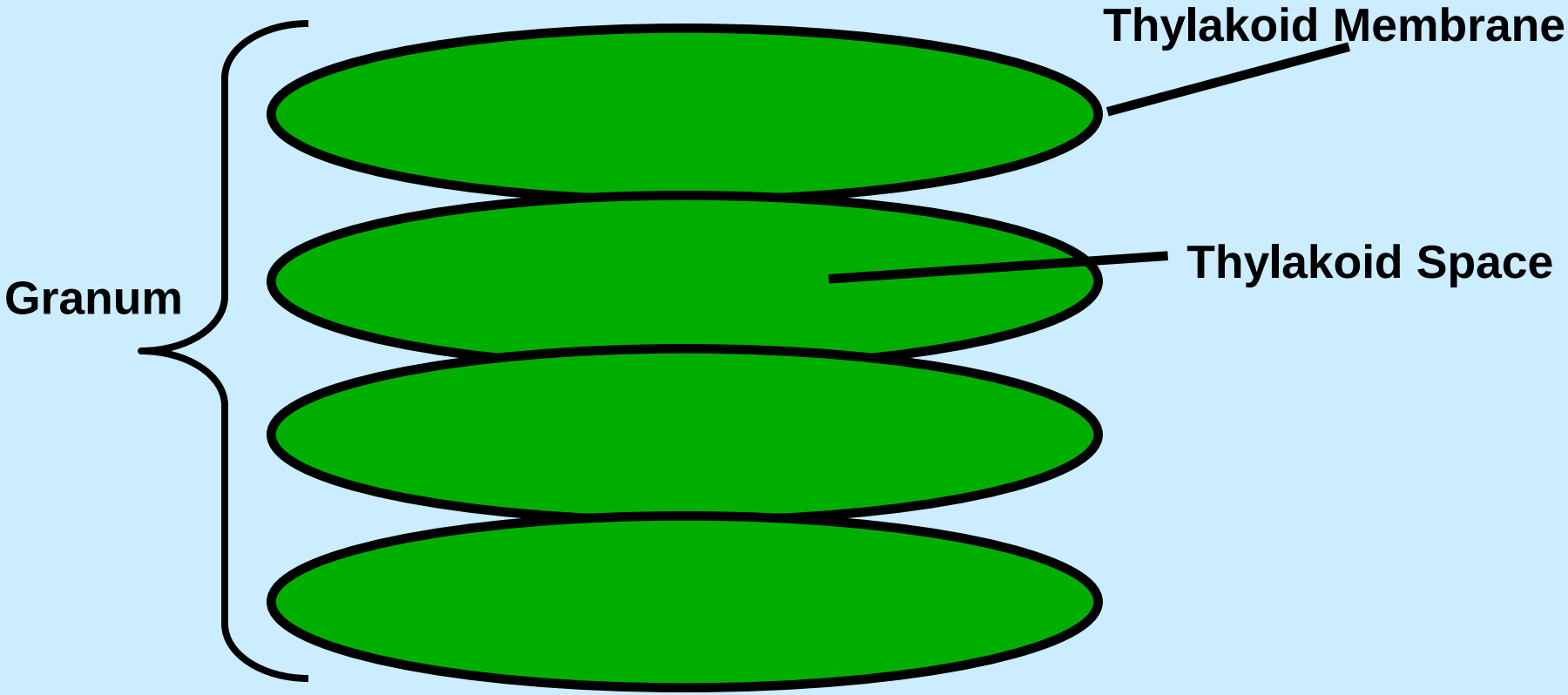


Chloroplast

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



Thylakoid



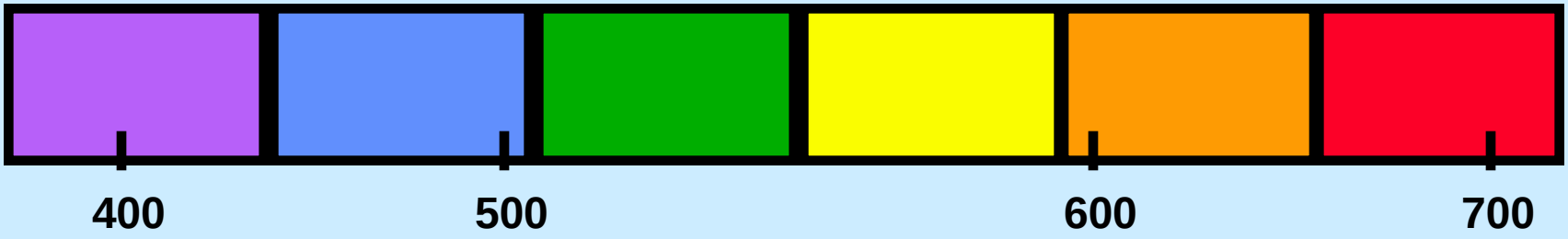
Question:

- **Why are plants green?**

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**.

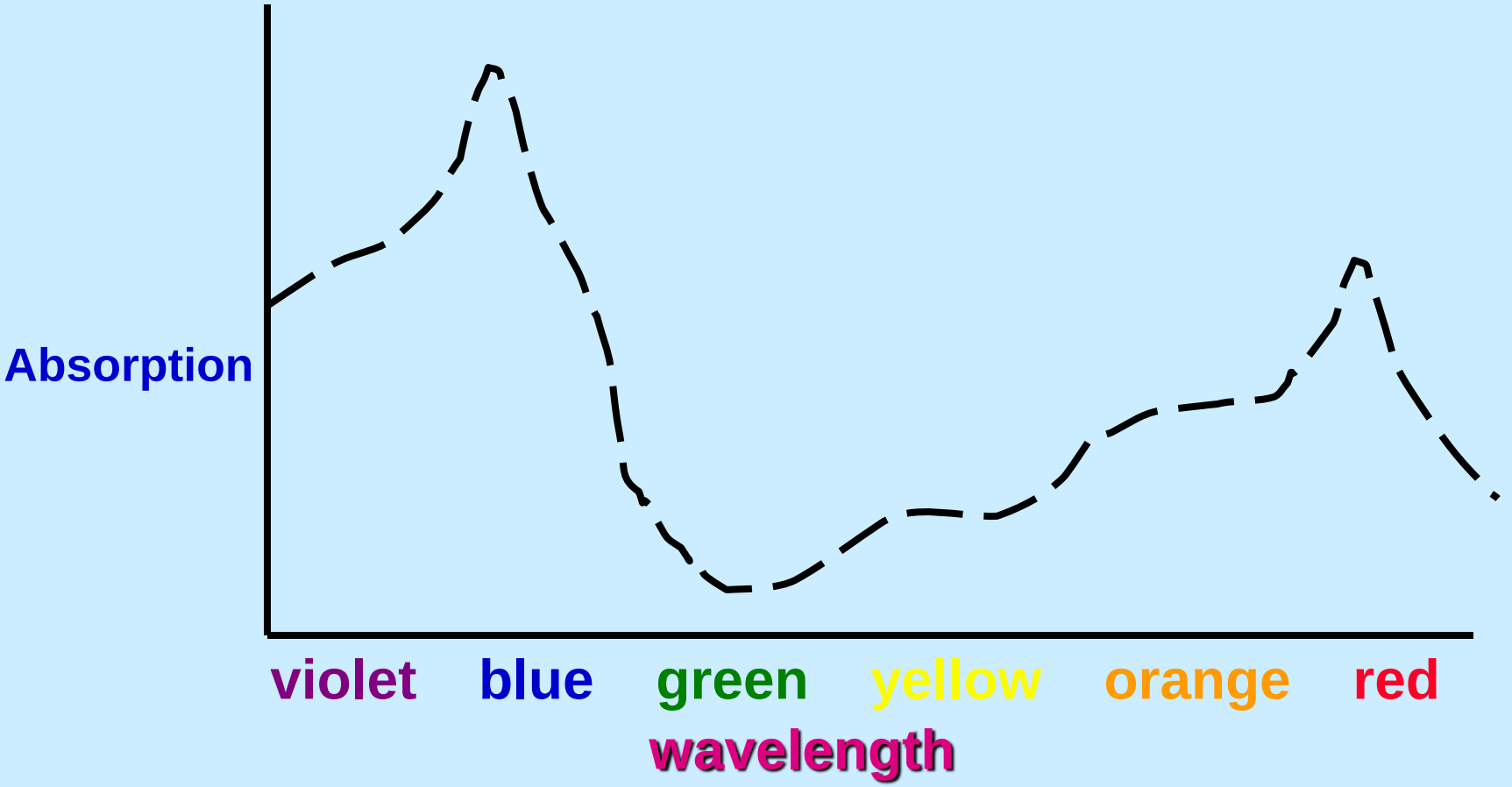
Wavelength of Light (nm)



Short wave
(more energy)

Long wave
(less energy)

Absorption of Chlorophyll



Question:

- **During the fall, what causes the leaves to change colors?**

Fall Colors

- In addition to the chlorophyll pigments, there are other **pigments** present.
- During the fall, the **green chlorophyll** pigments are **greatly reduced** revealing the other **pigments**.
- **Carotenoids** are pigments that are either **red** **or** **yellow**.

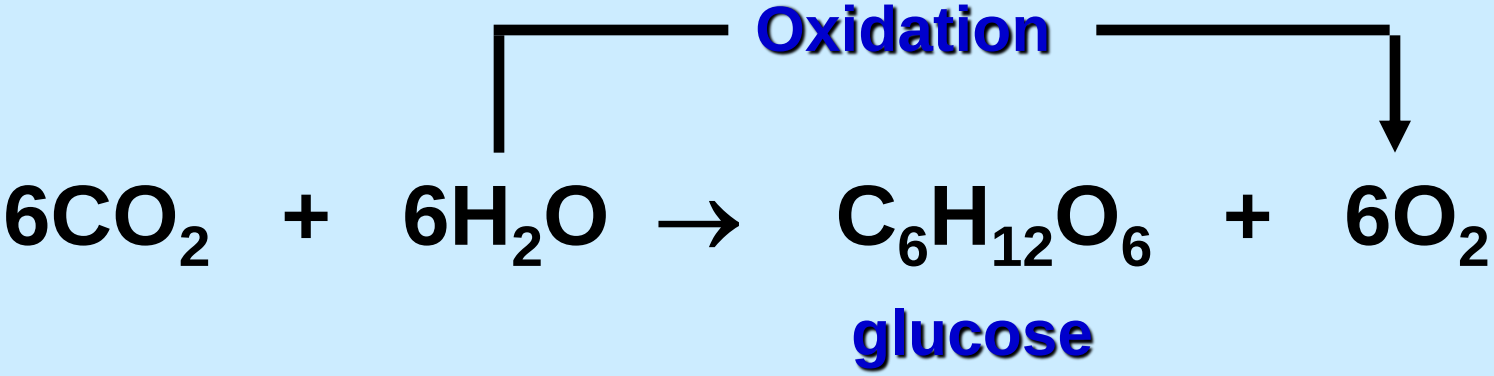
Redox Reaction

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

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

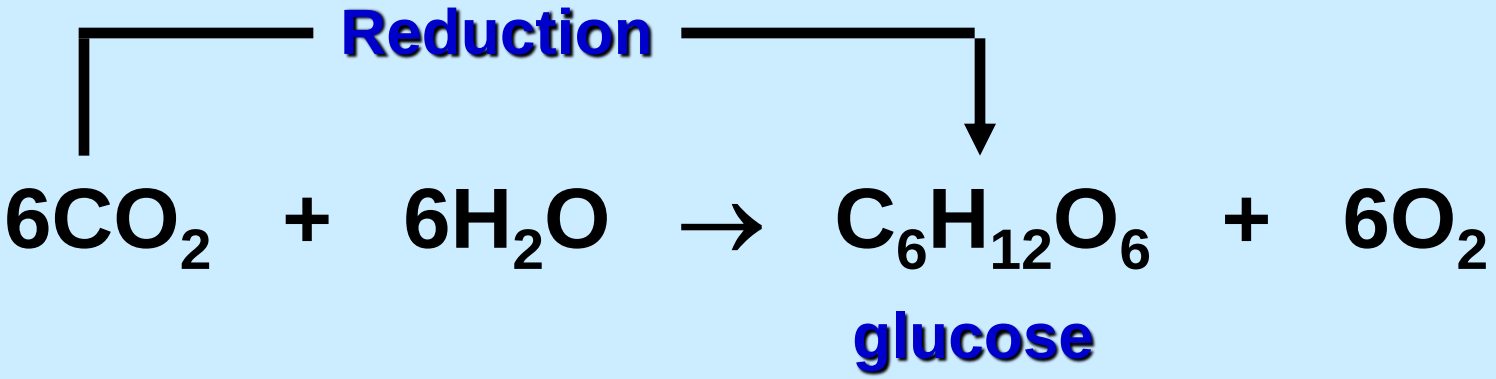
Oxidation Reaction

- 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**.

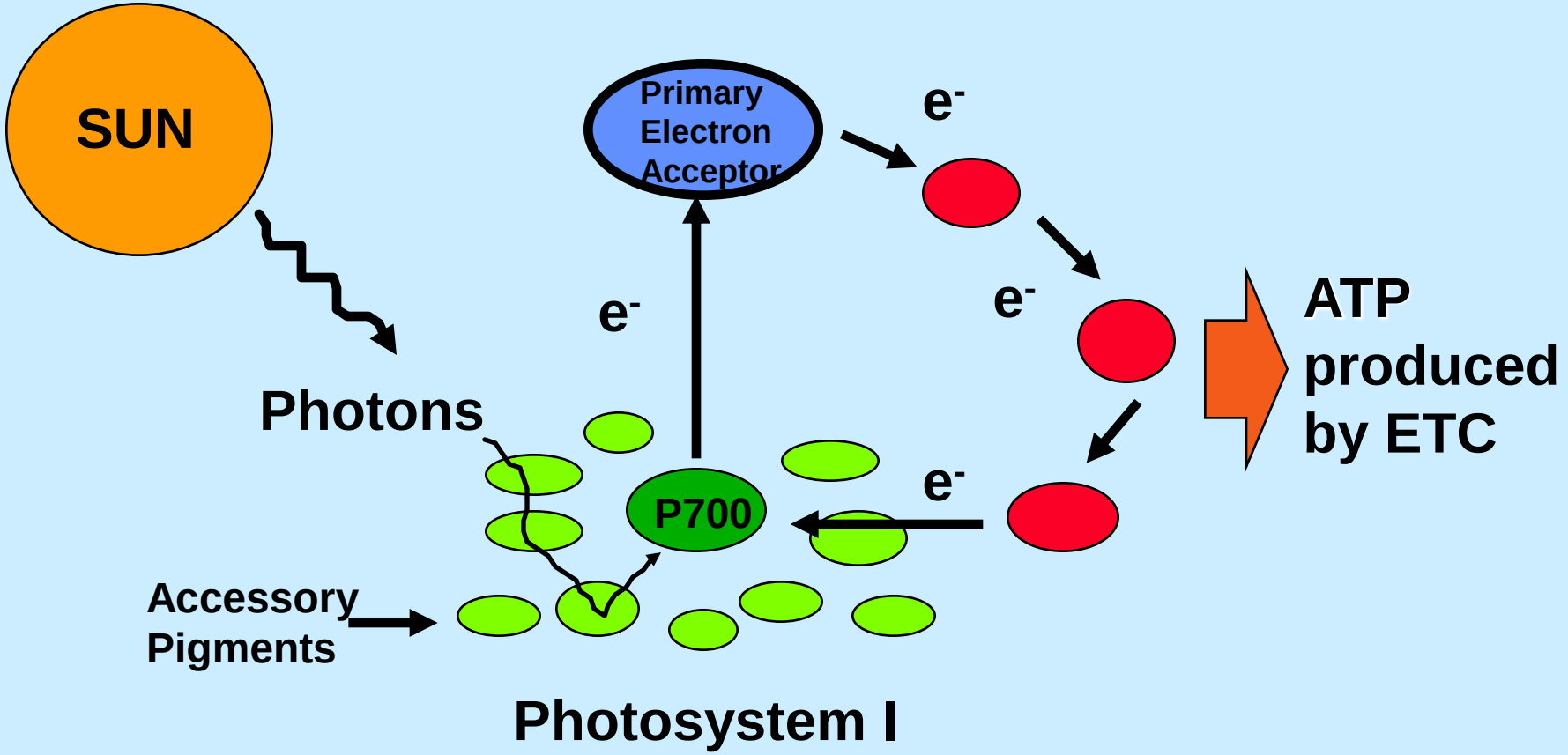
A. Cyclic Electron Flow

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**

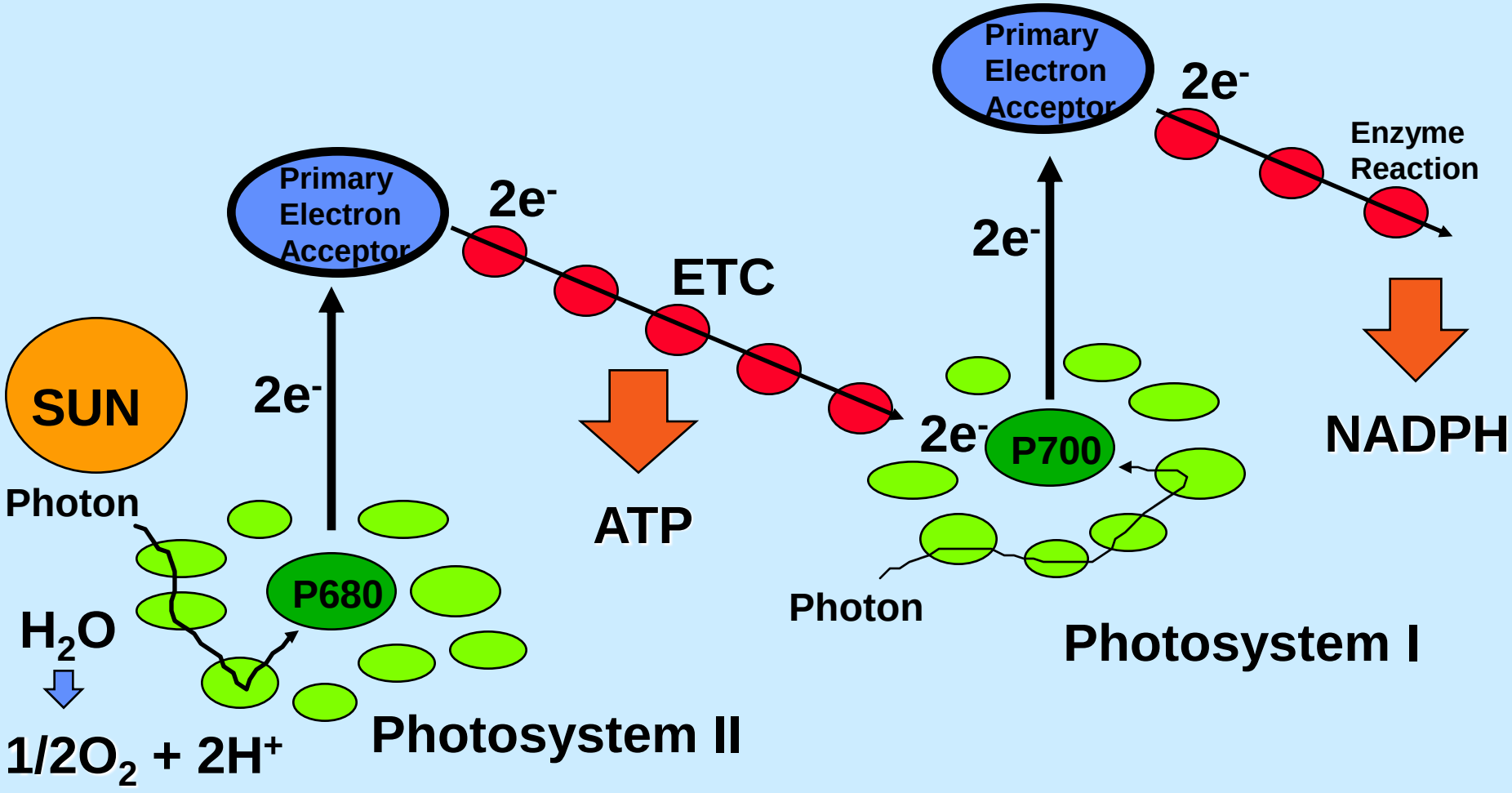
A. Cyclic Electron Flow



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)

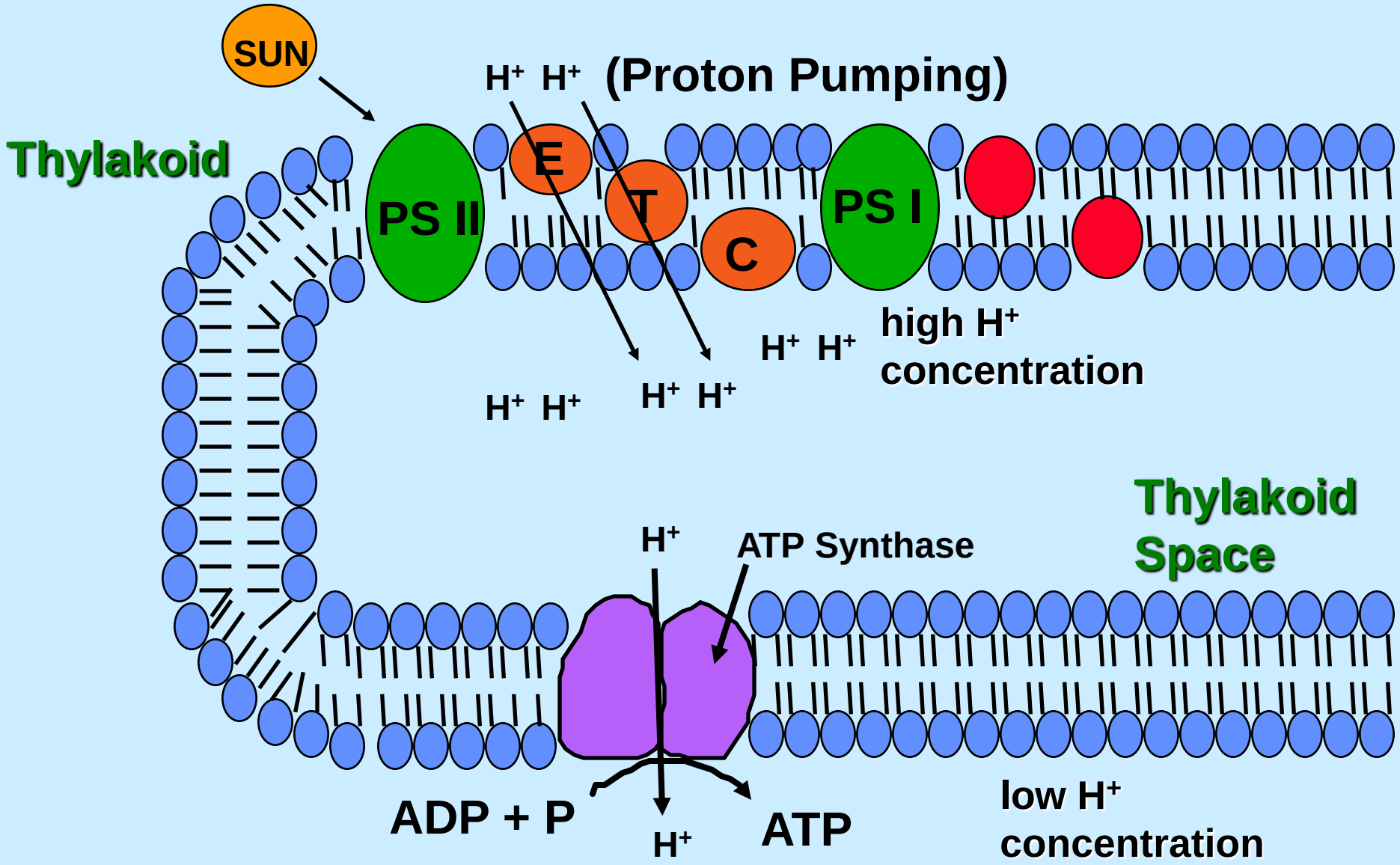
- **Oxygen comes from the splitting of H_2O, not CO_2**

H_2O → 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**.

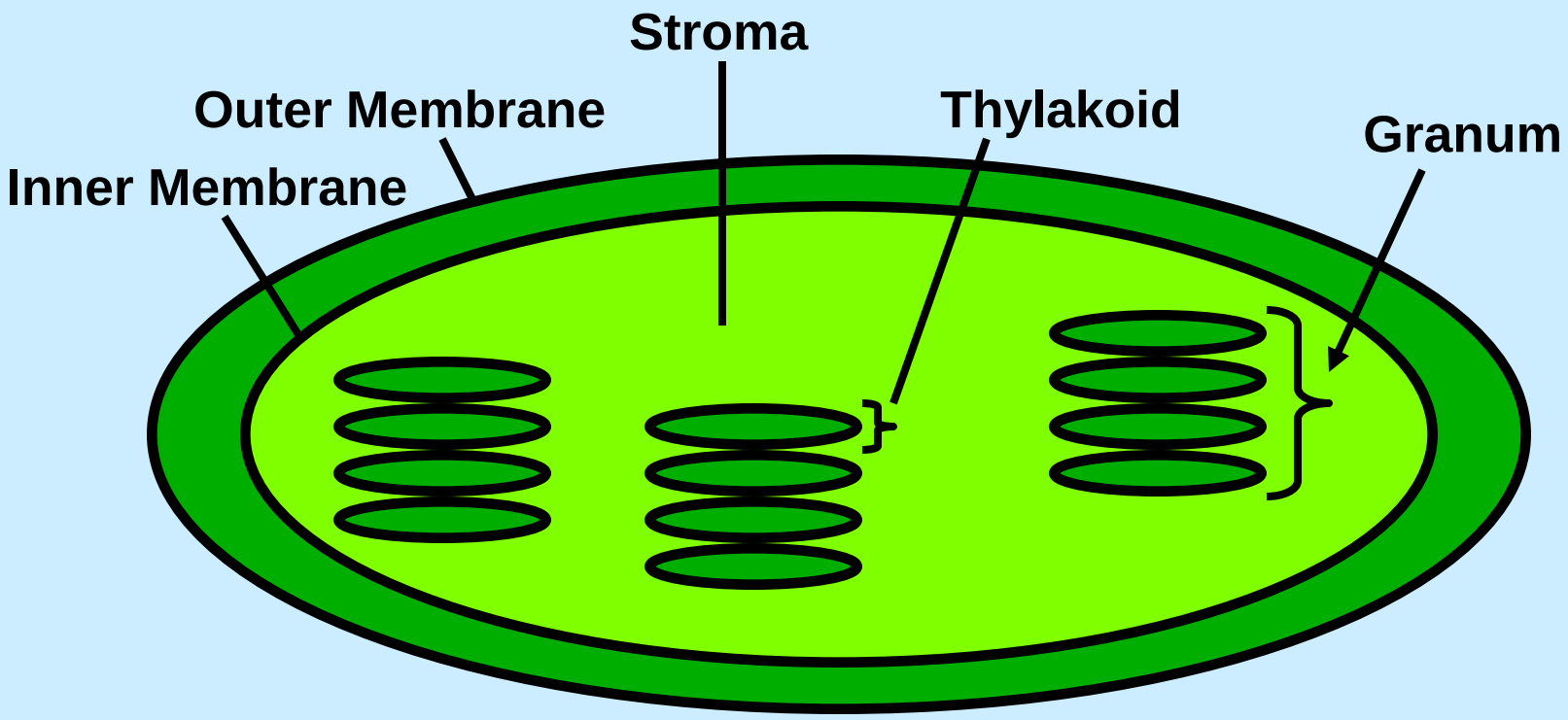
Chemiosmosis



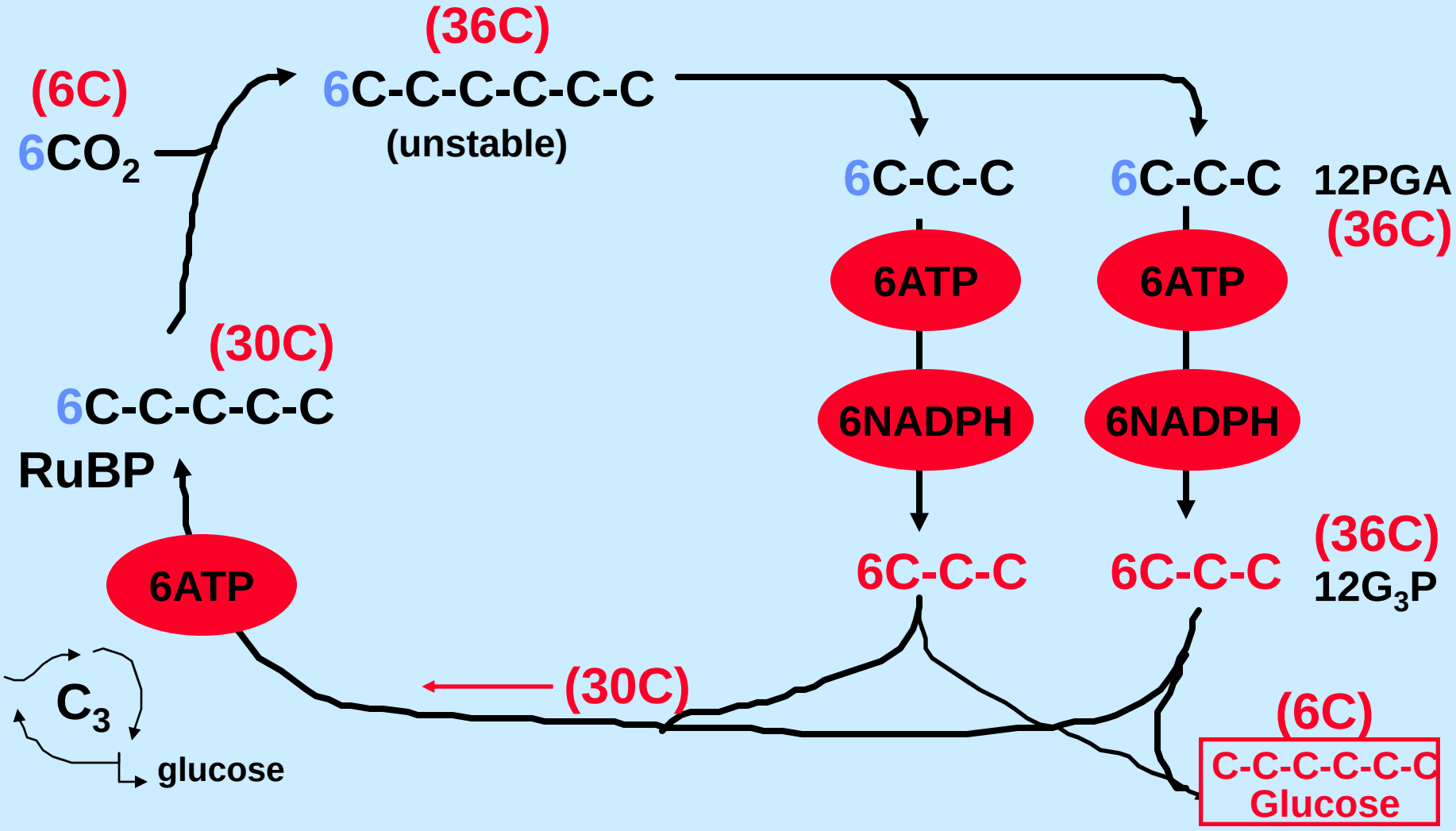
Calvin Cycle

- **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

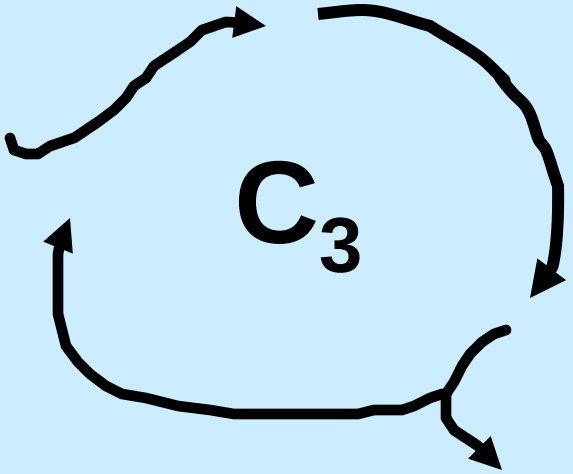


Calvin Cycle (C_3 fixation)



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

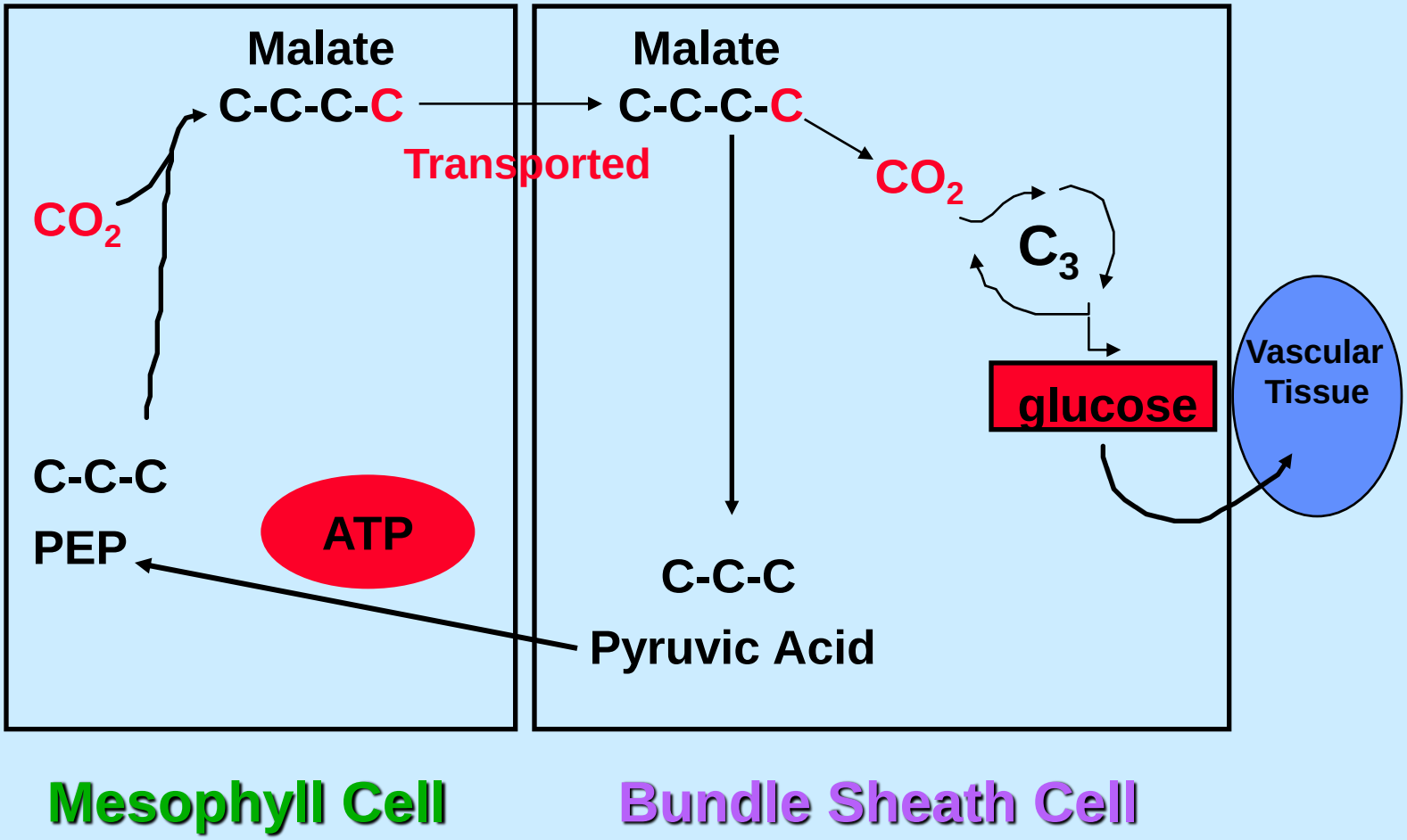
- **Because of photorespiration**: **Plants** have **special adaptations** to limit the effect of **photorespiration**.

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.

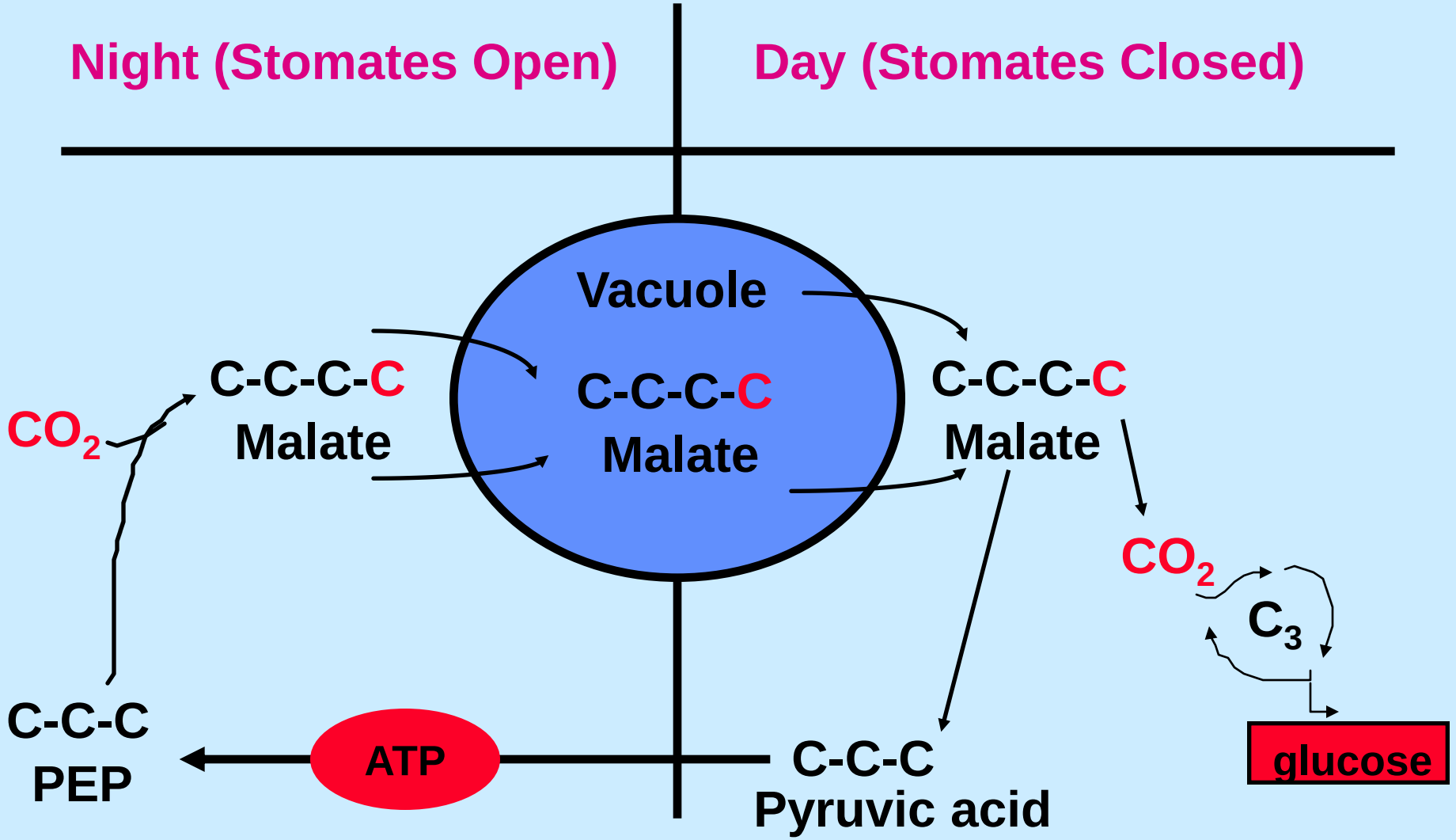
C4 Plants


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

CAM Plants

- **Hot, dry environments**.
- **5% of plants (cactus and ice plants).**
- **Stomates closed during day.**
- **Stomates open during the night**.
- Light rxn - occurs during the **day**.
- Calvin Cycle - occurs when CO_2 is present.

CAM Plants


Night (Stomates Open)
Day (Stomates Closed)
Vacuole
C-C-C-C
Malate
C-C-C-C
Malate
C-C-C-C
Malate
CO_2
CO_2
C_3
C-C-C
PEP
ATP
C-C-C
Pyruvic acid
glucose

Question:

- **Why would CAM plants close their stomates during the day?**