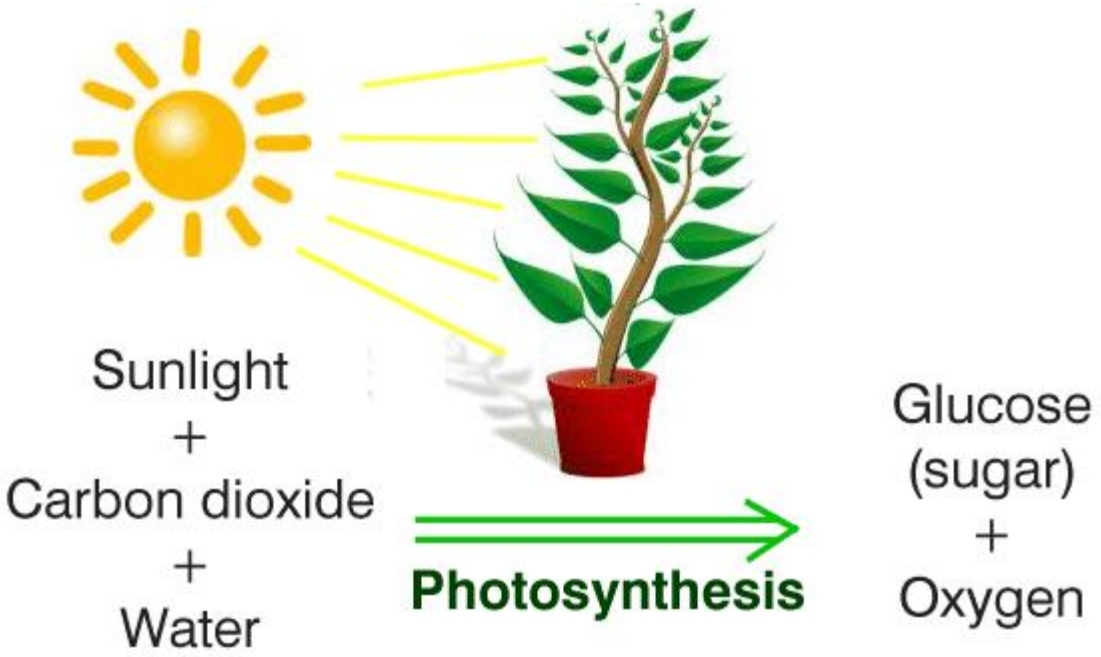
Bhagalpur National College, Bhagalpur

(A Constituent unit of Tilka Manjhi Bhagalpur University, Bhagalpur)

PPT Presentation- **Photosynthesis (B.Sc.-III)**



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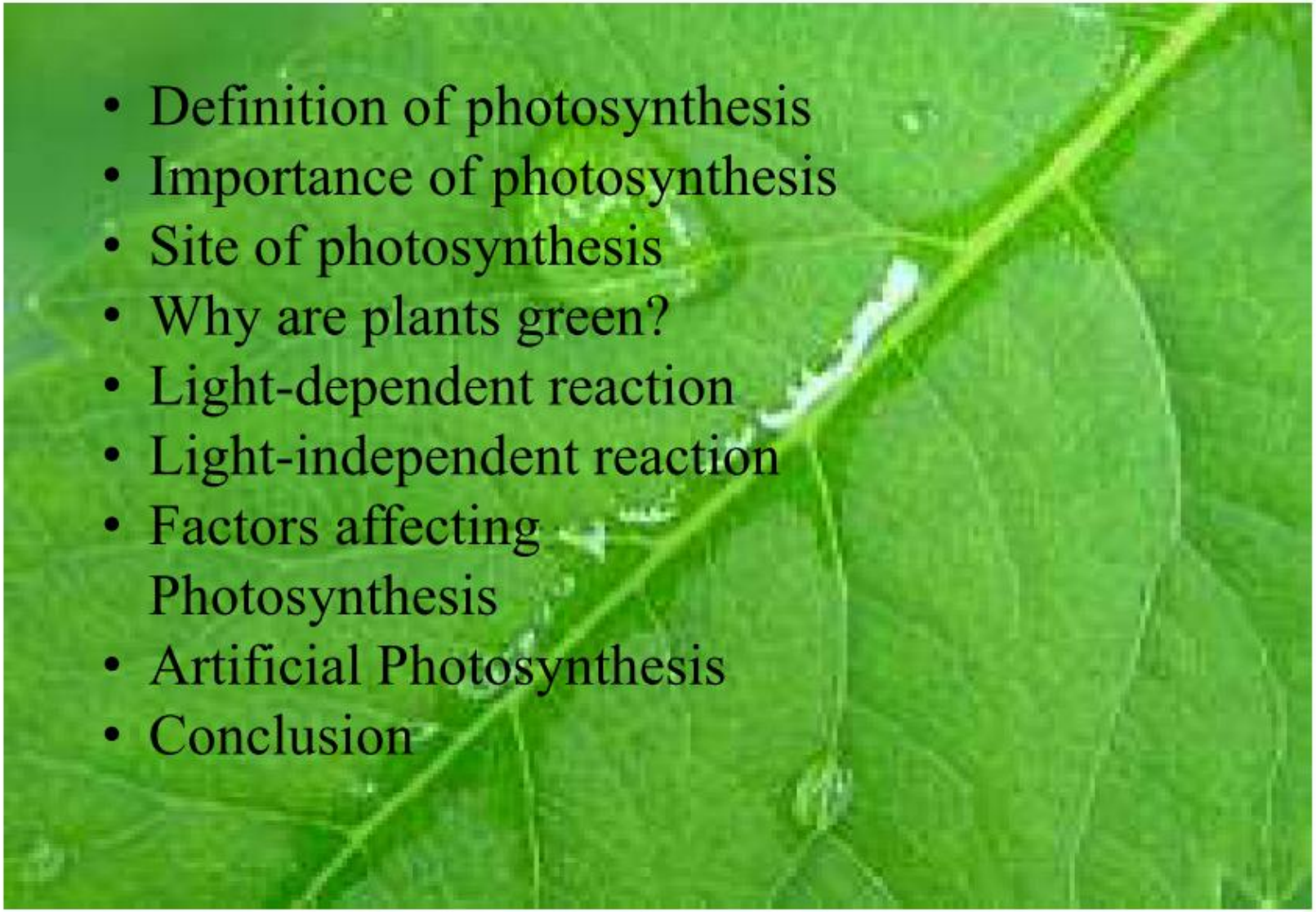
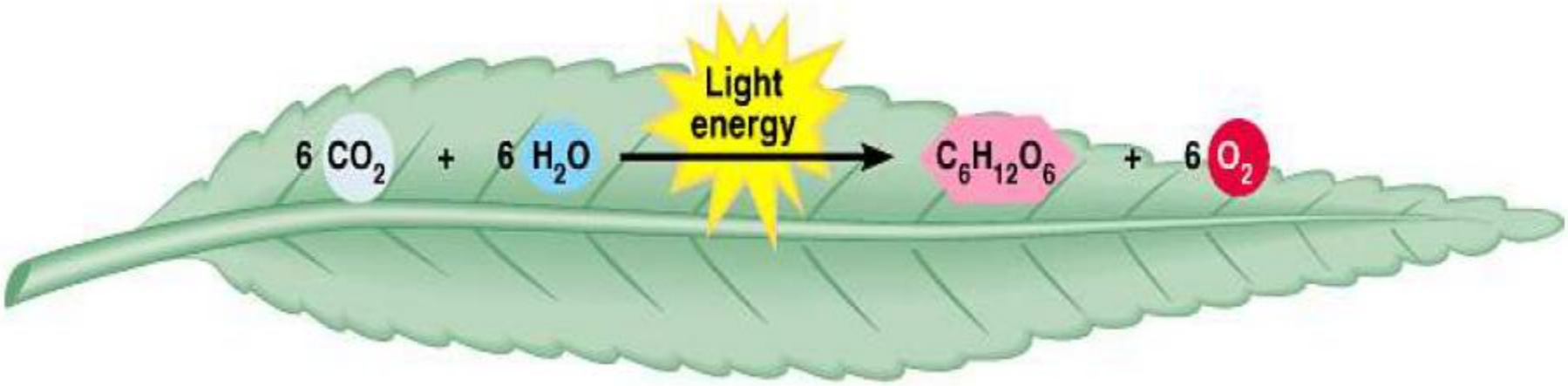
OVERVIEW



- Definition of photosynthesis
- Importance of photosynthesis
- Site of photosynthesis
- Why are plants green?
- Light-dependent reaction
- Light-independent reaction
- Factors affecting Photosynthesis
- Artificial Photosynthesis
- Conclusion

DEFINITION OF PHOTOSYNTHESIS

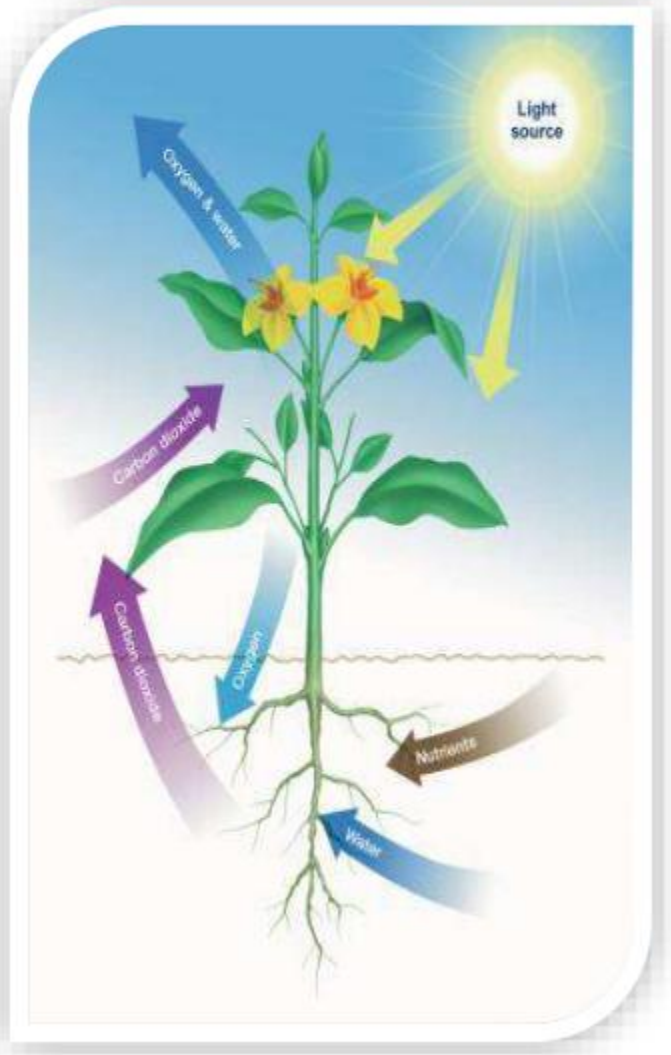
- Is the process by which autotrophic organisms use light energy to make sugar and oxygen gas from carbon dioxide and water.
- Occurs in plants, algae and some prokaryotes
- Anabolic (small molecules combined)
- Endergonic (stores energy)
- Stored as carbohydrate in their bodies.



IMPORTANCE OF PHOTOSYNTHESIS

Photosynthesis and Sun Energy:

- Harnesses the sun's energy into utilizable forms of energy on earth.
- A process that most biological organisms are unable to perform.
- ATP is used to power these processes.
- Converts light energy into chemical energy in the form of glucose.
- Then the process of cellular respiration converts energy in glucose to energy in the form of ATP which is used to power biological processes.



IMPORTANCE OF PHOTOSYNTHESIS

Photosynthesis and Carbon Dioxide Removal:

- Converts carbon dioxide into oxygen.
- During photosynthesis, carbon dioxide leaves the atmosphere and enters the plant and leaves as oxygen.
- A process which is ecologically and environmentally important in nature.

IMPORTANCE OF PHOTOSYNTHESIS

Photosynthesis and the Ecosystem:

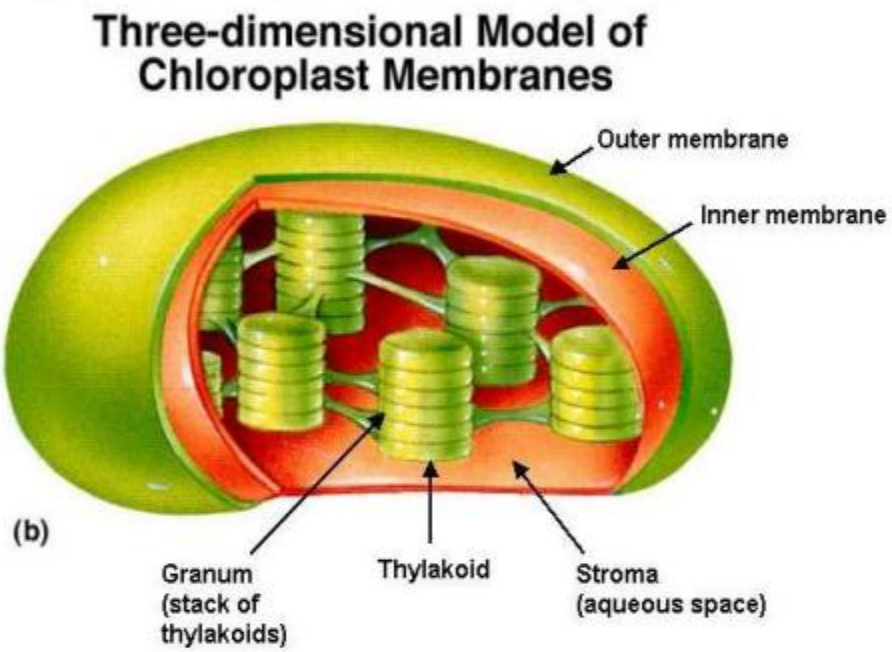
- The energy produced by photosynthesis forms the basis of virtually all terrestrial and aquatic food chains.
- As a result, photosynthesis is the ultimate source of carbon in the organic molecules found in most organisms.
- The high oxygen concentration in the atmosphere is derived directly from the light reactions of photosynthesis.
- Prior to the evolution of photosynthesis on earth, the atmosphere was anoxic.

Sites of Photosynthesis

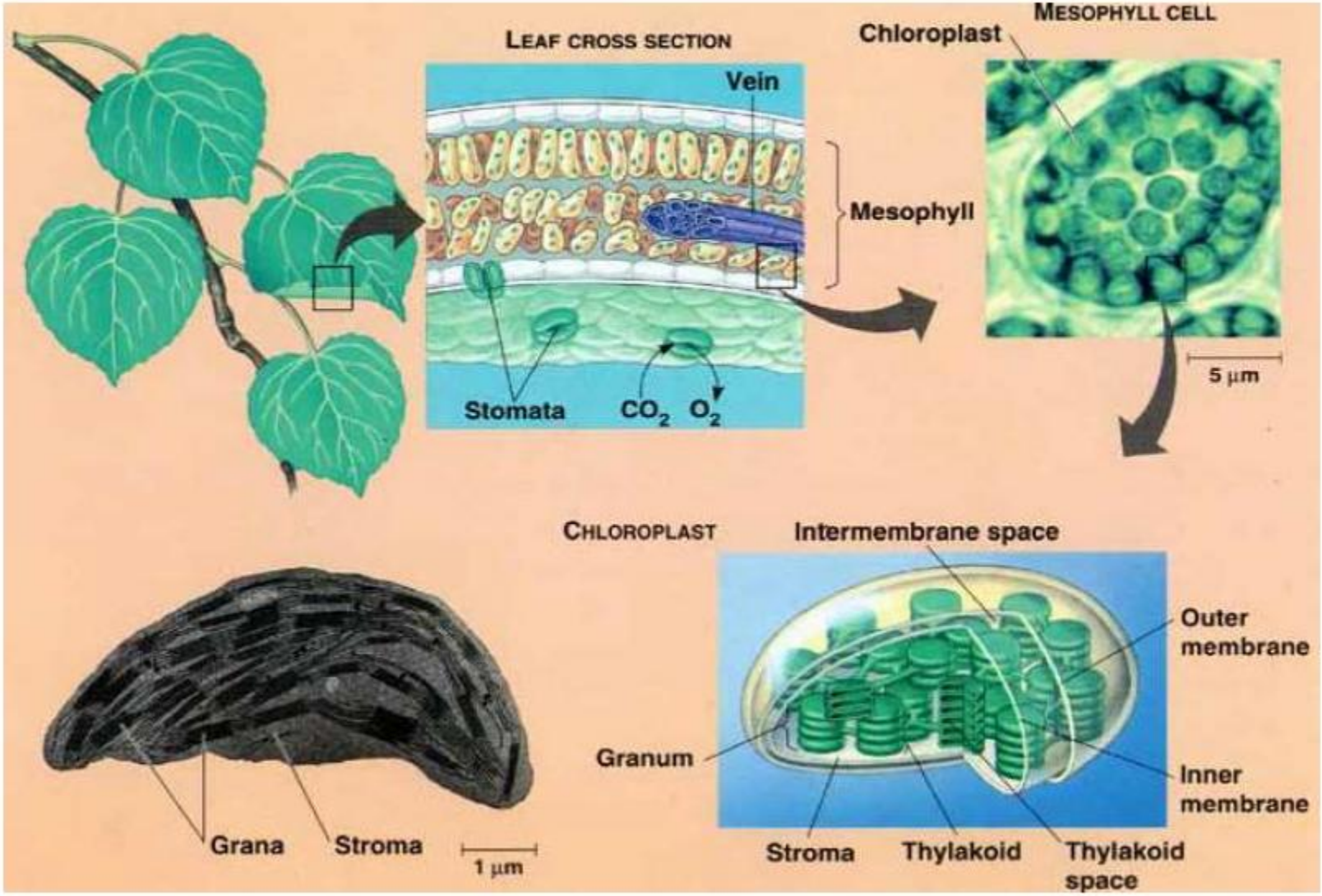
- Photosynthesis occurs in chloroplasts, organelles in certain plants
- All green plant parts have chloroplasts and carry out photosynthesis
- The leaves have the most chloroplasts
- The green colour comes from chlorophyll in the chloroplasts
- The pigments absorb light energy

Sites of Photosynthesis

- A chloroplast contains:
  - stroma, a fluid
  - grana, stacks of thylakoids
- The thylakoids contain chlorophyll
  - Chlorophyll is the green pigment that captures light for photosynthesis

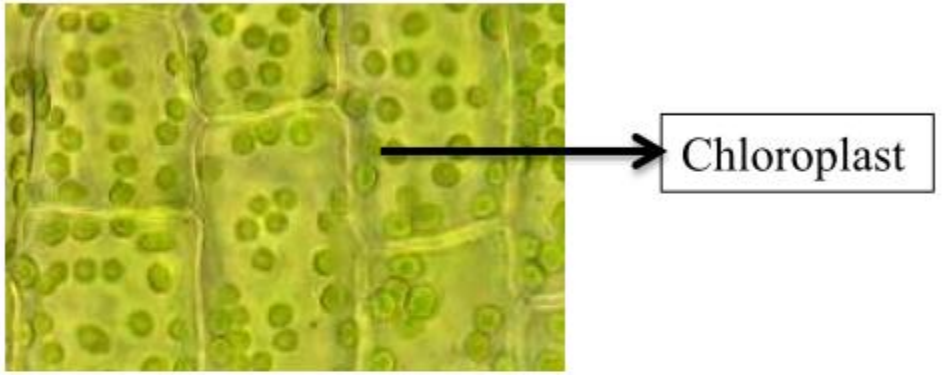


Site of Photosynthesis

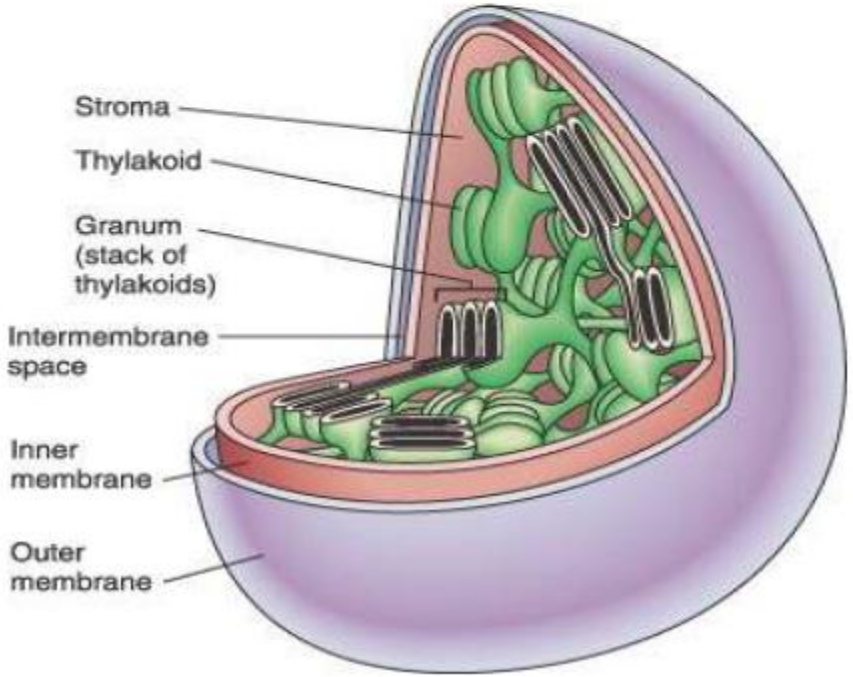


WHY ARE PLANTS GREEN?

- Plant cells have green chloroplast.



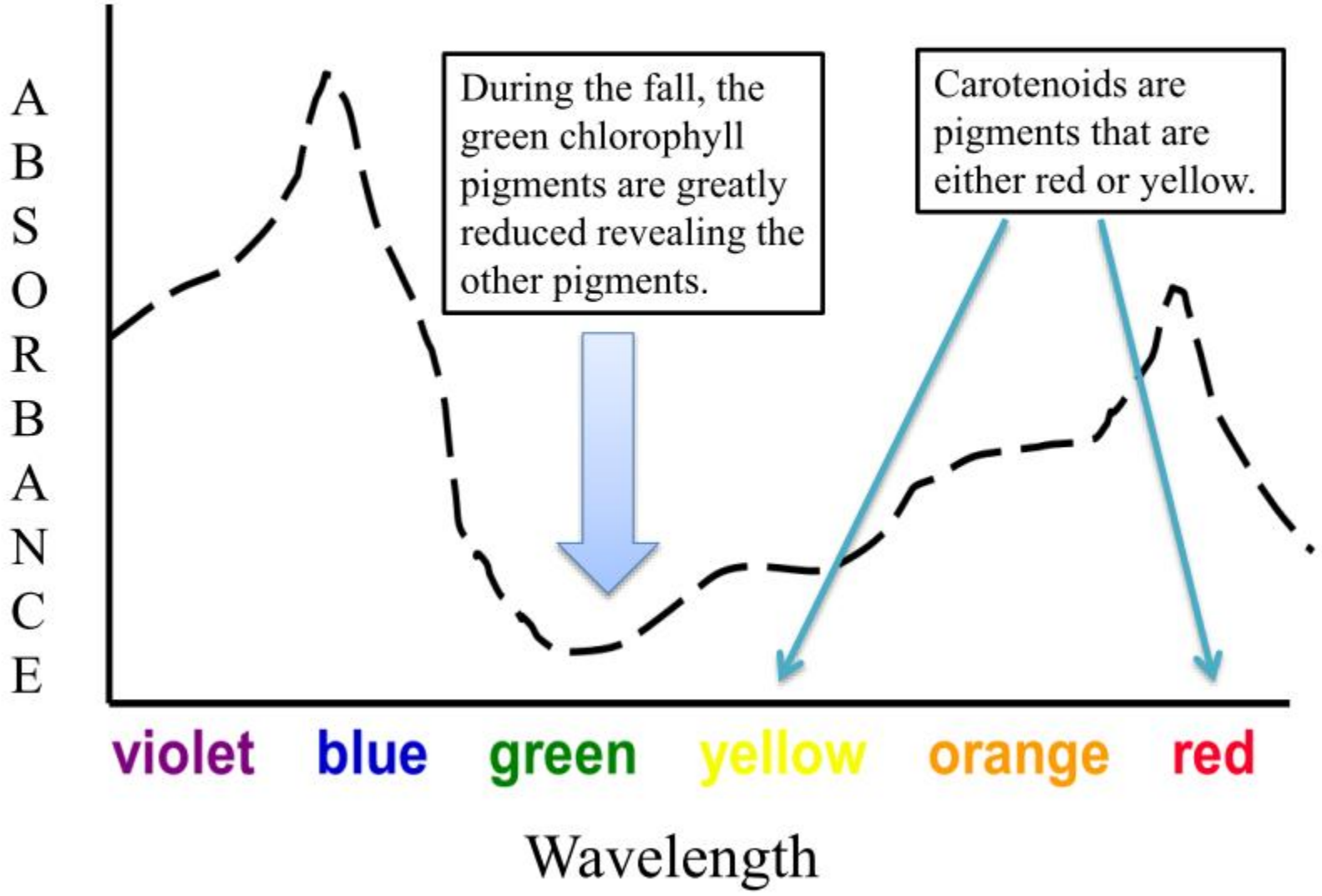
- The thylakoid membrane of the chloroplast is impregnated with photosynthetic pigments (chlorophylls, carotenoids).



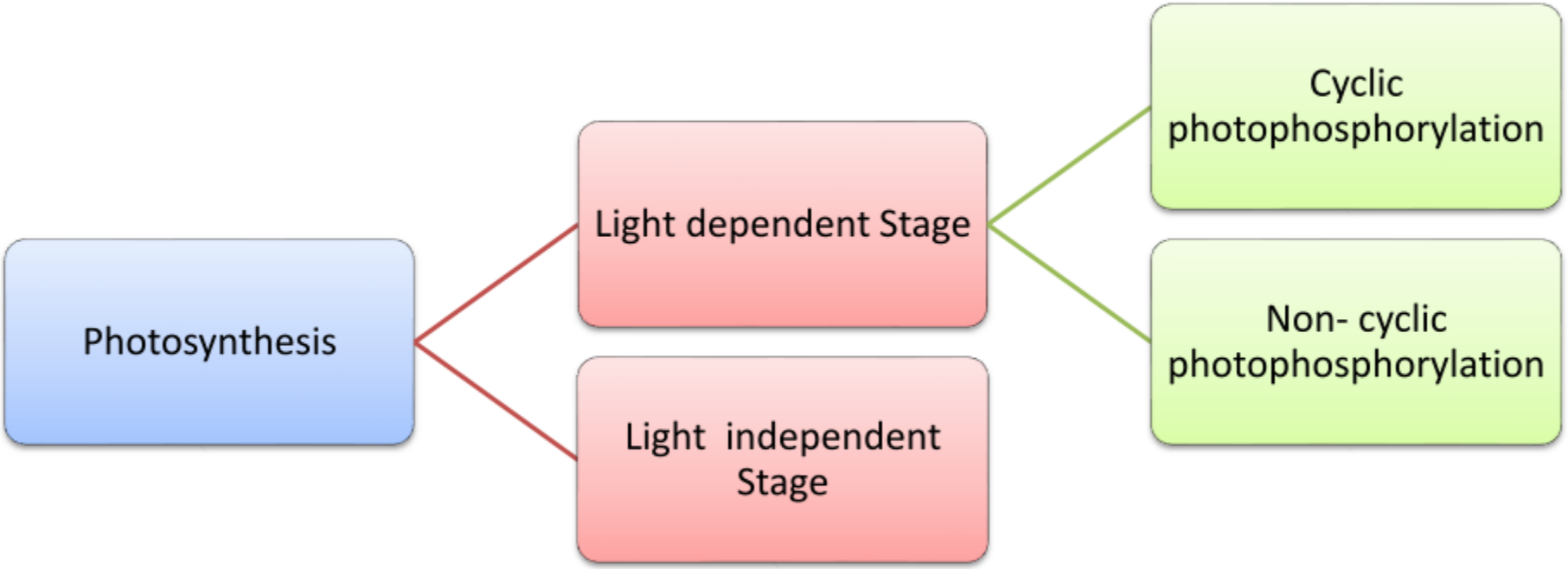
WHY ARE PLANTS GREEN?

- Chlorophyll is located in the thylakoid membranes.
- Chlorophyll have Mg+ in the centre.
- 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.

Absorption of Chlorophyll



Photosynthesis



Light Dependent Reaction

- Takes place in thylakoids (contain chlorophyll)
- Requires light
- Converts light energy into chemical energy
- Light independent reaction depends on the end products (reduced NADP and ATP) of light dependent reaction.

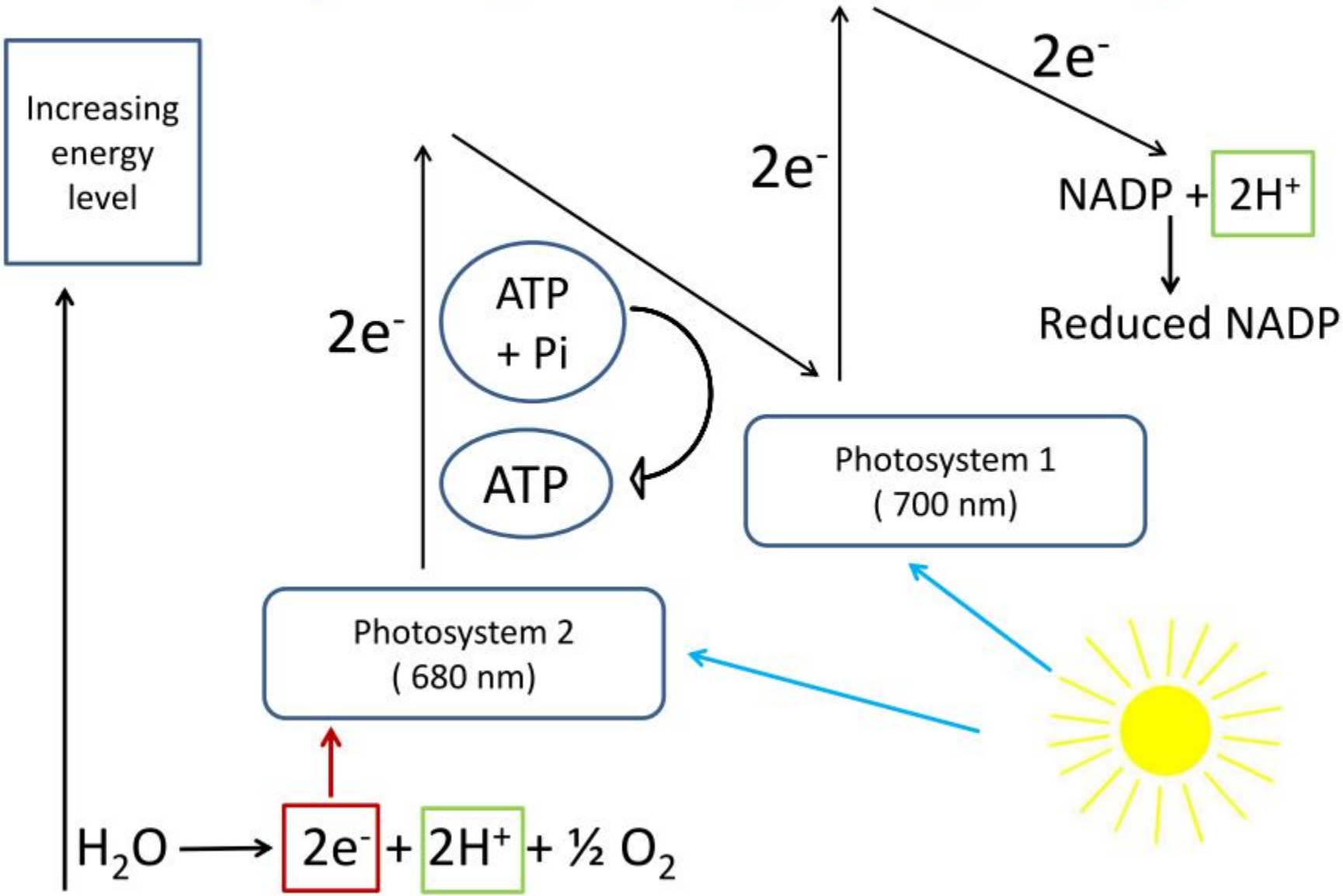
Non-Cyclic photophosphorylation

- Involves two photosystems (P680, P 700 nm)
- These photosystems contains chlorophyll a and chlorophyll b as well as accessory pigments.
- Flow of electron is non cyclic.
- Uses the photolysis of water

$$H_2O \longrightarrow 2H^+ + 2e^- + \tfrac{1}{2} O_2$$

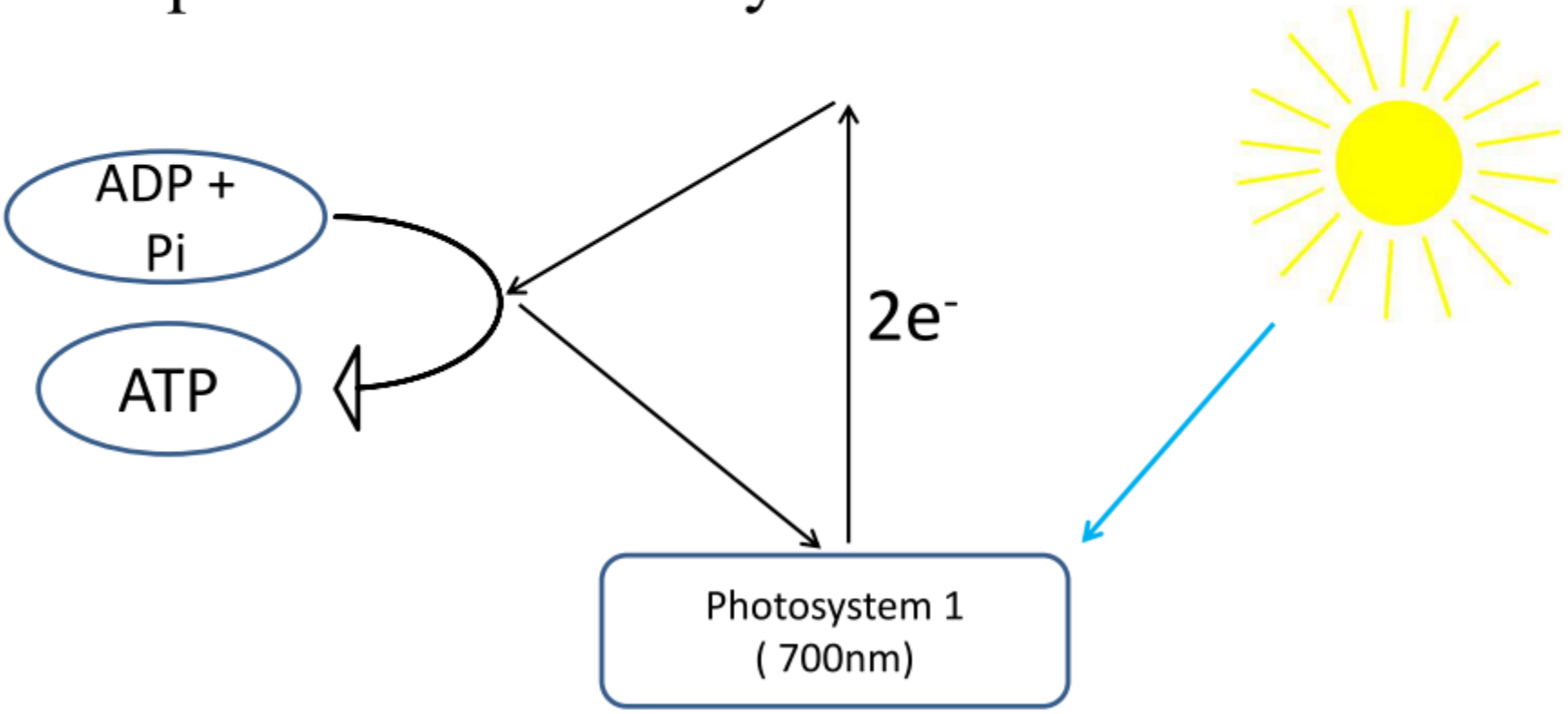
- End products are reduced NADP, ATP and O_2

Non-Cyclic photophosphorylation



Cyclic photophosphorylation

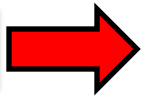
- Involves only photosystem 1 (at 700 nm)
- End product is ATP only



Light independent /Dark reaction

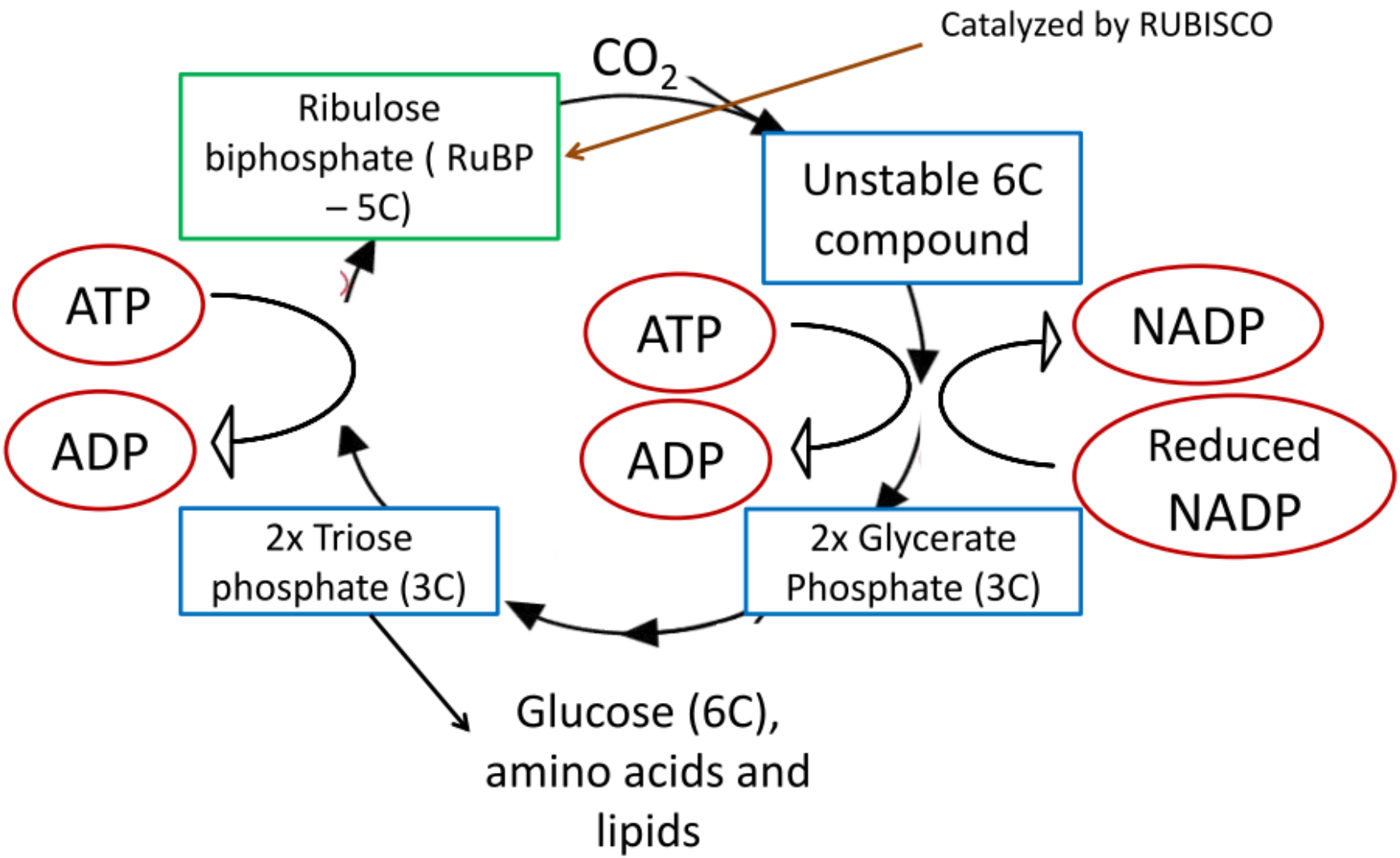
- Also known as calvin cycle
- Takes place in the stroma of the chloroplast
- No light required but need the end products (reduced NADP and ATP) of light dependent reaction reduced NADP and ATP to produce simple sugars.
- Need an enzyme RUBISCO (Ribulose Biphosphate Carboxylase) and carbon dioxide.

- Calvin cycle consists of following steps



- Carbon fixation
- Reduction
- Regeneration

Calvin Cycle



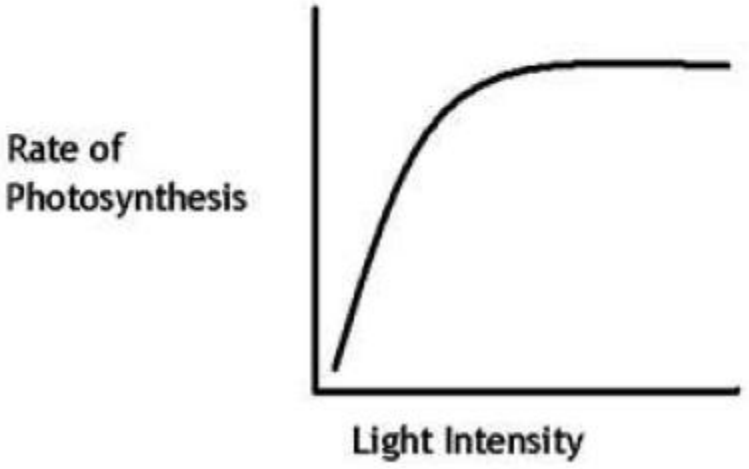
Factors affecting Photosynthesis

- The rate of photosynthesis is defined in terms of the rate of oxygen production per unit mass of green plant tissues or per unit weight of total chlorophyll.

- <u>The main factors are:</u>
  1. Light intensity
  2. Wavelength
  3. Carbon dioxide concentration
  4. Temperature
  5. Water supply
  6. Chlorophyll Concentration
  7. Pollution

1. Light intensity

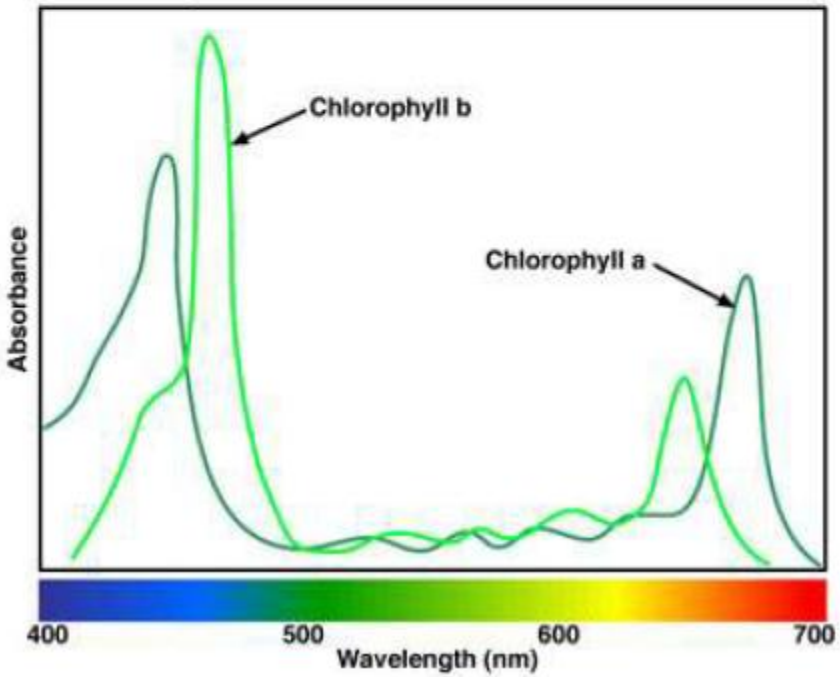
- The rate of photosynthesis would go up as intensity is increased.
- Because the more light a plant absorbs, the more photosynthesis can occur, which will lead to the production of more ATP.
- However, very high intensity slows down the rate as it bleaches the chlorophyll.
- Normal sunlight is quite sufficient for a normal rate of photosynthesis.



2. Wavelength

- Different colours of light can affect how much photosynthesis can occur.
- Because only certain colours are absorbed. The more colour that is absorbed, the more light that is absorbed, which will lead to more photosynthesis, and eventually more ATP.

- Photosynthesis depends upon the absorption of light by pigments in the leaves of plants. The most important of these is chlorophyll-a.

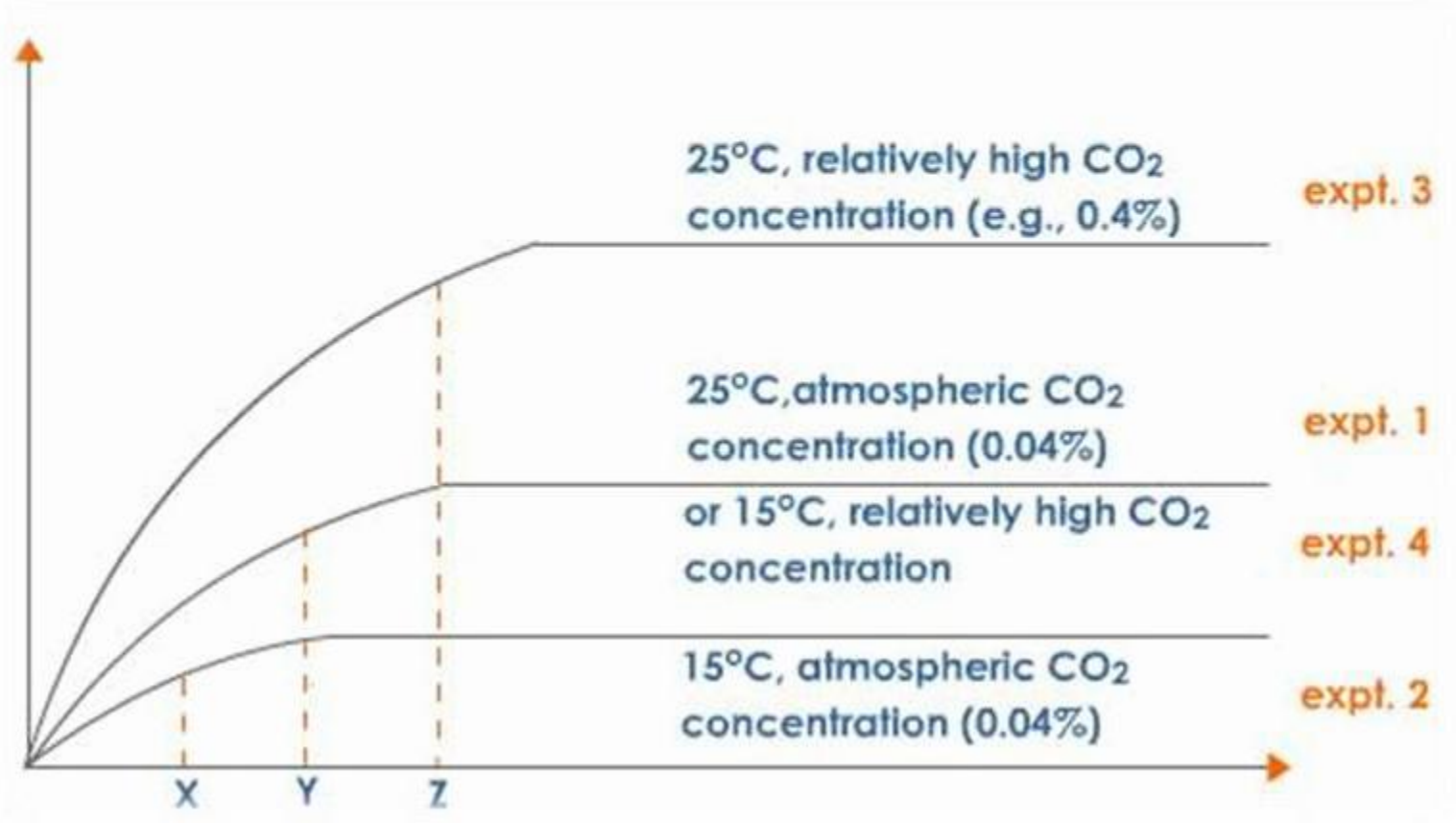


3. Carbon dioxide concentration

- As carbon dioxide concentrations rise, the rate at which sugars are made by the light-independent reactions increases.
- In the atmosphere, the concentration of carbon dioxide ranges from 0.03 to 0.04 %.
- However, it is found that 0.1% of carbon dioxide in the atmosphere increases the rate of photosynthesis significantly.
- This is done in greenhouses where plants are grown under controlled conditions obtaining CO2 from gas burners.

3. Carbon dioxide concentration

- The following graph shows how different concentrations of CO_2 affect the rate of photosynthesis.



4. Temperature

- The temperature has an affect on the rate of photosynthesis.
- An optimum temperature ranging from 25°C to 35°C is required for a good rate.
- At temperatures around 0°C the enzymes stop working and at very high temperatures the enzymes are denatured.

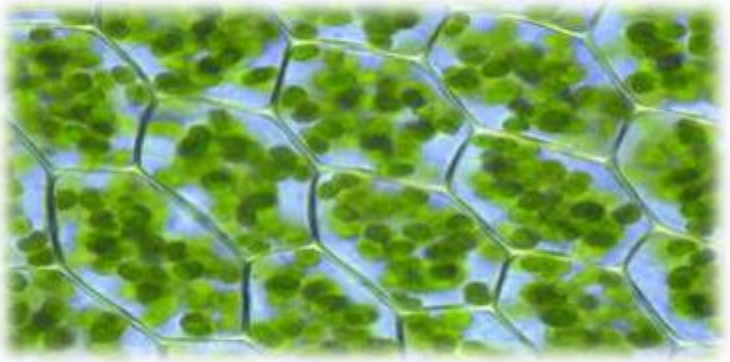
5. Water supply

- Water is an essential factor in photosynthesis.
- The lack of water not only cause the plant to wilt (and thereby lose its ability to capture sunlight) but also limits the quantity of carbon dioxide.
- This happens as when the leaves are dry, they close their stomata in order to conserve water being lost as water-vapour through them.

6. Chlorophyll Concentration

- The concentration of chlorophyll affects the rate of reaction as they absorb the light energy needed for the reactions.

- Lack of chlorophyll or deficiency of chlorophyll results in chlorosis or yellowing of leaves.



- It can occur due to disease, mineral deficiency or the natural process of aging (senescence).

- Lack of iron, magnesium, nitrogen and light affect the formation of chlorophyll and thereby causes chlorosis.