



ETHIO NATIONAL SCHOOL

2020 G. C 4TH QUARTER BIOLOGY LESSON NOTE FOR GRADE 11



☞ Dear students: - Copy the note and do the given homework on your exercise book!

Subject: Biology

Grade & section: 11 (B-E)

Unit:

Main topic: Energy transformation

Sub topic/s:

Page range from: 170

MONDAY, June 1/2020 G.C

5.2 Photosynthesis

How do plants harness light energy in photosynthesis?

What is photosynthesis?

- ❖ a process that nourishes almost all life forms in the biosphere by providing organic compound to eat and oxygen to breath.
- ❖ a process that converts inorganic molecules (water and carbon dioxide) into a range of organic molecule, most commonly carbohydrates.
- ❖ a process by which plants, some bacteria, and some protistans use the energy from sunlight to produce sugar.



How the structure of chloroplast is suited to its function?

Chloroplasts

- The site of photosynthesis in eukaryotic cells.
- Only present in photosynthetic cells like plant cells and algae.
- Generally biconvex or Plano-convex in shape.

Parts of Chloroplasts

- A. **Outer membrane** – is a semi-porous membrane and is permeable to small molecules and ions which diffuses easily.
- B. **Intermembrane Space** - is usually a thin intermembrane space about 10-20 nanometers and it is present between the outer and the inner membrane of the chloroplast.
- C. **Inner membrane** – the inner membrane of the chloroplast forms a border to the stroma.

It regulates passage of materials in and out of the chloroplast. In addition of regulation activity, the fatty acids, lipids, and carotenoids are synthesized in the inner chloroplast membrane.

D. **Stroma**- is an alkaline, aqueous fluid which is protein rich and is present within the inner membrane of the chloroplast. It contains chloroplast ribosomes and the thylakoid system, starch granules and many proteins..

E. **Thylakoid System**- is a collection of membranous sacks called thylakoids.

- ✓ The chlorophyll is found in the thylakoids and is the sight for the process of light reactions of photosynthesis to happen.
- ✓ The thylakoids are arranged in stacks known as grana. Each granum contains around 10-20 thylakoids.

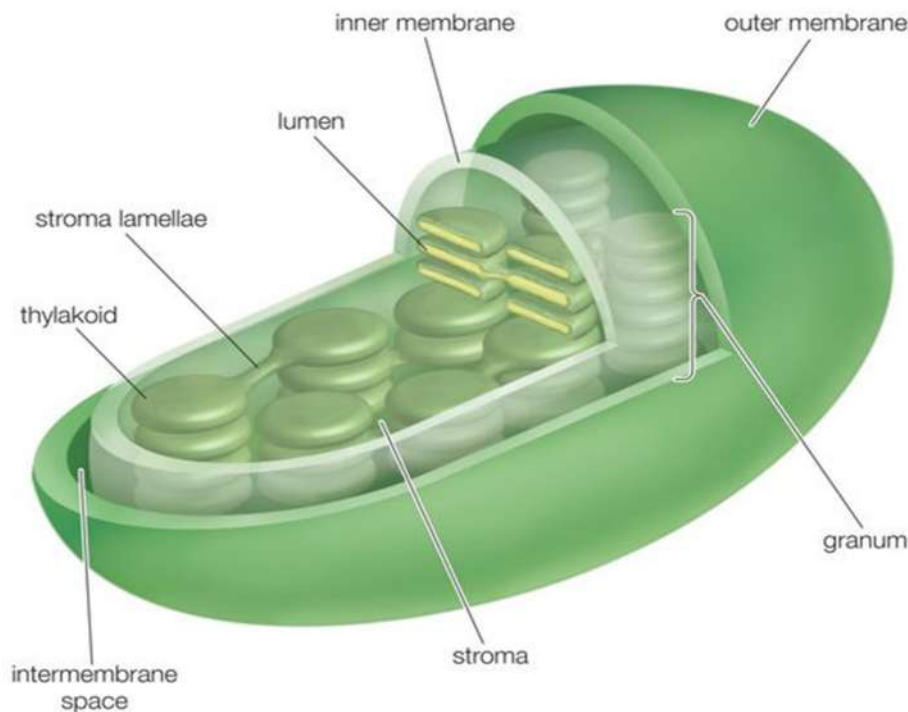


Figure 5.21 The structure of chloroplast

Functions of Chloroplast

- Absorption of light energy and conversion of it into biological energy.
- Production of NADPH and evolution of oxygen through the process of photolysis of water.
- Production of ATP by photophosphorylation.
- Transfer of CO₂ obtained from the air to 5 carbon sugar in the stream during dark reaction.
- Breaking of 6-carbon atom compound into two molecules of phosphoglyceric acid by the utilization of assimilatory powers (ATP and NADPH).
- Conversion of PGA (phosphoglyceric acid) into different sugars and store as starch.

What is a photosystem?

- Clusters of light-absorbing pigments with some associated protein molecules.
- Consists of a number of pigment molecules clustered around one chlorophyll molecule called reaction center molecule (positioned next to ETC).
- Each photosystem contains about 200 molecules of green pigments called chlorophyll and about 50 molecules of another family of pigments called carotenoids.

Antenna complex and Reaction center molecule

❖ **Antenna complex** is an array of protein and light harvesting chlorophyll molecules in thylakoid membrane.

- ✓ It is the cluster of pigment molecules in the chloroplast.
- ✓ Energy absorbed by other molecules in the photosystem is transferred to the **reaction center molecule**, where the light-dependent reactions begin.
- ✓ Different pigments in the **antenna complex** can absorb different wavelengths of light, making the whole system more efficient.
- ✓ The pigments in the antenna complex include chlorophyll **a**, chlorophyll **b** and Carotenoids.

❖ **Reaction center molecule** is a chlorophyll a molecule where the light dependent reaction begins.

- It releases the excited electrons to the primary electron acceptor.
- It is usually located next to the electron transport chain.

❖ There are two types of photosystems, namely photosystem I(PSI) and photosystem II(PSII).

The following table summarizes the basic differences between them.

Features	Photosystem I (PS I)	Photosystem II (PS II)
Location	• located at the outer surface of the grana thylakoid membrane	• located at the inner surface of the grana thylakoid membrane
Type of reaction center molecule	• P700	• P680
Wavelengths of light absorbed	• absorbs longer wavelengths of light (>680nm)	• absorbs shorter wavelengths of light(<680nm)
Chlorophyll distribution	• rich in chlorophyll a than chlorophyll b • consists of Chl. a, Chl. b and Carotenoids	• rich in chlorophyll b than chlorophyll a • consists of Chl. a, Chl. b, Xanthophyll and Phycobilin.
Type of photophosphorylation	• participates in cyclic as well as non- cyclic photophosphorylation	• participates only in non-cyclic photophosphorylation
Association with photolysis of water	• not associated with photolysis of water	• associated with photolysis of water
Main function	• ATP synthesis in cyclic photophosphorylation and NADPH synthesis in non-cyclic photophosphorylation	• ATP synthesis and hydrolysis of water

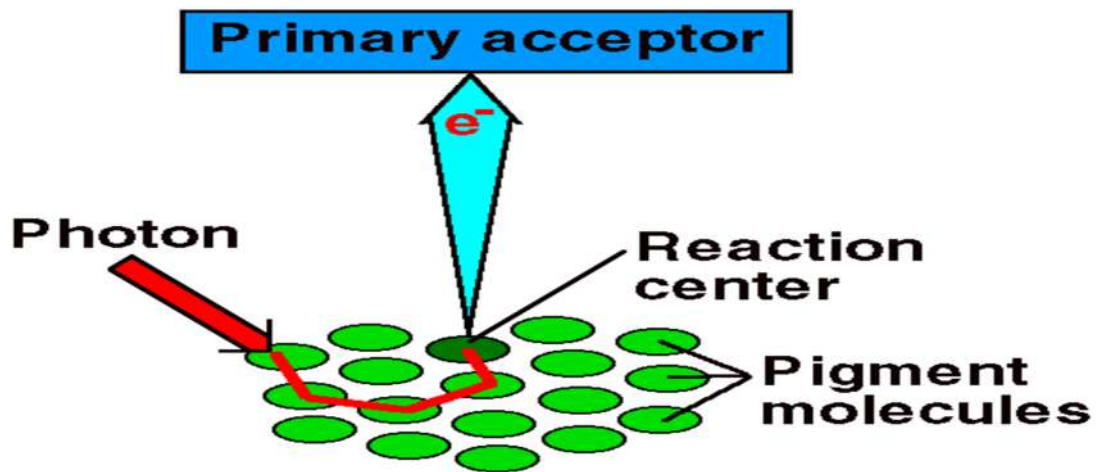


Figure 5.22 The structure of photosystem

Absorption spectrum and Action spectrum

- ✓ The absorption spectrum indicates the wavelengths of light absorbed by each pigment.
- ✓ It is a graphical representation of the amount of light of different wavelengths absorbed by a pigment.
- ❖ The action spectrum indicates the overall rate of photosynthesis at each wavelength of light
- ❖ It is a graphical representation of the rate of photosynthesis at different wavelengths of light.

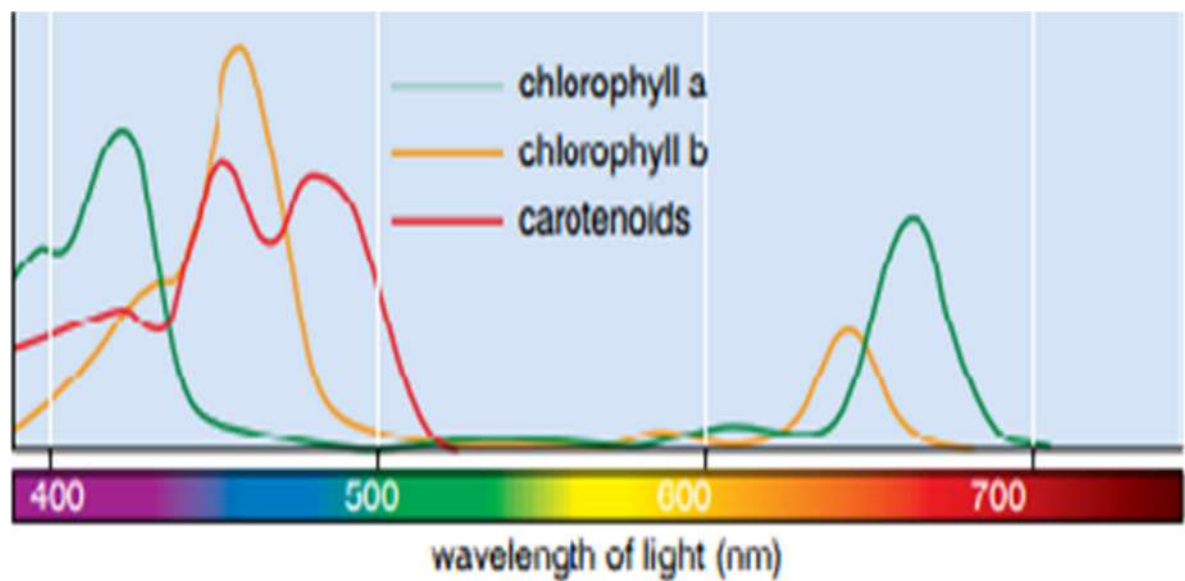


Figure 5.23 absorption spectrum

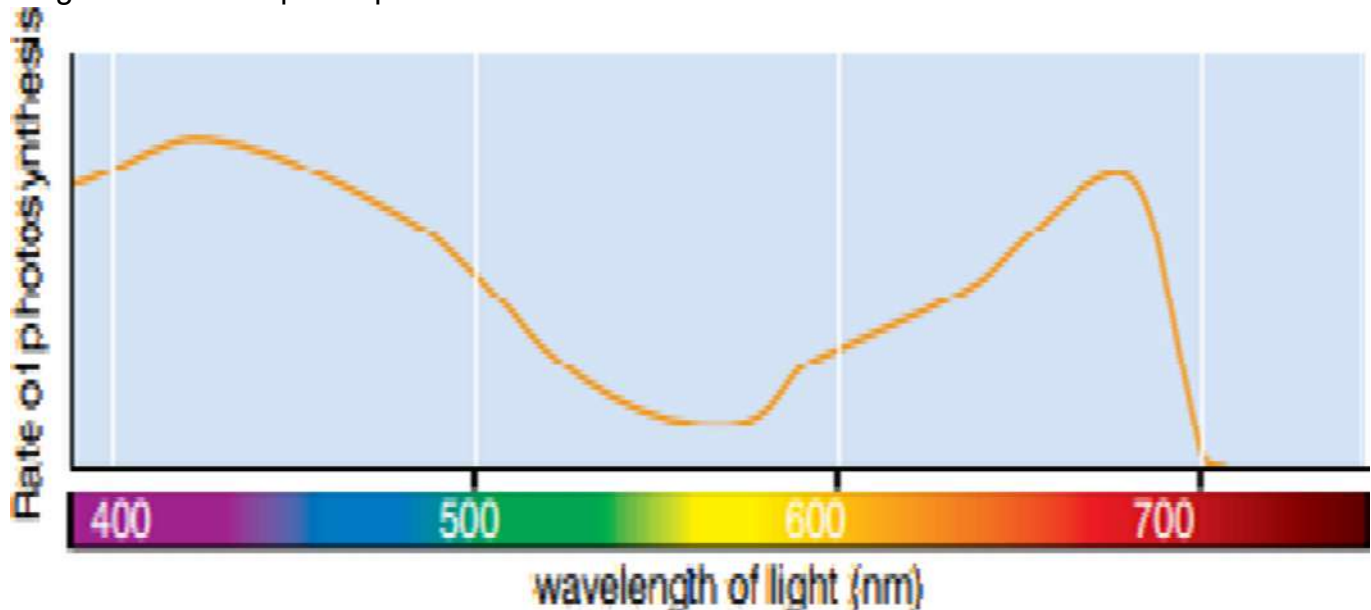


Figure 5.24 Action spectrum

✓ Photosynthesis is composed of two consecutive stages. These are:

I) Light dependent reaction

- The first stage that utilizes light energy to synthesize NADPH and ATP that drive the light independent reactions.
- Takes place in the thylakoid membrane (grana) of chloroplast.
- Involves the following major processes/steps.
 - A. Excitation of photosystems by light energy**
 - B. Production of ATP via an electron transport chain**
 - C. Reduction of NADP and the photolysis of water**

Step 1: Excitation of Photosystems by Light Energy

- When a photosystem absorbs light energy, delocalized electrons within the pigments of PSII become energized or 'excited'
- These excited electrons are transferred to carrier molecules within the thylakoid membrane.
 - ✓ The excited electrons from the chlorophyll molecules pass to **primary electron acceptor**.

Step 2: Photolysis of water and Production of ATP via an Electron Transport Chain

- Excited electrons from Photosystem II (P680) are transferred to an electron transport chain within the thylakoid membrane.
- Water is split by light energy (photolysis of water) into H^+ ions (used in chemiosmosis) and oxygen (released as a by-product).
$$2H_2O \rightarrow O_2 + 4H^+ + 4e^-$$
- The electrons lost from Photosystem II are replaced by electrons released from water via photolysis.
- As the electrons pass through the electron transport chain they lose energy, which is used to translocate H^+ ions into the thylakoid.
 - ✓ The ETC which is associated with PSII consists of three different electron carrier molecules: Plastoquinone (Pq), Cytochrome complex (Cyt) and Plastocyanin (Pc).
- This buildup of protons within the thylakoid creates an electrochemical gradient, or proton motive force.
- The H^+ ions return to the stroma (along the proton gradient) via the transmembrane enzyme ATP synthase (chemiosmosis).
- ATP synthase uses the passage of H^+ ions to catalyze the synthesis of ATP (from ADP + P_i).
 - ✓ This process is called photophosphorylation – as light provided the initial energy source for ATP production.
- The newly de-energized electrons from Photosystem II are taken up by Photosystem I.