Quadrant II– NOTES

Programme: Bachelor of Science (Third Year)

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Paper Title: Cell Biology and Biochemistry

Unit: 02. Cell and its components

Module Name: - Plastids - II (Chloroplast)

Module No: 17

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Notes:

Chloroplast is a semi autonomous organelle

- It has its own DNA,RNA and protein synthetic machinery.
- DNA of chloroplast codes for mRNA, r RNA and t RNA and ribosomal proteins, structural proteins of thylakoid membranes.
- Ribosomes are present which are 70S type, smaller than those in the cytoplasm.
- Morphology of the chloroplast
- Chloroplasts are found in the cytoplasm of cells. They exhibit passive and active movements in the cells and definite orientation.
- Size: Differs from species to species but the average size of the chloroplast is 5-10 µm in diameter and 2-3 µm in thickness. Polyploids plant cells/ growing in shade have large chloroplasts with more chlorophyll than diploid cells /those grown in sunlight.
- Shape: Differs from species to species and exhibit different shapes.
- Number : It varies from plant to plant.

  Number of Plastids

- The number of plastids per cell **varies from cell to cell / species to species** and also **depends on the physiological state** of the cell**.**
- **Normally cells of higher plants have 20 to 40 chloroplasts.**
- In unicellular algae, chloroplast is huge, **single**(Chlamydomonas) or **two** (Zygnema sp) and number also ranges from few to many in higher plants.

  In plants like ***Arabidopsis (*a genus of family Brassicaceae)**

  ***and Triticum aestivum (*wheat*)* chloroplasts *are* 100 per cell.**

  Ultrastructure of the chloroplast

A chloroplast consists of the following parts:

- **Envelope:** Consists of **double unit membranes , lack chlorophyll** pigment .Has small amount of carotenoids therefore its yellow colour.
- **Stroma:** Matrix of **gel-fluid phase**.
- **Thylakoids:** Sac-like closed plates.

Envelope of Chloroplast

Envelope of the chloroplast consists of approximately **300 Å** thickness (including the space) and made of **lipid bilayer and proteins. Each membrane is 50 Å thick.**

- **Outer membrane:** It is a semi-porous membrane and is permeable to small molecules and ions, which diffuses easily. The outer membrane is not permeable to larger proteins.
- **Inter-membrane Space:** It is present between the outer and the inner membrane of the chloroplast.
- **Inner membrane:** The inner membrane of the chloroplast forms a border to the stroma.

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

Stroma

- Stroma is an alkaline, aqueous fluid that is **protein-rich** and is present within the inner membrane of the chloroplast.
- The space **outside the thylakoid space** is called the stroma.
- The chloroplast DNA , ribosomes and the thylakoid system, starch granules and many proteins are found floating in the stroma.
- **Synthesis** of some **Structural proteins** of the chloroplast takes place in the stroma.
- **CO_2** fixation occurs and synthesis of starch occurs in the stroma.
- The heterogeneous nature of chloroplast is due to the presence of disc-like structures i.e., grana, in a colourless matrix called stroma.
- In stroma, there are many membranes running parallel to each other throughout the length of chloroplast which is called **lamellae**.
- **Stroma is the site for the dark reaction of photosynthesis.**
- Thylakoid is suspended in the stroma.
- The thylakoid system is a collection of membranous flat sacs called thylakoids which contain the chlorophyll, where light reactions of photosynthesis occur.
- The space the chlorophyll fills is called the **thylakoid space/lumen**.
- Each granum is made up of a stock of closed compartments called thylakoids.
- Each thylakoid consists of two parallel membranes joined at their margins.

- The membranes of thylakoids contain the **layer of particles called chlorophyll.**
- **Grana are the sites for the light reaction.**The stacks of thylakoids sacs are connected by stroma **lamellae**.
- The number of thylakoid per granum vary from 1 to 50 and depend on the plant species.
- Granum in **Red algae** has **single** thylakoid **multiple thylakoids are seen in green algae and higher plants.**

Difference between chloroplasts in C4 plants

***Saccharum officinarum (Sugarcane*) is a C4 plant and**

shows chloroplast dimorphism. - Chloroplast dimorphism means occurrence of two types of chloroplasts in the single **plant.**

Mesophyll cell	**Bundle sheath cell**
Chloroplast are smaller	**Chloroplast are bigger**
Grana present	**Grana absent**
Light reactions occur	**Dark reactions occur**
ATP and NADPH are produced	**ATP and NADPH are USED**
Starch absent	**Starch present**

Functions of Chloroplast

Chloroplast helps in Photosynthesis where the photosynthetic pigment chlorophyll captures the energy from sunlight, converts it.

Chloroplasts also stores it in the energy-storage molecules ATP and NADPH while releasing oxygen from water in plant and algal cells.

- Chloroplasts are the sites for photosynthesis, which comprises a set of **light-dependent** and **light-independent** reactions to harness solar energy and convert it into chemical energy.
- The chloroplast participates in **photorespiration**.
- The chloroplasts **along with** the **nucleus** , cell membrane and **ER** are the key organelles of **pathogen defence**.