**Cyanoacteria**

Cyanobacteria is prokaryotic, either may be unicellular, colonial or filamentous. Each filament consists of a sheath of mucilage and one or more cellular strands called trichomes. Single trichome filaments may further be of two types, homocystous (undifferentiated, e.g., Oscillatoria) and heterocystous (differentiated, having heterocysts, e.g., Nostoc). Spirulina has a spirally coiled filament. In some cases Colonies develop, e.g., Nostoc. Flagella are absent but gliding movements are known in a number of cyanobacteria. The name Oscillatoria has been given to a common blue green alga on the basis of pendulum like oscillating movements of its anterior region.

Cell Structure of Cyanobacteria:

Cyanobacterial cells are larger and more elaborate than bacteria. Cell structure is typically prokaryotic— one envelope organisation with peptidoglycan wall, naked DNA, 70S ribosomes and absence of membrane bound structures like endoplasmic reticulum, mitochondria, Golgi bodies, plastids, lysosomes, sap vacuoles. The outer part of the protoplast contains a number of photosynthetic thylakoids. It is called chromoplasm. The thylakoids lie freely in the cytoplasm. Their membranes contain chlorophyll a, carotenes and xanthophyll’s. Chlorophyll b is absent.

**Ultrastructure of a Cyanobacterial Cell**

The ultra-structural detail of a typical cyanobacterial cell is the following:

1. Mucilage Sheath:

The cells and filaments of most cyanobacteria are generally surrounded by a mucilaginous sheath. It is considered that these microorganisms secrete the mucilage through pores present in their cell walls.

2. Cell Wall:

The cell wall lies between the plasma membrane and the mucilage sheath. Like bacteria, peptidoglycan is the main constituent of the cyanobacterial cell wall. Ultra structurally, the wall consists of four layers (LI, LII, LIII, LIV) each of which is connected with the other one by a connection known as plasmodesma (plasmodesmata). All cyanobacterial cell walls like prokaryotes, possess diaminopimelic acid (DPA).

3. Plasma Membrane:

A typical cyanobacterial plasma membrane is around 70Å thick. It is selectively permeable, lacks sterole such as cholesterol, and consists of a high proportion of protein to phospholipid (typically 2:1) like other prokaryotes. It generally fuses with the photosynthetic lamellae and gives rise to inward folding’s in the cytoplasm; the folding’s are called lamellosomes or mesosomes. The latter are mostly similar in functions to mesosomes occurring in other prokaryotes.

4. The Cytoplasm:

The cytoplasm of cyanobacterial cell, like that of bacteria, is incredibly boring. It lacks eukaryotic organells such as chloroplasts, mitochondria, endoplasmic reticulum, Golgi bodies. But, it possesses photosynthetic apparatus, ribosomes, and a large number of subcellular inclusions such as glycogen or α-granules, polyphosphate bodies, polyhedral bodies, cyanophycin granules, and the genetic material.

(i) Photosynthetic apparatus:

In place of the chloroplasts of photosynthetic eukaryotes, cyanobacteria have flattened vesicular structures called thyllakoids or lamellae, which resemble the individual thyllakoids of the true chloroplasts of photosynthetic eukaryotes. The lamellae or thyllakoids are both physiologically or structurally complex and possess photosynthetic pigments. As described earlier, the principal pigment of all cyanobacteria is chlorophyll a. In addition, there are β-carotene and other accessory pigments, namely, phyeobiliproteins. The phycobiliproteins are phycocyanin (PC), allophycocyanin (AP), allophycocyanin-B (APB), and phycoerythrin. By possessing phycocyanin and phycoerythrin accessory pigments, the cyanobacteria resemble with red algae. However, the necessary pigments of these organisms are generally organized into organelles called phycobilisomes and trap light energy of lower wavelengths, which cannot be absorbed by chlorophyll a, and pass it on to the chlorophyll a. This is the reason why cyanobacteria, like green algae, can exploit deeper waters where the quality and quantity of illumination is inappropriate for the photosynthetic plants.

(ii) Ribosomes:

These are the sites of protein synthesis. Cyanobacterian ribosomes occur freely in the cytoplasm and are identical to those of bacteria in being 70S ribosomes.

(iii) Glycogen or α-granules:

Glycogen or α-granules are the sites for storage of excess photosynthetic products. The latter is used as energy source in darkness or when CO2 supply is limiting.

(iv) Polyphosphate and Polyhedral bodies:

These are the spherical structures formed as a result of the aggregation of high molecular weight linear polyphosphates. These subcellular inclusions are also called metachromatin granules or volutin granules and serve as phosphate stores and are consumed during periods of phosphate starvation. These structures develop mostly in those cyanobacteria that grow in a phosphate-rich environment.

All cyanobacteria store their ribulose 1, 5-bisphosphate carboxylase (RUBP carboxylase) enzyme in structures referred to as polyhedral bodies.

(vi) Cyanophycin granules:

Cyanobacteria growing in nitrogen-rich environment produce structures, called cyanophycin granules, which are made up of arginine and aspartic acid.

(vii) Genetic material:

The genetic material of cyanobacteria is made up of naked DNA fibrils found dispersed in the central region of the cytoplasm. Like other prokaryotes, they lack membrane-bound organized nucleus. The molecular weight of the cyanobacterial genome is considered to range from 2.7 to 7.5 x 109daltons.



Cyanophycean granule

Attached to the thylakoid membranes are small granules known as phycobilisomes. The latter possess accessory photosynthetic pigments known as phycobilins. The phycobilins are of three types— phycocyanin (blue), allophycocyanin (blue) and phycoerythrin (red). Differential formation of phycobilins produces specific colouration which is adapted to absorbing maximum amount of solar radiation. Therefore, cyanobacteria are not always blue green. They may appear purplish, violet, brownish, etc. Instead of typical vacuoles or sap vacuoles, gas vacuoles or pseudo-vacuoles are found. Each gas vacuole consists of a number of submicroscopic units called gas vesicles. Gas vacuoles function as light screen; provide buoyancy regulating mechanism and pneumatic strength.

A naked, circular, double stranded DNA lies coiled generally in the central part of the cytoplasm known as centroplasm. The coiled up DNA is equivalent to a single chromo­some of higher organisms. It is often called nucleoid. Like bacteria, small circular DNA segments may also occur in addition to nucleoid. They are known as plasmids or transposons. 70S ribosomes occur here and there. Semicircular group of coiled membranes often attaches the plasma membrane with the nucleoid. It is known as lamella some. Four types of inclusions occur in the cells. They are α-granules (cyanophycean starch), β-granules (lipid droplets), volutin granules and polyhedral bodies (ribulosebiphosphate carboxylase).

Heterocyst of Cyanobacteria:

It is a large-sized pale coloured thick-walled cell which occurs in terminal, intercalary or lateral position in filamentous cyanobacteria, e.g., Nostoc. The thick wall is impermeable to oxygen but permeable to nitrogen. Mucilage sheath is absent. Photosystem II is absent. Thylakoids lack phycobilisomes. Therefore, photosynthesis is absent but cyclic photophosphorylation occurs. Heterocyst is dependent for its nourishment on adjacent vegeta­tive cells. It has enzyme nitrogenase. Heterocyst is specialised to perform nitrogen fixation.