B.Sc. Botany
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Paper-I: CRYPTOGAMS
GROUP-A

CYANOBACTERIAL CELL

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CYANOBACTERIAL CELL

Cyanobacteria, formerly called "blue-green algae" are relatively simple, primitive life forms closely related to bacteria as largest and one of the important group. They are quite small and usually unicellular, though they often grow in colonies large enough to see. They have the distinction of being the oldest known fossils, more than 3.5 billion years old.

Characteristics:-

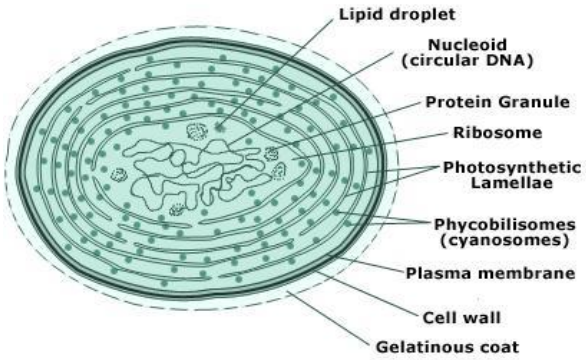
1. Cyanobacteria are relatives of the bacteria, not eukaryotes, and it is only the chloroplast in eukaryotic algae to which the cyanobacteria are related. Symbiogenesis argues that the chloroplasts found in plants and eukaryotic algae evolved from cyanobacterial ancestors via endosymbiosis.
2. Depending upon the species, cyanobacteria can occur as single cells, filaments of cells, or colonies.
3. They are the most genetically diverse; they occupy a broad range of habitats across all latitudes, widespread in freshwater, marine, and terrestrial ecosystems, and they are found in the most extreme niches such as hot springs, salt works, and hypersaline bays.
4. They may be free-living or form symbiotic relationships with plants or with lichen-forming fungi as in the lichen genus Peltigera.
5. Some filamentous species show the ability to differentiate into several different cell types: vegetative cells, the normal, photosynthetic cells that are formed under favorable growing conditions; akinetes, climate-resistant spores that may form when environmental conditions become harsh; and thick-walled heterocysts, which contain the enzyme nitrogenase, vital for nitrogen fixation.
6. Many cyanobacteria form motile filaments of cells, called hormogonia, that travel away from the main biomass to bud and form new colonies elsewhere.
7. Pigment System: Chlorophyll a chlorophyll b and phycobiliproteins .

   Phycobiliproteins are arranged in phycobilisomes,(hemispherical structures attached to photosystem II)

   1. Phycoerythrin (Absorbtion maximum at 550 nm)
   2. Phycocyanin (Absorbtion maximum at 620 nm)
   3. Allophycocyanin (Absorbtion maximum at 650 nm)

Ultra structure of Cell

Cyanobacterial cells are larger and more elaborate than bacteria. Cell structure is typically prokaryotic – one envelop organization with peptidoglycan wall, naked DNA, 70S ribosomes and absence of membrane bound structures like endoplasmic reticulum, mitochondria, golgi bodies, plastids, lysosomes, sap vaculoles.



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1. **Mucilage sheath:**
   - **i.** Cells of most of Cyanobacteria have thin (Anacystic) or thick (Anabaena) mucilaginous sheath all around.
   - **ii.** This sheath is made up of microfibrils. These microfibrils are also scattered uniformly in matrix.
   - **iii.** It contains peptic acid and mucopolysaccharides.
2. **Cell wall**:Cell wall is of gram negative type.
   - i. Cell wall has got four layers, known as LI, LII, LIII, and LIV. The LIV layer is outermost layer, which is in contact with mucilaginous sheath while the innermost layer is LI and is in contact with cytoplasm.
   - ii. Cell wall is made up of mucopeptide, & muramic acid, glucosamine alanin, glutamic acid and a-diaminopamelic acid.
   - iii. The layer LII provides shape and mechanical strength of the cell wall.
   - iv. All the layers are interconnected by plasmodesmata,

3. Cytoplasm:

Cytoplasm is covered by protoplasmic membrane. It is a semi-transparent membrane made up of protein. Cytoplasm can be divided into two parts:

(a) Chromatoplasm:

It is the outermost part of the cell, which contains thylakoids or lamellae (flattened vesicular structure). They are arranged in parallel rings or scattered. They are flat, sac-like structures, enclosed by unit membrane. Each membrane is 70-80 A thick. At their surface phycobilisome and biliproteins are present.

Apart from these structures, cytoplasm also contains ribosomes, cyanophycean granules, polyglucan granules, carboxysome, polyhedral bodies, Gas vacuoles, polyphosphate granules etc,

(b) Centroplasm:

Central transparent part of the cell is called centroplasm. Genetic material is found in this portion.Genetic material is in the form of DNA. Nuclear membrane, nucleoli and histones are absent. In this part besides DNA, RNA is also present. Thus, in Cyanobacteria organised nucleus is not present and this nucleus is called incipient nucleus.

4. **Cytoplasmic inclusions**
   Several glycogen granules , oil droplets and other inclusions are dispersed in chromoplasm as well as in centroplasm regions.

The main components include gas vesicles,which promote floatation of the cell within the water column; carboxysomes (polyhedral bodies) ,deposits of the key enzyme catalyzing CO_2 fixation , ribulose-1,5 bisphosphate carboxylase/oxygenase(RuBisCO); cyanophycin granules, consisting of a unique polypeptide built of L-arginine and L-aspartate residues and acting as an alternative nitrogen source; granules of glycon (a-granules), lipids granules (b-granules) and granules of poly-b-hydroxybutyrate acting as sources of carbon and energy ;and polyphosphate granules, sources of phosphorus. They are also other inclusions, as well as various microtubels and microfilaments

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Heterocyst of Cyanobacteria

It is 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. Mucilege sheath is absent. Photosystem II is absent.

Thylakoids lack phycobillisomes. Therefore , photosynthesis is absent but cyclic photophosphorylation occurs. Heterocyst is dependent for its nourishment on adjacent vegetataive cells. It has enzyme nitrogenase. Heterocyst is specialized to perform nitrogen fixation.

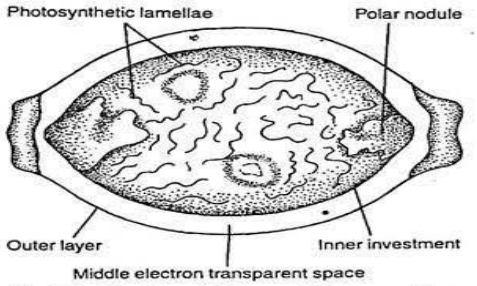

Fig. 3.26 : Structure of Heterocyst (diagrammatic) as seen under electron microscope (based on Lang)

Cyanobacteria have existed for 3.5 billion years, yet they are still the most important photosynthetic organisms on the planet for cycling carbon and nitrogen.The ecosystems where they have key roles range from the warmer oceans to many Antarctic sites.

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