Lecture -2-

Cyanophyta

Cyanobacteria also known as blue-green bacteria, blue-green algae, and Cyanophyta, is obtain their energy through photosynthesis.

1-General Characteristics

1-Prokaryotic, no true nucleus, amorphous interior. ~1350 freshwater species.

2-Sometimes specialize in extreme environments (pH, temperature, nutrients), reflecting extraordinary structural and functional heterogeneity of group.

3-Some capable of Nitrogen-fixation, buoyancy regulation, toxin production.

4- form large colonies that are resistant to grazing; generally lower nutritional value than other algal groups.

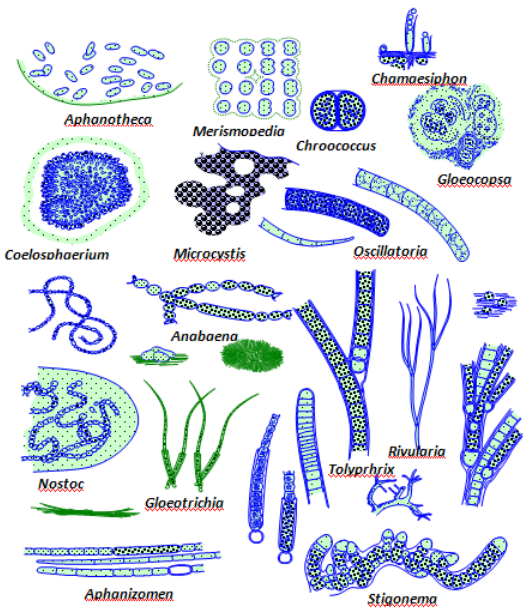

Figure 1: Cyanophyta forms

2- Ecology

Cyanobacteria can be found in almost every terrestrial and aquatic habitat: in oceans, fresh water - even bare rock and soil. They can occur as planktonic cells or form phototrophic biofilms in fresh water and marine environments, they occur in damp soil, or even on temporarily moistened rocks in deserts. A few are endosymbionts in lichens, plants, various protists, or sponges and provide energy for the host.

3-Nitrogen fixation

The climate-resistant spores that may form when environmental conditions become unfavorable, and thick-walled heterocysts, which contain the enzyme nitrogenase is so necessary for nitrogen fixation. Heterocysts may also form under the appropriate environmental conditions (anoxic) when fixed is scarce. Heterocyst-forming species are specialized for nitrogen fixation and are able to fix nitrogen gas into ammonia (NH_3), nitrites (NO^{-}_2) or nitrates (NO^{-}_3) which can be absorbed by plants and converted to protein and nucleic acids.

4-Metabolism and organelles

As with any prokaryotic organism, cyanobacteria do not have nuclei or an internal membrane system. However, many cyanobacteria species have folds on their external membranes which function in photosynthesis. Cyanobacteria get their color from the bluish pigment phycocyanin, which they use to capture light for photosynthesis. Photosynthesis in cyanobacteria generally uses water as an electron donor and produces oxygen as a by-product, though some may also use hydrogen a process which occurs among other photosynthetic bacteria. Carbon dioxide is reduced to form carbohydrates via the Calvin cycle. In most forms the photosynthetic machinery is embedded into folds of the cell membrane, called thylakoids.

Many cyanobacteria are able to reduce nitrogen and carbon dioxide under aerobic conditions, a fact that may be responsible for their evolutionary and ecological success. The water-oxidizing photosynthesis is accomplished by coupling the activity of photosystem (PS) II and I.

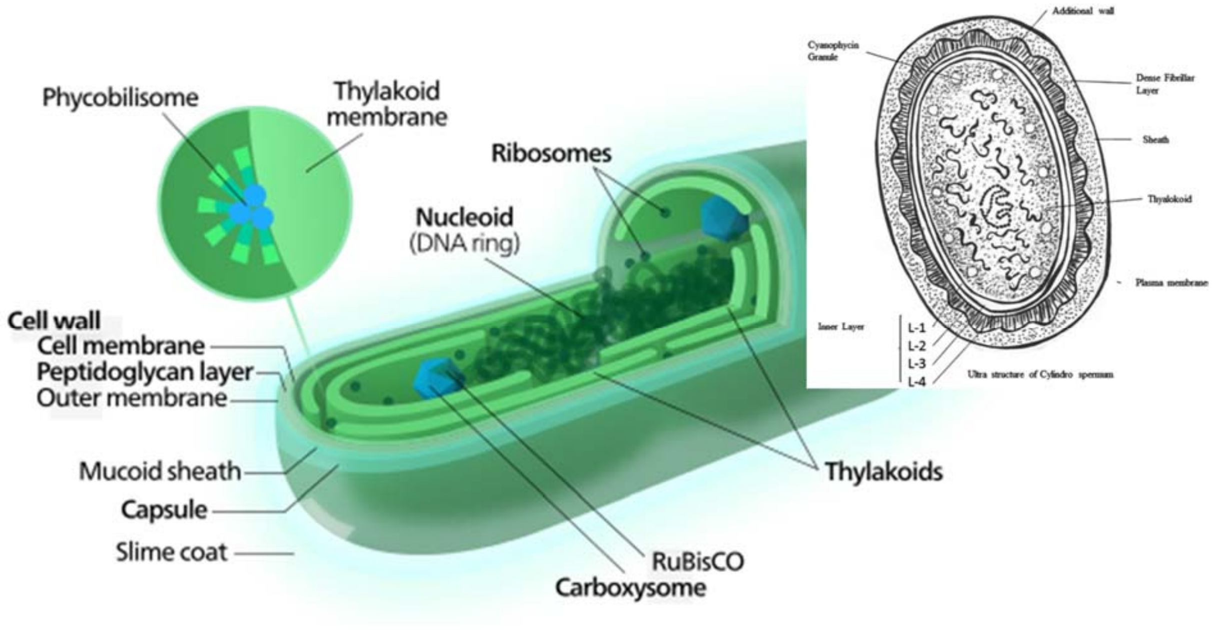

Figure 2: General Structure of Cyanophyta

5- Classification

The cyanobacteria were traditionally classified by morphology into five sections, referred to by the numerals I-V. The first three Chroococcales,Pleurocapsales, and Oscillatoriales – are not supported by phylogeneticstudies.However,thelattertwo Nostocales and Stigonematales are monophyletic, and make up the heterocystous cyanobacteria. The members of Chroococales are unicellular and usually aggregate in colonies. The classic taxonomic criterion has been the cell morphology and the plane of cell division.

A-The classes **Chroobacteria**, Hormogoneae and Gloeobacteria

B-The orders **Chroococcales**, Gloeobacterales, Nostocales, Oscillatoriales, Pleurocapsales and Stigonematales

C- The families **Prochloraceae** and Prochlorotrichaceae

D-The genera **Halospirulina**, Planktothricoides, Prochlorococcus, Prochloron, Prochlorothrix.

6-Reproduction

Reproduction:

A-Vegetative Reproduction:

1) Binary fission – dividing in two

2) Fragmentation of colonies

B-Asexual reproduction through:

1) Endospores/Exospores

2) Hormogonia

3) Akinetes

4) Heterocyst.

Asexual reproduction occurs by the formation of thick walled cells called akinites, which can also store reserve food material.

Figure 3: The germination of an akinetes

Figure 4: Types of Reproduction tools inCyanophyta

Figure 5: The ultrastructure of a heterocyst

7- life cycle of cyanophyta

They are photosynthetic, like most other plants, but lack most of the structures of terrestrial plant life, such as stalks, leaves and rhizomes. All algae goes through a haploid life cycle of development, starting with a diploidzygote, or spore, and ending up with a fully mature algae for example, NostocalesVegetative cells grow only until nitrogen depletion forces them to build heterocysts, thus enabling the cells to grow further by nitrogen fixation. At the end of summer ,a few light prevents further growth; some of the cells differentiate into akinetes, the resting spores which sink to the bottom where they take up nutrients and mature during winter and spring. Finally, if the conditions are sufficiently favorable the cells germinate and begin to rise to the surface with the help of gas vacuoles. Here, light is abundant and growth of vegetative cells takes place, starting the life cycle again.

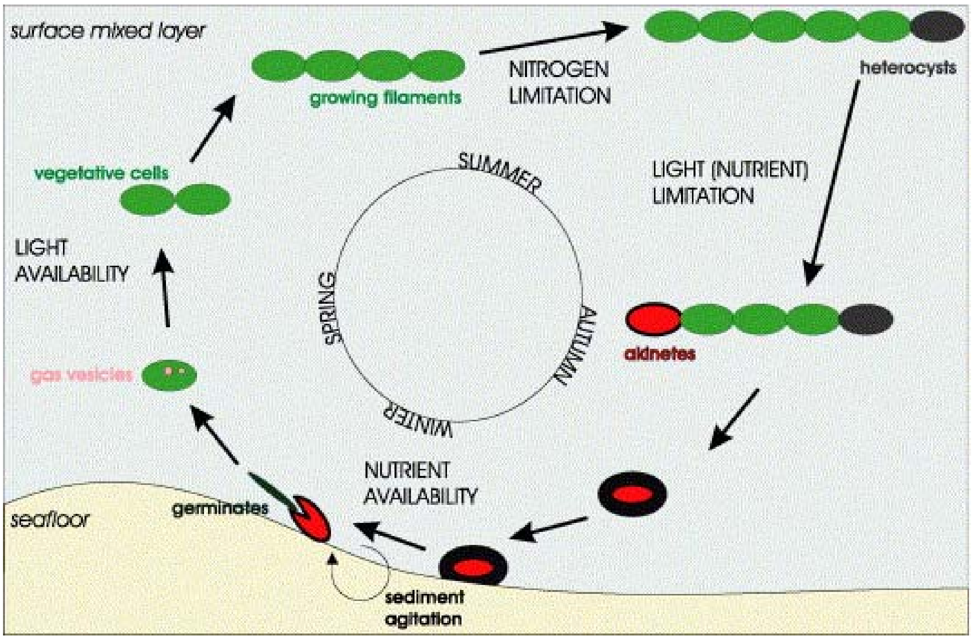

Figure 6: Life cycle of Cyanophyta (Nostocales)

8- Cyanophyta Toxin

Cyanobacteria can produce neurotoxins, cytotoxins, endotoxins and hepatotoxins (i.e. the microcystin producing bacteria species microcystis), and are called cyanotoxins.

8-1 What are microcystins?

One group of toxins produced and released by cyanobacteria are called microcystinsbecause they were isolated from a cyanobacterium called Microcystis aeruginosa. Microcystins are the most common of the

9- Biological Remediation by Algae

Throughout the world's ever growing population and industrial advancement results in environmental pollution problem e.g., heavy metal, pesticides that are not easily biodegraded and persist in the environment. The removal of such pollutants from wastes prior to disposal, are absolutely essential. The success of bioremediation is dependent on the selection of appropriate micro-organism with precise ecological state. Cyanobacteria (especially those capable of diazotrophic growth) offer distinct advantages as potential biodegradation organism, since their survival is not dependent on the presence of high concentration of organic compounds.

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