CYANOBACTERIA -STRUCTURE AND REPRODUCTION

INTRODUCTION

1. **Cyanobacteria** are photosynthetic bacteria formerly known as *blue-green algae*.
2. Most are found in the soil and in freshwater and saltwater environments.
3. The majority of species are unicellular, but some may remain linked and form filaments.

4.Cyanobacteria, which are autotrophic, serve as important fixers of nitrogen in food chains. 5.In addition, cyanobacteria, a key component of the plankton found in the oceans and seas, produce a major share of the oxygen present in the atmosphere, while also serving as food for fish.

6.Some species of cyanobacteria coexist with fungi to form **lichens.**

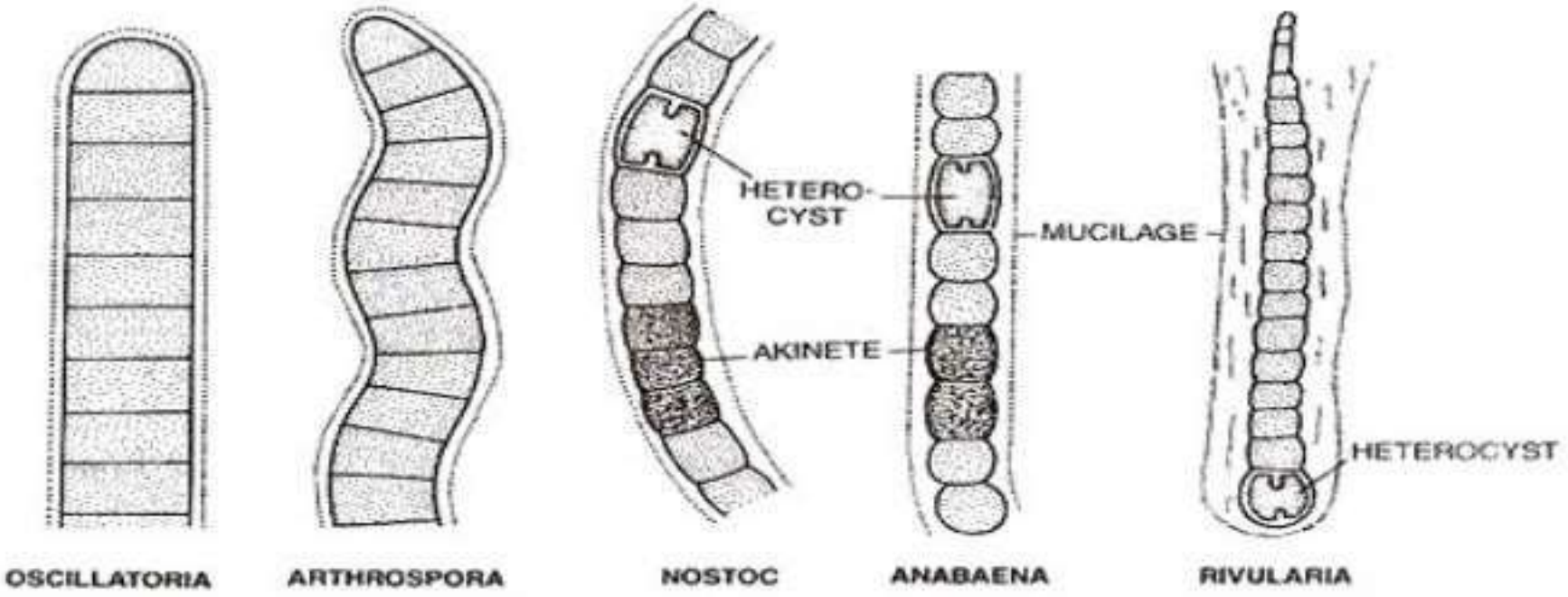


Fig. 2.17. Some common filamentous blue-green algae.

STRUCTURE OF CYANOBACTERIA

Blue-green algae are the most primitive organisms in the plant kingdom and show typical prokaryotic organization

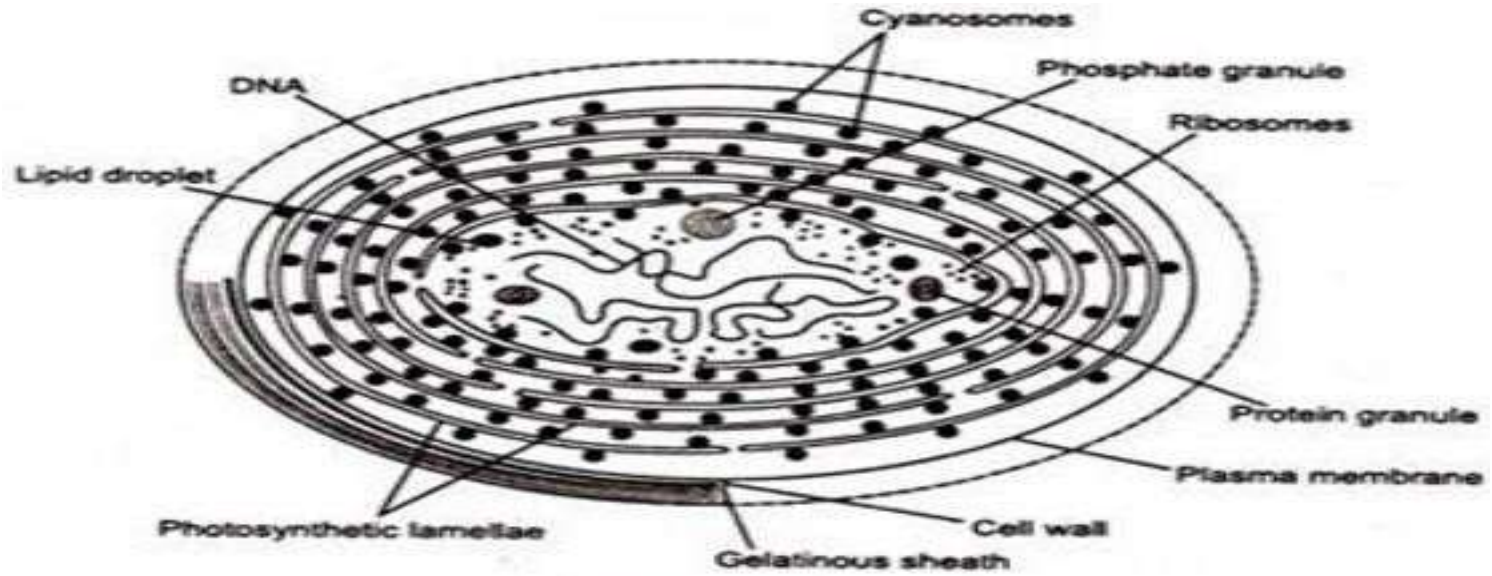


Fig. 1.13 Diagram of Myxophycean cell.

A typical cell of blue-green algae is composed of the following components:

1. Outer cellular covering.
2. Cytoplasm. 3. Nucleic material.

1. Outer Cellular Covering:

The outer covering of cell includes:

(a) Mucilaginous layer
(b) Cell wall and
(c) Innermost plasma membrane.

(a) Mucilaginous layer:

Mucilaginous sheath is the outermost layer covering the cell wall. In some cases the mucilaginous layer is very conspicuous and forms mucilaginous sheath but in others it may be inconspicuous. It protects the cell from the injurious factors of the environment.

(b) Cell wall:

Just below the mucilaginous layer is present cell wall. Electron microscopy has revealed that the cell wall is relatively complex structure. The cell wall is 2 or 3-layered and the inner layer lies in between outer wall layer and plasma membrane. The cell wall is formed of polysaccharides and mucopeptides.

(c) Plasma membrane:

The plasma membrane is selectively permeable living membrane enclosing the cytoplasm and is lipoproteinic in nature.

2. Cytoplasm:

Below the plasma membrane is seen the groundplasm which contains structures of different shapes and functions. In the peripheral region of cytoplasm are located lamellae which contain pigmemts. Fine structure study has made it clear that the pigmented lamellae are not organised into plastid. Lamellae or membranes are derived from plasma membrane.

The pigments in lamellae include chlorophylls, carotenes, xanthophylls, c-phycoerythrin and c-phycocyanin, the last two are characteristically found in blue-green algae only.

In addition to lamellae, several membrane bound vesicles may also be seen in the cytoplasm and they may sometimes be stacked in layers.

Besides, ribosomes may be found scattered in the groundplasm.

3. Nuclear Material:

The nucleoplasm or DNA containing region is centrally located in the cell and shows a fibrillar structure.

Nucleoplasm is feulgen- positive but is not organised into an electron micrograph of cell, nucleus, i.e., there is no nuclear boundary and no nucleolus.

During division the nucleoplasmic material dispersed throughout the cell divides into two and no spindle apparatus participates in this process.

REPRODUCTION IN CYANOBACTERIA

Reproduction in Cyanobacteria:

Cyanobacteria also reproduce asexually and the commonest mode of reproduction in them is transverse binary fission.

In addition, there are certain specialized structures such as akinetes,hormogonia, hormocysts and spores, which are partly involved in the process of reproduction.

1. Akinetes:

Most filamentous cyanobacteria develop perennating structures (dormant structures) in adverse condition. These structures are larger than the vegetative cells, are equipped with thick walls, and are called akinetes (Fig.). When favourable condi-tions return, they germinate and produce new filaments.

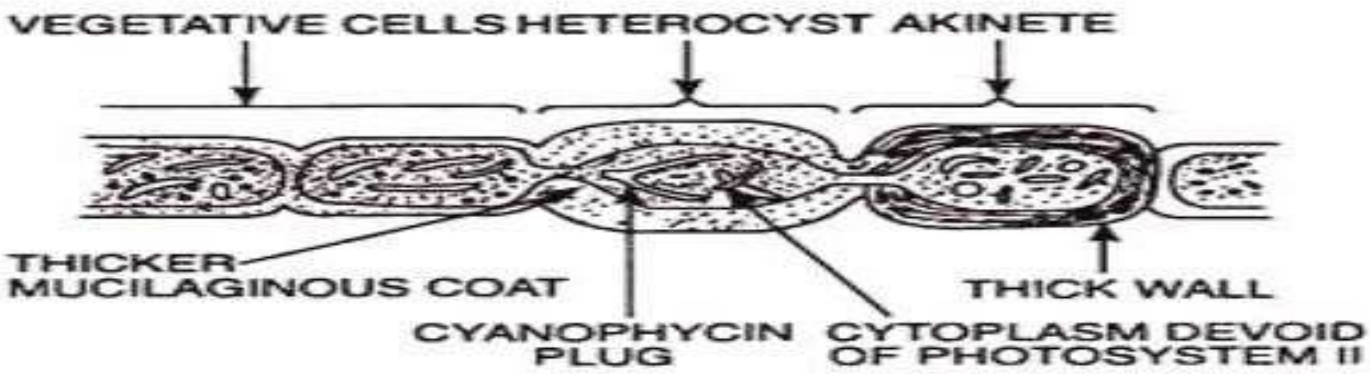


FIG. 6.12. Trichome of *Anabaena* possessing heterocyst and akinete.

2. Hormogonia:

All filamentous cyanobacteria reproduce by fragmentation of their filaments (trichomes) at more or less regular intervals to form short pieces each consisting of 5-15 cells.

These short pieces of filaments are called hormogonia.

The latter show gliding motility and develop into new full- fledged filaments.

3. Hormocysts:

Some cyanobacteria produce hormocysts, which are multicellular structures having a thick and massive sheath.

They may be intercalary or terminal in position and may germinate from either end or both the ends to give rise to the new filaments.

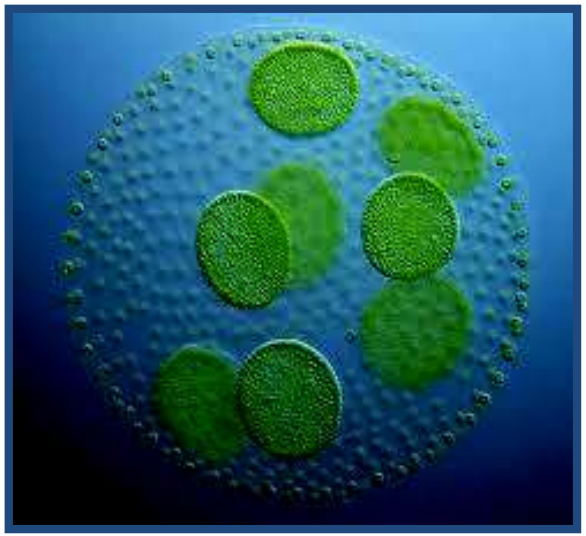
4. Spores:

Non-filamentous cyanobacteria generally produce spores such as endospores, exospores and nanocysts which contribute by germinating and giving rise to new vegetative cells when the unfavourable condition is over.

Endospores are produced endogenously like those in bacteria; exospores are the result to exogenous budding of cells, and the nanocysts are produced endogenously like endospores.

The difference between an endospore and a nanocyst is that in endospore formation the parent cell concomittantly enlarges in size, whereas in nanocyst formation there is no such enlargement of the cell.

BLUE GREEN ALGAE



Blue green algae found in almost every environment, from oceans to fresh water to bare rock to soil. They occur as plantonic cells or form phototrophic biofilm in marine environments, in damp soil, moistened rocks ,deserts

BLUE GREEN ALGAE AS COMPONENT OF INTEGRATED NUTRIENT MANAGEMENT

•Blue green algae are photosynthetic

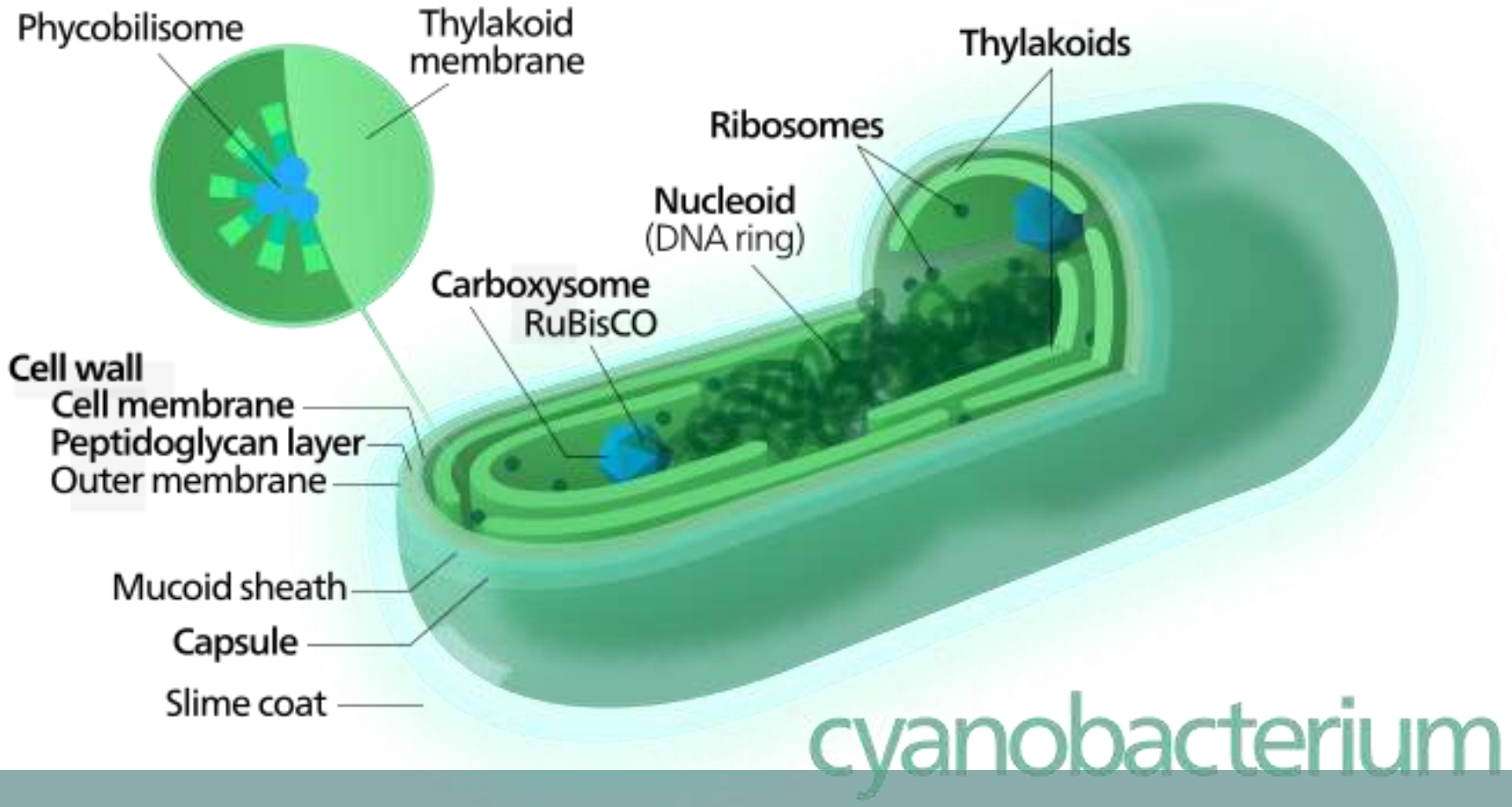
•Cyanobacteria promote the growth of lowland paddy by supplying nitrogen.

•BGA strains used for biofertilizer are *Anabaena variabilis* ,*Nostoc muscorum*, *Aulosira fertilissima* and *Tolypothrix tenuis.*

•BGA application @ 10 kg/ha one week after rice transplantation contribute 25 - 30 kg N/ha /season with a yield increase of 10-15 percent

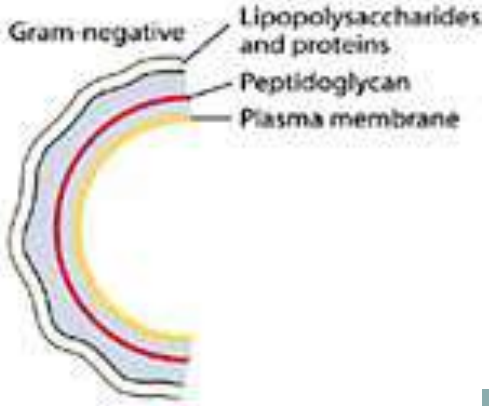
•Blue green algae excrete vitamins and hormones, which enhance rice growth. BGA also enhances soil fertility

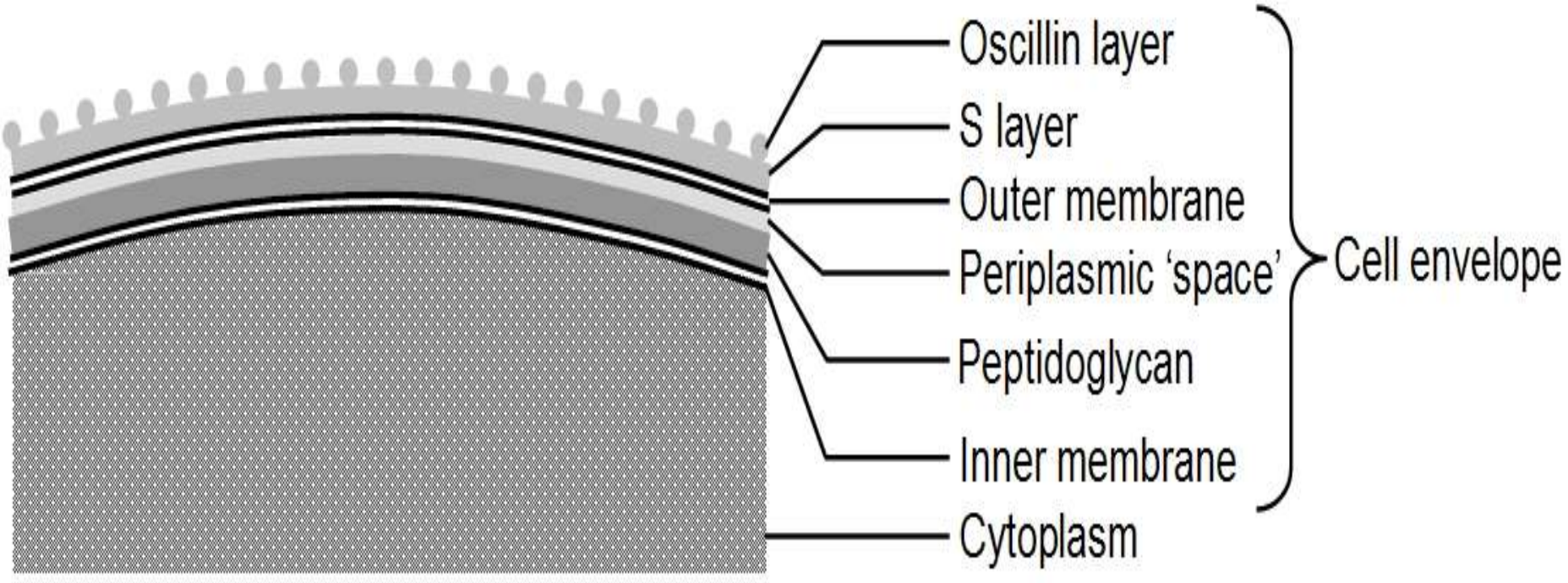
CYANOBACTERIA



Cyanobacteria- Gram Negative Bacteria

Gram positive- peptidoglycan layer; stains with crystal violet.
Gram negative- peptidoglycan layer sandwiched by lipopolysaccharide and protein layers; does not stain with crystal violet.





Structure of the Cyanobacterial Cell Envelope

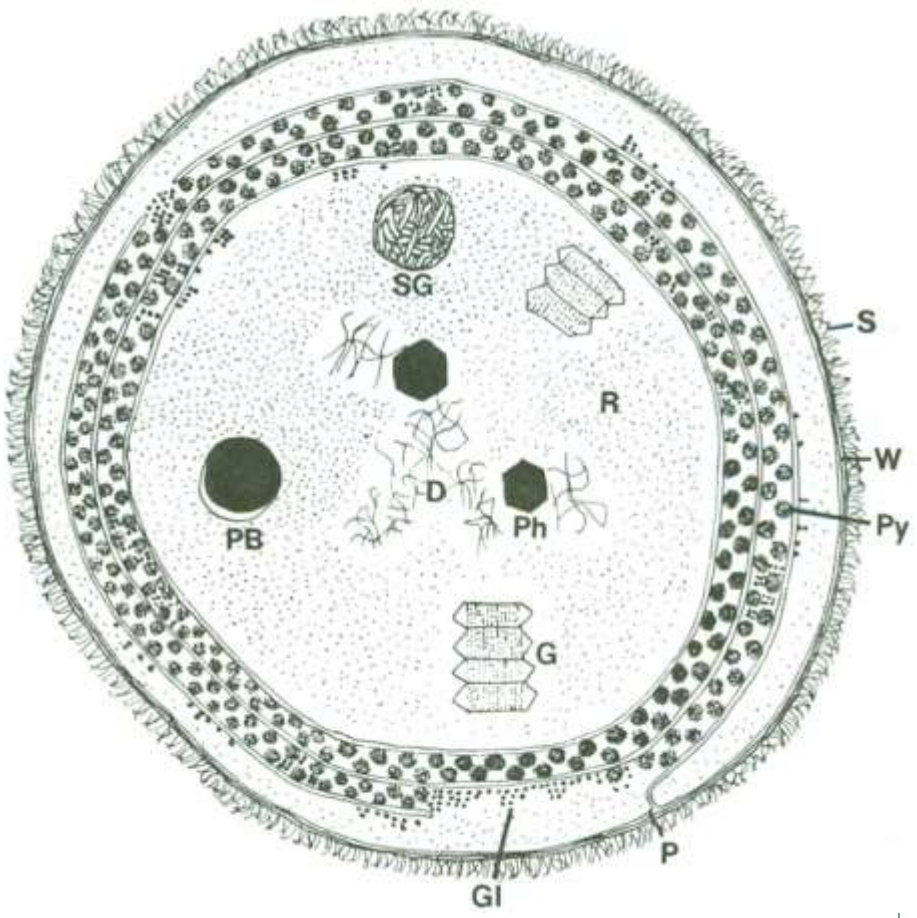
•Oscillin is a 646aa protein and appeared to be glycosylated. They appears to favors passive role in gliding movement.

• S layers are 2D glycoprotein function as protective coats and involve in adhesion.

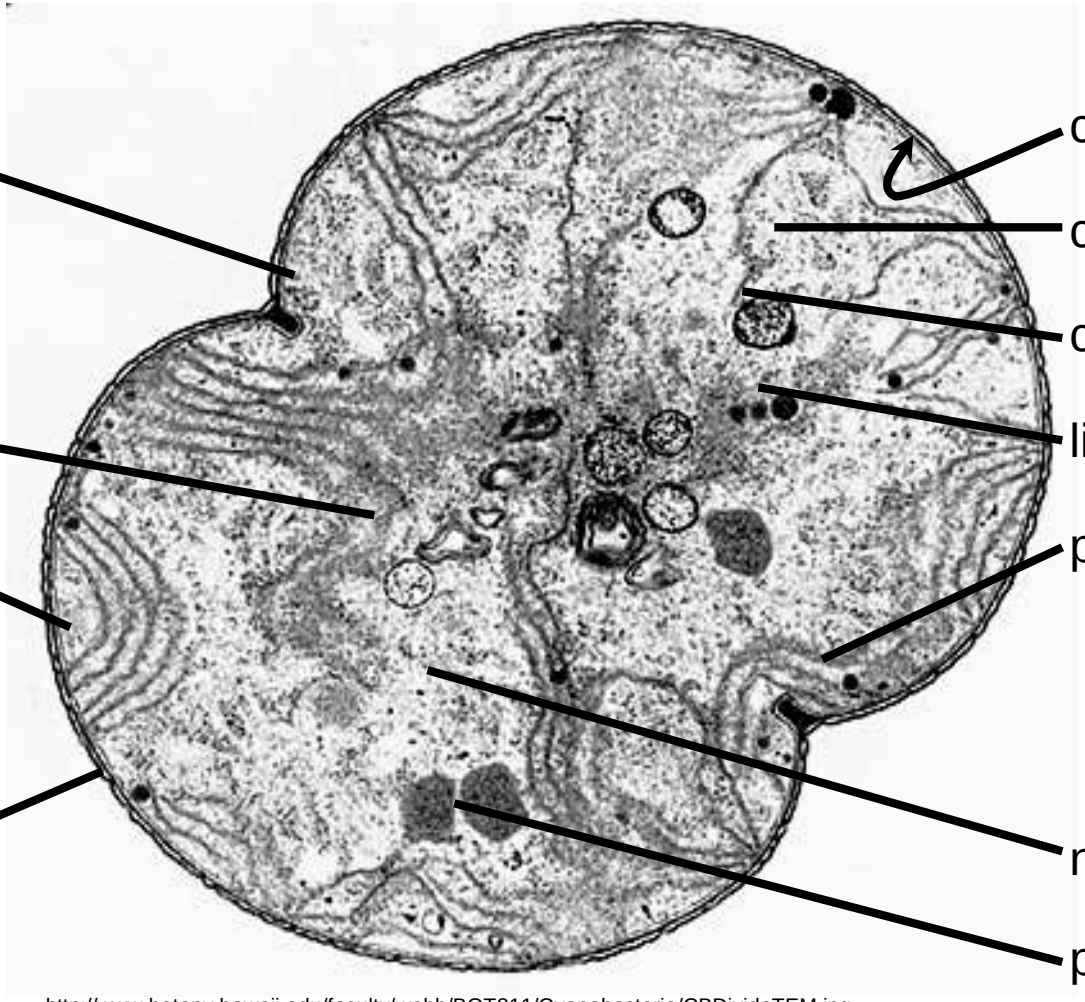
Cyanobacteria

Characteristics

Chlorophyll A
Phycobilisomes
Thylakoids occur singly
70s ribosomes
Polyhedral bodies
Gas vesicles
Habitat- ubiquitous.
Examples- Anabaena, Nostoc, Oscillatoria, Lyngbya, Synechococcus, Synechocystis.



Cyanobacterial Vegetative Cell (photosynthesis)



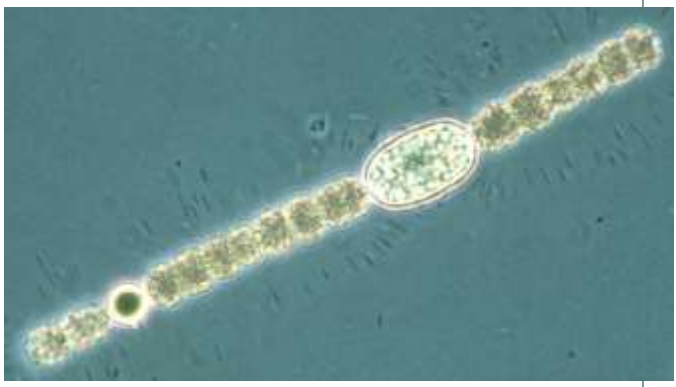
http://www.botany.hawaii.edu/faculty/webb/BOT311/Cyanobacteria/CBDivideTEM.jpg

Division by Binary Fission and Cytokinesis by Furrowing

Heterocyst

Heterocyst- a thick-walled large cell that fixes atmospheric nitrogen (diazotroph).

- Photosynthetically inactive.
- Their formation is directly related to nitrogen concentration.
- Microplasmodesmata- cytoplasmic connections that transfer metabolites and ammonium.



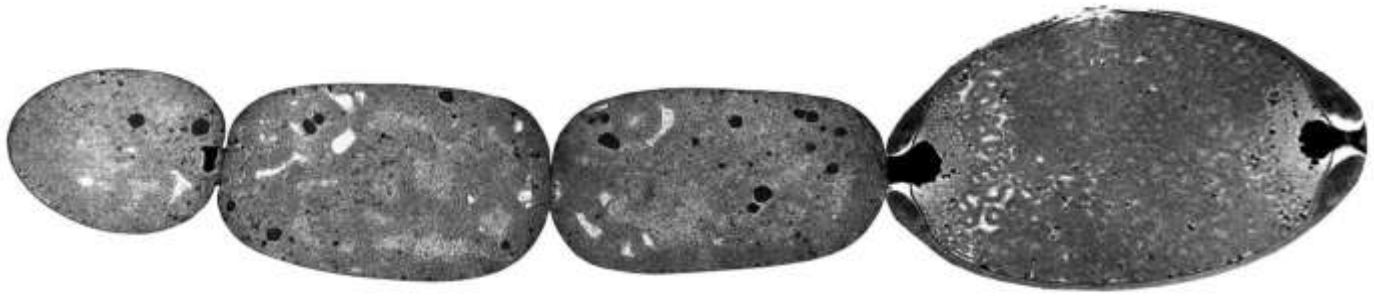
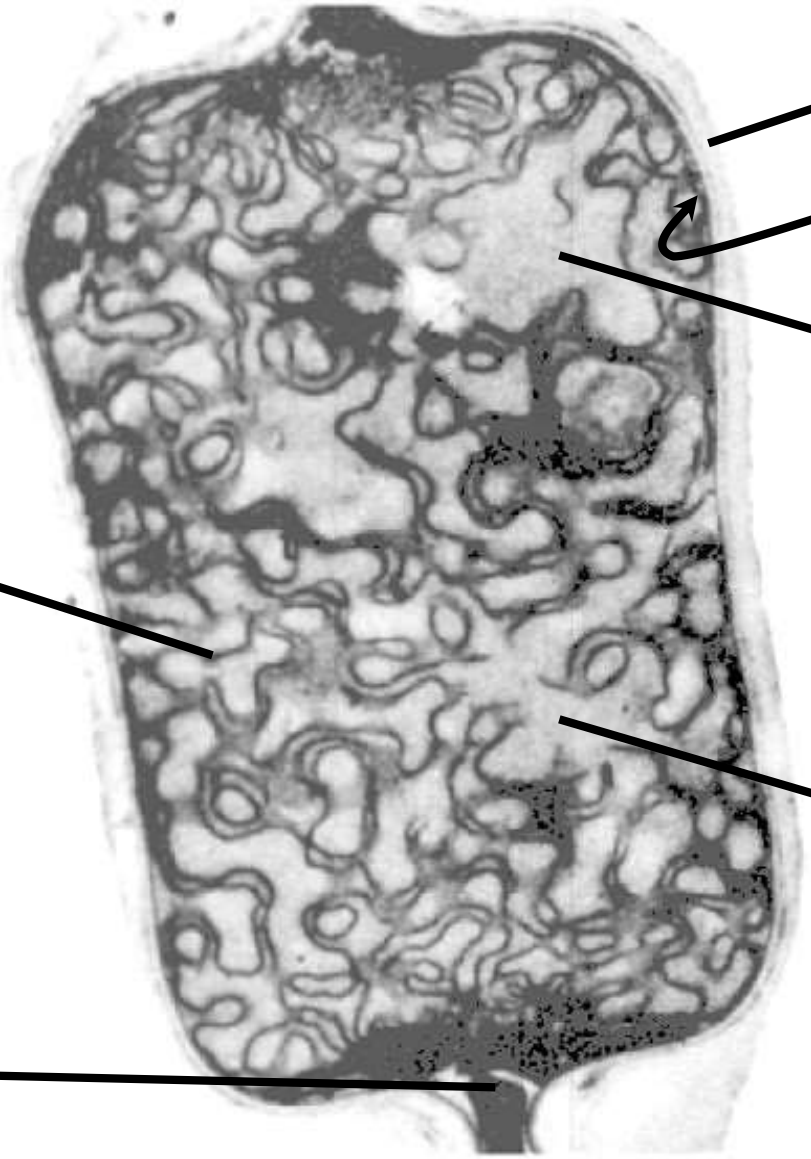


Figure 13-13a
Biology of Plants, Seventh Edition

Cyanobacterial Heterocyst (N_2 fixation)



cell wall **O_2 block**

cell membrane

nucleoid

mesosome

ETS for O_2 reduction

cytosol

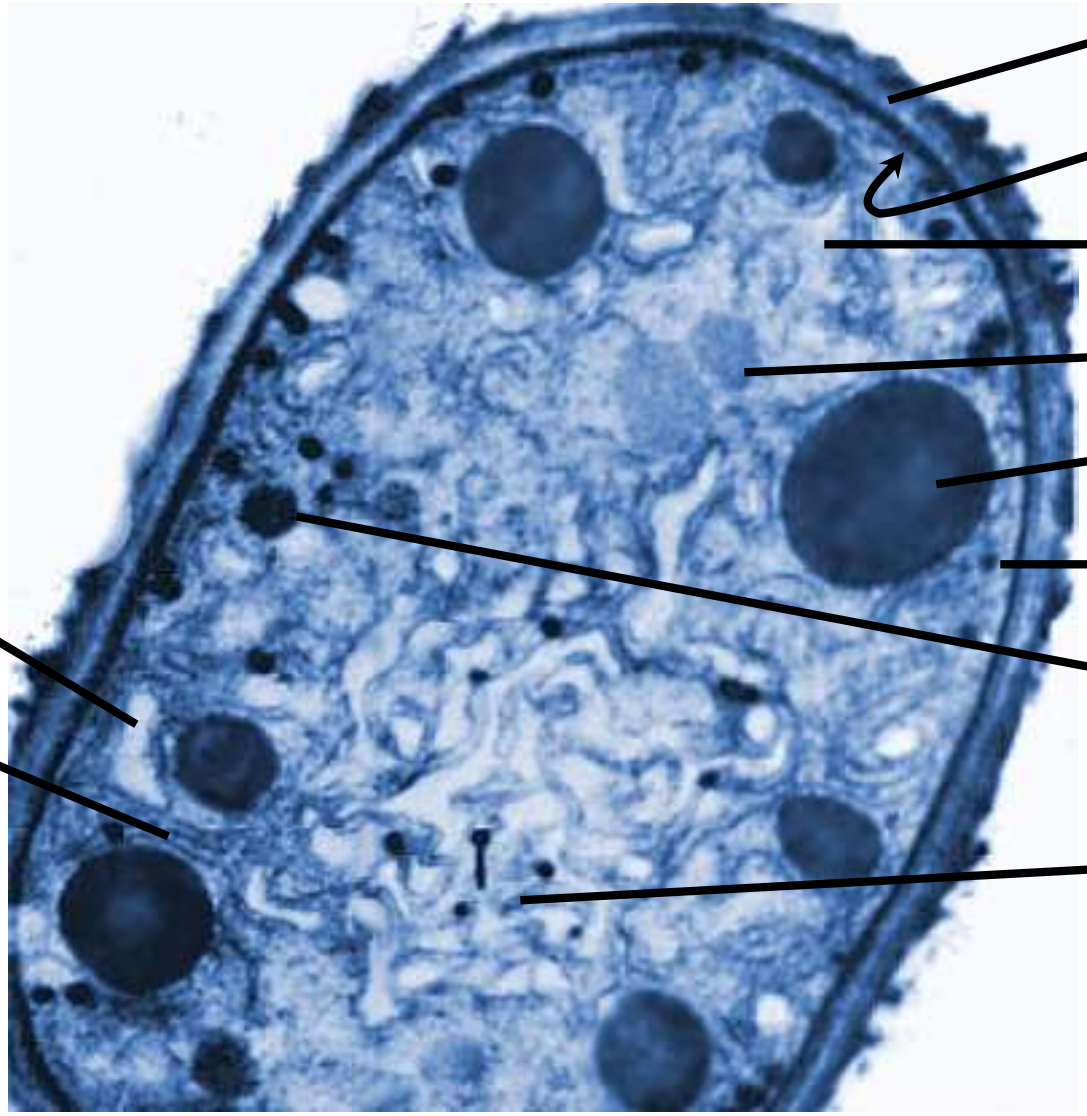
Nitrogenase reduces N_2 (requires anaerobic conditions)

pore in wall

fuel input for respiration

http://www.botany.hawaii.edu/faculty/webb/BOT311/Cyanobacteria/Heterocyst.jpg

Cyanobacterial Akinete (Dormant state)



http://www.botany.hawaii.edu/faculty/webb/BOT311/Cyanobacteria/AkineteEMBlue400.jpg

Asexual Reproduction

Endospores- internal division of the protoplast results in a mass of spores.
Fragmentation- filament breaks into 2 parts, each of which forms a new thallus.
Hormogonia- short sections of a trichome detach and form a new thallus.
Akinetes- resting spores; cells that are resistant to unfavorable conditions.
Binary Fission- division of a single-celled individual into two new single-celled individuals.

Bacteria	Cyanobacteria
1. Cells are comparatively small.	1. Cells are comparatively longer.
2. They may possess flagella.	2. They lack flagella.
3. They are both autotrophic and heterotrophic.	3. They are autotrophic.
4. They are anoxygenic photosynthetic.	4. They are oxygenic photosynthetic.
5. They may be aerobic and anaerobic.	5. They are always aerobic.
6. Reserve food is glycogen.	6. Reserve food is cyanophycean starch.