Phycology **Lecture 1** **By Dr. Zakaria Sami (2020-2021)**

Introduction

(General characters of algae)

The branch of science that deals with the study of algae is called **phycology**(or **algology**). The term phycology is derived from Greek words **PHYKOS** (=see weeds) & **LOGOS** (=discourse). The group includes lowly evolved plants with simple thalloid plant body. They are autotrphic (photosynthetic) & O_2 evolving chlorophyll bearing green plants. The group possesses plants with unicellular or sometimes multicellular sex organs not enclosed by sterile jackets (naked). The plants show wide differences in their morphology, composition of pigments, metabolic products & details of their life histories.

Distribution & Habitat

The group algae includes about 30000 species distributed all over the world. They occupy a wide variety of habitats from pole to pole & grow almost everywhere wherever they get suitable moisture & temperature conditions. Some authorities consider them as being ubiquitous & cosmopolitans .

They are predominantly aquatic occur both in **marine** as well as **fresh** water habitats. However some are **terrestrial** & grow in moist places. Some others grow in moist uncommon places. Depending upon the **habitats**, the algal members can be categorized under three broad categories

1. Aquatic habitats
2. Terretrial habitats
3. Special habitats

Aquatic habitats:

Forms of algae which occur as floating or submerged in water bodies. They grow in fresh-water aquatic habitats, such as ponds, tanks, rivers, streams, lakes, etc. as well as in marine habitats. Algae growing in aquatic habitats are further grouped as ----

(a) **Phytoplanktons**: The aquatic plants growing & covering the surface of water body whose powers of locomotion are insufficient to enable them to move against the water current. Thus, the planktons move on the mercy of water currents. Examples- *Diatoms*, *Chlorella*, *Chlamydomonas*, *Volvox*, *Scenedesmus*. Sometimes the color of water changes due to the color of plankton. It is called water bloom. Example- *Microcycstis* imparts dark blue- green color to the water surface. Redness of the red sea is due to luxuriant growth of *Trichodesmium erythraeum* , a member of blue green algae on the water surface of sea.

(b) **Benthos**: all the bottom dwelling organisms both plants & animals constitute benthos (the algae & other plants growing attached to the bottom of water reservoir [lake or ocean] are called benthos), example- *Chara* & *Nitella*. The forms which grow attached to the bottom soil or mud are called epipellic & those which grow attached to rock & stones are called epilithic.

Terrestrial habitats:

Some algae grow well in moist & well aerated soils. These may grow on the surface of soil, example, *Vaucheria*, *Botrydium*, etc., or below the soil surface. A well-known terrestrial alga grows on moist acid soils is *Fritchiella*. Some forms grow well in alkaline soils, example- *Oscillatoria*, *Phormidium*, *Scytonema*, *Nostoc*, etc.

Special abitats:

Some algae grow under very special environmental conditions & on special substratum. Examples of these are:

(i) Thermal algae (**Thermophytes**): Some algae grow in hot water springs with a temperature ranging between 70 to 85 ^{0}C, where ordinary plant life is impossible. Examples are members of blue green algae such as a few species of *Mastigocladus* & *phormidium*.

(ii) **Cryophytes**: such algae grow in the polar regions on <u>ice & snow</u>. Examples, are *Chlamydomonas* sp. & *Scottiella* sp. among green algae & *Nostoc* among blue green algae.

(iii) **Epiphytes**: Algae growing <u>on the surface of other plant parts</u> are called epiphytes. Examples- species of *Oedogonium*, *ulothrix*, etc., sometimes grow on other aquatic plants such as grasses, sedges, etc. Some algae such as *Trentepohlia*, *Rhodochytrium*, etc. grow on the <u>surface</u> <u>of</u> <u>angiospermous</u> <u>leaves</u> called <u>epiphyllophytes</u>. Some algae such as *Pleurococcus* sp. grow on <u>barks</u>, called <u>epiphloeophytes</u>.

(iv) **Endophytes**: Some algae grow <u>within the tissues of other plants</u>. Examples- *Nostoc* grows inside the *Anthoceros* thalli, *Anabaena* grows inside the *Azolla* (a pteridophytes), etc.

(v) **Epizoophytes**: Algae growing <u>on the bodies of animals</u> are called epipzoophytes. Example- *Lyngbya* on sponges, *Chladophora* on snails.

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(vii) **Symbiotic algae**: Some algae grow in symbiotic association with other plants. <u>Lichen</u> is the best example of symbiosis of an alga with a fungus. Blue green algae *Nostoc* & *Anabaena* grow in symbiotic association with coralloid root of *Cycas*, *Anthoceros* thallus & *Azolla* plants.

(viii) **Parasitic algae**: Some algae grow as <u>parasite on other plants</u>. The best example is a green alga- *Cephaleuros* , which causes red rust disease. *Cephaleuros virescens* causes red rust on the leaves of tea & *C. coffeae* causes red rust on the leaves of coffee. The example of parasite algae are- *Rhodochytrium* sp., *Ceratocolax*, *Choreonema* , etc.

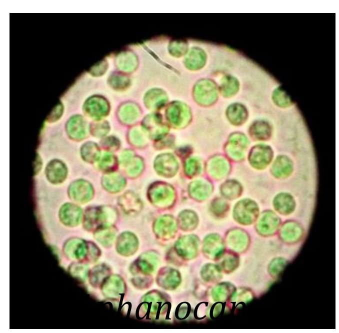
Range of thallus structure:

The plant body of algae is thalloid (not differentiated into true root, true stem & true leaves). The vegetative structure show a great variation of forms. The plants may be unicellular, small microscopic or very large & highly organized. There are two categories- <u>unicellular</u> & <u>multicellular</u>.

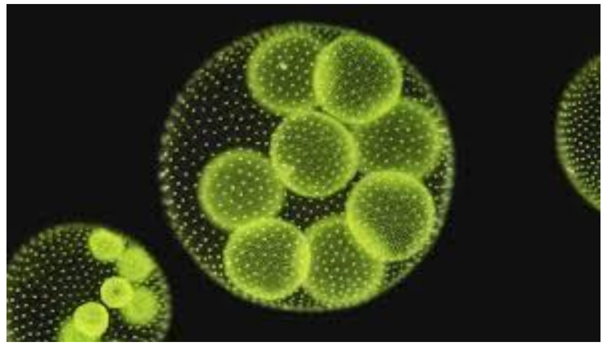
[A]. **Unicellular forms**: The plant body consists of a <u>single</u> cell. It is the simplest form among algae. The unicellular forms may be <u>motile</u> (flagellated) or <u>non- motile</u> (non- flagellated). Examples of motile unicellular forms are- *Chlamydomonas* (green algae), *Chlorochromonas* (Xanthophyta), & the non-motile unicellular forms are- *Anacystis*, *Chroococcus*, *Gloeocapsa* (blue green algae), *Porphyridium* (red alga), *Chlorella* (green alga). However, unicellular forms are not found in Phaeophyta.

[B]. **Multicellular forms**: As against unicellular plant body, a multicellular form is more advanced & highly evolved. A multicellular body <u>has many cells</u> which share the life activities of an organism & exhibit division of labour. Multicellular forms may be of following types:

(i) **<u>Palmelloid forms</u>**: It is a colonial form of algae where many cells constitute a plant body. Palmelloid forms are characterized by having <u>no definite or fixed number & size of cells</u>. Examples- *Aphanocapsa* (cyanophyta), *Tetraspora* (Chlorophyta), *Mischococcus* (Xanthophyta), *Asterocystis* (Rhodophyta), etc.

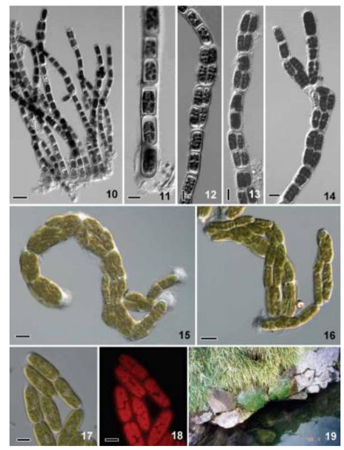


(ii) **Coenobial forms**: Coenobium is a multicellular colonial plant body with fixed number of cells arranged in a definite manner. It may be motile or non- motile. The best example of motile coenobium, where hundreds of cells surround a hollow space , is exhibited in *Volvox*. Example of non- motile coenobium is *Hydrodictyon* (green alga).



Volvox

(iii) **Dendroid forms**: It is a multicellular colonial form where the plant body appears as a microscopic tree. Example- *Ecballocystis* & *Ecballocytopsis*.



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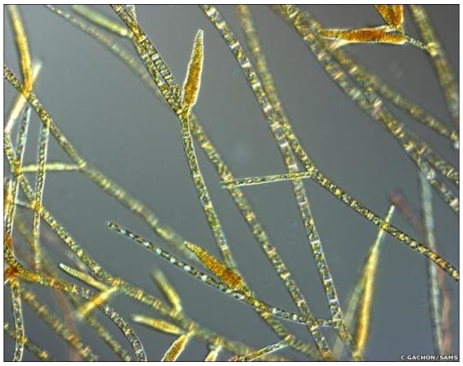
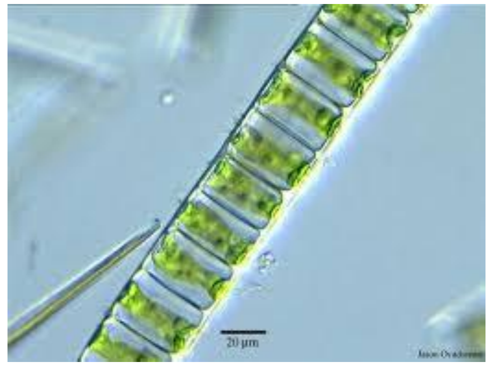
(v**) Filamentous forms**: Most of the algal thalli are multicellular & filamentous. A thread –like elongated thallus consisting of a linear uniseriate row of cells is called a trichome. When a trichome is surrounded by a sheath , it is called a filament. The filaments may be unbranched or branched.

Examples of unbranched filaments are- *Nostoc*, *Ulothrix*, *Spirogyra*, *Oedogonium*, etc. Examples of branched filaments are- *Bulbochaete* (Chlorophyta), *Ectocarpus* (Phaeophyta), *Polysiphonia* (Rhodophyta).



Ectocarpus



Ulothrix

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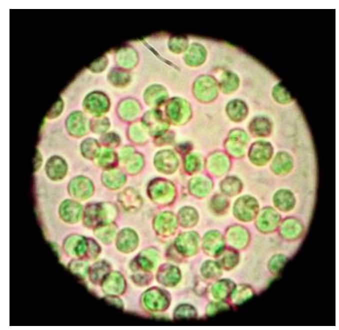

Aphanocapsa

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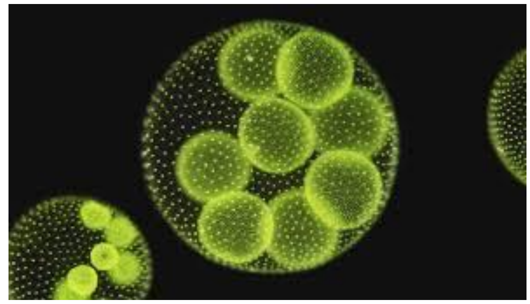

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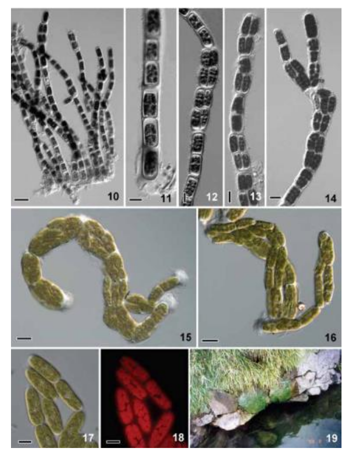

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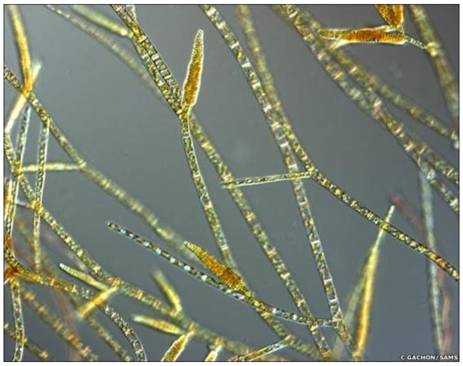
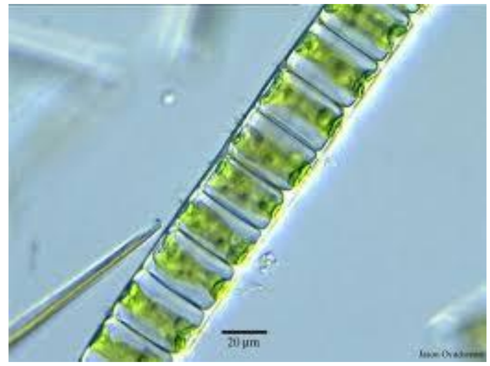


Ectocarpus



Ulothrix

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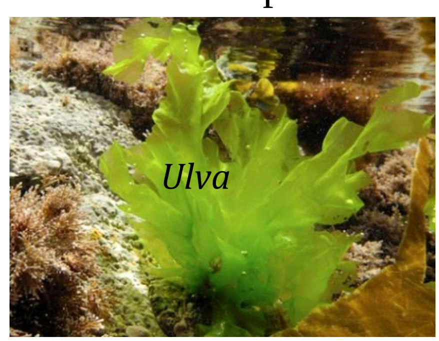


Examples- *Ulva* (Chlorophyta), *Laminaria* (Phaeophyta), *Porphyhra* (Rhodophyta).

Division: Cyanophyta

(also called Cyanobacteria or blue-green algae) are an ancient group of photosynthetic microbes that occur in most inland waters. They include about 2000 species in 150 genera, with a wide range of shapes and sizes.

Cyanobacteria are photosynthetic prokaryotes that capture sunlight for energy using chlorophyll a and various accessory pigments. They are common in lakes, ponds, springs, streams, and rivers, and they play a major role in the nitrogen, carbon, and oxygen dynamics of many aquatic environments. Cyanobacteria were formerly classified as blue-green algae because of their algal-like appearance, their possession of chlorophyll, and their photosynthetic production of oxygen by a two-photosystem process as in algae and higher plants.

Ultrastructural studies, however, clearly show that the Cyanobacteria are **prokaryotic**; that is, they lack nuclei and other organelles and they have a peptidoglycan cell wall that is typical of gram-negative Eubacteria. They also possess several features that set them apart from other bacteria, especially their photosynthetic apparatus and oxygen production.

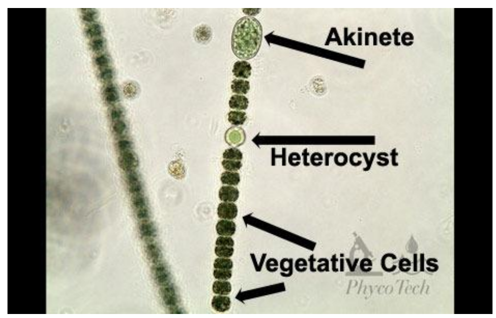
All cyanobacteria contain chlorophyll a and most contain the blue **phycobiliproteins phycocyanin** and **allophycocyanin**, giving the cells their characteristic blue-green color. Many taxa also contain the phycobiliprotein **phycoerythrin**, making the cells red, or sometimes black.

Although cyanobacteria lack membrane-bound organelles, they have a variety of **cellular structures** and inclusions that have specialized functions and that contribute to their ecological success.

The cells contain various **storage bodies**, including **glycogen** granules, which **store carbon**; **cyanophycin** granules, which are **nitrogen stores**; **carboxysomes** composed of ribulose 1,5-bisphosphate carboxylase/oxygenase, which act as a store of this photosynthetic enzyme as well as of nitrogen; and **polyphosphate** granules. These inclusions **allow cells to accumulate energy and nutrients** far in excess of their present requirements when they are under favorable conditions, and to subsequently use these reserves for maintenance and growth when they encounter resource-poor conditions.

The cells of several planktonic genera contain up to several thousand **gas vacuoles**, which are hollow, water impermeable cylinders **made up of protein subunits**. These fill with gases that diffuse in from the surrounding medium. They serve to regulate the buoyancy of the planktonic forms. In low light intensities , they are large & help to bring the alga at the surface, but in bright light they collapse so that the alga sinks to the bottom. Some authors believe that gas vacuoles help in respiration. Some species may undergo diurnal migration up and down the water column by **varying the amount of dense carbohydrate inclusions** that act as ballast in their cells.

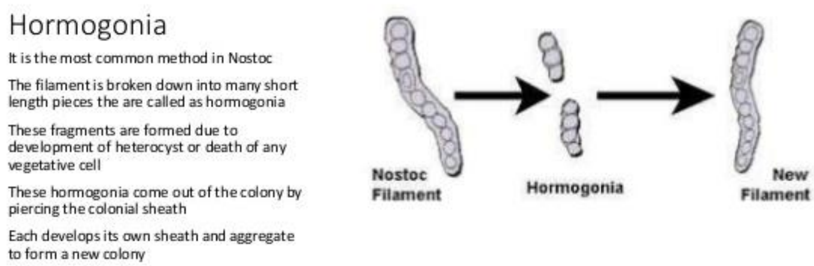
Many filamentous cyanobacteria produce different cell types that play specific physiological, reproductive, or ecological roles. The most well-known of these is the heterocyte (often called a heterocyst).



The heterocysts are usually large sized, rounded & thick walled cells which possess 1 or 2 polar nodules on the sides of attachment with vegetative cells. They may be terminal or intercalary in position. They formed by members of the orders Nostocales and Stigonematales. It is the location of the enzyme nitrogenase for nitrogen fixation (the conversion of nitrogen gas into ammonium and then amino acids).

Another specialized cell type is the akinete. An **akinete** is an enveloped, thick-walled, non-motile, dormant cell formed by filamentous, heterocyst-forming cyanobacteria. **Akinetes** are resistant to cold and desiccation.

Some genera such as *Nostoc* produce hormogonia, a motile series of cells formed for reproduction (example: *Nostoc*, *Oscillatoria*).



Risks of Cyanobacteria:

Cyanobacteria produce a variety of **compounds** that strongly **affect water quality**.

These include molecules that affect the taste and odor of water, notably **geosmin** (bicyclic alcohol, produced by the gram-positive bacteria *Streptomyces* and various cyanobacteria, and released when these microorganisms die) and **2-methylisoborneol**, both of which impart an **earthy or musty odor to the water**. An additional cyanobacterial group of compounds is **cyclocitrals** (volatile compound), which are **carotenoid breakdown products** that impart a **grassy odor to the water**.

Of greater concern to water resource managers is the **production of three classes of toxins**: **hepatotoxins**, which attack the liver;**neurotoxins**, which attack the nervous system; and **dermatotoxins**, which cause skin irritation. These toxins are especially produced by certain planktonic species ***Microcystis aeruginosa***, a bloom-forming species that is common in eutrophic lakes and reservoirs throughout the world, **produces microcystin**, a cyclic peptide that is a **hepatotoxin**. Two other bloom-forming genera ***Anabaena*** and ***Aphanizomenon*** often occur in association with *Microcystis* and produce the **alkaloid neurotoxin anatoxin**. ***Cylindrospermopsis***, a filamentous cyanobacteria, known for its blooms in eutrophic waters, contains the potent **hepatotoxin cylindrospermopsin**, also an alkaloid. Several benthic species produce **anatoxins** as well as the **dermatotoxins lyngbyatoxin** and **aplysiatoxins**. Cyanobacterial toxins have been implicated in the death of animals, including birds, farm stock, dogs, and a small number of humans. **The toxins are water-soluble and are not destroyed by boiling the water prior to drinking.**

Importance of Cyanobacteria:

Beside the ability of Cyanobacteria to produce oxygen photosynthetically & fixation of nitrogen, they synthesize a vast array of novel secondary metabolites including biologically active compounds with **antibacterial**, **antiviral**, **antifungal**, and **anticancer** activities.

Cell wall and gliding

Cyanophyta do not possess flagellated motile cells, yet a few forms show a gliding movement.

The cell wall of cyanobacteria is basically the same as the cell wall of Gram-negative bacteria. A **peptidoglycan layer** is outside of the **cell membrane**. Outside of the peptidoglycan is a **periplasmic space**. An **outer membrane** surrounds the periplasmic space (figure below).

Gliding is a slow motion in a solid substrate at a direction parallel to the long axis of the cell and is occasionally interrupted by reversals in direction. Gliding is accompanied by a steady secretion of slime, which is left behind as a mucilaginous trail. Some cyanobacteria (*Phormidium*, *Oscillatoria*) rotate during gliding while other cyanobacteria (*Anabaena*) do not rotate.

The cell wall of gliding bacteria has two additional layers outside of the cell wall. A **serrated external layer (S-layer)** and a layer of **fibers** composed of a glycoprotein called **oscillin.** The cross walls of neighboring cells of gliding cyanobacteria contain **junctional pores** that are 15 nm in diameter and radiate outward from the cytoplasm at an angle of about 30–40° relative to the plane of each septum (Figure below). The junctional pore spans the entire multilayered cell wall.

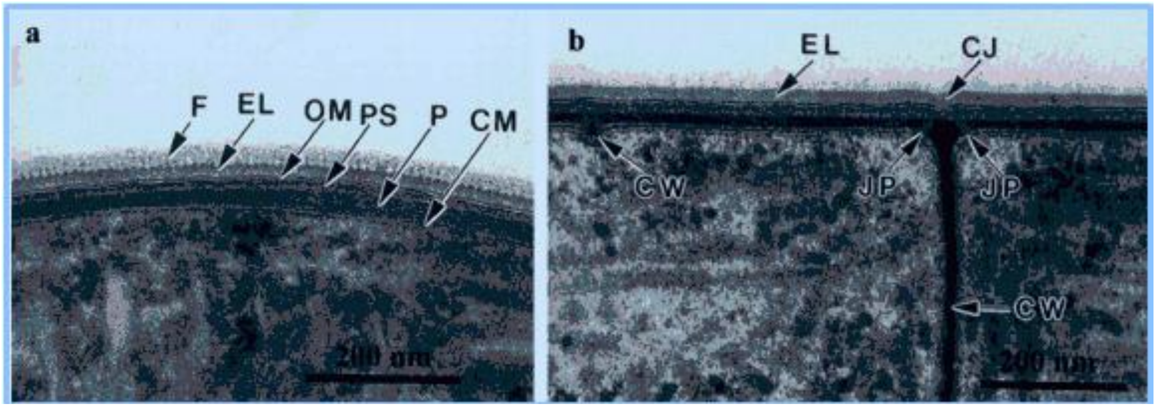
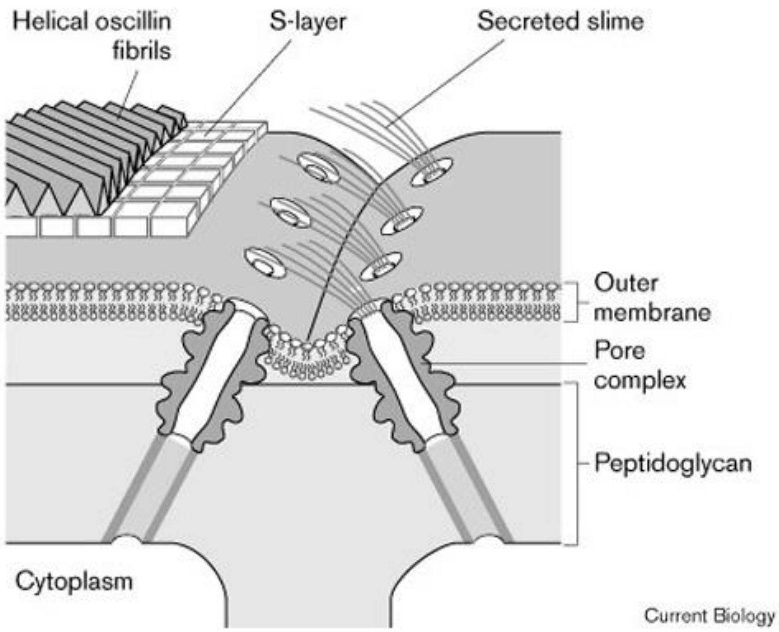


Fig. 2.1 Transmission electron micrographs of sections of the wall of the cyanobacterium *Phormidium uncinatum*. The cell wall (CW) contains layers similar to those of a Gram-negative bacterium, e.g., the cytoplasmic membrane (CM), peptidoglycan layers (P), periplasmic space (PS) and outer membrane (OM). In addition, the cyanobacterium contains the additional two external layers typical of a motile cell, the serrated external layer (EL) and hair-like fibers (F). (CJ) Circumferential junction; (JP) junctional pore. (From Hoiczyk and Baumeister, 1995.)

Gliding occurs by slime secretion through the circumferential junctional pores on one side of the septum. The slime passes along the surface of the oscillin fibers of the outer layer of the cell wall and onto the adjacent substrate, propelling the filament forward. The orientation of the oscillin fibers of the outer layer determines whether the filament rotates during gliding. In *Anabaena*, the spiral oscillin fibers produce a clockwise rotation while in *Oscillatoria princeps* and *Lyngbya aeruginosa* the oscillin fibers are spiraled in the opposite direction and produce acounterclockwise rotation during gliding. In *Phormidium*, the oscillin fibers are not spiraled and the filament does not rotate during gliding.



Reversal of gliding occurs when slime stops coming out of the ring of junctional pores on one side of the septum, and when slime begins coming out of the ring of junctional pores on the other side of the septum.

Symbiosis

Because of their ability to fix nitrogen, heterocystous cyanobacteria develop symbiotic relationships with a variety of eukaryotic plant species such as algae, liverworts, and ferns. Also, several cyanobacterial species develop symbiotic relationships with fungi to constitute the lichens.

Examples of Cyanobacteria

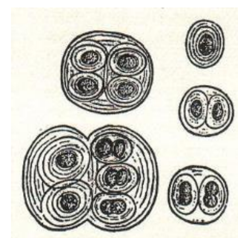
Division: Cyanophyta

Class: Cyanophyceae

Order: Chroococcales

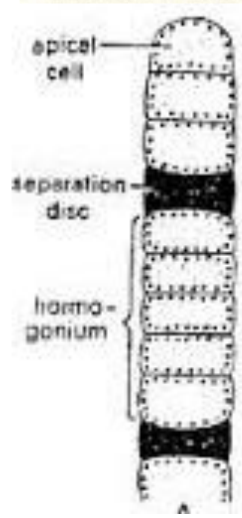
Genus**: *Gloeocpsa***

Non-motile, either single or clustered cells enclosed in concentric layers of mucilage. The cells secrete individual gelatinous sheaths which can often be seen as sheaths around recently divided cells within outer sheaths.



Order: Oscillatoriales

Genus**:*Oscillatoria***



Oscillatoria, a fresh water blue green alga, is represented by 76 species. The alga grows abundantly in dirty stagnant & polluted water channels forming blackish blue green masses.

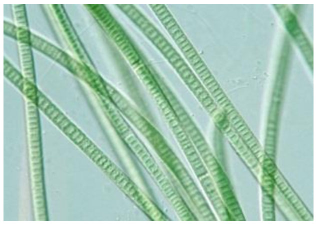
Forms long, unbranch filaments of cells, each filament of *oscillatoria* consists of trichome without sheath & made up of rows of cells.

In most of the species the cells are shorter than wide.

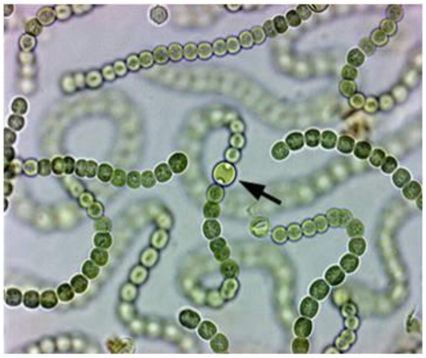
Growth of trichome is intercalary & occurs by cell division. The cells divide only in one direction so that the trichome elongates in the longitidunal axis.

Oscillatoria reproduces by **fragmentation**. Oscillatoria forms long filaments of cells which can break into fragments called hormogonia. The hommgonia can grow into a new, longer **filament**.

Breaks in the **filament** usually occur where dead cells (necridia or separating disc) are present.



The cells are broader than in their length. Apical cells is rounded or aciculate**.** Filament can break into fragments called hormogonia. The hormogonia can grow into a new, longer filament. Breaks in the filament usually occur where dead cells (necridia or separating discs) are present. Each hormogonium consist of one or more cells and grow into a filament by cell division in one direction.



Order: Nostocales

Genus: ***Nostoc***

It is widely distributed in alkaline soils, moist rocks, water ponds, streams & lakes.

Nostoc colony forms a Jelly- like mass. Colonies contain many of helical filaments. Trichome is unbranched and it appears bead- like structure. It consist of many rounded cells which are arranged in a chain like manner. All the cells are similar. The whole filament is covered by a gelatinous sheath.

Heterocysts are large sized, colourless, spherical, thick walled cells present between the vegetative cells helps in nitrogen fixation, vegetative reproduction (point of breakage), stimulate production of akinetes & serves as storage organs.

Anabaena:

Order: Nostocales

Many species have been reported to grow abundantly in rice fields & enrich the soil with nitrogen fertilizer by atmospheric nitrogen fixation(example: *A. cylindrical*). Some species grow in close symbiotic association with other plants such as *Azolla* (example: *A. azollae*).

The plant body is multicellular, unbranched & filamentous. The filaments either singly or in groups forming irregular thalli. The individual filaments are either straight or curved with indistinct or without a mucilaginous sheath. The gelatinous sheath , if present, is diffluent & never imparts a definite shape to the colony.

Each filament is uniformly broad throughout consisting of cylindrical, rectangular, spherical or short barrel-shaped cells.

The heterocysts are usually intercalary & located at regular intervals throughout the entire length of filament, in some species the heterocysts are both terminal & intercalary. The akinetes occur singly or in long chains either near the heterocysts or in between the heterocysts. The akinetes are cylindrical, oval, or subspherical in shape& usually produced when alga grows in nitrogen-deficient medium.

The alga reproduce by formation of hormogonia, akinete, heterocysts or endospores.

Order: Scytonematales

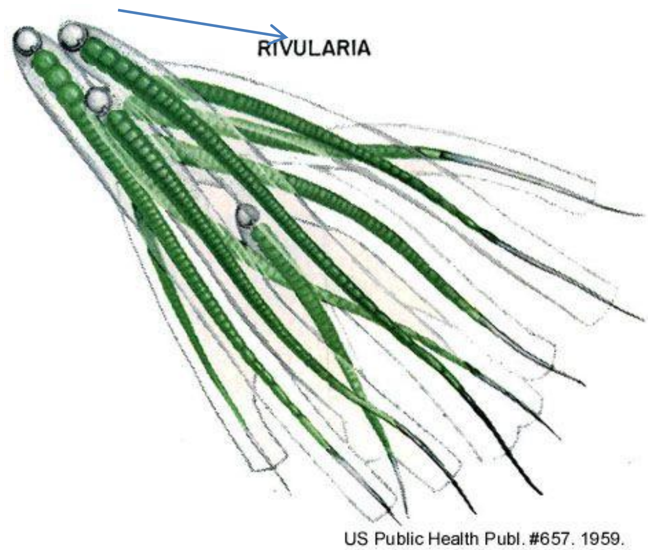
Genus: ***Rivularia***

Growing on submerged stones, moist rocks, and damp soils near the riverside. The genus is colonial & forms large, mucilaginous colonies. The colonies are spherical, hemispherical or irregulary. Each colony contains a large number of radially arrange, whip-like filaments.

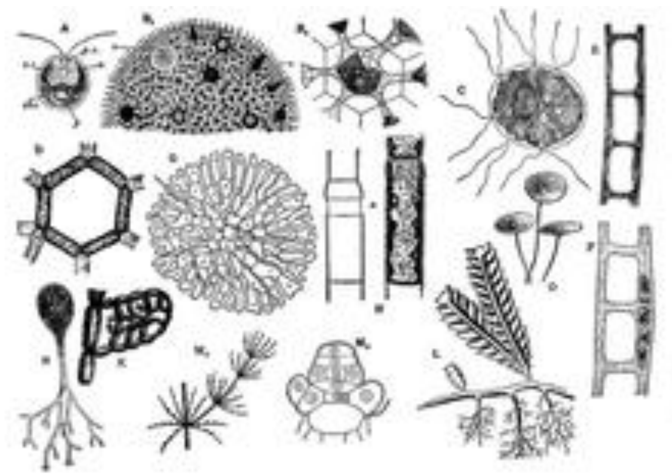
The filaments are usually unbranched but sometimes exhibit false branching. Each filament is uniseriate, broad at the base & gradually tapers towards its distal end which is whip- or tail-like consisting of a row of small cells (like hair).

The trichomes have a **basal** heterocyst**.** Akinetes are absent. The species multiply with the aid of hormogonia.

Heterocyst



Chlorophyta: Class, Important Features and Orders



Chlorophyta

Scientific classification

Domain: Eukaryota
(unranked): Diaphoretickes
(unranked): Archaeplastida
(unranked): Viridiplantae

Class: Chlorophyceae:

The class Chlorophyceae is commonly called as green algae. Chlorophyceae is very large group of algae and is represented by about 429 genera and 6500 species. Chlorophyceae are mainly fresh water algae (about 90 percent species are fresh water and 10 percent marine). Fresh water forms are common in ponds, pools, lakes, ditches, water tanks, and in river and canals.

Majority of Volvocales, Chlorococcales are planktonic forms.

Many Chaetophorales e.g., Coleochaete, Protococcus. Trentepohlia are epiphytic algae.

Many species of Cladophora and Characium are epizoic algae.

Some green algae like Trebouxia, Chlorella form symbiotic association ship with animals like Zoo chlorella and Hydra.

Some green algae form symbiotic association with fungi to form lichens.

Cephaleuros is parasitic algae on leaves of tea, coffee, piper and magnolia plants. Cephaleuros causes red rust of tea.

Chlamydomonas nivalis causes red snow and Chlamydomanas yellowstonensis causes green snow. Some Chlamydomonas species are thermophilic.

The range of thallus structure of Chlorophyceae is as follows:

(i) Unicellular motile forms—e.g., Chlamydomonas.

(ii) Unicellular non-motile forms—e.g., Chlorella.

(iii) Colonial motile form—e.g., Volvox, Eudorina, Pandorina.

(iv) Colonial coccoid forms—e.g., Hydrodictyon, Pediastrum.

(v) Palmelloid forms—e.g., Tetraspora.

(vi) Dendroid forms—e.g., Prasinocladus.

(vii) Un-branched filaments—e.g., Ulothrix, Oedogonium.

(viii) Branched filaments—e.g., Cladophora.

(ix) Heterotrichous forms—e.g., Coleochaete.

(x) Siphonaceous forms—e.g. ***Codium***

(xi) Parenchymatous forms—e.g., Ulva, Codium, Enteromorpha.

Important Features:

(i) The cells are eukaryotic and contain mitochondria, Golgi bodies, plastids, endoplasmic reticulum and ribosomes.

(ii) The cell wall is made of two layers, the inner layer mainly consisting of cellulose and the outer layer consisting of pectic substances.

(iii) The chloroplasts are well organized, the main pigments are chlorophyll a and b, the other pigments are α and β carotene and xanthophyll's.

(iv) The shape of the chloroplast is variable. It may be cup shaped e.g., Chlamydomonas, girdle shaped e.g., Ulothrix, reticulate e.g., Cladophora, stellate e.g., Zygonema, spiral e.g., Spirogyra, discoid e.g., Chara or parietal e.g., Draparnaldiopsis.

(v) The reserve food is in form of starch and its formation is associated with pyrenoids.

(vi) The motile reproductive structures i.e., zoospores and gametes have 2, 4 flagella which can be apical, sub apical, equal in size and acronematic type.

(vii) The sexual reproduction can be isogamous, anisogamous or oogamous.

Classification:

Characteristics used for the classification of Chlorophyta are: type of zoid, mitosis (karyokynesis), cytokinesis, organization level, life cycle, type of gametes, cell wall polysaccharides and more recently genetic dat

Smith (1955) divided division Chlorophyta into two classes—Chlorophyceae and Charophyceae.

The Chlorophyceae was divided in ten orders and Charophyceae has only single order:

Division. Chlorophyta

I. Class. Chlorophyceae

Orders:

I. Volvocales The thallus may be unicellular e.g., Chlamydomonas or motile colony e.g., Volvox, Eudorina and Pandorina.

The members are characterized by presence of flagellated motile vegetative cells. The flagella can be two or four, equal, apical and acronematic. The cells have large cup shaped chloroplast with single pyrenoid covered with starch plate.

2. Tetrasporales an order of green algae having vegetative cells that are immobile but capable of changing temporarily into a motile stage and that form colonies that are not filamentous and are often amorphous

3. Ulotrichales an order of green algae that includes the family Ulotrichaceae and in some classifications also Ulvaceae and that comprises freshwater or marine forms having a multicellular thallus with usually simple or branched filaments sometimes aggregated to form pseudoparenchymatous masses or sheets, asexual reproduction effected by zoospores, and sexual reproduction by fusion of isogametes or of differentiated egg and sperm cells

4. Oedogoniales have a highly specialized type of oogamy, and an elaborate method of cell division which results in the accumulation of apical caps. The **order** comprises one family, Oedogoniaceae, with three genera.

5. Ulvales sea-lettuce family; Ulvaceae (thin flat or tubular green algae) Plants are usually tubular or parenchymatous thalloid, capillary to broad, occasionally reduced to one or two rows of cells; attached or becoming free-floating; one or two cells in thickness. Cells possess one or two large lateral chromatophores with pyrenoids and single nucleus. Sexual and asexual plants are morphologically indistinguishable exhibiting isomorphic alternation of generaions.

6. Schizogoniales a monotypic order of green algae (class Chlorophyceae) having a filamentous, flat and expanded, or solid cylindrical body made of uninucleate cells with single stellate chloroplasts .

7. Chlorococcales distinguished from other similar forms in not dividing vegetatively but reproducing only by spores.

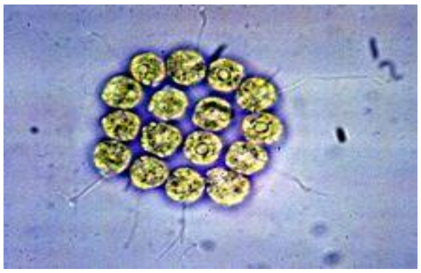
8. Siphonales filaments consist essentially of a large multinucleate cell with cross walls rare and usually only adjacent to reproductive organs — compare codium , siphonocladales

9. Siphonocladales originally including all multinucleate members of the class capable of vegetative division but now usually restricted to those that are apparently derived from the Siphonales and are nonseptate when young (as in the families Valoniaceae and Dasycladaceae)

10. Zygnematales. are distinguished by the absence of asexual reproduction and lack of flagellated reproductive structure, and reproduce sexually by fusion of amoeboid gametes

— compare akontae _also called the **Conjugatales**, . Here filaments of opposite gender line up, and tubes form between corresponding cells. The male cells then become amoeboid and crawl across, or sometimes both cells crawl into the tube. The cells then meet and fuse to form a zygote, which later undergoes meiosis to produce new filaments.

Volvocaceae

Volvocaceae	
	
Gonium pectorale	
Scientific classification	
(unranked):	Viridiplantae
Class:	Chlorophyceae
Order:	Chlamydomonad
Family:	**Volvocaceae**

The **Volvocaceae** are a family of unicellular or colonial biflagellates, including the typical genus Volvox. The family was named by Ehrenberg in 1834, and is known in older classifications as the Volvocidae. All species are colonial and inhabit freshwater environments.

Description

The simplest of the Volvocaeans are ordered assemblies of cells, each similar to the related unicellar protist Chlamydomonas and embedded in a gelatinous matrix. In the genus Gonium, for example, each individual organism is a flat plate consisting of 4 to 16 separate cells, each with two flagella. Similarly, the genera Eudorina and Pandorina form hollow spheres, the former consisting of 16 cells, the latter of 32 to 64 cells. In these genera each cell can reproduce a new organism by mitosis.ss

Volvox sp.

Other genera of Volvocaceans represent another principle of biological development as each organism develops differented cell types. In Pleodorina and Volvox, most cells are somatic and only a few are reproductive. In Pleodorina californica a colony normally has either 128 or 64 cells, of which those in the anterior region have only a somatic function, while those in the posterior region can reproduce; the ratio being 3:5. In *Volvox* only very few cells are able to reproduce new individuals, and in some species of *Volvox* the reproductive cells are derived from cells looking and behaving like somatic cells. In V. carteri, on the other hand, the division of labor is complete with reproductive cells being set aside during cell division, and they never assume somatic functions or develop functional flagella[

Thus, the simplest Volvocaceans are colonial organisms but others are truly multicellular organisms. Larger volvocaceans have evolved a specialized form of heterogamy called oogamy, the production of small motile sperm by one mating type and relatively larger immotile eggs by another. Among the Volvocaceans are thus the simplest organisms with distinguishable male and female members. In all Volvocaceans, the fertilization reaction results in the production of a dormant diploid zygote (zygospore) capable of surviving in harsh environments. Once conditions have improved the zygospore germinates and undergoes meiosis to produce haploid offspring of both mating types.

Genera	Number of cells in an asexual coenobium	Cell types	Sexual reproduction
Pandorina	8 or 16	All cells reproductive	Isogamous
Volvulina	8 or 16	The same	The same
Yamagishiella	16 or 32	"	"
Eudorina	16 or 32	All cells reproductive, except *E. illinoisensis*, in which four anterior cells are facultative somatic	Anisogamous, with antheridial packets
Platydorina	16 or 32	All cells reproductive	The same
Pleodorina	32, 64 or 128	In the anterior part of coenobium obligate somatic cells and in the posterior part, reproductive	"
Volvox	200, 500 and more (up to 50000)	The overwhelming majority of cells obligate somatic; a small number of reproductive cells in the	Oogamous, with antheridial pac in some species, sexual develop

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Family :

Zygnemataceae

Scientific classification	
Kingdom:	Plantae
Division:	Charophyta
(unranked):	Phragmoplastophyta
Class:	Zygnematophyceae
Order:	**Zygnematales**

Family

- Zygnemataceae

The **Zygnematales** (Greek: ζυγός (*zygós*) and νῆμα (*nếma*) (nom.), νήματος (*nḗmatos*) (gen.)), also called the **Conjugatales**, are an order of green algae, comprising several thousand different species in two families. The larger family

Zygnemataceae, with well-known genera such as *Zygnema* and Spirogyra, includes members that grow as unbranched filaments, which grow longer through normal cell division. This group includes the desmids. Most members of both families live in freshwater, and form an important component of the algal scum that grows on or near plants, rocks, and various debris.

Sexual reproduction in Zygnematales takes place through a process called conjugation. Here filaments of opposite gender line up, and tubes form between corresponding cells. The male cells then become amoeboid and crawl across, or sometimes both cells crawl into the tube. The cells then meet and fuse to form a zygote, which later undergoes meiosis to produce new filaments. As in plants, only the female passes chloroplasts on to the offspring.

Other conjugating algae are the Mesotaeniaceae, sister of the Zygnematales, and spirotaenia, a basal green algae. Additionally, the Desmidiales appear to have emerged deep within the Zygnematales, and are also conjugating.

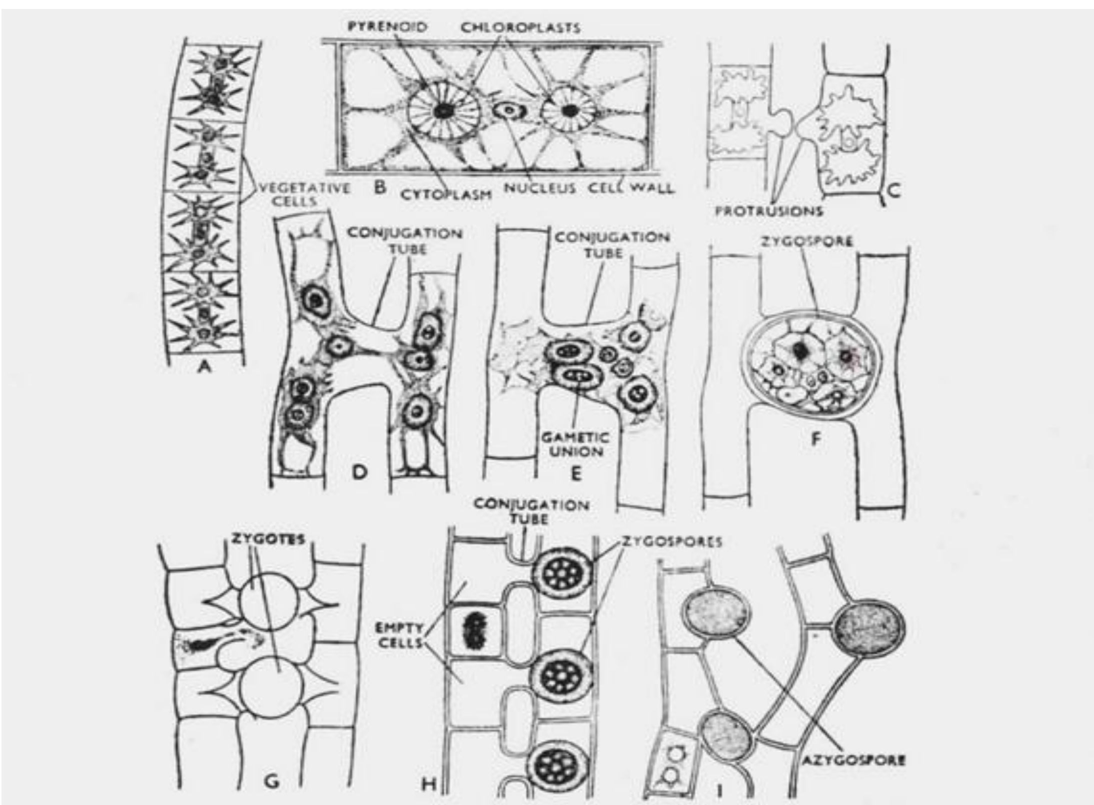
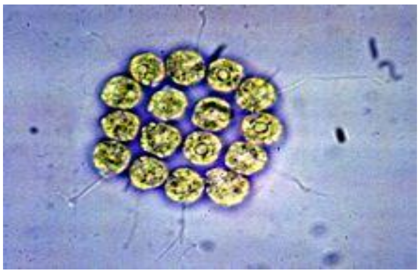


Fig. 77. *Zygnema* sp. A. Portion of a vegetative filament. B. Details of cell structure. C–I. Successive stages of scalariform and lateral conjugation.

Volvocaceae
د. مي طه حامد

Volvocaceae	
	
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Order:	Chlamydomonadales
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Thus, the simplest Volvocaceans are colonial organisms but others are truly multicellular organisms. Larger volvocaceans have evolved a specialized form of heterogamy called oogamy, the production of small motile sperm by one mating type and relatively larger immotile eggs by another. Among the Volvocaceans are thus the simplest organisms with distinguishable male and female members. In all Volvocaceans, the fertilization reaction results in the production of a dormant diploid zygote (zygospore) capable of surviving in harsh environments. Once conditions have improved the zygospore germinates and undergoes meiosis to produce haploid offspring of both mating types.

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Family : **Zygnemataceae**

Scientific classification	
Kingdom:	Plantae
Division:	Charophyta
(unranked):	Phragmoplastophyta
Class:	Zygnematophyceae
Order:	**Zygnematales**

Family

- Zygnemataceae

The **Zygnematales** (Greek: ζυγός (*zygós*) and νῆμα (*nḗma*) (nom.), νήματος (*nḗmatos*) (gen.)), also called the **Conjugatales**, are an order of green algae, comprising several thousand different species in two families. The larger family Zygnemataceae, with well-known genera such as *Zygnema* and *Spirogyra*, includes members that grow as unbranched filaments, which grow longer through normal cell division. This group includes the desmids. Most members of both families live in freshwater, and form an important component of the algal scum that grows on or near plants, rocks, and various debris.

Systematically they fall within the division Charophyta/Streptophyta, in which the land plants (Embryophyta) emerged.

Sexual reproduction in Zygnematales takes place through a process called *conjugation*.[3] Here filaments of opposite gender line up, and tubes form between corresponding cells. The male cells then become amoeboid and crawl across, or sometimes both cells crawl into the tube. The cells then meet and fuse to form a zygote, which later undergoes meiosis to produce new filaments. As in plants, only the female passes chloroplasts on to the offspring.

Other conjugating algae are the Mesotaeniaceae, sister of the Zygnematales, and spirotaenia, a basal green algae. Additionally, the Desmidiales appear to have emerged deep within the Zygnematales, and are also conjugating.

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[*Zygnema*]

Single [*Spirogyra*] cell   Microscopic view of [*Spirogyra*] conjugation

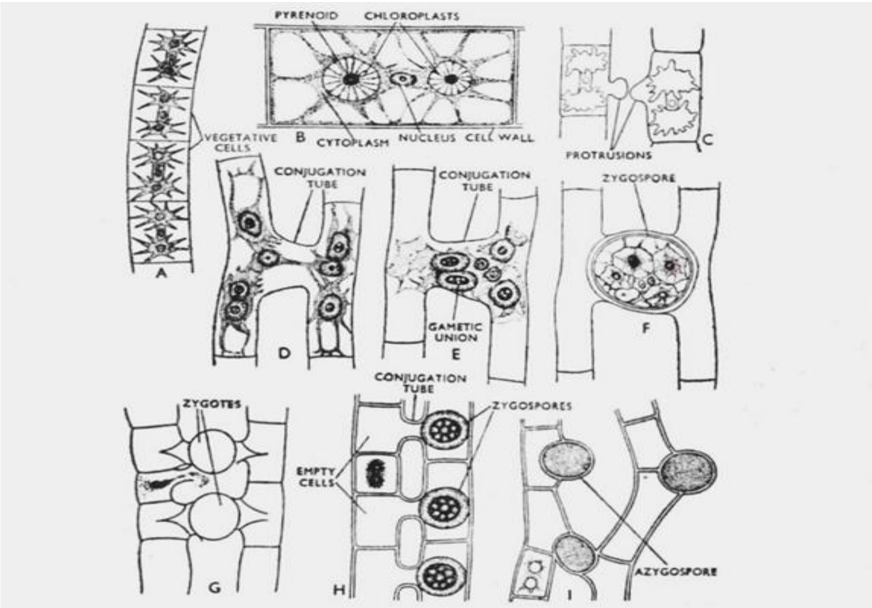


Fig. 77. *Zygnema* sp. A. Portion of a vegetative filament. B. Details of cell structure. C–I. Successive stages of scalariform and lateral conjugation.

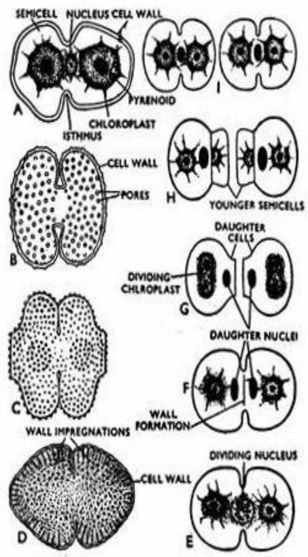


Fig. 78. *Cosmarium* sp. A. Details of cell structure. B–D. Nature of cell wall. E–I. Stages in the cell division.

Division: Charophyta

The Charophytes form an original group of aquatic plants, often considered as a distinct phylum, in an intermediate position between the Green Algae and the land plants.

General characteristics:

1. The plant body is differentiated into nodes and internodes. The nodes bear whorls of branches of limited growth are present that resemble the leaves of angiospermic plants.
2. The cells contain discoid chloroplasts, and are bounded by cellulosic cell wall. The nucleus occupies center of the cell. A prominent large central vacuole occupies the center of the internodal cells, therefore, the cytoplasm is peripheral.
3. The reproduction is vegetative and sexual. There is a distinct protonema stage form during zygote germination which then grow to the new plant.
4. The vegetative reproduction is by:

   Amylum Stars: These are star-shaped aggregates of cell developed from the lower nodes. They are densely filled with starch.

   Bulbils: These are bodies with food stored in them that develop upon stem or rhizoid.
5. The sexual reproduction is strictly oogamous and the gametes are produced in specialized complex structures, the globules (male organelles) and nucules (female organelles).

Class: Charophyceae

Order: Charales

Chara

Chara is a fresh water, green alga found submerged in shallow water ponds, tanks, lakes and slow running water. *Chara* is found mostly in hard fresh water, rich in organic matter, calcium and deficient in oxygen. *Chara* plants are often encrusted with calcium carbonate**.**

1. *Chara* often emits disagreeable onion like odor due to presence of sulphur compounds.

2. The thallus of *Chara* is branched & multicellular. The thallus is normally 20-30 cm. in height but may be up to 90 cm to l m. Some species like *C. hatei* are small and may be 2-3 cm. long.

3. The thallus is mainly differentiated into rhizoids and main axis. The rhizoids are white, thread like, multicellular, and branched structures. The main axis is erect, long, branched and differentiated into nodes and internodes**.**

4. The internode consists of single, much elongated or oblong cell. The inter-nodal cells in some species may be surrounded by one celled thick layer called cortex and such species are called as corticate species. The species in which cortical layer is absent are called ecorticate species.

5. The node consists of a pair of central small cells surrounded by 6-20 peripheral cells.

6.There are two types of branches in the *Chara*:

(i) Branches of limited growth.

The branches of limited growth arise in whorls of 6-20 from peripheral cells of the nodes of main axis or on branches of unlimited growth. These are also called branchlets, branches of first order, primary laterals or leaves. These branches stop to grow after forming 5-15 nodes and hence are called branches of limited growth. The stipules (short, oval, pointed single cell outgrowths) and reproductive structures are formed on the node of these branches.

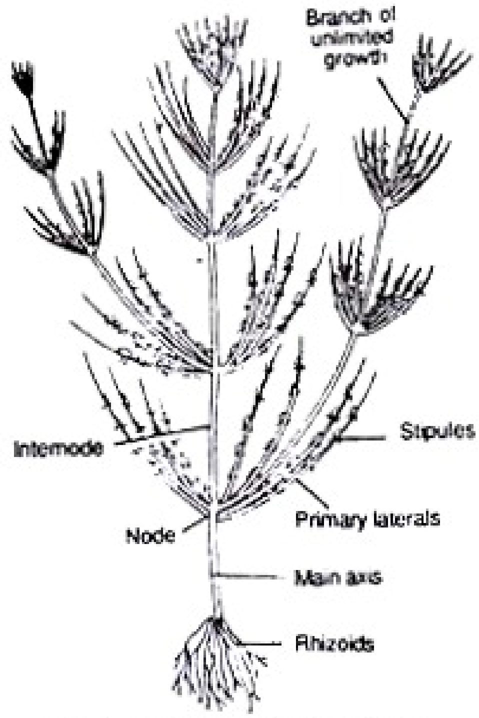


Fig. 1. *Chara.* External features.

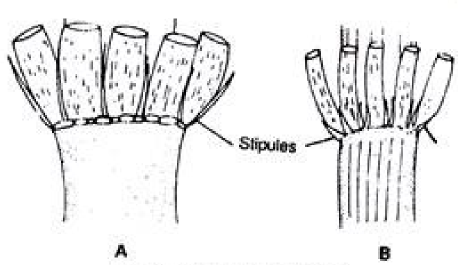


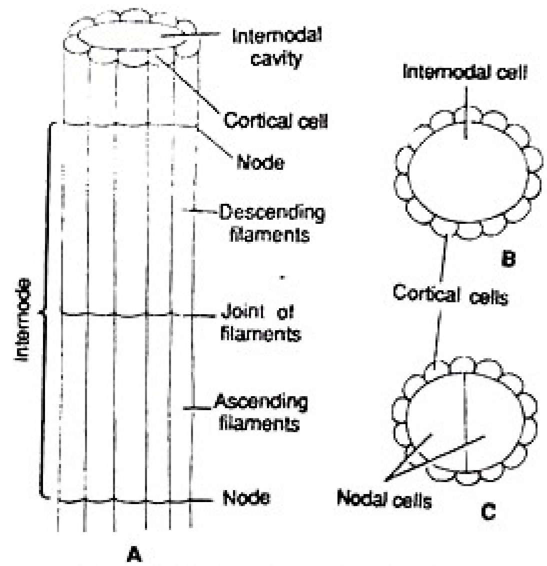
Fig. 4. *Chara.* Stipulodes.

(II) BRANCHES OF UNLIMITED GROWTH:

The branches – of unlimited growth arise from the axils of the branches of limited growth hence these are also called auxiliary branches or long laterals. These are also differentiated into nodes and internodes. At nodes they bear primary laterals and these branches look like the main axis. Their growth is also unlimited like main axis.

CORTEX:

If the inter-nodal cells of main axis en-sheathed by cortex cells. Such species are called corticated species. The cortex consists of vertically elongated narrow cells. The internode up to half of its length is surrounded by corticating filaments developed from upper node called descending filaments, the lower half of internode is covered by filaments developed from lower node called ascending filaments. The ascending and descending filaments meet at the middle of internode. The species without cortex e.g., *C. corallina* are called ecorticated species.



Cell structure of *Chara*:

The main axis of *Chara* consists of mainly two types of cells:

(i) Nodal cells

(ii) Inter-nodal cells.

The nodal cells are smaller in size and isodiametric**.** The cells are dense cytoplasmic, uninucleate with few small ellipsoidal chloroplasts.

The inter-nodal cells are much elongated. The cytoplasm is present around a large central vacuole. The cells are multinucleate and contain many discoid chloroplasts. The cell walls between the nodal cells and inter-nodal cells are porous to help in cytoplasmic continuity between cells.

Reproduction in *Chara*:

Reproduction in *Chara* takes place by vegetative and sexual methods. Asexual reproduction is absent.

(I) VEGETATIVE REPRODUCTION IN *CHARA*:

Vegetative reproduction in *Chara* takes place by following methods:

(a) Bulbils:

These are small oval or spherical bodies developed on stem or rhizoid nodes. Bulbils are formed on **root** of ***C. aspera*** and **stem** of ***C. baltica***. After detachment, they germinate and develop new plants**.**

(b) Amylum Stars:

In some species of *Chara* e.g., ***C. stelligna***, on the lower nodes of **main axis** develop multicellular star shape aggregates of cells. These cells are full of amylum starch and hence are called amylum stars. The amylum stars do detachment from plants & develops into new *Chara* thalli.

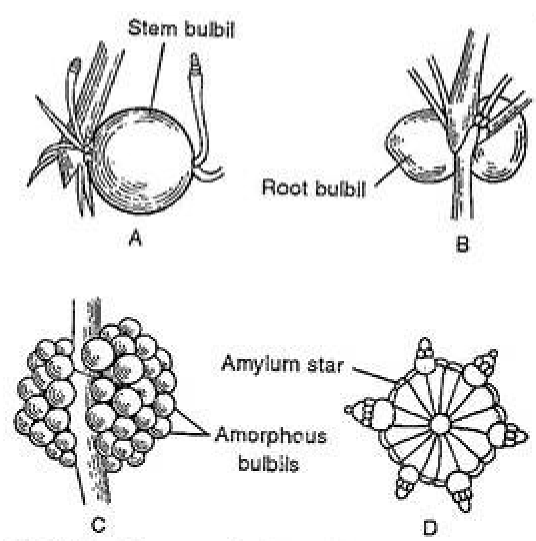


Fig. 3.93 : *Chara* sp. : A. Stem bulbil, B. Root bulbil, C. Amorphous bulbil, and D. Amylum star

(c) Amorphous bulbils:

The amorphous bulbils are group, many cells, irregular in shape which develop on lower node **main axis** e.g., ***C. delicatula*** or on **rhizoids** *e.g.*, ***C. fragifera* and *C. baltica***. The amorphous bulbils are perennating structures**,** when the main plant dies under unfavorable conditions; these bulbils survive and make *Chara* plants on return of favourable conditions.

SEXUAL REPRODUCTION IN CHARA:

The sexual reproduction in *Chara* is of highly advanced **oogamous** type. The sex organs are macroscopic and complex in organization. The gametes are produced in antheridia and oogonia that are enveloped in multicellular sheaths formed of sterile cells derived from the cells present below the sex organs.

The male sex organs are called globule (contains antheridia) and the female nucule (oogonium). Most of the *Chara* species are homothallic i.e., the male and female sex organs are borne on the same nodes (same plant), some species e.g., ***C. wallichii*** are heterothallic i.e., male and female sex organs are borne on different plants. The sex organs arise on the branches of limited growth or primary laterals, the nucule above the globule. The development of globule and nucule takes place simultaneously but globule matures before nucule.

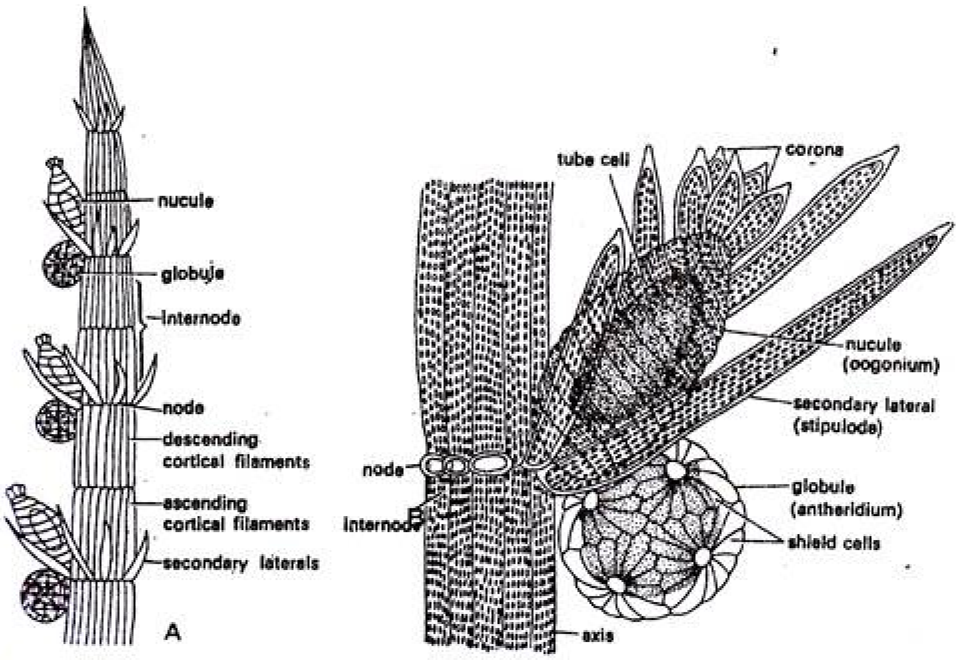


Fig 7. (A, B). *Chara*. Sexual reproduction. (A) A branch of limited growth with sex organs on its node; (B) Mature nucule (above), globule (below).

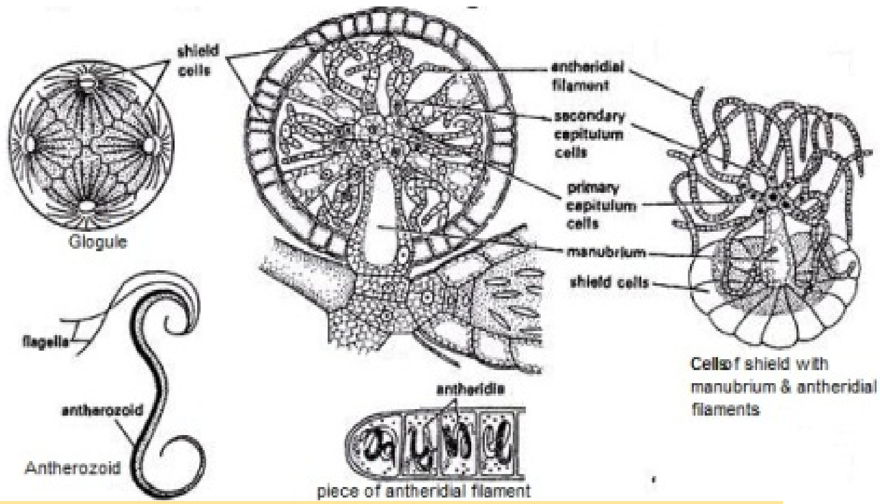
Globule:

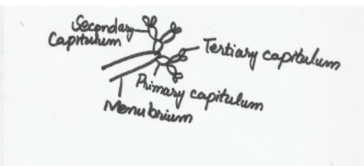
The globule is large, spherical, red or yellow structure contain many antheridial filaments. The antheridial filament composed of many uninucleate cells. These cells function as sperm mother cell and each cell form a single spirally coiled, uninucleate, bi-flagellated antherozoid.

Liberation of Antherozoids:

Globule is surrounded by shield cells which are eight in number. At maturity these cells separate from each other exposing antheridial filaments in water. From each cell a rod-shaped handle like outgrowth is formed moving inwards which is called manubrium. The tapering end of manubrium divides into two rounded bodies called primary capitulum.

Each primary capitulum further divided into two rounded bodies called secondary capitulum. In some species this secondary capitulum divides into tertiary capitulum.



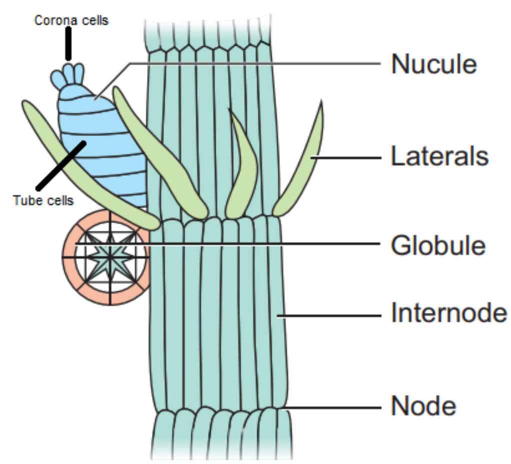


Each capitulum has ability to form antheridial filaments continuously which is the male structures of *chara* i.e. contains male gametes. In the antheridial filament each cell is separated and form coiled structure called antherozoid (male gamete). It develops two flagella to move in water.

Nucule: The nucule is a stalked oval structure being surrounded by an envelope of five long filaments placed side by side arranged spirally which are called thetube cells. They exhibiting a twisted appearance and affording protection to the enclosing oogonium. Each filament terminates in a small erect cell. The five erect cells of the five filaments together form five-celled crown or corona capping a mature nucule.

Reproduction:

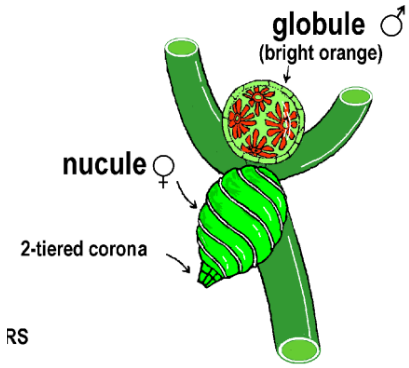
When the oogonium is mature, the five tube cells get separated from each other forming narrow slits between them. Antherozoids are attracted towards ovum. The antherozoids enter through these slits and penetrate gelatinized wall of the oogonium. Many antherozoids enter oogonium but one of those fertilizes the egg to make a diploid zygote. The zygote secretes a thick wall around itself to make oospore.



Nitella

Similar to *Chara* but

1. Has no odor and are soft in touch.
2. Main axis single celled & ecorticate (no longitudinal striations)
3. Globule are produced above the nucule.
4. Oogonium are with a crown of 10 cells in two rows.
5. The nucule is relatively less elongated than that in *Chara*, so the crown cells are much shorter.

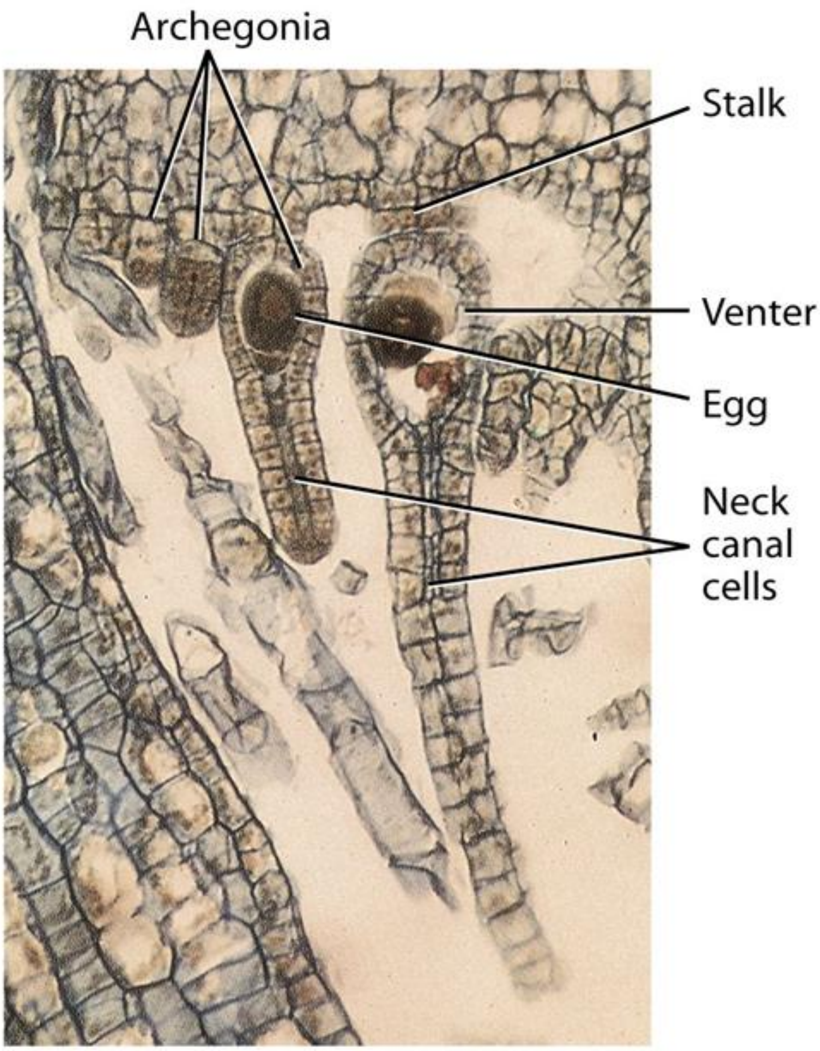


What is archegoniate in plants? د. مي طه

1. Life cycle consist of **alternation of generation** gametophyte (1N) + (2N)sporophyte .
2. Bearing **archegonia**.   and the archegonium is the female sex organ in mosses, liverworts, ferns, and most conifers.
3. The male sex organ known as **antheridium** , ovoid or spherical organ cpmposed of spermatogenous tissue coverd with sterilized wall .

A mature **archegonium** is flask-like in shape, with   neck **canal cells** and with an egg (oosphere) in its venter.• At the top of the **neck** of the archegonium there are one to four cover cells **(cap cells)** , which become separated from the archegonium, as soon as the gelatinization of the **venter** and neck canal cells is over.

For an instance , in anthoceras The development of archegonium begins from a singlesuperficial cell. This cell becomes prominent and acts asarchegonial initial.The archegonial initial first divides vertically& transversely producing the aechegonium .


Archegonia
Stalk
Venter
Egg
Neck
canal
cells

Marchantia, an example of a liverwort.

Bryophytes are an consisting of three divisions of non-vascular land plants (embryophytes): the liverworts, hornworts and mosses. They are characteristically limited in size and prefer moist habitats although they can survive in drier environments . Bryophytes produce enclosed reproductive structures (gametangia and sporangia), but they do not produce flowers or seeds. They reproduce via spores. The term "bryophyte" comes from Greek, bryon "tree-moss, oyster-green" and, phyton "plant".

The **defining features** of bryophytes are:

- Their life cycles are dominated by the **gametophyte** stage
- Their sporophytes are unbranched
- They do not have a true **vascular** tissue containing **lignin** (although some have specialized tissues for the transport of water)

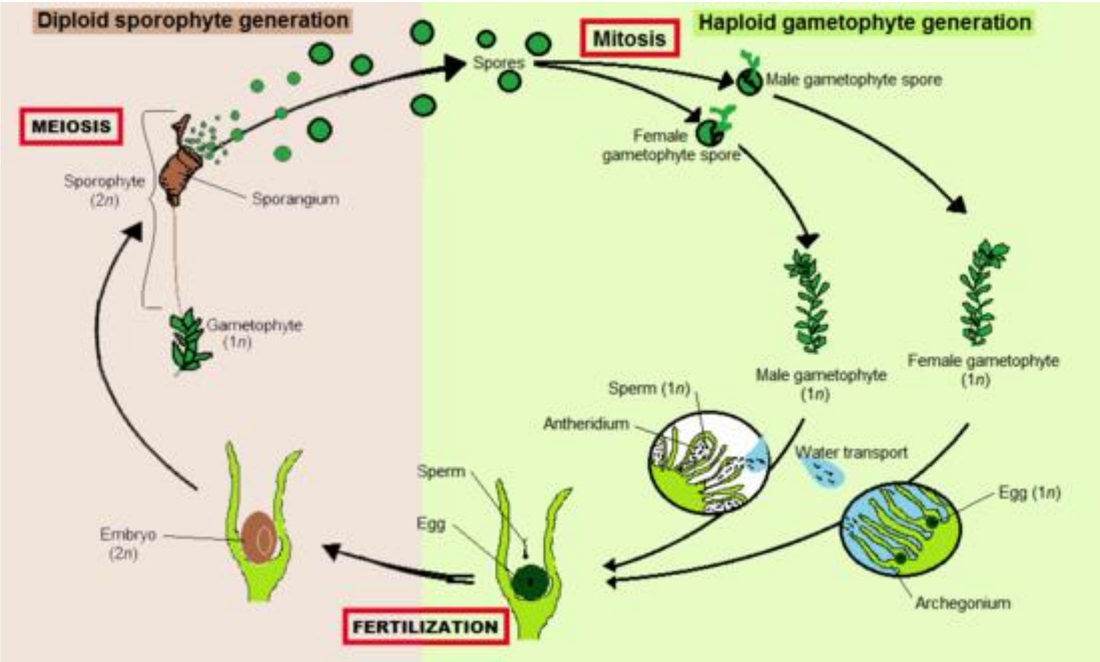
Habitat

Bryophytes exist in a wide variety of habitats. They can be found growing in a range of temperatures (cold arctics and in hot deserts), elevations (sea-level to alpine), and moisture (dry deserts to wet rainforests).

Environmental Uses

Soil Conditioning Bioindicators Moss gardens Pesticides

Life cycle (Alternation of generations)



The life cycle of a dioicous bryophyte. The gametophyte (haploid) structures are shown in green, the sporophyte (diploid) in brown.

Like all land plants (embryophytes), bryophytes have life cycles with **alternation of generations**. In each cycle, a **haploid gametophyte**, each of whose cells contains a fixed number of unpaired chromosomes, alternates with a **diploid sporophyte**, whose cell contain two sets of paired chromosomes. Gametophytes produce haploid sperm and eggs which fuse to form diploid zygotes that grow into sporophytes. Sporophytes produce haploid spores by meiosis, that grow into gametophytes.

Bryophytes are gametophyte dominant, meaning that the more prominent, longer-lived plant is the haploid gametophyte. The diploid sporophytes appear only occasionally and remain attached to and nutritionally dependent on the gametophyte. In bryophytes, the sporophytes are always unbranched and produce a single **sporangium** (spore producing capsule).

Liverworts, **mosses** and **hornworts** spend most of their lives as gametophytes. Gametangia (gamete-producing organs), archegonia and antheridia, are produced on the gametophytes, sometimes at the tips of shoots, in the axils of leaves or hidden under thalli. Some bryophytes, such as the liverwort *Marchantia*, create elaborate structures to bear the gametangia that are called gametangiophores. Sperm are flagellated and must swim from the antheridia that produce them to archegonia which may be on a different plant. Arthropods can assist in transfer of sperm.

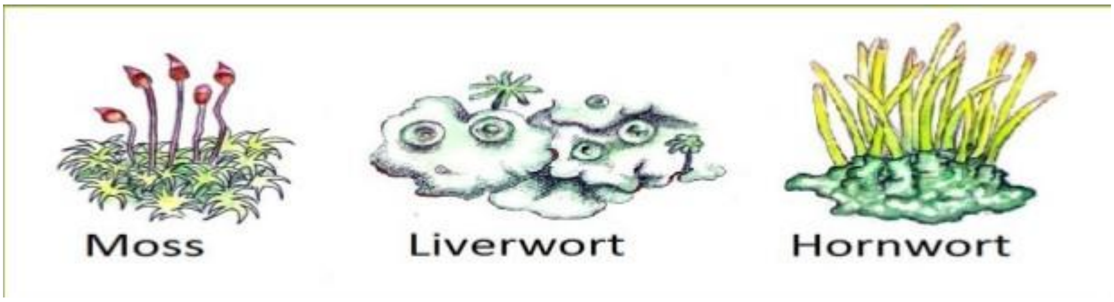
Fertilized eggs become zygotes, which develop into sporophyte embryos inside the archegonia. Mature sporophytes remain attached to the gametophyte. They consist of a stalk called a seta and a single sporangium or capsule. Inside the sporangium, haploid spores are produced by meiosis. These are dispersed, most commonly by wind, and if they land in a suitable environment can develop into a new gametophyte. Thus bryophytes disperse by a combination of swimming sperm and spores, in a manner similar to lycophytes, ferns and other cryptogams.

Sexuality

The arrangement of antheridia and archegonia on an individual bryophyte plant is usually constant within a species, although in some species it may depend on environmental conditions. The main division is between species in which the antheridia and archegonia occur on the same plant and those in which they occur on different plants. The term **monoicous** may be used where antheridia and archegonia occur on the same gametophyte and the term **dioicous** where they occur on different gametophytes.

Monoicous plants are necessarily **bisexual** (or hermaphroditic), meaning that the same plant has both sexes. The exact arrangement of the antheridia and archegonia in monoicous plants varies. They may be borne on different shoots (autoicous or autoecious), on the same shoot but not together in a common structure (paroicous or paroecious), or together in a common "inflorescence" (synoicous or synoecious). Dioicous plants are **unisexual**, meaning that the same plant has only one sex .

Classification and phylogeny



Mosses are one group of bryophytes.

The three bryophyte clades (which may be treated as divisions) are the Marchantiophyta (liverworts), Bryophyta (mosses) and Anthocerotophyta (hornworts). The term "bryophyte" thus refers to a grade of lineages defined primarily by what they lack. Compared to other living land plants, they lack vascular tissue containing lignin and branched sporophytes bearing multiple sporangia.

Similarities to land plants

A waxy cuticle covering the soft tissue of the plant provides protection. The development of gametangia provided further protection specifically for gametes. They also have embryonic development which is a significant adaptation seen in land plants and not green algae. While bryophytes have no truly vascularized tissue, they do have organs that have specific functions, similar to those functions of leaves and stems in higher level land plants.

Similarities to aquatic plants

Bryophytes also exhibit connections to their aquatic ancestry. They share various features with their green algae ancestors. Both green algae and bryophytes have chlorophyll a and b, and the chloroplast structures are similar Like algae and land plants, bryophytes also produce starch and contain cellulose in their walls , Bryophytes depend on water for reproduction and survival. A thin layer of water is required on the surface of the plant to enable the movement of sperm between gametophytes and the fertilization of an egg.

Comparative morphology

Summary of the morphological characteristics of the **gametophytes** of the three groups of bryophytes:

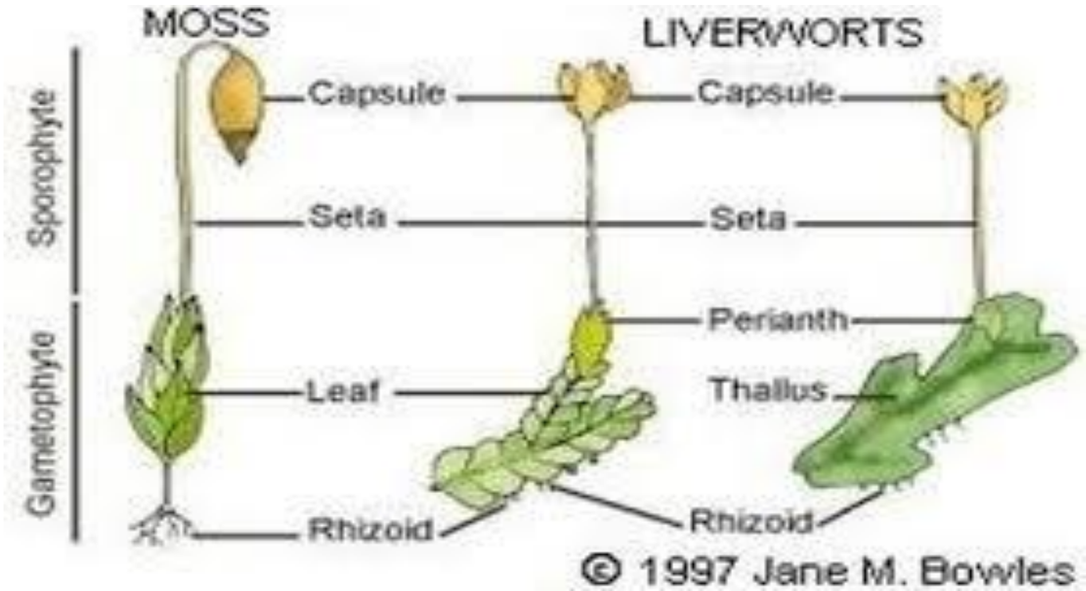
	Liverworts	**Mosses**	**Hornworts**
Structure	Thalloid or foliose	Foliose	Thalloid
Symmetry	Dorsiventral or radia	Radial	Dorsiventral
Rhizoids	Unicellular	Pluricellular	Unicellular
Chloroplasts/cell	Many	Many	One
Protonemata	Reduced	Present	Absent
Gametangia (antheridia and archegonia)	Superficial	Superficial	Immersed

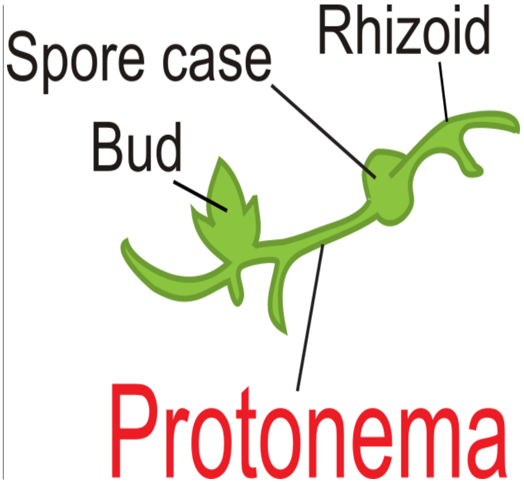
Summary of the morphological characteristics of the **sporophytes** of the three groups :

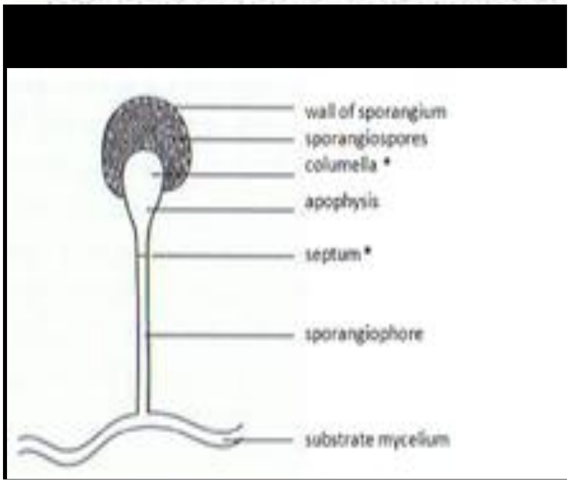
	Liverworts	**Mosses**	**Hornworts**
Stomata	Absent	Present	Present
Structure	Small, without chlorophyll	Large, with chlorophyll	Large, with chlorophyll
Persistence	Ephemeral	Persistent	Persistent
Growth	Defined	Defined	Continuous
Seta	Present	Present	Absent
Capsule form	Simple	Differentiated (operculum, peristome)	Elongated
Maturation of spores	Simultaneous	Simultaneous	Graduate
Dispersion of s	Elaters	Peristome teeth	Pseudo-elaters
Columella	Absent	Present	Present
Dehiscence	Longitudinal or irreg	Transverse	Longitudinal

The **columella :** is a sterile dome-shaped structure on the tip of a sporangiophore, its function is to allow for nutrient exchange between the active protoplasm below and the developing spores inside the upper part of the sporangial head. ... The **columella** is typically located within the theca of various types of mosses.

A **protonema** : is a thread-like chain of cells that forms the earliest stage of development of the gametophyte (the haploid phase) in the life cycle of mosses







Pteridophyte د. مي طه حامد

A **pteridophyte** is a vascular plant (with xylem and phloem) that reproduces by spores and lacks seeds. Because pteridophytes produce neither flowers nor seeds, they are also referred to as "cryptogams", meaning that their means of reproduction is hidden. The pteridophytes include the ferns, horsetails, and the lycophytes

Description

Ferns and lycophytes (pteridophytes) are free-sporing vascular plants that have a life cycle with free-living, independent gametophyte and sporophyte phases. Their other common characteristics, include vascular plant apomorphies (e.g., vascular tissue) and land plant plesiomorphies (e.g., spore dispersal and the absence of seeds) .

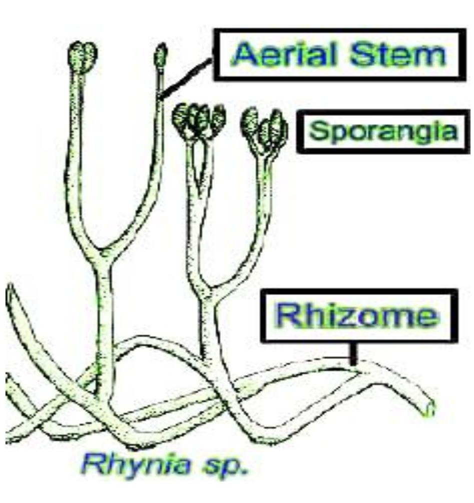
- **Taxonomy & Phylogeny**Division Tracheophyta (tracheophytes) - vascular plants
  - Sub division Euphyllophytina (euphyllophytes)
    - Infradivision Moniliformopses (**monilophytes**)
    - Infradivision Spermatophyta - seed plants, ~260,000 species

- Subdivision Lycopodiophyta (lycophytes) - less than 1% of extant vascular plants

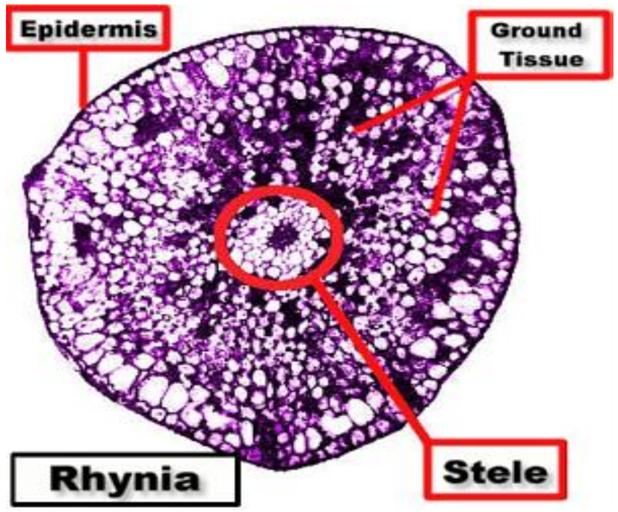
Pteridophyte life cycle

Just as with seed plants and mosses, the life cycle of pteridophytes involves alternation of generations. This means that a diploid generation (the sporophyte, which produces spores) is followed by a haploid generation (the gametophyte or prothallus, which produces gametes). Pteridophytes differ from mosses and seed plants in that both generations are independent and free-living, although the sporophyte is generally much larger and more conspicuous.

1. **Psilophyta** The first fossil land plant had horizontal & vertical shoots. Either leaflessor had minute leaves ex. *Rhnia*



Reconstruction of *Rhynia*



Cross section of a Rhynia Stem: The term **Stele** is is used to indicate the **Xylem and Phloem**

The Psilophyta contains a genus *Psilotum* which closely resembles plants like *Rhynia*. It is essentially a stem that has two interconnected forms. The underground stem (Rhizome) produces Aerial Stems which are Photosynthetic. The Leaves are minute and contribute little to the plant's nutrition. The Rhizome produces Rhizoids .

Equisetophyta د. مي طه حامد

Equisetophya class of primitive spore-bearing vascular plants. Most members of the group are extinct and known only from their fossilized remains. The sole living genus, Equisetum, order Equisetales, ancient herbaceous plants, known as horsetails .

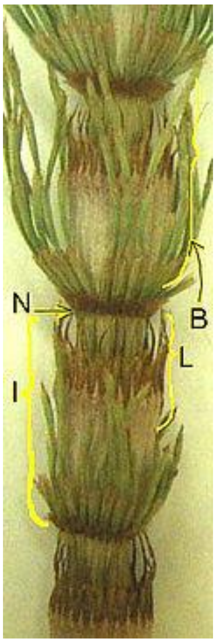
General features

characteristically have whorled leaves and branches and conspicuously jointed stems, which in many cases are also ribbed. Reproductive structures are present in the form of greatly compressed stems called cones, or strobili, which form at the ends of branches.

The giant extinct horsetails (Calamites) were trees up to 1 metre (3 feet) in diameter and 30 metres (100 feet) in height. Their leaves—like those of extant horsetails—were arranged in spokelike whorls at regular intervals along the jointed stems. The living species of Equisetum are distributed environment. The majority are found in wet or damp habitats, often in shaded locations along streams.

Description

In these plants the leaves are greatly reduced and usually non-photosynthetic. They contain a single, non-branching vascular trace, which is the defining feature of microphyllsThe leaves of horsetails are arranged in whorls fused into nodal sheaths. The stems are usually green and photosynthetic, and are distinctive in being hollow, jointed and ridged (with sometimes 3 but usually 6–40 ridges). There may or may not be whorls of branches at the nodes.

Life cycle

Horsetails, like other vascular plants, display an alternation of generations: an asexual phase, represented by a sporophyte (the horsetail plant), and a sexual phase, the gametophyte, an inconspicuous, delicate, green plant. Each year, many gametophytes are initiated from spores, but apparently very few produce sporophytes in nature. Horsetails apparently survive mainly by vegetative reproduction rather than by a regular dependence on the sexual cycle.

Some horsetails carry terminal cones (strobili) on green aerial branches. Other species, however, have separate upright, aerial branches for vegetative and for reproductive shoots. In these species the strobilate branches appear first, and, after the spores are shed, the green vegetative shoots develop. The fertile components of the strobilus are called sporangiophores; each consists of a stalk bearing a flattened disk at its apex, on the lower edge of which is a ring of 5 to 10 sporangia, each one opening and shedding spores by a longitudinal slit on its inner side.

Spores

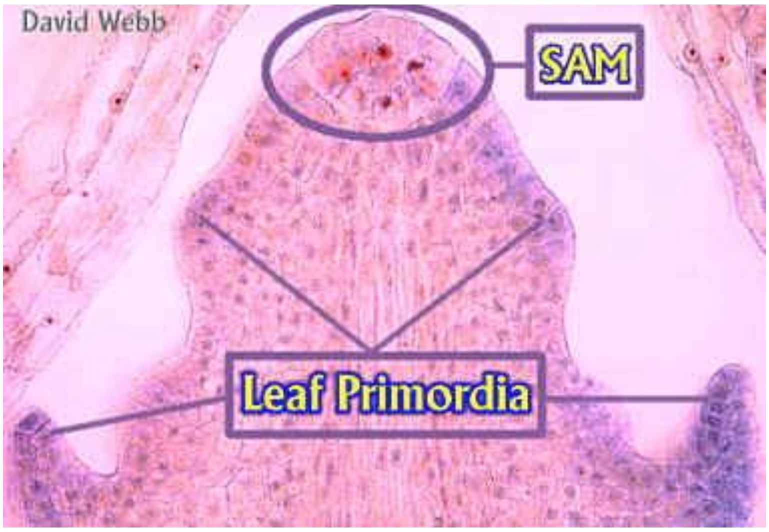
The spores are borne under sporangiophores in strobili, cone-like structures at the tips of some of the stems. In many species the cone-bearing shoots are unbranched, Horsetails are mostly homosporous, though in the field horsetail smaller spores give rise to male prothalli.

Lycophyta د. مي طه حامد

Plants in the Lycophyta have erect stems as well as Stolons and Rhizomes. They are relatively large compared to Hepatophyta, Bryophyta and Psilophyta but they rarely exceed a meter in height. They can be epiphytic and pendant stems can be more than a meter in length. They have Microphylls and Roots. Branching is Dichotomous for both organs. The Apical Meristem has several "Initials" rather than a solitary Apical Cell.

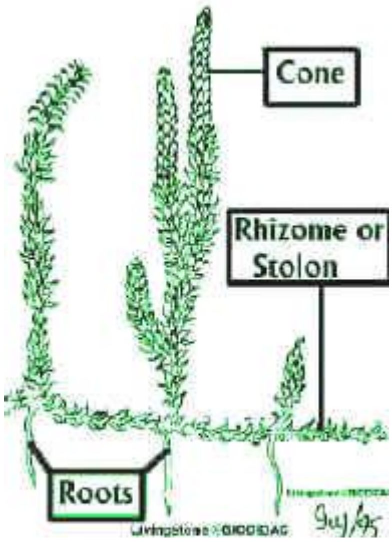
We will examine the genus *Lycopodium* first.

Vertical *Lycopodium* with Isotomous Branching. This plant is about 15-20 cm tall.

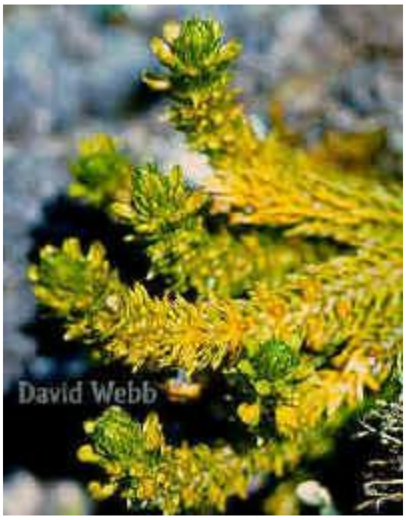


Long Section of a Lycopod SAM: Note the presence of several large "Initials" at the summit of the stem.

These plants are most abundant in the tropics but a few can survive cold, dry environments.



A composite *Lycopodium*



A species growing in the Arctic/Alpine zone near Jasper Canada. This plant is approx. 10 cm in length.

Division: Xanthophyta

Yellow – green algae

The xanthophyta include about 118 genera & 600 species . Members of this group are photosynthetic organisms which live primarily in freshwater, though some are found in marine waters, in damp soil, or on tree trunks. They are the dominant producers in some salt marshes, and some, like *Tribonema*, are cosmopolitan in their distribution.

General characteristics:

1. The photosynthetic pigments consist of chlorophyll a and e, β -carotene and xanthophylls; there is an excess of carotenoids as compared to chlorophylls.

2. Cell wall may be frequently absent and when present it generally has a higher concentration of pectic materials with smaller amounts of cellulose; in some members the cell walls may be silicified. The walls are often, but not always, composed of two halves.

3. The food reserves are oil, lipid, and a glucose polymer termed leucosin or chrysolaminarin.

4. Xanthophytes may be sessile or free-living. Some members are flagellated unicells with two anteriorly unequal length flagella, the longer being pantonematic and the shorter acronematic, but many are colonial, living as naked cells in a gelatinous envelope. There are also filamentous forms, which produce long chains of cells, and there are coenocytic forms, such as *Vaucheria*. Some members may live as an amoeboid stage, living on or within plants.

5. Most reproduction is **asexual**, and this is accomplished by a wide variety of means, including fragmentation of filaments, but often involving the production of some kind of spore. Spores may be motile (**zoospores**), or they may be non-motile (**aplanospores**).

Sexual reproduction is recorded only **in few genera** such as *Vaucheria*.

Order: Vaucheriales

Vaucheria

Vaucheria is found mostly in fresh water but about six species are marine and some are terrestrial found on moist soil.

The thallus is made of long, cylindrical well branched filaments. The filament is aseptate(coenocytic)structure (the septa formation occurs only during reproduction or for sealing of an injury). The thallus is attached to substratum by branched rhizoids. The cell wall is thin, weak, made of two layers. Inner to the cell wall there is thick layer of protoplasm. A very large central vacuole fill the coenocyte forming a continuous canal or siphon & restrict the cytoplasm to the periphery which have many elliptical chloroplasts which lack pyrenoids, nuclei are present in the center of the cytoplasm.

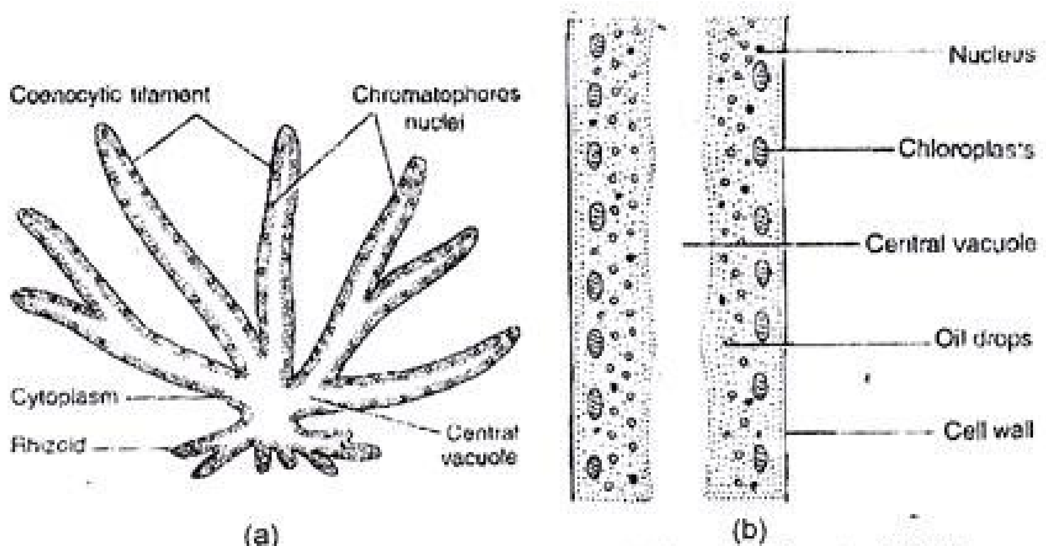


Fig. 1. (A, B). ***Vaucheria*** **structure. (A) Entire thallus, (B) A part of thallus**

The cytoplasm also contains other membrane bound cell organelle such as mitochondria, small vesicles and food is stored in form of oil. The growth of filament is apical, the filament increases in length by apical growth of all the branches.

Reproduction in *Vaucheria*:

Reproduction takes place by vegetative, asexual and sexual methods.

(i) Vegetative Reproduction:

by fragmentation

(ii) Asexual Reproduction:

It take place by formation of oval zoospore (a multi-flagellate structure), aplanospores and hypnospore (akinetes).

Zoosporangia are produced at the tip of the filament, then the protoplasm metamorphosed into a single large zoospore. This multinucleate zoospore is regarded as compound zoospore or coenozoospore as it is a composite structure of many nuclei with flagellar pairs.

Akinetes or hypnospores are thick walled structures formed during unfavorable conditions like drought, and low temperature.

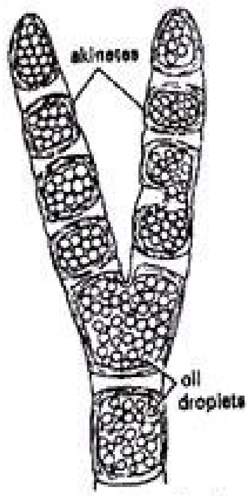


Fig. 4. *Vaucheria.* *Akinetes.*

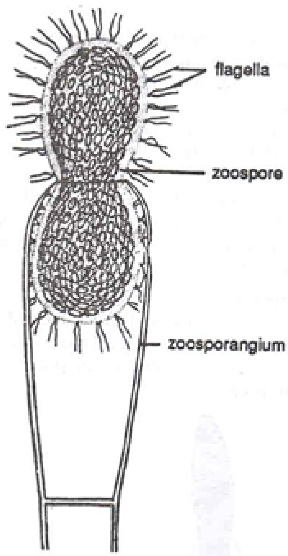


Fig. 31. *Vaucheria. A zoosporangium with multiflagellate zoospore.*

Sexual Reproduction:

1. It is of oogamous type.
2. Most of the species are monoecious but a few are dioecious.
3. In homothallic species, antheridia and oogonia develop side by side. More than one oogonia may also develop along with an antheridium (Fig. 34).

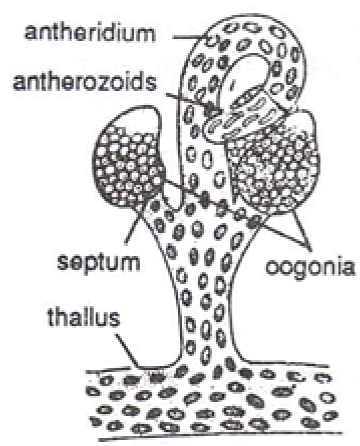


Fig. 34. *Vaucheria. An antheridium with two oogonia.*

Antheridium:

It is a tubular, straight or curved and hook-like structure, at maturity it is separated from rest of the thallus by a septum. Many nuclei and chloroplasts are present in the antheridium when young, but at maturity it is filled up with many antherozoids.

Uninucleate and biflagellate antherozoids are liberated through an opening formed at the tip of antheridium.

Oogonium:

It is ovoid or spherical and sessile structure. It is a uninucleate body with many chloroplasts. Oil is the reserve food material. At maturity it is also separated from rest of the portion of the thallus by a septum. All the contents of oogonium become rounded and form a single uninucleate egg. Mature oogonium contains a short, rounded beak, through which it receives antherozoids.

On **fertilization**, zygote is formed. The zygote secretes a thick 3-7 layered wall and is now called as oospore.

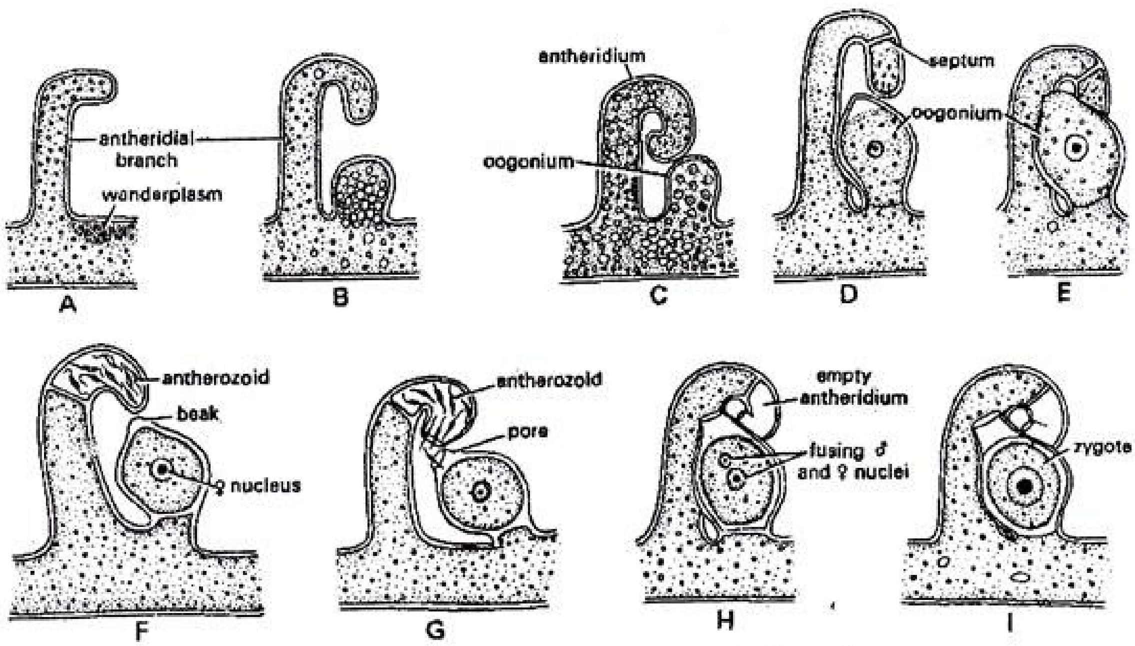


Fig. 6. (A–I). *Vaucheria.* Sexual reproduction in *V. sessilis.*

The oospore undergoes a period of rest before germination. During favorable season the oogonial wall disintegrates and the oospore is liberated. The oospore germinates directly into new filaments by forming many tubular branches.

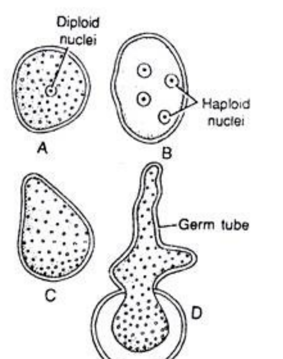


Fig. 7. (A–D). *Vaucheria.* Germination of oospore.

Division: Bacillariophyta (Diatoms)

Class: Bacillariophyceae

Diatoms is the collective name of about 170 genera & 5500 species. Most of the diatoms occur as phytoplankton, some occur at the bottom of water reservoirs. Some occur as terrestrial forms usually on moist soil imparting it brown colour. Fossilised diatoms when found in large deposits are called diatomaceous earth.

Cell structure:

Diatoms are microscopic, unicellular photosynthetic organisms. Each cell is called frustule. It is made up of two parts: the cell wall & the protoplast. The cell wall is two layered. The inner layer is continuous & made up of pectin. The outer layer is impregnated with silica. It is made up of two overlapping halves. Both halves fit closely together like a petridish.

The upper half is called **epithecia**. It fits closely over the lower half, the **hypothecia**. The epithacia is older than hypothecia. The main surface of each half (or each theca) is called valve, which is convex in shape. The incurved margins of both theca are called connecting bands. The side of two overlapping connecting bands is called girdle. The upper & lower view of theca are called valve views whereas the view of connecting bands is called girdle view (or side view).

The valves contain ridges, pits & fine pores arranged in fine patterns. Usually the valves exhibit fine marking or ridges, called striae. They are arranged in radially or in concentric rings (in Centrales) or in two series, each on either side of apical axis (in Pennales). The dots in the region of striae represent the fine pores called punctae.

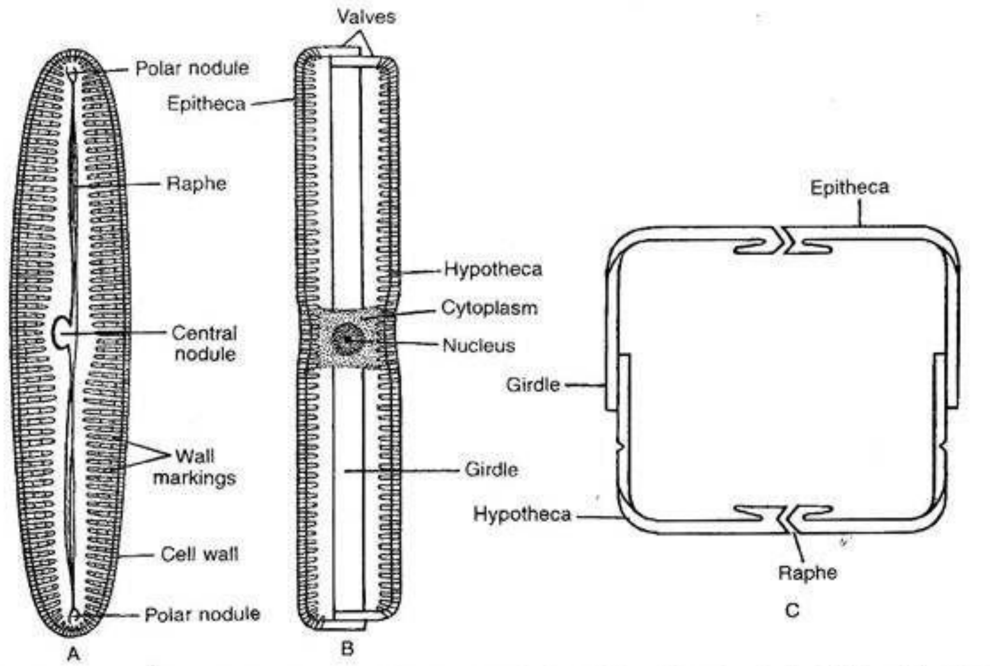


Fig. 3.101 : Cell structure of *Pinnularia viridis* (Pennales) : A. Frustule in valve view, B. Frustule in girdle view, and C. Frustule in transverse section

The class Bacillariophyceae includes two orders:

Order: Pennales

Includes those forms which possess frustules like oblong boxes with isobilateral symmetry (e.g.: *Pinnularia*).

1-The inscriptions are feathery.

2- The cell contains one or two parietal chloroplasts.

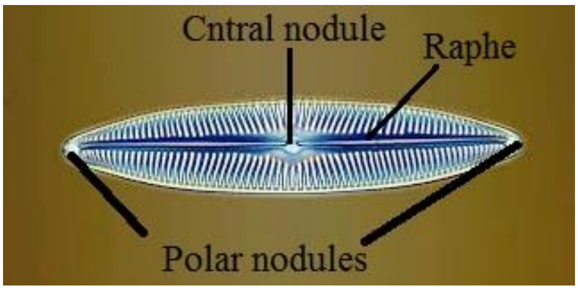
3- The cell contains a groove that extends along the axis of the cell wall called the Raphe groove. Inscriptions on either side. In the center of the groove, a central thickening called the central nodule. In each pole of the groove there is a thickening called the polar nodule

4- Cells move in a gliding motion.

5- Sexual reproduction by Isogamy.

6- They are common in fresh water.

Example: genus: *Navicula*



Order: Centrales

Includes those forms which possess frustules like circular pill box with radial symmetry.

1- The inscriptions are of radial shapes.

2- The cell contains multiple chloroplasts, which are often disc-shaped.

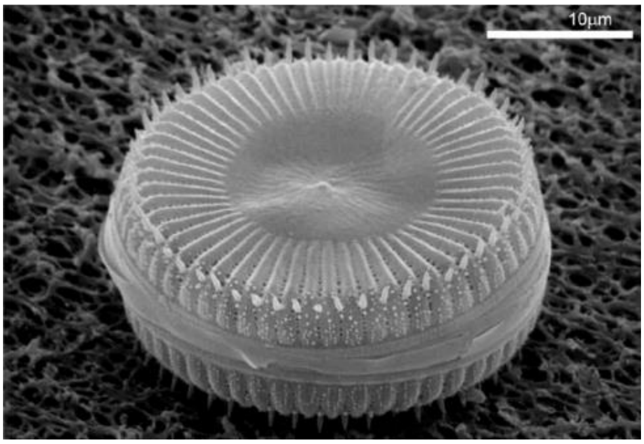
3- The cell has no raphe.

4- Members of this order are non-motile.

5- Sexual reproduction by oogamy.

6- They are common in marine waters.

Examples genus: *Cyclotella*.



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