ALGAE, FUNGI AND BRYOPHYTES

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PREFACE

The present book has been written according to the latest syllabus suggested by U.G.C. It is written in simple and easy language. This book provides knowledge about lower plants especially algae, fungi and bryophytes. As we know that algae and fungi have a wide range of distribution and widely used as a source of food, medicine and also have industrial application. All of these factors are discussed in the book.

First of all I thank to almighty for giving me strength for this noble cause. My respectful thank to Dr. Y. S. Tomar, Dr. Sudhir Kumar, Dr. Baljeet Singh, Dr.S. P. Singh, Dr. A. K. Sharma, Dr. Rajeshwari Sharma, Dr. Bharatveer, Dr. K.P. Singh and my colleagues Dr. Sanjay, Mr. Manoj, Dr. Amarpal and Dr. Umendra.

Last but not least, I would like to pay thanks to my parents and other family members-Ranjna, Varusha and Harshit Bhardwaj and I also thank to my publisher Dr.R.K.Jain and all those who are directly or indirectly engaged in the publication of this book.

—Authour

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CHAPTER 1

Algae

The Ancient Greek word for seaweed was phykos, which could mean either the seaweed (probably red algae) or a red dye derived from it. Algae (singular: alga) are eukaryotes ("true-nucleus") and informal grouping of primitive, mainly aquatic plants that possesses chlorophyll a as their primary photosynthetic pigment and can manufacture their own food through the process of photosynthesis. Plant body is thallus like i.e. do not have true roots, stems, leaves, vascular tissue and have simple reproductive structures. They never produce multicellular embryos inside the female reproductive organ. There are unicellular (e.g. planktons) and multicellular (e.g. seaweeds) algae found in freshwater (e.g. lakes and rivers), marine (e.g. sea) and terrestrial (e.g. moist pavements) habitats.

Accordingly the modern study of marine and freshwater algae is called either phycology or algology, depending on whether the Greek or Latin root is used. The name Fucus appears in a number of taxa. Algae (Latin for "seaweed") are a very large and diverse group of simple, typically autotrophic organisms, ranging from unicellular to multicellular forms, such as the giant kelps that grow to 65 meters in length. Most are photosynthetic like plants and "simple because they lack the many distinct cell and organ types found in land plants. The largest and most complex marine forms are called seaweeds.

The prokaryotic cyanobacteria are informally referred to as blue-green algae; this usage is incorrect since they are regarded as bacteria. The term algae are now restricted to eukaryotic organisms. All true algae therefore have a nucleus enclosed within a membrane and plastids bound in one or more membranes. Algae constitute a polyphyletic group, as they do not include a common ancestor, although their plastids seem to have a single origin. Diatoms are also examples of algae. Algae lack the various structures that characterize land plants, such as the leaf-like phyllids of bryophytes, rhizoids in non-vascular plants and the roots, leaves and other organs that are found in tracheophytes (vascular plants). Many are photo- autotrophic, although some groups are mixotrophic, deriving energy both from photosynthesis and uptake of organic carbon either by osmotrophy, myzotrophy, or phagotrophy. Some unicellular species depends entirely on external energy sources and have limited or no photosynthetic

apparatus. Nearly all algae have photosynthetic machinery ultimately derived from cyanobacteria, and so produce oxygen as a by-product of photosynthesis, unlike other photosynthetic bacteria such as purple and green sulfur bacteria.

Algae exhibit a wide range of reproductive strategies, from simple, asexual cell division to complex forms of sexual reproduction.

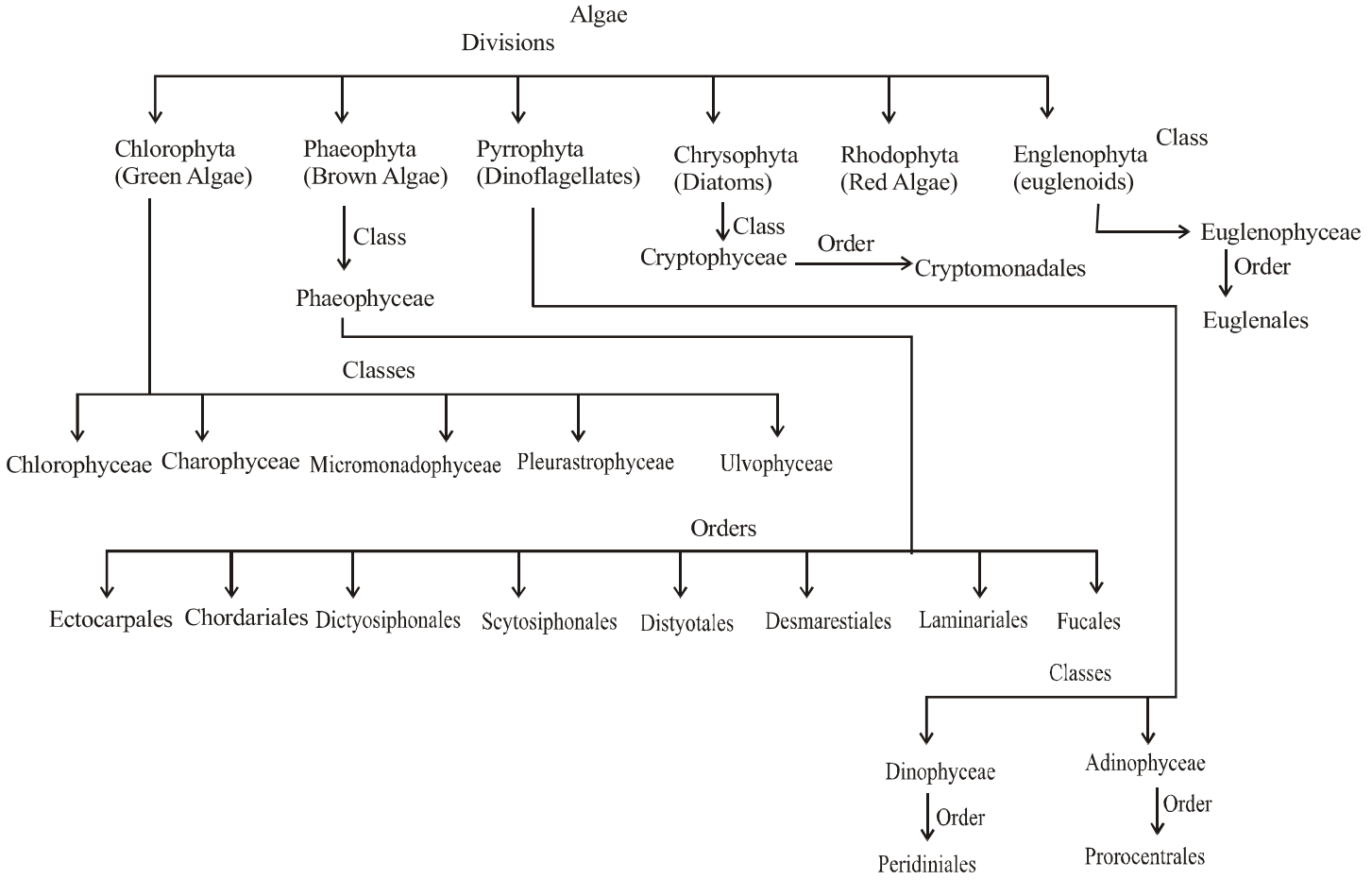
By modern definitions, algae are Eukaryotes and conduct photosynthesis within membrane-bound organelles called chloroplasts. Chloroplasts contain circular DNA and are similar in structure to cyanobacteria, presumably representing reduced cyanobacterial endosymbionts. The exact nature of the chloroplasts is different among separate lineages of algae, reflecting different endosymbiotic events. The table below describes the composition of the three major groups of algae. Their lineage relationships are shown in the figure in the upper right. Many of these groups contain some members that are no longer photosynthetic. Some retain plastids, but not chloroplasts, while others have lost plastids entirely.

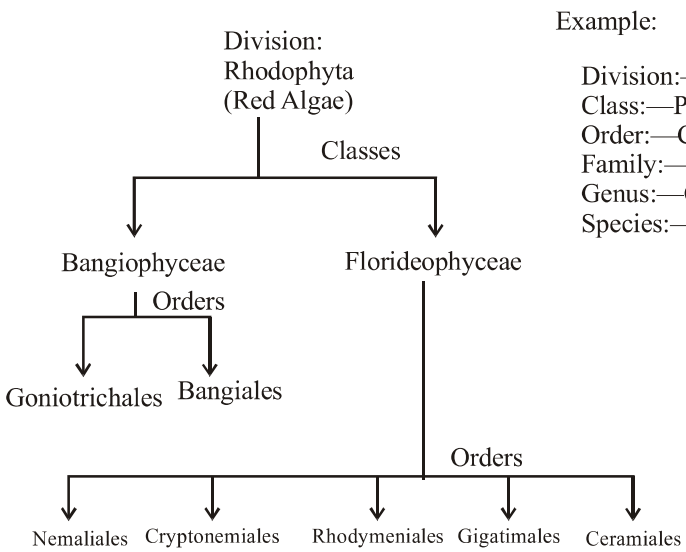
The study of algae is termed phycology or algology, and one who studies algae is known as a phycologist.

Classification of algae

Algae belong to Eukaryote and Kingdom - Protista (Protoctista). In 1959 American biologist R. H. Whittaker described a classification system of five primary kingdoms: plants, animals, fungi, protists, and bacteria. Because the Protista are so diverse in form, classification within the kingdom has proved difficult. The classification of the Protista is currently based largely on the structure and organization of the cell, the presence of organelles, and the pattern of reproduction or life cycles. The five-kingdom classification system divides the Protista into 27 distinct phyla. More recently, however, classifications based on comparisons of cell physiology and DNA sequences suggest that many protist phyla may be sufficiently large and diverse to be classified as kingdoms. Possible classifications are discussed, and a summary classification of the living world into kingdoms (Monera, Protista, Fungi, Animalia, and Plantae) and phyla is suggested.

Classification of algae :—





Example:

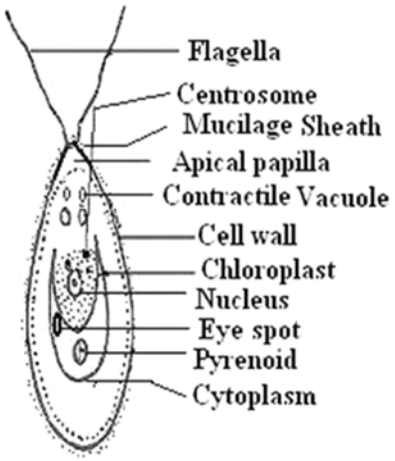
Division:—Phaeophyta
Class:—Phaeophyceae
Order:—Chordariales
Family:—Chordariaceae
Genus:—Cladosiphon
Species:—occidentalis

Classification With Important Classes of Algae

Class (1) Chlorophyceae (green algae): Pigments are present in plastids or chromatophores. Pigments are chlorophyll, xanthophyll and carotene. Starch is photosynthetic food product, but rarely oil as in *Vaucheria*. In chromatophores pyrenoids are present. Both flagella are equal in length i.e. they are isokonate. Majority of genera live in fresh water and few live in marine water. Cell wall is of cellulose e.g. *Chlamydononas, Chara, Vaucheria, Volvox, Cladophora, Stigiocloxeum, Ulothrix* and *Chlorena.*

RANGE OF THALLUS ORGANISATION IN CHLOROPHYCEAE

1. Unicellular algae:-These algae are single cells. All the vital function of life is performed by the single cell (occasionally the term a cellular). The unicellular algae are all sizes and shapes. They range from small spherical cells to large irregular shaped cells. Most of the shape variations are designed to increase the surface to volume ratio of the cells. The unicellular forms are :-
   - Unicellular motile forms (with flagella):- The motile uni-cell may be spherical, oblong, and pear-shaped or sometimes elongated bearing flagella eg. *Chlamydomonas.*



The two flagella may of equal length known as isokont.
Example- Chlamydomonas

Or of unequal length known as heterokont
Example -Gonyostomum

Fig. 1. 2: Unicellular (Single celled) motile forms (with flagella) Chlamydomonas

- Non-motile unicellular (without flagella -organ for locomotion):- Many unicellular algae do not possess any outgrowth for locomotion. Example - Chlorella

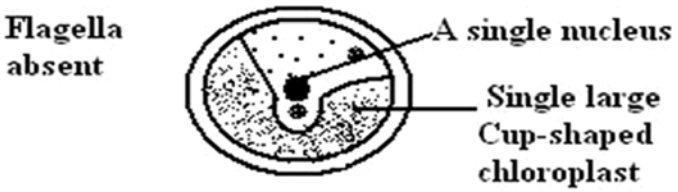


Fig. 1. 3: Non-motile uniclells-without flagella (organ for locomotion) - chlorella

Classification of Oocystis:-
Division -Chlorophyta
Class - Chlorophyceae
Order - Chlorococcales
Family - Oocystaceae
Genus - Oocystis

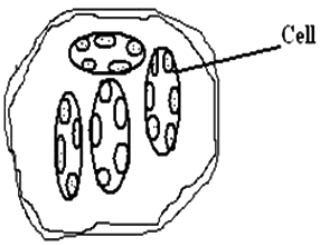


Fig. 1.4: Colony of Oocystis

Characteristic of family Oocystaceae- Colonies of non-fixed number of cells; cell body are of different shape; one or more chloroplasts variable in shape; asexual reproduction by auto spore or auto coenobium.

Characteristic of genus Oocystis-colony of 2-8 cells surrounded by cell wall of their mother cell, but sometimes unicellular; cell body broad ellipsoidal, both ends slightly pointed and with a thick cell wall; 1-3 chloroplasts parietal plate-like, with a single pyrenoid.

Some colonial algae possess flagella for motility. Oocystis is an example of a colonial green alga.

3. Coenobium algae:-These organisms are also found primarily in the aquatic environment. The coenobium (plural coenobia) is a colony with a fixed number of cells.

Classification of Pandorina

Division - Chlorophyta
Class - Chlorophyta
Order - Volvocales
Family - Volvocales
Genus - *Pandorina*

Characteristic of family Volvocaceae: Colonies consisting of a fixed of cells (coenobia)Characteristic of genus Pandorina : Colony (motile coenobium) spherical, 8-16 cells of similar size, close together, mutually compressed, 2-level mucliaginous envelope,cells with 2 equal-length flagella (isokont)2 contractile vacuoles anterior, nucleus central.

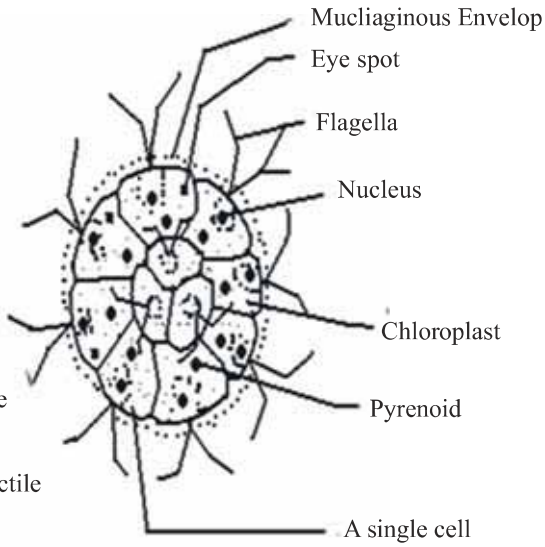


Fig. 5. Motile Coenbiun of *Pandorina*

Fig. 1. 6: Scendesnus a non-motile coenobium. Typically, this coenobium comprises 4 cells. The 2 end cells have horn-like projections of their walls.

The cells are often embedded in a mucilaginous matrix. Colonies are typically aggregations of cells, with 4 cells as in *Gonium*, 16 cells in *Pandorina*, 32 cells in *Eudorina*. *Volvox* is a colonial organism composed of thousands of cells that very closely resemble *Chlamydomonas*. So, each cell would be capable of independent life, but they are arranged to work in a coordinated fashion. Morphological variation is due to differences in number and plane of cell division only. Division in definite and consistent planes results in formation of a regular colony while division in random planes results in the formation of irregular colonies. Majority of the cells are vegetative and only a few are reproductive. The main point about colonies is that there is no division of labour and each cell can survive on its own.

Both motile (possess flagella) and non-motile coenobium are found among algae colonial algae.

1. Filamentous algae (floating or attached) :- When the colonial body form appears to be a dead end from an evolutionary viewpoint, the filamentous algae apparently had the morphological flexibility to develop into more complex aquatic and terrestrial plants. The simplest filamentous algae consist of a thallus (body) of a single chain of cells. This is the result of cell division in one plane only. The filaments may be :-
   - Unbrached filamentous forms:-Such types of thalli are found in many algae and consist of a straight row of cells.As a free living e.g. *Spirogyra* or attached e.g. *Ulothrix* and *Oedogonium*.
   - Simple branched filamentous forms: - When some cells in a filament show lateral outgrowth. Branching filaments occur when there is periodic division in a second plane.e.g *Cladophora*.
   - Heterotrichous forms (heteros =different): -Some cells in the filaments divide several times in different planes resulting in two parts.

Finally, some filamentous algae began to show some cellular differentiation. Where there are basal, prostrate filaments for attachment and erect branches for photosynthesis, this is said to be a heterotrichous filament e.g. *Fritschiella* sp.

1. These morphological features are an example of a parallel evolutionary adaptation to terrestrial life with the land plants. The flagellated reproductive cells show that *Fritschiella* is in fact closely related to the chlorophyte green algae, rather than to the charophyte green algae that gave rise to land plants

As a result tubular structure with the multinuclear cytoplasm lining is formed known as coenocytic as in Siphonales e.g. *Vaucheria, Caulerpa*

- Uniaxial type:-The outer sheathing layer of the axis is always one celled in thickness eg. Plant body of *Chara* consists of a series of nodes and internodes, a structure shared with other plant groups. The nodes are points where branching does occur and the internodes are the stem-like segments in between. These organisms differ from the green algae in having tissue types, including the differentiated reproductive bodies, but they do not have vascular tissues characteristic of many land plants.

- Parenchymatous algae:- Seaweeds made up of “boxy” cells like those of higher plants are termed parenchymatous. They may be membranous like *Ulva*, the sea lettuce. Some even have tissues and organs that resemble those of the higher land plants. However, these seaweeds are more closely related to the unicellular algae then they are to the land plants, and their anatomical complexity evolved independently. The term thallus (thalli pl.) is used to describe the seaweed body form. Typical seaweed has a root like holdfast which anchors the plant to the substrate, a stem like stipe, and a leaf like blade. The blades provide most of the photosynthetic surface for the algae.
- Siphonous algae :- The plant body undergoes repeated nuclear division without the accompanying formation of cell walls.

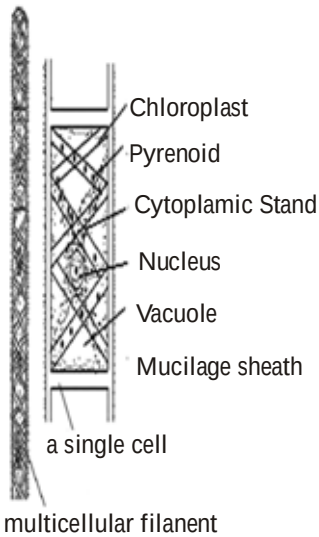
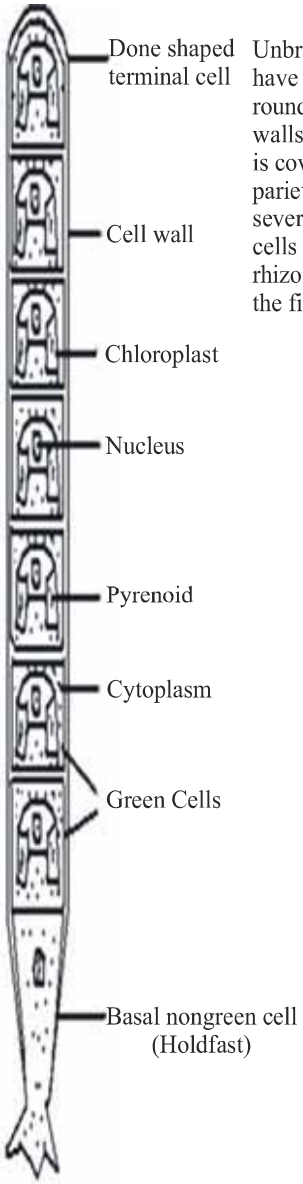


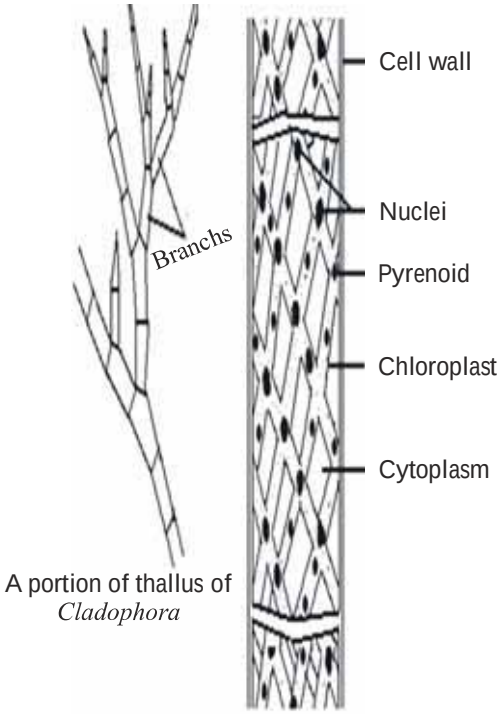
Fig. 1. 7: Free living unbrahed filamentous forms-*Spirogyra*

Spirogyra filaments are unbranched, straight and wiseriate. The cells are longer than broad and each contain at least one and as many as sixteen spiraled, ribbon-shaped, parietal chloroplast with numerous round paranoids. The nucleus is located in the center of the cells and is suspended stands of cytoplasm the cell periphery.



Unbranched *Ulothrix* filaments have cylindrical or occasionally rounded cells with thin or thick cell walls in H-shaped pieces. Each cell is covered by a single, lobed parietal, band-like chloroplast with several paranoids. Basal rhizoidal cells (holdfast) or a series of rhizoids from other cells can attach the filaments of the substrate.

Fig. 1. 8: Attached unbrached filamentous forms-*Ulothrix*



Cladophora is characterized by branching green filaments, whether sparse of profuse. The alga is divided into two parts basal, rhizodia base with short branches forming a so of mini holdfast to substrate, and erect thalli branching out of form filmentous sheets, dense cushions, 01 in certain environment, free living hollow "balls" The cells are multincleate and contain plenty of pyrenoid-packed chloroplast.

Fig. 9: Thallus of *Cladophora* showing branching

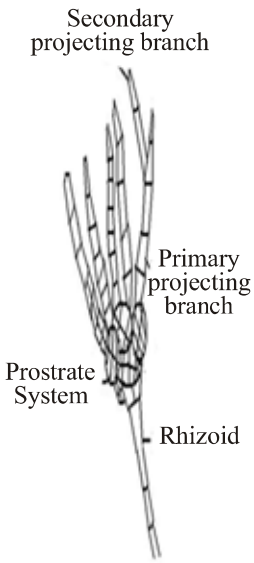
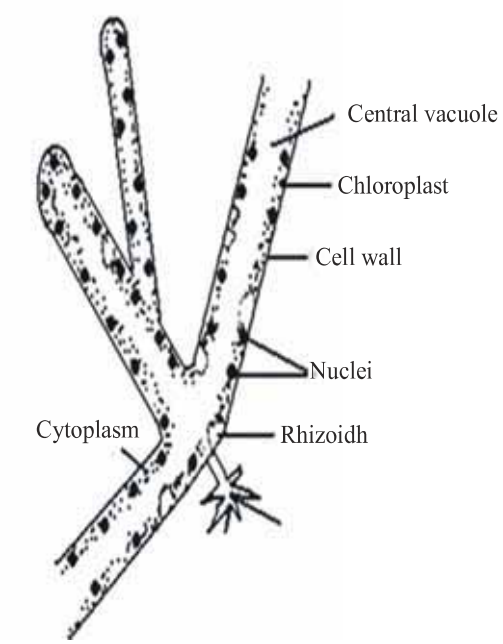


Fig. 1. 10: Heterotrichoses branching of *Fritschiella*



Vaucheria has saponaceous, coenocytic filaments that can form feel like mats, commonly known as "water felt" Cytokinesis does not usually follow mitosis, so the cells retain multiple nuclei. the thallus has cross walls only where gametes or zoospores were produced, and may be branched.The cytoplasm of *Vaucheria* is pushed to the cell periphery by large vacuoloes, and contains many nuclei and discoid plastids. The plastids can change their orientation in response to change in light levels. The large cells rely on cytoplasmic streaming to move materials around as needed.

Fig. 1. 10. Siphonous algae a portion of thallus of *Vaucheria*

Reproduction in Chlorophyceae

Most green algae reproduce both asexually (by mitosis) and sexually. The green algae also reproduce by vegetative method. Vegetative reproduction is by fragmentation.

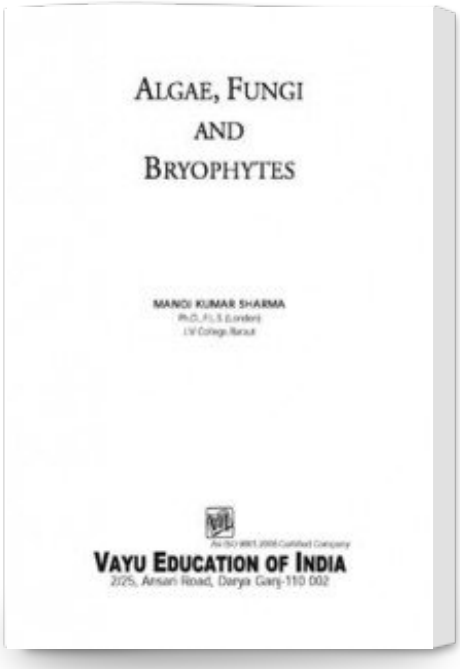
1. Asexual reproduction -In asexual reproduction only one parent is involved. On the basis of the types of spores produced, asexual reproduction is of different types. The spores may be motile i.e. zoospores or nonmotile i.e. Aplanospores.The spores on germination gives rise to new plants.
2. Sexual reproduction-Sexual reproduction takes place through fusion of two gametes takes places. On the basis of morphology and physiology of gametes, sexual reproduction is of three types.

   (i) Isogamous

   (ii) Anisogamous

   (iii) Oogamous

Algae, Fungi, and Bryophytes



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