ALGAE

Characteristics of Algae:

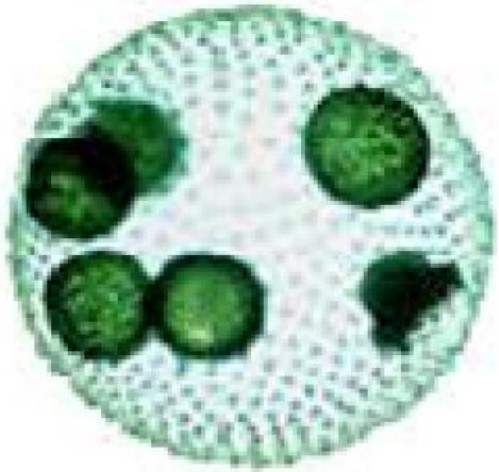
Algae are chlorophyll-bearing autotrophic thalloid plant body.

Almost all the **algae** are aquatic. ...

The plant body may be unicellular to large robust multicellular structure.

The multicellular complex thalli lack vascular tissue and also show little differentiation of tissues.

Chalmydomonas

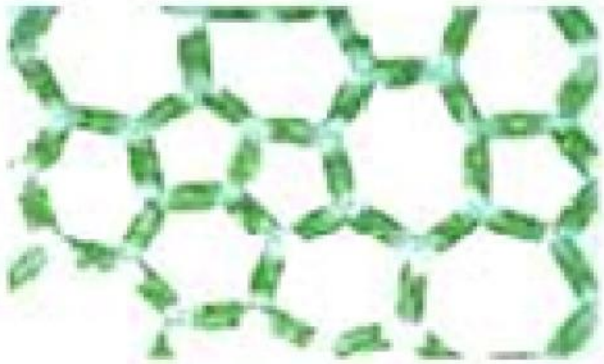


Volvox

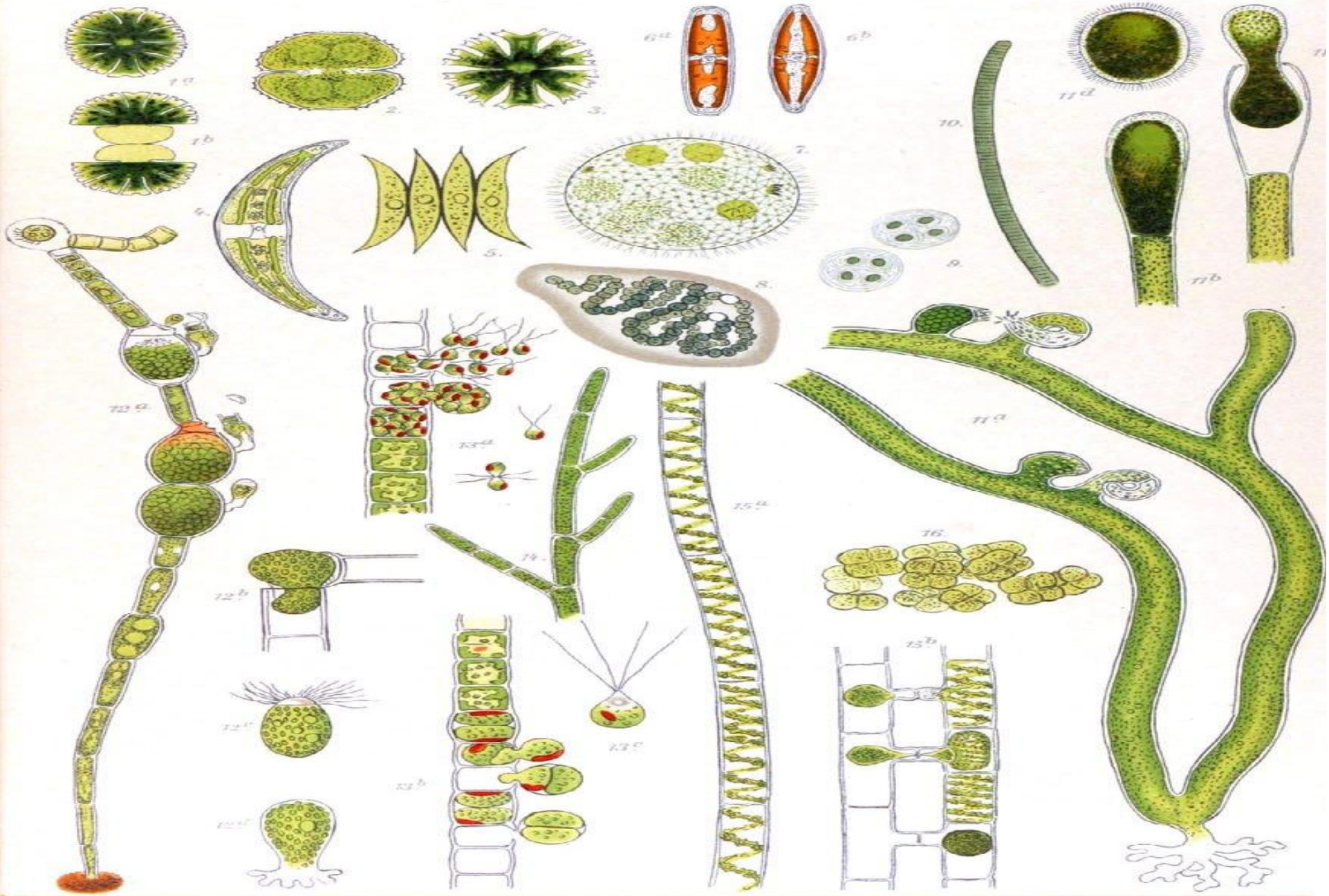
Ulothrix

Fristschiella

Ulva



Hydrodictyon



Algen.

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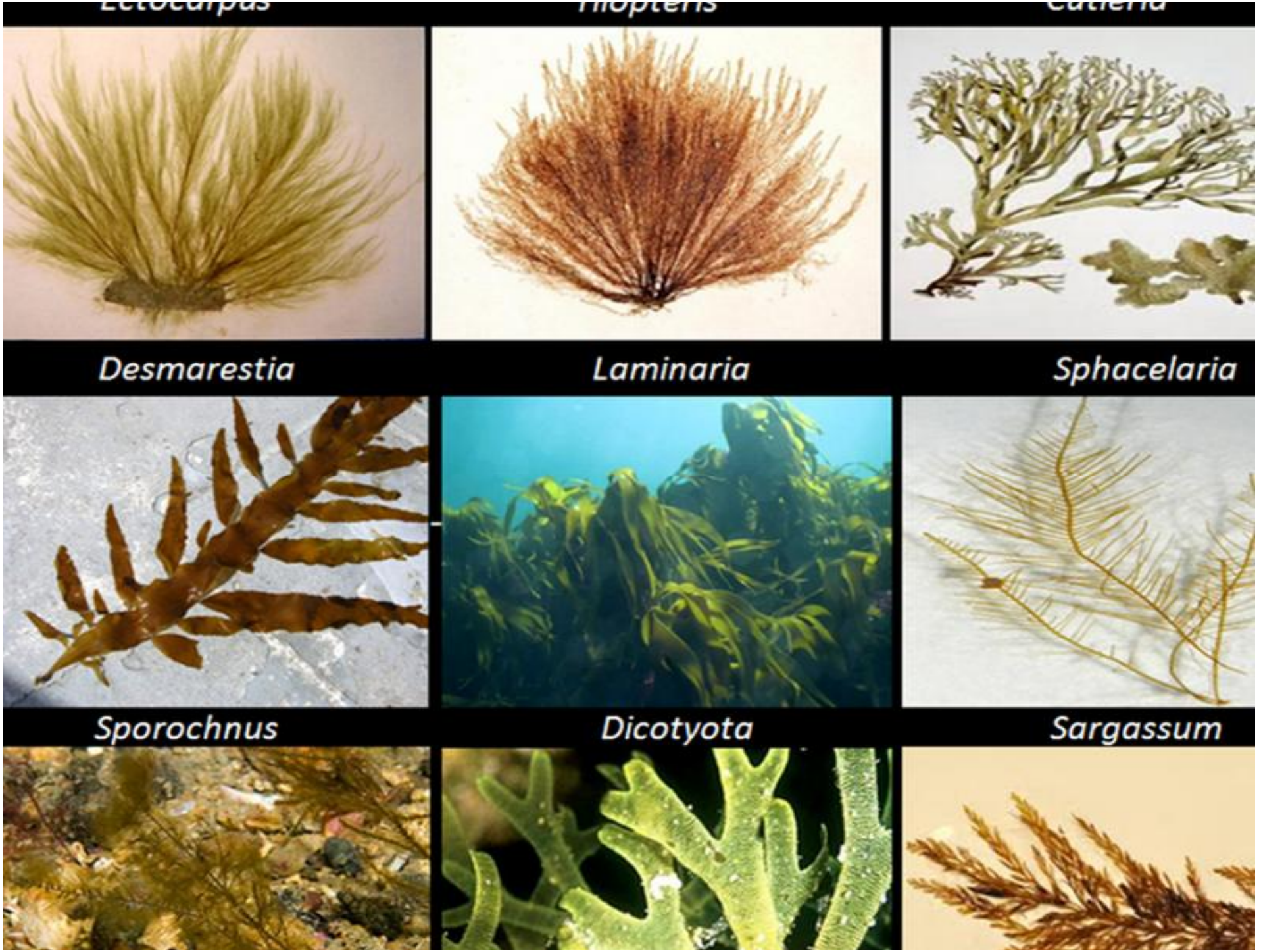
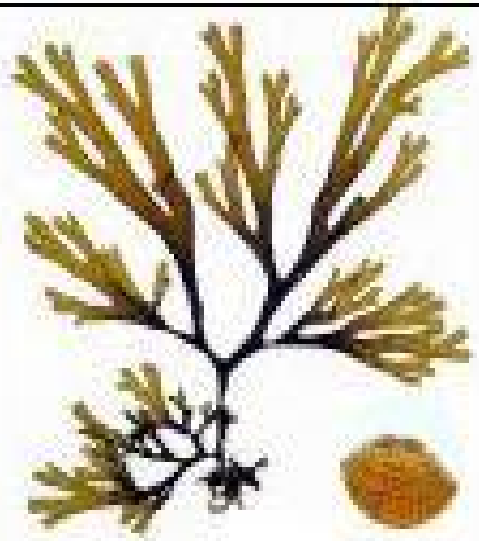

Desmarestia
Laminaria
Sphacelaria
Sporochnus
Dicotyota
Sargassum



Dictyota

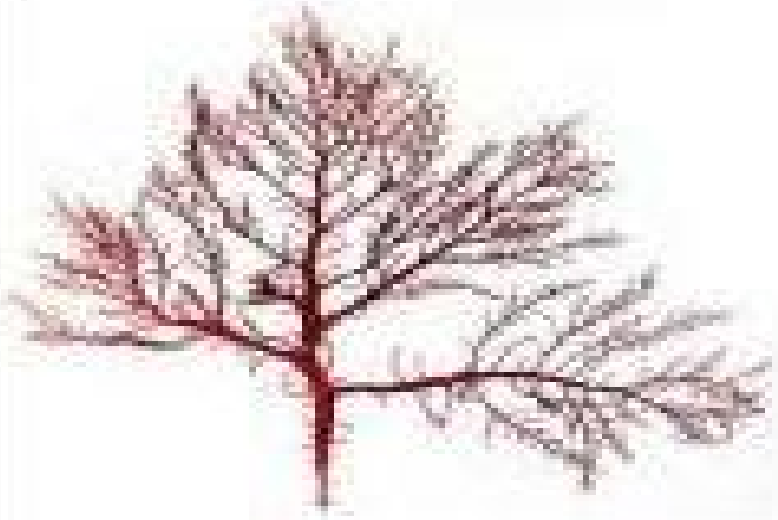
Cutleria

Fucus

Marcocytosis

Sargassum

Padina



Gelidium

Chondrus

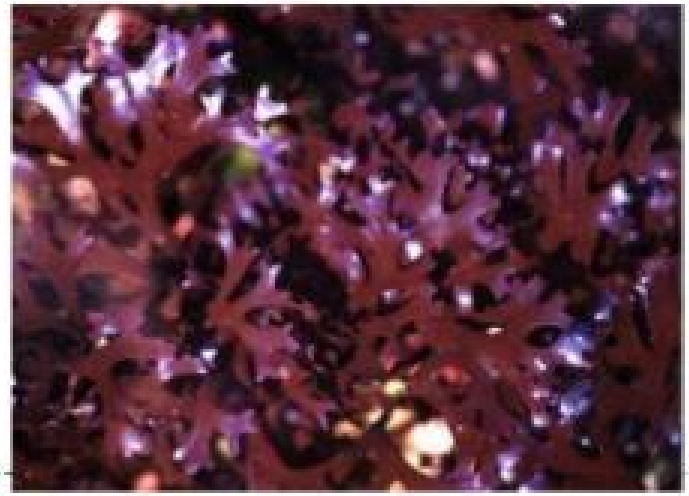
Plumaria

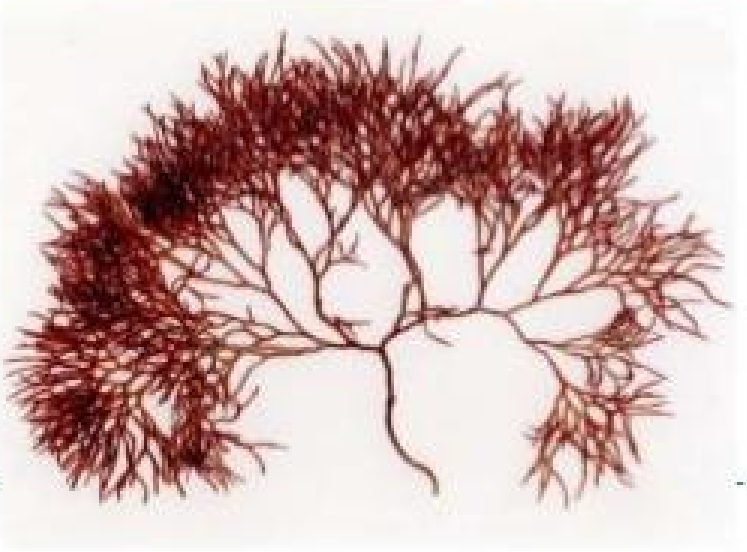
Rhodymenia palmata

Other Red Algae

- Palmaria

- Chondrus





Characteristics of Algae:

1. Algae are chlorophyll-bearing autotrophic thalloid plant body.
2. Almost all the algae are aquatic.
3. The plant body may be unicellular to large robust multicellular structure.
4. The multicellular complex thalli lack vascular tissue and also show little differentiation of tissues.
5. The sex organs are generally unicellular but, when multicellular, all cells are fertile and in most cases the entire structure does not have any protection jacket.
6. The zygote undergoes further development either by mitosis or meiosis, but not through embryo formation.
7. Plants having distinct alternation of generations. Both gametophyte and sporophyte generations — when present in the life cycle are independent.

Occurrence of Algae:

Algae are commonly presumed to be occurring in water and moist places but algae are found in a variety of habitats.

The common places of occurrence of algae are as follows:

(i) Aquatic Algae:

Aquatic algae can be:

(a) Fresh water forms

(b) Marine forms.

(a) Fresh water forms:

Fresh water forms are found in water of low salinity such as in ponds, lakes, rivers, ditches etc. Cladophora, Vaucheria, Chara and some algae found in slow running water while Spirogyra, Chlamydomonas, Hydrodictyon and Volvox are found in stagnant water.

(b) Marine forms:

The algae found in sea water are called marine algae. Such algae grow in water of high salinity. Marine algae can be macroscopic and very large in size e.g., Macrocystis (70 meters) and Nereocystis (100 meters).

Some other examples of marine algae are:

Enteromorpha, Sargassum, Fucus, Polysiplionia, Gelidium and Gracilaria etc.

(ii) Terrestrial Algae:

Algae growing on moist soil surface, stones and rocks are terrestrial algae. The algae growing on surface of soil are called saprophytes and the algae growing under the surface of soil are called cryptophytes. Some terrestrial algae grow on moist walls and barks of trees. These algae absorb CO_2 and water from atmosphere.

Some common terrestrial algae are:

Fritschiella, Vaucheria, Chlorella, and Oscillatoria.

(iii) Lithophytic Algae:

Algae growing on surface of rocks and stones are lithophytic e.g., Nostoc, Gloeocapsa.

(iv) Halophytic Algae:

Algae growing in water of high concentration of salts as in salt lakes are halophytic algae e.g., Chlamydomonas ehrenbergii and Dunaliella.

(v) Thermophytic Algae:

The thermophytic algae grow in water of high temperature where other plant forms cannot grow. Some blue green algae are capable of growing at very high temperature because of unorganized nucleus. The thermal algae found in hot water springs are Oscillatoria, Scytonema etc.

(vi) Cryophytic Algae:

Algae occurring in snow and ice are cryophytic algae. These algae impart special colours to snow due to their pigments. Red snow is caused by Haematococcus nivalis and Chlamydomonas nivalis. Green snow is caused by Chlamydomonas yellowstonensis. Purple brown snow is caused by Ancyclonema nordenskliooldii. Black snow is caused by Raphidonema.

(vii) Epiphytic Algae:
Algae growing on other algae and plants are called epiphytic algae e.g., Polysiphonia, Oedogonium are found growing on other algae, bryophytes and aquatic angiosperms.

(viii) Epizoic Algae:
Algae growing on other animals are called epizoic algae e.g., Cladophora crisposa grows on snails, Stigeoclonium grows on gills of fishes.

(ix) Endophytic Algae:
Algae growing inside other plants are called endophytic algae e.g., Nostoc is found in thallus of Anthoceros, Anabaena cycadearum is found in coralloid root of Cycas, Anabaena azollae is found in Azolla.

(x) Endozoic Algae:
Algae found inside the body of animals are endozoic algae e.g., Zoo chlorella is found in Hydra and sponges. Some blue green algae are found in respiratory and digestive tracts of animals.

(xi) Parasitic Algae:

Some algae can be found as parasites on plants and animals e.g., Cephaleuros is found on leaves of tea, coffee and mango plants and causes red rust. Polysiphonia fastigiate is semi-parasitic on algae Ascophyllum.

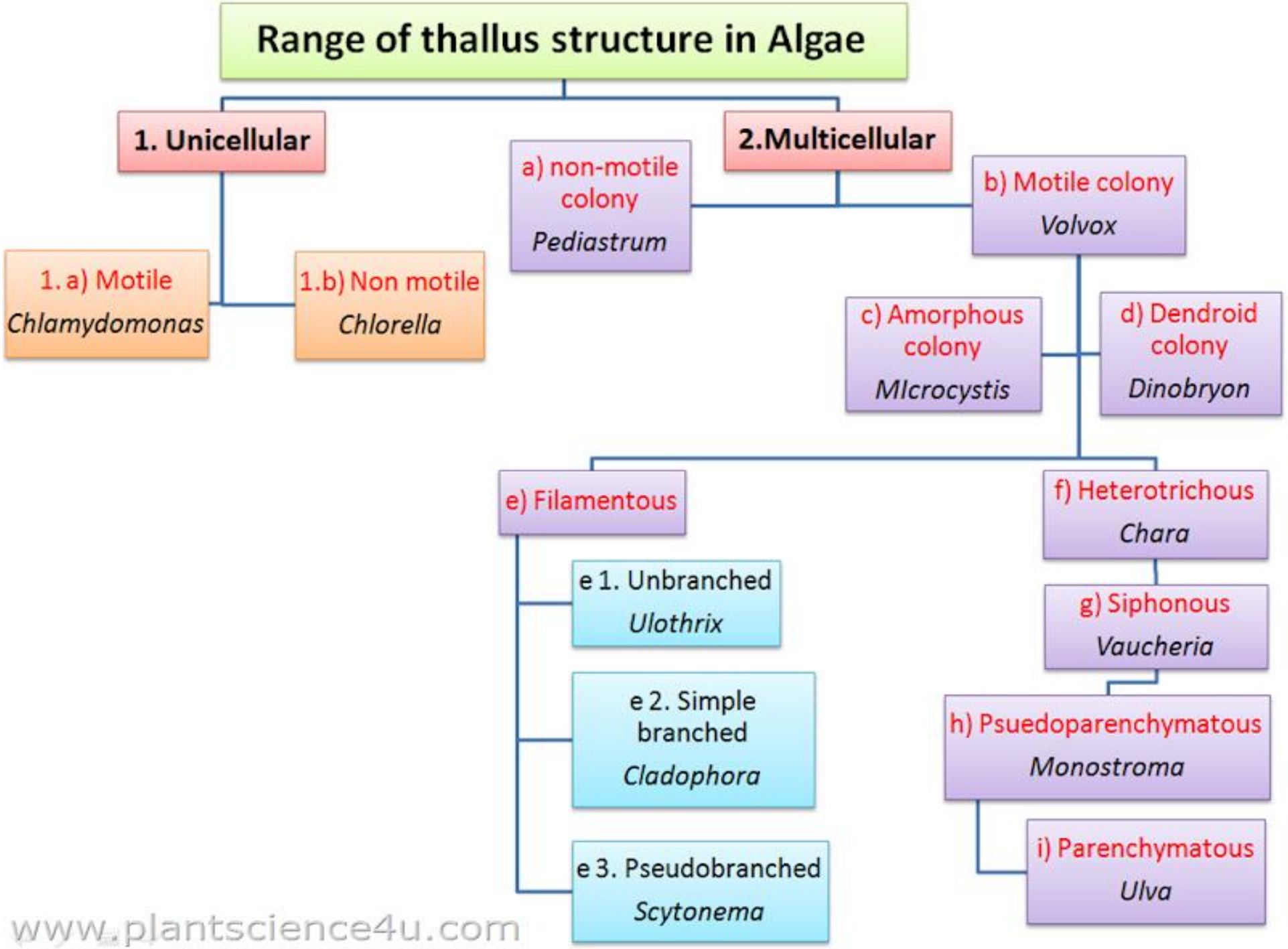
(xii) Symbiotic Algae:

Some algae of Chlorophyceae and Cyanophyceae are found in symbiotic association with other plants. Nostoc and Anabaena make symbiotic association with Anthoceros and coralloid roots of Cycas. Lichens are symbiotic association of algae and fungi.

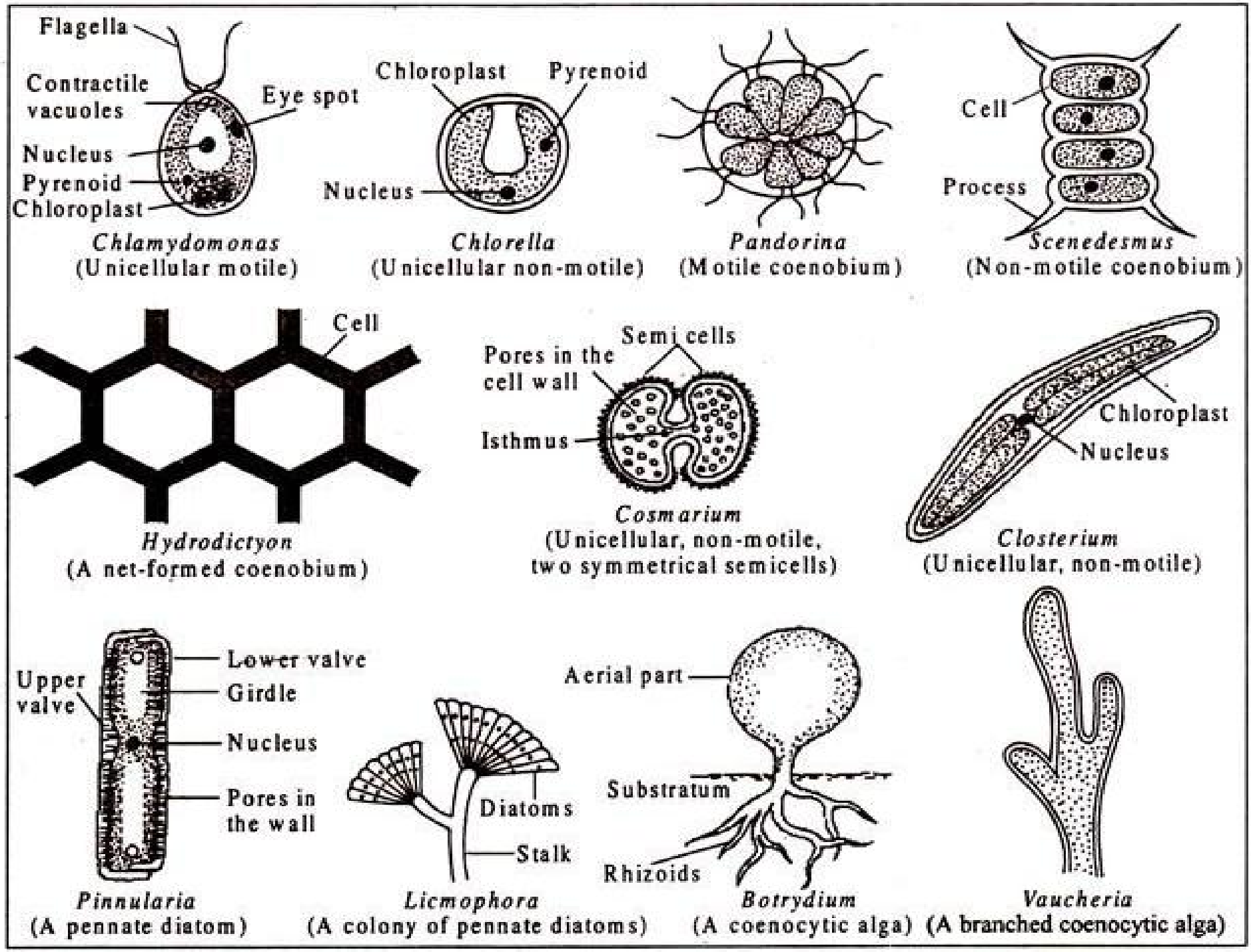
(xiii) Planktons:

Algae growing on surface of water and found as free floating on surface of water are called planktons. Planktonic algae are mainly members of Chlorophyceae, Cyanophyceae and Bacillariophyceae. When planktonic algae grow fast and increase enormously in number, these algae form water blooms.

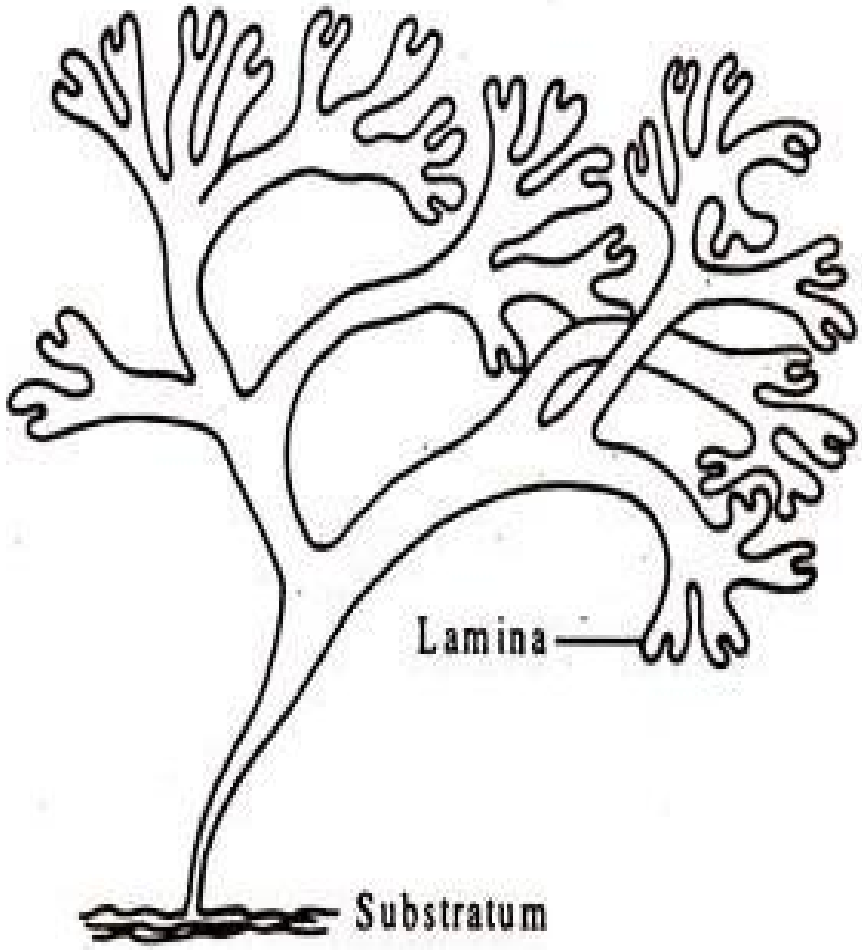
Type	Habitat	Example
1. Freshwater	in ponds, rivers, lakes etc.	*Spirogyra*, *Ulothrix*, *Zygnema*, *Cladophora*
2. Benthic	in mud	*Chara*, *Nitella*
3. Marine	in sea waters	Red algae & Brown algae (Sea weeds or kelps)
4. Terrestrial	on moist soil, stores	*Nostoc Vaucheria*, *Fritscheiella*, *Botrydium*
5. Thermophytic	in hot springs or in high temperature 70-80° C	*Oscillatoria*, *Phormidium*, *Haplosiphon*, *Scytonema*, *Synechococcus* etc.
6. Lithophytic	on rocks	*Rivularia*, *Parasiola*
7. Halophytic	in saline water	*Stephanoptera*, *Dunaliella*, *Enteromorpha*
8. Cryophytic	In show or ice	*Chamydomonas nivalis* in red snow, *C. yellowstonesis* in green snow and *Scotiella nivalis* in black snow.
7. Cryptophytic	oil surface	*Nostoc*
8. Epiphytic	on plants	*Microspora*, *Oedogonium*
9. Endophytic	inside plants	*Anabaena* inside coralloid root of *Cycas*
10. Epizoic	on animals	*Cladophora* on snail
11. Endozoic	inside animals	*Zoochorella* in hydra
12. Parasitic	Obtain food from host	*Cephaleuros* caused red rust of tea
13. Symbiotic	Mutually beneficial relationship	*Nostoc*, *Anabaena* etc., in Lichen, BGA, inside protozoa (cyanallae)



Leliaert *et al.*, *Crit. Rev. Plant Sci.* 31:1-46 (2012)

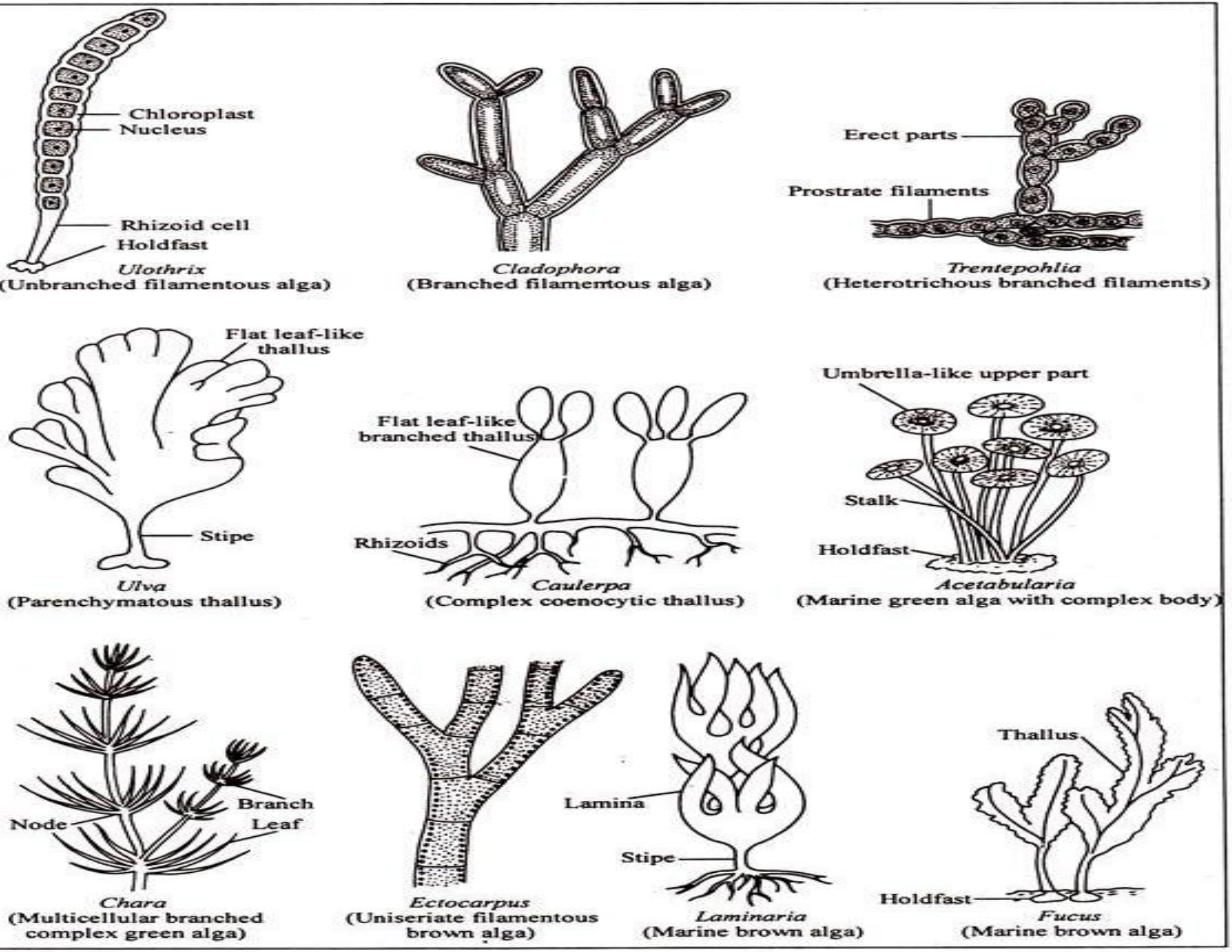

Flagella
Contractile vacuoles
Eye spot
Nucleus
Pyrenoid
Chloroplast
Chlamydomonas
(Unicellular motile)
Chloroplast
Pyrenoid
Nucleus
Chlorella
(Unicellular non-motile)
Pandorina
(Motile coenobium)
Cell
Process
Scenedesmus
(Non-motile coenobium)
Cell
Hydrodictyon
(A net-formed coenobium)
Semi cells
Pores in the cell wall
Isthmus
Cosmarium
(Unicellular, non-motile, two symmetrical semicells)
Chloroplast
Nucleus
Closterium
(Unicellular, non-motile)
Upper valve
Lower valve
Girdle
Nucleus
Pores in the wall
Pinnularia
(A pennate diatom)
Diatoms
Stalk
Licmophora
(A colony of pennate diatoms)
Aerial part
Substratum
Rhizoids
Botrydium
(A coenocytic alga)
Vaucheria
(A branched coenocytic alga)

Batrachospermum (fresh-water red alga)



Chondrus (marine red alga)

Fig. 5.31 : Gross morphology of some representative algae belonging to different taxonomic groups


Chloroplast
Nucleus
Rhizoid cell
Holdfast
Ulothrix
(Unbranched filamentous alga)
Cladophora
(Branched filamentous alga)
Erect parts
Prostrate filaments
Trentepohlia
(Heterotrichous branched filaments)
Flat leaf-like thallus
Stipe
Ulva
(Parenchymatous thallus)
Flat leaf-like branched thallus
Rhizoids
Caulerpa
(Complex coenocytic thallus)
Umbrella-like upper part
Stalk
Holdfast
Acetabularia
(Marine green alga with complex body)
Branch
Node
Leaf
Chara
(Multicellular branched complex green alga)
Ectocarpus
(Uniseriate filamentous brown alga)
Lamina
Stipe
Laminaria
(Marine brown alga)
Thallus
Holdfast
Fucus
(Marine brown alga)

Thallus Organization in Algae:

Thalli of algae show a range of organization starting from unicellular form to highly organized multicellular habit where the plant body is differentiated into root-like, stem-like, and leaf -like structures giving a higher plant-like appearance. Their size ranges from a few micron to several meters.

A. Unicellular Algae:

Unicellular forms of algae are also called acellular algae as they function as complete living organisms.

Unicellular forms are common in all the groups of algae except Rhodophyceae, Phaeophyceae and Charophyceae.

The unicells may be motile or non-motile.

a. The motile unicells are either rhizopodial or flagellated.

The rhizopodial forms lack rigid cell wall and have cytoplasmic projections that help them in amoeboid movement, e.g., Chrysamoeba (Chrysophyceae, Fig. 3.1 A), Rhizochloris (Xanthophyceae).

The flagellated unicells resemble the motile gametes and zoospores. The flagella function as the organ of locomotion varying in number and type in different groups. The flagellated unicells are found in many groups of algae, e.g., Phacotus (Fig. 3.1 B) and Chlamydomonas (Fig. 3.1 C), of Chlorophyceae. Euglena of Euglenophyceae etc.

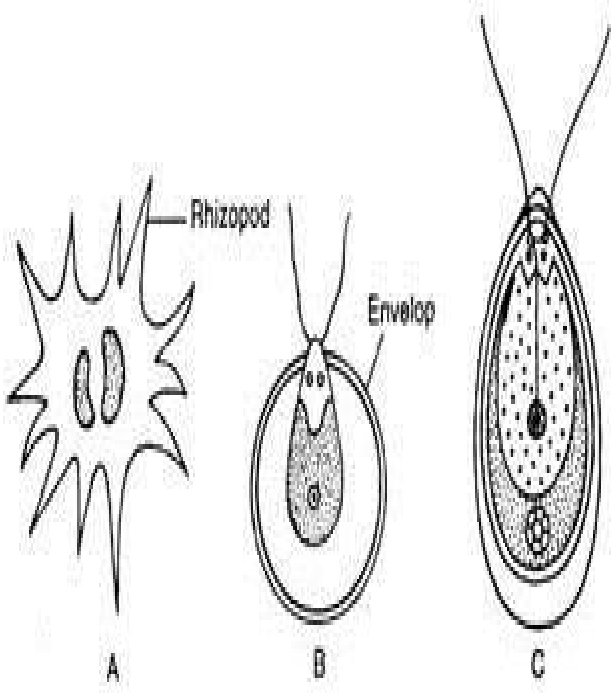


Fig. 3.1 : Unicellular motile algae : A. *Chrysamoeba*, B. *Phacotus*, and C. *Chlamydomonas*

b. The non-motile cells may be spiral filament as found in Spirulina (Cyanophyceae) (Fig. 3.2A). The coccoid unicellular algae are the simplest forms of algae found in Cyanophyceae, Chlorophyceae etc., e.g., Gloeocapsa, Chlorella (Fig. 3.2B).

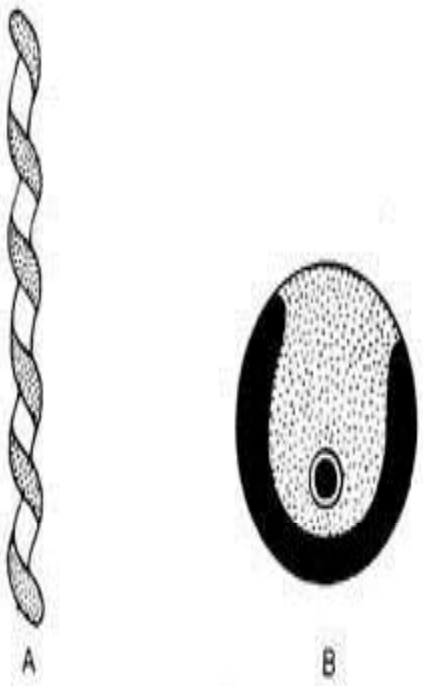


Fig. 3.2 : Unicellular non-motile algae, A. *Spirulina*, and B. *Chlorella*

B. Multicellular Algae:

1. Colonial:

The colonial habit is achieved by loose aggregation of cells within a common mucilaginous investment. The cells of these usually remain connected with each other by cytoplasmic threads.

a. Coenohium:

When a colony has a definite number of cells with a definite shape and arrangement, it is called coenobium.

Coenobium may be:

i. Motile, or

ii. Non- motile.

i. In motile form, cells are flagellated and whole coenobium can move by the organised beating action of flagella, e.g., Volvox (Fig. 3.3A), Pandorina (Fig. 3.3B), Eudorina etc. In Volvox the coenobium is a hollow sphere.

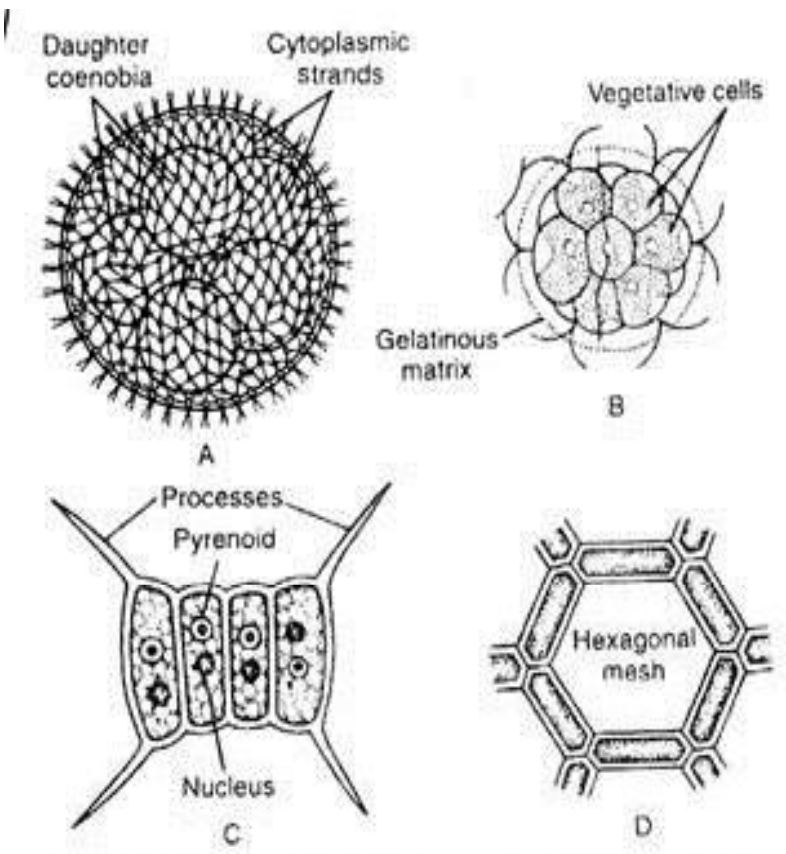


Fig. 3.3 : Colonial algae : A. *Volvox*, B. *Pandorina*, C. *Scenedesmus*, and D. *Hydrodictyon*

ii. In non-motile form, the cells are without flagella, thereby the coenobium is non- motile, e.g., Scenedesmus (Fig. 3.3C), Hydrodictyon (Fig. 3.3D).

b. Aggregated Form:

Unlike coenobium the cells are aggregated irregularly showing a colonial mass of various size and shape.

It is of three types:

i. Palmelloid,

ii. Dendroid, and

iii. Rhizopodial.

i. Palmelloid:

In this type the non- motile cells remain embedded in an amorphous gelatinous or mucilaginous matrix. Each and every cell of the organization is independent and can perform all the functions as an individual. Chlamydomonas and Chromulina represent palmelloid as a temporary feature in their life cycle.

But in Tetraspora (Fig. 3.4A, B) and Palmodictyon (Chlorophyceae), Gleochloris and Chlorosaccus (Xanthophyceae), Phaeocystis (Chrysophyceae) and Microcystis (Cyanophyceae), the palmelloid habit is a permanent feature.

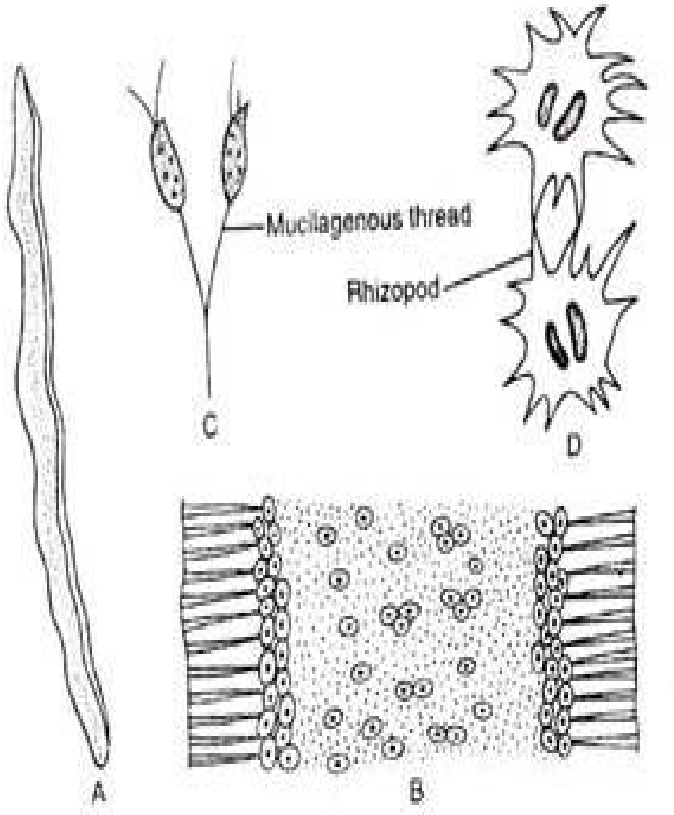


Fig. 3.4 : Aggregated form : A. *Tetraspora*, B. *Tetraspora*, (portion of a colony in T.S.), C. *Chrysodendron* and D. *Chrysidiastrum*

ii. Dendroid:
In this type the number, shape and size of the cell is variable. They look like microscopic trees (e.g., Chrysodendron, Fig. 3.4C; etc.). A mucilaginous thread is present at the base of each cell.

iii. Rhizopodial:
In this type the cells are united through rhizopodia. e.g., Chrysidiastrum (Chrysophyceae, Fig. 3.4D).

2. Filamentous:

The filamentous plant body is formed through repeated cell divisions in a single plane and in a single direction, where the cells remain firmly attached to each other — end to end forming a chain or a thread. The fila-ments may be unbranched or branched.

a. Unbranched Filament:

It may be free-floating (e.g., Spirogyra, Fig. 3.5A) or attached to the substratum (e.g., Ulothrix, Oedogonium, etc.). The free-floating unbranched filaments are not differentiated into basal and apical ends. All the cells in the filament are alike. But the Unbranched filaments that remain attached to the substratum are differentiated into base and apex.

b. Branched Filament:

It is formed when a filament occasionally starts division in a second plane.

It is of two types:

i. Falsely branched, and

ii. Truly branched.

i. Falsely Branched:

The trichomes of blue greens may break either due to death or decay of the intercalary cells. The broken ends emerge out of the mucilaginous sheath in the form of a branch. They do not arise as lateral out-growths, e.g., Scytonema (Fig. 3.5C).

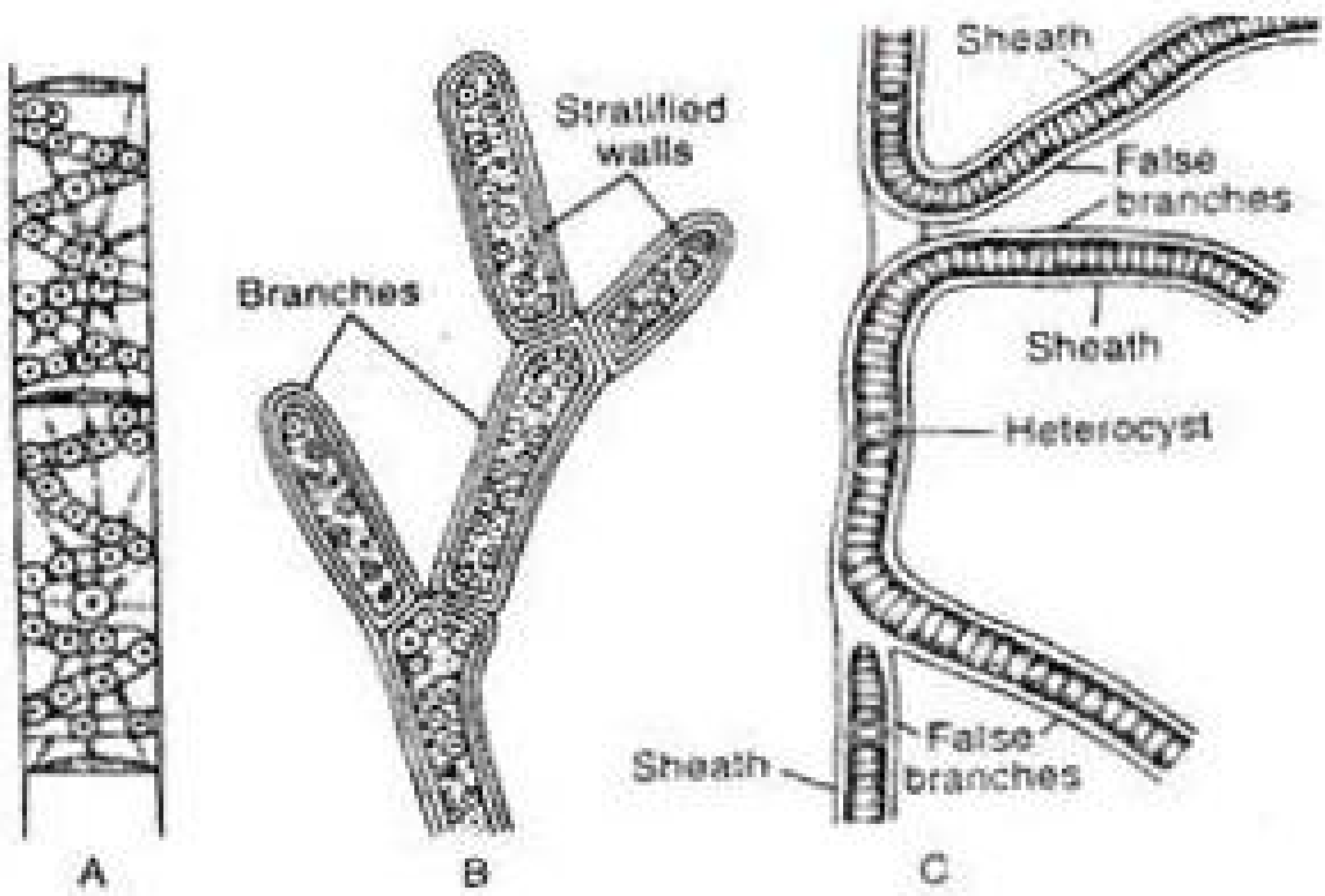
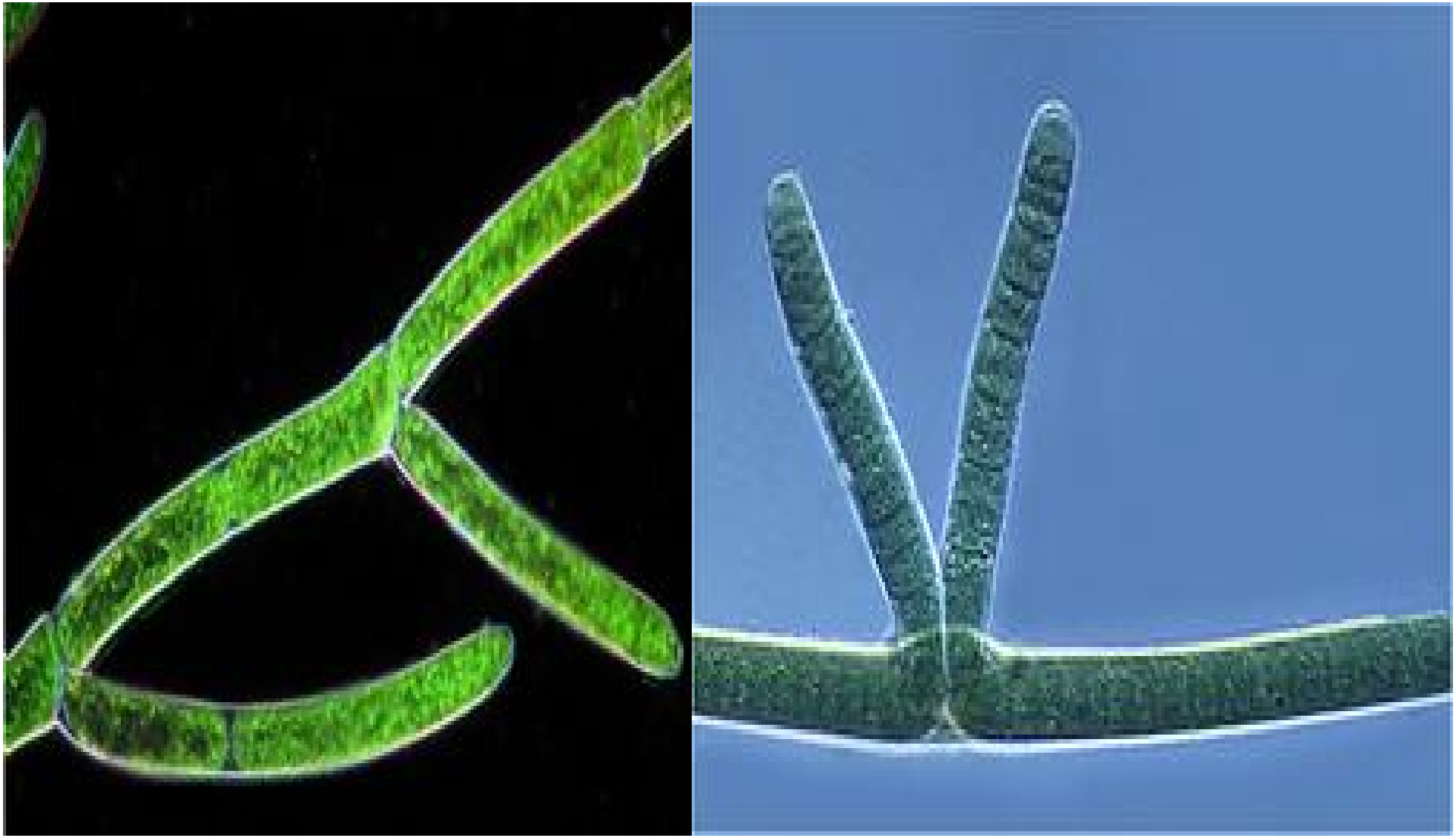


Fig. 3.5 : Filamentous type : A. *Spirogyra*, B. *Cladophora* and C. *Scytonema*



Cladophora and Scytonema

ii. Truly Branched:

When a cell in the filament occasionally starts division in a second plane, true branch is formed. Thus true branches arise as lateral outgrowths of the main filament. True branches are of the following three types: Simple filament, Heterotrichous habit, and Pseudoparenchymatous habit.

Simple Filament:

In this branching system the whole thallus remain attached to the substratum by a basal cell and the branches may arise from any cell of the filament except the basal cell, e.g., Cladophora (Fig. 3.5B).

Heterotrichous Habit:
In this branching system the whole thallus is differentiated into prostrate and erect system. Both the prostrate and erect systems may be well-developed (e.g., Fritschiella, Ectocarpus, Fig. 3.6A). Progressive elimination of the prostrate system is observed in Draparnaldiopsis (Fig. 3.6B), Stigoclonium, oi of the erect system as in Coleochaete (Fig. 3.6C).

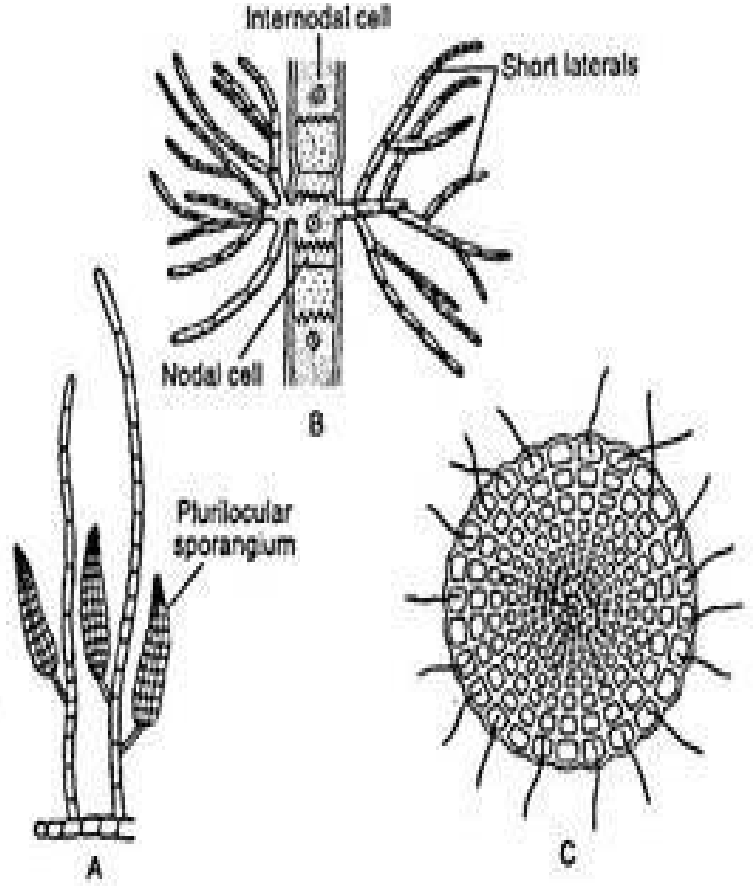


Fig. 3.6 : Branched filament showing heterotrichous habit : A. *Ectocarpus*, B. *Draparnaldiopsis*, and C. *Coleochaete*

Pseudoparenchymatous Habit:

If one or more central or axial filaments together with their branches fuse to form a parenchymatous structure, it is called pseudoparenchymatous. thallus. Again, if it is formed by the branches of a single filament it is known as uniaxial (e.g., Batrachospermum, Fig. 3.7A, B), or it may be multiaxial where more than one filament are involved (e.g., Polysiphonia, Fig. 3.7C).

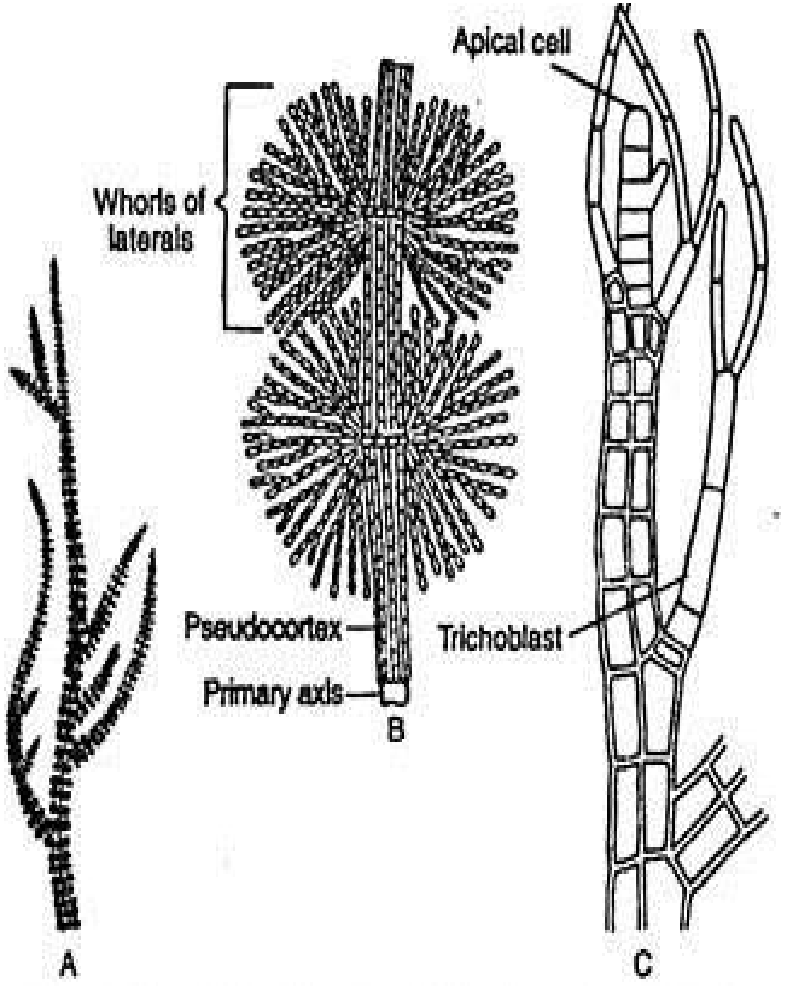


Fig. 3.7 : Pseudoparenchymatous habit : A. *Batrachospermum*, B. *Batrachospermum* (portion of the plant body), and C. *Polysiphonia*

3. Siphonaceous Forms:
In this form the thallus is aseptate and multinucleate i.e., a coenocyte. It may be simple branched (e.g., Vaucheria, Fig. 3.8A) or may be very elaborate with clear division of labour, differentiated into aerial and subterranean portions (e.g., Botrydium, Fig. 3.8B).

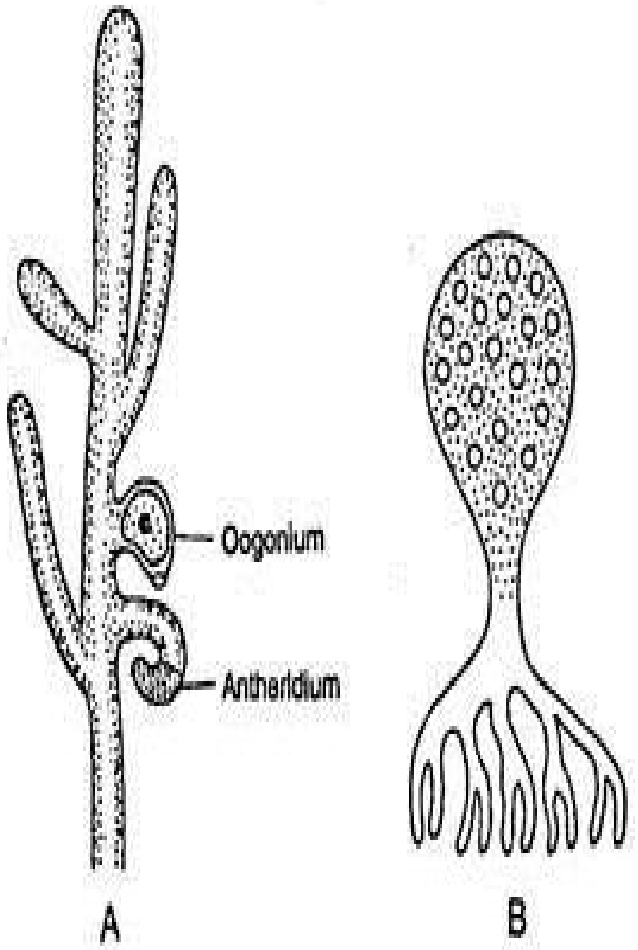


Fig. 3.8 : Siphonaceous algae : A. *Vaucheria*, and B. *Botrydium*

4. Parenchymatous Forms:
When the cells of a filament divide in multidirectional planes, it results the formation c a parenchymatous thallus and ultimately becoming foliose and flat (e.g., Ulva, Fig. 3.9A), tubular (e.g., Enteromorpha, Scytosiphon) or complex (e.g., Sargassum, Fig. 3.9B) structure. Growth of the parenchymatous thalli may be diffused (when all the cells can divide), intercalar (when the dividing region remain in the intercalary position) e.g., Laminaria (Fig. 3.9C), trichothallic (growth by a specialized intercalary meristem at the base of a terminal hair) e.g., Porphyra or apical (when one or more well-defined apical cells divide to produce the remainder of the thallus), e.g., Fucus.

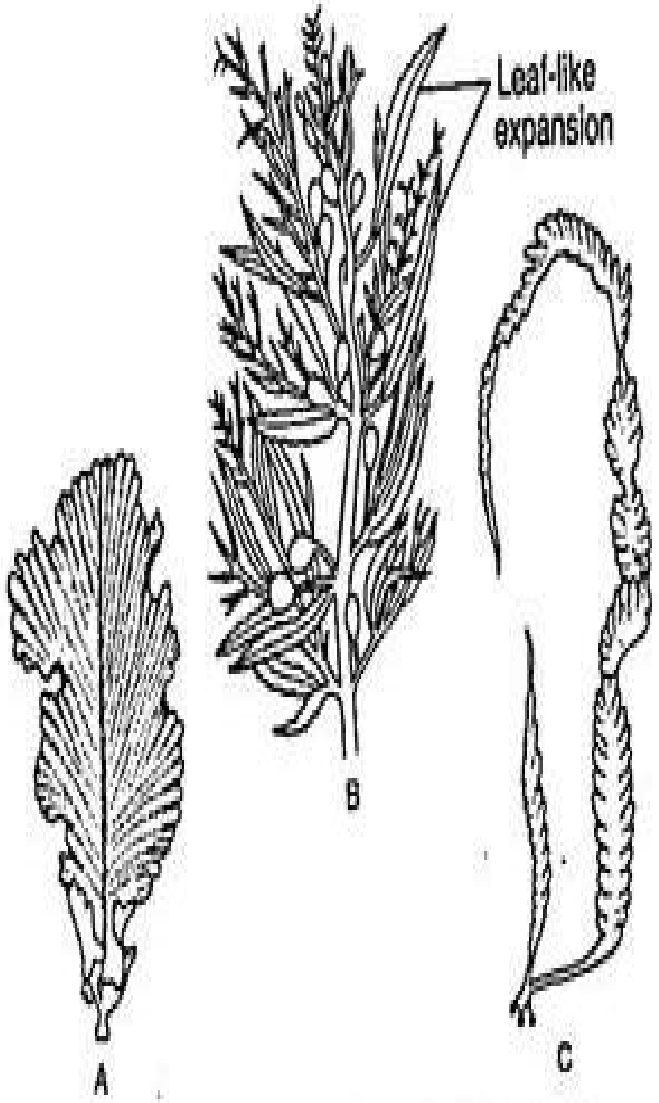


Fig. 3.9 : Parenchymatous algae : A. *Ulva*, B. *Sargassum*, and C. *Laminaria*

THANKS