PHYCOLOGY
ALGAE:
GENERAL CHARACTERISTICS

Dr. SONI GUPTA

- What are algae?
- General characteristics of algae
- Classification of algae based on habitat
- Thallus diversity in algae
- Chloroplast shape variations in algae
- Pigmentation in algae
- Reproduction in algae
- Life cycle in algae

Derived from Latin word *Algos*-sea weed
PHYCOLOGY: Branch of biology which deals with algae
PHYCOLOGISTS: Scientists who study algae
Thallophyta: Along with fungi

Distinct features:

- Presence of chlorophyll
- Plant body is thalloid: do not get differentiated into root, stem or leaf
- Mode of nutrition is autotrophic
- Sex organs are unicellular, when multicellular each cell is fertile and there is no jacket of sterile cells
- There is no embryo formation after gamete fusion
- Vascular system is absent
- Cell wall generally contain cellulose
- Shows distinct alternation of generation

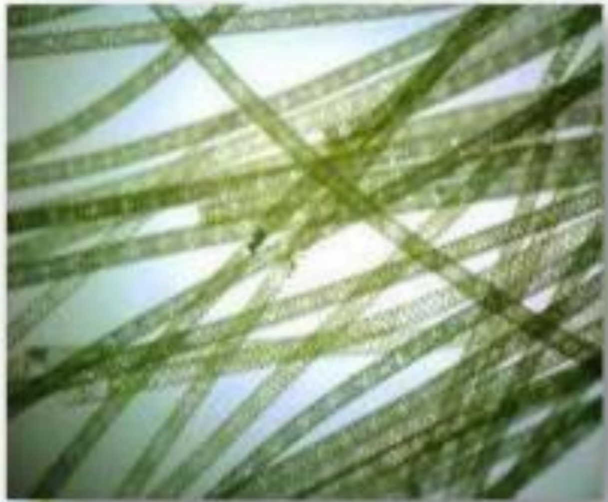
Smallest: Chlamydomonas, Chlorella (Unicellular and microscopic
Largest: Macrocystis (Multicelluar, macroscopic, several metres in length)

ALGAE: THALLUS DIVERSITY

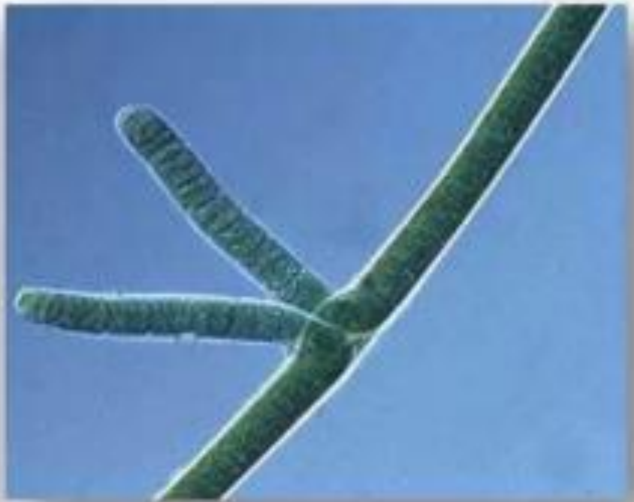
Desmids

Cladophora

Oscillatoria



Spirogyra



Scytonema

Cladophora

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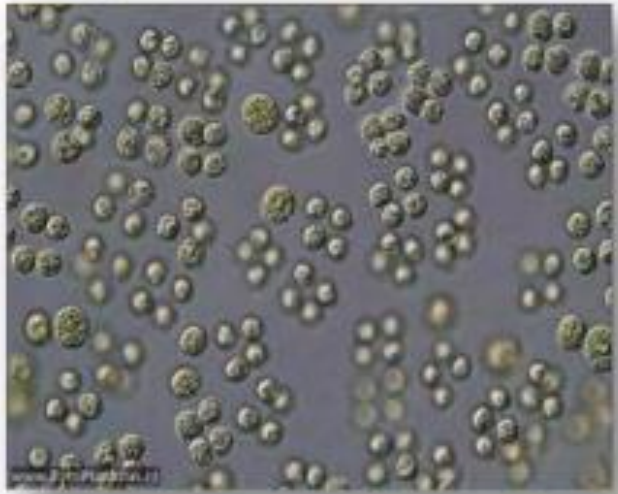
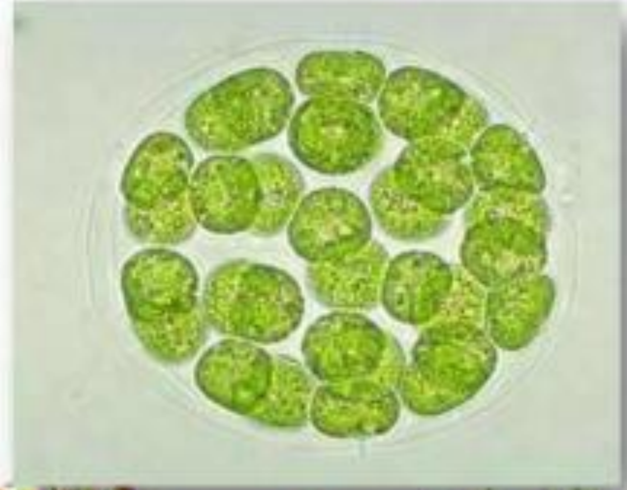
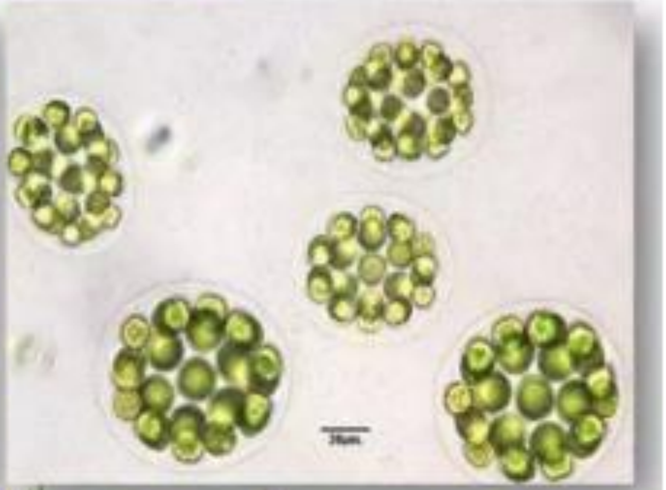


Colonial Forms





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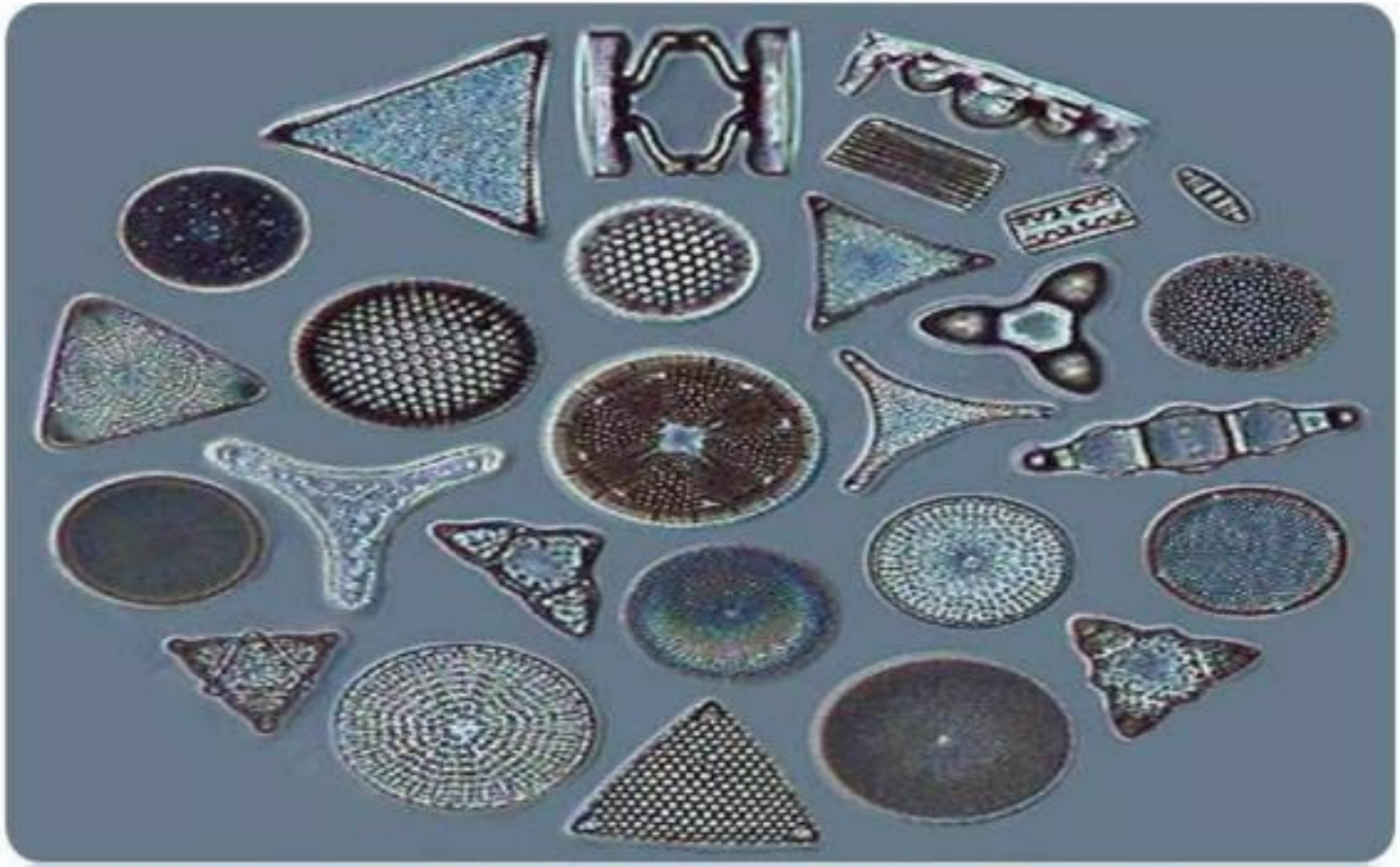
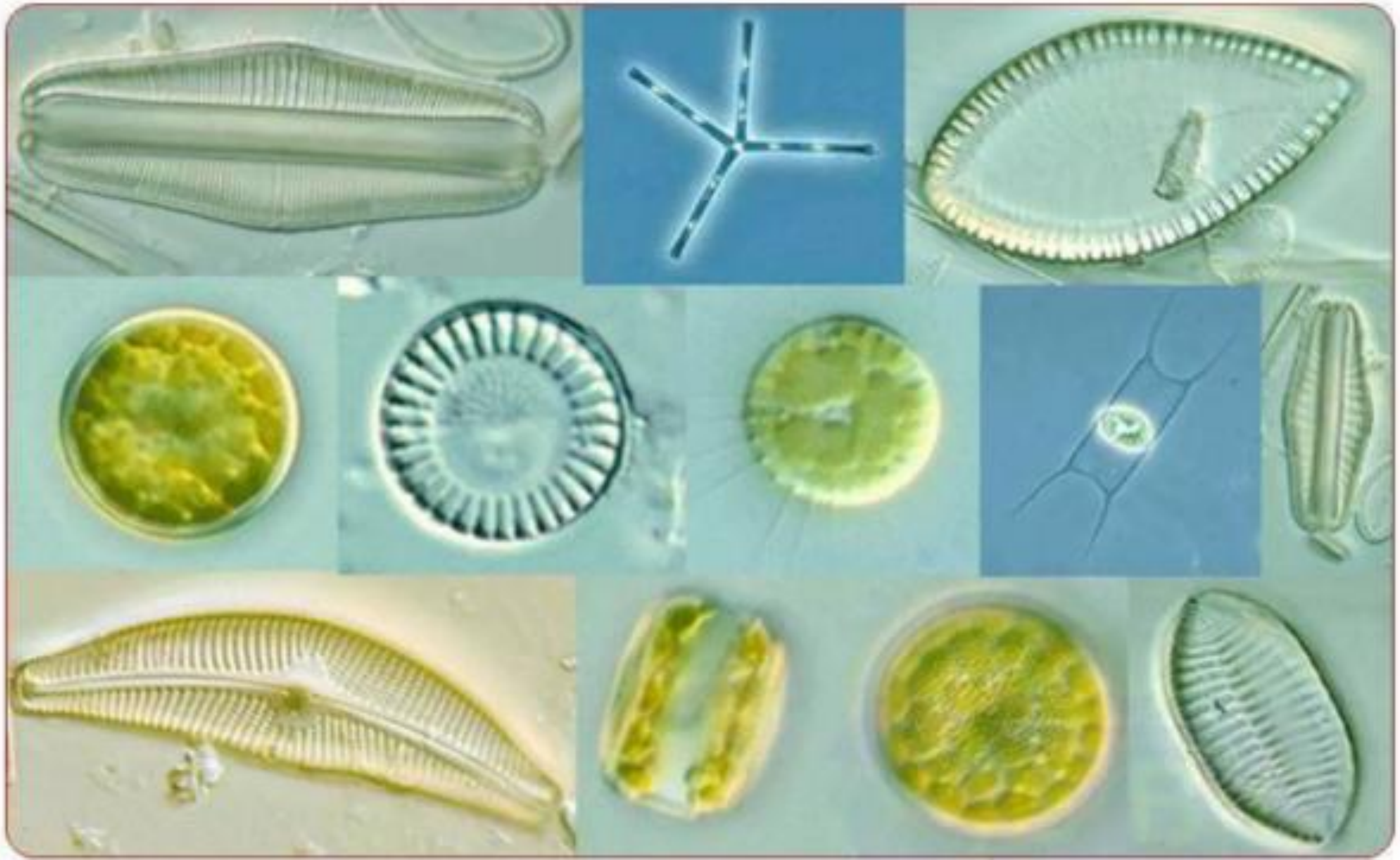


Diatoms

ALGAE: THALLUS DIVERSITY



Diatoms

ALGAE: THALLUS DIVERSITY

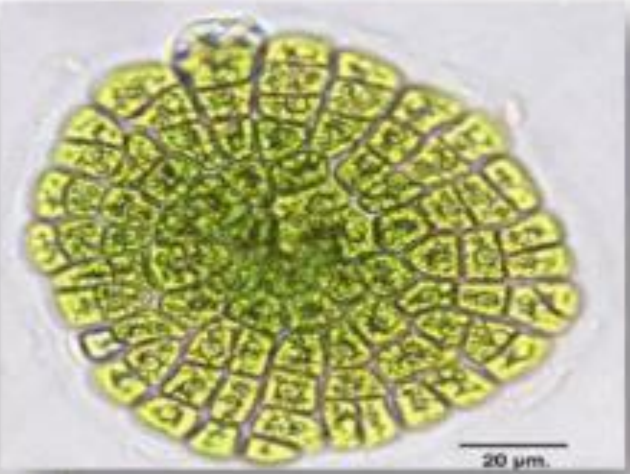
Sargassum

Macrocystis

Fucus

Scytosiphon

Ulva



Coleochaete

ALGAE: GENERAL CHARACTERS

Oscillatoria Thallus

- A group of chlorophyll containing thalloid plants
- ***Thallus***: undifferentiated plant body
- Not differentiated into true roots, stem and leaf or leaf like organ
- Placed in the division **Thallophyta** along with Fungi and Lichens
- Most of algae are autotrophs (synthesize food using light energy)
- Differ from fungi:
  - Presence of photosynthetic pigment - chlorophyll
  - Mode of nutrition (autotrophs)

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- **Habitat**: majority are aquatic, Universal occurrence
- Sex organs are unicellular
- Sex organs lack jacket cells around them
- If jacket cells are present, they have different origin
- There is a progressive complexity in reproduction
- Embryos is not formed after zygote formation
- Show distinct alternation of generation
- Cellular organization may be prokaryotic or eukaryotic

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Occurrence of algae:

- Found in a variety of habitats
- Fresh water, marine, on rocks, with in plants or animals
- Aquatic forms are most common
- On the basis of habitat, algae are classified into three groups

1. ***Aquatic forms***
2. ***Terrestrial forms***
3. ***Algae of unusual habitats***

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(1). Aquatic algae:

- Two types: Fresh water and marine
  - ***Fresh water:*** Occurs in ponds, lakes, river etc. (*Spirogyra*)
  - ***Marine water:*** Occurs in saline condition (seas and oceans)
    - Mainly members of brown algae and red algae (*Sargassum*)

Spirogyra

Sargassum

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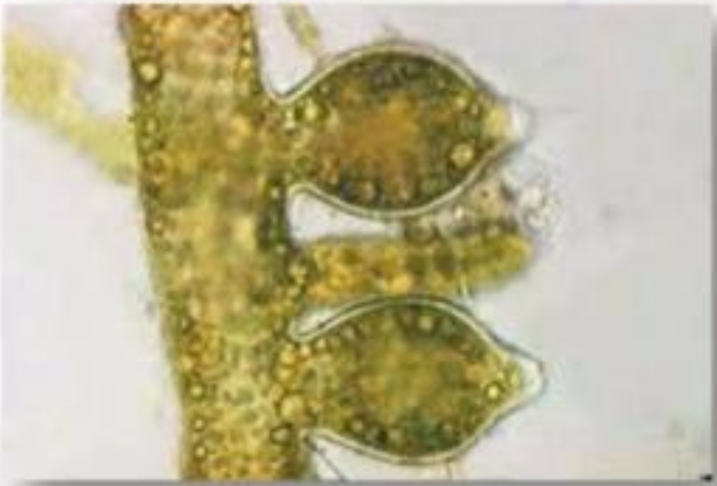
(2). Terrestrial Algae:

- Found in soil, rocks, moist wall, tree trunks etc.
- Example: *Vaucheria*, *Fritschiella* found on the surface of soil



Vaucheria

Fritschiella

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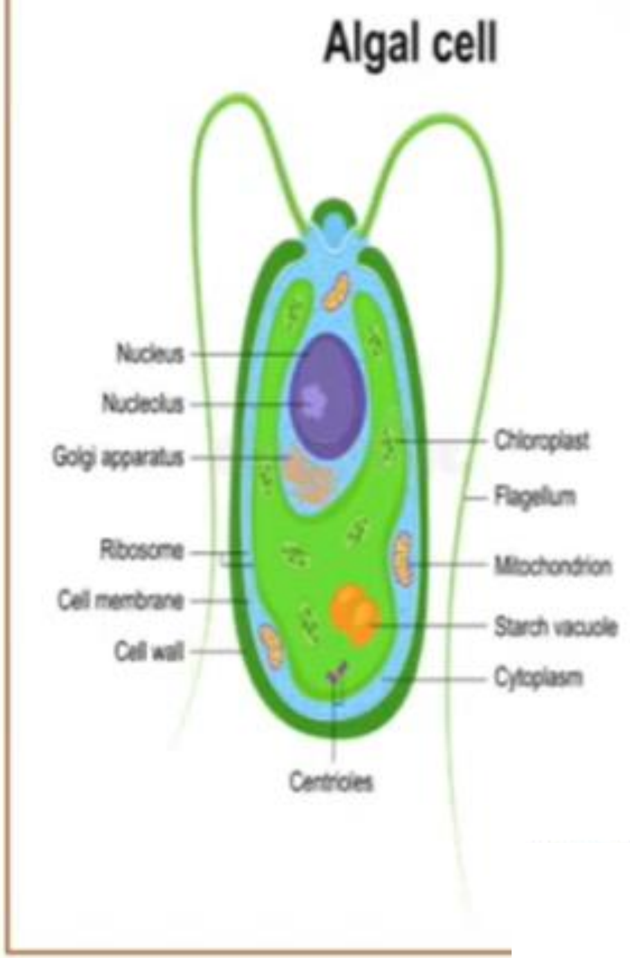
(3). Algae of unusual habitat:

- ***Halophytic algae:*** found in highly saline water (*Dunaliella*)
- ***Epiphytic algae:*** on surface of other plants/algae (*Oedogonium*)
- ***Epizoic algae:*** on animals - snails, fishes (*Cladophora* grow on snails)
- ***Endozoic algae:*** grow inside animals (*Zoochlorella* inside *Hydra*)
- ***Symbiotic algae***: Symbiotic association with fungi in lichen, in bryophytes, pteridophytes, gymnosperms and angiosperms.
- ***Parasitic algae:*** parasite on pants/animals (*Cephaleuros* red rust)
- ***Thermophytic algae:*** grow in hot springs. (Heterohormogonium)

Cell structure

- Algae exhibit 2 different basic kinds of cell structure: a) Prokaryotic, b) Eukaryotic
- **Cell Wall:**
- Algal cell wall is primarily composed of cellulose. Other extra compounds may be added to it during growth. In brown algae hemicelluloses, fucin, alginic acid, fucoidin are also present. In diatoms wall material is mainly silica.
- **Plastids:**
- The different types of plastids are frequently classified according to the kinds of pigments they contain. Chloroplasts are so named because they contain chlorophyll. **Chromoplasts** lack chlorophyll but contain carotenoids; they are responsible for the yellow, orange, and red colors of some flowers and fruits. **Leucoplasts** are nonpigmented plastids.
- **Pyrenoids:**
- Plastids of several green algae have major proteinaceous granules known as pyrenoids around which starch is deposited.
- **Flagella:**
- Flagella are mean of locomotion for motile cells of algae, found in every divisions except Rhodophyta.
- **Eyespots:** The motile cell of algal flagella possess a pigmented spot known as eye-spot or stigma which is considered to be a light sensitive organelle that directs the movement of swimming cells.



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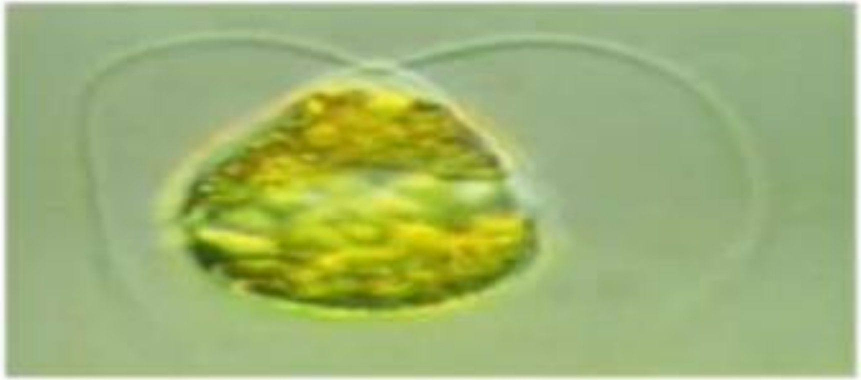
Thallus diversity:

- Wide range, unicellular to multicellular, microscopic to macroscopic
- Size range from micron to several meters
- On the basins of thallus organization algae are following types:-

  1. Unicellular forms
  2. Colonial forms
  3. Filamentous forms
  4. Siphonaceous forms
  5. Parenchymatous forms

• Unicellular algae:

- single cells, motile with flagellate (like *Chlamydomonas and Euglena) or nonmotile (like Diatoms).*



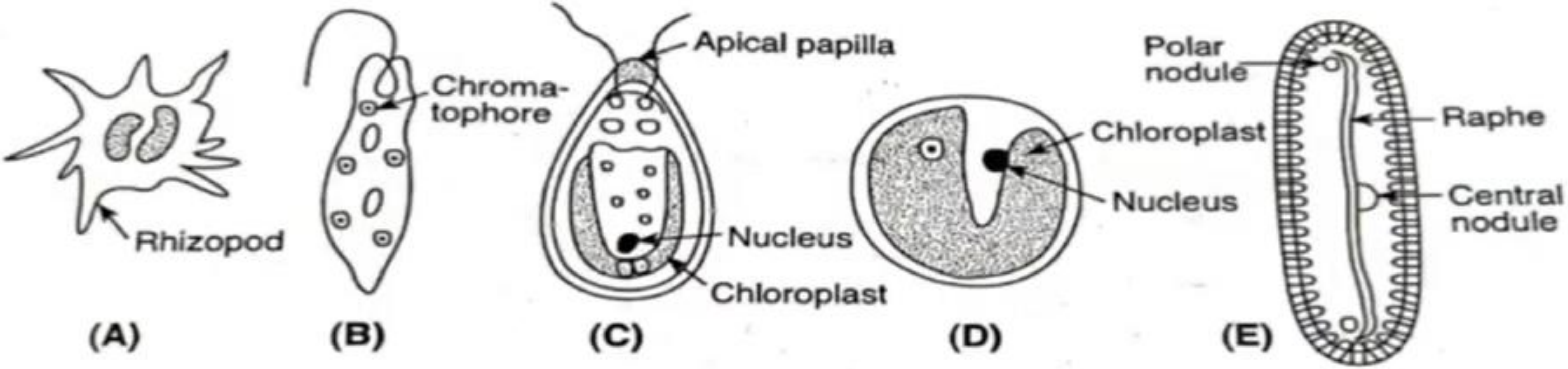
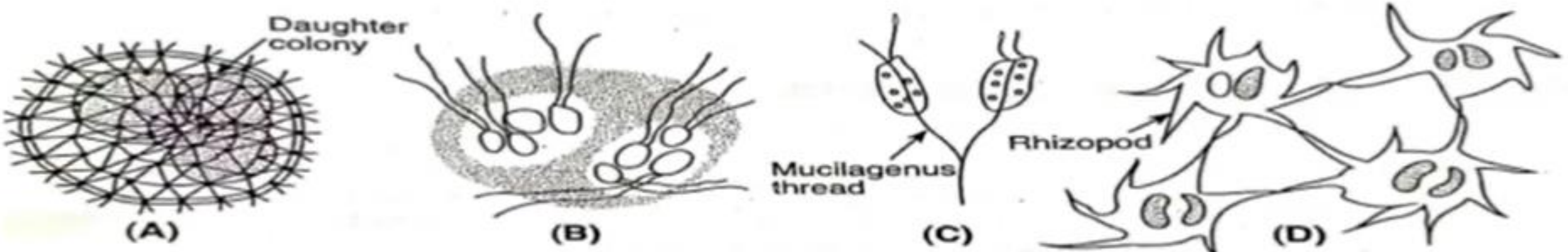


FIG. 8.1. Unicellular algae. (A) *Chrysamoeba*, (B) *Euglena*, (C) *Chlamydomonas*, (D) *Chlorella*, (E) diatom *Pinnularia*

Thallus organization

- **Colonial algae:** Motile or non motile algae may form a colony by aggreg the products of cell division with in a mucillagenous mass.

- **Coenobial** :The colony is formed with a definite shape, size and arrangement of cells. Ex: *volvox*
- **Palmelloid** : Irregular arrangement of cells varying in number, shape and size. Ex: *Chlamydomonas* , *Tetraspora*
- **Dendroid:** Looks like microscopic tree due to union of mucilagenous threads present at base of each cell. Ex: *Chrysodendron*
- **Rhizopodial colony:** Cells are united through rhizopodia. Ex: *Chrysidiastrum*

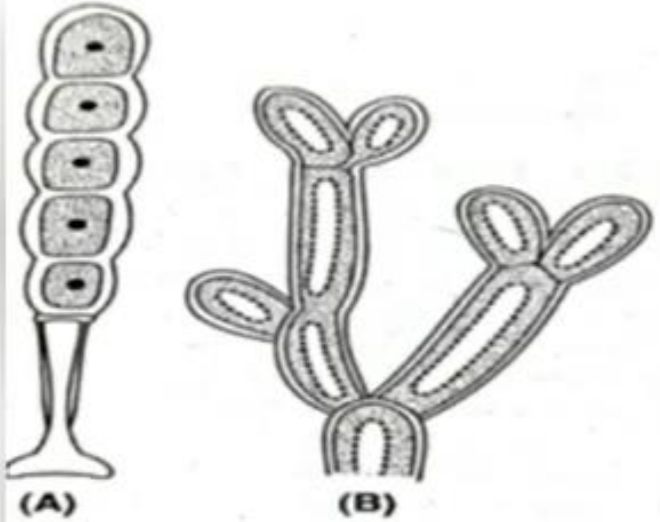


. Colonial algae. (A) Coenobial colony (*Volvox*), (B) Palmelloid colony (*Tetraspora*). (C) dendroid colony (*Chrysodendron*), and (D) rhizopodial colony (Chrysidiastrum).

Thallus organization

• Filamentous algae:

- Daughter cells remain attached after cell division and form a cell chain.
- Adjacent cells share cell wall (distinguish them from linear colonies)
- May be unbranched (uniseriate such as *Ulothrix) or* branched (regular multiseriate such as *Cladophora or unregular* multiseriate such as *Fritschiella).*



.3. Multicellular filamentous algae. (A) unbranched uniseriate thallus of *Ulothrix*, and (B) branched uniseriate thallus of *Cladophora*.

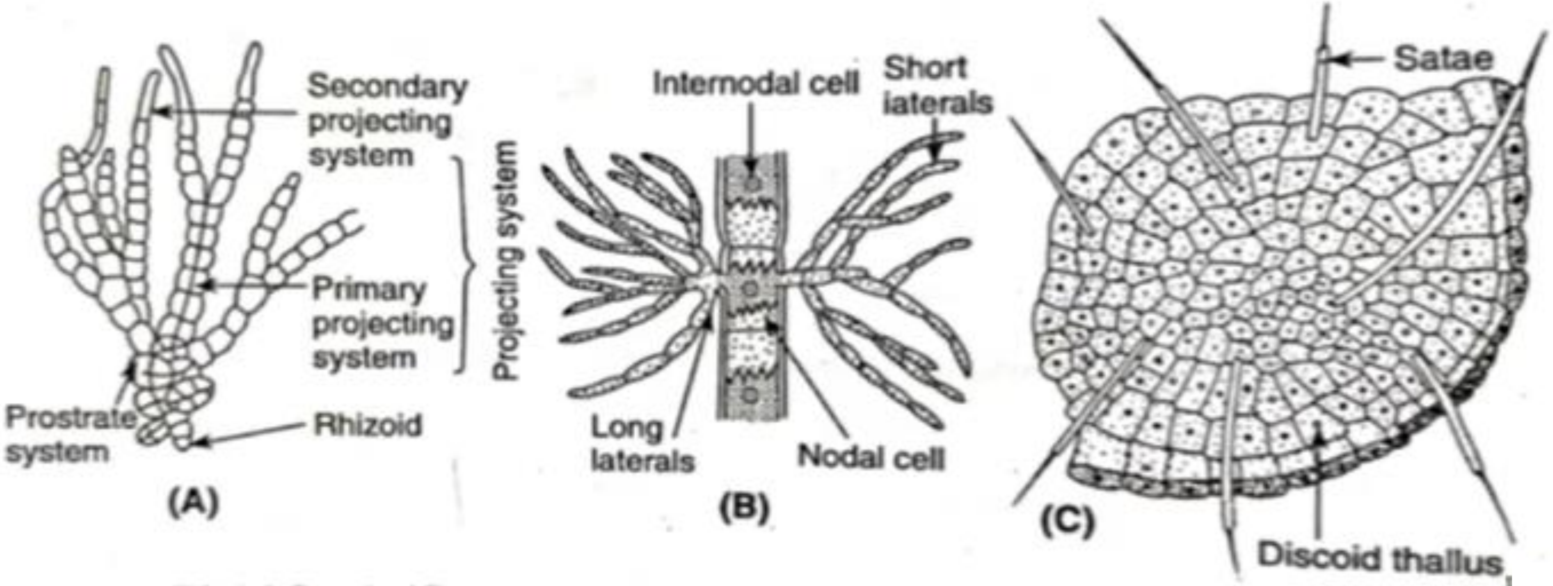


FIG. 8.4. Branched filamentous algae. (A) *Fritschiella*, (B) *Draparanaldiopsis*, and (C) *Coleochaete*.

Thallus organization

- **Siphonaceous algae:**
- (Siphon like or tube like)
- one large, multinucleate cell without cross walls such as *Vaucheria*

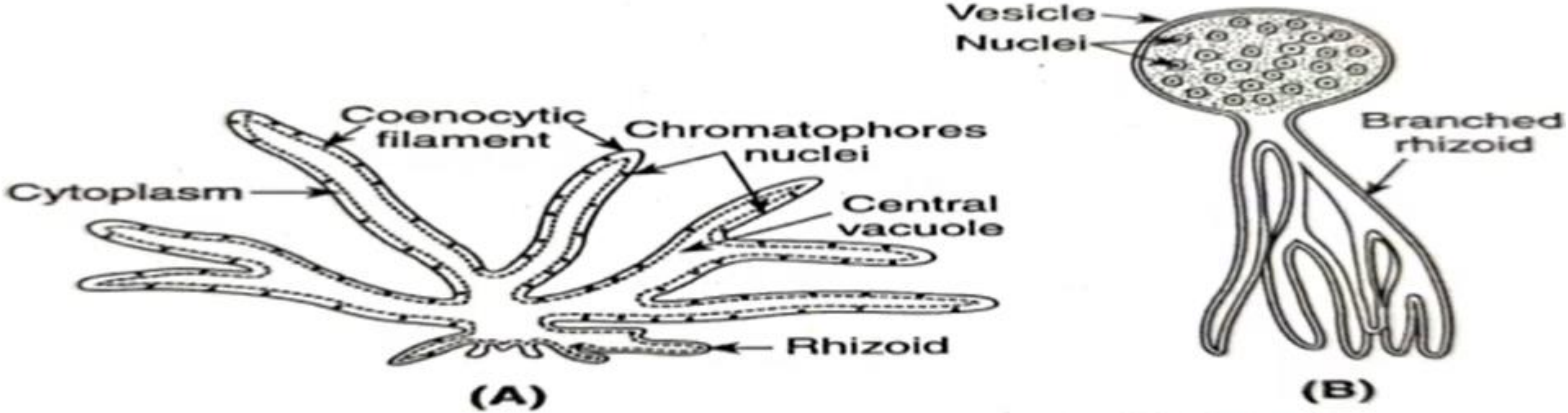


FIG. 8.5. Siphonaceous algae. (A) *Vaucheria*. (B) *Botrydium*.

Share

Thallus organization

- **Parenchymatous algae:**

- (parenchyma cell like structure)
- Thin walled, undifferentiated daughter cell, leave like structure.
- This occurs when cells of the primary fi lament divide in all directions, any essentially fi lamentous structure is thus lost early.
- mostly macro-scopic algae with tissue of undifferentiated cells and growth originating from a meristem with cell division in three dimensions such as *Ulva*

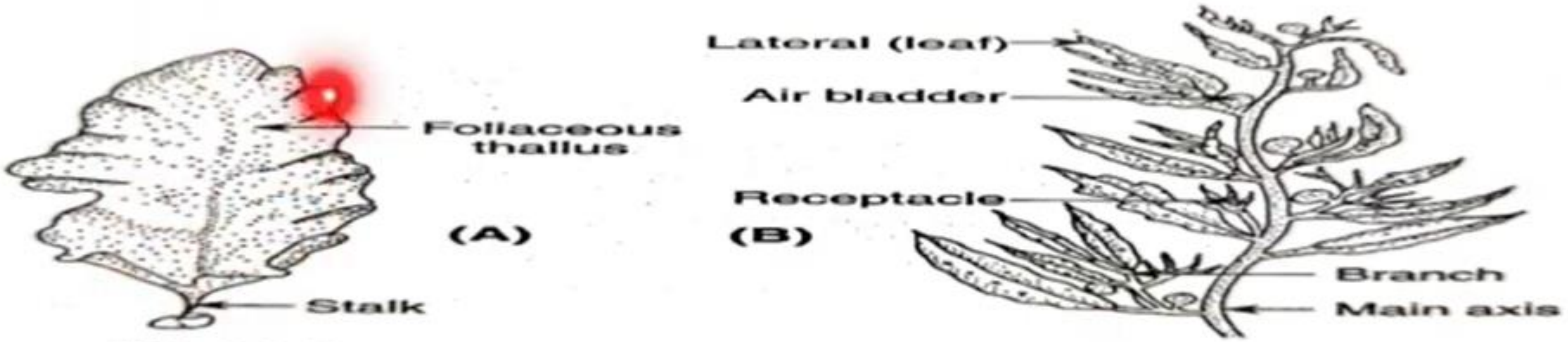


FIG. 8.6. Parenchymatous algae (A) *Ulva* and (B) *Sargassum*.

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Pigmentation in algae:

- Great diversity in pigmentation of algae
- Different groups of algae have different pigments
- Distribution pattern of pigments has great taxonomic significance
- All major algal groups have at least one characteristic pigment
- Pigments in algae belongs to three major categories:

1. ***Chlorophylls***
2. ***Carotenoids***
3. ***Phycobilins***

Algal pigments

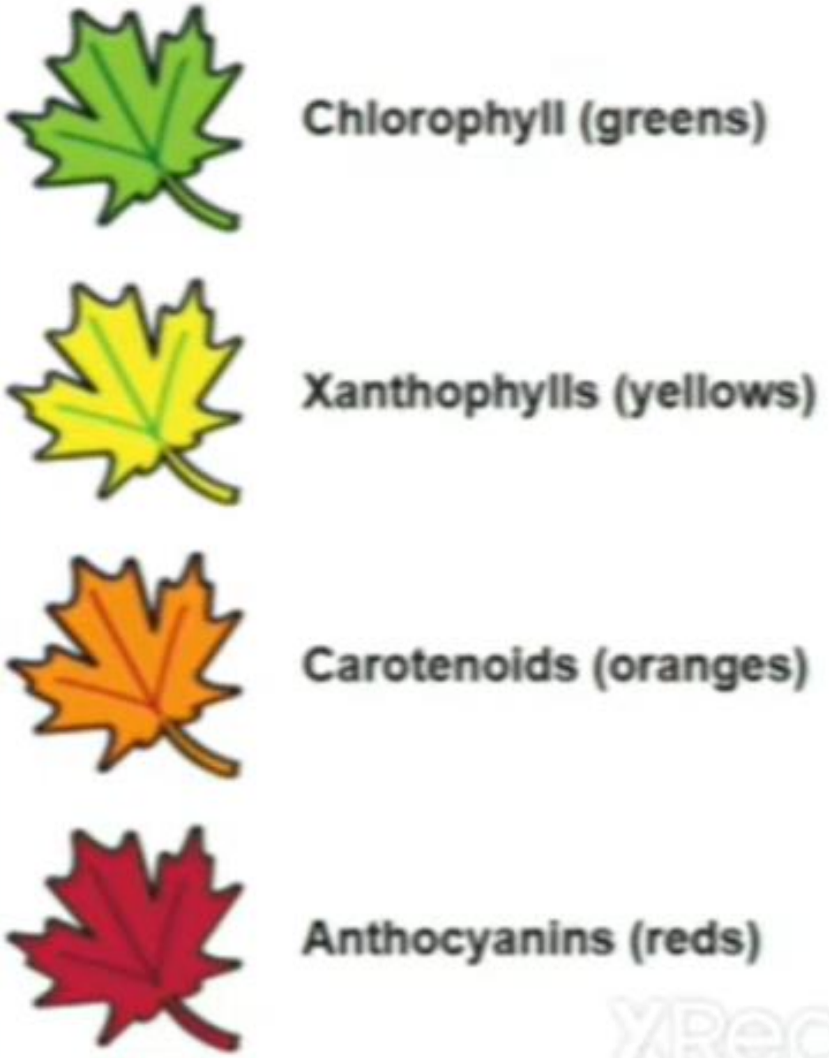
- Algal pigments are present within plastids.
- 4 kinds of pigments

a)<u>Chlorophylls (5 types):</u> a,b,c,d,e- chlorophyll a present in all algae

b)<u>Xanthophylls (20 types):</u> yellow or brown pigments- Chlorophyceae and Pheophyceae.

c)<u>Carotenes (5 types):</u> out of 5 , beta Carotene is present in most algae.

d)<u>Phycobilins (7 types):</u> red (Phycoerythrin) and blue (phycocyanin) -Rhodophyceae



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Plastids in algae:

- Except Cyanophyceae (blue green algae, BGA) pigments in algae are found in membrane bound organelles called plastids
- In BGA, plastids are absent, pigments located at peripheral cytoplasm (chromoplasm)
- Plastids are two types:
  - Leuoplast: - Colourless plastids
  - Chromoplast: - Coloured plastids

ALGAE: GENERAL CHARACTERISTICS

Pyrenoids:

- They are proteinacious bodies present in chromatophores
- Considered as the organelle of synthesis and storage of starch
- In some Chlorophyceae pyrenoids are surrounded by starch grains
- Pyrenoids arise *de-novo* or by the division of pre existing pyrenoids
- Pyrenoids absent in blue green algae

ALGAE: GENERAL CHARACTERISTICS

Reserved food materials in algae:

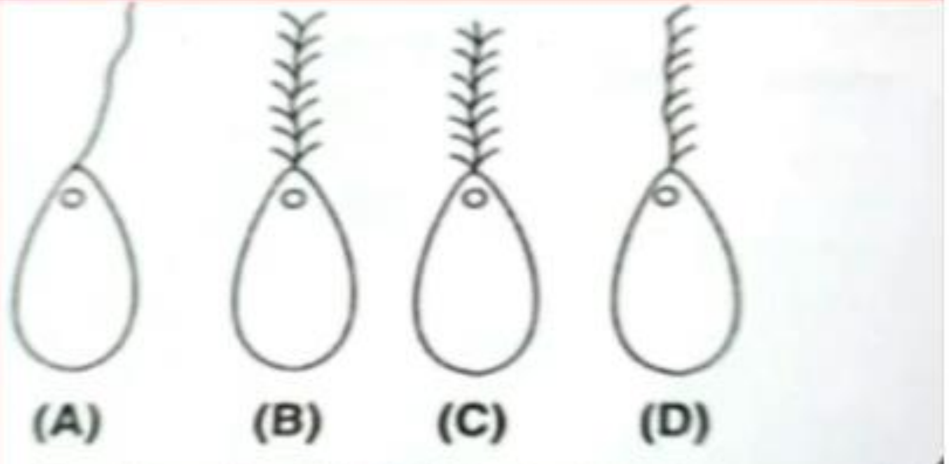
- Also called as food reserve
- Stored form of food function as an important store of energy that can be released and used in ATP production when required.
    - **Cyanophyceae**: cyanophycean starch
    - **Chlorphyceae**: Starch
    - **Rhodophyceae**: Floridean starch
    - **Phaeophyceae**: Laminarin, manitol and oil

Food Reserves

- Food materials accumulated as polysaccharides
- **True Starch** (consist of alpha-1,4 linked linear and helical amylose and alpha-1,4 and alpha-1,6 linked branched amylopectin)-chlorophyta
- **Floridian starch** (similar to amylopectin and mostly lacking amylose)- Rhodophyta
- **Laminarin** (linear polysaccharide with beta-1,3 and beta-1,6 linkage in a ratio of 3:1)- Brown algae
- **Paramylon** (Beta-1,3 polymer of glucose)-Euglena
- **Leucosin** (linear polymer of beta-1,3 and beta 1,6 linked glucose units in a ratio of 11:1)-phytoplankton (Bacillariophyta)
- Fats occur as reserved food in appreciable amounts in the cells of xanthophyta , bacillariophyta & chrysophyta

Algal flagella

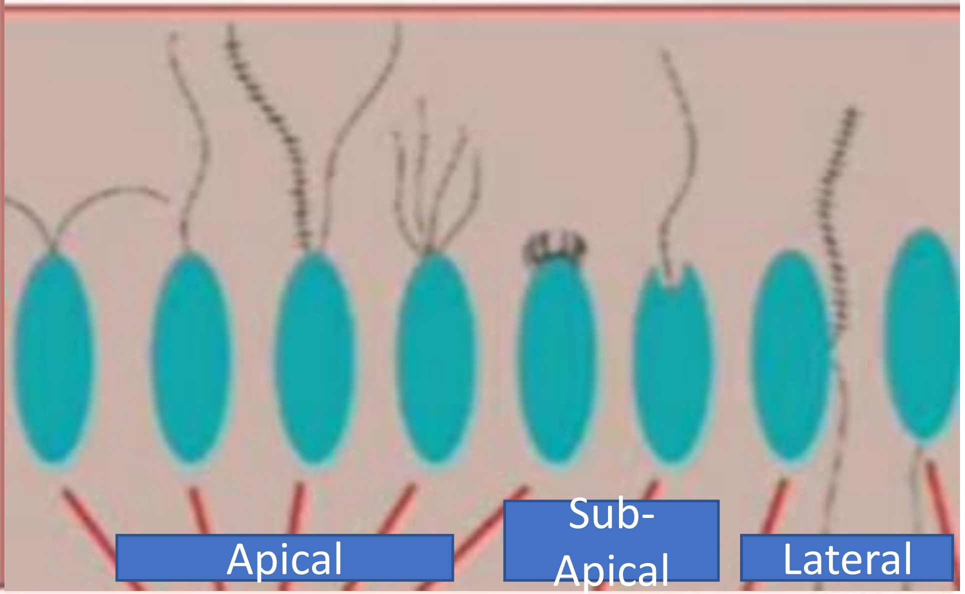
- Found in all algae except Rhotophyceae
- The main function is motility.
- They are of 2 types-
- Whiplash or acronematic-possess smooth surface
- Tinsel or pleuronematic-covered by fine filamentous appendages called as mastigonemes or flimmers



Algal flagella. (A) Whiplash, (B) Pantonematic, (C) Panto-cronematic and (D) Sticho-nematic.

Tinsel is divided into 3 types-

a) Pantonematic- mastigonemes arranged in two opposite rows or radially
b) Pantocronematic- Pantonematic flagellum with a terminal fibril
c) Stichonematic- mastigonemes develop only on one side of the flagellum



Algal nutrition

- Almost all algae are photoautotropic.
- The aquatic form obtain CO2 and H2O by diffusion and osmosis from water and produce their own carbohydrate.
- The aerial form obtain water from the damp area and CO2 from air.
- They also able to synthesize oils and proteins from the carbohydrates.

Algal nutrition

- On the basis of their nutritional strategies, algae are into classified four gro

Obligate heterotrophic algae. They are primarily heterotrophic, but are capable of sustaining themselves by phototrophy when prey concentrations limit heterotrophic growth (e.g., *Gymnodium gracilentum, Dinophyta*).

- **Obligate phototrophic algae.** Their primary mode of nutrition is phototrophy, but they can supplement growth by phagotrophy and/or osmotrophy when light is limiting (e.g., *Dinobryon divergens, Heterokontophyta*).

- **Facultative mixotrophic algae.** They can grow equally well as phototrophs and as heterotrophs (e.g., *Fragilidium subglobosum, Dinophyta*).

- **Obligate mixotrophic algae.** Their primary mode of nutrition is phototrophy, but phagotrophy and/or osmotrophy provides substances essential for growth such as the vitamins of the B12 complex or fatty acids (photoauxotrophic algae can be included in this group) (e.g., *Euglena gracilis, Euglenophyta*).

ALGAE: GENERAL CHARACTERISTICS

Reproduction in algae:

- Algae reproduce by three methods:

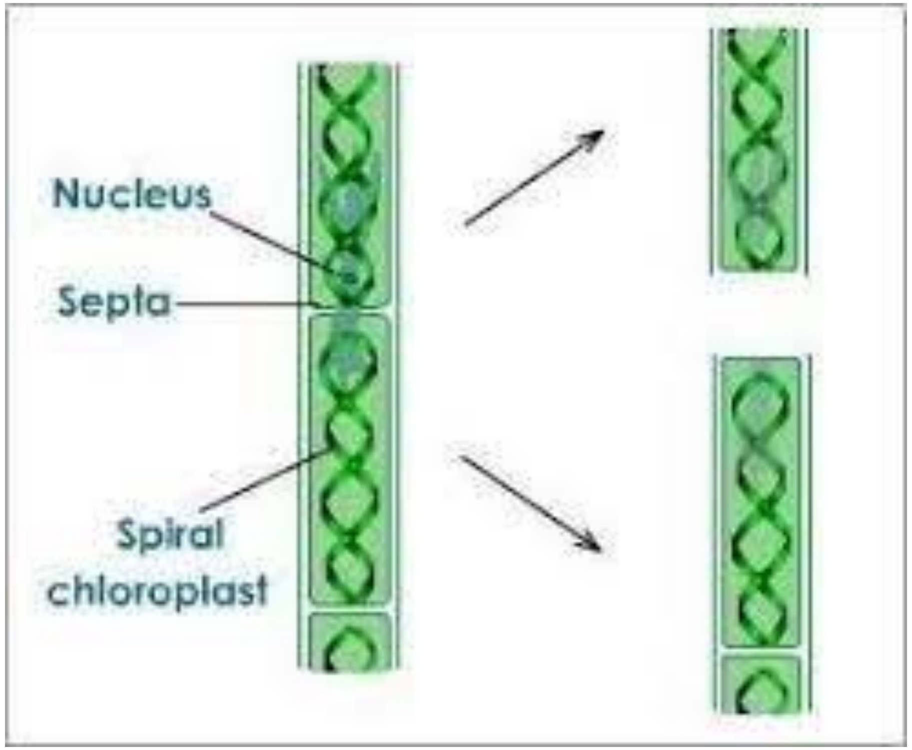
1. ***Vegetative reproduction:*** Cell division, fission, fragmentation, Hormogonia, formation of adventitious branches, tubers, buddings etc
2. ***Asexual reproduction:*** By a variety of motile or non motile spores (Zoospore, aplanospore, hypnospore, tetraspore, autospore, akinetes)
3. ***Sexual reproduction:*** (union of gametes involved): Autogamy, hologamy, isogamy, anisogamy and oogamy

1. Vegetative Reproduction

All those processes of propagation in which portions of the plant body become separated off to give rise to new individuals without any obvious changes in the protoplasts is called vegetative propagation. Vegetative reproduction may be the following types-

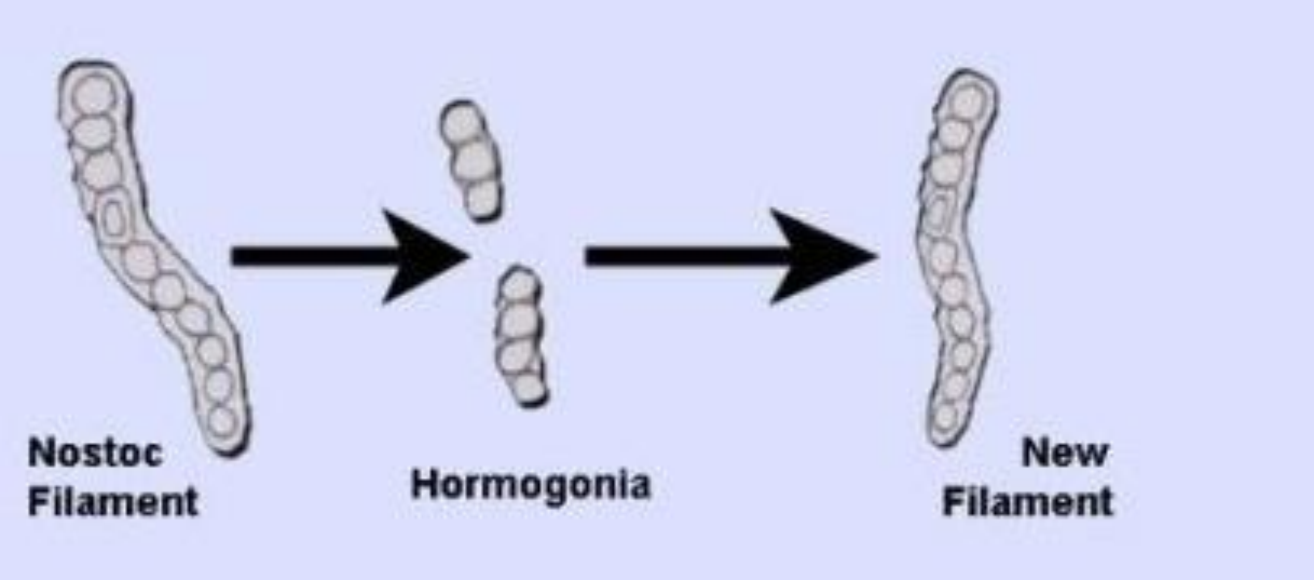
(a) By fragmentation-

A filament may break up into fragments either accident or when cells become weak due to the formation and liberation reproductive bodies. The fragments grow into new plants. This type of vegetative reproduction is common in Chlorophyceae, Xanthophyceae and Phaeophyce

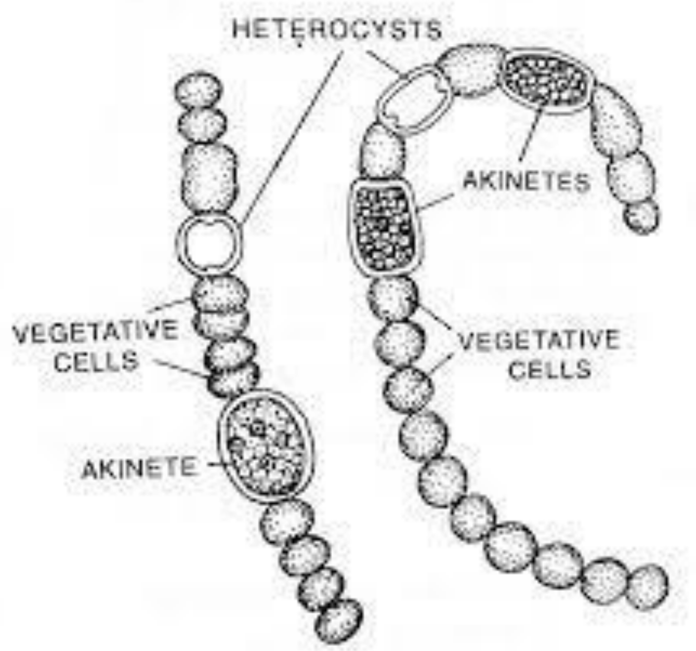


(a) By hormogones-

Somewhat more specialized is the process formations of hormogone met within the filamentous Myxophyceae; where the fragments are endowed with a power of slow movement.



(c) By akinetes-A more specialized type of vegetative reproduction is seen when structures are formed which are to tide over a period of unfavourable ordinary vegetative development. In these cases the cells involved under thickenings of their membranes and at the same time plentiful reserves (starch) accumulate within the protoplast and in some cases special pigments are formed, so that the cells assume a distinctive (often red) tint. Such structures are called akinetes and are most typically developed in filamentous forms. Usually the cells thus modified ultimately round off more or less and separate from one another so that each constitutes a distinct reproductive unit. The akinete is in all cases distinguished by the fact that the entire cell (including the wall)involved in its formation. Akinetes generally found in Pithophora of Chlorophyceand Cyanophyceae, Chlorophyceae and Xanthophyceae.



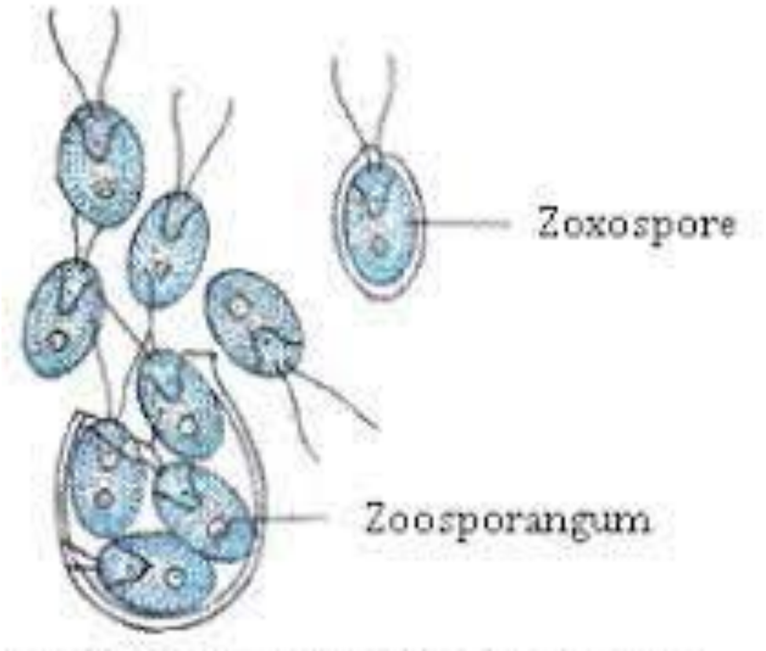
2. Asexual Reproduction

In asexual reproduction, a rejuvenation of the protoplasts of certain cells the alga, commonly this is associated with division of the protoplast but whether this occurs or not the cell contents ultimately escape from the membrane of t parent cell and give rise to a new plant. The genetic material of both cell a similar. Asexual reproduction may be of the following types-

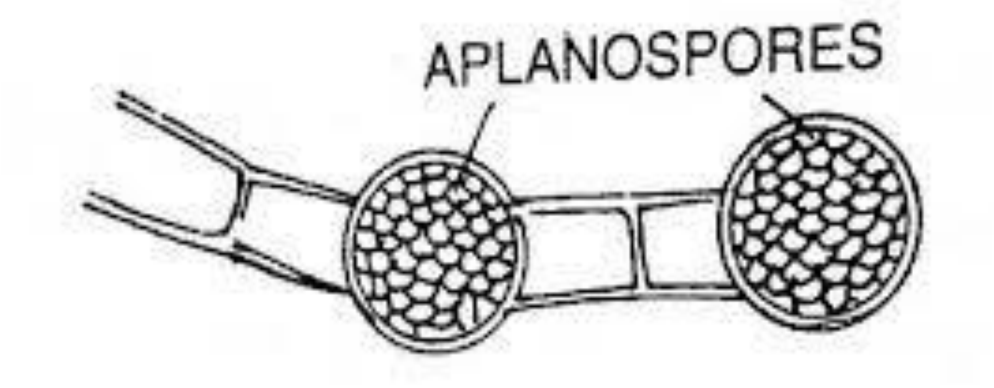
(a) **By zoospores**-It is the commonest method of asexual reproduction algae. Zoospores are the naked flagellate protoplasts that show the distinctive features of their class. Zoospores may be formed either in a specialized structure, zoosporangium or directly from the vegetative cells. The zoospores may **biflagellate**, e.g., *Ectocarpus*, **quadriflagellate**, e.g., *Ulothrix* or **multiflagella** e.g., *Oedogonium*. The multiflagellate zoospores may again be of two types with

(i) **flagella distributed throughout the entire body**, e.g., *Vaucheria*,

(ii) **flagella arranged in a ring surrounding a beak like projection**, e.g., *Oedogonium* Zoospores are generally produced during favourable conditions. Each zoospore swarms around in water comes to rest, sheds its flagella and germinates in new individual.



(b) By aplanospores Nonmotile spores are produced in some memb like Ulothrix and Protosiphon and Vaucheria. They have thin walls which distinct from the parent cell wall. These spores are called aplanospores. Usu one, rarely more than one aplanospore is produced in a cell. Aplanospores considered to be abortive zoospores which remained non-motile. They produced during unfavourable conditions. Upon germination, they either deve directly into new plants or produce zoospores which develop into new plant.



ZOOSPORES

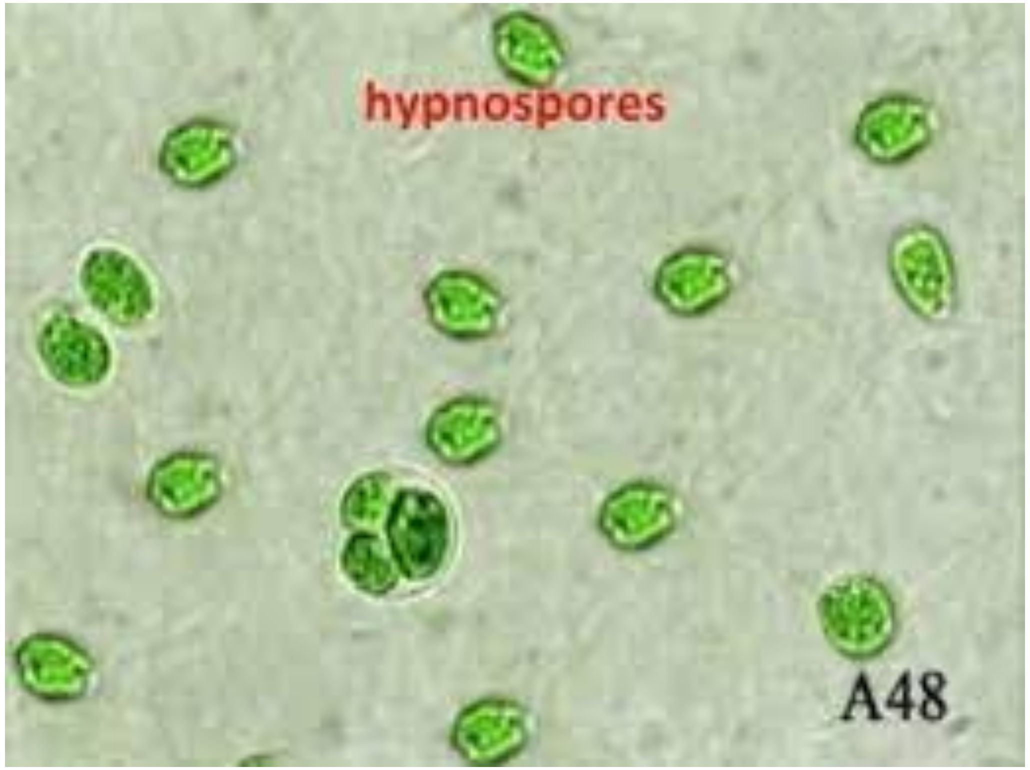
VERSUS

APLANOSPORES

A zoospore is a motile asexual spore produced by certain algae, fungi, and protozoans	An aplanospores is a nonmotile asexual spore produced by certain algae and fungi
Occur in phycomycetes	Occur in green algae
Motile	Non-motile
Do not possess a true cell wall	Possess a true cell wall
Small in size	Comparatively larger
Incapable of enduring harsh environmental conditions	Capable of enduring harsh environmental conditions
Produced by oomycetes like *Phytophthora*, Chytridiomycota, Myxomycota, Opisthokonts, etc.	Produced by lower fungi, algae like Haematococcus Pluvialis, Chlamydomonas and Vaucheria

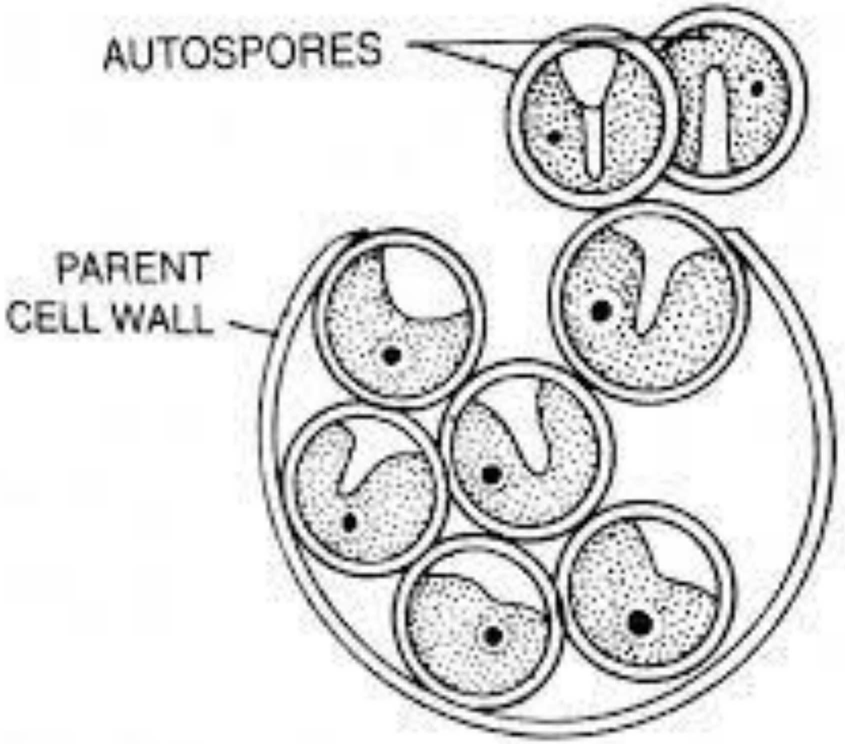
(c) **By hypnospores-**

These are thick walled nonflagellate spores with abundant food reserve. They can stand unfavourable condition. Examples are *Ulothrix, Vaucheria*.



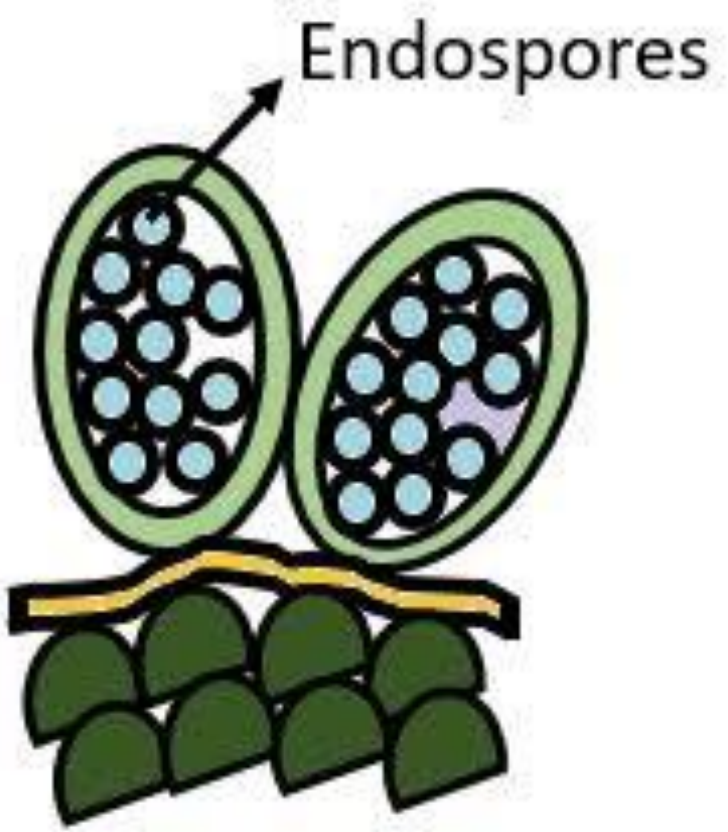
(d) By autospores

When an aplanospore has the same shape as that of the parent cell, it is called autospore. Autospores are produced in Chlorococcales of Chlorophyceae.



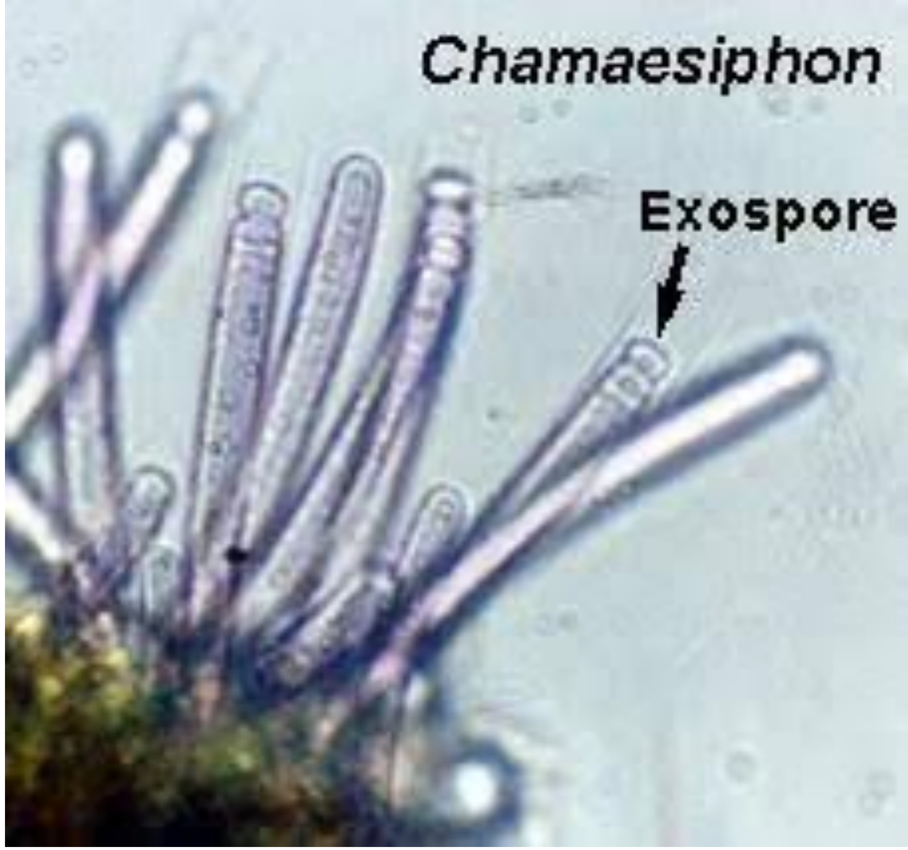
(e) By endospores-

Of a comparable nature to aplanospores are the endospores formed in certain Myxophyceae. They are naked and endogenously produced spores, e.g., Dermocarpa.



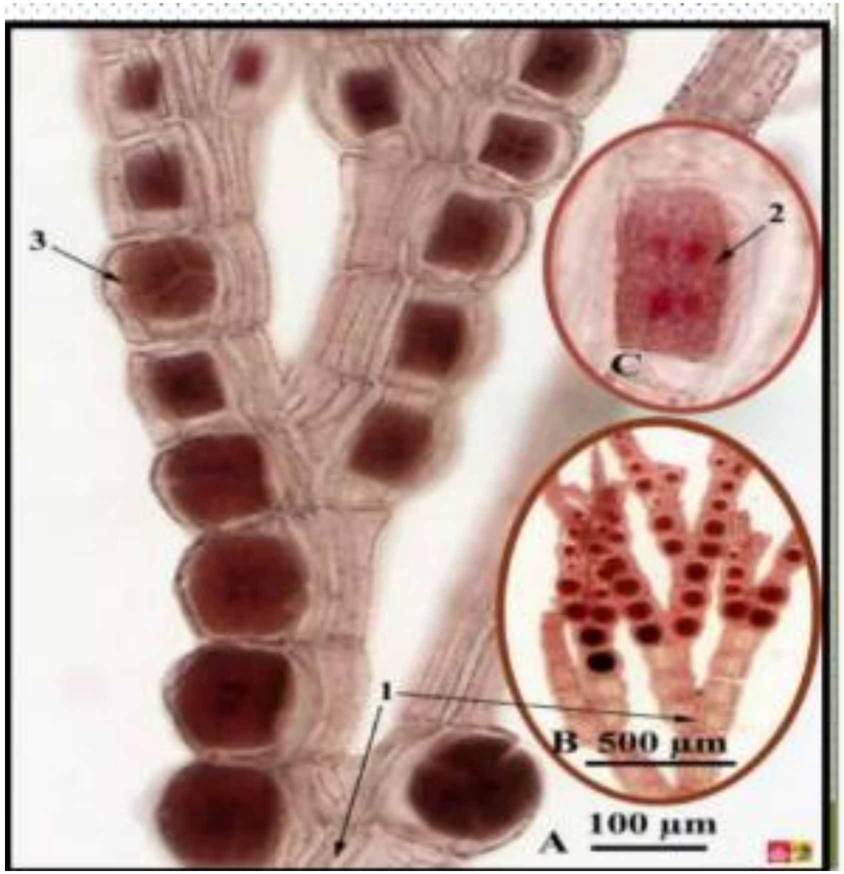
(f) By exospores-

Rarely, members of Cyanophyceae or Myxophyceae reproduce by exospores. These spores are develop exogenously at the distal ends of the cells, e.g.,. *Chamaesiphon*



(g) **By tetraspores-**

In brown algae non-motile spores known as tetraspores are produced within specialized cells known as the tetrasporangia. Tetraspores are produced on the diploid plant and are haploid, e.g., Dictyotales. In Rhodophyceae too tetraspores are produced by the sporophyte plant. They germinate to give rise to the haploid or the sexual plant, e.g., Polysiphonia. In Batrachospermum not motile monospores are produced singly within the monosporangia.



(h) **Palmella stages-In** certain unicellular, e.g., Chlamydomonas and filamentous, e.g., Ulothrix members the protoplast of a cell divided repeatedly and a number of daughter protoplast are formed. These protoplast are not liberated and their cell walls gelatinize. The parent cell wall also gelatinizes. This structure is called Palmella stage as it resembles Palmella, an alga, and is meant for perennation. It is able to withstand desiccation because it is gelatinous. When favourable conditions return, daughter protoplast of a Palmella stage modify into zoospores which develop into new individuals.

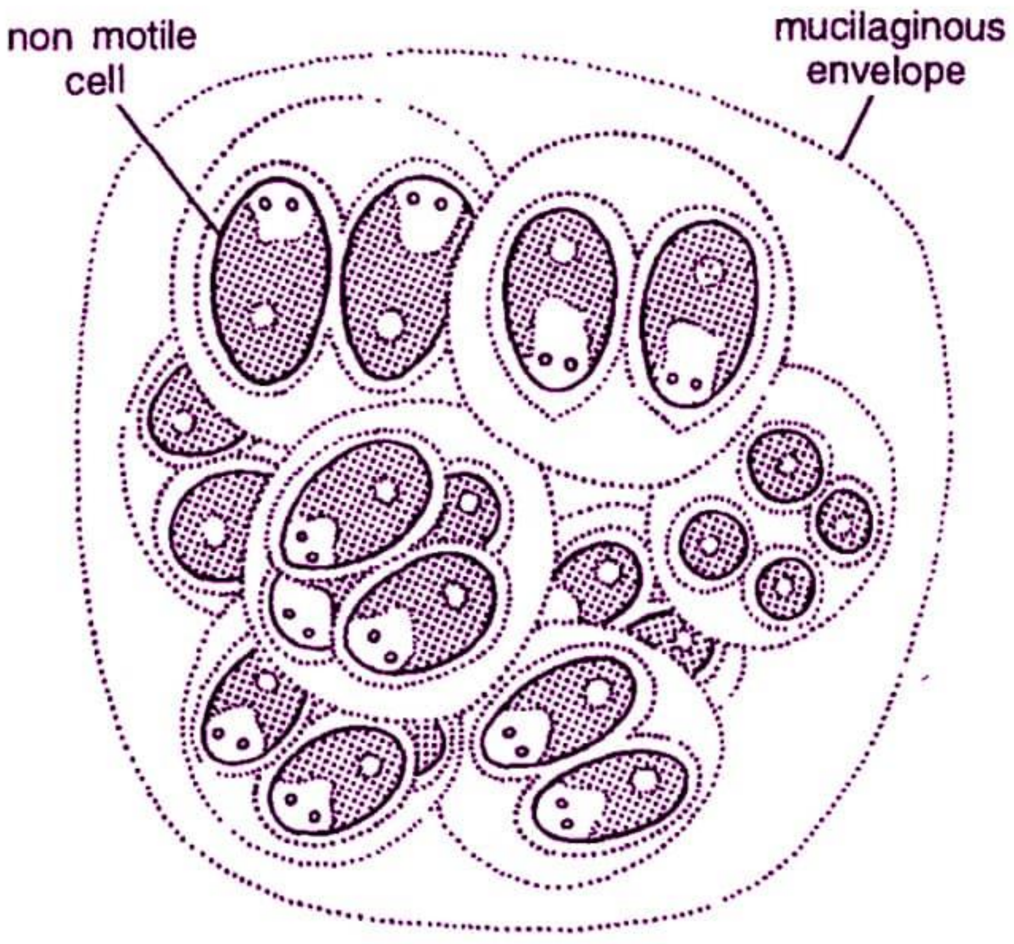


Fig. *Chlamydomonas*. Palmella stage.

(i) By the formation of adventitious branches-

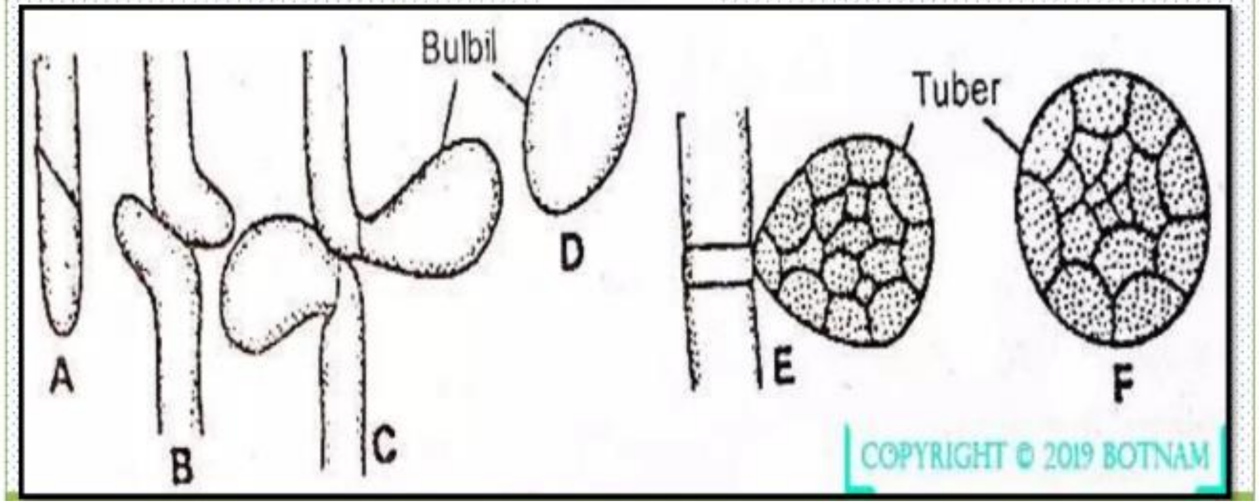
In Chara certain nodal cells have been reported to produce naked adventitious branches that can give rise to new plants independently. In Dictyota adventitious branches arise from the lower cylindrical part of the thallus.

(j) By the formation of tubers-

Rhizoids of Chara or its buried nodes form tuber like growth that become filled with food material. The detached tuber germinates to produce the Chara plant.

(iii) Tubers:

- Tubers are spherical or globular bodies formed on lower nodes and rhizoids in *Chara.*
- Tubers are formed due to storage of food. On detachment from parent plant, these develop into new plants.



3. Sexual Reproduction

It involves the fusion of two specialized reproductive cells called the gametes.

Fusion may occur between two gametes from the same plant (Monoecious) or from different plants (Dioecious).

The process of fusion is called **fertilization** and the product of fusion is called the **zygote**.

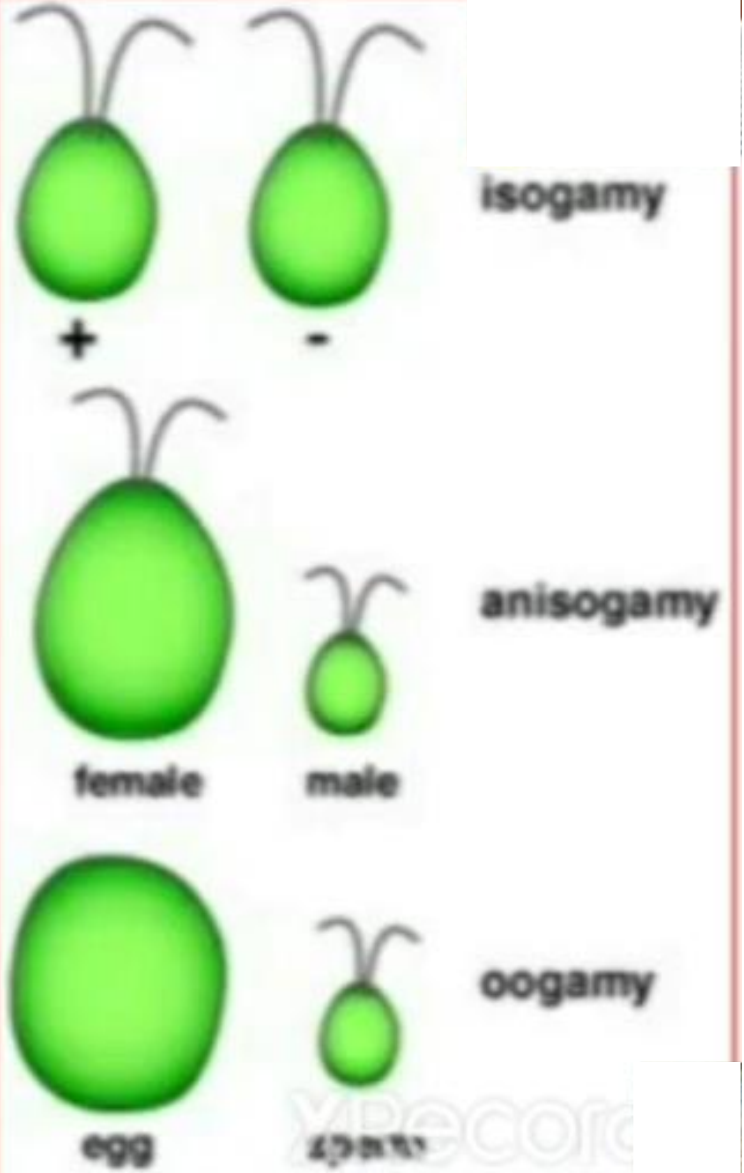
The gametes are always haploid.

Sexual reproduction ranges from isogamy to anisogamy and oogamy.

Sexual Reproduction

- Sexual reproduction has been reported from all members of algae except cyanophyceae. In sexual reproduction two opposite mating types (gametes) fuse to form a zygote. Depending on the structure and behaviour of fusing gametes it can be classified as:

- **Isogamy:** In it the fusing gametes are iso gametes (iso – similar) i.e. they are morphologically and physiologically similar. Example: Chlamydomonas , Ulothrix etc.
- **Anisogamy:** In it the fusing gametes are aniso gametes (aniso – dissimilar) i.e. they are morphologically and physiologically not similar and are different. In some algae physiological anisogamy has been reported where the gametes are morphologically similar but physiologically different (e.g. Spirogyra). Example: Chlamydomonas braunii etc.
- **Oogamy:** It is observed in higher plants and animals too. In algae, usually the male partner is motile and female partner is non-motile. Example: Chlamydomonas , Chara, Porphyra etc.
- **Autogamy:** It is commonly reported in Diatoms, where the fusing gametes are formed from the same mother cell and are haploid. After fusion they form a diploid zygote with no genetic variation.



ALGAE: GENERAL CHARACTERISTICS

Alternation of generation:

- Alternation of generations (also known as alternation of phases) is a term primarily used to describe the life cycle of plants
- Most algae have an alternation of many celled haploid gemetophytic generation with many celled diploid sporophytic generation, which alternate regularly

ALGAE: GENERAL CHARACTERISTICS

Life cycle in algae:

- The growth and development consists of a number of distinct morphological and cytological stages
- The sequence of these orderly changes is called life cycle
- Life cycle: sequence of all deferent phases or events through which an organism passes from zygote (diploid) of one generation to the zygote of the next generation through gametes (haploid)
- There are five types of life cycles in algae based on the number of haploid and diploid generation

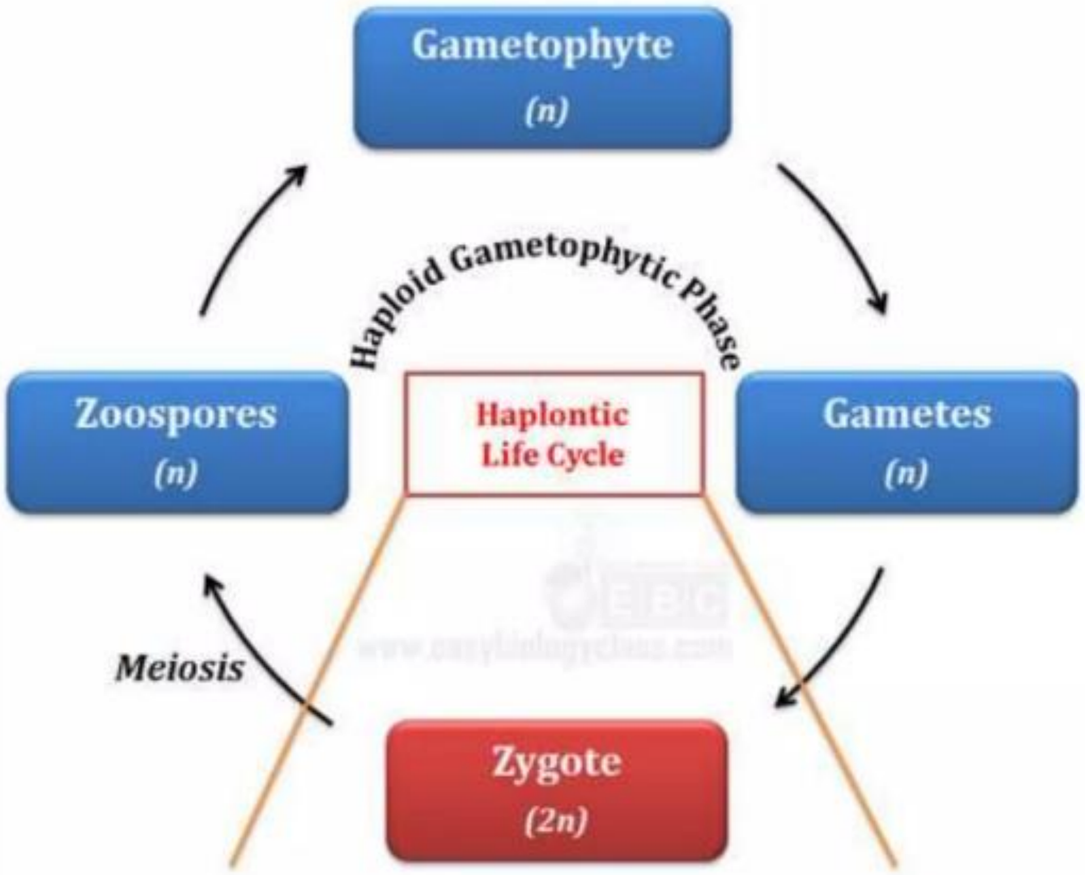
ALGAE: GENERAL CHARACTERISTICS

Life cycle in algae:

- ***Haplontic***
- ***Diplontic***
- ***Haplobiontic***
- ***Diplobiontic***
- ***Haplodiplontic***

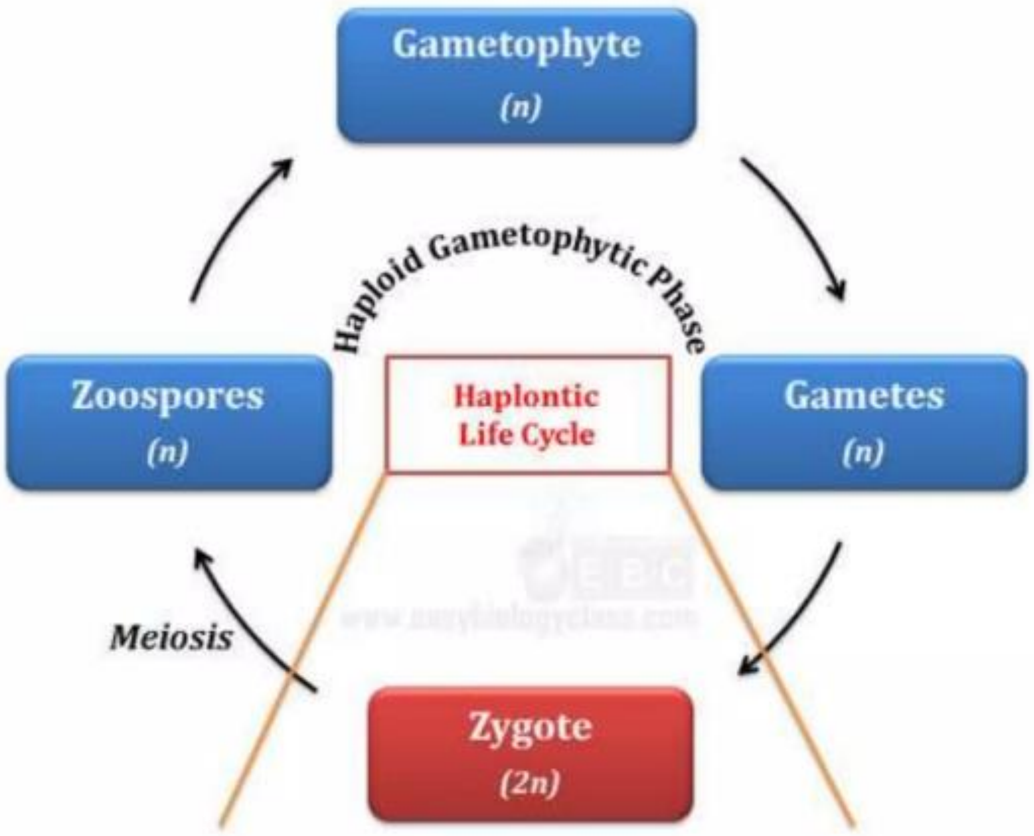
Haplontic cycle

- Most common type of life cycle in algae
- It is the most **primitive and simplest** type of life cycle
- Life cycle is **diphasic**
- The prominent phase is haploid **gametophytic phase**
- The diploid phase in the life cycle is represented by the **zygote**



Haplontic Life Cycle

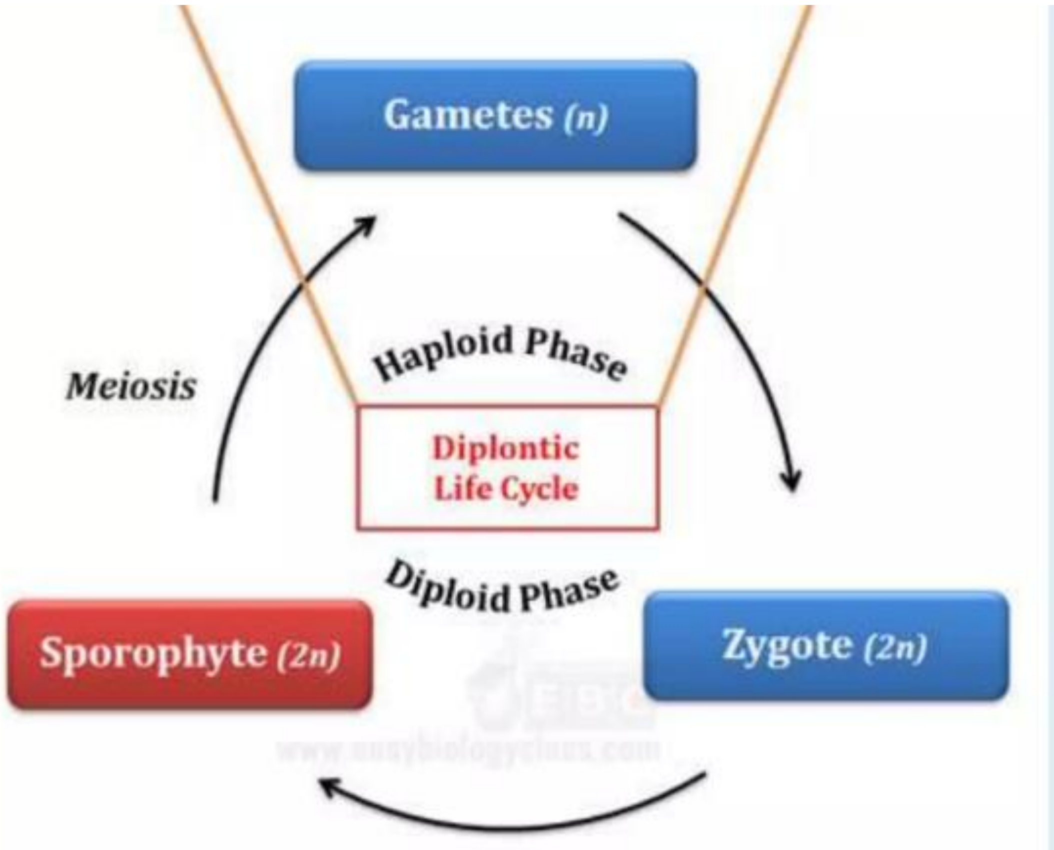
- Zygote is formed by the fusion of haploid male and female gametes
- Zygote immediately undergo meiosis to produce **haploid zoospores**
- Zoospores germinate and grow by **mitosis** to produce the **haploid gametophytic generation**
- Gametophytic plant produce **male and female gametes by mitosis**
- Ex. ***Chlamydomonas and Ulothrix***



Haplontic Life Cycle

Diplontic life cycle

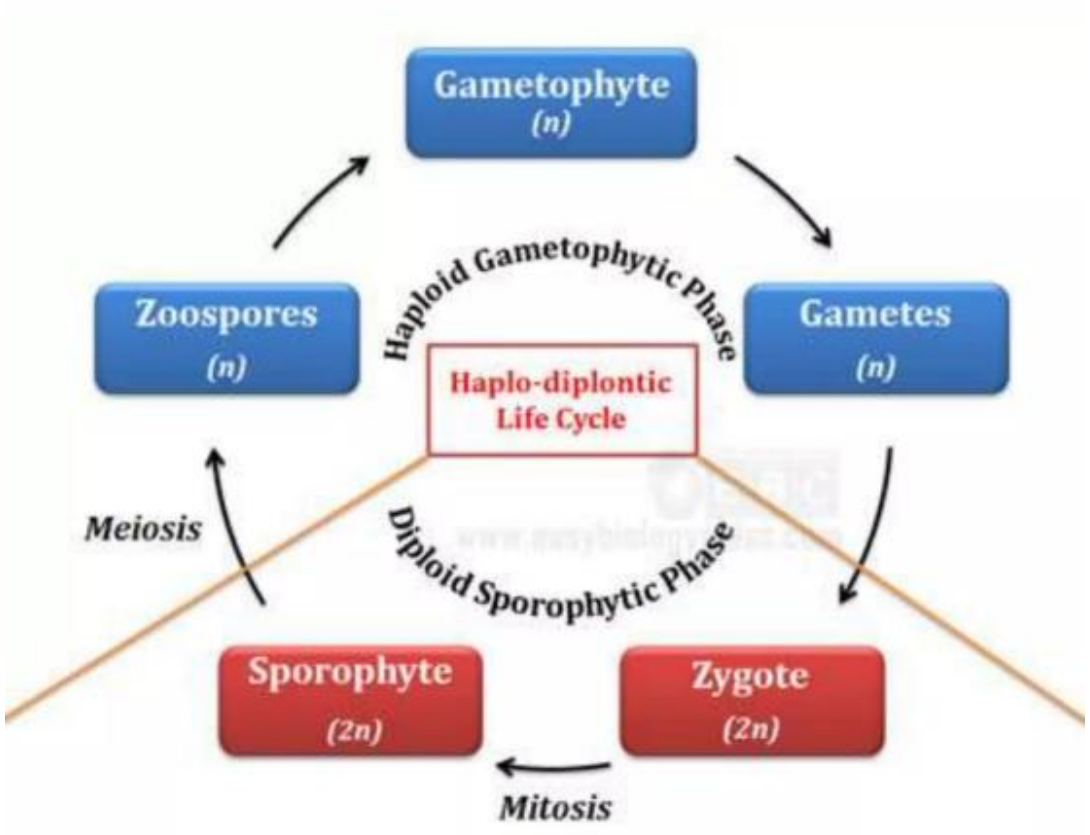
- This type is just a **reversal of the haplontic** type od life cycle
- Life cycle is diphasic, but the **prominent phase is diploid sporophytic phase**
- Haploid gametophytic phase in the life cycle is represented only by the **gametes**
- Here gametes are produced in the **gametangia by meiosis**
- Moreover zygote do not undergo **meiosis,** rather it develop into a **diploid sporophytic phase by mitosis**



Diplontic Life Cycle

Haplodiplontic life cycle

- Life cycle is **diphasic**
- One phase is **haploid gametophyte** and the other is **diploid sporophyte**
- Sporophytic plant produce **sporangia** which produce **haploid zoospores by meiosis**
- Zoospores develop into **haploid gametophytic generation**
- Gametophyte produces **gametes**

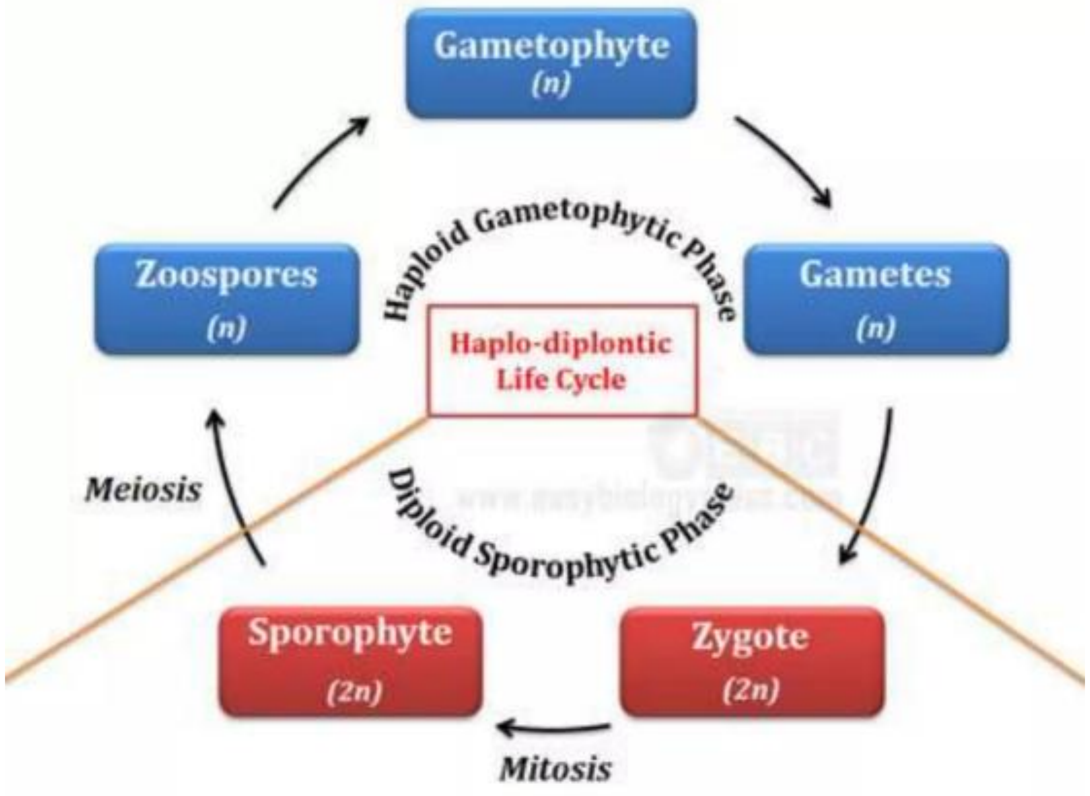


Haplo-Diplontic Life Cycle

- Male and female gametes fuse to form the **diploid zygote**
- There are two types of haplodiplontic life cycle

a.isomorphic : gametophytic and sporophytic phase are **morphologically similar** [eg. ***Ulva, Chaetophora***]

b.Heteromorphic : gametophytic and sporophytic phase are **morphologically dissimilar** [eg. ***Laminaria, Urospora***]



Haplo-Diplontic Life Cycle

Haplobiontic life cycle

- Here the life cycle is **triphasic** [three phases]
- **One diploid and two haploid phases**

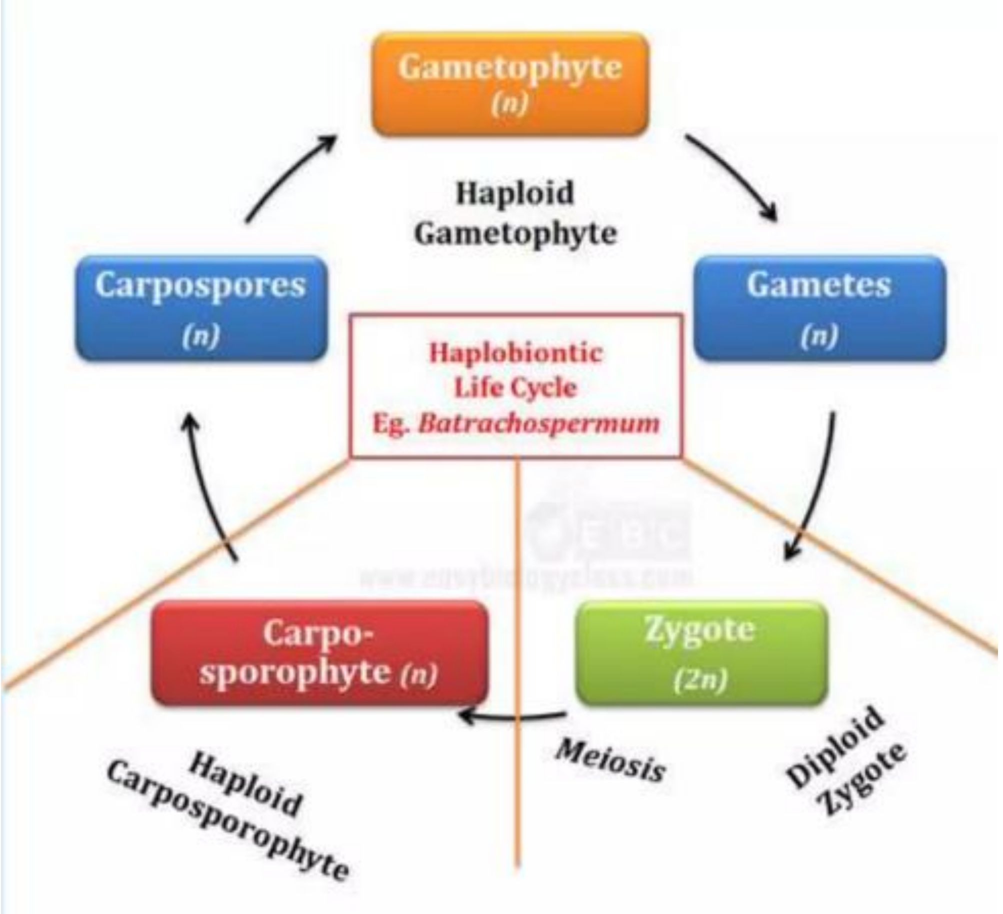
The three phases are:

A. **Gametophyte phase [n]: haploid phase 1**

B. **zygote [2n]: diploid phase**

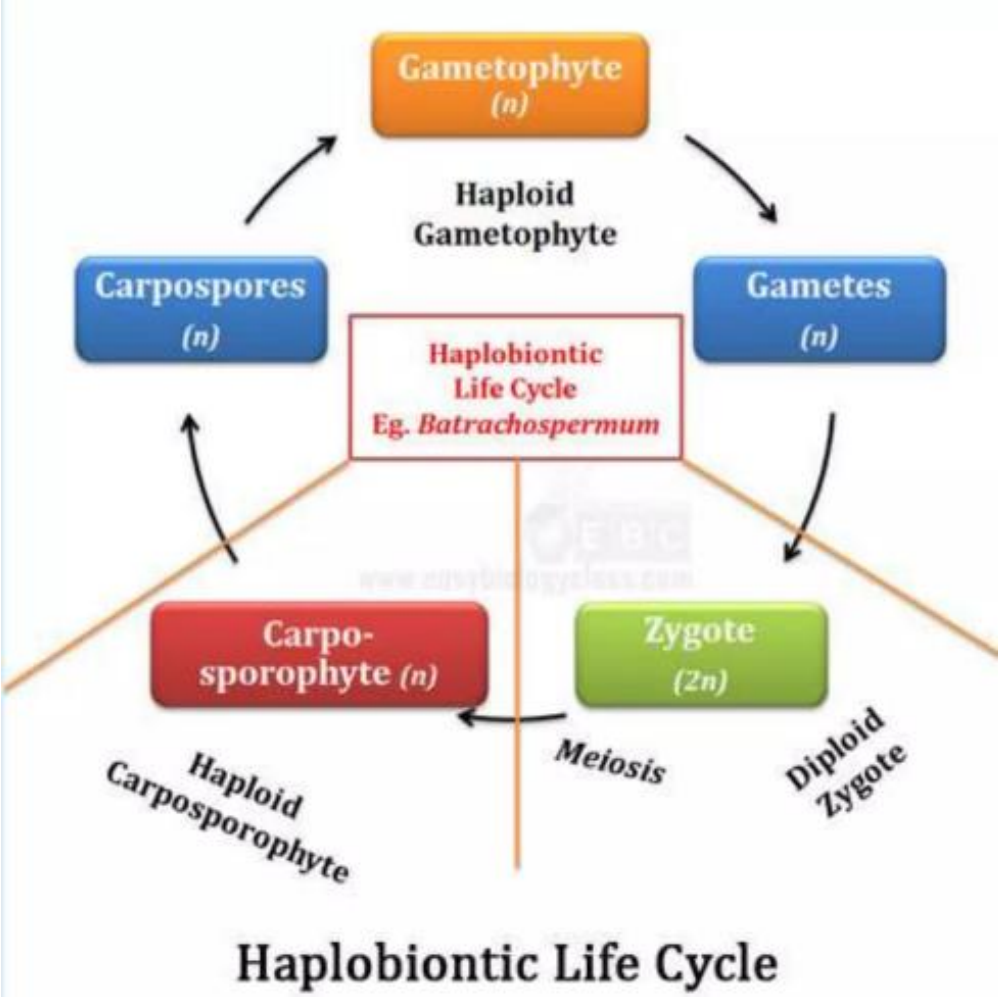
C. **Carposporophyte phase [n]: haploid phase 2**

- Gametophyte phase produce haploid gametes



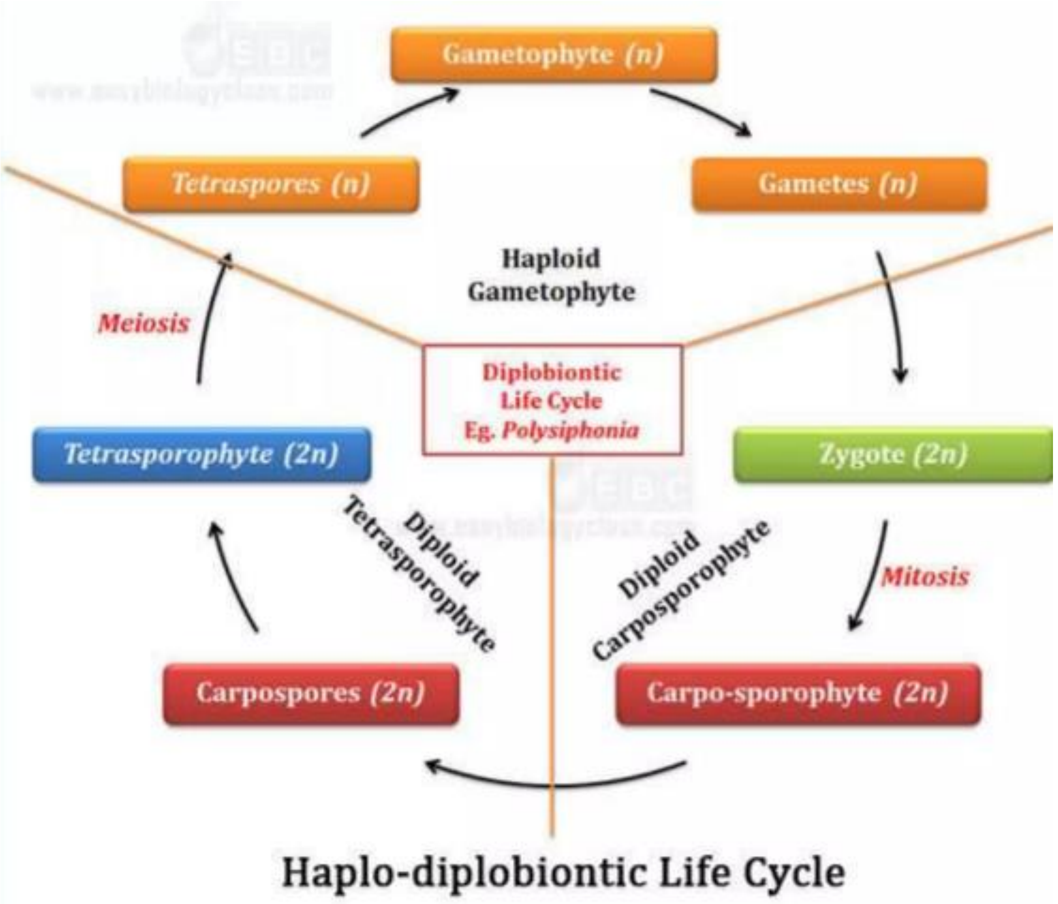
Haplobiontic Life Cycle

- Male and female gametes fuse to form **zygote which is diploid**
- Zygote upon **reduction division** produces haploid spores which germinate in to a intermediate haploid phase called **carposporophyte**
- Carposporophyte reproduce **asexually by carpospores [n]**
- Carposopores germinate and develop into **haploid gametophytic generation**
- Eg. Rhodophyceae members

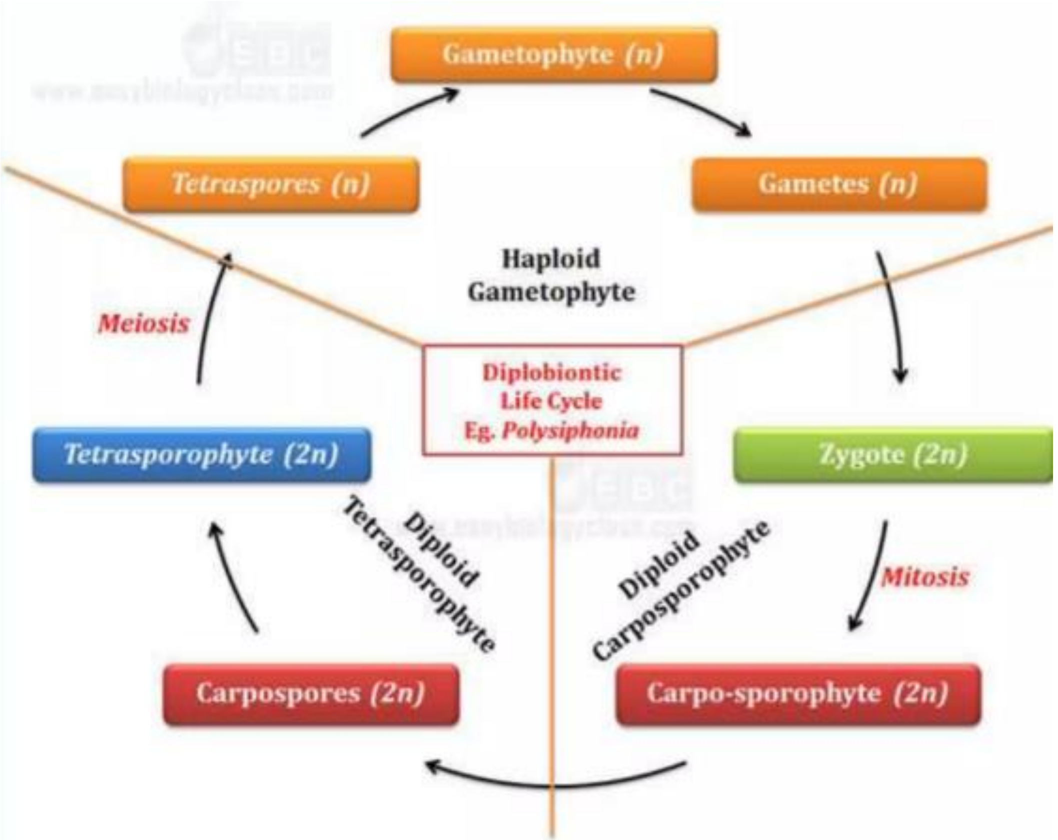


Diplobiontic life cycle

- Most **complex and advanced type** of life cycle in algae
- Life cycle is **triphasic** with one haploid phase and two diploid phase
- The life cycle includes
    - **A. Carposporophyte – diploid [2n]**
    - **B. Gameophyte – haploid [n]**
    - **C. Tetresporophyte – diploid [2n]**
- Diploid zygote develop **mitotically** to diploid **carpospophytic phase**
- Carposporophyte produce diploid **carpospores [2n]**



- Carposporophyte germinate into **diploid tetrasporophytic phase**
- Tetrasporophyte produce haploid **tetraspores by meiosis**
- Tetraspore germinate into the **haploid gametophytic generation**
- Gametophytic generation produce **male and female gametes**
- Gametes fuse to form diploid **zygote**
- Thus in haplo-diplontic life cycle, two diploid phase [carposporophyte and tetrasporophyte] alternate with haploid gametophytic phase
- Eg. Rhodophyceae - ***Polysiphonia***



Haplo-diplobiontic Life Cycle

THANK YOU