

Subject- Botany

- **Production of Courseware – Content for UG course**
- **Paper – Plant Life and Utilization- I**
- **Module- Algae**



Chapter -2

Algae

Plant Life and Utilization –I

Paper -I, Sem- I

FYBSc

By

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Learning Objectives

2.1: Introduction

2.2: General Characters

2.3: Classification (Bold and Wynne 1978) up to classes with reasons

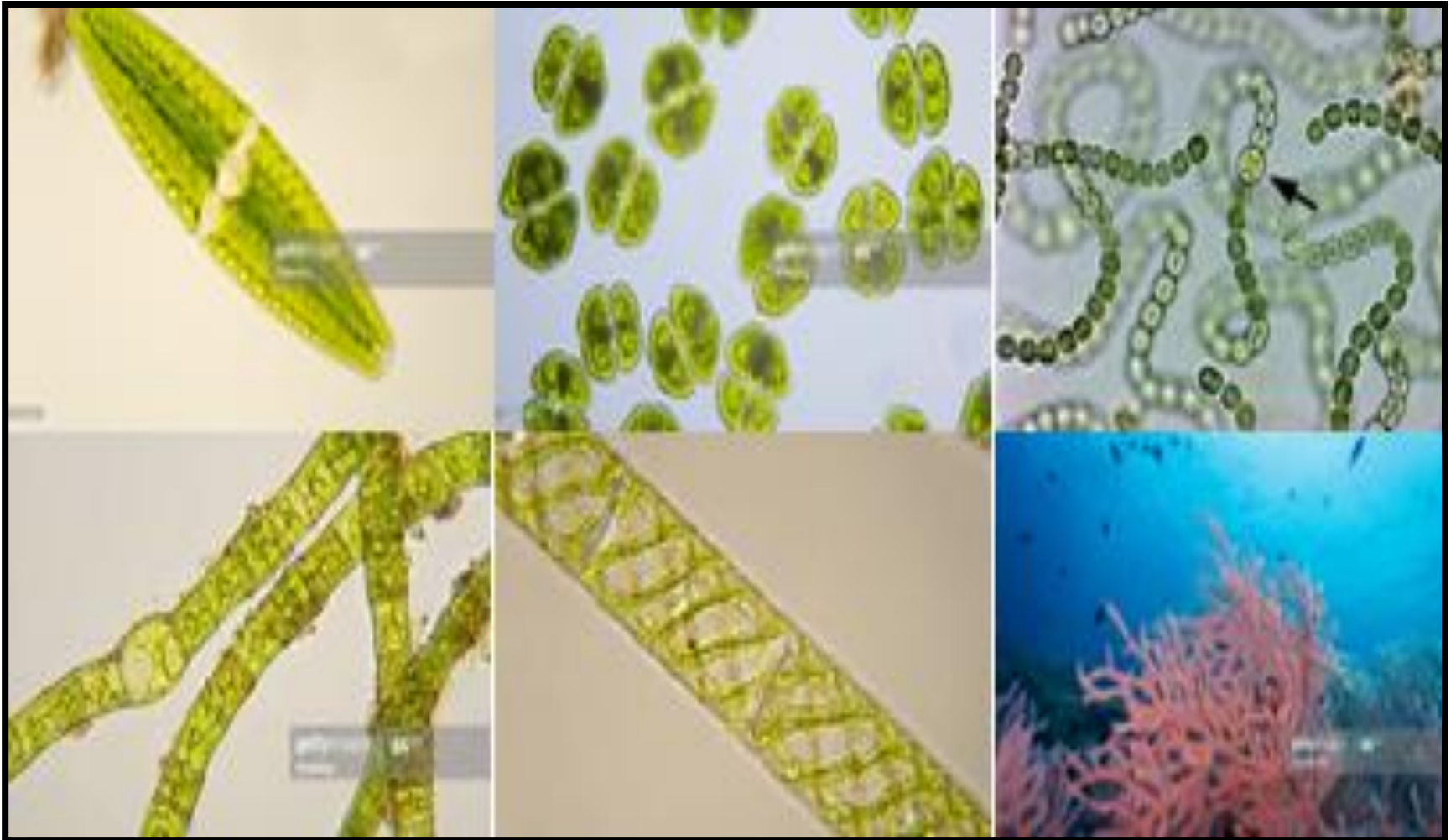
2.4: Life Cycle of *Spirogyra* w.r.t. Habit, Habitat, Structure of thallus, structure of typical cell, Reproduction- Vegetative, Asexual and Sexual, systematic position with reasons

2.5: Utilization of Algae in Bio-fuel Industry, Agriculture, Pharmaceuticals, Food and Fodder

2.2: General Characters

- Plant body may be unicellular e.g. *Chlorella* (*non-motile*), *Chlamydomonas* (*motile*) or multicellular unbranched filamentous like *Spirogyra* and *Ulothrix*, or branched filamentous like *Chara* or colonial forms like *Volvox*
- Some are huge macroscopic such as sea weeds which measure more than 60 meters in length. e.g. *Sargassum*
- Variation in Habit , Habitat, Size, form and reproduction.
- Thalloid plant body, Prokaryotic and Eukaryotic, unicellular or multicellular.
- Autotrophic mode of nutrition.
- Chlorophyll bearing plant body is autotrophic,thalloid.
- Prokaryotic or Eukaryotic
- Mostly aquatic,marine or fresh water, some are terrestrial
- Both generation (Saprophytic and Gamatophytic) are independent.
- Common examples are *Volvox*, *Spirogyra*, *Chara*, *Polysiphonia*, *Ulothrix*, etc.

Algae showing their diversity of shape and growth form (multicellular, unicellular, and colonial)



Reproduction

Vegetative

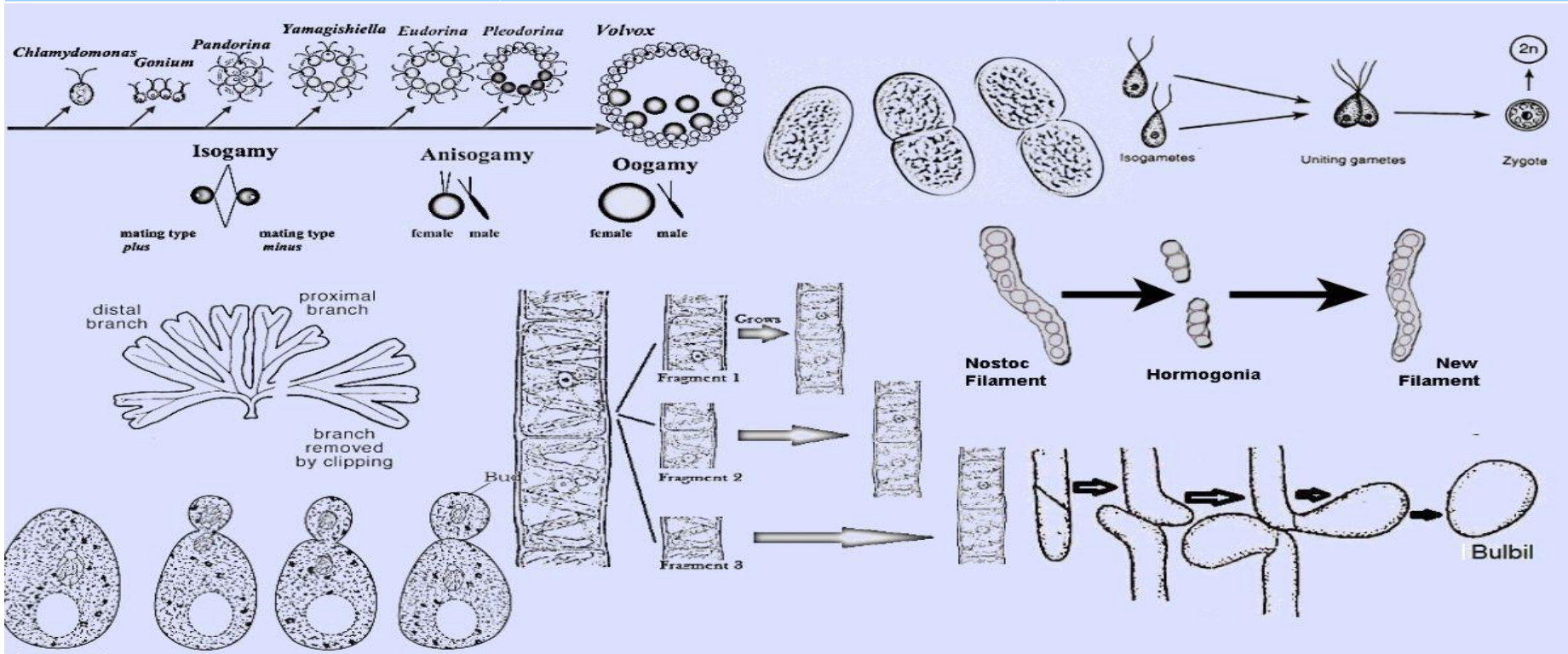
1. Fragmentation
2. Formation of hormogonia
3. Budding
4. Cell division

Asexual

- Formation of spore-
1. Zoospore
 2. Aplanospore
 3. Autospore

Sexual

- Fusion of gametes
1. Isogamy
 2. Unisogamy
 3. Oogamy



2.3: Classification

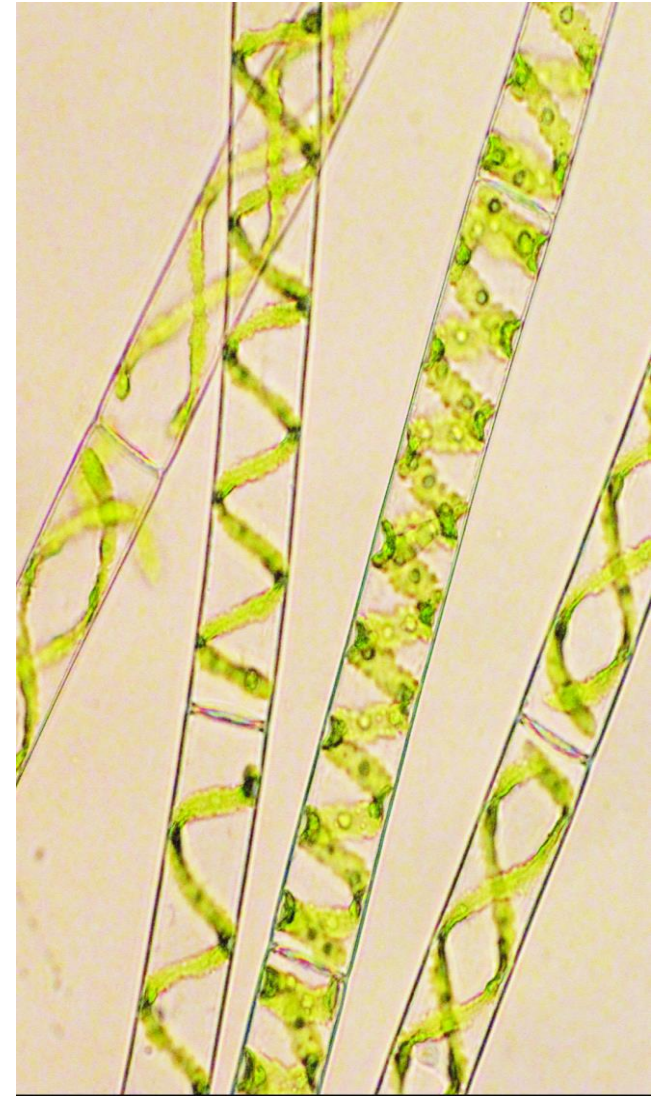
H.C. Bold and M J Wayne (1978) classified the algae into nine division

Sr. No	Division	Order	Chlorophyll Pigment	Reserve food Material	Important Character	Example
1	Cyanochloronta	3	Chlorophyll a,b,c phycocyanin and c phycoerythrin	Cyanophycean starch, glycogen	Sexual reproduction is absent	<i>Nostoc</i> , <i>Anabaena</i> , <i>Gloeocapsa</i>
2	Chlorophycophyta	15	Chlorophyll a ,b, carotene and xanthophylls	Starch	Zoospores are bi or quadri-flagellate ,flagella are equal and whiplash type	<i>Spirogyra</i>
3	Charophyta	3	Chlorophyll a ,b,	Starch	Thallus with nodes and internodes	<i>Chara</i>
4	Euglenophycophyta	3	Chlorophyll and β carotene	Paraphyllum and fats	Zoospores are uni,bi or triflagellate ,flagella anterior	<i>Euglena</i> , <i>Colacium</i>
5	Phaeophycophyta	13	fucoxanthin	Laminarin and mannitol	Zoospores are pyriform with lateral flagella	<i>Dictyota</i> , <i>Ectocarpus</i>

Sr. No.	Division	Order	Chlorophyll Pigment	Reserve food Material	Important Character	Example
6	Chrysophycophyta	14	carotene and xanthophylls	Leucosin and oil	Sexual reproduction is Iso, uniso or Oogamous	<i>Pinnularia, Cyclotella</i>
7	Pyrrohophycophyta		Chlorophyll a, c, carotene and xanthophylls	Starch/oil	Sexual reproduction is rarely absent	<i>Exuviaella</i>
8	Rhodophycophyta	9	r- phycoerythrin	Floridean starch	Zoospores are not found	<i>Erythrocladia, Kappaphycus</i>
9	Cryptophycophyta		Chlorophyll a and c A and β carotene	starch	Two anterior flagella of unequal length	<i>Cryptomonas, Chroomonas, Chilomonas</i>

2.4.3 Structure of Thallus of *Spirigyra*

- Plant body is thalloid, multicellular, unbranch filament
- There is no differentiation of base and apex and all the cells are same throughout the filament.
- All the cell in the filament join end to end in the single row.
- Adjacent are separated by a cross wall called septum, cross wall of the filament are of five types, like, plane, replicate, semireplicate, colligate and undulliseptate.
- In some species the middle lamella of the cross wall develops on either side a ring like in-growth such septum is called replicate septum.



2.4.4. Structure of typical cell of *Spirogyra*

- Shape of vegetative cell of *Spirogyra* is cylindrical.
- Cell wall is made up of two layer, inner wall is made up of cellulose and outer is of Pectin.
- Ribbon shape spirally arranged chloroplast is most prominent feature of *Spirogyra* cell.
- Each chloroplast is decorated with pyrenoid at some distance interval.
- In every cell there is one nucleus which is suspended in the center by means of cytoplasmic strand.
- Center of the cell is occupied by vacuole.
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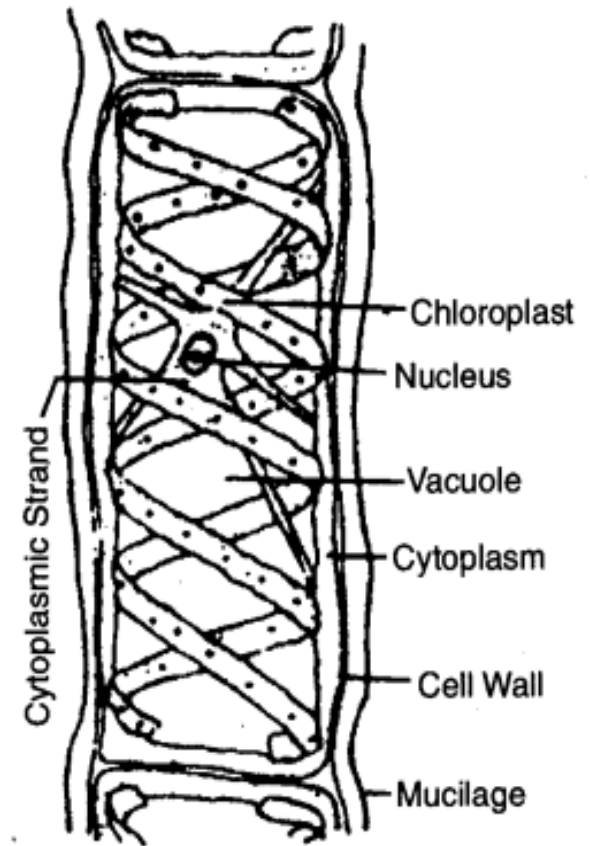
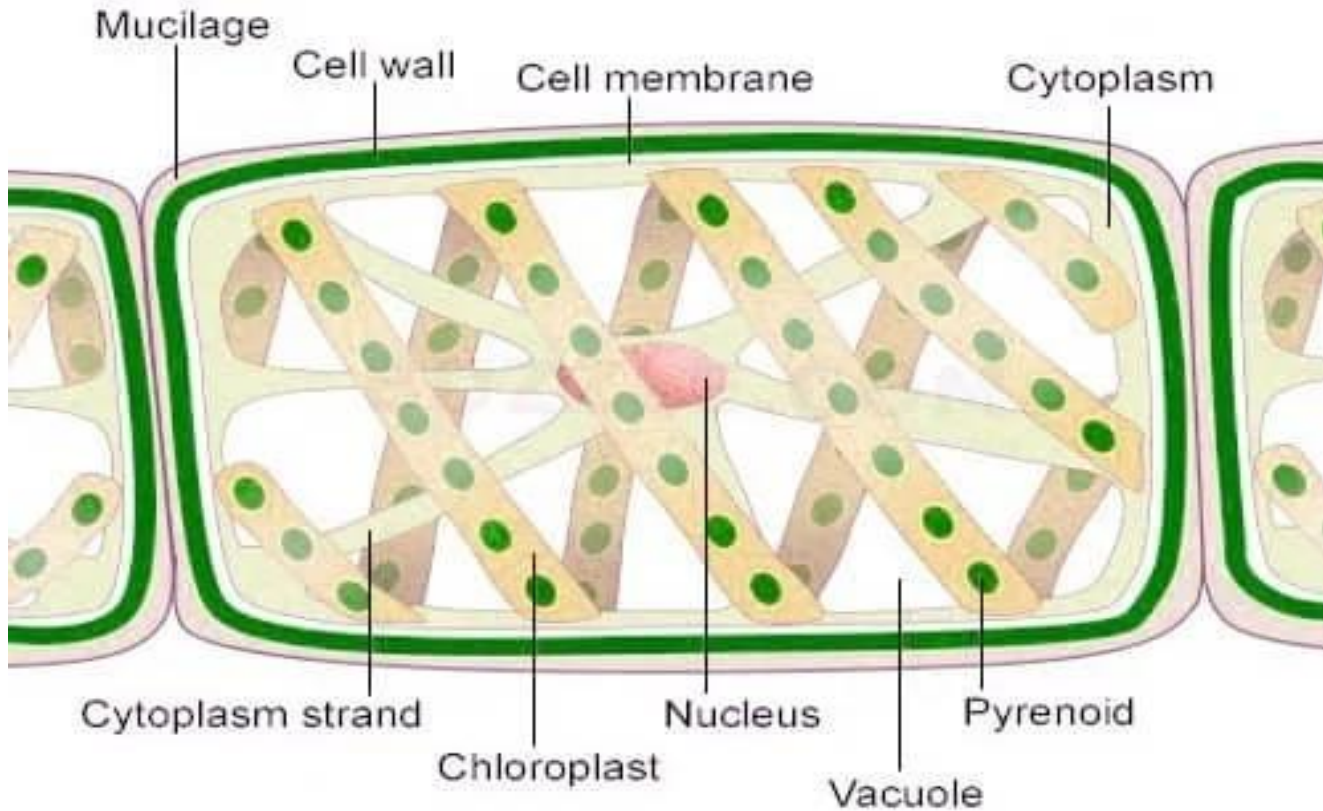


Fig. Cell structure of *Spirogyra*.

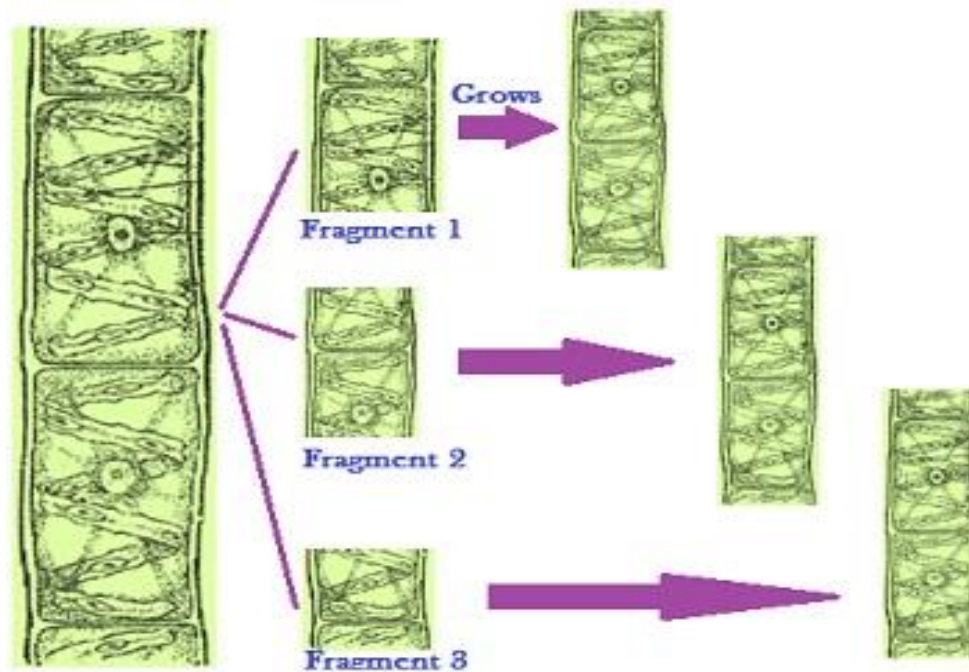
A Single of *Spirogyra* showing structural details



2.4.5.Reproduction- Vegetative, Asexual and Sexual

Vegetative Reproduction:

Veg. Reproduction is take place by Fragmentation method



Asexual Reproduction

Asexual reproduction is less common and reported only in a few *Spirogyra* sp. Asexual reproduction involve the formation of aplanospores, akinetes, azygospores.

(i) Formation of aplanospores:

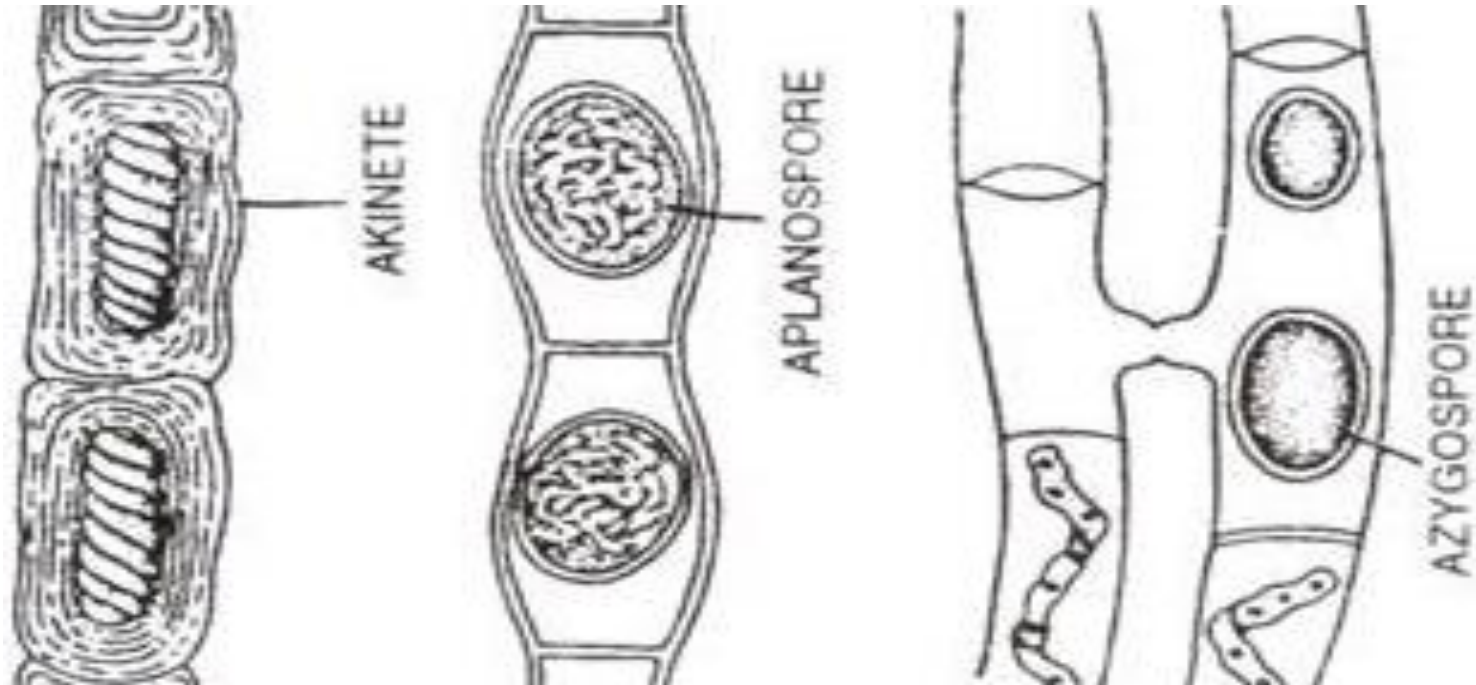
- Under un-favourable conditions, the protoplast of each vegetative cell shrinks and develops a wall around it to form an aplanospore. Each non-motile aplanospore germinates to form a new filament.

(ii) Formation of akinetes:

- Under unfavorable conditions, the vegetative cells develop thick-walled cells called akinetes. On the return of favourable conditions each akinete germinate into a new filament.

(iii) Formation of azygospores or parthemspores:

- sometimes the gametes fail to fuse and each get enclosed by thick cell wall to become azygospore or parthenospore. Each azygospore germinates into a new filament.



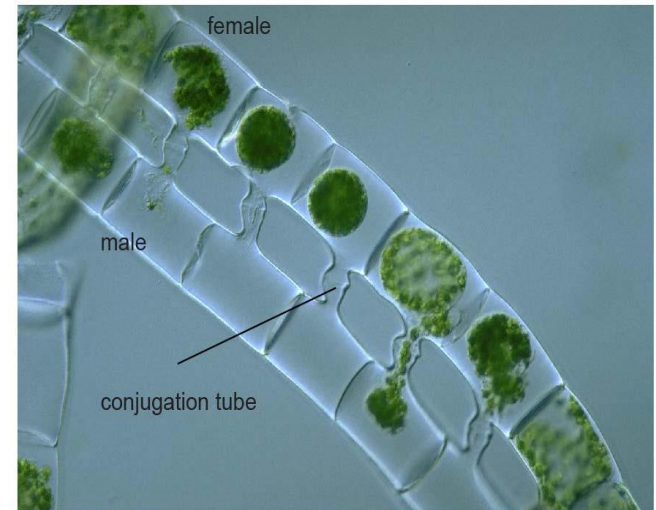
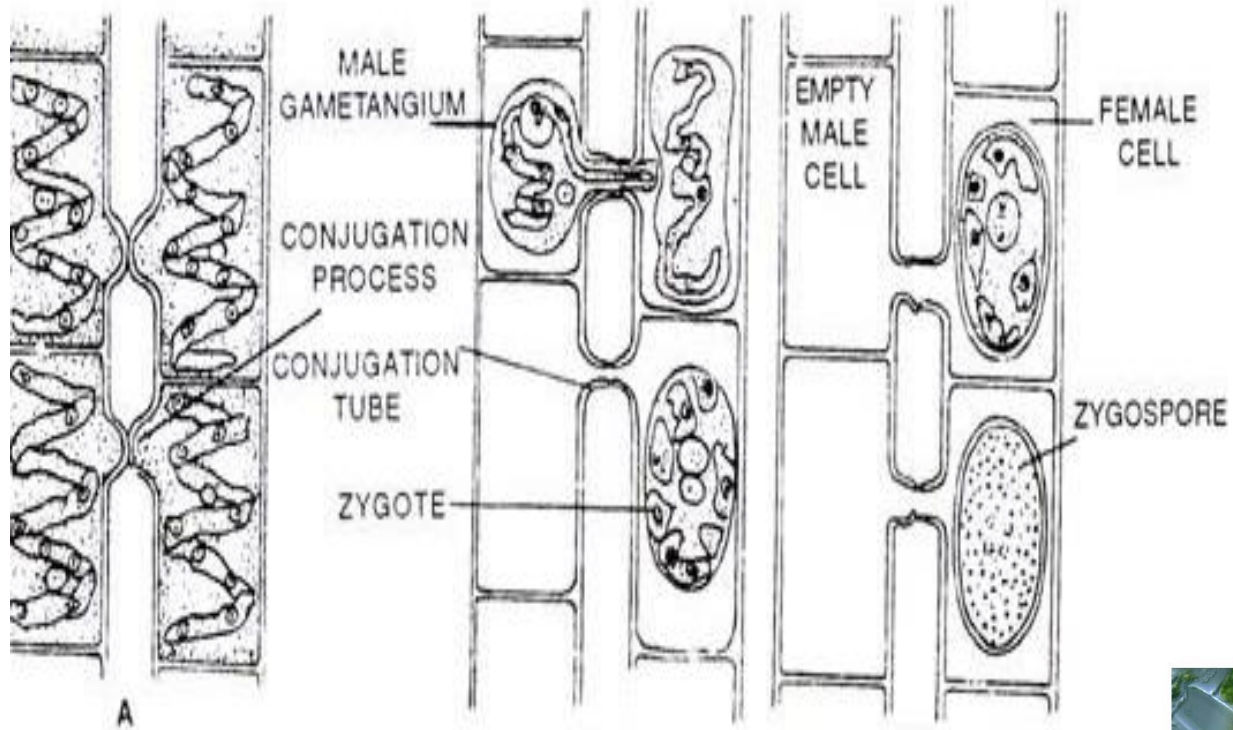
Sexual Reproduction

- Sexual reproduction in *Spirogyra* take place by Conjugation method- an aplanogametic isogamy.
- In this processes two vegetative cell combine their cytoplasmic content to form a zygote.
- Process of conjugation is of two types:-
 1. Scalariform conjugation
 2. Lateral conjugation: It divide into two types
 - a. Indirect lateral conjugation
 - b. Direct lateral conjugation

1. Scalariform conjugation

- It takes place between two cells of different filaments so it is called heterothallic.
- In this type of conjugation opposite cells of two neighboring filaments which are in contact, form protrusions which lie opposite one another and as they elongate, the filaments are pushed apart.
- At the point of contact, the tips of these processes dissolve (by cytolysis) to form a conjugation tube between opposite cells. This resembles a ladder. Hence, the conjugation is called scalariform (Gr. scala = ladder; forma = shape) or H-shape conjugation.
- Meanwhile the contents of the two participating cells contract.
- Fusion of the contracted cell contents takes place within one of the two conjugating cells.
- The active gamete whose cell contents pass through the conjugation tube may be called the male gamete and the cell where fusion occurs is known as the female gamete.
- The fusion product of conjugation is a zygospore.

Spirogyra – Scalariform conjugation



2. Lateral conjugation

- Conjugation occurs in between adjacent cell of same filament so it is called as homothalic. Lateral conjugation is of two types
- **Indirect lateral conjugation :**
- Conjugation occurs in between the adjacent cell of the same filament, small protrusion arise as a result of the growth of the lateral wall on the either side of cross wall of the participating cell.
- With the growth of protrusion cross wall also become stretched, the later loose their contact with the former, a side gap is thus produced between the two cell through which the protoplast of the one cell migrate into the other fusing to form zygote.

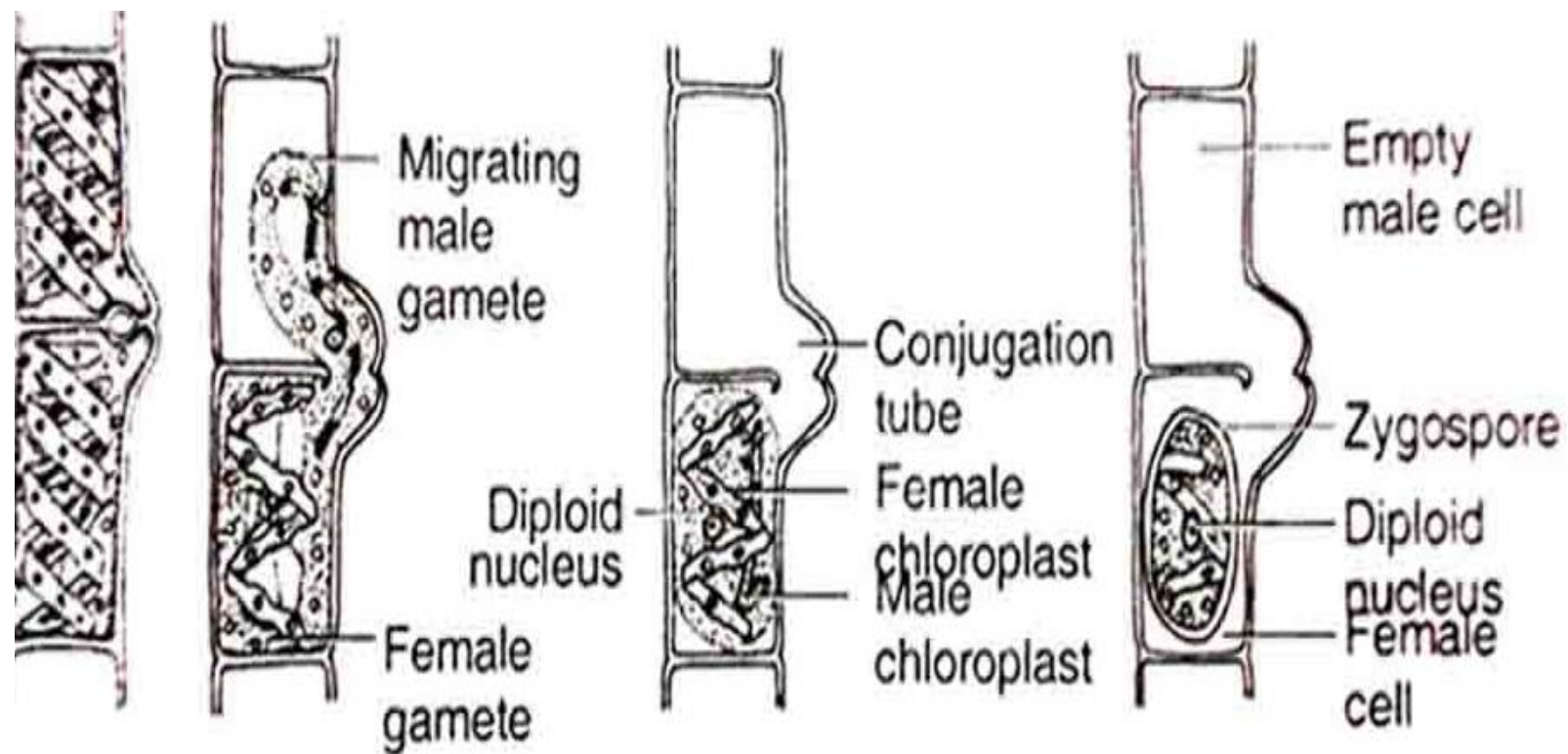
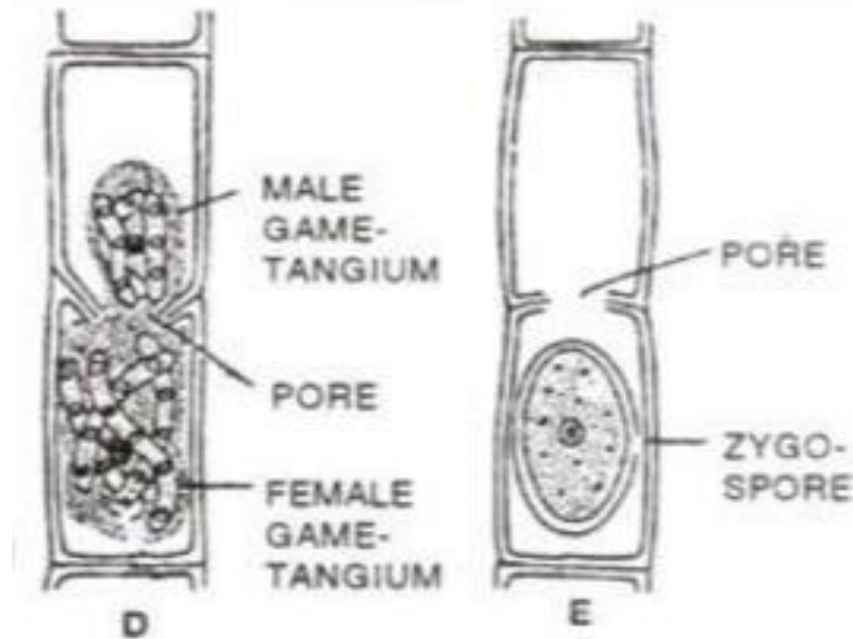


Fig: *Spirogyra*. Indirect Lateral Conjugation.

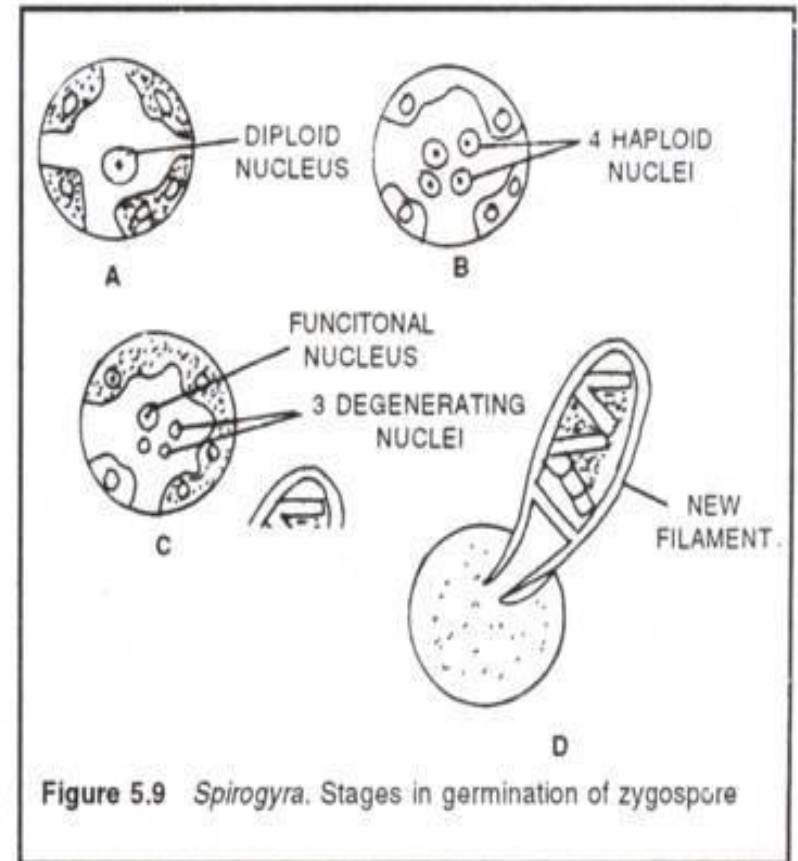
- **Direct lateral conjugation :**

During conjugation, cell content of male gamete get rounded and create a pressure on cross wall and rupture it, make a pore, through this pore cell content of upper cell transfer to lower cell which act as female gamete. Mean while cell content of female gamete also shrink and fuse with cell content of male gamete and formed diploid zygote.

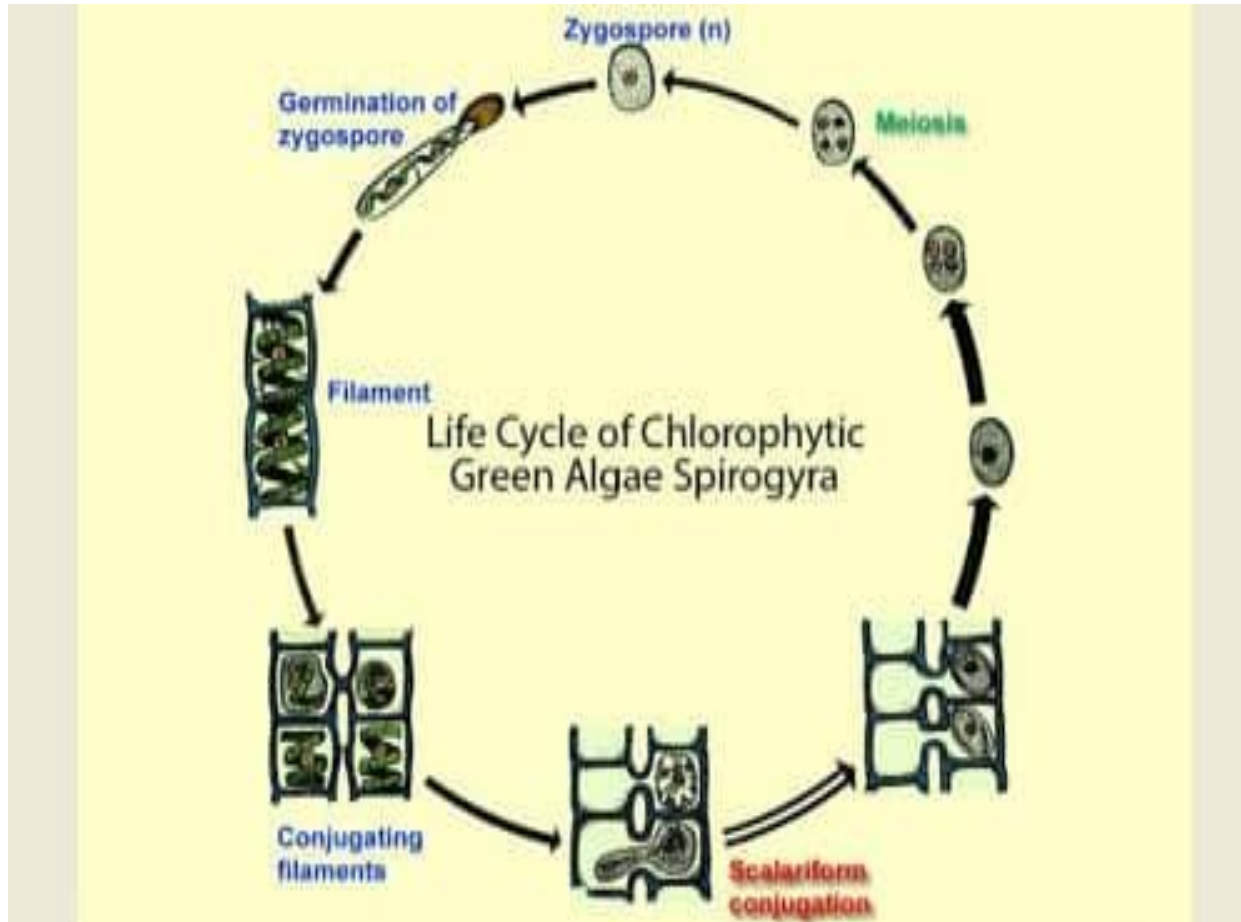


Germination of Zygospore

- Fusion product of conjugation is zygospore which develops 3 layered thick wall.
- During germination two outer layer burst open, the innermost cellulose wall elongates forming a cylindrical germ tube which divides transversely to form a new filament.
- Zygospore divide meiotically, out of four haploid nuclei three degenerate so that each filament is derived from a haploid uni nucleate cell and haploid in nature.



Life Cycle of *Spirogyra*



2.4.6. Systematic position with reasons

- Division: Chlorophyta

- Dominant pigment are chlorophyll a and b, xanthophylls and carotene.

- The reserve food material is starch.

- Motile cells may be bi-, quadri- or multiflagellate and are extremely variable in size.

- Order: Zygnematales

- Lacking zoospores

- Sexual reproduction by conjugation of amoeboid gametes.

- Family: Zygnemataceae:

- Having filamentous body.

- Genus: *Spirogyra*

- Spiral chloroplast

2.5: Utilization of Algae

- **In Bio-fuel Industry:**

- Algae are the origin of petroleum and gas. Present day fossil fuel is derived from marine algae.

- **In Agriculture:**

- Algae used as Fertilizer-Increase water holding capacity of soil.

- **Utilize as Food and Fodder:**

- Algae are rich in vitamins A and E and inorganic substance , e.g., iodine.

- fodder- Kelp meal has made possible its use in various poultry and other animal rations.

- **In Pharmaceuticals:**

- From earliest time the Chinese used Sargassum and various Laminariales treatment of goiter and other glandular troubles.

- Chlorella* is used for the preparation of antibiotic Chlorellin.

- Agar-Agar is produced by boiling and cooling seaweeds which is used in medium for bacterial cultivation.

Summary

- Plant body is thalloid, multicellular, unbranch filament. There is no differentiation of base and apex and all the cells are same throughout the filament.
- Presence of replicate septa.
- Ribbon shape spirally arranged chloroplast is most prominent feature of *Spirogyra* cell.
- Absence of flagellate gametes.
- Sexual reproduction by conjugation – morphological isogamy, but physiological heterogamy.
- Conjugation both lateral and scalariform.
- Algae are utilized in Agriculture as fertilizer, in Bio-fuel Industry ,in Pharmaceuticals and utilize as Food and Fodder.

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