The name of *genus* should be the derivative of a *Greek* word.

The name of *species* should be the derivative of a *Latin* word.

Fritsch's System

F.E.Fritsch, the well-known ***Algologist*** of the ***Great Britain***, has published two volumes of books on ***Structure and Reproduction of the Algae*** in 1935 and 48. In this book he has and discussed his own system of classification for algae. His system is the most comprehensive and authoritative account on algae even today.

His classification is based on the following characters:

- ***Pigmentation***
- Details of ***flagella***
- Reserve ***food***
- Presence or absence of true ***nucleus*** in the cells
- Range of ***thallus structures***
- Methods of ***reproduction***
- Patterns of ***life cycle***.

Based on these characters, ***Fritsch*** divided algae into ***11*** classes. They are :

1. *Chlorophyceae*
2. *Xanthophyceae*
3. *Chrysophyceae*
4. *Bacillariophyceae*
5. *Cryptophyceae*
6. *Dinophyceae*
7. *Chloromonadineae*
8. *Euglenophyceae (Euglenineae)*
9. *Phaeophyceae*
10. *Rhodophyceae*
11. *Cyanophyceae (Myxophyceae).*

1. Chlorophyceae

The members of Chlorophyceae are otherwise called ***green algae.*** This class includes ***orders***, namely:

Volvocales
Chlorococcales
Ulotrichales
Cladophorales
Chaetophorales
Oedogoniales
Conjugales
Siphonales
Charales.

It includes ***43 families*** with ***360 genera*** and about ***5700 species***.

The distinctive features of this class are given below :

1. Chlorophyceae are ***green algae***.
2. They are more common in ***freshwater*** than in ***salt water***.
3. The thallus may be ***unicellular*** or ***multicellular***. If multicellular, it may be ***filamentous*** or ***heterotrichous*** or ***siphonous*** or ***pseudoparenchymatous***.
4. The cell wall is rich in ***cellulose***.
5. These algae have ***grassy-green chromatophores*** which contain ***chlorophyll -a, chlorophyll -b, xanthophyll*** and ***carotenoids***. All these pigments are approximately in the ***same proportion*** as in higher plants.
6. The ***pyrenoids*** present in the chromatophores are surrounded by ***starch sheath***.
7. Their storage food is true ***starch*** and ***oil***.
8. The cells exhibit 2 or 4 ***flagella*** which are ***equal*** in length, if motile.

9. Many species are ***haploid***, but some are ***diploid***.
10. Reproduction may be ***vegetative, asexual*** or ***sexual***.
11. The sexual reproduction may be ***isogamy, anisogamy*** or ***oogamy***.
12. Life cycle may be ***haplontic, diplontic*** or ***diplohaplontic***.
13. It shows ***alternation of generation***.

Examples:

Chlamydomonas
Volvox
Chlorella
Oedogonium
Caulerpa
Coleochaete, etc.

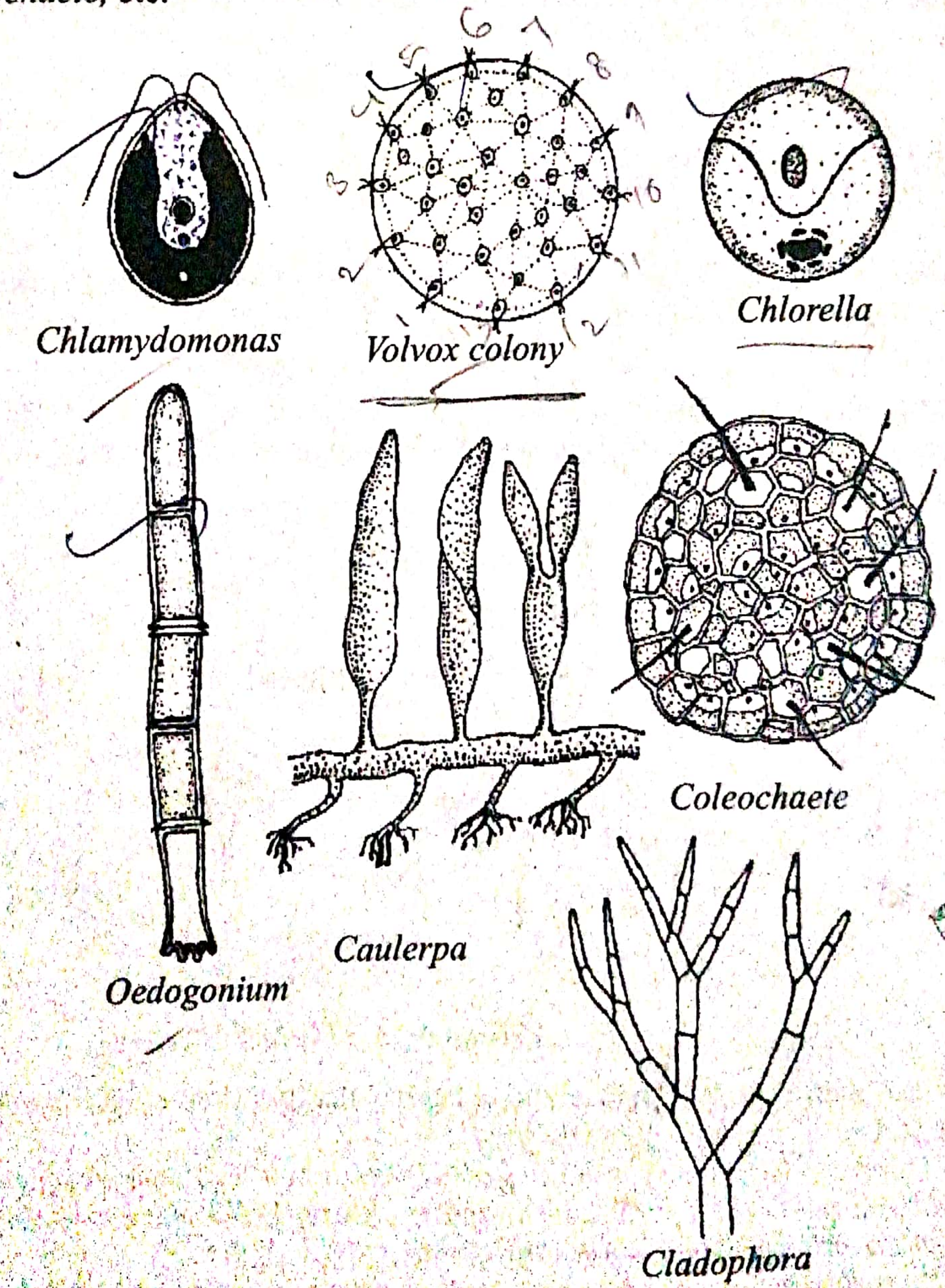


Fig.2.1: Some green algae.

2. Xanthophyceae

The members of this class are commonly called ***yellow-green algae.*** This class includes ***4 orders***, namely:

Heterochloridales
Heterococcales
Heterotrichales
Heterosiphonales.

There are ***12 families*** with ***75 genera*** and about ***675 species*** in this class.

The distinctive features of the class are given below:

1. Xanthophyceae are ***yellow-green algae***.
2. The members of this class are more widely distributed in ***freshwater*** than in sea.
3. The thallus may be ***motile, unicellular*** or ***multicellular***.
4. If multicellular, it may be ***palmelloid*** or ***dendroid*** or ***filamentous*** or siphonous.

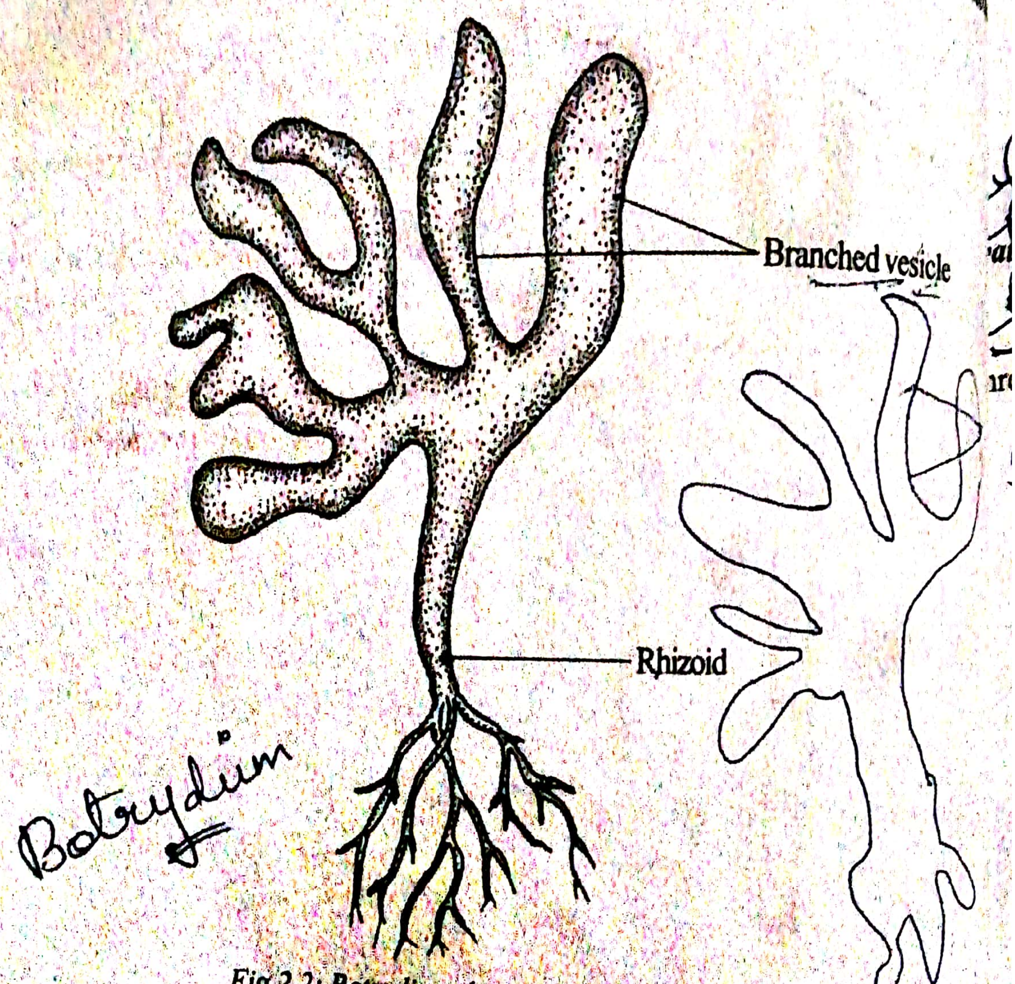


Fig.2.2: Botrydium divisum with a branched vesicle.

5. The ***cell wall*** is rich in ***pectin*** and is mostly made of two equal or unequal pieces overlapping at their edges. It is often ***silicified***.
6. The chromatophores are ***yellowish green*** in colour owing to the presence of excess ***xanthophylls*** and small amount of ***chlorophyll-a, chlorophyll-e*** and ***carotenoids*** in them.
7. Pyrenoids are absent in the chromatophores.
8. Starch is absent. Reserve food are stored in the form of ***oil*** and ***leucosin****.

Leucosin* *A white coloured carbohydrate of unknown combination*

9. There are two (rarely one) ***unequal flagella*** at the front end of the cell, if motile.
10. Many members are ***haploid***, but some are ***diploid***.
11. ***Asexual*** and ***vegetative reproductions*** are common.
12. ***Sexual reproduction*** is rare. It is ***isogamous***, if present.
13. *Botrydium* is an example for Xanthophycean algae.

3. Chrysophyceae

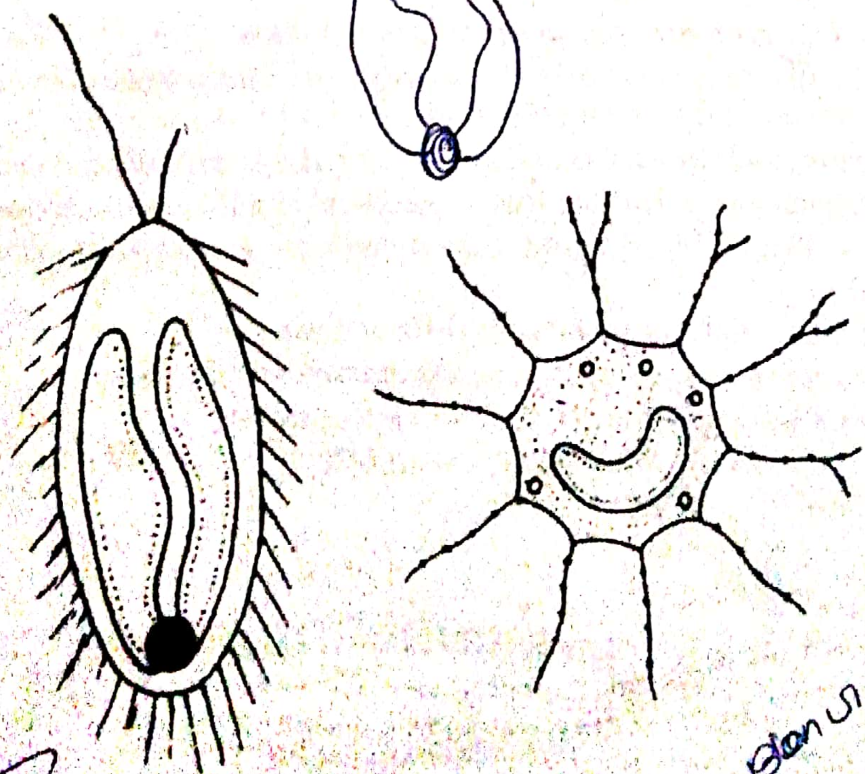
The members of this class are often known as ***orange algae.*** This class includes ***3 orders,*** namely:

Chrysomonadales
Chrysosphaerales
Chrysotrichales.

There are ***22 families*** with ***82 genera*** in this class.

The distinctive features of this class are given below:

1. Chrysophyceae are ***orange algae***.
2. The members of the class are mostly living in ***freshwater***, but some are in ***marine water***.
3. The thallus may be a ***single cell*** or ***coccoid*** or ***palmelloid*** or ***dendroid*** or ***filamentous.***
4. The members of this class are mostly ***flagellates***. The flagella may be one or two rarely three. They may be ***equal*** or ***unequal.***
5. Their cell wall is non-cellulosic and bears ***silicified scales*** or ***calcified plates***.
6. The members of this class contain 1-2 ***brown*** or ***orange coloured chromatophores*** in



Mallomonas *Chrysamoeba*

Fig.2.3: Some Chrysophycean algae.

each cell. These chromatophores possess excess of *phycochrysin* and small propor... *chlorophylls*, *b - carotenes* and *xanthophylls*.

7. *Pyrenoids* are present, but are not enclosed by starch layer.

8. Photosynthetic reserves are stored in the form of *fat droplets* and *leucosin*.

9. *Sexual reproduction* is rare. It is *isogamous*, if present.

10. Examples:

Mallomonas,
Chrysamoeba,
Phaeothamnion,
Pedinella, etc.

4. Bacillariophyceae

The members of the class are otherwise called *golden - brown algae* or *diatoms*. ... class includes *two orders*, namely :

Centrales
Pennales.

There are *11 families* with about *170 genera* and *5300 species* in this class.

The distinctive features of Bacillariophyceae are given below:

1. Bacillariophyceae are *golden-brown algae* or *diatoms*.
2. They are widely distributed in *freshwater*, *sea water*, *soils* and other *terrestrial ha... tats*.
3. The members of the class are *unicellular* or *filamentous colonies*.
4. The colonial forms are enclosed by *mucilage*.
5. The cells are mostly *diploid*.
6. The cell wall is made of *pectin* substances and *silica*.
7. The cell wall consists of two equal halves each of which is made of two or more hea... *ornamented* pieces.
8. The members of this class contain *yellow* or *golden - brown* chromatophores.
9. The chromatophores contain excess of *xanthophyll* and *carotenoids* and small amo... of *chlorophyll-a* and *c*. The common xanthophylls are *fucoxanthin*, *diatoxanthin* a... *diadinoxanthin*.
10. The storage products are *fats*, *leucosin* and *volutin*.
11. Motile cells possess a single anterior *pantonematic flagellum*.
12. Reproduction may be *vegetative*, *asexual* or *sexual*.
13. Sexual fusion takes place between the protoplasts of individual cells and results... *auxospore formation*.

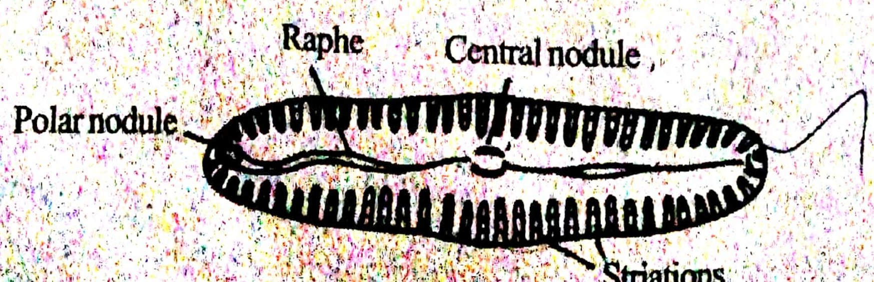


Fig.2.4: Pinnularia.

14. Life cycle is *diplontic type.*

15. It shows *alternation of generation.*

16. Examples:

Pinnularia,
Surirella,
Triceratium,
Diplonesis,
Navicula,
Cyclothera, etc.

5. Cryptophyceae

This class includes ***two orders***, namely:

Cryptomonadales
Cryptococcales.

There are ***four families*** with ***14 genera*** in this class.

The distinctive features of Cryptophyceae are listed below:

1. They are more common in ***marine water.***
2. The members are mostly ***motile*** single cells.
3. The motile cells have two slightly ***unequal flagella*** at their anterior ends.
4. The members of the class usually bear two parietal chromatophores with various colours.
5. The cells may be ***red, blue, olive yellow, brown*** or ***green*** because of various proportions of ***chlorophyll-a*** and ***c***, ***β - carotene***, ***diatoxanthin*** and ***biliproteins*** in their chromatophores.
6. ***Pyrenoids*** may be present.
7. The storage products are ***starch*** and ***oil.***
8. Reproduction is mostly by longitudinal ***cell division*** and ***cyst formation.***
9. ***Sexual reproduction*** is rare. It is ***isogamous***, if present.
10. Examples:

Chroomonas
Cryptomonas.

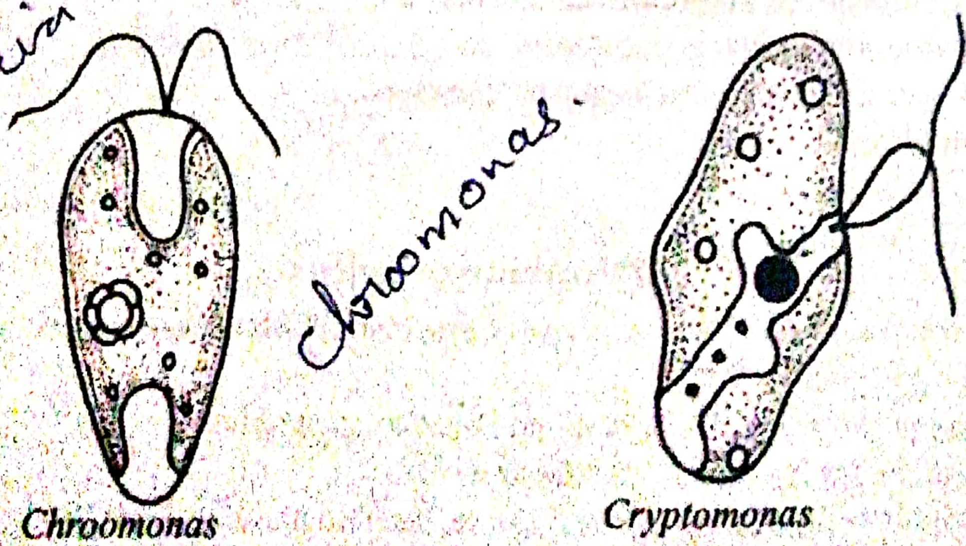


Fig.2.5: Common members of Cryptophyceae.

6. Dinophyceae

This class includes *6 orders*, namely :

Desmomonadales — *Dinoflagellata*
Dinophysiales — *Dinococcales*
Thecatales — *Dinotrichales.*

There are about ***25 families*** with about ***58 genera*** in this class.

The distinctive features of Dinophyceae are given below:

1. They are mostly phytoplanktons living in ***freshwater, brackish water*** and marine.
2. The members are mostly ***motile single cells.***
3. The motile cell has one ***transverse furrow*** and a ***longitudinal furrow.***

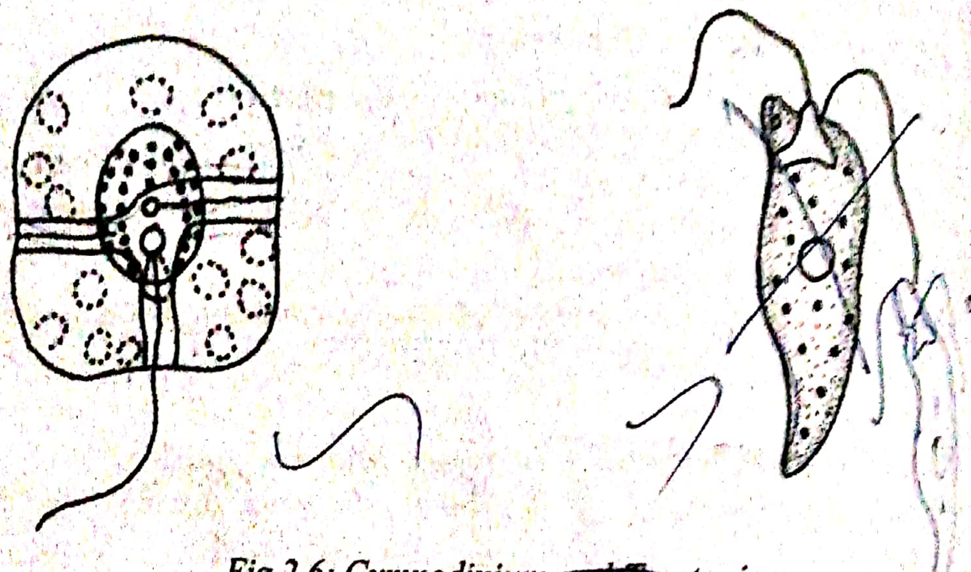


Fig.2.6: Gymnodinium and Trentonia.

4. A ***flagellum*** arises from the transverse furrow and encircles the cell and another flagellum arises from the longitudinal furrow and faces backwards.
5. The ***cell wall*** is composed of heavily sculptured plates made of ***cellulose.***
6. The members of the class bear numerous discoid chromatophores which are ***dark yellow*** or ***brown*** in colour. However, in some ***saprophytic*** species the chromatophores are ***colourless.***
7. The storage products are ***starch*** and ***oil.***
8. ***Sexual reproduction*** is common.
9. Many species form characteristic resting cysts.
10. Examples :

    Gymnodinium
    Trentonia.

7. Chloromonadineae

This is the ***smallest class*** consisting of ***one order, Chloromonadales*** with ***one family*** consisting of a ***few genera.***

The distinctive features of Chloromonadineae are given below:

1. Most of the species inhabit ***freshwater.***
2. The motile cells bear two ***equal flagella***, inserted apically in a slight depression.
3. The members of the class contain numerous ***bright green*** chromatophores which contain excess of ***xanthophylls.***

4. Pyrenoids are absent.

5. Reserve food are stored as ***oil***.

6. Reproduction is mainly by longitudinal division of individuals.

7. ***Sexual reproduction*** is rare. It is ***isogamous***, if present.

8. Examples :

Trentonia
Vacuolaria

8. Euglenophyceae (Euglenineae)

This class is otherwise called ***Euglenoids.*** It is directly divided into ***11 families*** with about ***29 genera***.

The distinctive features of the class are listed below:

1. This class is restricted to ***freshwater.***

2. Almost all members are ***flagellates*** and ***unicellular***.

3. They have one or two flagella inserted in a canal-like invagination at their front end.

4. The members of this class have ***pure green*** chromatophores which contain ***chlorophylls*** and ***carotenoids***.

5. Reserves food is stored as ***paramylon***, a form of ***white polysaccharide granule***.

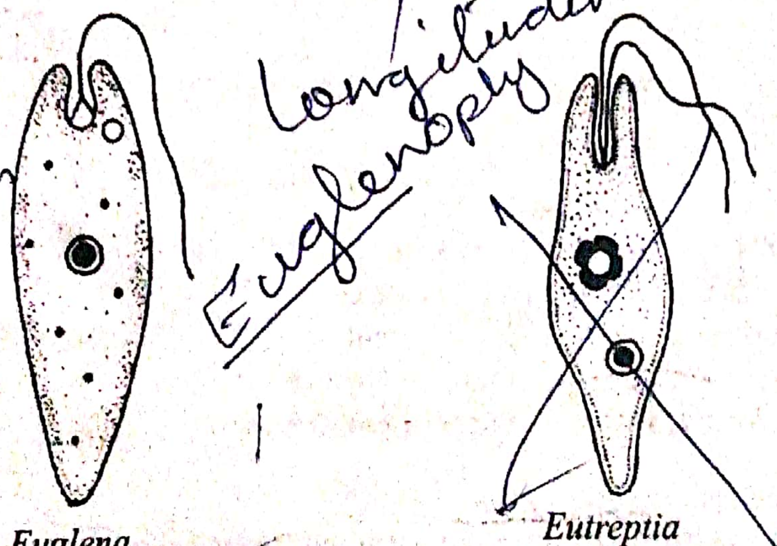


Fig.2.7: Euglenophyceae.

6. ***Pyrenoids*** are often well-developed.

7. Reproduction is by ***longitudinal fission*** of individual cells.

8. The resting cysts are covered by ***mucilage***.

9. Examples:

Euglena
Eutreptia
Astasia
Colacium
Hyalophacus.

9. Phaeophyceae

Phaeophyceae includes ***brown algae***. Phaeophyceae includes ***9 orders***, namely,

Ectocarpales
Tilopteridales
Cutleriales
Sporochnales
Desmarestiales
Laminariales
Sphacelariales
Dictyotales
Fucales.

There are ***64 families*** with about ***195 genera*** and ***1000 species***.

The distinctive features of Phaeophyceae are as under :

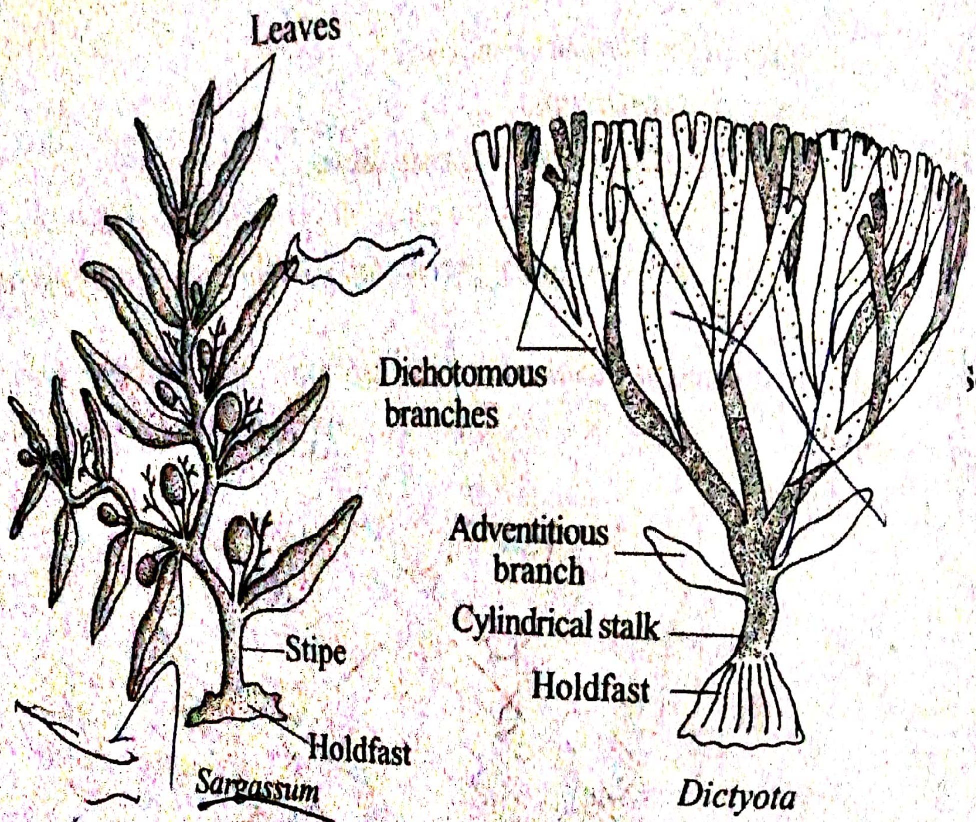


Fig.2.8: Phaeophyceae.

1. Phaeophyceae are ***brown algae***.
2. Most of the members live in ***marine water*** as ***brown sea-weeds***. A few live in fresh ***water***.
3. The thallus may be ***heterotrichous*** filaments or ***pseudo-parenchymatous*** filaments or ***true parenchymatous*** filaments.
4. The motile reproductive cells possess two lateral ***flagella***, of which one faces upwards and the other faces downwards.
5. The ***cell wall*** is made of ***cellulose*** and ***alginic acid***.
6. The members of the class have ***brown*** coloured chromatophores which contain excess of ***fucoxanthin*** and small proportion of ***chlorophyll-a*** and ***c***, ***carotenoids***.
7. In majority of the cases, the cells contain ***fucosan vesicles***.
8. Reserve food is stored as ***alcohols, mannitol*** and ***laminarin***. Rarely ***oils*** or ***fucosan granules***.
9. ***Sexual reproduction*** is very common and it varies from ***isogamy*** to ***oogamy***.

10. The zygote exhibits no resting period.

11. Examples :

Sargassum
Dictyota
Fucus
Macrocystis.

10. Rhodophyceae

The members of this class are ***red algae***. Rhodophyceae includes ***7 orders***, namely:

Bangiales	*Gigartinales*
Nemalionales	*Rhodymeniales*
Gelidiales	*Ceramiales.*
Cryptonemiales	

There are ***42 families*** with ***400 genera*** and ***2500 species***.

The distinctive features of Rhodophyceae are listed below :

1. Rhodophyceae are ***red algae***.

2. Many species live in ***marine water*** as ***red sea-weeds***, but a few live in ***fresh- water***. Some are living on ***muddy soil***.

3. The thallus may be ***unicellular*** or ***multicellular***.

4. The multicellular forms may be either ***filamentous*** or ***pseudo-parenchymatous***.

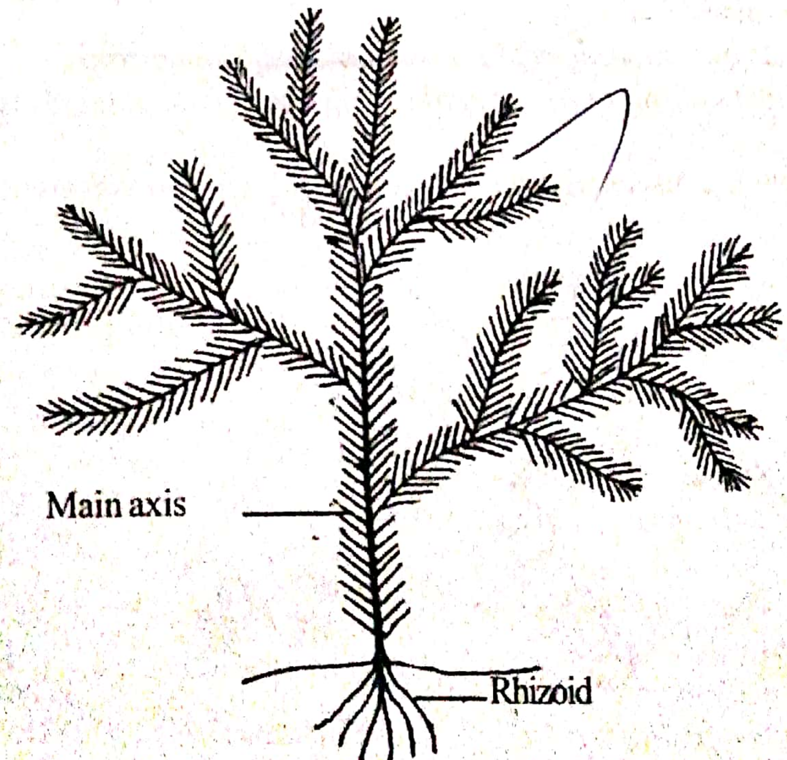


Fig.2.9: Polysiphonia.

5. Motile reproductive cells and flagellated members are not known.

6. The ***cell wall*** is made of ***polysaccharides*** and ***polyuronic acids***.

7. The members of the class have ***red colour*** chromatophores which contain excess of ***phycoerythrin*** and small amount of ***chlorophylls***, ***carotenoids*** and ***xanthophylls***.

8. Pyrenoids are present in lower forms.
9. Reserve food is stored as ***floridean starch, galactan sulfate*** and flori[illegible]
10. ***Asexual*** and ***sexual reproductions*** are common.
11. ***Sexual reproduction*** is ***oogamous*** type.
After fertilization many branches of female sex organs fuse together and pr[illegible] of ***carpospores***. This phenomenon is called ***post fertilization change.***
12. Example :
Polysiphonia
Gracilaria
Batrachospermum, etc.

11. Cyanophyceae (Myxophyceae)

The members of this class are otherwise called ***blue-green algae (BGA)***. Th[illegible] cludes ***5 orders***, namely:

Chroococcales
Chamaesiphonales
Pleurocapsales
Nostocales
Stigonematales.

There are ***18 families*** with about ***150 genera*** and ***1500 species*** in the class.
The distinctive features of the class are listed below :
1. Cyanophyceae are ***blue -green algae.***
2. The members of the class are widely distributed in ***freshwater*** and moi[illegible] some species live in ***sea water*** also.
3. The thallus may be ***unicellular*** or ***colonial*** or ***filamentous***.
4. The members of this class are ***prokaryotic*** and do not possess membrane [illegible] organelles.
5. The ***cell wall*** consists of ***mucopolysaccharides*** and ***gelatinous*** envelope.

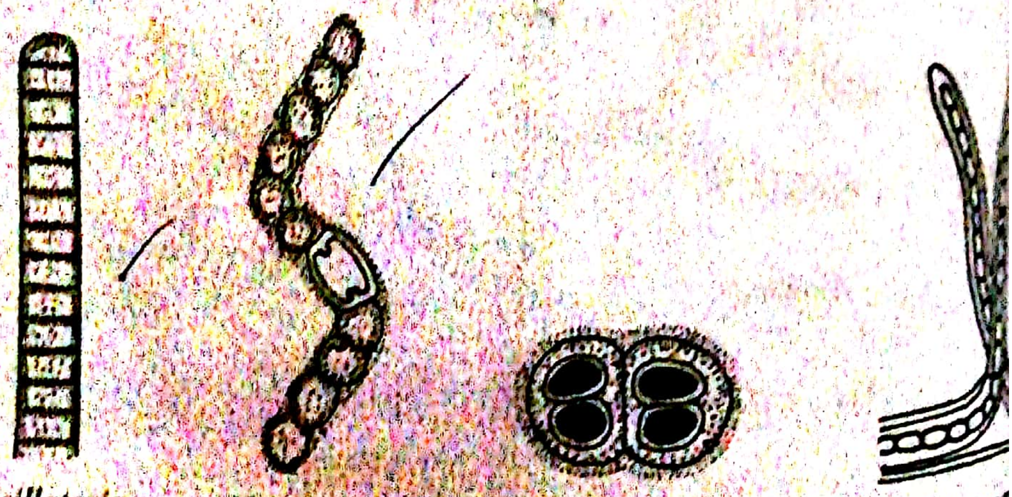


Fig.2.10: Blue - green algae.

6. The colour of the cells is ***blue - green*** due to the presence of excess of phy[illegible] and varying proportions of ***chlorophyll-a, b- carotene, flavacine, myxoxan***[illegible] ***myxoxanthin, oscillatoxanthin*** and ***phycoerythrin*** in their protoplasm.
7. Chromatophores and pyrenoids are absent.
8. Reserve foods are stored as ***sugars*** (Cyanophycean starch) and ***glycogen***.

9. There is no sexual reproduction.

10. *Vegetative* and *asexual reproductions* are common.

11. Example :

Oscillatoria

Nostoc

Gloeocapsa

Scytonema, etc.

The modern Algologists have slightly modified the Fritsch's system and divided algae into 11 divisions. They are :

Cyanophyta	*Pyrrophyta*
Chlorophyta	*Cryptophyta*
Charophyta	*Euglenophyta*
Xanthophyta	*Phaeophyta*
Chrysophyta	*Rhodophyta.*
Bacillariophyta	

G.M.Smith System

G.M.Smith was a well-known ***Algologist*** of the ***Great Britain.*** He has proposed a system of classification for ***Algae*** in his book '***Cryptogamic Botany***' between 1935 and 1955.

Smith classified Algae based on the following characters:

- Vegetative characters
- Pigmentation
- Reproductive structures and cells
- Life cycle patterns.

Smith's classification is easy to follow and to identify algae using the ***Manual of Phycology*** prepared by ***Smith.***

Smith has divided algae into ***seven divisions.*** They are:

1. *Chlorophyta*
2. *Euglenophyta*
3. *Pyrrophyta*
4. *Chrysophyta*
5. *Phaeophyta*
6. *Cyanophyta*
7. *Rhodophyta*

Division 1. Chlorophyta

This division is also called ***green algae.*** There are about 5700 species in this division. It has two classes namely, ***Chlorophyceae*** and ***Charophyceae.***

The distinctive features of chlorophyta are given below:

1. Thallus may be ***unicellular, colonial, filamentous, siphonous*** or ***pseudo - parenchymatous.***

2. Green algae are distributed in ***freshwaters, salt waters*** and ***moist soils.***

3. Cell wall is rich in ***cellulose.***

4. The members of this class contain ***green*** chromatophores.

5. The chromatophores contain excess of ***chlorophyll -a*** and ***b.***

6. ***Pyrenoid*** is surrounded by starch plates.

23

Economic Importance of Algae

Algae are important to ***man*** and his ***plants*** and ***animals***. Though many algae are ***useful*** to man, some are ***harmful*** to him directly or indirectly.

The ***economic importance*** of algae can be discussed under two aspects.

A. Beneficial roles of algae

B. Harmful roles of algae.

A. Beneficial Roles of Algae

The following are the beneficial roles of algae :

1. Algae as food for man

2. Algae as fodder

3. Algae in agriculture

4. Algae in industries

5. Algae as pollution indicators

6. Algae in sewage treatment

1. Algae as Food

Many ***freshwater*** and ***marine algae*** have been utilized as a direct source of ***food*** by people of different parts of the world.

Algae are rich in ***proteins, carbohydrates, oils, vitamins A,B,C*** and ***E*** and ***minerals***.

Since the algae possess ***minerals*** like ***Cu, Fe, Zn, I, Co, V, Mn, Br*** and ***Cr***. The deficiencies in man and ***domestic animals*** are rectified by consuming the algae as food.

Porphyra, Rhodymenia, Ulva, Alaria, Chlorella, Chondrus, Nostoc, Laminaria, etc. are very useful in ***human diet***.

In ***Japan***, *Porphyra tenera* is cultured in ***shallow water*** at ***coastal regions*** by using ***bamboo frame nets*** and the resulting ***thalli*** are ***harvested***.

The thalli are then ***washed*** with ***fresh water***, cut into ***small pieces***, ***dried*** and pressed into ***cakes***.

These cakes are ***eaten*** with ***rice***. They are rich sources of ***carbohydrates, proteins*** ... ***vitamins***.

In ***England***, *P. umbilicalis* is ***cultured*** in ***shallow waters*** and made into ***cakes*** for use ... ***food***.

Americans incorporate *Porphyra perforata* in their ***dishes***.

In ***Brazil***, *Nostoc* colonies are ***collected, boiled*** and consumed as ***a liquid food***.

People of ***Chile*** have been consuming *Durvillea antartica* and *Ulva lactuca* as food.

Caulerpa racemosa is consumed with ***rice*** in ***Philippines***. *Laminaria saccharina*, ... *lactua*, *Rhodymenia palmata*, etc. are being included in various dishes in ***Scotland, Ireland***, ***China, Malaya, Burma*** and ***Thailand***.

Suimono is a ***Japanese dish*** prepared from ***dried fishes*** and ***sea-weeds***.

Mitu is another ***Japanese dish*** prepared by using ***fresh sea-weeds, fruits, sugar*** ... ***dried kidney beans***.

Amanori and ***Asakusa-nori*** are some other ***Japanese*** foods prepared from sea weeds.

Dulse is an ***English dish*** prepared from *Rhodymenia*.

Seatron is an ***American dish*** prepared from *Nerocystis*.

Green Laver is a ***south Indian dish*** prepared from various species of *Spirogyra* and *Oedogonium*.

Kombu is an another dish prepared from *Laminariales*.

In ***Japan, Germany*** and in the ***USA***, the ***one celled green alga***, ***Chlorella*** is used for ***human diet***.

Chlorella is rich in ***fats, proteins*** and ***vitamins*** and it ***grows fast*** in ***culture vessels***. Hence it is cultured in ***large tanks*** and the ***cells*** are ***harvested*** from the ***tanks***.

The harvested cells are then ***washed*** with ***water***, ***dried*** and ***powdered***.

This powder is often called ***single cell protein***.

It contains ***vitamins*** like ***thiamine, riboflavin, niacin, pyridoxin, pantothenic acid, choline, biotin, vitamin*** B_{12} and ***lipoic acid***. Hence it is used as ***supplementary protein*** ... ***human diet***.

Carrageenin is a ***jelly-like substance*** prepared from *Chondrus crispus*. It is used in making ***jellies*** and ***puddings***. It is also used in the manufacture of ***fruit juices*** and ***ice-creams***.

The unicellular algae *Chlorella pyrenoidosa* and *Synechococcus* are used in ***spacecraft*** for producing enough ***food*** for ***spaceman*** and for ***producing enough oxygen*** for his ***respiration***. They decompose ***human faeces*** and ***urine*** during their growth so that the wastes will be minimised.

The commonly used ***edible algae*** are given below :

1. Cyanophyceae (or) Blue green algae

Species of Nostoc | *Anabaenopsis* and *Spirulina*
Microcystis | *Nostoc commune*

2. Chlorophyceae (or) Green algae

Monostroma
Ulva
Codicene
Enteromorpha
Spirogyra
Oedogonium
Chlorella
Caulerpa racemosa

3. Phaeophyceae (or) Brown algae

Laminaria saccharina *Alaria esculenta*
Alaria fistulosa *Sargassum sp.*

4. **Rhodophyceae (or) Red algae**

Porphyra perforata *P. Umbilicalis*
Chondrus crispus *Rhodymenia palmata.*

2. Algae as fodder

Many ***sea-weeds*** are directly used as feed for ***cattle, poultry*** and ***aquatic organisms.***

In countries like ***Norway, France,*** the ***U.S.A., Denmark*** and ***New Zealand,*** seaweeds are being used as ***feed*** for ***cattle.***

Ascophyllum, Laminaria, Fucus, Sargassum, etc. are commonly used for this purpose.

Seaweeds contain ***vitamins*** and ***all essential minerals.*** Hence ***cows*** give ***more milk*** with ***high fat content*** when foods are supplemented with sea-weeds.

To increase the ***milk yield*** *Pelvetia* and *Sargassum* are used as ***cattle feed*** in ***China*** and *Rhodymenia* is used in ***France.***

Sea-weed meal increases the ***egg laying capacity of fowls*** and the resulting ***eggs*** contain high level of ***iodine*** and ***carotenes***.

In some countries sea weeds are used as ***feed to sheep*** also.

Algae are chief primary producers in aquatic ecosystems and form for ***aquatic animals*** which are then going to be a ***food*** for ***man***.

3. Algae in Agriculture

In agriculture algae are used as ***green manure, nitrogen fixers*** and as agents for correcting the ***pH*** of the soil with a view to increasing ***productivity or crops***. The different uses of algae in agriculture are as follows :

1. Algae as green manure
2. Algae as nitrogen fixers
3. Reclamation of soils.
4. Pest control

1. Algae as Green manure

Sea-weeds are used as ***green manure*** for the ***agricultural crops***.

They are used directly either by adding ***sea-weeds*** alone to the soil or by adding them along with the ***farm-yard manure.***

They increase the ***quality of plants*** and their ***yield*** due to the presence of ***nitrogen*** and ***potash*** in their cells.

They also contain ***trace elements*** like ***cobalt, manganese, boron, barium, iodine***, etc. These elements increase the manurial value of the seaweeds.

Sometimes sea-weeds are ***sprayed*** over the crops after proper ***homogenation*** and ***filtering.***

Lithospermum, Phymatolithon, Macrocystis, Sargassum, Gracilaria, Turbinaria, Laminaria, Enteromorpha, etc. are commonly used as green manures in agriculture.

The sea-weed green manure checks the ***leaching of minerals*** from the ***field*** to a considerable extent.

Potash content is generally poor in ***sandy soils***.

Seaweeds enhance the ***potash*** and ***mineral contents*** of the soils.

Since they have ***gelatinous substance,*** they improve the ***physical*** and ***chemical properties*** of the soils.

The *calcium carbonate* present in the seaweeds increases the ***pH*** of the soil

Seaweed manure increases the yield of ***barley, potato, coconut palms, citrus,*** etc.

2. Algae as Nitrogen Fixers (Biofertilizers)

Many *blue-green algae* have the ability to ***fix the atmospheric nitrogen*** in the soil.

The blue green algae fix the atmospheric nitrogen.

Blue green algae can fix ***20-30 kg*** of ***nitrogen*** in a ***hectare per annum.***

The important blue green algae used in agriculture are *Anabaena, Spirulina, Nostoc, Cylindrospermum, Tolypothrix, Oscillatoria princeps, O. formosa,* etc.

In addition to nitrogen fixation, blue green algae release ***vitamin B₁₂, auxins,*** etc. which induce the *growth* of *higher plants*. Thus they are efficient nitrogen fixers in agriculture, especially for maintaining nitrogen fertility of the soil. Fertility of tropical soil can be increased by increasing the wealth of blue green algae in the soils.

3. Reclamation of Soils

Saline and *alkaline soils* can be converted into productive ones by ***growing some blue green algae*** on the soils.

During rainy season, the blue green algae form a ***dense growth*** on ***alkaline soils*** on which crops cannot grow normally and fix the atmospheric nitrogen in the soil.

Gelatinous sheath and ***humus*** formed during the death and decay of the algae increase the ***water holding capacity*** of the soils and ***reduce the pH*** of the soil from ***9.7*** to ***7.6***. Hence the soils become suitable for the cultivation of crops.

R.N.Singh (1950) has demonstrated that ***blue green algae reclaim, alkaline soils*** within one year after introducing the algae in the soil and that in the reclaimed soils, paddy gave as much yield as 1576-2000 1b.per acre.

The important blue green algae being used for the ***reclamation of alkaline soils*** are *Nostoc, Scytonema, Anabaena, Rivularia, Gloeocapsa, Spirulina, Oscillatoria,* etc.

Sea weeds contain plenty of ***calcium carbonate*** in their cells so that they have been used in agriculture to ***reclaim acidic soils***. *Lithothamnion, Lichophyllum, Gracilaria, Enteromorpha,* etc. are used for this purpose. They may be applied as ***green manure*** or as ***sea-weed powder.***

4. Pest Control

Caballero (1919) proved that the members of Charophyta cause death of larvae of mosquito and other insects.

4. Algae in Industries

In industries many algae have been used as sources for the ***extraction of some commercial products*** such as ***agar-agar, carrageenin, algin.***

These products and ***diatomite*** are used in several industries. The important uses of algae and algal products in industries :

1. Agar - agar

2. Algin

3. Carrageenin

4. Diatomite

5. Other industrial uses.

1. Agar-agar

Agar-agar is a ***mucilaginous*** substance produced by certain ***Rhodophycean*** algae. It is a complex ***polysaccharide*** and is free of ***nitrogen.***

- It melts at *high temperatures (90 - 100°F)* and becomes *solid* at *low temperatures*.
- It is *soluble* in *hot water*, but remains *undissolved* in *cold water*.

The main sources of agar-agar are Rhodophycean algae such as *Gelidium, Gracilaria* and *Gigartina*. Apart from these, *Furcellaria, Hypnea, Sarconema, Eucheuma*, etc. also yield *agar-agar* to certain extent.

Japan produces about *95%* of the *total agar production* of the *world*.

In India nearly *14 metric tons* of dry red algae are used for *agar production* every year.

The important uses of agar are :

- Agar-agar is an *inert material*. So it is used for making *artificial culture media* for *algae, fungi, bacteria* and *plant tissues* in *clinical* and *biological laboratories*.
- Agar is used as *emulsifier* in the preparation of *ice-creams, fruit jellies* and *dairy products*.
- It is used in the manufacture of *shaving creams, cosmetics, shoe polishes* and some *pharmaceutical products*.
- It is used as *sizing agent in leather* and *textile industries*.
- It is used in *paper making*.
- It is also used for *clearing some liquids*.

2. Algin

Alginic acid is extracted from Phaeophycean algae such as *Fucus, Laminaria, Macrocystis* and *Ascophyllum*. The *salts* of *alginic acid* are called *alginates*.

Alginates are *colloidal in nature*, but *hard when dry*.

Alginic acid and *alginates* are collectively called *algin*.

They occur in the *middle lamella* and *primary cell* wall of the *Rhodophycean algae*.

The main source of algin in India is *Fucus*.

The important uses of algin are given below :

- Some derivatives of alginic acid are used in making *antibiotic capsules* like *aureomycin*.
- Alginates are used in making *flame proof fabrics* and *plastics*.
- In clinics *alginate-gauzes* are used in surgical operations to *soak blood* and *stop bleeding*.
- In *textile industry* alginates are used as *painting pastes*.
- Alginates are used as *thickeners* in *cosmetics, pharmaceutical products, paints and polishes* and in *food industries* and *textiles*.
- *Sodium alginates* are used in making *dyes, buttons, handles, combs* and *water proof materials*.
- *Calcium alginates* are used as *emulsifiers* in *toothpaste, ice creams*, etc.
- *Alginates* are also used in the production of *plastics, artificial fibres* and *rubber*.

3. Carrageenin

It is a *mucilaginous substance extracted* from *Chondrus crispus* and *Gigartina*.

It has been used in *food industry, textiles, pharmaceutical industry* and *leather industry*. It is a remedy for *cough*.

It is also used in making *toothpastes, paints* and so on.

4. Diatomite

Diatomite is a rock-like deposit formed by the deposition of *siliceous cell walls* of *diatoms* over millions of years back.

It occurs as sediments on the *floor* of *sea* and *lakes*.

The thickness of the deposits may be extended upto several thousand feet in certain areas.

Since cell walls of diatoms are chief components, and since they occur as sediments on the floor of aquatic habitats ***diatomite*** is often called ***diatomaceous earth*** or ***kieselgahr.***

Diatomite is ***porus*** and ***light in weight***.

It is a ***white*** and ***inert substance***.

It is mined from the deposits and put to several commercial uses. The important uses of diatomite are :

- ***Fire proof bricks*** used in ***blast -furnaces*** are made from ***diatomite***.
- Diatomite is used as ***filtering medium*** for ***oils*** and ***solvents*** and as ***cleaning agent*** for some solvents.
- It catalyses ***dehydrogenation*** of ***vegetable oils***.
- It is used in the ***insulation*** of ***refrigerators, boilers, pipes,*** etc.
- It is used to construct ***heat proof*** and ***sound proof rooms***.
- In industries it is used for ***polishing metals*** like ***iron*** and ***silver***.
- It is employed in ***wine making*** and ***paper making***.
- It increases ***cementing action*** of ***cements***.
- It is also used in the manufacture of ***tooth powder, bleaching powder, dynamite, paints, lipsticks*** and so on.

5. Other Industrial Uses

Besides the above mentioned uses, algae have been used in some other industries also. In ***Japan, France, Norway*** and ***Java, Iodine*** is manufactured from ***brown sea weeds*** and ***marketed commercially.***

Drugs such as ***kelpeck, Isokelp*** and ***Chlorellin*** are manufactured from ***seaweeds*** and used in ***treating diseases***.

Ashes of some sea weeds are employed in the ***manufacture of soaps*** and ***alums***.

Some ***freshwater*** and ***marine algae*** are used in ***paper making***. A ***glue*** is prepared from the ***red algae Gloeopeltis furcata*** are used in ***sizing papers*** and ***cloths***.

In Germany, ***seaweeds are mixed with cement*** and the mixture is used for making ***light weight buildings.***

5. Algae as Pollution Indicators

Although algae occur everywhere in aquatic habitats, some algae ***grow well*** in ***polluted water.***

Such species are more tolerent towards the pollutants. Hence these species are ***more dominant*** in ***polluted water***. Since these algae indicate the presence of pollutants in water, they are known as ***pollution indicators***.

Algae ***detect pollution rapidly*** because of their quick response to ***pollutants***.

When an aquatic system gets polluted, the pollution stress ***reduces*** the populations of ***sensitive species*** and may eliminate them rapidly, while the tolerent species thrive well in the water. Because of this response individuals of ***tolerent species increase in number rapidly*** and form ***dense growth***.

Generally ***green algae*** and ***diatoms*** are sensitive towards various pollutants, but ***Cyanophycean algae are tolerent towards*** the pollutants.

Pollution indicators have been detected from algal flora by using ***Nygaard's algal index***

(1949), *Shanon* and *Weaver's species diversity index* (1949) and ***Palmer's algal pollution indices*** (1969).

Zanceveld (1940) has demonstrated that *Chara* and *Nitella* clean water by utilizing ***small impurities***.

Some important species of algae being used as ***pollution indicators*** are listed below :

1. Indicators of Copper Wastes

Calothrix braunii, Scenedesmus obliquus, Stigeoclonium tenue, Navicula viridula, Cymbella ventricosa, Achananthes affinis and *Nitzschia palea*.

2. Indicators of Iron Wastes

Pinnularia subcapitata, Suriella delicatissima and *Trachelomonas hispida*.

3. Indicators of Chromium Wastes

Stigeoclonium tenue, Closteridium acerosum, Euglena acus, E. viridis, Navicula cuspidata and *Nitzschia linearis*.

4. Indicators of Oil Wastes

Amphora ovalis, Diatoma vulgare, Melosira varians, Navicula radiosa and *Synedra acus*.

5. Indicators of Paper Mill Wastes

Ulothrix zonata, Pandorina morum, Pediastrum simplex, Scenedesmus bijuga, Cymbella ventricosa, Navicula cryptocephata, Synedra pulchella and *Surirella ovata*.

6. Indicators of Distillary Wastes

Chlamydobotrys sps. and *Chlorogonium gracillima*.

7. Indicators of Phenolic Wastes

Achananthes affinis, Cocconeis placentula, Cyclotella kuetzingii, Cymbella naviculiformis, Fragilaria virescens and *Pinnularia borelis*.

8. Indicators of Hydrogen Sulphide Wastes

Cymbella ventricosa, Navicula minima and *Nitzschia ignorata*.

9. Indicators of Acidic Wastes

Euglena mutabilis, E. tellata, Lepocinclis ovum, Xanthidium antilopacum and *Cryptomonas erosa*.

10. Indicators of Organic Wastes

Euglena acus, E. viridis, Oscillatoria chlorina, O. limosa, O. tenuis, Scenedesmus quadricauda, Stigeoclonium tenue, Chlorella vulgaris, Navicula and *Nitzschia*.

6. Algae in Sewage Treatment

Sewage contains various kinds of ***organic*** and ***inorganic wastes*** both in ***soluble*** and ***insoluble*** forms. It has some ***harmful bacteria*** and ***minerals*** like ***N, P, K*** and ***S***.

In ***sewage oxidation ponds*** many algae ***grow well*** and release ***oxygen*** during ***photosynthesis***.

This ***oxygen*** is useful for ***aerobic bacteria*** to ***oxidise*** the ***organic wastes***. ***Bilgrami et.al*** (1985) found out *Euglena, Chlamydomonas, Oscillatoria, Scenedesmus, Chlorella, Nitzschia, Naviculata* and *Stigeoclonium* from ***sewage disposal sites*** in the ***Ganga*** between ***Patna*** and ***Frakka***.

Algae take up ***ions*** of ***heavy metals*** from the ***polluted water***, so the concentration of the metals will be ***greatly reduced***. As a result the sewage becomes ***suitable*** for ***agricultural use***.

7. Algae in Medicine

In olden days, brown algae are used as animal feed because of its poor taste. Now a days, *Fucoidan* is extracted from the brown algae. It has ***anticancer*** and ***inflammation*** effects.

The brown alga extract *fucoidan*, inhibits the tumour cells. It inhibits the ***lung cancer***, ***liver cancer***.

It also improves metabolism of liver functions and healing wounds as dressing.

Extracts of some algae have bactericidal effects. So people have been applying them on wounds.

Several antibiotics, such as *chlorellin*, are extracted from algae.

8. Algae in Biofuel

The dense growth of algae provides enough organic matter to produce natural gas by action of *methanogenic bacteria*. The natural gas is used as ***fuel gas***.

Algenol is a biofuel prepared from the algae. It reduces CO_2 emissions about 50 to 7... when compared to the petroleum.

B. Harmful Roles of Algae

Algae not only play beneficial roles but also play ***some harmful roles*** in ***aquatic habitats***. The harmful activities of algae may affect man ***directly*** or ***indirectly***.

The development of water blooms is considered to be a ***bad effect of algae***.

The dense growth of algae, especially ***Cyanophycean algae*** in water is called ***water bloom*** or ***water flower***.

Because of the development of water blooms, the water becomes ***green*** or ***bluish green*** in colour.

The important algae found in water blooms include *Oscillatoria, Nostoc, Anabaena, Gloeotrichia, Rivularia, Macrocystis, Aphanizomenon*, etc.

Water blooms commonly develop in ***city reservoirs, temple ponds, lakes*** and ***water tanks***.

The ***water blooms*** increase the ***acidity*** of water.

As a result the water becomes ***corrosive*** on ***metalic pipes*** and ***concretes***.

The water becomes ***abnormal in taste*** and ***other qualities***.

The water in which water bloom occurs is ***not suitable*** for ***drinking, bathing, swimming***, and ***finishing***.

Blue greens cause ***depletion of*** O_2 in the water during nights by using the dissolved oxygen for their respiration.

This depletion of oxygen causes ***death of fishes*** and ***other animals*** living in the water. Owing to the death and decay of these algae, the ***dead organic matter settles*** at the bottom of the ***water body***.

This organic matter contains ***mucilaginous substance*** also. Hence ***decomposing bacteria*** grow well and decompose the organic matter into simple substances.

This microbial decomposition gives ***bad odour*** to the water.

Algae such as *Prymnesium, Gymnodinium*, etc. produce some ***toxins*** in the water.

These ***toxins kill fishes*** and ***domestic animals*** which drink the water.

Some algae produce ***endotoxins*** which cause ***paralysis*** in man and ***domestic animals***.

Some algae cause troubles in ***digestion***, while some others cause ***respiratory disorders***.

Some parasitic algae attack ***plantation crops*** like ***coffee, tea, Rhododendron***, etc. and cause characteristic ***rust disease***. Thus they cause great loss to the economy of the country.

Some algae ***destroy cloths*** and ***fabrics***.

Control of Algae

The following methods have been practiced to check the growth of algae :

1. Cyanophages selectively kill ***blue greens*** by causing the death of ***their cells***. So cyanophages are introduced into the water.

2. ***Crustaceans*** and ***fishes eat algae*** as food and reduce their population. Hence they are introduced into the water.

3. ***Algicides***, such as ***Chlorophenyl-Dimethyl-Urea,*** are added to the water reservoirs and tanks for checking the growth of algae.

4. Water is made to circulate in the system to avoid colonization and rapid growth of algae.

5. Swimming pools are frequently treated with ***Dichlorophen*** and ***algicide*** to reduce the growth of algae.

6. The water blooms of algae can be checked by treating the water with ***enough chlorine***.

Highlights

Economic Importance of Algae

- Algae are important to man, plants and animals.
- Many algae are useful to man, some are harmful to him directly or indirectly.
- The ***economic importance*** of algae can be discussed under ***two aspects***.
  1. *Beneficial roles*
  2. *Harmful roles*.

1. Beneficial Roles

- Some algae are utilized as food for man.

  Eg. *Porphyra*, *Ulva*, *Chlorella*, *Nostoc*, *Rhodymenia*, *Alaria*, *Chondrus*, *Laminaria*, etc.
- Algae are also called ***sea weeds***.
- They are rich in ***proteins, carbohydrates, oils, vitamins*** and ***minerals***.
- ***Single cell protein*** is prepared from the algae. It contains vitamins like ***thiamin, riboflavin, niacin, pyridoxin, pantothenic acid, choline, biotin, vitamin*** B_{12} and ***lipoic acid.***
- Algae are directly used as feed for ***cattle, poultry*** and ***aquatic organisms***.
- ***Sea-weed meal*** increases the ***egg laying capacity of the fowls***.
- In ***agriculture***, algae are used as a ***green manure*** and ***nitrogen fixers***.
- Algae correct the pH of the soil.
- Many ***blue green algae*** have the ability to fix the atmospheric nitrogen in the soil.
- ***Agar-agar, carrageenin*** and ***algin*** are prepared from different algae.
- ***Agar*** is used as a ***emulsifier*** and ***sizing agent*** in ***leather*** and ***textile industries***.

3 Oscillatoria

Class	:	*Cyanophyceae*
Order	:	*Nostocales*
Family	:	*Oscillatoriaceae*
Genus	:	*Oscillatoria*

Oscillatoria is a ***blue-green alga***. It is included in the class ***Cyanophyceae*** or ***Myxophyceae***. It is placed in the order ***Nostocales.*** It exhibits ***oscillatory*** movement. Therefore, it is included in the family ***Oscillatoriaceae***.

Occurrence

Oscillatoria is commonly found in ***freshwater*** habitats such as ***ponds, pools, streams,*** etc.

Some species are ***marine***. Eg. *Oscillatoria salina* and *Oscillatoria sancta.*

Some species live on ***moist soils*** and fix the atmospheric nitrogen in the soil. Eg. *Oscillatoria princeps* and *Oscillatoria formosa.*

Oscillatoria annae is ***epiphytic*** on aquatic plants.

Oscillatoria includes about 100 species.

Some common Indian species of *Oscillatoria* are :

Oscillatoria chlorina — *Oscillatoria tenuis*
Oscillatoria limosa — *Oscillatoria formosa*
Oscillatoria princeps — *Oscillatoria annae.*

Structure

Oscillatoria is a **blue - green alga.** It is included in the class ***Cyanophyceae***.

The plant is a ***haploid gametophyte***.

It is a ***prokaryote.***

It lives in ***freshwater***.

They are *free floating* forms.

Usually, a few *Oscillatoria* filaments aggregate together and occur as a slightly ro... ***ha...*** *mass*, floating on the surface of water.

The plant body of *Oscillatoria* is called ***thallus*** as it has no differentiation into ro... and leaves. It is a simple, ***unbranched filament.***

The filament of *Oscillatoria* is known as a ***trichome.***

Each trichome is surrounded by a ***mucilaginous sheath***. It consists of a row of ... arranged one above the other.

The cells are broader than their length.

All the cells of the trichome are alike, except the terminal cell which is ***round*** or ... shaped.

In some species, the terminal cell has a thickening, at the apex, called ***cap*** or ***calyptra*** in *Oscillatoria proboscidea.*

In the filament, there are biconcave ***dead cells*** filled with ***mucilage.*** These dead cells ... called ***'necridia'*** or ***'separation discs'.***

The small piece of the filament between the adjacent necridia is called a ***hormog...*** ***hormogonium.***

The cells of *Oscillatoria* are ***prokaryotic.***

Each cell consists of an outer ***cell wall***, a middle ***plasma membrane*** and an inner ***p... plasm.***

The cell wall is firm and is composed of ***hemicellulose*** and ***pectin.***

The cell wall is made up of 2 layers. It bears many pores. There is a ***mucilage*** ... around the cell wall.

The protoplast is enclosed by a ***plasma membrane.***

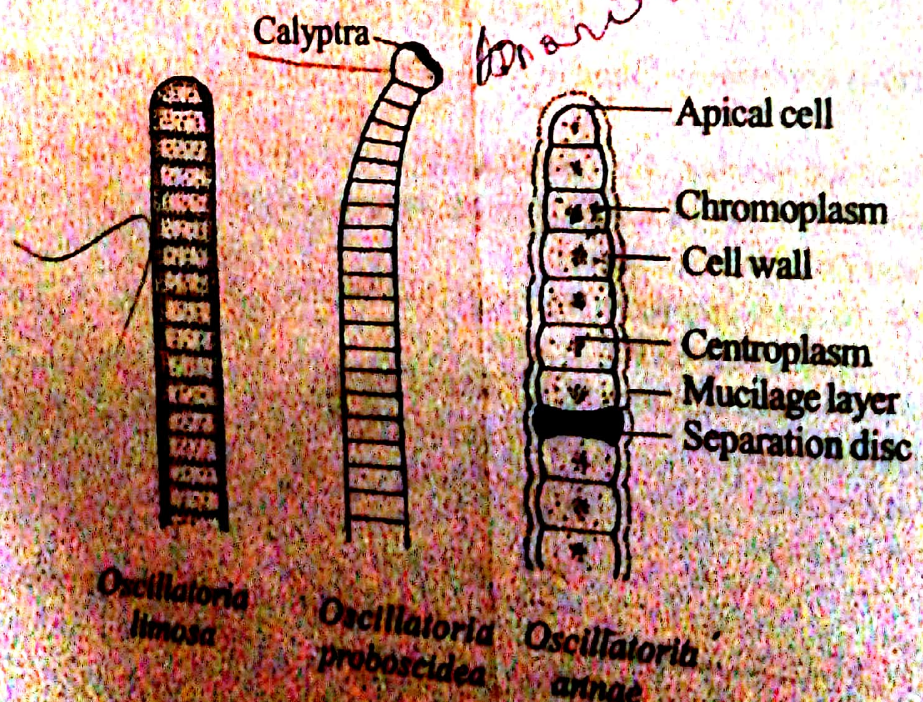


Fig.3.1: Oscillatoria.

The *protoplasm* is differentiated into an outer pigmented portion called ***chromoplasm*** and an inner colourless portion called ***centroplasm*** or ***central body.***

Many elongated sacs called ***thylakoids*** are freely dispersed in the chromoplasm.

The pigments such as ***chlorophyll-a, carotenes, xanthophylls, phycocyanin-c*** and ***phycoerythrin-c*** are found in the chromoplasm.

Small gas vacuoles called ***pseudovacuoles*** are also found in the chromoplasm.

Reserve food is in the form of ***cyanophycean starch*** and ***β-granules*** present in the protoplasm.

Membrane bound cell organelles such as ***nucleus, endoplasmic reticulum, plastids, mitochondria, dictyosomes*** and ***vacuoles*** are absent. However, small ***ribosomes*** are found in the protoplasm.

The nuclear material is found at the centre of the protoplasm.

The nuclear material consists of irregularly arranged ***DNA fibrils***. The nuclear membrane is absent. This type of nuclear material without nuclear membrane is called ***nucleoid*** or ***incipient nucleus.*** There is ***no nucleolus.***

Some ***polyhedral bodies*** are found associated with the DNA fibrils.

The structure of cells resemble ***bacteria*** in many aspects. So, *Oscillatoria* is also known as a *Cyanobacterium*.

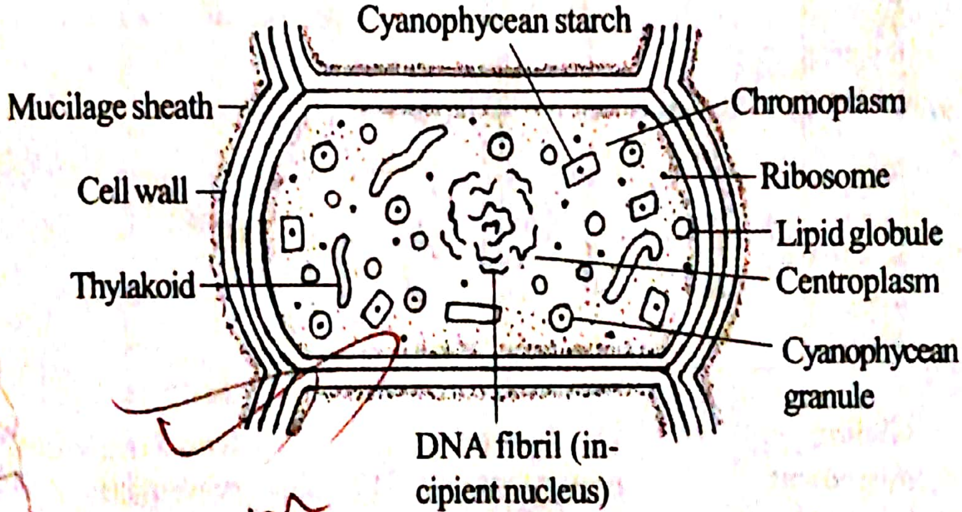


Fig.3.2: Oscillatoria cell -Ultrastructure.

Growth

The growth takes place by ***amitotic*** division of ***intercalary cells*** of the filament.

Movement of Trichome

Oscillatoria shows ***three*** types of movements. They are :

1. ***Gliding movement*** or ***axial movement***
2. ***Oscillatory movement***
3. ***Bending movement*** or ***tip revolving movement.***

1. Gliding Movement

This type of movement is exhibited by the entire filament. Here, the trichome moves ***back-***

wards and *forwards* rhythmically in the direction of the long axis of the trichome. So it is known as ***axial movement***.

2. Oscillatory Movement

The genus *Oscillatoria* has been named on account of this type of movement. movement, the tip of the trichome shows ***pendulum-like*** oscillation.

3. Bending Movement

This is similar to the oscillatory movement, but the apical cell bends rapidly at the each oscillation. So, this movement is called ***bending movement.***

The movement of trichomes may be due to -

- The presence of invisible cilia at the tip of the trichome.
- The secretion of mucilage through the pores of cell wall.
- The rhythmic contraction and expansion of the protoplasm.
- The wave-like movement of mucilage layer along the length of the trichome.

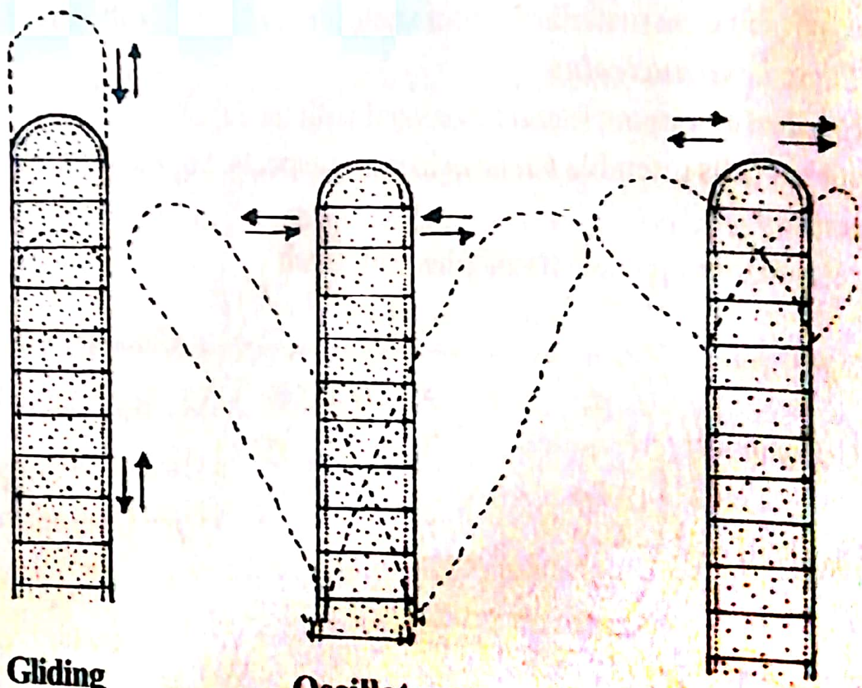


Fig.3.3: Oscillatoria - Movements.

Nutrition

- Nutrition is ***photoautotrophic*** by ***photosynthesis.***
- Photosynthetic pigments trap the solar energy and synthesize ***starch*** and g which are later converted into ***cyanophycean starch*** and ***glycoprotein.***

Highlights

Oscillatoria

- *Oscillatoria* is a ***freshwater, blue-green alga.***
- It is included in the class *Cyanophyceae.*

- It is prokaryotic.
- The vegetative thallus is a ***haploid gametophyte***.
- In this alga, the tip of the trichome shows ***pendulum- like oscillating*** movement. So this alga is named as *Oscillatoria*.
- The thallus is an ***unbranched trichome***.
- The filaments are ***uniseriate.***
- It is surrounded by a ***mucilaginous sheath***.
- The trichome consists of a row of closely arranged uniform cells.
- The terminal cell has a thickening at the apex called ***cap*** or ***calyptra***.
- The filament contains ***necridia*** and ***hormogone.***
- Each cell consists of an outer ***cell wall***, a middle ***plasma membrane*** and an inner ***protoplasm***.
- The cell wall is made up of ***pectin*** and ***cellulose.***
- The ***plasma membrane*** lies below the cell wall.
- The ***protoplasm*** is differentiated into an outer ***chromoplasm*** and an ***inner centroplasm.***
- Protoplasm contains ***pigments, pseudovacuoles, thylakoids, reserve foods*** and ***nuclear material***.
- ***Cyanophycean starch*** and ***β-granules*** are the stored reserve food.
- The nuclear material is not surrounded by a nuclear membrane. Hence it is called ***nucleoid*** or ***incipient nucleus.***
- Nutrition is ***photoautotrophic.***
- Growth takes place by ***amitotic division*** of ***intercalary cells*** of the filament.
- *Oscillatoria* shows ***three*** types of movements. They are:
  - *Gliding movement* or *axial movement*
  - *Oscillatory movement*
  - *Bending movement* or *tip revolving movement.*
- It reproduces by ***vegetative methods***. They are:
  - *Fragmentation*
  - *Hormogone formation.*
- ***Sexual reproduction*** is absent.
- There is ***no alternation of generation.***

Reproduction

Oscillatoria reproduces by ***vegetative methods.*** Sexual reproduction is ***absent***. The vegetative methods of reproduction are:

1. *Fragmentation*
2. *Hormogone formation.*

1. Fragmentation

The filament breaks into many small pieces called ***fragments*** by mechanical forces or due to the formation of hormogones in the filament. Each fragment later on grows into a new filament. This method is known as ***fragmentation***.

2. Hormogone Formation

Hormogones or hormogonia are produced in mature filaments during the *favourable* *son*.

Some intercalary cells of the filament lose their protoplast and die. These dead cells come biconcave and filled with ***mucilage***.

The mucilage filled dead cells are called ***necridia*** or ***separation discs***.

The small piece of the filament between the two adjacent necridia is called a ***hormog*** or ***hormogonium.***

When the filament breaks at necridia, the hormogones are released free in water. T grow into new filaments.

Conclusion

The life cycle of *Oscillatoria* is very ***simple*** and purely ***vegetative***. Sexual reproductio completely ***absent***. The vegetative thallus is a ***haploid gametophyte*** (N) and it is ***prokaryo*** It reproduces vegetatively by ***fragments*** and ***hormogones***. They grow into new vegetative (N). There is ***no alternation of generation*** in the life cycle of *Oscillatoria*.

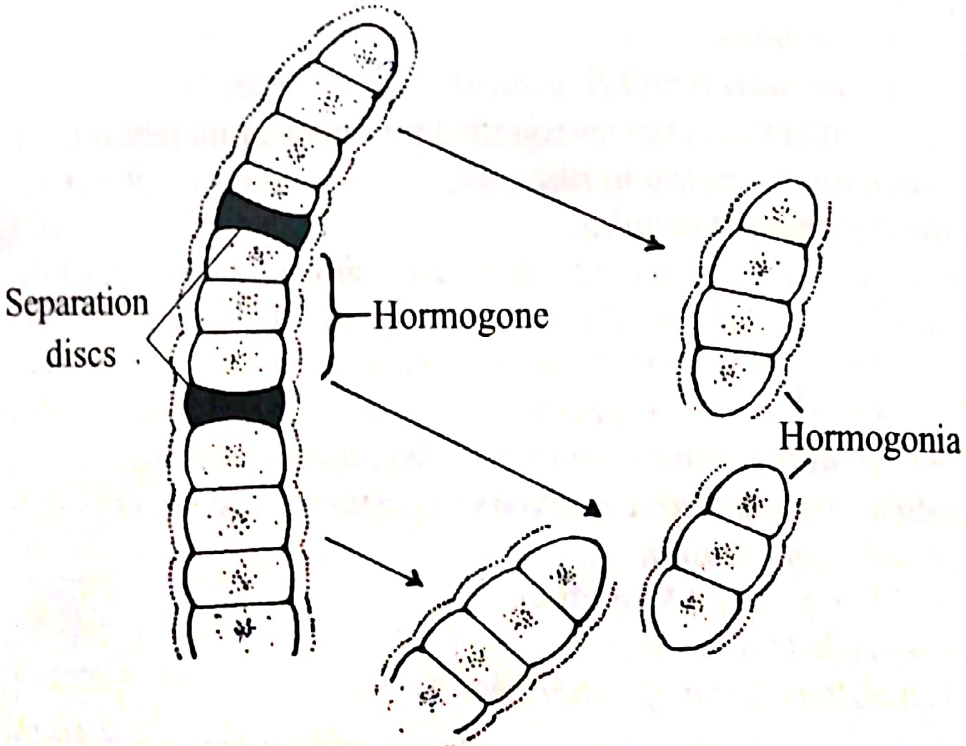


Fig.3.4: Oscillatoria - Hormogone formation.

Economic Importance

1. *Oscillatoria* is consumed as ***food*** by ***fishes***.

2. It increases the ***soil fertility*** by fixing the atmospheric nitrogen in the soil and by addi organic matter to the soil.

3. Together with some other blue-greens, it causes depletion of oxygen in water. Th depletion of oxygen causes the death of fishes and aquatic animals.

4. It causes bronchial asthma, blocking of nasal passage, etc. in human beings.

5. *Oscillatoria limosa* serves as an ***indicator*** of organic wastes in water.

Life Cycle of *Oscillatoria*

Oscillatoria is a simple, ***unbranched, filamentous blue-green alga.*** It comes under the class *Cyanophyceae* or ***Myxophyceae***. The plant is a ***haploid gametophyte.*** Most species occur in ***freshwaters*** and a few are ***marine***.

The filament of *Oscillatoria* is called a ***trichome***.

The trichome is surrounded by a ***mucilaginous sheath***.

It is freely floating on the surface of water.

Each trichome consists of a row of cells arranged one above the other.

The cells of the trichomes are broader than the length.

All cells of the trichome are alike, except the terminal cell which is rounded or dome-shaped. In some species, the terminal cell has a thickening called ***cap*** or ***calyptra*** at the apex.

The cells of *Oscillatoria* are ***prokaryotic***. Each cell consists of an outer ***cell wall*** and an inner ***protoplasm***.

The cell wall is composed of ***hemicellulose*** and ***pectin.*** The protoplasm is enclosed by a ***plasma membrane.*** The protoplasm is differentiated into an outer pigmented portion called ***chromoplasm*** and an inner colourless portion called ***centroplasm*** or ***central body***.

The pigments like ***chlorophyll-a, carotenes, xanthophylls, phycocyanin-c*** and ***phycoerythrin-c*** are found in the chromoplasm.

The reserve food like ***cyanophycean starch*** and ***β-granules*** are seen in the protoplasm. Membrane bound organelles such as ***nucleus, endoplasmic reticulum, plastids, mitochondria, dictyosomes*** and ***vacuoles*** are absent.

Under electron microscope, the *Oscillatoria* cell shows the presence of many elongated, flattened sacs called ***thylakoids*** or ***lamellae***. They contain photosynthetic pigments.

The nuclear material is found at the centre of the protoplasm and it consists of ***DNA fibrils***. The nuclear membrane and nucleolus are absent. There is no definite nucleus. So, the nuclear material is called ***incipient nucleus***.

Oscillatoria shows ***three*** types of movements. They are ***gliding movement, oscillatory movement*** and ***bending movement***.

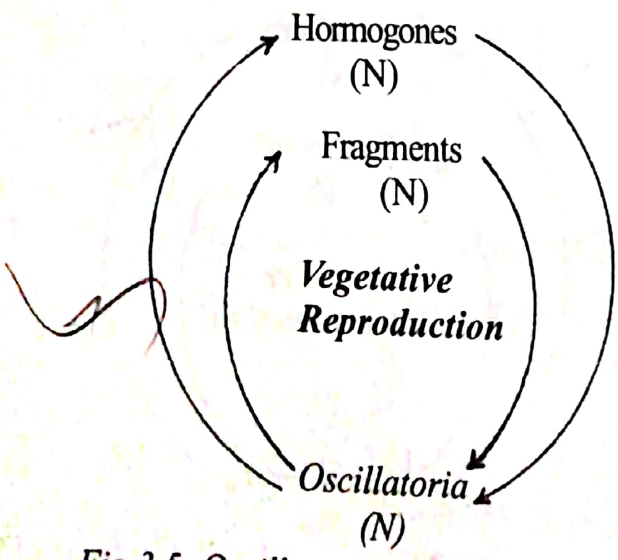


Fig.3.5: Oscillatoria - Graphic life cycle.

Oscillatoria reproduces only by ***vegetative*** methods. Sexual reproduction is ab... vegetative methods of reproduction are:

Fragmentation

Hormogone formation.

The filament breaks into many ***small pieces*** or ***fragments*** by mechanical forces... fragment later on grows into a new filament. This method is known as ***fragmentation***.

Hormogones or ***hormogonia*** are produced in mature filaments. Some of the inter... cells lose their protoplast and die. These dead cells become ***biconcave*** and filled with ... ***lage***. The mucilage filled dead cells are called ***necridia*** or ***separation discs***.

The small piece of the filament between the two adjacent necridia are known as ***hormo...*** or ***hormogonium***. These hormogone gets separated from the trichome and grows into a filament.

Conclusion

The life cycle of *Oscillatoria* is ***very simple*** and ***purely vegetative***. Sexual reprodu... is completely ***absent***. The vegetative thallus is a ***haploid gametophyte*** (N) and it is ***pro...otic***. It reproduces vegetatively by ***fragments*** and ***hormogones***. They grow into new ve...tive thalli (N). There is no ***alternation of generations*** in the life cycle of *Oscillatoria*.

Highlights

Life Cycle of *Oscillatoria*

- *Oscillatoria* is a filamentous ***blue-green alga***.
- It is found in ***freshwater*** habitats.
- It is a ***haploid gametophyte.***
- It is ***prokaryotic.***
- The thallus is a ***filament.***
- It reproduces vegetatively by
  - *Fragmentation*
  - *Hormogones.*

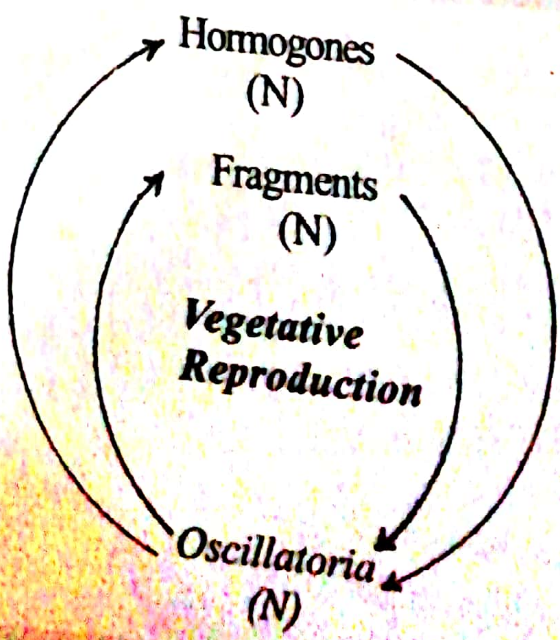


Fig.3.6: Oscill...

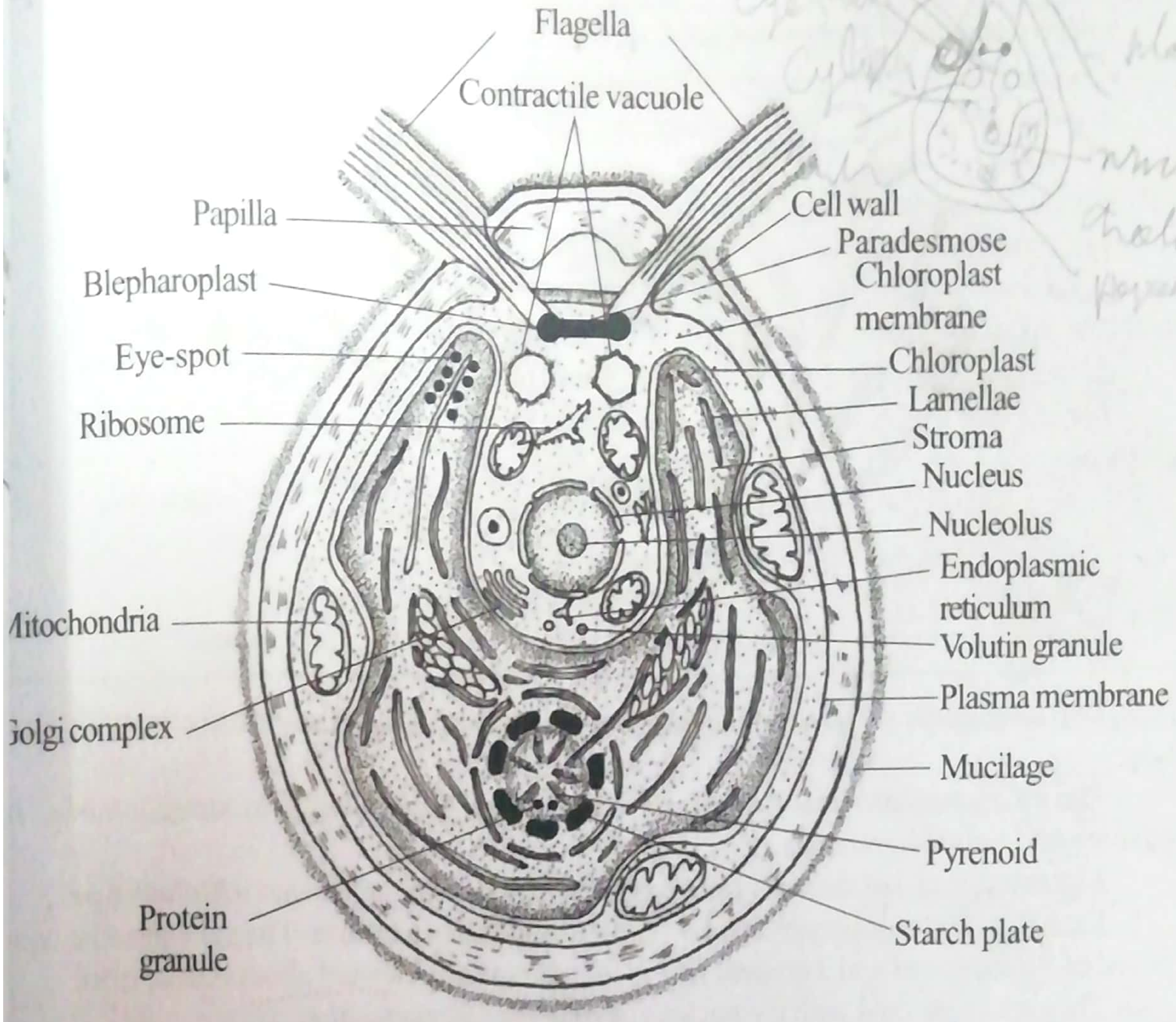


Fig. 5.2: Chlamydomonas - Electron Microscopic view.

Pyrenoid is the ***site of starch formation***. It functions as a ***temporary storage*** for early roducts of ***photosynthesis***, that are converted into starch.

Towards the anterior end, on one side of the chloroplast, there is a photo-receptive organ lled ***eye-spot*** or ***stigma***. It governs the movement of the cell towards light.

There is a single large ***eukaryotic*** nucleus in the cytoplasm lying above the chloroplast.

Highlights

Pyrenoids

- *Pyrenoid is a protein granule surrounded by a starch sheath present inside the chloroplast of **Algae** and **Bryophytes**.*
- It is ***spherical*** in shape.
- It has a central ***proteinaceous core*** surrounded by ***starch plates***.
- The number of pyrenoids is one or more. In some species it is absent.
- In some species, the ***thylakoid membrane*** extends into the pyrenoid.

Functions

- Pyrenoid is the center of ***carbondioxide fixation.***
- It is the site of ***starch formation***.

- It is the site of *temporary storage* of the early products of photosyn

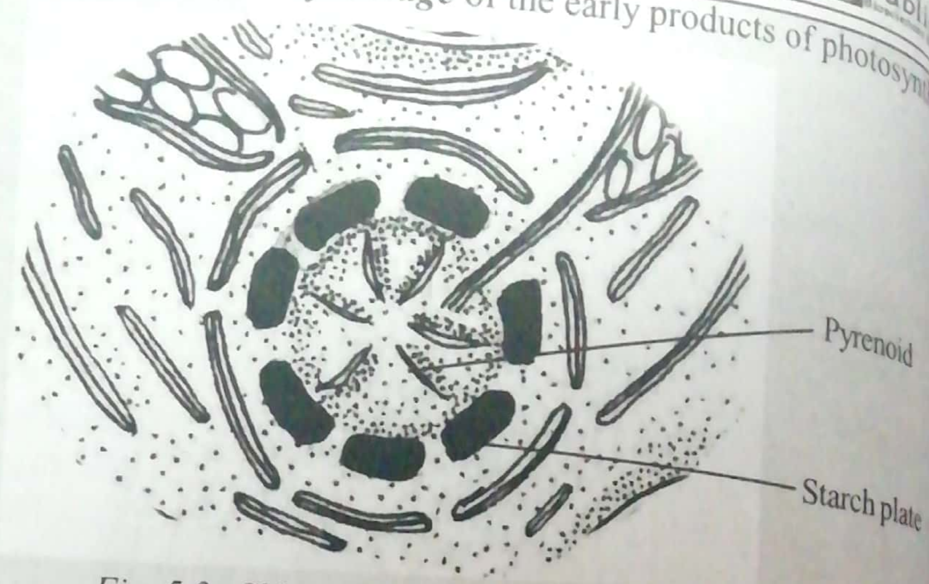


Fig. 5.3: Chlamydomonas - Pyrenoid.

Two ***contractile vacuoles*** are present just below the papilla. They are excretory in tion.

The cytoplasm contains ***endoplasmic reticulum, Golgi complex, mitochondr bosome*** and ***volutin granules.***

The anterior end of the cell has two equal ***flagella***. The flagella are ***whiplash type***

Each flagellum consists of ***axial thread*** surrounded by a ***sheath***. The axial thread is posed of ***9 peripheral*** and ***2 central fibrils*** that are spirally twisted about one another.

They are connected with the nucleus by ***neuromotor apparatus***.

Each flagellum arises from a basal granule called ***blepharoplast***.

The two blepharoplasts are interconnected by a fine protoplasmic thread c ***paradesmose***.

Another thread called ***rhizoplast*** connects one of the blepharoplasts with the centro attached to the nucleus.

The centrosome may be ***intranuclear*** or ***extra nuclear.***

The flagella function as ***locomotary organs***.

Highlights

Neuromotor Apparatus

- Neuromotor apparatus is the ***incipient nervous system*** of *Chlamydomo*
- It consists of two ***blepharoplasts*** (basal granules), a ***paradesmose***, a ***rhizoplast***, a ***centrosome*** and ***microtubular roots***.
- The ***flagella*** arise from the blepharoplast.
- The two ***blepharoplasts*** are ***inter connected*** by a fine protoplasmic thre called ***paradesmose***.
- The ***rhizoplast*** connects one of the blepharoplasts with the centrosome
- The ***centrosome*** is attached to the ***nucleus.***
- The ***centrosome*** is connected by a ***delicate fibril*** with the ***nucleus***.

- *Microtubular roots* originate from the paradesmose. They are distributed to the different parts of the body.

Nutrition

Chlamydomonas is ***autotrophic*** in nutrition.

It synthesizes its food from the carbondioxide dissolved in water using the sunlight. This ɔcess is called ***photosynthesis***. This mode of nutrition is known as ***photoautotrophic***.

The excess of food materials is stored as ***starch plates*** around the pyrenoid.

C.dysosoms is a facultative heterotroph and can grow in dark in the presence of acetate as :arbon source.

Highlights

Chlamydomonas

- *Chlamydomonas* is a ***motile, free- floating, unicellular green alga***.
- It is included in the class ***Chlorophyceae***.
- It is ***eukaryotic***.
- *Chlamydomonas* is a ***haploid gametophyte.***
- It is found in stagnant ***freshwaters*** of *ponds, rivers, slow running streams,* etc.
- It is ***pear-shaped***.
- It is narrow at its anterior end and broad at the posterior end.
- The anterior end bears two whiplash-type ***flagella***.
- It consists of an outer ***cell wall***, a middle ***plasma membrane*** and an inner ***protoplasm***.
- The ***cell wall*** is made up of ***cellulose***.
- The ***plasma membrane*** lies below the cell wall.
- The ***protoplasm*** contains a single cup-shaped *chloroplast, a nucleus, two contractile vacuoles, endoplasmic reticulum, ribosomes,* etc.
- ***Chloroplast*** contains ***pyrenoid, lamellae, stroma, chlorophyll*** and an ***eye - spot***.
- It is ***autotrophic*** in nutrition.
- Reproduction is of ***two*** types. They are:
  - *Asexual reproduction*
  - *Sexual reproduction.*
- Asexual reproduction takes place by-
  - *Zoospores*
  - *Aplanospores*
  - *Palmella stage.*
- Sexual reproduction involves the fusion of two haploid cells.
- There are ***four*** kinds of sexual reproduction -
  - *Isogamy*
  - *Anisogamy*
  - *Oogamy*
  - *Hologamy*

- Life cycle is ***haplontic type***.
- There is no ***alternation of generation***.

Reproduction

The reproduction in *Chlamydomonas* is of ***two*** types. They are:

- *Asexual reproduction*
- *Sexual reproduction.*

Asexual Reproduction

The asexual reproduction in *Chlamydomonas* takes place by

1. *Zoospores*
2. *Aplanospores*
3. *Palmella stage.*

1. Zoospores

Zoospores are ***motile, biflagellate, asexual spores***.

They are usually produced during the ***favourable conditions*** when water is a

The vegetative cell first comes to rest by dropping its flagella and becomes non-

The protoplast of the cell then divides repeatedly to form 2, 4, 8 and 16 daughter p

Each daughter protoplast develops two equal flagella at its anterior end to

zoospore.

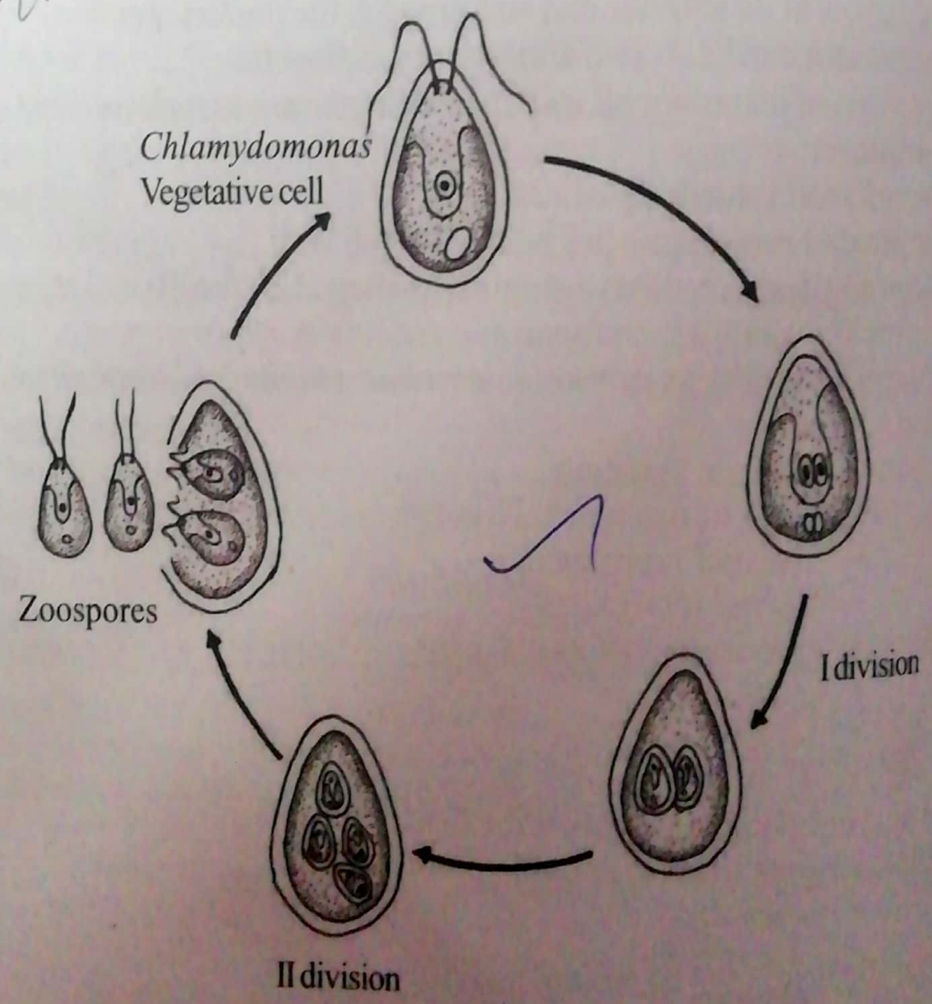


Fig. 5.4: Chlamydomonas - Zoospore formation.

The mature zoospores are released free in the water by the rupture or gelatinisation of cell all of the parent cell.

The liberated zoospores grow into new vegetative cells.

Aplanospores

Aplanospores are ***non-motile, non-flagellate, asexual spores***.

They are produced during the ***dry season***. Here, protoplasm of a vegetative cell undergoes repeated divisions to form 8 or 16 daughter protoplasts. Each daughter protoplast then metamorphoses into a non-motile, non-flagellate, cell called ***aplanospore***.

When ***favourable*** season comes, it develops two flagella at its anterior end and grows into new vegetative cell. Eg. *Chlamydomonas caudata*.

Palmella Stage

During ***unfavourable season*** non-motile *Chlamydomonas* cells remain embedded in an

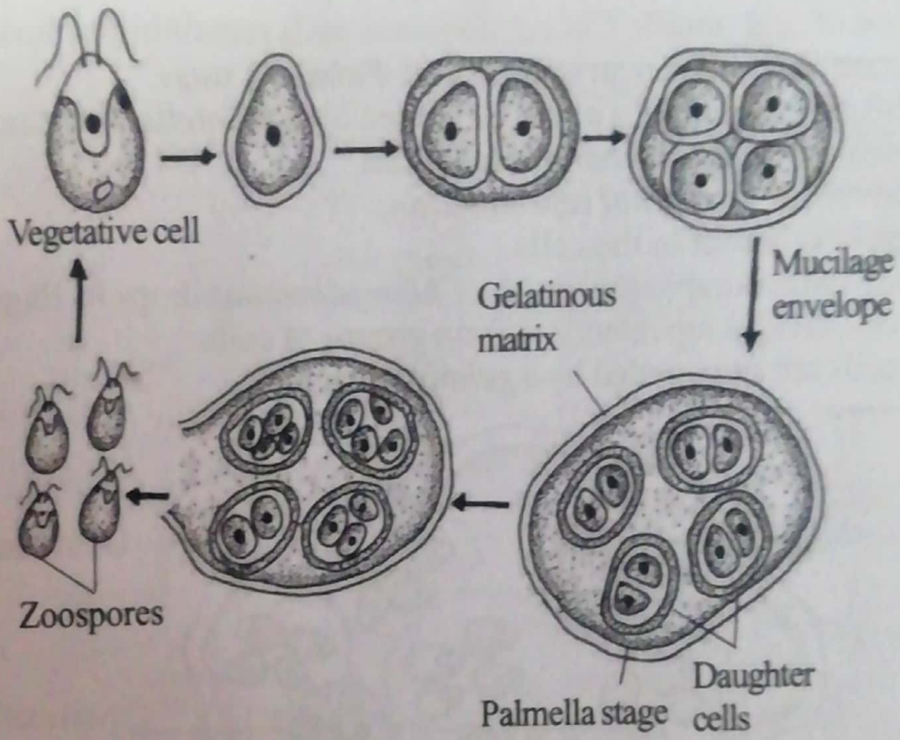


Fig. 5.5: Chlamydomona - Development of Palmella stage.

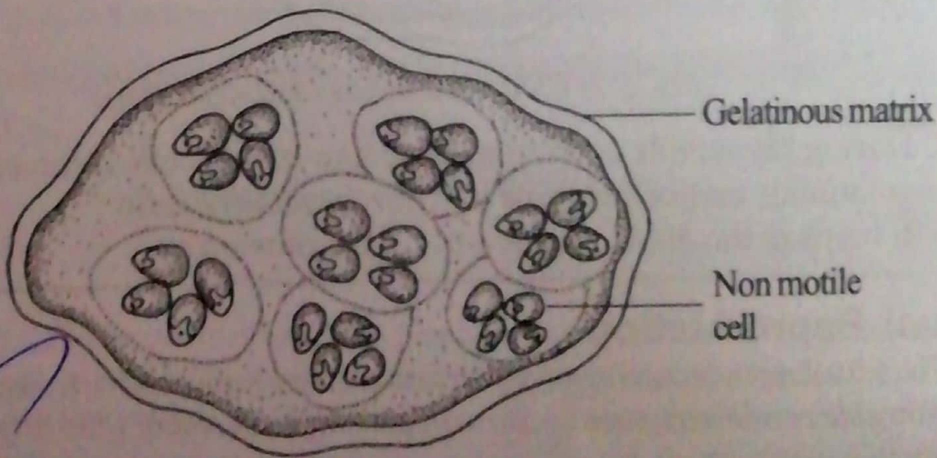


Fig. 5.6: Chlamydomonas - Palmella stage.

Scanned with CamScanner

amorphous gelatinous matrix. As this stage resembles a colonial green alga *Palmella*, it is known as ***Palmella stage***.

Palmella stage develops when conditions are ***unfavourable***.

The vegetative cell drops its flagella and its protoplast then divides repeatedly to form groups of 2-4 cells. These daughter cells do not develop flagella and lie within the parent wall.

The parent cell wall and the wall of the daughter cells become gelatinous and hence non-motile cells remain embedded in a common ***gelatinous matrix.***

In the next favourable season, these non-motile cells develop flagella and escape from gelatinous matrix to grow into new adult cells. Eg. *Chlamydomonas nivalis*.

Highlights

Palmella Stage

- Groups of non -motile *Chlamydomonas* cells remaining embedded in common gelatinous matrix constitute ***Palmella stage***.
- As this stage resembles a colonial green alga *Palmella*, it is named so.
- It develops during ***unfavourable season***.
- It is involved in ***asexual reproduction***.
- ***Flagella*** is absent in the cells.
- During unfavourable season, the *Chlamydomonas* drops its flagella.
- The cell divides repeatedly to form groups of cells.
- The cells are surrounded by a ***gelatinous matrix***.

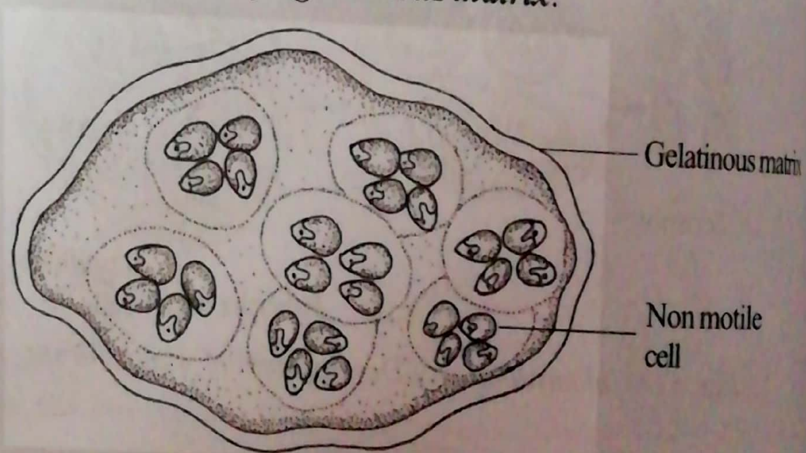


Fig. 5.7: Chlamydomonas - Palmella stage.

- During favourable condition, these non-motile cells come out from the gelatinous matrix and grow into new ***vegetative cells.***
- It helps in the ***multiplication*** of *Chlamydomonas*.

Sexual Reproduction

The sexual reproduction involves the fusion of two haploid cells. It takes place during ***unfavourable conditions***, such as *low nitrogen, high content of CO_2, bright sunlight, deficiency of nutrients, etc.*

Chlamydomonas is a ***haploid gametophyte***.

Most of the species produce male and female gametes in two separate individuals, and are own as ***heterothallic*** species. Eg. *Chlamydomonas moewusii.*

Some species are ***homothallic***. They produce gametes of two opposite strains in the ***ne individual.*** Eg. *Chlamydomonas media.*

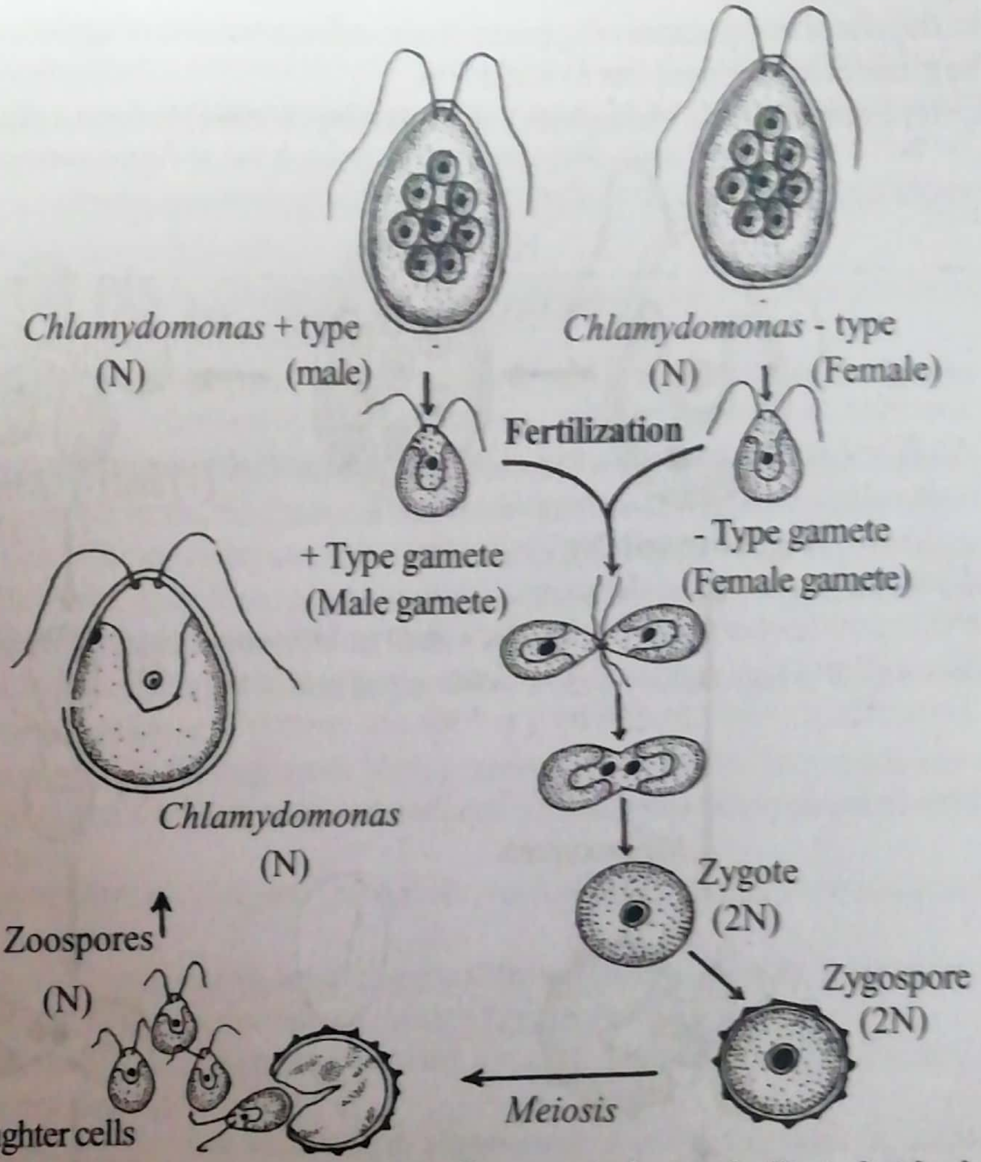


Fig.5.8: Chlamydomonas moewusii - Isogamy in heterothallic individuals.

There are four kinds of sexual reproduction in *Chlamydomonas*. They are:

1. *Isogamy*
2. *Anisogamy*
3. *Oogamy*
4. *Hologamy.*

sogamy

Isogamy is a sexual reproduction where similar motile gametes fuse together to form gote. It takes place both in ***homothallic*** *and* ***heterothallic individuals.***

In ***heterothallic individuals***, the two fusing gametes are produced from two different ent cells. Eg. *Chlamydomonas moewusii*. The vegetative cells first lose their flagella and r protoplast undergoes repeated mitotic divisions to produce 16-64 daughter protoplasts.

Each daughter protoplast develops two equal flagella at its anterior end to form a

The gamete of one parent is called + *type* (male) and that of the other parent is ca (female). The flagella of gametes are covered by agglutinins, the chemical substances in the recognition of gametes of the opposite strains. These substances are not present in the of the vegetative cells.

The flagella of two gametes of opposite strains adhere because of agglutins.

The gametes are released free in water.

A + type gamete (male) fuses with a -type gamete (female) to form a *diploid* ty

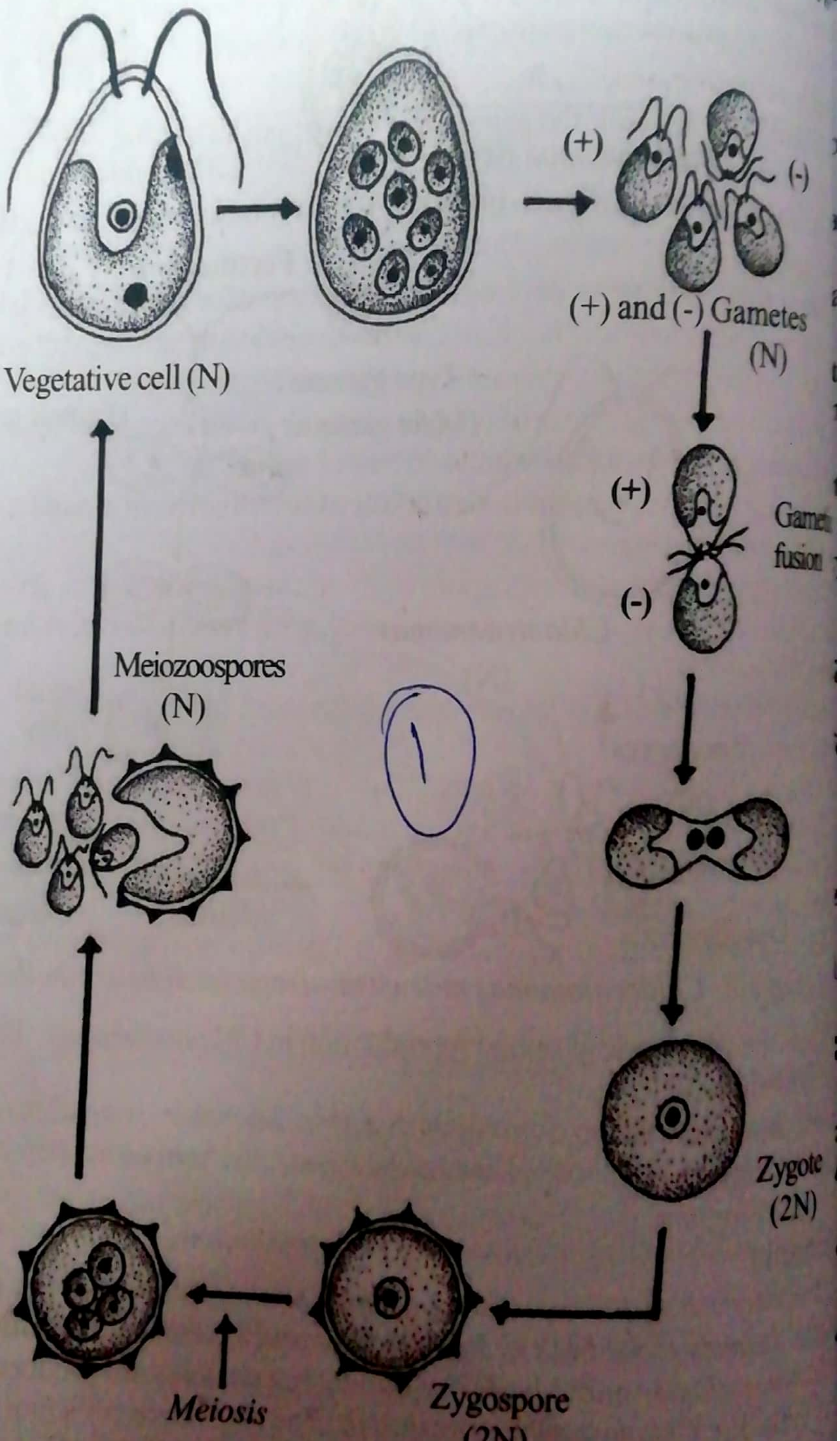


Fig. 5.9: Chlamydomonas - Isogamy in homothallic individuals.

The diploid zygote enlarges in size and secretes a thick wall around it. This thick-walled gote is known as *zygospore*.

After a period of rest, the zygospore starts germination during the favourable season.

The diploid nucleus of the zygospore undergoes a ***reduction division*** (***meiosis***) to form ***ur haploid nuclei***.

Then the cytoplasm divides into four pieces, each of which collects around a nucleus to m a haploid protoplast.

Each protoplast develops two equal flagella to form a motile cell called ***meiozoospore***.

Thus four meiozoospores are formed inside a zygospore wall.

The wall of the zygospore ruptures and the zoospores are released in the water. These ospores grow into new adult cells.

In ***homothallic species***, the gametes of two opposite mating types are produced by the me parent cell. Eg. *Chlamydomonas media*.

Here, a vegetative cell drops its flagella and its protoplast divides ***mitotically*** into 8 or 16 ughter protoplasts.

Each daughter protoplast develops two flagella and forms a ***gamete***. The flagella of gam-es are covered by agglutinins, the chemical substances involved in the recognition of gametes of e opposite strains. These substances are not present in the flagella of the vegetative cells.

The flagella of two gametes of opposite strains adhere because of agglutinins. Two gam-es fuse together by their anterior ends to form a ***zygote***.

The diploid zygote enlarges in size and secretes a thick wall around it. This thick-walled gote is known as ***zygospore***.

After a period of rest, the zygospore starts germination during the favourable season.

The diploid nucleus of the zygospore undergoes a ***reduction division*** (***meiosis***) to form ***ur haploid nuclei***.

Then the cytoplasm divides into four pieces, each of which collects around a nucleus to rm a haploid protoplast.

Each protoplast develops two equal flagella to form a motile cell called ***meiozoospore***.

Thus four meiozoospores are formed inside a zygospore wall.

The wall of the zygospore ruptures and the zoospores are released in the water. These ospores grow into new adult cells.

The zygote secretes a thick wall to form a ***zygospore***. It undergoes ***meiosis*** to form hap-id ***zoospores***.

The zoospores develop into *Chlamydomonas* cells.

Anisogamy

Anisogamy is a sexual reproduction where dissimilar gametes fuse together to form a gote. The gametes are ***motile***. These gametes are called ***anisogametes***. Eg. *Chlamydomonas aunii.*

The protoplasts of a vegetative cell undergoes mitotic divisions to form 8 or 16 haploid ughter protoplasts.

Each daughter protoplast develops two flagella to form a small male gamete called ***micro-mete***.

The protoplast of another cell divides ***mitotically*** into 2 or 4 haploid daughter protoplasts. developing two flagella, each daughter protoplast becomes a large female gamete called ***acrogamete***.

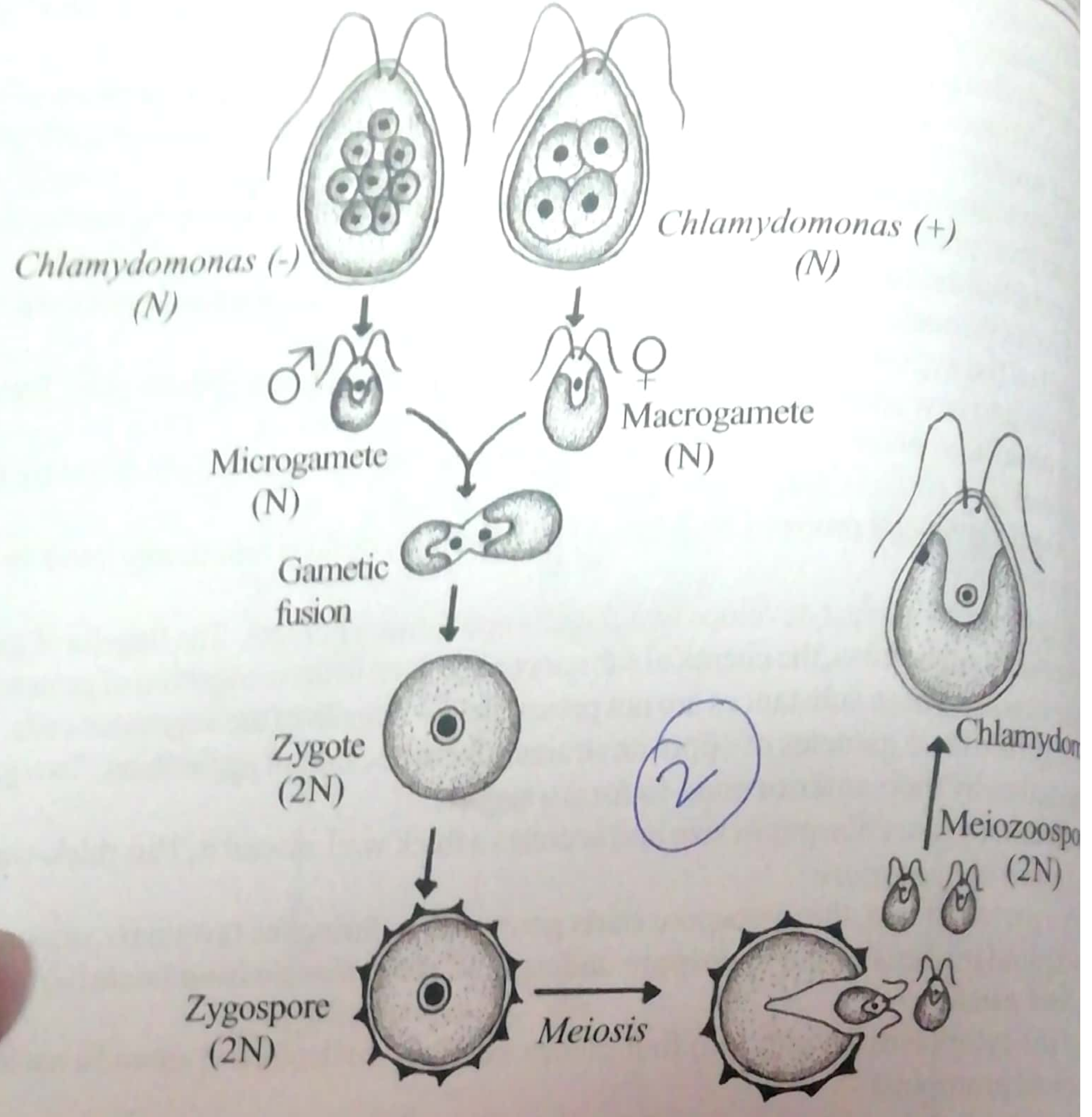


Fig. 5.10: Chlamydomonas braunii - Anisogamy.

The flagella of gametes are covered by agglutinins, the chemical substances involve recognition of gametes of the opposite strains. These substances are not present in the fla the vegetative cells.

The flagella of two gametes of opposite strains adhere because of agglutinins.

The microgamete fuses with a macrogamete to form a ***diploid zygote***.

The zygote secretes a thick wall to form a ***zygospore***.

The diploid zygote enlarges in size and secretes a thick wall around it. This thick-zygote is known as ***zygospore***.

After a period of rest, the zygospore starts germination during the favourable seaso

The diploid nucleus of the zygospore undergoes a ***reduction division*** (***meiosis***) t ***four haploid nuclei***.

Then the cytoplasm divides into four pieces, each of which collects around a nuc form a haploid protoplast.

Each protoplast develops two equal flagella to form a motile cell called ***meiozoosp***

Thus four meiozoospores are formed inside a zygospore wall.

The wall of the zygospore ruptures and the zoospores are released in the water. zoospores grow into new adult cells.

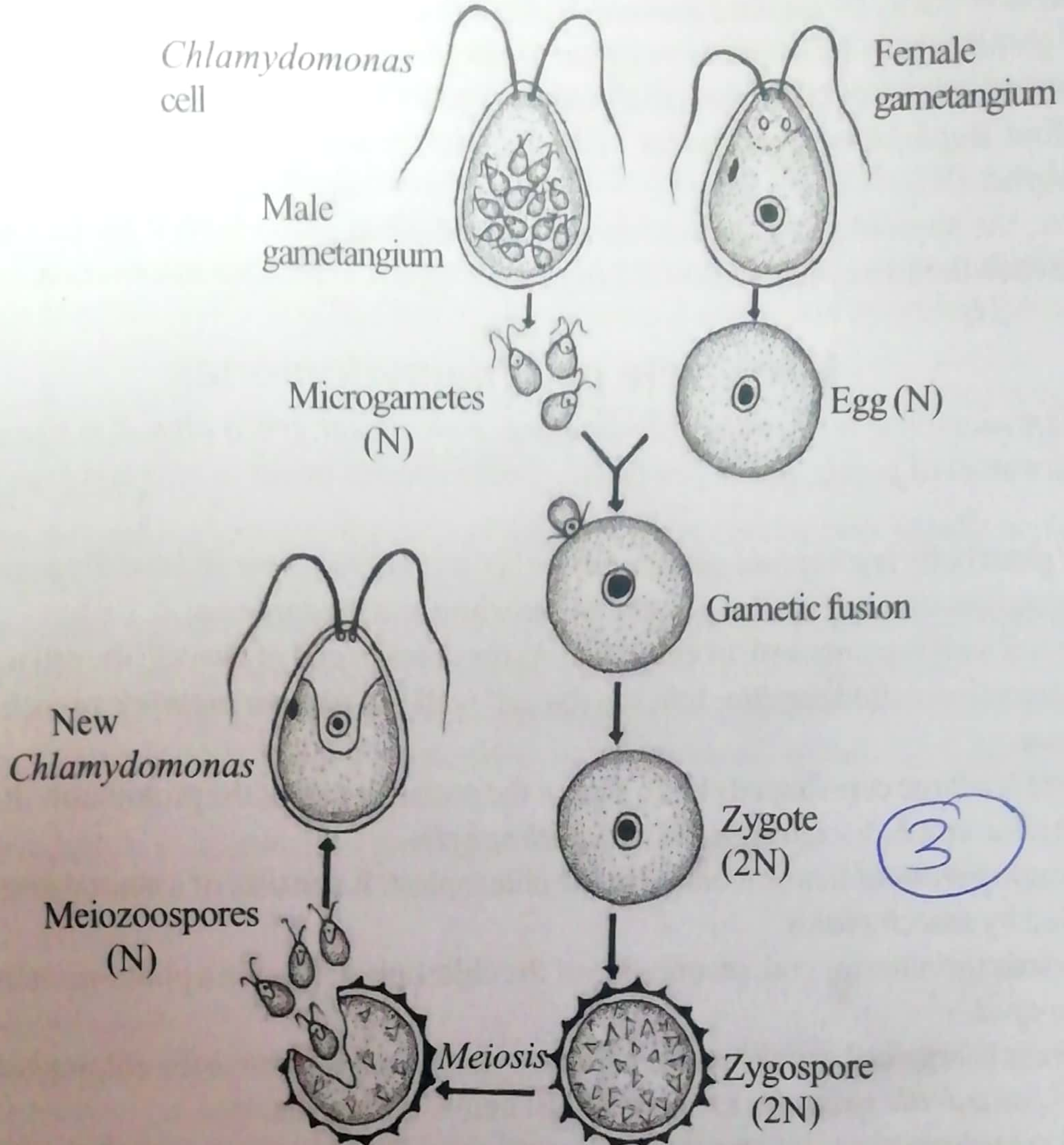


Fig. 5.11: Oogamy in Chlamydomonas oogonium.

3. Oogamy

Oogamy, is a sexual reproduction where a ***small motile*** *male gamete fuses with a larger, non-motile female gamete to form a zygote. Eg. Chlamydomonas oogamum.*

The protoplast of a vegetative cell undergoes mitotic divisions to form 16 or 32 daughter protoplasts.

Each protoplast becomes a ***biflagellate male gamete***.

At the same time, another vegetative cell drops its flagella, and becomes enlarged and rounded. This round cell is called ***egg*** or ***ovum***. It is ***non-motile*** and ***non-flagellate***.

The male gamete migrates towards the egg and fuses with it to form a ***diploid zygote***.

4. Hologamy

In *Chlamydomonas eugametos*, the vegetative cells as such function as gametes and fuse together to form a ***diploid zygote***. This type of fusion is called ***hologamy***.

Conclusion

The life cycle of *Chlamydomonas* is ***haplontic***. The vegetative cell is a ***haploid gametophyte*** (N). Asexually, it reproduces by ***zoospores***, ***aplanospores*** and ***palmella stage***.

It reproduces sexually by *haploid gametes* by simple mitotic division of *gametoph*

The gametes may be *isogametes* or *anisogametes* or *oogametes* or *holo gam* haploid gametes fuse together to form a *diploid zygote* (2N). This zygote underg to form four *haploid meiozoospores*. The haploid meiozoospores develop in *gametophytes* (N).

Here, the haploid phase is dominant and the diploid phase is represented zygote. Hence the life cycle is known a ***haplontic type***. There is ***no alternation of tion.***

Life Cycle of *Chlamydomonas*

Chlamydomonas is a ***motile, free-floating, unicellular green alga.*** It is foun nant freshwaters of *ponds, lakes, pools*, etc. Some species occur in seas and even fields.

The plant body is a ***haploid gametophyte*** (N). It is ***microscopic*** and usually *pear* The cell consists of a ***cell wall***, a ***plasma membrane*** and ***protoplasm***.

The ***cell wall*** is composed of ***cellulose***. At the anterior end of the cell, the cell w a small projection called ***papilla***. Inner to the cell wall is a ***plasma membrane*** enclo ***protoplasm***.

There is a large cup-shaped chloroplast at the posterior part of the protoplasm. It ***chlorophyll-a*** and ***b***, ***γ - carotenes*** and ***xanthophylls***.

A single ***pyrenoid*** lies embedded in the chloroplast. It consists of a central *prote* surrounded by ***starch plates***.

Towards the anterior end, on one side of the chloroplast, there is a photo-receptive called ***eye-spot.***

There is a large ***eukaryotic nucleus*** in the cytoplasm lying above the chloroplast.

Two ***contractile vacuoles*** are present just below the papilla.

The ***cytoplasm*** contains small *endoplasmic reticulum, dictyosomes, mitochondr starch granules*.

The cell has two equal, ***whiplash type flagella*** at its anterior end. They are conn with the nucleus by ***neuromotor apparatus***.

Chlamydomonas synthesizes its food from ***carbondioxide*** and ***water*** using sunlight. It is ***photoautotrophic*** in nutrition. ***Starch*** is the ***reserve food*** material.

Chlamydomonas reproduces by two methods, namely :

Asexual reproduction

Sexual reproduction.

The asexual reproduction takes place by means of ***zoospores, aplanospores*** and ***Palm stage***.

The zoospores are ***motile, biflagellate*** asexual spores. They are produced when the abundant water.

The vegetative cell drops its flagella and then its protoplast divides ***mitotically*** to form 16 daughter protoplasts.

Each protoplast develops two equal flagella at its anterior end and becomes a *zoosp*

The zoospores are released free by the rupture of parent cell wall. The zoospores grow new vegetative cells.

The aplanospores are ***non-motile, non-flagellate*** asexual spores. They are produced in some terrestrial species during the dry season. The protoplast of a vegetative cell divides ***mitotically*** into 8 or 16 daughter protoplasts. Each daughter protoplast develops into a non-flagellate ***aplanospore***.

During the favourable season, the aplanospores develop two equal flagella, come out of the parent cell and grow into new vegetative cells. Eg. *Chlamydomonas caudata*.

During unfavourable season the vegetative cell, drops its flagella and its protoplast divides ***mitotically*** so as to form 2-4 cells. They do not develop flagella and lie within the parent cell wall.

The cell wall of the parent cells and daughter cells get gelatinised so that many non-motile cells lie embedded in a gelatinous matrix. As this stage resembles a green alga *Palmella*, it is known as ***Palmella stage.***

In the next growing season, the cells of Palmella stage develop two flagella and grow into new vegetative cells. Eg. *Chlamydomonas nivalis*.

The ***sexual reproduction*** involves the fusion of two haploid gametes. Most species of *Chlamydomonas* are ***heterothallic*** so that they produce male and female gametes in two separate individuals. Eg. *Chlamydomonas moewusii*. Some species, however, are ***homothallic*** so that they produce male and female gametes in the same individual. Eg. *Chlamydomonas media*.

The sexual reproduction is of ***four*** types :

1. *Isogamy*
2. *Anisogamy*
3. *Oogamy*
4. *Hologamy.*

In isogamy, the two fusing gametes are ***morphologically alike*** and ***motile*** and the gametes are known as ***isogametes***.

In ***heterothallic*** species the gametes are ***self-incompatible***, so fusion takes place between gametes of two different parents.

In ***homothallic*** species, the gametes are ***self-compatible,*** so that fusion takes place between two gametes of an individual.

The vegetative cell loses its flagella and its protoplast undergoes mitotic divisions to form 16 to 64 daughter protoplasts. These daughter protoplasts develop two equal flagella to form gametes.

The gametes are released by the rupture of parent wall. Two gametes fuse together to form a diploid ***zygote*** (2N). The zygote secretes a thick wall to become a ***zygospore***. Eg. *C. media*.

In anisogamy the two fusing gametes are ***dissimilar*** and ***motile***. The gametes are known as ***anisogametes***.

The protoplast of one cell undergoes ***mitotic*** divisions to form 8 or 16 daughter protoplasts. Each daughter protoplast develops into a biflagellate male gamete called ***microgamete***.

The protoplast of another cell divides into 2 or 4 daughter protoplasts. They later become biflagellate female gametes called ***macrogametes***.

A microgamete fuses with a macrogamete to form a diploid ***zygote*** (2N). Eg. ***Chlamydomonas braunii.***

In Oogamy, the ***male gamete is small*** and ***motile*** due to the presence of flagella and the ***female gamete*** is ***larger*** and ***non-motile.***

The protoplast of a vegetative cell divides into 16 or 32 daughter protopl... velop two flagella to form small biflagellate ***male gametes***.

At the same time, a vegetative cell loses its flagella and becomes enlarged. This round cell is called an ***egg*** or ***ovum***. It is ***non-motile.***

The male gamete moves towards the egg and fuses with it to form a diplo...

C.Oogamum.

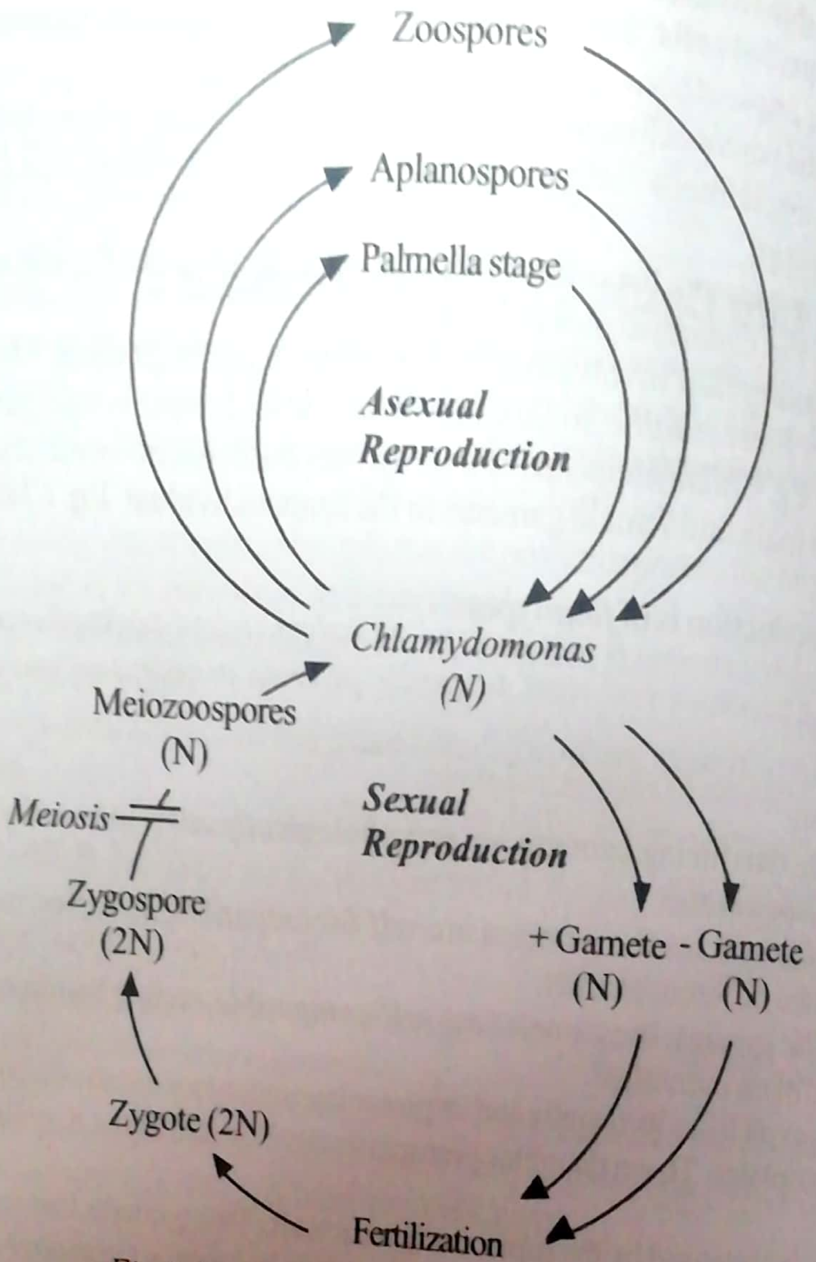
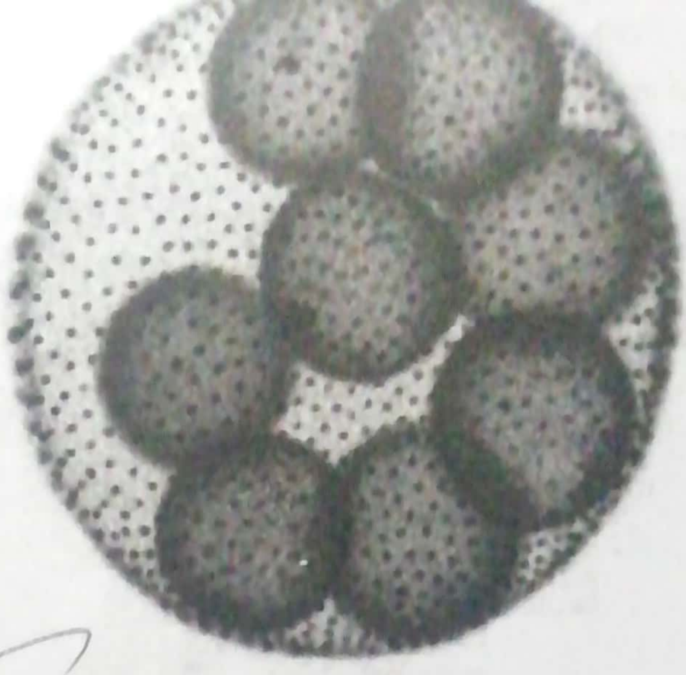


Fig.5.12: Chlamydomonas - Graphic life cycle.

The zygospore, after a period of rest, starts its germination. The diploid nucleu... vides ***meiotically*** into four ***haploid nuclei***. This is followed by ***cytokinesis*** to f... ***haploid protoplasts.*** These haploid protoplasts develop cell wall and two flagella... ***meiozoospores***.

The meiozoospores come out by the rupture of zygospore wall and grow into new ***gametophytic cells*** (N).

In *Chlamydomonas eugametes*, the haploid vegetative cells as such act as gam... fuse together to form a ***zygote***. This type of fusion is called ***hologamy***.



6 *Volvox*

Class	:	*Chlorophyceae*
Order	:	*Volvocales*
Family	:	*Volvocaceae*
Genus	:	*Volvox*

Volvox is a ***green alga.*** It is included in the class ***Chlorophyceae. Linnaeus*** named the genus, *Volvox*.

Occurrence

Volvox is a ***colonial green alga***.

It is a ***freshwater alga***. It is found in *ponds, lakes, tanks, pools, ditches,* etc. During favourable season, it grows vigorously to form ***water blooms*** and gives ***green colour*** to the water. *Volvox* colony floats during bright light and goes deep during night.

Volvox includes about 20 species. There are five species of *Volvox* in India.

Volvox africanus *Volvox prolificus* *Volvox merelli.*
Volvox globator *Volvox rousseletii*

Structure of *Volvox*

Volvox is a ***colonial green alga***. It is included in the class ***Chlorophyceae***.

It is a ***freshwater*** alga.

It is a ***free-floating*** form. It is ***spherical*** in shape.

It is ***macroscopic***. It is visible to the naked eye in the size of a ***pin-head.***

Volvox colony is 1to1.5mm in diameter. The colony of *Volvox* consists of 500 to 50,000 *Chlamydomonas*-like cells.

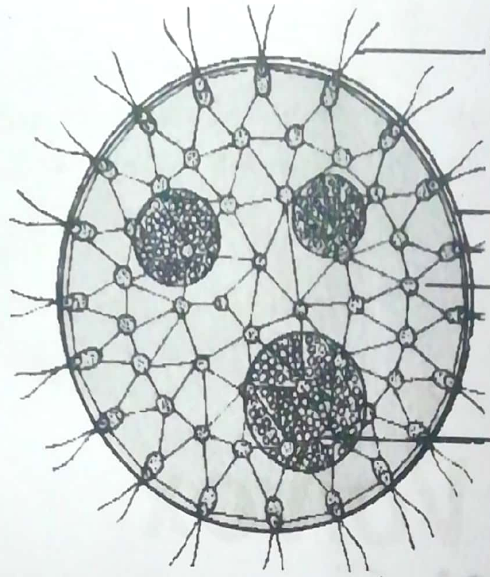
Volvox is an assemblage of similar and independent cells.

Each cell functions like an individual, carrying out its own nutrition, respiration and excretion.

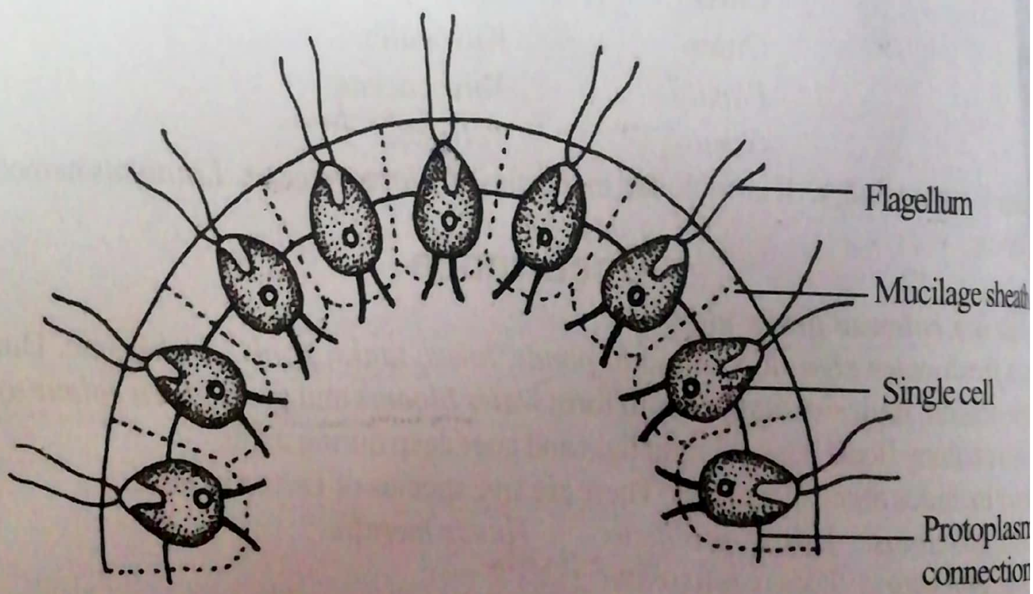
Volvox is a ***haploid gametophyte***. It is a ***colony***. The colony is ***spherical*** in shape.

The colony is made up of *Chlamydomonas*-like cells. The ***number*** and ar... cells in a ***particular*** colony are definite. Hence the colony is called a ***coenobium***.

The cells of the colony are embedded in a mass of ***mucilage.*** Each cell is al... by a ***mucilage sheath.*** The cells are interconnected by protoplasmic strands call... ***mata.***



An entire colony



Part of the colony showing detailed structure

Fig. 6.1: Volvox colony.

The cells are arranged as a ***single layer*** along the periphery of the colony. The... the colony is ***hollow*** and it is filled with ***mucilage.***

The colony has a ***polarity.*** It has an ***anterior*** side and a ***posterior*** side.

At the posterior side of the colony, there is a perforation called ***phialopore***.

The cells of *Volvox* resemble a *Chlamydomonas*. They are ***green*** in ***colour.*** E... ***oval*** in shape. Its anterior end is ***pointed*** and the posterior end is ***rounded***. The an... faces outwards.

The cell is surrounded by a ***cell wall*** made up of ***cellulose***. A thin ***plasma membrane*** lies below the cell wall. The plasma membrane surrounds the ***protoplasm.***

The anterior end has a ***thickening of cell-wall*** called ***papilla.*** The anterior end bears two ***flagella.*** The flagella arise from ***basal granules***. The flagella are ***equal in length***. They bring out the movement of the colony.

The protoplasm contains a pair of ***contractile vacuoles*** near the anterior end. A ***nucleus*** is present in the centre. The nucleus is ***eukaryotic*** and ***haploid.***

A large ***chloroplast*** is situated at the posterior side of the protoplasm. It is cup-shaped. The chloroplast contains pigments like ***chlorophyll-a*** and- ***b, carotenes*** and ***xanthophyll.*** The chloroplast has an ***eye-spot*** anteriorly and a ***pyrenoid*** in the centre. ***Starch*** is stored in the ***pyrenoid*** in the form of ***starch plates.***

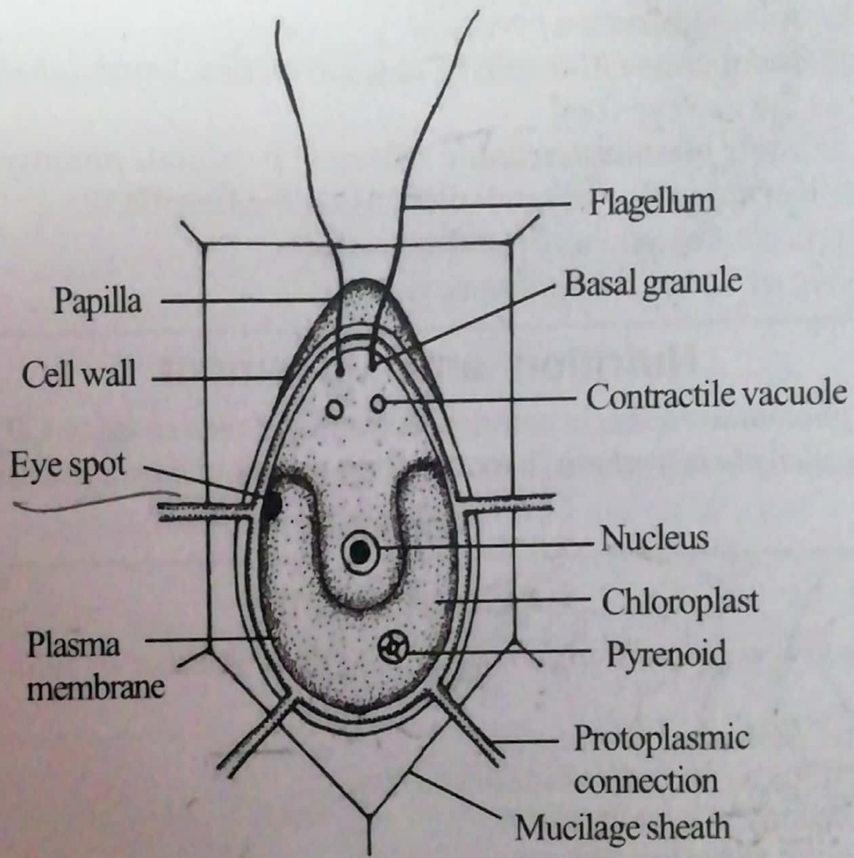


Fig.6.2: Volvox-A single cell.

Highlights

Volvox

- *Volvox* is a free ***floating, freshwater, macroscopic*** and ***colonial green alga.***
- It is included in the class ***Chlorophyceae.***
- It is a ***haploid gametophyte.***
- It is a ***colony***.
- It is a ***plant animal***.
- It is made up of *Chlamydomonas* like cells.
- Each cell of *Volvox* is covered by a ***mucilage sheath*** and the cells are interconnected by ***protoplasmic strands*** called ***plasmodesmata.***

Highlights

Male coenobium

Coenobium is a colonial alga having a definite number of cells and organization.

Eg. *Volvox, Eudorina, Pandorina*, etc.

- The coenobium containing antheridium is called ***male coenobium***.
- The male coenobium contains ***many antheridia***.
- Each antheridium develops from a ***vegetative cell***.
- The vegetative cell enlarges in size and loses its flagella to become an ***antheridial cell***.
- The antheridial cell divides and forms 16 to 128 cells by ***mitosis***.
- Each cell develops ***two flagella*** at its anterior end to become a ***sperm*** or ***antherozoid***.
- The mature sperms are liberated in water.

Highlights

Female coenobium

Coenobium is a colonial alga having a definite number of cells and organization .

E.g. *Volvox, Eudorina, Pandorina,* etc.

- The coenobium containing oogonium is called ***female coenobium.***
- A few ***oogonia*** develop in a coenobium.
- They are ***flask-shaped.***
- Each oogonium develops from a ***vegetative cell.***
- The vegetative cell ***enlarges*** in ***size,*** loses its flagella and eye-spot.
- The protoplast of the cell gets rounded to form a single ***egg*** or ***ovum.***
- The egg contains a ***haploid nucleus*** and dense ***cytoplasm.***

Reproduction

Volvox reproduces by ***two methods*** -

Asexual reproduction

Sexual reproduction

Asexual Reproduction

In *Volvox,* asexual reproduction takes place by the formation of ***daughte***
from ***gonidia.***

It takes place during ***favourable season.*** At the posterior part of a mature co
cells enlarge and function as reproductive cells called ***gonidia.***

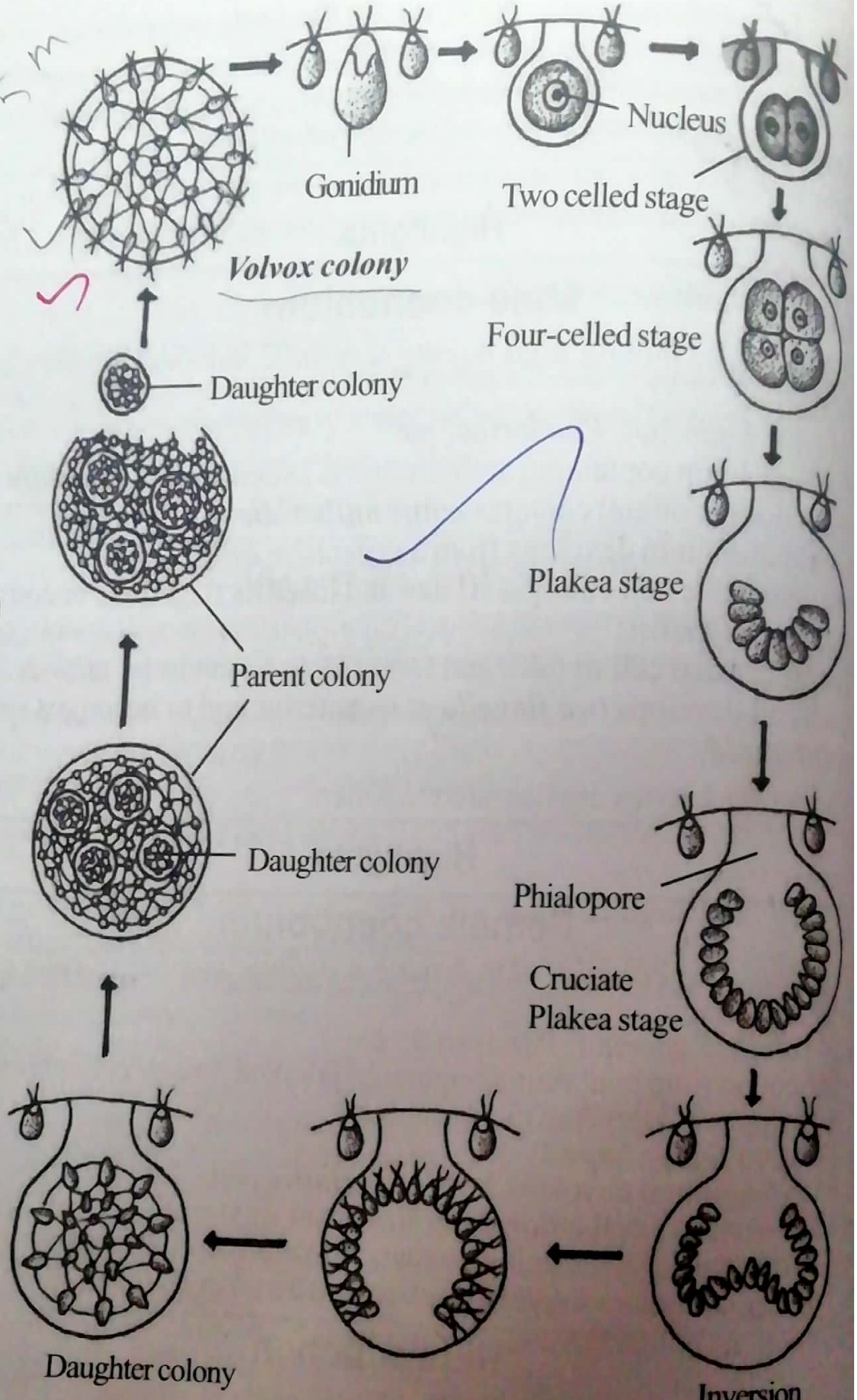


Fig.6.3: Volvox - Asexual reproduction; Stages of development of daughter colony from gonidium.

The gonidia ***lack eye-spots*** and ***flagella.*** They have well defined ***nuclei*** and ***dense granular cytoplasm.***

Each gonidial cell divides 3times into 2, 4 and then into ***8 daughter cells.*** The 8 celled stage is called ***octant stage.*** The eight daughter cells are arranged in the form of a ***curved plate.*** This stage is known as ***plakea stage.***

The cells of the plakea stage divide into 16 cells. These 16 cells rearrange to form a ***hollow sphere.*** This stage is called ***cruciate plakea*** stage. It has a ***layer of cells,*** a ***terminal pore*** and a ***central cavity.*** The pore is called ***phialopore.*** The cells are arranged in such a way that the anterior ends point inwards.

Then the number of cells increases by repeated ***mitotic*** divisions.

The sphere of cells turn ***completely inside out*** through the ***phialopore.*** This process is called ***inversion.***

At this stage,the anterior ends of cells point outwards.

Each cell then develops an ***eye-spot*** and ***two flagella*** at its anterior end. In this way, a daughter colony is formed inside the ***gonidial wall.***

The daughter colonies come out by the rupture of parent colony and live as ***independent colonies.***

Highlights

Plakea Stage

Plakea stage is a curved plate of eight cells formed during the development of Volvox.

- This stage is called ***octant stage*** because it contains ***eight cells.***
- It develops from ***gonidium*** in asexual reproduction and ***antheridium*** in sexual reproduction.
- The cells at the posterior part of a mature colony enlarge and function as reproductive cells called ***gonidia.***
- The gonidia lack ***eye-spots*** and ***flagella.***
- Each gonidial cell divides into 2,4 and then into 8 daughter cells.
- The eight daughter cells are arranged in the form of a ***curved plate.*** This stage is known as ***plakea stage.***
- The cells of the plakea stage divides into 16 cells. These 16 cells rearrange to form a ***hollow sphere.*** This stage is called ***cruciate plakea*** stage. It has a ***layer of cells,*** a ***terminal pore*** and a ***central cavity.*** The pore is called ***phialopore.*** The cells are arranged in such a way that the anterior ends point inwards.
- The number of cells increases by ***mitosis.***
- The sphere of cells turn completely inside out through the ***phialopore.*** This process is called ***inversion.***
- The inverted sphere becomes the daughter colony.
- The cells of the antheridium develop into ***sperms*** through plakea stage.

Sexual Reproduction

The sexual reproduction in *Volvox* is ***oogamous type.*** It takes place during unfavourable season. Many species of *Volvox* are ***homothallic*** or ***monoecious.*** They produce ... ***female*** sex organs in the same colony. Eg. *Volvox globator.*

Some species are ***heterothallic*** or ***dioecious.*** They produce male and female ... in two different colonies. Eg. *Volvox aureus*. The plant is a ***haploid gametophyte*** ... sex organ is called ***antheridium*** and the female sex organ is called ***oogonium.***

Antheridium

The male sex organs of *Volvox* are called ***antheridia*** or ***androgonidia.*** They ... duced at the ***posterior part*** of the colony.

Each ***antheridium*** develops from a ***vegetative cell.***

The ***vegetative*** cell first enlarges in size and loses its flagella to become an an... ***cell.***

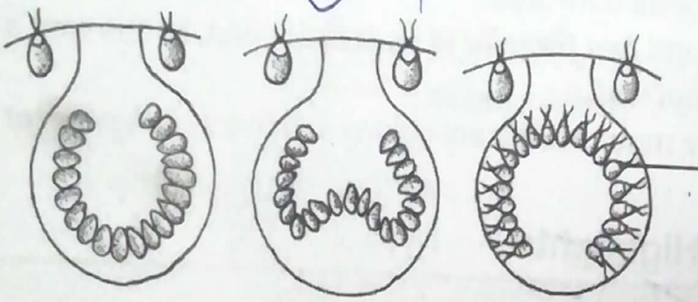


Fig.6.4: Volvox - Stages of development of antheridia.

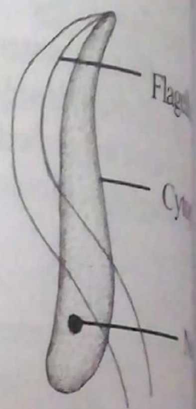


Fig .6.5: Volvox- A sper...

The antheridial cell divides into 2, 4 and then into 8 cells. The eight daughter c... arranged in the form of a ***curved plate.*** This stage is known as ***plakea stage*** or octan...

The cells of the plakea stage divides into 16 cells. These 16 cells rearrange to ... ***hollow sphere***. This stage is called ***cruciate plakea stage***. It has a ***central cavity***, a la... ***cells***, a ***terminal pore*** and a ***central cavity***. The pore is called ***phialopore***. The ce... arranged in such a way that the anterior ends point inwards.

16 to 128 cells are formed by ***mitotic*** divisions.

The sphere of cells turn completely inside out through the ***phialopore.*** This pro... called ***inversion.***

At this stage, the anterior ends of the cells point outwards.

Each cell then develops ***two flagella*** at its anterior end to become a ***sperm*** or *anther...*

Mature sperms are liberated in ***water*** in a ***cluster*** or ***singly.***

The cluster of sperms gets separated, when they reach near the egg.

The sperms or male gametes are ***narrow*** and spindle-shaped. They have ***two an... flagella.*** They are ***haploid.*** They have a large ***nucleus*** and ***dense cytoplasm.*** They a... ***low*** in colour. They swim freely in water towards the oogonium.

Highlights

Inversion

Inversion is the turning inside-out of the colony of some of the Volvoca...
Eg. *Volvox*

- The cells at the posterior part of a mature colony enlarge and ... reproductive cells called ***gonidia***.
- Each gonidial cell divides into ***8 daughter cells.***
- The eight daughter cells are arranged in the form of a ***curved plate.*** This stage is known as ***plakea stage.***
- The cells of the plakea stage divides into 16 cells. These 16 cells rearrange to form a ***hollow sphere.*** This stage is called ***cruciate plakea stage.*** It has a layer of cells, a ***terminal pore*** and a ***central cavity.*** The pore is called ***phialopore.*** The cells are arranged in such a way that the anterior ends point inwards.
- The sphere of cells turns completely inside out through the ***phialopore.*** This process is called ***inversion.***
- At this stage, the ***anterior ends*** of the cells point ***outwards.***
- The inverted sphere becomes the ***daughter colony.***
- At the development of sperms also inversion occurs.
- The antheridium divides and passes through the ***plakea stage*** and ***cruciate plakea stage*** as in the development of ***gonidia.*** Here also the cruciate plakea undergoes inversion to form sperms.

gonium

The female sex organs in *Volvox* are known as ***oogonia*** or ***gynogonidia.***
A few ***oogonia*** develop in a colony. They are ***flask*** shaped.
They are formed in the ***posterior*** part of the colony.
Each oogonium develops from a ***vegetative cell.***
The vegetative cell enlarges in size, loses its flagella and eye-spot. The protoplast of the gets rounded to form a single ***egg*** or ***ovum.***
The egg contains a ***haploid nucleus*** and ***dense cytoplasm.***

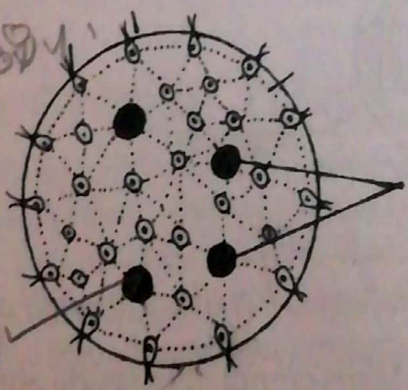


Fig. 6.6: Volvox - Colony showing oogonia

rtilization

The sperms liberated from the antheridium swim towards the oogonium and enter the oo-ium. One of the sperms fuses with the egg to form a ***diploid zygote.*** (2N).

The zygote secretes a thick three layered, smooth or spiny wall around it to form an ***oospore.*** e thick-walled oospores remain in the parent coenobium. The oospore is released by the ture of the colony.

Germination of Oospore

The oospore *germinates* after a period of rest. The diploid nucleus undergoes reduction division or *meiosis* to form four *haploid nuclei.* Of these, *three nuclei* get disintegrated and the remaining *one is functional.* At this stage, the oospore wall ruptures and the protoplast comes out in the form of a *vesicle.* This protoplast develops into a *biflagellate zoospore.*

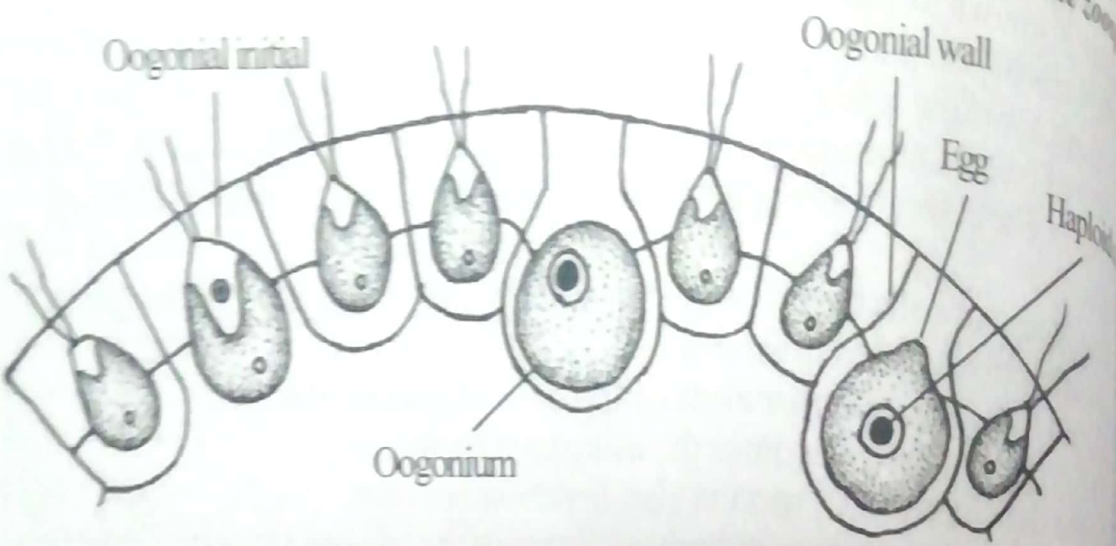


Fig. 6.7: Volvox - Stages of development of oogonium.

The zoospore swims in water and divides mitotically into 2,4,8 and then into a mass of cells. These cells are arranged in a single *layer* to form a *hollow sphere.* The anterior end of the cells faces inwards. The hollow sphere has a pore called *phialopore.*

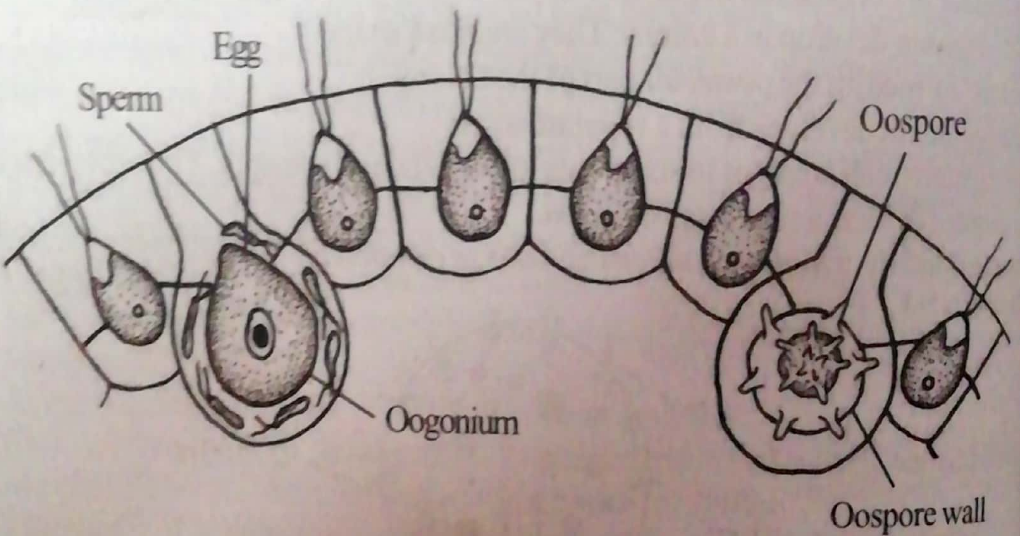


Fig.6.8: Volvox - Fertilization and oospore formation.

Then the sphere of cells turns completely inside out by a process called *inversion.* Now the anterior ends of the cells face outwards. Each cell then develops a pair of *flagella.* In this way, the hollow sphere develops into a *daughter colony.*

Conclusion

The life cycle of *Volvox* is *haplontic type.* The plant is a *haploid gametophyte.* It reproduces *asexually* by *daughter colonies.*

It produces sexually, a *diploid zygote* by the fusion of two gametes. The zygote undergoes

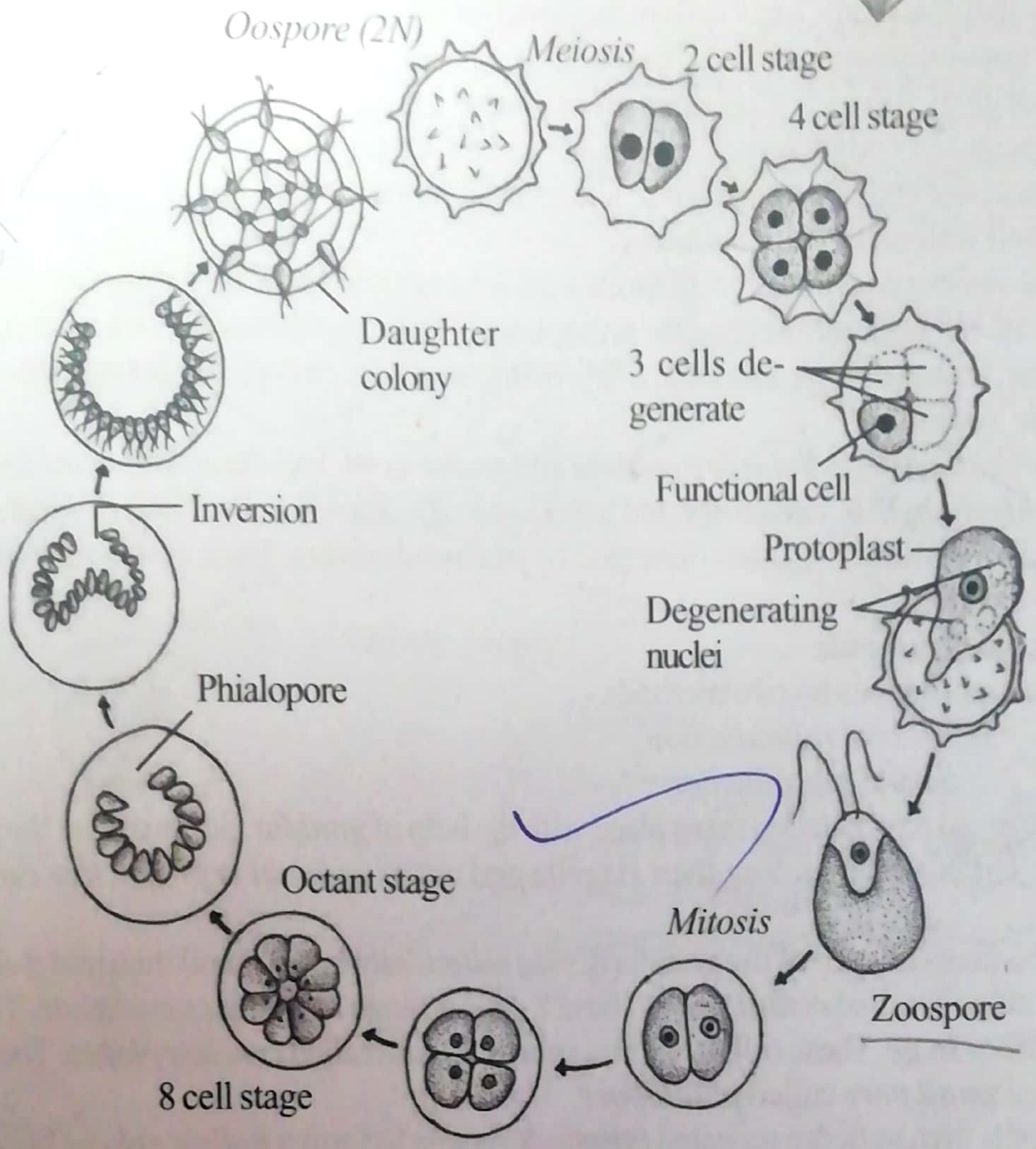


Fig. 6.9: Volvox Stages of germination of oospore.

meiosis to form a ***haploid daughter colony.*** Here the haploid phase is dominant and diploid phase is represented only by the zygote. The life cycle of *Volvox* is, therefore, called ***haplontic type.***

Life Cycle of *Volvox*

Volvox is a ***colonial green alga***. It is included in the class ***Chlorophyceae***. It is found in ***freshwaters*** of *ponds, lakes, tanks* and *pools*. Sometimes, it forms ***water blooms***.

It floats during the day time and sinks during the night. It moves by ***spinning*** of the colony.

The colony of *Volvox* consists of 500-50,000 *Chlamydomonas*-like cells. The number and arrangement of cells in the colony ***remain constant*** through out the life. Hence the colony of *Volvox* is known as ***coenobium***.

The colony is in the form of a ***hollow sphere***. It is surrounded by a ***mucilage matrix***.

Every cell of the colony is also surrounded by a ***hexagonal mucilage envelope.***

The central hollow portion is filled with ***mucilage***.

At the posterior end of the colony there is a perforation known as ***phialopore***.

The cells of the colony are interconnected by delicate ***protoplasmic strands***.

Each cell has ***two flagella***.

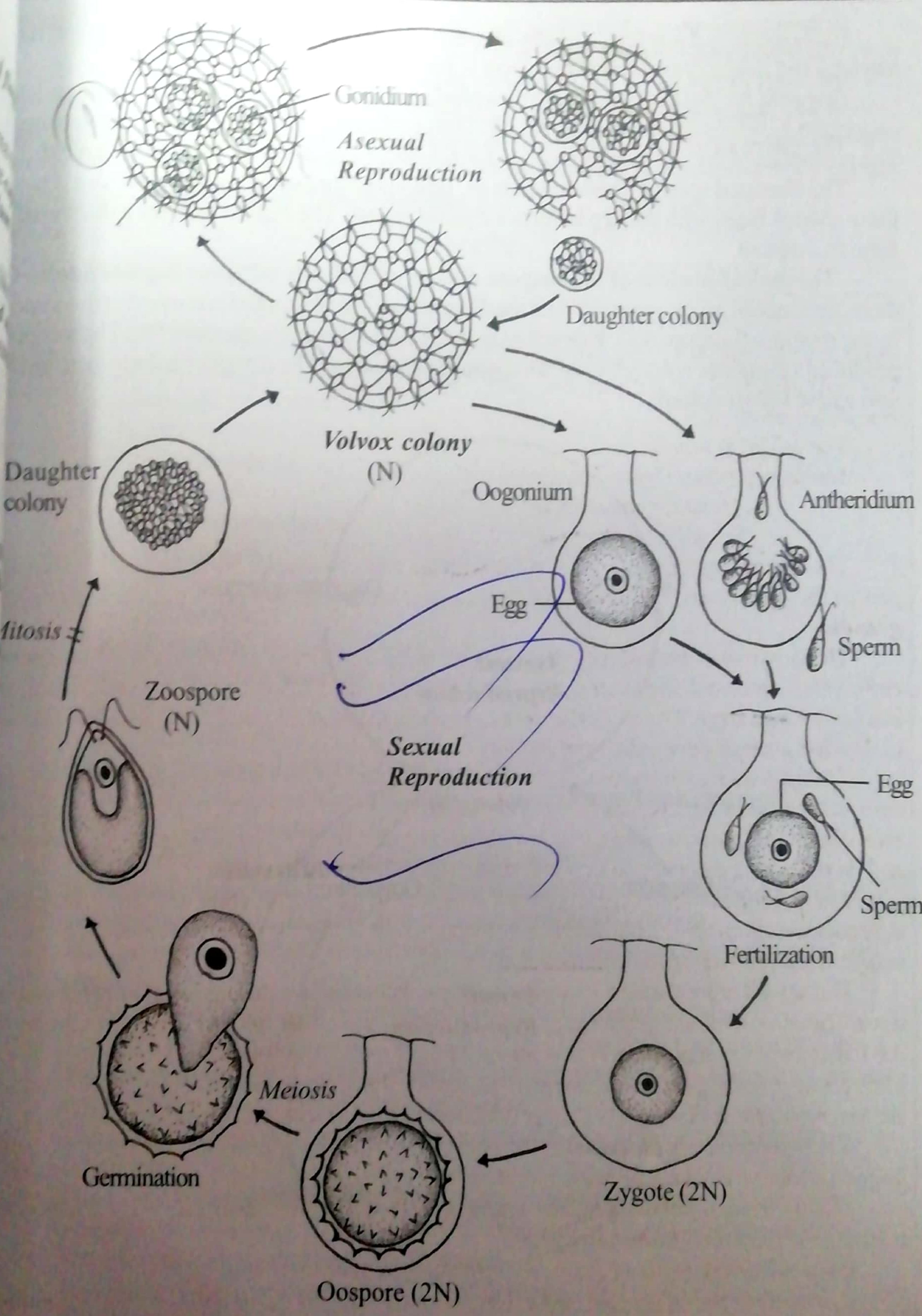


Fig.6.10: Volvox - Diagrammatic life cycle.

Each sperm is a ***narrow, spindle-shaped*** structure with ***two anterior flage*** ***nucleus*** and ***dense cytoplasm***. The sperm is ***haploid***.

Oogonia are ***flask-shaped*** structures produced at the ***posterior part*** of the co oogonium develops from a ***vegetative cell***. The vegetative cell loses its flagella and The protoplast of the cell gets rounded to form a single ***egg*** or ***ovum***. The egg is ha

The liberated sperms swim towards the oogonium and enter the oogonial w these sperms fuses with the egg to form a ***diploid zygote***. The zygote ***secretes a thi*** form an ***oospore***.

The diploid nucleus of the oospore divides ***meiotically*** into ***four haploid n*** these, three nuclei get disappeared. The resulting uninucleate protoplast comes out of the by the rupture of oospore wall. It develops two flagella to become a ***zoospore*** (N). The produces a daughter colony by repeated ***mitotic divisions***. The daughter colony the into a new *Volvox* colony.

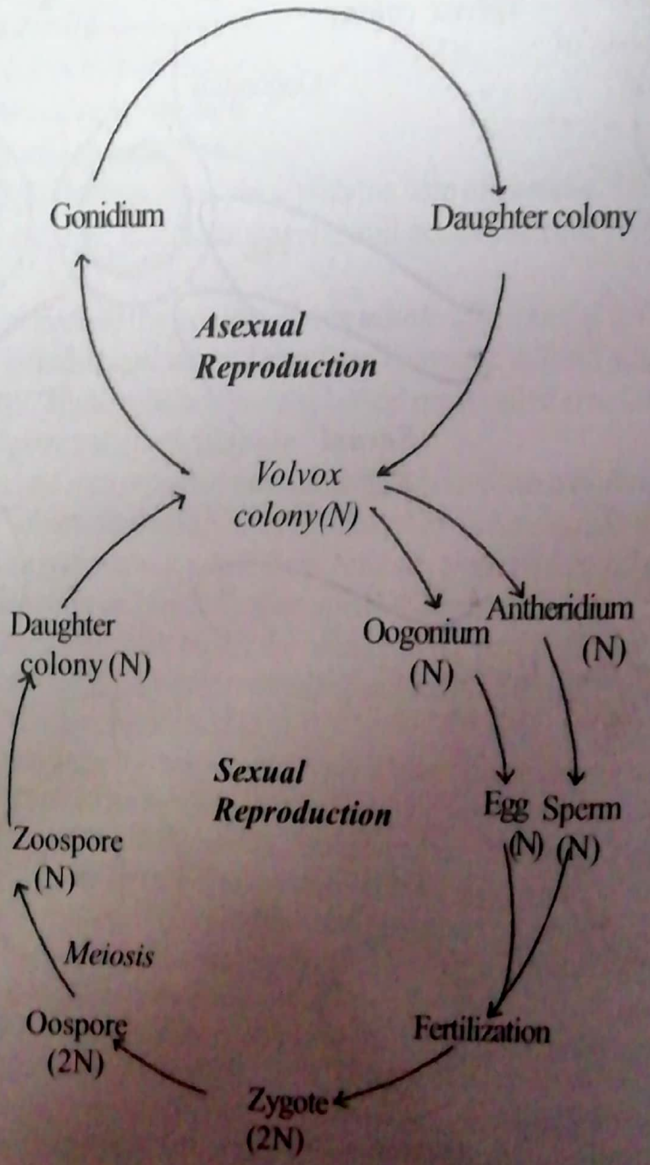


Fig. 6.11: Volvox - Graphic life cycle.

10 Oedogonium

Class : *Chlorophyceae*
Order : *Oedogoniales*
Family : *Oedogoniaceae*
Genus : *Oedogonium*

Oedogonium is a ***green alga.*** It is placed in the class ***Chlorophyceae***. This genus was named by ***Link***.

Occurrence

Oedogonium is widely distributed in ***freshwater habitats*** such as *ponds, lakes, tanks, rivers*, etc.

The mature filaments are ***free-floating*** but the ***younger ones*** are ***attached***.

They are found attached to *stones, woods* and to *large algae* and *aquatic angiosperms*.

There are about 285 species in *Oedogonium*. Of these, 144 species are found in India. The common Indian species are:

Oedogonium nodulosum *Oedogonium aquaticum*
Oedogonium fragile *Oedogonium gracilius*.

Structure

Oedogonium is a unbranched filamentous ***green alga***.
It is included in the class ***Chlorophyceae***.
It is cosmopolitan in distribution.
The plant is a ***haploid gametophyte.***
It is a ***freshwater alga***.
It is an ***attached form***.
It is a ***filamentous alga***.
The thallus consists of a long ***filament*** and a ***holdfast***.
The filament is ***unbranched***.

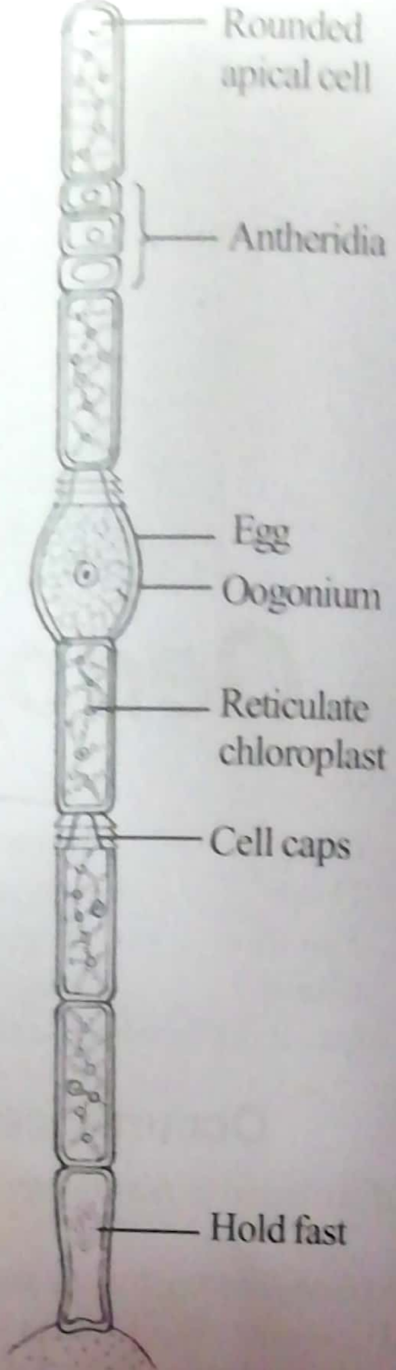


Fig.10.1: Oedogonium - Thallus structure.

The filament is ***uniseriate*** and it consists of ***elongated*** and ***cylindrical cells*** arra
end to end.

The basal cell of the filament is modified into the ***holdfast*** or ***hapteron***.

The holdfast is devoid of chloroplast.

The holdfast attaches the filament with the substratum by its lobed base.

The free end of the filament is ***acute*** or ***round***.

Some cells have ring-like thickenings called ***cell caps***.

The cells with caps are called ***cap cells***.

The mature filament has a few swollen ***oogonia*** and ***antheridia***.

The cell has an outer ***cell wall***, a middle ***plasma membrane*** and an inner ***protopla***

The cell wall consists of ***three layers***, namely an outer ***chitinous layer***, a middle p
layer and an inner ***cellulose layer***.

The cell wall has ring-like thickenings called ***cell caps***.

The plasma membrane lies below the cell wall.

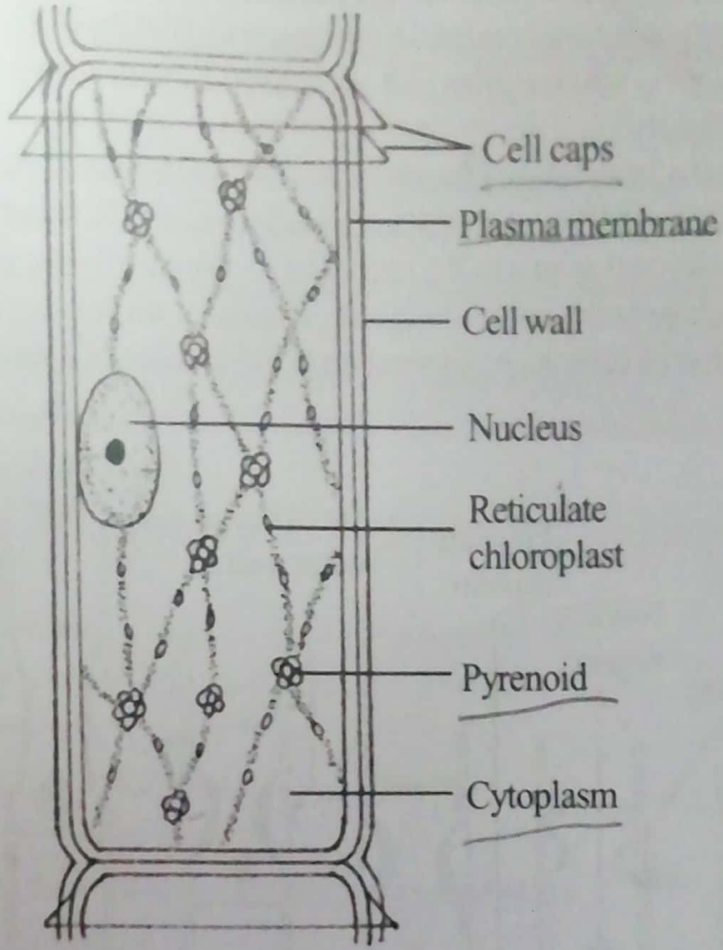


Fig.10.2: Oedogonium - Structure of cell.

The protoplasm contains a single ***reticulate chloroplast*** with many ***pyrenoids***, a ***nu-
eus*** and ***vacuole***.

The nucleus is ***large*** and ***eukaryotic***.

The chloroplast contains ***chlorophyll-a*** and ***-b***, ***carotenes*** and ***xanthophylls***. ***Starch*** is
e ***reserve food***.

Growth

The growth of the filament takes place by the division of ***terminal cell*** or ***intercalary
ell***. The cell division is a peculiar type and it results in the formation of ***cap cells***.

Cell Division and Formation of Cap Cells

The cell division in *Oedogonium* is a ***peculiar type***. This type of cell division is not seen in
ther families. All cells of the filament, except the holdfast, are capable of cell division. The
nportant events of cell division are given below:

1. Just before the cell division, the ***nucleus moves to the centre*** from the periphery of the
ell.

2. The nucleus divides ***mitotically*** into ***two daughter nuclei***. At the same time, a ***con-
entric ring*** of hemicellulose develops on the inner surface of the lateral wall just below the
pper transverse wall. It develops by invagination of inner and middle layers of the cell wall.

3. The concentric ring becomes ***thickened*** by the addition of hemicellulose. Now a float-
ng ***septum*** develops between the two daughter nuclei.

4. The floating *septum moves upward* and reaches ***near the base of the ring***

5. The septum is connected with the lateral wall of the cell.

6. As a result a ***small upper cell*** and a large ***basal cell*** are formed. In the mea... ring stretches slightly.

7. Due to the stretching of the ring, the outer wall layer at the ring, ruptures and ... a ring around the cell. The ruptured outer wall layer is called ***cell cap.***

8. The upper cell grows to the normal size, the ring becomes fully stretched an... wall layer develops at the point of rupture. The cell with cell cap is called ***cap cell.***

The number of caps is corresponding to the number of previous divisions of the

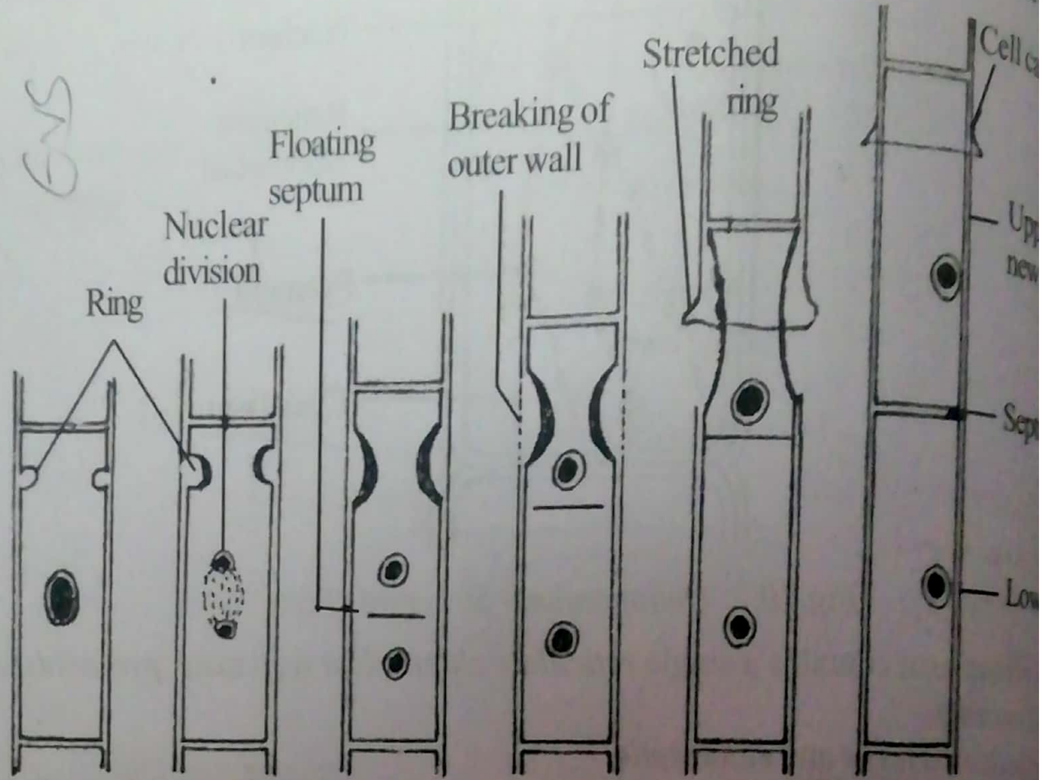


Fig.10.3: Oedogonium - Cell division.

Highlights

Oedogonium

- *Oedogonium* is a ***sedentary, unbranched filamentous green alga.***
- It is included in the class ***Chlorophyceae.***
- It is a ***freshwater*** alga.
- The plant is a ***haploid gametophyte.***
- The thallus consists of a long ***filament*** and a ***holdfast.***
- The filament is attached to the substratum by ***holdfast.***
- All cells of the filament except the basal and apical cells, are cylindrica... alike.
- The apical cell of the filament is rounded.
- Some intercalary cells have ***caps*** at their upper end. These cells are cal... ***cap cells.***
- In the mature filament, some cells are converted into ***antheridia*** and ***oog...***

- The cell consists of an outer ***cell wall***, a middle ***plasma membrane*** and inner ***protoplasm***.
- The ***cell wall*** has ring-like thickenings called ***cell caps***.
- The ***plasma membrane*** lies below the cell wall.
- The ***protoplasm*** contains a single ***reticulate chloroplast***, a ***nucleus*** and ***vacuole.***
- The ***chloroplast*** contains ***pigments*** and many ***pyrenoids***.
- ***Starch*** is the reserve food.
- The nucleus is ***eukaryotic***.
- The ***growth*** of the filament takes place by the division of ***terminal cell*** or ***intercalary cells***.
- The cell division is a ***peculiar*** type as it produces a ***cap***.
- *Oedogonium* reproduces by ***three*** methods. They are:
    - *Vegetative reproduction*
    - *Asexual reproduction*
    - *Sexual reproduction.*
- ***Vegetative reproduction*** takes place by ***fragmentation***.
- ***Asexual reproduction*** takes place by -
    - *Zoospores*
    - *Aplanospores*
    - *Akinetes.*
- ***Zoospores*** are motile, uninucleate, multiflagellate spores produced in ***zoosporangia***. They germinate into ***haploid gametophytes.***
- The ***sexual reproduction*** is ***oogamous type***.
- The male sex organ is called ***antheridium*** and the female sex organ is called ***oogonium***.
- Antheridium produces ***sperm*** and oogonium produces ***egg***.
- The motile sperm fuses with the non-motile egg to form a ***diploid zygote.***
- The zygote secretes a thick wall to form an ***oospore***.
- Oospore divides ***meiotically*** into four ***haploid zoospores***.
- Haploid zoospores germinate into ***haploid gametophytes***.
- Depending upon the distribution of sex organ, species of *Oedogonium* are divided into ***two*** groups. They are:
    - *Macrandrous species* → *Homothallic*, *Heterothallic*
    - *Nannandrous species* → *Gynandrosporous species*, *Idiandrosporous species*
- ***Oedogonium*** that produces antheridia and oogonia in ***normal filament*** is called

Reproduction

The reproduction in *Oedogonium* takes place by ***three*** methods. They are:

* *Vegetative reproduction*
* *Asexual reproduction*
* *Sexual reproduction.*

Vegetative Reproduction

The vegetative reproduction takes place by ***fragmentation***. The filament brea[ks into] small fragments by mechanical actions. Each fragment grows into a new filament. Th[is is] called ***fragmentation***.

Asexual Reproduction

In *Oedogonium,* asexual reproduction takes place by ***three*** kinds of asex[ual ...] They are:

1. *Zoospores*
2. *Aplanospores*
3. *Akinetes.*

Zoospores

Asexual reproduction takes place by means of ***multiflagellate zoospores.***

The zoospores are formed ***singly*** from any cap cells.

The cell producing the zoospore is known as ***zoosporangium***.

The protoplast of the zoosporangium contracts from the cell wall and becomes [...] ***mass***. It gradually becomes ***oval*** in shape and green in colour with a ***hyaline*** anteri[or ...]

Around this hyaline part a ring of about ***120 flagella*** arise and now it is called [...] This type of flagella arrangement is called ***stephanokont type***.

The zoospore with stephanokont arrangement of flagella is called ***stephanko[nt ...]***

Each zoospore has a ***reticulate chloroplast***, a haploid ***nucleus*** and plenty o[f] ***food.***

The cross wall at the upper end of the cell separates as a ***lid***. The zoospore [...] within a ***vesicle***, comes out of the ***zoosporangium***. Then the vesicle disappears and the [...] swims freely in the water.

The released zoospore becomes upside down and loses its flagella.

The cell then divides transversely into a ***lower cell*** and an ***upper cell***.

The lower cell becomes the ***holdfast*** and the upper cell forms the ***uniseriate f[ilament]***

2. Aplanospores

Aplanospores are ***non-motile***, ***non-flagellate, uninucleate cells***.

The cell of the filament producing the aplanospore is called ***aplanosporangium***

The aplanospore is produced during the dry season.

When favourable season comes, the aplanospore comes out of the aplanospora[ngium ...] germinates into a new plant.

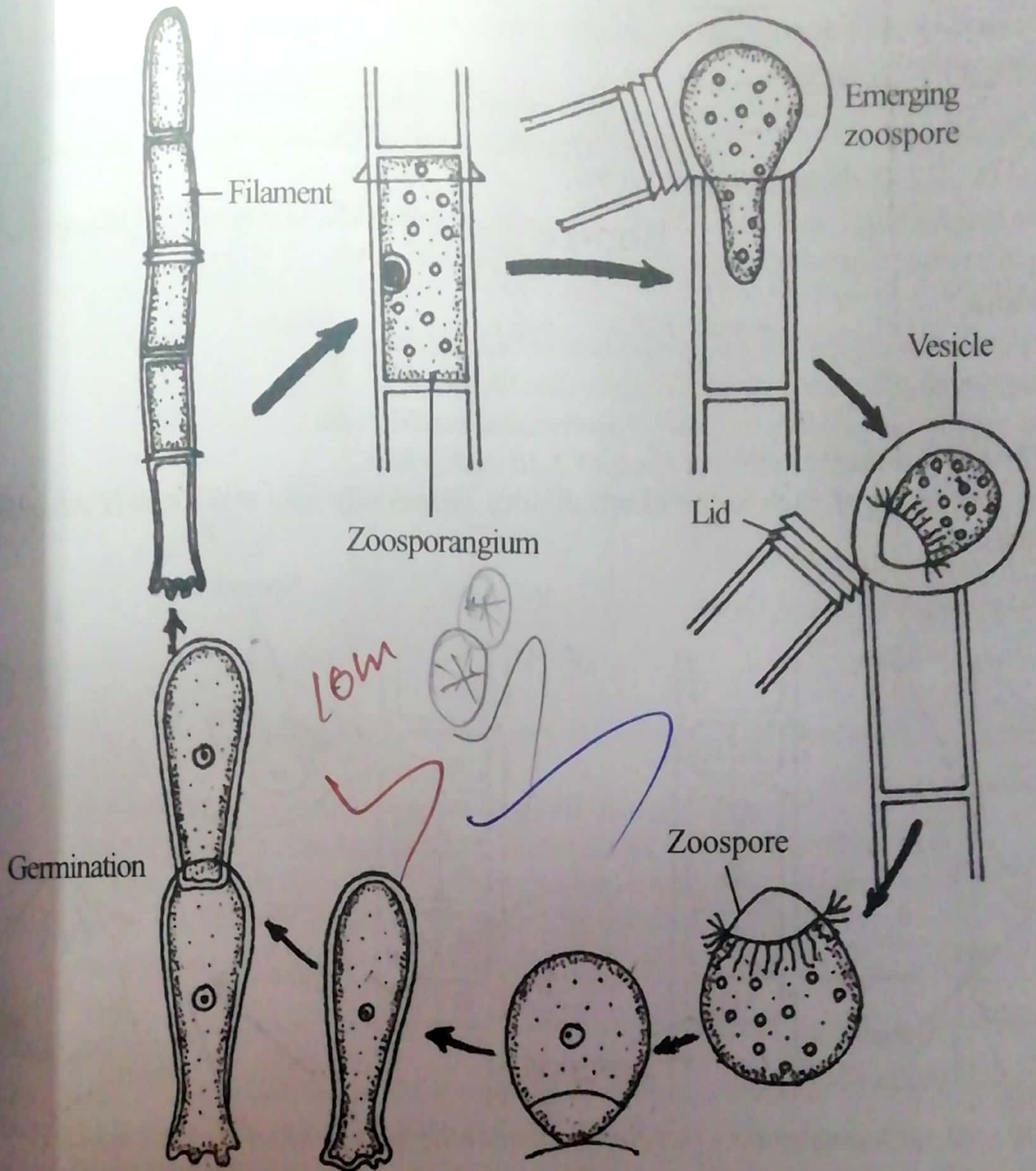


Fig.10.4: Oedogonium - Asexual reproduction by the formation of zoospore.

3. Akinetes

Akinetes are thick-walled vegetative cells of *Oedogonium*.

Sometimes, the vegetative cell stores plenty of reserve food and develops a thick wall round it. This thick walled cell is called ***akinete***.

During the favourable season, it germinates into a new filament.

Sexual Reproduction

The sexual reproduction in *Oedogonium* is ***oogamous type***. The male sex organ is called ***antheridium*** and the female sex organ is called ***oogonium***.

Depending upon the distribution of sex organs, all species of *Oedogonium* are divided into two groups. They are:

1. Macrandrous species

2. Nannandrous species.

Macrandrous Species

The species of Oedogonium that produces antheridia and oogonia in normal filaments are called *macrandrous species*.

The macrandrous species may be ***homothallic*** *or* ***heterothallic***.

The ***homothallic*** species (monoecious) produces antheridia and oogonia in the same filament. Eg. *Oedogonium nodulosum*.

The ***heterothallic*** species (dioecious) produces antheridia in one normal filament and oogonia in another normal filament. Eg. *Oedogonium aquaticum*.

Antheridia

The male sex organs of *Oedogonium* are called antheridia.

They develop from any vegetative cell of the filament.

The vegetative cell functions as an ***antheridial mother cell***.

It divides repeatedly to form a chain of ***2-40 antheridia***.

The protoplast of each antheridium divides ***mitotically*** into ***two haploid protoplasts***.

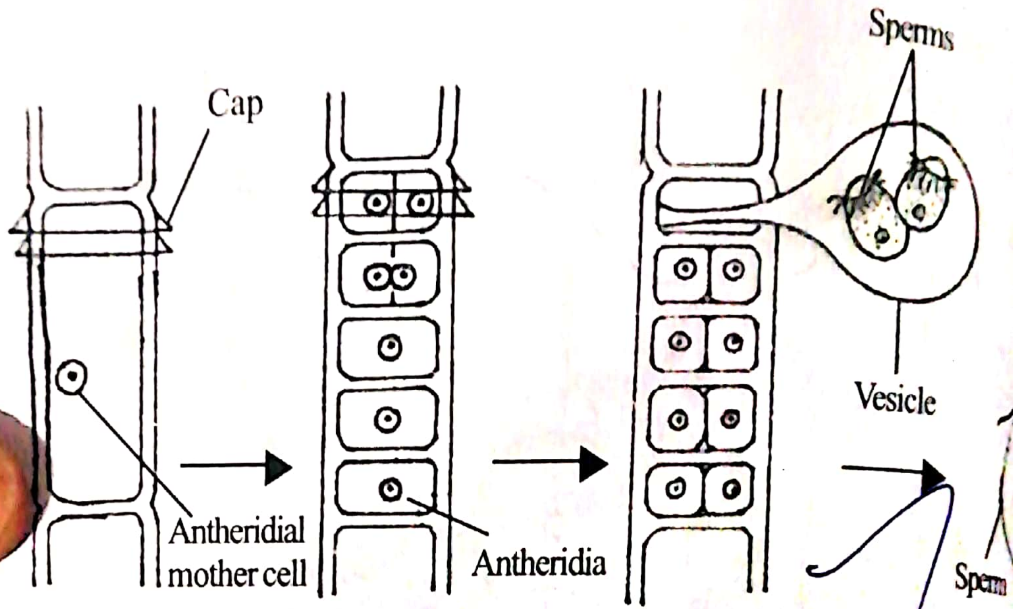


Fig.10.5: Oedogonium - Development of antheridia in Macrandrous species

Each protoplast becomes pear-shaped and develops a ring of many flagella around a colourless portion at its one end. This becomes a ***sperm***. Thus two sperms are produced in each antheridium.

The wall of the mature antheridium ruptures transversely to form a ***gap***.

The two sperms secrete a common ***mucilage vesicle*** around them.

The vesicle comes out through the gap. Later, the sperms come out of the vesicle and swim freely in the water in search of an oogonium.

The sperms are similar to the zoospores but smaller in size.

Oogonia

The female sex organs are called ***oogonia***.

Any cell of the filament, functions as ***oogonial mother cell***.

This cell divides transversely into an ***upper cell*** with cell cap and a ***lower cell***.

The upper cell develops into an ***oogonium***.

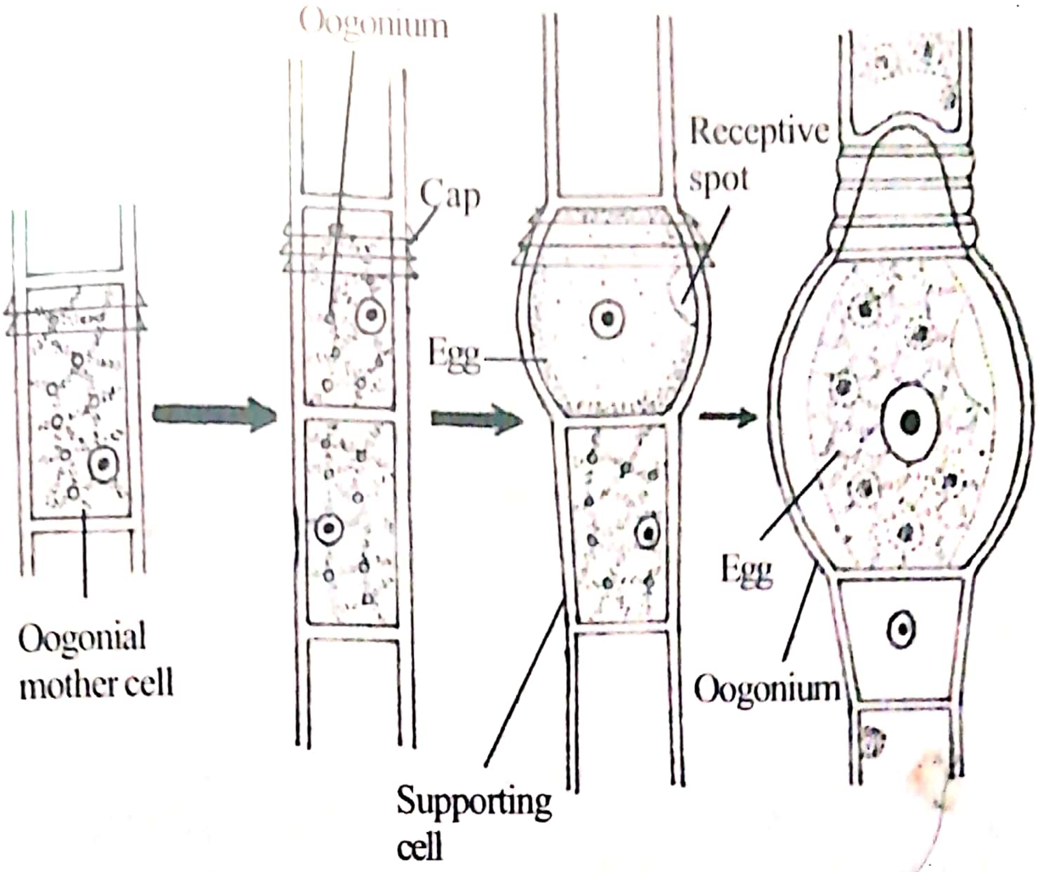


Fig.10.6: Oedogonium - Development of oogonium.

The lower cell becomes a ***supporting cell*** or ***suffultory cell.***

In some rare cases, the supporting cell also divides and forms one or few oogonia.

The protoplast of oogonial cell becomes ***round*** and it contracts from the oogonial wall to form an ***egg***. The egg develops a small colourless part called ***receptive spot*** at its lateral side.

The oogonial wall at the receptive spot forms a ***pore*** or ***slit*** to give a way for the entry of the sperms.

Fertilization

As the oogonium matures, the oogonial wall at the receptive spot gelatinises and forms a ***mucilage mount***. This mucilage attracts the sperms towards the oogonium.

One sperm enters the oogonium through the slit and fuses with the egg to form a ***zygote***.

The zygote is ***diploid***.

The zygote secretes a thick wall to form an ***oospore***.

Germination of Oospore

After a period of rest, the diploid nucleus of the oospore divides ***meiotically*** into ***four haploid nuclei***.

Each nucleus with the cytoplasm develops many flagella to form a ***zoospore***.

The oospore wall ruptures and releases the ***four zoospores*** in water. The zoospores are ***haploid***.

The zoospores swim in water and germinate into haploid *Oedogonium* plants.

Nannandrous Species

The species of Oedogonium that produces oogonium in normal filament and antheridium in small dwarf filament is called nannandrous species.

Here, the normal filament produces a special type of zoospore called ***androspore***. The

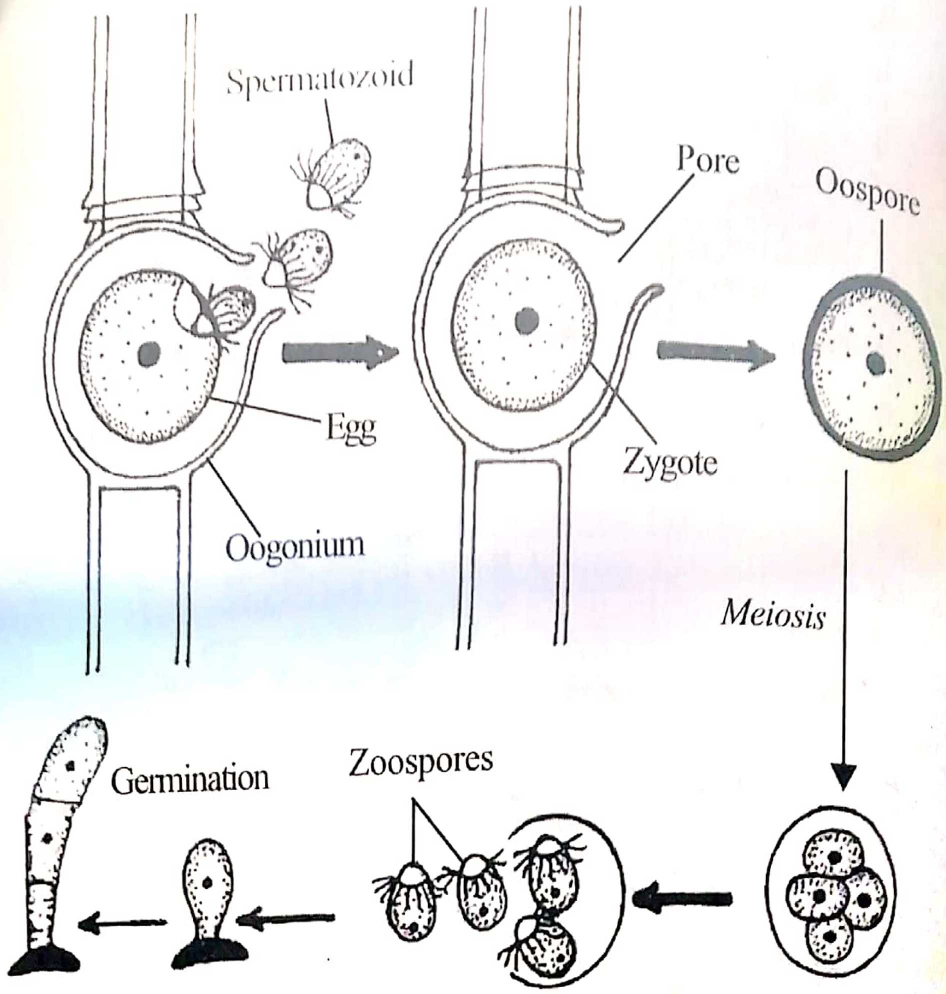


Fig.10.7: Oedogonium - Fertilization and germination of oospore.

...spores are produced in ***androsporangia***. The androsporangia are similar to the ...macrandrous species.

The androspores settle either on the oogonium or on the supporting cell. They ... into short filaments called ***dwarf males*** or ***nannandria***.

The nannandrous species are often known as ***androspore - forming sp...*** nannandrous species are of ***two*** types:

1. Gynandrosporous species (monoecious)

2. Idiandrosporous species (dioecious).

In the ***gynandrosporous*** species, androsporangia and oogonia are produced i... filament (i.e, monoecious) Eg. *Oedogonium concatenatum*.

In ***idiandrosporous*** species androsporangia and oogonia are produced in se... ments (i.e., dioecious) Eg. *Oedogonium iyengarii*.

The androspores are liberated from the androsporangia. Each androspore dev... few celled filament known as ***dwarf male*** or ***nannandrium***.

Nannandrium

The nannandrium is the ***male filament*** of *Oedogonium*.

It is a short filament and it produces male gametes. So it is known as dwarf... ***ment***. It develops from androspore. It is found attached to the supporting cell or the...

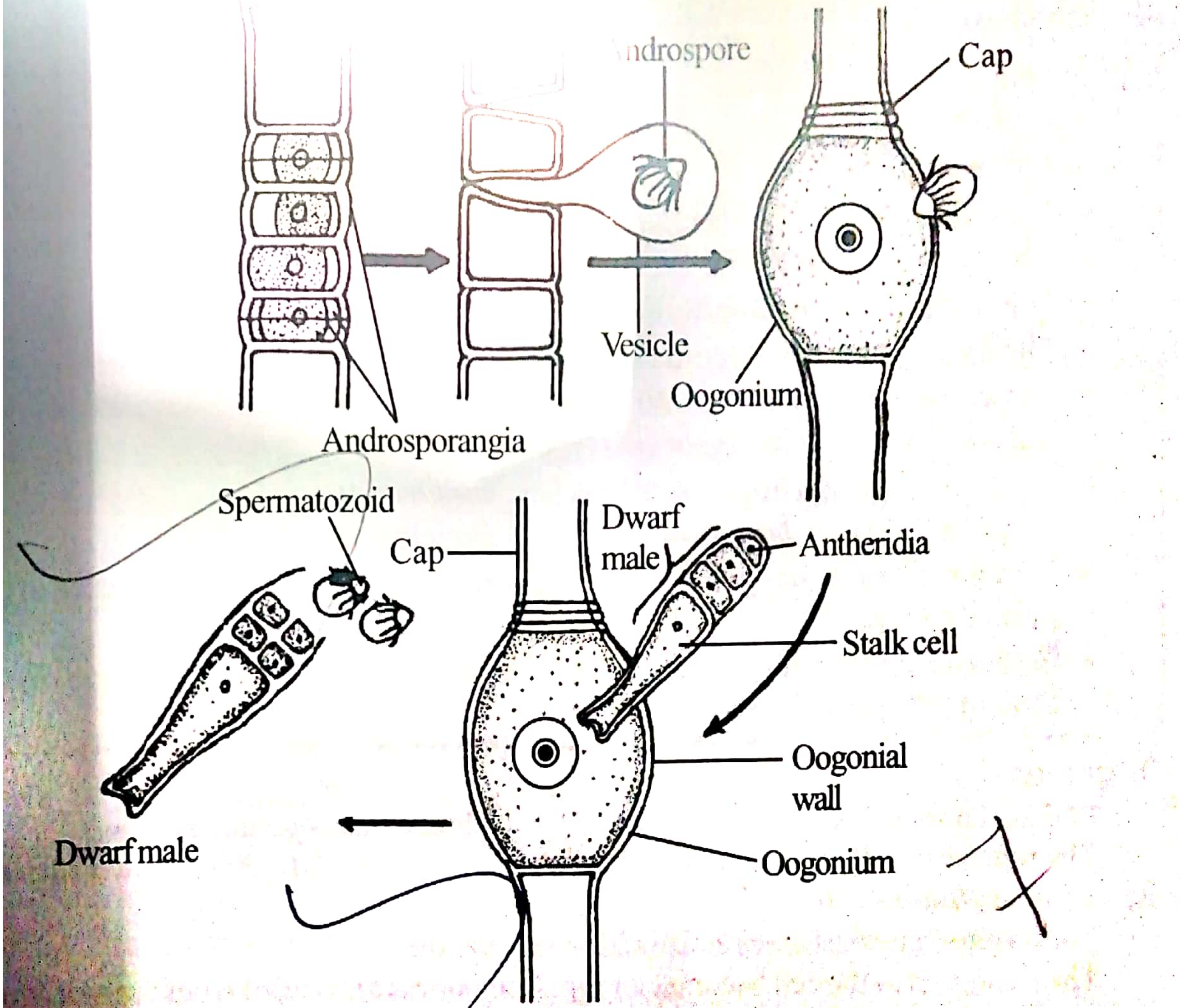


Fig.10.8: Oedogonium - Development of nannandrium and formation of sperms.

Each nannandrium consists of a basal ***stalk cell*** and one or two ***antheridia***.

The protoplast of the antheridium divides ***mitotically*** into two daughter protoplasts.

Each daughter protoplast develops a ring of many flagella at one end and forms a ***ultiflagellate sperm*** or ***antherozoid***.

The sperms come out of the antheridium by the rupture of antheridial wall. They swim in ater in search of an oogonium.

Highlights

Nannandrous Species

- ***The species of Oedogonium that produces antheridium in small dwarf male filament is called nannandrous species.***
- The dwarf male filament is called ***nannandrium***.
- It develops from the ***androspore***, formed in ***androsporangium*** of normal filament.
- The androspore gets attached either with ***oogonium*** or ***supporting cells***. Here the androspore germinates into the dwarf male filament.

- The dwarf male consists of a *stalk cell* and an *antheridium*.
- There may be one or two *antheridia*.
- Each antheridium develops into two *sperms*.
- The sperms come out by the rupture of the antheridial wall.
- The sperm fuses with the egg of oogonium to form a *diploid zygo*
- The zygote develops into the *oospore*.
- The nucleus of oospore divides ***meiotically*** to form four *haploid n*
- The haploid nucleus becomes a *zoospore*.
- The zoospore germinates into a new plant.
- Nannandrous species are of ***two*** types:
    - *Gynandrosporous species (monoecious)*
    - *Indiandrosporous species (dioecious)*
- In ***gynandrosporous species***, androsporangia and oogonia are produ same filament.
- In ***idiandrosporous species***, androsporangia and oogonia are produ separate filaments.

Oogonium

Oogonium is the female sex organ and it is produced in the ***oogonial filament***.

The vegetative cell divides transversely into an upper ***oogonial cell*** and a lower *ing cell* or ***suffultory cell***.

The oogonial initial enlarges in size and becomes round.

The protoplast of the cell becomes an egg. A colourless area called ***receptive spo*** ops at the lateral side of the oogonium.

Towards maturity, the oogonial wall at the receptive spot produces a ***mucilage***

Fertilization

The sperms coming from the nannandrium move towards the oogonium and enter gonium through a pore of oogonial wall. One sperm fuses with the egg to form a ***diploid*** The zygote secretes a thick wall to form an ***oospore***.

Germination of Oospore

After a period of rest, the diploid nucleus of the oospore undergoes ***meiosis*** to for ***haploid nuclei.***

Each nucleus is surrounded by cytoplasm to form a ***haploid, multiflagellate zo***

The zoospores germinate into new ***haploid filaments.***

Conclusion

The life cycle of *Oedogonium* is ***haplontic type***.

The plant is ***haploid***. It reproduces vegetatively by ***fragmentation***. Asexually it duces by ***multiflagellate zoospores, aplanospores*** and ***akinetes.***

The zoospores are ***haploid*** and they develop into haploid ***Oedogonium*** filaments.

Sexually it reproduces by gametes called ***sperms*** and ***egg***.

The sperms and eggs are ***haploid***. The sperm and egg fuse together to form a di ***zygote.***

...es *meiosis* to form four ***haploid zoospores***. These zoospores germi-
...*ments*.

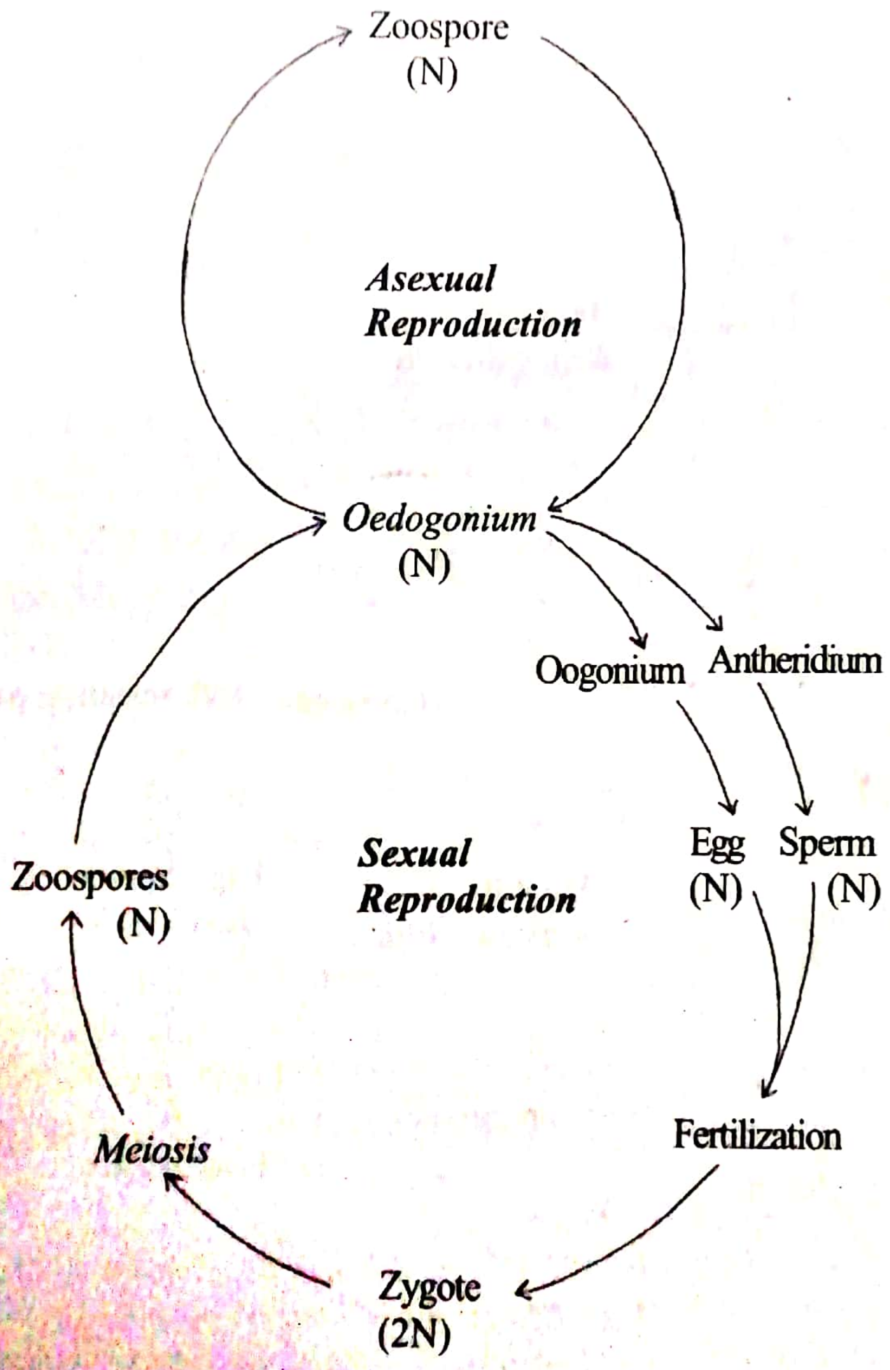
...*oid* plant is the dominant phase and the ***diploid phase*** is represented only ...herefore, the life cycle of *Oedogonium* is called ***haplontic type***.

Life Cycle of Oedogonium

...*gonium* is a ***green alga***. It is placed in the class ***Chlorophyceae***. It is widely distrib-...*sh water habitats* like *ponds, lakes, tanks* and *rivers*.

...und attached to *rock, wood* or *aquatic* plants. The mature thalli float freely on the ...water.

...lant is a ***haploid gametophyte*** (N). It is an ***unbranched uniseriate filament*** ...of a row of ***cylindrical cells***. These cells are longer than the breadth. Some cells ...*like thickenings* called ***cell caps***.



10.9: Oedogonium - Life cycle in Macrandrous monoecious species.

The apical cell is ***acute*** or ***rounded***. The basal cell of the filament is modified ... The holdfast has many finger-like projections called ***haptera*** at its lower end. ... filament on the substratum. The mature filament has a few ***swollen oogonia*** and a fe...

The cell is ***eukaryotic*** and ***cylindrical***. The protoplasm contains a ***reticulate*** ... a ***nucleus*** and a ***vacuole***. The intersections of the reticulate chloroplast have a sing...

The nucleus is ***large*** and ***spherical***. It has one or a few ***nucleoli***.

The chloroplast contains ***chlorophyll -a*** and ***-b***, ***carotenes*** and ***xanthophyll*** ... the reserve food. It occurs as starch plates around the pyrenoids.

The growth takes place by the ***division of intercalary cells*** of the filament ... formed on one of the daughter cells in each division. This is a peculiar feature of O[illegible]

Oedogonium reproduces by ***three*** methods:

Vegetative reproduction

Asexual reproduction

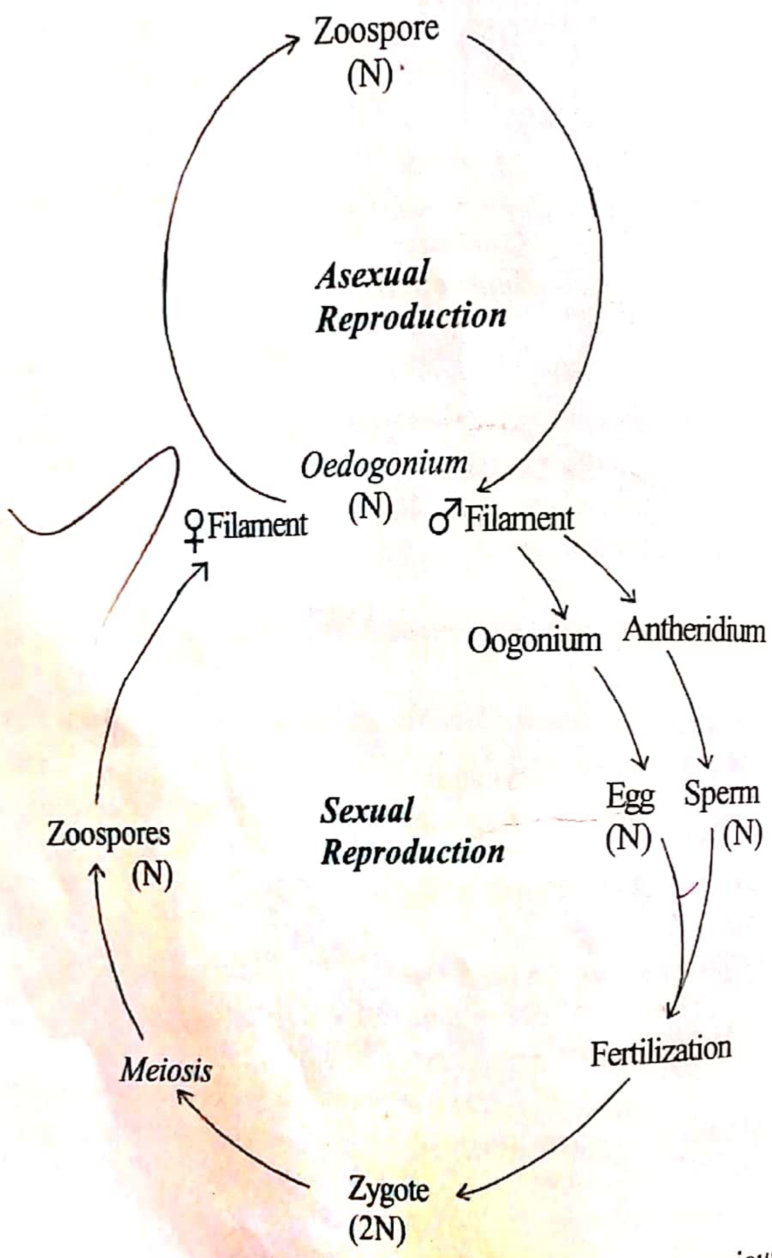


Fig.10.10: Oedogonium - Life cycle in Macrandrous monoecious specie[illegible]

Sexual reproduction.

The vegetative reproduction takes place by ***fragmentation***. The filament breaks into small fragments, each of which then develops into a new plant.

The asexual reproduction takes place by:

Zoospores

Aplanospores

Akinetes.

The zoospores are ***motile, uninucleate*** and ***multiflagellate.*** They are produced in ***zoosporangia***. The protoplast of the zoosporangium ***contracts*** slightly and becomes ***pear-shaped***.

A colourless ***cytoplasmic dome*** develops at one end of the protoplast.

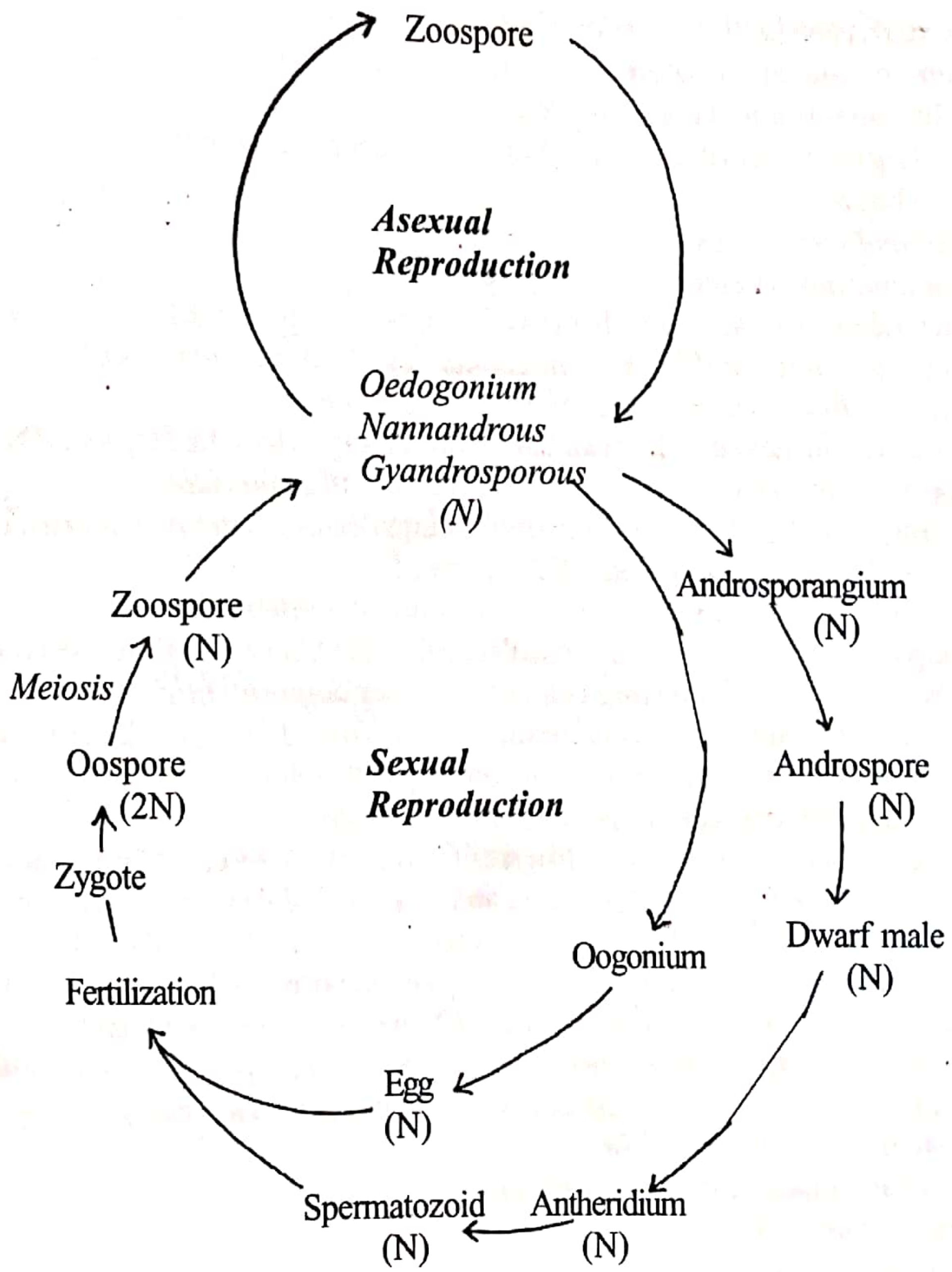


Fig.10.11: Oedogonium sp.: Graphic life cycle of nannandrous gynandrosporous species.

Then a ring of many flagella develops around the cytoplasmic dome. This type of arrangement is called ***stephanokont type***. The resulting ***multiflagellate cell*** is called ... or ***stephanokonton***.

Each zoospore contains a ***reticulate chloroplast,*** a ***haploid nucleus*** and ... ***reserve food***. As the wall of the zoosporangium ruptures, the zoospore comes out and ... water, later it ***germinates*** into new gametophytic plant (N).

Aplanospores are ***non-motile, non-flagellate spore*** produced in ***aplanospo...*** They are produced during dry season. During the favourable season, they germinate in... plants.

Sometimes, the vegetative cell ***stores plenty*** of ***reserve foods*** and ***secretes a thi...*** around it. This thick walled cell is called ***akinete***. During favourable season, it germinates ... new filament.

The sexual reproduction in *Oedogonium* is ***oogamous type***. The male sex organ is ... ***antheridium*** or ***male gametangium***. It produces ***sperms*** or ***antherozoids***. The female organ is called ***oogonium***. It contains a ***haploid egg***.

Depending on the distribution of sex organs, all species of *Oedogonium* are divided ... two groups. They are:

Macrandrous species

Nannandrous species.

In macrandrous species, the antheridia and oogonia are produced in the ***normal fila...*** Some species are ***homothallic*** or ***monoecious***. Eg. *Oedogonium nodulosum*. A few ... ***heterothallic*** or ***dioecious***. Eg. *Oedogonium aquaticum*.

The antheridium develops from ***apical*** or ***intercalary cell*** of the filament. The vege... cell, by repeated transverse divisions, forms a row of ***2-40 antheridia***.

The protoplast of each antheridium divides into ***two daughter protoplasts***. Each pr... plast metamorphoses into a ***multiflagellate sperm.***

The sperms are released in water by the rupture of ***antheridial wall.***

The oogonium develops from an intercalary cell of the filament. The vegetative cell di... transversely into a lower ***supporting cell*** and an upper ***oogonial initial***.

The ***oogonial initial*** enlarges in size and becomes round. Its protoplast contracts sli... to form an egg. A colourless spot called ***receptive spot*** develops at the lateral side of the ... The oogonial wall at the receptive spot forms a ***pore*** or ***slit***.

The released sperms are attracted towards the oogonium by chemostatic attraction ... sperm enters the oogonium through the pore and fuses with the egg at the receptive spot. ... result a diploid zygote is formed. The zygote secretes a thick wall around it to form an *oosp...*

In ***nannandrous*** species, oogonia are produced in normal ***filaments***, but antheridi... produced in small filaments called ***dwarf male filaments*** or ***nannandrium***.

Here, the normal filament produces a special type of zoospores called ***androspores*** ... stead of producing sperms. The androspores look like ***zoospores***. They germinate into s... ***dwarf filaments*** called ***nannandria***.

The nannandrous species are of two types:

Gynandrosporous species

Idiandrosporous species.

In ***gynandrosporous*** species, androsporangia and oogonia are produced in the same ... ment. Eg. *Oedogonium concatenatum*.

In ***idiandrosporous*** species, androsporangia and oogonia are produced in two separate filaments. Eg. *Oedogonium iyengarii*.

The androspore germinates into a ***nannandrium***. The nannandrium consists of a ***few-celled filament*** and a basal ***rhizoidal cell***.

The cells of the filament are ***smaller*** in size. The protoplast of the vegetative cell divides into ***two daughter protoplasts***. These protoplasts metamorphose into ***multiflagellate sperms.*** The sperms are released free in water.

The structure and the development of oogonium are similar to those of oogonium of macrandrous species. The released sperms enter the oogonium and fuses with the egg to form a ***diploid zygote*** (2N). The zygote secretes a thick wall to form an ***oospore***.

After a period of rest, the protoplast of oospore divides ***meiotically*** into four ***haploid, multiflagellate zoospores***. These zoospores germinate into ***new filaments (N).***

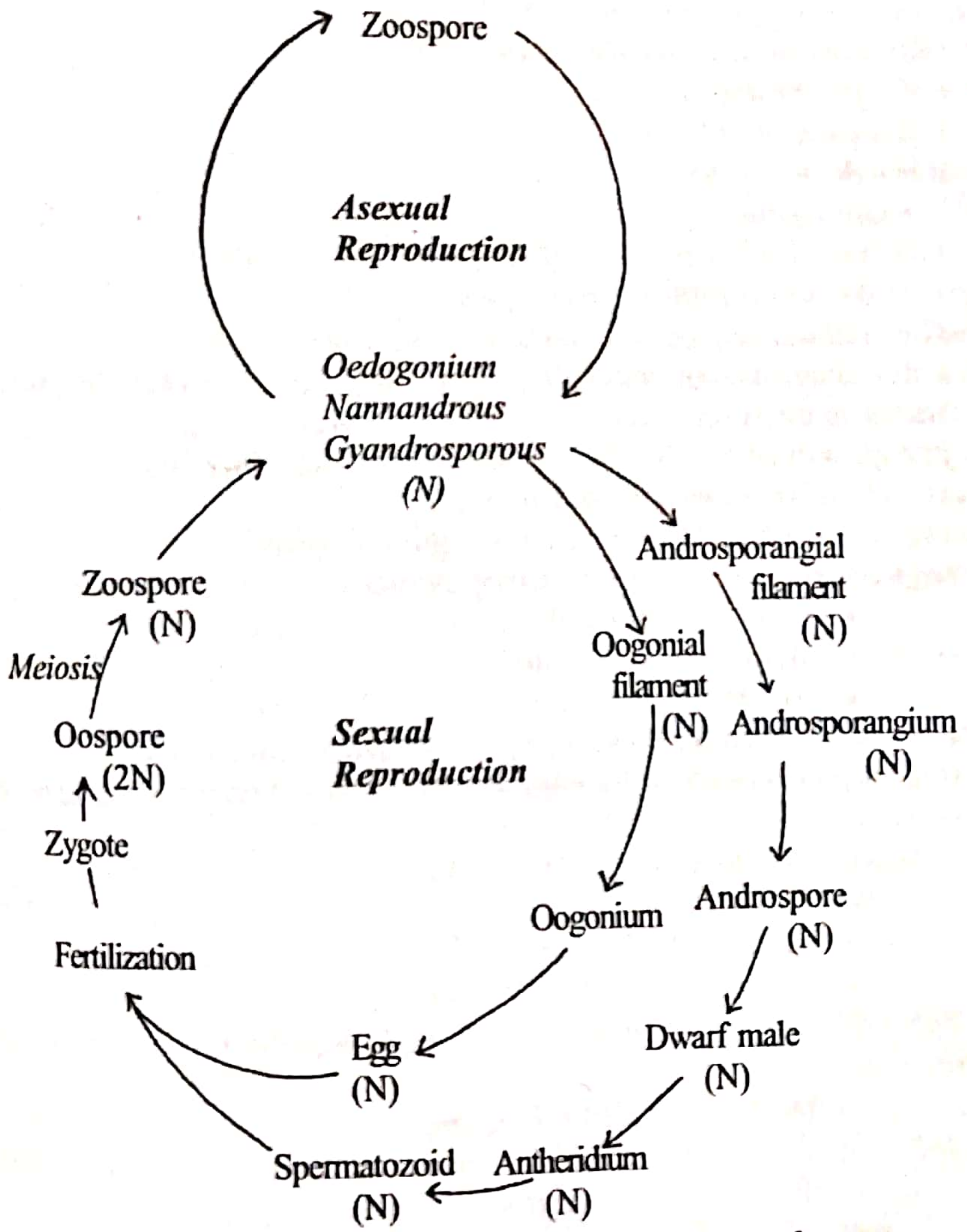


Fig.10.12: Oedogonium sp.: Graphic life cycle of nannandrous idioandrosporous species.

Conclusion

The life cycle of *Oedogonium* is ***haplontic type***. The vegetative thallu
Vegetatively, it reproduces by ***fragmentation***. Asexually, it reproduces b
aplanospores and ***akinetes***. Sexually, it reproduces by means of gametes calle
eggs. As a result of the fusion of these gametes, a ***diploid zygote*** (2N) is formed
undergoes ***meiosis*** and forms ***four haploid zoospores***. These zoospores germin
loid filaments.

Here, the haploid phase is dominant and the diploid phase is represented onl
The life cycle of *Oedogonium* is called ***haplontic type.***

Highlights

Life Cycle of *Oedogonium*

- *Oedogonium* is an ***unbranched filamentous green alga***.
- It is a ***freshwater*** alga.
- It is an ***attached form***.
- It is a ***filamentous alga***.
- It is ***eukaryotic***.
- The thallus consists of a long ***filament*** and a ***holdfast***.
- The filament is ***unbranched***.
- The holdfast attaches the filament to the substratum.
- The cell consists of ***cell wall, plasma membrane*** and ***protoplasm***.
- ***Starch*** is the reserve food.
- The growth takes place by the division of intercalary cells.
- The plant is a ***haploid gametophyte***.
- The life cycle of *Oedogonium* is ***haplontic type***.
- *Oedogonium* reproduces by ***three*** methods:
    - *Vegetative reproduction*
    - *Asexual reproduction*
    - *Sexual reproduction.*
- ***Vegetative reproduction*** takes place by ***fragmentation***.
- In ***fragmentation***, the filament breaks into small fragments and they g
into new plants.
- ***Asexual reproduction*** takes place by -
    - *Zoospores*
    - *Aplanospores*
    - *Akinetes.*
- ***Zoospores*** are ***motile, uninucleate, multiflagellate*** spores produced in
zoosporangia.
- Zoospore germinates into a new gametophyte.
- ***Aplanospore*** is a non-motile, non-flagellate, uninucleate cell. It comes o
the aplanosporangium and germinates into a new plant.
- ***Akinete*** is a non-motile thick walled cell and it g
filament during favourable season.