KINGDOM PROTISTA

- **Ernst Heackel** coined the term **Protista**.

General Characters:

- **(i)** They are **unicellular, eukaryotic organisms** mostly found in aquatic habitat (sometimes colonial).
- **(ii)** They bear well defined nucleus. Protists can be uninucleate, binucleate or multinucleate.
- **(iii)** Locomotion takes place by **flagella, cilia,** pseudopodia, contractions or by mucilage extrusion.
- **(iv)** Cyclosis or cytoplasmic streaming is found in cytoplasm.
- **(v)** Cell wall, may be present or absent.
- **(vi)** Mode of nutrition is of various types – **Holophytic (Photosynthetic), ingestive (=Holozoic), absorptive (parasitic, saprobic).**
- **(vii)** **80% of the photosynthesis on earth is performed by photosynthetic protists**.
- **(viii)** Reserve food is **starch, glycogen, paramylum, chrysolaminarin and fat.**
- **(ix)** Flagella and cilia, when present, have 9 + 2 pattern of microtubular strands.
- **(x)** The common mode of reproduction is asexual reproduction. The latter occurs through binary fission, budding, plasmotomy, sporulation, cyst formation etc.
- **(xi)** Sexual reproduction involves meiosis and karyogamy. Meiosis is zygotic in some forms and gametic in others.
- **(xii)** Members of protista are primarily aquatic.
- **(xiii)** This kingdoms forms a link with the other Kingdoms dealing with plants, animals and fungi.
- **(xiv)** Kingdom protista includes **Chrysophytes, Dinoflagellates, Euglenoids, Slime moulds and Protozoa.**

(I) Photosynthetic protists:

It involves three types

(1) Chrysophytes **(2) Dinoflagellates** **(3) Euglenoids**

(1) Chrysophytes/Bacillariophytes:

These are commonly called **Jewels of plant Kingdom. The division chrysophyta includes diatoms & desmids (golden algae)**

General Characters:

- **(i)** Diatoms are found in fresh water (mainly desmids) as well as marine (mainly diatoms) environment. Most of the diatoms are phytoplanktons.
- **(ii)** Most of **Diatoms** are **photosynthetic protists** (Chief producers in the oceans).
- **(iii)** Float passively in water currents (plankton) due to **stored fat**. Flagella are absent in somatic phase.
- **(iv)** The reserved food is **oil and chrysolaminarin or leucosin** (a polysaccharide). Proteinaceous volutin globules are also present.
- **(v)** The body is covered by **two thin overlaping transparent siliceous shell (**called **frustule)** which fit together as in a soap box. (The walls are embedded with silica and thus the walls are indestructible).

(vi) The cell wall is composed of two halves, upper larger and older half or **epitheca** and a lower smaller and younger half or **hypotheca**.

(vii) The most common mode of multiplication is **binary fission (cell division)**. In this process, each daughter cell retains one half of the parent cell (epitheca) and the other half is synthesized (Hypotheca)

(viii) Binary fission reduces the size of daughters due to retention of one valve of the parent. It is restored by the development of **zygote or rejuvenescent cells or auxospores (sexual spores)**.

(ix) Sexual Reproduction varies from **isogamy to oogamy** and is connected to a reduction in diatom cell size in order to restore them to their original size. It takes place by the fusion of gametes and auxospore formation.

(x) Since the diatoms are diploid (2N) in nature so they participate in gametic meiosis.

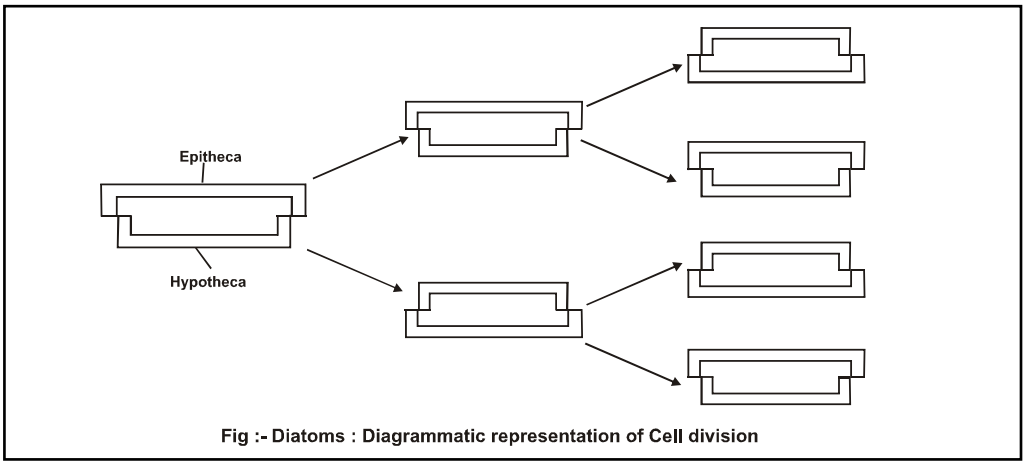


Fig :- Diatoms : Diagrammatic representation of Cell division

(xi) They bear plate like or discoid chromatophore having **Chl a, Chl c, carotenes, fucoxanthin,** diadinoxanthin and diatoxanthin pigments.

(xii) Due to the presence of different types of pigments, the colour of diatoms may be yellow, brown or green. Hence these are called **golden brown algae**.

(xiii) On the basis of symmetry, diatoms are of two types– **(a) Pennate–bilateral symmetry e.g.** *Navicula, Pinnularia* **(b) Centric–radial symmetry e.g.** *Melosira.*

(xiv) There is a single large nucleus which is commonly suspended in the central vacuole by means of cytoplasmic strands.

(xv) Some marine diatoms form uniflagellate motile gametes.

(xvi) During unfavourable condition resting spores called as statospores are formed.

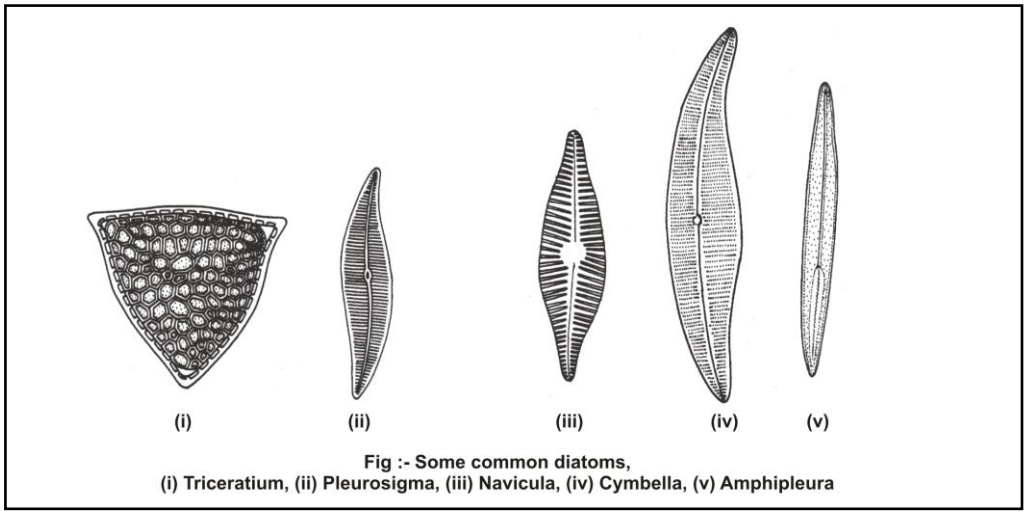


Fig :- Some common diatoms,
(i) Triceratium, (ii) Pleurosigma, (iii) Navicula, (iv) Cymbella, (v) Amphipleura

Economic importance:

- **(i)** Siliceous shells of diatoms do not deccay but pile up and forms heaps called **diatomaceous earth or diatomite or kiselgurh.** The latter is used as insulation material in refrigerators, boilers and furnaces.
- **(ii)** Diatomite is also used as cleaning agent in tooth pastes and metal **polishing.**
- **(iii)** Diatomite is porous and chemically inert. Therefore, it is used in **filtration of oil, syrup,** alcohols and antibiotics.
- **(iv)** Diatoms are chief **producers of oceans in the form of phytoplanktons** and they are major sources of food to aquatic animals.
- **(v)** Diatomaceous earth is used to make **sound proof rooms**.
- **(vi)** The oils extracted from some fishes and whales are actually the ones produced by diatoms.
- **(vii)** They are good indicator of water pollution (their presence indicate clean water).

(2) Dinoflagellates: Armoured algae / Night light.

- These are motile golden brown photosynthetic protists they belong to the phylum Pyrrophyta and class **Dinophyceae**.

General Characters:

- **(i)** These organisms are aquatic, **mostly marine**, photosynthetic, unicellular eukaryotes.
- **(ii)** The cell is covered by stiff cellulose plates called **theca or Lorica**. Because of the presence of sculptured plates of cellulose, the protists are called **armoured dinoflagellates**.
- **(iii)** They bear two grooves. Out of them one is **transverse cingulum or annulus or girdle** and other is **longitudinal sulcus.** The two flagella are different or **heterokont**. Smooth flagellum lies posteriorly in a longitudinal groove while ribbon like transverse flagellum lies in a transverse groove thus in dinoflagellatges two flagella lie at right angles to each other and show peculiar spinning movement. Hence, they are called **whirling whips**.
- **(iv)** They are **Mesokaryotes (term coined by Dodge)** having large nucleus with nuclear membrane and has **condensed chromosomes** even in the **interphase**. **Histone is absent**.
- **(v)** They appear yellow, green, brown and blue or red depending on the main pigments present in their cells (Pigments involve **chl a, chl c, fucoxanthin rich carotenoids** in chromatophores).

Note : Nutrition is mainly holophytic but Noctulica - Holozoic, Ceratium - Mixotrophic

- **(vi)** Noncontractile vacuole is present for osmoregulation called **pusule**.
- **(vii)** Some dinoflagellates show **bioluminescence (due to luciferin protein) and called fire algae e.g. Noctiluca (Night light), Pyrocystis.**
- **(viii)** Very often, red dinoflagellates (e.g. ***Gonyaulax****, Gymnodinium, Ceratium, Taceratium)* undergo such rapid multiplication that they make the sea appear red **(red tides)**.
- **(ix)** In dinoflagellates division occurs through **dinomitosis** in which nuclear envelope and nucleolus persists. Spindle is not formed. And it is replaced by cytoplasmic microtubules.
- **(x)** Nutritionally they are autotrophic except some forms.
- **(xi)** **Reserve food is starch and oil**.
- **(xii)** Reproduction takes place mostly by asexual methods. Like zoospores, cysts formation.
- **(xiii)** Sexual reproduction has been observed in some dinoflagellates (Ceratium). **Zygotic meiosis** is observed in them **e.g.** Life cycle of **Ceratium** is **haplontic** but exceptionally cell of Noctiluca is diploid thus **gametic meiosis** takes place in **Noctiluca** during reproduction and life cycle is **diplontic**.

- **(xiv)** Many dinoflagellates release neurotoxins like Sexitoxin (e.g. Gonyaulax), when they are eaten by mussels and the toxin accumulate in them. When mussels are eaten by man, toxin cause Paralytic Shellfish Poisoning (PSP)

(xv) Some dinoflagellates bear trichocysts. Cnidoblasts have been reported in some dinoflagellates.

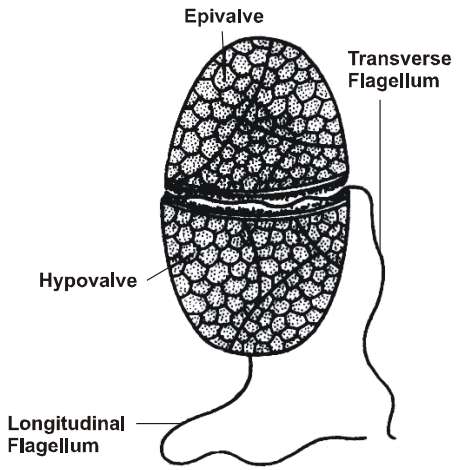
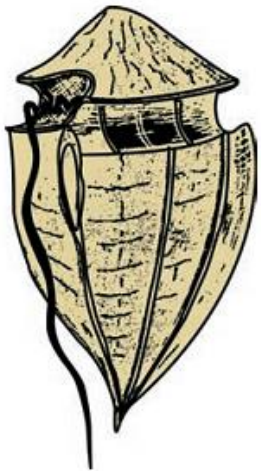


Fig.: Dinoflagellates



NCERT Diagram

(3) Euglenoids:

Euglena is considered as connecting link between Plant kingdom & Animal kingdom because it shows features of both plants and animals.

General characters

- **(i)** Majority of them are fresh water organisms found in stagnant water.
- **(ii)** Cell wall is absent and they have a protein rich layer called **pellicle** which makes their body flexible.

(iii) Chloroplast contains pigments similar to higher plants like **Chl. a, Chl. b, and xanthophyll (zeaxanthin)**.

(iv) They have two flagella (tinsel flagella), a short and a long one. Out of them one is reduced while second flagellum is long and seems to have two branches at the base with each of which having its own basal granule.

- **(v)** **Nutrition:** They are **mixotrophic**. **e.g. Euglena**, They show both **holophytic and holozoic nutrition**. Though they are photosynthetic in the presence of sunlight (holophytic), when deprived of sunlight they behave like heterotrophs (holozoic) by predating on other smaller organisms.

(vi) **Contractile vacuole** is found fixed in the anterior part of the cell below the reservoir for osmoregulation.

- **(vii)** The reserve food is **paramylum** as **paramylum granules** that is stored in the cytoplasm instead of chloroplasts. Paramylum granules are polysaccharide, β-1, 3 glucan.

(viii) They performs multiplication by **longtiudinal binary fission** in favourable conditions and by cyst formation in unfavourable conditions. Sexual reproduction has not yet been definitely proved.

(ix) **Movement in euglenoids:** Flagellated Euglenoids perform movements by flagella while non Flagellated Euglenoids perform wriggling movement with the help of pellicle. It is called **euglenoid movement or metaboly.**

(x) The flagellum bears a swelling at the area of union of two branches, called **paraflagellar body** or photoreceptor. **Stigma or eye spot** lies on the membrane of resevoir at the level of paraflagellar body. The former and the latter are the sites receiving light stimulus.

(xi) The apical end has invagination containing three parts-Cytostome (mouth), Cytopharynx (canal) and reservoir.

(xii) Single large nucleus is found in the middle part of the cell.

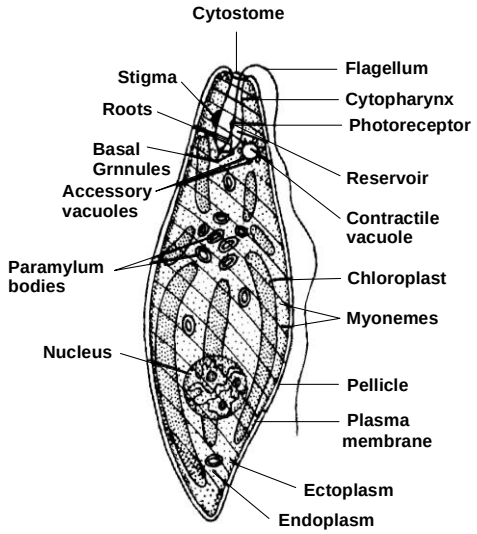


Fig:- Euglena : Ultrastructure

Euglena			
S.No.	**Plant like characters**	**S.No.**	**Animal like characters**
1	Presence of chloroplasts with chlorophyll.	1	Presence of proteinaceous pellicle / Absence of cell wall
2	Holophytic nutrition.	2	Presence of paraflagellar body and stigma.
		3	Presence of contractile vacuole.
		4	Reproduction by longitudinal binary fission.

(4) Slime Moulds: Protistian fungi / False fungi.

- Initially some biologists placed the slime moulds in **mycetazoa** alongwith animals. However, many mycologists placed them under fungi in the sub-division **Myxomycotina** and the class **Myxomycetes**. Modern biologists keep them in class **Gymnomycota of kingdom protista** due to their protistan nature.

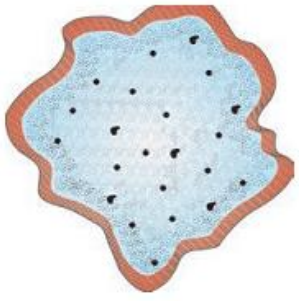


Fig. Slime Moulds

General characters:

- **(i)** Cell wall is absent (Animal like character) around somatic cell but spores have cellulosic cell wall (true walls)
- **(ii)** The protoplasts are covered by plasmalemma.
- **(iii)** Slime moulds are saprophytic protists **(phagotrophic nutrition)**. The body moves along decaying twigs and leaves engulfing organic material (Pseudopodia like structure present).
- **(iv)** The reserve food is **Glycogen and oil.**
- **(v)** Reproduction takes place through both asexual and sexual methods.
- **(vi)** Under **suitable conditions**, they form an aggregation called **plasmodium** which may grow and spread over several feet.
- **(vii)** During **unfavourable conditions**, the plasmodium differentiates and forms **fruiting bodies** bearing spores at their tips (Sexual reproduction).
- **(viii)** **Spores** are extremely resistant and survive for many years, even under adverse conditions due to cellulosic cell wall. The spores are dispersed by air currents.

- On the basis of structure slime moulds are of two types.

Acellular Slime Moulds		Cellular Slime Moulds	
1.	Diplontic life cycle and gametic meiosis.	1.	Haplontic life cycle and zygotic meiosis.
2.	Body is multinucleatid plasmodium	2.	Uni-nucleated pseudoplasmodium / Myxomoeba.
3.	holocarpic and Polycentric	3.	Holocarpic and monocentric
4.	**e.g.** *Physarum*		**e.g.** *Dictyostelium*

Resonate the Concept

- The cellular slime moulds bear features of both plants and animals. Absence of cell wall in vegetative phase and feeding like amoeba are animal like characters while the reproductive phase is plant-like as the spores have a cell wall composed of cellulose.
- Cellular slime moulds are more advanced protists because of division of labour.

(5) Protozoa: Protistian animal.

- Protozoans were first studied by - Leeuwenhoek.
- Term protozoa coined by - Goldfuss.
- Study of protozoans - Protozoology.

General characters

- **(i)** Whittaker included all the protozoan in a separate Kingdom- Protista, alongwith all other eukaryotic unicellular micro-organisms.
- **(ii)** One celled body performed all the biological activities like multicellular animals. So, they are termed as "Acellular " organism. (Physiological division of labour is found).
- **(iii)** **Habitat -** They are world wide (Cosmopolitan), mostly microscopic, Aquatic, terrestrial, free living (Amoeba) or parasitic (Plasmodium), solitary or colonical (Proterospongia).
- **(iv)** **Nutrition -** All protozoans are **heterotrophs & live as predator or parasite**. Mainly holozoic (*Amoeba*), Parasitic (*Plasmodium*), sporozoic & Digestion is intracellular take place in food vacuole
- **(v)** They are believed to be primitive relatives of animals.

(vi) Body level of organization - Protoplasmic level.

(vii) Body form - Their protoplasm is uninucleated or multinucleated, animals are naked or some have body bounded by delicate membrane or a firm pellicle / Test / Shell (loose outer covering). e.g, Forminiferans). In few groups of protozoa $CaCO_3$ & Silica shell's exoskeleton is found. e.g., Radiolarian group & Foraminiferan group.

(viii) Locomotion -

- Finger - like Pseudopodia e.g. *Amoeba*
- Whip like Flagella e.g. *Trypanosoma*
- Hairy cilia. e.g. *Paramecium*
- By Gliding e.g, *Monocystis*

Note: Locomotory structures are absent in the parasitic forms belonging to sporozoa group.

(ix) Respiration - Take place by exchange of gases through body surface.

(x) Excretion - Nitrogenous waste is **Ammonia**. Some excretion may occure through - **contractile vacuole**. Some fresh water protozoans get rid of excess water through contractile vacuole known as **osmoregulation**. *Amoeba* has one and paramecium has two contractile vacuoles.

(xi) Reproduction -

Asexual

1. **Binary fission-**
   (a) Irregular - *Amoeba*
   (b) Transverse fission - *Paramecium*
   (c) Longitudinal fission - *Trypanosoma*
   (d) Oblique fission - *Ceratium*
2. **Multiple fission -** *Plasmodium*.

Sexual

1. Syngamy - *Plasmodium*
2. Conjugation - *Paramecium* - interchange genetic material.

- Some members also form cyst which helps in reproduction under unfavourable condition. They are considered as **immortal** i.e. do not have natural death because there is no division of somatoplasm and germplasm.

Classification

1. **Rhizopoda (Amoeboid protozoans):**
   These organisms live in fresh water, sea water or moist soil. They move and capture their prey by putting out pseudopodia (false feet) as in *Amoeba*. Marine forms have silica shells on their surface.

- ***Amoeba*** - Free living, fresh water (Amoeba proteus have flattened discoidal and biconcave nucleus).

  Note - Cytoplasm of amoeba show continous change in viscosity in cytoplasm (a) Sol to gel (at advanced end) and (b) Gel to sol (posterior end). Posterior end of amoeba is characterised by lack of food vacuole.

- ***Entamoeba histolytica*** - Amoebic dysentery; Contractile vacuole absent.

  Entamoeba gingivalis - Pyorrhoea

  Foraminiforans - *Globegerina, Euglypha*

  Heliozoans - *Actinophrys* (Sun animalcule)

2. **Flagellata** *(Flagellated protozoans) :* The members of this group are either free-living or parasitic. They have flagella.

- ***Trypanosoma*** – Sleeping sickness (caused by *T. gambiense*) and Chagas disease (caused by *T. cruzi*) spread by Tse-Tse fly - *Glossina palpalis.*
- ***Leishmania*** – Kala azar (caused by *L. donovani*) and oriental sore (caused by *L. tropica*) spread by send fly - *Phlebotamus*
- ***Giardia*** – Giadiasis
- ***Trichomonas*** – Trichomoniasis (characterized by whitish, frothy vaginal discharge in human females)
- ***Lophomonas*** – Symbiont in the gut of termite, for cellulose digestion
- ***Trichonympha*** – Symbiont in the gut of termite, for cellulose digestion
- ***Proterospongia*** – Connecting link between protozoa and porifera

3. Ciliata *(Ciliated protozoans):* These are aquatic, actively moving organisms because of the presence of thousands of cilia. They have a cavity (gullet) that opens to the outside of the cell surface. The coordinated movement of rows of cilia causes the water laden with food to be steered into the gullet.

- ***Balantidium*** – Diarrhoea in humans
- ***Paramoecium*** – Slipper animalcule (nuclear dimorphism present)
- ***Opalina*** – In rectum of frog
- ***Nyctotherus*** – In rectum of frog
- ***Vorticella*** – Bell animalcule
- ***Didinum*** – Water bear

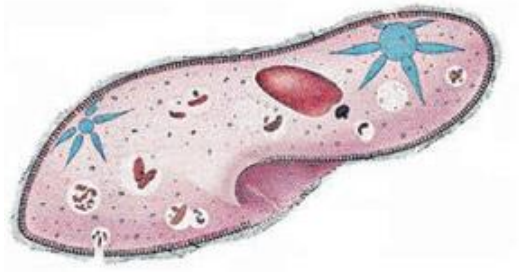


Fig. Paramoecium

4. Sporozoa *(Sporozoans) :* This includes diverse organisms that have an infectious spore-like stage in their life cycle.

- ***Plasmodium*** – Malaria in humans
- ***Nosema*** – Pebrin disease in silk moth
- ***Babesia*** – Red water fever in cattle
- ***Eimeria*** – Coccidiosis in rabbit
- ***Monocystis*** – Endoparasite of coelomic epithelial cells and seminal vesicles of earthworm