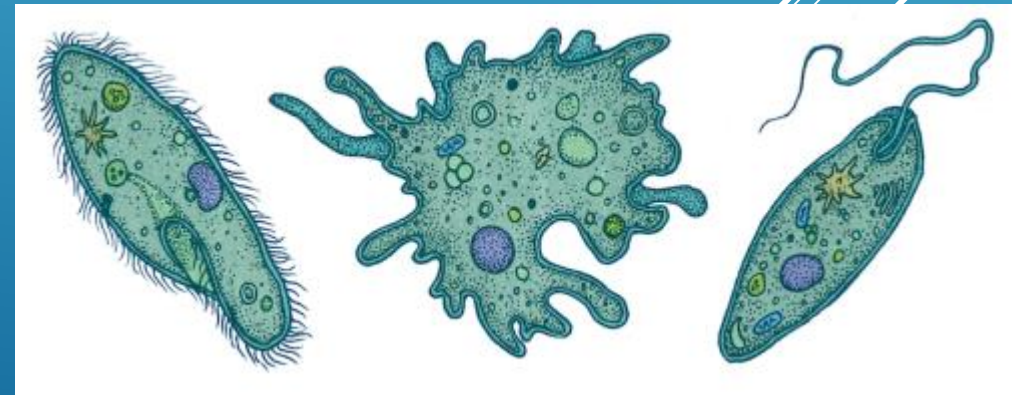


# Lecture No.B1MICP1U5.1

## General Characteristics and Classification of Algae and Protozoa

### VOLUME -3- General Characters and Classification of Protozoa

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Term Protozoa (From Greek, **protos** meaning **first**, **zoon** meaning **animals**) was given by **Goldfuss**.

According to five-kingdom classification system, protozoans belong to the phylum Protozoa of kingdom **Protista**

### **General characteristics:**

The protozoans are minute, generally microscopic and eukaryotic organisms. They are the simplest and primitive of all the animals with very simple body organization, i.e. **Protoplasmic grade** of organization. They are **unicellular** organisms without tissues and organs.

## Habit and habitat:

They may either be **free-living** (inhabiting fresh water, salt water or damp places) or **parasitic** (living as ecto- or endoparasites). Some are **commensals** in habit.

Body is either naked or covered by a **pellicle** (plasmalemma or theca or lorica).

Protozoans are either **solitary** or **colonial**; in colonial forms, the individuals are alike and independent.

## Cell structure:

Body shape is variable; it may be spherical, oval, elongated or flattened.

They are usually **asymmetrical** but *Giardia* is **bilaterally symmetrical**.

The protoplasm is differentiated into outer **ectoplasm** and inner **endoplasm**.

They may have one or more nuclei.

Nucleus may be **monomorphic** or **dimorphic**, **vesicular** (e.g. *Entamoeba*) or massive (e.g. *Amoeba*).

Vesicular nucleus is commonly spherical, oval or biconvex.

Dimorphic nuclei are found in **Ciliata**, one larger **macronucleus** (with **trophochromatin**) and other small **miconucleus** (with **ididochromatin**).

## Life processes:

There is **no physiological division of labor** and all the vital activities of life are performed by a single cell.

Nutrition may be **holozoic** (animal like), **holophytic** (plant like) **sporozoic** or **parasitic**.

\*In **Euglena**, the mode of nutrition is mixotrophic (both holozoic and holophytic).

Digestion takes place inside the food vacuoles, i.e. **intracellular**.

Respiration occurs by **diffusion** through general body surface.

Excretion occurs through general body surface like respiration.

They are **ammonotelic** (excrete nitrogenous waste product in the form of ammonia).

In some forms, egestion occurs through a temporary opening in the ectoplasm or through permanent opening called **Cytopyge**.

**Contractile vacuoles** perform **osmoregulation** in fresh water forms and also help in removing excretory products.

\*Contractile vacuole is absent in marine and parasitic forms

## Reproduction:

Reproduction is either sexual or asexual; **asexual binary reproduction** occurs by **fission, multiple fission, budding** or **sporulation** and **sexual reproduction** occurs by **gamete formation** or **conjugation**.

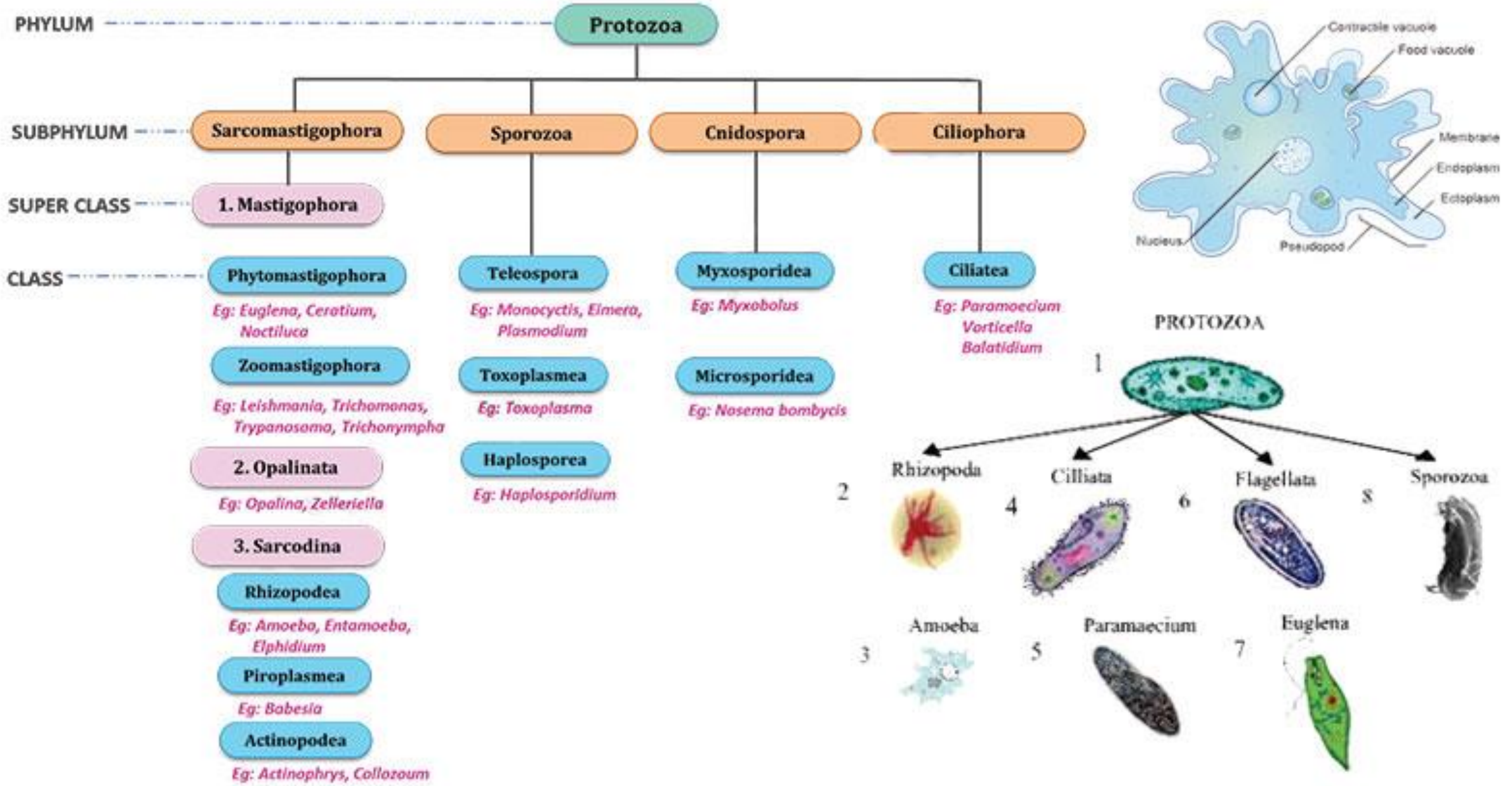
Binary fission may be simple or transverse or longitudinal or oblique.

Life cycle often exhibits alternation of generation, i.e. it includes asexual and sexual phases.

**Encystment** usually occurs to protect the cell from the **unfavorable conditions** and it also helps in dispersal.



# Classification of Phylum Protozoa



# Classification of Phylum Protozoa

The conventional scheme followed by **Hyman (1940), Hickman (1961) and Storer (1965)**, etc. recognizes two subphyla on the basis of organs of locomotion and 5 classes as follows:

## Sub Phylum A: **Plasmodroma**

Locomotory organelles are flagella, pseudopodia, or none. Nuclei is of one kind.

### **Class 1: Mastigophora**

Move by one to many flagella .Example: *Euglena*.

### **Class 2: Sarcodina**

Move and capture food by pseudopodia.Example: *Amoeba*.

### **Class 3: Sporozoa**

No locomotory organs. All parasitic.Spore-formation is common.

Example: *Plasmodium*.

## Sub Phylum B: Plasmodroma

Locomotory organelles are cilia or sucking tentacles.

Nuclei of two kinds.

### Class 4: Ciliate

Move by cilia.

Example: *Paramecium*.

### Class 5: Suctoria

Move by cilia as young and by tentacles as an adult.

Example: *Podophyra*.

**Another classification is based on the scheme given by the Committee on Taxonomy and Taxonomic Problems of the Society of Protozoologists, and mainly **proposed by BM Honigberg and others (1964)**.**

**It divides protozoa into four subphyla.**

Subphylum I: Sarcomastigophora

Subphylum II: Sporozoa

Subphylum III: Cnidospora

Subphylum IV: Ciliophora



# Subphylum I: Sarcomastigophora

Locomotory organelles are pseudopodia or flagella.

The nucleus is of a single type (monomorphic).

There is no spore formation.

Syngamy occurs in reproduction.

## Superclass A: Mastigophora

They are commonly called flagellates.

Locomotory organelles are flagella in adults.

The body is covered by a pellicle.

Binary fission is longitudinal.

They are mostly free-living though some are parasitic.

Nutrition is autotrophic or heterotrophic or both.

## Class 1: Phytomastigophorea

Chlorophyll-bearing chromatophores present.

Nutrition mainly holophytic by phototrophy.

Reserve food is starch or paramylon.

They have usually only one or two flagella

The nucleus is vesicular.

**Order 1: Chrysomonadina.** Examples: *Chromulina*, *Ochromonas*, *Dinobryon*, *Synura*, *Chrysamoeba*, etc.

**Order 2: Coccolithophorida.** Examples: *Coccolithus*, *Rhabdosphaera*, etc.

**Order 3: Heterochloride.** Examples: *Heterochloris*, *Myxochloris*, etc.

**Order 4: Cryptomonadida.** Examples: *Chilomonas*, *Cryptomonas*, etc.

**Order 5: Dinoflagellida.** Examples: *Noctiluca*, *Ceratium*, etc.

**Order 6: Euglenida.** Examples: *Euglena*, *Phacus*, *Copromonas*, *Peranema*, etc.

**Order 7: Volvocida (Phytomonadida).** Examples: *Volvox*, *Chlamydomonas*, *Eudorina*, etc.

**Order 8: Chloromonadida.** Examples: *Vacularia*, *Coelomonas*, *Gonyostomum*, etc.



## **Class 2: Zoomastigophorea**

Chlorophyll or chromatophores absent.

Mostly parasitic.

Reserve food as glycogen.

Flagella one to many.

There is an undulating membrane.

**Order 1: Choanoflagellida.** Example: *Proterospongia*.

**Order 2: Rhizomastigida.** Examples: *Mastigoamoeba*, *Dimorpha*, etc.

**Order 3: Hypermastigida.** Examples: *Trichonympha*, *Lophomonas*, *Leptomonas*, etc.

**Order 4: Diplomonadida.** Examples: *Giardia*, *Hexamita*, etc.

**Order 5: Kinetoplastida.**

**Suborder 1: Bodonina.** Examples: *Bodo*.

**Suborder 2: Trypanosomatina.** Examples: *Trypanosoma*, *Leishmania*, etc.

**Order 6: Bicosoecida** Examples: *Salpingoeca*, *Poteroiodendron*, etc.

**Order 7: Retortamonadida.** Example: *Chilomonas*.

**Order 8: Oxymonadida.** Example: *Oxymonas*, *Pyrsonympha*, etc.

**Order 9: Trichomonadida.** Example: *Trichomonas*.

## Superclass B: Opalinata

They have numerous cilia like organelles in oblique rows over the entire body surface.

There is no cytostome.

Two or more monomorphic nuclei are present.

Binary fission is interkinetal.

There is syngamy with flagellated anisogametes.

All are parasitic, mainly in frogs and toads.

Examples: *Opalina*, *Protoopalina*, *Zelleriella*, *Protozelleriella*, and *Cepedea*.

## Superclass C: Sarcodina

Locomotory organelles are pseudopodia.

The amoeboid form is predominant.

Some have a hard shell.

They generally do not form spores.

The formation of gametes and flagellated young ones are common.

Nutrition holozoic or saprozoic.

### Class 1: Rhizopodea

Locomotory organelles are pseudopodia (lobopodian or filopodia but never axopodia).

They are generally creeping forms.

#### Subclass a: Lobosia

Pseudopodia as lobopodian.

**Order 1: Amoebida.** Examples: **Amoeba**, *Entamoeba*, *Pelomyxa*, etc.

**Order 2: Arcellinida.** Examples: *Arcella*, *Diffugia*, *Euglypha*, etc.

#### Subclass b: Filosia

They have tapering and branching filopodia.

## **Subclass c: Granuloreticulosa**

They have finely granular reticulose rhizopodia (reticulopodia).

**Order 1: Foraminiferida** Examples: *Globigerina*, *Elphidium*, etc.

## **Subclass d: Mycetozoa**

The amoeboid trophic stage develops either into a multicellular aggregation or into a true multinucleate plasmodium.

The life cycle is complex and has sexual reproduction.

Usually, sporangia are formed which liberate spores.

Nutrition is phagocytic.

Example: *Plasmodiophora*.

## **Class 2: Actinopodea**

Pseudopodia mainly axopodia with axial filaments, radiating from a spherical body.

They are primarily sessile or floating forms.

Gametes are usually flagellated.

Reproduction is both sexual and asexual.



## **Subclass a: Radiolaria**

The central capsule is perforated by one to many pores.

They have spicules or siliceous skeleton.

Filopodia or axopodia are present.

The capsule separates the protoplasm into ectoplasm and endoplasm.

All are marine.

Examples: *Thalassicola*, *Collozoum*, *Lithocircus*, etc.

## **Subclass b: Acantharia**

Imperforate, non-chitinoid central capsule without pores.

The anisotropic skeleton of strontium sulfate.

Axopodia present.

Marine

Example: *Acanthometra*.

## **Subclass c: Heliozoia**

There is no central capsule.

Rounded body with radiating axopodia.

Usually naked, if a skeleton is present it is made of siliceous scales and spines.

They have axopodia or filopodia.

## **Subclass d: Proteomyxidia**

Largely marine and freshwater parasites of algae and higher plants.

Filopodia and reticulopodia in some species.

Examples: *Vampyrella*, *Pseudospora*, etc.

## **Class 3: Piroplasma**

Small, round-shaped or amoeboid parasites in vertebrate red blood cells.

Example: *Babesia*.

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# Subphylum II: Sporozoa

Locomotory organelles absent.

Spores usually present.

Exclusively endoparasites.

Cilia or flagella may be present in gametes.

Syngamy takes place after which many spores are formed.

The spores are simple and contain one to many sporozoites.

Sporozoites are the infective phase.

The nucleus is of the single type.

## Class 1: Telosporea

Pseudopodia are generally absent.

Locomotion by gliding or body flexion.

Spores are formed and there are flagellated microgametes in some.

Spores are without polar capsules and filaments, naked or encysted.

Reproduction by both sexual and asexual methods.

### Subclass a: Gregarina

Mature trophozoites are large and extracellular.

Reproduction is entirely sexual with sporogony.

The spores contain eight sporozoites.

They are parasites of the digestive tract and body cavity of invertebrates.

Examples: *Gregarina*, *Monocystis*, *Nematocystis*, etc.

## **Subclass b: Coccidia**

Mature trophozoites are small and typically intracellular.

Each oocyst produces many sporozoites.

They are parasites of the digestive tract or blood of vertebrates.

Gametocytes are dimorphic

### **Order 1: Eucoccida**

Schizogony takes place.

Both sexual and asexual phases take place.

They are parasitic in epithelial and blood cells of invertebrates and vertebrates.

### **Suborder 1: Eimeriina**

Macrogamete and microgametocyte develop independently.

There is no syzygy.

Macrogametocyte produces many microgametes.

The zygote is non-motile.

Oocyst does not increase the size during sporogony.

Sporozoites are encased in sporocyst.

Example: *Eimeria*.

## **Suborder 2: Haemosporina**

Macrogamete and microgametocyte develop independently.

There is no syzygy.

Microgametocyte produces only a few microgametes.

Zygote of often motile.

Oocyst increases size during sporogony.

Sporozoites are naked.

Schizogony takes place in vertebrates and sporogony in an invertebrate host.

Example: ***Plasmodium***

## **Class 2: Toxoplasmea**

Spores are absent.

There are no flagella or pseudopodia at any stage.

Reproduction by asexual reproduction (binary fission).

Cysts are formed which have many naked sporozoites.

Examples: *Sarcocystis*, *Toxoplasma*, etc.

## **Class 3: Haplosporea**

Spores are present.

Pseudopodia may be present but flagella are absent.

Reproduction only by an asexual method.

Schizogony takes place.

Examples: *Caelosporidium*, *Ichthyosporidium*, etc.

# Subphylum III: Cnidospora

Spores have several cells having one or more polar filaments which are coiled threads and can be shot out, and one or more sarcoplasms or sporoplasms (analogous to sporozoites).

All are parasitic.

Zygote gives rise to one or more trophozoites without sporogony.

## Class 1: Myxosporidea

Spores are of multicellular origin and large.

There are one or more sporoplasms with two or three valves.

They are parasites of fish.

Examples: *Myxobolus*, *Myxidium*, *Ceratomyxa*, etc.

## Class 2: Microsporidea

Spores are of unicellular origin and small.

There is one long tubular polar filament through which the sporoplasms emerges one valve only.

They are cytozoic (intracellular parasites) in arthropods and vertebrates.

Example: *Nosema*.



# Subphylum IV: Ciliophora

**They possess simple ciliary organelles for locomotion, infra-ciliature is subpeculiar.**

**They have two nuclei, a trophic macronucleus, and a reproductive micronucleus.  
Binary fission is perkinetal.**

**Conjugation takes place with the fusion of nuclei, autogamy and cytogamy also occur.**

**There are never any free gametes.**

**Nutrition is mixotrophic or heterotrophic.  
They usually have a cytostome.**

# Class 1: Ciliata

They possess cilia or compound ciliary structure as locomotory or food acquiring organelles. There is the presence of an infraciliary system, composed of basal granules below the cell surface and interconnected by longitudinal fibrils.

Most ciliates possess a cell mouth or cytostome.

Anal aperture (cytopyge) permanent.

Two types of nuclei, one vegetative (macronucleus) and the other reproductive (micronucleus).

Fission is transverse.

Sexual reproduction never involves the formation of free gametes.

One or more contractile vacuoles present even in marine and parasitic types.

## Subclass 1: Holotricha

Body cilia simple and uniform.

Buccal cilia mostly absent.

**Order 1: Gymnostomatida.** Examples: *Coleps*, *Dileptus*, *Didinium*, *Prorodon*, *Nassula*, etc.

**Order 2: Trichostomatida.** Examples: *Colpoda*, *Balantidium*, etc.

**Order 3: Chonotrichida.** Examples: *Spirochona*, *Lobochona*, *Chilodochona*, etc.

**Order 4: Apostomatida.** Example: *Hyalophysa*.

**Order 5: Astomatida.** Examples: *Anoplophyra*, *Maupasella*, *Hoplitophyra*, etc

**Order 6: Hymenostomatida.** Examples: *Colpidium*, *Tetrahymena*, ***Paramecium***, etc.

**Order 7: Thigmotrichida.** Examples: *Thigmophyra*, *Boveria*, etc.

## Subclass 2: Peritricha

Adults without body cilia.

Apical end with buccal cilia.

**Order 1: Peritrichida.** Examples: *Vorticella*, *Carchesium*, *Trichodina*, etc.

## Subclass 3: Suctoria

Sessile and stalked body.

Young with cilia, and adult with suctorial tentacles.

**Order 1: Suctorida.** Examples: *Acineta*, *Ephelota*, *Podophyra*, etc.

## Subclass 4: Spirotrichia

Reduced body cilia.

Buccal cilia are well marked.

**Order 1: Heterotrichida.** Examples: *Stentor*, *Bursaria*, *Spirostomum*, *Nyctotherus*, etc.

**Order 2: Oligotrichida.** Examples: *Halteria*, *Strombidium*.

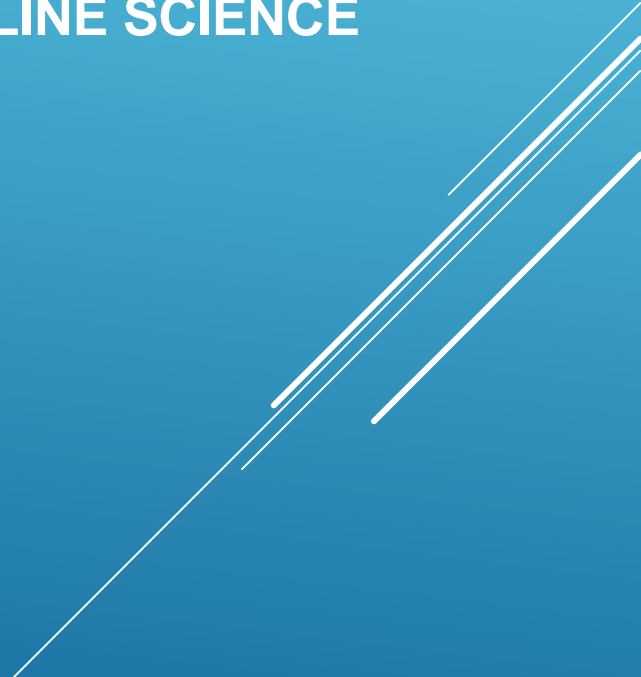
**Order 3: Tintinnida.** Examples: *Codonella*, *Favella*, etc.

**Order 4: Entodinomorphida.** Examples: *Entodinium*, *Cycloposthium*, etc.

**Order 5: Odontostomatida.** Example: *Saprodinium*.

**Order 6: Hypotrichida.** Examples: *Euplotes*, *Stylonychia*, *Urostyla*, *Oxytricha*, etc.

# References

1. **Sagar Aryal**, Online Microbiology Notes, Protozoa- Definition, characteristics, classification, examples
  2. General characteristics and classification of phylum Protozoa ONLINE SCIENCE NOTES
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