

## PROTOZOA

Definition 'Protozoa may be defined as 'microscopic acellular animalcules existing singly or in colonies, without tissue and organs, having one or more nuclei'

### Characters

1. There are about 50,000 known species of Phylum Protozoa.
2. Protozoans exhibit mainly two forms of life; **free-living** (aquatic, freshwater, seawater) and **parasitic** (ectoparasites or endoparasites). They are also **commensal** in habitat.
3. They are **small**, usually **microscopic**, not visualize without a microscope.
4. They are the **simplest** and **primitive** of all animals.
5. They have a simple body organization. i.e. with a **protoplasmic grade** of organization.
6. The body is **unicellular** (without tissue and organs).
7. They have one or more **nuclei** which are monomorphic or dimorphic.
8. Body **naked** or bounded by a **pellicle**, but in some forms may be covered with shells and often provided with an internal skeleton.
9. They are **solitary** (existing alone/single) or **colonial** (individuals are alike and independent).
10. Body **shape variables** may be spherical, oval, elongated or flattened.
11. Body **symmetry** either none or bilateral or radial or spherical.
12. Body form usually **constant**, varied in some, while changing with environment or age in many.
13. Body protoplasm is differentiated into an outer **ectoplasm** and inner **endoplasm**.
14. The single-cell body performs all the essential and vital activities, which characterize the animal body; hence only **subcellular physiological division of labor**.
15. Locomotory organs are fingers like **pseudopodia**, whip-like **flagella**, hair-like **cilia** or none.
16. Nutrition may be **holozoic** (animal-like), **holophytic** (plant-like), **saprozoic** or **parasitic**.
17. Digestion occurs **intracellularly** which takes place inside the food vacuoles.
18. Respiration occurs by **diffusion** through the general body surface.
19. Excretion occurs through the **general body surface**, but in some forms through a temporary opening in the ectoplasm or through a permanent pore called **cytopyge**.
20. Contractile vacuoles perform **osmoregulation** in freshwater forms and also help in removing excretory products.
21. Reproduction **asexual** (binary or multiple fission, budding, sporulation) or **sexual** (conjugation (hologamy), game formation (syngamy)).
22. The life cycle often complicated with alternation of asexual and sexual phases (**alternation of generation**).
23. **Encystment** commonly occurs to resist unfavorable conditions of food, temperature, and moisture, and also helps in dispersal.
24. The single-celled individual not differentiated into somatoplasm and germplasm; therefore, exempt from natural death which is the price paid for the body.
25. Protozoans exhibit mainly two forms of life; **free-living** (aquatic, freshwater, seawater) and **parasitic** (ectoparasites or endoparasites). They are also **commensal** in habitat.

26. Examples: *Euglena*, *Amoeba*, *Plasmodium*, *Paramecium*, *Podophyra*, etc.

## **Classification:**

**It divides protozoa into four subphyla.**

Subphylum I: Sarcomastigophora

Subphylum II: Sporozoa

Subphylum III: Cnidospora

Subphylum IV: Ciliophora

### **Subphylum I: Sarcomastigophora**

- Locomotor organelles are pseudopodia or flagella.
- The nucleus is of a single type (monomorphic).
- There is no spore formation.
- Syngamy occurs in reproduction.

Superclass A: Mastogophora

- 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: *Vacuolaria*, *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: *Mastigamoeba*, *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*, *Poteriodendron*, 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.
- Examples: *Gromia*, *Allogromia*, *Penardia* (naked).

##### Subclass c: Granuloreticulosa

- They have finely granular reticulate 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-chitinous 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.
- There may be more than one nucleus, mostly in freshwater.

Examples: *Actinophrys*, *Actinosphaerium*, *Clathrulina*, etc.

#### 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*.

### **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 I: 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.
- Sporozoites multiply by schizogony in tissue cells.

Examples: *Eimeria*, *Isospora*, *Plasmodium*, etc.

#### 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 is often motile.
- Oocyst increases size during sporogony.
- Sporozoites are naked.
- Schizogony takes place in vertebrates and sporogony in an invertebrate host.
- Hemoglobin of host cells forms pigment.

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 I: 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 II: 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, infraciliature 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 I: 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.