

BIO 102

PHYLUM PROTOZOA

Protozoa may be defined as “microscopic acellular animalcules existing singly or in colonies, without tissue and organs, having one or more nuclei”. They belong to the kingdom Protista

Some of the characteristics of protozoans

1. There are about 50,000 known species of Phylum Protozoans
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 may be 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. Protozoans exhibit mainly two forms of life; free-living (aquatic, freshwater, seawater) and parasitic (ectoparasites or endoparasites). They are also commensal in habitat. Examples: Euglena, Amoeba, Plasmodium, Paramecium, Podophyra, etc.

Classification of Protozoans

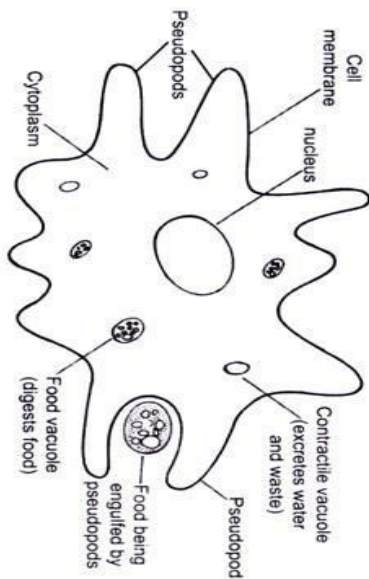
In the simplest form, protozoans can be grouped basically into four classes. They are classified basically on the type of locomotory organelles. The classes are listed below;

Different classes of protozoans

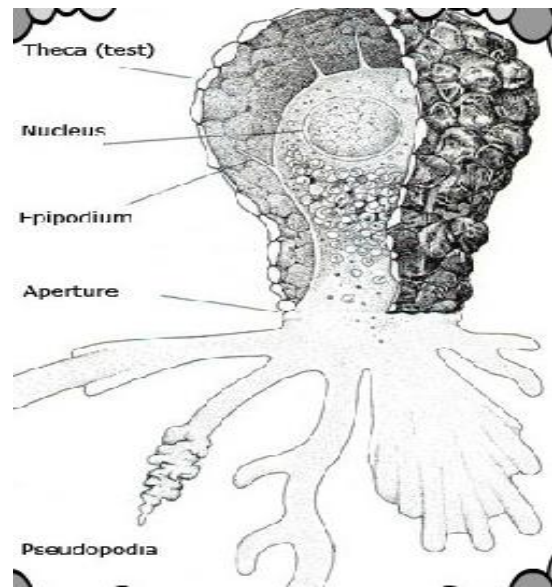
S/N	CLASS	LOCOMOTORY ORGANELLE	MODE OF LIFE	EXAMPLES
1.	Sarcodina	Pseudopodia	Free-living and Parasitic	<i>Amoebas, Entamoeba, Diffugia, Arcella</i>
2.	Mastigophorans	Flagella	Free living, commensals and Parasitic	<i>Euglena, Trypanosomes, Leishmania, Peranema, Ceratium, Volvox, Clymadomonax, Trichonympha, Opalina</i>
3	Ciliata	Cilia	Free living, commensals and Parasitic	<i>Paramecium, Balantidium, Vorticella, Stentor, Nyctotherus, Codonella</i>
4	Sporozoans	None	Parasitic	<i>Plasmodium, Toxoplasma, Babesia, Monocyst, Eimeria</i>

Characteristics of class Sarcodina

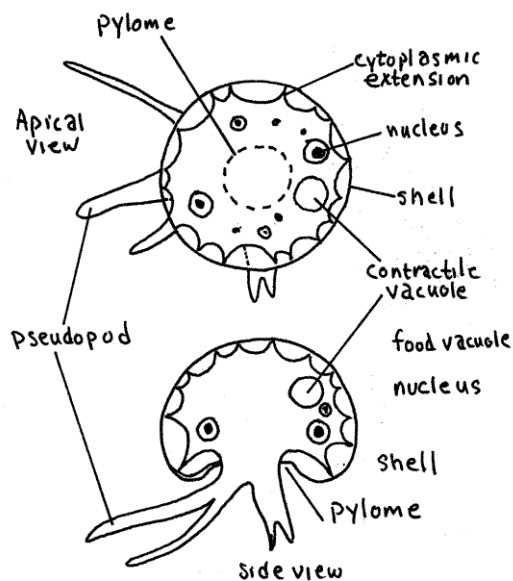
1. These organisms have streaming cytoplasm and use temporary cytoplasmic extensions called pseudopodia in locomotion (called amoeboid movement) and feeding.
2. Sarcodines include the genus *Amoeba* e.g *Amoeba proteus* and pathogenic species, e.g., dysentery-causing *Entamoeba histolytica*.
3. These protozoans' cells may be spherical or irregular in shape; the pellicle (or envelope) is usually thin and flexible.
4. Sometimes there is an external shell (see foraminiferan) or skeleton (see radiolarian).
5. The cytoplasm, composed of ectoplasm and endoplasm, may contain more than one nucleus. Food, which adheres to the body surface or is trapped by pseudopodia, is digested in food vacuoles.
6. Some sarcodines have flagella during certain stages of their development; in other groups flagellated and unflagellated generations alternate.
7. Sarcodines may be either solitary or colonial. Although some are parasitic on plants or animals, most sarcodines are free-living, feeding on bacteria, algae, other protozoans, or organic debris. The genera are distinguished by the structure of their pseudopodia.



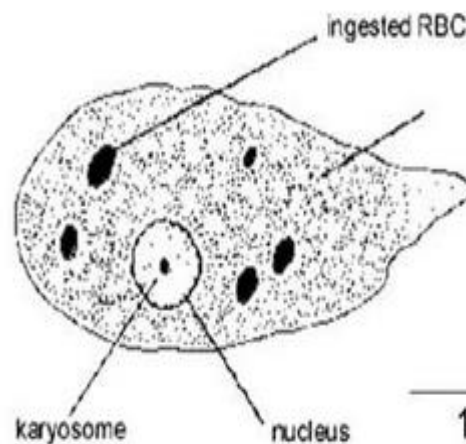
Amoeba proteus (Naked Amoeba)



Diffugia (Shelled or Testate Amoeba)



Arcella (Shelled or testate Amoeba)

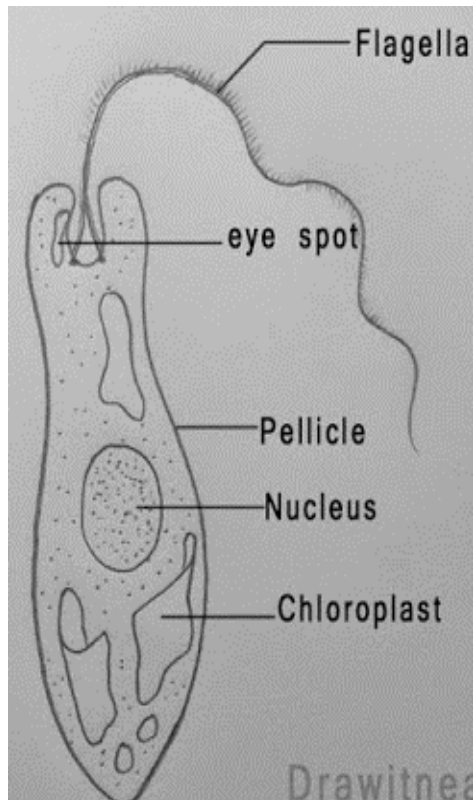


Entamoeba histolytica (Parasitic Amoeba)

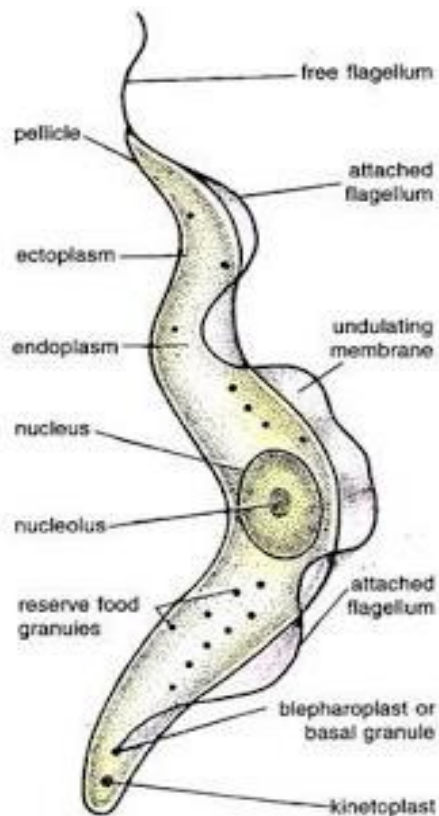
Characteristics of the class mastigophora

1. They are group of flagellates with one to many flagella
2. Mastigophorans can be divided into 2; Phytomastigophora (Plant-like e.g. Euglena, Peranema, Clymadomonas) and Zoomastigophora (Animal-like e.g., Trypanosome, leishmania, Opalina)
3. They are unicellular with one nucleus
4. In zoomastigophorans, one of the flagellum is free (trailing flagellum) and the other flagellum is attached to the pellicle to form an undulating membrane
5. Body is covered with thin pellicle or test of cellulose, chitin or silica
6. Nutrition can be autotrophic (Euglena) or heterotrophic

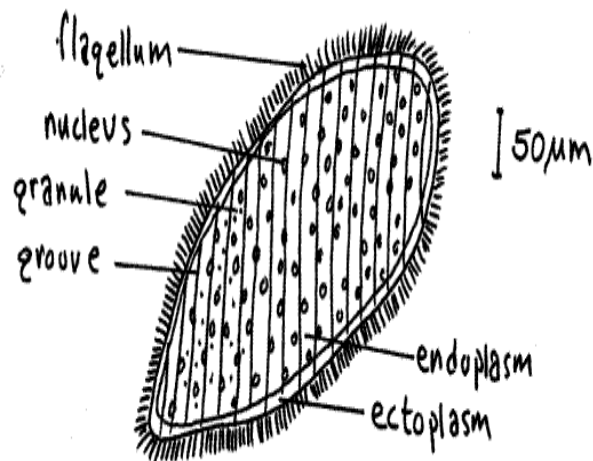
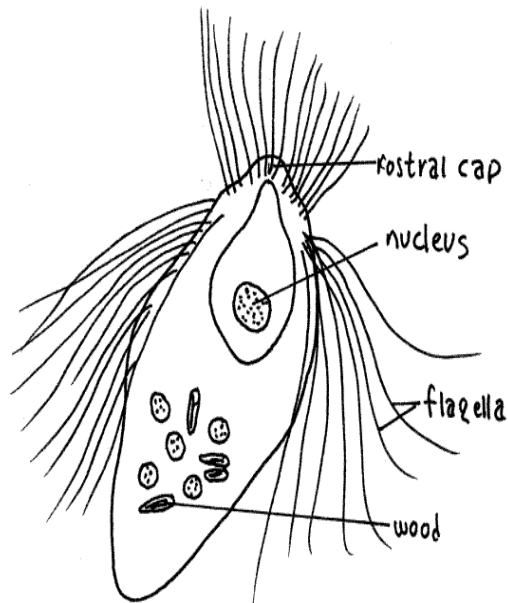
7. Asexual reproduction by longitudinal fission
8. Can be free-living or parasitic
9. Some of them are important pathogens of humans and other animals.
10. Parasitic members of the Mastigophora are the causative organisms of disease in humans and other animals. *Trypanosomes*, for example, are the cause of African sleeping sickness and Chagas' disease, and giardiasis is caused by the mastigophoran *Giardia lamblia*



Euglena



Trypanosome



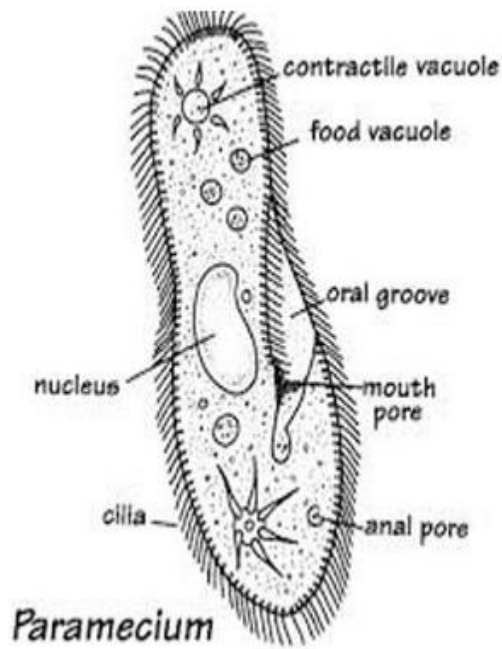
Trichonympha

Opalina

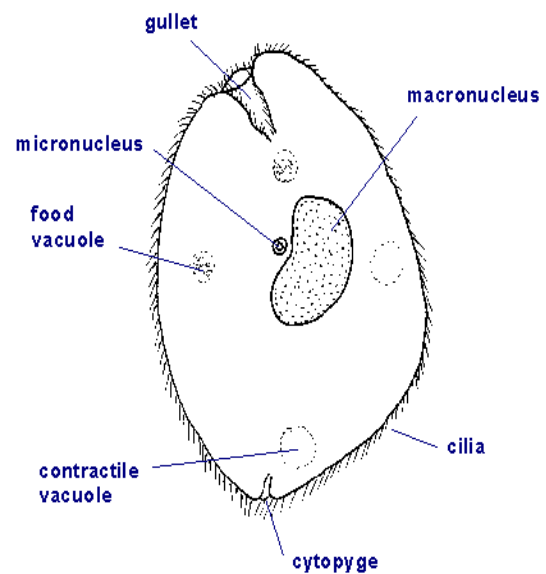
Characteristics of class Ciliata

1. They possess cilia for locomotion and for the generation of feeding currents in water
2. Relatively rigid pellicle and more or less fixed shape
3. Distinct cytostome (mouth) structure
4. Dimorphic nuclei, typically a larger macronucleus and one or more smaller micro nuclei
5. They possess trichocysts which are pellicular structures primarily used for protection. They are rod-like or oval organelles oriented perpendicular to the plasma membrane.
6. Some ciliates, such as Paramecium, have a ciliated oral groove along one side of the body
7. Cilia of the oral groove sweep small food particles toward the cytopharynx, where a food vacuole forms.
8. When the food vacuole reaches an upper size limit, it breaks free and circulates through the endoplasm.

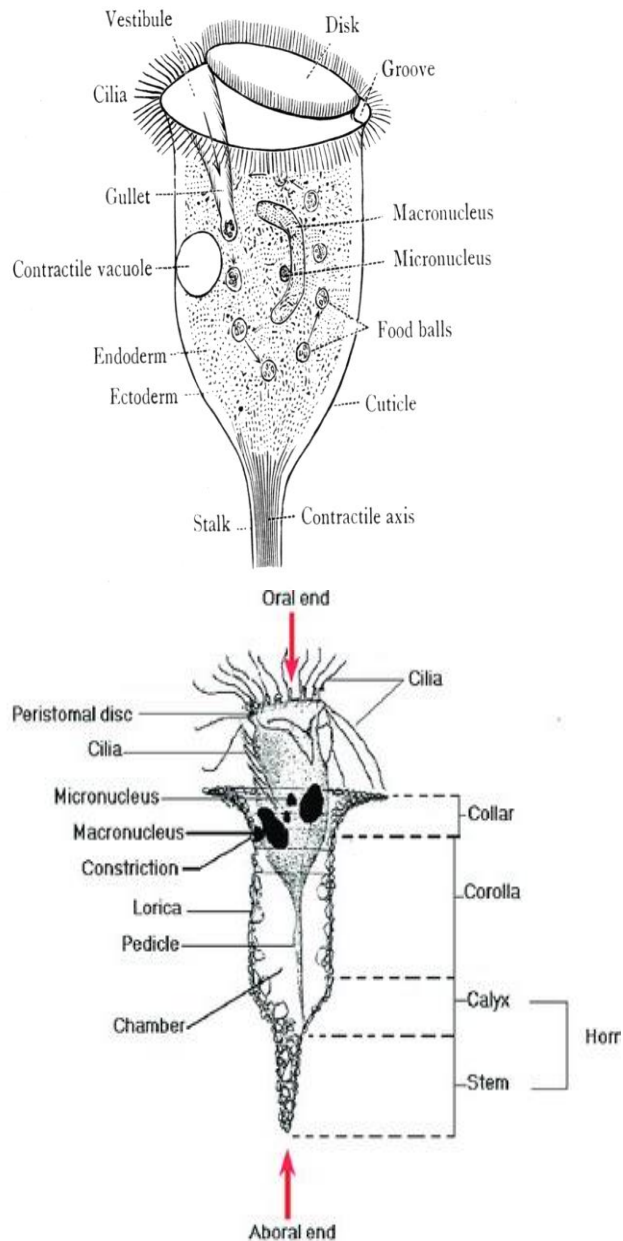
9. Some free-living ciliates prey upon other protists or small animals.
10. Suctorians are ciliates that live attached to their substrate. They possess tentacles whose secretions paralyze prey, often ciliates or amoebae.
11. Ciliates have two kinds of nuclei: A large, polyploidy macronucleus regulates daily metabolic activities. It is not involve in reproduction. One or more smaller micronuclei are the genetic reserve of the cell and it is involved in reproduction.
12. Asexual Reproduction: is by Transverse binary fission and budding, while that of sexual reproduction is through conjugation.



Paramecium



Balantidium coli



Vorticella

Tintinnid species

Characteristics of the sporozoans

Sporozoa is a large subphylum consisting of many unicellular, intracellular parasites. Currently, the group is suggested to contain over 65,000 species with varying morphological characteristics. Given that they are strictly parasitic, members of the subphylum are responsible for a variety of diseases in human beings e.g.

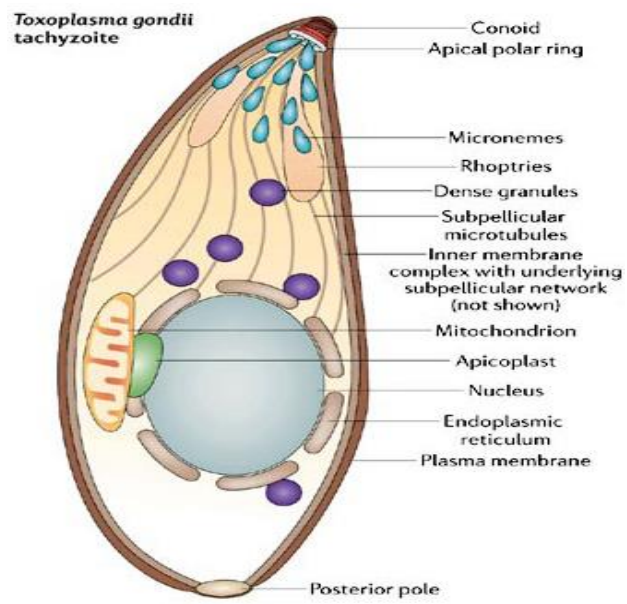
- (i) Malaria caused by *Plasmodium falciparum*, *P. malariae*, *P. ovale* and *P. vivax* ;
- (ii) Babesiosis caused by *Babesia divergens*, *B. microti*, and *B. duncani*

(iii) Cyclosporiasis is caused by *Cylospora* species.

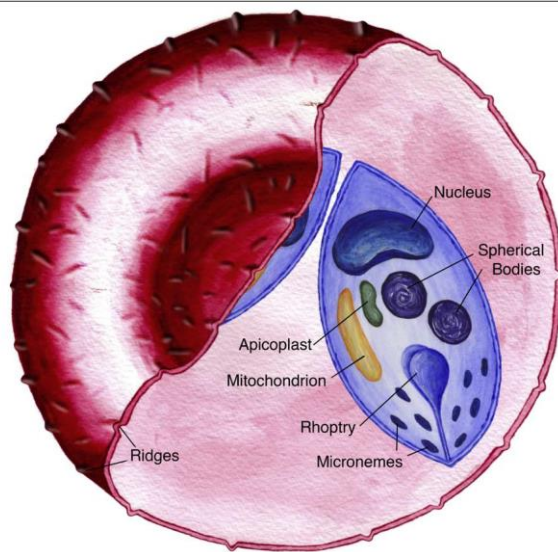
1. No locomotory organs.
2. Spore-formation is common.
3. It is comprised of protozoans that are characterized by having a special organelle called an apical complex.
4. Most of them are single-celled, parasitic, and spore-forming.
5. All sporozoa are obligate parasites, they form temporary non-motile spores which contain infective cells.
6. The majority of these organisms are also characterized by a complex life cycle that not only requires two hosts (vertebrate and invertebrate) but also alternates between sexual and asexual stages.
7. Unlike the adult/mature forms of some protozoa, sporozoans do not have flagella or cilia used for locomotion. For this reason, they depend on gliding, twisting, and bending to move.
8. Gliding also allows the parasites to penetrate host cells in order to maintain an intracellular lifestyle.
9. Being very simple organisms, members of the class Sporozoa lack organs required for feeding and digesting food material in their environment (within the cell of the host). For this reason, they heavily rely on osmosis to absorb nutrients (fluid nutrients).
10. While they are simple and do not have many of the organelles found in other eukaryotes, Sporozoa have been shown to have micropores
11. Schizonts of *Plasmodium* and other parasites are capable of phagotrophy (engulf food particles through phagocytic nutrition)
12. Four major groups are recognized on the basis of different spore morphology:
13. Generally, both sexual (Syngamy) and asexual reproduction (Schizogony) occurs in sporozoans:

Sporozoans have been grouped into 4 based on general spore morphology, these include:

- a. **Apicomplexan** parasites form distinctive oocysts containing infective sporozoites. Many species occur only in invertebrates whereas others may infect vertebrates causing severe diseases (such as malaria, tick fever, diarrhoea or abortion). They are characterized by the presence of *Apical complex*
- b. **Microsporan** parasites form unicellular spores containing coiled polar tubes used to infect host cells. Most species infect invertebrates (especially insects) although some form cysts in vertebrates (mainly fish).
- c. **Haplosporidian** parasites form unicellular spores without polar filaments in the tissues of aquatic invertebrates. They cause significant morbidity and mortality in oysters throughout the world.
- d. **Paramyxean** parasites form unique spore-within-spore arrangements within the tissues of bivalves and polychaetes. They cause QX and Aber disease in oysters.



Toxoplasma gondii tachyzoite



Schematic diagram of Babesia in red blood cell