

Phylum Protozoa

The animals included in phylum Protozoa can be defined as microscopic and a cellular animalcules without tissues and organs. They have one or more nuclei. Protozoa exist either singly or in colonies. Almost about 50,000 species are known till date.

1- General Characteristics of Protozoa

❖ **Habitat-** Protozoa are found in the aquatic environment. They live in freshwater or oceans. Some are free-living and some are parasitic in plants and animals. Mostly they are aerobic but some are anaerobic and present in the rumen or human intestine.

Some of the species are found in extreme environments like hot springs. Some of them form resting cyst to overcome dry environments.

❖ **Size and Shape-** The size and shape of Protozoa vary greatly, from microbial (1 μ m) to large enough and can be seen by the naked eye. The shell of unicellular foraminifera can have a diameter of 20 cm.

❖ They lack a rigid cell wall, so they are flexible and found in various shapes. Cells are enclosed in a thin plasma membrane. Some of the species have a hard shell on the outer surface. In some of the protozoans especially in ciliates, the cell is supported by **Pellicle**, which may be flexible or rigid and give organisms the definite shape and help in locomotion.

❖ **Cellular Structure-** They are unicellular having a eukaryotic cell. The metabolic functions are performed by some specialised internal structures.

- They mostly have one membrane-bound nucleus in the cell
- The nucleus has diffused appearance due to scattered chromatin, the vesicular nucleus contains a central body called endosome or nucleoli. Nucleoli of apicomplexans have DNA, whereas amoeboids lack DNA in their endosome. Ciliates have micronucleus and macronucleus
- The plasma membrane encloses the cytoplasm and other locomotory projections like flagella, pseudopodia and cilia

- Some of the genera have a membranous envelope called pellicle, which gives a definite shape to the cell. In some of the protozoans, epibiotic bacteria attach to the pellicle by their fimbriae
- The cytoplasm is differentiated into outer ectoplasm and inner endoplasm, ectoplasm is transparent and endoplasm contains cell organelles
- Some of the protozoa have cytostome for ingesting food. Food vacuoles are present, where ingested food comes. Ciliates have a gullet, a body cavity which opens outside
- The central vacuole is present for osmoregulation, that removes excess water
- Membrane-bound cell organelles, like mitochondria, Golgi bodies, lysosomes and other specialised structures are present
- ❖ **Nutrition-** Protozoa are heterotrophic and have holozoic nutrition. They ingest their food by phagocytosis. Some of the protozoan groups have a specialised structure called **cytostome** for phagocytosis.
- The pseudopodia of amoeboids help in catching the prey. Thousands of cilia present in ciliates drive the food-laden water into the gullet.
- The ingested food comes to the food vacuole and gets acted on by lysosomal enzymes. The digested food gets distributed throughout the cell.
- ❖ **Locomotion-** Most of the protozoa species have flagella, cilia or pseudopodia. Sporozoa, which don't have any locomotory structure, have subpellicular microtubules, which help in the slow movement.
- ❖ **Life Cycle-** The life cycle of most of the protozoa alternates between dormant cyst stage and proliferating vegetative stage, e.g. trophozoites.

The cyst stage can survive harsh conditions without water and nutrients. It can remain outside the host for a longer duration and get transmitted.

The trophozoite stage is infectious, and they feed and multiply during this stage.

- ❖ **Reproduction-** Mostly they reproduce by asexual means. They multiply by binary fission, longitudinal fission, transverse fission or budding. In some of the species, sexual reproduction is present. The sexual reproduction is by conjugation, syngamy or by gametocytes formation.

2- Protozoa Classification and Examples

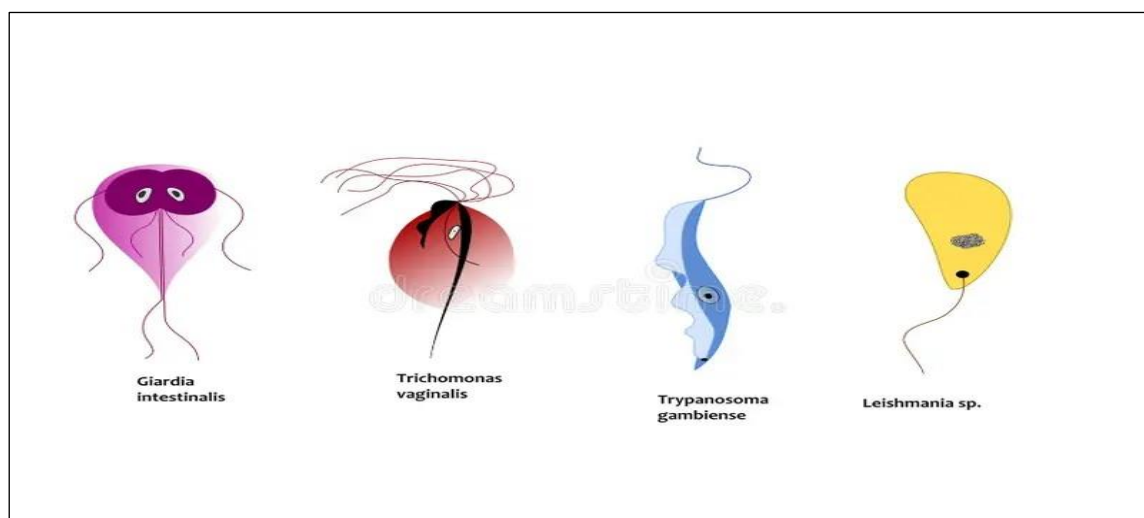
Protozoa is a phylum having unicellular heterotrophs. It comes under Kingdom Protista.

Protozoa are divided into four major groups based on the structure and the part involved in the locomotion:

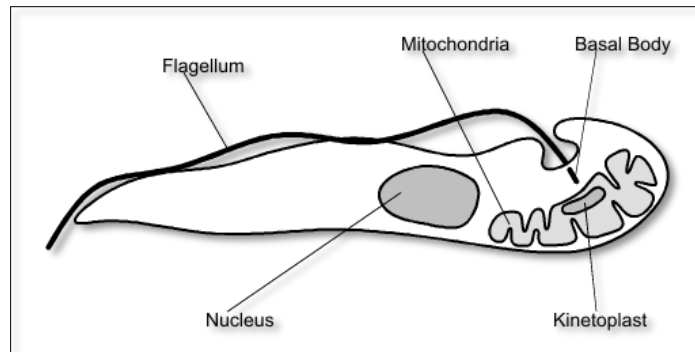
2-1 Sub-Phylum Mastigophora (Flagellata) or Flagellated protozoans:

They are parasites or free-living.

- They have flagella for locomotion
- Their body is covered by a cuticle or pellicle
- Freshwater forms have a contractile vacuole
- Reproduction is by binary fission (longitudinal division)
- Examples of Mastigophora
 - Trichomonas: This genus includes species like *Trichomonas vaginalis*, which is a parasite that causes trichomoniasis in humans.
 - Giardia: *Giardia lamblia* (also known as *Giardia intestinalis*) is responsible for giardiasis, a common cause of diarrheal illness.
 - Trypanosoma: This genus includes species like *Trypanosoma brucei*, which causes African sleeping sickness.



Examples of flagellated protozoan

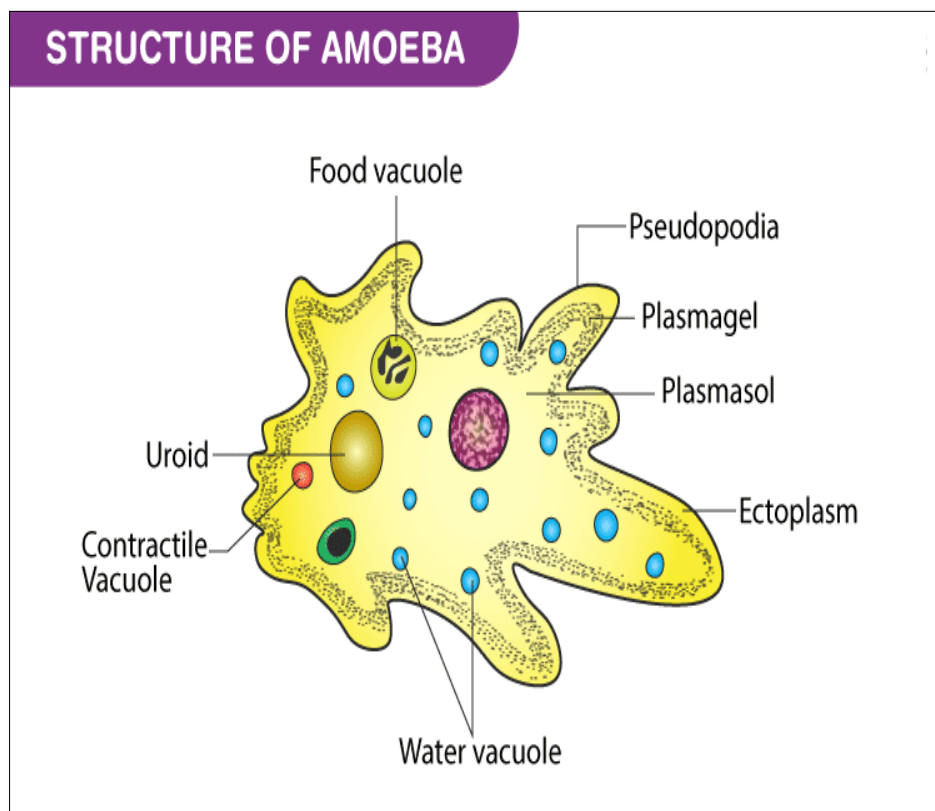


Trypanosoma

2-2 Sub-Phylum Sarcodina or Amoeboids:

They live in the freshwater, sea or moist soil.

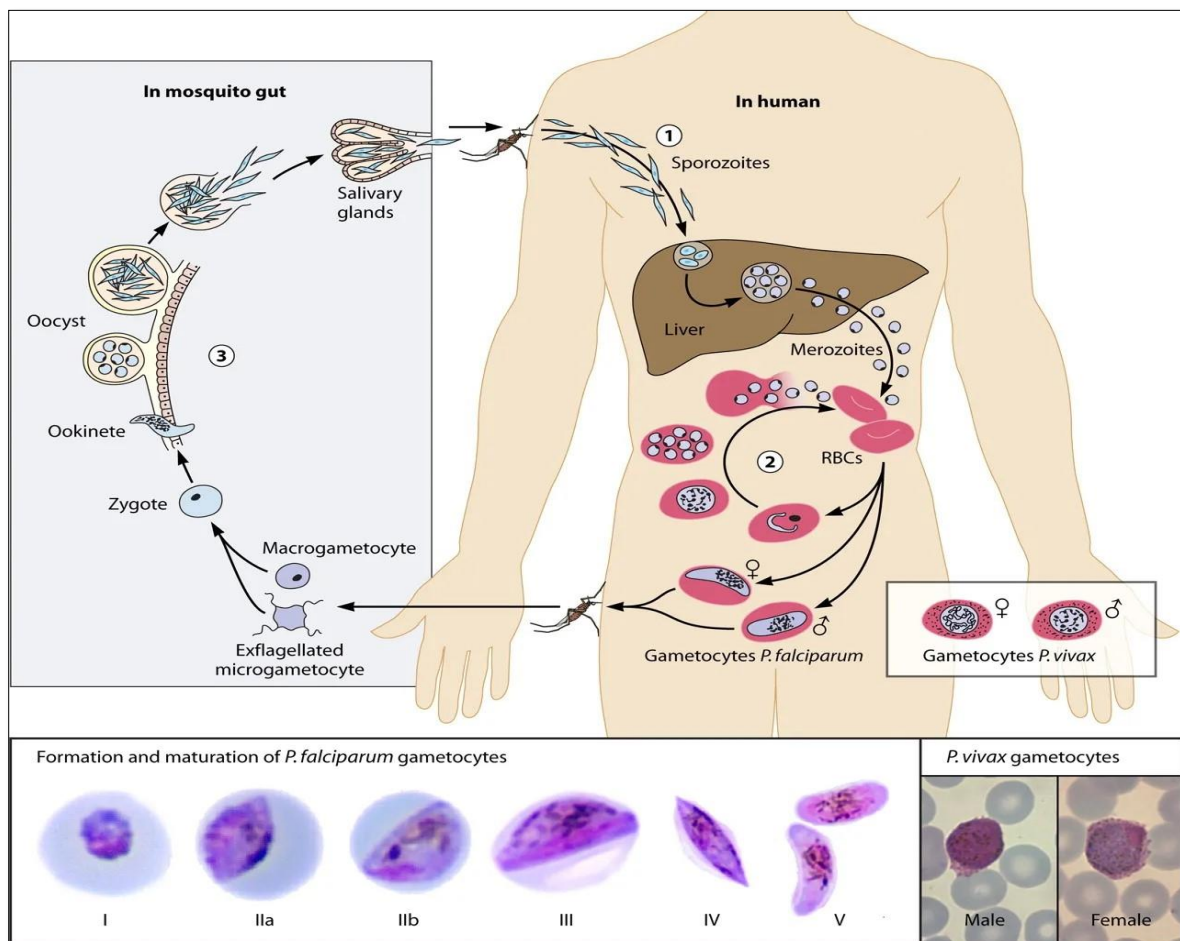
- The movement is by **pseudopodia**. They capture their prey by pseudopodia
- There is no definite shape and pellicle is absent
- The contractile vacuole is present in the amoeboids living in freshwater
- Reproduction is by binary fission and cyst formation
- Examples: *Amoeba*, *Entamoeba*, etc.



2-3 Sub-Phylum Apicomplexa (Sporozoa or Sporozoans):

They are endoparasitic.

- They don't have any specialised organ for locomotion
- The pellicle is present, which has subpellicular microtubules, that help in movement
- Reproduction is by sporozoite formation
- Examples of Sporozoa :
 - *Plasmodium*: Causes malaria in humans.
 - *Toxoplasma*: Responsible for toxoplasmosis.
 - *Cryptosporidium*: Causes cryptosporidiosis, a diarrheal disease

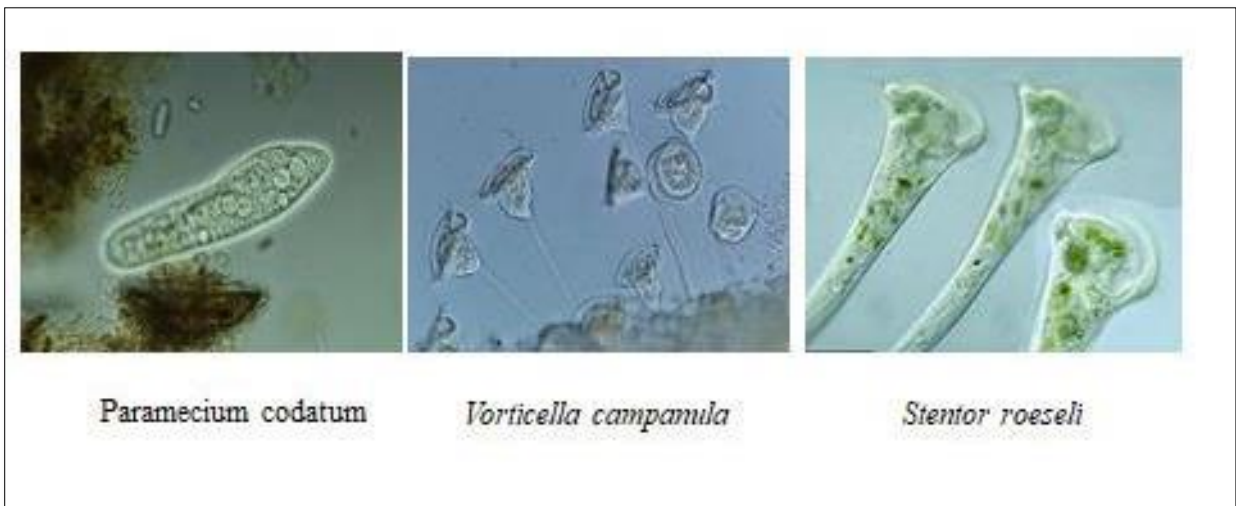


Life cycle of *Plasmodium falciparum*

2-4 Sub-Phylum Ciliophora or Ciliated protozoans:

They are aquatic and move actively with the help of thousands of **cilia**.

- They have fixed shape due to covering of pellicle
- They may have tentacles, e.g. in the sub-class Suctororia
- Contractile vacuoles are present
- Some species have an organ for defence called **trichocysts**
- They move with the help of cilia and the movement of cilia also helps in taking food inside the gullet
- They reproduce by transverse division and also form cysts
- Examples: *Paramecium*, *Vorticella*, *Balantidium*, etc.



Examples of Ciliated protozoans

3- Examples of Diseases caused by Protozoa

Many of the protozoans are parasites and are disease causing pathogens. Find below the common diseases caused by protozoans.

Table 1: List of diseases caused by protozoans

Name of the Disease	Causal organism	Vector	Pathogenesis	Disease symptoms
Malaria	<i>Plasmodium falciparum</i> , <i>P. vivax</i> , <i>P. malariae</i> , <i>P. ovale</i>	Female Anopheles mosquito	The parasite attacks the liver and RBCs. It multiplies within liver cells, enters the bloodstream and ruptures RBCs. It releases a toxic substance called 'hemozoin', which causes fever. The sporozoite is the infectious stage	Fever, headache, vomiting, abdominal pain and it may lead to fatal conditions if not treated like organ failure and convulsions
Amoebiasis or Amoebic dysentery	<i>Entamoeba histolytica</i>	None. It gets transmitted by contaminated food or water	Invades intestinal mucosa and spreads to other parts like liver. Causes dysentery and liver abscesses. The infected stage is trophozoites	Abdominal pain, loose bowel movement, bloody stool, loss of appetite, nausea, fever
African Sleeping sickness or Trypanosomiasis	<i>Trypanosoma brucei gambiense</i> , <i>T. brucei rhodesiense</i>	Tsetse fly	B-lymphocyte proliferation leading to tissue damage	High fever, muscle and joint pain, irritability, swollen lymph nodes, skin rashes. If left untreated, neurological problems develop, which become fatal
Trichomoniasis	<i>Trichomoniasis vaginalis</i>	Sexually transmitted disease (STD)	Destroys epithelial cells and cytotoxic substances are released. Vaginal pH increases and the number of leukocytes also increases in response to the toxic substance released by the pathogen	Itching and burning in genital organs and discharge. Mostly asymptomatic in males, but in females it may lead to many complications such as complication during pregnancy and after birth
Toxoplasmosis	<i>Toxoplasma gondii</i>	Transmission by contaminated water and soil or get attached to fur	Sporozoites penetrate the intestinal cells and multiply in the intestine. It invades the lymphatic system and blood and damages the tissue leading	Redness of eye, blurred vision, flu-like symptoms

		of animals	to necrosis	
Balantidiasis	<i>Balantidium coli</i>	Pigs	Excystation occurs in the small intestine. Sporozoites migrate to the colon	Ulcer due to lesion in the colon, colitis, blood and mucus in the stool,
Giardiasis	<i>Giardia lamblia or duodenalis</i>	None. It gets transmitted by contaminated food or water	Mucosal damage is related to the mucosal inflammation and release of lectin or proteinases. Malabsorption may also be due to inhibition of pancreatic enzymes and depletion of bile concentration	The parasite is present in the duodenum. Watery or foul-smelling diarrhoea, nausea, flatulence, weight loss
Leishmaniasis or Kala-azar	<i>Leishmania donovani</i>	Female Sandflies (of the genus Phlebotomus)	The flagellated promastigotes of the parasite bind to macrophages present in the skin. There is marked suppression of cell-mediated immunity	Enlarged liver and spleen, fever, skin turns dark

