



Physiology of Parasites (512) Zoo 3(2+1)

Ultrastructure of protozoa and its adaption for host cell invasion



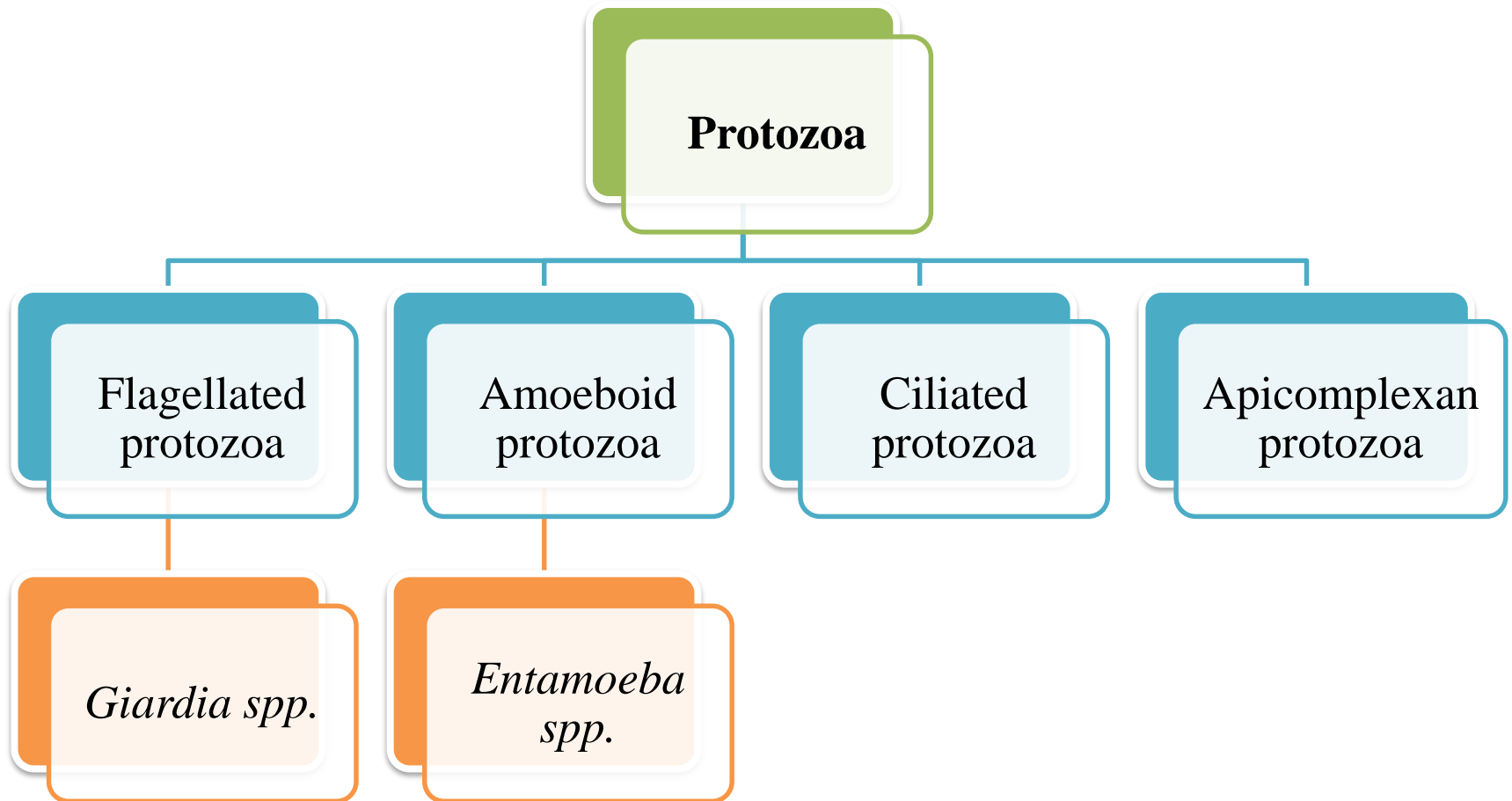
Introduction

- **protozoa**

- Many are important nutrient cyclers.
- Many are photoautotrophic & make up 40% of all primary productivity.
- Major component of plankton communities.
- 25% of the described species live as symbionts; many parasitic.



Mind map





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I-Introduction to protozoa

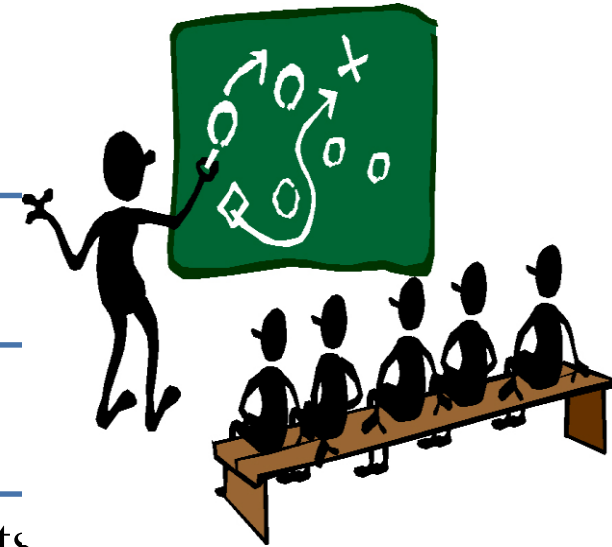
II-Establishment and growth

III-Activation and excystation of protozoan cysts

IV-Major pathogenic protozoa

V- Ultrstructure of flagellated protozoa(*Giardia lamblia*)

VI-Ultrstructure of amoeboid protozoa(*E.histolytica*)





Objectives

- The purpose of this lecture is to provide an up-to-date accessible source of information about the adapted basic physiological and metabolic pathways for each protozoan .
- **The lecture** provides a variety of information such as anatomy and physiology of protozoa.
- At the end of this unit, the student is able to:
Describe mechanisms of host parasite invasion ,
establishment and feeding in the host.



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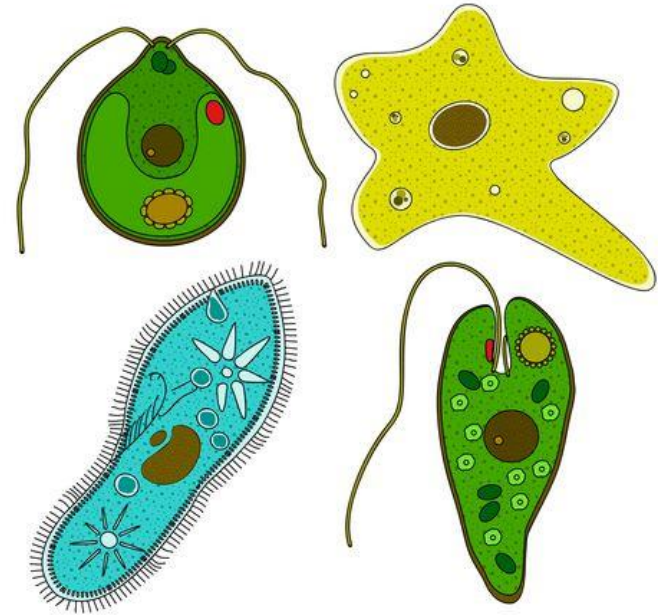
- Ultrastructure flagella and cilia
- Difference between flagella and cilia
- Structure of pseudopodium
- Adaptation of protozoa for host cell invasion.



I-Introduction to protozoa

Protozoa are:

- Heterotrophic
- Eukaryotic
- Most are unicellular, colonies are rare.
- Most have locomotive structures as ,cilia or pseudopods
- Vary in shape
- Typically inhabit water or soil





II-Establishment and growth

- Establishment and growth require a complex series of physiological conditions to be met. These are summarized as:
- **Physiological barriers** encountered upon entry (pH, temperature, pCO₂, pO₂, osmotic pressure, RH, nutrient availability, hatching and excystation).
- **Biotic barriers** (host defenses, phagocytes, nutrients, maturation signals, migration signals,...).



III-Activation and excystation of protozoan cysts

Activation and **excystation** of protozoan cysts was examined using a few species *in vitro*. It is generally found that optimum conditions include: elevation of the ambient temperature to the appropriate level, employing a medium of neutral pH, high pO₂ and containing reducing agents.

Activation of encysted parasite may be a process distinct from excystation ; the **former** depending particularly upon a high pCO₂ and the **latter** requiring the action of proteolytic enzymes.

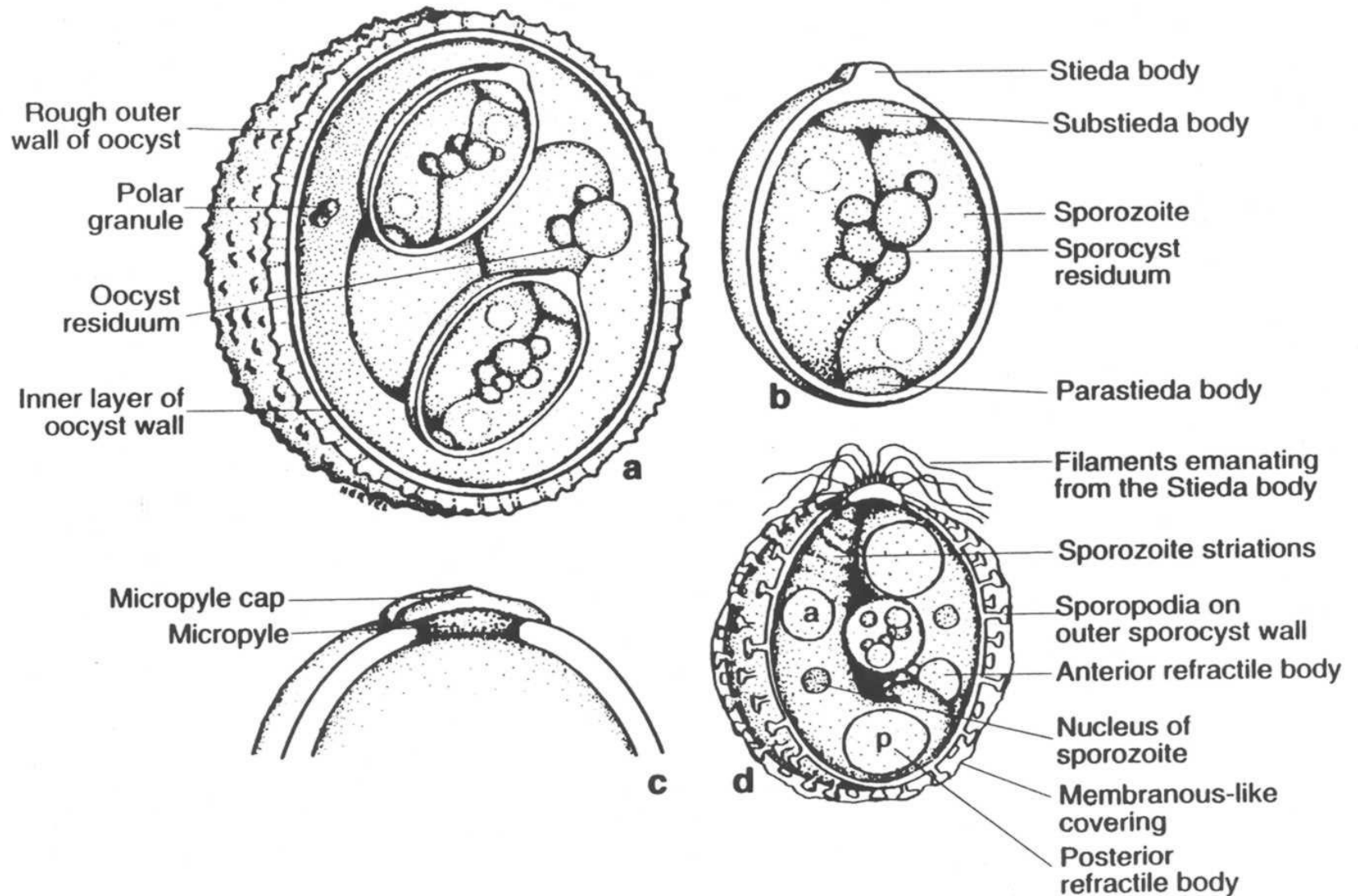
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III-Activation and excystation of protozoan cysts (Cont.)

- In the coccidian, **excystation** of the **sporocyst** after release from the **oocyst** may involve **the breakdown** of a localized region of the cyst wall the **Stieda body**. This is affected by the action of **bile and trypsin**.
(e.g. *Eimeria sp.* and *Isospora sp.*). Some species **lack a Stieda body** and excyst following the **action of proteolytic enzymes on the entire sporocyst wall**.

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Fully-formed oocyst (Fig. a, c) and its sporocysts (Fig. b, d)

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IV-Major pathogenic protozoa

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TABLE 23.1

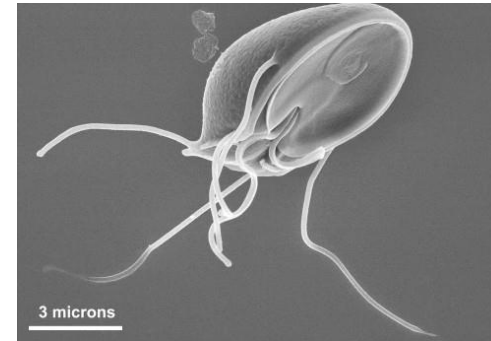
Major Pathogenic Protozoa, Infections, and Primary Sources

Protozoan/Disease	Reservoir/Source
Ameboid Protozoa	
Amebiasis: <i>Entamoeba histolytica</i>	Human/water and food
Brain infection: <i>Naegleria, Acanthamoeba</i>	Free-living in water
Ciliated Protozoa	
Balantidiosis: <i>Balantidium coli</i>	Zoonotic in pigs
Flagellated Protozoa	
Giardiasis: <i>Giardia lamblia</i>	Zoonotic/water and food
Trichomoniasis: <i>Trichomonas tenax,</i> <i>T. hominis, T. vaginalis</i>	Human
Hemoflagellates	
Trypanosomiasis: <i>Trypanosoma brucei,</i> <i>T. cruzi</i>	Zoonotic/vector-borne
Leishmaniasis: <i>Leishmania donovani,</i> <i>L. tropica, L. brasiliensis</i>	Zoonotic/vector-borne
Apicomplexan Protozoa	
Malaria: <i>Plasmodium vivax,</i> <i>P. falciparum, P. malariae</i>	Human/vector-borne
Toxoplasmosis: <i>Toxoplasma gondii</i>	Zoonotic/vector-borne
Cryptosporidiosis: <i>Cryptosporidium</i>	Free-living/water, food
Isosporosis: <i>Isospora belli</i>	Dogs, other mammals
Cyclosporiasis: <i>Cyclospora cayetanensis</i>	Water/fresh produce

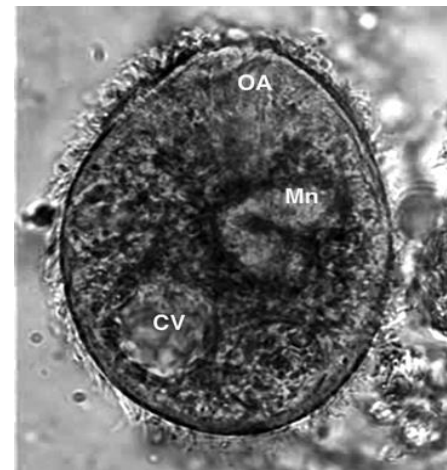


V-Ultrastructure of flagellated/ciliated protozoa

No real morphological distinction between the cilia and flagella, but cilia are usually shorter and more abundant



(a) *Giardia intestinalis*



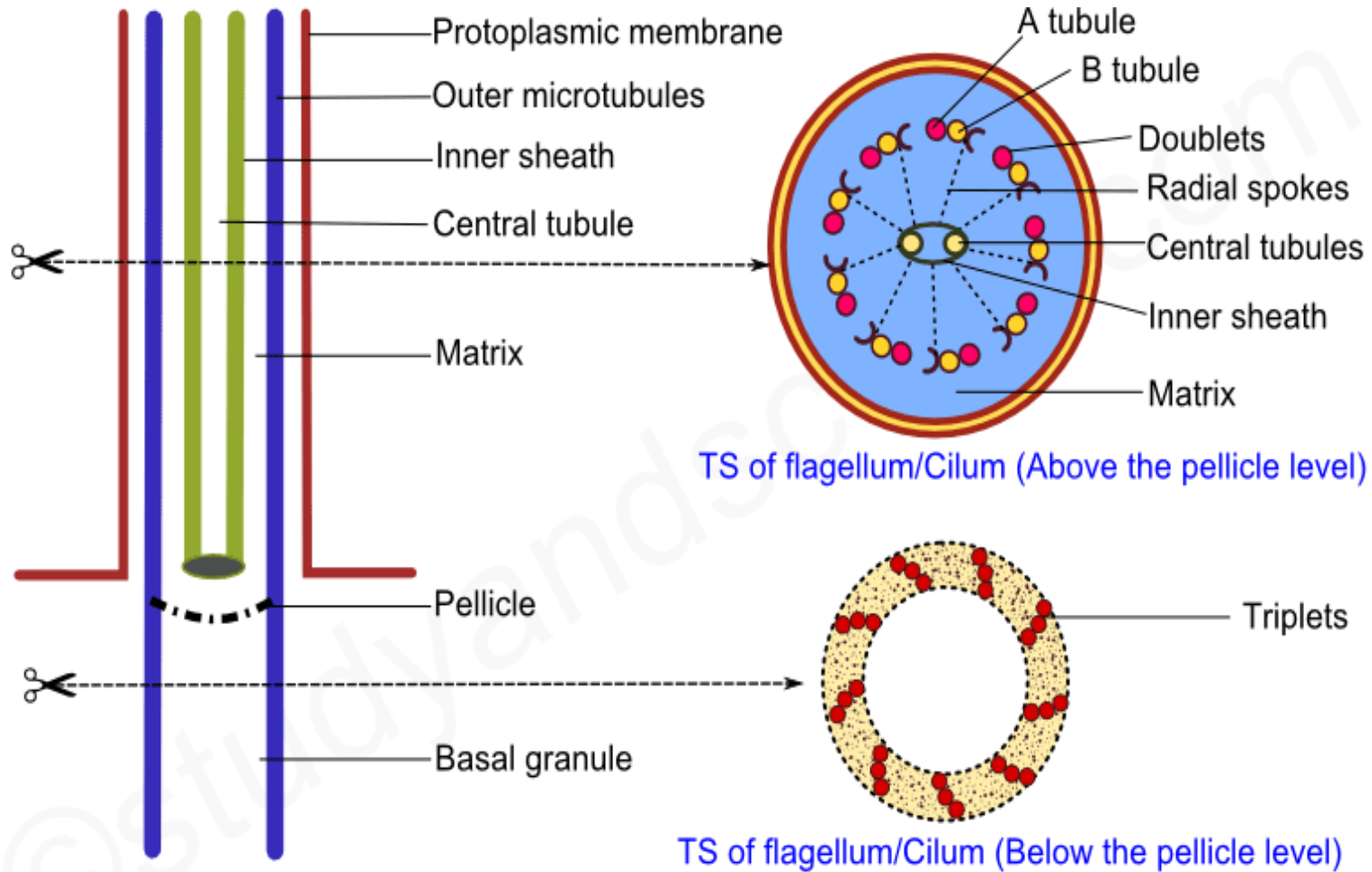
(b) *Blantidium coli*



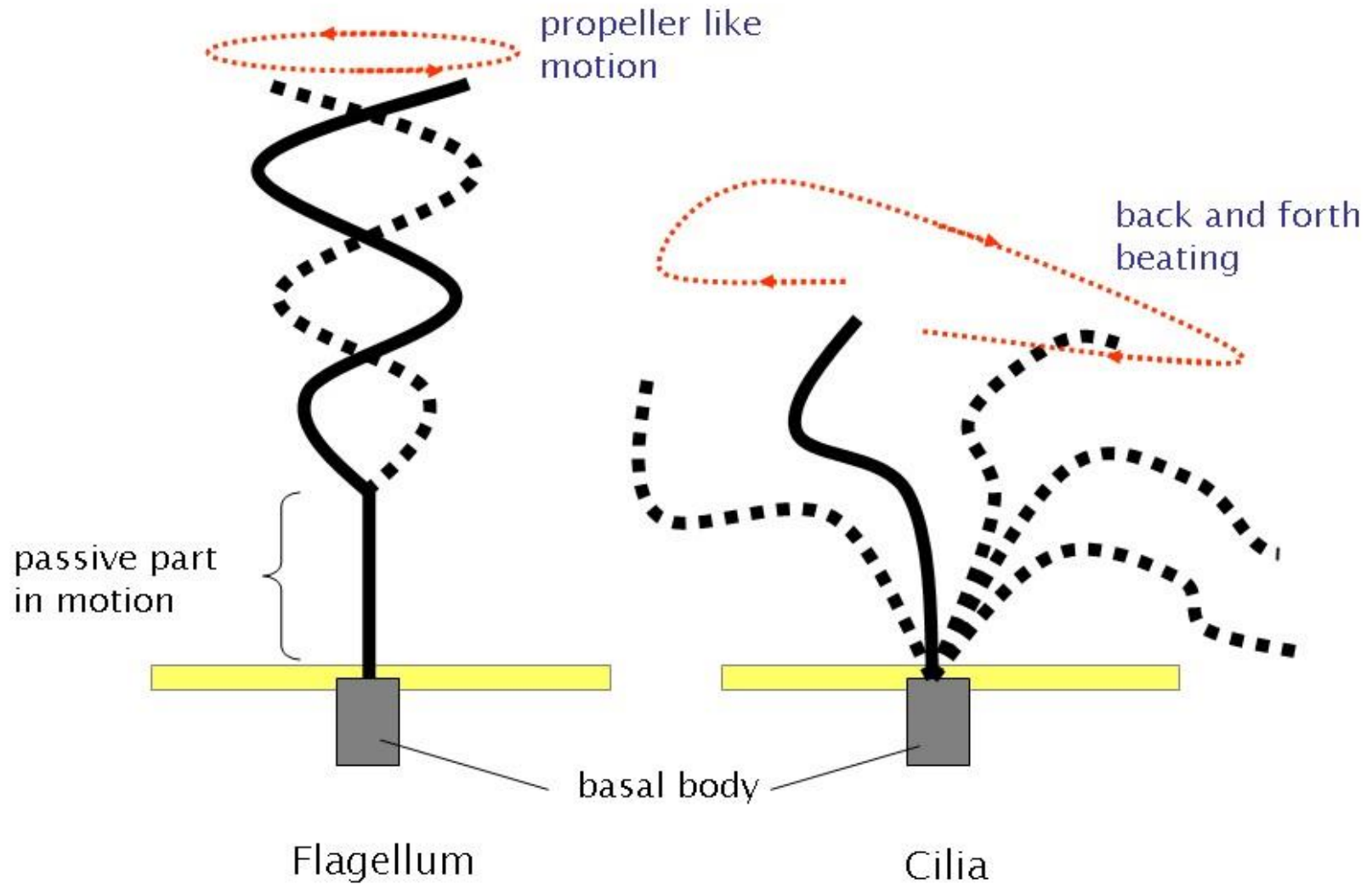
- The collection of tubules is referred to as the ***axoneme*** and it is covered with a membrane continuous with the rest of the organism's cell membrane.
- Axoneme anchors where it inserts into the main body of the cell with a basal body.
- The outer microtubules are connected to the central pair by protein spokes.
- Neighboring pairs of outer microtubules (**doublets**) are connected to each other by an elastic protein.



- Flagellum is powered by **dynein motors** on the outer doublets. As these motors crawl up the adjacent doublet (**movement is powered by ATP**) they cause the entire axoneme to bend.
- The **dynein motors do not cause the doublets to slide past each other** because the doublets are attached to each other by the elastic proteins and the radial spokes and have little freedom of movement up and down. Instead the walking motion causes the doublets to bend.

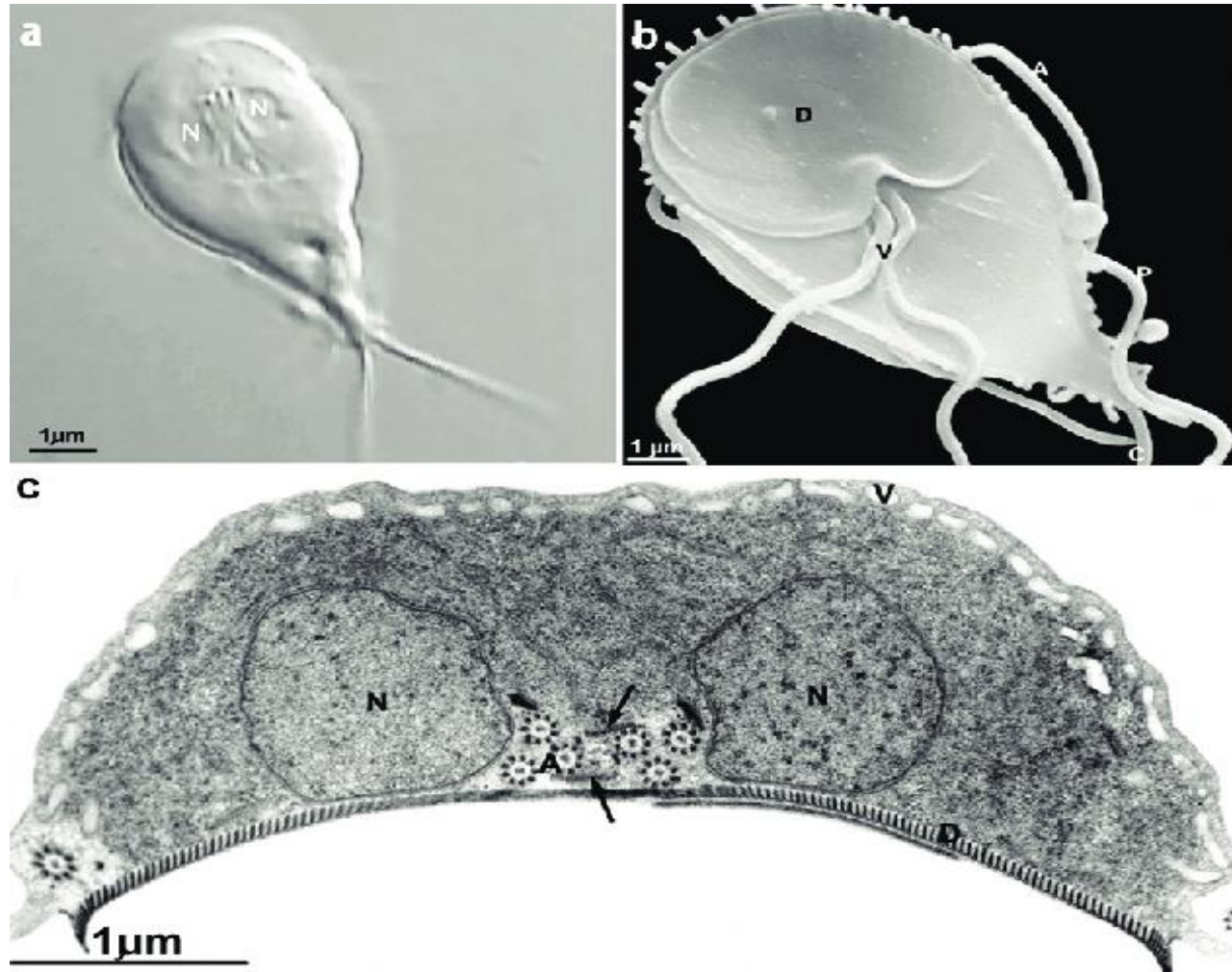


ULTRA STRUCTURE OF FLAGELLUM/CILIUM

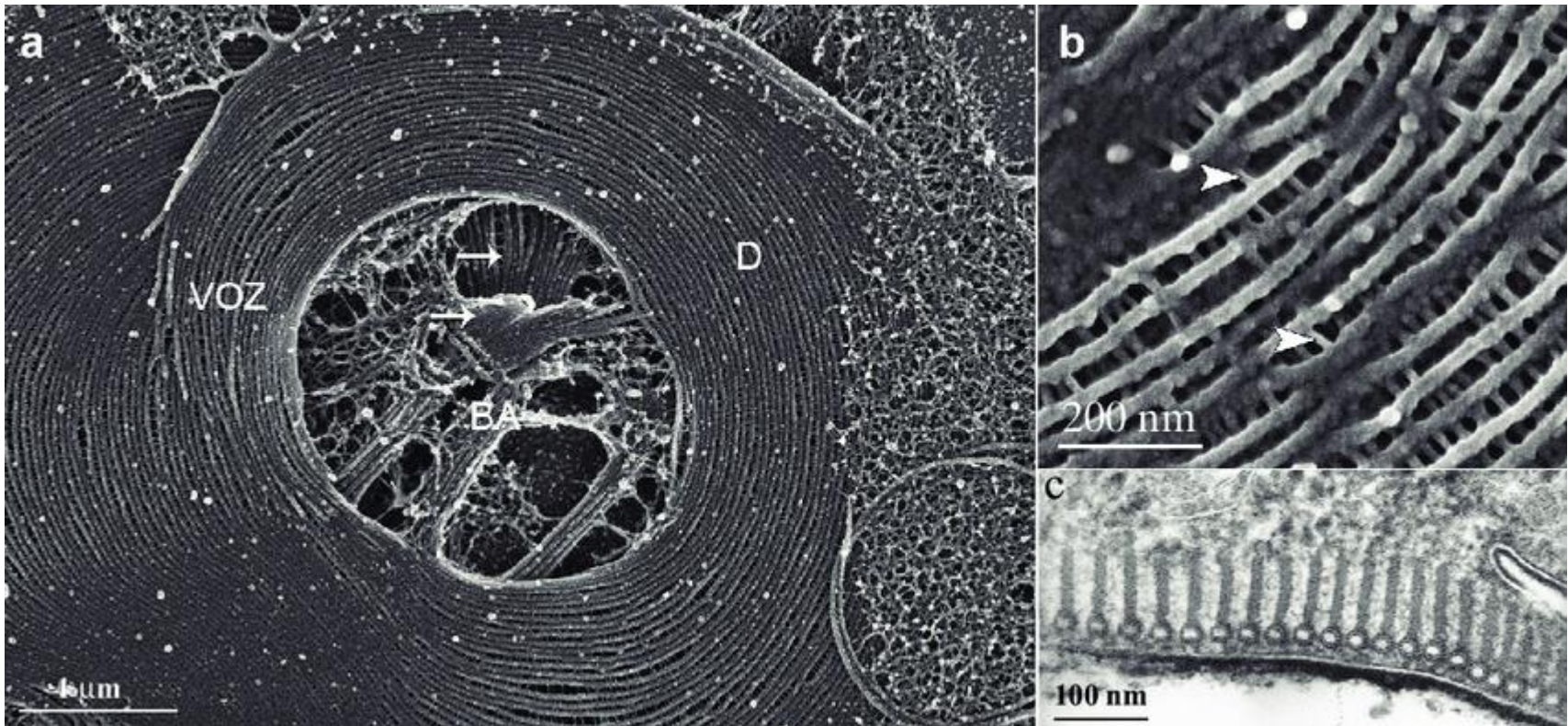


Giardia intestinalis

A general view of *G. intestinalis* trophozoites by light and electron microscopy. (a) Dorsal side of the trophozoite as observed by differential interference contrast (DIC). The two nuclei (N) are observed in the anterior region of the cell. (b) Scanning electron microscopy of the ventral side of the trophozoites. Note that the parasite displays the pairs of flagella (anterior flagella-A, posterior flagella-P, ventral flagella-V, caudal flagella-C), the ventral disk (D), and the ventro-lateral flange. (c) Routine preparation for transmission electron microscopy (TEM) of the trophozoite showing the ventral disk (D), the two nuclei (N), peripheral vesicles (V), flagellar axonemes (A) and funis (arrows) [1]. Bars = 1 μm .



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Cytoskeleton of *Giardia intestinalis* as observed in UHRSEM. (a) The spiral of ventral disk (D) and bare area (*) can be observed. Notice the microtubule nucleation zone with two sets of microtubules (arrows) that form the body ventral disk (D) and the ventral overlap zone (VOZ). (b, c) High magnification showing the microribbons that connect the disk microtubules (arrowheads) as seen by UHRSEM (b) and electron transmission microscopy (c) [1]. Bars = 1 μ m.

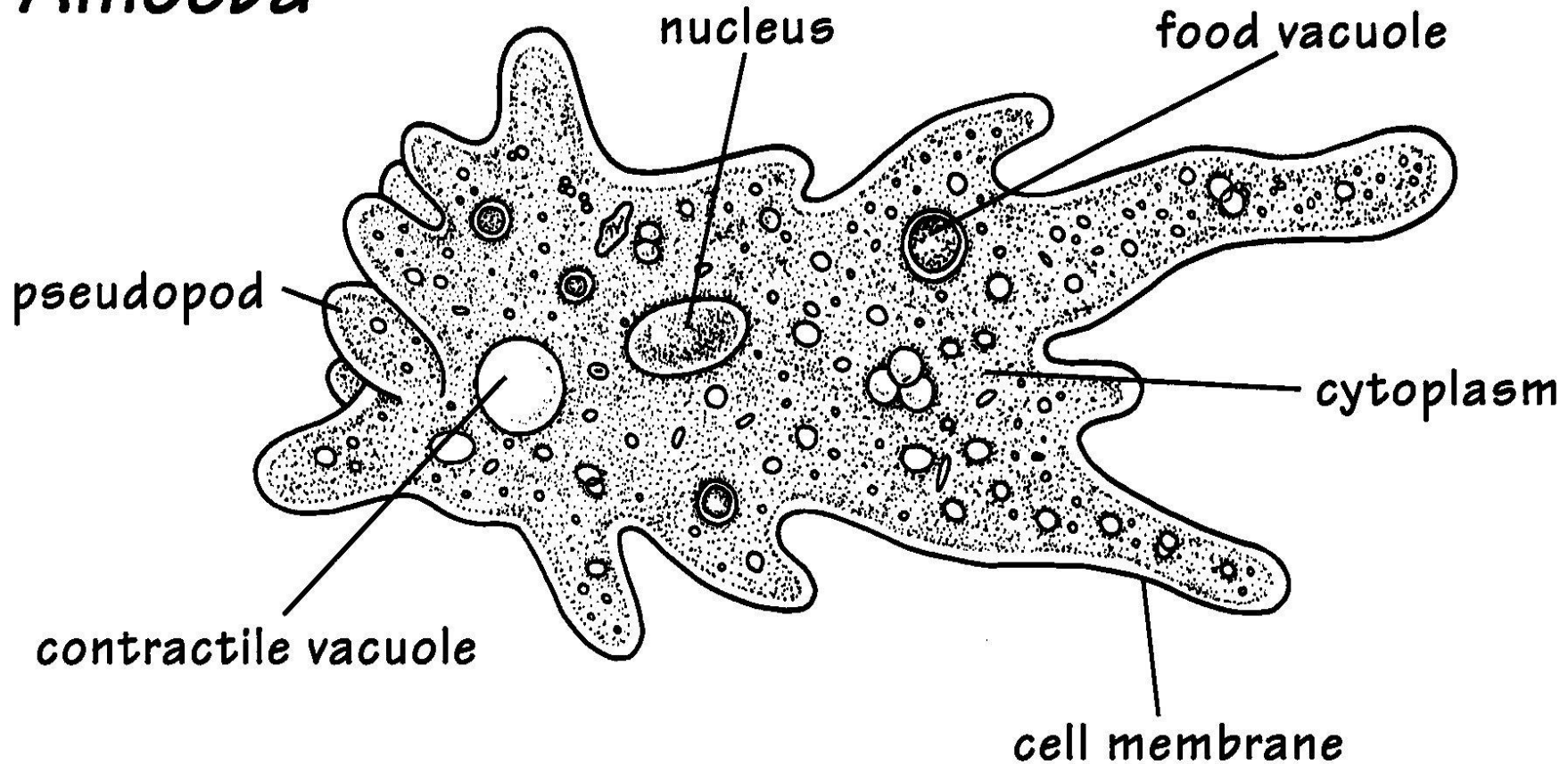


Amoeboid protozoa

- Pseudopodia are chief means of locomotion of amoebas.
- In amoeboid movement the organism extends a pseudopodium in the direction it wishes to travel and then flows into it.
- Amoeboid movement involves endoplasm and ectoplasm. Endoplasm is more fluid than ectoplasm which is gel-like.
- When a pseudopodium forms, an extension of ectoplasm (the hyaline cap) appears and endoplasm flows into it and fountains to the periphery where it becomes ectoplasm. Thus, a tube of ectoplasm forms that the endoplasm flows through. The pseudopodium anchors to the substrate and the organism moves forward.

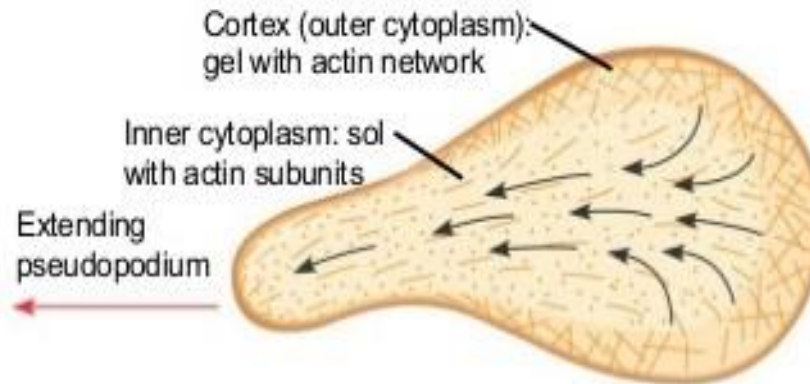


Amoeba





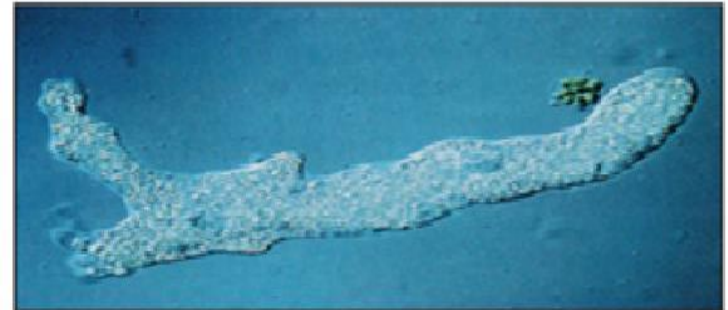
Amoeboid movement



Involves the contraction of actin and myosin filaments [2]

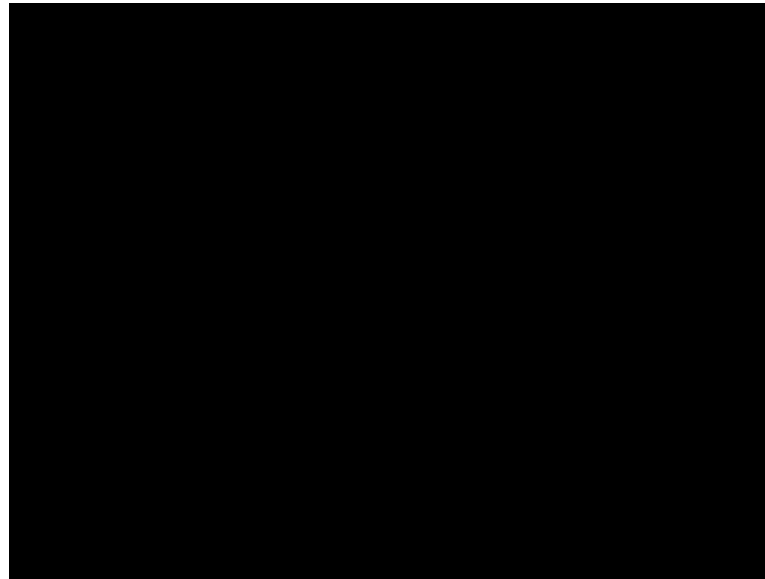
Feeding in amoebas

- Feeding in amoebas involves using pseudopodia to surround and engulf a particle in the process of **phagocytosis**.
- The particle is surrounded and a food vacuole forms into which digestive enzymes are poured and the digested remains are absorbed across the cell membrane.

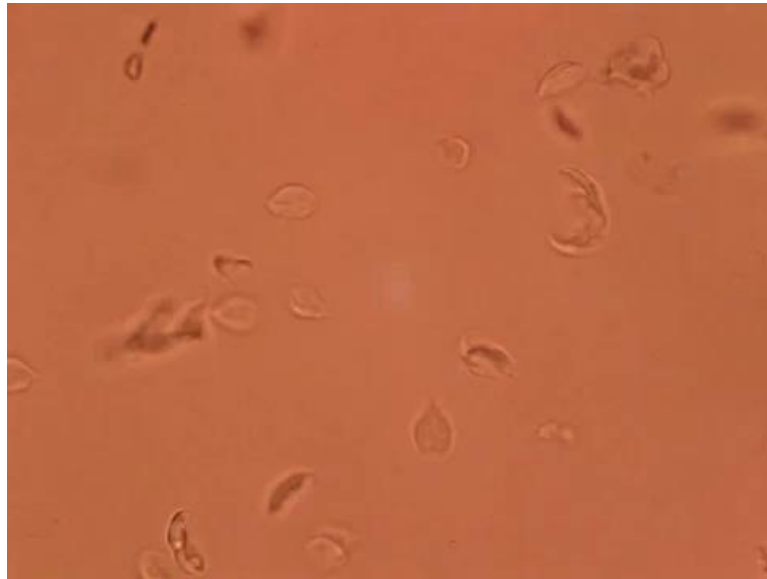




Activity



Amoeba [3]



Giardia lamblia [4]

References

1. <https://www.researchgate.net/publication/321782296> The Cytoskeleton of Giardia intestinalis
2. <https://www.slideshare.net/dalicano/06-cell-text-25594569>
3. <https://www.youtube.com/watch?v=Nn1aSz36Ra0#action=share>
4. <https://www.youtube.com/watch?v=QFZTX2tQt9s&t=12s>