Chapter 1 : Protozoa
(Proto : first ; Zoon : animal)

Presented by Pr. SOUTTOU Karim

Zoology course

Chapter 1 : Protozoa

*Microscopic unicellular organisms (1 to 100 µm), eukaryotic, heterotrophic (lacking chlorophyll), feed by osmosis for parasitic forms or by phagocytosis for free-living forms.

*One single cell performs all vital functions (respiration, digestion, excretion, and reproduction).

*They live in aquatic environments, in moist soils, and as parasites of vertebrates and invertebrates.

* Respiration through simple diffusion of oxygen.

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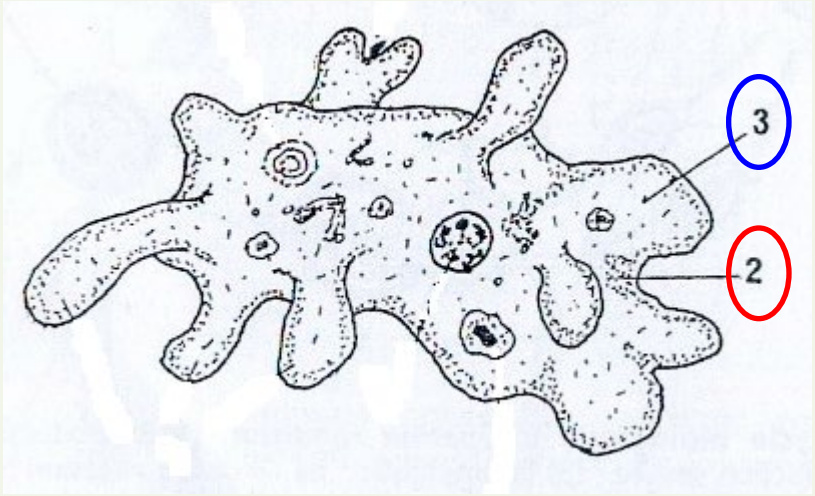
I. – Structural characteristics of protozoa

1.- The cytoplasm: one can distinguish an internal **endoplasm**, fluid, rich in inclusions, and a peripheral **ectoplasm**, hyaline, viscous, elastic, devoid of organelles.



2.- The cytoplasmic membrane: generally thin, resistant, elastic. It can be reinforced by a skeletal envelope of cellulosic nature (Flagellates), chitinous or siliceous (Rhizopoda), or proteinaceous (Sporozoa).

3.- The cytoplasmic organelles:

- The chondriome: mitochondria, is located not far from the nucleus or around the axostyle.

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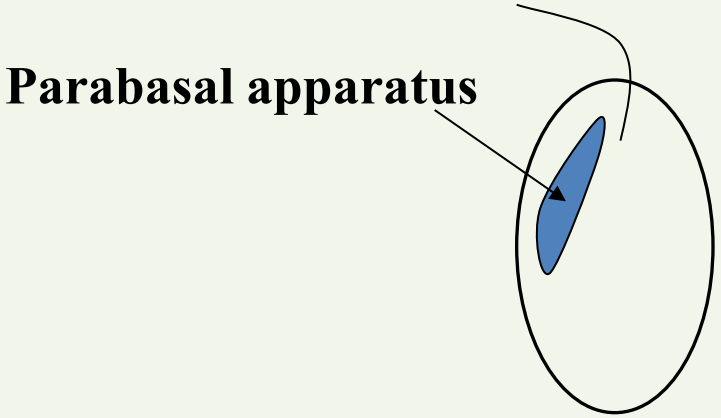
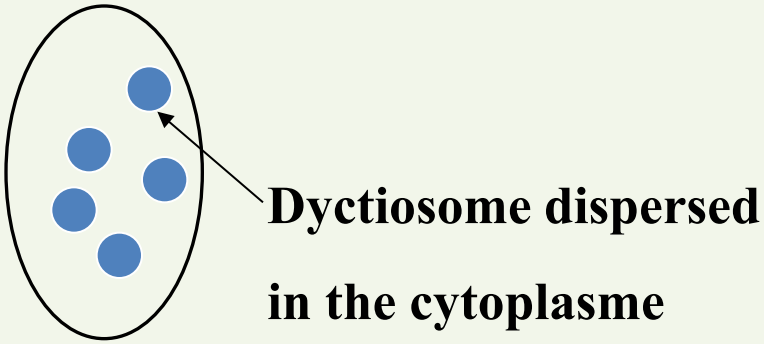
- Golgi apparatus: in Sporozoans, Amoebas, Ciliates (infusoria), and various Flagellates, it is represented by several dictyosomes dispersed in the cytoplasm. In most Flagellates, it is indivisible = parabasal apparatus, of large size.



Flagellates



Other protozoans

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The endoplasmic reticulum: exists in all protozoa, has a granular appearance, exists in the form of flattened, simple, and branched sacs.

Food vacuole: formed around prey ingested by endocytosis, limited by a simple membrane, then the phagosomes (digestive vacuoles) fuse with lysosomes, and the proteolytic enzymes are released into the digestive vacuole. Gradually, the products of digestion diffuse into the cytoplasm, while the waste forms a residual body destined to be eliminated by exocytosis.

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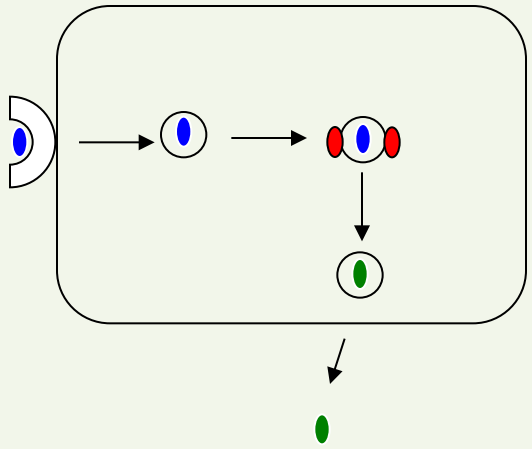

The different stages of phagocytosis

- Food
- Lysosome
- Waste

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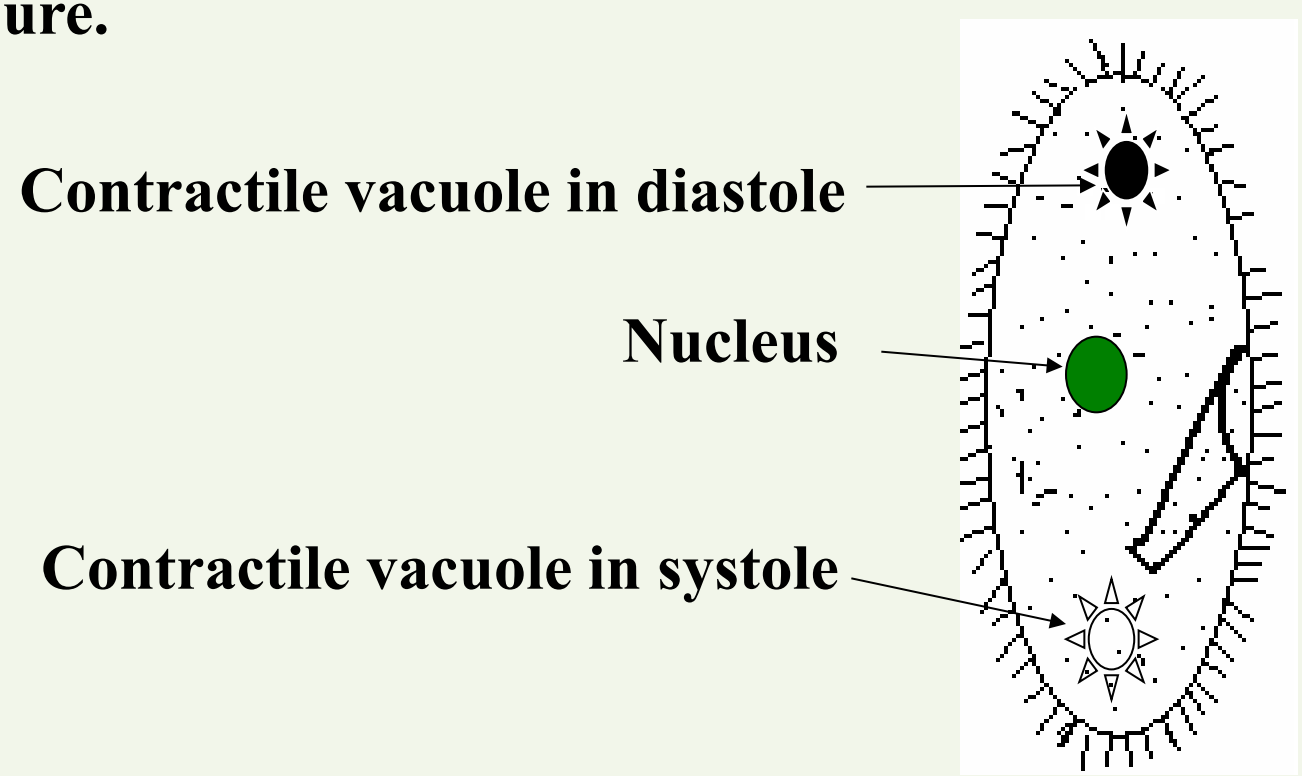
Contractile or pulsatile vacuoles: permanent formations, in a fixed position. Fluid-filled cavities whose contraction expels the contents into the surrounding environment. It exists in free-living species, but is rare in parasites. They participate in the expulsion of metabolic waste and the regulation of osmotic pressure.



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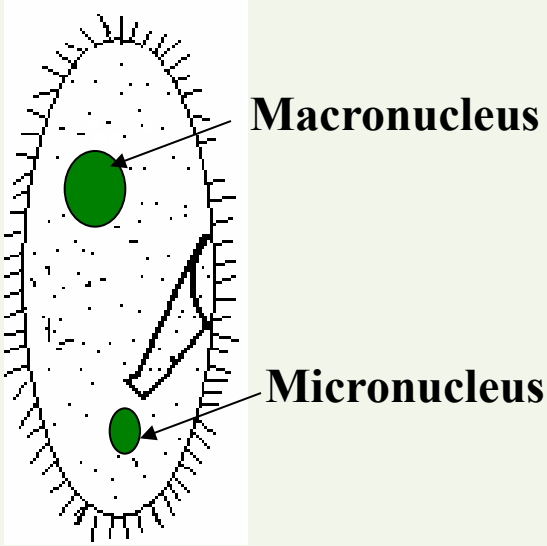
4.- The nucleus:

- Limited by a nuclear membrane (type eucaryote).
- Chromosomes similar to those of metazoans, with a fixed number for each species.
- It contains one or more nucleoli (= caryosome = endosome).
- In ciliates, there is a large nucleus with a trophic function = Macronucleus and a smaller nucleus with a reproductive function = Micronucleus.



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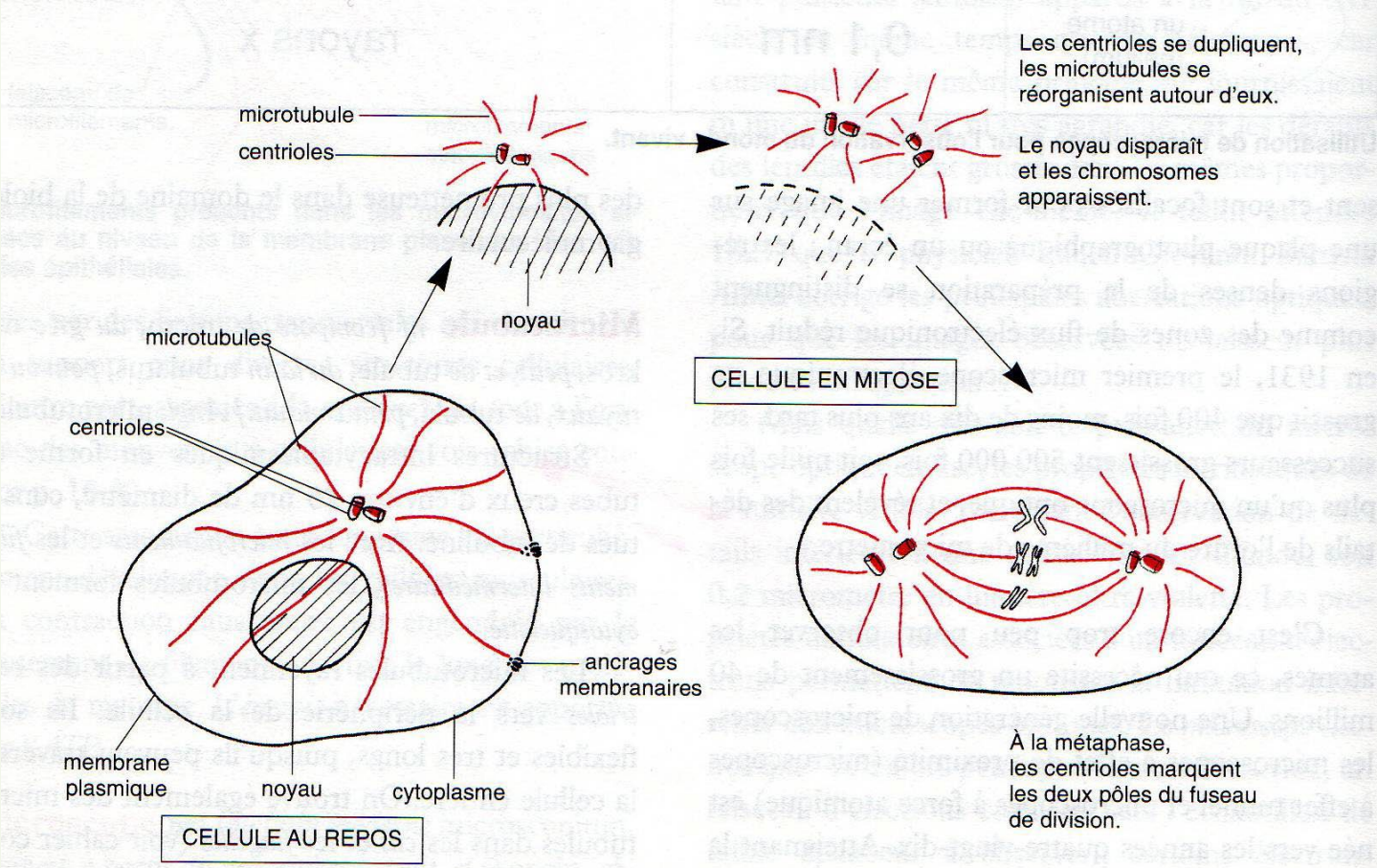
5.- The centrosome: an organelle near or in contact with the nucleus, it exists in most protozoa, but is absent in amoebas.



Rôle des microtubules et des centrioles lors de la mitose.

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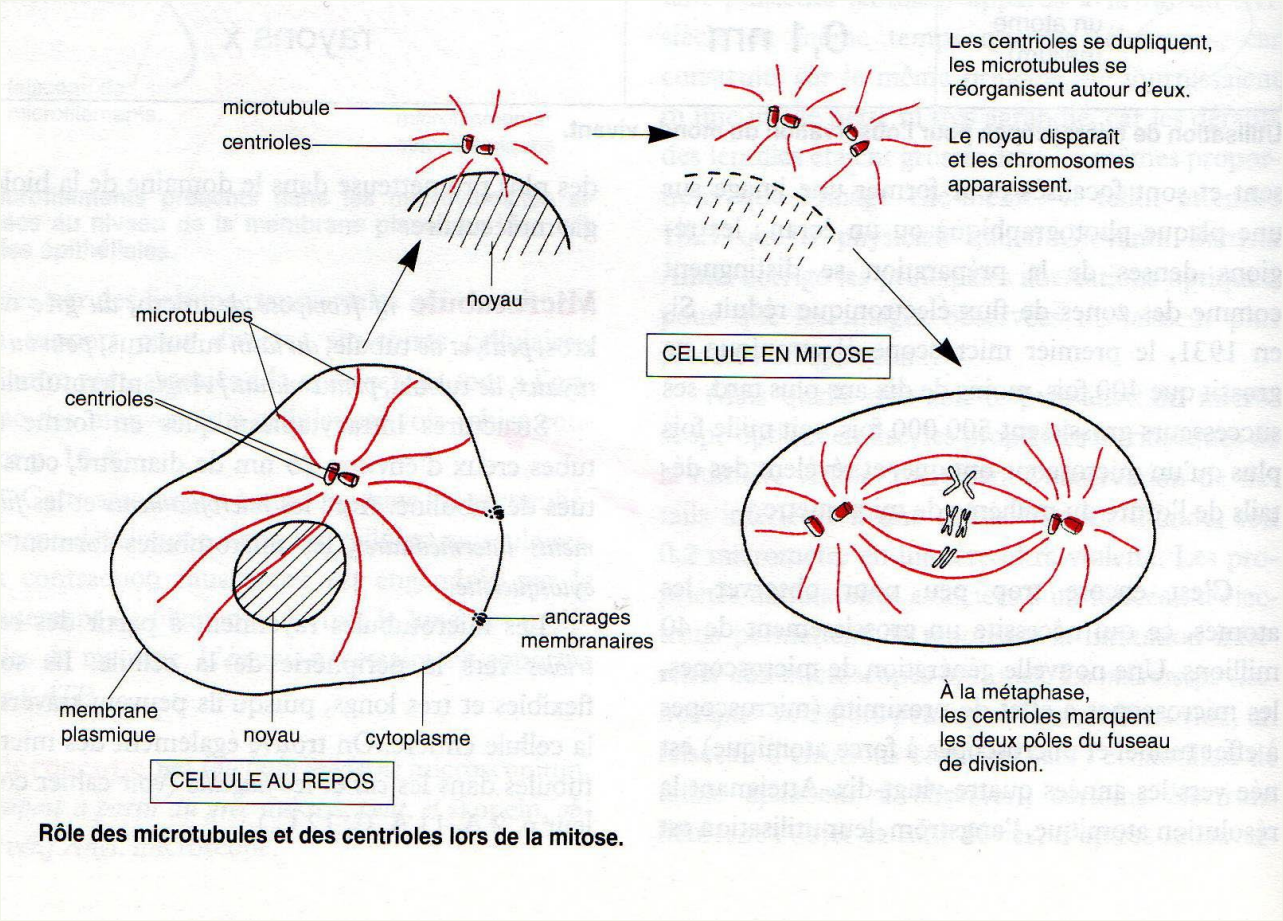
5.- The centrosome: It plays a role in the mitotic division of protozoa by forming the achromatic spindle and in the development of locomotor organelles (flagella, blepharoplast, cilia) and skeletal formations (axostyles and fibrillar system).



Rôle des microtubules et des centrioles lors de la mitose.

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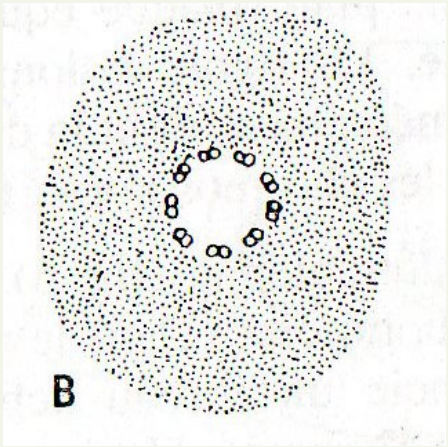
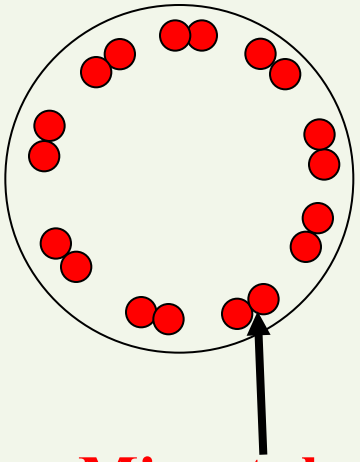
- Centrosome = centriole + archoplasme (mass of cytoplasme).

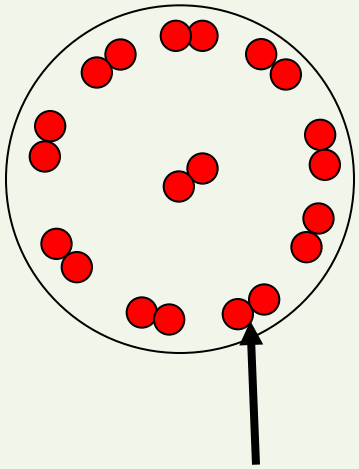
- Centriole : it composed by 9 pairs of microtubules.





- Microtubules: hollow filaments composed of protofilaments and a protein called Tubulin. They contribute to the morphological support of the cell.

- **Blepharoplast (= kinetosome = basals bodies)** : Located at the base of the cilia or flagella. They have the structure of the centriole with an additional axial pair (9 pairs + 2).



- Axostyle : microtubule bundle induces cell rigidity in flagellates.

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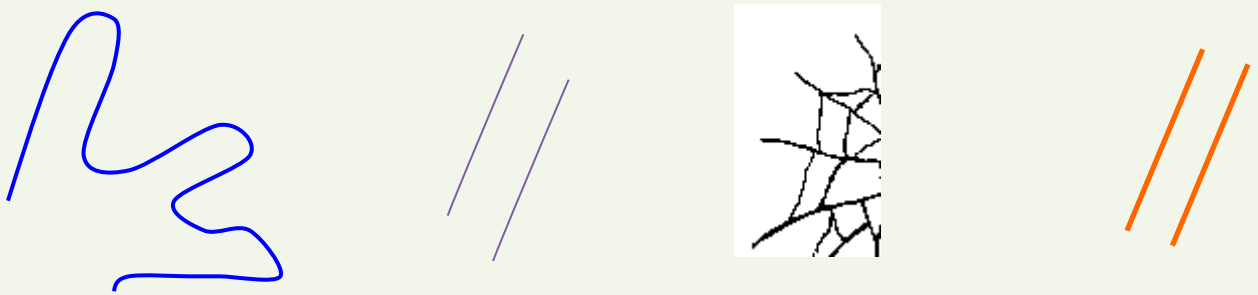
6.- Pseudopodia, cilia et flagella :

Protozoa move chiefly by cilia and flagella and by pseudopodial movement. These mechanisms are extremely important in the biology of higher animals as well.

- **Pseudopodia :** peripheral and temporary expansions, related to differences in cytoplasmic fluidity allowing crawling on the surface of a substrate. Pseudopodia can be **lobopodia** (Amoebae), **filopodia** (Foraminifera), **reticulopodia** (Foraminifera and Acantharia), and **axopodia** (Acantharia and Heliozoa).



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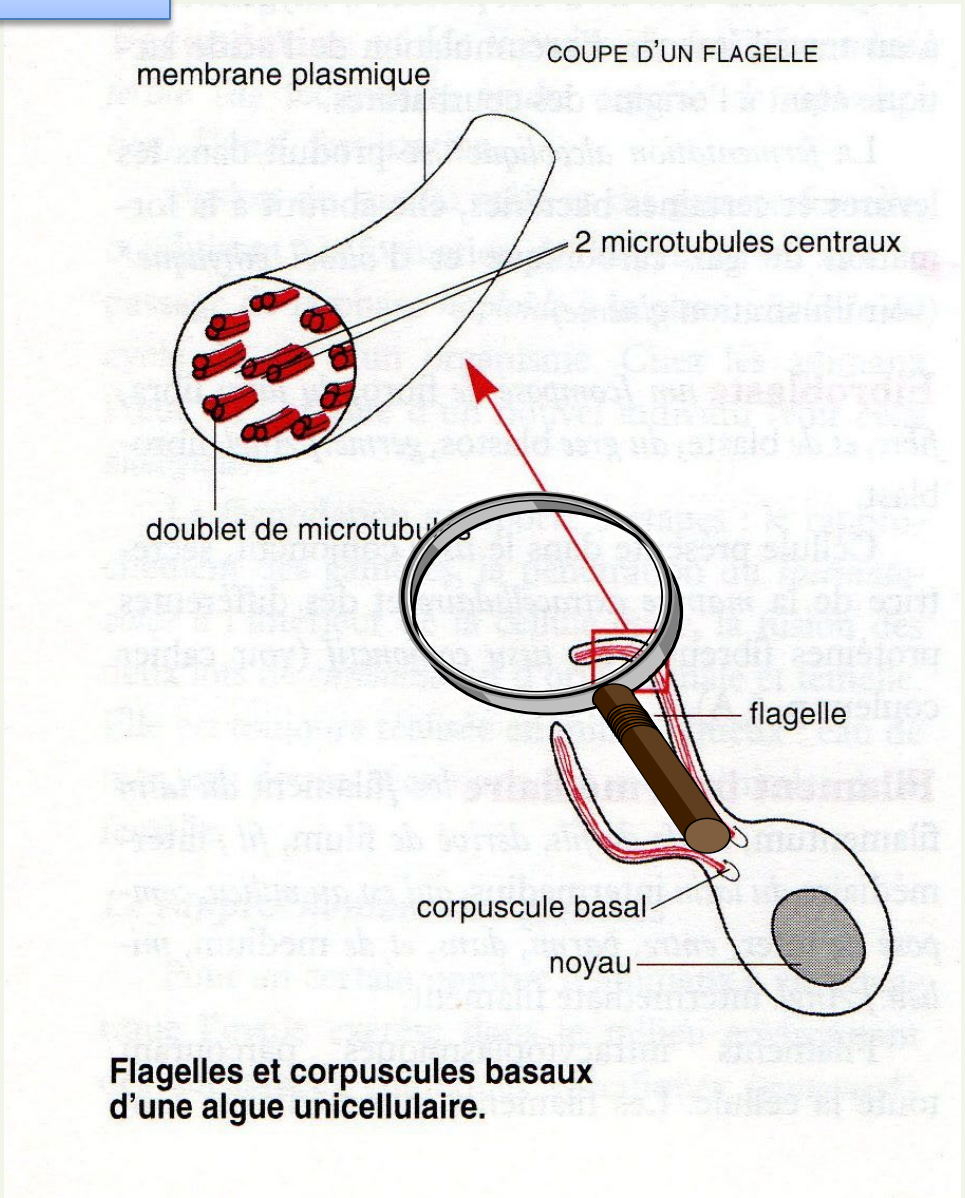
- **Flagella et cilia : permanent cytoplasmic expansions, supported by a framework of microtubules associated with contractile microfilaments.**



Flagelles et corpuscules basaux d'une algue unicellulaire.

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7.- Reproduction: The adult stage of the protozoan, outside of reproduction, is called trophozoite. There are two types of reproduction: asexual and sexual.

- Asexual reproduction: it is advantageous because it is more energy-efficient. However, it maintains low genetic variability within the lines, which reduces the speed at which the lines can evolve. Asexual reproduction can be:

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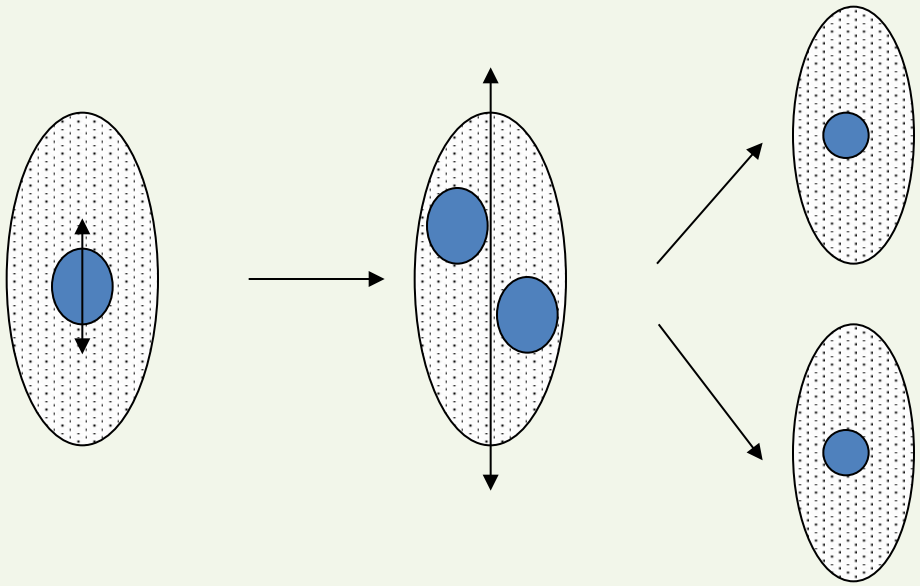
- **Binary fission :**



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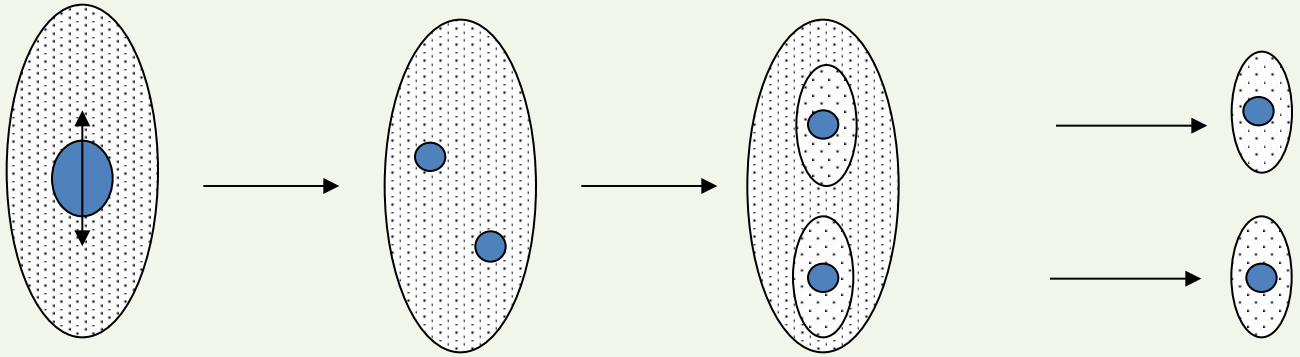
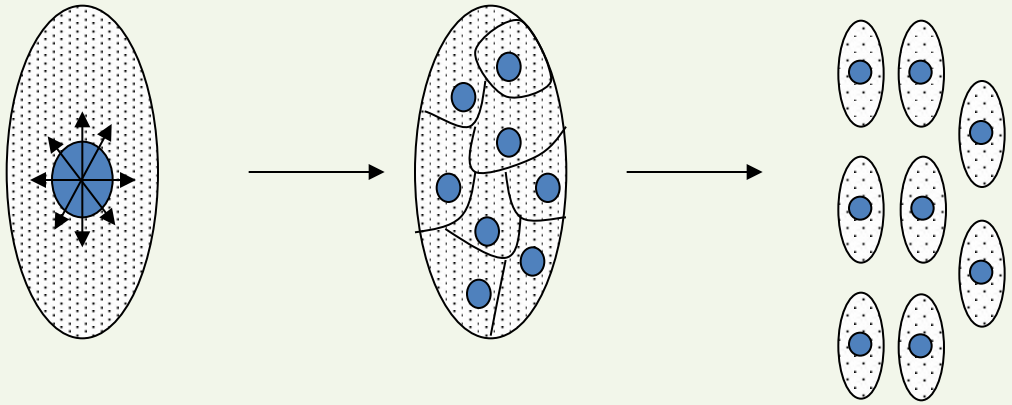
- Internal budding :



- Multiple fission (Schizogony) :



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- **Sexual reproduction :**

- Gametogony: The trophozoite transforms into a gamont (= gametocyte), which will produce one or more gametes. The fusion of 2 gametes (= syngamy) produces an egg or zygote.

- The two gametes of the fusion are identical = Isogamy.

- The two gametes are very different, which allows for the distinction between a female gamete (macrogamete) and a male gamete (microgamete), resulting in anisogamy.

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- **Sexual reproduction :**

Sometimes fertilization is followed by repeated, asexual divisions, leading to the production of spores: sporogony.

Conjugation: especially known in ciliates, conjugation, in which an exchange of gametic nuclei occurs between paired organisms (conjugants): See Ciliates.

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Forms of resistance: Ensures the dissemination of protozoa and protects them from desiccation. Their production is often accompanied, or followed by the division of the parasite, and can therefore be linked to reproductive phenomena.

Cysts: formed by the production of a thick shell surrounding the protozoan in its entirety and created by the protozoan itself. They can from an egg (= oocyst) or from a trophozoite (= vegetative cyst).

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I. – Subkingdom Protozoa

1. – Phylum Mastigophora

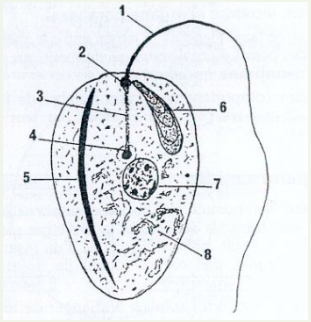
2. – Phylum Rhizopoda

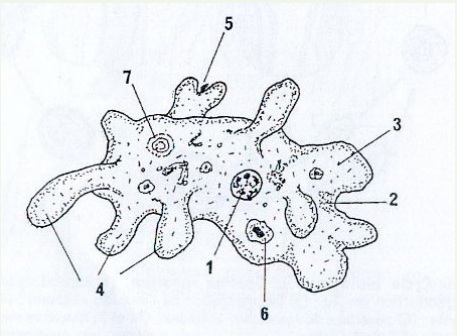
3. – Phylum Actinopoda

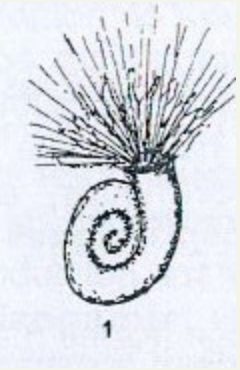
4. – Phylum Apicomplexa

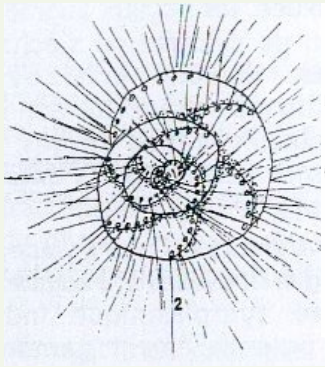
5. – Phylum Ciliophora

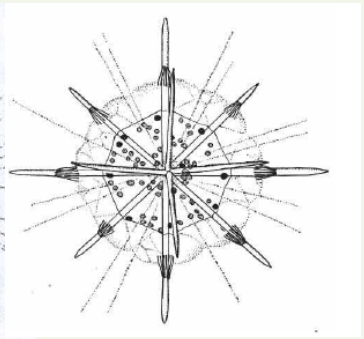
6. – Phylum Cnidosporidia

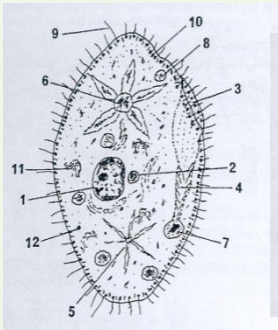


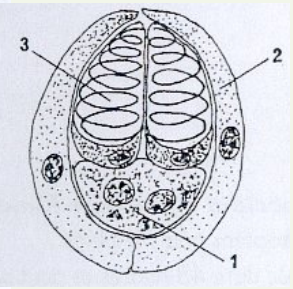




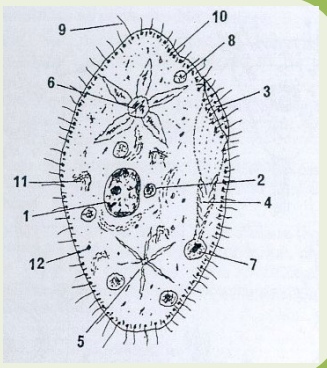




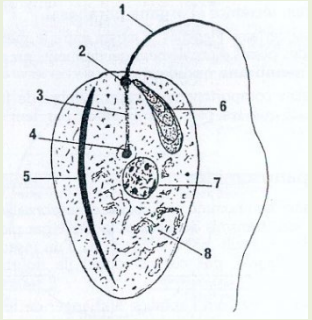




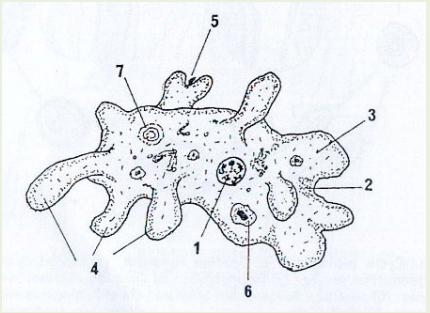
Phylum of Ciliophora have cilia as a locomotor organ.



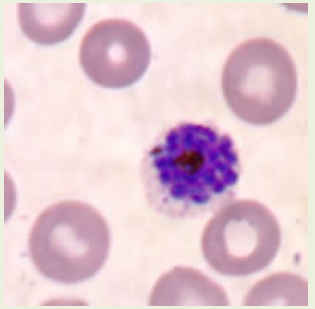
Phylum of Mastigophora have a flagella as a locomotor organ.



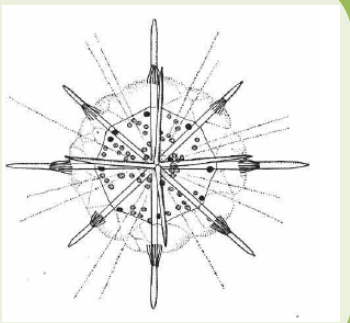
Phylum of Rhizopoda have a pseudopodia as a locomotor organ.



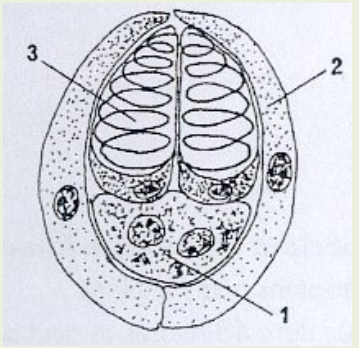
Phylum of Apicomplexa are intracellular parasites, devoid of any locomotor organelles.



Phylum of Actinopoda have a pseudopodia as a Locomotor organ.



Phylum of Cnidosporidia are parasites of invertebrates and vertebrates.



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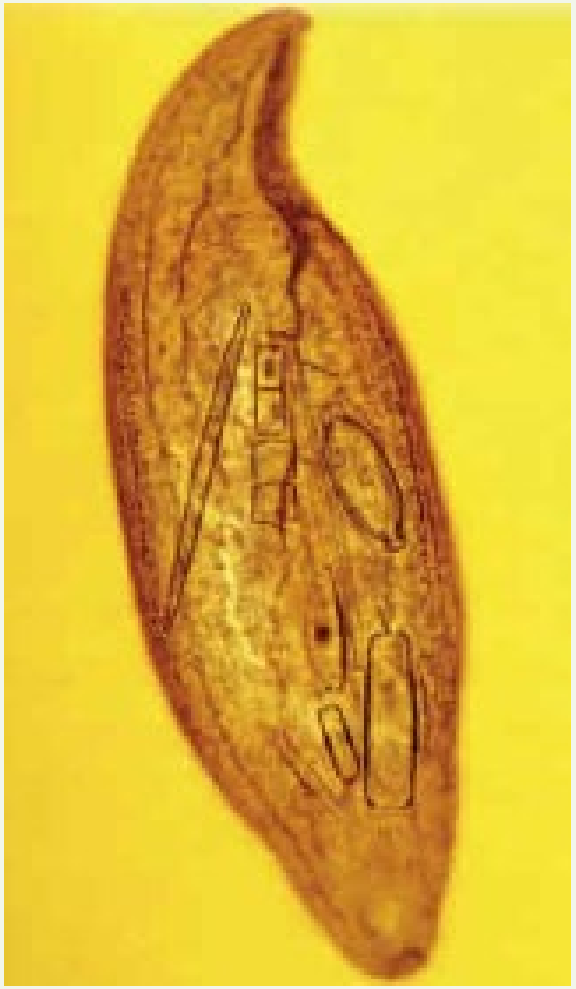
1. – Phylum Ciliophora

It is the Protozoa that exhibit the highest degree of organization. The different parts of the cell are morphologically and physiologically specialized: there is intracellular differentiation.



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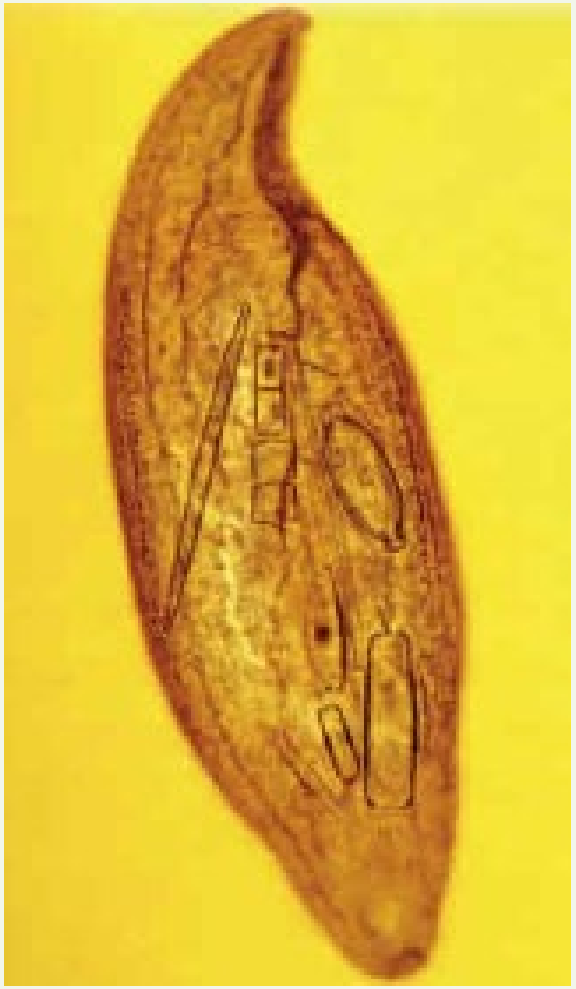
1. – Phylum Ciliophora

The body is covered with cilia arranged in regular rows, the coordinated beating of the cilia allows for locomotion as well as the intake of food particles and the renewal of oxygen.



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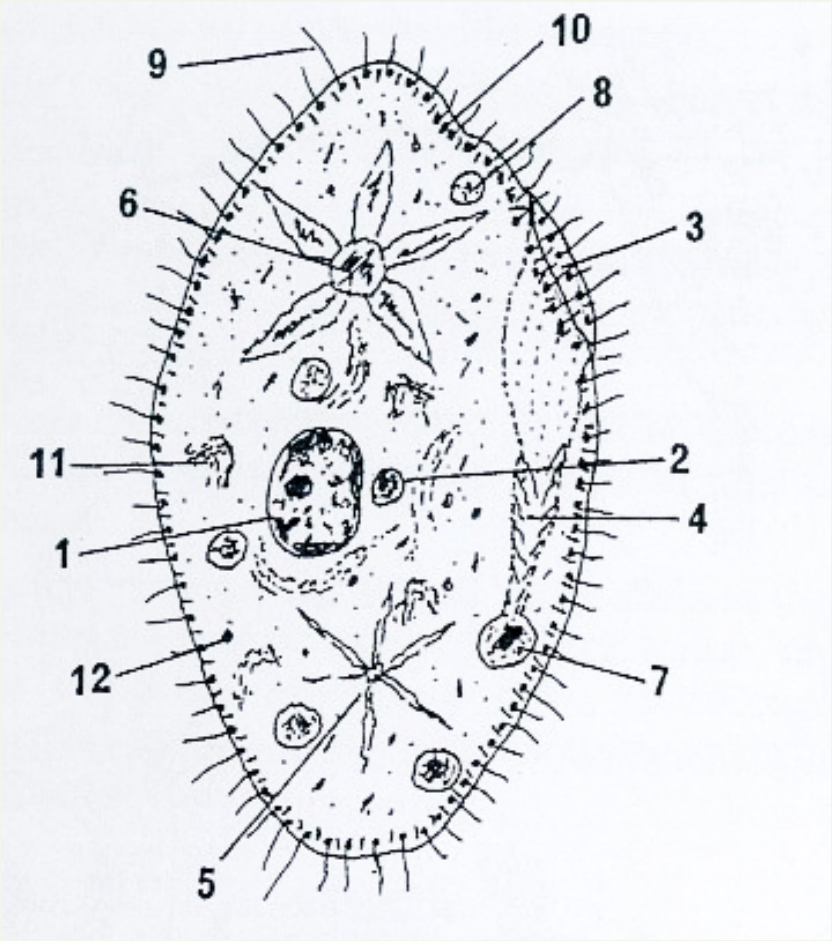
They possess two nuclei, one large (Macronucleus = 1) and the other small (Micronucleus = 2).

The first is involved in metabolism, the second in the cycle of reproduction and sexual division.



(1) macrocucleus, (2) micronucleus, (3) oral grove, (4) cytopharynx, (5) contractile vacuole in systole, (6) contractile vacuole in diastole, (7) food vacuole, (8) cytoproct, (9) cilium, (10) trichocyst, (11) various organelles, (12) enclaves.

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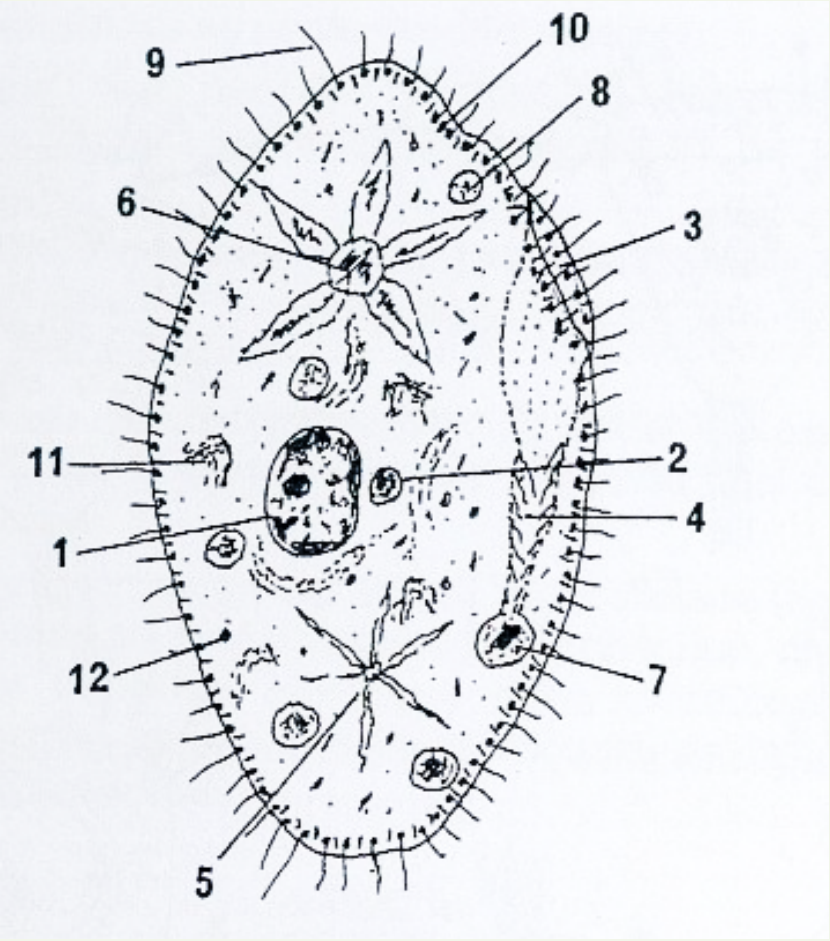
Presence of two contractile vacuoles, one at the top and the other at the bottom. These two pulsatile vacuoles (5 and 6) function alternately: when one is in diastole, the other is in systole.



(1) macrocucleus, (2) micronucleus, (3) oral grove, (4) cytopharynx, (5) contractile vacuole in systole, (6) contractile vacuole in diastole, (7) food vacuole, (8) cytoproct, (9) cilium, (10) trichocyst, (11) various organelles, (12) enclaves.

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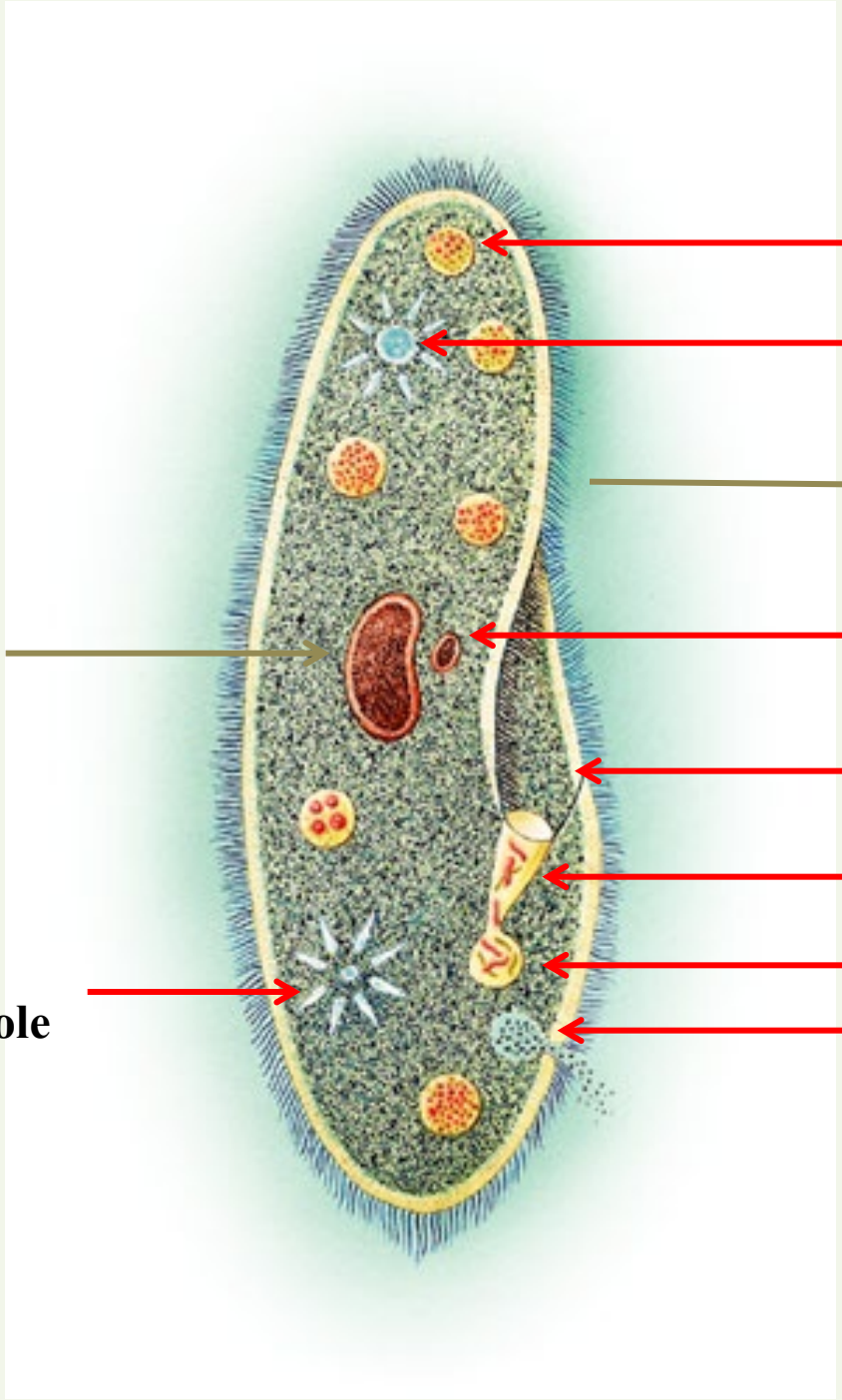
- They inhabit freshwater, soil, and marine waters.

- They encyst themselves in unfavorable conditions.

- Most Ciliates can encyst when conditions are unfavorable. There is rounding, loss of cilia, the cytopharynx, and digestive vacuoles. The surface secretes a resistant film and continues to differentiate: only the nucleus is visible. The cytoplasm slightly dehydrates and the cell enters a state of slowed life. This phenomenon ensures the resistance and dissemination of the species.


Food vacuole
Contractile vacuole in diastole
Cilium
Macronucleus
Micronucleus
Oral grove
Cytopharynx
Contractile vacuole in systole
Food vacuole
Cytoproct

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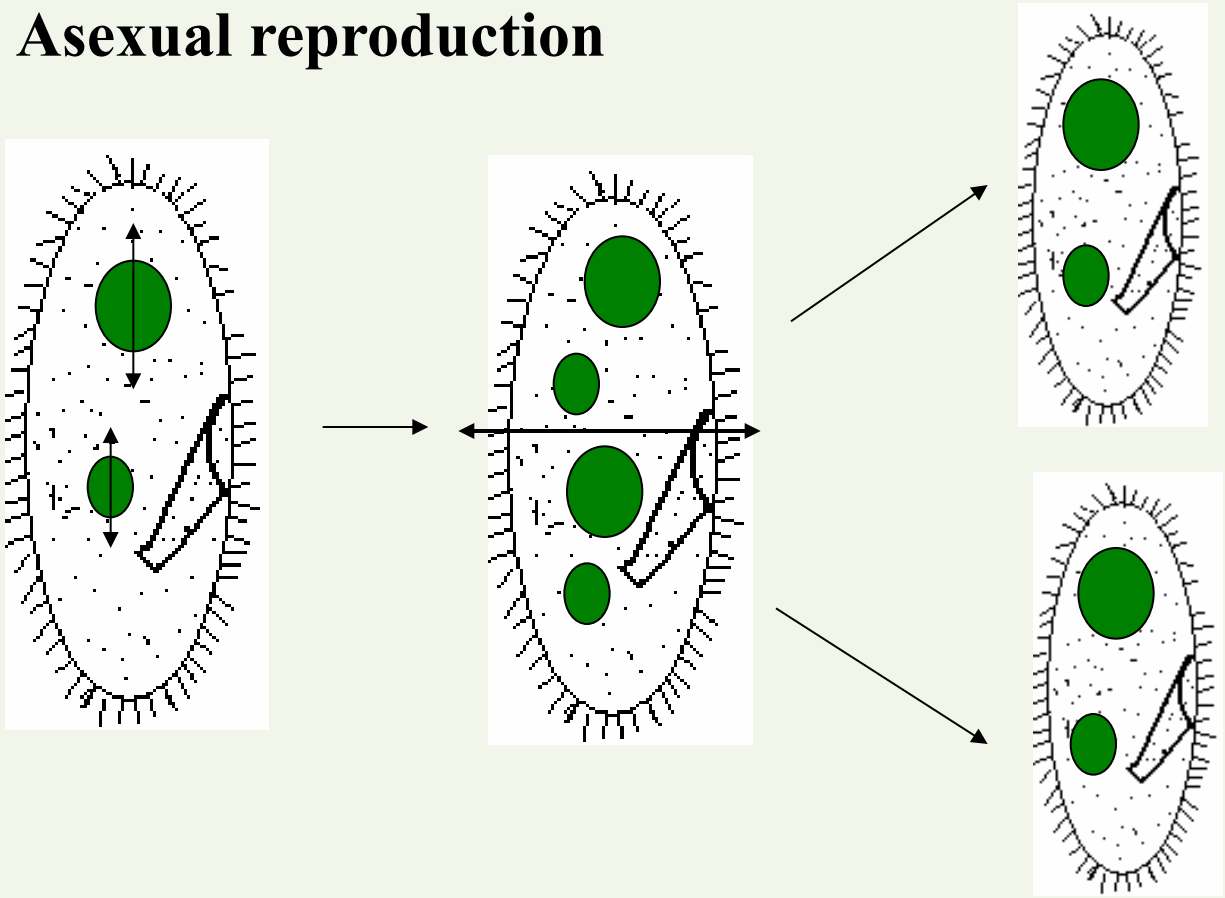
* Asexual reproduction



Binary fission in a ciliophoran

Division is transverse, across rows of cilia

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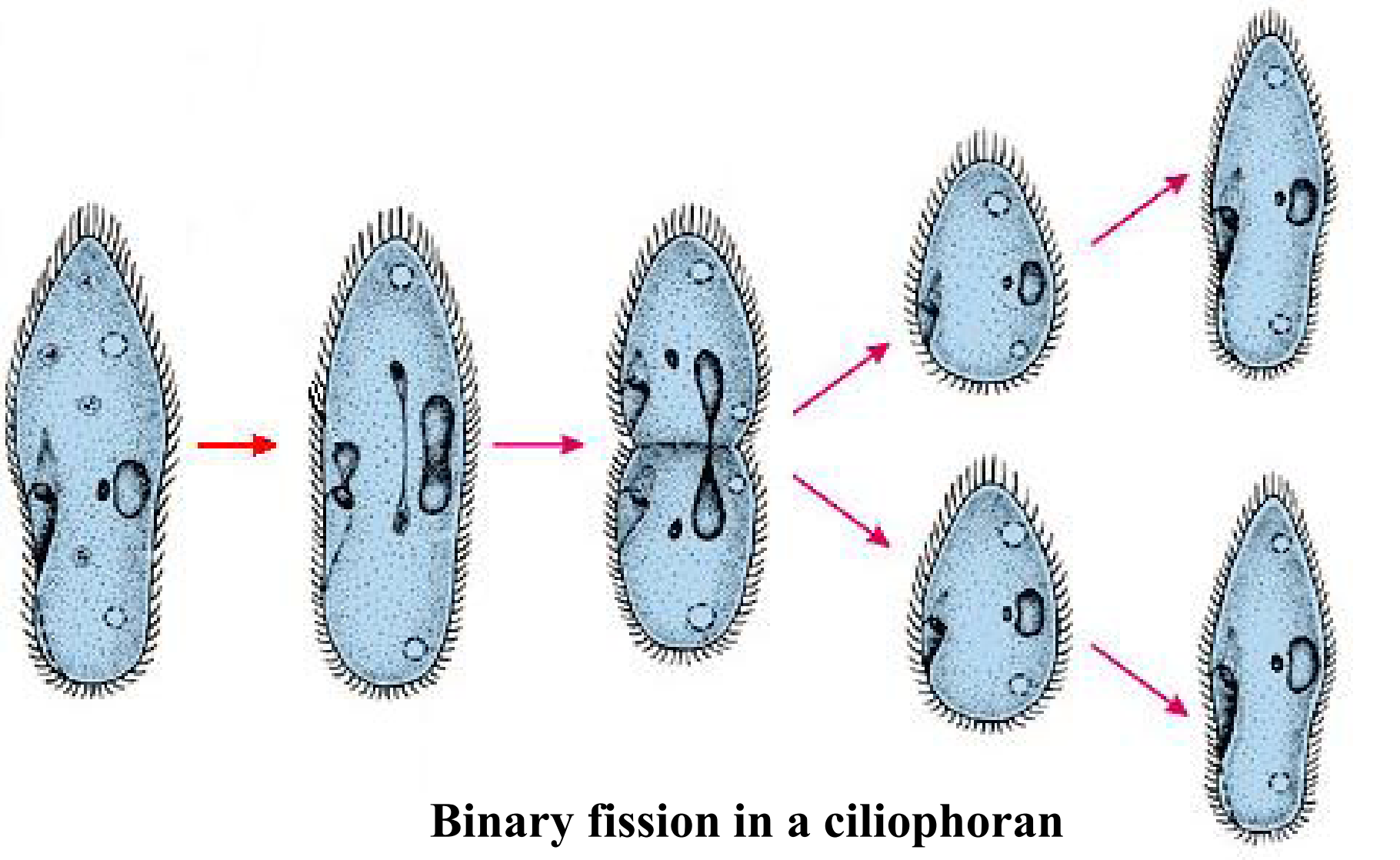

Binary fission in a ciliophoran

Division is transverse, across rows of cilia

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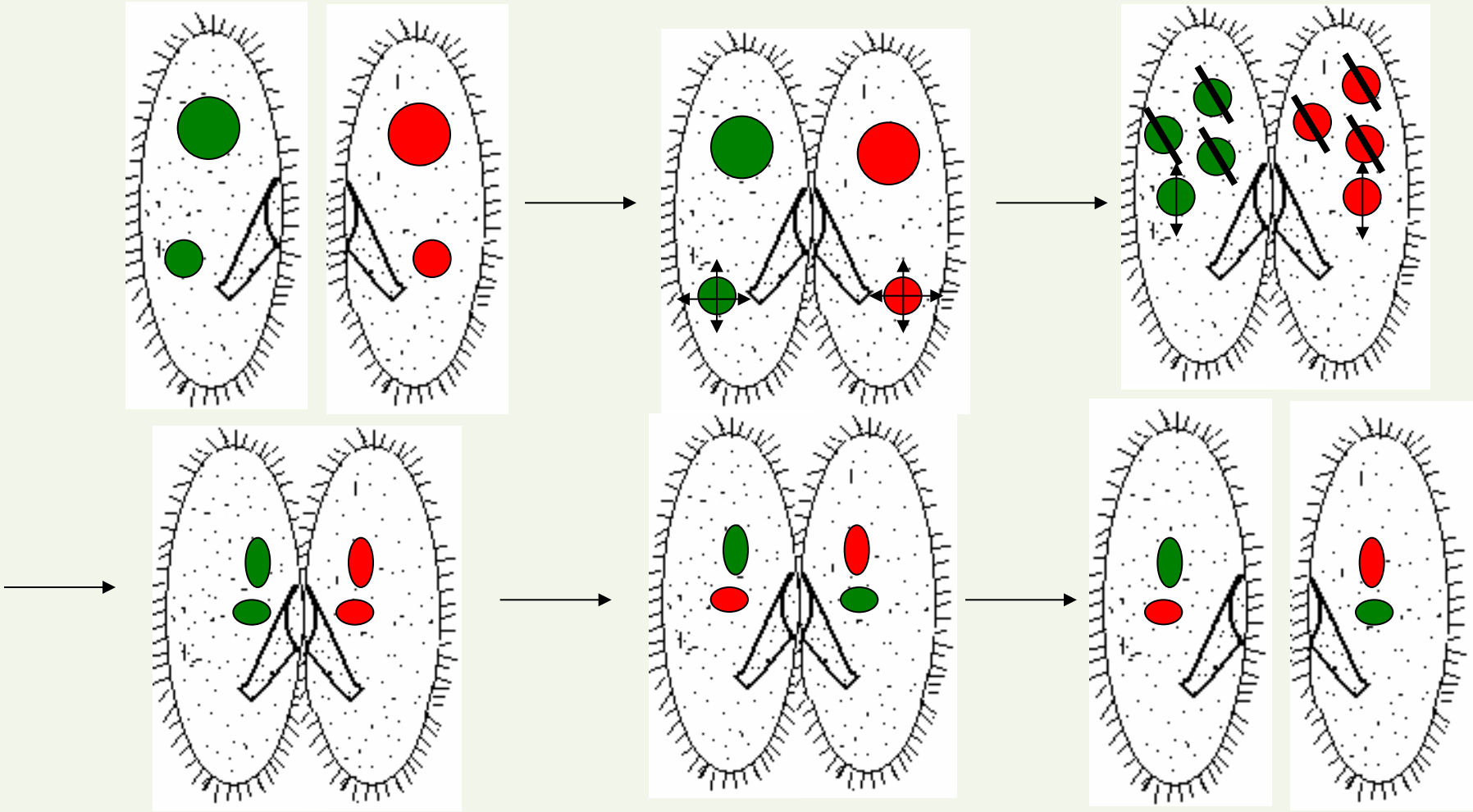
* Sexual reproduction : Conjugation



Scheme of conjugation in *Paramecium*

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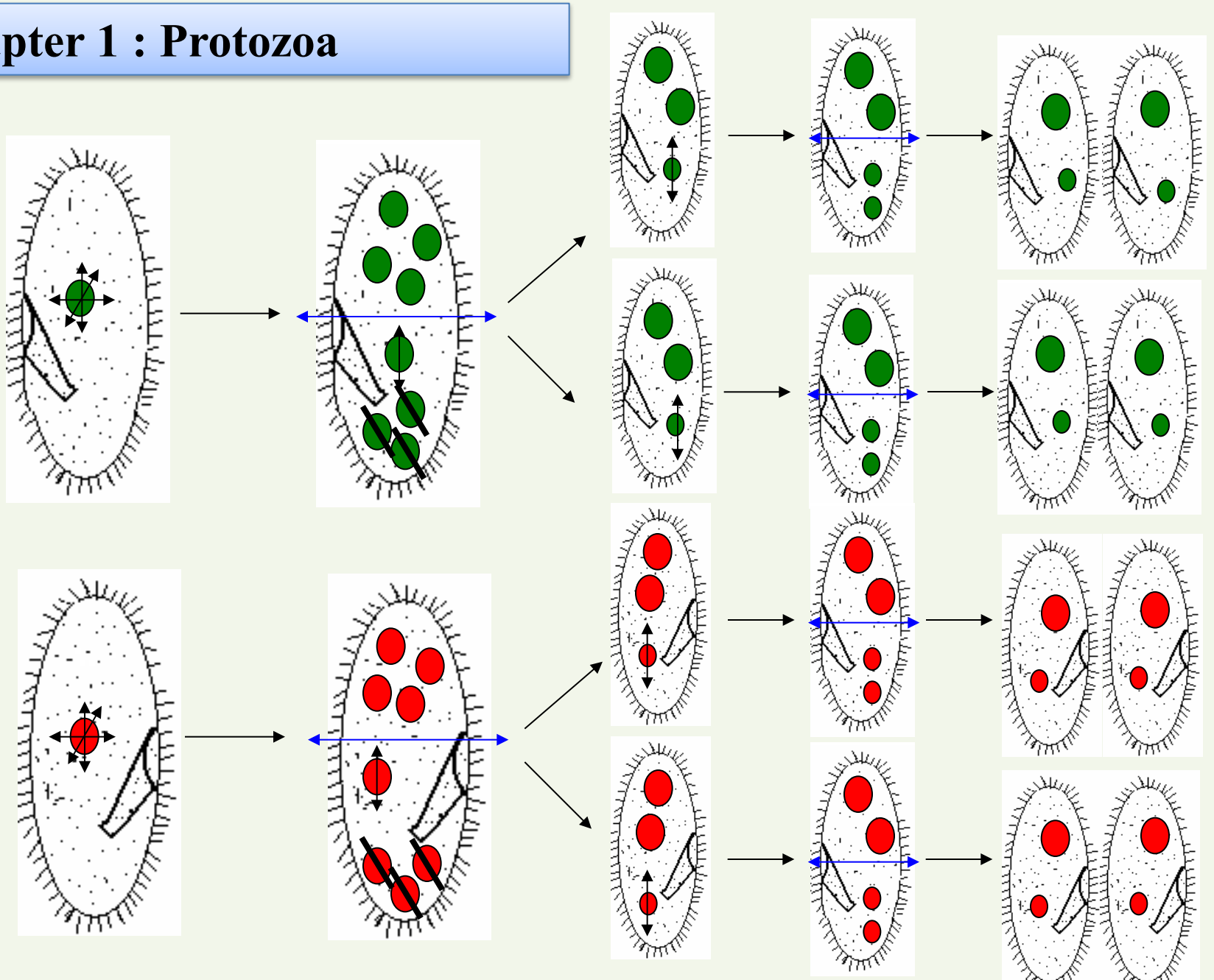

Scheme of conjugation in *Paramecium*

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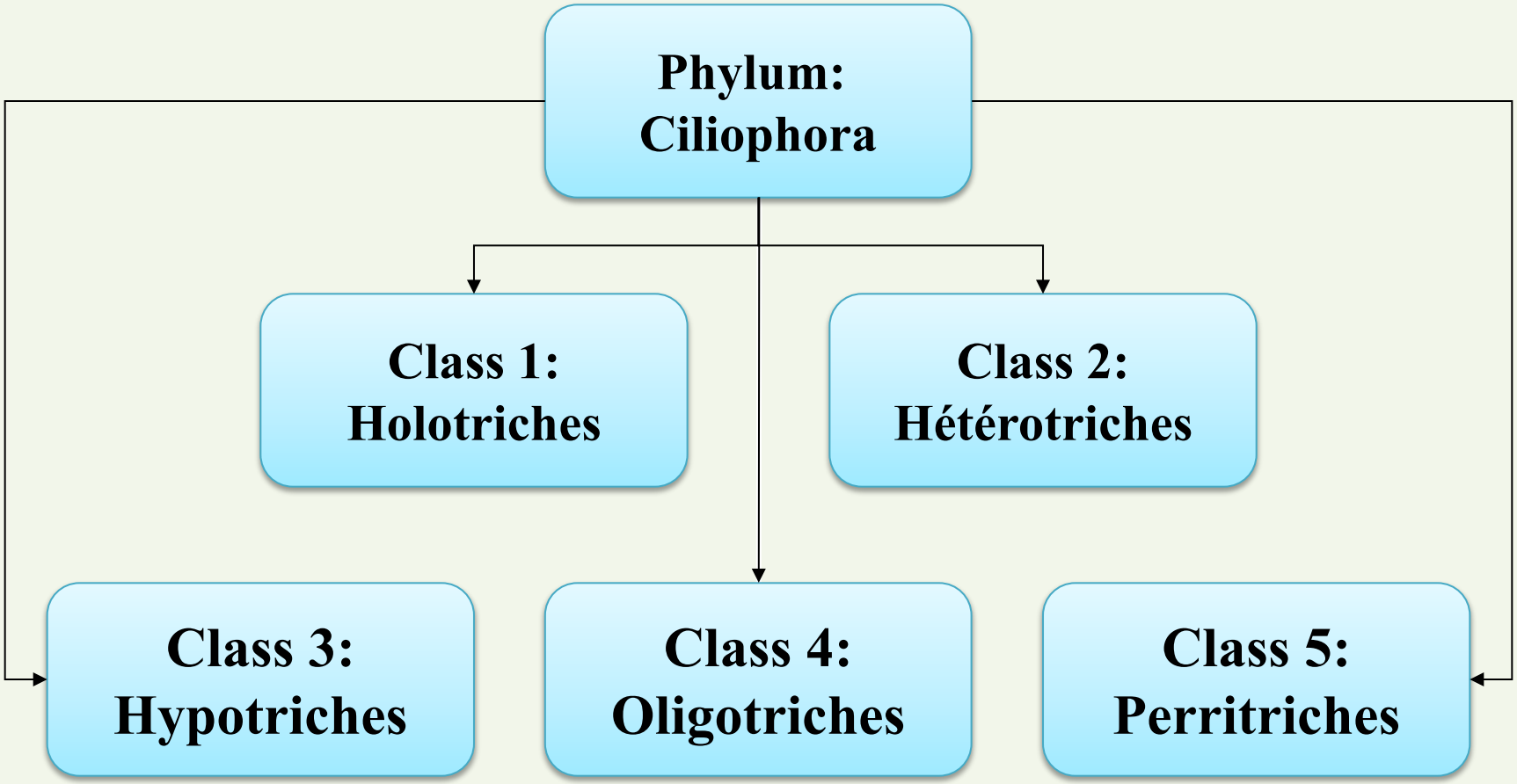

Phylum of Ciliophora

a) Class 1 : Holotriches : (Holo : homogeneous; triches : cilia) : The cilia are evenly distributed, absence of an adorale fringe.

b) Class 2 Heterotriches : (Hetero : different; triches : cilia) : The cilia are evenly distributed, présence of an adorale fringe.

c) Class 3 Oligotriches : (Oligo : few; triches : cilia) : The cilia on some parts of the body.

d) Class 4 Hypotriches : (Hypo : ventral; triches : cilia) : The cilia on the ventral side.

e) Class 5 Perritriches : (Peri : around; triches : cilia) : The cilia of an adorale fringe only.

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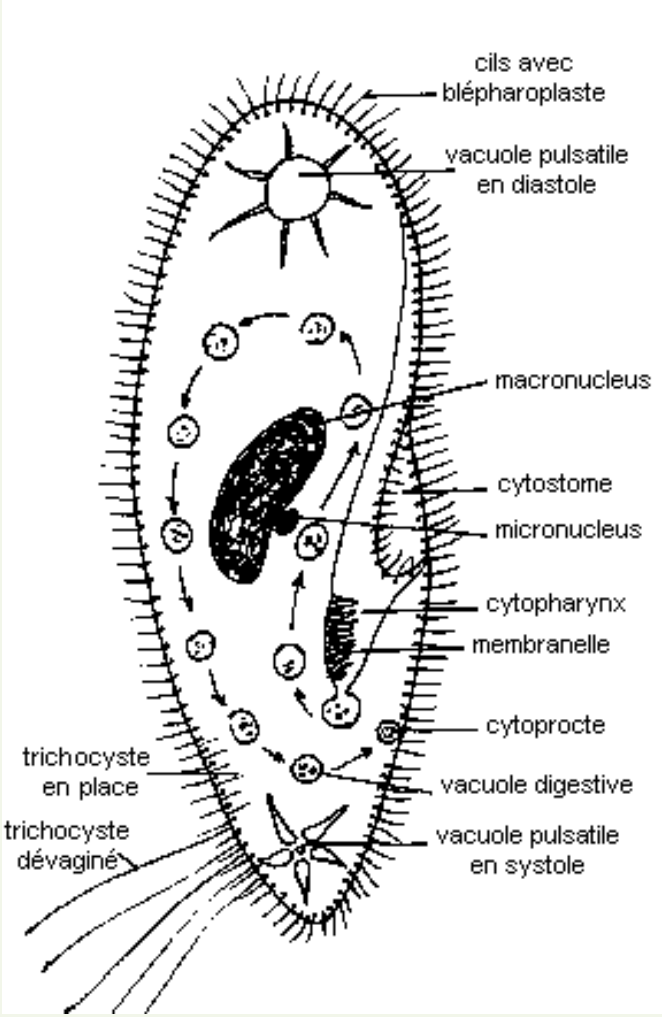
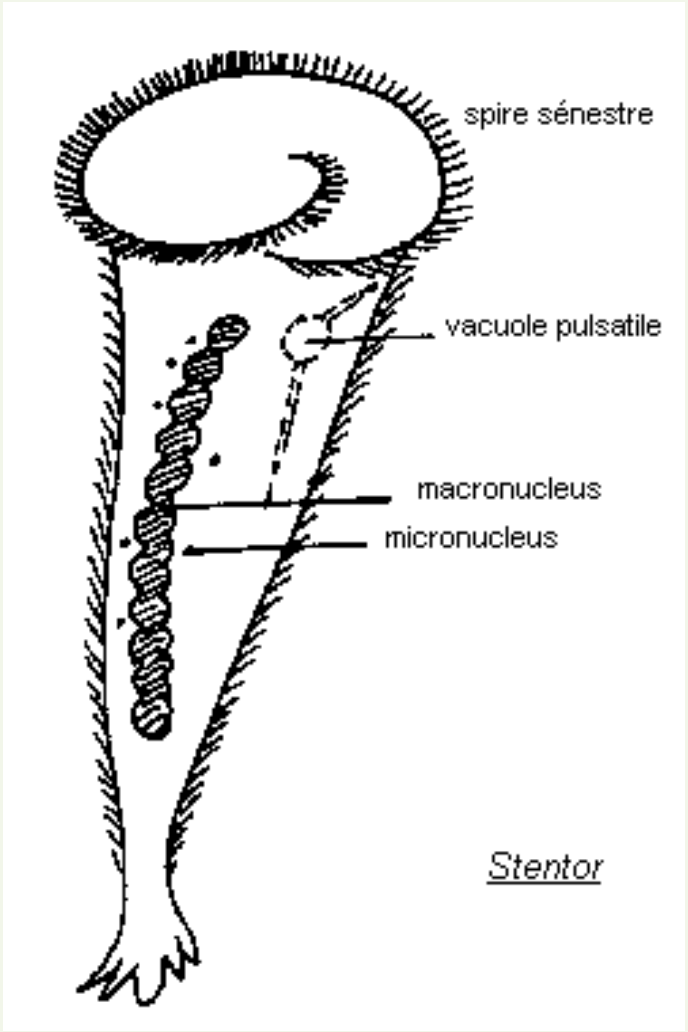


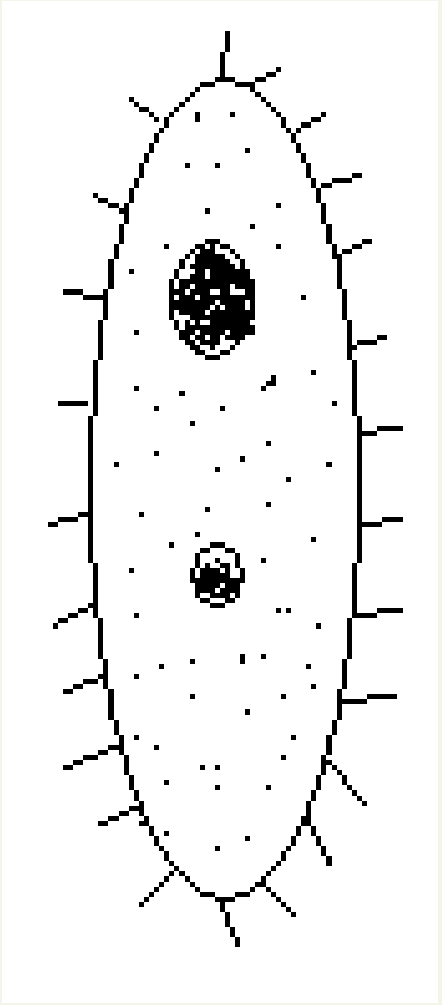
Class 1 : Holotriches *Paramecium caudatum*

b) Class 2 Heterotriches : (Hetero : different; triches : cilia) : The cilia are evenly distributed, présence of an adorale fringe.



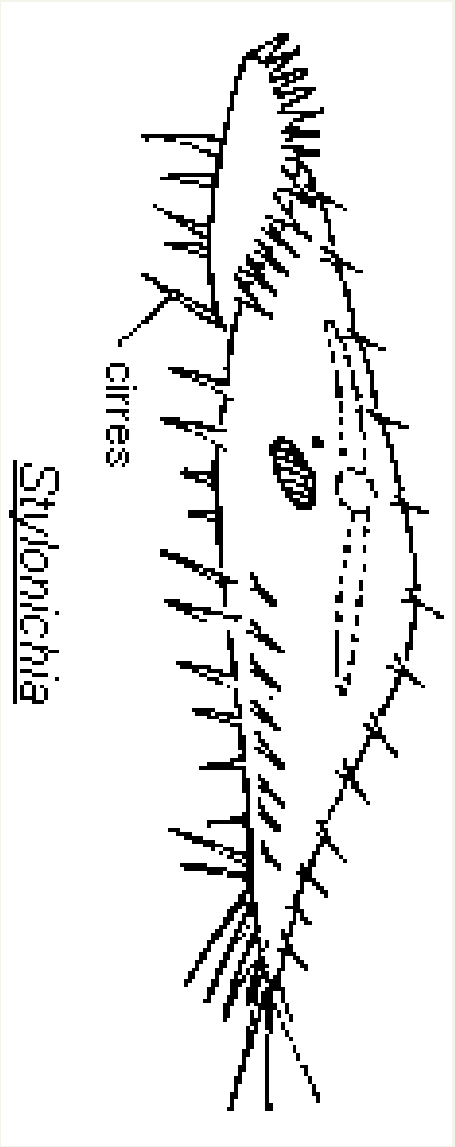
Class 2 : Heterotriches : *Stentor polymorphus*

c) Class 3 Oligotriches : (Oligo : few; triches : cilia) : The cilia on some parts of the body.



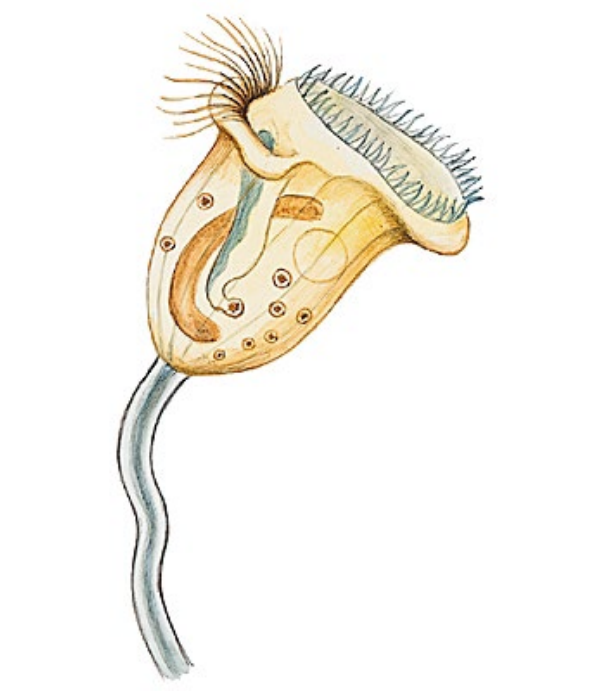
Class 3 : Oligotriches : *Entodinium caudatum*

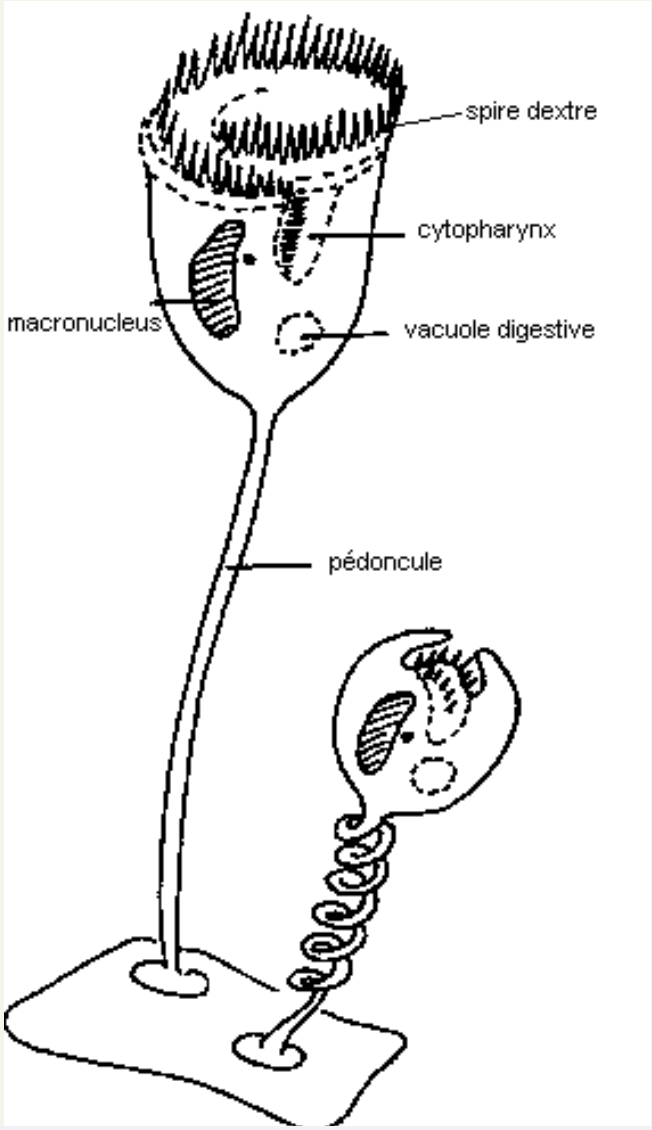
d) Class 4 Hypotriches : (Hypo : ventral; triches : cilia) : The cilia on the ventral side.



Class 4 : Hypotriches : *Stylonichia mytilus*

e) Class 5 Perritriches : (Peri : around; triches : cilia) : The cilia of an adorale fringe only.





Class 5 : Peritriches : *Vorticella convallaria* (Vorticelle = tourbillon)

Phylum of Ciliophora

a) Class 1 : Holotriches : (Holo : homogeneous; triches : cilia) : The cilia are evenly distributed, absence of an adorale fringe.

b) Class 2 Heterotriches : (Hetero : different; triches : cilia) : The cilia are evenly distributed, présence of an adorale fringe.

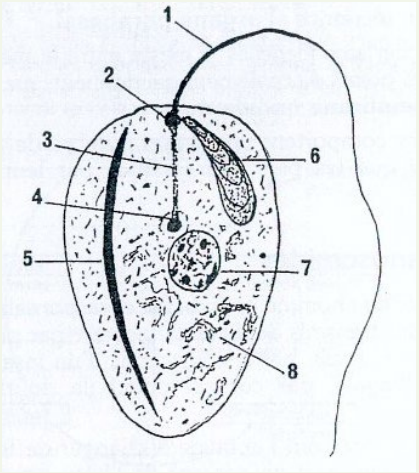
c) Class 3 Oligotriches : (Oligo : few; triches : cilia) : The cilia on some parts of the body.

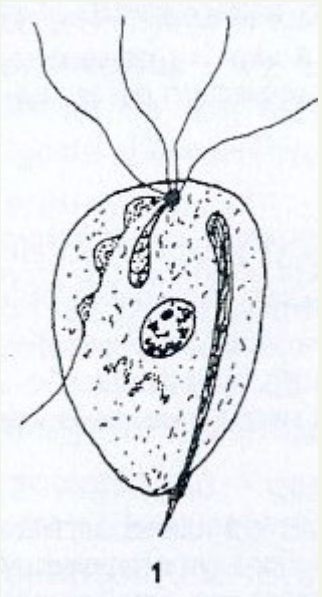
d) Class 4 Hypotriches : (Hypo : ventral; triches : cilia) : The cilia on the ventral side.

e) Class 5 Perritriches : (Peri : around; triches : cilia) : The cilia of an adorale fringe only.

Chapter 1 : Protozoa

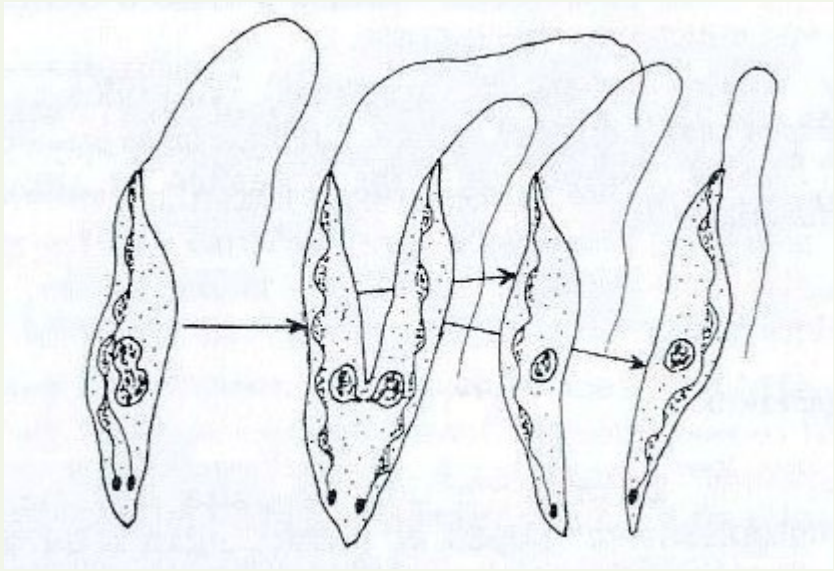
2. – Phylum Mastigophora





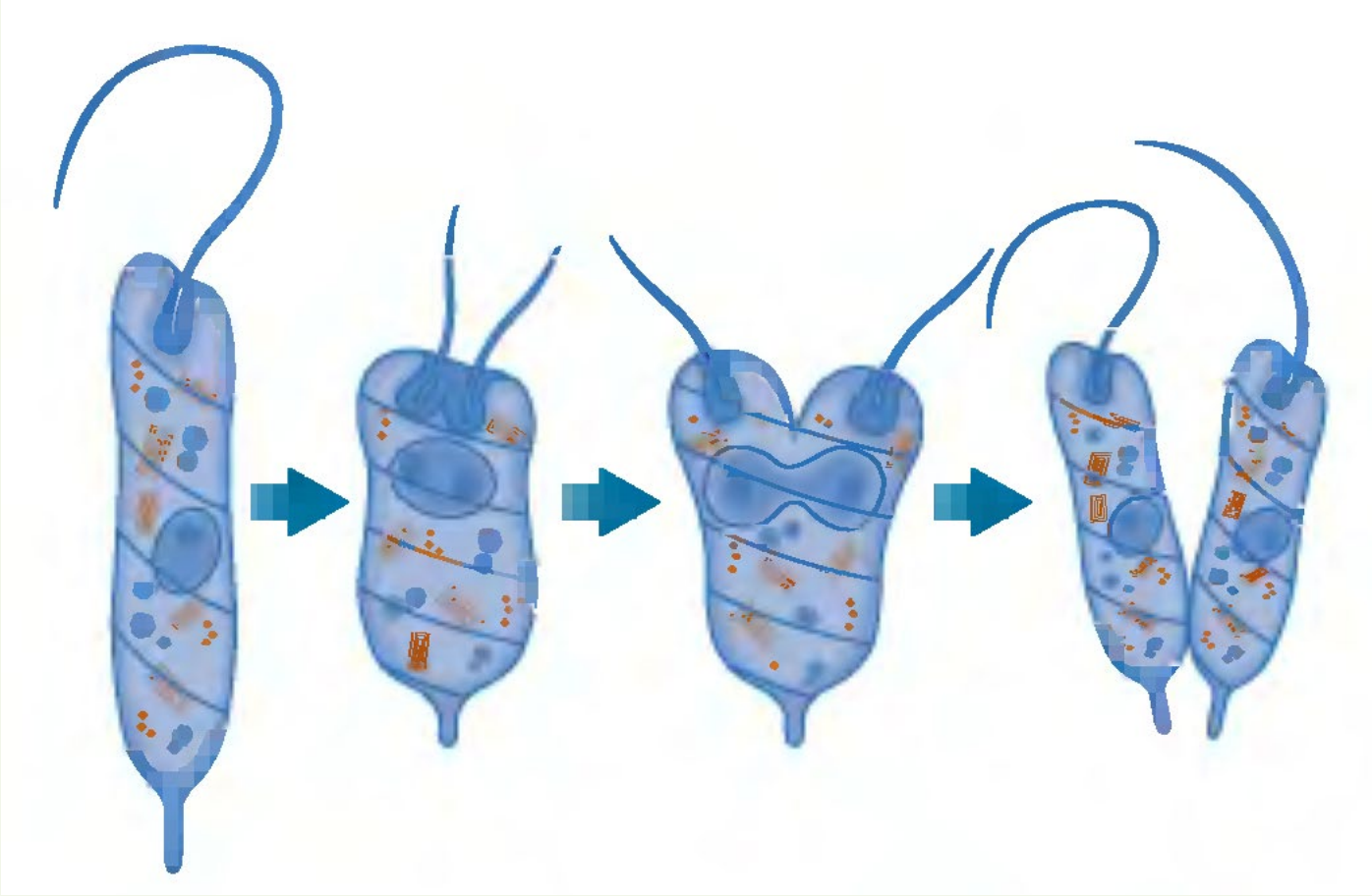
- They possess one or more flagella.

- They multiply by longitudinal division.



Chapter 1 : Protozoa

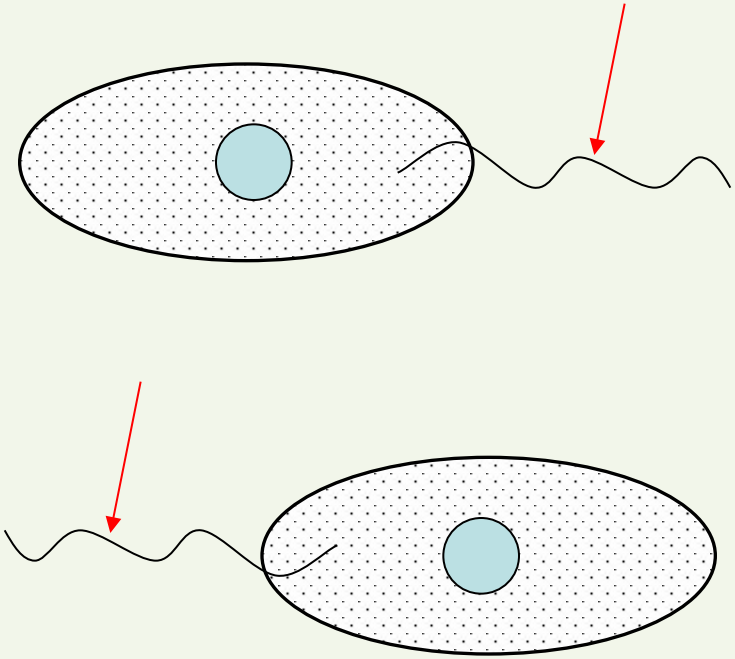
2. – Phylum Mastigophora



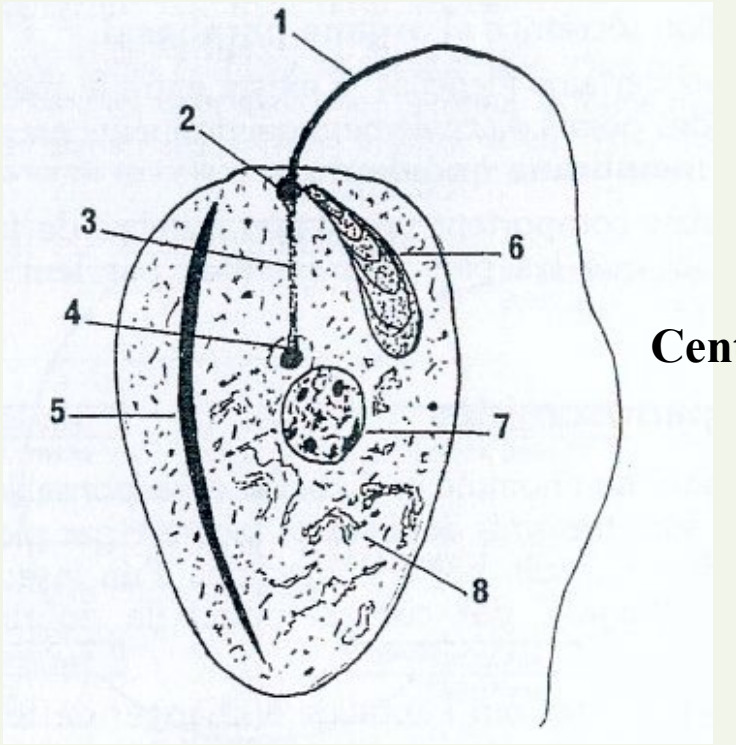
Chapter 1 : Protozoa

2. – Phylum Mastigophora

The flagellum is a locomotor organelle that pulls or pushes the protozoan: it is a <u>Tractelle</u> or a <u>Pulselle</u>.



Chapter 1 : Protozoa



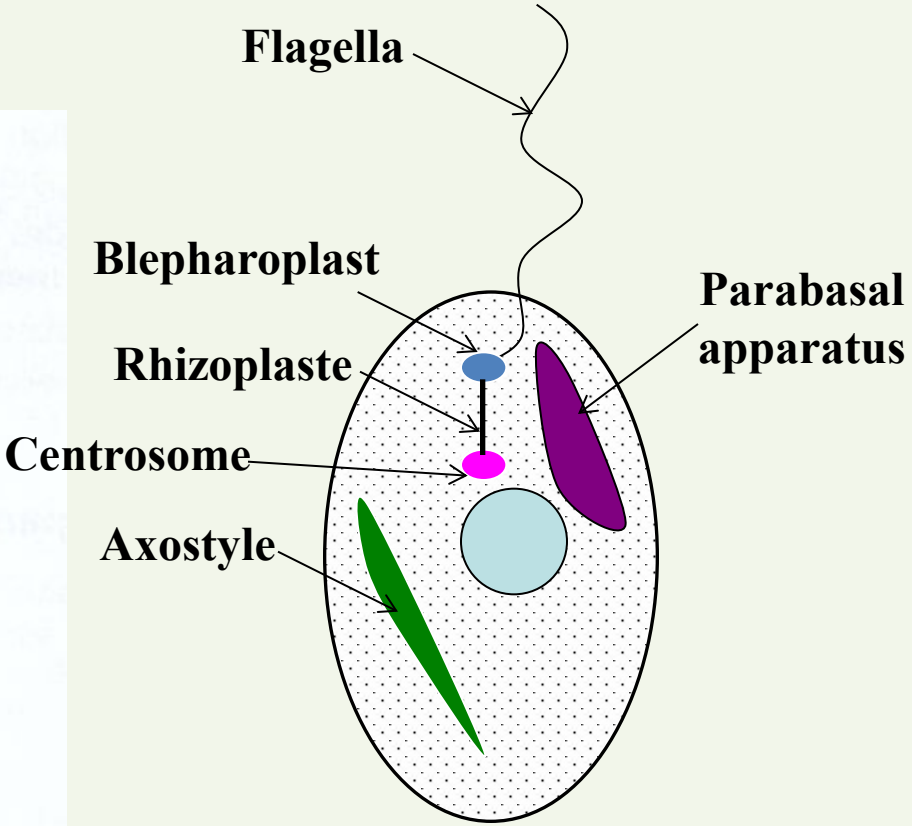
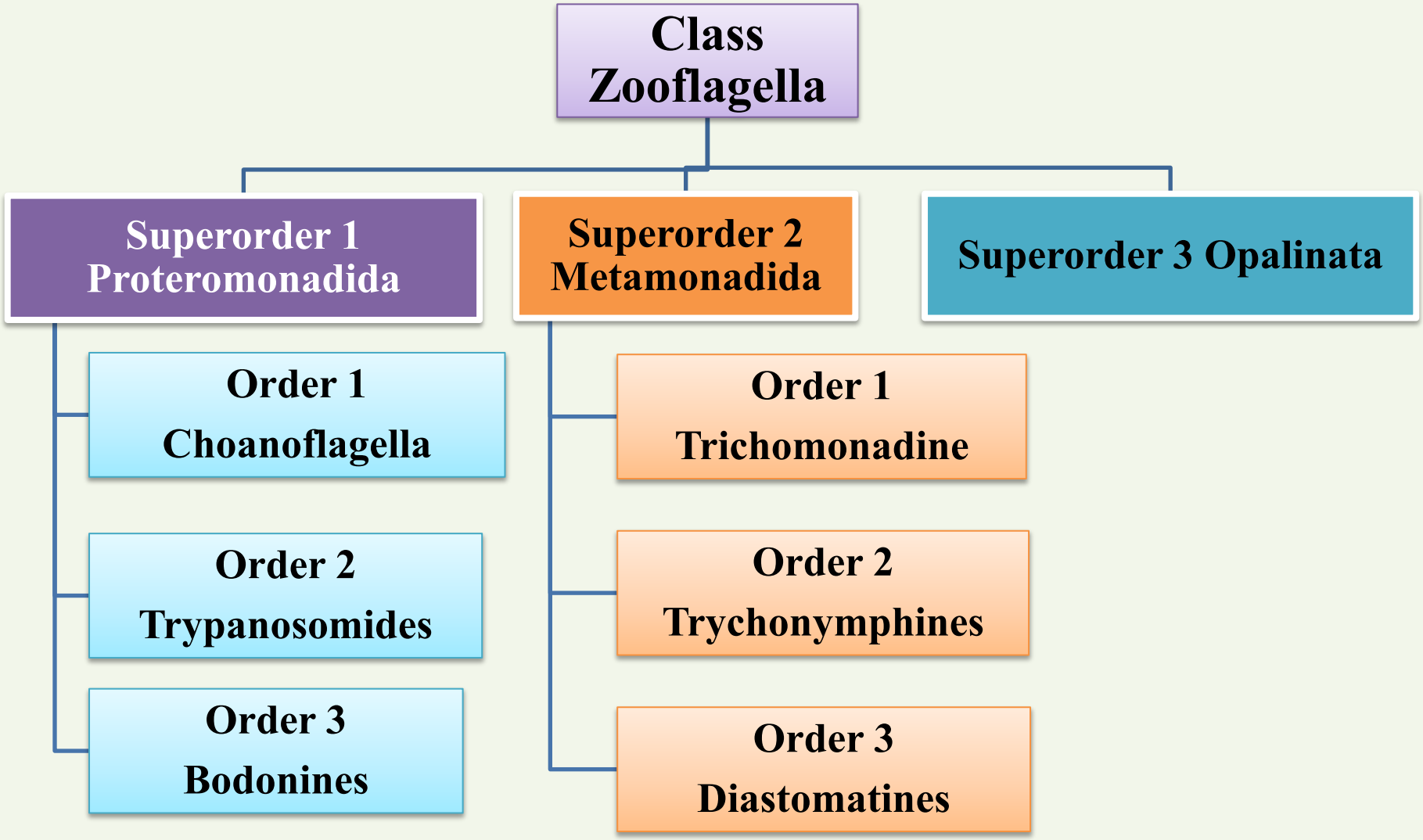


Figure : Scheme of Mastigophora

(1) flagella, (2) blepharoblaste, (3) rhizoplaste, (4) centrosome, (5) axostyle, (6) parabasal apparatus, (7) nucleus, (8) various organelles.

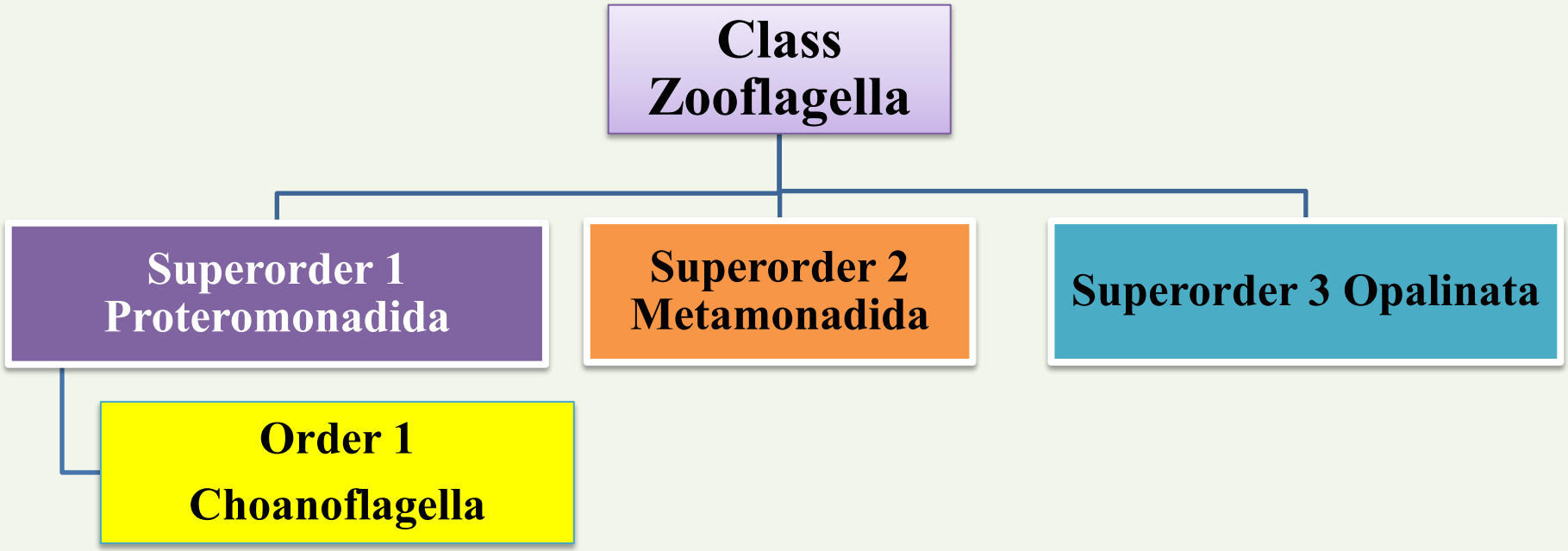
Chapter 1 : Protozoa

2. – Phylum Mastigophora



Chapter 1 : Protozoa

2. – Phylum Mastigophora



Chapter 1 : Protozoa

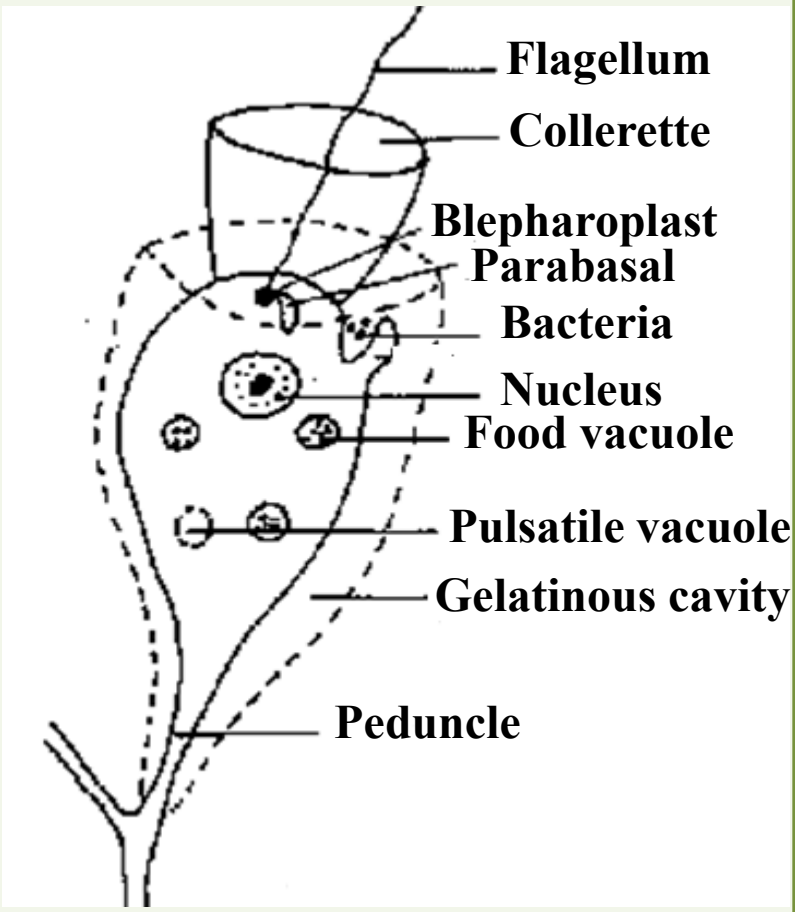
2. – Phylum Mastigophora

a) Choanoflagella :

- Free flagellates.

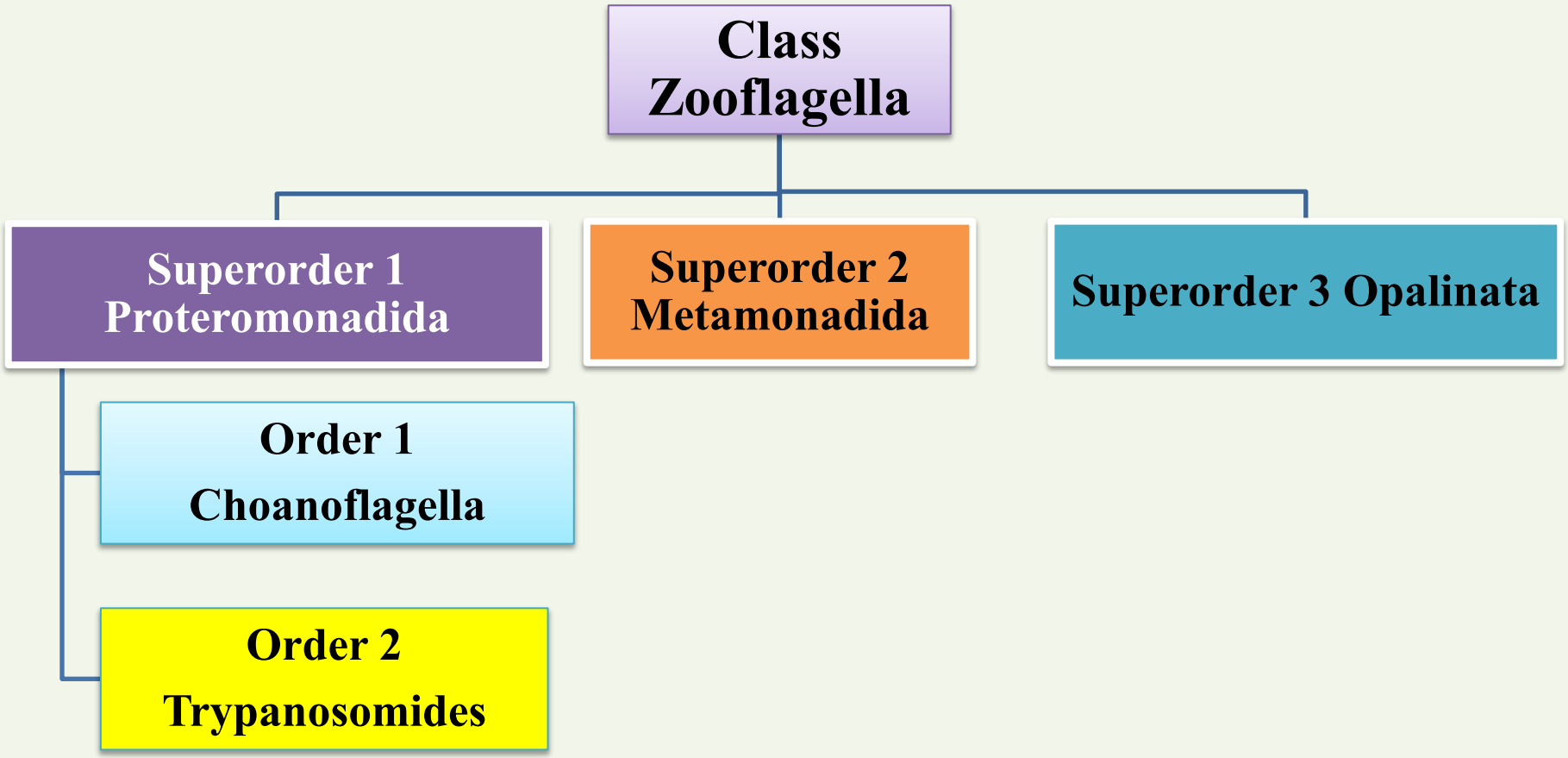
- They possess pseudopodia and a flagellum at the center of a funnel-shaped cytoplasmic collar, formed by almost fused microvilli.

- The choanoflagellates secrete a coat around themselves.



Chapter 1 : Protozoa

2. – Phylum Mastigophora



Chapter 1 : Protozoa

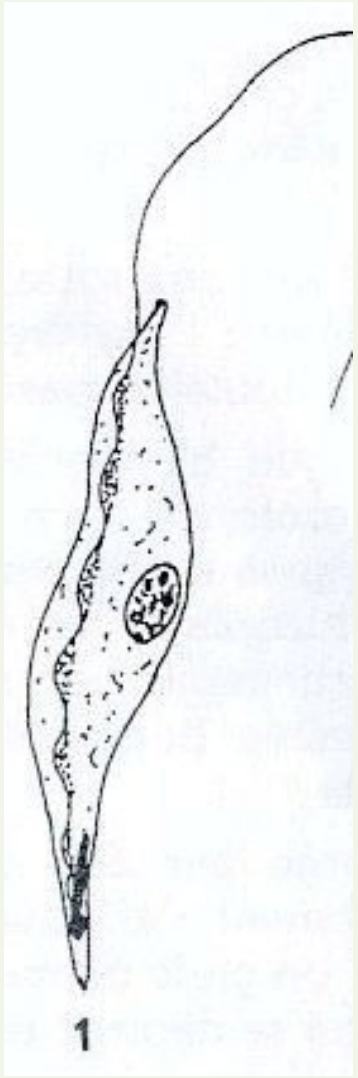
b) Trypanosomides :

- The known species are generally parasitic.

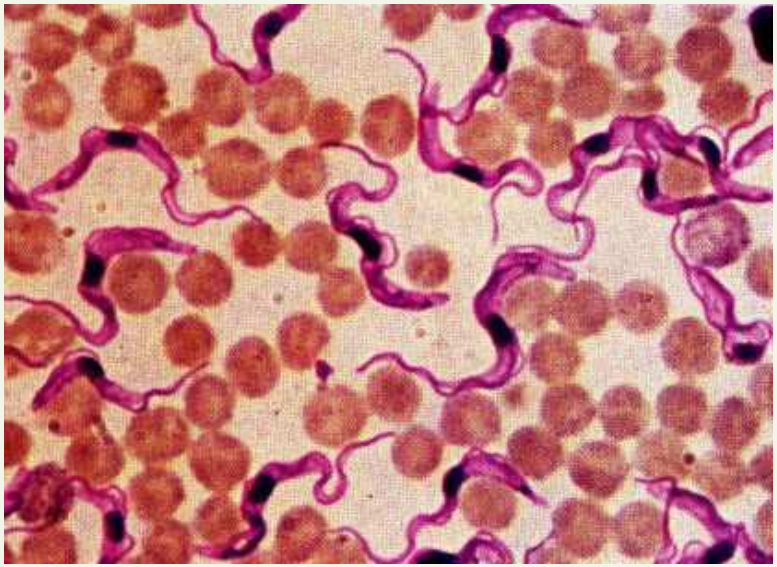
- They develop on two hosts.

- They possess a single flagellum directed forward and connected to the cytoplasmic mass by a undulating membrane.

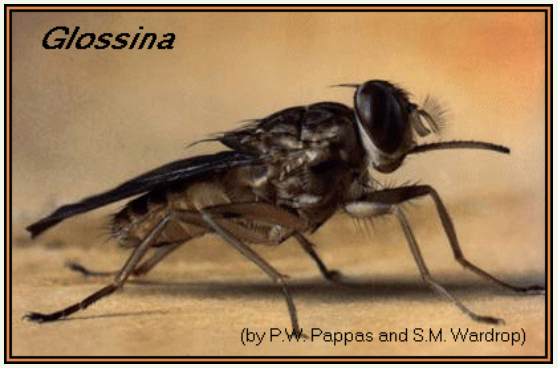
- Very posterior position of their kinetosome, it is located behind the nucleus. (trypomastigote).



Chapter 1 : Protozoa



- *Trypanosoma gambiense* : The transmission of this trypanosome to humans and mammals in tropical Africa occurs through the bites of the vector agent or tsetse fly Glossina palpalis (Glossina: tongue, palpalis: touch).

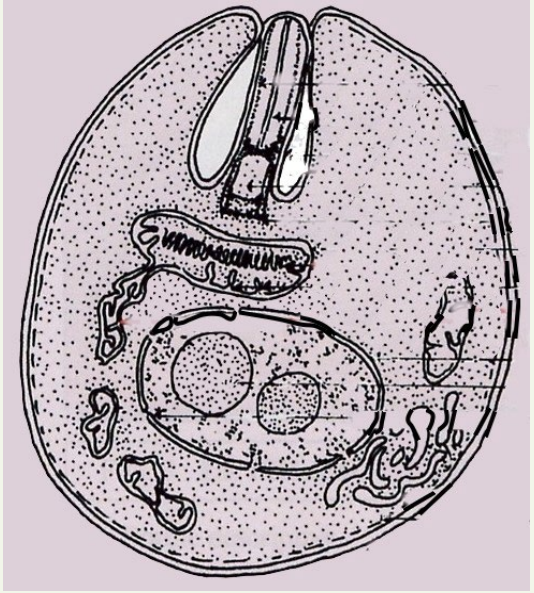


The transmitted trypanosome lives in the blood and cerebrospinal fluid. It is the causative agent of sleeping sickness.

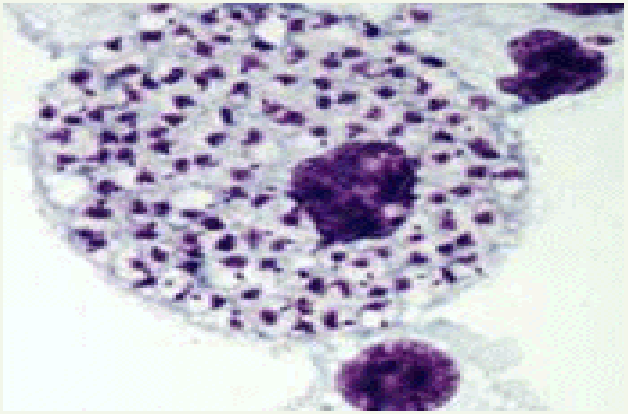
The affected man presents with intermittent and irregular fever, various nervous disorders. (somnolence).

Chapter 1 : Protozoa

* ***Leishmania*** **: These are polymorphic heteroxenous parasites whose evolutionary cycle requires passage through a vertebrate and a biting insect (sandfly).**



Amastigote form (D.H.)



Amastigote form (H.D.)

Men

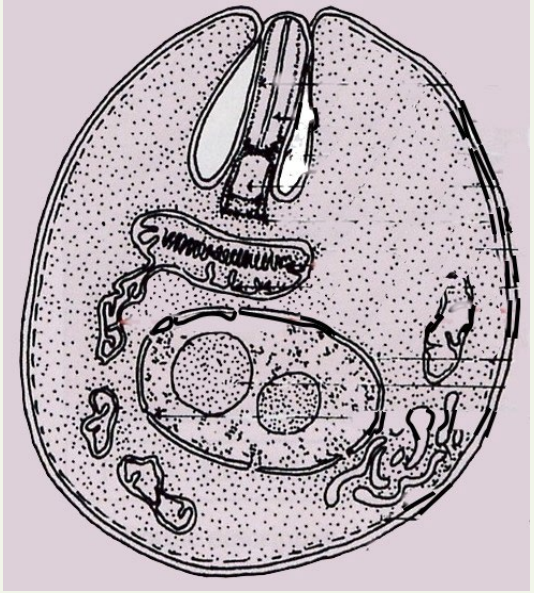
Promastigote form (I.H.)

Digestive tract of the sandfly

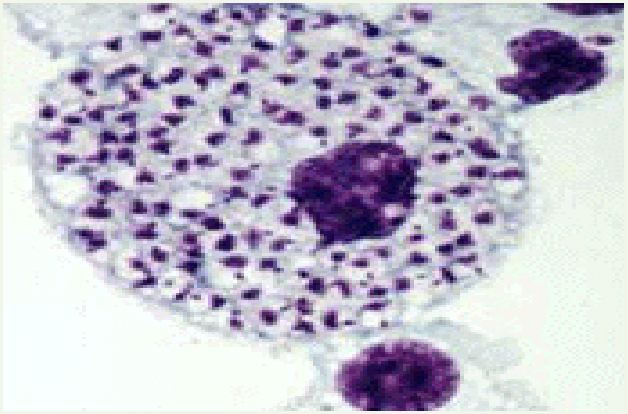
Vecteur (I.H.)

Chapter 1 : Protozoa

*_Leishmania_ : These are polymorphic heteroxenous parasites. In vertebrates, they are intracellular globular parasites with a central nucleus, whose flagellum is reduced to a short intracytoplasmic portion (amastigote).



Amastigote form (D.H.)



Amastigote form (H.D.)

Men

Promastigote form (I.H.)

Digestive tract of the sandfly

Vecteur (I.H.)

Chapter 1 : Protozoa

- *Leishmania donovani* : Causes a very serious disease, visceral leishmaniasis (ou kala-azar).

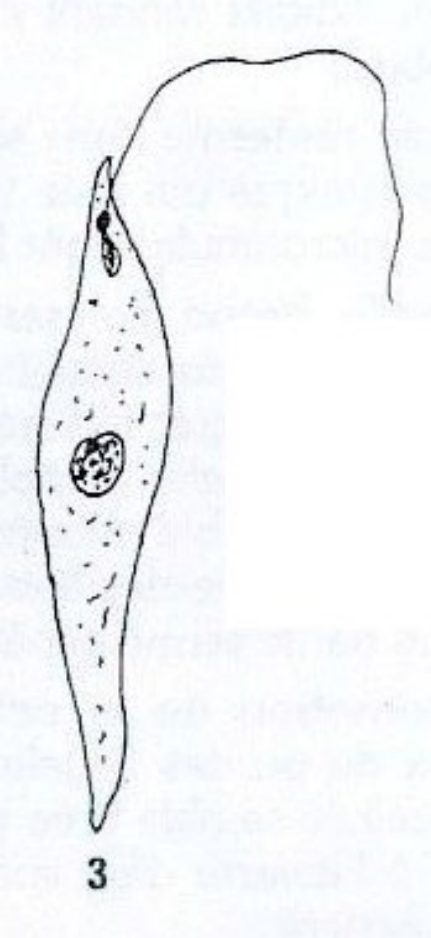
Chapter 1 : Protozoa

- ***Leishmania tropica*** **: causes a skin ulcer on exposed surfaces of the body in humans, proliferates under the skin (cutaneous leishmaniasis).**

Chapter 1 : Protozoa

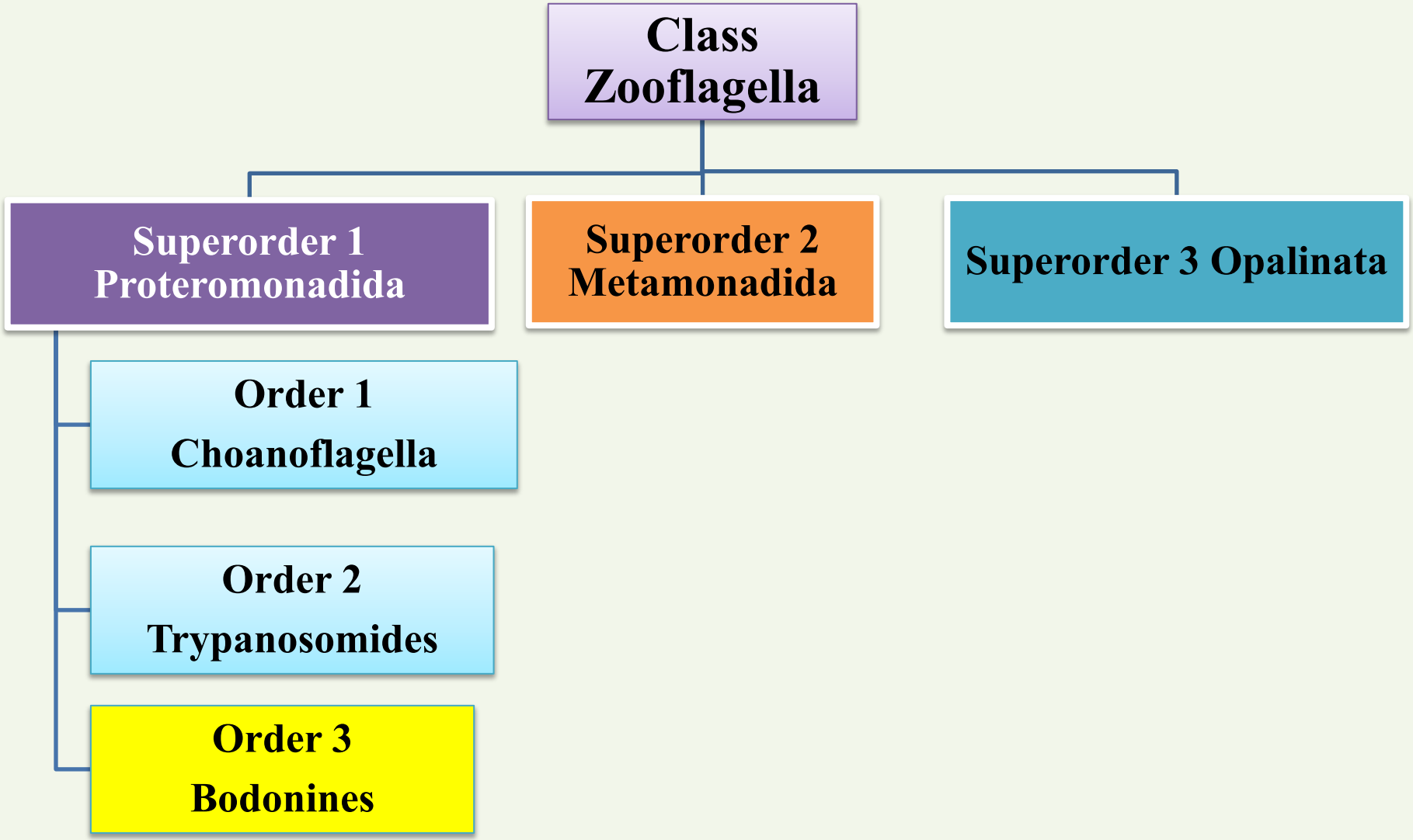
Leptomonas **: Very anterior position of their kinetosome, it is located in front of the nucleus (promastigote).**

- These are common parasites in certain invertebrates : *Leptomonas muscarum*.



Chapter 1 : Protozoa

2. – Phylum Mastigophora



Chapter 1 : Protozoa

c) Bodonines :

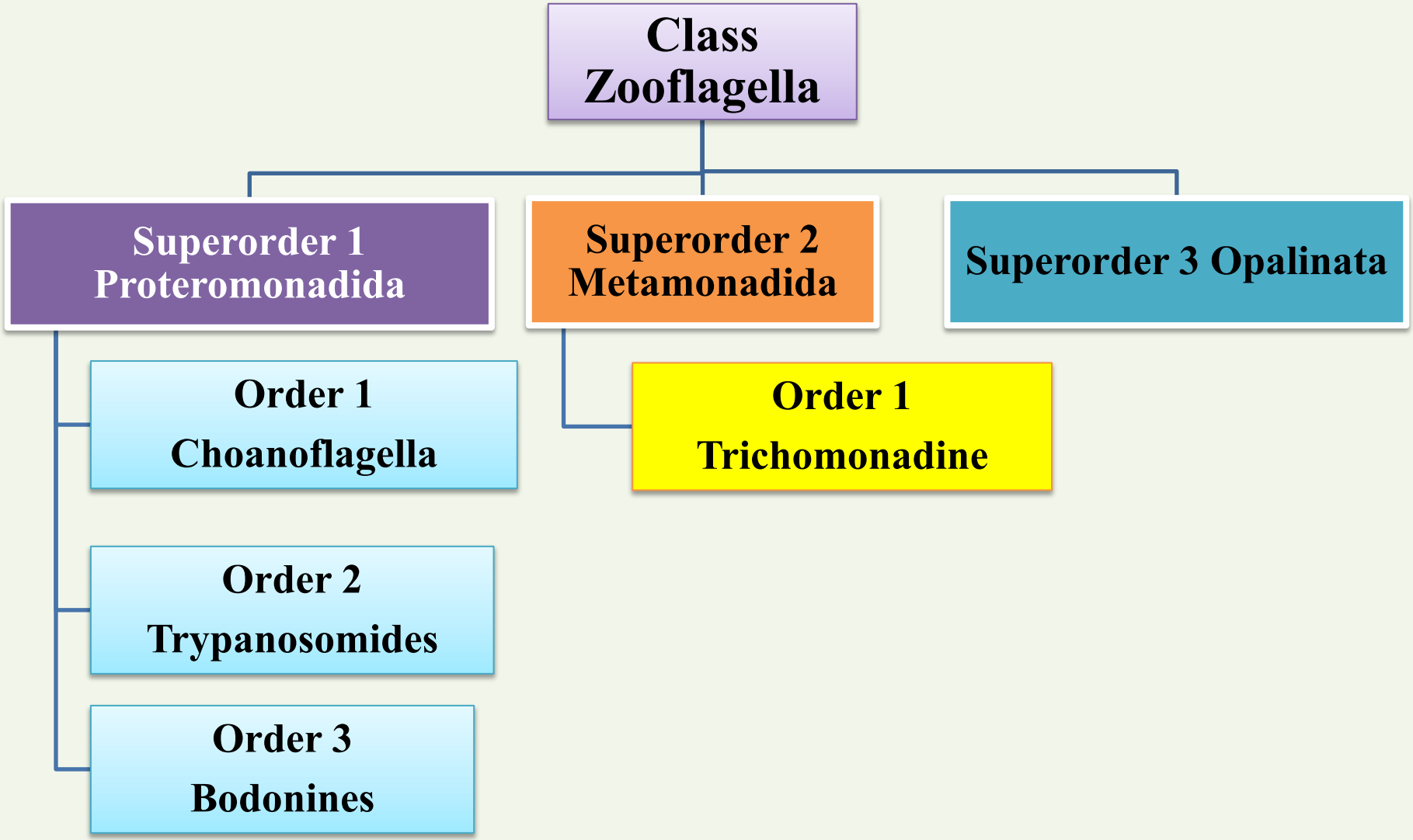
Free or parasitic Bodonines possess 2 unequal flagella, one directed forward, the other directed backward, either free (Bodo) or attached to the cytoplasm by a short undulating membrane (Cryptobia).

Bodo saltans

Cryptobia helicis

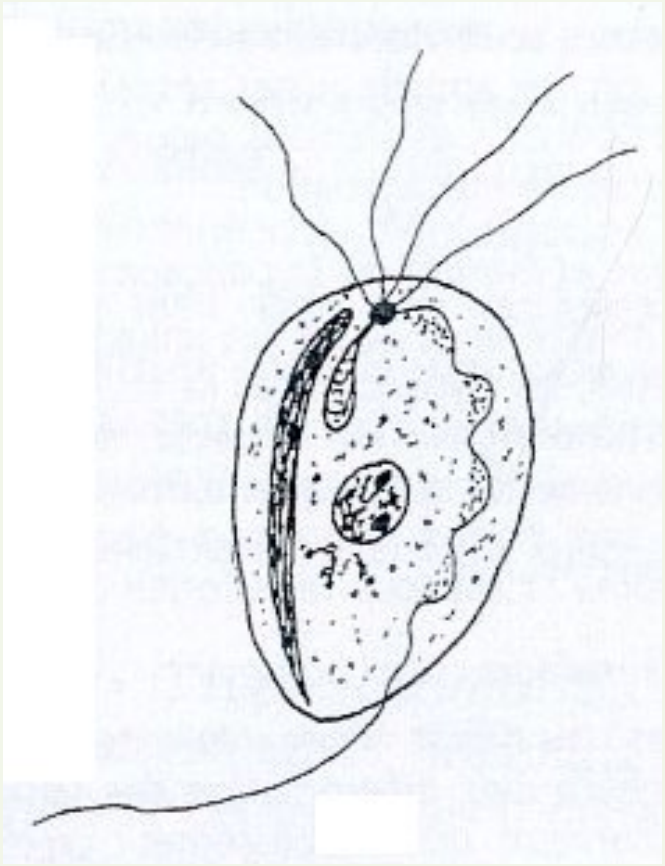
Chapter 1 : Protozoa

2. – Phylum Mastigophora

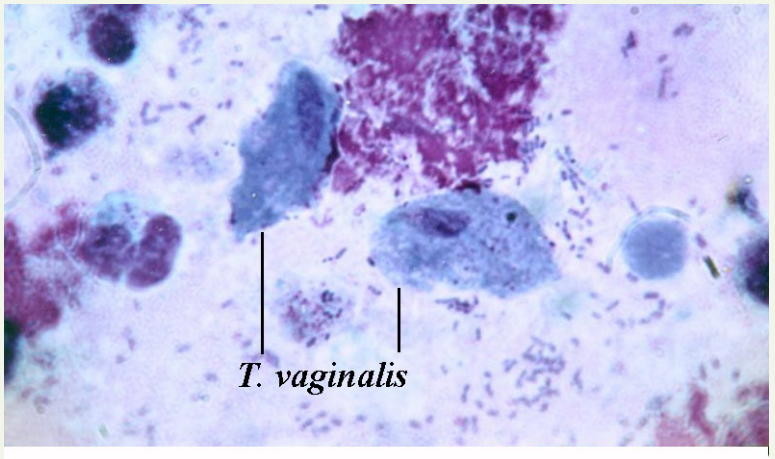


Chapter 1 : Protozoa

a) Trichomonadine :

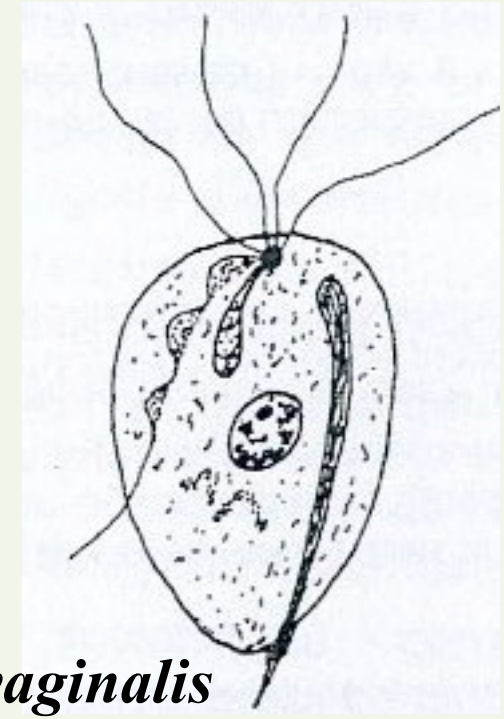


Trichomonas intestinalis



T. vaginalis

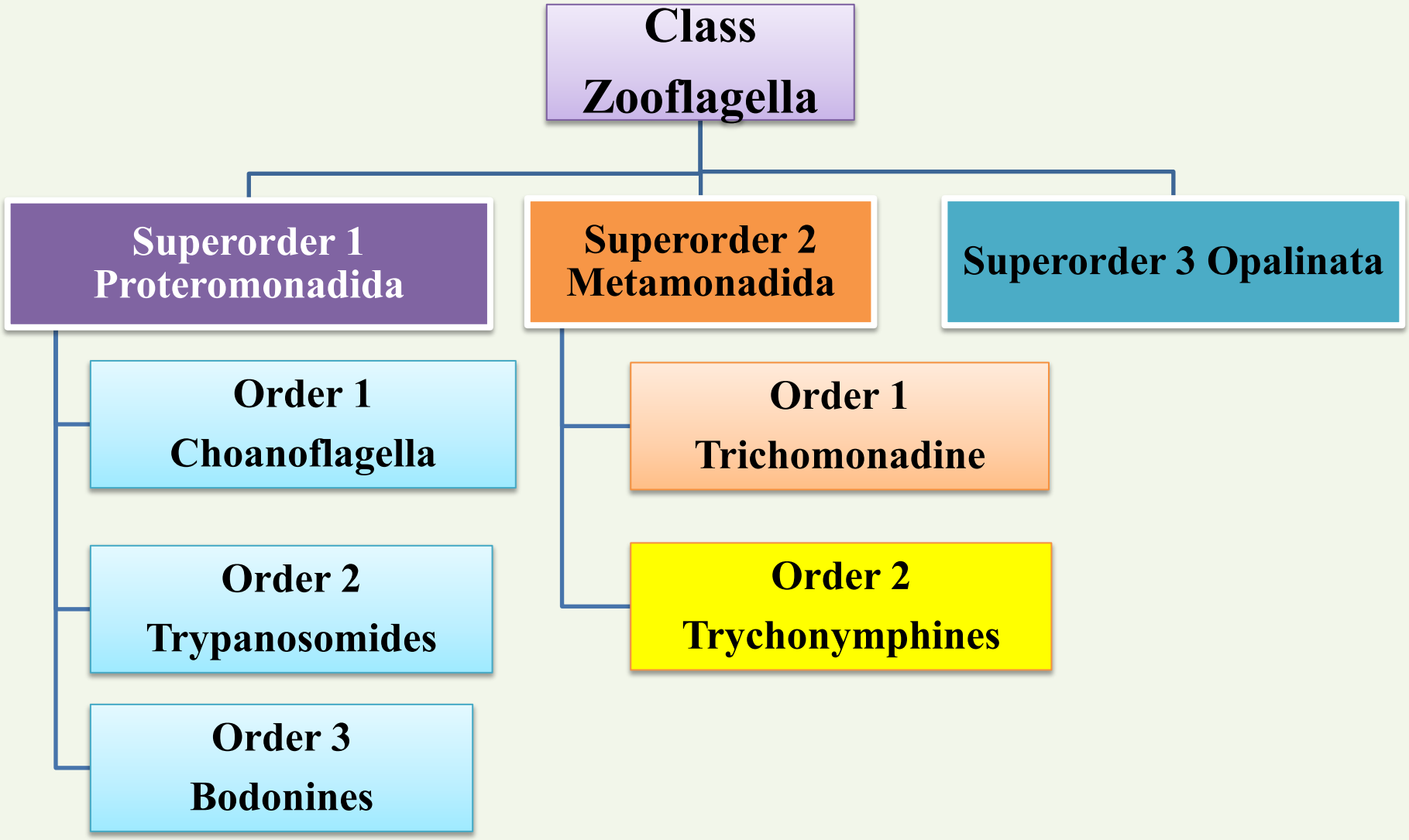
prélévement vaginal, aggrandissement



Trichomonas vaginalis

Chapter 1 : Protozoa

2. – Phylum Mastigophora

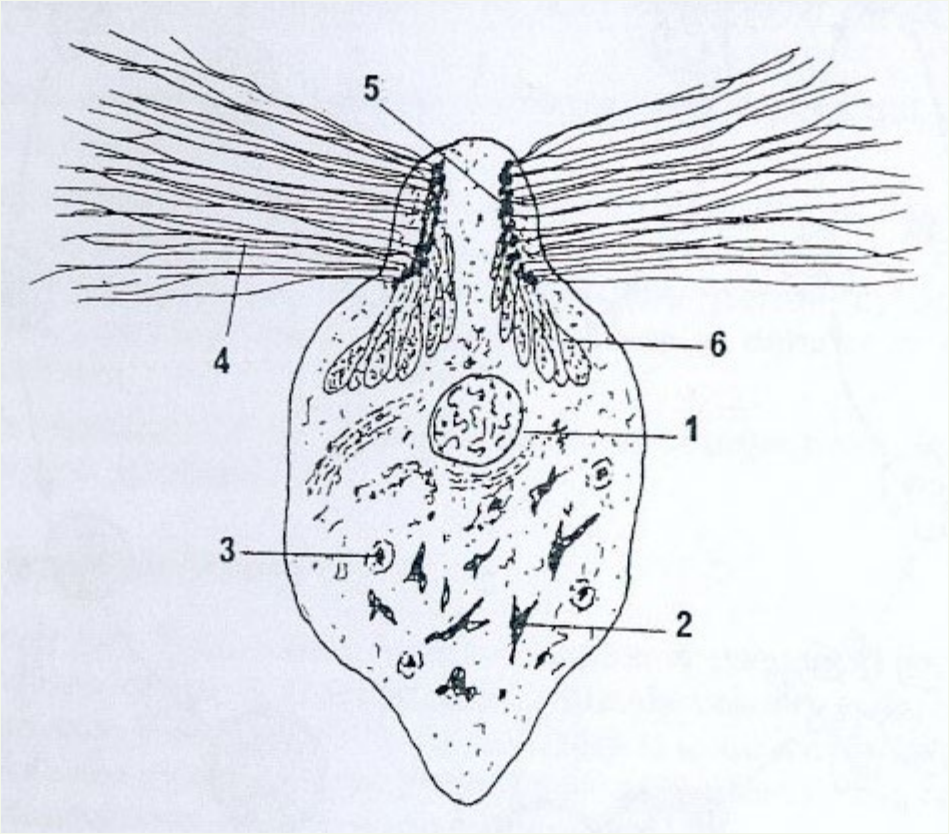


Chapter 1 : Protozoa

b) Trychonymphines

Lives in the rectal pouch of various termites, it feeds on wood.

Flagellate-Termite Symbiosis: Termites secrete an enzyme that promotes these protozoa to multiply and reproduce. These protozoa can break down glycogen into simple sugars useful for these termites.

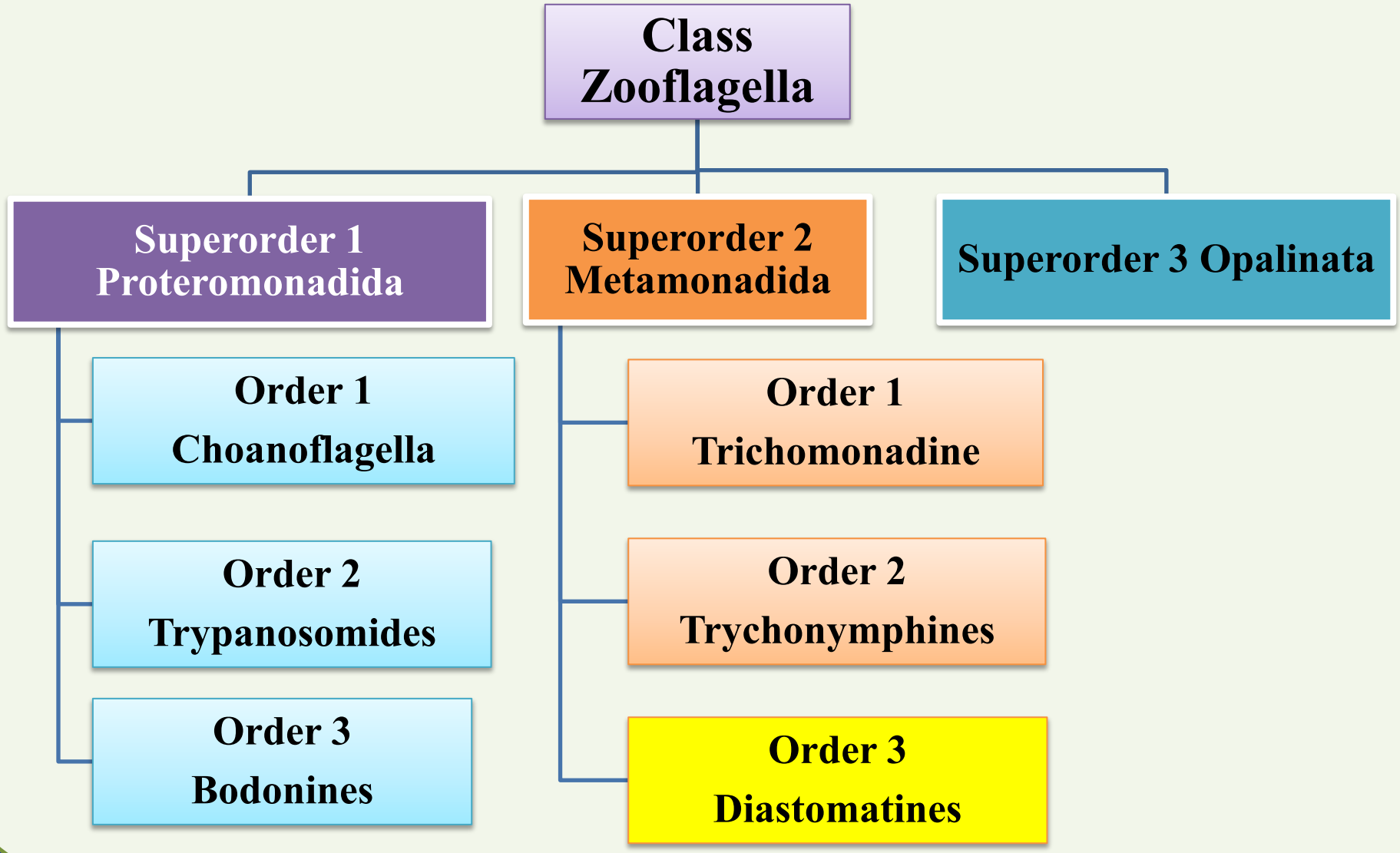


Trichonympha agilis

(1) nucleus, (2) Morceau de bois, (3) food vacuole, (4) flagella, (5) Blepharoplast, (6) parabasal apparatus.

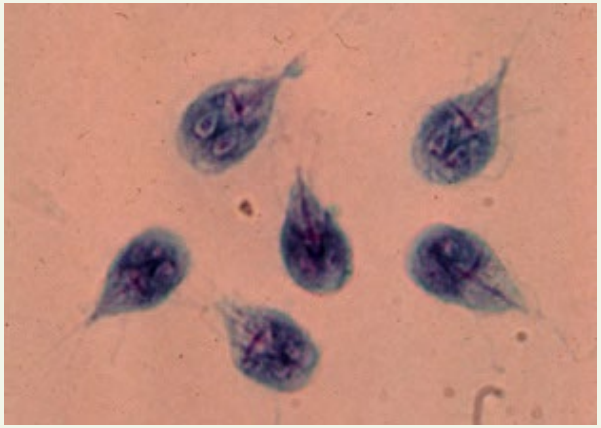
Chapter 1 : Protozoa

2. – Phylum Mastigophora

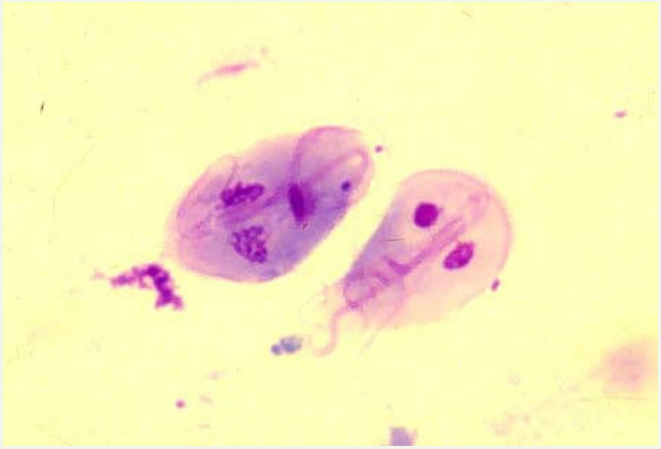


c) Diastomatines :

- Medium or small-sized zooflagellates, having all their organelles in pairs which are symmetrical, with 8 flagella arranged in various ways.

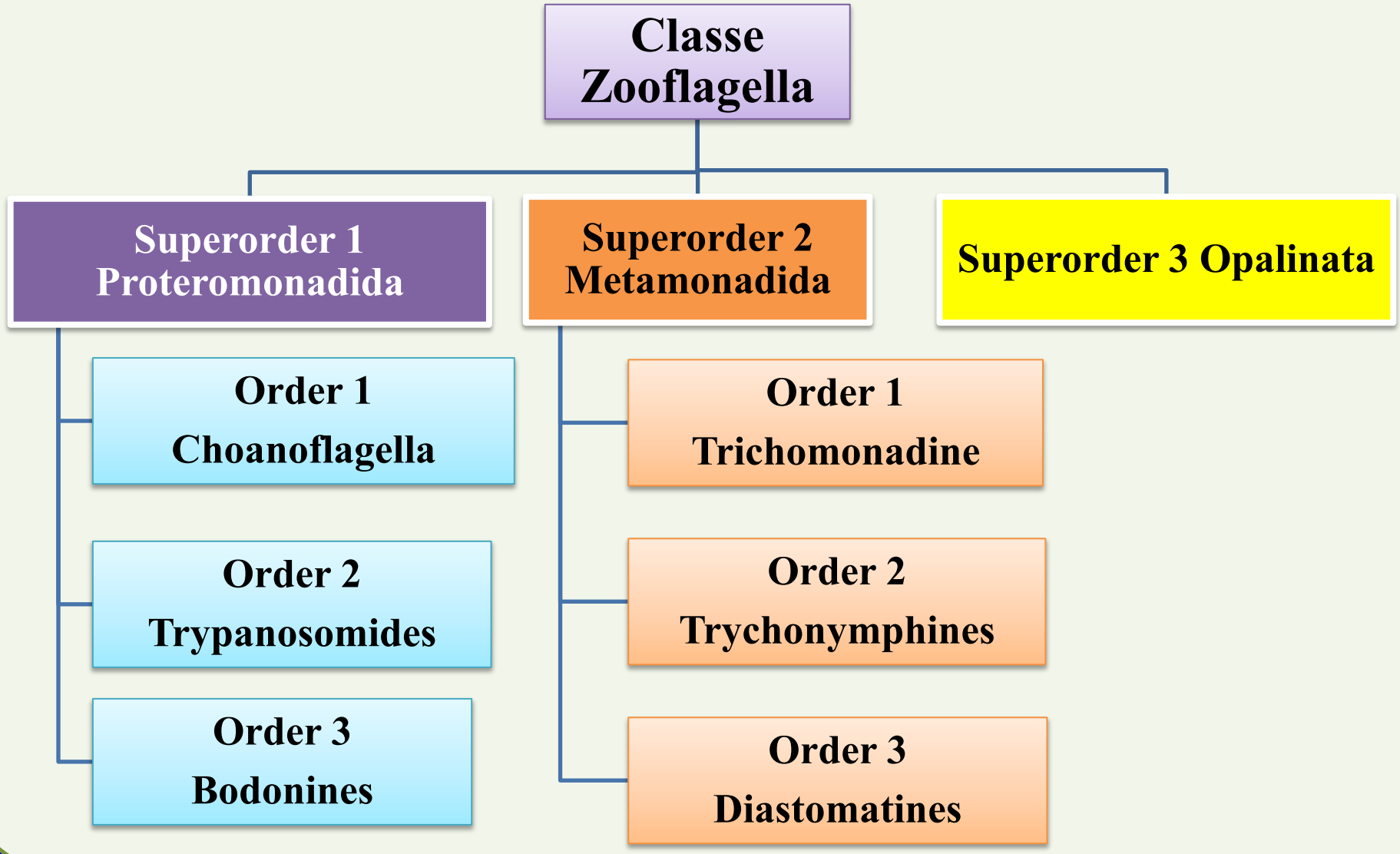


Giardia intestinalis: lives in the human intestine causing various intestinal disorders, this parasite is transmitted from host to host through resistant cysts.



Chapter 1 : Protozoa

2. – Phylum Mastigophora



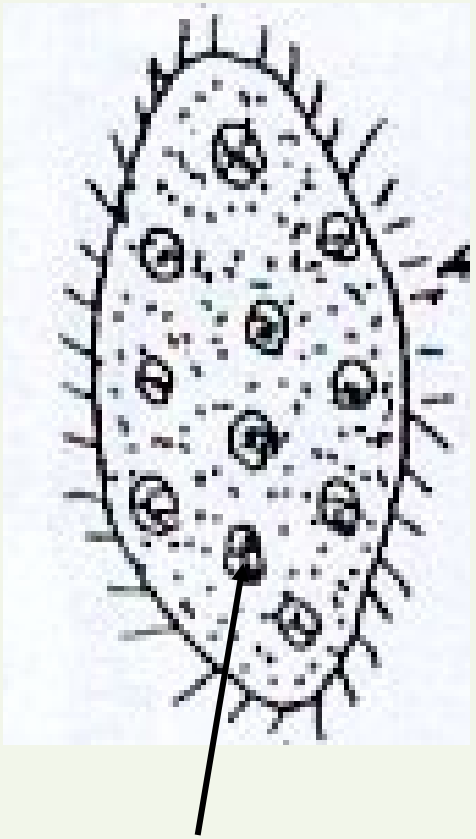
Superorder 3 Opalinata (Figure)

- These are flagellates that are commensal to frogs and more generally to vertebrates.

- They are equipped with numerous short flagella, with the absence of a centrosome.

- It has numerous similar nucleus.

- They live anaerobically in the bladders of frogs, like *Opalina ranarum*.



Opalina ranarum

Chapter 1 : Protozoa

3. – Phylum Rhizopoda = Sarcodina

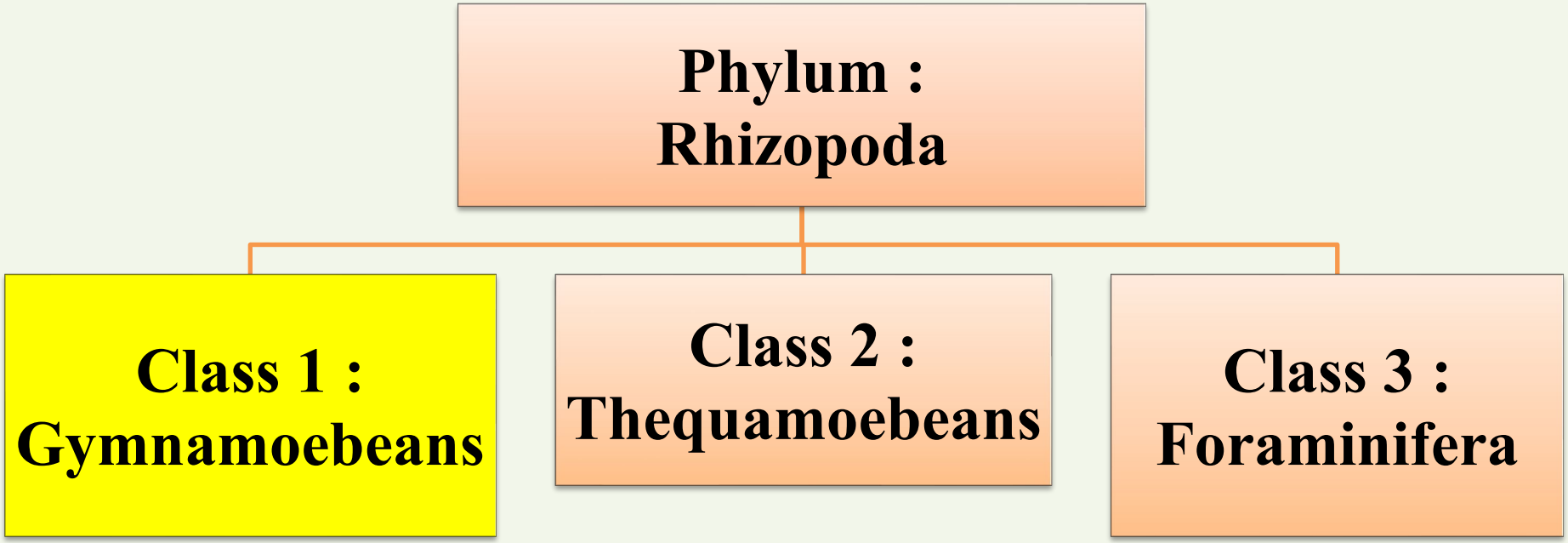
- Amebas are found in both fresh and salt water and in moist soils. Some are planktonic; some prefer a substratum. A few are parasitic.

- Pseudopods are cytoplasmic extensions used for locomotion and absorption. They can be lobed, filamentous, or reticulated.

- The Classification of amebas was based in part on the characteristics of their pseudopodia and on characteristics of their protective tests (skeletons), if any.

Chapter 1 : Protozoa

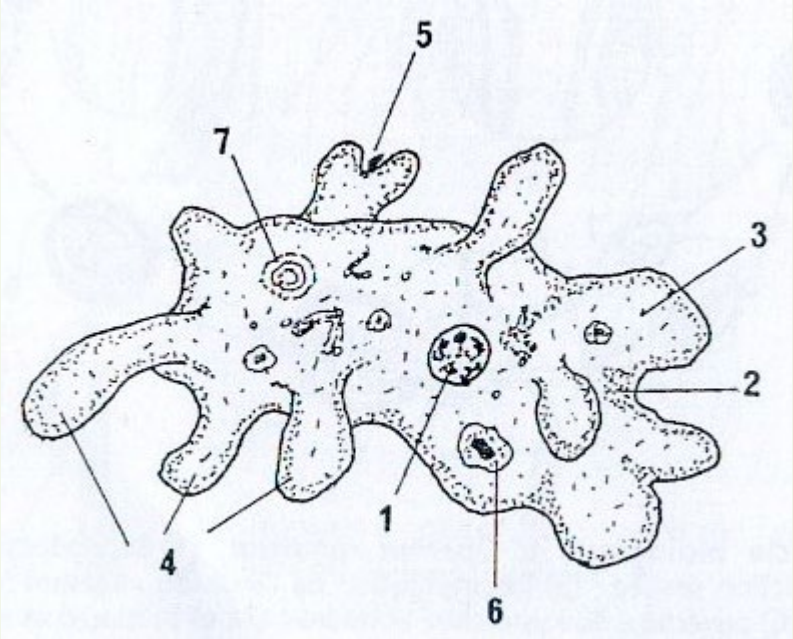
3. – Phylum Rhizopoda = Sarcodina



Chapter 1 : Protozoa

a) The naked amoebas : Gymnamoebeans (Gymnos = naked)

During their movements, amoebas are capable of deforming the periphery of their body by emitting sorts of projections called pseudopods in various shapes, rarely thread-like and never anastomosed.



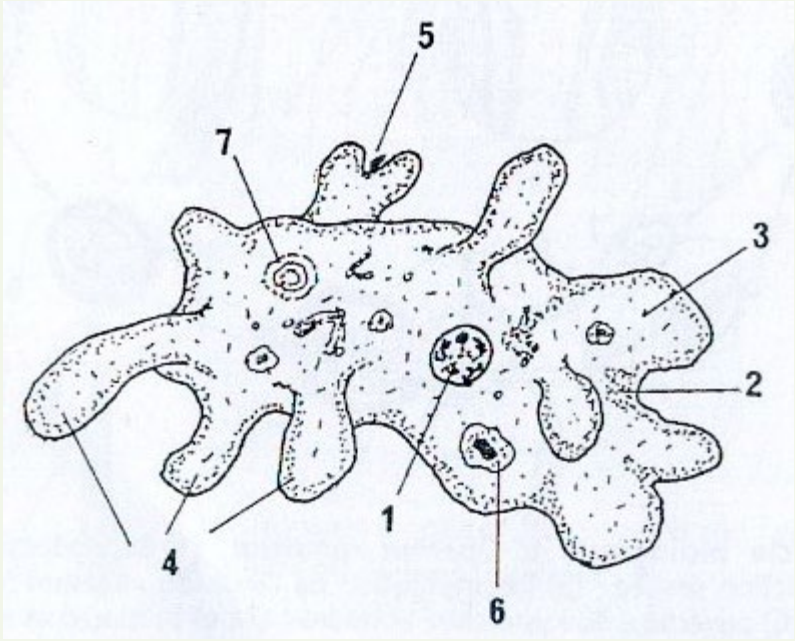
Amoeba proteus **Pallas**
(1) nucleus (2) ectoplasm, (3) endoplasm, (4) pseudopodium, (5) phagocytocis of prey, (6) food vacuole, (7) pulsatile vacuole

Chapter 1 : Protozoa

a) The naked amoebas : Gymnamoebeans (Gymnos = naked)

- They participate in the capture of prey or food fragments. This trophic action is phagocytosis.

- Amoebas live in both freshwater and marine waters.

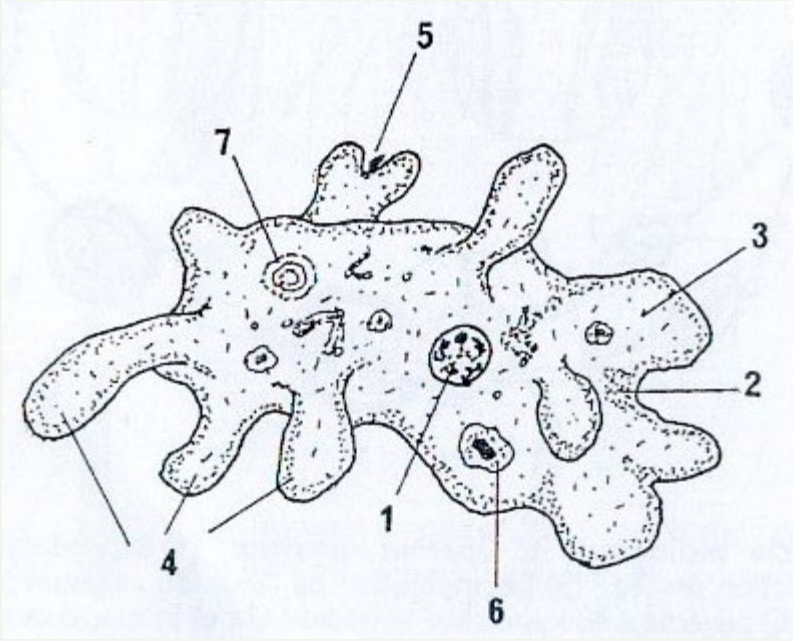


Amoeba proteus Pallas
(1) nucleus (2) ectoplasm, (3) endoplasm, (4) pseudopodium, (5) phagocytocis of prey, (6) food vacuole, (7) pulsatile vacuole

Chapter 1 : Protozoa

***The free amoebas :**

***Amoeba proteus* Pallas: It owes its name to the fact that it continuously changes the shape of its body. Sometimes it contracts. Sometimes it flattens out. She emits pseudopodia to move or to feed. Indeed, the concept of amoeba comes from the Greek amoibe. (changement).**



***Amoeba proteus* Pallas**
(1) nucleus (2) ectoplasm, (3) endoplasm, (4) pseudopodium, (5) phagocytocis of prey, (6) food vacuole, (7) pulsatile vacuole

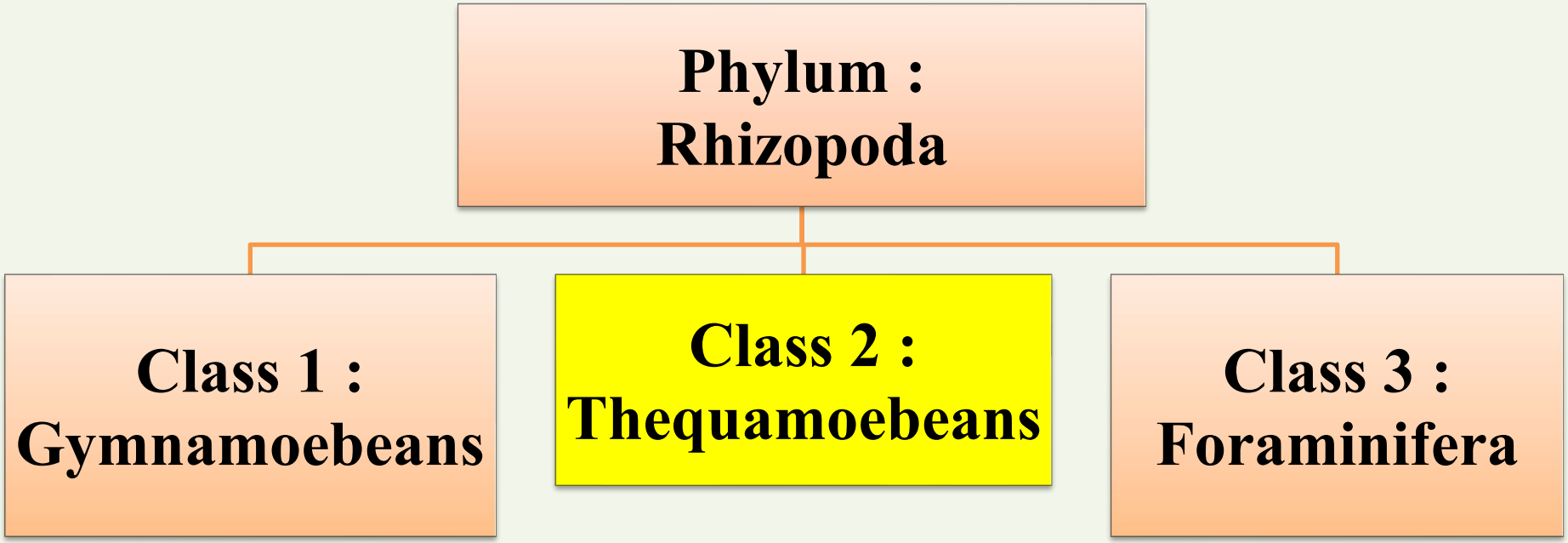
Chapter 1 : Protozoa

***The parasitic amoebas :**

***Entamoeba histolytica*: It lives as a parasite in the cells of the intestinal wall in humans. It phagocytizes intestinal and blood cells. It causes ulcerative complications and a kind of dysentery.**

Chapter 1 : Protozoa

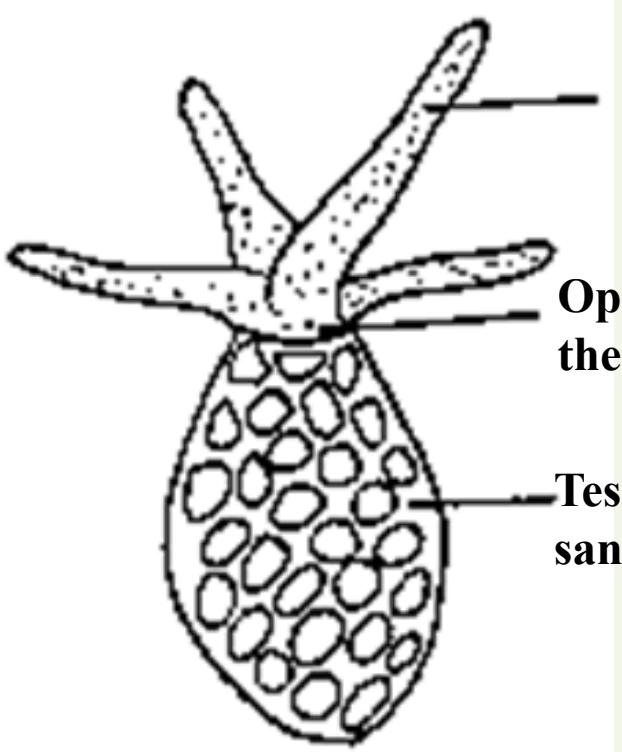
3. – Phylum Rhizopoda = Sarcodina



Chapter 1 : Protozoa

b) The protected amoebas : Thequamoebeans (Theca : wardrobe, box, case, moebeans : amoebas)

Each individual of the genus Difflugia is enclosed in a capsule that produces a sticky substance onto which various fragments and residues of digestion attach.



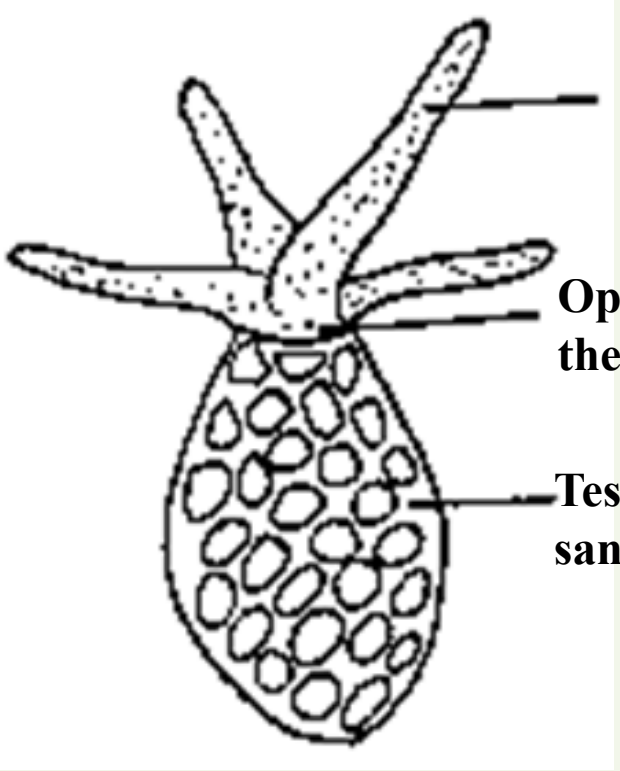
Difflugia sp.

Chapter 1 : Protozoa

b) The protected amoebas : Thequamoebeans (Theca : wardrobe, box, case, moebeans : amoebas)

-The Thecamoebeans are aquatic. Some lives in hot spring waters reaching a temperature of 58 °C.

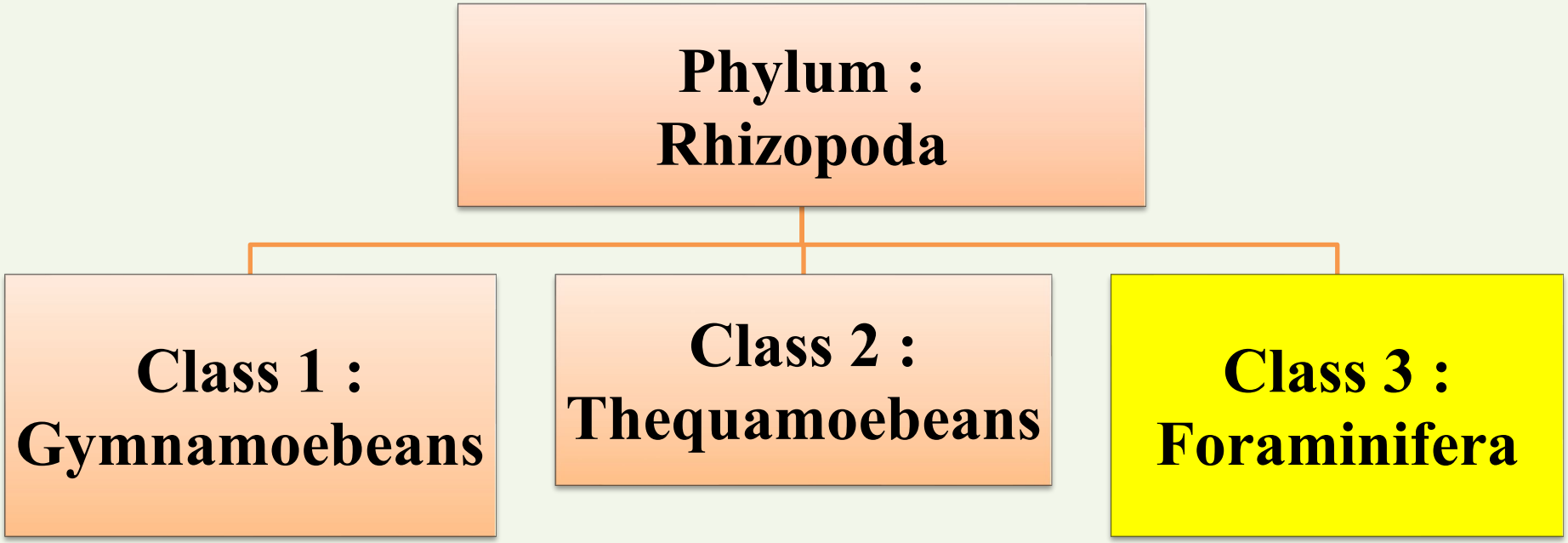
- They are coated with mineral particles such as grains of sand and quartz.



Difflugia sp.

Chapter 1 : Protozoa

3. – Phylum Rhizopoda = Sarcodina



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c) Foraminifera (Figure)

- The foraminiferans (*foramen*: hole + *fero*: bear) are mostly marine forms (pelagic or benthic) that secrete complex many-chambered tests of calcium carbonate.

- Foraminiferans exhibit a chitinous covering covered with calcium, pierced by one or more orifices through which fine pseudopods emerge, anastomosed in a network.

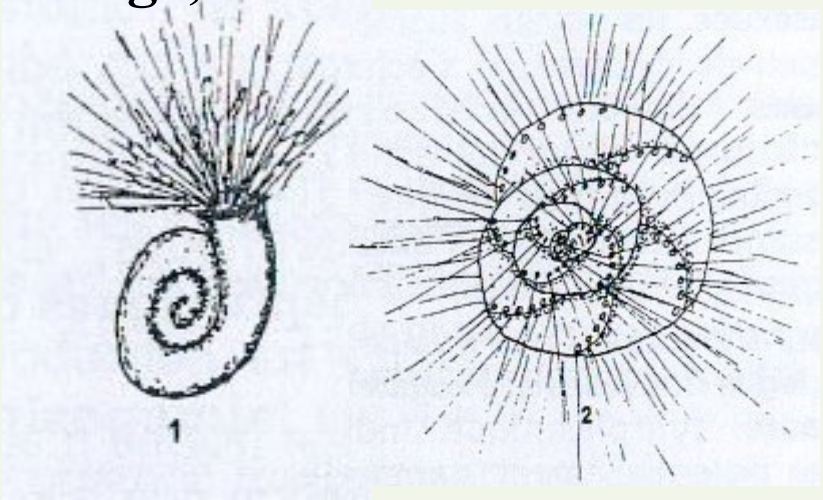

Figure : Foraminefera imperforate (1) and perforate (2)

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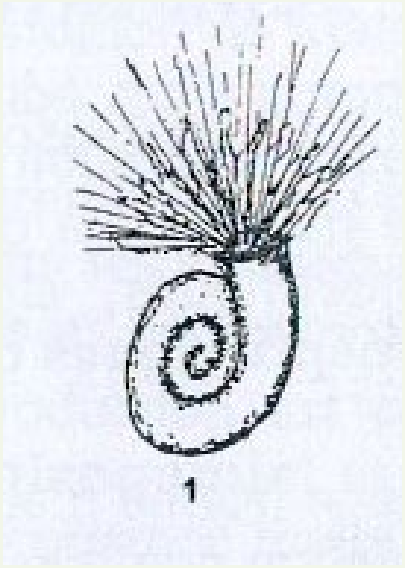
c) Foraminifera (Figure)



The imperforate test Foraminifera have only one opening, from which a bundle of pseudopodia emerges.

There are perforated test Foraminifera that have numerous perforations allowing pseudopodia to pass through.

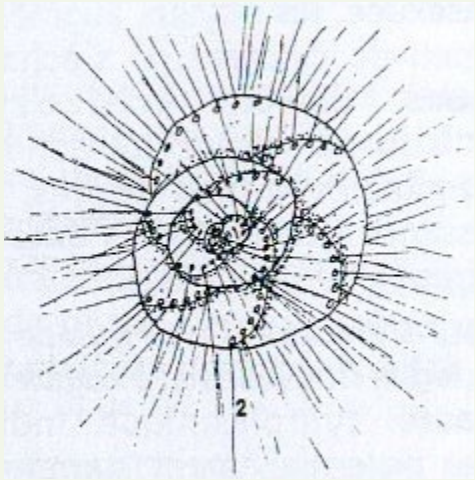
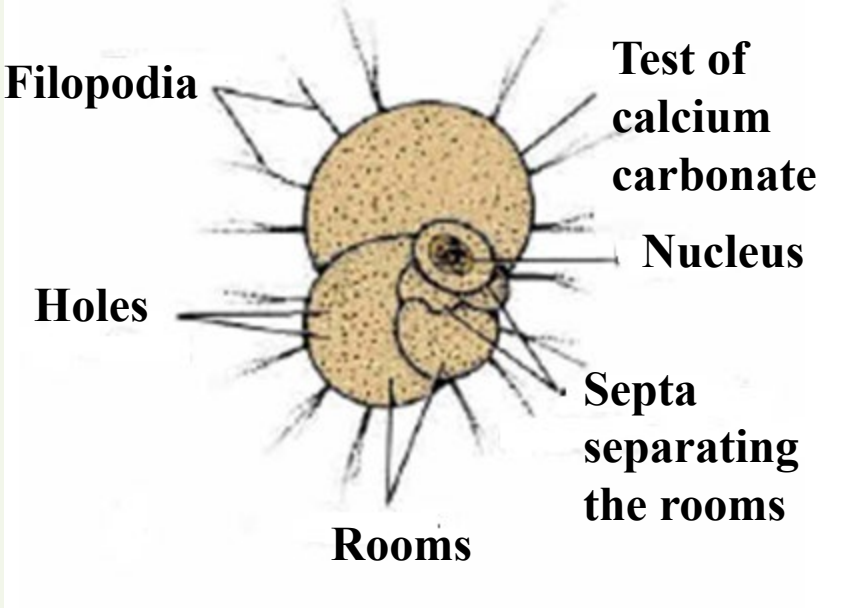


Figure : Foraminefera imperforate (1) and perforate (2)

The shape of the test varies: there are Unilocular tests containing only a single chamber and Multilocular tests where the adult animal lives in several chambers constructed successively during its development. These communicate through openings or Foramen.



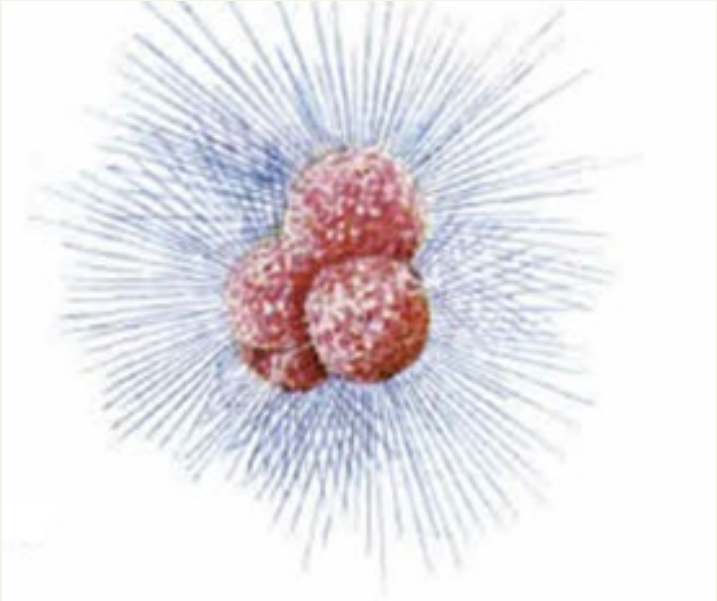


Figure: Main morphological characteristics of a Foraminifera

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4. – Phylum Actinopoda

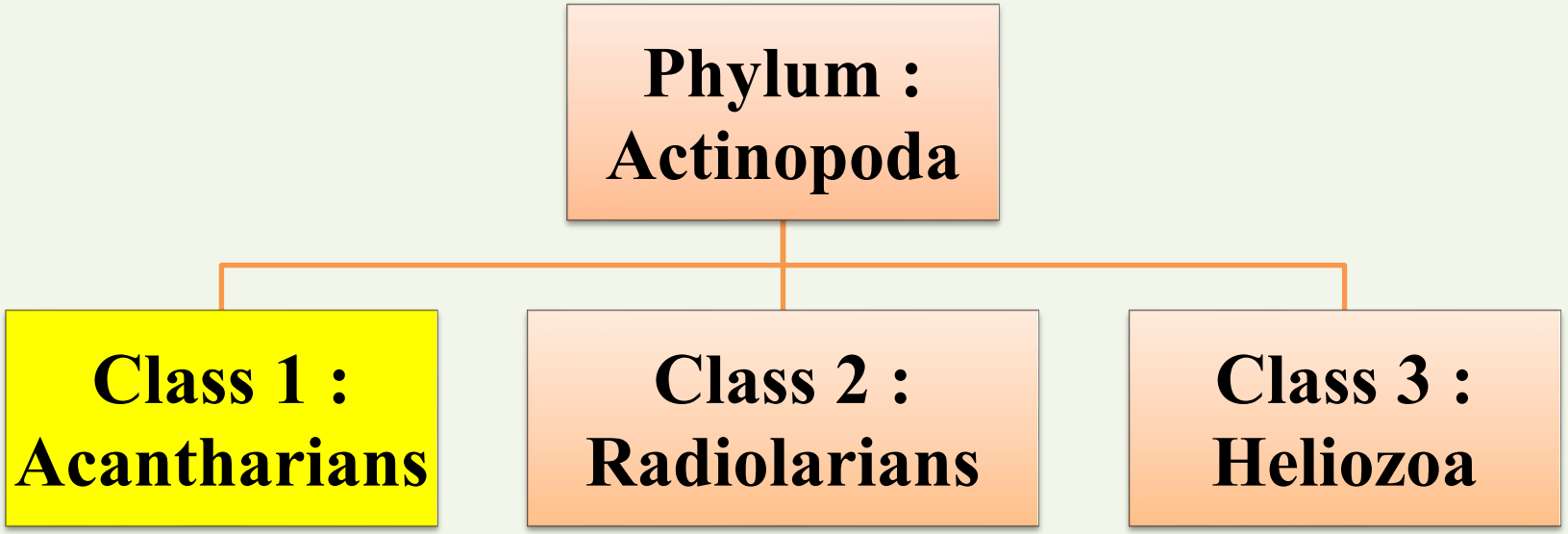
- Actinopoda : Actino = ray; poda = feet.

- In these animals, there are fine radiating pseudopodia: Filopodia.

- To which Axopodium can be added, more or less rigid filaments resembling flagella, but immobile: these are centrosomal derivatives that do not exist in all Actinopoda.

- They have a siliceous skeleton formed initially from radiating rods to which spicules and plates are added.

Chapter 1 : Protozoa



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4.1. – Class 1 Acantharians

- They are marine and planktonic.

- Their intracellular siliceous skeleton is formed of twenty spicules fused at the center and radiating into five circles of four spicules each. The spicules are composed of an organic material associated with Celestine.

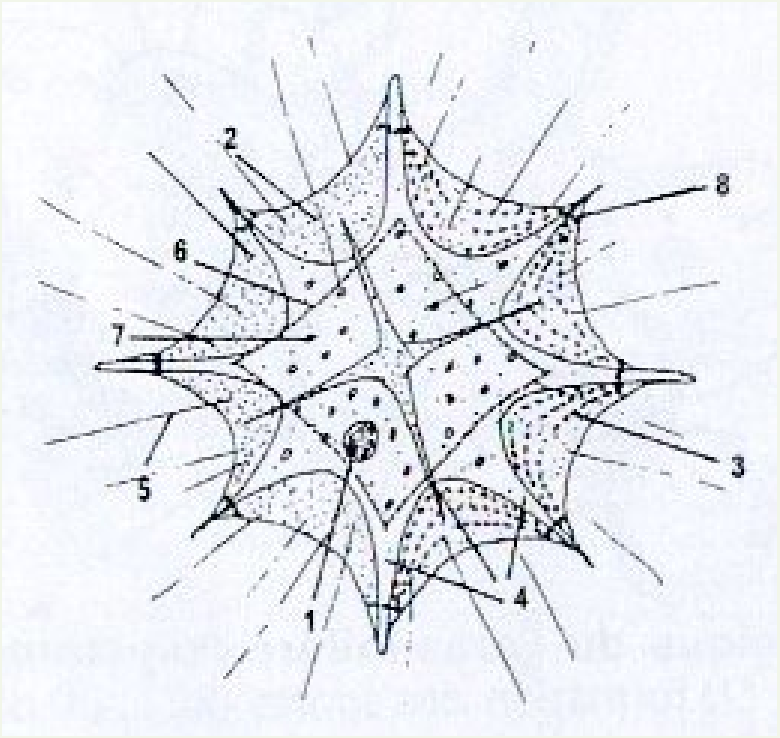
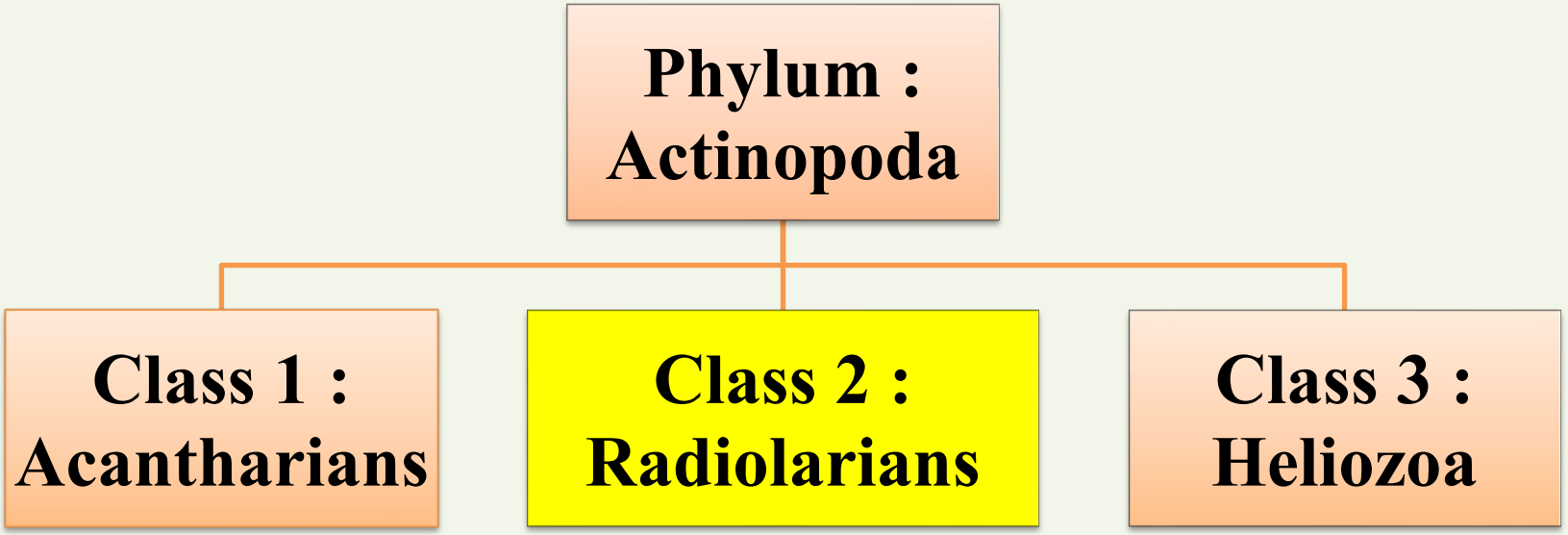


Figure: Organization of an acantharian *Acanthostaurus* sp.

(1) Nucleus, (2) ectoplasm, (3) myoneme, (4) spicules, (5) axopodium, (6) central box, (7) symbiotic algae, (8) myoneme.

Chapter 1 : Protozoa



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4.2. – Classe 2 Radiolarians (Figure)

- They are marine, planktonic, and can be solitary or colonial.

- They have a siliceous skeleton and lack axopods.

- Their shell is perforated and serves as a basis for their classification.

- The endoplasm is composed of a nucleus and numerous lipid droplets ensuring buoyancy.

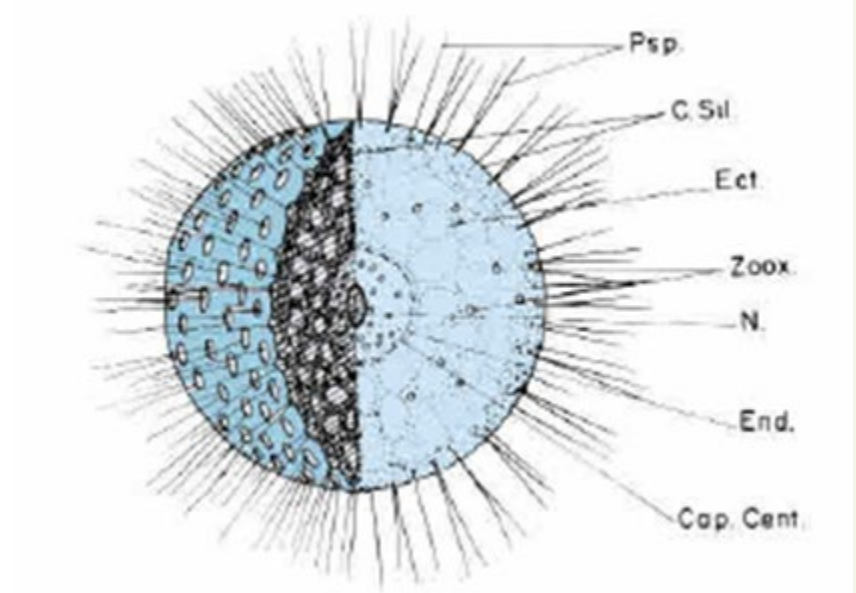

Figure: *Thalassicola* sp.

Psp.: pseudopodia, Ect.: ectoplasm,
End.: endoplasm, N. Nucleus,
Zoox. : zooxanthellae, C. sil.: silicious shell,
Cap. Cent. : central capsule.

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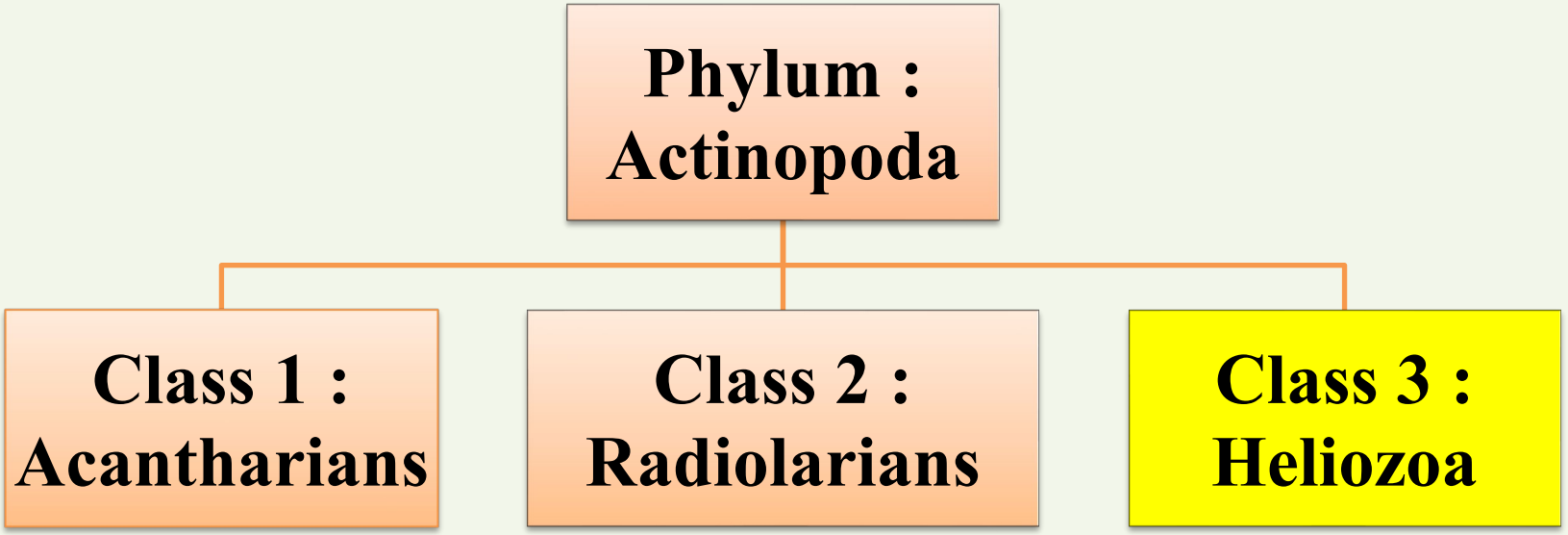

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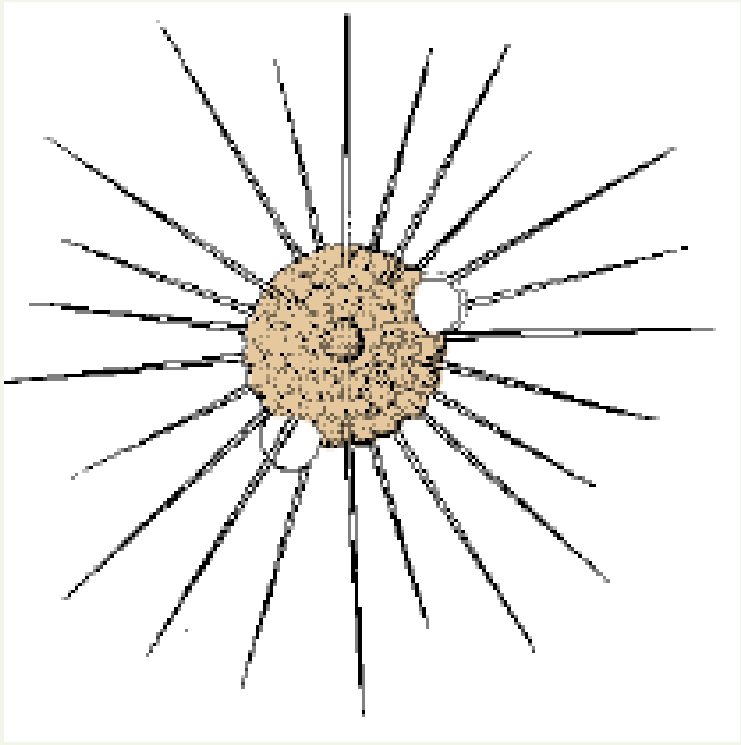
4.3. – Classe 3 Heliozoa (Helio : sun; zoon : animal)

They are freshwater-dwelling and have slender, pointed, and radiating axopods.



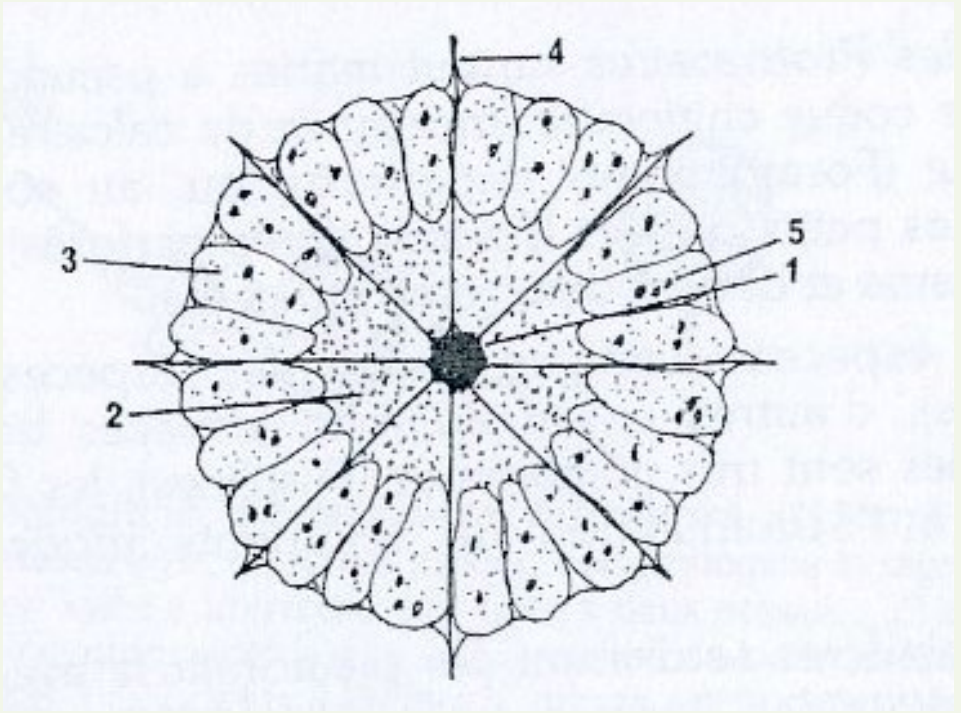


Figure: Organization of an Heliozoa *Actinphrys* sp.

(1) centroplast, (2) endoplasm, (3) ectoplasm (4) axopodium, (5) zooxanthellae.

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5. – Phylum Apicomplexa (Sporozoa)

- ***Sporozoa*** **(Grec, spora: seed ; zoon: animal).**

- **These protozoans are all parasites and exhibit a characteristic cycle in three phases: Schizogony, Gamogony, and Sporogony. The gametes are often flagellated.**

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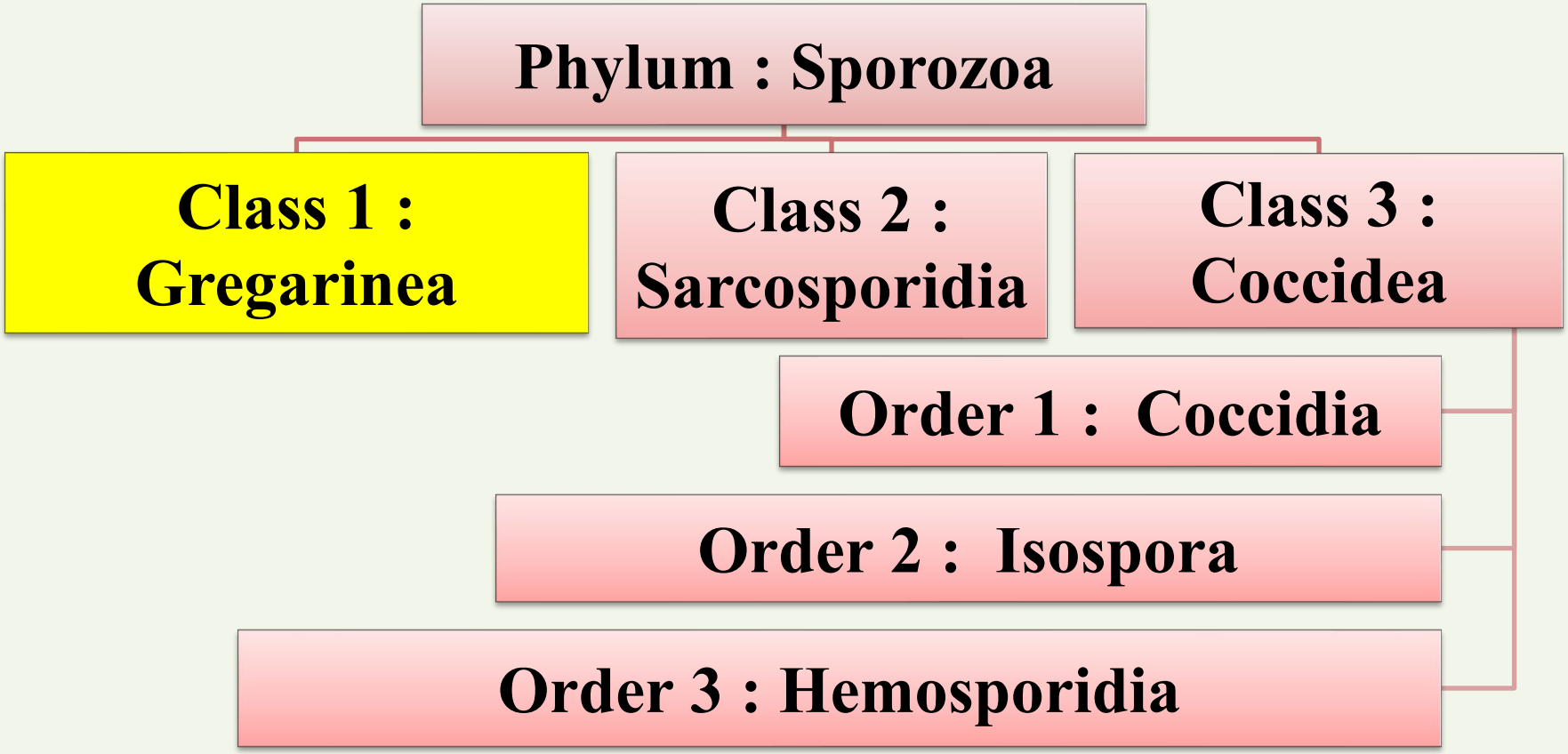
5. – Phylum Apicomplexa (Sporozoa)



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5.1. – Gregarinea (Gregarine : herd)

- These are Protozoa that parasitize Invertebrates (Annelids and Arthropods).

- They are generally Monoxenous (one guest), needing only one host.

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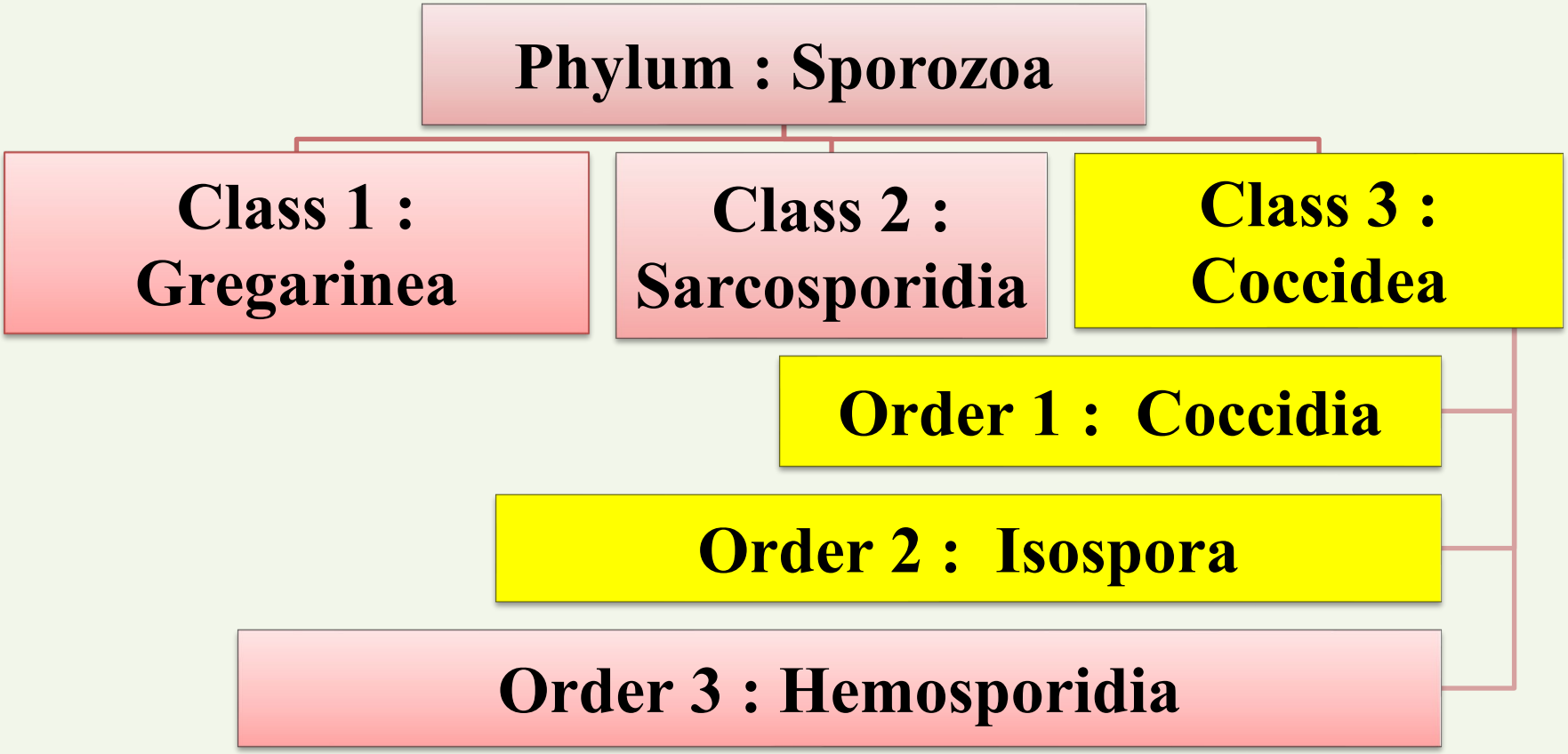
5. – Phylum Sporozoaires



5.2. – Coccidea

a) Coccidia

- *Emeria perforans* : lives in the intestinal epithelium of the rabbit.

b) Isospora

- These are the agents of toxoplasmosis. *Isospora gondii* parasites the cat, it is monoxenous or heteroxenous.
- He lives in the cat's intestine.
- He can affect humans, pigs, cattle, mice.

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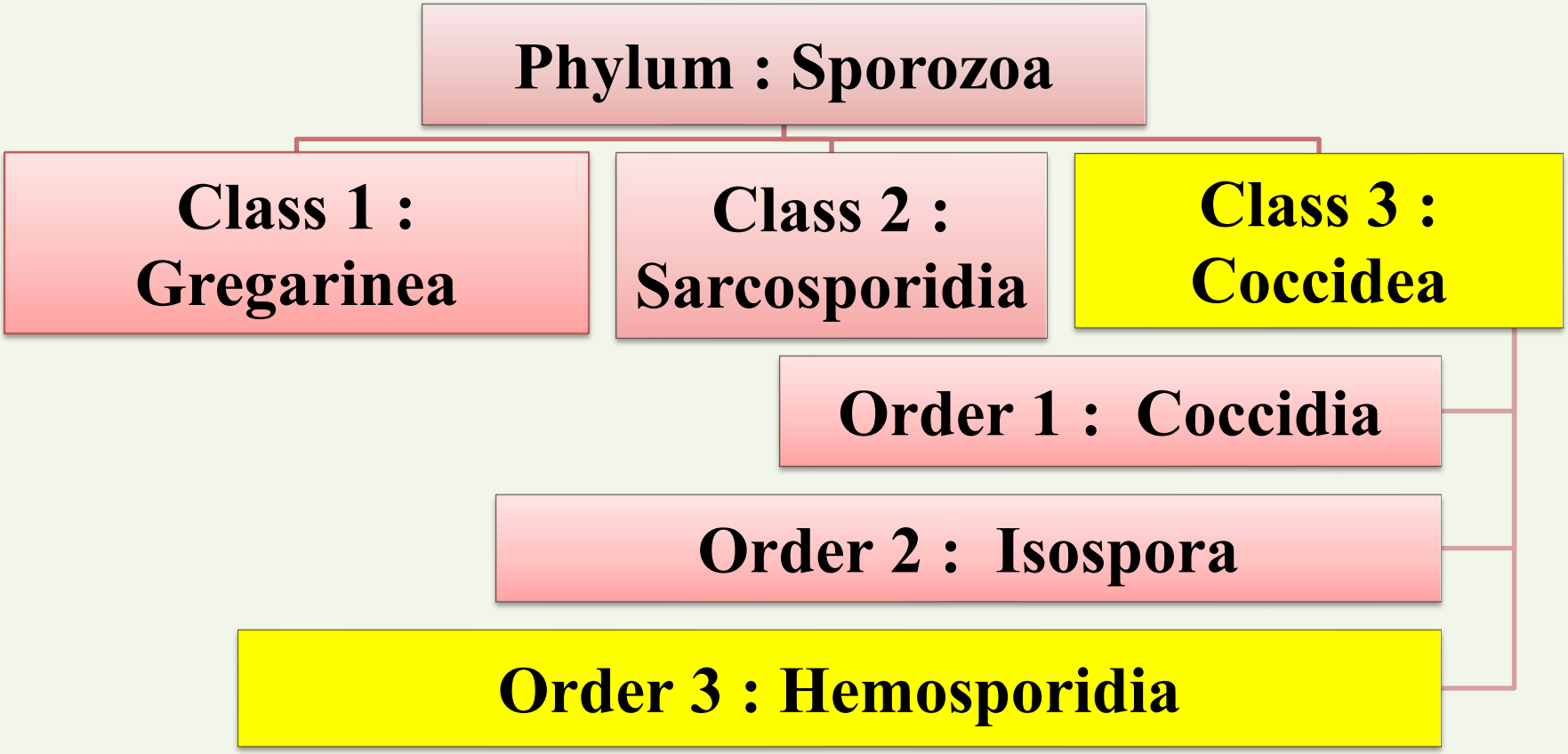
5. – Phylum Sporozoaires



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c) Hemosporidia (Hemo : blood ; spore : seed)

- They are blood parasites.
- Hemosporidia are heteroxenous coccidia.
- Schizogony occurs inside the red blood cells of vertebrates, while gamogony and sporogony take place in an *Anopheles* mosquito.

***Plasmodium falciparum*: causes Malaria diseases.**
P. vivax
P. malariae

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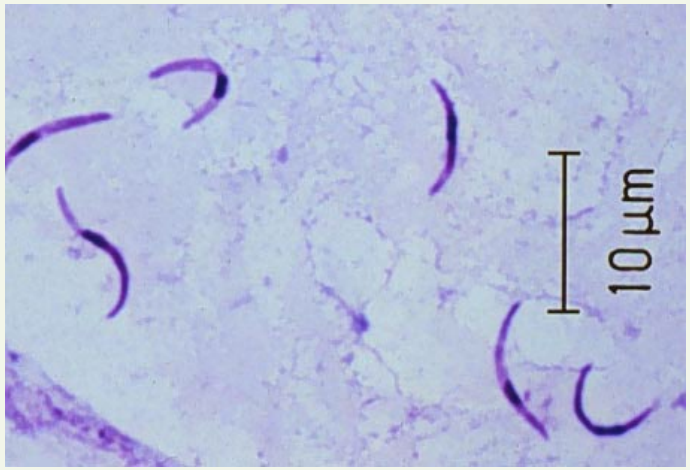
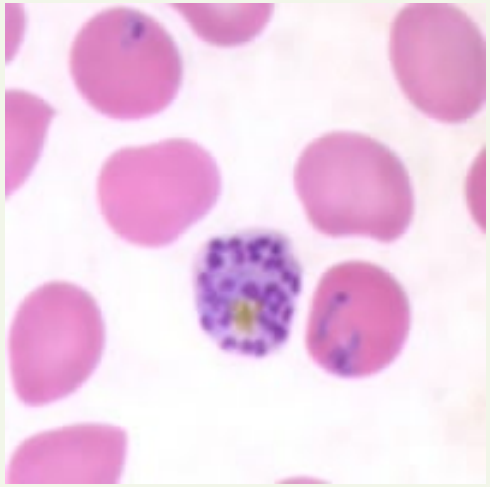
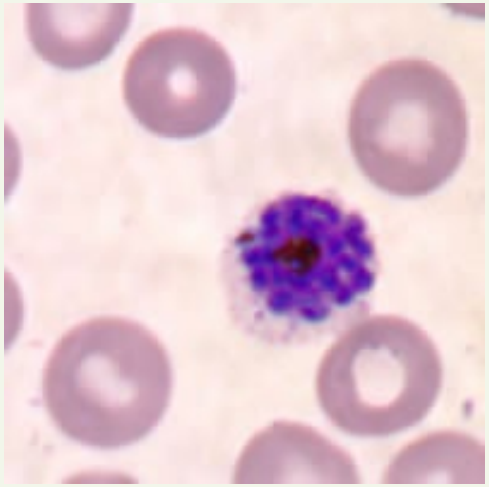
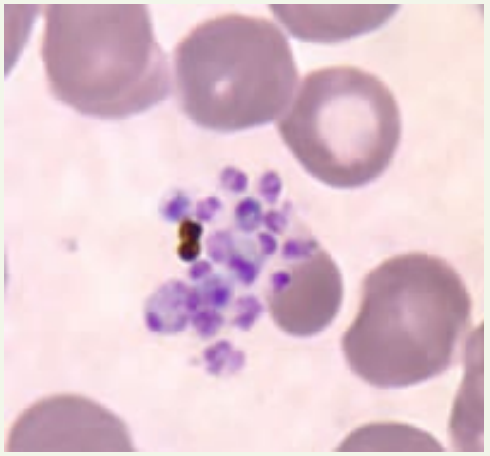


Plasmodium falciparum

Vector of Malaria : *Anopheles* mosquito







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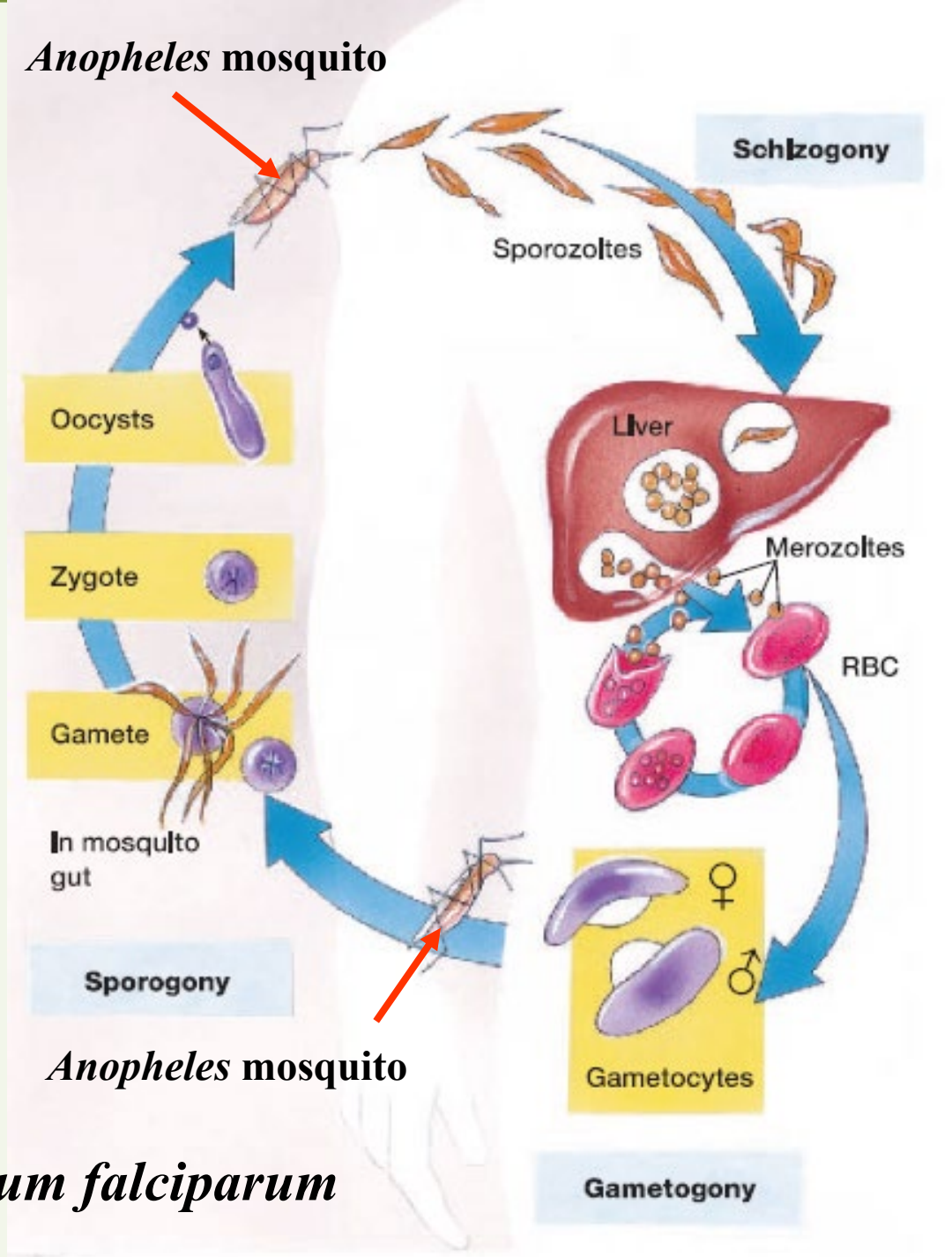

The life cycle of *Plasmodium falciparum*

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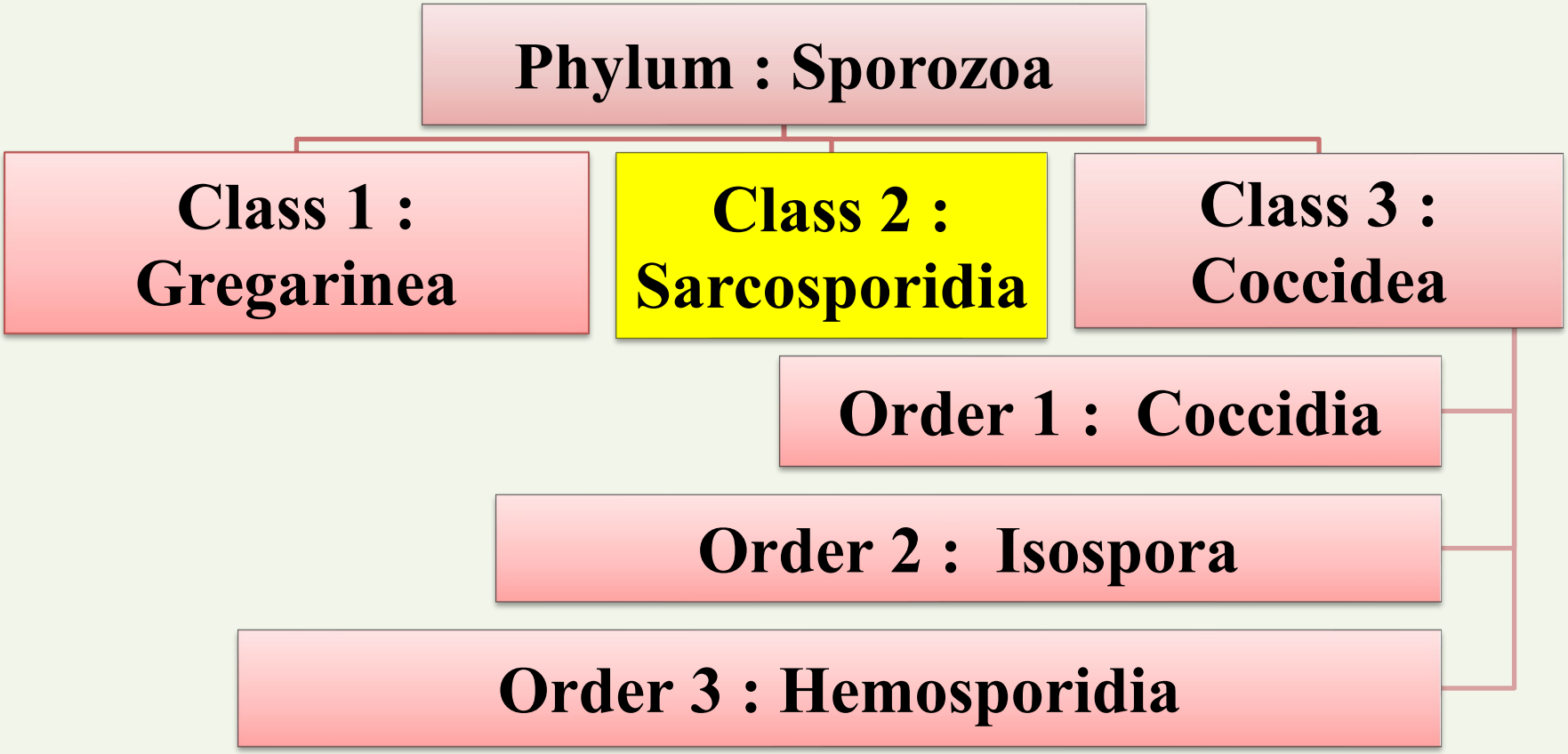
5. – Phylum Sporozoaires



5.3. – Sarcosporidia (Sarco : meat ; spore : seed)

- They are parasites of the muscles and nervous structures of mammals, birds, and reptiles where they form elongated cysts containing numerous nuclei. (plasmodes).

- These plasmodia give rise to crescent-shaped schizozoites whose development is not known.

Sarcocystis muris : he parasitizes mice.

Sarcocystis tenella : he parasitizes sheep by forming cysts in the oesophagus, diaphragm and heart.

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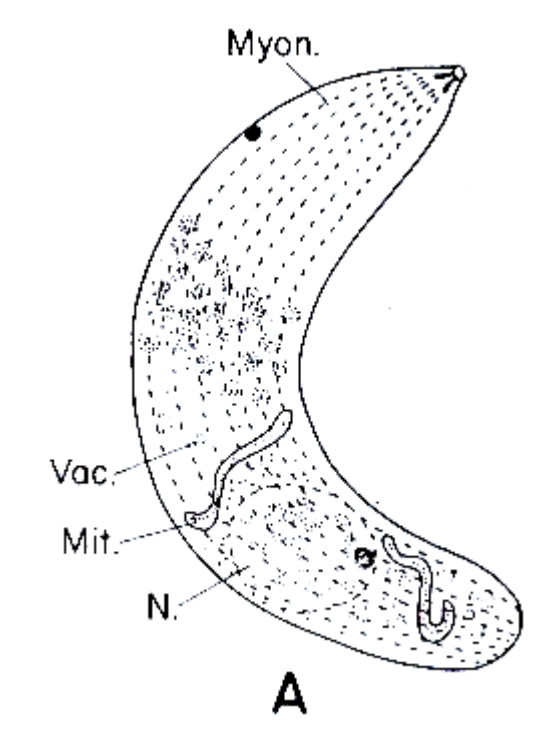
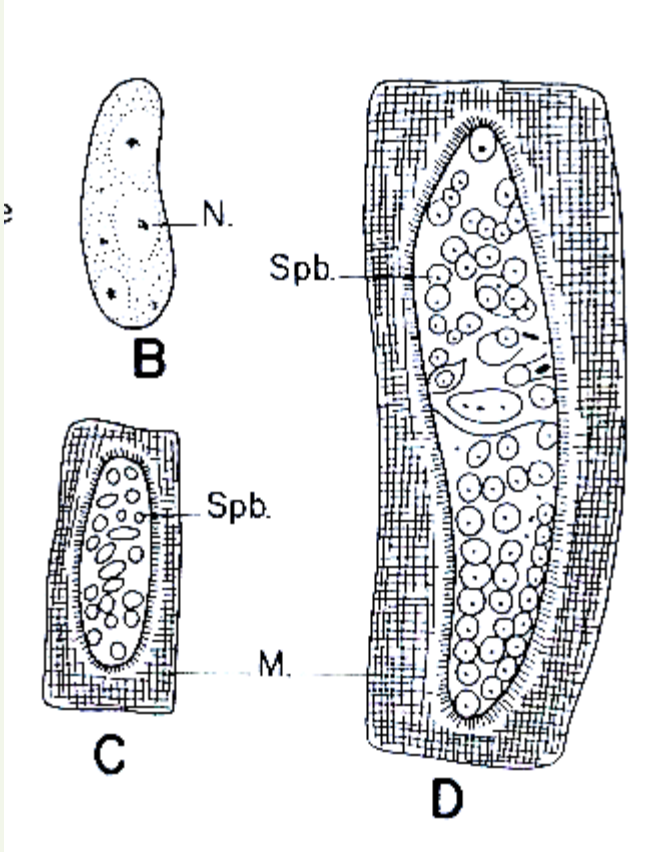
5.3. – Sarcosporidia (Sarco : meat ; spore : seed)



Mature schizozoite



Developmental stage of *Sarcocystis tenella* in a muscle

Myon.: myoneme, Vac.: vacuole, Spb.: sporoblast, N.: nucleus, M.: muscle, Mit.: mitochondrie

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6. – Phylum Cnidosporidia

- These are protozoa that parasitize invertebrates and vertebrates, with a plasmodial structure. The spores have a complex structure.

- These parasites are eukaryotic intracellular organisms, devoid of mitochondria and flagella. They appear in the form of spores.

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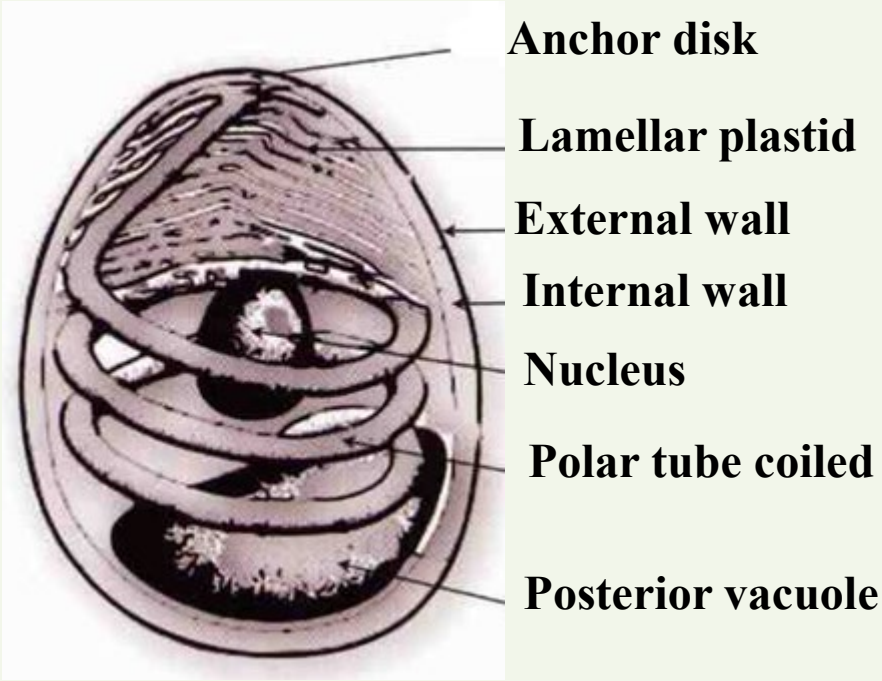

The spores have a form of resistance and dissemination and are characterized by the polar tube: a filament coiled inside the spore.

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Small-sized spores. Included in this phylum are several species that parasitize beneficial insects. For example, *Nosema* :

Nosema apis **causes serious dysentery (foul brood) in honeybees *Apis mellifera*.**

Nosema bombycis **parasitizes silkworms *Bombyx muri*, causing the disease pebrine.**

There are species that parasitize humans:

Enterocytozoon bieneusi
Encephalitozoon intestinalis

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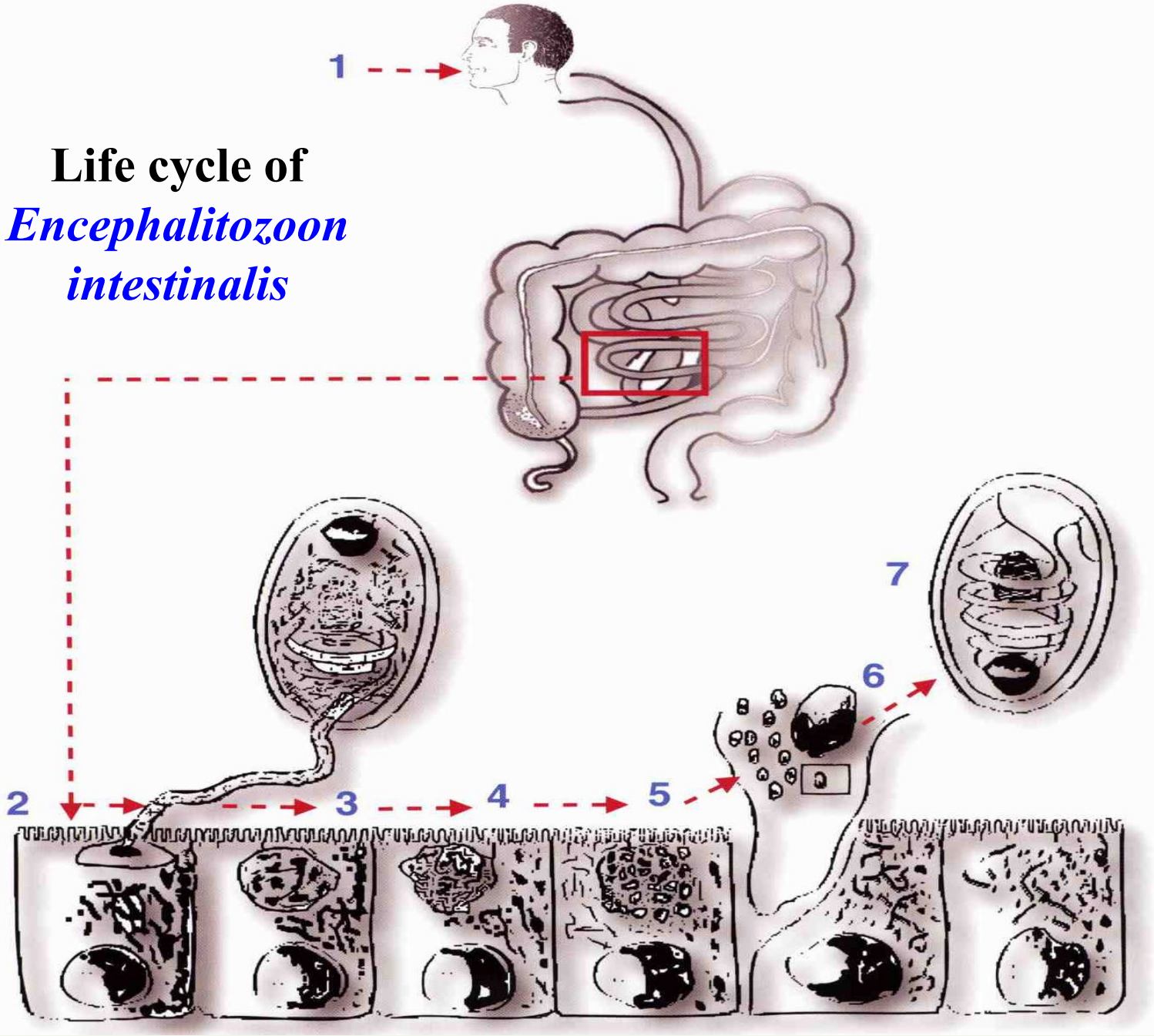
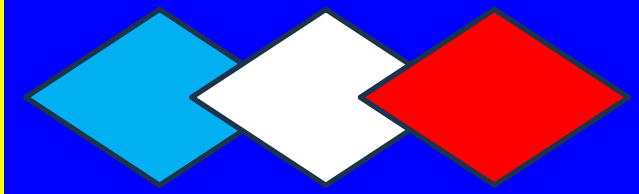
Encephalitozoon intestinalis

Polar tube in the intestinal cell of human

Life cycle of *Encephalitozoon intestinalis*





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