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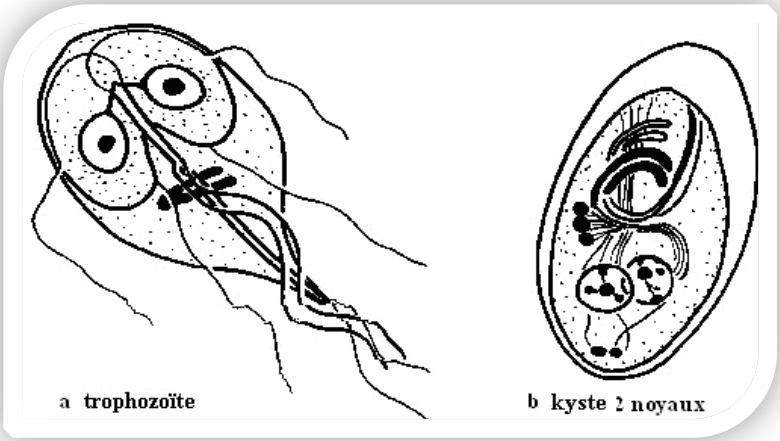
Diagnose of parasites



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MCA , Speciality : Parasitology

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CONTENTS

Title of Subject: Diagnose of parasites

Sector: Parasitology

Level: 3rd year

Bachelor's degree

Teaching unit:

Methodological unit

Hourly volume: 90h00 (Lessons +

Practical work Material)

coefficient: 3

Number of credits: 6

General objective of the course

This material targets the knowledge of parasitic species that infest humans and animals through the study of their morpho-anatomy, their development, their classification.

Introduction

Parasitic organisms are the causative agents of some of the world's most devastating and prevalent infections. This group of pathogens includes members such as the protozoans Trypanosoma (Chagas disease and African sleeping sickness), Leishmania (leishmaniasis), Plasmodium (malaria), and the helminths such as Schistosoma (schistosomiasis), Wuchereria (filariasis), and Echinococcus (echinococcosis), among others. Many of these infections have always been described as being tropical or subtropical. However, the increase in international travel as well as the arrival of new immigrants has made some of these tropical diseases realities in developed countries as well. In addition, a new trend arose; individuals, who never traveled to endemic areas were being infected by "tropical" blood-borne protozoans. This unusual observation could be traced back to blood transfusions and organ transplants. Asymptomatic carriers migrate and become part of the blood bank donor and transplant donor populations. Quick diagnosis has always been a priority to determine the appropriate treatment and prevent fatalities. In addition, now more than ever, advances in diagnostics can help prevent transmission and provide active surveillance. Unfortunately, there have been few major advances in diagnostic methods for parasitic infections. Efforts have stagnated, and the majority of definitive diagnoses still rely on labor-intensive and timeconsuming methods such as microscopy. To have the most significant diagnostic impact, new techniques and assays should be simple and yield rapid results. Such characteristics could be achieved by reducing the number of steps to be performed in a procedure and making result interpretation obvious enough to avoid significant operator-dependent biases. An optimal diagnosis method would possess these favorable features while still maintaining a high level of sensitivity and specificity. Moreover, many of the tests that are used today cannot differentiate between current and past infections. Assays that are capable of making this distinction are necessary to properly determine disease prevalence, choose the appropriate treatment, and assess the effect of treatment. Currently, diagnostic and reference laboratories use several techniques, including microscopy, molecular assays, and serological assays. Each method has its advantages as well as disadvantages. Furthermore, many research laboratories are focusing on the development of new diagnostic methods as well as the improvement of old ones. There has especially been a focus on the development of molecular diagnostic techniques. Real-time polymerase chain reaction (PCR) procedures for the detection of various parasites are continuously being optimized. Recently, loop-mediated isothermal amplification (LAMP) has attracted much attention and seems to be the molecular tool of the future.

Chapitre I.

I. Protozoa (Reign of the Protists)

1.1.General characters

Protozoa (from Greek, protos: first, zoo:animal) are single-celled organisms. These n organizations are part of a kingdom of their own: that of the Protists. The apparent simplicity of Protozoa is misleading. In fact, the single cell of Protozoa is more complex than the typical animal cell. All the functions necessary for animal life are fulfilled by this single cell. It is the organelles of this cell that fulfill the role of the tissues and organs of more complex animals.

- **Respiration and circulation** Protozoa depend exclusively on diffusion for respiration and circulation of oxygen and nutrients. The film must therefore be permeable, which prevents protozoa from colonizing terrestrial environments unless the air is continuously saturated with moisture**.**

- **Food & Digestion**

Most protozoa feed by phagocytosis where the food particle is incorporated into the cytoplasm surrounded by a membrane forming a vacuole. This vacuole then fuses to one or more lysosomes that contain digestive enzymes that degrade carbohydrates and proteins.

- **Excretion and osmoregulation**

The digestion and degradation of proteins by animals produces waste products containing nitrogen. This nitrogenous waste must be disposed of as it is toxic. Protozoa remove their nitrogenous waste as ammonia by diffusion.

- **Reproduction**

The main mode of reproduction in Protozoa is asexual reproduction, but sexual reproduction is also common. Asexual reproduction is advantageous because it is energetically more economical.

- **Asexual reproduction can be:**

1- a binary fission or division, during which the individual literally splits into two to produce two identical individuals of the same size;

2- a budding during which an extension of the organism separates and produces a new individual;

3- a multiple fission or division (schizogony) where the multinucleate parent divides into several cells of similar size.

- **Sexual reproduction**

It usually involves the formation of male and female gametes (gametogenesis), but, in Ciliates, there is a special mechanism of exchange of genetic material that does not involve gametes but small nuclei called micronuclei: it is conjugation.

- **Defenses**

Different types of defenses against aggressors are noted in sporozoa

- Amoebas that live in the soil produce cysts when conditions become difficult. These cysts are resistant to desiccation and freezing.

Many Ciliates have trichocysts that look like small harpoons and are often coated with paralyzing substances. These trichocysts are used to immobilize prey and are discharged when a predator touches the ciliate.

- The flagellate responsible for sleeping sickness (Trypanosoma) protects itself from the attacks of the immune system by continuously modifying its glycocalyx in such a way as to render the antibodies inoperative.

- **Locomotion**

Protozoan ectoplasm can contain a wide variety of contractile appendages that are used for locomotion. In Amoebae and various other Rhizopods, the movement is by the emission of pseudopods; in Flagellata there are long flexible and contractile appendages (flagellums or flagella). The Ciliates have, as their name suggests, vibratile eyelashes.

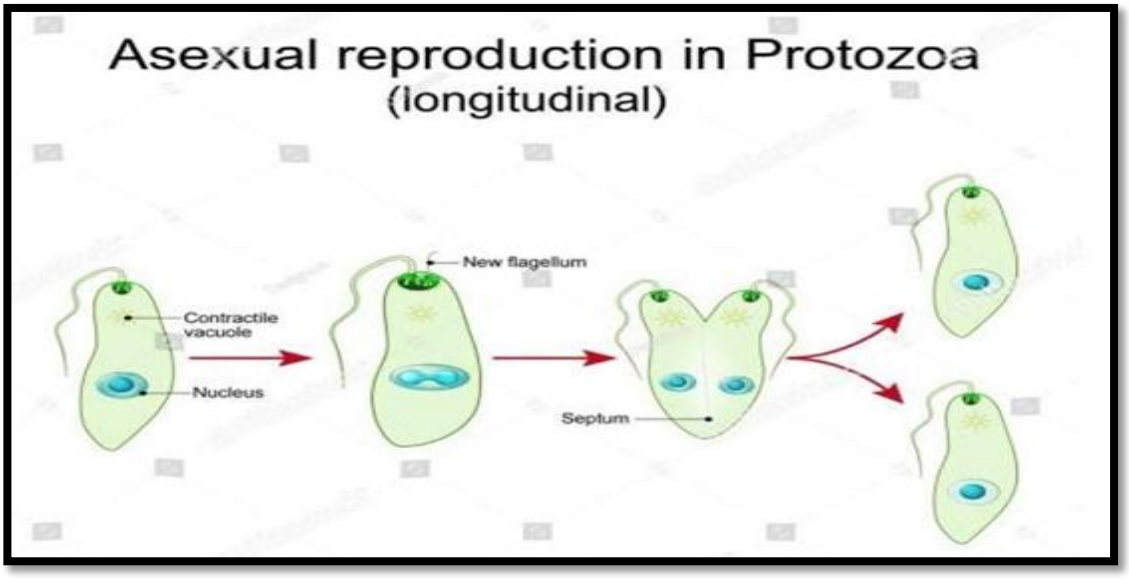

Fig 01: Asexual multiplication (longitudinal binary division) of a Trypanosome

I.2.Systematic Protozoa

Protozoa are divided into five branches

I.2.1. Branch: Rhizopoda (Rhizos=root; podos=foot)

I.2.1.1. General characters

- ✓ Very heterogeneous protozoa
- ✓ Have a locomotor apparatus formed of pseudopods of different shapes (lobed, filiform and reticulated)
- ✓ Generally free organisms that live at sea level, freshwater and wetland. There are parasitic species.
- ✓ They can encyst in unfavourable conditions

I.2.1.2. Classification

Their classification is based on the morphology of pseudopods. Thus, they are divided into six classes (Amoebiens, Thécamoebiens, Foraminifères, Acanthaires, Radiolaires and Heliozoaires).

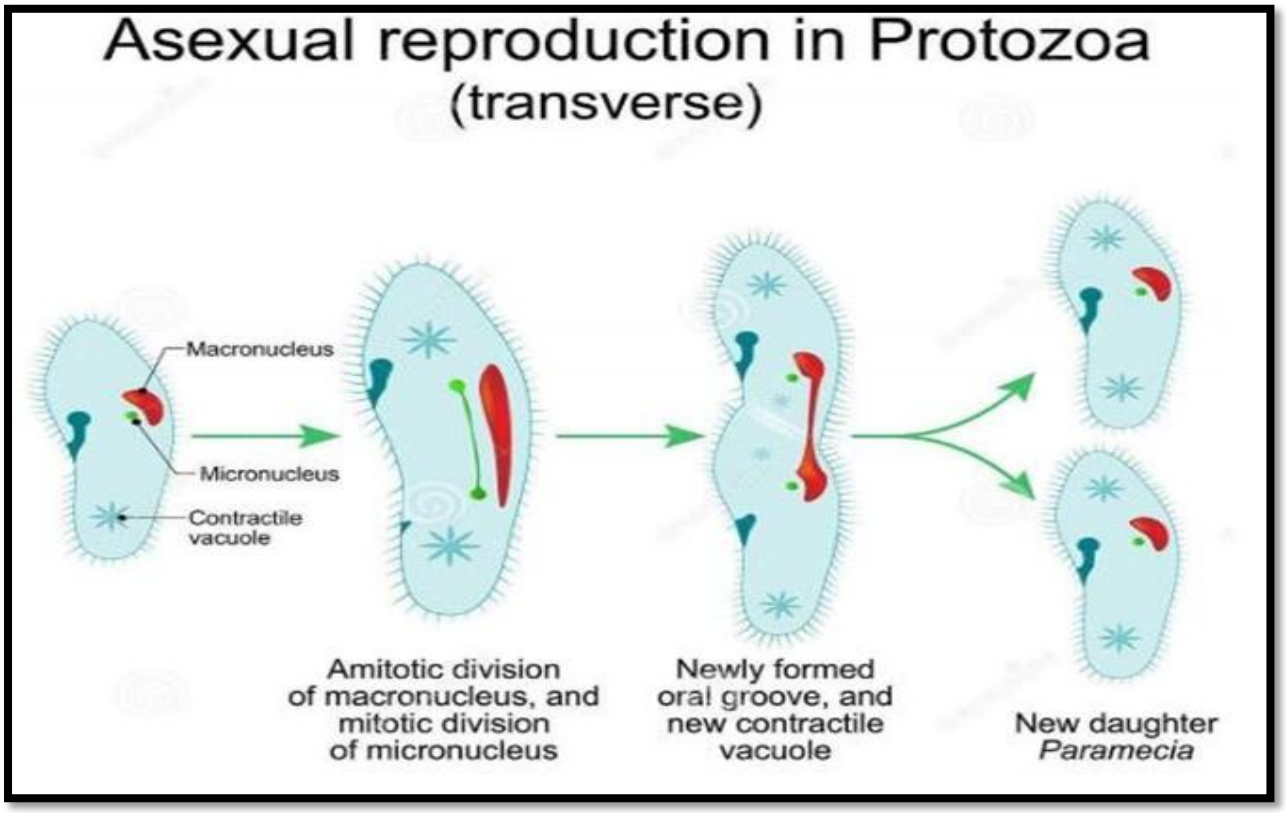

Fig 02: Asexual multiplication (transversal binary division) of a Paramecium

a. Class of Amoebians

Most amoebae are aquatic although some live as parasites in the human gut, lungs and liver

- The body deforms by pushing pseudopods, disappearing to reform at another point, they cause the body to move by creeping, which are called amoeboid movements
- They feed by phagocytosis throughout the surface of the body

Esp1: *Amoeba proteus* : A free-living species living in stagnant freshwater, it feeds on small animals and plants and has variable forms depending on outdoor conditions.

Esp2: Entamoeba histolytica : A haematophagous and pathogenic species, it lives in the intestine of humans and can cross the intestinal mucosa to lodge in the liver, lungs or brain. It feeds on food debris and red blood cells and causes a condition called amoebic dysentery or amoebiasis.

Esp3: Entamoeba coli : It lives in human colon and feeds on food debris and bacteria, it is not pathogenic.

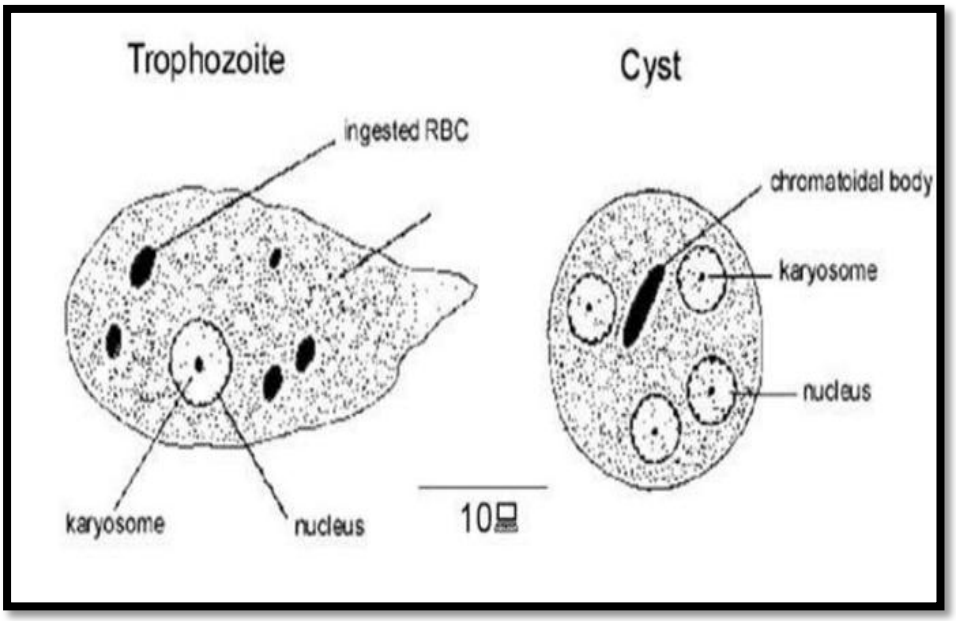

Fig 03: Vegetative (trophozoite) and Cystic (cyst) forms of *Entamoeba hitolytica.*

b. Class of zooflagéllés

They are divided into two super-orders

Super-order of Protomonadins: They are devoid of axostyl, in which mitosis seems to occur without participation of the blepharoplast **Order of Trypanosomides:** These are parasitic forms with a single anterior flagella

Genus Leptomonas: It is characterized by a kinetosome siti far in front of the nucleus and by the absence of the undulating membrane. The species of this genus are parasites of arthropods, molluscs and annelids.

Esp1: Leptomonas muscarum : It lives in the digestive tract of many flies including the housefly

Genus Crithidia : It is distinguished by a kinetosome located just before the drowning and by the presence of a short undulating membrane. They are biting insect pests

Esp: Crithidia pulicis : It lives in the digestive tract of the human flea

Genus Leishmania: Leishmania are endocellular parasites of white blood cells and lymphoid organs. Their cells are small and spherical with a large nucleus and flagella reduced to a short internal portion. They are transmitted by small dipteran insects called "Phlebotomes"

Esp1: Leishmania donovani : It is responsible for visceral leishmaniasis or Kala Azar characterized by enlargement of the liver and spleen and lowering of white blood cell levels. It is transmitted by *Phlebotomus perniciosus.*

Esp2: Leishmania tropica : It causes cutaneous leishmaniasis or oriental pimple which is an ulceration under the skin. It is transmitted by *Phlebotomus papatasi*

Genus Trypanosoma : Trypanosomes are very numerous and parasitize all classes of vertebrates and some phytophagous insects. They are characterized by a kinetosome located posterior to the nucleus from which starts a flagella that runs along the side of the cell with which lifts a long undulating membrane

Esp1: Trypanosoma gambiense : It lives in the blood of humans and causes sleeping sickness (West African trypanosomosis) and is transmitted by an insect - dipteran called fly Tsé-Tsé or Glossina palpalis.

Esp2: Trypanosoma rhodesiense : It lives in human blood and causes sleeping sickness (trypanosomosis is African) and is transmitted by a dipteran insect called fly Tsé-Tsé or Glossina morsitans.

Esp3: Trypanosoma cruzi : It is widespread in South and Central America and causes chagas disease or American trypanosomiasis in humans. She is transmitted by haemipteran insects

called reducves or bugs of the genus Triatoma or Rhodnius.

Superorder of Metamonadines : They carry three to n flagella and have an axostyle, in which the division is pleuromitosis with participation of the centrosome forming an extranuclear spindle (paradesmosis).

Order1: Trychomonadids : these are axostyle flagellates with 3 to 6 flagella

Esp1: Trichomonas intestinalis : It lives in the human intestine

Esp2: Trichomonas vaginalis : It lives in the genital tract of the man in whom it causes gonorrhoea. The man contaminates the woman who becomes the reservoir of the parasite.

Order 2: Diplomonadids: They have duplicate organelles, symmetrically arranged on either side of a median axostyle, they have 2 to 8 flagellars

Esp1: Giardia intestinalis : It lives in the human intestine and has 2 nuclei, 2 parabasal bodies and 8 flagella.

Super-order Opalines : these are large zooflagellates (100 to 300 μ). They have a foliate or fusiform body with many flagella arranged in regular rows. They are devoid of centrosomes and axostyle and contain many identical nuclei. They are parasites of the digestive tract including the rectum of various poikilothermal vertebrates

I.2.2. Branching of Ciliophora "Ciliates or Infusoria"

I.2.2.1. General Characters

- Most ciliates live in freshwater and feed on bacteria and plant debris
- The body of these unicellular cells is covered with vibratile eyelashes.
- The beats of the eyelashes are coordinated and ensure on the one hand the locomotion of the cell and on the other hand create currents of water bringing food particles to the animal.
- The eyelashes can agglutinate and form either waxes: organelles more especially locomotor, or membranelles generally located at the level of the peristome or the cytopharynx and having a nutritional role.
- The peristoma extends into the cytoplasm via a cytopharynx provided with a membrane, the movements of the membrane push microorganisms and food particles towards the bottom of the cytopharynx or form a food vacuole. When the latter is formed, it detaches and begins a cyclosis in the cytoplasm. As soon as she has

detached, a new vacuole forms behind her. Elaborate enzymes by the cytoplasm enter the vacuole and allow the digestion of ingested prey.

- Presence of a double nuclear device in the cell, a micronucleus with a reproductive role and a macronucleus involved in the nutrient exchanges, the expression of genetic characteristics.
- Presence of two pulsatile vacuoles with respiratory and osmotic roles
- They reproduce by asexual multiplication (transverse binary fission) and by sexual reproduction (conjugation)

I.2.2.2. Classification

The classification of ciliates is based on ciliature, i.e. the dimensions and arrangement of the vibratile eyelashes.

e. **Class of holotriches**:

It groups ciliates with simple and uniform ciliation (made of simple eyelashes and membranelles)

Esp1: Paramecium caudatum or paramecia: It is abundant in stagnant waters, its body consists of an ovoid body and elongated from 150 to 300 μm long.

Class of spirotrich:

They have complex ciliary organelles such as cirres or undulating membranes forming an adoral fringe.

Esp: ***Balantidium coli*** : It is a parasite of the intestine of pigs and occasionally of humans and dogs.

f. **Class of Peritriches** :

They are characterized by a ciliature reduced to a posterior circle of locomotor cilia. They are usually pedunculate and sedentary.

Esp: Opercularia sp

g. **Class of Oligotriches**:

They are distinguished by reduced ciliature, they live in the digestive tract of herbivorous mammals (Equidae, cattle..ect)

Esp: Halteria sp

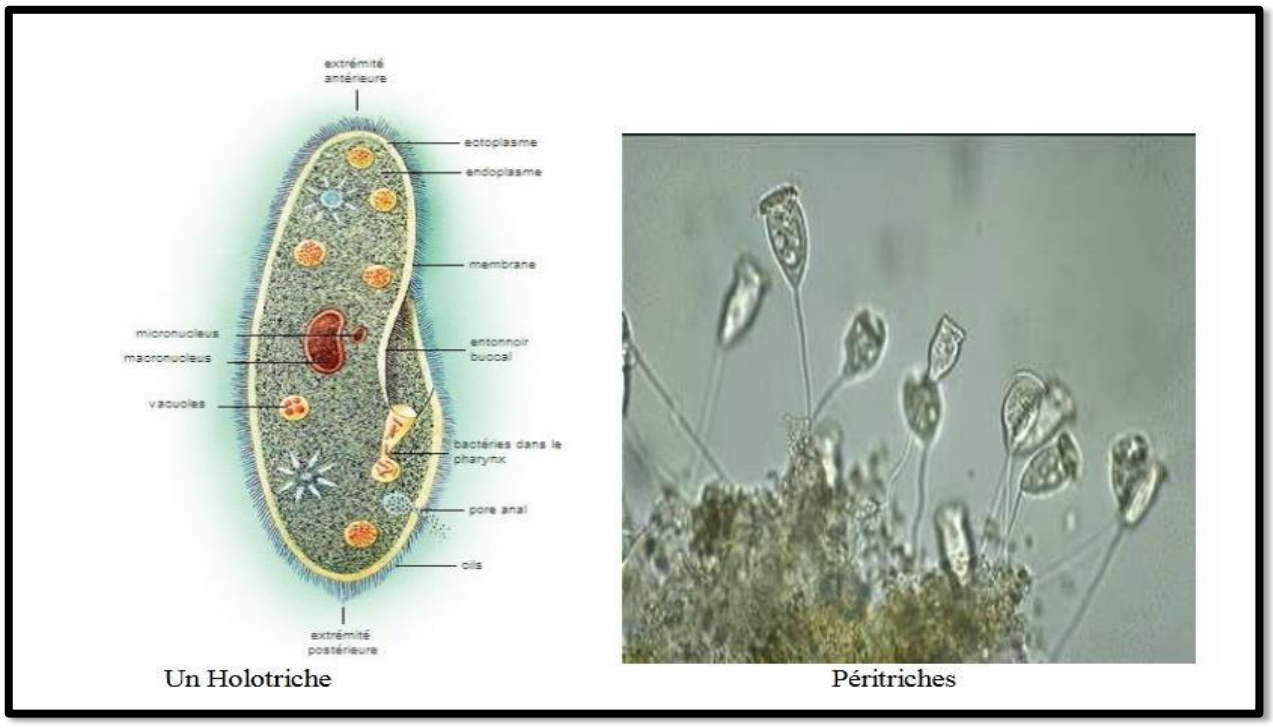

Fig 04: The classification of ciliates, class of holotriche and class Peritriche

I.2.3. Branching of Apicomplexa (Sporozoa)

I.2.3.1. General Characters

- Their name of Sporozoans comes from the mode of reproduction by sporulation
- The organisms in this group are endoparasites with a complex development cycle (obligate parasites),
- They do not have digestive vacuoles or pulsatile vacuoles
- They feed by absorption in the dissolved state of nutrients developed by the host
- They are usually immobile and do not have locomotor organs
- They are characterized by the presence of a typical apical complex in infectious stages called sporozoites, serving for penetration into the host cell. These uninucleated vermiform sporozoites are produced by sporocysts and/or oocysts
- The cycle involves a regular alternation of sexual and asexual generations. The typical sporozoan cell is uninucleated.

I.2.3.1. Classification

Sporozoa are divided into two classes.

a. Class of Gregarinomorphs (Gregarines)

Gregarines are sporozoan extracellular parasites of annelid and arthropod invertebrates. They can reach 10 mm in size.

Ex 1: Stylocephalus longicollis : It lives in the middle intestine of beetles (beetle) of the species *Blaps sp*

Ex 2: Lankesteria culicis lives in the intestine of the mosquito *Aedes aegypti*.

b. Class of Coccidomorphs

With the exception of a few species, coccidia are intracellular parasites of vertebrates and invertebrates

- **Subclass Coccidia**

They are sporozoa of medium or small size, endoparasite monoxenes of vertebrates and invertebrates

Esp1: Eimeria sp : Parasite of the intestinal epithelium and bile ducts of rabbits and poultry, it is responsible for a disease called coccidiosis.

Esp2: Toxoplasma gondii : Parasite of mammals and birds and causes a disease called

toxoplasmosis whose most serious form appears in immunocompromised and pregnant women who risk contamination of the fetus by transplacental route

***Ex 1: Cryptosporidium spp*= crytptosporidiosis**

Cryptosporidiosis is a cosmopolitan infection. Transmission is oral-fecal by ingestion of oocysts present in drinking water, recreational water, food. Similarly, transmission from animals to humans is common among breeders, veterinarians and people in contact with animals: cryptosporidiosis is therefore an anthropozoonosis.

- **Subclass Hemosporidia**

They are tenene parasites performing their schizogony in the red blood cells of a vertebrate, especially humans, and their gamogony in the digestive tract of a vector insect (mosquito). The best known species are those that cause in humans the various forms of malaria or malaria which is a disease characterized by periodic bouts of fever (malarial fevers or intermittent fevers)

Esp1: Plasmodium vivax benign third party fever agent whose outbreaks are separated by 48 hours

Esp2: Plasmodium malariae agent of mild fever four whose outbreaks are separated by 72 hours

Esp3: Plasmodium falciparum agent of daily fever that develops ùmanifest all year round in tropical countries and only in summer and autumn in temperate areas (summer-autumnal fevers). It is the most dangerous form of malaria and the outbreak of fever is daily

Esp3: Plasmodium ovalae agent of benign third fever whose outbreaks are separated by 48 hours but it does not live in tropical Africa. It is called the vivax of Africa.

Chapitre II.

II. Branching of the Plathelminths

These are commonly called flatworms, they are Metazoans, triploblasts: presence **of** a 3rd embryonic leaflet, the mesoderm which is inserted between the ectoderm and the endoderm. This mesoderm is very important because it is it that will shape the shape of the body and participate in the formation of organs.

Acoelomata : the mesoderm does not yet constitute a vesicle-limiting epithelium; the coelomata. It is formed of cells welded to each other and constitutes a species of spongy tissue: the mesodermal parenchyma.

On the other hand, in these animals, a bilateral symmetry clearly appears and a dorso-ventral polarity is recognized, an anterior or cephalic region and a posterior or caudal region.

Plathelminths **have 3 main classes: TURBELLARIES, TREMATODES** and **CESTODES**

II. 1. Class of Turbellarie

They are worms of foliaceous appearance whose unsegmented body is covered with a ciliated epithelium. They are usually free-ranging, but a few species live in or on aquatic hosts. They are mostly marine, but some live in freshwater or wetland habitats. Their size varies from 0.5 mm to 60 mm, but the majority does not exceed 5 cm.

a. Wall of a Turbellar

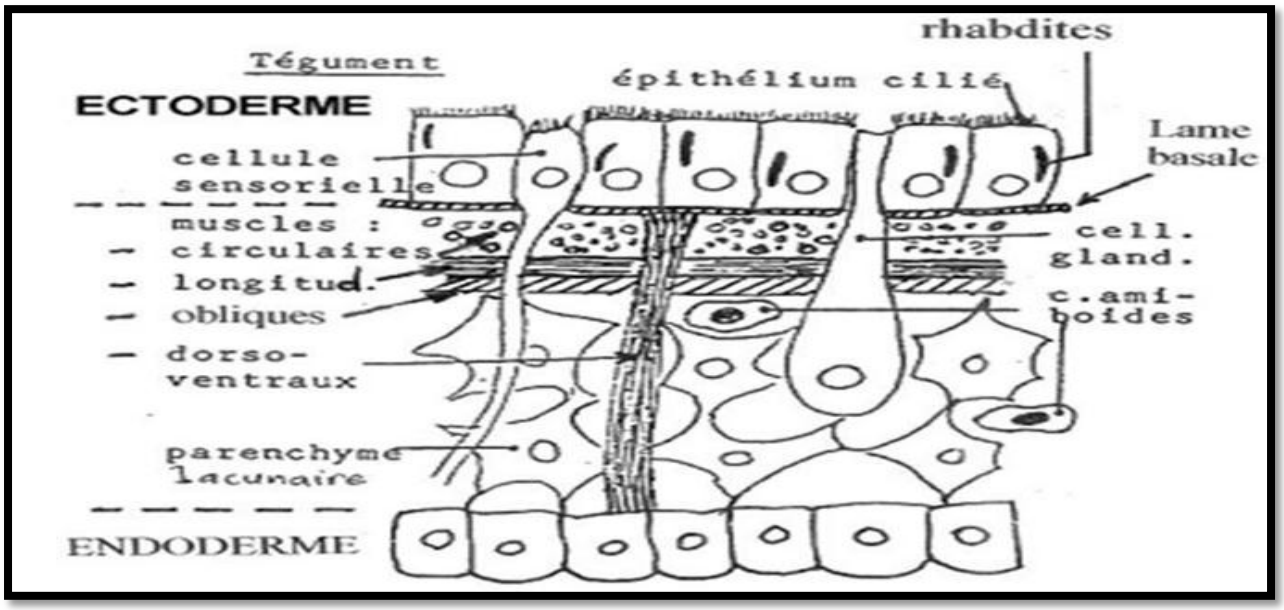

Fig 05: the wall of a Turbellar

- The epithelium is ciliated, epidermal. The flapping of the eyelashes on the epithelium allows locomotion.
- Under this epithelium, there is a basement membrane and then different muscle layers (circular, oblique,longitudinal).
- Between the muscle layers, there are glandular cells that can emit digitations to the epithelium.
- At the level of the basement membrane, we have sensory cells.
- The epithelial cells have a small corpuscle (rhabdite) with a still unknown role. They produce mucus outside the animal to coat foreign bodies.
- Under the muscle layers, there are two cell types:
- Ameboid cells that allow respiratory and nutritional exchanges.
- Starry cells bathed in haemolymph

b. Musculature : Mesodermal cells differentiate into contractile cells that form smooth fibers. Thus, under the integuments there will be an outer layer of circular fibers and an inner layer of longitudinal fibers. Between these 2 muscle layers there may also be a layer of oblique muscle fibers.

c-The peri-visceral cavity of Turbellariae : Parenchyma or coelenchyma of mesodermal origin formed by **anastomosed, star-shaped cells**. These cells delimit a set of deficiencies constituting **a lymphatiquerudimentary system (SLR)**

The (SLR) traversed by amoeboid cells, **neoblasts** and interstitial fluid

This **coelenchyma** performs the following functions: respiration, excretion, glycogenase, adipogenesis, etc.

d-The circulatory system: There is no differentiated circulatory system. The mesodermal parenchyma fills the space between the ectoderm and the endoderm forms a spongy, lacunar tissue,soaked with a liquid that will somehow play the role of lymph. The digested substances pass directly, through the digestive epithelium.

e-The respiratory system: there is no differentiated respiratory system. Breathing is cutaneous, gas exchange takes place by diffusion through the integuments.

f-The digestive tract: At the mouth, located anteriorly or on the ventral side, follows a pharynx of ectodermal origin, reinforced by a muscular sleeve and which can protrude outwards and serve as a tube. Then, there is no esophagus, the pharynx opens directly onto the endodermal intestine forming a vast sac that can have several branches according to orders.

There is no anus. Some Turbellarians, such as the order Acoeles, do not have a bowel, or even sometimes a pharynx. The mouth leads to a syncytium of mesenchymal cells that capture and digest prey. With the exception of a few representatives who are bacteriophages, Turbellariae are megalophagous carnivores. Their very stretchy mouth allows them to ingest large prey. Digestion is carried out partly extracellularly by releasing diastases into the digestive tract and partly intracellularly. The excrement is rejected through the mouth; the animal proceeds by real stomach washes, it absorbs water that it suddenly rejects with the waste products of digestion.

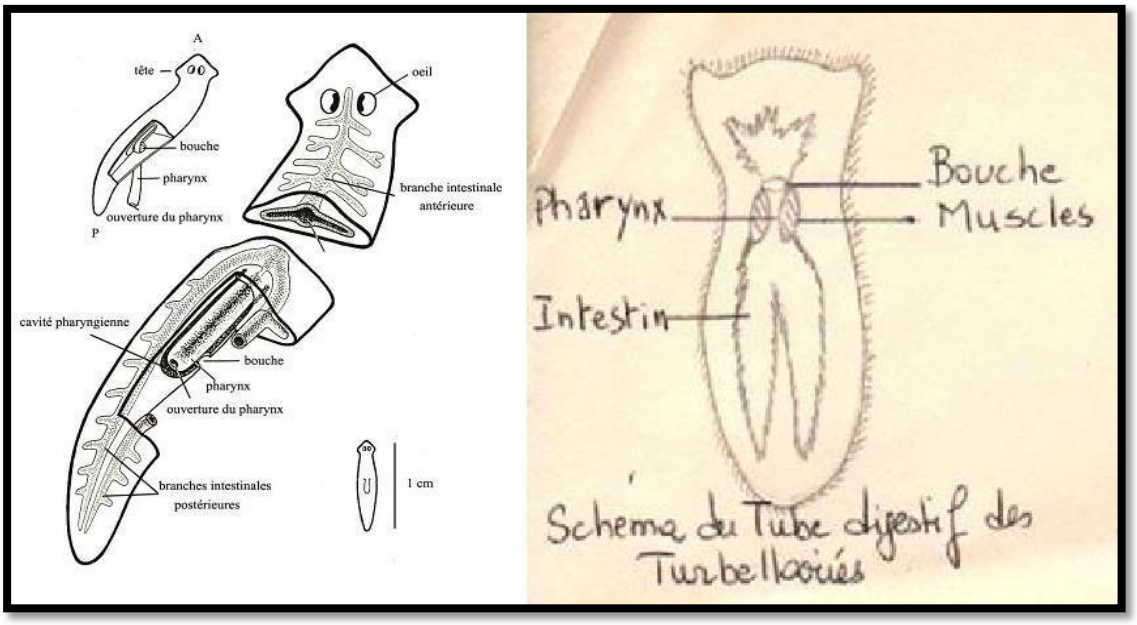

Fig 06: The digestive tract of Turbellar

g. The excretory apparatus : It consists of protoniphridies. Each Protelephridy presents itself as a kind of small tubule terminated by a particular cell: the Flame cell which are cells that have depressed to form ampoules inside which many flagella beat synchronously. The prothonephridial canalicules join others to finally flow into 2 right and left longitudinal channels that either open out through 2 small pores, or through several small pores. The excretion takes place thanks to the flame cells which will filter by selective permeability the waste products of the metabolism, such as urea, contained in the liquid of the parenchyma. These waste products are then discharged to the outside by the system of canalicules leaving the protonéphridies

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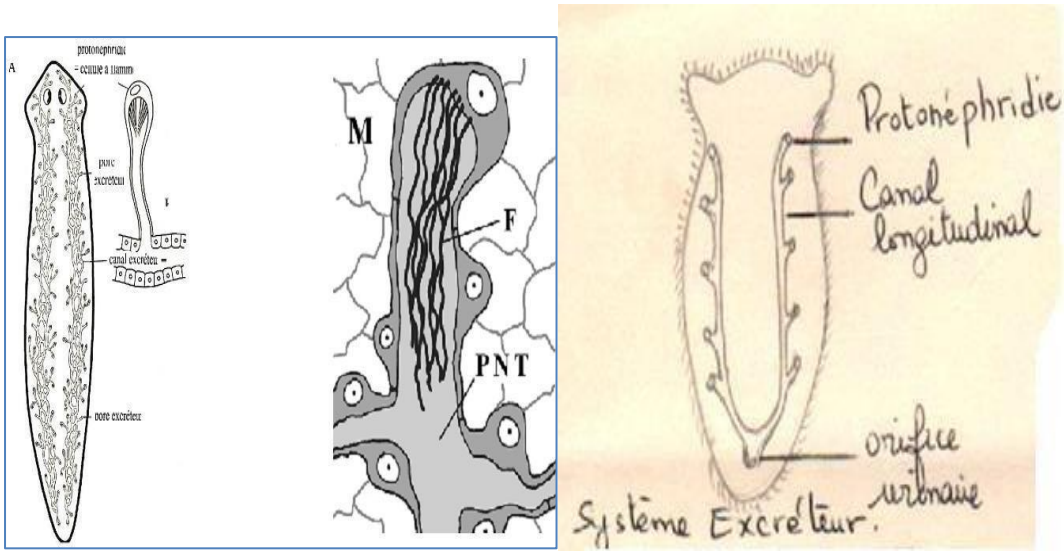

Fig 07: Planar excretory system (PNT: excretory channel, F: flame cell eyelashes,M Mesenchyme

The nervous system: comes from ectodermal cells that have specialized and differentiated into neurons. These sensory or motor cells will form a kind of network under the ectoderm. But in some regions, the cells in this network will pack against each other to form compact longitudinal nerve cords.

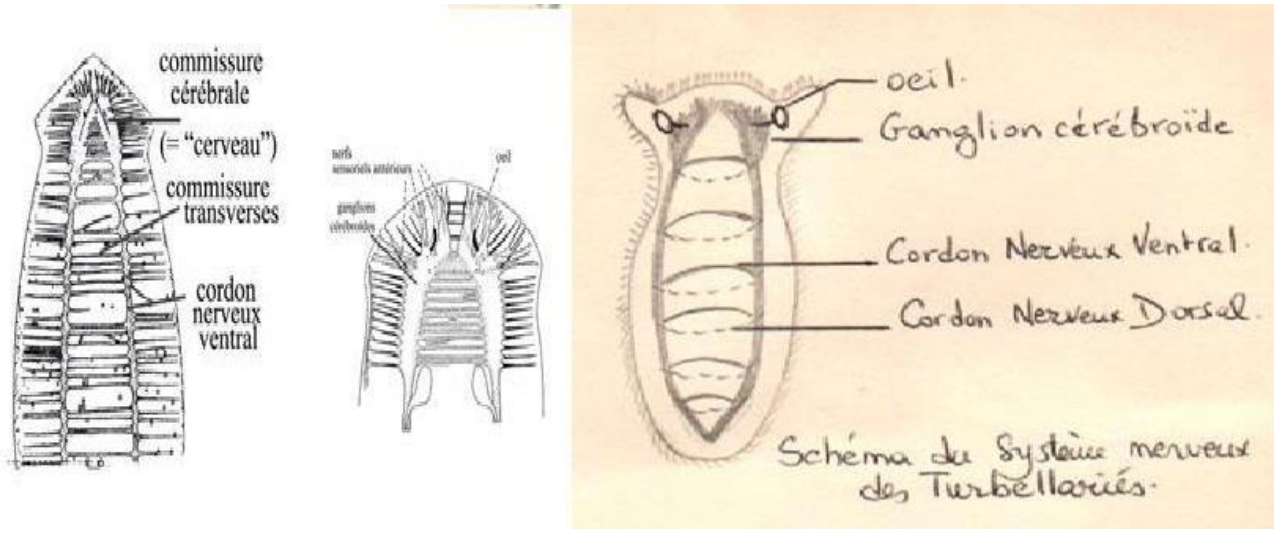

Fig08: Organization of the nervous system of a Turbellaria

h. Organization of the nervous system of a Turbellaria

It will also tend to condense in the anterior part of the animal and clusters of neurons will form more or less 2 lobes .We thus have the outline of a nervous system central Anterior

nerve mass is called brain or cerebroid nodes. From this brain, there are 2, 4, 6 or 8 longitudinal cords: the dorsal, lateral-dorsal and lateral-ventral cords. The belly cords are the most important .These longitudinal cords are connected to each other by transverse commissures. So, moving from Cnidarians to Turbellarians, we move from an unorganized SN to an organized and more or less centralized SN. This can be linked to the notion of a sedentary animal and a mobile animal.

In the mobile animal such as these flatworms having a bilateral symmetry, we have the privilege of having a part of their body, the one that is in front where there is a concentration of the sensory organs followed by a concentration of the SN, we witness the phenomenon of cephalisation, and cerebration.

There are several categories of sensory organs, which are not necessarily represented in the same animal:

- Tangoreceptors : sensitive to contact with solid bodies.
- Rheoreceptors : which are stimulated by the movement of liquid masses.
- Chemoreceptors : detect prey.
- Statocysts : ensure balance.
- Photoreceptors or Oceelles : sensitive to light.

i. The genital tract: There is the appearance of a real genital tract with glands and genital ducts. These are Proterandric hermaphrodites , i.e. these organisms possess the 2 genital systems, male and female, but since these 2 devices do not mature at the same time in the same animal, mating is mandatory.

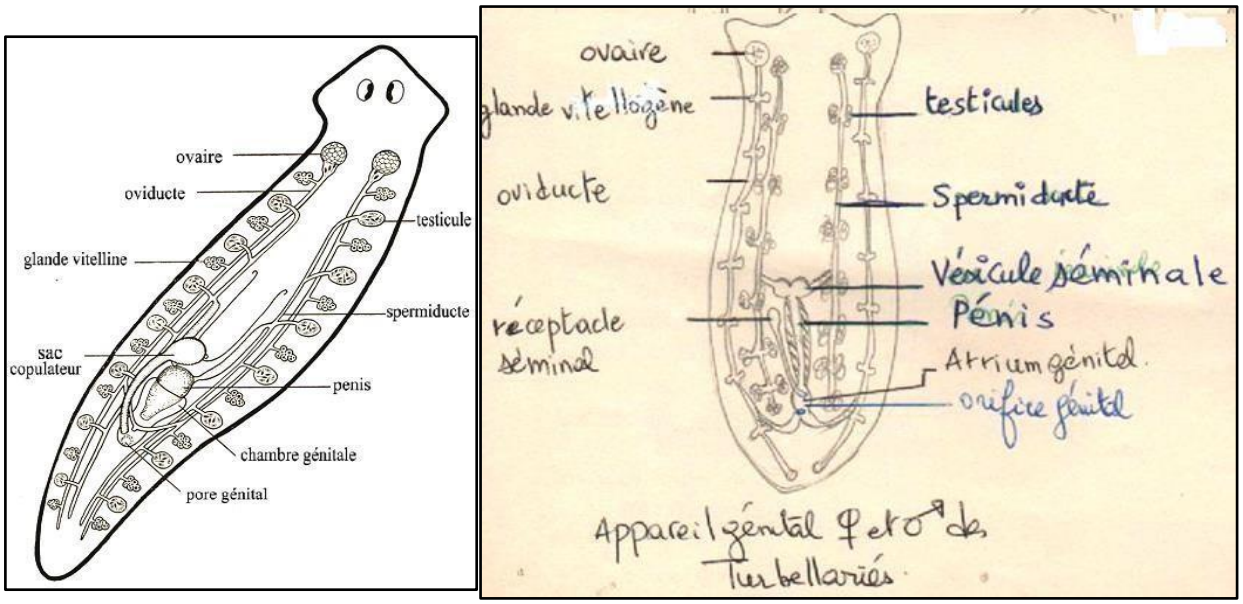

Fig 09: The male and female genital tracts of a Turbellaria

- ✓ **The male genital tract:** The testicles are born from mesodermal cells that will undergo spermatogenesis. There are either 2 massive testicles or several small follicular testicles. These testes flow into 2 spermiducts (or vas deferens) that come together in a single median canal. This can bulge to form a pocket of sperm accumulation: the seminal vesicle. At its end, this common channel is covered with several muscle layers, which allows it to form turning like a thumb a copulatory organ: the penis that does not open directly to the outside, but into the genital atrium.
- ✓ **The female genital tract:** From mesodermal cells, there is the formation of several masses that should be ovaries, but only one or two of these masses will give fertile ovaries. The others are aborted ovaries that form the vitellogenes giving the yolk. The ovaries and vitellogenes flow into 2 oviducts that open either separately or through a common uterus, after meeting, into the genital atrium. To this atrium is attached a copulatory bursa or seminal receptacle in which are stored the spermatozoa waiting for the passage of the eggs to fertilize them. During **sexual reproduction**, in some Turbellarians, sperm are received by the female partner at any point in the body there is a simple hypodermic impregnation or traumatic fertilization (Acoeles, Rhabdocoeles and Polyclades). In others fertilization is normal: there is intromission of the penis into the partner's atrium. Once fertilized, the egg incorporated with a few yolk cells in a cocoon, is usually laid quickly, it is rare that it is preserved for a long time. From the egg comes a young turbellariate that looks very similar to the adult: the development is direct.

- ▪ **Vegetative propagation**

Turbellarians have great regenerative power and can reproduce by **asexual multiplication**. The individual chokes and cuts in 2, each fragment regenerating the missing part thanks to embryonic totipotent cells dispersed in the mesenchyme: the Neoblasts. It'sdivision by architomy.

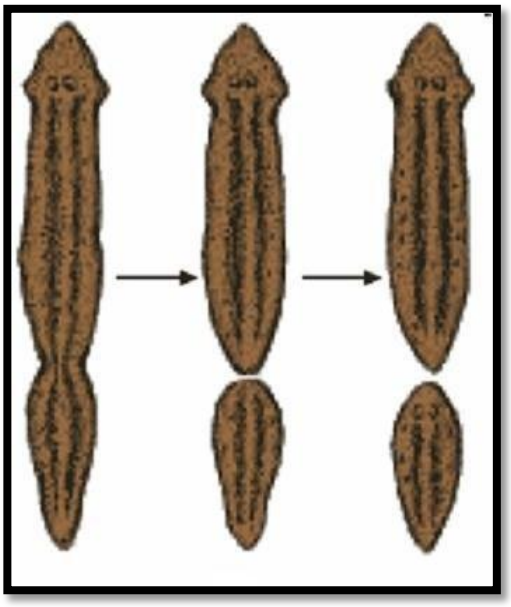

Fig 10: Division by architomy in some Turbellarians

- **Asexual reproduction of a planar**

In some cases, the regeneration may precede the separation of the son individuals: The father individual will present blisters in which all the apparatuses of a normal individual will form, then there is a transverse division between each of these species of ring which will each give a son individual.

- **There is also division by paratomy** : there is first regeneration then division.

It is the architomy that is most often encountered. The ability to regenerate missing parts can be observed in certain groups, as in the case of transverse cutting. A longitudinal cut will give an individual with two anterior regions.

II. 2- Class of Cestodes

II.2.1. The Ténia

II.2.1.1. General Organization

Strictly human endoparasite of the small intestine, it is a shiny white flatworm, whose body is foliate, of large size (4 to 10 m in length). The banded body and more often segmented into 1000 to 2000 consists of a linear series of reproductive units rings or proglottis. It is usually isolated (tapeworm).

The body can be subdivided into three main regions: the **anterior scolex** (the "head") equipped with hooks and suction cups, the narrow **neck** which is the site of asexual production of new proglottis (engenders the successive segments or proglottis that make up the strobile), and **the strobile** comprising the rest of the maturing proglottis and each proglottis contains a complete reproductive system. (Proglottis are not considered true segments because of the way they are formed and because each proglottis is a complete and separate reproductive unit).

The scolex (head) is a bulge at the anterior end of the worm, depressed at the top, with a diameter of 1.5 to 2 mm, It contains the rostrum, a terminal crest with two rows of hooks. The scolex has 4 elliptical side suction cups of 0.7 to 0.8 mm in diameter whose structure is comparable to that of the suction cups of the Trematodes; The scolex represents a very effective attachment organ, it carries neither mouth nor distinct sensory organs, but neither rostrum nor hook in *Teania saginata* (inert tapeworm).

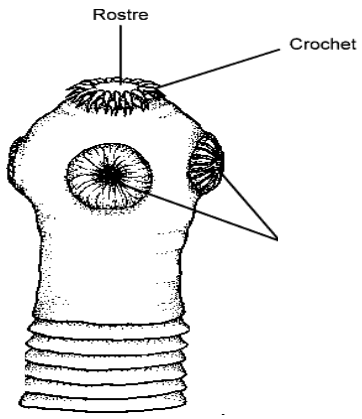

Fig 11: *Taenia solium,* Scolex; 4 Suction cups; cou; Proliferation zone

Cestodes are functional proterandric hermaphrodites.The level of maturity of the proglottis increases away from the scolex. Pregnant proglottids that are completely filled with eggs come off in isolation or in groups at the back of the strobile and are evacuated with the dog's feces. At this point, the eggs contain a larva called the oncosphere and are very resistant to desiccation.

The body of the Cestodes is entirely covered with a cuticle whose presence excludes that of the peripheral eyelashes; the digestive tract is absent and nutrition is ensured by osmosis through theteguments.

The Cestodes are divided into 9 orders: Cyclophyllidians,Tetrabothridians,Ichthyotaenidians, Nippotaenidians, Diphyllidians,Tetraphyllidians,Haplobothridians.

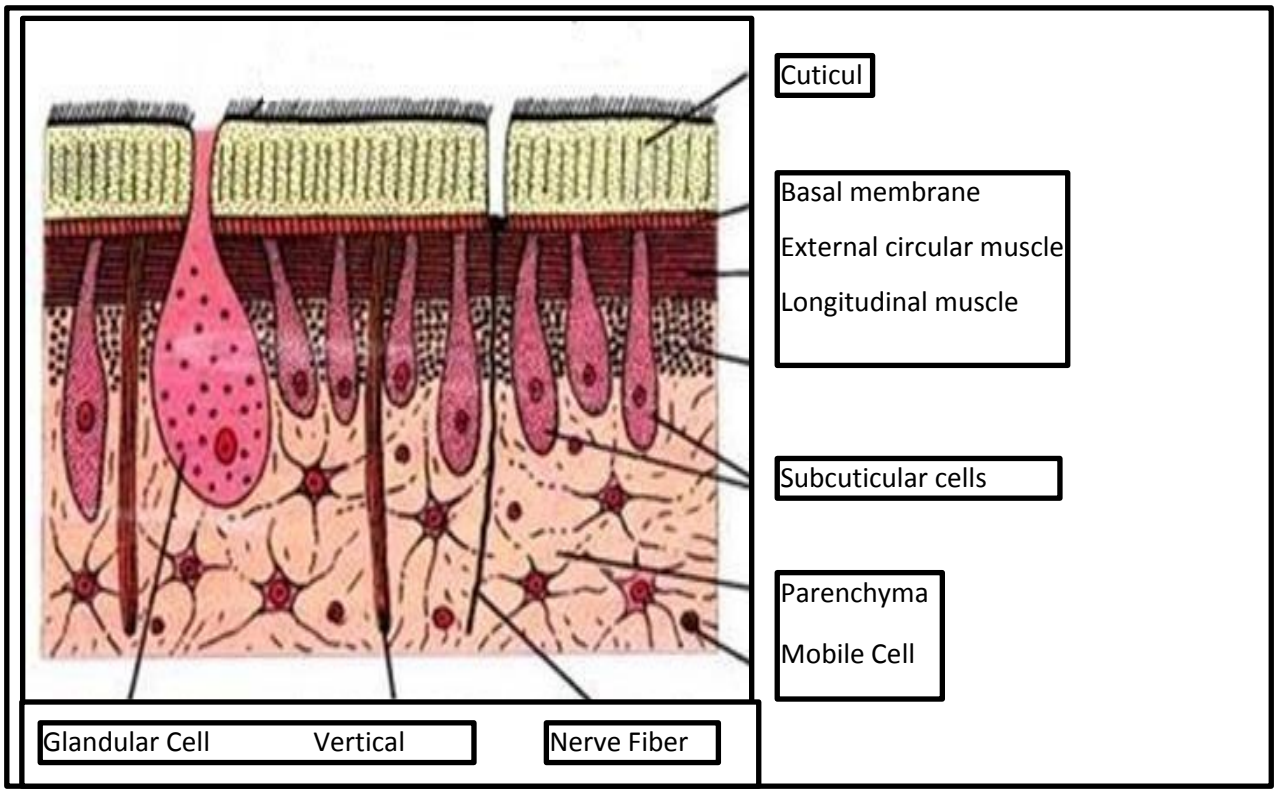

Fig 12: Cross section of *Taenia saginata* integument

c. The nervous system

The SN is located in the scolex and consists of two cerebroid nodes with anterior and posterior extensions. The anterior extensions are joined by a circular commissure where two dorsal nodes and two ventral nodes are located.From each ganglion runs a nerve cord, inside the strobile.

Towards the rear, there is a commissure with two lateral nodes from which two lateral cords extend into the strobile. At the posterior end of the proglottis, there is a connection (commissure) that connects the six nerve cords with the two nodes.

There is no differentiated sensory organ but many nerve endings lead to the cuticle.

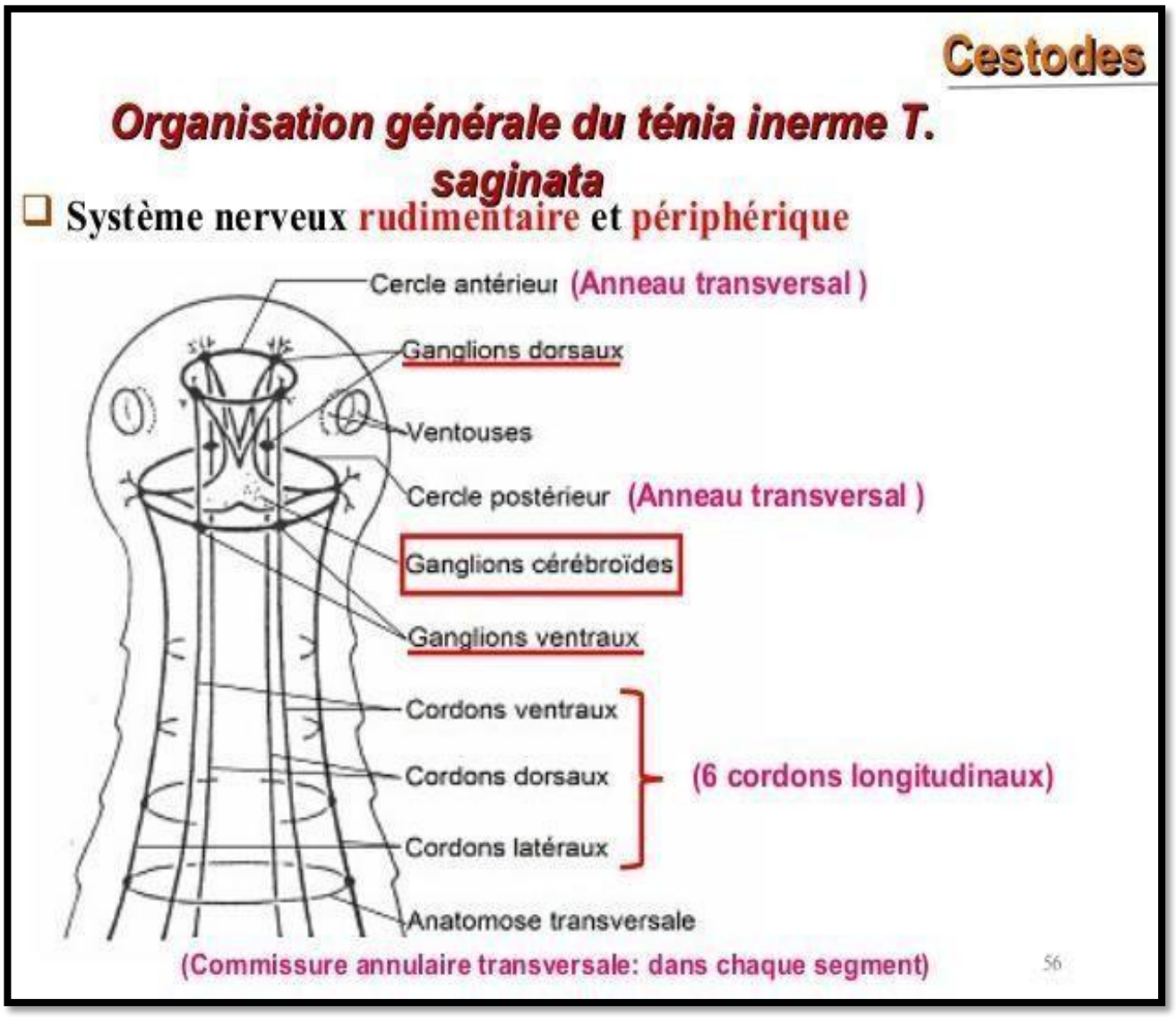

Fig13: The nervous system of Cestodes

d. Reproductive system

The reproductive system is reminiscent of that of the Trematodes; there is hermaphroditism. A genital pore is common to both sexes: it is the**genital atrium.** The reproductive system repeats in each segment of which it occupies almost all. The gonopores, lateral, alternate from one segment to the next**. Hermaphroditism is protandrous** : from the collar, the segments are male; female maturity is then established when moving away from this region. Fertilization is crossed. Eggs accumulate in the uterus. The last proglottids show an enlarged uterus stuffed with eggs; they are called cucurbitans (Fig.). They come off and fall into the intestinal lumen.

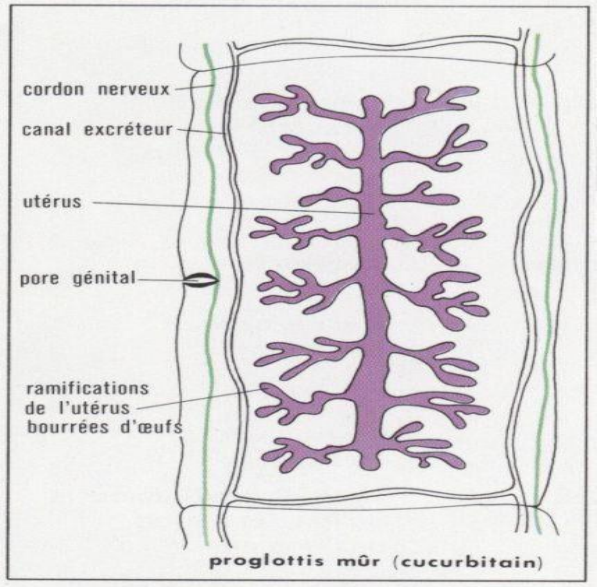

Fig 14: The female apparatus of Cestodes

The female apparatus : The reproductive system consists of 2 ovarian lobes, a cluster of 300 to 1200 testicular glands and a highly developed, branched uterus (more than 15 dichotomous branches on either side of the central axis) and filled with eggs. Proglottis is actively emitted in the external environment, outside the stool, alone or in chains of varying length.

The male apparatus : Consists of a large number of piriform testicles distributed over almost

the entire ring of spermiducts, the seminal vesicle, the pouch of the cirre and the genital pore. Inside the same proglottis, the vagina appears as a thin tube connecting the poregenital to the seminal receptacle. The receptacle is itself connected to the ootype (site of fertilization and addition of yolk). The ootype is also connected to the vitellogenic gland and a divided ovary (via the oviduct). The Mehlis gland is also associated with the ootype (safunction is indeterminate). The exchange of sperm can take place between two proglottids from the same worm, or from two different worms. Semen enters the genital pore, passes through the vagina, and travels to the seminal receptacle. It then moves to the ootype where fertilization takes place. Zygotes are quickly coated with yolk from the vitellogenic gland.

In the outdoor environment, eggs are spread after the ring has disintegrated. They have two shells

-an external or yolk membrane, fragile, thick, translucent containing refractive granules, delimiting the egg itself with an average size of 60 x 40 µm, often destroyed; -a dark brown, radiated, resistant internal, 4 to 5 µm thick, delimiting an embryophore of 30 to 40 µm x 20 to 30 µm containing an embryo with 3 pairs of hooks or hexacanth (or oncosphere).

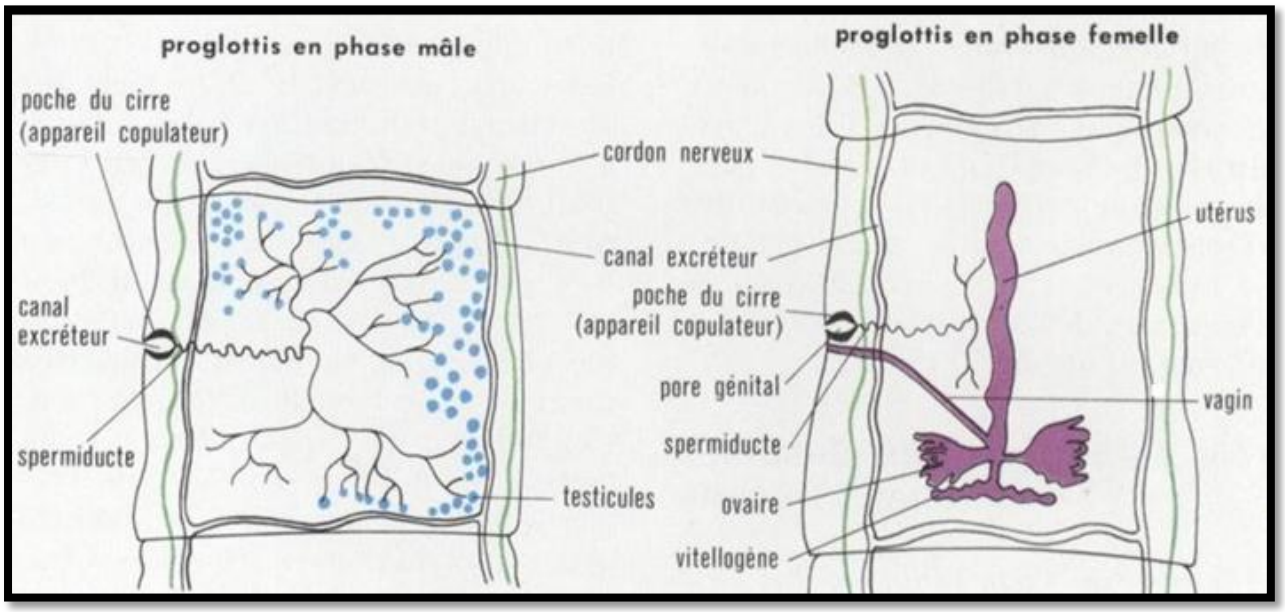

Fig 15: Evolution of a proglotti at of *Taenia solium*

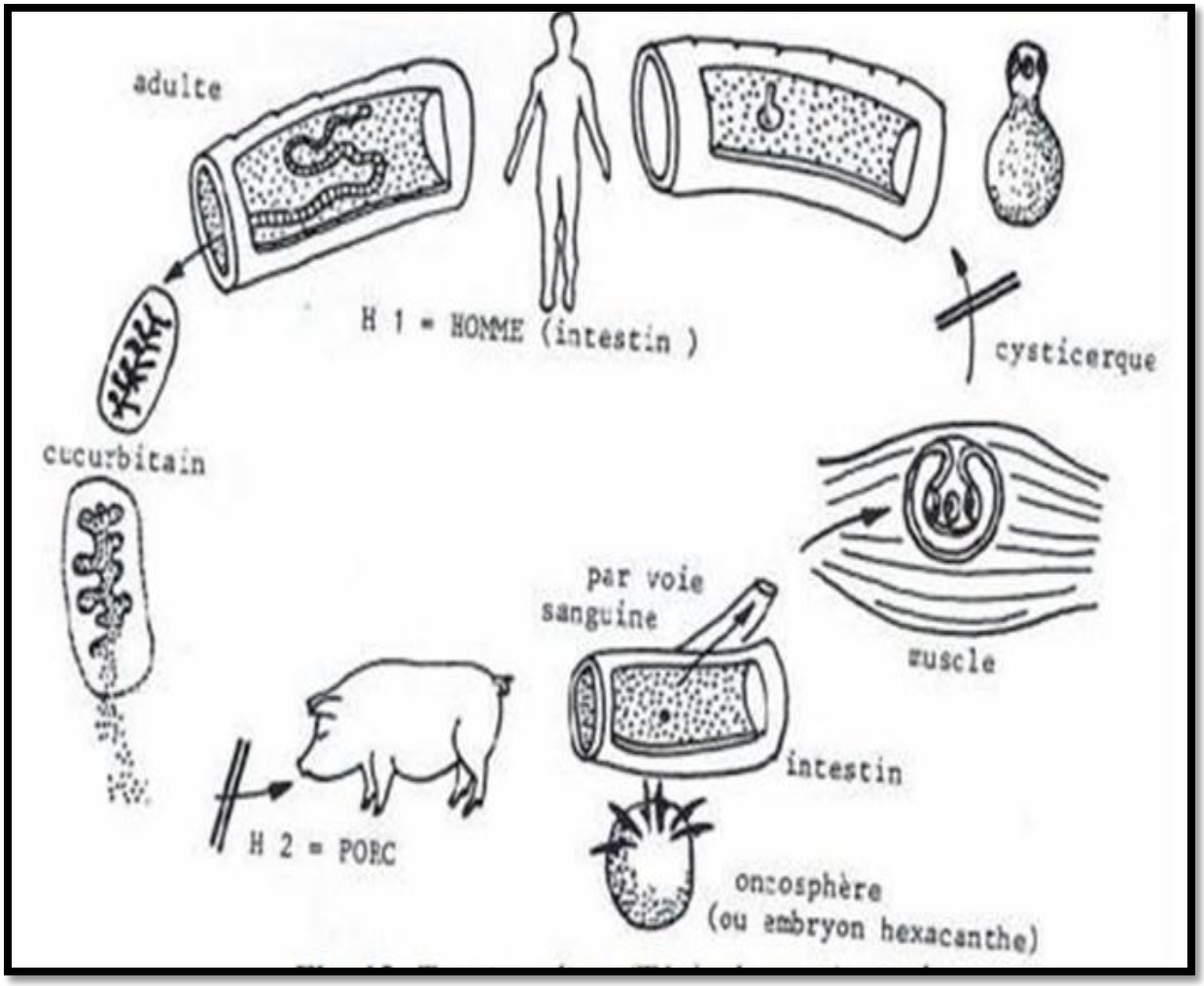

Fig 16: Development cycle of *Taenia solium*

CLASSIFICATION OF CESTODES OF CARNIVORES

Order OF CYCLOPHYLLIEA

A)**Taeniidea family**

B) Dilepididae family
B-1)*Dipyllidium caninum*
B-2) *Joyeuxella pasqualei*
B-3) Diplopyllidium

C) Mesocestoididae
C-1)*Mesocestoides lineatus*

A-1)**Taenia genus**
A-1-1)Taenia pisiformis A-1-2 Taenia hydatigena A-1-3) Taenia ovis
A-1-4) Taenia teniaformis A-1-5) Taenia multiceps A-1-6) Taenia serialis

A-2) **genus Echinococcus 3 species:**
Echinococcus granulosus Echinococcus multilocularis Echinococcus polymorphus

ORDER OF PSEUDOPHYLLIDEA

Diphyllobothriidea family

Species: *Diphyllobothrium latum* (bothriocephal large or lake taenia)

3. Teniasis of carnivores

3.1.Definition

Infestation with adult Cestodes, living in the small intestine of dogs and cats by adult cestodes of various families and species

Some of these parasites form larvae of the cysticerca, cornea or echinococcus type in intermediate hosts.

Induced cestodoses are often asymptomatic

Medical Significance: Low

Social: significant importance in certain cestodoses which are more pathogenic than others such as *: Diphyllobotrium latum* and *Dipylidium caninum* which can be found in humans, as well as *Echinococcus granulosus* causing the water cyst in herbivorous animals and humans

Economic: slaughterhouse seizures of parasitic organs from intermediate hosts (cattle, sheep, etc.)

3.2.Geographical distribution

Cosmopolites

Urban environment: *Dipylidium caninum* more than other cestodes

Rural: presence of all species of cestodes

3.3.Etiology

The parasites belong to two orders Order of Pseudophyllidea:

2 bothries: Dicestodes

Medio ventral genital orifices Tocostoma

Operculated egg, incompletely differentiated embryo 2 intermediate hosts.

e- <u>Diphyllobothriidea family</u>

Species: *Diphyllobothrium latum* (bothriocephal large or lake tapeworm)

Parasite of the small intestine of humans, cat dogs, adults feed on intestinal chyme

It is one of the longest of the cestodes 2 to 18m/10 to 20mm, the scolex is narrow 2-3×0.7mm Grayish rectangular ovigerous segments with a dark central spot (central rosette uterus), the mature segments wider than long, with genital pore at the anterior 1/3 of the ventral face

2 HI: lower crustacean and freshwater fish Order of Cyclophyllidea:

The scolex is equipped with 4 suction cups: Tétracestodes Rostre often armed, some species are said to be inert because they do not have hooks There is no egg-laying orifice the ovigerous segments filled with embryonated eggs Each unopculated egg:contains a hexacanth embryo it is the oncosphere There are marginal genital orifices (except Mesocestoides)

1 intermediate host except Mesocestoides: 2 HI

f- Taeniidea family

Scolex: non-retractable rostrum carrying 2 rows of dagger-shaped hooks Alternating simple genital cores

Ovigerous segments longer than wide Branched tubular uterus Larva type strobilocercum, cysticercum, coenure or echinococcus

Egg reduced to embryophore, oncosphere surrounded by a radially striated embryophore There are two genera and several species

- **Genus Taenia**

Larva of the cysticeric or coenure type

Large worm consisting of several segments

-- *Taenia pisiformis(Taenia serrata)*

In dogs (HD): the adult measures 0.8-1 m maximum width of 8 mm, the mature segments each have the rectilinear posterior edge

The larva, *Cysticercus pisiformis*, is of the cysticercus type and is located in the liver and peritoneum of leporidae.

--*T.**hydatigena(marginata)***

In dogs (HD): the adult measures 0.75 -5 m, width 8 mm, the mature segments each have the sinuous posterior edge

In ruminants (HI), the larva is of the cysticercal type (C. tenuicolis); called: boule d 'eau du boucher

--T.ovis

In the small intestine of the Dog (HD), the adult measures 0.5-1 m The larva is cysticeric in the striated muscles of sheep

--T.teniaformis

In the cat's small intestine (HD), the adult measures 015 -0.60 m, the rostrum is bulky without a neck

Strobilocercal larva in the liver of Muridae ***--T.multiceps***

In the dog's ileum, the ovigerous segments are 3 times longer than they are wide. The larva is of the corneal type *(Cœnurus cerebralis*) in the nerve centres of sheep and other ruminants, exceptionally humans.

--T.***serialis***

In the small intestine of the Dog (HD), the adult is very close *to* T.multiceps Larva type cœnure *(Cœnurus serialis*) in the subcutaneous connective tissue of leporidae

- **Genus Echinococcus Small taeniidae**, 3 to 4 segments, only the last is ovigerous Echinococcus type larvae

2 species: *E. granulosus*

E. multilocularis

--E. granulosus

The adult, lives in the duodenum of the canids, measures 4-6 mm, formed of 3 to 5 segments and only the last is ovigerous, at a length greater than half of the total length.

Rosary with 2 crowns of very thick guard hooks. Genital pore in the posterior half of each segment

*Echinococcus polymorphus*larvae, echinococcus type lives in herbivores that ingest eggs containing oncospheres in grass or drinking water

E. multilocularis

The adult, lives in the duodenum of foxes, measures 1.5-3.5 mm, formed of 2 to 4 segments, at a length less than half of the total length. Genital pore in the posterior half of each segment

Alveolar Echinococcus larva of the echinococcus type exclusively in the liver HI: muridae, voles and men

g- Dilepididae family

The adult lives in: canids, birds (HD), the rostrum is retractable, the scolex is armed with several crowns of rose prickly hooks

2 lateral genital pores, uterus in oviferous capsules containing 1 or more eggs

The larva is of the cysticercoid type in only 1 HI represented by invertebrates, sometimes reptiles or amphibians

--Dipyllidium caninum

The adult lives in the dog, cat, fox and sometimes the child, it measures 0.20 to 0.80 m, the maximum feeder is 3 to 4mm, scolex in the shape of a club carrying 4 to 7 rows of hooks

The mature segments carry 2 ovaries, the ovigerous segments are very elongated containing many oviferous capsules which each contain 3 to 30 eggs

The larva is of the cysticercoid type --Joyeuxella pasqualei

Adults live in dogs, cats and wild carnivores, the rostrum contains 14 to 18 rows of rose thorn hooks

Oviferous capsule with 1 egg

The intermediate host is represented by reptiles or amphibians

--Diplopylidium*sp*

Adults live in dogs, cats and sometimes foxes

2 to 5 rows of crowns of hooks with large ones in the shape of a dagger Oviferous capsule indistinguishable

HI: reptiles

h- Mesocestoididae family

Scolex inerme carrying 4 split suction cups 2 mid-ventral genital pores

Ovigerous segment with white spot: para uterine organ 2 intermediate hosts: the^{1st} host: coprophagous mite The^{2nd} host: reptiles, birds, insectivorous rodents

--Mesocestoides***lineatus***

The adult measures 0.30-0.60 m sometimes up to 2.50 m, the maximum width is 3 mm, it lives in the small intestine of the dog, cat and wild canids (foxes, wild cats...), Two intermediate hosts: the^{1st} HI is an oribatid mite, the 2nd HI: small mammal (Muridae) or reptiles harboring the larva *Tetrathyridium bailleti.* The immature larva will encyst and give tetrathyridiosis, it can pass into the peritoneal cavity and form a vesicle of 1 to 10 mm thin and fragile wall

In the definitive host, the ripe larvae give a perfect cestode.

-- ***Mesocestoides litteratus***

The adult measures 20-30 mm exceptionally up to 150 mm, with a width of 1 to 2 mm, it lives in the small intestine of the fox sometimes of the cat and the dog

Mesocestoides corti

Parasite of the small intestine of carnivores, it measures 40-80 mm, found in North America

4. Epidemiology

Age: young people are more susceptible Adults are more at risk Health status: exposure to Cestodes **Infestation Infestation Sources**

Directly, the intermediate hosts hosting the infesting larvae: vertebrates for Taeniidae, Diphyllobothriidae and Mesocestoididae, and invertebrates for Dilepididae.

Indirectly parasitized dogs and cats that reject ovigerous rings after 1 to 2 months after the time of their infestation Modes of infestation

Orally by ingesting larvae in intermediate hosts

- **The dog** is infested through:

- fleas *Ctenocephalus canis* or lice *Trichodectes canis (Dipylidium caninum)*

-*parasitic*guts or flesh

-small wild vertebrates

Fish

-viscera, muscles, organs containing the infesting larva

- **The cat** is infested through:

Fleas:

-small wild vertebrates

Fish

-viscera, muscles, organs containing the infesting larva

Favourable causes

Dog Diet

Shepherd, hunting and fishing dogs Distribution of parasitic viscera Dog access to slaughterhouses

7- Pathogenesis

Spoliative action

The spoliation is selective concerning certain elements: carbohydrates, phosphorus, calcium, this spoliation is all the stronger in *Diphyllobothrium latum* for vitamin B12

Irritative action

Action produced by the scolexes of adult worms in the intestinal mucosa causing catarrhal enteritis

Abdominal pruritus and rabiform seizures are due to irritation of the nerve endings of the small intestine

Mechanical action

Worms in large numbers can cause intestinal obstruction, as well as obstruction of the anal glands by the segments

Toxic and antigenic action

Due to verminous substances emitted by the ovigerous rings lysed in the digestive tract source of sensitization

8- Symptoms

Pruritic manifestations Anal pruritus

Sign of sledding, anitis and abdominal pruritus, at this stage the dog rejects the rings or the debris of rings, he then disperses the eggs on his coat

Digestive symptoms

Irregular appetite or bulimia

The rings eliminated with the stool or remaining stuck to the margins of the anus, sometimes the dog vomits the rings

When parasites are very numerous they can cause intestinal obstructions

Nervous symptoms

In rare cases, there are epileptiform seizures

Pernicious anemia

Severe macrocytic and hyperchromic anemia

Evolution

Longevity of parasites, reinfestations are frequent especially in the case of

Dipylidium caninum

Leaning accentuated when animals are undernourished

9- Injuries

Adult cestodes are found in the duodenum and jejunum

Peristalsis causes thickening of the wall of the small intestine showing transverse annels

Intestinal mucosa may be sclerosed with areas of acute inflammation

10- Diagnosis

Ante-mortem diagnosis

Clinic

Symptoms are not obvious but there may be Sled Sign

Observation of ovarian segments in cases of *Dipylidium caninum* and *Echinococcus*

granulosus

chemistry

Microscopic coprology: coproscopy technique in search of eggs but possible especially when the rings are lysed in the digestive tract with an impossibility of

make the diagnosis between Taeniidae eggs, on the other hand coproscopy gives good results in the case of Bothriocephales.

Except for Dipylidium caninum eggs which are in the form of oviferous capsules

Macroscopic coprology: harvesting and identification of Dipylidium rings: during the defecation interval

All cestodes with Dipylidium: in faeces

Dipilydium caninum: shaped like grains of rice. Smaller segments for Echinococci. Larger segments for Taeniidae.

Observation of ovary segments: Diphyllobothrium: dark median spot Mesocestoididae: white median spot Dilepididae: 2 lateral pores and Taeniidae median spot:1 lateral pore and no spot

Characteristics of the eggs of the Taeniidae of carnivores

Species	**Characteristics**
Dibothriocephalus	**Oval egg, lidded, 70µ**
Mesocestoididae	**40-50µ thin-walled embryophore**
Taeniidae	**Thin-walled 40µ stick embryophore**
Dipylidium caninum	**Oviferous capsules of 200µ, several eggs(15 to 30) from 30 to 40µ**
Dilepididae(others)	**Oviferous capsule of 70µ, 1 egg 30 to 40µ** [2]

Prognosis

Severe in case of intestinal obstruction or in case of association with infectious diseases such as canine distemper or cat typhus

11- Treatment

Cestodispersive: Quick action in 3 to 6 hours, removal of intact worm: easy identification. Arecoline hydrobromide

2 to 4 mg/kg, but not indicated for cats, puppies and pregnant women

Cestodicides: act by exposing the worm to the lytic action of the host's digestive enzymes, their action is between 24 and 72 hours releasing the eggs

-Praziquantel high efficacy even on adult and immature stages of echinococcal tapeworms, this product is administered orally at a rate of 5 mg/kg or subcutaneously For *Dipylidium caninum* the dose is 8 mg/kg

-Niclosamide**prior** diet sometimes insufficient effect it is administered in doses: 100 mg/kg for Taenias, 200 mg/kg *Dipylidium caninum*, 400 mg/kg on Echinococcus and on 500 mg/kg on Mesocestoides

-Bunamidine**12-hour** diet, 50 mg/kg for Taenia and Dipylidium and 100 mg/kg for Mesocestoides, this product has anesthetic properties so efforts should be avoided

Epsiprantel very close to Praziquantel 7.5 mg/kg to destroy Echinococcus, 1 mg/kg for Taenia and 2.5 mg/kg for Dipylidium

-Nematocides and Cestodicides

Mebendazole and Flubendazole most used for Taenias, active on Ascaridae, Ankylostomatidae and partially on Trichuris at a dose of 50 to 100 mg/kg twice a day for 5 days, this product is ineffective on Dipylidium and *Echinococcus granulosus* **Fenbendazole** active only on Taenia

Oxfendazole very effective on Dipylidium at a dose of 11.5 mg/kg for 3 days **Nitroscanate** 50 mg/kg on Taenia, Dipylidium, Ankylostomatidae, Ascaridae and 250 mg/kg on for 3 days on Echinococcus

Diuredosan 50 mg/kg for 2 days on Taenia, Dipylidium, Ankylostomatidae, Ascaridae

12- Prophylaxis

Essential especially for larval cestodoses especially hydatidosis

Offensive measures

In the definitive host the worm destruction dog

- every 4 weeks before ovarian segment formation

-all 6 weeks (prepatent period) in dogs carrying ovigerous segments parasites

NB: if a tenicide is used, the dog must be kept attached for 3 days and 6 hours if a taenifuge is used

For Intermediate Hosts

Taking action against arthropods lice and fleas

For slaughter animals: seize and destroy parasitic viscera or muscles infested with Taenia ovis

Sterilization of fish by freezing (-10°C for 18h or -40°C for 3 hours) Action on Murids (Taenia teniaformis)

Defensive measures

information

Use of vaccine in dogs against echinococcal tapeworm

hot water

Prohibit dog access to slaughterhouses

Do not distribute raw viscera to dogs

Do not consume or give raw fish to carnivores (Bothriocephalosis).

8- Class of Trematodes

All species of this class are parasites, not segmented more or less foliate is entirely covered by a cuticle, reinforced with scales and spines; trematodes are internal parasites of vertebrates. Their cycle involves two or more hosts: they are heteroxenes.

They look like Turbellariés.

The big differences are due to parasitism :

There is loss of ciliature of the epithelium (no displacement).

There is regression of the sense organs (in relation to the loss of locomotion): we will talk about a "regressive evolution" observed in the Trematodes.

There is development of fixation organs which are often an anterior buccal suction cup and a ventral suction cup or "acetabulum"».

Animals with two suction cups are called “distomies”.

The integument covering the body provides these parasites with resistance to attack by the host's enzymes and immune system, and functions as a nutrient absorption surface. In humans (the definitive host), adult flukes live in the liver ducts, releasing their fertilized eggs into the small intestine. These are discharged with the feces. If feces end up in the water, the eggs can be ingested by some species of**snails**, the first intermediate host. The eggs hatch in the snail's digestive tract, producing larvae called **miracidies**. These larvae penetrate the tissues of the snail and transform into bag-shaped **sporocysts** . These then produce several **redies**, which undergo asexual reproduction to produce several **cercariae**. In this way, a single egg can produce a very large number of offspring. This process is called **larval amplification**. These cercariae escape from the snail and swim in the water using their tails until they come into contact with a fish (the second intermediate host). If this happens, the cercariae penetrate the skin, lose their tails and form **cysts** in the muscles, becoming **metacercariae**. To complete the life cycle, a human (**definitive host**) must eat raw or undercooked fish. The walls of the cysts are digested and the metacercaria migrate to the liver ducts where they complete their maturation into adult worms. The life cycle is thus completed. The body has two suction cups: ventral and oral. The incomplete digestive system includes a mouth, a muscular pharynx and a short esophagus that divides into two intestinal caeca, which extend over almost the entire length of the animal.

Trematodes parasitic flatworms:

-**MONOGENES (or HETEROCOTYLES)** that develop on a single host. They are mostly ectoparasites and attach to the skin or gills of various aquatic organisms such as Pisces and Batrachians. They can however become secondarily endoparasitic and live in the urinary bladder of the frog.

- DIGENIENS (or MALACOCOTYLES) whose development cycle requires the passage of at least 2 hosts. In the larval state, the parasite infests an invertebrate whereas in the adult state it is hosted by a vertebrate.

This parasitism leads to a number of adaptations such as a high reproductive potential and the possession of fixing organs: suction cups or hooks or both.

General morphology: Male liver *fluke Fasciola hepatica*

Has the shape of a whitish sheet, whose narrowed anterior end (cephalic extension) carries the mouth. The ventral side has the **hermaphroditic genital opening at the front.** They have two suction cups, one ventral and the other terminal, surrounding the mouth. The digenetic moat integument **is an indispensable adaptation for an internal parasite**.

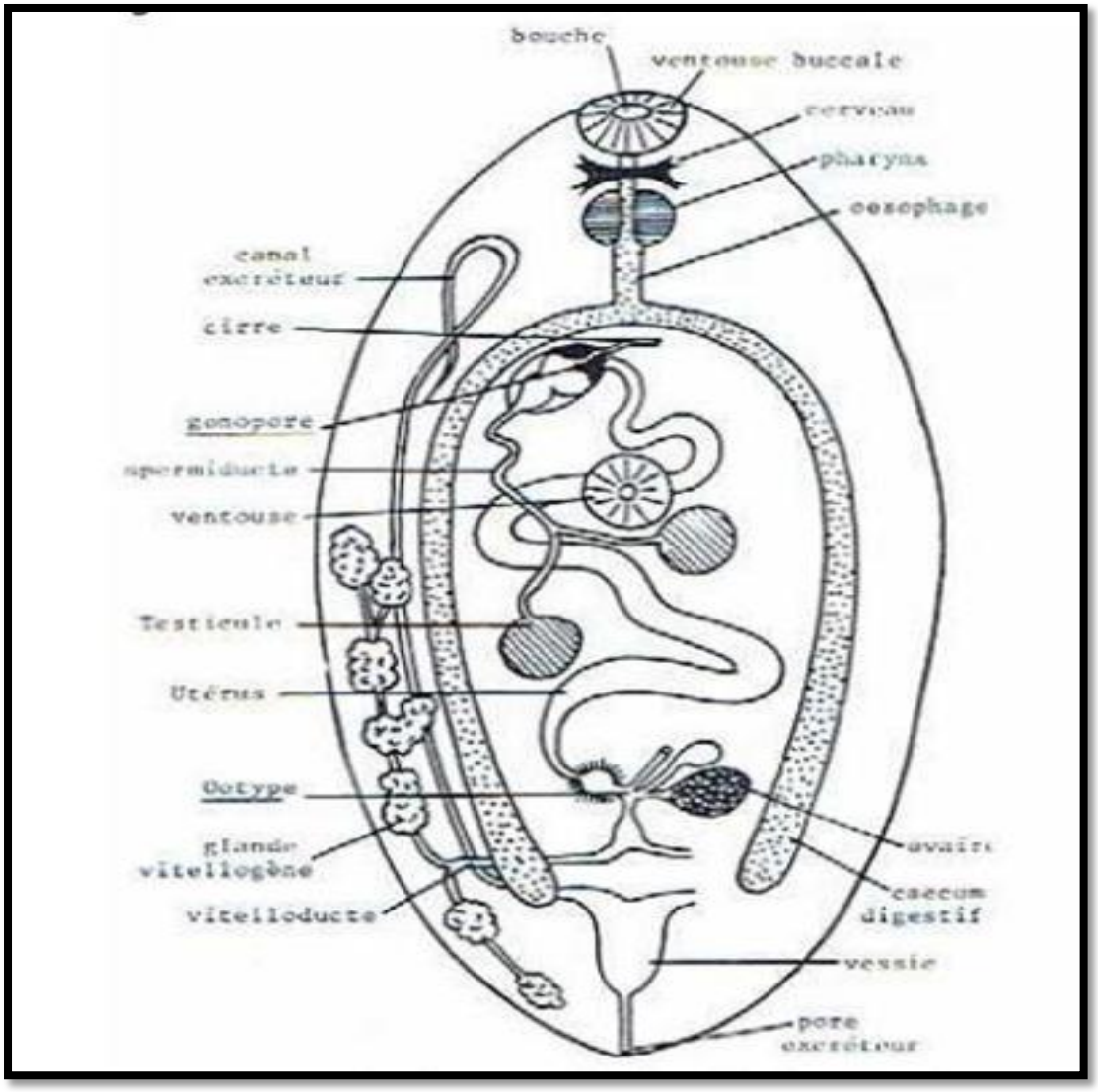

Fig 17: General organization of Trematode.

1-The integument

The presence of a cuticle has two main consequences:

-ciliary development is impossible on the epithelium;

-the discontinuous growth and is carried out by successive moults.

The cuticle has a basal lamina. Below, there is **a parenchyma** and different **muscle bundles** (circular and longitudinal). Underneath this set are **epidermal cells** that can emit diverticula to the cuticle.

Epidermal cells do not have a cell membrane: it is a syncitial integument.

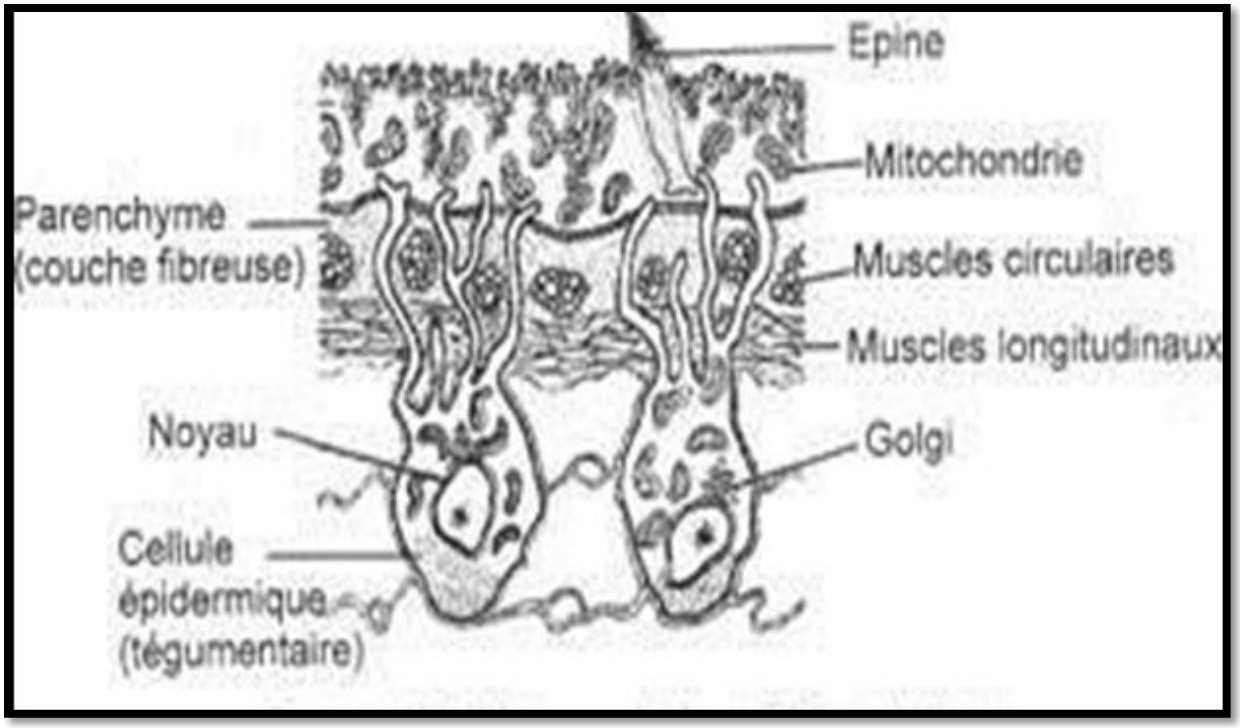

Fig 18: Tegument section of aTrematode

2- Musculature.

As with Turbellarities, there is an outer circular layer of smooth muscle fibers, an inner longitudinal layer and oblique bundles.

3- The nervous system

Consisting of two parts: a central nervous system and another peripheral:

-Central nervous system: includes 2 cerebroid nodes, located at the anterior part of the body linked by a peri-oesophageal ring, of each lymph node mass extend 3 longitudinal nerve cords.

-Peripheral nervous system formed by 3 pairs of longitudinal cords, a dorsal pair,a ventral and a lateral .The lateral nerves are the longest and reach the posterior end of the body. These nerves are connected by transverse commissures and allow the innervation of the anterior part and the buccal suction cup.

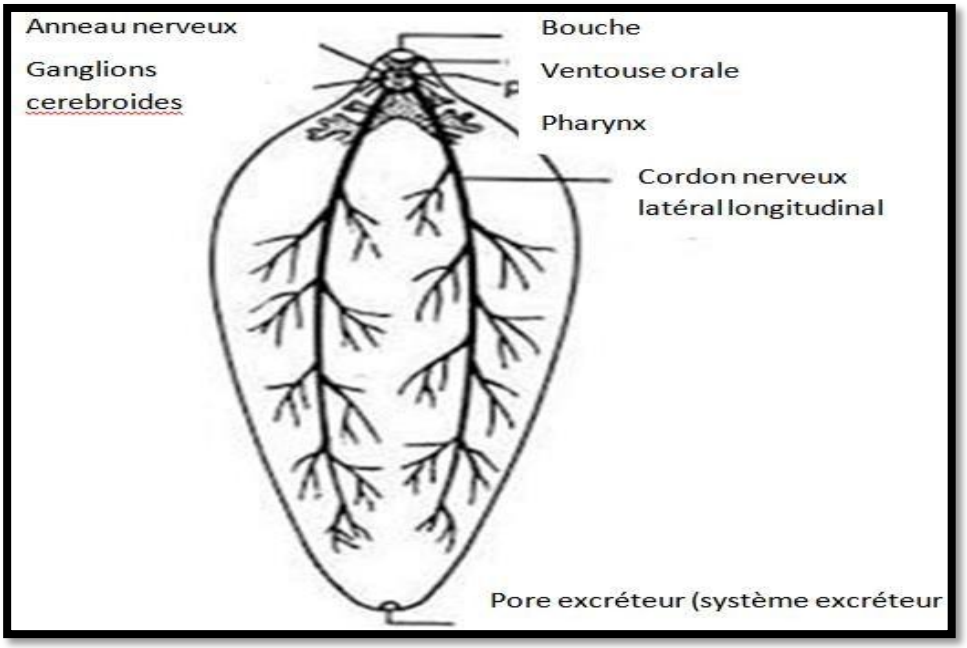

Fig 18: Nervous system of the Trematodes

4- **The respiratory system**.

There is no specialized body to perform this function. Breathing is essentially anaerobic

5- The digestive tract:

The mouth is anterior, terminal or sub-terminal and opens in the center of the mouth cup. The intestine is formed by two branches (digestive cecum), very branched where the blood is accumulated. There is no anus. **Digestive system is incomplete**

Digestion is mainly extracellular and it is likely that a certain proportion of food is absorbed through the surface of the body.

Some Trematodes secrete enzymes that break down host tissues through the mouth cup and pharynx, preparing them for digestion.

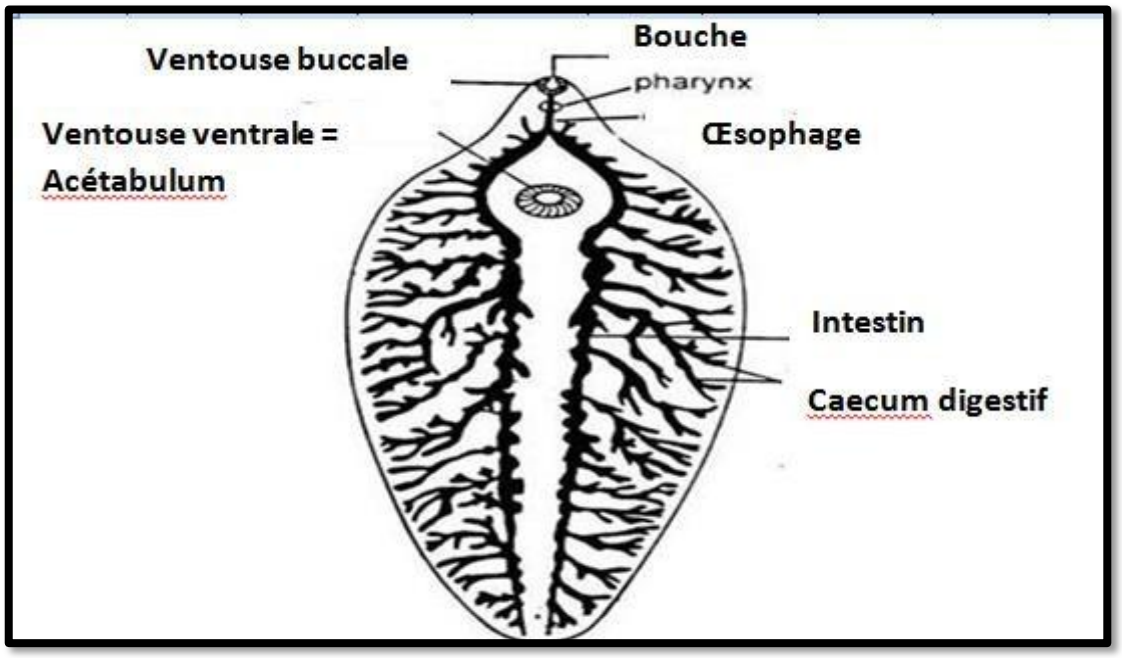

Fig 19: *Fasciola hepatica* digestive tract

6- Reproduction

Trematodes are hermaphrodite.

The male apparatus : This apparatus consists of two testicles (or testicular follicles) drainedby two spermiducts which converge to form the vas deferens. This widens at its point of contact with the seminal vesicle (storage). The seminal vesicle continues towards the ejaculatory canal, which opens outwards through the genital pore (common entrance of the two reproductive systems, located anterior to the ventral suction cup). No expandable copulatory organ (cirre).

The female device: The female device is relatively complex. Vitellogenic and gametogenic functions are spatially dissociated. It gravitates around a chamber (the**ootype**) where a short oviduct arrives, coming from a very branched ovary. This ootype is the site of fertilization and addition devitellus to the newly formed zygote). The ootype also receives a large, sinuous uterus where the eggs begin their development. Last, there is a vertical channel (Laurer's channel) with an undefined function.

The seminal receptacle and vitellogenic glands are also connected to the ootype by conduits. The ootype is usually surrounded by a diffuse Mehlis gland, the function of which is unknown. Fertilization is carried out by reciprocal bonding.

The fertilized egg is surrounded by a shell and accompanied by many yolk cells.

Reproduction occurs at the intermediate host (during the cycle).

An egg will then give many individuals.

From the ootype, the eggs travel to the convoluted uterus, where their shell can harden. They are eventually evacuated through the genital pore.

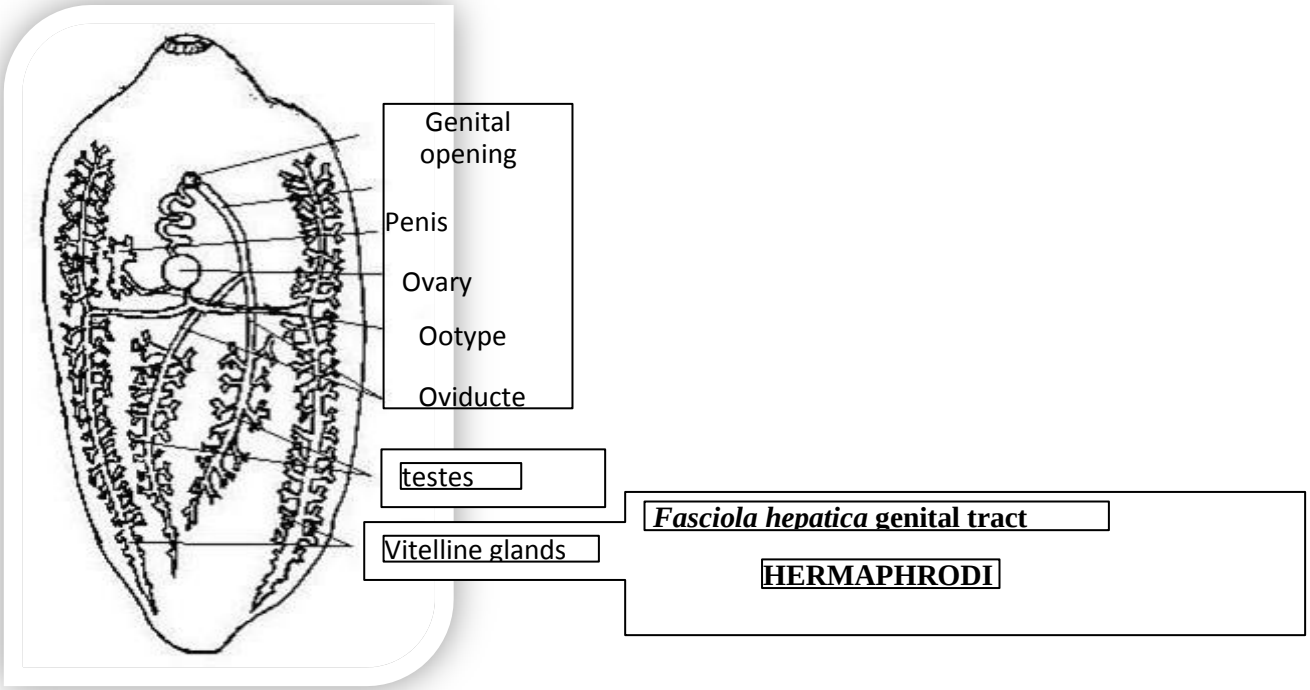

Fig 20: *Fasciola hepatica* genital tract

7- **Excretory system:**The excretory system of the Trematodes is of the protonephridial type In *Fasciola hepatica* ,the protonephridial canalicules from the "vibratile flame cells" converge towards 2 lateral collecting trunks that merge backwards in the Sagittal plane. The common collecting channel, provided at its end with a contractile bladder, leads to the excretory pore.

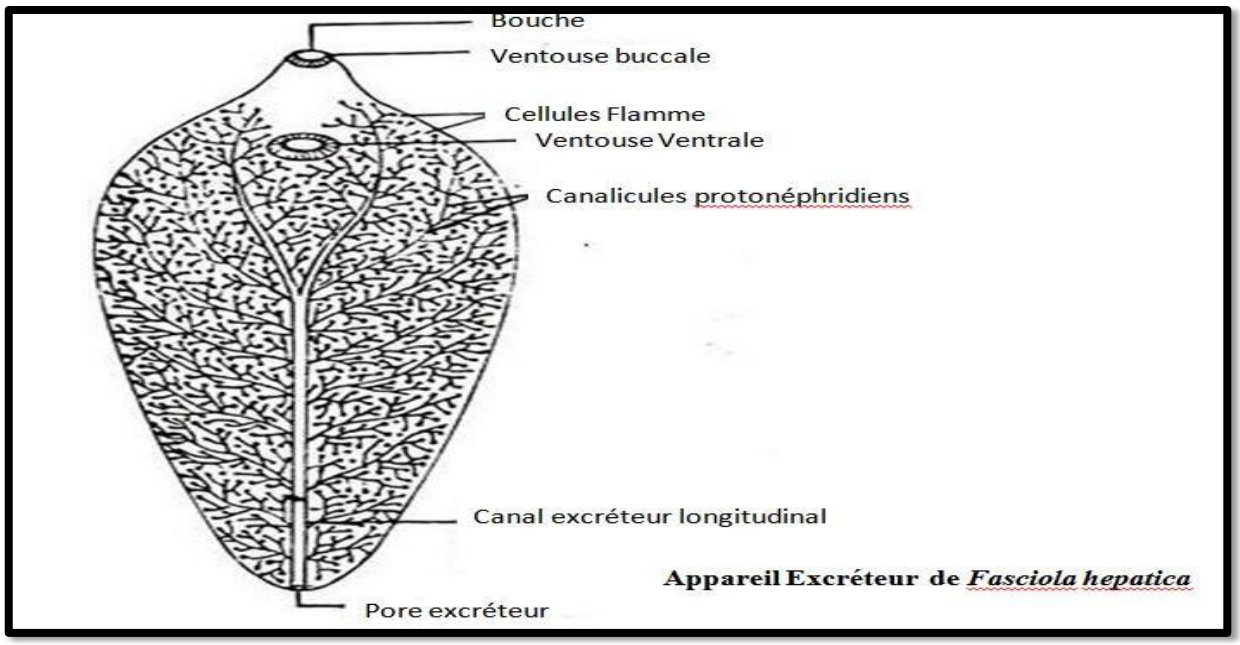

Fig 21: The excretory system of the Trematode

Parasite cycle

Definitive Host (HD) = herbivores (sheep, cattle) and human,

adult worms in the bile ducts of the liver, laying, eggs are carried with bile ==> duodenum, intestine, fecal elimination

Eggs embryogenize in water (temperature conditions, oxygen, light) ==> hatching of miracidium (130 µm swimming ciliary larvae)

Intermediate Host (HI) = Limnea (small aquatic gastropod mollusk with dexterous ovoid shell: Limneatruncatula) penetration of the miracidium through the tissues of the mollusk and transformation into **sporocyst I**, by internal budding ==> **sporocysts II**, by internal budding = = > redies (about 1 mm), the last budding gives **cercariae** (infectious forms with the appearance of tadpoles, whose body measures 300 µm with a tail of 700 µm) the cercariae escape from the body of the mollusk, and swim in search of an aquatic plant (cress, grass) on which the body of the cercariae is fixed ==> transformation into **metacercariae** (waiting forms) contamination by ingestion of metacercariae fixed on aquatic plants.

In HD, uncystic metacercariae in the intestine ==> the fluke that crosses the parenchymehepatic, when it meets a bile duct it attaches and becomes an adult.

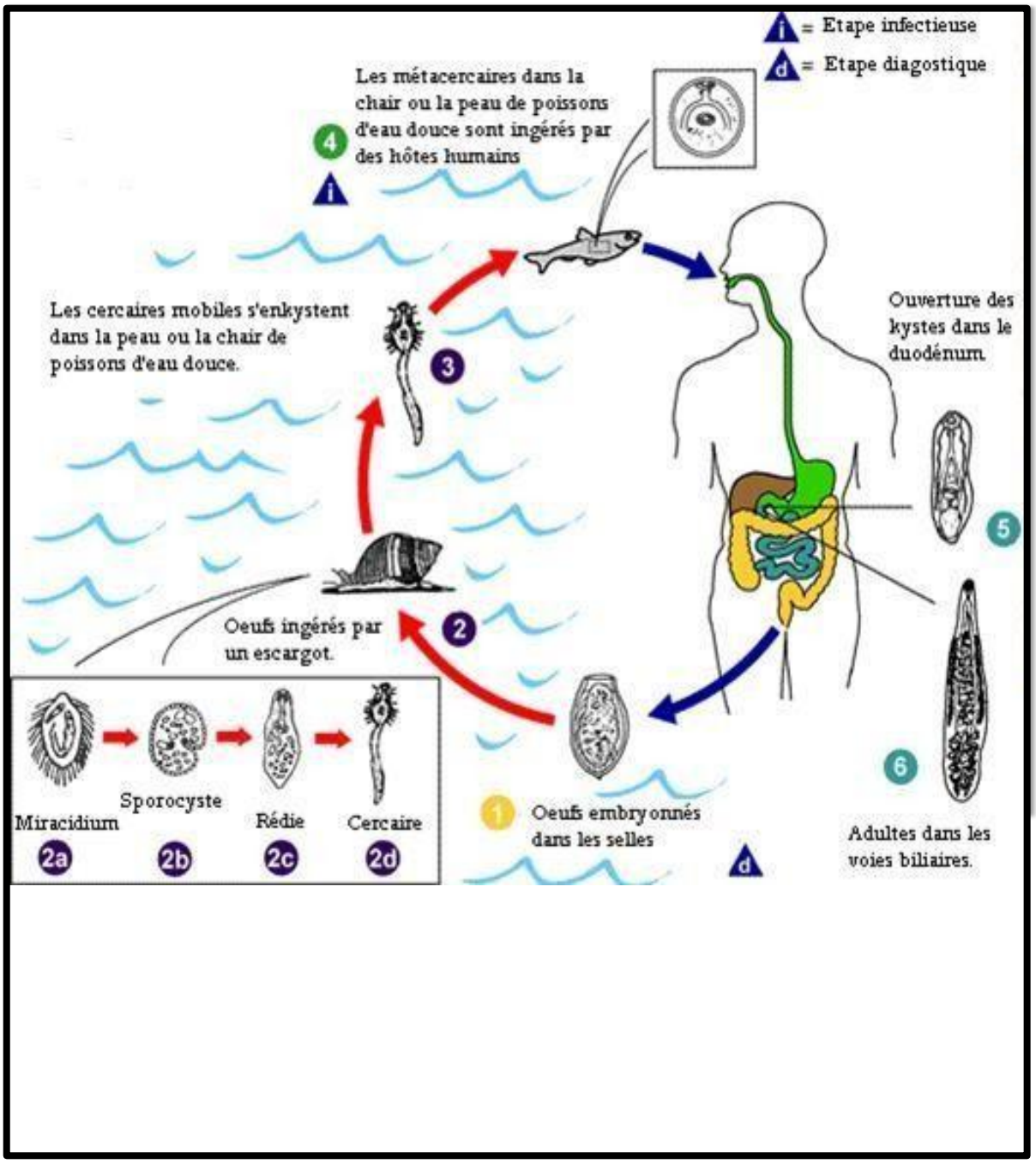

Fig 22: *Fasciola hepatica* parasitic life cycle

Branch of the Nemathelminths

General information on Nematodes

-Unsegmented cylindrical worms with tapered ends, separated sexes (gonochoric worms); the female is generally larger than the male, its posterior end is obtuse, the male often has a posterior end wound in a crook

-Central pseudocoelomic cavity containing an often allergenic liquid where the digestive tract and genitals float.

1- Anatomy:

-Wall: colorless and inextensible outer cuticle ==> growth by molts, sub-cuticle (hypodermis analog) medial inner ridges (ventral and dorsal for the passage of nerve nets); lateral inner ridges (for the passage of excretory channels); between the ridges existence of fields for the insertion of muscle cells

a- The integuments: The ectodermis is formed by a single cellular layer, forming inwards 4 longitudinal bulges, the epidermal cords: 1 dorsal, 1 ventral and 2 lateral which contain nerve trunks and excretory ducts and separating the muscle fields. The ectoderm secretes a chitin-containing, pluristratified cuticle. This cuticle is inextensible and will therefore impose discontinuous post-embryonic growth, by moulting. On the other hand, it is impermeable, except to respiratory gases, chlorides and may be to certain small ions. Water can also penetrate through the cuticle, but it cannot be discharged through the same pathway. It is resistant to digestive enzymes.

b- Musculature: mesoderm cells differentiate into myoepithelial cells, the part of these cells in contact with the ectoderm contains contractile fibrils oriented parallel to the longitudinal axis of the animal, while the opposite part hangs in the general cavity is related to nerve motor fibers.

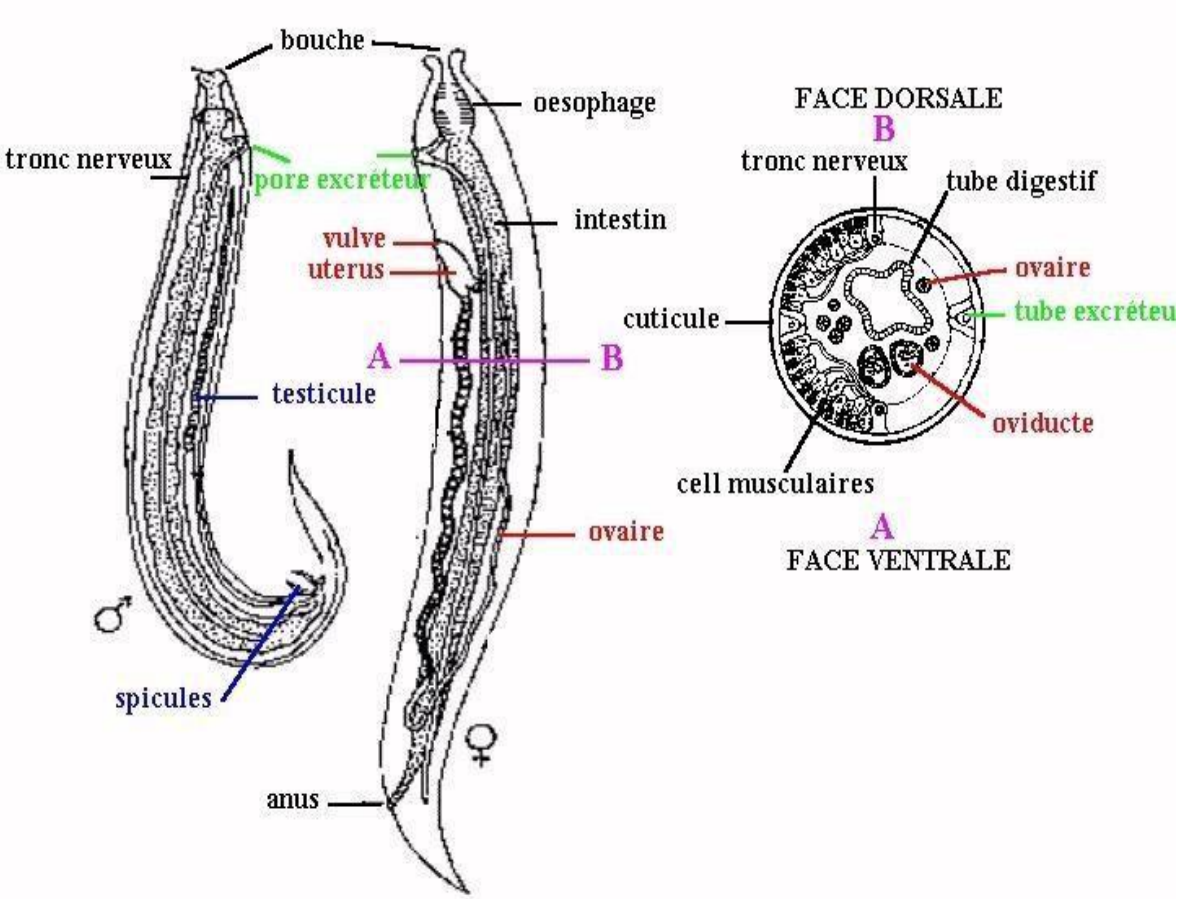

Fig 22 : General morphology of a Nematode

c- The respiratory system: no organ specialised in this function.

d-The digestive tract: It is rectilinear and opens anteriorly in the mouth. Very often this mouth is framed by 6 lips (2 dorsal, 2 lateral and 2 ventral) the arrangement of these lips is different according to the species (2 dorsal lips on the one hand, and on each side 1 lateral lip and 1 ventral lip, they merge to form 3 lips: 1 dorsal and 2 latero-ventral). In other species these lips are absent is replaced by hooks or complicated frames.

The mouth opens with an oral capsule or stomodeum (of ectodermal origin), covered with cuticle often presenting thickenings in the form of bulges, plaques or teeth. It can also be extraversible or have a pointed mouth stylus. The oral capsule is followed by the esophagus or pharynx. It is also of ectodermal origin and is therefore covered with cuticle. It's actually an extension of the stomodeum. This esophagus is surrounded by muscles that will allow it to play a suction role. Following this comes the intestine formed by a simple layer of endodermal cells; generally it is a simple cylindrical and rectilinear tube, which leads to the rectum or proctodeum, of ectodermal origin (therefore covered with cuticle) which opens to

the outside of the anus. In other species there is no mouth or anus and the intestine is reduced to small intestinal cells called trophosomes or fats. The complete digestive tract (mouth with lips, muscular esophagus of characteristic shape, simple intestine ending in the cloaca in the male and an anal pore in the female).

e- The excretory system: It is not of the nephrid type. There are 2 types:

The glandular type : represented by 1 or 2 giant cells, the Renettes located ventrally and which opens to the outside through a medioventral and anterior pore.

The tubular type : consisting of 2 channels housed in the lateral epidermal cords that meet anteriorly and ventrally by anastomosis and open to the outside through an excretory pore located just behind the mouth. In reality, each of these channels is a single enlarged renal cell.

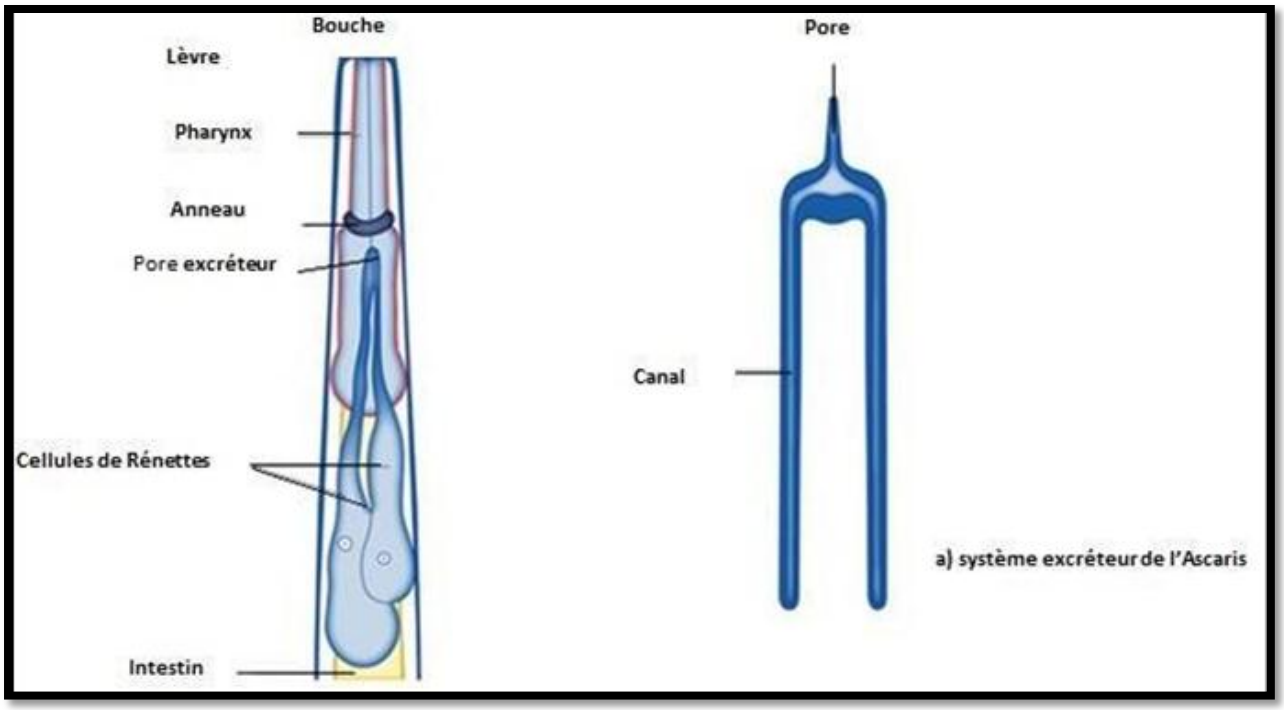

Fig 23: The excretory system of Nematodes

f-The nervous system: consisting of a periosophageal collar associated with lateral even nodes which are homologous to the cerebroid nodes and to one or more ventral nodes. From this collar go forward 6 nerves that innervate the lips and sensory organs and back 8 cords: 6 motor nerve trunks (1 dorsal, 1 ventral, 4 sub-lateral) and 2 sensory nerve trunks (2 lateral). The ventral nerve is larger and is connected to the dorsal nerve by commissures

- Sensory organs:

* Ectellae: in some parasitic forms.

*The bristles and taste buds at the level of the head whose role may be tactile.

*The Amphids or lateral organs: a pair is previously located, they are cuticular invaginations forming pockets opening to the outside through an amphidian pore into which an amphidial gland opens consisting of a single large cell.

This amphid leads to clusters of nerve endings of the amphidal nerves. These are chemoreceptors (often regressed in parasitic forms).

*Phasmids or precaudal or phasmidial glands: there are 1 pair whose excretory canals open posteriorly on either side of the tail. These are glandulosensory organs.

g-genital apparatus: Some nematodes are hermaphroditic but most are gonochoric, and there is pronounced sexual dimorphism. The genitals in both sexes consist of an elongated tube, the bottom of which functions as a sexual gland , while the remainder forms a vector channel and a reservoir; it is rare for this tube to be double or to branch off at the end in the male, and morphological considerations make it admitted that it remains simple in females, although it sometimes seems clearly double. The male appliance opens into the rectum; the vulva is located towards the middle of the body.

-THE male apparatus: It is formed by a single testicle (rarely 2) consisting of a very long, very thin tube, folded back on itself, immersed in peri-visceral fluid and whose walls, which are germ cells, produce spermatozoa.

The spermiducte that drains this testicle bulges at its end into a seminal vesicle where sperm accumulate. It ends in the proctodeum, which thus forms a cloaca, often provided with 2 copulatory styli. Sperm are devoid of flagella and move in amoeboid movements.

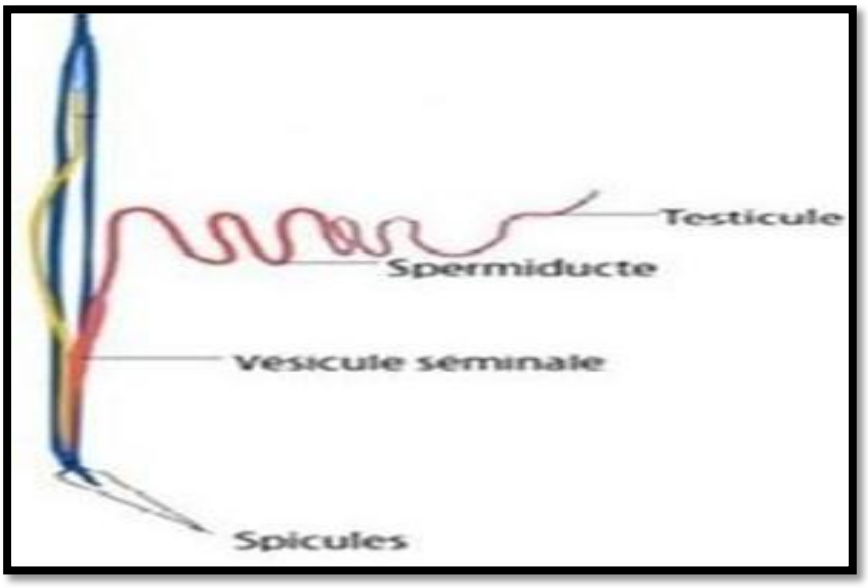

Fig 24: The male apparatus of Nematodes

- The female apparatus: composed of 2 ovaries (sometimes 1 alone), very long contoured, resulting in 2 oviducts giving themselves in 2 uteri which come together to form a short vagina throwing out medioventrally at the level of the anterior third of the body. The upper part of the uterus serves as a seminal receptacle where eggs will be fertilized.

Fertilization is internal, as well as shell formation and the beginning of embryonic development (take place in the uterus).In some nematodes eggs also hatch. Embryonic development includes 5 larval stages separated by 4 moults, this is the 5 stage that is

turns into an adult. During the 3 stage, this larva does not get rid of its old exuvia, so it is protected by a double cuticle, which gives it great resistance

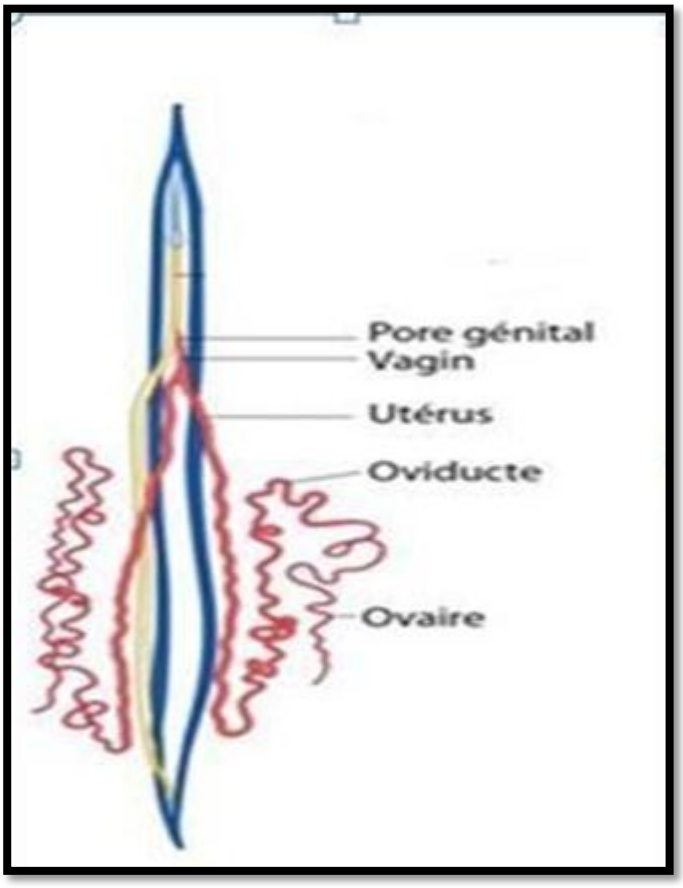

Fig 25: The female apparatus of Nematodes

Synthesis

Bilateral symmetry: Plathelminths and Nematodes, these vermiform animals have an

elongated and soft body.

Plathelminths or flatworms have a flattened body, while Nematodes or roundworms have a cylindrical body often ending in a point at the posterior end. These two branches are triploblastic, i.e. they have three cell sheets. In addition to the ectoderm and endoderm, these worms have a layer of mesoderm located between the other two layers. Triploblastic animals can be divided into three categories depending on the presence or absence of a body cavity or coeloma.

The **Plathelminthes** are part of the first group in which the three layers of tissue are glued together; the only cavity in the body is the digestive cavity. These animals are called **acoelomata**.

Nematodes belong to a second category of animals called **pseudocoelomats**. In this group, a cavity (pseudoceoloma) develops from the embryonic blastocoele, and is not completely coated with mesoderm inside.

The third group of animals, the **eucoelomates**, have a coeloma or true body cavity. Unlike pseudocoeloma, coeloma develops within the mesoderm and is usually completely coated with mesodermal tissue (peritoneum) on its inner surface.

Molluscs, annelids and all more complex animals fall into this category. In molluscs the true coeloma is reduced to the pericardial cavity, while in arthropods it has completely disappeared. Hemocoele in these two groups is all that remains of the embryonic blastocoele. It serves as a reservoir for blood from their open circulatory system.

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