

Doctor 021

MICROBIOLOGY

Sheet no. 16



Writer : Doctor 018

Corrector : Eman kittaneh

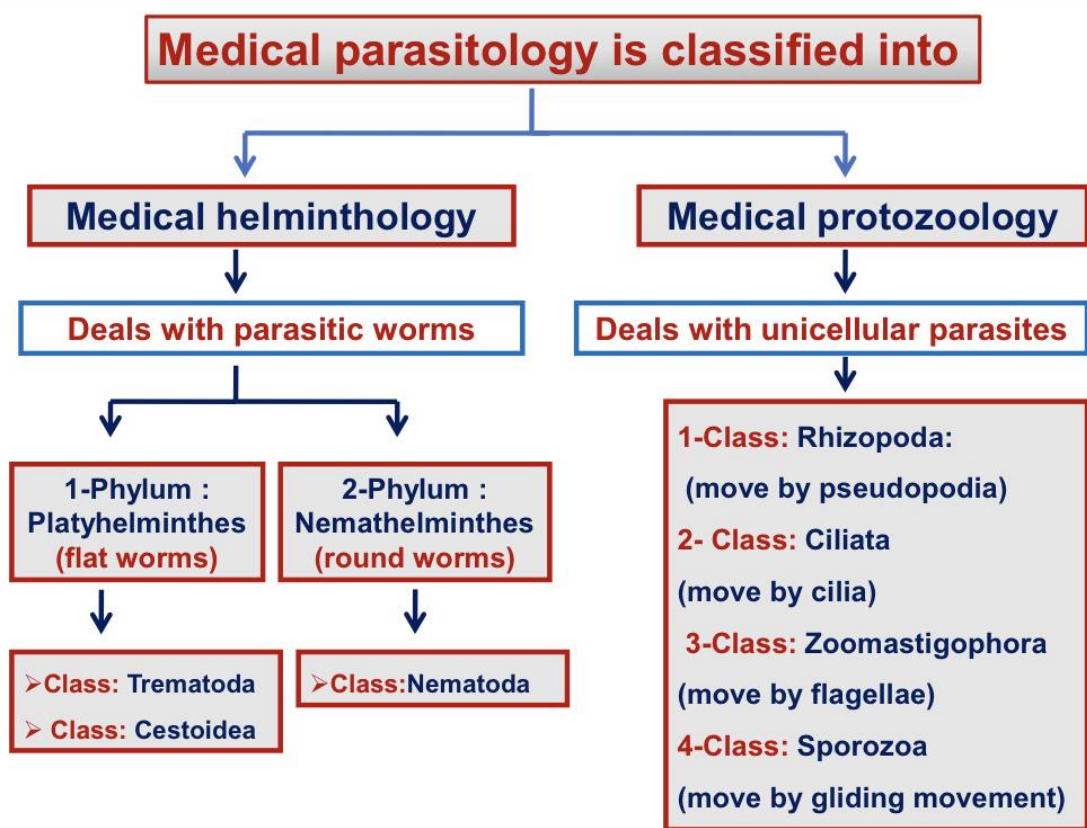
Doctor : DR.NADER

*In this lecture, we're going to discuss Medical Helminthology

* Medical parasitology is classified into:

- **Medical protozoology (Protozoa)**: deals with unicellular eukaryotic parasites
- **Medical helminthology (Metazoa)**: deals with multicellular eukaryotic organisms

(parasitic worms/helminths)



Note that:

- **Platyhelminthes (الديدان المسطحة)**: appears dorsoventrally flattened in cross section.
- ❖ **Trematodes**: are also called **leaf-like worms, or flukes**. They may exist in the lymphatic system, liver or lungs.
- ❖ **Cestodes**: are also called **flat ribbon-like worms or tapeworms** & mainly infect the GI tract.
- **Nemathelminthes (الديدان الأسطوانية)**: appears round in cross section
- ❖ **Nematoda**

- **Nematodes** have separate sexes (male & female), in contrast to **Platyhelminthes** which are **Hermaphroditus** (have both male and female reproductive organs(خنثی))
- ❖ An exception of **Platyhelminthes** that are hermaphrodites: **Schistosomiasis** ,(that causes bilharzia or snail fever), it has two sexes by which the female is very big and contains a groove. The male lives within this groove.
- No **multiplication** happens in **helminths**. (one egg > will give one larva>> one adult), Unlike **protozoa**, by which **multiplication** occurs.
- An exception of this rule (among helminths) is **Echinococcus granulosus** that causes hydatid cyst, by which multiplication occurs in.
- Helminths has definite life span.
- Note that in helminths Infection starts by the ingestion of infective stage (the eggs) some not the egg hatch and leave larva which penetrate the skin to enter the body other have no eggs in life cycle, the adult they lay larva
- Note: in all of the nematodes that we're going to discuss, the female is longer and bigger than the male.

NEMATODES:

Intestinal Nematodes:

1- ASCARIS LUMBRICOIDES:

- It is the species that causes **Ascaris** disease or **Ascariasis**(an infection of the small intestine)
- One of the commonest helminthic infections in human, related to poor sanitation or night soil(human feces used especially for fertilizing the soil) that causes infection persistent in nature
- Mostly benign infection.
- The disease is caused by ingestion of eggs, which can be also observed in stool samples for diagnosis.
- usually asymptomatic, but if present in high amount in the body it may cause irritation in the intestine lumen, diarrhea , abdominal pain..

• **Infect by eggs, that are strongly resistant to dissection and environmental conditions**

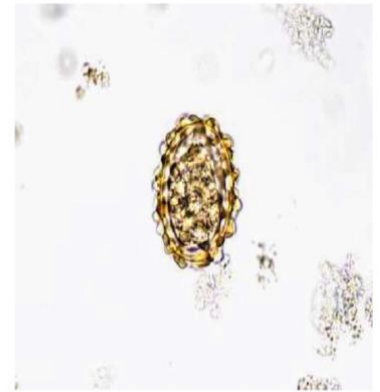
- Eggs are 75x40 with a thick mamillated brownish shell.
- Freshly passed eggs with stool are not infective they require 2-3 weeks to develop to be embryonated (contain larva).
- *Ascaris lumbricoides* is the largest nematode (roundworm) parasitizing the human intestine. (Adult females: 20 to 35 cm; adult male: 15 to 30 cm.)
- Humans can also be infected by pig roundworm (*Ascaris suum*). *Ascaris lumbricoides* (human roundworm) and *Ascaris suum* (pig roundworm) are indistinguishable. It is unknown how many people worldwide are infected with *Ascaris suum*.
 - Diagnosis: Usually by finding the eggs in the stool.
 - if the patient have heavy burden of infection, adult ascaris worms may be found feces.
 - It has definite life span (less than 2 years)

PATHOLOGY AND PATHOGENESIS:

- If present in high numbers, adult worms may cause mechanical obstruction of the bowel and bile and pancreatic ducts.
 - These species contain a primary digestive system, unlike **hermaphrodites** that depend on **absorption**. They may compete with our cells and cause malabsorption.
- Worms tend to migrate if drugs such as anesthetics or steroids are given, leading to bowel perforation and peritonitis, changes in the bowel movement (sometimes constipation, other times diarrhea), anal passage of worms, vomiting, and abdominal pain/discomfort.
- Larvae (اليرقة) migrating through lungs (during their life cycle) induce an inflammatory response (pneumonitis), especially after second infection, leading to bronchial spasm, mucus production, and Löffler syndrome (cough, eosinophilia, and pulmonary infiltrates).
 - this reflects an important point by which we can diagnose the disease though a **sputum sample**. (An intestinal disease may be diagnosed by a sputum sample due to the presence of the causative agent in the lungs during its life cycle).
 - **Löffler's syndrome** is a disease in which eosinophils accumulate in the lung in response to a parasitic infection.
 - **Pneumonitis**: related to the host immune response (the inflammation of the lung not caused directly by the infection process).

- **Pneumonia:** related to the perpetrator (the attacking microorganism)

➤ In the 1st picture to the left, we can observe that the female is bigger than the male, the male has a **curved posterior end** called **copulatory spicule** (the place where mating with the female occurs)



➤ In the 2nd picture you can see the Egg characteristic: the egg is distinct by **brown shell with bumps or lumps**. (It is the only egg with bumps) In addition, it is surrounded by an **albuminous coat** (it helps the egg in surviving different conditions).

➤ The eggs are seen under the microscope.

ASCARIS LIFECYCLE

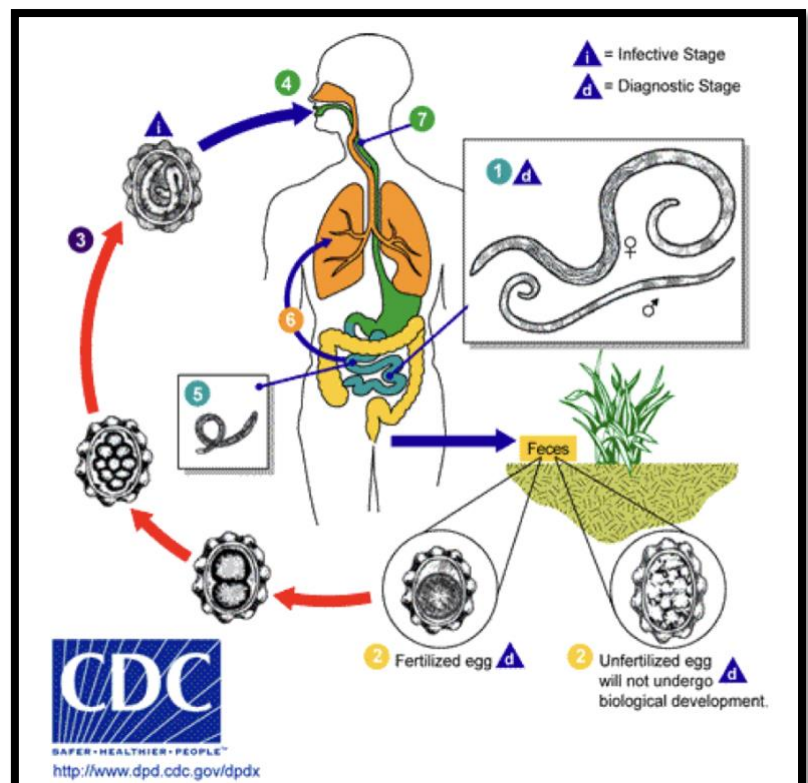
- The life cycle of *Ascaris lumbricoides* begins with the ingestion of an **embryonated egg** (the infective stage), through contaminated (water, soil, food)

- Note that the egg must be **embryonated** not fertilized

- Then, it crosses the digestive system (passes through the stomach) and reaches the small intestine, **the eggs hatch in the small intestines**

- Then it will cross the mucosa & sub-mucosa of the intestinal wall and move to the blood circulation until they reach the lungs capillaries and lodge there.

- They reach up and the patient swallow it again. Then they go back to the intestines for the 2nd time where they mature (become **adults**) and put

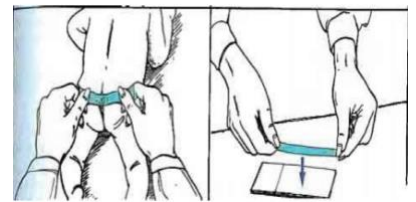
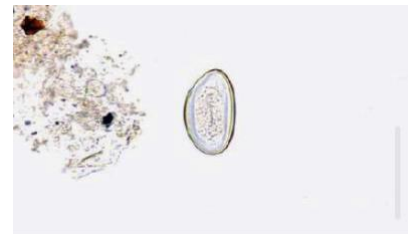


the eggs (ova position). Eventually, the eggs reach the anus and can be excreted with the stool (**Diagnostic stage**).

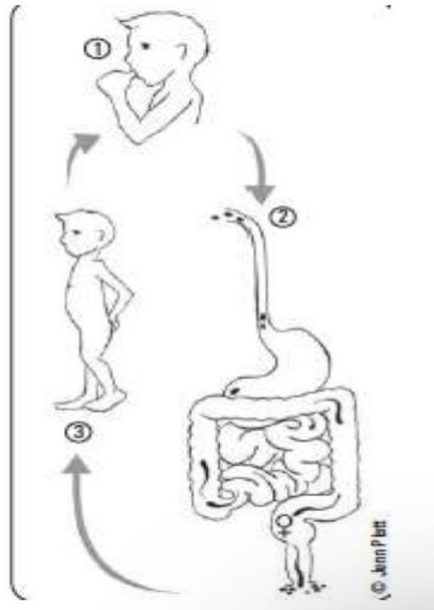
- The presence of adults in the small intestine causes **ASCARIS**
 - ❖ Now, note that these eggs aren't infectious because the Ascaris lays down approximately 200000 ova per day in the intestines even though it may not be fertilized. (female can lay eggs without being fertilized by a male), The **unfertilized** ones will be excreted in the stool & **won't complete the cycle**. On the other hand, the **fertilized** ones are what we're afraid of because they'll **continue the cycle**.
 - The fertilized eggs aren't immediately infective takes around 3 weeks in the **soil** to move from the **fertilized** egg stage to the **embryonated** egg stage, Then, it becomes infectious and this contaminated soil may reach the vegetables and so on.
 - ❖ Note that if humans eat contaminated food with fertilized eggs, they won't be infected! Why? Because the fertilized eggs must pass the stage from being fertilized then embryonated outside of the body and specifically in the soil, then they become infective and can cause diseases to humans if ingested.
- The main points in this life cycle (extremely important)
 - The infective stage>>> embryonated egg
 - The diagnostic stage>>> either the fertilized or the unfertilized egg.
 - ASCARIS has **pulmonary route** (it passes through the lungs)
 - It is a **soil transmitted helminths** (need's 3 weeks in the soil before becoming infective)

2- ENTEROBIUS VERMICULARIS (PINWORM–INTESTINAL NEMATODE)

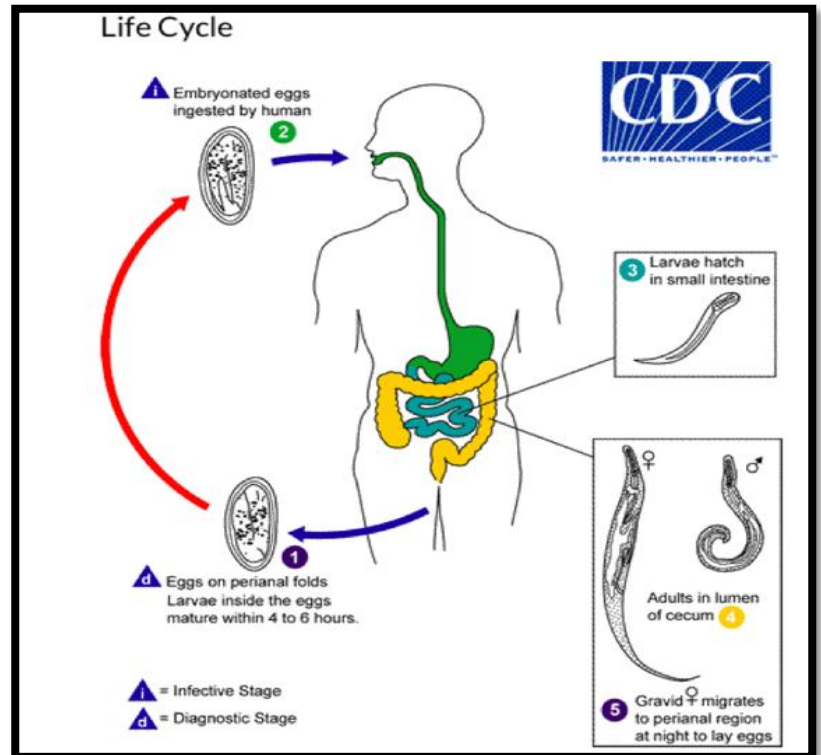
- Female pinworms (about 10 mm in length) have a slender, pointed posterior end. Males are approximately 3 mm in length and have a curved posterior end. (remember the copulatory spicule)
- Pinworms are found worldwide but more commonly in temperate than tropical climates. They are among the most common helminthic infection and infect mostly children
- Eggs are football shaped, have a thin outer shell, and are approximately 50–60 μ m in length. Infectious larvae are often visible inside the egg
- Eggs are recovered using the “Scotch Tape” technique in the morning before a bowel movement. They’re easily diagnosed and you can even perform this in your clinic if you have a small microscope, by which you put the scotch around the perianal region then transfer it to the slide of the microscope. You’ll observe the eggs, they’re clear or transparent by which the larvae may be also observed.
- The main symptom associated with pinworm infections is perianal pruritus, especially at night, (this is related to cortisone levels), caused by a hypersensitivity reaction to the eggs that are laid around the perianal region by female worms, which migrate down from the colon at night (This causes itchiness especially among children, which will prevent the child from having good sleep and that may reflect in developmental delay)
- Diagnosis: By Eggs (we may find worms but usually eggs)



- ❖ The eggs of **ENTEROBIUS VERMICULARIS** are **immediately infective**. (they need from 4-6 hours, unlike the **ASCARIS LUMBRICODES** which are **soil transmitted helminths** and not immediately infective because they need around 3 weeks in the soil). Now, being immediately infective means that the child may cause infection to himself, (**Auto infection**), if he puts his fingers in his mouth after itching the perianal region or even the bed covers and anything



around may be infected-(Bad Hygiene).



- ❖ Note: no other routes regarding **ENTEROBIUS VERMICULARIS**, they go through the intestines. Unlike **ASCARIS LUMBRICODES** that reaches the lung (**trans- pulmonary route**).

- Life span: less than Ascaris lumbricoides
- **The diagnostic:** The **eggs** found at the **perianal** region.
- **The infective stage:** The **embryonated** eggs.

**Now whether the infection comes back or not (retro-infection), or the eggs found at the perianal region hatch and re-infect the skin or the ones that left the body come again – all of these points are debatable and there's no definite answer*

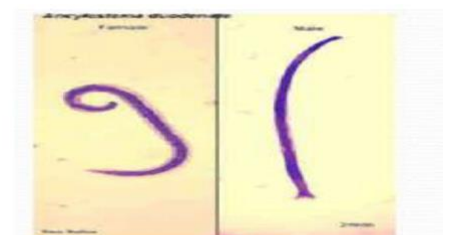
3- TRICHURIS TRICHIURA (WHIPWORM– INTESTINAL NEMATODE)



- Adult female whipworms are approximately 30–50 mm in length; adult male worms are smaller. The anterior end of the worms is slender, and the posterior end is thicker, giving it a “buggy whip” appearance, hence the name whipworm.
- Adult whipworms inhabit the colon, where male and female worms mate. Females release eggs that are passed in the feces, and eggs become infective after about 3 weeks of incubation in moist and shady soil.
 - (Soil transmitted helminths(2weeks-month) & not immediately infective).
 - Diagnosed by eggs
- Whipworm eggs (50 µm) with distinct polar plugs.
- Note: All 3 helminths mentioned above has co-oral route (need to be ingested), regardless if it’s immediately infectious or soil transmitted.

4-ANCYLOSTOMA DUODENALE AND NECATOR AMERICANUS (HUMAN HOOKWORMS– INTESTINAL NEMATODE)

- The most important thing here is that these hookworms do not cause disease by ingestion of eggs. Rather, the disease is caused by the **larvae penetrating the skin and the body** by different and random routes.(infection caused by **penetration** mainly through ankle and feet)



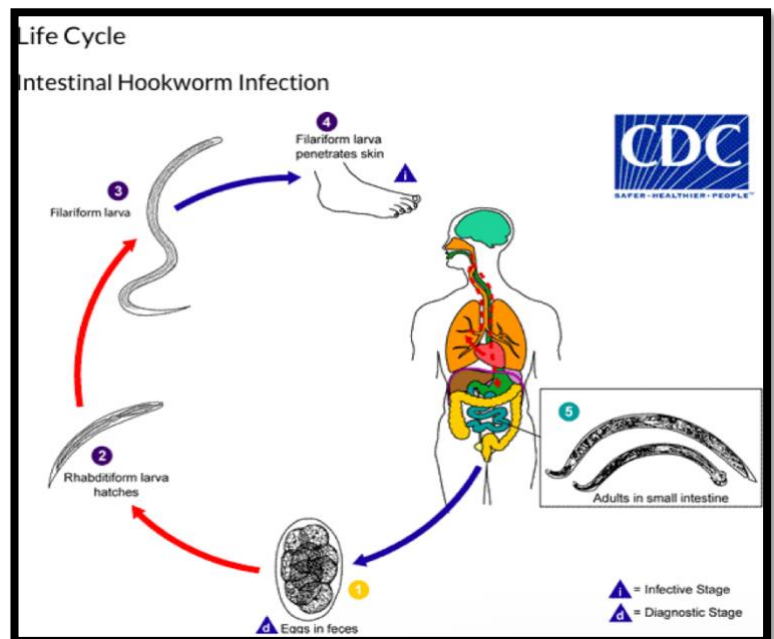
Adult male and female worms of *A. duodenale*



Egg of *A. duodenale* in faecal smear

- Female hookworms are approximately 10 mm in length; males are slightly smaller and have a taxonomically characteristic copulatory bursa (*broadened posterior end*), which is used to mate with females. Females can release more than 10,000 eggs per day into the feces, where a larva hatches from the egg within a day or two.

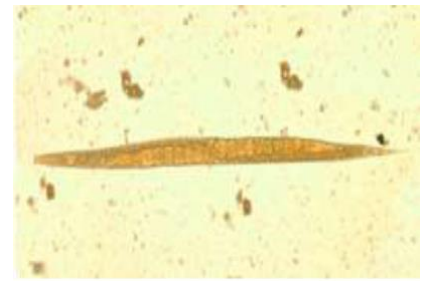
- Eggs are oval 60x40 mm
- The eggs hatch outside the body.
- ❖ **Life cycle:** they hatch in 48h to give the *rhabditiform* larva, after 2 days it moults to filariform larva which is the infective stage that penetrate skin and mucous membranes.



PATHOLOGY

- Larvae can survive in moist soil for several weeks, waiting for an unsuspecting barefooted host to walk by. These larvae penetrate host skin and migrate throughout the host similarly to *Ascaris* and end up in the small intestine where they mature into adult worms.
- In the intestine, adult worms attach to intestinal villi with their buccal teeth and feed on blood and tissue with the aid of anticoagulants, (which lead to the presence of blood with stool and if the bleeding was severe the patient will come with anemia symptoms.)
- A few hundred worms in the intestine can cause hookworm disease, which is characterized by severe anemia and iron deficiency. Intestinal symptoms also include abdominal discomfort and diarrhea. The initial skin infection by the larvae causes a condition known as “ground itch,” characterized by erythema and intense pruritus. Feet and ankles are common sites of infection due to exposure from walking barefoot.
- Important note → it goes through trans pulmonary root.

5-STRONGYLOIDES STERCORALIS (HUMAN THREADWORM– INTESTINAL AND TISSUE NEMATODE) (الدودة الخيطية)



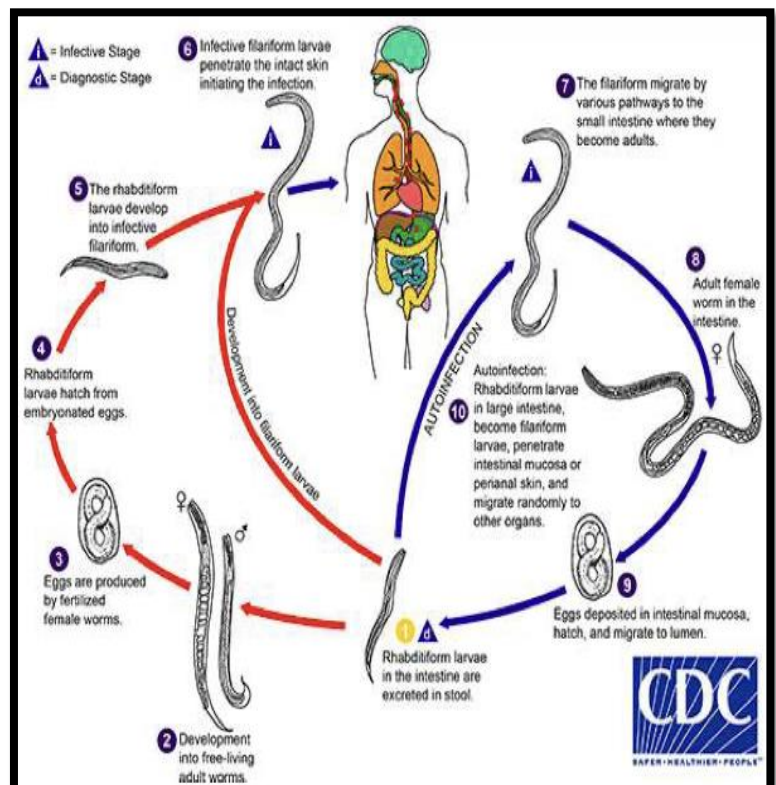
- **(INTERNAL AUTO INFECTION):** it's the only one able to complete its whole life cycle inside the body, the eggs of these thread worms do hatch inside the body and stay there to complete their complex life cycle No need for them to go outside of the body and this is different from other types of worms.
- Remember: most (worms/helminths) have to leave the body to complete a specific growth stage as an obligatory part of their life
- Parthenogenetic: type of asexual reproduction involving the development of female gametes without any fertilization
- Larvae (not eggs) are ingested

• **Adult females (about 2 mm long) of Strongyloides stercoralis that inhabit the intestine are parthenogenetic; that is, they do not need to mate with male worms to reproduce.**

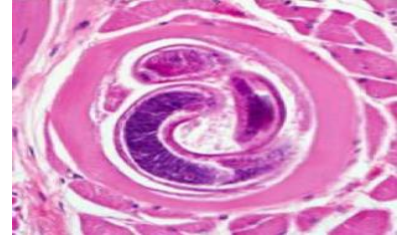
• **life cycle: They lay eggs within the intestine; larvae hatch from the eggs and are passed into the feces. These larvae can either develop into parasitic forms or develop into free-living male and female worms that mate and produce several generations of worm in the soil, a great example of an evolutionary adaptation to sustain a population.**

- diagnostic stage → the larva
- It has trans pulmonary route

*The doctor said its treated by 4 medications(praziquantel, ivermectin, albendazole, mebendazole)



6-TRICHINELLA SPIRALIS (INTESTINAL AND TISSUE NEMATODE)



- The only intracellular helminthic infection in humans from the helminths that we've discussed. All of the helminths that we've explained are extracellular. **TRICHINELLA SPIRALIS** is the only exception.
- These worms do not lay eggs. Instead, they put larvae directly without eggs. later, the larvae undergo **encystation** (كأنها تلدها ولادة ولا تضع بيوض ثم تتكيس هذه اليرقات-تكتيس-)
- Usually, the **encystation** take place in the **muscles** Thus, we may need a biopsy in order to diagnose **Trichinella spiralis**

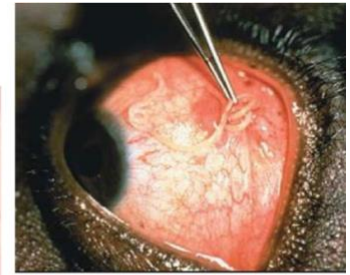
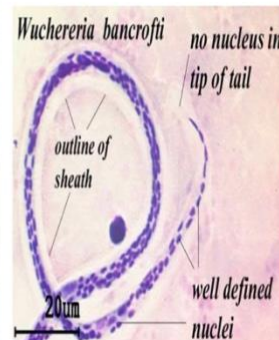
• **Trichinella spiralis is acquired by eating raw or improperly cooked pork infected with the larval stage of these nematodes. In the small intestine, the larvae molt into adult worms, and, after mating with male worms, the female worms release live larvae. The larvae penetrate the intestine, circulate in the blood, and eventually encyst in muscle tissue.(heart,brain,skeletal muscles)**

• **Adult female worms live for several weeks and after the first week of infection may cause diarrhea, abdominal pain, and nausea. Intestinal symptoms are mild to none and often go unnoticed.**

TISSUE NEMATODES

- **Adults are parasite of the lymphatic system or connective tissue .they are filariform or thread like.**
- **Female lay larvae but not eggs.**(مثل الإنسان تضع جنين مباشرة لا تبيض)
- **Microfilaria larvae (the infective stage)**
- **Larvae require an intermediate host to complete development resulting in the production of the infective stage.**
- **Family Filariidae, members are :**
 - **Wuchereria bancrofti (intermediate vector—>Mosquito)**
 - **Brugia malayi (intermediate vector—>Mosquito)**
 - **These two (Wuchereria bancrofti - Brugia malayi) cause elephantiasis(blockage of lymphatic circulation)because they're parasites of the lymphatics .**

- **Loa loa (eye worm) (intermediate vector—>fly -genus Chrysops, day-biting flies)**
- **Onchocerca volvulus (River blindness) (intermediate vector—>black flies)**
- These two (Loa loa and Onchocerca volvulus) cause eye worm disease. (Note: The names are very important)



LYMPHATIC FILARIA(elephantiasis)

- **Members to be found in lymphatics , body cavities and subcutaneous tissues.**
- **Progenies are embryos which are not fully developed (microfilariae), these are between eggs & larvae.**
- **Microfilariae require an intermediate host which sucks them . the infection is transmitted by mosquitoes.**
- **Elephantiasis; true elephantiasis is the result of parasitic infection caused by The filarid nematodes, Wuchereria bancrofti, Brugia malayi, and Onchocerca volvulus, are long, slender worms whose adult forms are found in tissues. The long thread like worms blocks the lymphatic system causing fluid to collect in tissues which lead to great swelling called "lymphedema". Limbs can swell so enormously that they resemble an elephant's foreleg in size texture and color.**

SUMMARY

➤ **Nematodes (round worms):**

- They are small, round elongated worms, non-segmented, with body cavity, have separate sexes, usually don't need an intermediate host and do not multiply in human host because eggs don't hatch unless they leave the body first.
- Infection pattern vary widely. Human intestinal nematodes infect via food borne, water borne, and soil borne routes.

- People infected with *Ascaris* often show no symptoms. If symptoms do occur, they can be light and include abdominal discomfort. Heavy infections can cause intestinal blockage and impair growth in children. Other symptoms such as cough are due to migration of the worms through the body

-key concepts:

- Most intestinal helminthic infections are fairly benign, except when worm burdens are high and numbers of adult worms in the intestine reach the hundreds.
- In intestinal worm infections, the intestine usually harbors the adult stage of the parasite, except for *Strongyloides*, *Trichinella*, and *Taenia solium*, which not only reside in the intestine as adults but also have larvae capable of migrating throughout tissues.
- In the case of the three most common intestinal infections (whipworm, hookworm, and ascariasis), the eggs require incubation in the soil for several days or weeks in warm, tropical climates.
- Most infections are acquired by ingestion of the egg or larval stage, with the exception of the hookworms, human threadworms, and schistosomes, whose larvae penetrate the skin, and the filarids, which are vectorborne.

PLATYHELMINTHIS(FLAT WORMS)

- **Platyhelminthes are flatworms that are dorsoventrally flattened in cross section and are hermaphroditic.(they absorb not digest)**
- **All medically important species belong to two classes:**
 1. **Cestoda (tapeworms)**(الديدان الشريطية)
 2. **Trematoda leaf shaped with two muscular suckers. (flukes)**
- **Families: Fasciolidae , Heterophyidae and schistosomatidae(Bilharzidae)**
- **The Trematodes : fertilization occur either cross between 2 worms or self fertilization (hermaphroditic).**
- **All trematodes undergo a complex asexual reproductive phase .larval stage in a snail (their 1st intermediate host)**
- **eggs are oval, operculated, pass to fresh water , hatch and release a ciliated snail seeking the 1st larval form –meracedium-swims to find its snail host and develops to the final larval stage –cercariae**

(infective stage)-these swarm out to penetrate a 2nd intermediate host and may encyst as metacercariae (infective stage).

- **Meracedium** requires at least 2 intermediate host
- After first host its called **CERCARIAE**
- After the second host its called **METACERCARIAE**
- (cercariae and metacercarie) are the infective stage
- Hermaphroditus can be fertilized either by it self (it has female and male organs), or by another male fertilizing the female by cross fertilization.

FASCILODAE




• Large sized trematodes in which the ventral sucker is near the anterior end.

- They usually require more thane 1 intermediate host
- They affect specific organ
- **Liver flukes:**
 - **CLONORCHIS SINENSIS** (Chinese/oriental liver fluke)
 - **FASCIOLA HEPATICA** (Sheep liver fluke)
- **Lung fluke:**
 - **PARAGONIMUS WESTERMANI** (lung fluke)(causes paragonimiasis)
- **Blood fluke:**

SCHISTOSOMA MANSONI, S JAPONICUM, AND S HAEMATOBIIUM (BLOOD FLUKES)

• The adult worms are long and slender (males are 6–12 mm in length; females are 7–17 mm in length) and can live for 10–20 years within the venous system.

- Mechanism of infection to human: penetration
- Note: **S. haematobium** is the major agent of schistosomiasis or bilharzi, it cause granulomatous reaction leads to fibrosis that causes metaplasia which may lead to urinary cancer (معلومة عالهامش: هي كانت السبب بوفاة عبد الحليم حافظ)
- **S. haematobium** intermediate is bulinus snail
- Diagnostic stage: eggs

<u>S. mansoni</u>	<u>S. japonicum</u>	<u>S. haematobium</u>
<i>inferior mesenteric veins of large intestine</i>	<i>inferior and superior mesenteric veins of small intestine</i>	<i>veins of urinary bladder</i>
fresh water <i>snails of <u>Biomphalaria alexandrina</u> are important hosts</i>	fresh water <i>snails of the <u>oncomelania</u> genus are important host</i>	fresh water <i>snails of the <u>bulinus truncatus</u> are an important hosts</i>
It has round eggs with <u>lateral spine (very important)</u>	Egg has a small <u>curved rudimentary spine</u>	Egg has a <u>terminal spine</u>
		

SCHISTOSOMIASIS PATHOLOGY

The most significant pathology is associated with the schistosome **eggs**, not the **adult worms**. Female schistosomes can lay hundreds or thousands of eggs per day within the venous system. When eggs are released, many are swept back into the circulation and lodge in the **liver** (S mansoni and S japonicum) or **urinary bladder** (S haematobium), while other eggs are able to reach the lumen of the intestine and pass out with the feces or urine.

- A **granulomatous reaction** surrounds the eggs and leads to **fibrosis** of the liver with S mansoni and japonicum. In chronic cases, blood flow to the liver is impeded, which leads to portal hypertension, accumulation of ascites in the abdominal cavity, hepatosplenomegaly, and esophageal varices.



Biomphalaria



Bulinus

- With S haematobium infections, there is urinary tract involvement: urethral pain, increased urinary frequency, dysuria (pain), hematuria (blood with urine), and bladder obstruction leading to secondary bacterial infections.

CESTODA (TAPEWORMS)

- Flat-ribbon like chain of segments with no mouth or digestive tract, (has head called scolex, neck and chain of segments called proglottids) **adult worms are hermaphroditic ,have complex life cycle and human acquire infection by eating infected flesh.**

- The segments may be seen with the patient feces (diagnostic structure)
- Proglottids that are nearest to the head is immature,
- the furthest are the mature ones. which may falls down with feces

- **3 groups infect humans:**

1. Taenia
2. ECHINOCOCCUS GRANULOSUS
3. Diphylopothrium latum (the longest)

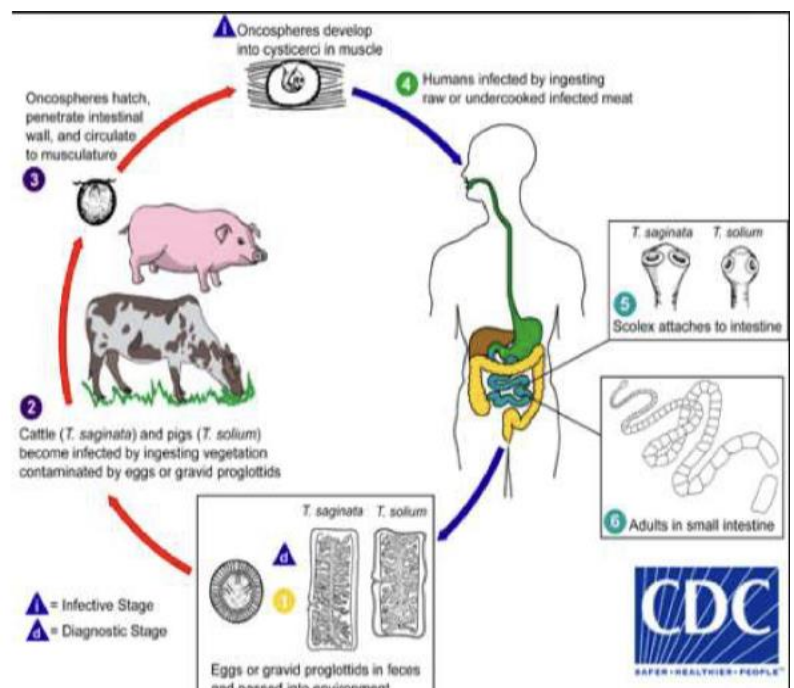
TAENIA SAGINATA (BEEF TAPEWORM)

- Worldwide , acquired by ingestion of contaminated , undercooked beef (containing the larvae stage)(cysticercus), a common infection but causes minimal symptoms.

It cause Teniasis(bengine)

- It is about 6-7 mm in width. The adult T.saginata usually grows to be about 4-8 m in length with about 1000 segments called proglottids.

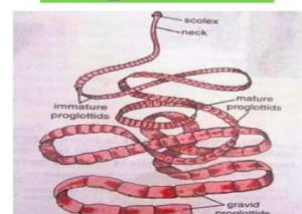
Diagnostic stage: ribbon like segments or eggs



TAENIA SOLIUM (PORK TAPEWORM)

- Morphologically similar to T.saginata, Taenia solium is slightly shorter and have a modified scolex. the adult tapeworm grows to be about 6mm in width and 2-7 meter in length with about 800 proglottids.

- Cysticercosis is the presence of larval stage (cysticercus cellulosae) in human tissue . It is a systemic



disease where cysticerci encyst in muscle and in the brain, may lead to epilepsy .

- Usually the patient eats contaminated beef that has the larvae stage encystation, but if the patient eats the egg directly, the larva will do encystation inside his brain causing neurocysticercosis(that happens with taenia solium especially)
- the human is called **definitive host** when he eats the contaminated beef and that cause **teniasis** (benign disease)
- the human is called **intermediate host** when he eats the eggs directly (because the immature stage is happening inside him), and that cause **neurocysticercosis**

ECHINOCOCCUS GRANULOSUS (HYDATID CYST)

• Echinococcus granulosus is a small, three- segmented tapeworm found only in the intestine of dogs and other canids. But has important intermediate host such as live stock and humans. Where it causes hydatid cyst.



- Dogs are the definitive host
- Infective stage(protoscolices)very infectious
- Treatment by surgery
- The problem happens when the patient is the intermediate host(eat eggs directly)

• The adult tapeworm is about 5mm .

• In humans, cysts containing the larvae develops after ingestion of eggs .Cysts forms primarily in the liver and spleen(mainly) and lung and brain (hydatid cyst).

DIPHYLLOBOTHRIUM LATUM (BROAD FISH TAPEWORM– INTESTINAL CESTODE)

• Diphyllbothrium latum, the broad fish tapeworm of humans (and many other fish-eating animals), reaches enormous size, sometimes exceeding 10 m in length.

• Humans acquire the infection when they eat improperly cooked or raw fish that is infected with the larvae known as plerocercoids, which look like white grains of rice in the fish flesh.

- Human is the definitive host
- Require 2 intermediate host

- **In the intestine, the worm rapidly grows and develops a chain of segments capable of releasing more than 1 million eggs per day**

- Note that (Taenia saginata, Taenia solium, DIPHYLLOBOTHRIUM LATUM) doesn't cause big problem when the human is the definitive host
- The problem happens when the human is the intermediate host