Microbiology

Doctor 2018 | Medicine | JU

◉ Sheet ○ Slides

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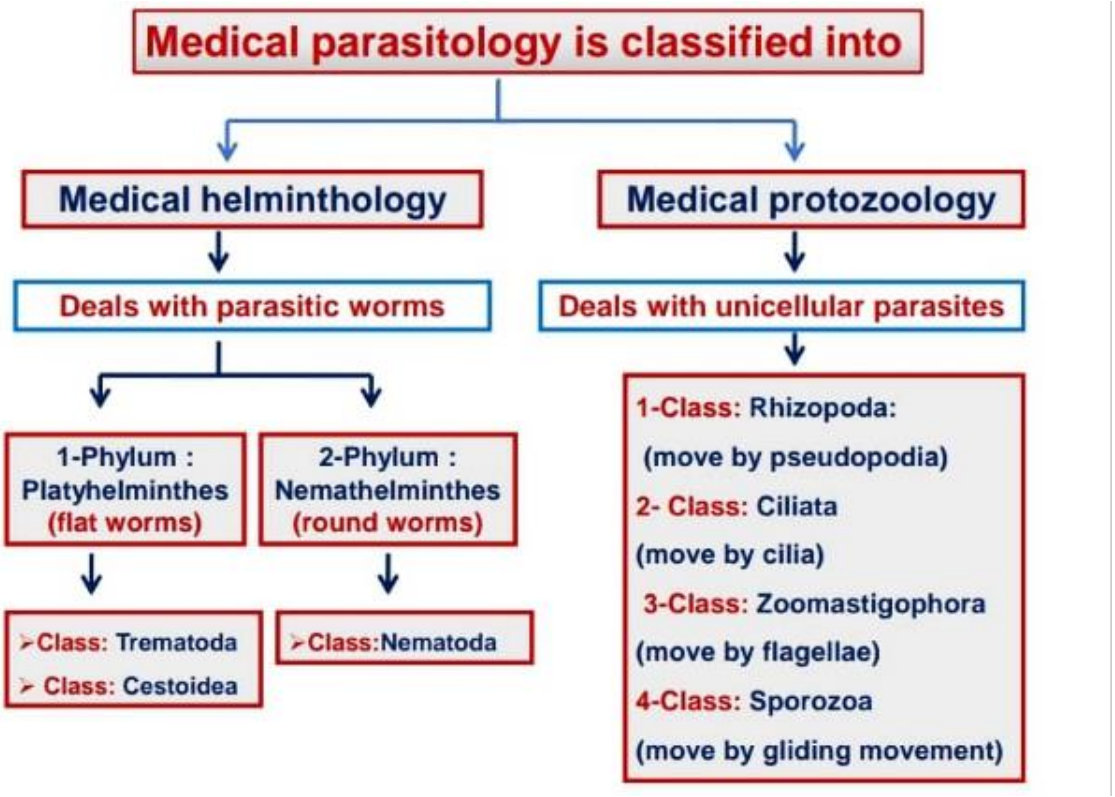
*In this lecture, we're going to discuss **Medical Helminthology***

***Medical parasitology is classified into:**

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

This concept map is extremely important. We have to memorize it



***Note that:**

- **Platyhelminthes**: الدّيدان المسطّحة
  - **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:** الدّيدان الأسطوانيّة

❖ **Helminthic infection is usually benign in humans. Many helminths do exist in our bodies asymptomatically in the beginning (with no symptoms or signs), but when their numbers become very large, e.g. Nematodes- they start to cause mechanical obstruction.**

NEMATODES

- **ASCARIS LUMBRICOIDES:** the species that causes Ascaris disease or **Ascariasis,** i.e**.** an infection of the small intestine.
- The disease is caused by ingestion of eggs, which can be also observed in stool samples for diagnosis.
- 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.

***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 (ألم غير محدّد في البطن).

• 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: inflammation of the lung not caused directly by the infection process. Rather, it's caused by the host immune response (the host's reaction in response to the existence of the helminth).

➢ Pneumonitis is different than pneumonia, but similar to allergy.
- Pneumonia is caused by infection.
* Hemoptysis: coughing up blood from the respiratory tract.

Remember that Nematodes have separate sexes (male &female), in contrast to Platyhelminthes which are Hermaphroditus (have both male and female reproductive organs*خنثى*.

*** An exception** of Platyhelminthes that are hermaphrodites: **Schistosoma** ,there're two sexes by which the female is very big and contains a groove. The male lives within this groove.

*****In all of the nematodes that we're going to discuss, the female is longer and bigger**

- 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- التّزاوج).
- In the 2nd picture, the **egg** is distinct due to containing "**bumps=مطبّات**" 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
- Remember: diagnosis by the presence of eggs in stool.

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*The life cycle of Ascaris lumbricoides begins with the ingestion of an **embryonated egg (the infective stage)**, through contamination (E.g. ***contaminated food***). Then, it crosses the digestive system (passes through the stomach) and reaches the small intestine (**Faeco-oral route**). Moreover, the eggs hatch in the small intestines (تفقس البيوض) , 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*** (تعود البيوض إلى الأمعاء مرّة أخرى-) 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).** 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***. I.e., it can also 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 egg takes around 3 weeks in the soil to become embryonated (the time from being fertilized until generating the larvae- اليرقة . Then, it becomes infectious and this contaminated soil may reach the vegetables and so on.

The main points in this life cycle (extremely important)

- ***The infective stage>>> embryonated egg***
- ***The diagnostic stage>>> either the fertilized or the unfertilized egg.***
- ***The Ascaris moves through the lungs. → very important***

- Once the eggs are in the stool or feces, they aren't immediately infective. They need around 3 weeks in the soil in order to move from the fertilized egg stage to the embryonated egg stage. Now, they're infective. ***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. That's why Ascaris lumbricodes are also called "soil transmitted helminths".***
  - The Ascaris moves through the lungs.
  - The Ascaris life span is around two years (it is definite), different than that of the protozoa.

Remember:** ***No multiplication in helminthes. i.e., one egg > will give one larva>> one adult. Not one egg with two larvae. Unlike protozoa, by which multiplication occurs. ****An exception of this rule (among helminthes) is Echinococcus granulosus that causes hydatid cyst, by which mutiplication occurs in it****

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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****

*** Diagnosis: By Eggs (we may find worms but usually eggs)**

Eggs ***are football shaped***, have a ***thin outer (clear)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.**

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! i.e., 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 reach the lung (trans-pulmonary route).***

- 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*

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***TRICHURIS TRICHIURA (Whipworm— intestinal nematode)- *الدّيدان السّوطيّة**

• 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 & not immediately infective).**

• Whipworm eggs (50 µm) with distinct polar plugs

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*__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.

• 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

•life cycle: they hatch in 48h to give the **rhabiditiform** 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 transpulmonary root.
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STRONGYLOIDES STERCORALIS
(Human threadworm— intestinal and tissue nematode)

****The most important thing here is that the eggs of these thread worms do hatch inside the body and stay there to complete their complex life cycle (AUTOINFECTION). 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 cycle).**

***Larvae (not eggs) are ingested**

• Adult females (about 2 mm long) of Strongyloides stercoralis that inhabit the intestine are parthenogenic; 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.

•the larva→ diagnostic stage
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TRICHINELLA SPIRALIS (Intestinal and tissue nematode)

*The only **intracellular helminthic infection** 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** تكيّس - كأنّها تلدها ولادة ولا تضع بيوض ثم تتكيّس هذه اليرقات 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.

- 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.

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***Tissue Nematodes* (very important)**

- 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
- Larvae **require an intermediate host** to complete development resulting in the production of the infective stage.

*Family ***Filariidae*****, members are:**

1) Wucherieria bancrofti (Mosquito)

2) Brugia malayi (Mosquito)

*These two (**Wucherieria bancrofti - Brugia malayi**) cause **elephantiasis** because they're parasites of the **lymphatics** .*

3) Loa loa (eye worm) (fly -genus Chrysops, day-biting flies)

4) Onchcerca volvulus (River blindness) (black flies)

These two ***(Loa loa and Onchcerca volvulus)*** cause **eye worm disease.**
(Note: The names are very important)

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 except for Schistosoma.** All medically important species belong to two classes:

- **Cestoda - (tapeworms)** – **الدّيدان الشريطية**
- **Trematoda (flukes):** leaf shaped with two muscular suckers.

Familes: Fascilodae , Heterophyidae and schistosomatidae(Bilharzidae)

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*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).**

--Fascilodae: Large sized trematodes in which the ventral sucker is near the anterior end.

- **Liver flukes** ***(the names are very important)***

  • CLONORCHIS SINENSIS (Chinese/oriental liver fluke)

  • FASCIOLA HEPATICA (Sheep liver fluke)

- **Lung fluke** ***(the names are very important)***

  • PARAGONIMUS WESTERMANI (lung fluke)

- **Blood flukes:**

SCHISTOSOMA MANSONI, S. JAPONICUM, AND S. HAEMATOBIUM (Blood flukes)/extremely important

• 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.

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

Note: **S. haematobium** is the major agent of **schistosomiasis** or **bilharzia**

***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** ***(important)*** 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***.

• With **S haematobium infections**, there is urinary tract involvement: ***urethral pain, increased urinary frequency, dysuria, hematuria, and bladder obstruction leading to secondary bacterial infections.***

*Cestoda (Tapeworms):

• **Flat-ribbon like chain of segments** with **no mouth or digestive tract,** adult worms are **hermaphroditic**, have complex life cycle and human acquire **infection by eating infected flesh.**

• 3 groups infect humans:

-***Taenia (Saginata & solium)(causes taeniasis)***

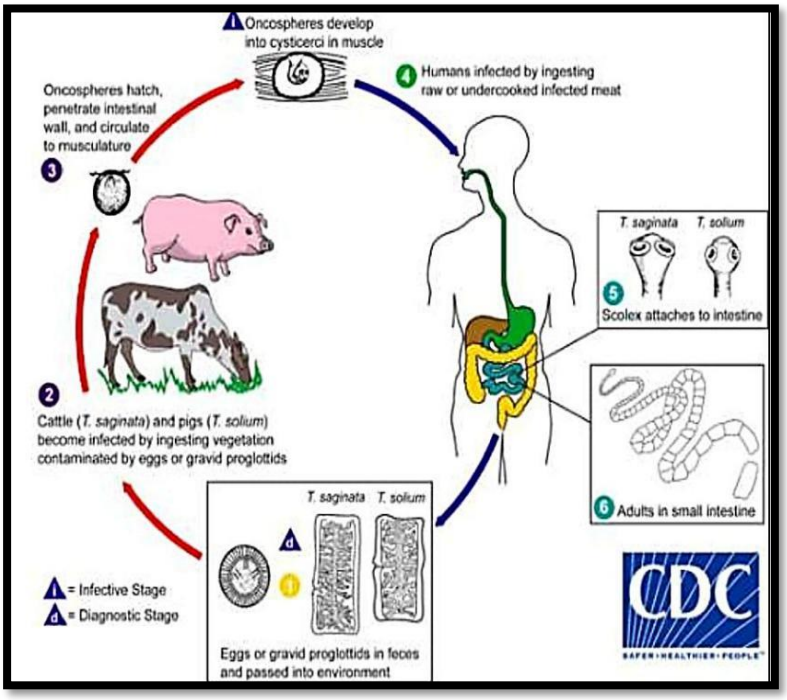
-***ECHINOCOCCUS GRANULOSUS***

-***Diphylopothrium latum***

Taenia saginata- (beef tapeworm)

• Worldwide, acquired by ingestion of contaminated, **undercooked beef (cysticercus)**, a common infection but causes minimal symptoms.

• 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.***



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.**

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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.**

• The adult tapeworm is about 5mm .

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

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DIPHYLLOBOTHRIUM LATUM (Broad fish tapeworm— intestinal cestode)

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

• 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.

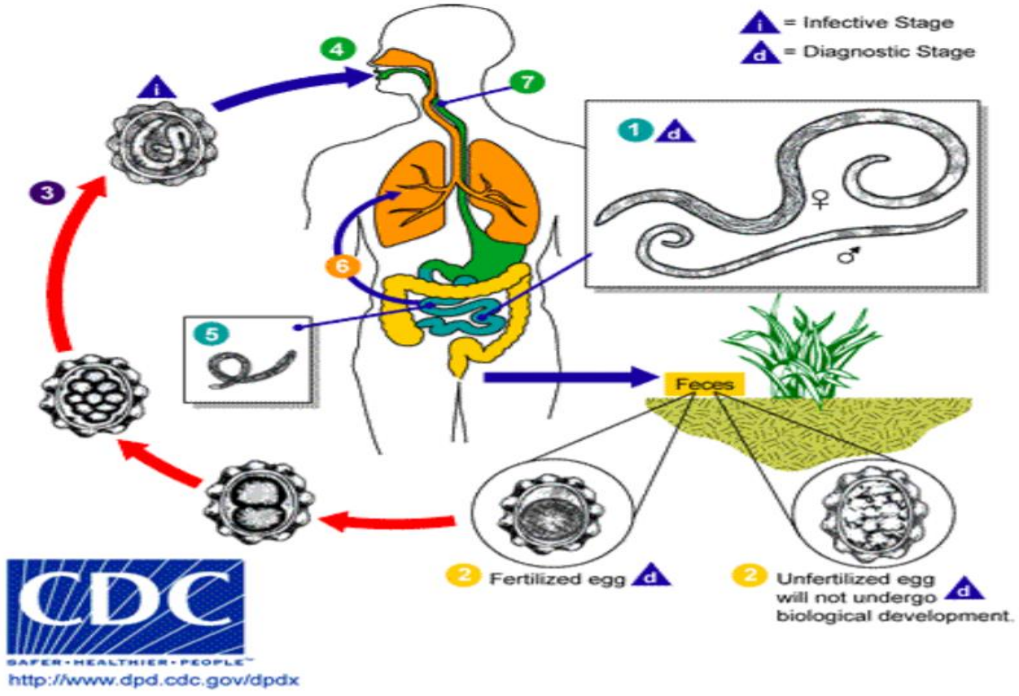
• In the intestine, the worm rapidly grows and develops a chain of segments capable of **releasing more than 1 million eggs per day.**

The End

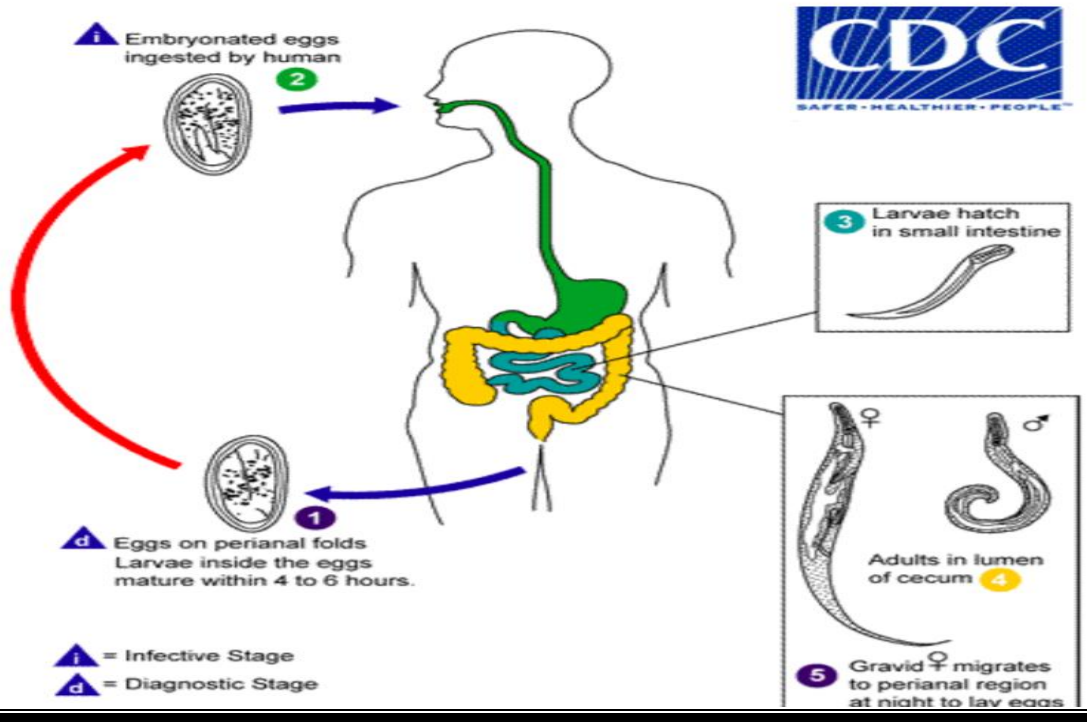
May God Bless you All

HELMINTHS LIFE CYCLE

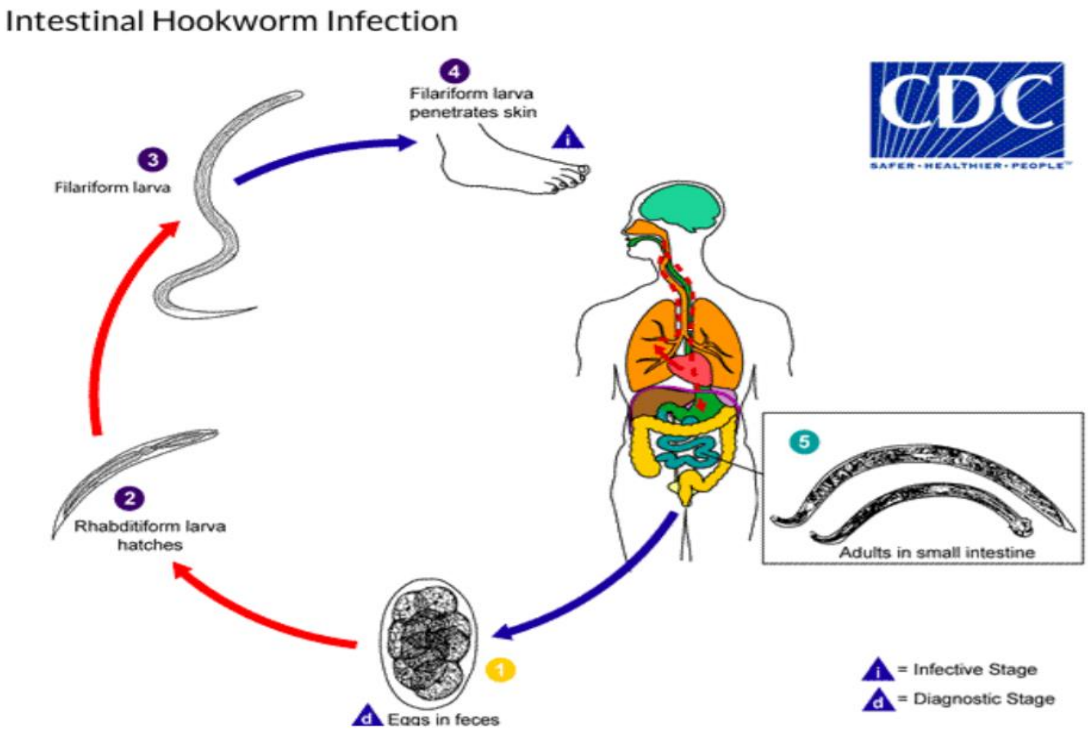
Ascaris lumbricoids



Enterobius Vermicularis



Ancylostoma Duodenale & Necator Americanus



Strongyloides stercoralis