بسم الله الرحمن الرحيم

FINAL | Lecture 5 Helminthic Infections of the GIT

MICROBIOLOGY

Written by: Rakan Haddad Qusai Al-Shannag

Reviewed by: Muthanna Khalil



﴿ وَإِن تَتَوَلَّوْا يَسْتَبْدِلْ قَوْمًا غَيْرَكُمْ ثُمَّ لَا يَكُونُوا أَمْتَ لَكُم ﴾

اللهم استعملنا ولا تستبدلنا



Click on the longest parasitic worm

Ascaris lumbricoides Diphyllobothrium latum

REMEMBER FROM GENERAL MICROBIOLOGY

- Doctor mentioned these points so study them...
- Let's remember! Parasites are split into two groups:
- A: Protozoa (Unicellular):

They multiply in human body, so their life-span is indefinite. B: Metazoa or Helminths (Multicellular):

> Amount in the body depends on how much larvae is ingested. Worms disintegrate with time, so they have a definite life span.

• Metazoa are further classified into two big phyla...

1- Nematodes: cylindrical, unsegmented and dioecious (separate sexes of worms)
Nematodes are also split into intestinal nematodes and extra-intestinal nematodes.
2- Platyhelminthes: Cestodes and Trematodes.

Common Helminthic Infections of the GI Tract

By: Nader Alaridah MD, PhD

Notice:

- Some information are written more than one time, especially if the doctor repeats it with direct emphasis.
- This is to ensure that the most important high-yield concepts, which are most relevant in exams, are fulfilled.
- When you read the same information more than one time, make sure you know it by heart as it is most like very important.
- Don't worry about the slide count. The lecture is simple.
- Have fun studying this file!
- Thanks for Dr. Nader Alaridah & Dr. Muhammad Hussein

ASCARIS LUMBRICOIDES

The most common helminthic infection worldwide

- Disease: Ascariasis or Ascaris
- Largest nematodal infection

Morphology :

- □ Male adult worm measures 15-20 cm in length.
- □ Female adult worm measures 20-40 cm in length.
 - Generally, female worms are larger than males.
- The posterior end of male adult worm is curved while the female adult worm is straight.
- Estimated prevalence more than 1 billion.
 - They have a definitive life-span of about 24-30 months.



- Definitive Diagnosis is by finding these eggs which have a characteristic appearance:
- 1. Bumps or lumps
- 2. Chitinous shell
- 3. Bile-stained (it inhabits the small intestine, so the bile present there will stain the eggs).



- ✓ Cylindrical worm.
- ✓ Yellow-Golden in color.
- ✓ Females >> Males.
- Males have a posterior curved end (copulatory spicule) which is a mating organ.
- ✓ Finding the worm (or parts of it) in the stool is also a definitive diagnosis.

Mode of transmission

□Fecal – oral transmission

□ Reinfection possible

Habitat

Small intestine

Infective stage

Embryonated egg

- Ingesting food or water contaminated with the infective stage (embryonated egg).
- Theres no immunity to it, so reinfections are highly possible, and it's connected to poor sanitation and hygiene of the recurrently infected individuals.
- > The eggs that are fertilized are the ones that can proceed in its life cycle, yet they aren't immediately infectious.
- Each female produces 200,000 eggs a day Some are fertilized, and some aren't. Anyway, it's highly likely to find the eggs in stool.
- Ascaris eggs are capable of survival within harsh environmental conditions, including dry or freezing temperatures (vital for their life cycle).
- When ingested they hatch in small intestine, migrate through the venous system to lungs where they break into the alveoli then to the bronchial tree before they are swallowed and develop into mature worm in the intestine.
- See next slide for the detailed life cycle.



- After ingestion of the infective stage (embryonated eggs), the eggs pass the stomach acidity and reach the small intestines, where they hatch to form larvae.
- The larvae erode the capillaries and return by venous circulation to finally reach the lungs, where they pass from the alveolar sacs finally reaching the bronchi, trachea and larynx, and then the patient swallows them again.
- ✓ When they reach the small intestines, if it is a female, it will lay about 200,000 unfertilized eggs. If a male is found, fertilized eggs will be laid by the female
- This is why the diagnostic stage is the fertilized or unfertilized eggs or adult worms or larvae in sputum during their route.
- ✓ To finish the life cycle, a fertilized egg must stay in soil (environment) for 3-4 weeks until embryonated → the infective stage.

Solidifying the concepts:

Diagnostic stage:

- Eggs (fertilized or not)
- Whole worms (or parts of them)
- Larvae in sputum (part of the transpulmonary route) or even gastric aspirates

Infective stage:

• Embryonated eggs, which are fertilized eggs that has been in soil for 3-4 weeks.

Ectopic Ascariasis:

- ✓ When the worm "wanders around" and end up going somewhere other than the normal route.
- ✓ For example, it can go to the ovaries or uterine tubes in females or to other ectopic locations.
- ✓ A reason for this wandering might be due to giving the patient:
- Anti-parasitic (anti-helminthic) drugs
- Steroids
- Anesthetics.

Pathogenesis and Spectrum of Disease

- Disease is called Ascariasis
- Children and young adolescents have higher infection rate
- Any A. lumbricoides infections are asymptomatic

Symptomatic:

- Pulmonary symptoms during migration (Loeffler's syndrome which is respiratory symptoms, infiltrates and eosinophilia)
 - Ascariasis can be asymptomatic because the patient might only have one or few worms not causing any damage (no multiplication unlike protozoa).
 - In some patients, Loeffler's syndrome can occur during the migration to lungs, and pneumonitis, cough, eosinophilia, hemoptysis (coughing of blood) can be seen.

Pathogenesis and Spectrum of Disease

GI manifestations: malnutrition, anemia, malabsorption, steatorrhea and intestinal obstruction, biliary obstruction and jaundice.

During the migration process, larvae cause damage to the intestinal mucosa. The adults on the other hand cause minimal irritation to mucosa, and their main effect is competing with the host for nutrients, causing several symptoms like the following:

- 1. Malnutrition and weight loss especially in children
- 2. Direct anemia due to feeding on host's blood.
- 3. Indirect anemia due to iron, vit B12 or folate malabsorption.
- 4. Other causes for indirect anemia include (1) co-infections with other blood-eating hookworms and (2) altering of the microbiome.
- 5. Blocking of the mucosal absorption surface area cause malabsorption, causing steatorrhea and other types of malabsorptive symptoms.
- 6. Blocking of the bile or pancreatic ducts causes steatorrhea and/or obstructive jaundice.

Lab diagnosis

 Eosinophilia
 Typical eosinophilia is noted when doing CBC tests. This is not noted with protozoal infections.

- Microscopic examination (looking for eggs) -> Definitive diagnosis
 Direct smear (stool mixed with saline) identified
 for both (fertilized and infertile) eggs
- Adult worm may also be identified in feces
- Larvae may be found in sputum or gastric aspirates

Sometimes they can be cultured on special media.

THERAPY (anti-helminthic or deworming drugs)

Oral Albendazole 400MG STAT

Taken once or thrice daily for three days depending on the severity.

Other drugs include mebendazole, tiabendazole, praziquantel, pyrantin and ivermectin.

STAT = immediately

ENTEROBIUS VERMICULARIS (Pinworm)

The most common helminthic infection in the USA; causes enterobiasis

- ✓ Also known as **seat worm** as the most common complaint is perianal pruritis.
- ✓ Called **pinworm** due to the thin posterior needle it possesses.
- ✓ Males have a curved posterior end.
- ✓ Females lay their eggs around the perianal region and then go back inside; the hatched eggs can also enter the same way; either can cause a retrograde infection.

□ Small, thin and white worm

- distributed worldwide and commonly identified in group settings of children ages 5 to 14 years
- The female worm measures 8 to 13 mm long with a pointed "pin" shaped tail (11000 ova and live for a month)
- The males measure only 2 to 5 mm in length, die following fertilization, and may be passed in feces.

□ Habitat: large intestine (Caecum)





Mode of transmission

- □ Fecal-oral or inhalation (autoinfection)
- Sexual transmission has been reported
- Direct; transmission occurs from an infected host to another
- Infections are associated with institutional crowding and families

Life cycle

- The female migrate at night to the perianal area where they deposit eggs.
- Eggs embryonate within hours and transferred from there by the aforementioned routes.

- Eggs are immediately infectious (only need 4-5 hours to become infectious).
- Eggs are extremely light weighted and can be carried by dust particles, creating another route of infection (inhalation), from where they then slip down the esophagus.
- Clustering of cases in schools or daycare centers or mental institutions is common.
- Can be found anywhere like on door handles, and if eggs are not found around the perineum (by scotch tape), fingernails can be used for diagnosis as children most likely have itched that area and do have the eggs under their fingernails.



Infective stage:

 Embryonated eggs that have been laid by the pinworm and have stayed for 4-5 hours.

Life cycle:

- The eggs hatch in the terminal ileum, and the larvae become adults in the large intestine.
- The female pinworm lay about 10,000 eggs per day nocturnally (it depends on the cortisol levels) in the perineum. The male fertilizes the female and dies.
- After that, the retrograde infection of the pinworm and the embryonated eggs that have hatched takes place.

Clinically:

- □ Infections with E. vermicularis are typically asymptomatic.
- The most common complaint is perianal pruritus (itching).
- The parasite may migrate to other nearby tissues, causing appendicitis, oophoritis, ulcerative bowel lesions.
- Ectopic ascariasis is more common than in *E. vermicularis*.
- **Diagnosis** is typically by microscopic identification of the characteristic flat-sided ovum
- the method that used for diagnosis of pinworm is a cellophane (Scotch) tape
- **Treatment**: albendazole 400 mg STAT repeated at 2w

Treatment options are similar to ascaris, and here the course is usually repeated after some time to ensure the eradication of the infection with minimal adverse effects.



✓ Diagnosis is by finding the colorless characteristic eggs.
 ✓ They are D-shaped, and they can be called football-shaped.



AMERICAN FOOTBALL

Enterobius vermicularis eggs





Scotch tape is usually used in the perineum to search for the eggs. Stool samples can be positive, but the scotch tape is the standard.

Quick revision for helminths classification:



Nematodes have been discussed. Now we'll discuss platyhelminths, starting with cestodes and then trematodes. Cestodes are also called tapeworms (الديدان الشريطية).

Hydatid cysts (Echinococcus granulosus):

>Echinococcus is one of the smallest of all tapeworms (3 to 9 mm long)

The smallest tapeworm that infects humans is Hymenolepis nana (the dwarf tapeworm).

- E. granulosus is a tapeworm found in the small intestine of the definitive host, the canine.
- Eggs are ingested by the intermediate_hosts_and include a variety of mammals including sheep, cattle_and_humans.
- Humans are typically accidental_hosts_and are considered a deadend since the life cycle of the organism is unable to continue in a human host leading to hydatid_cysts.

Note: The formation of hydatid sand is an **exception** to the general rule that **worms do not multiply within the host**, as it involves the production of multiple protoscolices (immature larvae) inside the hydatid cyst.

Echinococcus granulosus life cycle:

- Unlike nematodal infections (like Ascaris and Enterobius) that do not need an intermediate host for their life cycle, Echinococcus (dog tapeworm) needs an intermediate and definitive hosts for its life cycle.
- This tapeworm is composed of scolices (the head containing circle of hooks and suckers), and its body is composed of only three segments (proglottids), so it's called the 3-segment tapeworm.
- The definitive hosts are dogs (carnivores) where the adult stage takes place, and the intermediate hosts are sheep (herbivores) where larvae stage takes place.
- Humans could enter this cycle as an accidental host. Usually, it is transmitted to humans by eating food contaminated with dog feces that contain the eggs; mostly we can see these cases among shepherds (they feed their dogs the dead sheep, so the larvae is transmitted to the dogs, and then the human food can be contaminated by the dog's feces, causing infection).
- ✓ After eggs are introduced into the accidental host (humans!), they hatch but the larvae cannot complete their life cycle, and they encyst instead.

Autoinfection in cestodes:

 In *Taenia solium* (another cestode), taeniasis occurs when food contaminated with encysted larvae is consumed, and these larvae develop into adult worms inside the human body. In cases of autoinfection with *Taenia solium*, after the adults lay eggs, poor hygiene can lead to the ingestion of these eggs (auto fecal-oral transmission), resulting in neurocysticercosis—a more serious condition than typical taeniasis. This type of autoinfection can also occur with other cestodes, such as *Diphyllobothrium latum*, leading to sparganosis.

The doctor said that *Echinococcus granulosus* is similar in terms of that the eggs are what is ingested by humans, forming the hydatid cysts.

Hydatid cysts (*Echinococcus granulosus*): Water-filled

- <u>Hydatid disease</u> in humans is potentially dangerous depending on the size and location of the cyst.
- Majority occurs in liver and lungs and usually asymptomatic
- Some cysts may remain undetected for many years until they grow large enough to affect other organs.
- Diagnosis: incidentally by radiology , serology
- Treatment: surgery, albendazole

Cyst Structure

At gross examination, the vesicles resemble a bunch of grapes.

- ✓ Sites of hydatid cyst:
- ✓ Liver (65%), lungs (25%), muscles, spleen, kidneys, heart, bones, brain, etc...
- ✓ Hydatid cysts grow slowly: 2-3 cm / year
- Unilocular hydatid cysts (mother cyst and daughter cysts around), unlike *E. multilocularis*, which cause 100s of daughter cysts with no mother cyst.
- The cysts are filled with hydatid sand, containing protoscolices (larvae; the infective stage), which are highly antigenic, potentially causing anaphylactic shock if leakage happens.
- \checkmark The base of the cysts is called broad capsule.
- The cysts are most commonly incidentally discovered in liver (most common) examination for another reason (*E. multilocularis* most commonly infects the lungs then the liver).
- ✓ Sometimes, if the cysts is large enough, the symptoms will provoke seeking healthcare as in case of obstructive jaundice if the cysts exert pressure on the bile duct.



Continuation

- These cases are not uncommon in our region. Special caution is necessary because accidental rupture of a cyst can release its contents, triggering anaphylactic shock, which may be fatal. This can occur due to trauma, such as a car accident, particularly involving the spleen or liver.
- Treatment involves a surgical procedure called the PAIR technique after the patient receives Albendazole, Mebendazole, or Praziquantel:
- **1. P**uncture the cyst
- **2.** Aspirate the cystic fluid
- **3.** Inject hypertonic saline or ethanol into the cyst to kill the parasite
- 4. Reaspirate the fluid
- ✓ Hydatid cysts are frightening for surgeons and difficult to deal with.
- \checkmark The cysts do not typically rupture on their own, but they keep growing.

Trematodes classification based on the basis of their final habitats in humans:

Remember:

- Nematodes are dioecious, meaning they have separate sexes (distinct male and female individuals).
- Cestodes and trematodes (platyhelminths) are monoecious (hermaphroditic), meaning each organism has both male and female reproductive organs.
- The only exception is Schistosoma species (part of trematodes), which are dioecious (separate male and female worms).



Trematodes classification based on the basis of their final habitats in humans:



- All trematodes

 (flukes) require at least one intermediate host (usually freshwater snail) to complete their life cycle.
- ✓ Sometimes, even a second intermediate host is needed.

اللهم صل على محمد و على آله وصحبه أجمعين

SCHISTOSOMIASIS

Schistosomiasis is one of the most important parasitic diseases. It is the second most important after malaria.

Is a human disease syndrome due to infection by Schistosoma

Most human schistosomiasis is caused by

- 1. Schistosoma mansoni (mainly GIT).
- 2. Schistosoma japonicum (mainly GIT).
- **3. Schistosoma haematobium** discovered by Theodor Bilharz in Cairo in 1861 (mainly UTS).

There are other species, but these 3 are the most important human blood flukes.

Pathology of Schistosomiasis:

- The pathology caused by trematodes is mainly due to the adult worms except in the case of Schistosoma as the disease is primarily due to the eggs.
- Unlike most trematodes that infect through ingestion, Schistosoma infects humans by directly penetrating the skin.
- ✓ Adult stages of Schistosoma mansoni and Schistosoma japonicum occupy mesenteric venous plexus, on the other hand, Schistosoma haematobium resides at vesical venous plexus.
- ✓ As previously mentioned, the pathology of Schistosoma is primarily caused by the eggs, not the adult worms. This is due to two main factors:
- 1. The eggs are equipped with spines that cause mechanical irritation.
- 2. They also secrete proteolytic enzymes, which contribute to tissue damage.
- > As a result, granuloma and fibrosis typically develop around the deposited eggs.
- ✓ This leads to clinical manifestations such as hematuria and potentially urinary bladder carcinoma in the case of Schistosoma haematobium.
- ✓ If the eggs are deposited in the mesenteric venous plexus, they may enter the portal circulation, resulting in portal hypertension, esophageal varices, hepatosplenomegaly, and liver failure in severe cases.

- It is estimated that than 200 million are infected all over the world & about 500-600 million are exposed to infection..
- Adult worm inhabits the portal venous system. \Leftrightarrow Refer to the previous slide for details.
 - Schistosomiasis of the haematobium type (bilharzia) is endemic in our region, especially in Egypt.
 - In Jordan, we can find Schistosoma haematobium, especially among Egyptian expatriates. We can also see Schistosoma mansoni here.
 - ✓ *Schistosoma japonicum* is more common to be seen at East Asia.
 - Note: The geographic distribution of *Schistosoma* species is influenced by the type of freshwater snails, as each region has its own unique snail species that serve as intermediate hosts.

LIFE CYCLE

- The ovum is passed in the faeces of infected individuals and gains access to fresh water where the ciliated miracidium inside it is liberated; it enters its intermediate host, a species of freshwater snail, in which it multiplies .
- Large numbers of tailed cercariae are then liberated into the water.
- Infectious cercariae penetrate human skin and migrate through the lung and the liver to reach portal venous system

LIFE CYCLE



Life cycle of Schistosoma

- ✓ Eggs are excreted out of the human body.
- ✓ In water, the eggs hatch into miracidia.
- ✓ Miracidia infect specific freshwater snails (intermediate hosts).
- \checkmark Inside the snail, they develop into cercariae (which possess a fork tail end).
- ✓ Cercariae, which is the infective stage, are released from the snail into the water.
- Cercariae penetrate human skin using its fork tail end, becoming schistosomula after losing their tail.
- Schistosomula enter the bloodstream, migrate to target venous plexuses (vesical venous plexus if haematobium; mesenteric venous plexus if mansoni and japonicum) and then mature into adult worms.
- ✓ Adults lay eggs, and the cycle repeats.

Note: In other trematodes (like intestinal flukes), cercariae leave the snail and penetrate or attach to a second intermediate host (water plants). Inside the second host, they develop into the third stage (metacercaria). This metacercaria form enters the human body by ingestion after eating water plants (like watercress) or after eating a fish that fed on that water plant.

Morphology

- Adult male & female have oral sucker surrounding the mouth anteriorly & ventral sucker on the ventral surface with which it attaches itself to the wall of the vessel in which it lives.
- **The male** worm is flat, leaf like & folded to form the gynacophoric canal which enfolds the slender female for almost its entire length.
- Testes
- Ovary

أستغفر الله العظيم وأتوب إليه

 ✓ In Schistosoma species (diecious), the female is longer than the male. The male possesses a gynacophoric canal (Latin: *schist*) in which the female resides, allowing fertilization to occur.

 These worms possess two suckers—an oral sucker and a ventral sucker— used for attachment and feeding.



Pathogenesis and Manifestations

- Skin penetration causing itchy rash
- Travel via lung causing respiratory manifestations
- Production of eggs causing granulomatous reaction and sclerosis in portal venous system to eggs deposited in tissues. This may lead to portal hypertension, esophageal varices, HSM and liver failure.
- However, if the penetrating schistosomula belong to other types of schistosome species, they may remain in the skin and trigger a hypersensitivity reaction known as "swimmer's itch".

✓ After skin penetration,

site of entry.

patients infected with the

species (S. haematobium, S.

mansoni, and S. japonicum)

may develop "ground itch",

a localized dermatitis at the

three main schistosome



igure 1 Large esophageal varices at EGD.

:) الربط بالباثو

The most common cause of mortality in abdominal schistosomiasis is esophageal varices.

> DIAGNOSIS

- 1. CLINICAL
- 2. HEMATOLOGICAL, BIOCHEMICAL
- 3. CONFIRMED BY Detection of ova in STOOL or tissue biopsy





Praziquantel 40mg/kg for all types and as a single dose is treatment of choice.

Diagnosis and Treatment of Schistosoma

- ✓ In the diagnosis of schistosomiasis, eosinophilia may be observed on a CBC test. However, the definitive diagnosis—and the gold standard—is the detection of characteristic eggs in the stool (in the case of Schistosoma japonicum or S. mansoni) or in the urine (in the case of S. haematobium).
- Unlike the eggs of other trematodes, which are operculated (having a cap-like structure), schistosome eggs are non-operculated. They are also distinguished by the presence of a spine:
- S. japonicum: very small and short spine.
- S. haematobium: terminal spine.
- S. mansoni: lateral spine.

Note: After Schistosoma enters the bloodstream, it can cause what is known as Katayama Fever or Katayama Syndrome.

Treatment: Praziquantel (the dr. said the dosage in the slide is not correct; forget about it).

Intestinal Flukes

Infection is by **ingestion** of the infective stage (**metacercaria**).

- Intestinal flukes include :
- Fasciolopsis buski
- Heterophyes heterophyes This type is seen in our region.
- Metagonimus yokogawai

In intestinal flukes, cercariae leave the snail and penetrate or attach to a second intermediate host (water plants). Inside the second host, they develop into the third and infective stage (metacercaria). This metacercaria form enters the human body by ingestion after eating water plants (like watercress) or after eating a fish that fed on that water plant.

Liver Flukes

Infection is also by **ingestion** of the infective stage (**metacercaria**).

- Fasciola hepatica (Common sheep liver fluke)
- Fasciola gigantica (Giant liver fluke)
- Clonorchis sinensis (Chinese or oriental liver fluke)
- Opisthorchis felineus/viverrini
- Dicrocoelium dendriticum (The lancet liver fluke)



They reside in the bile ducts or even in the parenchyma of the liver.

The End Thank you

الحمد لله الذي بنعمته تتم الصالحات



For any feedback, scan the code or click on

Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1			
V1 → V2			

Additional Resources:

رسالة من الفريق العلمي:

Extra References for the Reader to Use:

Last semester's sheet 3

