



# GI MICROBIOLOGY

#1



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Parasites are divided into subkingdoms which are: protozoa (unicellular), helminths (metazoa, multicellular) and vectors.

Both metazoa and protozoa are eukaryotes

We will focus on protozoa and metazoa only.

They are furtherly divided based on either their mode of locomotion or mode of reproduction

## **PROTOZOA:**

### **-Entamoeba histolytica:**

The causative agent of Amoebiasis, amoebic dysentery is a single form of amoebiasis.

### **-Giardia lamblia:**

Other names: giardia duodenalis or giardia intestinalis.

The causative agent of giardiasis (beaver fever in Canada)

### **-Cryptosporidium parvum:**

The causative agent parvum Cryptosporidium, it usually affects the immunocompromised patients and causes self-limited diarrheal disease.

## **HELMINTHES:**

**Ascaris lumbricoides**

**Entrobilus vermicularis (pinworm)**

**Echinococcus granulosus**

**Schistosomia mansoni**

We will talk about them later on so don't rush things.

## **ENTAMOEBEA HISTOLYTICA:**

**Geographical distribution: Worldwide especially in the temperate zone and more common in areas with poor sanitary conditions**

-it is common in areas where night soils are used to use human feces as fertilizers.

**Habitat: Large intestine (caecum, colonic flexures and sigmoidorectal region).**

Why these places specifically? Because they are a common site for feces stasis

**D.H: Man**

**R.H: Man, Dogs, pigs, rats and monkeys.**

The principal definitive host as well as the reservoir host is human

Recap: the definitive host is in which the parasite reaches maturity and reproduce sexually while the reservoir host is the habitat in which the organism replicates normally and does not necessarily complete its life cycle.

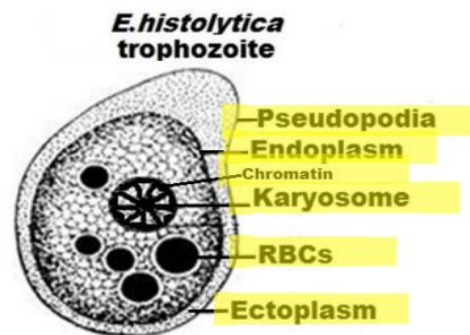
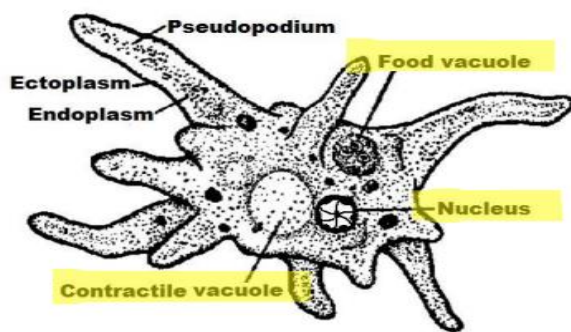
**Disease: Amoebiasis or amoebic dysentery**

-dysentery: contain mucus, RBCs and WBCs.

**Morphological characters:**

**1- trophozoite stage:**

this is the actively, feeding, motile form



Some points about these figures:

-this trophozoite form has finger-like projections called pseudopodia (for locomotion)

- Endoplasm (the inner plasmatic membrane) is usually granular containing the nucleus and karyosome

- Karyosome is a fine chromatin granule.

- Ingested RBCs are used to differentiate between Entamoeba Histolytica and nonpathogenic entamoeba (commensal) that can reside in the large bowel. It is a pathognomonic feature of the entamoeba histolytica.

**- Cyst stage (Luminal form):**

-it is also named quiescent stage or resistant stage

-It is usually found outside the body to resist Environmental changes and temp.

### (a) Immature cyst (Uninucleate cyst and Binucleate cyst):

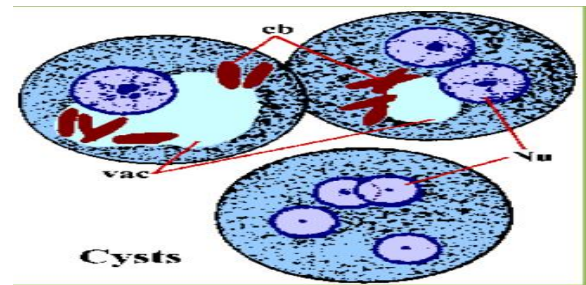
### b) Mature cyst (Quadrinucleate cyst):

- the infectious and mature form so if anyone eat contaminated with uninucleated or binucleated they will not complete their life cycle inside the body

- they are spherical in shape.

-the route of transmission is feco-oral

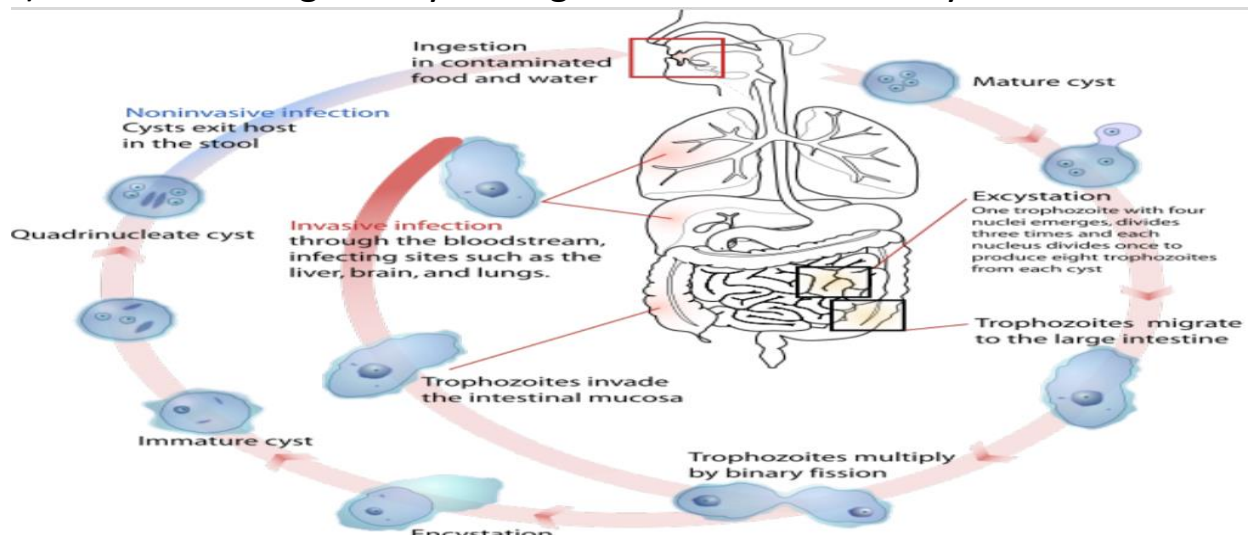
- the infective stage: mature cyst (Quadrinucleate cyst)



-the diagnostic stage: trophozoite or cyst regardless of any type, and trophozoites can be seen in the acute diarrhea, other than that cysts are mainly seen in the formed stool.

Now how does the infection take place?

- 1) Ingestion of quadrinucleated cysts through contaminated water or food
- 2) They pass the stomach and reach the small bowel where the excystation takes place.
  - Excystation is a process in which the cyst gets converted into trophozoite, while encystation is a process in which cyst get formed.
- 3) In the small bowel, during excystation, each cyst would divide to give off 8 trophozoites (quadrinucleated), and since they are motile, they reach the large intestines and either:
  - 1-some of them invade the mucosa and submucosa and hematogenously disseminate through the blood circulation to the lungs, liver or brain.
  - 2)some of them remain in the lumen without establishing the infection (asymptomatic carriers)
  - 3) some of them get encysted again and leave the body



- Quadrinucleate cyst is the infective stage in almost all cases except in Anal-oral practices in which trophozoites can be transmitted
- Most cases infected with entamoeba histolytica are asymptomatic (80%) And 10% in the form of intestinal amoebiasis and 10% in the form of extraintestinal infection (brain, liver, etc.)

**Mode of infection:**

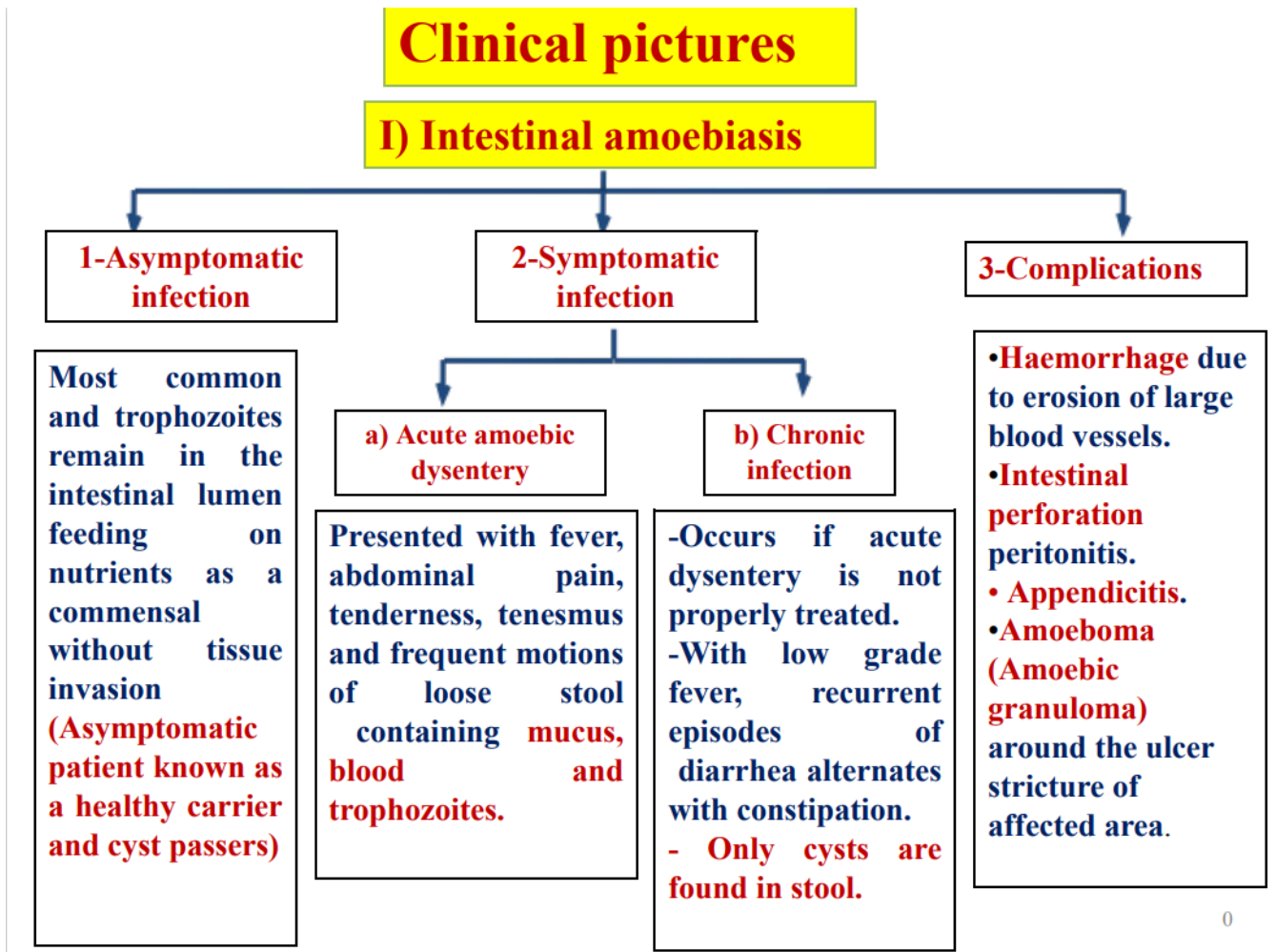
**1 Contaminated water and foods (ex. green vegetables) or drinks or hands with human stool containing mature cyst (most common)**

**2 Handling food by infected food handlers as cooks and waiters**

**3 Flies and cockroaches that carry the cysts from faeces to exposed food (indirect)**

**4- Autoinfection (feco-oral or hand to mouth infection).**

**5-Homosexual transmission**



Some clarifications about the table:

1-our problem is with cyst passers who are asymptomatic if they work as food handlers and they allow the life cycle going on communities (outbreaks)

2-symptomatic infection is the background of intestinal amoebiasis and both of them (acute or chronic) are associated with fever, abdominal pain and typical dysentery (mucus, RBCs, WBCs), and as we said we can see trophozoites in the diarrheal stool in the acute dysentery (diagnostic stage), in chronic infection we have mainly cysts and they have usually alteration in the bowel habit.

3-The presence of trophozoites which possess proteolytic enzymes for invasion and ulceration (flask-shape ulcer) that eventually ends with hemorrhage, and after the ulcer heals it can lead to the development of strictures (narrowing in the lumen)

**The ulcer is flask- shaped with deeply undermined edges containing cytolyzed cells, mucus and trophozoites.**

**The ulcer is flask- shaped with deeply undermined edges containing cytolyzed cells, mucus and trophozoites.**

**Extra-intestinal amoebiasis: Due to invasion of the blood vessels by the trophozoites in the intestinal ulcer to spread to different organs as:**

**1- Liver: Amoebic liver abscess or diffuse amoebic hepatitis. -Affect commonly right lobe either due to spread via portal vein or extension from perforating ulcer in right colonic flexure. -CP: include fever, hepatomegaly and pain in right hypochondrium**

-The spread of *E.histolytica* goes mostly to the liver (right quadrant mainly) either by hematogenous spread or by direct extension from the colonic flexures to the liver.

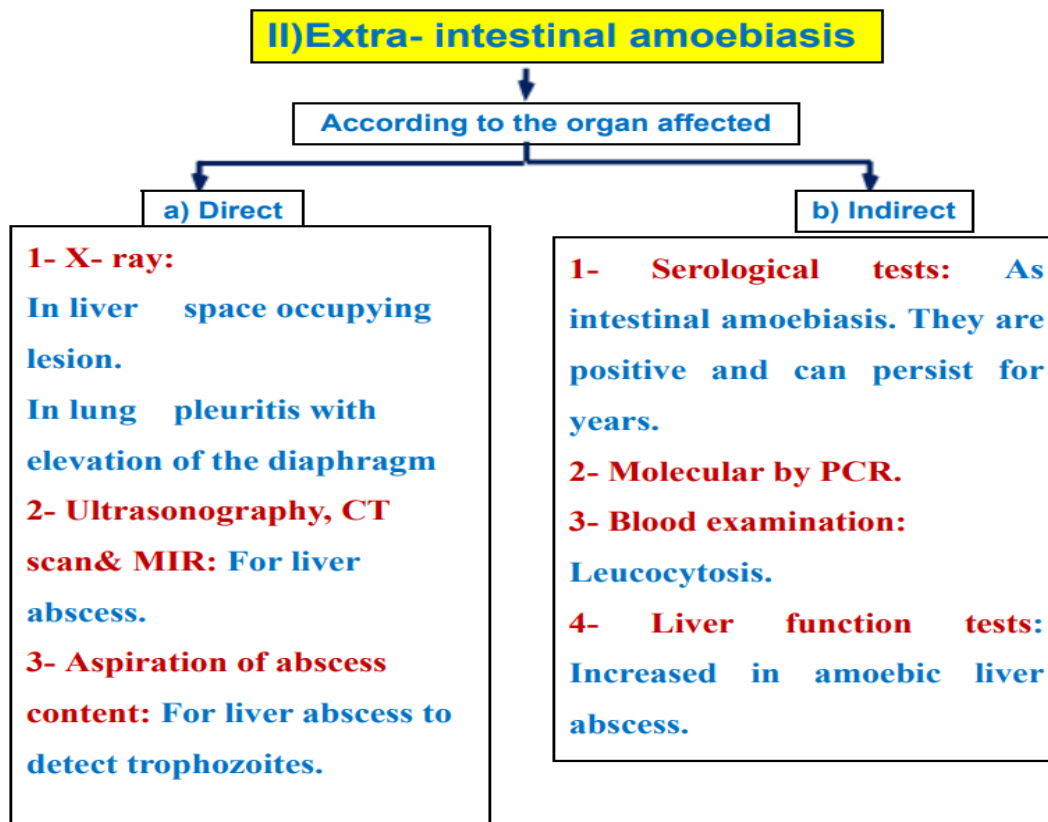
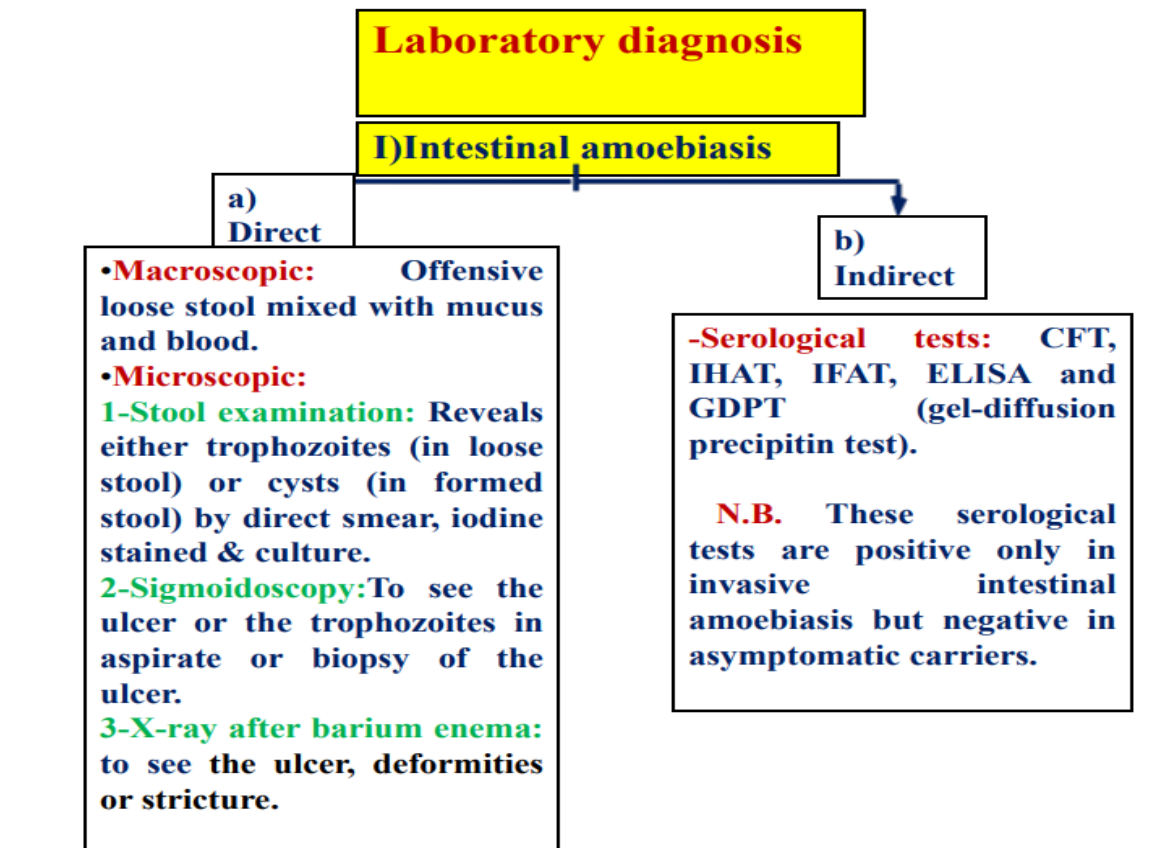
- the abscess formed is filled with trophozoites and when we drain it the fluid is yellow to brown (anchovy-like shape) with consistency, hepatosplenomegaly can develop on those patients.

**2- Lung: Lung abscess, pneumonitis with chest pain, cough, fever, Amoebic lung abscess usually occur in the lower part of the right lung due to direct spread from the liver lesions through the diaphragm or very rarely trophozoites may reach the lung via blood.**

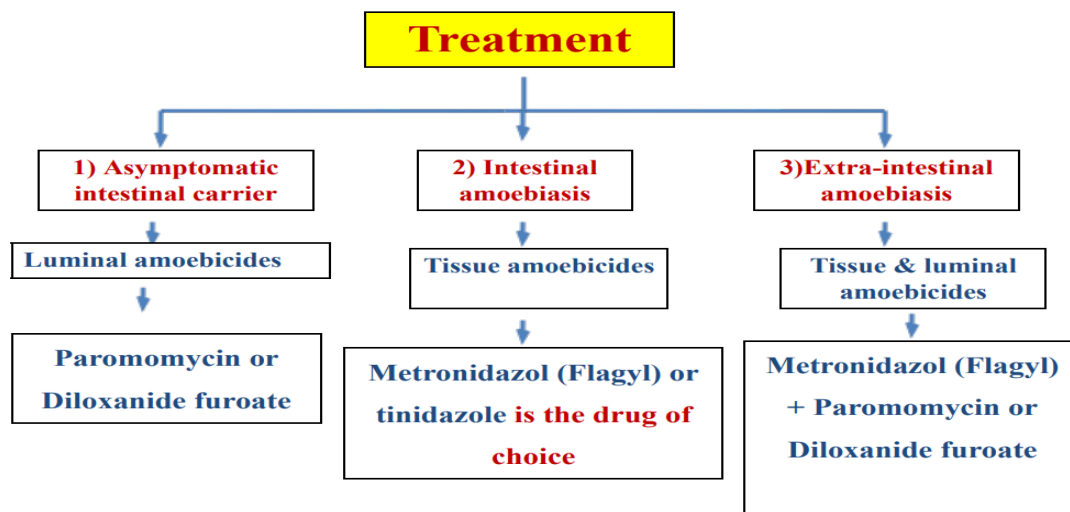
- The lung is the second most common site of extraintestinal invasive disease, especially the lower part of the right lung either hematogenously or by direct extension.
- They can reach also brain and cause brain abscesses and encephalitis and it is fatal.

**Skin: Cutaneous amoebiasis (Amoebiasis cutis)** due to either extension of acute amoebic colitis to the perianal region or through rupture on the abdominal wall from hepatic, colonic or appendicular lesions.

**Diagnosis:**



The doctor didn't mention the indirect methods of extraintestinal amoebiasis.



- Metronidazole (flagyl) is a drug of choice for both intestinal and extra-intestinal amoebiasis and we have a problem with that since 80% of this disease is in asymptomatic form and as you see the flagyl is not their treatment.
- Entamoeba histolytica is not killed by chlorine at concentrations used for water disinfections, so it is killed by boiling at a temperature more than 60°C for more than 5 minutes or iodine tablets can be used for disinfection.

**Prevention:**

- Amoebic infection is prevented by eradicating fecal contamination of food and water
- Water is a prime source of infection and therefore the most contaminated foods are vegetables such as lettuce
- Amoebic cysts are not killed with low doses of chlorine or iodine
- Bringing water to a boil ensures the absence of amoeba.

## **GIARDIA DUODENALIS:**

**Common cause of intestinal infection worldwide**

- it is a common infection in travelers' diarrhea, nurseries.
- it is also associated with poor sanitation and poor hygiene
- Other names: giardia duodenalis or giardia intestinalis
- Their pathogenesis is in the small bowel (unlike E. histolytica), mainly in the upper part of duodenum and jejunum



- Entamoeba histolytica primarily infects and resides in humans, serving as both the principal definitive host and reservoir. In contrast, Giardia can have animal reservoirs (beavers) in addition to infecting humans.

### -Flagellated

**-Both the trophozoite and the cyst are included in the life cycle**

**- found most commonly in the crypts in the duodenum**

**- Trophozoites are attached to the epithelium of the host villi by means of the ventral disk.**

**- Cyst formation takes place as the organisms move down through the jejunum after exposure to biliary secretions**

- The trophozoite of G lamblia is a heart-shaped organism, has four pairs of flagella, 2 nuclei with prominent central, prominent central karyosome, and 2 axostyles.

- they are motile since they have 4 pairs of flagella and their motility is called "falling leaf motion."

- It looks like a person who has hair and chin whiskers and he is wearing glasses

They have also median bodies (Para ventral discs) they use it for their attachment to the small bowel.

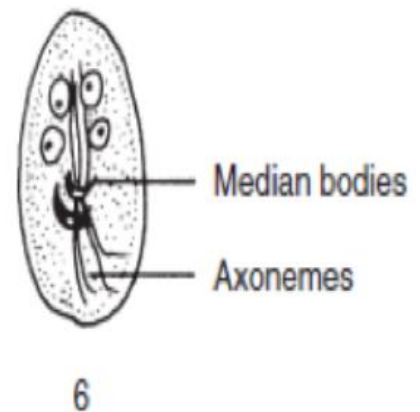
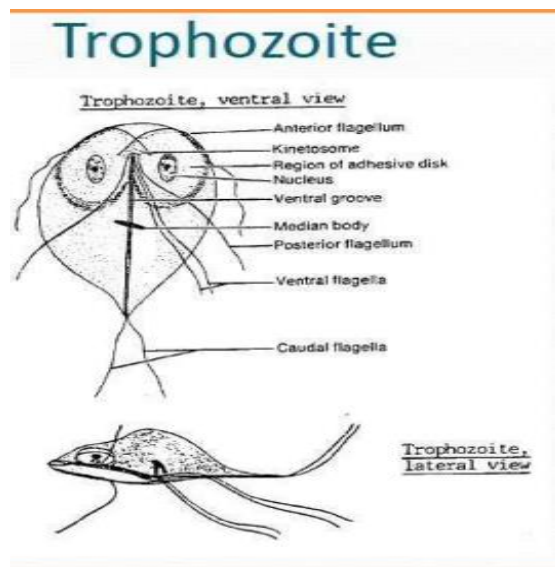
- In cyst form of giardia, you will not see RBCs like entamoeba also, the shape and the intracellular compartments are different so they are easily distinguishable.

### Epidemiology

**• Transmission of G. lamblia occurs by ingestion of viable cysts by fecal oral route**

- Both Giardia lamblia and Entamoeba histolytica have similar modes of transmission. In some instances, outbreaks of giardiasis can be associated with homosexual activity.

- **high incidence of giardiasis occurs in patients with immunodeficiency syndromes.**



- **The incubation period ranges from approximately 1-2 weeks and infectious dose is 10**
  - Usually, infected people suffer from malabsorption which lead to steatorrhea since its pathogenesis occurs in the small bowel.
  - Most common presentation is watery diarrhea, NO INVASION, NO fever is recognized.

### **Clinically:**

**Symptomatic: Diarrhea usually watery: profuse watery diarrhea that later becomes greasy foul smelling and may float (steatorrhea)**

- **Abdominal cramps, bloating, malaise, weight loss**
- **Malabsorption and weight loss**
- **Vomiting and tenesmus are not common**
- **Stools may be watery, semisolid, greasy, bulky, foul-smelling.**
- The infective stage is a quadrenucleated cyst (ingestion it through contaminated water, food), then it reaches the small intestine and each cyst gives rise to 2 trophozoites (four nuclei to two! → binary fission) then these trophozoites utilize their attachment to cause the malabsorption syndrome.
- The diagnostic stage is also quadrenucleated cyst and trophozoites
- The majority of patients infected with Giardia lamblia are asymptomatic, although the percentage of asymptomatic cases is lower compared to Entamoeba histolytica.

### **Lab Diagnosis:**

**Routine Methods: - Stool analysis: cysts and sometimes trophozoites**

**Antigen Detection: - Sensitive and specific in detecting G. lamblia in fecal specimens.**

Immunochromatographic assays are commonly used diagnostic tests for giardiasis. These assays detect the presence of specific antigens or antibodies associated with Giardia lamblia

**Treatment: Metronidazole (flagyl) or tinidazole**

Tinidazole: single dose injection

Metronidazole (flagyl) is used to treat infections caused by anaerobic bacteria and microaerophilic bacteria, it has one potential side effect which is disulfiram-like reactions.

## **CRYPTOSPORIDIUM SPP:**

- The disease is called cryptosporidiosis
- They live in crypts of the villi in the small intestine (as their name imply)
- They don't have a locomotion organ so they move by gliding, unlike E.hestolytica (pseudopods) and giardia (flagella)
- They have sexual-asexual parts in their life cycle
- Most commonly affected cases are asymptomatic, they are healthy individuals, watery diarrhea is the common symptom. Intracellular enteric parasites that infect epithelial cells of the stomach, intestine, and biliary ducts.
- Immunocompromised individuals, particularly those with HIV infection, may experience severe and persistent diarrhea that is difficult to manage.

**C. parvum (mammals, including humans) and C. hominis (primarily humans).**

**infections begin with ingestion of viable oocysts, each oocyst releases four sporozoites, which invade the epithelial cells and develop into merozoites then oocyst**

- Oocyst is the infective and diagnostic stage, how it is diagnosed? By modified acid-fast staining (modified: without heating step), they have red color after staining

**Prevalence of fecal oocyst 3-10%**

**Clinically:**

**Copious Diarrhea: These patients may have 3-17 liters of stool per day**

Copious: severe continuous intractable diarrhea

**Abdominal pain and vomiting**

**Diagnosis: oocyst in stool using modified acid-fast stain**

**Treatment: Usually self-limited with Oral or intravenous rehydration**

**Nitazoxanide is used for immunocompromised individuals e.g HIV patients.**

Now let's proceed to helminths (metazoa)

## **HELMINTHS:**

- Helminths are divided into flat worms and round worms, flat worms include two classes trematodes (leaf-like worms, or flukes) and cestodes also called flat ribbon-like worms or tapeworms, while round worms include nematodes (الديدان الأسطوانية)
- They are furtherly divided into nematodes, trematodes and cestodes
- No multiplication happens in helminths. (one egg > will give one larva>> one adult), Unlike protozoa, by which multiplication occurs.

## **ASCARIS LUMBRICOIDES**

- The disease is called ascariis or ascariasis
- Nematodes have separate sexes (male & female) and they have well-developed digestive system

### **Morphology:**

**Male adult worm measures 15-20 cm in length**

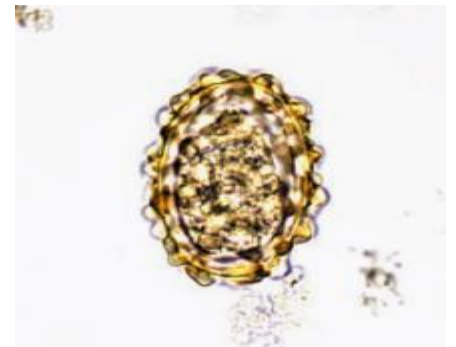
**Female adult worm measures 20-40 cm in length**

**The posterior end of male adult worm is curved while the female adult worm is straight**

**Estimated prevalence more than 1 billion**

Note: in all nematodes that we're going to discuss, the female is longer and bigger than the male.

- the male has a curved posterior end called copulatory spicule (the place where mating with the female occurs)
- in diagnosis we are looking for eggs and the picture above and right is showing u eggs characteristics: brown papillated shell with thick bumps or lumps, and it is surrounded by albuminous coat (essential for surviving)



### **Mode of transmission:**

**Fecal – oral transmission, Reinfection possible.**

**Habitat: small intestine**

**Infective stage: embryonated egg**

**Each female produces 200,000 eggs a day (Whether fertilized or not)**

**Ascaris eggs are capable of survival within harsh environmental conditions, including dry or freezing temperatures**

-ascaris lumbricoides is one of the soil-transmitted helminths which means eggs that excreted with feces are not immediately infectious even with contaminated water or food, to become infective, freshly passed eggs with stool require a period of time in the soil for maturation, during which they develop into larvae. This maturation process occurs over approximately 2-3 weeks.

- the infective stage: embryonated egg after getting matured (2-3 weeks in the soil)

- the diagnostic stage: eggs either fertilized or not. Larva in sputum, adults also can be found in stool.

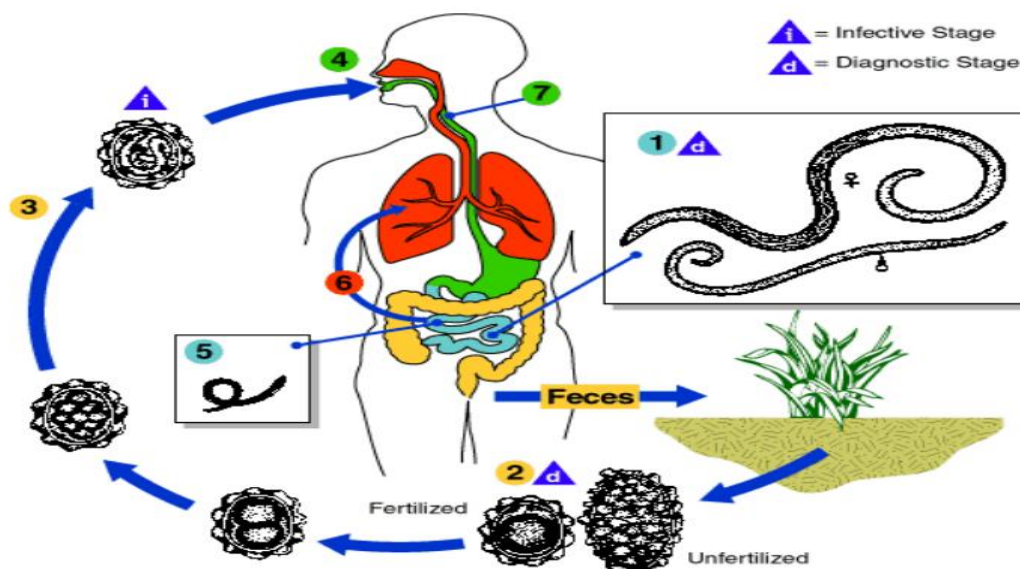
Repeated sampling in the case of sputum sampling since they are not getting out of the lungs in a regular manner.

- when they reach the small intestine hatch releasing the larva, this larva invades the mucosa and submucosa so it has an access to blood or portal circulation then they can reach the lung and gets out with sputum and the person swallow it again to be seeding again in the small intestine they become almost adults.

- this reflection is an important point which we can use the sputum as a diagnostic stage (u will see larva)

- there is a syndrome occurs as a result of passing the larva through the lungs and bronchi which called Loffler's syndrome

- most cases of ascaris are asymptomatic and that depends on the burden of the disease.



## **Pathogenesis and spectrum of disease:**

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

## **Symptomatic:**

**Pulmonary symptoms during migration (Loeffler's syndrome which is respiratory symptoms, infiltrates and eosinophilia)**

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

## **Lab diagnosis:**

**Eosinophilia**

**Microscopic examination (looking for eggs)**

**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**

**THERAPY: oral Albendazole 400MG STAT**

## **ENTEROBIUS VERMICULARIS (PINWORM):**

- one of the common infections in the children population.
- Disease is called Enterobiasis.

**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)**

- external auto infection (finger to mouth infection)

- 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

- a female parasite can lay thousands of eggs per day, some of these eggs get fertilized in the presence of male and then may migrate to the perianal region, where they are deposited, while in certain cases, the female parasite herself can travel backward, leading to a retrograde infection.

- most common complain perianal pruritus (itching)

- The diagnostic: The eggs found at the perianal region.

- The infective stage: The embryonated eggs

They are immediately infectious and highly contagious.

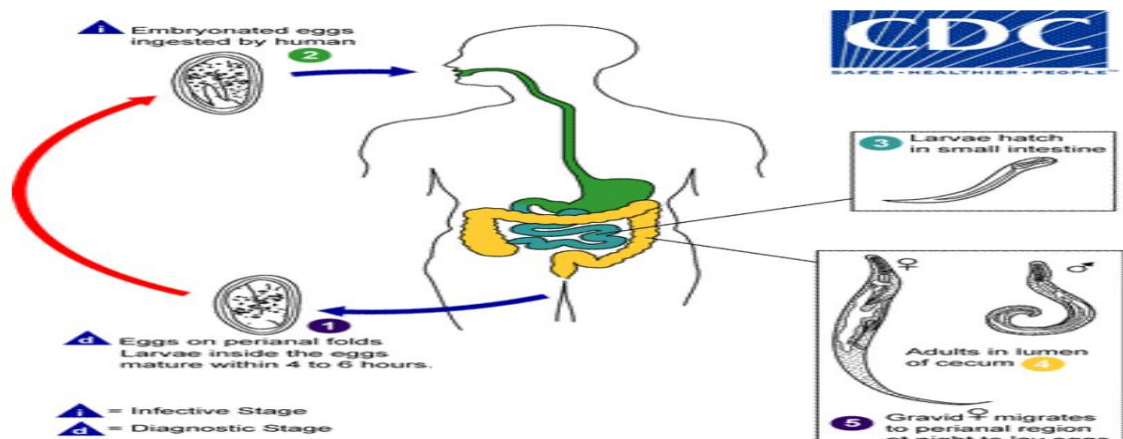
- **Sexual transmission has been reported**

- **direct; transmission occurs from an infected host to another**

- **Infections are associated with institutional crowding and families**

## Life cycle

- **The female migrates at night to the perianal area where they deposit eggs.**



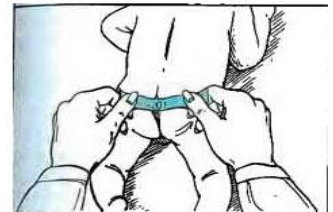
- **Eggs embryonate within hours and transferred from them by above mentioned routes.**

-Gravid (adult females) migrate nocturnally (at night) outside the anus and oviposit (lay eggs) on the skin of the perianal area. Eggs are immediately infectious because they embryonate within hours. No pulmonary route.

### **Clinically:**

- ❑ **Infections with *E. vermicularis* are typically asymptomatic**
- ❑ **The most common complaint is perianal pruritus (itching at night) --> this is *E.vermicularis* until proven otherwise**
- ❑ **the parasite may migrate to other nearby tissues, causing appendicitis, oophoritis, ulcerative bowel lesions.**
- **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**

Scotch tape is put in the perianal region then put it in the slide and then under the microscope you will see eggs Football in shape, flattened on the side, the larvae can be seen.



- **Treatment: albendazole 400 mg stat repeated at 2w**

## **HYDATID CYSTS (ECHINOCOCCUS GRANULOSUS):**

- Also called Dog tapeworm, three segmented tapeworms
- **Echinococcus is the smallest of all tapeworms (3 to 9 mm long)**
- ***E. granulosus* is a tapeworm found in the small intestine of the definitive host, the canine.**

the human can be intermediate host or apparent host (accidentally).

- How can you get the infection? By Eating contaminated food (with the feces of the definitive host containing the eggs of *Echinococcus granulosus*).
- Eggs are ingested then reach the small intestine and hatch there producing larva that invade and reach lungs forming cyst in the lung.
- They mainly form cysts in the liver and lungs





➤ Eggs are ingested by the intermediate hosts and include a variety of mammals including sheep, cattle and humans.

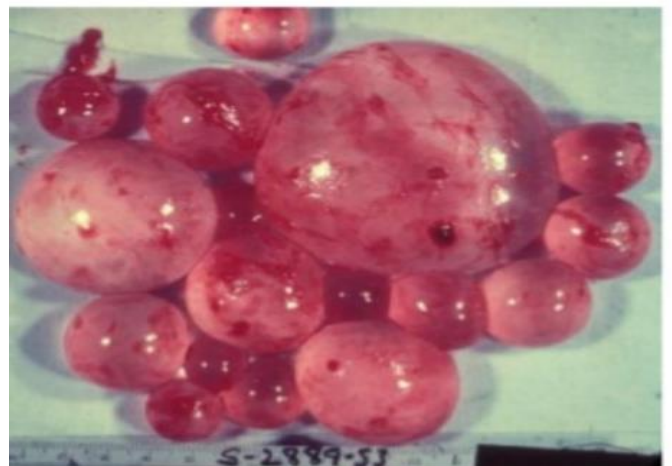
➤ Humans are typically accidental hosts and are considered a deadend since the life cycle of the organism is unable to continue in a human host leading to hydatid cysts

### **Hydatid cysts (*Echinococcus granulosus*):**

"cyst" is used to describe the protective structure formed by certain parasites during specific stages of their life cycle and it is fluid cyst which is very immunogenic so the treatment of choice is surgery.

- Surgeons are afraid of these cysts because they have Protocystic and if there is a leakage from it the patient will suffer from anaphylactic shock

- **Hydatid disease 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**



**SCHISTOSOMIASIS** 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).**

1+2 found in blood vessels (blood trematodes), *mansoni* found in the superior mesenteric vein and *japonicum* found in superior and inferior mesenteric veins

**3. *Schistosoma haematobium* discovered by Theodor Bilharz in Cairo in 1861 (mainly UTS).**

It inhabits in the venous plexus of urinary bladder

The primary source of pathology in schistosomiasis is attributed to the eggs produced by the schistosome parasites rather than the adult worms themselves. The female schistosomes lay eggs within the small veins of the portal system. The presence of these eggs triggers a granulomatous reaction and fibrosis in the portal venous system and surrounding tissues. Consequently, this can result in complications such as portal hypertension, esophageal varices, hepatosplenomegaly (HSM), and liver failure.

**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.**

### LIFE CYCLE

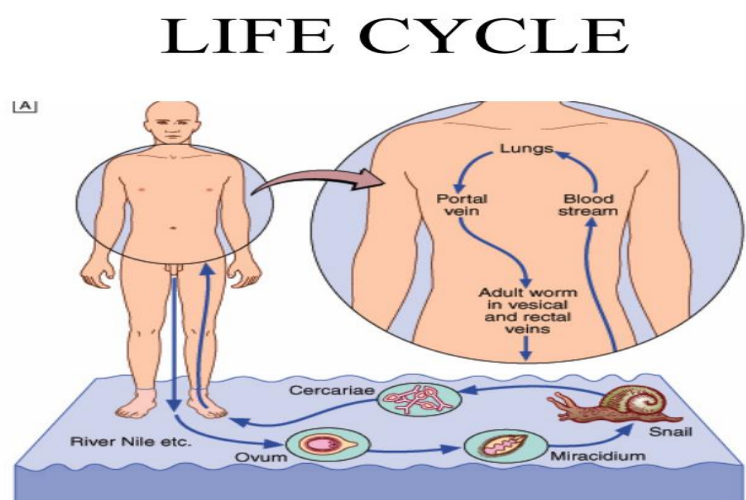
• **The ovum is passed in the faeces of infected individuals and gains access to fresh water where the ciliated miracidium inside it is liberated; it enters its intermediate host, a species of freshwater snail, in which it multiplies.**

- Route of infection: penetration
- Simply: eggs pass to fresh water, hatch and release a ciliated snail seeking the 1st larval form which is called (meracedium) then swims to find its snail host (the snail hist is the 1<sup>st</sup> intermediate host) and develops to the final larval stage –cercariae
- Infective stage: cercariae or metacercariae
- After the first intermediate host, it is called cercariae, and after the second intermediate host, it is referred to as metacercariae.

• **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**

Katayama fever is an acute systemic hypersensitivity reaction that can occur during the early phase of schistosome infection and it occurs in response to migrating larva in the body.



## 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
- it's not a hermaphrodite, it has female and male (one of the exceptions) and the female lives inside the male in gynacophoric canal.



## Pathogenesis and manifestations

- Transmission: 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, ascites.

## DIAGNOSIS:

### 1. CLINICAL

### 2. HEMATOLOGICAL, BIOCHEMICAL

### 3. CONFIRMED BY Detection of ova in STOOL or tissue biopsy

Treatment --> mebendazole, albendazole, ivermectin or Praziquantel 40mg /kg for all types and as a single dose is treatment of choice

We are looking for egg's characteristics: haematobium: terminal spine, japonicum: curved rudimentary spine, for mansoni: lateral spine.

V1: we add anchovy-like shape in the topic related to amoebiasis.