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Microbiology

Doctor 2017 | Medicine | JU

◉ Sheet ○ Slides

Done By

Tala Saleh

Contributed in the Scientific Correction

Shehab

Contributed in the Grammatical Correction

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Doctor

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Introduction to Parasitology

Important Terminologies: *"do not overlook them"*

- **Medical Parasitology**: It is the science which deals with the parasites that infect man.
- **Parasite**: Is an organism, which lives on or within another organism (host) for survival.
- **Host**: Is a living organism that harbours the parasite.

Parasitic kingdom includes three phyla: Protozoa, Helminths and Arthropods.

A- Protozoa (discussed in this sheet)

It is a phylum of the animal kingdom consisting of **unicellular** parasites, divided into 4 classes according to the **organ of locomotion** and their reproduction:

1- **Class Sarcodina** *(Rhizopoda):* Parasites that move by means of **pseudopodia**.

Example: Entamoeba histolytica.

2- **Class Mastigophore** *(Zoomastigophora):* Parasites that move by means of **flagella**.

Example: Giardia Lamblia.

3- **Class Ciliates** *(Ciliata):* parasites that move by means of **cilia**

Example: Balantidium coli

4- **Class Sporozoa**: Parasites have both **sexual** and **asexual** reproductive organs; all these parasites are **intracellular**, and they have **no** organ of locomotion. They move by **gliding**.

Example: Plasmodium parasites causing malaria and Coccidia.

Notes:
1- ***Pseudopodia (False foot):*** *They are cytoplasmic projections.*
2- ***Cilia:*** *They are short, usually many, hair-like cytoplasmic projections.*
3- ***Flagella:*** *They are usually singular in parasites, they rotate in a motion similar to that of a propeller.*

B- Helminths

They are **metazoan** *(Multicellular parasite)* **wormlike** parasite, divided into 3 classes:

1- **Class Nematoda (Roundworms):**

a- Intestinal nematodes, e.g. Ascaris lumbricoides.
b- Tissue nematodes, e.g. Wuchereriabancrofti.

2- Class Cestoda (Tapeworms):

They are **flattened and segmente**d worms,
e.g. Taenia saginata.

3- Class Trematoda (Flukes):

They are **flattened leaf-shaped** worms,
e.g. Schistosoma haematobium.
Also, they are hermaphrodites; having **both** male and female organs.

C- Arthropods

These parasites having exoskeleton and jointed legs and it is a mechanical vector, divided into 2 classes:

1- **Class Insecta:** e.g. Mosquitoes, lice and fleas.
2- **Class Arachnida**: e.g. Ticks and mites.

Types of Parasites

Ectoparasite	A parasite that lives **on the surface** (skin) of the host (infestation). *Example:* *Lice (القمل)*
Endoparasite	A parasite that lives **inside the body** of its host (infection). *Example:* *Entamoeba Histolytica*
Obligatory parasite	A parasite that is **completely dependent** upon a host for its survive to complete their life cycle.
Facultative parasite	A parasite that is capable of living both **freely(complete its life cycle without infecting the host)** and as a **parasite**.
Permanent parasite	A parasite that spends **all** stages of its **life cycle** on or in the **body** of its host. No free living
Temporary or Intermittent parasite	A parasite that **visits** its host only for a **short** period of time for its meal.
Opportunistic parasite	A parasite that causes disease only in **immunodeficient patients** (AIDS, cancer patients), while in immunocompetent individuals, the parasite may exist in a **latent** form producing **no** or **mild symptoms**.
Coprozoic or Spurious parasite	An organism that passes through the **human intestine** without causing any disease and is detected in the **stool** after ingestion.

Types of Hosts

(*usually a parasite encounter more than one host during its life cycle*)

1- **Definitive host (D.H):** It is the host which harbors the **mature adult stage** of the parasite or in which **sexual** reproduction of the parasite takes place.

Example: man, in case of Taenia.

2- **Reservoir host (R.H):** The host which harbors the **parasite** and considered the source of **human infection** as Dog in case of kala – azar which is caused by the parasite (Leishmaniadonovani). It acts also as a **source** of infection to man and maintains the parasite in nature.

3- **Intermediate host (I.H):** It is the host which harbors **larval stage** (immature or non-sexually reproducing forms of the parasites).

Example: Snail in case of Bilharzia.

4- **Accidental host:** The host which harbours the parasite which is **not normally** found in.

Example: The Toxo cara in man, where its normal hosts are dogs (dog nematode).

- **The relationship between the organism and its host occurs in the following forms:**

1- **Commensalism التعايش :** It is a relationship between two living organisms where **one** gets **benefit** (commensal), while the **other** (host) is **not harmed** nor benefited.
e.g. Entamoeba coli.

2- **Parasitism التطفل :** It is a relationship between two living organisms where **one** gets **benefit** (parasite), while the **other** (host) is **harmed**.

3- **Mutualism التقايض :** It is a beneficial relationship between two living organisms where **both drive a benefit** and can successfully live apart.

4- **Symbiosis التكافل :** It is a close and **long term** beneficial relationship between two living organisms where both drive a **benefit** and **cannot** live apart. It can be **any** of the other forms of relationships. Simply, it describes how two organisms live together regardless of the type of relationship.

Modes of transmission of parasitic infection

1- **Direct contact (physical contact)** through the skin, e.g. Pinworms.
2- **Penetration** of the skin, e.g. Hookworms.
3- **Ingestion** of contaminated food or drinking water containing the infective stage of the parasite.
4- **Inhalation** of dust carrying the infective stage of parasite.
5- **Congenital** from mother to fetus (transplacental) or may by trans-mammary (mother`s milk).
6- **Sexual contact**, e.g. Trichomonas vaginalis.
7- **Autoinfection** (either external or internal).
8- **Vectors** *(mechanical / biological)*, through bite or feces of infected vector or by swallowing the vector.
9- **Blood transfusion** or through contaminated syringes, e.g. Malaria.
10- **Organ transplantation**.

Terms used in Parasitology

- **Habitat**: The natural site where the parasite **lives**.
- **Carrier**: A **host** in a state of equilibrium with parasite without or with minimal symptoms of the disease, but the host is **infective** to others. There is no fatal symptoms.
- **Zoonosis**: Transmission of an infection from **animal** *(R.H)* **to man** either directly or indirectly via intermediate host e.g. viruses transmitted by arthropod vectors (arbovirus).
- **Infective stage (I.S):** The stage by which the **infection takes place**.
- **Diagnostic stage (D.S):** The stage by which we **can diagnose** the parasitic infection after it leaves the host.
- **Endemicity**: Steady or relativity **moderate level** of parasitic infection among a **population** *(in a specific region)* that has a certain degree of **resistance** and the parasite is **common** and well known to them.
- **Epidemicity**: Raging **outbreak** of a parasitic disease from a **new** parasite **not common** to the population who has **little** resistance.

Pathogenesis of parasitic infections

(how they cause disease)

- Parasitic infections are highly variable, affected by many factors and according to these factors they are classified into the following:

1- **Mechanical (depend on size)**: The parasite may **obstruct** normal passage like intestine or bile tract.

2- **Traumatic (size)**:
   - **a- External** due to invasion of the skin.
   - **b- Internal** by attachment to intestinal mucosa by buccal capsule producing ulcers.

3- **Toxin production (depend on their ability to produce toxins and the** Circulation of parasitic products; toxins and waste products)

4- **Tissue damage and necrosis (depend on their habitant)**: Due to enzymes secreted by parasites.

5- **Direct Cellular destruction**: As RBCs or RES damage.

6- **Immune stimulation**: Parasitic antigens produce **humoral** /or **cellular** immune response.
   → Cellular proliferation and infiltration.
   → Formation of fibrous encapsulation around parasites.

   Example: *hepatic granuloma in Schistosoma Ansonia.*

7- **Allergic reaction** (horst reaction), due to insect **bites** or parasitic **toxins**.

- The pathogenesis of the parasite depends on the **number**, **size** and **morphology** of the parasite, its **activity** (movement and migration), **site** (habitat), **specific toxin** and **host reaction**.

Diagnosis of parasitic infection

A- Clinical diagnosis:

Depends on the characteristic **signs** and **symptoms** related to the parasitic infection.

B- Laboratory diagnosis: the most important

Direct methods are used to detect the **diagnostic stage**, such as **microscopical** examination of the tested samples.

Samples can be:

1- Stool

- Must collected in **clean**, **dry**, **tight** fitting lid containers.
- **Macroscopic examination (firstly)**: for consistency, composition, color and presence of adult parasites such as Enterobius vermicularis, Taenia-segments & Ascaris-worm.
- **Microscopic examinations**:
  - **a- Direct saline smear or iodine smear:** when helminthic eggs & protozoa cyst are in **large** numbers.
  - **b- Concentration techniques**: if the parasites are **scanty**; meaning that they are small or insufficient in quantity or amount.
  - **c- Permanent stained smear**: for **correct identification** of most protozoa.

2- Urine

- The urine sample is examined **macro** & **microscopically**.
- Certain parasites can be **detected** in **urine** as Schist-soma-haematobium eggs, Trichomonas vaginalis trophozoites & eggs of Enterobius vermicularis.

3- Blood Examination

- **Thin blood film**: to demonstrate the **morphological** features of the parasites (used mainly to identify which species is causing the disease).
- **Thick blood film**: to obtain **large** amount of blood which **increase** possibility of detecting **light infection**. USED to detect the presence of parasite.

  Parasites detected in the blood are: Malaria, Leishmania, Filaria & Trypanosomes.

4- Tissue Biopsy

- Tissue biopsy specimens are recommended for diagnosis of a number of parasitic infections for example:
  - **a- Muscle biopsy**: In Trichinella spiralis.
  - **b- Rectal biopsy**: In detecting Schistsomaova.

5- Sputum (لعاب) Examination

- Sputum is examined to detect parasites either:
  - **a- living** in the **lung.**
  - **b- migrating** through the **lung**.
  - **c-** parasites resulting from **rupture** of **cysts** in the **lung**.

- **Parasites detected in the sputum are:** Eggs of Paragonimus, trophozoites of E. Histolytica, parts of ruptured hydatid cyst & migrating larvae of Ascaris, Ancylostoma & Strongyloides.

6- Aspirate Examination

- **Cerebrospinal fluid** may be used for detection of certain parasites of **CNS**, such as Trypanosoma spp & Naegleria.
- **Duodenal aspirates (Enterotest):** for examination of **duodenal contents**.

  Parasites which can be present as Giardialamblia, Strongyloideslarva & Cryptosporidiumparvum.

> ***Notes:*** *Aspirates, is a medical procedure that* ***removes*** *something from an area of the* ***body****. These substances can be air, body fluids, or bone fragments.*

Protozoa

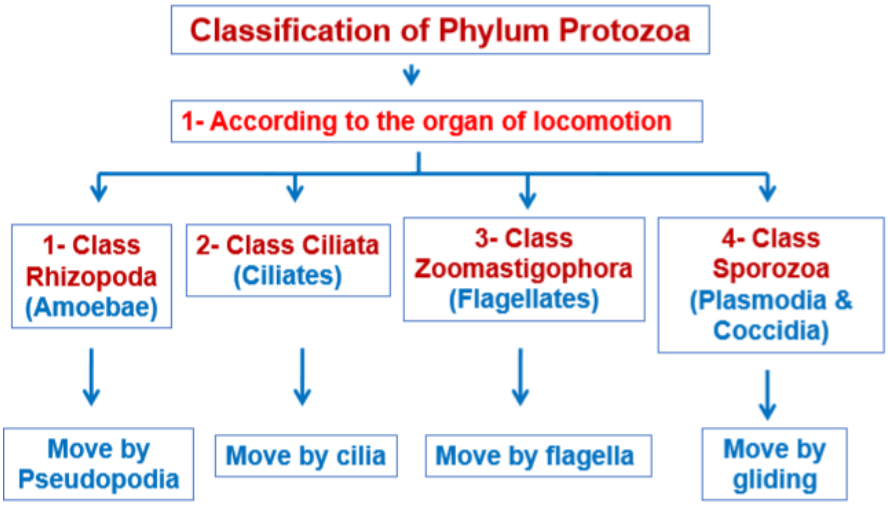
Important Terminologies:

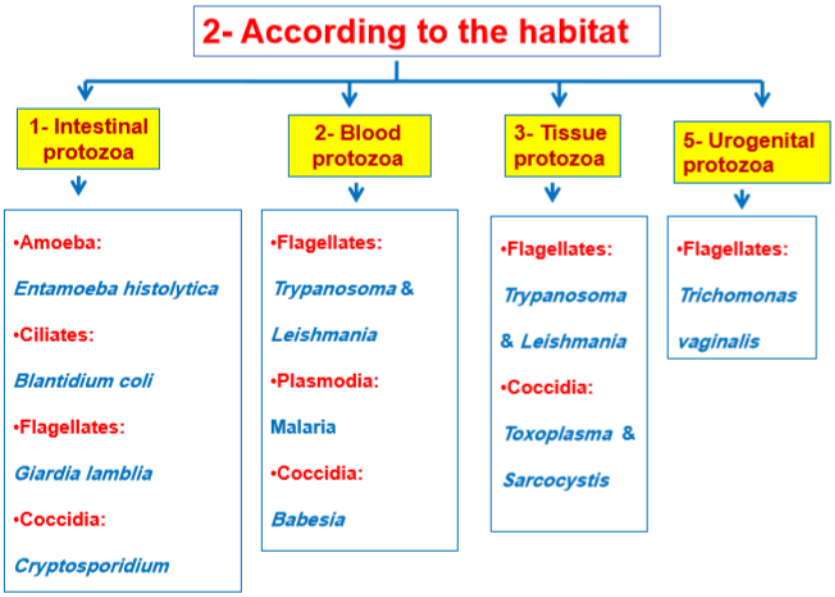
- **Medical Protozoology**: It is the study of protozoa of **medical importance**.
- **Protozoa**: are microscopic **unicellular** organisms. They perform all physiological functions of life.

Classification of Protozoa can be according to:

1- **Organ of locomotion** (as discussed before in page 1)

2- **Habitat**

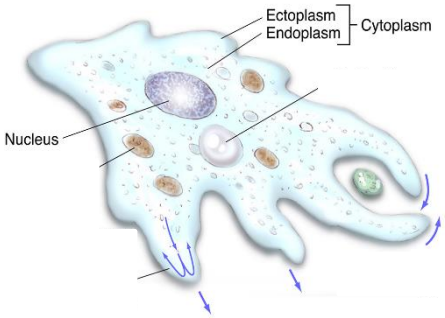




Morphology of Protozoa

Protozoa are made of **protoplasm** that differentiated into:

1- **Nucleoplasm**; inside the nucleus.
2- **Cytoplasm**; around the nucleus, which consists of:
   a- **Ectoplasm**: Outer thin hyaline.
   b- **Endoplasm**: Inner granular. (for food storage)



We will now discuss one class of the protozoa phyla, Class Sarcodina (Rhizopoda). Recall that the organ of locomotion was by the means of pseudopodia and one example of this class is Amoeba.

Amoeba, Class Rhizopoda

Amoeba can be of:

1- **Large Intestine**

Example: Entamoeba Histolytica (The only pathogenic, it causes diarrhea and amoebic dysentery. It can cause extraintesinal diseases that are life threating) and Entamoeba Coli (it is important because it can be confused with histolytica.

> ***Notes:*** *Other species of amoeba are **commensals** in the **large intestine**, such as **E. Hartmani** & **E. Dispar**. Both are morphologically **similar** to **E. histolytica**. Therefore, **PCR** is required to differentiate between those amoeba species.*

2- **Buccal cavity**

Example: Entamoeba Gingivalis

3- **Free living**

Pathogenic: Naegleria Fowleri & Ancanthamoeba

Non-pathogenic: Coprozoic Amoeba

Entamoeba Histolytica

- **Geographical distribution**: Worldwide especially in the **temperate zone** and more common in areas with **poor sanitary conditions**.
- **Habitat**: **Large intestine** (caecum, colonic flexures and sigmoid-rectal region).
- **Definitive Host**: Man
- **Reservoir Host**: Dogs, pigs, rats and monkeys.
- **Disease**: Amoebiasis or amoebic dysentery

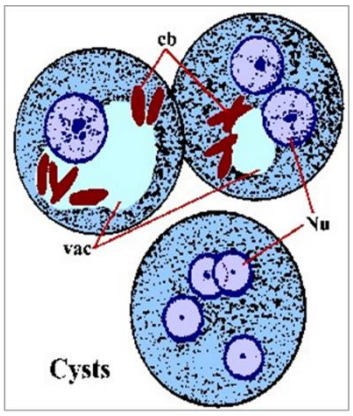
Morphological characters of E. Histolytica:

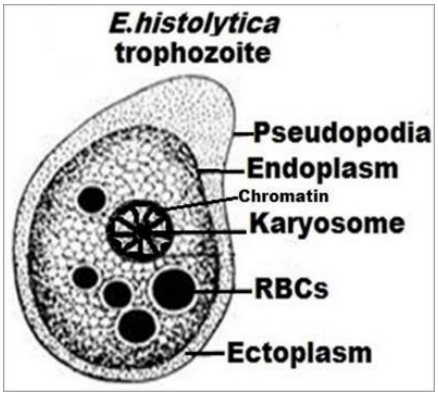
1- **Trophozoite Form** (Vegetative form / tissue form). It cannot live outside the host. RBCs indicate infection stage.

2- **Cyst Form** (Luminal form), small and circular

   a- **Immature cyst,** which can be either **Uninucleate** cyst with **one** nucleus, or **Binucleate** cyst with **2** nuclei.

   b- **Mature cyst** (Quadri-nucleate cyst)





Mode of infection:

1- **Contaminated foods** (ex. green vegetables) or drinks or hands with human stool containing mature **cysts.**

2- **Handling food** through infected food handlers as cookers and waiters.

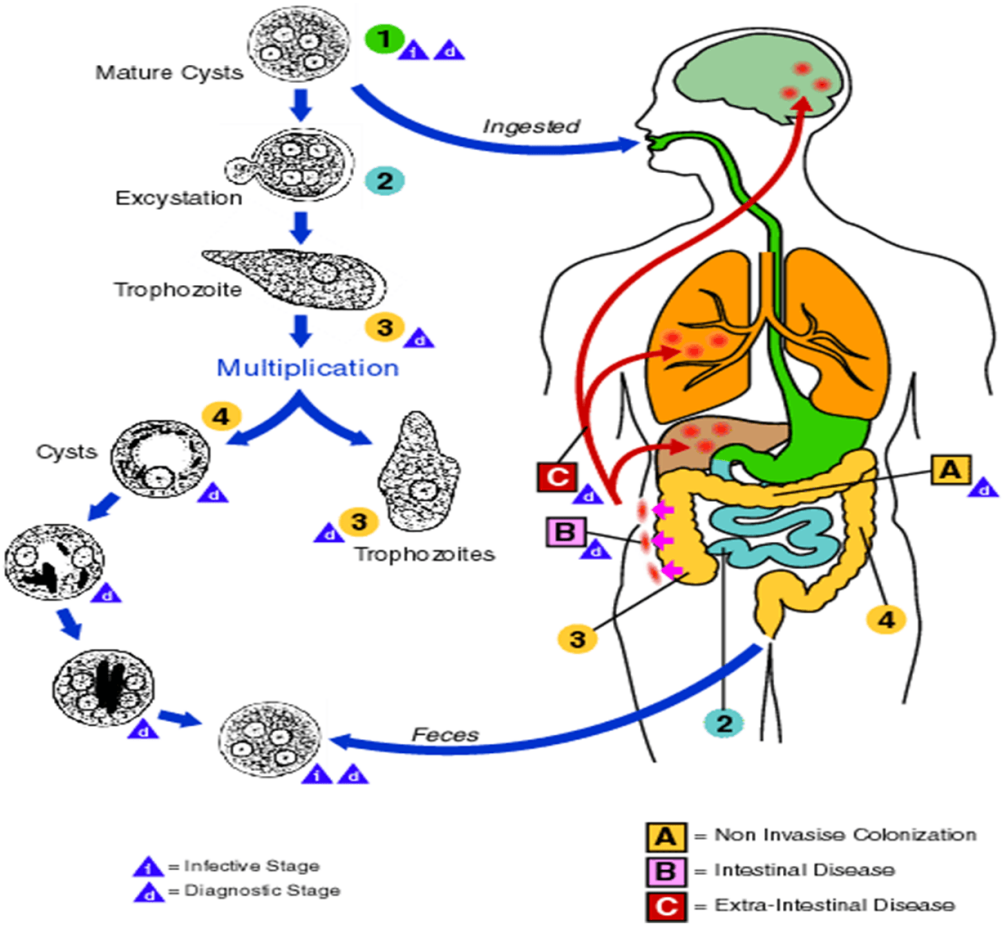
3- **Flies and cockroaches** that carry the **cysts** from faeces to exposed food.

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

5- **Homosexual transmission**.

The Life Cycle of E. Histolytica

1- Ingestion of the **cyst** (the infectious form).
2- A process known as **excystation** takes place to produce **Trophocytes**.
3- The Trophocytes **multiplicate** to produce **4 cysts.**
4- Cysts go to the **site of infection**



For better explanation, I highly recommend reading this just in case:

https://www.pharmacology2000.com/Chemotherapy/Antiparasitic/Amebiasis_Life_Cycle1.htm

I hope you bear with me through this part :(

Clinical Pictures of Intestinal Amoebiasis			
Asymptomatic infection	**Symptomatic infection**		**Complications**
	Acute amoebic dysentery	**Chronic infection**	
- Most common. - **Trophozoites** remain in the **intestinal lumen** feeding on nutrients as a **commensal** without tissue invasion. - **Asymptomatic** patients known as a **healthy carrier** and a cyst passer.	- Presented with fever, abdominal pain, tenderness, tenesmus *(difficult defecation)* and frequent motions of loose stool containing: mucus, blood and trophozoites.	- Occurs if acute dysentery is **not** properly treated. - With **low** grade fever, recurrent episodes of diarrhea alternating with constipations. - **Only cysts** found in stool (unlike acute).	- Hemorrhage due to **erosion** of large blood vessels. - Intestinal perforation → Peritonitis. - Appendicitis. - Amoebic granuloma (Amoeboma) around ulcers. → Stricture of affected area.
With heavy infections and lower host immunity: - The trophozoites of E. Histolytica **invade** the **mucosa** and **submucosa** of the **large intestine** by secreting **lytic enzymes** → Amoebic ulcers. - The ulcer is flask-shaped with deeply undermined edges containing **cytolyzed cells**, **mucus** and **trophozoites**. - The **most common** sites of amoebic ulcers are: Caecum, colonic flexures and sigmoid-rectal regions due to **decreased** peristalsis and **slow** chronic **flow** at these sites that help in invasion.			

Laboratory Diagnosis of Intestinal Amoebiasis	
Direct	**Indirect**
- **Macroscopic**: Offensive **loose stool** mixed with **mucus** and **blood**. - **Microscopic**: 1. **Stool examination**: Reveals either **trophozoites** (in loose stool) or **cysts** (in formed stool) by direct smear, iodine stained and culture. 2. **Sigmoidoscopy:** To see the ulcer or the trophozoites in **aspirate** or **biopsy** of ulcer. 3. **X-ray after barium enema**: To see the ulcer, deformities or strictures.	- **Serological Tests:** CFT, IHAT, IFAT, ELISA and GDPT (gel-diffusion precipitin test). - These serological tests are **positive** only in **invasive** intestinal amoebiasis, and **negative** in **asymptomatic** carriers.

Clinical Pictures of Extra-Intestinal Amoebiasis	
Due to the invasion of the blood vessels by the trophozoites in the intestinal ulcer, they reach the blood to reach different organs, such as:	
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. - Clinical Pictures: include fever, hepatomegaly and pain in right hypochondrium.
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**.
Brain	- Brain abscess → Encephalitis (fatal acute inflammation of the brain).
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.

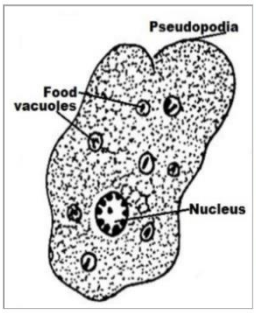
Laboratory Diagnosis of Extra-Intestinal Amoebiasis	
According to the organ affected:	
Direct	**Indirect**
1- X- ray: **In liver** → Space occupying lesion. **In lung** → Pleuritis with elevation of the diaphragm. **2- Ultrasonography, CT scan & MIR:** For liver abscess. **3- Aspiration of abscess content:** For liver abscess to detect trophozoites.	**1- Serological tests:** As intestinal amoebiasis. They are **positive** and can persist for years. **2- Molecular by PCR.** **3- Blood examination:** Leukocytosis. **4- Liver function tests:** Increased in **amoebic liver** abscess.

Treatment of:		
Asymptomatic intestinal carrier	With Luminal amoebicides	**e.g.** Paromomycin or Diloxanide furoate.
Intestinal Amoebiasis	With Tissue & luminal amoebicides	**e.g.** Metronidazol (Flagyl) is the drug of choice + Paromomycin or Diloxanide furoate.
Extra-Intestinal Amoebiasis	With Tissue & luminal amoebicides	**e.g.** Metronidazol (Flagyl) + Paromomycin or Diloxanide furoate.

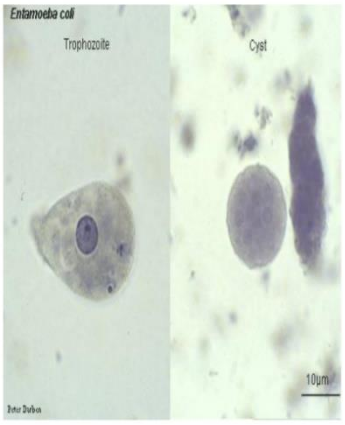
Recall: Large intestine amoebae are E. Histolytica (which was discussed in the previous pages) and E. Coli.

Entamoeba coli

- It is a **parasite** of the **large intestine**.
- Its life cycle is **similar** to that of **E. histolytica**.
- It is of medical importance **only** because it may be **mistaken for E. histolytica**.
- It has **two stages** (trophozoite & cyst). The important morphological features are:



E. Coli trophozoite



E. Coli cyst

Notes: *E. Histolytica is **smaller** than E. Coli and it can contain **1-4 nuclei**, while E. Coli can contain up to **8 nuclei.***

Good Luck 😊