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Doctor 22
فريق طوفان الاقصى



INTRODUCTION TO
PARASITOLOGY

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Week 10



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

This lecture is an introduction, so you'll find many things mentioned without content or explanation; many things will be explained in upcoming lectures as the material progresses.

PARASITOLOGY (علم الطفيليات)

Medical Parasitology: It is the science which deals with the parasites that infect man.

Parasite: Is an organism, which lives on (**ectoparasite** which causes **infestation**) or within (**endoparasite** which causes **infection**) another organism (**host**) for **survival**.

Host: Is a **living** organism that **harbors the parasite**.

Parasitic kingdom includes three phyla

I- Protozoa (الكائنات الأولية) II- Helminths (الديدان) III- Arthropods (نواقل الأمراض)

I- PROTOZOA

Is a phylum of the parasite kingdom consisting of **unicellular** parasites (single cell organisms), divided into **4 classes** according to:

- 1) **Locomotion**
- 2) **The presence of sexual reproduction**

1- Class Sarcodina (also known as Rhizopoda):

Parasites that move by means of **pseudopodia**,

e.g., *Entamoeba histolytica*; which causes **Amebiasis** الزحار الأميبي.

2- Class Mastigophora (also known as Flagellates):

Parasites that move by means of **flagella**,

e.g., *Giardia lamblia*; causes **Giardiasis** (Beaver Fever in Canada) – intestinal disease.

3- Class Ciliates:

Parasites that move by means of **cilia**,

e.g., *Balantidium coli*; causes **Balantidiasis**.

The previously mentioned **3 classes** reproduce **only asexually**.

4- Class Sporozoa:

- Alternate between both **sexual** and **asexual** reproduction
- Have **no** organ of locomotion (they move by **gliding**)

Are obligate intracellular parasites, so one of their pathogenesis is cellular destruction,

e.g., **(1) Plasmodium parasites** causing **malaria**; they live in RBCs (anemia)

(2) cryptosporidium & (3) Cyclosporas.

II- HELMINTHS

They are **metazoa** (**multicellular** wormlike parasites), divided into **3 classes**:

1- Class Nematoda (Roundworms):

Roundworms: If we take a cross section from them, it will look cylindrical.

a- Intestinal nematodes, e.g., *Ascaris lumbricoides*.

b- Tissue nematodes, e.g., *Wuchereria bancrofti*.

Wuchereria bancrofti causes elephantiasis (patient's foot becomes like elephants').

This class contains **separate sexes** male and female.

Classes 2 and 3 (Cestoda and Trematoda) are known as **Platyhelminthes (flatworms)**

Flatworms have flat dorso-ventral cross sections

Flatworms are also called **Hermaphrodites**. Which means that the same parasite contains **male** and **female reproductive organs**.

Schistosoma (exception), have **separate** sexes although they are **flatworms**.

2- Class Cestoda (Tapeworms; cestodes means segmented, so if we examine patient's stool, we'll find them segmented)

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

3- Class Trematoda (Flukes):

They are **flattened leaf-shaped** worms, e.g., *Schistosoma haematobium*.

It causes **Schistosomiasis** (there are three members)

1. *Schistosoma mansoni*

2. *Schistosoma japonicum*

The first 2 cause Schistosomiasis in the **intestines**

3. *Schistosoma haematobium*; causes Schistosomiasis in **urinary bladder (bilharzia)**.

III- ARTHROPODS (VECTORS)

- These parasites having **exoskeleton** and **jointed legs**, divided into **2 classes**:
- **1- Class Insecta**: e.g. **Mosquitoes, lice** (القمل) and **fleas** (البراغيث) .
- **2- Class Arachnida**: e.g. **Ticks** (القراد) and **mites** (العث).

Also, we can classify them into:

- **Mechanical Arthropods**: it only transfers the parasite **from infected to another non-infected susceptible host**.
- **Biological Arthropods**: it becomes **part of the life cycle** of transmitted parasite.

Mechanical vectors, such as flies, can pick up infectious agents on the outside of their bodies and transmit them through physical contact.

Biological vectors, such as mosquitoes and ticks may carry pathogens that can multiply within their bodies and be delivered to new hosts, usually by biting.

TYPES OF PARASITES

- 1- **Ectoparasite**: A parasite that lives **on the surface** of the host. It causes **infestation**.
E.g., Lice
- 2- **Endoparasite**: A parasite that lives **inside the body** of its host. It causes **infection**.
E.g., *Entamoeba Histolytica*
- 3- **Obligatory parasite**: A parasite that is **completely dependent** upon a host.
- 4- **Facultative parasite**: A parasite that is capable of living **both freely** and as a **parasite**.
Obligatory & Facultative Parasite: terms are related to survival of the parasite
- 5- **Permanent parasite**: A parasite that **spends its life cycle on or in the body of its host**. It can't complete its life cycle outside the host (note that here we are talking about life cycle too not just about survival).
- 6- **Temporary or Intermittent parasite**: A parasite that visits its host only for a short period of time for its meal; it can complete its life cycle inside or outside the host (free living stages).
- 7- **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.
- 8- **Coprozoic or spurious parasite**: An organism that passes through the human (it's common in animals too) intestinal canal without causing any symptom or disease and is detected in the stool after ingestion.

TYPES OF HOSTS

The most important are definitive host (D.H.) and intermediate host (I.H.).

- 1- Definitive host (D.H):** It is the host which (1) harbors the mature adult stage of the parasite or in which (2) sexual reproduction of the parasite takes place,
e.g., man in case of Taenia
or ⇔ one of the two conditions is enough for the result (D.H.) to hold true
- 2- Intermediate host (I.H):** It is the host which harbours larval stage (immature or non-sexually reproducing forms of the parasites),
e.g., Snail in the case of Bilharzia.
- 3- Reservoir host (R.H):** The host which harbors the parasite and is considered the source of human infection (potential source for the infection and we may also classify it D.H or I.H depending on the case).
Ex: Dog in case of kala – azar (visceral leishmaniasis, الحمى السوداء); it means black fever, which is caused by the parasite (Leishmaniadonovani). It acts also as a source of infection to man and maintains the parasite in nature.
- 4- Accidental host:** The host which harbors the parasite, which is not normally found, e.g., The Toxo cara (dog nematode, الديدات الخيطية) in man.
Normally, it affects dogs, but accidentally it might affect humans as well.

RELATIONSHIP BETWEEN THE ORGANISM AND ITS HOST

Symbiosis: the relationship between two living organisms where they live and interact with each other. It contains the three following types:

- 1- Commensalism:** It is a relationship between two living organisms where one gets benefit (commensal), while the other (host) is not harmed, 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 (التبادل):** It is a beneficial relationship between two living organisms where both drive a benefit and can successfully live apart.

MODES OF TRANSMISSION OF PARASITIC INFECTION

- 1- **Direct contact through the skin (will be explained later).**
- 2- **Penetration of the skin,**
e.g., schistosomes can cause **Schistosomiasis** when people **swim in contaminated water**, it can penetrate the skin and cause the infection.
- 3- **Ingestion of contaminated food or drinking water containing the infective stage of the parasite; Fecal-Oral transmission;** it is the most famous mode of all 10 modes, and it is the cause of intestinal parasitic infections.
- 4- **Inhalation of dust carrying the infective stage of parasite.**
- 5- **Congenital:**
 - a. from mother to fetus (**transplacental**)
 - b. from mother to infant by the mother's milk (**transmammary**)
- 6- **Sexual contact:** e.g., **Trichomonas vaginalis** which causes **Trichomoniasis**.
- 7- **Autoinfection:** is such a way that the complete life cycle of the parasite happens in a single organism without the involvement of another host.
 - a. **External;** such as **Pinworm females** migrate through the anus and go to the perineum (anal cleft) and lay their eggs there (it's considered **outside the body**); since it is itchy, the child will scratch it. Due to lack of hygiene, when they then put their hands in their mouth, the parasite **reenters the body**.
 - b. **Internal;** applies to one parasite only, namely **Strongyloides stercoralis** (human threadworm), which **doesn't require to be transported outside the host to reinitiate the infection**.
- 8- **Vectors: through bite or feces of infected vector or by swallowing the vector.**
e.g., **Sand Fly** can transfer **Leishmania Tropica/Major** which causes a disease called **Cutaneous Leishmaniasis** (In Jordan, we can see this in Aqaba).
- 9- **Blood transfusion or through contaminated syringes.**
- 10- **Organ transplantation.**

The modes 9 and 10 are mainly with Protozoa, e.g., plasmodium; it causes Malaria. Also, Trypanosoma, Toxoplasma, and Leishmania are transmitted by 9 and 10.

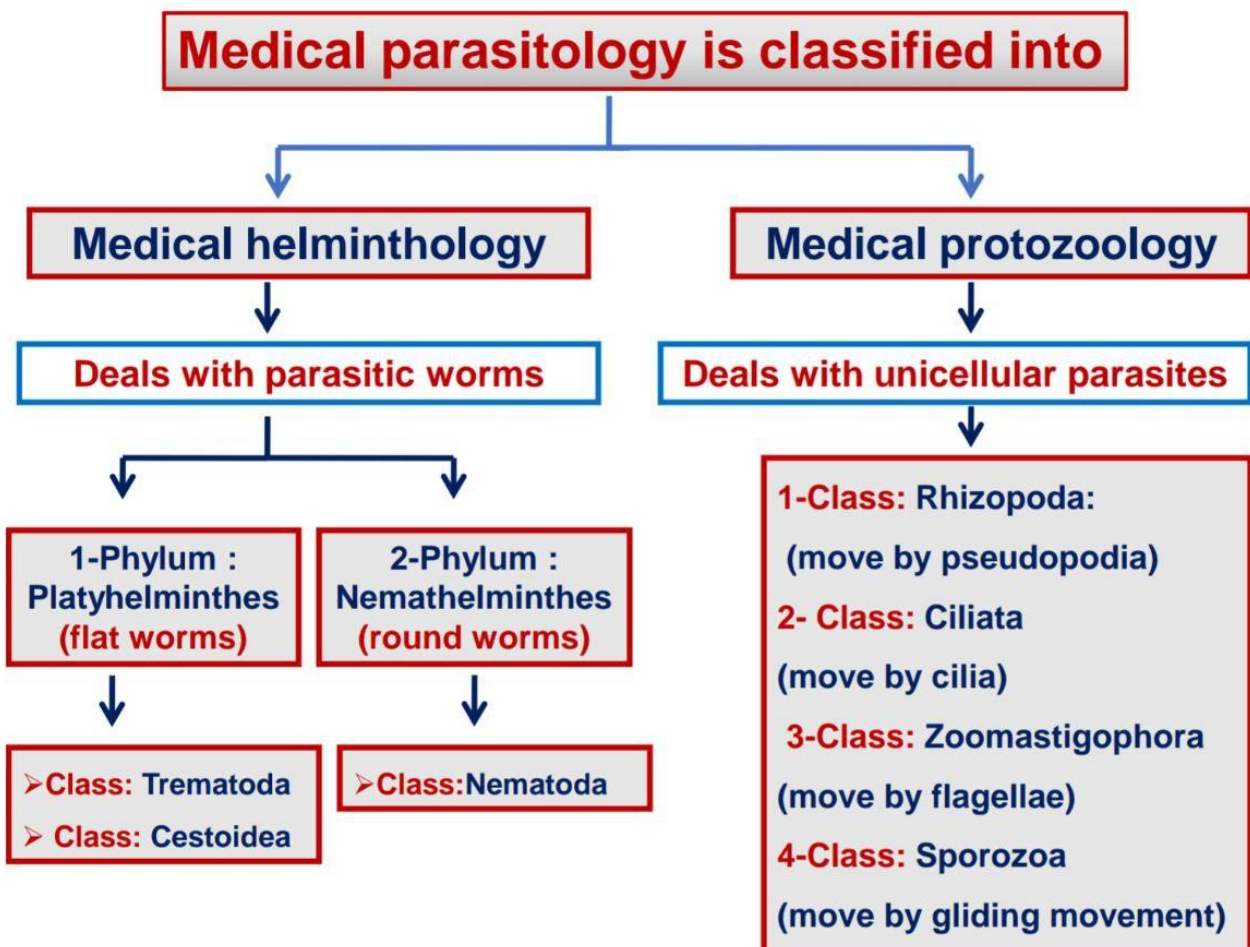
TERMS USED IN PARASITOLOGY

- **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 is infective to others.**

We must differentiate between **carrier** and a **host in latency state.**

Latency state: **no** symptoms and **not** infective to others.

- **Zoonosis:** is a term applied to **zoonotic diseases** which are diseases transmitted from **animals to human** either **directly** or **indirectly** via intermediate host (vector) e.g., viruses transmitted by arthropod vectors (**arbovirus**) causes a disease known as **Viral Hemorrhagic Fever** (الحمى النزفية).
- **Infective stage (I.S):** The stage at which the **infection takes place.**
Alternatively, it is the developmental stage when the **parasite enters the body.**
- **Diagnostic stage (D.S):** The stage at which **we can diagnose the parasitic infection.**
Alternatively, it is the developmental stage when the **parasite leaves the body.**



We will focus on Protozoa and Helminths (and not arthropods) for this course

PATHOGENESIS OF PARASITIC INFECTION

Occurs through the following:-

1) **Mechanical:** The parasite may **obstruct normal passage** like intestine or bile tract as large parasites (it's **helminths' main pathogenesis**) can cause obstruction in colon.

2) **Traumatic:** -

- ✓ **External due to invasion of the skin.**
- ✓ **Internal by attachment to intestinal mucosa by buccal capsule producing ulcers.**

As in Amebiasis (*Entamoeba histolytica*) in which the parasite lives **only in the colon** tube – **Luminal Amebiasis**. In other stages, there might be **invasion into the mucosa & submucosa**. Luminal Amebiasis causes diarrhea, but when invasion of the wall occurs, **dysentery** occurs (**Blood + Mucus** with diarrhea).

3) **Toxin production:** Circulation of parasitic products (**toxins and waste products**).

4) **Tissue damage and necrosis:** Due to **enzymes** secreted by parasites.

5) **Cellular destruction:**

- ✓ **As Plasmodium (lives intracellularly) in RBCs causing malaria.**
- ✓ **RES (reticuloendothelial system) damage.**

6) **Immune stimulation:** Parasitic **antigens** produce **humoral** or **cellular** immune response → cellular proliferation and infiltration → formation of **fibrous encapsulation** around parasites (e.g., **hepatic granuloma** in *Schistosoma mansonia*).

In Helminths most diseases result from immune reaction to the present of adult stage, but not in all cases – in Schistosomiasis, the main pathology is immune reaction to the eggs of *Schistosoma* not the adult stage.

7) **Allergic reaction due to insect bites or parasitic toxins.**

Remember (022 must have remembered, but we didn't take immunology yet!):

Lymphocytes → Viruses

Neutrophils → Bacteria

Eosinophil and IgE are the main mechanisms against **Parasites**

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 (The Parasite itself, Immune Response & the environments factors).

DIAGNOSIS OF PARASITIC INFECTION:

I) Clinical diagnosis:

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

II) Laboratory diagnosis (the 6 examples below):

Direct methods (to detect the diagnostic stage)

1- STOOL EXAMINATION

- **Mainly for intestinal infection.**
- **Must be collected in clean, dry, tight fitting lid containers.**
- **Macroscopic examination:**
for **consistency, composition, color**, and **presence of adult parasites** such as **Enterobius vermicularis, Taenia segments** (Proglottids) & **Ascaris worm**.

Sometimes the patient will macroscopically notice something abnormal in the stool.

- **Microscopic examinations:**
 - ❖ **Direct saline smear or iodine smear:** when helminthic eggs & protozoa cyst are in **large numbers**.
 - ❖ **Concentration techniques:** if the parasites are **scanty** (low amounts).
 - ❖ **Permanent stained smear:** we **fixed** the slide (**formalin fixed**) for correct identification of most protozoa. It can be referred to later (it stays preserved).

2- URINE EXAMINATION

- **Mainly for genitourinary tract infections**
 - ✓ The urine sample is examined **macroscopically & microscopically**.
 - ✓ Certain parasites can be detected in urine as:

1. **Eggs of *Schistosoma haematobium*,**
2. **Trophozoites of *Trichomonas vaginalis*** (a **sexually transmitted disease**; presents in the **vagina** and **can be detected** in the **urethra** ⇔ ectopic infection within the pelvis)
3. **Eggs of *Enterobius vermicularis*** (commonly known as the **pinworm**; here there is also an ectopic infection within the pelvis, these **eggs should present in the intestine not in the urine**, because it causes an **intestinal infection**.)

Ectopic infection within the pelvis: generally, refers to the **occurrence of an infection** in a location **outside its normal or expected site**, specifically **within the pelvic region**.

3- BLOOD EXAMINATION

Blood droplet (directly to the slide) = thick

Swept (ممسوحة) Blood droplet (over the slide as well) = thin

✓ **Thick blood film** (Only for detecting the existing of the parasite or not):

droplet from the blood to obtain large amount of it which increase possibility of detecting light infection. Parasites detected in the blood are

Malaria (plasmodium), Leishmania, Filaria (affect mainly lymphatic system) & **Trypanosomes**.

Trypanosomiasis: one of the blood flagellate diseases, **clinically** has **2 types**:

1- **American Trypanosomiasis (Chagas Disease)** → مشاكل بالقلب

2- **African Trypanosomiasis (Sleeping Sickness)** → CNS

✓ **Thin blood film**: to demonstrate the morphological features of the parasites.

Here the identification of the parasite can be done.

4- TISSUE BIOPSY

Tissue biopsy specimens are recommended for diagnosis of several parasitic infections.

For example:

In the muscle fibers

- **Muscle biopsy** in **Trichinella spiralis**. (The only helminth that lives intracellularly)
- **Rectal biopsy** in detecting **Schistosoma ova.**, not **Schistosoma haematobium** that affects **urinary bladder**.

5- SPUTUM EXAMINATION (بلغم)

Sputum is examined to detect parasites that are:

- ✓ Living in the lung, e.g., *Paragonimus westermani*.
- ✓ Migrating through the lung.

Like some helminths, to complete their life cycle, they must be transported through the pulmonary system; they may then be swallowed back into the intestines

- ✓ parasites which result from rupture of cysts in the lung.

Parasites detected in the sputum are:

- ✓ Eggs of *Paragonimus westermani*.
- ✓ Trophozoites of *Entamoeba histolytica* which causes Amebiasis, and it may cause extraintestinal amebiasis, they may migrate to several sites (skin, brain, liver, lung).
- ✓ Parts of ruptured hydatid cyst (very important in surgery) presents mainly in the lung and the liver. Its causative agent is a parasite known as *Echinococcus granulosus*.
- ✓ Migrating larvae of *Ascaris*, *Ancylostoma* (hookworm) & *Strongyloides*.

Those parasites migrate through the lungs as part of their life cycle.

6- ASPIRATES EXAMINATION

❖ Cerebrospinal fluid may be used for detection of certain parasites of CNS such as

- 1) *Trypanosoma* spp. like *Trypanosoma rhodesiense/gambiense*; cause African trypanosomiasis, also known as African sleeping sickness.

spp. = species of a certain genera

sp. = one species that is not mentioned

- 2) *Naegleria*

❖ Duodenal aspirates (Enterotest): for examination of duodenal contents.

(with helminths that affect GIT and live in the duodenum like *ancylostoma duodenale*)

Parasites which can be present affecting the GIT are, e.g., *Giardia lamblia*, *Strongyloides larva* & *Cryptosporidium parvum*.