Medical Laboratory Techniques Department
Lecture 1 : Medical parasitology
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Medical parasitology

Medical parasitology deals with the parasites, which cause human infections and the diseases they produce. It is broadly divided into 2 parts: **Protozoology** and **Helminthology**.

Parasites

Parasites are living organisms, which depend on a living host for their nourishment and survival. They multiply or undergo development in the host. The term '**parasite**' is usually applied to **Protozoa** (unicellular organisms) and **Helminths** (multicellular organisms).

Parasites can also be classified as:

Ectoparasite:

Ectoparasites inhabit only the body surface of the host without penetrating the tissue. Lice, ticks, and mites are examples of ectoparasites. The term **infestation** is often employed for parasitization with ectoparasites.

Endoparasite:

A parasite, which lives within the body of the host and is said to cause an infection is called an endoparasite. Most of the protozoan and helminthic parasites causing human disease are endoparasites.

Free-living parasite:

It refers to non-parasitic stages of active existence, which live independent of the host, e.g. cystic stage of *Naegleria floweri.*

Endoparasites can further be classified as:

Obligate parasite:

The parasite, which cannot exist without a host, e.g.*Toxoplasma gondii* and *Plasmodium.*

Facultative parasite:

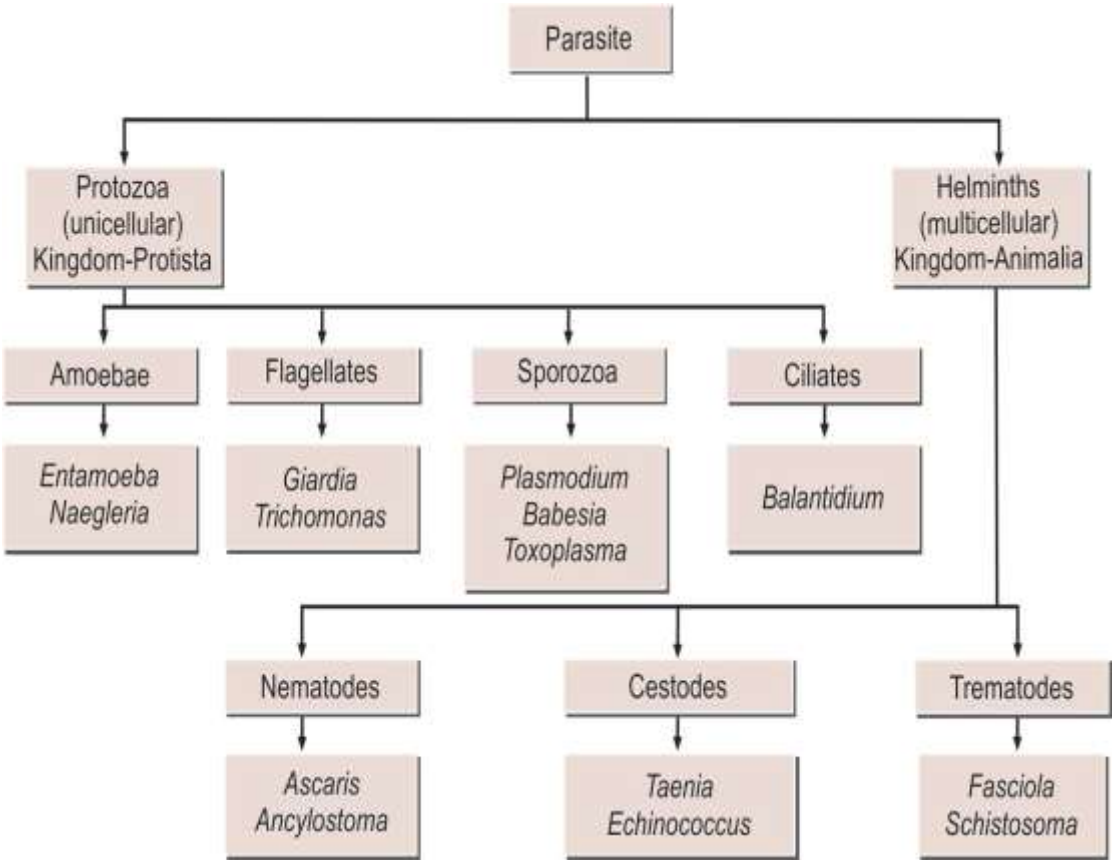
Organism which may either live as parasitic form or as free living form.

Accidental parasites:

Parasites, which infect an unusual host, are known as accidental parasites.
Echinococcus granulosus infects man accidentally, giving rise to hydatid cysts.

Aberrant parasites:

Parasites, which infect a host where they cannot develop further, are known as aberrant or wandering parasites, e.g. *Toxocara canis* (dog roundworm) infecting humans.



Types of parasitic host

Host

Host is defined as an organism, which harbors the parasite and provides nourishment and shelter to latter and is relatively larger than the parasite.

The host may be of the following types:

Definitive host:

The host, in which the adult parasite lives and undergoes sexual reproduction is called the definitive host, e.g. mosquito acts as definitive host in malaria.

*The definitive host may be a human or any other living being. However, in majority of human parasitic infections, man is the definitive host (e.g. filarial, roundworm, hookworm).

Intermediate host:

The host, in which the larval stage of the parasite lives or asexual multiplication takes place, is called the intermediate host. In some parasites, 2 different intermediate hosts may be required to complete different larval stages. These are known as **first and second intermediate hosts**, respectively.

Paratenic host:
A host, in which larval stage of the parasite remains viable without further development is referred as a paratenic host. Such host transmits the infection to another host.

Reservoir host:
In an endemic area, a parasitic infection is continuously kept up by the presence of a host, which harbors the parasite and acts as an important source of infection to other susceptible hosts, e.g. dog is the reservoir host of hydatid disease.

Accidental host:
The host, in which the parasite is not usually found, e.g. man is an accidental host for cystic echinococcosis.

Parasites with man as intermediate or secondary host

***Plasmodium* spp.**
***Babesia* spp.**
Toxoplasma gondii
Echinococcus granulosus
Echinococcus multilocularis
Taenia solium
***Spirometra* spp.**

Zoonosis
The word **zoonosis** was introduced by Rudolf Virchow in 1880 to include the diseases shared in nature by man and animals.

Later, in 1959, the World Health Organization (WHO) defined zoonosis as :
Those diseases and infections, which are naturally transmitted between vertebrate animals and man".

It is of following types:

Protozoal zoonoses, e.g. toxoplasmosis, leishmaniasis, balantidiasis, and cryptosporodiasis
Helminthic zoonoses, e.g. hydatid disease, taeniasis

Anthropozoonoses: Infections transmitted to man from lower vertebrate animals, e.g. cystic echinococcosis

Zooanthroponoses:
Infections transmitted from man to lower vertebrate animals, e.g. human tuberculosis to cattle.

Parasites having direct life cycle

Protozoa

- *Entamoeba histolytica*
- *Giardia lamblia*
- *Trichomonas vaginalis*
- *Balantidium coli*
- *Cryptosporidium parvum*
- *Cyclospora cayetanensis*
- *Isospora belli*
- *Microsporidia*

Helminths

- *Ascaris lumbricoides*
- *Enterobius vermicularis*
- *Trichuris trichiura*
- *Ancyclostoma duodenale*
- *Necator americanus*
- *Hymenolepis nana*

Parasites having indirect life cycle

Parasite	Definitive host	Intermediate host
Protozoa		
Plasmodium spp.	Female Anopheles mosquito	Man
Babesia	Tick	Man
Leishmania	Man, dog	Sandfly
Trypanosoma brucei	Man	Tsetse fly
Trypanosoma cruzi	Man	Triatomine bug
Toxoplasma gondii	Cat	Man
Cestodes		
Taenia solium	Man	Pig
Taenia saginata	Man	Cattle
Echinococcus granulosus	Dog	Man
Trematodes		
Fasciola hepatica	Man	Snail
Fasciolopsis buski	Man, pig	Snail
Schistosoma spp.	Man	Snail
Nematodes		
Trichinella spiralis	Man	Pig
Wuchereria bancrofti	Man	Mosquito
Brugia malayi	Man	Mosquito
Dracunculus medinensis	Man	Cyclops

Host-parasite Relationships

Host-parasite relationships are of following types
*Symbiosis تكافل
*Commensalism تغذية
*Parasitism. تطفل

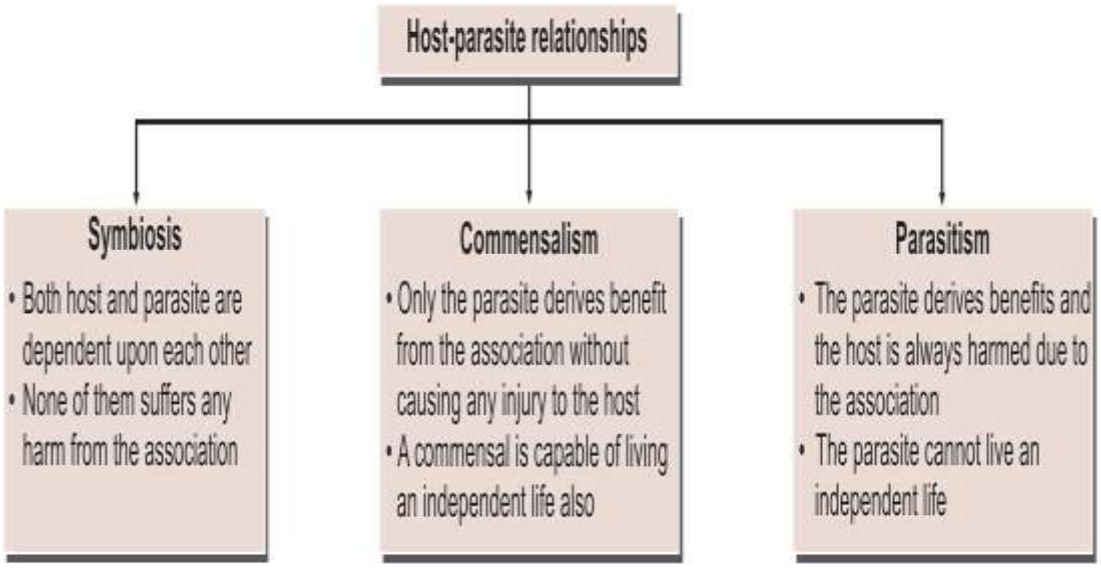
Life Cycle of Parasites

Direct life cycle:

When a parasite requires only single host to complete its development, it is called as direct life cycle, e.g. *Entamoeba histolytica* requires only a human host to complete its life cycle.

Indirect life cycle:

When a parasite requires 2 or more species of host to complete its development, the life cycle is called as indirect life cycle, e.g. malarial parasite requires both human host and mosquito to complete its life cycle.



Host-parasite relationships

Sources of Infection

1. **Contaminated soil and water:**

Soil polluted with embryonated eggs (roundworm, whipworm) may be ingested or infected larvae in soil, may penetrate exposed skin (hookworm).

Infective forms of parasites present in water may be ingested (cyst of amoeba and *Giardia*) Water containing the intermediate host may be swallowed (cyclops containing guinea worm larva *Dracunculus medinensis*). Infected larvae in water may enter by penetrating exposed skin, (cercariae of schisotosomes).
Free-living parasites in water may directly enter through vulnerable sites (*Naegleria* may enter through nasopharynx).

2. **Food:**

Ingestion of contaminated food or vegetables containing infective stage of parasite (amoebic cysts, *Toxoplasma* oocysts, *Echinococcus* eggs) Ingestion of raw or under-cooked meat harboring infective larvae (measly pork containing cysticercus cellulosae, the larval stage of *Taenia solium*).

Insect vectors:

A vector is an agent; usually an arthropod that transmits an infection from man to man or from other animals to man, e.g. female *Anopheles* is the vector of malarial parasite. Vectors can be:

Biological vectors:

The term biological vector refers to a vector, which not only assists in the transfer of parasites but the parasites undergo development or multiplication in their body as well. They are also called as **true vectors**. Example of true vectors are:

*Mosquito: Malaria, filariasis
*Sandflies: Kala-azar
*Tsetse flies: Sleeping sickness
* Reduviid bugs: Chagas' disease
*Ticks: Babesiosis.

Mechanical vectors:

The term mechanical vector refers to a vector, which assists in the transfer of parasitic form between hosts but is not essential in the life cycle of the parasite. Example of Mechanical vectors is: Housefly: amoebiasis.

Note:

In biological vectors, a certain period has to elapse after the parasite enters the vector, before it becomes infective. This is necessary because the vector can transmit the infection only after the parasite multiplies to a certain level or undergoes a developmental process in its body. This interval between the entry of the parasite into the vector and the time it takes to become capable of transmitting the infection is called the extrinsic incubation period.

3. **Animals:**

Domestic:

*Cow, e.g. *T. saginata*, Sarcocystis
*Pig, e.g. *T. solium*, *Trichinella spiralis*
*Dog, e.g. *Echinococcus granulosus*
*Cat, e.g. *Toxoplasma*, *Opisthrorochis.*

Wild:

* Wild game animals, e.g. trypanosomiasis
*Wild felines, e.g. *Paragonimus westermani*
*Fish, e.g. fish tapeworm
* Molluscs, e.g. liver flukes
*Copepods, e.g. guinea worm.

4. **Other persons**:

Which may be carriers of the parasite or patients, e.g. all anthroponotic infections, vertical transmission of congenital infections.

5. **Self (autoinfection)**

Finger-to-mouth transmission, e.g. pinworm internal re infection, e.g.

••*Strongyloides*.
••*Hymenolepis nana*
••*Enterobius vermicularis*
••*Taenia solium*
••*Strongyloides stercoralis*
••*Capillaria philippinensis*
••*Cryptosporidium parvum*

Modes of Infection

1. **Oral transmission:**

The most common method of transmission is through oral route by contaminated food, water, soiled fingers, or fomites. Many intestinal parasites enter the body in this manner, the infective stages being cysts, embryonated eggs, or larval forms. Infection with *E. histolytica* and other intestinal protozoa occurs when the infective cysts are swallowed.

2. **Skin transmission:**

Entry through skin is another important mode of transmission. Hookworm infection is acquired, when the larvae enter the skin of persons walking barefooted on contaminated soil. Schistosomiasis is acquired when the cercarial larvae in water penetrate the skin.

3. **Vector transmission:**

Many parasitic diseases are transmitted by insect bite, e.g., malaria is transmitted by bite of female *Anopheles* mosquito, filariasis is transmitted by bite of *Culex* mosquito. A vector could be a biological vector or a mechanical vector.

4. **Direct transmission:**

Parasitic infection may be transmitted by person-to-person contact in some cases, e.g. by kissing in the case of *Entamoeba gingivalis* and by sexual intercourse in trichomoniasis.

5. **Vertical transmission:**

Mother to fetus transmission may take place in malaria and toxoplasmosis.

6. **Iatrogenic transmission:**

It is seen in case of transfusion malaria and toxoplasmosis after organ transplantation.

Immunity in Parasitic Infection

Like other infectious agents, parasites also elicit immune responses in the host, both humoral as well as cellular. But immunological protection against parasitic infections is much less efficient, than it is against bacterial or viral infections. Several factors may contribute to this.

*Compared to bacteria and viruses, parasites are very larger or more complex structurally and antigenically, so that immune system may not be able to focus attack on the protective antigens.

*Many protozoan parasites are intracellular in location, and this protects them from immunological attack.
*Several protozoa and helminthes live inside body cavities This location limits the efficiency of immunological attack.

*Once the parasitic infection is completely eliminated, the host becomes again susceptible to re-infection. This continued presence of residual parasite population and is known as **'Premunition'**.

*Antibodies belonging to different immunoglobulin classes are produced in response to parasitic infections.

*Selective tests for IgM are helpful in differentiating current infections from old infections.

*Excessive IgE response occurs in helminthiasis. A characteristic cellular response in helminth parasite is eosinophilia both local and systemic host and most parasitic infections are chronic and show a degree of host specificity. For example, malarial parasites of human, bird, and rodents are confined to their own particular species.

*Parasites like trypanosomes exhibit antigenic variation within the host. This genetic switch protects them from antibodies. Similar mechanism may be operative in the recrudescence in human malaria.

•*Trypanosoma brucei gambiense*
•*Trypanosoma brucei rhodesiense*
•*Plasmodium* spp.
•*Giardia lamblia*

*Some parasites adopt antigenic disguise. Their surface antigens are so closely similar to host components that they are not recognized as foreign by the immune system.

* Some infections may produce immunodeficiency due to extensive damage to the reticuloendothelial system, as in case of visceral leishmaniasis.

Immune Evasion

All animal pathogens, including parasitic protozoa and worms have evolved effective mechanism to avoid elimination by the host defiance system.

Parasite escape mechanisms	Example
Intracellular habitat	Malarial *parasite*, *Leishmania*
Encystment	*Toxoplasma* *Trypanosoma cruzi*
Resistance to microbial phagocytosis	*Leishmania*
Masking of antigens	Schistosomes
Variation of antigen	Trypanosomes *Plasmodium* spp.
Suppression of immune response Malarial parasite	*Trichinella spiralis* *Schistosoma mansoni*
Interference by polyclonal activation	Trypanosomes
Sharing of antigens between parasite and host-molecular mimicry	Schistosomes
Continuous turnover and release of surface antigens of parasite	Schistosomes