

## **Introduction to parasitology**

**Medical parasitology**:- is the branch of sciences dealing with parasites which infect humans, the diseases caused by them, clinical picture and the response produced by humans against them. It is also concerned with various methods of their diagnosis, treatment and their prevention & control.

**A parasite** an organism living in, on, or with another organism in order to obtain nutrients, grow, or multiply often in a state that directly or indirectly harms the host. The parasites included in medical parasitology are protozoa, helminthes, and some arthropods

**Host** – An organism which harbors the parasite.

### **Host-Parasite Relationships**

When a parasite gains access to a host, the host has to compromise, and the parasite has to adopt itself in host environment. In this way host and parasite establish a sort of relationship which effects each other's growth, metabolism, etc

In general the series of events that constitutes the relation of host and parasite may be considered as beginning with the transmission of parasite from one host to another, then follows the distribution and localization of parasite on or within the host, then growth or multiplication of parasite, the resistance of host to the parasite and the parasite to the host. The method of attack of parasite, changes in host brought about by parasite and those in parasite due to residence in host. Host parasite adjustments during the infection, the escape of infective stages of the parasite from the host and then the recovery or death of host. Host Parasite relationship is defined as the influence of each partner (Host and parasite) by the activities of the other.

### **Host-Parasite Relationship Strategy**

In the host-parasite relationship, we can identify two categories of bio-physiological function. These are:

1. Parasite invasiveness which is aimed to obtain entry into the host and continue its life within the host, and
2. Host resistance which tends to prevent the invasion of parasite and its colonization. When a parasite is growing and multiplying within or in a host, the host is said to have an infection.

### **Symbiotic relationship between host & parasite**

**Symbiont**:- organism that spends a portion or all of its life cycle intimately associated with another organism of a different species.

**Symbiosis**:- is the relationship between living organisms that live together, in which both are so dependent upon each other that one cannot live without the help of the other. There are three common symbiotic relationships between two organisms:

**1- Mutualism** is the relationship between two organisms in which both of them depend on each other physiologically and one cannot live without the help of the other; however, none of the partners suffers any harm from the association. example is the relationship between certain species of flagellated protozoa living in the gut of termites. The protozoa, which depend entirely on a carbohydrate diet, acquire their nutrients from termites. In return they are capable of synthesizing and secreting cellulases; the cellulose digesting enzymes, which are utilized by termites in their digestion. Thus termite gets benefits by digesting its food and the protozoa at the same time get nutrition, multiplication, protection, suitable environment for living and shelter. So this association is helpful both to parasite and host.

**2- Commensalism** is the relationship in which one organism benefit and host remains unaffected. Ex. *Entamoeba coli* inhabits the intestinal tract of human so gets nutrition, protection, suitable environment for living but does not cause any pathogenic effects for the host. Also Most of the normal floras of the humans' body can be considered as commensals.

**3- parasitism** An association in which the parasite derives benefit but the host is affected. E.g. Worms like *Ascaris lumbricoides* reside in the gastrointestinal tract of man, and feed on important items of intestinal food causing various illnesses.

### **Classes of Parasites**

**1- Ectoparasite :-** The parasite that live on or in the skin of their host (inhabits the body surface only without penetrating into the tissues ), like mice, mosquito, fleas, flies, scabies, lice. This relationship is called infestation.

**2- Endoparasites:-** The parasite lives inside the body of the host in blood, tissues, body cavities,, ex. Malarial parasite ,*Ascaris*, *Taenia saginata*, Hydatid cyst. This relationship is called infection.

**3- Obligatory parasites :-** this parasite which cannot exist without a host such as Plasmodium (malaria), *Taenia saginata* and other helminthes.

**4- Facultative parasites (Opportunistic):-** The parasite can live either a parasitic or free living existence like *Acanthamoeba* and *Naegleria*.

**5- Occasional or accidental parasite:-** when a parasite attacks an unnatural host and survives (.Attacks an unusual Host) such as. *Hymenolepis diminuta* (rat tapeworm) and *Echinococcus granulosus*

**6-Temporary parasite-**Visits its host for a short period to obtain nutrition and leaves away such as Mosquito, flies.

**7-Permanent parasite:-**The parasites that remain on or in the body of the host for their entire life such as *Taenia saginata* which may live inside the body for long period may reach to 10 years or more.

**8- Pseudoparasite:-** A false parasite; may be either a commensal or a temporary parasite (the latter being an organism accidentally ingested and surviving briefly in the intestine)

**Types of hosts:-**

**1- Final host :-** host that harbors a parasite in the adult stage or where the parasite undergoes a sexual method of reproduction. sometimes called definitive host ex. Human for *Taenia saginata* , Ascaris.

**2- Intermediate host :-** harbors the larval stages of the parasite or an asexual cycle of development takes place. ,so some parasite need intermediate host while others not ex.cow for *T.saginata* and snails for schistosomal parasites. In some cases, larval development is completed in two different intermediate hosts, referred to as first and second intermediate hosts. such as *Paragonimus westermani* and *Diphyllobothrium latum*.

**3-Reservoir host:-** harbors the parasite on which parasite depends for its survival in nature and acts as an important source of infection to other susceptible hosts such as dog is reservoir host of hydatid disease and dogs and rodents in human leishmaniasis.

**4- Transport host or vector:-** Host that transmit parasites to human. If the transmitter is not essential to the life cycle it is called mechanical vector e.g. a housefly that transfers amoebic cysts from infected faces to food that is eaten by humans.. If it is essential , it is a biological vector. Also named as paratenic host.

**Another important terms in parasitology are:-**

**Zoonosis** is the disease of animals that are transmissible to man

**Carrier:-** A person who may carry a parasitic infection that is transmissible to others yet himself show no related signs or symptoms.

**Superinfection**:- It is applied when an individual harboring a parasite is reinfected with the same species of parasite.

**Sources of infection:-**

**1- Soil :-**

- Embryonated eggs which are presented in soil may be ingested ex. Round worm, whipworm
- Infective larva present in soil may enter by penetrating exposed skin, ex. Hook worms.

**2- Water :-**

- Infective forms of some parasite present in the water may be swallowed ex. cyst of amoeba and Giardia.
- Water containing the intermediate host for some parasite and may be swallowed ex. Infection with Guinea worm occur by drinking the water containing the Cyclops which is the intermediate host for this parasite
- . Infective larva in water may enter by penetrating exposed skin ex. Cercariae of schistosoma. Free-living parasite in the water may enter through vulnerable sites ex. Naegleria may enter through nasopharynx and cause meningoencephalitis.

**3- Food:-**

- Contamination with human or animal feces ex. Amoebic cysts, eggs of helminthes.
- Meat containing infective larva ex. *Taenia saginata*.

**4- Insect vectors:-**

- Biological vector, ex. Mosquito in the life cycle of malaria and sand flies in the life cycle of *leishmania donovani*.
- Mechanical vector, ex. house fly in the transmission of amoebiasis.

**5- Animals:-**

- Cow in the life cycle of beef tapeworm.
- Dog in the life cycle of hydatid disease.
- Cat in the toxoplasmosis.

**6- Other persons:-**

- Carriers and patients , ex. all anthroponotic infections, vertical infection (congenital infection).

**Portal of entry into the body (Transmission of parasites):-**

Transmission is the passing of a pathogen causing communicable disease from an infected host individual or group to a particular individual or group, regardless of whether the other individual was previously infected.

- **Mouth**-Commonest portal of entry of the parasites is oral through contaminated food, water, soiled fingers or fomites .( Ingestion)
- **Skin-Entry** through skin is another important portal of entry of parasites.Infection with *A. duodenale* and *S.stercoralis* is acquired when filariform larvae of these nematodes penetrate the unbroken skin of an individual walking over faecally contaminated soil. Schistosomiasis caused by *S. haematobium*, *S. mansoni* and *S. japonicum* is acquired when the cercarial larvae, in water, penetrate the skin. (Inoculation)
- **Sexual contact**-*Trichomonas vaginalis* is transmitted by sexual contact
- **Congenital-Infection** with *T.gondii* and Plasmodium spp. May be transmitted from mother to fetus transplacentally.
- **Inhalation**
- **Iatrogenic infection**- Malaria parasites may be transmitted by transfusion of blood from the donor with malaria containing asexual forms of erythrocytic schizogony.

Entry of parasite is called as **infection** whereas **clinical manifestations** are given the name of disease.

**Incubation period** the interval of time required for development; especially the time between invasion of the body by a pathogenic organism and appearance of the first symptoms of disease. This is usually followed by prodromal period which is characterized by general features of disease such as headache, malaise, fever, etc. and is short in duration.

**Modes of infection**

The major mode of infection are :-

- Oral transmission. E.g. *Entamoeba*
- Vector transmission. E.g. Malaria
- Direct transmission. E.g. Trichomoniasis
- Vertical transmission. E.g. Toxoplasmosis

- Iatrogenic transmission. E.g. Malaria, Toxoplasmosis

### **Pathological effects of parasite**

- Clinical manifestations may be acute, subacute, chronic latent, or recurrent,

### **Pathogenic mechanisms are:-**

- ❖ **Lytic necrosis** Produced by enzymes produced by some parasites E g *Entamoeba histolytica* lyses intestinal cells and produces amoebic ulcers., obligate intracellular parasites e.g. Plasmodium spp., Leishmania Spp., Trypanosoma cruzi and Toxoplasma gondii cause necrosis of parasitized host cells during their growth and multiplication
- ❖ **Trauma** Attachment of hookworms on jejunal mucosa leads to traumatic damage of villi and bleeding at the site of attachment, Physical damage is produced by entry of filariform larvae of *S.stercoralis*, *A.duodenale* and and cercarial larvae of *S.haematobium*, *S.mansoni* and *S.japonicum* into the skin
- ❖ **Allergic manifestations** Caused by host immune response to parasitic infection Eg Eosinophilic pneumonia in *Ascaris lumbricoides* infection, Schistosomes cause cercarial dermatitis and eosinophilia
- ❖ **Physical obstruction** Masses of roundworm causes intestinal obstruction
- ❖ **Inflammatory reaction** Clinical illness caused by inflammatory changes and consequent fibrosis such as lymphadenitis in Filariasis.
- ❖ **Neoplasia** Few parasitic infection may lead to malignancy E g Schistosoma haematobium causes urinary bladder carcinoma

### **Laboratory diagnosis:-**

Laboratory diagnosis of parasitic infections can be carried out by

- Demonstration of parasite
- -Immunodiagnosis
- Molecular biological methods

### **Demonstration of parasites**

**Blood**-In those parasitic infections,where the parasite itself, or in any stage of its development, circulates in the blood stream, the examination of blood film forms the main procedure for specific diagnosis e.g.

- ❖ Demonstration of Plasmodium spp. and Babesia spp. inside the erythrocytes
- ❖ L.donovani inside monocytes.
- ❖ microfilariae are found in the blood plasma.

**Stool**:- Examination of stool is important for the diagnosis of intestinal parasitic infections and helminthic infections of the biliary tract and discharge their eggs into the intestine. In protozoan infections, either trophozoites or cystic forms may be detected; the former during the active phase and the latter during the chronic phase. Example, Amoebiasis, Giardiasis, etc In the case of helminthic infections, the adult worms, their eggs, or larvae are found in the stool. It is the gold standard in the diagnosis of intestinal parasitic infections. Perianal and perineal skin scrapings-May show the eggs or adult worms of *E.vermicularis*.

**Urine** when the parasite localizes in the urinary tract, examination of the urine will be of help in establishing the parasitological diagnosis. For example in urinary Schistosomiasis, eggs of *Schistosoma haematobium* are found in the urine. In cases of chyluria caused by *Wuchereria bancrofti*, microfilariae are found in the urine.

**Genital specimens**-Trophozoites of *T.vaginalis* may be demonstrated in the vaginal and urethral discharge and in the prostatic secretions

**Sputum** examination of the sputum is useful in the following:

- In cases where the habitat of the parasite is in the respiratory tract.
- In amoebic abscess of lung or in the case of amoebic liver abscess bursting into the lungs, the trophozoites of *E. histolytica* are detected in the sputum..
  - larvae of Strongyloides, larvae of Ascaris, protoscolices and brood capsules of hydatid cyst and *Entamoeba gingivalis*.

**Duodenal aspirate and CSF**: Duodenal aspirate is collected for the demonstration of trophozoites of Giardia lamblia and eggs or larvae of *Strongyloides stercoralis*. CSF is examined for trypanosomes and free living amoebae.

**Tissue biopsy and aspiration**•

- Scolices and brood capsules may be demonstrated in the fluid aspirated from hydatid cyst.
- Amastigote forms of *L.donovani* may be demonstrated inside the reticuloendothelial cells in the aspirates of spleen, bone marrow, liver and lymph nodes.
- Trophozoites of *G.lamblia* may be demonstrated in the bile aspirated from duodenum by intubation.
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**Culture** Some parasites like *E. histolytica* and *G. lamblia* in stool and Leishmania spp. and Trypanosoma spp. in blood can be cultured in the laboratory. Culture of parasites is particularly useful when the number of parasites in the specimens is too small.

**Animal inoculation** It is useful in the detection of *T.gondii* and Babesia spp. in the clinical specimens

**Xenodiagnosis:** This methods employs an intermediate host or vector, within which the parasite multiplies, to detect low level of parasitism.

**Histopathology:** Tissue cysts due to *Trypanosoma cruzi* can be easily demonstrated in stained tissue sections

**Radiological and scanning techniques:** Some helminthes s calcify in human body and produce opacity on radiological examination

**Immunodiagnosis-two type of tests are available-.**

**Skin test**

**-Serological tests**

**Skin test-These tests are performed by intradermal injection of parasitic antigens.**

**1-Immediate hypersensitivity reaction-**It reveals erythema and induration after 30 minutes of injection.This reaction is seen in cases of hydatid disease, filariasis, schistosomiasis, ascariasis and strongyloidiasis.

**2. Delayed hypersensitivity reaction-**It reveals erythema and induration after 48 hours of injection. This reaction is seen in cases of leishmaniasis, trypanosomiasis, toxoplasmosis and amoebiasis

**Serological tests-**These tests detect antibodies or antigens in the patient serum and other clinical specimens.

**Molecular biological methods-**These include DNA probes and polymerase chain reactions (PCR). Molecular tests have been developed to increase the sensitivity and specificity of diagnosis of parasitic infections by way of amplification of the parasitic which may not be detectable by conventional methods.

**Classification of parasites**

. Parasites of medical importance come under the kingdom called protista and animalia. Protista includes the microscopic single-celled eukaryotes known as protozoa. In contrast, helminthes are macroscopic, multicellular worms possessing well-differentiated tissues and complex organs belonging to the kingdom animalia. The shape, size, mode of reproduction and type of locomotive organelle have been used to divide **protozoa** into four major classes:

A- **Rhizopodes**(amoebae): Organelles of locomotion are pseudopodes and the reproduction by binary fission.

B- **Flagellates**: Organelles of locomotion are flagella and the reproduction by binary fission.

C- **Ciliates**: Organelles of locomotion are cilia and reproductions by binary fission.

D- **Sporozoa**: Without locomotion organelles and the reproductions by sporogony and shizogony.

**The common helminthic parasites** of human being can be placed in one of the three classes on the basis of body and alimentary tract configuration, nature of the reproductive system and need for more than a single host species for the completion of life cycle:

- 1- Trematodes
- 2- Cestodes
- 3- Nematodes

Classification of Parasites

