**Dr.Ahmed Khudhair Al-Hamairy**  **(1st Lecture) Postgraduate student Microbiology**

**Parasitology**

**GENERAL PARASITOLOGY**

**LEARNING OBJECTIVES**

• Discuss the various types of parasites and hosts.

• Explain the relationship between a parasite and the host and their effects.

• Discuss in detail the classification of medically important parasites.

• Explain the difference between the Cestodes, Nematodes, Trematodes and Protozoa.

**INTRODUCTION**

Man and other living things on earth live in an entangling relationship with each other .They don’t exist in an isolated fashion. They are interdependent; each forms a strand in the web of life. Medical parasitology is the science that deals with organisms living in the human body (the host) and the medical significance of this host-parasite relationship.

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| **BOX 1-1 Populations at Risk for Contracting Parasites** | **BOX 1-2 Modes of Parasite Transmission** |
| **-Individuals in underdeveloped are as and countries**  **-Refugees**  **-Immigrants**  **-Visitors from foreign countries**  **-Individuals who are immunocompromised**  **-Individuals living in close quarters (e.g., prisons(**  **-Children who attend day care centers** | **-Ingestion of contaminated food or drink (primarily water)**  **-Hand-to-mouth transfer**  **-Insect bite**  **-Entry via drilling through the skin**  **-Unprotected sexual relations**  **-Mouth-to-mouth contact**  **-Droplet contamination**  **-Eye contact with infected swimming water** |

**ASSOCIATION BETWEEN PARASITE AND HOST**

**A parasite** is a living organism, which takes its nourishment and other needs from a host ; the host is an organism which supports the parasite. The parasites included in medical parasitology are protozoa, helminthes, and some arthropods. broader classification of parasites). The hosts vary depending on whether they harbor the various stages in parasitic development.

**PARASITE NOMENCLATURE AND CLASSIFICATION**

Kingdom: Protista \*

**Subkingdom : Protozoa**

**1- Phylum: Sarcomastigophora**

Subphylum: Sarcodina

Class: Lobosea (amebas) i.e ***Entamoeba histolytica***

Subphylum: Mastigophora

Class: Zoomastigophora flagellates/hemoflagellates i.e. ***Giardia lamblia*** and ***Leishmania* spp.**

**2- Phylum: Ciliophora**

Class: Kinetofragminophorea (ciliates) i.e. ***Balantidium coli***

**3- Phylum: Apicomplexa**

Class : Sporozoa i.e. ***Toxoplasma gondii***

**Order : Blastocystida i.e** ***Blastocystis***

**Subkingdom: Metazoa\*\***

**1- Phylum :Nemathelminthes**

A-Class: Nematoda (roundworms) i.e. ***Ascaris lumbricoides***

B-Class Filariae (tissue roundworms) i.e. ***Wuchereria buncrofti***

**2- Phylum :Platyhelminthes**

A- Class Cestoda (tapeworms) i.e ***Echinococcus granulosus***

B- Class:Trematoda (flukes) i.e ***Fasciola hepatica***

**DIFFERENT KINDS OF PARASITES**

• **Ectoparasite –** a parasitic organism that lives on the outer surface of its host, e.g. lice, ticks, mites etc.

• **Endoparasites** – parasites that live inside the body of their host, e.g. *Entamoeba histolytica.*

• **Obligate Parasite** - This parasite is completely dependent on the host during a segment or all of its life cycle, e.g. *Plasmodium* spp.

• **Facultative parasite –** an organism that exhibits both parasitic and non-parasitic modes of living and hence does not absolutely depend on the parasitic way of life, but is capable of adapting to it if placed on a host. e.g. *Naegleria fowleri*

• **Accidental parasite –** when a parasite attacks an unnatural host and survives. e.g. *Hymenolepis diminuta* (rat tapeworm).

• **Erratic parasite -** is one that wanders in to an organ in which it is not usually found. e.g. *Entamoeba histolytica* in the liver or lung of humans.

Most of the parasites which live in/on the body of the host do not cause disease (non-pathogenic parasites). In parasitology we will focus on most of the disease causing (pathogenic) parasites. However, understanding parasites which do not ordinarily produce disease in healthy immunocompetent) individuals but do cause illness in individuals with impaired defense mechanism (opportunistic parasites) is becoming of paramount importance because of the increasing prevalence of HIV/AIDS in our country.

**DIFFERENT KINDS OF HOSTS**

• **Definitive host –** a host that harbors a parasite in the adult stage or where the parasite undergoes a sexual method of reproduction.

• **Intermediate host** - harbors the larval stages of the parasite or an asexual cycle of development takes place. In some cases, larval development is completed in two different intermediate hosts, referred to as first and second intermediate hosts.

• **Paratenic host –** a host that serves as a temporary refuge and vehicle for reaching an obligatory host, usually the definitive host, i.e. it is not necessary for the completion of the parasites life cycle.

• **Reservoir host –** a host that makes the parasite available for the transmission to another host and is usually not affected by the infection.

• **Natural host –** a host that is naturally infected with certain species of parasite.

• **Accidental host –** a host that is under normal circumstances not infected with the parasite.

There is a dynamic equilibrium which exists in the interaction of organisms. Any organism that spends a portion or all of its life cycle intimately associated with another organism of a different species is considered as Symbiont (symbiote) and this relationship is called symbiosis (symbiotic relationships). The following are the three common symbiotic relationships between two organisms:

**Mutualism -** an association in which both partners are metabolically dependent upon each other and one cannot live without the help of the other; however, none of the partners suffers any harm from the association. One classic 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.

**Commensalism -** an association in which the commensal takes the benefit without causing injury to the host. E.g. Most of the normal floras of the humans’ body can be considered as commensals.

**Parasitism -** an association where one of the partners is harmed and the other lives at the expense of the other. e.g. Worms like *Ascaris lumbricoides* reside in the gastrointestinal tract of man, and feed on important items of intestinal food causing various illnesses. Once we are clear about the different types of associations between hosts and parasites, we can see the effect the parasite brings to the host and the reactions which develop in the host’s body due to parasitic invasion.

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| **TABLE 1-1 Terms Associated with Parasite-Host Relationships**  **Parameter Definition or Description** | |
| **Type of Parasite** | |
| **Parasite that cannot survive outside of a host** | **Obligatory parasite** |
| **Parasite that is capable of existing independently of a host** | **Facultative parasite** |
| **Parasite that is established inside of a host** | **Endoparasite** |
| **Parasite that is established in or on the exterior surface of a host** | **Ectoparasite** |
| **Type of Host** | |
| **Host other than the normal one that is harboring a parasite** | **Accidental or incidental host** |
| **Host in which the adult sexual phase of parasite development occurs** | **Definitive host** |
| **Host in which the larval asexual phase of parasite development occurs** | **Intermediate host** |
| **Host harboring parasites that are parasitic for humans and from which humans may become infected** | **Reservoir host** |
| **Host responsible for transferring a parasite from one location to another** | **Transport host** |
| **Parasite-harboring host that is not exhibiting any clinical symptoms but can infect others** | **Carrier** |
| **Parasite-Host Relationship Terms** | |
| **- Living together; the association of two living organisms, each of a different species .**  **- Association of two different species of organisms that is beneficial to one and neutral to the other** | **Symbiosis**  **Commensalism** |
| **Association of two different species of organisms that is beneficial to both** | **Mutualism** |
| **Association of two different species of organisms that is beneficial to one at the other’s expense** | **Parasitism** |
| **Relating to commensalism; the association between two different organisms in which one benefits and has a neutral effect on the other** | **Commensal** |
| **Parasite that has demonstrated the ability to cause disease** | **Pathogenic** |

**EFFECT OF PARASITES ON THE HOST**

The damage which pathogenic parasites produce in the tissues of the host may be described in the following two ways;

**(a) Direct effects of the parasite on the host**

• Mechanical injury - may be inflicted by a parasite by means of pressure as it grows larger, e.g. Hydatid cyst causes blockage of ducts such as blood vessels producing infraction.

• Deleterious effect of toxic substances- in *Plasmodium falciparum* production of toxic substances may cause rigors and other symptoms.

• Deprivation of nutrients, fluids and metabolites -parasite may produce disease by competing with the host for nutrients.

**(b) Indirect effects of the parasite on the host:**

Immunological reaction: Tissue damage may be caused by immunological

response of the host, e.g. nephritic syndrome following *Plasmodium* infections. Excessive proliferation of certain tissues due to invasion by some parasites can also cause tissue damage in man, e.g. fibrosis of liver after deposition of the ova of *Schistosoma*.

**BASIC CONCEPTS IN PARASITOLOGY**

In medical parasitology, each of the medically important parasites are discussed under the standard subheadings of morphology, geographical distribution, means of infection, life cycle, host/parasite relationship, pathology and clinical manifestations of infection, laboratory diagnosis, treatment and preventive/control measures of parasites. In the subsequent section some of these criteria are briefly presented.

**Morphology -** includes size, shape, color and position of different organelles in different parasites at various stages of their development. This is especially important in laboratory diagnosis which helps to identify the different stages of development and differentiate between pathogenic and commensal organisms. For example, *Entamoeba histolytica and Entamoeba coli*.

**Geographical distribution** - Even though revolutionary advances in transportation has made geographical isolation no longer a protection against many of the parasitic diseases, many of them are still found in abundance in the tropics. Distribution of parasites depends upon:

**a.** The presence and food habits of a suitable host:

• Host specificity, for example, *Ancylostoma duodenale* requires man as a host where *Ancylostoma caninum* requires a dog.

• Food habits, e.g. consumption of raw or undercooked meat or vegetables predisposes to Taeniasis

**b.** Easy escape of the parasite from the host- the different developmental stages of a parasite which are released from the body along with faeces and urine are widely distributed in many parts of the world as compared to those parasites which require a vector or direct body fluid contact for transmission.

**c.** Environmental conditions favoring survival outside the body of the host, i.e. temperature, the presence of water, humidity etc.

**d.** The presence of an appropriate vector or intermediate host – parasites that do not require an intermediate host (vector) for transmission are more widely distributed than those that do require vectors.

Once we are clear about the geographical distribution and conditions favoring survival in relation to different parasites, effective preventive and control measures can more easily be devised and implemented.

**Life cycle of parasites**

The route followed by a parasite from the time of entry to the host to exit, including the extracorporeal (outside the host) life. It can either be simple, when only one host is involved, or complex, involving one or more intermediate hosts. A parasite’s life cycle consists of two common phases **one phase** involves the route a parasite follows inside the body. This information provides an understanding of the symptomatology and pathology of the parasite. In addition the method of diagnosis and selection of appropriate medication may also be determined. The **other phase**, the route a parasite follows outside of the body, provides crucial information pertinent to epidemiology, prevention, and control.

**Host parasite relationship**

Infection is the result of entry and development within the body of any injurious organism regardless of its size. Once the infecting organism is introduced into the body of the host, it reacts in different ways and this could result in:

**a.** Carrier state - a perfect host parasite relationship where tissue destruction by a parasite is balanced with the host’s tissue repair. At this point the parasite and the host live harmoniously, i.e. they are at equilibrium.

**b.** Disease state - this is due to an imperfect host parasite relationship where the parasite dominates the upper hand. It can result either from lower resistance of the host or a higher pathogenecity of the parasite.

**c.** Parasite destruction – occurs when the host takes the upper hand.

**Laboratory diagnosis**

depending on the nature of the parasitic infections, the following specimens are selected for laboratory diagnosis:

**a)** **Blood** – in those parasitic infections where the parasite itself in any stage of its development circulates in the blood stream, examination of blood film forms one of the main procedures for specific diagnosis. For example, in malaria the parasites are found inside the red blood cells. In Bancroftian and Malayan filariasis, microfilariae are found in the blood plasma.

**b)** **Stool** – examination of the stool forms an important part in the diagnosis of intestinal parasitic infections and also for those helminthic parasites that localize in 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 helmithic infections, the adult worms, their eggs, or larvae are found in the stool.

**c)** **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.

**d)** **Sputum** – examination of the sputum is useful in the following:

• In cases where the habitat of the parasite is in the respiratory tract, as in

Paragonimiasis, the eggs of *Paragonimus westermani* are found.

• 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.

**e)** **Biopsy material** - varies with different parasitic infections. For example spleen punctures in cases of kala-azar, muscle biopsy in cases of Cysticercosis, Trichinelliasis, and Chagas’ disease, Skin snip for Onchocerciasis.

**f)** **Urethral or vaginal discharge** – for *Trichomonas vaginalis*

Indirect evidences – changes indicative of intestinal parasitic infections are:

**a. *Cytological changes in the blood*** – eosiniphilia often gives an indication

of tissue invasion by helminthes, a reduction in white blood cell count is

an indication of kala-azar, and anemia is a feature of hookworm infestation and malaria.

**b. *Serological tests*** – are carried out only in laboratories where special

antigens are available.

**Treatment** – many parasitic infections can be cured by specific chemotherapy. The greatest advances have been made in the treatment of protozoal diseases. For the treatment of intestinal helminthiasis, drugs are given orally for direct action on the helminthes. To obtain maximum parasiticidal effect, it is desirable that the drugs administered should not be absorbed and the drugs should also have minimum toxic effect on the host.

**Prevention and control** - measures may be taken against every parasite infectiving humans. Preventive measures designed to break the transmission cycle are crucial to successful parasitic eradication. Such measures include:

􀂃 Reduction of the source of infection- the parasite is attacked within the host, thereby preventing the dissemination of the infecting agent. Therefore, a prompt diagnosis and treatment of parasitic diseases is an important component in the prevention of dissemination.

􀂃 Sanitary control of drinking water and food.

􀂃 Proper waste disposal – through establishing safe sewage systems, use of screened latrines, and treatment of night soil.

􀂃 The use of insecticides and other chemicals used to control the vector population.

􀂃 Protective clothing that would prevent vectors from resting in the surface of the body and inoculate pathogens during their blood meal.

􀂃 Good personal hygiene.

􀂃 Avoidance of unprotected sexual practices.