

References

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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.

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. (See box 1 for broader classification of parasites). The hosts vary depending on whether they harbor the various stages in parasitic development. (See box 2)

BOX 1. 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 Medical 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.

BOX 2. 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

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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.

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 MEDICAL 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.

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

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2 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.

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.

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 pathogenicity 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:

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- i. **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.
- ii. **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 helminthic infections, the adult worms, their eggs, or larvae are found in the stool.
- iii. **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.
- iv. **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.
- i. **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.
- ii. **Urethral or vaginal discharge** – for *Trichomonas vaginalis*

Indirect evidences – changes indicative of intestinal parasitic infections are:

a. Cytological changes in the blood – eosinophilia 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.

CLASSIFICATION OF MEDICAL PARASITOLOGY

Parasites of medical importance come under the kingdom called protista and animalia. Protista includes the microscopic single-celled eukaryotes known as

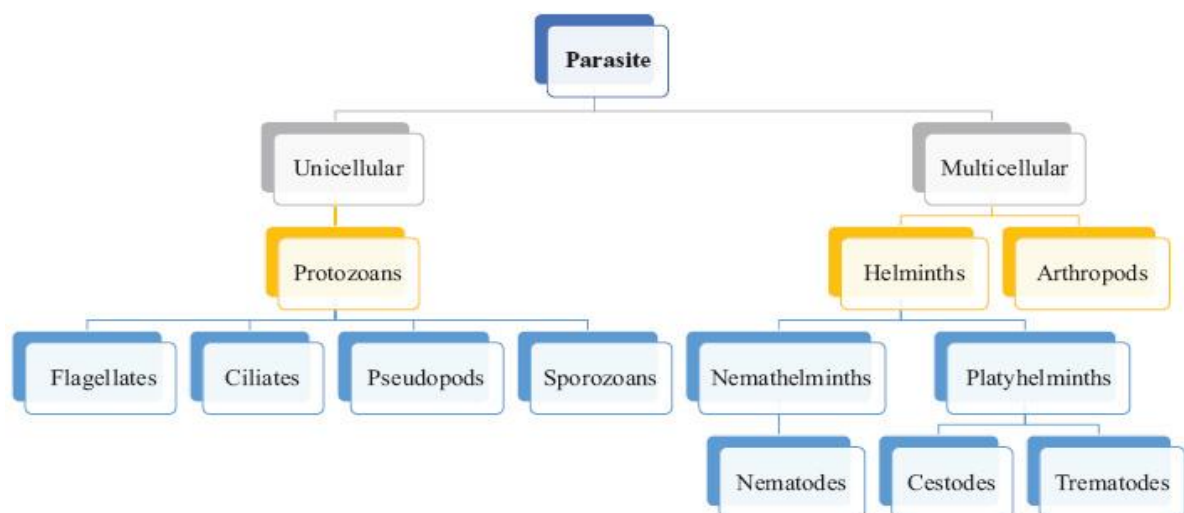
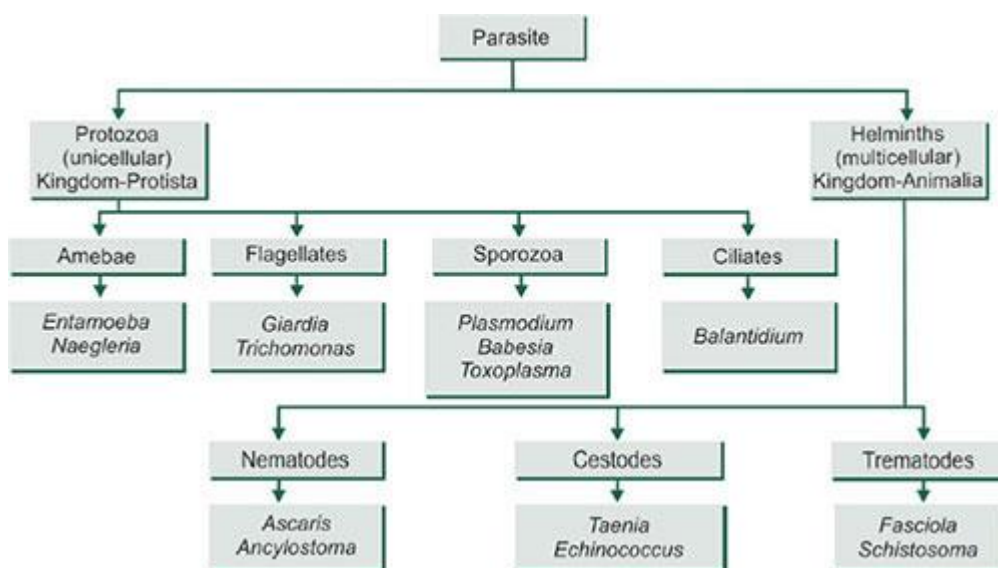
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protozoa. In contrast, helminthes are macroscopic, multicellular worms possessing well differentiated tissues and complex organs belonging to the kingdom animalia.

Medical Parasitology is generally classified into:

- a. Medical Protozoology - Deals with the study of medically important protozoa.
- b. Medical Helminthology - Deals with the study of helminthes (worms) that affect man.
- c. Medical Entomology - Deals with the study of arthropods which cause or transmit disease to man.



Stage 4**First lecture****GENERAL CHARACTERISTICS OF MEDICALLY IMPORTANT PARASITES**

Medically important protozoa, helminthes, and arthropods, which are identified as causes and propagators of disease have the following general features. These features also differ among parasites in a specific category.

(1) PROTOZOA

Protozoan parasites consist of a single "cell-like unit" which is morphologically and functionally complete and can perform all functions of life. They are made up of a mass of protoplasm differentiated into cytoplasm and nucleoplasm. The cytoplasm consists of an outer layer of hyaline ectoplasm and an inner voluminous granular endoplasm. The ectoplasm functions in protection, locomotion, and ingestion of food, excretion, and respiration. In the cytoplasm there are different vacuoles responsible for storage of food, digestion and excretion of waste products. The nucleus also functions in reproduction and maintaining life. The protozoal parasite possesses the property of being transformed from an active (trophozoite) to an inactive stage, losing its power of motility and enclosing itself within a tough wall. The protoplasmic body thus formed is known as a cyst. At this stage the parasite loses its power to grow and multiply. The cyst is the resistant stage of the parasite and is also infective to the human host.

Reproduction :

the methods of reproduction or multiplication among the parasitic protozoa are of the following types:

1. Asexual multiplication:

(a) Simple binary fission – in this process, after division of all the structures, the individual parasite divides either longitudinally or transversely into two more or less equal parts.

(b) Multiple fission or schizogony – in this process more than two individuals are produced, e.g. asexual reproduction in Plasmodia.

2. Sexual reproduction:

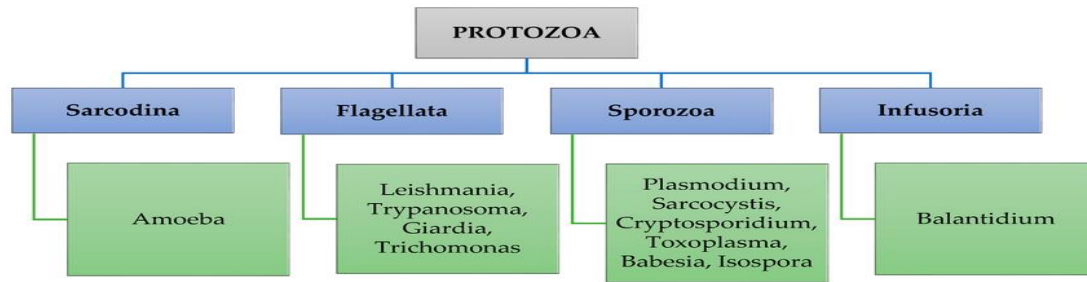
(a) Conjugation – in this process, a temporary union of two individuals occurs during which time interchange of nuclear material takes place. Later on, the two individuals separate.

(b) Syngamy – in this process, sexually differentiated cells, called gametes, unite permanently and a complete fusion of the nuclear material takes place. The resulting product is then known as a zygote.

TABLE 1. CLASSIFICATION OF THE PATHOGENIC PROTOZOA:

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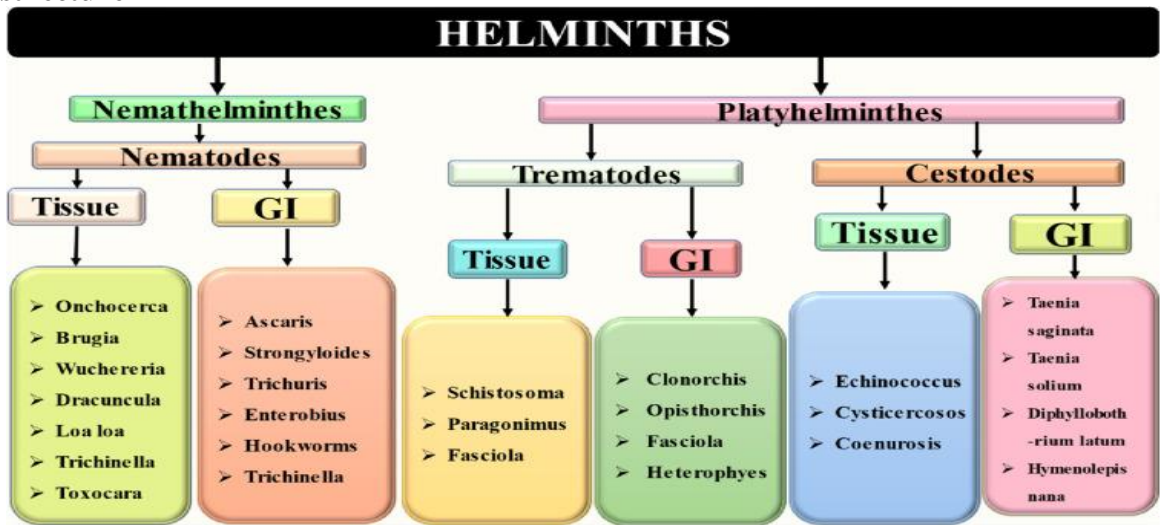
(2) **HELMINTHS:**

The helminthic parasites are multicellular, bilaterally symmetrical animals having three germ layers. The helminthes of importance to human beings are divided into three main groups with the peculiarities of the different categories described in table 2.

TABLE 2. DIFFERENTIATING FEATURES OF HELMINTHES

	CESTODE	TREMATODE	NEMATODE
Shape	Shape Tape like,	segmented Leaf like, Unsegmented	Elongated, Cylindrica
Sexes	Not separate (monoecious)	Not separate (monoecious)	Separate. (diecious)
"Head" End	Suckers: with hooks	Suckers: no hooks	No suckers, and hooks
Alimentary canal	Absent	present but incomplete	Present and complete
Body cavity	Absent	Absent	Present

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(3) ARTHROPODS

Arthropods, which form the largest group of species in the animal kingdom, are characterized by having a bilaterally symmetrical and segmented body with jointed appendages. They have a hard exoskeleton, which helps enclose and protect the muscles and other organs. An open circulatory system, with or without a dorsally situated heart pumps the blood (hemolymph) via arteries to the various organs and body tissues. Blood is returned to the heart through body spaces known as hemocoel. In addition, respiratory, excretory, and nervous systems are present. Arthropods affect the health of humans by being either direct agents for disease or agents for disease transmission. The arthropods of medical importance are found in Classes Insecta, Arachnida, and Crustacea which have their own distinguishing features. In Class insecta the body is divided into head, thorax, and abdomen, with one pair of antennae. Diseases like malaria, yellow fever, onchocerciasis, and trypanosomiasis are primarily transmitted by insects.

