Parasitology

Introduction

- Medical parasitology deals with the parasites, which cause human infections and the diseases they produce.
- **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

Parasitology is generally classified into:

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

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.

Pathogenesis of parasitic infection

- **Pathogenic parasite:** causes definite pathological lesions (*Ancylostoma*).
- **Non-pathogenic (commensal) parasite:** derives food and protection from host without causing pathological lesions (*Entamoeba coli*).
- **Opportunistic parasite:** causes mild disease in immunologically healthy individuals, and severe pathological lesions in immunodeficient hosts (*Cryptosporidium)*

Host

- Host is defined as an organism, which harbors the parasite and provides nourishment and shelter,and is relatively larger than the parasite.
- The host may be of the following types: · **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 ,under normal circumstances not infected with the parasite.

Host-parasite Relationships

Host-parasite relationships are of following types

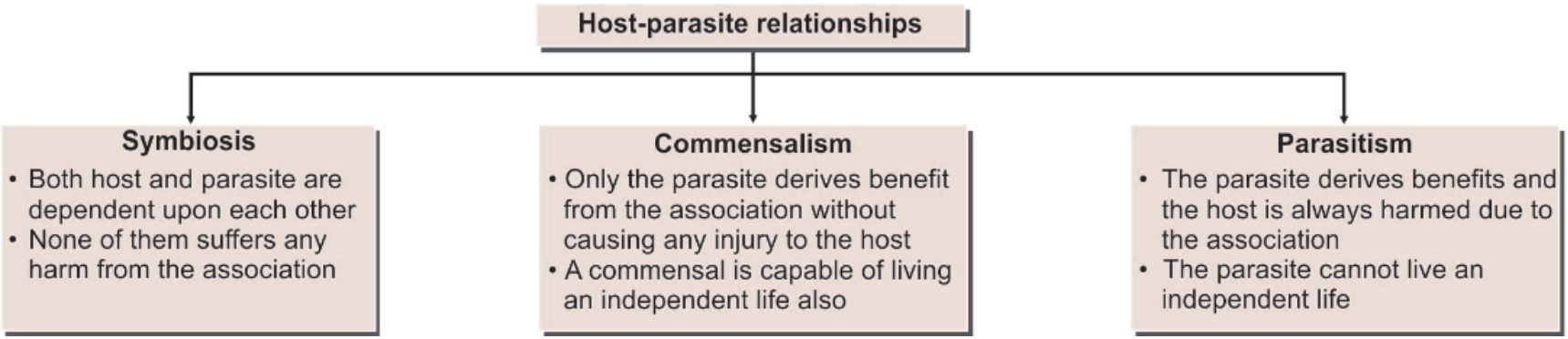
- Symbiosis
- Commensalism
- Parasitism.

Symbiosis: more or less permanent association of two organisms of different species.

This relationship occurs in 4 forms:

- Parasitism: one of the two organisms benefits, on the expense of the other that suffers from such association (*Schistosoma*).
- Commensalism: the parasite benefits without harming the host (non-pathogenic amoeba

- Mutualism: the relationship is beneficial to both associates (flagellates in the intestine of ants that feed on wood).
- Phoresis: in which the phoront is usually the smaller organism and is mechanically transmitted by the other which is usually large (e.g*Dientameoba fragils* or*Entrobius* egg).


Host-parasite relationships
Symbiosis
• Both host and parasite are dependent upon each other
• None of them suffers any harm from the association
Commensalism
• Only the parasite derives benefit from the association without causing any injury to the host
• A commensal is capable of living an independent life also
Parasitism
• The parasite derives benefits and the host is always harmed due to the association
• The parasite cannot live an independent life

- **Zoonosis:**Diseases and infections in which the causative agents are transmitted from animals to man.
- **Anthroponosis:** parasitic infection is found in man alone as in trichomoniasis and entrobiasis.
- **Zooanthroponosis:** parasitic infections mainly affect man and animals become infected in life cycle of parasite as in taeniasis.
- **Anthropozoonosis:** parasitic infection is mainly in animal and may be acquired by man as in trichinosis.

Classification of zoonotic diseases

According to the source of infection:

- **Feral or sylvatic zoonosis:** source of infection is a wild animal. Humans become infected when population move to infected area or become exposed during hunting as in African trypanosomiasis.
- **Domestic zoonosis:** these parasites transmitted from man,s own domestic animals as in hydatidosis

According to the method of transmission:

- **Direct zoonosis:** infection is directly transmitted from the vertebrate R.H. to man as in trichinosis.
- **Saprozoonosis:** infection is transmitted via a non developmental site as soil and water as in visceral larva migrans (VLM) and *Fasciola*
- **Metazoonosis:** infection is transmitted from the animal R.H. to man via an arthropod as in leishmaniasis and trypanosomiasis

Sources of infections

- Contaminated soil and water
- Fresh water fishes
- Pork
- Raw or undercooked beef
- Housefly
- Dog
- Man
- Auto infection

Entry

- Oral
- Skin
- Sexual
- Congenital
- Inhalation
- Iatrogenic

Effect of parasites on the host

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.

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

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** - Distribution of parasites depends upon:
- 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

- 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.

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

- 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:

- 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.

- 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. .
- 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:

- **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

- **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.

- **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.

- **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.

- **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

-) **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 infecting 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

- Safe 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.

Classification of medical parasitology

- Parasites of medical importance come under the kingdom called protista and animalia.
- Protista includes the microscopic single-celled eukaroytes known as protozoa.
- In contrast, helminthes are macroscopic, multicellular worms possessing well differentiated tissues and complex organs belonging to the kingdom animalia

Describing animal parasites follow certain rules of zoological nomenclature and each phylum may be further subdivided as follows:

- **Super class**
- **Super family**
- **Phylum**
- **Subphylum**
- **Class**
- **Order**
- **Family**
- **Genus**
- **Species**

Classification of medically important parasites

Helminthology (helminths):

- Helminthes or parasitic worms are multicellular, bilaterally symmetrical, elongated, flat or round organisms.
- They belong to the phylum
  - Platyhelminthes
  - Nemahelminthes

Platyhelminths (flat worms)

Platyhelminthes or flatworms are dorsal ventrically, flattened leaflike or tapelike.

- They are mostly hermaphrodites (monoecious).
- The human pathogenic helminth of this phylum belong to classes:
- **Trematoda and**
- **Cestoda**.

Platyhelminths (flat worms)

- **- Class: Trematoda (Flat Worms or Flukes).**
- **- Class: Cestoda (Tape worms).**

Nemathelminths (round worms)

Class: Nematoda (Round worms).

- Nematodes are unsegmented dioecious worms which are usually filiform.
- Phylum nemathelminths is divided into two classes:
  - **Adenophorea and**
  - **Secernentea**

- Protozology (protozoa).
- Arthropods

General characteristics of parasites

- Trematodes: Un-segmented, leaf-shaped, and hermaphrodite (except schistosomes), e.g. *Fasciola.*

- Cestodes: Long, segmented, tape-like and hermaphrodite, e.g. *Taenia saginata.*

- Nematodes: Elongated, cylindrical with pointed ends and unisexual, e.g.*Ascaris.*

- Protozoa: Unicellular microscopic parasites, e.g. *Giardia intestinalis*

The Helminthes

The helminthes are classified into three major groups. These are:

- 1. Trematodes (Flukes)
- 2. Nematodes (Round worms)
- 3. Cestodes (Tape worms)

The Trematodes and Cestodes are groups of flat worms.

- Helminthes are trophoblastic metazoa (multi-cellular organisms).
- Helminthes are among the common parasitic causes of human suffering.
- They are the cause of high morbidity and mortality of people worldwide.
- They cause different diseases in humans, but few helminthic infections cause life- threatening diseases.
- They cause anemia and malnutrition.
- In children they cause a reduction in academic performance. Helminthes also cause economic loss as a result of infections of domestic animals.

	CESTODES	TREMATODES	NEMATODES
SHAPE	Tape like, segmented	Leaf like, unsegmented	Elongated, cylindrical and unsegmented
SEXES	Monoecious(hermaphrodite)	Monoecious, except schistosomes	Dioecious
HEAD	Suckers often with hooks	Suckers, no hooks	No suckers, no hooks
ALIMENTARY CANAL	Absent	Present but incomplete(no anus)	Present and complete
BODY CAVITY	Absent	Absent	Present
MODE OF TRANSMISSION	Infection by encysted larva	Infection mainly by larval stages entering intestinal tract. Through skin	Infection by ingestion of eggs or penetration of larva through surface or anthropod vector or ingestion of encysted larva

Larval Forms

- There are various larval forms of helminths found in man and other hosts.
- These forms are as follows:

 Cestodes: The various larval forms are cysticercus,coenurus, coracidium, cystecercoid, procercoid, hydatid cyst, and plerocercoid forms.

- **Trematodes:** The various larval forms are miracidium,

cercaria, redia, metacercaria, and sporocyst.

- **Nematodes:** The various larval forms are micro laria, lariform larva, and rhabditiform larva.

Life Cycle

- **Cestodes:** They complete their life cycle in 2 different host except Hymenolepis nana, which completes its life cycle in a single host and Diphyllobothrium latum which completes its life cycle in 3 hosts.

- **Trematodes:** They complete their life cycle in 1 definitive host (man) and 2 intermediate hosts. Fresh water snail or mollusc act as first intermediate host and fish or crab act as second intermediate host except schistosomes which require 2 hosts – 1 definitive host (man) and other intermediate host (snail).
- **Nematodes:** Nematodes require only 1 host to complete their life cycle except filarial nematodes and Dracunculus medinensis, which complete their life cycle in 2 hosts.

Platyhelminthes (flat worms)

Class: Trematoda (Flukes)

- **General characteristics:**

1) Adults are leaf like; pear shaped or elongated worms, flattened dorsoventrally.

2) Bilaterally symmetrical except *schistosomes.*

3) Size: varies, some are large fleshy *(Fasciola)* others are just visible by naked eye *(Heterophyes).*

4) Covered with protective cuticle that may be smooth, spiny or tuberculated.

5) No body cavity, all organs are embedded in loose connective tissue cells.

6) Suckers: for attachment, usually 2 in number, in some there are 3 (*Heterophyes heterophyes*

7) Digestive system:

- - Starts by the mouth opening, found at the bottom of the oral sucker.
- - The mouth leads to a pharynx, then a short oesophagus which bifurcates into two long intestinal caeca.
- - Caeca end blindly with no anus

8) Excretory system

- - Starts by a definite number of excretory cells called (flame cells).
- - Waste products pass from the cell excretory tubules excretory duct excretory bladder excretory pore at the posterior end of the fluke.

9) Nervous system: consists of a ring of nerve ganglion around the pharynx, from which nerve fibers arise.

10) Respiration and nutrition:

- -Adult flukes are anaerobic.
- -They feed on biliary secretion, intestinal contents, tissue juices or blood according to their habitat.

11) Genital (reproductive system):

- Nearly all trematodes are hermaphroditic with exception (schistosomes)
- **The male reproductive organs** consist of two or more testes.
- **The female genital organs** consist of a single ovary situated in front of the two testes.

Trematode parasites (flukes) include:

1. Hepatic or liver flukes:

- - Fasciola gigantica - Fasciola hepatica
- - Opisthorchis viverrini

2. Intestinal flukes:

- - Heterophyes heterophyes

3. Lung flukes:

- -Paragonimus westermani

4. Blood flukes:

- -Schistosoma haematobium, mansoni, japonicum and intercalatum.