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

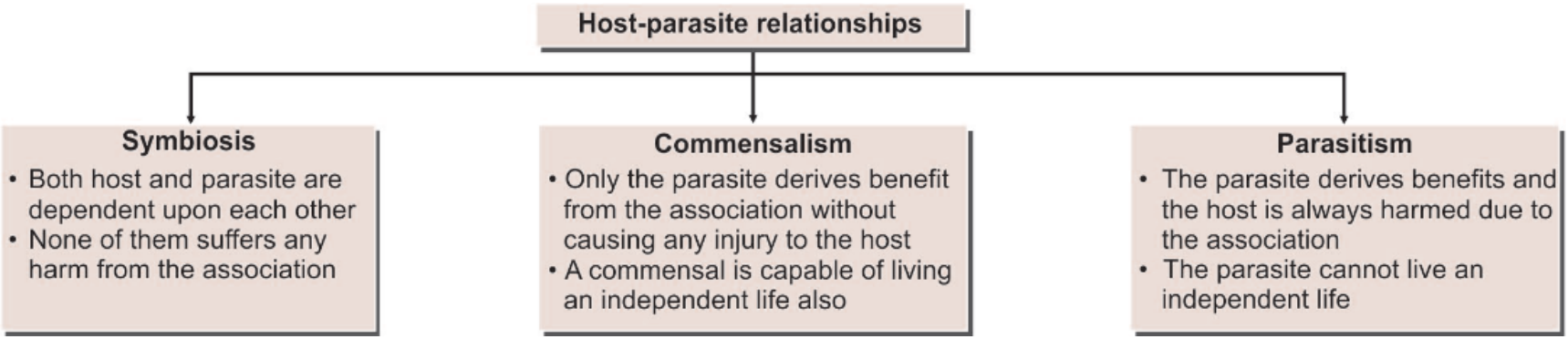
- Symbiosis
- Commensalism
- Parasitism.

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.

Topic 1:INTRODUCTION TO PARASITOLOGY

Historical perspective of parasitology

Antony van Leunhoek of Holland first described microscopic organisms in the faeces of man and animals and named them **animalcules.**

He described free living and parasitic protozoa, filamentous fungi of globular bodies (yeasts) in 1683.

The term protozoa was first used in 1817 by Goldfus of Germany.

Tape warms were first isolated in 1782.

DEFINITION OF TERMS IN MEDICAL PARASTOLOGY.

1. **Parasitology** is the area of biology concerned with the phenomenon of dependence of one living organism on another.
2. **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. It deals with the parasites which infect man, the diseases they produce, the response generated by him against them and various methods of diagnosis and prevention.
3. **Parasite:** is a living organism, which takes its nourishment and other needs from a host. The term parasite is usually applied to ***Protozoans (Unicellular micro-organism)*** and ***Helminths (Multicellular organism).***
4. **Host:** is an organism which supports the parasite.The parasites included in medical parasitology are **protozoa**, **helminthes**, and some **arthropods**.
5. **Ecto-parasite(Ectozoa) –** a parasitic organism that lives on the outer surface of its host, e.g.lice, ticks, mites etc.
6. **Endoparasites –** parasites that live inside the body of their host in the blood, tissues, body cavities, digestive tract and other organs.e.g. *Entamoeba histolytica.*
7. **Obligate Parasite** - This parasite is completely dependent on the host during a
8. segment or all of its life cycle, e.g. Plasmodium spp. It cannot exist without a parasitic life.
9. **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* (Lives a parasitic life when opportunity arises).
10. **Accidental parasite –** when a parasite attacks an unnatural host and survives. E.g. *Hymenolepis diminuta* (rat tapeworm). It's also known as occasional parasite
11. **Temporary parasite-**Visits its host for a short period.
12. **Permanent parasite**-leads a parasitic life throughout the whole period of its life.
13. **Wandering or Aberrant parasite-**Happens to reach a place where it cannot live.
14. **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.

CLASSES OF HOSTS-

1. **Definitive host –** a host that harbors a parasite in the adult stage or where the parasite undergoes the sexual method of reproduction. In majority of human parasitic infections, man is the definitive host
2. **Intermediate host -** harbors the larval stages of the parasite or the 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. In Malaria and Hydatid disease man is the intermediate host.
3. **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.
4. **Reservoir host –** a host that makes the parasite available for the transmission to another host and is usually not affected by the infection.
5. **Natural host –** a host that is naturally infected with certain species of parasite.
6. **Accidental host –** a host that is under normal circumstances is not infected with the parasite.

VECTORS

1. **Vector-**A vector is an agent, usually an insect, that transmits an infection from one human host to another.
2. **Mechanical vector-**This is a vector which assists in the transfer of parasitic forms between hosts but is not essential in the life cycle of the parasite.e.g. a housefly that transfers amoebic cysts from infected feaces to food that is eaten by humans.
3. **Biological vector-** In this group the parasite undergo a biological development or multiplication in the body of the vector. e.g Mosquito in the transmission of plasmodium.

LIFE CYCLE OF PARASITES

These are developmental stages that the organisms pass before a stage is attained and the organism reproduces and new cycle of development begins. The life cycle of parasite differ in different species. It maybe sexual or asexual.

1. **Direct life cycle (Simple**): When a parasite requires only one species of host to complete its development, it is referred to as direct life cycle. e.g.E. histolytica .
2. **Indirect life cycle (Complex**): When a parasite requires two or more species of hosts to complete its development, then the life cycle is referred to as indirect life cycle. E.g. Filariasis, Plasmodium.

HOST PARASITE RELATIONSHIP

1. **Symbiosis**-It is an association in which both organisms are so dependent upon each other that one cannot live without the help of the other. None of the partner suffers any harm from the association.

- N/B: 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).**

1. **Commensalism**-An association in which the parasite only is deriving benefit without causing injury to its host. A commensal is capable of leading an independent life.

- N/B: Most of the normal floras of the human body can be considered as commensals.

1. **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.
2. **Parasitism**-An association in which the parasite derives benefit and the host gets nothing in return but always suffers some injury. A parasite has lost its power of independent life. E.g. Worms like *Ascaris lumbricoides* reside in the gastrointestinal tract of man, and feed on important items of intestinal food causing various illnesses.
3. **Zoonosis:** Parasitic infection which are primarily confined to vertebrate animals but can cause disease in man if they become infected e.g. Leishmaniasis, echinococcosis trichinosis.
4. **Anthroponosis:** Parasitic infections that are confined to man only e.g. Malaria & filarial.
5. **Zooanthroponosis:** Infections in which human being is not an accidental host, but serves as an essential link in the life cycle of the parasite e.g. beef and pork tapeworm.

CLASSIFICATION OF PARASITES

a) Parasites are divided into two **phyla**:

1. **Protozoa** : These are unicellular parasites
2. **Metazoa :** These are multi cellular parasites.

d) Parasites of medical importance come under the kingdom called **protista** and **animalia**.

e) **Protista** includes the **microscopic single-celled eukaroytes** known as **protozoa**.

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

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

. Phylum protozoa:

These parasites are unicellular eukaryotic organisms and the single cell carries out all the functions of the parasite like reproduction, digestion, respiration and excretion.

They usually measure from 1-150 µm.

Examples of protozoa are:

Entamoeba histolytica, Giardia lamblia, Plasmodia,

Leishmania and Trypanosoma.

According to the site of infection the protozoan paraites are classified as under:

Blood & Tissue Flagellates : Leishmania, Trypanosoma

Intestinal Flagellates : Giardis lamblia, Trichomonas hominis Enteromonas hominis,Retromonas intestinalis

Oral flagellates: Trichomonas tenax

Genital flagellates: Trichomonas vaginalis.

B. Phylum Metazoa:

These parasites are multicellular. They consist of helminths. Examples of metazoan are Cestodes, Nematodes, and Trematodes.

Helminths are further classified into platyhelminths and nemathelminths. The platyhelminths are further classified into cestodes and trematodes.

Helminths: The following are common morphological features of helminths:

- No organs of locomotion
- Have tough cuticle
- Gastro intestinal tract (GIT) absent or rudimentary or developed
- Nervous system primitive
- Very well developed reproductive system
- Hermaphrodites or separate sexes
- Enormous number of eggs produced
- Do not multiply in humans (generally).

CLASSIFICATION OF MEDICALLY IMPORTANT PARASITES

PROTOZOA **METAZOA (HELIMINTHS)**

Sarcodina (Amoebae): **Platyhelminthes:**

(a) Genus, Entameba: **Trematodea:**

E.g. *Entameba histolytica*

(b) Genus Endolimax

E.g. *Endolimax nana*

(c) Genus Iodameba

E.g. *Iodameba butchlii*

(d) Genus Dientmeba

E.g. *Dientameba fragilis*

Mastigophora (Flagellates):

(a) Genus Giardia

E.g. *G. lamblia*

(b) Genus Trichomonas

E.g. *T. vaginalis*

(c) Genus Trypanosoma

E.g. *T. brucci*

(d) Genus Leishmania

E.g. *L. donovani*

Sporozoa

(1) Genus Plasmodium

E.g. *P. falciparum*

(2) Genus Toxoplasma

E.g. *T. gondi*

(3) Genus Cryptosporidum

E.g. *C. parvum*

(4) Genus Isospora E.g. *I. beli*

Ciliates

E.g. *Balantidium coli.*

(a) Genus Schistosoma

E.g. *S. mansoni*

(b) Genus Fasciola

E.g. *F. hepatica*

Cestoda:

(a) Genus Diphylobotrium

E.g. *D. latum*

(b) Genus Taenia

E.g. *T. saginata*

(c) Genus Echinococcus

E.g. *E. granulosus*

(d) Genus Hymenolepsis

E.g. *H. nana*

Nemathelminthes:

(a) Intestinal Nematodes

E.g. *A. lumbricoides*

(b) Somatic Nematodes

E.g. *W. bancrofti*

OURCES OF PARASITIC INFECTIONS:

1. Contaminated soil and water
2. Freshwater fishes-Diphyllobothrium latum and Clonorchis sinensis.
3. Crab and crayfishes-Paragonimus wertermani.
4. Raw or undercooked pork-Trichinella spiralis, T.solium.
5. Raw or undercooked beef-T.saginata, Toxoplasma gondii.
6. Watercress-Fasciola hepatica
7. Blood sucking insects
8. Housefly-Mechanical carrier-E.histolytica
9. Dog-Echinococcus granulosus and Toxocara canis.

10. Cat-T.gondii.
11. Man-E.histolytica, Enterobius vermicularis and H.nana.
12. Autoinfection-May occur with E.vermicularis and S.stercoralis leading to hyperinfection.

MODE OF INFECTION OF PARASITIC INFECTIONS:

a) Ingestion

It is called faecal-oral route by contaminated food, water soiled finger or formites

a) Ingest parasites in raw or undercooked meat e.g. Tinea saginata, Tinea Solium, Diplyllobothrium latun or paragoninus westermani in crab or cray fish.

b) By ingesting food or drink contaminated by infective form of parasite e.g. cysts of E.hitolytica, ova of Ascaries lumbricoides Tricluri,Trichura & Enterobius vermicularies.

c) By ingesting water containing infected Cyclops e.g. Drucuculus medinensis.

d) By ingesting aquatic plants containing metacercarial forms of parasite that have come out of its intermediate host & encyst in acquatic plants.

b) By skin transmission;

a) The ***Filariform larvae*** of Ancylostoma duodenale & strongyloides stercoralis in contaminated soil penetrate intact skin.

b) By contact with water containing cercarial forms of S.haematobium, S.Manson; S.Japonicam and penetrate the skin.

c) By the agency of insect host

Some anthropods (blood-sucking insects) may introduce the parasite while sucking blood e.g. Plasmodium by anoplyline mosquito, Trypanosoma by Tsetsefly, Leishmania by sand fly, Wucheria bancrofti by culex mosquito.

In this group the parasite undergo a biological development or multiplication in the body of the vector. These vectors are called ***Biological Vectors.***

d) Direct transmission

a) By sexual contact e.g. Trichomonas vaginalis.

b) By kissing in the case of gingival amoebae.

e) Inhalation-

f). Iatrogenic infection-Malaria parasites may be transmitted by transfusion of blood from the donor with malaria containing asexual forms of erythrocytic schizogony.This is known as trophozoite induced malaria or transfusion malaria. Malaria parasites may also be transmitted by the use of contaminated syringes and needles.This may occur in drug addicts.

PATHOGENIC EFFECT OF PARASITIC INFECTIONS

Parasite infections may remain inapparent or may cause disease of clinical significance depending on:-

a) **Parasite** – strain, number, size, metabolic process

b) **Host** – age, natural immunity, immunity to infection, co-existing disease, nutritional status, lifestyle.

Protozoal infections

The lesions are greatly influenced by proliferation, multiplication and metastatic spread to distant organs.

Helminthic infections

In most helminthic infections, man serves as the definitive host and adult parasites are found within the body.

No multiplication takes place except in cases of strongyloides sterecoralis & Hymenolepis nana.

The infection depend on the number of invading organisms

Clinically they present as:-

1. Physical obstruction

Round worms (Ascaris Lubricoides) causing intestinal obstruction. A single warm may also block the appendix or bile duct.

2. ***Pressure effect***

Hydatid cyst may cause pressure effect on surrounding tissues.

Pressure effects if parasites are present on vulnerable sites e.g. brain, eyes.

3. ***Vascular or Lymphatic obstruction***

P.falciparum infection causing blockage of capillaries of cerebral cortex leading to fatal cerebral malaria.

4. ***Trauma***

Clinical disease may result from trauma e.g. Hookworm infection.

5. ***Allergic Manifestations.***

Secretions and excretions of growing larvae and products released from dead parasites may lead to allergic manifestations.

6. ***Predisposition to Malignancy***

Parasitic infection may contribute to development of neoplastic growths. E.g. liver flukes; schistosoma haemalobium.

Immunity in parasitic infections.

Parasitic infection generate antibody response and effector T cell (cell mediated) response but the parasite elimination is much less efficient than that against bacterial & viral infectious.

Nb:

- Parasites have evolved to be closely adapted to the host
- The infections are chronic and show host specificity

Acquired immunity

1. ***Antibody response***

Immune response to parasites results in production of immunoglobulins type IgG. &IgM. IgE is produced in Helminthic infectious while IgA is produced in intestinal protozoal (Entamoeba, Gardia).

How do they work?

Neutralization (How anti-body response work).

Antibody combines with various surface molecules of parasites & neutralize them and thereby block or interfere with their proper functioning.

2. ***Agglutination***

Agglutination of blood parasites by IgM prevents spread of the parasite.

3. ***Physical clearance***

Antibodies that block orifices of certain worms e.g. oral or genital opening – interfere with their physiological functions & can cause starvation or curtail reproduction.

4. ***Opsonisation***

Antibody can increase the clearance of the parasite by phygocytic cells.

5. ***Antibody reacting with surface antigens***

Antibodies binding to the cells of parasites resulting in direct damage or lysis.

6. ***Antibody dependent cell-mediated cytotoxicity (ADCC).***

It is usually seen in some parasitic infections e.g. Trypansoma cruzi, S.Mansoni, Trichinella spirallis & Filarial worms.

Cellular Response.

1. T.Lympghocytes

CD_4 + T cells acts as helper cells in antibody production & CD_8 + T cells are cytotoxic in several instances.

2. Macrophages

Play a dominant role in the process of elimination of Protozoa and worms.

3. Granulocytes

Neutrophils & eosinophils play important roles in elimination of protozoa & helminthes.

Unlike bacterial infection, complete elimination of infecting parasites followed by immunity to reinfection is seldom observed.

Evasion Mechanisms

Like bacteria some parasites have evolved effective mechanism to avoid elimination by the host defense systems. The intracellular location of many protozoa helps them to evade immunological attack.

Escape mechanisms of parasites.

1. Intracellular habitat. E.g. Malaria parasites, trypanosome, leishmania
2. Encystment – Toxoplama godii, trypanosome cruzi.
3. Resistance to microbicidal products of phagocytes. Leishmania Donovani
4. Variation of antigen – Malaria parasite, trypanosome
5. Masking of antigen – Schistosomes
6. Interference by antigens – trypanosomes
7. Polyclonal activation – Trypanosomes
8. Suppression of immune response – Most parasite (Malaria parasites, T.Spirallis, S.mansoni).
9. Sharing of antigens – Schistosomes between parasite & host
10. Continuous turnover and schistosomes release of surface antigens

Topic 1.1: CESTODES (Taeniasis/Cysticercosis)

1. TAENIASIS AND CYTICERCOSIS

-
- Taeniasis and cysticercosis are diseases resulting from infection with parasitic tapeworms belonging to Taenia species. Approximately 45 species of Taenia have been identifi ed; however, the two most commonly responsible for human infection are;

1. The pork tapeworm Taenia solium and
2. The beef tapeworm Taenia saginata.

-
- Infection with adult tapeworms of either T. solium or T. saginata cause taeniasis in humans. Th e metacestode, or larval stage, of Taenia solium causes the tissue infection, cysticercosis.
-
- **Life-Cycle of Taeniasis;**
- The complete life-cycle of **Taenia solium** involves two hosts:

1. The pig and
2. The human,

whereas that of **Taenia saginata** involves;

1. The cow and
2. The human

- Humans act as the definitive host and harbor the adult tapeworm in the small intestine.
- Infection is acquired either through the accidental ingestion of embryonated eggs passed in the feces of an individual infected with the adult tapeworm, or through the consumption of raw or poorly cooked meat containing cysticerci.
- The cysticerca develops into an adult worm in the gut; these worms can survive up to 25 years.
- Depending on the species of Taenia, an adult worm can reach lengths between 2-25 meters and may produce as many as 300,000 eggs per day.
- The morphology of the adult worm consists of a scolex and a strombila. The scolex acts as the organ of attachment and consists of four suckers equipped with hooklets. The strombila consists of several segments (proglottids) with the gravid or egg-carrying proglottids located toward the posterior end of the worm.
- Individual proglottids may contain as many as 40,000 eggs in T. solium or as many as 100,000 eggs in T. saginata. Both the proglottids and the eggs are released with the feces of infected individuals and serve as a source of infection for pigs and cattle, which act as intermediate hosts for these parasites.
- Following the ingestion of eggs, mature larvae (onchospheres) are released in the gut. These onchospheres enter the blood
- stream by penetrating the small intestine and migrate to skeletal and cardiac muscles where they develop into cysticerci. Cysticerci may survive in the host tissues for several years causing cysticercosis
- The consumption of raw or undercooked meat containing cysticerci facilitates the spread of infection from pigs to humans. In humans, cysticerci transform into adult tapeworms which persist in the small intestines for years causing taeniasis. The time between initial infection and the development of the adult worm occurs over a period of approximately 2 months. In some instances, an infected individual harboring the adult worm can become auto-infected through the accidental ingestion of eggs released in the feces.
- **Signs and symptoms;**
- **1. Taeniasis**

1. Minor gastrointestinal irritation.
2. Nausea,
3. Diarrhea,
4. Constipation,
5. Hunger pains,
6. Passage of proglottids in the feces.

- **2. Cysticercosis:**
- The clinical manifestations associated with cysticercosis are a direct result of the
- inflammatory response induced to control parasite growth and may occur months to years after initial infection.
- Manifestations of disease are dependent upon a variety of factors including the site of infection as well as the number of
- cysticerci present within the tissues, which most often localize to sites within the eyes, skeletal muscles and brain.
- Cysticercosis is the most common intra-orbital parasitic infection and is observed in 13-46% of infected individuals. Infection may involve the sub-retinal space (intra-ocular) or the extraocular muscles, eyelid and/or lachrymal glands (extra-ocular) surrounding the eye(s).
- Patients infected with cysticerci in the skeletal muscles and/or subcutaneous tissues are usually asymptomatic. In most cases, multiple cysts are present within the tissues, although solitary cysts may also be detected. Cysts range from 10-15
- mm in length and arrange themselves in the same orientation as the muscle fibers.
- Leakage of fluid into the tissues, or death of the parasite, can trigger a strong inflammatory response, resulting in sterile abscess formation accompanied by localized pain and swelling.
- **Diagnosis of Taeniasis and Cysticercosis:**

1. Stool for ova and cysts.- Proglottids and eggs are identified by microscopy.
2. Histology for cysticercosis.
3. Serology detection tests with Enzyme Linked Immunosorbent Assay (ELISA).

Treatment;

1. Albendazole.

2. **Praziquantel for cysticercosis**

Topic 1.2: CESTODES
(Hydatidosis)

Hydatid disease, also called hydatidosis or echinococcosis, is a cyst-forming disease resulting from an infection with the metacestode, or larval form, of **parasitic dog tapeworms from the genus Echinococcus.**

- To date, five species of Echinococcus have been characterized. The vast majority of human diseases are from;

1. Echinococcus granulosus and
2. Echinococcus multioccularis which cause cystic echinococcosis and alveolar echinococcosis, respectively.

- **Life Cycle**
- Hydatid disease is caused by infection with the larval form of E. granulosus (and/ or E. multiocularis) and results in the formation of cysts within various host tissues.
- The complete life cycle of Echinococcus granulosus requires two hosts.Domestic dogs act as the primary definitive host of the mature adult worms and a single infected dog may harbor millions of adult worms within its intestines.
- Other canines such as wild dogs, wolves, coyotes, foxes and jackals may also act as a definitive host harboring the adult tapeworms. Intermediate hosts become infected with the larval form of the parasite and include a wide range of herbivorous animals, primarily sheep, cattle, pigs, goats and horses.
- The life cycle is completed by the ingestion of one or more cysts and its contents by the canine host through the consumption of infected viscera of sheep and and/or other livestock. Protoscoleces released in the small intestine attach to the intestinal wall through the action of four suckers and a row of hooks and within two months mature into adult worms capable of producing infective eggs.
- Humans may become infected though the ingestion of food and/or water contaminated with infective eggs released in the feces of dogs harboring the adult
- tapeworm(s). Once ingested, the eggs release oncospheres capable of actively
- penetrating the intestinal mucosa.
- These oncospheres gain access to the blood stream via the hepatic portal vein and migrate to various internal organs where they develop into cysts. Hydatid cysts most oft en localize within the liver and the lungs; however, cysts may also form in the bones, brain, skeletal muscles, kidney and spleen.
- The clinical manifestations of hydatid disease vary depending on a variety of factors including the location, size and number of cysts present within the infected tissues.
- Life cycle of Echinococcus.
- Similar to E. granulosus, the complete life cycle of E. multiocularis also requires two hosts. Th e primary defi nitive host for E. multiocularis is the fox, although the parasite may also infect wild and domesticated dogs and occasionally cats. Rodents such as field mice, voles and ground squirrels act as natural intermediate hosts and acquire infection by ingesting infective eggs released into the environment.
- **Signs and Symptoms:**
- Echinococcus granulosus and Echinococcus multiocularis are the two species most oft en identified in human hydatid disease. Cystic echinococcosis, caused by E. granulosus, is the most common and accounts for approximately 95% of all
- global cases.
- Cystic echinococcosis may affect people of all ages, but hydatid cysts are most oft en present in patients between 15-35 years of age. Infection with E. granulosus results in the rapid growth of large, uniocular cysts fi lled with fluid . Most cysts develop within the tissues of the liver and lung, with 55-75% of cysts found in the liver and 10-30% of cysts found in the lungs.
- Cysts may survive in the liver for several years and oft en do not cause any symptoms in the infected host. Symptoms arise when the cysts become large enough to be palpable and/or cause visual abdominal swelling and pressure. Patients frequently experience abdominal pain in the right upper quadrant, oft en accompanied by nausea and vomiting.
- The rupture or leakage of cysts within the tissue can result in anaphylactic shock and facilitate the spread of secondary cysts through the release and dissemination of germinal elements. Biliary tract disease and portal hypertension may complicate liver involvement and post obstructive infection due to erosion of cysts into the biliary tract may further complicate echinococcal infection. Pulmonary cystic echinococcosis is acquired early during childhood, but the clinical manifestations associated with the disease do not typically appear until the third or fourth decade of life.
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- Cysts residing within the lung tissue oft en remain silent producing little to no symptoms. Problems arise when cysts grow large enough to obstruct or erode a bronchus, oft en causing the rupture of cysts and the dissemination of cystic fluids. Patients infected with pulmonary cysts frequently experience;

1. Chronic dry cough,
2. Chest pain and hemoptysis often accompanied by
3. Headache,
4. Sweating,
5. Fever and malaise.

- Hydatid disease can affect a wide range of organs including the bones, central nervous system, heart, spleen, kidneys, muscles and eyes. Patients diagnosed with the disease should be screened for the presence of multiple cysts in various tissues.
- **Diagnosis of hydatidosis:**
- Individuals affected normaly remain asymptomatic for many years;

1. Ultrasound of abdominal organs.
2. CT scan.
3. MRI.
4. Serological assay.
5. DNA PCR.

Treatment of hydatidosis;

1. Surgery.
2. Albendazole 400mg BD X 1-6/12.

opic 1.3:CESTODES (DIPHYLOBOTRIUM LATUM (FISH TAPEWORM OR BROAD TAPEWORM)

The broad tapeworm infecting man has worldwide distribution, occurring in areas where improperly cooked or raw fresh water fish is prominent in diet.

Morphology

Diphylobotrium latum is the broadest and longest tapeworm. The adult worm measures up to 30 feet with 3000-4000 proglottids, which are wider than they are long. The tapeworm has no rostellum hooks or suckers.

Life cycle

Unlike Taenia, the gravid segments are retained by the worm. Operculated eggs passed in feces hatch into small ciliated coracidium larvae which swim about freely. These are eaten by crustaceans -Cyclops or Diaptomus - in which the larvae develop into second stage larvae- the procercoid. When the crustaceans are swallowed by fresh water fish, the larvae migrate into the flesh of the muscle fish and develop to pleurocercoid or sparganum larvae.

Humans are infected by ingesting raw or improperly cooked fish. The tapeworm matures in the intestine and after 3 weeks, the adult worm discharges eggs. The life cycle requires two intermediate hosts.

Clinical manifestation

1. Most infections are asymptomatic.
2. Rarely, it causes
    1. Severe cramping,
    2. Abdominal pain,
    3. Vomiting,
    4. Weakness and
    5. Weight loss.
    6. Pernicious anemia can also result, due to interference of vitamin B12 absorption in jejunum.

Diagnosis

Eggs in stool: Single shell with operculum at one end and a knob on the other.

Treatment

Niclosamide: 2 gm PO stat after light breakfast.

Prevention:

Prohibiting the disposal of untreated sewage into fresh water /lakes.

Personal protection: cooking of all fresh water fish.

opic 1.4: CESTODES (HYMENOLEPSIS NANA/DWARF TAPEWORM)

Morphology

Adult worm measures 1-3 cm in length. It is made up of head (scolex), neck and segmented body. The head carries four suckers and a rostellum armed with one row of hooks. The segments of the body are divided into mature and gravid segments. In the mature segment, there are three testes in the middle.

Infective stage and mode of infection

The egg, which is immediately infective when passed by the patient, is rounded, about 40 microns in diameter. It contains a six- hooked oncosphere within a rigid membrane (the embryosphere). This embryosphere has two polar thickening or knobs from which project 4-8 long, thin filaments called polar filaments.

Infection takes place by:

1. Ingestion of egg with contaminated raw vegetables.
2. Direct infection from a patient

3. Auto infection: the eggs of H. nana are infective as soon as they are passed with feces by the patient. If the hands of the patient are contaminated by these eggs, she/he infects herself/himself again and again.

Pathogenecity

Light infections produce no symptoms. In fairly heavy infections, children may show lack of appetite, abdominal pain and diarrhea.

Treatment - Niclosamide: 4 tablets chewed in a single dose daily for 5 days

opic 1.5: TREMATODES (SCHISTOSOMIASIS/BILHARZIOSIS)

It is estimated that about 600 million people in 79 countries suffer from schistosomiasis (Bilharziasis). The schistosomes cause intestinal, hepatosplenic, pulmonary, urogenital, cerebral and other forms of schistosomiasis.

Schistosome is the only fluke with separate sexes. The female worm lies in the gynecophoral canal of the male. This condition is important for transportation.

There are five medically important species:

1. Schistosoma mansoni: causes intestinal schistosomiasis.
2. Schistosoma haematobium: causes vesical (urinary) schistosomiasis.
3. Schistosoma japonicum: causes intestinal schistosomiasis.
4. Schistosoma intercalatum: causes intestinal schistosomiasis.
5. Schistosoma mekongi: causes intestinal schistosomiasis. This seems to cause milder disease in man. It causes disease in other vertebrate hosts.

The first two schistosomes (S. mansoni and S. haematobium) are the most prevalent.

SCHISTOSOMA MANSONI

Habitat - This species lives in the veins of the intestine.

Geographical distribution: It is found in Africa, South America, Middle East (some Arab countries) etc. Stream and lake-based transmission is common.

The snail hosts that harbor S. mansoni are the genera: Biomphalaria (B. glabrata) and Trobicorbis. These have oval shells.

Morphology

Male: The male ranges in size from 1-1.4 cm in length and the body is covered by coarse tubercles. It has 6-9 testes

Female:The female is 1.5-2.0 cm in length. The ovary is present in the anterior third and Vitelline glands occupy the posterior two-thirds. It lays about 100-300 eggs daily. The uterus is short containing few ova.

URINARY SCHISTOSOMIASIS

Etiology - Schistosoma haematobium

Habitat - The worm lives in the veins of the bladder of humans.

The peak prevalence is the 10-14 year age group. The snail hosts that harbor S. haematobium are the genera Bulinus (Bulinus africanus, B. truncatus) and Physopsis.

Male:The male ranges in size from 1-1.5 cm in length. The body is covered by fine tubercles. It has 4-5 testes.

Female:The female ranges in size from 2-2.5 cm in length. The ovary is present in the posterior third. Vitelline glands occupy the posterior thirds. Uterus is long containing many ova. It lays about 20-200 eggs daily.

Distribution: In Ethiopia, S. haematobium is found in the Lower Awash Valley in the east and in Benshangul-Gumuz (Assossa) regional state in the west in low altitudes below 1000 meters above sea level.

SCHISTOSOMA JAPONICUM

The female adult worm lays about 500-3500 eggs daily. The eggs are ovoid, bearing only a minute lateral spine or a small knob postero-laterally. It is found in Japan, China, and Philippines, etc.

SCHISTOSOMA INTERCALATUM

This is the rarest and least pathogenic schistosome that matures in man. It is found in Western and Central Africa. The daily egg output is about 300. The eggs have a terminal spine.

LIFE CYCLE OF SCHISTOSOMES

Adult worms reside in pairs: the female lying in the gynecophoral canal of the male. After fertilization, eggs are passed into the venules. A larval form – the miracidium - develops within the egg. Its lytic enzymes and the contraction of the venule rupture the wall of the venule liberating the egg into the perivascular tissues of the intestine (S. mansoni) or urinary bladder (S. haematobium).

The eggs pass into the lumens and organs and are evacuated in the feces (S.mansoni) or the urine (S. haematobium). On contact with fresh water the miracidia hatch from the eggs and swim about until they find the appropriate snail, which they penetrate. After two generations of sporocyst development and multiplication within the snail, the fork-tailed cercariae emerge. Infection to man takes place during bathing or swimming.

The cercariae penetrate the skin, are carried into the systemic circulation and pass through to the portal vessels.

Within the intrahepatic portion of the portal system, the worms feed and grow to maturity.

Symptoms and complications

1. Patients infected with S. haematobium suffer from terminal haematuria and painful micturition. There is inflammation of the urinary bladder (cystitis), and enlargement of spleen and liver.
2. Patients infected with S. mansoni suffer from cercarial dermatitis (swimmers itch) and dysentery (mucus and blood in stool with tenesmus) as well as enlargements of the spleen and liver.
3. S. haematobium causes squamous cell carcinoma in the bladder.

Laboratory Diagnosis

1. S. mansoni

1. Microscopic examination of the stool for eggs after concentration by sedimentation method. The egg has characteristic lateral spine.
2. Rectal snip

2. S. haematobium:

1. Examination of the urine after allowing it to sediment in a conical urinalysis glass. A drop from the sediment is taken and examined for eggs. Egg has terminal spine.
2. Biopsy from bladder

Treatment:

Praziquantel: single oral dose of 40 mg/kg divided into two doses.

Prevention:

1. Health education:

1. On use of clean latrines and safe water supply
2. Avoid urination and defecation in canals, avoid contact with canalwater

2. Snail control:

A. Physical methods:

1. Periodic clearance of canals from vegetations.
2. Manual removal of snails and their destruction.

B. Biological methods: Use of natural enemies to the snails such as Marisa.

C. Chemical methods: Molluscides are applied in the canals to kill the

snails. e.g. Endod

Topic 1.6: TREMATODES (FLUKES)

INTESTINAL FLUKES

1. Fasciolopsis buski: These giant intestinal flukes (2-7.5 cm in length) are found in some Asian countries.
2. Heterophyids: Minute flukes acquired by ingestion of raw fresh water fish. They are found in Asian countries.

1. LIVER FLUKES

1. Clonorchis sinensis: Chinese liver fluke - adult worms live in bile ducts.
2. Faciola hepatica: Sheep liver fluke - is a common parasite, cosmopolitan in distribution. It is large (3 cm in length). Adult worms reside in the large biliary passages and gall bladder.
3. Faciola gigantica: lives in the liver of cattle. Human infections are very rare.

2. LUNG FLUKES

At least eight different species of lung flukes, all belonging to the genus Paragonimus, are known to infect man. Paragonimus westermani, best known species, affects man causing paragonimiasis (lung disease). It is found in Asia (China, India, Indonesia, Malaya etc) and some African countries.

Topic 1.7: NEMATODES (INTRODUCTION)

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- All the important human parasites of the Phylum Nemathelminthes (Aschelminthes) belong to the Class Nematoda.
- **GENERAL CHARACTERISTICS OF NEMATODES**

1. They are un-segmented, elongated and cylindrical.
2. They have separate sexes with separate appearances.
3. They have a tough protective covering or cuticle.
4. They have a complete digestive tract with both oral and anal openings.
5. The nematodes are free living (Majority) or parasites of humans, plants or animals.

-
- **The parasitic nematodes:**
- The nematodes are generally light cream-white colored. Their life cycle includes: egg, larvae and adult.
- The parasitic nematodes are divided into:
- **1. Intestinal nematodes**
- **1) Intestinal nematodes with tissue stage**

1. Ascaris lumbricoides
2. Hookworms
3. Strongyloides stercoralis

-
- **2) Intestinal nematodes without tissue stage**

1. Enterobius vermicularis
2. Trichuris trichuira.

-
- **2. Tissue and blood dwelling nematodes**

1. Filarial worms
2. Dracunculus medinensis
3. Trichinella
4. Larva migrans.

opic 1.8:NEMATODES (ASCARIOSIS)

ASCARIS LUMBRICOIDES

These are common roundworms infecting more than 700 million people worldwide.

Morphology:

Male adult worm measures 15-20 cm in length. The posterior end is curved ventrally. The female worm measures 20-40 cm in length. Its posterior end is straight.

Infective stage and modes of infection: The egg containing larva when ingested with contaminated raw vegetables causes ascariasis.

Life cycle:

Ingested eggs hatch in the duodenum. The larvae penetrate the intestinal wall and circulate in the blood. From the heart they migrate to the lungs, ascend to the trachea, descend to the esophagus and finally reach the small intestine to become adult. The female pass immature eggs which pass to the soil and mature in 2 weeks.

Pathogenecity and clinical features

Adult worms in the intestine cause abdominal pain and may cause intestinal obstruction especially in children. Larvae in the lungs may cause inflammation of the lungs (Loeffler's syndrome) – pneumonia-like symptoms.

Diagnosis

1. Examination of stool for eggs by direct saline smear method. The egg is ovoidal, 75x60 microns, covered by albuminous mamillatins.
2. Demonstration of adult worms

Treatment

1. Mebendazole,
2. Albendazole and
3. Piperazine

Topic 1.9: NEMATODES (HOOK WORM)

There are two species of hookworm:

1. Ancylostoma duodenale
2. Necator americanus

The adults are found in the small intestines of man. Mixed infection is common. Both of the species are found in Kenya, but N. americanus is more common.

Ancylostoma duodenale:

Grayish-white in color. The body is slightly ventrally curved. The anterior end follows the body curvature. The buccal cavity is provided ventrally with pairs of teeth and dorsally with a notched dental plate.

Distribution: This species is found in the northern part of the world including China, Japan, Europe, North Africa and Ethiopia.

Morphology

Male: The male measures 10 cm in length. The posterior end is broadened into a membraneous copulatory bursa that is provided with two long spicules.

Female: The female measures 12 cm in length. The posterior end is straight.

Necator americanus

This species, so called American hookworm, is found in predominantly the tropics. The anterior end is hooked against the body curvature. The mouth is provided ventrally and dorsally with cutting plate.

Morphology

Male: The male measures 8 cm in length. The posterior end is broadened into a membraneous copulatory bursa, which is provided with two long spicules fused distally.

Female: The female measures 10 cm in length. The posterior end is straight Infective stage and methods of infection:

The filariform larva infects by skin penetration.

Life cycle

Adult male and female worms live in the small intestine. The female lays eggs (oval, 60x40 microns), which contain immature embryo in the 4 cell stage. When the eggs pass in the stool to the soil and under favorable conditions of temperature, moisture and oxygen, they hatch into larvae, which molt twice and become infective. When the filariform larvae penetrate the skin, they circulate in the blood, reach the lungs, ascend to the trachea, descend to esophagus to reach the small intestine and become adults.

Pathogenecity

Adult worms in the intestine feed on blood causing iron deficiency anemia. Thelarv ae may cause inflammation of the lungs.

Diagnosis: Examination of stool by direct saline smear to detect the eggs.

Treatment

Mebendazole: 1 tab 2x daily for 3 days.

opic 1.10; NEMATODES (LARVAE MIGRANS)

There are three types of larva migrans:

- **1. Cutaneous larva migrans (Creeping eruption)**
- Various animals harbor hookworms. Two species of dogs and cats are important.

    1. Ancylostoma braziliens: infects both dogs and cats.
    2. Ancylostoma caninum: infects only dogs.

Both of these are common in the tropics and subtropical regions where human hookworms can best complete their life cycles. If man comes in contact with infective larvae, penetration of the skin may take place; but the larvae are then unable to complete their migratory cycle. Trapped larvae may survive for weeks or even months, migrating through the subcutaneous tissues.

They may evoke a fairly severe reaction - pruritus and dermatitis. The dermatitis leads to scratching and then bacterial superinfection.

Treatment

1. Thiabendazole: Applied topically.

2. Visceral larva migrans

A syndrome caused by the migration of parasitic larvae in the viscera of a host for months or years. It may be caused by transient larval migration in the life cycles of several parasites such as hookworm, Ascaris lumbricoides, T. spiralis, S. strecoralis and other filarial worms.

3. Toxocariasis

This is a kind of visceral larva migrans caused by

1. Toxocara canis (Dog ascarid) and
2. Toxocara catis (Cat ascarid).

These cause persistent larval migration and thus the visceral larva migrans is called toxocariasis.

Morphology

1. The larvae of Toxocara canis and Toxocara catis measure about 400 µm in length.
2. The life cycle of these parasites in their respective hosts is similar to that of A. lumbricoides in humans.

Epidemiology

Visceral larva migrans is cosmopolitan in distribution.

Transmission:

Ingestion of eggs of Toxocara species in contaminated food or soil or direct contact with infected patients. Children are more at risk.

Clinical features:

1. Majority are asymptomatic.
2. Eosinophilia
3. Cerebral, myocardial and pulmonary involvement may cause death.

Diagnosis - Identification of larvae in tissue.

Treatment - Thiabendazole: 25 mg/kg twice daily for 5 days.

4. C. Intestinal larva migrans

This is an extremely rare kind of larva migrans

Topic 1.11:NEMATODES (STRONGYLOIDES STERCORALIS)

Morphology;

The worms may be present as parasitic in the host or free living in the soil.Morphology:

Male: The male measures1 mm in length with curved posterior end and carries two spicules

Female: The female measures 2.5 mm in length with straight posterior end.

Infection: follows skin penetration by filariform larvae.

Life cycle

Adult male and female worms live in the small intestine. After fertilization, the female penetrates the mucosa of the small intestine and lay eggs in the submucosa. The eggs hatch and the larvae penetrate the mucosa back to the lumen. If the environmental conditions are favorable, the larvae will come out with the stool to the soil.

They transform into adults, which lay eggs, and hatching larvae get transformed to adults and so on. If the environmental conditions are not favorable, the larvae in the stool will moult and transform into infective filariform larvae, which pierce the intestine (auto-infection). Larvae penetrating the skin from the soil or by autoinfection are carried by the blood to the lungs, ascend to the trachea, descend to the esophagus and mature in the small intestine.

Clinical presentation

The patient complains of mucoid diarrhea. Larvae in the lungs may cause pneumonia.

Disseminated strongyloidiasis:

Multiplicity of symptoms are present due to the injury of other organs by the migrating larvae. Organs such as liver, heart adrenals, pancreas, kidneys, and CNS, etc. may be affected. This is usually seen in immunocompromized individuals.

Diagnosis - Detection of rhabditiform larvae of strongyloides in stool.

Treatment:

1. Thiabendazole: 25 mg/kg twice daily for 3 days.

opic 1.12: NEMATODES (ENTEROBIUS VERMICULARIS/PIN WORM/THREAD WORM)

Enterobius vermicularis is a small white worm with thread-like appearance. The worm causes enterobiasis. Infection is common in children.

Morphology
Male: **The male measures 5 cm in length. The posterior end is curved and carries a single copulatory spicule.**
Female: **The female measures 13 cm in length. The posterior end is straight.**

Infective stage
Infection is by ingestion of eggs containing larvae with contaminated raw vegetables.

Mode of infection

1. **By direct infection from a patient (Fecal-oral route).**
2. **Autoinfection: the eggs are infective as soon as they are passed by the female worm. If the hands of the patient get contaminated with these eggs, he/she will infect him/herself again and again.**
3. **Aerosol inhalation from contaminated sheets and dust.**

Life cycle
Adult worm lives in the large intestine. After fertilization, the male dies and the female moves out through the anus to glue its eggs on the peri-anal skin. This takes place by night. The egg is 50x25 microns, plano-convex and contains larva. When the eggs are swallowed, they hatch in the small intestine and the larvae migrate to the large intestine to become adult.

Clinical presentation
The migration of the worms causes allergic reactions around the anus and during night it causes nocturnal itching (pruritus ani) and enuresis. The worms may obstruct the appendix causing appendicitis.

Diagnosis

1. **Eggs in stool: Examination of the stool by direct saline smear to detect the egg: this is positive in about 5% of cases because the eggs are glued to the peri-anal skin.**
2. **Peri-anal swab: The peri-anal region is swabbed with a piece of adhesive tape (cellotape) hold over a tongue depressor. The adhesive tape is placed on a glass slide and examined for eggs. The swab should be done in the early morning before bathing and defecation.**

Treatment
Mebendazole; Piperazine.
opic 1.13:NEMATODES (TRICHURIS TRICHURIA/WHIP WORM)

Morphology:

The worm is divided into a thin whip-like anterior part measuring 3/5 of the worm and a thick fleshy posterior part of 2/5 the length.

Male: The male measures 3-4.5 cm in length. Its posterior end is coiled and possesses a single cubicle.

Female: The female measures 4-5 cm in length. Its posterior end is straight Infective stage and mode of infection Infection is by ingestion of eggs containing larvae with contaminated raw vegetables.

Life cycle:

Ingested eggs hatch in the small intestine and the larvae migrate to the large intestine to become adult. After mating, the female lays immature eggs, which pass with the stool to the soil and mature in 2 weeks.

Symptoms

The patient complains of dysentery (blood and mucus in stool together with tenesmus). Rectal prolapse is also possible.

Diagnosis

Finding of characteristic eggs. The egg of trichuris is barrel-shaped, 50x25 microns. The shell is thick with a one mucoid plug at each pole.

Treatment

1. Mebendazole: 1 tablet twice daily for 2 days.

opic 1.14: NEMATODES (FILARIAL WORMS)

The filarial worms have complex life cycles involving a developmental stage in an insect vector. They require an arthropod vector for their transmission. The worms inhabit either the lymphatic system or the subcutaneous tissues of man.

The female worm gives rise to a young worm called microfilaria. The microfilariae, when taken by the arthropod intermediate host during biting, develop into filariform larvae, which are the infective stages. Humans get infected when bitten by the infected arthropod intermediate host.

1. Wuchereria bancrofti
This is a parasite of lymph nodes and lymphatic vessels- causing lymphatic filariasis. This filarial worm is transmitted by the bite of various species of mosquitoes. It is believed that over 100 million people are infected.
The microfilariae are nocturnal – seen in greatest numbers in peripheral blood in the night between 10 PM -2 AM.

The physiological basis of this nocturnal periodicity is not understood.

Mode of transmission and pathogenesis

The filariform larvae are introduced through the skin by the bite of the arthropod intermediate host. The larvae invade the lymphatics, usually the lower limb, where they develop into adult worms. The microfilariae are librated into the blood stream.

They remain in the pulmonary circulation during day, emerging into the peripheral circulation only during night, to coincide with the biting habit of the vector. Presence of the adult worms causes lymphatic blockage and gross lymphedema, which sometimes lead to elephantiasis.

Epidemiology: W. bancrofti infection is not reported in higher , but limited to lowlands of Gambella. The epidemic area covers a long distance along the Baro River.

Pathogenecity and clinical features:

1. The adult worm obstructs the flow of lymph in the lymph nodes and the lymphatic vessels draining the lower limbs and the external genitalia.
2. The lower limbs and external genitalia become swollen. The skin becomes thick and fissured. The disease is called bancroftian elephantiasis.
3. The major symptoms and findings include:
    1. Lymphangitis,
    2. Lymphedema,
    3. Fever,
    4. Headache,
    5. Myalgia,
    6. Hydrocele and
    7. Chyluria.

Diagnosis

Blood film examination after staining by Giemsa or Leishman stain to detect microfilaria. The film should be taken by night.

Treatment - Diethyl carbamazine (DEC): 2 mg/kg 3x daily for 2 weeks.

2. Endemic non-filarial elephantiasis (Podoconiosis)
Non-filarial elephantiasis of the lower limbs is common in mining areas. Silicon, aluminium and iron particles in the red clay soil are absorbed through skin abrasions in bare footed persons. The mineral particles cause obstruction of the lymphatics.

3. Onchocerca volvulus/river blindness
Morphology:

Male: Similar to that of Wuchereria bancrofti.

Female: The female measures 30-50 cm in length. It is present inside of a fibrous nodule (onchocercomata or onchocerca tumor).

Intermediate Host and vector

Female Simulium, (Simulium damnosum), Black fly, found around plantations following rivers or river basins.

Microfilaria;Measures 300 microns in length. It is non-sheathed microfilaria. It is present in the subcutaneous tissue fluids and not in blood.

Infective stage and mode of infection is similar to that of Wuchereria bancrofti.

Pathogenecity and clinical manifestations:

1. The disease, onchocerciasis or river blindness includes:
2. Skin fibrous nodules (onchocercomata) enclosing female worms. The nodules are common in neck, iliac crest and the coccyx.
3. Skin hypo- or hyper- pigmentation. Dermatitis is present. In advanced cases, the skin becomes thickened and wrinkled, showing lizard or leopard skin appearance.
4. Elephantiasis of the external genitalia and corneal opacity and optic atrophy may finally cause blindness.

Diagnosis

Superficial biopsy (skin snip) is taken from the skin using sharp razor blade. The specimen is allowed to stand for 30 minutes in saline before it is examined microscopically for microfilariae.

Treatment

Ivermectin: 50 mg/kg bodyweight, given every 6 or 12 months. Because it kills microfilariae but not adult worms, retreatment is necessary over a period of years.

Prevention

1. Vector control
2. Mass treatment
3. Establishment of villages away from Simulium breeding places.
4. Use of repellents
5. Protective clothing

4. Loa loa/ Eye worm
The eye worm, Loa loa, causes Loiasis. The insect vectors include mango flies of Chrysops - Chrysops silacea, Chrysops dimidiata. Loiasis is endemic in Central and West Equatorial Africa. The abundant rubber plantations provide a favorable environment for the vector to transmit the disease.

Morphology

1. Adult male worms: 30-34 mm in length
2. Adult female worms: 40-70 mm in length

Pathogenesis

The microfilaria have a sheath. Their diurnal periodicity corresponds to the feeding pattern of the insect vector, which bites humans from 10:00 AM to 4:00 PM.

Clinical Features

Incubation period is about one year. It causes calabar swelling beneath the skin due to parasites. There is fever, pain, pruritus, urticaria, allergic reactions, retinopathy, glomerulonephritis, meningo-encephalitis etc.

Laboratory diagnosis

1. Detection of microfilaria in peripheral blood, urine, sputum, CSF - stained with Giemsa or unstained
2. Eosinophilia

Treatment

DEC, 6 to 10 mg per kilogram per day for 2 to 3 weeks: but has side effects - allergic reactions

Topic 1.15: NEMATODES (DRACUNCULUS MEDINENSIS/GUINEA WORM/MEDINA WORM) AND TRICHINOSIS

DRACUNCULUS MEDINENSIS;

Dracunculus medinensis causes dracunculiasis. The infection is endemic to Asia and Africa: India, Nile Valley, central, western and equatorial Africa.

Morphology

Gravid female worms measure 70-120 cm in length. Their body cavity is almost fully occupied by a uterus greatly distended with rhabditiform larvae (250-750 μm in length). A digestive tube and cuticular annulations distinguish the larvae from microfilariae.

Pathogenecity and life cycle

Infection is acquired by drinking unfiltered or not boiled water that contains Cyclops species. The larvae are released in the stomach, penetrate the intestinal wall and find their way to the subcutaneous tissue. Mating takes place in the axillary or inguinal regions 3 months after infection.

The male worms then die in the tissue and the female worms move down to the limbs within 10 months. In about 1 year, female worms in the subcutaneous tissue provoke the formation of a burning blister in the skin of the legs. When in water, the blister bursts, and about 5 cm of the worm is extruded from the resulting ulcer - thus releasing many thousands of first stage larvae.

The larvae swim in water and are ingested by the intermediate host - Cyclops species- within about 4 days. Inside the Cyclops, the larvae molt twice and become infective in 2 weeks

Clinical features;

1. The female parasites in the subcutaneous tissue release toxic byproducts of histamine-like nature, which cause systemic allergic reactions, like;
    1. Erythema,
    2. Urticaria,
    3. Pruritus,
    4. Fainting,
    5. Asthma,
    6. Dyspnea, etc.
2. This is followed by the appearance of a blister on the legs, which ruptures on contact with water releasing larvae into the water by the female worm. The wound may ulcerate.
3. The worms migrate into other tissues and may cause;
    1. Arthritis,
    2. Pericarditis,
    3. Abscesses etc. It occasionally penetrates the eyeball and causes loss of the eye.

Diagnosis;

1. Clinical: Observation of blister, worm or larvae
2. Histologic features of subcutaneous sinus tract
3. Eosinophilia and radiographic evidence

Treatment

1. Surgical excision when the worm is in the leg
2. Niridazole (Ambilhar) or DEC

Prevention;

Health education on:

1. Boiling or filtering of drinking water
2. Treating of patients and educating them not to enter water bodies
3. Using insect larvicides to kill Cyclops in water.

TRICHINOSIS

Etiologic agent - Trichinella spiralis

This is the only important species in this group. It causes trichinosis - a cosmopolitan infection. More than 100 different animal species can be infected with Trichinella species, but the major reservoir host for human infections is swine.

Morphology

Adult female worm measures 3-4 mm in length and the adult male worm measures 1.4-2.6 mm in length. The encysted larvae measure 800-1300 µm in length.

Pathogenecity and life cycle

After ingesting infected meat, the capsule of the encysted larvae is digested by gastric juice, and the larvae are released in the duodenum or jejunum where they molt four times to become adult worm. After mating, the male worm dies and the female worm begins to deliver the embryos 4-7 days after the infection.

The larvae penetrate the intestinal wall and migrate through the lymphatic vessels to the blood stream, which carries them to various organs. Skeletal muscles and diaphragm are most frequently parasitized. Others include the tongue, masseter and ocular muscles.

Clinical features

There are two clinical phases.

1. The intestinal phase: lasting 1-7 days - asymptomatic; sometimes cause ;
    1. Nausea,
    2. Vomiting,
    3. Diarrhea,
    4. Constipation,
    5. Pain, etc, and
2. The muscle phase: which causes;
    1. Myalgia,
    2. Palpabral edema,
    3. Eosinophilia,
    4. Fever,
    5. Myocarditis,
    6. Meningitis,
    7. Bronchopneumonia etc.

Diagnosis:

1. Muscle Biopsy
2. Detection of larvae in blood or CSF
3. Detection of larvae and adult worms in stool (rare).
4. ELISA

Treatment - Thiabendazol

Prevention

1. Cooking of all meat before consumption
2. Inspection of pigs
3. Pork must be stored at -150C for 20 days.

SUMMARY OF HELMINTHS

1. Helminths are parasites that can inhabit the intestinal tract, blood, tissue and other body organs.
2. Helminths are broadly classified into three;
    1. Nematodes- the roundworms.
    2. Cestodes- the tapeworms.
    3. Trematodes- the flukes.
3. Helminths have several attaching structures including;
    1. Rostellum-crown of thorns with hooks.
    2. Cutting teeth.
    3. Cutting plate.
4. Helminths cause disruption of the host nutrients absorption by utilizing all nutrients passing through the intestinal tract.

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MEDICAL PARASITOLOGY

GENERAL PARASITOLOGY

TOPICS

Introduction to parasitology

Parasite

Why a human embryo or fetus is not a parasite?

Host

Host parasite relationship

Sources of infection

TOPIC CONT

Portal of entry into the body

Life cycle of human parasite

Pathogenicity

Immunity in parasitic infection

Laboratory diagnosis

Classification of parasites

INTRODUCTION TO PARASITOLOGY

Parasitology is the area of biology concerned with the phenomenon of dependence of one living organism on another.

INTRO CONT

Medical parasitology deals with the parasites which infects man , the disease they produce , the response generated by him against them, and various methods of diagnosis, prevention and treatment

PARASITE

A parasite is an organism that is entirely dependent on another organism ,referred to as HOST ,for all or part of its life cycle and metabolic requirements.

Strictly the term parasite can be applied to any infectious agent but, by convention, it is generally restricted to infections caused by protozoa and helminths and excludes the viruses, bacteria and fungi.

TYPES OF PARASITES

Parasite is of two types;

1] MICROPARASITE

2] MACROPARASITE

MICROPARASITE

It is a small ,unicellular and multiplies within vertebrate host, often inside cells.

Protozoa are microparasite

MACROPARASITE

It is a large , multicellular organism and has no direct reproduction within the vertebrate host.

This category includes helminths

BASED ON THE LOCATION

Parasites may also be divided into two

a] Ectoparasite

b] Endoparasite

ECTOPARASITE

These are organisms which live on the surface of the body ,e.g..,the human louse, *pediculus humanus* .

The infection by these parasites is known as ***infestation.***

They are important as vector transmitting pathogenic microorganisms

ENDOPARASITES

Organisms that live within the body of the host are known as endoparasites

All protozoa and helminthic parasites of man are endoparasites

The invasion by the endoparasites is known as ***infection***

ENDOPARASES can be further subdivided into;

A] ***Obligate parasite***; organism that can not exist without a host (e.g. *Toxoplasma gondii)*

B] ***Fucultative parasites***: Organisms that under favourable circumstances may live either a parasitic or free living existence (eg *Naegleria fowleri, Acanthaamoeba spp, and Balamuthia mandrilaris)*

ENDOPARASITES CONT;

C] ***Acidental parasite;*** Organism that attact an unusual host (eg *Echimoccocus granulosus* in man)

D] ***Abbarant parasites;*** Organism that attack a host where they cannot live or develop further. (Eg *Toxocara canis* in man)

E] ***Free –living;*** The term free-living describe the non-parasitic stage of existence which are lived independently of a host, eg hookworm have active free-living stage in the soil

WHY HUMAN EMBRYO OR FETUS IS NOT A PARASITE

Human embryo or fetus develop inside the uterus of the mother for more than nine months deriving its nourishment from the mother. In spite of this its never treated as a parasite.

Reasons being;

S.No	parasite	Human embryo or fetus
1	A parasite is an organism of one species living in or on an organism of other species(a hetero specific relationship)and deriving its nourishment from the host	A human embryo or foetus is an organism of one species(homo sapiens)living in the uterine cavity of an organism of the same species and deriving its nourishment from the mother. This is a dependent relationship, and not a parasitic relationship
2	A parasite is an invading organism coming to parasitize the host from an outside source	A human embryo or foetus is formed from a fertilized egg coming from an inside source, being formed in the ovary of the mother where it moves into the oviduct where it may be fertilized to form the zygot, the first cell of the new human being

3	**A parasite is generally hamful to some degree to the host**	**Human embryo or fetus developing in the uterine cavity does not usually cause harm to the mother, provided proper care and nutrition is maintaind by the mother**
4	A parasite makes direct contact with the host's tissue often holding by mouth parts, hooks, or suckers to the tissues involved (intestinal lining, lungs connective tissues etc)	Human embryo or fetus makes direct contact to the uterine lining of the mother for only a short period of time. It soon becomes isolated in its own amniotic sac and makes indirect contact with the mother only by way of umbilical cord and placenta
5	When a parasite invades the host tissue, the host tissue sometimes responds by making a capsule of connective tissue to surround the parasite and cut it off from other surrounding tissues	When the embryo or fetus attaches and invades te lining of the mother's uterus, the lining tissue responds by surrounding the human embryo but does not cut it off from the mother. Rather it establishes a means of close contact(placenta) between the mother and the new human being

6	When a parasite invades the host, the host usually responds by forming antibodies in respond to somatic antigens(molecule comprising the body of the parasite) or metabolic antigens9 molecules secreted or excreted by the parasite).Parasitism usually involves an immunological response on the part of the host.	Mother does not react to the presence of the embryo by producing humoral antibodies, but the trophoblast (the jacket of the cells surrounding the embryo) blocks the action of these antibodies and therefore the embryo of the foetus is not rejected. This reaction is unique to the embryo-mother relationship

End

questions

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MEDICAL PARASITOLOGY

HOST

DEFINITION;

HOST is defined as an organism which habours the parasite and provide nourishment and shelter to the latter.

TYPES OF HOSTS

Definitive Host; The host which harbours the adult parasite, the most highly developed form of a parasite or where the parasite replicates sexually.

When the most highly developed is not obvious, the definitive host is the mammalian host

Intermediate Host; This is the host which alternates with the definitive host and harbours the larval stage or sexual stages of a parasite.

Some parasites require two intermediate hosts for completion of their life cycle

Paratenic Host; It is host in which larval stage of parasites survives but does not develop further.

It is often not a necessary part of the life cycle.

Reservoir Host; It is a host that harbours the parasite and serves as an important source of infection to other susceptible hosts.

Epidemiologically reservoir hosts are important in the control of parasitic diseases.

Compromised Host; Is one in whom normal defense mechanisms are impaired (e.g. AIDS),absent (e.g. Congenital deficiencies), or bypassed (e.g. Penetration of skin barrier).

Such hosts are extremely susceptible to a variety of common as well as opportunistic pathogens

ZOONOSIS

This is a term used to describe an animal infection that is naturally transmittable to human either directly or indirectly via a vector.

Examples of parasitic diseases that are zoonotic include: *leishmaniasis, trypanosomiasis,rhodesiense trypanosomiasis,japonicum schistosomiasis, trichinois, fascioliasis, hydatid disease and cryptosporidiasis*.

VECTOR

A vector is an agent , usually an insect, that transmits an infection from one human host to another.

Mechanical vector is a term used to describe a vector which assists in the transfer of parasitic form between host but is not essential in the life cycle of the parasite.

Example of a vector is …a housefly that transfers amoebic cysts from infected faeces to food that is eaten by human

HOST- PARASITE RELATIONSHIP

This is the way the host and the parasites relates;

These relationship are;

SYMBIOSIS

It is an associations in which both host and the parasite are so dependent upon each other that one cannot live without the help of the other.

Neither of the partners suffers from any harm from this association.

COMMENSALISM

An association in which only parasite derives benefit without causing any injury to the host.

A commensal lives on food residues or waste products of the body and is capable of leading an independent life.

PARASITISM

Parasitism is a relationship in which a parasite benefits and the host provides the benefit. The host gets nothing in return and always suffer some injury.

The degree of dependence of a parasite on its host varies

End

questions

SOURCES OF INFECTIONS

Infections by parasites(parasitic infections)originates from the following sources:

1]Contaminated soil and water; soil polluted by human excreta acts as a source of infection with

-Ascaris lumbricoides-,Trichuris trichiura ,-Ancylostoma duoenale-,Necator americanus, Strongiloides stercoralis

Before acquiring infectivity for man , eggs of these parasites undergo certain development in soil

These are known as ***soil transmitted helminths***

Water polluted with human excreta may contain viable cysts of ….*Entamaoeba histolytica, Giardia lamblia, Balantidium coli,* eggs of *Taenia solium, Hymenolepsis nana,* and infective cercaria stages of *Schistosoma haematobium, S. mansoni and S. japonicum*

2] Fresh water fishes; constitute the source of *Diphyllobothrium latum* and *Clonorchis sinensis.*

3]Crabs and crayfishes; are the sources of *Paragonimus westermani.*

4] Raw or undercooked pork; is the source of *Trichinella spiralis,T.solium,T.saginata asiatica and Sarcocystis suihominis.*

5] ***Raw or undercooked beef;*** is the source of *T. saginata, Toxoplasma gondii* and *S. hominis*

6]Watercress; Is the source of *Fasciolata hepatica*

+9N

7] blood sucking insect transmits *Plasmodium spp, Malayi , Onchocerca , Wuchereria bancrofti , Brugia brucei , T . cruzi , Leishmanial spp.* And *Babesia volvulsus, Tryposonoma spp.*

8] housefly (mechanical carrier) is the source of E.histolytica

9] dog is the source of *Echinococcoccus granulosus and Toxocarca canis (visceral migrans*)

10] cat is the source of E. *histolytica , Giarda lamblia , Entorobius vermicularis and H.nana*

11] man is the source of *E. histolytica, Giarda lamblia , XEntorobius vermicularis and H. nana*

12.]Autoinfection may occur with E. vermicularis and S. stercoralis leading to **hyperinfection**

THE

END

PORTAL OF ENTRY INTO THE BODY

A] Mouth

The commonest portal of entry of parasites is oral, through contaminated food ,water, soiled fingers or formites . This mode of transmission is referred to as ***faecal-oral route.***

Many intestinal parasites,e.g ***E. histoltyica,G, lamblia E. coli,E vermicularis,T trichiura, A. lumbricoides,T.spiralis, T. solium, T.saginata asiatica, D.latum, F.hepatica, Fasciolopsis buski, C. sinensis and p westermani*** , enter the body in this manner

B] Skin

Entry through the skin is another important portal of entry of parasites.

nfection with A . duodenale,N. americanus and S.stercoralis is acquired when filari form larvae of these nematodes penetrate the unbroken skin of an individual walking over faecally contaminated soil.

Schistosomiasiasis caused by *S.haematobium,S.mansoni and S. japonicum* is acquired when the cercarial larvae, in water, penetrate the skin.

A large number of parasites, e.g *plasmodium spp. W. bancrofti, B.malayi, O.volvulus, T. brucei gambiense, T.b. rhodesiense, T.cruzi,Leishmania spp and Babesia spp.* Are introduced percutaneously when blood sucking arthropods puncture the skin to feed.

C] Sexual contact

Trichomonas vaginalis is transmitted by sexual contact.

E.histolytica and G.lamblia may also be transmitted by anal- oral sexual practices among male homosexuals

D] Kissing

E. gingivalis is transmitted from person- to person by kissing or from contaminated drinking utensils.

E] Congenital

Infection with T.gondii and plasmodium spp. May be transmitted from mother to foetus transplacentally.

F] Inhalation

Airborne eggs of E. vermicularis may be inhaled into posterior pharynx leading to infection.

G] Iatrogenic infection

Malaria parasites may be transmitted by transfusion of blood from the donor with malaria containing asexual forms of erythrocytic schizogony.This is known as trophozoites-induced malaria or transfusion malaria.

Malaria parasites may also be transmitted by the use of contaminated syringes and needles.This may occur in drug addicts.

LIFE CYCLE OF HUMAN PARASITES

On the basis of their **life cycles** human parasites can be divided into three major group

1] NO INTERMEDIATE HOST

2] ONE INTERMEDIATE HOST

3] TWO INTERMEDIATE HOST

No intermediate host

Protozoa	helminths
Entamoeba histolytica	Enterobius vermicularis
Giarda lamblia	Trichuris trichiura
Chilomastix mesnilii	Ascaris lumbricodes
Trichomonas vaginalis	Ancylostoma americanus
Balantidium coli	Nectar americanus
	Hymenolepsis nana

ONE INTERMEDIATE HOST

Intermediate Host	parasite	intermediate host	parasite
Pig	*Taenia solium*	*Mosquito*	*Wuchereria bancrofti*
	T.saginata asiatica		*Brugia malayi*
	Trichinella spiralis	*Snail*	*Schistosoma spp*
cow	*Taenia saginata*	*Copepod*	*Dracunculus medinensis*
man	*E. granulosis*	**Fly**	
	plasmodium spp.	*Sandfly*	*Leishmania spp*
flea	*dipylidium caninum*	*Tsetse*	*Trypanosoma spp*
	hymenolepsis diminuta	*Chrysops*	*Loaloa*
Triatomine bug	*Typanosoma cruzi*	*Simulium*	*Onchoscerca volvulus*

TWO INTERMEDIATE HOSTS

Intermediate hosts	**parasites**
Snail,crustacean	*paragonimus westemani*
Cyclops,fish	*Diphylobothrium latum*
Snail,fish	*clonorchis sinensis*
Snail,plant	fasciola spp.

END

PATHOGENISITY

PATHOGENISITY

PARASITE MAY LIVE IN OR ON THE TISSUES OF ITS HOST WITHOUT CAUSING EVIDENT HARM.HOWEVER,IN MAJORITY OF CASES THE PARASITE HAS THE CAPACITY TO PRODUCE DAMAGE.

With the advent of AIDS there is an increase in the incidence of newer parasitic infection caused by Cryptosporidium parvum ,Isospora belli, Cyclospora cayetanensis and other hitherto unheard of parasites..

these parasites also cause infection in patients who are immunocompromised,e.g patients receiving cytotoxic drugs or organ transplant.

WAYS IN WHICH PARASITE CAN CAUSE HARM

Following are the ways in which the damage may be produced by the parasites.

1]Traumatic damage

Relatively slight **physical damage** is produced by entry of filariform larvae of *S.stercoralis,A.duodenale* and *N.americanus* and cercarial larvae of *S.haematobium,S.mansoni and S.japonicamum* into the skin.

Migration of several helminthic larvae through the lung produces **traumatic damage** of pulmonary capillaries leading to extravasation of blood into the lung.

Similar damage in cerebral,retinal or renal capillaries may lead to serious injury.

Eggs of S. haematobium and S. mansoni cause **extensive damage** with haemorrhage as they escape from vesical and mesenteric venules, respectively,into the lumen of the urinary bladder and intestinal canal.

Attachment of hoookworms (A.duodenale and N. americanus) to the intestinal wall results in **traumatic damage** of the villi and oozing of the blood at the site of attachment.

Large worms, such as A.lumbricoides and T.saginata may produce **intestinal obstruction.**

Ascaris,in addition,may occlude lumen of the appendix or common bile duct, may cause perforation of the intestinal wall,or may penetrate into the parenchyma of the liver and the lungs.

2] Lytic necrosis

E.histoltyica secretes lytic enzyme which lyses tissues for its nutritional needs and helps it to penetrate into the tissues of the colon and extraintestinal viscera.

Obligate intacellular parasites,e.g plasmodium spp.,leishmania spp.,Tryposonoma cruzi and Toxoplasma gondii cause **necrosis of parasitized host cells** during their growth and multiplication.

3] Competition for specific nutrients

Diphyllobothrium latum competes with the host for vitamin B12 leading to **parasite –induced pernicious anaemia.**

4] Inflammatory reaction

Most of the parasites provoke cellular proliferation and infiltration at the site of their location.In many instances, the host reaction walls off the parasite by fibrous encapsulation.in metazoan and in some protozoan parasites,there is a moderate –to-notable eosinophilia.

Iron deficiency,pernicious and haemolytic anaemia develop in patients with hookworm disease,diphyllobothriasis and malaria,particullaly blackwater fever, respectively.

E.histolytica may produce inflammation of the large intestine leading to the formation of amoebic glanuloma or amoeboma.

Parasitization of fixed macrophages in the spleen, bone marrow and lymph nodes by L.donovani causes proliferation of reticuloendothelial cells.

5] Allergic manifestations

In certain helminthic infections,the normal secretions and excretions of the growing larvae and the products liberated from the dead parasites may rise to various allergic manifestations, e.g.,

- Schistosomes cause cercarial dermatitis and eosinophilia
- D.medinensis and T.spiralis infections cause urticarial and eosinophilia, and
- Rupture of hydatid cyst may precipitate anaphylaxis

6] Secondary infection

In some helminthic infections (e.g., Strongyloidiasis, Trichinosis and Ascariasis), the migrating larvae may carry bacteria and viruses from the intestine to the blood and tissues leading to the secondary infection .

7] Neoplasia

The parasitic infection may contribute to the development of neoplastic growth eg C.sinensis and Opisthorchis viverrini has been associated with **cholangiocarsinoma** and Schistosoma with **vesicular carcinoma**

IMMUNITY IN PARASITIC INFECTIONS

Because of their biochemical and structural complexity ,protozoa and helminths present a large number of antigens to their hosts.

Protozoa (microparasites) are small and multiply within their vertebrate host, often inside cells, thus posing an intermediate threat unless contained by an appropriate immune response

.Helminths (Macroparasites)are large and do not multiply within their vertebrate host. Thus they do not present an immediate threat after initial infection.

However, the host must protect itself from large infections and reinvasion by infective stages by eliciting an appropriate immune response..

Therefore, immune responses to protozoa and helminths are different from one another

Like other infectious agents, parasites also elicit both *humoral* as well as *cellular responses*. But immunological protection against parasitic infections is much less efficient than it is against bacterial and viral infections. This is due to following factors:

- As compared to bacteria and viruses,parasites are large and more complex structurally and antigenically so that immune system may not be able to mount immune response against the protective antigens.

- **Many parasites ,both protozoa and helminths, live inside the intestines. This location limits the efficiency of immunological attack and also facilitates dispersal of the infective forms of the parasites.**

Many protozoan parasites (e.g., leishmania spp., T.cruzi and T.gondii) are intracellular. This protects them from immunological attack

- **T. brucei gambiense and T.b.rhodesiensee exhibit antigenic variations within the host.**

when antibody response to one antigenic type reaches peak,antigenic variation of the parasite occurs by mutation.the new antigenic type is unaffected by the antibodies against the parent strain. This enables the prolonged persistence of the parasite in the host.

- **Plasmodium spp.,the cause of malaria, also change their surface antigens and are poorly antigenic. Malaria may continue for several months in a person before the immune response is sufficiently strong to reduce the number of the parasite.**

- **Blood flukes of humans, schistom spp.,adsorb host-produced molecules onto its surface so that the host fails to recognize the worms as nonself. The blood flukes can remain alive in the blood vessels of the human host for more than 10 years at least in part by utilizing this mechanism.**

- **Many nematodes have a cuticle which is antigenically inert and evokes little immune response.**
- **.**

- **L. donovani causes extensive damage to the reticuloendothelial system thus leading to immunological tolerance.**
- **E. vermicularis does not breach the integrity of gut wall, thus immune system is not stimulated**

In most of the parasitic infections, immunity lasts till original infection remains active. This is known as concomitant immunity(previously called premonition or infection- immunity

.A possible exception is cutaneous leishmaniasis in which the ulcer heals leaving behind good protection against reinfection.

N/B All the above mechanisms have made the production of vaccine against eukaryotic parasites extremely difficult.

The protective immune response to parasitic infections has four arms:

- *Cytotoxic T (Tc) cells*
- *Natural killer (NK) cells*
- *Activated macrophages*
- *Antibody(procuded by B –cells).*

The first three constituting ‘cell-mediated immunity’ and the last constituting ‘humoral immunity’.the main classes or antibodies (immunoglobulins) produced are IgM,IgG and IgE. The first to appear is Ig

The first to appear is IgM which marks the presence of acute infection.

IgG antibodies are usually the most abundant type in parasitic infections. Helminths and ectoparasites also provoke high titres of IgE antibodies.

END

LABORATORY DIAGNOSIS

Laboratory diagnosis of parasitic infections can be carried out by:

- **Demonstration of parasite**
- **Immunodiagnosis**
- **Molecular biological methods**

Demonstration of parasite

The definitive diagnosis is made by demonstrating of parasites in appropriate clinical specimens.

Blood

In those parasitic infections, where the parasite itself, or in any stage of its development , circulates in the blood stream,the examination of the blood film forms the demonstration of plasmodium spp. Inside the erythrocytes

Stool

Examination of stool is important in the diagnosis of intestinal parasitic infections and helmimthic infections of biliary tract in which eggs are discharged in the intestine.

In protozoal infections, the trophozoites(during active phase) and cysts(during chronic phase) of E. histolytica,G.lamblia and B.coli can be demonstrated by wet mount of stool in normal saline and lugol’s iodine

. In helminthic infections eggs,larvae and adult worms may be demonstrated.

when direct stool smears are repeatedly negative for ova and cysts then the concentrated methods such as salt floatation or formalin –ether concentrated may be used.

Cryptosporidium parvum,isospora belli and other coccidian in stool specimens may be detected bymodified ziehl-neelsen staining of the fixedsmear.

Demonstration of parasites in the stools confirms the diagnosis and is the gold standard in the diagnosis of intestinal parasitic infections.

Perianal and perineal skin scrappings

may show the eggs or adult worms of E . vermicularis.

PARASITES FOUND IN STOOL

CYSTS/ TROPHOZOITES

Protozoa

Entamoeba histolytica
heterophyes

Giarda lamblia

Dientamoeba fragilis

Balantidium coli

Sarcocystis hominis

gastrodiscoides hominis

wastonius watsoni

heterophyes

metagonimus yokogawai

opisthrorchis species

Nematodes

trichuris trichiura

s.suihominis

isospora belli

cyclospora cayetanensis

vermicularis

cryptosporium parvum

encephalitozoon intestinalis

enterocytozoon

ancylostoma duodenale

nectator americanus

enterobius

capillaria philippinensis

trichostrongylus

orientalis

Eggs	Larvae
cestodes	Strongyloides stercoralis
diphyllobothrium latum	Trichinella spiralis(rarely)
taenia solium	
T.saginata asiatica	Adult worms
T. saginata	Cestodes
Hymenolepsis nana	Taenia solium
H.diminuta	T.saginata
Dipylidium caninum	T.saginata asiatica

Trematodes	Nematodes
Schistosoma mansoni	Ascaris lumbricoides
S.japonicum	Ancylostoma duodenale
Fasciolopsis buski	Necator americanus
Fasciola hepatica	Enterobius vermicularis
F.gigantica	Trichinella spiralis
Clonorchis sinensis	

Urine

Genital specimens

Cerebrospinal fluid(CSF)

Sputum

Tissue biopsy and aspiration

Culture

Some parasites like E histolytica,Naegleria fowleri,Acanthamoeba spp, Balamuthia mandrillaris,leishmania spp, Trypanosoma spp, Trichomonas vaginalis, giardia lamblia and balantidium coli can be cultured in the laboratory

- **Xenic culture**: Culture of parasites grown in association with unknown microbiota are referred to as xenic culture eg E .histolytica
- **Monoxenic culture**: Is when parasites are grown with a single known bacterium. Example using specimen culture wuth E coli as a means ofvrecovering spp of Acanthamoeba and Neigleria
- **Axenic** : is when parasites are grown as pure culture without bacterium. Example using of mdia for isolation of Leishmania spp or Trypanosoma cruzi

- Animal innoculation
- Animal inoculation is the detection of T.gondii and Babesia spp in the clinical specimen

- Imunodiagnosis
- Immunodiagnosis test is of 2 types
    - Skin test
    - Serology test

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MEDICAL PARASITOLOGY

- Laboratory diagnosis of parasitic infections can be carried out by:
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Nematodes

gastrodiscoides hominis

wastonius watsoni

heterophyes heterophyes

metagonimus yokogawai

opisthrorchis species

trichuris trichiura

- s.suihominis ancylostoma duodenale
- isospora belli nectator americanus
- cyclospora cayetanensis enterobius vermicularis
- cryptosporium parvum capillaria philippinensis
- encephalitozoon intestinalis trichostrongylus
- enterocytozoon orientalis

Eggs	Larvae
cestodes	Strongyloides stercoralis
diphyllobothrium latum	Trichinella spiralis(rarely)
taenia solium	
T.saginata asiatica	Adult worms
T. saginata	Cestodes
Hymenolepsis nana	Taenia solium
H.diminuta	T.saginata
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- Imunodiagnosis
- Immunodiagnosis test is of 2 types
    - Skin test
    - Serology test

- Skin test
- These tests are performed by intradermal injction of the parasitic antigens and read as under
  - 1] Immediate hypersensitivity reaction: it reveals a wheal and flair response within 30 mins of injection—seen in schistosomiasis, hydatid dzs, ascariasis and strongyloidiasi
  - 2] Delayed hypersansitivity reaction:--reveals an erythema and induration after 48 hrsof injection. This is seen as in trypanosomiasis, leishmaniasis, toxoplamosis and amoebiasis

- Serology test
- This test detect the antibodies ou antigens in the serum and other clinical specimen

- Molecular biological method
- These includes DNA probes and Polymerase Chain Reaction [PCR]

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Laboratory diagnosis of parasitic diseases

- Parasitic diagnosis --- either microcopically or macroscopically (parasites) --- very common
- Cultrure methods (parasites)
- Immunodiagnostic methods (antigen and antibody detection) --- common
- Intradermal skin tests (immune reaction)
- Animal inoculation (parasites)
- Imaging techniques (shape/structure of parasites)

summary

Common exam questions

- ***WRITE SHORT NOTES ON***
- ***A] Parasite***
- ***B] Host***
- ***C] Sources pf infection of parasites***
- ***D] Portal of entry of parasites***
- ***E] Pathogenicity of parasitic infection***
- ***F] Immunity in parasitic infection***
- ***G] Laboratory diagnosis of parasitic infection***

Expected questions

- Write short notes on:
  - (a) Life cycle of parasite
  - (b) Reservoir host
  - (c) Parasite
  - (d) Carrier
- Differentiate between:
  - (a) Definitive host and intermediate host
  - (b) Direct and indirect life cycle

- Single choice questions

1. A host harboring adult or sexual stage of a parasite is called:

   (a) Definitive host (b) Intermediate host

   (c) Reservoir host (d) None of above

2. Parasite which may be transmitted by sexual contact is:

   (a) *Trypanosoma cruzi* (b) *Trichomonas vaginalis*

   (c) *Trypanosoma bruci* (d) *Ascaris*

3. Which of the following parasite is transmitted by dog:

   (a) *Taenia saginata* (b) *Hymenolepis nana*

   (c) *Echinococcous granulosus*

   (d) None of above

4. blood-sucking vector may transmit:

   (a) *Ascaris lumbricoides* (b) Hookworm

   (c) *Taenia saginata* (d) *Plasmodium*

mwisho