Introduction to medical parasitology

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Learning Outcomes

- At the end of our discussions, you should be able to do the following:
- Define the terminology & importance of parasitology.
- Classify parasites of medical importance.
- For each parasite describe the following:

1. Geographical distribution and life cycle,
2. Mode of transmission and means of diagnosis
3. Prevention, control and treatment

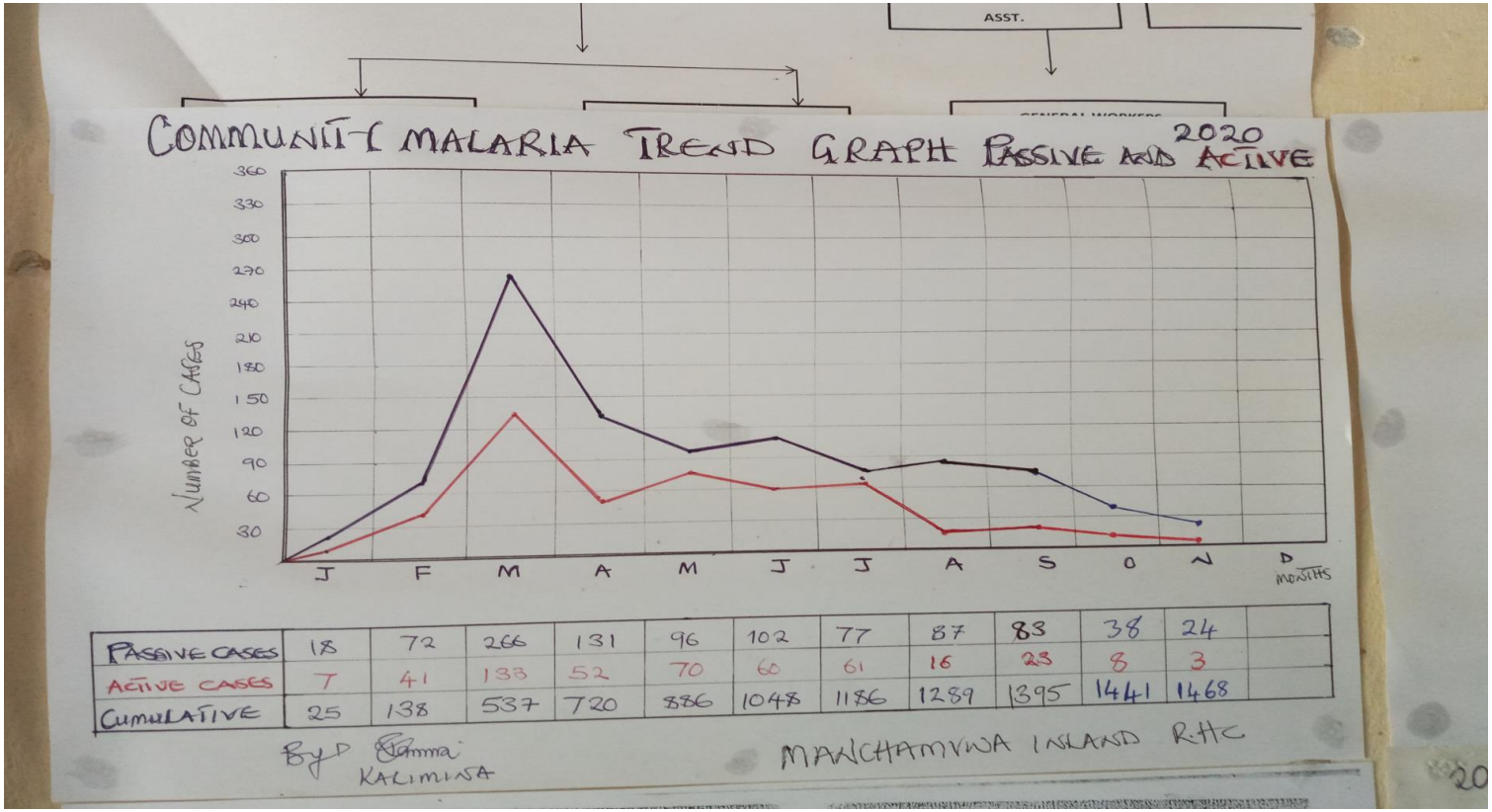
Definition of parasitology

- Medical parasitology is the study of parasites and their pathogenic effects.
- Or branch of science that deals with parasites that cause human infections and the diseases that they cause.
- It involves the study of parasites, their hosts and the relationship between them.
- Humans and other living organisms live in close relationship with each other.

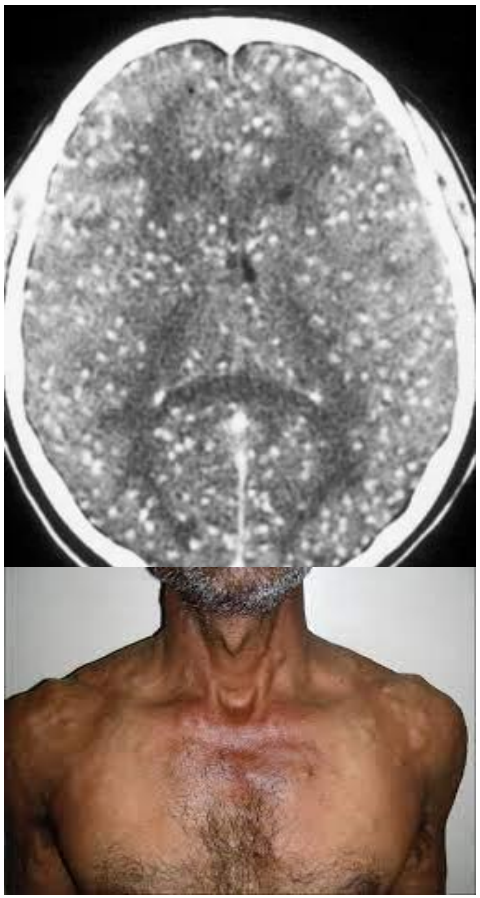
Importance of parasitology

- Inflicts significant morbidity and mortality to a huge population.
- 247 million cases of malaria recorded in 2021 (world malaria report 2021)
- 619,000 malaria deaths recorded during the same period.
- Neglected tropical diseases (NTDs) are a group of parasitic/bacterial infectious diseases affecting more than 1.7 billion people.
- Over 40% of the global NTD burden is concentrated in Africa.
- Amongst children, infection leads to malnutrition, cognitive impairment, stunted growth & the inability to attend school.

Malaria cases at a facility in Siavonga District



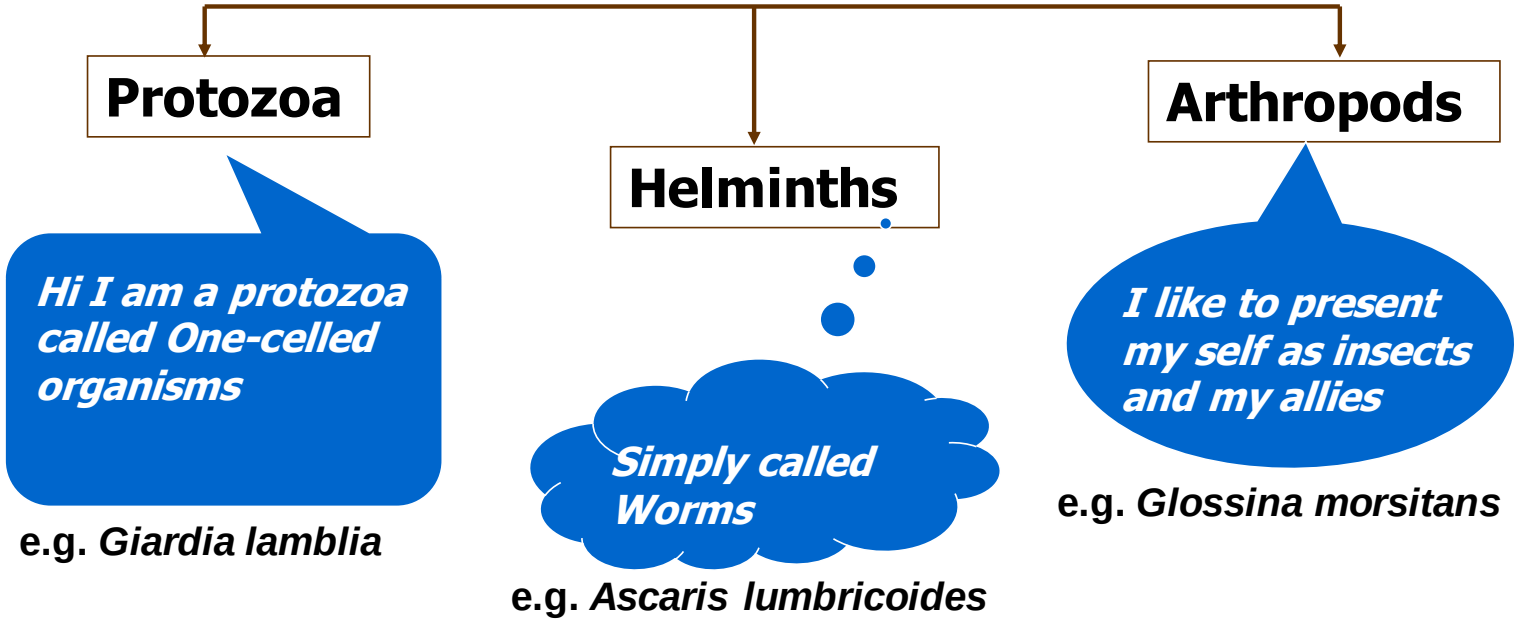
Parasite induced morbidity- Ascariasis/neurocystercosis



- It is broadly classified into three main categories.

1. Protozoology(protozoa)
2. Helminthology(helminths)
3. Entomology(arthropods)

Medical Parasitology includes the study of 3 major groups of parasites:



Terminology

- **Parasite**-A living organism which depend on another organism(host) for food and shelter.
- The term parasite usually applies to **Protozoa**(unicellular organisms) and **Helminths** (multicellular organisms e.g. worms) .
- Parasites are divide as follows:-

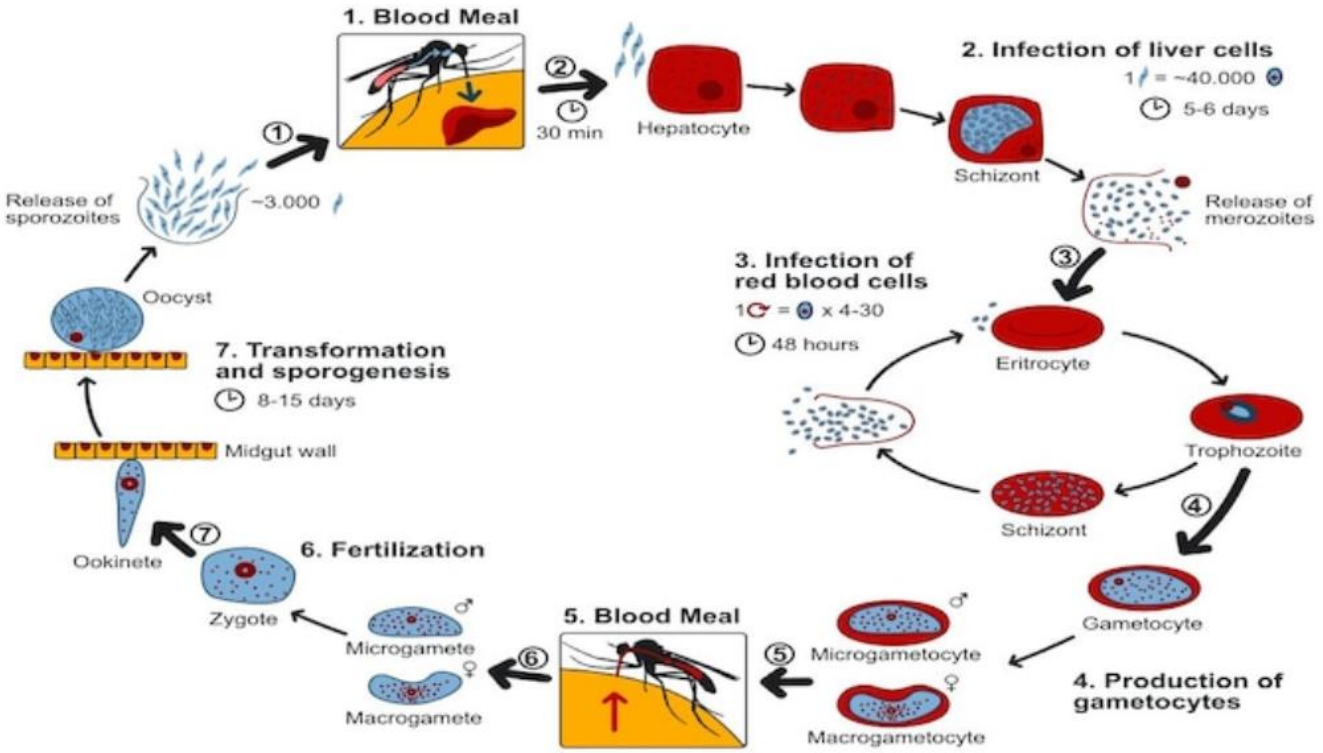
1. **Ectoparasite:** inhabit the body surface of the host without penetrating the tissue e.g. Lice, ticks & mites.
2. **Endoparasite:** lives inside the body of the host e.g. most protozoan and helminthic parasites causing human disease are endoparasites.
3. **Free-living parasite:** refers to nonparasitic stages which live independent of the host e.g. the cystic stage of *Naegleria fowleri.*

- **Host** -is an organism which harbors the parasite and provides nutrition and shelter.
- A host is usually larger than the parasite and are divided into the following:-
- **Definitive host:** An organism in which the adult forms of the parasite lives and undergoes sexual reproduction e.g. mosquito acts as definitive host in malaria.
- Man is the definitive host in majority of human parasitic infections, (e.g. filaria, roundworm, hookworm).

- **Intermediate host:** is an organism in which the parasite lives during a period of development(larval stage) or where asexual multiplication takes place .
- In some cases 2 different intermediate hosts **(first & second intermediate hosts)** may be required to complete different larval stages.
- **Reservoir host:** an organism which harbors the parasite and acts as an important source of infection to other susceptible hosts e.g. dog is the reservoir host of hydatid disease.

- **Paratenic host**: an intermediate host whose presence is needed to complete the parasite's life cycle but in which no development of the parasite occurs.
- **Accidental host**: an organism that's under normal circumstances not infected with the parasite.

Life cycle of malaria with the mosquito as the definitive host & humans as intermediate host



Habitat

A habitat is where the parasite lives and multiplies in the body of the definitive or intermediate host like:

- Large intestine
- Blood vessels
- Organs; liver, lung, heart, brain, …..
- Muscles
- Lymphatics
- Reticulo-endothelial system
- Red blood cells

- **Zoonosis** is defined as diseases and infections which are naturally transmitted between vertebrate animals and humans.
- Or a parasitic disease which an animal is normally the host but which also infects man.
- **Vector:** A vector is an agent or living carrier usually an arthropod that transmits an infection from man to man or from other animals to man, e.g. female *Anopheles* is the vector of malarial parasite.
- There are two types of vectors: mechanical and biological vectors.

1. **Biological vectors(Also referred to as true vectors):** Refers to a vector which not only assists in the transfer of parasites but the parasites undergo development or multiplication in their body as well.

- Example of true vectors are: Mosquito—Malaria, filariasis
  Sandflies—Kala-azar
  Tsetse flies—Sleeping sickness
  Reduviid bugs—Chagas' disease
  Ticks—Babesiosis

2. **Mechanical vectors:** Refers to a vector which assists in the transfer of parasitic form between hosts but is not essential in the life cycle of the parasite.

- Example of Mechanical vectors is: Housefly—amoebiasis

- Humans and other living organisms live in a close relation with each other.
- This intimate interaction or living together of organisms from different species is referred as **Symbiosis**
- The three common symbiotic relationships are:
- **Commensalism:** an association in which only the parasite benefits without causing harm or injury to its host e.g most of the normal floras of the human body.

- **Parasitism:** an association in which the parasite derives benefit and the host gets nothing in return and always suffers some injury e.g worms like ascaris lumbroicoides reside in the GIT of man and feed causing an illness.
- **Mutualism:** both organisms are metabolically dependent upon each other and one cannot live without the help of the other however none of them suffers any harm from the association e.g. the relationship between certain species of flagellated protozoa living in the gut of termites.

Epidemiology

- Environmental factors, social customs and habits of people greatly influence the distribution of parasites.
- Although parasitic infections occur globally , majority occur in tropical regions where there is: -poverty

  -poor sanitation and personal hygiene.

  -Low education standards

  -Inadequate nutrition

Why rich nations suffer less from parasites

- **High standards of education** - better housing, higher standard of living.
- **General good health** - poor health = more susceptible to disease.
- **Nutrition** - adequate diet.
- **Sanitation** - sewers and septic systems keeps raw sewage out of streams.
- **Temperate climate** - parasites do better in the warmth of the tropics.
- **Absence of certain vectors** - intermediate hosts such as the tsetse fly, certain snails, etc.

Life cycle of parasites

- **Direct life cycle:** The parasite only requires a single host to complete its development e.g. *Entamoeba histolytica* requires only a human host to complete its life cycle.

- **Indirect life cycle:** In this case the parasite requires 2 or more host species to complete its development e.g. malarial parasite needs both human host and mosquito to complete its life cycle .

What are the sources of Infection

1. **Contaminated soil and water**

- Soil polluted with embryonated eggs (roundworm, whipworm) may be ingested or infective larvae in soil may penetrate exposed skin (hookworm, S.stercolaris) .

2. **Food(Gain entrance to the GIT):**

- Ingestion of contaminated food or vegetables containing infective stage of parasite (amoebic cysts, *Toxoplasma* oocysts, *Echinococcus* eggs) .
- Ingestion of raw or undercooked meat harboring infective larvae e.g. pork containing cysticercus cellulosae, the larval stage of *Taenia solium,* cysticercus bovis-T.saginata larval stage and T.spiralis).

3. Insect vectors:

- Arthropods that transmits an infection from man to man or from other animals to man, e.g. a*nopheline* for malarial parasite, Tsetse flies for Trypanosoma, sand flies for Leishmanina,Culicine mosquitoes for Wuchereria banchroft.

4. Animals

- Include both domestic(Cow, e.g. *T. saginata* : Pig e.g. *T. solium*, *Trichinella spiralis* : Dog, e.g. *Echinococcus granulosus*) and wild animals(Wild game animals, e.g. trypanosomiasis: Fish, e.g. fish tapeworm)

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5. Self (autoinfection) .

- Finger to mouth transmission, e.g. pinworm
- Internal re-infection, e.g. *Strongyloides Stercolaris*.
- This results from poor personal hygiene hence the emphasis for hand washing.

Modes of transmission

1. **Oral transmission:**

- Most common mode occurring through contaminated food, water, soiled fingers, or fomites.
- The infective stages being cysts, embryonated eggs, or larval forms ,many intestinal parasites enter the body in this manner.

2. **Skin transmission:**

- Is another important mode of transmission.
- Hookworm infection is acquired, when the larvae enter the skin of persons walking barefooted on contaminated soil.
- Schistosomiasis is acquired when the cercarial larvae in water penetrate the skin.

3. **Vector transmission:**

- Many parasites are transmitted by insect bite, e.g., malaria by *Anopheles* mosquito, filariasis by *Culex* mosquito.

4. **Direct transmission:**

- Parasitic infection may be transmitted by person to person contact in some cases, e.g. kissing in the case of gingival amoebae and by sexual intercourse in trichomoniasis.

5. **Vertical transmission:**

- Maternal-fetal transmission occur in malaria and toxoplasmosis .

6. **Iatrogenic transmission:**

- Seen in case of blood transfusion in malaria and toxoplasmosis after organ transplantation.

Important pathogenic effects

- Parasitic infections may be dormant or give rise to clinical disease with a few organisms such as *E. histolytica* living without invading the tissue (commensals).
- Clinical infection produced may be acute, subacute, chronic, latent or recurrent.
- Pathological changes or disease mechanisms occur in the following ways:

- **Physical obstruction**: Masses of A.lumbricoides (roundworm) cause intestinal obstruction. *P.falciparum* malaria may produce blockage of brain capillaries in cerebral malaria
- **Inflammatory reaction:** Inflammatory changes and consequent fibrosis e.g. lymphadenitis in filariasis and urinary bladder granuloma in *Schistosoma haematobium* infection cause clinical illness.
- **Lytic necrosis:** Enzymes produced by some parasite can cause lytic necrosis e.g. *E. histolytica* lyses intestinal cells producing amoebic ulcers.

- **Neoplasia:** Some parasites are now classified as carcinogens or lead to malignancy. The liver fluke, *Clonorchis cause* bile duct carcinoma and *S. haematobium* may cause urinary bladder cancer .
- **Trauma:** Attachment of hookworms on jejunal mucosa leads to traumatic damage of villi and bleeding at the site of attachment-cause of anemia.
- **Allergic manifestations:** Clinical illness may be caused by host immune response to parasitic infection, e.g. eosinophilic pneumonia in *Ascaris* infection and anaphylactic shock in rupture of hydatid cyst

Laboratory diagnosis

- Whilst clinical symptoms or a case history may provide clues as to which parasite may be present, laboratory diagnosis remains key in finding the definitive diagnosis.
- Laboratory methods are divided into Direct and Indirect methods
- Direct methods involves visualization of the parasite in a particular specimen e.g. malaria parasites in RBCs , hookworm ova in stool etc.
- Indirect methods detect cytological changes, immune response or parasite products(antigens) without necessarily visualizing the parasite e.g. eosinophilia in worm infections or biochemical changes.

- Laboratory methods include the following

1. Microscopy for blood film , stool, urine , sputum and biopsy examination.
2. Culture e.g vaginal discharge or urine for diagnosis of T.vaginalis
3. Serological test .eg in toxoplasmosis,schistosomiasis etc
4. Skin test(Immunological skin reactions) e.g in protozoa infections such as Chagas disease,toxoplasmosis and helminth infections e.g schistosomiasis(fairley's),hydatid disease(Casoni's).
5. Molecular methods

- Xenodiagnosis
- Imaging(CT imaging in neurocystercosis)
- Hematology(eosinophilia in helminth infections)

Prevention and control

- Reduction of potential sources of infection
- Community education
- Destruction and/or control of reservoir hosts and vector

Treatment of parasitic infections

- Medical and surgical
- Chemotherapy
- Adequate nutrition

Websites of Interest

- There are thousands of reading resources on internet providing information and images on parasites, not all of them are as trustworthy.

- Two excellent sites to look for general information and visual illustrations:
  - CDC (Division of Parasitic Diseases)
  - WHO (Tropical Diseases Research Program)