



EDO UNIVERSITY IYAMHO
Department Of Biological Sciences
(Animal and Environmental Science Unit).
AEB 319 Introduction to Tropical Parasitology.

Instructor:

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Phone: (+234) 8023625582. Lectures: Tuesday, 8.00am – 9.00am and Thursday, 1.00pm – 3.00pm
Venue: MLT1 (Faculty of Science), Office hours: Monday-Friday, 8.00am to 4.00 pm, Office:

Dept. of Biological Sciences (AEB Unit), Block 2 Room 5.

General overview of the lecture: This course is intended to acquaint the students with the knowledge of host – parasite relationship, the various tropical parasites that are of great economic importance to humans and domestic animals. The students will also be exposed to simple methods of sample collection and identification of parasites in the laboratory.

Prerequisites: Students should have been familiar with various classification, identification and characteristics of invertebrates and vertebrates that are of public health importance from AEB214 class at the 200level.

Intendend Learnig Outcomes: At the completion of this course section, students are expected to:

- ▶ Understand the concept of parasitism and the relationship between parasites and hosts.
- ▶ Know the general epidemiological aspects of parasites that affect man.
- ▶ Know the life cycle of specific parasites and identify the important parasitic agent affecting human health.
- ▶ State preventive measures for specific parasitic infection.
- ▶ Identify various stages of parasitic infection in the laboratory.

Assignments: During the duration of this course, student will be given 3 individual homework assignments as well as a mid - semester test, group presentation and end of semester examination. The assignments due date of submission will be given to students and they are expected to submit on the said date. The topics for presentation will be given at the beginning of the semester and it will serve as a means to give them a better understanding of the course. The assignments, test and presentation topics will serve as studying materials for the course.

Grading: 10% will be assigned to presentation, 5% of the class grade will be assigned to homework assignments and 15 % will be assigned to mid – semester test. Lastly 70% of the grades will be final exam scores. The final exam will be all encompassing of what was taught throughout the semester.

Textbook: The recommended and referenced textbooks for this class are as follows:



Title: *Modern Parasitology*

Authors: F.E.G. Cox

Publisher: Blackwell Scientific Publications, London. 2nd edition

Title: *Elements of Parasitology.*

Authors: O.Otubanjo

Publisher: Panaf Publishing Inc., 3rd edition

ISBN: 978 – 978 -37049 – 7- 4

Title: *District Laboratory Practice in Tropical Countries. Part 1*

Author: Monica Cheesbrough, 2000

Publisher: Cambridge University Press.

ISBN: 0 521 68459 5.

Main Lecture: The course description is given below.

NATURE OF PARASITOLOGY

Parasitology is the study of the biology of parasites and their host. Flora and fauna bodies are rich environments which have been colonized by parasites throughout evolutionary history. The field of parasitology has developed out of the curious efforts of scientists to understand parasites and their relationship with their hosts.

Parasitism is a physiological association between two living organisms. It could be between animals, plants or between an animal and a plant. It could be short or long term association. In this association, one of the associates (the parasite) depends on the other (the host) for its nutritional requirements as well as other metabolic needs. The parasite needs the host because it has lost its physiological independence. The parasite benefits from the host as well as does damage (injures) or harm to the host.

FORMS OF PHYSIOLOGICAL ASSOCIATION.

- 1) **SYMBIOSIS/ MUTUALISM:** It is a physiological association between two living organisms and both benefit from the association. e.g. termites which harbours certain species of flagellate protozoa in their alimentary canal. The protozoa helps the termite to digest the cellulose in the gut while the gut of the termite serves as shelter for the flagellate.
- 2) **COMMENSALISM:** In this type of association, only one of the organisms benefit while the other one is neither harmed nor benefit from the association e.g the Pilot fish (*Naucrastes* spp.) and the Remora (Echeneidae). The remora gets free ride and scraps but does not harm the host or deprive it of its nutrients. The association could be facultative or obligate. In facultative, the commensals can survive without the association e.g the Vorticella on small C rustaceans. The Vorticella can also survive on sticks in the ponds. Obligatory commensals on the other hand, cannot survive without being in association e.g *Epistylis* species. *Entamoeba gingivalis* in the mouth of man. It feeds on bacteria, food particles and dead epithelial cells but never harm healthy tissues. It has no cyst or other resistant stages.
- 3) **PHORESIS:** It is an association between two animals for the purpose of travelling or transportation from one place to another. One of the phoront is usually smaller than the other.



The smaller one is carried by the larger companion. This association is mechanical rather than physiological or biochemical. An example of a phoretic association is the Temnocephalid flatworms which attach themselves to large fresh water crustaceans.

CHARACTERISTICS OF PARASITES

Animal parasites have developed certain biological characters which enables them to adapt to their various environments. These characters also distinguishes them from other animals. They are as follows:

Physiological adaptation. This is illustrated by intestinal worms which have the ability to adjust their respiratory processes to very low oxygen tensions and to resist the action of the digestive juices secreted by the intestinal gland and mucous membrane lining of the host.

Reduction or loss of organs. Sense organs, locomotor organs, specialised digestive organs and organs of predation, and other organs useful to a free-living animal but not to the sheltered parasite

Surrounded by its food and safe from attack by enemies, are frequently reduced or lacking.

Increased reproductive capacity. In order to compensate for the numerous adverse factors operating against the likelihood that the offspring will find and successfully invade new hosts and develop to maturity, reproductive capacity in parasitic forms is often much greater than in related free-living forms.

Modification of existing structures and development of new structures. The modification of the cuticle of intestinal worms to carry out selective absorption and the evolution of suckers, hooks

and other organs of attachment are examples. Such organs are specifically useful in a parasitic existence.

Modification of the life history. In order to facilitate transmission, from host to host the life history is often profoundly modified and may become very complex. In particular, reproduction by immature forms in order to facilitate production of offspring in large numbers, the adoption of intermediate and paratenic hosts, and the correlation of the life history of the parasite with the habits and life history of these and of the definitive host, may occur.

BRANCHES OF PARASITOLOGY.

A wide range of parasites affect man and his domestic animals and as such the field is segmented into several distinct discipline each dealing with the parasites belong to a particular taxonomic group.

- a. **PROTOZOLOGY:** It is the study of the parasite members of the group Protozoa. They are minute unicellular animals which are parasitic e.g. Amoeba, Toxoplasma, Plasmodium etc.
- b. **HELMINTHOLOGY:** It is the study of parasitic worms comprised within the following groups: trematoda (flukes), cestoda (tapeworms) and Nematoda (round worms).
- c. **ENTOMOLOGY:** It is the study of insects. It is essential in order to understand the study of the parasitic members of the Phylum Arthropoda which includes both the insects, mites, ticks, spiders and other forms of medical and veterinary importance.



KINDS OF PARASITE: Parasites are grouped based on certain factors such as

Habitat or Site of host parasitized:

Mode of life.

Pathogenicity

Life cycle pattern.

ACCORDING TO HABITAT OR SITE OF HOST PARASITIZED

Ectoparasites: These are parasites found to attach themselves to the outside of the host's body e.g. Fleas, ticks, lice e.t.c.

Endoparasites: These parasites are found in the internal organs of the host (live inside the body of the

Host) e.g. hookworms, tapeworms, round worms.

ACCORDING TO MODE OF LIFE

facultative or temporary parasites: These are organisms which are usually free living but can exhibit a parasitic life if they found themselves within a host. They can also be referred to as circumstantial parasites e.g. *Rhabditis hominus*, *Strongiloides stercoralis*.

Obligate or permanent parasites: These are organisms that must live a parasitic life in order to survive. They are incapable of existing outside the host. E.g. Tapeworm, *Plasmodium* spp. etc.

Intermittent or temporary parasites: These are parasites that may not be permanently resident in the host but make contact with host or visit the host from time to time when feeding is required e.g. mosquitoes. It also involves some organisms that are parasitic at certain stages of their life either as adults or larval e.g. Larvae of botflies that causes myiasis while their adults are free living flies.

ACCIDENTAL OR INCIDENTAL PARASITES:

These are parasites that have entered unusual host species in which they can maintain themselves for a while, but not permanently e.g. the dog tapeworm, *Dipylidium caninum*, can establish itself in man for a while.

Spurious Parasites

These are free-living forms which have become accidentally introduced into a host and succeed in surviving therein for a time. Vinegar eels, *Turbatrix aceti*, introduced into the human vagina during douching, can maintain themselves there for a time.

Erratic or Aberrant Parasites: These are parasites that can wander from one region of the body to another. They have no specific site and they cause a lot of tissue destruction e.g. Ascaris Nematodes.

ACCORDING TO LIFE CYCLE PATTERN.

Monoxenous parasites: They require only a single host to complete their life cycle e.g. hookworms.

Heteroxenous Parasites: they require two or more different host species, namely a definitive host and one or more intermediate hosts, to complete each life cycle e.g. tapeworms.



Autoheteroxenous Parasites: These parasites are those in which the definitive host of one generation becomes the intermediate host of the next generation e.g *Trichinella spiralis*

ACCORDING TO PATHOGENICITY

Pathogenic Parasite: It causes disease in the host e.g *Entamoeba histolytica*.

Non Pathogenic Parasites: They are also referred to as commensals. They obtain food and protection from the host without causing any disease or harm to the host e.g. *E. coli*.

Opportunistic Parasites: They cause mild disease in immunologically healthy individuals and cause severe disease in immunodeficient hosts e.g *Toxoplasma gondii* in the lumen of the intestine.

KINDS OF HOST

Hosts are classified based on the role they play in the life cycle of the parasite.

PRIMARY OR DEFINITIVE HOST

Host in which the most developed form of parasite occurs. It is the host in which parasite attains sexual maturity. The final host required for the completion of the parasite's life cycle. Higher vertebrates such as man, birds, reptiles, amphibians etc. serves as definitive host of parasites.

INTERMEDIATE HOST

Host in which the larva stages (intermediate stages) of parasites are found. Host in which asexual form of parasite occurs. Some parasites require one intermediate host e.g. *Plasmodium*, two intermediate hosts e.g. *Paragonimus westermani* etc.

PARATENIC HOST

Host in which larval stages of parasites are found but they do not undergo further development than it was acquired. The host only serve as a carrier of the larva stage until it gets to the definitive host.

RESEVOIR HOST

It is an animal host serving as a source from which other animals can become infected. Domestic animals like cattle, horses, sheep, pigs etc. serve as reservoir host for human sleeping sickness parasite called *Trypanosoma* sp. They are epidemiologically important in the control of parasitic diseases.

LIFE CYCLE OF PARASITES

A knowledge of the life cycle of parasite is very essential in order to design an effective and reliable diagnostic technique, measure of treatment, prevention and control.

There are two life cycle patterns namely:

Direct life cycle

Indirect life cycle.

DIRECT LIFE CYCLE: It involve those that their life cycle does not involve any intermediate host e.g *Entamoeba histolytica*.

INDIRECT LIFE CYCLE: This life cycle involves one or more intermediate hosts within which the larval stage must develop before becoming infective to the definitive host.

SOURCES OF EXPOSURE TO PARASITIC INFECTION.

The various ways of having contact with parasitic infections are as follows.

Contaminated soil: Soil polluted with excreta is a commonly responsible for exposure to infection with *Ascaris lumbricoides*, *Trichuris trichuria* etc.

Contaminated water which may contain viable cysts of Amoeba, flagellates, cercarial stages of flukes, Cyclops contain larva of *Dracunculus medinensis*.

Improperly cooked meat which could be beef or pork containing the infective stage of *Taenia* species.

Blood sucking Arthropods which are responsible for the transmission of a number of diseases such as malaria by female anopheles mosquito. Trypanosomiasis by *Trypanosoma* species.

Animals which could be wild or domestic which serve primarily as reservoir hosts.

Human beings: Exposure to parasitic infection can be through another person's clothings, beddings or the immediate environment which could be contaminated with infective stages of parasites.

Sexual intercourse, a means through which *Trichomonas vaginalis* can be contacted.

EFFE CTS OF PARASITES ON HOST

Spoliative action as in the case of hookworms, which rob the host of blood, and of tapeworms, which deprive it of digested food.

Toxic action due to the poisonous metabolic by-products which are liberated into the blood at intervals, in malaria parasites which are responsible for producing the characteristic febrile paroxysms of malaria.

Traumatic action which is as a result of damage to the muscular tissues caused by juveniles of *Trichinella spiralis* migrating to their encystment sites, and the damage to the wall of the colon caused by invading dysentery amoebae.

Mechanical action due to the pressure effects produced by large hydatid cysts and the blockage of the bile duct or pancreatic duct sometimes produced by wandering individuals of *Ascaris lumbricoides*.

Irritative and inflammatory action due to the duodenal irritation caused by *Giardia lamblia*.

Secondary effects as a result of the weakening of the resistance of the host to other infections, and the bacterial invasion of lesions in tissues and organs initially produced by animal parasites

RELATIONSHIP BETWEEN PARASITE AND HOST

The main purpose of association between parasite and host is for the purpose of acquiring food by the parasite from the host. A host is said to be susceptible if it is capable of been infected by the parasite and the parasite establishes itself successfully. On the other hand, a host is said to be resistant if its physiological state does not permit the establishment and survival of the parasite. This means by which a host resist infection is known as **immunity**. Immunity could be innate, natural or acquired.

Parasites are found in various specimens which are as follows:

- I.Faeces
- II.Urine
- III.Blood
- IV.Vaginal discharge



V.Sputum
VI.Skin.

SUMMARY

Parasitology is the study of parasite, host and their interaction. A parasite depend on host for food and survivability and does harm to the host. An association between two organisms is symbiotic. This association can take various forms such: mutualism, parasitism, commensalism and lastly phoresic. Parasitology is divided into protozoology, helminthology and Entomology which is actually the study of insects. It is essential because it will help to understand arthropod vectors better. A number of damages are done to host by the parasite through various activities such as spolative action, toxic action, irritative and inflammatory action, mechanical action, traumatic action and secondary effect from other actions. Life cycle of parasite could be direct or indirect. Same applies to mode of transmission of parasitic infection. When a parasite successfully invade a host and establish itself in the host, the host is said to be susceptible but if it is unsuccessful, the host is said to be resistant to the parasite infection. Resistance is made possible by immunity which could be innate, acquired or natural.

ASSIGNMENT

1. Explain the relationship between a parasite and host
2. Define the following terms: Parasite, Host, Phoresis, Commensalism and Symbiosis.
3. Exclusively classify parasites
4. Exclusively classify hosts
5. State the various effects of parasites on host.

MODULE 2: PARASITIC PROTOZOANS

INTENDEND LEARNIG OUTCOME.

At the completion of this section, students are expected to:

- ▶ State various parasitic protozoans.
- ▶ Know the epidemiological aspects of the parasites.
- ▶ Know the life cycle and disease symptoms of the parasites.
- ▶ State preventive measures for the parasitic infection.
- ▶ Identify various stages of the parasitic infections.

Parasitic protozoans belong to four different classes namely: Sarcodina, Mastigophora, Ciliata and Sporozoa.

SARCODINA:

It includes the *Entamoeba* spp. The most prominent and pathogenic amongst them is the *Entamoeba histolytica*.

ENTAMOEBIA HISTOLYTICA. It is a protozoan parasite of man found in the lumen of the intestine in man. It is typically amoeboid in shape. It measures between 5 – 40µm in size. It moves and feed by means of pseudopodia.

There are two sub – species which have now become individual species. The two sub – species are:

- *Entamoeba histolytica histolytica*
- *Entamoeba histolytica hatmani*.

Entamoeba histolytica histolytica is large in size and is found in the tropics. It is also pathogenic while *Entamoeba histolytica hatmani* is small in size, non-pathogenic and is restricted to the temperate countries of the world.

LIFE CYCLE: The trophozoite live an amoeboid life within the lumen of the

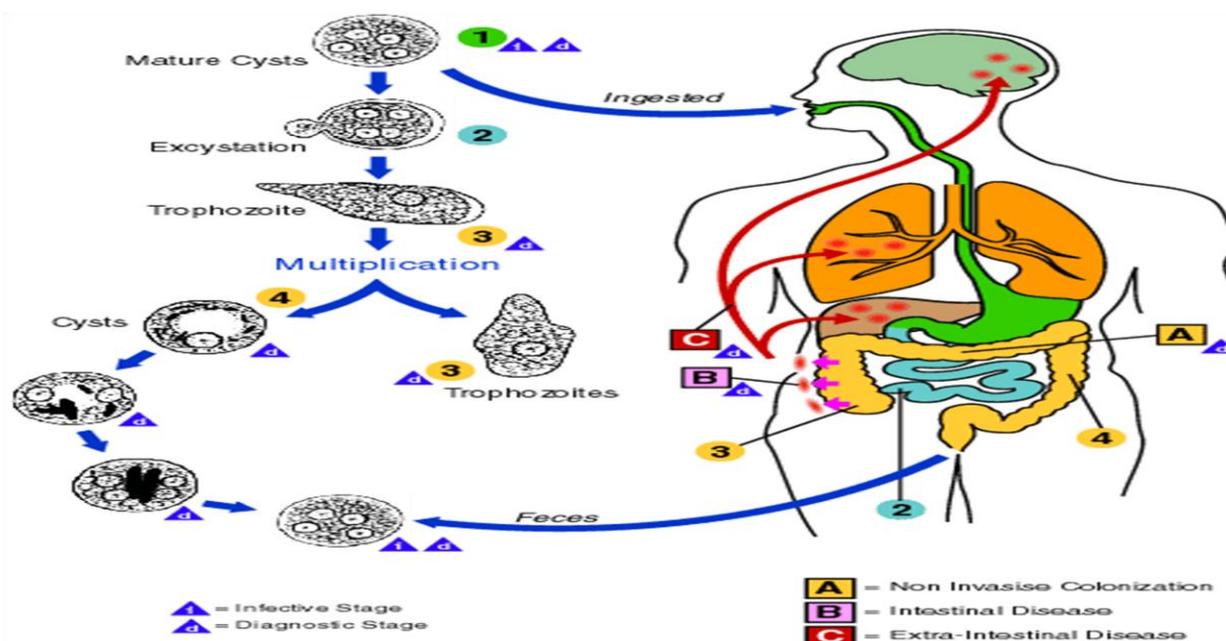


Fig 1: Life cycle of *Entamoeba histolytica*

Source: www.dpd.cdc.gov

intestine and reproduces by asexually by binary fission. The trophozoite can also round off itself, producing a cyst wall around itself to form a cyst. The cyst measures about 10 - 15µm in size and possesses 4 nuclei which is produced from the division of a single nucleus. The cysts are passed out with the stool by an infected person and new individuals are infected when they accidentally swallow the cyst under poor sanitary condition. The cyst is usually swallowed by man from contaminated water or vegetable matter not properly processed before been consumed for food. House flies can also act as vectors that carry the cyst to the house where they are made available to man. On swallowing the cyst, the cyst breaks open in the intestine and 4 new trophozoite develops to establish new infection.

DISEASE: The disease caused is Amoebic dysentery which is due to the ulcers created on the mucosa of the intestine. Blood stained watery stool is usually passed out. Frequent diarrhoea and vomiting can quickly lead to dehydration which can become life threatening in infants and young children. Some of the trophozoite may get into the portal circulation and are carried to other organs where they cause various diseases. Some of these diseases are abscesses of the liver. Asthma of the lungs and peritonitis of the coelomic organs. Amoebic dysentery is usually accompanied by secondary bacteria invasion which may lead to other diseases.

DIAGNOSIS: By identification of cyst in stool sample using the 4 nuclei as identification index.

TREATMENT: It involves the use of a combination of antibiotics and antiprotozoan drugs e.g a combination of chloroquine and Erythromycin etc.

PREVENTION / CONTROL: Maintaining good sanitary habit and living a healthy clean life.

Source:

Proper washing of hands with soap and water especially after using the toilet.

Eating properly cooked food and drinking clean water.

ENTAMOEBIA GINGIVALIS.

It is similar to *Entamoeba histolytica* in shape but it is found in the mouth, pharynx, trachea and bronchi. In the mouth, it lives between the gum of the teeth. The trophozoite is about 10 – 20µm in size and it is sluggish in locomotion.

LIFE CYCLE: The trophozoite reproduces asexually by binary fission but does not form cyst. The mode of transmission from one person to another is by direct contact of the trophozoite through communal use of eating utensils, tooth brushes and through kissing.

DISEASES: *Entamoeba gingivalis* is non – pathogenic but it lives a commensal life feeding on the bacteria and food remains in the mouth. However, it is known to be associated with bacteria that causes swellings of the gum (a disease known as pyorrhoea).

TREATMENT/PREVENTION: Maintaining good sanitary habit and regular washing of the mouth (morning and night before going to bed) with good tooth brush and toothpaste.

ENTAMOEBEA COLI

Morphologically, it is similar to *Entamoeba histolytica*. It inhabits the lumen of the small and large intestine of man and measures between 15 – 50µm in size. It has an eccentric karyosome in the nucleus and this differentiates it from *Entamoeba histolytica*.

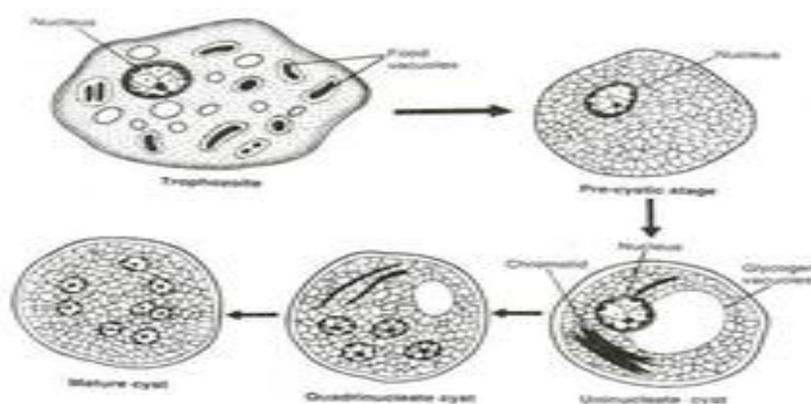


Fig 2: Stages of cyst of Entamoeba coli.
https://en.wikipedia.org/wiki/Entamoeba_coli

LIFE CYCLE: It is similar to *Entamoeba histolytica*. It produces cyst that differs from that of *Entamoeba histolytica* by having 8 nuclei instead of 4. **The mode** of transmission is also similar to that of *Entamoeba histolytica*.

DISEASE: It is not known to be pathogenic but they co- exist with *Entamoeba histolytica*. The presence of *Entamoeba coli* usually indicates the possible presence of *Entamoeba histolytica* infection.

Other Amoeba parasites are:

Endolimax nana: Intestine of man- Non-pathogenic.

Iodamoeba sp: Digestive tract but non-pathogenic.



Entamoeba bovis: Found in cattle and pathogenic

Entamoeba equi Found in horses and pathogenic.

SUMMARY.

Parasitic protozoans belong to four different classes namely: Sarcodina, Mastigophora, Ciliata and Sporozoa. Sarcodina includes *Entamoeba* spp. The most prominent and pathogenic amongst them is the *Entamoeba histolytica*. *Entamoeba coli* and *Entamoeba gingivalis* are also of economic importance. *Entamoeba histolytica* causes amoebic dysentery, *Entamoeba coli* is non pathogenic but it occurs in association with *Entamoeba histolytica*. *Entamoeba gingivalis* occurs in the mouth and causes swellings of the gum.



MODULE 3: FLAGELLATE PARASITES.

INTENDED LEARNING OUTCOME: At the end of this section, the students should be able to identify tissue and intestinal flagellates, know the causes, life cycle, diagnostic method, prevention and control.

MORPHOLOGY: Trypanosoma is a protozoan parasite found in the blood stream of man and other vertebrates as well as lymphatic system of man. That is why they are referred to as haemoflagellates. It measures between 15-30 μ m in size. The body is elongated with centrally placed nucleus. It has a blunt posterior end and a pointed anterior end. The flagellum arises from the posterior end and attaches to the body by means of an undulating membrane and becomes a free flagellum after the pointed anterior end. Different species are found in different parts of the tropical countries of the world and they cause different diseases e.g.

- 1) *Trypanosoma brucei brucei*, it affects cattle and is found in the Northern part of Africa cause Nagama disease.
- 2) *Trypanosoma brucei rhodesiense* (Zimbabwe) is found in East Africa causes sleeping sickness.
- 3) *Trypanosome brucei gambiense* causes sleeping sickness known as trypanosomiasis.
- 4) *Trypanosoma crucei* found in South America and causes chagas disease.

DISEASES: The parasite causes the sickness called **TRYPANOSOMIASIS** Symptoms include; headache, fever, anemia, joint pains and swollen tissues particularly the lymph node at the back of the neck. The diseases are due to the combined effect of the parasite in the blood which is haematic group and those that have migrated into the tissue which are the humoral group. As the infection progresses, the parasite invades the central nervous system (C.N.S, the involvement stage). During this period, the patient shows some signs of dizziness and inclination to sleep continuously. This characterizes the disease called

SLEEPING SICKNESS. If not treated, the situation later develops into mental deterioration which may lead to coma and eventually leads to death.

Symptoms of *Trypanosoma brucei gambiense*; It progresses slowly while those of *Trypanosoma brucei rhodesiense* are very acute and death can result within a few days. Trypanosomiasis is a disease of great economic importance in the tropics and it is one of the most deadly disease

TREATMENT: The drugs used for the treatment are pentamidine, suramin and melansoprol.

PREVENTION/ CONTROL: By avoiding the tse-tse fly by embarking on measures that can reduce the population of the tse-tse fly. Such measures are by clearing bushes to kill the larva and pupa stages. Clearing exposes the pupa to sunlight and the sun kills them. Another method of control is to control the reservoir host which are known to be wild rodents and some domestic animals. The domestic animals should be put in their proper pen.

TRYPANOSOMA CRUCEI.

LIFE CYCLE: Its intermediate host is the triatomine bug (Assasin bug) called *Rhodnius prolixus*. Within the intermediate host, the crithidea form migrates posteriorly and discharged with faeces of the insect. Mode of infection is by rubbing the faeces containing the crithidea forms into wounds created from the bite of the insect. The parasite then enters the blood stream of the host and transforms into trypanosome form. **DISEASE:**It causes chagas disease. The symptoms include: a sore or wound at the site of the insect bite. The site later swells up known as Romana sign. This site is usually on the face or the eye lid of the host.

Within a few day of the infection, symptoms similar to those of malaria fever develops particularly fever, rise in temperature and presences of swollen in lymph nodes (in different part of the body) for patients who survive this acute early phase, the infections goes into the second phase which is symptomless but the patient becomes progressively weaker. The second phase may last for month or even years and results in gradual destruction of the



internal organs. The disease usually end in sudden death if it not treated due to damage of internal of internal organs or sudden heart failure.

TREATMENT: It is similar to those of African trypanosomiasis but there are two drugs known to be particularly active for early stages of *Trypanosoma cruzei* when it is in the symptomless stage. It becomes very difficult to treat. The drugs are Nifurtimox and Benznidazole.

Prevention and control is the same as *Trypanosoma brucei* and *Trypanosoma brucei gambiense*. Also try to avoid bite of triatomine bug.

LEISHMANIA PARASITE.

MORPHOLOGY: It belongs to the family Trypanosomidae but occurs in Leishmania form within the definitive host. The parasite is found in the macrophage cells in the tissue of the host and in the peripheral blood vessels. It is about 1.5µm in size and have no free flagellum. It is also restricted to tropical countries of the world.

LIFE CYCLE: It reproduces asexually by binary or multiple fission within macrophage cells. They produces other leishmania form which are sucked up by the intermediate host from the peripheral blood vessels. The intermediate host is the sand fly (*Phlebotomus* spp.) within the mid-gut of the sand fly, the parasite divides several times and transform into the Leptomonas form which then migrate into the fore-gut, the oesophagus and proboscis and the salivary gland from where they are injected into a new host. When bitten by a sand fly, within the new host the Leishmania form and then establishes a new infection.

DISEASE: The disease caused depends on the *Leishmania* spp. involved.

- 1) **VISCERAL LEISHMANIASIS:** They are found in Eastern part of Africa popularly known as Kala azar. It is caused by *Leishmania donovani*. The disease is characterized by swelling of the tissue and the internal organs of the body leading to their inability to function. The parasite destroys the macrophage cells within the tissue and disposes them in their immunity. **SYMPTOMS:** Loss of weight, anaemia, Enlargement of liver and spleen (Lepatosplenomegaly) and results in protruding abdomen.
- 2) **CUTANEOUS LEISHMANIASIS (ORIENTAL):** It is caused by *Leishmania tropica*. It is characterized by occurrence of ulcers and sore on the skin and sub-cutaneous tissue. Some of the sores may heal on their own but only to reoccur at other parts of the body e.g. the pineal of the ear, nose or upper lips, the entire tissue may be completely eroded off. There is usually secondary bacterial infection at the wound created by infection and these may complicate the healing process of the sore or lead to other diseases.

TREATMENT: The disease is difficult to treat. Some of the drugs that

are useful are:

- 1) Glucatine
- 2) Pentostam.

The period of treatment must not be less than 6months. These drugs are used in combination with antibiotics, such as Amphotercin B

PREVENTION/ CONTROL: Avoiding bite of sand fly.

Eliminating possible reservoir host like wild rodents and maintain good sanitary habit

INTESTINAL FLAGELLATES

Giardia lamblia. This cosmopolitan species is the only flagellate parasite of the human alimentary tract which shows undisputed pathogenicity. There are two stages in the life-cycle, the trophozoite and the cyst .The **trophozoite** is a small (10-21 by 5-15 microns) pear-shaped organism with a convex dorsal surface and a flat ventral surface provided with a large oval sucker. It lives in the small intestine, especially the duodenum attached to the mucosa by means of its sucker but can move in a jerky, actively progressive way through the agency of four pairs of flagella and a pair of ovoid nuclei.

LIFE CYCLE: The trophozoite reproduces asexually by binary fission in the intestine and occasionally by multiple fission. It can also develop cyst wall and transform into a cyst with 4 nuclei which are at tandem in position. The cysts are released with the stool of the host to the outside and the mode of infection is by accidental swallow of the cyst with water or vegetable matter under poor sanitary condition. The cyst will produce two new individuals in the new host to establish a new infection.

DISEASE: It causes giardiasis. The infected individual is unable to absorb digested food especially fat as a result of this, stool that contains lot of fat is passed. Other symptoms of infection are diarrhoea, abdominal pain, difficulty in stooling, loss of appetite, loss of weight, headache and epigastric pain. In some other individuals, there is no symptoms at all except the passing of fatty stool.

DIAGNOSIS: Identification of the characteristic cysts in stool sample.

TREATMENT: It involves use of a combination of anti-protozoan and antibiotics drugs like Chloroquin and Erythromycin. A treated patient is known to regain appetite strongly.

PREVENTION AND CONTROL: Maintaining good sanitation and good sanitary habits.

Other Flagellates Parasitic in the Human Alimentary Tract

The following species are all non-pathogenic, but pathological conditions of the intestine due to other agents, especially those causing diarrhoea, probably favour their multiplication and discharge in the faeces. This has sometimes led to the erroneous conclusion.

(a) *Trichomonas hominis*. (b) *Enteromonas hominis*. (c) *Chilomastix mesnili*.

(d) *Embadomonas intestinalis*.

All four species are small, cosmopolitan forms with characteristic numbers and arrangement of flagellae. They are transmitted by means of characteristically shaped cysts, with the exception of

T. hominis, which apparently has no cystic stage but possesses a very resistant trophozoite.

Trichomonas buccalis occurs in the human mouth and it lacks cyst form. It is transmitted, like *E. gingivalis*, by direct contact, droplet spray, or contaminated dishes or vessels.

Vaginal Parasites of Man

Trichomonas vaginalis is found in the vagina of females and ureter of males.

MORPHOLOGY: It is spindle shaped with 3-5 flagella at times it may be up to 6. One of the flagella attaches to the body by a means of undulating flagella. It has a single nucleus and the body is supported by axostyle.

LIFE CYCLE:

The parasite reproduce by simple binary fission. There is no formation of cyst. The mode of transmission of infection is by direct contact with the trophozoite from the infected person's towel, toiletries and clothes especially pant through communal use of such person belongings. It can also be contacted through sexual intercourse as a venereal disease.

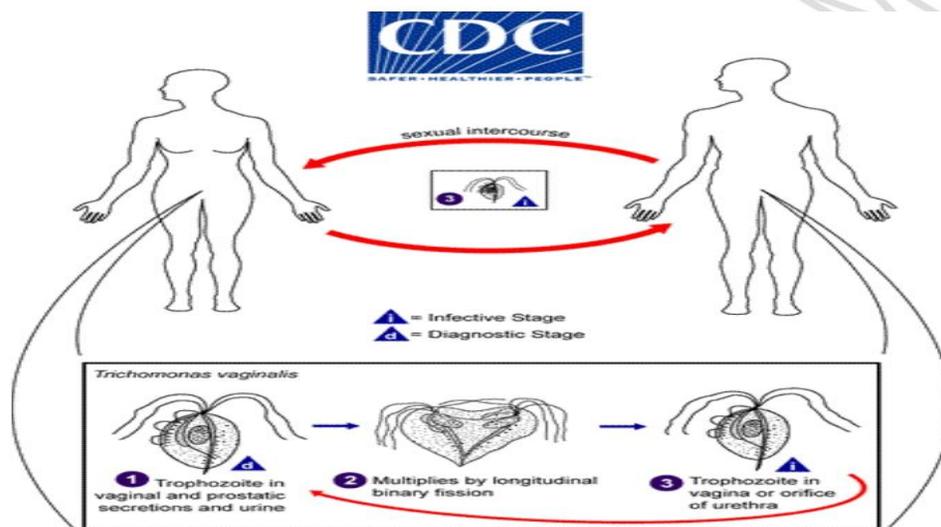


Fig.5: *Trichomonas vaginalis* life cycle.

<https://www.cdc.gov/dpdx/trichomoniasis/index.html>

SYMPTOMS: Creamy white discharge from the vagina or ureter.

Itching or scratching in the urogenital system. **DIAGNOSIS:** Identification of the parasite in fresh smears.

TREATMENT: Using a combination of anti-protozoal and anti – biotics drugs.

PREVENTION: Maintaining good sanitation and sanitary conditions Exhibiting good moral habit.

Avoid sharing or using other people's personal belongings such as towels, pants, toiletries etc.

CILIATES

They are protozoans that are completely covered by cilia. They have 2 nuclei. They reproduce asexually by binary fission and sexually by conjugation. Few of them are parasites and mainly parasites of aquatic organisms.

Balantidium coli. This cosmopolitan species is a parasite of vertebrates particularly in man, monkeys, cattle. It varies between 20µm- 200µm. actively motile form having an antero-lateral peristome leading in to a cystostome. It inhabits the lumen of the large intestine, but frequently invades and damages the intestinal wall. Highly resistant, spherical or ovoid cysts are formed and pass out in the faeces of the host.

LIFE CYCLE: The parasite reproduces asexually by binary fission and also sexually by conjugation. It also develop cyst with thick wall and a single nucleus. Mode of infection is by accidental swallowing of the cyst under poor sanitary condition. The cyst will produce new individual which will increase in number by binary fission

DISEASE: In man, it causes sores or blisters at the wall of the large intestine. This is due to the parasite eating up the mucosa lining of the large intestine. The infection is associated with diarrhoea with blood stained stool. The wounds caused by the parasite can lead to secondary bacterial infection.

DIAGNOSIS: Identification of the characteristic cysts in stool sample.

TREATMENT: It involves use of a combination of anti-protozoan and



anti-biotics drugs like Chloroquin and Erythromycin. A treated patient is known to regain appetite strongly.

PREVENTION AND CONTROL: Maintaining good sanitation and good sanitary habits.

OTHER CILIATES.

Opalina ranarum

Found in the rectum of frogs and other amphibians



SPOROZOANS

PLASMODIUM SP.

The trophozoite of *Plasmodium* sp. is also called the merozoite which occurs in the red blood cells of vertebrates. There are four species of Plasmodium that are known to cause malaria infection in man.

P. vivax occurs world-wide in tropical and some temperate countries of the world.

P. ovale which cause benign tertian malaria is found mainly in West Africa causes about 10% of the malaria. (*P. vivax* and *P. ovale* which cause benign tertian malaria characterised by a febrile paroxysm every 48 hours).

P. malariae: It occurs worldwide with patchy distribution. It causes quartan malaria (characterised by a febrile paroxysm every 72 hours

P. falciparum which causes malignant (pernicious) tertian malaria (characterised by febrile paroxysms at irregular intervals approximating to 48 hours in some cases).

The life-cycle of all four species is essentially similar. It involves certain mosquito species belonging to the genus *Anopheles* as intermediate host, and passes through four stages :

(a) The pre-erythrocytic cycle (b) The exo-erythrocytic cycle (c) The erythrocytic cycle (d) The sexual cycle.

(1) **The pre-erythrocytic cycle.** When a human being is bitten by an infected mosquito, the slender, motile **sporozoites** of the parasite are injected into the blood stream, which they leave within an hour to invade the liver. Here they enter the parenchymatous cells and grow rapidly to form schizonts which divide (**schizogony**) to form a large number of small **merozoites**.

(2) **The exo-erythrocytic cycle.** The majority of the merozoites emerge into the blood-stream and invade red blood corpuscles, but some may re-infect liver cells and form a reservoir of infection in the liver.

(3) **The erythrocytic cycle.** Those merozoites which invade erythrocytes feed on their contents and grow into **trophozoites**, each of which divides to form a further generation of merozoites (**schizogony**). Each daughter merozoite invades a further erythrocyte.

(4) **The sexual cycle** begins in man and is completed in the mosquito. Instead of developing into trophozoites and undergoing division, the merozoites grow into more compact cells known as

gamonts or **gametocytes**, of which two kinds may be distinguished —the male or **microgametocyte** and the female or **megagametocyte**.

The gametocytes undergo no further development unless they are ingested by an appropriate species of mosquito, when they are liberated by digestion from the enveloping corpuscle and divide to form elongate, motile male gametes or rounded passive female gametes, according to their sex. Male and female gametes unite to form **zygotes**, which become motile and penetrate epithelial cells of the stomach wall. Between the epithelial and subepithelial layers each zygote becomes enclosed in a cyst

and divides repeatedly therein to form a large number of minute, vermiform, actively motile **sporozoites**. Eventually the cyst bursts and the sporozoites are liberated into the haemocoel or body cavity of the mosquito, through which they make their way forwards to the salivary glands, there to lie in wait for an opportunity to invade a new human host when the infected mosquito bites again.

DISEASE: It causes malaria disease and symptoms include fever, shaking chills, high temperature, sweating, general weakness of the body, loss of appetite and anaemia. The period of development of these symptoms coincide with the time of the release of merozoites and destruction of red blood cells during erythrocytic cycle.

The periodicity of this cycle and the time symptoms are felt depends on the *Plasmodium* sp. For *P. ovale*, *vivax* and *falciparum* are felt every 48hrs while *P. malariae*, the symptoms are felt every 72hrs.

Death may result when parasitized red blood cells and the debris of the schizogony block blood vessels supply to the brain. This is called cerebral malaria. They may also cause damage to the vital organs of the body.

DIAGNOSIS: Identifying the parasite in the blood film

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DIAGNOSIS: Identifying the parasite in the blood film

TREATMENT: It involves the use of various drugs such as quinine, chloroquine, mefloquine, halofanquine, Artemisinin and Lumenfantrin.

CONTROL:

1. Avoiding mosquito bite by wearing clothes, using of mosquito repellent, mosquito nets, fumigant coils or insecticide sprays.
2. Destroying the breeding sites and life cycle of the mosquito vector by clearing the bushes, removing stagnant water or destroying the mosquito larvae by spraying of oil into the water
3. Constant treatment of infected persons through chemotherapy and general public health education (world-wide campaign against the disease directed and coordinated by the World Health Organisation have done much to reduce the ravages of malaria in the last fifteen years.) on the biology and mode of infection of the parasite.

REASONS WHY MALARIA IS DIFFICULT TO CONTROL

1. Mosquitoes breed at rapid rate in several stagnant water bodies in the environment.
2. The plasmodium parasite is zoonotic and can also infect wild animals like monkeys which serve as reservoir host and sources of infection and re-infection to man.
3. Drug abuse and development of resistant to drug by the parasite.

4. It has not be possible to develop a vaccine because of the different stages of the life cycle which carry different antigens which the parasite also vary.

OTHER SPOROZOA PARASITES.

There are other sporozoa parasites that are of great economic importance. They are:

- I. *Babesia* spp.
- II. *Toxoplasma gondii*
- III. *Eimera tenella*.



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