Intestinal protozoa (Amoeba)

Features of protozoa:

- ✓ Protozoa (from the Greek words *proto*, meaning "first", and zoa, meaning "animals") is a grouping of eukaryotes many of which are motile.
- ✓ The most important protozoans range usually from 10 to 52 micrometers, but can grow as large as 1 mm, and are seen easily by microscope
- ✓ They move by a variety of organs pseudopodia, flagella and cilia.
- ✓ They are found in different parts of the body intestine, blood and tissues, cavities like mouth, Uro-genital system.
- ✓ Most intestinal protozoa have direct life cycle. They have either: Trophozoit and cyst or Trophozoit only.

Life stages of intestinal Protozoa

A- Cyst stage: It is non motile, none feeding, non active stage, it is the infective stage if the parasite has trophozoite and cyst stage in the life cycle. It is diagnostic stage in case of chronic infection. Transmitted to the human by contamination of food and water.

B- Trophozoite stage: It is active, motile, feeding stage of parasite. *it is the pathogenic stage of parasite. *it is the diagnostic stage in case of acute infection.

C- Or It has only Trophozoite without cyst stage:

(Trophozoite stage will be the pathogenic, diagnostic and infective stage if the parasite has no cyst stage).

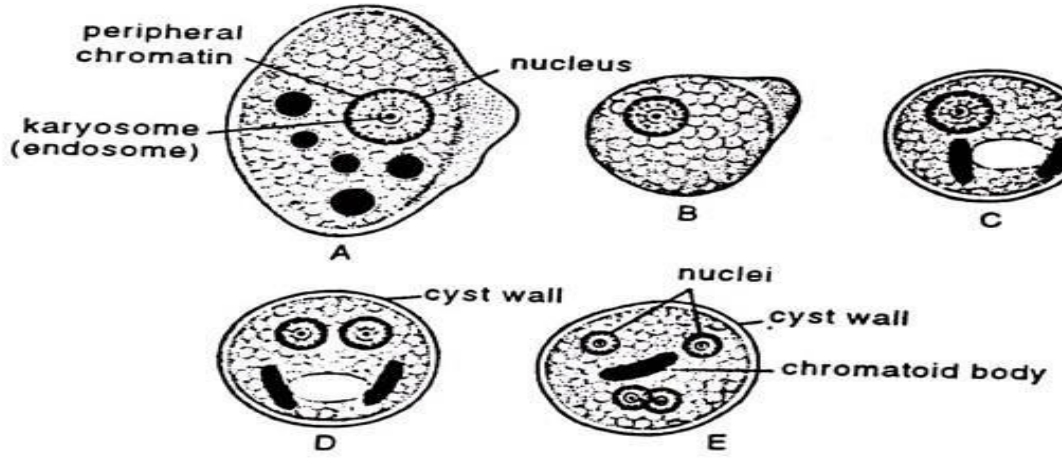


Fig. 18.4. Entamoeba histolytica. A. Trophozoite stage. B. Precystic stage. C-E. Cysts, C. Uninucleate. D. Binucleate. E. Quadrinucleate stage

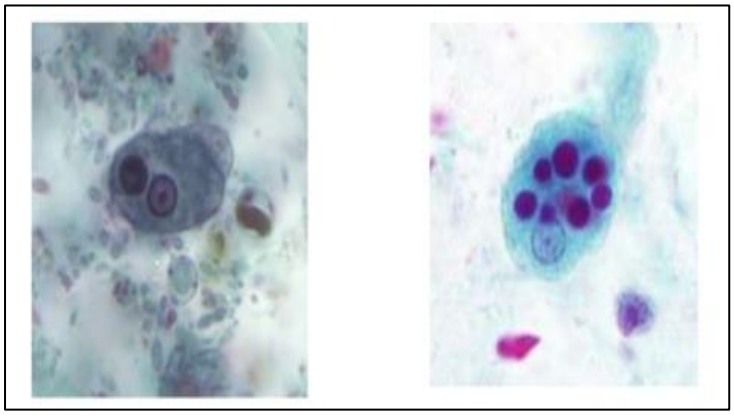
1.1 Pathogenic Intestinal Amoeba: AMOEBIASIS

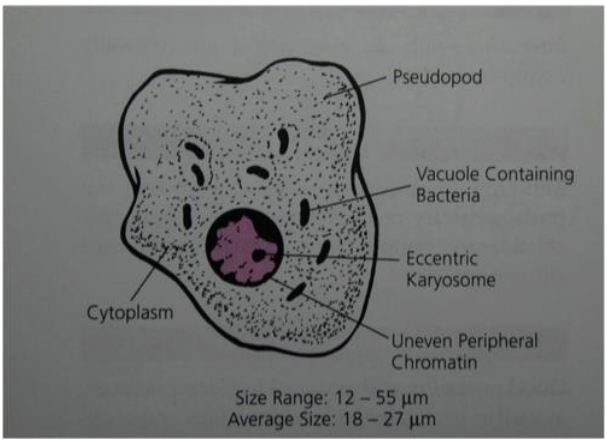
Intestinal Protozoa Amoeba: *Entamoeba histolytica*
Diseases: *Entamoeba histolytica* causes amebic dysentery and liver abscess.
Important Properties: The life cycle has two stages: the **motile** (**trophozoite**) the **nonmotile** (**cyst**)
These cysts are killed by boiling but not by chlorination of water supplies. They are removed by filtration of water.
The mature trophozoite has a single nucleus with lining of peripheral chromatin and a central nucleolus (karyosome).
The cyst has four nuclei, an important diagnostic criterion

Entamoeba histolytica:

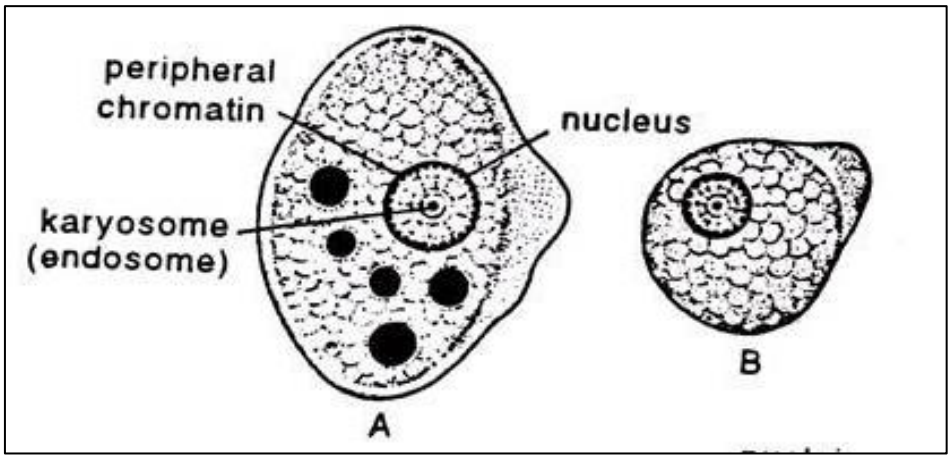
Morphological features

a- Trophozoites: Viable trophozoites vary in size from about 10-60µm in diameter. Motility is rapid, progressive, and unidirectional, through pseudopods. The nucleus is characterized by evenly arranged chromatin on the nuclear membrane and the presence of a small, compact, centrally located karyosome. The cytoplasm is usually described as finely granular with few ingested bacteria or debris in vacuoles. In the case of dysentery, however, RBCs may be visible in the cytoplasm, and this feature is diagnostic for *E.histolytica*.



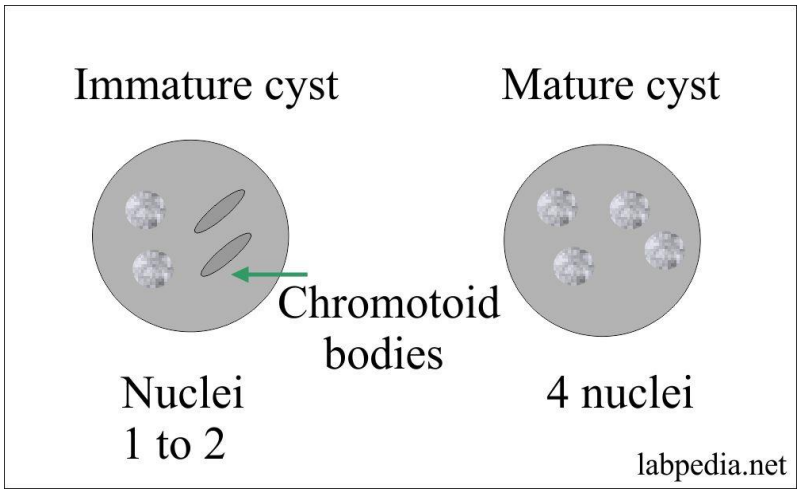


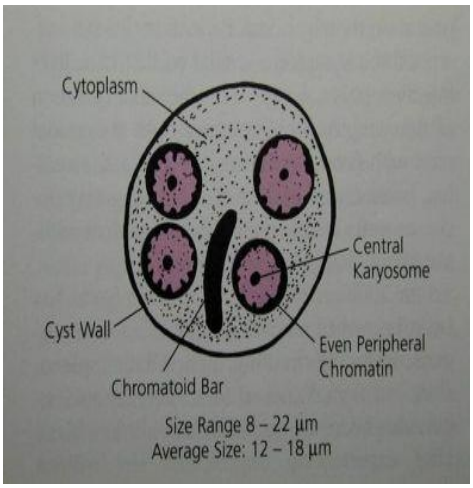
(b)- Pre Cyst: Smaller to trophozoite but larger to cyst (10-20µm), oval with blunt pseudopodia. Food vacuoles and RBCs are disappear. Single rounded nucleus, absence of digested materials and lack of a cyst wall.



Entamoeba histolytica. A. Trophozoite stage. B. Precystic stage.

(c)- Cyst: Cysts range in size from 10-20µm. The immature cyst has inclusions namely; glycogen mass and chromatoidal bars. As the cyst matures, the glycogen completely disappears; the chromotiodials may also be absent in the mature cyst. Mature ***Entamoeba histolytica*** **cysts** have 4 nuclei that characteristically have centrally-located karyosomes and fine, uniformly distributed peripheral chromatin.





Info before the life cycle:

- ✓ **Habitat:** Trophozoite in:

1-Large intestine

2- Extraintesinal infection. Cyst only in large intestine Life cycle: direct no intermediate host.

- ✓ **Infective stage:** Is mature quadrinucleated cyst.
- ✓ **Pathogenic stage:** Only Trophozoite which seen in diarrheic acute dysentery stool.
- ✓ **Diagnostic stage:** Cyst in chronic infection and trophozoite in acute diarrhic infection.
- ✓ **Mode of infection:** Contamination of food and water. Humans are the principal host, although dogs, cats and rodents may be infected

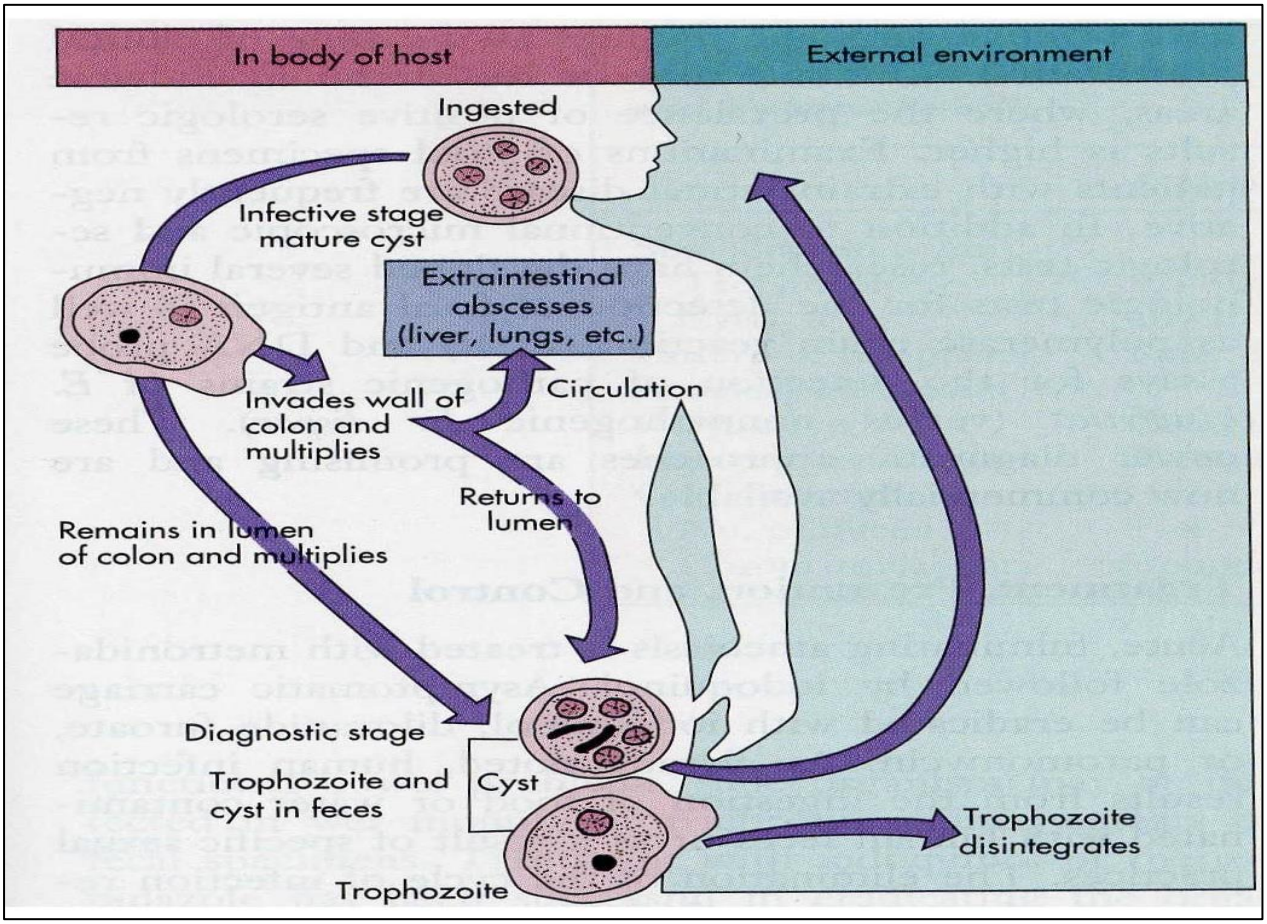
Life cycle of *Entamoeba histolytica:*

Intestinal infections occur through the ingestion of a mature quadrinucleate infective cyst, contaminated food or drink and also by hand to mouth contact. It is then passed unaltered through the stomach, as the cyst wall is resistant to gastric juice.

In terminal ileum (with alkaline pH), excystation takes place. Trophozoites being actively motile invade the tissues and ultimately lodge in the submucous layer of the large bowel. Here they grow and multiply by binary fission.

Trophozoites are responsible for producing lesions in amoebiasis. Invasion of blood vessels leads to secondary extra intestinal lesions. Gradually the effect of the parasite on the host is toned down together with concomitant increase in host tolerance, making it difficult for the parasite to continue its life cycle in the trophozoite phase.

A certain number of trophozoites come from tissues into lumen of bowel and are first transformed into pre-cyst forms. Pre-cysts secret a cyst wall and become a uninucleate cyst. Eventually, mature quadrinucleate cysts form. These are the infective forms. Both mature and immature cysts may be passed in faeces. Immature cysts can mature in external environments and become infective.



Reproduction of *E. histolytica*

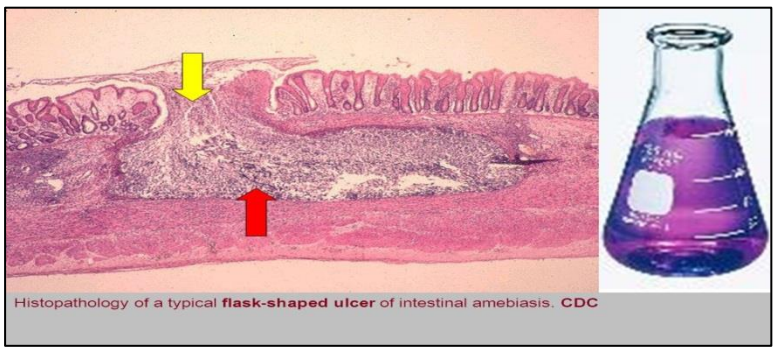
The Reproduction occurs in three stages:

- **Excystation**
- **Encystation**
- **Multiplication**

- **Excystation**: This is the process of transformation of cyst to trophozoites. During excystation a quadrinucleate cyst give rise to eight amoebulae each one of which is being capable of developing into trophozoites.
- **Encystation**: This is the process of transformation of trophozoite to cyst and occurs inside the lumen of the intestine of an infected individual.
- **Multiplication**: This occurs only in the trophozoite forms of the entamoeba histolytica , growing and multiplication takes place inside the tissue. Reproduction of trophozoites occurs by simple binary fission.

Pathogenesis & Epidemiology:

1. The organism is acquired by ingestion of cysts that are transmitted by the fecal-oral route in contaminated food and water.
2. The ingested cysts differentiate into trophozoites in the ileum but tend to colonize the cecum and colon.
3. The trophozoites invade the colonic epithelium and secrete enzymes that cause localized necrosis. As the lesion reaches the muscularis layer, a typical **"flask-shaped"** ulcer forms.
4. Progression into the submucosa leads to invasion of the portal circulation by the trophozoites. By far the most frequent site of systemic disease is the liver, where ab scesses containing trophozoites form.



Histopathology of a typical **flask-shaped ulcer** of intestinal amebiasis. CDC

Clinical Findings:

1. Acute amebiasis presents as dysentery (i.e., bloody, mucus-containing diarrhea) accompanied by lower abdominal discomfort, flatulence, and tenesmus.

2. Chronic amebiasis: diarrhea, weight loss, and fatigue also occur. Roughly 90% of those infected have asymptomatic infections, but they may be carriers, whose feces contain cysts that can be transmitted to others. In some patients, a granulomatous lesion called an ameboma may form in the cecal or rectosigmoid areas of the colon. These lesions can resemble an adenocarcinoma of the colon.

3. Amebic abscess of the liver is characterized by right-upper-quadrant pain, weight loss, fever, and a tender, enlarged liver. Right-lobe abscesses can penetrate the diaphragm and cause lung disease.

Immunity:

E.histolytica elicits both the humeral and cellular immune responses, but it is not yet clearly defined whether it modulates the initial infection or prevents reinfection.

Laboratory Diagnosis:

1. Intestinal amebiasis: finding either trophozoites in diarrheal stools or cysts in formed stools. Diarrheal stools should be examined within 1 hour of collection. Trophozoites contain ingested red blood cells, because cysts are passed intermittently.

-E. histolytica can be distinguished by two criteria:

(1) The nature of the nucleus of the trophozoite (has a small central nucleolus and fine chromatin granules along the border of the nuclear membrane). (2) The second is cyst size and number of its nuclei.

2. A complete examination for cysts includes a wet mount in saline, an iodine-stained wet mount, and a fixed, trichrome-stained preparation.

These preparations are also helpful in distinguishing amebic from bacillary dysentery.

3. Serologic testing ex. indirect hemagglutination test.

4. Detects nucleic acids of the organism in a PCR-based assay.

Treatment:

Acute, fulminating amebiasis is treated with metrondiazole followed by iodoquinol, and asymptomatic carriage can be eradicated with iodoquinol, diloxanide furoate, or paromomycin. The cysticidal agents are commonly recommended for asymptomatic carriers who handle food for public use. Metronidazole, chloroquine, and diloxanide furoate can be used for the treatment of extra intestinal amoebiasis.

Prevention:

1. Avoiding fecal contamination of food and water. **2.** Good personal hygiene such as hand washing. **3.** Purification of water supplies. **4.** In areas of endemic infection, vegetables should be cooked.

1.2 Nonpathogenic Intestinal Amoeba:

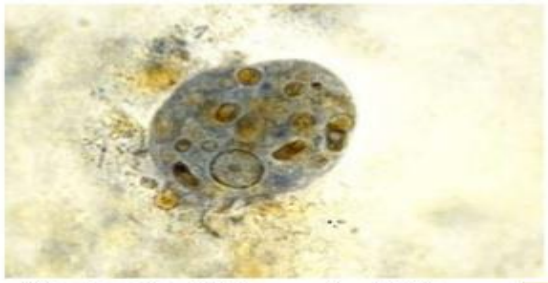
Most of these amoebae are commensal organisms that can parasitize the human gastrointestinal tract.

Entamoeba coli the life cycle stages include; trophozoite, precyst, cyst, metacyst, and metacystic trophozoite. Typically the movements of trophozoites are sluggish, with broad short pseudopodia and little locomotion, but at a focus the living specimen cannot be distinguished from the active trophotozoite of *E.histolytica.* However, the cysts are remarkably variable in size. *Entamoeba coli* are transmitted in its viable cystic stage through faecal contamination. *E.coli* as a lumen parasite is non-pathogenic and produces no symptoms. The mature cyst (with more

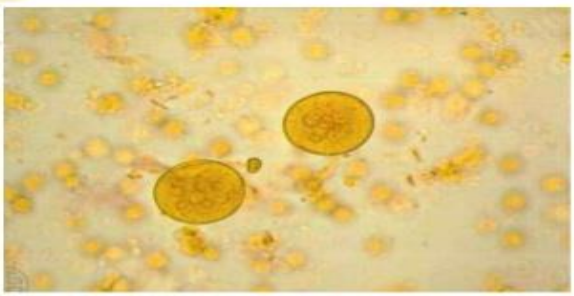
than four nuclei 8-nuclei) is the distinctive stage to differentiate *E.coli* from the pathogenic *E.histolytica*. Specific treatment is not indicated since this amoeba is non-pathogenic. The presence of *E.coli* in stool specimen is evidence for faecal contamination. Prevention depends on better personal hygiene and sanitary disposal of human excreta.

Trophozoites of Entamoeba **coli** usually measure 15–50 µm. The **trophozoites** have a single nucleus with a characteristically large, eccentric karyosome and coarse, irregular peripheral chromatin. The cytoplasm is usually coarsely granular and vacuolated (often described as "dirty" cytoplasm).

Cysts of Entamoeba **coli** are usually spherical but may be elongated and measure 10–35 µm. Mature **cysts** typically have **8 nuclei** but may have as many as 16 or more. *Entamoeba **coli*** is the only Entamoeba species found in humans that has more than four nuclei in the **cyst** stage.



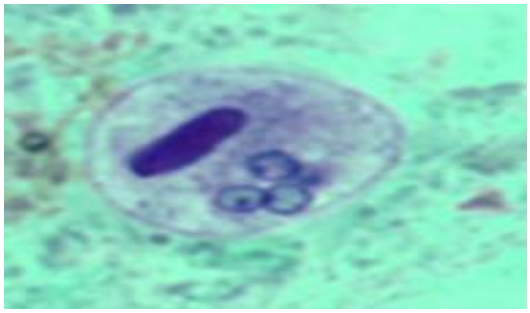
Trophozoite of *Entamoeba Coli* :
(iron hematoxylin stain)



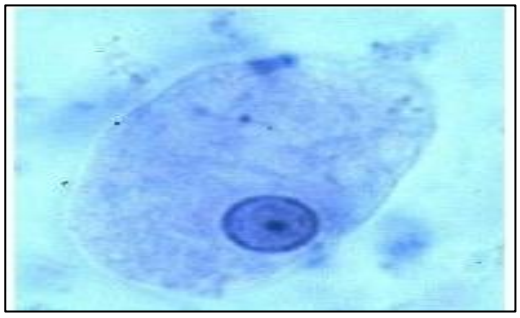
Cysts of *Entamoeba Coli* :
(iodine mount)

Entamoeba dispar: A common noninvasive parasite, is indistinguishable in its cysts and trophozoite forms from *Entamoeba histolytica*, the cause of invasive amebiasis, by microscopy.

Trophozoites in trichrome stained smears usually measure 15 to 20 µm. Presence of one nucleus with evenly arranged chromatin on the nuclear membrane and a small, centrally located karyosome are morphological features of trophozoites. The cytoplasm is finely granular and few ingested bacteria or debris may be present. Presence of red blood cells within the cytoplasm of trophozoites is a diagnostic feature for the identification of E. histolytica. Ingested RBCs are not frequently seen; in the absence of this diagnostic characteristic E. histolytica/E. dispar should be reported. Cysts usually measure 12 to 15 µm and have 1 to 4 nuclei. Chromatoid bodies with bluntly rounded ends may also be present.



Cyst



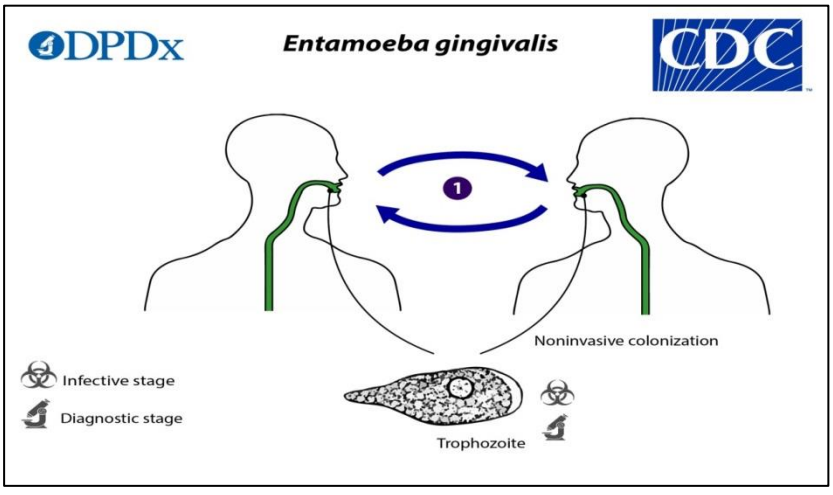
Trophozoites

Entamoeba hartmanni in all of its life-cycle stage, *E.hartmanni* resembles *E.histolytica* except in size, yet there is a slight overlap in the size range. The trophozoites do not ingest red blood cells, and their motility is generally less vigorous than that of *E.histolytica.* As in other amebae, infection is acquired by ingestion of food or water contaminated with cyst-bearing faeces. Identification is based on examination of small amebae in unstained or iodine-stained preparations. Usually no treatment is indicated, measures generally effective against faecal-borne infections will control this amoebic infection.

Endolimax **nana**: Is a lumen dweller in the large intestine, primarily at the cecal level, where it feeds on bacteria. The life cycle is similar to E.histolytica. Motility is typically sluggish (slug-like) with blunt hyaline pseudopodia, Projects shortly. Human infection results from ingestion of viable cysts in polluted water or contaminated food. Typical ovoid cysts of *E.nana* are confirmative. Rounded cysts and living trophozoites are often confused with *E.hartmanni* and *E.histolytica*. No treatment is indicated for this nonpathogenic infection. Prevention can be achieved through personal cleanliness and community sanitation.

Iodamoeba buetschlii: The natural habitat is the lumen of the large intestine, the principal site probably being the caecum. The trophozoite feeds on enteric bacteria; it is a natural parasite of man and lower primates. It is generally regarded as a nonpathogenic lumen parasite. No treatment is ordinarily indicated. Prevention is based on good personal hygiene and sanitation in the community.

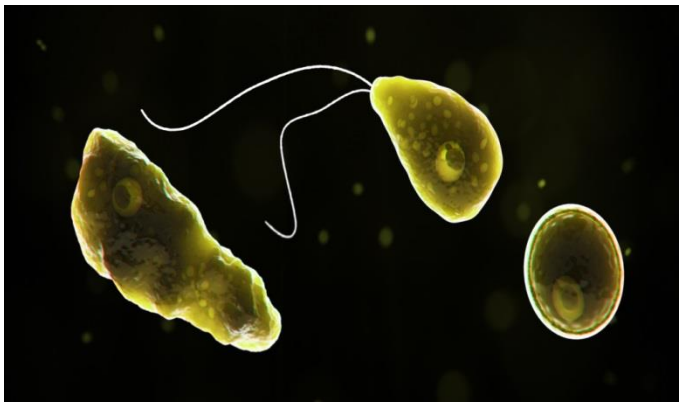
Entamoeba gingivalis: Only the trophozoite stage presents, and encystation probably does not occur. *E.gingivalis* is a commensal, living primarily on exudate from the margins of the gums, and thrives best on unhealthy gums. No specific treatment is indicated. However the presence of *E.giingivalis* suggests a need for better oral hygiene. The infection can be prevented by proper care of the teeth and gums.

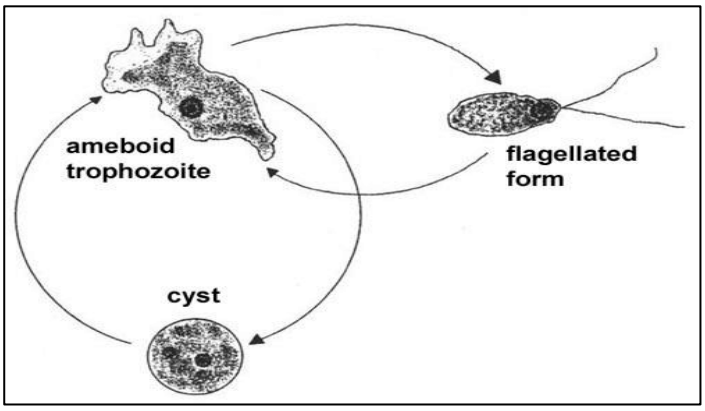


1.3. PATHOGENIC FREE-LIVING AMOEBAE:

Among the numerous free-living amoebae of soil and water habitats, certain species of Naegleria, Acanthamoeba and Balamuthia are facultative parasites of man. Most human infections of these amoebae are acquired by exposure to contaminated water while swimming. Inhalation of cysts from dust may account for some infections.

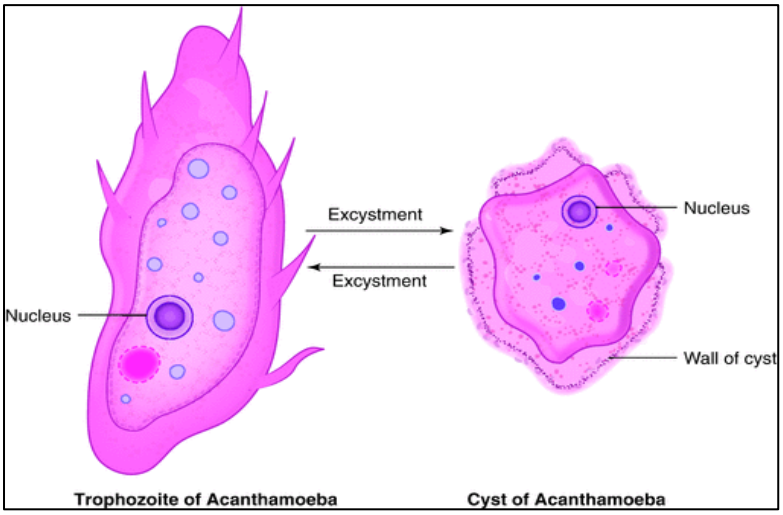
Naegleria fowleri: The trophozoites occur in two forms. Amoeboid forms with single pseudopodia and flagella forms with two flagella which usually appear a few hours after flooding water or in CSF.

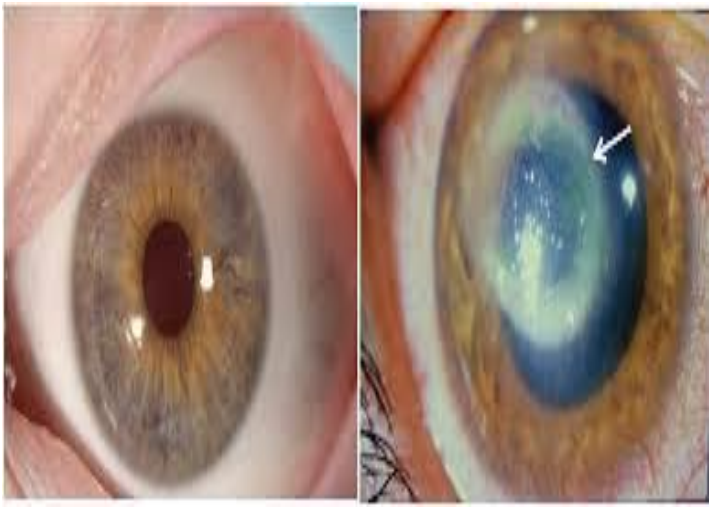




Acanthameba species: Are free-living amebae that inhabit a variety of air, soil, and water environments. However, these amebae can also act as opportunistic as well as nonopportunistic pathogens. *Acanthamoeba* has two forms, the metabolically active trophozoite and a dormant, stress-resistant cyst. The trophozoites have an irregular appearance with spine-like pseudopodia. Acanthamoeba causes three main types of illness involving **the eye** (**Acanthamoeba keratitis**), the **brain** and **spinal cord** (Granulomatous Encephalitis), and **infections** that can spread throughout

the entire body (disseminated **infection**). Naegleria fowleri causes acute primary amoebic meningoencephalitis.





Balamuthia species: The trophozoite may be bi-nucleated. Unlike most amoebae the nuclear envelope breaks down during mitosis. Naegleria, Acanthamoeba, Balamuthia organisms are opportunistic pathogens.

Acantamoeba & Balamuthia organisms are responsible for granulomatous amoebic encephalitis and single or multiple brain abscesses, primarily in immunocompromised individuals. For the diagnosis of Naegleria, canthamoeba, and Balamuthia infections, specimens of nasal discharge and cerebrospinal fluid; and in cases of eye infections corneal scraping should be collected. The clinical specimen can be examined with saline wet preparation and Iodine stained smear. Treatment of free-living amoebic infections is largely ineffective.

Intestinal Flagellates

Introduction:

The flagellates belong to the Magistophora and possess more than one flagellum. Beating these flagella enable them to move. A cytosome may be present which helps in the identification of the species.

Intestinal parasites are **parasites** that can infect the gastro-**intestinal** tract (**GIT**) of humans and other animals. They can live throughout the body, but most prefer the **intestinal** wall. Means of exposure include ingestion of undercooked meat, drinking infected water, and skin absorption.

There are **pathogenic** and **commensal** species of flagellates. The flagellates which are encountered in the intestinal tract are: Giardia lamblia, Dientamoeba fragilis, Chilomastix mesnili, Trichomonas hominis, Retortamonas intestinalis and Enteromonas hominis (the latter 2 being less common).

Giardia Lamblia

Giardia lamblia, a flagellate, is the only common pathogenic protozoan found in the **duodenum** and **jejunum** of humans. It is the cause of **giardiasis.**

Giardia duodenalis is another name commonly ascribed to the parasite that causes human giardiasis; the term ***Giardia intestinalis*** is frequently used in Europe and ***Lamblia intestinalis*** in the former USSR.

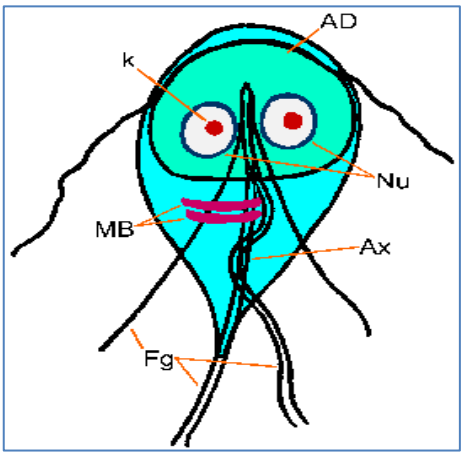
Giardia lamblia is a flagellate of worldwide distribution. It is more common in warm climates than moderate climates. It is the most common flagellate of the intestinal tract, causing *Giardiasis.* Humans are the only important **reservoir** of infection. Infection is most common in parts of the world where sanitation levels are the lowest. ***Giardiasis*** is an infection of the **upper small intestine**, which may cause **diarrhoea**. Only *Giardia* spreads disease.

Morphology & Identification

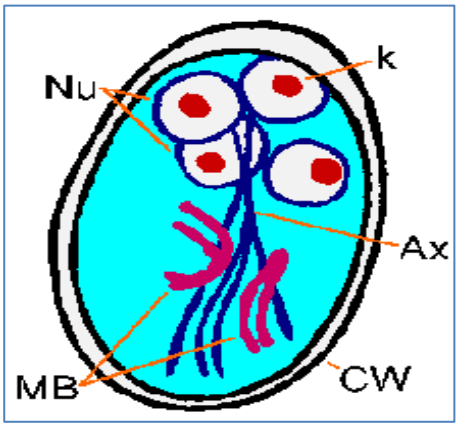
Typical Organisms:

The **trophozoite** of *G lamblia* is a heart-shaped, symmetric organism 10-20 m in length. There are four pairs of flagella, two nuclei with prominent central karyosomes, and two axostyles (rod-like supporting organelles). A large concave **sucking disk** in the anterior portion occupies much of the ventral surface. The swaying or dancing motion of giardia trophozoites in fresh preparations is unmistakable. As the parasites pass into the colon, they typically encyst. **Cysts** are found in the stool-often in enormous numbers. They are thick-walled, highly resistant, 8-14 m in length, and ellipsoid and contain two nuclei as immature, four as mature cysts.

- K= Karyosome
- Nu= Nucleus
- MB= Median body
- Fg= Flagella
- Ax= Axoneme
- AD= Adhesive disk



- Nu= Nuclues
- K= Karyosome
- Ax= Axoneme
- MB= Median body
- CW= Cyst wall



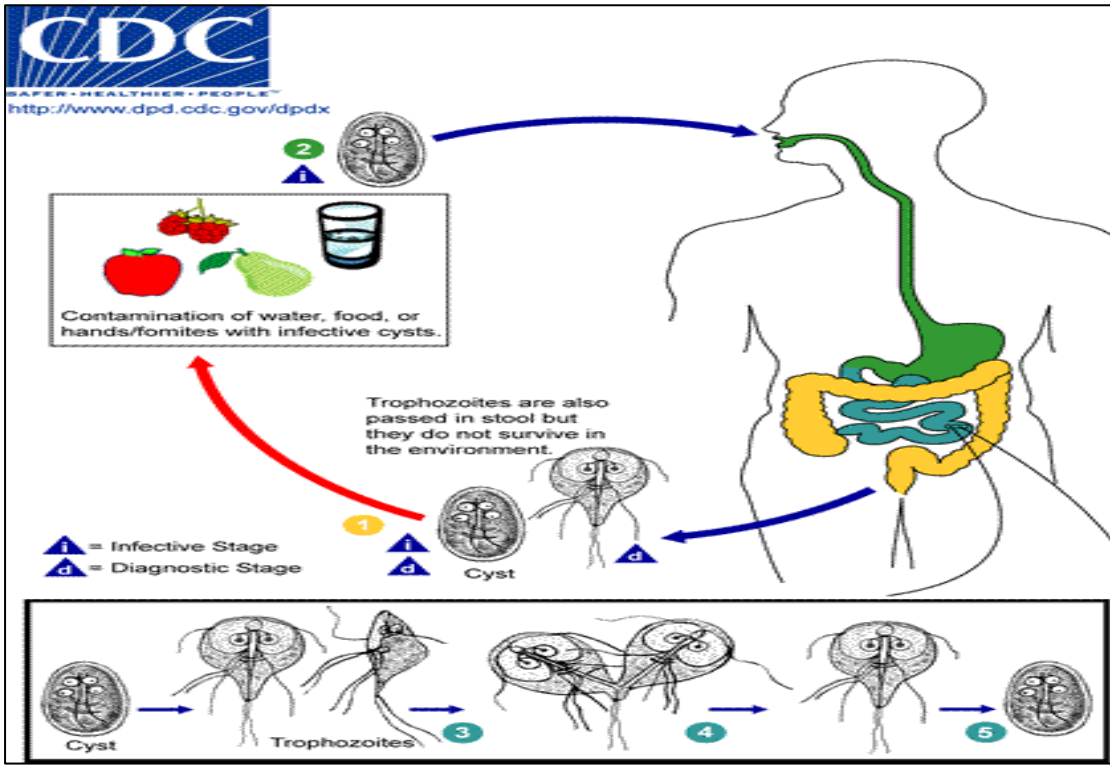
Life Cycle of Giardia:

< **Infection** occurs by ingestion of cysts (generally from fecally contaminated food or water)

< **Excystation** occurs in the small intestine

< **Trophozoites** multiply by binary fission in the small intestine. *G. lamblia* attach to the mucosal surface by means of its adhesive disk.

< **Cyst** formation is triggered by the dehydration of gut contents moving through the large intestine.



Encystation: is the process of forming the cyst or the process becoming enclosed in a capsule). This event takes place in the rectum of the host as feces are dehydrated or soon after the feces have been excreted.

Excystation: produces a trophozoite from the cyst stage, and it takes place in the Upper Small Intestine of the host after the cyst has been ingested.

Pathogenesis & Clinical Findings

These include protozoan damage to mucosa and villi structures, disturbance of the natural flora, and increased intestinal permeability via localized cytokine production. *G lamblia* is usually only weakly pathogenic for humans. Cysts may be found in large numbers in the stools of entirely asymptomatic persons. In some persons, however, large numbers of parasites attached to the bowel wall may cause irritation and low-grade inflammation of the duodenal or jejunal mucosa, with consequent acute or chronic diarrhea associated with crypt hypertrophy, villous atrophy or flattening, and epithelial cell damage. The stools may be watery, semisolid, greasy, bulky, and foul-smelling at various times during the course of the infection. Malaise, weakness, weight loss, abdominal cramps, distention, and flatulence can occur. **Children** are more liable to clinical giardiasis than adults. **Immunosuppressed** individuals are especially liable to massive infection with severe clinical manifestations. Symptoms may continue for long periods.

Histological aspects :

Shortening of villi, Cellular infiltration of lamnia propria of mucous membrane functional impairment of enterocytes Abdominal cramps Induce motility disturbance. **Severe cases:** get malabsorption syndrome and **steatorrhea**, and weight loss.

How the parasite attaches to the intestinal mucosa?

By the sucking disc /adhesive disc located on the ventral side of the cell. Attachment of *Giardia lamblia* trophozoites to enterocytes is essential for colonization of the small intestine and is considered a condition for parasite-induced enterocyte dysfunction and clinical disease.

Severe cases of this disease:

- Attachment of trophozoites to the brush border could produce a mechanical irritation or mucosal injury.
- In addition, normal villus structure is affected in some patients. For example, villus blunting (atrophy) and crypt cell hypertrophy and an increase in crypt depth have been observed to varying degrees.
- The increase in crypt cells will lead to a repopulation of the

intestinal epithelium by relatively immature enterocytes with reduced absorptive capacities. An increased inflammatory cell infiltration in the lamina propria has also been observed and this inflammation may be associated with the pathology.

- *Giardia* infection can also lead to lactase deficiency as well as other enzyme deficiencies in the microvilli. This reduced digestion and absorption of solutes may lead to an osmotic diarrhea and could also explain the malabsorption syndromes. Thus far, no single virulence factor or unifying mechanism explains the pathogenesis of giardiasis

Diagnostic Laboratory Tests

Diagnosis depends upon finding the distinctive cysts in formed stools, or cysts and trophozoites in liquid stools.

Differentiation is based on morphological examination of fecal preparations.

- Microscopic examination
- Serological assays
- Immunofluoresence methods
- Enzyme immunoassays

Treatment

Metronidazole (Flagyl) will clear over 90% of *G lamblia* infections. Oral **quinacrine** hydrochloride (Atabrine) and **furazolidone** (Furoxone) are alternatives. **Tinidazole** (Fasigyn), used for 1-day treatment, is widely and effectively used but is not available in the United States. **Paromomycin** (Humatin) may be useful in pregnancy.

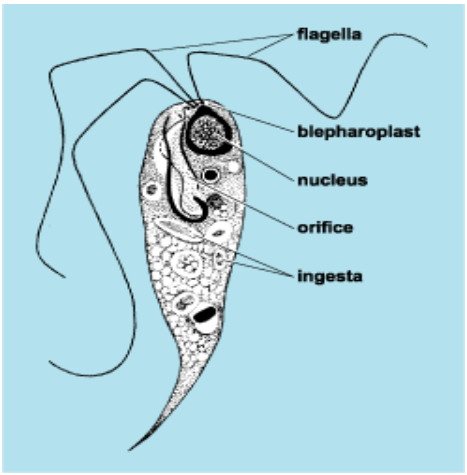
And Vit.B12 because??? Giardiasis should be considered as a cause of vitamin B_{12} deficiency as a result of the problems caused within the intestinal absorption system**.** Treatment may be repeated if necessary. Only symptomatic patients require treatment.

Prevention:

- By avoidance of contaminated water.
- Filtration (this parasite resistant to chemicals such as chlorine).
- Protecting water supplies from reservoir hosts such as beavers, muskrats and voles.
- Exercising good personal hygiene.
- Safe sexual practices.

Genus: Chilomastix

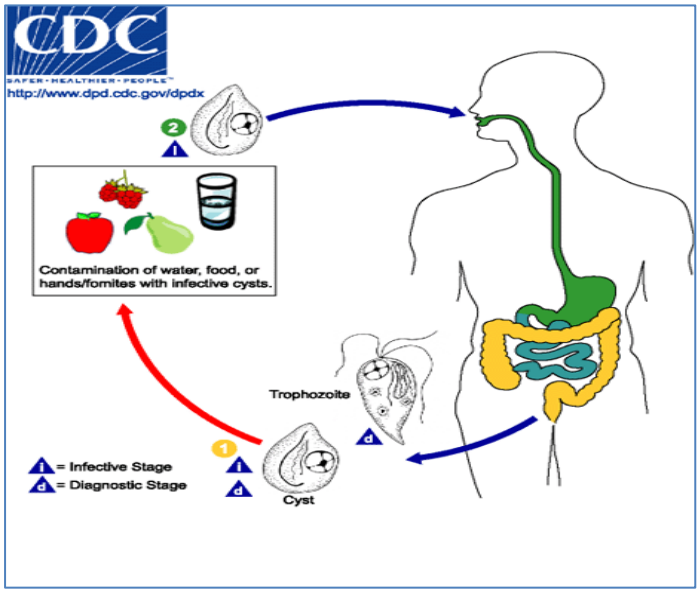
- **Spc:** *C. mesnili*.
- **Geog. Distribution**: all over the world.
- **Habitat**: in the caecal area of the large intestine.

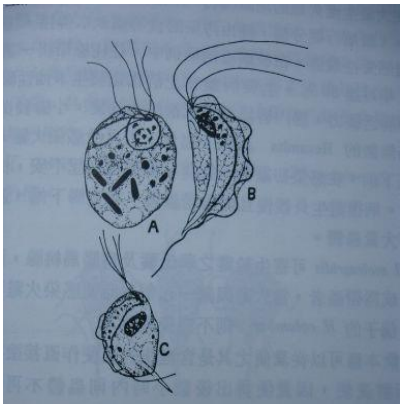


- **Morphology:**
- **Trophozoite**: pear form.
- Size: 7-10µm in length.
- 4 flagella, 3 forewords, 4th in the cleft.
- **Cyst**: pear form, 8µm, single nucleus.
- **Transmission**: ingestion of cyst in contaminated food and drink.
- **Pathogenicity**: none (if present with large numbers, may be result in some disturbance).
- **Diagnosis**:

Specimens: stool. 1-In saline and iodine preparation: cyst and flagellated forms are found in stool, the movement is Rotary.

2-Culture: in laboratory media.





Trichomonas vaginalis, trichomonas hominis, T. tenax, Enteromonas hominis, and Retortamonas intestinalis

*** T. hominis (intestinal).**

***T. vaginalis (genital organs).**

***T. tenax (human mouth)**

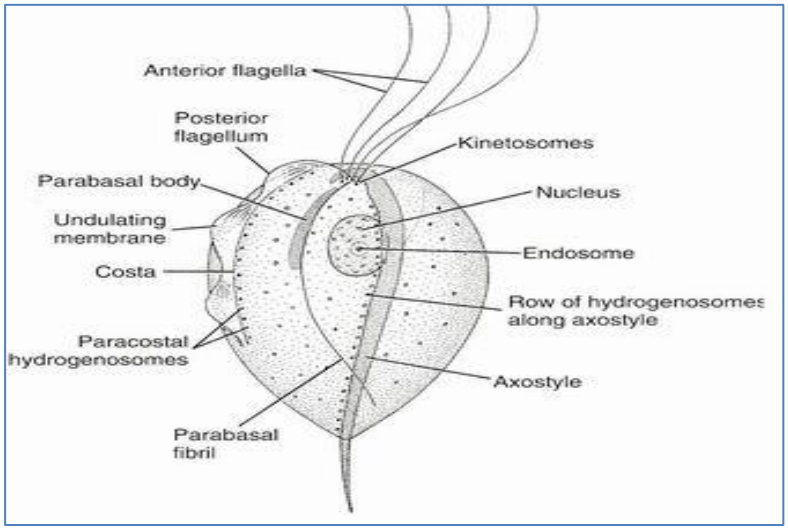
Trichomonas

The trichomonads are flagellate protozoa with three to five anterior flagella, other organelles, and an undulating membrane. ***Trichomonas vaginalis*** causes the most common form of **trichomoniasis** in humans.

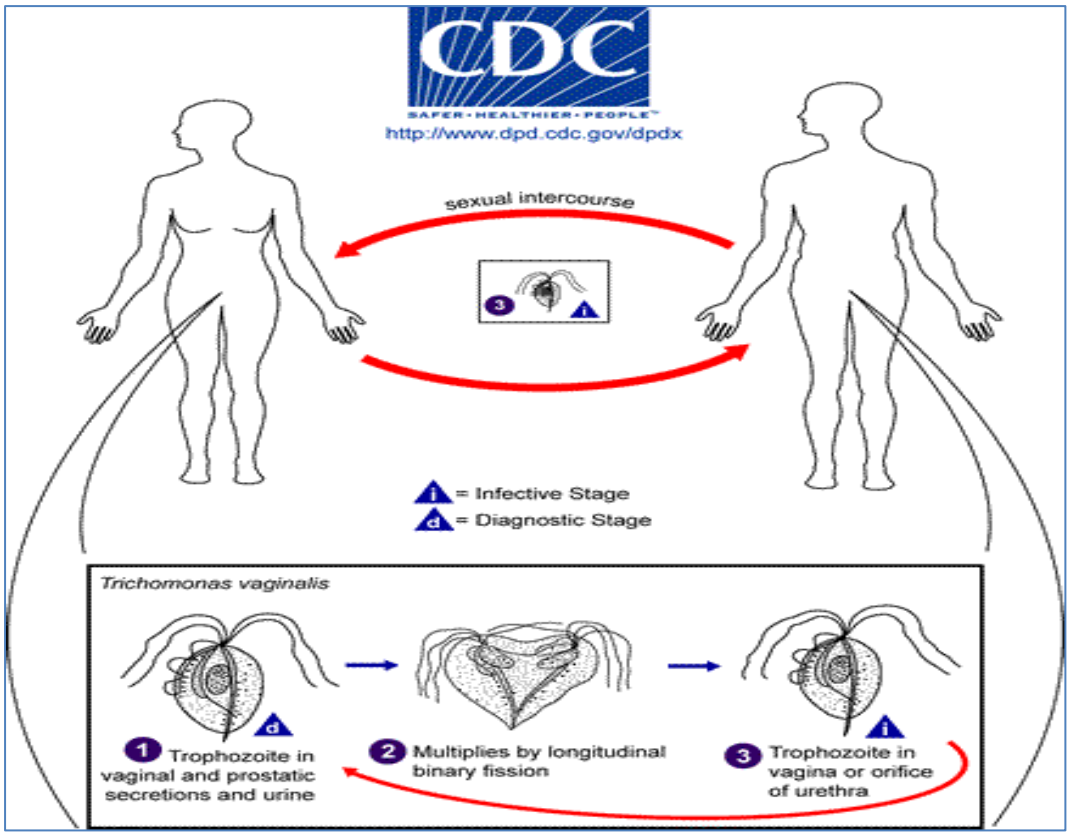
Morphology & Identification

UROGENITAL FLAGELLATES: Caused a sexually transmitted disease. Have **only trophozoite** stage. ***T vaginalis*** is pear-shaped, with a short undulating membrane lined with a flagellum and **four anterior** flagella. The organism moves with a characteristic wobbling and rotating motion. The nonpathogenic trichomonads, ***Trichomonas hominis*** and

Trichomonas tenax, cannot readily be distinguished from *T vaginalis* when alive. For all practical purposes, trichomonads found in the mouth are *T tenax;* in the intestine, *T hominis;* and in the genitourinary tract (both sexes), *T vaginalis.*



Life Cycle of T. Vaginalis:



Pathogenesis, Pathology, & Clinical Findings

T hominis and *T tenax* are generally considered to be harmless commensals. ***T vaginalis*** is capable of causing low-grade inflammation. The intensity of infection, the pH and physiologic status of the vaginal and other genitourinary tract surfaces, and the accompanying bacterial flora are among the factors affecting pathogenicity. The organisms do not survive at normal vaginal acidity of pH 3.8 - 4.4.

In females, the infection is normally limited to vulva, vagina (Vaginitis), and cervix; it does not usually extend to the uterus. The mucosal surfaces may be tender, inflamed, eroded, and covered with a frothy yellow or cream-colored discharge. **In males**, the prostate, seminal vesicles, and urethra may be infected. Signs and symptoms in females, in addition to profuse vaginal discharge, include local tenderness, vulval pruritus, and burning. About 10% of infected males have a thin, white urethral discharge and Infected male acting as carrier.

Diagnostic Laboratory Tests

Specimens and Microscopic Examination

Vaginal or urethral secretions or discharge should be examined microscopically in a drop of saline for characteristic motile trichomonads. Dried smears may be stained with hematoxylin or other stains for later study.

Culture

Culture of vaginal or urethral discharge, of prostatic secretion, or of a semen specimen may reveal organisms when direct examination is negative.

Treatment

Successful treatment of vaginal infection requires destruction of the trichomonads, for which topical and systemic **metronidazole** (Flagyl) is best. **Tinidazole** (Fasigyn) and **ornidazole** (Tiberal) are equally effective, with fewer side effects. The patient's sexual partner should be examined and treated simultaneously. Postmenopausal patients may require treatment with **estrogens** to improve the condition of the vaginal epithelium. Prostatic infection can be cured with certainty only by systemic treatment with **metronidazole** or one of the above-mentioned

nitroimidazoles.

Prevention and control

Normal sexual behavior, Fixed sexual partner and Safety sexual behavior

Trichomonas Hominis

Geog. Distribution: all over the world, more in worm areas.

Habitat: in the large intestine especially caecum of human.

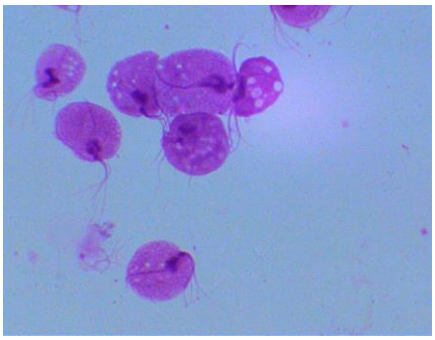
Morphology: Trophozoite:

Movement: Jerky.

Cyst: No cyst stage.

Transmission: perhaps by ingestion of the flagella form.

Infection/pathogenesis: not known.

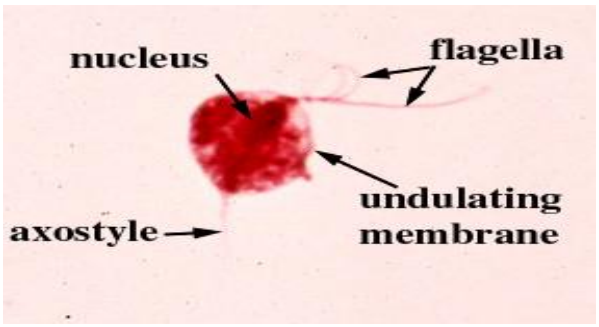


Diagnosis:

1.Wet preparation.

2.Seroimmnunological investigations.

3. culture



Trichomonas tenax

Trichomonas tenax, or oral trichomonas, is a species of trichomonas commonly found in the oral cavity of humans, dogs and cats. The parasite is frequently located in periodontal infections, affecting more than 50% of the population in some areas. *Trichomonas tenax* is not found on healthy gums. Its presence in necrotizing ulcerative gingivitis and necrotizing ulcerative periodontitis make it a possible pathogen, worsening the periodontal disease. This parasite is also present in some chronic lung diseases where recovery is brought by removing it.

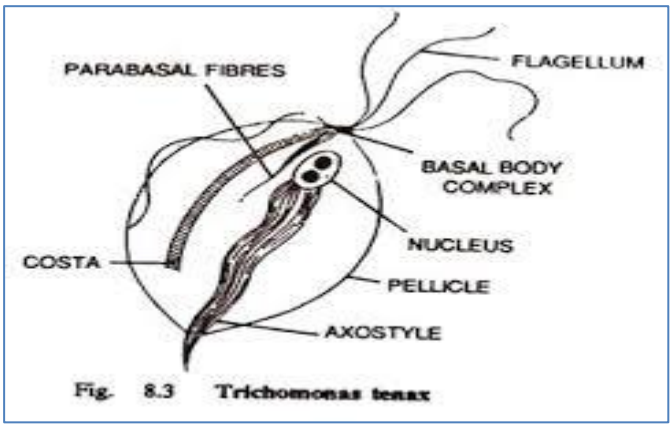
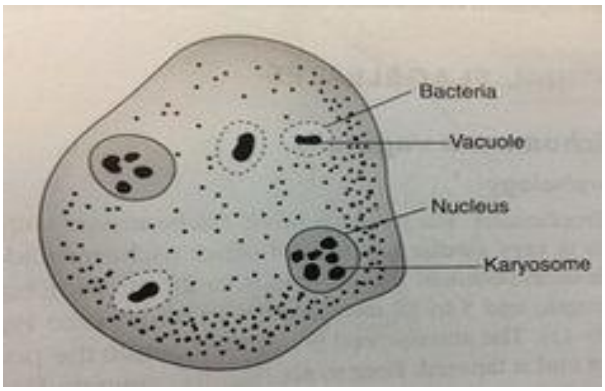


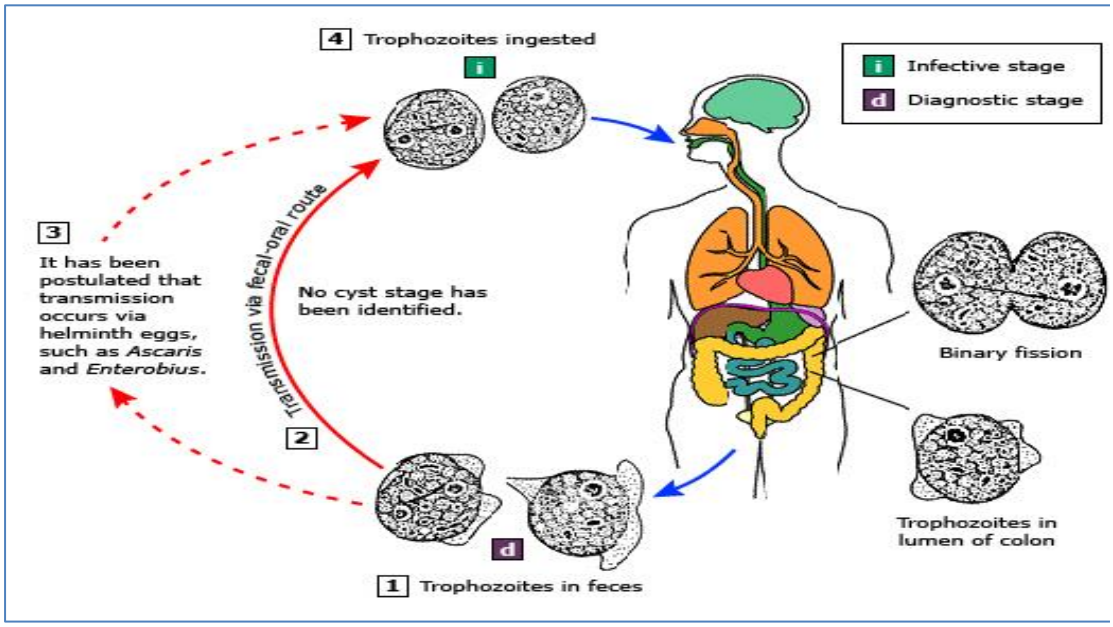
Fig. 8.3 Trichomonas tenax

Other Intestinal Flagellates

Dientamoeba Fragilis

Long classified with the amoebas, this occasionally pathogenic organism is now recognized as an **ameboflagellate** in the same order as trichomonas. In its ameba stage it measures 4–18 m, has one or two nuclei, and is often bilobate or bean-shaped. It is commonly found in the **human colon** along with the true amoebas, but it contains a flagellate structure (the parabasal body) near the nuclei and, like trichomonas, lacks a cyst stage. *Dientamoeba fragilis* is a parasite of humans but has been found in apes, monkeys, and sheep as well. It is mildly pathogenic in about 25% of infected individuals, who may experience abdominal pain and flatulence, diarrhea, vomiting, weakness, and weight loss similar to giardiasis. Treatment is as for *Entamoeba histolytica* infection. Morphologic distinction from intestinal amoebas is included in the section on amebiasis.


Bacteria
Vacuole
Nucleus
Karyosome


4 Trophozoites ingested
i
Infective stage
d
Diagnostic stage
3
It has been postulated that transmission occurs via helminth eggs, such as Ascaris and Enterobius.
Transmission via fecal-oral route
No cyst stage has been identified.
Binary fission
2
Trophozoites in lumen of colon
d
1 Trophozoites in feces

Balantidium coli

Balantidium coli is the **largest protozoan** and the only ciliate known to parasitize humans

Common Name:

❖Balantidiosis is also known as balantidiosis or ciliary dysentery

Distribution: Worldwide

Definitive hosts: Pigs and rat are important sources of infection for human beings (**Pigs** main animal reservoir) and is also reported in dogs, cows, horses, rodents and nonhuman primates

Man-to- man transmission is rare but possible **Intermediate hosts:** No intermediate hosts or vectors

Morphology:

Two forms:

1- Trophozoite: In dysenteric stool

2- Cyst: In carriers and chronic cases

Both forms: Bi-nucleated- large macronucleus and small micronucleus.

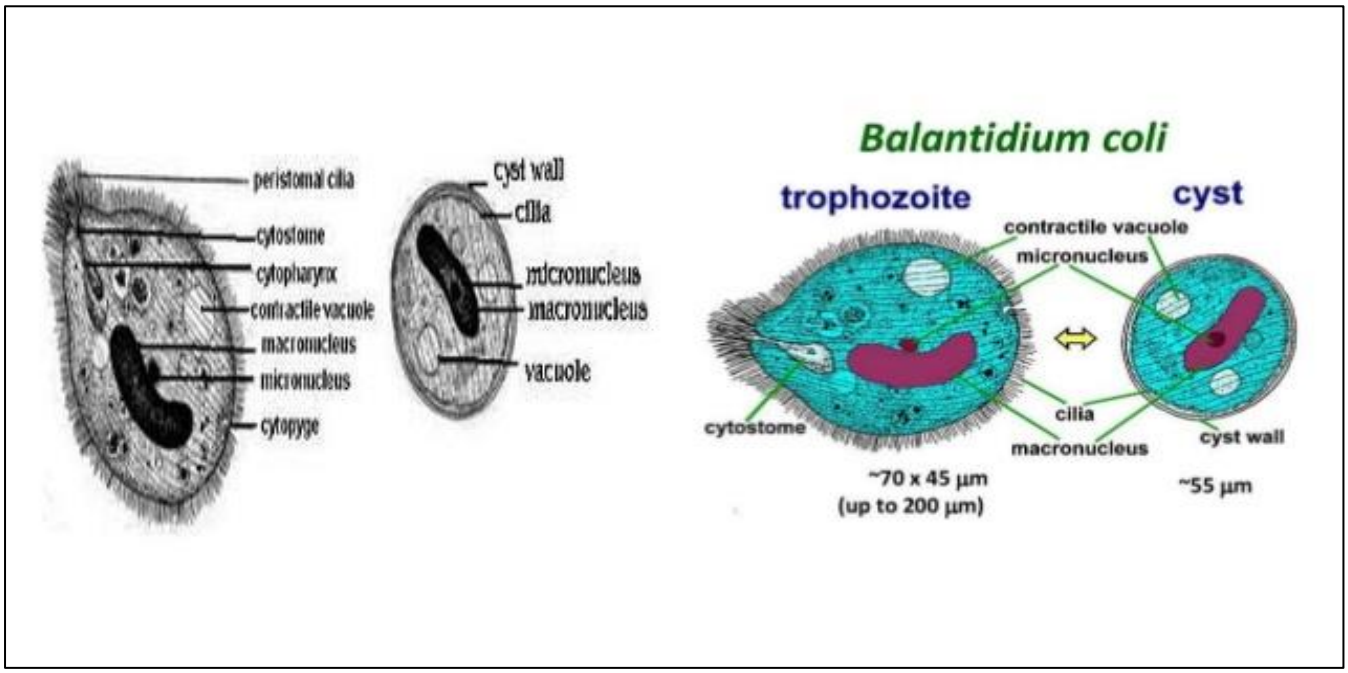
TROPHOZOITE:

- Found in active stage of disease (dysenteric stool), invasive form shape: oval
- Size: 30-300 μm long x 30-100 μm breadth
- Whole body covered with a row of tiny delicate cilia –organ of locomotion
- Cilia present near the mouth part –longer called "adoral cilia"
- Anterior end-narrow -Bears a groove (peristome) that leads to a mouth (cytostome) -followed by a short funnel shaped gullet (cytopharynx) extending up to one-third of the body.
- Posterior end-broad, round -Bears an excretory opening (Cytopyge)
- No anus
- Cytoplasm-outer clear ectoplasm and inner granular endoplasm

Endoplasm contains two nuclei **1.Macronucleus**: large kidney shaped macronucleus in center and responsible for the cytoplasmic activities **2.Micronucleus:** small vesicular nucleus, lie in the notch of macronucleus and responsible for **reproductive** process.

One or two contractile vacuoles: lie side by side or one above the other maintains the proper osmotic pressure inside cell.

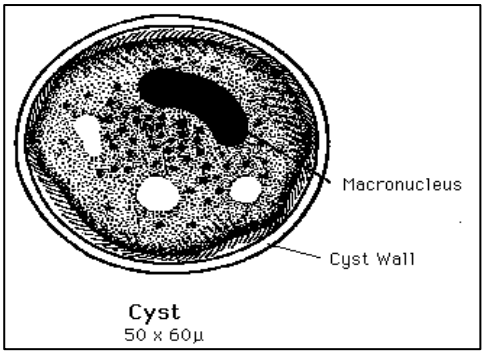
Numerous food vacuoles: contains food particles like debris from host gut, bacteria, starch grains, fat droplets and occasional RBCs, etc, where digestion of food particles takes place.

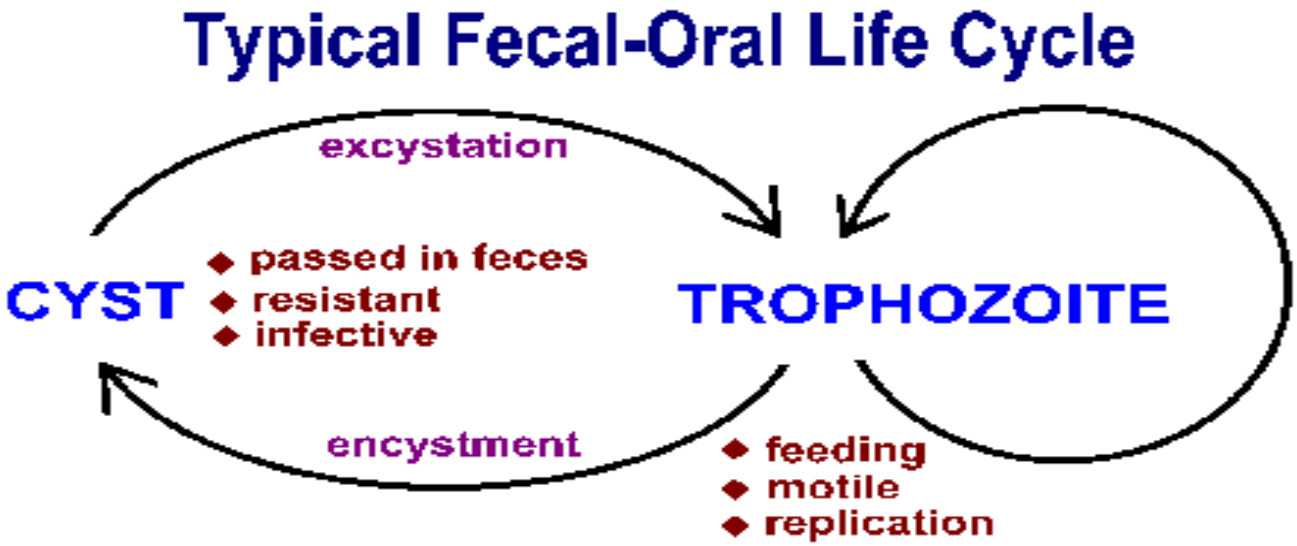


Cyst:

- Shape: round
- Size: 40-60 µm
- Immobile and dominant
- Surrounded by a thick transparent cyst wall allows the cysts to resist degradation in the acidic environment of the stomach and the basic environment of the small intestine
- Contains two nuclei-macronucleus and micronucleus and vacuoles
- Cilia-seen in younger cyst but is absorbed on maturity movement ceases

- Infective stage of Animals
- Non-reproductive stage



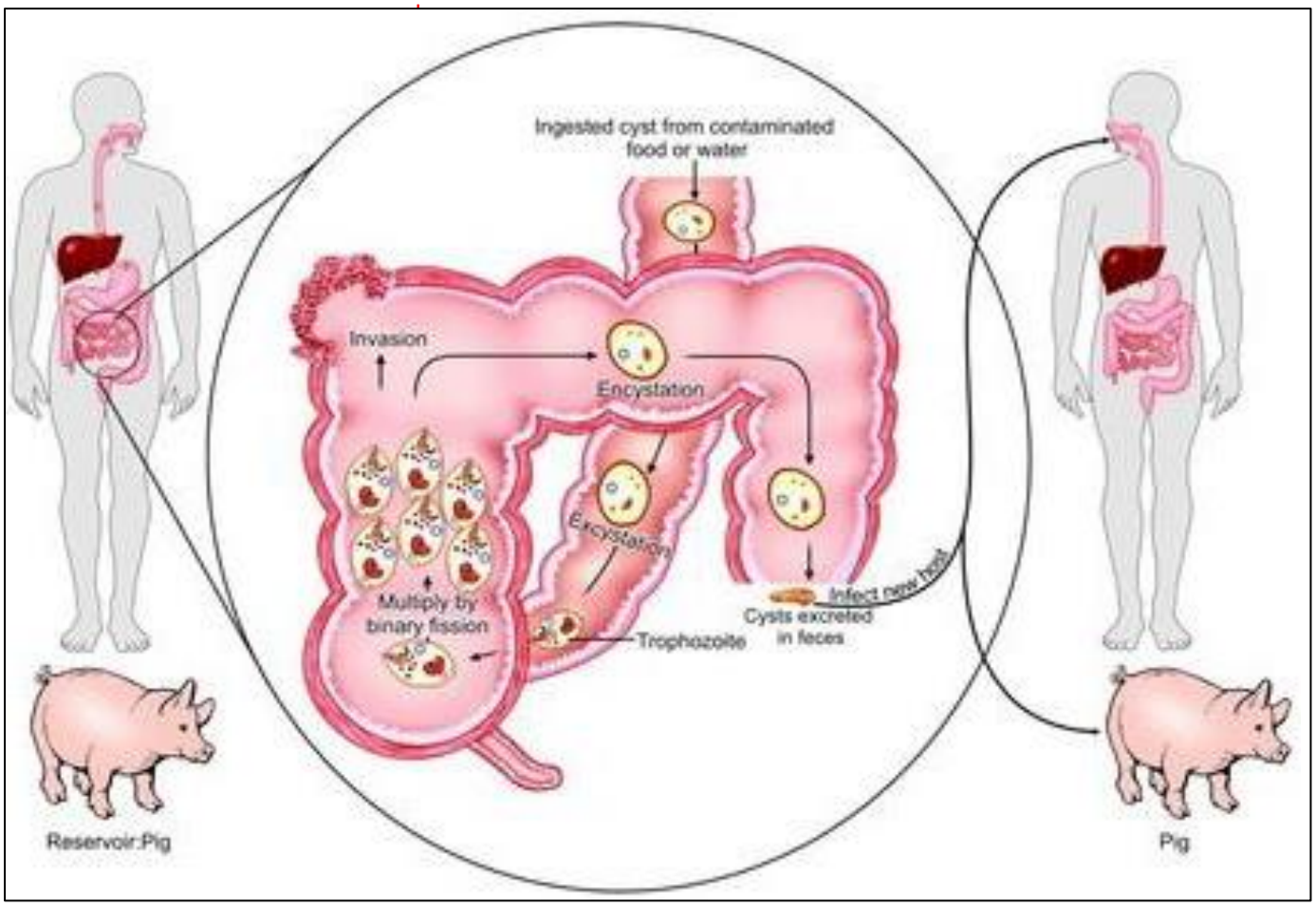


Development in large intestine- Life cycle

- Mode of transmission: faecal-oral route
- Virulence factor: Hyaluronidase- help to penetrate intestinal mucosa
- Excystation: occurs in small intestine- when trophozoites are produced from cysts

- Multiplication in large intestine
- Single trophozoite forms from each cyst
- trophozoite- is the feeding stage of the parasite → multiply either in gut lumen or enter the sub mucosa of large intestine

Cell division → Asexual reproduction
Cell division → Sexual reproduction



Life cycle:

The cyst is the infective stage of *Balantidium coli*

↓

Once the cyst is ingested via feces-contaminated food or water, it passes through the host digestive system

↓

There, excystation takes place in small intestine

↓

Excystation produces a trophozoite from the cyst stage

↓

Single trophozoite forms from each cyst

The motile trophozoite is the feeding stage of the parasite multiply either in gut lumen or enters the sub mucosa of large intestine

Trophozoites multiply by asexual binary fission or sexual conjugation

Risk factors:

Pig's faces carrying vast volumes of *Balantidium coli* Contaminates water sources.

Humans who work with pigs exposed to *Balantidium coli*.

Pathogenesis and Sign and Symptoms:

- Most cases are asymptomatic
- If symptomatic *B.coli* infections may cause severe infection that resembles acute amoebiosis.
- Trophozoites invade gut sub mucosa-form multiple tiny superficial ulcers-Ulcers with necrotic base and undermined edge just as those of *Entamoeba histolytica*.
- Microscopically-cluster of trophozoites is found in sub mucosa with inflammatory cells (lymphocytic).
- Symptoms include diarrhea with profuse mucus and blood, fever, nausea, vomiting, abdominal pain, anorexia (loss of appetite) and even dysentery.
- The diarrhea may persist for long periods of time resulting in acute fluid loss and weight loss.
- Metastatic and extra intestinal diseases, liver, lung and brain abscesses, usually are very rare.

Laboratory Diagnosis:

Stool microscopy

Trophozoites- detected in acute disease (dysenteric stool)-easy to identify by its rotatory motility, large kidney shaped macronucleus and presence of cilia.

Cysts- seen in chronic cases or carriers-round, 40-60µm in size, surrounded by a cyst wall and presence of two nuclei.

Histopathology:

Scrapings of colonic and ceacal mucosa can be stained with H&E.

Histopathological staining of biopsy tissue or scrapping of the ulcers taken by sigmoidoscopy-reveals clusters of trophozoites, cysts and lymphocytic infiltration found in sub mucosa.

Culture:

Media used: Boeck and Drbohlav egg serum media and Balamuth's media.

Culture rarely necessary as parasites are easily detected by stool microscopy or histopathology.

Prevention:

- Treatment of carriers shedding the cysts
- Hygienic rearing of pigs and prevention of pig to human contact
- Prevention of contamination of food or water with pig and human faeces.

Treatment:

- Tetracycline-500 mg four times a day for 10 days
- Alternatively Metronidazole-750 mg three times a day for 5-7 days
- Treatment of carriers-preventing spread of the disease
- No relapse or drug resistance reported

(HAEMOFLAGELATES)

Trypanosomiasis:-

Introduction:

Trypanosomes are hemoflagellates and three species of the genus *Trypanosoma* are responsible for disease in humans such as sleeping sickness. Trypanosomes occur in the blood of the majority of vertebrate animals. The life cycle involves intermediate host, which usually is an insect. Many species of trypanosomes can live in harmony with their hosts producing no pathogenic effect, but the best known species are those that are pathogenic to their definitive hosts. The disease is caused by the pathogenic types is called trypanosomiasis.

Salivarian Trypanosomes:

Trypanosoma brucei rhodesiense and ***Trypanosoma brucei gambiense*** - The metacyclic trypanosomes are found in the proboscis of the insect vector - infection is therefore inoculative. The above are the causative agents of African trypanosomiasis. It is a zoonotic species in that it multiplies in the blood of a range of many mammals including man. *Trypanosoma brucei rhodesiense* causes acute sleeping sickness in East Africa, while *T. b. gambiense* causes chronic sleeping sickness in West Africa.
These are known as salivarian trypanosomes as they complete their development in the salivary system (anterior portion of the vector). Transmission takes place by inoculation of the metacyclic stage.

Stercorarian Trypanosomes:

Trypanosoma cruzi - The metacyclic trypanosomes occupy a posterior position in the gut of the insect vector and are passed out in the feces - infection is therefore contaminative. This is the causative agent of American Trypanosomiasis.
These trypanosomes are known as stercocarian as they complete their development in the posterior region of the vector, so that the infective forms appear in the insect's feces. Hosts are infected by the contaminative route.

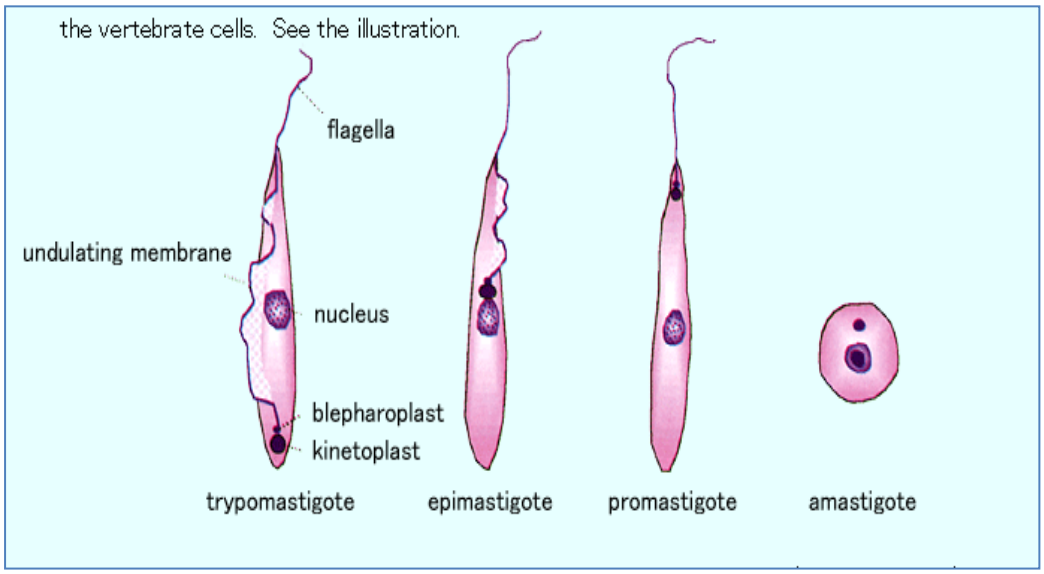
Etiologic agents:

Trypanosoma brucei complex – African trypanosomiasis (sleeping sickness)

Trypanosoma cruzi – American trypanosomiasis (Chagas' disease)

Important features:

These species may have **amastigote**, **promastigote**, **epimastigote**, and **trypomastigote** stages in their life cycle. In human trypanosomes of the African form, however, the amastigote and promastigote stages of development are absent. Typical trypanosome structure is an elongated spindle-shaped body that more or less tapers at both ends, a centrally situated nucleus, a kinetoplast posterior to nucleus, an undulating membrane arising from the kinetoplast and proceeding forward along the margin of the cell membrane and a single free flagellum at the anterior end.

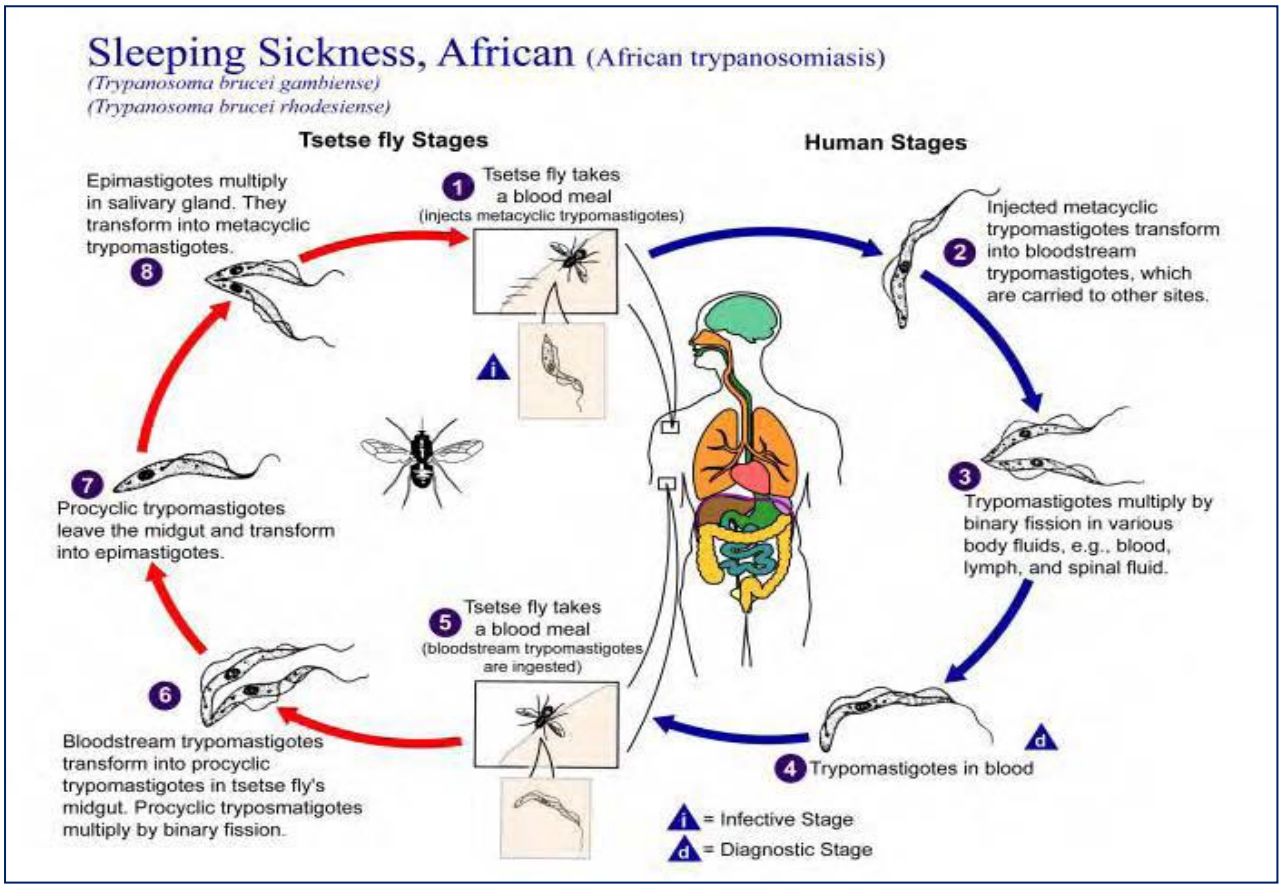


African Trypanosomiasis:

Life Cycle

Transmission from one vertebrate to another is carried out by blood-sucking invertebrates, usually an insect. The vector for African Trypanosomiasis is the Tsetse fly, *Glossina* spp. which cause the diseases *Trypanosoma brucei gambiense* and *Trypanosoma brucei rhodesiense.* Metacyclic (infective) trypomastigotes are inoculated through the skin when a tsetse fly takes a blood meal. The parasites develop into long slender trypomastigotes which multiply at the site of inoculation

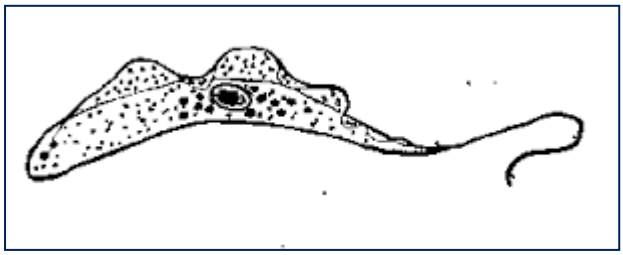
where ulceration occurs. The trypanosomes continue to develop and then may invade the lymphatic tissues, the heart, various organs and in later stages, the central nervous system. Trypomastigotes are taken up by the tsetse fly (male and female) during a blood meal. The parasites develop in the midgut of the fly where they multiply. 2-3 weeks later the trypomastigotes move to the salivary glands transforming from epimastigotes into metacyclic (infective) trypomastigotes. The tsetse fly remains infective for life i.e. about three months.

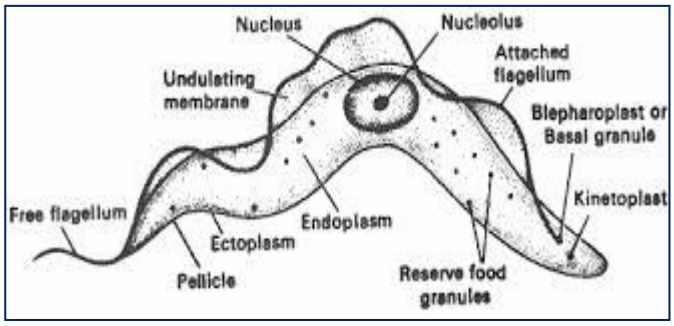


Morphology

The parasite is an elongated cell with single nucleus which usually lies near the centre of the cell. Each cell bears a single flagellum which appears to arise from a small granule - the kinetoplast. The kinetoplast is a specialized part of the mitochondria and contains DNA. The length and position of the trypanosome's flagellum is variable. In trypanosomes from the blood of a host the flagellum originates near the posterior end of the cell and passes forward over the cell surface, its sheath is expanded and forms a wavy flange called an undulating membrane. Development is characterized by the occurrence of three types of blood forms (polymorphic), **these are:**

1) **Slender forms**: long and thin, about 29µm long, free flagellum.
2) **Stumpy forms**: thick and short, average length 18µm, typically no free flagellum, but a short one may be present.
3) **Intermediate forms**: about 23µm long with a moderately thick body and a free flagellum of medium length.





Pathogenesis

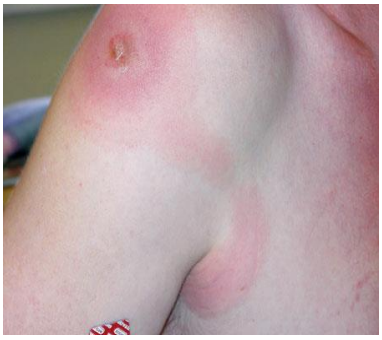
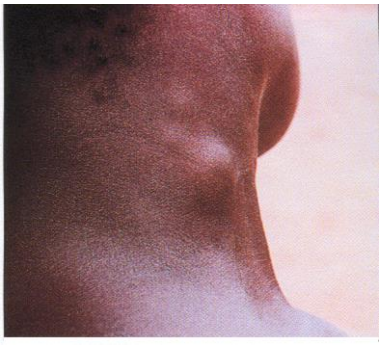
The trypomastigotes spread from the skin through the blood to the lymph node and the brain. The typical somnolence (sleeping sickness) usually progresses to coma as a result of demyelinating encephalitis. In acute form, cyclical fever spike (approximately every 2 weeks) occurs that is related to antigenic variation. As antibody mediated agglutination and lysis of the trypomastigotes occurs, the fever subsides. With a few remains of antigenic variants new fever spike occurs and the cycle repeats itself over a long period.

Clinical features

Although both species cause sleeping sickness, the progress of the disease is different. *T.gambiense* induced disease runs a low-grade chronic course over a few years. One of the earliest signs of disease is an occasional ulcer at the site of the fly bite. As reproduction of organisms continues, the lymph nodes are invaded, and fever, myalgia, arthralgia, and lymph node enlargement results. Swelling of 56 the posterior cervical lymph nodes is characteristic of Gambian sleeping sickness and is called winterbottom's sign.

Chronic disease progresses to CNS involvement with lethargy, tremors, meningoencephalitis, mental retardation, and general deterioration. In the final stages, convulsions, hemiplegia, and incontinence occur. The patient becomes difficult to arouse or obtain a response from, eventually progressing to a comatose state. Death is the result of CNS damage and other infections, such as pneumonia.

In *T.rhodesiense*, the disease caused is a more acute, rapidly progressive disease that is usually fatal. This more virulent organism also develops in greater numbers in the blood. Lymphadenopathy is uncommon, and early in the infection, CNS invasion occurs, resulting in lethargy, anorexia, and mental disturbance. The chronic stages described for *T.gambiense* are not often seen, because in addition to rapid CNS disease, the organism produces kidney damage & myocarditis, leading to death.

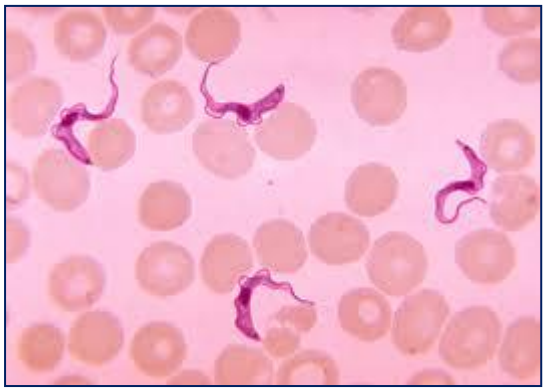
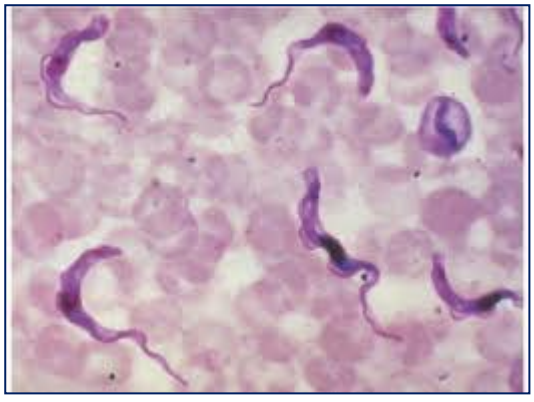




Immunity

Both the humoral and cellular immunity involve in these infections. The immune responses of the host to the presence of these parasites, however, is faced with antigenic variation, in which organisms that have changed their antigenic identity can escape the host immune response and initiate another disease process with increased level of parasitemia.

Laboratory Diagnosis of African trypanosomiasis

Examination of thin and thick films, in concentrated anticoagulated blood preparations, in aspiration from lymph nodes and concentrated spinal fluid. Methods for concentrating parasites in blood may be helpful approaches including centrifugation of heparinized samples and an ion-exchange chromatography. Levels of parasitosis vary widely, and several attempts to visualize the organism over a

number of days may be necessary.

Treatment:

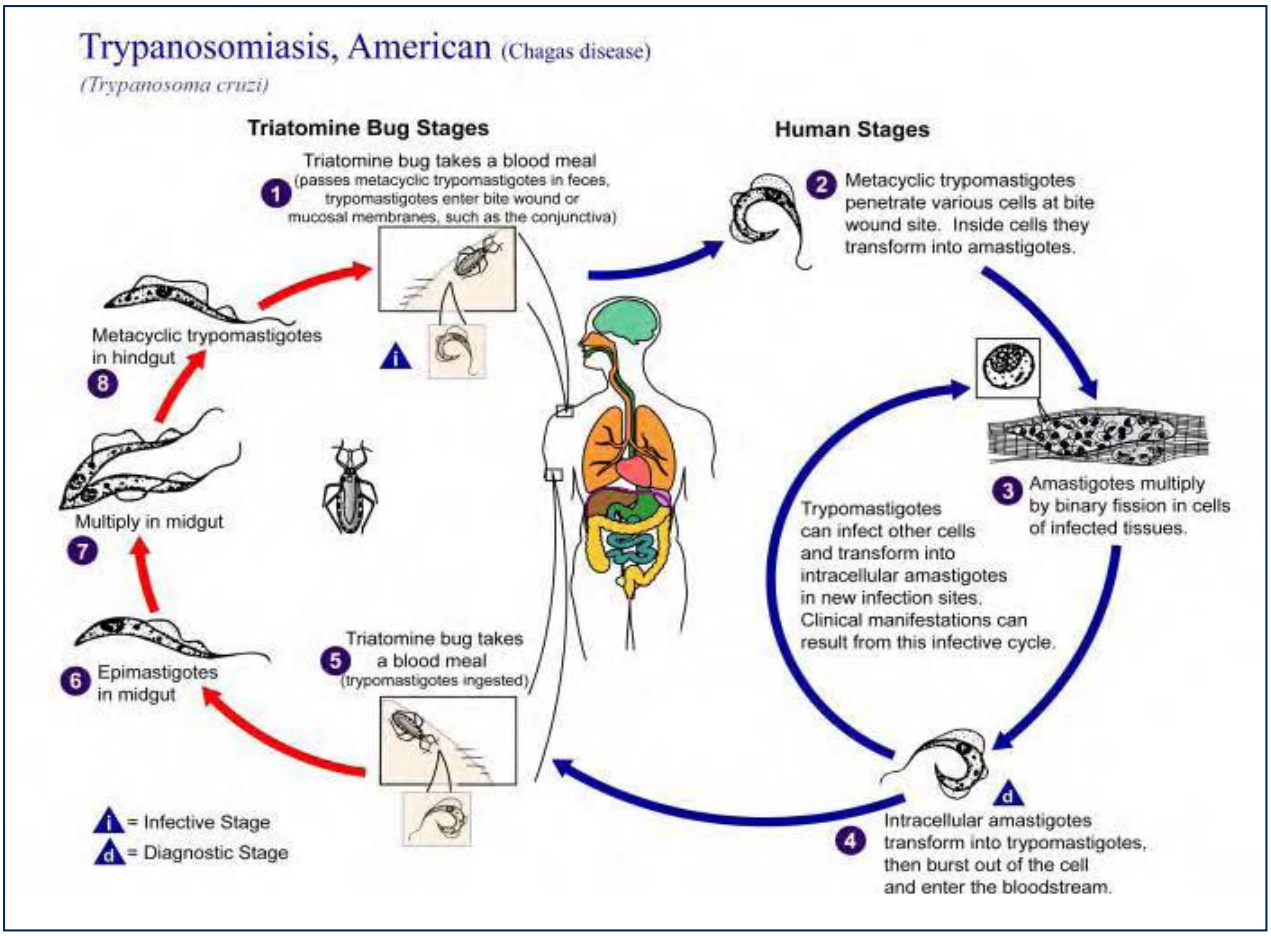
The same treatment protocol is applied for these parasites. For the acute stages of the disease the drug of choice is **suramin with pentamidine** as an alternative. In chronic disease with CNS involvement, the drug of choice is **melarsoprol**. Alternatives include trypars amide combined with suramin.

Prevention:

• Control of breeding sites of tsetse flies and use of insecticides.
• Treatment of human cases to reduce transmission to flies.
• Avoiding insect bite by wearing protective clothing & use of screen, bed netting and insect repellants.

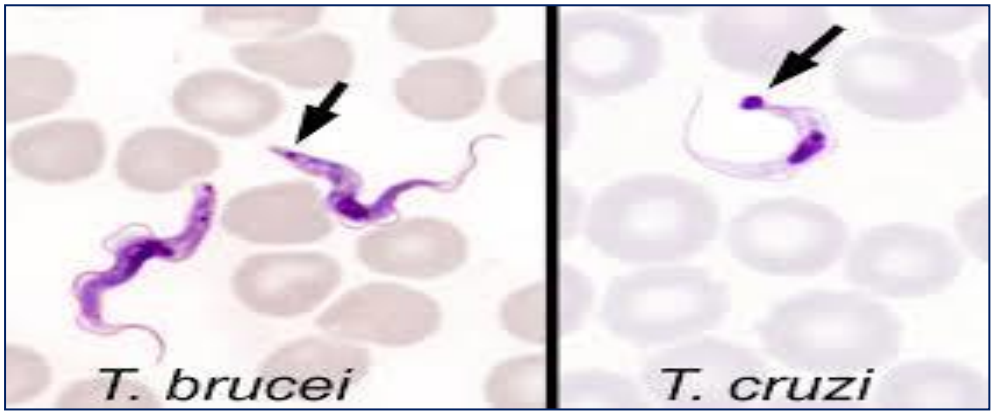
American trypanosomiasis

Trypanosoma cruzi is a pleomorphic trypanosome that includes an additional form of amastigote in its life cycle. The vector for transmission is reduviid bugs.



Morphology

Trypanosoma cruzi has a single form (monomorphic), about 20µm in length, and characteristically curved. The kinetoplast is large, considerably larger than the ***Trypanosoma brucei*** species already discussed. They sometimes appear as a bulge at the posterior end. The flagellum is medium in length.



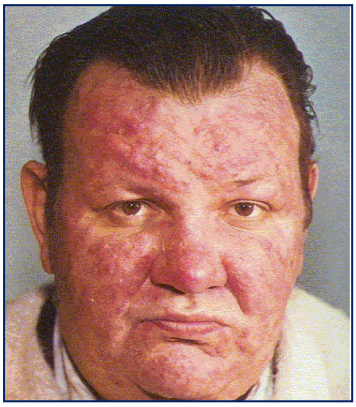
Pathogenesis

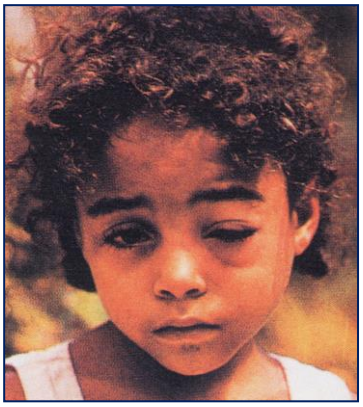
During the acute phase, the organism occurs in blood as a typical trypomastigote and in the reticuloendothelial cells as a typical amastigote. The amastigotes can kill cells and cause inflammation, consisting mainly of mononuclear cells. Cardiac muscle is the most frequently and severely affected tissue. In addition, neuronal damage leads to cardiac arrhythmias and loss of tone in the colon (megacolon) and esophagus (megaesophagus). In the chronic phase, the organism persists in the amastigote form.

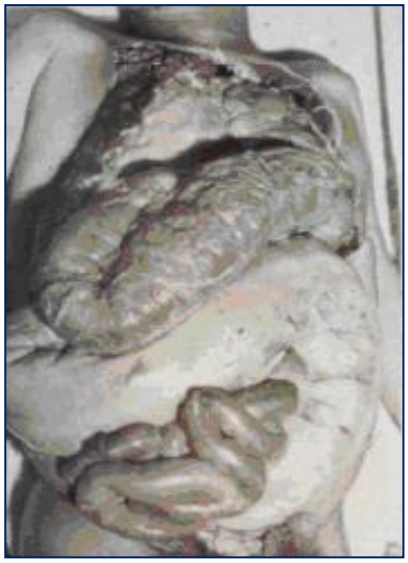
Clinical features

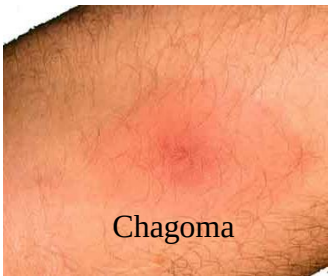
Chagas' disease may be asymptomatic acute or chronic disease. One of the earliest signs is development at the site of the bug bite of an erythematous and indurated area called a chagoma. This is often followed by a rash and edema around the eyes and face; in young children frequently an acute process with CNS involvement may occur. Acute infection is also characterized by fever, chills, malaise, myalgia, and fatigue. The chronic Chagas' disease is characterized by hepatosplenomegaly, myocarditis, and enlargement of the esophagus and colon as a result of the destruction of nerve cells (E.g. Auerbach's plexus) and other tissues that control the growth of these organs. Involvement of the CNS may produce granulomas in the brain with cyst

formation and a meningoencephalitis. Death from chronic Chagas' disease results from tissue destruction in the many areas invaded by the organisms, and sudden death results from complete heart block and brain damage.





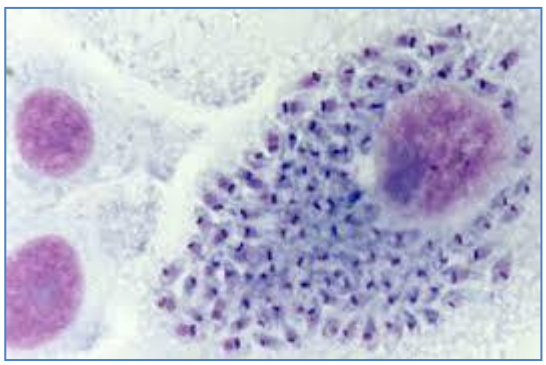




Chagoma

Laboratory Diagnosis of American Trypanosomiasis

Examine thin or thick stained preparations for trypomastigotes. Wet preparations should also be examined to look for motile organisms that leave the blood stream and become difficult to find. Biopsy of lymph nodes, liver, spleen, or bone marrow may demonstrate organisms in amastigote stage. Xenodiagnosis - which consists of allowing an uninfected, laboratory-raised reduviid bug to feed on the patient and, after several weeks, examining the intestinal contents of the bug for the organism.



Immunity

Unlike African trypanosomiasis, the antigenic variation is less common in ***T.cruzi*** infection. Therefore, the humoral and cellular immune responses function in the immune system.

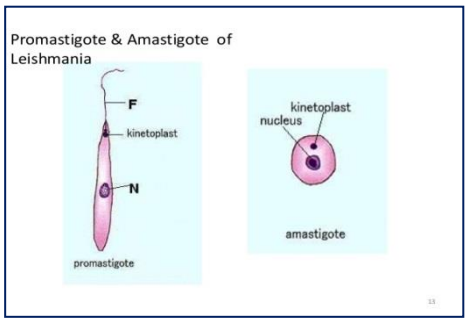
Treatment

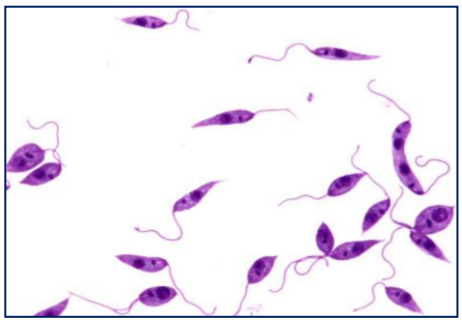
The drug of choice is **nifurtimox**. Alternative agents include **allopurinol** & **benzimidazole**.

Prevention

• Bug control, eradication of nests
• Treating infected person & exclusion of donors by screening blood.
• Development of vaccine.

Leishmanaiasis:-





Leishmania Species:

Clinical disease

- Veseral leishmaniasis

- Cutaneous leishmaniasis

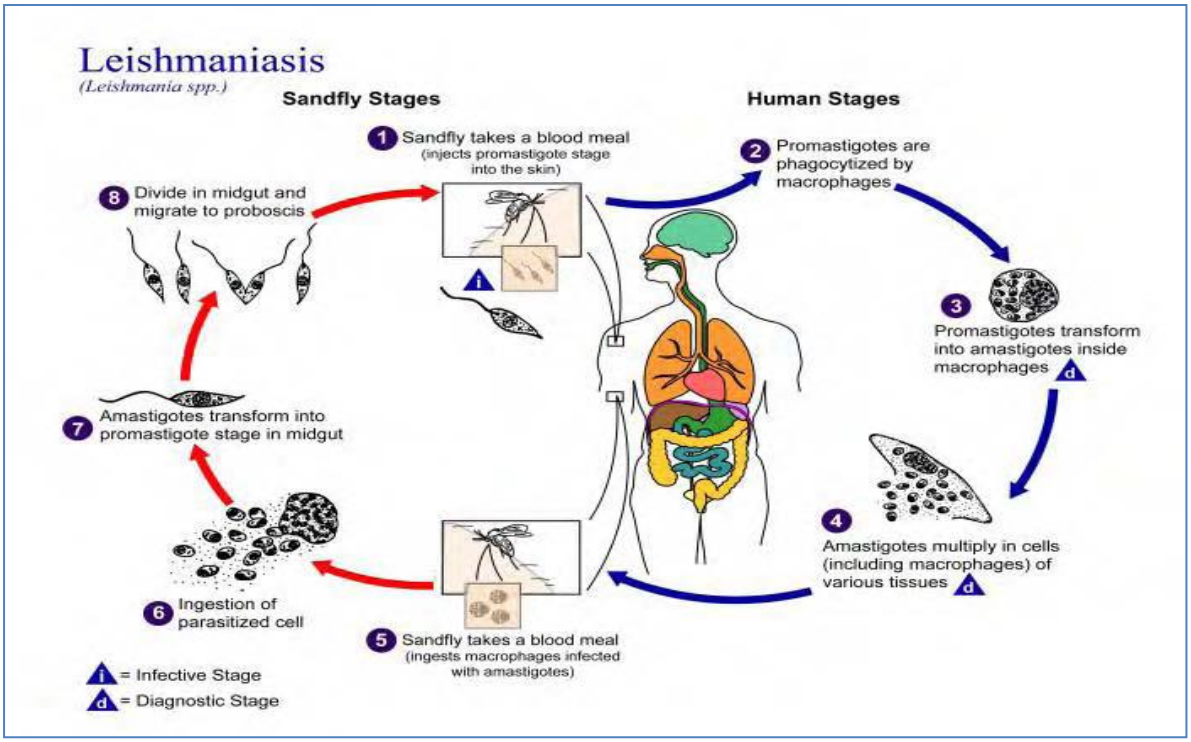
- Mucocutaneous leishmaniasis

The species of leishmania exist in two forms, **amastigote** (aflagellar) and **promastigote** (flagellated) in their life cycle. They are transmitted by certain species of sand flies (Phlebotomus & Lutzomyia).

Life cycle:

All forms of infection starts when a female sandfly (*Phlebotomus* species) takes a blood meal from an infected host. Small amounts of blood, lymph and macrophages infected with *Leishmania* **amastigotes** are ingested. Once ingested the **amastigotes** transform to **promastigotes** in the sandfly, the non-infective **promastigotes** divide

and develop into infective **metacyclic promastigotes**. These are formed in the midgut of the sandfly and migrate to the proboscis. When the sandfly bites, the extracellular



inoculated promastigotes at the site of the bite are phagocytosed by macrophages. After phagocytosis, transformation to dividing **amastigotes** occurs within 24 hours. Reproduction at all stages of the lifecycle is believed to occur by binary fission. No sexual stage has been identified.

Visceral leishmaniasis

Leishmania donovani

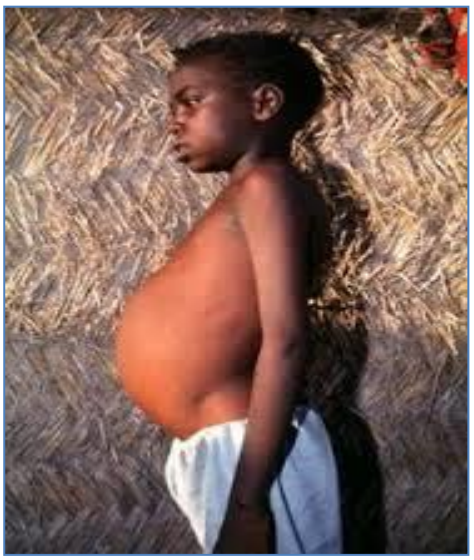
Important features: The natural habitat of *L.donovani* in man is the reticuloendothelial system of the viscera, in which the amastigote multiplies by 48 simple binary fission until the host cells are destroyed, whereupon new macrophages are parasitized. In the digestive tract of appropriate insects, the developmental cycle is also simple by longitudinal fission of promastigote forms. The amastigote stage appears as an ovoidal or rounded body, measuring about 2-3µm in length; and the promastigotes are 15-25µm lengths by 1.5-3.5µm
breadths.

Pathogenesis

In visceral leishmaniasis, the organs of the reticuloendothelial system (liver, spleen and bone marrow) are the most severely affected organs. Reduced bone marrow activity, coupled with cellular distraction in the spleen, results in anaemia, leukopenia and thrombocytopenia. This leads to secondary infections and a tendency to bleed. The spleen and liver become markedly enlarged, and hypersplenism contributes to the development of anaemia and lymphadenopathy also occurs. Increased production of globulin results in hyperglobulinemia, and reversal of the albumin-to-globulin ratio.

Clinical features

Symptoms begin with intermittent fever, weakness, and diarrhea; chills and sweating that may resemble malaria symptoms are also common early in the infection. As organisms proliferate & invade cells of the liver and spleen, marked enlargement of the organs, weight loss, anemia, and emaciation occurs. With persistence of the disease, deeply pigmented, granulomatous lesion of skin, referred to as post-kala-azar dermal leishmaniasis, occurs. Untreated visceral leishmaniasis is nearly always fatal as a result of secondary infection.



Immunity

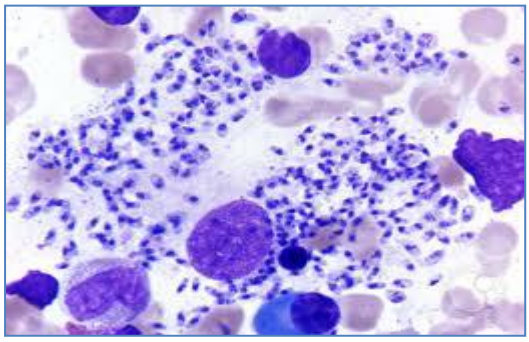
Host cellular and humoral defence mechanisms are stimulated.

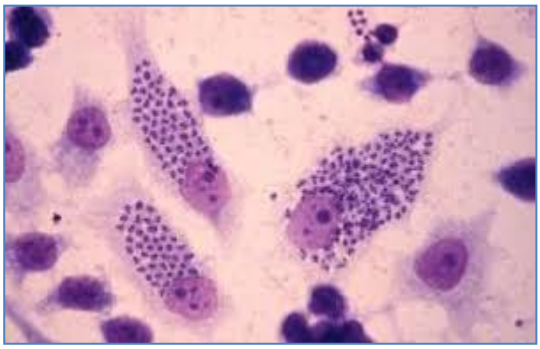
Laboratory diagnosis

• Examination of tissue biopsy, spleen aspiration, bone marrow aspiration or lymph node aspiration in properly stained smear (e.g. Giemsa stain).

• The amastigotes appear as intracellular & extra cellular L. donovan (LD) bodies.

• Culture of blood, bone marrow, and other tissue often demonstrates the promastigote stage of the organisms.





• Serologic testing is also available.

Treatment

The drug of choice is sodium stibogluconate, a pentavalent antimonial compound. Alternative approaches include the addition of allopurinol and the use of pentamidine or **amphotercin B.**

Prevention

• Prompt treatment of human infections and control of reservoir hosts.
• Protection from sand flies by screening and insect repellents.

Old World Cutaneous Leishmaniasis (Oriental sore)

Clinical disease

L.tropica minor - dry or urban cutaneous leishmaniasis

L.tropica major - wet or rural cutaneous leishmaniasis

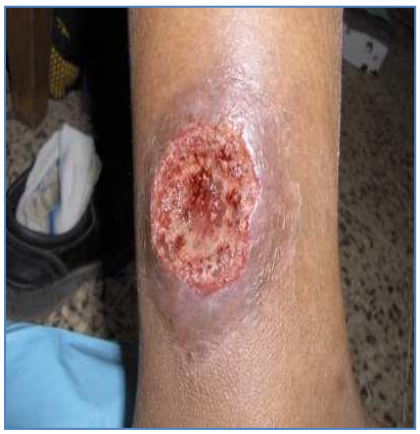
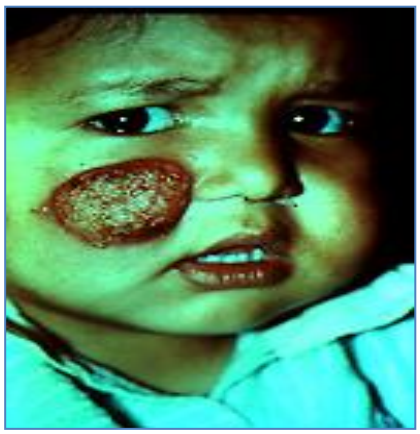
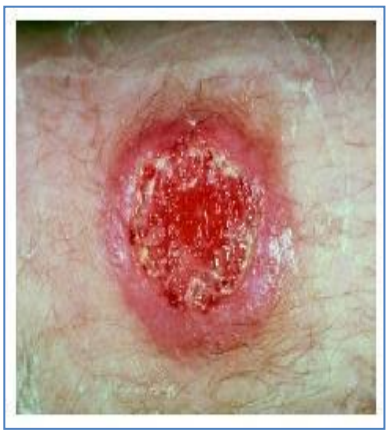
L.aethiopica - cutaneous leishmaniasis

Important features

These are parasites of the skin found in endothelial cells of the capillaries of the infected site, nearby lymph nodes, within large mononuclear cells, in neutrophilic leukocytes, and free in the serum exuding from the ulcerative site. Metastasis to other site or invasion of the viscera is rare.

Pathogenesis

In neutrophilic leukocytes, phagocytosis is usually successful, but in macrophages the introduced parasites round up to form amastigote and multiply. In the early stage, the lesion is characterized by the proliferation of macrophages that contain numerous amastigotes. There is a variable infiltration of lymphocytes and plasma cell. The overlying epithelium shows acanthosis and hyperkeratosis, which is usually followed by necrosis and ulceration.

Clinical features

The first sign, a red papule, appears at the site of the fly's bite. This lesion becomes irritated, with intense itching, and begins to enlarge & ulcerate. Gradually the ulcer becomes hard and crusted and exudes a thin, serous material. At this stage, secondary bacterial infection may complicate the disease. In the case of the Ethiopian cutaneous leishmaniasis, there are similar developments of lesions, but they may also give rise to diffuse cutaneous leishmaniasis (DCL) in patients who produce little or no cell mediated immunity against the parasite. This leads to the formation of disfiguring nodules over the
surface of the body.

Immunity

Both humoral and cell mediated immunity (CMI) are involved

Treatment

The drug of choice is sodium stibogluconate, with an alternative treatment of applying heat directly to the lesion. Treatment of *L.aethopica* remains to be a problem as there is no safe and effective drug.

Prevention

- Prompt treatment & eradication of ulcers
- Control of sand flies & reservoir hosts.

New World Cutaneous and Mucocutaneous Leishmaniasis

(American cutaneous leishmaniasis)

Clinical disease:

Leishmania mexicana complex- Cutaneous leishmaniasis.

Leishmania braziliensis complex- mucocutaneous or cutaneous leishmaniasis

Important features:

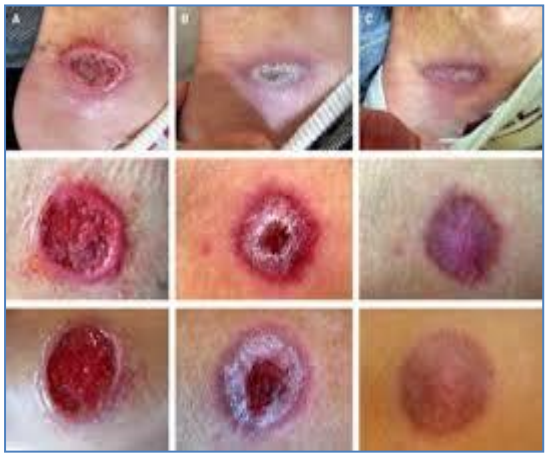
The American cutaneous leishmeniasis is the same as oriental sore. But some of the strains tend to invade the mucous membranes of the mouth, nose, pharynx, and larynx either initially by direct extension or by metastasis. The metastasis is usually via lymphatic channels but occasionally may be the bloodstream.

Pathogenesis

The lesions are confined to the skin in cutaneous leishmaiasis and to the mucous membranes, cartilage, and skin in mucocutaneous leishmaniasis. A granulomatous response occurs, and a necrotic ulcer forms at the bite site. The lesions tend to become superinfected with bacteria. Secondary lesions occur on the skin as well as in mucous membranes. Nasal, oral, and pharyngeal lesions may be polypoid initially, and then erode to form ulcers that expand to destroy the soft tissue and cartilage about the face and larynx. Regional lymphadenopathy is common.

Clinical features

The types of lesions are more varied than those of oriental sore and include Chiclero ulcer, Uta, Espundia, and Disseminated Cutaneous Leishmaniasis.



Laboratory diagnosis

- Demonstration of the amastigotes in properly stained smears from touch preparations of ulcer biopsy specimen.
- Serological tests based on fluorescent antibody tests.
- Leishman skin test in some species.

Immunity

The humoral and cellular immune systems are involved

Treatment

The drug of choice is **sodium stibogluconate**.

Prevention

- Avoiding endemic areas especially during times when local vectors are most active.
- Prompt treatment of infected individuals.

COCCIDIA (SPOROZOA)

INTRODUCTION

Coccidia are members of the class sporozoa, Phylum Apicomplexa. Apical complex is present at some stage and consists of elements visible with electron microscope. The life cycle is characterized by an alternation of generations, i.e. sexual (gametogony) and asexual (schizogony) reproduction and most members of the group also share alternative hosts.

The locomotion of a mature organism is by body flexion, gliding, or undulation of longitudinal ridges. The genus Plasmodium that is the causes of malaria is the prototype of this class.

Malaria:

There are four species normally infecting humans, namely, *Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale, and Plasmodium malariae.*

Life cycle:

The life cycle of malaria is passed in two hosts (alternation of hosts) and has sexual and asexual stage (alternation of generations).

Vertebrate host - man (intermediate host), where the asexual cycle takes place. The parasite multiplies by **schizogony** and there is formation of male and female gametocytes (**gametogony**).

Invertebrate host - mosquito (definitive host) where the sexual cycle takes place. Union of male and female gametes ends in the formation of sporozoites (sporogony).

The life cycle passes in four stages:

Three in man:- Pre - erythrocytic schizogony

- Erythrocytic schizogony
- Exo- erythrocytic schizogony

One in mosquito - Sporogony
Introduction into humans - when an infective female Anopheles mosquito bites man, it inoculates saliva containing sporozoites (infective stage).

Pre- Erythrocytic schizogony - sporozoites reach the blood stream and within 30 minutes enter the parenchymal cells of the liver, initiating a cycle of schizogony. Multiplication occurs in tissue schizonts, to form thousands of tiny merozoites.

Merozoites are then liberated on rupture of schizonts about 7th – 9th day of the bites and enter into the blood stream. These merozoites either invade the RBC's or other parenchymal liver cells. In case of *P. falciparum* and possibly *P. malariae*, all merozoites invade RBC's without re-invading liver cells.

However, for *P. vivax* and *P. ovale*, some merozoites invade RBC's and some re-invade liver cells initiating further *Exo-erythrocytic* schizogony, which is responsible for relapses. Some of the merozoites remain dormant (hypnozoites) becoming active later on.

Erythrocytic schizogony (blood phase) is completed in 48 hrs in P. vivax, P.ovale, and P. falciparum, and 72 hrs in P. malariae. The merozoites reinvade fresh RBC's repeating the schizogonic cycles.

Erythrocytic merozoites do not reinvade the liver cells. So malaria transmitted by blood transfusion reproduces only erythrocytic cycle.

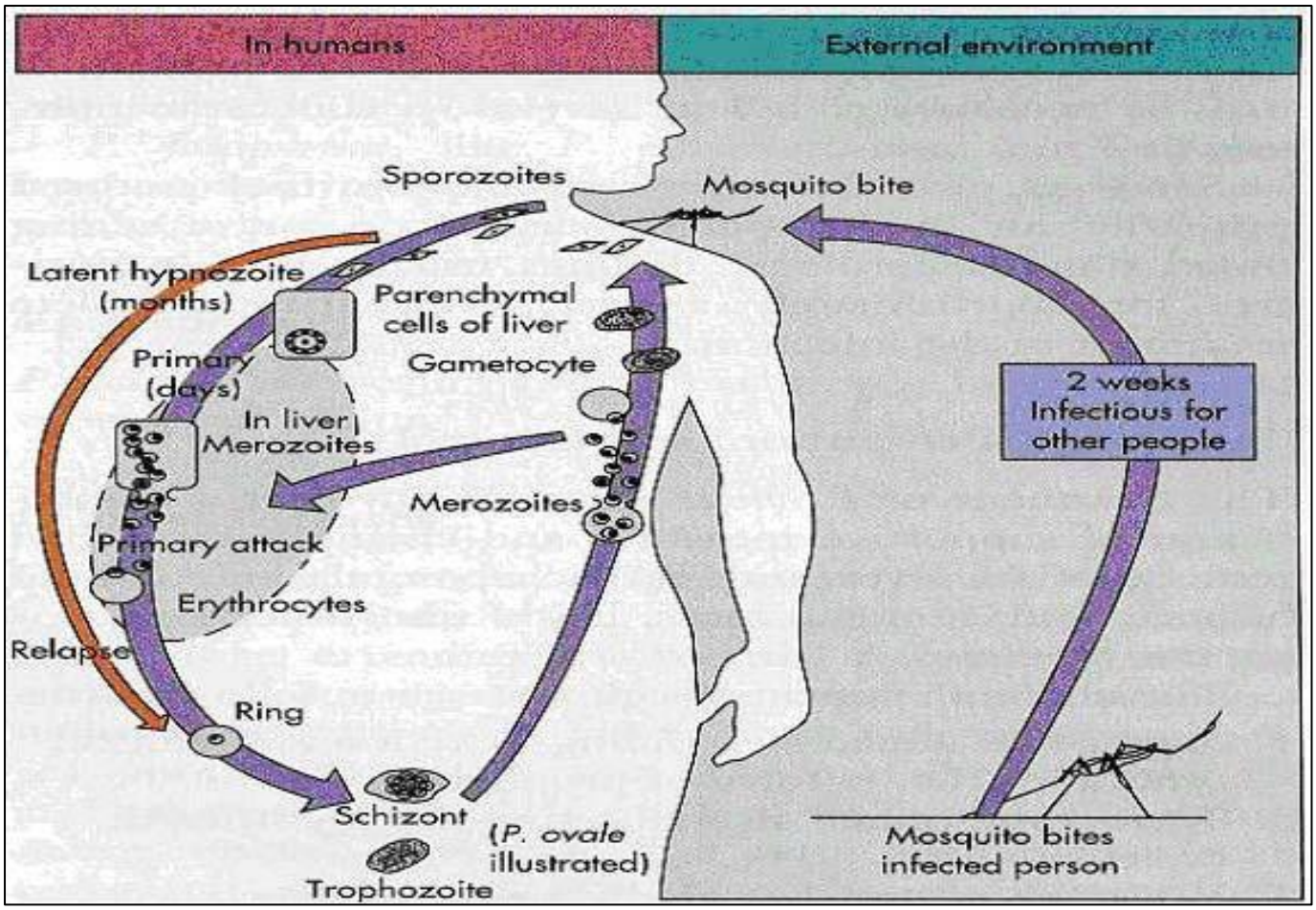
Gametogony
Some merozoites that invade RBC's develop into sexual stages (male and female gametocytes). These undergo no further development until taken by the mosquito.

Sporogony (extrinsic cycle in mosquito):

When a female Anopheles mosquito vector bites an infected person, it sucks blood containing the different stages of malaria parasite. All stages other than **gametocytes** are digested in the stomach.

The **microgametocyte** undergoes ex-flagellation. The nucleus divides by reduction division into 6-8 pieces, which migrate to the periphery. At the same, time 6-8 thin filaments of cytoplasm are thrust out, in each passes a piece of chromatin. These filaments, the microgametes, are actively motile and separate from the gametocyte.

The **macrogametocyte** by reduction division becomes a macrogamete. Fertilization occurs by entry of a micro gamete into the macro gamete forming a zygote. The zygote changes into a worm like form, the ookinete, which penetrates the wall of the stomach to develop into a spherical oocyst between the epithelium and basement membrane. The oocystes increase in size. Thousands of **sporozoites** develop inside the oocysts. **Oocysts** rupture and sporozoites are liberated in the body cavity and migrate everywhere particularly to the salivary glands. Now the mosquito is infective. The sporogonous cycle in the mosquito takes 8-12 days depending on temperature.



(Life cycle of Plasmodium species)

1- *Plasmodium falciparum:*

Plasmodium falciparum demonstrates no selectivity in host erythrocytes, i.e. it invades young and old RBCs cells. The infected red blood cells also do not enlarge and become distorted.

• Multiple sporozoites can infect a single erythrocyte, and show multiple infections of cells with small ring forms.

• The trophozoite is often seen in the host cells at the very edge or periphery of cell membrane at accole position.

• Occasionally, reddish granules known as Maurer's dots are observed

• Mature (large) trophozoite stages and schizonts are rarely seen in blood films, because their forms are sequestered in deep capillaries, liver and spleen.

• Peripheral blood smears characteristically contain only **young ring** forms and occasionally **crescent shaped gametocytes**.

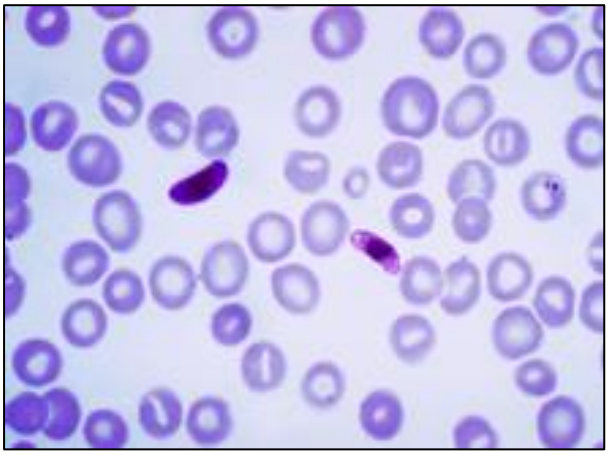
Epidemiology:

P.falciparum occurs almost exclusively in tropical and subtropical regions. Weather (rainfall, temperature & humidity) is the most obvious cause of seasonality in malaria transmission. To date, abnormal weather conditions are also important causes of significant and widespread epidemics. Moreover, drug-resistant infection of *P.falciparum* is the commonest challenge in many parts of the world. In Ethiopia, even though all the four species of plasmodium infecting man have been recorded, *P.falciparum* is the one that most causes the epidemic disease and followed by vivax and malariae. *P.ovale* is rare. Infection rates in Ethiopia are 60%, 40%, 1%, and <1% for *P. falciparum, P. vivax, P. malariae*, and *P. ovale*, respectively.

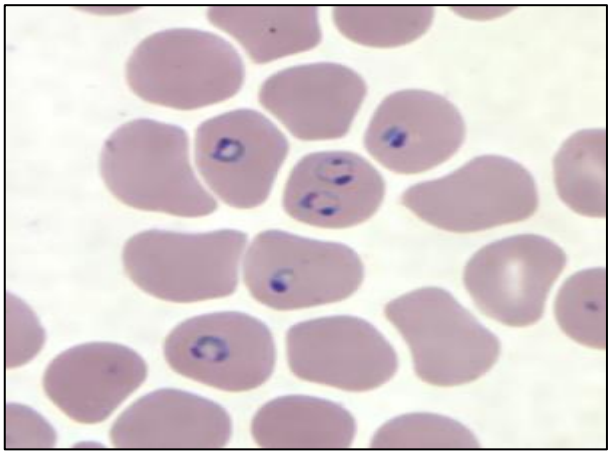
Clinical features:

Of all the four Plasmodia, *P. falciparum* has the shortest incubation period, which ranges from 7 to 10 days. After the early flu-like symptoms, *P.falciparum* rapidly produces daily (quotidian) chills and fever as well as severe nausea, vomiting and diarrhea. The periodicity of the attacks then becomes tertian (36 to 48 hours), and fulminating disease develops. Involvement of the brain (cerebral malaria) is most often seen in *P.falciparum* infection. Capillary plugging from an adhesion of infected red blood cells with each other and endothelial linings of capillaries causes hypoxic injury to the brain that can result in coma and death. Kidney damage is also associated with *P.falciparum* malaria, resulting in an illness called “black water” fever. Intravascular hemolysis

with rapid destruction of red blood cells produces a marked hemoglobinuria and can result in acute renal failure, tubular necrosis, nephrotic syndrome, and death. Liver involvement is characterized by abdominal pain, vomiting of bile, hepatosplenomegally, severe diarrhea, and rapid dehydration.



Mature gametocyte of P.falciparum.



Ring form of *P.falciparum*, with multiple infection of an erythrocyte

Treatment:

Because chloroquine – resistant stains of *P.falciparum* are present in many parts of the world, infection of *P.falciparum* may be treated with other agents including mefloquine, quinine, guanidine, pyrimethamine – sulfadoxine, and doxycycline. If the laboratory reports a mixed infection involving *P.falciparum* and *P.vivax*, the treatment must eradicate not only *P.falciparum* from the erythrocytes but also the liver stages of *P.vivax* to avoid relapses provided that the person no longer lives in a malaria endemic area.

2- Plasmodium vivax:

P.vivax is selective in that it invades only young immature erythrocytes.

Infections of *P. vivax* have the following characteristics:

• Infected red blood cells are usually enlarged and contain numerous

pink granules or schuffner's dots.

• The trophozoite is ring-shaped but amoeboid in appearance.

• More mature trophozoites and erythrocytic schizonts containing up to 24 merozoites are present.

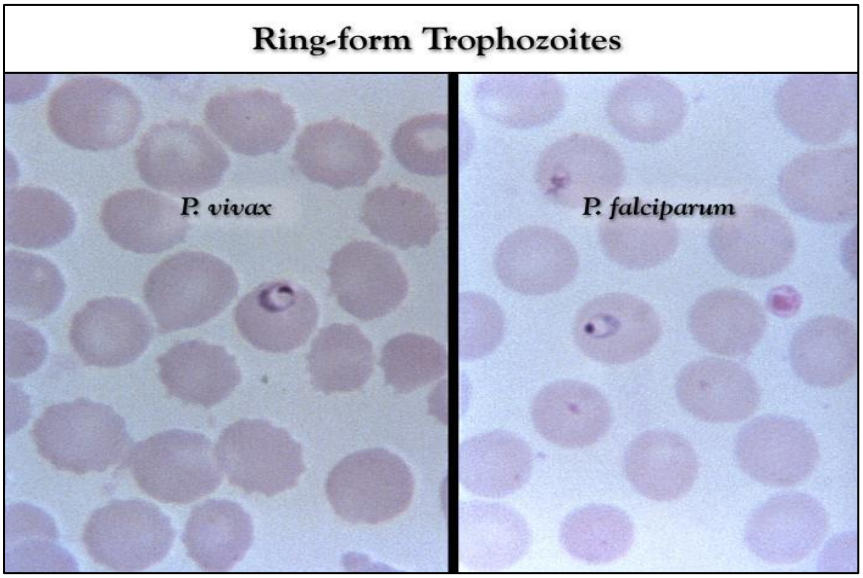
• The gametocytes are round

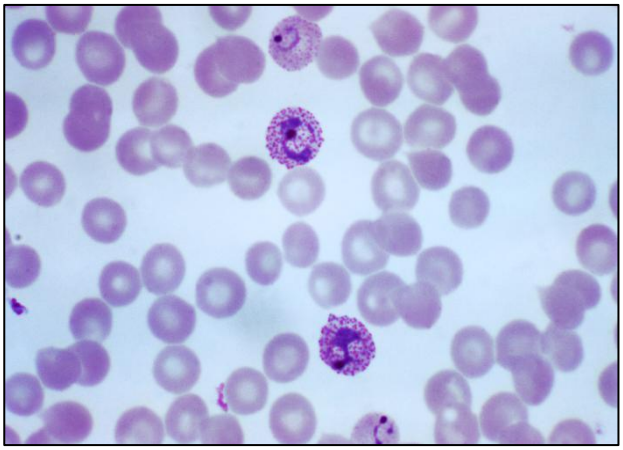
Epidemiology:

P. Vivax is the most prevalent of the human plasmodia with the widest geographic distribution, including the tropics, subtropics, and temperate regions. However, it is the second most prevalent in Ethiopia following *P. falciparum.*

Clinical features:

After an incubation period (usually 10 to 17 days), the patient experiences vague flu-like symptoms, such as headache, muscle pains, photophobia, anorexia, nausea and vomiting. As the infection progresses, increased numbers of rupturing erythrocytes liberate merozoites as well as toxic cellular debris and hemoglobin in to circulation. In combination, these substances produce the typical pattern chills, fever and malarial rigors. These paroxysms usually reappear periodically (generally every 48 hours) as the cycle of infection, replication, and cell lyses progresses. The paroxysms may remain relatively mild or may progress to severe attacks, with hours of sweating, chills, shaking persistently, high temperatures (103^0F to 106^0F) and exhaustion. Since *P.vivax* infects only the reticulocytes, the parasitemia is usually limited to around 2 to 5% of the available RBCs.





Plasmodium vivax **ring** form and **trophozoites**

Treatment:

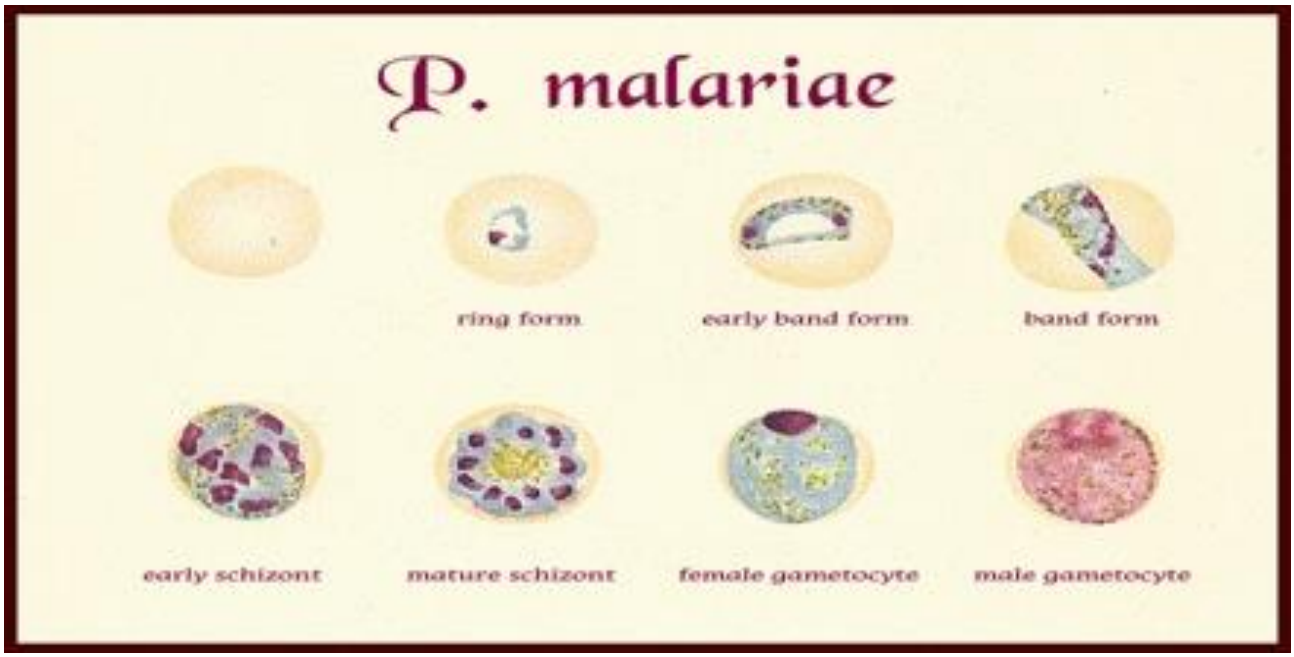
Chloroquine is the drug of choice for the suppression and therapeutic treatment of P.vivax, followed by premaquine for radical cure and elimination of gamatocytes.

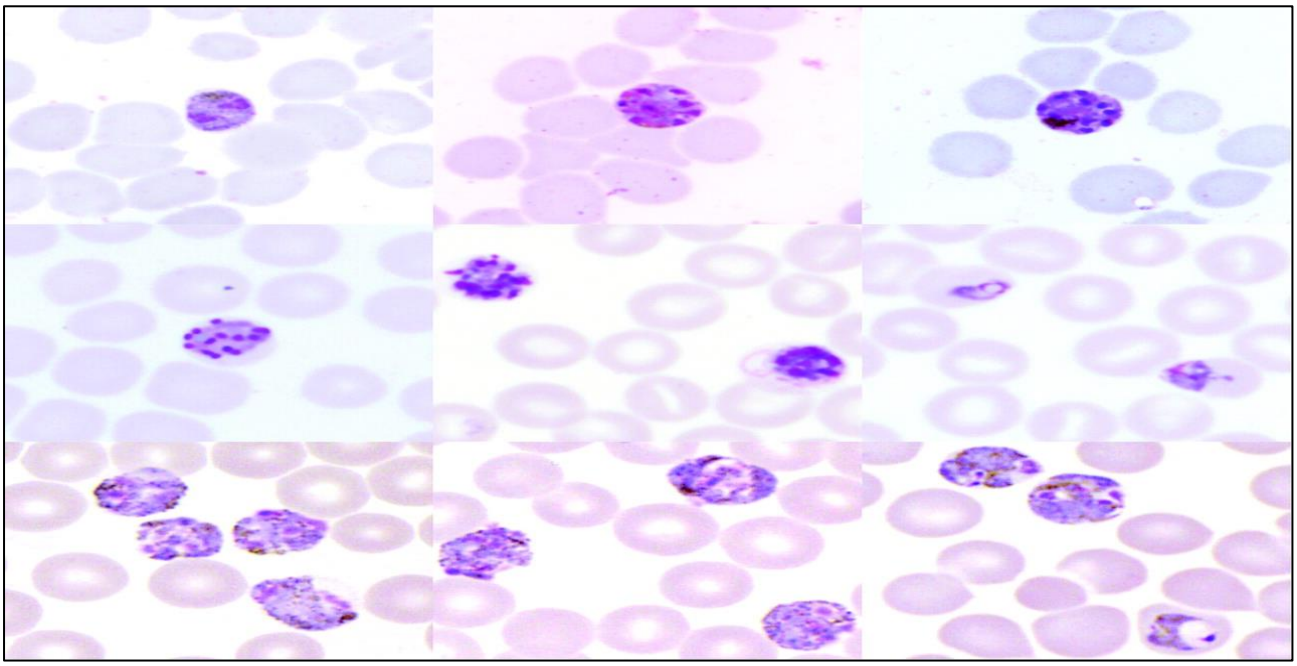
3- *Plasmodium malariae*:

In contrast with *P.vivax* and *P.ovale*, *P.malariae* can infect only mature erythrocytes with relatively rigid cell membranes. As a result, the parasite's growth must conform to the size and shape of red blood cell. This requirement produces no red cell enlargement or distortion, but it results in distinctive shapes of the parasite seen in the host cell, "band and bar forms" as well as very compact dark staining forms. The schizont of *P.malariae* is usually composed of eight merozoites appearing in a rosette.

Epidemiology:

P. malariae infection occurs primarily in the same sub-tropical and temperate regions as infections with the other plasmodia but is less prevalent.





***(Plasmodium malariae*)**

Clinical features:

The incubation period for *P. malariae* is the longest of the plasmodia, usually 18 to 40 days, but possibly several months to years. The early symptoms are flu-like with fever patterns of 72 hours (quartan or malarial) in periodicity.

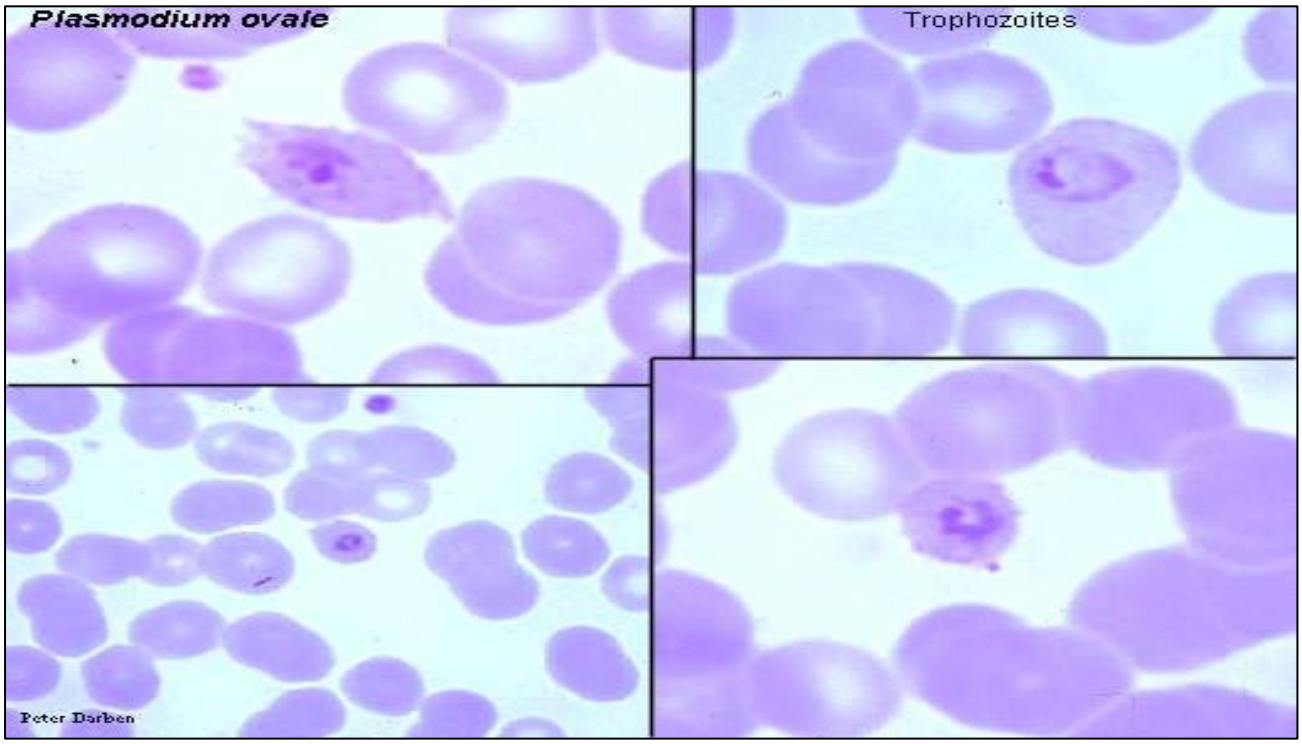
Treatment

Treatment is similar to that for *P.vivax* and *P.ovale.*

4- *Plasmodium ovale:*

P. ovale is similar to *P. vivax* in many respects, including its selectivity for young, pliable erythrocytes. As a consequence the classical characteristics include:

• The host cell becomes enlarged and distorted, usually in an oval form.
• Schiffner's dots appear as pale pink granules.
• The infected cell border is commonly fimbriated or ragged
• Mature schizonts contain about 10 merozoites.



Epidemiology
P.ovale is distributed primarily in tropical Africa. It is also found in Asia and South America.

Clinical features
The incubation period for *P.ovale* is 16-18 days but can be longer. Clinically, ovale malaria resembles vivax malaria with attacks recurring

every 48-50 hours. There are however, fewer relapses with *P.ovale*. Less than 2% of RBCs usually become infected.

Treatment

The treatment regimen, including the use of primaquine to prevent relapse from latent liver stages is similar to that used for *P.vivax* infection.

Laboratory diagnosis

Microscopic examination of thick and thin films of blood is the method of choice for confirming the clinical diagnosis of malaria and identifying the specific species responsible for disease. Malaria parasites in thick and thin blood films are best stained at pH 7.1 – 7.2 using a Romanowsky stain (contains azure dyes and eosin).

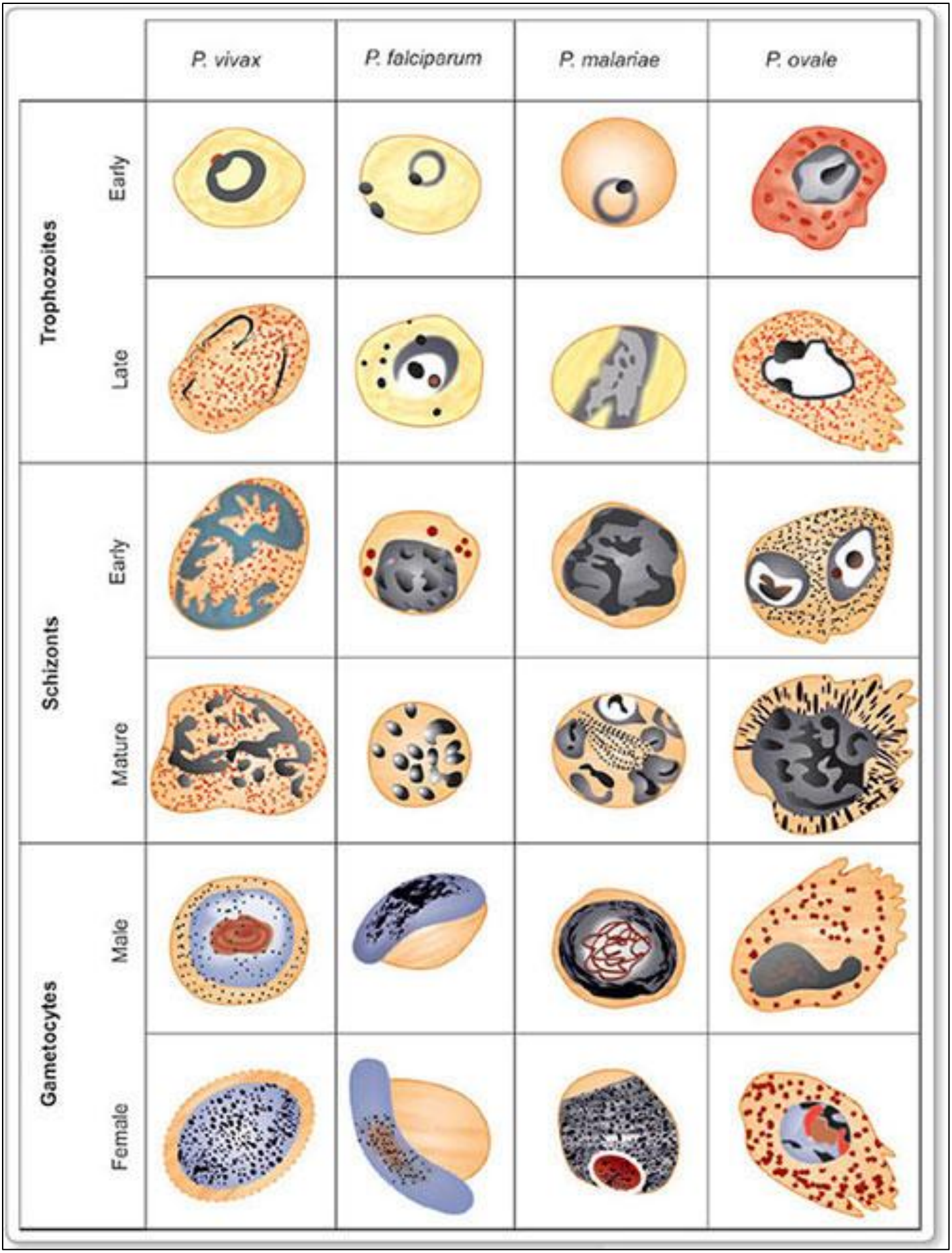
The thick film is a concentration method that may be used to detect the presence of organisms. The thin film is most useful for establishing species identification. Serologic procedures are available but they are used primarily for epidemiological surveys or for screening blood donors.

Immunity

There is evidence that antibodies can confer hormonal immunity against malaria infection.

Prevention

- Chemoprophylaxis and prompt diagnosis and treatment.
- Control of mosquito breeding
- Protection of insect bite by screening, netting and protective clothing
- Use of insect repellents.



(Romanowsky stained thin malaria films and their different stages)

Toxoplasmosis ----------A Risk in Pregnancy

What is Toxoplasmosis?

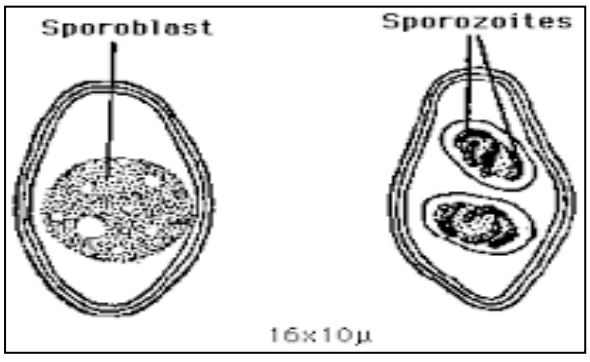
Toxoplasmosis: Is a disease of cats as well as other mammals and birds caused by a parasite called Toxoplasma gondii (*T. gondii*). Toxoplasma infection is common and cause intracellular infection. *T.gondii* is important because virtually all warm-blooded animals, including man, can become infected with it. Domestic, wild, & feral cats can transmit toxoplasma infection to humans. This parasite infects large number of the vertebrates host including man, mammals, birds and reptile.

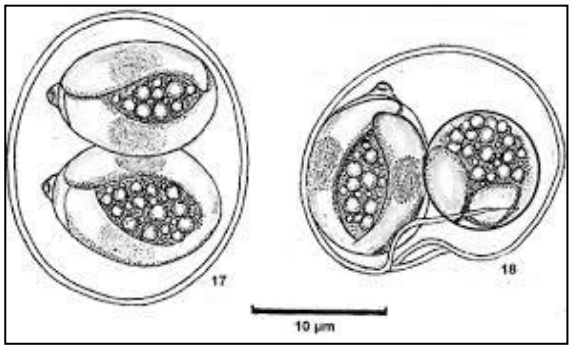
Geographical distribution: Is wide world distribution.

Habitual: Epithelial cells of small intestine or other tissue of the host.

The Infective stage: Sporozoite comes from three forms:

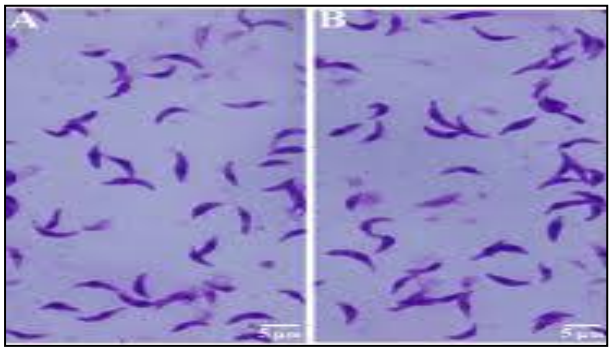
a) Sporozoites within mature oocyst: This is found in feces of cat and other felidue family (including cats, tigers, pumas Jacques ...ext) this found in fresh passed stool sample of cat with double wall of sub-spherical sporoblast contain a nucleus and in soil outside the body, the immature oocysts will develop sporoblast and from mature oocysts with 2 sporocysts each with 4 crescentric sporozoites.

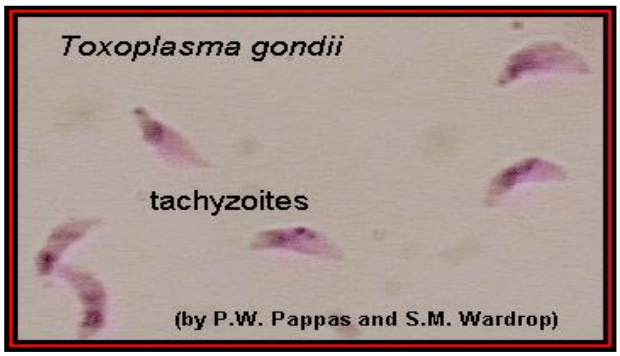




b) Tachyzoites with pseudocyst: (Crescent in shape) it is found in the acute stage of the parasite in any reticuloendothelial system or parenchymal tissue of man or other mammals, their number is usually 6-16 in one cell.

Thachyzoites can be found in any organ but occur most commonly in the brain, skeletal muscle, and heart muscle. Intracellular infection can occur in all mammalian cells except anuclear erythrocytes. Intracellular multiplication continues until host cells lyse or a tissue cyst is formed. In an immunocompetent host, tachyzoites are eliminated and tissue cysts form.

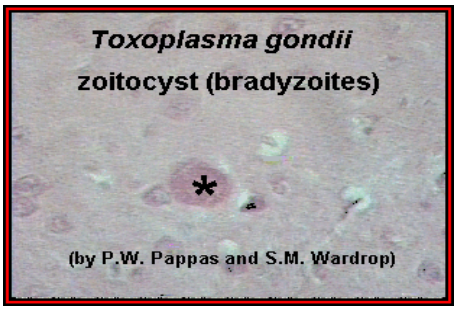


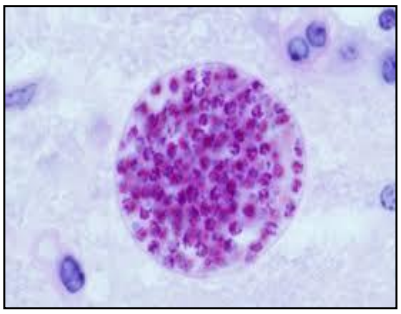


c) Bradyzoites with true cyst: (Tissue cysts) contain large number of 50 or more, it is present in chronic stage of the parasite. In case of mature oocyst, it found only in cat family, but other are found in other mammals including cats also. **Tissue cysts** are found most commonly in the brain, in skeletal and cardiac muscle but can occur in any organ. These cysts contain slowly growing trophozoites known as **bradyzoites**.

In an immunocompromised host, tachyzoite replication results in development of focal necrosis, such as necrotizing encephalitis, pneumonitis, or myocarditis. Tissue cysts usually are observed during the chronic or latent stage of infection, causing little, if any, inflammatory response. After ingestion, cysts are broken down by digestive enzymes

which release the organsims, allowing them to invade the GI tract where they spread via blood and lymphatics.



Life cycle of *Toxoplasma gondii:*

Divided into: Two phases:

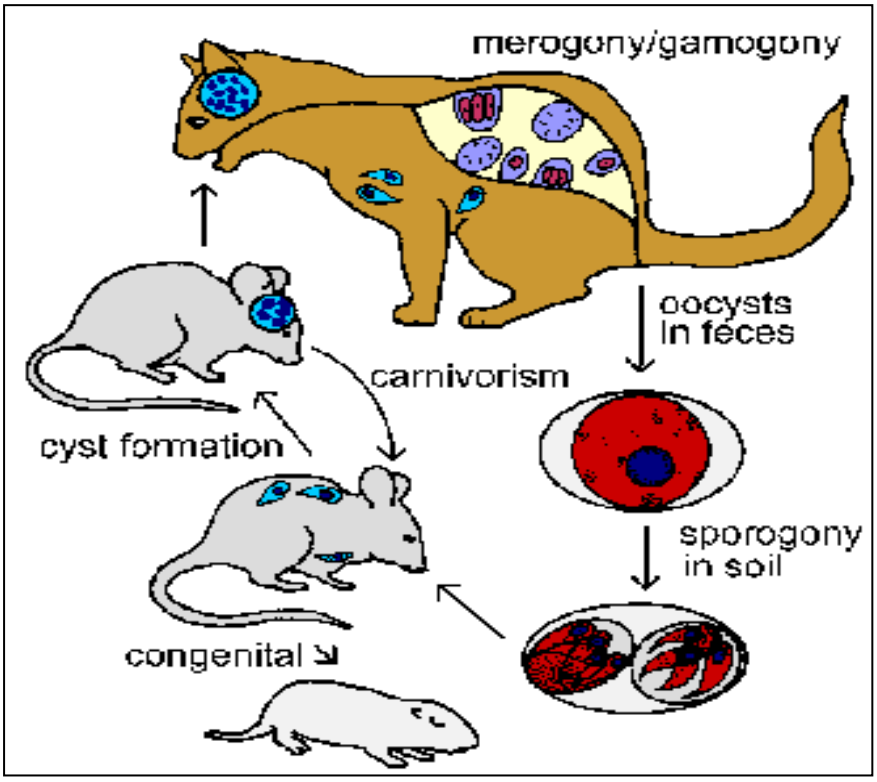
a) Intestinal or enteroepithelial or isosporian life cycle, The **intestinal** phase occurs in cats only and produces "**oocysts**".

b) Extra-intestinal or toxoplasma phase, the extraintestinal phase occurs in all infected animals and produces "**tachzoites**" and eventually "**bradyzoites**".

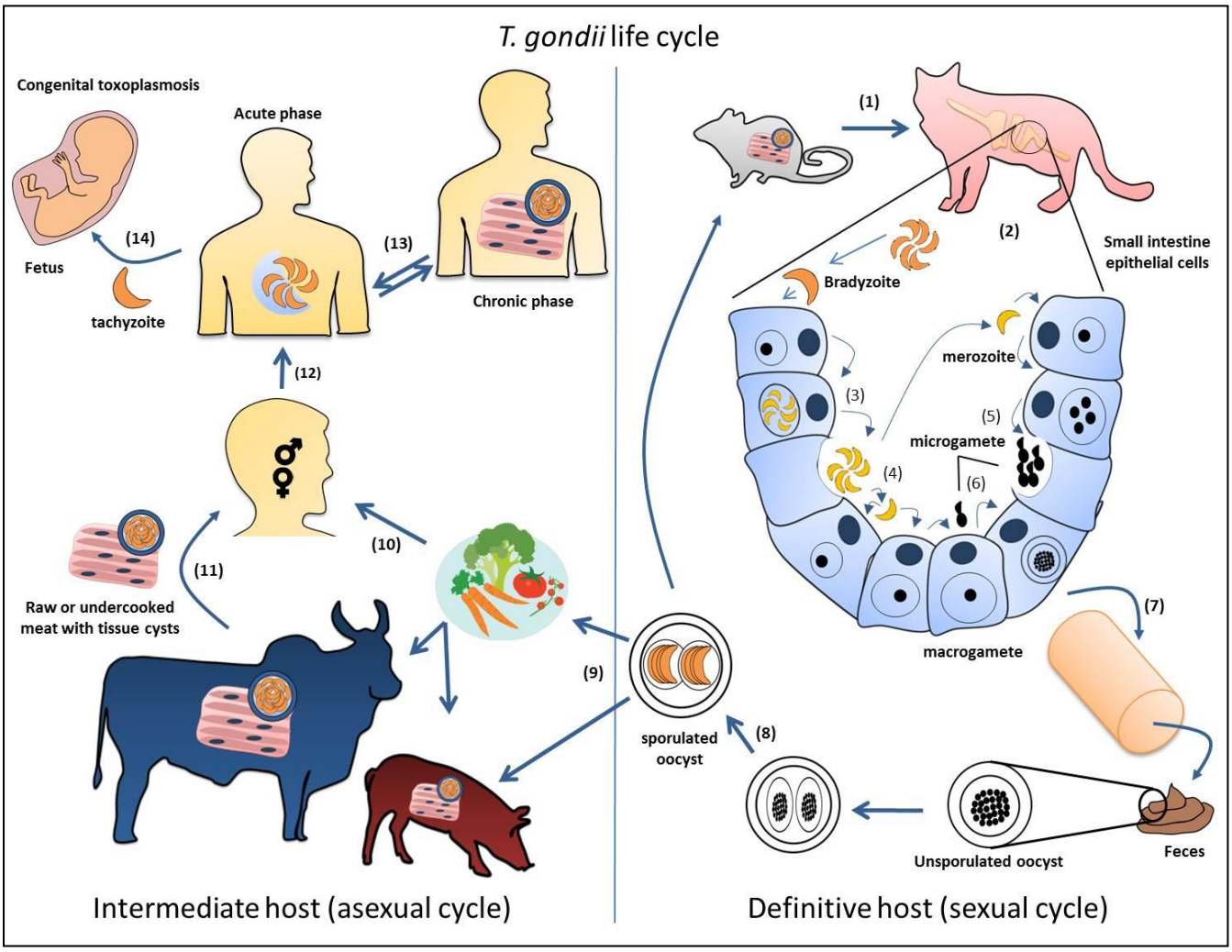
1- Intestinal life cycle: in cat and other felidue family only: they get infection by ingestion of mature oocysts from infected cat; in the small intestine of the cat the sporozoites are released. Some of these sporozoites will initiate the isosporian phase (asexual &sexual multiplication) .More or less resemblance to that of *Isospora belli*.

The merozoites will continue one or more Schizogony cycle and these continue to form both male and female gametocytes, so there will be male gametocyte that will divided a lot of (large number of male gametocytes) while the female gametocyte will form one ovum only. Male gametocyte will fertilize the ovum and form the zygote which secrete and surround themselves by a wall to form the immature oocysts and then shed out

epithelium lining of small intestine and go out with feces to outside where maturation take place (sexual and asexual cycle need 21-24 days). & after maturation the oocysts is ready to infect other cats.



2- Extra intestinal life cycle: while the other sporozoites take their way through intestinal wall & go by blood stream. At acute stage, they go to paranchymal cell & RES (Mcrophage, Neutrophil & Monocytes), in these cells , they divide to form **Tachyzoites** (pseudocyst) contain multiplied asexual (contain 6-16 Tachyzoites & again invade other paranchymal cells or RES with development of immunity, the multiplication of Tachyzoites will ceased down & form **Bradyzoites** surrounded by a cystic wall & contain 50 or more bradyzoites. in chronic stage form in brain , eye, muscle lung of infected cat, & viable for about one year ago to small intestine and release their sporozoites and cause intestinal and extra-intestinal phase maturation the oocysts is ready to infect other cats.
(Cats -----> final host mature oocyst -----> infective stage).



* In chronic s stage **Bradyzoites** is found in brain, eyes, muscle and lung of infected cats and remain viable for 1 year. So, the cat and its family considered as complete host because both (intestinal and extra-intestinal take place in it). If the mature oocyst from the cat is ingested by another host, man, other mammals, birds and reptile they become infected with the parasite of mature oocyst, in the small intestine is ruptured and sporozoites are released. All of the sporozoites will take their way through intestinal wall to any parenchymal and other RES, in the acute stage they will form tachyzoites and in the chronic stage they will form bradyzoites.

TRANSMISSION OF *T.gondii*

1- Major Routes of Transmission:

1- Ingestion of under cocked meat contaminated with *T.gondii.*

2- Ingestion of contaminated H2O.

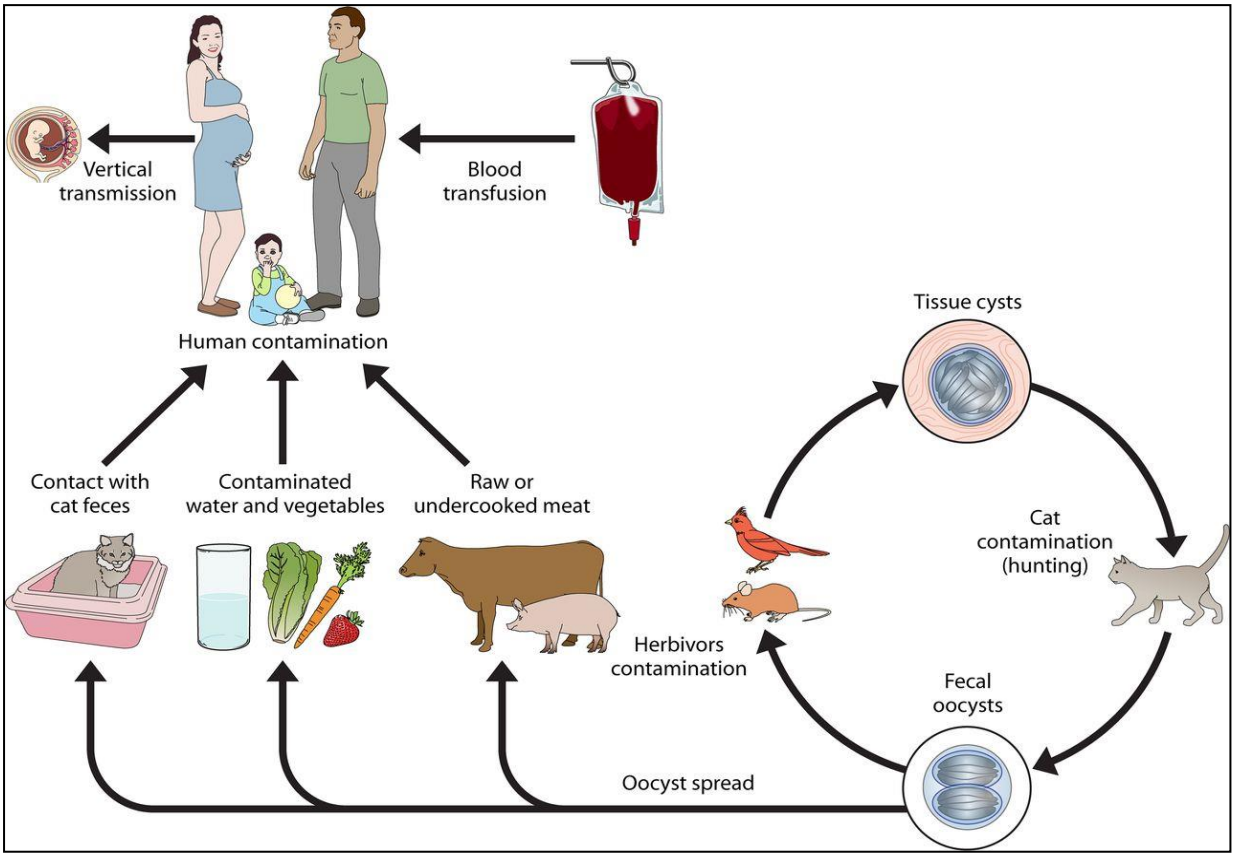
3- Because the parasite can cross transplacentally, so it can infect the fetus from infected mother.

2- Minor Routes of Transmission:

1- Blood transfusion from donors to recipient

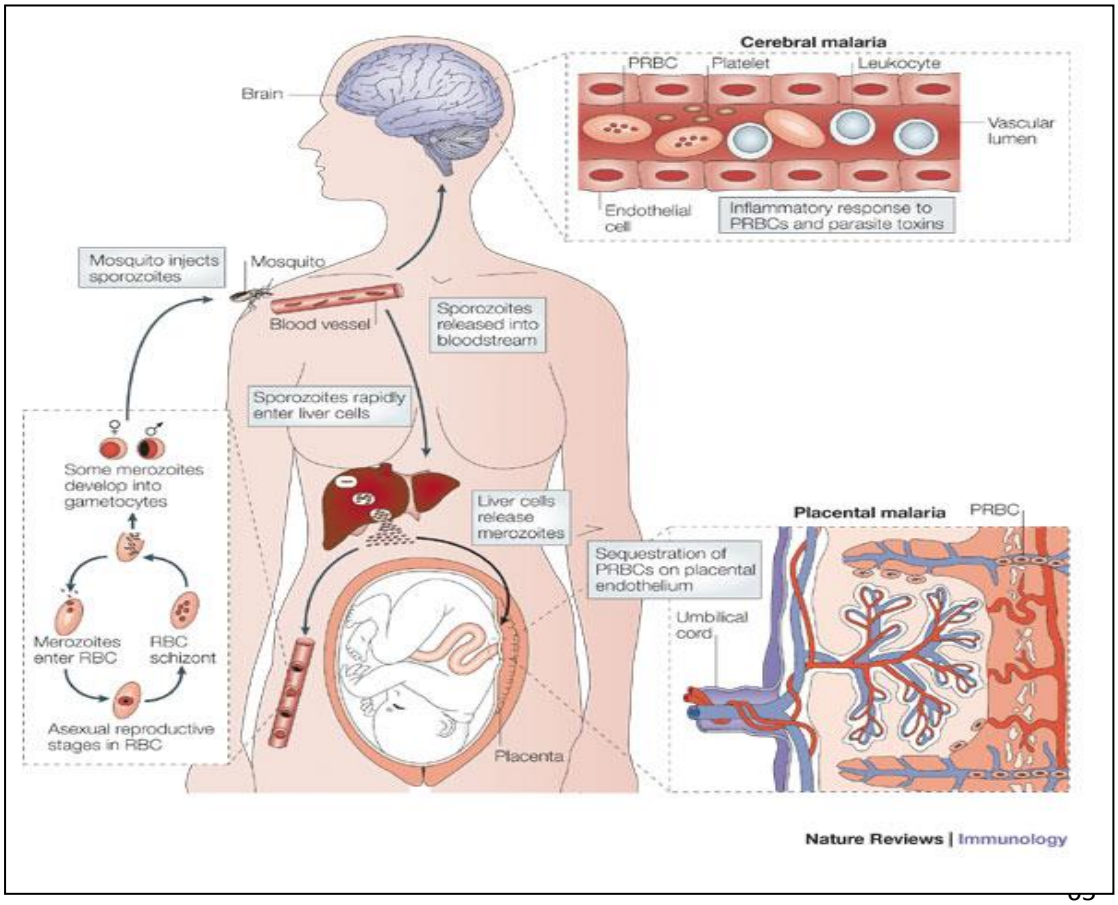
2- Organ Transplantation.

3- Drink not pasteurizing milk from infected cow.



Pathogenesis of toxoplasmosis

Most cases of toxoplasmosis in human are probably acquired by the ingestion of either **tissue cysts** with infected meat or **oocysts** in food contaminated with cat feces. Bradyzoites from the tissue cyst & Sporozoite released from oocysts penetrate the intestinal epithelial cells &multiply in the intestine, *T. gondii* may spread both locally to mesenteric lymph nodes to distant organs by invading lymphatic's blood. The clinical picture is determined by the extent of injury to these organs, especially to vital & vulnerable organs, such as eye, heart &adrenals. *T. gondii* does not produce toxins, necrosis is caused by intracellular multiplication of Tachyzoites. Opportunistic toxoplasmosis in AIDS patients usually represents reactivation of chronic infection. The predominant lesion of toxoplasmosis, encephalitis in these patients is necrosis which results in multiple abscesses, some as large as a tennis ball.



Host defenses: The host may die from toxoplasmosis but much more often recovers & acquires immunity. Inflammation usually follows necrosis. But about the third week after infection, *T.gondii* tachyzoite begins to disappear from visceral tissues may localize as tissue cyst in neural &muscular tissues. The tachtzoite may persist longer in the spinal cord the brain because immune responses are less effective in these organs. Chronic infection may be reactivated locally (for example, in the eye). Reactivation possibly results from the rapture of a tissue cyst. Probably tissue cysts rapture periodically during the life of the host, and the bradyzoites released are normally destroyed by the host immune response. This reaction may cause local necrosis accompanied by inflammation. Hypersensitivity is said to play major role in such reaction; however in immunocomptent hosts the infection usually subsides, with local renewed multiplication of toxoplasma in immunosuppressed patients rapture of a tissue cyst may result in renewed multiplication of bradyzoites into tachyzoites and the host may die from toxoplasmosis.

The cause of cyst rapture is not known. Chronic latent *T. gondii* infection can be experimentally reactivated by:
1- Excessive doses of corticosteroids
2- Anti-lymphocyte serum
3- Other immune-suppressive therapies.

Symptoms: The symptoms are divided into two main groups:

a- Neonatal (Congenital) Toxoplasmosis

b- Acquired (Postnatal) Toxoplasmosis

a- Neonatal Toxoplasmosis: If the fetus gets infected transplacentally from asymptomatic mother during 3rd trimester of pregnancy. At acute stage; it may lead sporadic abortion (only one) or still death, at birth or shortly after that (1-2) weeks, the infant shows signs & symptoms of Sabine's Tetrad & these are:

1-Intracerebral calcification
2-Retino-choroditis (birth)
3-Hydrocephalous
4-Microcephalous
5-Psychomotor disturbance
6-Generalized convulsion

B-Acquired (post-Natal) Toxoplasmosis: 90% of man &animals show no symptoms or signs and the other 10% have the most common forms (4 signs)
a- Lymphadenitis with fever, headache &malacia, the lymph nodes is either superficial or deep mostly the L.N of the neck region, also (1-2 weeks), Splenomegaly, Erythematous rash.

b- Typhus like Xanthomeatus, disease produce Myocarditis ,Meningeocephalitis, Atypical pneumonia…….death occur.

c- In rare cases, primary involve CNS &death occur.

d- Retino-choraditis of non-congenital infection in which the ocular lesion begins in Retina &spread to the choroid and in sever rare cases it causes enucleation of the eye (one eye) while in congenital it involves both eyes.

Diagnosis:

***1*-Finding or demonstrating the parasite in body fluids or tissues by microscopically examination of:**

a- Stained smear from CSF by leishmanstain (Sporozoite test)
b- Impression smear of L.N, spleen &liver ……press on slide &stain.
c- Histological stain smears section, to find pseudo cyst &true cyst.
In(a .staining) the parasite appear Crescentric or fusiform in shape with nucleus of border ends& appear red while total parasite appear blue.

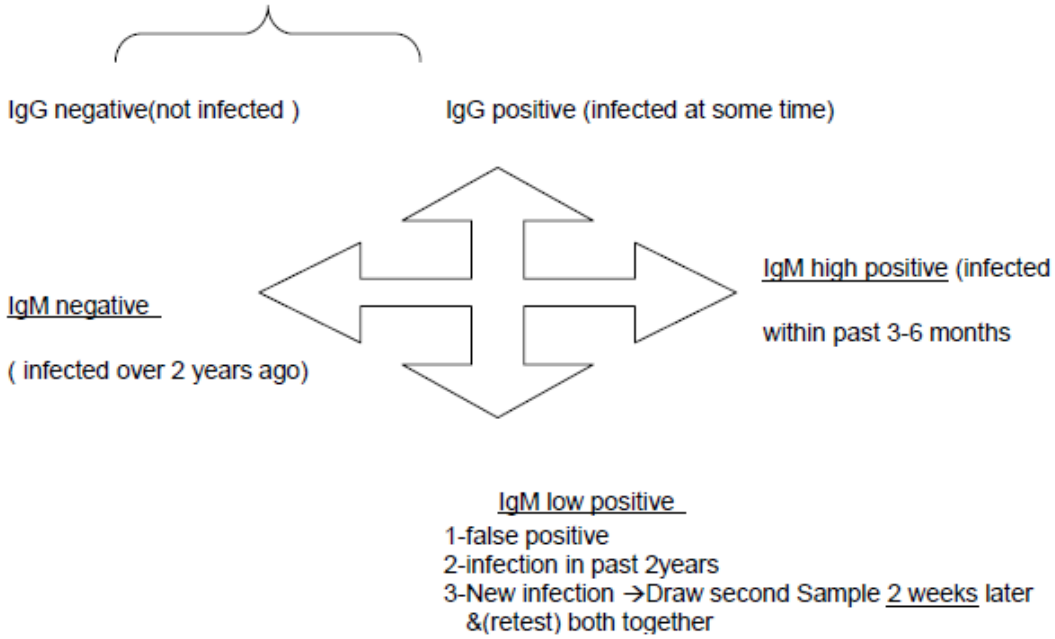
2- Isolation of parasite to find out it from man by animals inoculation. In this case,
a- We use small mice &take three of these laboratory mice &take Toxoplasma colony, and get body fluids of man or ground tissue of man & inoculate them intraperitonealy in mice and then kill the mice and examine by the same methods (stain smear).
b- Impression stain smear, for these (Tissue &also serum)

c- Histology stain smear, examination of the tissue of mice. If we find the parasite of *T. gondii* the patient has it & if the test is –ve, the patient is free from it.

3-Serological & intradermal test by:-

a- Sabin's Feldman dye test.
b -Indirect haemagglutination test (IHA)
c- Indirect fluorescent Ab test
d- ELISA
e- Complement fixation test
f- Latex agglutination test
g-Toxoplasmine skin test

4-Test for toxoplasma – specific IgG Ab



Prevention &Control:

1-Human infection with toxoplasma may come either from consumption or handling of infected meat or from contact with cat feces in litter pause or soil.

2-Meat should be heated throughout to (60C) before consumption, hands should be washed with Soap and water after handling uncooked meat.

3-In door cats that feed on dry, canned, or boiled food are unlikely to be infected, where is that can hunt or are feed uncooked food are liable to infection.

4-Such cats litter Paus should be cleaned daily &the Paus disinfected with boiling water.

5- Pregnant women, unless they have evidence of Toxoplasma infection, should avoid contact with cats whose source of food is not controlled & should not empty litter Paus.

6-Disposable gloves should be worn to clean litter boxes or work in soil contaminated with cat feces.

7-Childrens Sandboxes should be made cat proof.

NEMATODES (ROUND WORMS)

GENERAL CHARACTERISTICS OF NEMATODES:

They are un-segmented, elongated and cylindrical. They have separate sexes with separate appearances. They have a tough protective covering or cuticle. They have a complete digestive tract with both oral and anal openings. 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

1.1. Intestinal nematodes with tissue stage

A. Ascaris lumbricoides

B. Hookworms

C. Strongyloides stercoralis

1.2. Intestinal nematodes without tissue stage

A. Enterobius vermicularis

B. Trichuris trichuira.

2.1. Intestinal nematodes with tissue stage

2.1.1. Ascaris lumbricoides

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

Morphology:

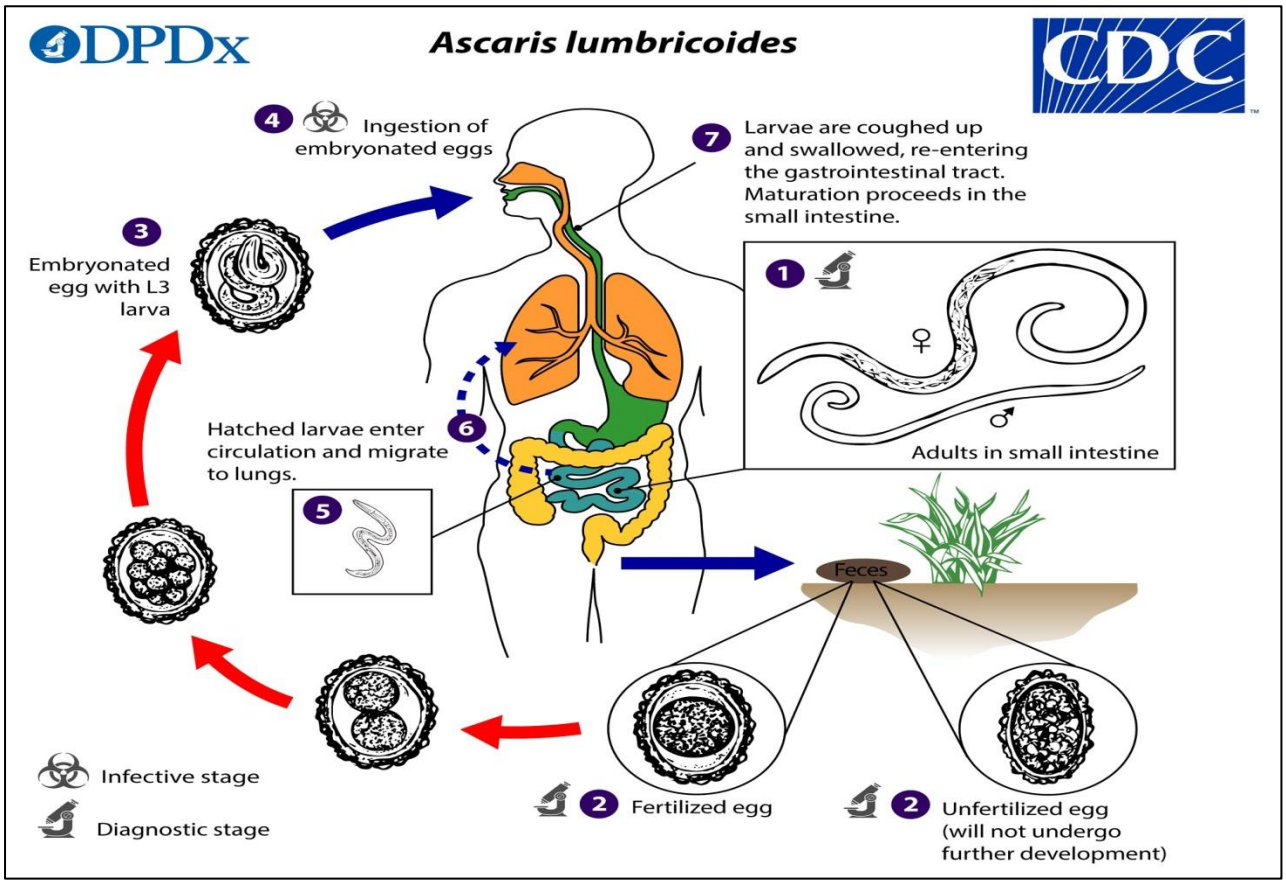
Male adult worm measures 15-20 cm in length. The posterior end is curved ventrally. The female worm measures 20-40 cm in length. Its posterior end is straight.

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.



Life cycle of *Ascaris lumbricoides*

Pathogenicity and clinical features:

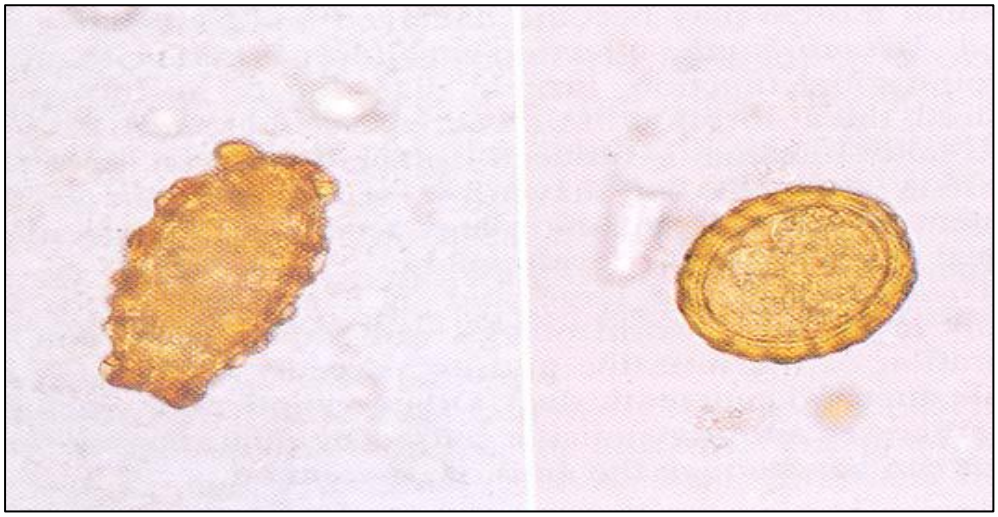
Adult worms in the intestine cause abdominal pain and may cause intestinal obstruction especially in children. Larvae in the lungs may

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.



Egg of *Ascaris lumbricoides*

Treatment:
Mebendazole, Albendazole and Piperazine

2.2. Intestinal nematodes without tissue stage

2.2.1. *Enterobius vermicularis* (pin worm or 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:

• By direct infection from a patient (Fecal-oral route).

• 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.

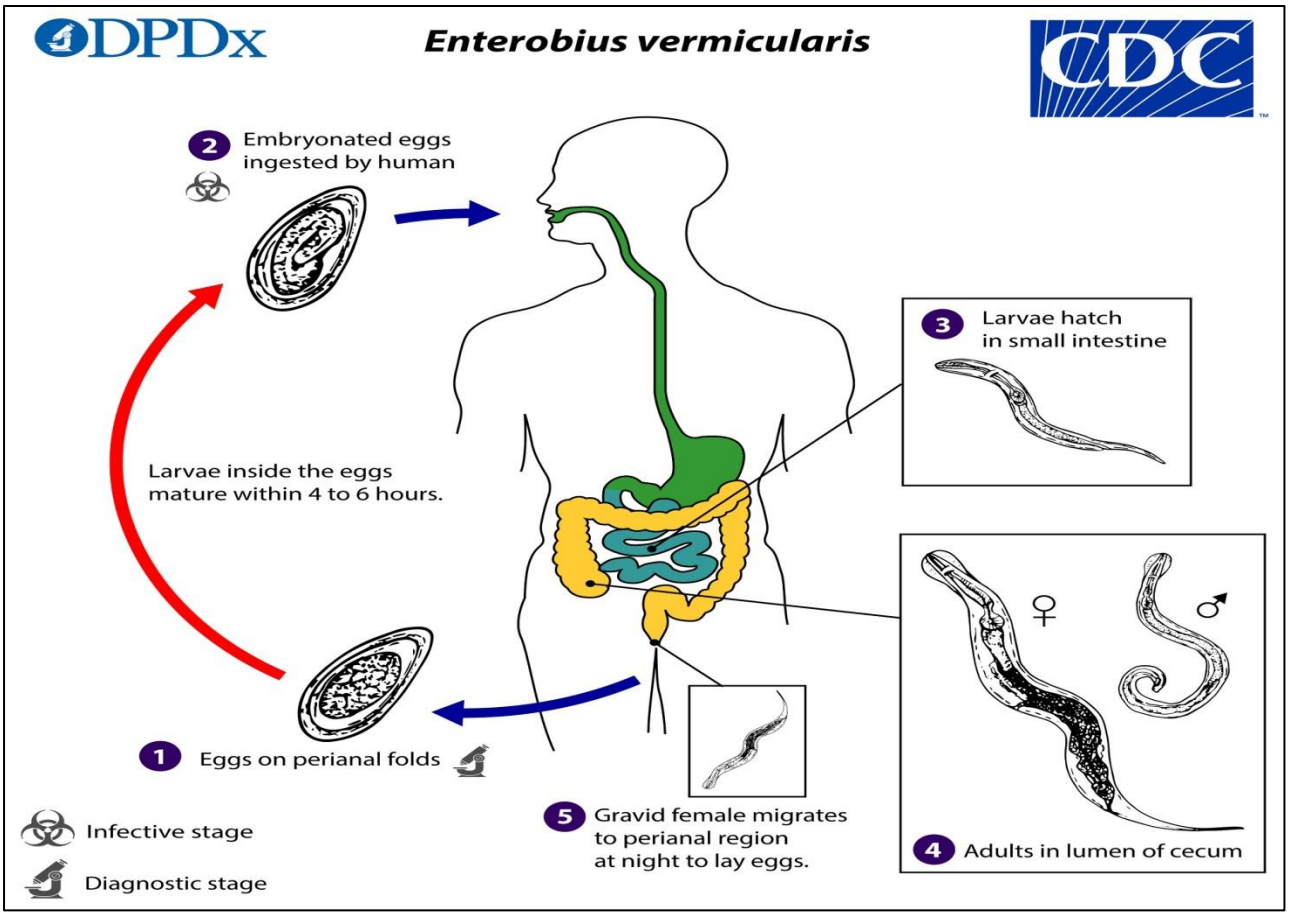
• Aerosol inhalation from contaminated sheets and dust.

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.



Life cycle of *E. vermicularis*

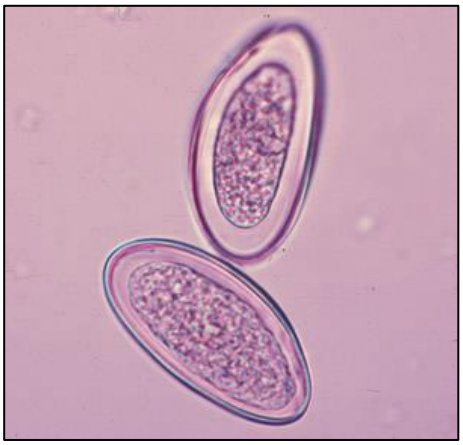
Diagnosis:

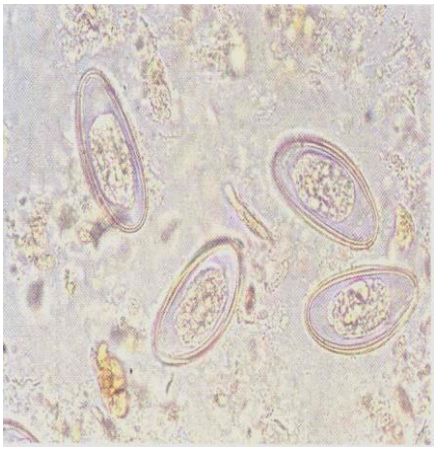
♦ Eggs in stool: Examination of the stool by direct saline smear to detect the egg: this is positive in about 5% of cases because the eggs are glued to the peri-anal skin.

♦ 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.

***Enterobius vermicularis* egg**





CESTODES (TAPEWORMS)

Introduction:

The tapeworms are hermaphroditic and require an intermediate host. The adult tapeworms found in humans have flat body, white or grayish in color. They consist of an anterior attachment organ or scolex and a chain of segments (proglottids) also called strobilla. The strobilla is the entire body except the scolex. The scolex has suckers or grooves. It has rosetellum, which has 1 or 2 rows of hooks situated on the center of the scolex. Adult tapeworms inhabit the small intestine, where they live attached to the mucosa. Tapeworms do not have a digestive system. Their food is absorbed from the host's intestine.

ECHINOCOCCUS

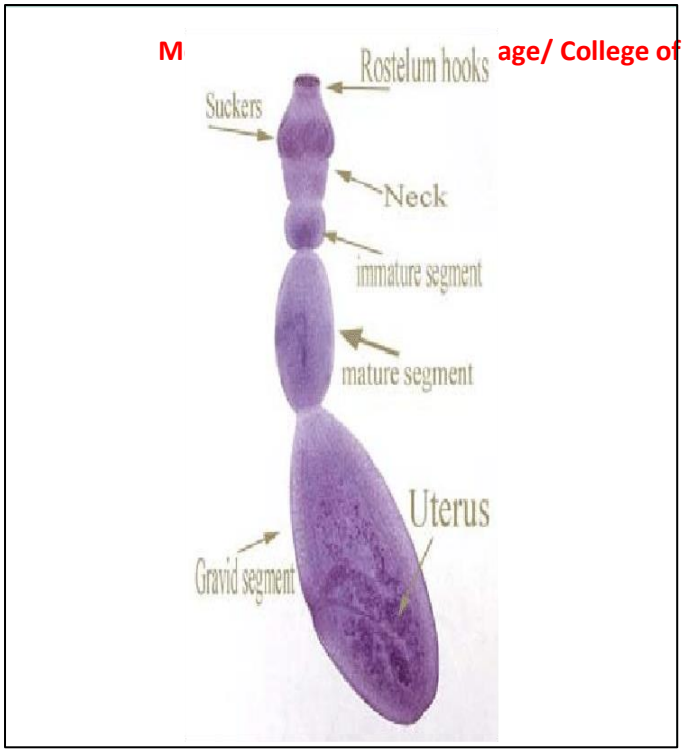
There are two different species. These are: *Echinococcus granulosus* and *Echinococcus multilocularis*

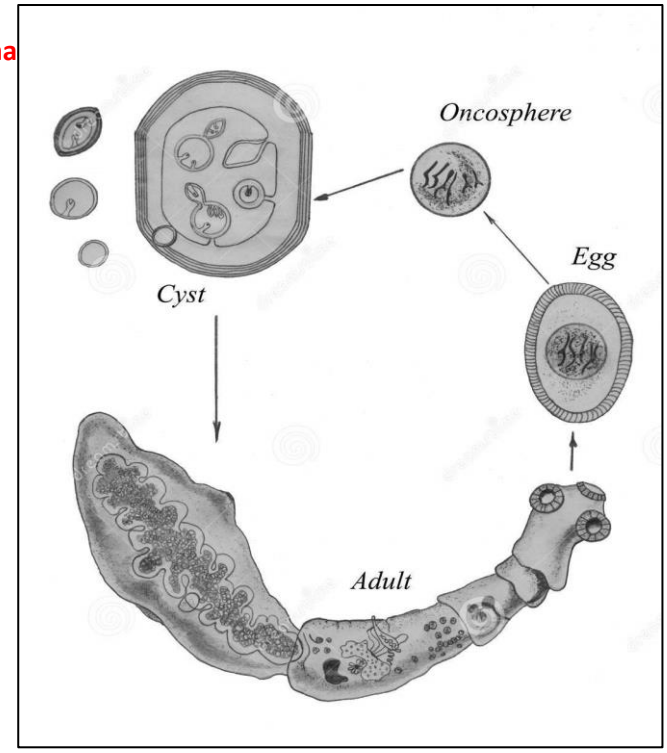
Echinococcus granulosus (dog tape worm)

Responsible for most cases of echinococcosis. Echinococcosis is caused by larval tapeworms. The disease is common in East Africa (the highest prevalence is seen in Kenya: 10-15%).

Morphology:

The adult worm measures 3-6 mm in length (up to 1 cm). It has scolex, neck and strobilla. Adult worms live in small intestine of definitive host (dog). Man is an intermediate host - carrying the hydatid cyst (larva). Man contracts infection by swallowing eggs in excreta of definitive host.





Life cycle and Pathogenicity:

Oncosphere hatch in duodenum or small intestine into embryos (oncosphere) which:

♦ Penetrate wall

♦ Enter portal veins

♦ Migrate via portal blood supply to organs: eg: lungs, liver, brain etc., thus, causing extra intestinal infections. In these organs, larvae develop into hydatid cysts. The cysts may be large, filled with clear fluid and contain characteristic protoscolices (immature forms of the head of the parasite). These mature into developed scolices, which are infective for dogs.

Mode of human infection:

Ingestion of eggs by the following ways:

i) Ingestion of water or vegetables polluted by infected dog feces.

ii) Handling or caressing infected dogs where the hairs are usually contaminated with eggs.

Clinical features:

Asymptomatic infection is common, but in symptomatic patients

120

♦ It may cause cough - with hemoptysis in lung hydatid disease.

♦ Hepatomegaly - with abdominal pain and discomfort

♦ Pressure -from expanding cyst

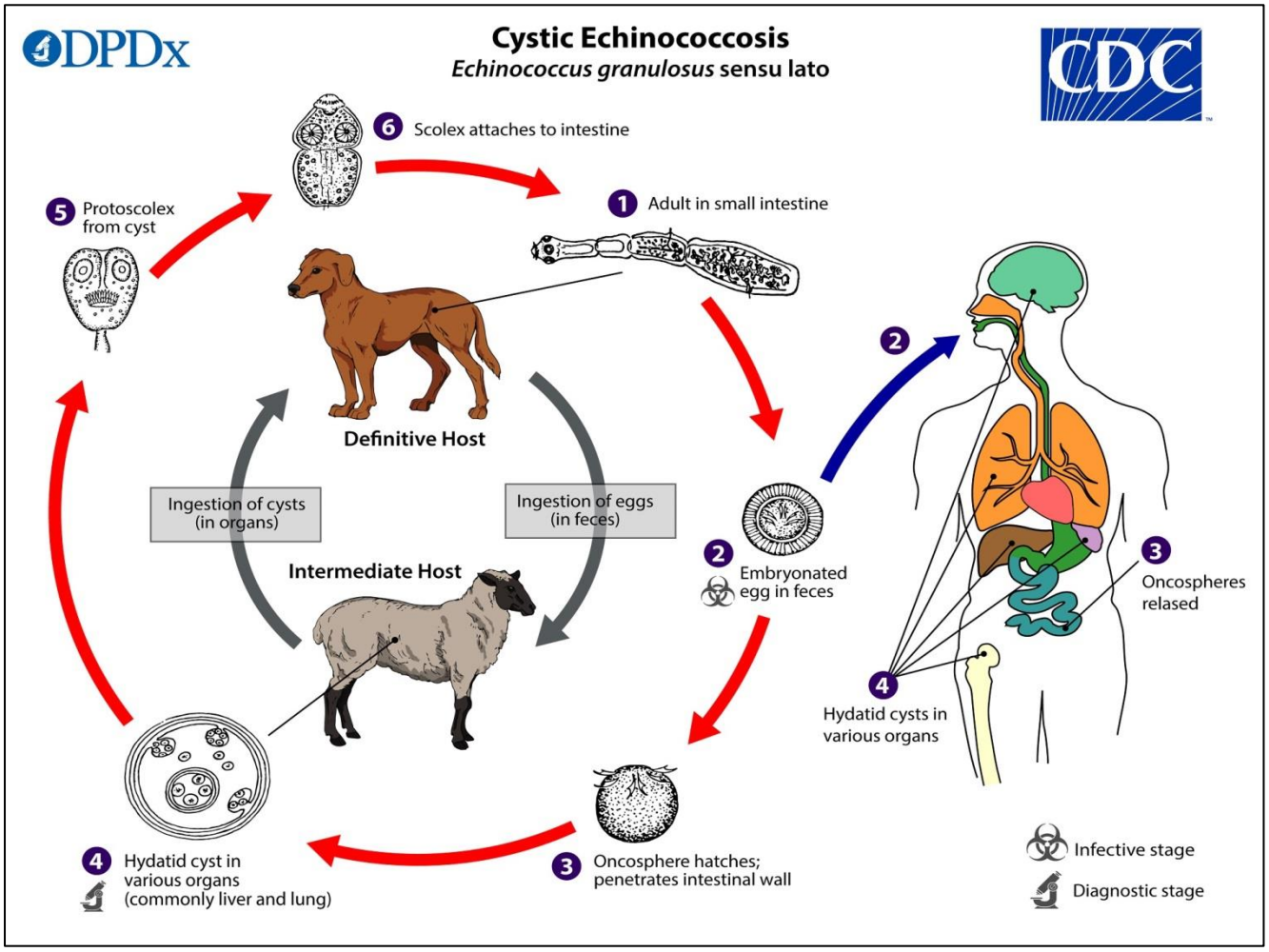
♦ Rupture of cyst - severe allergic reaction - anaphylaxis.

Diagnosis:

♦ X-ray or other body scans

♦ Demonstration of protoscolices in cyst after operation

♦ Serology



Life cycle of *Echinococcus granulosus*

Treatment:

♦ Surgery

♦ Albendazole 400 mg twice a day for one to eight periods of 28 days each, separated by drug-free rest intervals of 14 to 28 days.

Echinococcus multilocularis

Foxes are the definitive hosts, while various rodents such as mice serve as intermediate hosts.

***Taenia Saginata* (beef tapeworm):**

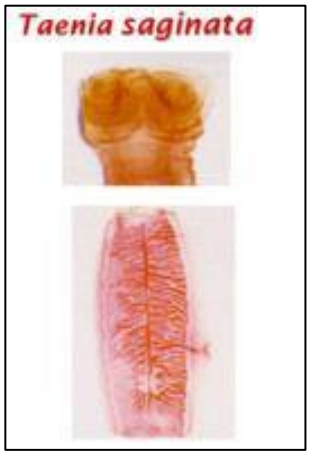
In adult stage, *T. saginata* inhabits the upper jejunum where it may survive for as long as 25 years. It causes intestinal infection, **Taeniasis**. It has worldwide distribution.

These are one of the true and segmented tapeworms. Their body is divided into three regions;

1. Scolex: the hold fast organ
2. Neck: posterior to the scolex
3. Stobilla: the main bulk, made up of proglottids.

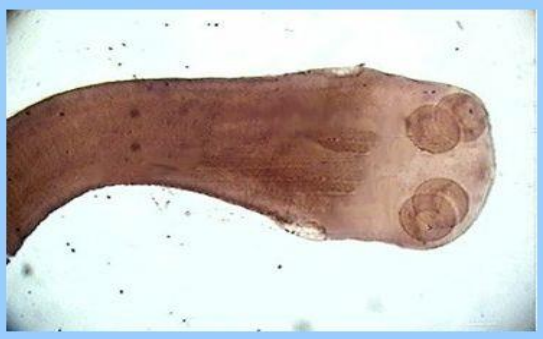
Morphology:

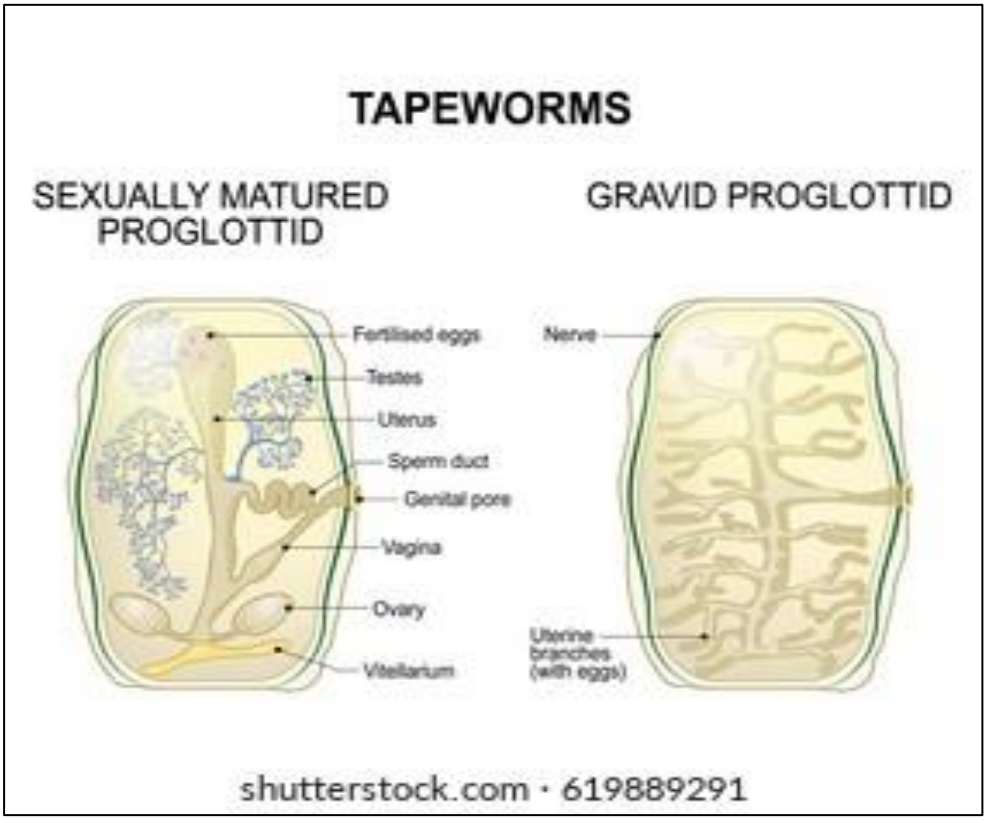
Adult worm measures 5-10 meters in length. The pyriform scolex has 4 suckers but no rostellum. The mature segments have irregularly alternate lateral genital pores. Each of the terminal segments contains only a uterus made up of a median stem with 15-30 lateral branches.



Taenia saginata

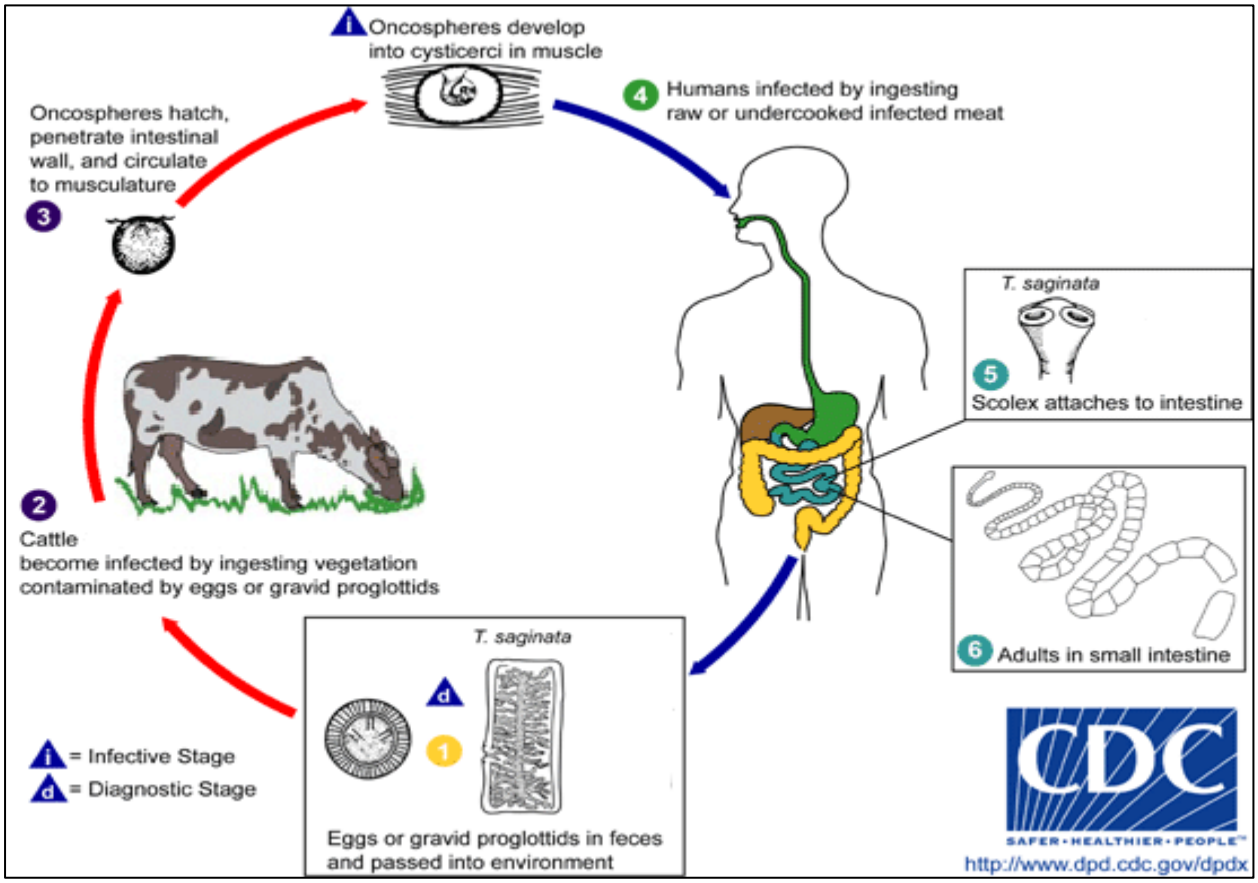
- Cestode worm is composed of 3 parts:
- 1- scolex : responsible for the attachment to intestinal mucosa by suckers.
- 2- Neck: responsible for strobilization / production of body segments.
- 3- Body : compose of segments (proglottids)
-





Life cycle

The adult worm lives in the small intestine of man. Gravid segments pass out in the stool and become disintegrated and eggs come out to the soil. The gravid proglottid uterus contains about 100,000 eggs. The egg of *T. saginata* is round, about 40 microns in diameter. The 6-hooked embryo is enclosed in a radially striated embryophore. Eggs are ingested by an intermediate host, cattle. The 6- hooked embryo escapes from its shell, penetrates through the intestinal wall into the blood vessels and is carried to the muscles where it develops into a larval stage, **cysticercus bovis** (made up of an invaginated /inverted head and spherical body). Infection to man takes place by the ingestion of raw or insufficiently cooked beef. In the small intestine of man, the head of the cysticercus gets invaginated and the body becomes segmented.



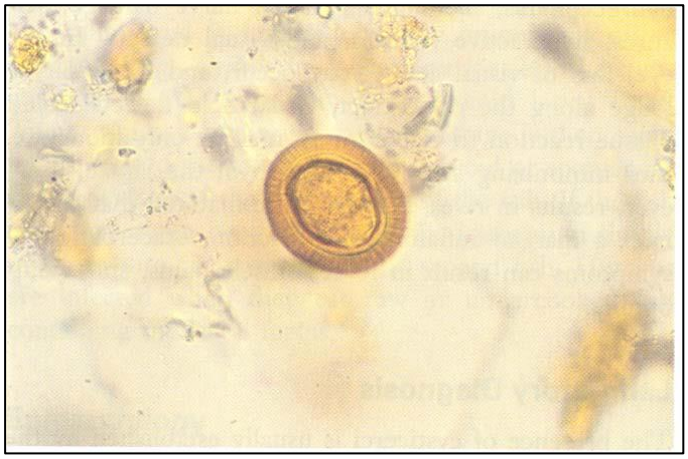
Life cycle of *Taenia saginata*

Pathogenicity

Infected persons may complain of epigastric pain, abdominal discomfort, diarrhea, weight loss, hunger sensation, vomiting, etc.

Diagnosis

Recovery of the gravid segments or the eggs from the stool



Egg of Taenia Spp

Treatment:

Niclosamide: Four tablets chewed in a single dose.

Mebendazole 100mg twice daily for three days

Prevention:

♦ Thorough cooking of meat (above 57^0C)

♦ Proper disposal of human excrete

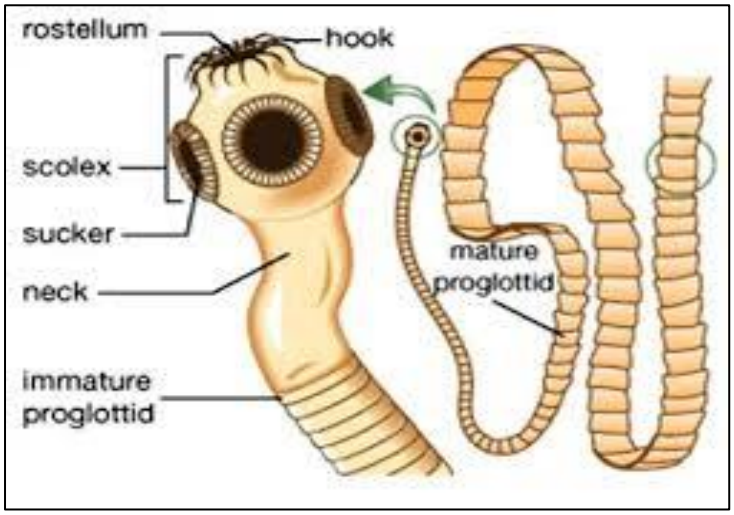
Taenia solium (pork tapeworm):

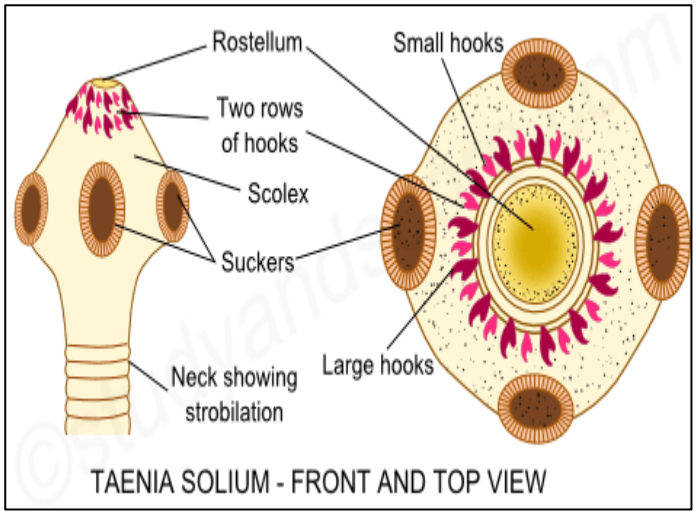
The adult worms of *T. solium* reside or inhabit the upper jejunum. Infection has worldwide distribution.

Morphology:

Adult worm measures about 3 meters in length. The globular scolex has rostellum with 2 rows of hooklets. There are <1000 proglottids.

Gravid proglottid liberates about 30,000-50,000 eggs.

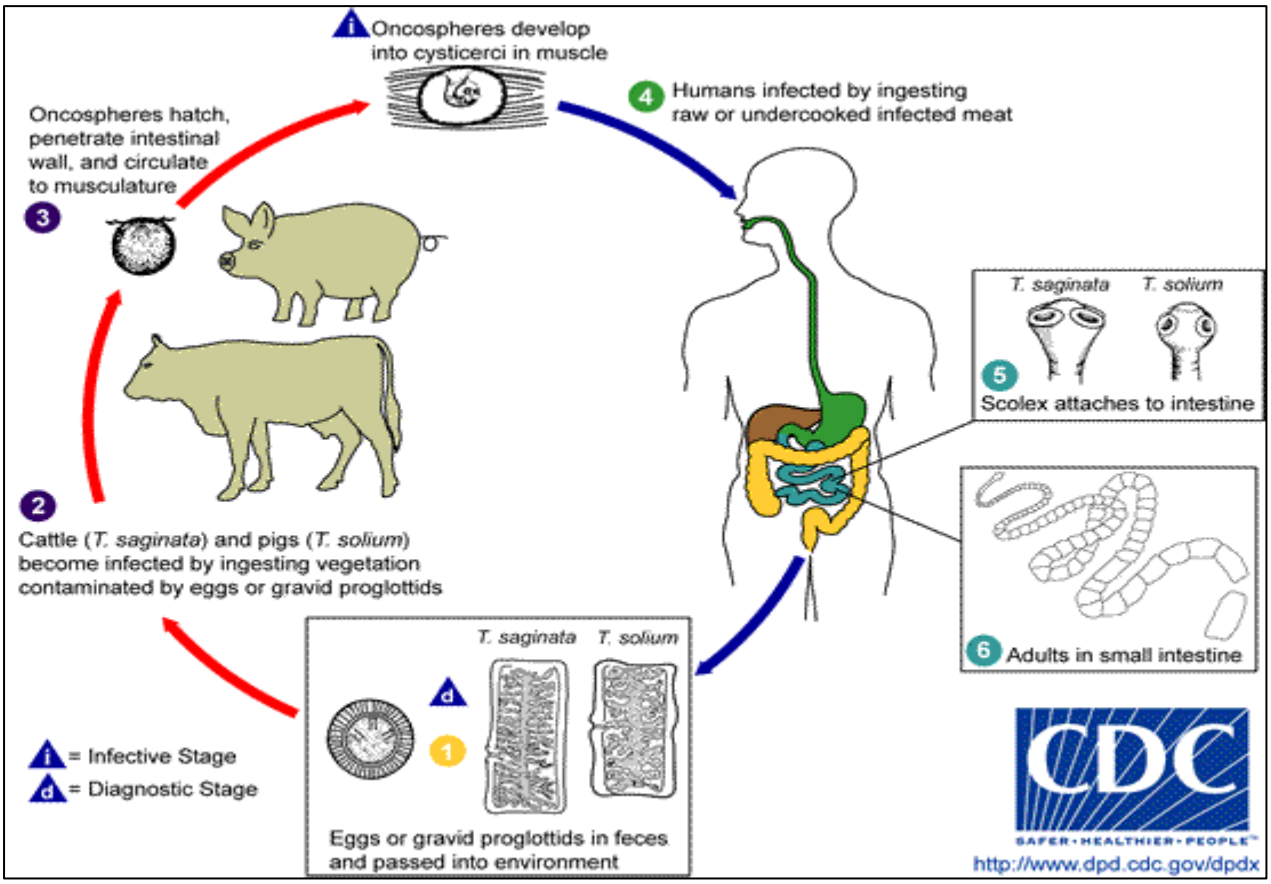




Life cycle

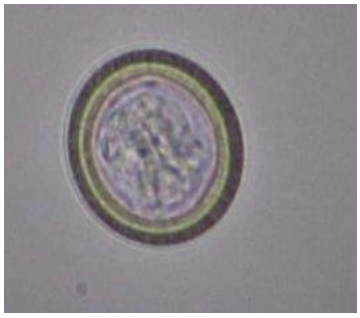
Embryonated eggs passed with stool are ingested by pig and the embryo is released. It penetrates the intestinal wall and is carried by vascular channels to all parts of the body. After a period of 2-3 months of development the encysted larval stage called cysticerci or bladder worm occurs in the striated muscles of the tongue, neck, trunk brain, eye, and the nervous system. The cysticercus survives for 5 years. Humans become infected by eating pork containing larvae, *cysticercus cellulosae*. When improperly cooked cysticercus infected meat is eaten by man, the

scolex remains undigested and attaches itself to the intestinal wall and chain of proglottids begin to grow to adult worm.



Clinical manifestations

Resembles that of *T. saginata* infection



Diagnosis

Demonstration of eggs in stool specimen

Treatment

Niclosamide: 2 gm PO stat

Prevention:

♦ Treatment of infected persons.

♦ Thorough cooking of pork and proper processing

♦ Proper disposal of human excreta (good hygiene/sanitation).

MEDICAL HELMINTHOLOGY

Medical helminthology is concerned with the study of helminthes or parasitic 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.

The sources of the parasites are different: Exposure of humans to the parasites may occur in one of the following ways:

1. Contaminated soil (Geo-helminthes), water (cercariae of blood flukes) and food (Taenia in raw meat).
2. Blood sucking insects or arthropods (as in filarial worms).
3. Domestic or wild animals harboring the parasite (as in echinococcus in dogs).
4. Person to person (as in *Enterobius vermicularis*, *Hymenolopis nana*).
5. Oneself (auto-infection) as in *Enterobius vermicularis.*

They enter the body through different routes including: mouth, skin and the respiratory tract by means of inhalation of airborne eggs.

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.

MEDICALLY IMPORTANT TREMATODES (FLUKES):

Trematodes belong to the phylum platyhelminthes. They are found in a wide range of habitats. The great majority inhabit the alimentary canal, liver, bile duct, ureter and bladder of vertebrate animals. According to the sites they inhabit, there are four groups of flukes. These are: **Blood flukes**, Intestinal flukes, **Liver flukes**, and Lung flukes.

1. BLOOD FLUKES

These are flukes that reside mainly in the blood vessels of various organs and the schistosomes are the prototype and the commonest flukes in our country.

SCHISTOSOMIASIS (BILHARZIASIS)

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.

- Disease of the venous system, acquired by people when they come in contact with contaminated water
- Adult Schistosomes take up residence in various abdominal veins, depending on the species; they are, therefore called (Blood Flukes)
- Very common among children
- Geo. Dis.: developing countries, affects up to 200 million people
- Transmission: *Direct skin penetration*

Fresh water becomes contaminated by Schistosoma eggs when infected people urinate or defecate in the water. The eggs hatch and the parasites grow and develop inside snails.

Schistosoma is not acquired by ingestion of contaminated food; it directly ***penetrates*** the skin of swimmers in contaminated rivers and lakes.

2 types of Schistosomiasis:

Intestinal Schistosomiasis

Urinary tract Schistosomiasis

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 prevalent in Ethiopia.

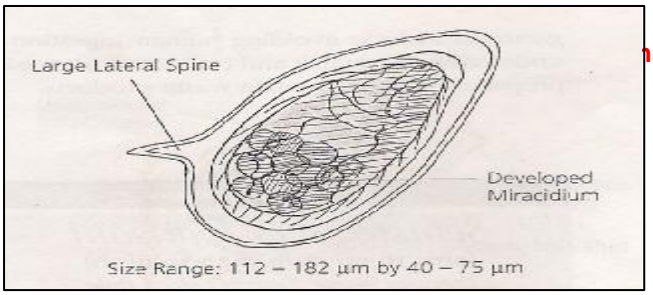
SCHISTOSOMA MANSONI

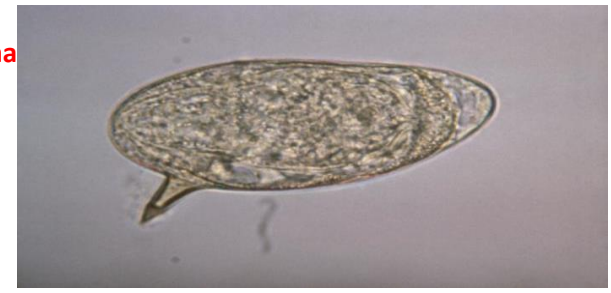
Habitat - This species lives in the veins of the intestine.

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.

Eggs : The average *Schistosoma* eggs is comprised of developed miracidium , these eggs are oval in shape and the presence of lateral or terminal spines distinguishes the egg of one species from the other species .





Egg of *Schistosoma mansoni*
***It's have large lateral spine and developed miracidium.**

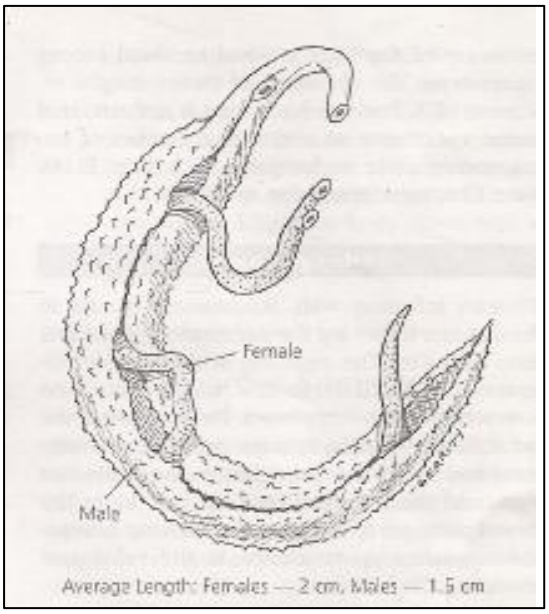
Adults: The adults of *Schistosoma sp*.are the only trematodes that have separate sexes. Unlike the other adult trematode , the Schistosomes are rounder in appearance.

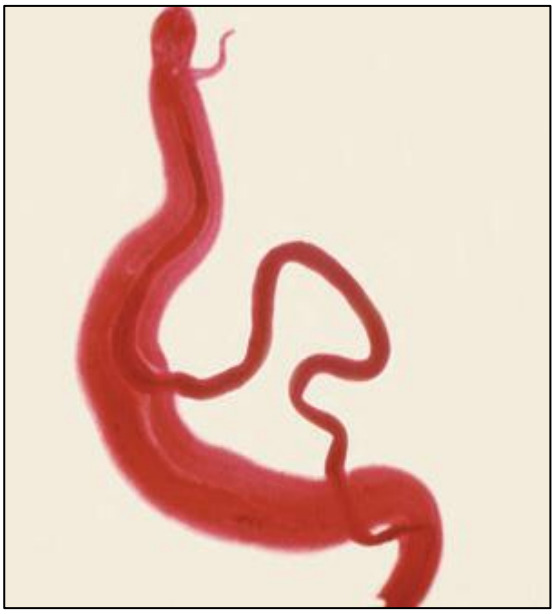
Although the typical female measures 2 cm in length and the male measures 1.5 cm in length, the male has the capability to almost completely surround the female during copulation.

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 SCISTOSOMIASIS:

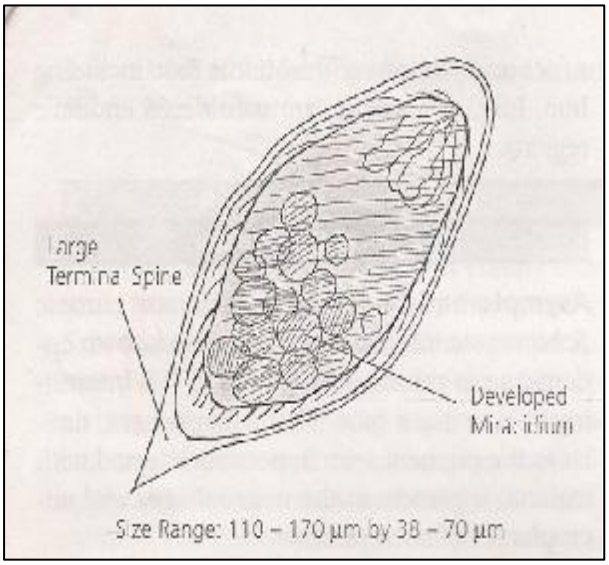
Etiology - *Schistosoma haematobium*

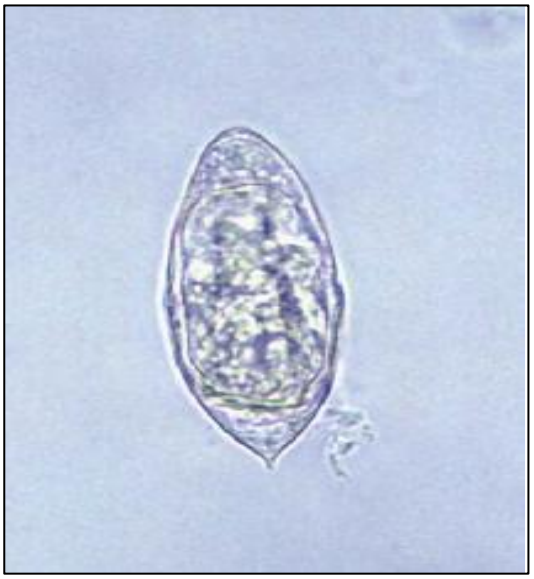
Habitat - The worm lives in the veins of the bladder of humans.
The peak prevalence is the 10-14 year age group.
The snail hosts that harbor *S. haematobium* are the genera Bulinus (Bulinus africanus, B. truncatus) and Physopsis.

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 presentin 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.

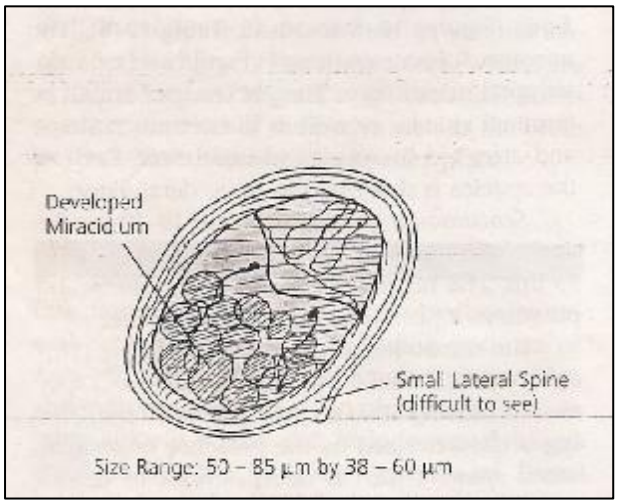


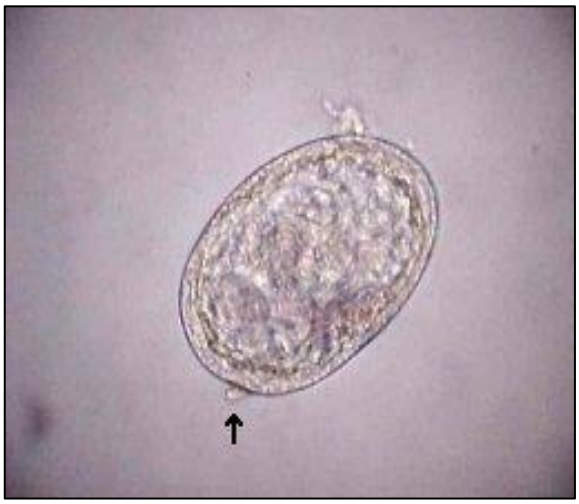


Egg of *Schistosoma haematobium*
***It's had large terminal spine and developed miracidium.**

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.





Egg of *Schistosoma japonicum*
***It's had small lateral spine and developed miracidium.**

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

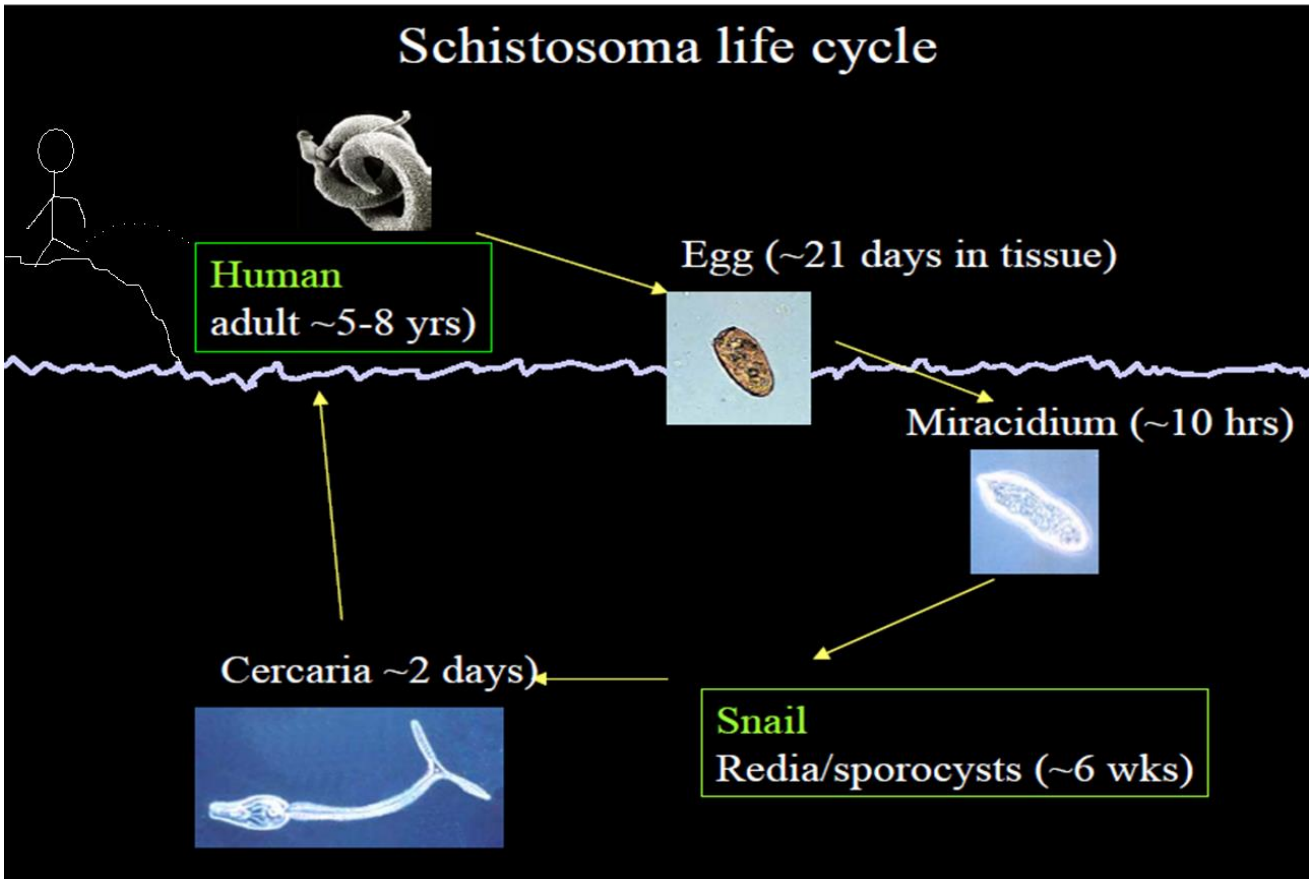
the miracidia hatch from the eggs and swim about until they find the appropriate snail, which they penetrate.

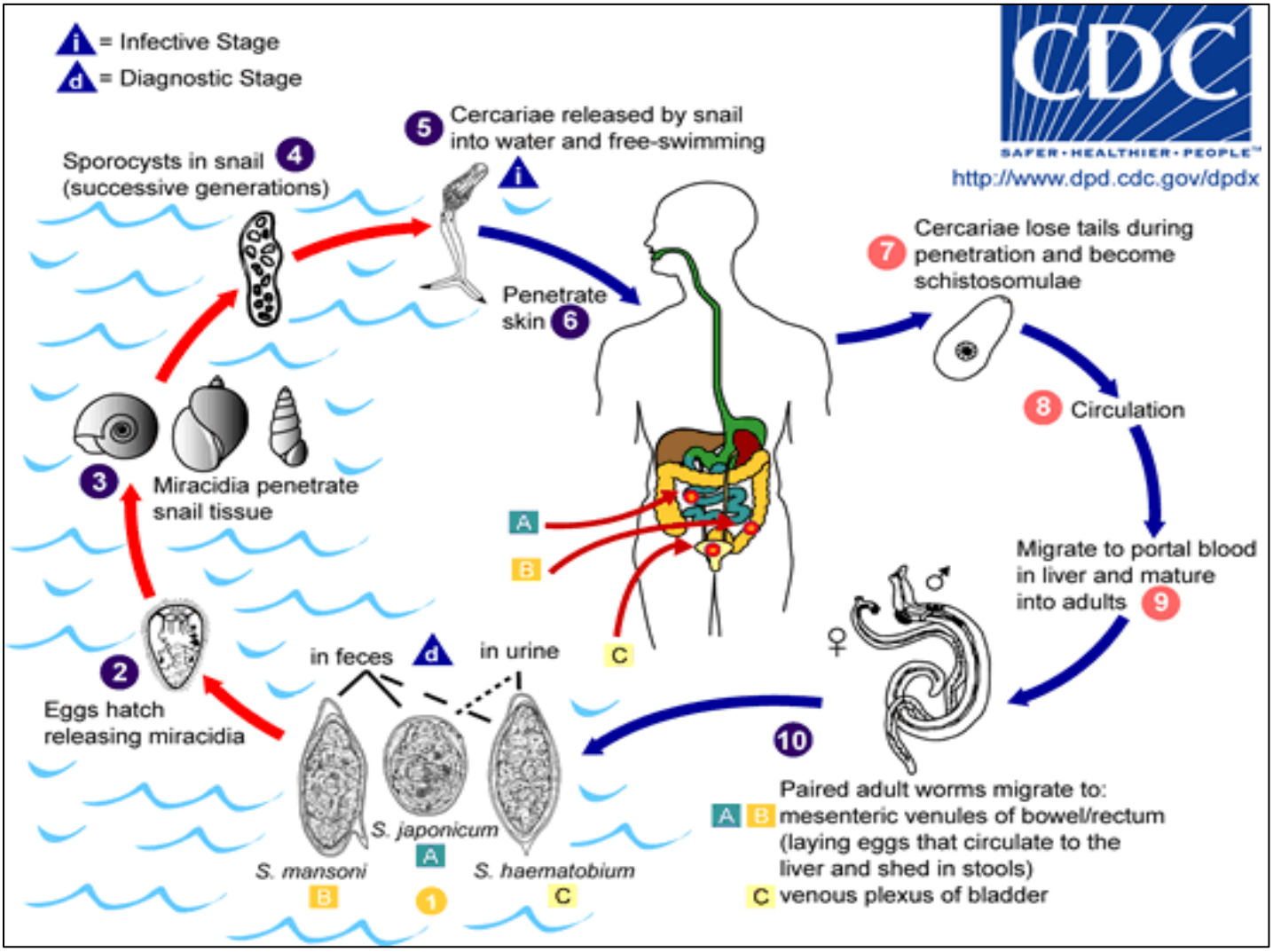
After two generations of sporocyst development and multiplication within the snail, the fork-tailed cercariae emerge. Infection to man takes place during bathing or swimming.

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.

Notes:

*Diagnostic stage is: **egg**
* Infective stage is: **cercaria**
* Final host is: **human**
* Intermediate is: **snail**



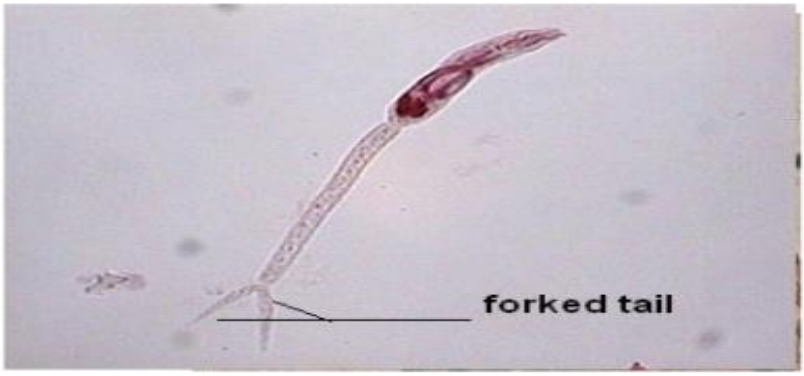


The cercariae

- Man is infected by **fork tailed cercaria** in fresh water by **skin penetration**
- The cercaria travel through the venous circulation to the heart, lungs and portal circulation
- They mature and reach:
- the mesenteric veins (*S. japonicum* and *S. mansoni*)
- The bladder vessels (*S. hematobium*) where they live and ovulate for the duration of the host's life.

Infective Stage

- *Schistosoma* cercaria (forked tail).
- Found in fresh water.
- Penetrate the skin of human upon contact with water containing it.



Symptoms and complications:

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.

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. *S. haematobium* causes squamous cell carcinoma in the bladder.

Pathology of schistosomiasis

- ***S. mansoni* and *S. japonicum* includes:**
- **Katayama fever, periportal fibrosis, portal hypertension, and embolic egg granulomas in brain or spinal cord.**

- ***S. haematobium* includes: hematuria, calcification, squamous cell carcinoma, and occasional embolic egg granulomas in brain or spinal cord.**

Laboratory Diagnosis

S. mansoni:

♦ Microscopic examination of the stool for eggs after concentration by sedimentation method. The egg has characteristic lateral spine.

♦ Rectal snip

***S. haematobium*:**

♦ 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.

♦ Biopsy from bladder

Treatment:

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

Prevention:

1. Health education:

A. On use of clean latrines and safe water supply

B. Avoid urination and defecation in canals, avoid contact with canal Water

2. Snail control:

A. Physical methods:

i. Periodic clearance of canals from vegetations.

ii. 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

Differentiation between *Schistosoma sp.*

Properties	*Schistosoma mansoni*	*Schistosoma japonicum*	*Schistosoma haematobium*
1- natural habitat	Adult live in vein of large intestine	Adult live in vein of small intestine	Adult live in vein of urinary bladder
2- male (No. of tests)	6 - 9	7	4 - 5
3- Female (Situation of ovary)	Near the anterior end	In the middle	Near the posterior end
4- Length of uterus	Short	medium	medium
5- Shape of eggs	Oval , with large lateral spine	Oval to rounded, with small lateral spine	Oval , with large terminal spine
6- Lab. Diagnosis	Fecal examination	Fecal examination	Urine examination
7- Disease name	Intestinal Schistosomiasis	Intestinal Schistosomiasis	Urinary Schistosomiasis

3. LIVER FLUKES:

♦ ***Clonorchis sinensis***: Chinese liver fluke - adult worms live in bile ducts.

♦ ***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.

♦ Other: ***Faciola gigantica:*** lives in the liver of cattle. Human infections are very rare.

Fasciola hepatica, also known as the **common liver fluke** or **sheep liver fluke**, is a parasitic trematode (fluke or flatworm, a type of helminth) of the class Trematoda, phylum Platyhelminthes. It infects the livers of

various mammals, including humans, and is transmitted by sheep and cattle to humans the world over. The disease caused by the fluke is called fasciolosis or fascioliasis, which is a type of helminthiasis and has been classified as a neglected tropical disease.