

## Protozoa

**Subkingdom: Protozoa**

**Phylum: Apicomplexa**

**Class: Sporozoa**

### **Malaria Parasites**

In human, the parasites are found in the erythrocytes and hepatocytes.  
The causative agents of human malaria:

1. ***Plasmodium vivax***: is the predominant type in most parts of the world, it producing **benign tertian malaria**.
2. ***Plasmodium falciparum***: producing **malignant tertian malaria**.
3. ***Plasmodium malariae***: producing **quartan malaria**.
4. ***Plasmodium ovale***: producing **tertian malaria**.

#### **Life Cycle**

Malaria parasite completes its life cycle in 2 hosts. Its definitive host is the female *Anopheles* mosquito. Humans are the intermediate host. Modes of transmission are via bite of infected *Anopheles* mosquito.

#### **1. Human cycle (Asexual cycle /schizogony):**

Humans acquire infection from the bites of infective female *Anopheles* mosquito. **The sporozoites, which are the infective forms of the parasite**, are present in the salivary gland of the mosquito. They are injected into blood capillaries when the mosquito takes a blood meal. The sporozoites circulate in the blood stream and enter the liver parenchymal cells (hepatocytes).

### **A- Exoerythrocytic cycle:**

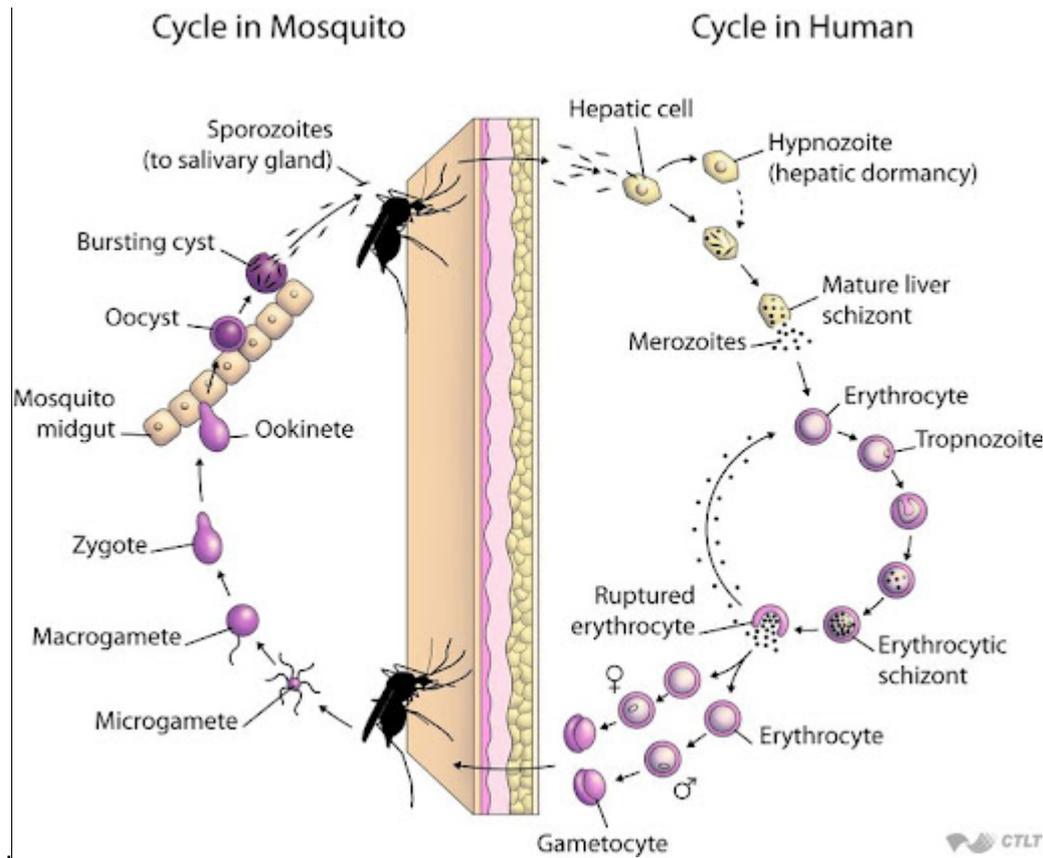
Within 30 min, the sporozoites reach the liver and enter the hepatocytes to initiate the stage of pre-erythrocytic schizogony. In *P. vivax* and *P. ovale*, they form schizonts which persist and remain dormant, the dormant schizonts are reactivated and release merozoites, which go on to infect RBCs causing clinical relapse.

### **B- Erythrocytic cycle:**

The merozoites released by pre-erythrocytic schizonts in the liver invade the RBCs and form **rings** or young trophozoites. The parasite feeds on the haemoglobin and become vacuolated developing into **trophozoites**. Rupture of parasitized red blood cell releases merozoites which invade new red cells to repeat the cycle. Some merozoites enter red cell to form male (microgametocyte) and female (macrogametocyte).

### **2. Anopheles mosquito cycle (Sexual cycle / Sporogony):**

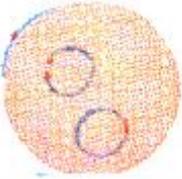
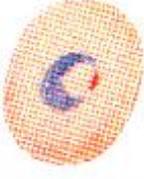
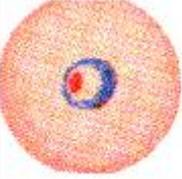
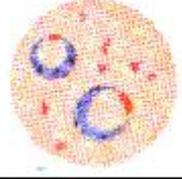
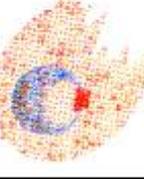
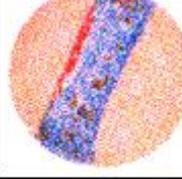
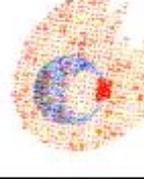
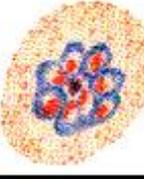
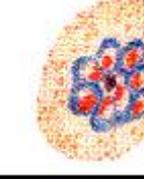
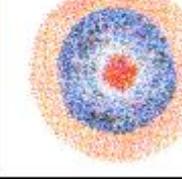
When a female *Anopheles* mosquito ingests parasitized erythrocytes along with its blood meal, the asexual forms of malaria parasite are digested. The gametocytes undergo further development in the midgut (stomach) of mosquito. The female gametocyte (macrogamete) is fertilized by the microgamete to form zygote. The zygote develops into a motile form called ookinete. It penetrates the epithelial lining of the mosquito stomach wall. It forms an oocyst within which numerous sporozoites are formed. The mature oocyst ruptures releasing sporozoites into the body cavity, from where some find their way to the salivary glands. The mosquito is now infective and when it feeds on humans, the sporozoites are injected into skin capillaries to initiate infection.



## Pathogenesis and Clinical Features

The disease process in malaria occurs due to local or systemic response of the host to parasite antigens. The typical symptoms of malaria is periodic bouts of fever with chills. When the mature schizont ruptures, releasing red cell fragments, merozoites, malaria pigments and other parasitic debris. It is commonly associated with severe headache, nausea, and vomiting.

Liver is enlarged and congested. Haemozoin pigments are found in the parenchymal cells. Spleen is soft, moderately enlarged, and congested in acute infection. In chronic infection, the spleen undergoes fibrosis and the sinusoids are dilated. Anaemia is caused by rupture of infected red blood cells. A decreased erythropoiesis in the bone marrow may also contribute to anaemia. Cerebral malaria is the most serious complication of *P. falciparum* infection.

Species / Stages	<i>P.falciparum</i>	<i>P.ovale</i>	<i>P.malariae</i>	<i>P.vivax</i>
Early Trophozoite				
Developing Trophozoite				
Mature Schizont				
Microgamete				
Macrogamete				

## Diagnosis

### 1. Microscopic examination (Gold standard)

Demonstration of malarial parasite in the peripheral blood in thin and thick smears. The thick smear is more sensitive and is used for detection of malarial parasite when there is low parasitaemia. Species identification is not easy in thick smear. Both thin and thick smears can be used to determine the parasitaemia level.

### 2. Rapid diagnostic tests (RDT)

The tests aid in the diagnosis of malaria by detecting malaria parasite antigens in human blood.

3. Molecular diagnosis  
PCR on blood.

### **Treatment**

In areas with chloroquine-susceptible infections, adults, and children are treated with either artemisinin-based combination therapy (ACT). In complicated malaria all patients with severe malaria should be treated with intravenous or intramuscular artesunate for at least 24 h or until they can tolerate oral medication.

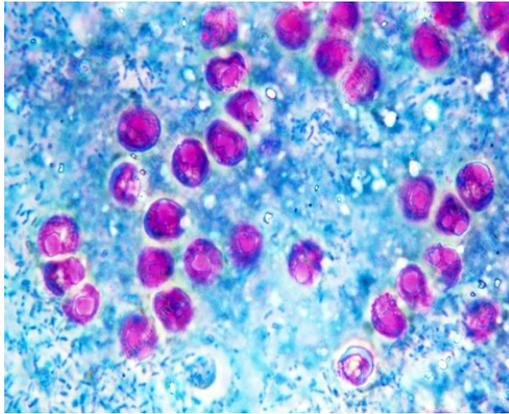
### ***Cryptosporidium parvum***

*Cryptosporidium parvum* inhabits the small intestine. It may also be found in stomach, large intestine and lungs. The infective form is the thick-walled oocyst. The oocyst is small, spherical, or oval shape. It contains four crescent shaped sporozoites (sporocysts not present). Oocyst does not stain with iodine stain, Modified acid fast stain is the method of choice for diagnosis this parasite and oocysts appear as pink color. The parasite completes its life cycle, sexual and asexual phases in a single host. Besides humans, the parasite can infect other animals. Sporulated oocyst is the infective stage to humans. This parasite can transmission through ingestion of food and water contaminated with oocysts or by direct contact with infected animals.

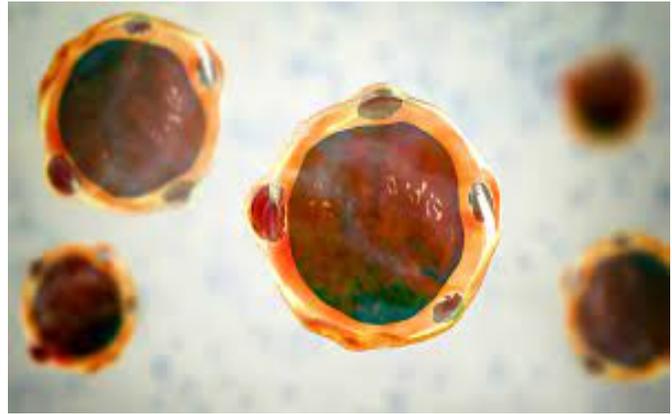
### **Other Intestinal Protozoa**

#### ***Blastocystis hominis***

*Blastocystis hominis* is an enteric parasite of humans and a wide variety of animals. Its geographic range is global. It is the causative agent of traveler's diarrhea, rectal bleeding, fever, and irritable bowel syndrome. The taxonomic status of the organism is still questionable but, according to studies it is considered a polymorphic protozoan in the stramenopile group of protists. Its life cycle includes four stages, **a vacuolated stage**, most commonly found in stool samples easily recognized and characterized by its large central vacuole, which pushes the cytoplasm and the nuclei (2-4) to the periphery, **amoeboid**, **precystic**, and **cystic stages**. Thick-walled cysts are passed out in the stool of infected human. Humans acquire infection via ingestion of contaminated water and food.



*Cryptosporidium parvum*



*Blastocystis hominis*

**Subkingdom: Protozoa**

**Phylum: Ciliophora**

**Class: Ciliates**

### *Balantidium coli*

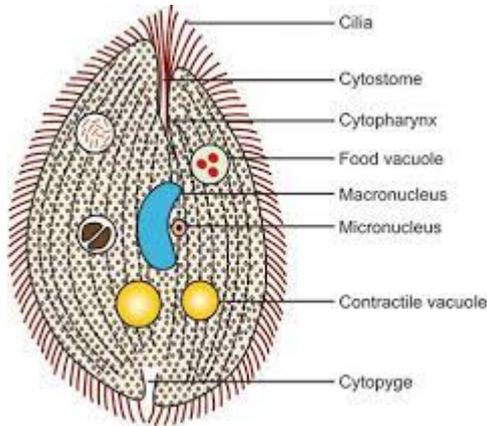
*Balantidium coli* resides in the large intestine of humans, monkeys and pigs.

#### **Morphology**

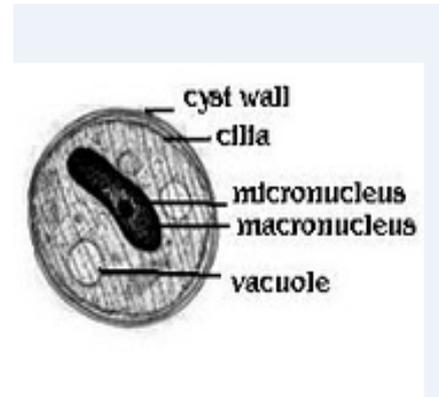
It is the largest intestinal protozoa of human. *Balantidium coli* exists in 2 stages-trophozoite and cyst.

- 1- The trophozoite stage:** is large, ovoid, measuring about 60–70  $\mu\text{m}$  in length and 40–50  $\mu\text{m}$  in breadth. There is presence of short cilia over the entire surface of the body. Its anterior end is narrow and posterior end is broad. At the anterior end, there is a groove (peristome) advancing to the mouth (cytostome) and a short funnel-shaped gullet (cytopharynx). Posteriorly, there is a small anal pore (cytopyge). The trophozoite has 2 nuclei—a large kidney-shaped macronucleus and a small micronucleus. The cytoplasm have tow contractile vacuoles which may lei side by side or one above the other and food vacuoles.

2- **The cyst stage:** is the infective stage of *B. coli*. It is spherical in shape, measuring 40–60 µm in diameter . It is surrounded by a thick double-layered wall. The cytoplasm is granular with presence of macronucleus, micronucleus and vacuoles.



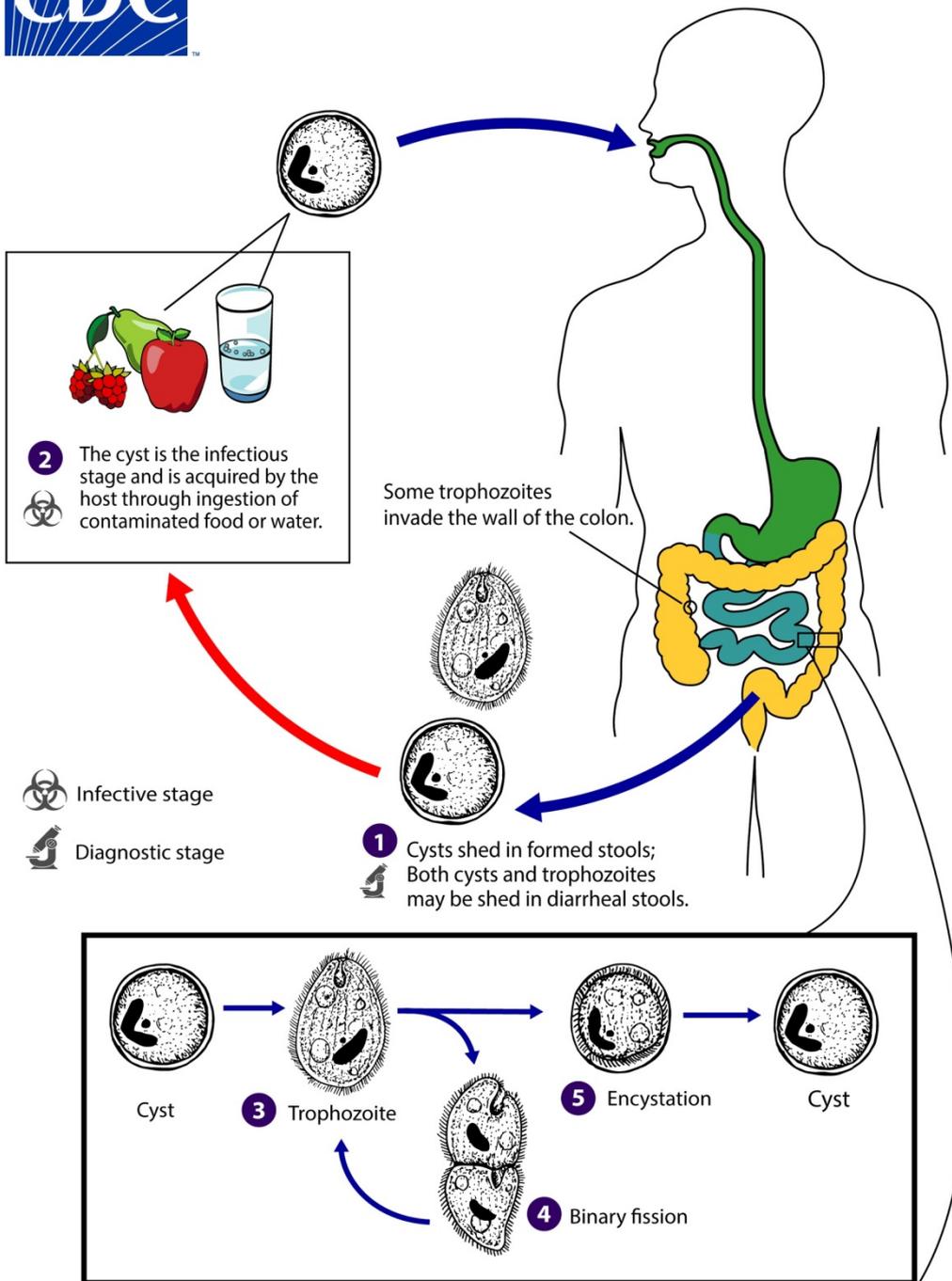
Trophozoite



Cyst

### Life Cycle

(1) Cyst is passed out in the stool of infected human. (2) Humans acquire infection by ingesting cyst through contaminated food or water. (3) In the intestine, the cyst undergoes excystation to release trophozoite. (4) The trophozoites divide by binary fission. (5) It encysts as it passes down the colon and is excreted in faeces. Trophozoites can be found in loose stools. *Balantidium coli* completes its life cycle in 1 host only. Infection is acquired from pigs and other animal reservoirs or from human carriers. Pig is its reservoir host. Balantidiasis is a zoonosis.



### **Pathogenesis and Clinical Features**

Most infections with *B. coli* are harmless, but rarely the trophozoite invade the mucosa and sub mucosa of the large intestine and initiate inflammatory reaction. This leads to mucosal ulcers. Unlike *E. histolytica*, *B. coli* infection does not involve extraintestinal sites. symptomatic disease resembles intestinal amoebiasis causing diarrhoea or dysentery with abdominal colic, nausea and vomiting.

### **Diagnosis**

#### 1. *Microscopic examination*

Detection of trophozoites and cysts in stool.

#### 2. *Biopsy*

When stool examination is negative, biopsy specimens and scrapings from intestinal ulcers can be examined for the presence of trophozoites.

### **Treatment**

Tetracycline is the drug of choice and doxycycline is an alternative drug. Metronidazole and nitroimidazole have been reported to be useful.