### Intestinal Protozoa

#### 1- Entamoeba Histolytica

<table>
<thead>
<tr>
<th>Morphology</th>
<th>Mode of infection</th>
<th>The Life Cycle</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Trophozoite Form</td>
<td>Contaminated stuff with human stool containing mature cysts.</td>
<td>1- Ingestion of the cyst (the infectious form).</td>
<td>- Worldwide distributed, more common in poor sanitary conditions.</td>
</tr>
<tr>
<td>(Vegetative form / tissue form).</td>
<td>2- Handling food through infected food handlers as cooks and waiters.</td>
<td>2- Excystation, to produce Trophocytes.</td>
<td>- Inhabit the L. intestine.</td>
</tr>
<tr>
<td>2- Cyst Form</td>
<td>3- Flies and cockroaches.</td>
<td>3- The Trophocytes multiply to produce 4 cysts.</td>
<td>- D.H: Man</td>
</tr>
<tr>
<td>(Luminal form),</td>
<td>4- Autoinfection (faeco-oral or hand to mouth infection).</td>
<td>4- Cysts go to the site of infection.</td>
<td>- R.H: Dogs, pigs, rats and monkeys.</td>
</tr>
<tr>
<td>small and circular,</td>
<td></td>
<td></td>
<td>- Causes: Amoebiasis (amoebic dysentery).</td>
</tr>
<tr>
<td>can be:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a- Immature cyst,</td>
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<tr>
<td>which can be either</td>
<td></td>
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<tr>
<td>Uninucleate cyst</td>
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<tr>
<td>with one nucleus, or</td>
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<tr>
<td>Binucleate cyst with 2 nuclei.</td>
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<tr>
<td>b- Mature cyst,</td>
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<tr>
<td>(Quadri-nucleate cyst)</td>
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</table>

#### 2- Giardia Lamblia

<table>
<thead>
<tr>
<th>Morphology</th>
<th>Pathogenesis</th>
<th>Transmission</th>
<th>Life Cycle</th>
<th>Clinical Aspects</th>
<th>Diagnosis</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Trophozoite (active)</td>
<td>- Usually weak pathogens.</td>
<td>- Fecal-oral route with the ingestion of cysts</td>
<td>1- Ingestion</td>
<td>- Varies from asymptomatic carriage to severe diarrhea and mal-absorption.</td>
<td>To detect Giardia antigen:</td>
<td>Quinacrine &amp; Metronidazole, Tinidazole, Furazolidone, paromomycin</td>
</tr>
<tr>
<td></td>
<td>- Large numbers of parasites cause irritation, low-grade inflammation of the duodenal or jejunal mucosa, with acute or chronic diarrhea, associated with epithelial cell damage.</td>
<td>- Personal contact with animals like beavers, oral–anal sex and man to man sex.</td>
<td>2- Excystation in small intestine. (cyst $\rightarrow$ 2trophozoite)</td>
<td></td>
<td>1- Immunologic enzyme-linked immunoassays (EIAs).</td>
<td></td>
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<tr>
<td></td>
<td>- Swaying/ dancing motion</td>
<td></td>
<td>3- Trophozoite undergoes binary fission.</td>
<td></td>
<td>2- Immune-fluorescence microscopy</td>
<td></td>
</tr>
<tr>
<td>2- Cyst (inactive)</td>
<td>- Found in stool</td>
<td></td>
<td>4- Encystation.</td>
<td></td>
<td>To detect Giardia:</td>
<td>Trichrome stain of preserved stool.</td>
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<td></td>
<td>- Ellipsoid, thick walled and highly resistant to chlorinated water.</td>
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<td></td>
<td>- Mature: 4 nuclei Immature: 2 nuclei</td>
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</tbody>
</table>

To detect Giardia antigen: 1- Immunologic enzyme-linked immunoassays (EIAs).
### 3- Cryptosporidium

<table>
<thead>
<tr>
<th>Morphology</th>
<th>Pathogenesis</th>
<th>Transmission</th>
<th>Life Cycle</th>
<th>Clinical Aspects</th>
<th>Diagnosis</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Small spherical structures arranged along the line of epithelial cells inhabiting the surface of villi of the lower small bowel.</td>
<td>- Usually asymptomatic and transient.</td>
<td>- Contact with contaminated water and food.</td>
<td>- Completes its life cycle within a host, including its asexual and sexual reproductive cycles.</td>
<td>- Immuno-competent patients: asymptomatic infection or self-limited watery diarrhea</td>
<td>- Detection of oocysts in fresh stool samples: Acid fast stain.</td>
<td>Nitazoxanide</td>
</tr>
<tr>
<td>- Acid-fast staining</td>
<td></td>
<td></td>
<td>- They are immediately infectious.</td>
<td></td>
<td>- Stool antigen detection: Direct fluorescent antibody or EIA tests.</td>
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<tr>
<td>- Infective stage of Cryptosporidium is called Sporulated oocyst.</td>
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#### 4- Cyclospora

<table>
<thead>
<tr>
<th>Life cycle</th>
<th>Clinical Aspects</th>
<th>Diagnosis</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Similar to the Cryptosporidium and appears to involve only a single host.</td>
<td>Causes altered mucosal architecture with shortening of intestinal villi due to diffused edema and infiltration of inflammatory cells which leads to diarrhea, anorexia, fatigue, and weight loss.</td>
<td>Examining stools for oocysts which are acid-fast positive (reddish color).</td>
<td>Trimethoprim-sulfamethoxazole (TMP-SMZ).</td>
</tr>
<tr>
<td>- Main difference is that Cyclospora oocysts are not immediately infectious when freshly passed in stools, so person to person transmission is uncommon.</td>
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</tbody>
</table>
### 5- Balantidium coli

<table>
<thead>
<tr>
<th>Morphology</th>
<th>Clinical Aspects</th>
<th>Treatment</th>
</tr>
</thead>
</table>
| - The **largest** intestinal protozoa of humans.  
- The trophozoite stage is a **ciliated oval organism.**  
- It rotates around a long axis motion (**Rotary motility**). | - It causes **Balantidiasis** (Balantidium dysentery).  
- Most infections are **harmless**. However, rarely, in acute outbreaks the trophozoites invade the **large bowel** and terminal ileum causing **erosions** and **ulceration.**  
- Some trophozoites invade the wall of the **colon** and multiply, leading to the presence of mucous and **blood in the stool.** | **Oxytetracycline**, which may be followed by **Iodoquinol** or **Metronidazole.** |

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### End on Intestinal Protozoa

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### Sexually Transmitted Protozoa, Trichomonas

<table>
<thead>
<tr>
<th>General characteristics</th>
<th>Diagnosis</th>
<th>Treatment</th>
</tr>
</thead>
</table>
| - **Flagellated** protozoa with 3-5 anterior flagella. | - In most symptomatic cases, **wet mount** examination for motile trophozoites is enough.  
- There is **no** Cyst stage within Trichomonas, so we depend on **Trophozoites** for diagnosis. | - **Topical** and **systemic** Metronidazole.  
- **Tinidazole** and **Ornidazole** are equally effective with fewer side effects.  
- These drugs belong to (Nitroimidazoles) family. |

**There are three members of the genus Trichomonas that parasitize humans:**

1. **Trichomonas Hominis:** parasitize the **intestine.**  
2. **Trichomonas Tenax:** parasitize the **mouth.**  
3. **Trichomonas Vaginalis:** Parasitize the **Vagina** in **females** causing low-grad inflammation limited to vulva vagina and cervix, causing vaginitis with frothy yellow or creamy discharge, while in **males** in parasitizes the **prostate, seminal vesicle and Urethra**
   - Trichomonas vaginalis cause **trichomoniasis** in humans.
   - It is **pear-shaped** with undulating membrane (which enhances motility of the parasite in a viscous fluid, such as blood) lined with a flagellum and 4 anterior flagella.
   - It moves with wobbling or **rotating motion**
   - Direct contact of T-vaginalis with the squamous epithelium of the genitourinary tract results in:
     a) Destruction of the involved epithelial cells.
     b) Development of a neutrophilic inflammatory reaction.
     c) Petechial hemorrhages (tiny pinpoint red mark).
     d) Pain during urination (dysuria) or sexual intercourse.
   - It is a sexual transmitted disease (STD) but sometimes, nonvenereal transmission can occur (non-sexual transmission) for example babies can get infected as they move through the birth.
# Blood and Tissue Protozoa

## 1- Hemoflagellates

- They are invasive either in **tissues** or in the **blood**. They produce highly **morbid**, and **lethal** diseases. They usually need **I.H (Vectors)**.
- Hemoflagellates have several morphologic forms:
  - a) **Amastigote** (rounded form): Found in intracellular Environments (Tissues)
  - b) **Epimastigote** and **Promastigote**: Found in insect hosts
  - c) **Trypomastigote**: Found in mammalian Bloodstream

### African Trypanosoma

- **Vector**: tsetse fly (Glossina species), Which is found only in rural Africa:
  - a) *Glossina palpalis* transmits → *Trypanosomiasis brucei gambiense.*
  - b) *Glossina morsitans* transmits → *Trypanosomiasis brucei rhodesiense.*

- Tsetse flies of **both sexes** transmit pathogenic African trypanosomes (if we compare it to malaria, only female anopheles mosquito can transmit the disease). A bite by the tsetse fly is often **painful** and can develop into a red sore (**Chancroid**) then **parasitemia** occurs and the infection invades the CNS.
- Tsetse fly bites humans and inoculates parasites that are found in its **saliva**.
- The infection leads to **Insomnia at night**, and **Sleepiness** during the **day**.
- The African trypanosomes shows two morphologic forms: **Trypomastigote** and **Epimastigote**.
- The African trypanosomes only attach to **RBCs**, without invading them, unlike malaria, which invades RBCs.
- **West** African Trypanosomiasis causes **slowly** developing **chronic** disease, while **East** African Trypanosomiasis causes **acute** disease.

### American Trypanosoma

- **Vector**: Reduviid bugs (also called Triatome bugs, kissing bugs). Causes zoonotic disease.
- It has 3 **developmental stages**:
  1. **Epimastigote**, Inhabits insects.
  2. **Trypomastigote**, Inhabits the bloodstream.
  3. **Amastigotes**, inhabits tissues. It is usually found in heart, liver and brain, so it’s a serious infection
- **D.H**: Humans, dogs, cats and rat.
- **Reduviid bug** defecates near wounds while taking a blood meal, then a **chagoma** forms (an inflammatory nodule at the bite site of the reduviid bug).

### Leishmania

- It is **flagellated**, obligate **intracellular** protozoa.
- Life cycle requires **two hosts**: a) **Vertebrate**; mammalian host  b) **Invertebrate** vector; female sand fly.
- Infects primarily **phagocytic** cells and **macrophages**.
- Transmission occurs through: 1. **Bite** of sand fly.  2. **Transfusion** blood and transplantation.  3. **Mother to baby**.  4. **Direct contact**; from man to man through nasal secretion.
Leishmaniasis is divided into clinical syndromes according to what part of the body is affected most:

1. Cutaneous Leishmaniasis it is also called (Baghdad boil, oriental sore), caused by (L. Tropica) and (Leishmania major). Leishmania major is the most common type in Jordan especially in areas near to Al Aqaba city.
2. Mucocutaneous leishmaniasis is caused by (L. Braziliensis).
3. Visceral Leishmaniasis (black fever, kala-azar), caused by (L. Donovani).

2- Plasmodium (Blood Sporozoa)

- Cause malaria in their hosts. The parasite always has two hosts in its life cycle: Dipteran insect host and a vertebrate host.
- The life cycle of Plasmodium can be divided into two distinct phases: 1- The asexual cycle (schizogony), in vertebrate hosts e.g. humans.
  2- The sexual cycle, in insect e.g. mosquitoes.
- The vector for malaria is the female anopheline mosquito.

<table>
<thead>
<tr>
<th>Types</th>
<th>Mechanism of infection</th>
<th>Diagnosis</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. P. Malaria:</td>
<td>1. The vector mosquito takes a blood meal.</td>
<td>To determine which type of plasmodium is causing the disease: 1- Thick and thin blood films, 200 - 300 oil immersion fields.</td>
<td>1- Quinolines (e.g. Chloroquine): Used for all types except for P. falciparum infections due to acquired resistance, they are treated using combination therapies.</td>
</tr>
<tr>
<td>Causes quartan fever, recur (occur again) every 72 hours or every fourth day (at three-day intervals). Also causes classical malaria in humans</td>
<td>2. Sporozoites, in the saliva of the Mosquito, are discharged into the punctured wound.</td>
<td>2- Blood is collected using EDTA anticoagulant.</td>
<td>2- Primaquine Treats Hypnozoites.</td>
</tr>
<tr>
<td>2. P. vivax:</td>
<td>3. Within an hour, infective sporozoites are carried via the blood to the liver.</td>
<td>3- Giemsa stain, Wright’s stain, Fluorescent nucleic acid stains, such as acridine orange are used.</td>
<td>3- Artemisinin.</td>
</tr>
<tr>
<td>The most frequent and widely distributed cause of malaria. Cause tertian fever, recur every 48 hours or every third day (two-day intervals).</td>
<td>4. They penetrate hepatocytes and begin to grow, initiating the pre-erythrocytic or primary exoerythrocytic cycle. The parenchyma cells of the host become infected before RBCs. Exoerythrocytic cycle: is the developmental stage of the malaria parasite in liver.</td>
<td>Or we use antigen-antibody detection.</td>
<td>4- Tetracycline, doxycycline, and clindamycin.</td>
</tr>
<tr>
<td>3. P. Ovalle:</td>
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<tr>
<td>Relatively uncommon. Also causes tertian fever.</td>
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**4. P. Falciparum:**

Major species associated with **deadly infections** throughout the world. It causes **malignant fever** which recurs every 48 hours but with more severe symptoms, the temperature can reach more than 42 degrees affecting the **brain** and cerebral cortex.

**5. P. Knowlesi:**

It causes **malaria** in monkeys and can infect human as well.

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5. The sporozoites become round/oval and begin **dividing** repeatedly. Schizogony results in large numbers of **exoerythrocytic merozoites** (a small ameboid trophozoite).

6. Once these merozoites leave the liver, they invade the **RBCs**, this mark the end of the exoerythrocytic cycle, initiating the **erythrocytic cycle** (Infection of RBCs).

7. Once the RBCs and reticulocytes (immature red blood cell) have been invaded, the parasites grow and feed on **hemoglobin**.

8. Within the RBC, the merozoite (or young trophozoite) becomes **vacuolated**, ring shaped, ameboid, and **uninucleate**.

9. Merozoites progress into **mature trophozoites**. Once the nucleus begins to divide, the trophozoite is called a developing schizont (contains many merozoites, which rupture releasing merozoites into the bloodstream).

10. The excess protein and hematin present from the metabolism of hemoglobin (hemolytic anemia) combine to form malarial pigment.

These drugs are classified into the following, according to the stage of **malarial growth that they target**:

1. **Tissue schizonticides**: kill tissue schizonts.

2. **Blood schizonticides**: kill blood schizonts.

3. **Gametocytocides**: kill gametocytes.

4. **Sporonticides**: prevent formation of sporozoites within the mosquito, inhibiting the life cycle of malarial parasite.

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**Tissue protozoa** (cysts of parasites in tissues are called bradyzoites)

**Toxoplasma Gondii**

- It is **coccidian** protozoa with **worldwide** distribution that infects wide range of animals and birds but **does not** appear to cause disease in them.

- The only host of which the oocyst-producing sexual stage of toxoplasma can develop are strictly the **cats and their relatives**.

- When oocysts are ingested, they either repeat their sexual life cycle in a **cat**, or if ingested by a **human** they can establish an infection in which it can reproduce **asexually**, where it opens and releases sporozoites to the duodenum then invade various cells especially **macrophages** where they form tachyzoites which spread infection to lymph nodes and other organs.

- **Latent infections** occur with Toxoplasma.

- It produces either **congenital** or **postnatal toxoplasmosis**. Congenital infections occur in **non-immune mothers** during pregnancy.
**Major Points**

- **E. Histolytica**: Causes Amoebiasis

- **Balantidium Coli**: Largest intestinal Protozoa, causes Balantidiasis and has a rotary motility.

- **G. Lamblia**: Swaying/Dancing motion. Infection Varies from asymptomatic carriage to severe diarrhea and mal-absorption.

- **Cyclospora & Cryptosporidium**: Single host & Acid-Fast staining

- **Cryptosporidium**: self-limited, mild gastroenteritis and diarrhea.

- **Cyclospora**: Altered mucosal architecture, diarrhea, anorexia, fatigue, and weight loss.

- **Sexually Transmitted Protozoa**: Trichomonas.

- **African Tryp. →** Tsetse fly, causes Insomnia and sleeplessness.

- **American Tryp. →** Reduviid Bugs, forms chagoma.

- **Trichomonas Vaginalis**: Causes Trichomoniasis

- **Toxoplasma Gondii**: Causes Toxoplasmosis

- **P. Malaria**: Quartan fever and classical Malaria.  
  **P. Vivax**: Most freq. and causes tertian fever.

- **P. Ovalle**: Uncommon, causing tertian fever.  
  **P. Knowlesi**: Malaria in monkeys.

- **P. Falciparum**: Causes major deadly infections and malignant fever.