Toxoplasmosis:

*Toxoplasma Gondii* has two cycles of reproduction; sexual, in the primary host, and asexual, in the intermediate host (opposite to malaria).

The primary host is the domestic cats or any other member of the feline family. While the intermediate host is ubiquitous (doesn't have a specific intermediate host. It could be human beings, rats, mice, pigs, etc). - It is not tissue specific (can infect any cell (neurons, myocytes ...etc)). (While malaria can only infect blood cells).

**Morphology:** It is a quiet small (1 micron) intracellular, pear-shaped, protozoan.

**Multiplication** of this organism is peculiar; it doesn't divide by binary fission. It divides by a process called *Endodyogeny*, in which the nucleus divides and the two daughters develop internally within the mother cell.

**Life Cycle:**

**Sexual:** When a cat (primary host) gets infected by ingestion of cysts in raw meat (e.g., mice). Bradyzoites are released from the cysts in the small intestine, infect the mucosal cells and differentiate into male (microgametocytes) and female (macrogametocytes) gametocytes, whose gametes fuse to form oocysts (the zygote). Oocysts divide into two oocysts (each contains four sporozoites) that are excreted in cat feces.

**Asexual:** when a mouse (intermediate host) ingests these feces, the cysts rupture and release sporozoites that invade the gut wall and then distribute all over the body (it’s not tissue specific). Within the host cells, sporozoites differentiate into rapidly multiplying trophozoites (tachyzoites), which will kill the cells and infect other cells. Cell-mediated immunity usually limits the spread of tachyzoites, and the parasite enter host cells in the brain, muscle, and other tissues, where they develop into cysts in which the parasites multiply slowly (bradyzoites). These bradyzoites are the ones which are going to transmit the infection to another primary host.

- When another primary host ingests these cysts, bradyzoites are released and transformed into:
  a) Trophozoites within cat cells.
  b) Gametocytes which will fuse to form oocyst that are going to be excreted in cat feces.
**Human Infection:**

Humans are accidental intermediate hosts and they are dead end hosts. Human infection usually occurs from ingesting oocysts from cat feces or from eating undercooked meat (e.g., lamb and pork (intermediate hosts)) from animals that grazed in soil contaminated with infected cat feces.

The infection is very common (up to 70% of the population is infected) but the disease itself is very rare. Wherever there are cats there is toxoplasmosis. The only places where you wouldn’t find toxoplasmosis are probably some islands where there are no cats at all.

**Diagnosis:**

We can’t look up for the cysts all over the body so we look up for antibodies against toxoplasma antigen (serology).

The two instances when we have a disease are:

1) **Congenital toxoplasmosis** from the mother to the fetus (transplacental). Occurs only when the mother is infected during pregnancy for the first time. If the mother is infected during pregnancy and has immunity from a previous infection, she will not transmit the organism to her child. Because of that, pregnant women must avoid cats. It could cause abortions and congenital malformations. The earlier the infection the more severe it is and the first trimester is the most dangerous. It could affect the eyes of the fetus leading to blindness or the CNS leading to loss of motor or sensory functions.

   If we suspect toxoplasmosis in an infant, we should perform a serological test. IgM is used to diagnose congenital infection (in utero infection), because IgG can be maternal in origin (previous infection).

2) In immunocompromised patients whether infected for the first time or sometimes people with AIDS may have reactivation of a previous infection and the main tissue affected is the CNS.

**Trypanosoma:**

**Morphology:** Trypanosoma has two morphs:

- **Trypomastigote:** in the primary host which is the human being or any other animal.
- **Epimastigote:** in the intermediate host.

The difference between them is in their undulating membranes (projection of plasma membrane that undulates causing some movement to the protozoan). It either extends the whole length in trypomastigote or only in the anterior aspect in epimastigote.

- Flagellum.
- Kinetoplast (a dense granule of DNA within a large mitochondrion at the base of the flagellum).
Life Cycle:

1) African Trypanosomiasis: Trypanosoma gambiense and Trypanosoma rhodesiense:
the morphology and life cycle of these two species are similar and their intermediate host is the tsetse fly that causes sleeping sickness.

- Trypanosoma rhodesiense: in relation to a country called Rhodesia in east Africa (Zimbabwe).
- Trypanosoma gambiense: in relation to a country called Gambia in west/central Africa.

They are somehow similar but in trypanosoma rhodesiense, humans are the primary host and other animals could get infected (e.g., cows, deers). Trypanosoma rhodesiense is a zoonosis; meaning there is an animal reservoir. It causes an economical disease because it kills the infected animals (cows). While trypanosoma gambiense, there is no reservoir (some books say it has a reservoir which is the small pigs).

When the Tsetse fly bites a human, it injects the trypomastigote (rhosiense or gambiense) into the skin. Then, trypomastigotes spread from the skin through the blood to lymph nodes. And For the first few months, they produce a disease which is constitutional in nature (intermittent fever, the patient feels a bit unwell, and cervical lymph nodes are swollen and this is a distinctive diagnostic sign known as winterbuttom’s sign). If the infection is not treated around this stage, there will be further invasion of the CNS and the patient will become detached from his environment, becomes lazy and sleeps a lot. Eventually he goes into coma and dies. At this stage, when the CNS is involved, there is no treatment but it could be treated if detected earlier.

- Trypanosoma gambiense usually reaches sleeping sickness stage after one year (longer duration and less severe).
- Trypanosoma rhodesiense is more sever and reaches the same stage within few months and the patient will die within one year if not treated.

Diagnosis:

Blood smear or CSF smear and you look for the trypomastigotes.

Its intermediate host is the kissing bug (reduviid bug). These bugs bite but don’t inject *trypanosoma cruzi*. They defecate as they feed, and the victim often scratches the area allowing feces contaminated with *trypanosoma* to enter. At the site of entry you will get swelling known as Chatom (an inflammatory nodule at the bite site of the reduviid bug which transmits chagas disease). Then those trypomastigotes invade cells (muscle cells, liver cells, heart cells and neurons) and become intracellular (amastigotes, nonflagellated). Amastigotes rupture the cells and transform into trypomastigotes that either are taken from the blood by the kissing bug or those trypomastigotes can infect other cells and form intracellular amastigotes. The patient may feel unwell but usually they recover. When they recover, individuals enter the chronic stage (having the infection without symptoms). After 20-40 years, less than 5% may have symptoms (*Chagas disease*). The amastigotes can kill cells and cause damage to the neurons of the myenteric plexus resulting in loss of tone (paralysis of the smooth muscles) in the esophagus (megaesophagus) and colon (megacolon). The patient will suffer from difficulty in swallowing and constipation but usually patients die because of the involvement of the heart (cardiac muscle is the most frequently and severely affected tissue) that affects the conductive system of the heart and results in arrhythmias.

**Diagnosis:** by looking for the trypomastigotes in the blood (not amastigotes (intracellular)).

**Cysticercosis:** tapeworms were discussed in previous semesters. Tapeworms are very specific. They develop in certain intermediate hosts. (*T. solium*: pigs, *T. Saginata*: cows, *diphyllobothrium latum*: fish). Except in the case of *T. solium*, which is able to use the human being as an intermediate host (dead end hosts). May be because there are some similarities in the tissues of humans and pigs. This means that if you eat the eggs of *T. solium*, the eggs will disintegrate and release their hexacanths which can develop into cysticerci (invaginated rudimentary scolex) that can give rise to inflammatory reaction (*Cysticercosis*). This disease is only found in endemic areas and it’s very rare in Jordan because we don’t eat pigs. Muscles and skin may be involved and swollen (or calcified) because of the presence of these tender and painful cysticerci.

These cysticerci may involve the brain and produce motor or sensory deficits, convulsions, or focal epilepsy. So the appearance of epilepsy in adults for the first time without history of brain injury in an endemic area may be because of *Cysticercosis*. These cysticerci may also involve the eyes resulting in destruction of the retina and partial scotoma (partial alteration in the visual field area).

**Transmission:** either by eating the eggs or if someone already have the worm and eats something contaminated with his own feces. **Diagnosis** is based on history and brain CT scan.