Lesson 1

Pathologic Protozoa

CHARACTERISTICS OF PROTOZOA

1. Unicellular
2. Chemoheterotrophs (get their energy by breaking down organic matter).
3. Most ingest their food; thus, they have special structures for this.

CHARACTERISTICS OF PROTOZOA

4. The vegetative form is the TROPHOZOA (tropho = movement; zoite = animal; they move like an animal). Trophozoa have special organelles for movement.
5. Capable of reproduction
   A. Asexual: fission, budding, or schizogony
      (produces a large number of trophozoites)
   B. Sexual: conjugation

CHARACTERISTICS OF PROTOZOA

6. Some produce cysts.

These are not tissue cysts like a human gets under their skin; protozoa cysts are cellular.

They have a thick cell wall that allows for survival in harsh environments better than the trophozoite form.

TERMS: Host Types

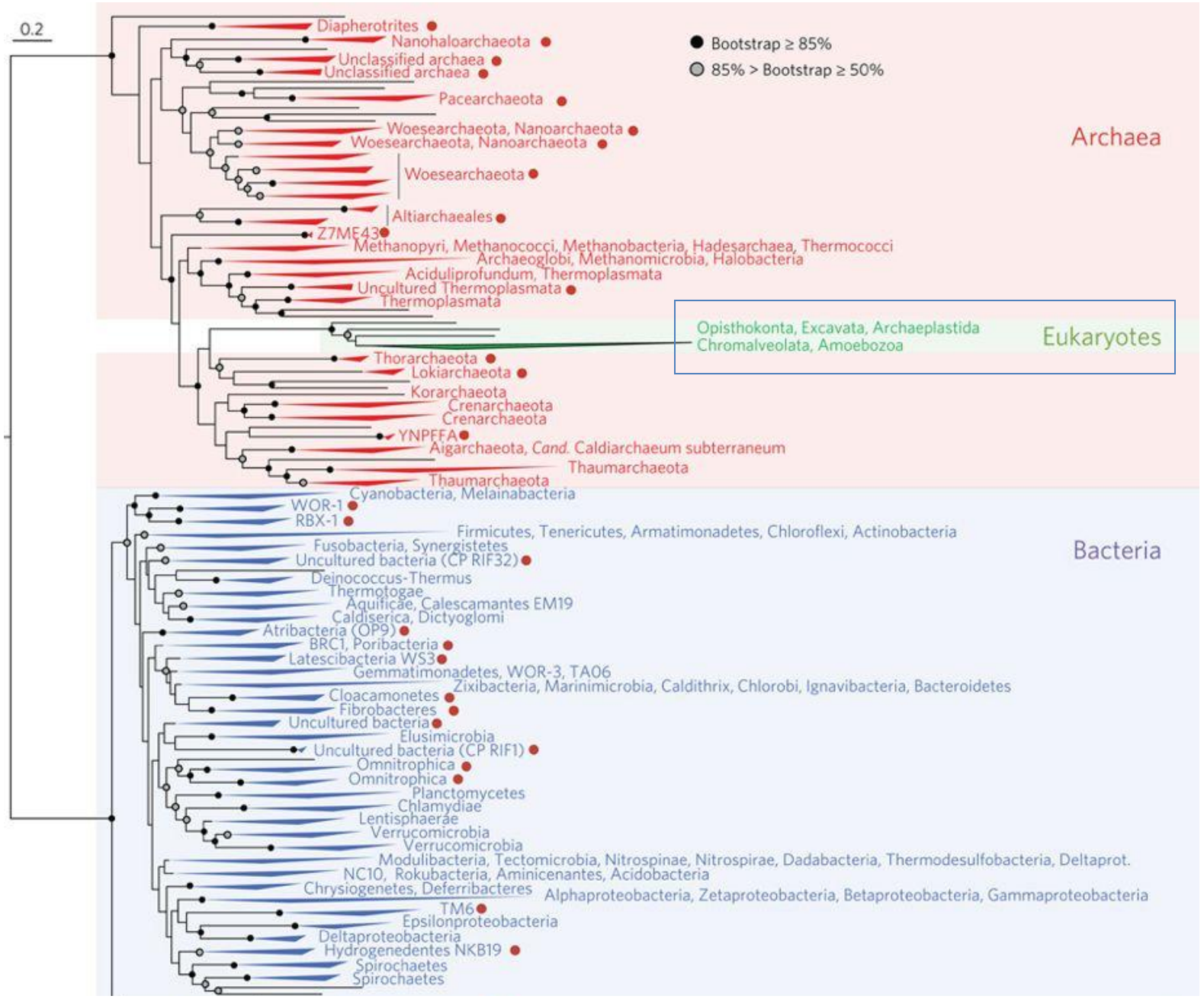
- The **definitive host** is the one in which the parasite completes its sexual life cycle.
- For instance, in *Plasmodium*, the definitive host is the tropical mosquito *anopheles*.
- The **intermediate host** is the human.

TERMS: Host Types

- Its sexual life cycle also starts in the human, so that can be confusing.
- What happens is the sporozoite form enters the bloodstream when the mosquito bites the human.
- First it begins its asexual reproduction, but if two mosquitoes inject one male and one female gametocyte into the human, there can be a sexual life cycle in the human as well.

TERMS

- **Trophozoite:** any stage in a protozoa's life cycle which can ingest food. In practice it refers to the motile form (pseudopods, cilia, flagella).
- **Cyst:** Non-motile form, protected by a membrane. *infective stage*
- **Excystation:** process of emergence of the trophozoite from the cyst.
- **Pseudopod:** "false foot" temporary cytoplasmic process at the surface of the trophozoite.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Bootstrap ≥ 85%
85% > Bootstrap ≥ 50%
Archaea
Eukaryotes
Bacteria
Diapherotrites
Nanohaloarchaeota
Unclassified archaea
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Woesearchaeota
Altiarchaeales
Z7ME43
Methanopyri, Methanococci, Methanobacteria, Hadesarchaea, Thermococci
Archaeoglobi, Methanomicrobia, Halobacteria
Aciduliprofundum, Thermoplasmata
Uncultured Thermoplasmata
Thermoplasmata
Opisthokonta, Excavata, Archaeplastida
Chromalveolata, Amoebozoa
Thorarchaeota
Lokiarchaeota
Korarchaeota
Crenarchaeota
Crenarchaeota
YNPFFA
Aigarchaeota, Cand. Caldiarchaeum subterraneum
Thaumarchaeota
Thaumarchaeota
Cyanobacteria, Melainabacteria
WOR-1
RBX-1
Firmicutes, Tenericutes, Armatimonadetes, Chloroflexi, Actinobacteria
Fusobacteria, Synergistetes
Uncultured bacteria (CP RIF32)
Deinococcus-Thermus
Thermotogae
Aquificae, Calescamantes EM19
Caldiserica, Dictyoglomi
Atribacteria (OP9)
BRC1, Poribacteria
Latescibacteria WS3
Gemmatimonadetes, WOR-3, TA06
Zixibacteria, Marinimicrobia, Caldithrix, Chlorobi, Ignavibacteria, Bacteroidetes
Cloacamonetes
Fibrobacteres
Uncultured bacteria
Elusimicrobia
Uncultured bacteria (CP RIF1)
Omnitrophica
Omnitrophica
Planctomycetes
Chlamydiae
Lentisphaerae
Verrucomicrobia
Verrucomicrobia
Modulibacteria, Tectomicrobia, Nitrospinae, Nitrospirae, Dadabacteria, Thermodesulfobacteria, Deltaprot.
NC10, Rokubacteria, Aminicenantes, Acidobacteria
Chrysiogenetes, Deferribacteres
Alphaproteobacteria, Zetaproteobacteria, Betaproteobacteria, Gammaproteobacteria
TM6
Epsilonproteobacteria
Deltaproteobacteria
Hydrogenedentes NKB19
Spirochaetes
Spirochaetes

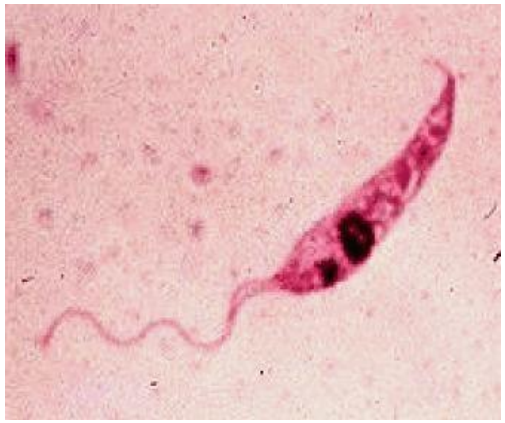
Phylum Euglenozoa

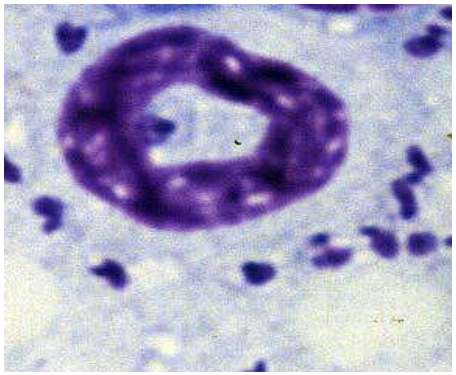
MASTIGOPHORA DISEASES

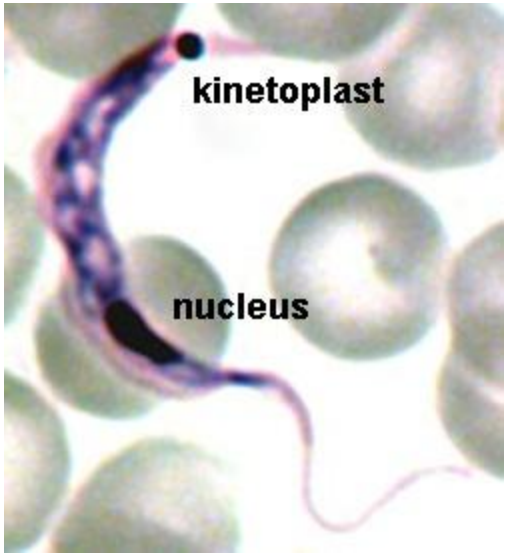
- Trypanosomiasis
- Leishmaniasis

TERMS

- Mastigote = flagella
- Promastigote: has single flagella
- Amastigote: has no flagella
- Kinetoplast: round mass of circular DNA







Phylum Euglenozoa

Class Kinetoplastea

Order Trypanosomatida

Family Trypanosomatidae

Genus *Trypanosoma*

Trypanosomiasis

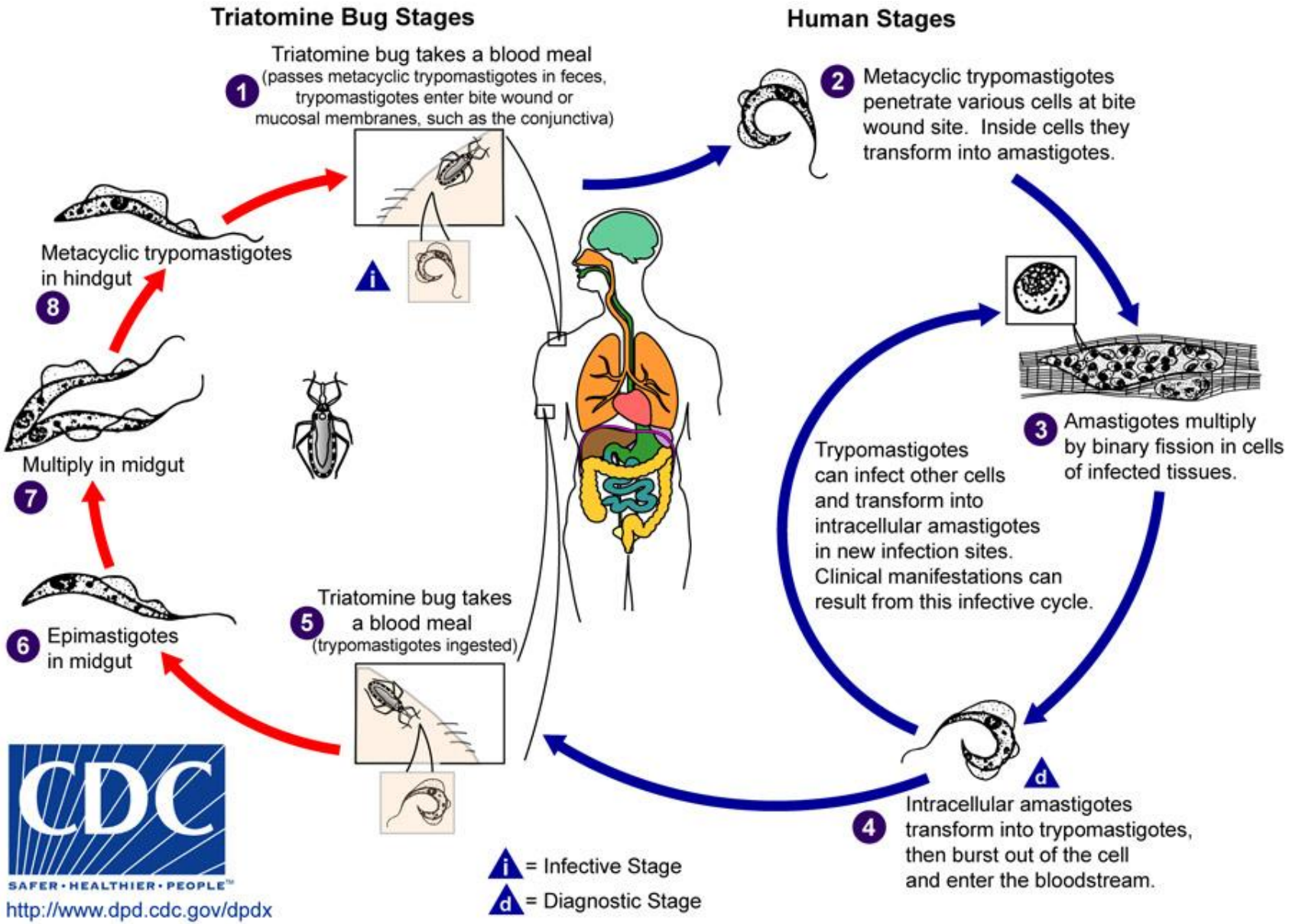
- African Trypanosomiasis
  - (African Sleeping Sickness)
- American Trypanosomiasis
  - (Chaga's Disease)

“African Sleeping Sickness”

- **Disease:** African Tryptanosomiasis

- **Causal Agents:**
  - *Trypanosoma brucei gambiense*
  - *Trypanosoma brucei rhodesiense*

Trypanosoma life cycle



Geographic Distribution

- *T. b. gambiense* is found in foci in large areas of West and Central Africa.
  - Humans are the main reservoir for *Trypanosoma brucei gambiense*, but this species can also be found in animals.
- *T. b. rhodesiense* is found in East and Southeast Africa.
  - Wild game animals are the main reservoir of *T. b. rhodesiense*.

Trypanosomiasis

- Trypanosomiasis has a biological vector, the tsetse (pronounced “set-see”) fly.
- Wild animals may also be a reservoir (Zooinotic is when a disease is transmitted to animals as well as humans.)

Trypanosomiasis

- The tsetse fly bites a human and injects the trypanomastigotes into the skin.
- This causes a chanchre (pronounced “shanker”), which is an ulcer on the skin.
- Then it enters the lymphatic system.

Trypanosomiasis

- It is characterized by Winterbottom's Sign: swelling of the cervical lymph nodes in the head and neck area.
- CNS symptoms include a shuffling gait (like a stroke victim), slurred speech, and malaise (needing to sleep longer and longer each day).
- They are also restless at night.

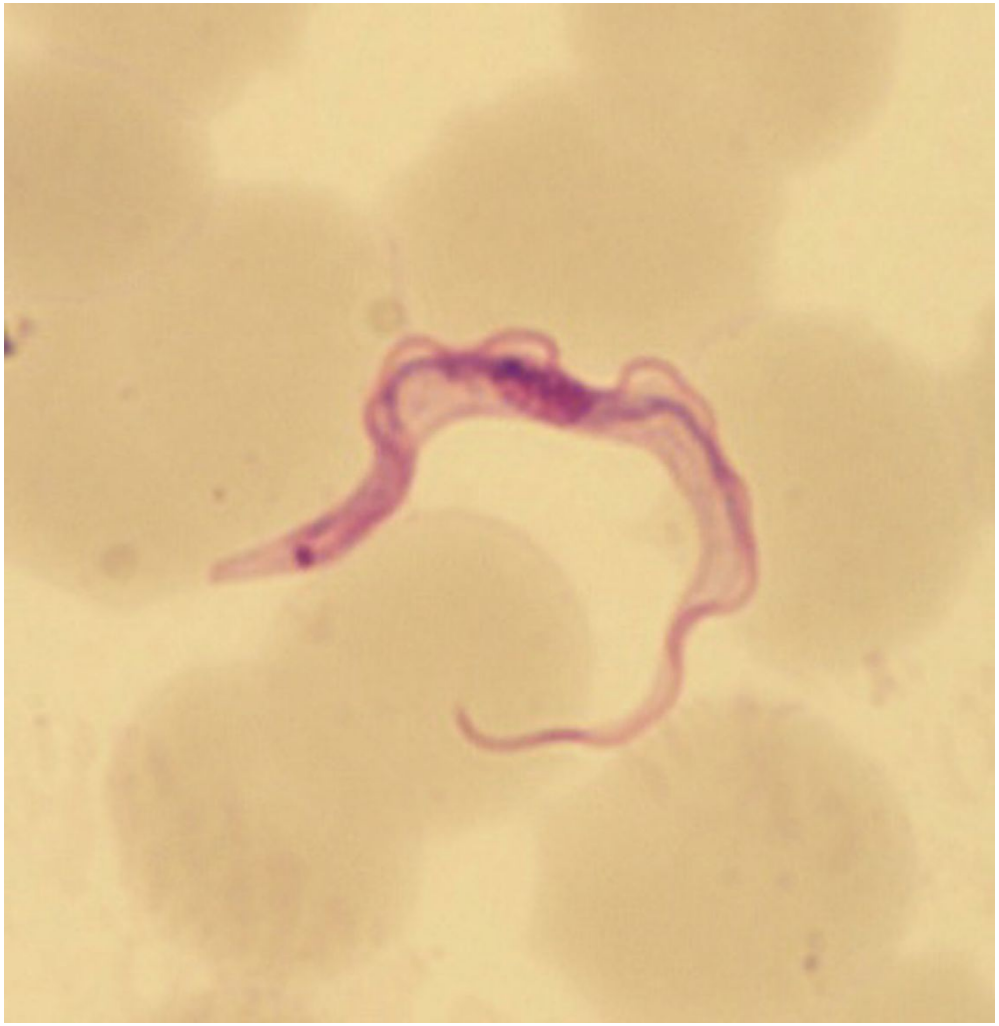
Trypanosomiasis

- CNS symptoms
  - Shuffling gait
  - Slurred speech
  - Malaise (sleeping all day)
- Treatment
  - Melarsoprol: which has dangerous side-effects like chemostherapy. This drug requires administration with a substance called ethylene glycol, which will break down regular plastic tubing, so the drug must be administered with **special plastic iv tubing.**

Trypanosoma brucei

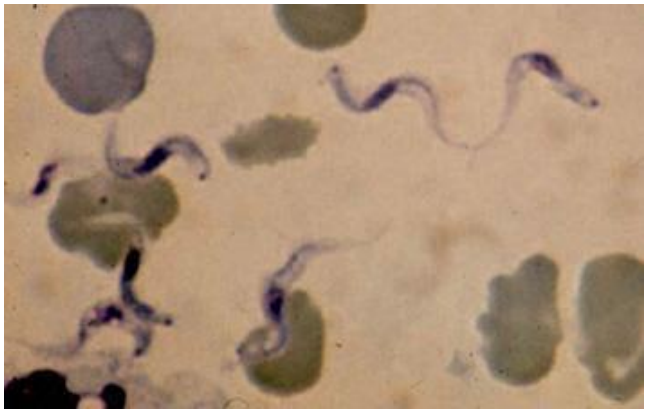
- **Trypomastigote stages are the only form found in patients.**
  - Posterior kinetoplast
  - Centrally located nucleus
  - Undulating membrane
  - Anterior flagellum

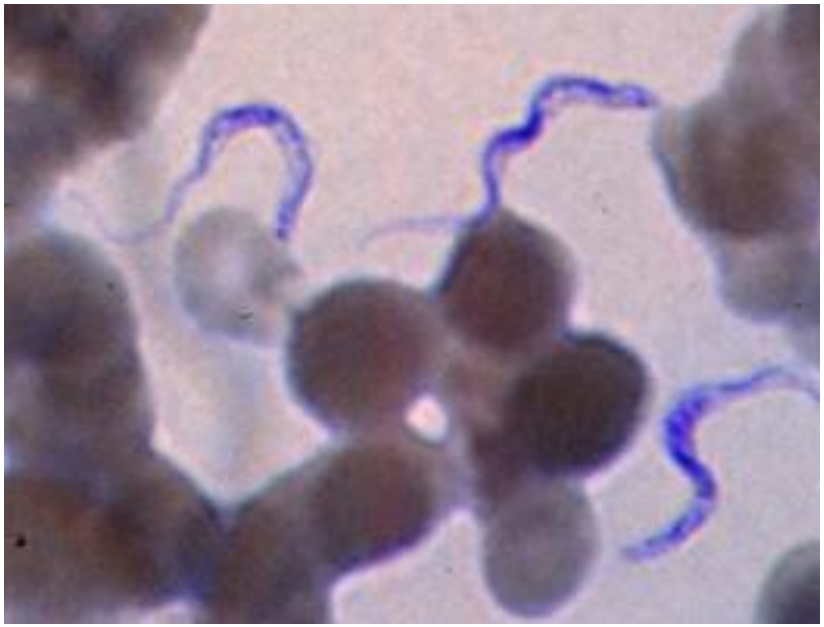
Trypanosoma brucei

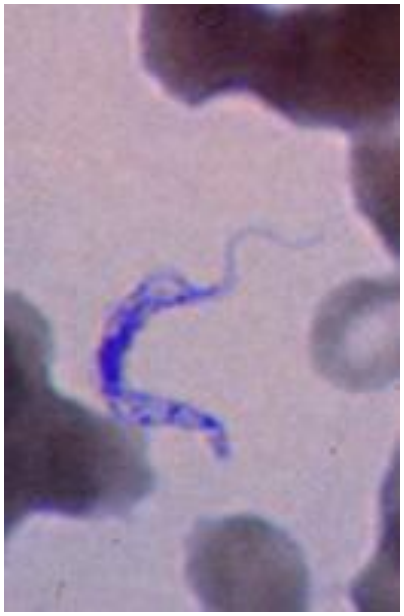


Trypanosoma brucei gambiense

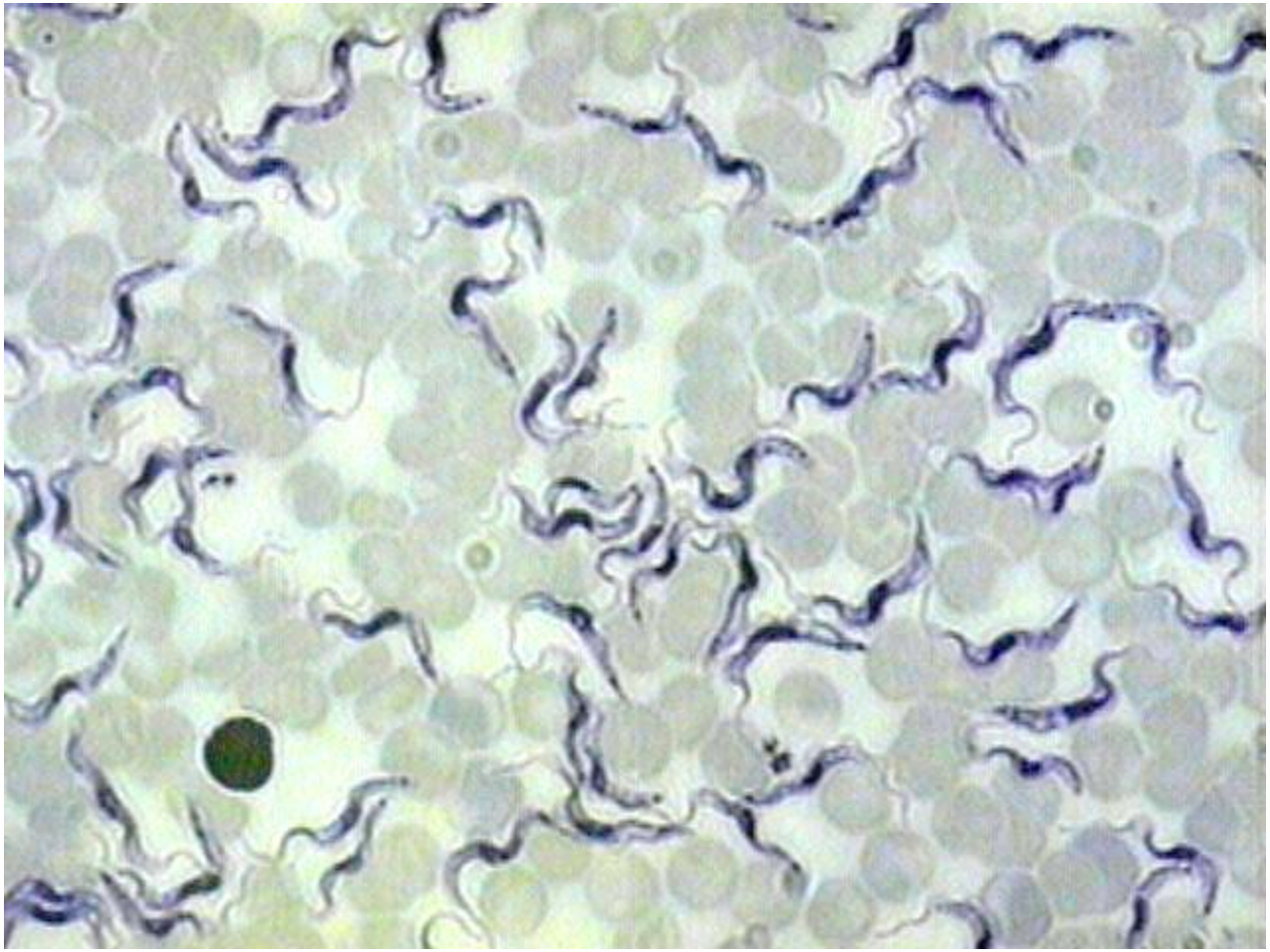
- trypomastigote



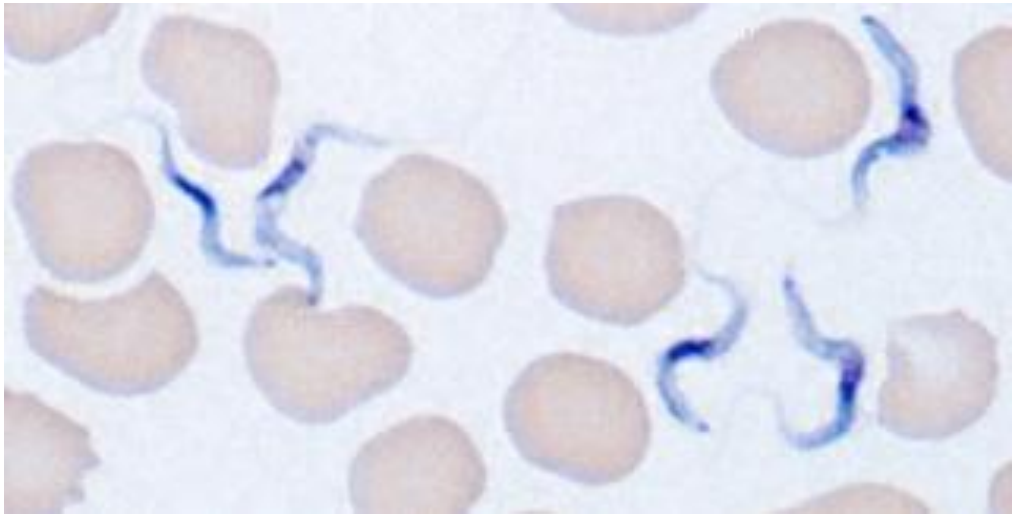


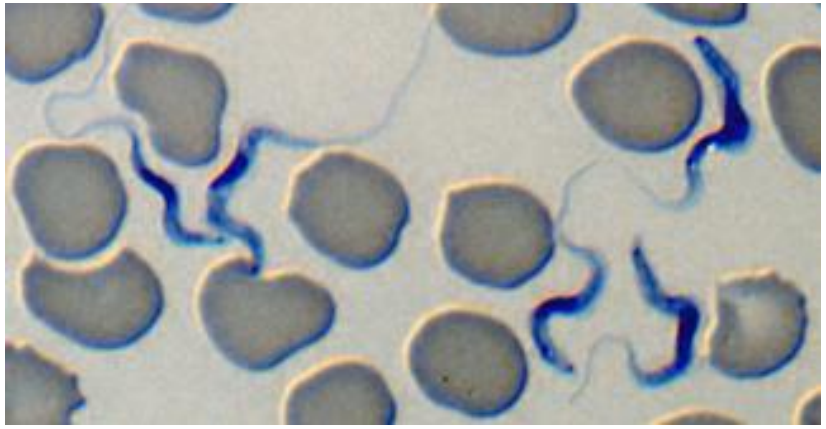


Trypanosoma



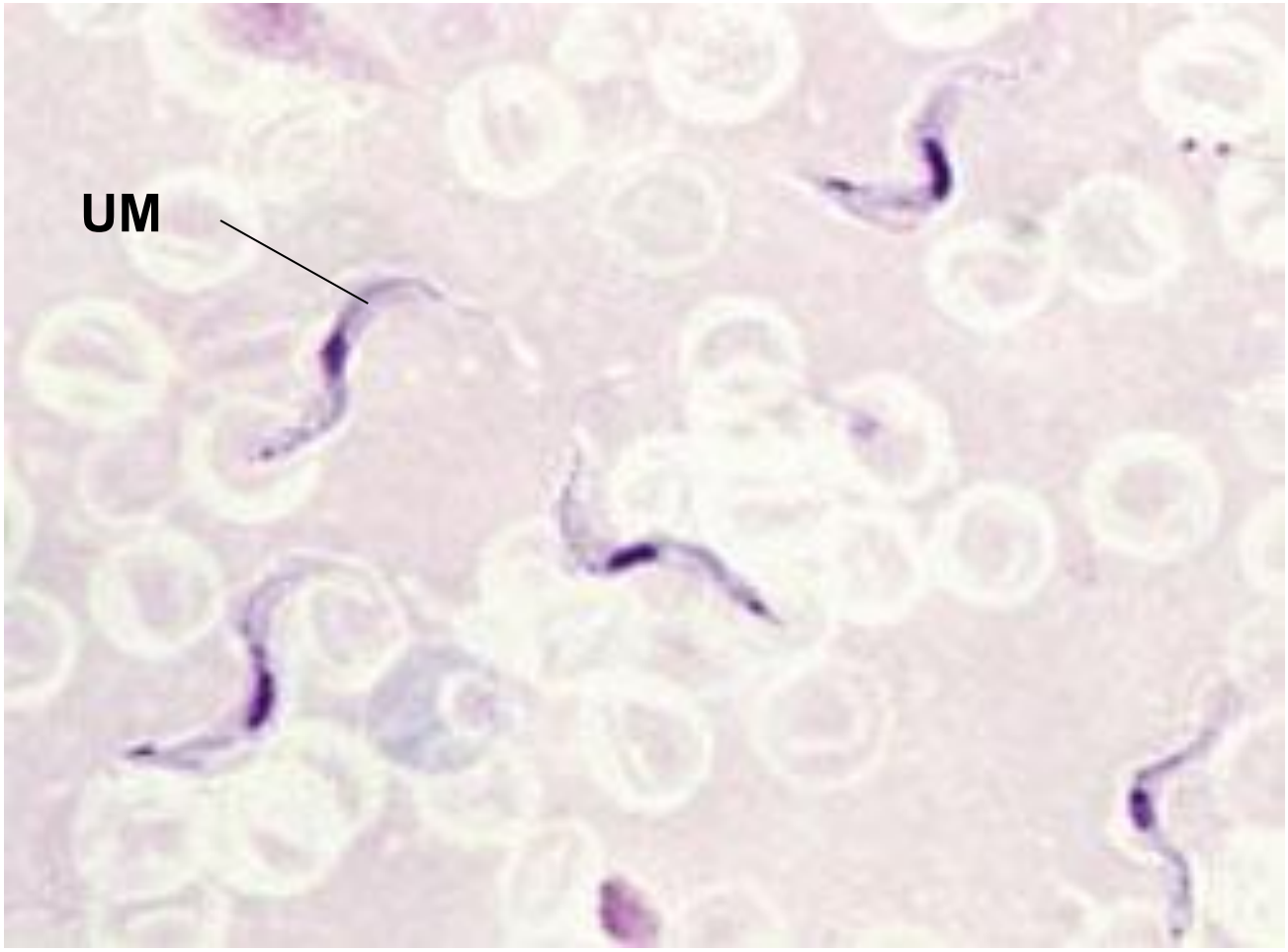
Trypanosoma brucei rhodesiense



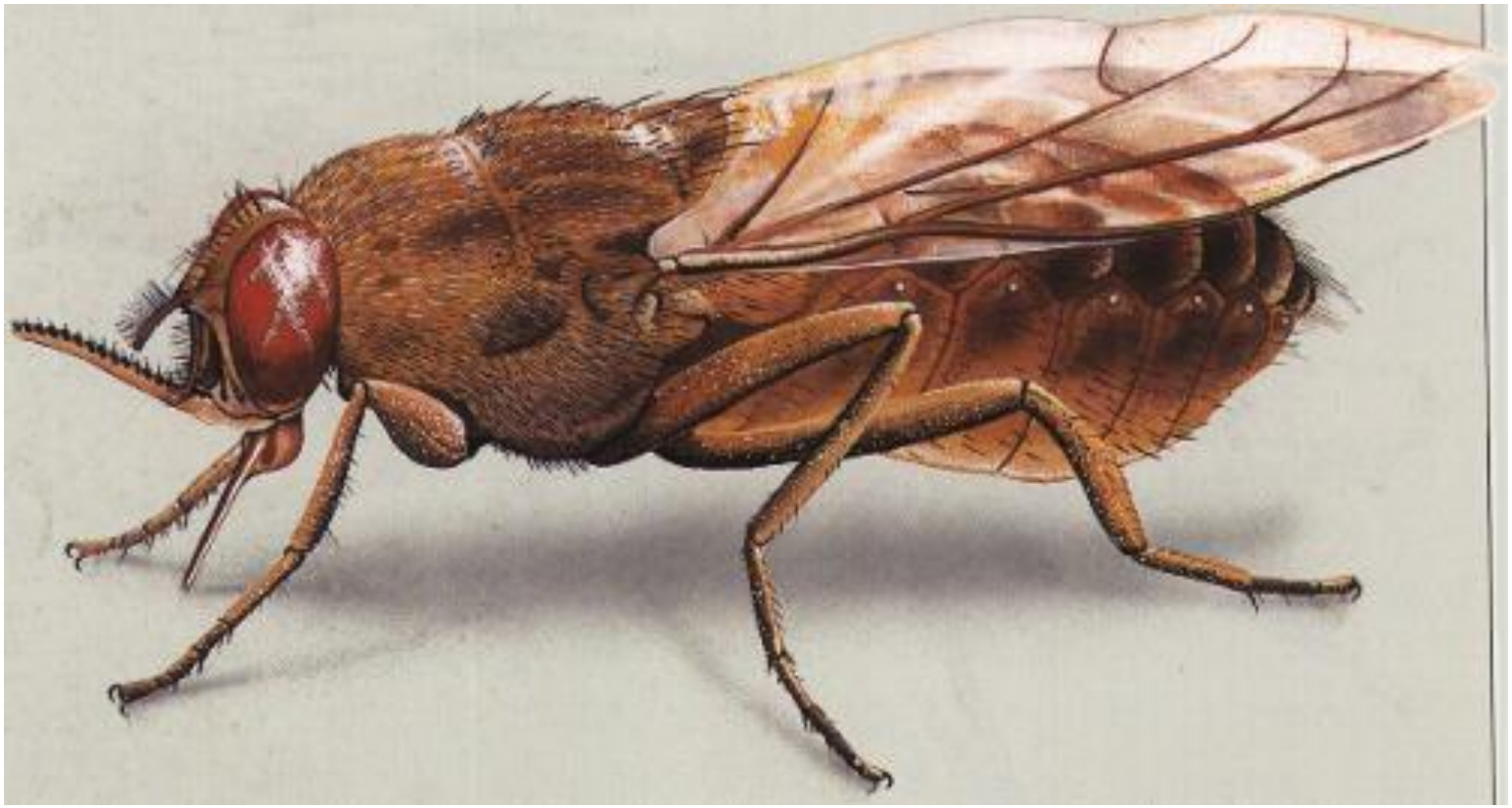



Blood smear showing Trypanosoma brucei
parasites, using a Giemsa stain technique
CDC

Trypanosoma brucei



Tsetse Fly



“Chaga’s Disease”

- **Disease:** American Tryptanosomiasis

  A zoonotic disease (can infect animals) that can be transmitted to humans by blood-sucking bugs.

- **Causal Agent:** *Trypanosoma cruzi*
  - This organism is a little smaller than *T. bruceii* and has a pronounced gametoplast.

“Chaga’s Disease”

- This disease is NOT found in Africa.
- This disease is also zoonotic; it can infect animals as well as humans.
- The vector is a large bug called the “Kissing Bug”.
- It is found in warm regions and crowded areas, especially in the cracks of adobe huts.
- It comes out at night and crawls on a human while they sleep.

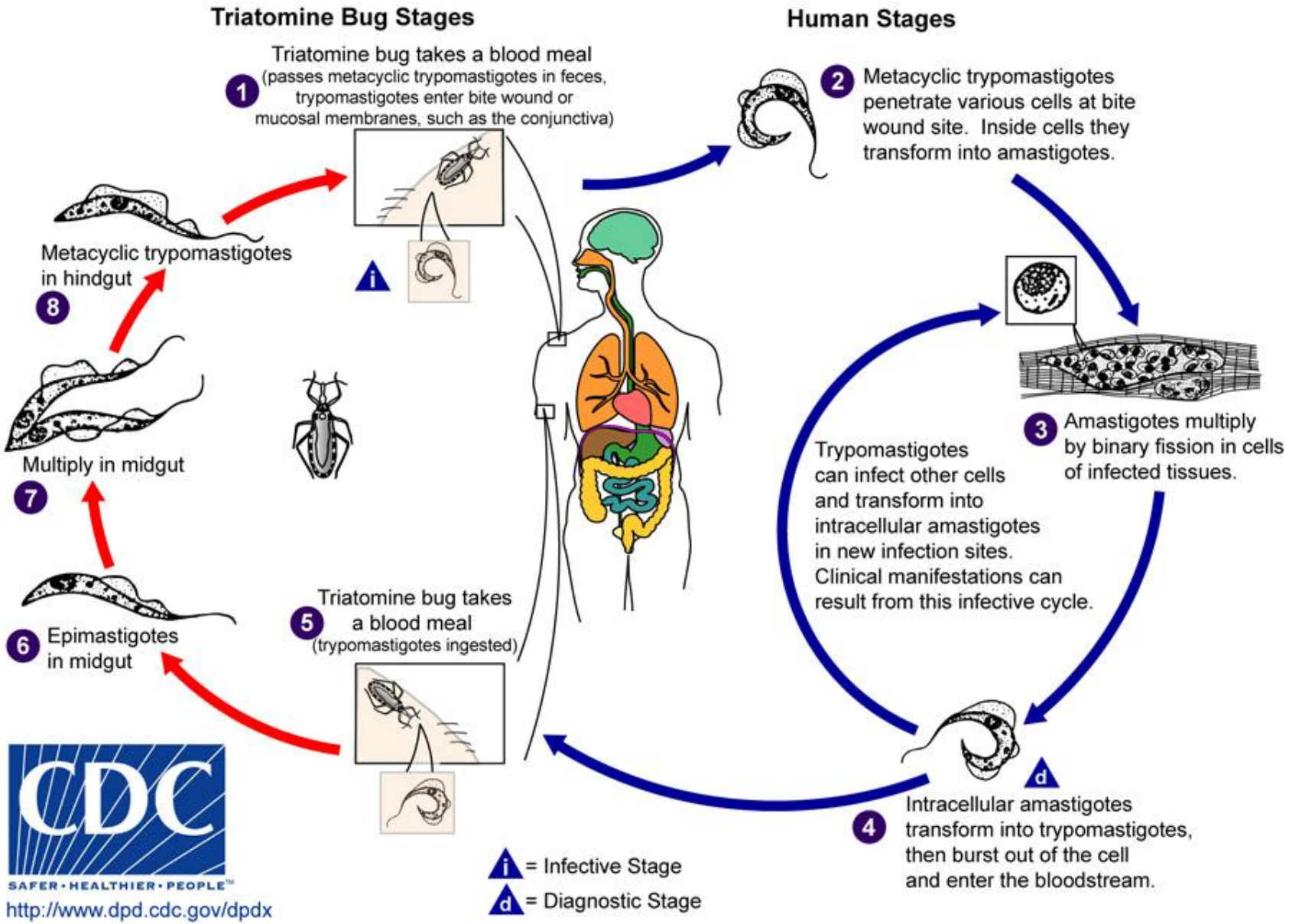
“Chaga’s Disease”

- It prefers the lips because the blood supply is close to the surface.
- It sucks the blood there, but they don’t transmit the organism this way.
- When they suck the blood, they also defecate, and the organism is in the feces.
- When the human wakes up to scratch the itch, feces get into the tiny wound.
- This is a fecal□ blood route.

“Chaga’s Disease”

- Symptoms include fever, anorexia, swollen lymph nodes, hepatosplenomegally (enlarged liver and spleen), and myocarditis (inflammation of the heart), which usually causes death.
- They also have megacolon (large colon) and megaesophagus (large esophagus).

Trypanosoma life cycle



Trypanosoma cruzi

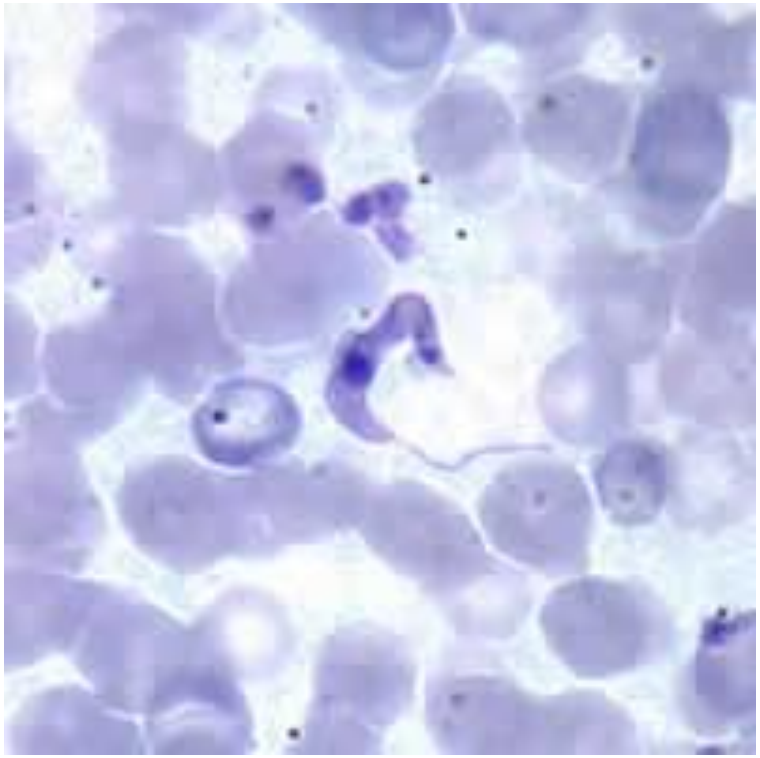
- Insect vector is the “kissing” bug. It takes a blood meal and releases trypomastigotes in its feces near the site of the bite wound.
- Trypomastigotes enter the host through the wound or through intact mucosal membranes, such as the conjunctiva.
- *Trypanosoma cruzi* can also be transmitted through blood transfusions, organ transplantation, transplacentally, and in laboratory accidents.

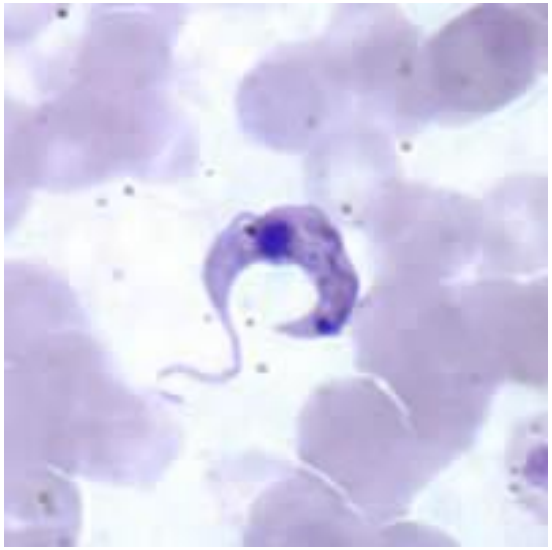
Trypanosoma cruzi

- **Geographic Distribution:**
  The Americas from the southern United States to southern Argentina. Mostly in poor, rural areas of Central and South America. Chronic Chagas disease is a major health problem in many Latin American countries. With increased population movements, the possibility of transmission by blood transfusion has become more substantial in the United States.

Trypanosoma cruzi

Trypanosoma cruzi






Trypanosoma cruzi
large kinetoplast

Trypanosoma cruzi

- Triatomine bug, *Trypanosoma cruzi* vector, defecating on the wound after taking a blood meal.



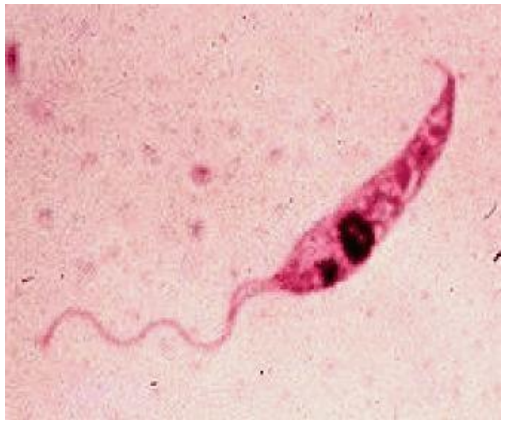
Kissing Bug

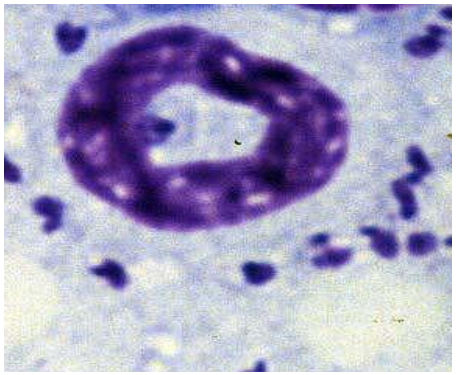
Romana’s sign

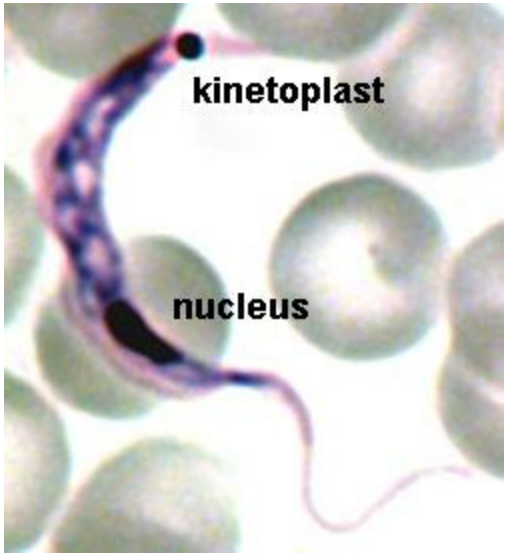
- Swollen eye, seen in Chagra’s disease.

TERMS

- Promastigote: has single flagella
- Amastigote: has no flagella
- Kinetoplast: round mass of circular DNA





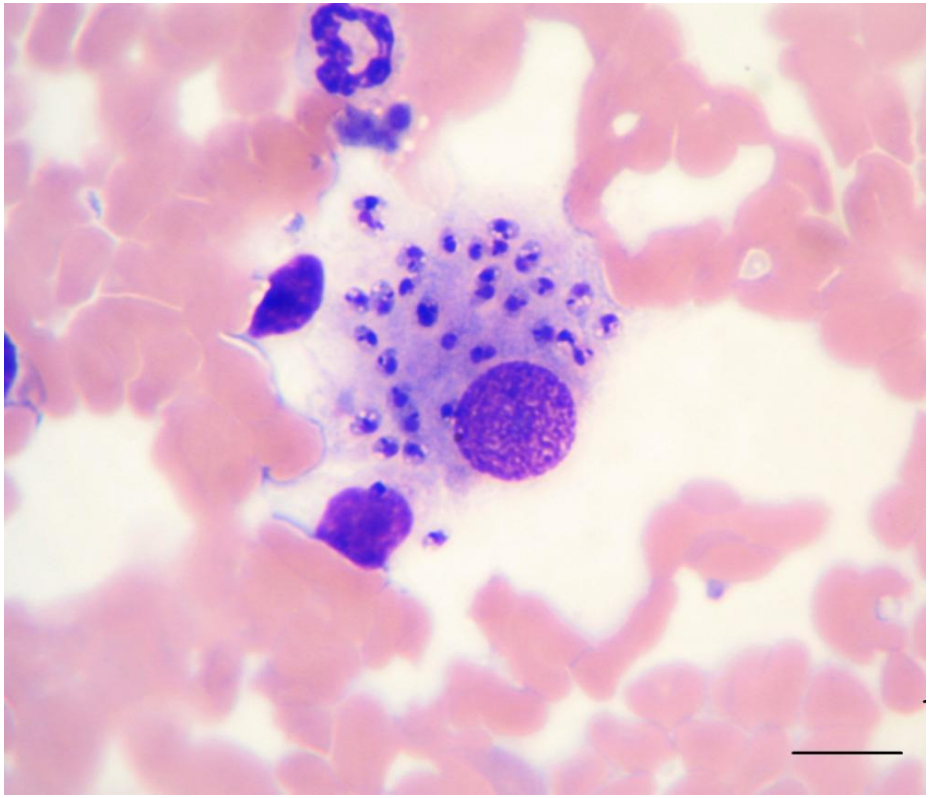


Class Kinetoplastida

Order Trypanosomatida

Family Trypanosomatidae

Genus *Leishmania*

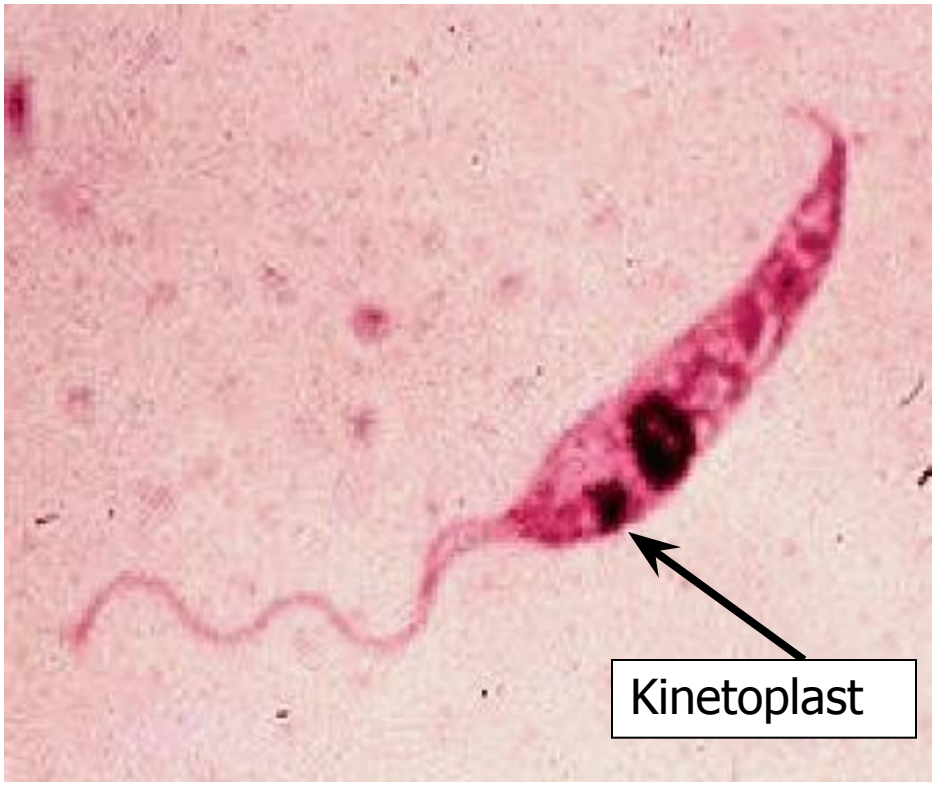


Leishmania donovani

- **Disease:** Leishmaniasis
- Vector-borne disease transmitted by sandflies.

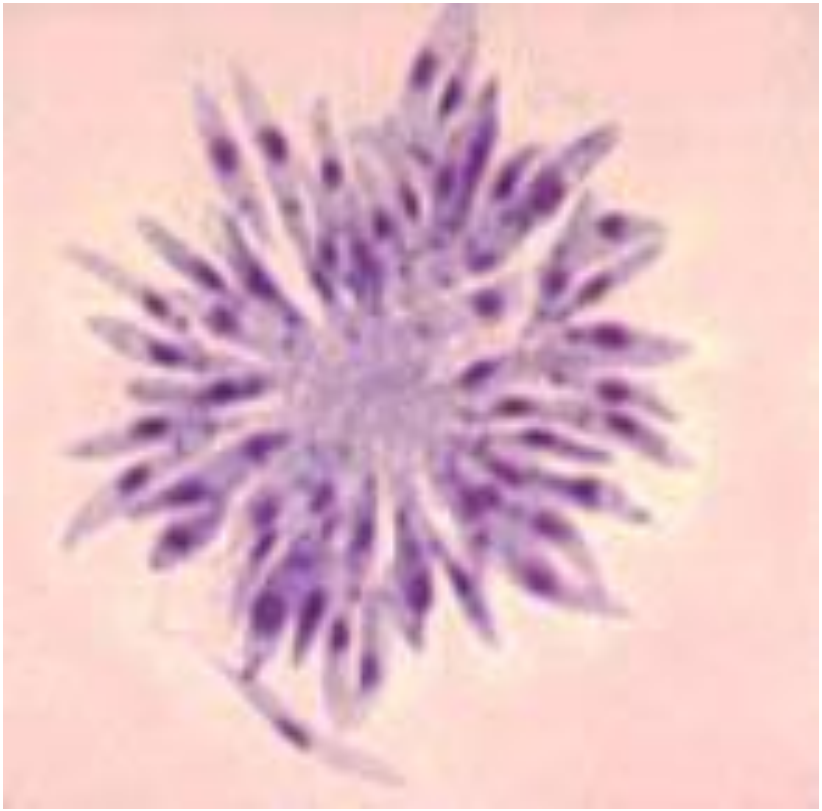
Leishmania Life Cycle

- It starts out as a spindle-shaped, single flagellated cell called a promastigote (mastigote means flagella).
- You can also see the nucleus and a kinetoplast (mass of circular DNA).

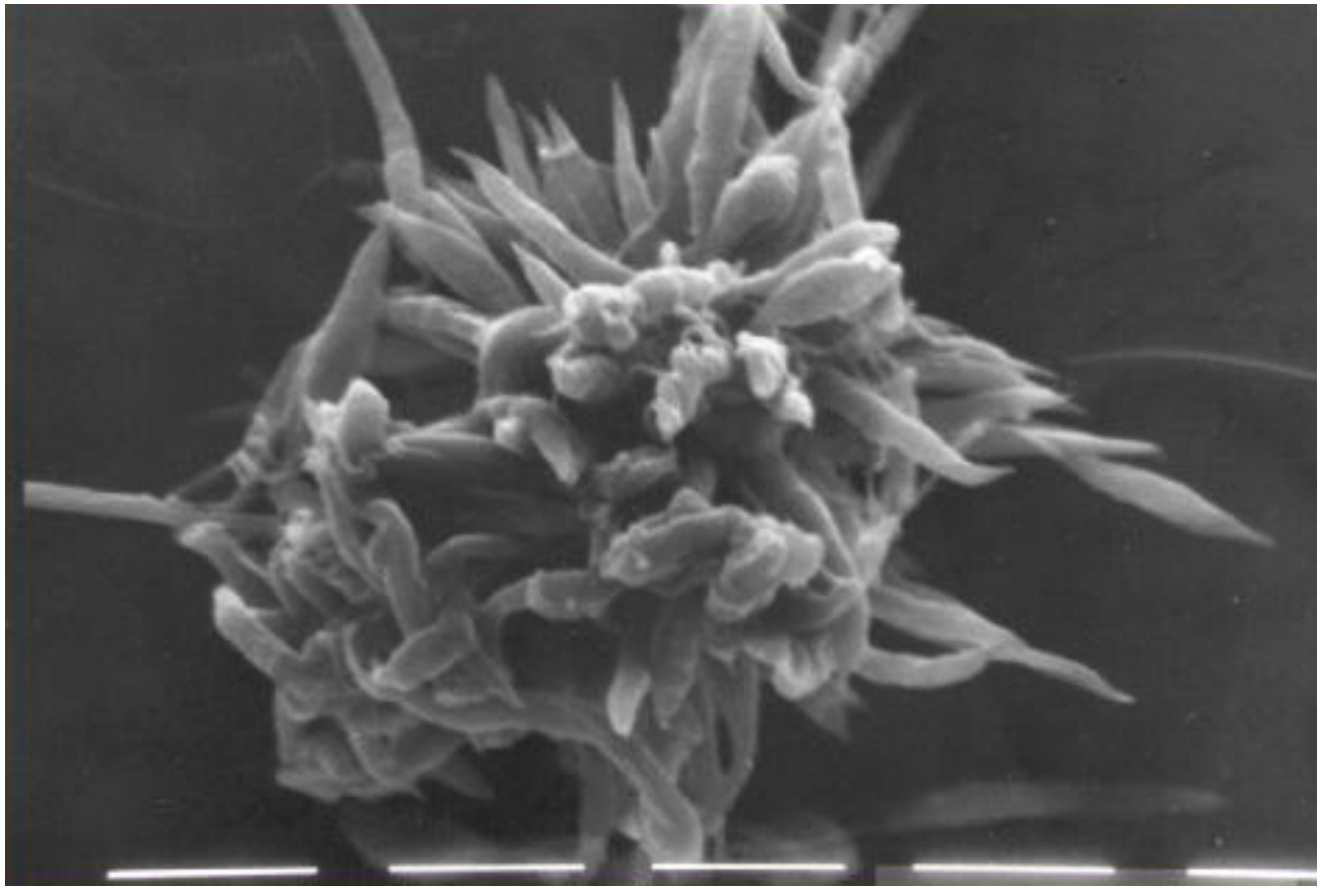


Leishmania rosette

- In prepared slides you can see promastigotes align their nose in a circle, called a rosette.



Leishmaniasis rosette



Leishmania Life Cycle

- It reproduces in the gut of a female **sandfly**, and migrates to her proboscis (mouth part).
- It is introduced into the human by her bite.
- It then enters a macrophage and becomes **intracellular**.
- Here, it loses its flagella and is now known as an **amastigote**.

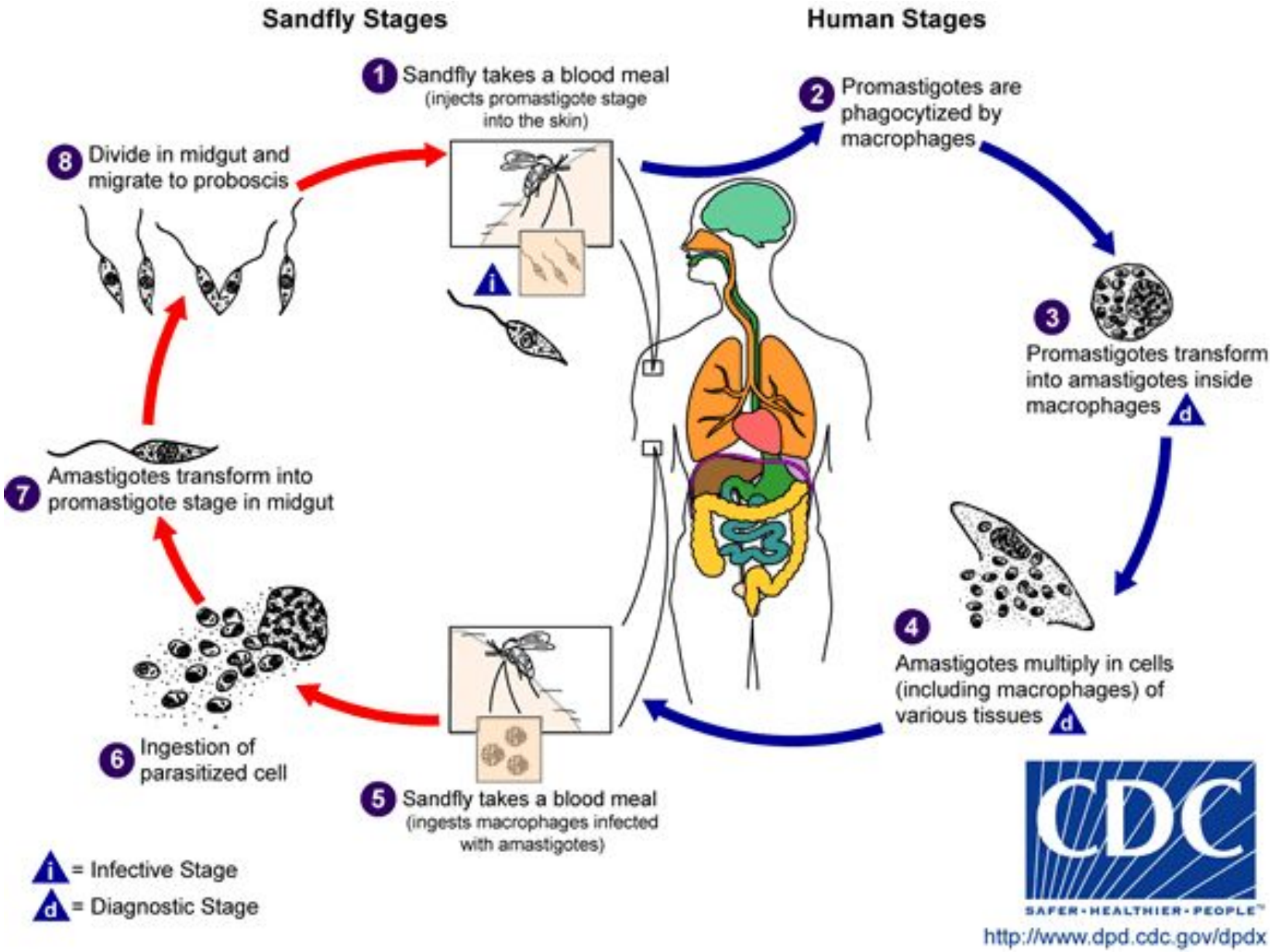
Leishmaniasis

- These amastigotes multiply in various organs including the spleen, liver, and lymph nodes.
- Symptoms include hepatosplenomegaly, lymph adenopathy, fever, weight loss, and a decrease in all blood cells: WBC, RBC, and platelets.
- The treatment is almost as bad as the disease because of the side effects. It is best to catch it early.

Leishmania Life Cycle

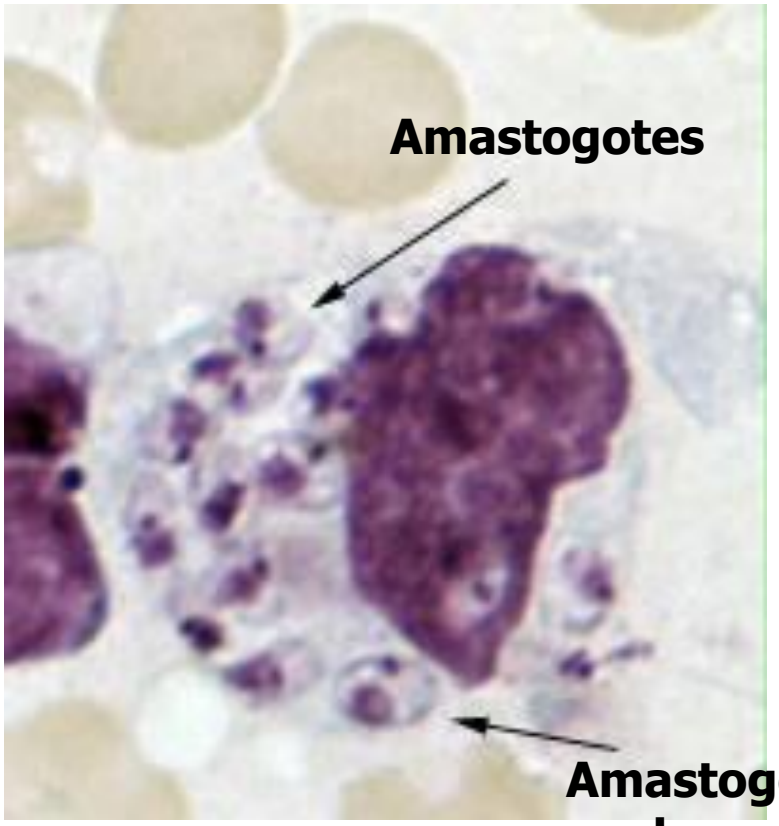
- The female sandflies inject the infective stage, promastigotes, during blood meals.
- Macrophages phagocytize them and they transform into amastigotes.
- Other sandflies become infected during blood meals when they ingest infected macrophages.
- In the sandfly's midgut, the parasites differentiate into promastigotes, which multiply and migrate to the proboscis.

Leishmania life cycle

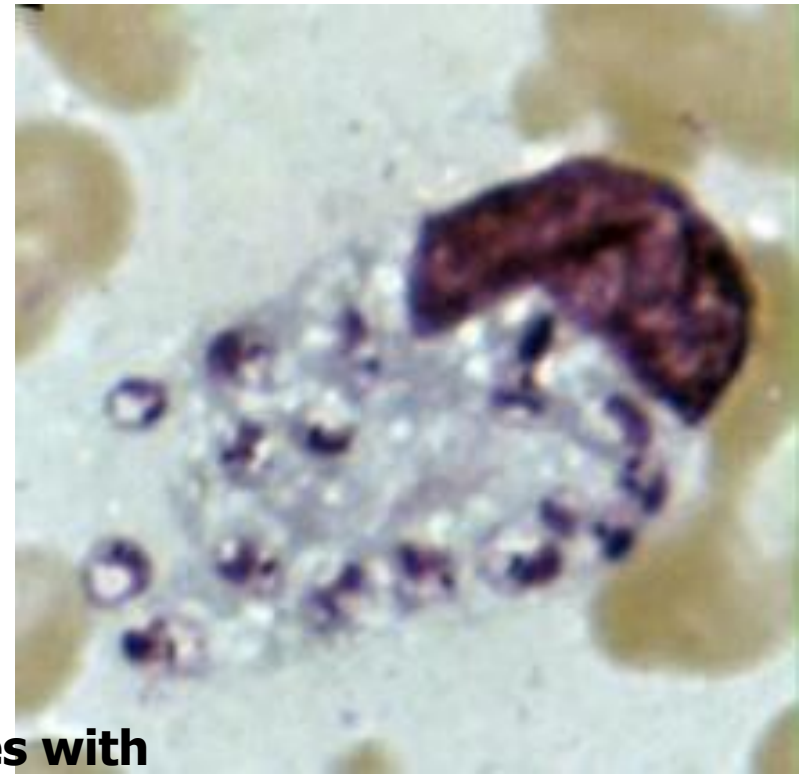



Leishmania donovani
(Promastigote)
Single flagellum found in sand flies

Leishmaniasis

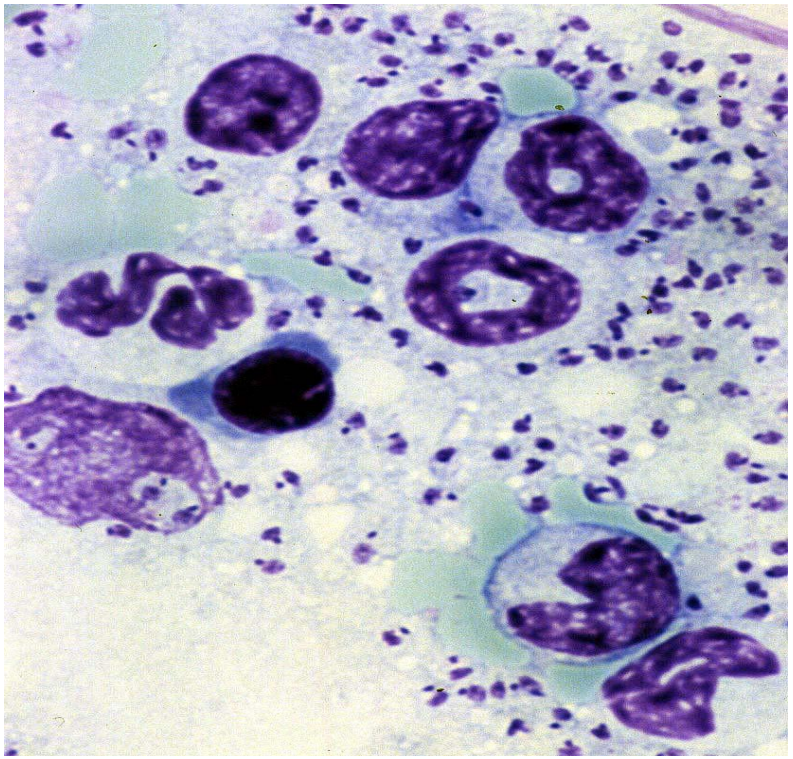


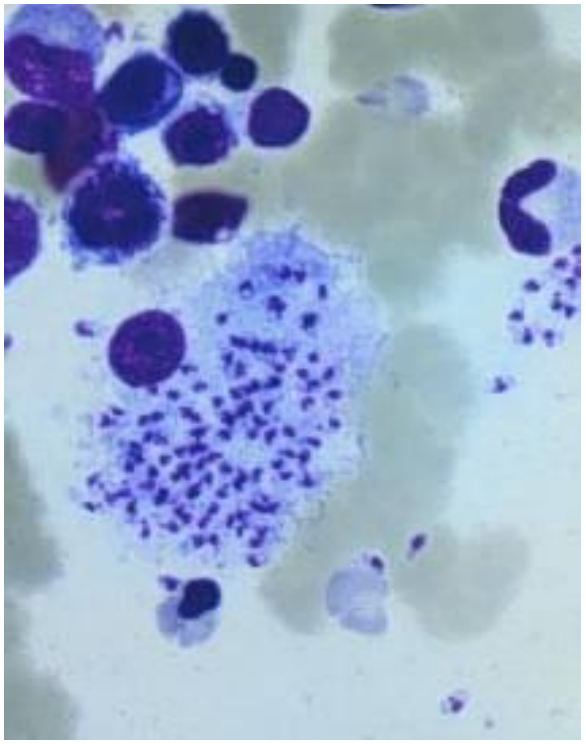
Macrophage rupturing



Leishmania

- Amastigotes





Sandfly

- This looks like a mosquito, except its body is hairy and the wings are feathery.

Leishmaniasis

- **Geographic Distribution:**
  More than 90 percent of the world's cases of visceral leishmaniasis are in India, Bangladesh, Nepal, Sudan, and Brazil.
- Leishmaniasis is also found in Mexico, Central America, and South America, southern Europe, Asia, the Middle East, and Africa.

Leishmaniasis

- There are three forms of Leishmaniasis:
  - Cutaneous
  - Mucocutaneus
  - Visceral

Cutaneous Leishmaniasis

- The disease is only at the site of the bite.
- This form is seen in Texas, Mexico, Asia, and the Middle East (our Iraq troops are coming down with this form).
- It manifests as a large, wet sore with raised edges. It looks like a volcano with weepy serum coming out of the center.
- The wound is not contagious, just the sandfly bite.
- Dogs can get this disease, too.

Leishmaniasis (cutaneous)

Leishmaniasis (cutaneous)

Leishmaniasis (cutaneous)

Leishmaniasis (mucocunateous)

- This is when the disease located in the mucous membranes of the nose and mouth.
- The most gruesome photos are of this form.

Leishmaniasis (mucocunateous)

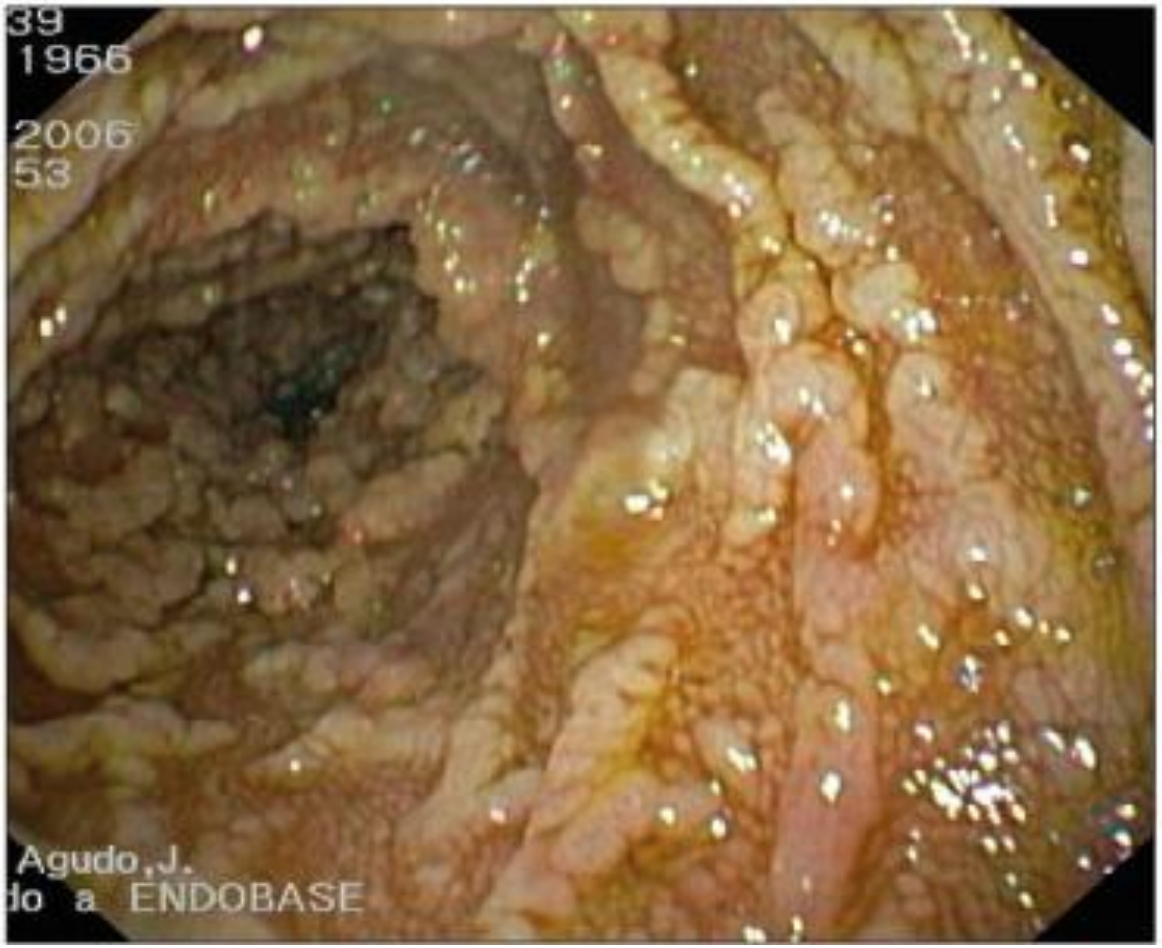
Leishmaniasis (visceral)

- This is the most serious form. It occurs especially in immunocompromised people, especially HIV patients.
  - The amastagotes reproduce inside macrophages.
  - Only T-cells can kill infected macrophages, but HIV is a disease that infects T-cells.
  - This form is known as Kala Azar.

Kala Azar

Hepatosplenomegaly

Kala Azar (duodenum)

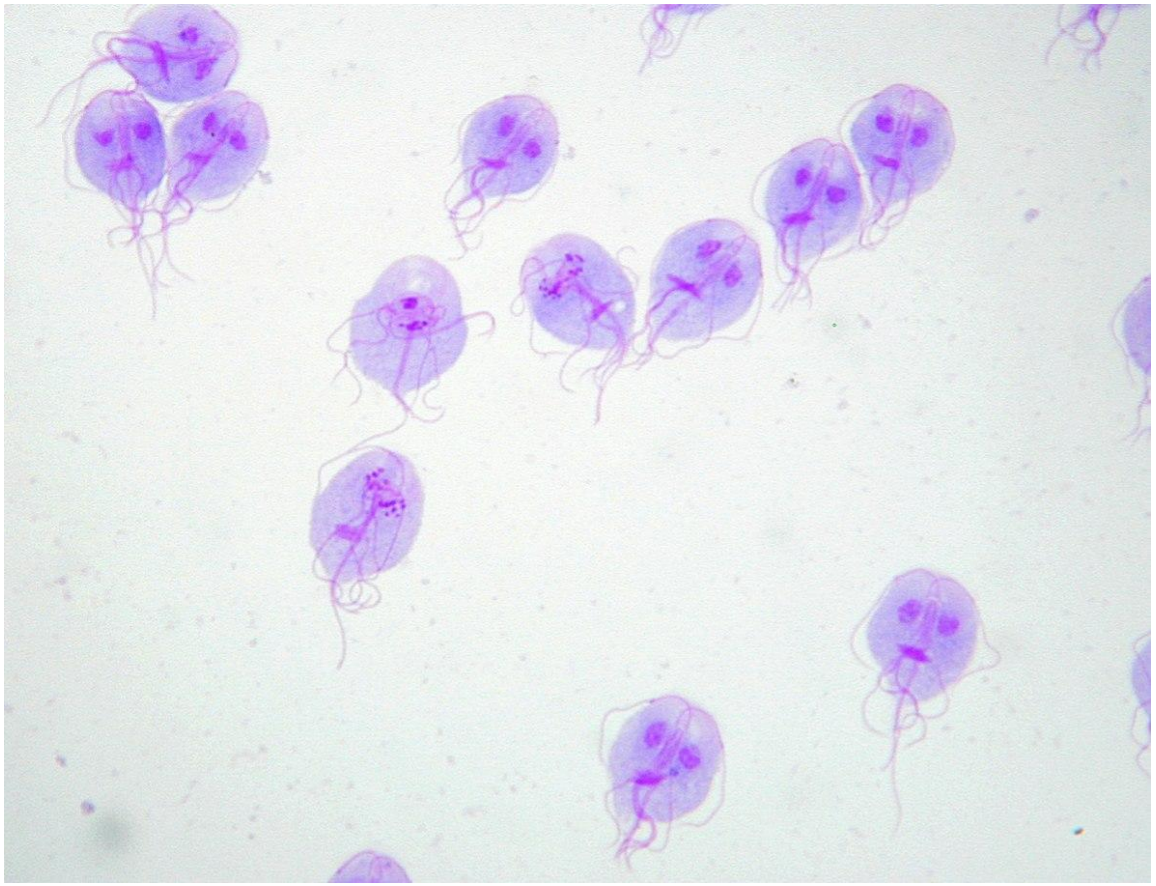


Phylum Metamonada

Phylum Metemonada
Order Diplomonada
Family Hexamitidae
Genus Giardia

ARCHAEZOA DISEASES

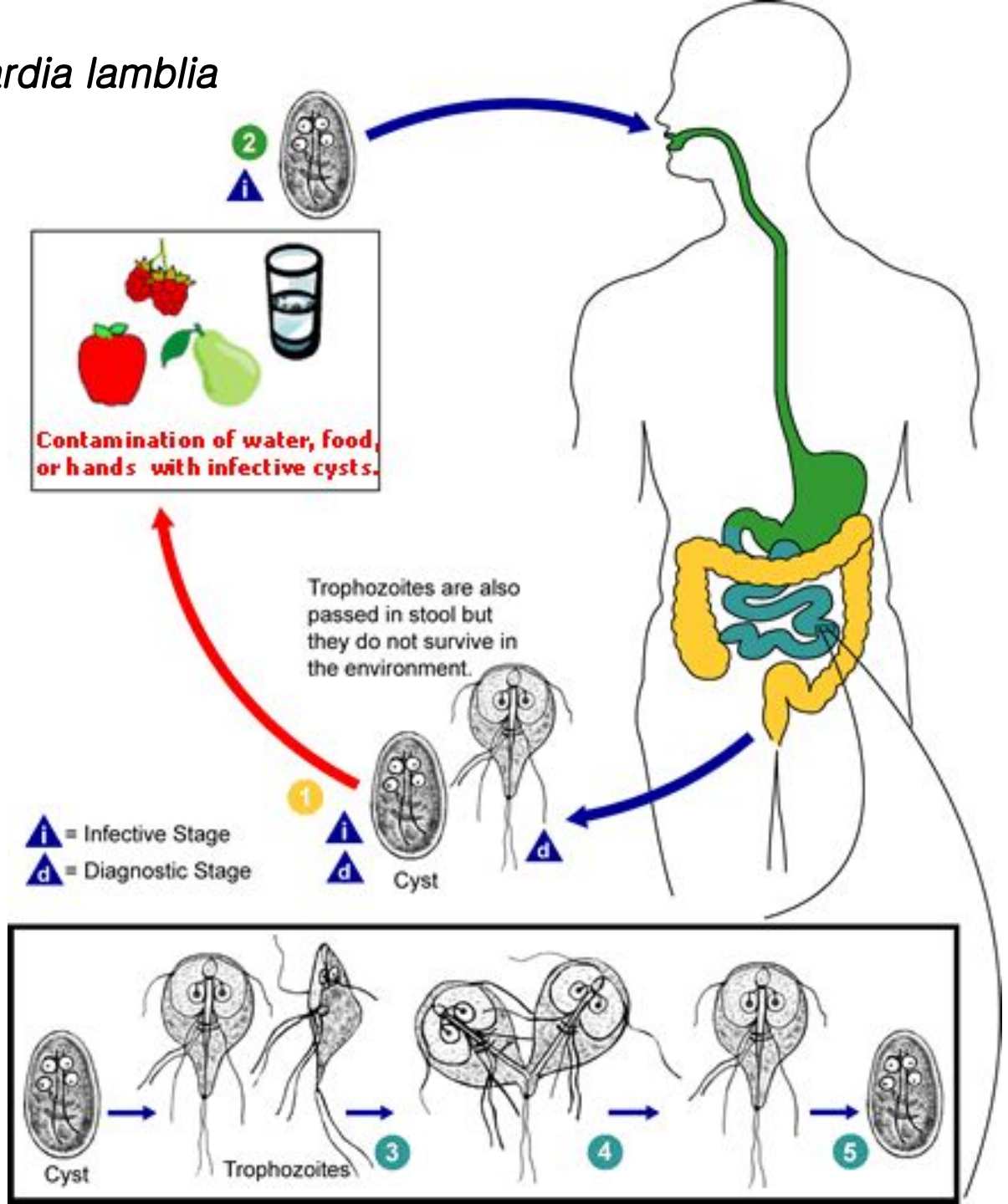
Giardia intestinalis



Giardiasis

- **Organism: *Giardia lamblia***
- Cysts are resistant forms and are responsible for transmission of giardiasis.
- Both cysts and trophozoites can be found in the feces.
- Infection occurs by the ingestion of cysts in contaminated water, food (includes undercooked meat), or by the fecal-oral route.

Life Cycle of *Giardia lamblia*



Giardia lamblia

- In the small intestine, excystation releases trophozoites (each cyst produces two trophozoites).
- Trophozoites multiply, remaining in the lumen where they can be free or attached to the mucosa by a ventral sucking disk.
- Encystation occurs as the parasites transit toward the colon. The cyst is the stage found most commonly in nondiarrheal feces.
- Because the cysts are infectious when passed in the stool or shortly afterward, person-to-person transmission is possible.

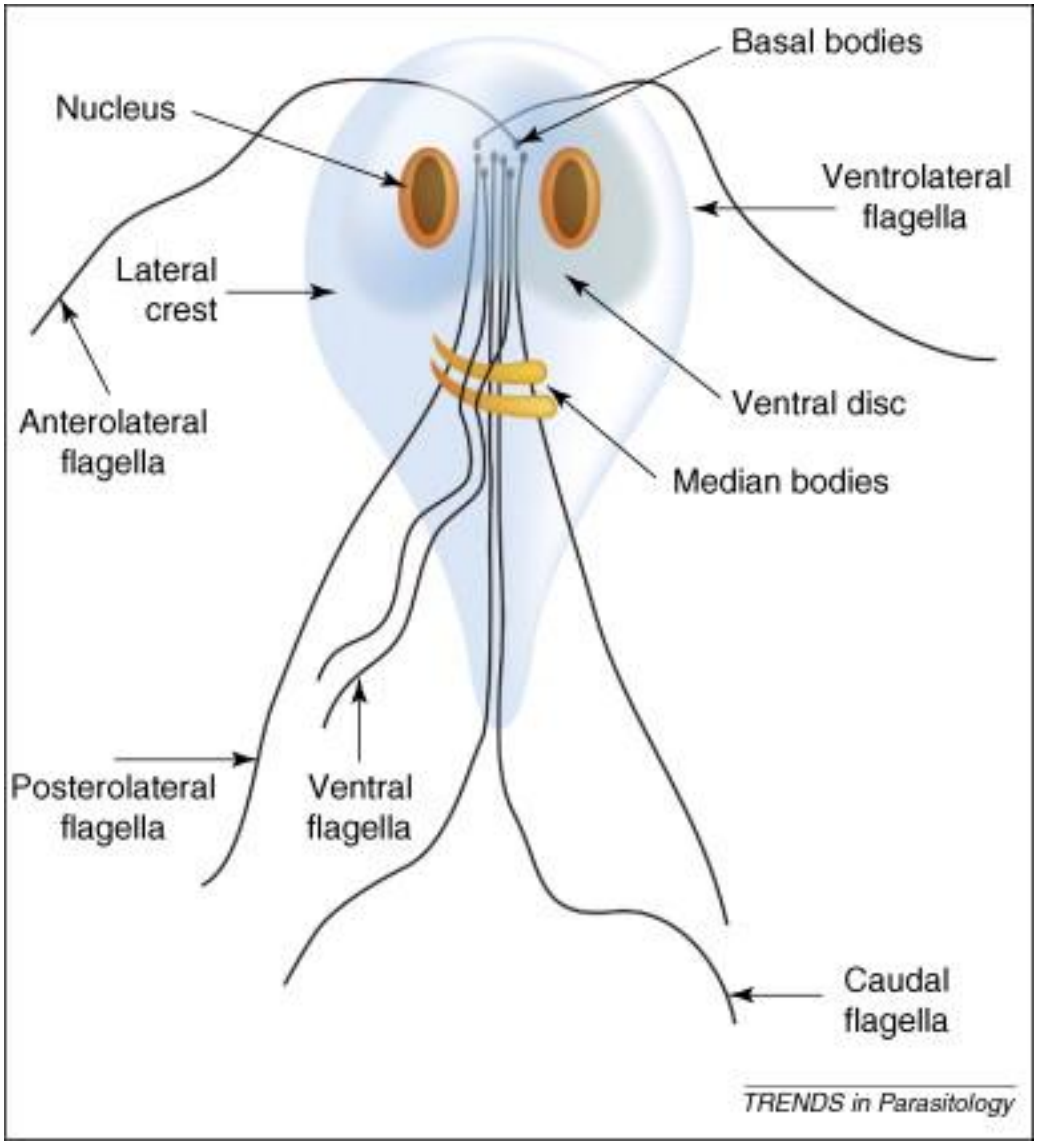
Giardia lamblia

- **Trophozoite form**: piroform (pear or teardrop shape), looks like a happy face.
- Discovered by Anton Van Leuwenhoek when he examined his own feces when he had this infection.
- You won't see the flagella in lab because you need a special stain for that.
- **Cyst form**: oval shaped. Nuclei looks like two eyes.

- **Geographic Distribution:**
  Worldwide, more prevalent in warm climates, and in children.

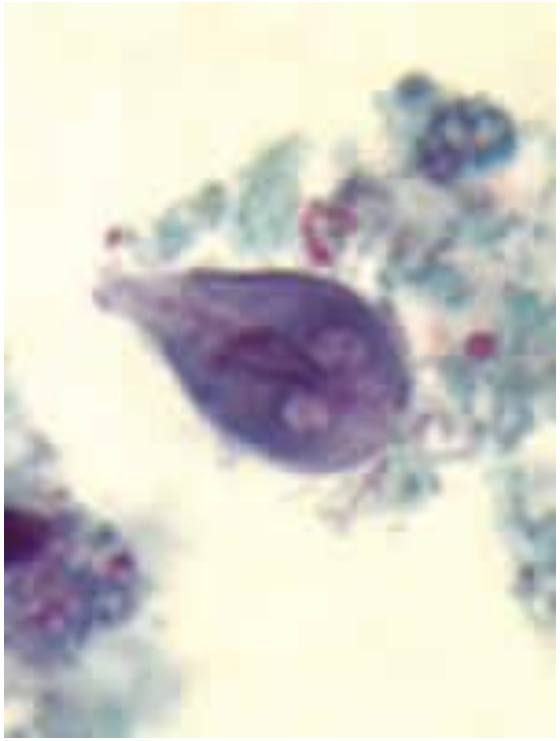
Giardia lamblia

- Trophozoite



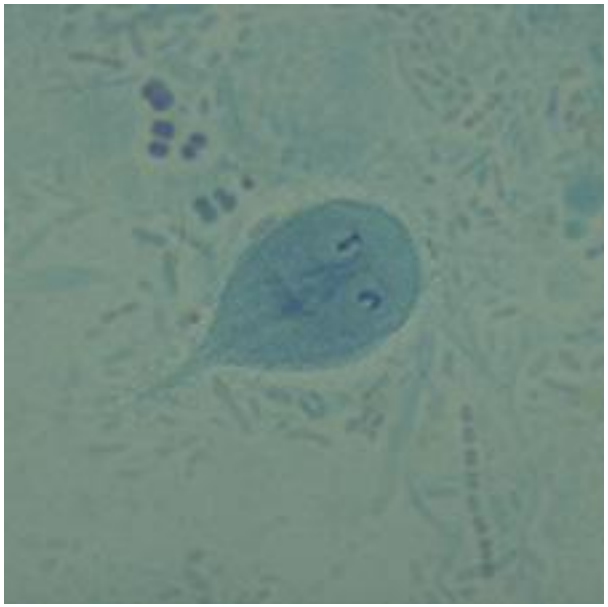
Giardia lamblia

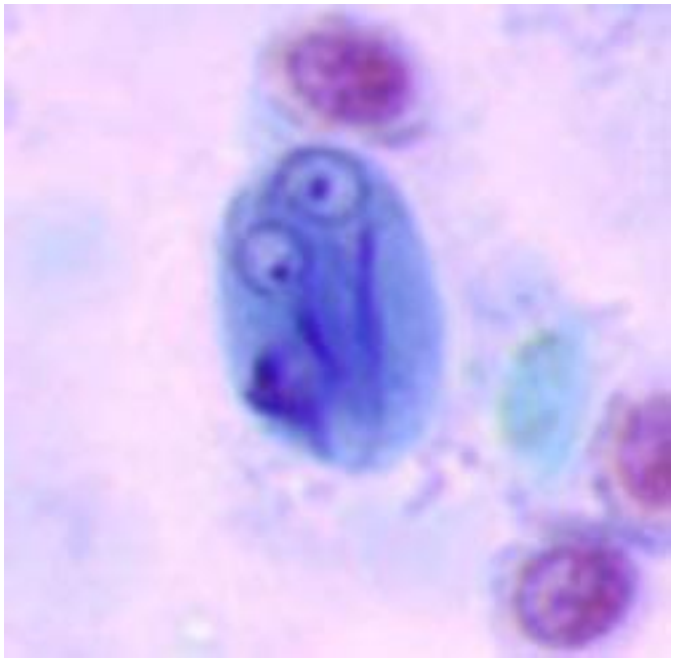
- Trophozoites



Giardia lamblia

- Trophozoites

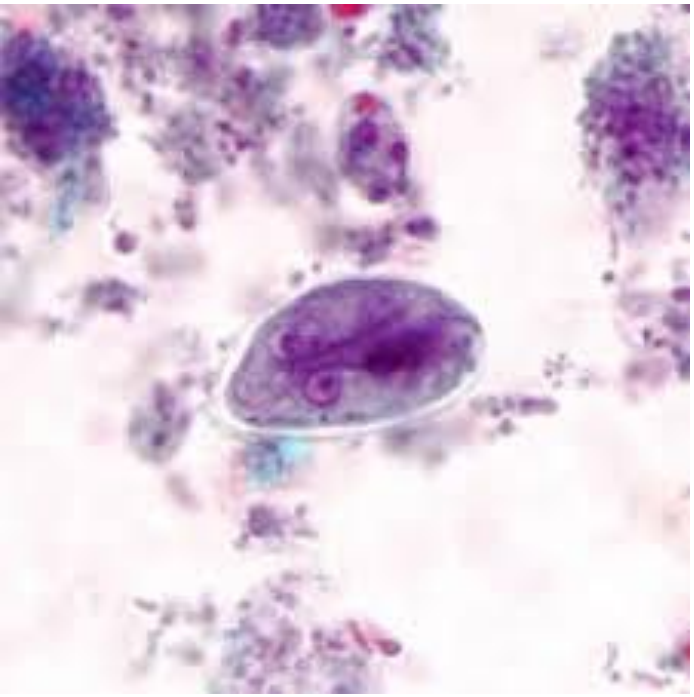


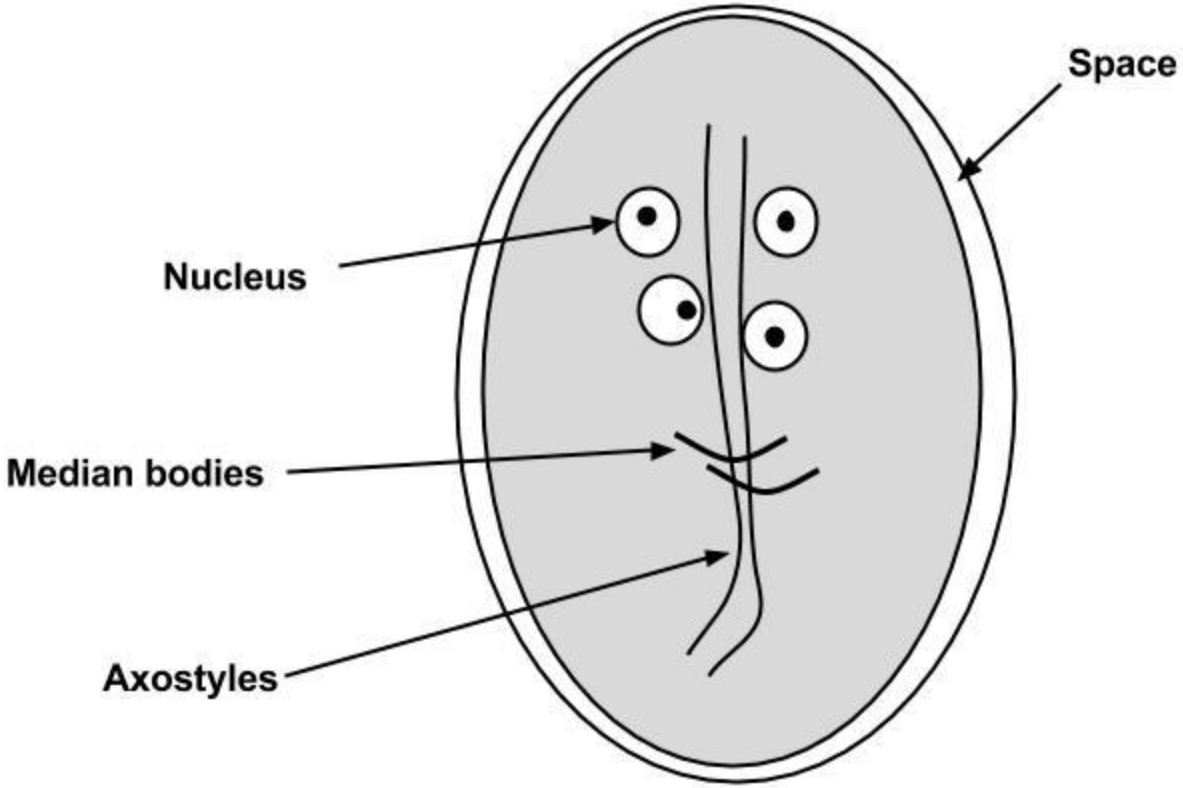


Giardia lamblia trophozoite

Giardia lamblia

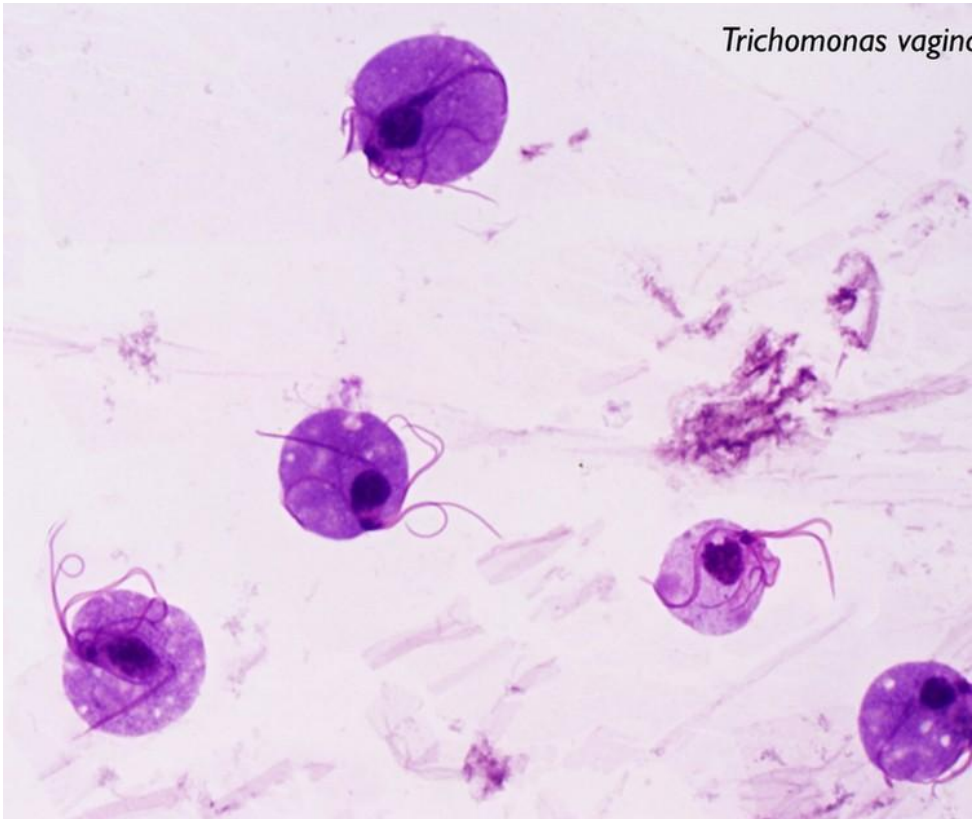
- Cysts





Phylum Metemonada
Order Trichomonadida
Family Trichomonadidae
Genus Trichomonas

Trichomonas vaginalis

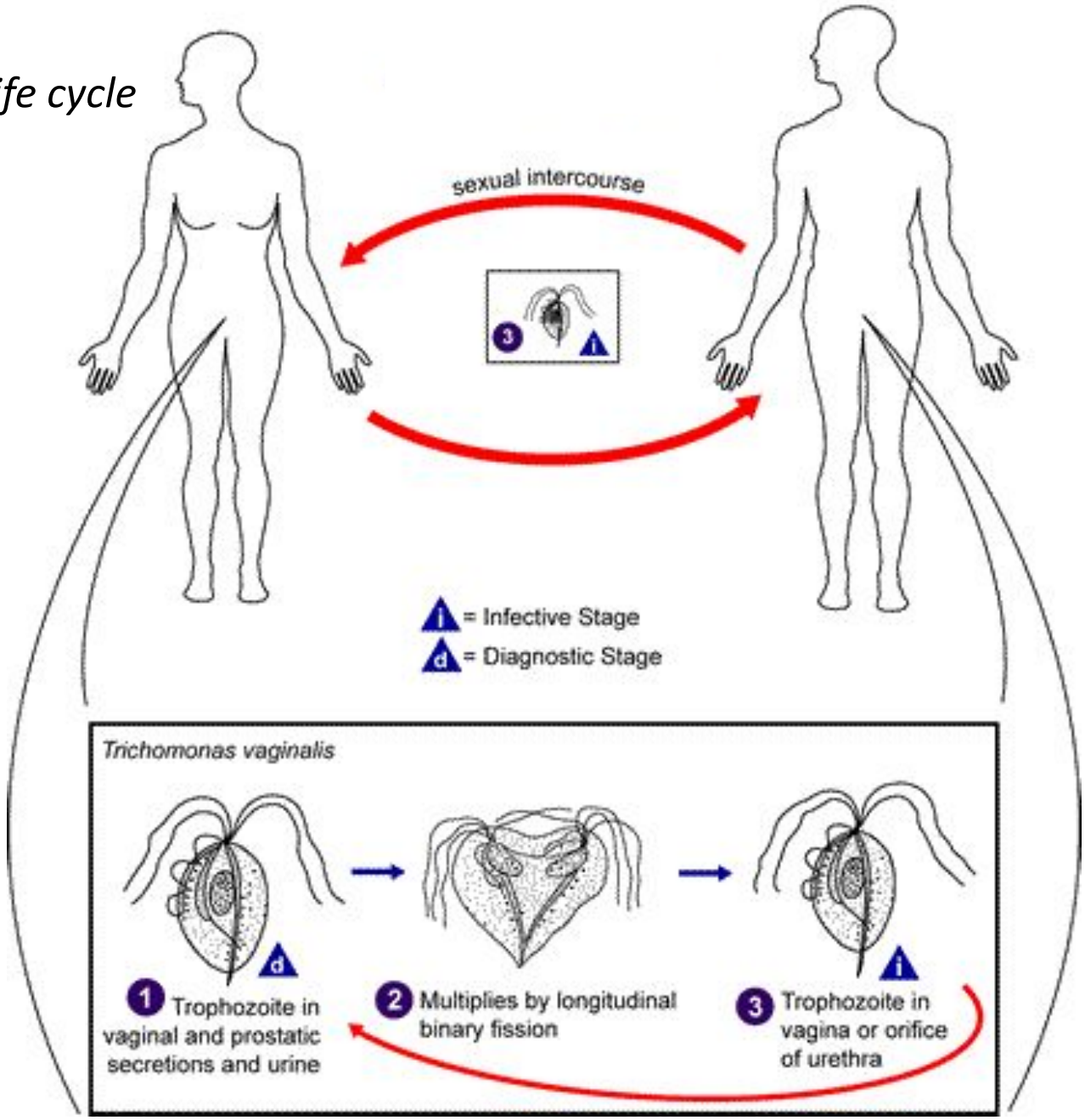


Trichomoniasis

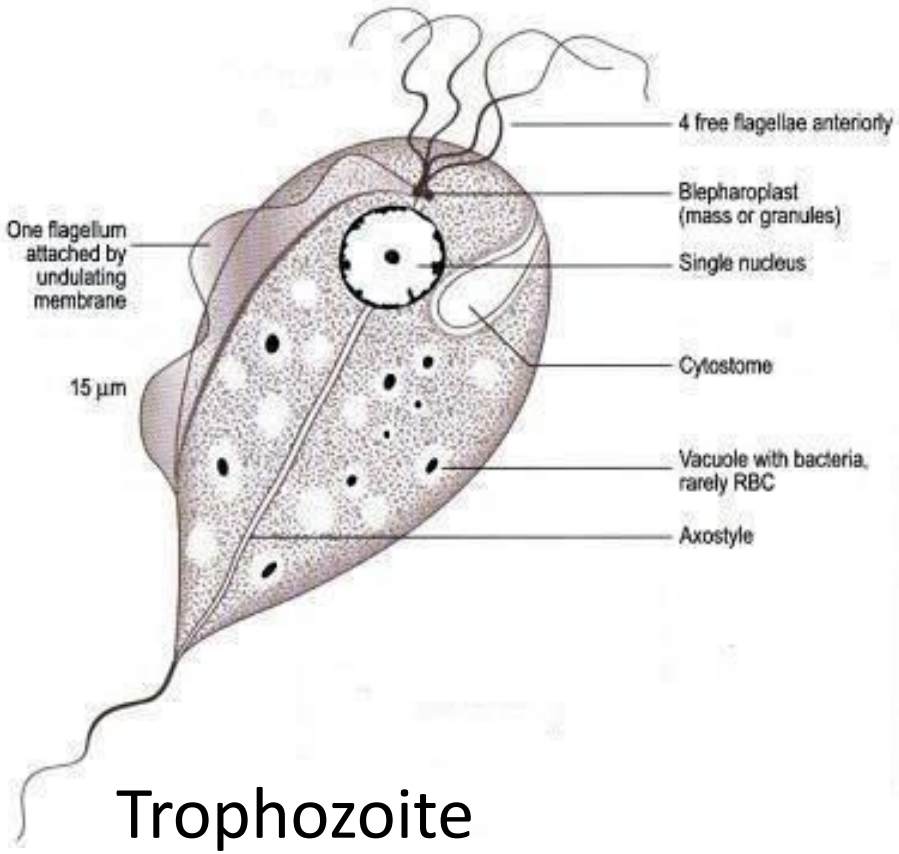
- **Organism:** *Trichomonas vaginalis*

- *Trichomonas vaginalis* resides in the female lower genital tract and the male urethra and prostate.
- The parasite is a trophozoite only; it does not have a cyst form, and does not survive well in the external environment.
- *Trichomonas vaginalis* is transmitted among humans, its only known host, primarily by sexual intercourse.

Trichomonas vaginalis life cycle

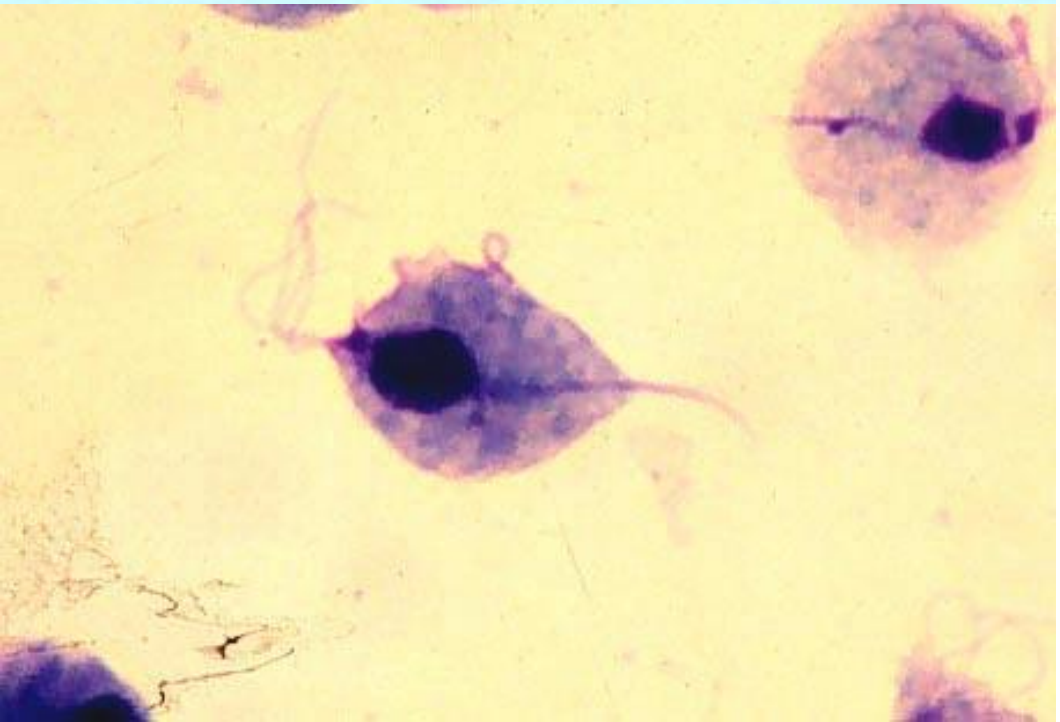


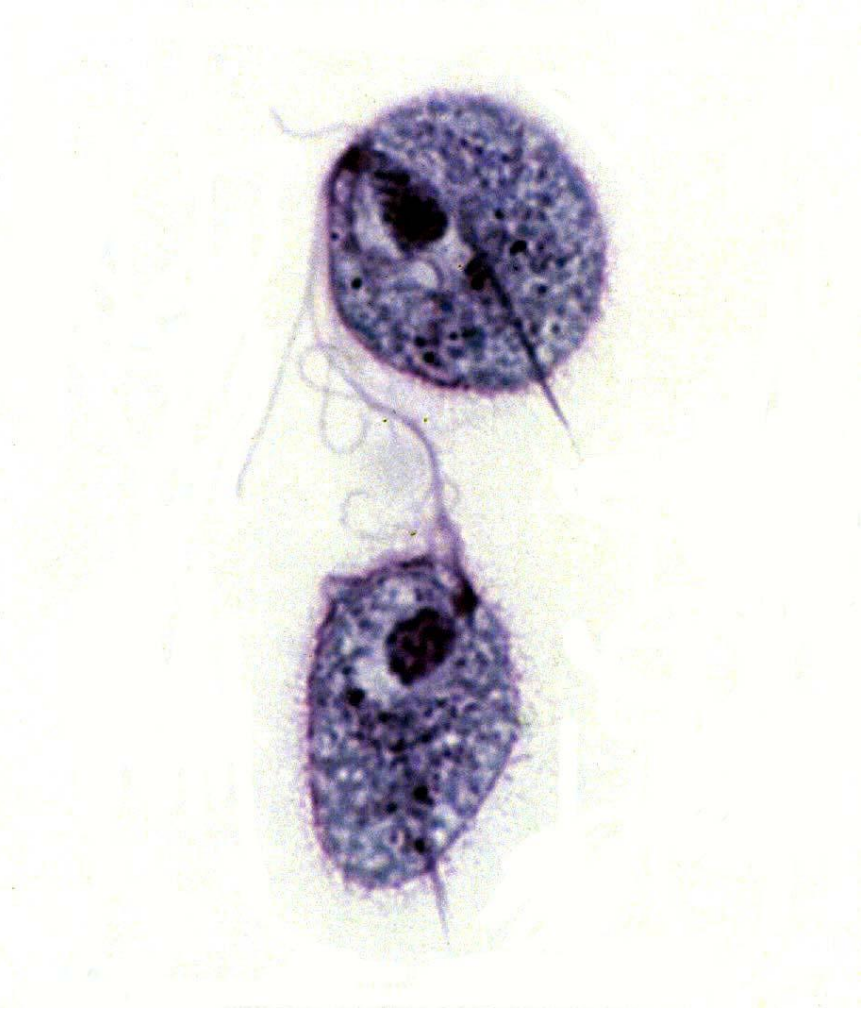
Trichomonas vaginalis



Trophozoite

Undulating membrane





Trichomonas vaginalis

Trichomonas vaginalis