



Diagnosis of Infectious Agents in the Peripheral Blood Smear

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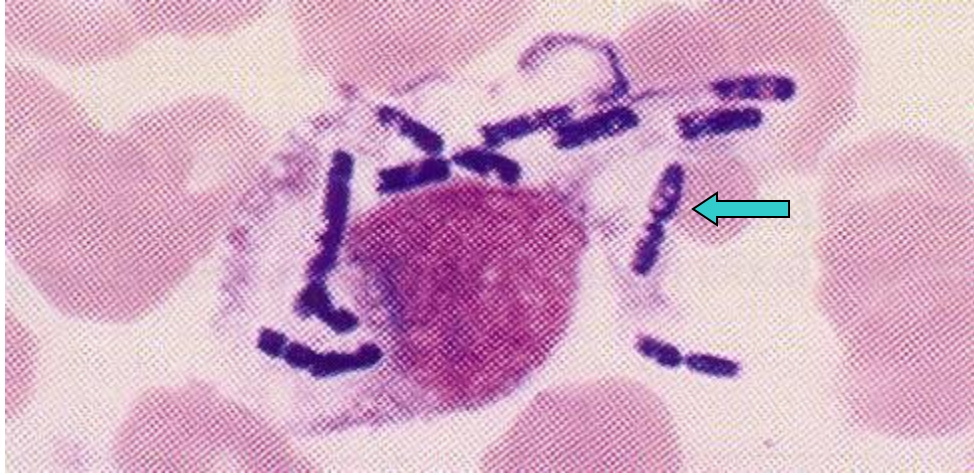
July 24, 2006

Pathogens detected in PS

- Bacteria
 - Neisseria meningitidis
 - Streptococcus pneumoniae
 - Staphylococcus sp.
 - Bartonella bacilliformis
 - Yersinia pestis
 - Bacillus anthracis
 - Mycobacteria (buffy coat)
 - Ehrlichia sp.
- Spirochetes
 - Borrelia
- Fungi
 - Candida sp.
 - Histoplasma
 - Cryptococcus
- Protozoa
 - Plasmodium sp.
 - Babesia sp.
 - Trypanosoma sp.
- Filariae
 - Loa loa
 - Wuchereria bancrofti
 - Brugia malayi

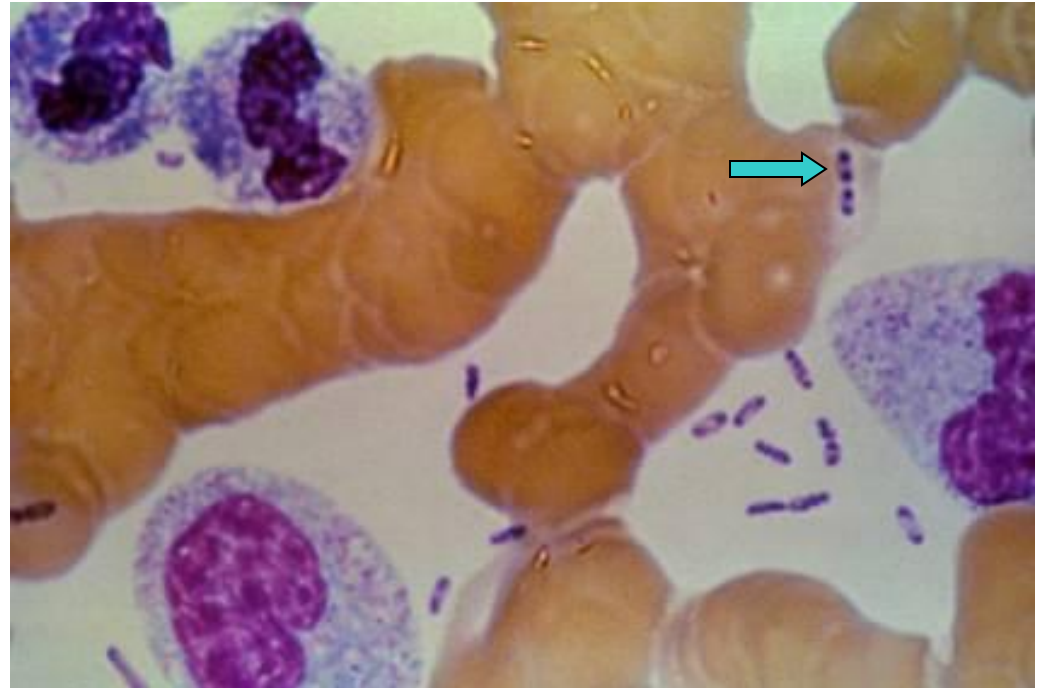


Bacteria



Streptococcus pneumoniae

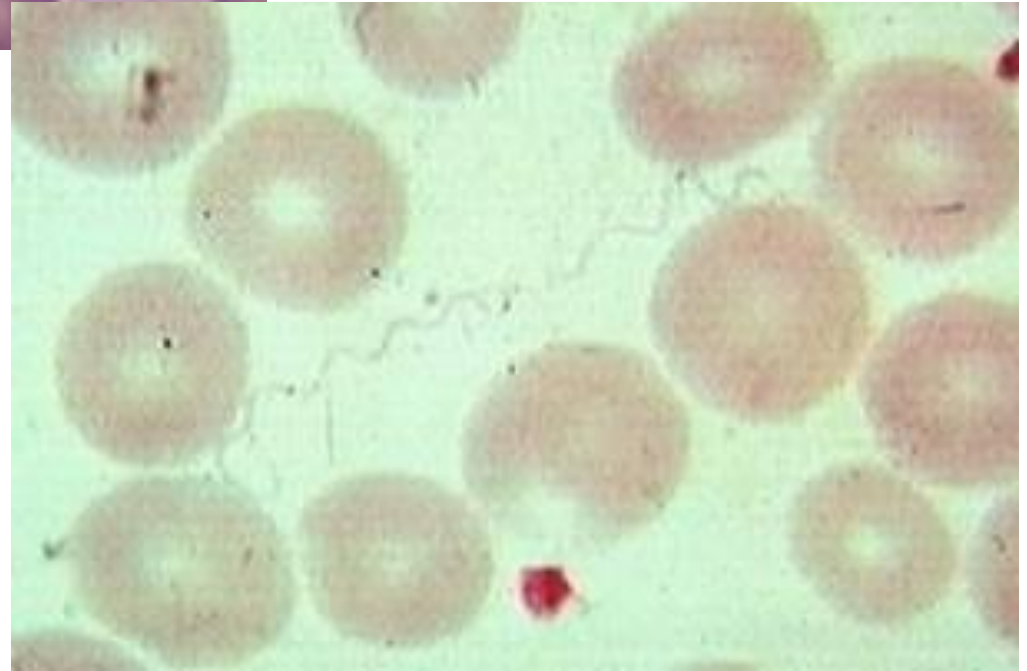
Yersinia pestis





Borrelia recurrentis

- Epidemic (louse-borne) relapsing fever – Ethiopia, Rwanda
- Endemic (tick-borne) relapsing fever – worldwide & western US
- Antigenic variation cycles & endotoxin



Ehrlichiosis

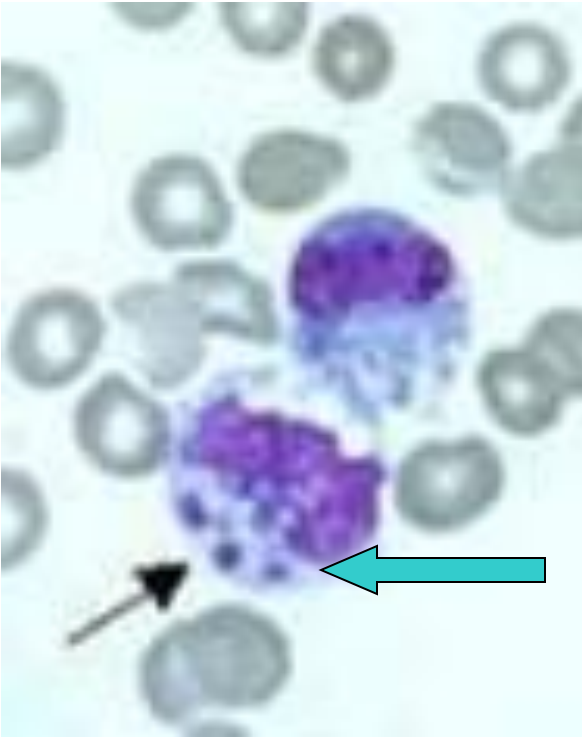
- *Ehrlichia sennetsu*
 - Sennetsu fever
 - Japan
 - Spread via consumption of raw fish
- **Ehrlichia chaffeensis*
 - Human monocytic ehrlichiosis
 - SE, Mid-Atlantic & South Central US
 - Spread via Lone Star Tick
 - Reservoir = white tailed deer
- *Ehrlichia ewingii* & *Ehrlichia phagocytophilia*
 - Human granulocytic ehrlichiosis
 - Midwestern & Atlantic US
 - Spread via Ixodes Tick
 - Reservoir = white-footed mouse, chipmunks



Ehrlichiosis Symptoms

- 1-3 weeks after bite
- High fever, headache, malaise, myalgias
- Leukopenia & Thrombocytopenia
 - Destruction of leukocytes
- 20% develop rash (more often in children than in adults)
- Mortality <5%
 - Death in elderly, immunocompromised (AIDS)
- Most common April-October

Ehrlichia sp.



Morulae

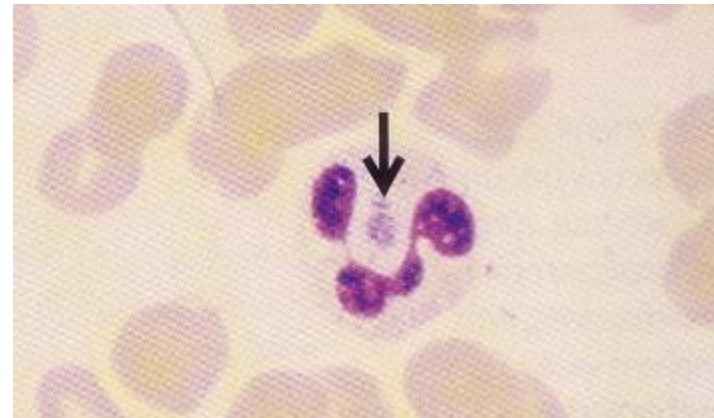
<10% of HME

20-80% of HGE

Better visualized with
Giemsa stain

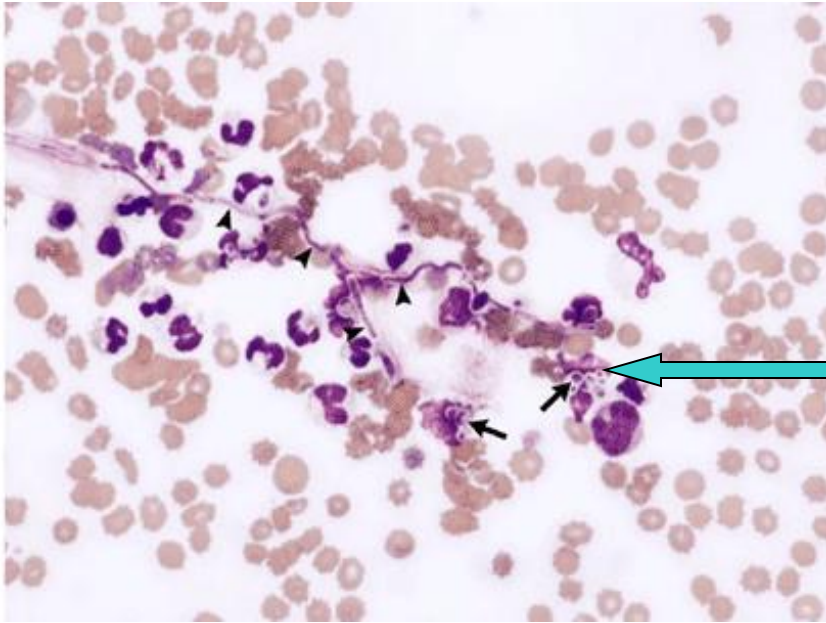
Diagnosis:

- Serology
- DNA probes



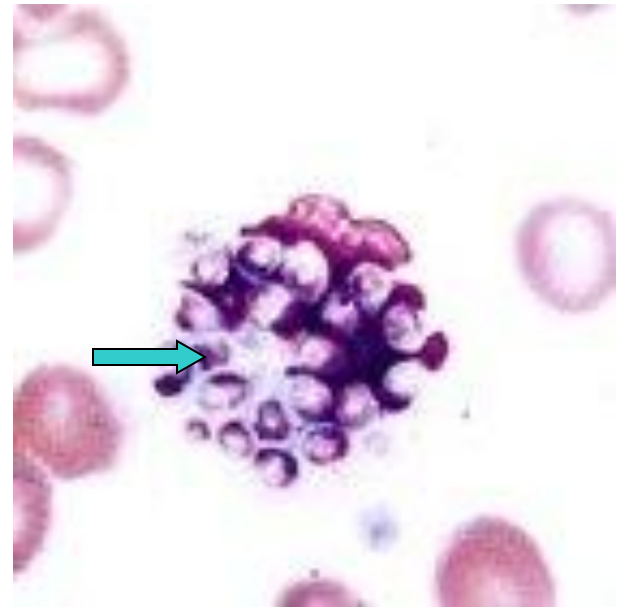
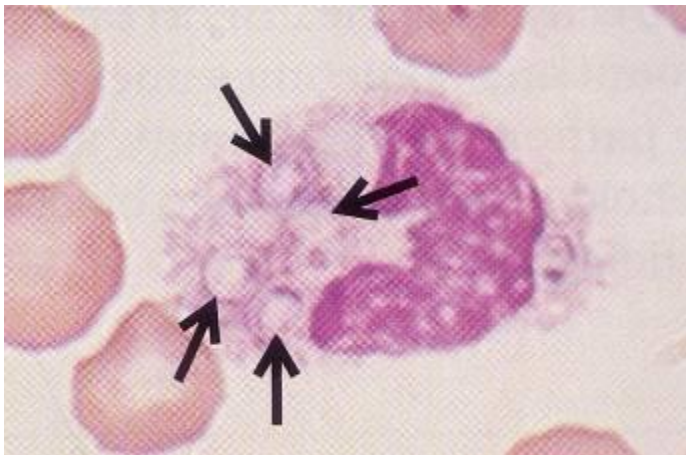


Fungi



Candida albicans

Histoplasma capsulatum





Protozoa

Malaria

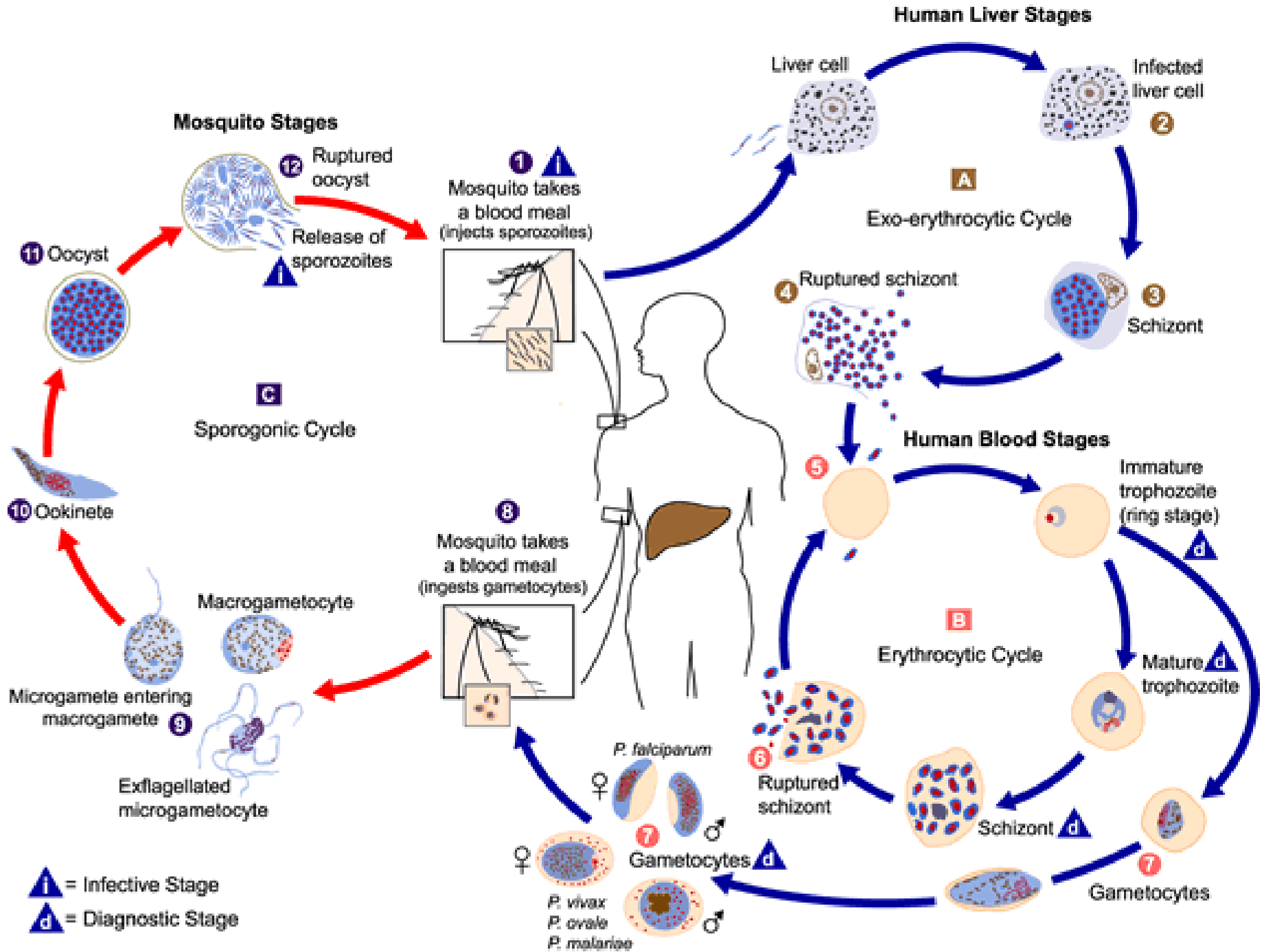


- 4 species of *Plasmodium*
- 300-500 million cases/year
- 1-2 million deaths/year
- Spread via female anopheles mosquitoes, blood transfusion, IVDA
- Cyclic fevers, headache & malaise
- Thick & thin blood smears prepared
 - Collection – midway between fever cycles

Estimate of World Malaria Burden



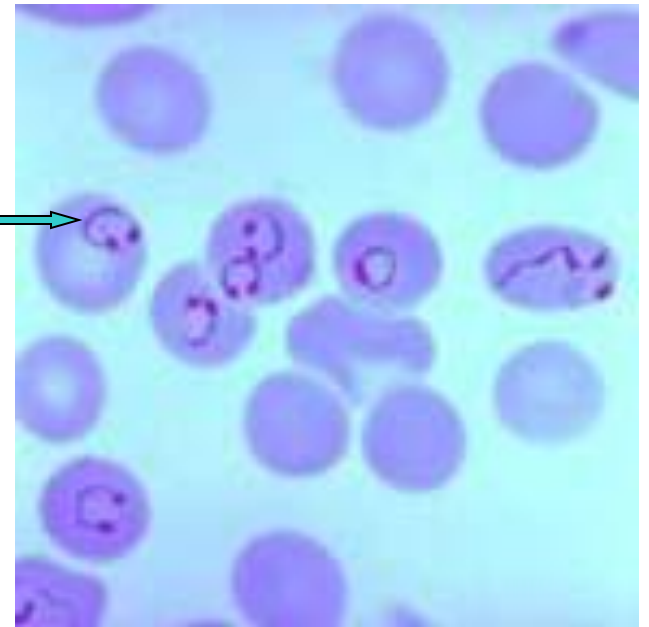
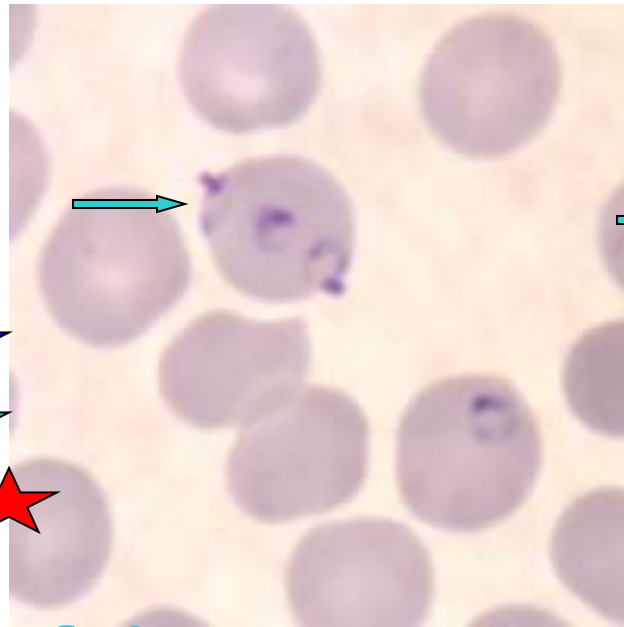
Source: RBM data/J.Sachs 1999



Plasmodium falciparum

- Malignant tertian malaria
- Asia & Africa
- Most deadly and severe infections
- Shortest incubation period = 7-10 days
- Infects all ages of RBCs → higher parasitemia
- Mature trophozoites and schizonts sequestered in microvascular system → tissue ischemia
 - Rarely seen in peripheral smear
- GI symptoms
- Black water fever
 - Intravascular hemolysis → kidney damage
 - Capillary plugging due to RBC debris
- Can involve CNS
- Widespread drug resistance

Trophozoites
(rings)



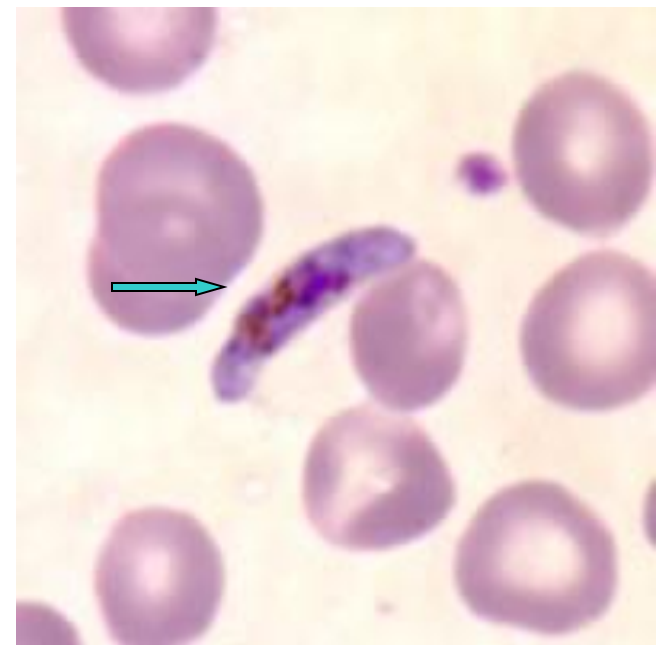
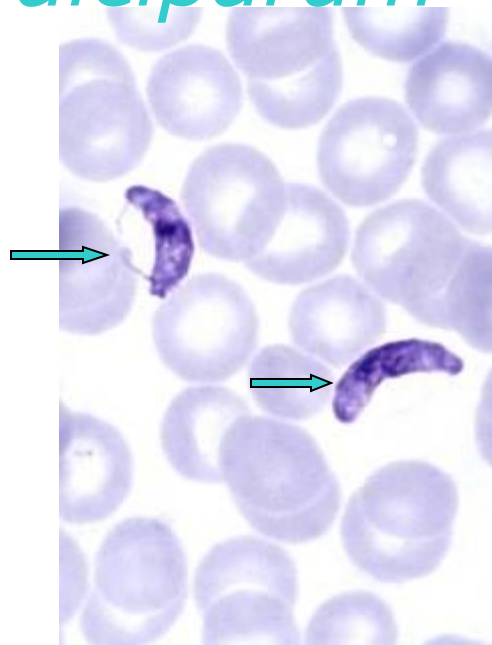
Multiple rings/cell 

Appliqué forms 

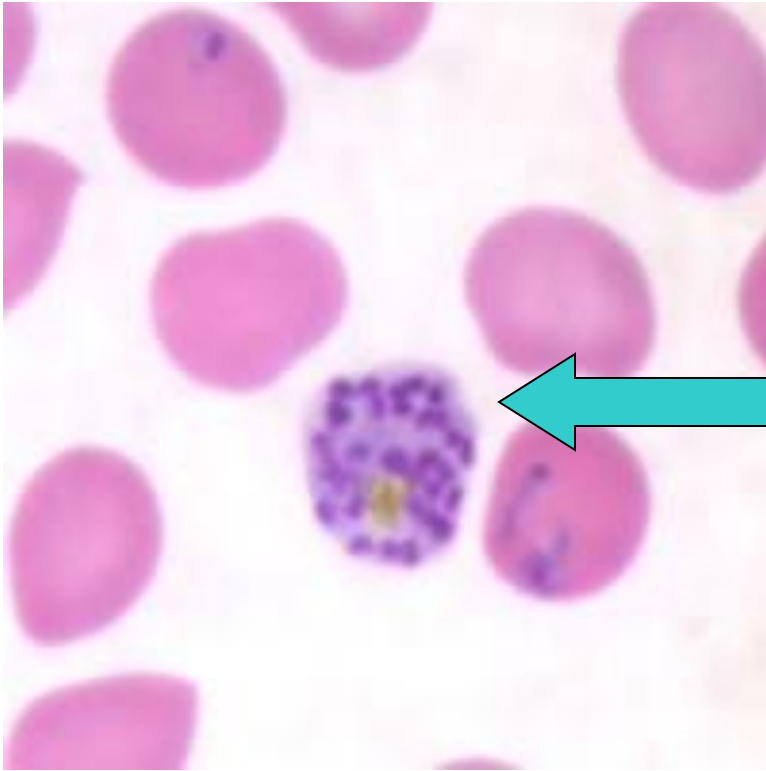
1-2 chromatin dots 

Plasmodium falciparum

Gametocytes

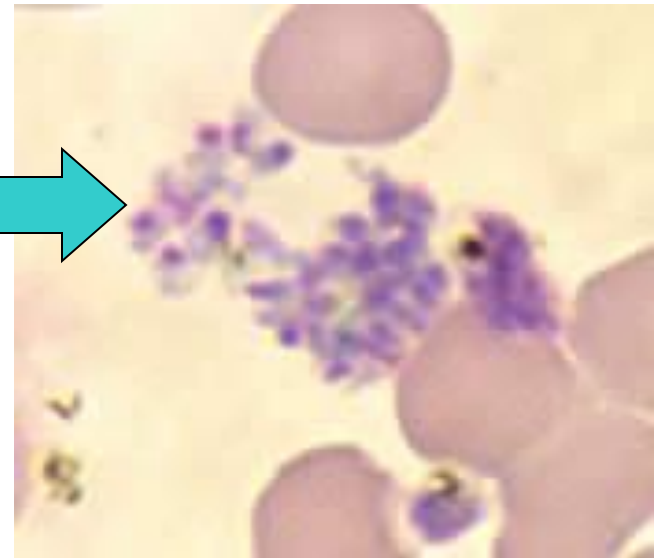


Plasmodium falciparum



Schizont

Ruptured Schizont





Plasmodium vivax

- Benign tertian malaria
- Latin America, India, Pakistan
- Only infects reticulocytes
- Produces HYPNOZOITES
- Relapses up to 5 years after infection
- Uses Duffy (Fy) antigen as receptor
- Treatment = Primaquine (for hypnozoite)

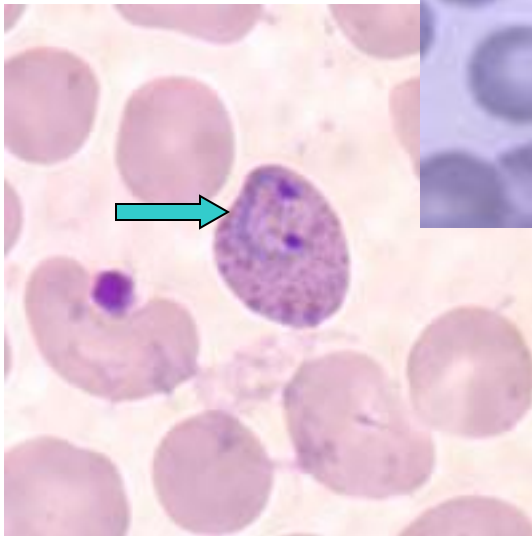
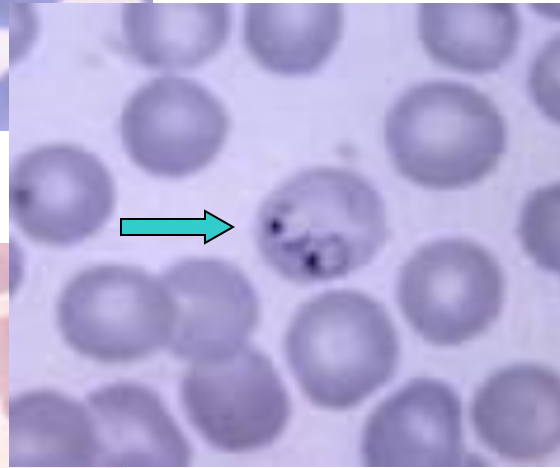
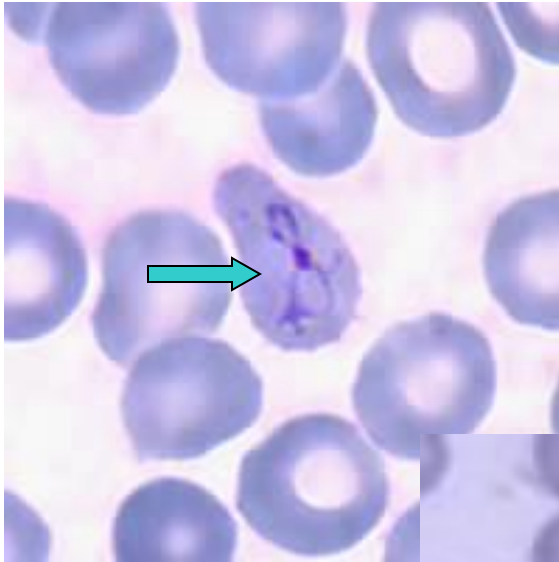
Plasmodium vivax

Early Trophozoites (rings)

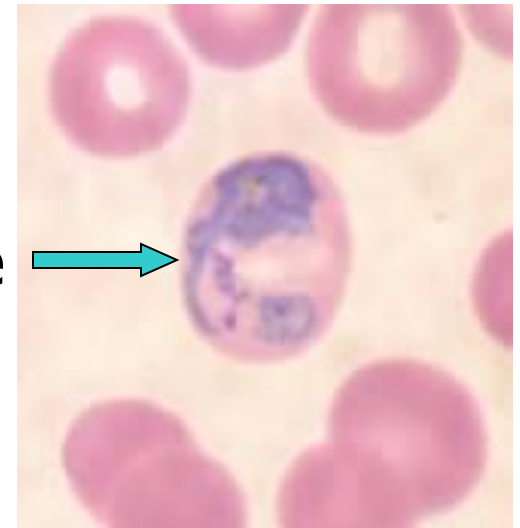
Ameoboid rings ★

Enlarged RBCs ★

Schuffner's Dots ★



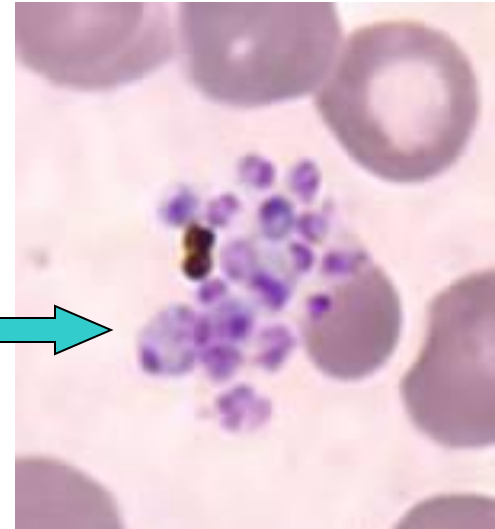
Mature trophozoite



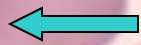
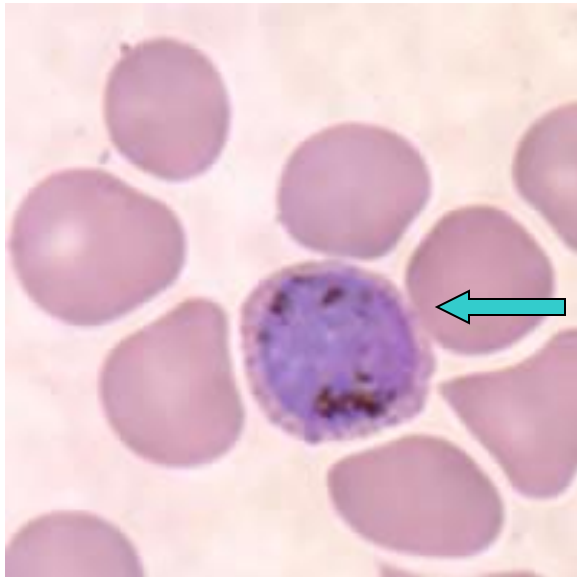
Plasmodium vivax



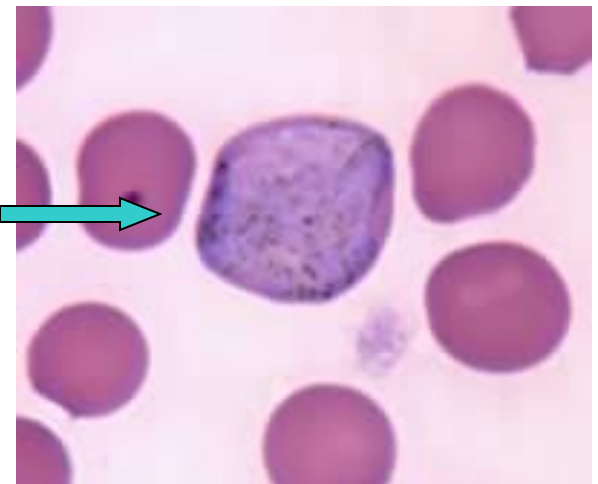
Schizont



Ruptured
Schizont



Gametocytes





Plasmodium ovale

- Ovale/benign tertian malaria
- Africa, Asia, South America
- Only infects reticulocytes
- Produces HYPNOZOITES
- Relapses up to 5 years after infection
- Treatment = Primaquine (for hypnozoite)

Plasmodium ovale

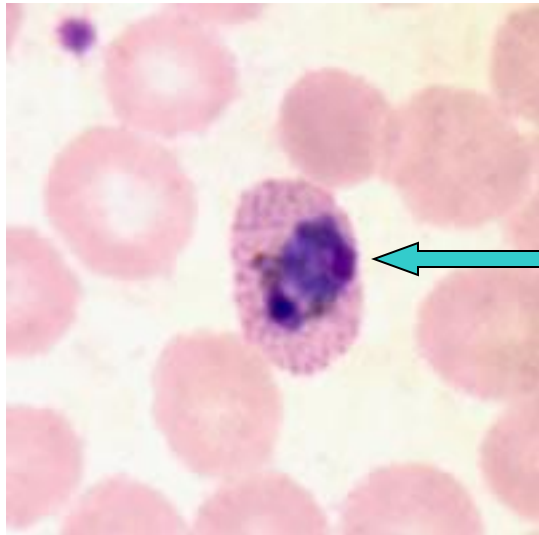


Early trophozoite (ring)

Enlarged RBCs ★

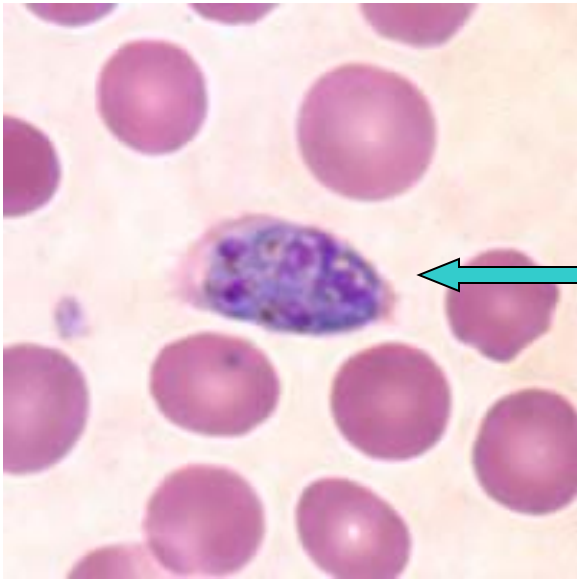
Fimbriated/Oval RBCs ★

Schuffner's Dots ★



Mature trophozoite

Plasmodium ovale



Schizont



Gametocytes





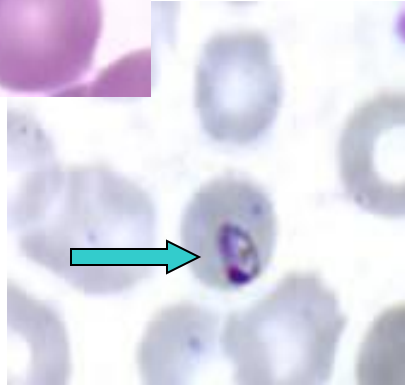
Plasmodium malariae

- Quartan malaria
- Asia & Africa
- Only infects mature RBCs
- Low-grade parasitemia that can persist >40 years
- Longest incubation period = 18-40 days, even years!

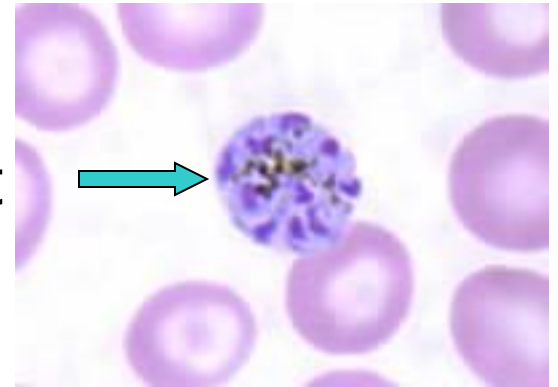
Plasmodium malariae



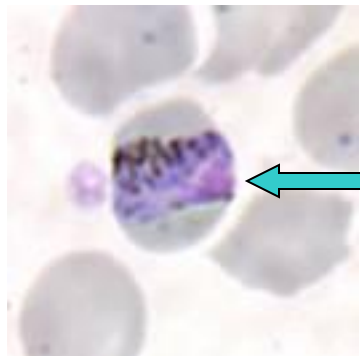
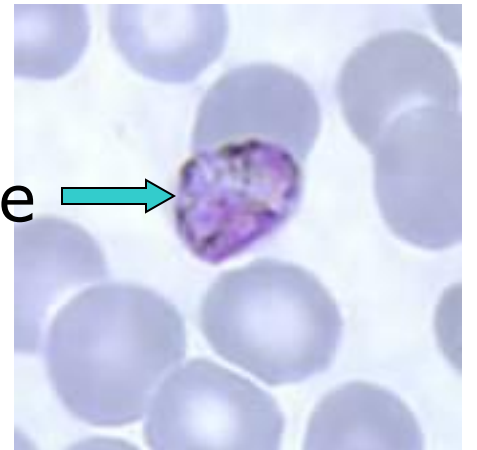
Early trophozoites (rings)



Schizont



Gametocyte

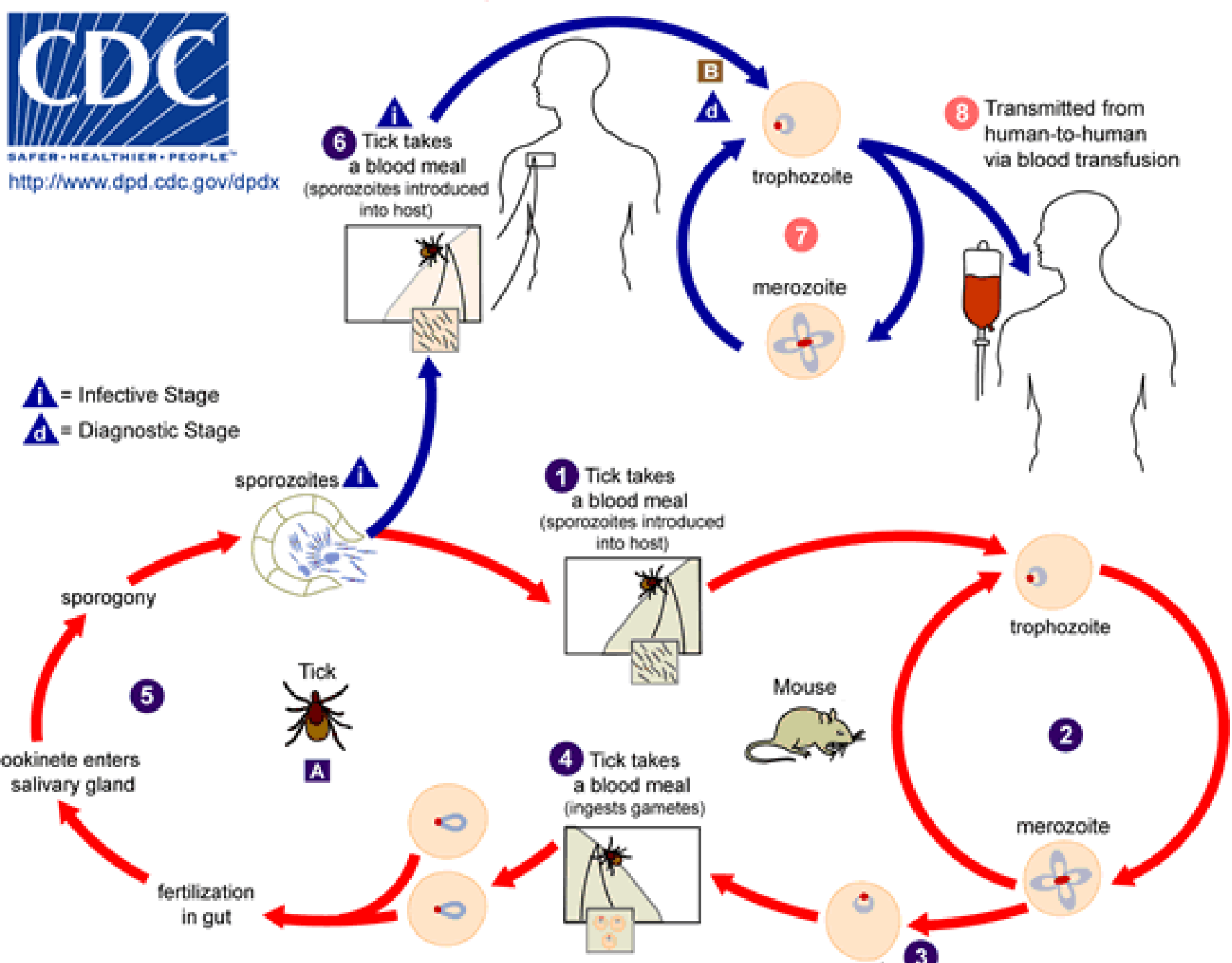


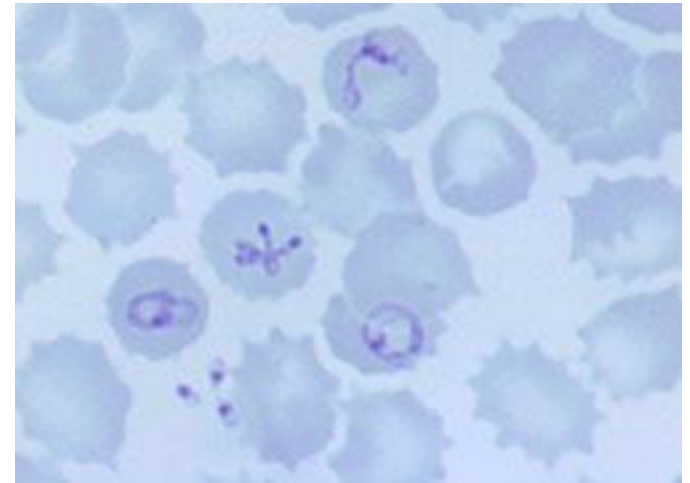
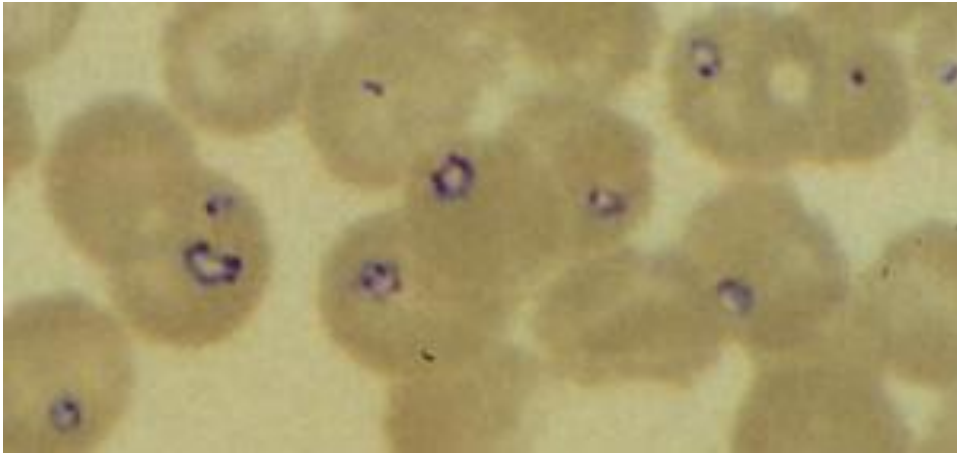
Mature trophozoite (band form)

Babesiosis

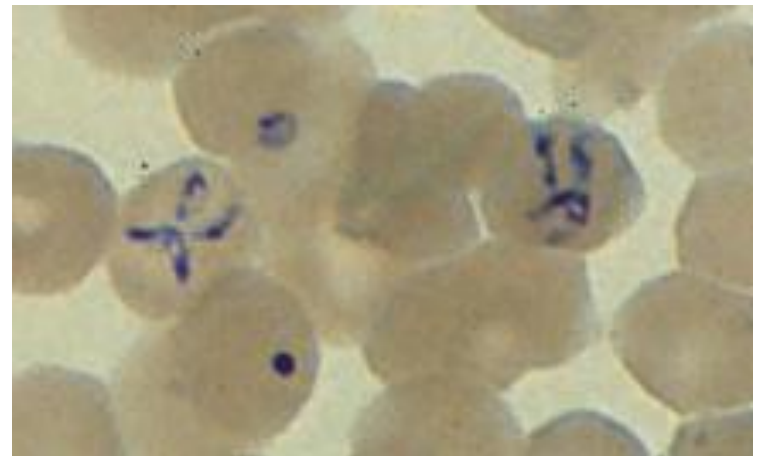
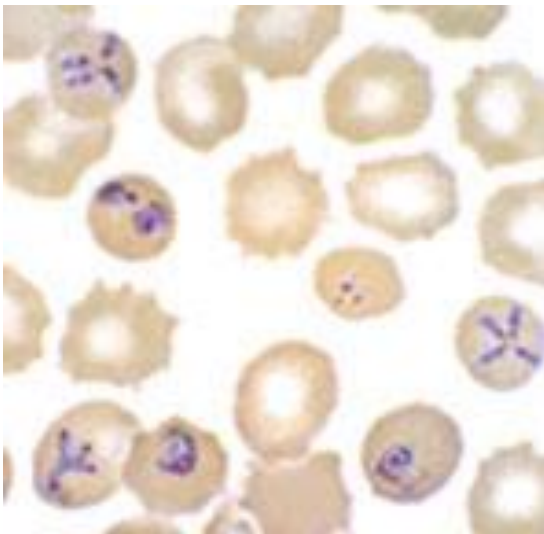


- *Babesia microti*
- Reservoir = deer, cattle, rodents
- Humans = accidental hosts
- Spread via Ixodes tick and transfusion
- Symptoms
 - Most infections asymptomatic or mild
 - 1-4 weeks after bite → headache, fever
 - Later may → hemolytic anemia, hepatomegaly, renal failure





Babesia microti



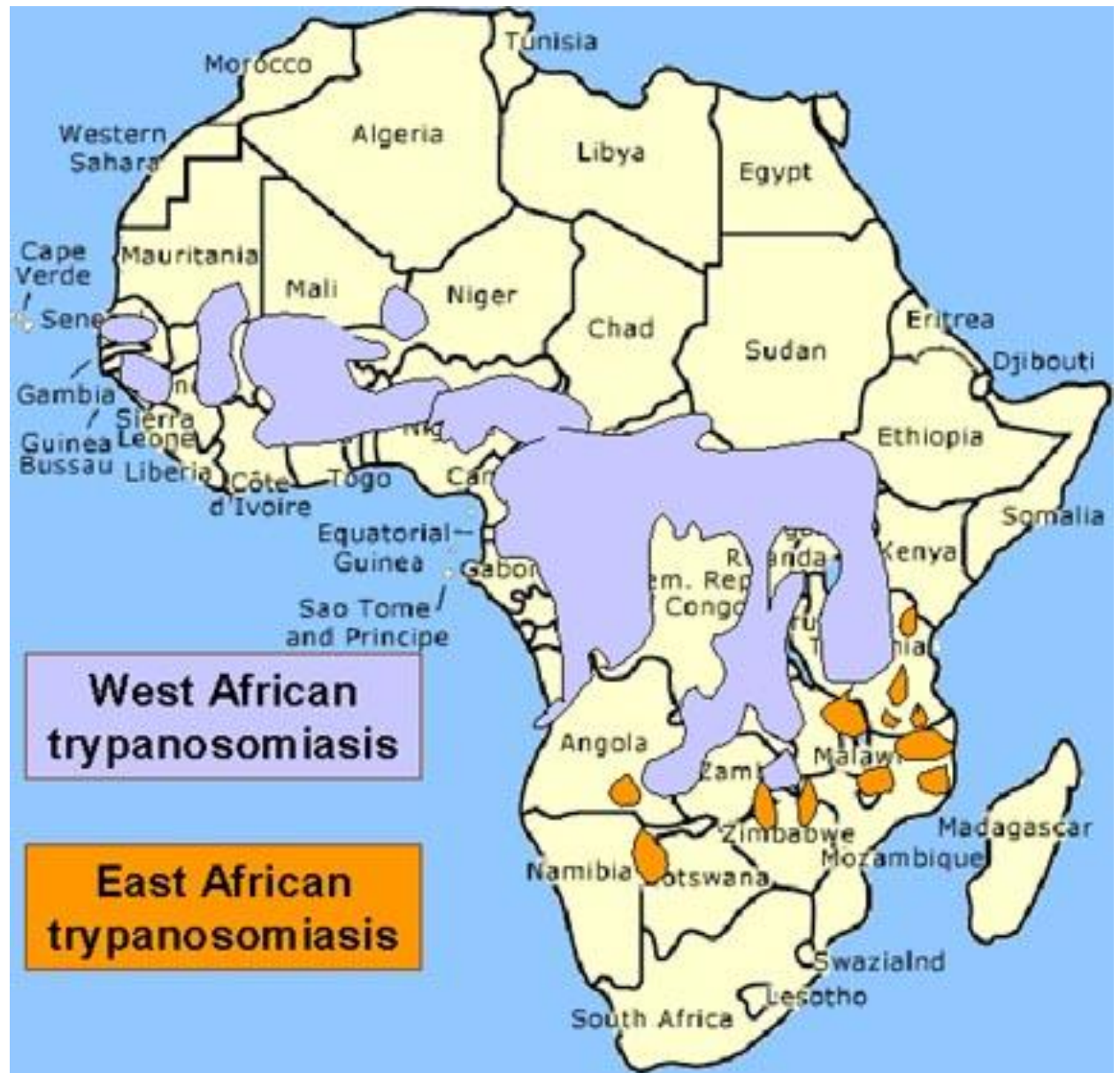


Trypanosomiasis

- African trypanosomiasis
 - Sleeping Sickness
- American trypanosomiasis
 - Chagas' Disease

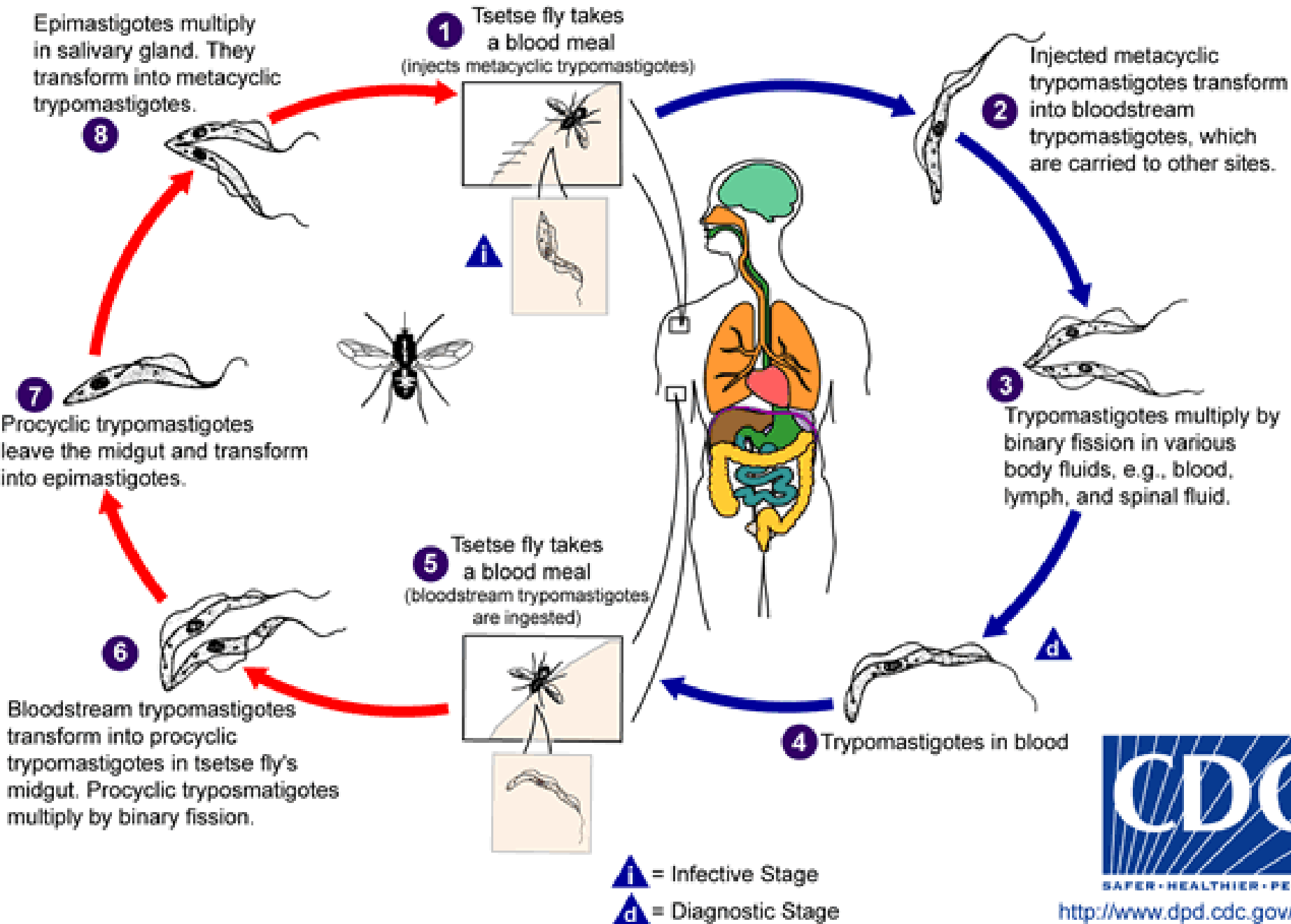
African Sleeping Sickness

- *Trypanosoma brucei gambiense*
 - West African Sleeping Sickness
 - Reservoir = humans
- *Trypanosoma brucei rhodesiense*
 - East African Sleeping Sickness
 - Progresses more rapidly with more severe symptoms
 - Reservoir = wild game
- 6000-10000 human cases annually
- Spread via Tsetse fly & blood transfusion



Tsetse fly Stages

Human Stages



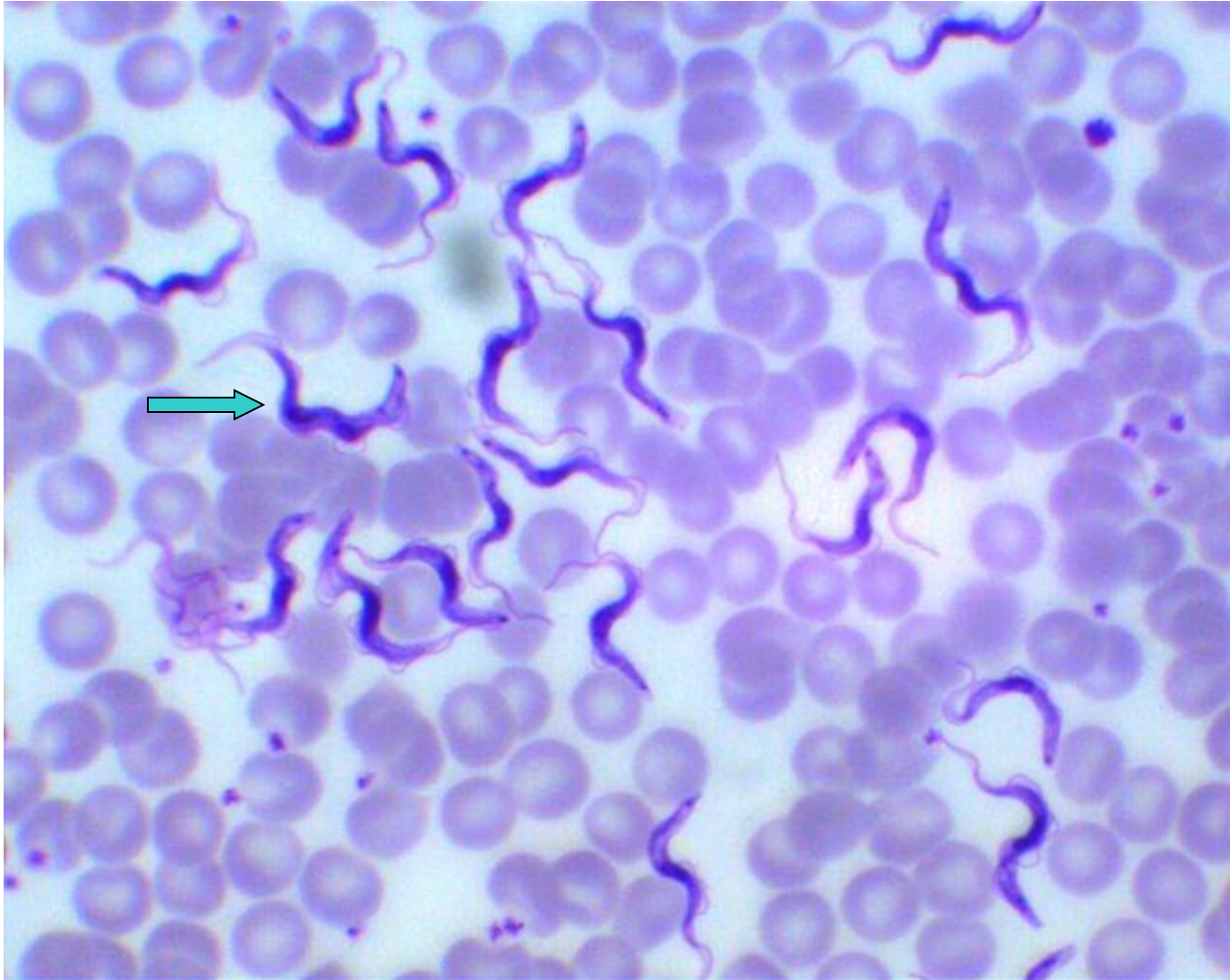
Symptoms

- Chancre (1-3 weeks) → parasitemia (2-3 weeks)
 - Fever, malaise, insomnia, headache
 - Winterbottom's sign = enlargement of posterior cervical glands
- CNS
 - Changes in character, tremors, sleepiness



Trypanosoma brucei

Trypomastigotes



Chagas' Disease

- *Trypanosoma cruzi*
 - Central and South America
 - Rare cases in Texas, California & Maryland
 - Estimated 16-18 million people infected
 - 50,000 die annually from disease
 - Spread via *Riduid* (kissing) bug
 - Also spread via blood transfusion and transplacentally
 - Many wild & domestic animals serve as reservoir

Trypanosoma cruzi
Chagas' disease
American trypanosomiasis



© CD-ROM ILLUSTRATED LECTURE NOTES ON TROPICAL MEDICINE

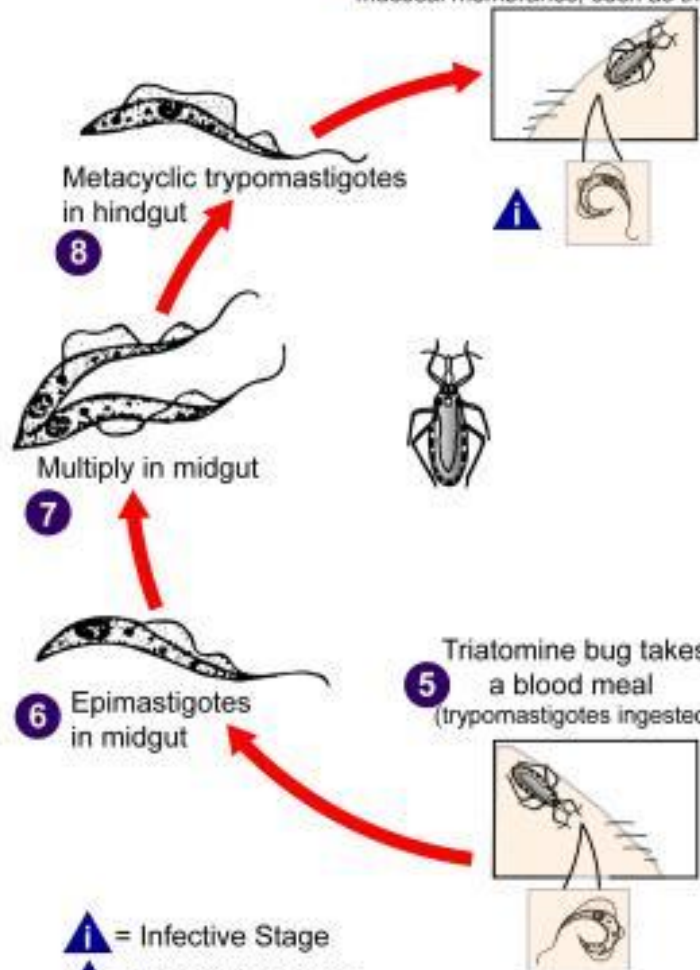


Trypanosomiasis, American (Chagas disease)

(*Trypanosoma cruzi*)

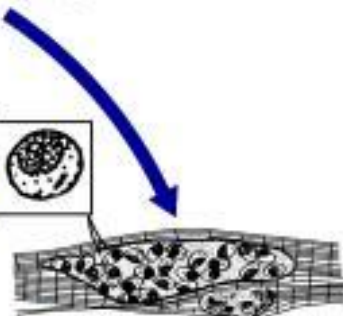
Triatomine Bug Stages

- 1** Triatomine bug takes a blood meal (passes metacyclic trypomastigotes in feces, trypomastigotes enter bite wound or mucosal membranes, such as the conjunctiva)



Human Stages

- 2** Metacyclic trypomastigotes penetrate various cells at bite wound site. Inside cells they transform into amastigotes.



Trypomastigotes can infect other cells and transform into intracellular amastigotes in new infection sites. Clinical manifestations can result from this infective cycle.

- 3** Amastigotes multiply by binary fission in cells of infected tissues.

- 4** Intracellular amastigotes transform into trypomastigotes, then burst out of the cell and enter the bloodstream.

i = Infective Stage
d = Diagnostic Stage

Symptoms

- Chagoma
 - Ramana's sign = unilateral conjunctivitis & orbital edema
- Acute Stage
 - 7-14 days after infection
 - Usually not recognized and resolves
 - Malaise, fever, hepatomegaly, rash
 - Acute myocarditis
 - Meningoencephalitis in children

Chronic Stage

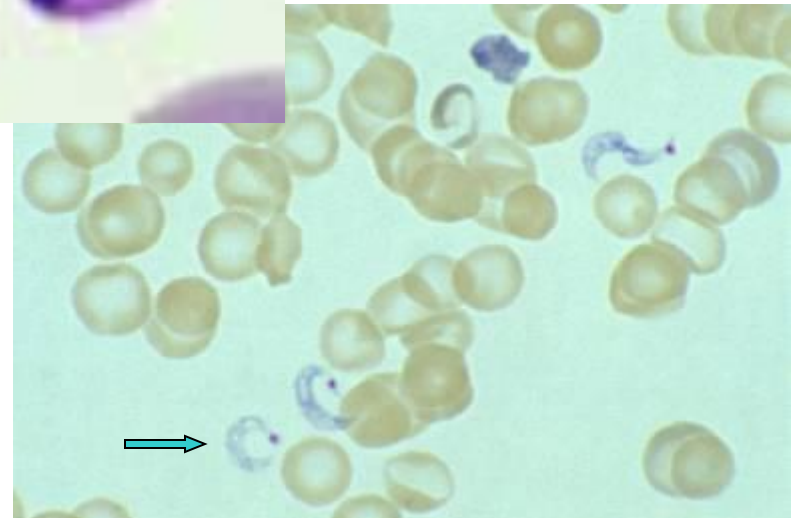
- Approximately 10-20% of infected
- Relapsing & remitting symptoms
- Myocardial insufficiency, cardiomegaly, arrhythmias
- Megaesophagus & megacolon

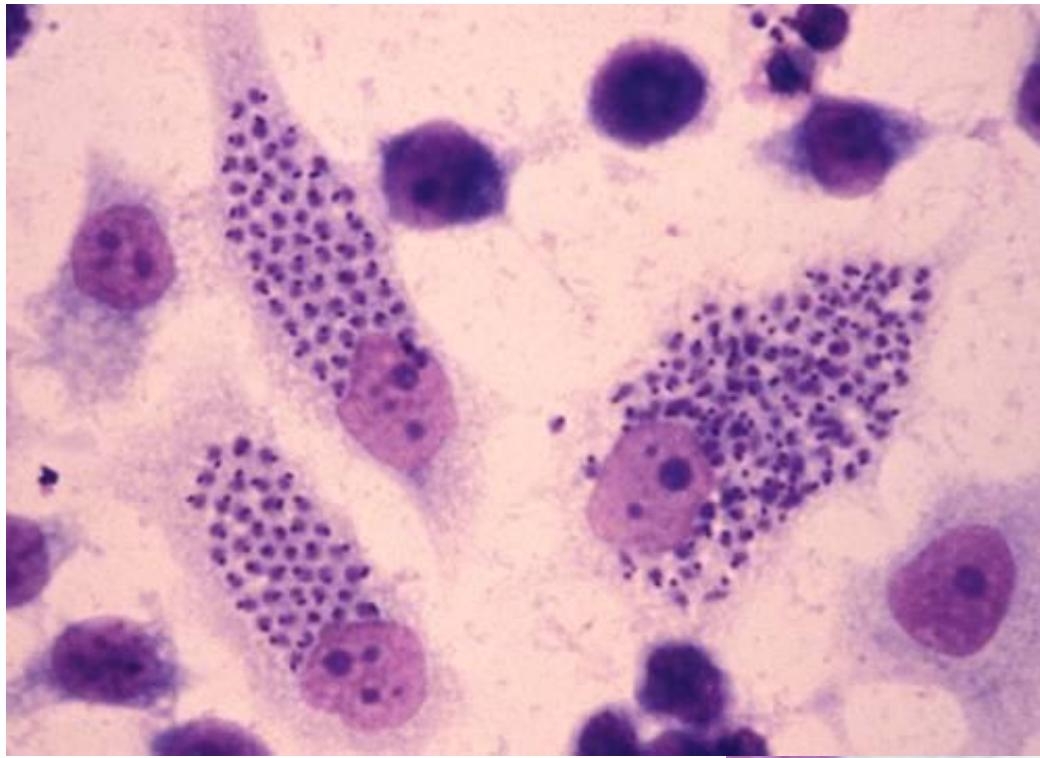


Trypanosoma cruzi



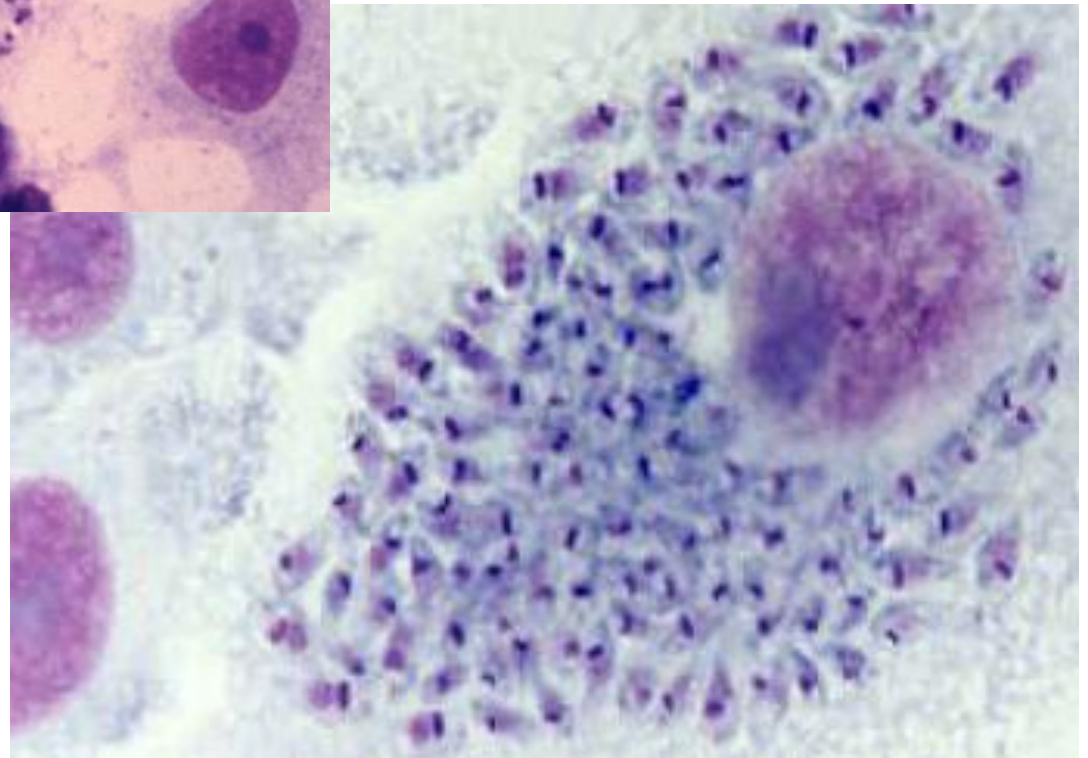
Trypomastigotes





*Trypanosoma
cruzi*

Amastigotes in tissue



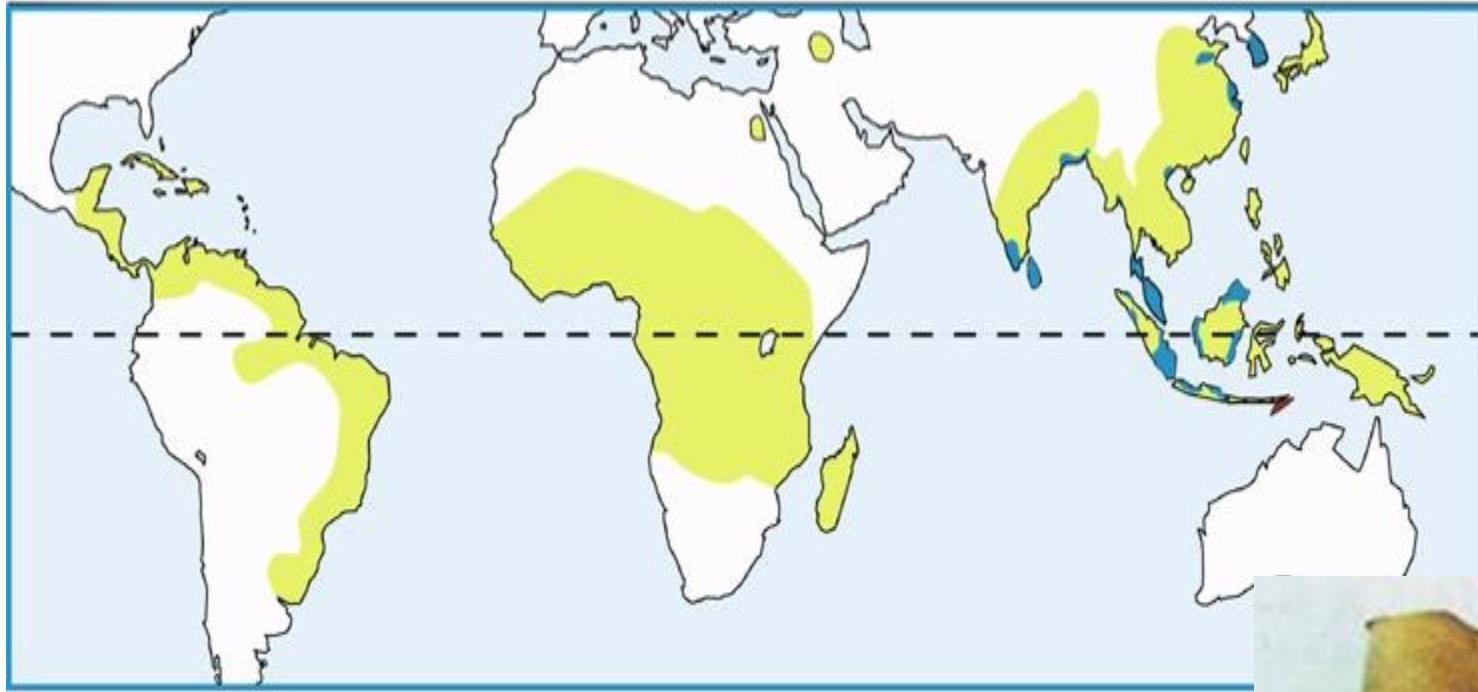


Filariidae

Elephantitis / Filariasis

- *Wuchereria bancrofti* & *Brugi malayi*
- Spread via mosquitos
- Can persist in humans up to 10 years
- May be asymptomatic
- Acute - Fever, lymphangitis
- Chronic – Filarial elephantitis
- Higher numbers of organisms in blood at night

Wucheria bancrofti, *Brugia malayi*





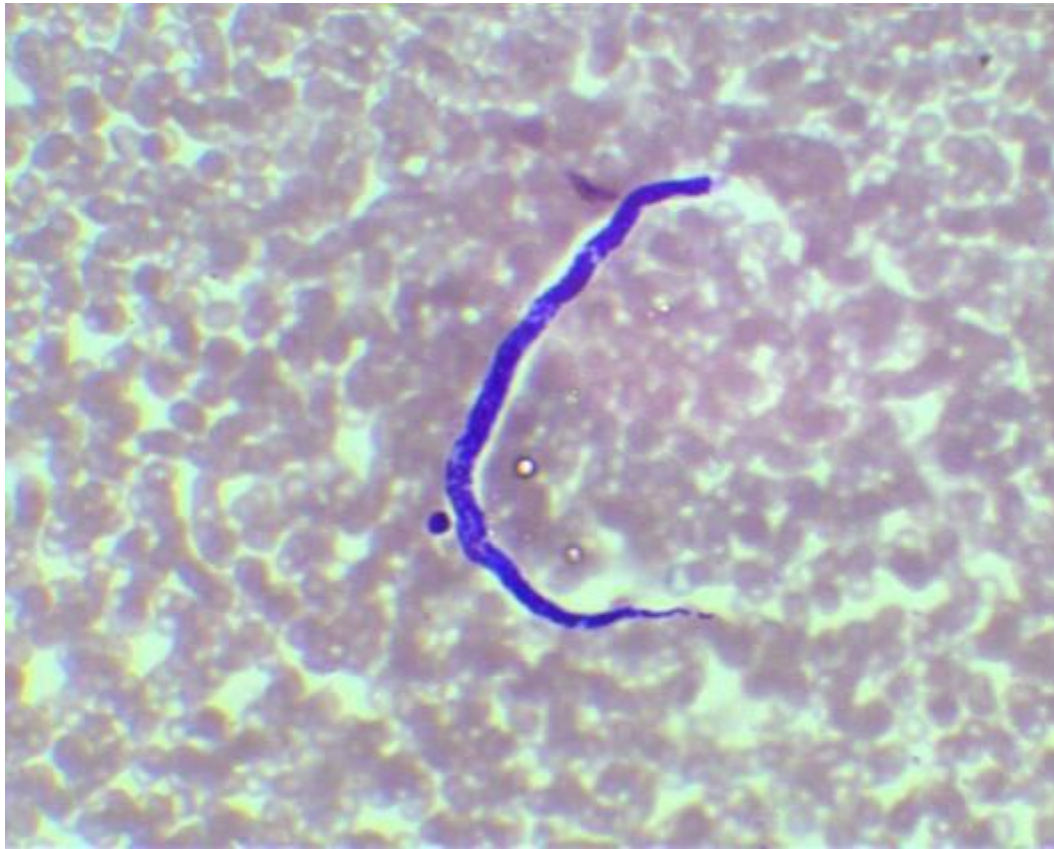
Brugia malayi



Wuchereria bancrofti

Loa Loa

- Endemic in West Africa, Nigeria
- Spread via mango fly
- Can persist up to 17 years
- Reservoir = monkey
- Symptoms 1 year after infection
 - Calabar swellings
 - Worm migration in conjunctiva
- Higher number of organisms in blood at daytime



Loa loa

