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# Parasitology 2021

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# Laboratory Diagnosis

Current diagnosis is predominately based on microscopic exam

Specimen types:

- Stool
- Non-stool
  - Perianal specimen
  - Sigmoidoscopic specimen
  - Duodenal aspirates
  - Liver abscess
  - Sputum
  - Urine
  - Urogenital
- Blood
- Tissue

Alternative testing methods:

- Serology for select pathogens
- Fluorescent stains of stool for select pathogens
- Molecular assays of stool for select pathogens

# Diarrheal Disease due to Parasites

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Travel history or poor sanitation puts you at the highest risk for parasitic diarrheal disease

Patients with poor immune status fare worse

Diarrheal disease usually has sporadic symptoms that are chronic in nature, dysentery not common

Most usual symptoms:

- Abdominal pain, cramping, long term nausea, and malaise, mucous in stool, and +/- fever

# Two-vial Stool Collection Kit

## Preservation of stool for parasite exam

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### 10% formalin vial

Concentration of stool performed with ethyl acetate washing to eliminate fecal debris

Can use to perform: Wet mount, Iodine mount, Direct Fluorescent antibody staining, and NAAT

Detect: Helminth eggs, larvae, microsporidia, and protozoan cysts

### PVA with fixative

Polyvinyl alcohol (PVA)

Permanent smear prepared from PVA stool vial and stained with Trichrome stain

Detect: Protozoan trophozoites and cysts

# Protozoa: Amebae found in stool

|             |      | AMEBAE                       |                            |                       |                                       |                       |                            |  |
|-------------|------|------------------------------|----------------------------|-----------------------|---------------------------------------|-----------------------|----------------------------|--|
|             |      | <i>Entamoeba histolytica</i> | <i>Entamoeba hartmanni</i> | <i>Entamoeba coli</i> | <i>Entamoeba polecki</i> <sup>1</sup> | <i>Endolimax nana</i> | <i>Iodamoeba bütschlii</i> | <i>Dientamoeba fragilis</i> <sup>2</sup> |
| Trophozoite |      |                              |                            |                       |                                       |                       |                            |  |
|             | Cyst |                              |                            |                       |                                       |                       |                            | No cyst                                  |

<sup>1</sup>Rare, probably of animal origin

Scale: 0 5 10 μm

Adapted from Brooke and Melvin, 1964

<sup>2</sup>Flagellate

# *Entamoeba histolytica/dispar*

*E. histolytica* (pathogen) and *E. dispar* (nonpathogen) both occur in the large intestine. Morphologically indistinguishable.

- Antigen testing or molecular method needed to distinguish the species.

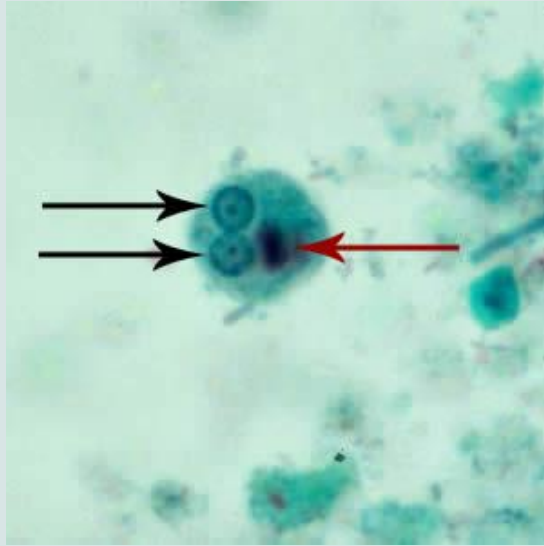
Disease = Amoebiasis, or amoebic dysentery

- Most infections are asymptomatic, invasive intestinal disease may occur manifesting with several weeks of cramping, abdominal pain, watery or bloody diarrhea, and weight loss

Diagnosis

- Cysts = infectious form found in stool specimens
  - Found in contaminated water and areas of poor sanitation
- Trophozoites = invasive form found in the intestine tissue and stool
  - Colon biopsy with “flask-shaped” ulcer and trophozoites in tissue

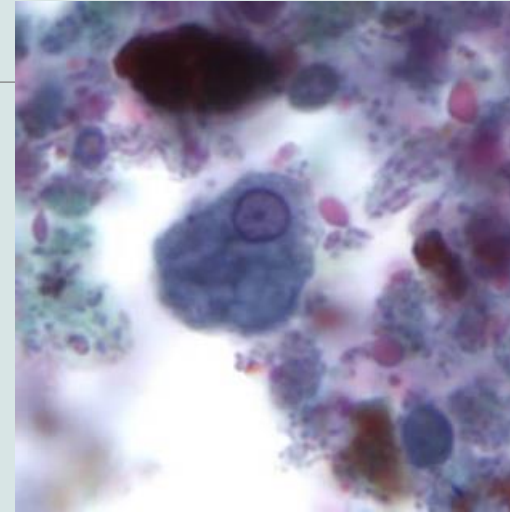
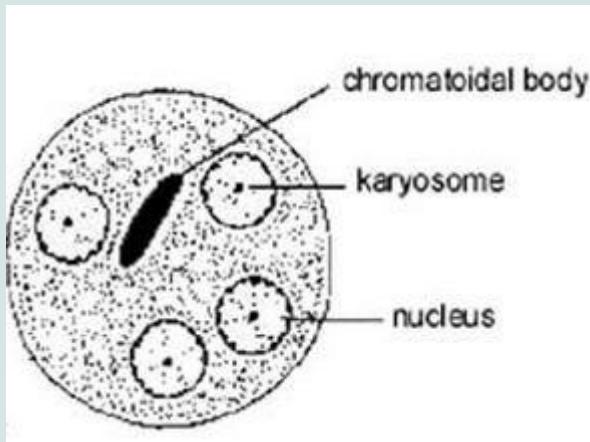
# *Entamoeba histolytica/dispar* cyst and trophozoite



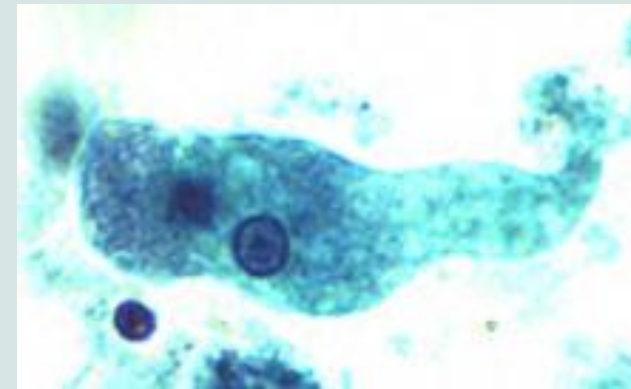
**Cysts** @ 10-12  $\mu\text{m}$   
in diameter

Up to 4 nuclei in  
the cyst/ central  
karyosome, clean  
chromatin ring

Chromatoidal body  
present in some cysts

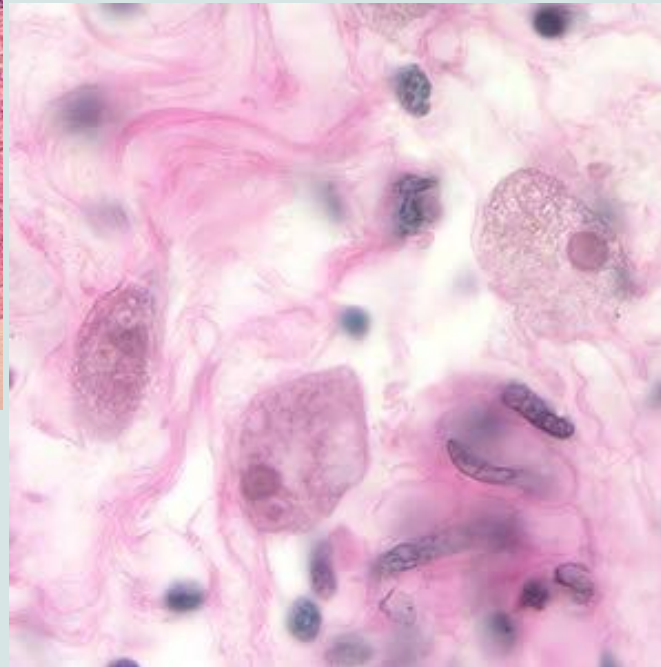


**Trophozoite** 20-30  $\mu\text{m}$   
in diameter  
One nucleus with  
centrally placed  
karyosome



# Intestinal Amoebiasis

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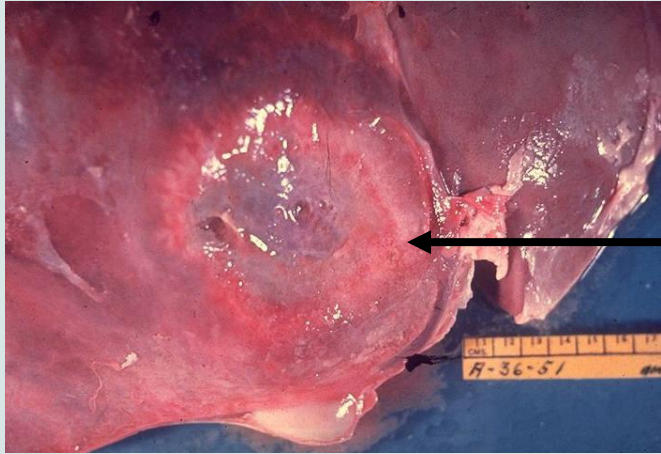


Flask shaped ulcer  
formed in tissue  
of the large intestine

Trophozoites of  
*E. histolytica*  
observed in intestinal  
tissue

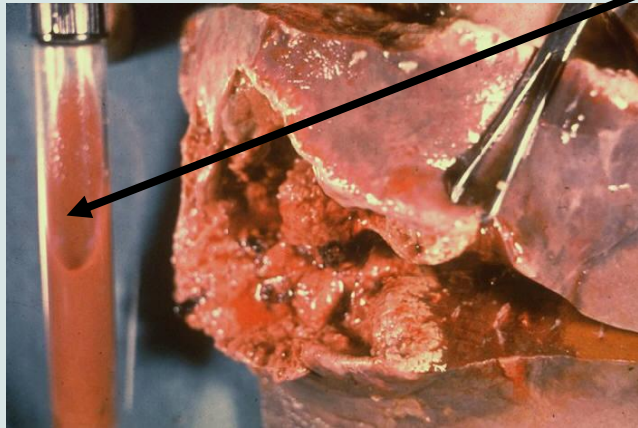


# Liver Amebic Abscess



Extra-intestinal disease:

Trophozoites from large intestine travel through the blood and invades the liver to form abscess. Abscess fluid is necrotic and will not contain trophozoites. Must biopsy infected tissue to observe trophozoites.

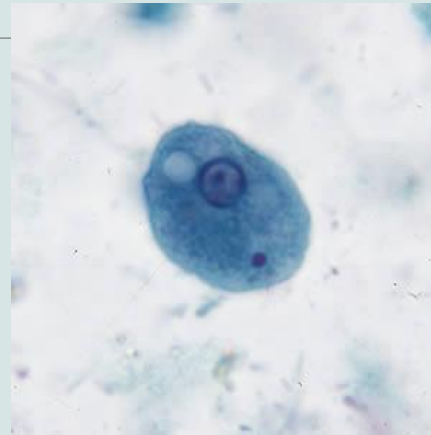


Serology will be positive in  $\geq 90\%$  patients with liver abscess compared to  $\leq 50\%$  of cases of intestinal infection only

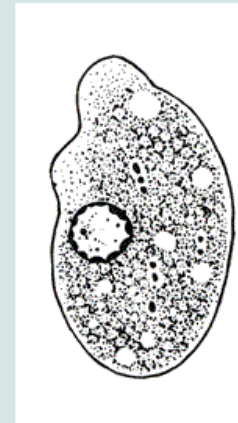
# *Entamoeba coli* – amoeba in large intestine, commensal not causing disease



**Cyst** @ 20–25µm  
Up to 8 nuclei  
Shed from host  
Lives in environment



**Trophozoite** is the  
invasive form that is  
found in the  
intestine



Single nucleus with a  
large karyosome located  
eccentrically with irregular  
chromatin ring (differs  
from *E. histolytica*).  
The cytoplasm appears  
dirty and vacuolated

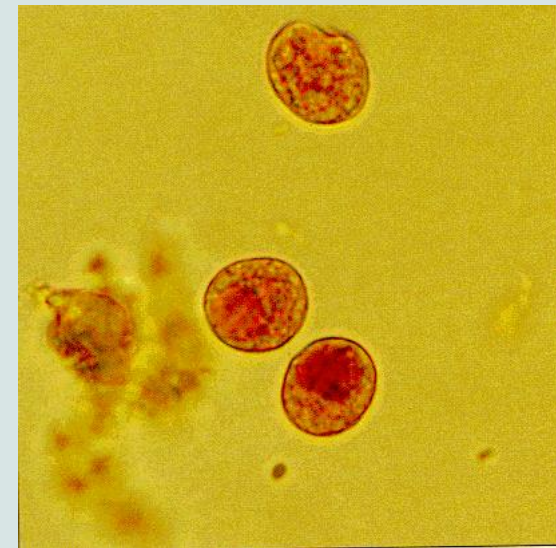
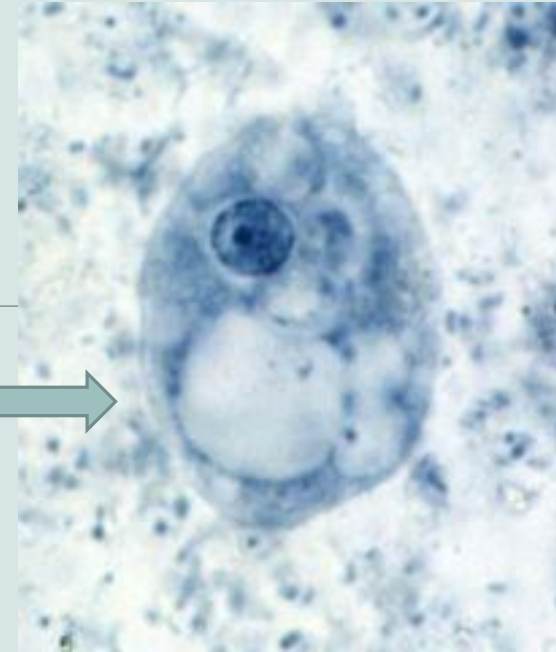
# *Iodamoeba butschlii*

Cysts, 10 – 12  $\mu\text{m}$

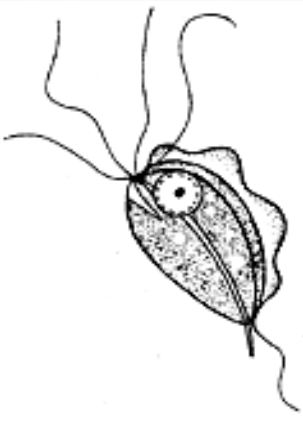
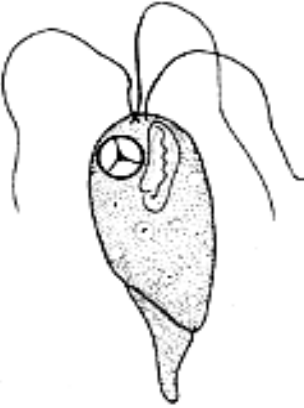
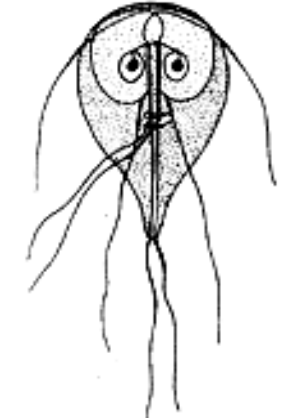

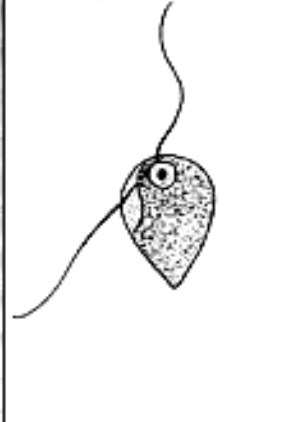




Unique large starch inclusion  
(glycogen mass)

Usually not considered a pathogen

Iodine-stained stool preparation –  
glycogen inclusions stain dark color with  
iodine



# Protozoa Found in Stool: Flagellates

| FLAGELLATES |   |  |   |   |   |
|-------------|---|--|---|---|---|
|             | <i>Trichomonas hominis</i>  | <i>Chilomastix mesnili</i>   | <b>Pathogen</b><br><i>Giardia lamblia</i>   | <i>Enteromonas hominis</i>  | <i>Retortamonas intestinalis</i>  |
| Trophozoite |  |    |    |    |    |
| Cyst        | No cyst<br><br>Scale:<br>0 5 10<br>μm   |  |  |  |  |

# *Giardia lamblia* (*G. intestinalis*, and *G. duodenalis*)

Found in contaminated water & undercooked foods

Mild diarrhea to severe malabsorption, waxing and waning symptoms

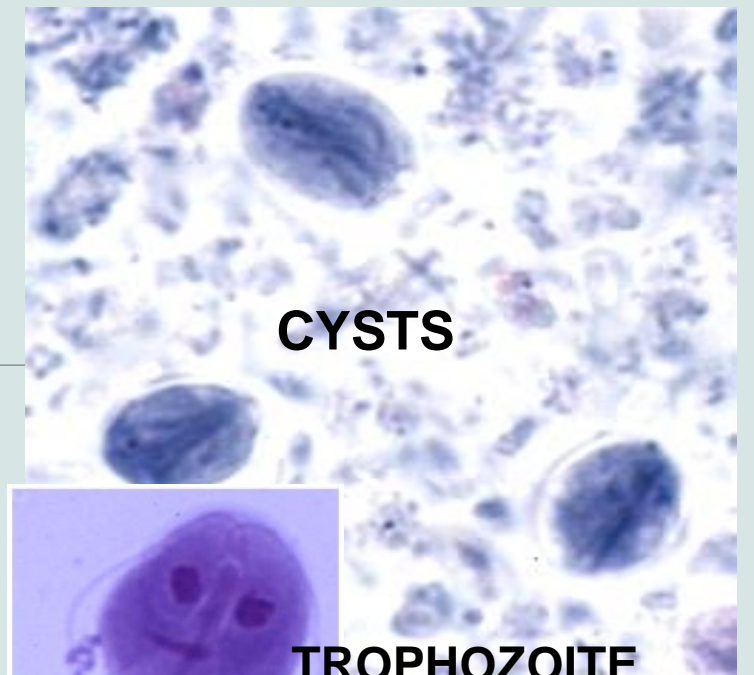
Foul smelling , watery diarrhea

Traveler's diarrhea (Russia and Mexico)

Day-care center outbreaks reported

Cysts/trophozoites may be irregularly shed in stool, and be difficult to detect; Fluorescent stains and NAAT for provide more sensitive detection

Confined to intestine / Therapy Flagyl (Metronidazole)



**CYSTS**



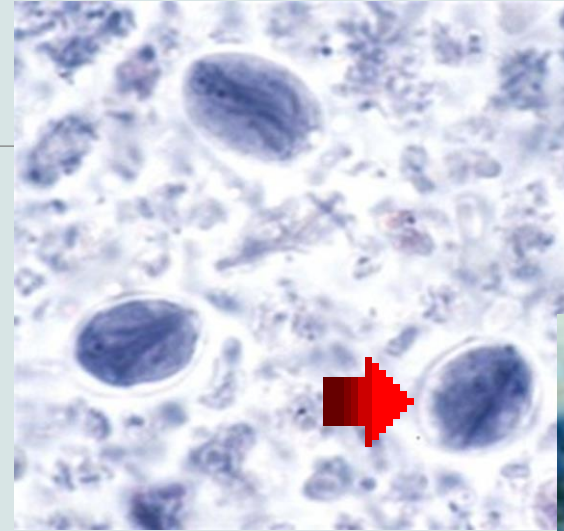
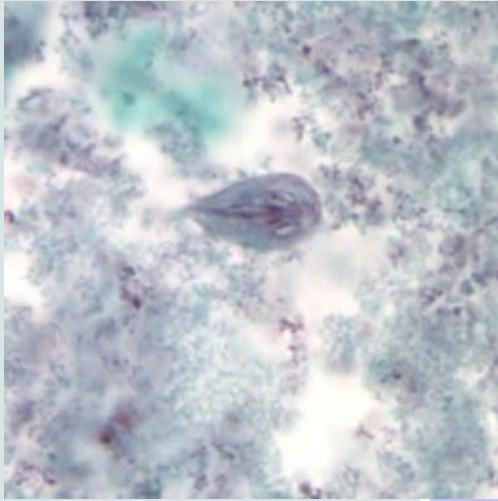
**TROPHOZOITE**

“falling leaf”  
motility



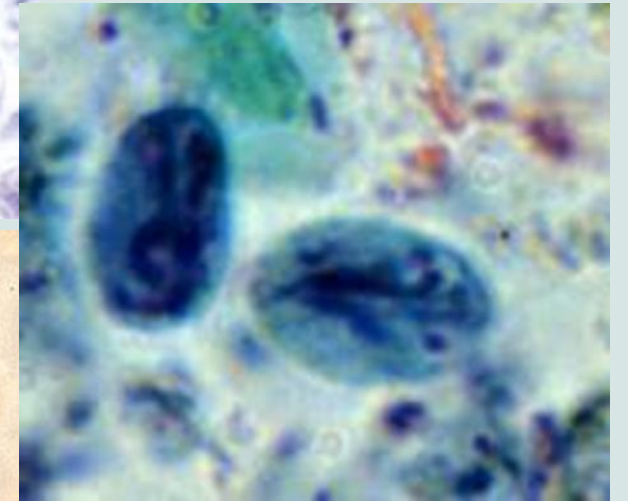
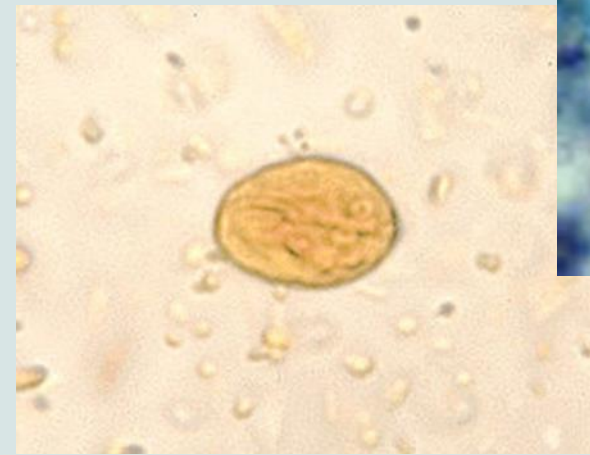
# *Giardia lamblia*

Trophozoite



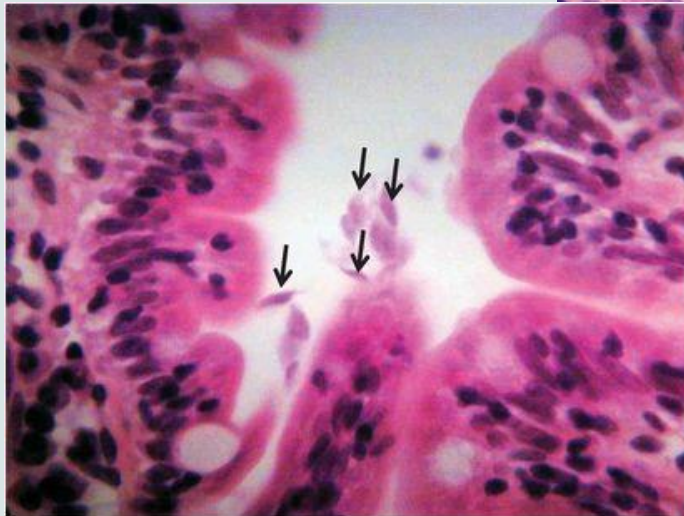
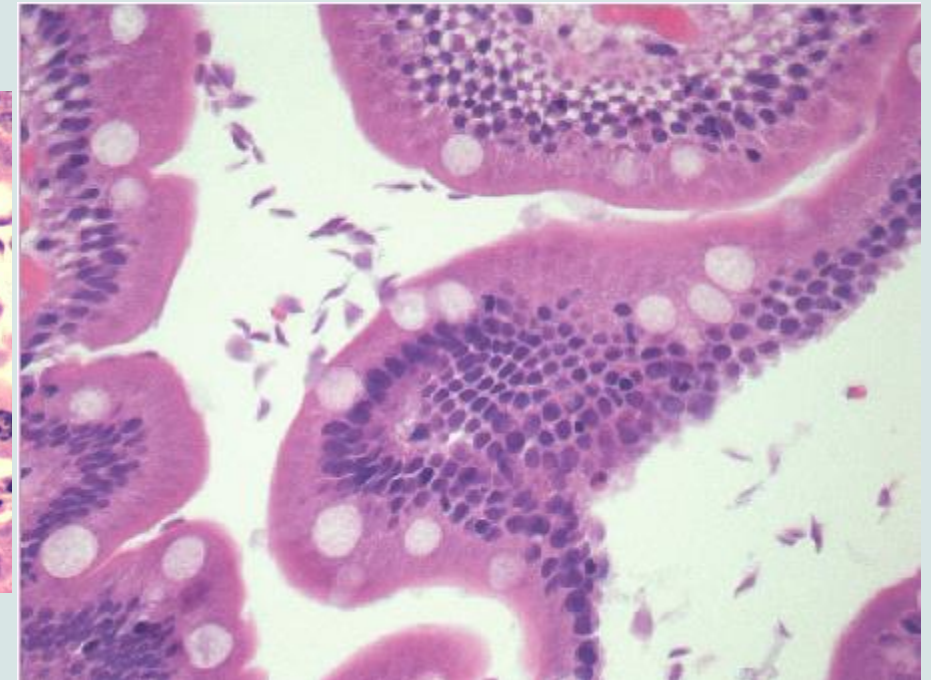
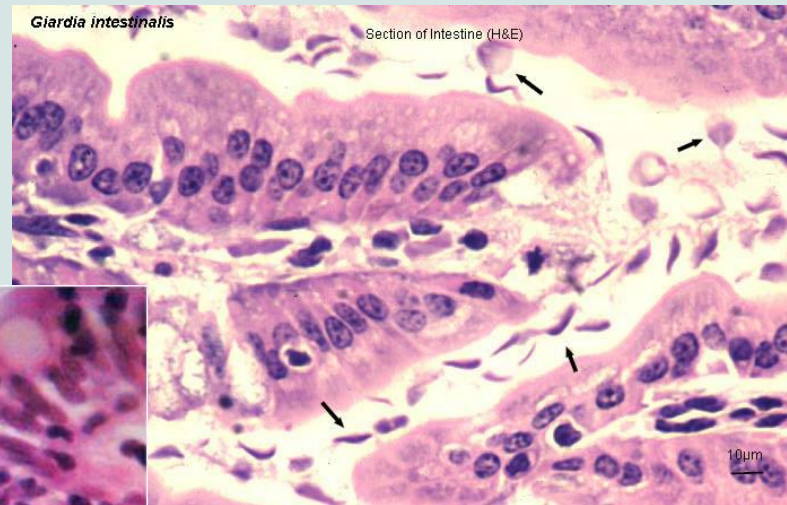
Cysts

Clearing between the cell wall and the cell membrane



# *Giardia lamblia*

invades intestinal tissue – shown are duodenal biopsies with trophozoites near the surface epithelium



# *Chilomastix mesnili* cyst



Nonpathogen

Morphology mimics Giardia lamblia cyst – except for the clear space at end of cyst

Internal structure looks like “shepherd’s crook” or safety pin



*C. mesnili* trophozoite – seldom seen in clinical specimens



# *Trichomonas vaginalis*

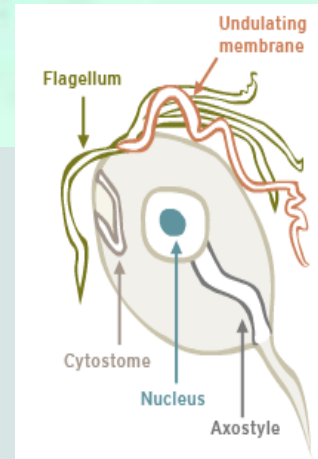
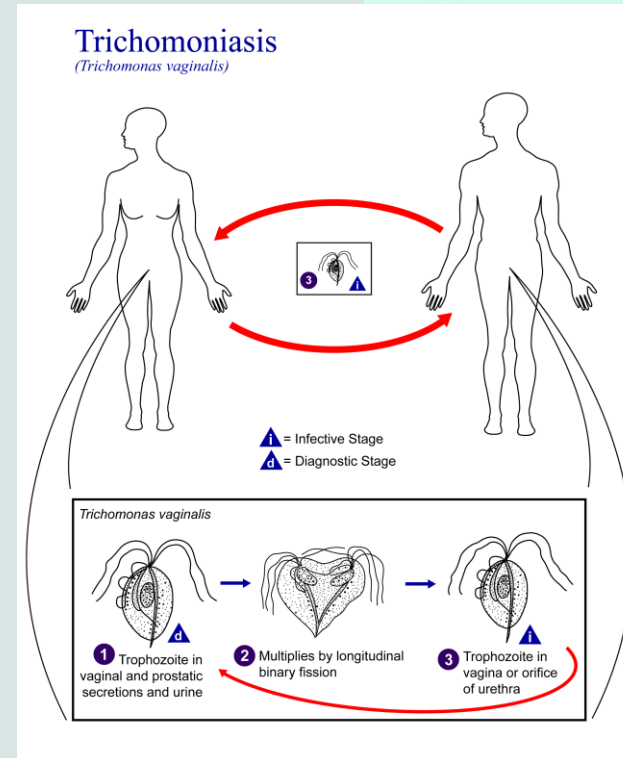
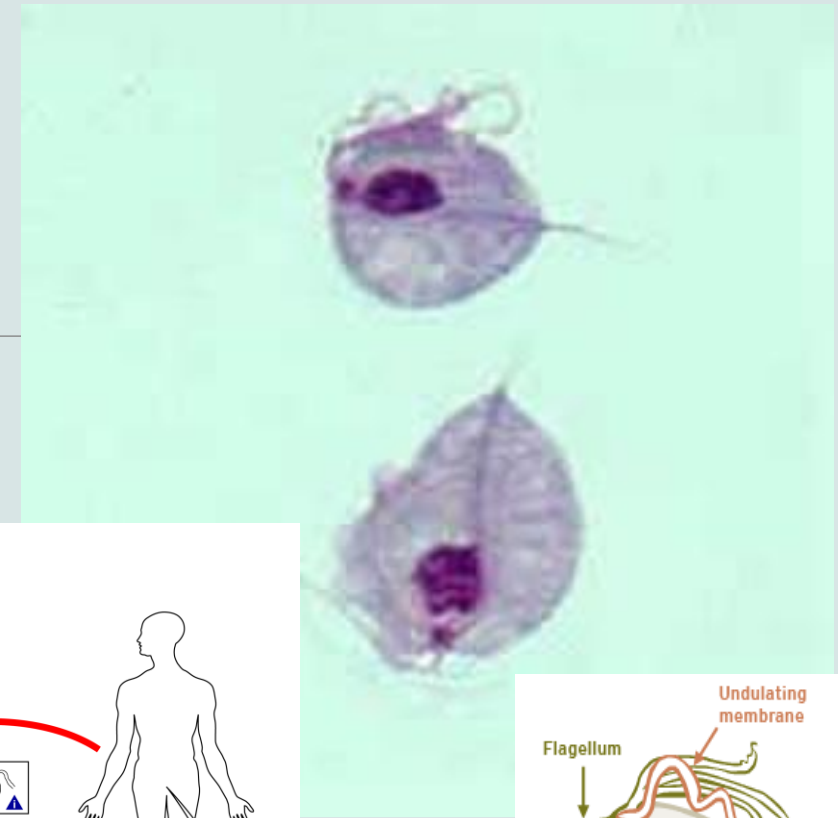
Urogenital protozoan

STD in both men and women

Infection leads to Scant, watery vaginal discharge in women

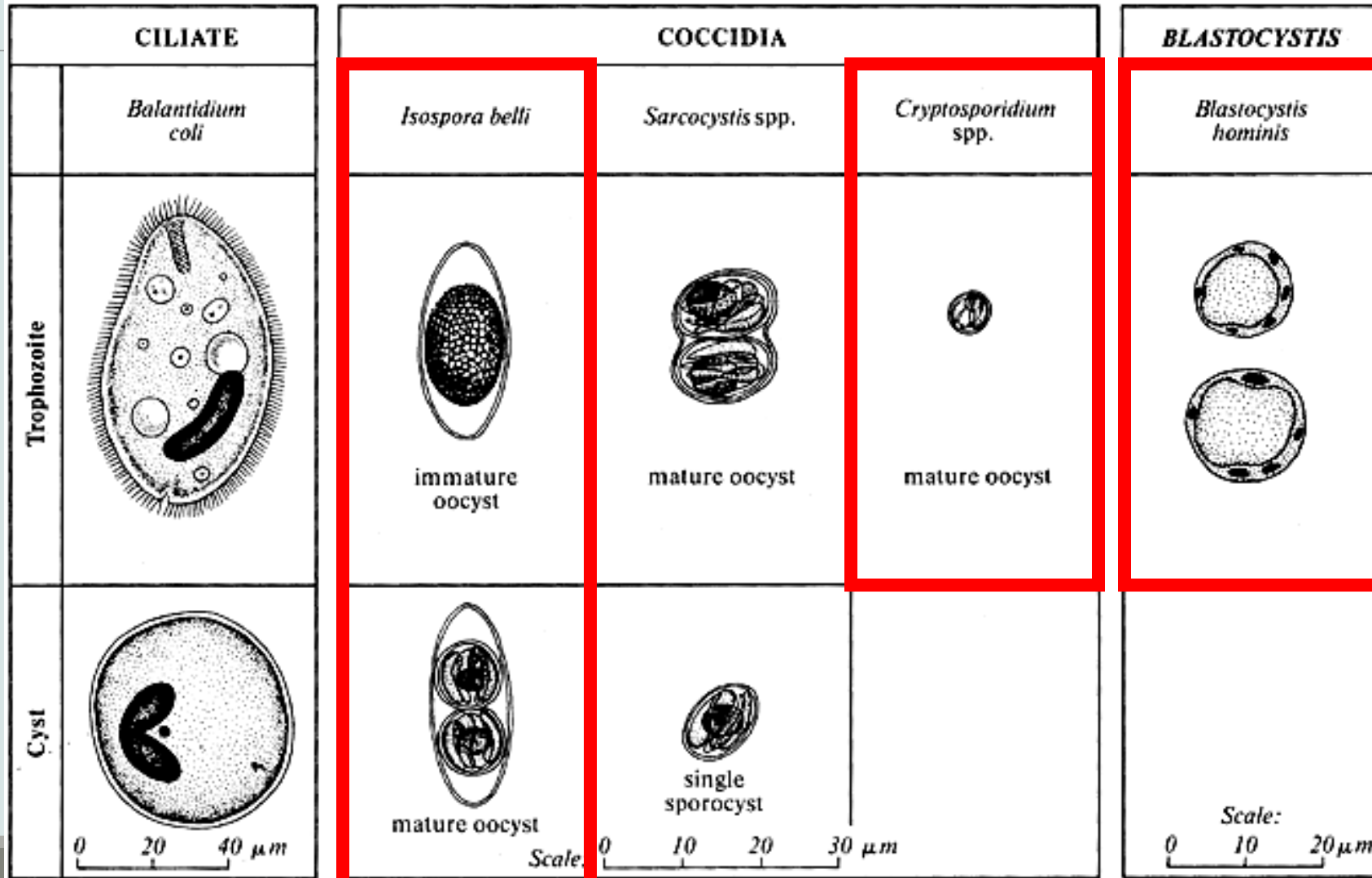
Infection in urethral orifice in men

Four flagella, short undulating membrane



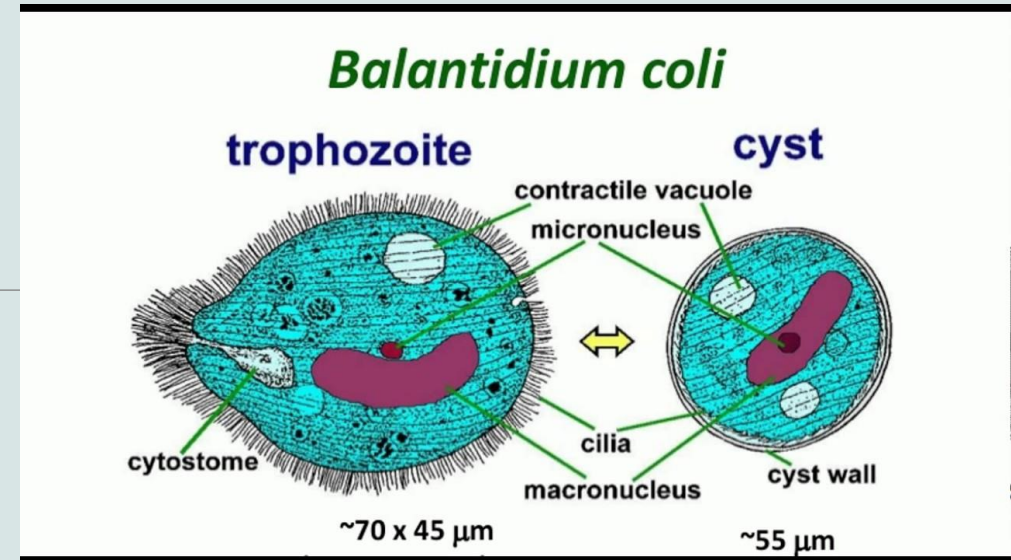
# Protozoa Found in Stool: Ciliates, Coccidia, *Blastocystis*

Primary Human Pathogens



# *Balantidium coli*

- Humans infected by contact with swine
- Poor hygiene
- Only ciliate that's pathogenic to humans
- Amebiasis like disease
- Largest (50-200  $\mu\text{m}$ ) trophozoite in parasitology
  - Surface covered with cilia; macronucleus
- Cyst 40-60  $\mu\text{m}$
- Readily identified in fresh stools and wet mounts
- Can cause flask shaped ulcer in intestine like that of *Entamoeba histolytica*



# *Coccidia: Isospora (Cystoisospora) belli*

Contaminated food/water, oral-anal route of infection

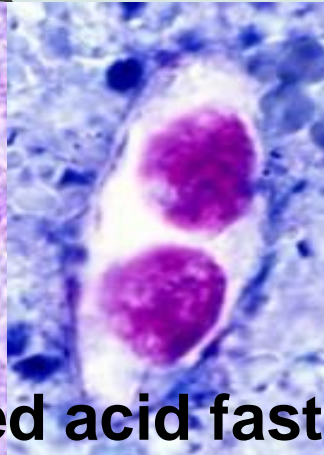
Found most commonly in HIV/AIDS patients

Infects small intestine epithelium

Malabsorption syndrome mimicking giardiasis

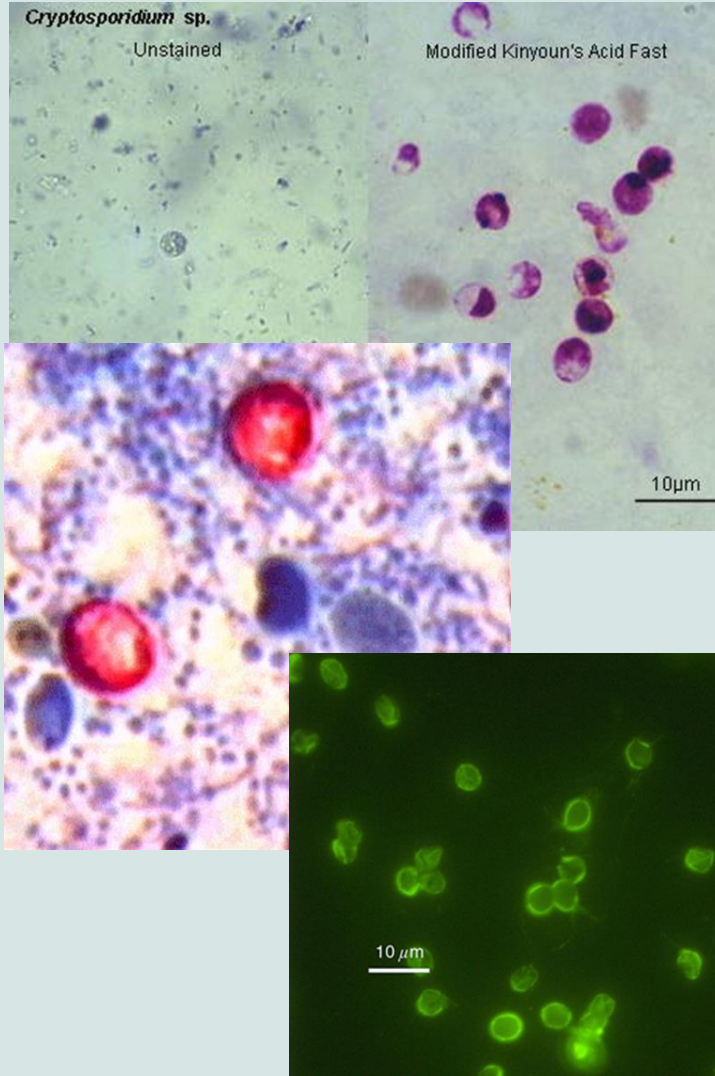
Egg is oval and 10 - 33 um in length

Stains positive with modified acid-fast staining



**(+) Modified acid fast stain**

# *Cryptosporidium* spp



Contaminated water is source of infection

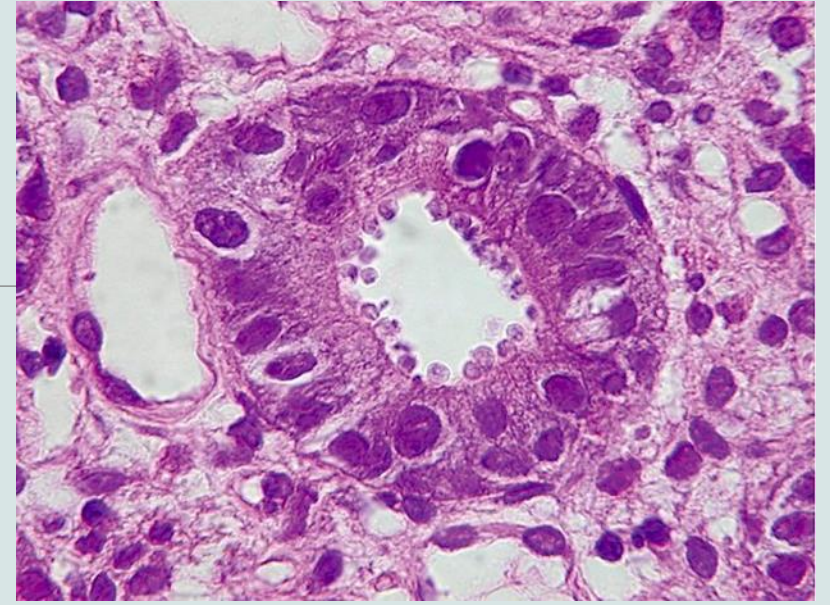
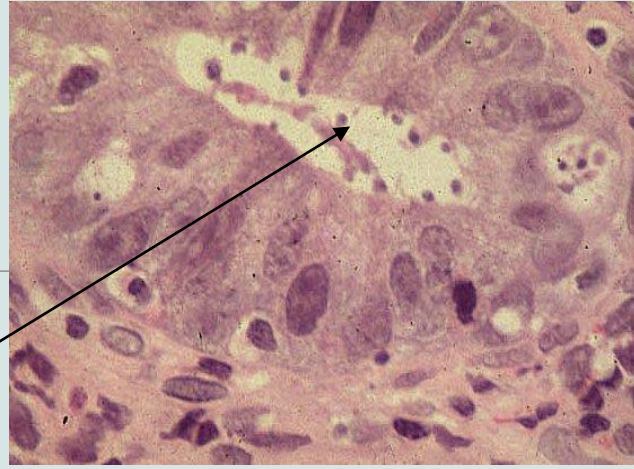
- Resistant to usual water-purification procedures (chlorination, ozone)

Watery diarrhea -

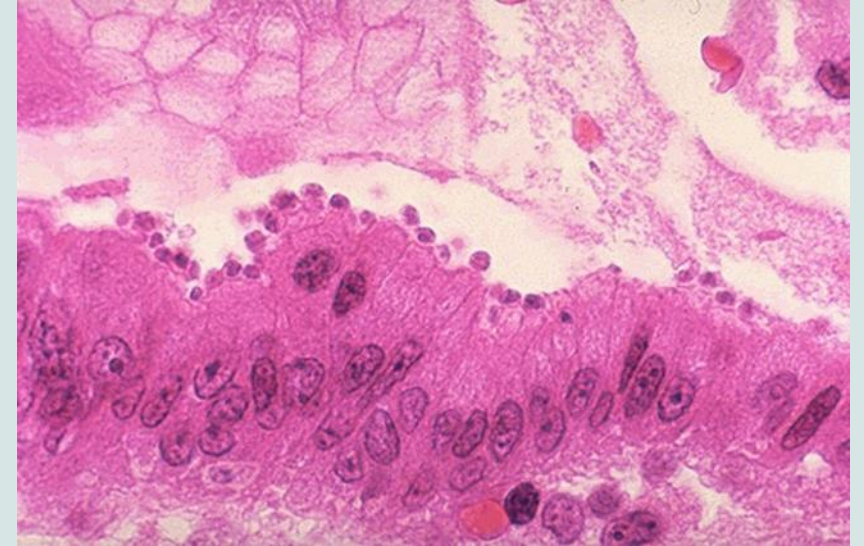
- More severe in HIV/AIDS – chronic/debilitating infection
- Daycare center outbreaks (fecal-oral transmission)

Not detected in routine O & P exams (left)  
Modified acid-fast stains (PAF) aid in detection,  
Oocysts measure 4-6 µm

Stool antigen, Direct Fluorescence antibody staining  
and Molecular assays aid detection.



*Cryptosporidia* located in intestinal tissue just below the plasma membrane



# *Cyclospora cayetanensis*



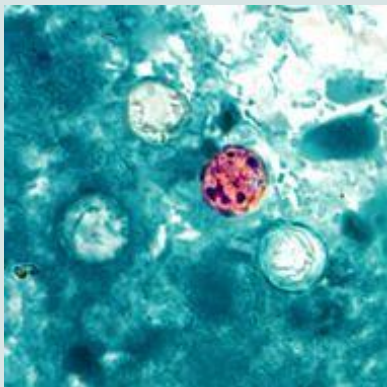
Contaminated fruits and vegetables – particularly ones with plant hairs

Watery diarrhea; fatigue, anorexia, weight loss, flu like symptoms. More severe in immune suppressed, can last for months

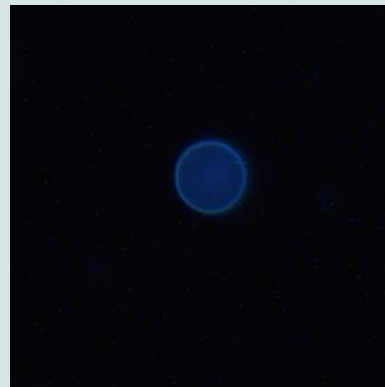
Infects upper small bowel

Treatment: Oral Trimethoprim/sulfamethoxazole

Found in vacuoles in cytoplasm of jejunal epithelium, villous atrophy, crypt hyperplasia

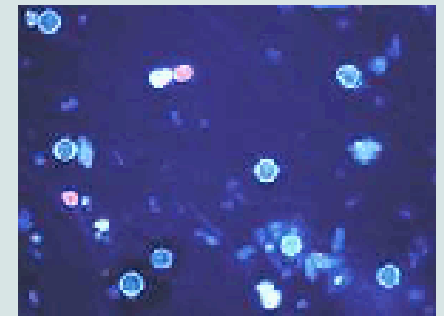


Modified acid  
fast positive  
Cysts 8-10  
microns



UV autofluorescence

Also positive on Calcofluor  
white stain

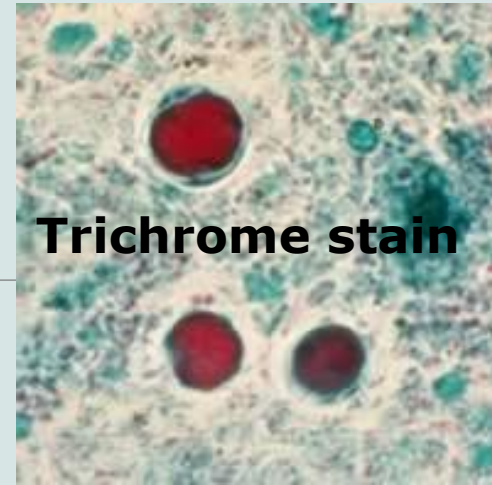


# *Blastocystis hominis*

*Blastocystis hominis* is a genetically diverse unicellular organism (algae) of variable size found in the stools of people who have ingested contaminated food or water

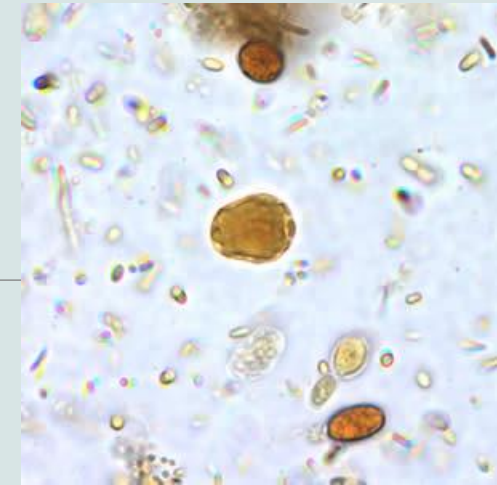
It can be found in healthy people who aren't having digestive symptoms, and sometimes found in the stools of people who have diarrhea, abdominal pain or other gastrointestinal problems.

The role in disease is not well understood / perhaps some forms are more pathogenic.

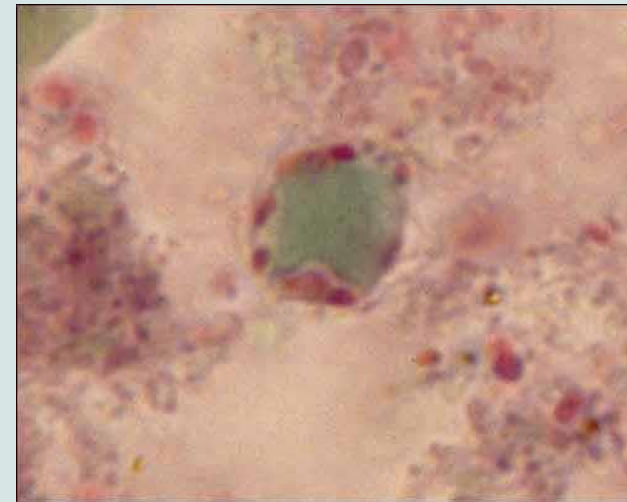


**Trichrome stain**

Nuclear blobs around the cell periphery



Iodine wet mount





# Microsporidia

*Enterocytozoon* and *Encephalitozoon* species most common genera

Infection by ingestion of spores (1-4  $\mu\text{m}$ )

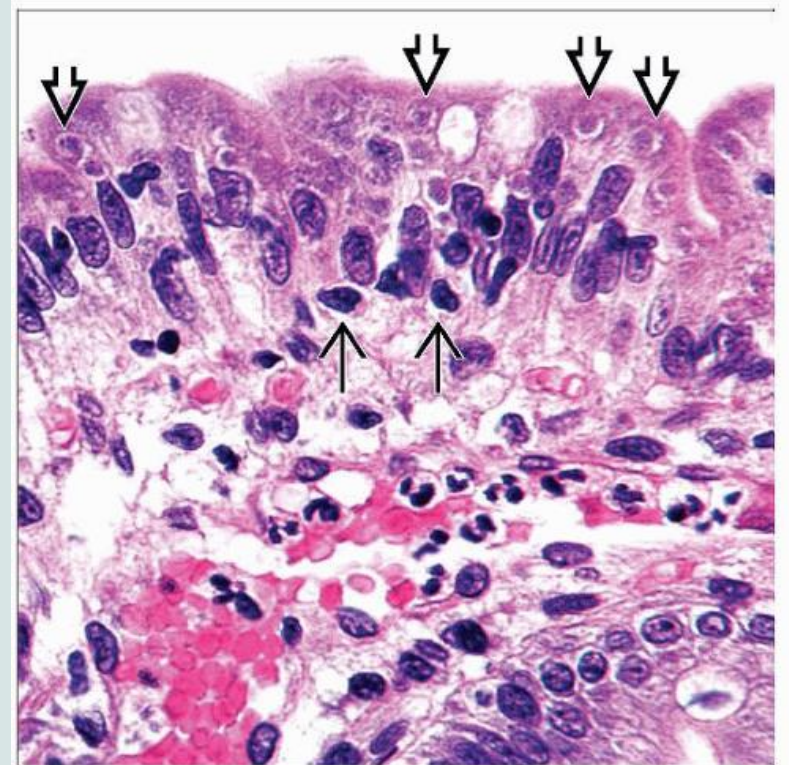
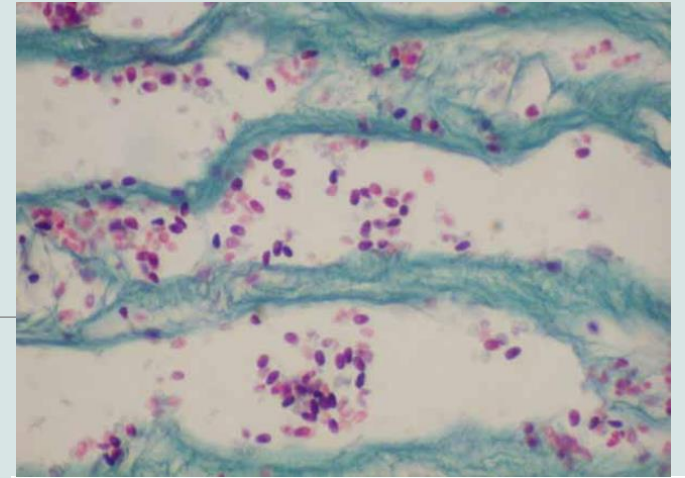
Chronic diarrhea in HIV/AIDS patients

Can disseminate and be found in cases of Myositis, hepatitis, peritonitis, keratitis, gastrointestinal and biliary tract infection

Stain on modified trichrome stain

Tissue histopathology (H&E)

Minimal to no changes in intestinal tissue with 3 - 5 micron, rounded, basophilic structures in enterocytes, often surrounded by a halo



# Nematodes/ Roundworms

## *Enterobius vermicularis* (pinworm)

Humans are the only host

Most common helminth in US

Worms: Females 8-13mm, males 2-5 mm

- Appear like strings in the stool

Worms dwell in the cecum

Migrate to perineum at night

- Deposit eggs
- Diagnosis- Scotch tape test or anal swab in AM

Eggs Oval with flattened side: 50-60um by 20-30um



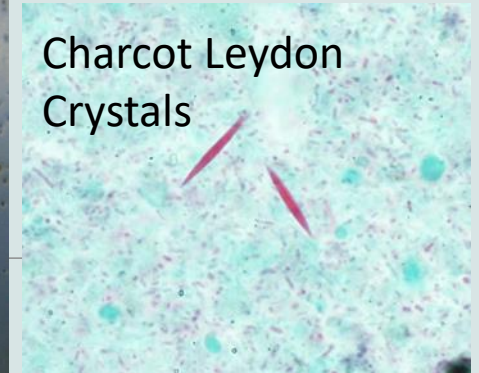
# *Ascaris lumbricoides*

1-1.2 billion people infected in Africa, the Americas, China and East Asia, common in children

Most common in developing countries with poor sanitation/ feces contaminated soil, humans ingest eggs

Largest helminth to affect humans

- Worms: Females 20-35cm long and straight, males 15-30cm with a curved tale
- Bolus of worms can cause intestinal obstruction
- Egg – thick-walled shell with internal larvae
- Charcot Leyden crystals can be seen in stool mounts
- Loeffler's syndrome – pulmonary infiltration and eosinophilia from worm migration through lung to reach the intestine



Bolus of worms

# *Trichuris trichuria* (whipworm)

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Soil transmitted/due to fecal contamination

Amebiasis-like disease

Adult worm attaches to large intestine, rarely recovered – best diagnosis by detecting egg in stool specimens

Head is the thinnest part of worm

Egg is barrel shaped, golden brown with knobs on both ends



# *Necator americanus* and *Ancylostoma duodenale* (Hookworms)

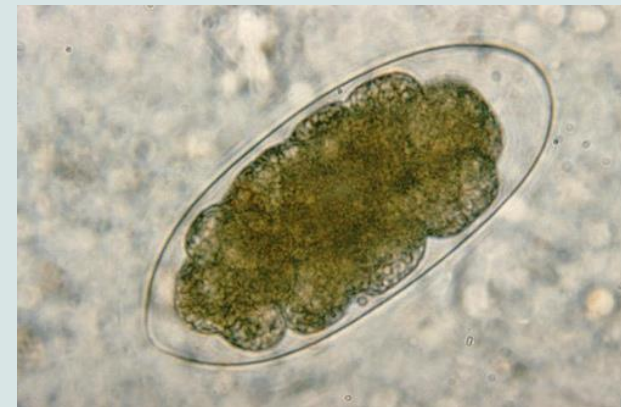
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soil transmission – filiform larvae penetrates the skin causing a slight skin rash then migrates to the intestine where it can cause abdominal pain and diarrhea

2<sup>nd</sup> most common helminth infection after *Ascaris*

*Necator* and *Ancylostoma* are known as Hookworms.

Hookworm egg, brownish colored with visible larvae, 60 X 40 um



# *Strongyloides stercoralis*

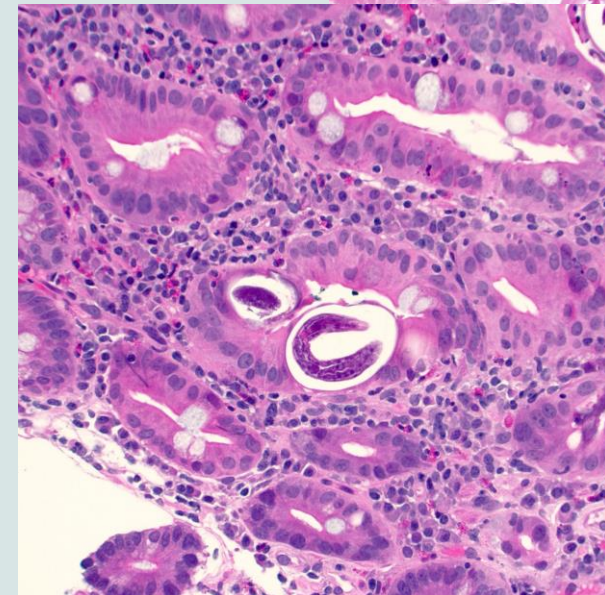
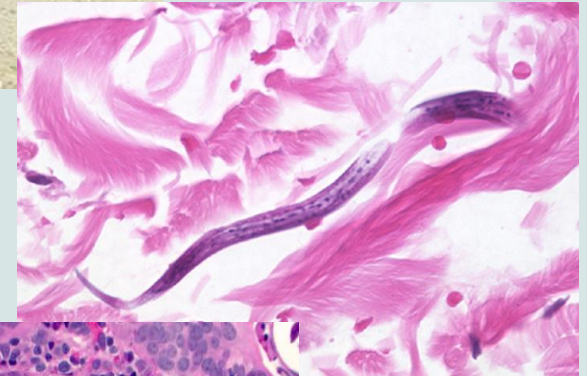
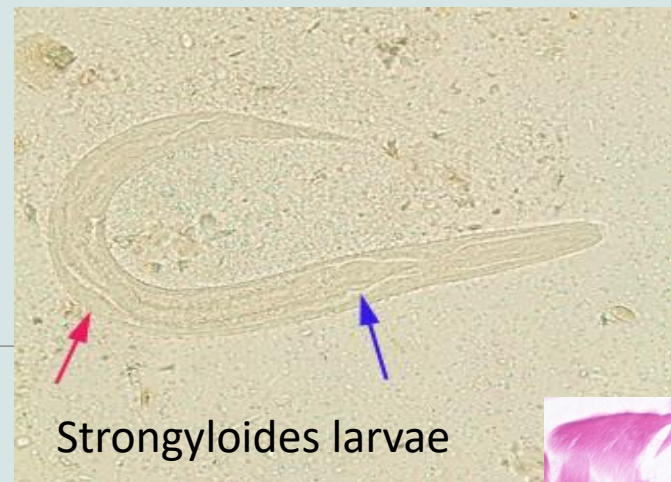
Life cycle occurs in humans

Larval form only

Larvae penetrates intact skin from contact with contaminated soil, then migrates to intestine

Majority do not have symptoms, some non-specific complaints or minor abdominal pain and diarrhea from the larvae's presence in intestine

In immune suppressed can evolve into a massive intestinal infection or with larvae migration to the respiratory tract causing an eosinophilic pneumoniae termed "autoinfection"



# *Anisakis simplex*

Infective larvae are ingested from fish or squid that humans eat raw or undercooked.

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Nematode worm present in the fish flesh invades the stomach wall or intestine of humans. Infection can occur without symptoms.

This infection is treated by removal of the larvae via endoscopy or surgery.

Rare cases cause granuloma formation and bowel obstruction.



# *Dracunculus medinensis*

Dracunculiasis (Guinea worm disease)

Due to eradication campaign, now isolated to narrow belt in Africa

Infected by drinking unfiltered water containing copepods (small crustaceans) which are infected with larvae of *D. medinensis*

Following ingestion, the copepods die, release the larvae, which penetrate the stomach and intestinal wall and the abdominal cavity and retroperitoneal space

The male worm dies, the female migrates in the subcutaneous tissue toward the skin surface

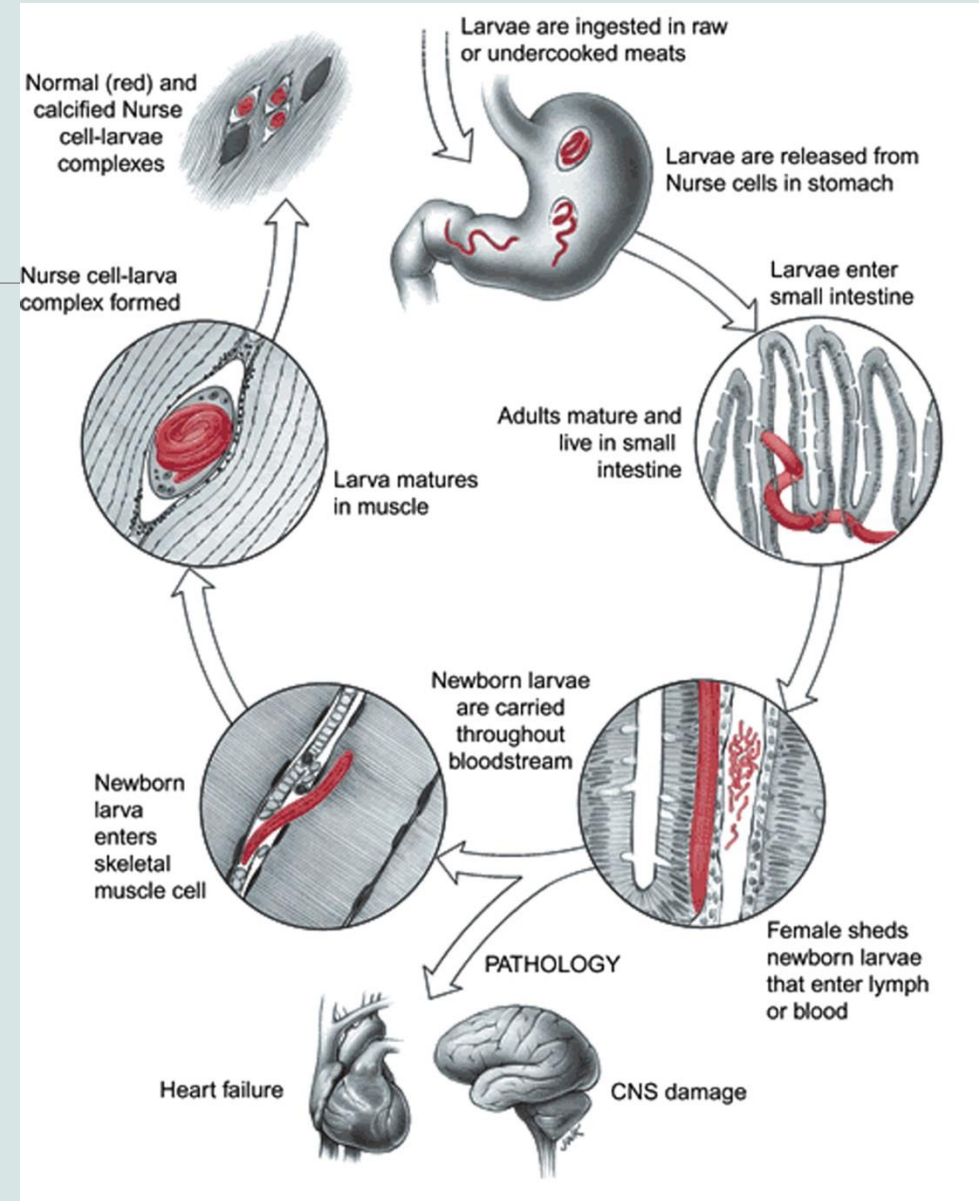
The clinical manifestations are localized but incapacitating. The worm emerges as a whitish filament (duration of emergence: 1 to 3 weeks) in the center of a painful ulcer, accompanied by inflammation and frequently by secondary bacterial infection.





# *Trichinella spiralis*

- Tissue nematode
- Infection from the ingestion of undercooked meat
- Usually only an incidental finding when viewing histopathology of muscle



# *Naegleria fowleri*

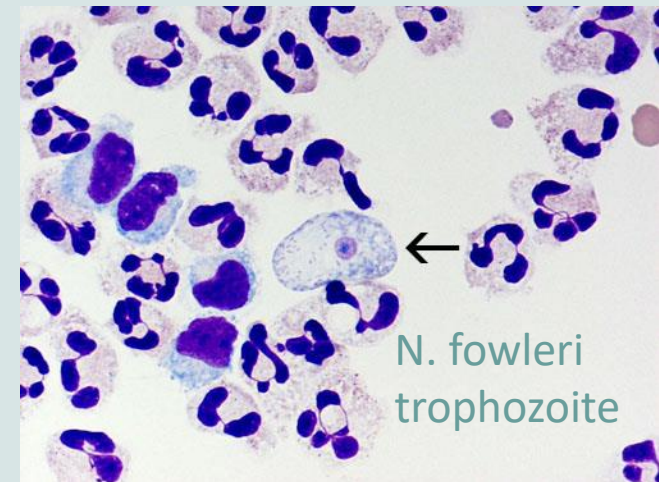
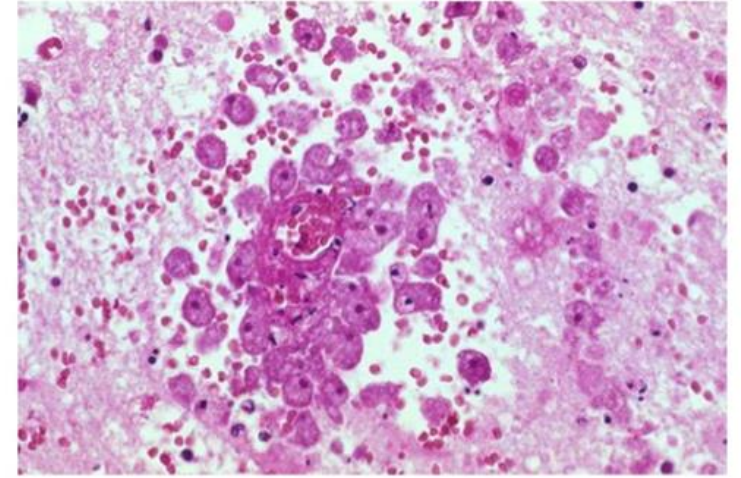
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Primary amoebic meningoencephalitis (PAM)

Acquired by swimming or diving into fresh-water pools and water goes up nose thru cribriform plate into the brain

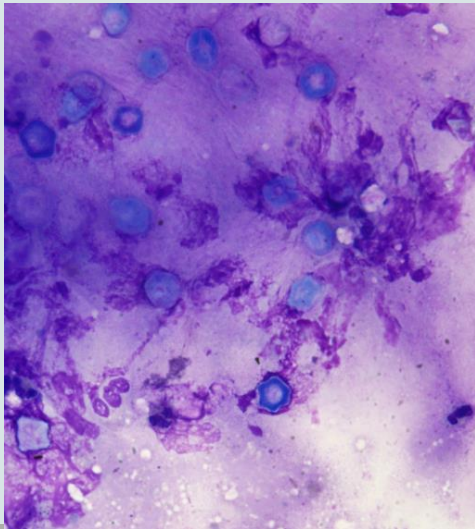
Usually, a fatal infection

NAEGLERIA FOWLERI



# *Acanthamoeba species*

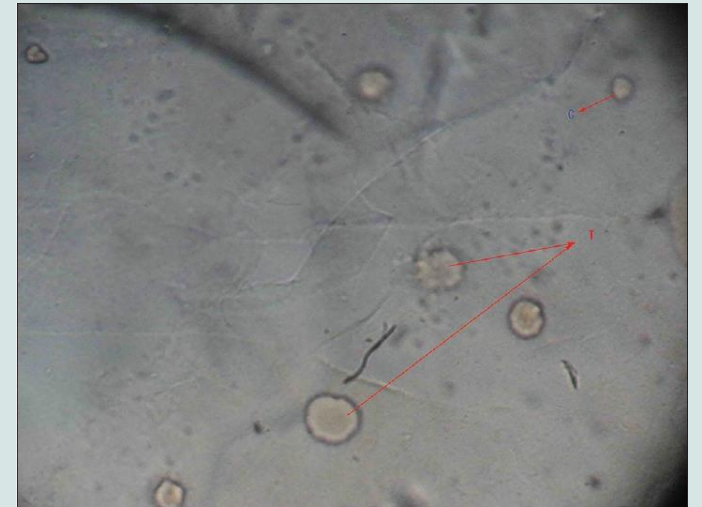
- Contact lens keratitis
- Primary diagnosis: Wright stain of corneal scrapings to visualize amoeba
- Can culture for *Acanthamoeba*. Corneal scrapings placed in a lawn of *E.coli*. Visible tracts made in *E. coli* growth. Do wet mount to look for amoeba



Wright's  
stain



Amoeba in  
wet mount



# *Trypanosoma brucei* → Sleeping sickness (African trypanosomiasis)



Vector: Tse Tse fly

The two *T. brucei* species that cause African trypanosomiasis are indistinguishable morphologically

- *T. brucei gambiense*
- *T. brucei rhodesiense*

A typical trypomastigote has:

- A small kinetoplast located at the posterior end
- A centrally located nucleus
- An undulating membrane and flagellum
- 14 to 33  $\mu\text{m}$  in length

Trypomastigote is the only stage found in clinical specimens



nucleus  
kinetoplast

# *Trypanosoma cruzi* → Chagas disease (American trypanosomiasis)

Vector: Reduviid/Triatoma (kissing) bug

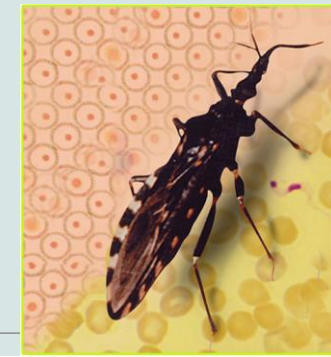
**Trypomastigote** is the form in the **blood** of an infected person and may be seen in CSF in CNS infections

Motile circulating trypomastigotes are readily seen on slides of fresh anticoagulated blood in acute infection

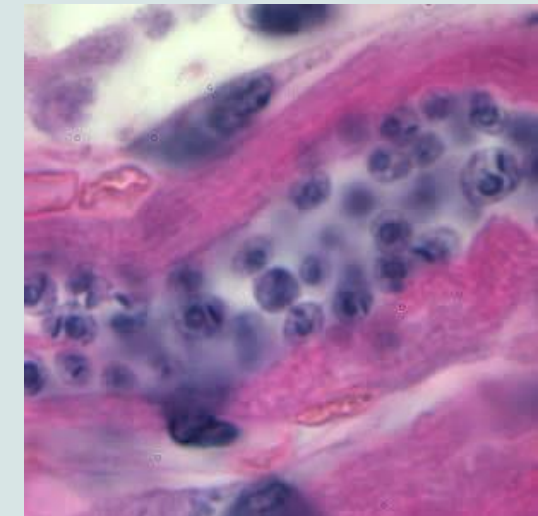
A typical **trypomastigote** has:

- Large, subterminal or terminal kinetoplast,
- Centrally located nucleus,
- Undulating membrane, and flagellum
- 12 to 30  $\mu\text{m}$  in length.
- Can appear **C shaped**

**Amastigote** stage parasite may be seen in histopathology specimens from affected organs.



Trypomastigote



Amastigote

# *Leishmania* – Clinical Disease

## **Cutaneous** – *L. tropica* and *L. brasiliensis*

- Single or few chronic, ulcerating lesions; many species
- Latin America, southern Europe, Middle east, southern Asia, Africa
- Mucocutaneous in Latin America

## **Visceral** – *L. donovani* complex most common

- primarily *L. donovani* complex (Asia), *L. infantum/chagasi* (Africa and Latin America)
- Hepatosplenomegaly, anemia, cytopenias, systemic symptoms
- India, Bangladesh, Nepal, Sudan, and Brazil
- Important opportunistic infection in HIV infection

**Vector** – Female sand fly



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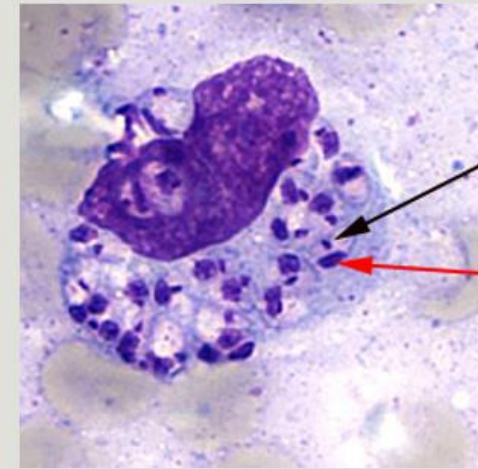
# *Leishmania*

## Diagnosis

- Biopsy of infected tissue (skin, bone marrow)
- Multiple, tiny 2-5 um amastigotes within histiocytes
- Distinct **kinetoplast** (bar-like structure adjacent to nucleus)
- PCR methods
- Urinary antigens (visceral)

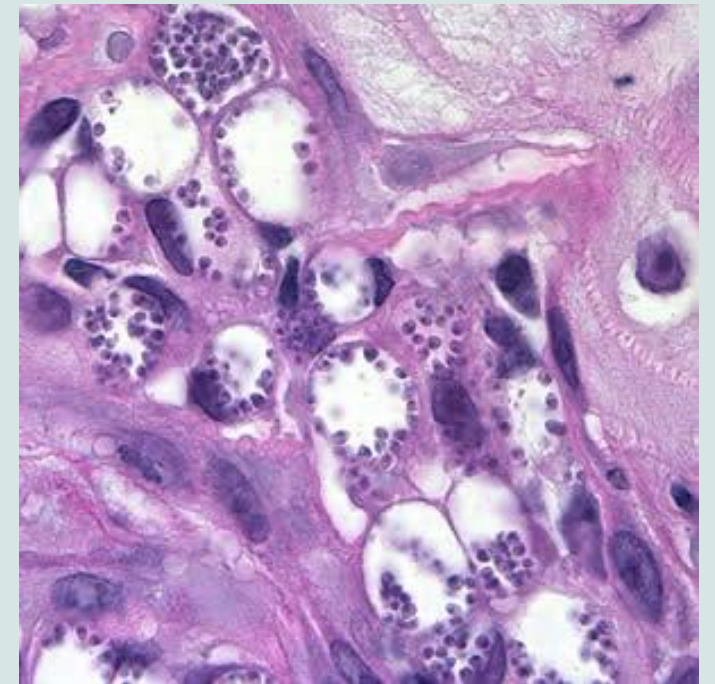
## DDx of multiple tiny intracellular organisms

- Leishmania – kinetoplast
- Histoplasma – budding
- Toxoplasma – somewhat curved, mostly extracellular



Kinetoplast

Nucleus



# Babesia

Two species: *B. microti*, *B. divergens*

Zoonosis (deer, cattle, rodents; humans accidental host)

Transmission vector: **Ixodes** tick bite

Infects red blood cells

Found world-wide

*B. microti* along the Northeast US

- Nantucket Island, Martha's vineyard, Shelter Island

Malaria-like syndrome

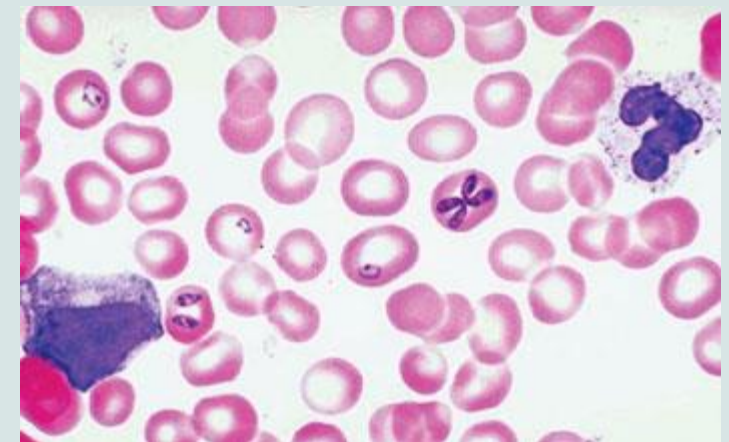
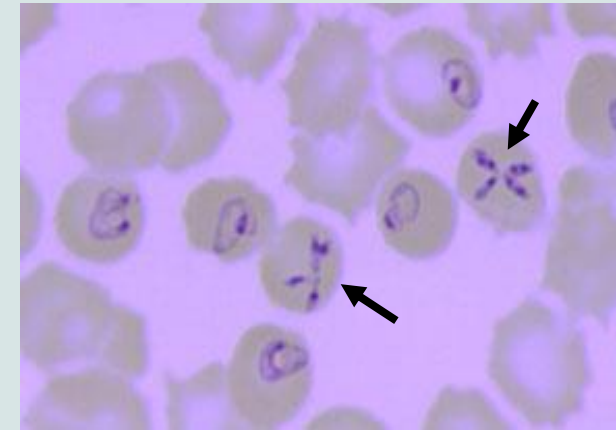
- Fever but without periodicity, night sweats, weight loss, hemolytic anemia, hemoglobinuria, renal failure

Diagnosis; Blood smear examination

- Ring form only (mimics *P. falciparum*)
- Tetrads (unlike *P. falciparum*)



**Ixodes tick**



**Maltese cross  
(tetrads)**



# MALARIA

Protozoan parasite

Transmitted by the anopheles mosquito

Endemic in tropical areas

## *Plasmodium* species

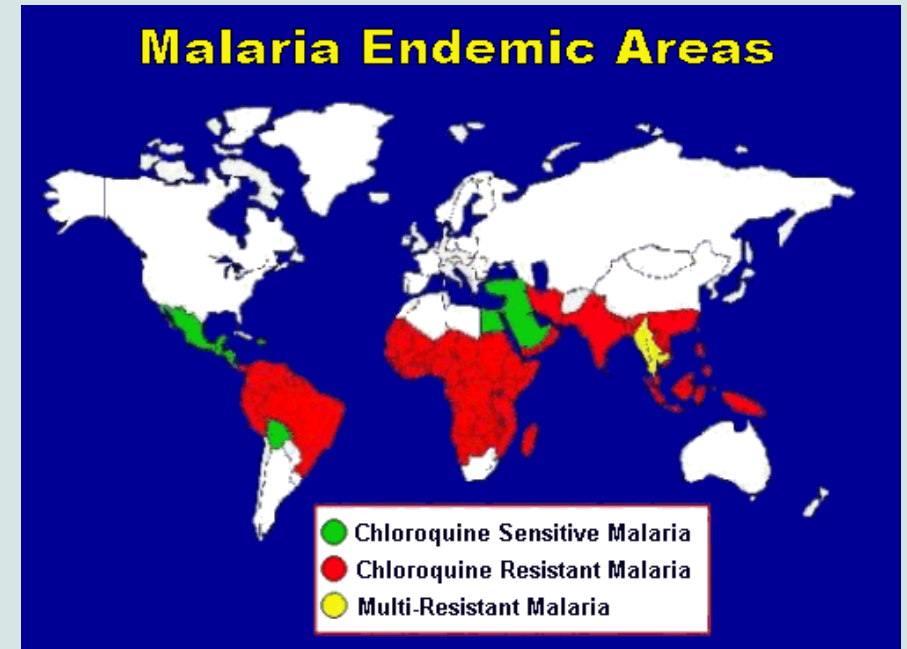
*Plasmodium falciparum*

*Plasmodium vivax*

*Plasmodium ovale*

*Plasmodium malariae*

*Plasmodium knowlesi* – primates only



# Malaria Physical Diagnosis

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Physical exam findings for most uncomplicated malarial cases:

- Fever and splenomegaly

*P. falciparum* - most pathogenic species\*\* lethal malignant tertian fever

- Jaundice
- Hepatomegaly
- Increase in respiratory rate
- Possible CNS involvement
- Blackwater fever – hemolysis, renal failure

Tertian = fever every 48 hours / Quartan = fever every 48 hours

# Malarial Slide Preparations – standard tool for diagnosis

## Thick smear

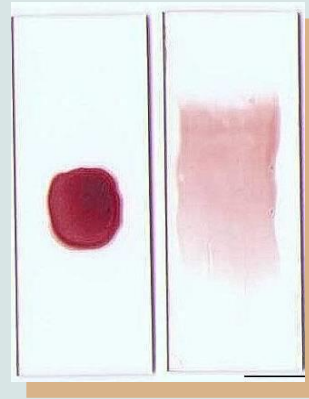
Drop of blood on slide (non-anticoagulate blood is best)

Water rinse to eliminate rbc's

Stain with Giemsa stain (not Wright-Giemsa) **proper pH**

**Need the proper pH to stain the Schuffner's granules**

Concentrated to spot malaria parasites



## Thin smear

Feather edge smear

For optimal morphology, stain with **Giemsa** (not Wright-Giemsa) stain with **proper pH**

**Speciation** of malaria

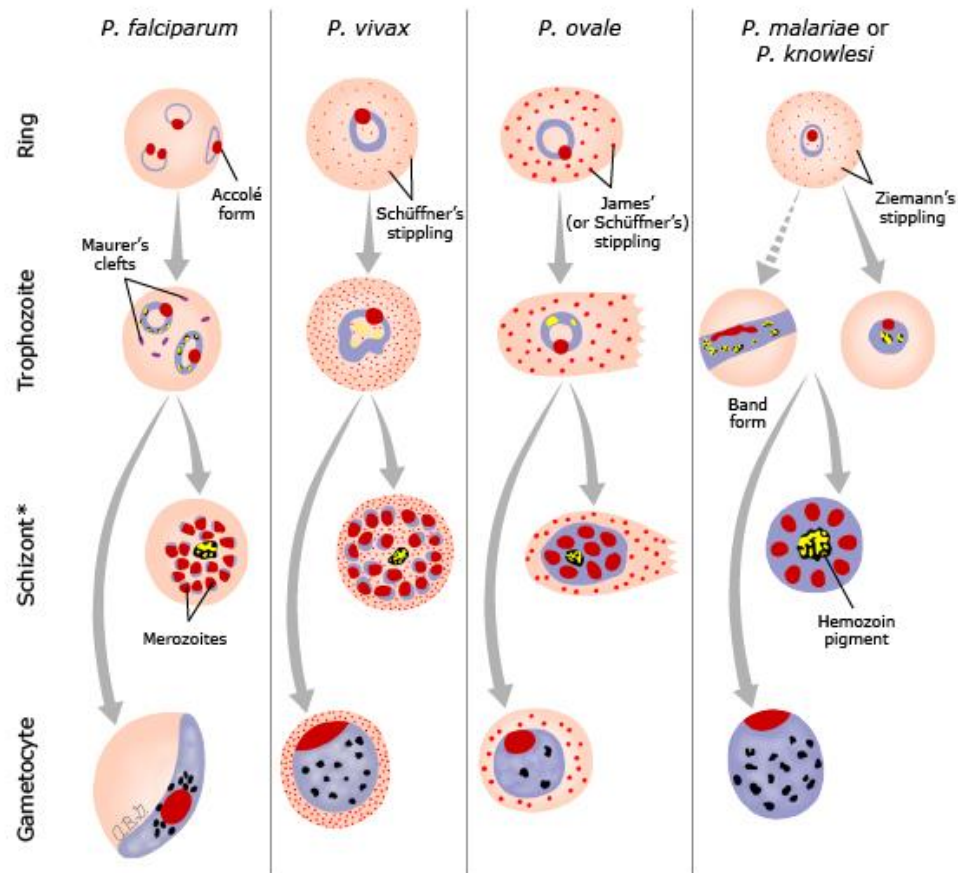
Parasitemia (%)

## Clues to species diagnosis via thin smear

|                             | <i>P. falciparum</i>   | <i>P. vivax</i>   |
|-----------------------------|--|---|
| Size of RBCs                | Normal size (sometimes distorted and crenated)                   | Enlarged  |
| Number of parasites per RBC | May be multiple  | Usually one   |
| Typical form of trophozoite | Rings  | Amoeboid, often fragmented                                |
| Other characteristics       | Banana-shaped gametocytes; black pigment in RBCs; schizonts rare | Schuffner's granules; often see gametocytes and schizonts |

| <i>P. ovale</i>   | <i>P. malariae</i>                  |
|---|-------------------------------------|
| Enlarged and usually oval in shape (with fimbriated ends) | Normal size                         |
| Usually one   | Usually one                         |
| Compact and regular                                       | Compact                             |
| Schuffner's granules; often see gametocytes and schizonts | Often see gametocytes and schizonts |

## Red blood cell morphology in various forms of *Plasmodium* infections



\* Identification of a schizont with >12 merozoites in the peripheral circulation is an important diagnostic clue for *P. vivax*. In general, schizonts of *P. falciparum* are very rarely seen in blood films; they are generally absent from the peripheral circulation except in cases of severe infection with overwhelming parasitemia.

Graphic 80296 Version 8.0

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Notes of importance:

### *P. falciparum*

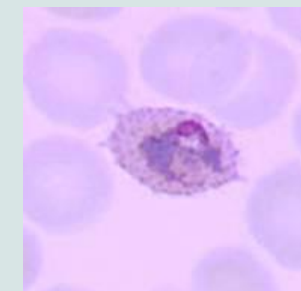
1. Calculation of % or parasitemia is used to assess seriousness of infection
2. Only ring and gametocyte seen in blood smears



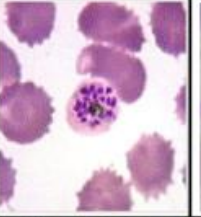
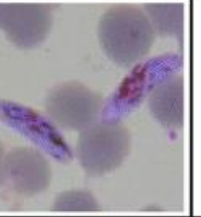
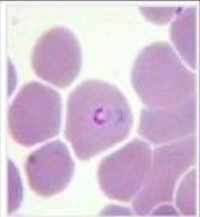
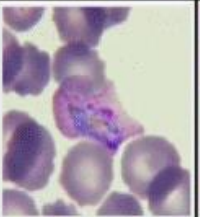
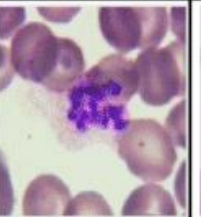
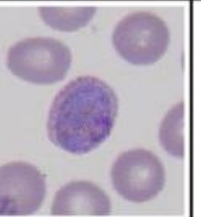
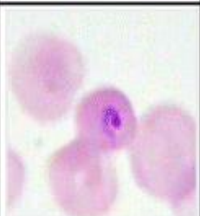
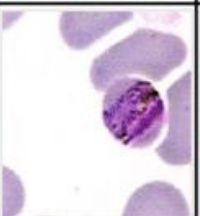

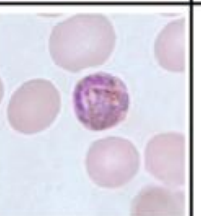

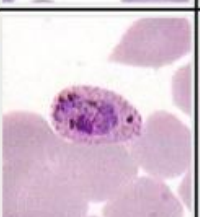
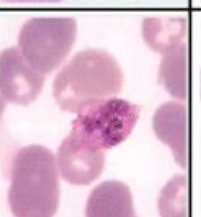
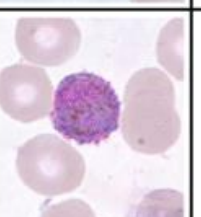

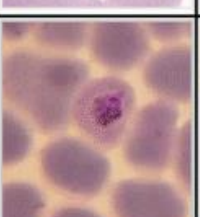
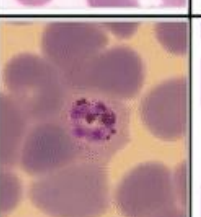
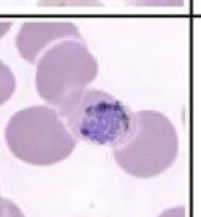
### *P. vivax*

1. Duffy negative red blood cell protect from *P. vivax* infection
2. Untreated infections can last several years and remain dormant in the liver. Recurrent and chronic infection can lead to brain, kidney and liver damage

### *P. ovale*

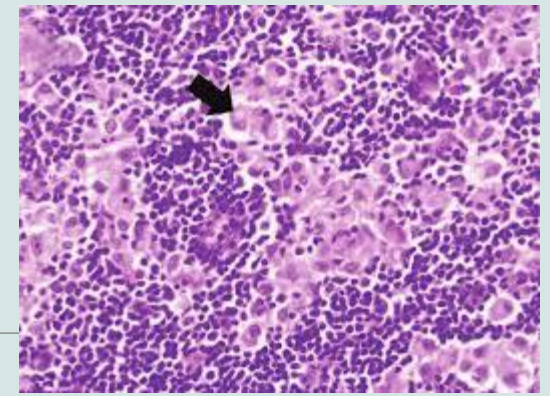
1. Fimbriated edge of red blood cell



| Human Malaria        |  |   |   |   |   |
|----------------------|--|---|---|---|---|
| Stages<br>Species    | Ring   | Trophozoite   | Schizont  | Gametocyte  |   |
| <i>P. falciparum</i> |    |    |    |    | <ul style="list-style-type: none"> <li>Parasitised red cells (pRBCs) not enlarged.</li> <li>RBCs containing mature trophozoites sequestered in deep vessels.</li> <li>Total parasite biomass = circulating parasites + sequestered parasites.</li> </ul>  |
| <i>P. vivax</i>      |    |    |    |    | <ul style="list-style-type: none"> <li>Parasites prefer young red cells</li> <li>pRBCs enlarged.</li> <li>Trophozoites are amoeboid in shape.</li> <li>All stages present in peripheral blood.</li> </ul>   |
| <i>P. malariae</i>   |    |    |    |    | <ul style="list-style-type: none"> <li>Parasites prefer old red cells.</li> <li>pRBCs not enlarged.</li> <li>Trophozoites tend to have a band shape.</li> <li>All stages present in peripheral blood</li> </ul>   |
| <i>P. ovale</i>      |   |   |   |   | <ul style="list-style-type: none"> <li>pRBCs slightly enlarged and have an oval shape, with tufted ends.</li> <li>All stages present in peripheral blood.</li> </ul>  |
| <i>P. knowlesi</i>   |  |  |  |  | <ul style="list-style-type: none"> <li>pRBCs not enlarged.</li> <li>Trophozoites, pigment spreads inside cytoplasm, like <i>P. malariae</i>, band form may be seen</li> <li>Multiple invasion &amp; high parasitaemia can be seen like <i>P. falciparum</i></li> <li>All stages present in peripheral blood.</li> </ul> |

# *Toxoplasma gondii*

Toxoplasmic lymphadenitis

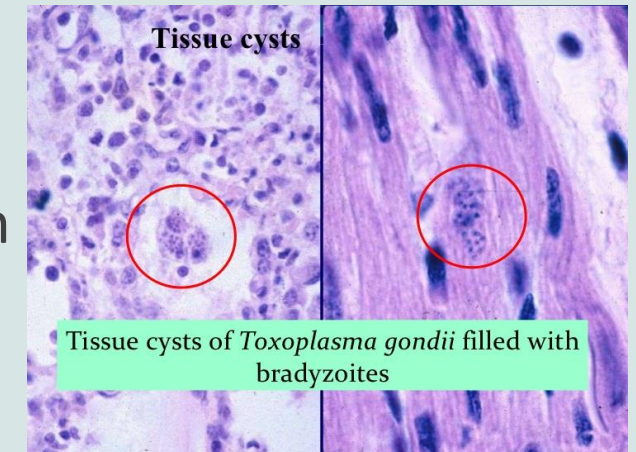


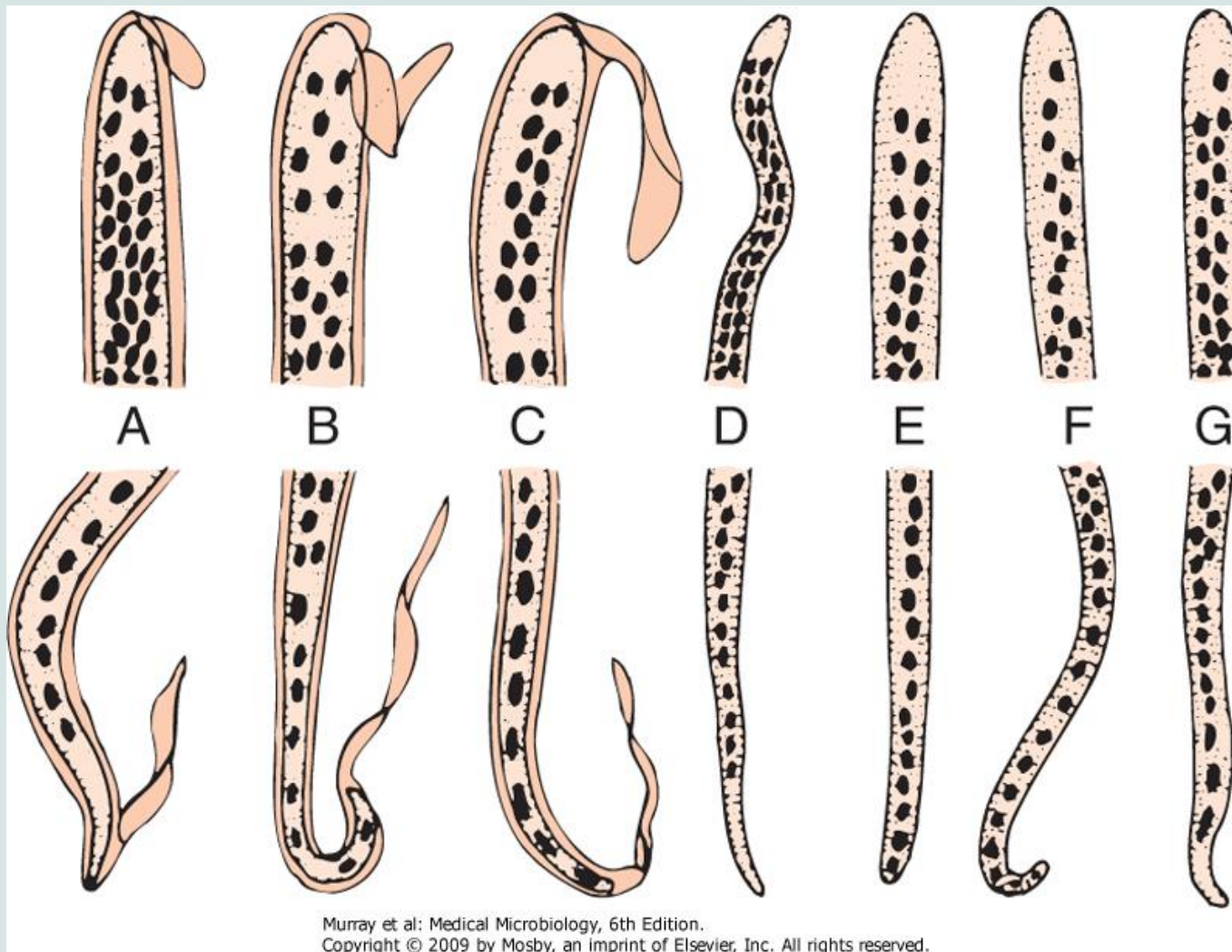
Toxoplasmosis is considered to be a leading cause of death attributed to foodborne illness in the United States.

Caused by eating undercooked, contaminated meat (especially pork, lamb, and venison) and accidental ingestion of oocysts from cat's litter box, esp a problem in the immunodeficient patient.

Immunocompetent, mostly solitary posterior cervical lymphadenopathy.

**Histology of toxoplasmic lymphadenitis:** Usually lack of necrosis or well-formed granulomas. Follicular hyperplasia, interfollicular epithelioid histiocytes, singly or in small clusters. Usually involves monocytoïd B cells in a sinusoidal and parasinusoidal pattern.





## Microfilariae

- Identification is based on the microfilariae being either sheathed or non-sheathed
- Sheathed / thin covering over the larvae
  - *Wucheria bancrofti* and
  - *Loa loa*
- Not sheathed
  - *Onchocerca volvulus*

Identification of microfilariae is based on the presence of a sheath covering the larvae, as well as the distribution of nuclei in the tail region

**A,** *W. bancrofti*. **B,** *B. malayi*. **C,** *L. loa*. **D,** *O. volvulus*. **E,** *Mansonella perstans*. **F,** *Mansonella streptocerca*. **G,** *Mansonella ozzardi*.





## *Wuchereria bancrofti*



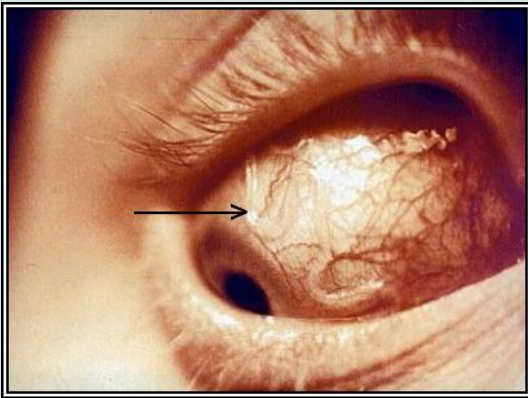
- [Filarial nematode](#) (roundworm) that is the major cause of [lymphatic filariasis](#).
- Filarial worms are spread by a variety of [mosquito vector](#) species.
- *W. bancrofti* is the most common filarial worm and affects over 120 million people, primarily in Central Africa and the Nile delta, South and Central America, the tropical regions of Asia including southern China, and the Pacific islands.
- If left untreated, the infection can develop into a chronic disease called [lymphatic filariasis](#)



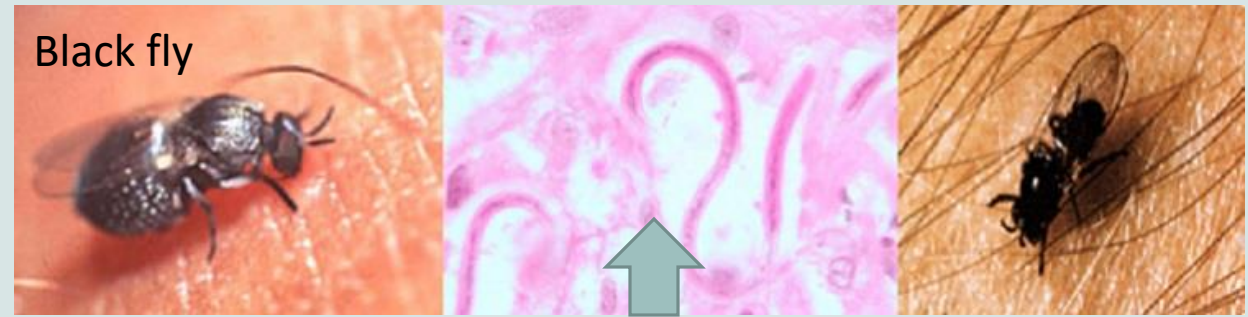
# *Loa loa*



- Loiasis (African eye worm)
- It is passed on to humans through the repeated bites of deerflies of the genus *Chrysops*. The flies that pass on the parasite breed in certain rain forests of West and Central Africa.
- Infection with the parasite can also cause repeated episodes of itchy swellings of the body known as Calabar swellings.
- There may be more than 29 million people who are at risk of getting loiasis in affected areas of Central and West Africa.

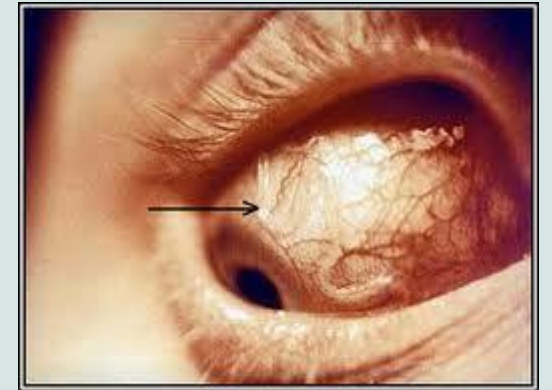


# Onchocerciasis



Microfilaria of *Onchocerca*  
from skin nodule

- Onchocerciasis, or river blindness, is caused by the parasitic worm *Onchocerca volvulus*.
- It is transmitted through repeated bites by blackflies of the genus *Simulium*.
- The disease is called river blindness because the blackfly that transmits the infection lives and breeds near fast-flowing streams and rivers, mostly near remote rural villages. The infection can result in visual impairment and sometimes blindness.
- Onchocerciasis can also cause skin disease, including intense itching, rashes, or nodules under the skin.



# *Diphyllobothrium latum*

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Infected by ingesting poorly-cooked fresh-water fish (salmon particularly problematic)

Scandinavian, Russia, Canada, N. USA, Alaska

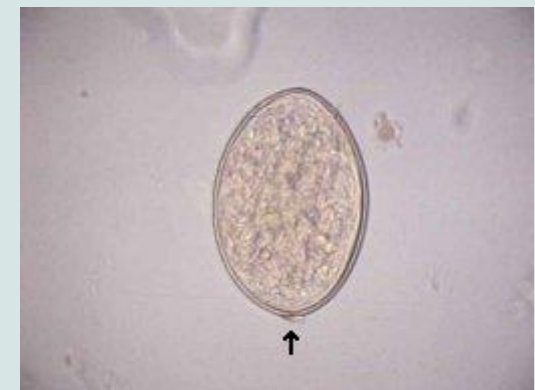
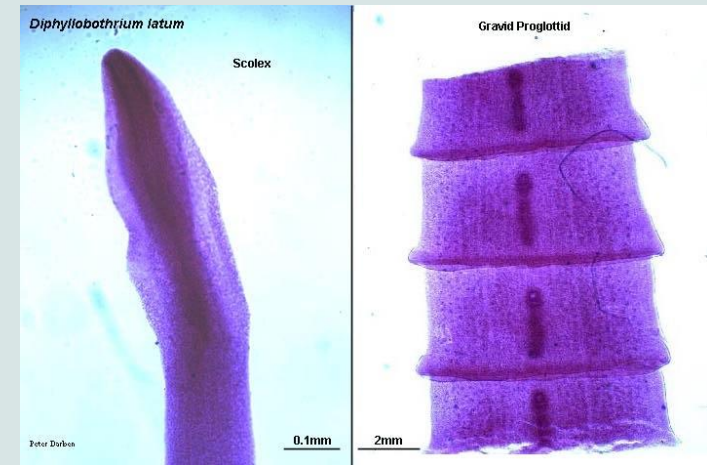
Known as the Broad fish tapeworm

Scolex has a Longitudinal sucker

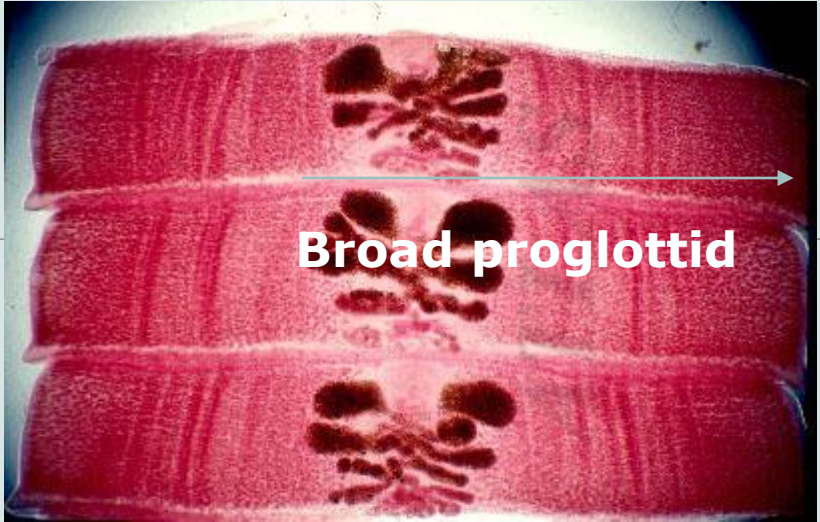
Eggs have non-shouldered operculum and knob

- They are not embryonated

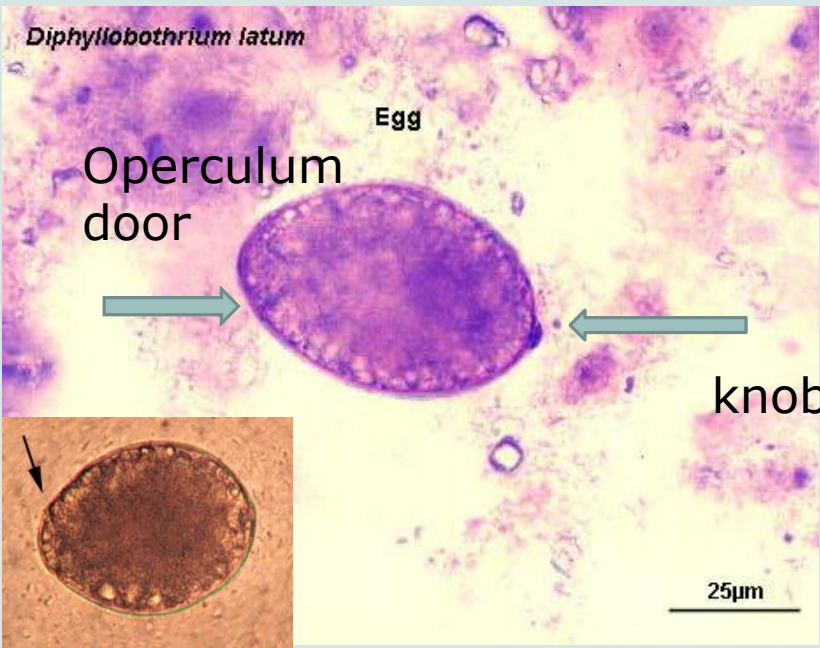
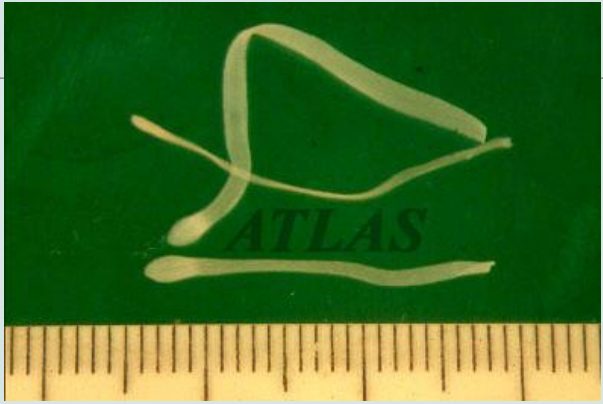
Infection causes VitaminB12 deficiency



# *Diphyllobothrium latum*



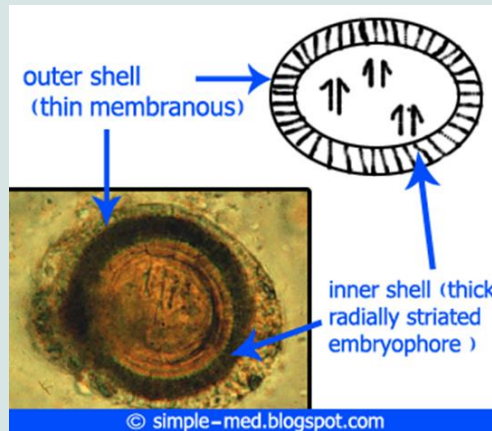
Broad proglottid



Longitudinal sucking plate

## Taenia saginata

- Beef tapeworm
- 4 suckers on scolex
- >12 uterine branches in proglottids
- Ingestion of cysticerci in beef
  - Intestinal tapeworm
- Ingestion of eggs -> Non-human pathogen  
No disease

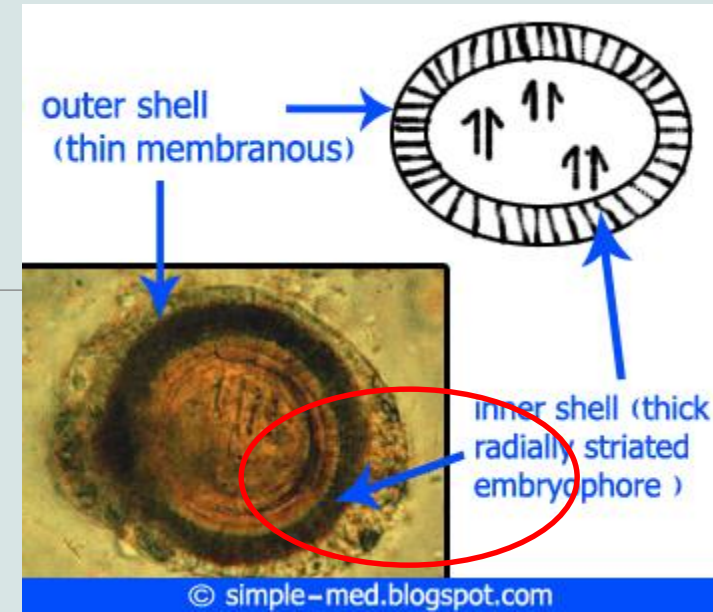
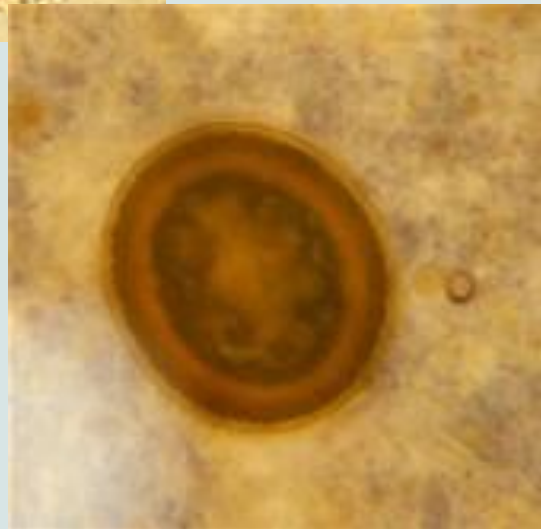


## Taenia solium

- Pig tapeworm
- Ring of thorns/crown on scolex
- <12 uterine branches in proglottids
- Ingestion of cysticerci in pork
  - Intestinal tapeworm
- Ingestion of eggs -> Cysticercosis

# *Taenia* eggs

Identical eggs for the two species



# *Taenia saginata*

# *Taenia solium*



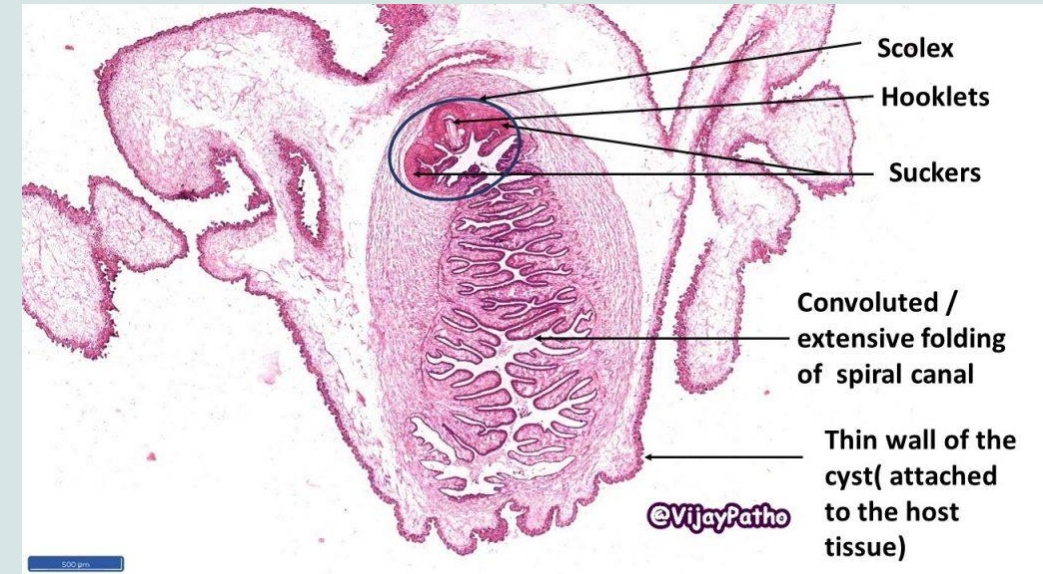
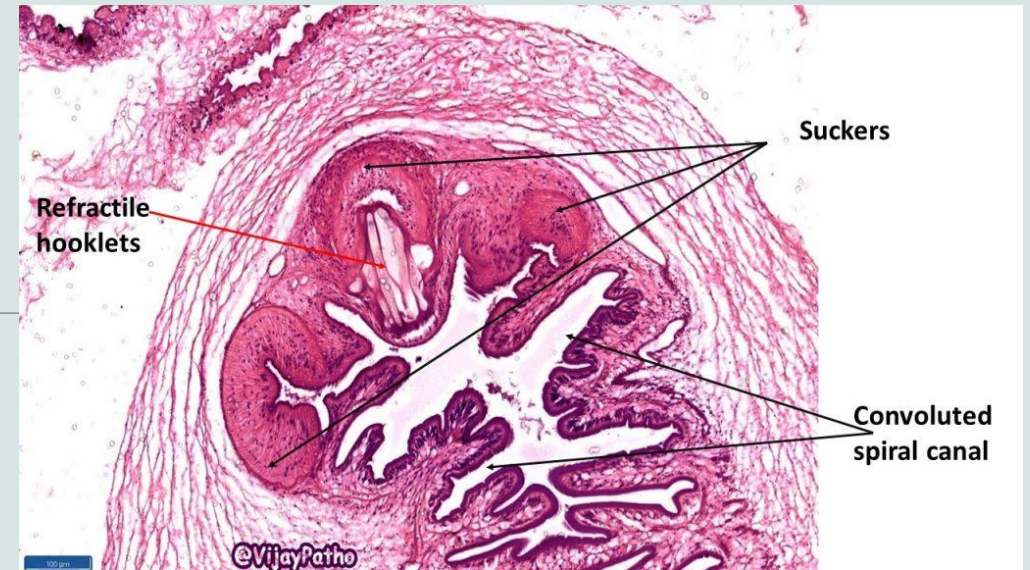
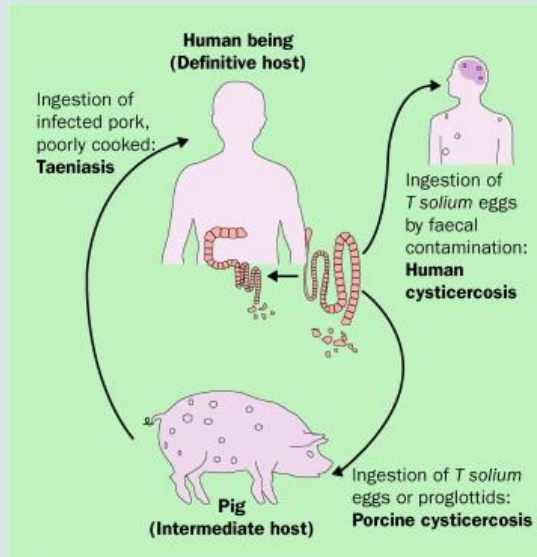
Proglottid > 12 uterine branches



Proglottid < 12 uterine branches



# Cysticercosis



Parasitic tissue infection caused by larval cysts of the tapeworm *Taenia solium* from ingestion of *T. solium* eggs.

The larval cysts infect brain, muscle, or other tissue, and are a major cause of adult onset seizures.

# *Hymenolepis nana*

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Dwarf Tapeworm

Definitive host: Human and rodent

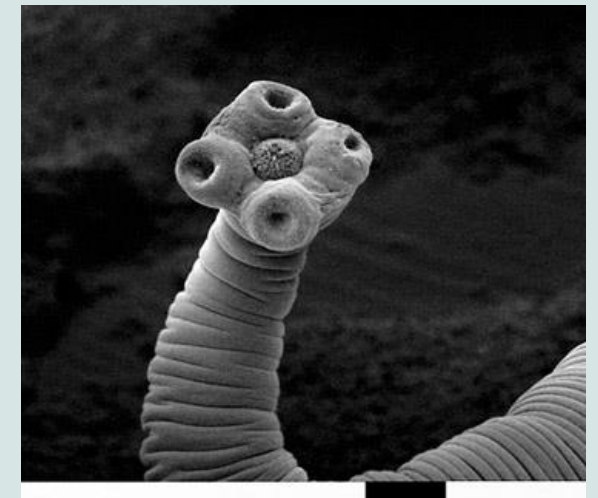
Infected by rodent contaminating food and water

Worm is 2-4 cm, smallest tapeworm

Egg 30-45  $\mu\text{m}$  in diameter, thick shell covering  
with 6 hooks



*Hymenolepis nana*: typical egg, measuring between 30 and 47  $\mu\text{m}$  in diameter, containing an oncosphere with an internal cover with polar thickenings and 6 hooks (1,000 X).



# *Echinococcus granulosus*



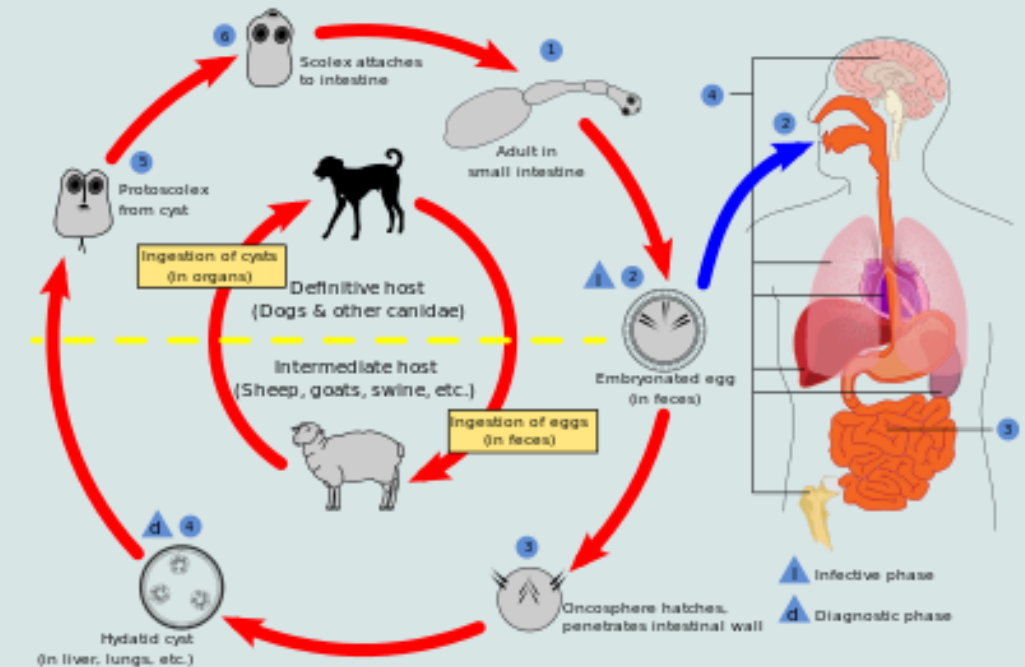
## Hydatid cyst disease

Most commonly found in Africa, Europe, Asia, the Middle East, and Central and South America.

Highest prevalence in populations that raise sheep

Dogs (definitive host) ingest cysts in organs of infected sheep (intermediate host) and dog produces eggs that are ingested by human

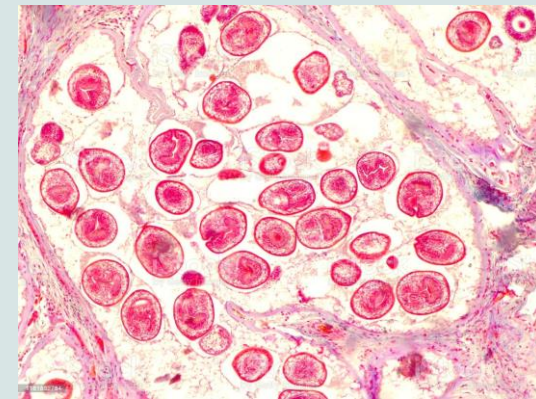
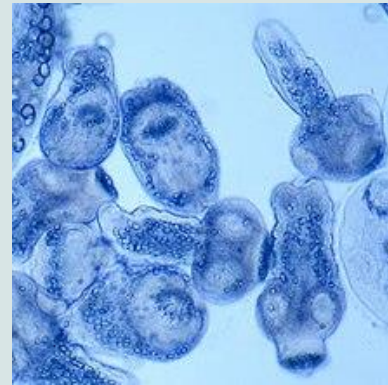
Ingestion of embryonated egg leads to hydatid cyst formation



# *Echinococcus* – hydatid cyst

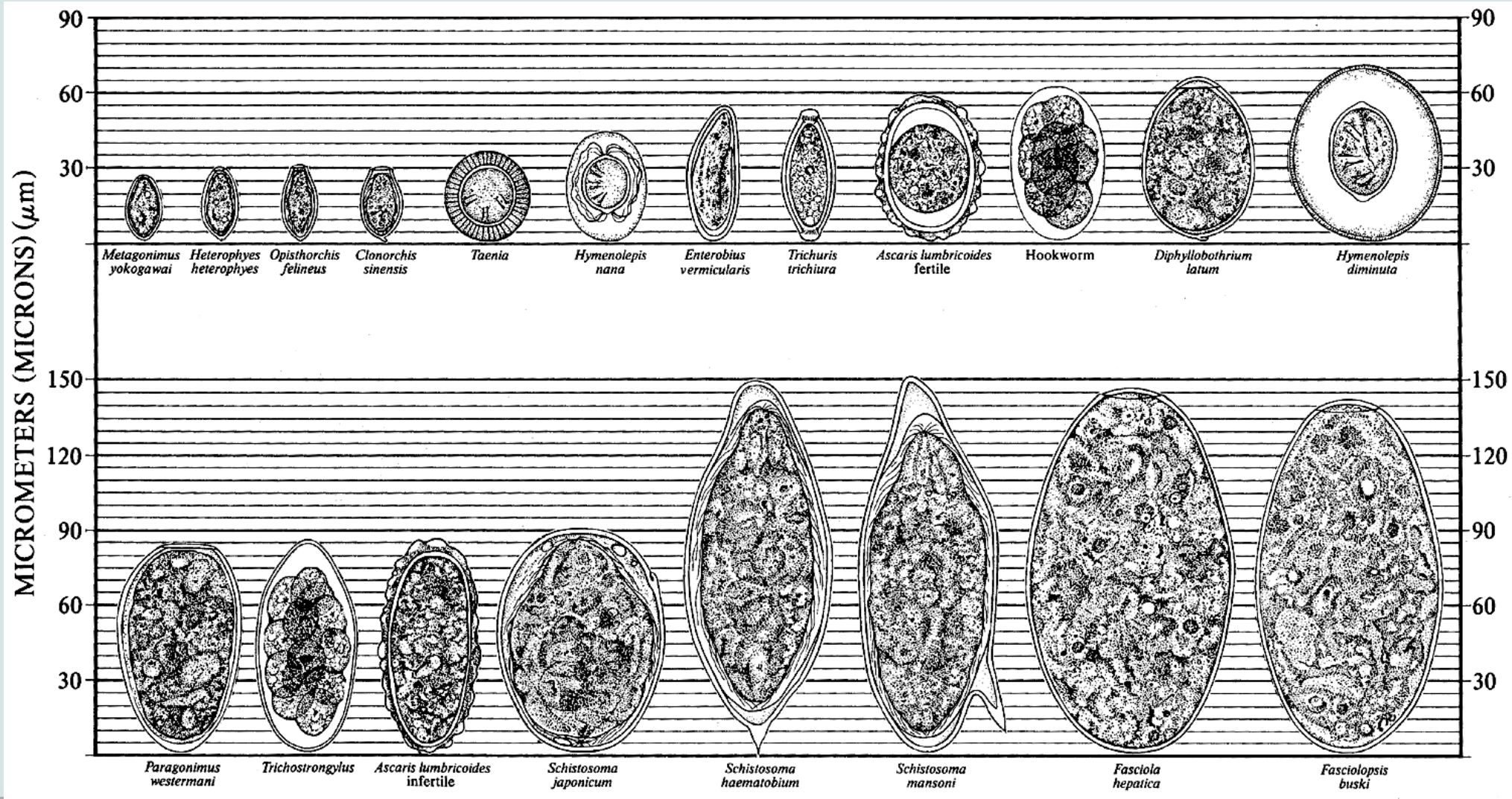


Sand like material contained in the hydatid cyst results from the inverted folded tapeworms



Hydatid cyst in liver

# Relative size and appearance of Helminth eggs



Maggots/  
House fly larvae



Bot fly bites human,  
larvae develops in  
subcutaneous area,  
matures and then  
extrudes from the  
skin

Native to central and  
south America

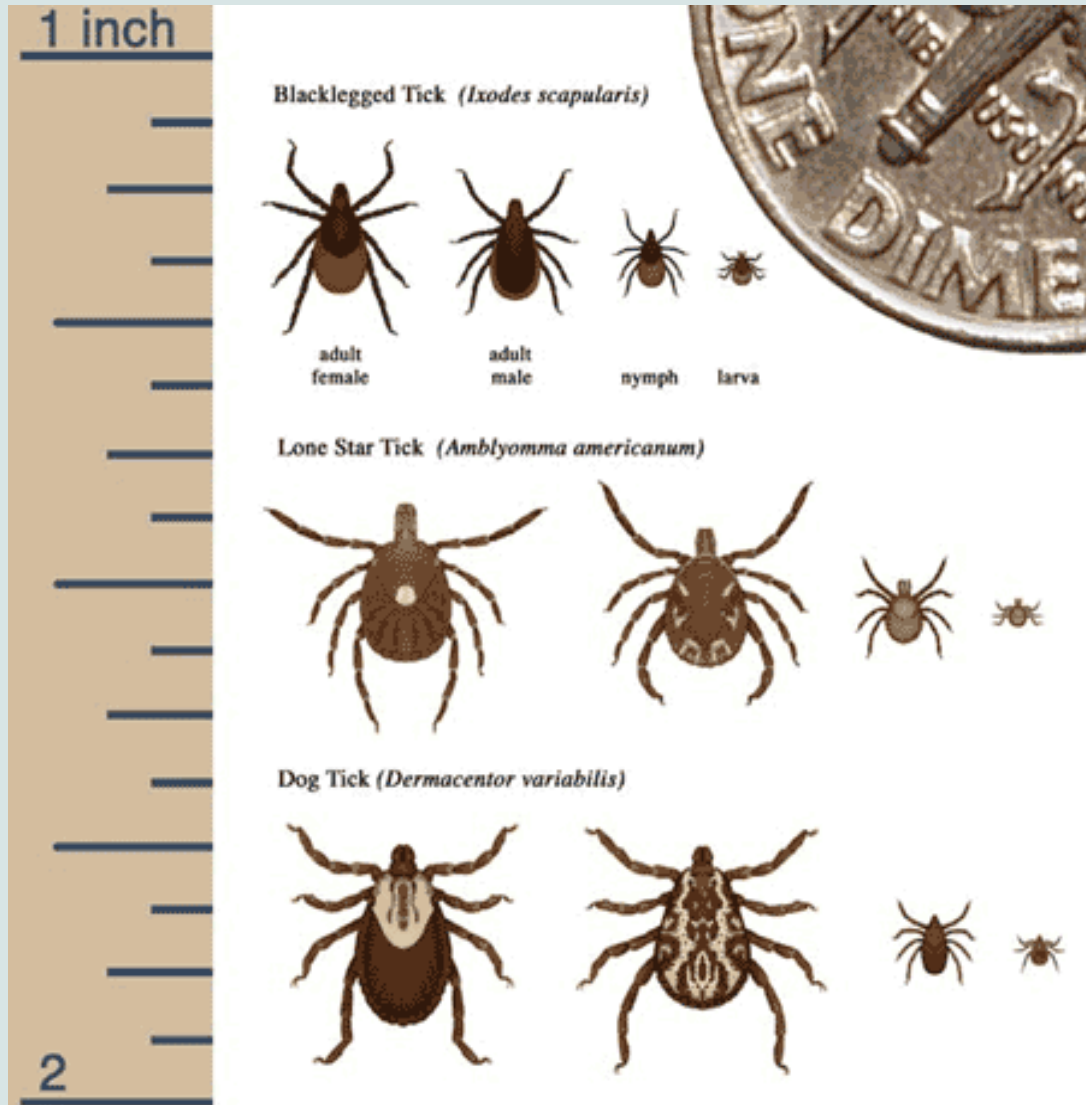
Bot fly



Bot fly larvae



# Hard Ticks



# Ticks



Soft tick -  
Expands with blood meal

# Spiders

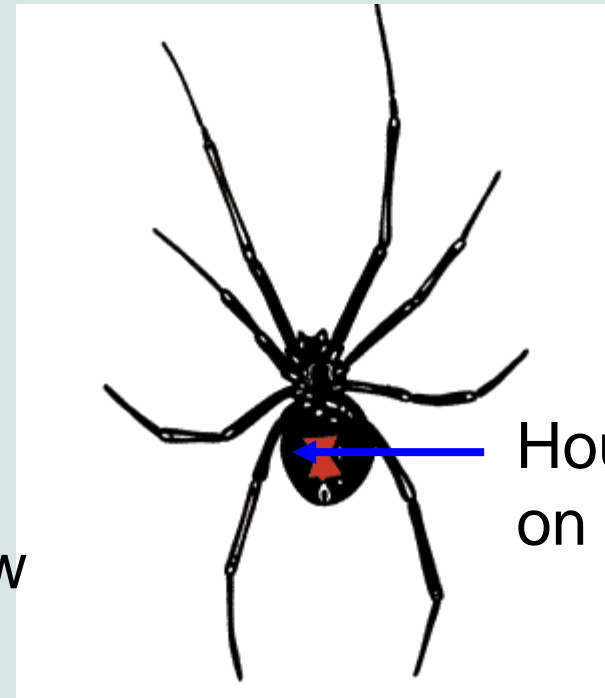
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Brown recluse spider

Length: 0.5 in. (1.3 cm)

Black Widow spider



Hour glass on underside



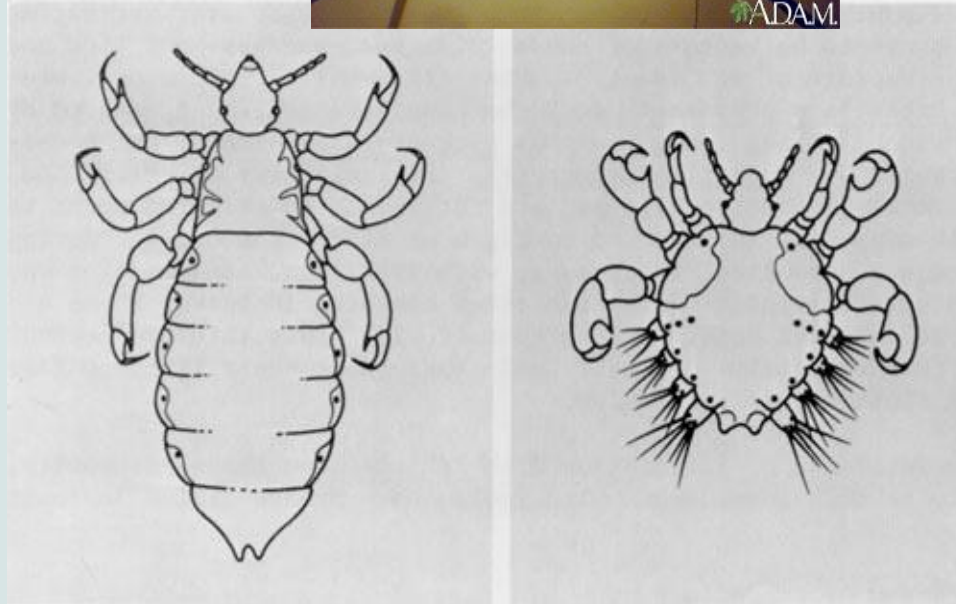
Flea



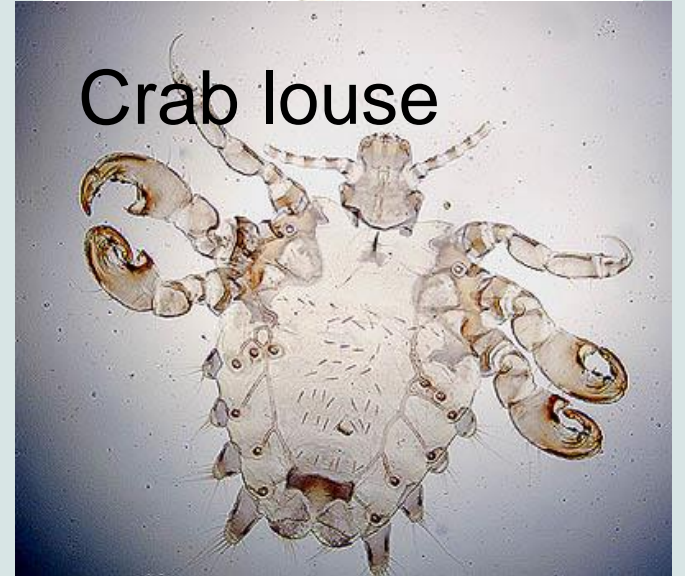
Hair nit – Body louse egg on hair shaft



Body louse

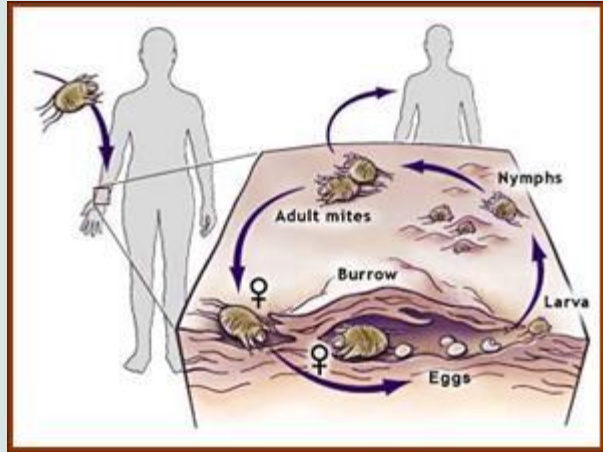
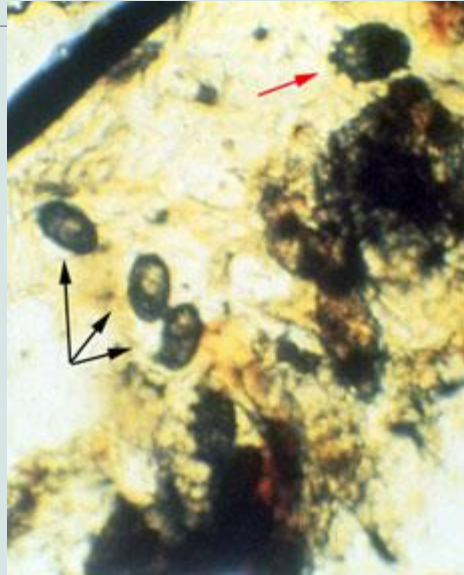


Crab louse

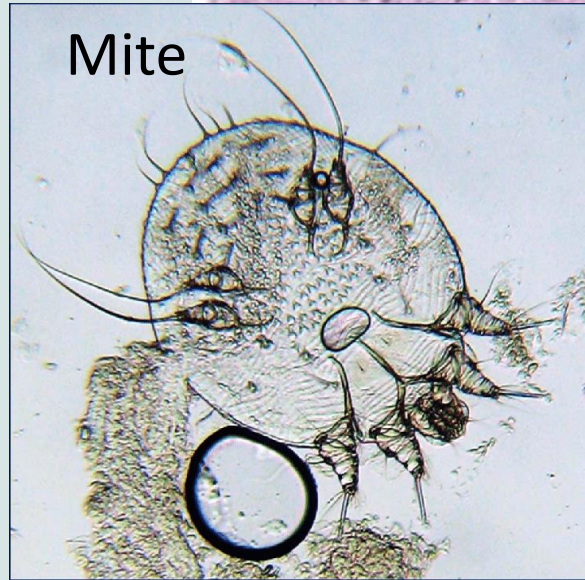


# Scabies

Mite Eggs



Mite



Bumps created from Mites  
Burrowing under the skin

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Additional slides for study/ not included in  
recorded lecture

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# Trematodes (Flatworms)

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## Intestinal and Liver flukes

- Fasciolopsis buski
- Fasciola hepatica

## Liver flukes

- Clonorchis sinensis (Chinese liver fluke)

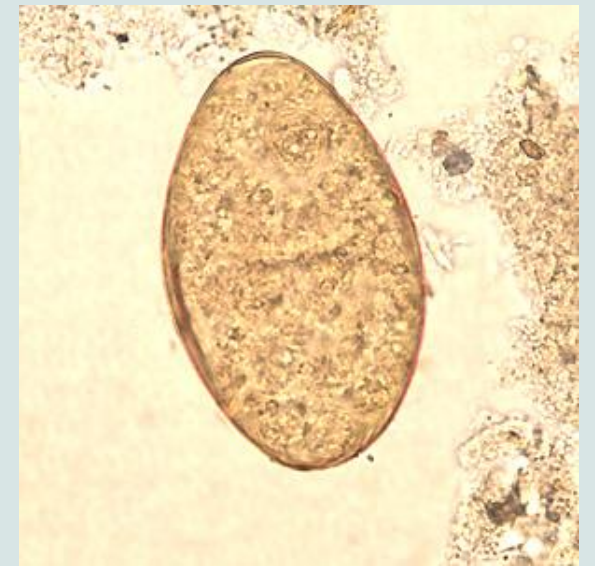
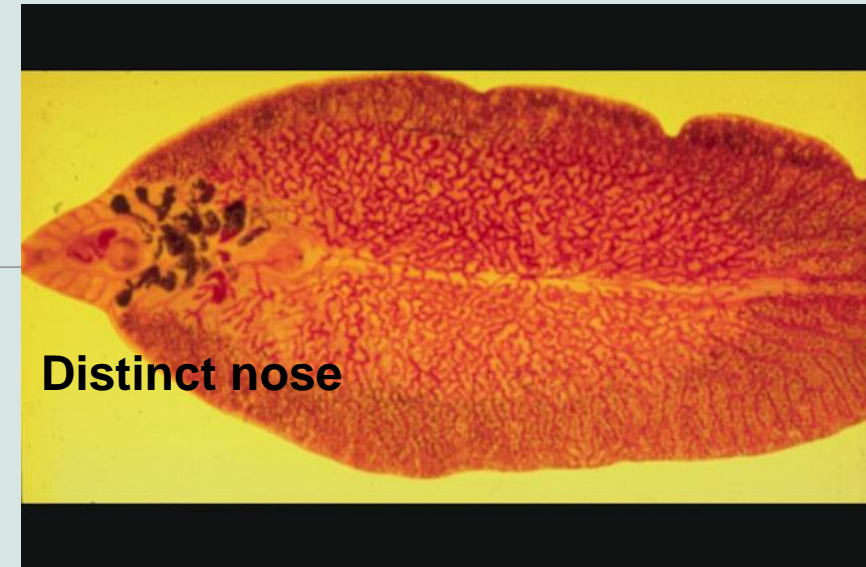
## Paragonimus westermani – oriental lung fluke

## Schistosomes

- S mansoni – intestinal bilharziasis
- S haematobium - urinary
- S japonicum – blood fluke, found in intestines

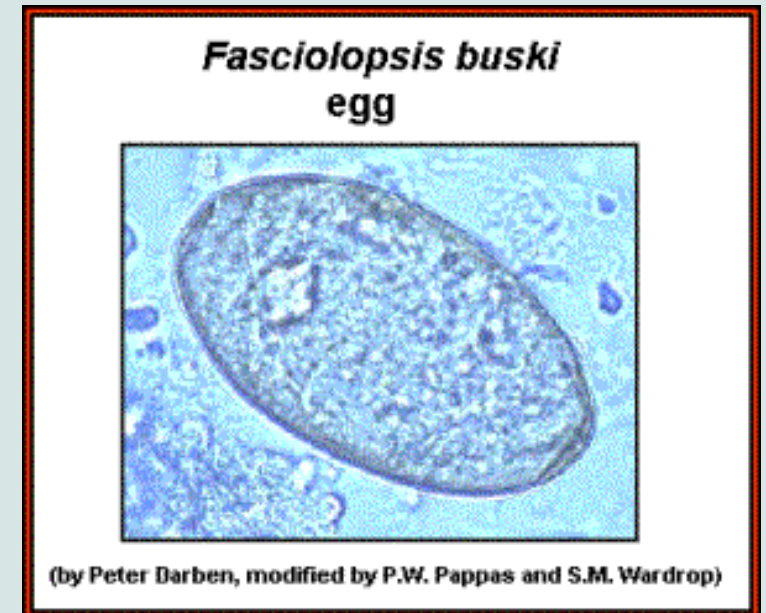
# Fasciola hepatica, "common liver fluke" or "sheep liver fluke."

- Associated with raising sheep and cattle, they contaminate water with feces
- Infected by eating raw watercress or other water plants contaminated with immature larvae.
- The immature larval flukes migrate through the intestinal wall, the abdominal cavity, and the liver tissue, into the bile ducts. The pathology is most pronounced in the bile ducts and liver.
- Fasciola infection is both treatable and preventable
- Eggs – ellipsoidal, operculated and large 140 X 80µm



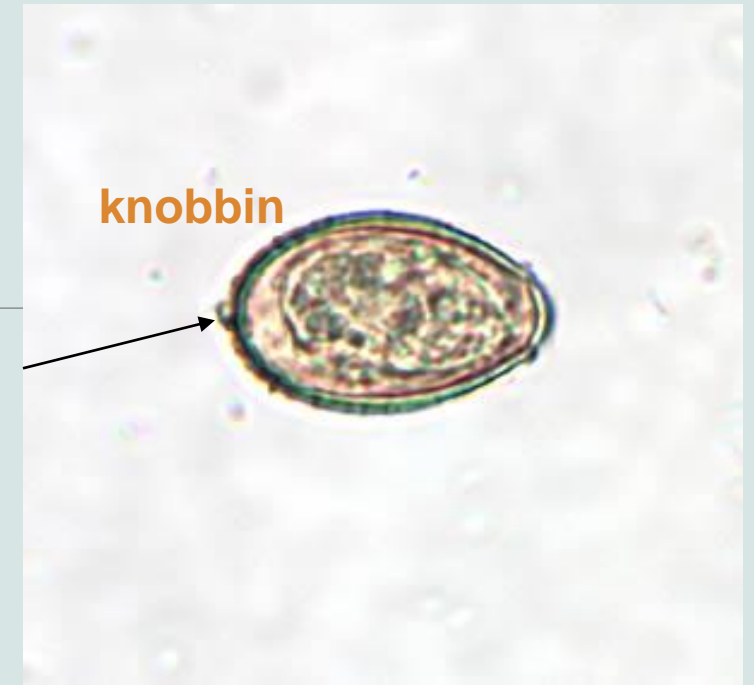
**Fasciolopsis buski**, is the largest intestinal fluke of humans.

- Prevented by cooking aquatic plants before ingestion
- Found in south and southeastern Asia.
- Many people do not have symptoms from Fasciolopsis infection. However, abdominal pain and diarrhea can occur 1 or 2 months after infection.
- With heavy infections Fasciolopsis flukes can cause intestinal obstruction, abdominal pain, nausea, vomiting, and fever.
- Treatable infection



# Clonorchis sinensis

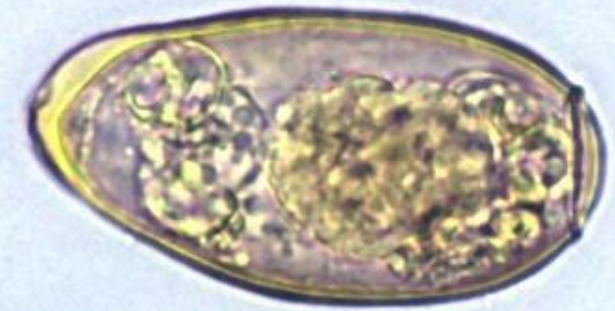
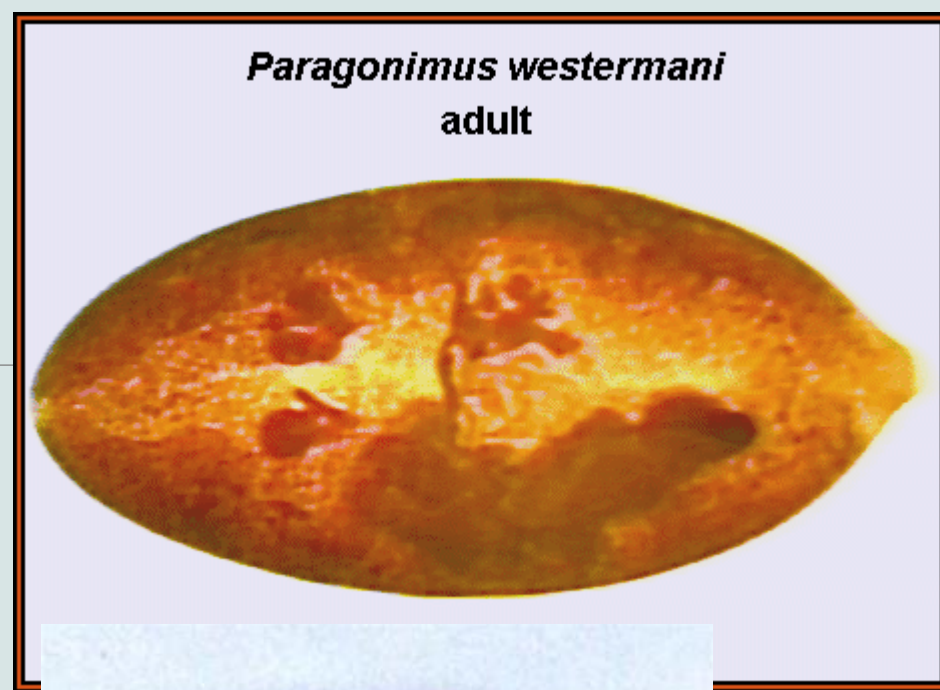
- Liver fluke that infects the liver, gallbladder and bile duct.
- Found across parts of Asia, it is also known as the Chinese or oriental liver fluke.



**Paragonimus westermani** is a parasitic lung fluke.

Infections occur after a person eats raw or undercooked infected crab or crayfish.

Infection also can be quite serious if the fluke travels to the central nervous system, where it can cause symptoms of meningitis.



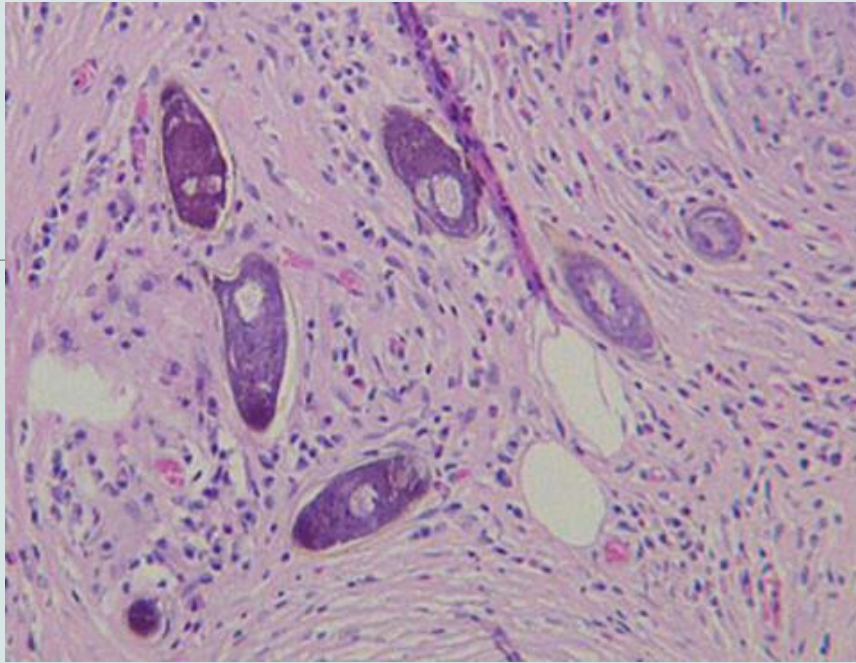
Egg is operculate, not embryonated, thick shell, asymmetrical and large



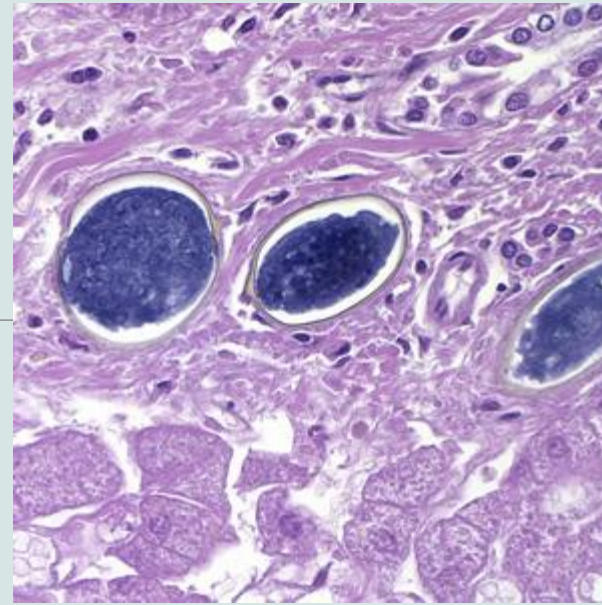
# Schistosoma species, Schistosomiasis

- Also known as bilharzia, more than 200 million people are infected worldwide. Second only to malaria as the most devastating parasitic disease.
- Live in certain types of freshwater snails.
- The infectious form of the parasite, known as cercariae, emerge from the snail, and contaminate water.
- You become infected when your skin comes in contact with contaminated freshwater.
- Most human infections are caused by (1) *Schistosoma mansoni*, (2) *S. haematobium*, or (3) *S. japonicum*.





*Schistosoma mansoni*  
Liver tissue



*Schistosoma japonicum*  
Intestine tissue

*Schistosoma haematobium* –  
bladder tissue  
Intense  
inflammation  
with eosinophils

