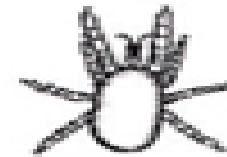


PARASITES



red mite



mite



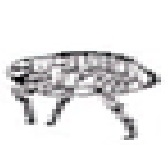
tick



louse



flea



Parasitism is a non-mutual symbiotic relationship between species, where one species, the **parasite**, benefits at the expense of the other, the host.

Traditionally *parasite* (in biological usage) referred primarily to organisms visible to the naked eye, or macroparasites (such as helminths). *Parasite* can include microparasites, which are typically smaller, such as protozoa.

Parasitic Classification, Structure, and Replication

- intestinal and urogenital protozoa,
- blood and tissue protozoa,
- nematodes,
- trematodes,
- cestodes,
- arthropods

Protozoa (single-celled, eukaryotes)

- Amebas
 - move by extending cytoplasmic projections
- Flagellates
 - move by rotating whip-like flagella
- ciliates
 - move by synchronous beating of hair-like cilia
- sporozoa
 - generally have non-motile adult forms

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Tissue infections

- Toxocara canis and cati
- Wuchereria bancrofti (filarial worm)
- Brugia malayi
- Onchocerca volvulus
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Platyhelminthes/Flatworms

Trematodes/Flukes

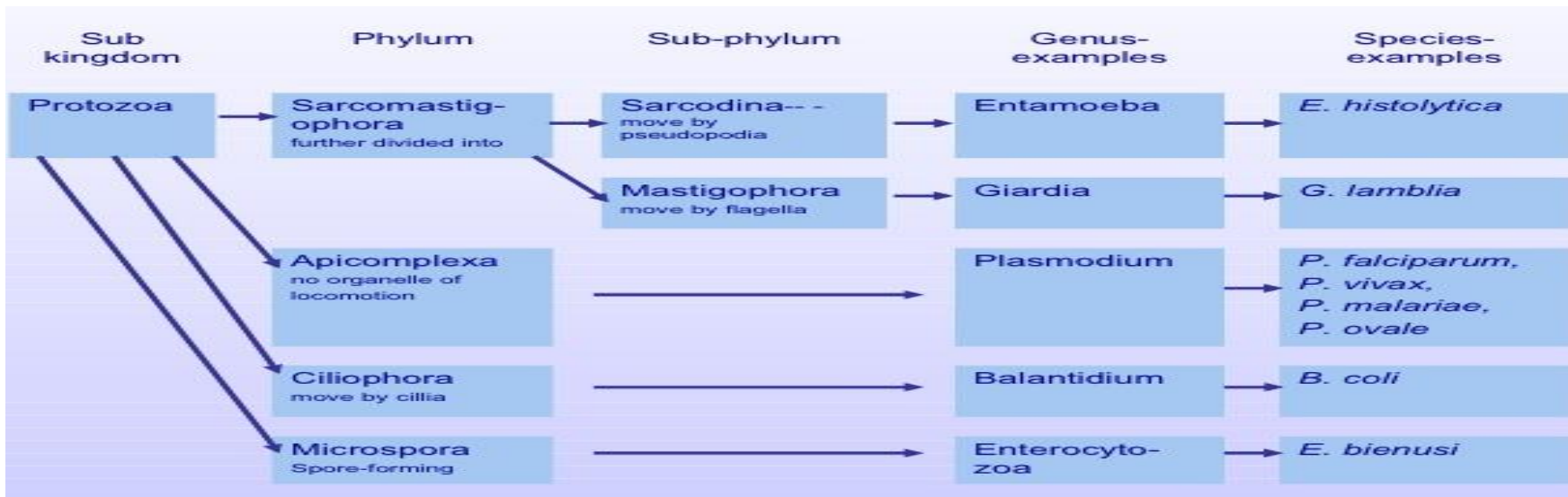
- Schistosoma mansoni
- Schistosoma haematobium
- Fasciola hepatica

Cestodes/Tapeworms

- Taenia saginata
- Taenia solium

Protozoa – life cycle

- microscopic unicellular eukaryotes
- protozoan infections are inapparent or mild in normal individuals or life-threatening in immunosuppressed patients, particularly patients with acquired immune deficiency syndrome (AIDS).
- Most species causing human disease are members of the phyla Sacromastigophora and Apicomplexa.
- protozoan generally passes through several **stages** that differ in structure and activity.
- **Trophozoite** (Greek for “animal that feeds”) is a general term for the active, feeding, multiplying stage of most protozoa.
- **Cysts** are characterized by a resistant wall and are excreted with the feces (intestinal protozoa)
- **Reproduction in the Protozoa may be**
- asexual (amebas and flagellates) or both asexual and sexual, as in the Apicomplexa
- asexual multiplication - binary fission.



Protozoa

NAME	DISEASE FEATURES	IDENTIFICATION	PATHOGENESIS	TRANSMISSION	TREATMENT
<i>Cryptosporidium</i> species	Watery diarrhea; severe in AIDS patients	Acid-fast stain of oocysts in stools	Invasion of gastrointestinal tract mucosa	Fecal-oral spread of oocysts	Rehydration, nitazoxanide
<i>Entamoeba histolytica</i>	Amebic dysentery, right upper quadrant pain, urn-shaped intestinal ulcers; Liver abscess	Cysts or trophozoites in stools or biopsy	Invasion of intestinal mucosa, cell destruction	Fecal-oral spread of cysts	Metronidazole, iodoquinol, paromomycin
<i>Giardia lamblia</i>	Mild to severe watery foul-smelling diarrhea; nausea, anorexia, cramps	Cysts or flagellated trophozoites (less common) in stools; stool antigen	Adherence to villi, perhaps causing malabsorption and irritation	Fecal-oral spread of cysts	Metronidazole, tinidazole,
<i>Leishmania donovani</i>	Visceral disease (kala-azar): blackening of skin, anemia, fever, hepatosplenomegaly	Intracellular organisms seen in tissue biopsy	Multiplication in macrophages; spread to liver and spleen	Bite of sandfly (<i>Phlebotomus</i> species)	Stibogluconate (antimony)
<i>Naegleria</i> species	Meningoencephalitis	Amebae in CSF or other sterile tissue	Colonization of nasal passages; invades nasal mucosa and travels to brain	Swimming in contaminated water	Amphotericin B plus miconazole and rifampin
<i>Plasmodium</i> species	Malaria: cyclical fever and chills; anemia, liver and spleen enlarged; Cerebral involvement and blackwater fever (<i>P. falciparum</i>)	Blood smear showing ring forms and signet-like trophozoites within RBCs and crescent-shaped gametophytes	Sporozoites invade hepatocytes and form merozoites, which infect and reproduce asexually in RBCs causing hemolysis	Bite of female <i>Anopheles</i> species mosquito	Chloroquine, primaquine, artemisinin, quinine, mefloquine, pyrimethamine, doxycycline, artesunate as single drug or combinations
<i>Toxoplasma gondii</i>	Mononucleosis-like illness: fever, enlarged lymph nodes; Lesions in brain, eyes, and liver possible in AIDS patients and neonates	ELISA for increased antibody titer; cysts or trophozoites in biopsy	Proliferation of organisms within cells; induced cellular immune response	Ingestion of cysts in meat; cat feces; transplacental	Sulfonamides plus pyrimethamine; clindamycin plus dapsone
<i>Trichomonas vaginalis</i>	Vaginitis with frothy discharge, itching, and burning; Asymptomatic in men	Trophozoites in vaginal secretions or Papanicolaou smear	Adherence to vaginal wall; erosion of surface cells	Sexual contact	Metronidazole, tinidazole
<i>Trypanosoma brucei</i> (African)	Sleeping sickness: fever, Winterbottom sign, CNS involvement (headache, blank look, lethargy)	Trypanosomes visible in blood, CSF, or lymph node aspirates	Invasion of brain; antigenic shift	Bite of tsetse fly	Suramin for acute disease; melarsoprol for chronic disease involving CNS
<i>Trypanosoma cruzi</i> (American)	Chagas disease: fever, enlarged liver and spleen, Romaña sign (orbital edema) Chronic form: cardiac involvement common, cardiomegaly; megacolon, megaesophagus	Trypanosomes visible in blood	Proliferation within cells (especially muscle and neuroglial cells); induced cellular immune response	Contact with cysts in feces of reduviid bugs at bite site	Nifurtimox

Mastigophora:

- All are flagellates
- one or more flagella - locomotion
- In some cases - undulating membrane (Trypanosoma)
- intestinal and genitourinary flagellates :

Giardia,

Trichomonas,

Dientamoeba,

Chilomastix,

- blood and tissue flagellates :

Trypanosoma,

Leishmania,

- They reproduce asexually by binary fission.

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- Trematodes/Flukes**
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 - Schistosoma haematobium
 - Fasciola hepatica
- Cestodes/Tapeworms**
 - Taenia saginata
 - Taenia solium

Sarcodina

- typically amoeboid

Entamoeba,

Endolimax,

Iodamoeba,

Naegleria (flagella, when present, develop only during
the early stages)

Acanthamoeba, etc.

shapeless mass of moving cytoplasm - divided in to granular
endoplasm and clear ectoplasm.

- They move by pushing out the ectoplasm to form pseudopodia (false feet) into which the endoplasm then flow.
- Amoebae reproduce asexually by simply dividing into two (binary fission)

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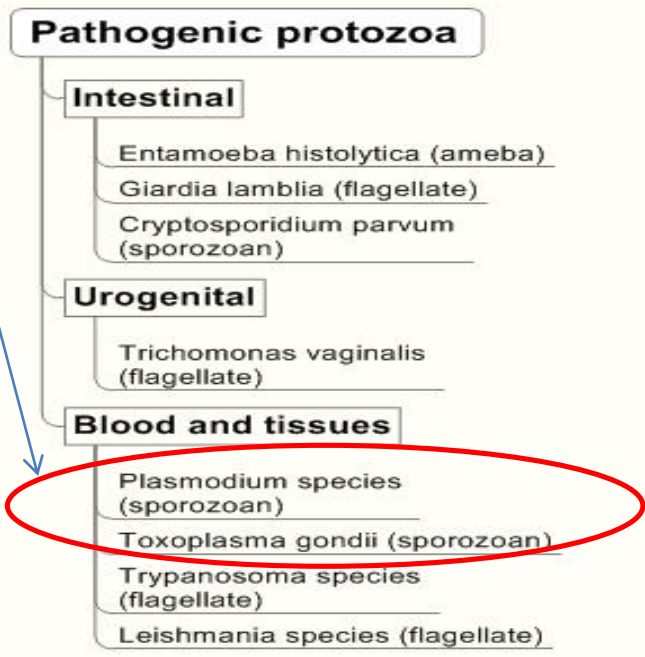
Cestodes/Tapeworms

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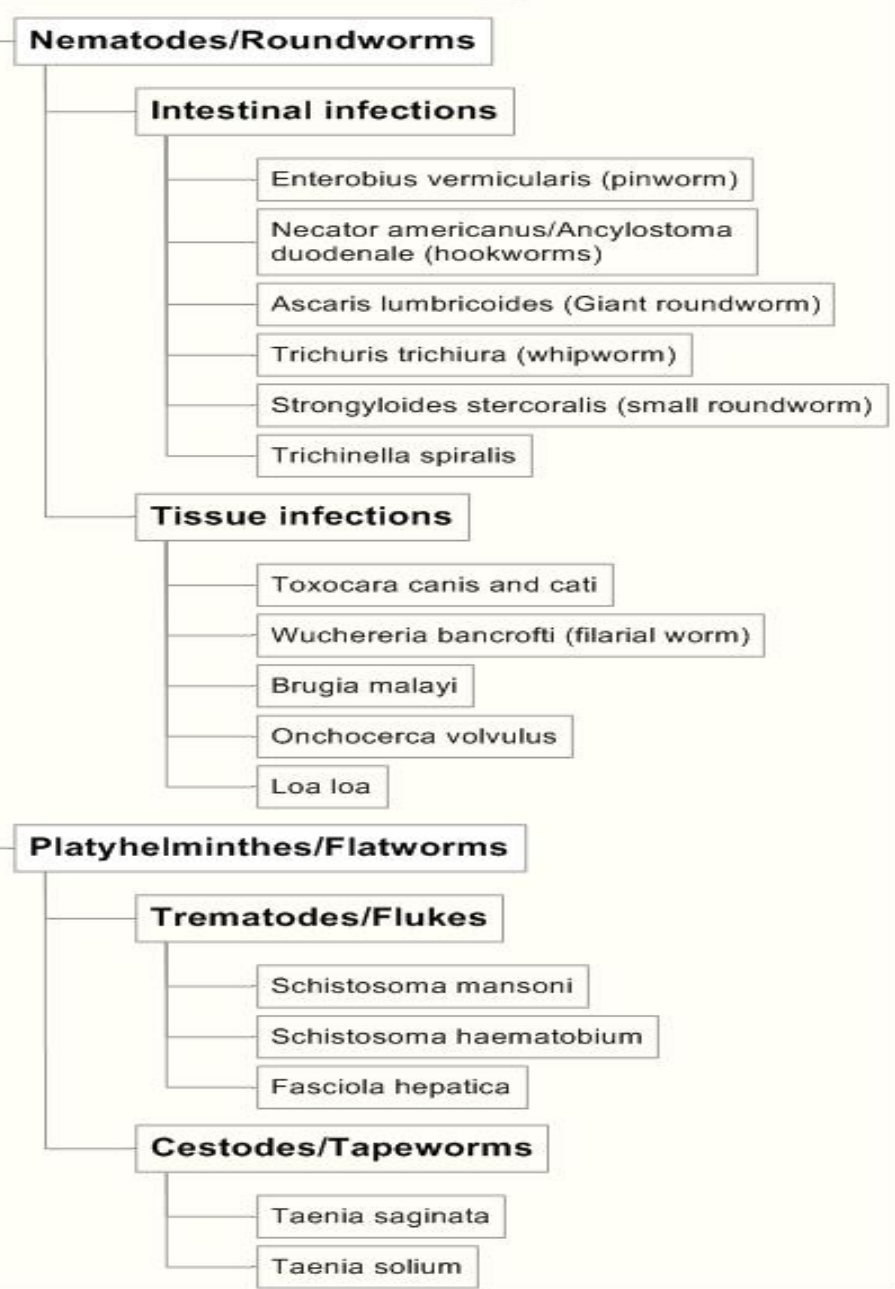
Sporozoa

- super-class
- complex life cycle with alternating
- sexual and
- asexual reproductive phases (two different hosts)
- Coccidia -intracellular parasites,
asexually = schizogony
sexually = sporogony.
- Class Coccidia
 - Isospora and **Toxoplasma gondii**
- class Haematozoa
 - malarial parasites- **Plasmodium species.**

Protozoa (single-celled, eukaryotes)

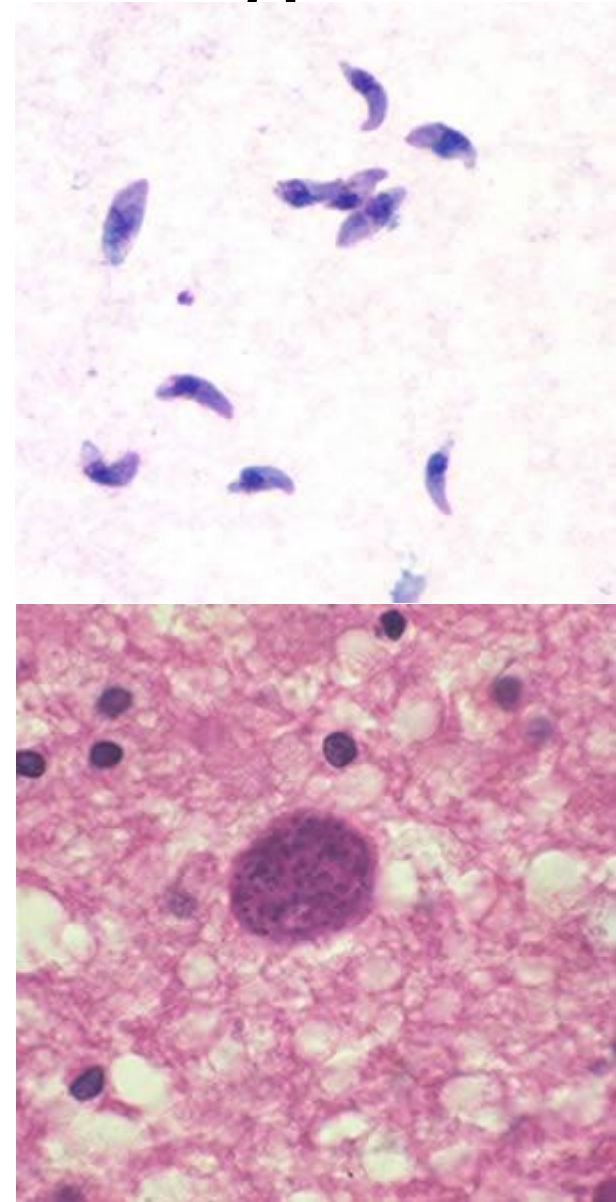


Metazoa (Helminths/worms/multicellular, eukaryotes)



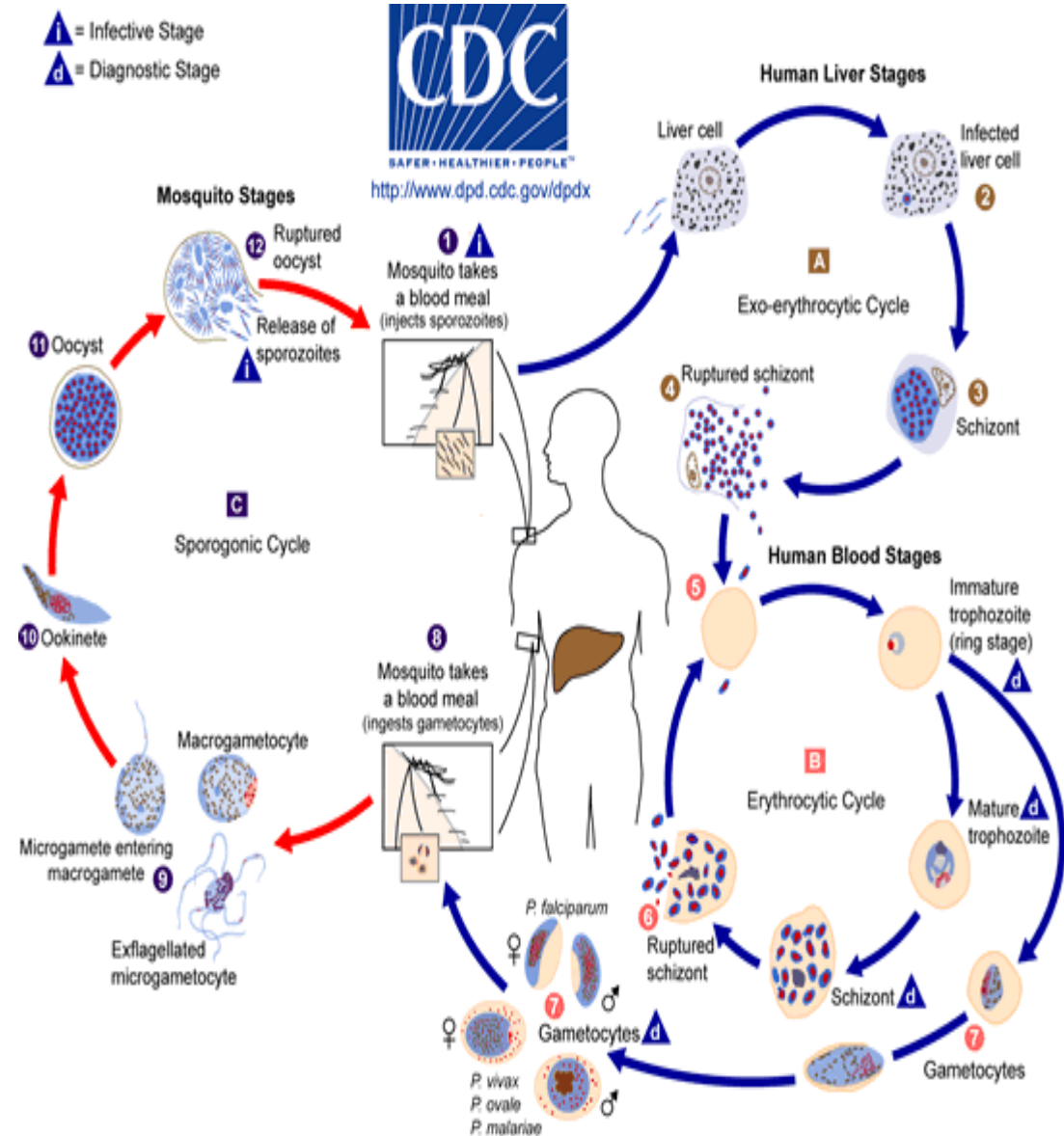
Sporozoa- Toxoplasma - Dg

- **Observation of parasites - bronchoalveolar lavage material from immunocompromised patients, lymph node biopsy.**
- **Isolation** - from **blood** or other body fluids, by intraperitoneal inoculation into mice or tissue culture. The mice should be tested for the presence of *Toxoplasma* organisms in the peritoneal fluid 6 to 10 days post inoculation; if no organisms are found, serology can be performed on the animals 4 to 6 weeks post inoculation.
- **Detection - PCR**, - detecting congenital infections in utero.
- **Serologic testing is the routine method of diagnosis.**

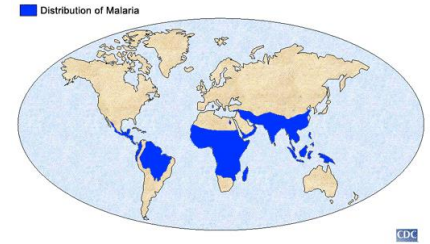


Sporozoa- Plasmodium

- *P. falciparum*,
- *P. vivax*,
- *P. ovale*
- *P. malariae*



Plasmodium-malariae, falciparum



- Definitive host: Anopheles
- Transient host: human, monkey
- dg. microscopy thick drop
- Transmission insect bite
- disease: malaria acc. to the rate of schizogonia- clinically as fever attacks

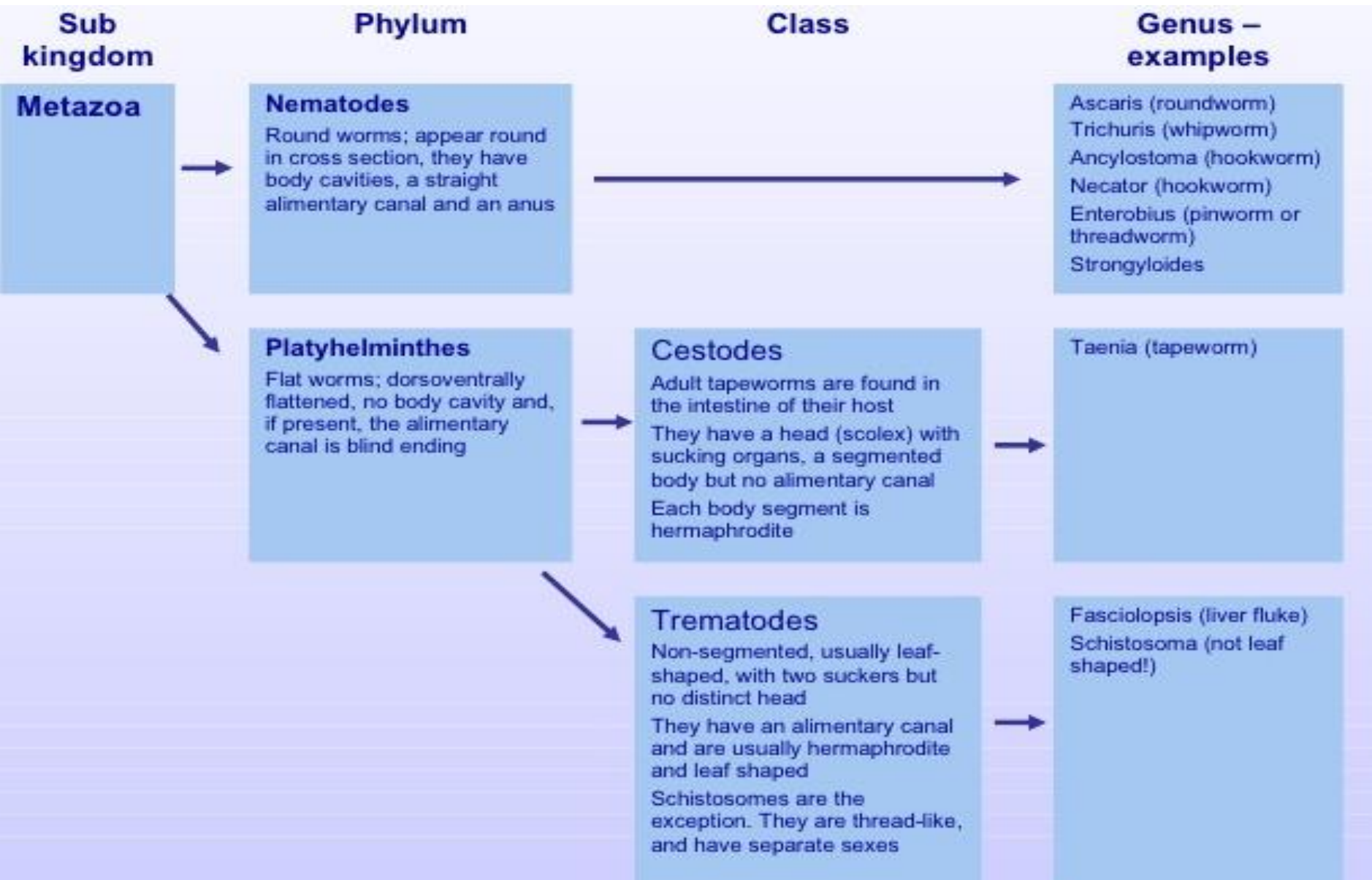
Table of differences between the various types of parasites that cause malaria

Plasmodium type	Type that causes malaria	Endemic area	Febrile seizures period	Involvement and severity
Falciparum	tropical malaria	In all endemic areas	Irregular Crisis	Very serious It can cause death if not treated quickly and effectively.
Vivax	tertian malaria	South America and Asia	Every 2 days	Grave, but with a delayed onset.
malariae	quartan malaria	South America and Asia	Every 3 days	Moderate, less frequently.
Ovale	tertian malaria	Africa	Every 2 days	Moderate, less frequently.
Knowlesi	It is mistaken with quartan malaria	Malaysia, Thailand and Cambodia	Every 24 hours	It can cause death if not treated quickly and effectively.





Classification of Parasitic Helminths



Nematodes

- Their body is elongated, cylindrical and unsegmented. Sexes are separate (diecious). They also lack hooks and suckers.
- They possess the complete alimentary canal and body cavity. Examples are:
 - **1. Intestinal**
 - i. **Small intestine only:**
 - *Ascaris lumbricoides* (Common round worm),
 - ii. **Caecum and vermiform appendix:**
 - *Enterobius vermicularis* (Threadworm or pin worm),
 - **2. Somatic (inside the tissues and organs)**
 - i. **Lymphatic system:** *Wuchereria bancrofti*, *Brugia malayi*
 - ii. **Subcutaneous tissue:** *Onchocerca volvulus*, *Dracunculus medinensis*
 - iii. **Lungs:** *Strongyloides stercoralis*
 - iv. **Conjunctiva:** *Loa loa*

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- Fasciola hepatica

Cestodes/Tapeworms

- Taenia saginata
- Taenia solium

Cestodes

- The cestodes (or tapeworms) two unmistakable morphological features; **they all possess flat, ribbon like bodies and lack an alimentary canal**

The body consists of a chain of segments (proglottids), which can be immature, mature or gravid; the latter of which contain a fully developed uterus packed with eggs.

- *Diphyllobothrium*, *Taenia*, *Echinococcus*, *Hymenolepsis*, etc



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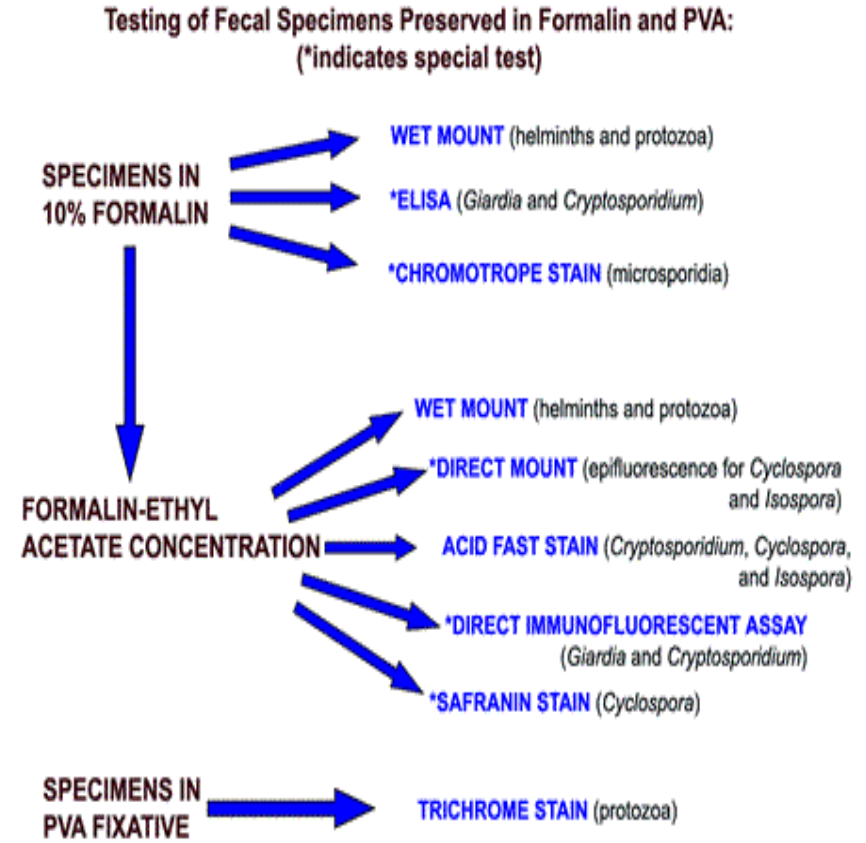
How are parasitic diseases diagnosed?

- **A fecal (stool) exam, also called an ova and parasite test (O&P)**
- **Endoscopy/Colonoscopy**
- **Blood tests**
 - Serology*
 - Blood smear*
- **X-ray, Magnetic Resonance Imaging (MRI) scan, Computerized Axial Tomography scan (CAT)**

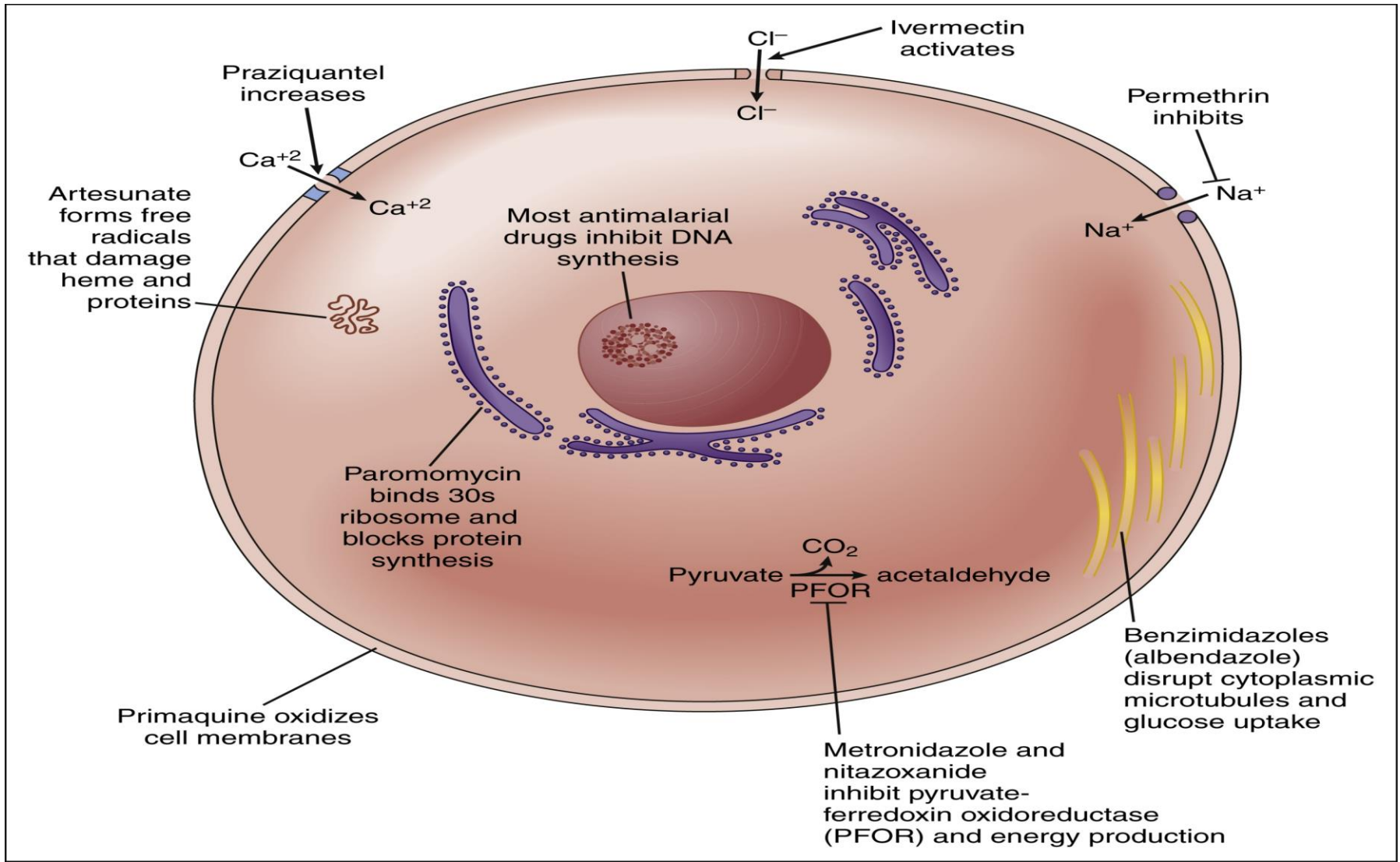
Stool specimens

Concentration procedure separate parasites from fecal debris and increase the chances of detecting parasitic organisms when these are in small numbers.

- **Flotation techniques** - solutions (Zinc sulfate) have higher specific gravity than the organisms -the organisms rise to the top and the debris sinks to the bottom.
- **Sedimentation techniques** – solutions (formalin-ether) of lower specific gravity than the parasitic organisms, thus concentrating in the sediment.



Parasites - therapy



Parasites - therapy

PARASITE	DRUG	TARGET	EXAMPLES
Protozoa	Sulfonamides	Folate pathway	Toxoplasma, malaria
	Doxycycline, clindamycin	Protein synthesis	Malaria, amebiasis, babesia, cryptosporidia
	Diamidines	Bind to DNA	Pneumocystis, leishmania
	Arsenic, antimony compounds	Sulfhydryl groups	Trypanosomes, leishmania
Antimalarial	Aminoquinoline analogues (e.g., chloroquine, primaquine)	DNA replication, heme digestion	
	Doxycycline	Protein synthesis	
	Artemisinin	Reacts with heme	
	Halofantrine	Reacts with heme	
Antihelminth and antiworm	Mebendazole, thiabendazole, albendazole	Fumarate reductase, glucose metabolism, microtubules	Broad-spectrum antihelminth, antinematode, anticestode
	Pyrantel pamoate	Blocks neuromuscular action: fumarate reductase	Ascariasis, pinworm, hookworm
	Ivermectin	Blocks neuromuscular action, reproduction	Filaria
	Praziquantel	Calcium agonist	Antihelminth, antinematode, anticestode
	Niclosamide	Uncouples ox phos	Intestinal tapeworm
	Suramin	Blocks G proteins	Trypanosomes

- Sources:
- Murray et al.: Medical microbiology 7th edition
- <https://basicmedicalkey.com/antiparasitic-drugs-2/>
- <https://clinicalgate.com/parasites/>