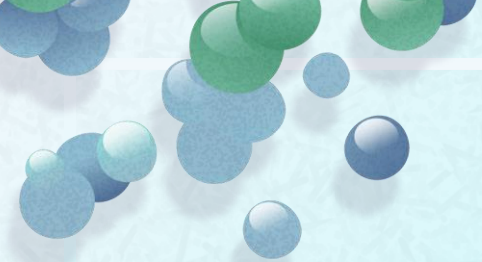
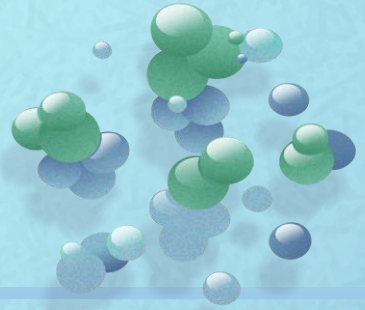
Medical Parasitology

22ZOOVC23

Introduction
to
Medical Parasitology



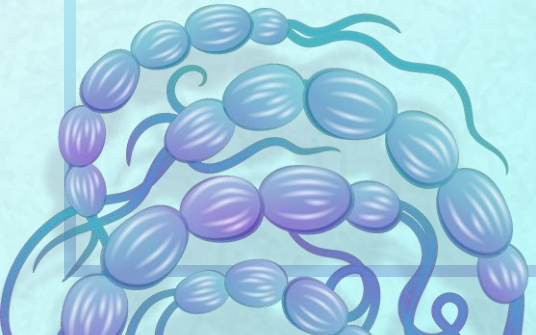


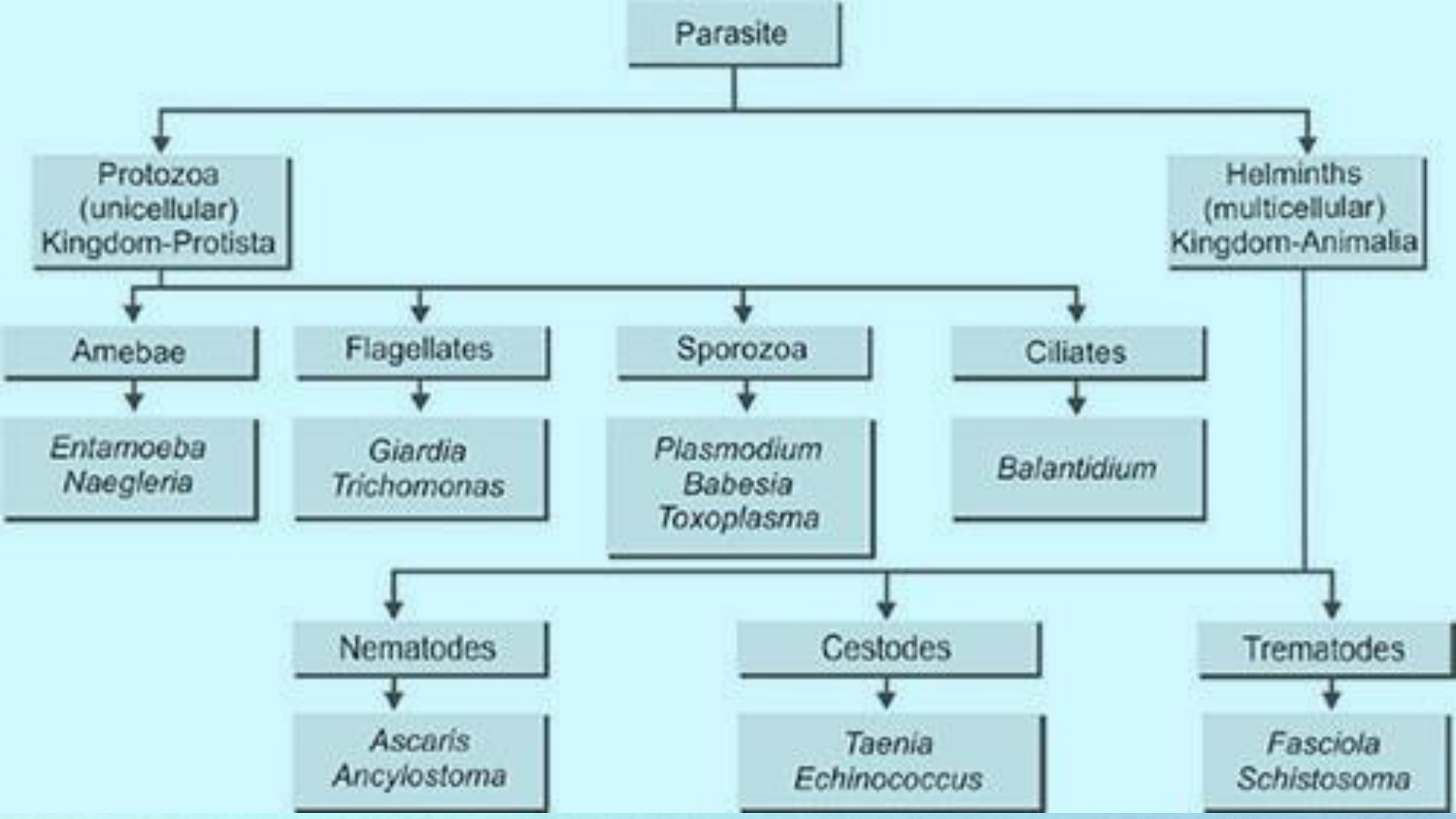
What is medical parasitology?

- Medical parasitology deals with the study parasites that causes human infection and other diseases.
- A parasite is a pathogen, it injures and derives nourishment from its host.
- They multiply and undergo development in the host
- They directly cause disease or act as vectors of various pathogens.
- Parasites are of three major groups of animals:
  - **Parasitic protozoa**
    - Single-celled organisms causing diseases like malaria and amoebiasis.
  - **Parasitic helminths** (worms), and
    - Multicelluar oraganisms includes Nematodes, Trematodes, and Cestodes.
  - **Arthropods**
    - Multicelluar organisms such as lice, fleas, and ticks.

Types of parasites

1. **Ectoparasite:** Inhabits on the surface of the host. Eg. Ticks.
2. **Endoparasite:** Parasites lives within the host body. Eg. most helminths and protozoans.
3. **Free living parasite:** Non- parasitic stage, lives independent of the host. Eg. *Naegleria fowleri* (brain – eating amoeba)
4. **Obligate parasite:** Parasite can't live without host. Eg. *Plasmodium.*
5. **Facultative parasite:** either parasitic or free-living organism. Eg. *Naegleria fowleri.*
6. **Accidental parasite:** parasite infects a unusual host. Eg. *Echinococcus granulosus.*
7. **Abberant parasite:** Parasite infects host, cannot develop further, also called wandering parasites. Eg. *Toxocara canis* (dog worms) infecting human.

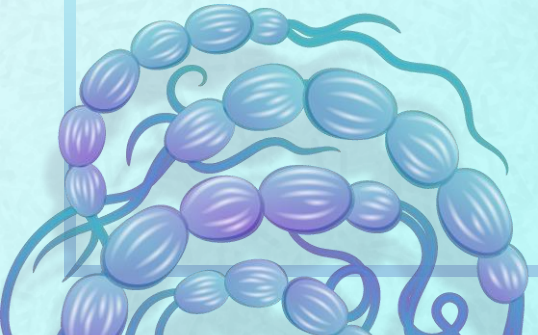



Parasite
Protozoa (unicellular) Kingdom-Protista
Helminths (multicellular) Kingdom-Animalia
Amebae
Flagellates
Sporozoa
Ciliates
Entamoeba Naegleria
Giardia Trichomonas
Plasmodium Babesia Toxoplasma
Balantidium
Nematodes
Cestodes
Trematodes
Ascaris Ancylostoma
Taenia Echinococcus
Fasciola Schistosoma

Types of Host

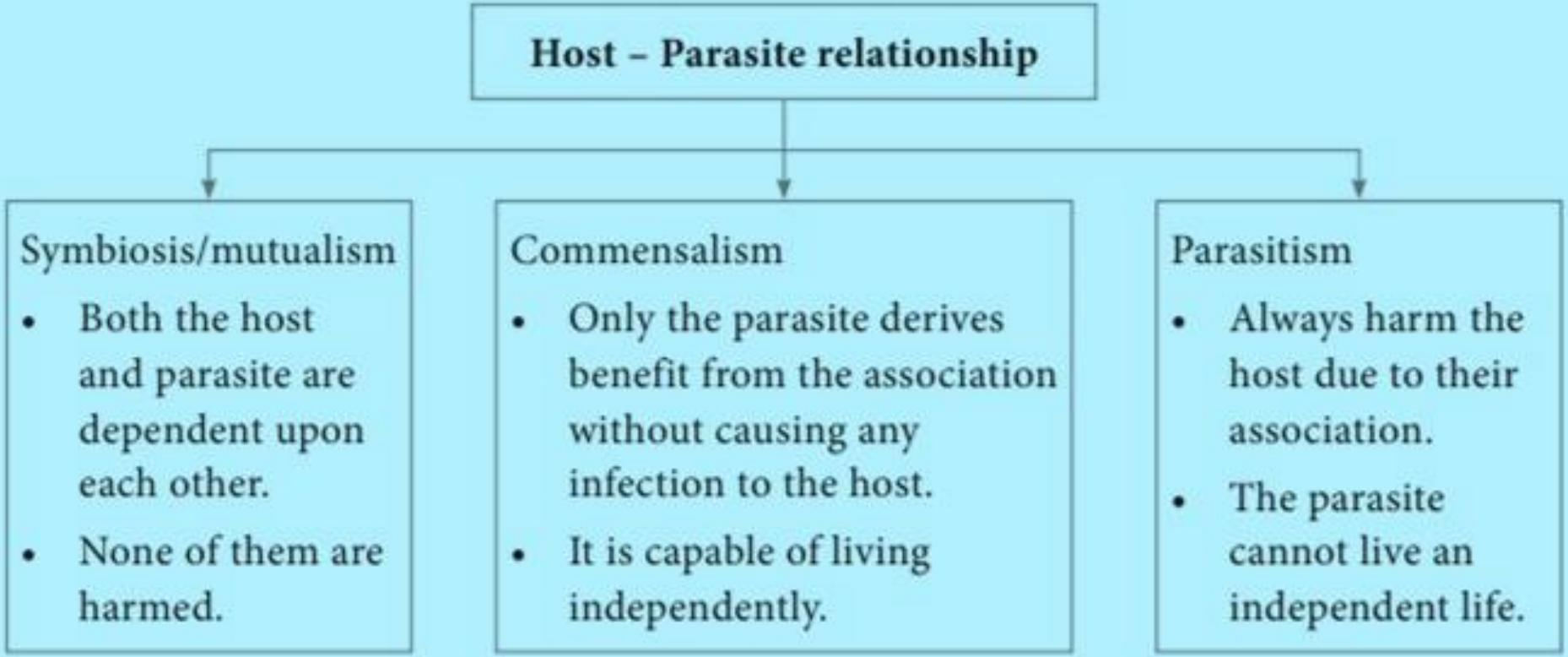
Host: Harbours parasite and provides nourishment. Larger than the parasite.

1. **Definitive host:** Adult parasite undergoes sexual reproduction. Eg. Mosquito for malaria.
2. **Intermediate host:** Either larval stage of the parasite lives or asexual multication takes place. In some cases, two intermediates host are needed to complete larval cycle. Eg. *Plasmodium* spp. , *Taenia solium, Echinococcus granulosus.*
3. **Paratenic host:** Larval stage of the parasite remains in host without development. Eg. Fish for plerocercoid larva of D. *latum*
4. **Reservoir host:** Host harbours the parasite and act as a source of infection to another host. Eg. Dog host for hydatid disease.
5. **Accedental host:** Parasite is not found in the host. Eg. Man is a accidental host of cyctic echinococcosis.



Zoonosis

- **Zoonosis:** Disease naturally transmitted between humans and animals.
- Introduced by Rudolf Virchow in 1880.
- Types:
  - Protozoal zoonoses: Toxoplasmosis, Leishmaniasis
  - Helminthic zoonoses: Hydatid disease, taeniasis.
  - Anthropozoonoses: from lower vertebrate animals to humans eg. Cystic echinococcosis.
  - Zooanthroponoses: From humans to lower vertebrates. Eg. Human tuberculosis


Host – Parasite relationship
Symbiosis/mutualism
• Both the host and parasite are dependent upon each other.
• None of them are harmed.
Commensalism
• Only the parasite derives benefit from the association without causing any infection to the host.
• It is capable of living independently.
Parasitism
• Always harm the host due to their association.
• The parasite cannot live an independent life.

Lifecycle of Parasites

- **Direct life cycle**
  - The life cycle of parasite requires only single host to complete its development.
  - Example: *Entamoeba histolytica* requires only human host to complete its life cycle.
- **Indirect life cycle**
  - The life cycle of parasite requires two or more species of hosts to complete its development,.
  - Example: Malarial parasite (Plasmodium spp.) requires both human host and mosquito to complete its life cycle.

Source of Infection

Contaminated soil and water:

•Penetration eggs of infectious parasites (roundworms) or infected larvae in the soil.

•Ingestion of parasites or larvae through water (amoeba).

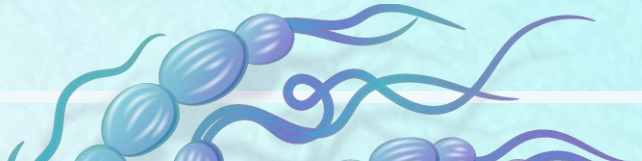
•Water with intermediate hosts.

•Ingestion of larvae or egg from contaminated drinking water or penetration through skin

Food:

•Contaminated food or vegetable with infective stages of parasites (amoebic cyst, *Echinococcus* eggs).

•Ingestion of raw or undercooked meat with infective larvae (pork with larve of *Taenia solium)*



Vectors

- Vector ia an agent that transmit infection from one organism to another.
- Usually an arthropod transmits infection
- From man to man or animals to man.
- Eg. Female Anopheles acts as a vector for malarial parasite
- **Biological Vector:**
- Vector assists in the transfer of infection
- Also undergoes parasite development and multiplication in the host.
- True vectors.
- Eg. 1. Mosquito: Malaria, filariasis
- 2. Sandflies: Kala-azar
- Tsetse flies: Sleeping sickness

•**Mechanical Vector:** only transfers parasite between hosts.

•Not essential for life cycle of parasites.

•Eg. House fly: amoebiasis

Animals:

Domestic:

• Cow, e.g. *T. saginata, Sarcocystis*

• Pig, e.g. *T. solium, Trichinella spiralis*

• Dog, e.g. *Echinococcus granulosus*

• Cat, e.g. *Toxoplasma, Opisthorchis.*

Wild:

• Wild game animals, e.g. trypanosomiasis

• Wild felines, e.g. *Paragonimus westermani*

• Fish, e.g. fish tapeworm

• Molluscs, e.g. liver flukes

• Copepods, e.g. guinea worm

- **Carrier:**
  - A person with person who is infected with parasite without any clinical or subcl inical disease.
  - He can transmit parasite to others.
  - For example, all anthroponotic infections, vertical transmission of congenital infections.
- **Self(autoinfection):**
  - Finger-to-mouth transmission, e.g. pinworm
  - Internal reinfection, e.g. *Strongyloides*.

Mode of infection

- **Oral transmission**:
  - This is through ingestion of contaminated food, water, vegetables, soiled fingers or fomites contaminated by faeces that contain the infective stage of parasite.
  - This mode of transmission is referred to as faecal-oral route.
  - Example: Cysts of *Entamoeba histolytica*.
- **Skin transmission**:
  - The infective larvae of hookworm enter the skin of persons walking bare footed on contaminated soil.
  - Schistosomiasis is aquired when water contaminated with cercarial larvae with skin.

- **Vector transmission**:
  - It could be a biological or a mechanical means.
  - Many parasitic diseases are transmitted by insect bite.
  - Example: sandfly is vector for *Leishmania, Culex* mosquito vector for filariasis.
- **Direct transmission:**
  - by person to person contact.
  - *Entamoeba, Giardia* and *Trichomonas* are transmitted by sexual contact among homosexuals.
- **Vertical transmission:**
  - It is the transmission from mother to fetus. Example: Toxoplasmosis, Malaria
- **Iatrogenic transmission:**
  - seen in transfusion of malaria and toxoplasmosis after organ transplantation.

Pathogenesis

- Parasitic infections may remain in apparent or give rise to clinical disease.
  - A few organisms, such as *E. histolytica may* live as surface commensals, without invading the tissue.
  - Clinical infection produced by parasite may take many forms: acute, subacute, chronic, latent, or recurrent.
- Pathogenic mechanisms, which can occur in parasitic infections are:
- **Lytic necrosis:** Enzymes produced by some parasite can cause lytic necrosis. *E. histolylica lyses intestinal* cells and produces amebic ulcers.
- **Trauma:** Attachment of hookworms on jejunal mucosa leads to traumatic damage of villi and bleeding at the site of attachment.

- **Allergic manifestations:** Clinical illness may be caused by host immune response to parasitic infection.
- e.g. eosinophilic pneumonia in *Ascaris infection and* anaphylactic shock in rupture of hydatid cyst.
- **Physical obstruction***:* Masses of roundworm cause intestinal obstruction.
- *Plasmodium falciparum* malaria may produce blockage of brain capillaries in cerebral malaria.
- **inflammatory reaction:** Clinical illness may be caused by inflammatory changes and consequent fibrosis,
- e.g. lymphadenitis in filariasis and urinary bladder granuloma in *Schistosoma haemalobium infection.*

- **Neoplasia:** A few parasitic infection have been shown to lead to malignancy. The liver fluke, *Clonorchis may* induce bile duct carcinoma, and *S. Haematobium* may cause urinary bladder cancer.
- **Space occupying lesions:** Some parasites produce cystic lesion that may compress the surrounding tissue or organ, e.g. hydatid cyst.

IMMUNITY IN PARASITIC INFECTION

- Primary immunity
  - Physical and Cehmical barriers
- Secondary immune response
- Innate immunity
  - Natural
  - Acquired immunity

LABORATORY DIAGNOSIS

- Most of the parasitic infection cannot be conclusively diagnosed.
- Clinical features and physical examination laboratory diagnosis depends upon:
  - Microscopy
  - Culture .
  - Serological test .
  - Skin test
  - Molecular method
  - Animal inoculation
  - Xenodiagnosis
  - Imaging
  - Hematology .

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Protozoan Parasites

Trichomonas vaginalis

- Parasitic protozoa, which possess ***whip-like flagella*** as their organs of locomotion are called as **flagellates** and classified as:
  - *Phylum: Sarcomasrigophora*
  - *Subphylum: Mastigophora*
  - *Class: Zoomastigophora (mastix: whip)*
- Depending on their habitat, they can be considered under:
  - **Lumen-dwellingflagellates:** Flagellates found in the alimentary tract and urogenital tract
  - **Hemoflagellates:** Flagellates found in blood and tissues.
- Most luminal flagellates are nonpathogenic commensals.

Trichomonas

- Trichomonas are flagellates.
- Exist only as trophozoite stage.
- Cystic stage is not seen.
- Three species of genus trichomonas infects humans
  - *T. Vaginalis-* only pathogen resides in the genital tract
  - *T. hominis* -Non-pathogen, resides in large intestine
  - *T. tenax-* resides in mouth (teeth and gum).

Morphology of Tropozoite: *Trichomonas Vaginalis*

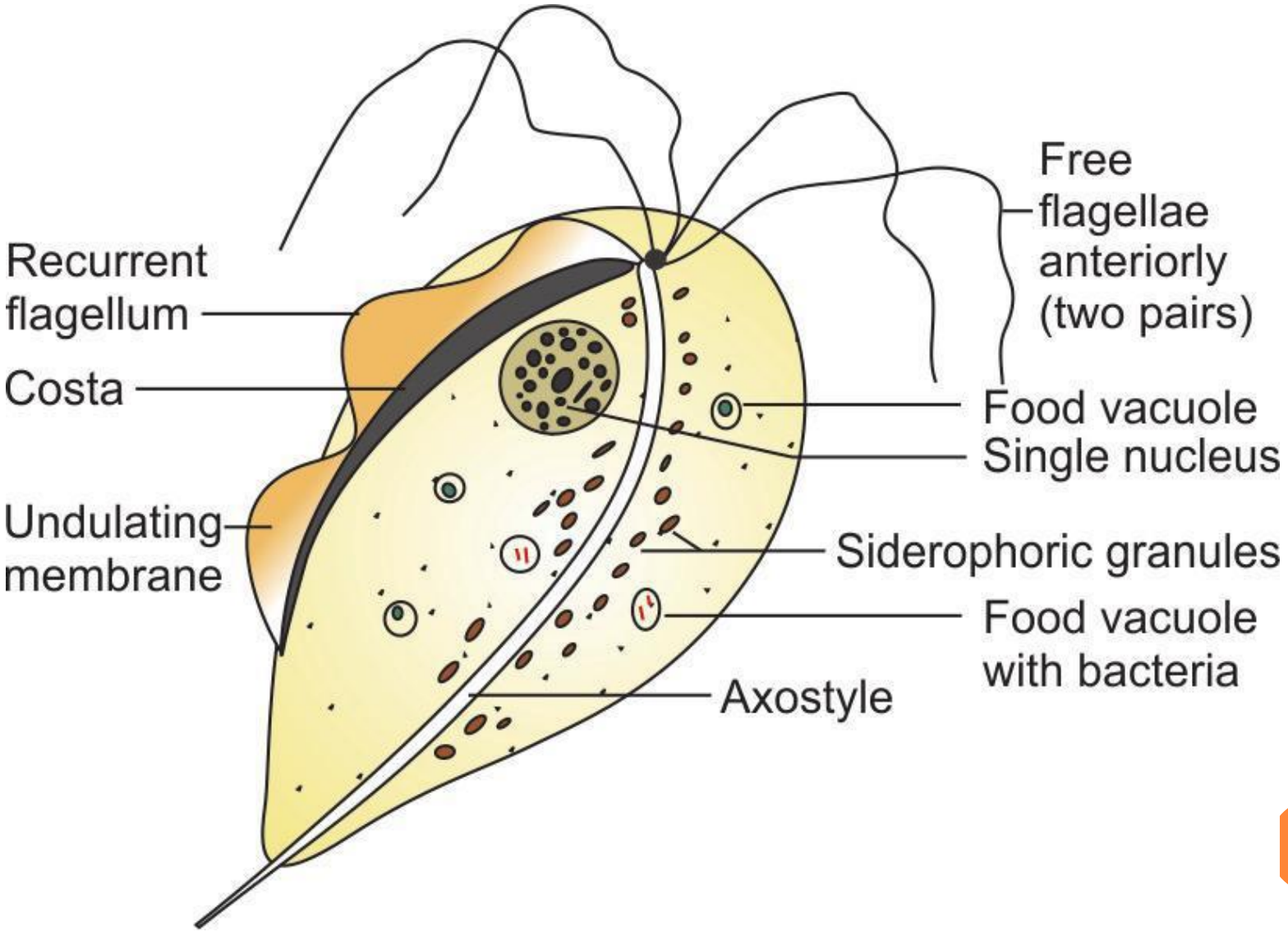
- **Pear-shaped or ovoid**
- Measures **10-30 µm length** and **5-10 µm breadth**
- Has a short **undulating membrane** running in the middle of the body
- **Five flagellas-**
  - Four anterior flagella and fifth running along the outer margin of the undulating membrane.
  - Undulating membrane is supported at its base by a flexible rod, **costa.**
- A **axostyle** runs throughout the length of the body and projects posteriorly like a tail.

- The cytoplasm has siderophilic granules, alongside the axostyle and costa.
- **Characteristic motile**: rapid **jerky** or **twitching type movement.**

Habitat

- In females:
  - Lives in vagina and cervix
  - Found in Bartholin's glands, urethra and urinary bladder.
- In males,
  - Anterior urethra,
  - Found in the prostate and preputial sac.

Trophozoite of *Trichomonas vaginalis*

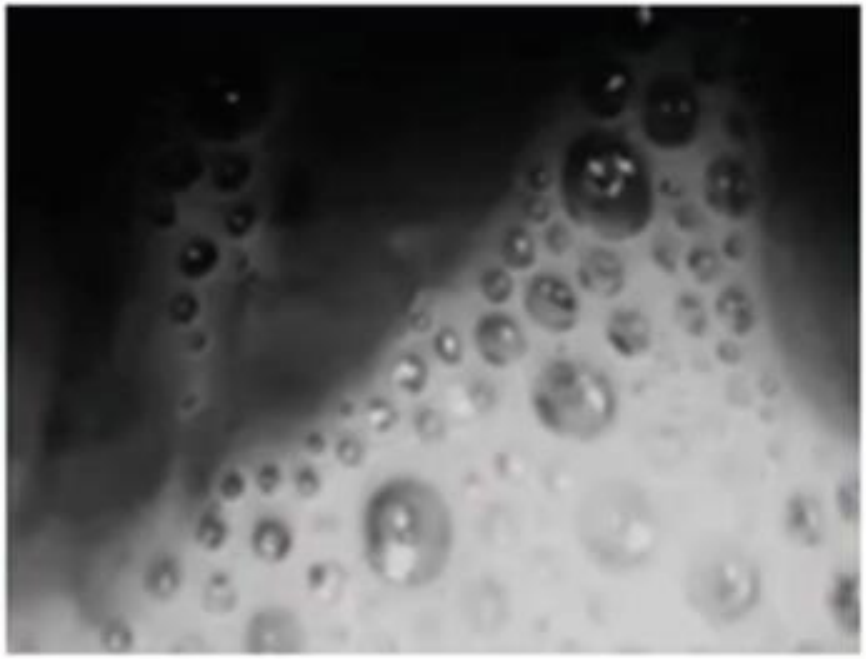


Life Cycle

- Trophozoites are both infective stage and the diagnostic stage.
- The trophozoite cannot survive outside.
- Asymptomatic females are the reservoir of infection.
- Infection transmitted directly from person-to-person.
- **Sexual transmission** is the usual **mode of infection**
- Trophozoites divide by longitudinal binary fission.
- Trophozoites in the urogenital tract can infect other individuals.
- Vaginal pH of more than 4.5 facilitates infection.
- Obejects like towels have been implicated in transmission.
- **Incubation period is roughly 10 days.**

Petechial hemorrhage
(strawberry mucosa)

Frothy discharge



Strawberry cervix

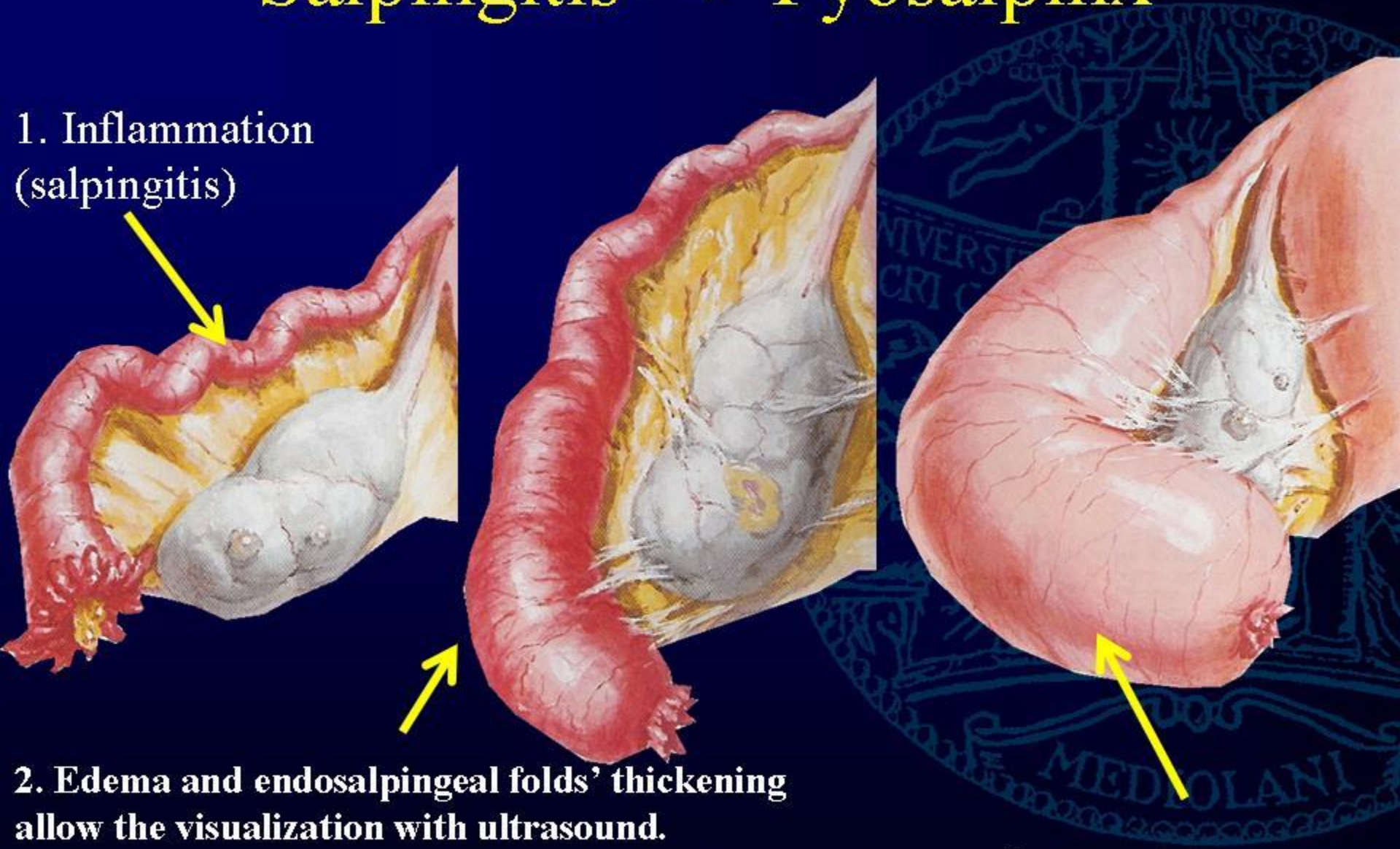
Clinical Features

- Infection - asymptomatic, particularly in males.
- Develop- urethritis, epididymitis and prostatitis.
- In females, -severe pruritic(itchy) vaginitis with an offensive, yellowish green, frothy discharge, dysuria and dyspareunia.
- Rarely, neonatal pneumonia and conjunctivitis have been reported in infants born to infected mothers.
- The incubation period of trichomoniasis is 4 days to 4 weeks.

Complications:

- Complications like pyosalpinx, endometritis, infertility, low birth weight and cervical erosions

Salpingitis ⟶ Pyosalpinx



Treatment

- **Metronidazole or tinidazole-**
  - Drug of choice, 2g, single dose is effective
  - 500 mg orally twice a day for 7 days is the drug of choice.
  - Both the sexual partners must be treated simultaneously to prevent reinfection,
- **Resistance to metronidazole:**
  - Resistance is rare but has been reported:
  - 2.5–10% to metronidazole
  - Less than 1% to tinidazole
- In pregnancy, metronidazole is safe in 2nd and 3rd trimesters.

Prevention

- Trichomoniasis can be prevented by:
- Treatment of both the partners
- Safe sex practices like use of condoms
- Avoidance of sex with infected person
- **Vaccine:** There is no effective vaccine trials are going on targeting potential immunogenic antigens.

Trypanosoma

General characters

- Hemofagellates
- Reside in peripheral blood and tissues of their host.
- Trypanes: to bore, soma: body
- Trypanosoma exist as **trypomastigote stage** and **amastigote forms.**
- **Life cycle in two hosts:**
  - (l) **Hosts: vertebrate** (definitive hosts)
  - (2) **Vectors: insect** (intermediate hosts).
- Trypanosoma called as digenetic parasites.

- **Modes of development in vectors-** classified into two groups:
  - **(1) Salivaria (anterior station):**
    - Trypanosomes migrate to mouth parts of the vectors.
    - Infection is transmitted by the insect bite (inoculative transmission).
    - Examples: *T. Gambiense* and *T. rhodesiense* causing African trypanosomiasis, by tselse flies.
  - **(2) Stercoraria (posterior station):**
    - Trypanosomes migrate to the hindgut and passed in feces (stercorarian transmission).
    - Example: *T. cruzi* causing Chagas disease, by rubbing the feces of the vector bug into the wound caused by its bite.
    - *T. lewisi,* the rat trypanosome, by ingestion of feces of infected rat fleas.

Distribution:

- Human trypanosomiasis is **strictly restricted to certain geographical regions.**
- The African and South American trypanosomiasis being seen only in the respective continents.
- The vector being confined to these places alone.
- African trypanosomiasis (sleeping sickness)
- South American trypanosomiasis (Chagas disease).

Trypanosoma classified as

Human Trypanosomes

- ***Trypanosoma cruzi:***
  - South American trypanosomiasis (**Chagas' disease**) in man.
  - Transmitted by insect vector **reduviid bug.**
- ***Trypanosoma brucei:***
  - Causes African trypanosomiasis transmitted by tsetse fly.
  - Three important subspecies (only two of them infect humans)
  - ***Trypanosma brucei rhodesiense***: East African sleeping sickness.
  - ***Trypanosma brucei gambiense***: West African sleeping sickness
  - ***Trypanosoma rangeli***: nonpathogenic species, rarely infects humans in South America.

Animal Trypanosomes

- ***Trypanosoma brucei brucei***:
  - Causes **"Nagana",** a disease affecting cattle in Africa
  - *T. congolense* and *T.vivax* cause disease similar to that of *T. brucei brucei*
- ***Trypanosma evansi***:
  - Causes **"Surra"** in horses and other animals.
  - It is transmitted by tabanidae and stomoxys flies.
  - Many animal cases are reported in India.
- ***Trypanosma lewisi***:
  - Causes a harmless infection affecting rodents.
- ***Trypanosma equiperdum:***
  - Causes **"Stallion's disease"** in horses.
  - It is transmitted by sexual route (not by insect vector).

Trypanosoma Brucei Gambiense: (West African Trypanosomiasis)

History and Distribution

- Distributed in tropical Africa.
- First isolation: blood of a steamboat captain on the Gambia river in **1901by Forde**.
- Dutton, in 1902, proposed the name Trypanosoma gambiense.
- Endemic: scattered in West and Central Africa between 15° land 18°S latitudes.

Habitat

- Trypanosomes live in man and other vertebrate host.
- Parasite of connective tissue, multiplies and invade regional lymph nodes, blood and finally central nervous system.

Life Cycle Host:

- ***T. brucei gambiense:*** two hosts:
- l . Vertebrate host: Man, game animals and other domestic animals.
- 2. Invertebrate host: Tsetse fly. Both male and female tsetse fly of Glossina species (*G. palpalis*)
- These flies dwell on the banks of shaded streams, wooded Savanna and agricultural areas.
- Infectiveform: Metacyclic trypomastigote forms are infective to humans.

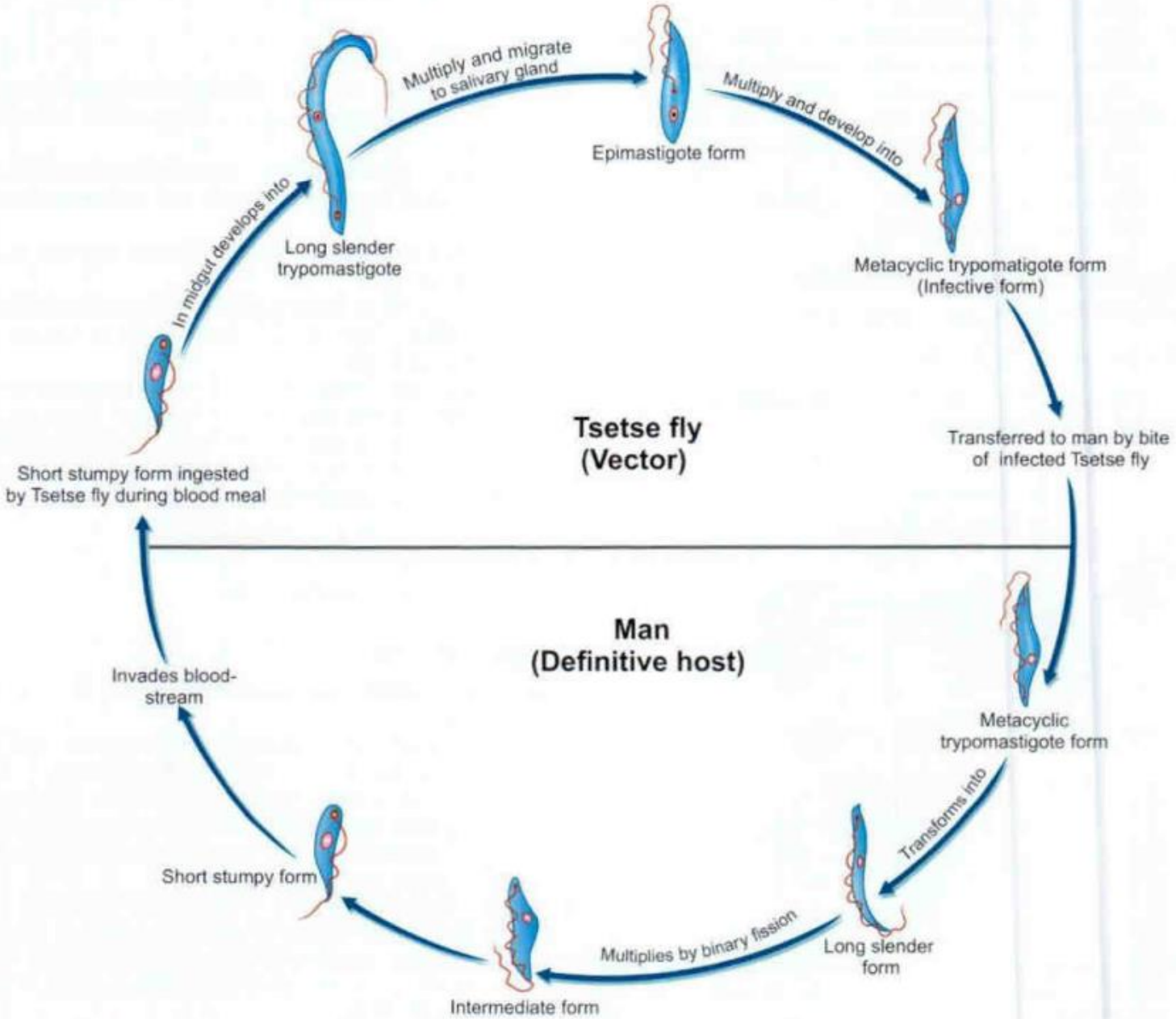
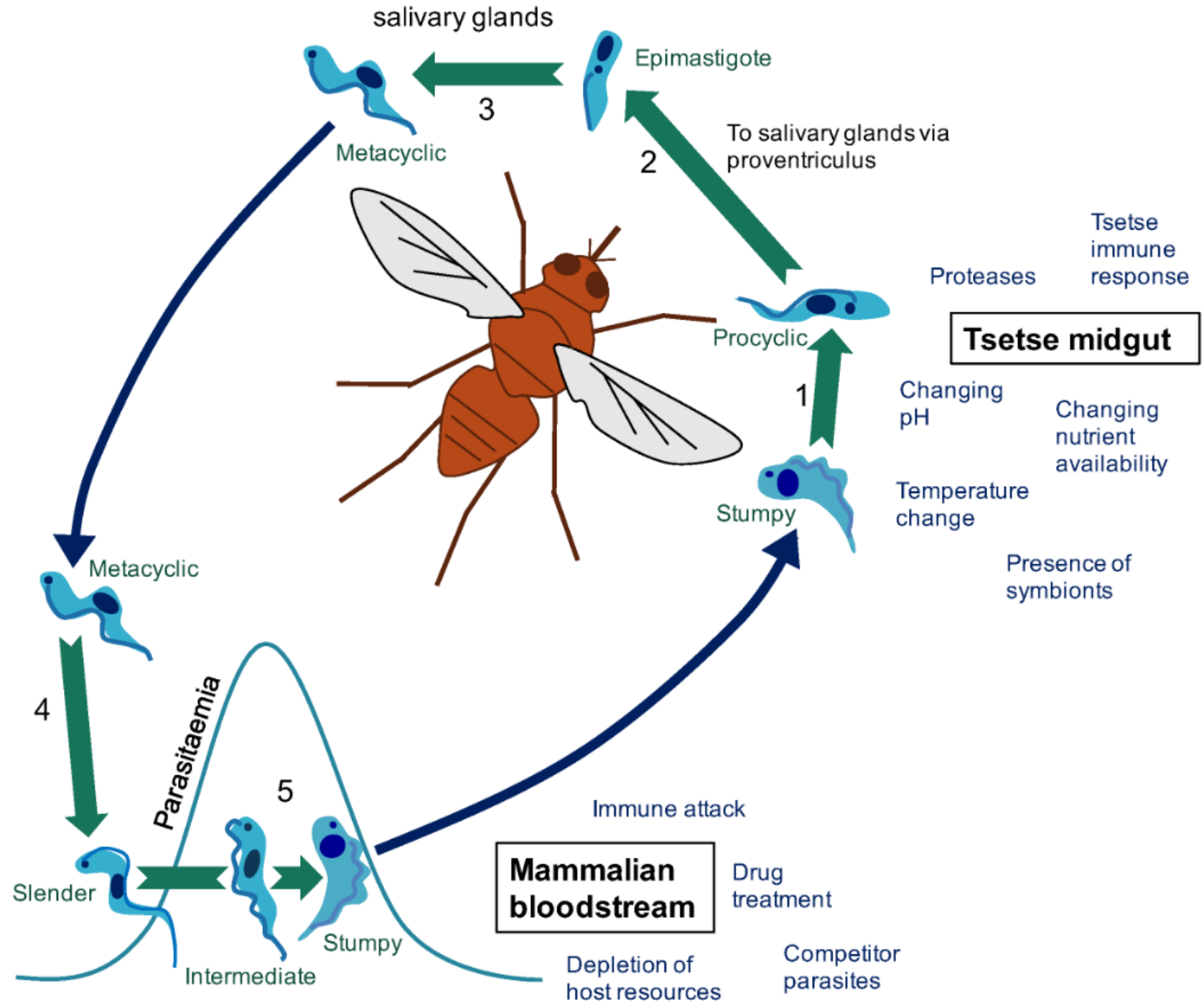


Fig. 3: Life cycle of *Trypanosoma brucei*


salivary glands
Epimastigote
3
Metacyclic
2
To salivary glands via proventriculus
Tsetse immune response
Proteases
Procyclic
Tsetse midgut
1
Changing pH
Changing nutrient availability
Temperature change
Stumpy
Presence of symbionts
Metacyclic
4
Parasitaemia
5
Immune attack
Slender
Mammalian bloodstream
Drug treatment
Stumpy
Intermediate
Depletion of host resources
Competitor parasites

Treatment

- In the initial stages, when central nervous system is not involved, i.e. stage I, pentamidine is the drug of choice for gambiense human African trypanosomiasis (HAT) and suramin is the drug of choice for rhodesiense HAT.
- Dose: Pentamidine: Dose 3- 4 mg/ kg of body weight, intramuscularly daily for 7- 10 days.
- Suramin: Dose 20 mg/ kg of body weight in a course of five injections intravenously, at an interval of 5- 7 days.
- Suramin does not cross blood-brain barrier but it is nephrotoxic.
- In patients with central nervous system involvement, melarsoprol (Mel-B) is the drug of choice, as it can cross the blood-brain barrier.
- Dose: 2-3 mg/ kg/ per day (maximwn 40 mg) for 3-4 days (Table 3).

Prevention

- Control is based on early diagnosis and treatment of cases to reduce the reservoir of infection.
- Control of tsetse fly population (most important preventive measure) by wide spraying of insecticides, traps and baits impregnated with insecticides.
- No vaccine is available.

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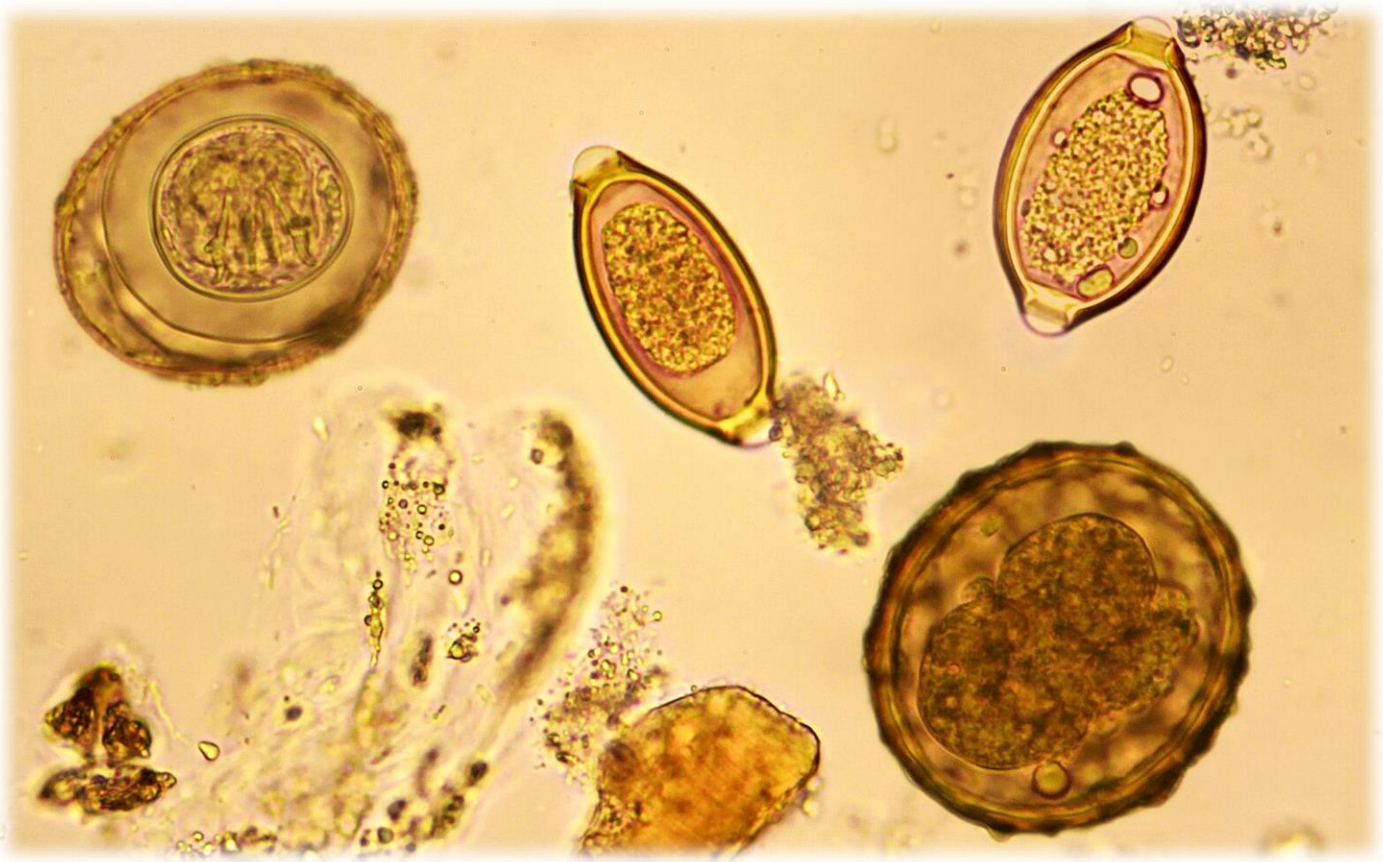
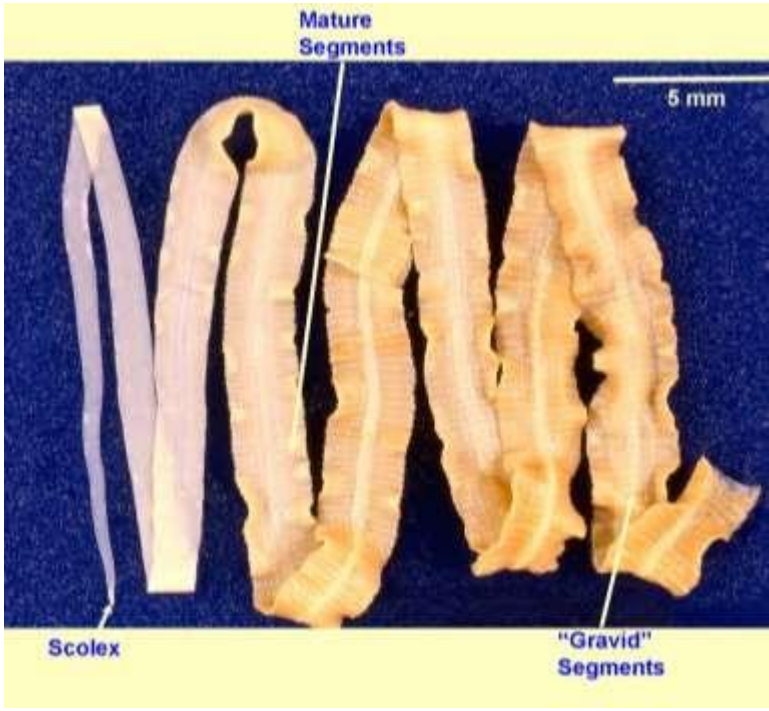


Helminth Parasites

Class Cestodes: **Dipyllobothrium sps.**

Diphyllobothrium latum

- Largest cestode
- **Habitat**: small intestine of human.
- **Fish tapeworm** or **human broad tapeworm**
- **Broader proglottids** latum means broader
- Other species
  - *D. dendriticum,*
  - *D. pacifi cum*
  - *D. nihonkaiense etc*

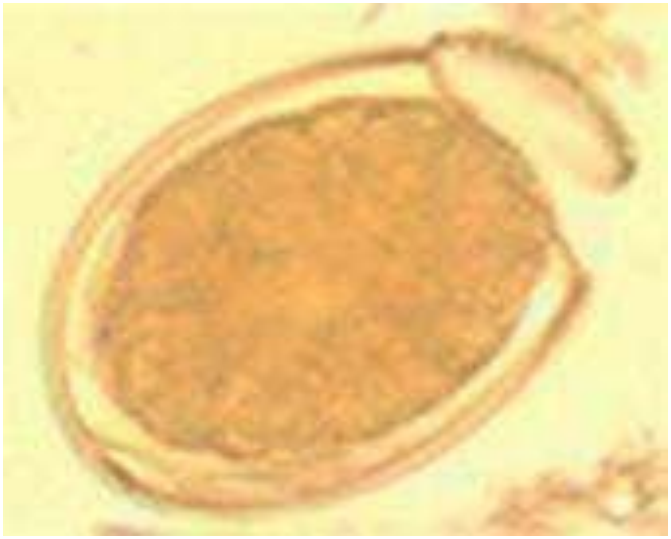


Epidemiology

- *D. latum* endemic to Europe like Russia and Finland, Japan, South America and Scandinavia
- ***D. latum* is very rare in India.**
- **Three** cases of diphyllobothriasis are reported from Southern India:Vellore ,1998; Pondicherry, 2007 and Karimnagar, 2011

Morphology

- **Adult worm-** 10 m long
  - Head has grooves called as **bothria** helps to attaches to the small intestine. There are no suckers and rostellum.
  - Neck
  - Strobila
- **Eggs:**Oval, operculated, hexacanth oncosphere
- **Larva:** three larval stages:
  - 1. First stage larva (coracidium)
  - 2. Second stage larva (procercoid)
  - 3. Third stage larva (plerocercoid)



Egg of Diphyllobothrium

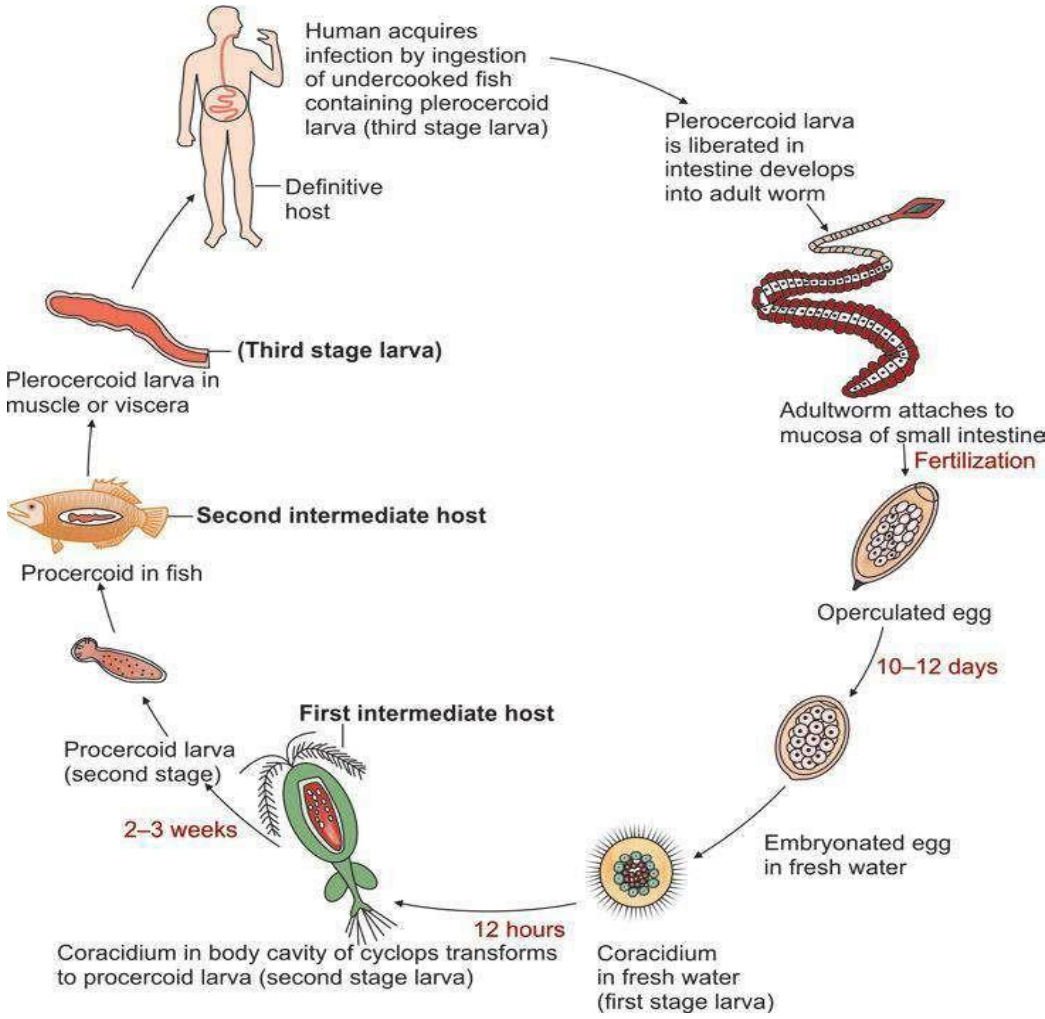
Life cycle:

Host:

- **Definitive host- Humans,** Dogs, cats and foxes - rare definitive hosts.

- **Two intermediate hosts:**

  - **1. First intermediate hosts:** Fresh water copepods
  - **2. Second intermediate hosts:** Fresh water fishes (pike, salmon, perch and trout)



Infective form: Third stage plerocercoid larvae

Modes of transmission:undercooked fresh water fish containing third stage plerocercoid larva.

Pathogenesis and Clinical features

- Asymptomatic.
- Minor Infections
  - abdominal discomfort, diarrhea, vomiting, weakness and weight loss.
  - rarely acute abdominal pain and intestinal obstruction, **cholangitis or cholecystitis** (by migrating proglottids)
- **Vitamin B12 deficiency:**
- **The adult worm** absorbs large quantities of vitamin B12 and interferes with ileal B12 absorption
- Vitamin B12 deficiency leads to **megaloblastic anemia** and neurologic sequelae like paresthesia.

Laboratory diagnosis

- Stool examination—eggs and proglottids
- Blood examination shows megaloblastic anemia—MCV, MCH, Macrocytes.

Treatment

- Praziquantel (5–10 mg/kg once) is highly effective
- Niclosamide is given alternatively
- Parenteral vitamin B12 should be given if B12 deficiency is manifested.

Prevention

- Proper cooking of fi sh (10 minutes at 50°C)
- Deep freezing (–10°C for 24 hours) of raw fish

Dipylidium caninum
(double pored tapeworm)

- **Common tapeworm of dogs and cats.**

Morphology

- Adult worm is 10–70 cm long,
- Scolex -four oval suckers with rostellum and 1–7 rows of hooklets.

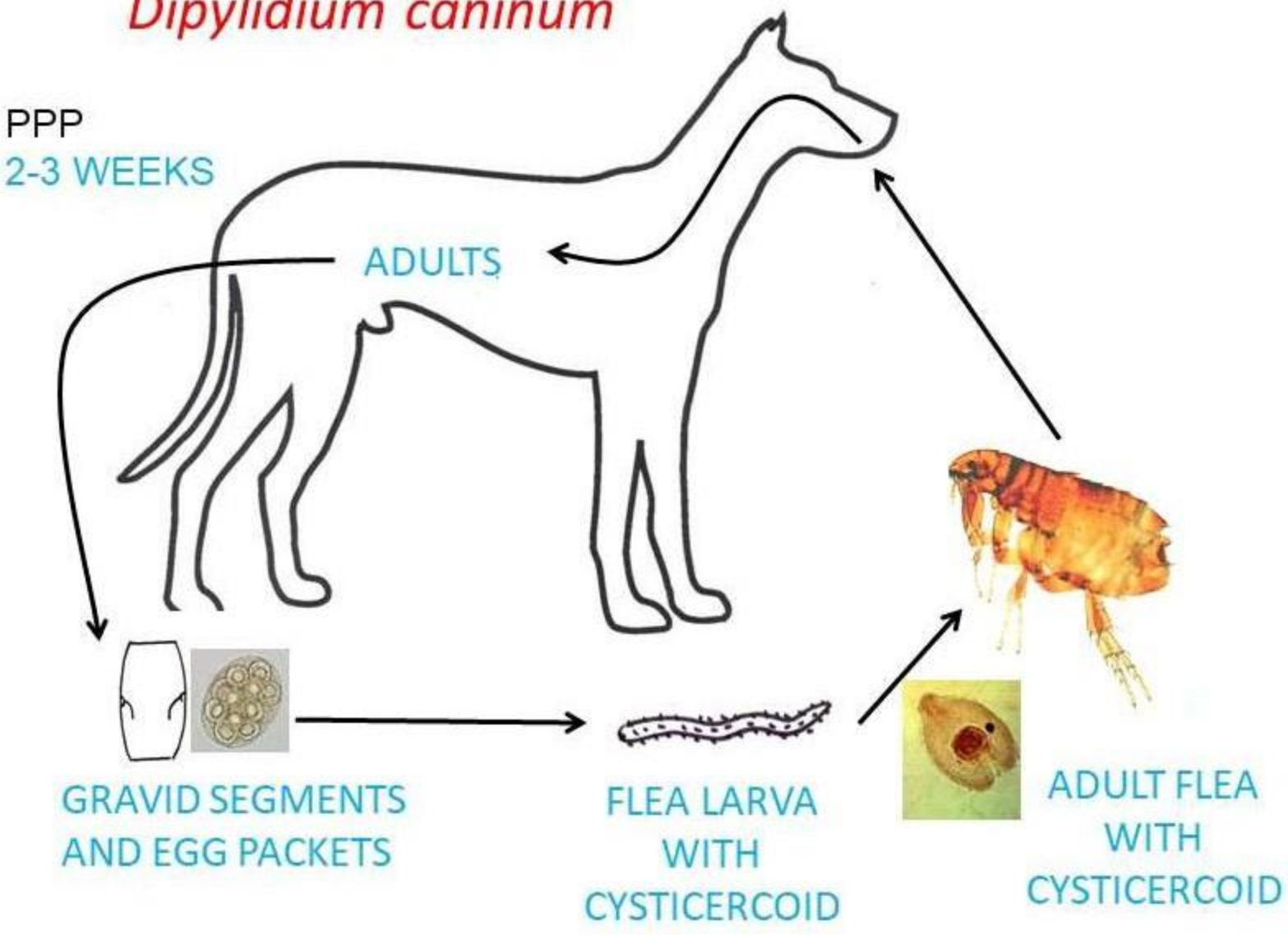
Life Cycle: resembles with the indirect cycle of *H. nana*.

Host:

- **1. Defi nitive host:** Dogs and cats (rarely men)
- **2. Intermediate host:** Insects (fleas)
- Man acquires infection by ingestion of flea containing cysticercoid larva.

LIFE CYCLE

Dipylidium caninum



Clinical features

- Mostly, asymptomatic.
- Indigestion, loss of appetite, diarrhea, pruritus ani, abdominal pain.
- Children are affected commonly.

Laboratary diagnosis: Stool examination for proglottids or eggs.

Epidemiology

- Human cases are rare and reported from Austria, Japan and the USA.

Treatment: Praziquantel is the drug of choice

Prevention: Requires flea control.

Intestinal Trematodes

- ***Paragonimus westermani*** is also known as **oriental lung fluke.**
- It causes endemic hemoptysis in man.
- endemic in many parts of the world, except North America and Europe.
- **India: Paragonimiasis** is endemic in North East states of India, reported from **Manipur**
- The other species are
  - *P. miyazaki* (Japan)
  - *P. skrjabini and P. hueitungensis* (China)
  - *P. heterotrema* (China, Southeast Asia)
  - *P. uterobilateralis*, *P. africanus* (Central and West Africa)
  - *P. mexicanus* (Central and South America)
  - *P. kellicotti* (North America)

Habitat

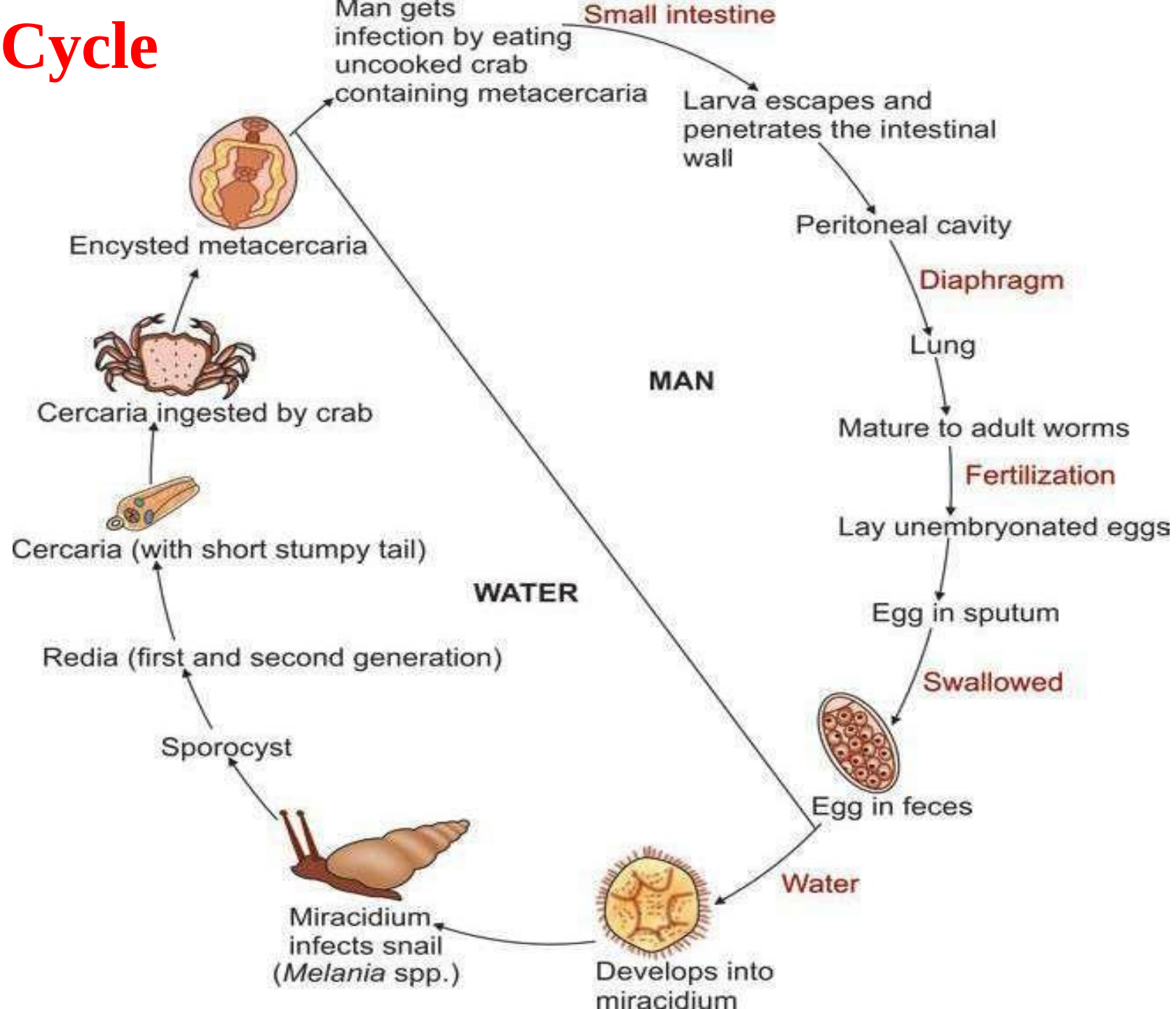
- The adult worm lives in the parenchyma of lung.
- **Morphology**

Adult Worm

Eggs

Larvae – Metacercaria larvae

Life Cycle


Man gets infection by eating uncooked crab containing metacercaria
Small intestine
Larva escapes and penetrates the intestinal wall
Peritoneal cavity
Diaphragm
Lung
MAN
Mature to adult worms
Fertilization
Lay unembryonated eggs
Egg in sputum
Swallowed
Egg in feces
Water
Develops into miracidium
Miracidium infects snail (Melania spp.)
Sporocyst
Redia (first and second generation)
Cercaria (with short stumpy tail)
WATER
Cercaria ingested by crab
Encysted metacercaria

Pathogenesis

- Metacercariae penetrate to the abdominal cavity cause abdominal tenderness, nausea and vomiting.
- Then they migrate to lungs and develop to adult worms that cause **pulmonary paragonimiasis.**
  - **Form encapsulated esonophilic cyst**
- **Extrapulmonary Paragonimiasis**
  - The worms migrate from the ruptured cysts to various sites such as liver, spleen, abdominal wall and less commonly in brain.
  - associated with *P. mexicanus*, *P. Heterotremus* and *P. westermani.*
  - **Cerebral paragonimiasis:** Encapsulated cysts in the brain parenchyma present as spaceoccupying lesions. Symptoms include fever, headache, vomiting, motor weakness or epilepsy

Laboratory Diagnosis

- Sputum micoscopy—detects operculated eggs
- Serological tests—antibody detection (CFT, ELISA), antigen detection (Dot ELISA)
- MRI, CT scan, X-ray—detect lesions in lungs and other organs
- Peripheral blood eosinophilia.

Treatment

- Praziquantel, Bithionol and niclofolan can also be used with 100% cure rate without any side effects
- Surgical management may be needed forpulmonary or cerebral Lesions.

Prevention

- Sanitary disposal of sputum
- Control of snails
- Treatment of cases
- Health education

Clonorchis Sinensis

- *Clonorchis sinensis is also called* ***Chinese*** **liver fluke.**

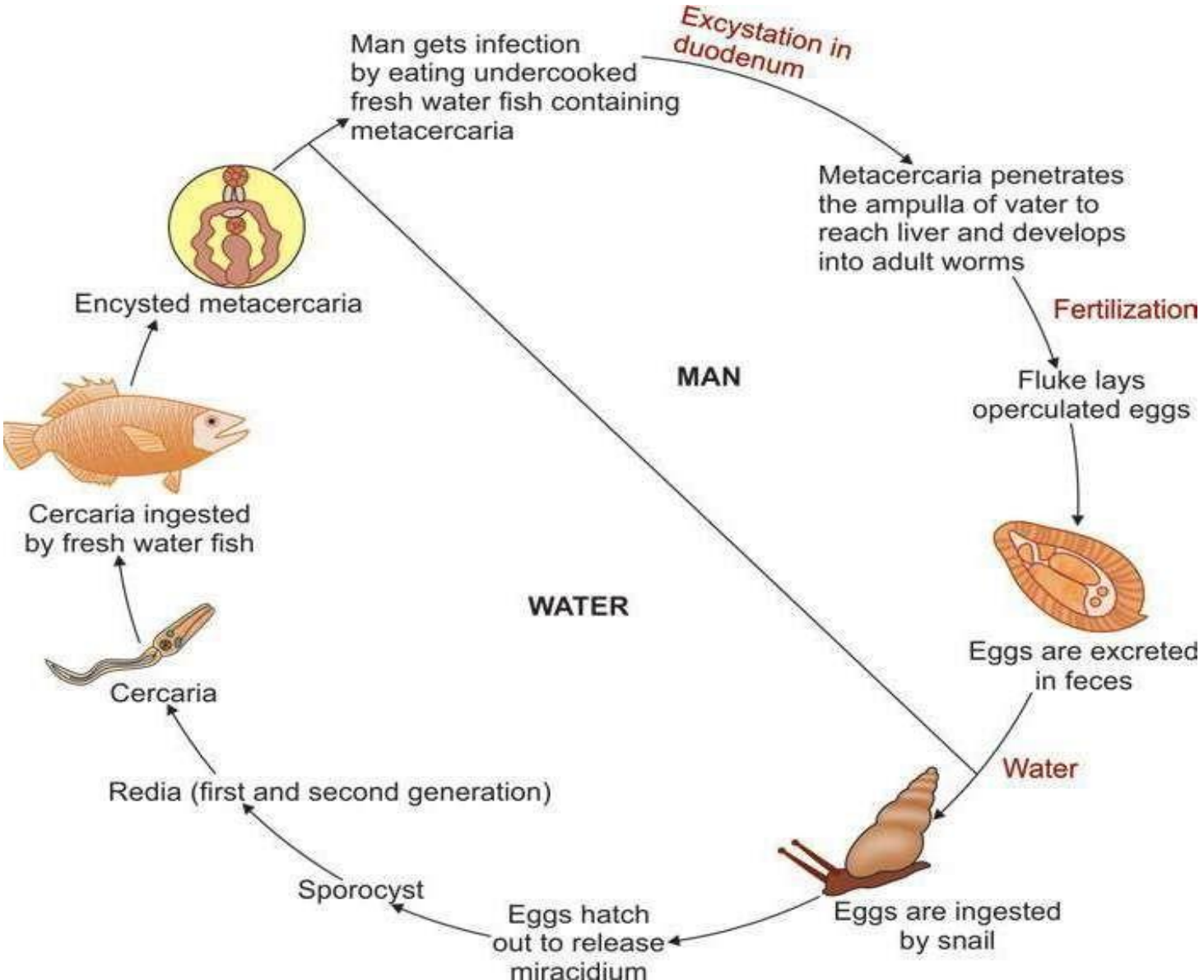
Habitat

- Adult worm lives in the bile duct, pancreatic duct and common bile duct of man and other domestic animals.

Morphology

- Adult worm
- Egg
- Larvae- Metacercaria is the infective form
- It is found in the flesh of the fresh water fish.
- Other larval stages are cercaria, redia, sporocyst and miracidium.

Life Cycle


Man gets infection by eating undercooked fresh water fish containing metacercaria
Excystation in duodenum
Metacercaria penetrates the ampulla of vater to reach liver and develops into adult worms
Fertilization
Fluke lays operculated eggs
Eggs are excreted in feces
Water
Eggs are ingested by snail
Eggs hatch out to release miracidium
Sporocyst
Redia (first and second generation)
Cercaria
Cercaria ingested by fresh water fish
Encysted metacercaria
MAN
WATER

Pathogenesis

- **Light worm burden:** asymptomatic
- **Chronic infection with heavy worm burden:**
  - obstruction of the bile duct and irritation leads to cholangitis.
  - ductal epithelial hyperplasia, periductal inflammation and fibrosis
  - adenomatous hyperplasia of the ductal epithelium is seen
  - **Bile duct carcinoma:** Chronic irritation of the bile duct for long periods can lead to **cholangiocarcinoma.**
  - **Risk factors for the** bile duct carcinoma include elderly people (60–80 years old) and preexisting Primary sclerosing cholangitis.

Laboratory Diagnosis

- Stool microscopy—Detects flask shaped operculated eggs
- Serodiagnosis—CFT, IHA, ELISA for antibody detection, ELISA for antigen detection
- Molecula r methods—Multiplex PCR
- **Treatment:** Praziquantel (25 mg/kg, three doses in 1 day)
- **Prevention**
  - Avoidance of eating raw or undercooked fresh water fish
  - Sanitary disposal of stool and sewage
  - Control of snail hosts.

Nematode: Dracunculus medinensis

- *Dracunculus medinensis* causes **Guinea worm disease or dracunculiasis.**

Life Cycle

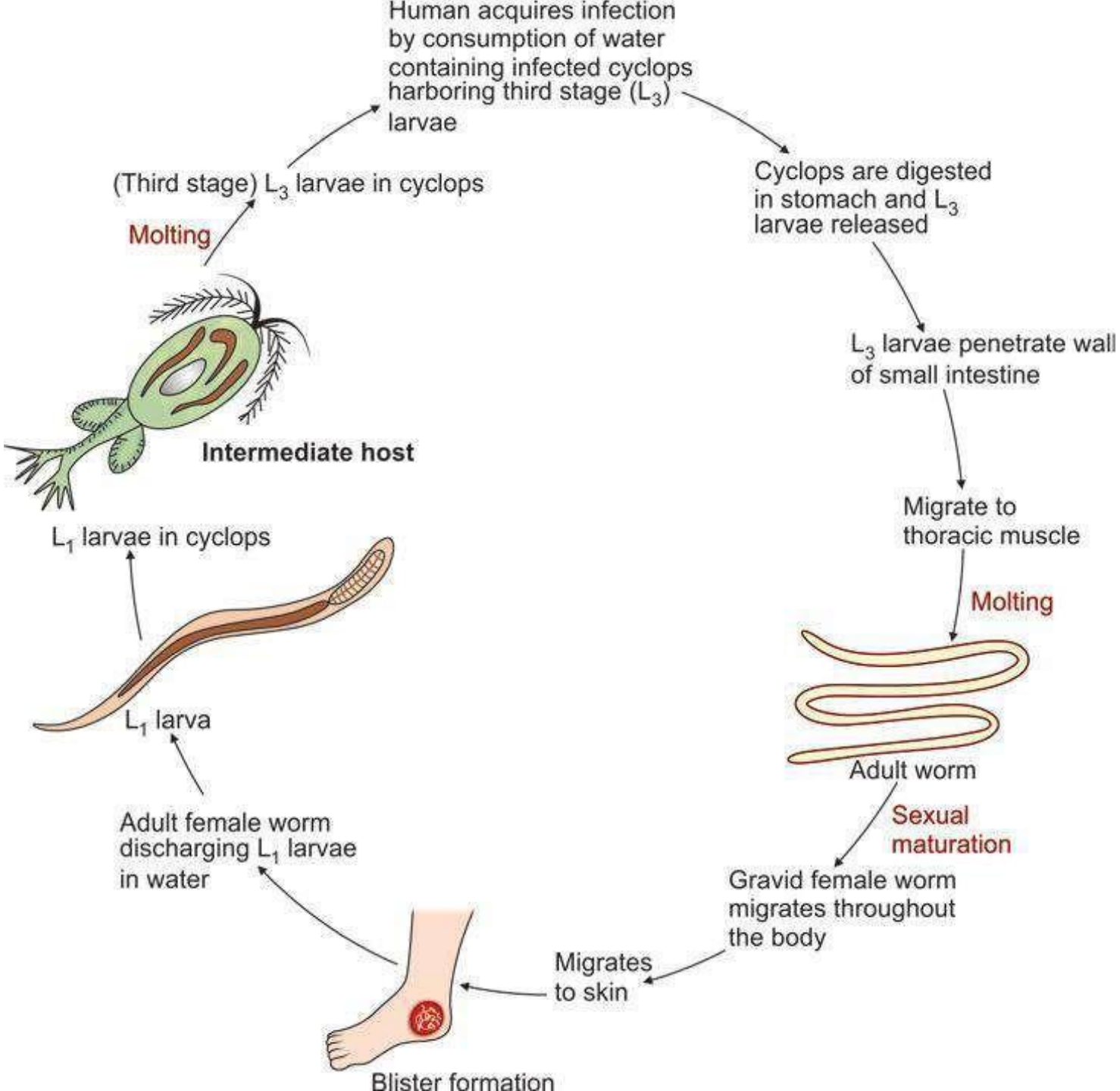
Host:

- **1. Defi nitive host:** Man
- **2. Intermediate host:** Copepods (*Cyclops)*

Infective form: Third stage fi lariform larvae**.**

Mode of transmission:

- Man gets infection by drinking fresh water from stagnant pools containing minute fresh water crustaceans (Cyclops) infected with L3 larvae.


Human acquires infection by consumption of water containing infected cyclops harboring third stage (L_3) larvae
Cyclops are digested in stomach and L_3 larvae released
L_3 larvae penetrate wall of small intestine
Migrate to thoracic muscle
Molting
Adult worm
Sexual maturation
Gravid female worm migrates throughout the body
Migrates to skin
Blister formation
Adult female worm discharging L_1 larvae in water
L_1 larva
L_1 larvae in cyclops
Intermediate host
Molting
(Third stage) L_3 larvae in cyclops

Pathogenesis and Clinical Feature

- Signs and symptoms appear approximately 1 year after the infection when gravid adult female worm emerges near the surface of the skin.
- Blister with erythema, urticaria, fever, nausea and pruritus.
- The entire worm may emerge over a period of several weeks
- Secondary bacterial infections lead to sepsis, local abscesses and pyogenic arthritis
- The most common site—lower leg, ankle and foot.
- The manifestations are seasonal (June to September).

Diagnosis

- Detection of adult worm
- Detection of Larve 1
- Antibody detection
- Peripheral blood Eosinophilia.

Treatment:

- Worm removal
- Anti-helminthic drug
- Prevent secondary bacterial infection.