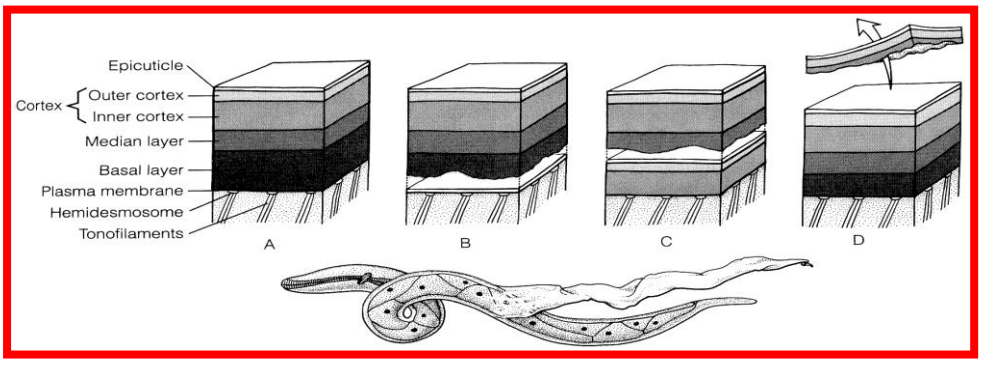
Nematodes

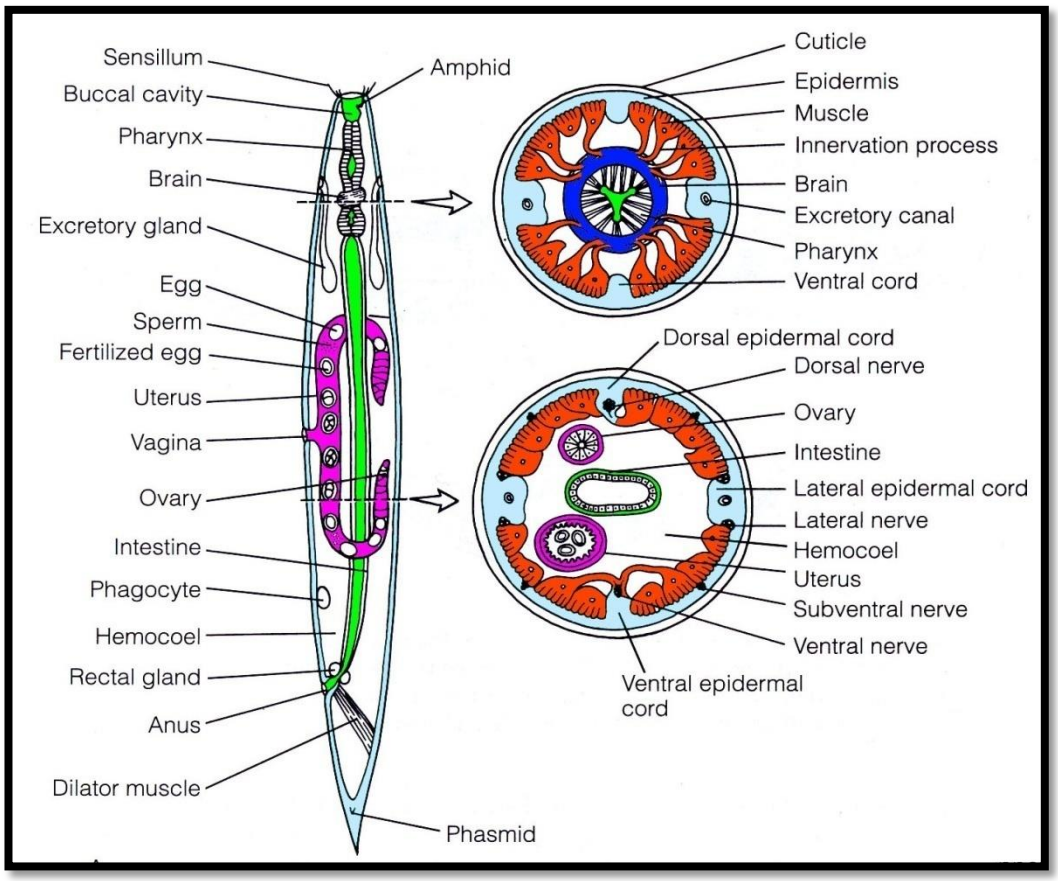
Nematodes, belonging to the phylum Aschelminthes, are non-segmented worms generally cylindrical, tapered at both ends, elongated, bilateral symmetry with triradiated symmetry at the anterior end. The name nematodes means thread-like worms from (nema) that means thread.

In contrast to the trematodes and cestodes, all of which are parasitic, the majority of nematodes are free living . There are an estimated 500.000 species of nematodes many have considerable economic importance as parasites on plant, animals, and dozen or more are commonly encountered in humans.

The body of nematodes covered by a tough protective covering or outer cuticle, inner muscular layer, and intermediate thin hypodermis which secret the cuticle and binds the outer surface of the muscular fibers that contain myosin and actin like in vertebrates. Arising from the hypodermis, four cords project towards the body cavity at the dorsal, ventral, lateral lines which dividing the muscles into distinct quadrants.

The cuticle also lines the stomodeum, proctodeum, excretory pore and vagina. The cuticle mat also be provided with scales, spines especially at the anterior part, but generally the body surface of nematodes is smooth. Overlying the cuticle in free-living and parasitic nematodes is a carbohydrates rich-surface coat, 5-20 nm in thickness, this may be important in evasion of the immune response in parasitic infection.





- **Nematodes molt 4 times. The old cuticle separates from the epidermis and the innermost layer is partially hydrolyzed. A new cuticula is secreted by the hypodermis starting with the epicuticle. The old cuticle is shed**

❖ **Nematode digestive system, pumping against the pressure**

They have complete digestive tract is divided into three main portions :-

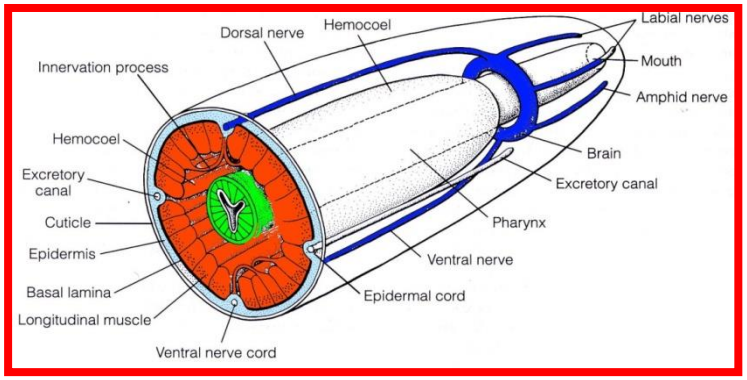
1. **Anterior part (stomodeum) consists of oral cavity and esophagus, both lined with internal extension of cuticle.**
2. **Mid-gut with a single layer of epithelia cells (columnar or cuboidal resting on the basement membrane) without cuticle.**
3. **Posterior part (proctodeum) or rectum which lined with cuticle.**

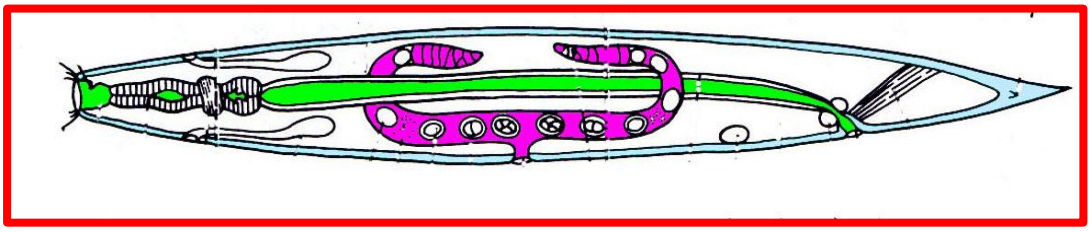
Types of esophagus in nematodes:

1. **Filariform esophagus , thread like structure and rounded as in filarial worms.**
2. **Cylindrical esophagus, rounded and thick as in *Ascaris lumbricoides* .**

3. **Cellular esophagus, surrounded by large number of cells as in *Trichuris trichiura*.**
4. **Single-bulbed esophagus, composed of spindle anterior part and bulbed posterior part as in *Enterobius vermicularis*.**
5. **Rhabditiform esophagus, composed of spindle anterior part followed by narrow neck and ends by bulbed posterior part as in free living *Strongyloides stercoralis***

Excretory system consists of two lateral excretory canal and comissures as (H) shape. The nervous system is composed of cicumesophageal nerve ring, six short anterior trunks and six long posterior trunks which unite near the caudal extremity.





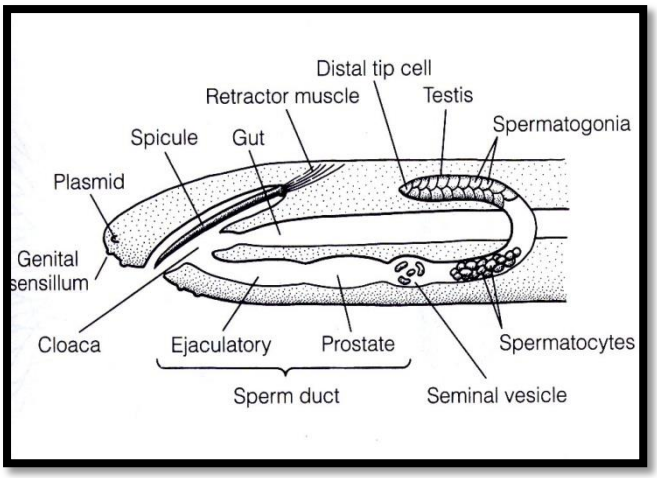
Most nematodes possess two types of cuticular organs called (Phasmids), post anal in position which act as chemo-receptors and (Amphids), located at anterior end which act as sensory-receptors.

The sexes are separated, generally males are much smaller than females worms. The reproductive organs are tubular and lie coiled in the body cavity. In the male there is a single tubule which at its smaller end consists of testicular cells, it extends into a vas deferens and seminal vesicle and terminates in an ejaculatory duct opening into the cloaca. Accessory copulatory structures consist of one or two copulatory spicules, which may be equal length and bristle-like or unequal length and variously shaped. In hook worms and their relatives the posterior end of the

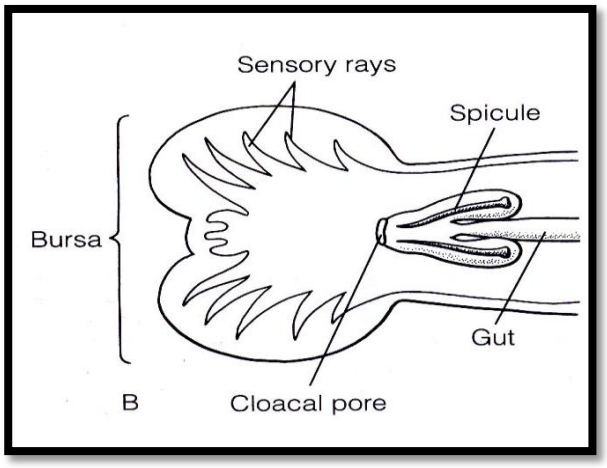
male is extended into umbrella-like structure of cuticle supported by flesh rays this structure known as (capulatory bursa) which is applied around the female in the copulation.

The female worm has two cylindrical ovaries , which expand into uteri. The uteri may open to the exterior through a single vulva or there may be a common vagina between the vulva and uteri. The vulva is frequently located near the middle of the body but varies in position in different species. Nematodes may produce eggs (oviparous), larvae(viviparous), and some of nematodes lay eggs containing larva which immediately hatch out (ovoviviparous).

The ovum is characteristically provided with yolk materials, after passing down the oviduct and being fertilized , it secrets around itself an inner , very resistant, thin vitelline membrane and a somewhat thicker chitinous layer. In some nematodes such as *Ascaris* an additional outer shell an additional outer shell is laid on as a secretion from uterine wall.



Reproductive system of male of nematodes



Posterior end of male

Classification of nematodes:

These organisms may be classified according to various ways:

A- Location of adult in the body of host:

1- Intestinal nematodes:-

a*- Small intestine……*Ascaris, Ancylostoma, Necator, Strongyloides, Trichinella.

b*- Large intestine……..*Enterobius, Trichuris.

2-Tissue nematodes:-

a-Lymphatics……..*Wuchereria, Brugia.*

b-Subcutaneous…..*Loa loa, Onchocerca, Dracunculus.*

c-Mesentry……..*Mansonella.*

d-Conjunctiva…….*Loa loa.*

B-Mode of infection:-

1-Ingestion:

a-Eggs….. *Ascaris, Enterobius, Trichuris.*

b-Larva within intermediate host…. *Dracunculus.*

c-Encysted larva in muscles……. *Trichinella.*

2-Skin penetration:

***Ancylostoma, Necator, Strongyloides*.**

3-Blood-sucking insects:

Filarial worms……. *Wuchereria, Brugia, Loa loa.*

4-Inhalation of dust containing eggs:

***Ascaris, Enterobius*.**

C-Producing of eggs or larvae:-

1-Oviparous (laying eggs):

a-Unsegmented eggs…… *Ascaris, Trichuris.*

b-Segmented eggs…… *Ancylostoma, Necator*.

c-Eggs containing larva…. *Enterobius*.

2-Viviparous (producing larvae):

Trichinella, Wuchereria, Brugia*, *Dracunculus.

3-Ovoviviparous:

Laying eggs with fully formed larvae which hatch out immediately; *Strongyloides*.

D-**According to absence or presence of caudal chemo-receptors (phasmids):-**

1-Aphasmidia (adenophorea), no phasmids…….. *Trichinella, Trichuris.*

2-Phasmidia (secernentea), with phasmids……

Thread worm……. *Strongyloides stercoralis*

Hook worms…… *Ancylostoma duodenale, Necator amercanuus*.

Pin worm……. *Enterobius vermicularis*.

Roundworm…… *Ascaris lumbricoides.*

Filarial worms…. *Wuchereria bancrofti, Brugia spp., Loa loa, Onchocerca volvulus, Mansonella spp.*

Guinea worm……. *Dracunculus medinensis*.

Trichuris trichiura:

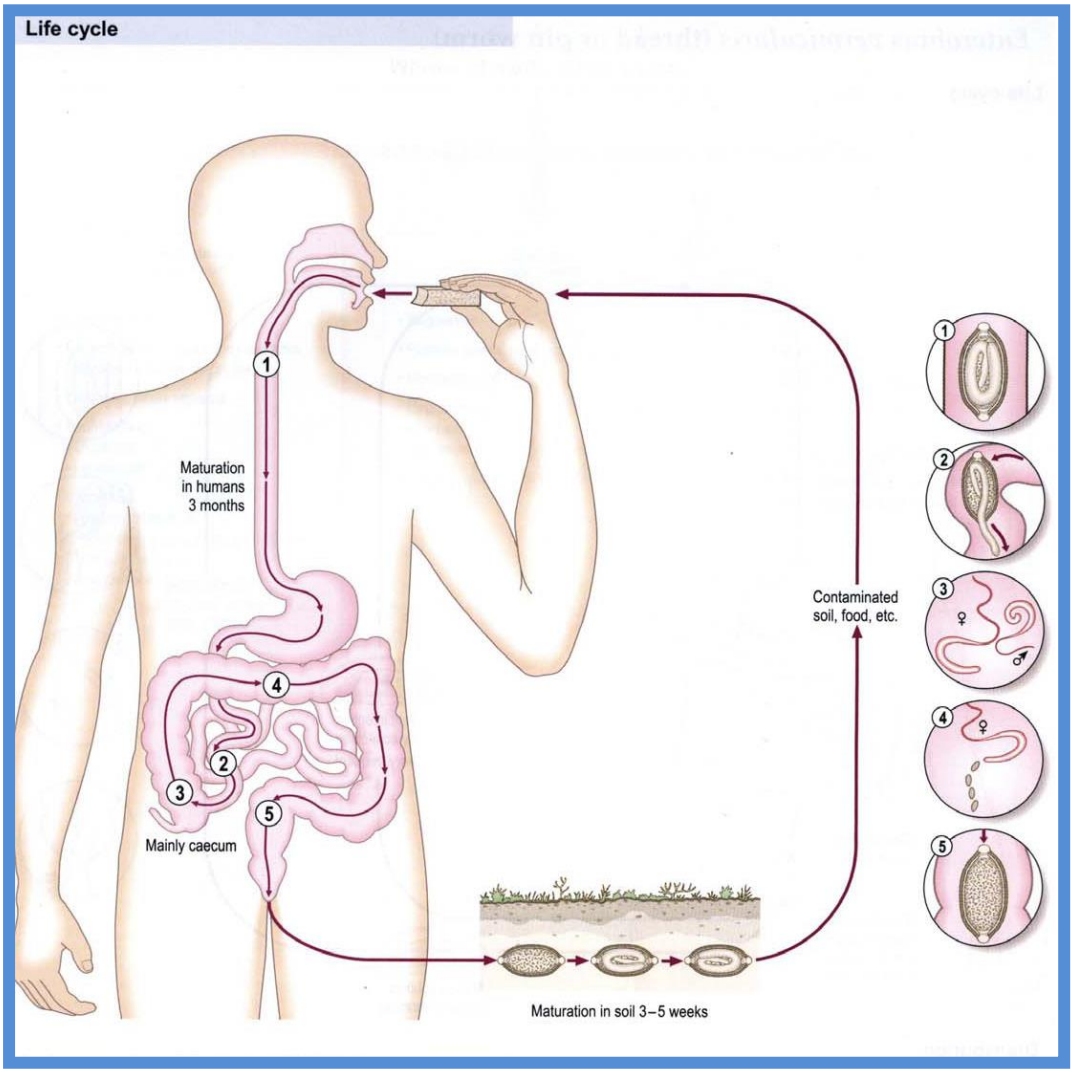
This parasite commonly named as whip worm has worldwide distribution but it is more common in tropics areas and in regions where situation is poor. The common name of whip worm is most descriptive, the thick posterior part of the body forming the stock and long thin anterior part the lash. The generic name trichuris, hair-tail is less fortunate having been applied under the impression that the attenuated portion of the worm was its posterior end. Subsequently the name trichocephalus was given to genus and has been adopted by some workers, it is

much more apt but unfortunately should not be used as the name trichuris has priority.

Morphology and life cycle:

The adult worms are found attached to the wall of cecum and appendix , the male measuring about 30 mm long while the female is slightly larger 40-50 mm , the posterior part contain reproductive system and intestine , the posterior end of the male is coiled ventrally while the female is straight blunt and rounded. The fertilized female lays about 5000 eggs per day , these eggs are characteristic brown bile stained , it has triple shell , barrel-shaped about 25 by 50 µm in size with a projecting mucus plug at each pole.

The eggs passed in feces contains unsegmented ovum at this stage it is not infective for human , the eggs undergo development in soil , under warm, moist, shady conditions. When the rhabditiform larva develops within the egg in 3-4 weeks, at lower temperature this may be delayed for three months or more. Infection occur when the mature embryonated eggs containing the infective larvae are swallowed in food or water. The eggs hatch in small intestine and the larvae which emerges through the pole of the egg passes down into the cecum. In about 2-3 months they become mature adult and lay embedded on the cecal wall with the thread like anterior portion piercing the mucosa and thick posterior end projecting out. Eggs start appearing in the feces usually about three months after infection. The human are only natural host for Trichuris trichiura but morphologically similar worms are found to infect pigs and some monkeys.



Life cycle of *Trichuris trichiura*

Pathogenesis and clinical symptoms:

The disease caused by this parasite named trichuriasis , whipworm infection or trichocephaliasis is asymptomatic except when the worm load in heavy. Disease may result either due to mechanical effect or allergic reaction. Heavy infection may be characterized by abdominal pain and distention, bloody or mucoid diarrhea , tenesmus, weight loss and weakness. Prolapsed of the rectum is occasionally seen usually in children, worms may be visible on the prolapsed edematous rectum. Anemia and moderate eosinophilia may be seen in this case because the worms lie threaded into the cecal mucosa and though it is not blood feeder, oozing of blood may occur at site of attachment. The blood loss is about 0.005 ml per worm per day, over a period of time this may lead to anemia and malnutrition.

It has been suggested that mechanical blockage of the appendiceal lumen by masses of whipworms may cause acute appendicitis. In heavy infection the worms may be abundant on the colonic mucosa even up to the rectum.

Diagnosis:

The characteristic eggs are found in stools. The degree of infection can be assessed by egg counts. Less than 10 eggs per smear in direct stool preparation is considered light infection, and more than 50 eggs as heavy.

Proctoscopy is useful when worms are found on rectal mucosa in whipworm diarrhea and dysentery.

Charcot Leyden crystals are usually abundant in stool of patient with whipworm infection.

Treatment:

Mebendazole and albendazole are effective in treatment.

Prophylaxis:

- **Prevention of promiscuous defecation and proper disposal of feces would eliminate transmission and infection.**
- **Checking the consumption of unwashed fruits and vegetables grown on polluted field can minimize the risk of infection.**

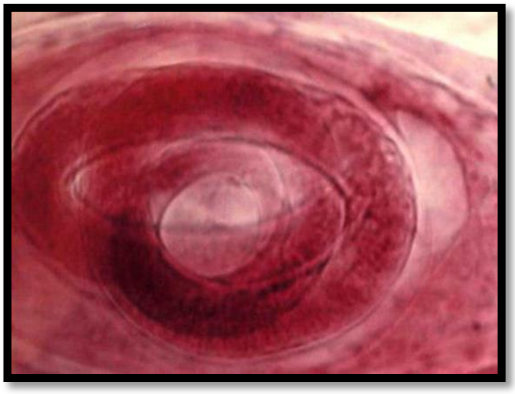
Trichinella spiralis:-

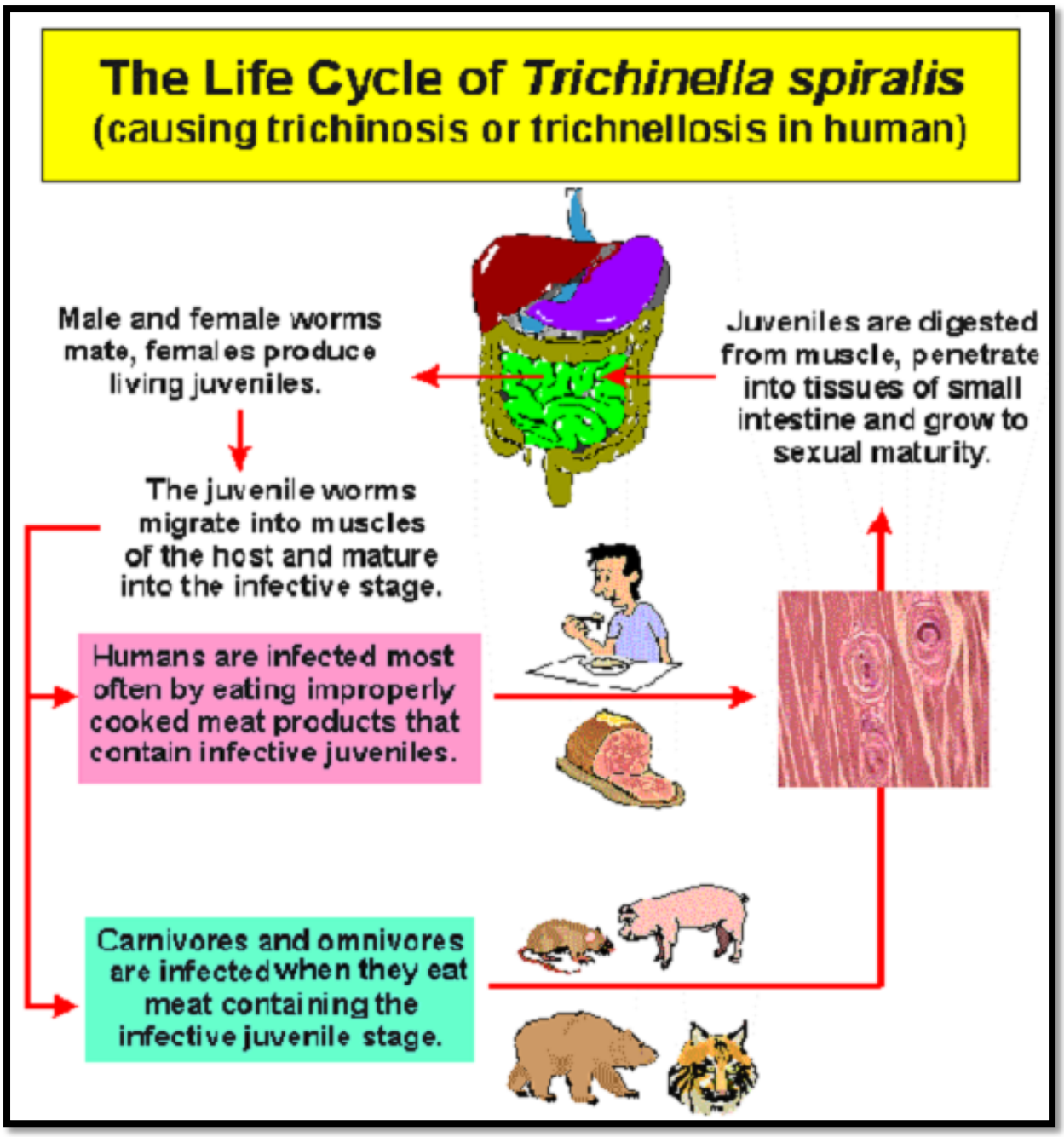
Trichinella spiralis **or the Trichina worm , the causative agent of disease named Trichinosis which is recognized as an important public health problem in Europe and America but is much less common in the tropics. In Asia, the disease had been reported from Malaysia, Vietnam, Thailand, China, and Syria.**

Morphology and life cycle:-

The adult of this parasite is white worm just visible by the naked eye which inhabits the small intestine is one of the smallest nematodes infecting human. The males measures 1.4-1.6 mm long and are more slender at the anterior end than the posterior end whereas females are about twice in size of males , 3mm and also taper toward the anterior end , the anterior half of the body is thin and pointed well-adapted for burrowing in to the mucosal epithelium.

The infective stage is the encysted larvae in the muscles of pigs and other animals, so the infection is acquired by ingestion of insufficient cooking meat containing larvae ,the cysts are digest by the gastric juice and viable larvae are released (excystation) in the stomach, duodenum and jejunum, the larvae immediately penetrate the mucosal epithelium, moults four times and rapidly develop into adults either male or female by the second day of infection.





Insemination occurs by the second day of infection, the male dies soon after wards whereas the fertilized female worm is viviparous start releasing motile larvae by the sixth day of infection. Larvae continue to be discharged during the life span of the parasite which ranges from 4 weeks to 4 months. These larvae inter the intestinal lymphatics or mesenteric venules and are transported by the circulation to different parts of the body, they get deposited in the muscles and central nervous system and other sites while they die in most situations, they grow and develop in the skeletal

muscles ,deposition in the muscles occurs mostly during the second week of infection. Larval development in the muscles takes place during the next three or four weeks after that they become encysted and remain as infective larva inside the cyst for many years.

At the time of deposition in the muscle fibers, the larvae are about 6x100µm in size they grow in size becoming about 1mm long, but remain tightly coiled and enclosed within the fibrous capsule. The cyst is formed by tissue reaction around the encapsulated larvae , cyst is ovoid measuring about 250x400µm laying longitudinally along the muscles.

They may get calcified in about two years but the larva remain viable even inside calcified cyst. Cyst develop preferentially in muscles which are constantly active, therefore the diaphragm, intercostals, pectoral girdle, cervical, tongue, larynx, jaw and extra ocular muscles. Cyst are more abundant near the sites of attachment of muscles to tendons and bones than in other parts. They are also more frequent in the superficial parts of muscles ,the deltoid being easily accessible is chosen for taking diagnostic specimen ,in heavy infection there may be about 1000 cysts per gram of muscles.

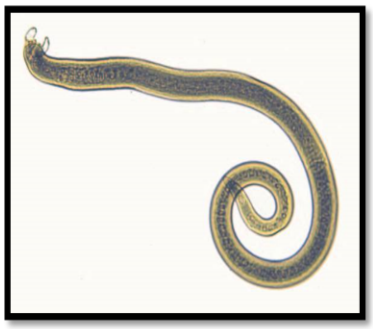
Pathogenesis and clinical features:-

The disease caused by *Trichinella spiralis* is called Trichinosis or less commonly Trichinelliasis or Trichiniasis. The manifestations vary from asymptomatic infection which is very common to an acute fatal illness which is extremely rare. The clinical features may be classified according to the stages in the life cycle of worm :-

1- Stage of intestinal invasion (Enteric phase):-

This occurs during the early stage of infection when the larvae excyst, invade the intestinal epithelium in the duodenum and jejunum and develop into adult worms, symptoms are gastrointestinal nausea, diarrhea, abdominal cramps and sometimes vomiting. This is diagnosed as acute food poisoning particularly when it occurs in group of persons who have partaken the same food. In some , constipation is seen instead of diarrhoea. The onset of illness may be from 2-3 hours of ingestion of the infected food.

- The larva is freed from its nurse cell, and enters the mucosa of the small intestine
- Larvae grow, molt 4 time and young adults copulate within 32 hours of infection
- The females give birth to live L1 larvae while tunneling the epithelium



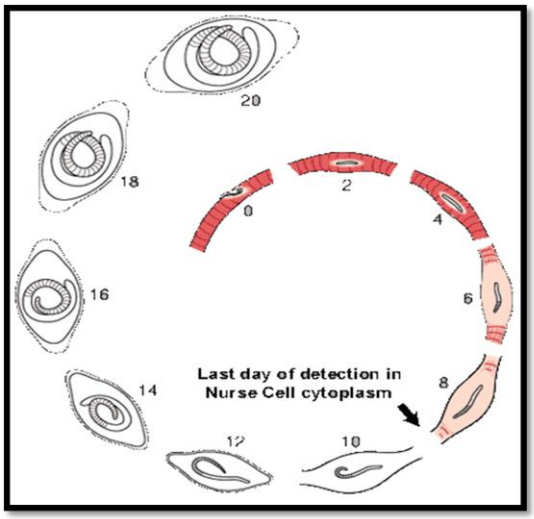
2- Stage of muscles invasion (Migratory phase):-

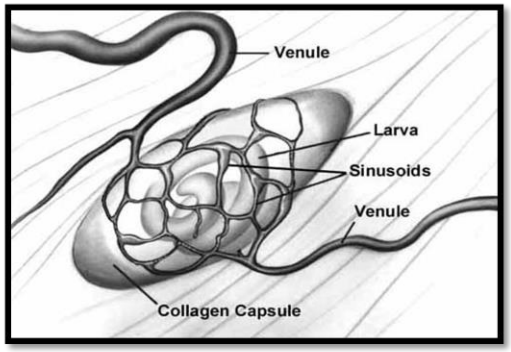
This occur during the release of larvae, their migration, deposition and encapsulation in muscles. Muscle invasion stage begins in the second week after infection. Fever and perorbital edema are followed by myalgia (muscle pain) and weakness. Characteristic splinter hemorrhages can be found under finger nails. Fever and chills can persist for weeks. Headache is common and dizziness may develop. Muscle swelling, aching and tenderness occurs often. Deaths are rare and due to (the serious and potentially fatal complications) myocarditis

(inflammation of the heart muscle), encephalitis and pneumonia (larvae in the diaphragm),This stage appears usually one to four weeks after infection.

3- Stage of capsulation (Encystment phase):-

This period lasting for 1-8 months after infection, during this stage fever and other symptoms may occur, after that the cyst being to calcify. The clinical disease is self-limited and usually last 2-3 weeks in light infection and 2-3 months in heavy infection.





- The host cell looses its myofilaments and several additional subcellular changes occur
- Both host cell and worm are enclosed by a collagen capsule (collagen mRNA has been detected in nurse cell, but some authors suggest the capsule is secreted by surrounding fibroblasts
- The larvae manipulates the host cell to its needs (probably by secretion of suitable effector proteins, the molecular mechanism is not well understood).
- The end product is a nurse cell
- A fine net of blood vessels forms around the nurse cell (angiogenesis)

Diagnosis:

- Clinical diagnosis is helped by the history of consumption of inadequately cooked pork or other meat, particularly when the number of persons sharing the same food are affected.
- Demonstration of adult worm in feces or of larvae in blood is seldom possible.
- Muscle biopsy is useful for demonstration the encysted larvae, from 3-4 weeks after infestation . biopsy bits from the deltoid or gastrocenmius can be

examined microscopically after crushing between glass slides or digestion in artificial gastric juice.

- For example xenodiagnosis, biopsy bits are fed to laboratory rats, which are killed in month or sp later. The larvae can be demonstrated more easily in the muscle of such infected rats.
- The Brachman intradermal test uses 1:5000 or 1:10000 dilution of larvae antigen. An erythematous wheal appears in positive cases within (5-20 minutes) the test remain positive for years after infection.
- Bentonite flocculation test and latex fixation test for demonstration of antibodies has been widely used , a positive test indicates rest infection .
- IFA & ELISA have also been described .
- Blood examination shows eosinophilia.

Treatment:

- Thiabendazole is effective if treatment is started soon after infection. Mebendazole also may be useful.

Prevention:

- Proper cooking of pork and other infected meat. Smoking , salting and drying of meat may not ensure killing of infective larvae. Strains of Trichinella spiralis appears to show differences in susceptibility to refrigeration and freezing.