our website www.jaypeebrothers.com, for detailed information on microbiology books, visit our website www.jaypeebrothers.com

JAYPEE

# The Short Textbook of Medical Helminthology



Satish Gupte

# CONTENTS


**1. Introduction to Helminths** **1-3**

- *Helminths 1*
- *Features of helminths 2*
- *Features of cestodes 2*
- *Features of trematodes 2*
- *Features of nematodes 3*
- *Significance of nematodes 3*

**2. Helminthiasis—A Review** **4-10**

- *History of helminths and associated helminth infections 4*
- *Helminthic diseases based on mode of infection 5*
- *Pathogenic role of helminth 5*
- *Worldwide status of helminths 7*
- *Food-borne trematode infections 8*
- *Helminths of eye importance 9*
- *Helminths of cardiac importance 9*
- *Helminths of gynecological importance 9*
- *Emergencies and helminthiasis 9*

**3. Intestinal Helminths** **11-57**

- *Trichinella spiralis 11*
- *Trichuris trichiura 15*
- *Strongyloides stercoralis 19*
- *Enterobius vermicularis 22*
- *Ascaris lumbricoides 26*
- *Ancylostoma duodenale 30*
- *Ancylostoma braziliense 35*
- *Clonorchis sinensis 35*
- *Fasciolopsis buski 38*
- *Diphyllobothrium latum 40*
- *Hymenolepis nana 44*
- *Taenia saginata 47*
- *Taenia solium 52*
- *Cysticercus cellulosae 55*

**4. Tissue Helminths** **58-70**

- *Paragonimus westermani 58*
- *Dracunculus medinensis 61*
- *Fasciola hepatica 65*
- *Larva migrans 67*

**5. Schistosomiasis** **71-79**
- *Schistosoma haematobium* *71*
- *Schistosoma mansoni* *74*
- *Schistosoma japonicum* *77*

**6. Echinococcosis (Hydatid Disease)** **80-89**
- *Echinococcosis hydatidosis* *80*
- *Echinococcus granulosus* *80*
- *Echinococcus multilocularis* *87*

**7. Filariasis** **90-103**
- *Wuchereria bancrofti* *90*
- *Brugia malayi* *95*
- *Loa loa* *97*
- *Onchocerca volvulus* *99*

**8. Oncogenic Helminths** **104-108**
- *Schistosomiasis* *104*
- *Liver fluke infections* *106*
- *Neurocysticercosis* *107*

**9. Helminthic Nosocomial Infections** **109-110**
- *Helminthic gastrointestinal nosocomial infections* *109*
- *Nosocomial infections in the immunocompromised persons* *110*

**10. Emerging Helminthic Infections** **111-117**
- *Gnathostomiasis* *111*
- *Esophagostomiasis* *112*
- *Capillariasis* *113*
- *Anisakidosis* *113*
- *Eosinophilic enteritis (Ancylostoma caninum)* *114*
- *Baylisascarisis* *114*
- *Angiostrongyliasis* *115*

**11. Helminthic Control, Preventive Measures and Vaccines** **118-123**
- *Control of helminths infections* *118*
- *Helminthic vaccines* *119*
- *Helminthic vaccine development challenges and problems* *119*
- *Protective helminth antigens and epitopes* *119*
- *Goals of an ideal helminthic vaccine* *119*
- *Human anti-helminthic disease vaccines under development* *122*

**12. Treatment of Intestinal Helminthiasis** **124-133**
- *Agents used in helminthic diseases* *124*
- *Albendazole (zentel, alminth, albezole)* *125*
- *Ivermectin (ivermectol, ivermec, vermin)* *125*
- *Diethylcarbamazine (hetrazan, banocide)* *126*
- *Mebendazole* *126*
- *Metrifonate* *127*
- *Niclosamide* *128*

- *Oxamniguine 128*
- *Praziquantel (cysticide, distocide) 129*
- *Pyrantel pamate 129*
- *Thiabendazole (mintezol) 130*
- *Triclabendazole (fasinex) 131*
- *Anthelminthic drugs at a glance 131*
- *Artemisinin derivatives (artemethur, artesunate) 133*

***Summary*** ***135-138***

**Glossary** ***139-142***

*Index* *143–146*

# Intestinal Helminths

3

## *TRICHINELLA SPIRALIS*

### Synonyms

Trichina worm.

### Discovery

- The disease trichinellosis was first of all described by Tidemann in Germany in 1821.
- Peacock and Owen from London reported this disease in 1835.
- Larval stage of *Trichinella spiralis* was demonstrated in human blood in 1909 by Herrick and Janewly.

### Geographical Distribution

- It is cosmopolitan disease.
- It is predominantly found in Europe and America.
- It is not prevalent as a human disease in Africa and India.
- One human case was reported from Punjab (India) in 1996.

### Habitat

It is an intestinal parasite. It remains buried in the mucosa of duodenum and jejunum where adult worms are found. Female fertilized adult worm discharges embryo into circulating blood which get encysted in striated muscles of host, e.g. pig, rat, man, etc.

### Morphology

- It exists as adult form and larval form.
- Adult males are 1.4 to 1.6 mm long.
- Adult female are 4 mm long.
- Females are viviparous.
- Larvae measures 0.5 mm × 0.2 mm which contain 1 mm long coiled larva. Encysted larvae live longitudinally along the striated muscle fibers.
- Each female produces 1000 to 1500 larvae in its life span of 5–7 weeks.
- Larvae are passed in the stools.

### Life Cycle

- The life cycle is passed in one host only (man, pig or rat).
- The primary host is pig which acts as reservoir host for man.
- Man is dead end for the parasite.

JAYPEE BROTHERS

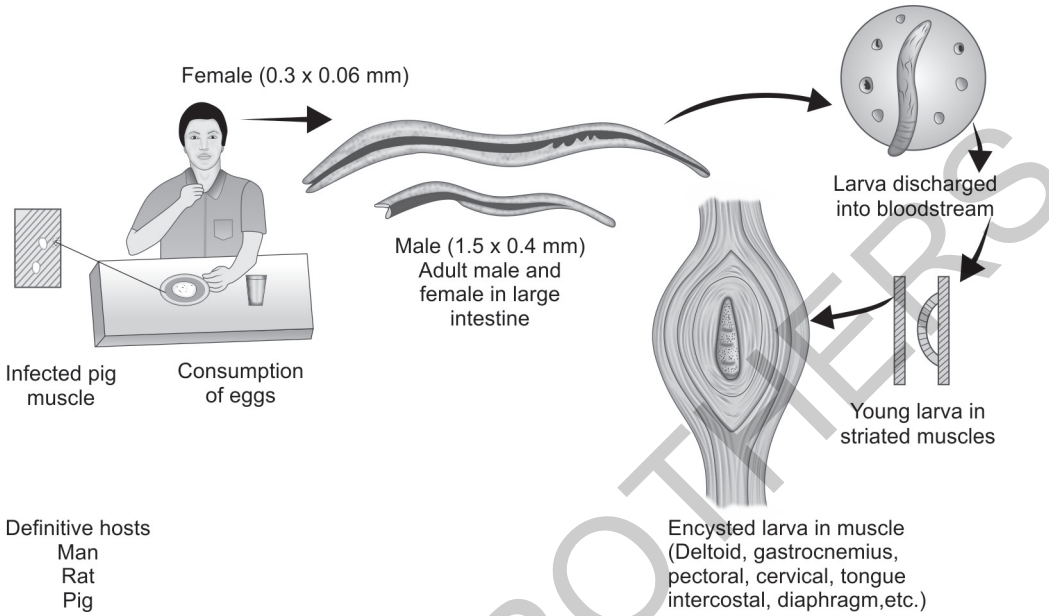



**Fig. 3.1:** Pathogenesis of *Trichinella spiralis*

- Transference of host is obligatory for continuation of race.
- After ingestion of infected meat the capsule of encysted larva is digested by gastric secretion, thus releasing larva in duodenum and jejunum.
- The newborn larva migrates from the small intestine to the muscle tissue via lymphatic circulation and blood stream invading tissues. The stage is most pathogenic form of parasite.[1]
- Four moultings occur in duodenum and jejunum, and larvae develop into adult forms.
- Male worm dies after mating female worm.
- Female worm get fertilized and deliver embryos, after 4–7 days of infection. The larvae after penetration of intestinal wall migrate through lymphatic vessels to blood stream taking them to various organs of the body.
- Larvae survive in skeletal muscles.
- During 3rd and 4th week of infection larvae develop in muscles.
- Larvae grow 10 times from 1 mm initial size.
- Cysts develop in muscles.
- Cysts usually occur at the insertion of muscles.
- The heavily affected muscles are diaphragm, intercostal, pectoral, tongue, muscles of jaw and extraocular.
- Deltoid musle is selected for the purpose of taking biopsy.
- There are three principal maintenance cycles, i.e.
  - Pig to pig
  - Rat to rat
  - Sylvatic, perpetuated by carnivorous wild hosts

JAYPEE BROTHERS

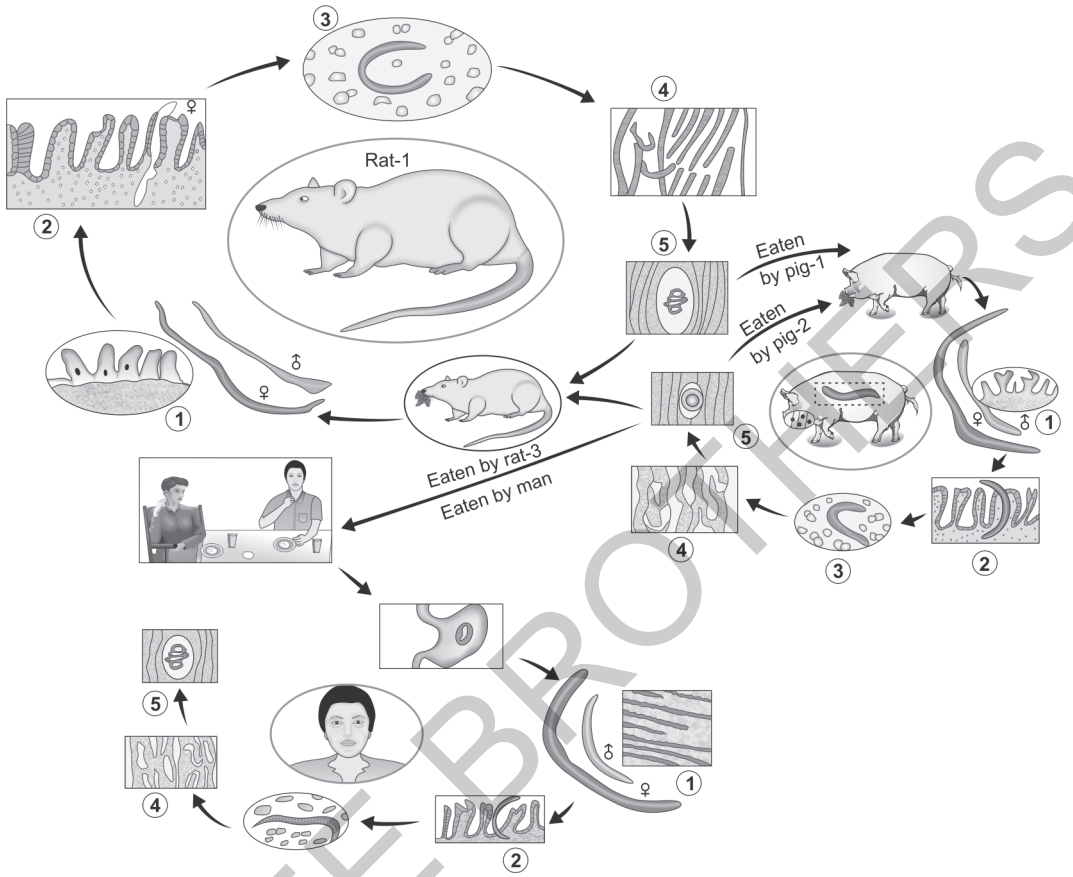



**Fig. 3.2:** Life cycle of *Trichinella spiralis*

## Pathology

- At the site of adherence of adult worm the mucosa becomes hyperemic with potential hemorrhage.
- Important pathologic changes occur because of presence of larvae in the muscles.
- Larvae may invade myocardium.
- Myocardium becomes soft and flabby with fatty degeneration.
- In lungs there occurs edema, hemorrhage and eosinophilic abscess indicating allergic responses.
- In brain matter edema, hyperemia, punctate hemorrhage may occur with microscopic nodules.
- Larvae are found in cerebrospinal fluid and meninges.
- In case of decomposition of muscle cyst may remain viable for 10 days.

## Clinical Features

- Light infections are asymptomatic.
- Manifestations of enteric phase include pain in abdomen, nausea, vomiting and diarrhea.

JAYPEE BROTHERS

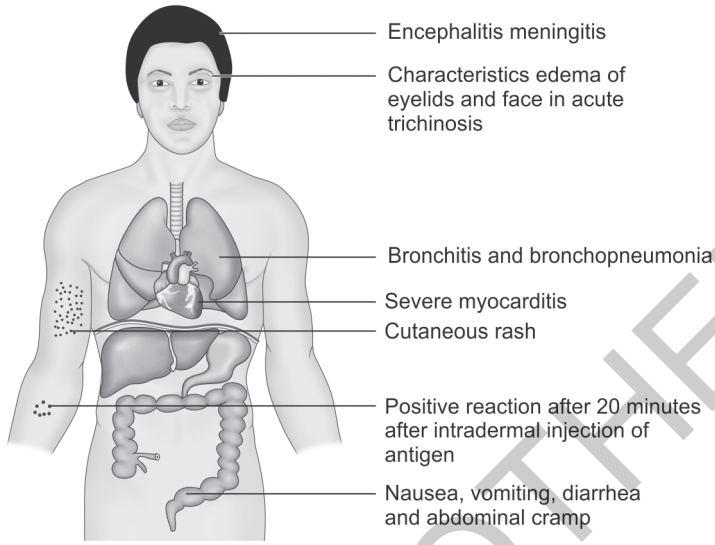



**Fig. 3.3:** Clinical features of *Trichinella spiralis*

- During larval migration hypersensitivity reactions occur, e.g. fever eosinophilia, periorbital edema, facial edema splinter hemorrhages, etc.
- In heavy infection (more than 50 larvae per gram of muscle), fatal myocarditis, encephatitis, pneumonitis, etc. may occur during larval migration only.
- The phase of larval migration may be asymptomatic in light infection (less than 10 larvae per gram) of muscle.
- In symptomatic case the patients may have manifestations of myalgia and weakness.

## Laboratory Diagnosis

1. **DLC**: It shows significant eosinophilia upto 50–70%
2. **Muscle enzymes**: Due to attack of larvae on muscle there is elevation of muscle enzyme, e.g. lactate dehydrogenase, aldolase and creatnine phosphokinase.
3. **Muscle biopsy**:
   - Ideally it is done after 4th week of infection
   - A sample of one gram of muscles (biceps or gastrocnemius) is excised
   - Muscle sample collected is divided into two parts one is examined unstained while other one is stained
   - In moderate infection 50–100 larvae per gram of biopsy material are present
   - More oftenly 5000 larvae per gram of tongue biopsy material have been observed.
4. **Muscle digestion**
   - Muscle digestion is done for 30 minutes in 2% pepsin in saline containing 5% hydrochloric acid at 37°C
   - Now larvae are observed under the microscope. This method may be used for epidemiological purposes to assess the prevalence of larvae.
5. **Xenodiagnosis**: The biopsy material is fed to rats. After killing rats in around one month, larvae may be demonstrated in the muscles of rat.

JAYPEE BROTHERS

6. **Skin test**: Brachman's antigen is used in 1:10,000 dilutions. This antigen is prepared using infected rabbit muscles. In positive case erythematous rash occurs within 15–20 minutes. However positive test remains positive upto 20 year.

Apart from above mentioned test larvae may be detected in blood, cerebrospinal fluid, etc. Some serological tests may be used like bentonite flocculation test (significant titer 1:5), indirect fluorescent antibody test, etc. These test cross react with salmonella.

### Treatment

- Thiabendazole in doses of 50 mg/kg body weight per day for 5–7 days is very effective against migrating larvae and to some extent encapsulated forms also
- Pyrantel pamoate may be used against intestinal infection
- For intestinal infection tetramisole may be administered
- In addition prednisolone (1 mg/kg body weight) can be given in severe myositis and myocarditis.

### Preventive Measures

- Eating meat is the typical way of acquiring infection with Trichinella spiralis.[2] One needs to be careful
- Proper cooking of pork. Larvae in porks are killed by heating above 55°C and may prevent human infection
- Proper storage by freezing pork at -15°C for 3 weeks is sufficient and safe for consumption
- Feeding of pigs with raw garbage must be avoided.

## TRICHURIS TRICHIURA

### Synonyms

Whip worm.

### Discovery

- First discovered by Linnaeus 1771
- Later important contribution in understanding this infection was added by Schrank 1768 and Stite 1901.

### Geographical Distribution

- It is the third commonest nematode after roundworm and hookworm to infect man.
- About 50 crore persons are infected worldwide
- It is common in moist and warm areas like South East Asia, Caribbean and tropical Africa
- Its distribution is restricted as its eggs are less resistant to environmental stress, e.g. drying and exposure to sunlight
- Interestingly the infestation of the *Trichuris trichiura* is most common but actually disease occurs in quite less number.

### Habitat

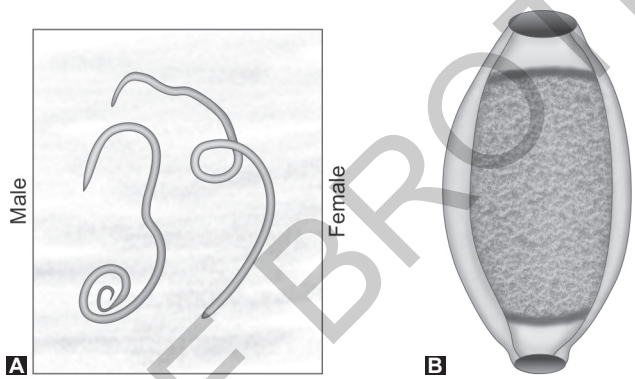
The adult worm lives in cecum and appendix of man. However in heavy infections, the organisms are present all over the length of large intestine.

JAYPEE BROTHERS

## Morphology

*Adult Worm*

- They are pinkish white.
- The male worm is 30 to 40 mm long with coiled posterior end single spicule.
- The caudal end of male worm is curved ventrally.
- The female worm is slightly longer, i.e. 40 to 50 mm with posterior end straight, blunt and rounded.
- Both sexes have narrow and thin anterior portion (3/5th) and wider posterior end (2/5th). Hence called whip worm.
- The anterior thin portion containing capillary esophagus remains buried in the intestinal mucosa of host. The intestine and reproductive organs are located in the posterior thick part of the body.
- The female worm is oviparfsous.




*T. trichiura* adult worm  Egg of *T. trichiura*

**Figs 3.4A and B:** Morphology of *Trichuris trichiura*, (A) Adult worms, (B) Eggs

*Eggs*

- It is barrel shaped with mucus plug at each pole.
- Size is 25 μ × 50 μ.
- Bile stained.
- Contains unsegmented ovum when freshly passed.
- Floats in saturated saline solution.
- The female worm may lays about 2000 to 10,000 eggs per day.

## Life Cycle

- Life cycle takes place in one host only and change of host is required to continue new life cycle
- Eggs take 3 weeks to develop in moist soil and remain infective for 2 weeks. If the climate is temperate it may take 10–12 months. In dry condition embryonation may be prevented
- On ingestion of embryonated eggs with food and water, the shell of eggs may be digested by digestive secretions and lavae are liberated through one pole
- Larvae liberated are migrated to cecum

JAYPEE BROTHERS

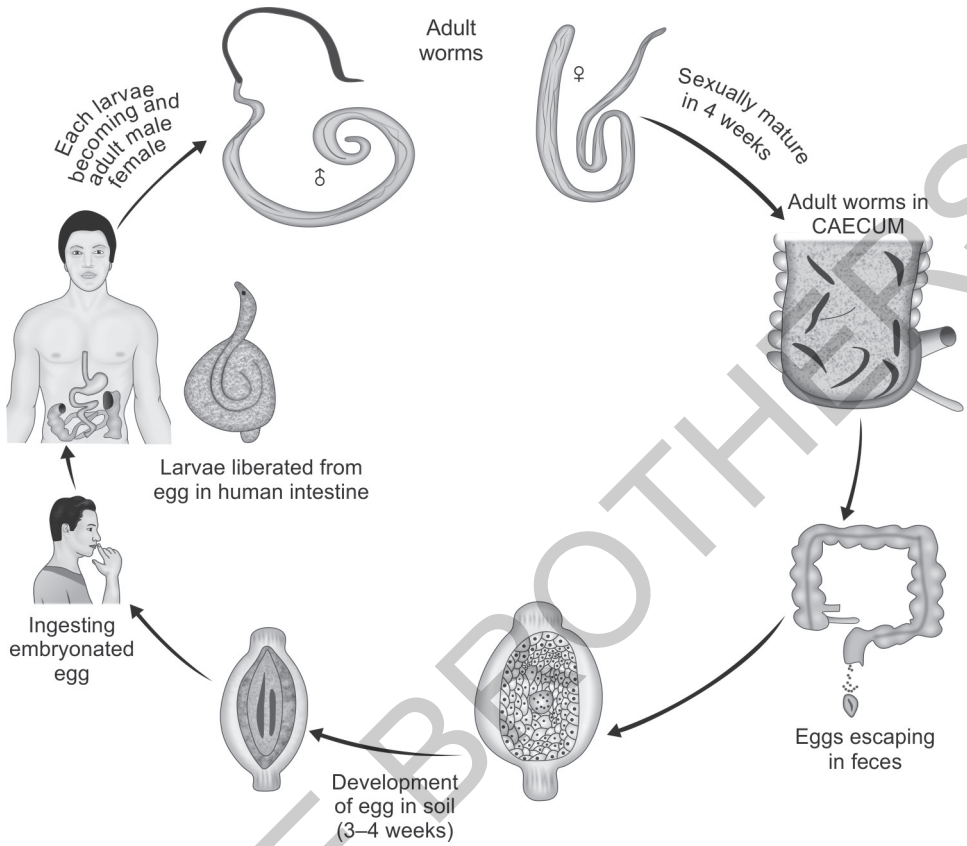



**Fig. 3.5:** Life cycle of *Trichuris trichiura*

- In cecum anterior thin portion gets embedded in the mucosa and posterior end hangs free projecting in the lumen of intestine. They develop into adult form and differentiate into males and females. Male fertilizes female.
- Egg starts appearing in stools usually in 3 months after ingestion of infective eggs. These eggs develop to infective form in the soil and hence infective to new host.
- The adult worms normally live for about 3 years but may survive upto 8 years.

## Pathogenesis

- Anterior portion of worm embedded in the mucosa of intestine may cause petechial hemorrhages which may predispose the patients to infections with *Entameba histolytica* and *Shigella* species.
- The degree of inflammation may extend from the disital part of small intestine to rectum depending on the intensity of infection.[3]
- Entry of parasites in the lumen of the appendix may cause appendicitis or granuloma formation.

JAYPEE BROTHERS

### Clinical Features

- *Trichuris trichiura* causes trichuriasis
- Light *Trichuris trichiura* infections are asymptomatic
- Heavy infections are highlighted as
  - Abdominal pain
  - Children having infection with this parasite often suffer from chronic dysentry[4]
  - Rectal prolapse is due to toxic irritation of nerve endings. Mechanism of prolapse is similar to that of intussusception. Remission often occurs within few days of effective anthelminthic chemotherapy
  - Anemia due to heavy worm load (blood loss is 0.005 ml per worm)
  - Malnutrition
  - Bloody diarrhea
  - Ingestion of non-food substances, e.g. soil
  - Acute appendicitis (mechanical blockage)
  - Reversible clubbing of fingers in children, because of congestive heart failure secondary to severe anemia.

### Laboratory Diagnosis

- DLC: It shows eosinophilia
- Stool examination: It shows
  - Charcoal Leydon crystals
  - Typically barrel shaped eggs
  - About 20,000 egg per gram are likely to produce clinical disease
- Sigmoidoscopy: In heavy infections it may show white bodies of worm hanging.

### Pathology

- Immature *Trichuris trichiura* buries its entire body in the epithelium of large intestine constituting a tunnel.
- With the maturation of worm, the posterior part is extruded or get ruptured from tunnel, hangs in the lumen of intestine and becomes available for copulation and ovipositions.
- The intimate contact of *Trichuris trichiura* with the mucosa of large intestine causes inflammation and petechial hemorrhages of mucosa which may extend from the distal part of intestine right upto rectum. The mucosa may be edematous and friable.
- Rectal prolapse may occur as a result of strain to defecate.
- Rectal bleeding with abdominal cramps may occur with servere rectal tenesmus in case of massive infection.
- Massive infection may lead to iron deficiency anemia because of malnutrition and blood loss from friable colon and prolapsed rectum. The reaction with inflamed mucosa called coconut cake rectum.

### Treatment

- Albendazole : 400 mg single dose
- Mebendazole : 100 mg in mild or moderate infection
  However heavy infection require 3 days treatment
- Oxantale : 20 mg/kg body weight for two consecutive days is highly effective

JAYPEE BROTHERS

### Prophylaxis

- Proper disposal of human excreta
- Use of solution of chloropicrin to kill eggs of this worm in soil
- Not to eat raw or uncooked vegetables and unwashed fruits
- Treatment of infected persons.

## *STRONGYLOIDES STERCORALIS*

### Synonyms

Anguillula stercoralis.

### History

- Normand in 1876 identified strongyloides first of all in stools of French troops suffering from cochin – China Diarrhea.

### Geographical Distribution

- This worm is widely distributed in Africa, Asia and South America
- It is found sporadically in North America and Europe.

### Habitat

After getting fertilized adult female lives buried within the mucosa of small intestine particularly duodenum and jejunum.

### Morphology

It occurs in adult form and larval form. It may be parasitic in nature or free living.

*Parasitic Adult Form*

- Males adult have not been seen in humans
- Males cannot penetrate intestinal wall and so they are immediately expelled by bowel by the time females start laying eggs
- Female adults live within mucosa of small intestine
- Female adult measures 2.5 mm × 0.04 to 0.05 mm
- It bears small buccal cavity surrounded by four lips
- It has two uteri filled with 10 to 20 eggs at a time
- It is ovo-viviparous. The eggs are thin shelled about 25 μ × 30 μ in dimension
- The eggs are laid in tissue.

*Free Living Adults*

- They live in moist soil
- Female is 1 mm long and males measure 0.7 mm long
- They mate in soil
- The fertilized females lay eggs that develop to rhabditiform larva

JAYPEE BROTHERS

*Larva*

- Rhabditiform larva comes out of eggs and makes its way into lumen of intestine.
- Rhabdiliform larvae (200 to 300 μ × 16 μ) are expelled with feces. The larvae are actively motile.
- The larval bear small mouth and characteristic double bulb esophagus.

## Life Cycle

- *Strongyloides stercoralis* complete the life cycle in one host.
- Man contacts this infection following contact with fecally contaminated soil or by autoinfection.
- Rhabiditiform larvae develop into filariform larvae in the soil.
- Flariform larvae are the infectious form that penetrate intact skin or mucus membranes
- After penetration larvae pass through blood stream enter lungs where they break into alveli, ascend bronchial tree, crawl over epiglottis and are swallowed down to small intestine. Here they develop and mature to adult form.
- Now female worm sheds eggs either by parthenogenesis or after fertilization by male worm
- Eggs develop locally in intestinal mucosa to release rhabdilitiform larvae which ultimately move into intestinal lumen.

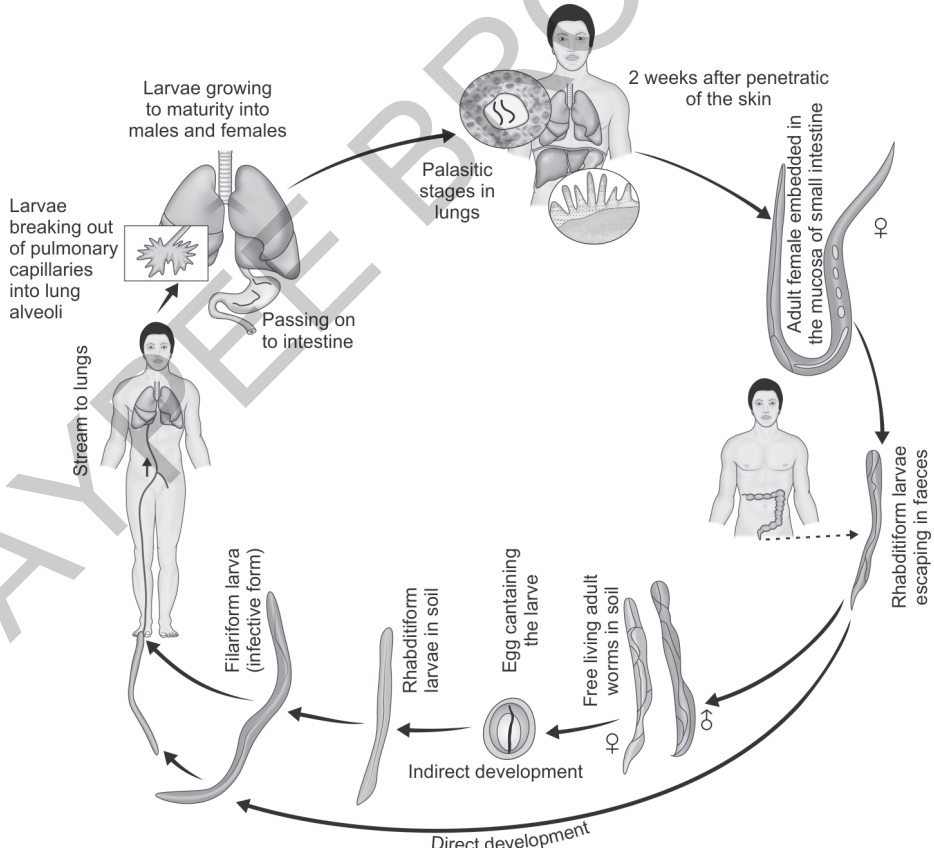



**Fig. 3.6:** Life cycle of *Strongyloides stercoralis*

JAYPEE BROTHERS

- The rhabditiform larvae either pass with feces to the soil or develop to filariform larvae in the lumen of intestine
- The filariform larval may result to auto infection by penetrating mucosa or perianal skin
- Rhabiditiform larvae expelled with feces into the soil develop in two ways:
  - They mature to infective form i.e. filariform larvae
  - They may transform into free living adult males and females. The male worm fertilized female worm. The gravid female sheds eggs in soil which grow to filariform larvae. Filariform larvae penetrate the skin of new human to continue the cycle.

### Pathogenesis

Infection caused by it is called strongyloidiasis. It may involve skin. The pathognomonic cutaneous symptoms of stongyloidiasis is larvae currens migrating larval produces raised erythematous lesion that moves along the course of migration larva currens also called running larva. It may move at 10 cm per hour. Migrating larvae may also produce hemorrhagic lesions in lungs. Burrowing adult worm may cause mild epigastric pain, gastrointestinal bleeding, mild chronic colitis, etc.

Conditions favouring suppressed or lowered immune status are immunosuppressive treatment, malignanacy, malnutrition, pregnancy, AIDS, etc. In this situation *Strongyloides stercoralis* infection results into hyperinfection. Large number of filariform larvae invade gastrointestinal tissues resulting to colitis, steatorrhea and dehydration. The larvae may harm CNS, peritoneum liver and kidneys, etc.

Several complication may occur because of bacteria from intestine which may enter through mucosa broken by penetrating larvae. These complications include septicemia, pneumonia, meningitis, etc.

### Clinical Features

- Chronic infection with this parasite is most oftenly asymptomatic[5]
- There may be abdominal pain, nausea, vomiting, weight loss, gastrointestinal bleeding, pruritis, etc. These are acute manifestations
- Chronic manifestations include paralytic ileus and protein losing enteropathy, etc.
- Other presentations may be rash, meningitis, bronchopneumoniae and so on.

### Laboratory Diagnosis

1. Demonstration of eggs, rhabditiform larvae, filariform larvae and adult female worm in papnicolou stained smear of stools, sputum or duodenal aspirate.
2. Repeated stool examination, aspiration of duodenal jejunal contents, biopsy or Entero test method may be used to improve detection rate of *Strongyloides stercoralis.*
3. Concentration techniques for stool examination may be tried, e.g. formal ether and Baermann method.
4. An ELISA test is useful to detect antibodies against excretory—secretory antigen of stongyloides.
5. Other immunological test like immunofluorescence test and radical allergosorbent test (RAST) are promising.

JAYPEE BROTHERS

6. An agar plate method that relies on the use of inverted microscope to identify tracks made be motile *Strongyloides stercoralis* larvae. This method is more sensitive than other techniques.

*Treatment*

Since strongyloidosis is a potentially life-threatening disease so it must be treated properly even if it is asymptomatic. Thiabendazole is drug of choice. It is given as 25 mg/kg body weight twice daily for 2 days. This treatment is extended to 7 days in disseminated stronglyloidiasis. Eosinophilia is a bad prognostic sign.

*Prevention Measures*

1. Avoid contact with fecally contaminated soil
2. Specific treatment to patients must be given
3. To avoid hyperinfection syndrome, patients must be screened for strongyloidosis, before starting corticosteroids and other immune suppressive therapy.

## *ENTEROBIUS VERMICULARIS*

### Synonyms

- Threadworm
- Pinworm
- Seatworm
- Oxyuria

### History

- Eggs of thread worm have been found in 10,000 years old coprolith in USA
- Leukart in 1865 described complete life cycle of *Enterobius vermicularis*.

### Geographical Distribution

- It has cosmopolitan distribution
- It is more prevalent in temperate and cold climates because of less frequent bathing and less frequent changing of underclothing
- Incidence is higher in developing countries.

### Habitat

- Adult worms inhabit in cecum, appendix and ascending colon
- They live in close contact with mucosa.

### Morphology

*Enterobius vermicularis* exists in adult form and larval form.

JAYPEE BROTHERS

for detailed information on microbiology books, visit our website www.jaypeebrothers.com, for detailed information on microbiolog

*The Short Textbook of*

# Medical Helminthology

This volume covers comprehensively medical helminths from all aspects in simple, lucid and easily understandable style. It also includes history, elementary knowledge on medical helminths along with recent advances applicable in clinical practice.

***Salient Features***

- Profusely illustrated
- User-friendly language
- Presentation is easy to read and recapitulate
- Also included topics like oncogenic helminths, helminthic nosocomial infections, helminthic control, preventive measures and vaccines, etc.
- Relevant references are provided at the end of each chapter.



**Satish Gupte** MBBS MD did his MBBS from Government Medical College, Srinagar, Jammu and Kashmir University in 1973, and MD (Microbiology) from Medical College, Rohtak, MD University, Rohtak in 1980. Presently working as Professor and Head, Department of Microbiology, Gian Sagar Medical College and Hospital, Ramnagar, Rajpura, Distt. Patiala, Punjab. He has a total of 36 years of teaching experience in microbiology. He is a University Examiner for MD, MBBS, BDS, MSc (Microbiology) of Jammu University, SKIMS, Srinagar, Kashmir University, Delhi University, Baba Farid University of Health Sciences, Punjab, Himachal Pradesh University, Rajasthan University, etc. He has authored 13 books on *Medical Microbiology, Blood Transfusion* and *Laboratory Medicine Disciplines*. He has about 40 research papers published in national and international journals. He has been conferred with the "Man of the Year Award 2002" by American Biographical Centre, New York. His biographical sketch appeared in "Who's Who World", USA.

Shelving
Recommendation
**MICROBIOLOGY**

**Available at all medical bookstores**
**or buy online at www.jaypeebrothers.com**

JAYPEE BROTHERS
Medical Publishers (P) Ltd.
www.jaypeebrothers.com

Join us on facebook.com/JaypeeMedicalPublishers

ISBN 978-93-5152-617-9