Nematodes
Nematodes – General Characters

- **Non-segmented** cylindrical worms tapering at both ends

- **Possess cuticle**

- **Sexes are separate** (diecious), male is smaller than female & its posterior end is curved ventrally

- **Females are either**
  - **Viviparous** (produce larvae/ embryos)
  - **Oviparous** (lay eggs) or
  - **Ovo-viviparous** (lay eggs which hatch immediately)

- **Live in intestinal tract or tissues**
## Classification – Intestinal Nematodes

<table>
<thead>
<tr>
<th>Location</th>
<th>Nematodes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Small Intestine only</strong></td>
<td>Ascaris lumbricoides (round worm)</td>
</tr>
<tr>
<td></td>
<td>Necator americanus (american hook worm)</td>
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<tr>
<td></td>
<td>Ancylostoma duodenale (hook worm)</td>
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<tr>
<td></td>
<td>Strongyloides stercoralis</td>
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<tr>
<td></td>
<td>Trichinella spiralis (trichina worm)</td>
</tr>
<tr>
<td></td>
<td>Capillaria philippinensis</td>
</tr>
<tr>
<td><strong>Caecum and Vermiform appendix</strong></td>
<td>Enterobius vermicularis (pin worm)</td>
</tr>
<tr>
<td></td>
<td>Trichuris trichiura (whip worm)</td>
</tr>
</tbody>
</table>
## Classification – Tissue Nematodes

<table>
<thead>
<tr>
<th>Lymphatic</th>
<th>Wuchereria bancrofti</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Brugia malayi</td>
</tr>
<tr>
<td></td>
<td>Brugia timori</td>
</tr>
<tr>
<td><strong>Subcutaneous</strong></td>
<td>Loa loa (african eye worm)</td>
</tr>
<tr>
<td></td>
<td>Onchocerca volvulus (blinding filaria)</td>
</tr>
<tr>
<td></td>
<td>Dracunculus medinensis (thread worm)</td>
</tr>
<tr>
<td><strong>Conjunctiva</strong></td>
<td>Loa loa</td>
</tr>
</tbody>
</table>
Modes of Infection of Nematodes

1. **Ingestion** of –
   - Embryonated eggs contaminating food & drinks, e.g. *A. lumbricoides, E. vermicularis* & *T. trichiura*
   - Growing embryos in an intermediate host (infected cyclops) e.g. *D. medinensis*
   - Encysted embryos in infected pig’s flesh e.g. *Trichinella spiralis*

2. **Penetration of skin** – filariform larvae bores through the skin e.g. *A. duodenale, S. stercoralis, N. americanus*

3. **By blood sucking insects** e.g. filarial worms

4. **Inhalation of infected dust** containing embryonated eggs e.g. *A. lumbricoides, E. vermicularis*
INTESTINAL NEMATODES
<table>
<thead>
<tr>
<th>Ascaris lumbricoides (roundworm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adult worms</strong></td>
</tr>
<tr>
<td>Male 15 to 30 cms</td>
</tr>
<tr>
<td>Female 20 to 40 cms, oviparous</td>
</tr>
<tr>
<td><strong>Eggs</strong></td>
</tr>
<tr>
<td>60 µ, bile stained</td>
</tr>
<tr>
<td>Albuminous coat with</td>
</tr>
<tr>
<td>unsegmented ovum</td>
</tr>
<tr>
<td><strong>Infective form</strong></td>
</tr>
<tr>
<td>Embryonated eggs</td>
</tr>
<tr>
<td><strong>Mode of transmission</strong></td>
</tr>
<tr>
<td>Ingestion</td>
</tr>
<tr>
<td><strong>Site of localization</strong></td>
</tr>
<tr>
<td>Small intestine</td>
</tr>
</tbody>
</table>
The Life Cycle Of ROUNDWORMS
Ascaris Lumbricoides and Ascaris Suum

Adult males and females are in the small intestine.

Females produce eggs that are passed in the host's feces.
(A single female can produce 200,000 eggs per day.)

Juveniles in eggs mature to the infective (second) stage.

Eggs ingested by host and hatch in the small intestine. The juveniles penetrate the tissues of the intestine and enter the blood stream.

The juveniles are "coughed up" and swallowed. The juveniles complete their development in the small intestine.

The third stage juveniles migrate from the pulmonary capillaries into the alveoli (air sacs).

The juveniles migrate to the lungs and molt into third stage juveniles.

(Parasites and Parasitological Resources)
Life cycle

Adult worms (intestine)

- Throat, swallow, small intestine
- Right heart, lung, respiratory passage
- Penetrate intestine, reach liver
- Rhabditiform larva hatches
- Ingestion of eggs

Unembryonated eggs (stool)

- Embryonated eggs in 2-3 weeks in soil (infective form)
Pathogenicity & Clinical Features

- **Ascariasis** – infection of *A. lumbricoides*
- Majority of infections are asymptomatic
- Clinical disease is largely restricted to individuals with a high worm load
- Symptoms divided into two groups: those produced by
  1. Migrating larvae
  2. Adult worms
Symptoms & Complications

Symptoms produced by Migrating larvae

1. **Pneumonia (loeffler’s syndrome)** – fever, cough, dyspnoea, blood tinged sputum that may contain larva, urticarial rash & eosinophilia

2. **Visceral larva migrans** – if larvae enter systemic circulation (from pulmonary capillaries) to reach other organs like brain, spinal cord, heart, kidney.
Symptoms & Complications

- Symptoms produced by Adult worms
  1. **Abdominal discomfort**, anorexia, nausea & **diarrhoea**.
  2. **PEM, Vit. A deficiency** (night blindness)
  3. Intestinal **obstruction** (particularly in children 1-5 years), **intussusception** & **volvulus**
  4. **Penetration** through intestinal ulcer (**perforation**) – **peritonitis**
  5. **Hypersensitivity reactions** to worm Ags (toxic body fluids) – urticaria, edema of face, conjunctivitis, irritation of URT
Pathogenicity & clinical features

- Symptoms produced by Adult worms

6. **Ectopic Ascariasis** – due to migration of worm up into the stomach. It may
  - be vomited out,
  - pass up through the oesophagus at night & comes out through mouth or nose,
  - enter larynx to cause asphyxia.
  - migrate to other organs and cause **appendicitis**, cholecystitis, biliary colic, cholangitis, pancreatitis
Laboratory Diagnosis

- **Macroscopic** - Direct detection of worm/s in stool or vomit

- **Microscopic** – direct examination of feces following floatation method: **bile stained eggs**. (eggs may not be seen at least 40 days after infection)

- **Blood examination** – **eosinophilia**.
Other modes of diagnosis

- **Imaging** – large collections of worms in abdomen
- **USG** - to diagnose hepatobiliary or pancreatic ascariasis
- **Serology (Ab detection)** – mainly reserved for epidemiological studies.
Treatment

- **Mebendazole/ Albendazole** – drug of choice but contraindicated in pregnancy & heavy infection

- **Pyrantel pamoate** – single dose

- **Piperazine citrate** - suspected intestinal or biliary obstruction since this drug paralyzes worms to aid expulsion.

- **Levamisole**
Prevention

- Good sanitation and personal hygiene

- **Mass treatments** with single dose mebendazole or albendazole for all school-age children every three to four months - serves dual function:
  - treats the children and
  - reduces the overall worm burden in the community
### Ancylostoma duodenale (hook worm)

<table>
<thead>
<tr>
<th>Biological Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adult worms</strong></td>
<td>Male 8-11mm</td>
</tr>
<tr>
<td></td>
<td>Female 10-13 mm, oviparous</td>
</tr>
<tr>
<td><strong>Eggs</strong></td>
<td>60 µ, non bile stained (colorless)</td>
</tr>
<tr>
<td></td>
<td>Segmented, 4 blastomeres</td>
</tr>
<tr>
<td><strong>Infective form</strong></td>
<td>3rd stage filariform larva</td>
</tr>
<tr>
<td><strong>Mode of infection</strong></td>
<td>Penetration into skin</td>
</tr>
<tr>
<td><strong>Site of localization</strong></td>
<td>Small intestine</td>
</tr>
</tbody>
</table>

*Image of a hookworm egg.*
Sites of skin penetration

- Most common sites are:
  1. Thin skin between toes
  2. Dorsum of the feet
  3. Inner side of the soles

- Gardeners & miners – skin of hands
Life cycle of hookworm

- Eggs in feces
  - Hatching
  - Rhabditiform larvae
  - 48 hours
  - Swallowed
  - Attached to small intestine
  - Trachea
  - Lungs
  - Circulation
  - Penetrates skin
  - Filariform larvae
  - 6 to 8 weeks
  - Humans
  - 6 to 8 days
  - 8 to 10 days

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Hook worms in the intestine
Pathogenicity & Clinical Features

- **Ancylostomiasis** or hookworm disease, characterised by iron deficiency anaemia

- Majority of infections are asymptomatic

- Symptoms develop in heavy infections and divided into two groups: those produced by
  1. Migrating larvae
  2. Adult worms
Symptoms produced by larvae

Lesions in the skin:

1. **Ancylostome dermatitis or Ground itch** – occurs at the site of entry (more common in necator), lasts for 2 to 4 weeks

2. **Creeping eruption** – reddish itchy papule along the path traversed by filariform larvae (*larva migrans*)

Lesions in the lungs – bronchitis & bronchopneumonia.
Symptoms produced by adult worm

- **Epigastric pain, diarrhoea & vomiting during early phase of infection.**

- **Microcytic hypochromic (Iron deficiency) anaemia** – due to chronic blood loss:
  - a single adult hookworm sucks 0.2ml of blood/ day
  - Hemorrhages from punctured sites
Clinical features of hookworm anemia

- Extreme **pallor**
- Abnormal appetite showing **Pica** or **Geophagy** – perverted taste for earth, mud or lime
- **Epigastric tenderness** with dyspepsia
- Constipation
- **Puffy face** with swelling of lower eyelids
- **Pedal edema**
- **Growth retardation**
- **General appearance** – pale plumpy with protuberant abdomen & dry lustreless hair.
Laboratory Diagnosis

- **Stool examination** – microscopy: non bile stained egg, segmented
- **Occult blood in stool** – positive
- **Blood examination** – anaemia, eosinophilia
Treatment

- Mebendazole / Albendazole
- Pyrantel pamoate
- Oral iron replacement – ferrous sulphate 400mg tid
- Nutritional support

* If Hb is below 30%, then anemia should be treated first with Iron till Hb comes over 50%.
Prevention & Control

- Proper sanitation measures & sewage disposal
- Personal hygiene
- Personal protection – wearing boots & gloves
- Simultaneous treatment of carriers & diseased with wholesale treatment of community
# Strongyloides stercoralis

| Adult worms | 2 - 2.5mm, ovoviviparous, eggs laid in the tissues |
| Free living worms | Moist soil |
| Infective form | Filariform larvae |
| Mode of transmission | Penetration / autoinfection |
| Site of localization | Wall of Small intestine, mainly duodenum & jejunum |
Life cycle – S. stercoralis

- Adult worms in intestine
- Eggs in intestine
- Rhabditiform larvae hatch
- Larvae in feces - soil
- Direct: Larvae into adults
- Indirect: Eggs produced

- Larvae reach intestine
- Larvae pass through similar to Ascaris
- Larvae in blood
- Autoinfection
- Rhabditiform to filariform
- Larvae penetrate intestine
- Filariform larvae (infected form)
- Penetrate skin
- Rhabditiform larvae hatch

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Pathogenicity

1. **Skin lesions (2 types) – “larva currens”**
   - At the site of entry – urticarial rash
   - In the perianal region – linear, erythematous urticarial wheal

2. **Pulmonary lesions – due to migrating larva**
   - Alveolar hemorrhages
   - Bronchopneumonia

3. **Intestinal lesions - “burrowing lesions”**
   - Epigastric pain
   - Diarrhoea with blood & mucus
   - Nausea
   - Weight loss
Important terms to know

- **Autoinfection – filariform larva**
  1. In the Intestinal lumen
  2. Perineal & perianal skin penetration

- **Hyperinfection – can result in autoinfection**
  1. Steroids or Immunosuppressive therapy
  2. Malignancy
  3. Malnutrition
  4. Pregnancy
  5. Puerperium
  6. AIDS

- **Persistence of infection – due to autoinfection**
Laboratory Diagnosis

- **Stool examination** – rhabditiform larva
- **Culture** – larva
- **ELISA** – to detect Abs
Treatment & Prevention

- Potentially life threatening disease – treat even if it's asymptomatic

- Thiabendazole for 2 days

  Disseminated strongyloidosis – 5 to 7 days.
<table>
<thead>
<tr>
<th><strong>Trichinella spiralis (Trichina Worm)</strong></th>
</tr>
</thead>
</table>
| **Adult worms** (smallest nematode infecting man) | Male 1.4 – 1.6 mm  
Female 3 - 4 mm, viviparous |
| **Infective form** | Encysted larvae (100µ) in striated muscles of pig |
| **Mode of transmission** | Ingestion of improperly cooked pork |
| **Site of localization** | Small intestine |
| **Commonly involved muscles** | Diaphragm, Intercostals, Deltoid, Pectoralis major, Biceps |
Life Cycle – *T. spiralis*

- Eating undercooked pork
- Larva released in small intestine
- Development into adult worms
- Larva deposits larva in intestinal mucosa
- Larva enters circulation
- Larva deposits and encysts in striated muscles
- Encysted larva in pig muscles (infective form)
Pathogenicity

- **Trichinelliasis / Trichinosis** – clinical features depends on the stage:
  1. **Stage of intestinal invasion**: 5-7 days, pain in abdomen, nausea, vomiting, diarrhoea
  2. **Stage of larval migration**: fever, urticarial rash, splinter hemorrhages, periorbital & facial edema
  3. **Stage of encystation**: asymptomatic in light infections; myalgia, weakness in heavy infections

- **Complications – during migration**:
  - myocarditis, encephalitis
Laboratory Diagnosis

- **Muscle biopsy** – encysted larva

- **Blood** – eosinophilia between 2\textsuperscript{nd} & 4\textsuperscript{th} week

- **Serology** – to detect specific Abs by:
  1. Bentonite flocculation test
  2. Latex agglutination test
Treatment & Prevention

**Treatment**
- Thiabendazole & Mebendazole – adult worms
- Corticosteroids – complications

**Prevention**
- Proper cooking of pork or proper storage
- Avoidance of feeding bits & refuse from slaughter houses & farms to pigs – breaks life cycle.
**Enterobius vermicularis**  
* (Pin Worm, Seatworm)

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
</table>
| Adult worms            | Male: 2 - 5 mm  
                          | Female: 8 - 13 mm, oviparous                     |
| Eggs                   | 60 µ, non bile stained                           |
|                        | Plano-convex with coiled embryo                  |
| Infective form         | Embryonated egg                                  |
| Mode of transmission   | Ingestion, Autoinfection                         |
| Site of localization   | Large intestine – caecum & appendix               |
Life cycle – *E. vermicularis*

1. Eggs on perianal folds
   Larvae inside the eggs mature within 4 to 6 hours.

2. Embryonated eggs ingested by human

3. Larvae hatch in small intestine

4. Adults in lumen of cecum

5. Gravid female migrates to perianal region at night to lay eggs

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Clinical features

- Due to migration of worm - Perianal, perineal & vaginal itching (pruritis) worsens at night.
- Insomnia and restlessness
- Nocturnal enuresis
Laboratory Diagnosis & Treatment

- Detection of adult worms in:
  - Feces
  - Perianal region

- NIH swab – scrapings from perianal region

- Microscopy – non bile stained eggs

- Mebendazole, pyrantel pamoate
<table>
<thead>
<tr>
<th><strong>Trichuris trichiura</strong> (Whip Worm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adult worm</strong></td>
</tr>
<tr>
<td><strong>Eggs</strong></td>
</tr>
<tr>
<td><strong>Barrel-shaped with Mucus plug</strong></td>
</tr>
<tr>
<td><strong>Unsegmented ovum</strong></td>
</tr>
<tr>
<td><strong>Infective form</strong></td>
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Life cycle

1. Unembryonated eggs passed in feces.
2. 2-cell stage
3. Advanced cleavage
4. Embryonated eggs are ingested.
5. Larvae hatch in small intestine

= Infective Stage
= Diagnostic Stage

Adults in cecum
Clinical features

- Infection – **Trichuriasis**

- Symptoms depend on worm burden
  - Less than 10 worms – asymptomatic
  - Heavier infections –
    1. chronic **profuse mucus and bloody diarrhea** with **abdominal pains** and edematous rectum
    2. malnutrition, **weight loss** and anemia
**Laboratory diagnosis & Treatment**

- **Stool examination** – bile stained eggs with bipolar mucus plugs
- **Treatment** – albendazole / mebendazole
- **Prevention** –
  - Proper disposal of night soil
  - Prevention of consumption of uncooked vegetables & fruits.
Key to the diagnosis of Intestinal Nematodes

Intestinal Nematodes

Larvae in Stool
- *S. stercoralis*

Eggs in stool
- Colored (Bile Stained)
  - *A. lumbricoides*
  - *T. trichiura*
- Colorless (Non Bile Stained)
  - *A. duodenale*
  - *N. americanus*
  - *E. vermicularis*

Eggs on Perianal Skin
- Colorless (Non Bile Stained)
  - *E. vermicularis*