

The Nematodes (Round worms)

- Small, round, elongated, Non-segmented worms with body cavity. They have **separate sexes**, usually **don't** need **an I.H** and do not multiply in human host because eggs don't hatch unless they leave the body first.
- Worms in the **juvenile, larval, or developmental** stages → Parasitize either an **intermediate host**
- Worms in the **adult** or in the **sexually reproductive** stage → Parasitize **final / definitive host**
- Infection pattern **vary widely**. Human intestinal nematodes infect via **food, water and soil borne** routes.
- People infected with Ascaris often show **no symptoms**. If symptoms do occur, they can be light and include **abdominal discomfort**. Heavy infections can cause intestinal **blockage** and impair growth in children. Other symptoms such as **cough** are due to **migration** of the worms through the body.

Ascaris Lumbricoids

- **Infect by eggs**, that are strongly resistant harsh conditions. Eggs have a **thick** mamillated **brownish shell**.
 - Freshly passed **eggs** with stool are **non-infective** they require weeks to develop to be embryonated (contain larva).
 - Ascaris lumbricoides is the **largest** nematode (roundworm) parasitizing the human **intestine**.
 - Humans can also be infected by **pig roundworm** (Ascaris suum). Ascaris lumbricoides (human roundworm) and Ascaris suum (pig roundworm) are indistinguishable.
- Pathogenicity:**
- If present in high numbers, adult worms may cause mechanical **obstruction** of the bowel and bile and pancreatic ducts.
 - Worms tend to **migrate** if drugs such as **anesthetics** or **steroids** are given, leading to bowel perforation and peritonitis, anal passage of worms, vomiting, and abdominal pain.
 - Larvae migrating through lungs induce an inflammatory response (**pneumonitis**), especially after second infection, leading to bronchial spasm, mucus production, and **Löffler syndrome** (cough, eosinophilia, and pulmonary infiltrates).

Enterobius Vermicularis

(Pinworm - intestinal nematode)

- Female pinworms have a slender, **pointed** posterior end. Males are **shorter** and have a **curved** posterior end.
- Pinworms are found **worldwide** but more commonly in **temperate** than tropical climates. They are among the **most common helminthic** infection and infect mostly children.
- Eggs are football shaped, have a **thin outer shell** with infectious larvae visible.
- Eggs are recovered using the “Scotch Tape” technique in the morning before a bowel movement.
- The main symptom associated with pinworm infections is **perianal pruritus**, especially at night, caused by a hypersensitivity reaction to the eggs that are laid around the perianal region by female worms, which migrate down from the colon at night.

Trichuris Trichiura

(Whipworm - intestinal nematode)

- Male worms are **smaller** than adult female whipworms. The anterior end of the worms is slender, and the posterior end is thicker, giving it a “buggy whip” appearance.
- Adult whipworms inhabit the **colon**, where male and female worms mate. Females release eggs that are passed in the feces, and eggs become infective after about 3 weeks of incubation in moist and shady soil.
- Whipworm eggs (50 µm) with distinct **polar plugs**.

<p>Ancylostoma Duodenale & Necator Americanus</p> <p><i>(Human hookworms - intestinal nematode)</i></p>	<ul style="list-style-type: none"> - Males are slightly smaller than Female hookworms, and males have a taxonomically characteristic copulatory bursa (broadened posterior end), which is used to mate with females. - Females can release more than 10,000 eggs per day into the feces, where a larva hatches from the egg within a day or two. - Eggs are oval, they hatch → the rhabditiform larva → filariform larva; which is the infective stage that penetrate skin and mucous membranes. <p>Pathogenicity:</p> <ul style="list-style-type: none"> - Larvae can survive in moist soil for several weeks, until barefooted host walk by → penetrate host skin → migrate throughout the host similarly to Ascaris → end up in the small intestine where they mature into adult worms. - In the intestine, adult worms attach to intestinal villi with their buccal teeth and feed on blood and tissue with the aid of anticoagulants. - A few hundred worms in the intestine can cause hookworm disease, characterized by severe anemia and iron deficiency. Intestinal symptoms also include: abdominal discomfort and diarrhea. - The initial skin infection by the larvae causes a condition known as “ground itch,” characterized by erythema and intense pruritus. - Feet and ankles are common sites of infection due to exposure from walking barefoot. 				
<p>Strongyloides Stercoralis</p> <p><i>(Human threadworm - intestinal and tissue nematode)</i></p>	<ul style="list-style-type: none"> - Adult females inhabit the intestine and are parthenogenic; that is, they do not need to mate with male worms to reproduce. - They lay eggs within the intestine; larvae hatch from the eggs and are passed into the feces. - These larvae can either develop into parasitic forms or develop into free-living male and female worms that mate and produce several generations of worm in the soil, a great example of an evolutionary adaptation to sustain a population. 				
<p>Tissue Nematodes</p>	<table border="1"> <tr> <td data-bbox="237 1230 428 1530"> <p>Trichinella Spiralis</p> </td> <td data-bbox="428 1230 1550 1530"> <ul style="list-style-type: none"> - Trichinella spiralis is acquired by eating raw or improperly cooked pork infected with the larval stage of these nematodes. - In the small intestine, the larvae → adult worms, and, after mating with male worms, the female worms release live larvae → The larvae penetrate the intestine, circulate in the blood, and eventually encyst in muscle tissue. - Adult female may cause diarrhea, abdominal pain, and nausea. Intestinal symptoms are mild to none and often go unnoticed. </td> </tr> <tr> <td data-bbox="237 1530 428 1957"> <p>Filarial</p> </td> <td data-bbox="428 1530 1550 1957"> <ul style="list-style-type: none"> - Adults are parasite, can be of the lymphatic system or connective tissue. They are thread like Filarial worms. - Female lay larvae but not eggs. - Larvae require an I.H to complete development resulting in the production of the infective stage. - Family Filariidae, members are: Lymphatic Filariasis: Wuchereria bancrofti & Brugia malayi (<i>Mosquitoes</i>) Subcutaneous Filariasis: Loa Loa (eye worm) day-biting flies & Onchocerca volvulus (black flies), River blindness. </td> </tr> </table>	<p>Trichinella Spiralis</p>	<ul style="list-style-type: none"> - Trichinella spiralis is acquired by eating raw or improperly cooked pork infected with the larval stage of these nematodes. - In the small intestine, the larvae → adult worms, and, after mating with male worms, the female worms release live larvae → The larvae penetrate the intestine, circulate in the blood, and eventually encyst in muscle tissue. - Adult female may cause diarrhea, abdominal pain, and nausea. Intestinal symptoms are mild to none and often go unnoticed. 	<p>Filarial</p>	<ul style="list-style-type: none"> - Adults are parasite, can be of the lymphatic system or connective tissue. They are thread like Filarial worms. - Female lay larvae but not eggs. - Larvae require an I.H to complete development resulting in the production of the infective stage. - Family Filariidae, members are: Lymphatic Filariasis: Wuchereria bancrofti & Brugia malayi (<i>Mosquitoes</i>) Subcutaneous Filariasis: Loa Loa (eye worm) day-biting flies & Onchocerca volvulus (black flies), River blindness.
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<p>Cont. Lymphatic Filaria</p>	<ul style="list-style-type: none"> - Members to be found in lymphatics, body cavities and subcutaneous tissues. - Progenies are embryos which are not fully developed (microfilariae), these are between eggs & larvae. - Microfilariae require an I.H which sucks them, the infection is transmitted by mosquitoes. - Causes Elephantiasis; result of parasitic infection caused by the filariid nematodes; <i>Wuchereria bancrofti</i>, <i>Brugia malayi</i>, and <i>Onchocerca volvulus</i>. are long, slender worms whose adult forms are found in tissues. The long thread like worms blocks the lymphatic system causing fluid to collect in tissues which lead to great swelling called 'lymphedema'. Limbs can swell so enormously that they resemble an elephant's foreleg in size texture and color.
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Platyhelminthes (Flat worms)

<p>Flukes (Trematoda)</p>	<ul style="list-style-type: none"> - Large sized trematodes in which the ventral sucker is near the anterior end. - Chinese/oriental Fluke: Clonorchis Sinesis - Sheep live Fluke (Fasciolidae): Fasciola Hepatica - Lung Fluke: Paragonimus Westermani
<p>Schistosoma <i>S. Mansoni, S. Japonicum & S. Haematobium.</i> (Blood flukes)</p>	<ul style="list-style-type: none"> - The adult worms are long and slender (females are longer than males) and can live for 10–20 years within the venous system. - S. Mansoni: Inferior mesenteric veins of large intestine. <ul style="list-style-type: none"> → Host: Biomphalaria Alexandrina, fresh water snails. → Eggs are round with a lateral spine. - S. Japonicum: Inferior and superior mesenteric veins of small intestine <ul style="list-style-type: none"> → Host: Oncomelania genus, fresh water snails. → Egg has a small curved rudimentary spine. - S. Haematobium: Veins of urinary bladder. <ul style="list-style-type: none"> → Host: Bulinus Tancatus, fresh water snails. → Eggs have a terminal spine. <p><u>Pathogenicity:</u></p> <ul style="list-style-type: none"> - The most significant pathology is associated with the schistosome eggs, not the adult worms. Female schistosomes can lay hundreds/thousands of eggs per day within the venous system. When eggs are released, many are: <ol style="list-style-type: none"> a- Swept back into the circulation and lodge in the liver (S. Mansoni & S. Japonicum). b- Or into the urinary bladder (S. Haematobium). c- Other eggs are able to reach the lumen of the intestine and pass out with the feces or urine. - S. Mansoni and Japonicum → A granulomatous reaction surrounds the eggs and leads to fibrosis of the liver. In chronic cases, blood flow to the liver is impeded, which leads to portal hypertension, accumulation of ascites in the abdominal cavity, hepatosplenomegaly, and esophageal varices. - S. haematobium → Urinary tract is involved; urethral pain, increased urinary frequency, dysuria, hematuria, and bladder obstruction leading to secondary bacterial infections.

Cestoda (Tapeworms)

- Flat-ribbon like chain of segments with **no mouth or digestive tract**. Adult worms are **hermaphroditic** and have a complex life cycle.
- Human acquire infection by eating **infected flesh**.
- Groups that infect Humans:

<p>Taenia saginata (beef tapeworm)</p>	<ul style="list-style-type: none"> - Worldwide, acquired by ingestion of contaminated, undercooked beef. - Causes: Cysticercosis, a common infection but causes minimal symptoms. - The adult T. saginata usually grows to be about 4-8 m in length with about 1000 segments (proglottids).
<p>Taenia solium (pork tapeworm)</p>	<ul style="list-style-type: none"> - Morphologically like T. saginata. But T. solium is slightly shorter and has a modified scolex. - The adult tapeworm grows to be about 6mm in width and 2-7 meter in length with about 800 proglottids. - Causes: Cysticercosis. <p><i>Cysticercosis is the presence of larval stage (cysticercus cellulosae) in human tissue. It is a systemic disease where cysticerci encyst in muscle and in the brain, may lead to epilepsy.</i></p>
<p>Echinococcus Granulosus (Hydatid cyst)</p>	<ul style="list-style-type: none"> - E. Granulosus is a small, three-segmented tapeworm found only in the intestine of dogs and other canids. But has important I.H such as livestock and humans where it causes hydatid cyst. - The adult tapeworm is about 5mm. - In humans, cysts containing the larvae develops after ingestion of eggs. Cysts forms primarily in the liver and the lung (hydatid cyst).
<p>Hymenolepis Nana (Dwarf tapeworm - intestinal cestode)</p>	<ul style="list-style-type: none"> - H. Nana, the dwarf tapeworm of humans (and rodents), is only about 4 cm in length. It is found worldwide and is one of the most common tapeworm infections in humans because the eggs can infect humans directly from eggs passed in feces of other humans (direct life cycle). - Alternatively, if the insect that harbors the larval stage is inadvertently eaten, the larvae develop into adult worms in humans (indirect life cycle). Humans can be infected in both ways. - Occasionally, massive infections, mostly in children, occur because of internal auto reinfection when the eggs hatch in the gut without leaving the intestine. Other than these instances of extremely heavy infection, disease caused by these worms is limited to minor intestinal disturbance.
<p>Diphyllobothrium Latum (Broad fish tapeworm - intestinal cestode)</p>	<ul style="list-style-type: none"> - Diphylobothrium latum, the broad fish tapeworm of humans (and many other fish-eating animals), reaches enormous size, sometimes exceeding 10 m in length. - Humans acquire the infection when they eat improperly cooked or raw fish that is infected with the larvae known as plerocercoids, which look like white grains of rice in the fish flesh. - In the intestine, the worm rapidly grows and develops a chain of segments capable of releasing more than 1 million eggs per day.

Major Points

- **Nematoda:** Developmental stage → I.H
Reproductive stage → D.H
- **Ascaris Lumbricoids:** Largest nematode, causes Loffler Syndrome.
- **Enterobius Vermicularis:** They are among the most common helminthic infection.
- **Ancylostoma Duodenale & Necator Americanus:** Causes hookworm diseases; anemia, diarrhea & ground itch. Feet and ankles are common sites of infection.
- **Strongyloides Stercoralis:** Females are infectious they don't need to mate.
- **Trichinella:** diarrhea, abdominal pain, and nausea.
- **Lymphatic Filaria:** Causes Elephantiasis.
- **Cestoda:** Has no mouth or digestive tract. Adult worms are hermaphroditic.
- **Taenia solium:** Cause Cysticercosis, shorter than T. saginata & has a modified scolex.
- **Echinococcus Granulosus:** Causes hydatid cyst.
- **Hymenolepis Nana:** One of the most common tapeworm infections.