Univ. of Mustansiriya
College of Pharmacy
Branch of Clinical Laboratory Sciences

Medical Parasitology

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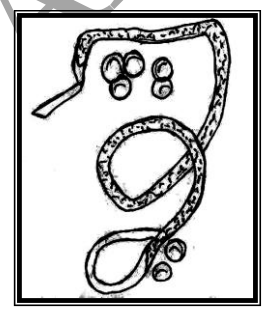
Lec. 8 Helminths

Phylum: Nematoda (or Nemathelminths)

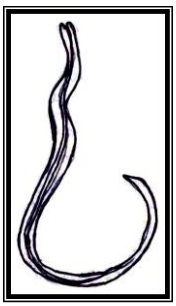
It is commonly known as thread worms. They are unsegmented typically elongate and cylindrical, with a fundamental bilateral symmetry. They have a complete digestive tract, dioecious with few exceptions (the nematodes are usually bisexual, however, in a few instances the female may be parthenogenetic). They range in size from minute, too small to be readily seen by unaided eye, to many centimeters in length and several millimeters in diameter. There are specialized structures at the anterior end of the body serve for attachment, penetration, and sensory purposes.

Generally, males are somewhat smaller than females and may be much smaller as in ***Dracunculus***. The life cycles are different from direct to indirect life cycles; require one or more intermediate hosts. The life cycle begins from the egg, embryo passing through many moltings inside or outside the egg, which leads to the growth and increase in size until it reaches to the infective stage (the third larval stage always) which infects the final host either by direct contact and penetration, or enter with the contaminated food or water. In the final host, the parasite either grows directly to reach the adult stage in the intestine, or start in a journey in the body organs until it returns again to the intestine to be adult their, after passing through fourth molting.

The first and second larval stages are rhabditiform, whereas the third larval stage (the infective stage) is filariform (strongyliform).



Microfilaria



Filariform larva.

Rhabditiform larva.

When the intermediate host is not involved, as in the majority of intestinal roundworms of man, there is a necessary period of development outside the body, frequently in soil,

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after there the larva in the egg, or free, become infective. Eggs freshly passed in the feces are not infective. The classification of the Nematodes dependent on the presence of organs called **phasmids**. **Phasmids** are pair of minute sense organs lay on minute papillae lay beside anus (or postanal) in position, it is believed that these organs are olfactory receptors. Accordingly, the phylum **Nematoda** or **Nemathelminths** divided into two classes:

I Class: Aphasmidia

Ex: 1 *Trichinella spiralis* (Trichina worm).
2 *Trichuris trichiura* (Whip worm).

II Class: Phasmidia

Ex: 1 *Ascaris lumbricoides* (Abdominal snake).
2 *Ancylostoma duodenale* (Hook worm).
3 *Necator americanus* (Hook worm).
4 *Strongyloides stercoralis*.
5 *Enterobius vermicularis* (Pin worm or seat worm).
6 *Dracunculus medinensis* (Medina worm).
7 *Wuchereria bancrofti* (Bancroft filaria).
8 *Loa loa* (Eye worm).

Class: Phasmidia

1. *Ascaris lumbricoides*

It's found in the small intestine of man and may be in other organs and causes Ascariasis. It may be the first parasite knew from the human. It's also called the abdominal snake (common name) because it is considered one of the tallest human nematode worms; therefore, sometime called the large round worm, it has world-wide distribution.

The worm is elongated, cylindrical, and tapers both anteriorly and posteriorly to relatively blunt conical ends. The mature female measures (20-35) cm in length by (3-6) mm in greatest diameter, but specimens up to (45) cm are occasionally observed. The sexually mature male worm measures (15-31) cm in length by (2-4) mm in greatest diameter. The female worms bigger in its thickness than male worms, it could be recognizing the male from the posterior end which is curved in the male and straight in female.

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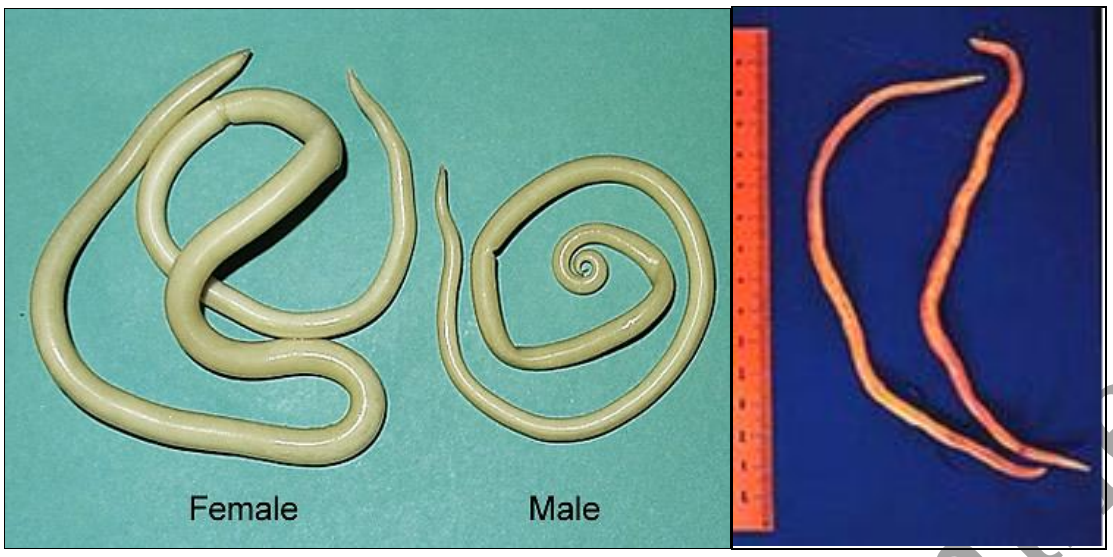

***Ascaris lumbricoides*: Adult worms.**

The worms are pink, the head provided with three fleshy lips, one broad, dorsal in position and a pair of ventrolateral lips, all of them are denticulate; the female genital opening lay in the end of the first third of the body, whereas the curved tail of the male has numerous papillae, and there is a pair of a structures called (copulatory spicules), equal or unequal in length.

Life cycle

The adult worms are found in the small intestine, they are feeding on the semidigested food, sometimes they bite the mucosa of the intestine by their denticulate lips and sucks the blood and the body fluids.

The daily egg production per female averages about (200,000). The egg (fertilized egg) at the time of oviposition is spherical or subspherical, measures in size (45-75) × (35-50)µ, and consists of the following observed structures:

1. A coarsely granular, spherical ovum that usually doesn't completely fill the shell.
2. A thin innermost membrane that is highly impermeable.
3. A relatively thick, colorless middle layer that is smooth on both inner and outer surfaces.
4. An outermost, coarsely mammillated, albuminoid layer laid down in uterus, serving as an auxiliary protective membrane.

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***Ascaris lumbricoides*, eggs.**

Female worms without males produce infertile eggs that are markedly subspherical. Internally they contain a mass of disorganized granules and globules that completely fill the shell. Both fertile and infertile eggs usually become tanned by the time; they are evacuated in the feces.

Fertile eggs are passed in one-cell stage. They survive putrefaction and can withstand considerable desiccation and cold. To start in development, they need a temperature less than that of the human body and a little humidity and O2, they are tolerant to the chemicals. At (22-33)˚C, development to the infective stage larva usually occurs in (3-4) weeks. Eggs may still viable in soil for more than a year.

The first larval stage (L1) produces in (10-14) days when the suitable conditions are available in the soil (shed, humidity, 22-33˚C temperature and O2) ,this larva passing through molting inside the egg and produce the second larval stage (L2) the infective stage in this case, on the opposite with other nematodes, but recently it is found that the larva inside the egg passing through two moltings, so the infective stage may be third stage (L3) as in the other nematodes.

When the human ingest the egg, the infective larvae hatch in the duodenum and penetrate the intestinal wall, enter the mesenteric venules or lymphatics, and via the liver, inferior vena cava or the hepatic duct reach the right side of the heart and pass through the pulmonary vessels to the lungs. On about the(9^{th}) of infection, after doubling their length in the tissues of the lung, they begin migration via the trachea, to the throat, pharynx, oesophagus, stomach to the intestine where they become sexually mature (8-12) weeks after exposure. The adult worms may live in the body up to (16-20) months, but usually they are passed spontaneously in about (12) months.

The most important method for infection is the entrance of the eggs to the mouth by the contaminated fingers especially in the children, also the drinking of the contaminated water.

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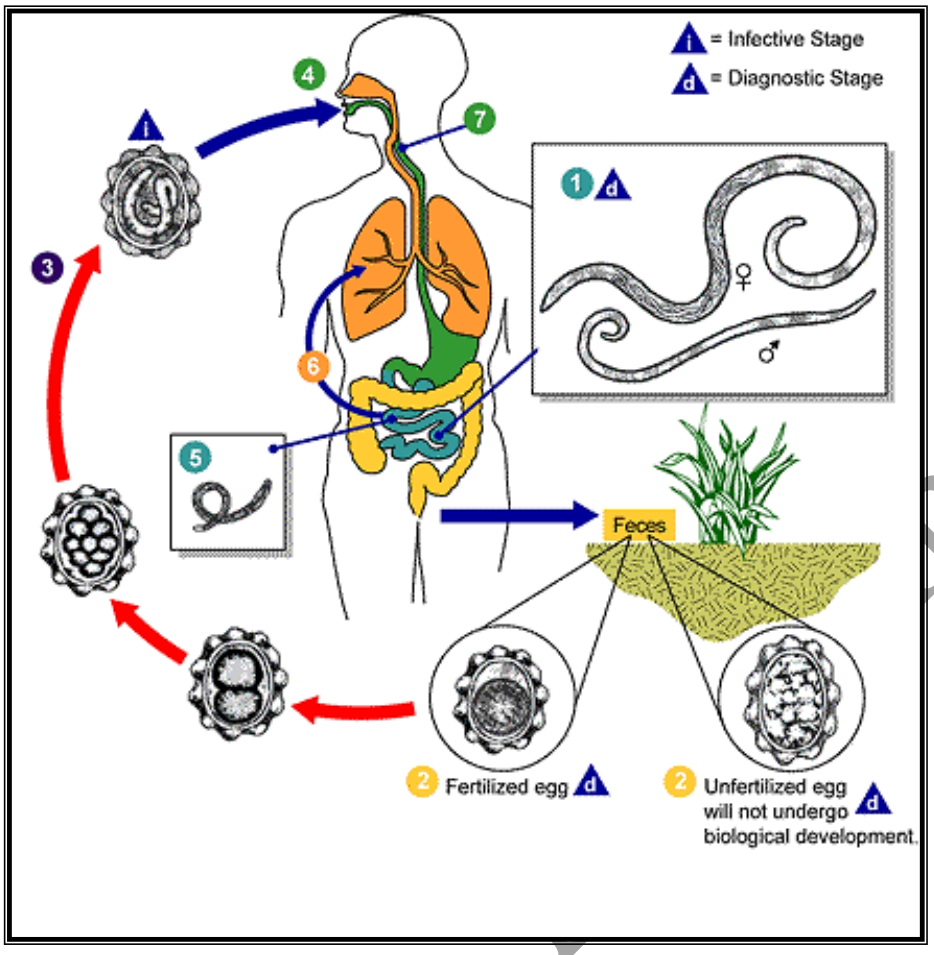
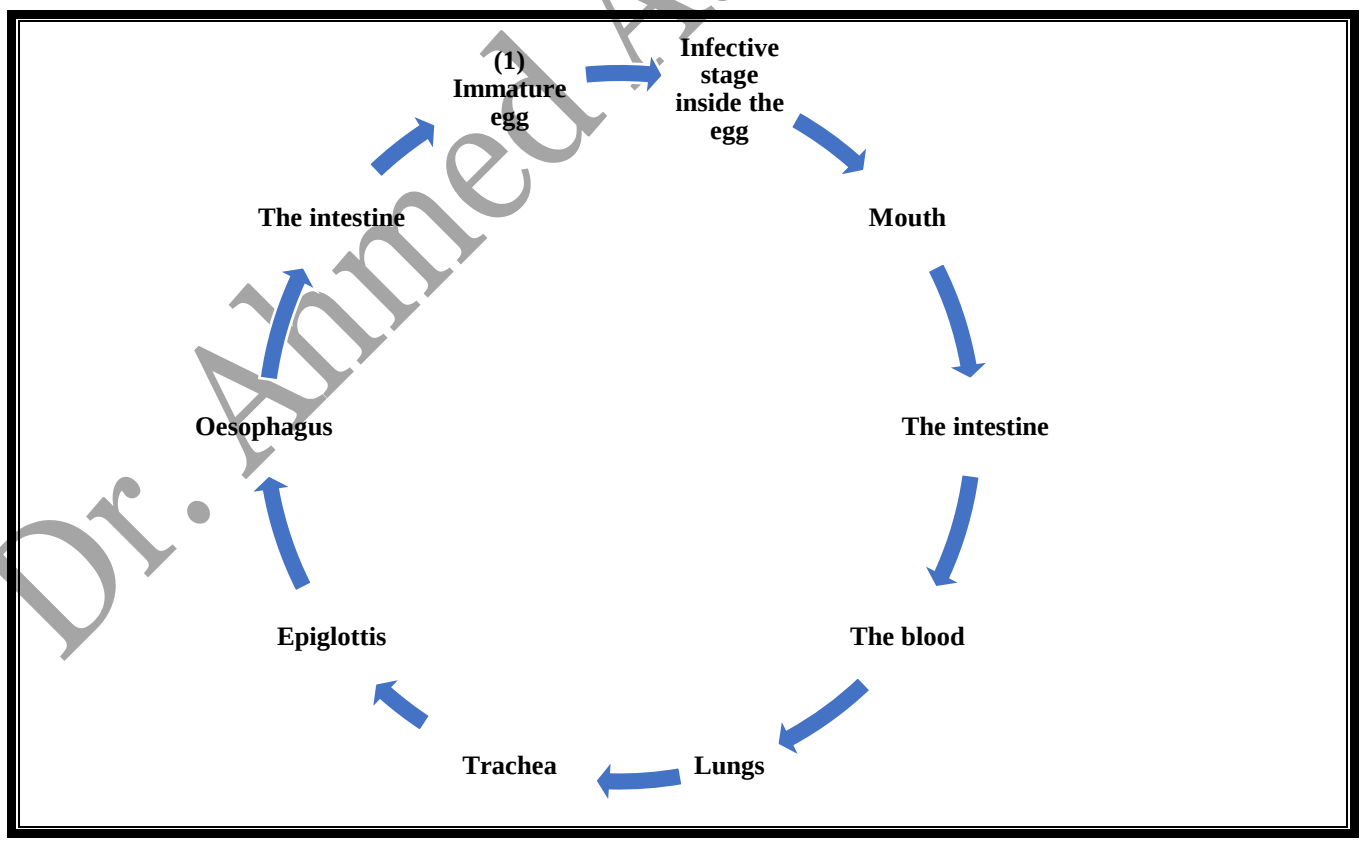


"Diagram for the life cycle of *Ascaris lumbricoides*".



"Scheme for the life cycle of *Ascaris lumbricoides*".

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Pathology and Symptoms

The infection causes Ascariasis, the infection with (10-20) worms considered normal infection, and mostly lasting without recognition for the infection from the patient. The feces examination detects the worms which exit with the feces of the infective persons spontaneously. The pathogenicity in the severe infections may be leads to dangerous symptoms as the following:

A. Juvenile larvae:

There is a slight injury caused by the larvae when they penetrate the mucosa of the intestine. They cause a little bleeding when they penetrate the pulmonary capillaries, but in the acute infection they cause blood aggregation that leads to oedema and obstruction of the air vesiculates. Many larvae may be reaches to the left side of the heart (especially in the heavy infections) and transmittal to the body organs and tissues, ex: the spleen, liver, lymph nodules and brain where they cause inflammations and other pathological changes. The larvae could also reach to the fetus transplacentally.

B. Adult worms:

The adult worm may be discomforting its host as an abdominal pain associated with vomiting, diarrhea and simple elevation of the body temperature, and sometimes the infected person feels out the mild infection. If the worms in the heavy infection discomforted by eating unsuitable foods or because of the drugs, they curve themselves around others and causes the obstruction of the intestine which leads to the death, and sometimes obstruct of the vermiform appendix.

A mass of convoluted adult Ascaris worms

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It is noted that there are chemical substances inhibits the trypsin enzyme action and prevent the digestion of the proteins and disturb the beneficiation from these important substances. It is noted also that the infected children become shorter and less memory than the non-infected children.

These worms may invade the pancreatic and bile ducts causes the obstruction, or either enter the liver; they may invade the peritoneum causes peritonitis which leads to the death rapidly, and either reaches to the urogenital system.

The metabolic products of the worms cause abdominal pain and sensitization appears as pruritus and rush. The worms sometimes exit from the mouth during the sleeping; the worms that reaches to the oesophagus may be enter the trachea causes obstruction also and damage in the lungs. It may also be causing a damage in Eustachian tube.

Diagnosis

By the detection of the eggs (warty eggs) in the feces, or the detection of the adult worms by the X-ray, and also the detection of the larvae in the sputum. The recommended procedure is as follows:

1. Collect a stool specimen.
2. Fix the specimen in 10% formalin.
3. Concentrate using the formalin–ethyl acetate sedimentation technique.
4. Examine a wet mount of the sediment.

Where concentration procedures are not available, a direct wet mount examination of the specimen is adequate for detecting moderate to heavy infections. For quantitative assessments of infection, various methods such as the Kato-Katz can be used. Larvae can be identified in sputum or gastric aspirate during the pulmonary migration phase (examine formalin-fixed organisms for morphology). Adult worms are occasionally passed in the stool or through the mouth or nose and are recognizable by their macroscopic characteristics.

Treatment: Mebendazole.

2. *Ancylostoma duodenale* (Hook worm)

This parasite (worm) causes a disease called Ancylostomiasis and also (old world hookworm). The infection has a world-wide distribution. The adult worms are found in the small intestine of man, hanging on the mucosa, feeding on the blood and tissue fluids.

The living adult worms are pinkish in color, their body is narrow anteriorly with curved head dorsally. The buccal cavity is wide and ovoid in shape; the cup-shaped mouth

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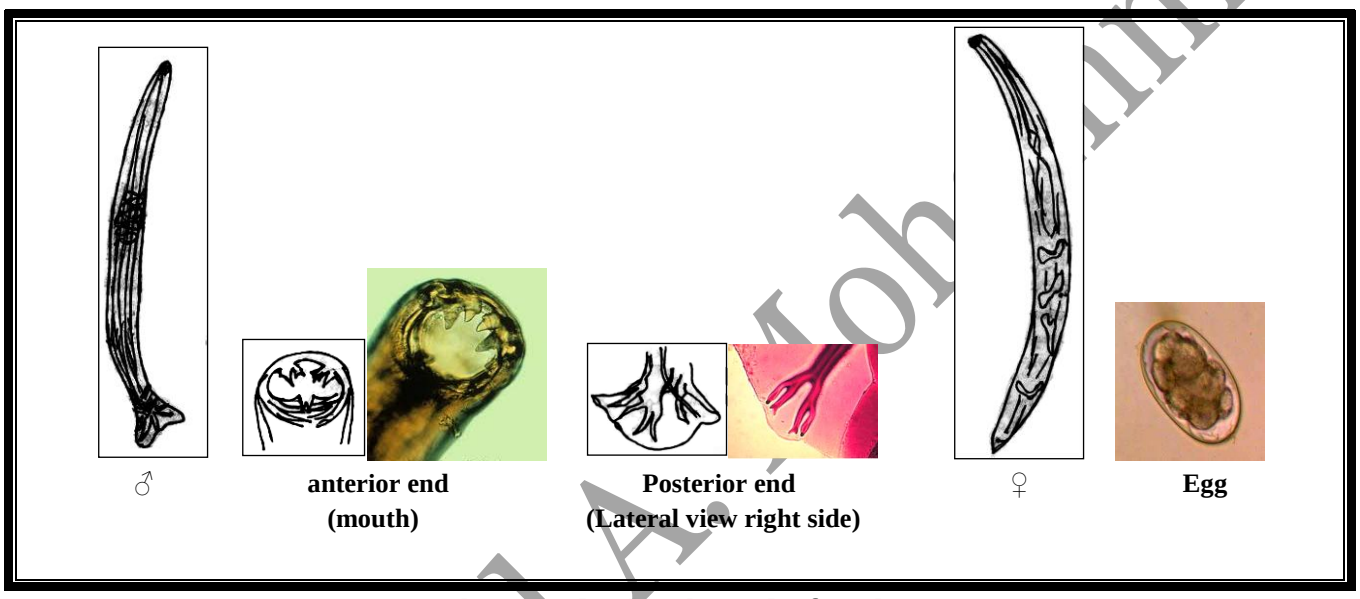
capsule is heavily reinforced and provided with two pairs of prominent, slightly curved subequal teeth from the anterior ventral side, and a third rudimentary pair on either side of the median ventral line. In the depth of the capsule, there is a pair of small teeth. Dorsally there is a plate with a median cleft (dental plate with a median cleft).

The adult worms are cylindrical, the male 8-11mm in length by 0.4-0.5mm in breadth. Its copulatory bursa is considerably broader than it is long and is supported by a ray. The female 10-13mm in length by 0.6mm in breadth. The anus lies ventrally near the caudal tip and the vulvar opening (female genital pore) is situated midventrally at the beginning of the posterior third of the body.



***Ancylostoma duodenale*: male, female, egg.**

Life cycle:

Each female worm lays up to 25.000-30.000 eggs daily. The broadly ovoid eggs average 60 by 40µ have a thin, transparent shell, and are in 2-8 cell stage of cleavage when evacuated. Embryonation to the first rhabditoid larval stage takes place in 24-48hrs on moist sandy loam in a shaded environment at an optimal temperature of about 25ºC. The rhabditoid larva is molting to produce the strongyliform larva which is feeding on the bacteria and other substances found in the feces. It grows rapidly, passing through two moltings and become filariform larva (the infective larva). The filariform larva migrates to the superficial layer of the soil, waiting a chance to be in contact with human skin to penetrate it and reach to the blood or lymph, migrate to the heart, lungs, pharynx and intestine attached to the villi, then molt once more and attach to the mucosa and growing to adult male and female worms in 5 weeks after their entrance to the body. The infection through foods and water contaminated with eggs is also possible.

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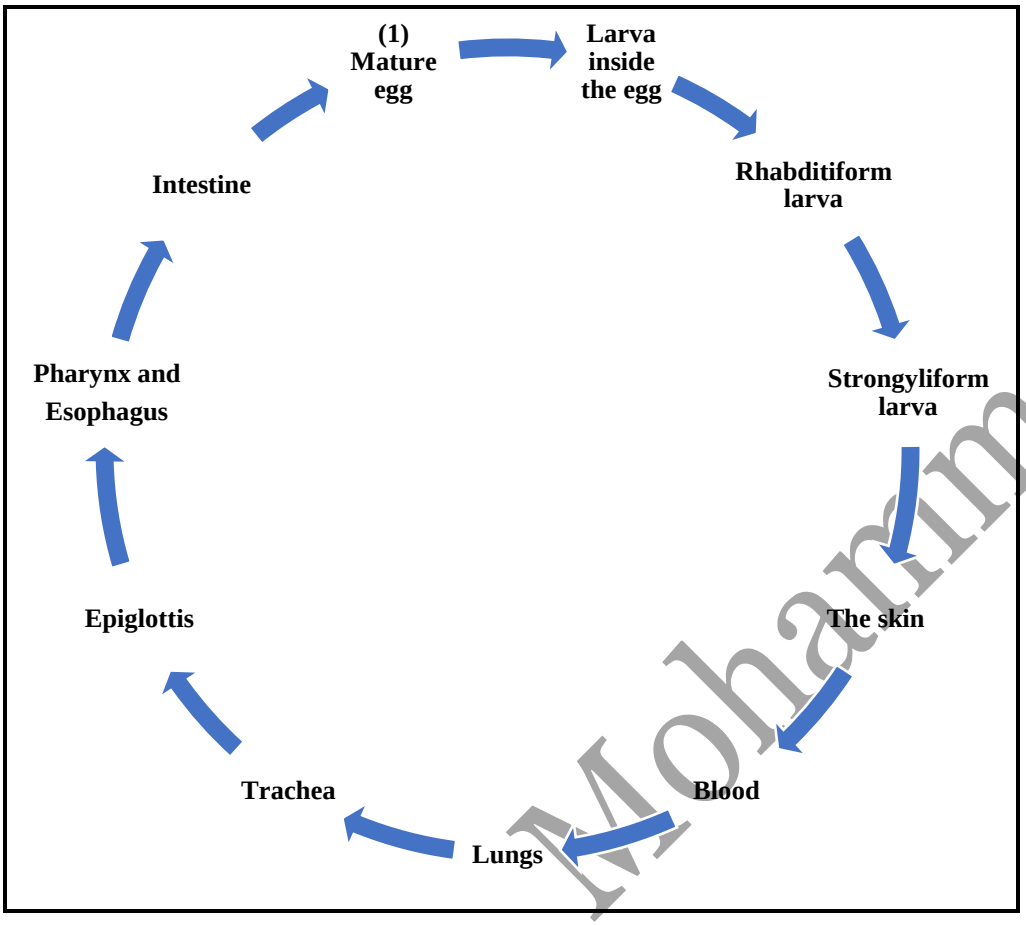

"A Scheme for the life cycle of *Ancylostoma duodenale*".

Pathology

The pathogenicity depends on the number of worms, the infective stage or phase and the feeding of the infected person, as in the following:

1. Cutaneous phase (the skin lesion):

At the site of entry on the feet, arms or other surface areas the larvae usually produce a popular eruption. This phase starts soon after the larval penetration to the skin, it causes mechanical injury in the skin layers because it slip through the spaces of the skin or enter the hair follicles which may cause the entry of the pathogenic bacteria with it and leads to inflammation with itch called ground itch, this phase short if the secondary infection with bacteria absent.

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2. Pulmonary phase (larval migration through the lungs):

It occurs when the juveniles exit from the blood vessels to the follicles then to the trachea and throat. This is lead to bleeding and its dangerous depends on the number of the juveniles; this is occurring in the acute infections and may lead to death. This phase always asymptomatic except the acute infections which are accompanied by dry coughing, sore throat and pneumonitis.

3. Intestinal phase:

It is the important phase. When the juveniles reach to the intestine, they stick themselves in the mucosa through the buccal cavity and the teeth, starts with feeding on the blood. This phase accompanied by nausea, slight abdominal pain, anorexia and sometimes diarrhea. But the main symptom is the anemia which results from the continuous blood sucking. The continuity of blood lose leads to lose most the body iron and large amounts of protein which leads to erythrocytopenia. The R.B.Cs. become smallest and the haemoglobin less than that of normal R.B.Cs. The worm sucking about 0.5cm3 of blood daily and about 200cm3 daily in the acute infection. Oedema around the eye and the lower limbs may be associated. There is also eosinophilia with Charcot-Leyden crystals in the feces appear during the late prepatent period. The infection is very dangerous during pregnancy because the infant requirement for protein and iron will increase.

Symptoms

In the acute cases resulting from single heavy exposure, there is characteristically a prodromal syndrome of nausea, headache and irritating cough (during lung migration of larvae). In the middle to late prepatent and early patent periods (29-38 days), there are frequently sever colicky pains, flatulence, diarrhea, loss of weight, dyspnea, dizziness and marked pallor. During this period there is an eosinophilic leukocytosis that may persist at a significantly high level for several months.

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In chronic hookworm disease, the signs and symptoms are essentially those of iron-deficiency anemia. Signs present in varying degrees are pallor, facial and pedal oedema, dull expression and listlessness. Haemoglobin levels may be reduced to 5g/dl or lower, and the heart is greatly enlarged. In children, mental and physical development may be markedly retarded.

In addition, local skin manifestations "ground itch" can occur during the penetration of the filariform (L3) larvae.

Diagnosis

It is based on the detection of eggs in the feces. Examination of the eggs cannot distinguish between Necator americanus and A. duodenale. Larvae can be used to differentiate between N. americanus and A. duodenale, by rearing filariform larvae in a fecal smear on a moist filter paper strip for 5 to 7 days. Occasionally, it may be necessary to distinguish between the rhabditiform larvae (L2) of hookworms and those of Strongyloides stercoralis.

Treatment

In light to moderate hookworm infections in which the anemia is not severe, specific treatment can usually be undertaken without a preliminary period of supportive treatment. For individuals with low haemoglobin levels, it is desirable to prescribe a diet rich in animal proteins for a week to 10 days before the specific chemotherapy. Iron must also be administered to replace that which is lost during the intestinal haemorrhage caused by the worms. Rarely, a whole blood transfusion may be needed.

The most effective drug without significant side effects is probably Mebendazole. Pyrantel pamoate is also effective. One or two weeks after treatment, a follow-up stool examination should be made. If necessary, retreatment may be undertaken in a week to remove the remaining worms.

3 *Enterobius vermicularis* (pin worm/or seat worm)

It may be the most common parasitic nematode worm of man. It is a small worm found in the large intestine of man and causes Enterobiasis or Oxyuriasis. It is called (pin worm) or (seat worm), has been Known since ancient times. It has a cosmopolitan distribution but is more common in cold or temperate zones than in tropical areas.

Adult worms characterized by its spindle shape, the mouth of the adult worm have (3) lips and the anterior end of the worm bears dorsal and ventral bladderlike inflations that can be thrust forward to form a vestibule around the mouth.

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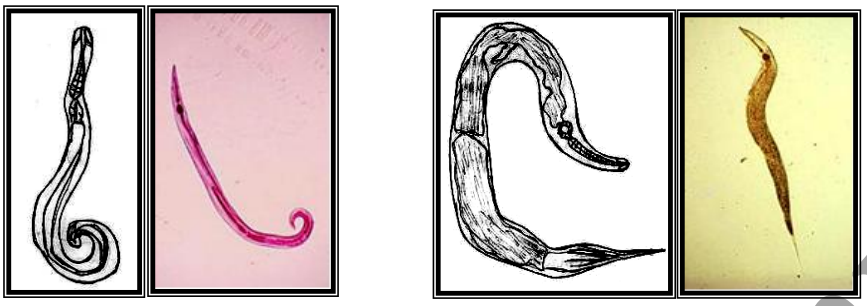
The male worm measures (2-5)mm long and (0.1-0.2)mm width. With its strongly curved posterior end, the lateral view of the worm forms an inverted question mark.

The female is considerably longer than male, having a length of (8-13)mm and (0.3-0.5)mm width. The sharply pointed postanal portion is nearly a third of the total length.



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***Enterobius vermicularis*: male and female worm.**

The male has a copulatory spicule about (70)µ in length, and caudal alae as well as the papillae, the males always less in number than female worms and rarely seen. The posterior part of the female is the cause of the name (pin worm).

Life cycle:

The characteristic habitat of these worms is the ileocecal region (cecum & appendix), but generally, they are crawling along the digestive tract from the stomach to the anus hanging on the mucosa where they are feeding on the epithelial cells and the bacteria. After the fertilization the males die and the detection of the males become difficult and rare; it must use a purgative for this purpose. When the female body become filled with eggs it become free in the intestine and migrates to the rectum and exits through the anus during the night (during the host's sleep or relaxation), and lays-up its eggs on the skin of the perianal region, sometimes the eggs exits with the feces.

The eggs are elongated, oval and flat from one side; it measures (50-60) × (20-30)µ, with a colorless double shell, an inner membrane, and an outer albuminous layer that causes them to stick to each other and to clothing and other objects. The female lays-up (4000-16000) eggs then die after the egg laying.

"Egg of *Enterobius vermicularis*"

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The eggs require about (6) hrs. in the body temperature to complete the larval growth which is found inside it. The eggs resist the putrefaction, disinfectants and still alive for about one week in a humid, cold weather. They need not an intermediate host, the infection occurs always throughout the ingestion of the mature eggs which contain the 3rd stage larva (L3) that is hatching in the duodenum; the larva will be free in the small intestine, passing through molting two times before the transformation to the adult worms when they reach to the cecum. The life cycle from the egg to the mature worms lasting for (16-43) days**.**

Mode of infections:

1. The most common method for infection is the **direct infection** from the anus to the mouth throughout the contaminated fingers, the migrant worms outside the anus causes pruritus over the perianal and sticks under nails and reach to the mouth, also the infection occurs through the contaminated beds and any other contaminated objects used from an infected person.

2. The eggs are very light, so they are very simple in spreading in the air during the cleaning of the beds and the clothes of the infected individuals, so the second method for infection is the **inhalation of the eggs** which found in the air with the dust.

3. The third method called the **retroinfection**, where the infection occur in the same individual, it occurs when the skin crypts of the perianal region is not clean for a long time, and the aggregated eggs may hatch and the larvae migrates to the intestine and grows to adult worms.

Pathology and Symptoms

The first recognizable symptom usually is pruritus as the worms emerge from the anus and crawl over the perianal and perineal skin. Itching is followed by scratching, which adds to the irritation, with scarification or weeping eczema of the area.

Because worms in various stages of development are seen in the appendix and occasionally are found deep in the inflamed mucosa, pinworms often are suspected of causing appendicitis. At times worms enter the females' genital tract and become encapsulated within the uterus or fallopian tubes or wander into peritoneal cavity and become encapsulated in the peritoneum. Rarely, they have been found in granulomata in the parenchyma of the lungs and liver. The common symptoms in children, in addition to pruritus ani, consist of restless sleep and tiredness during the daytime. The blood picture in pinworm infection is unremarkable.

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Diagnosis

Specific diagnosis made on recovery of the worms from the perianal area or following an enema, but more frequently it is made on demonstration of the eggs at the anus. Occasionally eggs are found in the feces.

The cellophane tape technique is used for the detection of pinworm eggs from around the anus and has been demonstrated to be the most satisfactory. It is doing by pressing a transparent adhesive tape (cellulose-tape) on the perianal skin and then examining the tape placed on a slide. This preparation is more likely to be positive when perianal impression specimens are taken in the early morning before defecation or a shower or bath.

Alternatively, anal swabs or "Swab tubes" (a paddle coated with adhesive material) can also be used. Eggs can also be found, but less frequently, in the stool, and occasionally are encountered in the urine or vaginal smears. Adult worms are also diagnostic, when found in the perianal area, or during ano-rectal or vaginal examinations.

Treatment

1. Mebendazole.
2. Pyrantel pamoate.
3. Piperazine hexahydrate.

All of them effective without important side effects.

4. Thiabendazole is also effective but causes nausea and vertigo.

Important notes:

1. It is often desirable to treat the entire family group at the same time.
2. Treatment should be repeated after about (2) weeks to eliminate worms acquired from eggs persisting in the environment after the initial treatment.
3. Patients and parents should be made aware of the probability of reinfection, which should not be mistaken for treatment failure.
4. During the treatment it should be make an examination for the feces daily for (7) days more to ensure the recovery.

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