



Nematode

Introduction to Medical Helminthology

- Medical helminthology : the study of parasitic worms (helminthes) affecting man, which :
 - Spend part or the entire life cycle in a human host
 - Animal parasite causing disease in human

Introduction

general characteristic

- Among the commonest of all parasites and responsible for diseases of major importance in humans
- Non-segmented roundworms belonging to the Phylum Nemathelminthes, Class Nematoda
- The sexes are usually separate (Dioecious), the male which is smaller than the female commonly has a curved posterior end

- Cylindrical and slender
- Bilaterally symmetrical
- Sex-differentiated
- Celomic cavity: protocoel
- The supporting body wall consists of cuticle layer, syncytial layer (subcutical layer) and longitudinal muscular layer
- The alimentary tract is a simple tube extending from the mouth to the anus

Common medical nematodes species

- Intestinal lumen residing nematodes:
 - Ascaris, Hookworm, Whip worm, Pinworm----the adult parasite inhabit in human intestinal tract
- Blood and tissue residing nematodes:
 - Filaria, Thichinella----the location of the adult parasite is blood or tissue

Nematodes Life cycle

- ❑ **Transmission to a new host :**
 - ✓ **Ingestion the mature infectious egg or larva**
 - ✓ **Penetration of the skin or mucous membranes by the larva**
- ❑ **Some species have an intermediate host – usually an arthropod**
- ❑ **The same animal both the definitive and intermediate host of *Trichinella spiralis***
- ❑ **Nematodes, do not multiply in man**

***Nematodes* Pathogenicity**

- ❑ The effect of parasitic nematodes upon the host depends upon : species, the intensity of the infection and the location of the parasite
- ❑ Simultaneous infection with several species of intestinal nematodes is common in tropical and subtropical countries
- ❑ Injury may be produced by adult and larval parasites
- ❑ Intestinal parasites produce less local and systemic effect than tissue parasites

***Nematodes* Pathogenicity**

- ❑ **The local reaction from intestinal parasites result from irritation, invasion of the intestinal wall and occasionally penetration to extraneous site**

The local reaction in the liver, lungs (and other) – may destroy or encapsulate the larvae

- ❑ **The degree of local reaction – depend upon the sensitivity of the host to the protein product of the parasite**

Intestinal mucosa is damaged by biting and bloodsucking, by lytic ferment secreted by the parasite and by mechanical irritation

Pathogenicity

- ❑ The general reaction are produced by loss of blood, absorption of toxin, nervous reflexes and proteic sensitization
- ❑ The larvae of certain species, produce local and general reaction
- ❑ In unnatural host the larvae may be pass through their invasive stages, never become established as adult parasite – paratenic host
- ❑ Immunity is acquired through the invasion of the tissues by the parasite and its larvae or through the absorption of its products
- ❑ Immunity is both humoral and cellular

NEMATODES

☐ Soil Transmitted Helminthes

- ✓ *Ascaris lumbricoides*
- ✓ *Trichuris trichiura*
- ✓ Hookworm (*Necator americanus*,
Ancylostoma duodenale)
- ✓ *Strongyloides stercoralis*

← Important

☐ Non-Soil Transmitted Helminthes

- ✓ *Enterobius vermicularis*
- ✓ *Trichinella spiralis*

☐ Filaria and Dracunculus

- ✓ *Wuchereria bancrofti*
- ✓ *Brugia malayi*
- ✓ *Brugia timori*

← Important

Disease caused by Soil transmitted helminthes
: DEFINITION Soil transmittedhelminth

**NEMATODE WORMS WHICH REQUIRE
PERIOD OF DEVELOPMENT AND
MATURATION DURING ITS LIFE
CYCLE ON SOIL**

IMMATURE

INTO

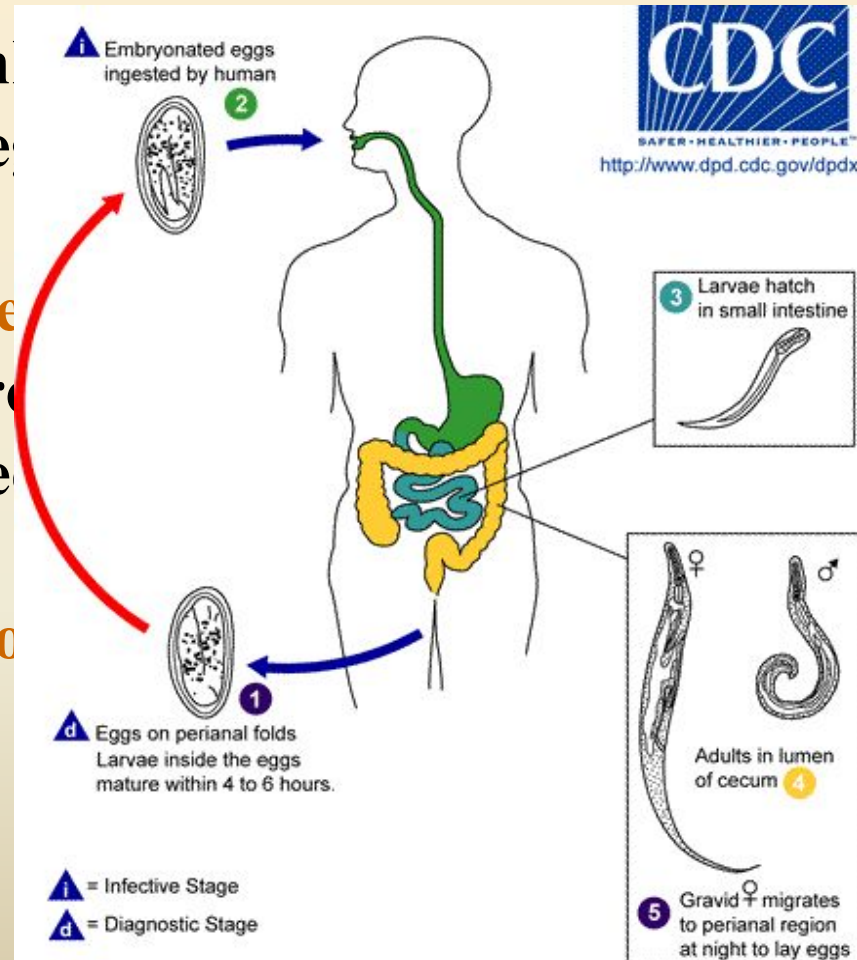
INFECTIVE

Life Cycle

• Adults in
Female lay e

No interme
takes are
mature

Mode of



Pathogenesis

The migratory phase of the pinworm is restricted to the gastrointestinal tract and thus the host does not experience any systemic reactions .1

Perianal itching may be complicated. Heavy infections in children may also produce such symptoms as sleeplessness, weight loss, hyperactivity, grinding of teeth, abdominal pain, and vomiting .2

Ectopic parasitism may happen, which can cause uro-genital inflammations or even the pelvic cavity .3
.be involved occasionally



Laboratory Diagnosis

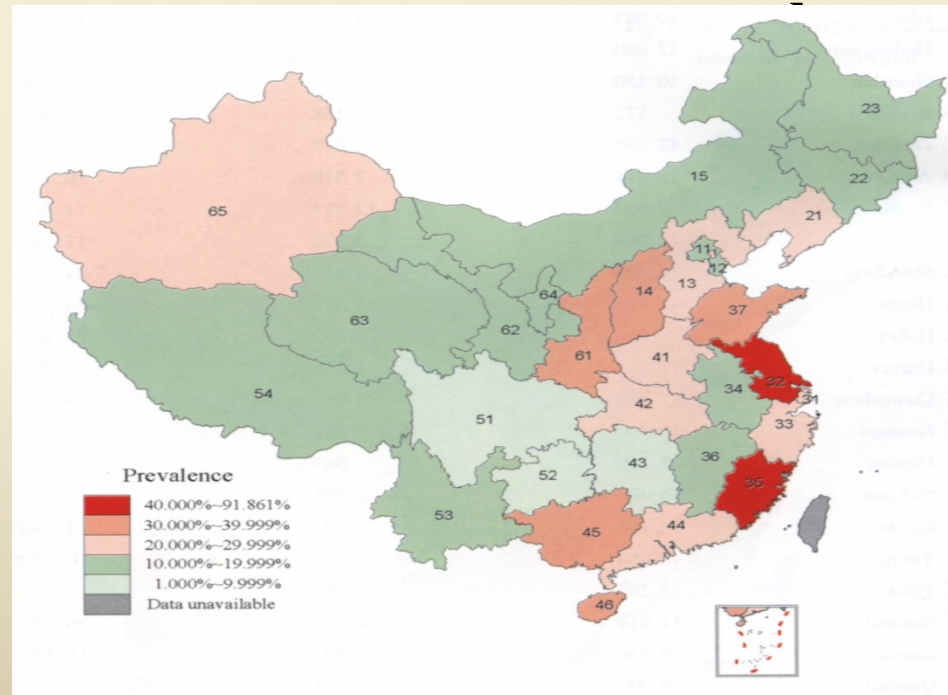
:Anal swab method

Cotton swab

Cellophane tape

Epidemiology

Endemic in children concentrated units. There is no differences on the basis of sex, race, or socio-economic



Principles of Control

Chemotherapy .1

Personal Sanitation .2



Ascaris lumbricoides

DISTRIBUTION

- **Cosmopolitan**
- **Prevalence 70-90 %**
- **Primarily affects under fives and school children**

HABITAT

- **Lumen of the intestine :**
 - **Jejunum**
 - **Media ileum**



Source : Dept. of Parasitologi FKUP, 1999

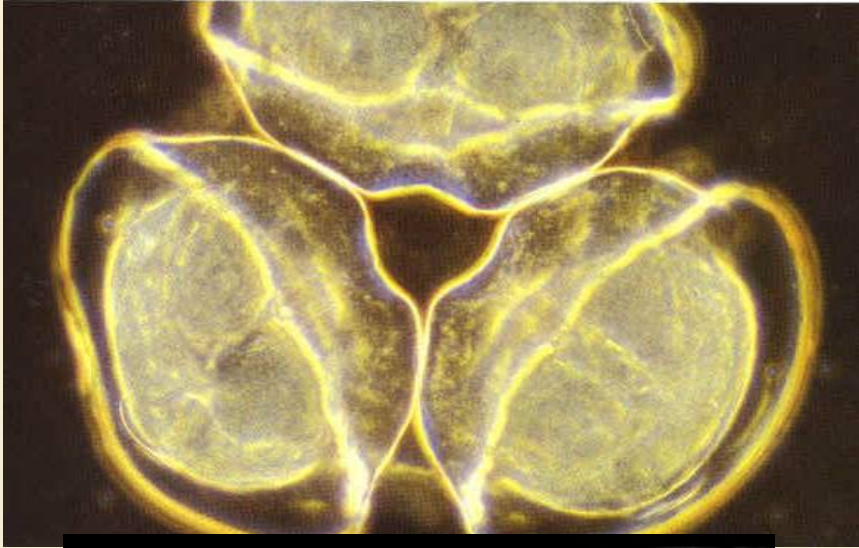
Adult worms expelled after deworming



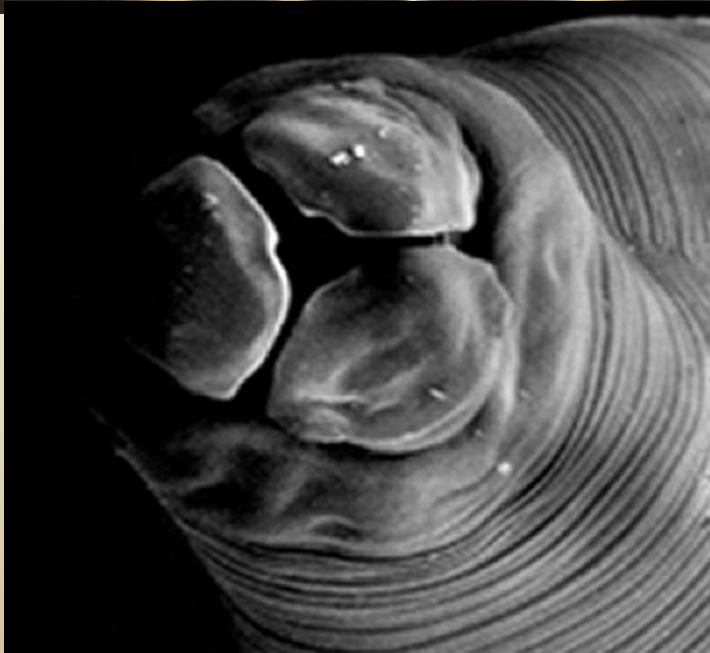
Source : Color Atlas of Medicine and Parasitology. 1977
.Peters W. & Gillers H.M



The lips of *A. lumbricoides*



The three lips are seen at the anterior end. The margin of each lip is lined with minute teeth which are not visible at this magnification



Ascaris lumbricoides and *Ascaris suum*
(intestinal roundworms of humans and pigs)

:Introduction

Ascaris lumbricoides is one of the largest and most common parasites found in humans. The adult females of this species can measure up to 25 cm long (males are generally shorter), and it is estimated that 25% of the world's population is infected with this nematode.

Life Cycle

- **Site of inhabitation: small intestine**
- **Infective stage: embryonated eggs**
- **Route of infection: by mouth**
- **Blood-lung migration: intestine--- blood stream --- right side of the heart --- lung --- respiratory tree --- coughed up and swallowed --- small intestine**

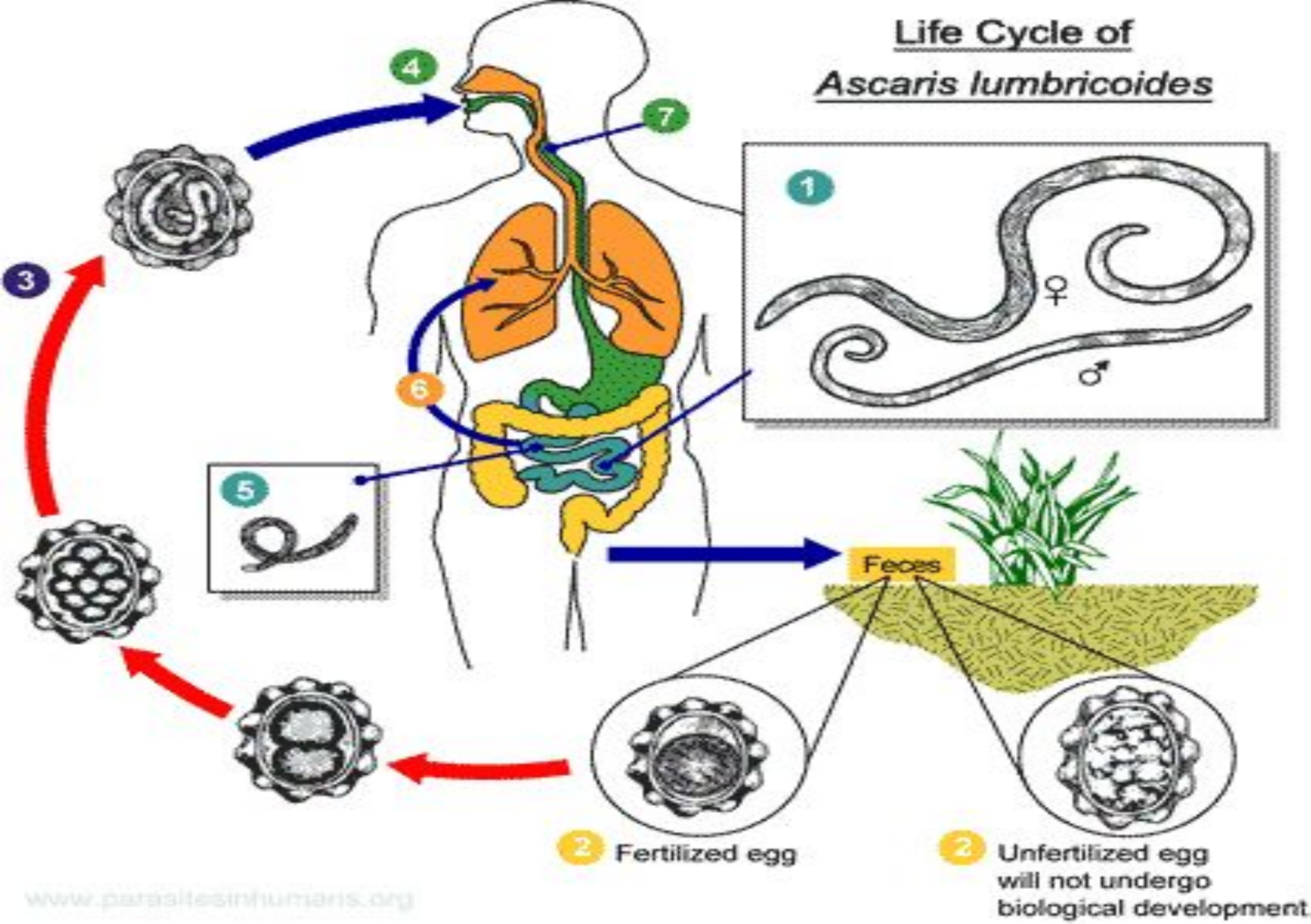
Life Cycle

- **No intermediate and reservoir hosts**
- **The time from the ingestion of embryonated eggs to oviposition by the females is about 60-75 days**
- **Life span of the adult: about 1 year**
- **Female may produce approximately 240,000 eggs per day, which are passed in feces**

● **Life cycle:**

- - The adult worms live in the small intestine and eggs are passed in the feces. A single female can produce up to 200,000 eggs each day
- - About two weeks after passage in the feces the eggs contain an infective larval or juvenile stage, and humans are infected when they ingest such infective eggs.
- - The eggs hatch in the small intestine, the juvenile penetrates the small intestine and enters the circulatory system, and eventually the juvenile worm enters the lungs.
- - In the lungs the juvenile worm leaves the circulatory system and enters the air passages of the lungs.
- - The juvenile worm then migrates up the air passages into the pharynx where it is swallowed, and once in the small intestine the juvenile grows into an adult worm. **Why *Ascaris* undergoes such a migration through the body to only end up where it started is unknown.** Such a migration is not unique to *Ascaris*, as its close relatives undergo a similar migration in the bodies of their hosts

Life Cycle of *Ascaris lumbricoides*



Morphology

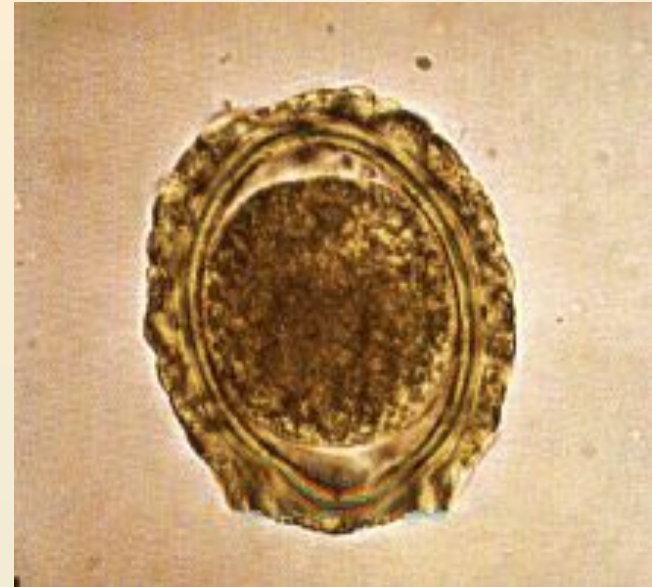
Egg

- **There are three kinds of the eggs**
 - fertilized eggs
 - unfertilized eggs
 - decorticated eggs
- **We usually describe an egg in 5 aspects**
 - size, color, shape, shell and content

Morphology

- **Fertilized egg:**

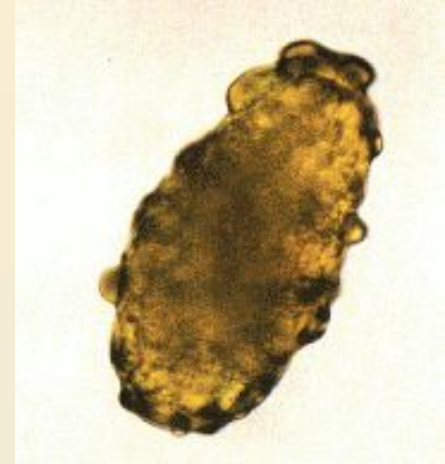
- **an average size $60 \times 45 \mu\text{m}$**
- **broad oval in shape**
- **brown in color**
- **The shell is thick**
- **Albuminous coat is thick and stained brown by bile**
- **The content is a fertilized ovum**
- **There is a new-moon(crescent) shaped clear space at each end inside the shell**



Morphology

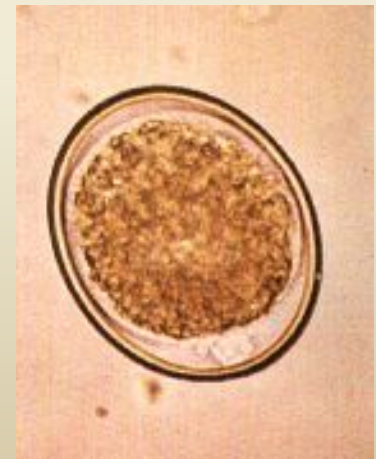
● Unfertilized egg

- Longer and slender than fertilized egg
- The shell and albuminous coat are thinner than those of the fertilized egg
- The content is made of many refractile granules various in size



● Decorticated egg:

- Both fertilized and unfertilized eggs sometimes may lack their outer albuminous coats and are colorless



Ascaris lumbricoides

PATHOGENESIS AND CLINICAL SYMPTOMS

Disease ; Ascariasis

Complaints due to direct effect

Larva ^{by} (1)

- Allergic manifestation : urticaria, swollen lips, asthma attack
- Loffler Syndromes :
 - Ascaris pneumonia (coughing)
 - Hyper-eosinophilia
 - Thorax X-ray : temporary white spots
- Larva migration

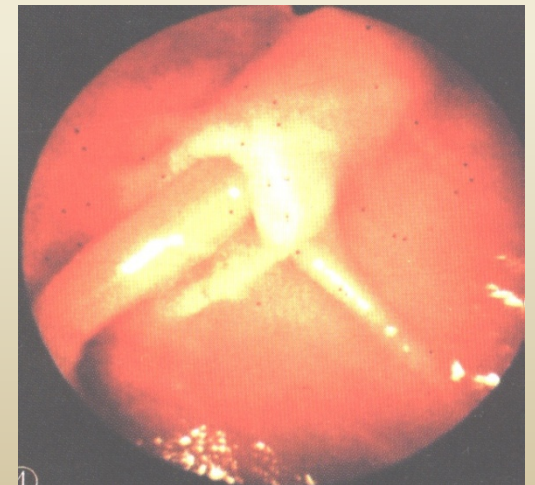
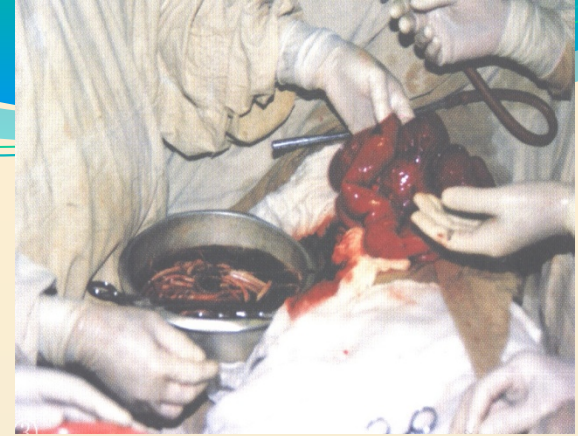
Pathogenesis

1. The blood-lung migration phase of the larvae: During the migration through the lungs, the larvae may cause a **pneumonia (temporary)**.
 - The symptoms of the pneumonia are low fever, cough, blood-tinged sputum, asthma
 - The clinical manifestation is also called **Loeffler's syndrome**

Pathogenesis

2. The intestinal phase of the adults

- No symptoms to vague abdominal pains or intermittent colic, especially in children
- A heavy worm burden can result in malnutrition
- Wandering adults may block the appendical lumen or the common bile duct and even perforate the intestinal wall which cause complications of ascariasis:
 - intestinal obstruction
 - Appendicitis
 - biliary ascariasis (the most common one)
 - perforation of the intestine
 - cholecystitis, pancreatitis and peritonitis



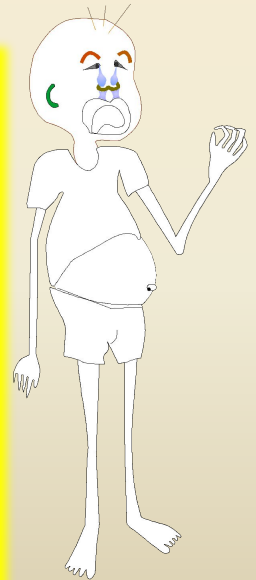


Ascaris lumbricoides

PATHOGENESIS AND CLINICAL SYMPTOMS

Complaints due to direct effect by Adult worm .(2)

- Irritations of the mucosal folds
- Blocking of the intestine - ileus
- Erratic migration
- Competes in the absorption of food and vitamins
- Release of toxic metabolic products



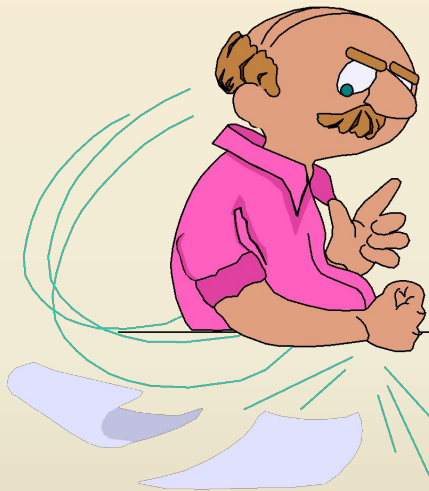
- . **extraintestinal ascariasis**

- *Ascaris* is infamous for its character to migrate within the small intestine, and when a large worm begins to migrate there is not much that can stop it. Cases have been reported in which *Ascaris* have migrated into and blocked the bile or pancreatic duct or in which the worms have penetrated the small intestine resulting in acute (and fatal) peritonitis. *Ascaris* seems to be especially sensitive to anesthetics, and numerous cases have been documented where patients in surgical recovery rooms have had worms migrate from the small intestine, through the stomach, and out the patient's nose or mouth.



Ascaris lumbricoides

Diagnosis



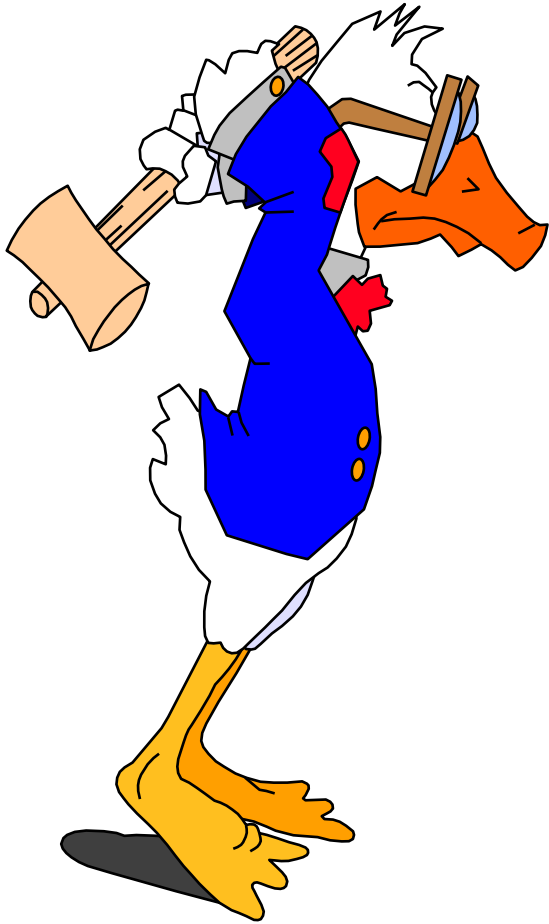
- Identify the eggs found in feces using following methods :
 - ✓ Direct smear method
 - ✓ Concentration method
- Identify larva found in sputum
- Identify adult worm found expelled from anus, mouth, nostril
- Do quantitative lab method to measure level of infection
- Additional : chest X-ray

● **Treatment**

- Treatment includes medications that paralyze or kill intestinal parasitic worms, such as albendazole or mebendazole. These drugs should not be used for pregnant patients.
- Pyrantel pamoate is the preferred medication for pregnant patients.
- If there is a blockage of the intestine caused by a large number of worms, endoscopy to remove the worms or, rarely, surgery may be needed.



Ascaris lumbricoides



PREVENTION

- **treatment of individual case**
- **Provision of sanitary public bath, wash and toilet facilities**
- **Media information and health education**
- **Routine health check up of children**

● **Factors favoring the spread of the transmission:**

- **Simple life cycle**
- **Enormous egg production (240,000 eggs/ day/ female)**
- **Eggs are highly resistant to ordinary disinfectants (due to the ascroside) which may remain viable for several years**
- **Social customs and living habits.**
- **Disposal of feces is unsuitable**

- ***Ascaris suum***

- *Ascaris suum* is found in pigs. Its life cycle is identical to that of *A. lumbricoides*. If a human ingests eggs of *A. suum* the larvae will migrate to the lungs and die. This can cause a particularly serious form of "ascaris pneumonia." Adult worms of this species do not develop in the human's intestine.

- **Diagnosis**

- Infections of *Ascaris* are diagnosed by finding characteristic eggs in the feces of the infected host.

Toxocara canis

(intestinal roundworm of dogs)

The life cycle of *Toxocara canis*, a common roundworm of dogs, is similar to that of *Ascaris lumbricoides*, but with a few additional accompaniments. Assuming a dog has never been infected with *Toxocara*, the first time it is infected the worms develop as described for *Ascaris*.

If a dog has been infected previously and ingests infective eggs, most of the larvae that hatch from the eggs do NOT develop into adults. Rather, they remain in the dog's tissues as **"second stage somatic larvae."**

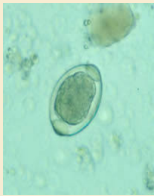
If these second stage somatic larvae are in a female and ● she gets pregnant, transplacental infection of the fetus will occur. This explains why, in some areas, up to 95% of .puppies are born with infections of *Toxocara canis*

If another animal, such as a rodent, eats infective eggs of ● *Toxocara*, second stage somatic larvae will develop in this animal. If a dog then eats this animal, the dog gets .infected

Humans can also be infected with second stage somatic ● larvae of *Toxocara canis*, as well as the larvae of other species of nematodes, resulting in a condition known as visceral larval migrans or VLM

- The eggs of *Toxocara* are extremely resistant to adverse environmental conditions, and, once an area is contaminated with eggs (such as a playground, park, or your yard), it's very difficult to sanitize the area. **Thus, it's very important that dogs be checked for this parasite on a regular basis, and that dog's not be allowed to defecate indiscriminately.**
- Diagnosis:
- *Toxocara canis* in dogs are diagnosed by finding characteristic eggs in the feces of the infected host. Infections of hosts with second stage somatic larvae of this parasite are more difficult to detect, and many **probably go undiagnosed.**

Trichuris trichiura (whipworm)





Infection by *Trichuris trichiura*

Distribution

- **Trichuriasis - cosmopolitan**
- **Primarily in hot and humid areas**
- **prevalence 80-90 %, especially among underfives and school children**

Habitat

- **Caecum, appendix, colon (proximal end)**

Mode of infection □ **oral**

- **Infective eggs embedded under fingernail (hand to mouth infection)**
- **Ingested with contaminated food/drinks (carried by insect vector: cockroach, flies)**

General Introductions

- A common nematode residing in human colon
- Worldwide distributed in the same areas where the *Ascaris* are found
- Trichuriasis are usually not serious clinically, but overwhelming infections leading to death have been reported in children

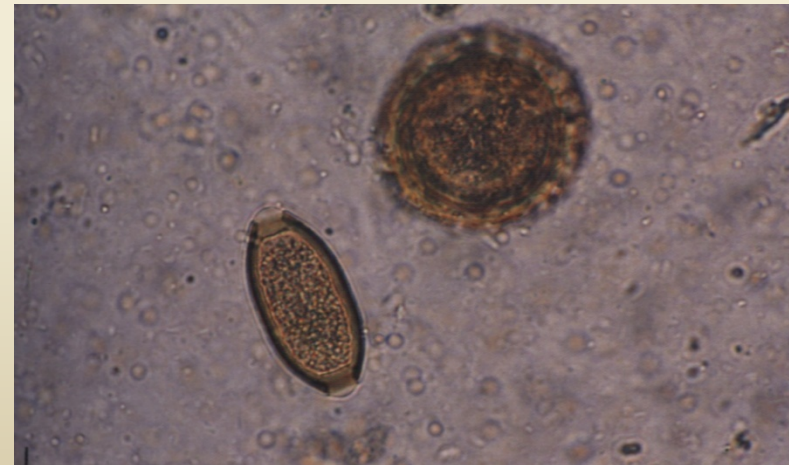
Morphology: adults

**The adult female
measures about 35-50
mm in length, and the
male about 30-45 mm**



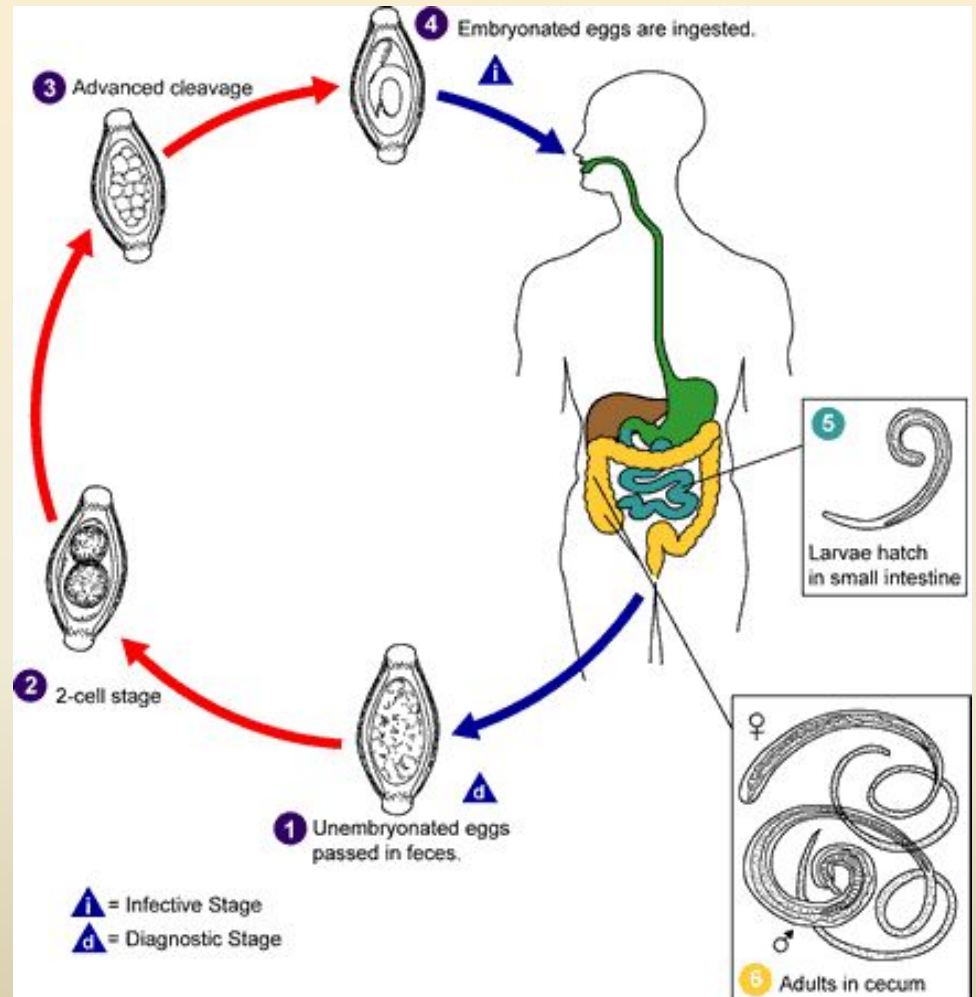
Morphology: eggs

- ☆ barrel-shaped or fusiform with bipolar prominences (plugs)
- ☆ measures 50-55 by 22-24 μm
- ☆ brown, smooth shell
- ☆ contains a single-cell ovum



Life cycle

- No intermediate host
- Infected through fecal-oral route by the embryonated egg
- Ileocecal portion is the most favorite site of residing



Pathogenesis

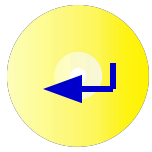
- Symptoms are determined largely by the worm burden: less than 10 worms are asymptomatic
- Only heavily infected patients develop clinical disease:
 - Chronic diarrhea, characterized by mucous stools, and associated with tenesmus
 - If the diarrhea is protracted, the patient may develop rectal prolapse, more likely to occur in small children
 - Many individuals infected with whipworm tend to be malnourished and anemic

Pathogenesis

prolapsed rectum

whipworms are often seen attached to the rectal tissue





Trichuris trichiura

PATHOLOGY AND CLINICAL SYMPTOMS

Chronic and heavy infection

- Heavy anemia (Hb = 3 gr%) (1 worm absorb 0,005 cc blood/day)
- Abdominal pain, nausea, weight loss, vomiting
- *Prolapsus recti*
- Headache, fever

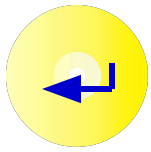
Mixed infection may occur with *Ascaris lumbricoides*, hookworm and *Entamoeba histolytica*



Trichuris trichiura

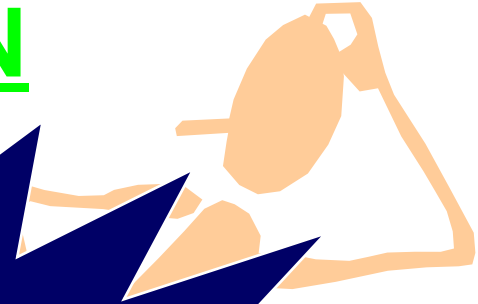
Diagnosis

- Identify egg worm found in fecal sample
- Identify adult worm from prolapsed anus and rectum (by proctoscopy)
- Measure level of infection by counting:
 - * Number of eggs per gram feces
 - * Number of female worm expelled through deworming



Trichuris trichiura

PREVENTION



- Elimination of source of infection
- Improved personal hygiene (hand washing, toilet training)
- Through washing of sold vegetables
- Health education
- Provision of sanitary public toilet

HOOK WORMS

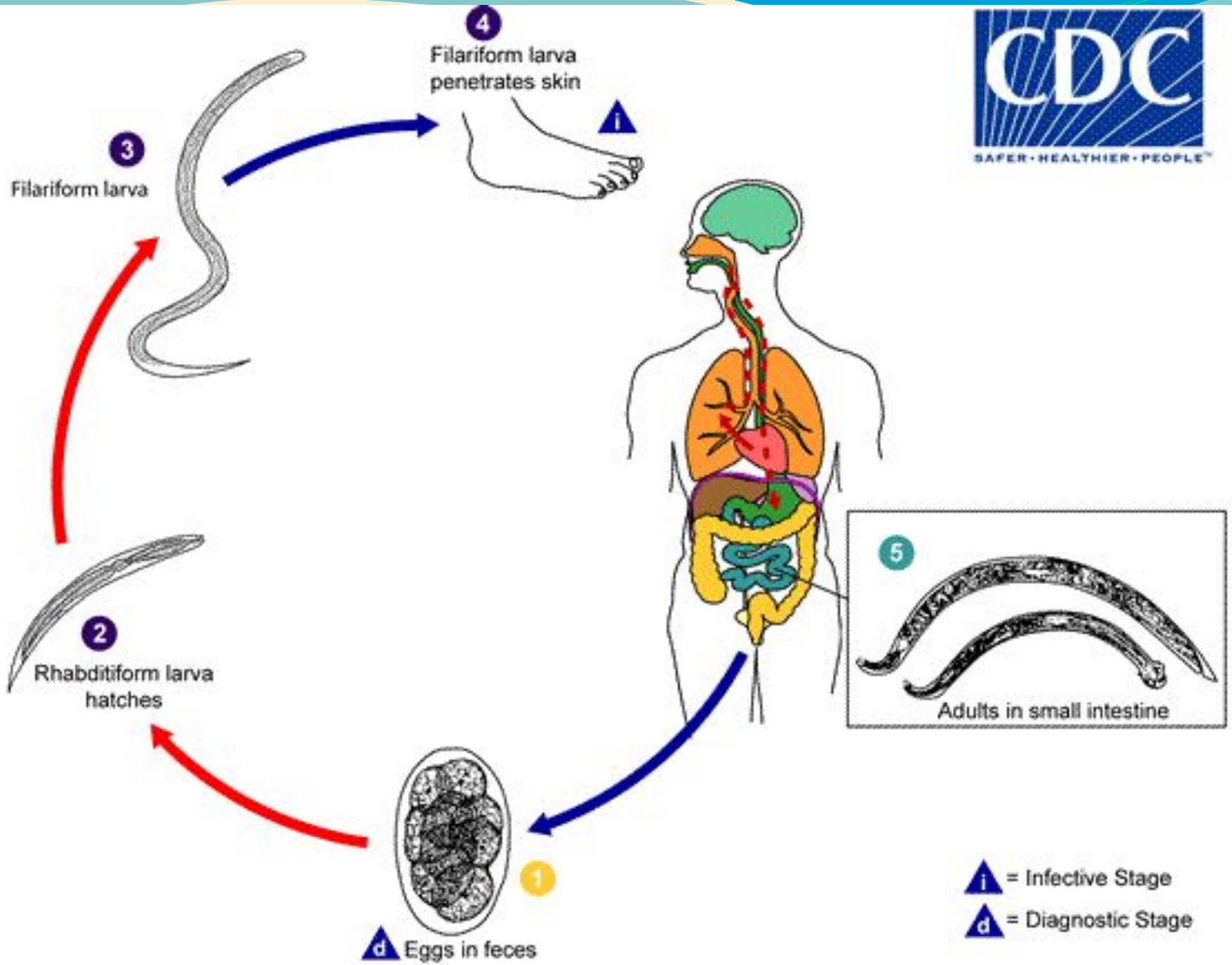
There are two species of hookworm:

1. *Ancylostoma duodenale*
2. *Necator americanus*

The adults are found in the small intestines of man.

Ancylostoma duodenale:

Habitat The adult worms live in the small intestines of infected persons, mostly in the jejunum, less often in the duodenum, and infrequently in the ileum.



Life Cycle:

Life cycle of *Ancylostoma* is completed in a single host

Definitive host: Humans are the only natural host.

No intermediate host is required like other helminths.

Infective form: Third stage filariform larva.

Adult worm inhabiting the small intestine of man attach themselves to the mucous membrane by means of their mouth parts.

The female worm lays eggs.

The eggs containing segmented ova with 4 blastomeres, are passed out in the feces of infected person .

Eggs freshly passed in feces are not infective for humans.

When deposited in the soil, the embryo develops inside the eggs.

Its development takes place optimally in sandy loamy soil with decaying vegetation under a moist, warm, shady environment.

In about 2 days, a rhabditiform larva, measuring 250 μm in length, hatches out of the egg. It feeds on bacteria and other organic matter in the soil and grows in size. It moults twice, on the 3rd and 5th days after hatching to become the third-stage infective filariform larva .

Filariform larva is about 500–600 μm long, with a sharp pointed tail.

The filariform larva are non-feeding. They can live in the soil for 5–6 weeks, with their heads waving in the air, waiting for their hosts.

They can also ascend on blades of grass or other vegetation, being carried in capillary water films on their surface.

Direct sunlight, drying, or salt water can kill the larva.

Mode of Infection: When a person walks barefooted on soil containing the filariform larva, they penetrate the skin and enter the subcutaneous tissue. The common sites of entry are the skin between the toes, the dorsum of the foot, and the medial aspect of the sole.

In farm workers and miners, the larvae may penetrate the skin of the hands. Rarely, infection may take place by the oral route, the filariform larva being carried on contaminated vegetables or fruits.

The larvae may penetrate the buccal mucosa to reach the venous circulation and complete their migration via the lungs.

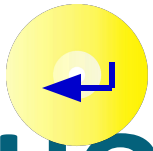
Transmammary and transplacental transmission has been also reported for *Ancylostoma*, but not for *Necator*.

- **Inside the human body**, the larvae are carried along the venous circulation to the right side of the heart and to the lungs.
- Here, they escape from the pulmonary capillaries into the alveoli, migrate up the respiratory tract to the pharynx, and are swallowed, reaching their final destination small intestine.
- During migration or on reaching the esophagus, they undergo third moulting.
- They feed, grow in size, and undergo a fourth and final moulting in the small intestine and develop the buccal capsule, by which they attach themselves to the small intestine and grow into adults.
- There is no multiplication in the host and a single infective larva develops into a single adult, male or female.
- It takes usually about 6 weeks from the time of infection for the adult worms to become sexually mature and start laying eggs. But sometimes, there may be an arrest in development and the process may take much longer, 6 months or more.
- Alternatively, the larvae may be swallowed and may develop directly into adults in the small intestine without a tissue phase

Pathogenicity and Clinical Features

Causes of anemia in Hookworm infection:

- Blood sucking by the parasite for their food
- Chronic hemorrhages from the punctured sites from jejunal mucosa
- Deficient absorption of vit B12 and folic acid
- Depression of hemopoietic system by deficient intake of proteins
- Average blood loss by the host per worm per day is 0.03 mL with *N. americanus* and 0.2 mL with *A. duodenale*
- **With iron deficiency, hypochromic microcytic anemia** is caused and with deficiency of both iron and vit B12 or folic acid, dimorphic anemia is caused.



HOOKWORM

PATHOLOGY CAUSED BY ADULT WORM

(Anemia by hookworm)

- Patient with atrophic glossitis also show fingernail deformity (koilonychia)
- Fingernail becomes thin and concave with elevated ridge



HOOKWORM

PATHOLOGY AND CLINICAL SYMPTOMS

- **Disease: Ancylostomiasis**
- **Synonym: Uncinariasis, necatoriasis**
- **infection by *A. duodenale* are more serious than *N. americanus***
- **Chronic infection rarely produce acute manifestation**
- **Tissue damage and symptoms are caused by :**
 - Larva stage
 - Adult worm



HOOKWORM

PATHOLOGY CAUSED BY LARVA STAGE



- Larva penetrates the skin - maculopapules - erythema - heavy itching : **ground itch/dew itch**
- In sensitive patient, larva carried in the circulation, may cause:
 - **Bronchitis / Pneumonitis**



HOOKWORM

PATHOLOGY CAUSED BY ADULT WORM

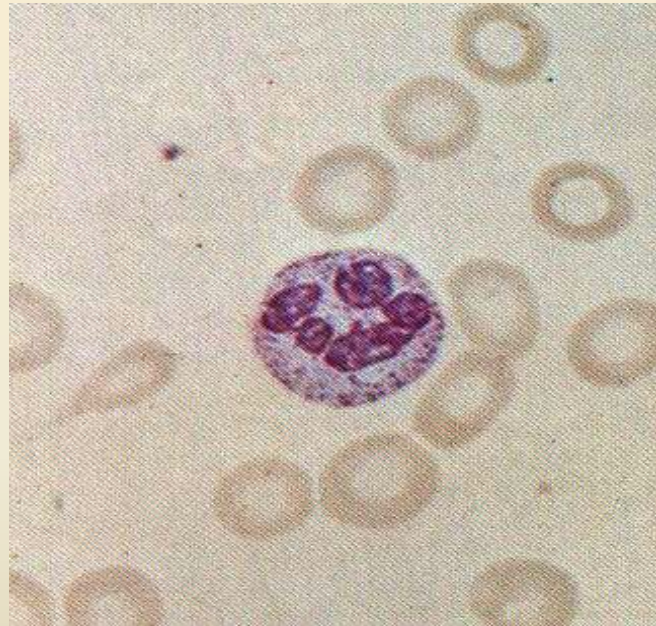
- Hooked to the intestinal mucosal wall :
abdominal pain, nausea, diarrhea
- Absorbing 0,2-0,3 ml of blood/day/worm :
progressive anemia, hypo chrome, microcytic
type of Fe deficiency anemia
- Heavy anemia (Hb may reach 2 gr %) :
 - Dyspnea, physical weakness, headache
 - Rapid pulse beat, cardiac weakness
 - Children : physical growth retardation, mental



HOOKWORM

PATHOLOGY CAUSED BY ADULT WORM

(Anemia by HOOKWORM)



Blood smear of patient with heavy infection caused by hookworm indicating Fe deficiency anemia with low MCHC and low serum Fe concentration

Source : Color Atlas of Medicine and Parasitology, 1977 Peters W. & Gillers H.M



HOOKWORM

Diagnosis

- Identify eggs from feces sample
- Identify larva from :
 - Fecal culture
 - Old feces sample

ANTIHELMINTHICS

HOOKWORM

- Tetrachlorethylen
- Mebendazole
- Albendazole
- Pyrantel pamoate
- Bitoskanate
- Bephenium hidroxynaphtoate

PREVENTION

- Same as with Ascariasis but with the addition of :
wearing shoes during work in plantation or mine
area

LARVA MIGRANS

- There are three types of larva migrans:
- **a. Cutaneous larva migrans (Creeping eruption)**
- Various animals harbor hookworms. Two species of dogs and cats are important.
- 1. *Ancylostoma braziliens*: infects both dogs and cats.
- 2. *Ancylostoma caninum*: infects only dogs.
- Both of these are common in the tropics and subtropical regions where human hookworms can best complete their life cycles.
- If man comes in contact with infective larvae, penetration of the skin may take place; but the larvae are then unable to complete their migratory cycle. Trapped larvae may survive for weeks or even months, migrating through the subcutaneous tissues. They may evoke a fairly severe reaction - pruritis and dermatitis.
- The dermatitis leads to scratching and then bacterial superinfection.
- **Treatment**
- Thiabendazole: Applied topically.



- **b. Visceral larva migrans**

- A syndrome caused by the migration of parasitic larvae in the viscera of a host for months or years. It may be caused by transient larval migration in the life cycles of several parasites such as hookworm, *Ascaris lumbricoides*, *T. spiralis*, *S. stercoralis*, other filarial worms and *Toxocara canis* (Dog ascarid) and *Toxocara cati* (Cat ascarid).

C. Intestinal larva migrans ●

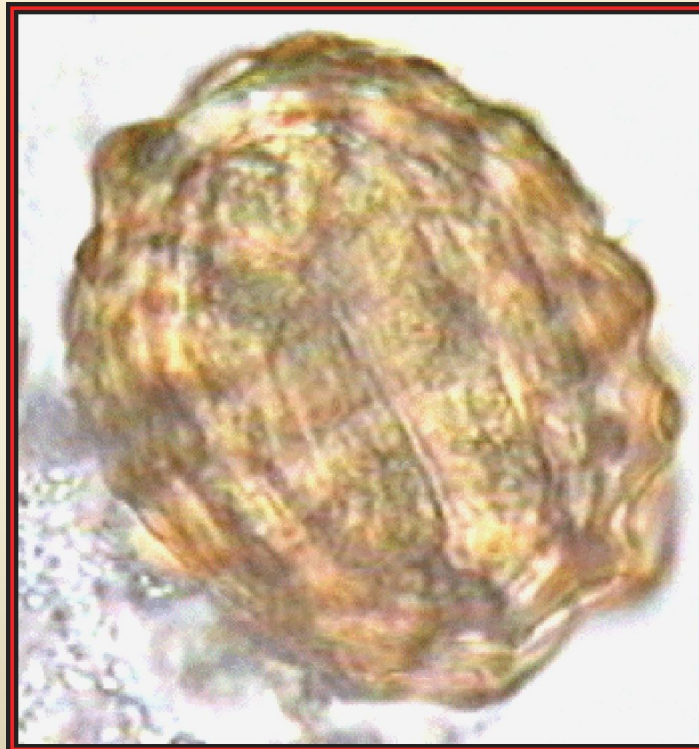
.This is an extremely rare kind of larva migrans ●



An interior view of *Ascaris*. Note the presence of three large lips, a characteristic of .all ascarids



Ascaris lumbricoides, fertilized egg. Note that the egg is covered with a thick shell that appears lumpy (bumpy) or mammillated; approximate size = 65 μm in length





Eggs of *Ascaris suum*. *A. suum* is a common parasite of pigs. The eggs are virtually indistinguishable from those of *A. lumbricoides*.



Ascaris lumbricoides

Ascaris lumbricoides

Female

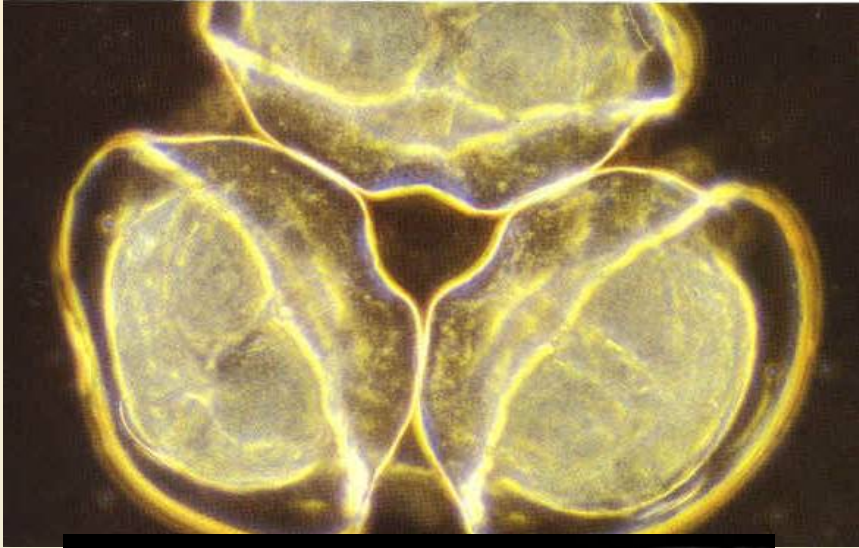


Male

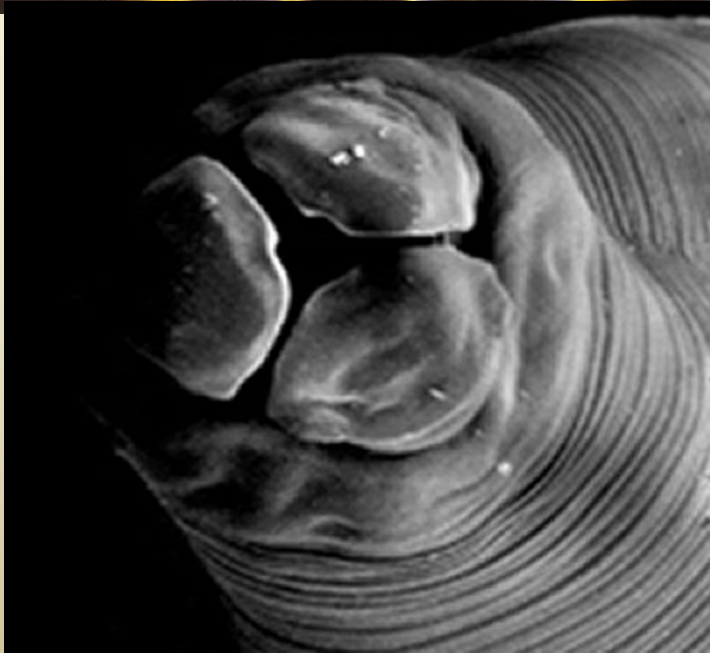


(by P.W. Pappas and S.M. Wardrop;
original by P. Darben)

The lips of *A. lumbricoides*



The three lips are seen at the anterior end. The margin of each lip is lined with minute teeth which are not visible at this magnification







An egg of *Toxocara canis*. Ingestion of these eggs by a human can result in visceral larval migrans

