

# Parasitic GI Infections

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## Amebas

- Amebas, are the most **primitive** of the protozoa, they multiply by simple **binary fission** and move by means of **pseudopodia**
- Amebas also use pseudopodia to **engulf food** sources found in its path.
- Several genera of amebas are **commensals** of human alimentary tract and produce protective **cysts** which are passed from host to host by the **fecal-oral route**
- Only ***Entamoeba histolytica***, regularly produces **disease**; it has been recently subdivided into two morphologically identical but **genetically distinct** species:
  - An **invasive** pathogen that retains the species appellation ***E. histolytica***
  - A **commensal** organism, now designated ***E. dispar***

## ***Entamoeba histolytica***

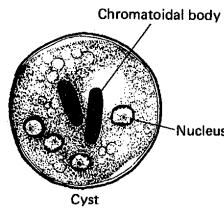
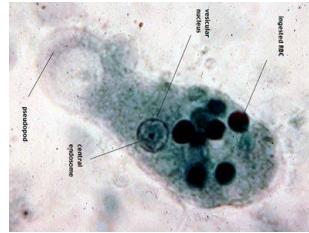
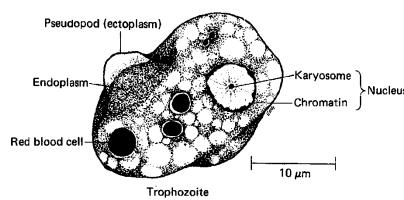
*E. histolytica* possesses both **trophozoite** and **cyst** forms:

- **Trophozoites :**
  - Microaerophilic
  - Live in the lumen or wall of the **colon**
  - Feed on **bacteria, RBCs and tissue cells**
  - **Multiply** rapidly in the **anaerobic** environment of the gut
  - **12 to 20 µm** in diameter
  - **Granular, vacuolated endoplasm** and sharply demarcated, clear **ectoplasm** with finger-like **pseudopods**

## ***Entamoeba histolytica***

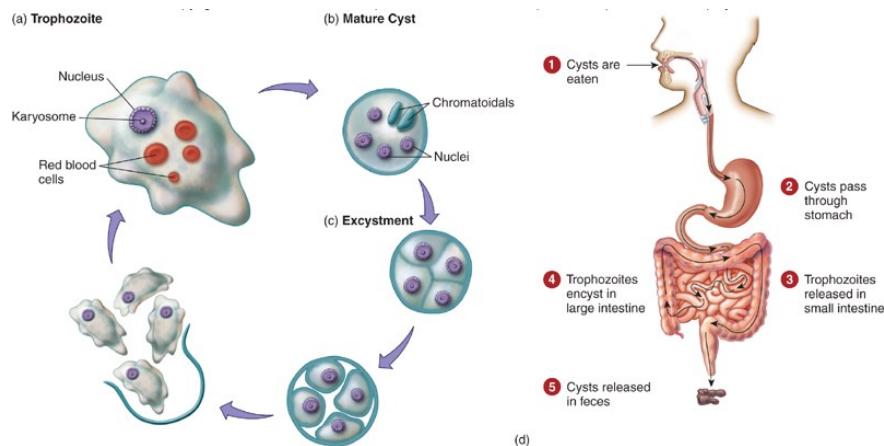
- **Cyst form:**
  - Trophozoites usually encyst **before leaving the gut**
  - **Initially**, a cyst contains a single **nucleus**, a **glycogen vacuole**, and one or more large, cigar-shaped **ribosomal clusters** known as **chromatoid bodies**
  - With **maturity**, the cyst becomes **quadri-nucleate**, and the **cytoplasmic inclusions are absorbed**
  - Mature cysts can **survive** environmental temperatures **up to 55°C**, **chlorine concentrations** normally found in municipal water supplies, and normal levels of **gastric acid**

## *Entamoeba histolytica*



## *Entamoeba histolytica*

- Life cycle:



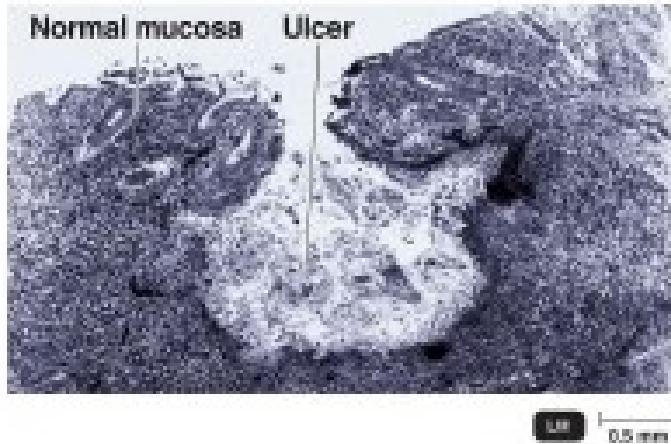
## ***Entamoeba histolytica***

- Epidemiology:
  - *E. histolytica* is the causative agent of **diarrhea** and amebic **dysentery**
  - *E. histolytica* infection rates are **higher in warm climates**, particularly in areas where the level of **sanitation is low**
  - Although stool surveys indicate that **1 to 5%** of the population harbors *Entamoeba*, the vast **majority** of these are now known to be colonized with the nonpathogenic *E. dispar*
  - Symptomatic amebiasis is usually **sporadic**, the result of **direct person-to-person fecal-oral spread** under conditions of **poor personal hygiene**
  - **Food- and water-borne** spread occur, occasionally in **epidemic form**

## ***Entamoeba histolytica***

- Pathogenesis:
  - In the colon, trophozoites move through the mucus layer and come in **contact** with the **epithelial cells**
  - Use **lectin** to **bind** to the surface of epithelial cells
  - Then **release degradation enzymes** such as pore forming proteins, lipases and proteases causing **lysis** of the epithelial cells
  - Epithelial cell damage attracts **immune cells** which can also be **lysed** (by the trophozoite) **releasing** their own **lytic enzymes** into the surrounding tissue causing **further tissue damage**
  - This produces **ulcers** which when **penetrate** below the superficial epithelium, it spreads laterally in the **submucosa**, producing a **flask-like lesion** with a narrow mucosal neck and a large submucosal body

## *Entamoeba histolytica*



## *Entamoeba histolytica*

- Pathogenesis :
  - Tissue destruction can also **involve blood vessels** leading to **bloody diarrhea (dysentery)**
  - It eventually **compromises the blood supply** of the overlying **mucosa**, resulting in **sloughing and a large necrotic ulcer**
  - Extensive **ulceration** leads to:
    - Secondary bacterial infection
    - Formation of granulation tissue
    - Fibrotic thickening of the colon
  - Amebas may also **enter the portal circulation** and be carried to the **liver** or, more rarely, to the **lung, brain, or spleen**. In these organs, **liquefaction necrosis** leads to the formation of **abscess cavities**

## ***Entamoeba histolytica***

- Clinical Manifestation:
  - Amebiasis may be:
    - Asymptomatic
    - Acute infection
    - Chronic infection
  - Amebiasis can induce infection in:
    - **Intestine** (most common)
    - **Extra-intestinal sites:** may spread to the **liver** or, more rarely, to the **lung, brain, or spleen** where tissue **necrosis** leads to the formation of **abscess**

## ***Entamoeba histolytica***

- Clinical Manifestation:
  - **Diarrhea, flatulence, and cramping abdominal pain** are the most frequent complaints of symptomatic patients
  - The diarrhea is:
    - **Intermittent**, alternating with episodes of normality or constipation over a period of months to years
    - Consists of **1-4 loose foul-smelling** passages that can contain **mucus and blood**
  - Complications:
    - Hemorrhage
    - Perforation
    - Appendicitis
    - Tumor-like growth (ameboma)
    - Liver abscess
  - **Severe forms of disease result in 10% fatality rate**

## ***Entamoeba histolytica***

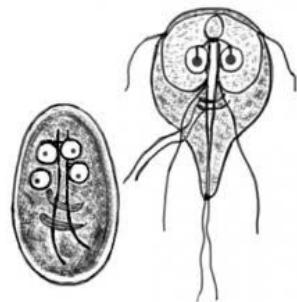
- Diagnosis:
  - Microscopic examination of **stool** sample
    - Trophozoites or **cysts** are seen
    - *E. histolytica* trophozoites can be differentiated from those of *E. dispar* only by the **presence of ingested erythrocytes**; the cysts appear identical
  - Antigen tests (e.g. ELISA) are also used
  - Culture and PCR based techniques are available but **not commonly used**
  - Abdominal **ultrasound, aspiration** and **biopsy** are very helpful in diagnosis of **liver abscess**

## ***Entamoeba histolytica***

- Prevention:
  - Sanitary disposal of human feces
  - Improvement in personal hygienic practices
  - The provision of safe drinking water
- Treatment:
  - For the invasive trophozoites: **metronidazole**
  - For luminal amoeba (especially cysts): **paromomycin** or **diloxanide**
  - **Fluid replacement** is also important

## *Giardia lamblia*

- *Giardia* are **flagellated** protozoans that possess both a **trophozoite** and a **cyst** form.
- Trophozoite:
  - **Sting-ray-shaped**
  - Has **2 nuclei** and **4 pairs of flagella**
  - Has the **appearance of a face** with two eyes and a crooked mouth



## *Giardia lamblia*

- **Trophozoites** reside in the **small intestines**, where they thrive in the **alkaline environment** and **absorb nutrients** from the intestinal tract.
- **Cystic forms** develop in colon, the **infective form** of the parasite, may **survive in cold water** for more than **2 months** and are **resistant to chlorine** at concentrations generally used in municipal water systems.
- Transmitted from host to host by the **fecal-oral route**

## ***Giardia lamblia***

- Epidemiology:
  - Giardiasis has a **international distribution**
  - Its prevalence is highest in areas with **poor sanitation** and among populations with **poor personal hygiene**
  - High attack rates in **day-care centers**.
  - In **developing countries**, infection rates may reach **25 to 30%**.
  - **Water-borne** and, less frequently, **food-borne** transmission of *G. lamblia* has been documented
  - ~ **70%** of infections are **asymptomatic**

## ***Giardia lamblia***

- Pathogenesis:
  - Giardia infection causes:
    - **Cell death** of small intestinal epithelial cells
    - Morphological changes to the **microvillus**
    - Decreased expression of brush **border enzymes** (e.g. lactase)
  - Which can result in:
    - **Intestinal malabsorption** (particularly of fat & carbohydrates)
    - **Disaccharidase deficiency** with **lactose intolerance**
    - **Mechanical blockade** of the intestinal mucosa
    - Altered **intestinal motility** and accelerated **turnover of mucosal** epithelium

## ***Giardia lamblia***

- Clinical Manifestation:
  - Symptoms begin **1 to 3 weeks after exposure**
  - They typically include **diarrhea**, which is **sudden** in onset and **explosive** in character.
    - The stool is **foul smelling, greasy** in appearance, and **floats** on water. It is **devoid of blood or mucus**.
  - **Upper abdominal cramping** is common.
  - Large quantities of intestinal gas produce **abdominal distention** and **flatulence**.
  - **Nausea, vomiting**, and **low-grade fever** may be present

## ***Giardia lamblia***

- Clinical Manifestation:
  - The **acute** illness generally **resolves in 1 to 4 weeks**;
  - In **children**, however, it may **persist for months**, leading to significant **malabsorption, weight loss, and malnutrition**.
- Diagnosis:
  - The diagnosis is made by finding the **cyst in formed stool** or the **trophozoite in diarrheal stools**
  - **Antigen tests** (e.g. ELISA) are also used

## ***Giardia lamblia***

- Prevention:
  - Same as amoebiasis
- Treatment:
  - Infection frequently resolves on its own
  - **Metronidazole** is the drug of choice
  - **Paromomycin** is preferred in **pregnancy**

## **Helminths**

- Helminths are **parasitic worms** that can infect (infest) humans and many animals
  - Although **microscopic** in certain stages of their life cycle (**eggs and larvae**), the size of **adult** worms can vary from less than 1 mm to **more than 10 m** in length
  - There are mainly 3 types of worms that are parasitic to humans:
    - **Nematodes** (roundworms): elongated, cylindrical non-segmented body
    - **Cestodes** (tapeworms): thin, flat segmented body which can be very long (tape-like)
    - **Trematodes** (flukes): flat ovoid body
- Cestodes and trematodes are called **platyhelminths** (**flatworms**)

## Helminths

- Helminths can be **transmitted** through the **fecal-oral route** or through **penetration of the skin**
- They mainly reside in the **intestines** but some of them can also be present in **other tissues**
- Each worm has a characteristic **life cycle** which include **egg, larva** and **adult** forms
- The life cycle usually involves one or more **host organisms** which include:
  - **Definitive host:** the host in which **sexual reproduction** and **adult maturation** occurs
  - **Intermediate host:** the host in which **larva development** occurs (asexual reproduction)

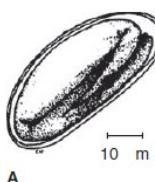
Helminths may require no intermediate host at all or may need one or more intermediate hosts for their entire life cycle

## Helminths

- Many worm infections cause an increase in eosinophils (**eosinophilia**) in the blood; a hallmark of worm infection
- Many helminths **don't have sophisticated virulence factors**. The **damage** they cause in the host is frequently the result of the **host's response** to their presence
- However, they do have numerous **adaptations** that allow them to survive in their hosts for a long time. This includes the secretion of **immunomodulatory agents**
- Helminth **eggs** also have a **strong shell** that protects them against a range of environmental conditions

## Pinworm

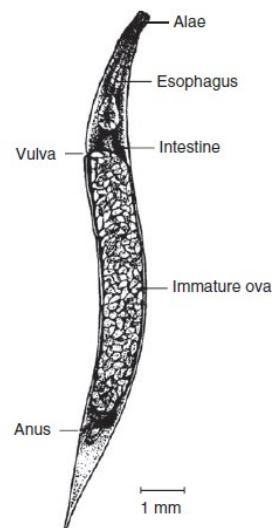
- ***Enterobius vermicularis*** is a roundworm commonly called pinworm
- It is the **most common worm disease of children in temperate zones**
- The **adult female worm** is about **10 mm long** with a **sharply pointed tail**
- They have **clear, thin-shelled, ovoid eggs** are **flattened on one side** and measure **25-50 µm**
- **Humans** are the only host



A



C



B

## Pinworm

- Life cycle:
  - Adult worms inhabit the cecum
  - The **gravid female** (laden with ~20,000 eggs) **migrates** to the **perianal area** where it lays the eggs.
  - The eggs **mature rapidly** and are **infective several hours after passage**.
  - Handling of bedclothes or **scratching** of the perianal area results in adhesion of the eggs to the fingers and **fingernails**
  - The eggs are relatively **resistant to desiccation** and may remain viable in linens, bedclothes, or house dust for several days
  - When the eggs are ingested, the larvae **hatch in the small intestine**, and then the larvae **migrate** to the **cecum** where they **mature** into adults and mate
  - The entire adult-to-adult cycle is completed in **2 weeks**

## Pinworm

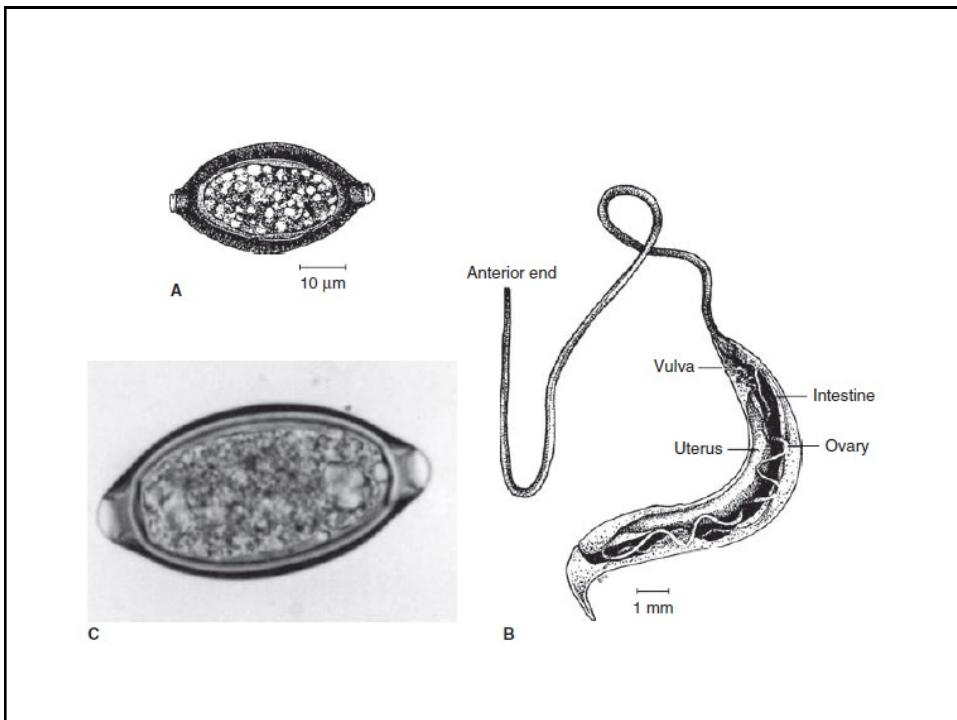
- Manifestations:
  - Most cases are **asymptomatic**
  - The main symptom of this condition are **pronounced anal itching** due to the migration of the gravid female
  - Children can suffer from **disrupted sleep**
  - Sometimes **nausea, abdominal discomfort, and diarrhea** occur
  - Once infection is introduced into a household, **other family members** are often rapidly infected

## Pinworm

- Diagnosis:
  - Diagnosis is by recovery of the **eggs** from the **perianal skin**.  
This is done by applying a **cellophane tape** to the mucocutaneous junction, then transferring the tape to a glass slide and examining the slide for eggs under a microscope
  - **Eosinophilia** is usually **absent**
- Prevention and treatment:
  - Prevention by **strict hygiene** to prevent autoinfection and infecting others
  - Treatment by **albendazole** or **mebendazole**
  - **Pyrantel pamoate** can also be used

## Whipworm

- ***Trichuris trichiura*** (a roundworm)
- The adult whipworm is **3 to 5 cm** in length
- The **anterior** two-thirds is **thin and threadlike**, whereas the **posterior** end is **bulbous**
- **Eggs** are **lemon shaped** or tea-tray like
- **Humans** are the **main host**.
- It is **very prevalent** in the world especially in **tropical countries**
- **Children** are more infected



## Whipworm

- Life cycle:
  - Adults mainly live in the **cecum**.
  - The gravid female releases its **eggs (3,000-10,000)** into the **lumen of the gut**
  - Eggs pass out of the body with the **feces** and deposited in **soil**
  - Eggs must **incubate** for at least **10 days** before becoming **infectious**
  - After ingestion, eggs **hatch** in the **small intestine**.
  - Larvae **mature** for approximately **1 month** in the small intestine before **migrating** to their adult habitat in the **cecum**
  - Adult worms may **live 4 to 8 years**

## Whipworm

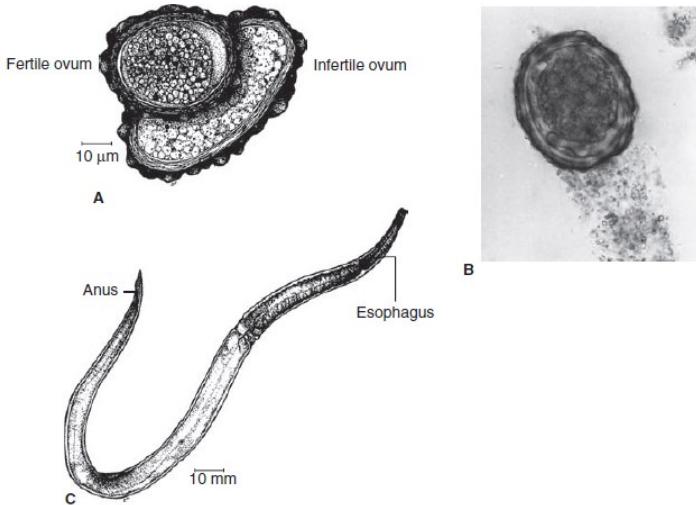
- Manifestations:
  - **Light infections** of trichuriasis are **asymptomatic**
  - **Moderate** worm loads can cause **damage to the intestinal mucosa** and may induce **nausea, abdominal pain, diarrhea and stunting of growth**
  - **Heavy loads** can also cause **significant mucosal damage, blood loss, anemia, dysentery and rectal prolapse**

## Whipworm

- Diagnosis:
  - By finding **eggs in the stool** (by examining 1 to 2 mg of emulsified stool with a microscope)
  - **Eosinophilia** can be present in **heavy infections**
- Prevention and treatment:
  - Prevention requires the **improvement of sanitary facilities**, both for **waste disposal** and **hand hygiene**
  - **Mebendazole** is the **drug of choice**
  - **Albendazole** is probably equally effective

## Ascariasis

- *Ascaris lumbricoides* is a white to pink roundworm
- The **largest** and **most common** of the intestinal roundworms; measuring **15 to 40 cm** in length
- **Short-lived** (6-18 months)
- Adults have **creamy cuticle** and **pointed extremities**
- Eggs are **elliptical**, measure 35 by 55  $\mu\text{m}$ , and have a rough, **albuminous coat** over their **chitinous shells**
- These eggs are **highly resistant** to environmental conditions and may remain **viable** for **up to 6 years** in mild climates

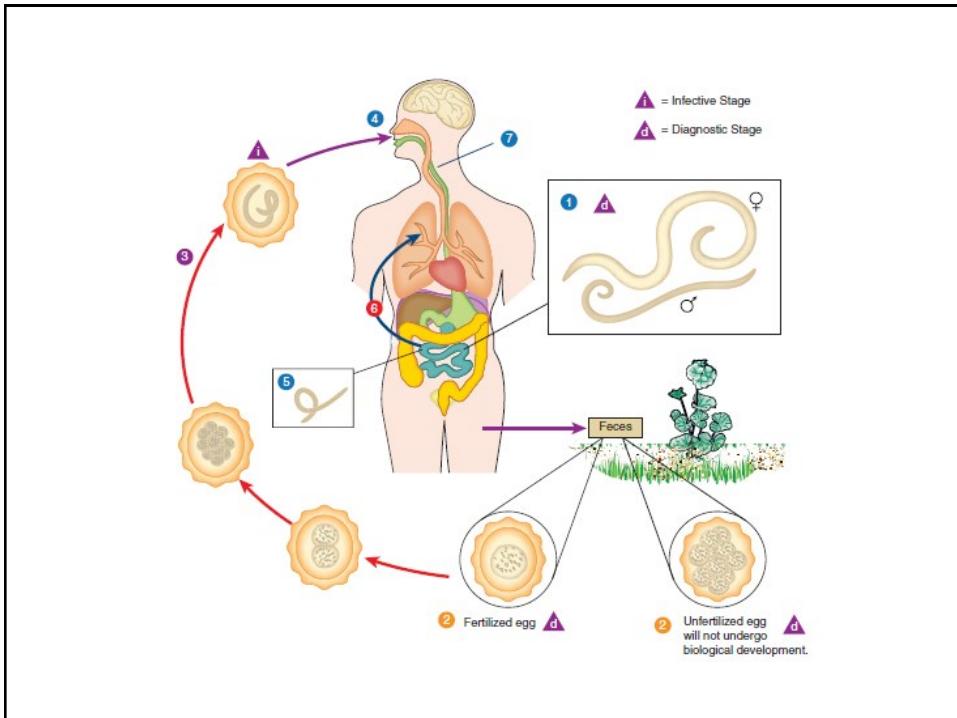


## Ascariasis

- Life cycle:
  - Adult worms live high in the **small intestine**, where they actively **maintain their position** by sheer strength of muscular activity (**swimming against the stream** of stool)
  - **Eggs** (200,000 eggs daily) are laid into the **intestinal lumen** and passed in the **feces**
  - The eggs must **mature in soil**, usually for a minimum of **3 weeks** before becoming infectious
  - After ingestion, eggs **hatch** in the **intestines**
  - **Larvae penetrate** the intestinal mucosa and reach the **circulation** via the hepatic vein

## Ascariasis

- Life cycle:
  - They reach the **pulmonary capillaries** break into the **alveolar space**
  - Then they are **coughed up**, and subsequently **swallowed** into the **small intestine** where they **mature** into adults and mate
  - Transmission is **fecal-oral**, where human **feces** are used as **fertilizer** it may be acquired through eating **contaminated vegetables**



## Ascariasis

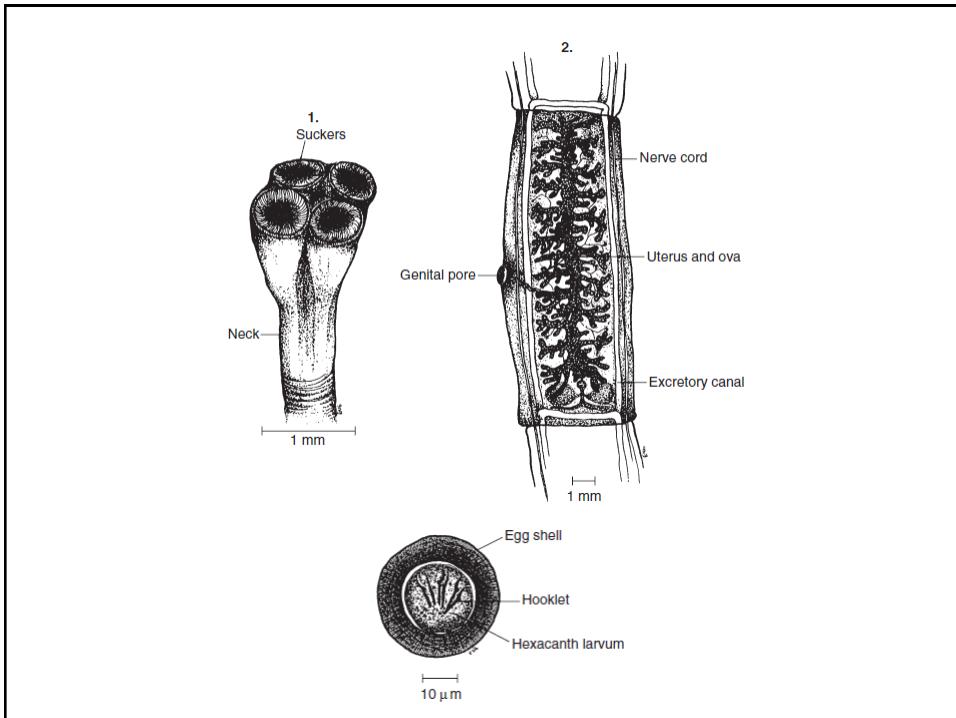
- Manifestations:
  - Low worm load (<10) may be asymptomatic
  - Clinical manifestations of ascariasis may result from either the migration of the larvae through the lung or the presence of the adult worms in the intestinal lumen
  - **Pulmonary migration** can lead to **severe inflammatory reactions** causing **bronchospasm, asthma and skin rash**
  - **Heavy intestinal loads** may cause **obstruction and inflammation** in **intestines, appendix, bile duct, or pancreatic duct**
  - Heavy loads can also cause **malabsorption** of fat, protein, carbohydrate and vitamins leading to **growth retardation** (i.e. in children)

## Ascariasis

- Diagnosis:
  - **Passage** of adult worm
  - Finding the characteristic **eggs in feces**
  - The **pulmonary phase** of ascariasis is diagnosed by the finding of **larvae and eosinophils** in the **sputum**
- Prevention and treatment:
  - Community-wide control of ascariasis can be achieved with **mass therapy** administered at 6-month intervals.
  - Ultimately, control requires **adequate sanitation facilities**
  - Treatment by **albendazole** or **mebendazole**
  - **Pyrantel** pamoate can also be used

## Beef Tapeworm

- Beef tapeworm is the common name of the cestode worm ***Taenia saginata***
- The **scolex** (head) has **4 suckers** which are used to **attach** the worm to the intestinal mucosa of its host
- Adult worm can reach **10 meters long**, and composed of up to **1,000-2,000 proglottids** (segments).
- Eggs are 30 to 40 µm in diameter, **spherical**, and possess a thick, radially striated **shell**



## Beef Tapeworm

- Life cycle:
  - *T. saginata* inhabits the human **jejunum**.
  - **Gravid proglottids** (containing up to 100,000 eggs) are **passed** in the **feces** or may **crawl** unassisted through the anal canal.
  - Proglottids are **motile**, after reaching the soil they may **move away** from human feces **into fresh grass** which then may be **eaten by a cow** during grazing
  - Proglottids **disintegrate** and then the **embryo is released** from the egg, **penetrates** the intestinal wall, and is carried by the **vascular system** to the **striated muscles**
  - In muscles, the embryo transforms into a white, ovoid (5 by 10 mm) **larva called cysticercus**

## Beef Tapeworm

- Life cycle:
  - Humans are infected when they **ingest inadequately cooked meat** containing these larval forms
  - After ingestion, the larvae **attach to the jejunal epithelium**, and begin to **grow** into a full-sized adult tapeworm, thus completing the life cycle

## Beef Tapeworm

- Manifestations:
  - **Most persons** infected with beef tapeworm are **asymptomatic** and become aware of the infection only through the **spontaneous passage of proglottids**
    - The proglottids may be observed on the **surface of the stool** or appear in the **underclothing** or **bedsheets** of the alarmed host.
  - Some patients may have **epigastric discomfort, nausea, irritability, diarrhea and weight loss**
  - Occasionally, the proglottids may **obstruct** the **appendix, biliary duct, or pancreatic duct**

## Beef Tapeworm

- Diagnosis:
  - By finding **eggs or proglottids** in the **stool**
  - Adhesive **cellophane tape** technique
    - **Eggs** may also be distributed on the **perianal area** secondary to rupture of proglottids during anal passage.
  - Because the **eggs** of ***T. solium*** and ***T. saginata*** are morphologically **identical**, it is necessary to examine a **proglottid** to identify the species correctly.

## Beef Tapeworm

- Prevention:
  - Sanitary disposal of human feces
  - Meat inspection is helpful; the cysticerci are readily visible
  - Thorough cooking of meat (beef)
  - Salting or freezing for 1 week at  $-15^{\circ}\text{C}$  or below is also effective
- Treatment:
  - The drugs of choice are **niclosamide** or **praziquantel**