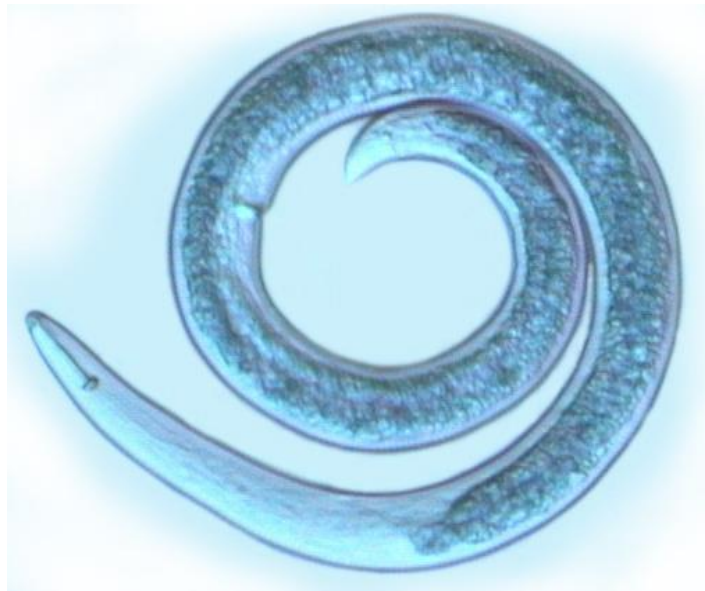


Invertebrate Zoology (Biol 242)

Chapter 13

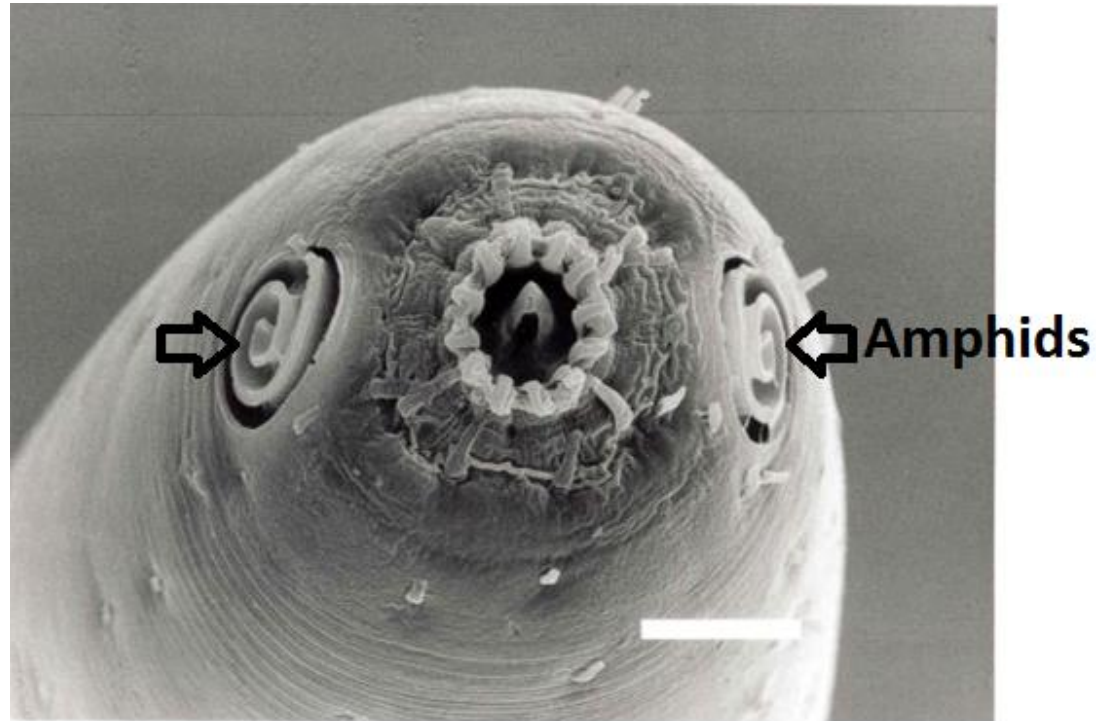
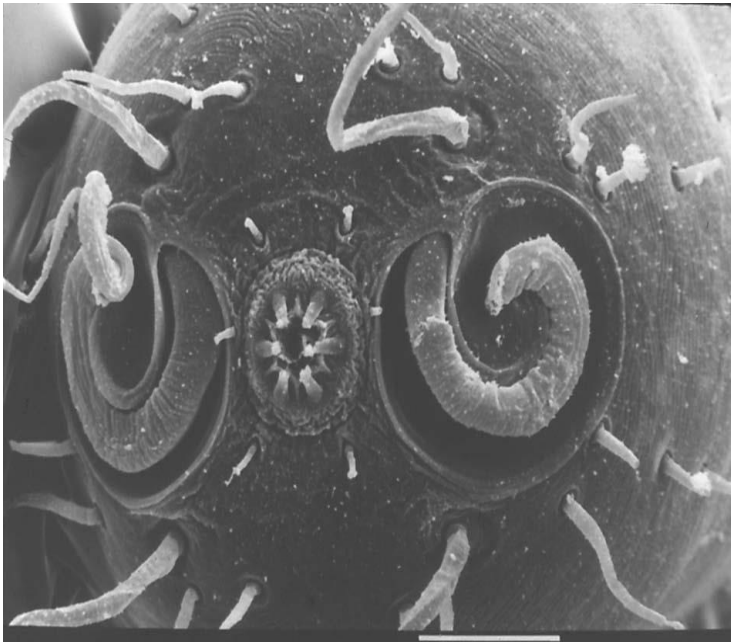
The Nematodes



► **Nematoda:** G.= **Thread**

► *Defining Characteristic:*

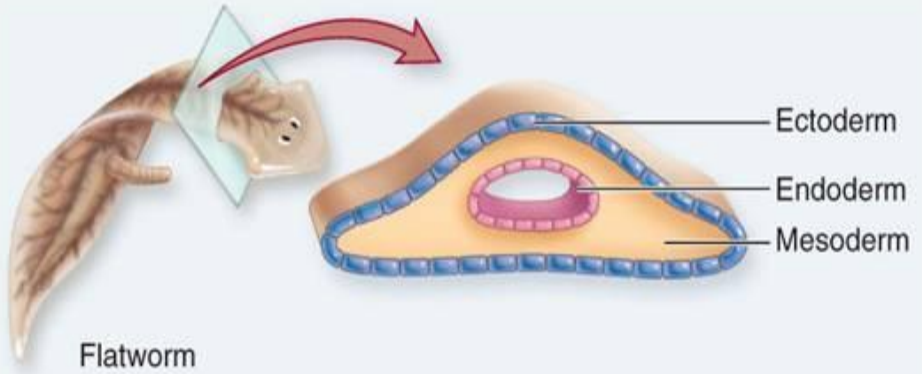
Paired lateral sensory organs (**amphids**) on the head, derived from the cilia and opening to the outside through a small pore.



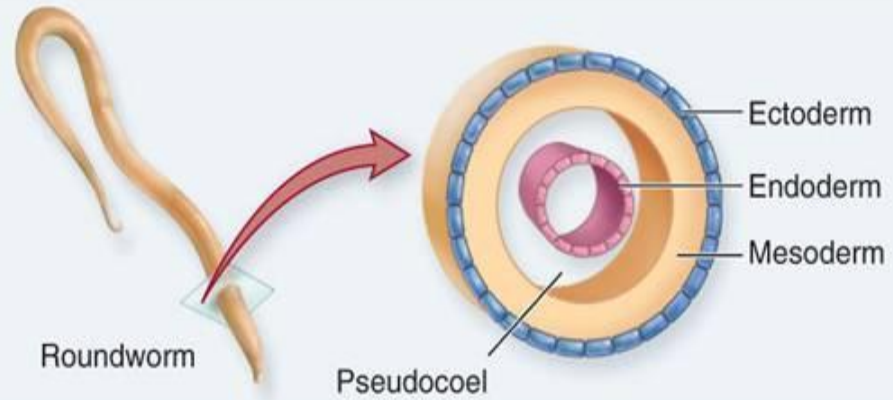
General Characteristics:

- ▶ Nematodes are widely-distributed, **unsegmented**, **acoelomate** (mostly) and **pseudocoelomate** worms.
- ▶ Nematodes are **usually small in size** (1-2 mm long).
- ▶ Body is tapered (pointed) at both ends.
- ▶ They could be found in **high densities** in sediments of aquatic habitats (1-4 Million/m²).
- ▶ Live in **aquatic** and **terrestrial** habitats. (16,000 species)
- ▶ **Free living** and **parasites** (of vertebrates, invertebrates and plants).

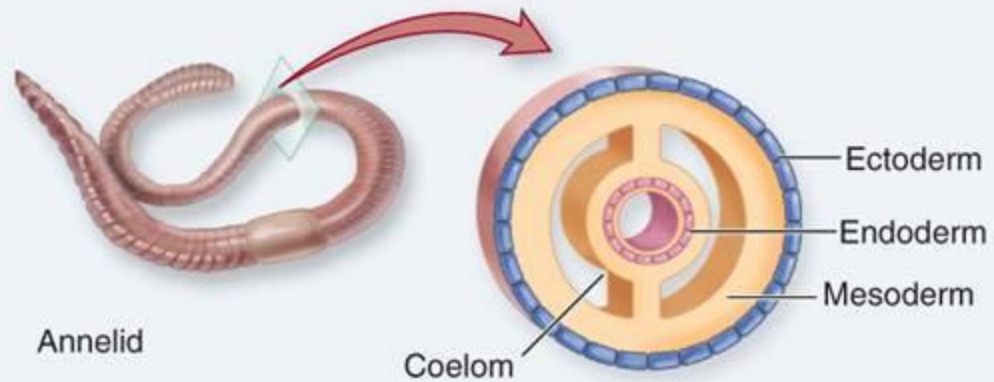
Acoelomate



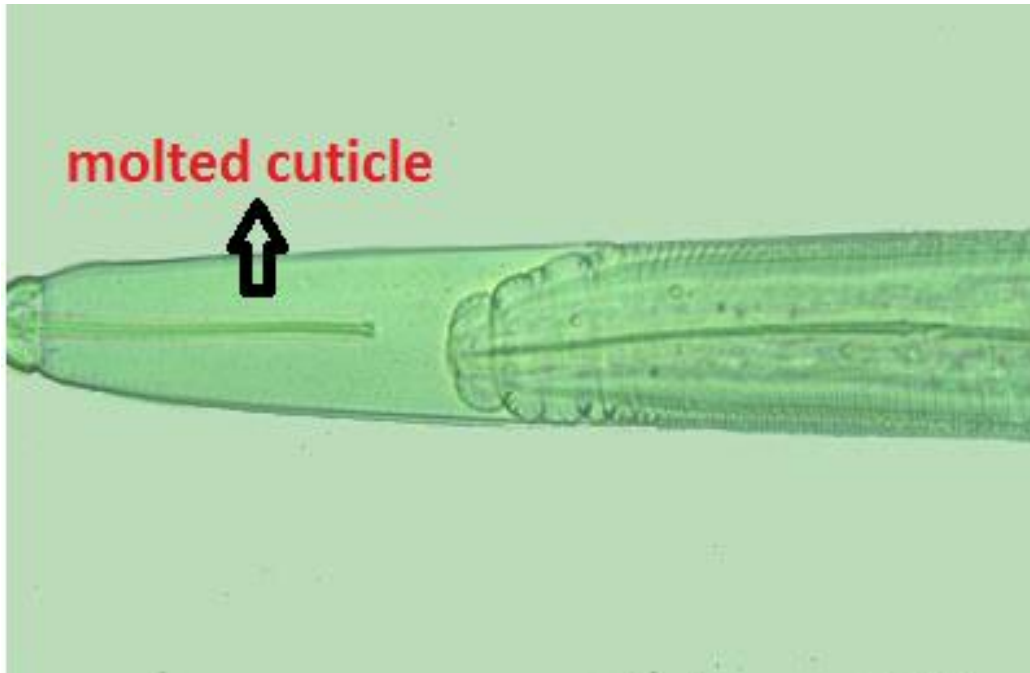
Pseudocoelomate



Coelomate

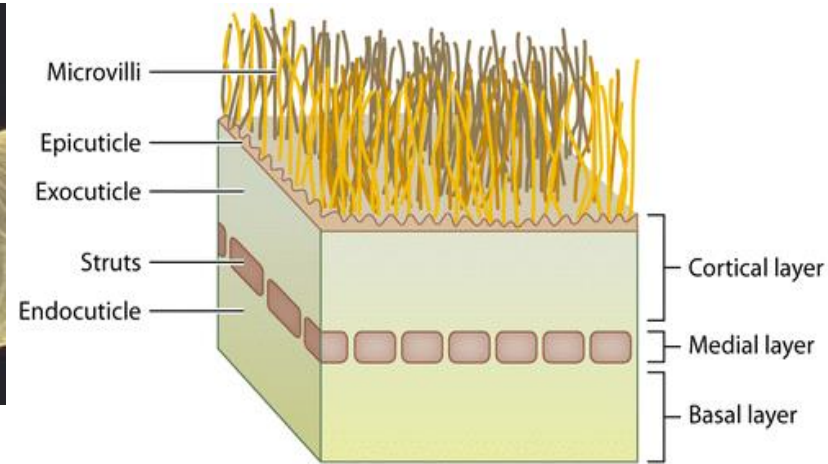
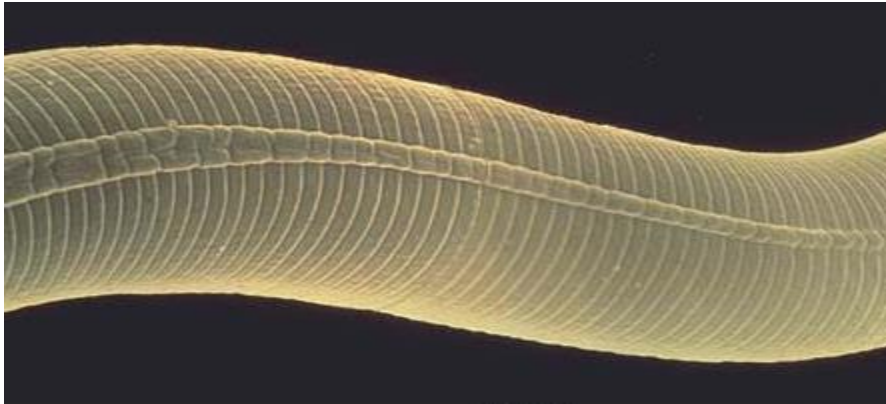


- ▶ Considered **close to arthropods** because **they molt their cuticle** (like arthropods).
- ▶ They are grouped together as **Ecdyzoans** (molting-animals).



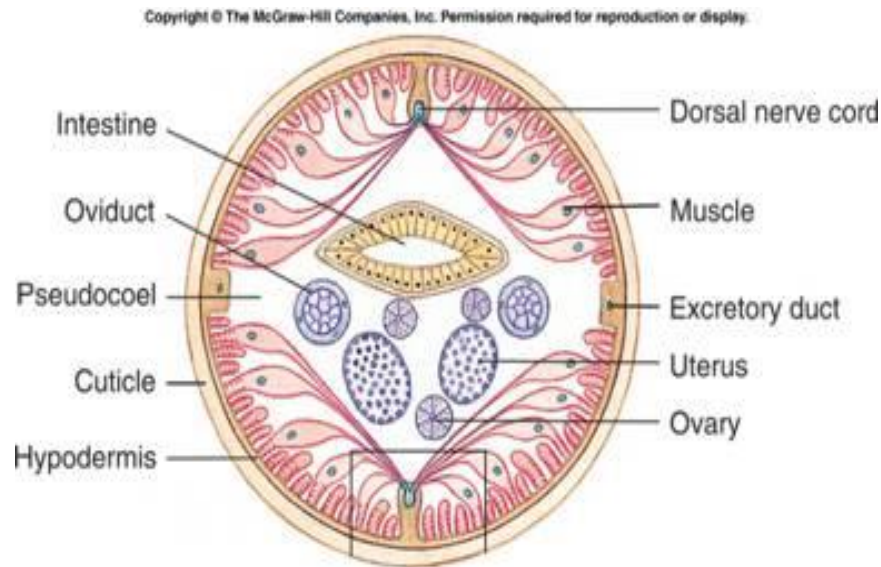
- *Body covering and body cavities:*

- ▶ Body is covered by a **thick, multilayered cuticle** (a noncellular covering) of **collagen** secreted by the underlying epidermis.



- ▶ Cuticle is **permeable to water and gases** and selectively permeable to **some ions and organic compounds**.
- ▶ Cuticle is **shed (molted) 4 times** from the juvenile to the adult stage.

- ▶ The epidermis is often **syncytial**.
- ▶ Nematodes (unlike most arthropods) **continue to grow between moltings**. However, increase in size is due to increase in cell size and not #.
- ▶ Cell # in adults is constant (this is called **eutely**).



Musculature, internal pressure and locomotion:

► **Movement of nematodes is limited by:**

- 1) Body wall of nematodes contains **no circular muscles**.
This puts limits on locomotion of nematodes, because *peristaltic waves of muscle contractions cannot be generated*.
- 2) The **high internal hydrostatic pressure** of some nematodes limits the movement ability of the nematodes.
- 3) The **cuticle is rigid** (cannot expand).

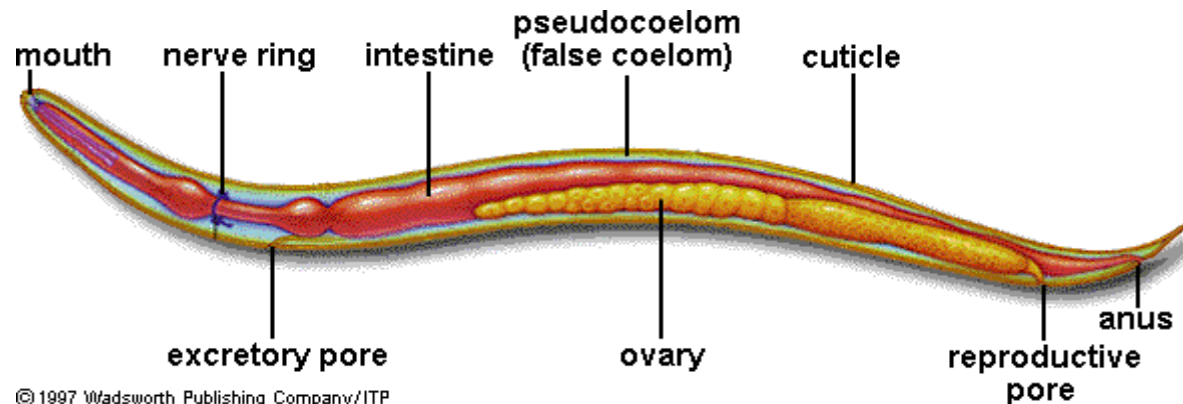
- ▶ The high internal pressure gives the nematodes a *very circular cross section*.
- ▶ **Cilia are lacking.**
- ▶ So, nematodes must move by undulating the body into **sinusoidal waves**. (*Through alternating contractions of the longitudinal muscles of the dorsal and ventral surfaces of the body*).

- **Muscle contraction** is under the control of **a simple nervous system** consisting of:
- 1) **An anterior brain** (nerve ring + associated ganglia).
 - 2) **Four** or more major **longitudinal nerve cords** (dorsal, ventral and at least 1 pair lateral).

Organ Systems and behavior:

➤ Digestive system:

- Digestive system of nematodes is **linear with mouth (stoma)** at the anterior end.
- **Mouth** (anterior) → a **muscular pharynx** → **intestine** → **rectum** → **anus** (posterior).

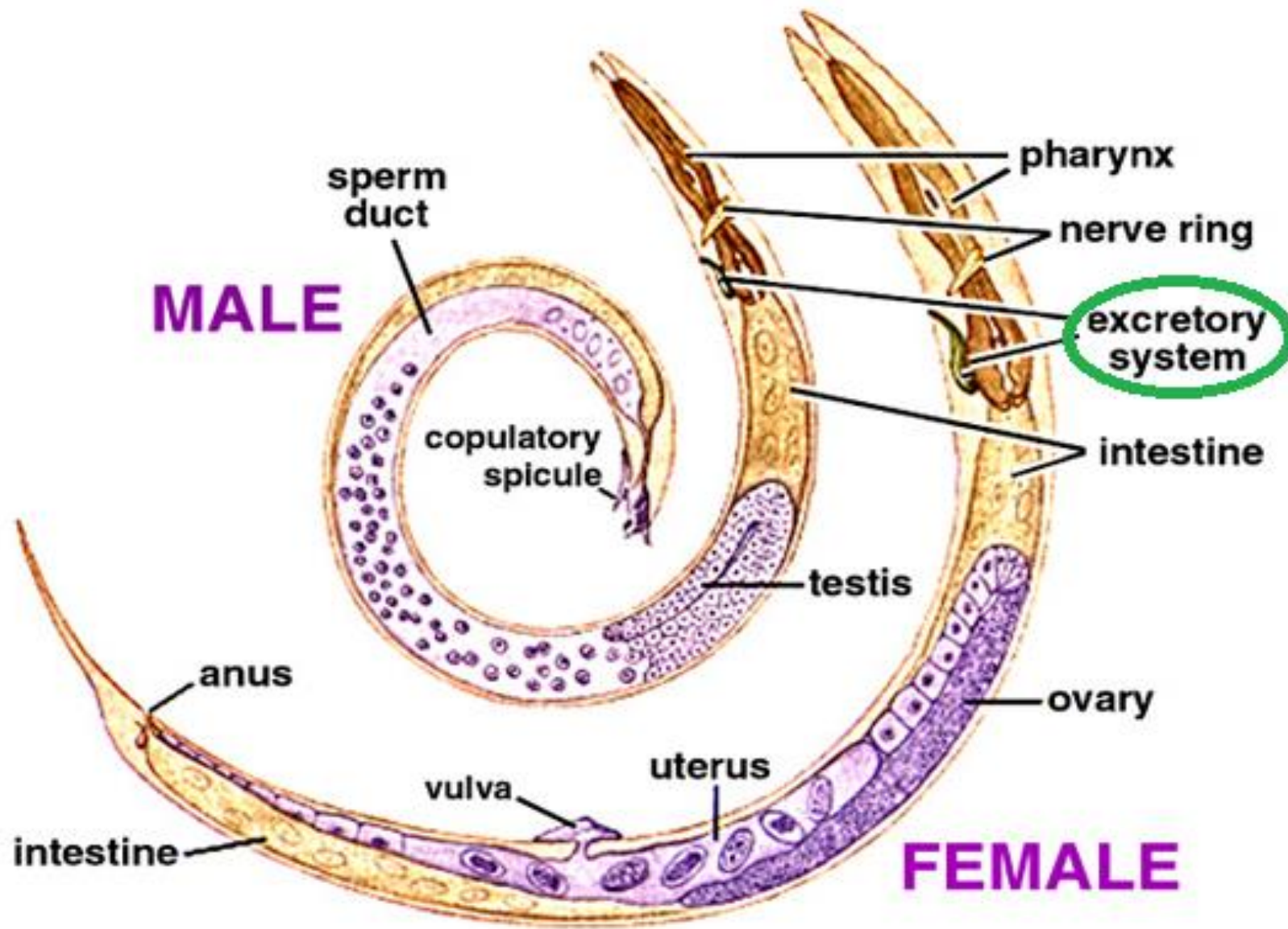


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- The **muscular pharynx pumps fluids** into the digestive system, **preventing the digestive system from collapsing** because of the high body pressure that surrounds it.
- **Pharynx** also **secretes lubricants and digestive enzymes**.
- **Digestion** is mainly **extracellular** and absorption takes place through the thin-walled intestine.

Respiration circulation and excretion:

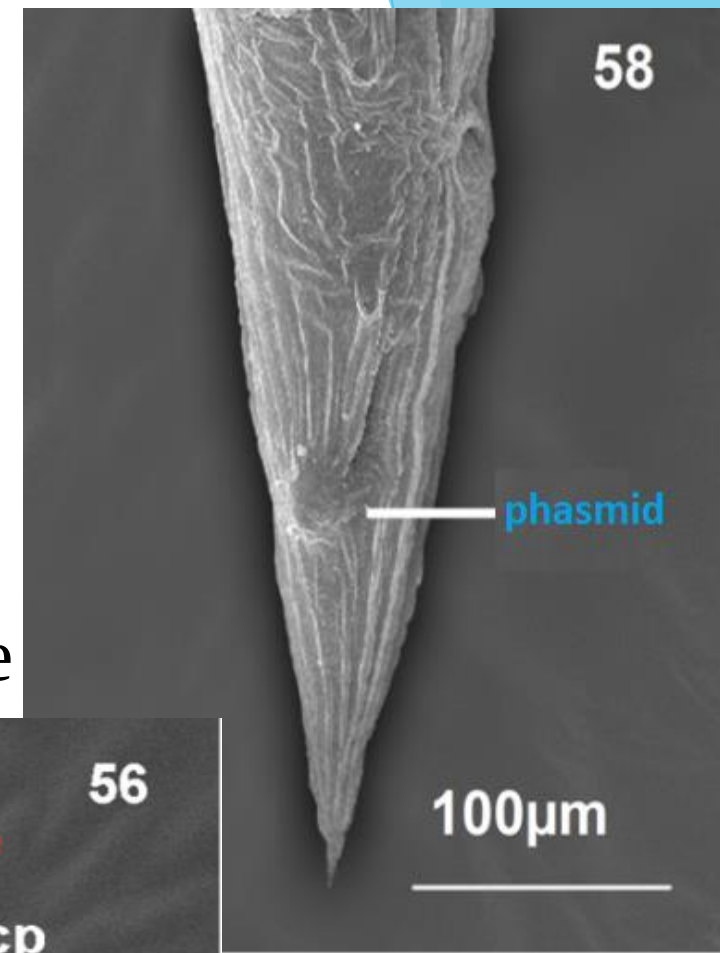
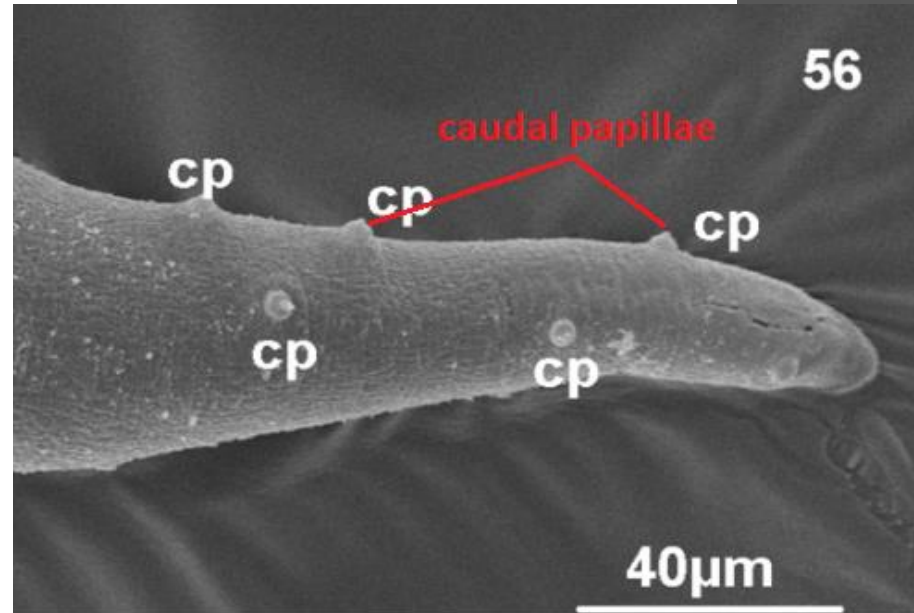
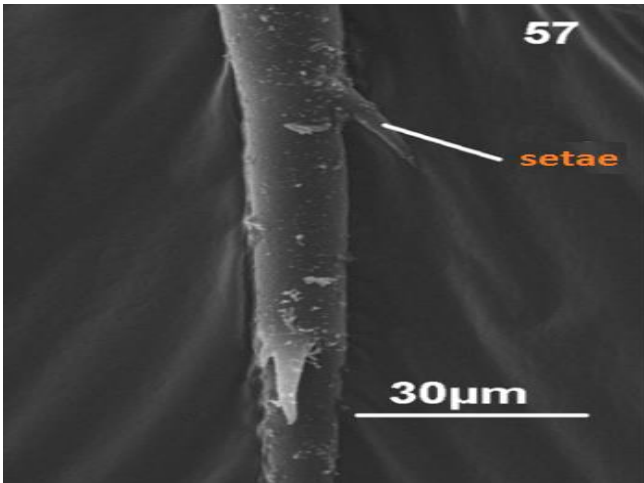
- **No** specialized organs for **gas exchange** (simple diffusion).
- **No specialized circulatory system** and **no nephridia**.
 - **Metabolic wastes** are discharged with other materials leaving the gut **through the anus**.
 - Some metabolic wastes may **diffuse through body wall**.
 - Most nematodes have an excretory gland **called renette**.



Sensory organs:

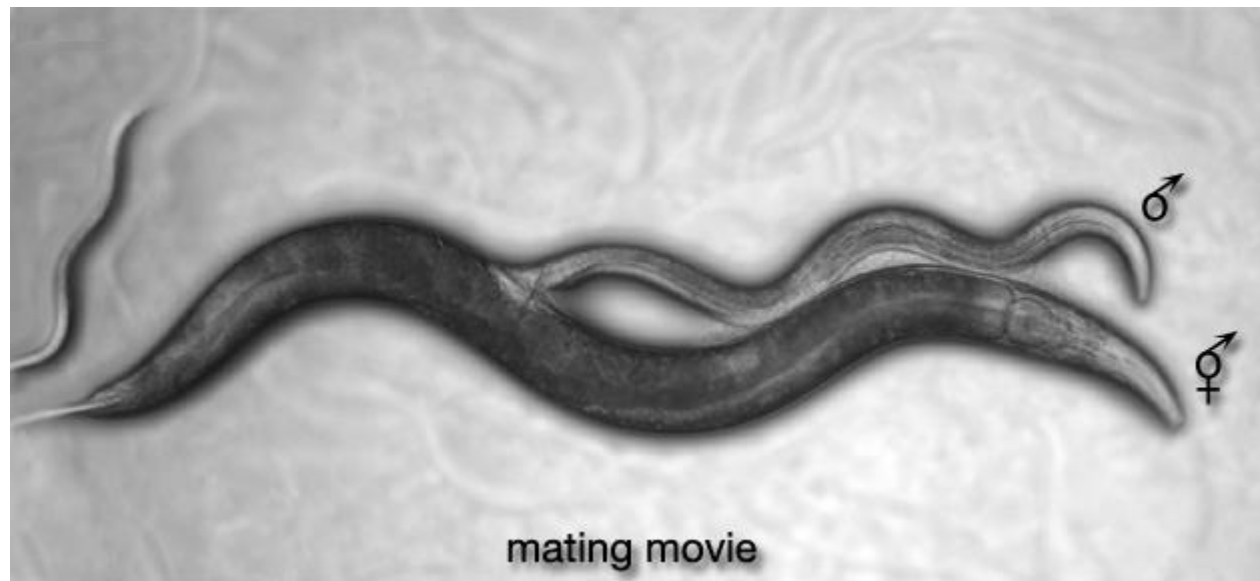
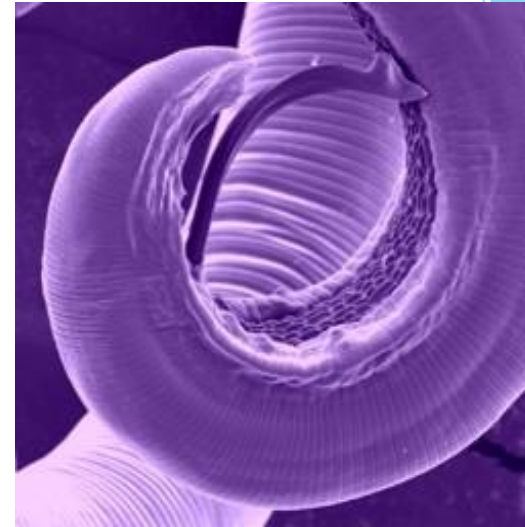
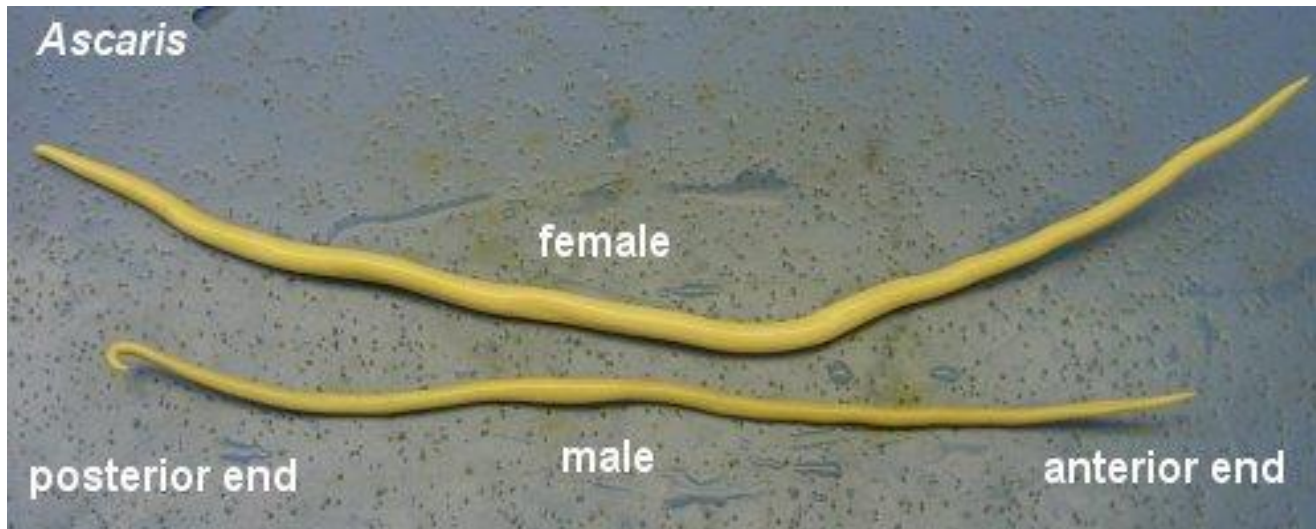
- Various species are known to respond to **temperature, light, mechanical stimuli** and a variety of stimuli including *chemicals produced by other individuals of the same species (pheromones)*.
- Many species have **ocelli**.
- However, the **major chemosensory organs** are the **amphids**.
- ▶ Similar structures of chemoreception are found **posteriorly of some nematodes** and called **phasmids**.

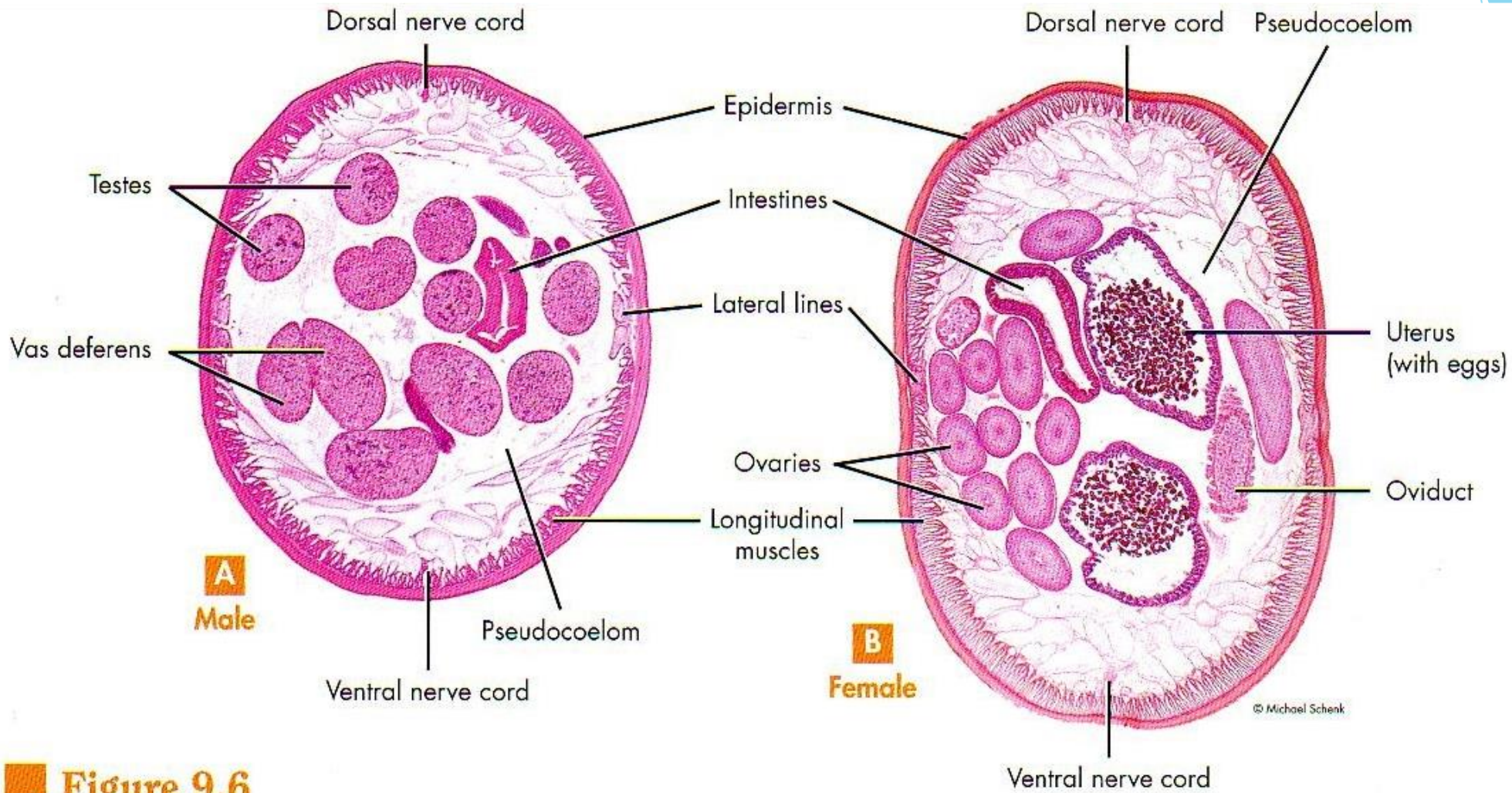
- **Cephalic** (anterior) and **caudal** (posterior) **papillae** are found and thought to be structures sensitive for **mechanical stimulation**.
- Many species have **external setae** at various location of the body; these are thought also to be **mechanoreceptors**.



- *Reproduction & Development:*

- ▶ Most nematodes are **gonochoristic** (separate sexes).
- ▶ **Fertilization** is **internal** (through copulation).
- ▶ Typically, males possess 1-2 **copulatory spicules** posteriorly that are inserted into the female gonopore during sperm transfer.
- ▶ **Sperms** of nematodes are **amoeboid** rather than flagellated.
- ▶ **Lack free-swimming larvae** (Fertilized eggs give rise to miniature worms).





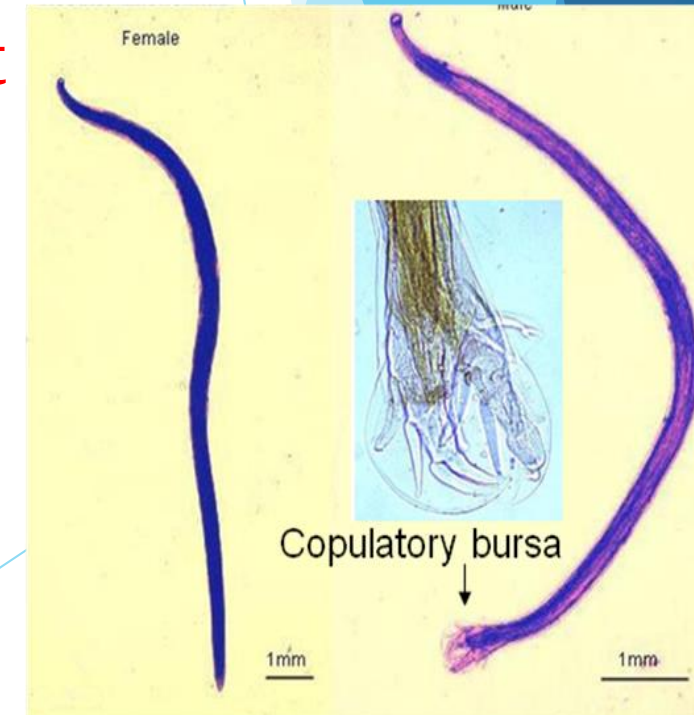
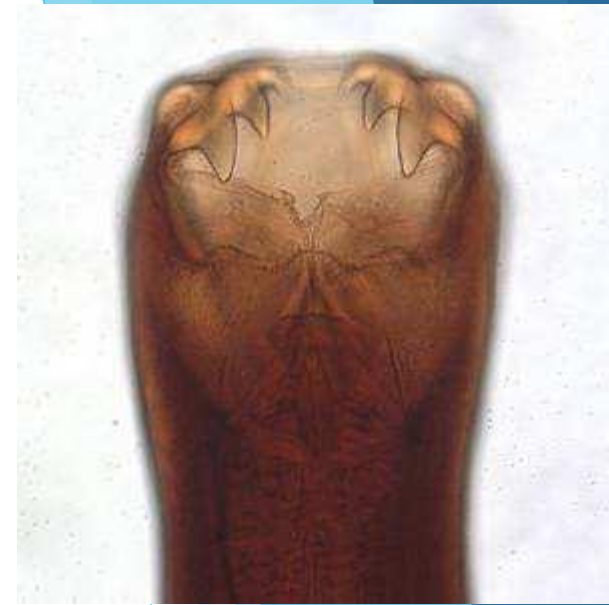
Parasitic nematodes:

- ▶ Nematodes **parasitize every major animal group** (from sponges to mammals).
- ▶ Nematodes are **also parasites of plants** (roots, leaves, stems and flowers).
- ▶ They can cause *serious damage to economically important plants*.
- ▶ Some parasitic nematodes can attain large size (**9 m in the placenta of female sperm whales**).



Bulb and stem nematode damage

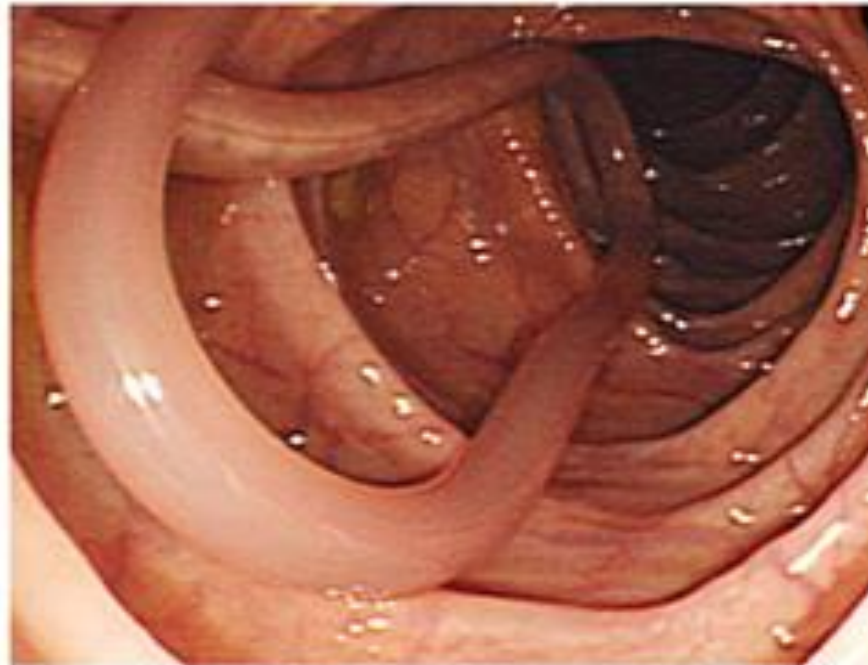
- **Hookworms and pinworms** are two main groups of parasitic nematodes.
- Hookworms include *Ancylostoma duodenale* and *Necator americanus*.
- Some **hookworms** can **suck 0.6 ml/day of the host blood** (this means loss of 60 ml of blood from a person infected with 100 worms).



- Some **Ascarid nematodes**, like *Ascaris*, can **block the intestine** or the **bile duct** of the host.
- Parasitic nematodes can produce huge amounts of eggs (a female *Ascaris* can produce 200,000 fertilized eggs/day).



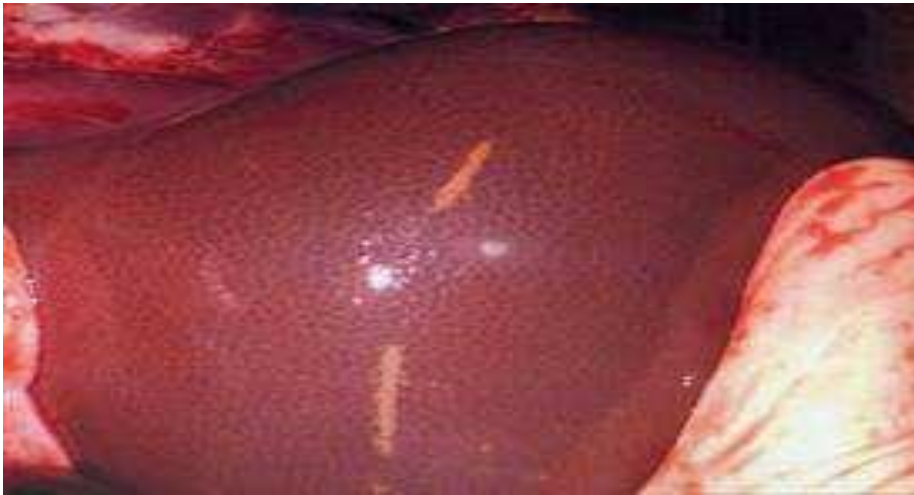
Ascaris lumbricoides roundworms - post-surgery in resected bowel
_Image by Dr. Vikas Arora, India



- Others, **roundworms**, like *Wuchereria* and *Onchocerca*, can plug the lymphatic system causing a disease called **elephantiasis**.



- Many nematodes **make extensive migration** during their development within the host: from intestine→ liver→ heart→ lungs→ esophagus→ back to intestine.
- ▶ This causes damage to these organs.



Ascaris in the liver of a pig

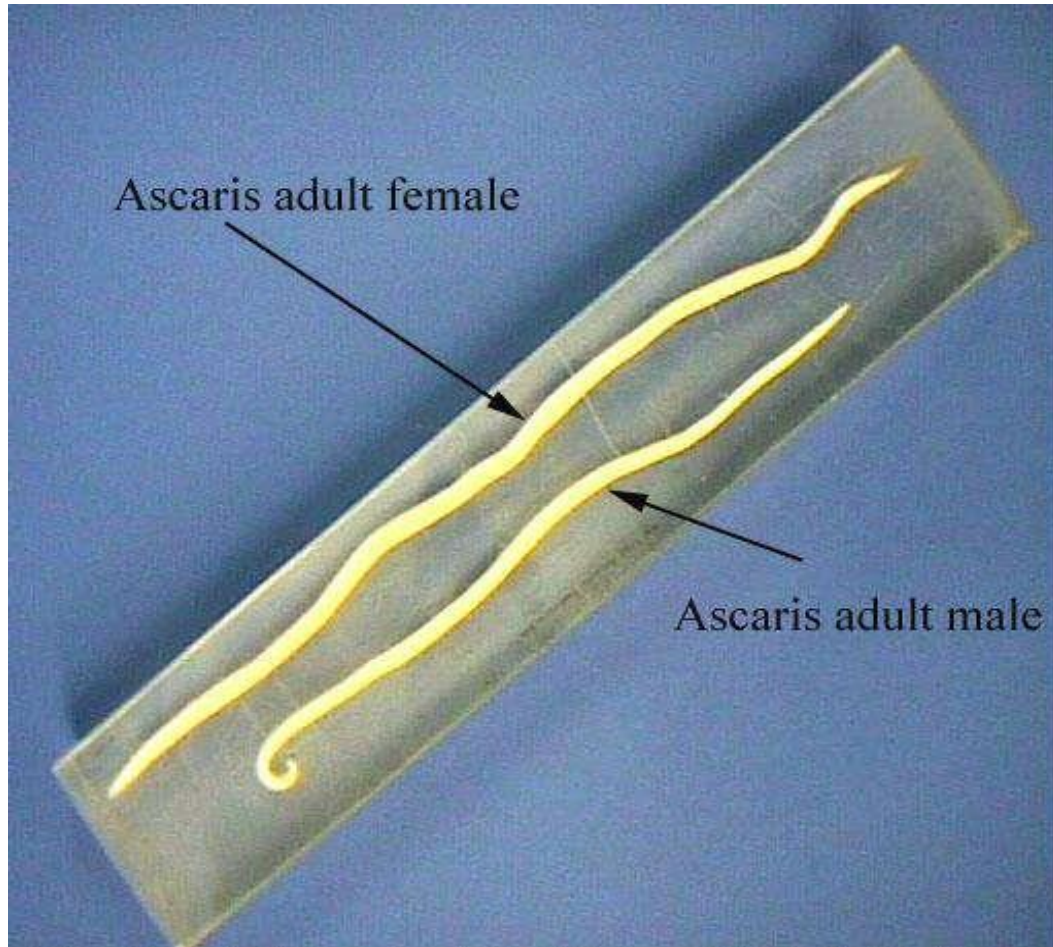
- Larvae of *Onchocerca* often migrate to the **victim's eye** **causing blindness** (This is called **River Blindness** or **onchocerciasis**).
- River blindness **infects about 40 million** people mostly in western Africa.



Examples of Parasitic Nematodes:

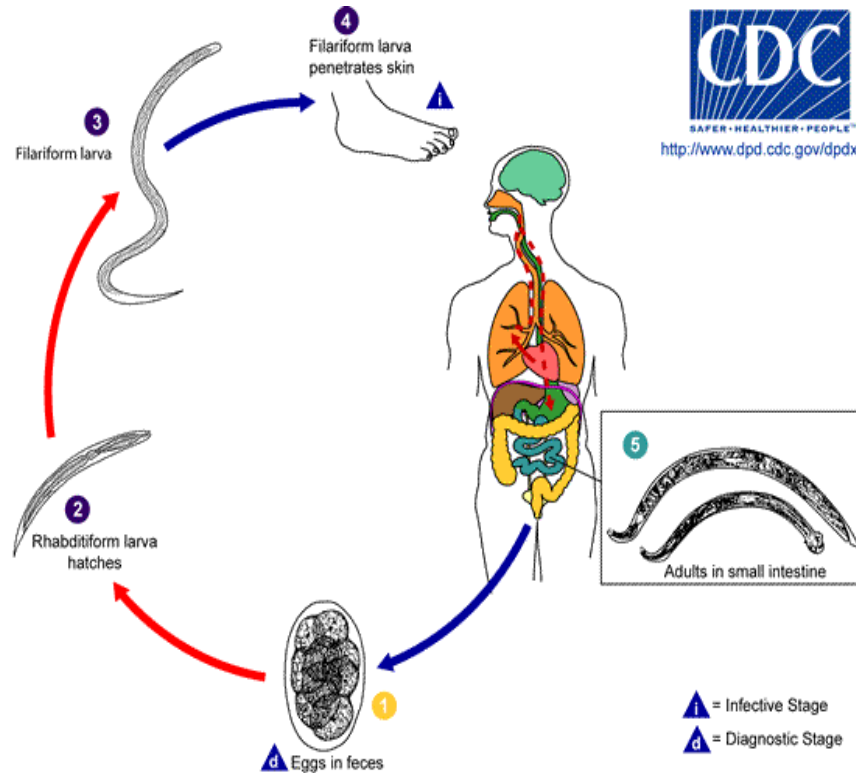
1) *Ascaris lumbricoides*

- The **largest intestinal roundworm** and is the most common helminth infection of humans worldwide, a disease known as ***ascariasis***.
- Causes **malnourishment, intestinal blockage, verminous intoxication.**



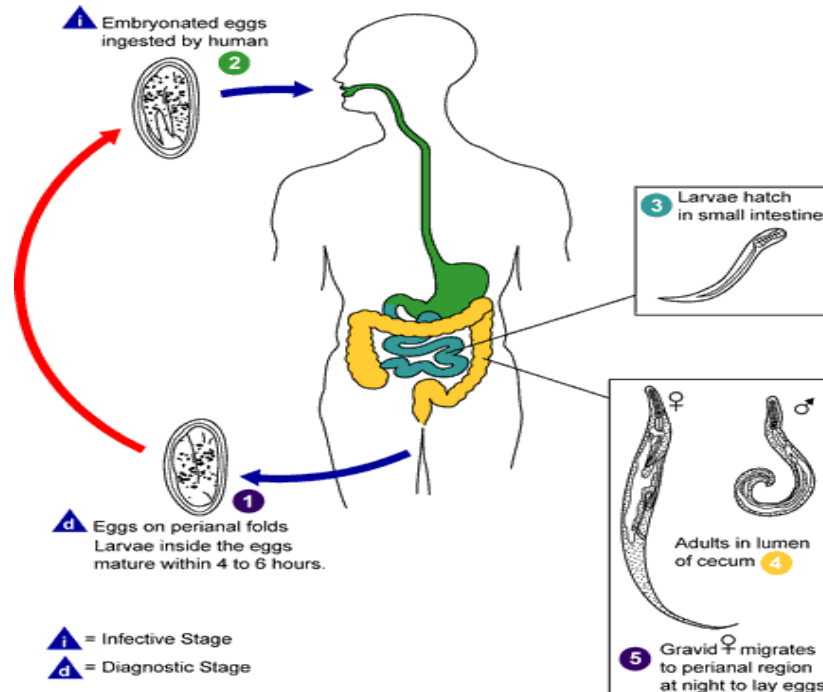
2) American Hookworm: *Necator Americanus*:

- Infects about **1.3 billion people** worldwide.
- Has a simple life cycle with a **single host** (human).
- Lives in the **host's intestine**.



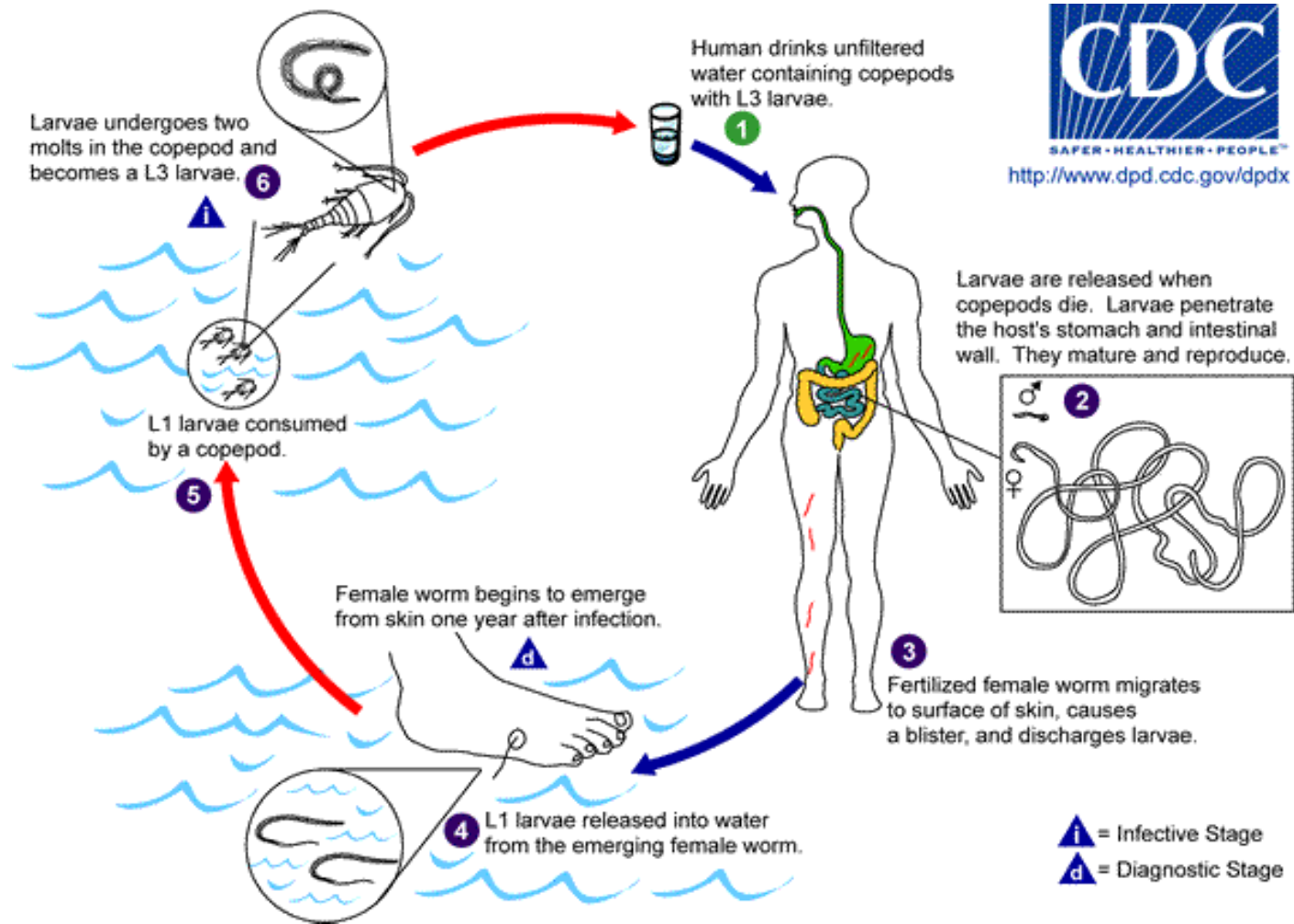
3) Pinworm: *Enterobius vermicularis*;

- Infects in temperate regions **about 500 Million** people mainly children.
- Life cycle involves **no intermediate host**.
- Lives in the **large intestine and the colon**.



4) The guinea worm: *Dracunculus medinensis*.

- ▶ Found in **Africa, South America and Western Asia**.
- ▶ The female is about **1mm thick and 1m or more long**
- ▶ It **lives subcutaneous of humans** (beneath the skin).
- ▶ It releases an **ulcer-producing secretion** to make a small hole in the skin.
- ▶ When skin comes in contact with water (bathing or swimming), the female ejects a considerable # of young (1.5×10^7 /day).



5) *Loa loa* (the African eye worm):

- A **filarial nematode** that produces a characteristic infective stage called **microfilaria**.
- Exhibit a **complex life cycles** that include an **arthropod intermediate host** and extensive migration within the definitive host.



Beneficial nematodes:

- ▶ Some nematodes that require insects and various agricultural pests are increasingly used to **control population size of these pests**.
- ▶ **Most nematodes are free-living** (nonparasitic) detritivores that play a valuable role in **cycling of materials** in ecosystems.
- ▶ Some free-living nematodes serve as **food for aquaculture** animals like: fish, shrimps...

- ▶ Many are used to **monitor environmental** pollution.
- ▶ Some, like ***Caenorhabditis elegans***, are used in **genetics and molecular biology research** because they have few chromosomes.



Classification of Nematodes:

- ▶ Phylum Nematoda (Nemata) includes **3 classes**.

1) Class Enoplia

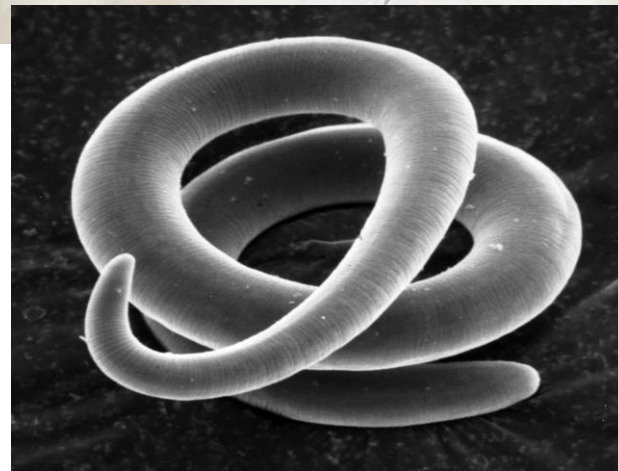
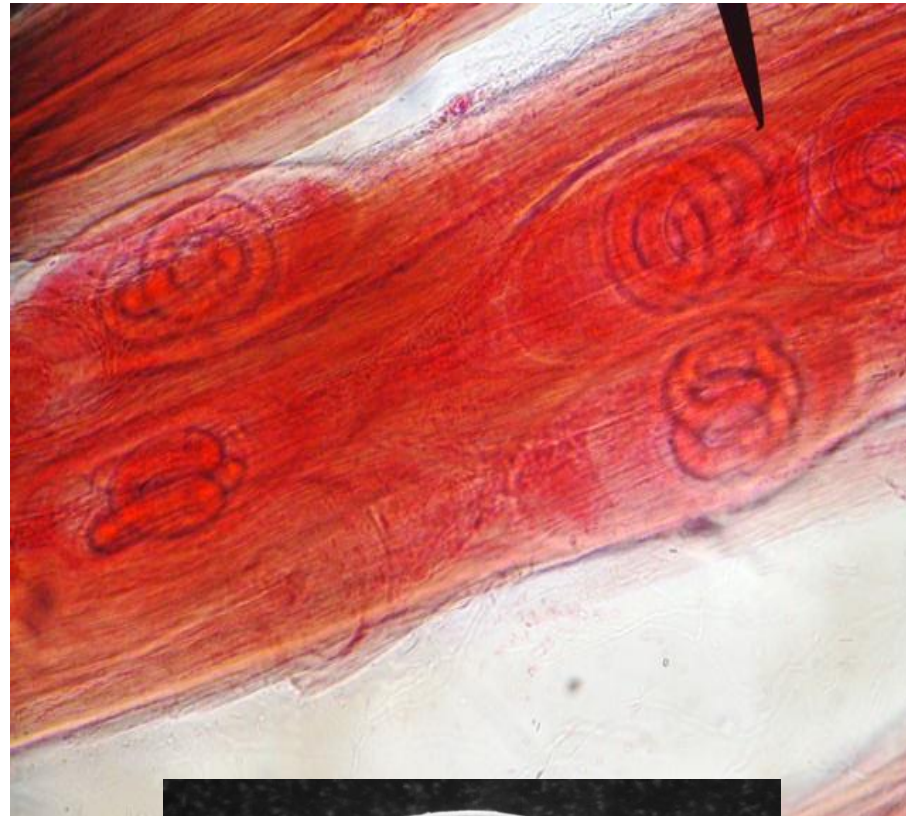
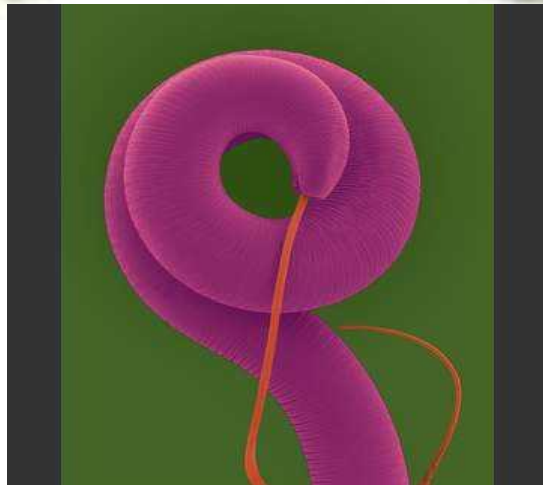
- Free-living and predatory nematodes
- Terrestrial, freshwater and marine.
- No parasitic species.
- Example: *Trichoris*

2) Class Dorylaimia

- Includes many free-living species and a number of plant and animal parasites.
- No marine species.
- Example: *Trichuris trichuis* (whipworm)
Trichinella spiralis



Trichuris



Trichinella

3) Class Chromadorea

- A huge group of great diversity
- Includes **mostly free-living, terrestrial** species and many **marine and freshwater ones**.
- Includes **some parasitic species**.
- *Ascaris, Enterobius, Necator, Ancylostoma, Wuchereria, Brugia, Onchocerca, Loa, Dracunculus.*

End of Chapter 16

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