Chapter 15
Pseudocoelomate Animals

Pseudocoelom

Structure
- The original blastocoel of the embryo persists as a space or cavity between enteron and body wall.
- Since it lacks the peritoneal lining of a true coelom, it is a pseudocoel.
- This defines the pseudocoelomates, a Protostomia division of the bilateral animals.
- They are polyphyletic, derived from more than one acoelomate ancestor.

Fig. 15.1

Biological Contributions
- The pseudocoelom may be filled with fluid or gelatinous material with mesenchyme cells.
- It generally provides greater freedom of movement.
- There is space for more development of digestive, excretory, and reproductive systems.
- It is simpler to distribute materials throughout the body.
- This provides a storage area for waste products to be later discharged.
- As a hydrostatic organ, the cavity is a base for muscles that provide movement.

Diversity
- All have a body wall that is often syncytial, a dermis and muscles surrounding the pseudocoel.
- Digestive tract, gonads and excretory organs are within the pseudocoel bathed in perivisceral fluid.
- In some, the epidermis secretes a nonliving cuticle.
- Eutely is a constant number of cells or nuclei per species, a property in several groups.

Phylum Nematoda: Roundworms

Diversity
- About 12,000 species are described; perhaps a half million exist.
- They live in virtually all habitats in all biomes; topsoil may contain billions per acre.
- Nematode parasites exist in nearly all animal and plant species; they are economically important.
- Free-living nematodes feed on bacteria, yeasts, fungal hyphae and algae.
- Predatory nematodes eat rotifers, tardigrades, small annelids and other nematodes.
- Nematodes are also important as food for mites, insects, larvae and fungi.
- Caenorhabditis elegans is an important model for studies of genomics and cell development and differentiation.
Form and Function

- **Distinguishing Characteristics**
  - They have a cylindrical shape.
  - They have nonliving cuticle.
  - They lack motile cilia or flagella, except for one species.
  - Muscles in the body wall only run longitudinally.
  - They express eutely, a set number of cells.

Muscles

- **Longitudinal muscles lie beneath the cuticle; there are no circular muscles.**
- **Muscles run in four bands, marked off by the four hypodermal cords.** Each muscle cell has a contractile fibrillar portion and a noncontractile sarcoplasmic portion.
- **The sarcoplasmic cell body extends into the pseudocoel and stores glycogen.**
- Unlike other animals, the cell body or muscle arm extends to the ventral or dorsal nerve.

Metabolism

- **Some parasitic adults have an anaerobic metabolism without the Krebs cycle and cytochrome system.**
- **Free-living nematodes and free-living stages of parasitic nematodes or obligate aerobes utilize both the Krebs cycle and cytochrome systems.**

Digestion

- **The alimentary canal consists of mouth, pharynx, a non-muscular intestine, a short rectum and the anus.**
- The pharynx is muscular with a triradiate lumen.
- The pharynx sucks food in.
- The intestine is one cell thick; food moves back as new food enters and the body moves.
- Defecation occurs from opening the anus and allowing the pseudocoelomic pressure to expel it.

Nervous System

- A ring of nerve tissue and ganglia around the pharynx lead to dorsal and ventral nerve cords.
- Sensory papillae are at the head and tail; amphids are a pair of sensory organs on head and lead into a deep cuticular pit with modified cilia.
- Amphids are thought to be chemoreceptors, but actual function is unknown at present.
Most nematodes are dioecious with males smaller than females; the male has copulatory spicules to hold the female vulva open against hydrostatic pressure.

Fertilization is internal and eggs are stored in the uterus until deposited.

The cuticle is shed between each of four juvenile stages.

Some nematodes are important pathogens of humans; most are tropical.

**Ascaris lumbricoides:** The Large Roundworm of Humans

- *Ascaris lumbricoides* occurs in up to 64% of people in some areas of the southeastern U.S.
- More than 1.2 billion are affected worldwide.
- *A. megalocephala* is found in the intestines of horses, *A. suum* is found in pig intestines.

A female *Ascaris* lays 200,000 eggs a day, passing out in the host's feces.

Embryonic development completes in two weeks. Viable eggs remain after signs of fecal matter have disappeared; eggs survive long periods in soil.

When a host swallows embryonated eggs, juveniles hatch and burrow through intestinal wall. Carried through the heart to the lungs, they break into the alveoli and are carried up to the tracheae. Coughed up and swallowed, they mature in the intestine two months after they were swallowed.

They feed on intestinal contents and may block or perforate the intestines.

**Hookworms**

- The anterior end has a hook-like curve.
- *Necator americanus* is most common
- The males and females are separate.
- Large plates in their mouths cut into intestine; then suck the host’s blood.
- They pump through more blood than they digest; heavy infections cause anemia.
- Eggs pass in feces and juveniles hatch in soil where they live on bacteria.
- When skin comes in contact with soil, infective larvae burrow through to blood.
- Like *Ascaris*, they travel in blood to lungs, are coughed up then swallowed, and mature in the intestine.
**Trichinella**

- *Trichinella spiralis* is tiny but causes a potentially lethal infection.
- Adults burrow into the intestinal mucosa and females directly produce juvenile worms.
- Juveniles penetrate blood vessels and circulate throughout the body to all tissues and spaces.
- They penetrate skeletal muscle cells, redirecting gene expression of the musculature so it loses its striations and becomes a nurse cell to the parasite.
- When meat containing live juveniles is eaten, worms are liberated and mature in the intestine.
- They infect humans, hogs, rats, cats and dogs; hogs can become infected eating uncooked scraps of infected meat or rats.
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- There are four other sibling species with variable distribution, freezing resistance, etc.
- Heavy infections cause death; about 2.4% of the U.S. population is infected, mostly lightly.

**Pinworms**

- It is the most common helminth parasite in the U.S. but causes little disease.
- Adults live in the large intestine and rectum.
- Females, about 12 mm long, migrate to the anal region at night and lay eggs, causing itching.
- Scratching the anal region contaminates hands and bedclothes.
- Eggs develop rapidly and become infective within six hours at body temperature.
- When swallowed, they hatch in the duodenum and mature in the large intestine.
- Members of this order have haploid males from unfertilized eggs; females are diploid and come from fertilized eggs (*haplodiplody*).

**Filarial Worm Diseases**

- Elephantiasis is caused by repeated exposure; swelling and growth of connective tissue causes enormous swelling of body parts.
- Dog heartworm, *Dirofilaria immitis*, is carried by mosquitoes and is most common U.S. filarial worm.
- River blindness or onchocerciasis is carried by black flies and infects 30 million people in tropics.
- Lymphatic filariasis, also known as elephantiasis, is best known from dramatic photos of people with grossly enlarged or swollen arms and legs. The disease is caused by parasitic worms, including *Wuchereria bancrofti*, *Brugia malayi*, and *B. timori*, all transmitted by mosquitoes. Lymphatic filariasis currently affects 120 million people worldwide, and 40 million of these people have serious disease.
Elephantiasis Victims

Elephantasis

Heart worms

Phylum Nematomorpha

- “Horsehair worms” resemble coarse hairs.
- Adult structures resemble those of nematodes: cuticle, epidermal cords, only longitudinal muscles, and a nervous system.
- About 250 species are known; they occur worldwide.
- Adults are free-living in moist habitats; juveniles are parasites of arthropods.
- Gordius encysts on vegetation that will be eaten by grasshoppers; marine forms occur in crabs.

Form and Function

- They range from 10 to 70 cm long but only 0.3 to 2.5 mm in diameter.
- The anterior end is rounded, the posterior end has two or three caudal lobes.
- The body wall resembles that of nematodes but lateral hypodermal cords are absent.

Form and Function (continued)

- The ventral nerve cord is connected to the ventral hypodermal cord by nervous lamellae.
- The digestive system is vestigial; larvae absorb food from arthropod hosts and adults live on these stored nutrients.
- Circulatory, respiratory and excretory systems are lacking.
- Juveniles only emerge from the arthropod host when water is nearby.
- Each sex has paired gonads and gonoducts that empty into a cloaca.
- Females discharge eggs into water; juveniles hatch and gain entry to the arthropod host.
- After months in an arthropod host, the mature worm emerges into nearby water or during rainfall.
- Somehow, the parasite stimulates terrestrial insects to seek water.

Phylum Rotifera

Characteristics

- Rotifers have a ciliated crown, the corona, that beats like a rotating wheel.
- Rotifers are highly diverse in color, size and shape; some are colonial.
- Floaters are globular, creepers are elongated and sessile forms are vase-like.
- Rotifers are found worldwide with over 1800 species known.
- Most are freshwater species but a few are marine, terrestrial or parasitic.
- Aquatic species are mostly benthic but some are pelagic.
- Cyclomorphosis is a regular variation in body form to accommodate seasonal and food changes.
- Many endure dessication and temperature changes by encystment.
Diversity in Rotifers

Form and Function

A rotifer body has a head, trunk and tail; only the corona is ciliated.

The ciliated corona or crown surrounds a nonciliated central area with sensory bristles and a mouth.

The corona is often a pair of trochal discs, beating of the cilia help in feeding and locomotion.

Some have a secreted cuticle and all have a fibrous epidermis layer, and a lorica that may be case-like.

The narrow foot has one to four toes and it may be retractile; it attaches with pedal glands that secrete an adhesive.

Internal Features

Under the cuticle, a syncytial epidermis secretes cuticle and bands of subepidermal muscles.

The pseudocoel is large, filled with fluid and a network of mesenchymal ameboid cells.

Digestion

Coronal cilia sort out larger unsuitable particles.

The mastax is a muscular pharynx equipped with hard jaws, the trophi.

Trappers have a funnel-shaped area around the mouth; side lobes fold inward to entrap prey.

Hunters project trophi to seize prey.

Salivary and gastric glands secrete enzymes for extracellular digestion.

The stomach absorbs nutrients.

Excretion

A pair of protonephridial tubules has flame cells and empty into a common bladder.

The bladder pulsates and empties into the cloaca.

Osmoregulation is important in both freshwater and marine species; water enters by the mouth.

Nervous System

A bilobed brain is dorsal to the mastax with paired nerves leading off to the organs.

Sensory organs include eyespots, sensory bristles and papillae, and ciliated pits and dorsal antennae.
Reproduction

- Rotifers are dioecious; males are smaller than females.
- In some classes, males are unknown, and in others, males occur only briefly.
- Female systems may provide yolk to developing ova by cytoplasmic bridges.
- Bdelloidea females are parthenogenetic, producing diploid eggs that hatch into diploid females.
- Males have a single testis and ciliated sperm duct running to a genital pore and copulatory organ.
- Mating is by hypodermic penetration; sperm are injected into the pseudocoel of the female.
- Females hatch with adult features and mature in a few days; males are mature at hatching.

Nuclear Constancy

- Most structures in rotifers are syncytial; the nuclei are remarkably constant in number.
- One species always has 183 nuclei in the brain, 39 in the stomach, 172 in the corona, etc.
- Organisms with eutely have precise control of nuclear division with programmed division.

Adaptive Radiation

- Nematodes are by far the most adaptive of this set of organisms, mostly due to their ability to survive suboptimal conditions.
- A wide range of unusual strategies including cryptobiosis, hermaphroditism, alternation of generations, etc. has helped keep some groups extant and adapted.