BIOL 2015 – Evolution and Diversity

Lab 8: Lophotrochozoa – Part I:

Platyhelminthes, Rotifera, Bryozoa, and Brachiopoda

Introduction

Last week we studied the porifera and the cnideria. Sponges lack true tissue and any symmetrical organization of the body, while cnideria has true tissue (with two germ layers) and radial symmetry. Today we begin the study of the animals with **bilateral symmetry (Bilateria)**. All bilateral animals have three germ layers (endoderm, mesoderm and ectoderm). The bilateria are divided into two major groups (see Figure 1), the **protostomes** and the **deuterostomes** (these names refer to where the mouth forms in the early embryo. See Figure 32.7 of your 2010 textbook).

The animal phylogeny has been revolutionized in the last 15 years by molecular phylogenetic studies, which have changed many of the accepted relationships that were based solely on morphological data. One such group is the Lophotrochozoa (Figure 1), which are a large group of animals within the protostomes and will be our focus for the next two labs. Figure 2 shows a more detailed phylogeny of the major groups in the Lophotrochozoa – they are diverse! The name Lophotrochozoa comes from the names of the two major animal groups included: the Lophophorata and the Trochozoa.

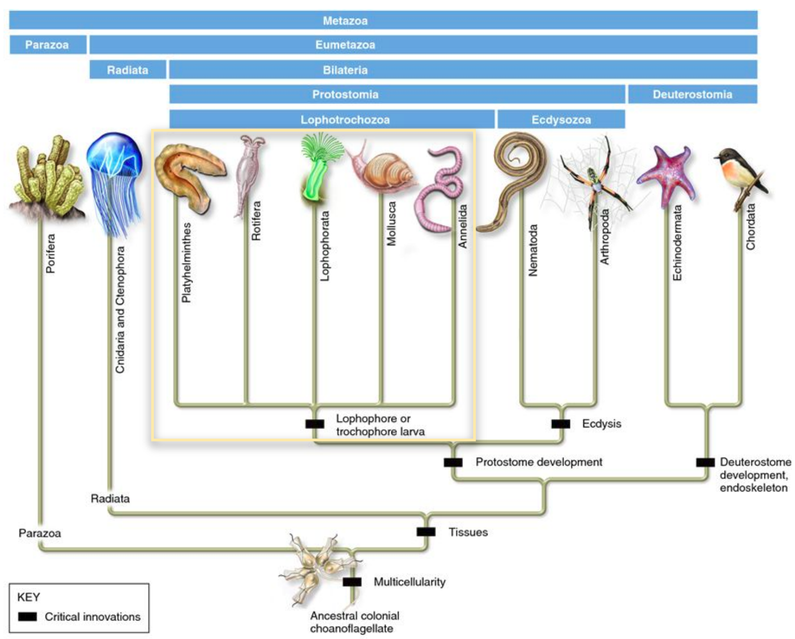


Figure 1. A simplified phylogenetic tree of animals.

Trochozoa: Many of the members are worm-like, though not all of them are familiar or common. The two largest groups of trochozoans are the Mollusca (mollusks) and the Annelida (segmented worms).

It might seem strange at first to group earthworms and squids together. They certainly don't look much alike, but that is only true when looking at the adult form; they share a fundamental feature of their life

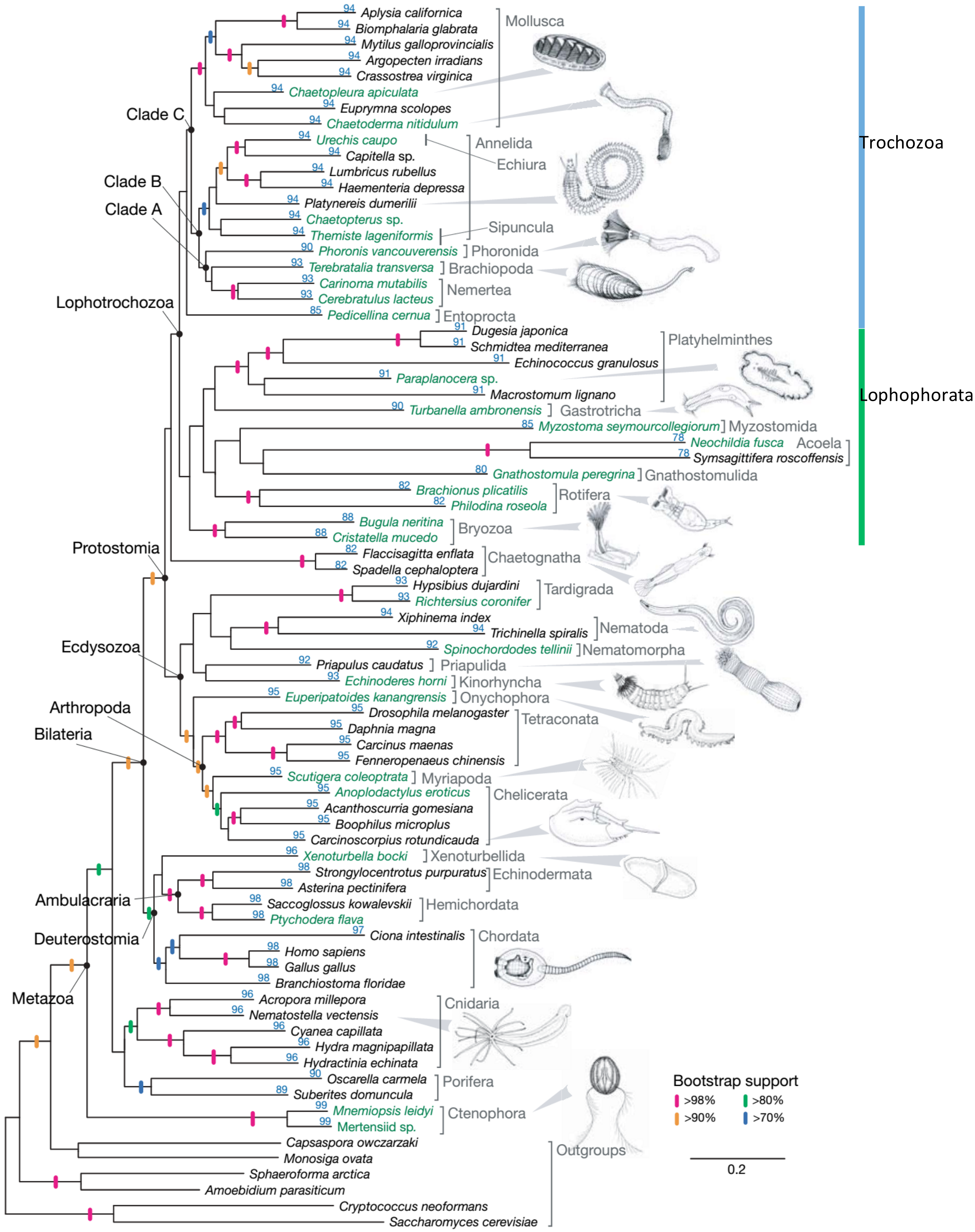


Figure 2. A phylogenetic tree based on DNA data. Dunn et al. 2008.

history. Many annelids and mollusks share patterns of development in early embryonic stages. When their larvae hatch, each is a microscopic swimmer known as a **trochophore larva**. The larva has two bands of cilia around the middle that are used for swimming and for gathering food, and at the "top" is a cluster of longer flagellae. So the larvae of these groups are nearly identical, even though they mature into very different adult forms. Until very recently, the Arthropoda (insects & crustaceans) were considered close relatives of the Annelida, based on the fact that both groups are segmented, but no arthropod has a trochophore larva and no molecular studies support a close relationship between them.

Lophophorata: This group includes the phyla Phoronida, Entoprocta (both small groups), Bryozoa (formerly called Ectoprocta) and Brachiopoda, with the latter two having an extensive fossil record. The feature shared by this group is the **lophophore**, an unusual feeding appendage bearing hollow tentacles.

While the Lophophorata are a well-recognized group, phylogenetic studies do not yet agree on the identity of their closest relatives. These animals were once included in the Pseudocoelomata, because they do not have a distinct internal body cavity like the Trochozoa, but this grouping does not hold together in modern studies.

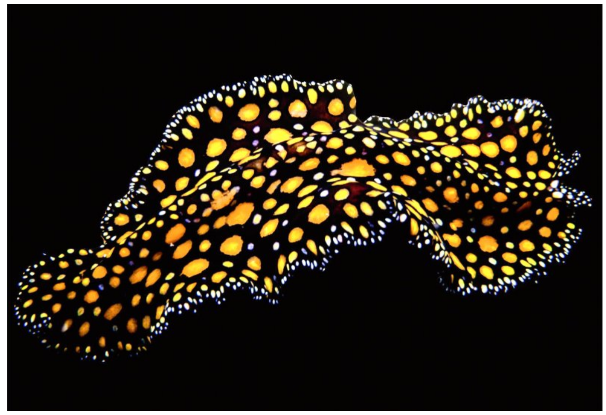
Platyhelminthes (Flatworms)

Flatworms are anatomically simple compared to nematodes and annelids. They lack circulatory and respiratory systems. Many members of this phylum are parasitic (e.g., flukes and tapeworms) but there are also a number of species that are free-living, like the planarians we will have in lab this week. These non-parasitic Platyhelminthes are found in fresh water, marine and in some terrestrial environments and are fun to watch.

Flatworm features:

- **Three tissue layers in embryo.** Almost all animals share this basic feature; the sponges and cnidarians are exceptions.
- **Acoelomate:** Flatworms don't have any kind of coelom or pseudocoelom; their bodies are basically solid. This simple body structure led biologists to believe that the phylum Platyhelminthes branched off from the rest of the animals before the evolution of the coelom. However, new phylogenetic studies have led some researchers to conclude that flatworms descended from an ancestor that had a coelom, and later lost the coelom.
- **Gastrovascular cavity:** The digestive tract has only one opening, and branches throughout the body. Flatworms have extracellular digestion, like most animals (but unlike sponges).
- **Pharynx**: a muscular tube through which the flatworm can suck food into its gastrovascular cavity. The opening into the pharynx could be considered the mouth, but since this animal has a two-way gut, that opening also must function as the anus.

Trepaxonemata



There are approximately 4,500 species of planarians. Most are free-living and marine, although you can also find them in fresh water and on land. Many are predators, they feed on protozoans, small invertebrates or dead animals. The can clone themselves by longitudinal or transversal partitioning; they are also hermaphrodites.

Dugesia (Planarians)

Observe living *Dugesia* at a dissecting microscope. Notice the flattened bodies of these animals, and their graceful movements. A thick mucous coating and densely ciliated epidermis on their ventral side allows them to glide along surfaces. Also note that they have a “head-end” where photosensitive **eyespots** or **ocelli** are located (lending the *Dugesia* a "cross-eyed" appearance), which help them avoid bright light.

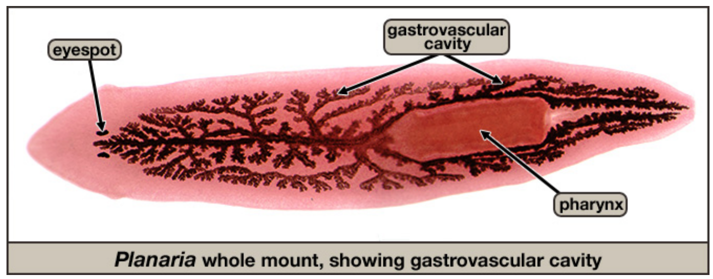


Figure 3. A whole mount view of a *Planaria*.

Find the following slides:

- **Find a prepared slide labeled "*Planaria* w.m.".**
- **Find a prepared slide labeled "*Planaria* combination w.m.".**
- **Find a prepared slide labeled "*Planaria* c.s.".**

This specimen is stained to highlight the **gastrovascular cavity**, showing the small branches called **diverticula**. Note that there is one main branch of the gastrovascular cavity in the anterior part of the body, but two main branches posterior to the **pharynx**.

The **eyespots** are simple and don't form an image; that's why they are called eyespots instead of eyes. However, they are slightly cup-shaped and face toward the sides. With this arrangement, the flatworm can tell light from dark and move toward the dark. Cup-shaped

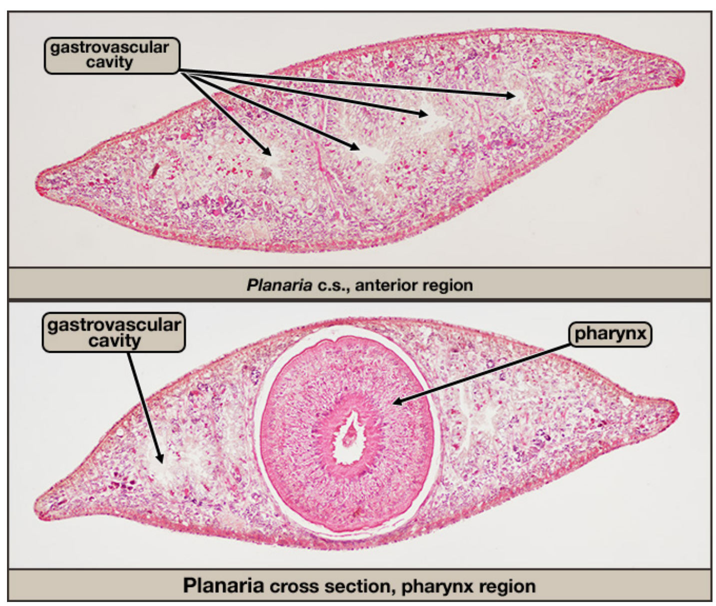


Figure 4. Cross-section views of *Planaria.*

eyes are just one step in the transition from photoreceptive cells to eye balls.

***Planaria* cross sections:** This microscope slide has several different cross sections of a *Planaria*, showing different regions of the body. On the ventral surfaces you can observe cilia used for locomotion.

Anterior region: This section anterior to (in front of) the pharynx. The body is more or less solid; the only openings are the diverticula of the gastrovascular cavity.

Pharynx region: This cross section shows the **pharynx**, which is retracted into the **pharyngeal cavity** (the empty white space surrounding the pharynx). The pharynx itself is a thick, muscular tube; when *Planaria* eats, it everts the pharynx, sticking it out of the body to suck up bits of food.

Posterior region: The gastrovascular cavity is divided into two main branches, with smaller diverticula. The vertical pink lines are dorsoventral **muscles**.

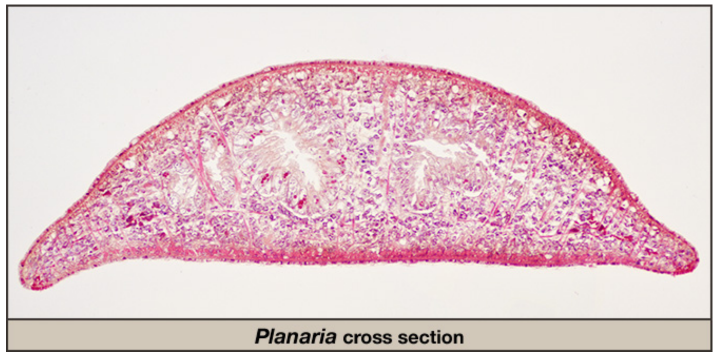


Figure 5. Cross-section of the posterior region of *Planaria.*

Trematoda (Flukes)

The flatworms of the class Trematoda, also called flukes, are internal parasites of mollusks and vertebrates. There are approximately 18,000 to 24,000 species. They have oral suckers, sometimes supplemented by hooks, with which they attach to their vertebrate hosts. Trematodes have retained the same body form and digestive cavity as the turbellarians. However, practically the entire interior is occupied by the reproductive system; these organisms are capable of producing huge numbers of offspring. Trematodes of the order Digenea have complex life cycles involving two or more hosts. The larval worms occupy small animals, typically snails and fish, and the adult worms are internal parasites of vertebrates. Many species, such as the liver fluke *Clonorchis sinensis* and the blood fluke (*Schistosoma*), cause serious diseases in humans.

Clonorchis sinensis (Chinese Liver Fluke)

Find a prepared slide labeled "*Clonorchis sinensis* w.m.".

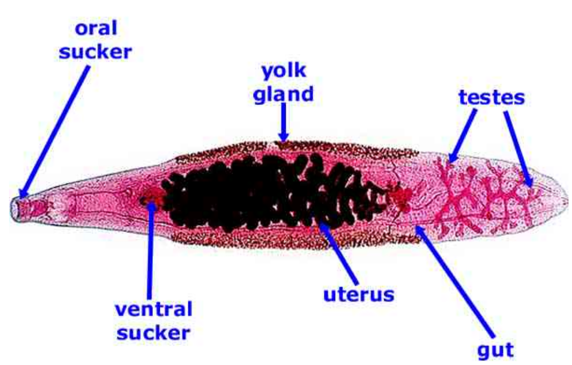


Figure 6. A whole mount view of the Chinese liver fluke.

Some of these slides contain larger animals, some smaller ones – make sure to look at both.

Find the **oral sucker**; the **acetabulum** or **ventral sucker**; and the paired and elongate **intestines** (labeled "gut" in Figure 6). Note that it has reduced digestive system and also, how much of the space within the adult fluke is devoted to reproduction.

Notice also that Trematodes have both male and female reproductive organs (they are hermaphrodites). The large uterus (not homologous with our uterus) is filled with eggs and is located anterior to the testes, which produce sperm. Why do you think that the organism invests so much energy on reproduction?

Fasciola hepatica (Common Liver *Fluke*)

The common liver fluke or sheep liver fluke is globally distributed, and infects the livers of various mammals, including humans. *Fasciola* has a complex life cycle with multiple intermediate stages and hosts (Figure 7). The disease caused by the fluke is called **fascioliasis** and causes great economic losses in sheep and cattle. Observe the preserved specimens of *Fasciola hepatica* on display and be able to identify it.

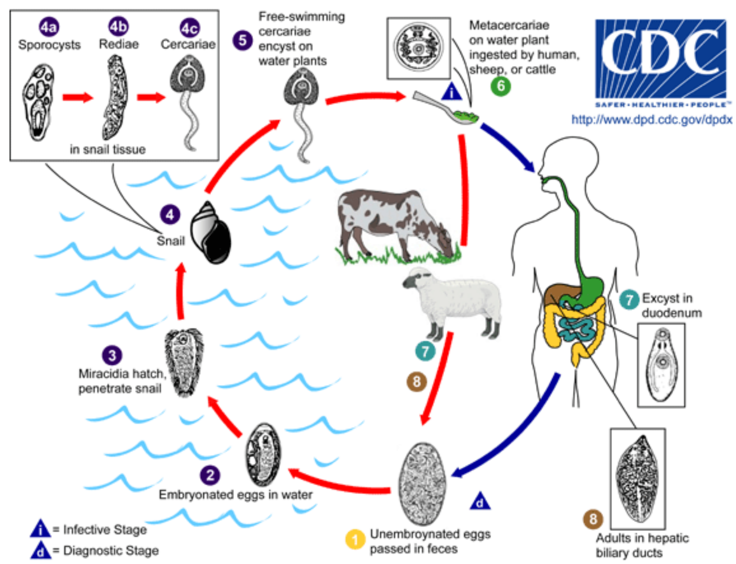


Figure 7. *Fasciola* life cycle.

Find a prepared slide labeled "*Fasciola hepatica* miracidia w.m.".

Fasciola take on different forms depending on the stage of their life cycle. **Miracidia** are the free-living motile form, covered with cilia, and settle into a mollusk host. They are small and variable in form, so observe more than one.

Find a prepared slide labeled "*Fasciola hepatica* rediae w.m." and "*Fasciola hepatica* metacercaria w.m." to see what form this parasite takes in its intermediate hosts (Figure 7).

***Schistosoma mansoni* - Blood Fluke**

This fluke causes the disease **schistosomiasis**, which affects more than 20 million people a year. Schistosomes are atypical trematodes in that the adult stages have two sexes (dioecious) and are located in blood vessels of the definitive host (most other trematodes are hermaphroditic and are found in the intestinal tract or in organs, such as the liver). Schistosomes have two hosts: a definitive host (i.e. human) where the parasite undergoes sexual reproduction, and a single intermediate snail host where there are a number of asexual reproductive stages.

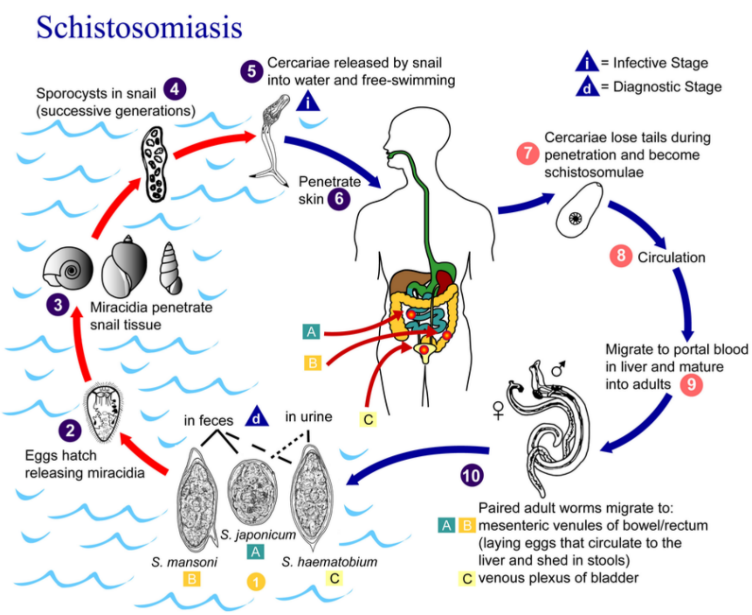


Figure 8. Life cycle of *Schistosoma mansoni.*

Find a prepared slide (demonstration) labeled "*Schistosoma mansoni* male and female w.m.". You will observe a pair of mating flukes. During copulation, the female is held in a special channel (the **gynecophoral groove**).

Cestoda (Tapeworms)

Cestoda is the name given to a class of parasitic flatworms, commonly called tapeworms. As adults they live in the digestive tract of vertebrates, and often in the bodies of various animals as juveniles. Over a thousand species have been described, and all vertebrate species can be parasitized by at least one species of tapeworm! Infection in humans occurs because of consumption of improperly cooked or processed meat (pork, beef, or fish, for example). *Taenia saginata*, the beef tapeworm, can grow up to 20 m in the gut of its host, but the whale tapeworm, *Polygonoporus giganticus*, can grow to over 30 m! Cestode eggs have even been discovered in fossil shark feces (coprolites) dating to the mid- to late Permian, some 270 mya.

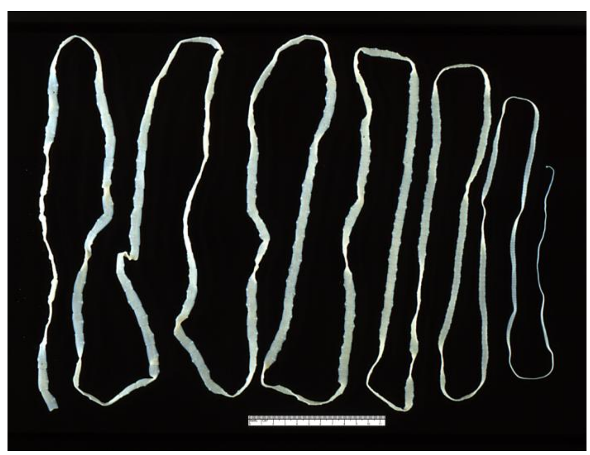


Figure 9. This is an adult *Taenia saginata* tapeworm. Which side is the head?

Tapeworms lack a digestive track. All nutrients are absorbed directly through the body surface. The host's digestive enzymes do all the work. The head region, or **scolex**, is modified for attachment to the intestinal wall. The scolex has suckers, and often has a ring of hooks as well.

Most of the tapeworm's body consists of repeated segments called **proglottids** (although it's not an example of true segmentation). Each proglottid is a self-contained packet containing mostly reproductive organs. New proglottids are produced near the scolex. The most mature proglottids are at the opposite end of the animal.

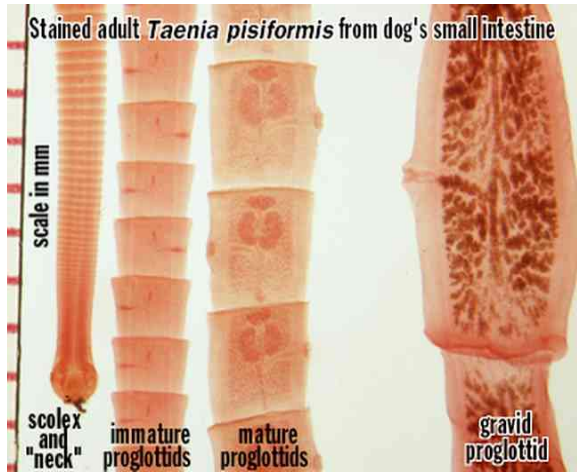


Figure 10. Stained adult *Taenia pisiformis.*

Find the prepared slides labeled "*Taenia pisiformis* scolex w.m." and "*Taenia pisiformis* mature and gravid w.m.". On the former observe the suckers and hooks, on the latter observe how much of the body is devoted to the reproductive structures. Also note how the "segments" called proglottids change shape over the length of the animal.

Rotifera

Bdelloidea

Rotifera means "wheel bearer". They are generally microscopic (barely seen with the naked eye), with two main distinguishing features. The first is an anterior region called the **corona** that is used in feeding and in locomotion. The second is a muscular pharynx (called a **mastax**) that possesses complex jaws known as **trophi**. Rotifers are pseudocelomates

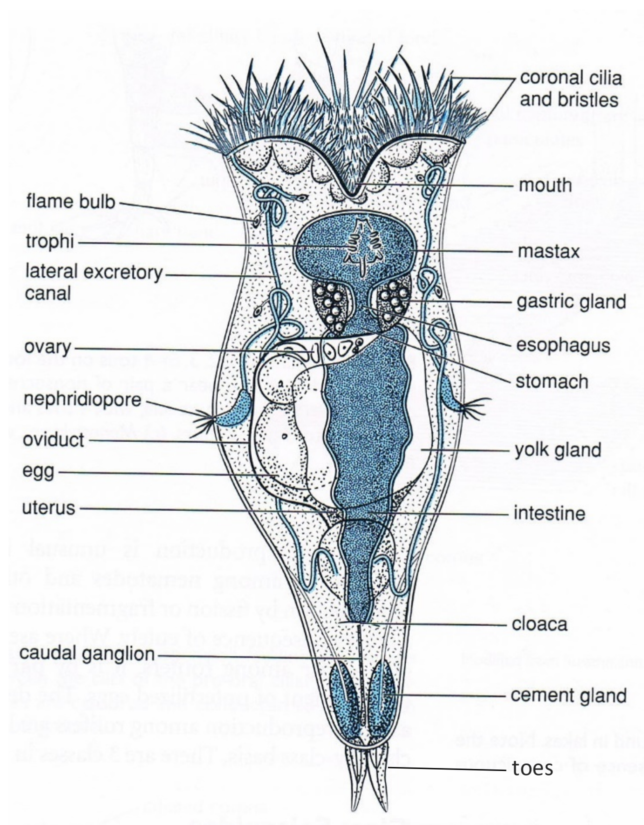


Figure 11. A schematic drawing of a rotifer.

Examine the live specimens and the prepared slides of a rotifer to familiarize yourself with their functional morphology. Note the 3 general regions: **head**, **body** and **foot (and toes)**. Observe a live specimen at increasingly higher magnification, ultimately aiming to observe the pattern of ciliation on the corona.

As in many freshwater organisms, many rotifers possess remarkable adaptations to withstand periods of drought and/or cold temperatures. The most notable of these are their ability to undergo **parthenogenesis** (growth and development of eggs without fertilization) and produce resting eggs. Many species have the ability to undergo **anhydrobioisis**, a resting stage that occurs during dry conditions in which the animal can survive completely desiccated for long periods of time.

Find a prepared slide labeled "Rotifers w.m.". Find the same structures as above, but also try to find the **stomach** and **pseudocoel**.

Bryozoa

Phylactolaemata

Bryozoa (formerly called ectoprocta), means "moss animals"). They are a geologically important group of small animals. The vast majority of Bryozoans are colonial and most are marine. Superficially they can resemble corals. Bryozoans are most abundant in temperate-tropical waters that are not too turbid. They require a firm substrate onto which they attach or encrust, and clear agitated water from which they obtain their suspended food.

Figure 12. A close-up of a Bryozoan colony. The horseshoe-shaped lophophores are clearly visible.

Enclosed within a skeleton of calcite, Bryozoans have a sac-like coelomate body with a well-defined mouth, anus, and other specialized organs. One such organ is the **lophophore** (a ciliated structure used in food gathering) that is attached to tentacles that surround the mouth.

Find a prepared slide labeled "Bryozoa *Pectinatella* w.m.". Be able to identify the organism and the lophophores.

Brachiopoda

Lingulata

While recent brachiopods are a rather rare and insignificant group, their long fossil history shows that they were at times the most prominent animals in the seas. Consequently, brachiopods receive only passing interest from zoologists, but a great deal of attention from paleontologists. The phylum is quite important for biostratigraphy, paleoecology, and evolutionary studies because it shows a great variety of changes in form and function through time.

Brachiopods resemble clams, but their shells are dorsal-ventral (that is, there's a top shell and a bottom shell), whereas clams have lateral shells (there's a left and a right shell). Brachiopods feed using a lophophore like Ecoproctans, which creates a water current that enables them to filter food particles out of the water.

Find preserved specimens of *Lingula* on display. The genus *Lingula* first evolved over 400 million year ago, making it the oldest living animal genus that still contains extant species! Identify the internal structures labeled in Figure 13 on the preserved specimens in the lab.

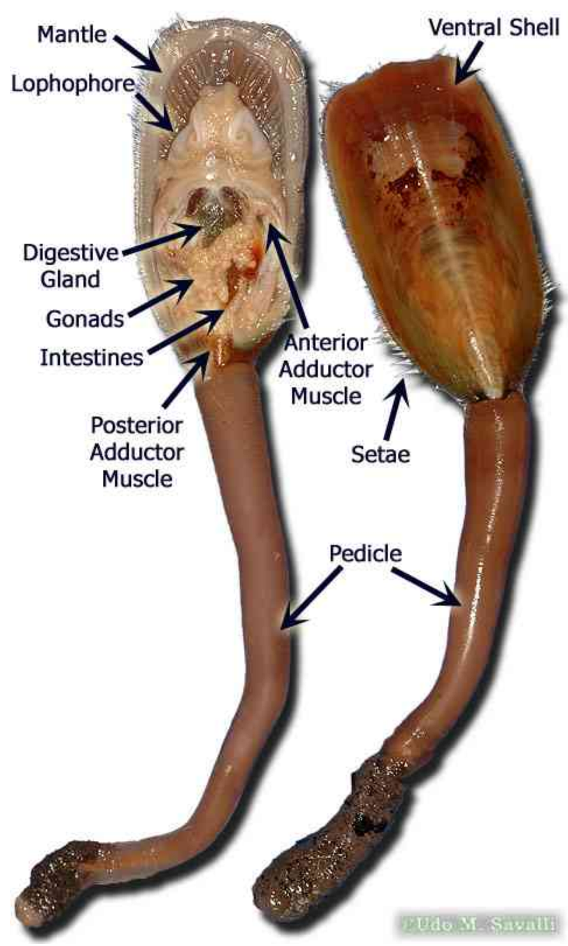


Figure 13. A dissected brachiopod showing the internal structure.