Animal Diversity I:
Porifera, Cnidaria, Ctenophora, Platyhelminthes, and Lophotrochozoa

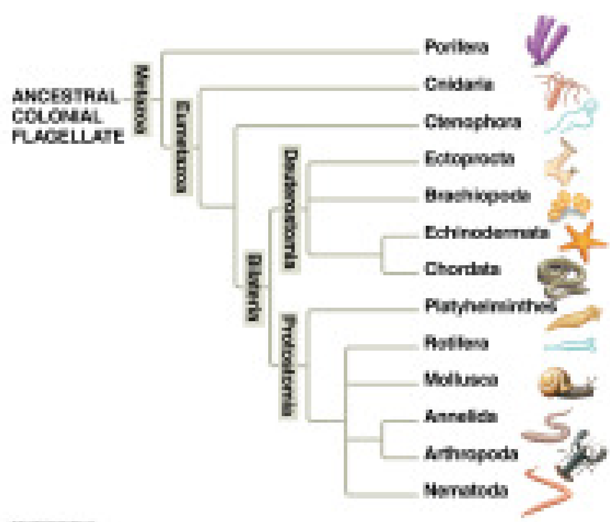
Objectives:

- Be able to distinguish **radial symmetry** from **bilateral symmetry**.
- Be able to identify which of the phyla represented here exhibit **radial** or **bilateral symmetry**, the presence or absence of different **tissues**, and **diploblastic** versus **triploblastic** organization.
- Be able to use a **dichotomous key**.
- Be able to identify the major taxonomic groups of animals.
- Be able to describe important features of the animals covered in these labs, including their movement, nervous and sensory systems, reproduction and life history, feeding, circulation, and excretion.

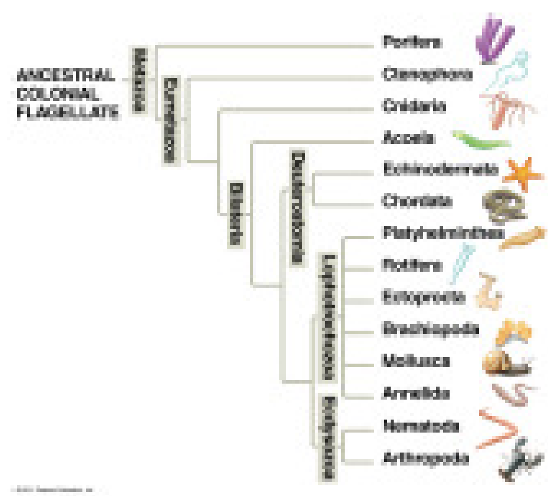
Animal Phylogeny

All phylogenies are hypotheses about the evolution of groups of organisms. Below are two phylogenies of the animal kingdom, one based on data available before about 1995, and the other based on data first published in 2005 using RNA sequence homologies.

Tree before 1995



Tree using RNA sequence homologies



Dichotomous keys

A dichotomous key is a tool for identifying organisms based on a series of either/or questions that lead you to an identification. It is important to know that a dichotomous key is not a phylogeny, but only a tool for identification. A dichotomous key can be based on the same traits used to construct a phylogeny, or it can use different criteria, as long as it uses either/or questions that lead to an identification. Below is an example of a dichotomous key based on the phylogeny shown earlier in this lab:

Dichotomous key for major groups of Metazoa:

1. Does the animal have spicules and no distinct tissues?
   a. Yes: **Porifera (sponges)**
   b. No: Go to **2**
2. Does the animal have radial symmetry, two tissue layers, and stinging cells containing nematocysts?
   a. Yes: **Cnidaria (jellyfish, corals, etc.)**
   b. No, it has 3 tissue layers, no nematocysts, and shows bilateral symmetry: Go to **3**
3. During embryonic development, does the **blastopore** (the opening into the initial cavity of the gastrula stage) develop into a mouth?
   a. Yes (mouth is primary): **Protostomes**, go to **4**
   b. No (mouth forms at the opposite end and is secondary): **Deuterostomes**, go to **6**
4. Does the animal molt at least once in its lifetime?
   a. Yes: **Ecdysozoa**, go to **5**
   b. No: **Lophotrochozoa** (go to Lophotrochozoa key)
5. Is the general body form
   a. Round and wormlike, with no apppendages: **Nematoda**
   b. With multiple, jointed appendages: **Arthropoda**
6. Does the animal have a hollow nerve chord?
   a. No: **Echinodermata**
   b. Yes: **Chordata**

Dichotomous keys are usually prepared when a new group is described for the first time, to helpo students identify the specimens. A key can be as short as a few lines or as long as many dozens of pages.

Tissues:

A **tissue** is a group of similar cells and their products, built together (structurally integrated) and functioning together (functionally integrated). Sponges (Porifera) do not have distinct tissues-- their whole body is organized as a single tissue. All other animals have distinct tissues that initially develop in separate layers.

Tissue layers (diploblastic vs. triploblastic) and body plans:

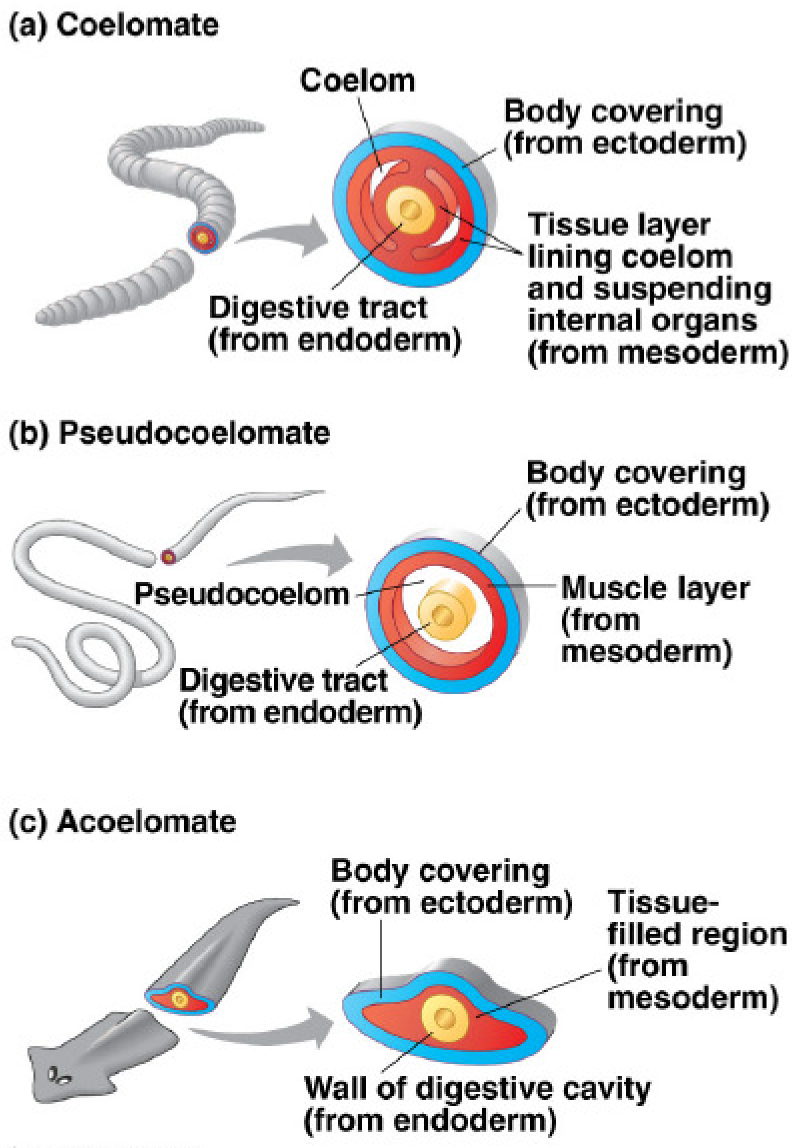
With the exception of the phylum Porifera (sponges), all animals have tissues that derive from embryonic germ layers. Those with two embryonic germ layers are **diploblastic;** those with three embryonic germ layers are **triploblastic.** In general, triploblastic animals also exhibit **bilateral symmetry:** their left sides and right sides are mirror images of one another, with only minor and occasional exceptions.

Examine slides of ***Hydra*** (phylum Cnidaria, a diploblastic animal) and ***Lumbricus*** (the common earthworm, phylum Annelida, a triploblastic animal) and see if you can identify and label the tissue layers.

Acoelomate vs. Coelomate vs. Pseudocoelomate:

Many animals have a body cavity. If it is lined entirely with tissue formed from the middle germ layer (**mesoderm**), it is called a **coelom;** otherwise, it is called a **pseudocoel.** Animals that do not have a body cavity (e.g., flatworms) are considered **acoelomate.** If a body cavity is present, the manner in which it forms may be phylogenetically informative, but it seems that body cavities have evolved multiple times. Thus, animals with pseudocoels are not always closely related; their nearest relatives may in some cases be coelomate animals, and certain monophyletic groups may contain both coelomate and pseudocoelomate animals.

Examine sections of a **flatworm** (acoelomate), a **nematode** (pseudocoelomate), and an **earthworm** (coelomate). Use your textbook and the accompanying illustrations as a guide.



Identifying major taxonomic groups:

You should be able to identify the major taxonomic groups listed below. Draw at least one example of each.

Animals with no separate tissues:

Phylum Porifera (sponges)

Class Hyalospongea — Sponges with spicules composed of silicon dioxide (glass), often with beautiful shapes and radial symmetry.

Class Calcarea — Sponges with spicules composed of calcium carbonate. Examine a prepared slide of a calcareous sponge and identify the choanocytes.

Class Demospongea — Sponges with spicules composed of hard protein (spongin), often with irregular shapes and no symmetry. Over 80% of sponges are in this class. Draw a bath sponge.

Diploblastic animals with radial or biradial symmetry:

Phylum Ctenophora — The comb jellies, with many comb-like rows of cilia and biradial symmetry (like a two-armed pinwheel). Examine a ctenophore, and see how it can be distinguished from a cnidarian.

Phylum Cnidaria (radially symmetrical animals with stinging cells):

Class Hydrozoa — Solitary or colonial cnidaria with a polyp (mouth facing upward) as the predominant body type. Examine *Hydra*, *Obelia*, and other examples, and draw at least one of them.

Class Scyphozoa — Jellyfish, characterized by a mobile floating form (medusa, with downward-facing mouth). Examine preserved specimens in jars and draw at least one of them.

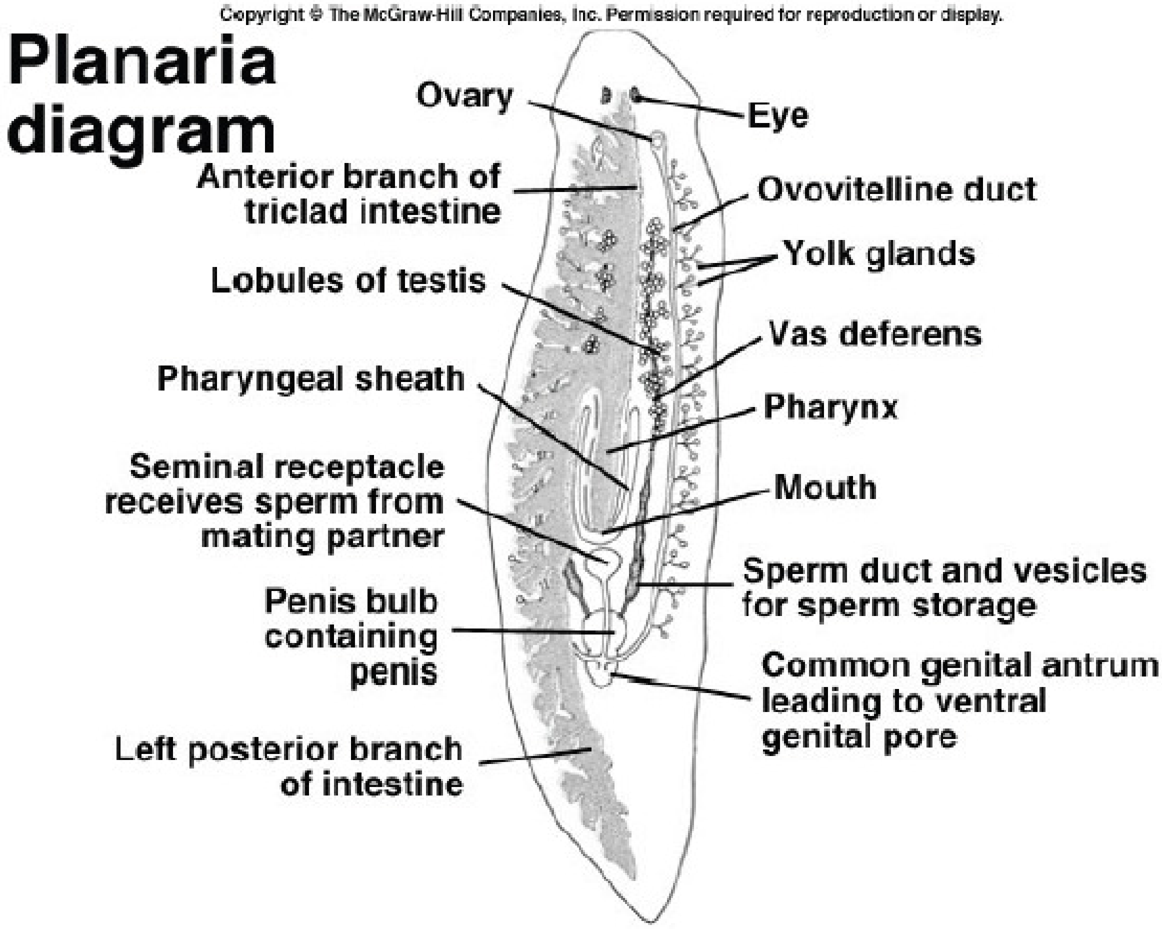
Class Anthozoa — The corals, sea pens, and anemones, with polypoid forms and often with supporting skeletons of calcium carbonate. Draw at least two types of coral.

Triploblastic animals with bilateral symmetry:

All triploblastic animals go through an embryonic stage known as a **gastrula,** which has a hollow interior (**archenteron**) and a single opening (**blastopore**) to the outside. In most phyla, the blastopore becomes the mouth; animals with this type of development are called **protostomes,** meaning "first (or primary) mouth". In the Chordata, Echinodermata, and a few smaller phyla (to be considered in later labs), the blastopore marks the hind end of the animal (near the anus), and the mouth develops as a secondary structure at the opposite end; animals with this type of development are called **deuterostomes,** meaning "secondary mouth". In the remainder of this lab, we will examine three groups of protostomes.

Phylum Platyhelminthes (flatworms).

Class Turbellaria The free-living flatworms. Examine a whole mount of a Planaria. Make sure to draw and label the eye spots, lateral nerve cords, pharynx, and mouth.



Class Trematoda The parasitic flukes. Draw *Clonorchis,* the human liver fluke.

Class Cestoda The tapeworms, highly degenerate parasites. Examine whole tapeworms and slides showing the head-like **scolex.**

Phylum Rotifera Rotifers ("wheel animals", with a circular crown of cilia that beat in a pattern that resembles a rotating wheel). Examine a slide showing a rotifer. How does its size compare with unicellular protists? Rotifers are common animals in freshwater ponds and streams.

Phylum Annelida (segmented worms):

Class Polychaeta Polychaete worms, mostly marine, with well-developed heads. Many bristles (chaetae) per segment.

Class Oligochaeta Terrestrial earthworms, with poorly developed heads and few bristles per segment. Draw an earthworm from a preserved specimen, and label the clitellum.

Class Hirudinea Parasitic leeches. Draw a leech from a preserved specimen.

PHYLUM Mollusca

The Mollusca are the "insects of the sea" in terms of diversity. The classes Bivalvia and Gastropoda show great disparity of shell shapes and sizes, and even lack of a shell in some cases. Molluscs play an important ecological role in marine ecosystems and, like insects on land, occupy almost every conceivable niche in the sea and many in freshwater habitats and also on land.

All molluscs have a shell-secreting organ or **mantle,** and most also have a shell. The hind end of the mantle is withdrawn to form a **mantle cavity** which is considered the hallmark trait that defines the phylum as a monophyletic group. Primitive molluscs have a toothed scraping organ, the **radula,** that allows them to feed off algae that cling to rocky surfaces. Primitive molluscs also have a muscular **foot** on which they can slowly creep forward.

In this lab, you will study the most important classes of molluscs and dissect a squid. Make sure that you study all the interesting morphological features that will help you study for the lab quiz!

CLASS Polyplacophora (chitons)

Look at the multiple plates forming the outer shell, which gives the group its name. Which internal organ secretes the shell? All chitons use their radula to eat algae.

CLASS Gastropoda (snails and slugs)

This is the largest and most diverse group of molluscs. Pay special attention to the torsion (coiling) of the shell. All gastropods use their radula as a feeding organ; some also use the radula to burrow.

CLASS Bivalvia (clams)

Look at the two valves. Notice that the plane of bilateral symmetry passes between the valves. Compare this with the preserved brachiopods (Phylum Brachiopoda), whose plane of symmetry bisects each valve down the middle. Bivalves have a wedge-shaped foot that assists them in burrowing; the older name for the bivalves is Pelecypoda, which means "hatchet-foot."

CLASS Cephalopoda (squids, octopus, and nautiloids)

The foot in these molluscs is located in the head region (the name Cephalopoda means "head-foot") and has become subdivided into a series of **tentacles** that surround the mouth. The mantle cavity in these molluscs has been folded beneath the head to form a **siphon** with a nozzle-like opening that faces forward. All living species share an unusual escape behavior: an **ink gland** secretes a dark inky fluid into the siphon, from which it forcefully squirts forward. This action propels the animal backward, in an unexpected direction, and simultaneously confuses any predator by releasing a cloud of ink that holds the predator's attention until the mollusc escapes.

Nautiloids all have a shell. They were once a large and diverse group, but only the one living genus *Nautilus* (the chambered nautilus) remains. Examine the chambered shell of *Nautilus*.
The animal lives in the outermost chamber only; the earlier chambers are filled with a gas (about 98% N_2) that help it float at a controlled depth.

Ammonoids were extinct cephalopods related to the nautiloids. Some of them had enormous coiled shells, up to a meter or more in diameter.

Octopoids, including both octopuses and squids, have lost their shells (except for one squid species, the cuttlefish, that has a diamond-shaped remnant, the "cuttlebone", just under its dorsal surface).

If a demonstration is available showing the internal organs of a squid, examine the following:

- Tentacles or "arms": The long ones are used mostly for locomotion by "rowing".
  The shorter ones are used mostly for seizing and manipulating food.
  How many of each can you count?
- Eye: Fairly large, built similar to vertebrate eyes in overall construction.
- Siphon (Mantle cavity), with its nozzle-like opening.
- Gills, located within the mantle cavity or siphon.
- Ink gland, opening into the mantle cavity, capable of squirting out a dense cloud
  of dark material that confuses predators during the squid's "escape" defense.
- Gonad (testis or ovary).
- Nidamental (egg-laying) gland (in females only).