

Animals 2: Mollusca, Echinodermata, Arthropoda

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This lab will cover three animal phyla:

- **Mollusca:** snails, clams, octopus, etc.
- **Echinodermata:** Sea urchins, starfish, sea cucumbers, etc.
- **Arthropoda:** Crabs, shrimp, pillbugs, spiders, insects, etc.

There is a lot of terminology in this lab; try to remember the terms in bold type. Refer to chapter 33 in Campbell for more information on the phyla covered in this lab.

Phylum Mollusca: Snails, Clams, Octopus, etc.

TISSUES:	• Three well-defined tissue layers in embryo.
SYMMETRY:	• Bilateral.
BODY CAVITY:	• True coelom.
PROTO/DEUTEROSTOME:	• Protostome.
DIGESTIVE TRACT:	• Complete digestive tract.
OTHER FEATURES	• Gills contained in mantle cavity. • Many have a radula, which is a hard, tongue-like structure used for feeding. • Most have external shell.

Mollusk means soft, and the members of this phylum have soft bodies – but generally inside hard shells. Mollusks include snails, octopus, clams, and some others.

Mollusks have a true **coelom**, which seems to open the way to more complex development. One key effect of the coelom is the circulatory system. Mollusks have circulatory system with a heart, which develops in the coelom. Octopus and squid, the most active mollusks, have a **closed circulatory system** similar to that found in vertebrates. Most other mollusks have an **open circulatory system**, in which hemolymph is pumped by a heart but is not confined to blood vessels. In adult mollusks, the coelom is small, typically just a space that contains the heart.

The **mantle cavity** of mollusks provides an excellent example of the way a structure that functions a particular way can change over evolutionary time to become something quite different. In the earliest mollusks, the mantle cavity was a space beneath the shell containing the gills. The mantle cavity serves different functions in various classes of mollusks, as described below.

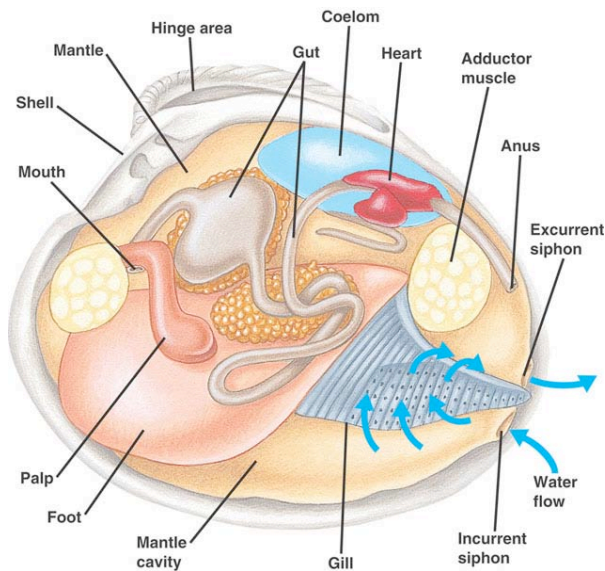
Four classes of Mollusks:

- **Chitons** (class Polyplacophora): Marine. Shell consists of 8 plates. Chitons are grazers; they use a radula (hard, tongue-like scraper) to scrape algae off rocks. The mantle cavity contains gills, used for gas exchange.
- **Snails** (class **Gastropoda**): Includes freshwater and marine, and terrestrial snails and slugs. Single shell, often curled into a tight spiral. Many snails are grazers, like chitons, and scrape

algae or plants with their radula. They have gills, used for gas exchange, in the mantle cavity. Terrestrial gastropods don't have gills; the mantle cavity functions like a lung. Some gastropods, such as cone snails are predators.

- **Bivalves** (Class Bivalvia or Pelecypoda): Includes clams, mussels, oysters, scallops, etc. Two shells that can be closed together tightly. Bivalves are filter feeders. They use siphons to pump water into and out of their mantle cavity. In the mantle cavity, the water passes over the gills. The gills not only do gas exchange, they also capture small particles of food from the water.
- **Cephalopods** (Class cephalopoda): Includes squid, octopus, cuttlefish, and nautilus. Single shell, which becomes very small or disappears in some cephalopods (such as octopus). Cephalopods are active predators, with large focusable eyes, large brains, a closed circulatory system, and the ability to swim rapidly. Cephalopods can pump water through the mantle cavity for gas exchange and also use this pumping action for jet propulsion when swimming.

Anatomy of a Bivalve:



Specimens:

- 📖 **Live specimens of various mollusks.** Take a look at the various species. How would you recognize them as mollusks? How would you know what class they belong to?
- 📖 **Model of clam anatomy.** Note the mantle cavity, gills, siphons, foot, and gonad. These same basic features are also found in most other kinds of mollusks, though they may look very different.

We also have a number of preserved specimens in jars:

- 📖 **Class Gastropoda. (specimens in jars).** Gastropods ("stomach foot") are snails, including marine and terrestrial forms, slugs, and various other animals that don't look much like snails.
- 📖 **Class Bivalvia. (specimens in jars).** Bivalves (named for the two "valves" of the shell) like clams, oysters, and mussels use their gills for filtering food particles from the water.

Most have a siphon for sucking water in and another for expelling water. The one-way flow of water across the gill is similar to that of a fish.

☞ **Class Cephalopoda. (specimens in jars).** Cephalopods (“head foot”) are the high-performance mollusks. With big eyes, closed circulatory systems, and the ability to swim fast, they are active predators.

☞ **Class Polyplacophora. (specimens in jars).** The Polyplacophora, commonly called chitons, are named for the multiple plates of their shells. The gills are along the side, under the edge of the mantle. They don’t have a big, highly developed mantle cavity like the others.

And a single microscope slide:

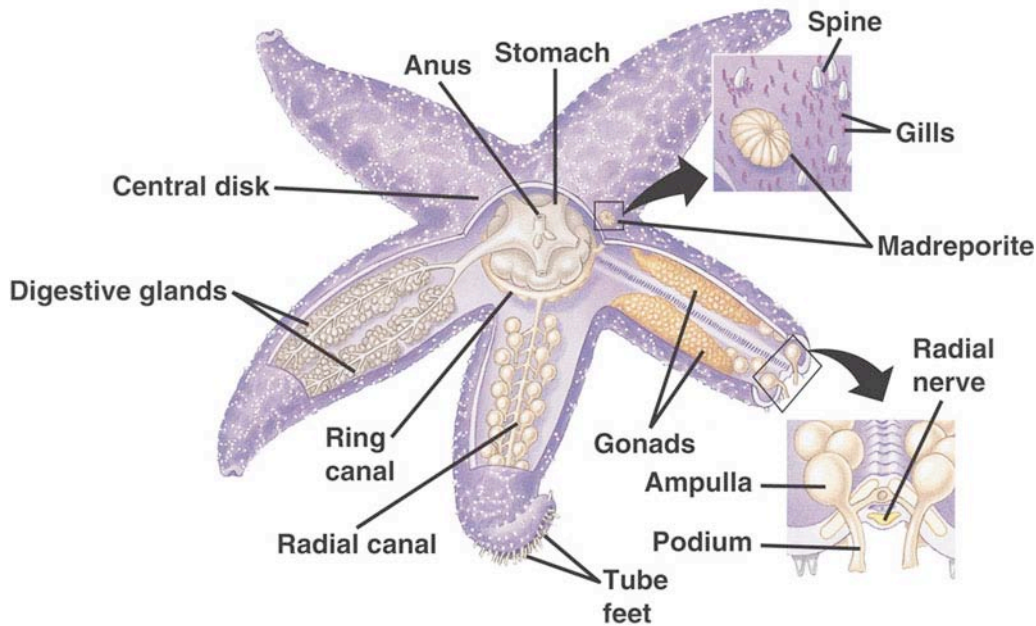
☞ **Snail radula. (prepared slide).** Snails use this hard, tonguelike organ for scraping off bits of food to eat. You may also be able to see the radula on live snails, if they are feeding – especially if they are scraping algae from the inside of a glass aquarium.

Phylum Echinodermata: Starfish, Sea Urchins

TISSUES:	• Three well-defined tissue layers in embryo.
SYMMETRY:	• Bilateral in the larva, but adults are more or less radially symmetrical (pentaradial, since they have 5 arms).
BODY CAVITY:	• Coelom
PROTO/DEUTEROSTOME:	• Deuterostome
DIGESTIVE TRACT:	• Complete
OTHER FEATURES	• Calcareous endoskeleton • Hydrostatic skeleton (water vascular system) • Planktonic larva

You might not guess it from looking, but the echinoderms are probably our closest relatives outside our own phylum. Key echinoderm features include:

- **Endoskeleton.** Much like our own skeleton, the echinoderm skeleton consists of numerous calcified structures joined by more flexible tissues.
- **Water vascular system.** A system of water-filled tubes running throughout the animal’s body, the water-vascular system functions as an elaborate and flexible hydrostatic skeleton. (Echinoderms therefore have two skeletons: the hard plates of the endoskeleton and the flexible hydrostatic skeleton.) The water-vascular system includes tube feet, which are used by sea stars and other echinoderms to walk and to grab prey items.
- **Coelom.** The coelom in echinoderms is large, filling much of the body. The coelom is just a big, fluid-filled space. It’s not the water vascular system, which contains water in a closed system of vessels, and it’s not the gut, which is smaller and also enclosed. The coelom is the space where the other organs (water vascular system, gut, gonads, etc.) form.



To get more pictures of the strange anatomy of echinoderms, take a look at pages 665-667 in Campbell. Note that the phylum Echinodermata contains several classes, including:

- **Sea urchins** (class **Echinoidea**).
- **Sea stars or starfish** (class **Asteroidea**; see diagram above).
- **Sea cucumbers** (class **Holothuroidea**).
- **Brittle stars** (class **Ophiuroidea**).

Then look at the specimens:

- ☞ **Various live echinoderms.** Look for the characteristic echinoderm features. In particular, note the tube feet and hard endoskeleton.
- ☞ **Various whole echinoderms (preserved specimens in jars).** Note that the basic features of the body are common to sea urchins (Echinoidea), starfish (Asteroidea), brittle stars (Ophiuroidea) and sea cucumbers (Holothuroidea), despite their different body forms.
- ☞ **Starfish arm c.s. (prepared slide).** Note the **coelom**, **tube feet** and radial canal (parts of the **water vascular system**), pyloric ceca (digestive glands), and **pedicellaria** (pinchers on the outer surface of the body).
- ☞ **Starfish pedicellaria (prepared slide).** The slides don't look like much, but you can see the hard little pinchers that were ripped off the outside of a starfish. These pedicellaria help protect the starfish against attack.

Phylum Arthropoda: Insects, Crabs, Spiders, etc.

TISSUES:	<ul style="list-style-type: none">• Three well-defined tissue layers in embryo
SYMMETRY:	<ul style="list-style-type: none">• Bilateral, with cephalization
BODY CAVITY:	<ul style="list-style-type: none">• Coelom
PROTO/DEUTEROSTOME:	<ul style="list-style-type: none">• Protostome
DIGESTIVE TRACT:	<ul style="list-style-type: none">• Complete digestive tract.
OTHER FEATURES	<ul style="list-style-type: none">• Segmented body. Segments are usually very different from one another.• Exoskeleton made of chitin.• Jointed appendages ("arthropod" means "jointed leg").• Open circulatory system.

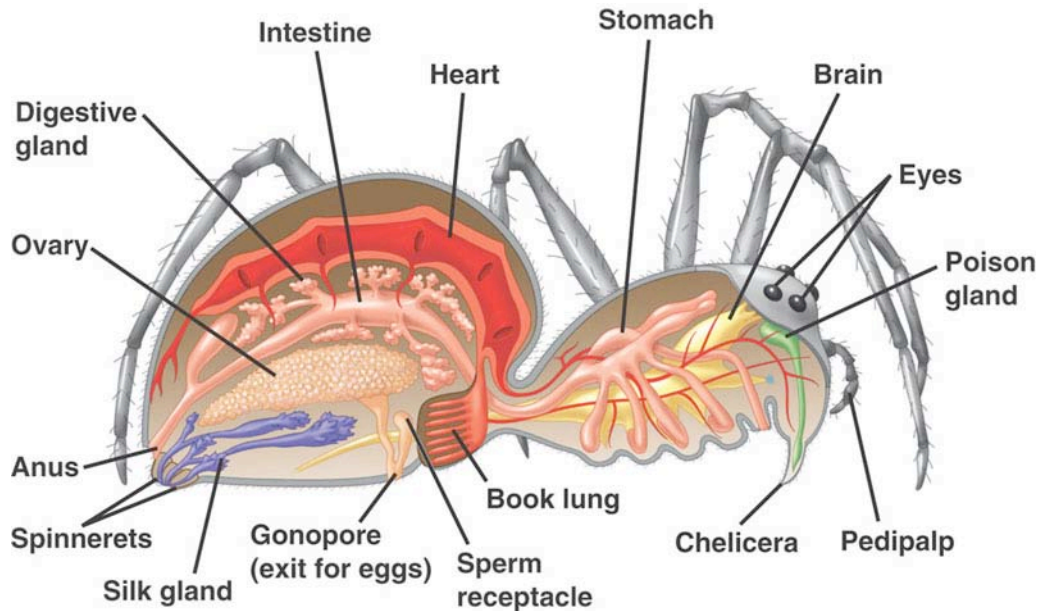
Arthropods similar to annelids in having segmented bodies, with each segment having a coelomic cavity. However, they are distinctly different in several obvious respects.

- **Specialized segments.** In annelids, all the segments are more or less the same. Arthropods are clearly segmented, but the different segments are very different from one another in form and function. Also, arthropod bodies are made of several groups of fused segments; the fused segments are called **tagmata**, and they act like individual super-segments.
- **Jointed appendages.** Annelids have setae, which are like small appendages on each segment. Setae are not jointed, however, so they are limited in the variety of functions they can serve. Annelids don't walk on their setae; they just use them to push through the dirt. The jointed appendages of arthropods are much more versatile, functioning as legs, wings, antennae, mouthparts, and other body parts.
- **Exoskeleton.** Arthropods have exoskeletons made of chitin (the same complex carbohydrate found in fungal cell walls) and protein. In some arthropods, the exoskeleton is made more rigid with calcium deposition. The first arthropods lived in the ocean; their exoskeletons protected them from attack and provided places for their muscles to attach. When later groups of arthropods moved onto the land, it turned out that the exoskeleton happened to be very functional in preventing the body from drying out. This is a good example of how a characteristic that evolved in one situation can become important in organisms adapting to another situation. Having an exoskeleton also affects a couple of other important aspects of life:
- **Gas Exchange & Osmoregulation.** Confined in their exoskeletons, arthropods need special structures for gas exchange, osmoregulation, and excretion. These specialized structures also seem to create opportunities for some arthropods: with their tracheal system for gas exchange and their Malpighian tubules for osmoregulation, the insects are able to live in dry conditions that would kill most invertebrates.
- **Metamorphosis.** Many animals can simply grow continuously throughout their lives. Arthropods, however, are confined in their rigid exoskeletons. In order to grow, they must **molt**, crawling out of the old exoskeleton. Then they quickly grow bigger by absorbing water before they form a new hard exoskeleton. Their development doesn't always proceed in a series of gradual changes; instead, they often go through a distinct **metamorphosis**, in which they change their body form dramatically as they molt and form a new exoskeleton. The classic example of this is the metamorphosis of a caterpillar into a butterfly.

There are a lot of arthropods, both in terms of numbers of species and numbers of individuals. Almost a million species have so far been identified, and it has been estimated that there are 200

million individual insects for every person on earth! In this lab, we'll focus on a few classes of arthropods:

Arachnids: spiders, mites, & ticks.



Mostly terrestrial. Two tagmata: the cephalothorax (also called the prosoma) and the abdomen (also called the opisthoma). The cephalothorax has all the appendages: 4 pairs of walking legs, a pair of pedipalps for eating, and a pair of fanglike chelicerae that often contain poison. Arachnids don't have antennae or mandibles, two features that are prominent in insects.

☞ **Tick and mite. (prepared slide; whole mount).**

☞ **Garden spider. (preserved whole specimens).**

Crustaceans: crabs, shrimp, isopods (including pillbugs), etc.

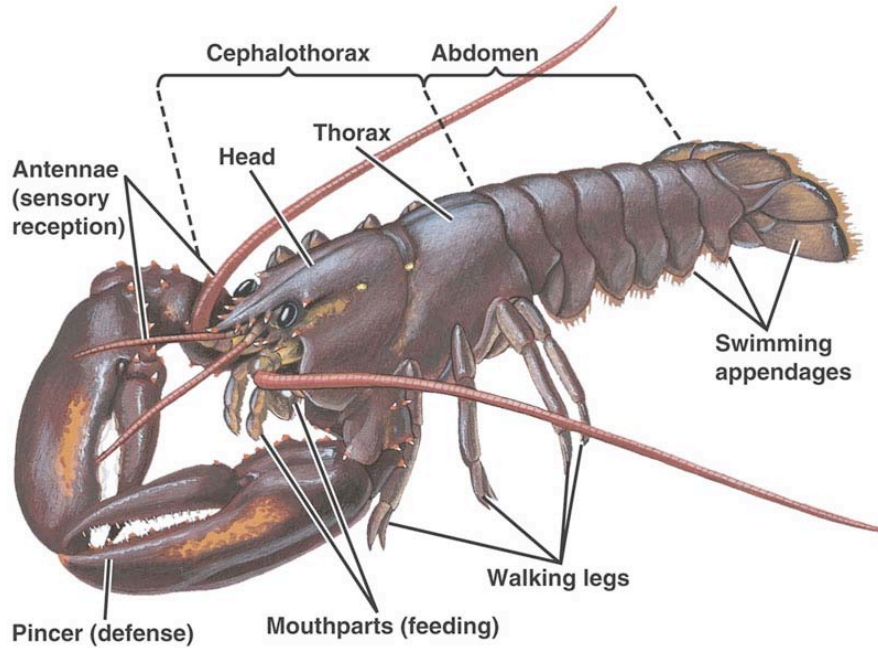
Mostly aquatic. Two tagmata: cephalothorax & abdomen, just like the arachnids. Branched appendages, like the claws of a crab or lobster. Two pairs of antennae. Compound eyes on stalks.

☞ **Crayfish. (preserved specimens).**

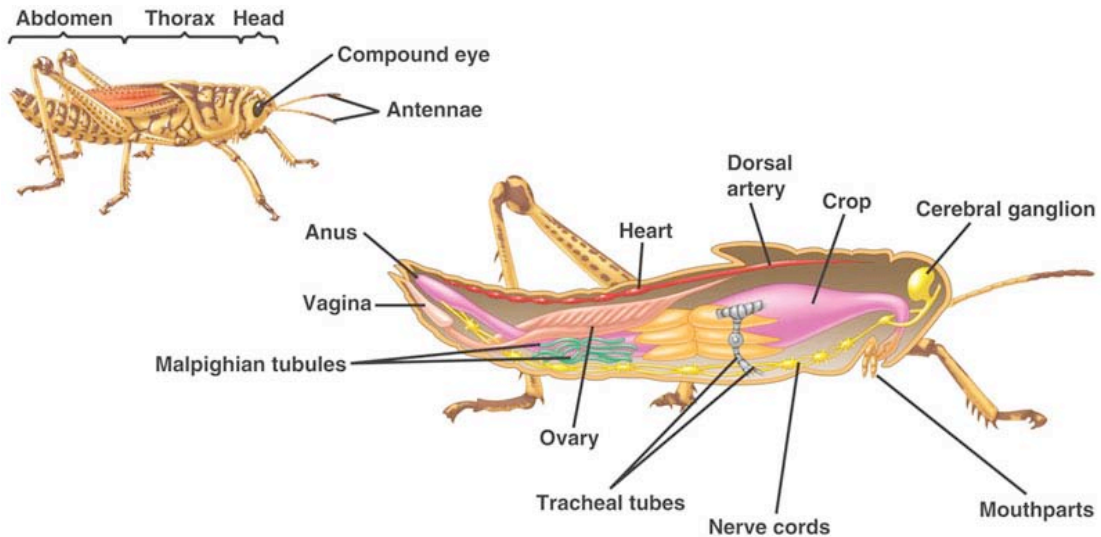
☞ **Daphnia. (prepared slide; whole mount).**

☞ **Terrestrial isopods (also called pillbugs; live specimens).** Note the numerous appendages and the gills.

☞ **Various crabs (live specimens).** Note the numerous appendages and the gills.



Insects.



Mostly terrestrial or in fresh water. Three tagmata: head, thorax, abdomen. The thorax has all the walking legs. Mouth usually has jawlike mandibles. 3 pairs of legs and usually 2 pairs of wings. One pair antennae. Compound eyes.

Insects are so important and so diverse that we will devote a whole lab to them later; for today's lab, you should simply note that insects share all the key characteristics of arthropods in general.

☞ **Lubber grasshoppers (preserved whole specimens).** Note the numerous appendages and the spiracles, which are openings into the tracheae.

📖 **Various insects. (dried specimens).** We have a large insect collection. For today, note the variations on the theme of three tagma, three pairs of legs, and two pairs of wings.

Terms to remember:

- Arachnida
- Arthropod. Classes include Crustacea and Insecta.
- Branched appendages
- Crustacea
- Cuticle.
- Echinodermata. Several classes, including sea urchins (Echinoidea) and starfish (Asteroidea).
- Endoskeleton vs. exoskeleton. What other phylum have you seen that has an endoskeleton?
- Gastrula & Gastrulation
- Hydrostatic skeleton
- Hydrostatic skeletons. What phyla have you seen so far that have a hydrostatic skeleton?
- Insecta
- Jointed appendages
- Mantle cavity and how it functions in different classes of mollusks
- Mollusca. 3 classes: Bivalvia, Gastropoda, Cephalopoda.
- Pedicellaria
- Planktonic
- Radula
- Segmentation; specialization of segments
- Spiracles & tracheae
- Tagma (plural: tagmata)
- Water vascular system