

phylum Mollusca

Molluscs

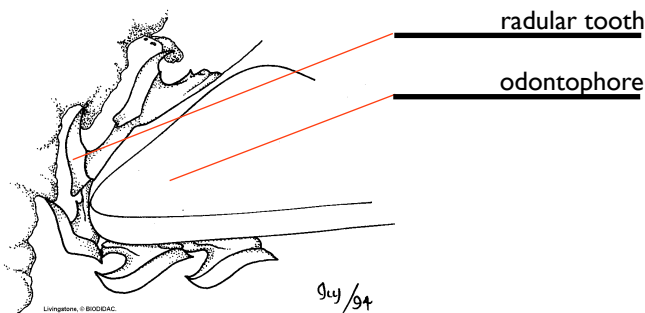
The phylum Mollusca (Latin *mollusca* = "soft") is the largest, most diverse phylum in the clade Lophotrochozoa. Like the annelids, they are triploblastic eucoelomates that develop from a trochophore larva. However, they do not possess the characteristic segmentation of annelids. Also, unlike annelids, most molluscs possess an open circulatory system. It is thought that closed circulatory systems evolved at least three times in the Animalia: in an ancestor of the Annelida, an ancestor of the Chordates, and within the Mollusca. One group of modern molluscs, the cephalopods, has a closed circulatory system.

Organization

Molluscs generally have soft, muscular bodies that are protected by a calcareous shell. Molluscs have two main parts of the body:

head-foot - Usually involved in locomotion and feeding, the muscular head foot contains most of the sensory structures of the mollusc, as well as the radula that is used for feeding.

visceral mass - The viscera of a mollusc are contained in the visceral mass, which is usually surrounded by the mantle, a thick, tough layer of tissues that produces the shell.



Head Foot

The head of the mollusc contains feeding and sensory structures, and is generally connected to the foot. However, there is a great deal of diversity in the molluscs, with in many adaptations of the foot for various purposes.

Most molluscs feed using a radula. The radula is an autapomorphy for molluscs (relative to other animal phyla), which is usually used for scraping food particles such as algae from a substrate. The radula is a tongue-like structure with a cartilaginous core (odontophore) that

is covered with rows of chitinous teeth. The shape and orientation of radular teeth is species specific in most molluscs.

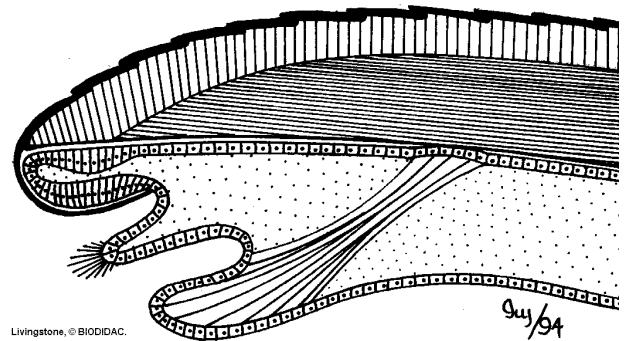
Some molluscs possess a highly specialized radula that may be used for a particular feeding style. Some snails, i.e. *Conus*, have a radula that is used for delivering toxins in prey capture. *Conus* sp. have a special proboscis which is used to stab prey. A radular tooth on the end of the proboscis pierces the prey and delivers powerful "conotoxin" to the fish, which is then engulfed by the eversible stomach of the snail.

Other snails are adapted for feeding on other molluscs (e.g. bivalves) and use a highly adapted radula to bore a hole through the shell of an oyster or clam. The snail will then slowly feed on its victim through the tiny hole.

* Obtain a prepared slide of a snail radula and observe it under the light microscope.

Shell

Most of the internal organs of a mollusc are contained inside the visceral mass which is covered by the mantle, a layer of tissues that protects the body and encloses the respiratory structures. The outermost layer of the mantle generates the shell, which comprises three layers: the nacreous layer, the prismatic layer, and the periostracum.



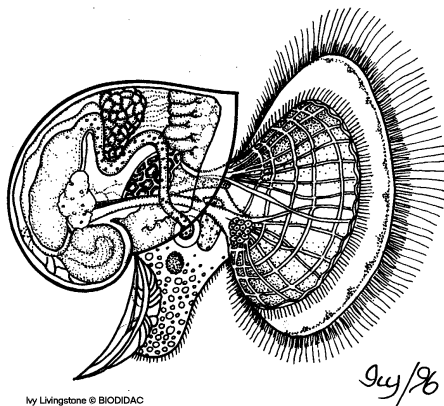
nacre - Thin innermost layer of the shell.

Composed of thin layers of calcium carbonate. This layer gets thicker as the mollusc ages. The iridescent "mother of pearl" found on the inside of bivalve shells is composed of thin layers of nacre. Pearls are produced when the mantle secretes nacreous layer onto an irritant such as a grain of sand. As more layers of nacre are laid down, the irritant gradually grows into a smooth pearl.

prismatic layer - This relatively thick layer of the shell is composed of a protein matrix hardened with deposits of calcium carbonate. This is the hardest layer of the shell. Shell growth occurs at the margins of the prismatic layer.

periostracum - The outermost layer of the shell. The periostracum is a rough proteinaceous layer that covers the prismatic layer. New periostracum is added at the margins of the shell.

Development



Generally, molluscs develop from a planktonic trochophore larva similar to the one found in annelids. This form of larva is somewhat spherical (but pointed at the ends), with bands of cilia around its middle, and tufts of cilia at its poles. This is considered to be a plesiomorphic larval form for the molluscs and is also found in the annelids, turbellarians, nemerteans, and other members of the Trochozoan clade.

In some molluscs, the trochophore develops into a more derived swimming larvae called a veliger. The veliger is a larval form found only in the molluscs, and only in some classes. Unlike the trochophore, the veliger possesses some characteristics that reflect the class of which it is a member. For example, in bivalves, the veliger already possesses the bivalve condition. In gastropods, the veliger (shown left) already exhibits the coiled shell found in many species. The term veliger refers to the characteristic **velum**, the ciliated funnel used for feeding and swimming.

In some groups, e.g. the cephalopods, there is no larval form. The juvenile emerges from the egg looking like a tiny version of the adult form.

Classification

The name of the classes of molluscs often characterize the foot or the shell of that group. The suffix “-placophora” means shell-bearing, and describes the shell. The suffix “-poda” refers to the foot. There are eight currently recognized classes of molluscs:

Class Solenogastres and Class Caudofoveata - These classes are worm-like, possessing no shell, and similar in many ways to the ancestor of the molluscs.

Class Scaphopoda - Tusk shells. These molluscs possess a long shell shaped like a tusk, open on either end. They burrow into marine sediments to deposit feed using tentacles called **captacula**.

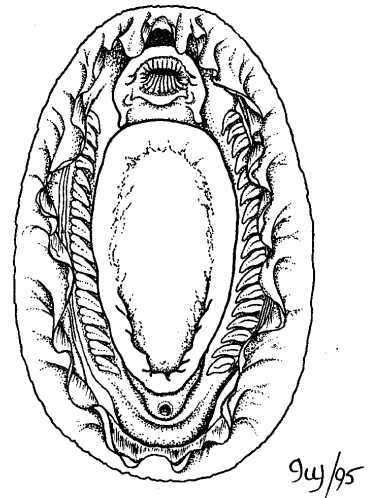
Class Monoplacophora - A small group of single shelled molluscs, possessing serially repetitious gills like the Polyplacophora. The shell resembles half of a bivalve shell. Thought to be extinct until extant species were discovered in 1952.

Class Polyplacophora - Chitons. These molluscs possess a series of 8 articulated calcareous dorsal plates. Most scrape algae from substrates using a radula.

Class Gastropoda - Snails, slugs, nudibranchs. This is one of the more diverse groups of molluscs. Most possess a coiled shell. May exhibit torsion or detorsion.

Class Bivalvia - Clams, oysters, scallops, mussels. Bivalves are highly specialized for filter-feeding. The shell is made up of two halves.

Class Cephalopoda - Squid, octopus, cuttlefish, chambered nautilus. Most are active predators. Cephalopods have very well developed image-forming eyes. Head with tentacles used to grasp prey.



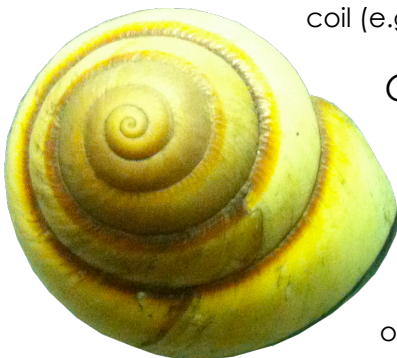
Chitons

Polyplacophorans are relatively easy to identify due to the characteristic set of 8 plates on the dorsal aspect of the body, covering the visceral mass. Examination of the foot reveals the serially repetitious gills which surround the margin of the mantle encircling the foot. The mouth is visible at one end of the body, and the smaller anus is visible on the other end. Tissue of the mantle can be seen around the outer edge of the body, outside of the gills.

* Examine the preserved chitons. Note the following structures: **ctenidia, mouth, foot, mantle, anus, plates**.

Gastropods

Snails and slugs are in the class Gastropoda. Most people instantly recognize a snail because of its characteristic coiled shell. However, many species of gastropod have a shell that does not coil (e.g. limpets and abalone) or have lost the shell altogether (e.g. slugs, nudibranchs).



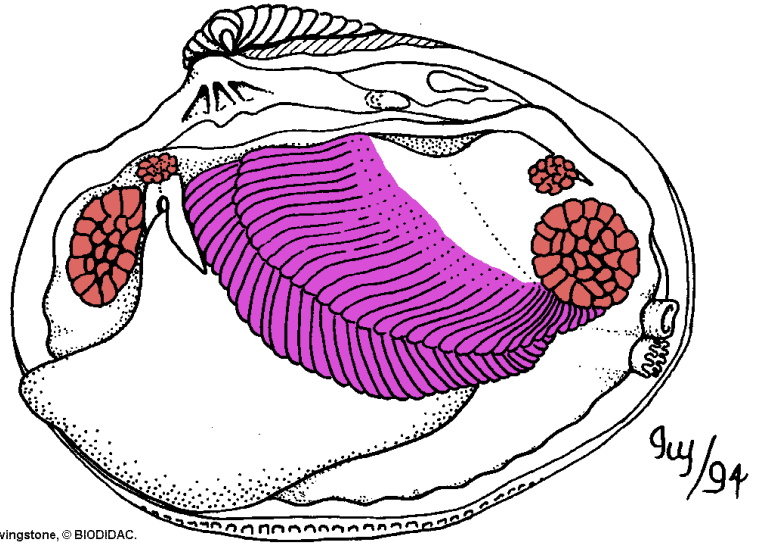
Coiling

Several types of coiling can be seen in gastropods. The ancestral type of coiling was bilaterally symmetrical, and is referred to as **planospiral**. Planospiral coiling is relatively uncommon in modern snails. This type of coiling is rather unwieldy, since it has such a high center of gravity. It is also not as compact as the alternative. The most common type of coiling in modern gastropods is **conispiral**, which is an asymmetrical coiling that is cone-shaped, and shifted to one side. This type of coiling is not bilaterally symmetrical.

Conspiral shells either curve one direction or the other. If you hold the shell with the apex facing you (as shown to the right), the shell will either curve clockwise or counterclockwise. If the shell curves counterclockwise, or to the left, it is considered to be **sinistral**. This form of conspiral coiling is less common. Most shells curve clockwise, or to the right. This type of coiling is described as **dextral**. The terms dextral and sinistral refer, respectively, to right-handed and left-handed coiling.

* Examine the examples of gastropod shells. Make note of the type of coiling exhibited by each shell. Be sure you look at whelks, limpets, marine snails, and pulmonate snails.

* Observe live snail specimen.



Livingstone, © BIODIDAC.

Bivalves

Bivalves include organisms such as clams, scallops, and oysters. The body of a bivalve is heavily adapted to life as a suspension feeder resulting in loss of the radula. At one end of the body, the mantle forms an **incurrent** and **excurrent siphon**. Water passes in through the incurrent siphon, where it passes across the gills into the **suprabranchial** chamber and out of the body through the excurrent siphon. Food particles in the water are caught in mucus secreted by the palps and gills. Cilia carry the food particles towards the **labial palps** which sort food particles for ingestion. In the stomach of many bivalves is an elongated gelatinous structure called a **crystalline style**. The style is constantly rotating and releases digestive enzymes which help to digest the particles trapped in the mucus string.

Gas exchange occurs in both the gills and the mantle chamber. Bivalves have an open circulatory system with a three-chambered heart. The heart has two atria and one ventricle. The ventricle pumps hemolymph out to the tissue sinuses, through an anterior and posterior aorta. The anterior aorta sends hemolymph to the major organs (including the kidneys and gills) and the foot. The posterior aorta sends hemolymph to the mantle. Hemolymph returns to the heart through the atria.

* Examine the plastimount block with the preserved bivalve.

The large feathery structures (indicated in fuchsia above) are the **ctenidia**. To orient the bivalve, find the siphons. The siphons are on the posterior end of the body. The labial palps are on the anterior end of the body. There are two large muscles called **adductor muscles** (anterior and posterior) that are used to close the bivalve shell around the body. Near the adductor muscles are smaller retractor muscles which are used to retract the foot. Another muscle, the pallial muscle attaches the shell to the mantle. This muscle leaves a linear scar around the margin of the shell which is easily visible.

* Examine the preserved whole mount slide of bivalve ctenidia under the light microscope.

The apex of the bivalve shell is the **umbo**, which is also the oldest part of the shell. Cyclic growth patterns produce concentric growth rings outward from the umbo. In many clams, the umbo curves to the anterior (as above). If you examine the inside of the shell of a bivalve, you can see the adductor muscle scars. The two halves of the bivalve shell are held together at the umbo by a hinge ligament.

* Examine the bivalve shell samples. Be sure you can distinguish clams, oysters, scallops, and mussels.

Cephalopods

There are three subclasses of cephalopods: Nautiloidea, Ammonoidea (extinct), and Coleoidea. The Nautiloidea and the Ammonoidea possess a coiled or uncoiled shell. In the Coleoidea, the shell is reduced or

lost. The Nautiloidea are represented by only a single extant genus, *Nautilus*. The chambered nautilus uses its shell as a buoyancy device. The shell of the nautilus is divided into multiple chambers, with the visceral mass only in the outermost chamber. A living cord of tissue called the **siphuncle** runs down the center of the chambers. The siphuncle is able exchange gasses with the blood to modify the gas-water ratio in the chambers and change buoyancy. Ammonites probably used their shells in similar ways.

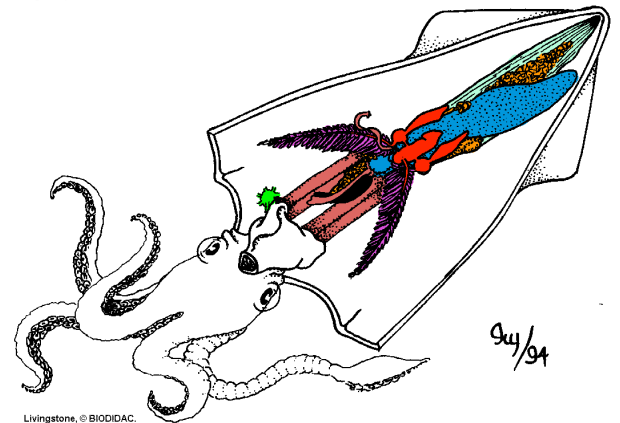
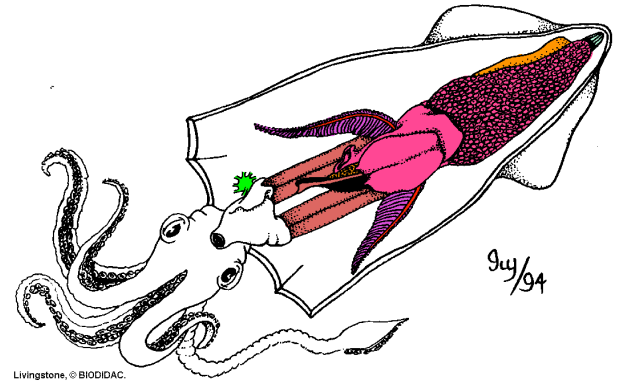
The Ammonoidea included the now extinct ammonites, which are well represented by fossil evidence. Nautiloidea were once a very large group, and are also well represented in the fossil record. To the casual observer, an ancient nautilus looks very similar to an ammonite. One of the biggest differences is in the sutures between chambers of the shell. In the ammonites, these sutures were highly complex, but in the nautilus, they were much more simple.

- * Examine the examples *Nautilus* shells. Note the holes where the siphuncle passed through the chambers.
- * Examine the examples of fossilized ammonites.

Squid dissection

- * Obtain a preserved squid for dissection.

Examine the external features of the preserved squid. The preserved squid should already have a partial cut in the ventral surface of the mantle. The siphon should be visible from this side. The opposite side of the body is the dorsal side. Just below the dorsal surface of the mantle is the pen. The pen is a remnant of the reduced shell, still present in squid. A whorl of eight arms and two longer tentacles surround the mouth on the anterior end of the body. The other end of the body is the posterior end. On either side of the body at the posterior end are two triangular fins which are used for swimming.



If necessary, use a scalpel to extend the cut already present in the mantle, exposing the internal organs. A thin membrane covers the viscera. Carefully cut the membrane using scissors, being careful not to damage the ink sac or the other internal organs. It should be immediately obvious if the squid is a mature female. A large mass of ovaries/eggs should be visible at the posterior end of the body. Individual eggs if present will be a sort of translucent orange color. In front of the egg mass, a large off-white bilaterally symmetrical gland called the nidamental gland should be obvious. The nidamental gland is involved in nourishing eggs and producing the gelatinous covering of the eggs.

In a male squid, the testis is large and cream-colored granular organ in the posterior end of the body. On the left side of the dissection (actually the right side of the squid), the spiral spermatophoric gland should be visible about halfway up the body. The penis extends anteriorly from this gland.

On either side of the visceral cavity are two feathery gill that extend anteriorly from the midpoint of the body. At the base of each gill is a brachial heart which pumps blood across the gill. Posterior to each brachial heart is a large vena cava. Both the vena cava and the branchial hearts should be filled with blue latex representing deoxygenated blood. Between the two brachial hearts, in the center of the body is the systemic heart, which pumps blood out to the tissues for exchange of nutrients and gasses. The systemic heart will appear thick-walled and muscular.

Behind the egg mass, or beside the testis a large digestive caecum should be visible. The caecum is thin-walled and is easily destroyed, so care must be taken not to damage it. At the anterior end of the caecum is the more muscular stomach. The stomach is attached at the anterior end, and extends posteriorly and to the right. If you wish, you may open the stomach with a scalpel to investigate its contents.

At the anterior end of the body, the ink sac, rectum, esophagus, and siphon retractor muscle run in parallel. The rectum and esophagus can be distinguished by tracing them from start to end. The esophagus runs through a thicker digestive gland. Dorsal to the esophagus and rectum is the liver, which appears yellowish and granular.

* Dissect your squid. Draw and label the following structures: arms, tentacles, mantle, lateral fins, siphon, pen, ctenidia, branchial hearts, systemic heart, spermatophoric gland (male), egg mass (female), nidamental gland (female), ink sac, esophagus, liver

questions

mollusca

1. List three characteristics that molluscs share with annelids:
2. How can you tell if a shell is dextral or sinistral?
3. How can you tell which end is the posterior end of a bivalve?
4. How can you tell a male from a female squid during dissection?

Drawings

***Loligo sp.* dissection**

Kingdom: _____

Phylum: _____

Class: _____

Order: _____