Mercenaria mercenaria ©

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Ph. MOLLUSCA, Cl.Bivalvia, sCl.Heterodonta, O.Veneroida, F.Veneridae

Introduction

Mollusca

The phylum Mollusca is the second largest in the animal kingdom and comprises several classes consisting of the Monoplacophora, Polyplacophora, Gastropoda, Bivalvia, Scaphopoda, Aplacophora, and Cephalopoda. The typical mollusc has a shell, muscular foot, head with mouth and sense organs, and a visceral mass containing most of the gut and the heart, gonads, and kidney. Part of the body is enclosed in a mantle formed of a fold of the body wall. The mantle encloses a space known as the mantle cavity which is filled with water or air and in which the respiratory organs, anus, nephridiopore(s) and gonopore(s) are located. The coelom is reduced to small spaces including the pericardial cavity and gonocoel.

The well-developed blood vascular system consists of the heart and vessels leading to a spacious hemocoel in which most of the viscera are located. The kidneys are large metanephridia.

Molluscs may be either gonochoristic or hermaphroditic. Spiral cleavage produces a characteristic veliger larva in most groups unless it is suppressed in favor of direct development or another larva. Molluscs are well represented in marine, freshwater, and terrestrial habitats.

Bivalvia

Bivalvia is a large class of molluscs whose shell is divided into right and left portions. There is usually a crystalline style but never a radula. Bivalves are flattened from side to side and the head is reduced and bears no special sense organs. The large mantle cavity is located on the sides and contains the large gills. The gills are greatly enlarged and are used for respiration and filter feeding. The foot is usually large, well developed and is often used for digging into soft sediments.

Laboratory Specimens

The clam *Mercenaria mercenaria* (= *Venus mercenaria*), variously known as the northern quahog, hardshell, littleneck, cherrystone, or chowder clam, is a common and commercially important species on the east coast of North America where it lives in sand and mud in shallow water. This species is farmed commercially and is often available alive in inland supermarkets and seafood markets.

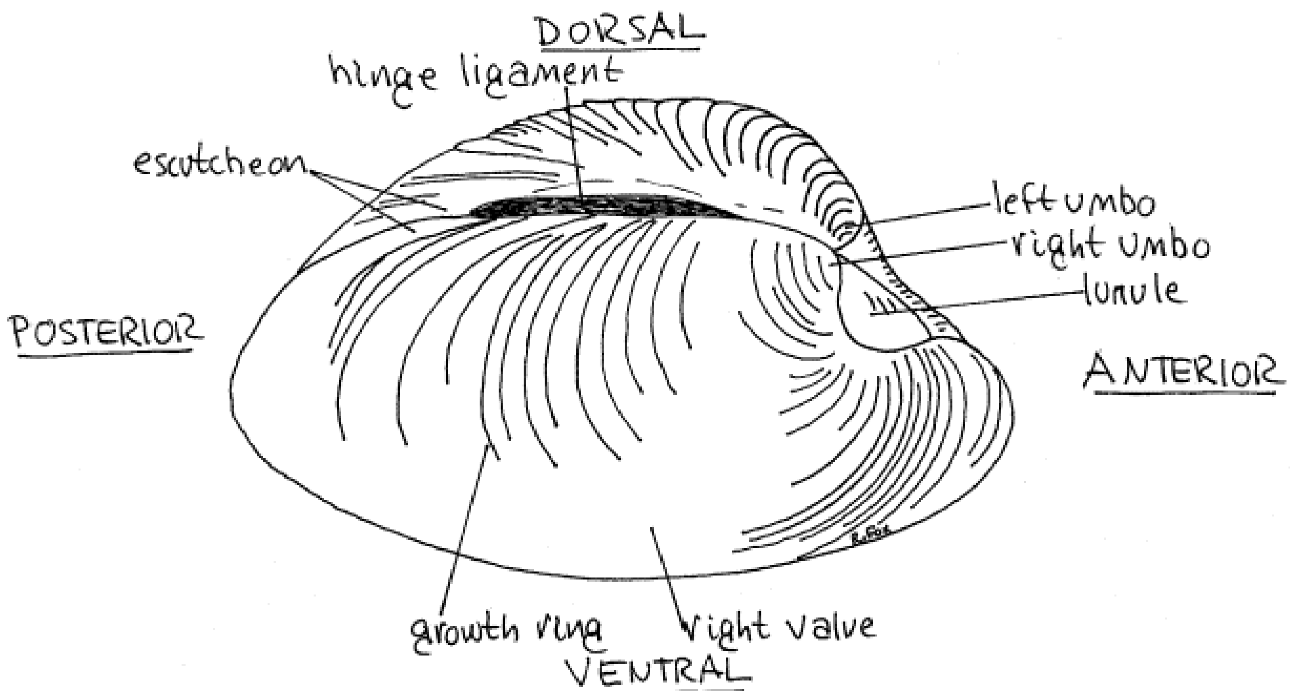
Preserved or living specimens of *Mercenaria* can be used for this study. The exercise is written for living specimens. Parenthetical comments refer to a similar species, the Japanese steamer clam, *Tapes japonicus*, which has been introduced to the west coast of North America. Use the dissecting microscope as needed.

External Anatomy

Shell

❋ It is best to study the features of the shell using an empty one. The thick chalky **shell** of *Mercenaria* consists of two similar **valves**, which fit tightly together to enclose and protect the animal (Fig 1). The exterior of each valve is rough and ornamented with irregularly spaced, raised, concentric **growth ridges**. (*Tapes* has, in addition, distinct **radial ridges**.)

Figure 1. Oblique view of the right side of an intact shell of *Mercenaria mercenaria*.



The shell is bilaterally symmetrical and the plane of symmetry passes through the hinge to divide the shell into similar **right** and **left valves**.

Each valve is strongly convex outwards and bears a conspicuous raised area, the **umbo**, on its dorsal surface near the hinge. The umbo is the oldest part of the valve and the concentric growth ridges are centered around it.

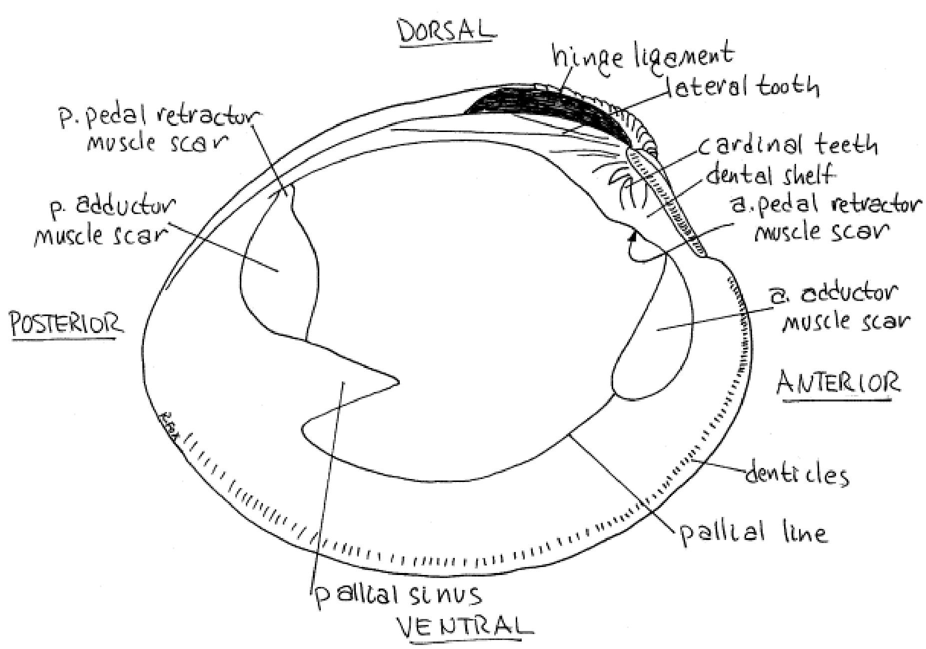
The two valves are joined dorsally at the flexible (in life) **hinge** and are free to separate from each other along the ventral margin. The dark brown, proteinaceous **hinge ligament** occupies part of the hinge. The hinge ligament is a good dorsal landmark. The space between the ventral margins of the opened valves is the **gape**.

The umbos are dorsal and slightly anterior to the middle of the hinge. Use them as landmarks to recognize **anterior** and, having accomplished that, decide which valve is **left** and which is **right**. Find **posterior** and **ventral** and identify the **plane of symmetry**.

❋ Look at the medial side of one of the two valves (Fig 2). Dorsally, the margin is occupied by the hinge, which is the articulation between the two valves. The hinge ligament is a conspicuous feature of the hinge. The ligament is composed of protein (conchiolin) and may or may not be present on dry empty shells. Look at a fresh, undissected specimen and find the ligament if your empty shell does not have one. The ligament of living animals is elastic but that of dry valves is hard and brittle.

The hinge is equipped with strong **teeth** to assure the proper alignment between the valves each time the shell closes. The teeth are located on a platform called the **dental shelf** (Fig 2).

Figure 2. Interior of the left valve of the shell of *Mercenaria mercenaria*.



The anterior and ventral margins of the valves bear fine teeth known as **denticles**. (*Tapes* lacks denticles.) The denticles probably prevent shear (sideways slipping) when the valves are pulled tightly together by the powerful adductor muscles. Note that the teeth mesh with each other when the valves come together. If you have the teeth properly aligned, the valves will fit snugly together and cannot be made to slip past each other.

The large, smooth **anterior** and **posterior adductor muscle scars** are easily seen at their respective ends of the inside of each valve (Fig 2). In intact clams the two adductor muscles run transversly from one valve to the other and their action is to pull the valves together (adduct) and hold them closed. Two additional muscles, the anterior and posterior pedal retractor muscles, insert on the shell near the adductor muscles. The **anterior pedal retractor scar** is separated by a small space from the anterior adductor scar and is under the anterior end of the dental shelf. (The anterior pedal retractor muscle scar is easy to see in *Tapes* and is located just anterior to the dental shelf.) The **posterior pedal retractor scar** is continuous with the posterior adductor scar (Fig 2).

The **pallial line** runs from one adductor to the other and parallels the ventral to margin of the valve. It is the site of insertion of muscles in the mantle and is indented sharply beside the posterior muscle scar. This V-shaped indentation is the **pallial sinus** and is a recess for the withdrawn siphons.

The inside of each valve of *M. mercenaria* is white with posterior purple markings. The shells of this species were cut into beads and used by east coast North American Indians as money, called wampum. This is the basis of the scientific name "mercenaria" (mercenari=hired for wages).

The typical mollusc shell comprises three layers. The outermost is the periostracum composed of the protein conchiolin. This layer is eroded and insignificant in *Mercenaria*. The dull, chalky **prismatic layer** is the middle layer. It is exposed on the outside of the valve due to the absence of the periostracum. The innermost layer, and the one in contact with the clam, is the calcareous **nacreous layer** which is smooth and glossy. (The thin, brown periostracum of *Tapes* remains intact and the prismatic layer is not evident.)

Soft Anatomy

✂ Open the shell of your clam to study the soft anatomy within. The adductor muscles keep the shell closed and it cannot be opened until they are severed. If you are dissecting a preserved specimen, the valves may already be pegged open with a wooden wedge. If this is the case, you may skip the remainder of this paragraph and proceed to the instructions for cutting the adductor muscles.

If you have a living specimen or an unpegged preserved specimen, you must make anterior and posterior openings in the shell to give you access to the adductor muscles so you can cut them. This is not easy to do but the best procedure is to use a pair of pliers to pinch away the anterior and posterior edges of the shell. Do not strike the shell as it cracks easily. Refer to the empty valves to help determine the positions of the two adductor muscles and begin removing the shell closest to them. You will not be able to get as close to the posterior adductor muscle as to the anterior because the posterior shell does not provide a raised edge to pinch. Remove enough shell to create a narrow opening at each end wide.

Insert a scalpel blade into the anterior opening and feel for the adductor muscle. Use the longest and sharpest blade you have but be very careful that you do not cut anything until you find the muscle. The muscle is firm and unyielding whereas the other tissues are soft and do not resist gentle probing. Once you have found the muscle, sever it completely with the scalpel. Do the same with the posterior adductor muscle. The pedal retractor muscles should be cut also.

Arrange the clam so the left valve is up, facing you, so you are looking at the left side of the animal. With all the muscles severed, carefully lift the left valve a little so you can see into the gape. The body will be cradled in the concavity of the right valve but a thin sheet of tissue, the left mantle lobe, adheres closely to the inner surface of the left valve. Slip the *blunt* end of your scalpel handle between the left mantle lobe and the left valve and use it to free the soft tissue from the shell. Carefully work the scalpel handle around the stumps of the adductor muscles being careful that you do not damage the mantle. Note the two pedal retractor muscles that insert on the shell beside the much larger adductor muscles. Cut them now if you did not do so earlier. When the mantle is free, detach the left valve and set it aside.

Place the clam in a culture dish or dissecting pan with the right valve down. Cover the clam with seawater or isotonic magnesium chloride (if living) or tapwater (if preserved).

Muscles

Look at the clam and find the **anterior and posterior adductor muscles** and note that each is composed of two distinct regions (Fig 3). The anterior part of the anterior adductor muscle and the posterior half of the posterior adductor muscle are **catch muscles** composed of smooth muscle fibers with abundant connective tissue. They are capable of sustained, slow contraction and in life are white. The remainder of each muscle is the **fast muscle** composed of obliquely striated fibers with abundant supplies of myoglobin and mitochondria but with relatively little connective tissue. In life fast muscle is red due to its myoglobin. Catch muscle contracts and relaxes rapidly but fatigues easily. The adductor muscles are opposed by the elastic recoil of the hinge.

The pedal retractor muscles are paired. Find one of the small **anterior pedal retractor muscles** (Fig 3). It is a short cord of muscle and connective tissue running from the anterior end of the foot to the shell. The **posterior pedal retractor muscle** is a similar cord extending from the posterior end of the foot to the shell. The retractors pull the foot back into the shell as is necessary before closing the gape, or, when digging, to pull the clam toward its foot.

Mantle Lobes

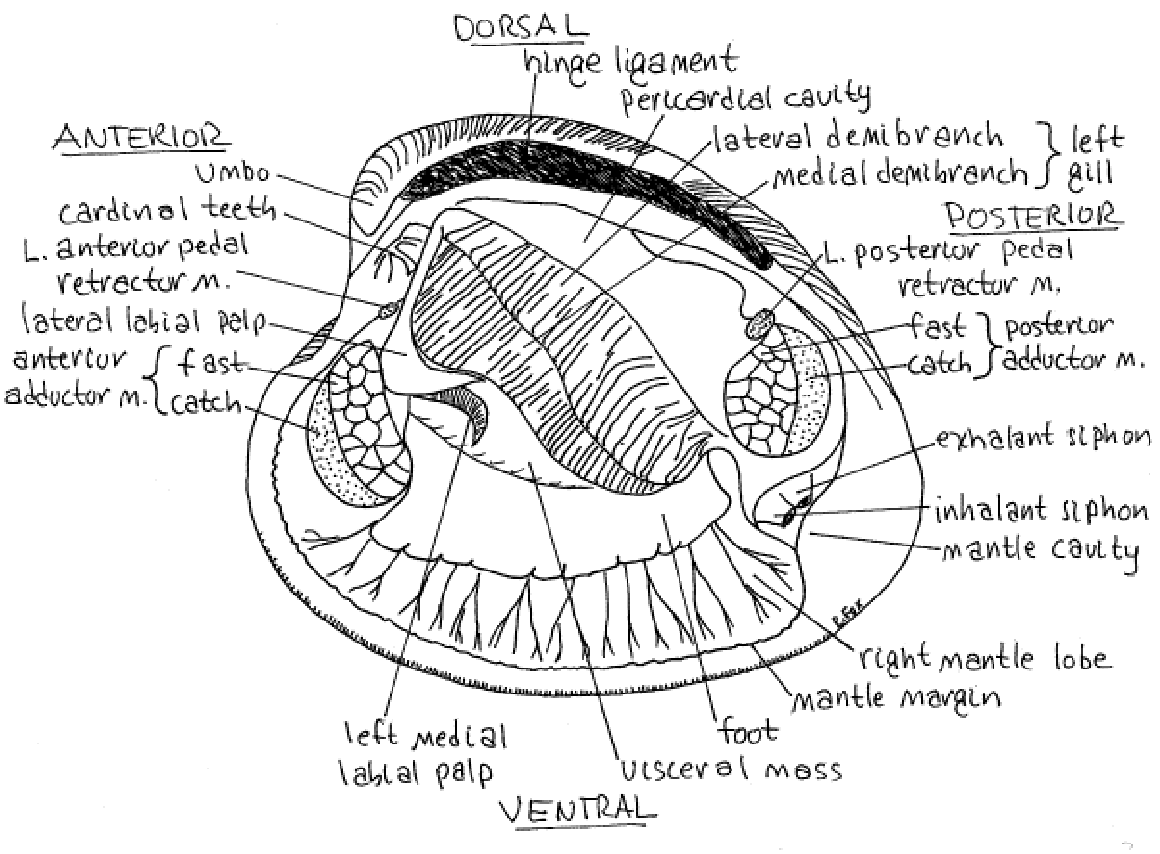
The bivalve body is enclosed on the right and left by two large, thin folds of the body wall (Fig 5). These folds are the **right and left mantle lobes**. Each is a thin sheet of tissue, free at the ventral edge but connected with the body dorsally. The pallial muscles attach the mantle lobe to the shell along the pallial line.

Mantle Cavity

Between the right and left mantle lobes lies a large space, the **mantle cavity**, in which lies the body (Fig 3). The mantle cavity is continuous with the sea and is filled with seawater. Without cutting tissue, lift the left mantle lobe and find the mantle cavity. It is divided into a large ventral region below and beside the body, known as the **branchial chamber**, and a smaller dorsal region above the body, the suprabranchial chamber. The two chambers are separated from each other by the gills. The space you see now is the branchial chamber and you cannot yet see the suprabranchial chamber.

Look into the mantle cavity and make a quick identification of the most conspicuous features of the body so you can use them for landmarks later. With the left mantle lobe held out of the way, closest to you is the long, leaflike **left gill** (Fig 3). Medial to the gill is the large bulging **visceral mass** with the thinner, muscular, bladelike (in life) **foot** attached to its ventral midline. Lift the foot and visceral mass to see the **right mantle cavity**, **right gill**, **right mantle lobe**, and **right valve**, in that order.

Figure 3. The left side of *Mercenaria* with the left valve and left mantle lobe removed.



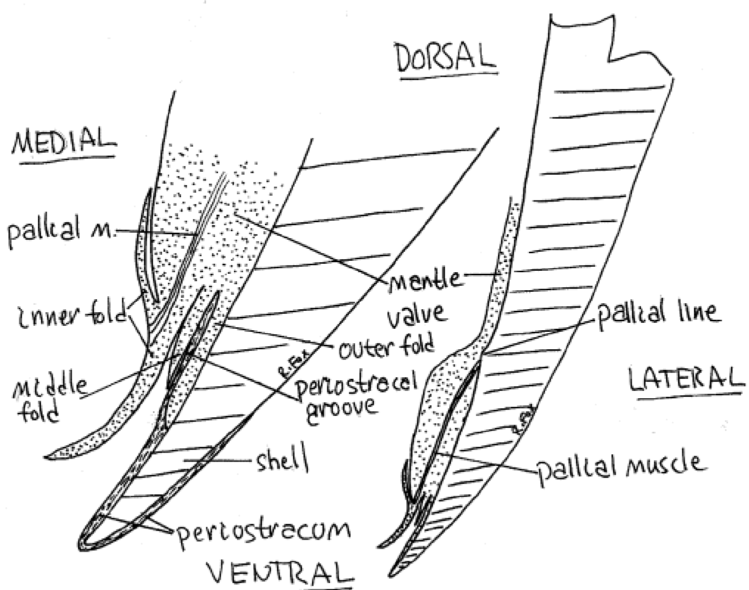
Mantle Folds

✱ Study the ventral margin of the right mantle lobe with magnification. The mantle margin of *Mercenaria* and other venereid clams is composed of four folds although most bivalves have only three (Fig 4). The homologies between the four venerid lobes and the three lobes of other bivalves are unclear but they probably arise through subdivision of the inner fold.

The **outer fold**, which is adjacent to the shell, secretes the prismatic layer and periostracum. The lateral side of the outer fold secretes the prismatic layer of the shell whereas the medial side secretes the periostracum. The nacreous layer is secreted by the entire later surface of the mantle lobe.

The **inner fold** is muscular and in *Mercenaria* is double. The wide border of the mantle, from its free edge to the pallial line, is thicker than the rest of the mantle due to the presence of the pallial muscles that insert on the shell along the pallial line. These muscles can be seen radiating across the mantle border peripheral to the pallial line. Tug gently on the free edge of the right mantle and observe that {in life} it is firmly attached to the shell at the pallial line.

Figure 4. Cross section through the ventral edge of a valve and the associated mantle lobe of *Mercenaria*.



The **middle fold** lies between the inner and outer folds and is sensory. It is weakly developed in *Mercanaria*.

The groove between the outer and middle folds is the **periostracal groove**. In living specimens the freshly secreted **periostracum** can be seen extending out of this groove across the exposed surface of the margin of the valve. It is a very thin, transparent, delicate, glistening membrane.

Siphons

Posteriorly, the right and left mantle lobes join each other across the midline to form the two short tubular siphons Fig 3). The siphons are darkly pigmented and each has short sensory **tentacles** surrounding its outer aperture. The ventral tube is the **inhalant siphon** and the dorsal one is the **exhalant siphon**.

The inhalant siphon brings water into the branchial chamber. Insert your blunt probe into the external opening of the inhalent siphon and show that water entering here would enter the branchial chamber of the mantle cavity.

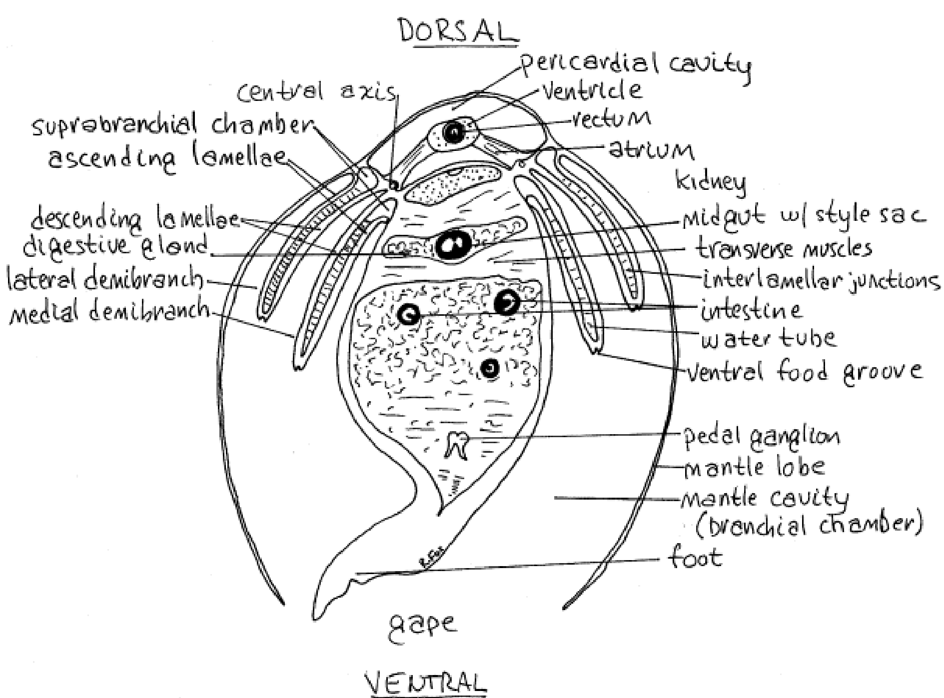
Water in the branchial chamber must pass through openings in the gills to enter the suprabranchial chamber, from which it then exits via the exhalent siphon.

Dorsal to the siphons the entire right and left mantle margins are fused to each other on the midline beneath the hinge. The siphons are formed by an elaboration of the fused right and left mantle margins. The sensory tentacles are part of the middle mantle fold.

Gills

With scissors, remove the left mantle lobe and look at the left gill, or ctenidium. This organ is a single complete gill, or **holobranch**, and there is one on each side of the body (Figs 3, 5). A holobranch is composed of two delicate, leaflike **demibranchs**, or half gills. These are the outer **lateral demibranch** and the inner **medial demibranch** (Figs 3, 5). The two are joined dorsally along the **central axis** which is attached to the body (Fig 5).

Figure 5. Cross section of *Mercenaria*. The shell is not included.



Each of the two surfaces of a demibranch is a **lamella** (Fig 5). One surface is the **descending lamella** attached to the central axis and the other is the **ascending lamella** attached to either the mantle or the visceral mass (Fig 5). In *Mercenaria*, but not *Tapes*, the connections of the ascending lamellae to the body are fragile and the margins of the gills are easily torn free of their attachments. At present you are probably looking at the ascending lamella of the lateral demibranch of the left gill.

The demibranchs are composed of filaments. The surface of the lamella is conspicuously ridged. ach ridge is a **plica**, running parallel to the short axis of the gill. Each plica is made up of several gill filaments and contains a water tube (Fig 5). The water tubes are part of the suprabranchial chamber.

Examine one of the plicae with the highest power of your dissecting microscope and you will see faintly the long slender **gill filaments** that make up its walls. In venus clams, such as *Mercenaria*, adjacent filaments are fused together and the only openings between them are the microscopic ostia.

The ciliated longitudinal groove along the ventral edge of each demibranch is a **ventral food groove** used to transport food particles anteriorly to the mouth (Fig 5). The ciliary beat in the food grooves is anteriorly toward the head, labial palps, and mouth whereas that of the lamella is either dorsal or ventral.

During feeding and respiration a water current bearing food and oxygen enters the branchial chamber via the inhalant siphon. The eater enters the ostia and passes into the suprabranchial chamber. Food particles are filtered from the current as it passes through the ostia of the gills, remain on the branchial side of the gill where they are mixed with mucus and transported to the food grooves by cilia.

❋ If your clam is living, remove it from its dish and place it, on a towel, on the stage of your dissecting microscope. Arrange the animal so the surface of a lamella is horizontal. Place a drop of carmine/seawater suspension on the lamella. Watch the motion of the particles along the face of the lamella and in the ventral food groove.

✂ With scissors, remove a small square (about 5x5 mm) from the lateral demibranch, being sure to include the ventral food groove. Make a wetmount and examine it with the compound microscope. Find the food groove along one margin and use it as a landmark. Adjust the light, focus carefully on the uppermost of the two lamellae, and study the construction of the demibranch. The surface of the lamella is composed of large parallel ridges, the **plicae**, which are themselves formed of smaller ridges, the **gill filaments**. Focus down to bring the filaments of the other lamella into view. Trace a filament to the food groove and note that it reverses direction here and extends up the opposite side of the demibranch. Look in the grooves between the filaments and you may be able to see the small oval **ostia**.

Labial Palps

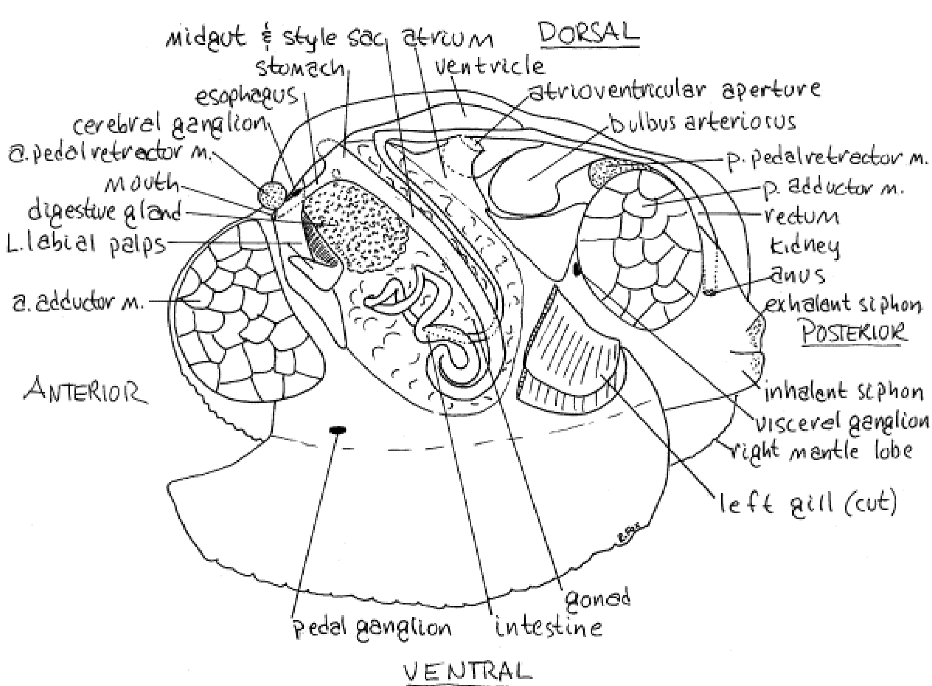
The two long narrow **labial palps** on each side of the mouth are anterior extensions of the gills (Figs 3, 6). There is a **lateral** and a **medial palp** on each side. The lateral demibranch connects with the lateral palp and the medial demibranch with the medial palp. Each palp bears ciliated ridges and grooves that form a **sorting field** on one surface. The fields are arranged so that when the palps lie together, the sorting fields face each other.

Mucus and food particles from the gills move along the food grooves to the labial palps where the sorting fields separate desirable organic matter from indigestible mineral particles. Organic particles move to the mouth whereas mineral particles, trapped in mucus, move to the tip of the palp from which they are dropped into the mantle cavity. This mixture of discarded mineral particles and mucus is known as pesudofeces and it is periodically expelled through the inhalant siphon by sudden contractions of the mantle cavity.

✱ If you have a living specimen, place carmine/seawater on the sorting field of one of the labial palps and see if you can see the ciliary currents described above. Try the same thing with chalk dust.

Trace the edges of the two labial palps across the midline and note that each is connected with its counterpart on the opposite side of the body. These two thin folds of tissue are the **lips**. The lip that connects the two lateral palps is the **upper lip** and the one that connects the two medial palps is the **lower lip**. Exactly on the midline, between the upper and lower lips, is the **mouth**. Tilt the animal and find the mouth with the dissecting microscope. This area may have been damaged when the anterior adductor muscle was cut.

Figure 6. Dissection of the ledft side of *Mercenaria*. The left side of the visceral mass has been dissected. The left mantle lobe and most of the kidney and left gill have been removed.



Internal Anatomy

Blood Vascular System

The bivalve blood vascular system consists of heart, arteries, and an extensive hemocoel. Only the heart will be studied in this exercise.

The heart lies in the **pericardial cavity** located dorsally just below the hinge (Figs 3, 5, 6). The body wall in this area is very thin and the pericardium is close to the surface. The pericardial cavity is a remnant of the coelom. The dark reddish brown (pale beige in *Tapes*) metanephridium, or **kidney**, can be seen on the walls of the pericardium, especially posteriorly. Paler, greenish brown tissue situated more anteriorly is the **digestive gland**.

With fine scissors, make a *shallow*, longitudinal, middorsal incision in the thin dorsal body wall paralleling and extending the length of the hinge ligament. This cut opens the pericardial cavity to reveal the **heart** within. The heart consists of a single large **ventricle** into which the paired right and left **atria** empty (Fig 6). The ventricle lies on the midline and is a long, soft, ovoid organ. It is penetrated by the posterior intestine, or **rectum**, which runs the length of its lumen (Fig 6). The intestine can be seen faintly through the walls of the ventricle.

With a blunt probe, carefully lift the edge of the ventricle and find the **left atrium** attached to its left side (Fig 6). The atrium is a thin-walled, transparent, truncated triangle extending from the ventrolateral pericardial wall to the ventrolateral wall of the ventricle. The truncated apex of the atrium attaches to the ventricle and its broad base extends along the length of the central axis of the gill. Oxygenated blood from the gills drains into the atria and from there enters the ventricle.

If your animal is alive, count the heartbeats for three minutes and calculate a pulse rate for your specimen.

A variety of classical physiological experiments can be performed on the heart. You could test the effects of heat, cold, ions (eg. potassium chloride, calcium chloride), drugs (caffein, nicotine), and neurotransmitters (adrenalin, acetylcholine) on the rate, strength, and regularity of the heart beat. A kymograph or physiograph can be used if desired.

Anteriorly, the ventricle narrows to become the wide, transparent anterior aorta which may be visible beside the base of the anterior pedal retractor muscle. The anterior aorta lies on top of the intestine. The intestine emerges from the visceral mass at the end of the aorta and bends almost 90° to enter the lumen of the ventricle (Fig 6).

Posteriorly, the ventricle constricts to become the posterior aorta which then immediately expands to form the large swollen **bulbus arteriosus**. The size of the bulbus varies depending on the amount of blood it contains. The posterior aorta then narrows and continues posteriorly, ventral to the rectum.

Suprabranchial Chamber

The ventrolateral floor of the pericardium is the roof of the **suprabranchial chambers** (Fig 5). Insert the blunt probe into the exhalent aperture and into the suprabranchial chamber. The transparent roof of the chamber extends anteriorly from the exhalent siphon but may have been cut when you severed the posterior adductor muscle. (The visceral ganglion of the nervous system is in the tissue between the roof of the chamber and the adductor muscle. In living clams the ganglion is orange (neuroglobin). Be careful that you do not destroy it.)

Open the suprabranchial chamber by cutting through its roof or by tearing the ascending lamella away from its attachment to the mantle. Look inside the chamber and find the upper ends of the **water tubes** inside the plicae. Insert a blunt probe into the exhalent siphon to demonstrate its continuity with the suprabranchial chamber.

Excretory System

The two **kidneys** are large metanephridia, one on each side on the floor and walls of the pericardium at the dorsal margin of the visceral mass (Figs 5, 6). They are brown or reddish-brown (in life) and are easily seen without dissection although their structure is not apparent. The metanephridia are elaborate ducts extending from the pericardial cavity to nephridiopores in the suprabranchial cavity. Urine is released from this pore into the exhalant water stream.

Digestive System

The bivalve gut consists of a mouth, esophagus, stomach, digestive glands, midgut, rectum, and anus. There is a style and style sac but no radula. Most of the gut is within the visceral mass and cannot be seen without dissection. Relocate the **mouth** on the anterior midline between the upper and lower lips of the labial palps (Fig 6). The mouth opens directly into the **esophagus**.

❋ Gently insert the tip of a blunt probe into the mouth to reveal the esophagus. The probe will follow the gut and you can see it (the probe) through the gut wall. The esophagus extends obliquely dorsoposteriorly between the bases of the two anterior pedal retractor muscles (Fig 6). The esophagus more or less parallels the edge of the dental shelf in the vicinity of the cardinal teeth.

❋ If you plan to study the nervous system, refer to the nervous system section and find the cerebral ganglia at this time as they are usually destroyed during the dissection of the anterior gut.

✂ Remove the left gill and left labial palp so you have unobstructed access to the left side of the visceral mass. The short esophagus passes into the greenish **digestive gland** to join the **stomach** (Fig 6). The anterior end of the stomach, which is otherwise embedded in the visceral mass, lies very close to the surface of the anterodorsal corner of the visceral mass and can sometimes be seen without cutting.

✂ Insert a blunt probe into the esophagus and open the stomach by inserting a blade of your fine scissors into the mouth and cut along the esophagus, following the probe to the stomach. Once you have entered the stomach, cut posteriorly through the lateral wall of the visceral mass and digestive gland, opening the stomach as you go (Fig 6). Continue this cut posteriorly, paralleling the dorsal border of the visceral mass. The incision should follow and open the midgut which extends posteriorly from the stomach. Continue this cut, following the midgut, around the posterior curve of the visceral mass to the foot.

Use a pipet with rubber bulb to squirt clean water over the freshly cut surfaces and in the lumen of the stomach to blow away the accumulating debris that would otherwise obscure your view.

Examine the intact right wall, floor, and roof of the stomach. Find the opening of the esophagus on the midline at the anterior end of the stomach. It lies under a fleshy overhang of tissue.

Two openings to the digestive glands are located on the floor of the stomach just posterior to the opening of the esophagus. A branching network of tubules extends from these openings throughout the glands.

On the right of the esophageal opening, and extending dorsally to the left side, is a large, ciliated sorting field. The field is composed of numerous fine ridges and grooves.

The roof and much of the left wall of the stomach are covered by a thin, chitinous gastric shield but it is difficult to see. Although the shield itself is nearly invisible, the wall of the stomach under it is smooth and can thereby be distinguished from the surrounding walls.

The **intestine** extends from stomach to anus (Fig 6). Its anterior end is the **midgut** whereas the rectum is its posterior end. The midgut exits the posterior end of the stomach and parallels the dorsal and posterior edges of the visceral mass. Note that the midgut is divided into two parallel tubes by two longitudinal ridges of tissue that approach each other in the middle of the midgut lumen (Fig 5). These two ridges are **typhlosoles**. The typhlosoles are ciliated ridges that transport particulate material.

The two tubes of the midgut are the dorsal **style sac** and the ventral **intestine**. The style sac of your specimen may or may not contain a **crystalline style**. The style is produced only when needed and if your animal has been maintained without food it probably will not have a style. It is a *very* long, narrow, flexible, pellucid, gelatinous rod that occupies the length of the style sac and protrudes from the sac into the stomach lumen. It is composed of hydrolytic enzymes (amylase, cellulase, lipase) and is secreted by the glandular walls of the sac. It stirs the stomach contents, serves as a windlass to help pull mucus/food strings from the labial palps into the stomach, and is a source of digestive enzymes for the extracellular hydrolysis of carbohydrates and lipids in the stomach. Protein digestion occurs intracellularly in the digestive glands.

The midgut extends posteriorly from the stomach, curves around the posterior edge of the visceral mass to the foot where it changes direction and turns anteriorly (Fig 6). It soon changes direction again and heads dorsally. Only the midgut, and not the style sac or the style, continues past this point.

The intestine loops in a characteristic pattern through the visceral mass, and emerges at the base of the anterior aorta (Fig 6). Here it makes a right angle turn to extend posteriorly through the center of the pericardium and ventricle as the **rectum**. Beginning at the point where the style sac ends, the intestine is characterized by the presence of a single, large, rounded **typhlosole** that occupies most of its lumen (Fig 5). Continue tracing the intestine a little beyond the point where the typhlosole begins so you can get a good look at this part of the gut. The gut is easiest to trace by opening it and following the typhlosole. Trace the intestine as far as you wish into the visceral mass. If you have the time you may follow it all the way to the heart but the procedure is tedious and time-consuming.

Locate the **rectum** where it exits the heart and trace it posteriorly. It passes between the bases of the two posterior pedal retractor muscles and then curves over the top of the posterior adductor muscle and partway around its posterior margin. It ends in the suprabranchial chamber at the **anus** on the posterior edge of the adductor muscle. Fecal pellets released from the anus are caught in the exhalant current and swept out the siphon.

Nervous System

The nervous system of bivalves is relatively simple and consists of three major pairs of ganglia (cerebral, pedal, and visceral), connectives and commissures between them, and the nerves radiating from them.

Despite its simplicity, the system is not easily studied. The ganglia can usually be found but tracing the connectives and nerves is difficult. In living animals the ganglia are orange or yellow with neuroglobin, making them easier to recognize. The bivalve sensory system is weakly developed. Most sensory receptors are in the middle fold of the mantle margin.

The two cerebral ganglia are situated close to each other atop the anterior end of the esophagus, very close to the mouth. They are embedded in connective tissue on the posterior dorsal edge of the anterior adductor muscle. The two cerebral ganglia are connected to each other via a short transverse commissure across the top of the esophagus and nerves extend from them to the labial palps, anterior adductor muscle, anterior mantle, and anterior pedal retractor muscle.

From the cerebral ganglia a pair of cerebrovisceral connectives runs posteriorly through the dorsal visceral mass to the visceral ganglia. The visceral ganglia are located on the anterior face of the posterior adductor muscle between the origins of the two posterior pedal retractor muscles. They are fused with each other on the midline. The visceral ganglia send nerves to the siphons, posterior adductor muscle, posterior pedal retractor muscle, posterior mantle, kidney, gill, and heart.

A pair of cerebropedal connectives extends ventrally and posteriorly from the cerebral ganglia to the pedal ganglia in the foot.

The two pedal ganglia are fused with each other and lie on the midline in the visceral mass, very near the muscles of the foot (Figs 5, 6). The pedal ganglia innervate the musculature of the foot.

Reproductive System

Like most bivalves, *Mercenaria* is gonochoristic and the two **gonads**, either ovaries or testes, fill most of the space in the visceral mass (Figs 5,6). The size of the gonads depends on the degree of development. Although there are two of them, they cannot usually be distinguished from each other.

❋ Determine the sex of your individual by making a wetmount of some of the gonadal tissue and examining it with the compound microscope. Look for gametes, either large spherical **eggs** or tiny flagellated **spermatozoa**.

The gonads occupy remnants of the embryonic coelomic cavity but that will not be apparent to you in gross dissection. Each gonad empties into the suprabranchial chamber via a gonoduct that opens at a gonopore at the tip of a small genital papilla just anterior to the nephridiopore. The genital papilla is located at about the level of the posterior end of the ventricle in the medial suprabranchial chamber but is difficult to locate.

Cross Sections

✂ If extra specimens are available, you may want to make a cross section of one. This works best if the tissues are firm, as are those of preserved specimens. If you have fresh or living specimens, drop them, shell and all, into boiling water for about five minutes to denature and solidify the proteins. Remove the clam from the shell and, using a very sharp scalpel, razor blade, or scissors make one or more cross sections entirely through the body including the gills and mantle. Most useful is a slightly oblique section passing through the heart and anterior end of the base of the foot (Fig 5). Rinse the sections gently and then immerse them in fluid in a small dissecting pan for study with the dissecting microscope. Use Figure 5 to identify the structures already familiar to you from your conventional dissection.

References

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