

An Illustrated Guide to the Dissection of the *Shark*

Introduction

Sharks used in dissection classes are usually the dogfish: *Squalus acanthias*. Because of its ready availability and primitive chordate structure, it is often the only fish a student will dissect in a comparative anatomy course. Tools you will need for the dissection are:

1. **A large dissecting tray**
2. **Surgical scissors with one blunt tip**
3. **Scalpel**
4. **Dull probe**
5. **T-pins to hold skins flaps down**
6. **Forceps**

Each day when you have finished dissection work, wet your specimen with Delta-Sol in order to prevent the tissues from drying or molding. Then replace it in the plastic bag the shark came in. Delta-Sol should be used during dissection to rid the specimen of preservative fumes. Delta-Sol is a non-toxic, odorless fluid that reduces the unpleasant smell associated with preserved specimens. Delta-Sol can be purchased from our catalog in easy to mix concentrate form.

Dissection is a learned skill that takes practice and patience. Some general rules to remember are: do not make deep cuts with scissors or scalpels; you may inadvertently damage underlying tissues. Know the anatomical terms such as: caudal, cranial, [etc. so](#) you can follow the text directions. Read the section you are working on before you start cutting. Do most of the work yourself; try to answer your own questions about anatomy before asking for the teacher's help.

An Illustrated Dissection Guide
To The Shark
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Anatomical Terms

Cranial—toward the head

Caudal—toward the rear

Dorsal—toward the spinal cord (back)

Ventral— toward the belly

Medial—toward the middle

Distal—away from

I. External Features (*Figure 1*)

Familiarize yourself with the following external features:

1. External Nares—These are a pair of openings (nostrils) on each side of the head, cranial from the eyes. Water is taken into the smaller of the two openings and expelled through the larger opening. The water passes by a sensory membrane allowing the shark to detect chemicals in the water.

2. Spiracles—These are small openings caudal from the eyes. These openings allow water to pass through the gills even when the shark's mouth is closed.

3. Mouth—Although the eating function is self evident, the mouth is also used for the intake of water that passes through the gills.

4. Gill Slits—Five vertical slits which allow water to exit after passing over the gills. They are located caudally from the mouth.

5. Lateral Line—A pale line that extends noticeably from the pectoral fin past the pelvic fin. This line is actually a group of small pores which open into the underlying lateral line canal, a sensory organ that detects water movements.

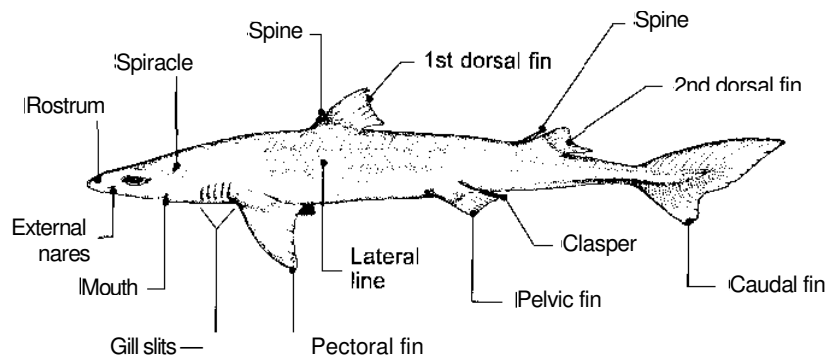


Figure 1. External features.

6. Cloaca—This is the exit from the digestive tract combined with being the opening for the sex organs. The cloaca lies between the pelvic fins.

7. Clasper— Found on male sharks only, these are finger-like extensions of the medial edge of each pelvic fin. They may have a single spine associated with each clasper. The claspers aid in sperm transfer during mating.

8. Fins— Refer to Figure 1 and familiarize yourself with each fin and its name.

9. Rostrum—This is the pointed snout at the cranial end of the head.

10. Dorsal Spines—Just cranial to each dorsal fin is a spine that is used defensively by the shark. Each spine has a poison gland associated with it.

II. The Skeletal System

Unlike the other 'higher vertebrates' (teleost fish, reptiles, birds, etc.) the shark does not have a bony skeleton but instead a skeleton composed of cartilage. Cartilage is laid down by cells called chondrocytes. Some of the cartilage in the shark skeleton has been hardened by deposits of calcium salts. However, unlike bone, calcium is not laid down by bone cells but by the precipitation of the salts into the gel-like matrix of the cartilage.

Figure 2 shows a lateral view of the entire shark skeleton. Familiarize yourself with the parts outlined within this figure.

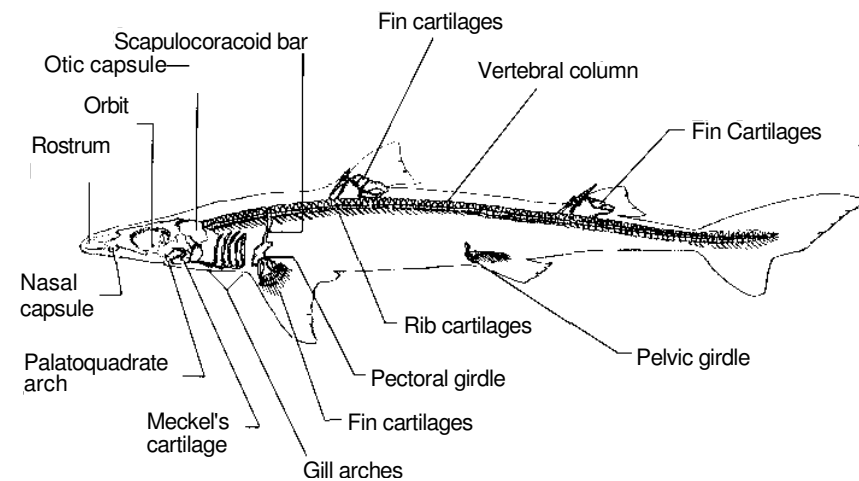


Figure 2. Shark skeleton - lateral view

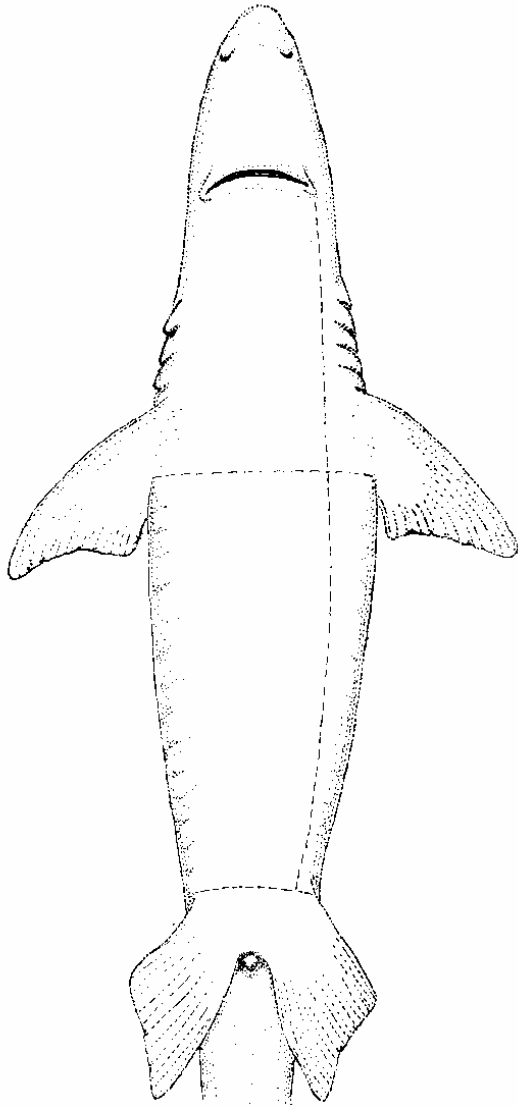


Figure 5. Body wall incisions

IV. Dissecting the Abdominal Cavity

Place your shark ventral side up on the dissection tray. Using scissors make a cut from the left side of the jaw caudally down through the middle of the gill slits and through the pectoral girdle down to just above the cloaca. Make certain that the blunt tip of the scissors is the edge used inside the shark. From the cloaca make transverse cuts around the shark. From the pectoral girdle make transverse cut around dorsally. See *Figure 5* for a diagram of dissection incisions.

Pin the body wall flaps to the side that will expose the abdominal cavity. With the aid of *Figure 6* identify the following organs:

Esophagus—The connection between the pharynx (caudal mouth region) to the stomach. In the shark the esophagus is very short and wide.

Stomach—This J-shaped organ is composed of a cardiac portion which lies near to the heart and a limb portion which is after the bend of the stomach. The stomach ends at the pyloric sphincter a muscular ring which opens or closes the stomach into the intestine. The pyloric sphincter can be felt in order find it.

Duodenum—This is a short section immediately caudal from the stomach. It receives liver secretions known as bile from the bile duct.

Liver—The liver is composed of three lobes, two large and one smaller. The gall bladder is located within the smaller lobe. The bladder stores the bile secreted by the liver.

Pancreas—Divided into two parts: **The** ventral pancreas, which is easily viewed on the ventral surface of **the** duodenum and the dorsal pancreas which is long and thin located behind the duodenum and extends to the spleen.

Spiral Intestine—Located cranially from the duodenum and distinguished by the extensive network of arteries and veins over its surface. **Cut** this organ open and wash the contents out with running water. Observe the funnel shaped folds.

These are the spiral folds also known as the typhlosole. This structure greatly increases surface area which makes the intestine more efficient in food absorption.

Rectum—This is the short end portion of the digestive tract between the intestine and the cloaca. The rectum stores solid wastes.

Spleen—Located just caudal to the stomach and proximal to the spiral intestine. This organ is not a part of the digestive tract, **but** is associated with the circulatory system.

Circulatory System-The Heart

Lift the flaps over the pericardial cavity and pin them away. Do this carefully while dissecting any tissue that is holding the heart in place. Identify the following parts of the heart (*Figure 7*).

Sinus Venosus—Dorsal to the ventricle, this is a thin walled, non-muscular sac which acts as a collecting place for venous blood.

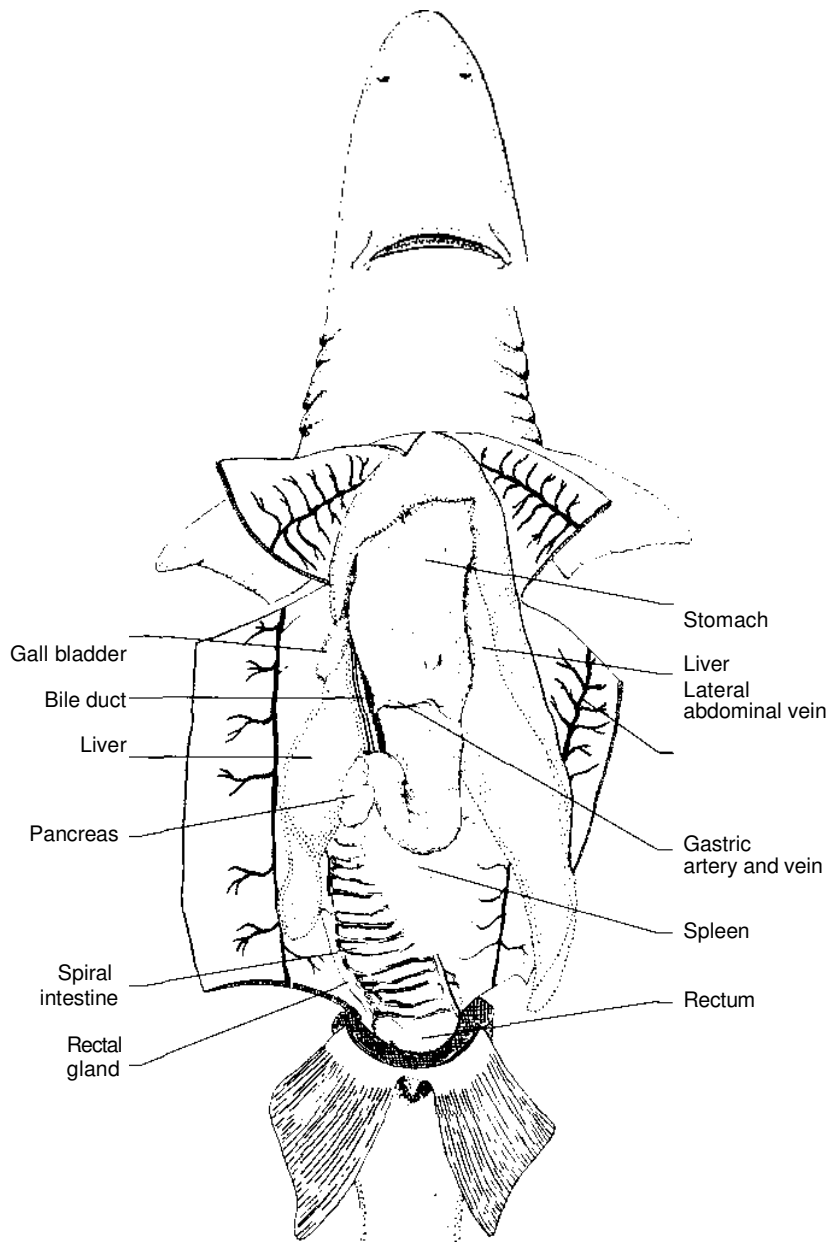


Figure 6. Digestive organs.

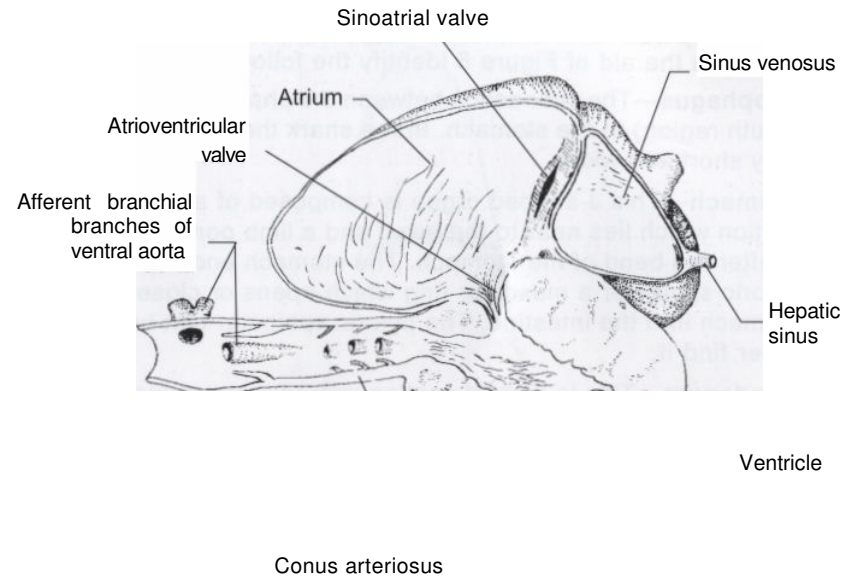


Figure 7. Lateral cross section of the shark heart.

Atrium—Another thin walled, distensible reservoir for the ventricle.

Ventricle—The main contractile chamber of the heart, a heavily muscularized section.

Conus Arteriosus—A muscularized reservoir that empties after the ventricular contraction. It gives the blood flow an added boost in addition to maintaining blood flow during the period of ventricle relaxation (diastole).

Before continuing with the circulatory system, familiarize yourself with the following mouth structures.

Teeth—These are derived from the scales which cover the shark's body that have been adapted to function as cutting structures. There is no functional specialization among the teeth, and the teeth are replaced regularly as they wear.

Pharynx—The cavity caudal from the spiracles to the esophagus. The gill slits open on either side of the caudal region. The gill rakers are cartilagenous protrusions which prevent large particles of food from entering the gills.

Tongue—The tongue of the shark is immovable.

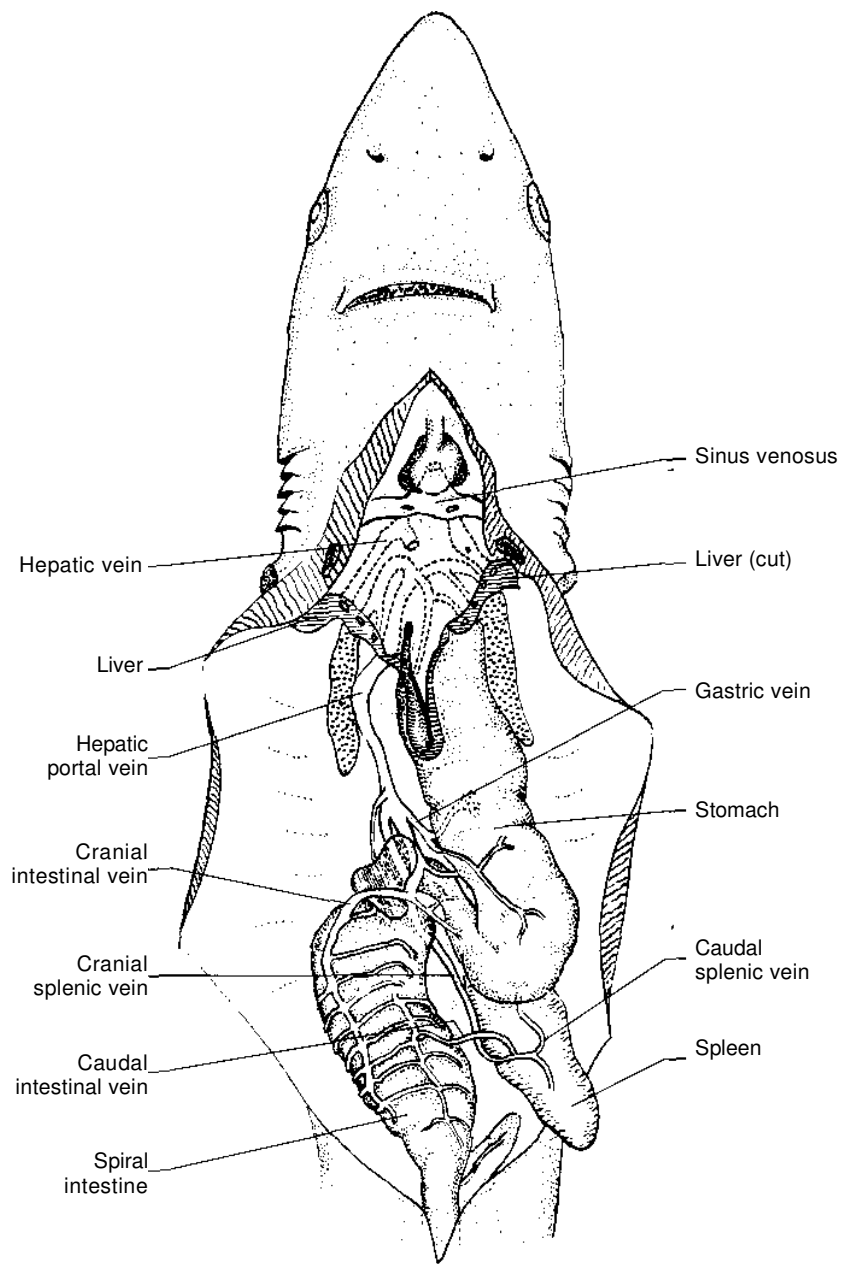


Figure 11. Hepatic portal system.

Hepatic Portal System (Figure 11)

Hepatic Portal Vein—Receiving veins from the bile duct and pancreas
This vessel parallels the bile duct and also joins the following:

Gastric Vein—Formed by the union of the dorsal and ventral gastric veins.

Gastrosplenic—The gastrosplenic receives blood from the spleen, stomach, pancreas, and the intestine.

Gastrointestinal—Receives blood from the pyloric stomach and intestine.

Renal Portal System—Dissect away the tail tissue just caudal to the anus to expose the caudal artery and vein.

Caudal Vein—Collects blood from the tail region and the iliac vein (blood from the pelvic fins) and empties into the renal portal veins. These break into capillary beds around the kidney collecting tubules which join again to form the renal vein.

VI. The Urogenital System

To view this system you need to remove all of the digestive tract. Remove the liver at its cranial end. Cut through the esophagus where it enters the body cavity above the stomach. Cut the colon from its caudal end. Free the stomach, intestine, pancreas and spleen from their attachment membranes and vascular systems. This procedure exposes the sex organs, kidneys and various ducts associated with these organs. Figure 11 shows the male urogenital system. Figure 12 shows the female urogenital system.

Kidneys—The shark has two dark-colored kidneys on either side of the midline. The shark osmoregulates in a way unique compared to most other vertebrates. The shark kidney extracts urea from urine and returns the urea to the blood, whereby it concentrates urea in the blood. In this way the osmotic pressure of the shark's body fluids are maintained as high as that of sea water. With this system the shark does not lose water or gain salts through osmosis.

Rectal Glands—These are tube-like extensions of the rectum. This gland controls the salt (NaCl) concentration within the body. Excess salt is secreted into the gland tubule. Via the central gland cavity, salt is released into the rectum for expulsion,

Archinephric Ducts—In females these are the ducts that drain into the cloaca through the urinary papilla. In the male shark, this duct transports both urine and sperm (not necessarily at the same time). This duct is much easier to find on the males than it is in females. Also in the male shark the ducts enlarge caudally to form the seminal vesicle.

Accessory Urinary Ducts—In general, these are absent in female sharks. In males these ducts drain the caudal portion of the kidneys. These are found dorsal to the seminal vesicles.

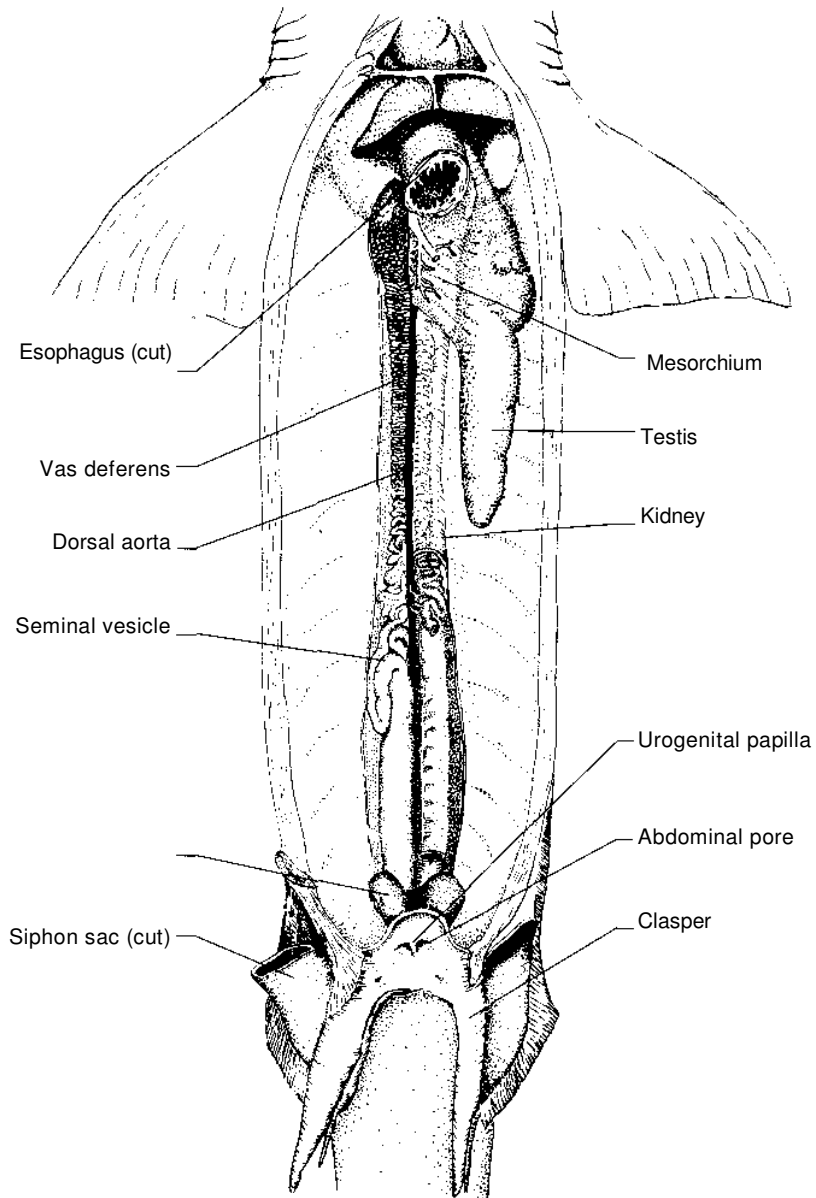


Figure 12. Male urogenital syste

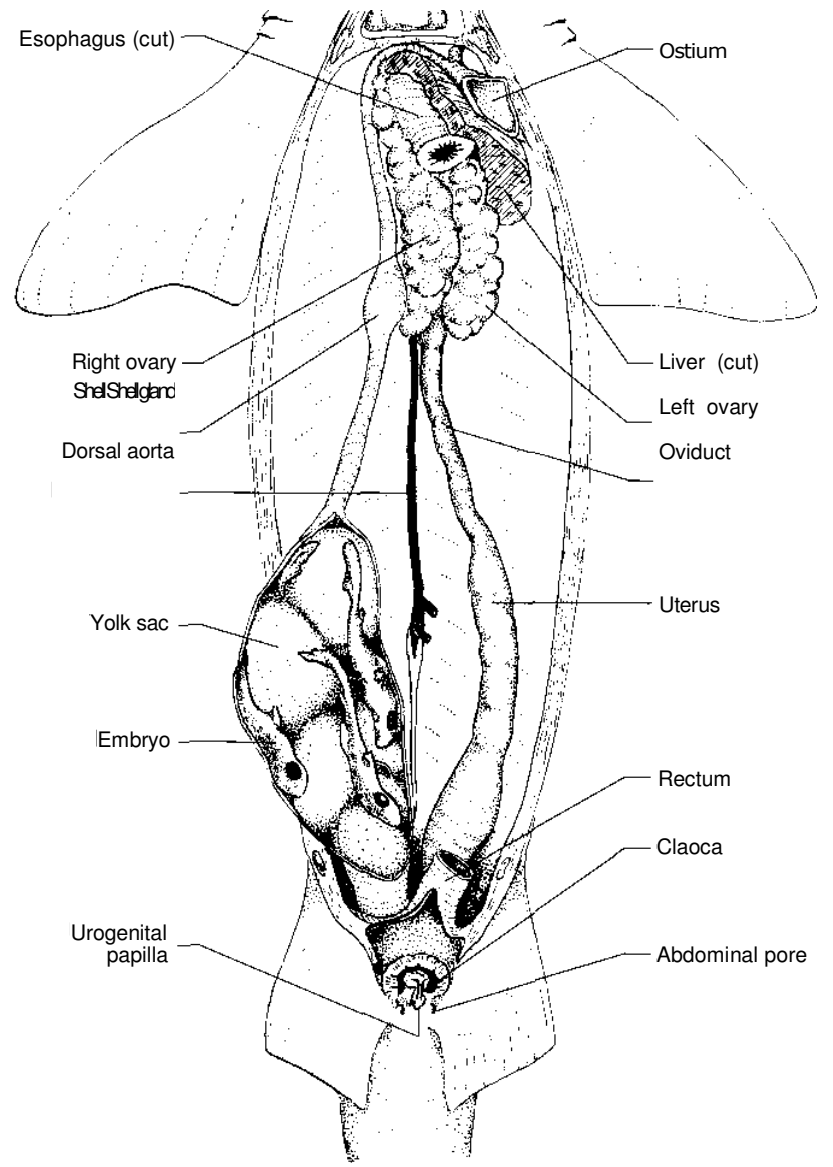


Figure 13. Female reproductive system (kidneys not shown).

Male Genital System (Figure 12)

The Testes—The pair of testes is dorsal to where the liver was and oval in shape. This organ is where male gametes are produced.

Efferent Ductuies—Small tubes that carry the sperm from the testes into the kidneys. These are located on the membrane holding the testes to the body wall: the **mesorchium**.

Epididymis—The cranial part of the kidney that collects sperm.

Vas Deferens (Archinephric duct)—A highly coil tube that carries sperm to the seminal vesicle.

Seminal Vesicle—An enlarged section of the vas deferens that adds secretions to the sperm.

Sperm Sacs—A pair of small sacs created by invaginations of the seminal vesicles that receives sperm and seminal secretions from the seminal vesicles.

Siphon—A closed sac cranially. It produces a secretion that is expelled with the aid of the clasper during mating.

Female Genital System (Figure 13)

Ovaries—Two cream colored organs that were dorsal to the liver and are on each side of the mid-dorsal line. Depending on the maturity of your specimen, it may or may not show eggs within each ovary. The eggs move into the body cavity and then into the oviducts when they are ready to be fertilized.

Oviducts—Elongated tubes that lay dorsal and lateral along the body cavity. These structures are very prominent in mature sharks. Both oviducts share a common opening to the body cavity called the ostium.

Shell Gland—Found at the cranial end of the oviducts. This gland secretes a thin shell around a group of eggs and is a reservoir for sperm storage. Eggs are fertilized in this gland as they pass through.

Uterus—The enlarged caudal end of the oviduct. Here fertilized eggs develop.

VII. The Nervous System: The Brain

Remove the skin from the dorsal section of the head. With your scalpel carefully shave the chondocranium down to expose the brain, the olfactory lobes and the major brain nerves. Shave off one millimeter thick sections so that you don't cut into the brain or nerves. Remove chips of cartilage with forceps. Remove the chondocranium from the tip of the rostrum back to the gill slits.

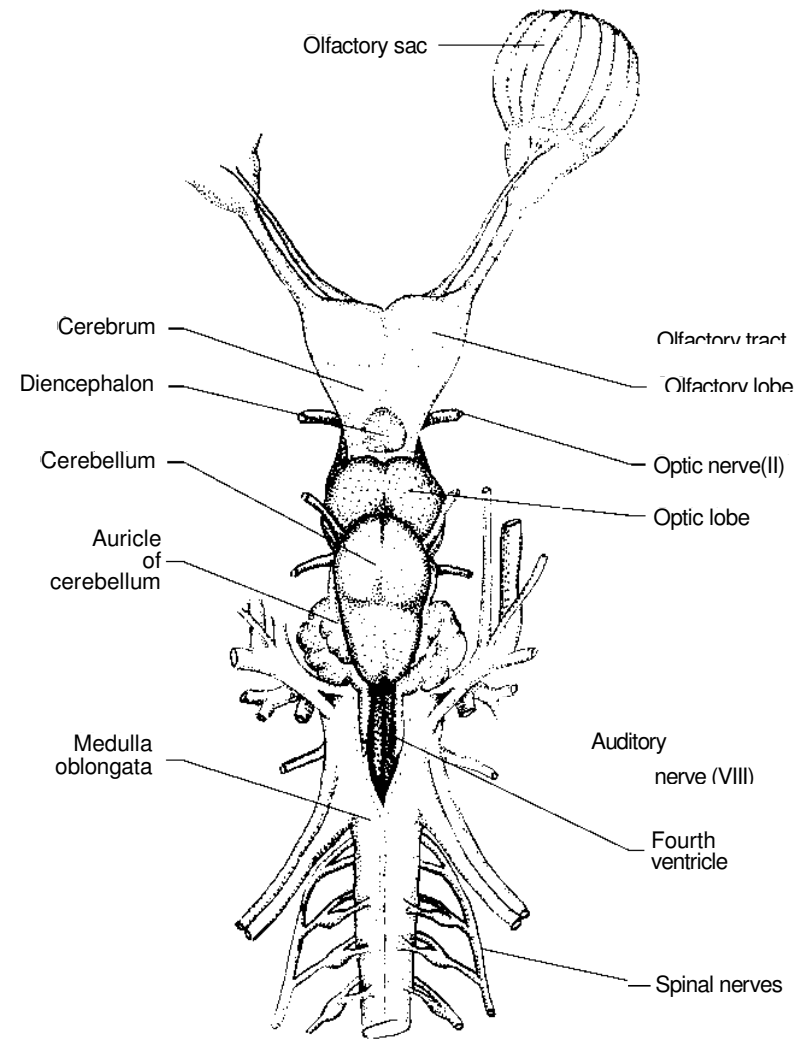


Figure 14. Dorsal view of the shark brain.

Figure 14 shows a dorsal view of the brain with the following sections and nerves outlined.

Olfactory Sacs—Two large bulbous nerve sensors that detect chemicals in the surrounding water. Nerve fibers from these lobes go to the brain via cranial nerve I.

Olfactory Lobes—Area of the brain that receives nerve signals from the olfactory sacs and processes them.

Cerebrum—The two hemispheres between the olfactory lobes and are associated with sight and smell.

Diencephalon—The region just caudal from the cerebrum and separates the fore and mid-brain. Includes the thalamus and the hypothalamus.

Optic Lobe— Large prominent lobes of the mid-brain that receive nerves from the eyes.

Cerebellum—Just caudal from the optic lobes it controls muscular coordination and position.

Auricle of Cerebellum (Restiform body)—A lateral extension of the cerebellum.

Medulla Oblongata—The base of the brain, a widening of the spinal cord. Controls many spinal reflexes.