

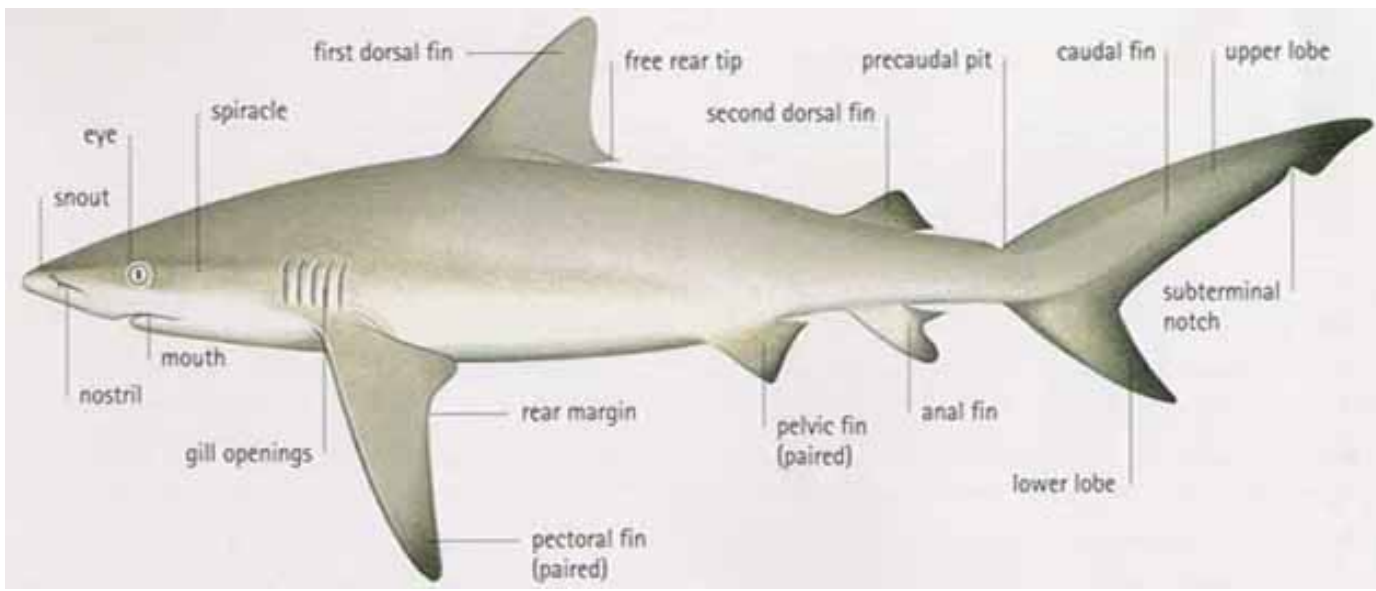
# SHARK DISSECTION

## Introduction

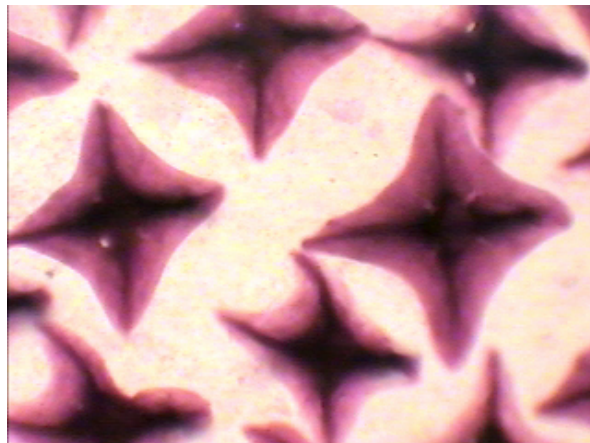
In this lab we will dissect the dogfish *Squalus acanthias*. Sharks are very primitive fishes. They have a cartilagenous skeleton, biting jaws and paired appendages. Their skin is tough and leathery, covered with placoid scales.

Sharks belong to the Class Elasmobranchiomorphii (Chondrichyes) of the subphylum Vertebrata. They are commonly referred to as elasmobranchs because of their exposed gill openings.

## External Anatomy



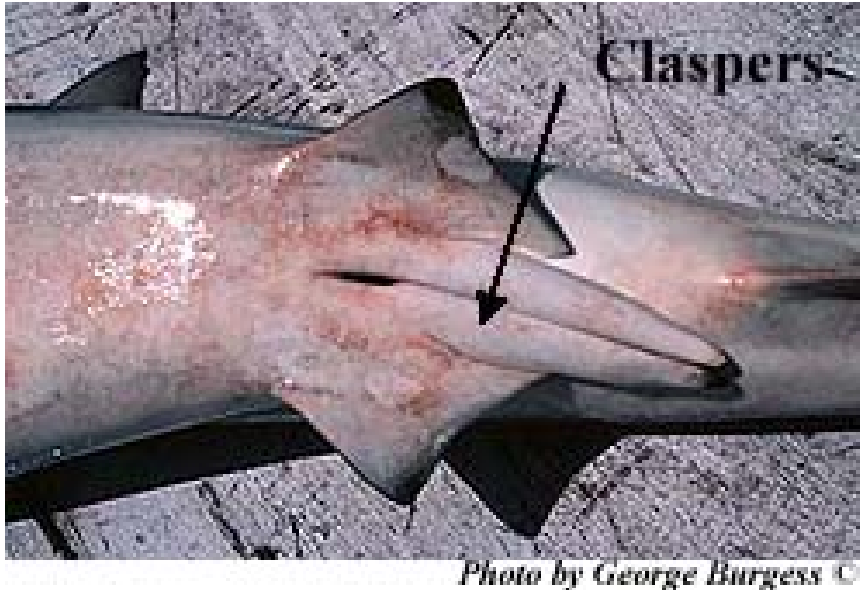
The skin of the shark is covered with placoid scales. These scales give the skin a rough "sand-paper" texture.



Photomicrograph of placoid scales 100X

Be able to identify the following external features on the shark:

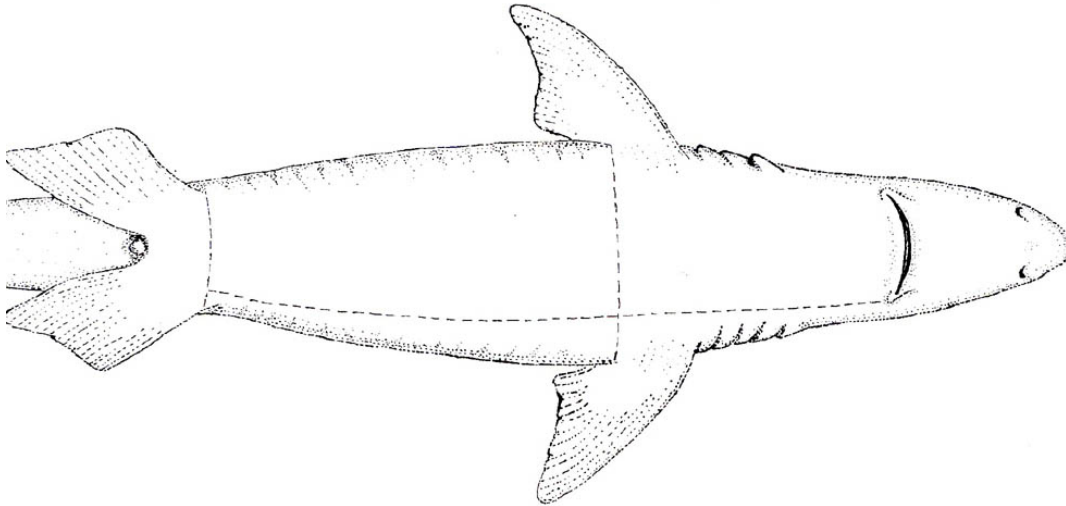
1. Paired **Pectoral** and **Pelvic** fins. In male sharks, the pelvic fins are modified to form rodlike **Claspers** that aid in mating.



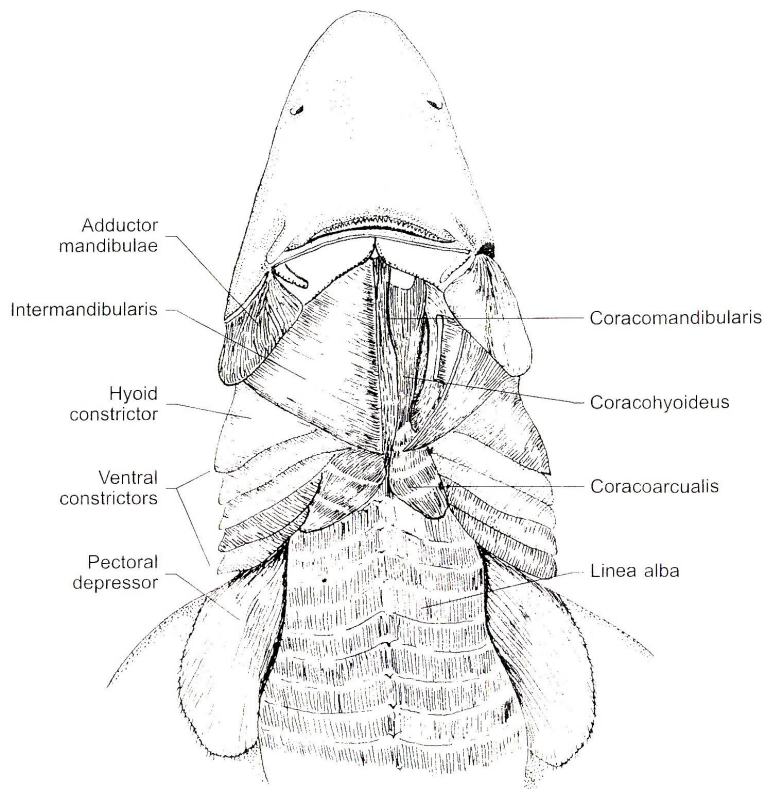
2. The dogfish has two median **Dorsal fins**, each with a sharp spine at its anterior end (these may have been removed by the biological supply).
3. Sharks have a large **Caudal fin** consisting of two unequal lobes ( a larger dorsal lobe and a smaller ventral lobe). This type of unequal lobe caudal fin is referred to as a **Heterocercal tail**.
4. The **Mouth** and **Nostrils** are obvious on the flat head of the shark. Note the numerous teeth (evolutionarily derived from placoid scales).
5. The **Eyes** have rudimentary eyelids.
6. The **Spiracles** are two openings slightly behind and above the eyes. These are openings for water intake when the sharks mouth is closed.
7. Behind the mouth near the ventral surface five pairs of **Gill slits** can be seen. The gills open into the **Pharynx**.
8. Two light-colored **Lateral Lines** run posteriorly from the spiracles to the tail. They function as sensory organs to detect water movement.
9. The **Cloaca** is the opening that lies between the pelvic fins. It serves as common exit point for the digestive system and reproductive system.

## The Dissection Procedure

1. Make a mid-ventral incision from the cloaca cranially to just below the jaw. Make the incisions shallow. Cut around the head, around each fin, the spiracles and cloaca. From the cloaca cut dorsally around the shark. Remember, you are cutting through the skin only.



2. Working with a dull probe carefully peel off the skin exposing the underlying muscles.



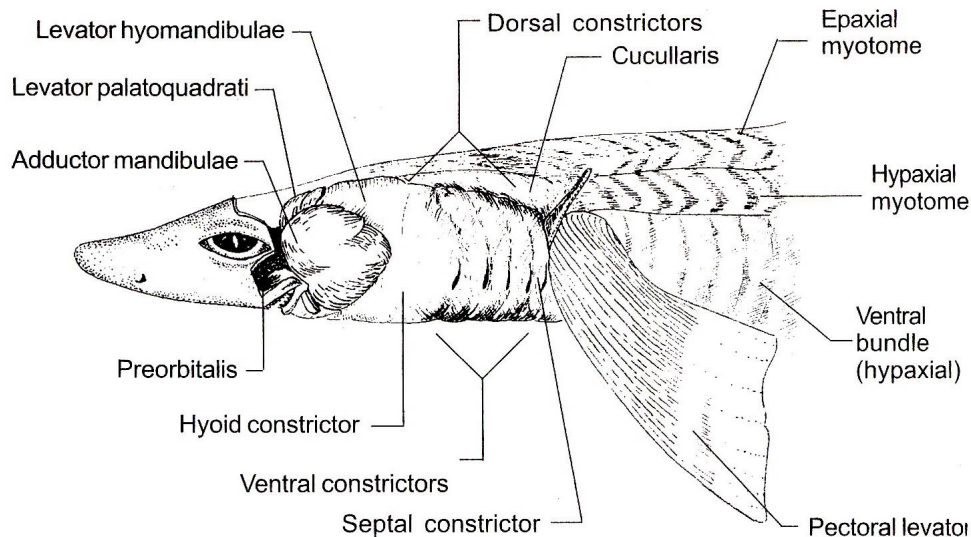
3. Compare your specimen with the photos and diagrams provided above and identify the indicated muscles.

### **Body Musculature - Trunk and Tail**

**Myotomes** - These are the segments of muscles in the trunk and tail that are arranged in a unique zig-zag pattern. Each myotome is separated from another by connective tissue called Myosepta. There are two groups of myotome muscles that are separated from one another by a sheet of connective tissue known as the transverse septum.

1. **Epaxial** muscles are the myotomic muscle groups located dorsally from the transverse septum.

2. **Hypaxial** muscles are the ventral groups of myotomic muscles (ventral from the transverse septum).



### **Muscles of the Head and Branchial Region**

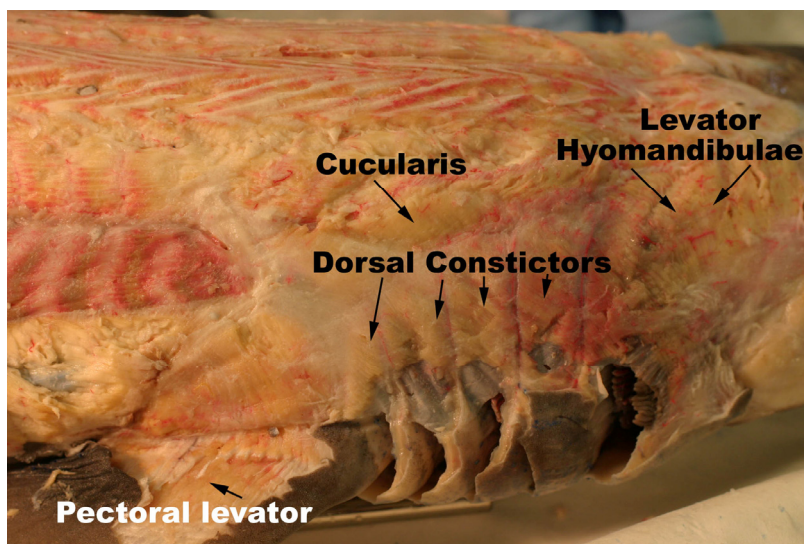
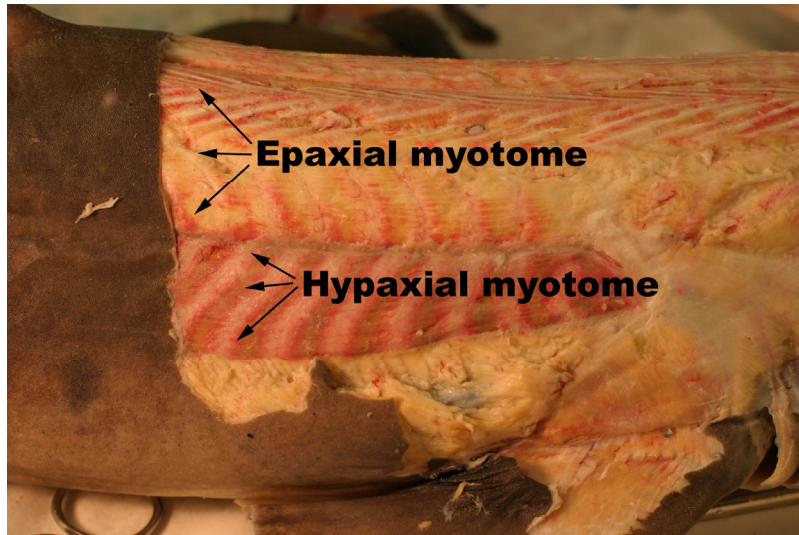
1. **Adductor Mandibulae** are large muscles, just caudal from the eye. They are the main muscles in closing the jaw.

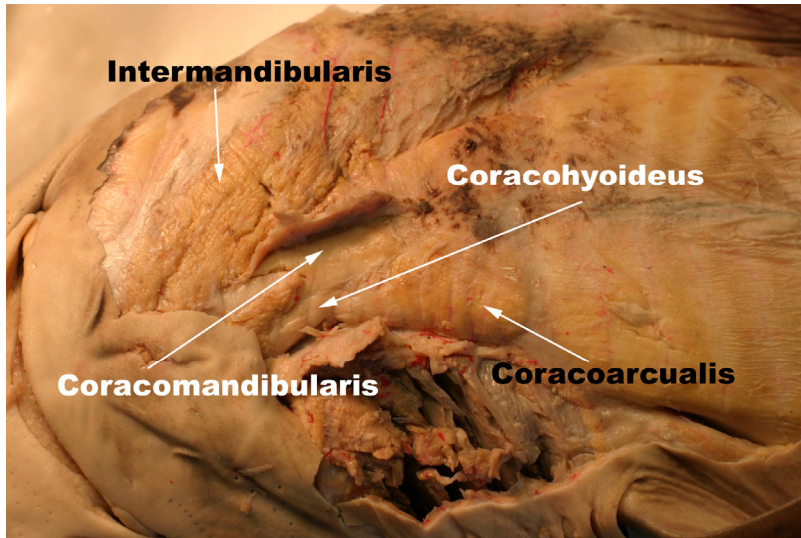
2. **Levator Palatoquadrati** are located above the adductor mandibulae muscle. It helps raise the jaw.

3. **Intermandibularis** is the large muscle that emerges from under the Adductor Mandibulae on the ventral side. It covers up the Coracomandibularis and the Coracohyoideus and must be reflected on one side. It assists in closing the jaw.

4. **Levator Hyomandibulae** is located just behind the spiracle and is overlapped by the cranial portion of the Hyoid Constrictor. This muscle raises the jaw.

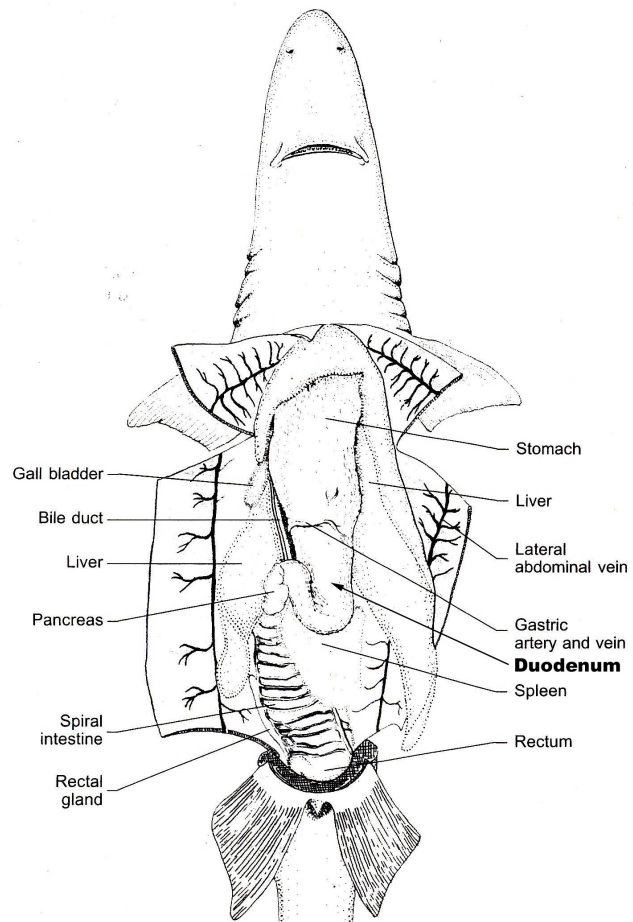
5. **Hyoid constrictor** is the muscle associated with the first gill arch. It acts to constrict the gill cavity.
6. **Ventral Constrictors** are the muscles associated with the ventral section of the gill arches. These also constrict the gill cavity.
7. **Dorsal Constrictors** are the muscles associated with the dorsal section of the gill arches. These also constrict the gill cavities.
8. **Pectoral Levators** are located on the dorsal side of the pectoral fin. They raise this limb.
9. **Cucullaris** muscle is located above and cranial from the pectoral levators. This muscle moves the pectoral fin dorsal and cranially.





**Dissecting the Abdominal Cavity**

Position the shark so you can examine the ventral side. Using scissors open the abdominal cavity at the midline. Identify the organs seen in the diagram below.



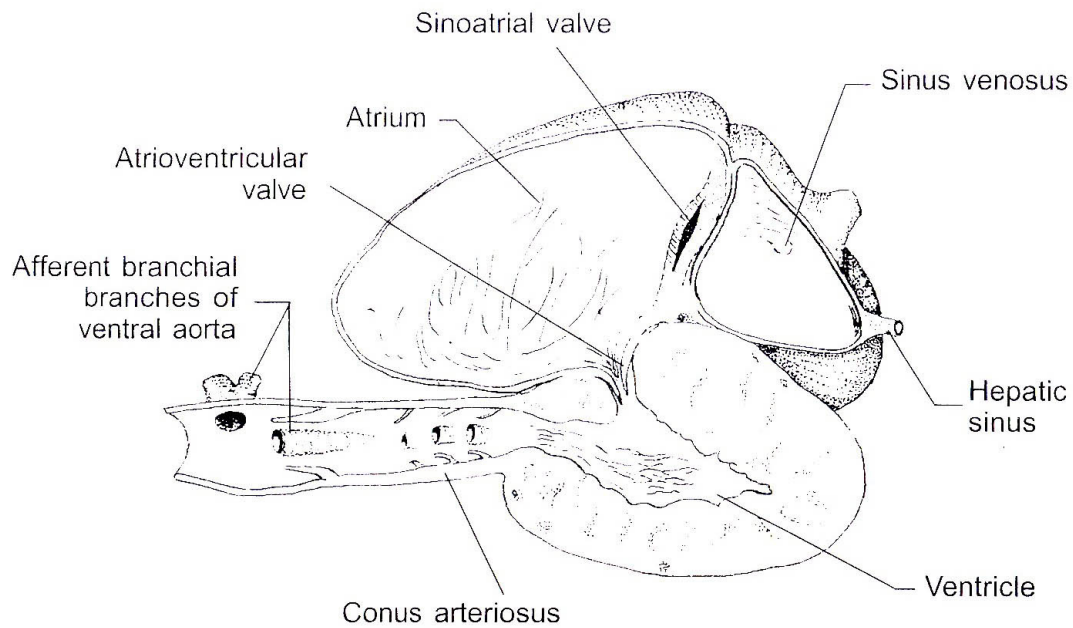
### **Identify the following organs of the digestive system**

1. **Esophagus** - the connection between the pharynx (throat) and the stomach. In the shark it is very short and wide.
2. **Stomach** - this is a J shaped organ that ends in a pyloric sphincter (a muscular ring) that controls the expulsion of Chyme (the contents of the stomach).
3. **Duodenum** - this is the short section immediately caudal from the stomach. It receives bile secretions from the liver (via the Common Bile Duct).
4. **Liver** - this organ 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.
5. **Pancreas** - is divided into two parts: The ventral pancreas, can be easily viewed on the ventral surface of the duodenum and the dorsal pancreas (which is long and thin) can be located behind the duodenum where it extends to the spleen.
6. **Spiral Intestine** - is located caudally from the duodenum and is distinguished by the extensive network of veins and arteries over its surface. Cut this organ open and wash the contents out with running water. Observe the funnel shaped folds. This surface greatly increases surface area for more efficient food absorption.
7. **Rectum** - this is the short end portion of the digestive tract between the intestine and the cloaca. The rectum stores solid wastes.
8. **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**

Open the thoracic cavity until you can see the heart. Gently (using a blunt probe) tease the heart away from any tissue holding the heart in place. Identify the following parts of the heart.

1. **Sinus Venosus** - dorsal to the ventricle, this is a thin walled, nonmuscular sac which acts as a collecting place for venous blood.
2. **Atrium** - another thin walled, distensible reservoir for the ventricle.
3. **Ventricle** - the main contractile chamber of the heart. It is heavily muscularized.
4. **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 ventricular relaxation (diastole).



**Systemic Arteries**

Identify as many of the arteries illustrated below as you can without further dissection.

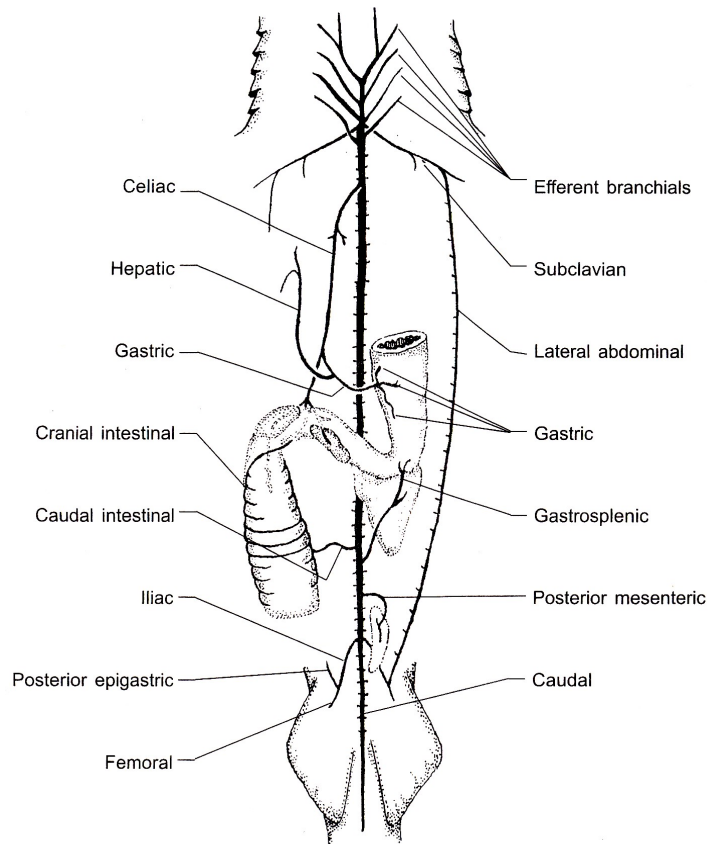


Figure 9. Dorsal aorta and major body arteries.



## Systemic Veins and Sinuses

The systemic veins (dyed blue) return blood from tissues and organs to the heart. The sinuses differ from systemic veins in that they are thin-walled, large spaces that collect venous blood. Identify as many of the veins and sinuses illustrated below, as you can, without further dissection.

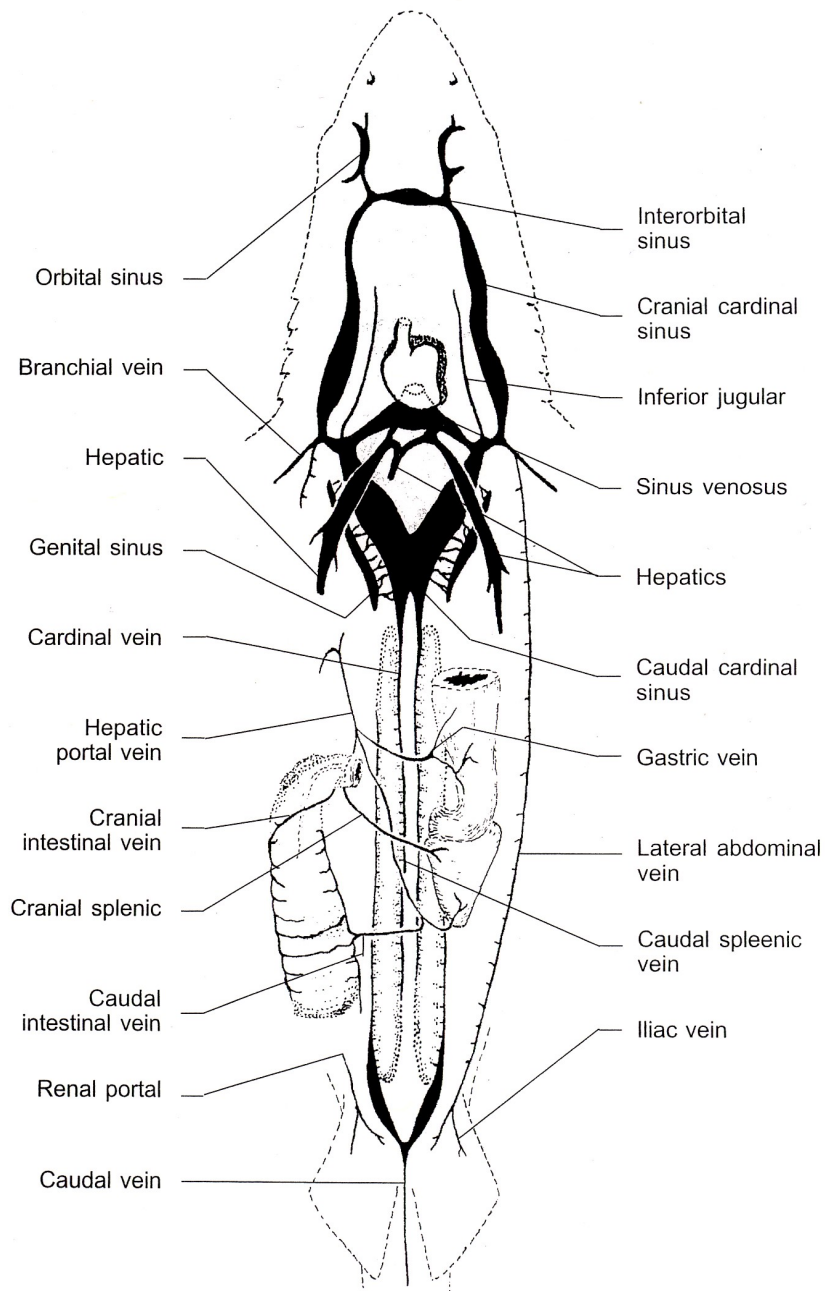
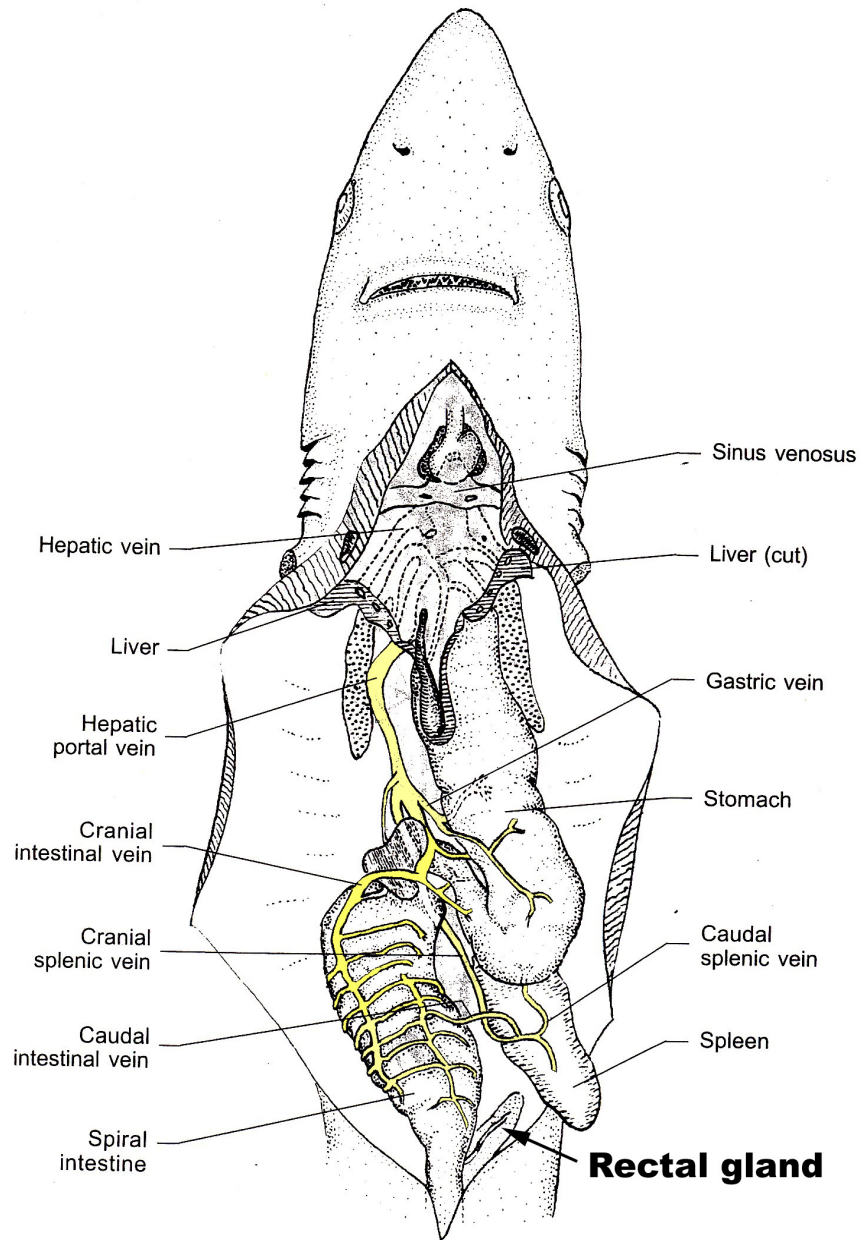


Figure 10. Systemic veins and sinuses.

The hepatic portal system (dyed yellow) involves taking blood from the capillary systems of the digestive tract, collecting it and then breaking it into another system of capillary beds within the liver.



1. **Hepatic Portal Vein** - receives blood returning from the entire digestive system.
2. **Gastric Portal Vein** - receives blood from the stomach.
3. **Gastrosplenic Vein** - receives blood from the spleen, stomach, pancreas, and the intestines.
4. **Caudal Intestinal Vein** - collects blood from the spiral valve.

## The Urogenital System

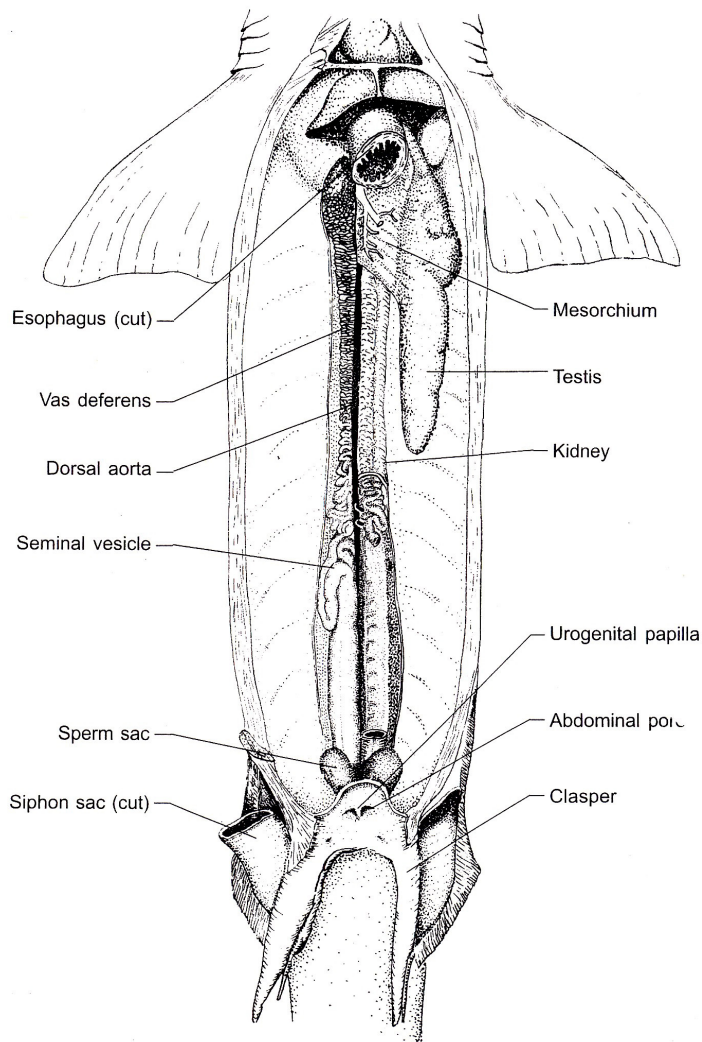
To view this system you have to loosen the organs of the digestive system by gently removing loose connective tissue with your blunt probe. Do not use scissors or scalpel to remove any digestive organs.

Identify the kidneys and rectal glands on both male and female sharks.

**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** - 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.

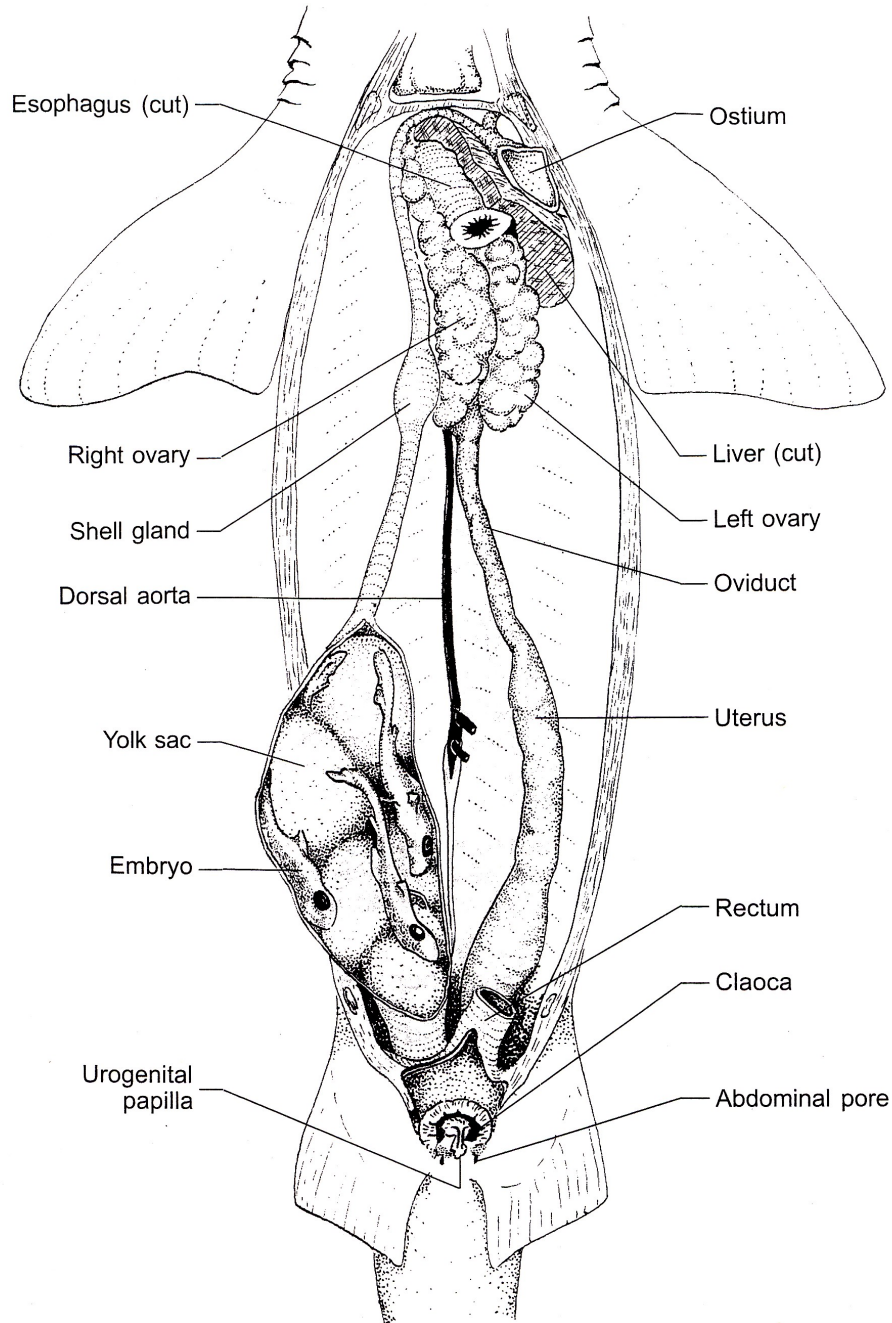
The male urogenital system is illustrated below.



## The Male Urogenital System

1. **The Testes** - are paired organs dorsal to the liver and appear oval in shape. This is where the male gametes (sperm) are produced.
2. **Vas Deferens** - a highly coiled tube that carries sperm to the seminal vesicle.
3. **Seminal Vesicle** - an enlarged section of the vas deferens that adds secretions to the sperm to form seminal fluid.
4. **Sperm Sacs** - a pair of small sacs created by invaginations of the seminal vesicles that receives sperm and seminal secretions from the seminal vesicles.

The female urogenital system is illustrated below.



## The Female Genital System

1. **Ovaries** - two cream colored organs that lie dorsal to the liver on either side of the mid-dorsal line. In ovulating females the eggs may be seen within each ovary. The eggs move into the body cavity and then into the oviducts when they are ready to be fertilized.

2. **Oviducts** - are elongated tubes that lay dorsal and lateral along the body cavity. These structures are very obvious in mature females. Both oviducts share a common opening to the body cavity called the ostium.

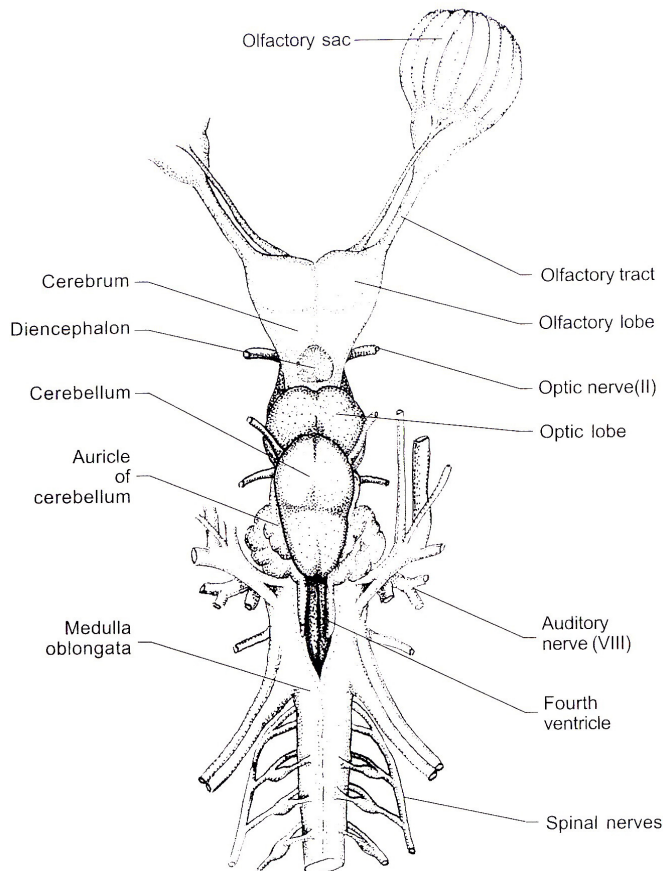
3. **Shell Gland** - is found at the cranial end of the oviducts. This gland secretes a thin shell around a group of eggs and is a reservoir for sperm storage. Eggs are fertilized as they pass through.

4. **Uterus** - the enlarged caudal end of the oviduct. Here fertilized eggs develop.

## The Nervous System: the Brain

Remove the skin from the dorsal section of the head. With your scalpel carefully shave the chondrocranium 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 chondrocranium from the tip of the rostrum back to the gill slits.

The drawing below illustrates the related structures.



**Identify the following structures on the brain**

1. **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 (the Olfactory Nerve)
2. **Olfactory Lobes** - area of the brain that receives nerve signals from the olfactory sacs and processes them.
3. **Cerebrum** - the two hemispheres between the olfactory lobes and are associated with sight and smell.
4. **Diencephalon** - the region just caudal from the cerebrum and separates the fore and mid-brain. Includes the thalamus and hypothalamus.
5. **Optic Lobe** - large prominent lobes of the mid-brain that receive nerves from the eyes.
6. **Cerebellum** - just caudal from the optic lobes it controls muscular coordination and position.
7. **Medulla oblongata** - the base of the brain, a widening of the spinal cord. Controls many spinal reflexes, blood pressure, and heart rate.