MARINE CONSERVATION SCIENCE AND POLICY LEARNING SERVICE PROGRAM

The **spiny dogfish**, spurdog, mud shark, or piked dogfish, Squalus acanthias, is one of the best known of the dogfish which are members of the family Squalidae in the order Squaliformes. While these common names may apply to several species, Squalus acanthias is distinguished by having two spines (one anterior to each dorsal fin) and lacks an anal fin. It is found mostly in shallow waters and further offshore in most parts of the world, especially in temperate waters.

MODULE 2: ICHTHYOLOGY

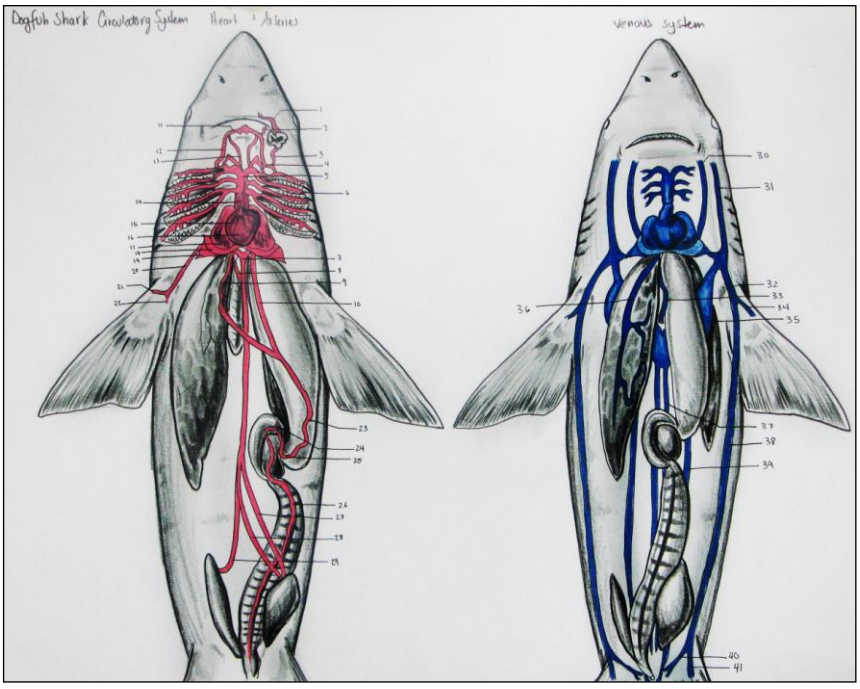
SECTION 5: SHARK DISSECTION

SUNSHINE STATE STANDARDS

SC.912.L.15.1, SC.912.L.15.6, SC. 912.L15.7, SC.912.L.15.13, SC.L.15.14, SC.912.17.2, SC.912.l.17.3, SC.912.L.17.7

OBJECTIVES

- Understand the internal and external anatomy of a shark
- Compare the different organs of a cartilaginous fish with a mammal.



VOCABULARY

Uterus- functions in the egg development

Pericardial Cavity- holds the heart and branching arteries; protection

Testes- oval shaped; dorsal to the liver; produces the male gametes

Ovaries- two cream colored organs, dorsal to the liver; function in the storage of eggs

Heart- has two halves- atrium and ventricles; it is a specialized muscle

Efferent brachial Arteries- Brings blood into the fins and back to the heart

Atrium- smaller and functions in forcing blood into the ventricals

Gill rakers- increases the surface area of the gills in order to take in more oxygen

Ventricle- larger and function in contracting blood to the rest of the body

Gill arches- made of cartilaginous arches that support the gills and gill rakers

Nares- used to detect chemicals in the water

Ampullae of Lorenzini- allows the shark to detect prey by feeling vibrations from movement
Spiracles- openings on the head, allow water to pass through the gills even when the sharks mouth is closed

Gill slits- allow waer to exit after passing over the gills; they have 5

Lateral line- a pale line begining at the pectoral fins and ending at the pelvic fins; small openings that open into the underlying lateral line canal, a sensory organ that detects water movement

Cloaca- the digestive tracts exit and opening for the sex organs

Claspers- a finger-like projection that assist in sperm transfer during mating; males only!

Myomers- musclular bundles of segmented muscle in the trumk and tail; arranged in a zig-zag pattern

Myosepta- where the muscle originates and inserts

List of the 5 fins of the dogfish shark- 2 dorsal, pectoral, pelvic, caudal

The Depressor of the Pectoral Fin- allows the pectoral fins to lower; located caudal side of the pectoral fin

Pleuroperitoneal Cavity- holds all the organs in the abdonimal cavity; such as liver, gallbladder, stomach, pancreas etc..

Gallbladder- functions in storage and floatation; has 3 lobes liver
functions in the storage of bile secreted from the liver; located within the smaller lobe of the liver

Adductor muscle- a large muscle just caudal to the eye; its the main muscle in closing the jaw

Esophagus - connects the mouth to the stomach

Esophageal papillae- helps move food to the stomach

Stomach- a J-shaped organ; has a cardiac part and pyloric part; functions in digestion

Pyloric Sphincter- the end of the stomach, a musclular ring which opens and closes the stomach to the intestines

Duodenum- right after the stomach; recieves bile from the gallbladder

Colon- Absorbs water and salts from the solid wastes before its stored in the rectum

Ileum and spiral valve- After the Duodenum; absorbs nutrients like Vitamin B12 and bile salts

Rectum- functions in the storage of solid waste; btw the intestine and the cloaca

Rectal gland- controls salt concentration within the body and releases it into the rectum to be excreted

Spleen- works with filtering blood; caudal to the stomach and proximal to the spiral intestine

Pancreas- has two parts; ventral and dorsal, long and thin organ

Dorsal Aorta- Distribution of blood throughout the body

BACKGROUND

Dogfish Dissection

The Digestive Tract and Body Cavities

Vertebrates have a coelomic body cavity. This coelomic space is divided anteriorly into a **pericardial** (heart) cavity and a posterior **pleuroperitoneal** cavity by the transverse septum, a tough, white membrane. This is the situation in the dogfish and *Necturus*. In mammals, the **thoracic** cavity is subdivided into a central **pericardial** cavity and paired lateral **pleural** cavities around the lungs. The esophagus runs through this cavity, but we will be looking primarily at the posterior cavity, the **abdominal** cavity in this lab. These cavities are separated by a muscular diaphragm in mammals.

The posterior pleuroperitoneal, visceral or abdominal cavity, houses the liver, digestive tract, and gonads. This body cavity has muscular walls (mesoderm). The visceral cavity is lined on the inside with a transparent parietal (somatic) peritoneum. It is attached to the muscles of the body wall but it also overlies the urogenital system, which is retroperitoneal. The parietal peritoneum from each side meet dorsally and ventrally to form a double walled mesentery. This splits to line the digestive tract and other organs as the splanchnic (visceral) peritoneum. The peritoneum is **serous** (wet). The fluid serves as a lubricant to allow frictionless movement of the organs.

The primary mesenteries are dorsal and ventral, although the dorsal mesentery is often interrupted and moved to one side or the other with the organs and the ventral mesentery is reduced to the membranes of the liver and bladder. Mesenteries running from organ to organ are usually called **ligaments**.

Digestive Organs

The digestive tract is a tube, with coils and branches, which begins at the mouth and ends either at a cloaca or anus. It processes food, which moves by peristalsis through the process of digestion, absorption and elimination. The general pattern is to have an oral cavity, pharynx, esophagus, stomach and intestine. Accessory organs are the pancreas, liver and gallbladder, which arise as evaginations from the embryonic digestive tract. We will be looking at the variations and similarities in the digestive tracts of the dogfish, salamander and mammal in this lab.

Dogfish Digestive Tract

Use scissors to cut through the body wall. Make your longitudinal cut off center from the midventral line and out to the pectoral and pelvic fins, then turn back the flaps. Note the falciform ligament hanging midventrally from the liver in the anterior half of the pleuroperitoneal cavity. You will have to cut this ligament to look into the cavity. Other

remnants of the ventral mesentery are the lesser omentum from the liver to the stomach and small intestine and reproductive mesenteries, which will be looked at later. The dorsal mesentery is seen as the greater omentum holding the esophagus and stomach to the dorsal body wall and dorsal mesentery holding the intestine. From the stomach to the spleen is a gastrosplenic ligament.

The oral cavity contains the tongue and teeth. The pharynx is the portion leading past the spiracle and five gill slits and also contains the tongue in dogfish. Note the taste buds on the tongue. To view this area, cut through the left jaw of the dogfish and perpendicularly through the center of the gills to the pectoral fin. Fold a paper towel over the teeth and use your scissors to open the mouth wide. Make sure you cut all the way through to the pharynx. Cut horizontally across to the other pelvic fin, making sure you are posterior to the transverse septum. You do not want to cut into the pericardial cavity. You will have to cut through the esophagus until you get to the gill slits on the other side. Pull the lower jaw open and clear out any debris. The esophagus extends from the pharynx at the transverse septum and is lined with papillae, which form a tight seal to keep water out. Cut into the esophagus to see the papillae and the stomach with its longitudinal folds called rugae. The "U" shaped stomach, with an anterior cardiac limb and a posterior pyloric limb ends in a constricted pyloric sphincter. The small intestine is composed of, anteriorly, a duodenum, and posteriorly, an ileum, which contains a spiral valve. Cut into the ilium to see the valve, which increases the surface area. The large intestine, rectum or colon, a shorter section than the small intestine has a rectal gland entering it. The rectal gland is for salt excretion for osmoregulation. The rectum, the most posterior portion, ends in the anus which projects into the cloaca, a common opening with the urogenital ducts.

Digestive Organs

Liver, composed of three lobes, and a greenish gall bladder. These extend posteriorly from the transverse septum. Note the bile duct, from the gall bladder, which goes to the duodenum along with two hepatic vessels. Pancreas, consisting of two lobes; a ventral lobe overlying the duodenum, and a dorsal lobe, in the curve between pyloric stomach and duodenum. The pancreatic duct is usually difficult to locate, it runs from the junction of the lobes into the duodenum.
Spleen, an organ of the circulatory system (lymphoid tissue), extends posteriorly from the curvature of the stomach.

Necturus Digestive Tract

Use your scissors to make a longitudinal cut off center from the cloaca to the transverse septum. Note the mid-ventral **falciform** ligament. Cut across the posterior edge of the transverse septum avoiding the pericardial cavity. Like the dogfish, the main digestive tract is in the **pleuroperitoneal** cavity. The **greater omentum** extends from the dorsal wall to the stomach and the **gastrosplenic ligament** goes from the stomach to the spleen. The dorsal mesentery holds the intestines to the dorsal wall; it is called the

mesocolon at the large intestine. Other ligaments support the lungs and urogenital tract. Be careful not to destroy these delicate membranes when observing the organs.

Use your scissors to cut through the left jaw and ventral to the gills to the pectoral girdle. Cut horizontally through the esophagus to open up the mouth. Be sure to avoid the pericardial area and any blood vessels. In the oral cavity are teeth, two rows in the upper jaw, and one in the lower. The tongue is better developed than that of the shark. The **pharynx** has two pairs of gill slits. On the posterior floor of the pharynx lies the glottis, a slit that leads into the trachea. From the pharynx to the stomach is a short, poorly defined **esophagus**. The straight **stomach** has internal **rugae** and ends with a muscular **pyloric sphincter**. The **small intestine** is the **duodenum** anteriorly, and then a long coiled portion with internal small folds called **plicae**, which increase the surface area. There is a short **large intestine**, which enters the **cloaca** via the **anus**.

Digestive Organs

The large **liver** is not lobed but weakly scalloped posteriorly. The **gall bladder** is on the liver near the duodenum. The hepatic ducts and bile duct empties into the duodenum as in the shark, but may be difficult to see. The irregular pinkish mass of the **pancreas** lies on the hepato-duodenal ligament and is fused into one. Two small ducts lead to the duodenum. The pancreas is both an exocrine gland, producing digestive enzymes and an endocrine gland regulating metabolism. The spleen, a lymphatic organ, lies to the left of the stomach.

Mammal Digestive Tract

In mammals, the coelomic cavity is divided into thoracic and abdominal cavities by the diaphragm. The thoracic cavity will be examined in future labs. Make an incision in the midventral line through the abdominal wall muscles of the cat or rat from the sternum to about an inch anterior to the clitoris or penis. Make lateral incisions at the extremities of this first incision and deflect the flaps. Exposed is the **abdominal** or visceral cavity. Between the diaphragm and the liver are three ligaments, the most prominent of which is the **falciform ligament**, which connects the right and left liver halves to the abdominal wall. The **greater omentum** is double layered and filled with fat in cats. It extends from the greater curvature of the stomach to the dorsal body wall and extends to the pelvic region covering and tucking under the intestine. The portion of this mesentery from the stomach to the spleen is the **gastrosplenic ligament**. From the lesser curvature of the stomach and duodenum to the liver is the **lesser omentum.** The **dorsal mesentery** holds the intestines to the dorsal body wall. Other mesenteries hold the urogenital system in place. Try not to tear any of the mesenteries when doing your dissection.

Glands

During the course of your dissection you will remove or view the following glands. For today's lab, observe the three salivary glands, the **submaxillary**, **sublingual** and **parotid** glands, which are located in the head and neck region.

Table of Glands and Functions

Gland	Location	Function
Submaxillary	central throat, large	salivary
Sublingual	anterior on submaxillary, whitish	mucous
Parotid	towards ear, outside submaxillary, soft	salivary
Lacrimal	below ear	tears
Lymph nodes	4, above submaxillary, dark, round	lymphocytes
Thymus	above heart, large on young animals	lymphatic-disease Immunity
Thyroid	side of larynx, dark red	ion and calcium Binding
Adrenal	above kidney	adrenalin or epinephrines

Digestive System

The digestive tract starts with the mouth and its associated salivary glands. To view the inside of the mouth, cut through the left jaw after prying the mouth open with a folded paper towel over the teeth. Be sure you are not trying to cut through the molars. Bone cutters may need to be used for the cat. To open the lower jaw, cut through the soft palate. In the oral cavity note the differentiated teeth and the mobile tongue. Lift the tongue to see the **lingual frenulim**. Note the **papillae** on the surface of the tongue. Feel the roof of the mouth with its anterior hard palate and posterior soft palate. The **pharynx** extends from the oral cavity to the larynx and allows passage of food and air. The food, when swallowed, travels down the tubular **esophagus,** which lies dorsal to the larynx. The soft, distensible esophagus penetrates the diaphragm separating the

thoracic and abdominal cavities. Food is moved down it by peristalsis. The esophagus ends at the **cardiac sphincter**. The J-shaped **stomach** ends at the **pyloric sphincter**. The convex side is the greater curvature; the concave side is the lesser curvature. The small intestine starts at the pyloric sphincter with the **duodenum** a long curved piece, then begins looping back and forth, still descending as the **jejunum**. The ascending, looping portion is the **ileum** and it ends in a T-junction with the large intestine. The blind end of the T is the **caecum** or appendix, large in the rat, small in cats and humans. The other end is the ascending portion of the large intestine or **colon** followed by a short transverse portion and a descending portion, which ends in a muscular **rectum** hidden under the pelvic girdle. It opens at the **anus,** controlled by sphincter muscles, at the base of the tail. The enlarged and constricted areas of the colon are due to peristalsis.

Digestive Organs

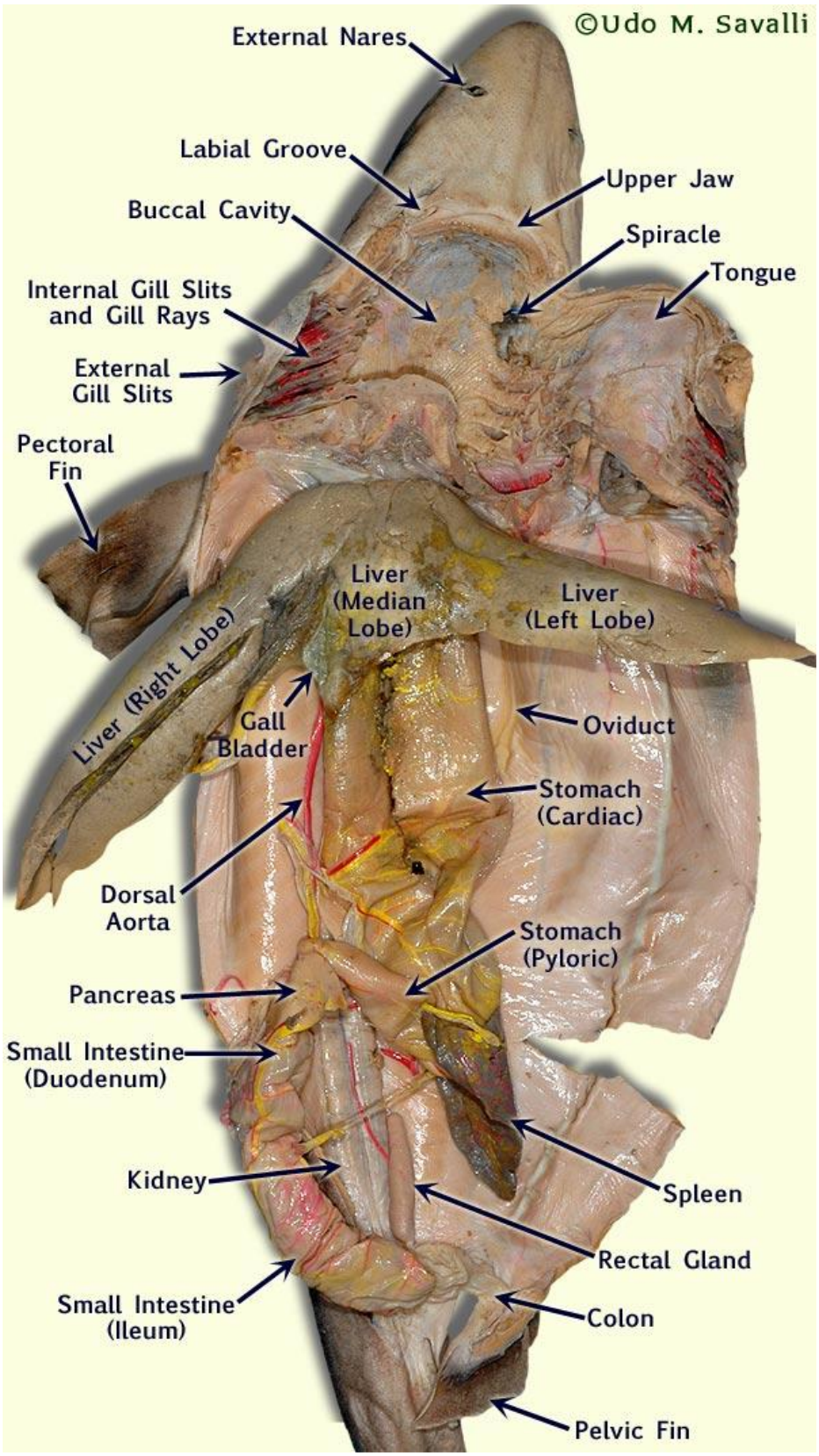
The dark reddish brown lobes of the **liver** (five in rat, six in cat) are attached to the diaphragm. The central lobe has a **gall bladder** in a cat, but it is absent in the rat, although both animals have a bile duct leading to the anterior duodenum. The mesentery called the greater omentum, stretching from the spleen to the duodenum contains the two lobes of the **pancreas**, which look like pink granular bubble gum. One lobe runs from the pyloric sphincter to the spleen, the other along the edge of the duodenum. They meet anteriorly forming one duct, which enters the duodenum beside or with the bile duct. The dark reddish brown spleen is an elongate lobe on the left side just below the stomach.

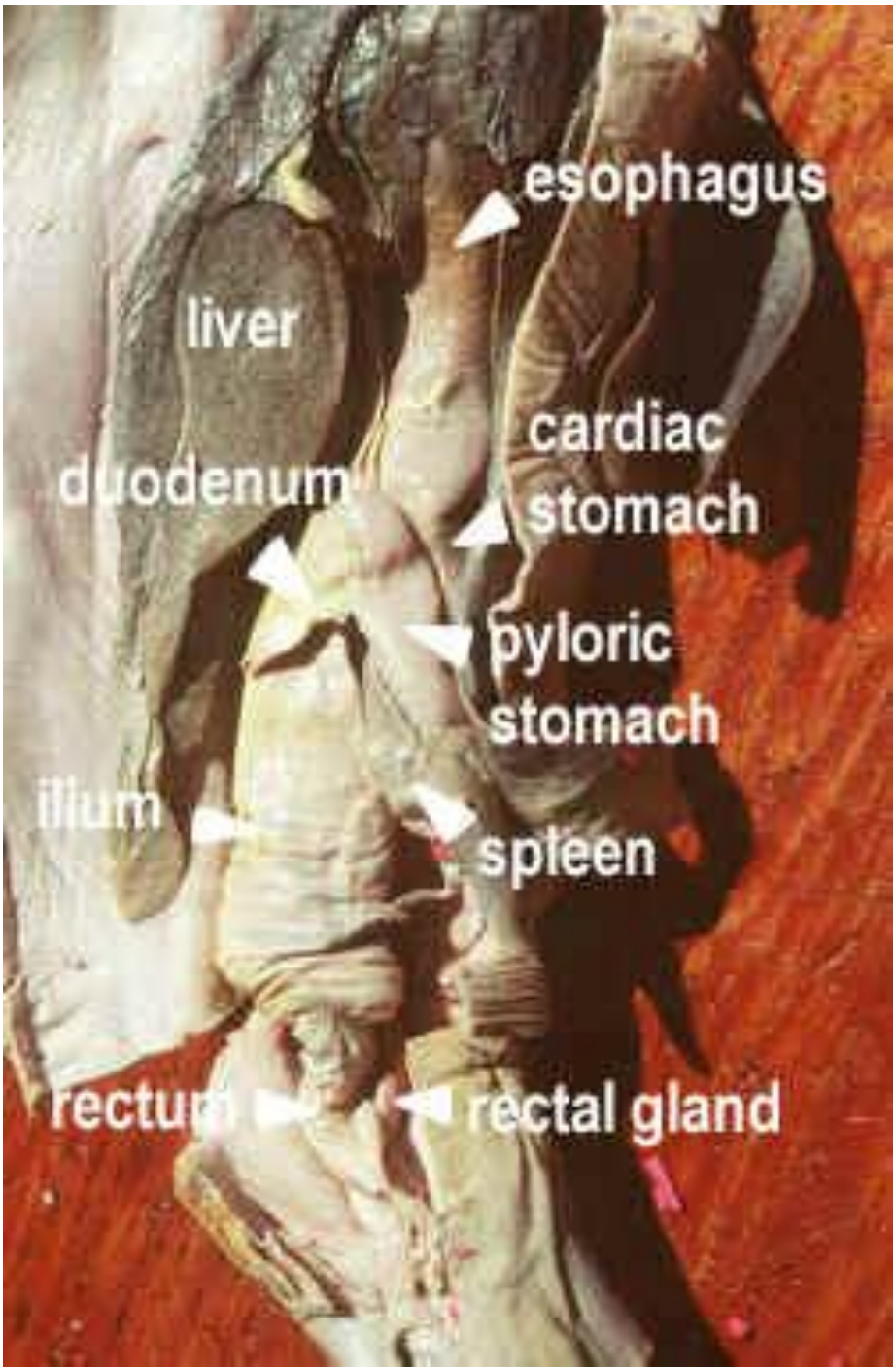
Assignment:

Fill in the table with the functions of the digestive tract, comparing the digestive system of a mammal with *Necturus* and the Dogfish. For equivalent structures, write same, absent or the new structure.

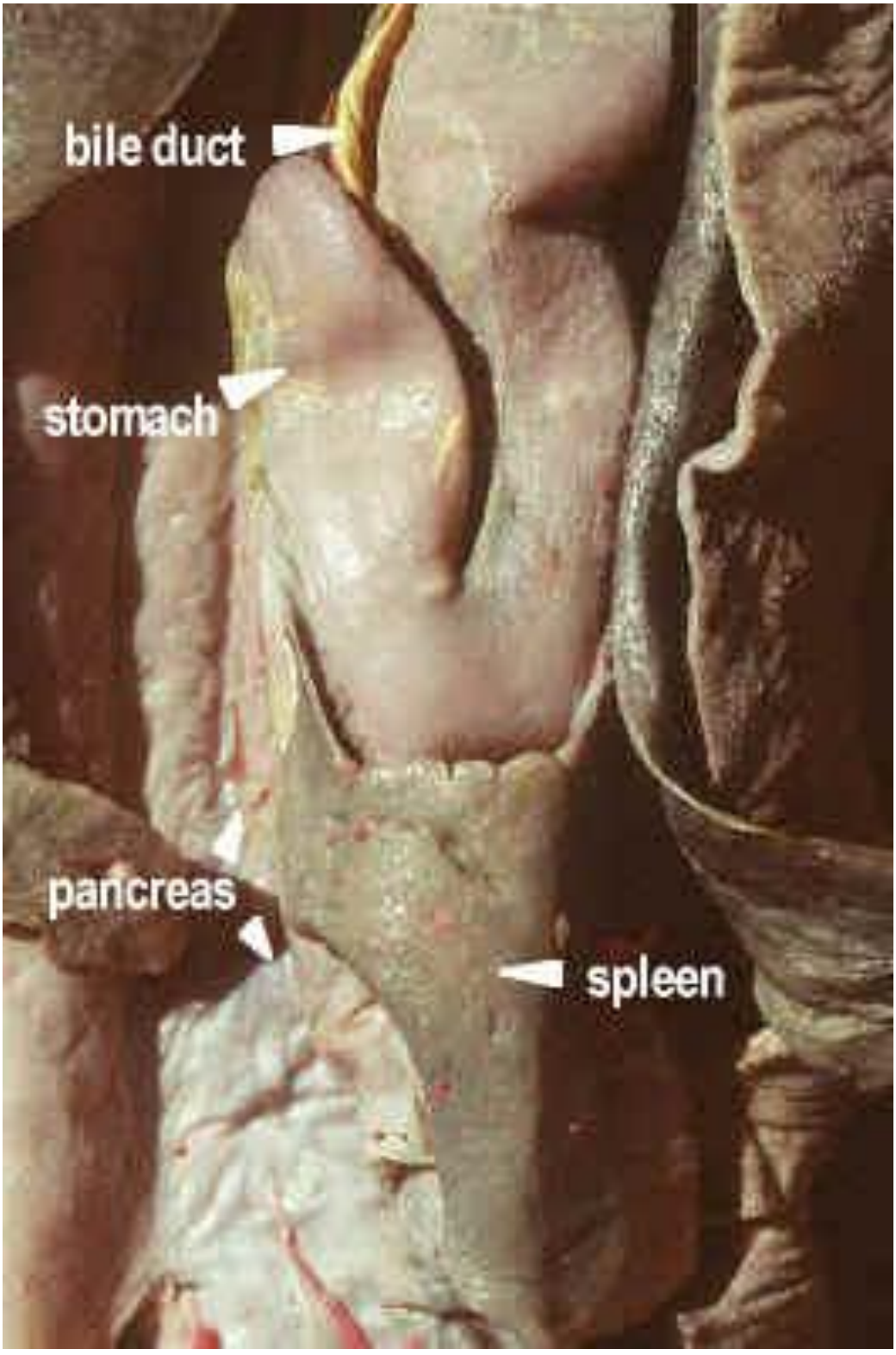
Organ	**Function in Mammal**	***Necturus* Equivalent**	**Dogfish Equivalent**
Esophagus			
Stomach			
Pyloric sphincter			
Small intestine			

Large intestine			
Caecum			
Anus			
Pancreas			
Spleen			
Gall bladder			
Liver			


©Udo M. Savalli
External Nares
Labial Groove
Upper Jaw
Buccal Cavity
Spiracle
Tongue
Internal Gill Slits and Gill Rays
External Gill Slits
Pectoral Fin
Liver (Median Lobe)
Liver (Left Lobe)
Liver (Right Lobe)
Gall Bladder
Oviduct
Stomach (Cardiac)
Dorsal Aorta
Stomach (Pyloric)
Pancreas
Small Intestine (Duodenum)
Kidney
Spleen
Rectal Gland
Small Intestine (Ileum)
Colon
Pelvic Fin



Dogfish Abdominal Cavity



Dogfish DigestiveTrack

Dogfish Liver

ACTIVITY: DOGFISH SHARK DISSECTION

DURATION: 2 hours

MATERIALS

You will be dissecting a dogfish shark: ***Squalus acanthias***. The equipment you will be using includes:

- a large dissection tray
- surgical scissors
- scalpel
- probe
- forceps

Dissection is a learned skill that takes practice and patience. Some general rules to remember are:

1. Do not make deep cuts with scissors or scalpels as you may damage tissue underneath.
2. Know the anatomical terms listed next so you can follow the directions.
3. Read the section you are working on **before** you start cutting.
4. Try to answer each other's questions about anatomy before asking your teacher for help. Use the notes from earlier this 6-weeks to help you identify organs.

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

Lateral- to the side

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 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.
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

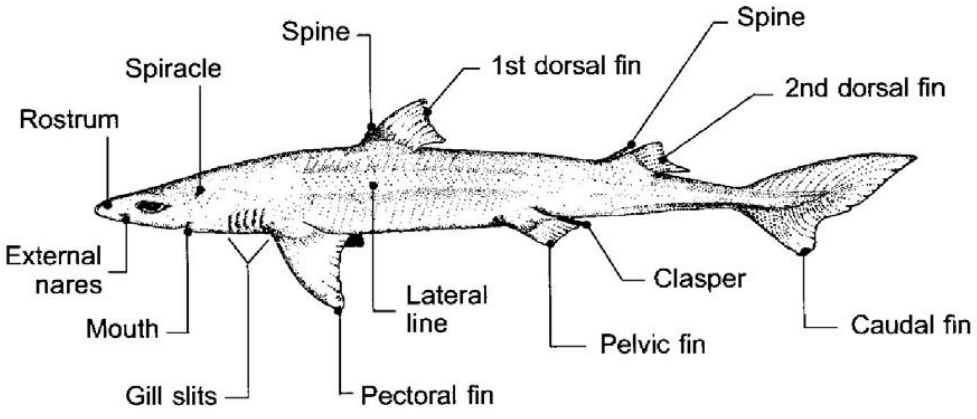


Figure 1. External features.

Observations:
1. How is the shark's nose different from our own?
2. Why are the Spiracles important?
3. The mouth of the shark is part of which organ system(s)?
4. What is the function of the Gill Slits?
5. What does the Lateral Line do?
6. What two organ systems is the Cloaca a part of?
7. Since the Clasper is only present on male dogfish sharks, what gender is your shark?
8. How many fins does a dogfish shark have?
9. What's another name for the Rostrum?
10. Where are the Dorsal Spines located?

II. The Skeletal System (Figure 2)
Unlike the other 'higher vertebrates' (fish, reptiles, birds, etc.) the shark does not have a bony skeleton but instead has a skeleton composed of cartilage.

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

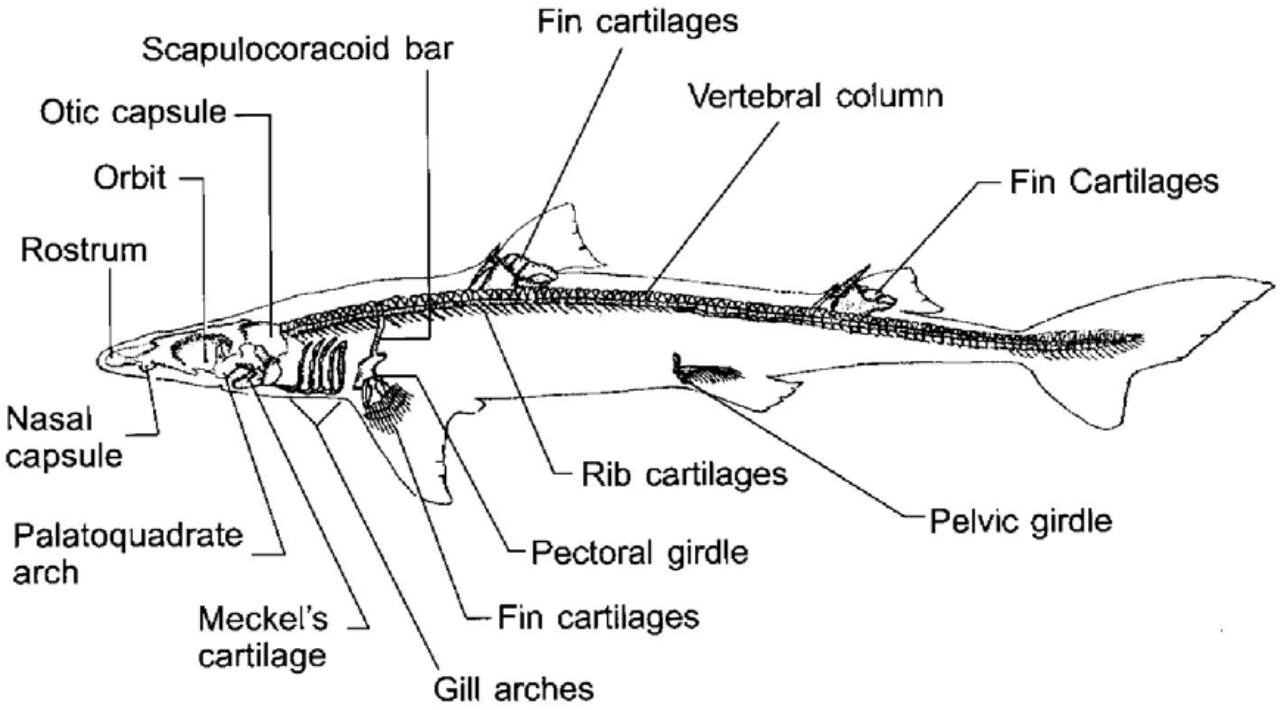


Figure 2. Shark skeleton - lateral view.

III. Beginning the Dissection:

You will want to have Page 1 with the anatomical terms handy to help you translate.
Place your shark ventral side down to begin. You will need to flip the shark over after step one to complete this section.

1. Remove each of the dorsal spines by cutting where it meets the body. This will prevent you from stabbing yourself unintentionally.

Flip your shark over onto its back. **Be sure to refer to the diagram as you begin cutting into the skin.**

2. Make a mid-ventral incision from the cloaca cranially to just below the jaw. **Make your incisions shallow.**
3. Cut around the head, around each fin, around the spircles, and around the cloaca.
4. From the cloaca cut dorsally around the shark – this will make a circle around the tail. **Remember you are cutting through the skin only.**
5. Using the handles of your scissors or your gloved fingers carefully peel off the skin to expose the muscles.
6. Compare your specimen with Figure 3 and Figure 4.
7. Try to identify as many of the structures listed as possible.

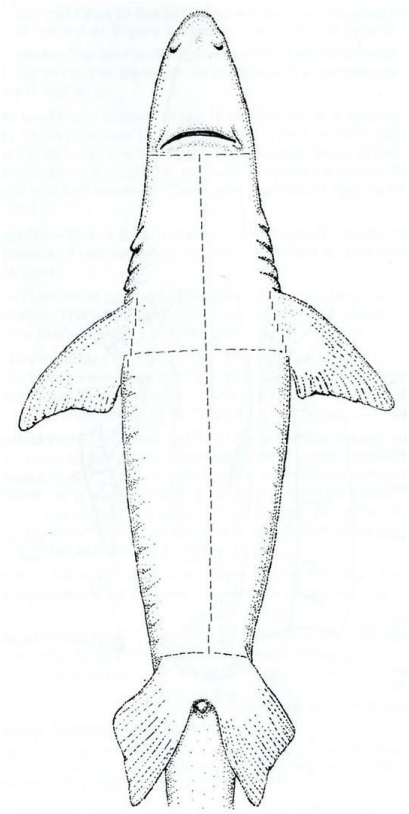


Figure 5. Body wall incisions

<u>Body Musculature – Trunk and Tail</u>

Myotomes-** These are the segments of muscles in the trunk and tail that are arranged in a unique zig-zag pattern.

Epaxial Muscles- These are the myotomic muscle groups located on the dorsal side.

Hypaxial Muscles- These are the myotomic muscle groups located below the Epaxial Muscles.

<u>Muscles of the Head and Branchial Region</u>

Preorbitalis- This muscle is just ventral from the eye and above the jaw. **It helps in opening the jaw.** It is cylindrical in shape.

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

Levator Palatoquadrati- Located above the adductor

mandibulae muscle, it **helps raise the jaw.**

Intermandibularis- Large muscle which is partially underneath the Adductor Mandibula; it **assists in jaw closing.**

Levator Hyomandibulae- Just behind the spiracle and overlapped by the cranial portion of the Hyoid Constrictor, this muscle **raises the jaw.**

Hyoid Constrictor- Muscle associated with first gill arch, it acts to **constrict the gill cavity.**

Ventral Constrictors- The muscles associated with the ventral section of the three middle gill arches. These also **constrict the gill cavities.**

Dorsal Constrictors- The muscles associated with the dorsal section of the gill arches. These also **constrict the gill cavities.**

Septal Constrictors- The muscle that is associated with the caudal gill arch. **Constricts the caudal gill cavity.**

Pectoral Levators- Located on the dorsal side of the pectoral fin, they **raise the pectoral fin.**

Cucullaris- Located above and cranial from the pectoral levators this muscle **moves the pectoral fin dorsally and crainally** *

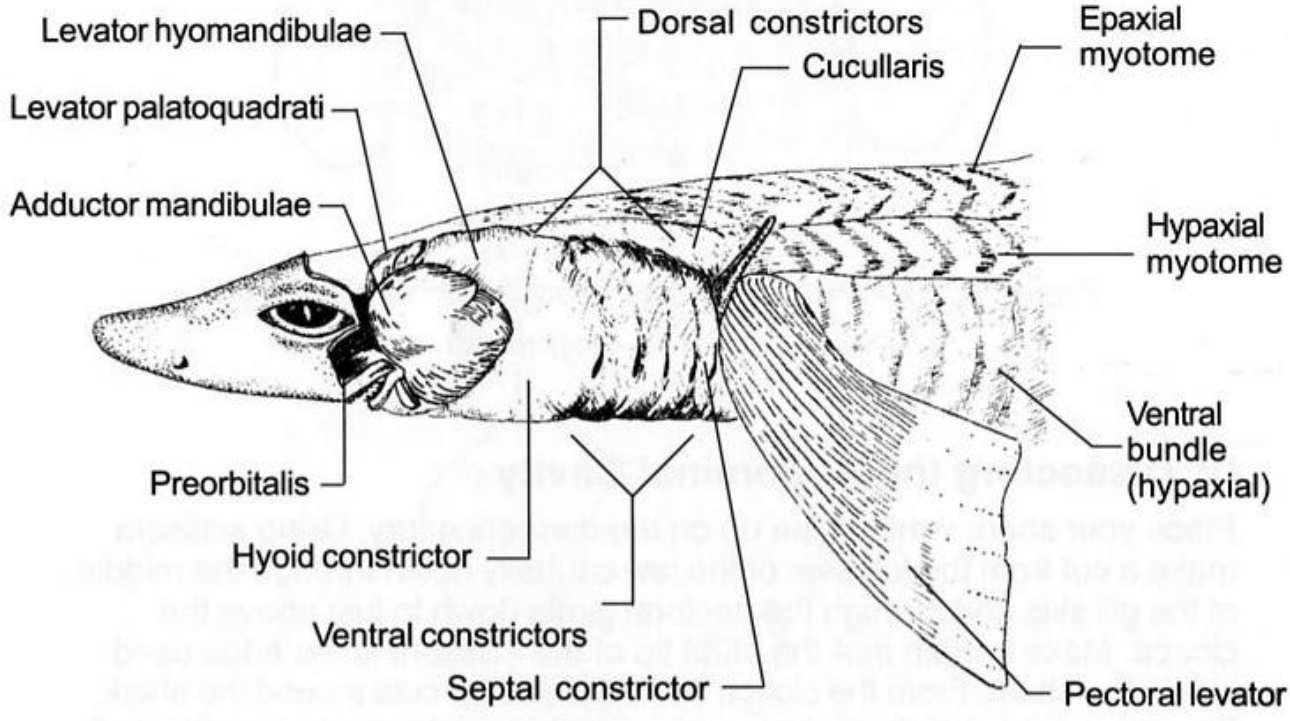


Figure 3. Body musculature - lateral view

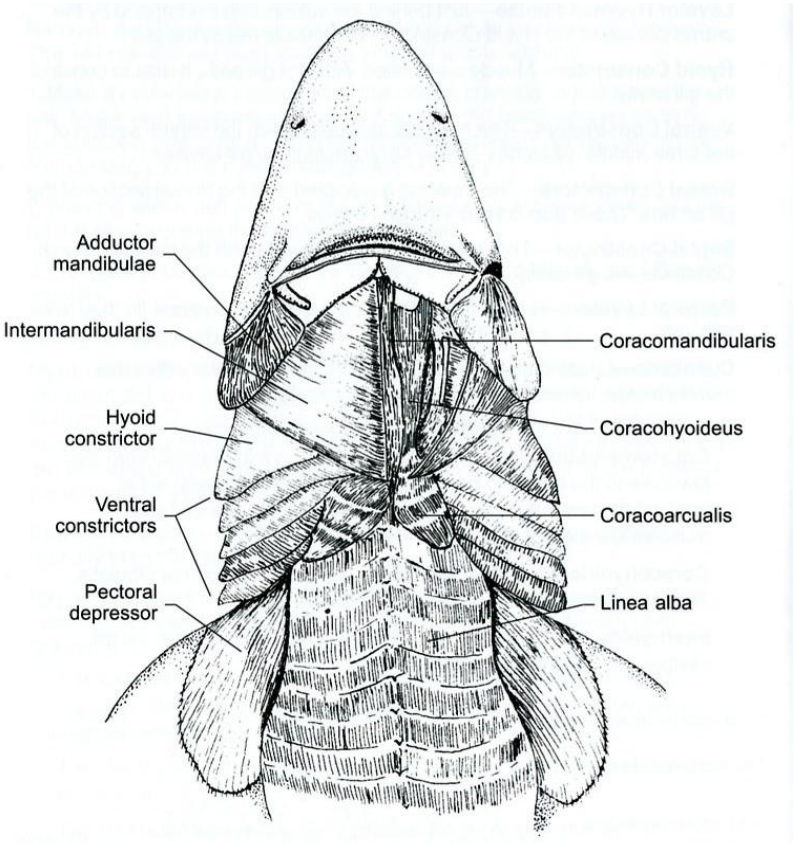


Figure 4. Ventral muscles of head and branchial region (Superficial and deep muscles).

Was the shark's skin as thick as you expected it to be?

IV. Dissecting * the Abdominal Cavity

Use the figure 5 to show you where to cut through the muscles.

1. Place your shark ventral side up on the dissection tray.

2. Using scissors – blunt tip inside the shark – make a cut from the left side of the jaw (the shark's left) caudally down through the middle of the gill slits and through the pectoral girdle down to just above the cloaca. **Cutting through the pectoral girdle may be difficult. Ask if you need help.**

3. From the cloaca make transverse (side to side) cuts around the shark.

4. From the pectoral girdle, make transverse cuts around dorsally.

5. You may pin the flaps of muscle tissue to the dorsal sides of the shark or remove the tissue and place to the side so you can cover the internal organs overnight.

Mouth Structures

Teeth- These are derived from the scales which cover the shark's body! They have been adapted to function as cutting structures. The teeth of a shark are replaced regularly as they wear out.

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 cartilaginous protrusions which prevent large particles of food from entering the gills.

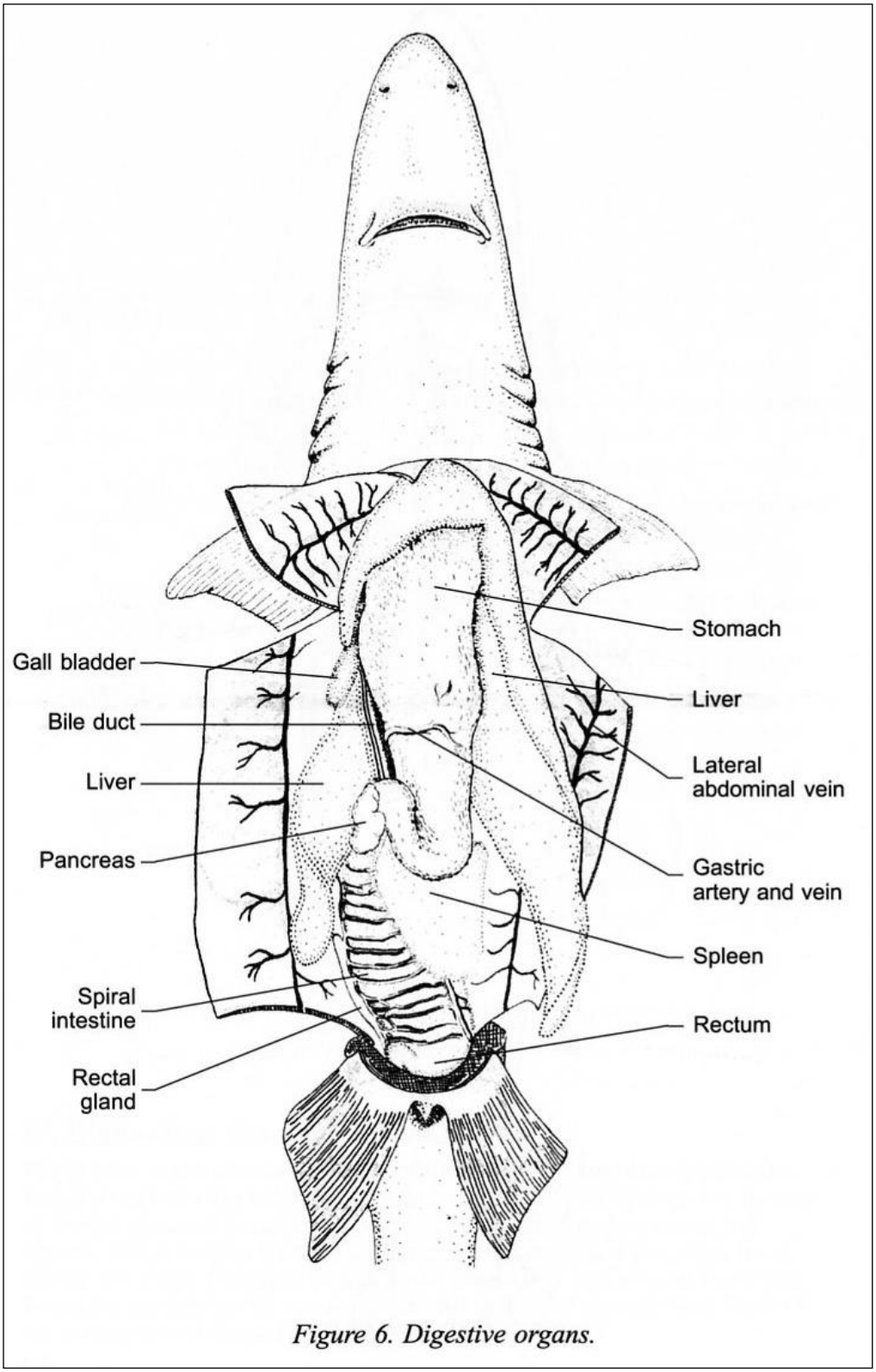


Figure 6. Digestive organs.

At this point, with the help of the figure 6

you should be able to identify the organs in the list below.

Esophagus-** The connection between the pharynx 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 heard 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 if you choose to 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.

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 (before) to the spiral intestine. This organ is not part of the digestive tract, but is associated with the circulatory system.

Circulatory System

1. Lift the flaps over the area of the heart and pin them where they stay out of the way.

2. It may be necessary to cut some tissue that may be attached to the heart.

3. If you would like to cut open the chambers of the heart for a better look you may do so.

You should now be able to identify the some of the structures that are listed below.

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

Atrium- Similar to the atrium of a human.

Ventricle- The main contracting chamber of the heart.

Conus Arteriosus- A muscular reservoir that empties after the ventricle contracts. It gives the blood flow an added boost.

V. The Urogenital System

To view this system you need to remove all of the digestive tract

1. Remove the liver by cutting at its cranial end.

2. Cut through the esophagus where it enters the body cavity above the stomach.

3. Cut the colon at its caudal end.

4. Cut the membranes attaching the stomach, intestine, pancreas and spleen to the body wall.

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.

You should be able to identify the organs listed below once you have completed steps 1-4 above.

Kidneys- The shark has two dark-colored kidneys on either side of the midline. The shark regulates its urinary system in a way unique compared to most other vertebrates. The shark kidney extracts urea from urine and returns the urea to the blood. In this way the water pressure of the shark's body fluids are maintained as high as that of sea water.

Rectal Glands- These are tube-like extensions of the rectum. This gland controls the salt 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 Urine 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.

Male Genital System (Figure 12)

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

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

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

Seminal Vesicle- An enlarged section of the vas deferens that dds 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 vesicle.

Siphon- Produces a secretion that is expelled with the aid of the clasper during mating.

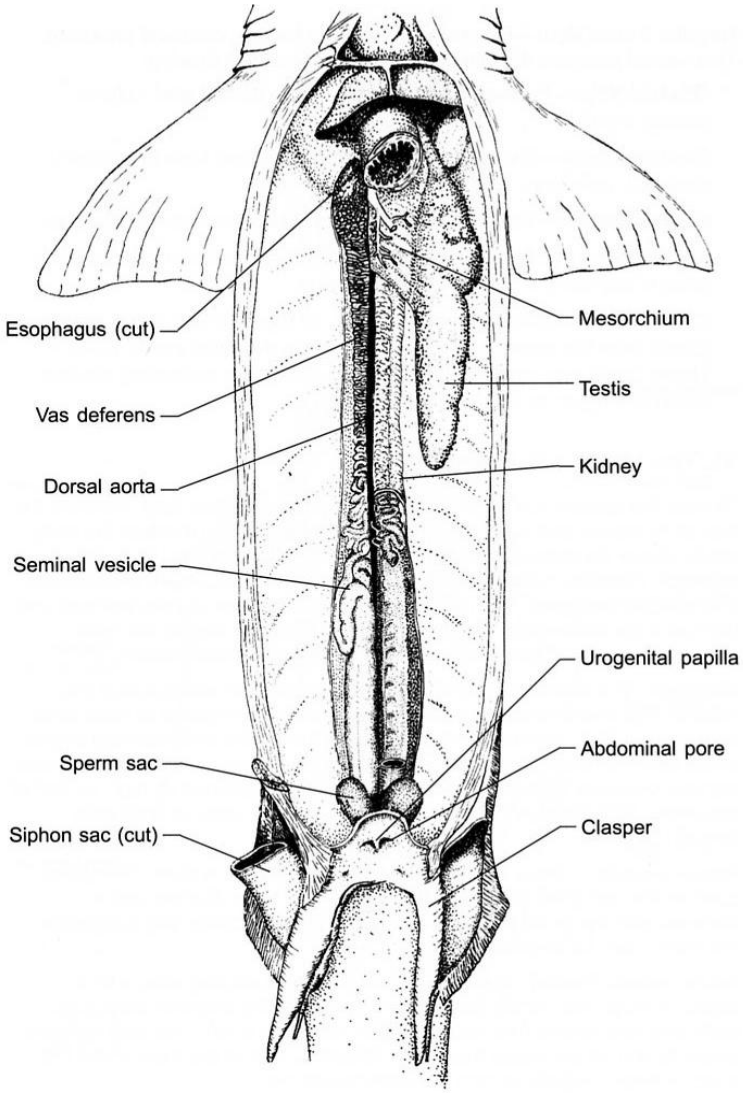


Figure 12. Male urogenital system.

Female Genital System (Figure 13)

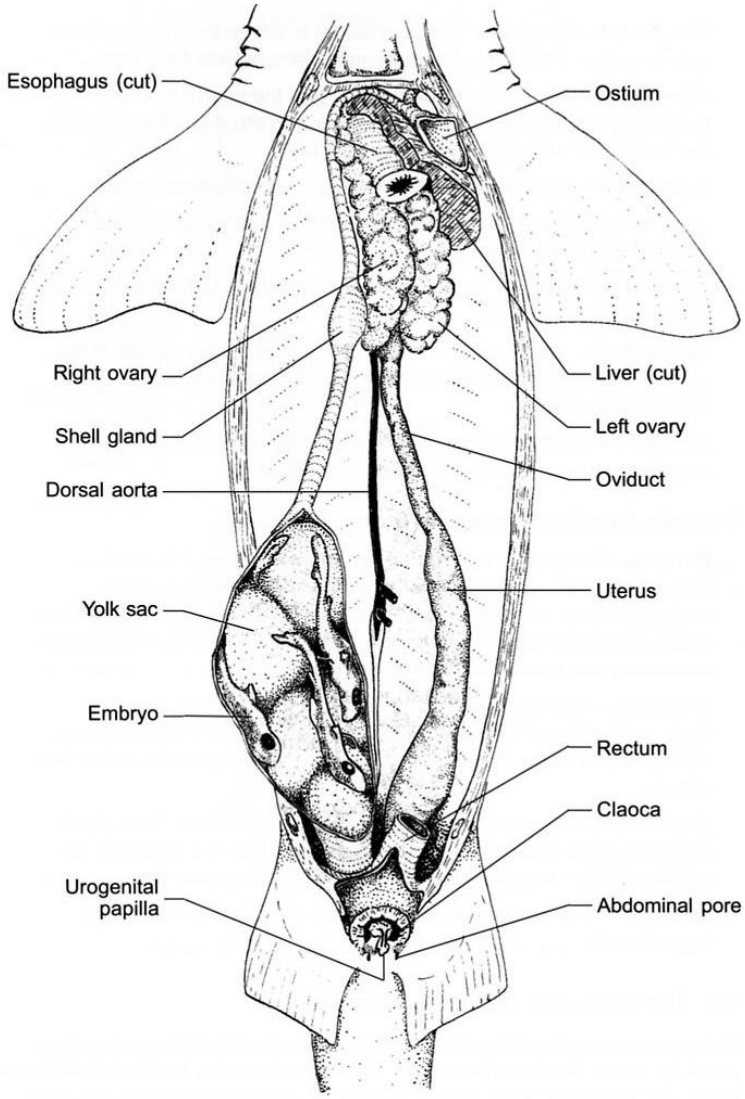


Figure 13. Female reproductive system (kidneys not shown).

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. It is here that eggs develop.

VI. The Nervous System: The Brain

1. Remove the skin from the dorsal section of the head.
2. With your scalpel, carefully shave the chondocranium (shark's cranium) down to expose the brain, the olfactory lobes, and the major brain nerves. **Shave off thin sections so that you don't cut into the brain or nerves.**
3. Remove chips of cartilage with forceps. Remove the chondocranium from the tip of the rostrum back to the gill slits.

Now that you've exposed the nervous system, you should be able to identify the following organs.

Olfactory Sacs-** Two large bulbous nerve sensors that detect chemicals in the surrounding water

.

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.

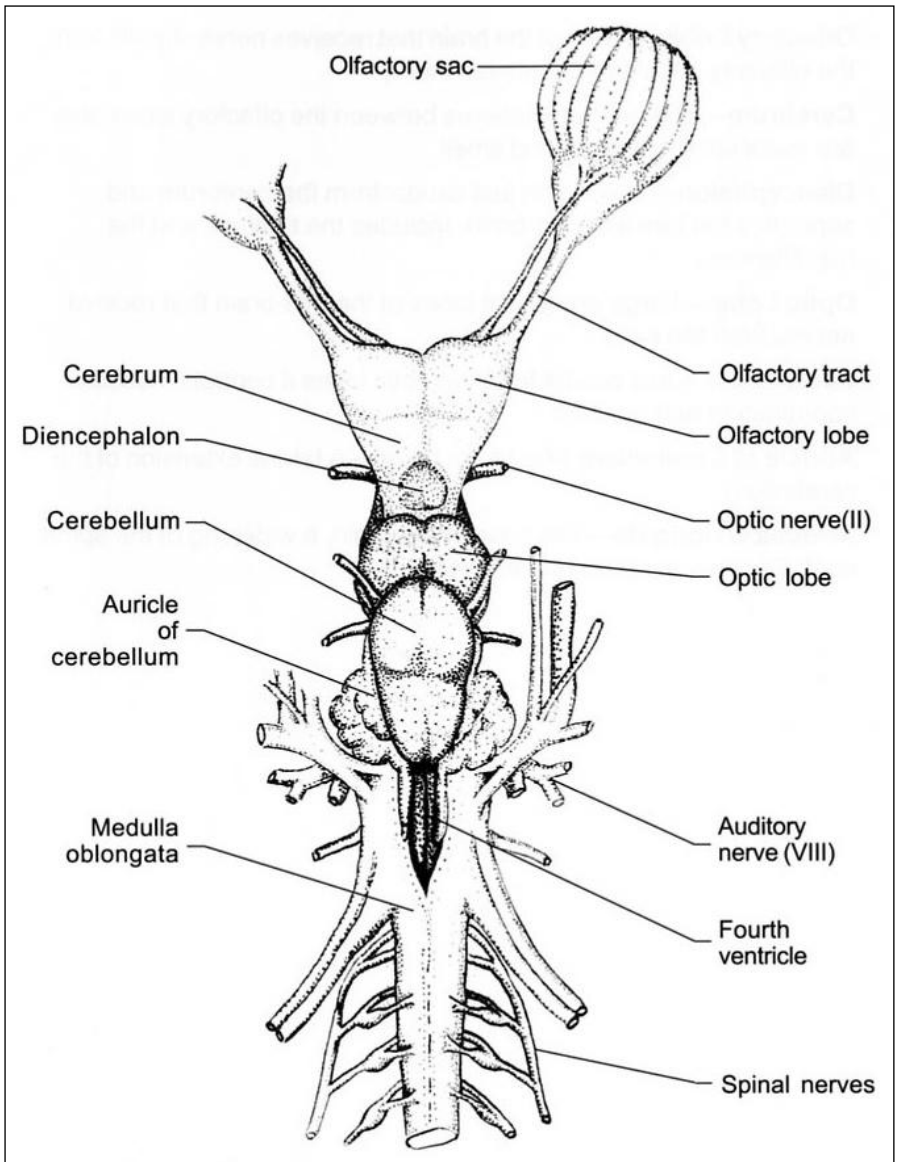


Figure 14. Dorsal view of the shark brain.

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 of the spinal reflexes.

Dissection Clean-up

Now that you have completed your dissection it is time to clean up!

1. Return **all parts** of the shark to the bag it came in.
2. Secure the bag with a rubber band – just like when we started the lab.
3. Place the secured bag in one of the boxes we removed them from at the beginning of the lab.
4. Wash and dry all of your dissection tools.
5. Return all of the tools to your teacher.
6. Wash and dry your dissection tray.
7. Return your dissection tray to your teacher.

RESOURCES

http://cms.springbranchisd.com/LinkClick.aspx?fileticket=Zf%2BmY1NEbCk%3D&tabid=1003&mid=2217

http://home.comcast.net/~pa.pedersen/Zoology/Shark-dogfish+Dissection.pdf

http://jb004.k12.sd.us/MY%20WEBSITE%20INFO/BIOLOGY%202/ANIMAL%20KINGDOM/SHARK%20DISSECTION/SHARK%20DISSECTION%20HOMEPAGE.htm

http://www.docstoc.com/docs/19886202/Shark-Dissection-%E2%80%93-Dogfish-Squal

http://quizlet.com/1456921/bio-lab-final-part-3-dogfish-shark-dissection-flash-cards/

http://www.mrmorrison.org/shark/index.html