Grade Level: 6-8
Time Estimate: 3-5 days

SHARK ANATOMY / INSTRUCTOR INFO

Summary

This lesson includes vocabulary, content, and activities to help students learn and understand basic taxonomy, how sharks are classified, and shark anatomy. Students will learn how to identify external and internal anatomy of sharks as well as the functions of each system.

Part 1. Taxonomy
Part 2. Shark Classification
Part 3. Shark Skin
Part 4. External Anatomy
Part 5. Internal Anatomy

Goals & Objectives

The students will:

- learn basic taxonomy;
- classify sharks taxonomically based on morphology;
- learn external anatomy of sharks;
- learn internal anatomy of sharks.

// STANDARDS

This lesson aligns with the following TEKS:

6th Grade Science: 1A, 1B, 2A, 3A, 4A, 4B, 12A, 12B
7th Grade Science: 1A, 1B, 2A, 3A, 4A, 4B, 12A, 12B
8th Grade Science: 1A, 1B, 2A, 3A, 4A, 4B

This lesson aligns with the following Next Generation Science Standards:

Framework

1. Asking questions and defining problems
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Obtaining, evaluating, and communicating information

MS. Structure, Function, and Information Processing – MS-LS1-2; MS-LS1-3

Disciplinary Core Ideas

LS1.A Structure and Function

- In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (ML-LS1-3)

Crosscutting Concepts

Systems and System Models

- Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. (MS-LS1-3)

Structure and Function

- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural and designed structures/systems can be analyzed to determine how they function. (MS-LS1-2)

Helpful Tips

1) The content in this lesson is based on the conservation work of OCEARCH™ and the Global Shark Tracker™. Spend a few minutes getting familiar with the website and the tracker if you have not done so already. The Global Shark Tracker™ is also available as an app for iPhone and Android.
2) This lesson plan is designed to be adaptable to suit your specific needs. Use the entire lesson plan or just parts of it. This material can be expanded to be an entire unit or condensed for just one day in the classroom.
3) Vocabulary words will be underlined as they first appear in the lesson plan. A complete list of vocabulary words is included as well.
4) Answers to questions and prompts for discussions will appear in *italics*.
5) Optional activities and content (side notes) will appear in a box. Use these to enhance your lesson and adapt it to suit your needs!
6) Have questions for OCEARCH Expedition Leader, Chris Fischer? Email info@OCEARCH.org to schedule a Skype session and let your students/child talk directly to Chris and the OCEARCH crew!
7) Email all questions about this lesson to info@OCEARCH.org.

Vocabulary

Ampullae of Lorenzini – Electroreceptors used to detect electrical currents in the water; help shark swim in dark, murky water.
Anal fin – Located on the underside of the shark; assists in balance.
Anterior – Anatomical direction meaning toward or near the head.
Binomial nomenclature – A system in which an organism is given a name composed of two parts: genus and species.
Cartilage – Tough, flexible connective tissue.
Caudal – Anatomical direction meaning toward or near the tail.
Caudal fin – Provides forward thrust for locomotion; also known as the tail fin.
Classical dissection – Act or process of disassembling an organism to observe the internal anatomy or musculature.
Cranial – Anatomical direction meaning toward or near the head.
Dentine – Hard tissue composed of calcium and phosphate; found underneath enamel of teeth and placoid scales.
Dermis – One of the two layers of the integument or skin. The dermis is below the epidermis and contains nerve endings, blood, and lymph vessels.
Dermal denticles – Small scales that cover the skin of sharks; also known as placoid scales.
Diffusion – Movement of particles or gases down a concentration gradient.
Dorsal – Anatomical direction; top of animal.
Dorsal fin – Provides balance during swimming.
Epidermis – One of the two layers of the integument or skin. The epidermis is the superficial layer and is composed of living cells. The epidermis of sharks does not have a hard keratinized outer layer, like terrestrial (land-living) vertebrates.
Enamel – Tough, mineralized outer coating of teeth and placoid scales.
Eukaryotes – Multicellular organisms containing complex structures within the cells.

Gills – An organ in fish for obtaining oxygen from water.
Lateral line – A series of specialized pores used in the detection of pressure and vibration. The lateral line is present in all fish.
Medial – Anatomical direction meaning toward the midline. The midline is an imaginary line that divides the body in identical halves.
Morphology – Branch of science that studies the form, function, and structure of organisms.
Nares – Provide shark with a sense of smell.
Nictitating membrane – White membrane that forms an inner, third eyelid.
Oviparity – Type of reproduction in which the females deposit fertilized eggs into the ocean where they will hatch later on their own.
Ovoviviparous – Type of reproduction in which eggs hatch inside the mother and pups are born live. However, unlike viviparous species, there is no placenta to feed the young. Instead of being nourished by the placenta, the pups are nourished by egg yolk and, once hatched, consume unfertilized eggs.
Pectoral fin – Fins located on the side of the fish; provide lift, steering, and braking.
Pelvic fin – Located on the underside of the shark, near the tail; assists in balance.
Posterior – Anatomical direction meaning toward or near the tail.
Prokaryotes – Single-celled organisms (bacteria) lacking an organized nucleus.
Pulp – Center layer of a placoid scale or tooth; composed of living connective tissue.
Species – One of the lowest taxonomic ranks; defined as a group of organisms or individuals capable of interbreeding and producing offspring.
Spiracles – Modified gill slits; help the shark breath by pulling water into the gills while the shark is not moving.
Taxonomist – Scientist that classifies organisms into groups.
Taxonomy – The science of classifying organisms into groups based on structure, origin, and common ancestor.
Ventral – Anatomical direction; bottom of animal.
Viviparity – Type of reproduction where females produce eggs that hatch inside the mother and pups are fed and nourished by a placenta.

Grade Level: 6-8
Time Estimate: 5-15 mins

SHARK ANATOMY / PRE-LESSON ASSESSMENT

Use the following true/false and multiple choice questions as an introduction/warm-up to the lesson topics. You can do this in a verbal or written format, as a game, individually, or as a whole class! A handout is provided if you wish to hand the questions out in a quiz format.

The questions do not need to be graded. They are intended to give the students an idea of what they will be learning and to see what they already know.

1) True or False The highest taxonomic ranking is 'species'.
Answer: *False*

2) True or False Sharks have a two-chambered heart.
Answer: *True*

3) True or False A shark uses pectoral fins to move forward in the water.
Answer: *False*

4) What system does the spleen belong in?
a. digestive
b. urogenital
c. immune
d. respiratory
Answer: *c*

5) What structure provides a passageway for food to travel from the mouth to the stomach?
a. spleen
b. kidney
c. colon
d. esophagus
e. pancreas
Answer: *d*

6) Which organ produces bile?
a. spleen
b. pancreas
c. colon
d. stomach
e. liver
Answer: *e*

7) What system does the kidney belong in?
a. urogenital
b. circulatory
c. digestive
d. respiratory
Answer: *a*

Name: _____ Date: _____

Shark Anatomy

Select the correct answer(s) to each of the following questions.

1) True or False The highest taxonomic ranking is 'species'.

2) True or False Sharks have a two-chambered heart.

3) True or False A shark uses pectoral fins to move forward in the water.

4) What system does the spleen belong in?

a. digestive
b. urogenital
c. immune
d. respiratory

5) What structure provides a passageway for food to travel from the mouth to the stomach?

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c. colon
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6) Which organ produces bile?

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7) What system does the kidney belong in?

a. urogenital
b. circulatory
c. digestive
d. respiratory

Grade Level: 6-8

SHARK ANATOMY / LESSON PLAN

Part 1. Taxonomy (10 – 20 minutes)

Sharks and rays, unlike bony fish, have skeletons made of cartilage. Cartilage is tough, flexible connective tissue similar to what is found in our ears and nose. This is why sharks and rays are collectively known as cartilaginous fishes.

Taxonomy is the science of classifying organisms into groups, including bacteria, fungi, plants, and animals. Organisms are classified using seven taxonomic categories: kingdom, phylum, class, order, family, genus, and species. Taxonomists place related organisms in the same genera (or genus), related genera in the same family, group families into orders, orders into classes, classes into phyla (phylum), and phyla into kingdoms.

Below is an example of the taxonomic classification of the great white shark.
Note: As you move down the taxonomic classification, you must indent.

Kingdom: Animalia
Phylum: Chordata
Class: Chondrichthyes
Order: Lamniformes
Family: Lamnidae
Genus: Carcharodon
Species: carcharias

How can you remember the order of the taxonomic categories?
King **P**hilip **C**ame **O**ver **F**or **G**ood **S**paghetti!

Kingdom is the highest and most inclusive taxonomic category. Traditionally, there are five kingdoms: Monera, Plantae, Fungi, Animalia, Protista. This five kingdom system separates organisms based on cell types: prokaryotes versus eukaryotes. Prokaryotes, or bacteria, are placed in their own kingdom Monera. Eukaryotes, multicellular organisms, include the kingdoms Plantae, Fungi, and Animalia, and Protista.

How does a taxonomist define a species? Species is the lowest of the taxonomic ranks and is defined as a group of organisms or individuals capable of interbreeding and producing offspring. Taxonomists use a system called binomial nomenclature to classify and group organisms. Binomial nomenclature, also known as a scientific name, is a system of naming an organism based on its genus and species. The specific way to write a scientific name is to always capitalize the genus and keep the species lower cased. If typing the scientific name, you must italicize the name. For example, the scientific name for

great white sharks is *Carcharodon carcharias*. If hand-writing the scientific name, you must underline the name (Carcharodon carcharias). This is the universal way of knowing that this is the scientific name of an organism.

Part 2. Shark Classification (20 – 30 minutes)

There are over 350 shark species worldwide. Living sharks are divided into eight orders. Sharks can be classified into orders based on morphology. Taxonomists look at different morphological characteristics including the number of gill slits, fins, fin spines, location of the mouth, and presence of the nictitating membrane (third eye lid). Below is a table representing a few of the morphological traits used to place species in one of the eight orders. Keep in mind, these are just a few examples of morphological traits used for classification. Many other characteristics are also used to classify sharks.

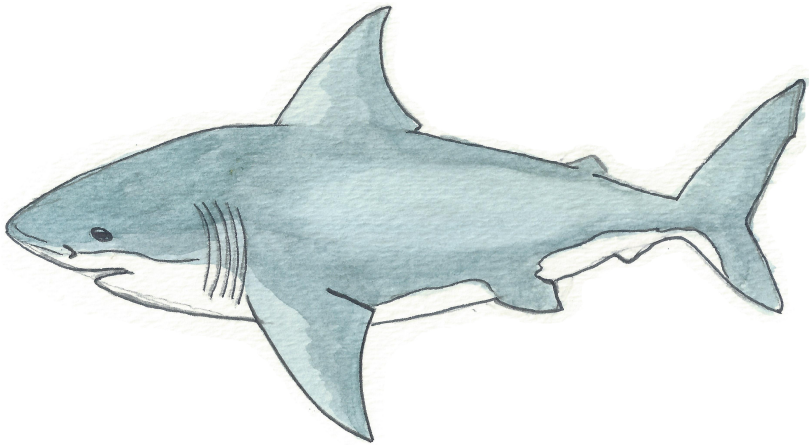
Table 1 – Shark Classification Based on Morphology

	Two dorsal fins	Anal fin	Flattened body	Mouth at front	Mouth extends past eye	Five external gill slits	Six or seven gill slits	Fin spines	Nictitating membrane
Pristiophoroformes						X			
Squatiniformes			X	X		X			
Orectolobiformes	X	X				X			
Carcharhiniformes	X	X			X	X			X
Lamniformes	X	X			X	X			
Squaliformes						X		X	
Heterodontiformes	X	X				X		X	
Hexanchiformes		X					X		

Activity – Classify Sharks Based on Morphology (10 – 20 minutes)

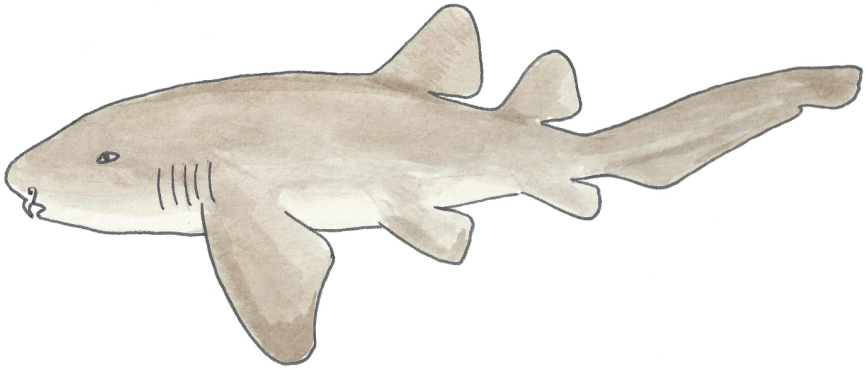
For each shark, answer the questions to determine what order the shark belongs in. A student handout is provided below.

1. Great White Shark



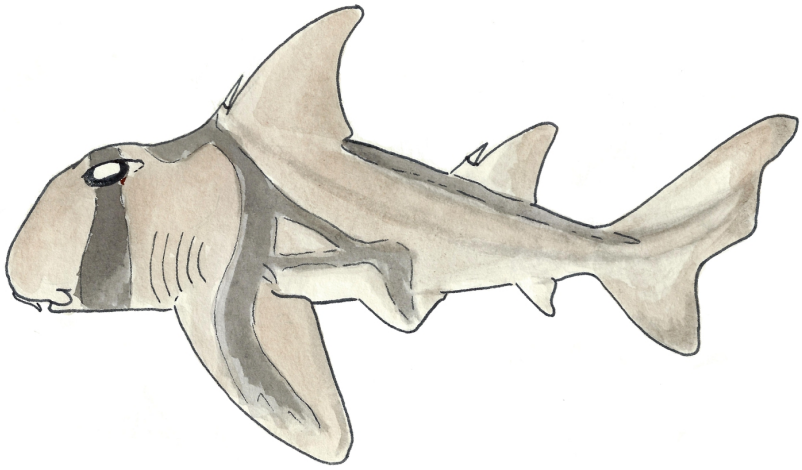
Answers: Does the shark have two dorsal fins? *Yes*
Does the shark have an anal fin? *Yes*
Does the shark have a flattened body or a mouth in the front? *No*
Does the shark have a mouth that extends past the eye? *Yes*
Does the shark have five external gills? *Yes*
Does the shark have a fin spine or a nictitating membrane? *No*
The great white shark belongs in the order *Lamniformes*.

2. Nurse Shark



Answers: Does the shark have two dorsal fins? *Yes*
Does the shark have an anal fin? *Yes*
Does the shark have a flattened body or a mouth in the front? *No*
Does the shark have a mouth that extends past the eye? *No*
Does the shark have five external gills? *Yes*
Does the shark have a fin spine or a nictitating membrane? *No*
The nurse shark belongs to the order *Orectolobiformes*.

3. Port Jackson Shark



Answer: Does the shark have two dorsal fins? *Yes*

Does the shark have an anal fin? *Yes*

Does the shark have a flattened body or a mouth in the front? *No*

Does the shark have a mouth that extends past the eye? *No*

Does the shark have five external gills? *Yes*

Does the shark have a fin spine anterior to the dorsal fins? *Yes*

Does the shark have a nictitating membrane? *No*

The nurse shark belongs to the order *Heterodontiformes.*

Illustration Credit: Sarah Rich – Landry's Downtown Aquarium

Shark Anatomy – Shark Classification

Name: _____

Date: _____

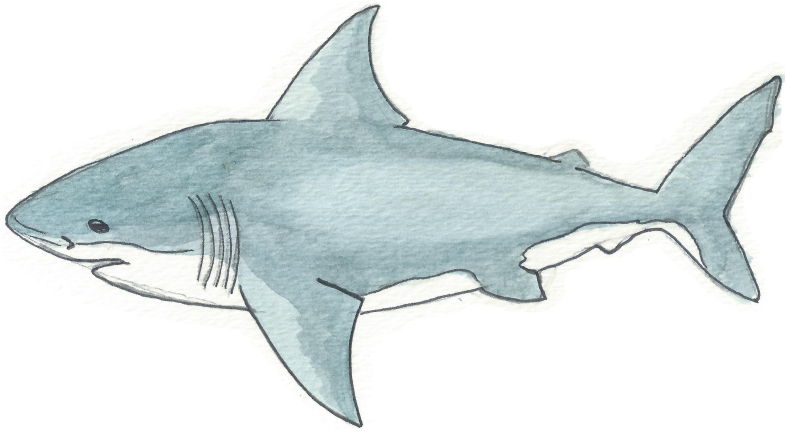
Classify Sharks Based on Morphology

For each shark, answer the questions and use the table below to determine what order the shark belongs in.

Table 1 – Shark Classification Table Based on Morphology

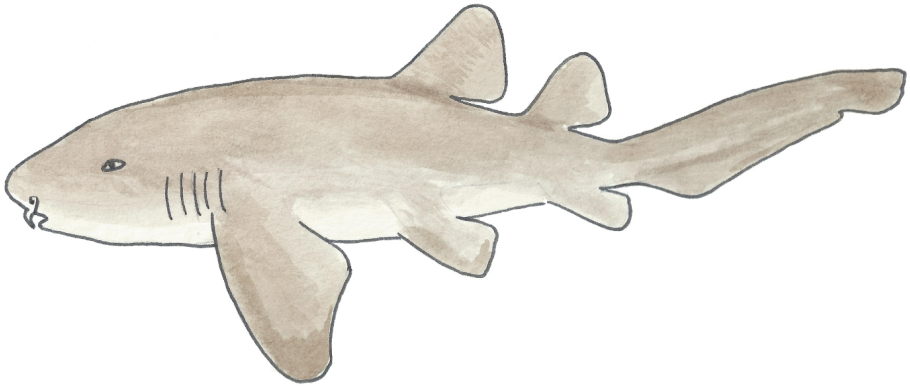
	Two dorsal fins	Anal fin	Flattened body	Mouth at front	Mouth extends past eye	Five external gill slits	Six or seven gill slits	Fin spines	Nictitating membrane
Pristiophoroformes						X			
Squatiniformes			X	X		X			
Orectolobiformes	X	X				X			
Carcharhiniformes	X	X			X	X			X
Lamniformes	X	X			X	X			
Squaliformes						X		X	
Heterodontiformes	X	X				X		X	
Hexanchiformes		X					X		

1. <u>Great White Shark</u>



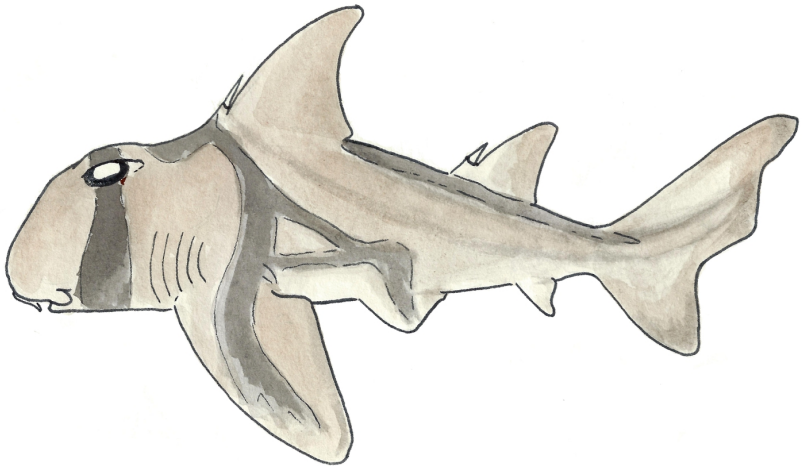
Answer: Does the shark have two dorsal fins? _____
Does the shark have an anal fin? _____
Does the shark have a flattened body or a mouth in the front? _____
Does the shark have a mouth that extends past the eye? _____
Does the shark have five external gills? _____
Does the shark have a fin spine or a nictitating membrane? _____
The great white shark belongs in the order _____.

2. Nurse Shark



Answer: Does the shark have two dorsal fins? _____
Does the shark have an anal fin? _____
Does the shark have a flattened body or a mouth in the front? _____
Does the shark have a mouth that extends past the eye? _____
Does the shark have five external gills? _____
Does the shark have a fin spine or a nictitating membrane? _____
The nurse shark belongs to the order _____.

3. Port Jackson Shark



Answer: Does the shark have two dorsal fins? _____
Does the shark have an anal fin? _____
Does the shark have a flattened body or a mouth in the front? _____
Does the shark have a mouth that extends past the eye? _____
Does the shark have five external gills? _____
Does the shark have a fin spine anterior to the dorsal fins? _____
Does the shark have a nictitating membrane?
The nurse shark belongs to the order _____.

Part 3. Shark Skin (10 – 20 minutes)

Shark skin is composed of two layers: the epidermis and dermis (Figure 1). The epidermis is the top layer, is composed of living cells, and lacks the hard outer layer found in the epidermis of land vertebrates. The dermis is the lower layer of the skin and is composed of dense connective tissue.

Shark skin is made up of dermal denticles, which are made out of dentine. Dermal denticles are also known as placoid scales. Placoid scales are located in the top portion of the dermis and extend upward through the epidermis (Figure 1). The function of scales is to protect the internal organs of the shark and allow for hydrodynamic movement through the water. Scales are arranged to make the shark streamlined. If you were to touch a shark from head to tail, the shark would feel smooth. However, if you were to touch a shark from tail to head, the shark would feel rough, like sandpaper.

A cross-section of a placoid scale shows how the scale is composed of several layers, similar to that of a tooth (Figure 1). Placoid scales are composed of an inner core called a pulp, middle layer called dentine, and a tough, mineralized outer coating called enamel.

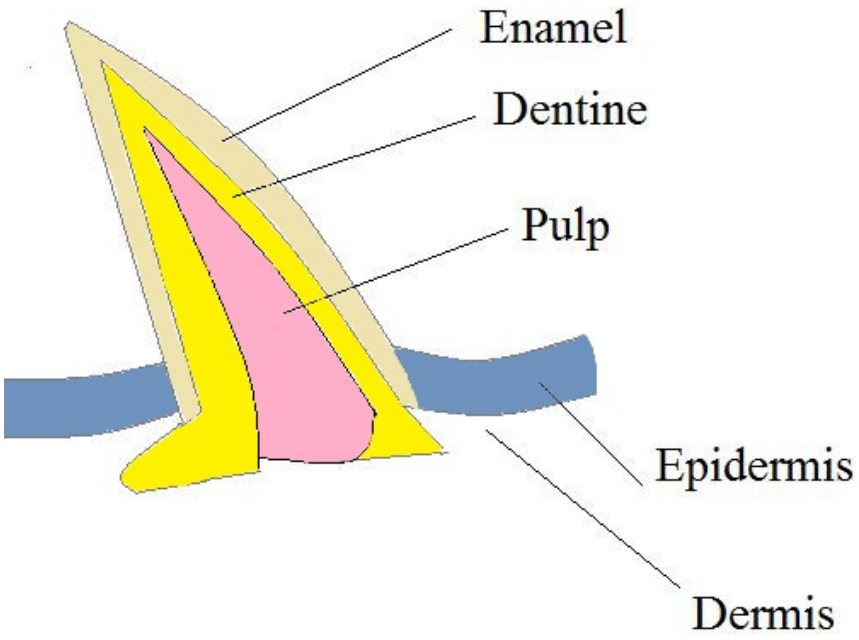


Figure 1. Placoid denticle of a shark – side view.
Illustration Credit: Lori Timm, Ph.D. – Landry's Downtown Aquarium

Part 4. External Anatomy (30 – 45 minutes)

Before You Begin – Anatomical Directional Terms

Many anatomical names include a directional term. For example, a shark can have more than one dorsal fin. The directional term distinguishes one dorsal fin from the other and helps avoid confusion when identifying other structures. Figure 2 shows the most common directional terms used in

anatomy. The imaginary vertical line divides the shark into the anterior end, toward the head, and the posterior end, toward the tail. Sometimes you may hear the term cranial used in place of anterior and caudal in place of posterior. The imaginary horizontal line divides the shark into the dorsal end, toward the back, and the ventral end, toward the belly.

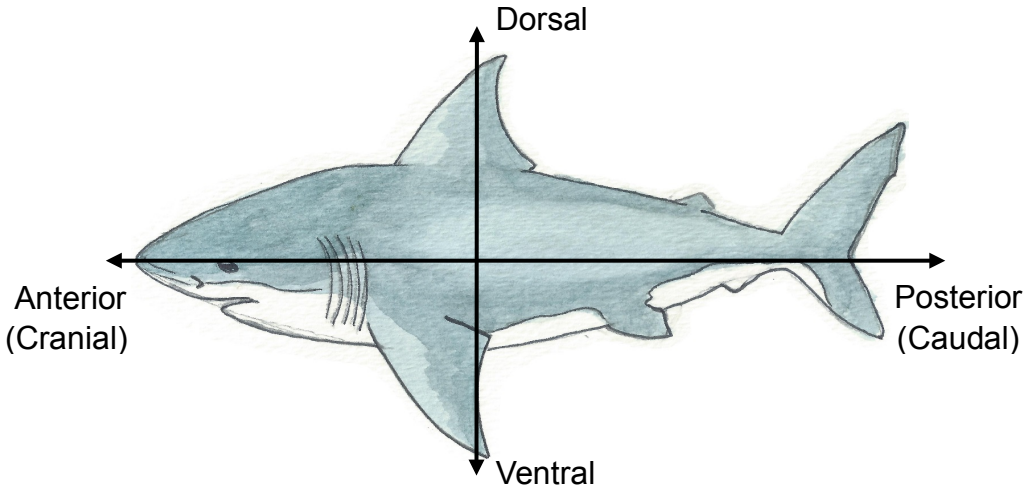


Figure 2. Anatomical Directional Terms
Illustration Credit: Sarah Rich – Landry's Downtown Aquarium

External Anatomy of Sharks

There are over 350 species of shark worldwide. The external anatomy of each species varies based on the habitat in which it lives. For example, species living on the sea floor possess spiracles which are necessary in maintaining water flow over the gills in order to breathe. Species living in the open ocean have hydrodynamic, torpedo-shaped bodies making them more efficient swimmers.

Below is the basic external anatomy of a shark, regardless of its habitat (Figure 3).

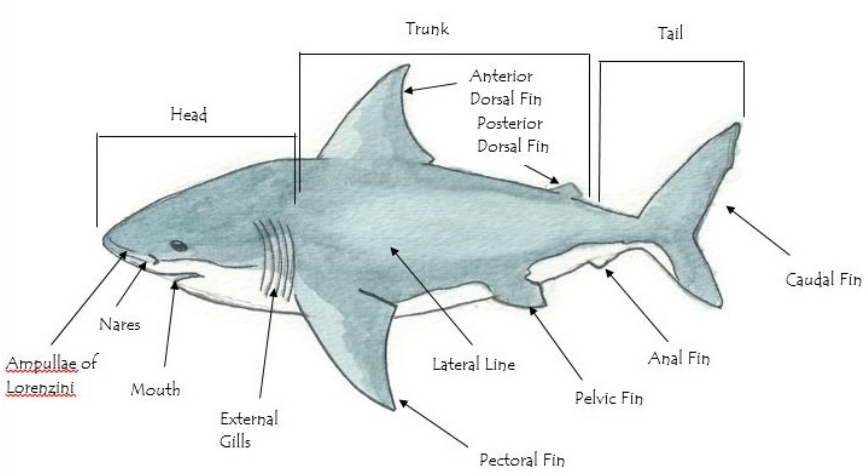


Figure 3. Basic External Anatomy of a Shark
Illustration Credit: Sarah Rich – Landry's Downtown Aquarium

The Head

The head of the shark is where you can find sensory organs like the eyes, nares (nostrils), and mouth (Figure 3). Sharks have additional sensory organs to help them survive in their habitats.

The ampullae of Lorenzini (Figure 3) are small electroreceptors used to detect electrical currents in the water. The majority of these special cells are located on the underside of the snout and help the shark swim in dark, murky water.

External gills (Figure 3) are openings to the internal gills. Most sharks have five gill slits on each side of their body, but some species can have up to seven. Water enters the sharks mouth, flows over the internal gills, and exits through the external gill slits.

The Trunk

The trunk of the shark is sometimes referred to as the body and houses most of the shark's internal organs. Externally, this is where most of the fins are located. Great white sharks have two dorsal fins: the anterior dorsal fin (Figure 3) and the posterior dorsal fin (Figure 3). The names of these fins tell you exactly where it is located on the shark: dorsal tells you the fins will be located on the animals back; anterior distinguishes the dorsal fin closest to the head; posterior distinguishes the dorsal fin closest to the tail. The main function of the dorsal fin is to provide balance while swimming. Without it, the shark would rollover and be unable to make sudden turns. The single anal fin is located on the ventral side of the shark and also provides balance while swimming.

Sharks have one pair of pectoral fins (Figure 3), one located on each side of the body, providing a way to steer and break while swimming. Sharks cannot move these fins freely like other fish, instead they act more like the handlebars on a bicycle. When a shark wants to turn, it has to move its entire upper body. The pectoral fins are in the shape of a hydrofoil, which generate lift while the shark swims through the water. Lift woks against gravity and keeps the shark from sinking as it swims.

The pelvic fins (Figure 3) are located on the ventral side of the shark with one located on each side of the body. These fins help the shark balance while swimming.

The lateral line (Figure 3) is a series of specialized pores used in the detection of pressure changes in the water. The lateral line is present in all fish. This special sensory organ consists of hundreds of mechanoreceptors called neuromasts. Neuromasts are the smallest functional unit of the lateral line and consists of hair cell epithelium that connects these hair cells with the surrounding water. A longer hair-like fragment of these cells extends into a jelly–like dome which is exposed to the external environment. Any vibrations in the water will cause the gelatinous substance to move bending the longer 'hair' of the hair sensory cell which triggers a message to the brain. The lateral line is often considered the sixth sense for sharks!

The Tail

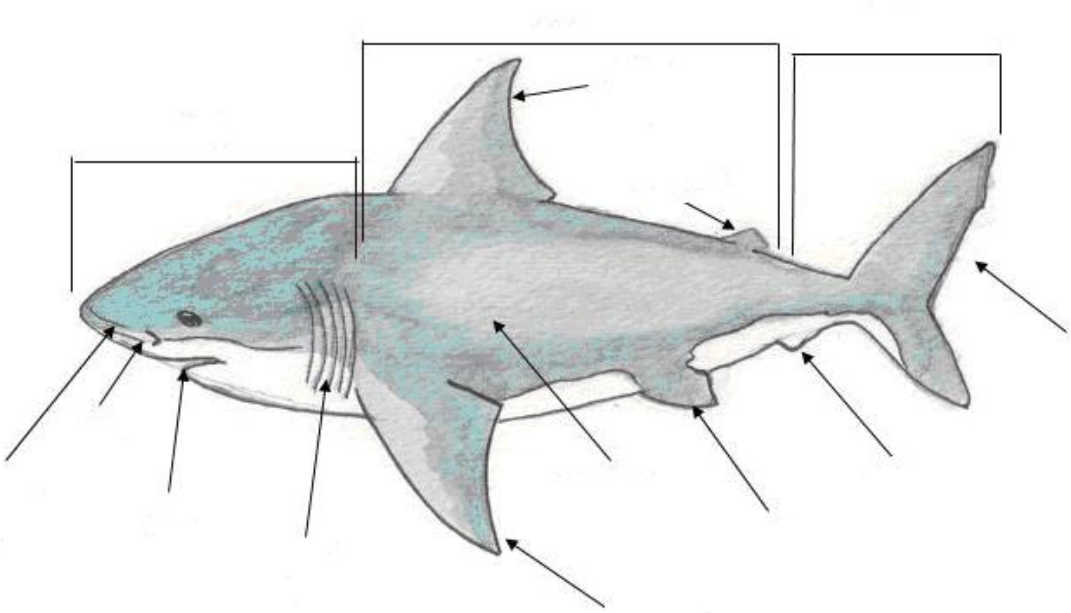
The caudal fin (Figure 3), also known as the tail fin, is divided into the upper lobe and lower lobe and is responsible for propelling a shark through the water. Caudal fins in sharks vary dramatically depending on where the shark lives and what it hunts. The fin is connected to the trunk by the caudal peduncle.

Shark Anatomy –

Name: _____

Label the external anatomy of a shark.

Use the word bank provided.



Word Bank

nares	pelvic fin	anal fin
mouth	tail	posterior dorsal fin
eye	pectoral fin	lateral line
external gills	head	anterior dorsal fin
caudal fin	ampullae of Lorenzini	lateral line

Part 5. Internal Anatomy (30 – 45 minutes)

Respiratory System

The primary function of the respiratory system is to provide oxygen to the body and remove carbon dioxide. This process is also called gas exchange. Gas exchange is accomplished by the diffusion of gases between water and gills. The respiratory system is composed of spiracles, internal gill slits, gill rakers, gill filaments, gill chambers, and gill arches.

Circulatory System

Sharks have a two-chambered heart: one atrium and one ventricle. Deoxygenated (DO) blood from the body pumps into the atrium and into the ventricle (Figure 4). Deoxygenated blood is then pumped into the gills (site of gas exchange) and the blood becomes oxygenated (O). Oxygenated blood is then pumped to the rest of the organs (body).

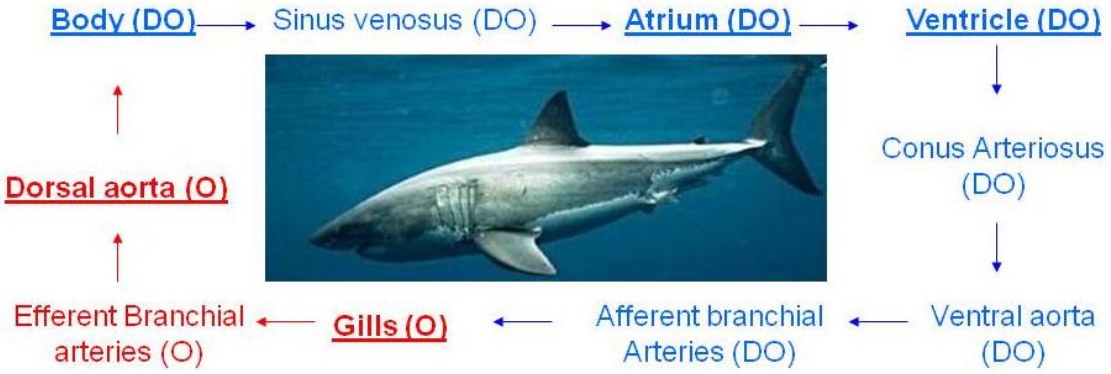


Figure 4. Blood Circulation Flow Chart for a Shark
Underlined and bolded terms are part of the structures for this lesson. Other structures are kept in the flow chart to keep the circulation pattern accurate.
DO = deoxygenated blood; *O* = oxygenated blood.

Digestive System

The digestive process begins in the mouth. Once in the mouth, food passes into the esophagus. The esophagus is a tube that connects the mouth to the stomach. The function of the stomach is to break food down.

Digested food, also known as chyme, passes through a pyloric sphincter, which controls the passage of chyme into the duodenum. The duodenum is the first section of the small intestine. Chyme then travels into the ileum, the second part of the small intestine for further digestion.

The internal anatomy of the ileum in sharks is quite unique in that it possesses a spiral valve. The spiral valve increases the surface area of the ileum and slows down the digestive process. This enables the shark to absorb as much nutrients as possible. After digested materials exit the ileum, it passes into the colon, or large intestine, and exits the cloaca (single opening for removal of waste and reproductive cells).

The liver is also part of the digestive system. The liver is not only used to produce bile (used to break down fats in the duodenum), but is also used for buoyancy. Unlike bony fish that have a swim bladder, sharks use oil (squalene) produced in the liver to remain balanced in the water column.

Urogenital System

Unlike bony fish, shark eggs are fertilized inside the female's body. This is known as internal fertilization. Males use claspers to transfer sperm into the female. Some species of sharks, such as lemon sharks and white-tip reef sharks, produce eggs that hatch inside the mother and pups are fed and nourished by a placenta. Nutrients are passed from the mother to the pups by an umbilical cord. This type of reproduction is called viviparity (viv-*uh*-par-i-tee).

Other sharks, such as zebra sharks, deposit fertilized eggs into the ocean where they will later hatch on their own (Figure 5). These eggs are nourished by yolk, similar to that of a chicken egg. This type of reproduction is called oviparity (oh-v*uh*-par-i-tee).

Figure 5. Mermaid's purse of chain catshark *Scyliorhinus retifer*.
Illustration Credit: Sarah Rich – Landry's Downtown Aquarium

Some sharks, such as great white sharks, mako sharks, and nurse sharks are ovoviviparous (oh-voh-vahy-vip-er-uhs). These sharks produce eggs that hatch inside the female, similar to viviparous sharks. In contrast, ovoviviparous sharks lack a placental connection and embryos are nourished by yolk. Once the pups hatch inside the mother, they are nourished by consuming unfertilized eggs and pups are born live.

Immune System

The spleen is responsible to filtering blood of harmful toxins and bacteria. This helps the shark to avoid infections and sickness. There is a misconception that sharks never get sick. Although sharks can get sick, diseases such as cancer are rare. Scientists believe this is mainly because a shark's skeleton is composed of cartilage, which lacks blood vessels. Tumors rarely form and grow without blood vessels.

Shark Anatomy

ACTIVITY 1. Shark Dissection

(60 minutes)

Introduction

You will have the option to provide either (A) classical dissection or (B) a presentation and worksheet for the students.

A document titled 'Shark Anatomy Dissection Manual' is available to use. It includes instructions on how to prep the specimen for dissection as well as labeled photos of all the structures students will identify.

If Option A is selected, you can dissect a single shark for the class or present the Dissection Manual on a projector while the students perform their own dissections in pairs or groups. Sharks can be ordered online from any biological supply company. Sharks can be ordered as plain, single color injected, or double color injected. Plain sharks are not dyed. Single injected sharks are dyed with red latex (arteries). Double injected sharks are dyed with red latex (arteries) and yellow latex (hepatic system). The shark dissected for this program was double injected.

If Option B is selected, you can present the Dissection Manual to the class and have students label the pictures on the following pages.

NOTE: All sharks are fixed and preserved and must be disposed of properly.

Materials for Option A. Classical Dissection

- Spiny dogfish shark(s)
- Dissection tray
- Scalpel
- Dissecting scissors
- Probe or pointer
- Latex gloves
- Hazardous waste bag for disposal
- Ventilating hood
- Shark Anatomy Dissection Manual PowerPoint (optional)
- Activity 1 Worksheets (optional)

Materials for Option B. Dissection Presentation

- Shark Anatomy Dissection Manual PowerPoint
- Activity 1 Worksheets

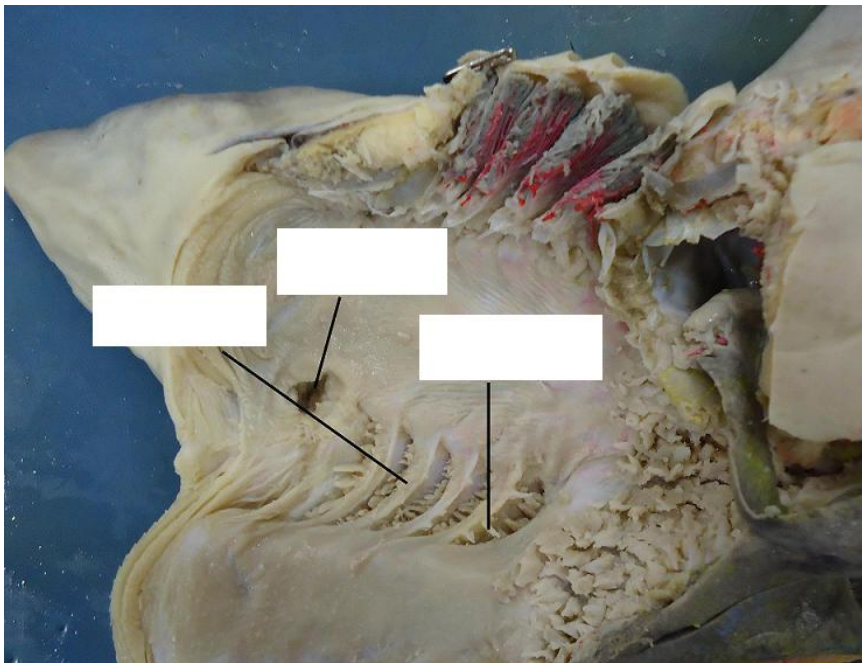
Activity 1.
Shark Dissection

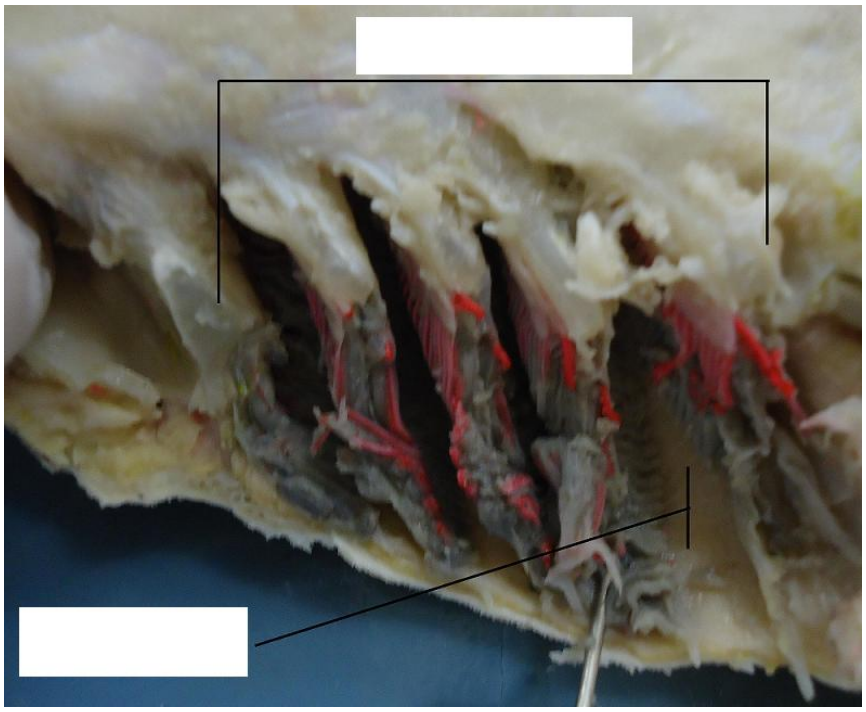
Name: _____

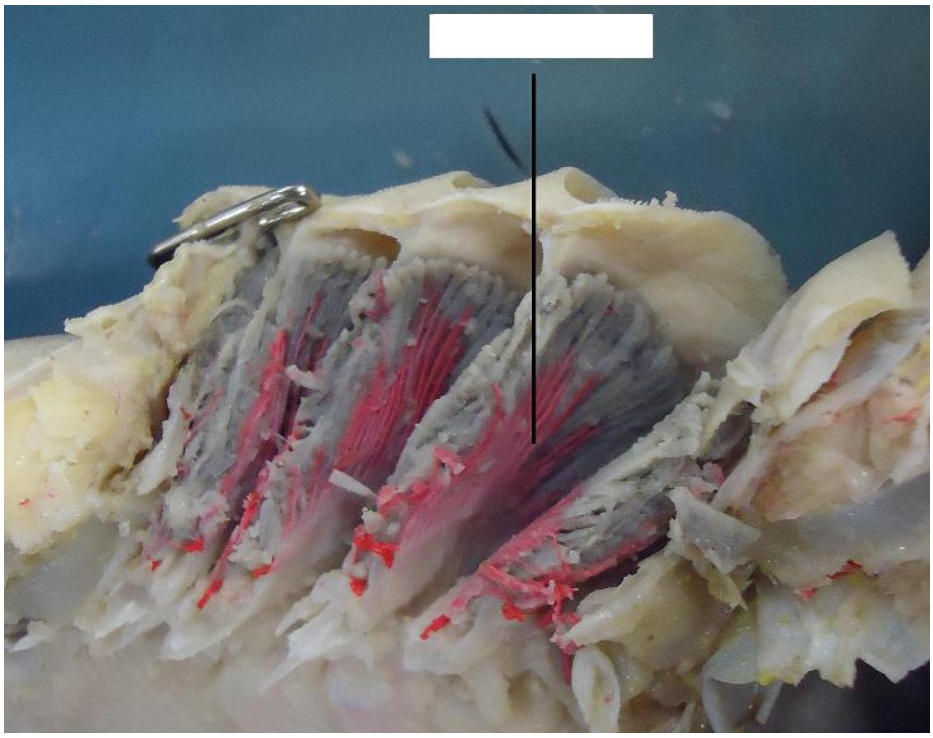
Date: _____

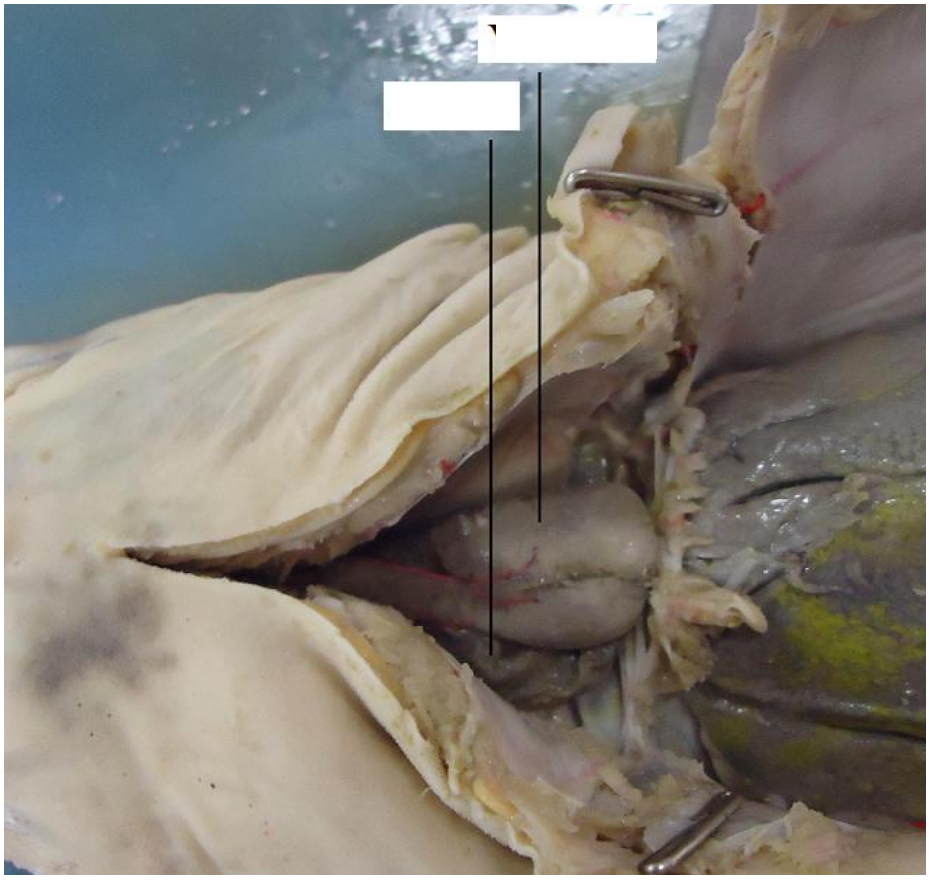
Instructions

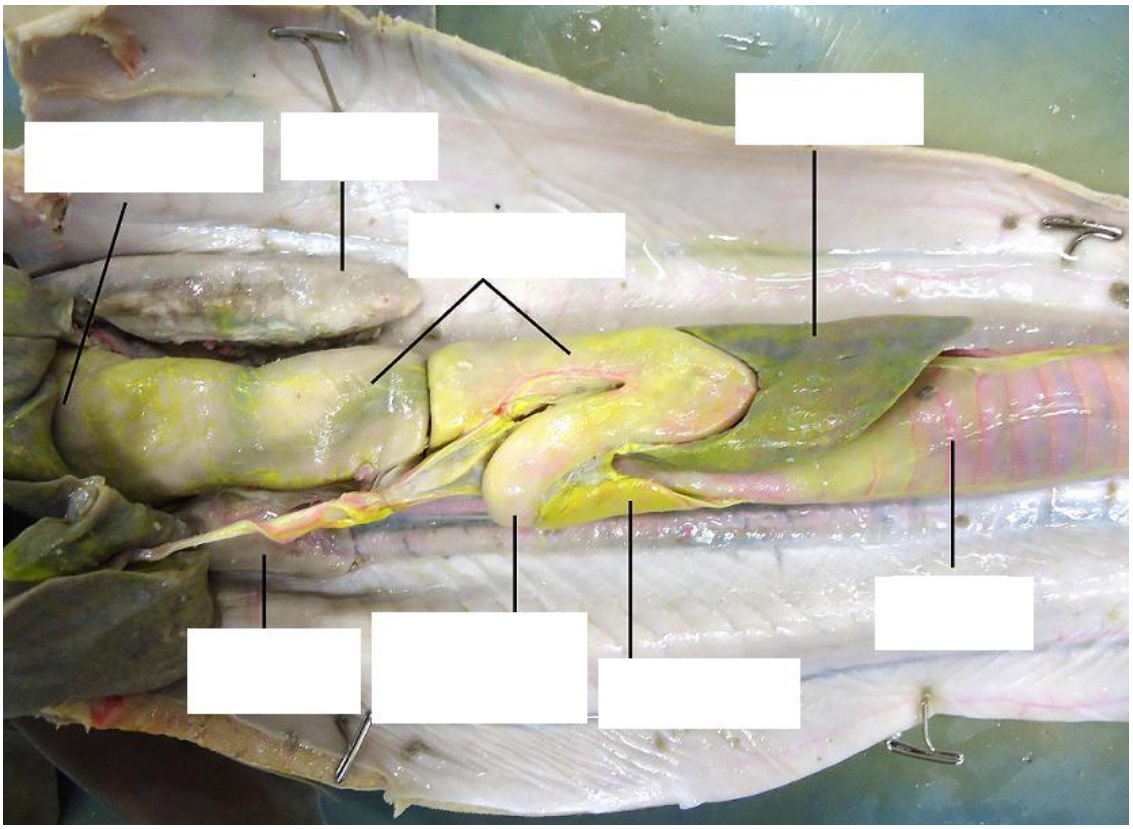
Label the following internal anatomy of the spiny dogfish shark.

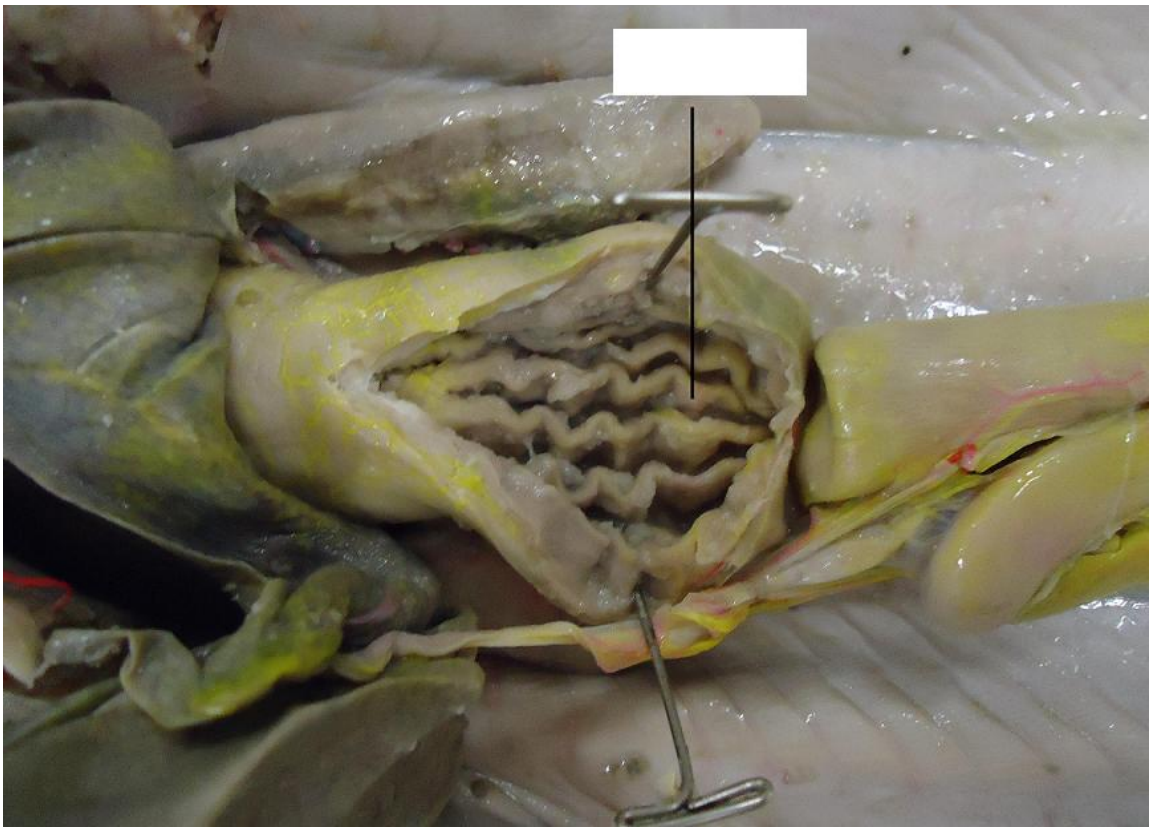


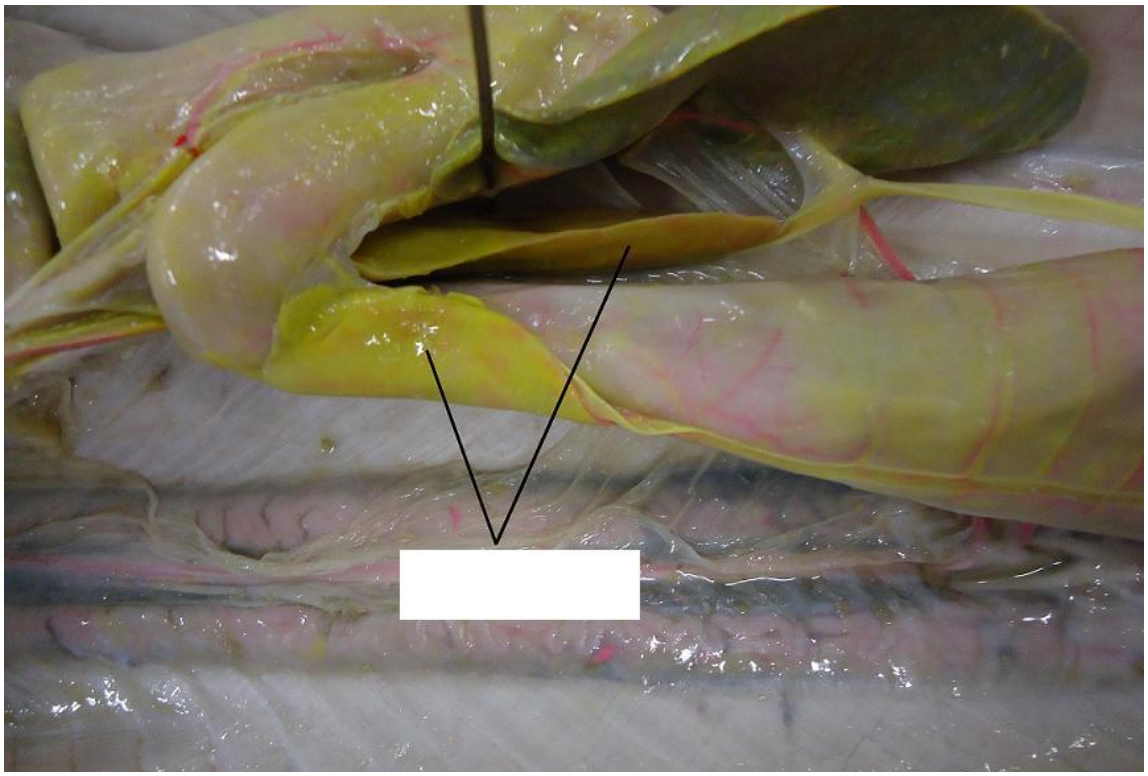


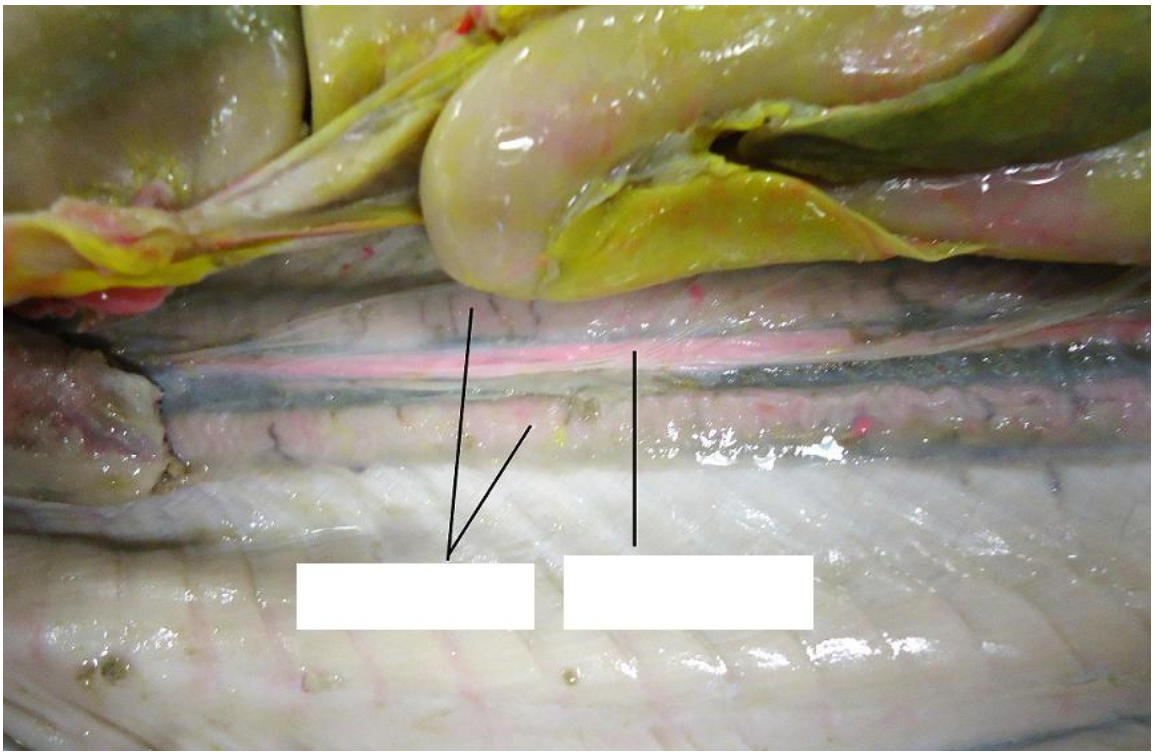


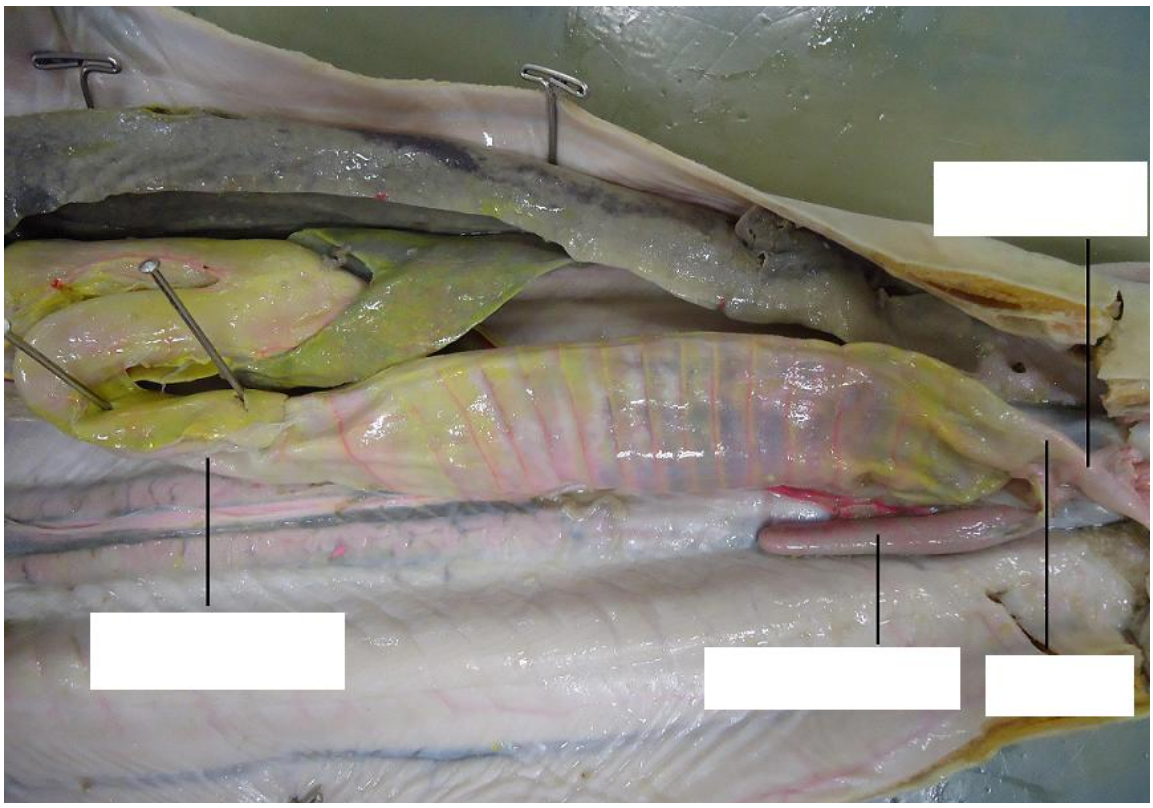


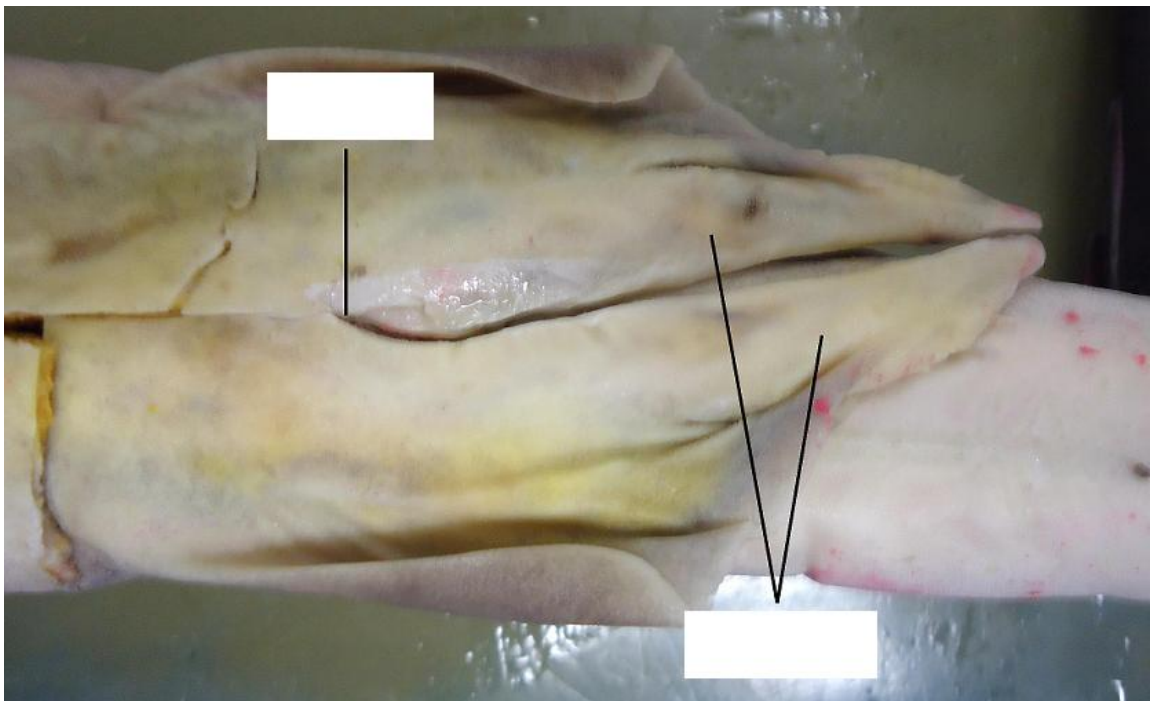












Describe the function and name the system for each structure.

Structure	Function	System
Gall bladder		
Liver		
Esophagus		
Stomach		
Pyloric sphincter		
Rugae		
Duodenum		
Ileum		
Spiral valve		
Colon		
Pancreas		
Spleen		
Kidney		
Rectum		

Cloaca		
Testes		
Claspers		
Ovary		
Rectal gland		
Spiracle		
Internal gill slits		
Gill rakers		
Gill filaments		
Gill chamber		
Gill arch		
Dorsal aorta		
Ventricle		
Atrium		