Topic/Lesson:	**Anatomy Fish Dissection: Are sturgeon more like sharks or bony fish?**
Subject:	Sturgeon Anatomy
Author:	Rob Yeomans
Time Duration:	Two 90 minute blocks or three 45 minute classes
Overview:	After learning the internal and external anatomy of class chondrichthyes, students will compare this knowledge to fish by dissecting a whole, legally and locally caught species (Pollock, trout, etc.) of class osteichthyes. Then, they will be presented with pictures of sturgeon and asked to identify their morphology. Finally, students will have to make a decision as to which class sturgeon belong based on their findings. A class discussion should end the classroom session as to their reasoning for placing the sturgeon in the class they chose.
Objectives:	Students will be able to: • Differentiate the morphology between chondrichthyes and osteichthyes. • Compare the anatomy of both classes. • Utilize their observations to place sturgeon into one of the two classes. • Defend their reasoning for placing sturgeon into a class. • Understand why sturgeon are actually placed into class Osteichthyes.
Background Knowledge:	• Shark morphology • Shark anatomy
Materials:	• Copy of the lab, "Are Sturgeon More Like Sharks or Bony Fish." • Dissection equipment (WARNING: Scalpels are sharp.) • Whole, fresh, legally and locally caught fish. Ask a local fish monger for help in obtaining these. If none are available, preserved species will do. Carolina Biological Supply sells preserved perch. http://www.carolina.com/product/preserved+organisms/preserved+animals+%28non-mammals%29/preserved+perch/preserved+carosafe%26reg-

	+perch.do?sortby=ourPicks
Procedures:	1) Pass out assignment the day before the dissection. Students are to complete the pre-lab assignment and read the procedures. 2) The day of the dissection, ask the students to discuss their responses to the pre-lab assignment. Direct them toward the following: cartilaginous skeleton, nictitating membrane, gill slits, placoid scales and immovable fins. 3) Have the students perform the dissection as the procedures instruct, and write their answers to the lab questions throughout the procedures for external and internal anatomy. 4) Have the students complete the post lab questions for homework.
Conclusions:	5) The day after the dissection, review and discuss post lab questions 1-5. 6) Have the students break into two groups: one in which they believe sturgeon are more like sharks, while the other group thinks sturgeon are more similar to bony fish. As a group, they are to create a poster defending their position by listing and illustrating structures and traits of sturgeon that are shark- or bony fish-like. 7) When completed, members of each group should present to the class their poster. A discussion should follow between the two groups as to who is correct, with the teacher mediating. At the end of the discussion, the teacher should explain why sturgeon are benthic feeding fish.
Massachusetts Frameworks:	**High School Biology** 4.1 Explain generally how the digestive system (mouth, pharynx, esophagus, stomach, small and large intestines, rectum) converts macromolecules from food into smaller molecules that can be used by cells for energy and for repair and growth. 4.2 Explain how the circulatory system (heart, arteries, veins, capillaries, red blood cells) transports nutrients and oxygen to cells and removes cell wastes. Describe how the kidneys and the liver are closely associated with the circulatory system as they perform the excretory function of removing waste from the blood. Recognize that kidneys remove nitrogenous wastes, and the liver removes many toxic compounds from blood.

Marine Biology Name _____

Lab: Are sturgeon More Like Sharks or Bony Fish?

Introduction

Ichthyology is the study of fish in the oceans, but, "fish" is a broad term. Fish are defined as any free swimming vertebrate that is **ecotothermic**, has two sets of paired fins and several unpaired fins. Fish can actually be divided into two smaller groups, either **Chondrichthyes** (sharks, rays and skates) or **Osteichthyes** (bony fish). This class has already examined sharks. This lab will illustrate the characteristics of bony fish that separate them from sharks. Finally, you will be presented with pictures of sturgeon, a once abundant species that inhabits the rivers and coastal marine waters from Canada to Florida. You must decide if sturgeon belong in class Chondrichthyes or class Osteichthyes.

Pre-Lab Assignment Below, write five different characteristics that are unique of sharks.

1. _____
2. _____
3. _____
4. _____
5. _____

Procedure: External Anatomy

1. At your lab stations, you will have a dissection kit. Please be careful with the scalpel as they are very sharp.

2. Bring the pan to the front bench and get a fish.

3. Back at your station, and using the descriptions below, identify the external structures of your fish writing the answers to any questions that are posed.

Eyes - Fish eyes serve a variety of purposes - to seek out food, to avoid predators and other dangers, and, perhaps even to navigate in the ocean. Fish do not have eyelids. They are constantly bathed in water and do not need tears.

4. Using your finger, gently move the eye in its socket. Is there an eyelid present?_____

Nostrils – Some fish have a well developed sense of smell and use this ability to seek out their home streams for spawning. In some cases, this scent is also helpful in avoiding predators. Fish breathe through their gills, not their nostrils.

Lateral Line - Fish do not have ears, as such. In part, low frequency sounds are detected in the water through a system of small holes along each side of a fish called the lateral line, which is connected to a delicate system of nerves. They also react to medium frequencies suggesting they detect these as well (this reaction is not well understood at this time).

Mouth - Fish use their mouth to catch and hold food of various types, but their food is not chewed before swallowing, it is swallowed whole. The mouth is the beginning of the fish's alimentary canal (digestive tract). In addition, it is a very important part of the breathing process. Water is constantly taken in through the mouth and forced out over the gills where oxygen is extracted.

5. Feel inside the mouth for teeth. Open and close the mouth. Describe how the upper and lower jaw articulates during this movement.

_____
_____
_____
_____

6. Examine the upper and lower jaw. Does the lower jaw stick out further? This would mean the fish eats by attacking its prey from below. Or does the upper jaw stick out further? This would mean the fish eats by attacking its prey from above. Do both jaws meet at one common point? This fish eats by attacking from above or below. What direction do you think your fish attacks its prey from and why?

_____
_____
_____

Vent - The external opening of the alimentary canal. Urine, feces, eggs and milt exit here.

Gills - Fish gills are composed of two basic parts, the gill covers and the gill filaments. The gill cover, a bony structure called the **operculum**, protects delicate filaments and, together with the mouth, forces water containing oxygen over the gills. The gills are probably one of the most important organs in the body of a fish. They are delicate but very effective breathing mechanisms. Gills are far more efficient than human lungs, because they extract 80% of the oxygen dissolved in water, while human lungs only extract 25% of the oxygen in the air.

7. Grasp the operculum to feel the bony structure. What is the benefit of having an operculum?

_____
_____
_____
_____

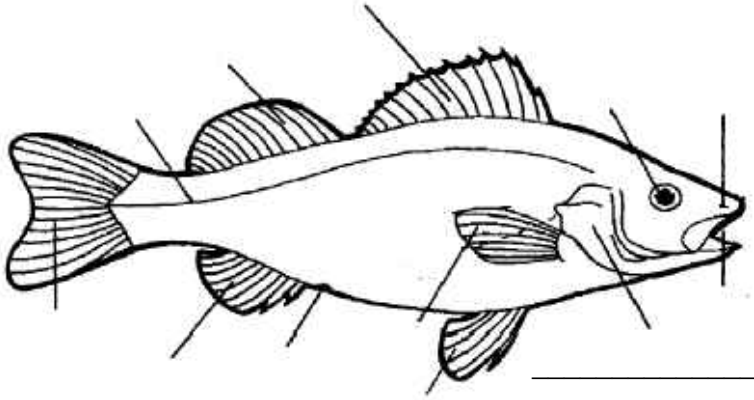
Gills are thin walled structures, filled with blood vessels. Their structure is arranged so that they are constantly bathed in water. The fish takes in the water through its mouth. The oxygen dissolved in the water is absorbed through the thin membranes into the fish's blood. Carbon dioxide is simultaneously released from the blood into the water across the same membranes.

8. Open the operculum and look inside at the gills. Describe them, using three different adjectives. _____
_____

Fins – Fish have two sets of paired fins (pelvic and pectoral) and four single fins (dorsal, caudal and anal). Fish can contract their muscles and move the pelvic and pectoral fins for movement in all directions. The caudal fin is used for forward momentum. The dorsal and anal fins aid in

stabilizing the fish in the water and preventing it from rolling. All fish fins are made of bony fin rays that are connected to each other with a thin membranous tissue.

9. On the fish diagram below, label it with the name of the structures as well as determining the anterior, posterior, dorsal and ventral sides of the fish.



Scales - The bodies of fish are protected by scales which grow in regular concentric patterns and can be used to determine the age and life history of the fish. Over the scales is a layer of mucous (slime) which further protects the fish from disease organisms and helps it slide through the water more easily.

10. Use the sharp edge of your scissors to take off one of the scales. Use a hand lens to look at the rings. By counting the larger rings, researchers can tell the approximate age of a fish. How old is your fish?

_____

_____

Procedure: Internal Anatomy

1. Place the fish on its side in the dissection pan, belly towards you, head pointing to your right. Insert a pair of sharp dissection scissors into the vent and make a shallow cut up to and between the pectoral fins all the way to where the opercula meet.

2. Locate the **heart**. It will be in the cavity anterior to the pectoral fins. Use the scissors to snip the aorta (large, white tube on top of the heart) and remove the heart.

3. The large, brownish organ in the body cavity posterior to the pectoral fins is the **liver**. It is used to synthesize and secrete the essential nutrients that were contained in the food. It plays a part in maintaining the proper levels of blood chemicals and sugars. The **gall bladder**, which is attached to the liver, contains green bile which in part is used to help digest fats.

4. Locate and remove the **alimentary canal**. It starts at the esophagus which is connected to the mouth and ends at the intestines at the vent. Once removed, locate the following:

Esophagus: muscular tube that moves food from the mouth to the stomach

Stomach: a saclike organ that receives the food from the esophagus; mechanical digestion occurs here

Intestines: tube running from the vent to the stomach; chemical digestion and nutrient absorption occurs here

5. The **air bladder** is the only remaining organ in the body cavity. It is a whitish organ and the fish use it to control their buoyancy. They can inflate or deflate it with gas. Remove the air bladder.

6. The dark red line along the backbone is the **kidney**. The forward part of the kidney of a fish functions to replace red blood cells, and the rearward part filters waste out of the blood. The kidney can be removed by slicing through the membrane along each side, and then scraping with a spoon.

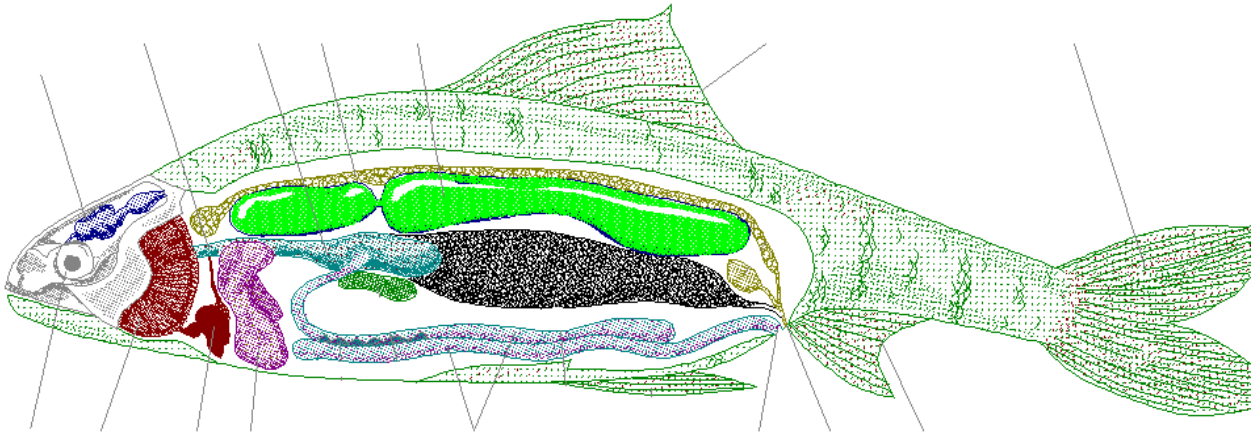
7. What is left is the body cavity, or **coelom**, that houses major organs. If your fish is female, you should find the **ovaries** near the vent—they are an orange mass of eggs. Fish lay thousands of eggs and only a small percentage ever makes it to adulthood. If your fish is male, you should find a bladder of **milt**, or fish sperm, near the vent. Reproduction is carried out when the female deposits her eggs into the water and the male quickly fertilizes them with his sperm—this is called **external fertilization**. Any resulting fertilized eggs will develop in the water column without aid from the parents.

8. Is your fish male or female? _____

9. Clean up by disposing of the fish, cleaning the dissection materials and wiping down your lab area.

Post Lab Questions

1. Identify the structures in the diagram below.



http://cas.bellarmine.edu/tietjen/AnimalDiversity/fish!.gif

2. What external features (3) separate bony fish from sharks?

_____

3. What internal features (2) separate bony fish from sharks?

_____

4. How is swimming accomplished in bony fish as compared to sharks?

_____

_____

5. What sensory organs do sharks and bony fish both have? What sensory structures are unique to sharks?

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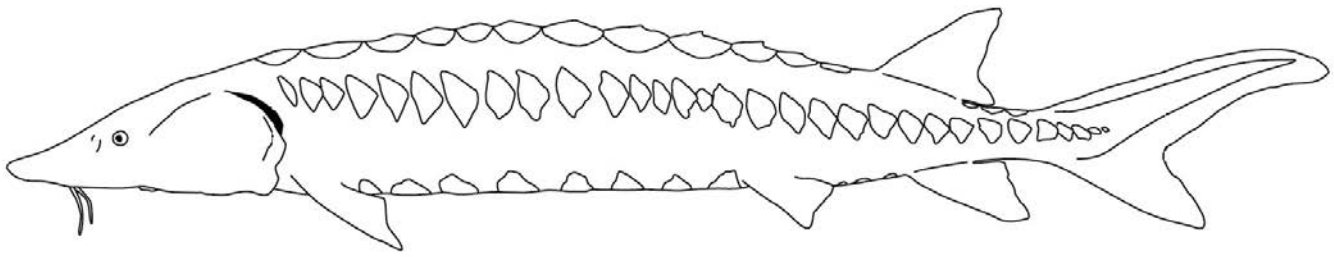
The following is a diagram of a sturgeon. These organisms have a cartilaginous skeleton, heterocercal caudal fin, and ganoid scales. Use it to answer the following questions.



Credit: Damon-Randall et al. in press, Atlantic Sturgeon Research Protocols

6. Label the diagram with as many external structures as possible.

7. Does this organism live on the bottom or does it swim in the water column? How can you tell? _____

_____

_____

_____

8. What structures COULD make this organism a shark? A bony fish?

_____

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_____

_____

9. Are sturgeon sharks or bony fish? Use structures that you know from sharks and this lab to support your decision. Explain why you made that choice.

_____

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_____

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_____

Dissection procedures modified from
http://www.sf.adfg.state.ak.us/region2/ie/sicc/dissectn.cfm#parts%20of%20a%20fish

Lab: Are sturgeon More Like Sharks or Bony Fish?

Teacher Answer Key

Pre-Lab Assignment Below, write five different characteristics that are unique of sharks.

Cartilaginous skeleton
Heterocercal caudal fin
Gill slits
Large liver for buoyancy
Ampullae of lorenzini
Nictitating membrane over eyes
Conveyor belt of new teeth

Procedure: External Anatomy

1. At your lab stations, you will have a dissection kit. Please be careful with the scalpel as they are very sharp.

2. Bring the pan to the front bench and get a fish.

3. Back at your station, and using the descriptions below, identify the external structures of your fish writing the answers to any questions that are posed.

Eyes - Fish eyes serve a variety of purposes - to seek out food, to avoid predators and other dangers, and, perhaps even to navigate in the ocean. Fish do not have eyelids. They are constantly bathed in water and do not need tears.

4. Using your finger, gently move the eye in its socket. Is there an eyelid present?

Depends on the specimen. If bony fish, then eye lids not present nor is there a nictitating membrane.

Nostrils – Some fish have a well developed sense of smell and use this ability to seek out their home streams for spawning. In some cases, this scent is also helpful in avoiding predators. Fish breathe through their gills, not their nostrils.

Lateral Line - Fish do not have ears, as such. In part, low frequency sounds are detected in the water through a system of small holes along each side of a fish called the lateral line, which is connected to a delicate system of nerves. They also react to medium frequencies suggesting they detect these as well (this reaction is not well understood at this time).

Mouth - Fish use their mouth to catch and hold food of various types, but their food is not chewed before swallowing, it is swallowed whole. The mouth is the beginning of the fish's alimentary canal (digestive tract). In addition, it is a very important part of the breathing process. Water is constantly taken in through the mouth and forced out over the gills where oxygen is extracted.

5. Feel inside the mouth for teeth. Open and close the mouth. Describe how the upper and lower jaw articulates during this movement.

Lower jaw moves while the upper jaw is immobile.

6. Examine the upper and lower jaw. Does the lower jaw stick out further? This would mean the fish eats by attacking its prey from below. Or does the upper jaw stick out further? This would mean the fish eats by attacking its prey from above. Do both jaws meet at one common point? This fish eats by attacking from above or below. What direction do you think your fish attacks its prey from and why?

Answers will vary depending upon the fish species used.

Vent - The external opening of the alimentary canal. Urine, feces, eggs and milt exit here.

Gills - Fish gills are composed of two basic parts, the gill covers and the gill filaments. The gill cover, a bony structure called the **operculum**, protects delicate filaments and, together with the mouth, forces water containing oxygen over the gills. The gills are probably one of the most important organs in the body of a fish. They are delicate but very effective breathing mechanisms. Gills are far more efficient than human lungs, because they extract 80% of the oxygen dissolved in water, while human lungs only extract 25% of the oxygen in the air.

7. Grasp the operculum to feel the bony structure. What is the benefit of having an operculum?

Protects the gills from damage due to predators, the habitat the fish is in or food items.

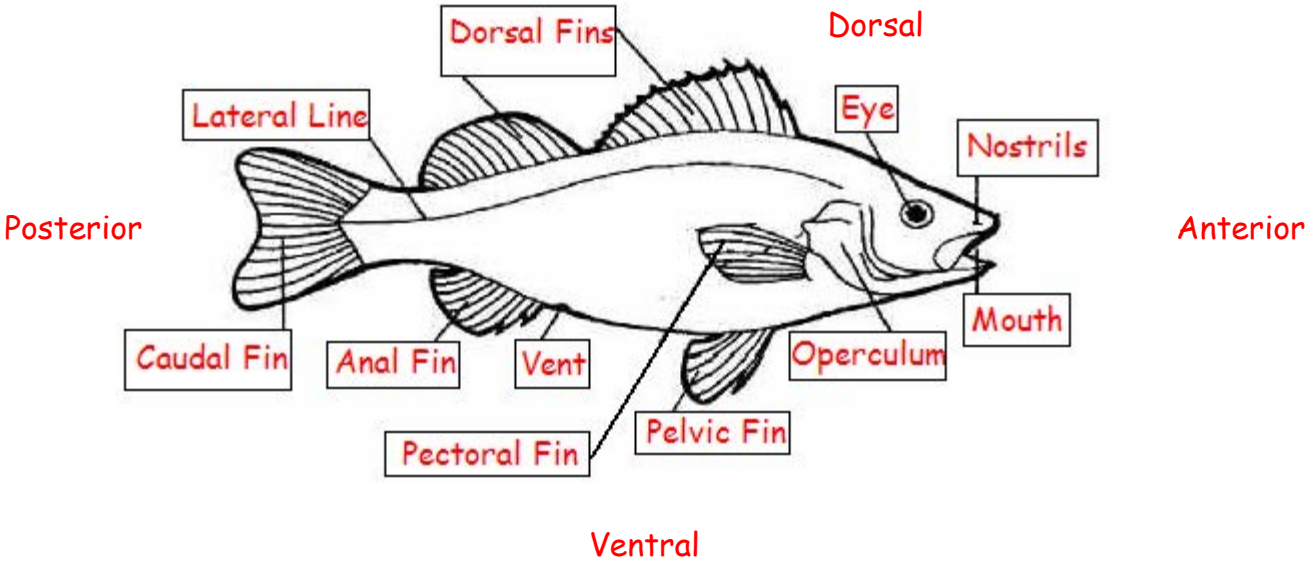
Gills are thin walled structures, filled with blood vessels. Their structure is arranged so that they are constantly bathed in water. The fish takes in the water through its mouth. The oxygen dissolved in the water is absorbed through the thin membranes into the fish's blood. Carbon dioxide is simultaneously released from the blood into the water across the same membranes.

8. Open the operculum and look inside at the gills. Describe them, using three different adjectives.

Blood red, Frilly, Feathery, Slippery, Organized in neat rows, Layered

Fins – Fish have two sets of paired fins (pelvic and pectoral) and four single fins (dorsal, caudal and anal). Fish can contract their muscles and move the pelvic and pectoral fins for movement in all directions. The caudal fin is used for forward momentum. The dorsal and anal fins aid in stabilizing the fish in the water and preventing it from rolling. All fish fins are made of bony fin rays that are connected to each other with a thin membranous tissue.

9. On the fish diagram below, label it with the name of the structures as well as determining the anterior, posterior, dorsal and ventral sides of the fish.



Scales - The bodies of fish are protected by scales which grow in regular concentric patterns and can be used to determine the age and life history of the fish. Over the scales is a layer of mucous (slime) which further protects the fish from disease organisms and helps it slide through the water more easily.

10. Use the sharp edge of your scissors to take off one of the scales. Use a hand lens to look at the rings. By counting the larger rings, researchers can tell the approximate age of a fish. How old is your fish?

Age will vary. Make sure the students only count the darker rings, as they are made during the winter when there is slow growth.

Procedure: Internal Anatomy

1. Place the fish on its side in the dissection pan, belly towards you, head pointing to your right. Insert a pair of sharp dissection scissors into the vent and make a shallow cut up to and between the pectoral fins all the way to where the opercula meet.

2. Locate the **heart**. It will be in the cavity anterior to the pectoral fins. Use the scissors to snip the aorta (large, white tube on top of the heart) and remove the heart.

3. The large, brownish organ in the body cavity posterior to the pectoral fins is the **liver**. It is used to synthesize and secrete the essential nutrients that were contained in the food. It plays a part in maintaining the proper levels of blood chemicals and sugars. The **gall bladder**, which is attached to the liver, contains green bile which in part is used to help digest fats.

4. Locate and remove the **alimentary canal**. It starts at the esophagus which is connected to the mouth and ends at the intestines at the vent. Once removed, locate the following:

Esophagus: muscular tube that moves food from the mouth to the stomach

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Intestines: tube running from the vent to the stomach; chemical digestion and nutrient absorption occurs here

5. The **air bladder** is the only remaining organ in the body cavity. It is a whitish organ and the fish use it to control their buoyancy. They can inflate or deflate it with gas. Remove the air bladder.

6. The dark red line along the backbone is the **kidney**. The forward part of the kidney of a fish functions to replace red blood cells, and the rearward part filters waste out of the blood. The kidney can be removed by slicing through the membrane along each side, and then scraping with a spoon.

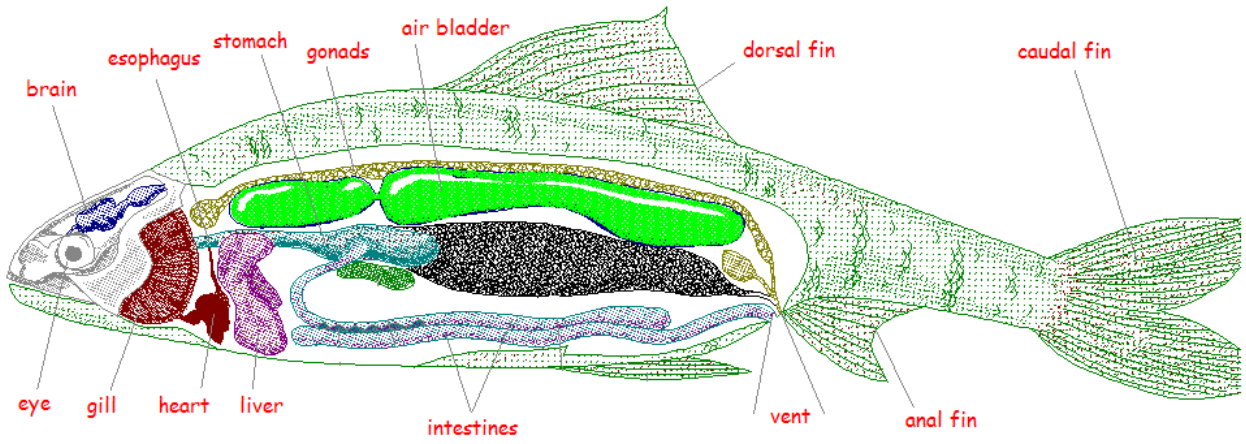
7. What is left is the body cavity, or **coelom**, that houses major organs. If your fish is female, you should find the **ovaries** near the vent—they are an orange mass of eggs. Fish lay thousands of eggs and only a small percentage ever makes it to adulthood. If your fish is male, you should find a bladder of **milt**, or fish sperm, near the vent. Reproduction is carried out when the female deposits her eggs into the water and the male quickly fertilizes them with his sperm—this is called **external fertilization**. Any resulting fertilized eggs will develop in the water column without aid from the parents.

8. Is your fish male or female? *Answers will vary and may be hard to tell if fish is a juvenile.*

9. Clean up by disposing of the fish, cleaning the dissection materials and wiping down your lab area.

Post Lab Questions

1. Identify the structures in the diagram below.



http://cas.bellarmine.edu/tietjen/AnimalDiversity/fish!.gif

2. What external features (3) separate bony fish from sharks?

Potential answers:

Operculum

Fin rays

Nictitating membrane

Fish can move their fins, sharks cannot

3. What internal features (2) separate bony fish from sharks?

Potential answers:

Air bladder

Small liver

4. How is swimming accomplished in bony fish as compared to sharks?

Fish can maneuver using their fins to stabilize themselves in the water. To go up or down in the water column, fish use their air bladder while sharks must point their nose in the direction they wish to travel.

5. What sensory organs do sharks and bony fish both have? What sensory structures are unique to sharks?

They both have nostrils, lateral line, eyes. Sharks are the only ones with the ampullae of lorenzini.

The following is a diagram of a sturgeon. These organisms have a cartilaginous skeleton, heterocercal caudal fin, and ganoid scales. Use it to answer the following questions.

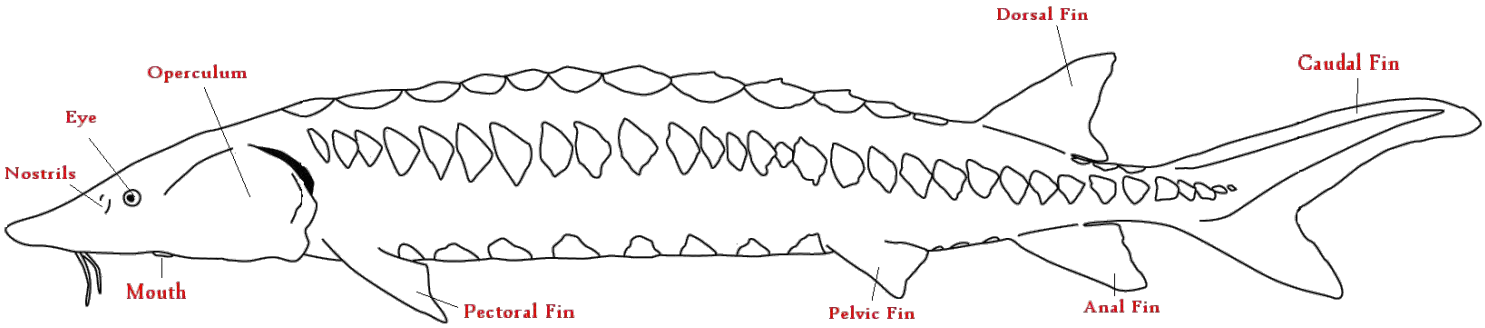


Illustration from Damon-Randall *et al*., 2010

6. Label the diagram with as many external structures as possible.

7. Does this organism live on the bottom or does it swim in the water column? How can you tell?

Sturgeon live on the bottom due to the placement of the mouth on the underside of the body.

8. What structures COULD make this organism a shark? A bony fish?

Sharks: cartilaginous skeleton and heterocercal tail

Fish: Air bladder, operculum, no ampullae of lorenzini

9. Are sturgeon sharks or bony fish? Use structures that you know from sharks and this lab to support your decision. Explain why you made that choice.

Answers will vary, but sturgeon are actually a bony fish. They have a cartilaginous skeleton, but they are part of a class of ray finned fishes under bony fish. Sturgeon are a bony fish due to the structures they have that sharks do not possess including the swim bladder and operculum.

Dissection procedures modified from
http://www.sf.adfg.state.ak.us/region2/ie/sicc/dissectn.cfm#parts%20of%20a%20fish

Literature Cited

Damon-Randall K, Bohl R, Bolden S, Fox D, Hager C, Hickson B, Hilton E, Mohler J, Robbins E, Savoy T, Spells A. 2010. Atlantic Sturgeon Research Techniques. NOAA Technical Memorandum NMFS NE 215; 19 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://www.nefsc.noaa.gov/nefsc/publications/