Fish Dissection

Grade Level(s): 6th – 8th
Time: 40-80 minutes
Group Size: 20-30 students

NYS Learning Standards
Core Curriculum MST

Living Environment: Standard 4
Students will: understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

- *Key Idea 1*: Living things are both similar to and different from each other and nonliving things.
- *Key Idea 4*: The continuity of life is sustained through reproduction and development.
- *Key Idea 5*: Organisms maintain a dynamic equilibrium that sustains life.

Summary

Living things are similar to and different from each other. When we look at the inside of a fish, we will learn that certain organs and systems in fish are similar to those in humans; and other organs and systems are not. Stomach contents can tell us much about a fish's habit. The external anatomical features (outside body parts) of fish can also tell us a lot about a species--where it lives in the water, how it finds food, and how it protects itself from predators.

Objectives

The objectives are to create a dynamic hands-on experience to assist in understanding the internal organs and system functions of a local fish species; for students to understand the external body parts of fish; and to discuss both internal and external features in relation to the human anatomy. After this presentation, students will be able to:

- Identify 3-5 external anatomical features of a fish.
- Identify the major internal organs of a fish.
- Compare and contrast human and fish internal organs, structures, and systems.

Materials

- 2 Fish for dissection
- 2 scissors, scalpels, filet knives, or dissecting kits
- 2 dissecting trays or cutting boards
- Organ definition cards
- Hand sanitizer
- Laptop computer & projector
- Fish mounts, models or pictures
- Newspaper or protective table cover, 2 or more rags
- Box of plastic gloves (non-latex)
- Dissection Power Point presentation
- Dissection Worksheet
- Internal Anatomy Crossword Puzzle

Illustration by Duane Raver

Vocabulary

- **Anal Fin -** fin located near the anal opening; used for balance and steering.
- **Caudal or Tail Fin** - fin at the tail of a fish; used for propulsion.
- **Circulatory System** - delivers blood and oxygen throughout the body via the heart.
- **Digestive System** – breaks down and processes proteins, carbohydrates and fats.
- **Dorsal Fin** – backside (top) fin on a fish; used for balance and protection.
- **External Anatomy** - the outside body parts, such as, fins, scales, mouth.
- **Gills** – organ used to obtain oxygen from the water and rid carbon dioxide.
- **Gill Rakers** – filter feed tiny prey; appendages along the front edge of the gill arch.
- **Gonads** – the sex organs; males have testes, females have ovaries. Some fish are hermaphroditic, meaning having both sets of gonads (male & female) in one fish.
- **Lateral Line** – organ of microscopic pores that sense low vibrations and water pressure.
- **Nares** - organ to smell; similar to nostrils.
- **Nervous System** - organs receiving and interpreting stimuli for nares, eyes, lateral line, muscles, and other tissues.
- **Pectoral Fin** - fins on the sides; used for balance and assist turning.
- **Pelvic Fin** - belly fins on a fish; used for balance and steering.
- **Pyloric Caece** – "finger-like" organ that aids in digestion, using bile from the liver.
- **Reproductive System** – the organs and tissues involved in reproduction, including gonads, eggs, sperm.
- **Respiratory System** – organs and tissues involved in the oxygen & carbon dioxide gas exchange, including gills, gill rakers, and gill filaments.
- **Scales** - protective cover on a fish; similar to skin.
- **Slime** – slippery covering on scales, protecting fish from bacteria, parasites, etc.
- **Swim bladder** – found only in "ray-finned" fish; a double sac used to assist in buoyancy.
- **Urinary System** – the kidneys remove nitrogen (ammonia) from the blood and regulate water balance in the blood and tissues.
- **Vertebrate** – an organism with a backbone or spine.

Vocabulary words will show up once in **bold**

Background

Fish and other vertebrates have much in common with humans. Many of the systems and organs are the same. Yet there are many unique differences in the organs and their functions in fish, and even between fish species. This lesson will be one for inquisitive exploration, and hands-on learning.

Internal Anatomy

Heart

This organ pumps blood throughout the body delivering oxygen and digested nutrients to the cells of various organs. It transports waste products from the cells to the kidneys and liver for elimination. In fish, the circulatory system is a single circuit, with a 2-chambered heart, unlike the typical 4-chambered heart found in land animals like mammals and birds. From the fish's atrium blood is pumped into the ventricle of the heart. From the ventricle, blood is pumped to the gills where gas exchange takes place in the gill filaments. Carbon dioxide (CO_2) is expelled and oxygen (O_2) is taken in. This re-oxygenated blood then flows on to the rest of the body's tissues and organs removing carbon dioxide and replacing it with life-giving oxygen. Blood is finally pumped back to the heart's atrium chamber where the process begins again.

Liver

The liver has many digestive and storage functions. One is the production of bile, a solution which emulsifies or breaks down fats in the intestine. The liver also stores fats and carbohydrates, destroys old blood cells, maintains proper blood chemistry, and plays a role in nitrogen waste removal.

Pyloric Caeca

This organ with finger-like projections is located near the junction of the stomach and the intestines. It is thought that through the secretion of enzymes it assists in breaking down the food further and absorbs needed nutrients, yet the function of this organ is still not well understood.

Gonads

Gonads are the sex organs. Males have paired testes that produce sperm, and females have paired ovaries that produce eggs. In most cases, fertilization of the eggs is performed externally, called spawning.

Swim Bladder

Most fish have an organ called the swim bladder. It is a flexible, gas-filled sac located in the dorsal or top portion of the body cavity and helps to control the fish's buoyancy. Since fish have a density that is heavier than water, they need this swim bladder to not sink when they stop swimming. There are two types of swim bladders, the physostomous and physoclistous.

Fish with a physostomous swim bladder are usually found in shallow water, though some are in deeper water. They will expel bubbles as they swim closer to the surface of the water and then they will swallow air at the surface before diving back down into the water. This air is passed into the guts and then they will force it into the swim bladder.

On the other hand, the physoclistous swim bladder is completely closed off from the swim bladder. These fish are able to control gas exchange or the amount of gas in their swim bladder through the capillaries that are found where the membrane of the swim bladder is very thin. When a fish is too buoyant, and starts to float upward, gas diffuses out of the swim bladder into the blood. The gas in the blood is removed at the gill filaments and expelled. Conversely, if a fish starts to sink, air enters the swim bladder via a gas gland. . Sometimes if a fish is caught and quickly brought to the surface from deep water, their swim bladder may expand so fast that it inflates into their mouth or even burst which usually will kill the fish, unfortunately

Swim bladders are only found in ray-finned fish. In carp and catfish, the swim bladder is located close to their inner ear and thus giving better auditory ability. Fish with small or no swim bladders, such as darters and flat fish like flounder, sink to the bottom if they stop swimming and have a lowered hearing ability.

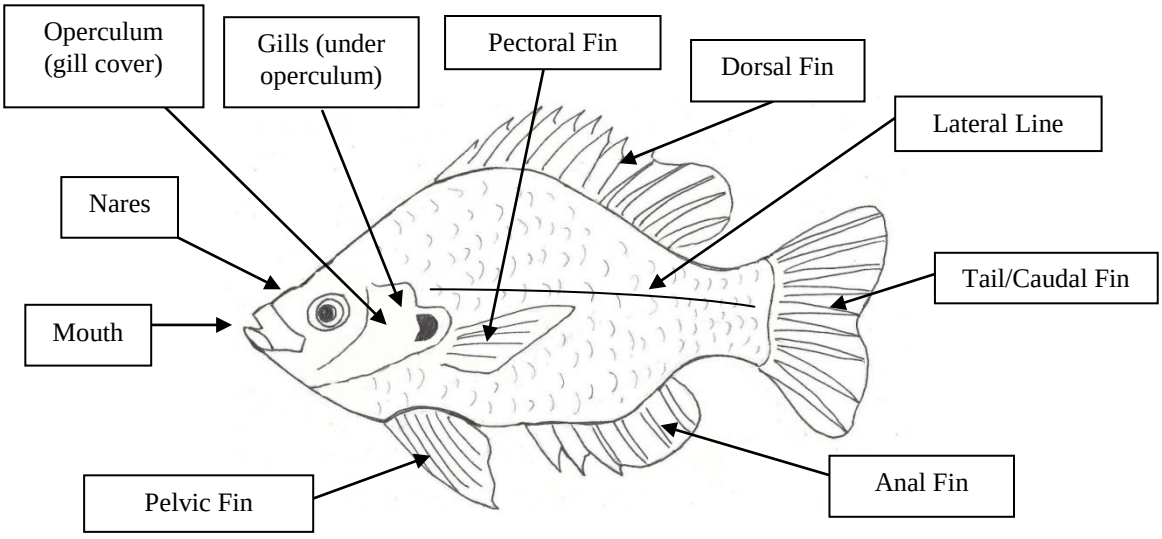
Stomach

The stomach is often referred to as the gut, and is where food is digested and nutrients absorbed. Fish such as bass are carnivores. Carnivores have fairly short intestines because such food is easy to chemically break down and digest. Fish such as tilapia that are herbivores (eat plants) and require longer intestines because plant matter is usually tough and fibrous and more difficult to break down into usable elements. By examining stomach contents, one can learn a great deal about fish feeding habits. Knowing what a specific fish species eats can also help with bait selection when fishing!

Kidneys

Kidneys are organs that filter liquid waste from the blood. The kidney is also extremely important in regulating water and salt concentrations within the fish's body. This allows certain fish species to exist in freshwater or saltwater, and in some cases both as in salmon.

External Anatomy



Fins

All fish have external appendages called fins. Fins allow fish to balance and steer while swimming. Fins are either single along the centerline of the fish like the dorsal fin, anal fin, and tail fin; or paired fins like the pectoral fins and pelvic fins.

The **dorsal fin** helps in steering but its main function is protection, with some species having a very sharp, spiny dorsal fin. **Pectoral fins** help fish balance and turn. The **pelvic fin** and **anal fin** are located on the belly and help with steering as well as balance. The **tail fin**, also called the caudal fin helps propel a fish forward.

Gills

Located on either side of a fish's head, gills remove oxygen from the water and diffuse carbon dioxide from the body. The gills are covered by a flexible bony plate called the operculum. Some fish have spines located on the operculum as a defense mechanism to protect them from predators.

Lateral Line

Running down the length of a fish's body is the lateral line. It is made up of a series of microscopic holes located just under the scales of the fish. One of the fish's primary sense organs, the lateral line can sense low vibrations in the water, and is capable of determining the direction of their source.

Nares

All fish possess a sense of smell. Paired holes called nares, are used for detecting odors in the water, and are located on a fish's snout. Some fish, such as some shark varieties, catfish, and eels, have a very sharp sense of smell.

Scales and Slime

Most fish have scales covering the length of their body. Scales protect fish from injury, much like skin on the human body. On top of these scales is a mucous covering known as the slime layer. Slime protects fish from bacteria and parasites in the water. Anglers should be careful not to remove the slime layer when handling a fish.

Body Shape

A fish's body shape, as well as the shape and size of certain external features, can tell us a lot about that fish. For example, the body shape of a fish can indicate where that fish lives in the water and what type of swimmer it might be. In addition, tail fin shape also signifies a fish's swimming speed. A sharply forked tail, like that of a shark, implies a fast swimmer, where as a rounded tail means the fish is good at turning.

Mouth

The mouth parts of a fish will vary in size and may or may not contain teeth. The location of the mouth on a fish's body can also give us a clue as to what may be the fish's diet. A superior mouth, a mouth pointing upward, means the fish will eat food located above it; where as a fish with an inferior mouth, a mouth pointing downward, will eat food located below it.

Compare & Contrast

Even though humans and fish do not look the same, we share similar organs and body parts.

Human		**Fish**	**Human**		**Fish**
Lungs	=	Gills	Kidneys	=	Kidneys
Intestines	=	Pyloric Caeca	Ears	=	Lateral Line
Stomach	=	Stomach	Skin	=	Scales & Slime Layer
Liver	=	Liver	Nose	=	Nares
Ovaries/Testes	=	Ovaries/Testes	Arms	=	Pectoral Fins
			Legs	=	Pelvic Fins

Main Activity

Pre-Lesson Set Up

Establish two dissection stations – tables with covering (i.e. newspaper or plastic). At each table, have necessary dissection equipment as listed in Materials above.

Introduction

The instructor will begin the program by introducing themselves and describing to the students what they will be learning, and there will be a dissection. The instructor will explain that the students will be learning about a few fish systems (respiratory, digestive, circulatory, nervous, urinary, and reproductive) and functions of certain organs. The class should be informed to look for both similarities and differences between fish and human anatomies.

A Power Point presentation will review basic external fish anatomy, and introduce the internal anatomy of humans and fish.

External Anatomy Overview

Use the PowerPoint presentation to review external fish anatomy.

1. Basics: eye, mouth, scales
2. Fins: dorsal, caudal, pelvic, pectoral
3. Senses: nares and lateral line

Have students explain how/why external features relate to fishing.

Examples:

Protection: sharp fins, teeth, slime layer. Also speed, camouflage
Where to target fish in water column
What fishing techniques to use; e.g., rig, etc.

Dissection & Internal Anatomy

Use the PowerPoint presentation to introduce human and fish internal anatomy.

Advise students to also view PowerPoint during dissection period. (Tip: This is especially helpful for those students resisting participation.)

1. Split the class into two equal groups.
2. During the dissection, have interested students put on gloves and identify organs.
3. Have students read organ definition cards out loud.
4. Tell students they will be playing a game based on this lesson plan at which time they'll be responsible for both the form and function of the internal structures.

Game

Tell students that each dissection group will compete with each other in a game. Give directions to the game and answer any questions.

1. Select a member from each team to serve as the team representative.
2. Project a question from the PowerPoint and have teams discuss possible answers. Then have the team representatives each state a response aloud; the first team to correctly answer the question receives a determined number of points. The team with the most points at the end of the game wins.
3. At the end, determine the winner. (Tip: Consider offering the winning team a small treat or prize.)

Fish Identification

1. If time permits, use fish models or pictures to help students identify fish that may be found during the upcoming fishing trip.
2. Re-iterate anatomical features and relationship to fishing.

Worksheet Activity (see attachment)

Have students fill complete the worksheet. Discussion may be included.

Crossword Puzzle Activity (see attachment)

After I FISH NY presentation, distribute Internal Anatomy Crossword Puzzle for students to complete. Review answers together.

Wrap Up

Review

Have students name and/or describe:

1. Identify 3-5 external anatomical features of a fish.
2. Identify a few major internal organs of a fish.
3. Compare and contrast human and fish internal organs, structures, and systems.

Questions for Discussion

Q: What is the purpose of a swim bladder, and how does it work?
A: Only found in “ray-finned” fish, the swim bladder is a gas-filled sac, assisting with maintaining neutral buoyancy. In some fish, also assists in better hearing due to proximity to otoliths.

Q: What is the purpose of the Lateral Line?
A: To sense vibrations in the water, as well as, changes in water pressure.

Q: How does the Heart differ between humans and fish?
A: Humans have a 4-chambered heart increasing efficiency of oxygen delivery, while fish have just 2 chambers.

Human circulatory system is a double circuit (heart⇨lungs⇨heart⇨ body⇨heart). Fish circulatory system is a single circuit (heart⇨gills⇨body⇨heart).

Q: Name two organs fish have that humans do not.
A: Gills, Lateral Line

Web Resources

"Animals and Sound in the Sea." Office of Marine Programs. Discovery of Sound in the Sea (DOSITS) 10 October 2008
http://omp.gso.uri.edu/dosits/animals/produce/2f.htm - introduction to the science and uses of sound in ocean research and education. Hear underwater sounds created by marine animals, human activities, and natural phenomena. Video interviews with scientists. For teachers, section with resources and classroom activities.

"Fisheries Biology and Management" Maryland Department of Natural Resources (MDNR) 10 October 2008
http://www.dnr.state.md.us/education/envirothon/FISH%20ANATOMY.pdf - descriptions of fish anatomy, organ functions, how fish swim, and otoliths.

Florida Fisheries
http://www.iowas.co.uk/fish%20anatomy.html - descriptions of internal and external fish anatomy, organ functions, and details on fish scales.

Internal/External Anatomy of a Fish

Name: _____

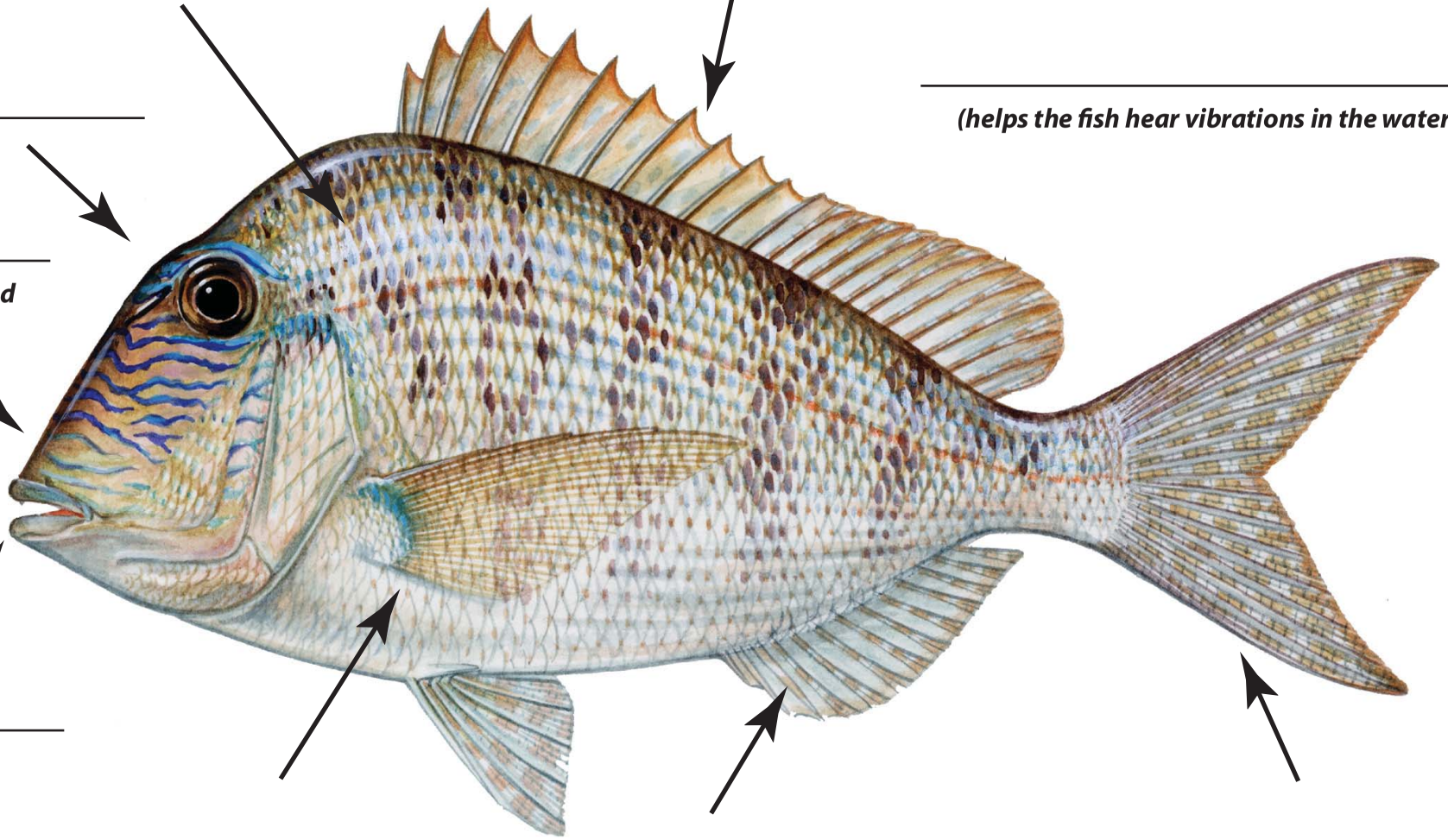
1. List three body systems that both humans and fish have.

2. Draw a line and match each fish organ/body part to its appropriate function.

Gills	Protects fish from parasites and bacteria in the water
Lateral Line	Filters toxins from a fish's blood stream and creates waste
Slime Layer	Filled with gases; helps the fish move up and down in the water column.
Swim Bladder	Helps with digestion processes
Kidneys	Allows the fish to hear and feel vibrations in the water
Pyloric Cacae	Secretes bile to aid in digestion
Liver	Allows fish to breath underwater

I NY Sea Grant New York

Label the external anatomy features of the fish found in the Porgy family below.



_____ *(like skin; used for protection)*

_____ *(top fin; used for balance, movement, and protection)*

_____ *(helps the fish hear vibrations in the water)*

_____ *(like nostrils; used for smelling)*

_____

_____ *(chest fin; used for balance and movement)*

_____ *(belly fin; used for balance and movement)*

_____ *(tail fin; used to move the fish)*

Word Box:

Dorsal Fin | Nares | Lateral Line | Caudal Fin | Pectoral Fin | Scales | Ventral Fin | Mouth | Eye

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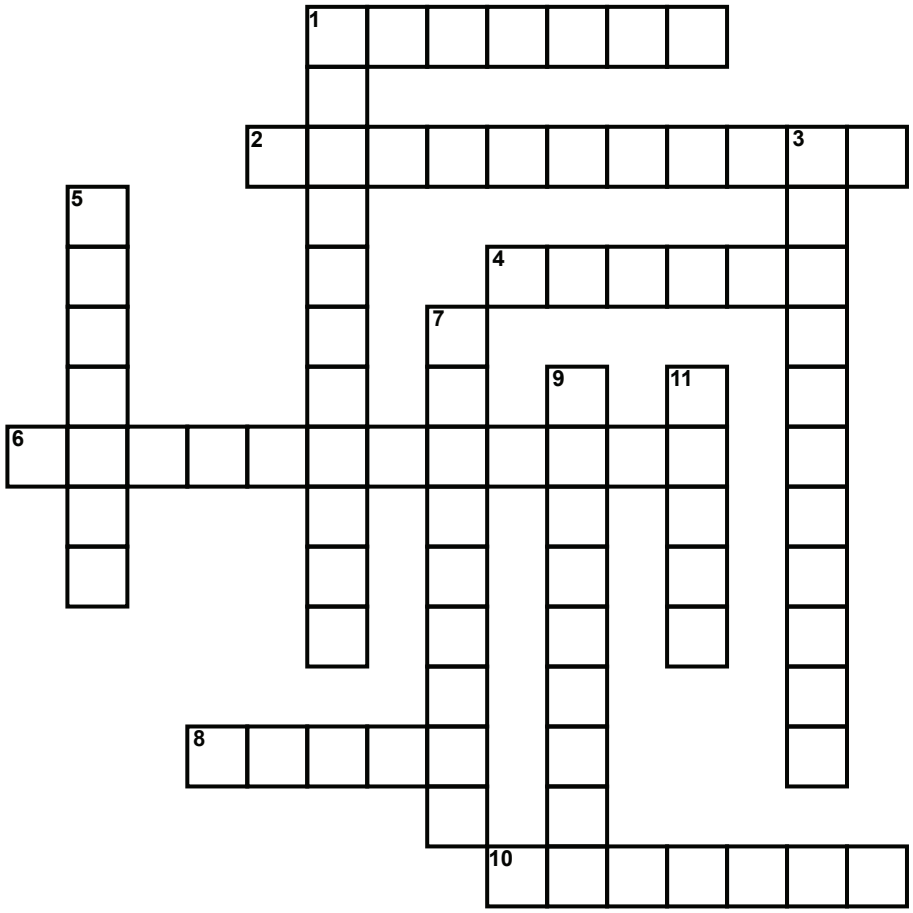
Name_____

Internal Anatomy

Crossword Puzzle



Clues Down:

1. I am the organ that helps fish maintain buoyancy in water.
3. I am the system whose main function is breathing and gas exchange.
5. We are the organs involved in secretion and regulation of water.
7. I am the system that removes wastes.
9. I am the system that breaks down and processes proteins, carbohydrates and fats.
11. I am the organ that helps transport blood.

Clues Across:

1. I am one organ in the digestive system.
2. I am the system that moves blood.
4. We are the organs that help fish reproduce.
6. I am the system that helps make babies.
8. I am the organ that has many digestive and storage functions.
10. I am the system that includes the brain.

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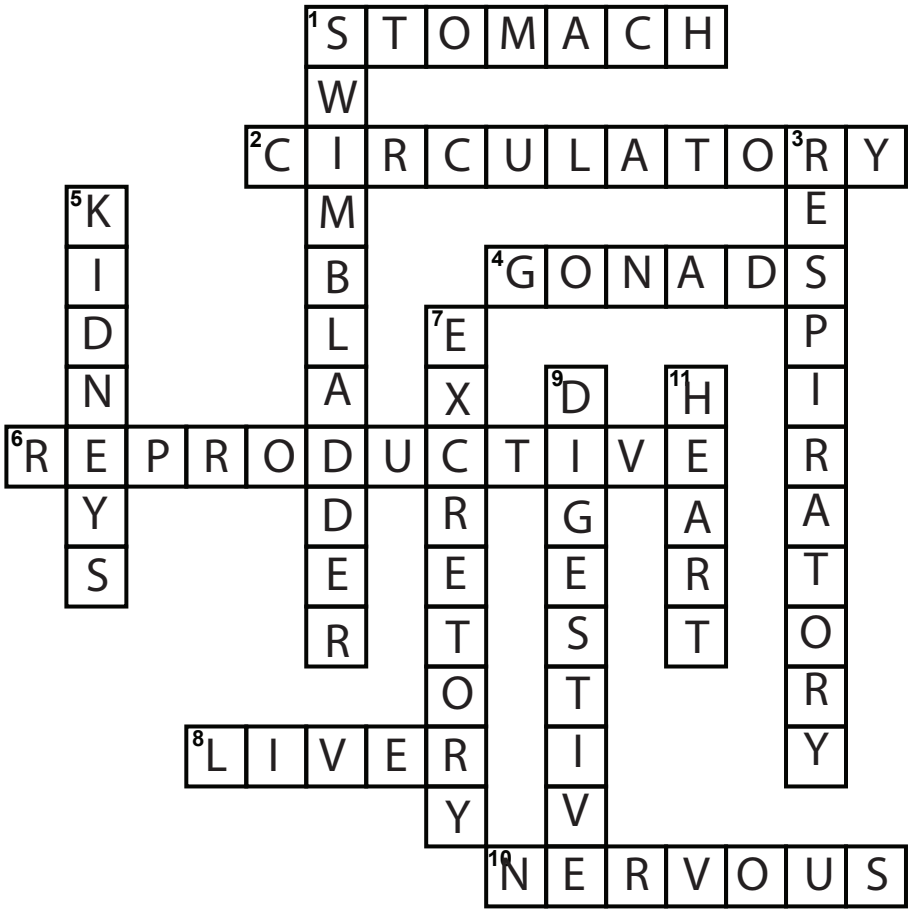
Name_____

Internal Anatomy

Crossword Puzzle



Clues Down:

1. I am the organ that helps fish maintain buoyancy in water.
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7. I am the system that removes wastes.
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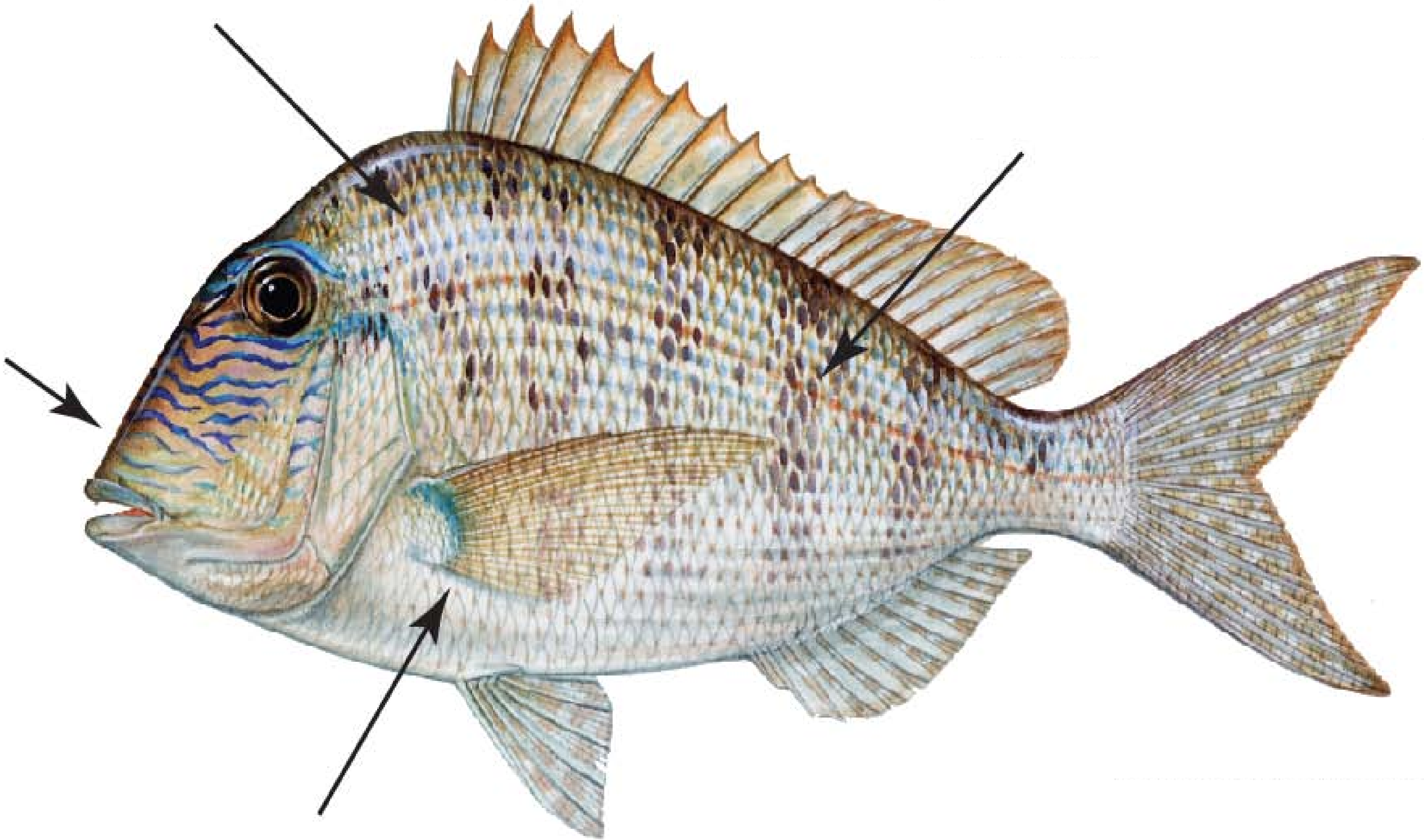
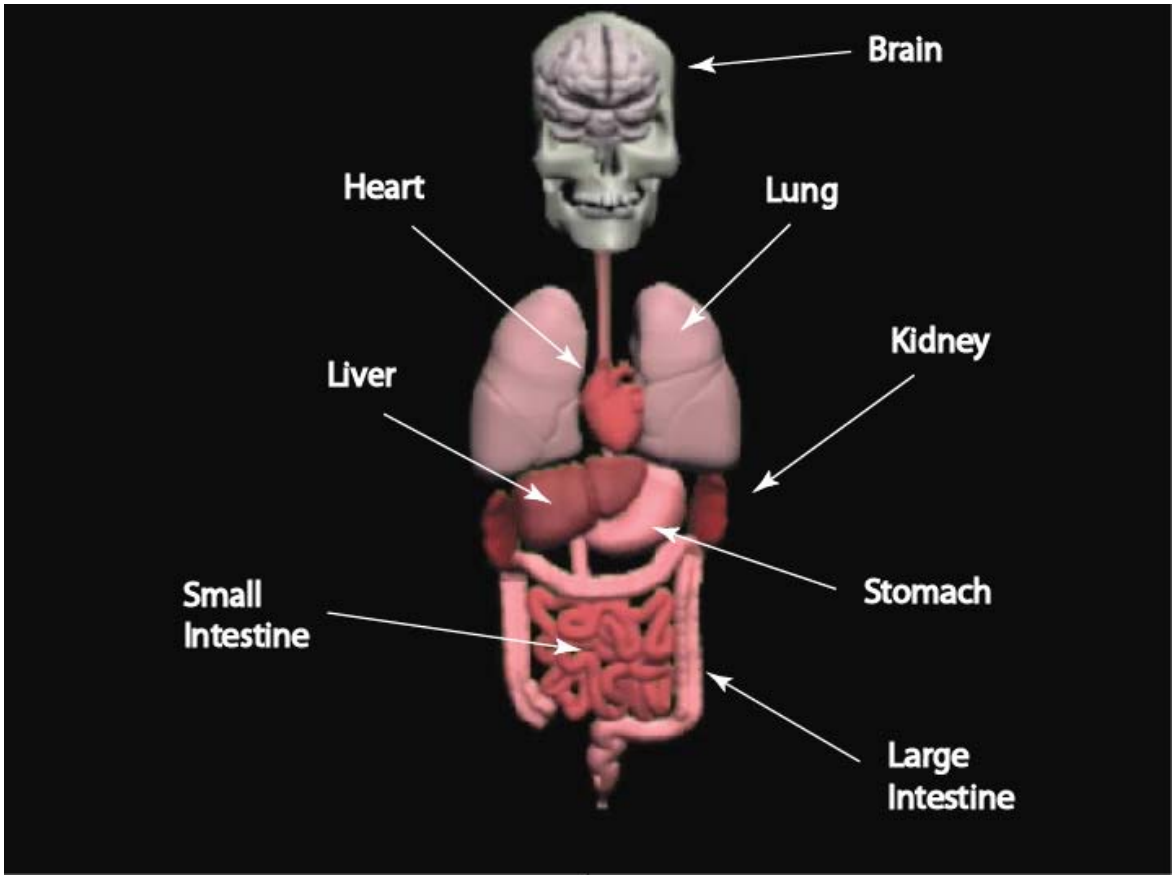
Something's Fishy…

an anatomy lesson for middle school students

External Anatomy of a Bony Fish



Internal Anatomy: Human



- Six Organ Systems:
  - Circulatory*
  - Digestive*
  - Excretory*
    - Urinary
  - Nervous
    - Endocrine
  - Reproductive*
  - Respiratory*

Circulatory System: Human

- Main function: delivery of materials throughout the human body.

- Includes:
  - Blood
  - Blood vessels
  - Lymph and lymph vessels
  - Heart

Digestive System: Human

- Main function: break down and process proteins, carbohydrates and fats.

- Includes:
  - Mouth
  - Tongue
  - Stomach
  - Liver
  - Gall bladder
  - Pancreas
  - Small intestine
  - Large intestine
  - Anus

Excretory and Urinary Systems: Human

- Main function: removal of metabolic wastes, such as carbon dioxide, water, salts and urea from the body.

- Includes:
  - Kidneys
  - Ureters
  - Urinary bladder
  - Urethra

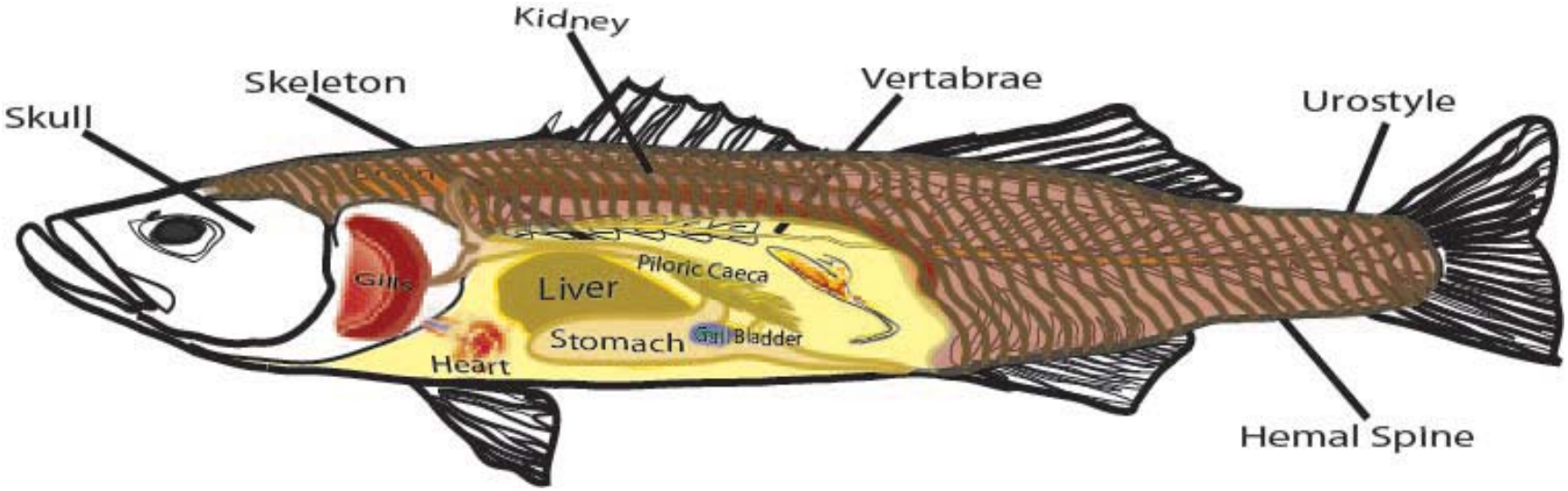
Reproductive System: Humans

- Main function: reproduction, continuation of life
- Includes:
  - Male sex organs
  - Female sex organs

Respiratory System: Humans

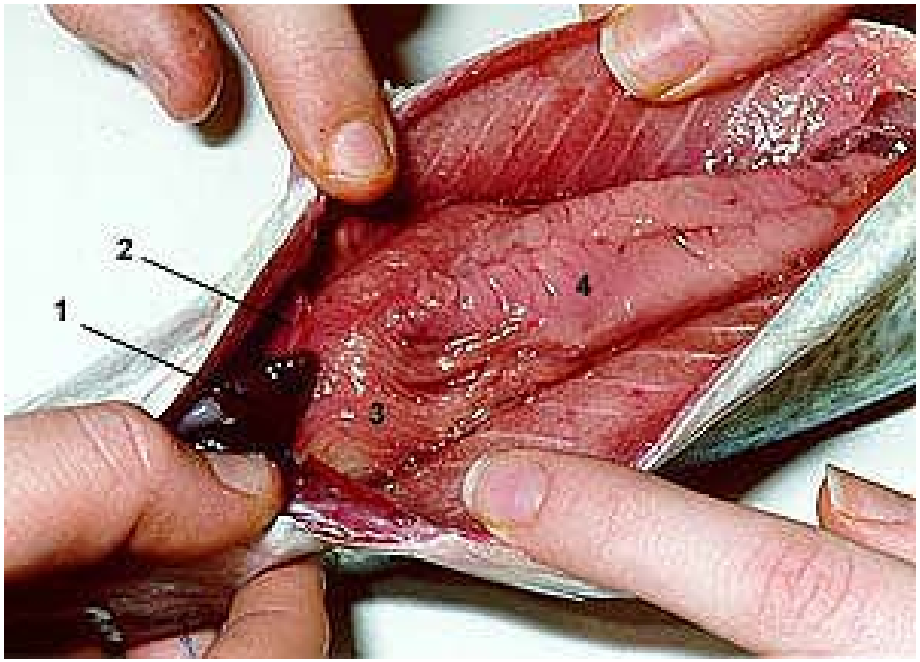
- Main function: breathing and gas exchange
- Includes:
  - Lungs
    - Bronchi
    - Bronchioles
    - Alveoli
  - Network of passageways
  - Diaphragm

Fish Dissection Overview



Fish Dissection: Organ Identification

1. Heart
2. Liver
3. Pyloric caecae
4. Adipose, fatty tissue



Definitions

- Heart
  - The heart of slow moving fish are small, whereas active swimming species are large.
- Liver
  - The liver has many digestive and storage functions. One of these is the production of bile, a solution which emulsifies fats.
  - The liver is also responsible in some species for the storage of fats, blood sugar, and vitamins A and D.
- Pyloric Caeca
  - Pyloric caeca are fingerlike pouches connected to the gut.
  - Pyloric caeca may play a principal role in protein digestion.

Fish Dissection: Organ Identification

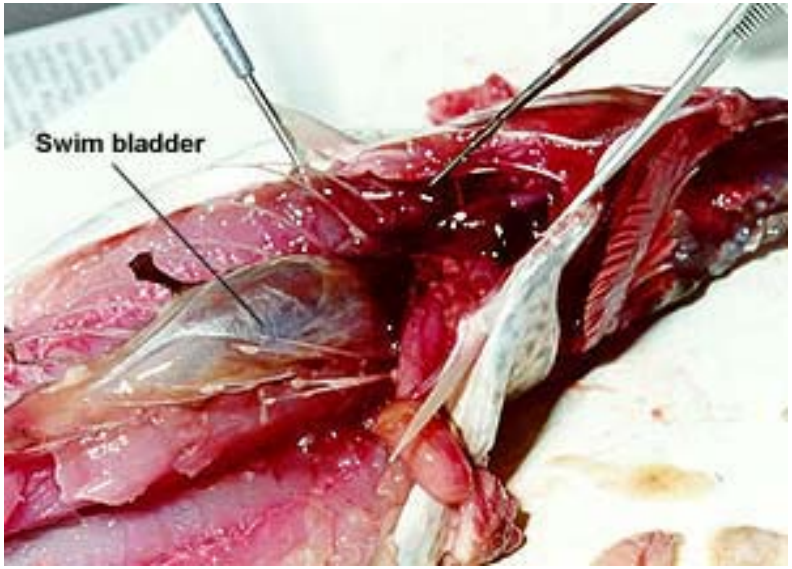
- Pull the adipose tissue (1) and gut (2) aside to expose the swim bladder (3), gonads (4) and kidneys (5).
- As a general rule, carnivorous fishes have relatively short guts. Herbivorous fishes have much longer guts.
- The gonads and kidneys are paired. One of each can be seen on both sides of the swim bladder.

Definitions

- Gonads
  - Gonads are sex organs; ovaries in females and testes in males.
  - In most cases, fertilization of eggs is performed externally, called spawning.
  - Often these organs are found separate in fish, male and female. However, some fish are hermaphroditic, meaning they carry both types of gonads.
- Kidneys
  - Kidneys are paired organs located ventral to the spinal column. They are involved in excretion and regulation of water in fish.

Fish Dissection: Organ Identification

- Push aside other organs to expose the swim bladder; located at the top of the body cavity.
- The swim bladder is a flexible-walled, gas-filled sac located in the dorsal portion of body cavity. This organ controls the fish's buoyancy and is used for hearing in some species.

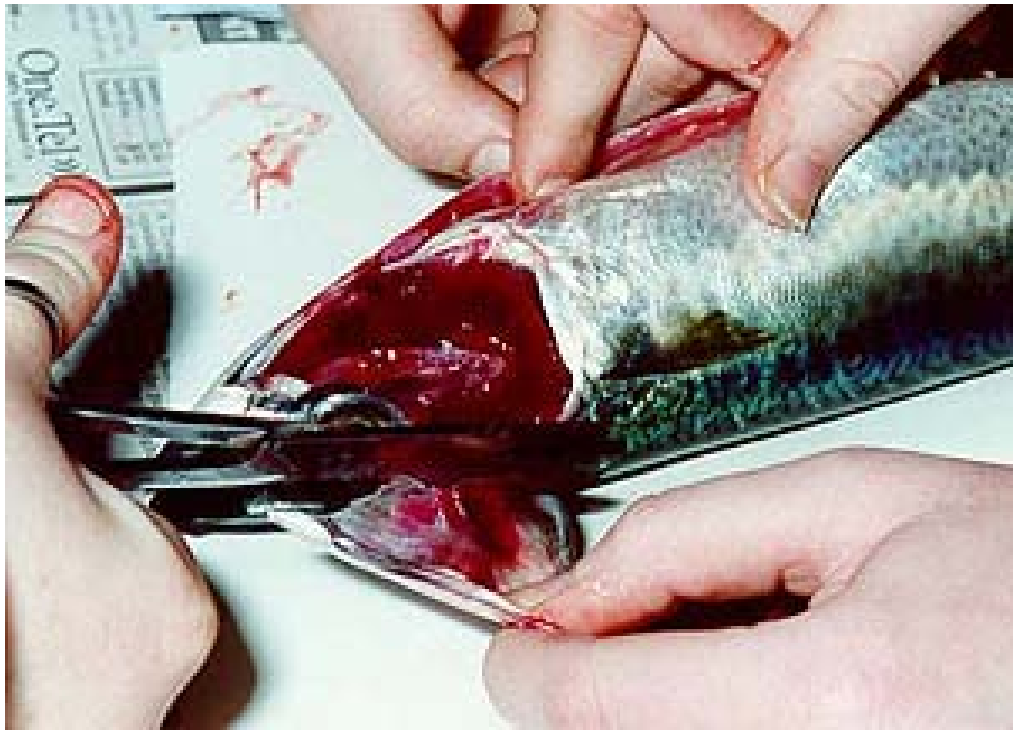


Swim Bladder

- If a fish becomes buoyant, and starts to float upwards, gas diffuses out of the swim bladder into the blood. This occurs at a site known as the oval. The gas in the blood is removed from the body at the gills, and expelled into the surrounding water.
- Conversely, if a fish starts to sink, air enters the swim bladder at a region called the gas gland. The way the fish does this involves three processes; the acidification of the blood, an increase in the concentration of lactate and hydrogen ions, and the movement of blood through a complex structure called the rete mirabile.

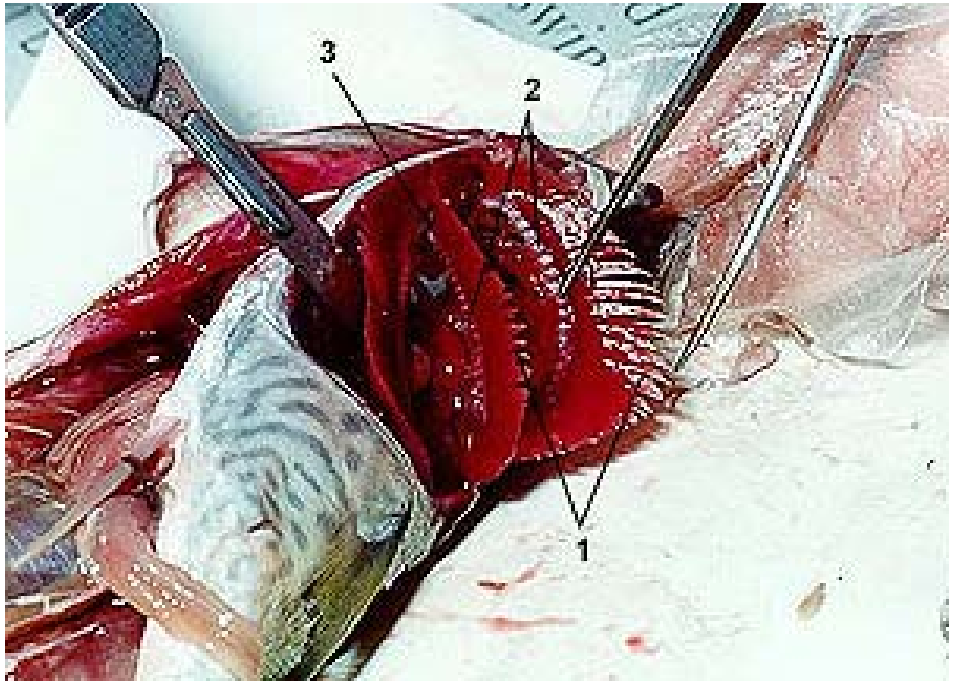
Fish Dissection: Organ Identification

- Remove the right gill cover (operculum) to expose the gills.
- Bony fish have a single opening behind each operculum.



Definitions

1. Gill filaments
2. Gill rakers
3. Gill arches



Gills: Filaments, Rakers, and Arches

- Gills are organs used for breathing. Water enters the mouth, and passes between the gills. Gill filaments absorb the oxygen from the water, and release carbon dioxide. Gill rakers, which aid in feeding processes, are appendages along the front edge of the gill arch. The gill arch provides support for the gills.

Dissection Derby

- Each dissection group will work as a team
- Question will pop up on screen
  - Team works together to determine the answer
- Each team selects a vocal representative
  - Person answers the question as soon as the group comes up with an answer
- Team which answers the most correct questions wins!

Question One

Q: What is the organ involved in the secretion and regulation of water? Is this organ found in both humans and fish? 

A: Kidney; Yes

Question Two

Q: Fins of a fish are used for movement, balance, and steering. What has similar functions for a human? 

A: Legs and Arms

Question Three

Q: Skin is to human protection as _____ is to fish protection? 

A: Scales and/or Slime

Question Four

Q: Name the main organ in humans and fish that is responsible for breathing. 

A: Lungs and Gills

Question Five

Q: What is the function of the lateral line? Is there a similar organ in humans? If so, what is it? 

A: Helps the fish hear vibrations in the water; Yes; the Ear

Question Six

Q: This organ has many digestive and storage functions. One of these is the production of bile, a solution which emulsifies or breaks down fats. Name the organ.

A: Liver

Question Seven

Q: Name the six organ systems found in both humans and fish? 

A: Circulatory, Digestive, Excretory (urinary), Nervous (endocrine), Reproductive, and Respiratory

Take Home Messages

- External anatomy features can help us when fishing.
  - For example, where to fish, what rig to use, etc.
- External features are also important for protection.
  - Slime
    - When handling live fish, never use a rag or shirt.
  - Dorsal fin
    - Fins can cause injury and infection.
- Organ systems of fish are similar to those of humans.
  - Digestive, reproductive, excretory, etc.

References

- Biology Notes: http://ohs-bio.www1.50megs.com/Biology_Notes/Fish.htm#BF%20Senses
- Australian Museum Fish Site: http://ohs-bio.www1.50megs.com/Biology_Notes/Fish.htm#BF%20Senses
- Illustrations by Diane Peebles, Florida Fish and Wildlife Conservation Commission