Insides and Outsides – The Anatomy of a Bluegill

Grade Levels: Upper Elementary, Middle School, High School
Subject Areas: Life science
Duration: Two 45 minute periods

Next Generation Science Standards:

- 4-LS1-1 – Construct and argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- MS-LS1-5 – Use argument supported by evidence for how the body is a system of interaction subsystems composed of groups of cells.
- HS-LS1-2 – Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
    - Practices of science
        - Asking questions
        - Planning and carrying out investigations
        - Obtaining, evaluating, and communicating information
    - Cross cutting concepts
        - Structure and function

Common Core State Standards – ELA/Literacy

- SL.4-5.1 - Engage effectively in a range of collaborative texts, discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade appropriate *topics and* building on others' ideas and expressing their own clearly.
- SL.6-8.1 - Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade appropriate topics, texts, and issues, building on others' ideas and expressing their own clearly.

Objectives:

- Students will be able to compare and contrast human and fish anatomy.
- Students will understand that the internal and external adaptations of a fish help it survive in its environment.

Teacher Background:

This activity can be done either as a demonstration or as a student activity. Necessary background information will be included in the activity. **If you are uncomfortable doing a dissection, you can stop the activity after the External Anatomy section.**

To prepare students, you might want to let them watch the following video: https://www.youtube.com/watch?v=J2URdwTA3Q8

Materials:

- Whole, uncleaned fish, preferably bluegills

    - If the activity is to be done as a demonstration, you are going to want a fairly large fish. If the students are going to do their own dissection, smaller fish will work – one fish for every four students.
    - If someone you know is an angler, he or she might be happy to supply you with bluegills (preferably at least 6 inches long)
        - If no bluegills are available, perch, spot or croakers work well
        - Otherwise you will have to see if the local grocery store or seafood market can supply whole uncleaned fish.
    - Keep the fish frozen until ready to use. Defrost the day of the activity. Do not thaw and refreeze fish – they will get mushy! They can be kept in the refrigerator for several days.
- Dissecting trays
- Paper towels
- Scissors with pointed tips
- Probe – toothpick, coffee stirrer, etc.
- Microscope
- Student worksheet – one per team of four
- Hand sanitizer

Activity:

- Introduction - Before beginning this activity, it helps if students know the functions of the various parts of the human digestive system, liver, pancreas, spleen, kidneys, lungs, heart and so on. This enables them to compare and contrast fish and human anatomy. You might also want to have them do some research on fish anatomy.
- If students are doing their own dissection:
    - Have students work in teams of four.
    - Remind them that a dissection is a scientific procedure; they must work carefully and neatly.
    - Unless told otherwise, the fish is to remain in the dissecting tray.
- If the fish being dissected are not bluegills, explain to the students before beginning that most of the concepts being discussed apply to bluegills as well as to the actual fish they are using.

- Outsides - External anatomy
    - Shape and color of the fish
        - Describe the general shape of the fish. *Bluegills are laterally compressed (flattened from side to side); many of the other fish will be fusiform (streamlined).*
        - What does the shape tell about where the fish lives? *Laterally compressed fish tend to live where there is cover to hide in; fusiform fish tend to live in open water.*
        - What are other possible fish shapes? *Flat like a flounder; snakelike like an eel*

        - Describe the color pattern of the fish. What does the color tell about where the fish lives? *Striped fish, like bluegill, tend to live where there is cover such as submerged aquatic vegetation. Silvery colored fish tend to live in open water. Fish that are spotted tend to live in clear water with dappled sunlight.*
- Skin and scales
    - What does the fish feel like?
    - What is the purpose of the slime? *It protects the fish from disease (primary function) and allows it to glide through the water more easily.*
    - What is the purpose of the scales? *Protection and reducing drag*
    - Remove a scale look at it under a microscope. What might the rings mean? *The number of prominent dark bands often correlates with the age of the fish. Scientists also use the internal ring structure of the otoliths (ear bones) to determine a fish's age.*
- Most fish have a lateral line running from the head to the tail. What purpose does it serve? *Senses sound, vibrations, moving water, and changes in pressure*
- Fins
    - Locate and identify the fins. What is the purpose of each fin?
        - Caudal (tail) fin – *Usually provides propulsion. A rounded, slightly forked tail means the fish swims slowly but can accelerate quickly and is more maneuverable. A deeply forked tail often means the fish is a fast constant swimmer.*
        - Dorsal fin – These are the fins on the fish's back; there may be one or two dorsal fins. *These fins usually serve to keep the fish upright but some fish use them for propulsion.*
        - Anal fin – This is the single fin on the bottom of the fish near the tail. *This fin is used to help keep the fish upright.*
        - Pectoral fins – These are the pair of fins on either side of the body. *These fins are usually used for stopping and steering but some fish, like bluegill, also use them for propulsion.*
        - Pelvic fins – This is the pair of fins on the bottom of the fish nearer the head. *These fins are used for steering and balance.*
    - Note the location of the spines (hard and sharp) or rays (soft) in the fins; what is their purpose? *They support the fin and may serve as protection by making the fish hard to swallow.*
- Locate the nares (nostrils), two tiny holes in front of the eyes. What are they for? *Unlike humans, fish only use their nostrils for smelling; they breathe through their mouth.*
- Eye
    - Does the fish have an eyelid? *No*

        - Notice the size of the eye and pupil. A relatively large eye and pupil often indicates that vision is important to the fish, *Bluegills have a relatively large eye; vision in bluegills is important for locating prey, avoiding predators and recognizing potential mates.*
    - Mouth – have the students pick up their fish and look in its mouth
        - Does the fish have a tongue? *Most fish have "tongues" which are formed from a fold in the floor of the mouth; they are not like the muscular tongues of humans.*
        - Have them use their finger to carefully feel inside the mouth. Does the fish have teeth? Where? *Fish can have teeth on their jaws (like humans), on their tongue, on the roof of the mouth or in the back of the throat.* What do the teeth feel like?
        - Look at the location and size of the mouth. Based on the location and the type of teeth, predict how the fish catches food and the fish might eat.
        - Have the students open the fish's mouth wide and look in. They should be able to see the red gills on either side of the throat.
            - Using the probe, stick it in the mouth and see where it comes out. *It should come out the side of the head*.
            - If a fish took water into its mouth where would it go? What about food? *Have the students think about this; the question will be answered in the next section.*
    - Gills
        - Place the fish back in the tray and lift the hard flap on the side of the head. This flap is called the operculum. What is its purpose? *To protect the gills*
        - Using the scissors, cut away the operculum to expose the gills.
            - Remove the gills by cutting the upper and lower attachments of the gill arch.
            - The bony projections along the inside curve of the arches are the gill rakers. What is their purpose? *Food taken into the mouth is directed by the gill rakers back to the esophagus, instead of going out through the gills.*
            - Notice the feathery gill filaments attached to the gill arches. What is their purpose? *They provide a lot of surface area. This is where oxygen and carbon dioxide exchange takes place.*

- Insides – Internal anatomy
    - Locate the vent, a small hole on the bottom of the fish near the tail. Insert the scissors into the vent and make a **shallow** cut all the way to the head. Carefully lift and cut away the flap of skin so the internal organs can be seen.
    - Digestive system

- Find the beginning of the digestive tract by inserting the probe into the mouth and into the esophagus – the esophagus is usually fairly short.
- The large reddish organ on top of the stomach is the liver.
    - The liver maintains proper blood chemistry and produces enzymes that help digest fats.
    - The dark greenish tissue in the liver is the gall bladder - produces bile which digests fats and neutralizes acid
- Stomach
    - The esophagus empties into a J-shaped bag called the cardiac stomach; this is where digestion of food begins.
    - The spleen is attached to the lower end of the cardiac stomach; the spleen produces red blood cells.
    - The area below the cardiac stomach is the pyloric stomach; the branching projections are called pyloric ceca and provide additional surface area for nutrient absorption.
    - The pancreas surrounds the ceca and produces digestive enzymes.
- The pyloric stomach empties into the intestine.
    - This is where digestion is completed and food is absorbed.
    - Herbivorous fish have a longer intestine than carnivorous fish because plant material is more difficult to digest. Have students make a hypothesis concerning the diet of their fish, based on the length of the intestine.
- Waste products are eliminated through the vent.
- Have students cut open the stomach and examine the contents. Was there a correlation between the type of teeth, the length of the intestine and the stomach contents?

o Swim bladder
- The swim bladder is the silvery sack that runs the entire length of the fish's body between the digestive tract and the backbone.
- The swim bladder is filled with air and provides buoyancy. It may also be involved in respiration (lungfish), hearing and sound production.
- In some fish the swim bladder is connected to the throat and the fish swallows air; in most fish oxygen is absorbed from the blood.
- Some fish, such as sharks, rays and lampreys do not have a swim bladder.

o Kidney – the streak of red tissue along the backbone is the kidney; its function is to filter waste from the blood and regulate salt/water concentrations.

o Heart
- The heart is the small dark triangular shaped organ just below the esophagus near the fish's mouth.

        - Fish have a four chambered heart, like humans. Have students discuss the flow of blood through the heart.
        - Are fish warm-blooded or cold-blooded?
    - Some students may find a large sack filled with little round yellow, red or black things. The sack is an ovary. These are eggs or roe and indicate that the fish was ready to reproduce. Some specimens may be mature males in which case the testes are long, thin to thick, ribbon-like, and whitish cream colored.

Discussion:

- Have students compare and contrast human and fish anatomy – both external and internal. Are they surprised at the similarities? Where there are differences, why do they think these differences exist? Why is internal anatomy similar between fish and human anatomy?
    - *Similarities – most of the internal organs of fish have the same basic functions as those of humans*
    - *Differences – the majority of differences are related to an aquatic existence versus a terrestrial one (fins are more efficient for swimming than arms and legs; scales provide better waterproofing than skin, gills instead of lungs, and so on)*
    - *Shared evolutionary ancestry.*

Extensions:

- Have students research the anatomy of another group of vertebrates. How does their external and internal anatomy compare with that of a fish?
    - Frog dissection - https://www.youtube.com/watch?v=iARB5vWbHsc
- Have students think about the adaptations humans have to make if they are going to spend time under water. How do these adaptations compare to a fish's anatomy? *(Example: fish have slime to help them glide through the water; humans wear a wet suit.)*

Insides and Outsides – The Anatomy of a Bluegill

Important reminders!

- You will be working in teams. Be sure to share tasks with each other.
- Unless you are told otherwise, the fish is to remain in the dissecting tray at all times.
- A dissection is a scientific procedure; you must work carefully and neatly.

Outsides - External anatomy

- Shape and color
    - Describe the general shape of your fish.

    - What does the shape tell about where your fish lives?

    - What color is your fish? What might this tell you about where it lives?

- Skin and scales
    - What does the fish feel like?
        - What is the purpose of the slime?

        - What is the purpose of the scales?

        - Use forceps to remove a scale and look at it under a microscope. What do you think the rings indicate?

    - Most fish have a faint line called the lateral line running from the head to the tail.
        - Does your fish have one?
        - What is its purpose?

- Fins
    - Locate and identify the fins. What is the purpose of each fin?
        - Caudal or tail fin

        - Dorsal fin – These are the fins on the fish's dorsal side (back); there may be one or two dorsal fins.

        - Anal fin – This is the single fin on the ventral side (bottom) of the fish near the caudal peduncle (tail).

        - Pectoral fins – These are the pair of fins on either side of the fish's body posterior (behind) to the operculum.

        - Pelvic fins – This is the pair of fins on the ventral side (bottom) of the fish, nearer the head.

    - What is the purpose of the spines (hard and sharp) or rays (soft) in the fins?

- Locate the nares (nostrils), two tiny holes in front of the eyes. What are they for? Be careful! This is a fish, not a human!

- Eye
    - Does the fish have an eyelid?
    - Notice the size of the eye and pupil. A relatively large eye and pupil often indicates that vision is important to the fish. How important do you think vision is for your fish? Why might it be important?

- Mouth – Pick up your fish and look in its mouth.
    - Does your fish have a tongue?

- Use your finger to feel carefully inside the mouth.
  - Are there teeth? If so, where?
  - What do they feel like?
- Based on the location and size of the mouth and the type of teeth, predict how the fish catches food and what the fish might eat.
- Open your fish's mouth wide and look inside. You should be able to see red things on either side of the throat. What do you think these are?
  - Stick your probe into the fish's mouth. Where does it come out?
  - If a fish took water into its mouth, where would it come out? What about food?

- Gills
  - Place the fish back in the tray and lift the hard flap on the side of the head. This is called the operculum. What do you think it is for?
  - Use your scissors and cut away the operculum.
    - Remove the gills by cutting the upper and lower attachments of the gill arch.
    - The bony things on the inside curve of the gill arches are called gill rakers. What do you think they are for? Hint: think about food.
    - The feathery things are called gill filaments. What do you think they are for?

Insides – Internal anatomy

- Locate the small hole on the bottom of the fish near the tail. This is called the vent. Insert your scissors into the vent and **carefully make a shallow cut** all the way to the operculum along the bottom of the fish. Carefully lift the flap of skin and cut it away so you can see the internal organs. Notice how neatly everything fits together!
- Digestive system
  - Find the beginning of the digestive tract by inserting the probe into the mouth and down the esophagus.
  - The large reddish organ on top of the stomach is the liver. What is its function?

        - The dark greenish tissue in the liver is the gall bladder which produces bile. What does bile do?

    - Stomach
        - The esophagus empties into a J-shaped bag called the cardiac stomach. What happens to food here?

        - The spleen is attached to the lower end of the cardiac stomach. The spleen produces red blood cells.
        - Food next goes into the pyloric stomach with lots of branching projections called ceca. What is the advantage of the ceca?

        - The pancreas surrounds the pyloric stomach and produces digestive enzymes.

    - The pyloric stomach empties into the intestine.
        - What is the function of the intestine?

        - Herbivorous fish have a longer intestine than carnivorous fish because plant material is harder to digest. Based on the length of your fish's intestine do you think it is herbivorous or carnivorous?

    - Waste products are eliminated through the vent.
    - Now use your scissors, cut open the stomach and look at the contents.
        - What did your fish eat last?

        - Does this agree with what you guessed, based on the type of teeth and the length of the intestine?

- Swim bladder
    - The swim bladder is the silvery or clear sack that runs the entire length of your fish's body between the digestive tract and the backbone.
    - What is its function?

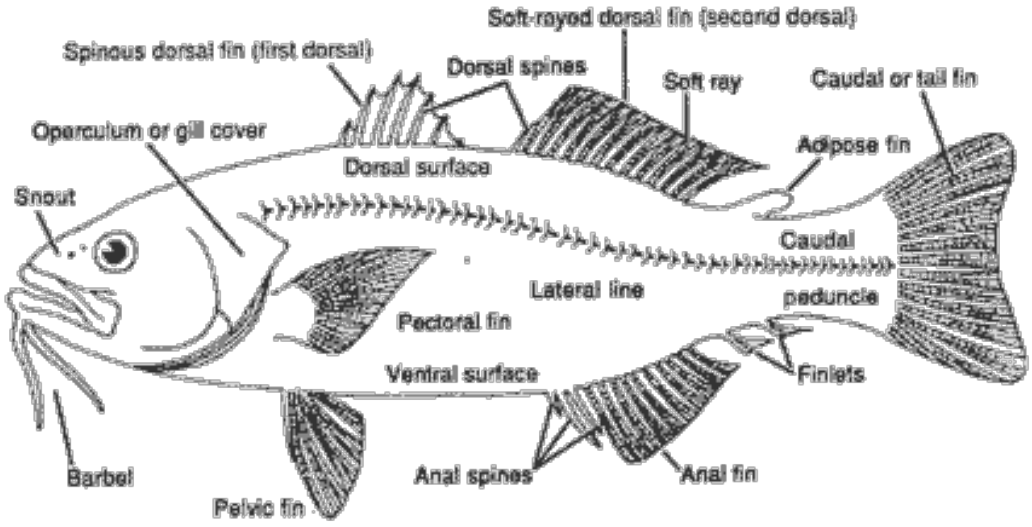
    - Do all fish have a swim bladder? If not, what would that tell you about where the fish lives?

- Kidney

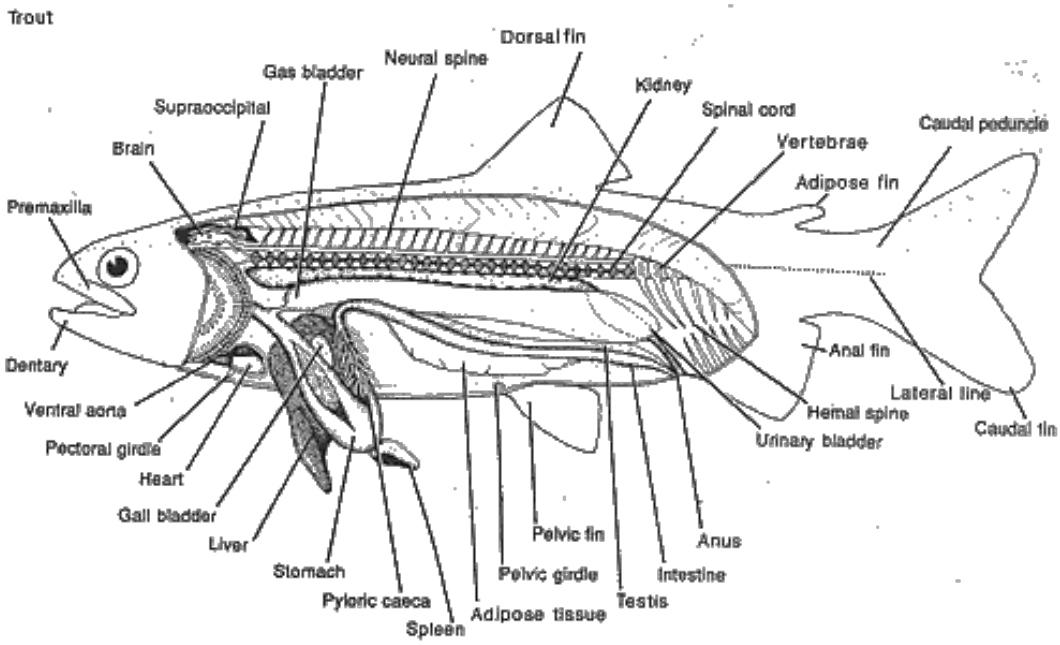
- The streak of red tissue along the backbone is the kidney.
- What is its function?

- Heart
  - The heart is the small triangular shaped organ just below the esophagus, near the fish's mouth.
  - How many chambers does it have?
  - Why do you think the heart is located near the gills?

- Does your fish contain a large sack filled with little round yellow, red or black things? If so, your fish is a female carrying eggs or roe.
- Does your fish contain a large creamy-white ribbon? If so, your fish is a male carrying sperm or milt.



External Anatomy



Internal Anatomy