Salmonid Dissection Guide

This activity focuses on the dissection of a salmonid. For a more basic dissection activity, use the illustration of the internal organs of a largemouth bass provided in *Hook, Line & Thinker: Science Guide*.

You may choose to lead this dissection or have the students conduct the dissection on their own. Check with a fisheries research lab or a fish wholesale market to obtain specimens for the dissection, if you can't catch one yourself.

Materials:

- fish (salmon or trout)
- sharp kitchen knife
- plastic drinking straw
- plastic spoon
- magnifying lens
- golf ball (represents human eye)
- probe
- latex or plastic gloves
- paper plates
- cleaning supplies
- garbage bags for waste
- Otolith removal and processing: (freshwater drum or yellow perch are the best species to use if you plan to do this advanced dissection of the otolith)
- alcohol (95% ethanol)
- modeling clay
- Bunsen burner or other flame source
- immersion oil (or mineral oil)
- tweezers
- 25x microscope
- safety goggles

External Anatomy

Shape

Salmonids are streamlined to move easily through water. Water has much more resistance to movement than air does, so it takes more energy to move through water. A streamlined shape saves the fish energy.

Fins

Salmonids have eight fins, including the tail. They are made up of a fan of bone-like spines with a thin skin stretched between them. The fins are embedded in the fish's muscle, not linked to other bones, as limbs are in people. This gives them a great deal of flexibility and maneuverability. Each fin has a different function. The caudal, or tail fin, is the largest and most powerful. It pushes from side to side and moves the fish forward in a wavy path. The dorsal fin acts like a keel on a ship. It keeps the fish upright, and it also controls the direction the fish moves in. The anal fin also helps keep the fish stable and upright. The pectoral and pelvic fins are both used for steering and for balance. They can also move the fish up and down in the water. The adipose fin has no known function. It is sometimes clipped off in hatchery fish to help identify the fish in research projects when they return to streams to spawn or are caught. Only members of the Salmonidae, Ictaluridae, (catfish and bullheads), and Characidae (a tropical fish) families have adipose fins.

Slime

Many fish, including salmonids, have a layer of slime or mucus covering their bodies. The slime helps fish to slip away from predators, slip over rocks to avoid injuries, and slide easily through water when swimming. It also protects them from fungi, parasites, disease and pollutants in the water.

Scales

Remove a scale by scraping backwards with a knife. Look at the scale with a magnifying lens. Most fish, including salmonids, have a layer of scales covering their skin. Scales are small, hard plates, like fingernails, that cover the body for protection. The scales overlap to form a flexible plating to protect the fish from

predators and bruising. Salmonids begin to grow scales at the fry stage. The scale arrangement pattern is different for each species. Fish have the same number of scales for their entire lives. As the fish grows, the scales grow. The scales form rings, just as a tree does, which can be used by biologists to age the fish. If a scale is lost, a new one will take its place. For this reason, researchers often take several scales from the fish when aging it.

Inner ear

Fish have inner ears, but no outer ears. Sound waves travel through the water and through their bodies to the bones (otoliths) in the inner ears. Salmonids probably use hearing to detect predators and other threats. The otoliths can also be used to age a fish. Otoliths may be removed during the dissection. Fish also detect sound waves through their lateral lines.

Lateral lines

The lateral lines functions somewhat like ears. They detect vibrations and pressure waves in the water, just as ears do in air. A lateral line is a series of liquid-filled canals below the skin along each side of the fish. They combine aspects of touch, hearing and seeing. Fish use lateral lines mainly to tell distance and water flow and to detect disturbances in the water. Some fish can use lateral lines to find their way when it is too dark or muddy to see.

Nostrils

Salmonids have nostrils above their mouths, but no noses. Fish do not breathe through their nostrils. The nostrils are a small indention that is not connected to the mouth. Fish are able to smell very tiny amounts of chemicals in the water. They use this information to find food, detect harmful pollution, and avoid potential threats. Salmon use smell to find their way back to their spawning streams.

Mouth

Salmonids have teeth that are sharp and needle-like, which they use to grab their prey. Their tongues also have two sharp shafts. Salmonids do not chew their food.

Salmonids have taste buds inside their mouths, like people do. They probably taste salt, sweet, bitter and acid, but their sense of taste has not been studied in detail.

Opercula (gill covers)

On each side of the body, an operculum protects the gills. The opercula are hard outer linings like flexible plates that the fish open and close to let water pass over the gills.

Dissection

Gills

Gills are very thin and have many fine branches. These structures provide a large surface area to absorb oxygen from the water. Gills are red because they are filled with blood. Oxygen in the water passes through the gills and into the blood. Remove the gills on one side of the fish. Cut through the bone at the top where the gills are joined to the head. Cut through the bone at the bottom where the gills are joined to the head. Lift the back edge (farthest from the mouth) of the gills and cut them away from the skin. Every pair of gills has four arches, each with a row of gill rakers. These rakers prevent food from entering the gills by guiding it into the throat.

Ventral Cut

The vent opening is on the ventral side of the salmon. Eggs or sperm are released from the vent, depending on the sex of the fish. Both males and females eliminate waste from the vent. Cut the fish open beginning at the vent and proceeding in a superior direction to the throat. Do not cut too deeply or the internal organs will be damaged. Open the fish from the vent to the throat.

Reproductive Organs

If the fish is female, there are two ovaries of eggs, each held with a membrane. When the female is ready to spawn, the eggs come loose inside her body and are laid from the vent. Males have two testes that produce milt. When fish spawn, the milt becomes liquid and is squeezed out the vent opening to fertilize the eggs. The testes are usually firm and white if the male has not

spawned. Remove the eggs or milt by gently pulling the sacs away from the body.

Liver and Gall Bladder

The liver is the largest organ in the fish's body. It is part of the digestive system. As in humans, it is essential for maintaining the proper level of blood chemicals and sugars. Turn the liver over to view the gall bladder. The gall bladder contains green bile, which is used to help digest fats. Remove the liver and gall bladder by gently cutting any small membranes that join it to the digestive system. Pull them away from the stomach and remove.

Digestive System

Observe the digestive system by gently pushing a probe (8" spoon handle or chopstick) through the mouth and into the stomach. The fish digestive system is shorter and simpler than those found in mammals. Because fish are poikilotherms, they do not use as much energy to keep warm and do not need as much energy from their food, so they expel it more quickly. The stomach breaks down food with digestive juices. The pyloric caeca absorbs nutrients into the blood. It is similar to the small intestine in people. The spleen is a storehouse of blood for emergencies and recycles worn-out red blood cells. Most food is absorbed in the intestine, the tube-like section at the end of the digestive system. Remove the stomach by cutting it away at the throat and gently pulling. Remove the complete digestive system and intestines, which end at the vent.

Heart

The heart pumps blood through the body. It is very close to the gills where fresh oxygen enters the blood. In humans, the heart is close to the lungs to pump fresh oxygen through our bodies. Remove the heart.

Swim Bladder

Salmonids fill their swim bladders with air for the first time as fry. The air provides buoyancy, allowing them to float in the water. Salmonids can adjust the air in their swim bladder so they can hover at different levels in the water. Often the swim bladder remains full of air after the fish dies. If the shiny swim bladder is flat, inflate it by inserting a straw in the tear and gently blowing in air. Remove the swim bladder by gently scraping it away from the sides of the body with the flat side of the knife. At the vent end of the fish, reach one finger under the swim bladder and pull it away. Continue pulling up to the throat, where a gentle tug will release it. Make a clean cut at the vent end of the swim bladder. With a fingertip, gently pull back the top layer of the bladder ¼". With a straw, blow firmly at this end, and the bladder will open up. Slide the straw into the opening and gently blow to fill the bladder. Seal the bladder opening by pinching it against the straw. Now slide the bladder off the straw. Twist the bladder to lightly seal the opening. Float the bladder in water to demonstrate buoyancy.

Kidneys

Salmonids have two kidneys joined together. The front kidney produces red blood cells and the back kidney cleans the blood. Urine is collected by ducts near the vent. In ocean-going salmon, the kidneys are critical in the smolting process (going from fresh to saltwater) in a process called osmoregulation. Remove the kidneys by cutting along each side. Use a spoon to lift them out.

Skeletal System

Fish have flexible backbones, as do mammals. The backbone is a series of interlocked disks. Salmonids can move from side to side, but can only bend up and down a small amount. The backbone protects the spinal cord, which runs through the body to the brain. Membranes carry messages via nerves from the lateral line to the spine. You may want to cut off the tail to see the spine. The ribs are lightweight, curved bones that give the fish its shape and protect the fish's internal organs. Remove a rib by cutting on each side of it and then pulling it up toward the backbone. Cut to disconnect it.

Eyes

Salmonids have two eyes, but, unlike people, they do not have binocular vision, which would give them depth perception. They swivel each eye independently forward and backward to cover a much wider field of vision than people have. Fish have very sharp vision underwater. Some can see 15 feet or more. Remove

one eye by reaching under the gill with a finger and pushing hard to loosen the muscles in the socket behind the eye. When it is pushed out of the socket, remove your finger. From the outside, gently pull up on the eye with one hand as you cut it away from the head. The human eye is approximately the size of a golf ball. Like the human eye, most of the salmonid eye is hidden inside the skull for protection. Unlike humans, salmonids have no eyelids and no need to blink. Their eyes are continuously washed in water.

Brain

As with all chordate species, the salmonid brain is at the end of the spinal cord. Detach the fish's head by cutting behind the gill covers. Hold the head by the nose and place the back of the head on a cutting surface. Remove a very thin slice (1/8") from the top of the head. If removing the otoliths, make thin cuts on each side of the head as well (from "ear" to eye). Gently poke around behind the cuts until you find the thin, hard otoliths. They look like chips of bone fragments. Set them aside in an alcohol solution for later processing. Return to the brain dissection by taking a second 1/8" slice off the top of the head. Thin slices will prevent damage to the soft brain tissue as you cut through the tough cartilage surrounding the brain. Remove a third 1/8" slice. There are three pea-shaped sections in a salmonid brain. Use the tip of the knife to gently probe and scrape out the brain. Tilt the head upside down and continue to scrape until removed. The forebrain controls the salmonid's sense of smell. The midbrain controls vision, learning, and responses to stimuli. The hindbrain coordinates movement, muscles, and balance. Compare the size of the fish's eye to the size of its brain. Compare the size of a human eye to the size of a human brain. Salmonids rely on their senses and an inborn knowledge called instinct to help them survive.

Otolith Processing

Once the otoliths are clean, you may store them in a vial for later use or process them immediately. If processing, scrape the membrane off the otoliths. Put the otoliths on the tip of your index finger, one at a time, and press firmly with your thumbnail to crack the otoliths in half. Grasp half an otolith with the tweezers so that the cross section is parallel to the length of the tweezers. Burn the flat, cross-sectional side of each otolith. As you burn each bone, you will see it go through stages, like you see when you toast a marshmallow. When a bone is one quarter done, it will turn a golden brown; when half done, it will turn dark brown. The bone will turn black when almost done, and then become ashy white when complete. Remove the otoliths from the heat and stick the edges opposite the burned ones into wads of clay. Carefully put less than a drop of oil on each burned edge and allow a moment for it to soak in. View the burned edges under a 25-power lens on a microscope to count the otoliths' rings and age the fish. If performed correctly, this is a much more accurate method of aging a fish than using scales.

Clean-Up and Summary

Clean the dissection area and all instruments with disinfectant and paper towels. You may wish to conclude this dissection by comparing the structural and internal anatomy of humans and fish.

Further Assistance

For images of a dissection, see:

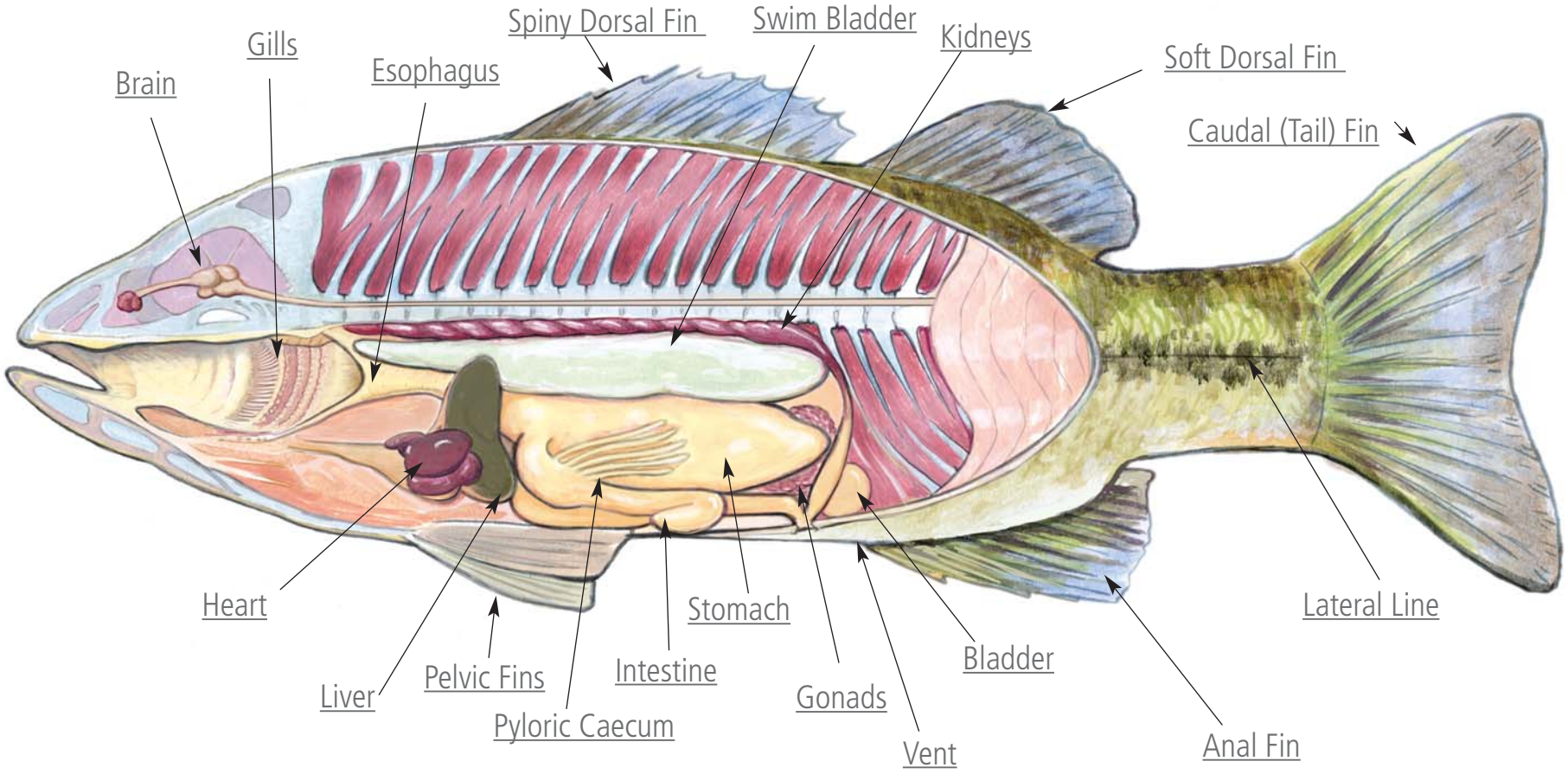
pskf.ca/sd/print/dissection.pdf

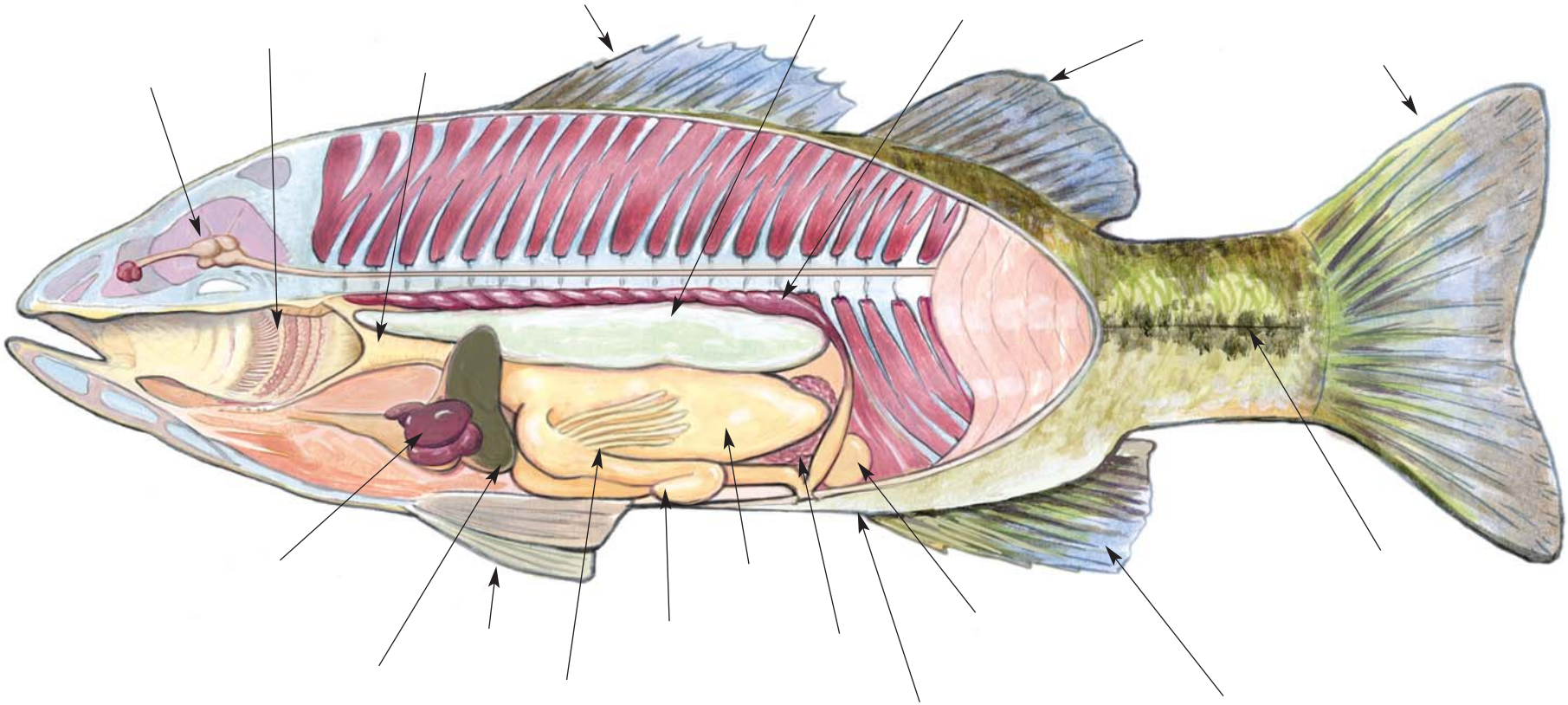
library.thinkquest.org/05aug/00548/DissectionGame

Sources

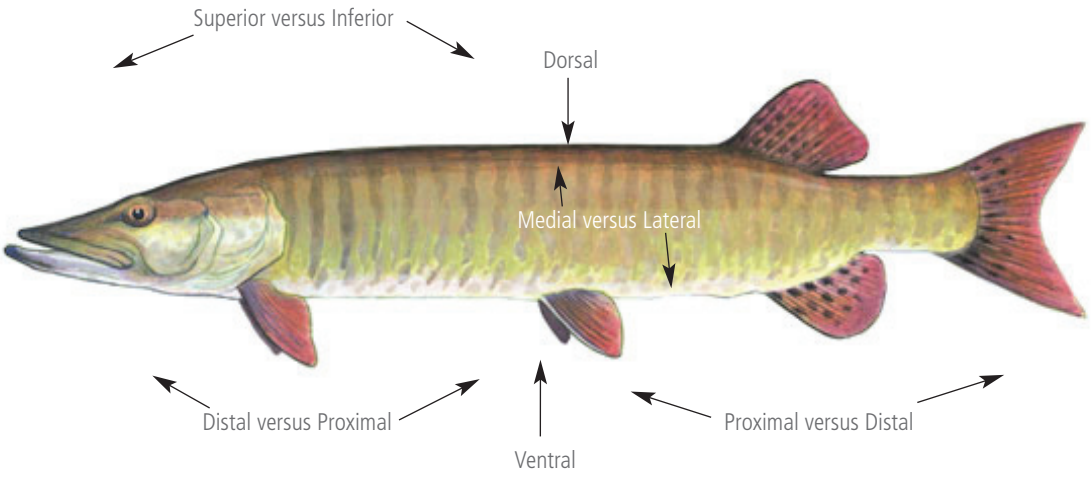
Dissection taken from: The Pacific Streamkeeper's Federation: **pskf.ca**

Otolith addition taken from Otolith Research Laboratory, Bedford Institute of Oceanography, **marinebiodiversity.ca/otolith/english/remove**


Brain
Gills
Esophagus
Spiny Dorsal Fin
Swim Bladder
Kidneys
Soft Dorsal Fin
Caudal (Tail) Fin
Heart
Liver
Pelvic Fins
Pyloric Caecum
Intestine
Stomach
Gonads
Vent
Bladder
Anal Fin
Lateral Line



Speaking Anatomically



Speaking Anatomically

Which side of a fish is the top? Common words like "top," "bottom," "left," and "right" can be confusing when trying to describe to someone where a fin or a barbel is located, especially if the fish is laying on its back or its side. Scientists get around this confusion by using anatomical words. The words listed below help pinpoint a location on an organism. They can be used for humans, dogs, insects, and, of course, for fish.

Dorsal The back. In vertebrates, the backbone is located on the dorsal side of the body.

Ventral Located near or on or lower surface of opposite the back.

Superior Toward/nearer the head. The eye is located on the superior part of the body.

Inferior Toward/nearer the lower extremity. The caudal fin is located on the inferior part of the body.

Medial Toward/nearer the mid-line of the body. The dorsal fin is located medially.

Lateral Away/farther from the mid-line of the body. The pectoral fin is located laterally.

Proximal Toward/nearer the center. The musky's dorsal fin is proximal to its tail.

Distal Away from/further from the center. The musky's tail is distal to its dorsal fin.

Relative Direction

Fill in the blanks using the words above:

The pelvic fin is _____ to the anal fin.

The gills are located _____ on the body.

The soft rays of the largemouth bass are _____ to the spiny rays.

A brown bullhead has an adipose fin on the _____ side of its body.

The bluegill's vent is on the _____ side of its body.