SALMON DISSECTION

[demonstration]

MATERIALS

Each group conducting a dissection will need the following:

- A whole salmon (may require time to thaw)
- A Zak Knife (small gut hook) or a kitchen knife
- A spoon
- A plastic drinking straw
- Paper plates
- A magnifying lens
- Toothpicks or bamboo skewers (optional)
- Newspapers
- Paper towels
- A bucket of water with disinfectant for cleaning
- Heavy plastic garbage bags for waste
- One copy of "Handout 2.7: Salmon Key"
- One copy of "Handout 2.8: Dissecting a Salmon" for each student
- One copy of "Handout 2.9: Salmon External Anatomy" for each student
- One copy of "Handout 2.10: Salmon Internal Anatomy" for each student
- Writing supplies

PREPARATION

- *Before you begin - Use Handout 2.7 to determine the species of salmon you are dissecting.*
- *Option: Some independent education suppliers, education supply stores, and science education catalogues carry cloth fish, salmon anatomy puzzles, 3-D models, and posters that can help introduce this dissection activity to students. Teachers may also want to photocopy "Handout 2.9 (Part 1 & Part 2): Salmon External Anatomy" and "Handout 2.10 (Part 1 & Part 2): Salmon Internal Anatomy" onto an overhead transparency for reference.*
- Dissections may be offered as demonstrations or as a hands-on activity with pairs or groups of students dissecting salmon as teachers model the procedure. Have non-participating students use the handout for taking notes describing the procedure and their observations. If conducted as a demonstration, ask students to pass the dissected parts and magnifying lens around the observation table.
- This is an anatomy lesson, intended to provide elements of form and function, basic comparative physiology, and proper catch handling. It is recommended prior to removing any part of the fish that it be examined and discussed. Encourage students to identify, name, and determine function of the various fish parts. Students are also encouraged to think about their own bodies and organs and to consider whether similarities exist.
- It is recommended that all students participate physically in the dissection. Students may need to be reminded prior to and throughout this lesson that this is science and, although science can be fun, fish must be respected and not destroyed. Students are encouraged to participate at their individual comfort levels.
- Obtain a whole salmon for each group of students, plus one for modeling correct dissection.
- To obtain a salmon for dissection, contact your local fisheries biologist. Remember: It is illegal to waste sport-harvested fish or game.

SALMON DISSECTION

Time Required:
45-90 minutes

Level of Conceptual Difficulty:
Simple

Suggestions for Assessment:
Monitor students' responses during the dissection. Review their observations and ensure that they can identify and describe the basic parts of a fish, their functions, and their relationships to human physiology.

Safety Warning:
When working with sharp instruments, safety guidelines should be discussed with all participants. This dissection is a guideline only, and individuals participate at their own risk. To reduce risk, it is recommended that a teacher or adult volunteer monitor all facets of the dissection.

INTRODUCTION

- Have a discussion with students about showing respect for all species. This should serve as a guiding principle for the students' behavior during the following activity.
- Provide each student with a copy of "Handout 2.9 (Part 1 & Part 2): Salmon External Anatomy" and "Handout 2.10: Salmon Internal Anatomy." Sketch an outline of a human on the chalkboard. Refer to the salmon handouts, as needed, to explain the dissection. Refer to the human sketch to compare human physiology with fish physiology. (If convenient, you may prefer to make overhead transparencies from the illustrations.)
- If possible, have teacher or adult volunteer assist with any cutting required. If students will be using knives, warn them to use caution. If students are not doing the dissection, have them their hands (or optional skewers).
- This guide will follow the standard progression of salmon dissection. Instruction will cover first the external (outside) features and then progress to the internal (inside) organs. Instructors may choose to omit some dissection aspects, depending on students' ages and scholastic levels.
- Advise students that, if they feel uncomfortable during the dissection, they may look away or move their chairs farther back.
- Have students in pairs or individually use "Handout 2.8: Dissecting a Salmon" to follow the dissection and record their information.

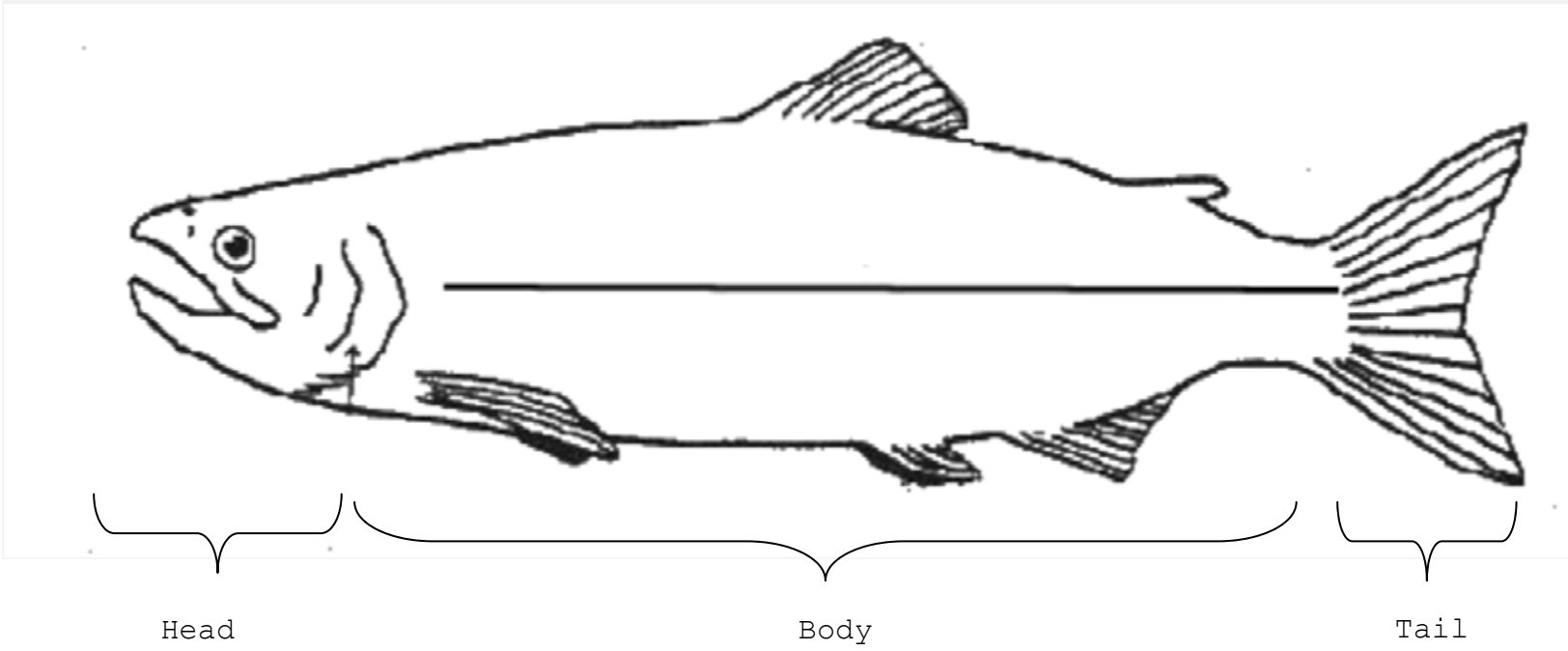
Terms and Background Information:

External Anatomy of the Fish:

- **Head**: A salmon's head includes the eyes, nostrils, mouth, and gills. The area in front of the eyes above the mouth is often referred to as the snout. The position of the mouth varies among species. Fish absorb oxygen from the water. The water is taken through the mouth, flows over the gills, and then exits through the gill openings. The gills are protected by a cover, called the operculum. Fish have teeth in the jaws, mouth and pharynx.

- **Body**: The area immediately behind the operculum is called the pectoral or chest region. The humeral area, or shoulders, lies above the base of the pectoral fins. The belly extends from the pectoral fins to the anus.

- **Tail**: The tail is the part of the fish behind the anus. The slender section between the base of the caudal fin and the anal or dorsal fin is called the caudal peduncle.



External Anatomy Structures and Their Functions:

- **Eyes**: As with humans, fish depend upon eyesight to see food, avoid predators, and to navigate. Because their eyes are bathed in water constantly, fish do not have eyelids and do not need tears.

- **Nostrils**: Salmon have a well-developed sense of smell and use this ability to seek out their natal streams. (The term "natal stream" refers to a salmon's water of origin.) Scent can also aid in avoiding predators and finding food. 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 the lateral line, a system of fluid-filled sacks with hair-like sensory apparatus that are open to the water through a series of pores along each side of a fish. The lateral line allows fish to detect movement of other fish and predators in the water. The full spectrum of frequencies fish can sense is not completely understood. There is some evidence the fish also sense medium frequencies.

- **Mouth:** Fish use their mouths to catch food and hold food of various types, but food is not chewed before swallowing. Salmon swallow food whole and the teeth are used for primary purpose of holding prey that is struggling to escape. In addition, the mouth is a very important part of the breathing process. Water is constantly taken in through the mouth and forced over the gills.

- **Gills:** Fish gills are composed of two basic parts, the gill covers and the gills. The gill covers protect delicate gill respiratory apparatus and, together with the mouth, force water containing oxygen over the gills. The gills are delicate, but effective breathing mechanisms, and are one of the most important organs of a fish's body. Gills are far more efficient than human lungs, because they can extract up to 80 percent of the oxygen dissolved in water, while human lungs only extract up to 25 percent of the oxygen in the air.

    - Gills are thin-walled structures filled with blood vessels. The fish takes in water through its mouth, and 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 membrane. This exchange is essential to the normal functions of the fish and contact with the gills on a live fish should be avoided.

    - The gills have many blood vessels which accounts for their red color. The lamellae, or branches of the gills, perform the same function as the small sacs (alveoli) within human lungs. They act to transfer carbon dioxide from the body of the fish and absorb the oxygen from the water. The lamellae are only two cells thick and present maximum surface area to permit the most efficient transmission of gases. Under a lens, the lamellae look like a Christmas tree.

- **Fins:** Salmon have two sets of paired fins (pelvic and pectoral) and four single fins (dorsal, caudal, anal, and adipose). Except for the adipose and caudal fins, the others are used basically to maneuver and balance the fish in the water. The adipose is a small, fleshy fin which serves no known purpose. The most important fin is the caudal, more commonly called the tail. The caudal functions as a means of propulsion. In addition, the caudal acts as a rudder. The caudal fin is also used by female salmon to dig the redd, in which eggs are deposited.

- **Scales**: The bodies of salmon are protected by scales which grow in regular concentric patterns and can be used to determine the age and life history of the fish. Covering the scales is a layer of mucous (slime) which further protects the fish from diseases, fungi and viruses. The slime also helps fish slide through the water more easily, a term called hydrodynamics. Slime also aids the fish in escaping from predators.

Internal Anatomy Structures and Their Function:

- **Ovaries:** The female reproductive organ, ovaries produce eggs. A group of eggs is often referred to as a skein. Eggs are often used for bait when sport fishing.
- **Testis**: The male reproductive organ, testis produce milt which contains salmon sperm.
- **Liver**: The liver stores, synthesizes and secretes essential nutrients that contained in food. It destroys old blood cells and maintains proper levels of blood chemicals and sugars. The liver assists in digestion by secreting enzymes that break down fats.
- **Gall Bladder**: The gall bladder is a sac attached to the liver in which bile is stored and used to digest fats.
- **Heart**: Bony fish like salmon have a two-chambered heart. This muscular organ circulates blood throughout the body and is part of the circulatory system.
- **Esophagus**: The gullet, or esophagus, carries food from the mouth to the stomach.
- **Stomach**: A sac-like digestive organ receiving food from the esophagus and opening into the intestine.
- **Pyloric Caeca**: An appendage in the form of a blind sac, connected with the alimentary canal, in which digestion takes place. It also absorbs nutrients into the blood.
- **Intestine**: The intestine extends from the pyloric caeca to the anal vent.
- **Anal Vent**: Anal vent is also referred to as the anus. This is where urine, feces, eggs and milt exit the digestive system.
- **Air Bladder**: Air bladder is also called the gas or swim bladder. The air bladder is a membranous sac filled with gas, situated in the body cavity of fish, ventral to the vertebral column which is used to control buoyancy.
- **Kidney**: These organs have multiple functions. They remove waste from the blood and produce urine. Kidneys also aid in osmoregulation and production of red blood cells. Osmoregulation is the ability to control the concentration of substances in body fluids compared to the liquid outside of the fish.
- **Spleen**: The organ in which white blood cells are produced and red blood cells are recycled. The spleen is also the storage location of blood for emergencies.
- **Brain:** The control center of the nervous center.
- **Otolith**: referred to as "ear bone" or "ear stone." These mostly calcium carbonate ($CaCO_3$) structures help keep fish upright in the water column. Growth rings formed in otoliths allow biologists to determine the age of a fish.

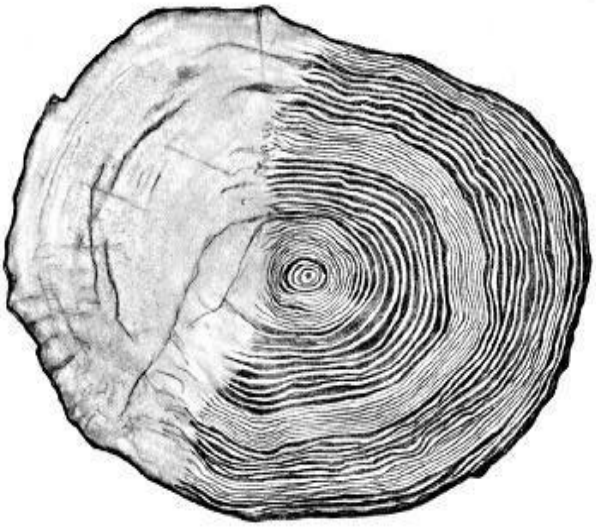
Dissection Preparation:

- Before the dissection begins, prepare all materials in a convenient area.
- Cover the dissection surface with newspapers, and then butcher paper on top of the newspaper.
- Take time to consider the physical arrangement of the room.
- Keep in mind that some students may not want to physically participate, but make it easy for them to participate at their own comfort level.
- Make sure that you have adequate volunteer support for the number of participants.
- Talk to the volunteers and ask them to encourage their students to discover the different parts, but not to remove any parts until they have had a chance to discuss them.

External Anatomy Features:

- Use handout 2.7 to identify the type of Pacific salmon you have:
    - King, or Chinook salmon
    - Coho, or Silver salmon
    - Pink, or Humpy salmon
    - Chum, or Dog salmon
    - Sockeye, or Red salmon

Slime Layer and Scales



Fish scale

What is the first thing you notice when you hold a fish?

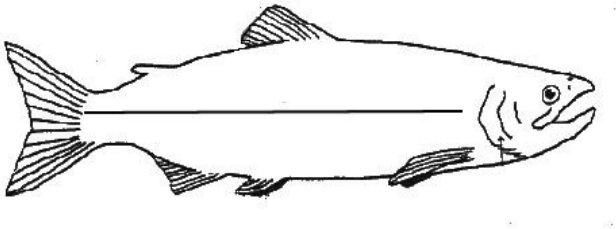
- *The fish is slippery.*
- *Many fish, including salmon, have a layer of slime covering their bodies.*
- *The slime layer helps fish to:*
  - o *Slip away from predators, such as bears;*
  - o *Slide easily through water;*
  - o *Protect it from disease, fungi, parasites and pollutants that might be in the water. (It's a living bandage that protects the salmon.)*

What should you do to protect the slime coat on a fish that is alive?

What covers the fish's body under the slime layer?

- *Small scales, hard plates like fingernails that cover a fish's whole body.*
- *The scales overlap to form flexible armor plating that protects fish from predators and bruising.*
- *They start to reabsorb their scales when they spawn. (Scales aren't usually completely reabsorbed at the time of death.)*
- *The way scales are arranged in rows or patterns is different for each species of fish. You can tell one species from another by the size of the scales and the way they are arranged.*
- *Fish have the same number of scales all their lives. As fish grow, the scales grow. Along the way, they form lines like the rings in a tree. Biologists can tell the age of a fish and how many years it spent in freshwater or saltwater from the lines on its scales.*
- *If a fish loses a scale, it can grow another to replace it. New scales have a clear focus, because they do not have the growth lines.*

Remove a scale and have students examine it later under a hand lens or microscope.



Fish Shape and Features

What shape is a fish? What shape is a salmon? Why are fish shaped this way?

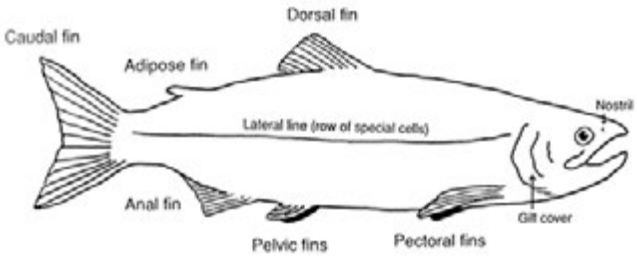
Fish come in many shapes, although torpedo shape is the most common. Salmon are torpedo shaped.

However, some fish, like flounder and halibut, are flat. Some are almost string-like and a few are round, like a balloon.

The streamlined shape of a fish lets it move easily through water. Water has much more resistance to movement than air does, so it takes much more energy to move through water. A streamlined shape saves energy.

What are the main parts of a salmon that you can see on the outside?

- *On the head, you can see the mouth, eyes, and nostrils.*
- *On the body, you can see the fins and tail, the vent and the lateral line.*



Fins and Tail

How many fins can you see? How are they arranged?

- *Salmon have eight fins, including the tail.*
- *Some fins are arranged in pairs, one on each side of the salmon's body.*
- *The pectoral fins are in the front, below the shoulder.*
- *The pelvic, or ventral, fins are on the belly, farther back from the head.*
- *The others, known as median fins, are arranged in a line on the salmon's belly and back.*
- *The dorsal fin is in the center of the back.*
- *The anal fin is in the center of the belly, just in front of the tail.*
- *The adipose fin is on the back, in front of the tail. (The adipose fin is sometimes clipped off in hatchery fish to help identify the fish when they return or are caught.) The tail is a special fin at the back of the body, called the caudal fin. It includes the end of the backbone.*

What do the fins do?

- *The fins have different functions.*
- *The caudal fin, or tail, 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 in which the fish moves.*
- *The anal fin also helps keep the fish stable and upright.*
- *The pectoral and pelvic fins are 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 does not seem to harm salmon if it is cut off from nursery fish.*
- *Note that a fish uses its whole body to move through water, but the fins give it much more control. Even without fins, however, a fish would be able to swim, but it would not be able to right itself easily.*

What do all the fins have in common (except the adipose fin)?

- *The fins are made up of a fan of bone-like spines with a thin skin stretched between them.*
- *The fins are embedded in the salmon's muscle, not linked to other bones, as limbs are in people. This gives them a great deal of flexibility and maneuverability.*

Should you hold a fish by the tail or fins?

- *Handling and care for your catch is very important for the health of fish you intend to release, and for those you choose to retain as table fare. It is good to discuss and practice proper fish handling skills.*

Danielle Cyr, 10 years old, properly displays a Dolly Varden that she caught.

Photo courtesy of her father, Paul Cyr.

Proper Fish Handling

Handling and care for your catch is very important for the health of fish you intend to release, and for those you choose to retain as table fare. It is good to discuss and practice proper fish handling skills.

Live fish that you intend to release should be kept in the water.

Before touching the fish, remove any gloves and wet your hands. Wetting your hands will protect the fish's slime layer.

- *Slime aids fish in swimming and moving through water*
- *Slime helps fish escape predators*
- *Slime protects fish from bacteria and infection*

Handle fish with care

If you are going to hold a fish up for a picture or to show to a friend or family member, support the fish's entire weight with your hands. Return fish back to the water as soon as possible. As an exercise, try holding your breath when you pull the fish out of the water – this is what the fish is having to do – and then take a breath when you return the fish to the water. This way you realize what the fish is going through.

If you are considering releasing your fish, carefully remove the hook, taking care not to damage the fish's mouth.

Fish retained to be eaten should be cooled as soon as possible. This will keep the meat from spoiling.

Do not:

- *Do not hold the fish by the tail!*
  - *This can cause damage the fish and meat*
- *If releasing the fish do not hold the fish by its fins*
  - *Fins help the fish maneuver in the water*
- *If releasing a fish, do not touch the gills or hold the fish by the gill plates*
  - *Gills are what allow the fish to breath in the water*

Lateral Line

- *Have students examine the line that goes laterally across the body of the fish.*

What is the lateral line for?
The lateral line is a specialized organ which all fish have, and which functions like an ear. It detects vibrations and pressure waves in the water, just as an ear does in air. The lateral line is a series of liquid-filled canals below the skin along the side of the fish.

It combines aspects of an organ of touch, an organ of hearing, and an organ of seeing.
Fish use the lateral line mainly to tell distance and water flow, and to detect disturbances in the water. Some fish can use the lateral line to find their way when it is too dark or muddy to see, and to feel movement around them or detect changes in the water.

From external features can you tell if the salmon is a Male or Female?

- *<u>Male salmon</u> will have unique identifiable characteristics:*
  - o *Hump on back*
  - o *Hooked upper jaw, referred to as kype*
  - o *Flat belly*

These features are more identifiable the closer the salmon is to their spawning grounds.

- *<u>Female salmon</u> will have unique identifiable characteristics:*
  - o *No hump on back*
  - o *Slightly rounded upper jaw*
  - o *Rounded belly due to eggs developing inside*

These features are more identifiable the closer the salmon is to their spawning grounds.

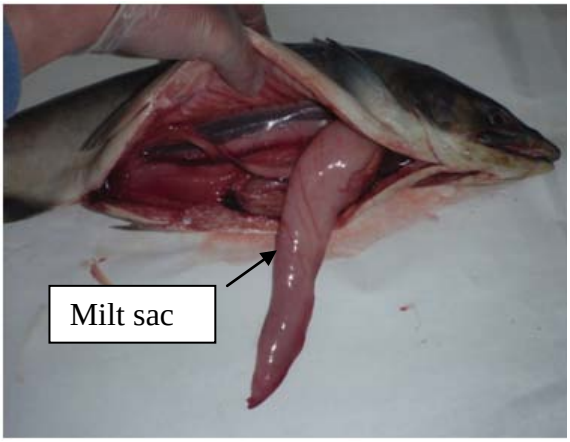
- *Remind students that as scientist we always need to be respectful of our subjects.*
- *If this is going to be table fare, remind them of that.*
- *If it is not going to be food for human consumption, let them know that these salmon are going to be food for other animals.*
- *We do not want to destroy fish in our quest to learn about them.*

Cutting the Fish Open:

Zak Knives and other knives are not to be left out for participants to use and should only be handled by a responsible adult. A safe cut is always away from your body and not toward participants.

Before making a cut, be sure that no hands or participants are in the way of the incision.

It is recommended that a Zak Safety Knife is used by an adult to make one incision from the anal vent toward the head until immediately past the pectoral fins. Additional cuts may be required if you are unable to cut through the belly meat in between the pectoral and pelvic fins.



Eggs or Milt

What hypothesis would you make about whether the fish is male or female?

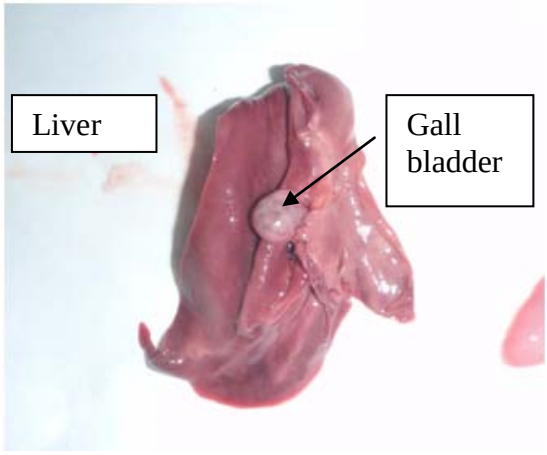
If the fish is a mature female, a large portion of the body cavity will be filled with eggs. If the fish is ripe and ready to spawn, the eggs will be loose within the body cavity; more likely, the eggs will be contained within a membrane (skein). Pull out one of the roe sacs by hand and observe the blood vessels contained within the membrane.

If the fish is a mature male, you will find two whitish-pink sacks that go the length of the body cavity. These milt sacks are where millions of sperm are made. Milt provides half the genetic information needed for fertilization to occur.

Using your hands, carefully remove the two skeins of eggs or the milt sacks.

Why does one salmon have so many eggs?

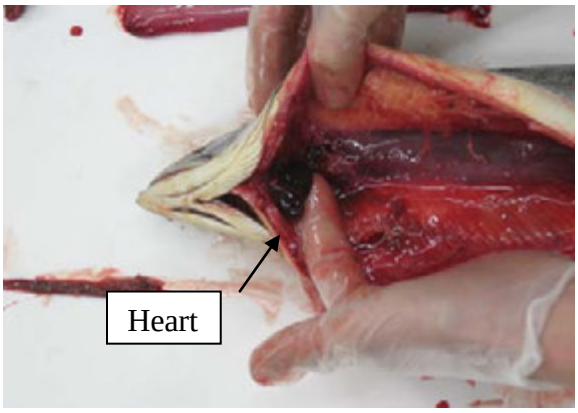
A female coho salmon has about 2,500 eggs, while other salmon species have from 2,000 to 5,000. In coho, only about 15 percent survive to hatch and only about 30 survive the first year. About four will grow to become adults, and only two will live long enough to spawn. So each female produces enough eggs to replace only one pair of fish.



What is the largest organ in the fish's body (and in a person's body, too)? Before you remove this organ look to see if a sack of fluid is attached. What is this sack?

The liver is the largest organ. It is dark red and firm in texture. The liver aids the fish in digestion, storage and excretion. This sack is the gall bladder. The gall bladder is a sack in which bile is stored and used to digest fats.

Carefully remove the liver and gall bladder using your hands. Place it on a paper plate, cut it open, and have the students examine it.



The Heart

Where would you find the salmon heart?

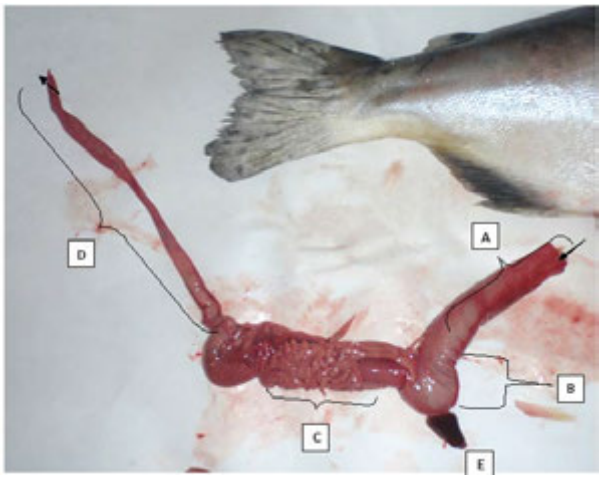
The heart is located where the gill covers fuse together high up in the throat.

Carefully remove the heart with your fingers and place it on a paper plate.

What does the heart feel like? Why?

The heart feels tough but flexible. It is a strong muscle, It is triangular in shape, and consists of two chambers. The white tube is the ventral aorta, which leads to the gills and gill capillaries.

The Digestive System



How would you find the digestive system?

Start at the mouth and feel the tongue and look down the throat follow the route that food would go through the salmon. You can use your finger or a straw to stick down the throat to see where it is on the inside of the salmon.

Mouth: food is not chewed, prey is swallowed whole and alive. Teeth are on their tongue to hold the fish from escaping. Throat/Esophagus

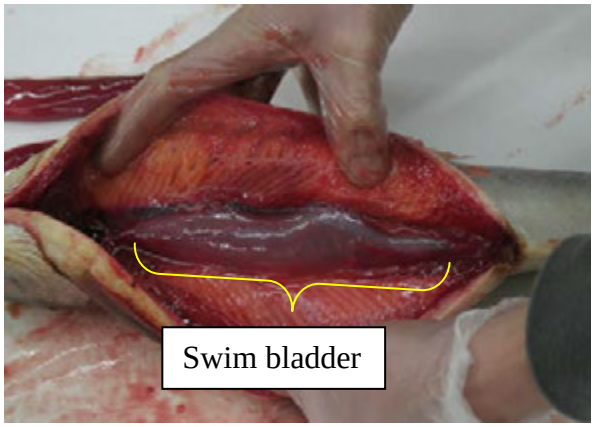
- *(A) The esophagus is tough so prey do not damage or break it.*
- *(B) The stomach is where food starts to break down nutrients.*
- *(C) Pyloric caeca aids in digestion and absorption.*
- *(D) Intestine facilitates absorption and transport of waste to the anal vent.*
- *(E) Look for bright red organ attached to stomach. This is the spleen. The spleen acts as a storehouse of blood and aids in development.*

Carefully remove the digestive system. Assistance with a Zak Knife might be needed to cut the tough tissue of the esophagus.

Does your salmon of have any partially digested food in its stomach?

If the fish has been taken from a river, it is unlikely that that food will be found in the digestive system. Salmon do not eat once they enter freshwater. The digestive tract is short and simple, and does not feature the extensive intestine that mammals have.

The Swim Bladder



Carefully look for the swim bladder. It often looks like pink, glossy deflated balloon.

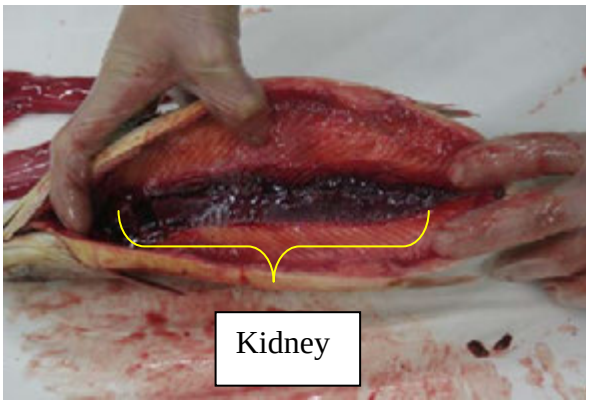
The swim bladder, also called a gas bladder or air bladder, is a whitish, thin-walled sack that may look like a deflated balloon. On salmon the swim bladder is attached to the esophagus by stripping it out from the front with your fingers. Be careful not to damage the swim bladder as you are removing it.

Would anyone care to demonstrate how the bladder can be inflated?

Most fish are able to adjust their swim bladder in order to regulate their buoyancy in the surrounding water. Notice that the swim bladder is just below the spine, which is just below the center line, or the center of balance, of a fish. This is why fish float upside-down when they die.

When a fish, such as a salmon, is deep in the ocean, it adjusts the amount of air in its swim bladder so that it can hover comfortably without sinking or rising in the water. This enables the fish to conserve energy. Some bottom fish, such as a rockfish, are unable to adjust their swim bladders by burping, and can only adjust their swim bladder slowly to different levels. This is why when a rockfish is caught and quickly brought to the surface its swim bladder protrudes from mouth; the swim bladder has expanded due to the rapid decrease in pressure and is forcing the internal organs out through their throat; this is a severe sign of barotrauma.

Gently detach the swim bladder, without tearing it, by stripping it out with your fingers. Cut open one end and insert a straw. Have a student gently inflate the bladder by blowing through the straw, then twist the end and float it in the bucket of water. Place the bladder on a paper plate and ask students to examine it.



The Kidney

What color should the kidney be? What is the purpose of the kidney?
The kidney looks like a dark red line along the backbone. The kidney cleans the blood and produces red blood cells.

Tear through the membrane holding the kidney in place and use the spoon carefully to remove it. Place it on a paper plate and ask students to examine it.

The Ribs and Backbone

What are the bones that surround the abdominal cavity?

The ribs are lightweight, curved bones that give the fish its shape, just as ribs create the barrel-like shape of a human torso. The ribs protect the salmon's internal organs.

Slice through the membrane on either side of a rib and pull it up toward the backbone. Pull to disconnect it, place it on a paper plate and have students examine it.

What does the backbone look like?

Mammals and boney fish both have a flexible backbone. The backbone is made up of a series of interlocked disks. They can move from side to side, but fish can only bend up and down a small amount. The backbone protects the spinal cord that runs through the body to the brain and gives structure to the fish's body.

Muscle

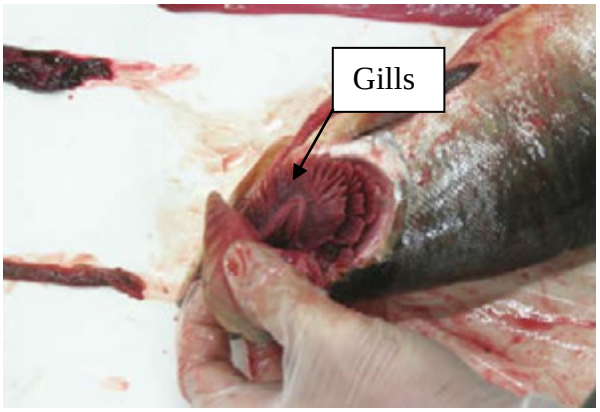
What is the tissue in between the ribs and what does it do for the fish?
Muscle is the main source of locomotion for the fish. It is also the primary part which people use for food. Salmon use their muscles to swim thousands of miles, often surviving only on the fats that have stored while out in the ocean.

- Option: <u>It is illegal to waste sport harvested fish or game!</u> If the fish is edible, have an adult filet the fish by slicing the flesh away from the ribs and backbone, first on one side, then on the other, exposing the ribs and backbone. Refrigerate the filets.

The Head

The salmon head is boiled in many cultures for soups.

Gills



How do fish breathe? Can someone demonstrate the motions for the class?

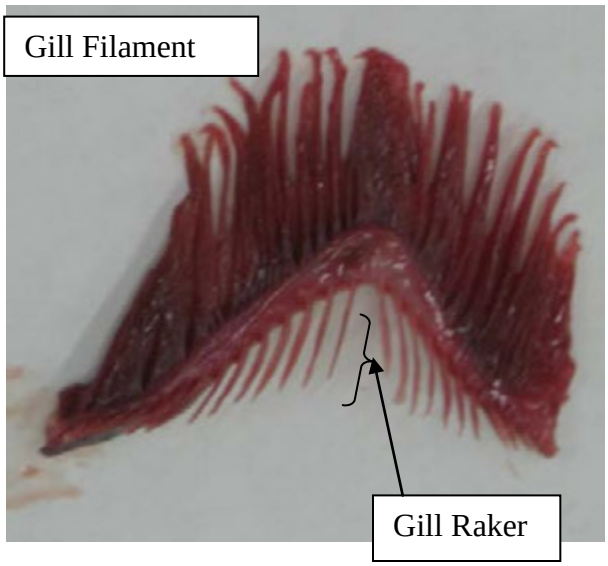
The gulping action demonstrates how water is drawn in through the open mouth. The mouth and throat close and the water is forced out past the gills. Gills extract oxygen from the water. Cold water, if saturated with oxygen and holding as much as it can, may have 13 parts of oxygen for every million parts of water.

To demonstrate what 13 parts per million (ppm) is, imagine that you have a million marbles, of which 13 are white oxygen marbles, and the rest are blue water marbles. If you were to drop one marble per second into your pocket, how long would it take you to reach a million? 12 days! Imagine how large your pocket must be.

At the end of 12 days of marble dropping, you would then drop in the 13 oxygen marbles: that shows how efficient gills must be, and how sensitive they are to material in the water. In fact, some pollutants cause problems at levels of parts per billion. Using the same analogy, it would take 38 years of marble dropping to get a billion! Fish and all living things must live within a healthy environment, which is why it must be clean.

What protects the outside of the gills?

The operculum, or gill cover, is a hard outer lining like a flexible plate that the fish opens and closes to let water through.



What do they look like?

They are red because you can see the blood through the thin cell walls of the gill filaments. The thin walls aid in the transfer of oxygen. Look for the gill filaments and the gill rakers (the sharp spines that guard the opening of the throat).

Remove the gills from the opening of the throat. Place them on a paper plate and have students examine them.

Why does a fish need spines lining the gill opening on the inside of the throat?

The gill rakers prevent food from passing through the gill passage, and instead contain, trap, and direct food into the throat.

Vision

Reach under the gill with a finger and push up to loosen the muscles around the eye. Then cut the muscles attaching the eye to the eye socket and pull it out. Place the eye on a paper plate and have students examine it.

How are fish eyes similar to and different from people's eyes?

Salmon have two eyes but, unlike people, salmon do not have binocular vision, which would give them depth perception. However, the salmon can swivel each eye independently forward and backward, to cover a much wider field of vision than people have.

- Fish have very sharp vision under water.
- Some can see five meters or more.
- Fish have no eyelids.
- Their eyes are continuously *washed in water.*

How do salmon smell?

Fish have nostrils above their mouths, but no noses. The nostrils are not connected to the mouth cavity. Their olfactory organs detect chemicals in the water in very tiny concentrations. They use this information to detect harmful pollution and avoid potential threats. They also use smells to recognize their way home.

Can salmon hear?

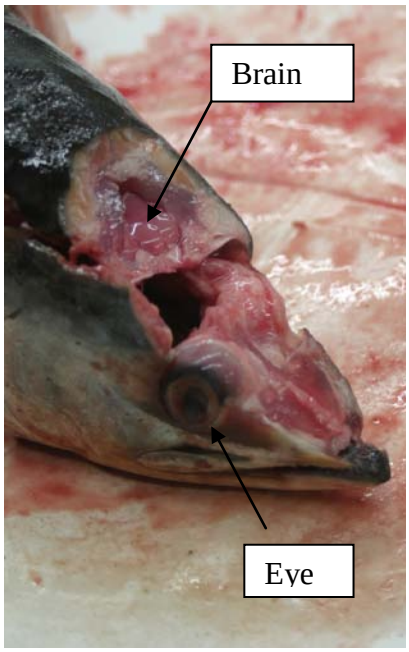
- Fish have an inner ear, but no outer ear. Sound waves travel through the water and through the fish's body to the inner ear.
- Fish may also detect sound waves through their lateral lines.
- The hearing range in fish is probably not as wide as in humans. However, fish likely use hearing to detect predators and other threats.

Do salmon have a sense of taste?

Salmon 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.

The Brain

- *(Adult) Split the head open by placing the fish on its back, pressing the knife vertically into the backbone at the base of the head, and levering forward into the mouth. The brain will be visible in the split.*



What organ do salmon use to process all the information their senses gather and to respond to stimuli in their environment?

Like all chordates, salmon have a brain at the end of their spinal cords where the nervous system transmits the information they receive about their environment. Salmon brains have three pea-shaped sections. The forebrain controls the salmon's sense of smell. The midbrain controls vision, learning and responses to stimuli. The hindbrain coordinates movement, muscles, and balance.

Clean-up and Conclusion

- *If students are conducting a dissection, have them gather all scraps, rubber gloves, newspaper, paper towels, paper plates, etc. in the garbage bags (unless you have made provisions for returning or disposing of the waste).*

- *Have students use buckets of clean water with disinfectant and paper towels to thoroughly clean tables, chairs, sink, etc.*

- *Have students draw a stick figure on a sheet of paper, with a large thought bubble on one side and a speech balloon on the other. Have them write in the thought bubble words that describe how they felt during the dissection. Have them write in the speech balloon words that describe what a scientist would conclude following the dissection.*

- *Invite students to share their thought bubbles and speech balloons with the class and discuss their reactions. If necessary, prompt them with questions, such as:*

What would make people feel uncomfortable during a dissection?

Cutting open a body can create new sights and smells, etc.

How do scientists react if they feel uncomfortable?

They talk about their concerns, discuss why they feel uncomfortable, and why they want to continue or stop the investigation.

What would a scientist conclude from the observations?

Salmon have many complex biological systems that are made up of specialized organs in order to live. Some of these organs have similarities to humans and other animals. Some organs are unique to fish.

- *Have students refer to their notes and information sheets and compare the structural and internal anatomy of a fish with that of a human, including the muscular, skeletal, respiratory, digestive and reproductive systems.*

Pacific Salmon ID
Marine Phase

Chinook (king)
- Spots on both lobes of tail
- Large spots on back
- Mouth is dark with a black gum line

Coho (silver)
- Black spots on back
- Black spots on upper lobe of tail
- Sliver streaks on tail
- Wide caudal peduncle
- Mouth is light with a white gum line

Pink (humpy)
- Large oval spots on both lobes of tail
- Large oval on back above lateral line
- Very small scales
- No silver on tail
- Mouth is white with a black gum line

Chum (dog)
- Calico markings (vertical bars) faint on bright fish
- No spots on tail or back
- Grey streaks on tail
- Mouth is white with a white gum line

Sockeye (red)
- Green head
- No spots on tail or back
- No streak on tail
- Mouth is white with a white gum line

Handout 2.8

Dissecting a Salmon

Name:

Mouth
Why does the salmon tongue have teeth on it?

Slime Layer and Scales
The slime layer helps salmon to:

-
-
-

Lateral Line
The lateral line helps salmon to:

Draw a salmon scale, showing its growth lines:

Fish Shape and Features:

Draw the main external features you can see on a salmon:

Handout 2.8

Dissecting a Salmon

Fins and Tail

On your diagram, label four median fins and two sets of paired fins you see on a salmon.

Draw one of the salmon's bony fins, showing its parts.

Gills and Gill Rakers

Write three or more observations about the gills and gill rakers.

Eggs or Milt

State whether your fish is male or female and explain how you know.

Describe the egg or milt sac from the dissection (e.g., its shape, texture, any features, number of eggs)

Handout 2.8

Dissecting a Salmon

The Liver

Describe the color and texture of the liver.

The Heart

Describe where the heart is located and explain why it is located there:

The Digestive System

Draw and label the main parts of the digestive system:

The Swim Bladder

Describe how the swim bladder works:

Handout 2.8

Dissecting a Salmon

The Kidney

Describe the salmon kidney and what it looks and feels like:

The Ribs and Backbone

Sketch the skeleton of a salmon, showing the ribs and backbone:

Explain how you should hold a salmon you caught so you don’t hurt the fish:

What part of the fish could you damage by improperly holding a fish?

Handout 2.8

Dissecting a Salmon

The Head

What sense organs are located in the head of a salmon?

The Brain

Draw the location of the brain on your sketch of the salmon’s skeleton:

Handout 2.9 (Part 1)

Salmon External Anatomy

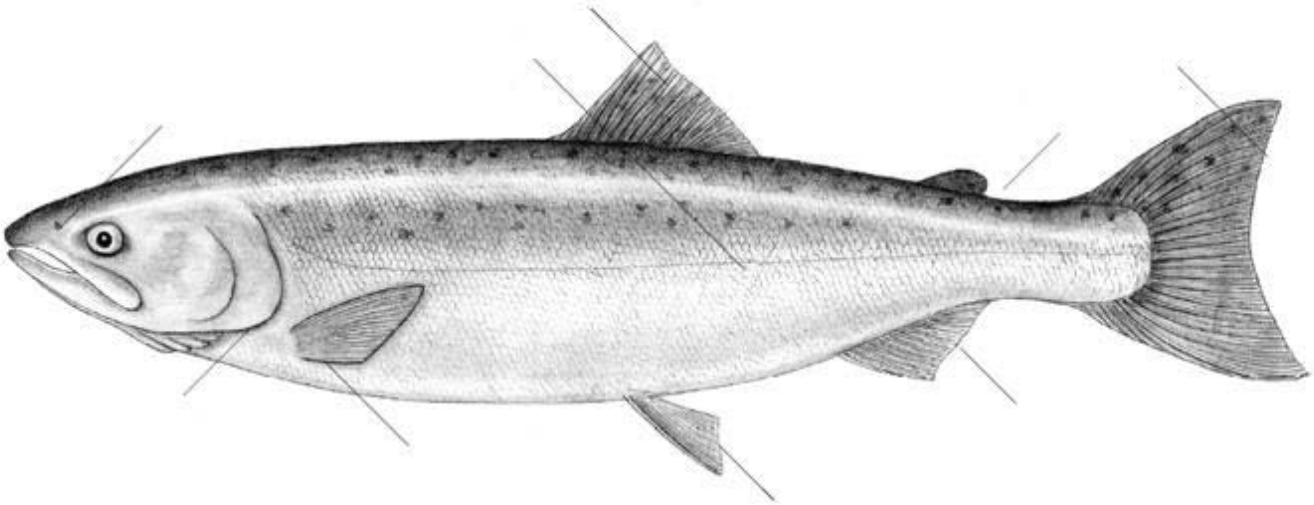
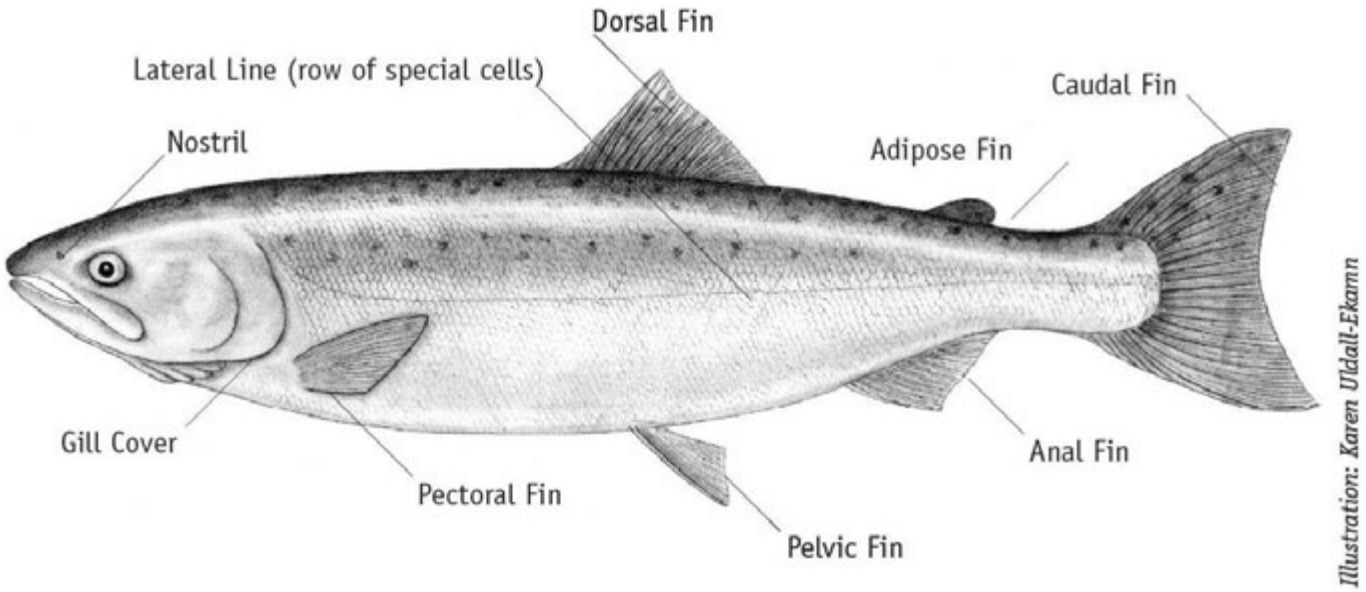


Illustration: Karen Udall-Ekamn

Handout 2.9 (Part 2)

Salmon External Anatomy



Handout 2.10 (Part 1)

Salmon Internal Anatomy

female salmon

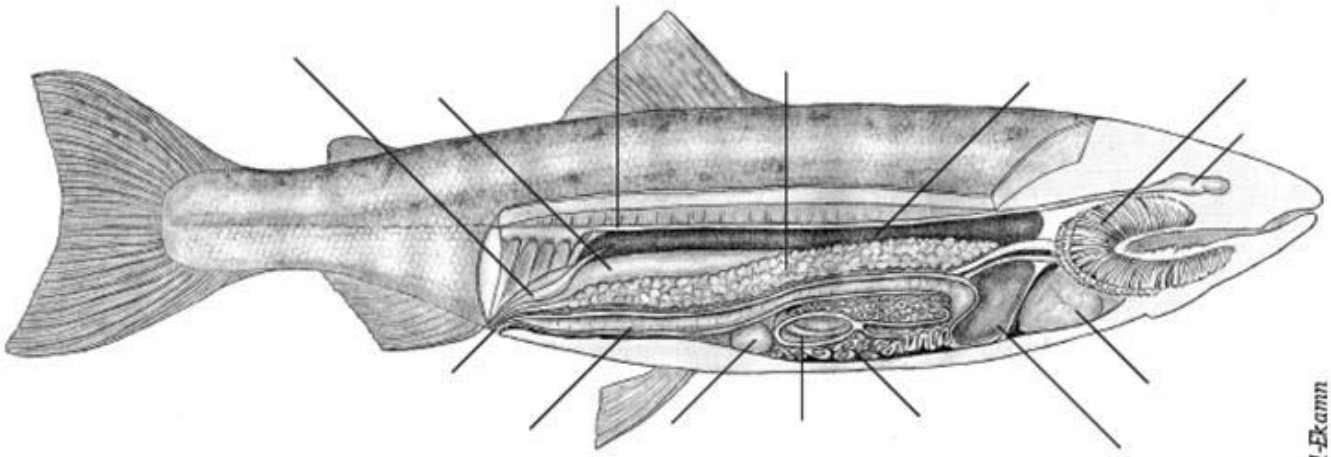
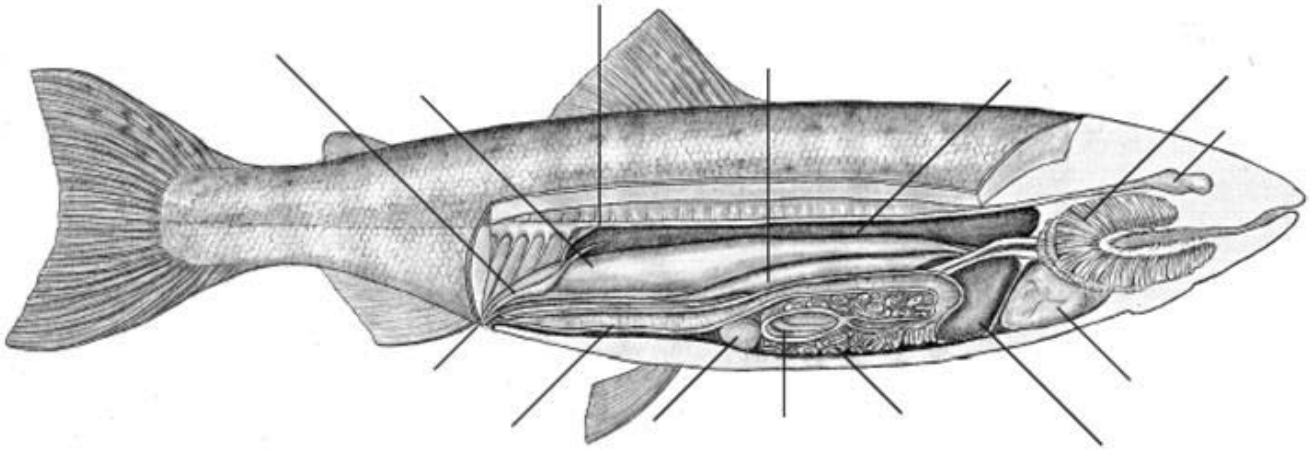


Illustration: Karen Udall-Ekamn

male salmon



Handout 2.10 (Part 2)

Salmon Internal Anatomy

female salmon

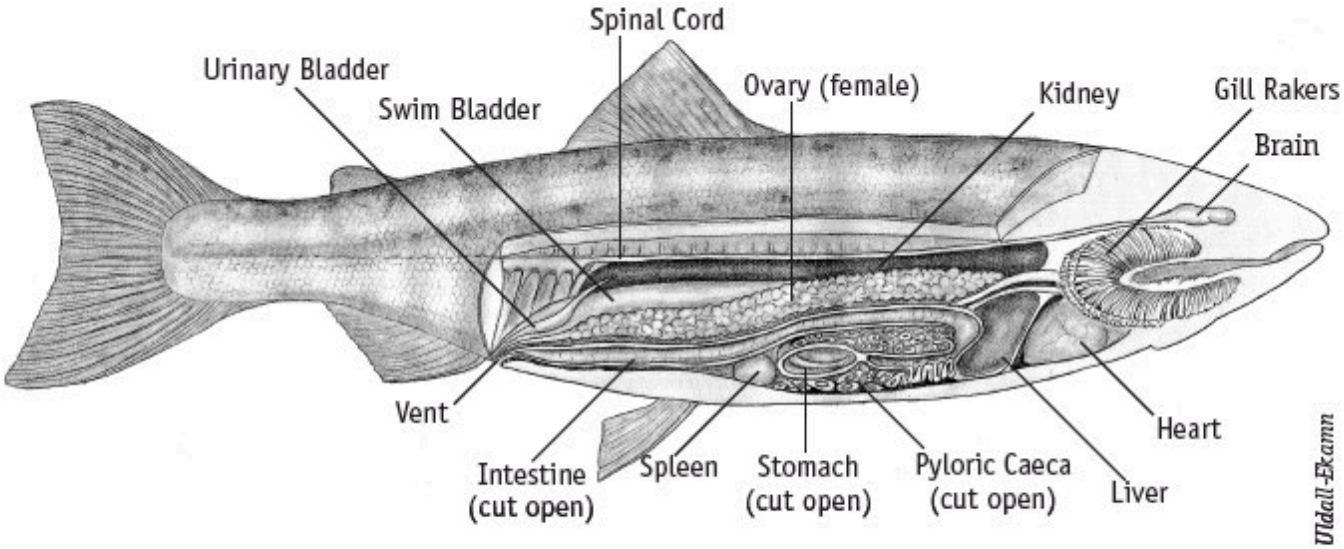


Illustration: Karen Uldall-Ekamn

male salmon