

Salmon Dissection

Science Fair & Investigation Nights

Overview: *Friends of the Issaquah Salmon Hatchery offers a hands-on opportunity for students to learn more about our salmon neighbors. We will bring several salmon props and learning tools, a microscope with salmon-related slides that you make, and a partially dissected salmon! Kids and people of all ages can get as up-close and personal with the salmon as they like, checking out the internal anatomy, or just looking at the designs made by the scales on the skin, and counting fins.*

Goal: *Introduce a broad range of students and their families to FISH and our programs. Provide an extended salmon learning opportunity for a wide range of ages including young children.*

Theme: *Salmon anatomy and science*

Key Words: *Dissection, anatomy, internal, external, microscope, organs, riparian, climate change*

Objectives: *Each person will...*

- 1. Observe a dead salmon, specifically observing some or all parts of external and internal anatomy*
- 2. Compare some or all of a salmon's organs and anatomy to humans*
- 3. Understand of the effects of urban runoff on salmon populations*

Details

Set Up: Arrive at least 30 minutes prior to the Fair start time and check in with the contact person. If there is time left over after setting up, you can roam around and network!

Typically we request two tables. Cover whatever area of the table you'll be using for the dissection with the plastic table cloths provided. Place salmon on newspaper/butcher paper/ tray. Optional—place some (maybe 5 or 6, not ALL) popsicle sticks/toothpicks out for students to use to open up salmon and investigate ("probe") the internal anatomy. Place laminated diagrams nearby so they can be referenced. Make sure tools are not accessible. Can pre-dissect or wait for first group to cut open.

Put up display board at back of other table. Place other items in front of table like camp flyers, volunteer flyers, business cards, information sign-up sheets. Set up the microscope, slides, and "A Fish Riddle" sheets. Cut off some of the salmon skin, part of a fin, the flesh, or any part of the salmon for students to view through microscope. Make a sign of what students are viewing in microscope. Mount skin or salmon piece on slide using a drop of water so it stays in place. **Make sure to turn off the light/microscope when not in use. The bulbs burn out quickly.**

Use talking points provided to guide discussion as needed. ***Switch roles when and if you want. **Take photos!**

SALMON DISSECTION VOLUNTEER :

- Invite people to use the sticks "**probe**" the salmon. Avoid the word "poke" (probe is more scientific, and it encourages careful looking, not poking the internal organs).
- People may say "GROSS" a lot. I like to redirect those negatively-worded exclamations to "WOW, Interesting!" by framing things in a more "scientific" way. (I.e., Scientists would not say, "eww, gross" they might say, "Interesting!"). Acknowledge the smelliness, but ask them why it's smelly (...because it's a fish, because it's dead, because there are bacteria already decomposing the salmon, etc).
- Ask people to **identify** the organs based on the diagrams; have people check out the fins and skin (if the internal anatomy is too "gross" for them). They can look at microscope.
- **Use talking points to guide discussion or answer questions from attendees**
- **Compare** the salmon's internal organs to human's organs. Main differences are gills, swim bladder and stomach/digestive system.
- **Discuss** the effects that pesticides/herbicides, fecal coliform, pollution, etc have on salmon

DISPLAY AND OUTREACH VOLUNTEER: **Take photos!**

- Acknowledge every person that comes up to the table, at least by saying hello or making eye contact and smiling, even if you're in the middle of a conversation.
- Ask: "*Have you ever been to the Issaquah Hatchery?*" "*Do you know what a hatchery does?*" or "*Are you interested in learning about summer camp opportunities or volunteering in Issaquah to help salmon?*"
- **Keep an eye on the microscope and remember to turn off the light when not in use.** HINT: Take the microscope off the table and hold it down lower for little kids that can't reach. Help younger kids experiment with where their eyes should be to see in the eye pieces. You can even close off one of the eyes with tape.
- Ask parents and kids if they know about our summer camp, and give them a flyer (or have them leave their email address).
- Interpret salmon vials and answer questions

Clean Up: Clean up tools, and put away all materials in bin. Wipe down plastic table cloth with Clorox wipes, try to let dry, refold and put in fair bin unless really bloody or torn to bits. Wrap the salmon up in the newspapers, put in original plastic bag, and bring back to hatchery dumpster or throw the fish back in Issaquah Creek. All other waste goes in dumpster even if it is compostable! Do not leave waste at school!

Please return supplies back to the volunteer office as soon as possible, as they might be used the next day (and possibly picked up in the morning). **If there are things missing or used up, YOUR JOB IS TO REPLACE SUPPLIES FROM THE "Extra Supplies for Science Fairs" BOX. INFORM PROGRAM COORDINATOR WHEN EXTRAS ARE RUNNING LOW at education@issaquahfish.org**

Basic Talking Points

"He may not look like it right now but this is a very fortunate Coho salmon. He is less than 1% of all the eggs hatched at the Issaquah Hatchery that made it back from the Pacific Ocean and was able to complete his life cycle!"

External Anatomy

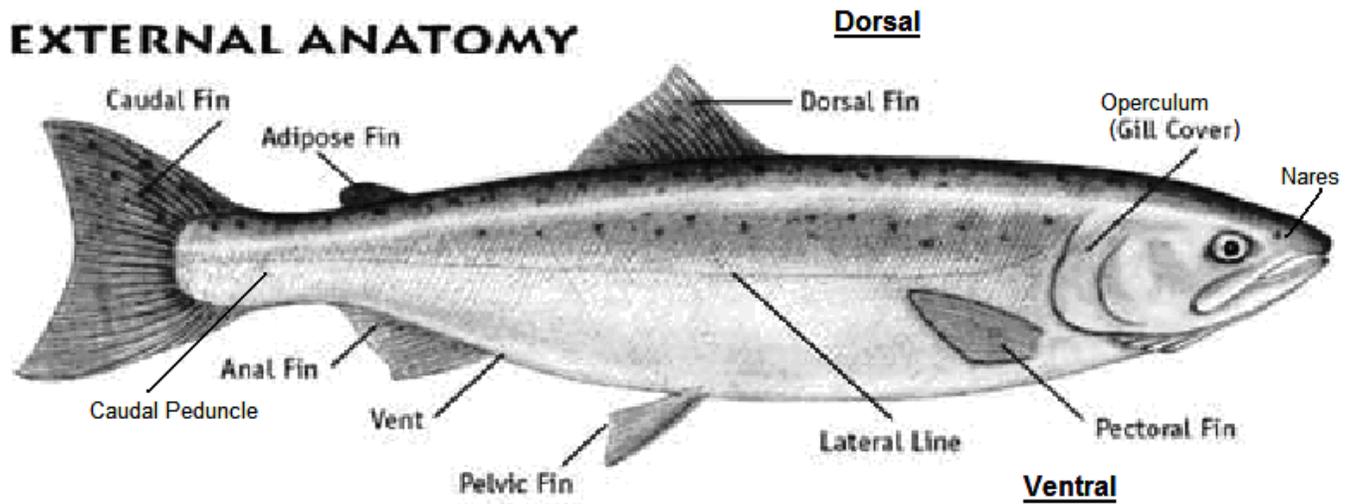
- 1) Do you think this is a male or a female salmon?
- 2) What do you see on the outside of his body that makes this salmon a fish? (Point out if not offered)
 - a) **Slime!** How does all this slime help him? It protects against parasites attaching on to scales. Acts like a band-aid covering wounds and scrapes and helps them glide through water
 - b) **Scales** – we can tell how old a salmon is by the rings on their scales! They also maintain the same number of scales their whole lives; they just grow larger throughout their lives
 - c) **Fins** – They use these to steer, only the caudal fin to propel them forward
 - d) **Eyes** – Fish use their large eyes to find their prey and to evade predators (can remove)
 - i. "Why don't they have eyelids? -don't have to keep eyes moist like we do
 - e) **Nares** – Did you know salmon have nostrils?
 - i. What do they use these for? - Smell their way home!
 - f) **Teeth** – on tongue, along jaw, on kype not used for eating, but filtering sediment.
 - g) **Lateral Line**– 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; allows fish to detect movement of other fish and predators in the water. It also separates the dark upper body from the light upper body when it is in the ocean and a "silver" salmon. Silver is another name for Coho. *Oncorhynchus Kisutch* is its scientific name.

Internal Anatomy

- 3) Open up this salmon's abdomen with a hen knife if not pre-cut. This is the same knife we use to remove eggs from female salmon when we spawn them. Show hen knife if pre-cut.
 - a) **Respiratory System**
 - i. "Take a big deep breath. Good! Where did your air go in your body?" -**Lungs**
 - ii. "How do salmon take a breath?- They open their mouth to flow water over **gills** {Docent removes 1 or all gills} pointing out **Gill Rakers**
 - b) **Swim bladder** – controls buoyancy
 - c) **Circulatory System**
 - i. What pumping body part is located right next to your lungs? -**Heart**

- ii. Show me with your hands how big your heart is (slightly smaller than their fist); Now show me how big you think this salmon's heart is?
 - iii. Where do you think the salmon's heart is? Pop out and then back in. Some remove it.
 - iv. **Repeat with other organs of circulatory system**
- d) **Spleen:** Who knows what a spleen is? A store house of blood for emergencies as well as a recycling plant for worn-out red blood cells. It also produces white blood cells to help protect the body against disease and infection.
- e) **Liver:** What does the liver do for us and salmon? -It absorbs or synthesizes and secretes or release the essential nutrients that are contained in food. It also helps to maintain proper levels of blood chemicals and sugars.
- f) **Digestive System**
- i. Where in your body does food get digested? **-Stomach**
 - ii. **Pyloric cecae**- The stomach needs the help of the Pyloric Cecae, which absorbs nutrients from food into the blood.
 - iii. **Liver**- stores, synthesizes and secretes essential nutrients and assists in digestion by secreting enzymes that break down fats.
 - iv. **Gall Bladder**- sac attached to the liver in which bile is stored and used to digest fats
- g) **Reproductive System**
- i. **MALE** Testicles/male reproductive organs – as this fish journeyed back home, its testis grew large and filled with milt so that it could fertilize eggs.
 - ii. **FEMALE** Develops a skein of eggs, up to 2,500-3,000 for female coho
 - iii. Did you know that in the wild salmon have about 10-60 seconds at most to release their eggs and fertilizer? They have to make sure they release eggs and milt into the nest at the same exact time! If the female releases her eggs in the redd and 5 minutes later the male comes by and fertilizes the eggs, they will not develop at all!!
- h) **Urogenital System**
- i. Where do salmon go as adults? **Ocean**
 - ii. Do you think it is easy or difficult for salmon when they transition from fresh to salt water? **Osmoregulation** (salt/fresh water).
 - iii. What organ makes your urine? **Kidneys** – remove waste (in the ocean it is salt) from the blood and produce urine
 - iv. What organ do you use to get rid of salt in your body?
 - v. Sweat and tears taste salty because we need to release the excess salt from our body. Same with salmon.

External Anatomy



External Anatomy

Dorsal: The top of the fish, or the back of a human.

Ventral: The bottom of the fish or the belly of a human.

The Fins

Dorsal Fin: Provides steering control and balance

Adipose Fin: There is no known use; however, this fin is often clipped to differentiate hatchery fish from wild fish

Pectoral Fins: Aids in stabilization, maneuvering, and braking.

Pelvic Fins: Aids in stabilization, maneuvering, and braking.

Anal Fin: Provides balance.

Caudal Fin: Also known as the tail fin it provides the main source of propulsion. Females use their caudal fin to dig their redd (nest).

Body Shape

The overall body of a salmon is streamlined for easier movement through the water.

Nares: Fish use their nostrils for smelling, not for breathing.

Eyes: Fish eyes can see both to the left and right at the same time, and each eye can move independently.

Mouth: Allows the fish to take in food. All salmon have teeth, but some have bigger teeth than others.

Operculum (Gill Cover): Protects the gills, similar to how a human's rib cage protects the lungs.

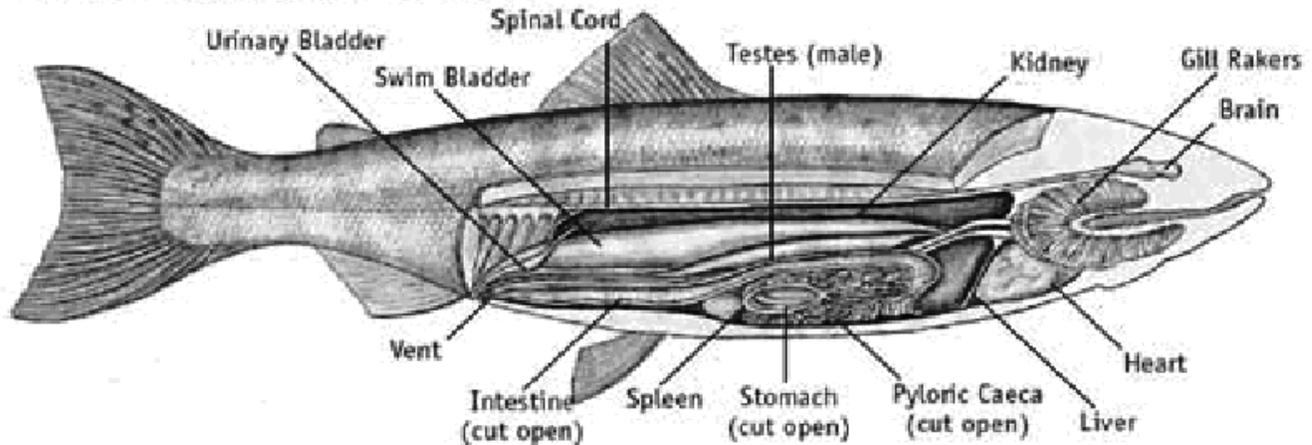
Lateral Line: A line that runs down the center of the fish. The line has little holes in it to help the fish sense vibrations in the water. These vibrations help fish tell the movements of other animals and objects in the water.

Scales: Protective outer layer. Scales overlap one another to form armor like plating around the fish. An up-close look at a scale reveals rings that can be used to determine the age of a fish, much like counting the rings on a tree.

Caudal Peduncle: The narrow region of the body of a fish just in front of the caudal fin. Provides the muscle to power the caudal fin.

Internal Anatomy

INTERNAL ANATOMY



Brain: This organ coordinates the messages received about the environment from the sensory organs i.e.: eyes, lateral line, nares etc. The forebrain controls smell, the midbrain vision, and learning responses to stimuli, and the hindbrain coordinates movement, muscles, and balance. (Nervous system)

Gills: Salmon breath oxygen. They extract oxygen from the water using gills. Each gill consists of a bony arch fringed with thin-walled tissues called gill filaments. These filaments have many small blood vessels. Water is pumped in through the mouth and sent over the gills. As the water flows over the gills oxygen diffuses in to the blood and CO₂ diffuses out of the blood. (Respiratory system)

Gill Rakers: Rakers are attached to the gill arch to guide food to the throat and to prevent it from entering the gills. (Respiratory system)

Kidney: Salmon have 2 kidneys that are joined together. Kidney's help maintain the body's fluid and chemical balance. The front kidney produces and replaces red blood cells and the back kidney filters waste from the blood. The Kidney is the main excretory organ that removes waste from the body. (Excretory system)

Testes/Eggs: Male produces fertilizer called "milt" and female has eggs which create the next generation. (Reproductive system)

Spinal Cord: Runs parallel to the backbone and nerves branch from it to various parts of the body. (Nervous system)

Swim Bladder: The bladder is filled with gas and is used for buoyancy control. Gas passes into and out of the bladder from the blood. A full bladder will allow the fish to rise in the water column, while an empty bladder will allow the fish to move deeper into the water column. (Nervous system)

Urinary Bladder: Reservoir which collects urine from the the kidneys. (Excretory System)

Vent: The body's exit. The vent releases undigested materials as well as eggs and milt/sperm during spawning. (Excretory system)

Intestine: Section of the digestive tract between the stomach and the anus where nutrients are absorbed and waste is transformed into fecal matter. (Digestive System)

Spleen: A store house of blood for emergencies as well as a recycling plant for worn-out red blood cells. It also produces white blood cells to help protect the body against disease and infection. (Circulatory system)

Stomach: Stores food and begins to digest food with digestion juices. (Digestive system)

Pyloric Caeca: A special intestinal pouch where most of the fish's digestion and food absorption. (Digestive system)

Liver: Largest organ in the salmon's body, it synthesizes and secretes the essential nutrients (amino acids i.e. proteins) that are contained in food. It also helps to maintain proper levels of blood chemicals and sugars. In addition it secretes green bile that is used to break down fats in food. (Digestive system)

Gallbladder: Stores the green bile secreted by the liver. (Digestive system)

Heart: The fish heart has one atrium and one ventricle; this is in contrast to the human (mammalian) heart that has two separate atria and two separate ventricles. In the fish heart, two other chambers can also be found: the sinus venosus and the bulbus arteriosus. The blood from the body, which is low in oxygen, enters the atrium via the sinus venosus. The blood is pumped into the ventricle by the atrium, which is a thin-walled muscular chamber. Then the blood is pumped out into the bulbus arteriosus by the ventricle: a thick-walled chamber with lots of cardiac muscle. The ventricle is responsible for the generation of the blood pressure. The last chamber, the bulbus arteriosus, is a unique structure and one of the functions is to dampen the pressure pulse generated by the ventricle. Why? The next organ after the bulbus arteriosus are the gills, and they are thin walled and may be damaged if the pulse pressure (or absolute pressure) becomes too high. The bulbus arteriosus contains elastic components but not many muscle fibers. (Circulatory system)

30-45 Minute Lesson Plan 6th-12th grade

Dissection Demo: Typically performed on a hatchery coho (post spawned male)

- Be careful with hatchery salmon! We do not want to be spreading any potential diseases. Always dispose in the natal stream origins or creek.

Safety first! Then respect:

- Remind participants to look away if uncomfortable and to sit down if dizzy/sick.
- These fish have beaten major odds to return as an adult. That demands our respect.

What species is this?

- Five finger/species memorizing method
 - Thumb = Chum (dog salmon)
 - Index = Sockeye (red salmon) – use index finger to poke someone in the eye
 - Middle = Chinook (king salmon) – longest finger is “king”
 - Ring = coho (silver salmon) – people often wear silver rings
 - Pinky = pink (humpy salmon)
 - Also: steelhead trout (in the salmonid family) and kokanee salmon (landlocked sockeye)

Is it a male or female?

- Point out the hooked jaw (kype) and fangs (for male)
 - Males and females look the same until they return to fresh water
 - Salmon do not feed after re-entering the fresh water
 - Why do they develop a kype with prominent fangs (tissue recedes) if not for feeding?
 - Males fight to establish dominance for spawning partners/habitat
 - They also protect their spawning zone (redd) from egg predators

What’s with the color?

- Salmon can manipulate their skin color for a number of purposes. To display dominance (and attract a mate), recognize their own species (especially during overlapping runs), display their readiness to spawn and camouflage (for some species, like chum).
 - http://wdfw.wa.gov/fishing/salmon/chum/chum_colors.html

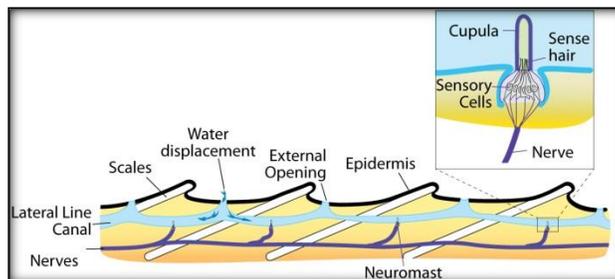
External Anatomy and Features: Be sure to compare/contrast with human anatomy

- **Slime:** Who has touched a fish before? How does it feel?
 - In what ways does slime help a fish survive?
 - Slip away from predators (bears, etc) ,
 - Slip over rocks and through/around obstacles (beaver dams) without injury
 - slide through the water with less friction
 - protect from diseases (bacteria & fungus) and parasites
 - So. Anglers, always wet your hand before handling a live fish so you don’t strip off their slime if you are releasing back in to wild

- **Scales:** What covers most of the fish's body under the slime layer?
 - **In what ways do scales help a fish survive?**
 - Armor/protection from predators and bruising.
 - **Salmon scales grow in rings and we can age a fish by looking at the ring pattern**
 - A little different from tree rings as it is not one per year (seasonal spacing differences instead)
 - Fun Fact: Fish have the same # of scales their whole lives (they just grow)

Do fish have ears?

- **Otolith** (optional to mention):
 - They can hear somewhat in their inner ear. Sound can travel through the water, through their body to the otolith bone.
 - **BUT...** The **primary** function is to detect direction
- **Lateral line:** Any idea as to what this line is for?
 - **It has a similar function to our ears, but more sensitive and complex**
 - They can detect sound and displacement waves in the water
 - Helps them find food, avoid predators, and "school" effectively.
 - What might affect a salmon's senses and its ability to find its way? Where do these chemicals come from? (Pesticides, fertilizers)
 - Don't need to cover the following detail but it's good to know in case you have questions from older/advanced students.



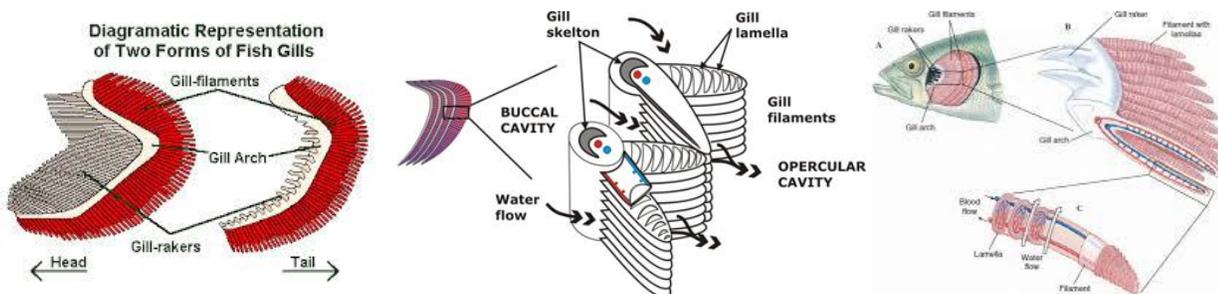
The Head: You can either skip and finish with this or briefly go over the basics and revisit for the conclusion of the dissection (gills and eyes)

- **Eyes:** How are they similar and different to ours?
 - **Similarities:** Two of them with the basic components (lens, cornea, etc)
 - **Differences:** No binocular vision (no depth of field), close to 180 field of view for each, each eye can move independent of the other, no eyelids (as moisture is not an issue)
 - Impairment from turbid water resulting from riparian habitat loss. (This is a good time to talk about how urban development often destroys riparian zones and how increased impervious surfaces lead to increased turbidity. Mention pervious pavement and encourage participation in restoration work and planting trees in deforested areas at home.)

Note: I usually finish the entire dissection session with eye extraction due to the popularity.

- **Nares (Nostrils):** Does this salmon have a nose? No. Just nostrils (“nares”).
 - The nares are not utilized for breathing as ours (not connect to the mouth cavity)
 - Sense of smell: (dog = 1,000 x human), (salmon = 1,000 x dog)
 - Thus, a salmon’s sense of smell is around 1,000,000 times better than ours.
 - Important for finding food, avoiding predators, and homing
 - Homing analogy: like walking into someone’s house and it smells different/funny. Those fish imprint the chemical signature of their home stream.
 - Can be impaired by pollutants (agriculture, brake pad copper, etc)(go over more, and ask them to share)
- **Gills:** Do salmon have lungs?
 - Explain the respiration process (gulping water, closing mouth, compressing gill plates (operculum), water moves over gills and out of gill cover
 - Dissect the gills: Either remove one gill arch or the entire set.
 - Far less oxygen in water so the gills have to be VERY efficient (≈90%). Human lungs are far less efficient (≈ 30%)
 - Oxygen levels highly dependent on water temperature. Climate change and poor riparian habitat have influenced water temps in WA.
 - Point out the gill rakers. Keeps the food from escaping through the gills (works like baleen on a whale). Fish that eat large prey will have fewer and shorter gill rakers. Fish that eat smaller prey (plankton, etc) have more and longer rakers)

Note: I usually take out the entire set. You can put it back in or lay it out for display



- **Fins:**
 - What fin is responsible for propulsion or moving the fish forward? Caudal fin (tail)
 - What fins are responsible for balance? Anal (like a keel on a boat) and dorsal fins.
 - What fins are responsible for steering and breaks? Pectoral and pelvic (compare to human legs and arms)
 - Adipose Fin
 - Scientists use to think that it served no function (vestigial fin perhaps) and salmonids can technically survive without it (useful for hatchery marking)
 - Recent studies show that it does have a function (adipose fin may be a pre caudal sensor that allows the caudal fin to work more efficiently (lots of nerves in the fin and tank flow testing fish with and without showed significant caudal efficiency with intact adipose)

Internal Organs:

Note: Better access to the liver is on the left side of the fish. But I tend to go with whatever side is in better shape. Show the participants the body cavity and then take out and show the difference (small organs may be in poor shape because investing everything into reproduction).

Testes:

- Two testicle-largest organ in salmon- carry the "milt" it's "the stuff that fertilizes the eggs"
- roughly 2,500 total eggs per (coho)

Liver (with pancreas & gall bladder):

- Normally the largest organ in the body (until reproductive maturation)
 - The pancreas is incorporated into the liver and difficult to see.
 - Gall bladder is on the liver (small green sack) but is often ruptured.
- **Liver:** Detox, energy storage and digestion (secretes bile salts)
 - **Detox: Can be significantly impacted by pollution (variety). Scientists are finding enlarged livers in juveniles from polluted areas (often urban). Enlarged livers are a indication that an animal is putting a lot of energy towards detoxifying the system (= less energy towards growth). So we can all contribute to fish health by practicing stewardship (stormwater runoff, dumping chemicals, leaky cars, pesticides, etc)**
 - Energy storage: storage (glycogen storage – "animal starch")
 - Digestion: See pancreas and gall bladder
- **Pancreas:** produces/sends enzymes for/to the intestine for digestion (three types of enzymes – proteins, carbs and fat).
- **Gall bladder:** stores the bile (secreted by the liver) that is eventually distributed to the small intestine to aid in digestion.

Digestive track (esophagus, stomach, pyloric caeca, intestines) – with spleen attached

Notice how empty the stomach & intestines are (esophagus closes when they re-enter fresh water)

The Esophagus: Is very tough (so the live prey do not damage it).

Stomach: Initial digestion takes place here.

Pyloric Caeca: Secretes digestive enzymes or juices to break down food (like chemicals)

- Important because salmon do little, if any, chewing/mastication (via pharyngeal teeth)
- Increases surface area (just say expands) in the stomach for nutrient absorption

Intestines: Much simpler than ours, but they still have small & large intestines.

I don't go into this detail, but if asked...

- Small (where most digestion takes place)
- Large (absorbs water from waste material, concentrates/compacts/passes waste)

The Swim Bladder:

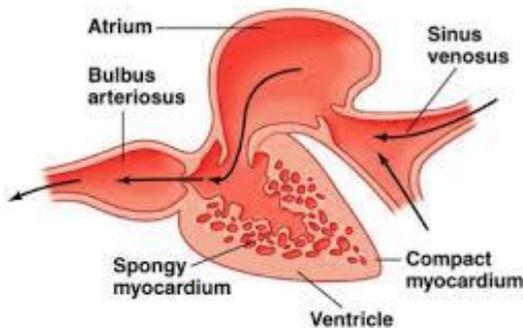
- Like a balloon that regulates buoyancy (neutral is the goal)
- Salmon can fill it by either gulping (connection with the gut) or blood gas exchange
 - Fish with this ability are physostomous. Other fish are physoclistous (just gas exchange)

The Kidney:

- Lower kidney: Produces urine (very concentrated to conserve water in the body)
- Upper: Red blood cell production
- Also: Helps gather excess salt (and is excreted via the gills) – **critical for anadromy**

Heart:

- Found in close proximity to the gills (just underneath/between) & is in its own compartment.
- Pumps Blood and has two “true” chambers
 - Sinus Venosus
 - **Atrium** – Receives the blood
 - **Ventricle (large muscular portion)** – pumps the blood
 - Bulbus Arteriosus (white part/tube) - dampens the intense pressure from the ventricle



(a) Bony fish heart

EXTRAS - I do not suggest cutting the head off. You will be asked to do this.

- Remove the whole gill set
 - (or do so on another fish ahead of time).
 - Re-emphasize how challenging it is for them to extract O₂ from water
 - Show how the gill arches prevent food from escaping
- Remove the eye from other side of salmon
 - Try to take out the lens ahead of time from eye on other side.
 - Can pop eye in and out of viewing side for ooh's and ahh's....

2018 Dissection Check-List

Call Pepper for emergencies only* at (407) 222-2880

**Can't make fair due to car break down, minor-accident, family emergency, etc.*

- Salmon in bucket
- Tool Kit
 - Hen knife
 - Scissors
 - Plastic forceps (optional)
- Notebook with Guides and visuals
- Tri-fold
- Newspaper
- Plastic Tablecloth
- First Aid Kit
- Popsicle sticks or toothpicks
- Clorox wipes for cleaning
- Hand wipes (for volunteers only)
- Garbage Bag
- Microscope and blank slides
- Extension Cord (Microscope)
- Business cards (Program and Volunteer Coordinator)
- Summer camp flyers and/or sign-up
- Volunteer Sign-up for more information
- Egg Vial/s
- Glove with salmon species

