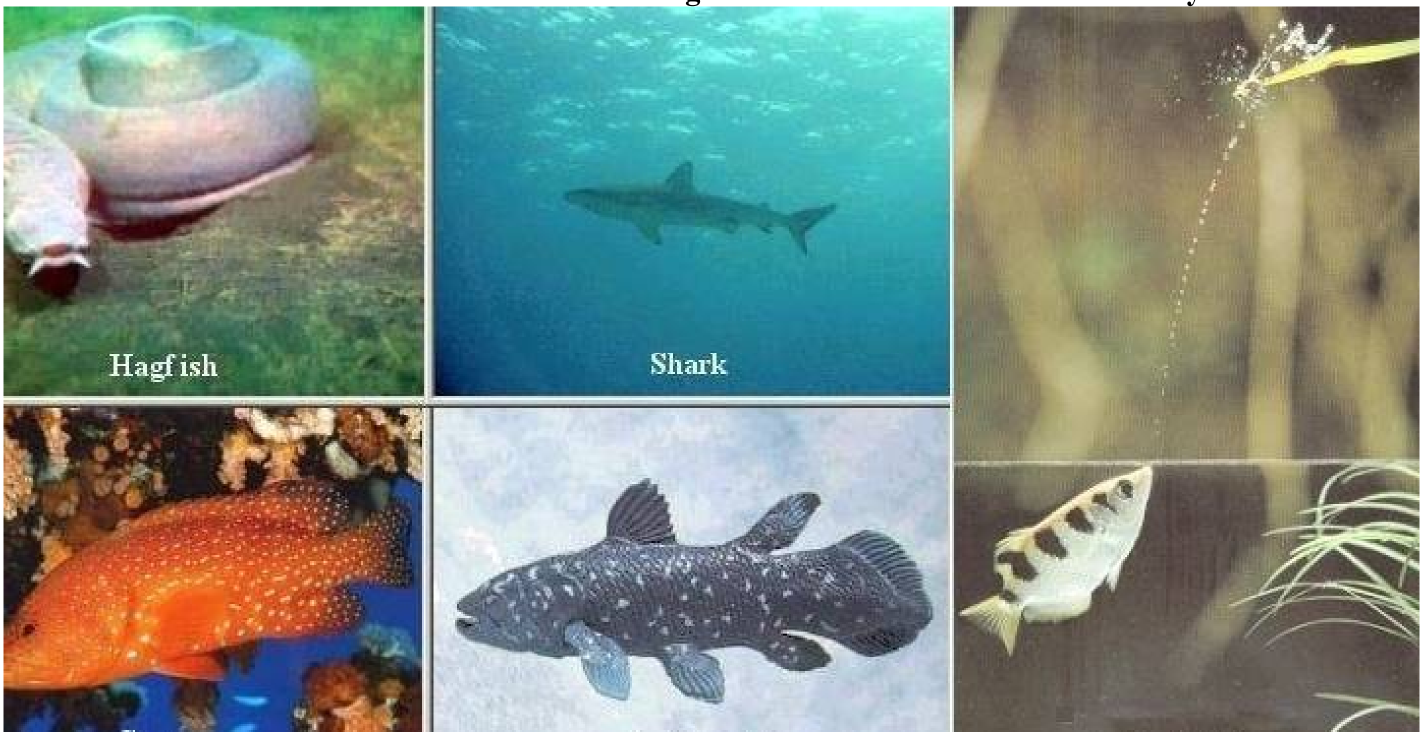
The Major Fish Groups

Jawless	Cartilaginous Fish	Bony

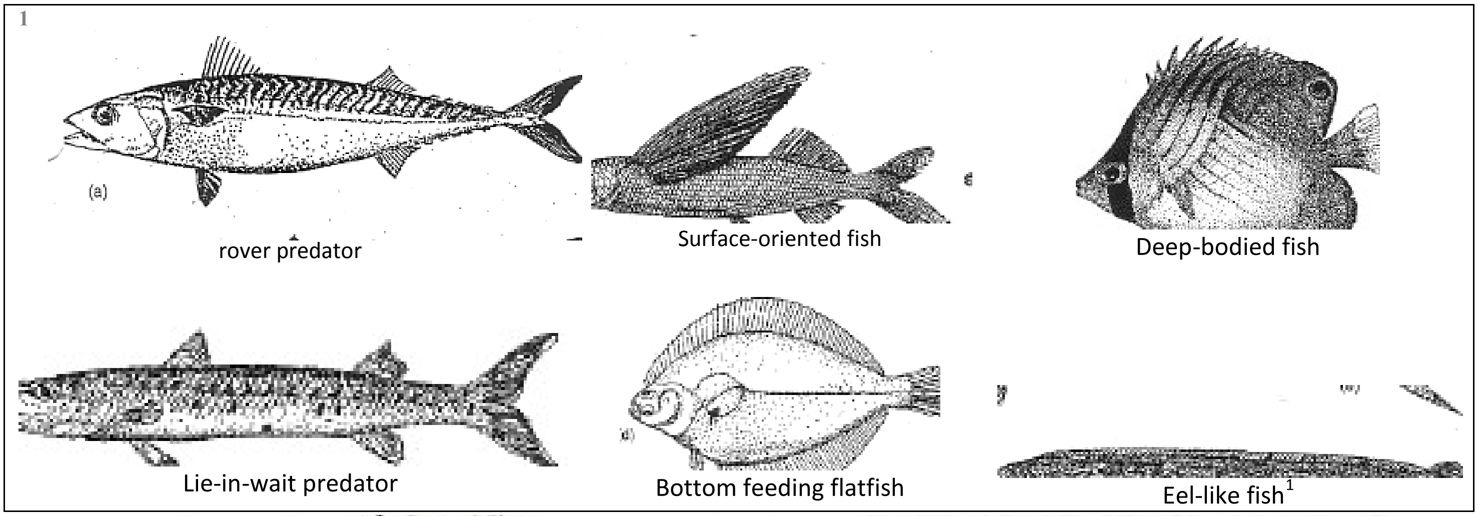


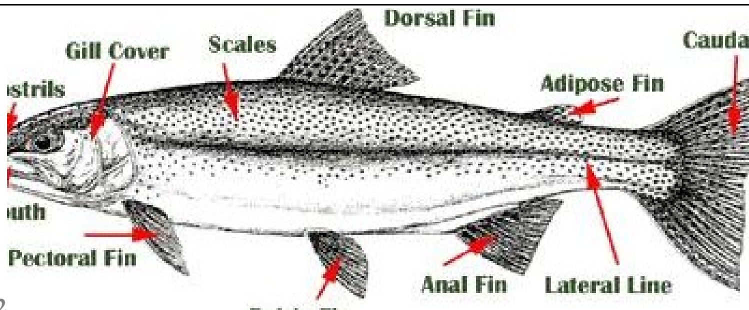
[1]

	Agnanthans	Gnathostomes	
		Elasmobranchs	**Teleosts**
		Cartilaginous Fish	**Bony Fish**
Examples	**Hagfish**	**Skarks, Skates, & Rays**	
Jaws	Jaws are **Absent**	Jaws are **Present**	Jaws are **Present**
Swim Bladder		Swim bladder is **Absent**	Swim bladder is **Present**

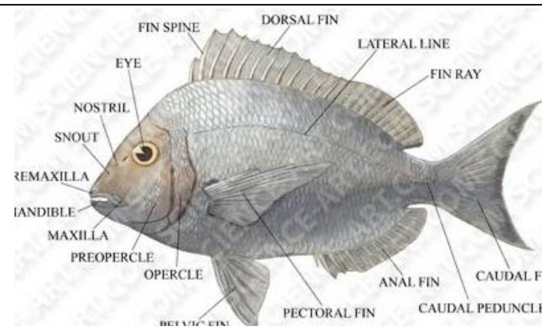
[1] http://universe-review.ca/I10-82-fishes.jpg

Variations in Fish Structure

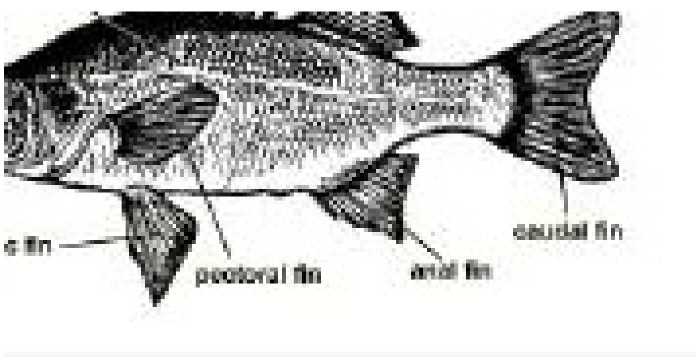
1




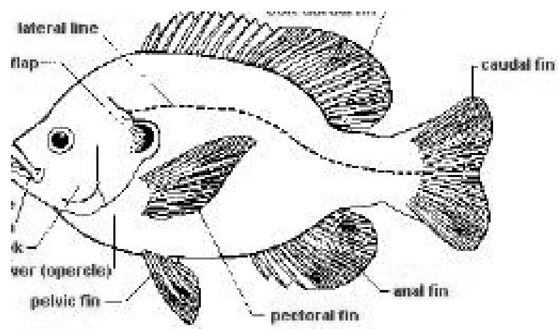
2



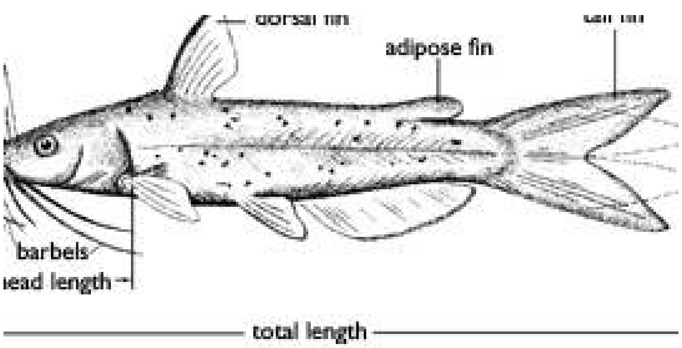
3

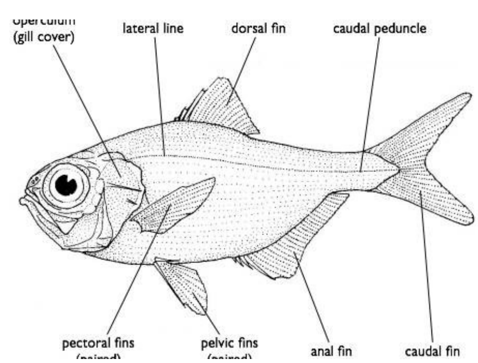


4



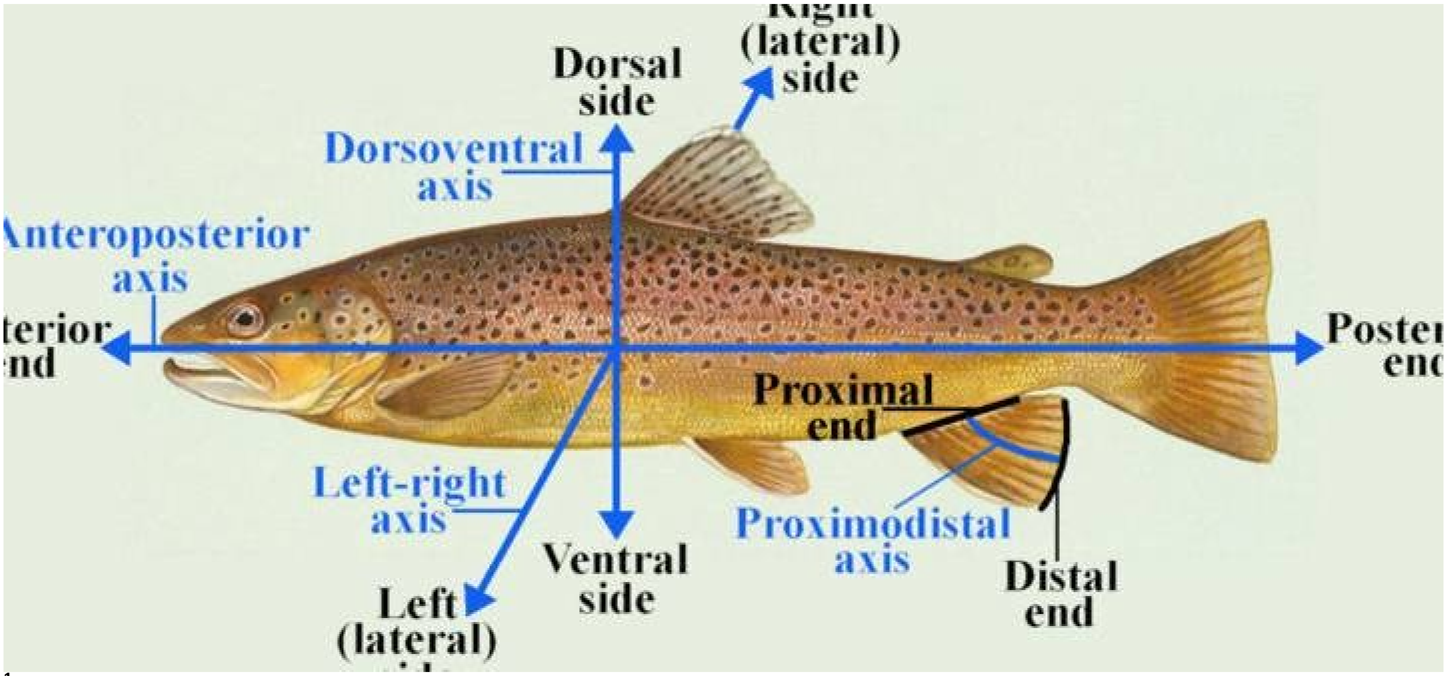
5





7

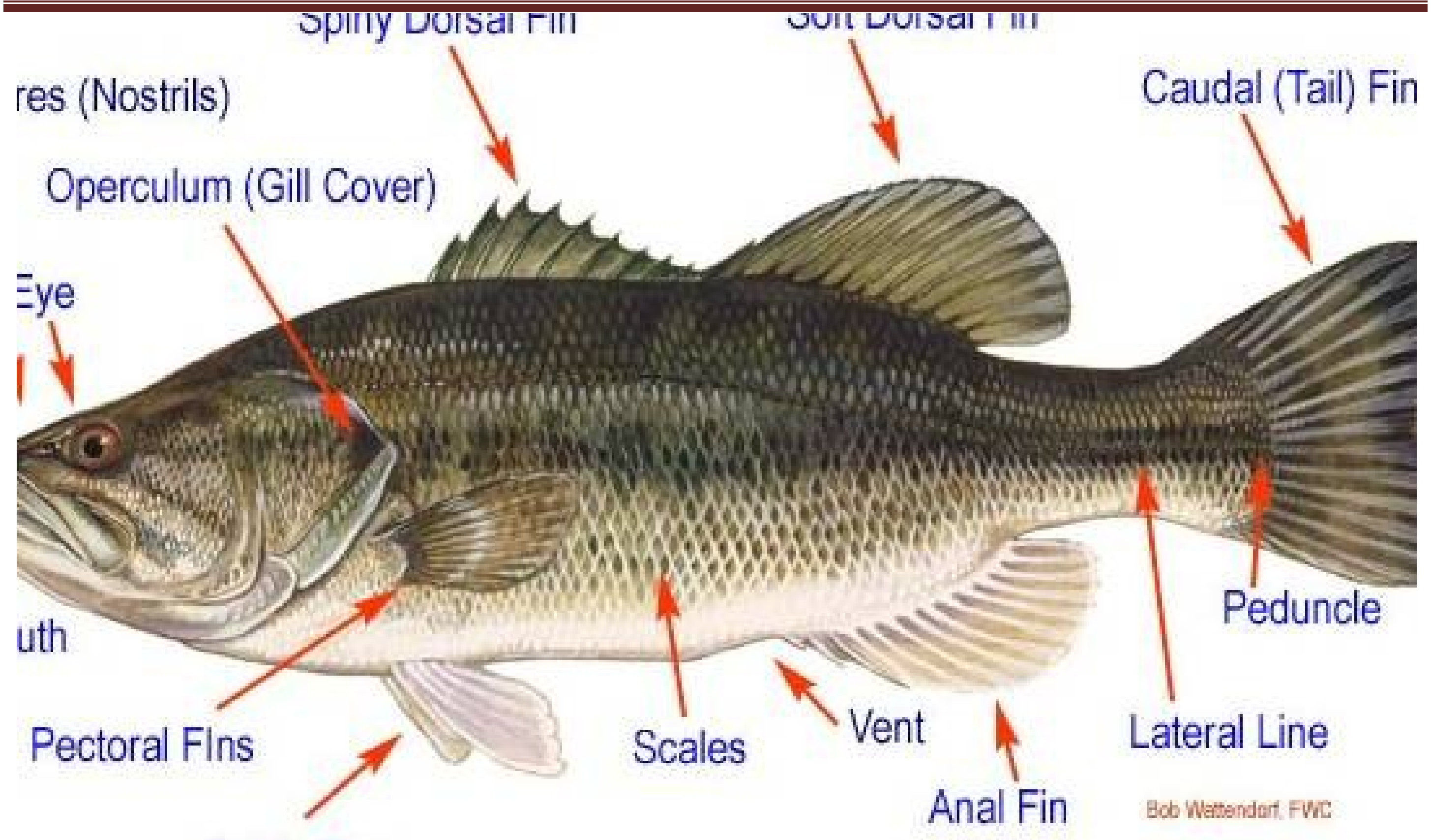
[1] My Biological Oceanography course notes, pg. 19
[2] http://www.kidfish.bc.ca/fish/index.html
[4] www.great-lakes.net/teach/envt/fish/fish_3.html
[6] mdc.mo.gov/fish/fishid/sizes.htm
[3] www.science-art.com/image.asp?id=2749&search=1
[5] www.manitoulinstreams.com/ecosystem.html
[7] http://commons.wikimedia.org/wiki/Image:Fish_anatomy_(berycid).png

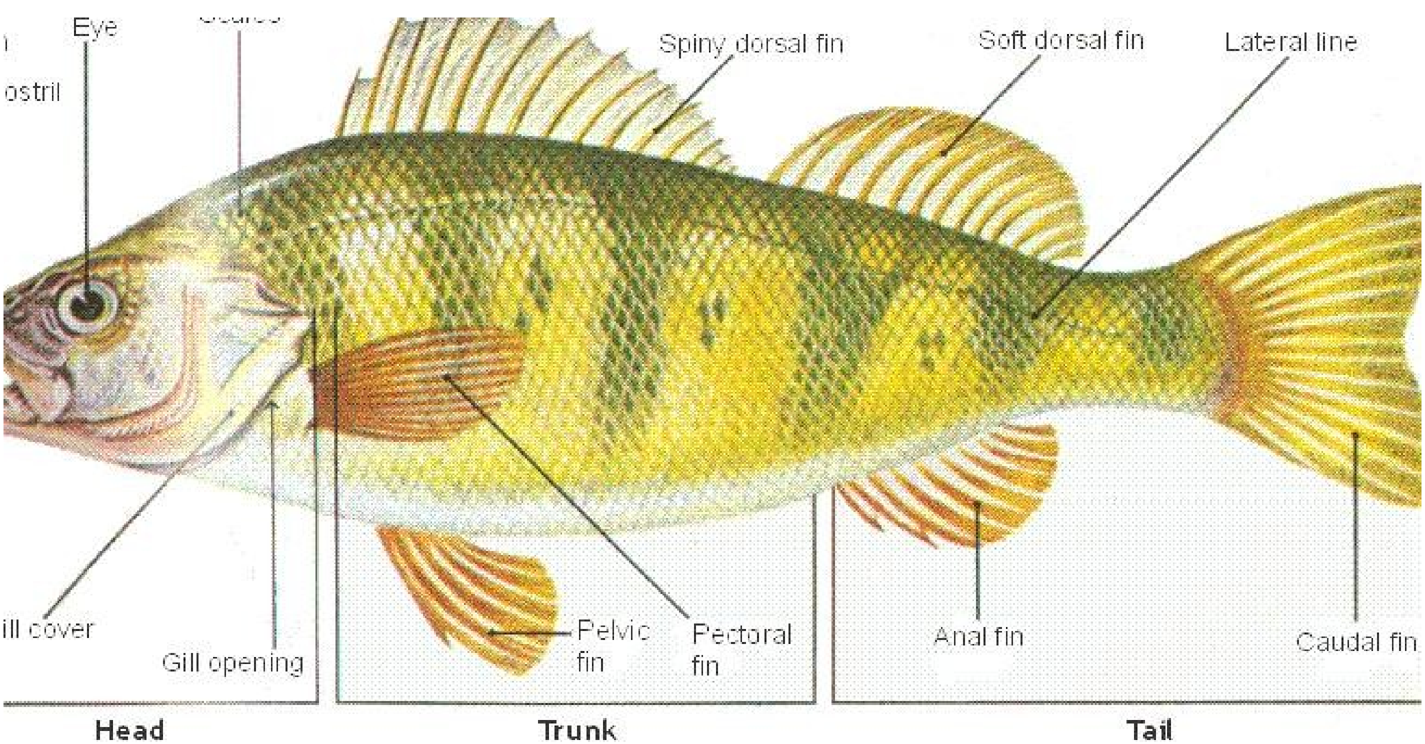


[1]

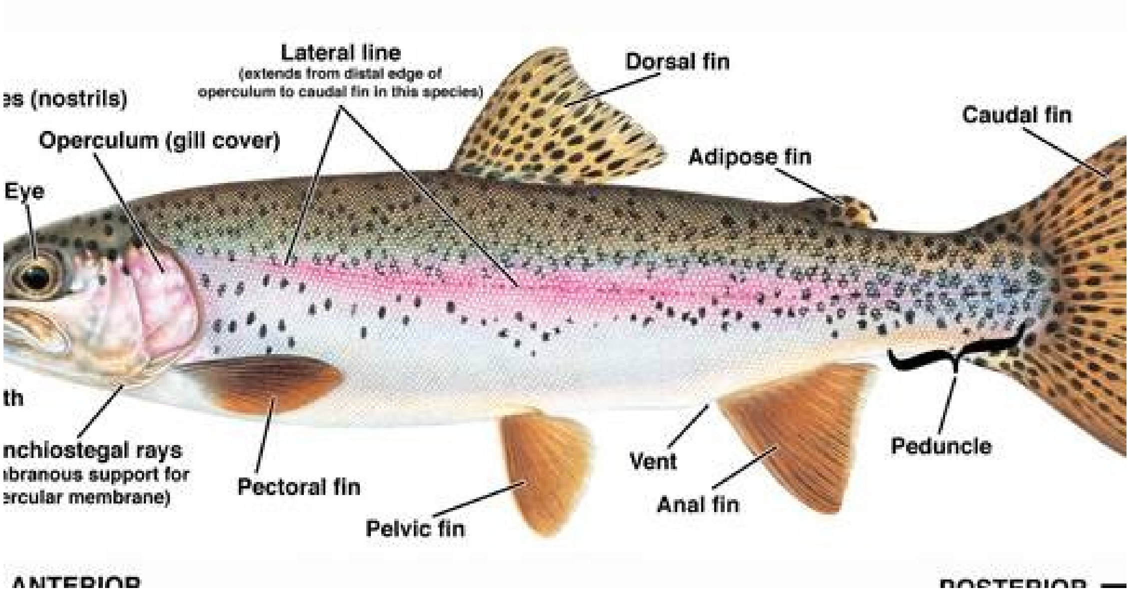
Dorsal	Nearer the back of the animal than	The backbone is dorsal to the bel
Ventral	Nearer the belly of the animal than	The breastbone is ventral to the heart
anial (or anterior)	Nearer to the skull than	The diaphragm is cranial to the stomach
udal (or posterior)	Nearer to the tail than	The ribs are caudal to the neck
Proximal	Closer to the body than (only used for structures on limbs)	The shoulder is proximal to the elb
Distal	Further from the body than (only used for structures on limbs)	The ankle is distal to the knee
Medial	Nearer to the midline than	The bladder is medial to the hips
Lateral	Further from the midline than	The ribs are lateral to the lungs
Rostral	Towards the muzzle	There are more grey hairs in the rostral part of the head
Palmar	The "walking" surface of the front paw	There is a small cut on the left palmar surface
Plantar	The "walking" surface of the hind	The pads are on the plantar side

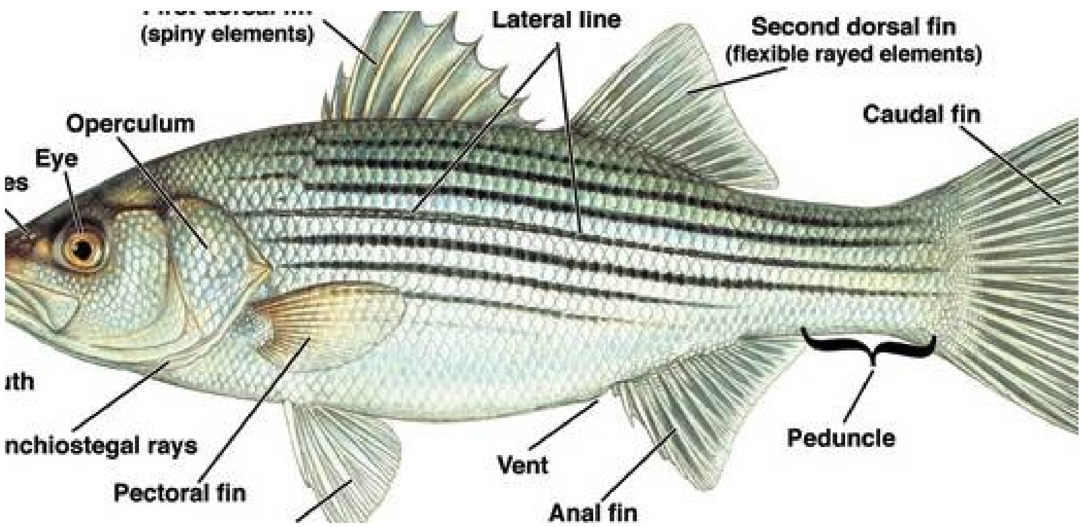
[1] http://en.wikipedia.org/wiki/Image:Anatomical_Directions_and_Axes.JPG
[2] http://en.wikibooks.org/wiki/Image:Anatomy_and_physiology_of_animals_directional_terms.jpg

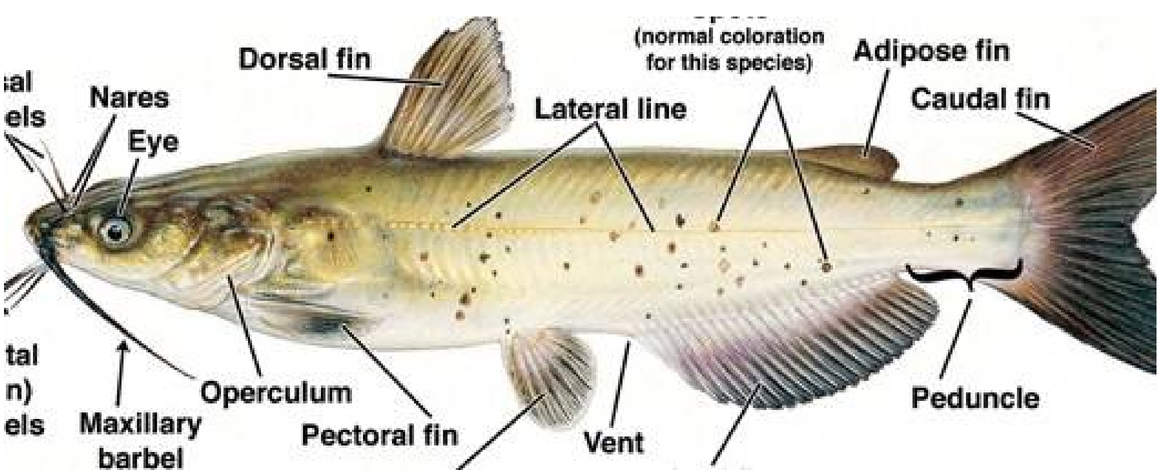




[1] www.kentuckylake.com/.../fishfacts/anatomy.html [2] library.thinkquest.org/.../2anatomy_external.htm

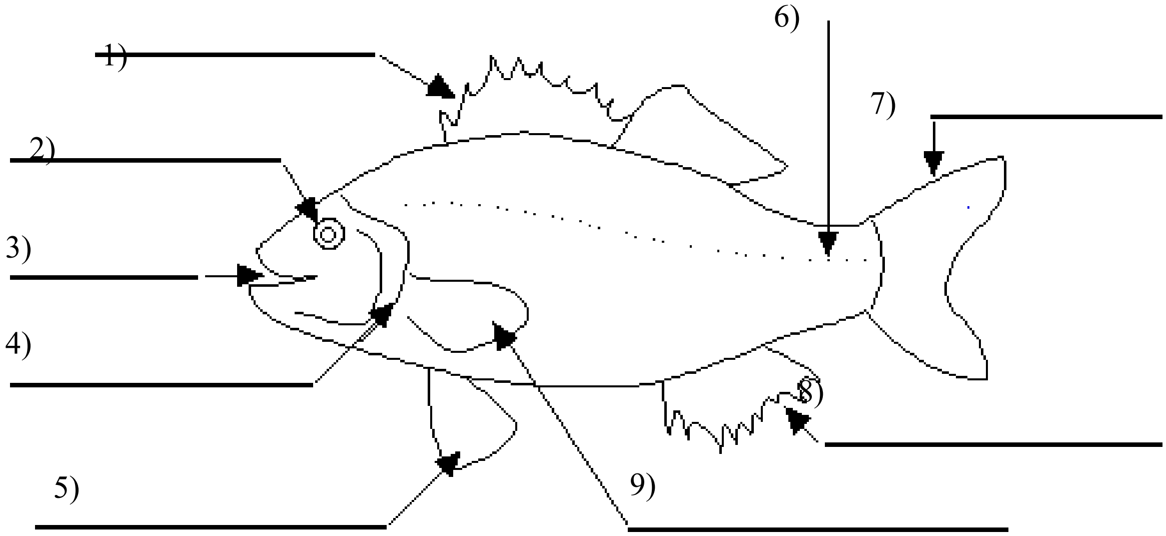




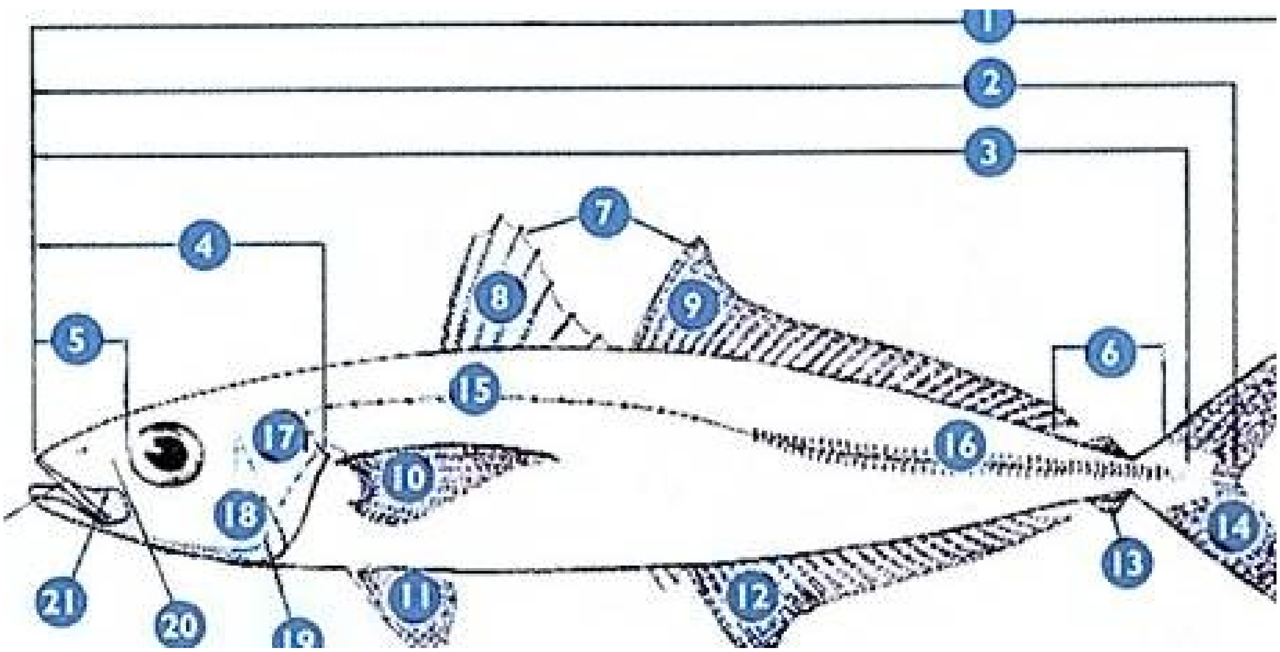


[1] mybay.umd.edu/lesionguide.html (Rainbow Trout; Striped Bass; Channel Catfish)

External Fish Anatomy



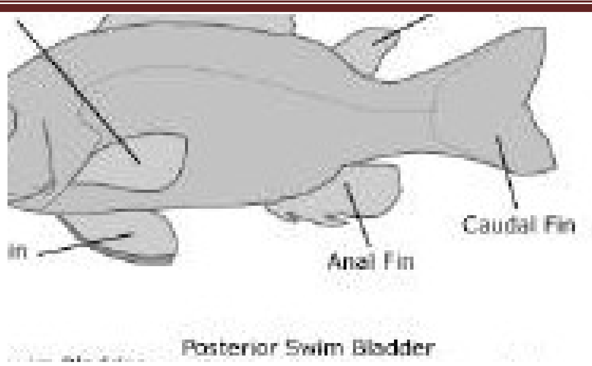
1) Dorsal Fin
2) Eye
3) Mouth
4) Gills
5) Pelvic Fin
6) Lateral Line
7) Caudal Fin
8) Anal Fin
9) Pectoral Fin

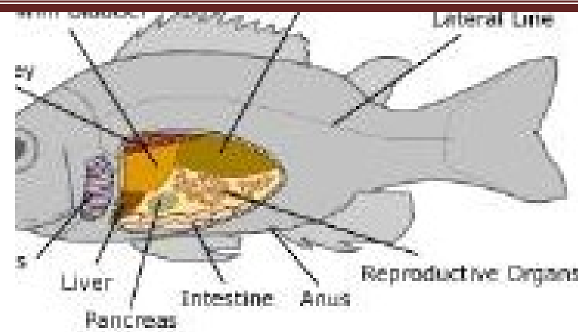


1) Total length
2) Fork length
3) Standard length
4) Head length
5) Snout length
6) Caudal peduncle (where body attaches to tail)
7) Fin rays, spinous (unsegmented) & soft (segmented)
8) First (spinous) dorsal fin
9) Second (soft) dorsal fin
10) Pectoral fin
11) Pelvic (ventral) fin
12) Anal fin
13) Finlet
14) Caudal (tail) fin
15) Lateral line
16) Scutes (bone-like projections)
17) Opercle (gill cover)
18) Preopercle (cheek)
19) Interopercle
20) Adipose eyelid
21) Supramaxilla (rear portion of upper jaw bone)
22) Premaxilla (forward portion of upper jaw bone)

[1] www.enchantedlearning.com/.../labelfish.shtml & http://www.enchantedlearning.com/subjects/fish/label/labelfishanswers.shtml
[2] www.offshorebig3.org/The%20Fish.html

External Fish Anatomy





Gills - The primary function of the gills is the absorbtion of oxygen & the excretion of carbon dioxide and ammonia. Healthy gills are deep red & do not stick together. Unhealthy gills are usually pale and the layers appear to clump. Additional signs of unhealthy gill function are listlessness, flashing and rubbing. Upon examination, damaged gills show excess mucous along with pale color.

Adipose Fin - The adipose fin is a small fin composed of fatty tissue, located b/w the dorsal and caudal fins of some fish, notably characins and catfish as well as Salmonidae. Not all fish have an adipose fin.

Swim Bladder (Air Sac) - Located in the dorsal area of the abdomen, this dumbell- shaped sac is just below the kidney. It allows fish to have buoyancy and balance.

Gonads - These are the reproductive structures, egg sacs in females and testes in males. The egg sack in females may fill a major portion of the abdominal cavity.

Gastrointestinal Tract - This long tubular organ is slightly smaller than the stomach. The stomach is behind the head and above the liver.

Spleen - This organ produces and stores red blood cells and is found embedded in the intestine as a small red mass. Can only be seen after removing intestinal fat.

Pancreas - The pancreas secretes enzymes into the intestine for digestion.

Liver - Liver function is the digestion, filtration and storage of glucose. It appears as a brownish red mass toward the anterior part of the body cavity. The liver also produces enzymes that are stored in the gall bladder that help breakdown food. The liver can only be seen after removing intestinal fat.

Gall Bladder - Digestive enzymes and bile are stored here. It is a small sac found embedded in the liver tissue.

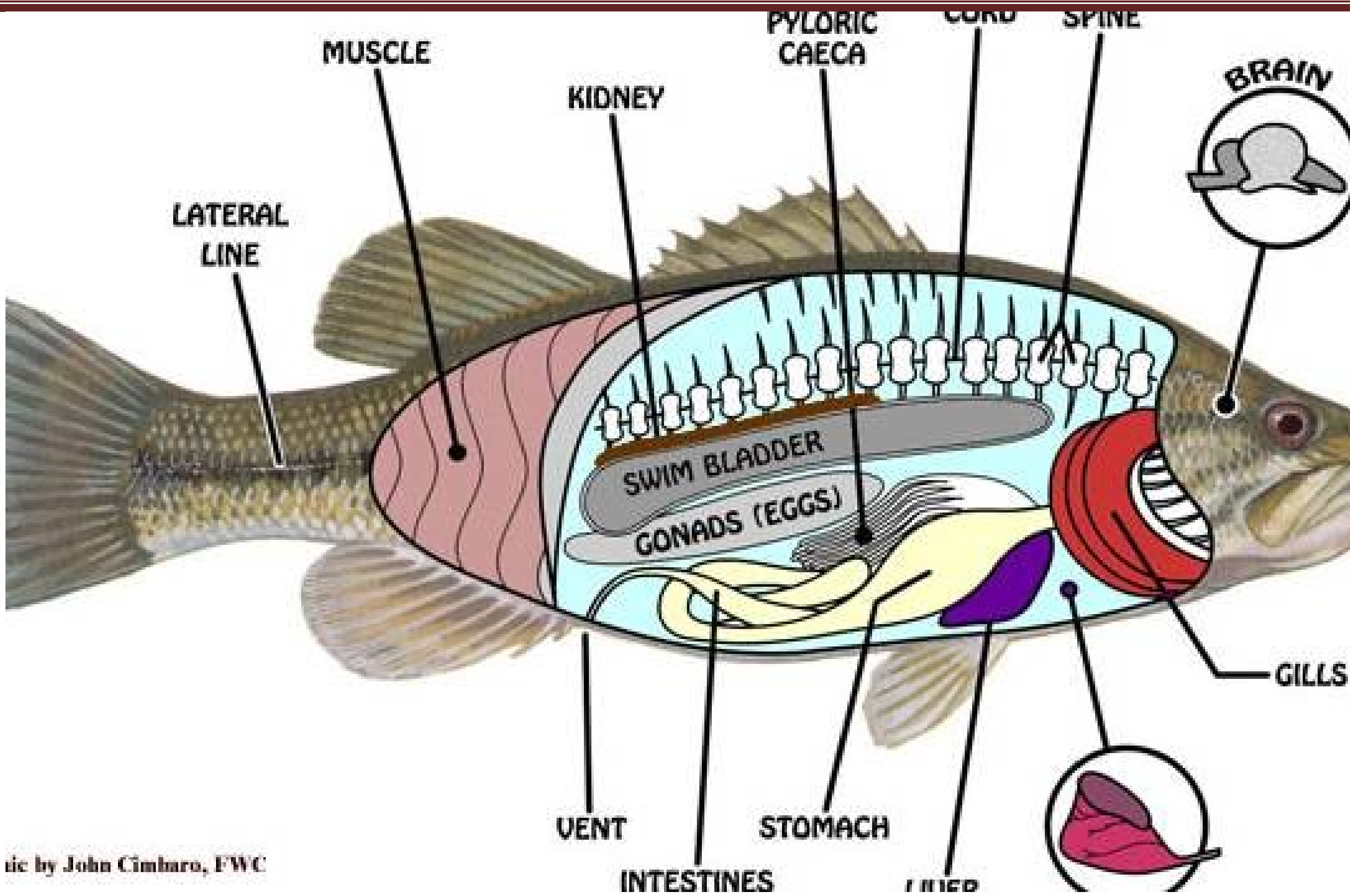
Heart - The heart is a two chambered organ that circulates blood, located adjacent to the gills, just behind the head.

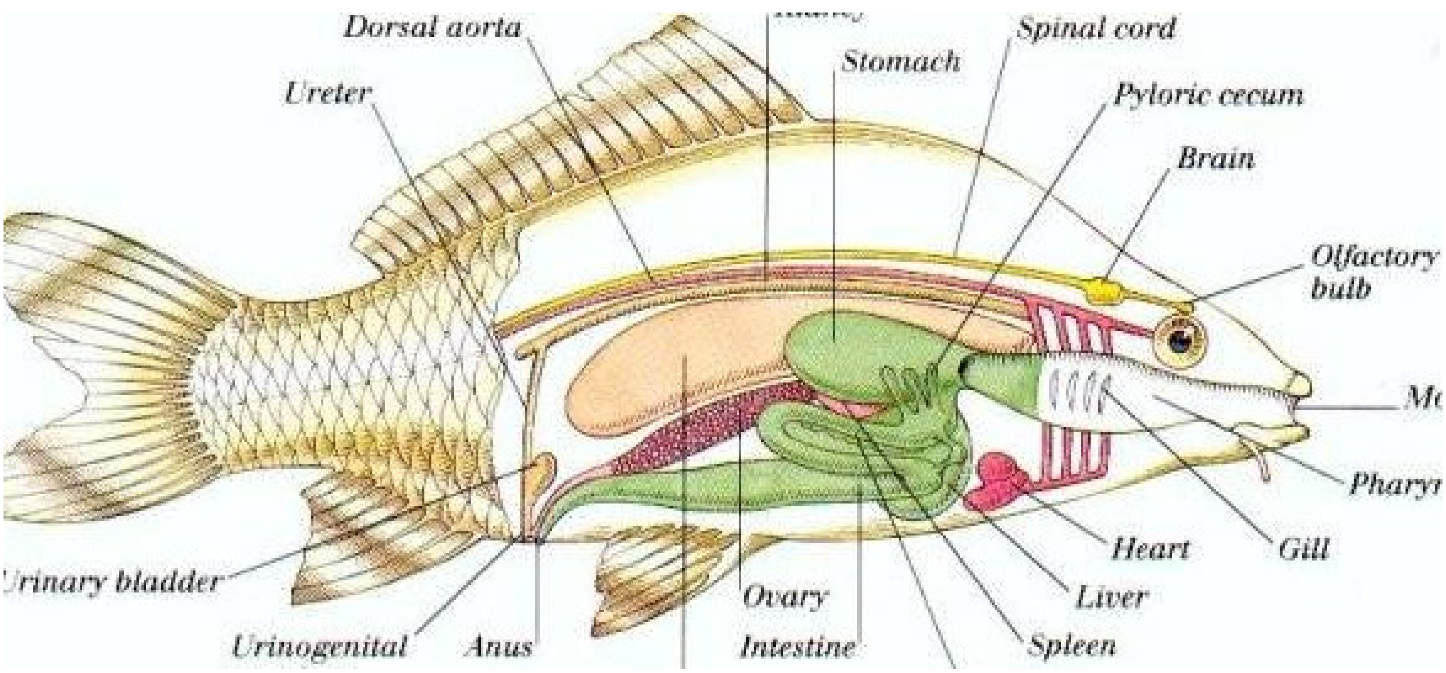
Kidneys - There are two kidneys, one above the air sac and one slightly in front of it. Both are below the vertebrae. Kidneys produce white blood cells and filter wastes.

Brain - This organ is located in the head between but slightly behind the eyes.
- The brain controls all voluntary and involuntary functions but probably won't get many rockets off the ground and contains no owner serviceable parts.

[1] www.123fish.net/gc/getArticle.php?ArtID=265

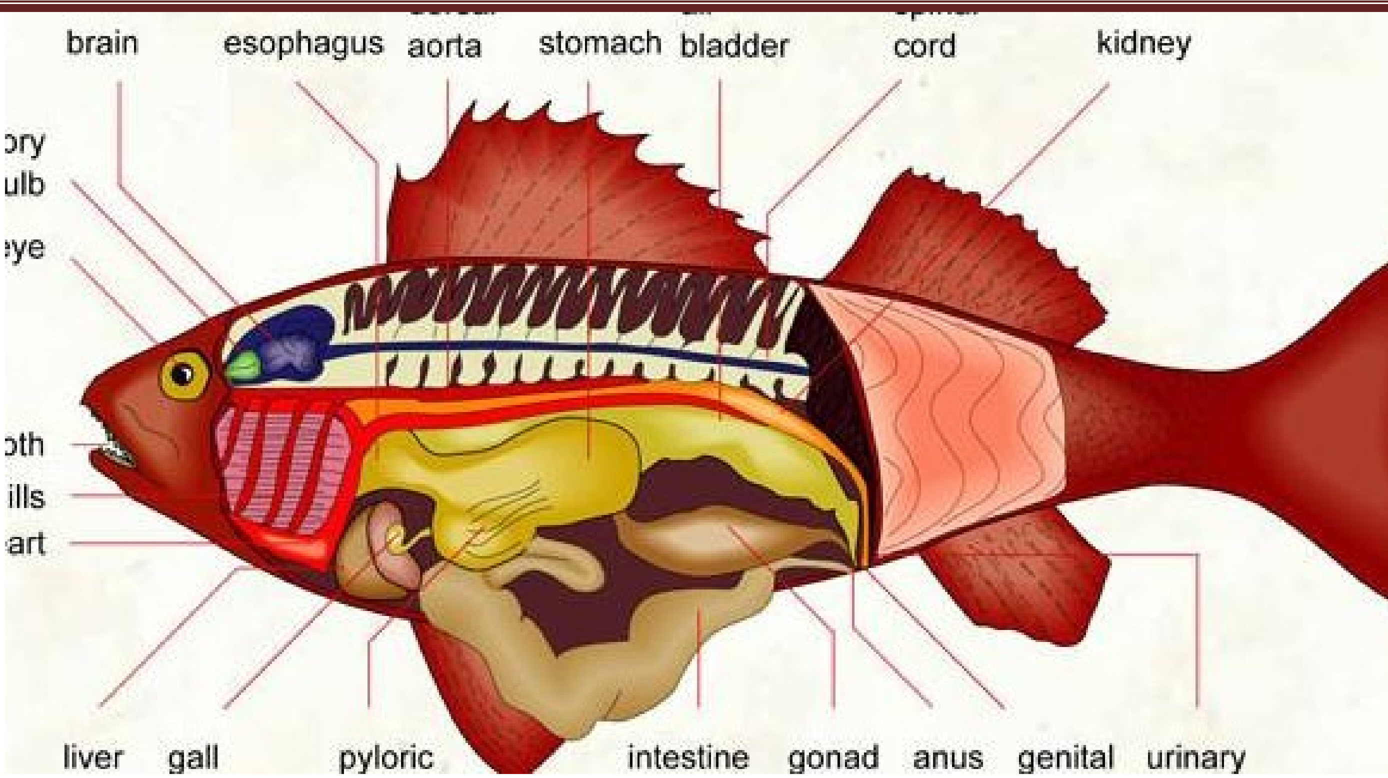
Internal Fish Anatomy

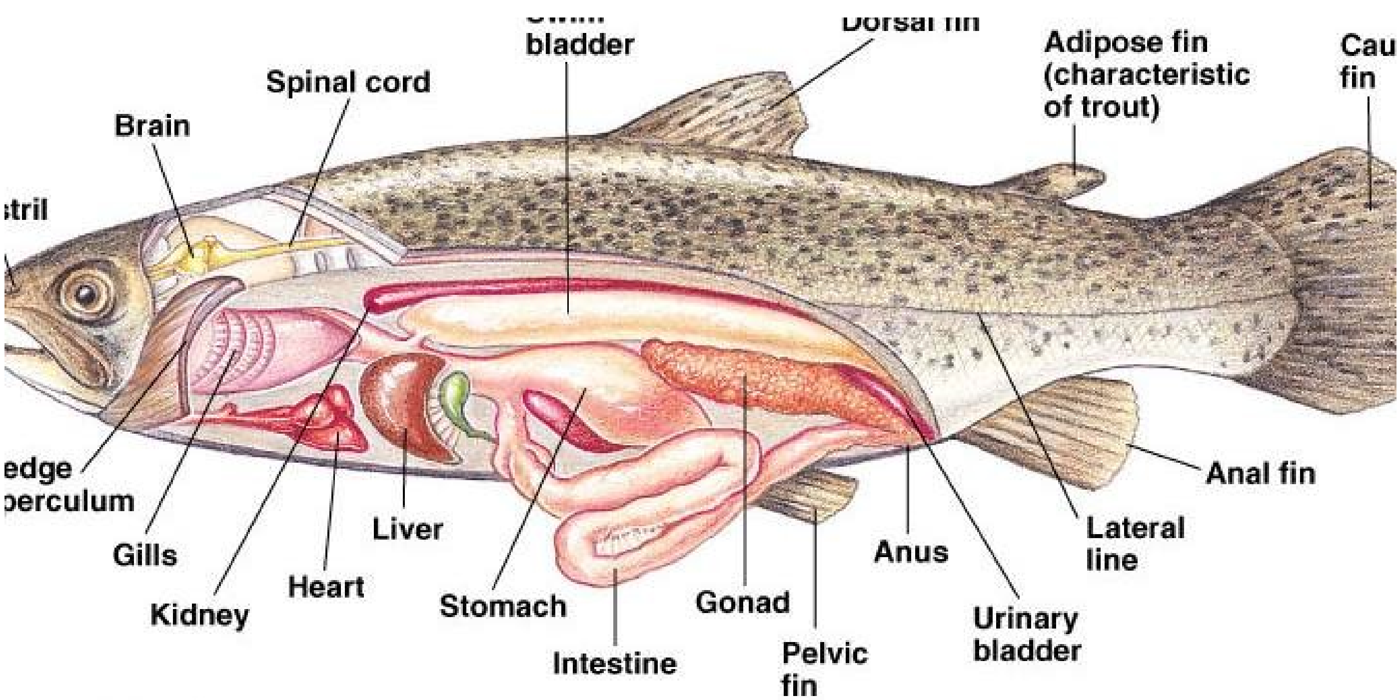




[1] www.kentuckylake.com/.../fishfacts/anatomy.html
[2] universe-review.ca/R10-33-anatomy.htm

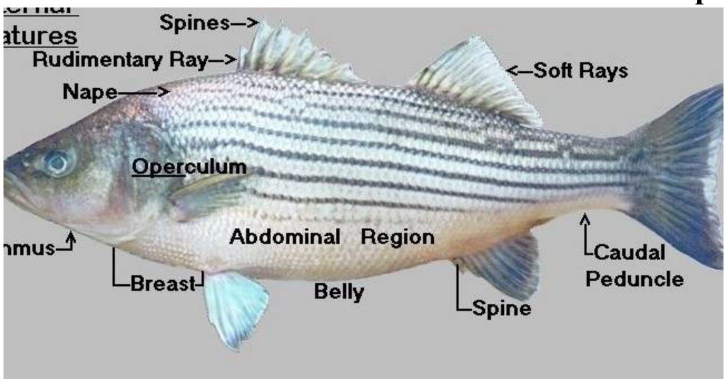
Internal Fish Anatomy

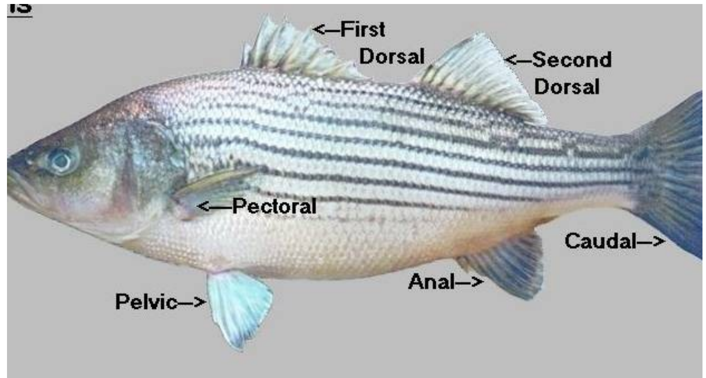


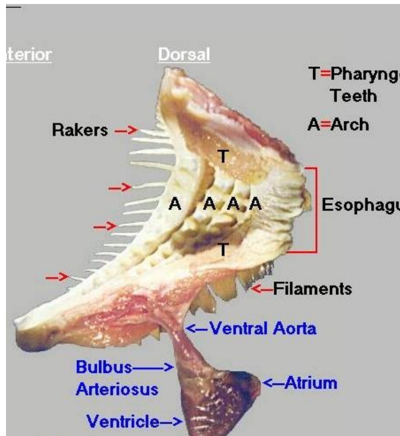


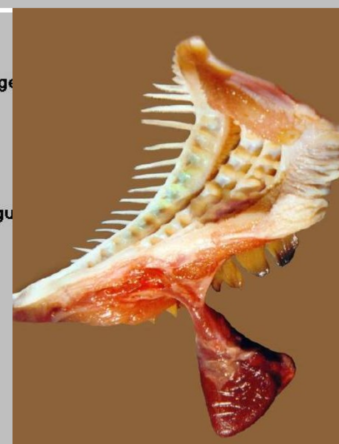
[1] http://io.uwinnipeg.ca/~simmons/16cm05/1116/chordate.htm

Striped Bass

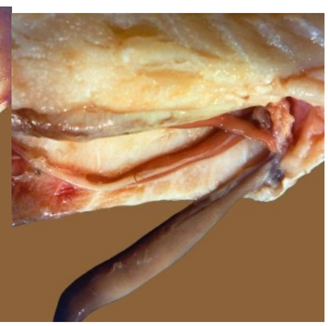






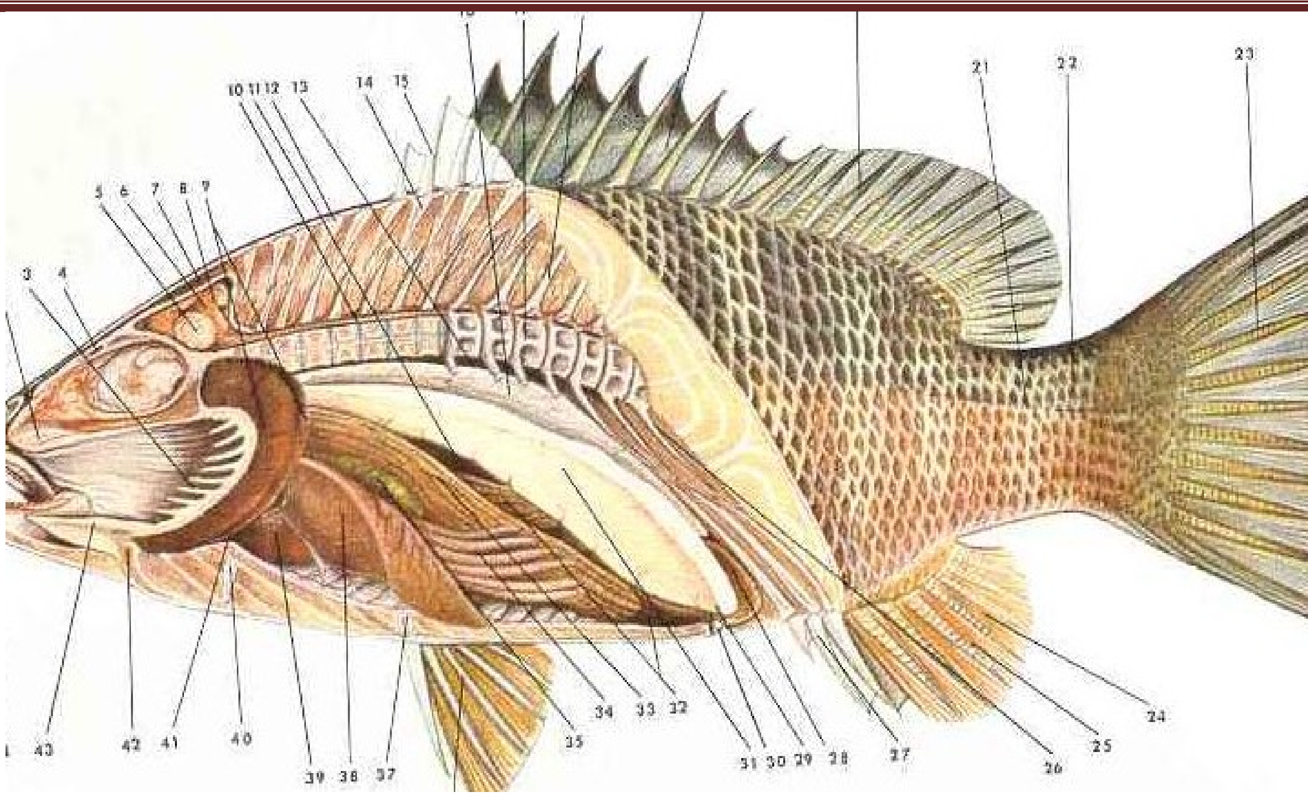


Liver

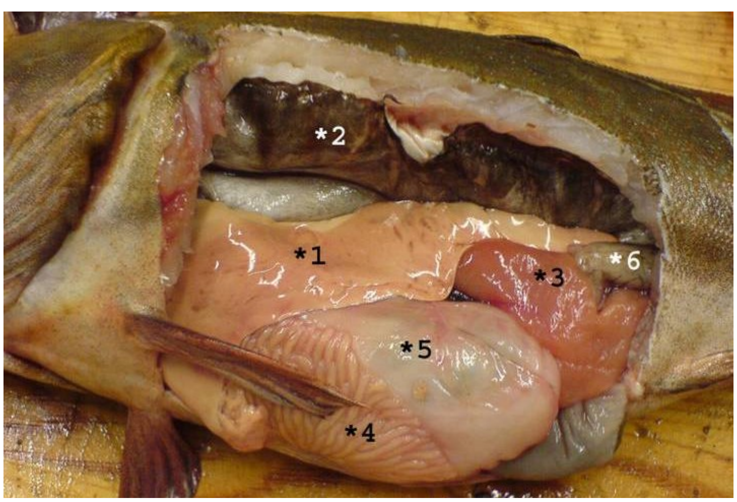


1 http://fishanatomy.net/webpages/fish/bass/bass.htm

Internal Fish Anatomy



1) Premaxillary
2) Vomer
3) Gill Rakers
4) Mesotheroid
5) Optic Lobe
6) Brain
7) Frontal Bone
8) Cerebellum
9) Gills
10) Spinal cord
11) Spleen
12) Interneural bone
13) Kidney
14) Pterygiophores
15) Spryray
16) Gas bladder
17) Vertebre
18) Neural spine
19) Dorsal fin
20) Softray
21) Lateral line
22) Caudal peduncle
23) Caudal fin
24) Softray
25) Anal fin
26) Hemal spine
27) Anal spine
28) Urinary bladder
29) Ovary
30) Vent
31) Fatty tissue
32) Intestine
33) Stomach
34) Pyloric caeca
35) Gall bladder
36) Pelvic fin
37) Pelvic girdle
38) Liver
39) Heart
40) Pectoral girdle
41) Ventral aorta
42) Basibranchial bone
43) Entoglossal bone
44) Dentary bone

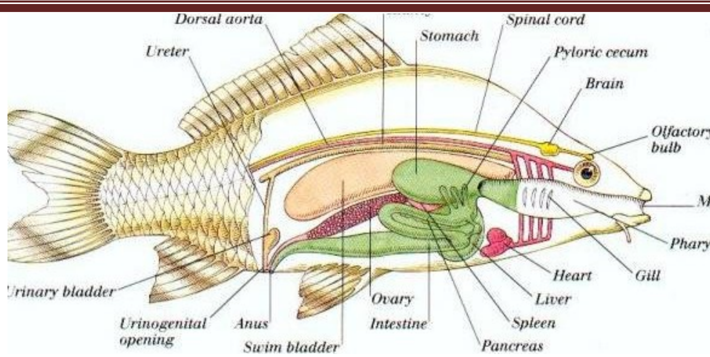


1) **Liver**
2) **Gas Bladder**
3) **Roe**
4) **Duodenum**
5) **Stomach**
6) **Intestine**

Organs

[1] www.schoolofflyfishing.com/resources/anatomy.htm [2] http://en.wikipedia.org/wiki/Fish

Internal Fish Anatomy

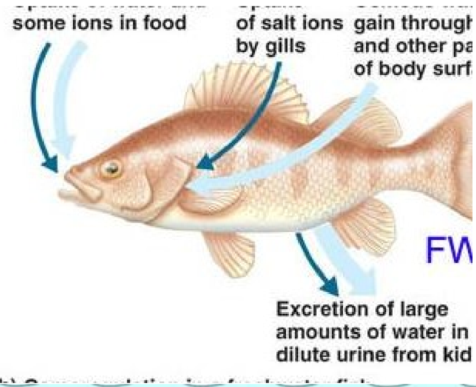


Circulatory	- The fish heart is a simple pump, blood flows through the chambers, including a non-divided atrium & ventricle, to the gills only - Oxygenated blood leaves the gills & goes to the body proper.
Digestive	- The mouths shape is a good clue to what fish eat → The larger it is the bigger the prey it can consume. - Fish have a sense of taste & may sample items before swallowing if they are not obvious prey items. - The stomach & intestines break down (digest) food & absorb nutrients. • Carnivorous fish (bass): fairly short intestines because such food is easy to chemically break down & digest • Herbivorous fish (tilapia): require longer intestines because plant matter is usually tough & fibrous & more difficult to break down into usable components. - The function of the pyloric caeca is not entirely understood, but it is known to secrete enzymes that aid in digestion, may function to absorb digested food, or do both. - The liver has a number of functions. • It assists in digestion by secreting enzymes that break down fats, & it is a storage area for fats & carbohydrates. • The liver is also important in the destruction of old blood cells & in maintaining proper blood chemistry, as well as playing a role in nitrogen (waste) excretion.
Endocrine	- All vertebrate animals (fish, amphibians, reptiles, birds and mammals, including humans) have the same endocrine glands & release similar hormones to control development, growth, reproduction & other responses. - However, the pineal gland of fish is located near the skin & functions to detect light (it's often referred to as the third eye)
Excretory	- The kidney filters liquid waste materials from the blood; these wastes are then passed out of the body. - The kidney is also extremely important in regulating water & salt concentrations within the fish's body, allowing certain fish species to exist in freshwater or saltwater, and in some cases both. - The vent is the external opening to digestive urinary & reproductive tracts. In most fish it is immediately in front of the anal fin. - Ammonia is formed immediately after the amino group is removed from protein. This process requires very little energy. - Ammonia is highly soluble in water but very toxic. Aquatic animals such as bony fishes, aquatic invertebrates, and amphibians excrete ammonia because it is easily eliminated in the water.
Immune	- The fish immune system comprises of the non-specific & specific immune defences, having both humoral & cellular mechanisms to resist against infectious diseases. - Studies in various species of fish have shown that the spleen & head kidney are major locations of immunological activity. The relative importance of these two organs varies among different species. - Previous studies have demonstrated that the head kidney is a major source of lymphocytes (including B cells) in Bluegill. - In general, for them to be successful there has to be an underlying predisposing factor such as poor environmental conditions, poor nutrition, overcrowding or poor water quality. In addition to causing stress, which will depress the fish's immune system, such conditions will often encourage increased numbers of opportunistic pathogens.
Musculo-skeletal	- Fish are covered by scales, which protect the body but do not prevent water loss. - The spine is the primary structural framework upon which the fish's body is built. - It connects to the skull at the front of the fish and to the tail at the rear.
Nervous & Sensory	- Fish see through their eyes & can detect color. - Paired nostrils, or nares, in fish are used to detect odors in water and can be quite sensitive. - The lateral line is a sensory organ consisting of fluid filled sacs with hair-like sensory apparatus that are open to the water through a series of pores (creating a line along the side of the fish). • The lateral line primarily senses water currents and pressure, & movement in the water.
Reproductive	- Reproduction in the fishes usually requires external water; sperm & eggs are shed into the water, where fertilization occurs. - The zygote develops into a swimming larva that can fend for itself until it develops into the adult form.
Respiratory	- Gills are respiratory organs that are kept continuously moist by the passage of water through the mouth & out the gill slits. - As the water passes over the gills, oxygen is absorbed by blood and carbon dioxide is given off (breathing)

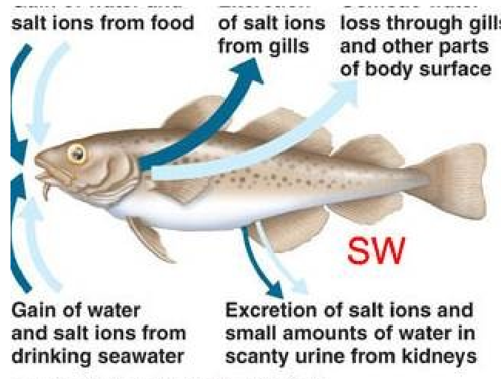
[1] http://universe-review.ca/I10-82-fish.jpg

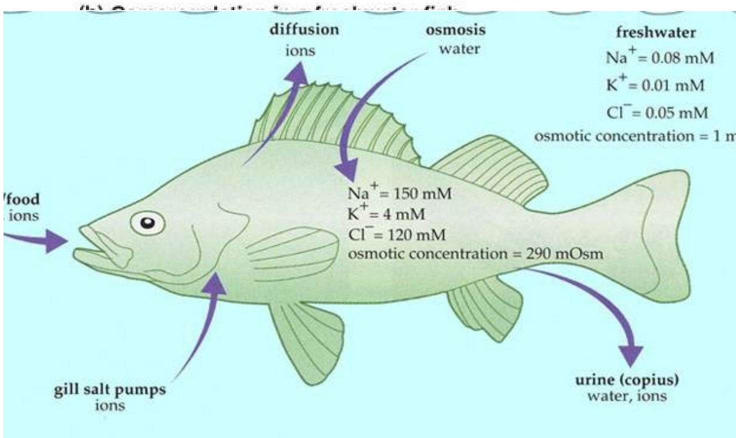
Fish Osmoregulation

Freshwater Fish



Saltwater Fish





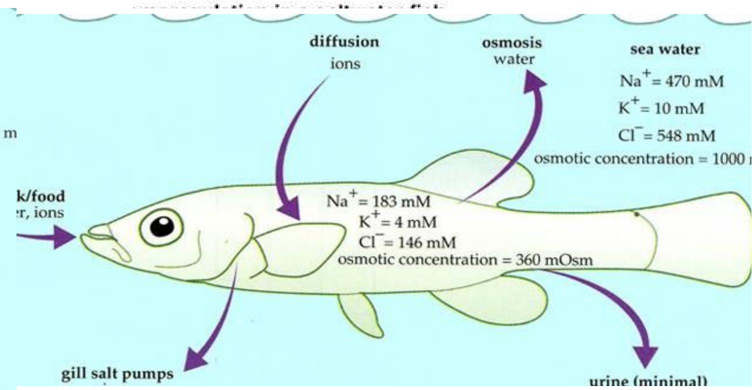
- Freshwater teleost fish have higher body fluid ion & osmotic concentrations than does their freshwater medium.
- Water is gained by osmosis, by drinking & in food
- Water is excreted by producing a copious amount of dilute urine
- Ions are obtained through food & lost by diffusion & in urin
- Ions are actively absorbed by gill salt pumps

Freshwater fish produce a large amount of dilute urine as they are gaining water through osmosis.

- As these fishes are gaining water, they are losing salts.
- Salts contained in their foods are insufficient to maintain the proper salt balance.
- Freshwater fishes have therefore developed the capacity to absorb salts from water by means of their gills.

What would happen if you put a freshwater fish in the ocean?

- the water in the freshwater fish would have a lower salt concentration than the surrounding ocean.
  - → The water in the fish moves through the semi-permeable membrane (the cells of the living fish) from the area of low salt concentration (the fish) to the area of high salt concentration (the ocean).
    - → fish dies of dehydration while surrounded by water.



- A marine teleost is an **ionoregulator** & **osmoregulator** at a body fluid osmotic concentration of about 360 mOsm.
- Consequently, there is a constant influx of ions by diffusion & a loss of water by osmosis.
- Water is replaced through drinking & food, & the excess salts are removed by active gill pumps.
- There is some loss of water & ions by the production of small amounts of urine.

Seawater fish drink lots of seawater & produce very little urine

- Seawater fish have blood that is less salty than sea water, & consequently they lose water & absorb salts.
- To offset this loss of fluid, marine fishes drink seawater which ↑ the amount of salts which are expelled in concentrated urin
- Sodium, potassium, chloride, & nitrogenous compounds, such as urea, are excreted through the gills.

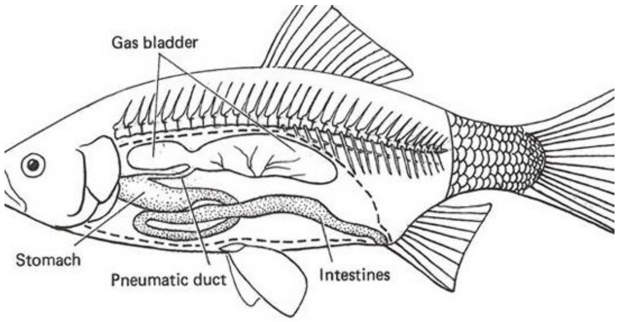
What would happen if you put a seawater fish in freshwater?

- the water in the saltwater fish would have a higher salt concentration than the surrounding freshwater.
  - → the surrounding freshwater moves through the semi-permeable membrane, from the area of low salt concentration (freshwater) to the area of high salt concentration (the fish).
    - → the fish fills up with water that it can't get rid of & dies

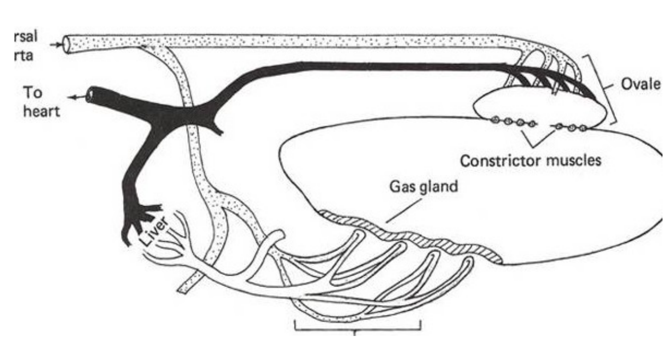
Fish in freshwater & seawater need to regulate their body salts

- The blood of freshwater fishes is typically more salty than the water in which they live & vice versa for fish in seawater.
- Blood salt level of freshwater fish is around 15‰ compared with ~35‰ for seawater fish.

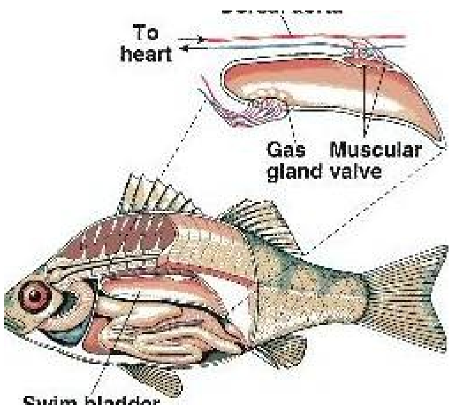
Swim Bladder



swim bladder is dorsal in the body cavity just beneath the vertebral column connected to the digestive system by the pneumatic duct



vascular connections of a physoclistous swim bladder which is not connected to the digestive system



Why do fish have swim bladders?

- The swim bladder is an internal organ that contributes to the ability of a fish to control its buoyancy
  - → to stay at a chosen water depth, ascend, or descend without having to waste energy.
- The swim bladder is a flexible-walled, gas-filled sac located in the dorsal (top) portion of a fish's body cavity

A weightless, or buoyant, body requires a minimum of energy to keep it at a given depth, and because a weightless body requires less energy than a weighted body to move at a given speed, many fishes have evolved a swim- bladder.

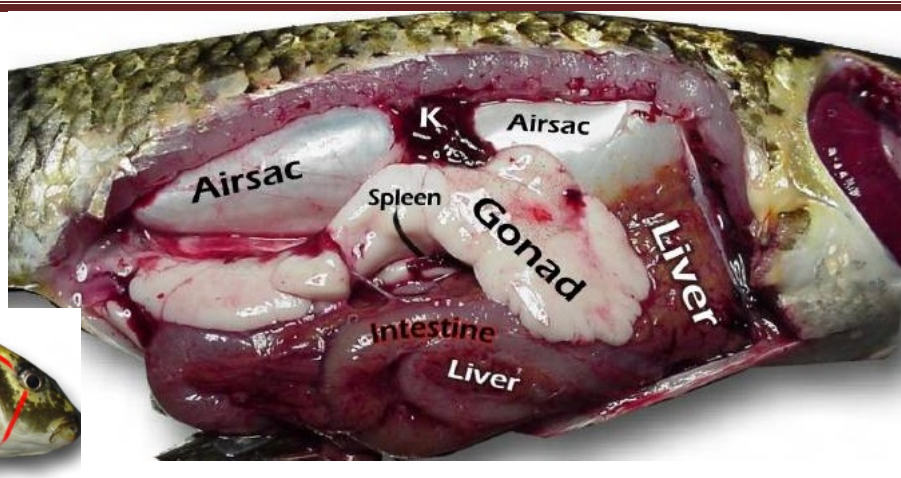
Do fresh- & seawater fish have the same sized swim-bladders?

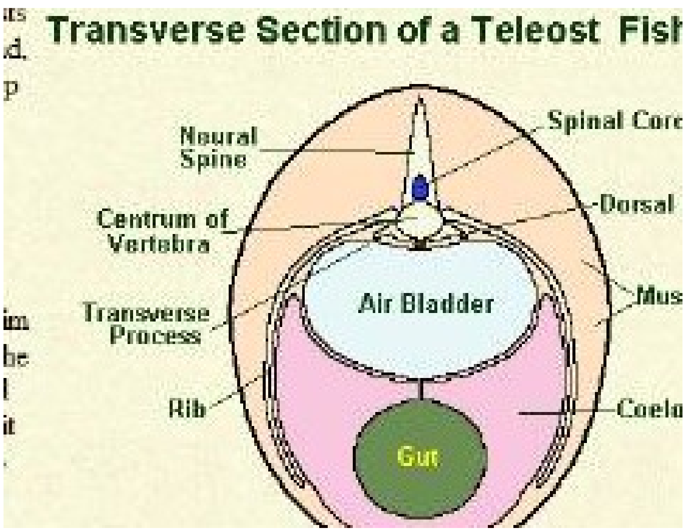
- The degree of body volume that must be taken up by gas in order to achieve weightlessness depends mainly upon whether the fish is freshwater or marine.
- Freshwater is less dense than seawater and consequently provides less buoyancy.
- Freshwater fishes, therefore, require a larger gas bladder than do marine fishes to keep them from sinking.

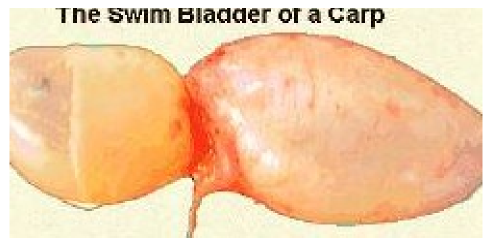
Does the amount of gas in the swim bladder change?

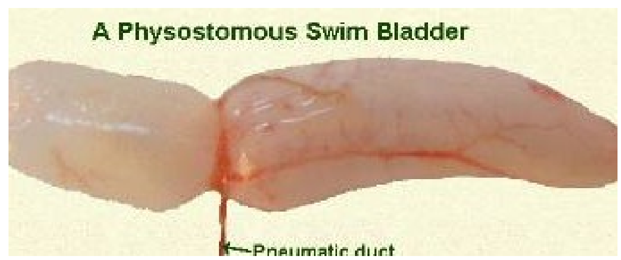
- The amount of gas in a fish's bladder must be adjustable (otherwise the fish would only be neutrally buoyant at 1 depth)
- The reason for this is that as pressure ↑ with depth, the gas in the bladder is compressed, ↓ decreasing the bladder's volume & ↑ the relative density of the fish.
- The fish would then have to use considerable energy to stop its increasingly denser body from sinking.
- Conversely, when a fish rises from great depths and pressure is decreased, the volume of the bladder expands and the fish becomes too light to remain at a given depth without considerable effort (in extreme cases, such as with certain deep-water fishes, excessive expansion of gases in the bladder can cause the bladder to burst).
- During the larval or juvenile stages all bony fish have a connection between the esophagus and the swim bladder called the pneumatic duct. In relatively primitive teleost fish such as salmon this connection remains.
- Fish with this type of swim bladder are termed physostomous and they are capable of filling their swim bladder quickly by gulping air at the surface and also releasing excess air quickly through their mouth and gills.
- In most marine species the pneumatic duct disappears and the fish develop what is called a physoclist swim bladder.
- This bladder has a gas gland that can introduce gases (usually oxygen) to the bladder to increase its volume & thus ↑ buoyancy.
- To ↓ buoyancy, gases are released from the bladder into the blood stream & expelled into the water via the gills.
- In order to introduce gas into the bladder, the gas gland excretes **lactic acid**; the resulting acidity causes the **haemoglobin** of the blood to lose its oxygen, which then diffuses into the bladder.
- In another area of the swim bladder, separated from the majority of the bladder by a sphincter, a structure known as the oval body connects the bladder to the blood supply & the oxygen can diffuse out into the blood & deflate the bladder.

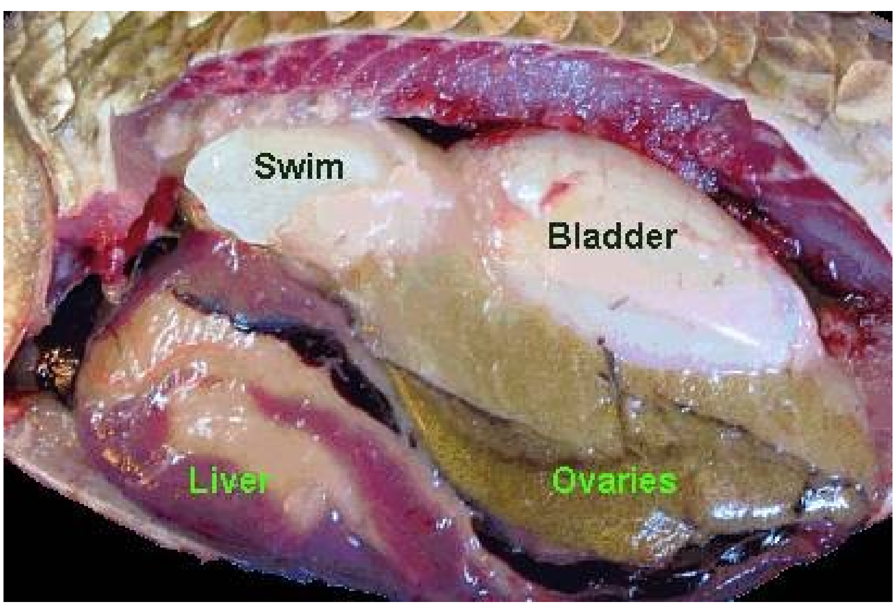
Swim Bladder





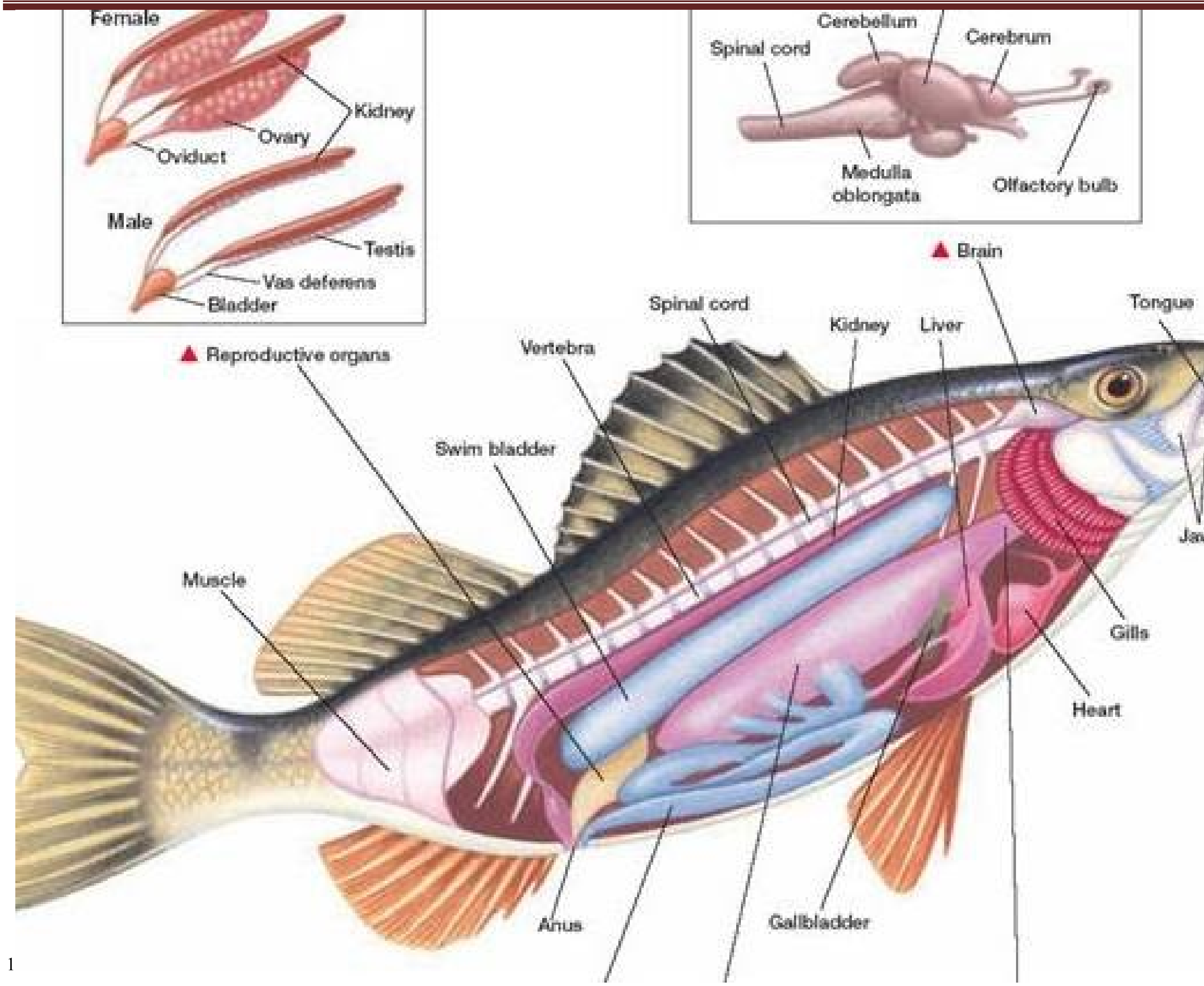






[1] http://putitintheshredder.blogspot.com/2007_07_01_archive.html

[2] www.earthlife.net/fish/bladder.html



[1]

[1] http://www.castlefordschools.com/kent/07-08%20lessons/Lessons/Advanced%20Biology%20Lessons/chapter%2033/Advanced%20Biology%20Chapter%2033%20Fishes%20and%20Amphibians.htm