Fish – *Perca flavescens* (yellow perch)

Fish Classification

Kingdom:	Animalia
Phylum:	Chordata (having a notochord, dorsal nerve cord, postanal tail)
Subphylum:	Vertebrata (cartilaginous or bony vertebrae surround nerve cord)
Class:	Actinopterygii (bony, ray-finned fishes with paired fins)
Superorder:	Teleostei (most living fish; swim bladder with hydrostatic function)
Order:	Perciformes (true perches, basses, tuna)

Natural History

The most numerous of all vertebrates are the bony fishes. They occupy every marine environment and also comprise the vast majority of the freshwater fish population. The perch belongs to this group of fish and is a good example of an aquatic vertebrate.

Yellow perch (*Perca flavescens*) are often called “jumbo perch” and are found in the United States and Canada. They have 6-8 dark vertical bars on their sides. Yellow perch size can vary greatly between bodies of water, but adults are usually between 4-10 inches (10-25.5 cm) in length. The perch can live for up to 11 years, and older perch are often much larger than average. The maximum recorded length is 21.0 inches (53.3 cm) and the largest recorded weight is 4.2 lb (1.91 kg).

Yellow Perch reach sexual maturity at one to three years of age for males and two to three years of age for females. Spawning occurs at the end of April or beginning of May, depositing 10,000 to 40,000 eggs upon weeds, or the branches of trees or shrubs that have become immersed in the water. After fertilization the eggs hatch in 11 to 27 days depending on temperature and other weather conditions.

Yellow Perch are fairly easy to catch and are often caught while fishing for other species in which they share the same body of water. They are also an important source of food for larger species, and therefore many fishing lures are designed to look like yellow perch.

The distance measured from the anterior tip to the last vertebra is called the **standard length** of the fish. The caudal fin, which is not included in standard length, is inserted in the flesh behind the last vertebra and is included in the **total length**. For taxonomic purposes, average standard lengths are usually given whereas the sports fisherman wanting to boost his "bragging rights" will invariably use total length in describing the catch.

Like most fishes, perch have a **swim bladder** to keep them buoyant without which they would sink to the bottom. Most fish gain buoyancy by inflating their swim bladder with gases produced by their blood. But water pressure increases with depth. As a fish swims deeper, the increased water pressure makes its swim bladder smaller and so reduces the fish's buoyancy. The amount of gas in the bladder must be increased so that the bladder remains large enough to maintain buoyancy. A fish's nervous system automatically regulates the amount of gas in the bladder so that it is kept properly filled. In the yellow perch, the swim bladder is immediately dorsal to the peritoneal cavity.

Basic Body Plan

The body of a fish is divided into three regions for study: the head, the trunk, and the tail. The head extends from the tip of the snout to the caudal edge of the **operculum,** the gill opening. The trunk extends from there to the ventral openings for the anus and urogenital organs. The tail extends caudally from these openings. The body of the perch is somewhat **fusiform** (or torpedo-shaped, laterally flattened and streamlined to minimize resistance), indicating that the perch is capable of rapids bursts of speed.

The position of the mouth is often a key to the fish's style of feeding. Perch have a **terminal mouth** that is located at the anterior, leading tip of the head. Terminal mouths indicate that the animal is a **predator**, overtaking prey while swimming. On the lower jaw are many sharp **uniform teeth**, used to capture and hold prey during swallowing (prey are swallowed whole). The mouth is surrounded by membranous lips. The forward, upper lip is called the **premaxilla** and just posterior and slightly ventral to that is the **maxilla**. The lower jaw is called the **mandible** and of course, as in other jawed vertebrates, is hinged.

Just above the mouth are four **nostrils** (nares), two on each side. One can push a fine probe through one of the **anterior nostrils** and it will emerge through a **posterior nostril**. The **nostrils** of fish don't connect with the pharynx (mouth) as they do in terrestrial vertebrates. Instead the nostrils serve as passages for water as it moves over the **olfactory epithelium**. Water enters through the anterior nostril and exits through the posterior nostril.

Like all fish, perch have lidless **eyes** situated on opposite sides of the head. The large eyes have no eyelids, but are covered with a layer of transparent integument. The lateral location of the eyes prevents binocular vision.

At the caudal end of the head, on the lateral surfaces, are large, crescent-shaped openings to the gill chamber known as the **operculum**. Operculum are external bony shields that protect the gills and allow water to pass out of the oral cavity during swallowing and breathing.

One of the most notable features of fish is the fins. There are two sets of paired fins that provide directional movement, the pectoral and pelvic fins. These paired appendages (fins) are homologous to the paired appendages of tetrapods. The pectoral fins are attached to the **pectoral girdle** which can be felt immediately beneath the skin and are homologous to the shoulder and forelimb of other vertebrates.

- Paired **pectoral fins** – on opposite sides of the trunk, behind the operculum
- Paired **pelvic fins** – ventral and caudal to the pectoral fins

Three unpaired fins act as stabilizers. This two-parted dorsal fin is a family characteristic of the Percidae.

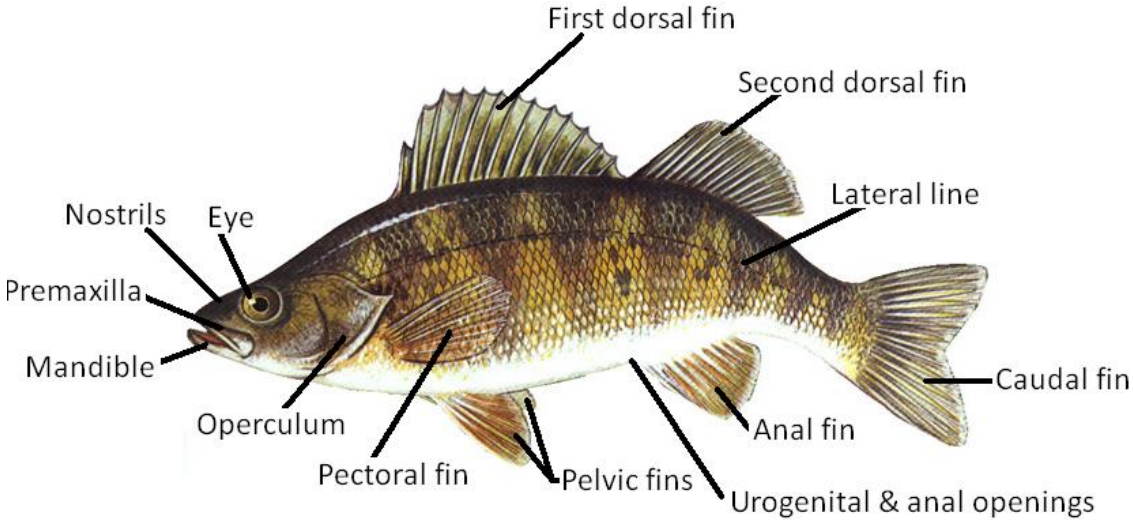
- **First dorsal fin** – anteriorly, on the back of the trunk
    - Supported by 12 to 14 sharp **spines**
- **Second dorsal fin** – posteriorly, on the back of the trunk
    - Usually supported first by 2 sharp spines, then by several 12 soft **rays**
- **Anal fin** – just posterior to the anal and urogenital openings, on the ventral side of the tail
    - Supported by 2 sharp spines then 7 to 8 soft rays

The **caudal fin** has no sharp spines, only soft rays. The caudal fin rays are modified caudal vertebrae. Tapering from the trunk, the tail ends as a laterally compressed paddle. The symmetrical **caudal fin** surrounds the fleshy end of the tail. This type of symmetrical caudal fin is correlated with the presence of a **swim bladder**. The caudal fin provides the

fish with propulsion. This fin is **homocercal**, having dorsal and ventral halves that are shaped roughly the same.

A distinct **lateral line** can be seen running along the middle of each side from the operculum to the caudal fin. Lateral line systems are formed by modified scales containing sensory pits. The lateral line detects vibrations, current directions, temperature, and possibly minute electrical charges in the water. In essence, it gives the perch a sense of "distant touch."

On the ventral surface of the fish are two openings. The larger, more anterior opening is the **anus**, which empties the digestive tract. The smaller, more posterior opening is the **urogenital opening** which drains both the urinary and reproductive systems.



Drawing modified from: http://kentsimmons.uwinnipeg.ca/16cm05/16labman05/lb7pg2.htm

Circulatory System

The **closed circulatory system** of vertebrates consists of the **heart**, **arteries**, **veins**, **capillaries** and **blood**. Arteries carry blood away from the heart to the sites of exchange in the tissues, in the **capillaries**. Veins carry blood from tissue capillaries back to the heart. The circulatory system is the major transport system of the vertebrate body. It distributes blood to all parts of the body. Lying on the posterior dorsal surface of the stomach is the highly vascularized **spleen.** It filters blood, produces white blood cells, and plays an active role in immunity.

The circulatory system of the perch is a typical **low pressure single type** system in which the heart is a single pump and there is a single circuit of blood flow. Venous (deoxygenated) blood from the body is pumped through the heart forward to the gills. From the gills, where it is oxygenated, the blood goes directly to the body. Thus the blood makes a single circuit during which it is pumped, oxygenated, and distributed to the body, before it returns to the heart. In this pattern of circulation the heart pumps only deoxygenated blood.

A fish's heart is located within the **pericardial cavity**. The heart consists of two main chambers - the single, thin-walled **atrium** and a single, thick-walled **ventricle**. Two other chamberlike structures are evident, a saclike **sinus venosus** and a muscular tube, the **bulbous arteriosus**. Deoxygenated blood from the body is returned to the heart via the veins. It then passes to the ventricle. Muscles in the ventricle pump the blood through

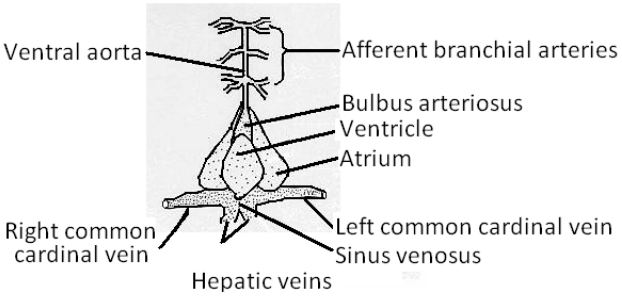
arteries to the gills, where the blood receives oxygen and gives off carbon dioxide. Arteries then carry the blood throughout the body. The blood carries food from the intestines and oxygen from the gills to the body cells. It also carries away waste products from the cells. A fish's kidneys remove the waste products from the blood, which returns to the heart through the veins.

If one considers the path of the blood in greater detail, the blood comes to the heart from the sinus venosus. From the sinus venosus, it passes into the atrium. There is no valve between the atrium and sinus venosus to keep blood from flowing backward. Blood enters the ventricle from the atrium. A **bicuspid valve** between the atrium and ventricle prevents blood from flowing back into the atrium as the ventricle contracts. Blood passes through another valve as it leaves the ventricle and passes into the bulbous arteriosus. The bulbous arteriosus is actually an expansion of the ventral aorta and is cannot contract forcibly because it isn't very muscular.

From the bulbous arteriosus, blood flows into the short, muscular **ventral aorta**. From the ventral aorta, blood flows to the gills. It enters the gills through the **afferent branchial arteries**, passes through the capillaries in the gill filaments, and leaves the gills through the **efferent branchial arteries**. From the efferent arteries, blood enters the **dorsal aorta**. Numerous arteries branch from the dorsal aorta to supply blood to the various regions of the body.

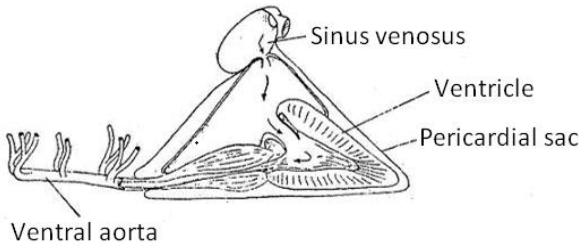
Microscopic **capillaries** lie between the arteries and veins. The diameter of the capillaries is so small that blood cells often must pass through them in single file. The walls of capillaries are very thin, allowing gases and nutrients to pass out of the blood to the individual cells, and waste products to pass from the cells into the blood. Blood returns to the heart through the systemic veins and the hepatic portal system. The **hepatic portal system** consists of veins from the stomach, intestine, and other organs that pass blood into the capillary beds of the liver where it is filtered and toxins are removed. It then passes into the **hepatic veins** and directly into the sinus venosus.

Ventral View of Perch Heart



Longitudinal section: Perch Heart

(Lateral view). Arrows indicate the direction of blood flow.



Perch Heart Images modified from: http://kentsimmons.uwinnipeg.ca/16cm05/16labman05/lb8pg11.htm

Major circulatory vessels of the perch. (Lateral view)

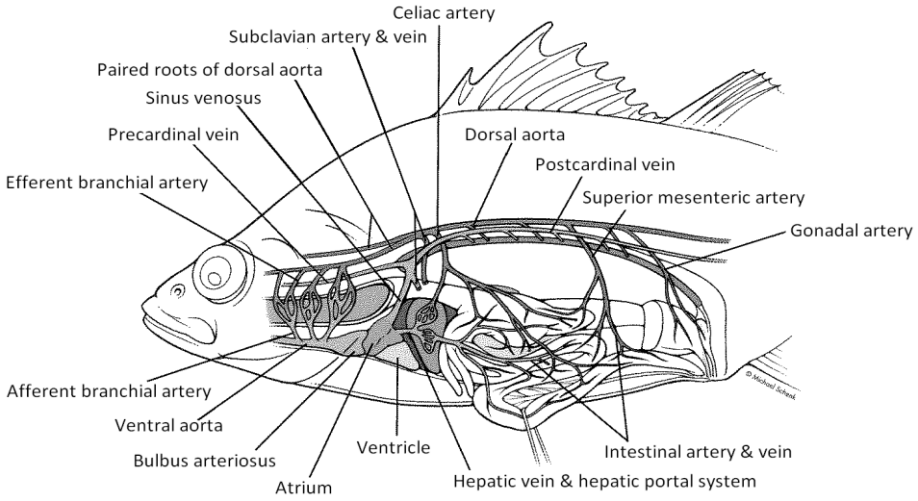


Image modified from: Smith, David G., and Michael P. Schenk. *Exploring Zoology: A Laboratory Guide*. Englewood: Morton Publishing Company, 2010.

Digestive System

The digestive system chemically and physically breaks food down into materials that nourish the body cells and eliminates materials that are not used. Digestive systems include the digestive tract, through which the food passes, and the accessory digestive glands such as the liver and pancreas. In fish, the digestive tract leads from the mouth to the anus, an opening in front of the anal fin. Perch have a jawed mouth with an immovable tongue and teeth rooted in the lower jaw. Fish swallow their food whole. Again, it is helpful to consider the passage of food through the digestive system.

From the mouth, food passes into the **pharynx** (throat), a short tube behind the mouth. The food then passes into the expanding **esophagus** which is located in the extreme anterior end of the body cavity and leads to the stomach. The **stomach** is a larger, thick-walled U-shaped tube where the mechanical and chemical digestion of food begins. The stomach can expand considerably as the fish eats food. From the stomach, the food will enter the **intestine,** where food digestion is completed. The intestine forms an S-shaped loop that constricts and straightens at its end. The length of intestine in perch is less than its body length which correlates with its carnivorous life style. (Because plant matter is harder to digest, the intestine of herbivorous fish is 2 to 15 times their body length.) The intestine empties waste products and undigested food through the **anus.**

The digestion of food couldn't occur without the assistance of the accessory organs. The junction of the stomach and the intestine is marked by the presence of three **pyloric caeca**. These are blind-ended tubes extending from the gut that serve secretory and absorptive functions. Situated just anterior to the stomach is the **liver.** The liver has many functions: it produces bile which aids in the digestion of fats; it filters and breaks down toxins in the blood; it produces, stores, and releases glycogen; and it stores nutrients. The **gall bladder** drains bile from the liver, and opens by a number of ducts into the intestine. Bile is necessary for the proper digestion of fats. Usually found along the ventral border of the intestine is the **pancreas.** The pancreas secretes digestive enzymes into the intestine and hormones (insulin and glucagons) into the blood.

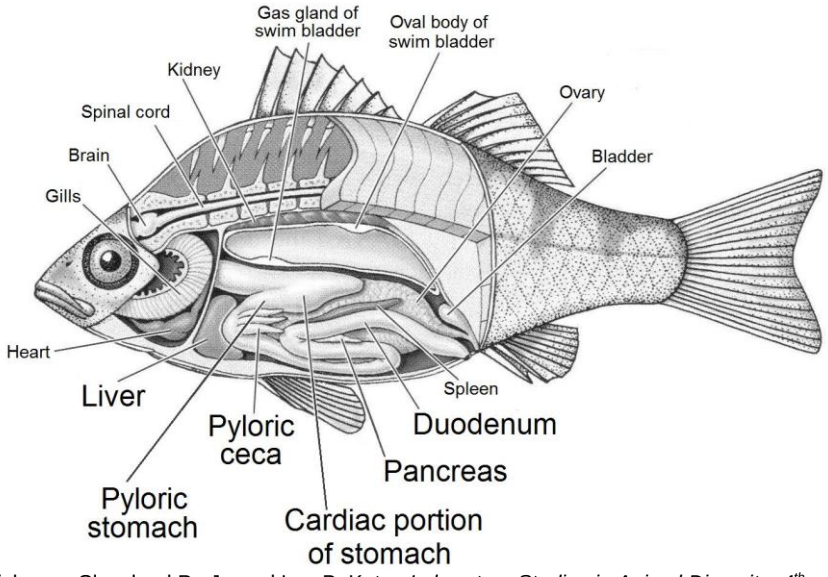


Image modified from: Hickman, Cleveland P., Jr. and Lee B. Kats. *Laboratory Studies in Animal Diversity, 4th ed.* Boston: McGraw Hill Higher Education. 2007.

Excretory System

The excretory system (commonly known as the **urinary system**) consists of the **kidneys**, which lie dorsal to the swim bladder. The pair of kidneys is elongated and slender and functions primarily to **regulate the osmolarity of the blood**. At the posterior ends of the kidneys, two small ducts unite to form one common **ureter** (also known as the Wolffian duct) which drains wastes into the urinary bladder. The **urinary bladder** is a small sac at the most posterior, ventral end of the body cavity that voids urine almost as fast as it is produced. In males, the urinary bladder is a separate structure that voids wastes through the **urinary pore.** In females, the urinary bladder is incorporated into the oviducts to form the urogenital sinus which empties via the common **urogenital opening**.

In freshwater fish, such as the perch, the elimination of nitrogenous waste occurs primarily across the gill epithelium. In these animals, the kidney functions are **osmoregulatory**. The body fluids of freshwater fish are hyperosmotic (hypertonic) to their environment. Although the skin of the perch (with its mucous coating) is virtually impermeable, the lining of the oropharyngeal cavity and the gill epithelium are permeable to water and salts. Thus, there is constant **osmotic entry of water** into the body fluids and diffusional loss of salts (e.g. NaCl) from body fluids, across these surfaces.

To compensate for this ongoing intake of water, the kidneys of freshwater fish continually produce large volumes of **dilute urine**. In these animals, the kidneys are quite efficient in reabsorbing ions (salts) from the urine being produced. Freshwater fish also actively take up ions at the gills to replace those lost in urine and feces.

In Phylum Chordata, the kidneys eliminate the nitrogenous wastes of cellular metabolism as well as a variety of other materials that may be present in the blood in excess of the body's need. In addition, they conserve materials not in excess. Thus, the kidneys have a vital function both in excretion and in maintaining an internal environment that is nearly constant in the water and salt content of body fluids, in pH, and in the content of sugar and other substances in the blood.

Integumentary System

No discussion of external anatomy would be complete without considering the skin and its scales. The skin is an extensive organ that forms the interface between an animal's internal environment and the outside world. The skin is vital to the maintenance an internal environment different from their external environment. The skin typically contains many sensory receptors which informs the vertebrate about the outside world.

Like all vertebrates, fish skin is composed of both an outer **epidermis** and a thick underlying **dermis**. Fish skin is unique in the origin of the scales that cover it. Fish scales are produced from the mesoderm layer of the dermis, whereas reptilian scales are produced by the epidermis. Thus, fish scales aren't homologous to reptile scales (or bird feathers or mammalian hair, all epidermal structures).

The aquatic environment is less stressful and more stable than the terrestrial environment. Since all fish are aquatic, fish skin is relatively simple in structure. The epidermis in fish is relatively thin. It contains many mucous glands that produce the fish's protective covering of **mucus**. Besides making fish slippery and possibly providing some lubrication, mucus protects the fish against bacteria, external irritants, and certain heavy metal salts.

The dermis contains connective tissue, nerves, blood vessels, and pigment glands, and is the site of production of **scales**. Scales of modern fish are the remnants of bony armour, which covered the bodies of ancient vertebrates. Most of the skin of the perch is covered with these flexible scales, arranged in orderly rows and slightly overlapping each other. Scales provide a tough protective barrier for the skin. Perch have **ctenoid** scales. Cycloid and ctenoid scales are overlapping, making them more flexible than cosmoid and ganoid scales. A highly magnified view of a scale shows many minute spines or **ctenii** along the exposed caudal edge. Also evident are growth rings, or annuli, which result from the seasonal deposition of new material along the margins of the scale. They grow in size through additions to the margin, creating bands that can be used to age the fish. Scales will grow continuously throughout the life of the fish and are not regenerated if lost.

	Fish Scale Types				
	Placoid	Cosmoid	Ganoid	Cycloid	Ctenoid
					
Fish Group	Cartilaginous	Lobe-finned	Nonteleost bony fishes	Teleost Bony fishes with soft fin rays	Teleost Bony fishes; fins have spines
Example Fish	Sharks, rays, chimaeras	Coelacanths & lungfishes	Sturgeons, paddlefishes, gars, bowfin, & bichirs	Salmon, minnows, trout, carp	Perch

Muscular System

Like all vertebrates, fish have three kinds of muscles: (1) **skeletal** muscles, (2) **smooth** muscles, and (3) **cardiac** or heart muscles. Fish use their skeletal muscles to move their bones and fins. A fish's smooth muscles and heart muscles work automatically (i.e. involuntarily). The smooth muscles are responsible for operating such internal organs as the stomach and intestines. Heart muscles form and operate the heart.

A fish's flesh consists almost entirely of skeletal muscles. They are arranged one behind the other in broad vertical bands called **myomeres**. The myomeres are zig-zag shaped and look like a large "W" tilted on its side. Each myomere can easily be seen in a skinned fish. A **horizontal septum** divides the myomeres into a dorsal **epaxial** portion and a ventral **hypaxial** portion. The main function of the musculature is not locomotory but is to support the body viscera.

Each myomere is controlled by a separate nerve. As a result, a fish can bend the front part of its body in one direction while bending its tail in the opposite direction (an **undulation**). Most fish make such movements with their bodies to swim. These contractions are relatively inefficient, thus a larger muscle mass is required for locomotion in the perch.

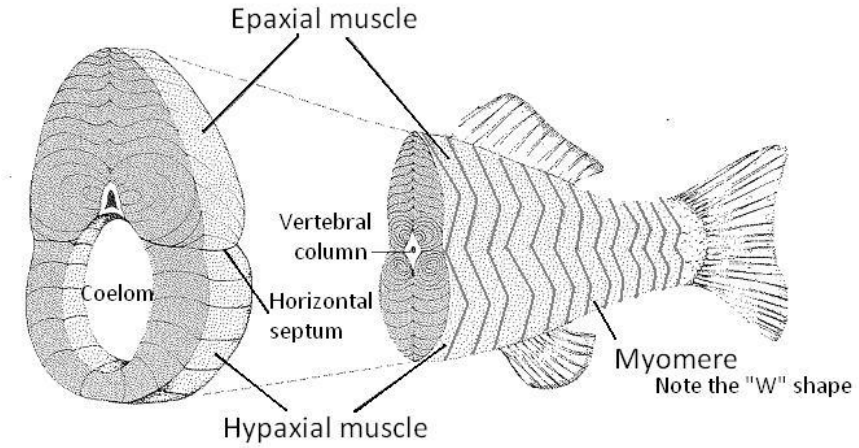


Image modified from: Hickman, Cleveland P., Jr. and Lee B. Kats. *Laboratory Studies in Animal Diversity, 4th ed.* Boston: McGraw Hill Higher Education. 2007.

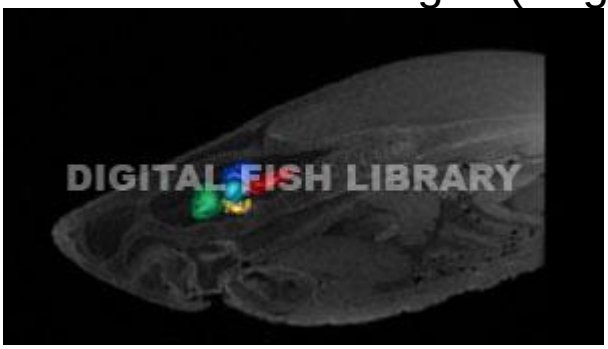
Nervous System

The nervous system of fish, like that of other vertebrates, consists of a spinal cord, brain, and nerves. However, a fish's nervous system is not so complex as that of mammals and other higher vertebrates. The nervous system is divided into two main portions: the **central nervous system** includes the brain and spinal cord while the **peripheral nervous system** includes the nerves outside of the brain and spinal cord. The **spinal cord**, which consists of soft nerve tissue, runs from the brain through the backbone. The **brain** is an enlargement of the spinal cord and is enclosed in the skull. The **nerves** extend from the brain and spinal cord to every part of the body. Some nerves, called **sensory nerves**, carry messages from the sense organs to the spinal cord and brain. Other nerves, called **motor nerves**, carry messages from the brain and spinal cord to the muscles.

The brain has five division which we will consider from the anterior (the rostral end) to the posterior end.

- The **telencephalon** has the olfactory lobes and the cerebral hemispheres
  - Where the fish processes smell
  - Also responsible for the integration of memory, learning, and spatial awareness
- The **dienchephalon** which includes the thalamus, hypothalamus, pineal gland, and pituitary gland
  - Helps regulate body functions through hormones
  - Also functions in controlling motivation
- The **mesencephalon** composed of the optic lobs
  - Where the fish processes visual information
  - May also integrate mechanosensory information
- The **metencephalon** composed of the **cerebellum**
  - Coordinates muscular activity and equilibrium
- The **myelencephalon** composed of the **medulla oblongata**
  - Controls many reflexes and vital functions, including heartbeat
  - Acts as relay station between the brain and spinal cord

3D Segmentation of the Great White Shark brain from MRI images (Segmentation by Kara Yopak)



Telencephalon – green, Diencephalon – yellow, Mesencephalon – cyan, Cerebellum – blue, Medulla – magenta

Images from: http://www.digitalfishlibrary.org/featured/great_white/
(I would have liked to have images of perch brains, but apparently, there wasn't research funding available to do those studies. Alas.)

Reproductive System

As in all vertebrates, the reproductive organs of fish are **testes** in males and **ovaries** in females.

In male fish, the white, elongated, paired testes are located caudal to the stomach and ventral to the air bladder. The testes fuse together toward the posterior end. The testes produce male sex cells, or **sperm**, and male sex hormones. The sperm is contained in a fluid called **milt**. Sperm pass through the **vasa derfentia** to the **genital sinus**, and then to the exterior through the **genital pore.** (The males of some fish species have special structures for transferring sperm directly into the females.)

The female has a single large ovary that produces the female sex cells, or eggs. The ovary is an epithelial sac filled with eggs that is located caudal to the stomach and

ventral to the air bladder. The ovaries are paired in early stages, as they are in other vertebrates, but during development, they fuse into a single organ. Fish eggs are also called **roe** or **spawn**. Eggs are released from the ovary into the **oviduct.** Eggs then pass to the exterior through the **urogenital sinus** and **urogenital pore**.

Fertilization occurs exterior to the body after the eggs are released by the female.

Respiratory System

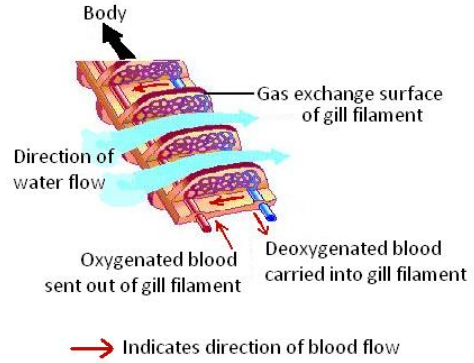
Unlike land animals, almost all fish get their oxygen from water. Because oxygen is about 20 times less soluble in water than air (210 cm^3 of O_2/liter of air, 4 to 11 cm^3 of O_2/liter of water) aquatic animals have developed a wide variety of mechanisms for extracting it from water. To get oxygen from water, fish gulp water through the mouth and pump it over the gills. Most fish have **four pairs of gills** enclosed in a **gill chamber** on each side of the head. Each gill consists of two rows of fleshy **gill filaments** attached to a gill arch. The gill filaments are highly vascularized fingerlike structures that provide a large surface area for the exchange of gases. The gill arch is bony structure that provides support for the gill filaments. There are also **gill rakers**, hard spiny projections that support the gill filaments and prevent large objects from passing through the gills.

Water passes into the gill chambers through gill slits. A flap of bone called the **operculum** protects the gills of bony fish. In a bony fish, the breathing process begins when the gill covers close and the mouth opens. At the same time, the walls of the mouth expand outward, drawing water into the mouth. The walls of the mouth then move inward, the mouth closes, and the gill covers open. This action forces the water from the mouth into the gill chambers. In each chamber, the water passes over the gill filaments. They absorb oxygen from the water and replace it with carbon dioxide formed during cellular respiration. The water then passes out through the gill openings, and the process is repeated.

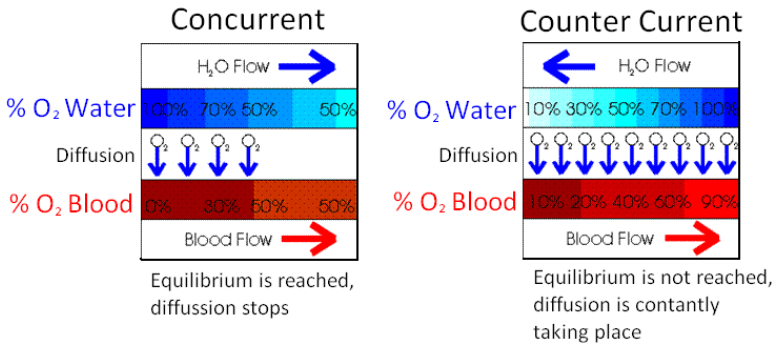
Because obtaining enough oxygen from the water is such a challenge, fish have evolved one of the most efficient respiratory systems on earth, a **counter current system**. The flow of oxygen-rich water is often in the opposite direction of oxygen-poor blood to keep the concentration gradient as high as possible.

In addition to their respiratory function, gills also perform important excretory functions. Without exception, all fish primarily excrete their nitrogenous wastes via the gills rather than via kidneys. Marine fish also excrete excess salts via the gills. Freshwater fish absorb needed salts via the gills.

Counter Current Exchange of Gill



Efficiency Comparison



Images modified from: http://bio-isu.tripod.com/sitebuildercontent/sitebuilderpictures/3.jpg AND
http://www.cbu.edu/~seisen/LcEx02Fa2008EssayAnswers_files/image002.gif

Skeletal System

The skeleton is the basis of form and support of the vertebrate body. Muscles attach to the skeleton and produce movement by pulling on the bones like levers. Furthermore, the skeleton surrounds and protects vital organs. Compared to terrestrial vertebrates, fish have much simpler skeletons, lacking limb complexity, development of additional bone strength, and the development of complex pectoral and pelvic girdles.

The skeletal system of vertebrates is composed of bone and/or cartilage. Bone tissue is found only in the Subphylum Vertebrata. In vertebrates, bone functions as a supporting tissue, a calcium reserve and as a hemopoietic (blood forming) tissue. The skeletons of most fish consist mainly of (1) skull, (2) a backbone, (3) ribs, (4) fin rays, and (5) supports for fin rays or fins. A fish's skeleton provides a framework for the head, trunk, tail, and fins. The perch skeleton can be divided into two primary divisions, the **axial skeleton**, composed of the skull, vertebral column, and the unpaired fins, and the **appendicular skeleton**, composed of the pectoral and pelvic girdles and their appendages.

The central framework for the trunk and tail is the backbone. It consists of many separate segments of bone or cartilage called **vertebrae**. In bony fish, each vertebra has a spine at the top, and each tail vertebra also has a spine at the bottom. **Ribs** are attached to the vertebrae. The skull consists chiefly of the brain case and supports for the mouth and gills. The pectoral fins of most fish are attached to the back of the skull by a structure called a pectoral girdle. The pelvic fins are supported by a structure called a pelvic girdle, which is attached to the pectoral girdle or supported by muscular tissue in the abdomen. The dorsal fins are supported by structures of bone or cartilage, which are rooted in tissue above the backbone. The caudal fin is supported by the tail and the anal fin by structures of bone or cartilage below the backbone.

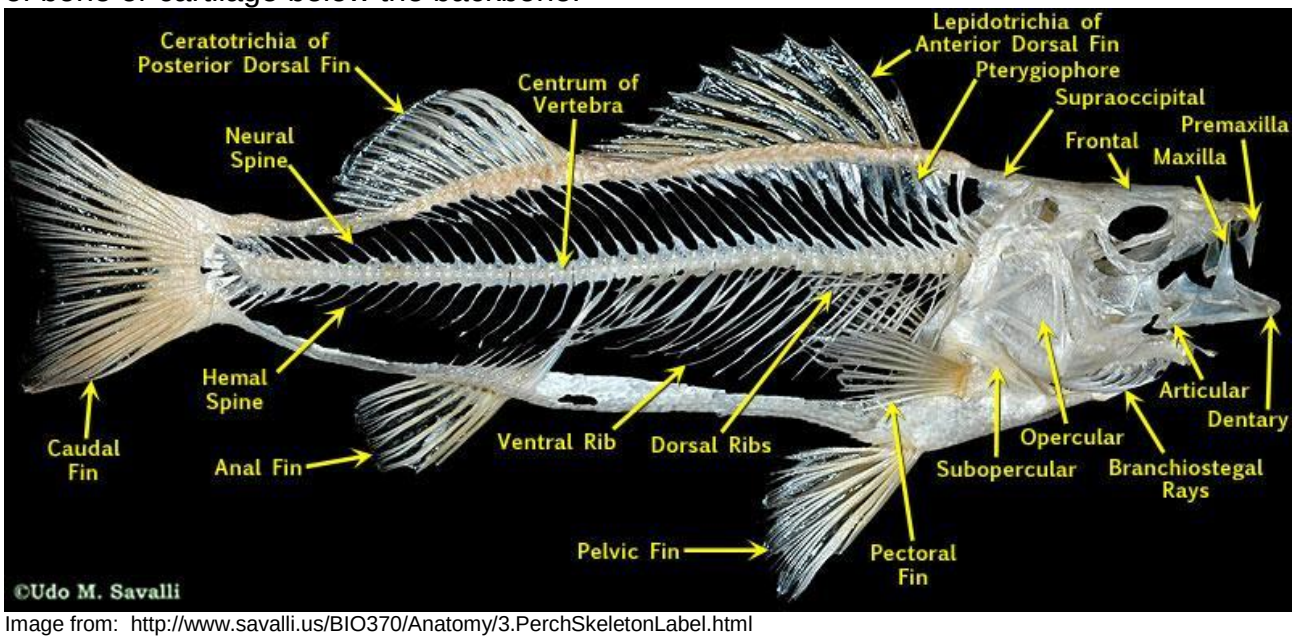
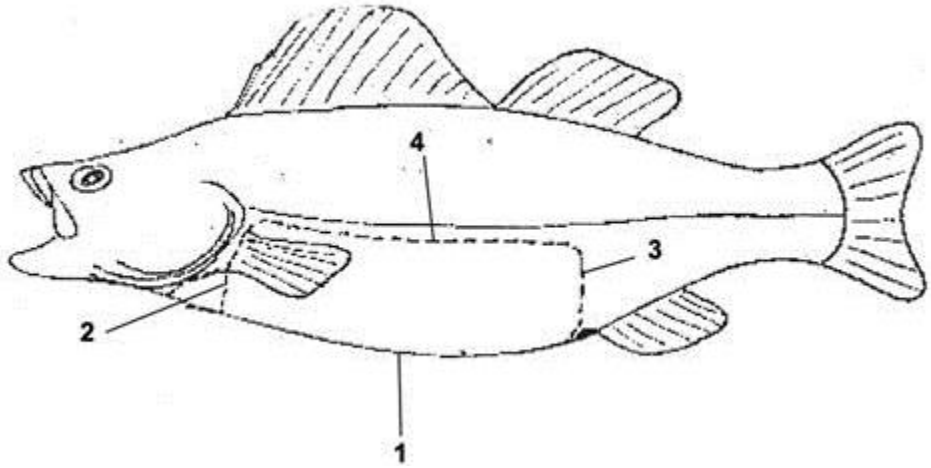


Image from: http://www.savalli.us/BIO370/Anatomy/3.PerchSkeletonLabel.html

Dissection Instructions

1. Place a preserved perch in a dissecting pan.
    a. Observe the **fusiform** body shape.
    b. Note the pattern of the scales.
    c. Locate the **lateral line**.
    d. On the ventral surface, locate the **anus** (larger, more anterior of the two) and **urogenital** opening.
    e. Find the **operculum** and bend it backward to observe the four **gill arches**.
2. To expose the internal organs, hold the fish with the ventral side up and the head pointing toward you.



    a. Insert the point of your razor through the body wall in front of the anus and cut up the midline of the body to the space between the opercula **(cut 1)**.
    b. Now lay the fish on its right side in the dissecting pan, and remove the skin and the muscles of its left side.
        i. To do that, continue to cut up around the back edge of the gill chamber to the top of the body cavity **(cut 2).**
        ii. Make another incision from the starting point of the ventral incision close to the anus, and cut upward to the top of the body cavity **(cut 3).**
    c. Be careful not to disturb the internal organs. Remove the lateral body wall by cutting along the top of the body cavity **(cut 4).** This procedure will expose the body organs in their anatomical position (**in situ**)**.**
3. Locate the organs indicated on the following page and determine the sex of your fish.
4. Place the dissected specimen and all scraps in the designated container. Scrape out and rinse out the dissecting pan. Clean up any other mess.

On the next page is a diagram representing a dorsal view of the internal structures of a female yellow perch. Use the terms above the diagram to identify the indicated structures.

Images on next page modified from: Hickman, Cleveland P., Jr. and Lee B. Kats. *Laboratory Studies in Animal Diversity, 4th ed.* Boston: McGraw Hill Higher Education. 2007.

Organ System	Structures to Identify
External Body	Anal fin, Caudal fin, Eye, First dorsal fin, Lateral line, Mouth, Nostril, Operculum, Pectoral fin, Pelvic fin, Second dorsal fin
Circulatory	Heart, Gas gland of swim bladder, Oval body of swim bladder, Spleen
Digestive	Cardiac portion of stomach, Duodenum, Liver, Pancreas, Pyloric ceca, Pyloric stomach
Excretory	Bladder, Kidney
Nervous	Brain, Spinal cord
Reproductive	Ovary
Respiratory	Gills