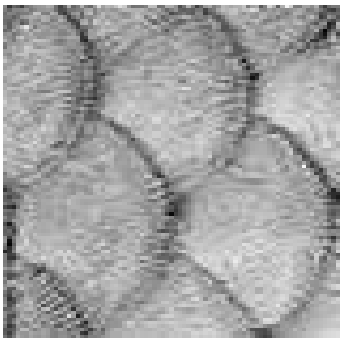
NAME _____

OSTEICHTHYES LAB

PHYLUM: Chordates
SUBPHYLUM: VERTEBRATA "bone covering nerve cord"
CLASS: OSTEICHTHYES 'bony fish"

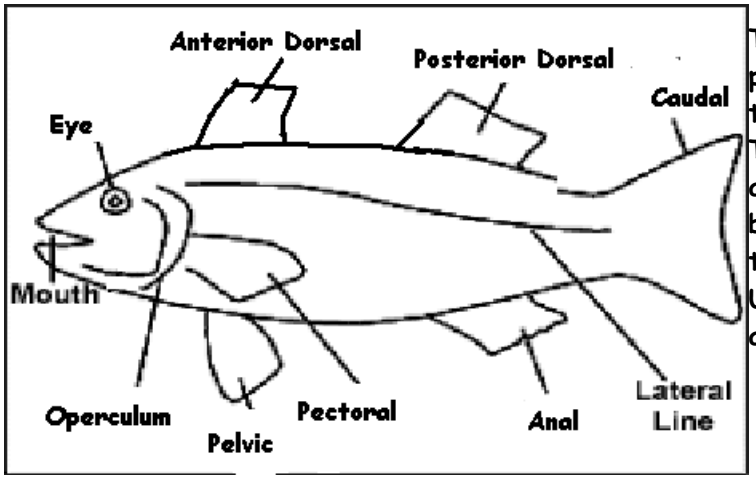
Fishes are the oldest vertebrate group and the most numerous and widespread of all living vertebrates today. 95% of all fish are in the class OSTEICHTHYES meaning "bony fish". All BONY FISH have three characteristics:

1). an endoskeleton made of BONE
2.) lungs or a SWIM BLADDER, and
3.) a body surface covered with SCALES



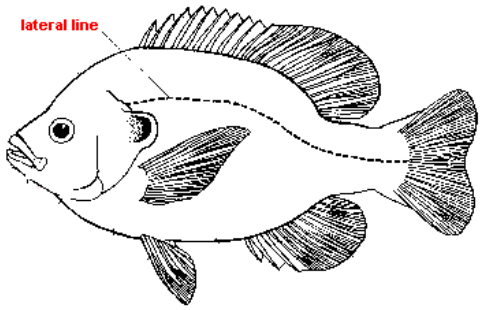
INTEGUMENTARY:
The skin of the perch is covered with SCALES (thin round discs of bonelike material that grow from pockets in the skin). The scales overlap like roof shingles and point toward the tail to REDUCE FRICTION AS THE FISH SWIMS. Scales grow throughout the fish's life and the resulting growth rings give a good approximation of the fish's age. Scales also PROVIDE PROTECTION.

The fins on a fish are adaptations for swimming and navigation and are supported by RAYS or SPINES which also PROVIDE PROTECTION FROM PREDATORS.



The two DORSAL FINS (one anterior and one posterior) and a ventral ANAL FIN help keep the fish upright and moving in a straight line. The paired PELVIC FINS and PECTORAL FINS are used to stop, move up and down, and even back up. The CAUDAL FIN extends from the tail for propulsion. The ANUS and UROGENITAL OPENING are located near the anal fin.

NERVOUS (Sense organs)
The LATERAL LINE system, which runs along each side of fish, is a sensory structure which detects water pressure vibrations in the water. Find the NOSTRILS (dead end pockets) and EYES (with NO EYELIDS).



Fish have a highly developed sense of smell and sight and parts of the fish's brain that process info from these two (OPTIC TECTUM and OLFACTORY LOBES) are the largest of a fish's brain.

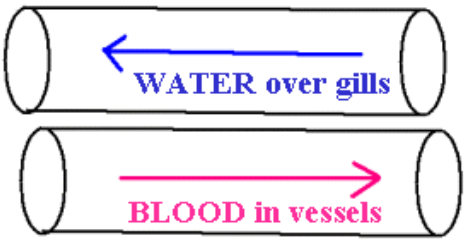
the
and
the
areas
parts

COLORATION:

Pigment cells (CHROMATOPHORES) in the skin give the fish its color and allow it to blend in with its surroundings. Notice the fish has lighter coloration on its ventral surface and is darker on the top so it is less easily seen from above or below.

RESPIRATORY/EXCRETORY:

On each side of the head is the OPERCULUM, a hard plate that covers and protects the GILLS. Water enters through the fish's mouth, passes over the gills, and out through the slits behind the OPERCULUM.



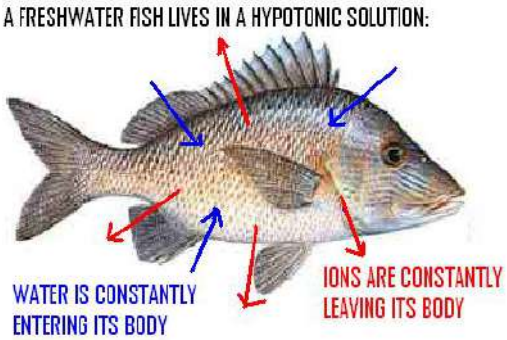
Water moving over the gills flows away from the head, while the blood inside the gills flows toward the head. This arrangement, known as COUNTERCURRENT FLOW, allows more oxygen to diffuse into the gills than would be possible if blood and water both flowed in the same direction.

The GILLS in a fish serve THREE FUNCTIONS:

1. **EXCHANGE OF GASES**
   (oxygen is taken in and carbon dioxide is released),
2. **REMOVAL OF NITROGEN WASTE**
   (AMMONIA is removed from blood and released)
3. **OSMOREGULATION OF WATER/ION CONCENTRATIONS IN BLOOD.**
   (IONS are actively transported IN or OUT depending on environment

In order to stay alive an organism must keep the balance of ions and water in a constant range. This is done through a process called OSMOREGULATION, which means maintaining the proper balance of water and ions in the blood and body tissues.

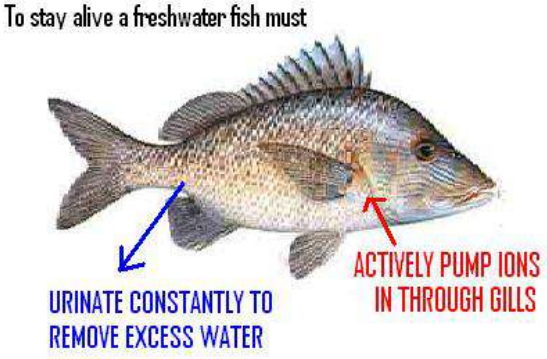
FRESHWATER FISH:



Freshwater fish tend to GAIN WATER and LOSE IONS in their HYPOTONIC environment.

The GILLS in a perch (freshwater dweller) have special cells that ACTIVELY TRANSPORT sodium and chloride ions in

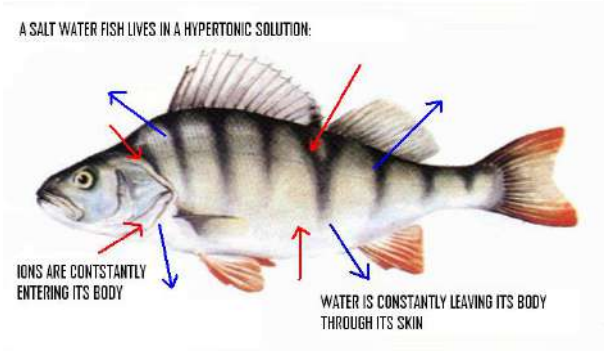
Kelly Riedell



through the gills to maintain the correct ion balance. The KIDNEYS also remove excess water by making urine. Freshwater fish urinate constantly to remove the excess water that is always entering their bodies from their hypotonic environment.

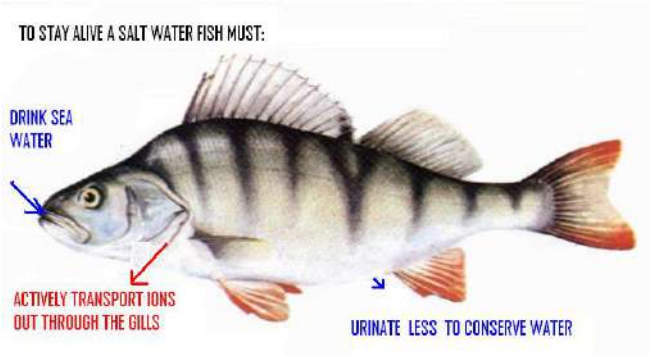
SALTWATER (MARINE) FISH:

The



reverse happens in SALT-WATER fish. Since sea water is HYPERTONIC, water is constantly leaving the fish's body via osmosis and ions are entering through diffusion.

To maintain the water/ion balance, salt water fish urinate less and drink sea water to replace lost water. They excrete the extra ions taken in through special cells in their gills that maintain the proper osmotic concentration in their blood and tissues. Extra ions are also excreted in urine.



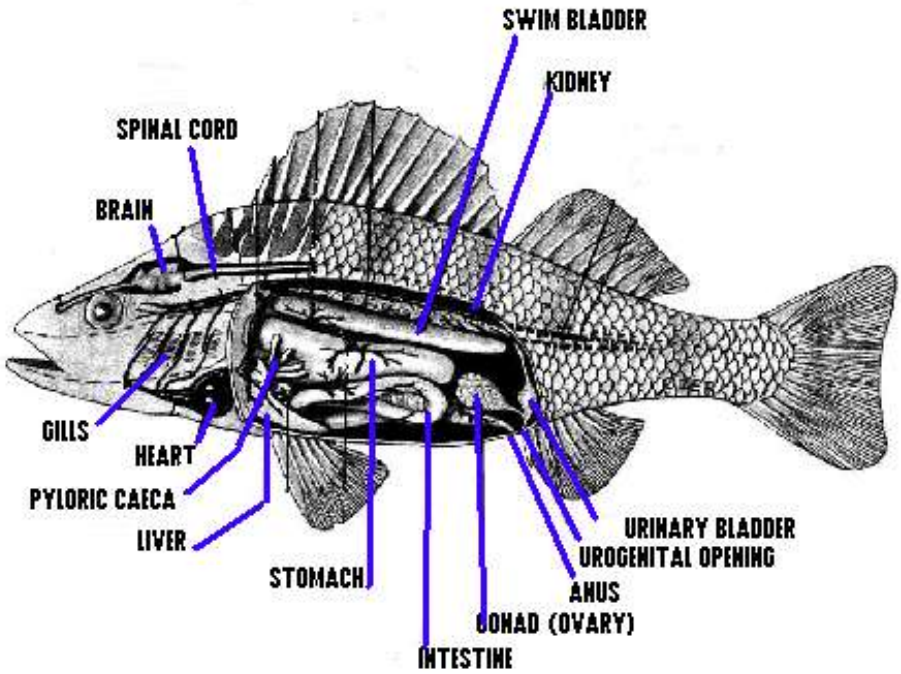
INTERNAL ORGANS: Use your scissors to slice along the ventral surface and peek inside to see the SWIM BLADDER (also called AIR/GAS BLADDER). This organ is thought to have evolved from the lungs of early bony fish. Gases (oxygen, carbon dioxide, and nitrogen) from the blood can be added to or removed from the SWIM BLADDER to control the fish's buoyancy. By adjusting the volume of gas in the swim bladder, a fish can remain suspended at any depth with no muscular effort.

MUSCULAR/SKELETAL

Fish are "top heavy" with muscle because the body muscles are concentrated along the dorsal surface and in the tail of your fish. (One of the reasons fish float "belly up" when they are dead). An ENDOSKELETON of bone provides support and helps in movement. Having an ENDOSKELETON allows a vertebrate to grow without molting.

Bones (called vertebrae) surround their SPINAL CORD, as well.

Now remove the skin and muscle on one side of your fish so you can see the internal organs. Fish, like all vertebrates, are EUCOELOMATES. The space you see surrounding the organs is true COELOM. Notice the location of the liver, gills, and heart. It is no accident these vital organs are so close together.



REPRODUCTIVE

Fish have SEPARATE SEXES. The male reproductive system consists of paired TESTES that produce sperm which are carried by the VAS DEFERENS to the shared UROGENITAL OPENING that releases both urine and eggs or sperm. In females eggs are produced in paired OVARIES and carried via OVIDUCTS to the UROGENITAL OPENING. Eggs and sperm are released through this UROGENITAL opening behind the ANUS. Most fish have EXTERNAL FERTILIZATION. The female lays eggs and the male passes over them, depositing the sperm to fertilize them. Mortality among eggs and young is high and fish lay large numbers of eggs to ensure at least some will survive. Immature fish that hatch are called FRY. Many fish display complex reproductive behaviors (SPAWNING) for courtship, nest building, migrating, and caring for young.

DIGESTIVE

Examine the MOUTH and PHARYNX (opening to the digestive system in the back of the throat). The ESOPHAGUS is a short muscular tube that connects the pharynx and the STOMACH which produces acid and some digestive enzymes to begin the breakdown of food. The CARDIAC STOMACH is closest to the mouth. The PYLORIC STOMACH connects to the INTESTINE. The PYLORIC CAECA are group of fingerlike projections located at the junction of the PYLORIC STOMACH and the DUODENUM (lst part of INTESTINE). VILLI (fingerlike extensions along the inside surface of the intestine) help to INCREASE SURFACE AREA for better nutrient absorption by the intestine. The PYLORIC CAECA are believed to be involved in digestion of plants and absorption of nutrients. Digestive waste moves through the intestine and exits the body through the ANUS. The reproductive organs and KIDNEYS also exit in this area through the UROGENITAL OPENING.

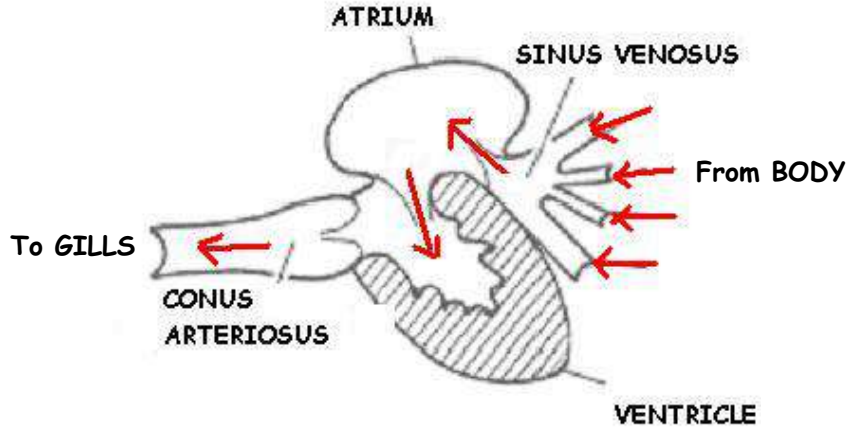
The LIVER lies just in front of STOMACH. It secretes BILE (to help digest fats) which is stored in the GALL BLADDER (darker tissue on the LIVER) until it is used in the INTESTINE. In addition to SECRETING BILE, the liver also functions in GLYCOGEN STORAGE, VITAMIN STORAGE, and PROCESSES TOXINS (including NITROGEN WASTE from the body cells) which are then removed from the blood by the KIDNEYS and GILLS (as AMMONIA). The PANCREAS makes a digestive enzyme called TRYPSIN (that digests proteins) which is released into the intestine.

ENDOCRINE

The endocrine system controls sexual development, heart rate, and metabolism.
In addition to digestive enzymes (trypsin) the PANCREAS makes two hormones that regulate blood sugar levels. INSULIN causes cells to take up glucose from the blood stream and store it as glycogen. GLUCAGON causes cells to release their stored glycogen as glucose into the bloodstream. These to hormones work together to control blood sugar levels.

CIRCULATORY

The circulatory system in a fish delivers oxygen and nutrients to the cells of the body. It also transports carbon dioxide and nitrogen waste to the gills and kidneys for elimination. The circulatory system consists of a HEART, BLOOD VESSELS, and BLOOD. Fish have a CLOSED circulatory system with blood contained in blood vessels. The heart pumps blood in a SINGLE CLOSED loop through ARTERIES (vessels that carry blood away from the heart) to small thin walled vessels in the GILLS called CAPILLARIES where oxygen is picked up and carbon dioxide is released. From the gills, blood travels to the tissues where nutrients and wastes are exchanged. Blood returns to the heart in vessels called VEINS.



The heart in a fish has 2 MAIN CHAMBERS: an ATRIUM and a VENTRICLE. Deoxygenated (low oxygen) blood returning to the heart empties into a collecting space called the SINUS VENOSUS before moving into the ATRIUM. Contraction of the atrium speeds up the blood and drives it into the VENTRICLE (main pumping chamber). Contraction of the ventricle forces the blood through the circulatory system. An exit space called the CONUS ARTERIOSUS smoothes the flow of blood as it leaves the heart.

The SPLEEN is a red oblong structure that lies near the end of the CARDIAC STOMACH and functions in red blood cell formation, destruction, and storage. During times of low oxygen the spleen can release extra red blood cells to carry more oxygen.

NERVOUS

The nervous system in a fish includes the BRAIN, SPINAL CORD, NERVES that lead to and from all the parts of the body, and various SENSORY ORGANS. Fish are VERTEBRATES with a DORSAL NERVE CORD running along the dorsal body wall. A nerve cord covered with bone is called a SPINAL CORD. The brain in a fish is more complex than you have seen in invertebrates.

THE BRAIN consists of several areas with different functions. Fish have a highly developed sense of smell and sight and the parts of the fish's brain that process info from these two areas (OPTIC TECTUM and OLFACTORY LOBES) are the largest parts of a fish's brain. The most anterior part are the OLFACTORY LOBES (process info for smell). The CEREBRUM is for higher thinking (that means learning, memory, and problem solving) and integrates information from all the other areas of the brain. The largest part is the OPTIC TECTUM (receives and processes information from the fish's visual, auditory {hearing}, and LATERAL LINE systems). The most posterior portions are the CEREBELLUM (controls motor coordination & balance), and the MEDULLA OBLONGATA (controls autonomic body organs and acts as a relay station for information from sensory receptors throughout the body). The SPINAL CORD extends along the body and carries nerve impulses to and from the brain.

EXCRETORY

The KIDNEYS are dark colored organs located on the dorsal body wall alongside the SPINAL CORD. Their function is to REMOVE NITROGEN WASTE (ammonia and urea) from the blood that has been produced and processed by the LIVER. AMMONIA, the major nitrogen waste product, is highly TOXIC (poisonous) and must be diluted with large amounts of water. The kidneys do this by making URINE, which contains AMMONIA, IONS (like sodium and chloride) and WATER. Urine is produced by kidneys and stored in the URINARY BLADDER. Urine passes out through the UROGENITAL PORE behind the ANUS. Remember sperm and eggs also use this opening!

The kidneys also function along with the GILLS in OSMOREGULATION to remove excess water that enters the body via osmosis and keep the correct balance of ions in the blood and tissues. Freshwater fish urinate constantly (up to 30% of their body weight daily) to remove the excess water that is always entering their bodies due to the HYPOTONIC environment in which they live.

MARINE (salt water) fish have the opposite. Because they live in a HYPERtonic environment, water is always leaving a marine fish's body. They urinate very little and must drink sea water and actively excrete the ions in order to maintain their osmotic balance.

NAME _____

FISH LAB QUESTIONS

KINGDOM: _____

PHYLUM: _____

SUBPHYLUM: _____ "animals with a backbone"

CLASS: _____ "bony fish"

Even though a fish has CEPHALIZATION, not all its sensory organs are located on its head. Which sensory organ is located along the sides of a fish's body instead of in its head?

_____

Which 2 organs are involved in EXCRETION & OSMOREGULATION (getting rid of nitrogen waste and maintaining the balance of water and ions in the blood and tissues) of a fish?

_____ _____

Name the three functions of the GILLS in a fish.

1. _____
2. _____
3. _____

Name 4 functions of the LIVER in a fish:

1. _____
2. _____
3. _____
4. _____

Bile is made by the _____

Stored in the _____ and

Used in the _____ to break down fats.

The _____ in fish are like the _____ in earthworms because both are structures found inside the intestine that increase surface to help absorb more nutrients.

COMPARE FUNCTIONS OF DIGESTIVE GLANDS SEEN IN CRAYFISH AND STARFISH AND NEW IMPROVED LIVER SEEN IN FISH:

	DIGESTIVE GLANDS	LIVER
DIFFERENT		
ALIKE		

NAME the molecule described:

Digestive enzyme made by liver and used in the intestine to help break down fats _____

Digestive enzyme made by the pancreas and used in the intestine to breakdown proteins _____

Polysaccharide made by joining glucose molecules together which is used by animal cells to store energy _____

Hormone made by the pancreas which causes cells to take glucose from the blood and store it as glycogen _____

Hormone made by the pancreas which causes cells to break down their stored glycogen and release glucose into the bloodstream _____

Use DORSAL and VENTRAL to describe how the layout of the body in a perch and other vertebrates is DIFFERENT from the invertebrates with a heart you have dissected so far (like earthworms, clams, & crayfish).

Invertebrates have a _____ heart and a _____ nerve cord.

Vertebrates have a _____ heart and a _____ nerve cord.

* * * * * * * * * * * * * * *

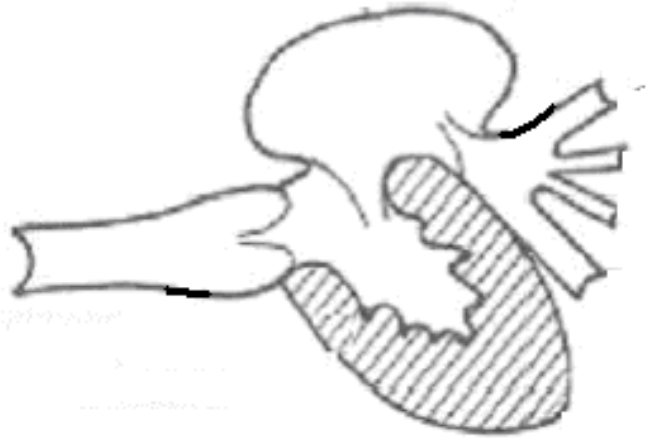
COMPARE:	FUNCTION:
GALL BLADDER	
SWIM BLADDER	
URINARY BLADDER	

Label the following parts in the diagram of the heart below and use arrows to show the flow of blood in a fish's single loop circulatory system.

USE RED for HIGH OXYGEN BLOOD
USE BLUE for LOW OXYGEN BLOOD

Atrium	Ventricle	Sinus Venosus	Conus Arteriosus

GILLS



BODY ORGANS

* * * * * * * * * * * * * * *

MATCH THE NERVOUS SYSTEM PART WITH ITS FUNCTION

Integrates info from senses and other parts of the brain; does higher thinking (memory, learning, problem solving) _____

Receives and processes info from visual, auditory (hearing), and lateral line systems _____

Receives and processes info about smell _____

Controls muscle coordination and balance _____

Controls "automatic" body organs and relays sensory info from body _____

Carries signals from brain to body parts _____

MATCH THE FUNCTION WITH THE BODY PART:
(You can use them more than once!)

Produces, destroys, and stores red blood cells _____

Main pumping chamber of heart that sends blood to the conus arteriosus _____

Makes insulin, glucagon, and trypsin _____

Makes bile, stores glycogen, stores vitamins _____

Removes nitrogen waste from blood and excretes it _____ **&** _____

Stores bile _____

Processes toxins (including nitrogen waste) for the kidneys _____

Completes digestion and absorbs nutrients _____

Produces acid and some digestive enzymes to begin the breakdown and grinds food _____

Controls buoyancy _____

Stores urine _____

Exchanges gases _____

Fingerlike extensions INSIDE the intestine that increase surface area to absorb more nutrients _____

Pouches at the junction of stomach and intestine that help break down plants and absorb nutrients _____

First portion of intestine where bile and trypsin are added _____

Blood vessels where gas, nitrogen waste, and nutrient exchange occurs _____

Blood vessels that carry blood away from heart _____

Blood vessels that return blood to the heart _____

Receives blood from sinus venosus and sends it to the ventricle _____

Exit opening for digestive waste _____

Exit opening for sperm/urine OR eggs/urine _____

Senses vibration and water pressure _____

Body system that controls sexual development, metabolism, and heart rate _____ **system**

Tubules that carry sperm _____

Make sperm _____

Make eggs _____

*** * * * * * * * * * * * * ***

CIRCLE ALL THAT APPLY:

Bony fish are/have:

Invertebrate protostomes | **Invertebrate deuterostomes** | **Vertebrate deuterostomes**

blastopore → mouth (Determinate spiral cleavage) | **blastopore → anus (indeterminate radial cleavage)**

ACOELOMATES | **PSEUDOCOELOMATES** | **EUCOELOMATES**

No cephalization | **Cephalization**

Open circulation | **Closed circulation**

Asexual reproduction | **Sexual reproduction**

Hermaphrodites | **Separate sexes**

Indirect development | **Direct development**

External fertilization | **Internal fertilization**

VENTRAL nerve cord/DORSAL heart | **DORSAL nerve cord/VENTRAL heart**

Asymmetry | **Radial symmetry** | **Bilateral symmetry**