Honors Biology Chapter 25 & 26 & Biology Chapter 25 & 26 Introduction to the CHORDATES

Kingdom: Animalia

Phylum: Chordata

4 Basic Characteristics of Chordates

- (Some of these characteristics may not be present entire life cycle of animal!)

1. Dorsal, hollow nerve cord = central communication cable

   Ex. Spinal cord

2. Notochord = long support rod below nerve cord (in embryos)

   Ex. May change to vertebrae

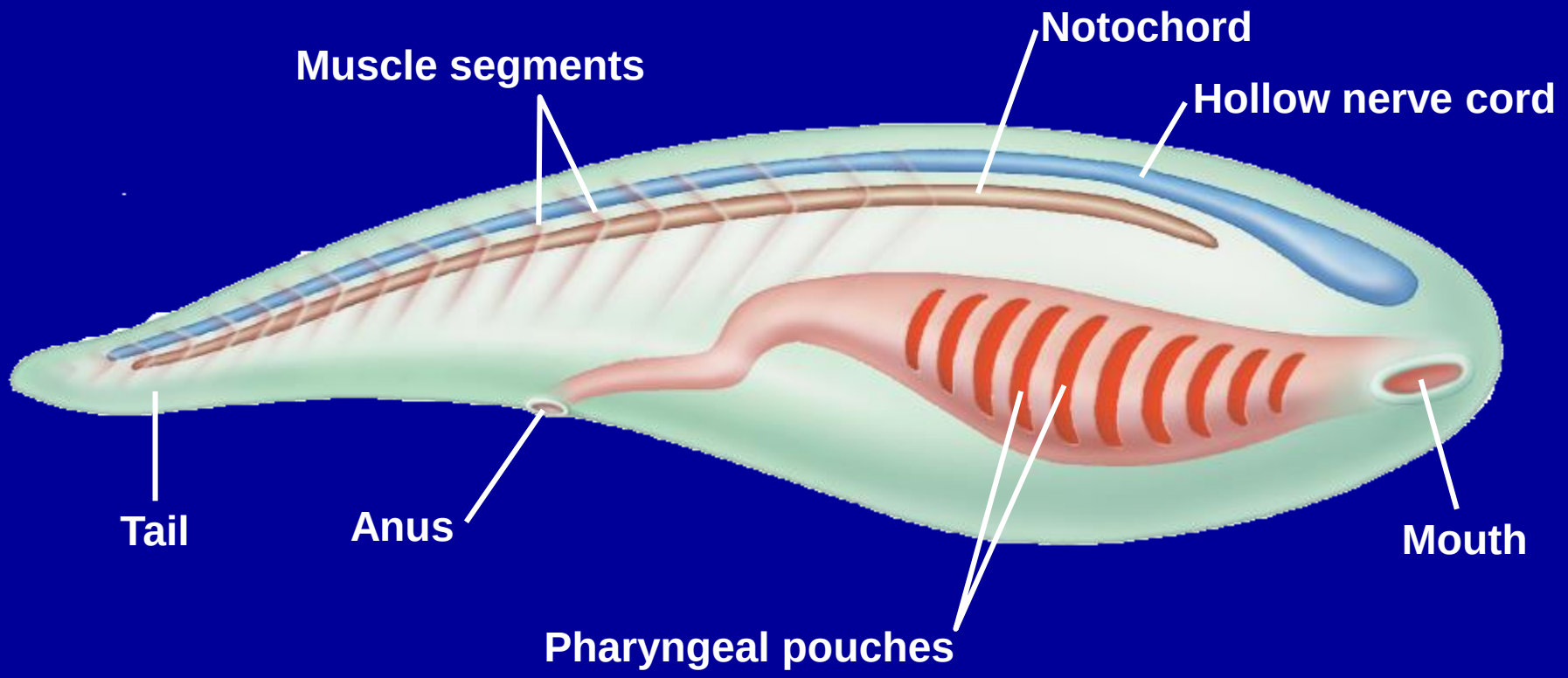
4 Basic Characteristics of Chordates (cont.)

3. Pharyngeal Pouches = paired sacs in throat region
    - Ex. Become gill ***slits*** in some animals

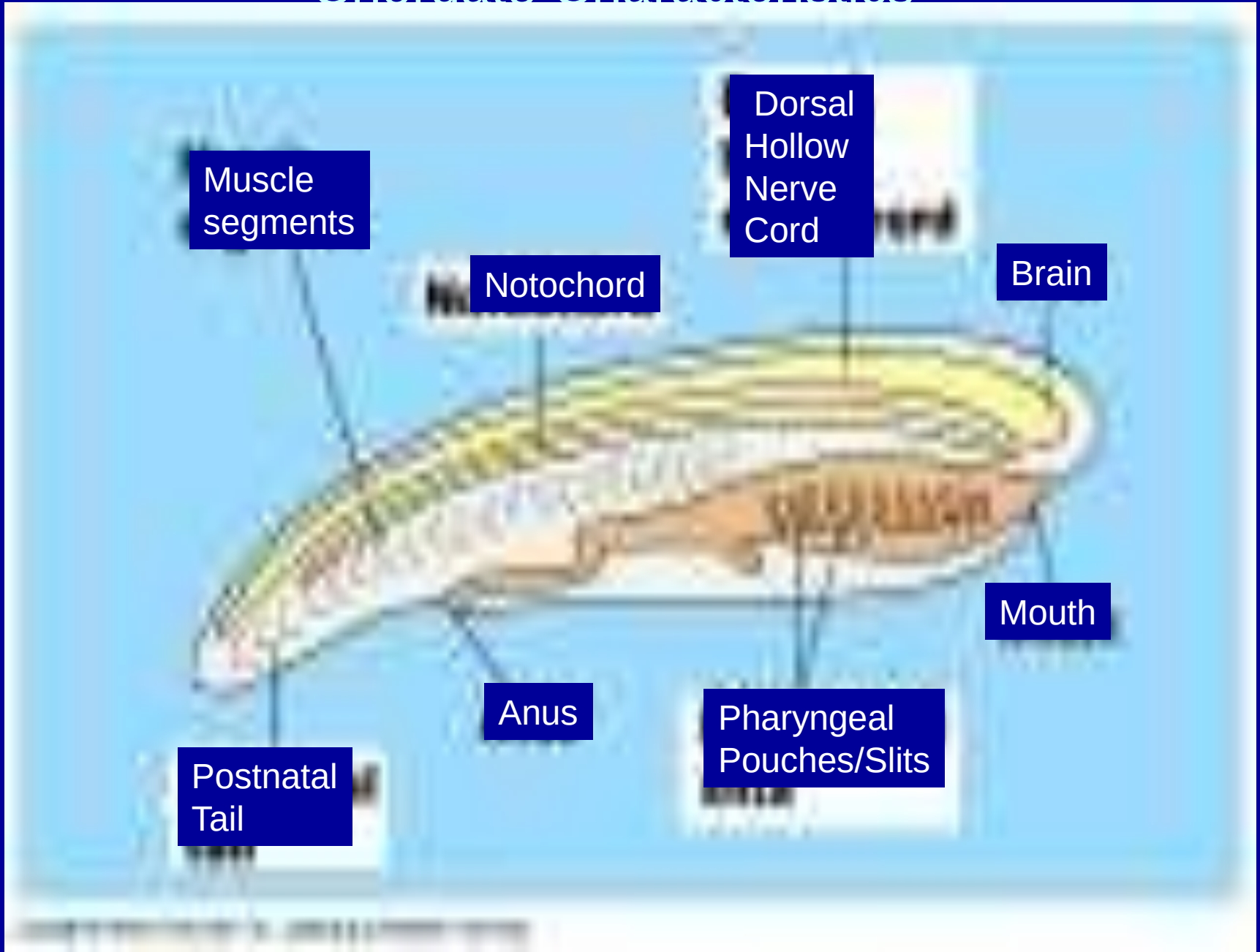
4. Tail = section of body that extends beyond anus

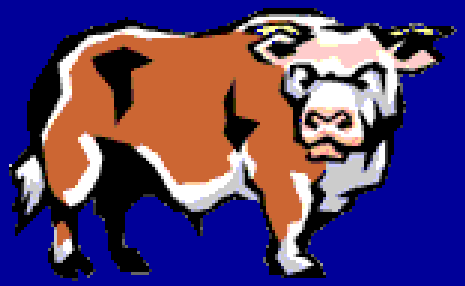
What Is a Chordate?

- Characteristics of Chordates

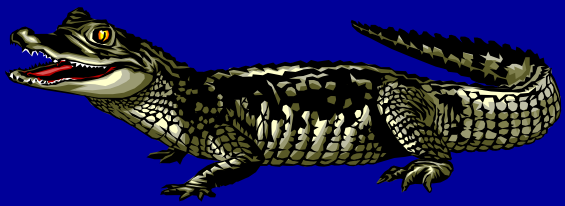


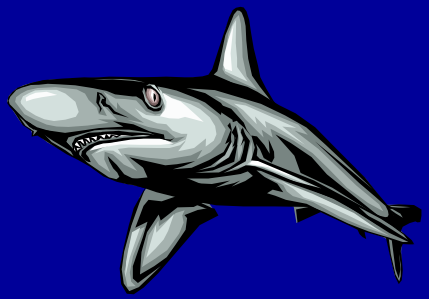
Chordate Characteristics

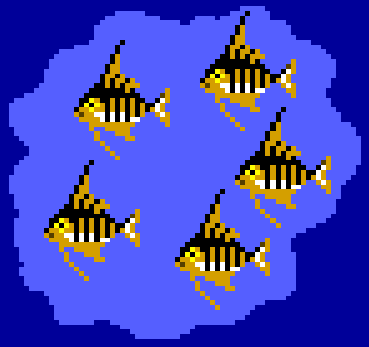




Vertebrates







Subphyla of Chordates

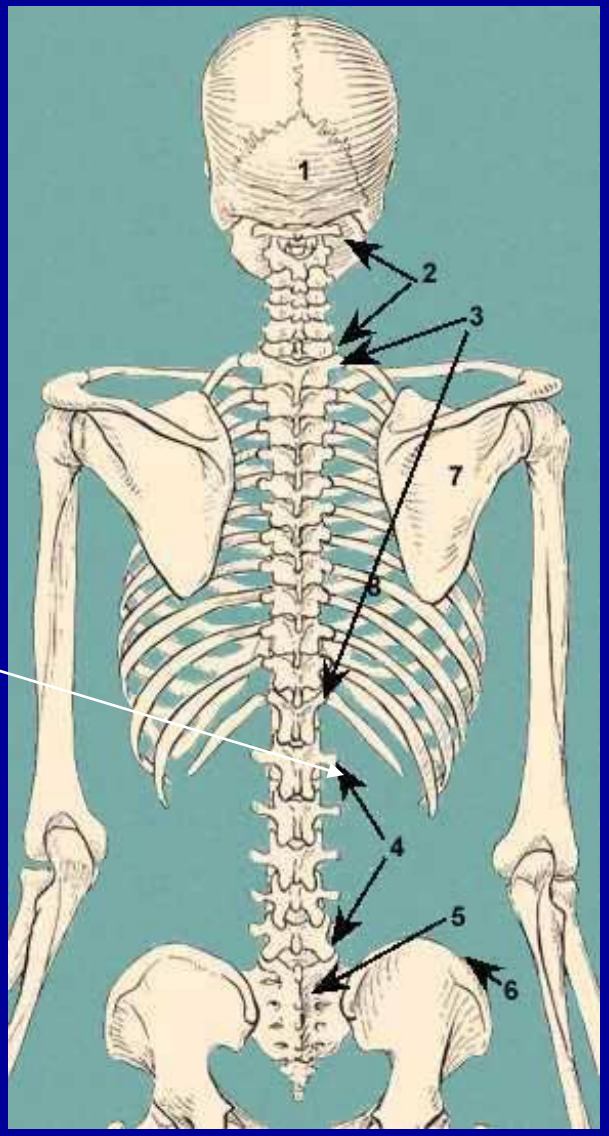
- Most chordates are ***VERTEBRATES!!!***
- ***(99 %)***

- There are ***3*** Subphyla of Chordates:
  - 1. Subphylum Urochordata
  - 2. Subphylum Cephalochordata
  - 3. Subphylum Vertebrata

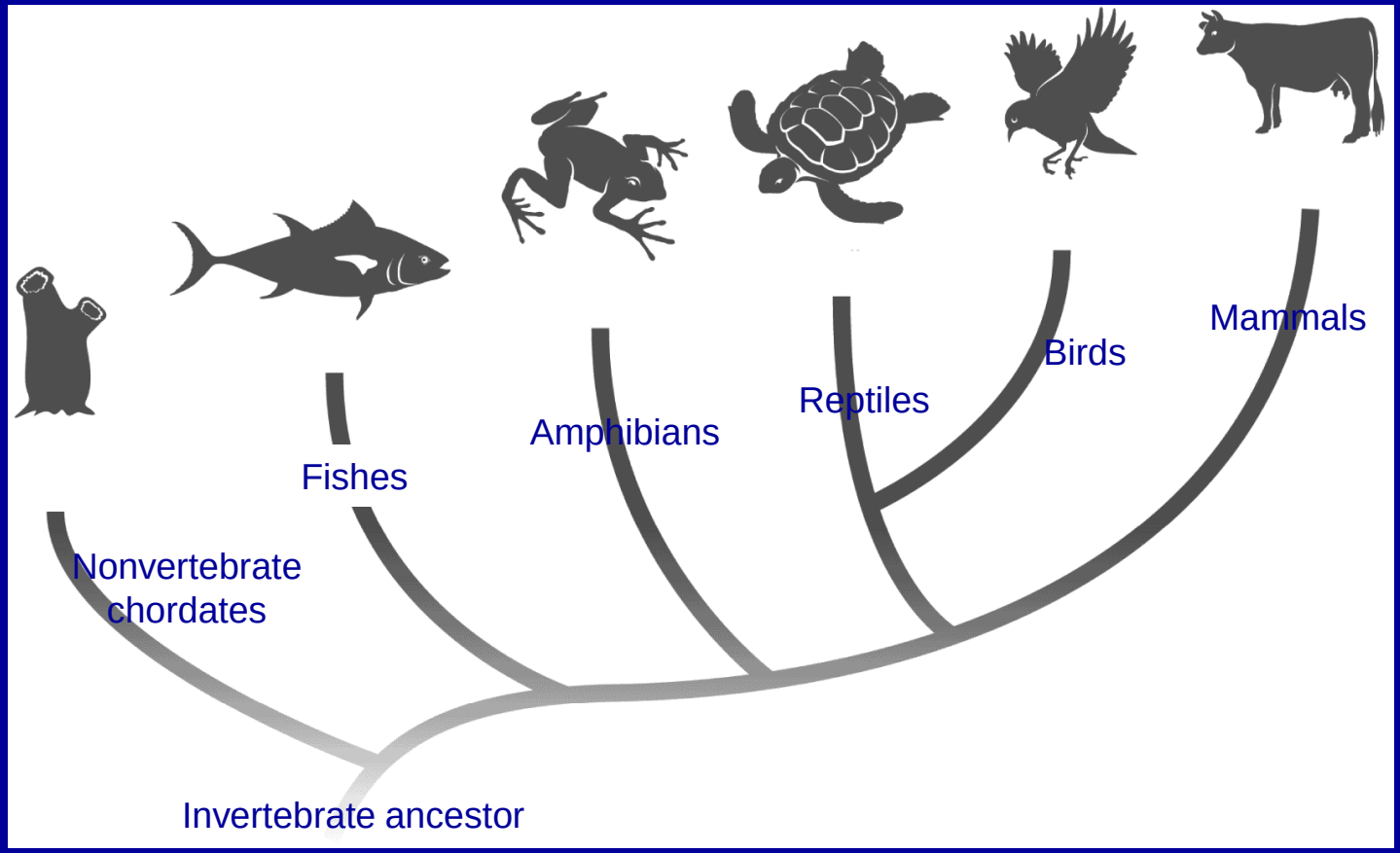
3 Vertebrate Changes:

(as the embryo develops, some chordate characteristics are altered)

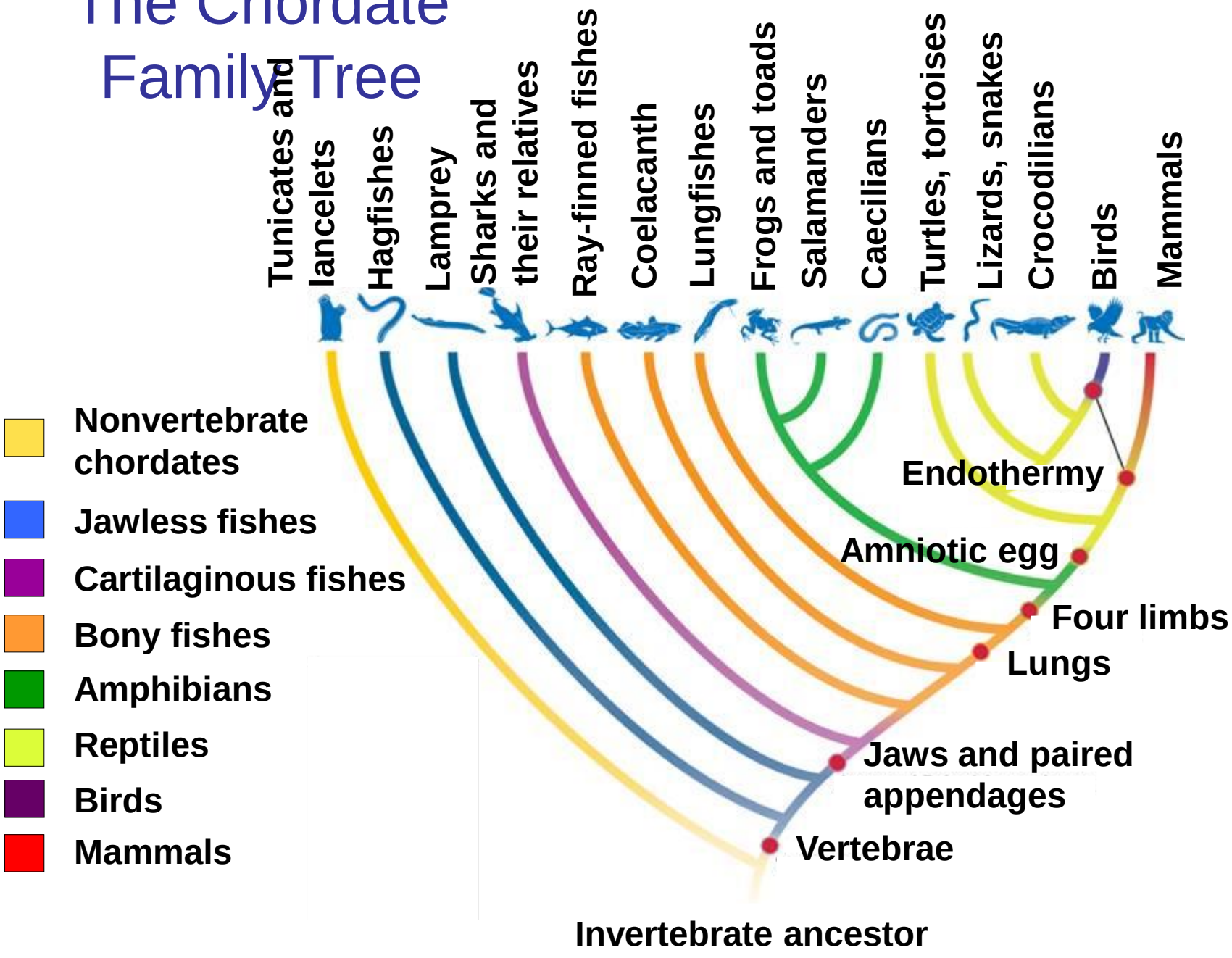
1. Notochord becomes vertebral column. (backbone)
2. Dorsal nerve cord becomes spinal cord.
3. Endoskeleton of living cells that can grow.



Chordate Cladogram



The Chordate Family Tree



Evolutionary Trends in Vertebrates

– What is a main trend in the evolution of chordates?

Evolutionary Trends in Vertebrates

– Adaptive Radiations

» **Over the course of evolution, the appearance of new adaptations—such as jaws and paired appendages—has launched adaptive radiations in chordate groups.**

» **Adaptive radiation** is the rapid diversification of species as they adapt to new conditions.

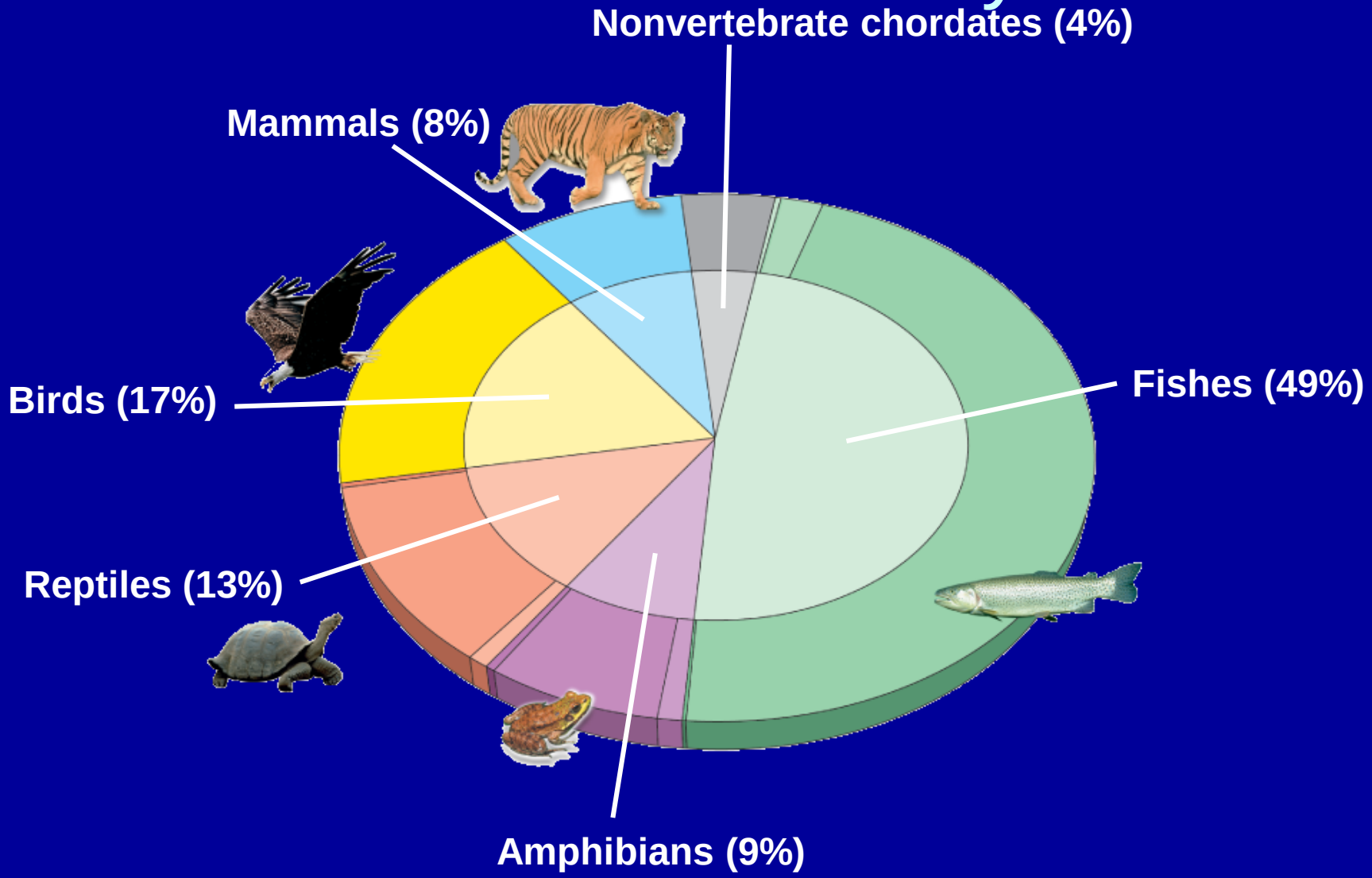
Evolutionary Trends in Vertebrates

- Convergent Evolution
  - Adaptive radiations can produce species that are similar in appearance and behavior, but not closely related.
  - This is called convergent evolution.
  - Convergent evolution has produced flying vertebrates as different as birds and bats.

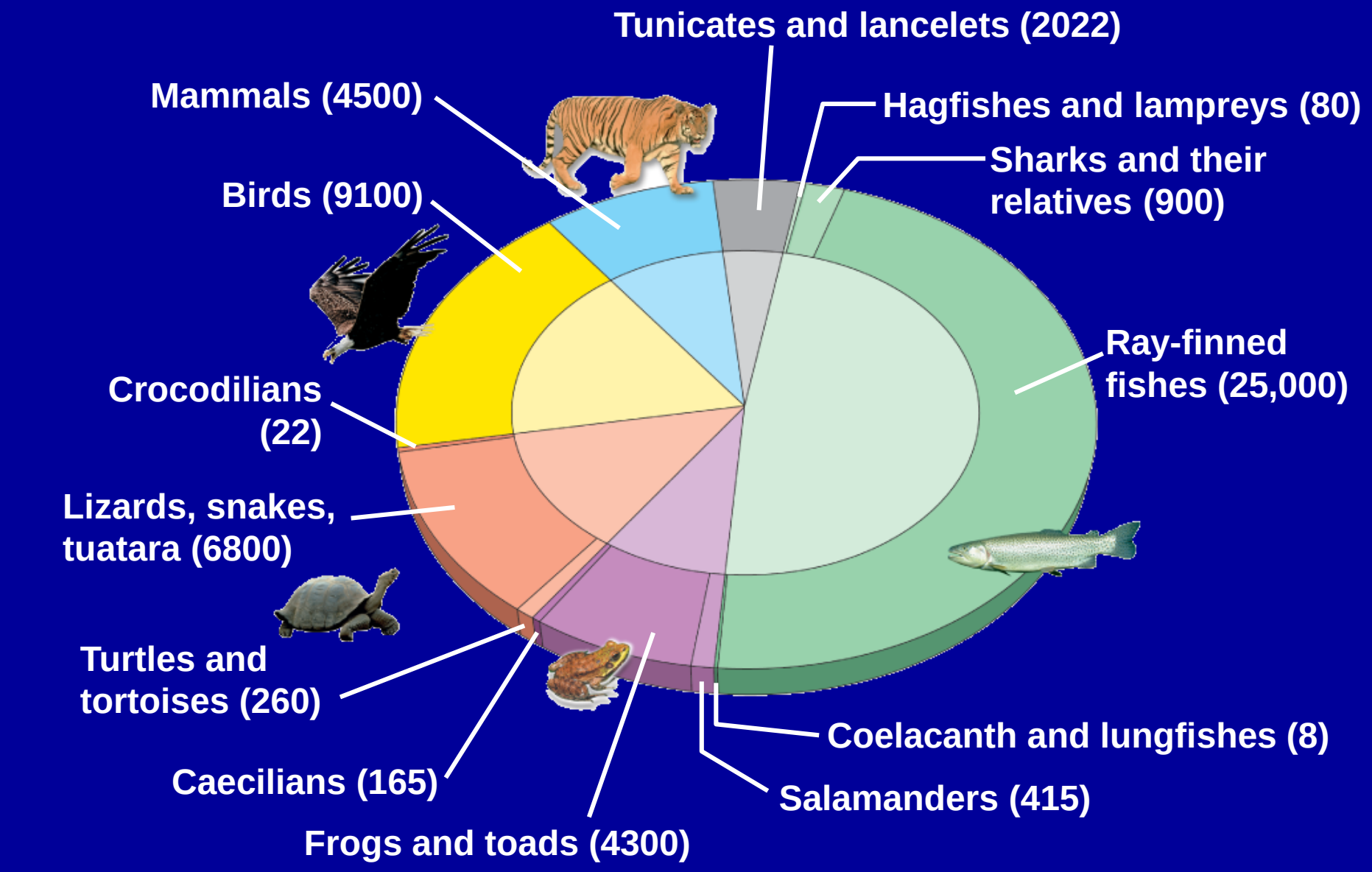
Chordate Diversity

- Chordate Diversity
  - Living chordates are diverse:
    - nonvertebrate chordates, which include tunicates and lancelets
    - vertebrates, which include fishes, amphibians, reptiles, birds, and mammals

Chordate Diversity



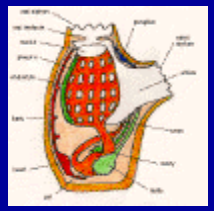
Chordate Diversity



Nonvertebrate Chordates

- General Characteristics
  - 1. Soft bodied
  - 2. All marine organisms
  - 3. Shared common ancestor 550 mya

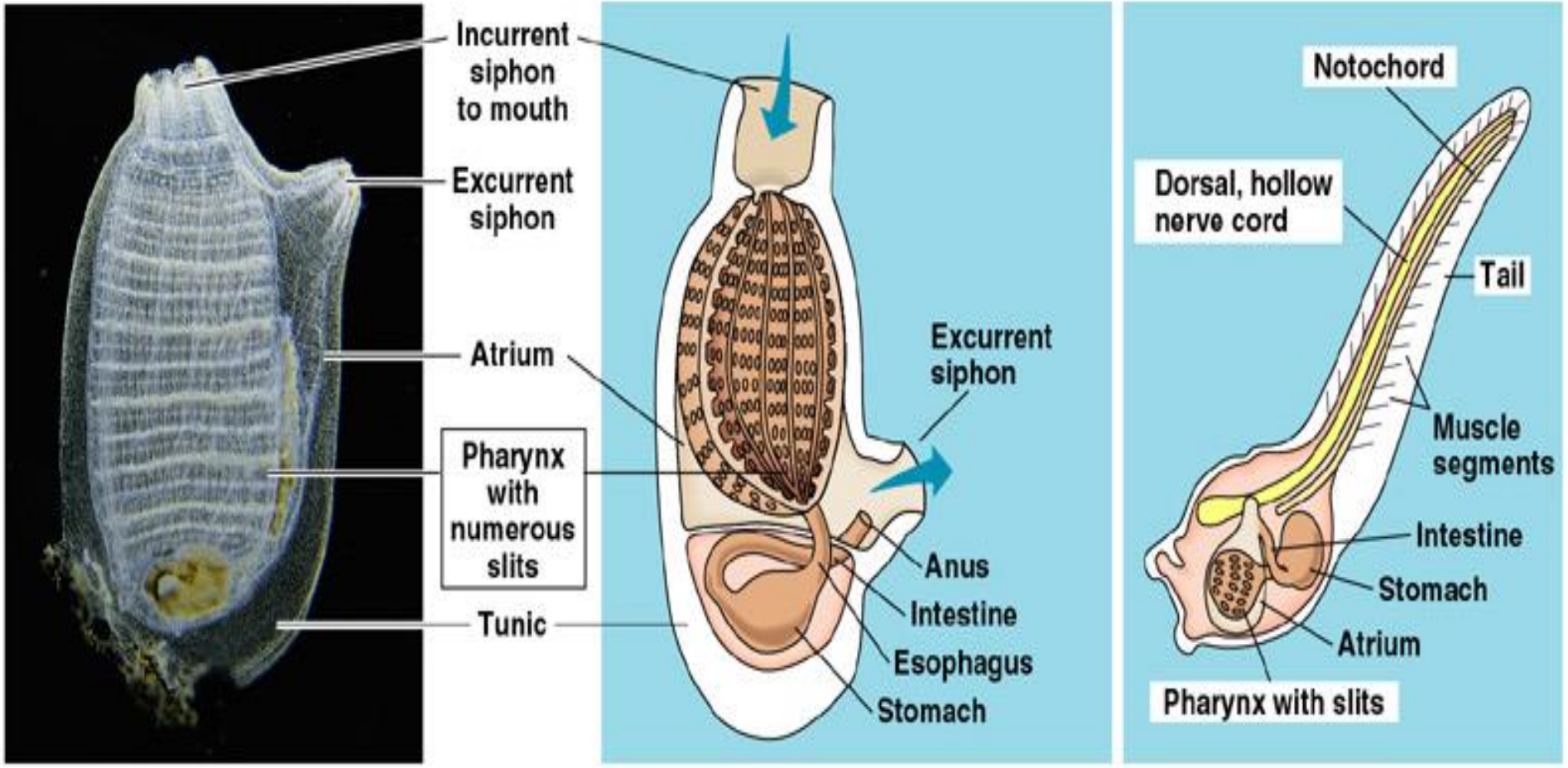
- 2 Groups:
  - 1. Tunicates
  - 2. Lancelets



Subphylum Urochordata = Tunicates

- Larva – have all 4 chordate characteristics
- Adults –have only the pharyngeal pouches; other 3 char. disappear!!
- Pharyngeal pouches become gill slits, used for filter feeding. (NOT RESPIRATION!)
- Nickname: “Sea Squirts” Why??

Diagrams of Tunicates



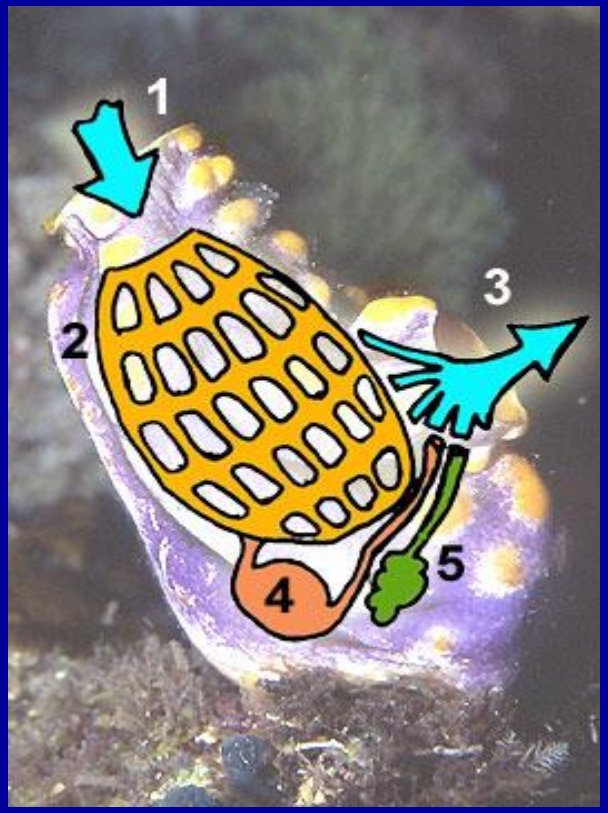
(a) Adult Tunicate

(b) Adult Tunicate

(c) Larval Tunicate

Pictures of Tunicates

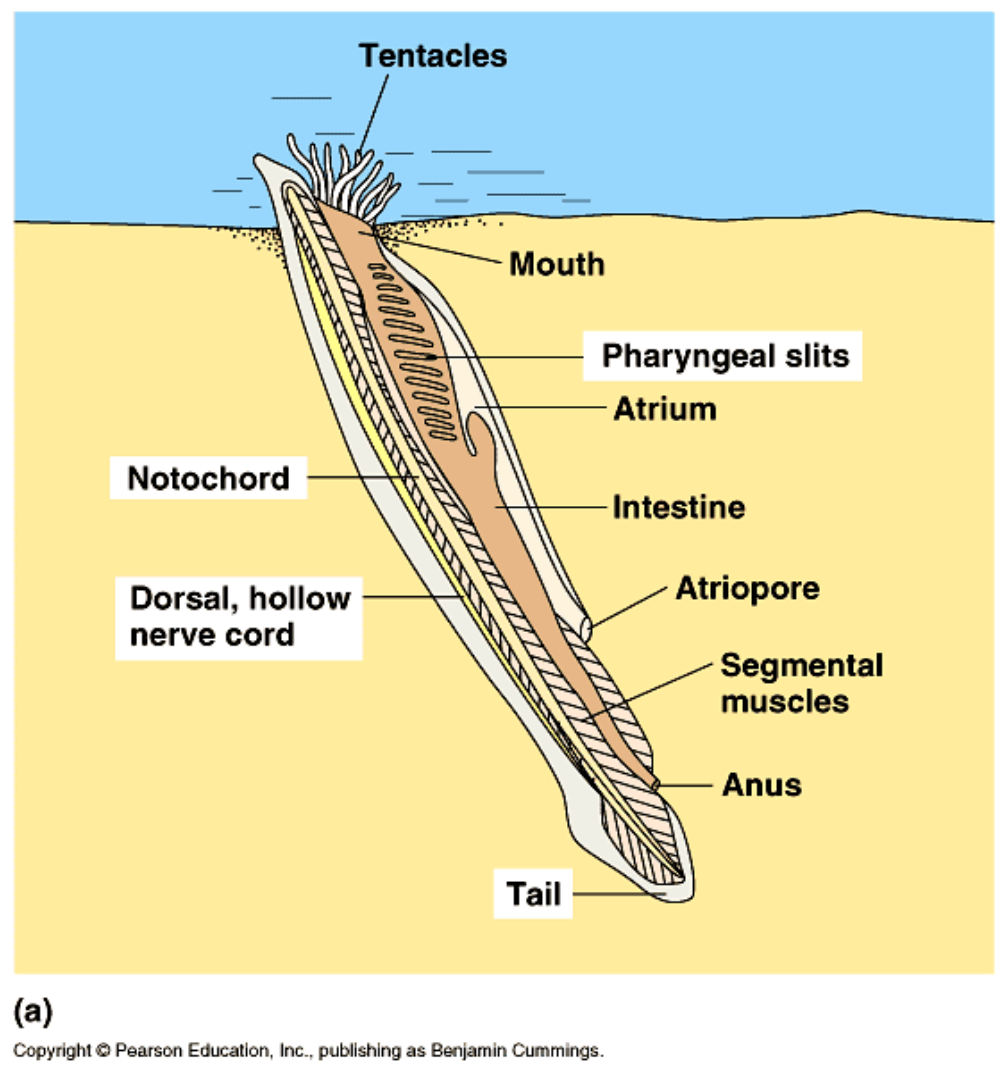
- 1. Oral siphon; 2. Branchial sac; 3. Cloacal siphon; 4. Stomach; 5. Gonad

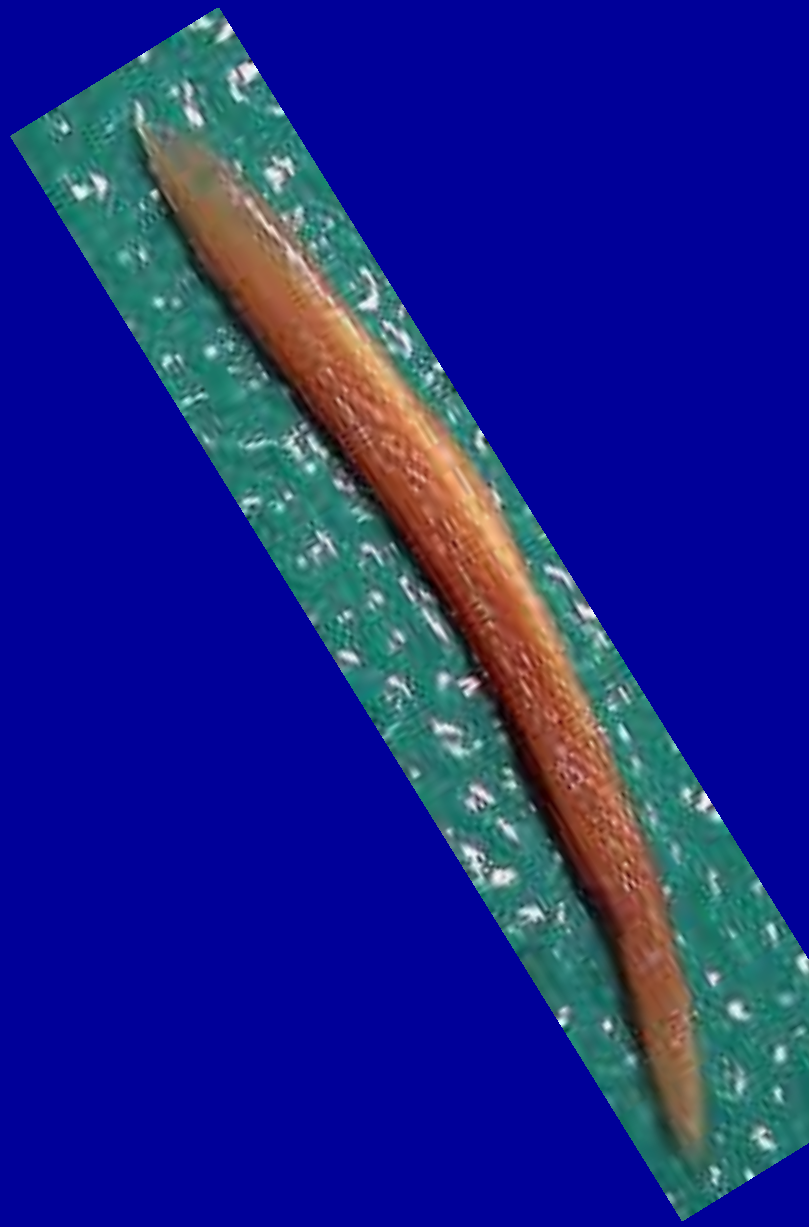


Subphylum Cephalochordata = Lancelets

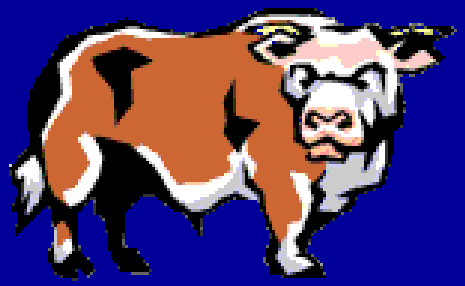
- Distinct head with mouth = “Cephalo”
- Filter feeders with mucous in gill slits
- Gas exchange through all of thin body (don’t use gill slits for this!)
- Live in sandy ocean bottoms, buried with head sticking out.
- Closed circulatory system- vessels “pump” blood by contracting.

Diagrams and Pictures of Lancelets

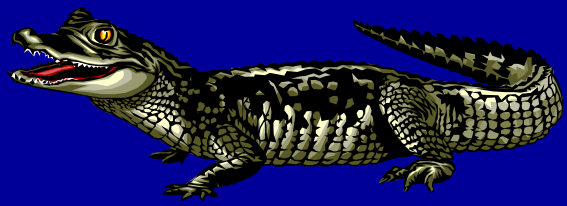


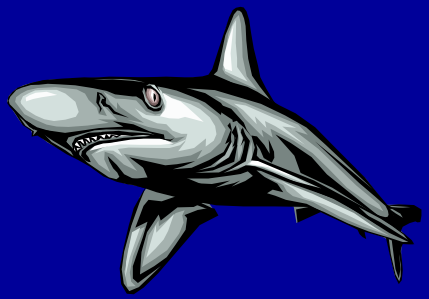


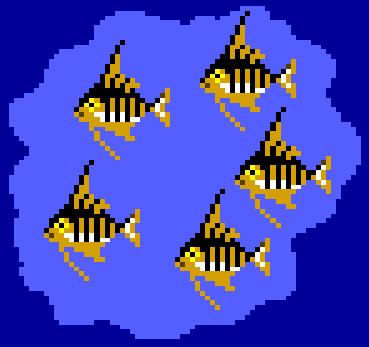
Diagrams and Pictures of Lancelets



Subphylum Vertebrata





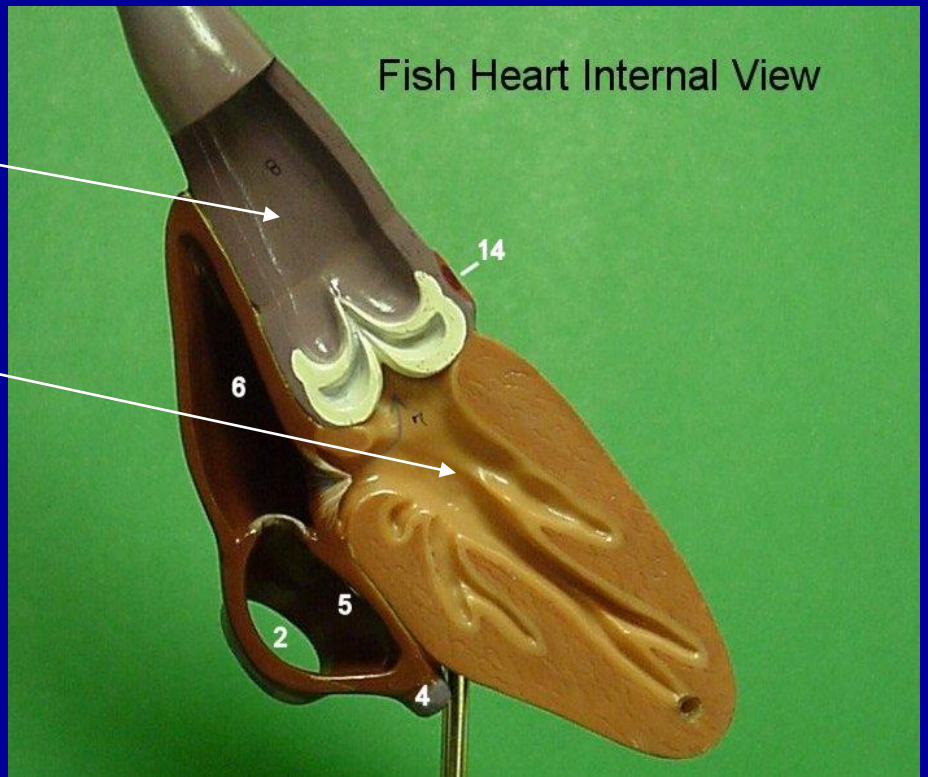


Characteristics of All Fish (* = some exceptions)

1. Ectothermic
2. Gills for oxygen exchange*
3. Scales – protection*
4. Aquatic
5. Paired Fins*
6. 2 Chambered Heart single loop circulation

atrium

ventricle



C. Jawless Fish: Class Agnatha

1. Sucker like mouth
2. No fins
3. Cartilage skeleton

   Ex: lamprey & hagfish

D. Cartilage Fish: Class Chondrichthyes

1. Cartilage skeleton
2. Lateral line system for sensing movement

   - line of fluid filled canals running down the sides of the fish, detects movement & vibrations in the water

3. Placoid scales (small)

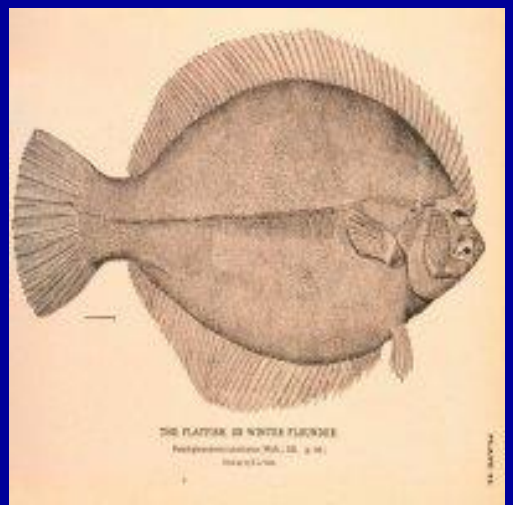
   Ex: sharks, skates, rays

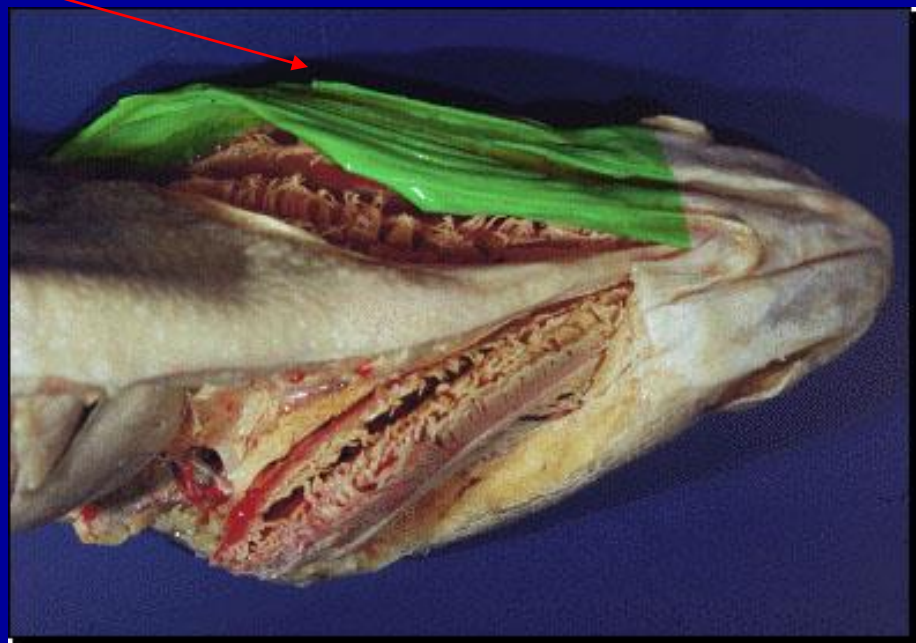
4. Sharks are ovoviviparous

E. Bony fish: Class Osteichthyes

1. Bony skeleton
2. Lateral line system
3. Swim bladder to help control depth
4. Lay eggs(Oviparous)
5. Have operculum over gills (to protect gills)

   Ex: perch, bass, flounder





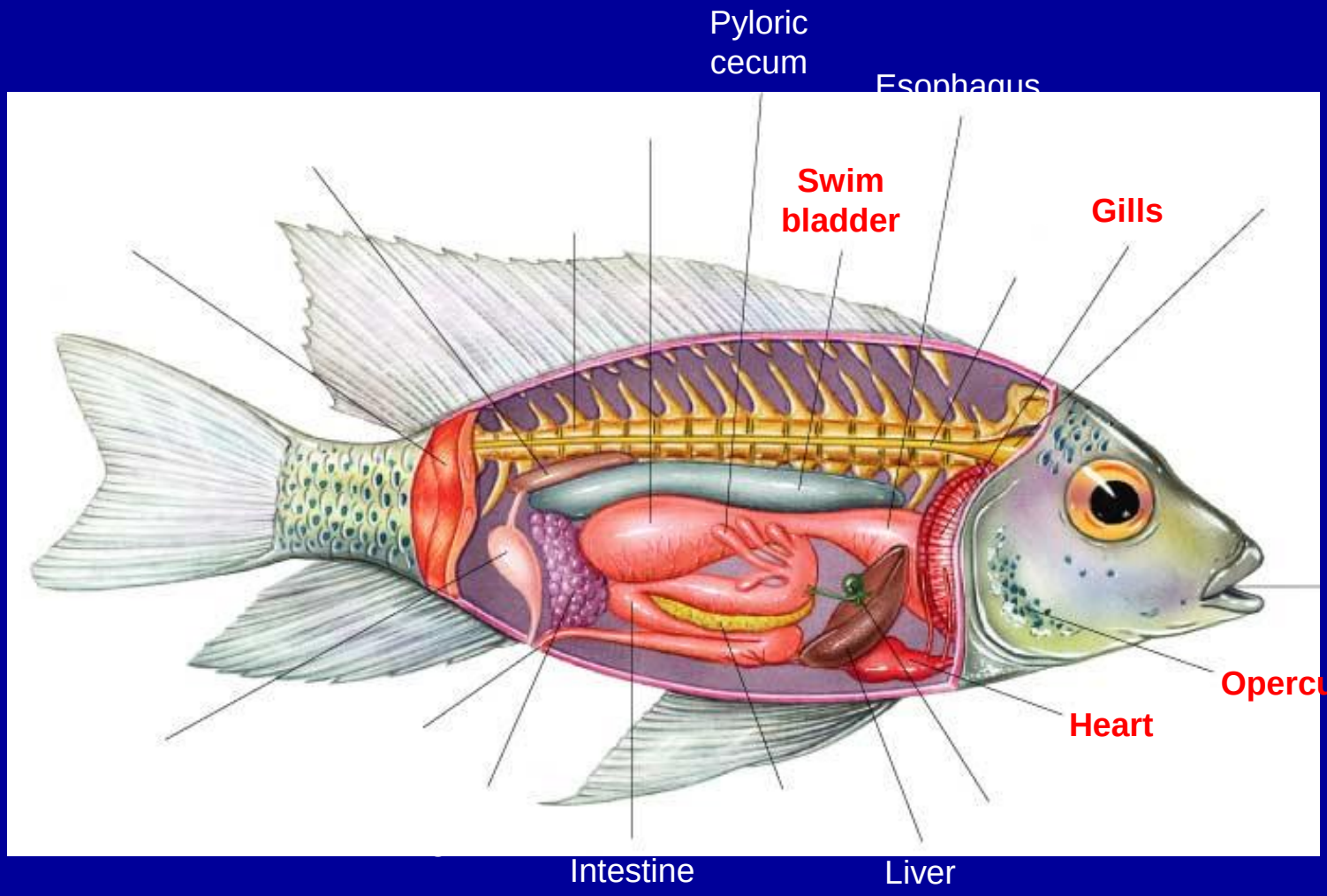
Groups of Bony Fish

- Lung fish (only live in FW)
  - Can supplement gill breathing with air bladder “lungs”
  - Can lie dormant in mud for up to 10 years, breathing air

- Ray-finned fish:
  - Have thin, bony spines or “Rays” in their fins
  - Most FW and SW fish: tuna, salmon, bass, perch, walleye, pike, swordfish, etc.

- Lobe –finned fish (once thought extinct!)
- Ex. coelocanth – discovered off coast
  - of Africa in 1938 , uses fleshy limbs
  - to “walk” along ocean floor

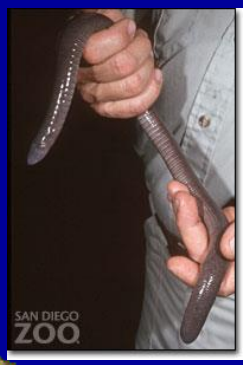
Anatomy of a Fish



Characteristics of All Amphibians:

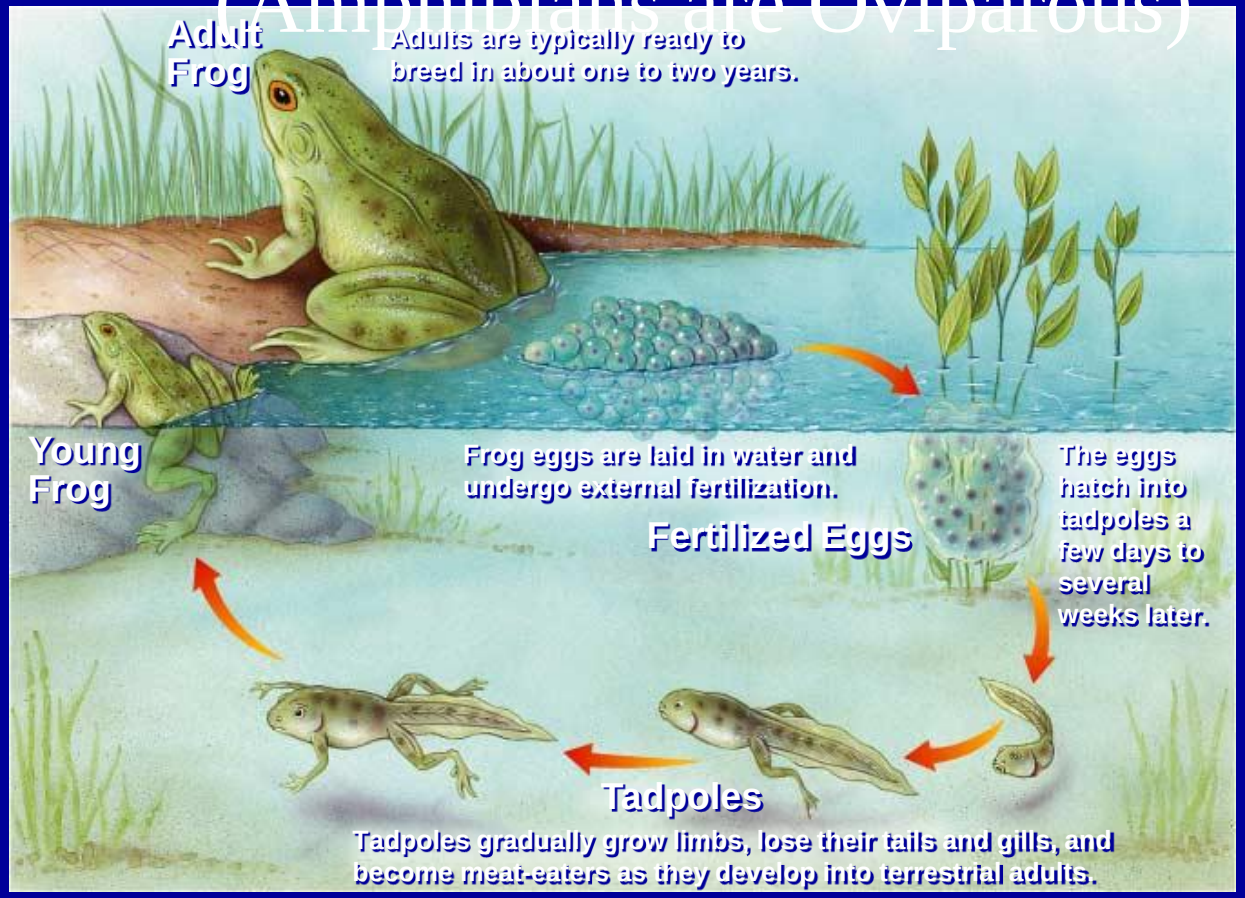
"Amphi + bio" = "double life"

1. Larva: a.) Aquatic, b.) 2 chambered heart, c.) gill breather
2. Adult: a.) Most live on land, b.) 3 chambered heart, 2 loop circulation c.) skin & lung breather
3. Need water to breed and for egg development
4. Ectothermic
5. Metamorphosis
6. Smooth, moist skin with mucous glands
7. **No** scales or claws



Life Cycle of a Frog

(Amphibians are Oviparous)



Groups of Amphibians

- Order Anura = “Without Tail”
  - Frogs & Toads
- Order Urodela
  - Salamanders & Newts

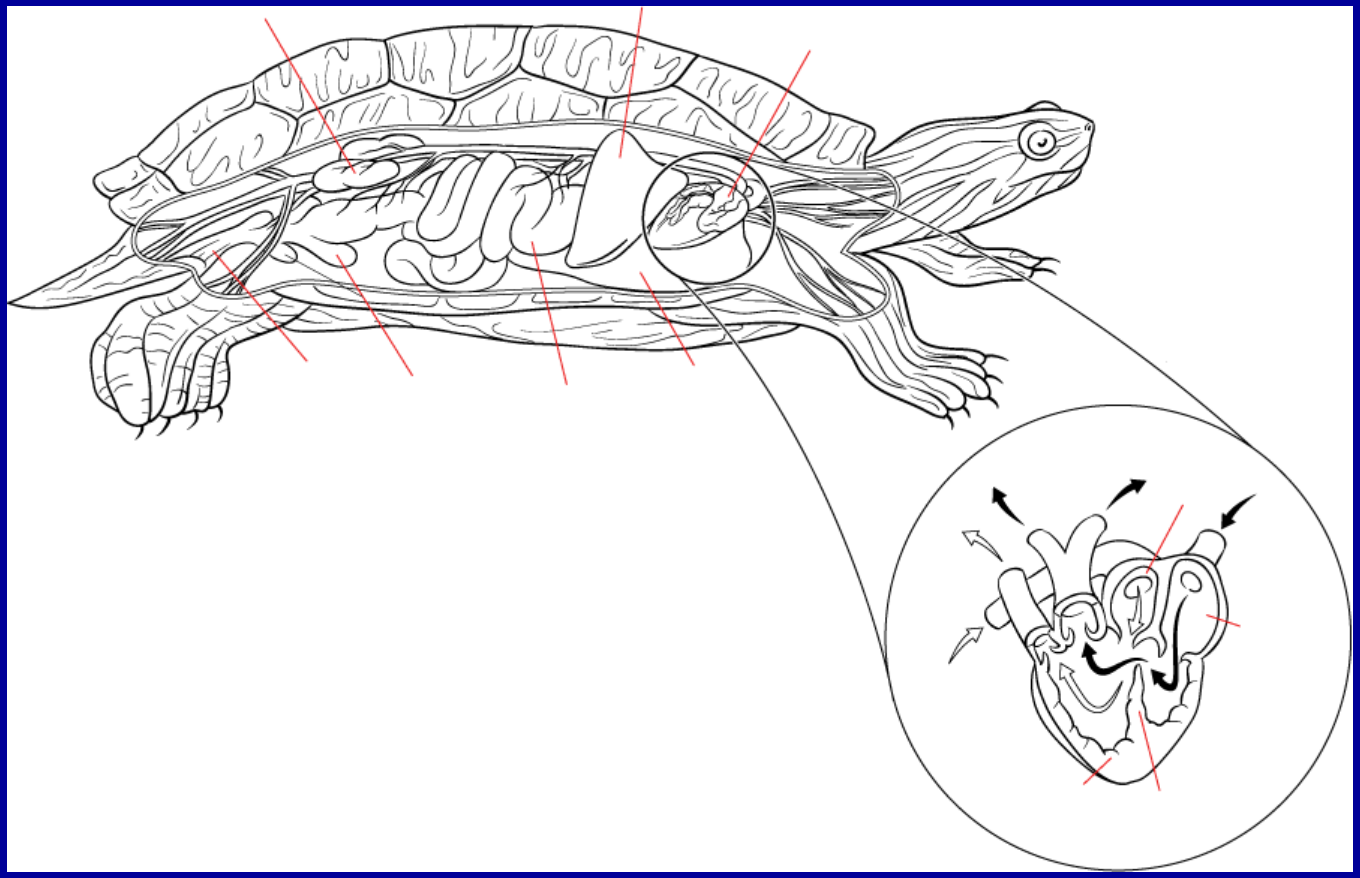
- Order Apoda = “Without Feet”
  - Caecilian

Characteristics of All Reptiles:

1. Ectothermic (found everywhere except very cold!)
2. Dry, scaly skin – scales of keratin prevent water loss, but must molt to grow
3. Claws on toes (if they have toes!)
4. Breathe with lungs
5. Lay amniotic eggs, with tough shell (Oviparous)
6. Jacobson's organ to test for chemicals in the air
7. 3 Chambered Heart (most), 2 loop circulation

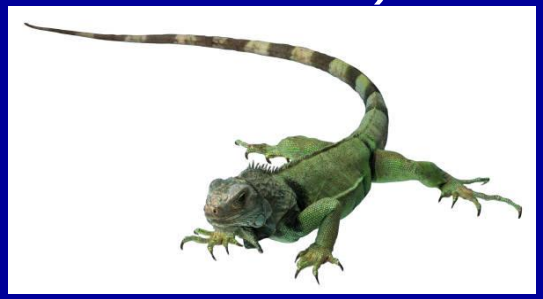
Ex: snake,
turtle,
crocodile

Structure of a Reptile's Heart



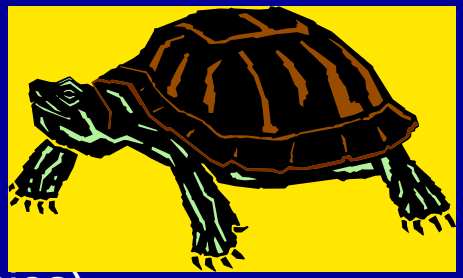
Groups of Reptiles

- 16 total groups (But 12 of them are Extinct!)
- Order Squamata
  - Snakes and Lizards



Order Crocodilia
- Crocodiles, Alligators, Caimans & Gavials

Order Testudines
- Turtles and Tortoises



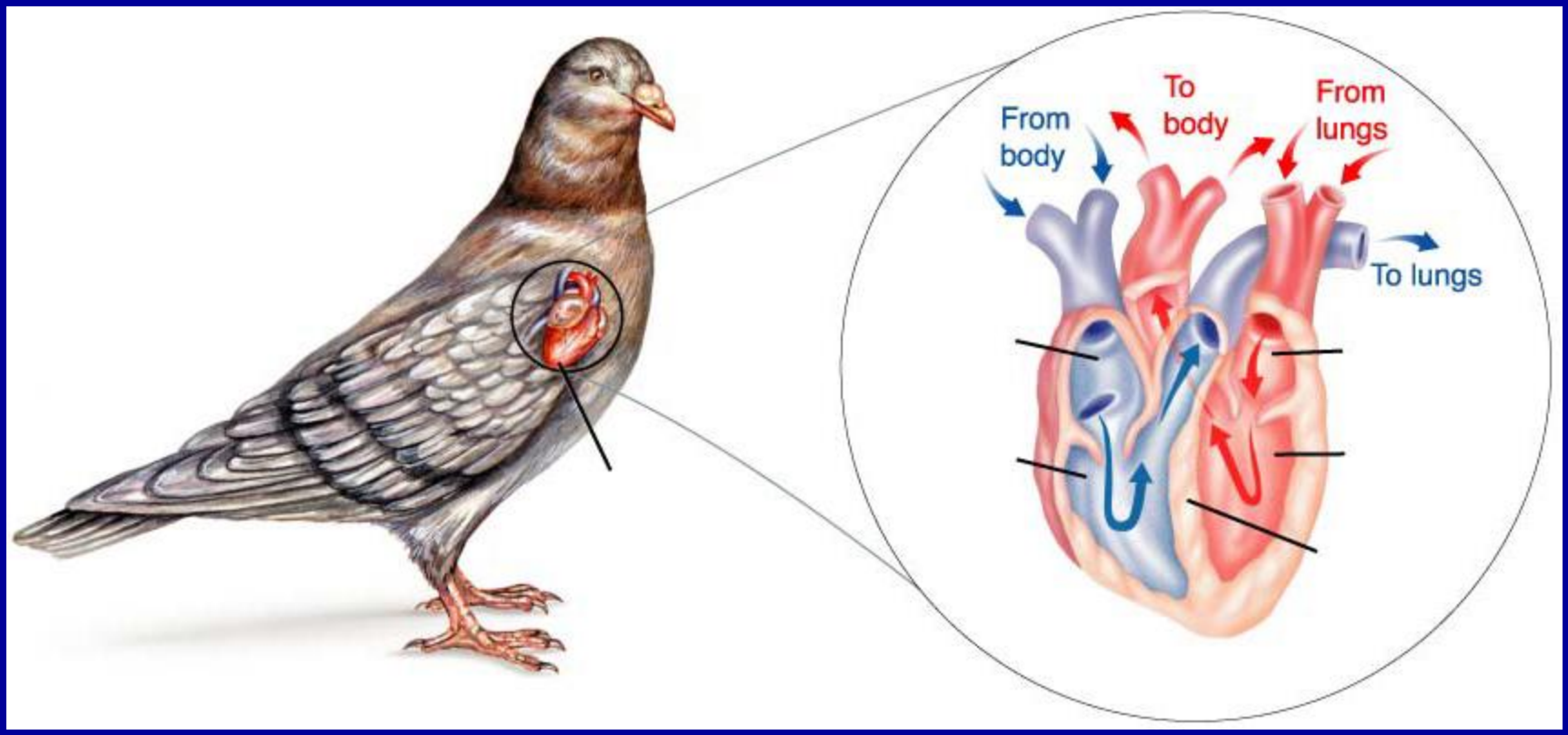
Order Rhyncocephalia
- Tuatara(only living species)
- Only in New Zealand
- “Parietal Eye” on top of head

Characteristics of All Birds

1. Endothermic
2. Feathers – modified scales of protein for:
   a.) insulation – down feathers; b.) flight; c.) contour
3. Oil/Powder – waterproofs feathers when "preening"
4. 2 legs with scales
5. Beak with No teeth
6. Molt feathers

7. 4 chambered heart + 2 loop circulation
8. Amniotic Egg (Oviparous)

Structure of a Bird's Heart

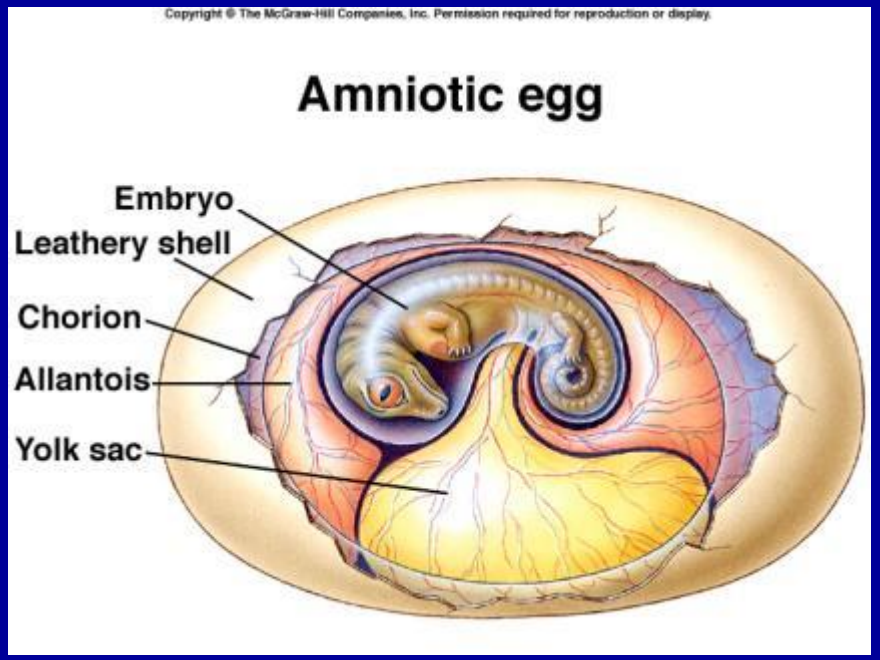


Groups of Birds

- 30 different orders!
- Main groups:
  - Pelicans + Relatives (Aquatic Birds)
  - Birds of Prey (Raptors)
  - Parrots (African grey, Amazon parrots, cockatoos, macaws)
  - Perching Birds (cardinal, sparrow, crow,
  - Cavity nesting Birds (Woodpeckers, toucans)
  - Herons + relatives (Wading birds)
  - Ostriches + relatives (Flightless)

I. Characteristics Reptiles & Birds share

1. Amniotic egg
2. Internal fertilization
3. Molt periodically
4. Scales on feet

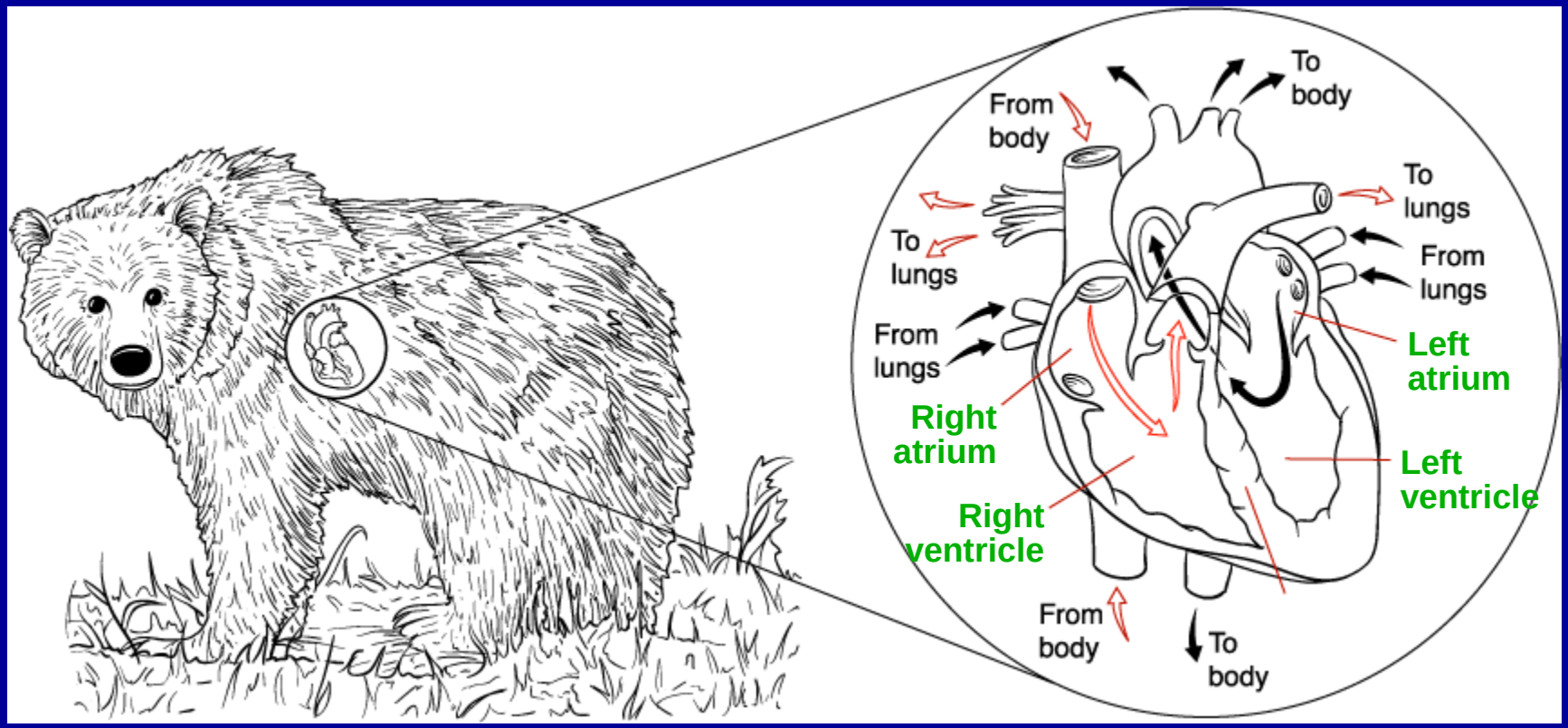


molting

Characteristics of All Mammals:

1. Have fur/hair
2. Mammary glands
3. 4 chambered heart
   + 2 loop circulation
4. Lungs
5. Endothermic

Heart of a Mammal



- Placental Mammals:
  - *Develop inside uterus
  - *Ex: people, cats, dogs
  - *Viviparous

- Marsupials:
  - *Develop inside pouch
  - *Ex: kangaroos, opossums

- Monotremes:
  - *Lay eggs
  - (Oviparous)
    Ex: platypus

3 GROUPS OF MAMMALS

- 1. MONOTREMES
  - LAY SOFT SHELLED EGGS (OVIPAROUS)
  - HAVE CLOACA
  - MOMS NOURISH YOUNG AFTER HATCH
  - EX)DUCKBILL PLAYTPUS, SPINY ANTEATER

MARSUPIALS

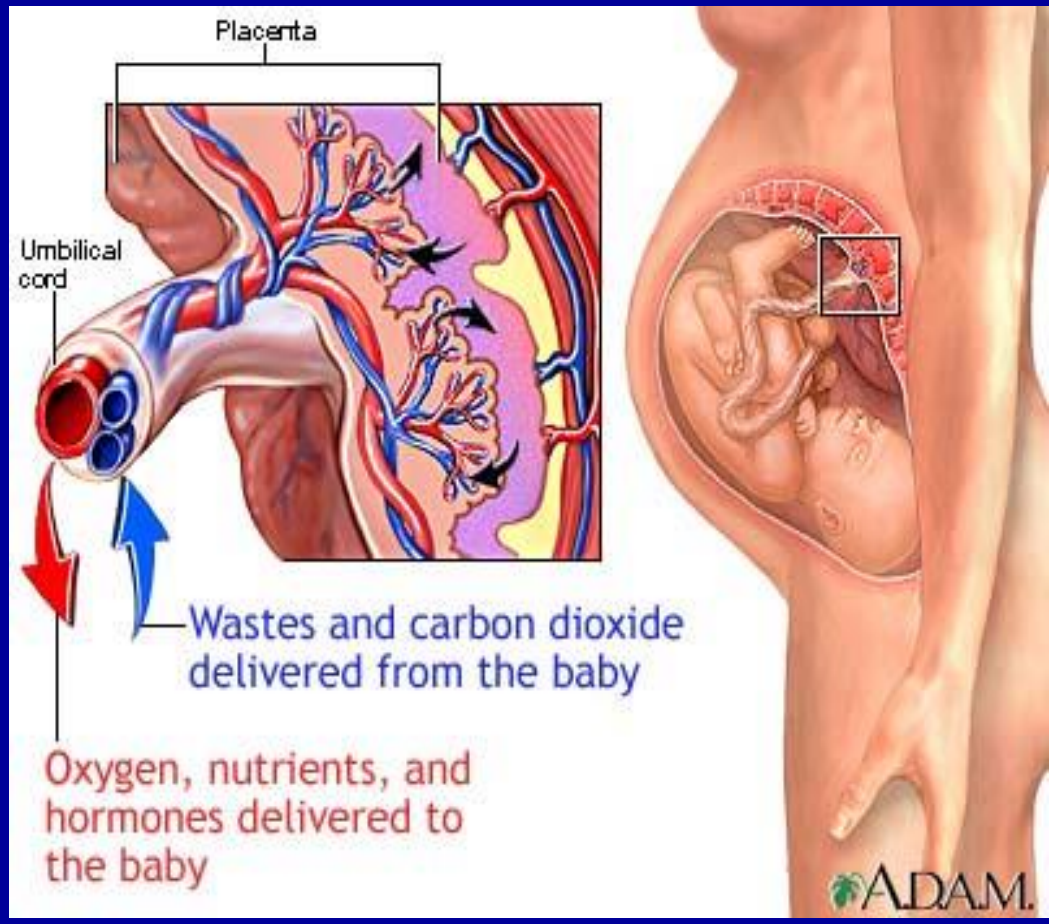
- BEAR LIVE YOUNG

WHICH COMPLETELY DEVELOP IN A POUCH

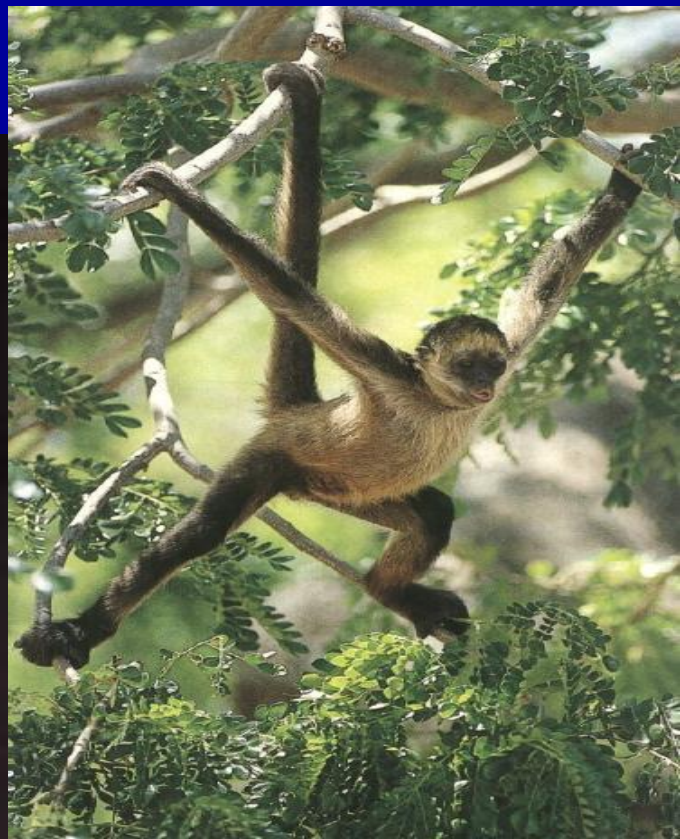
EX) KANGAROOS, KOALAS, WOMBATS

PLACENTAL MAMMALS

- PLACENTA FORMS WHEN IMPLANTATION OCCURS INSIDE MOM
- PLACENTA IS WHERE EXCHANGE OF NUTRIENTS AND WASTES BETWEEN EMBRYO AND MOM TAKES PLACE



32-3 PRIMATES & HUMAN ORIGINS



CHARACTERISTICS

- BINOCULAR VISION (MERGES VISUAL IMAGES FROM BOTH EYES—3D VISION)
- WELL DEVELOPED CEREBRUM
- SOCIAL BEHAVIOR, COGNITIVE (THINK) AND LEARNING ABILITIES

- FINGERS/TOES AND OPPOSABLE THUMBS (GRASP OBJECTS)
- SHOULDER JOINT ROTATION

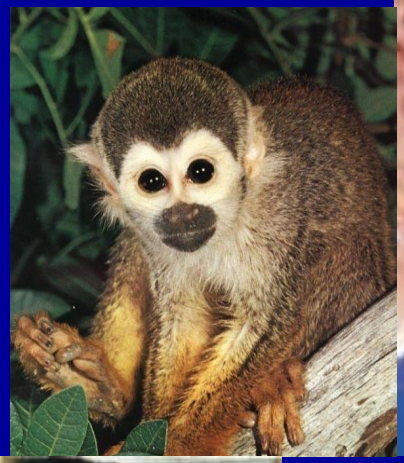
2 GROUPS

1. PROSIMIANS— Small nocturnal primates with large eyes.

EX) Lemurs, tarsiers, bush babies

2 GROUPS (CONT)

- 2. ANTHROPOIDS- Humans, apes, monkeys
- Includes old and new world monkeys
- New—have prehensile tails. Ex) squirrel/spider monkeys live in trees in C. and S. A.
- Old—No prehensile tails Ex) baboons, gibbons, orangutans, chimps



HUMAN CLASSIFICATION

KINGDOM: ANIMALIA

PHYLUM: CHORDATA

CLASS: MAMMALIA

ORDER: PRIMATA

FAMILY: HOMINIDAE (walk upright, bipedal motion, opposable thumbs, lg. brain)

GENUS: *Homo*

SPECIES: *sapien*

Feeding

- How do the digestive systems of the different groups of vertebrates compare?

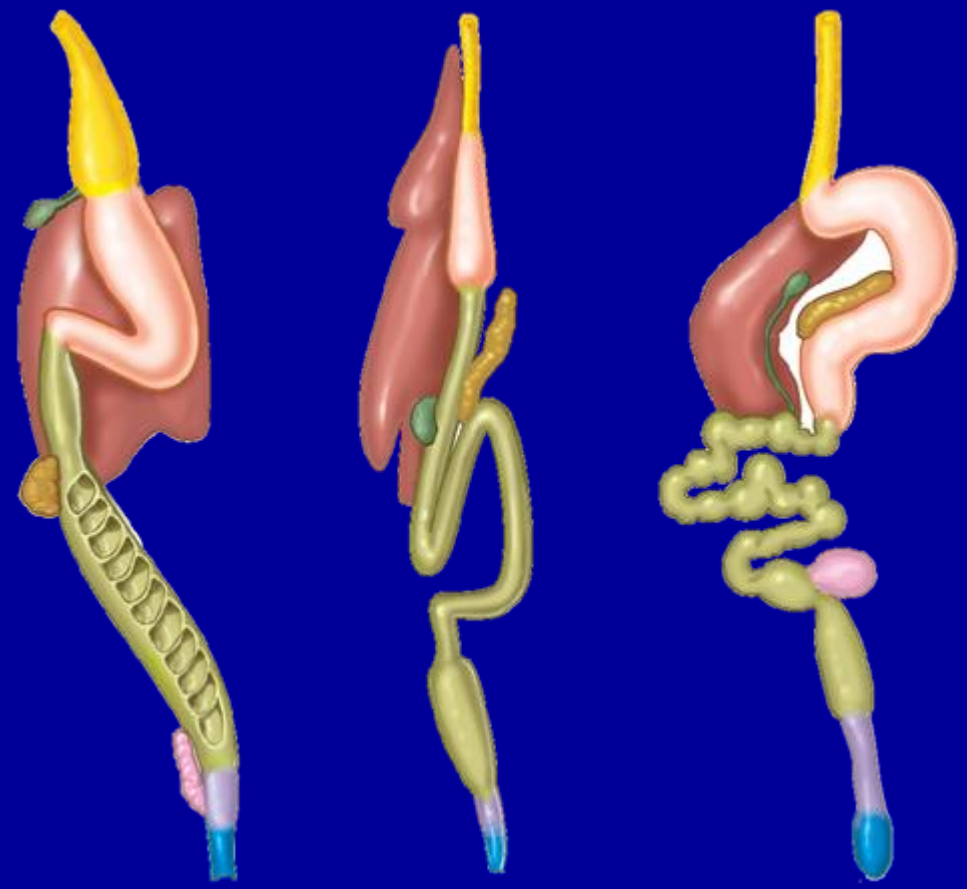
Feeding

- The digestive systems of vertebrates have organs that are well adapted for different feeding habits.
- **Carnivores have short digestive tracts with fast-acting, meat-digesting enzymes.**
- **Herbivores have long intestines. Some have bacteria that help digest the tough cellulose fibers in plant tissues.**

Feeding

- Vertebrate Digestive Systems

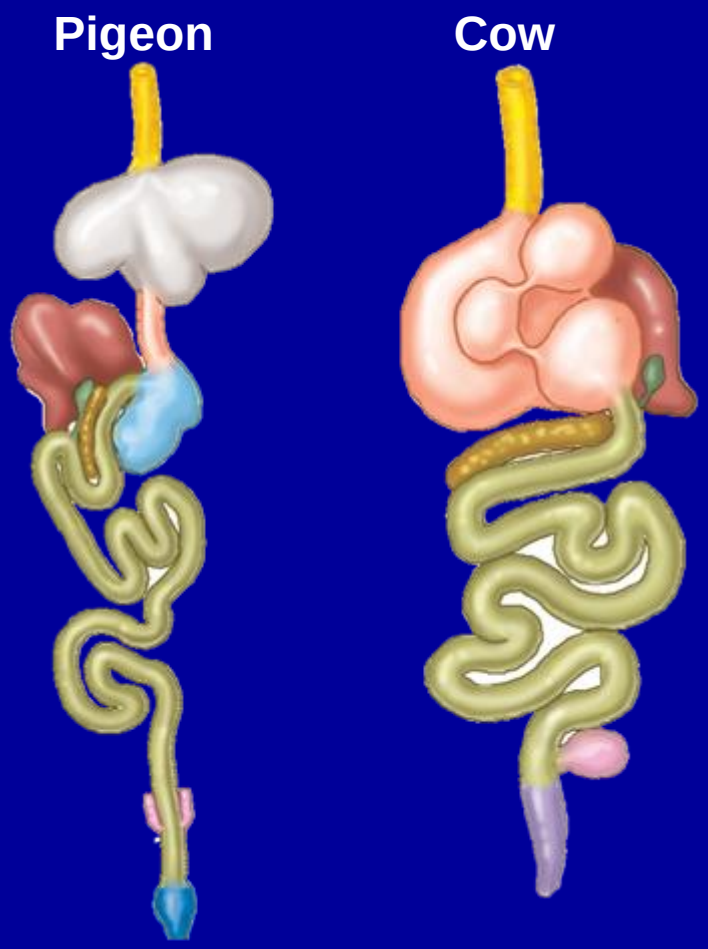
Shark **Salamander** **Lizard**

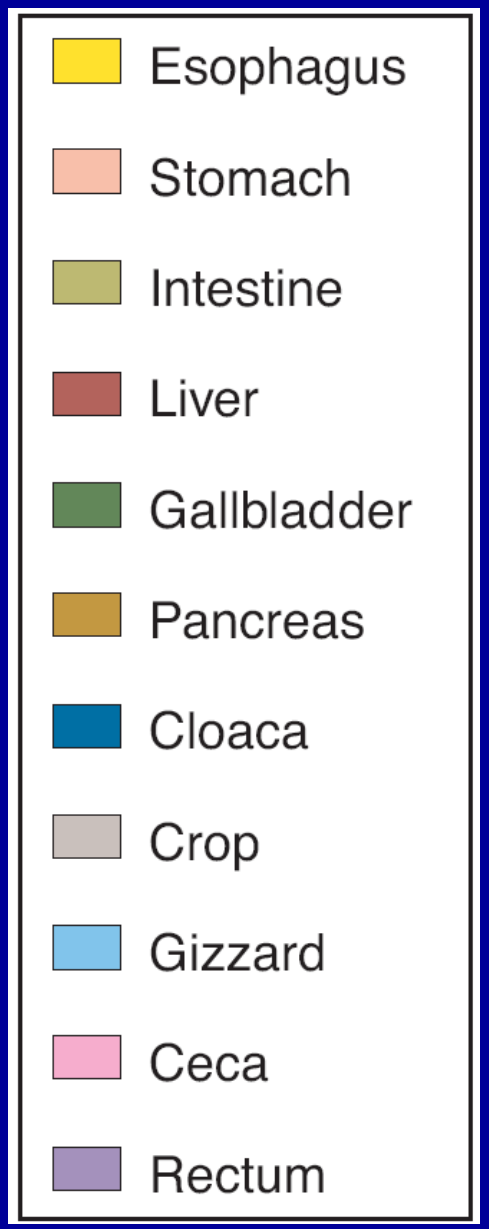


Esophagus
Stomach
Intestine
Liver
Gallbladder
Pancreas
Cloaca
Crop
Gizzard
Ceca
Rectum

Feeding

- Vertebrate Digestive Systems





Respiration

– How do the respiratory systems of the different groups of chordates compare?

Respiration

- Respiration
  - Aquatic chordates—such as tunicates, fishes, and amphibian larvae—use gills for respiration.
  - Land vertebrates, including adult amphibians, reptiles, birds, and mammals, use lungs.

Respiration

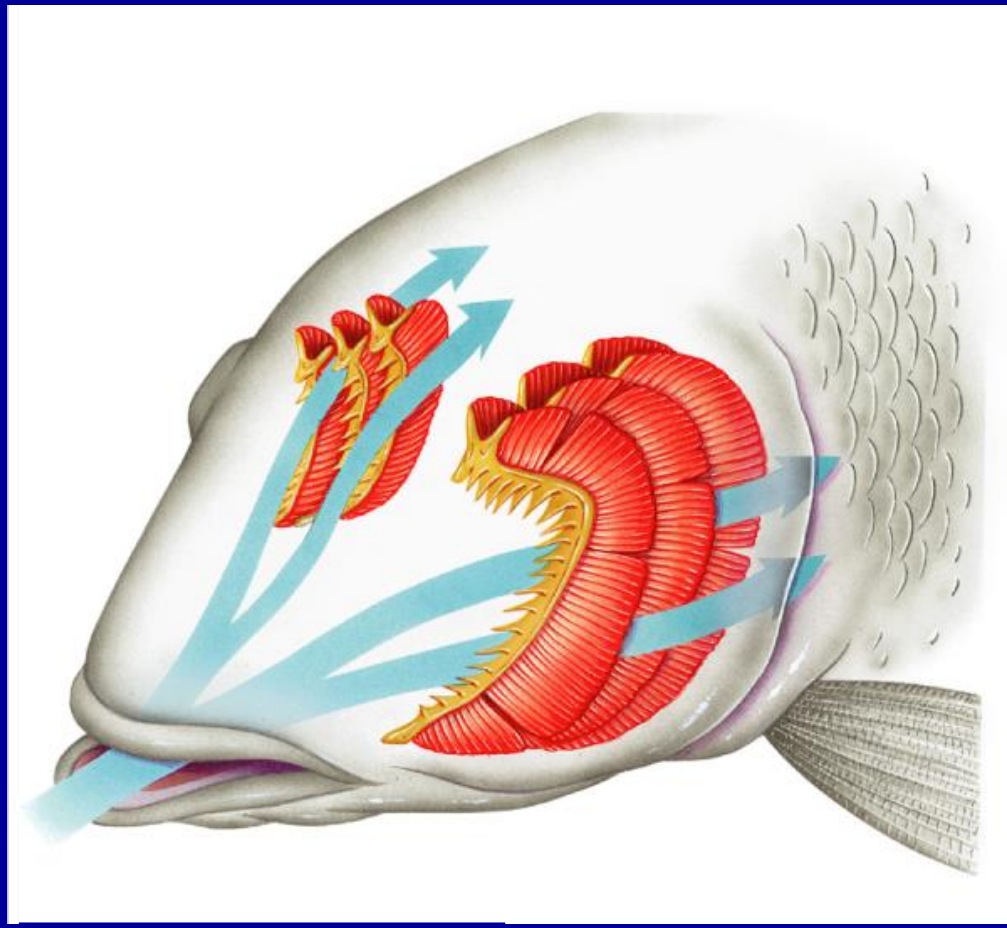
- Some chordates have respiratory structures in addition to gills and lungs.
- Bony fishes have accessory organs such as simple air sacs.
- Lancelets respire by diffusion of oxygen across their body.
- Many adult amphibians use moist skin and the lining of their mouths and pharynxes to respire by diffusion.

Respiration

- Gills
  - As water passes over the gill filaments, oxygen molecules diffuse into blood in tiny blood vessels called capillaries.
  - At the same time, carbon dioxide diffuses from blood into the water.

Respiration

- Water flows in through the fish's mouth. Muscles pump the water across the gills



Respiration

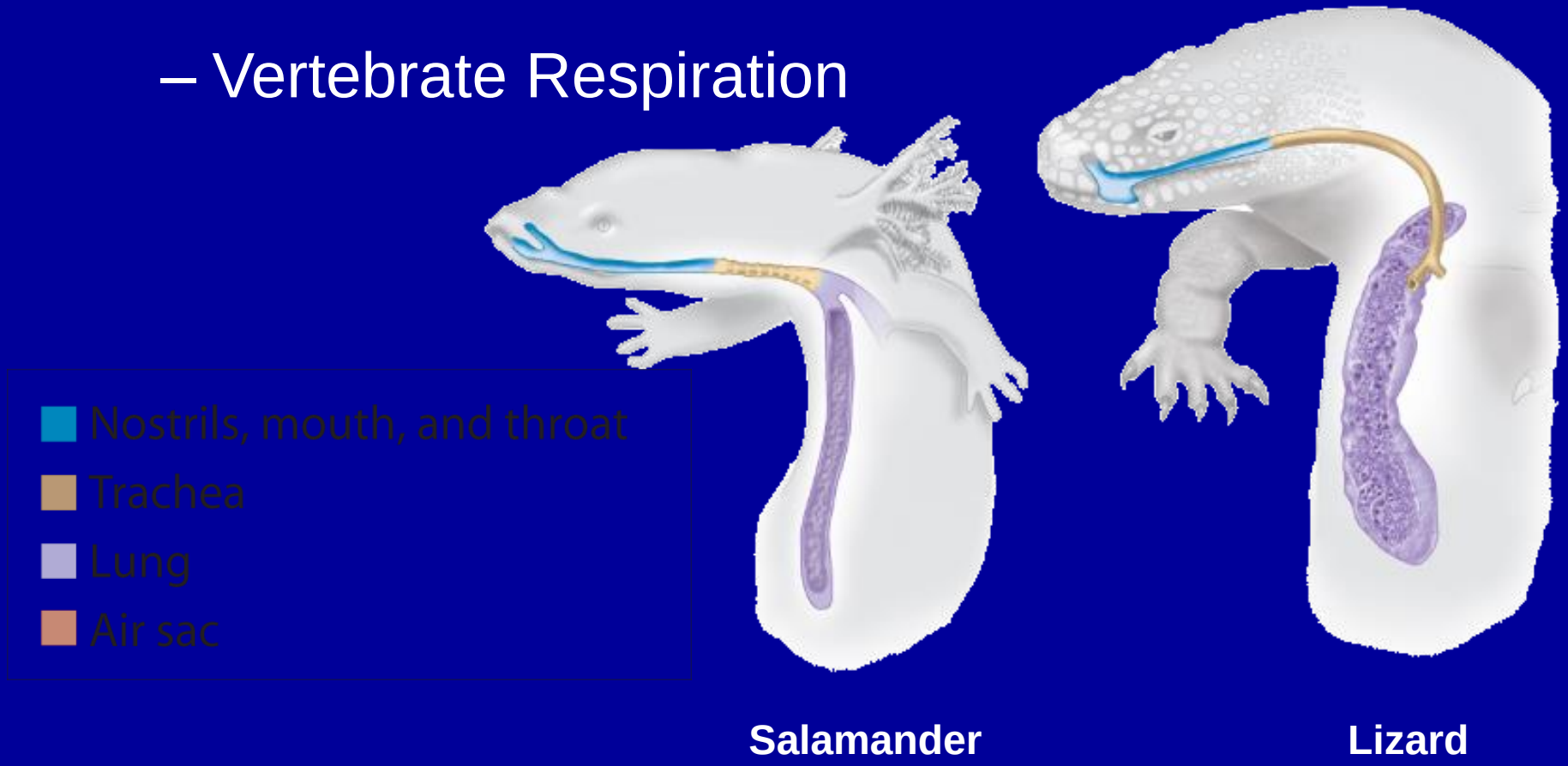
- Lungs
  - Although the structure of the lungs varies, the basic process of breathing is the same among land vertebrates.

Respiration

- Inhaling brings oxygen-rich air from outside the body through the trachea and into the lungs. Oxygen diffuses into the blood inside the lung capillaries.
- Carbon dioxide diffuses out of the capillaries into the air within the lungs. Oxygen-poor air is then exhaled.

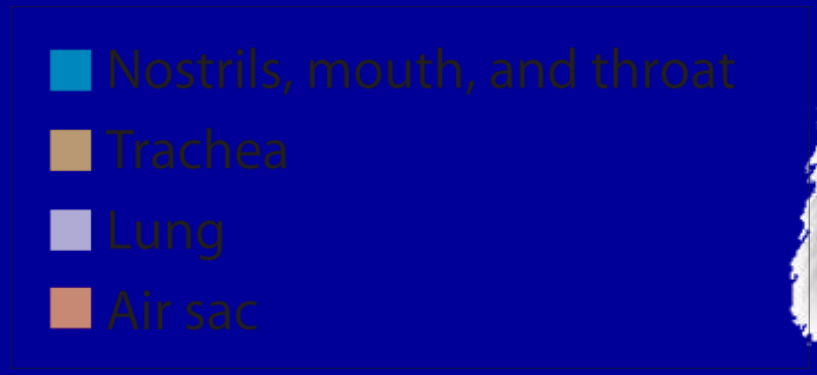
Respiration

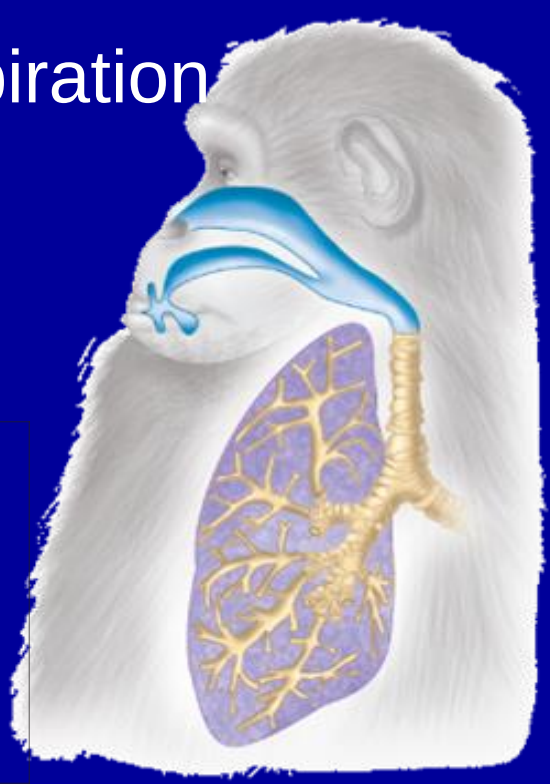
– Vertebrate Respiration



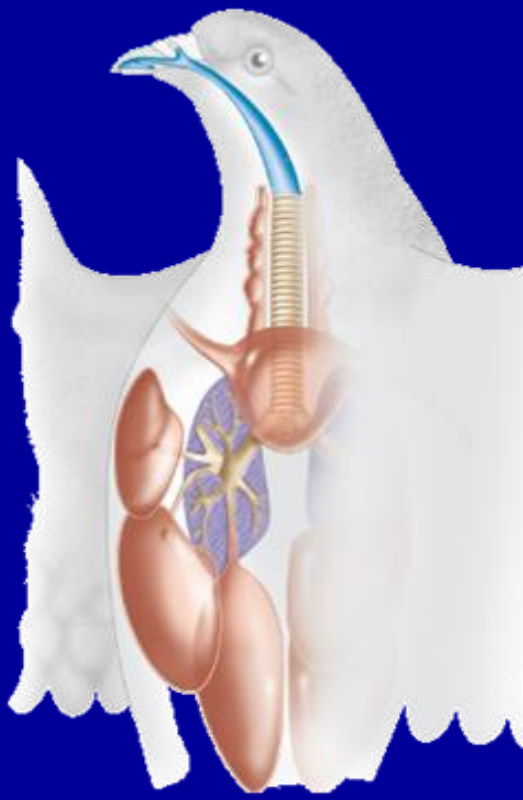
Respiration

– Vertebrate Respiration





Primate



Bird

Respiration

- The surface area of lungs increases as you move from the amphibians to mammals.
- The amphibian lung is little more than a sac with ridges.
- Reptilian lungs are divided into a series of large and small chambers that increase the surface area for gas exchange.

Respiration

- In mammals, the lungs branch, and their entire volume is filled with bubblelike structures called **alveoli**.
- Alveoli provide an enormous surface area for gas exchange.
- This enables mammals to take in the large amounts of oxygen required by their endothermic metabolism.

Respiration

- In birds, air flows in only one direction. A system of tubes, plus air sacs, enables one-way air flow.
- Gas exchange surfaces are constantly in contact with fresh air that contains a lot of oxygen.
- This enables birds to fly at high altitudes, where there is less oxygen in the atmosphere than at lower altitudes.

Circulation

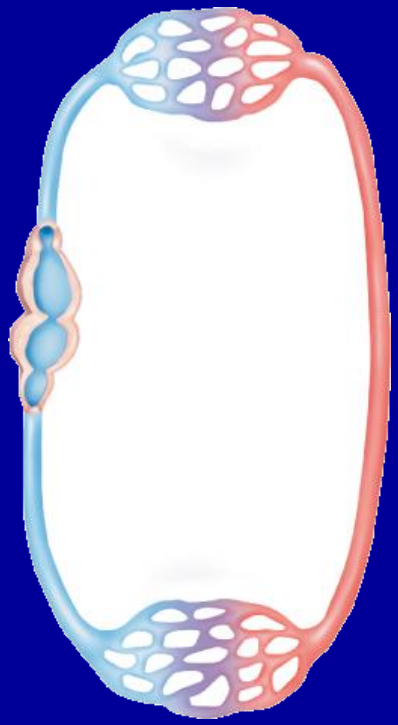
– How do the circulatory systems of the different groups of chordates compare?

Circulation

- Circulation
  - Circulatory systems maintain homeostasis by transporting materials throughout animals' bodies.

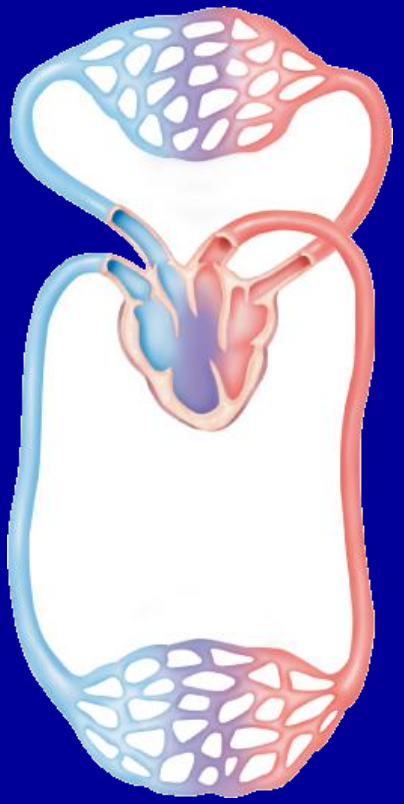
Circulation

Single-loop circulatory system

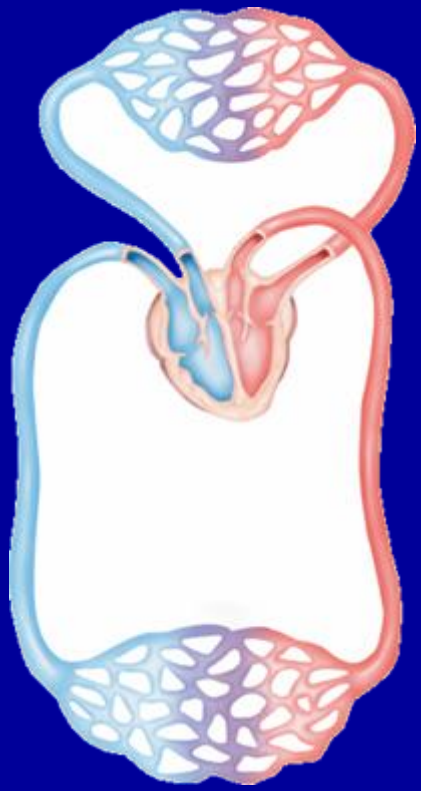


Fishes

Double-loop circulatory system



Most reptiles

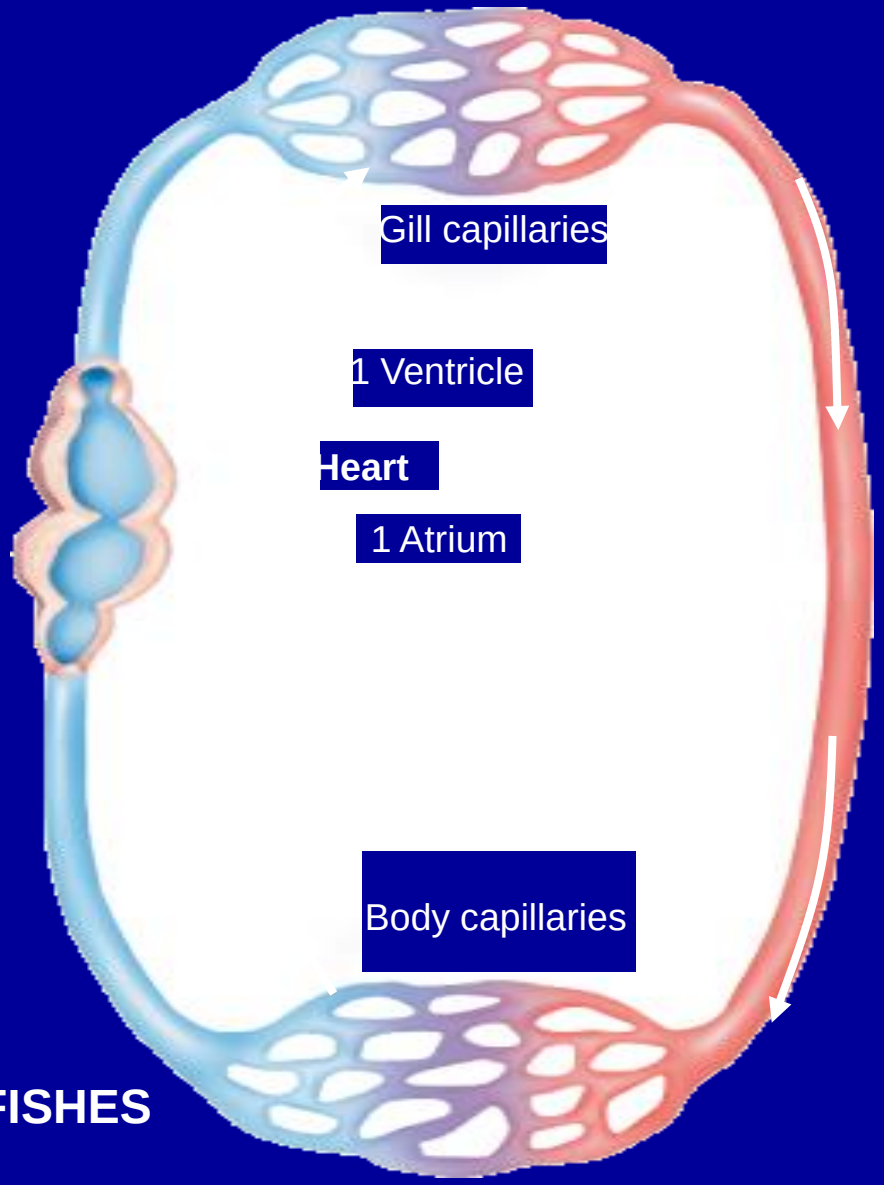


Crocodilians, birds, and mammals

Circulation

- Single- and Double-Loop Circulation
  - Chordates that use gills for respiration have a single-loop circulatory system.
  - In this system, blood travels from the heart to the gills, then to the rest of the body, and back to the heart in one circuit.

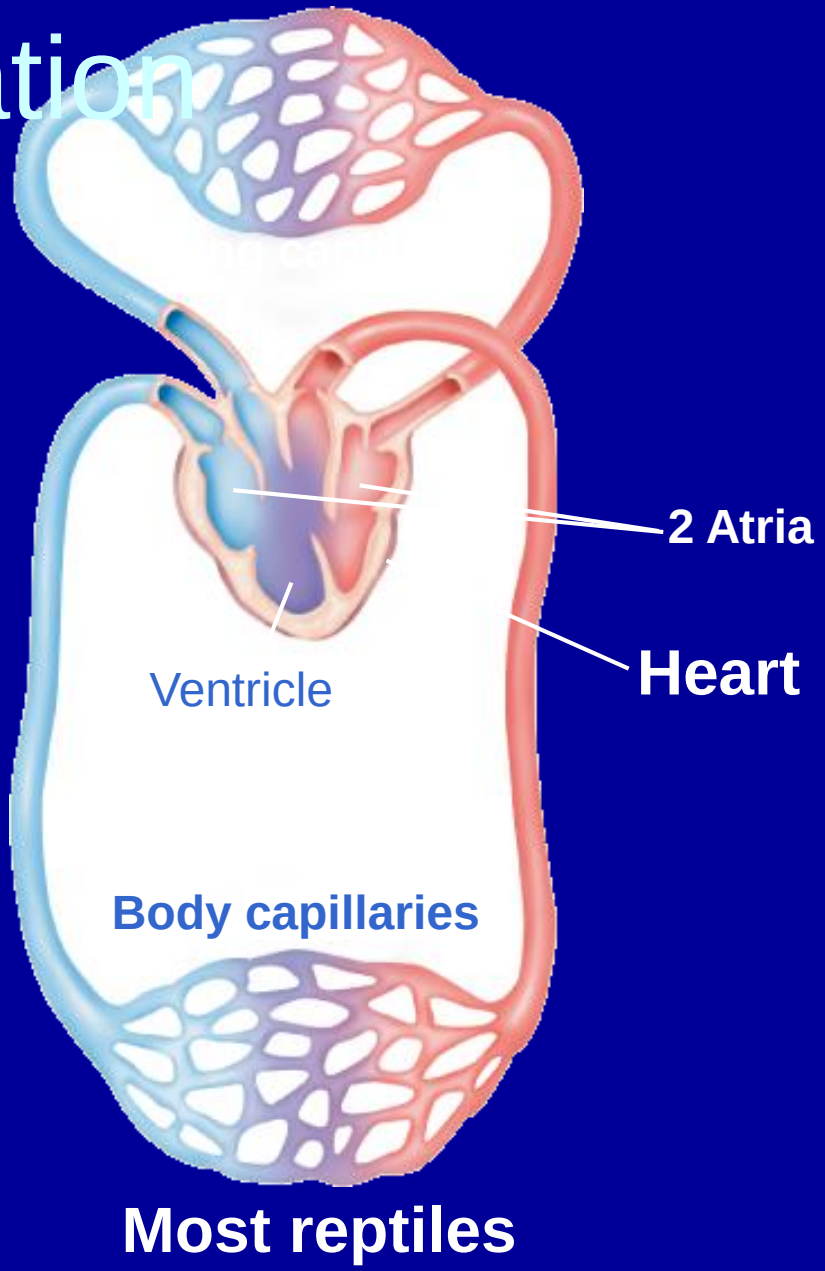
Circulatio



FISHES

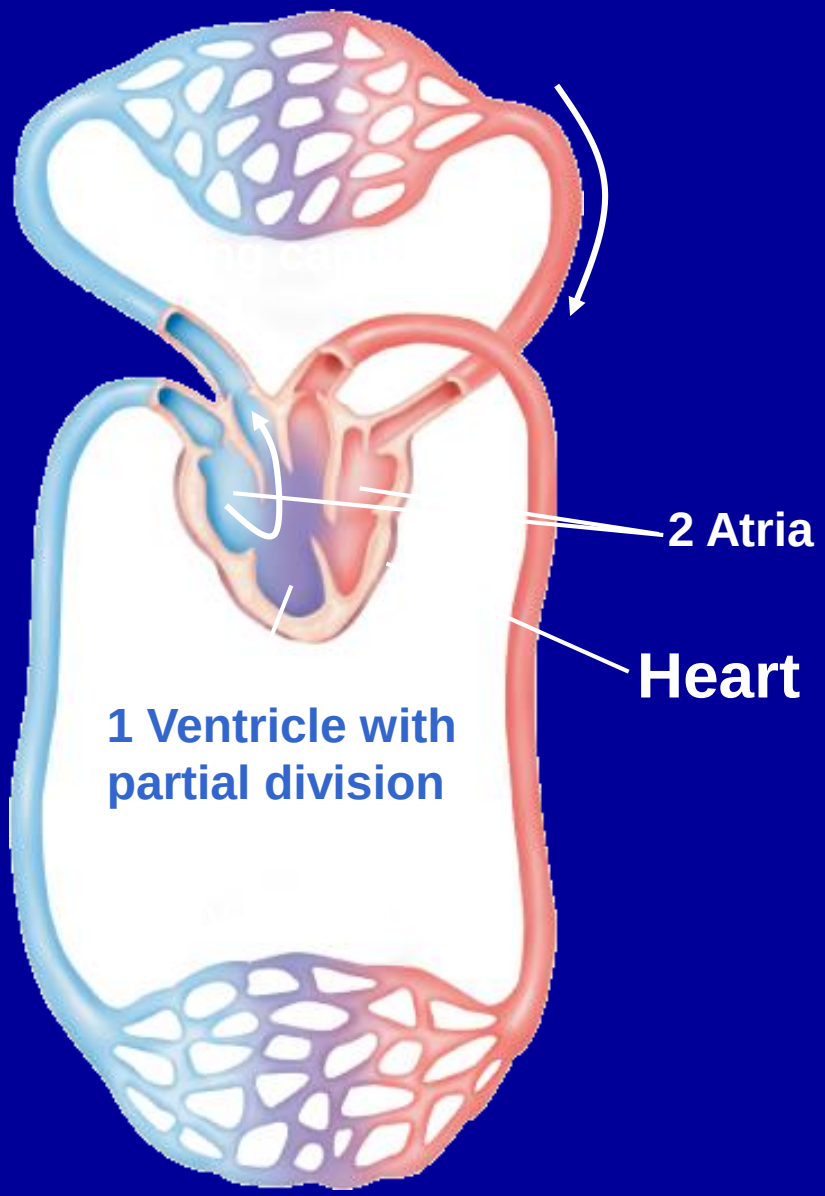
Circulation

- Vertebrates with lungs have a double-loop circulatory system.



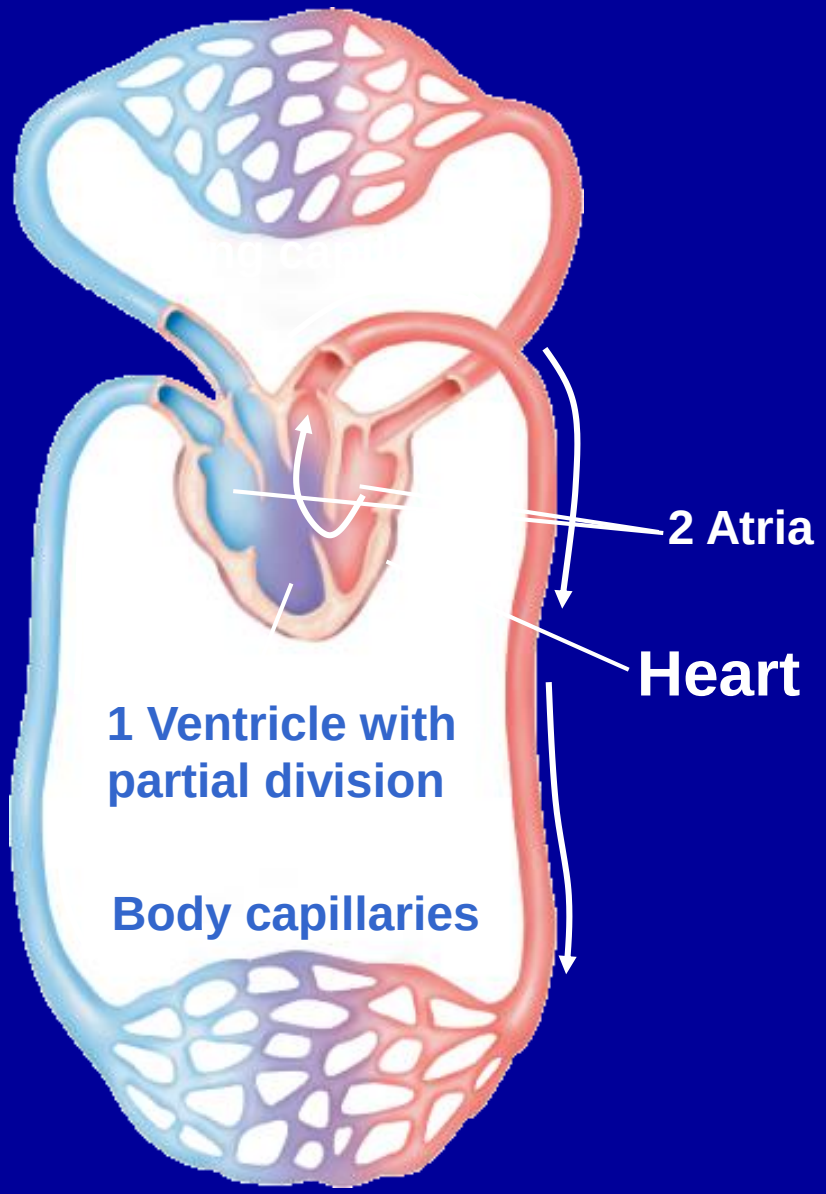
Circulation

- The first loop carries blood between the heart and lungs.
- Oxygen-poor blood from the heart is pumped to the lungs.
- Oxygen-rich blood from the lungs returns to the heart.



Circulation

- The second loop carries blood between the heart and the body.
- Oxygen-rich blood from the heart is pumped to the body.
- Oxygen-poor blood from the body returns to the heart.

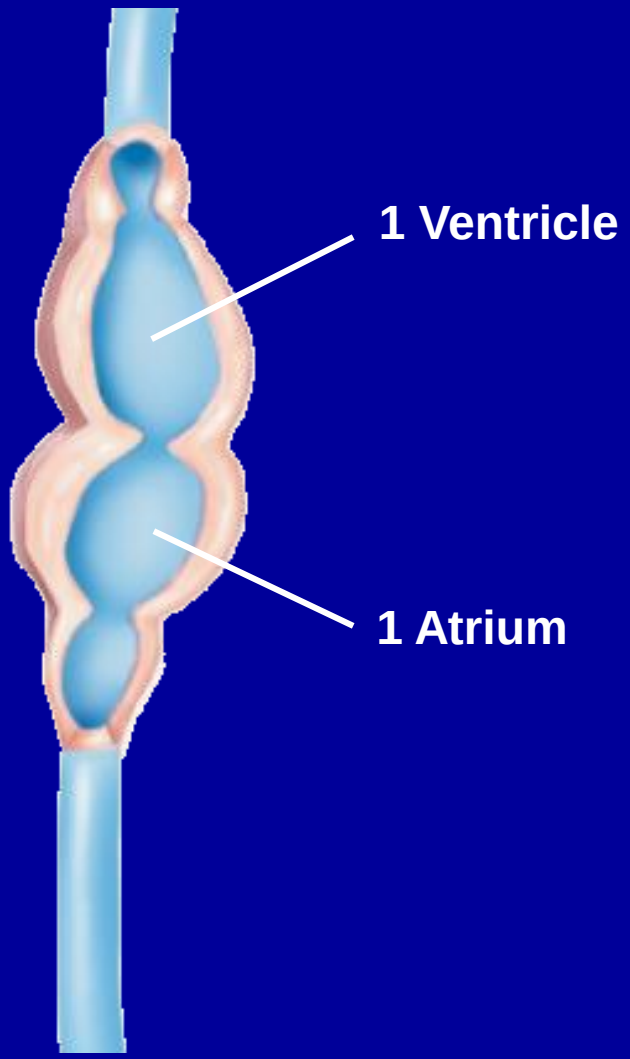


Circulation

- Heart Chambers
  - » **During the course of chordate evolution, the heart developed chambers and partitions that help separate oxygen-rich and oxygen-poor blood traveling in the circulatory system.**

Circulation

- In vertebrates with gills, such as fishes, the heart consists of two chambers:
  - an atrium that receives blood from the body
  - a ventricle that pumps blood to the gills and then on to the rest of the body
-

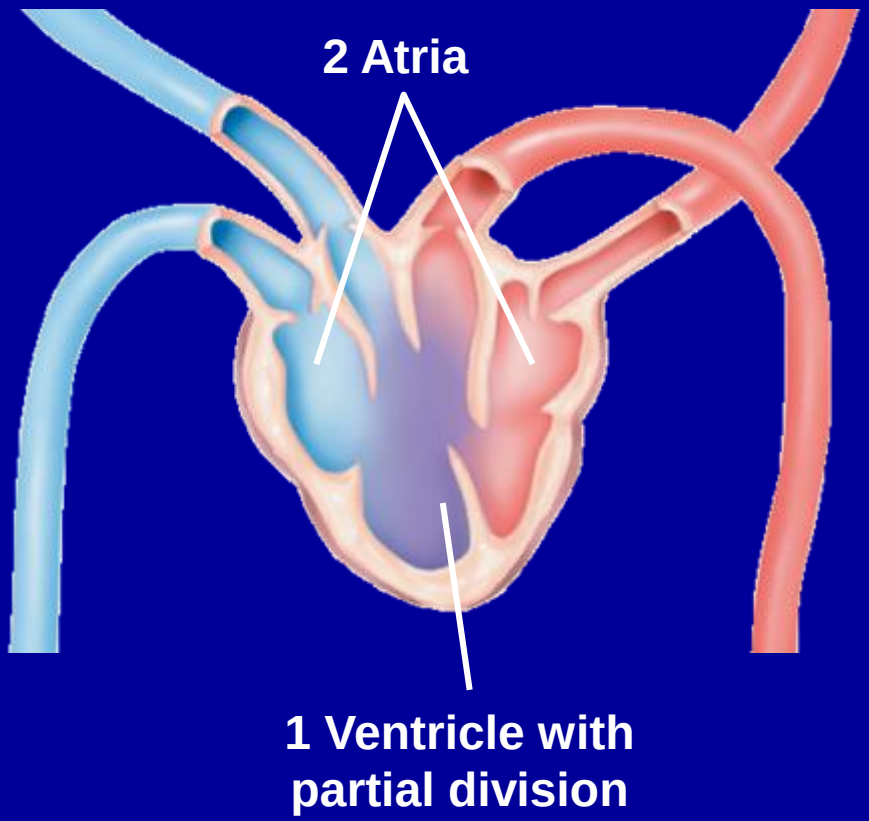


Circulation

- Most amphibians have three-chambered hearts.
  - The left atrium receives oxygen-rich blood from the lungs.
  - The right atrium receives oxygen-poor blood from the body.
  - Both atria empty into the ventricle, which directs blood flow.
-

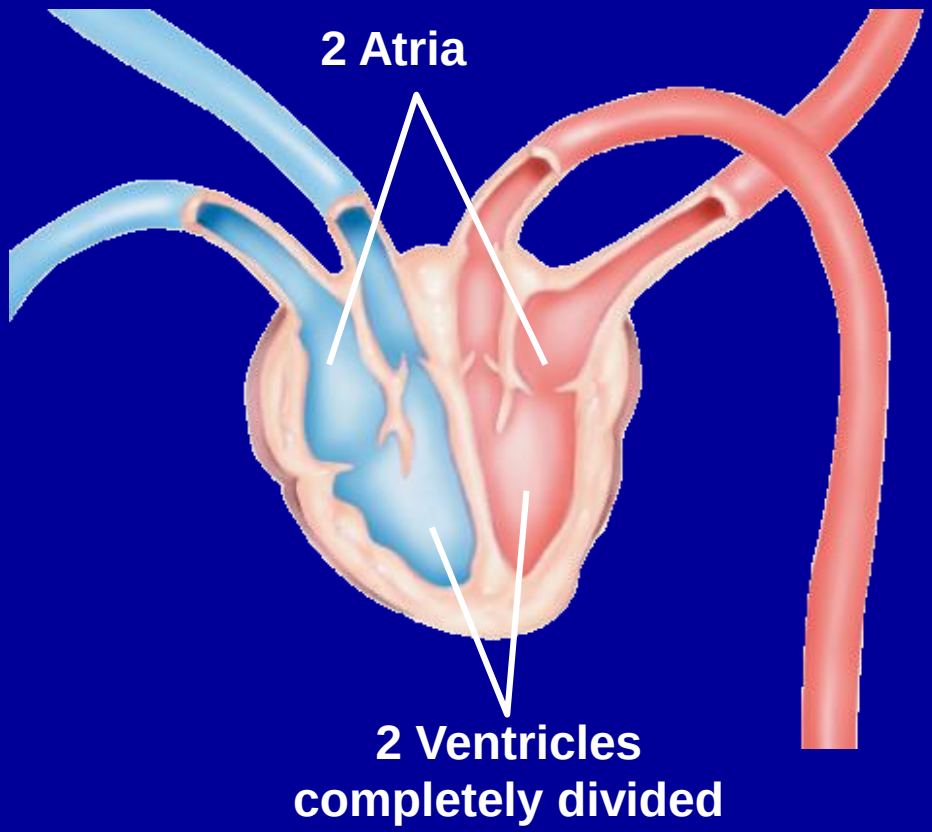
Circulation

- Most reptiles have a three-chambered heart.
- Unlike amphibians, most reptiles have a partial partition in their ventricle that reduces the mixing of oxygen-rich and oxygen-poor blood.



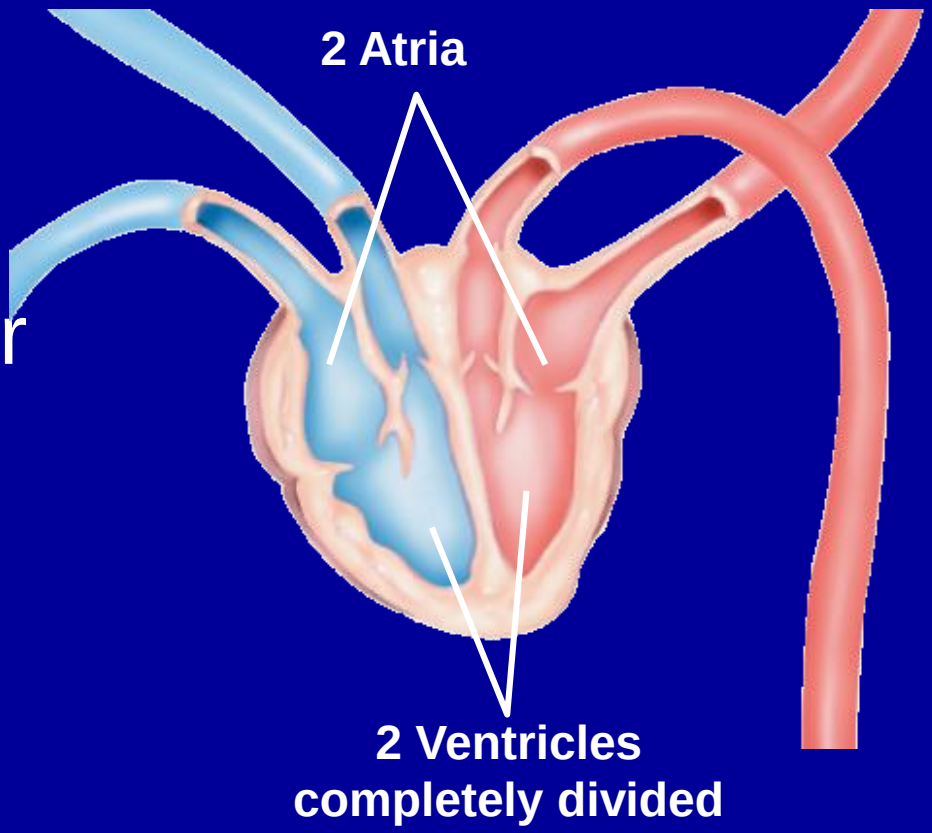
Circulation

- Birds, mammals, and crocodilians have four-chambered hearts sometimes called a double pump.
- One pump moves blood through the lung loop and the other moves blood through the body loop.



Circulation

- The two loops are separated. Therefore, oxygen-rich and oxygen-poor blood do not mix.



Excretion

- Excretion
  - Excretory systems eliminate nitrogenous wastes.
  - In nonvertebrate chordates and fishes, gills and gill slits play an important role in excretion.
  - Most vertebrates rely on kidneys—excretory organs composed of small filtering tubes that remove wastes from the blood.

Excretion

- Nitrogenous wastes are first produced in the form of ammonia.
- Ammonia is highly toxic. Therefore, it must quickly be eliminated from the body or changed into a less poisonous form.

Excretion

- In tunicates, ammonia leaves the body through the outflow siphons.
- Other waste byproducts are stored within the tunicate’s body and released only when the animal dies.

Excretion

- In vertebrates, excretion is carried out mostly by the kidneys.
- Aquatic amphibians and most fishes also excrete ammonia from gills into the water through diffusion.
- Mammals, land amphibians, and cartilaginous fishes change ammonia into urea before it is excreted.
- In reptiles and birds, ammonia is changed into uric acid.

Excretion

- In addition to eliminating nitrogenous wastes, kidneys help maintain homeostasis by regulating the amounts of water, salt, and other substances dissolved in body fluids.

Response

– How do the nervous systems of the different groups of chordates compare?

Response

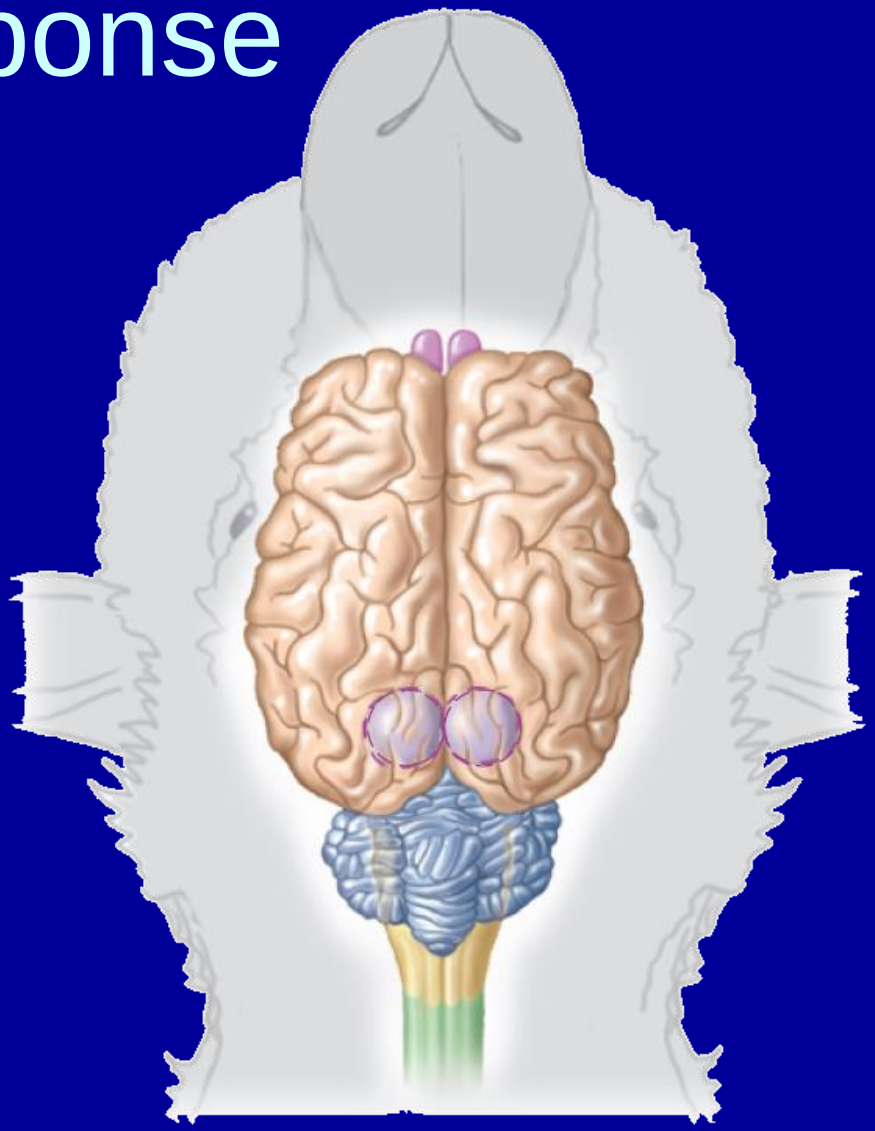
- Response
  - Nonvertebrate chordates have a relatively simple nervous system with a mass of nerve cells that form a brain.
  - Vertebrates have a more complex brain with distinct regions, each with a different function.

Response

- Nonvertebrate chordates do not have specialized sensory organs.
- Vertebrates display a high degree of cephalization, or concentration of sense organs and nerve cells at the front of the body.
- The head contains a well-developed brain, which is situated on the anterior end of the spinal cord.

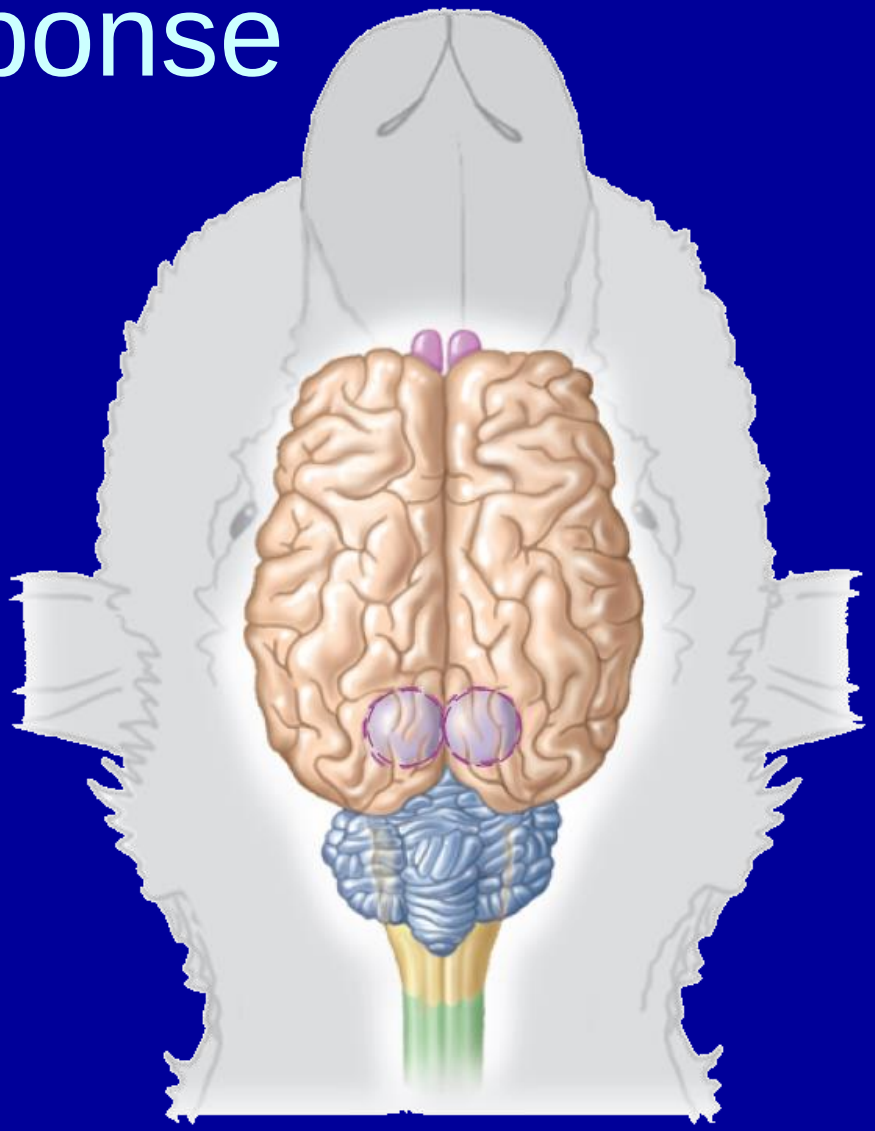
Response

- The vertebrate brain is divided into several parts:
  - cerebrum, or “thinking and learning” region
  - cerebellum, which coordinates movement and balance



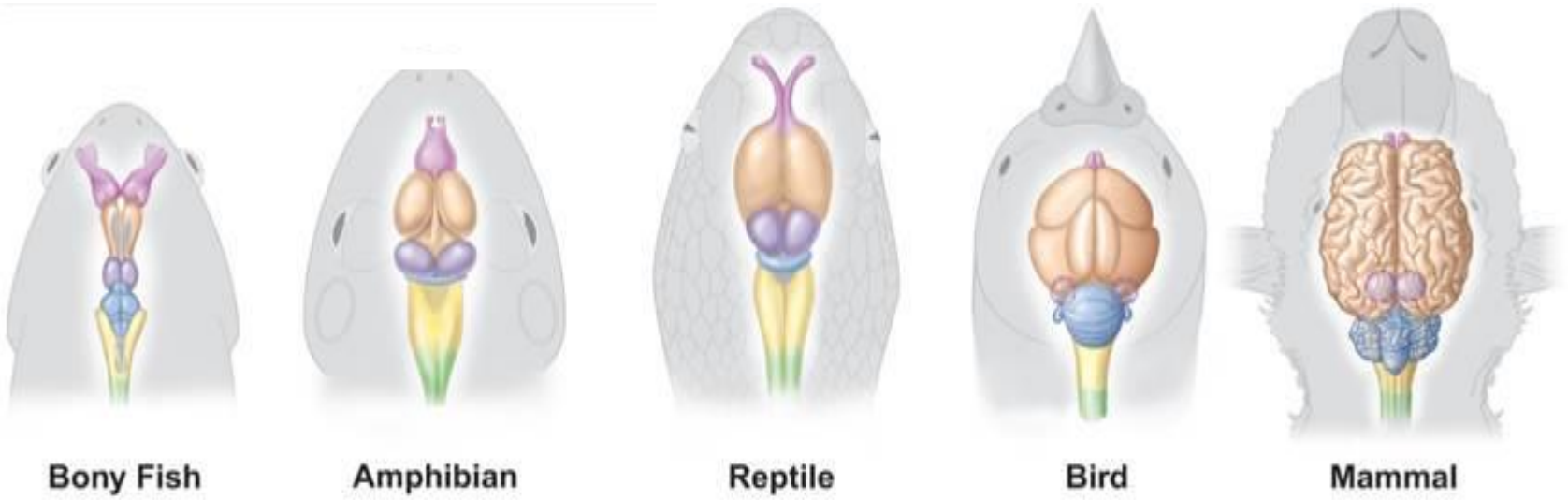
Response

- medulla oblongata, which controls many internal organs
- optic lobes, which are involved in vision
- olfactory bulbs, which are involved in smell



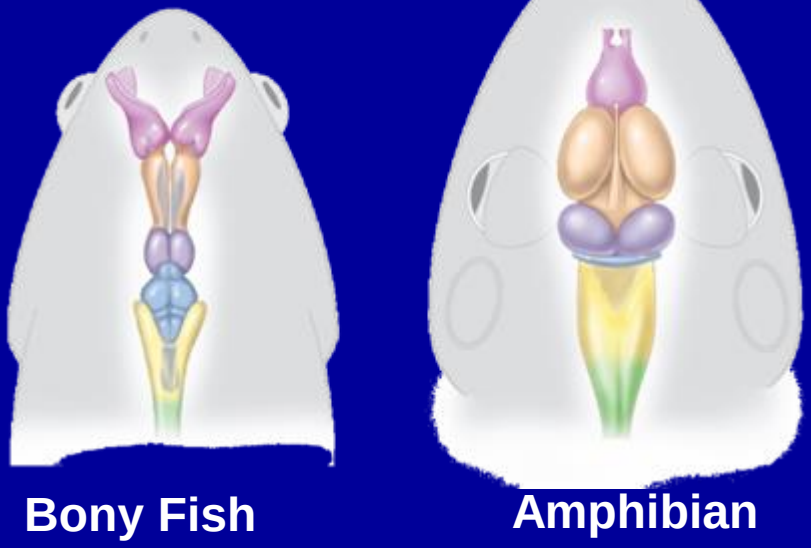
Response

- The size and complexity of the cerebrum and cerebellum increase from fishes to mammals.



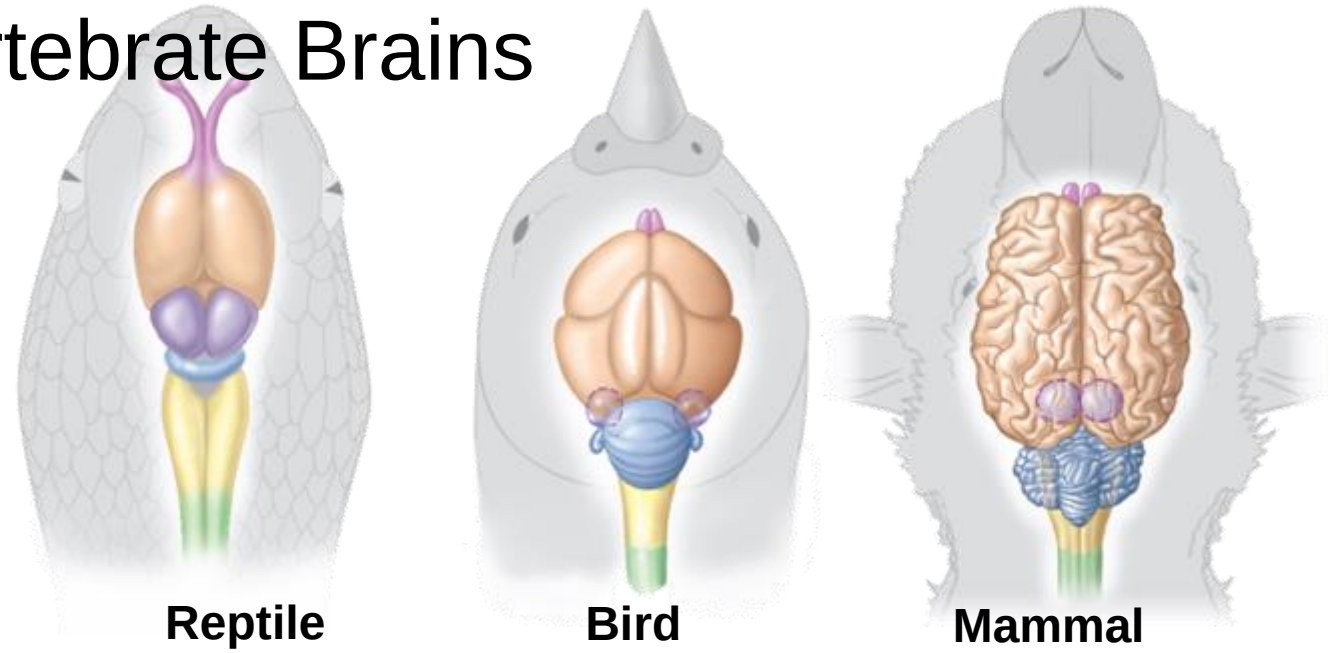
Response

- Vertebrate Brains



Response

- Vertebrate Brains



Movement

- How do the skeletal and muscular systems of the different groups of chordates compare?

Movement

- Movement
  - Unlike most chordates, nonvertebrate chordates lack bones.
  - Nonvertebrate chordates, however, do have muscles.
  - Lancelets and larval tunicates swim with a fishlike movement of their muscular tails.

Movement

– The skeletal and muscular systems support a vertebrate's body and make it possible to control movement.

Movement

- Most vertebrates have an internal skeleton of bone or cartilage.
- The skeleton includes a backbone of individual bones called vertebrae.
- Ligaments connect vertebrae and allow the backbone to bend.
- Most vertebrates have fin or limb girdles that support fins or limbs.

Movement

- In many fishes and snakes, the main body muscles are arranged in blocks on either side of the backbone. These muscles generate forward thrust.
- In many amphibians and reptiles, limbs stick out sideways from the body in a position resembling a push-up.
- Most mammals stand with their legs straight under them, a position that supports body weight efficiently.

Reproduction

- Reproduction
  - Almost all chordates reproduce sexually.
  - Vertebrate evolution shows a general trend from external to internal fertilization.
  - Eggs of nonvertebrate chordates—and many fishes and amphibians—are fertilized externally.
  - Eggs of reptiles, birds, and mammals are fertilized internally.

Reproduction

- After fertilization, the development of chordates can be:
  - Oviparous—eggs develop outside the mother's body.
  - Ovoviviparous—eggs develop within the mother's body, but are born alive.
  - Viviparous—developing embryos obtain nutrients directly from the mother's body and are born alive.

Reproduction

- Some vertebrates, such as most amphibians, produce many offspring but give them little care. This reproductive strategy favors populations that disperse and grow rapidly.
- Mammals and birds produce few young but care for them. This reproductive strategy aids survival in crowded, competitive environments.

Ecology of Vertebrates

- Bony fish & Jawless Fish:
  - Anadromous fish: Live in SW, migrate to FW to breed. Adv?
    - Ex. Salmon, sturgeon, lamprey
  - Catadromous fish: Live in FW, migrate to SW to breed. Adv?
    - Ex. European Eels

Ecology of Vertebrates

- Amphibians:
  - Protection from predators by: camoflauge, poisons, bright colors, mimicry
  - Declining in numbers due to:
    - Change in climate
    - Envir. Changes: man destroys habitat, water pollution, acid rain, etc.

Ecology of Vertebrates

- Reptiles:
  - Endangered due to:
    - Habitat destruction
    - Human hunting for: food (eggs), pets, skins

    Some laws to protect, but need more!

    Ex. Sea Turtle recovery program

Ecology of Vertebrates

- Birds:
  - Useful as: pollinators, seed dispersal
  - Environmental health indicators:
    - Ex. Pesticides can accumulate in birds that eat insects, causing weak shelled eggs.
      - Rachel Carson – Book Silent Spring – songbird eggs weak as a result of DDT pesticide