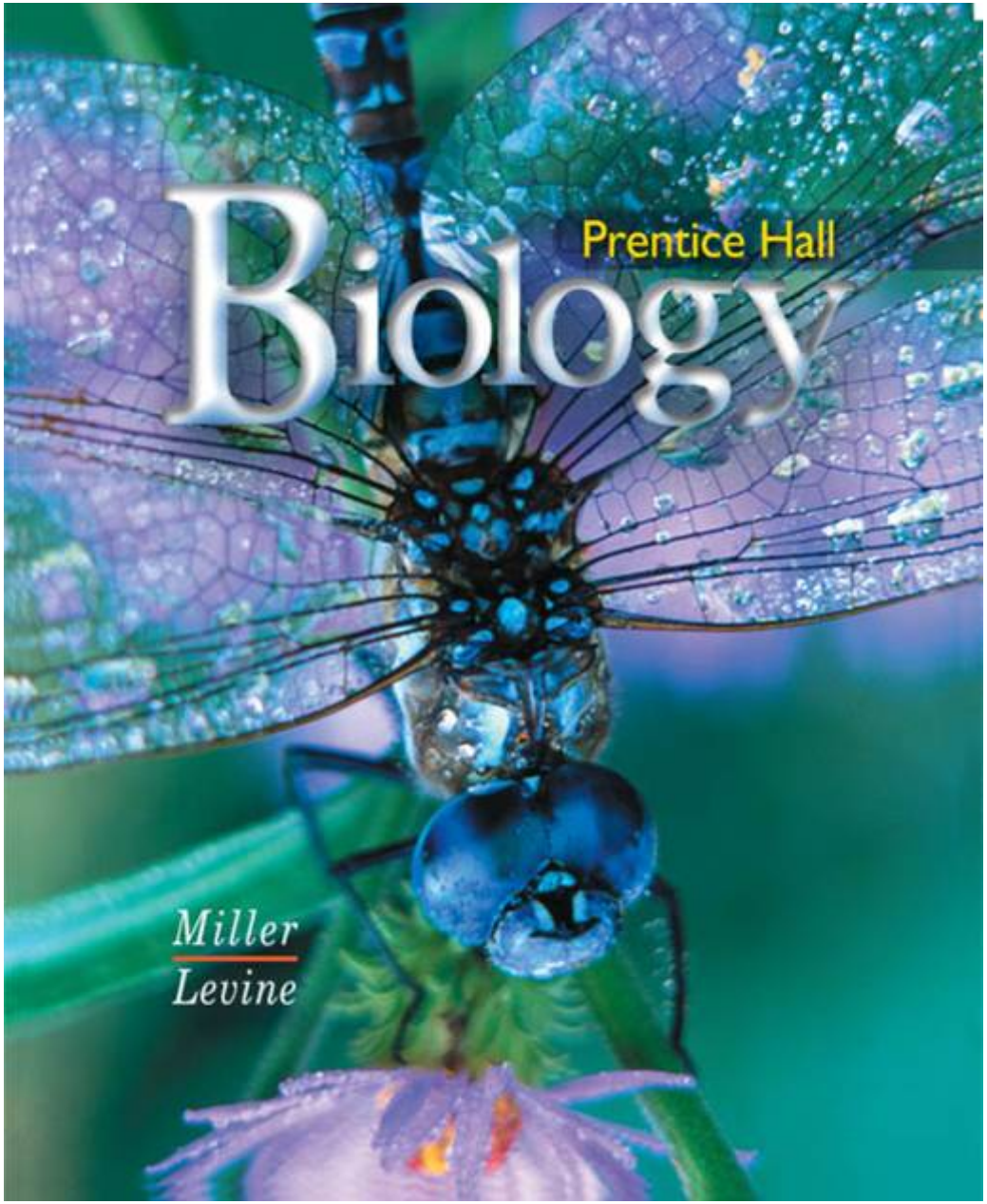
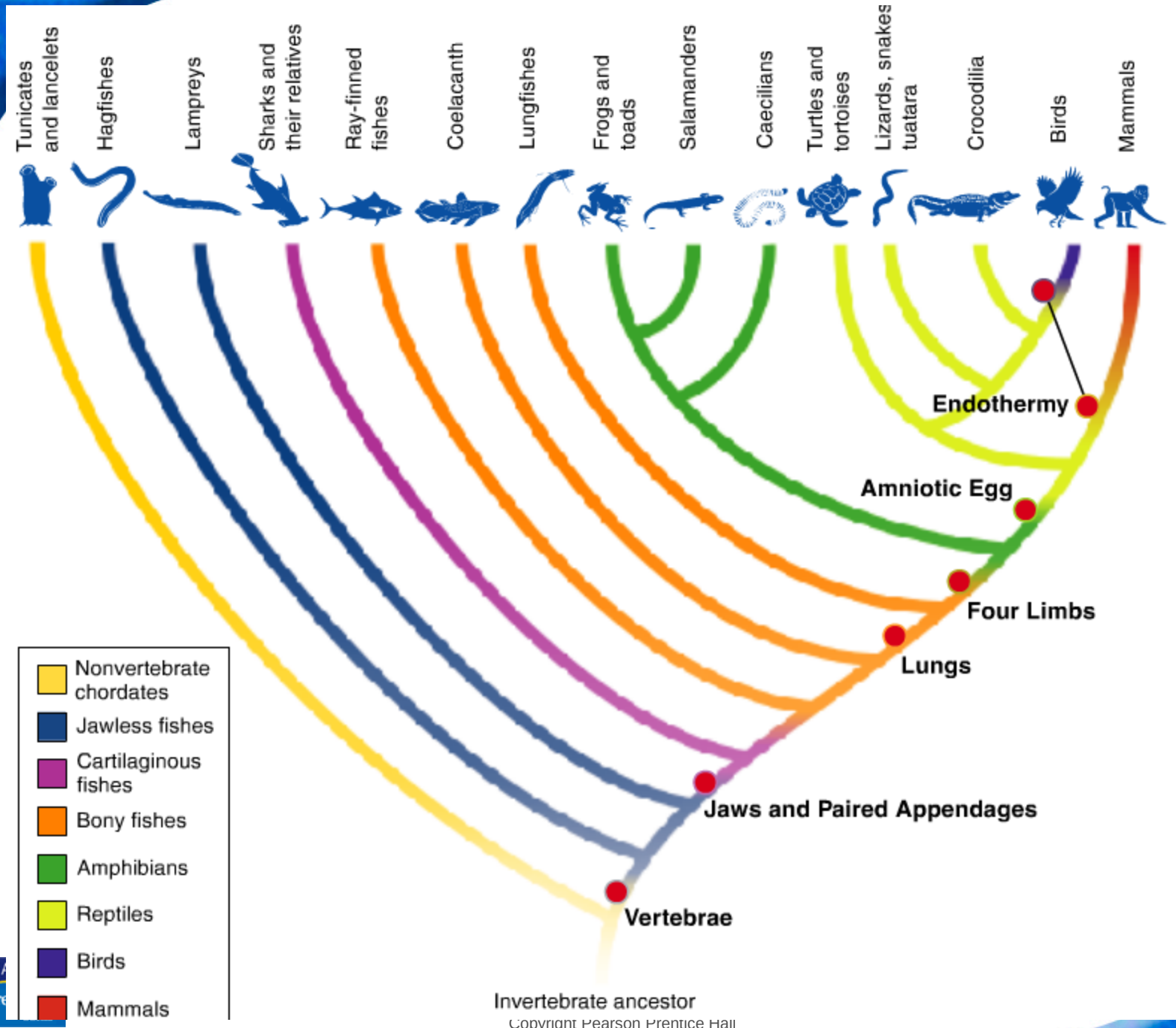


Chapter 33 – Comparing Chordates

This chapter is a good revision of the material we saw during Unit III.

End Show



Controlling Body Temperature

• The control of body temperature is important for **maintaining homeostasis** in vertebrates, particularly in habitats where temperature varies widely with time of day and with season.

• In terms of how they generate and control their body heat, vertebrates can be classified into two basic groups: **ectotherms** and **endotherms**.

Controlling Body Temperature

- **Ectotherms**:
  - **Fishes, amphibians and** most **reptiles** are ectotherms—animals whose body temperatures are **controlled primarily by** picking up heat from, or losing heat to, **their environment**.
  - Ectotherms have relatively **low rates of metabolism** when they are resting. Thus, their bodies do not generate much heat.
  - Ectotherms often warm up by basking in the sun, and may cool down by seeking shelter in underground burrows.

Controlling Body Temperature

- **Endotherms**:
  - **Birds and mammals** are endotherms, which means they can **generate and retain heat** inside their bodies.
  - Endotherms have relatively **high metabolic rates** that generate a significant amount of heat, even when they are resting.

  - Birds conserve body heat primarily through insulating **feathers**, such as down.
  - Mammals have body **fat and hair** for insulation. Mammals can get rid of excess heat by **panting**, as dogs do, or by **sweating**, as humans do.

Controlling Body Temperature

- **Advantages of Ectotherms:**
  - In environments where temperatures stay warm and fairly constant most of the time, ectothermy is a more energy-efficient strategy
  - Do not need as much food
- **Advantages of Endotherms:**
  - Move around easily during cool nights or in cold weather

Form and Function in Chordates

- The complexity of vertebrate organ systems can be seen in the different ways that vertebrates feed, breathe, respond, move, and reproduce.

Form and Function in Chordates

Feeding

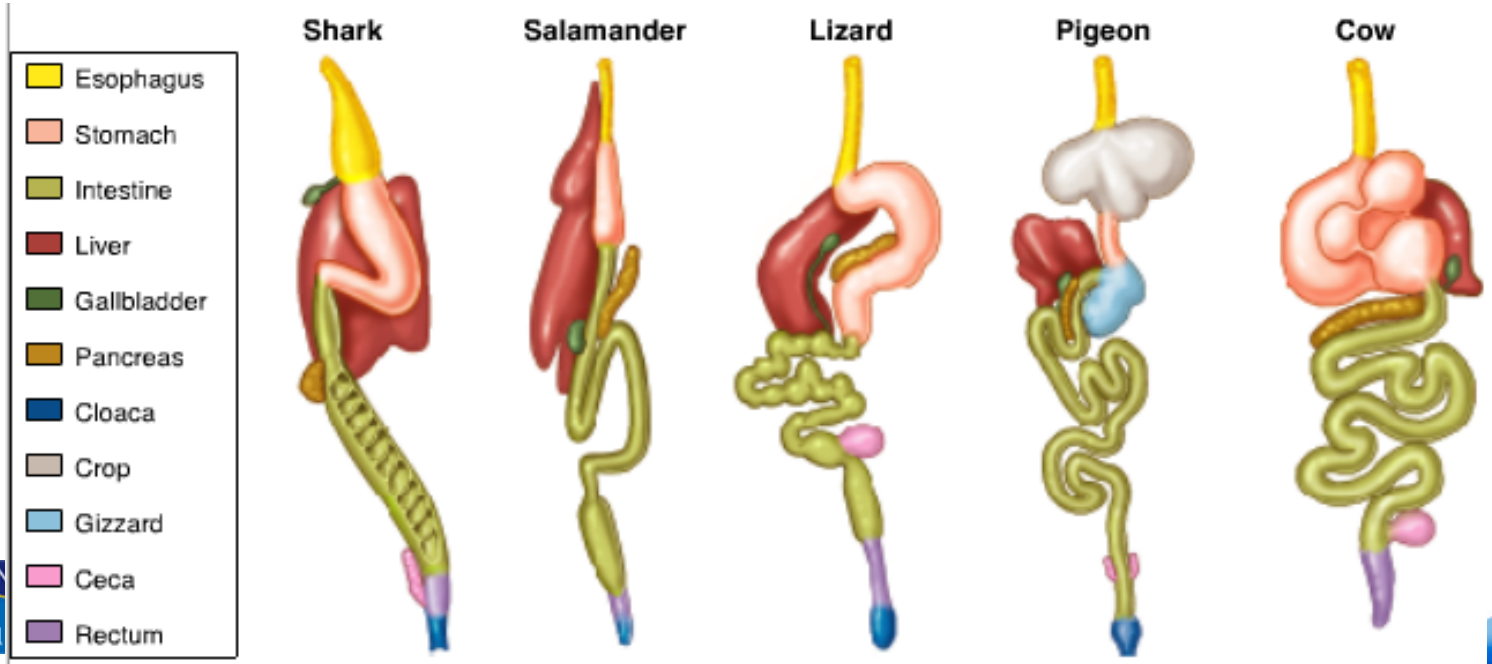
- Most tunicates, and all lancelets, are filter feeders.
- The skulls and teeth of vertebrates are adapted for feeding on a much wider assortment of foods, ranging from insects to large mammals, and from leaves to fruits and seeds.

Form and Function in Chordates

Feeding

• The digestive systems of vertebrates have organs that are well adapted for different feeding habits.

• Carnivores such as sharks typically have short digestive tracts that produce fast-acting, meat-digesting enzymes. Herbivores such as cows, on the other hand, often have long intestines that harbor colonies of bacteria.



Form and Function in Chordates

Respiration

• As a general rule, aquatic chordates—such as tunicates, fishes, and amphibian larvae—use **gills** for respiration.

• Land vertebrates, including adult amphibians, reptiles, birds, and mammals, use **lungs**.

• However, some animals “break the rules.” For example, several fishes, such as lungfishes, have both gills and lungs.

Form and Function in Chordates

Respiration

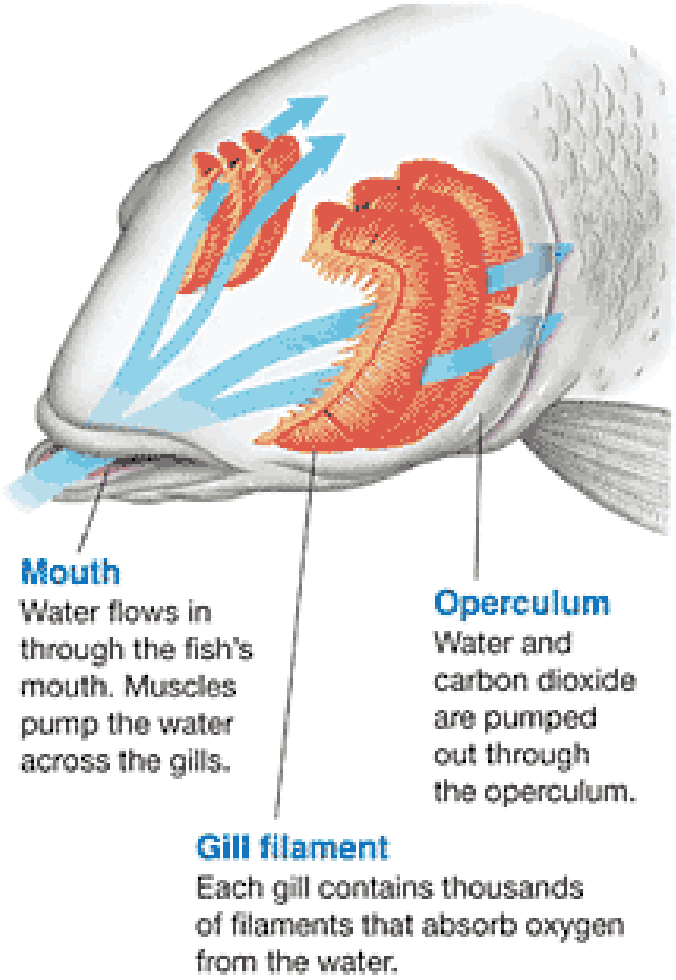
- Some chordates have respiratory structures in addition to gills and lungs:
  - Many bony fishes have accessory organs for respiration, such as simple air sacs
  - Many adult amphibians use their moist skins and the linings of their mouths and pharynxes to respire by diffusion.

Form and Function in Chordates

Respiration

• Fishes and many other **aquatic chordates use gills** for respiration.

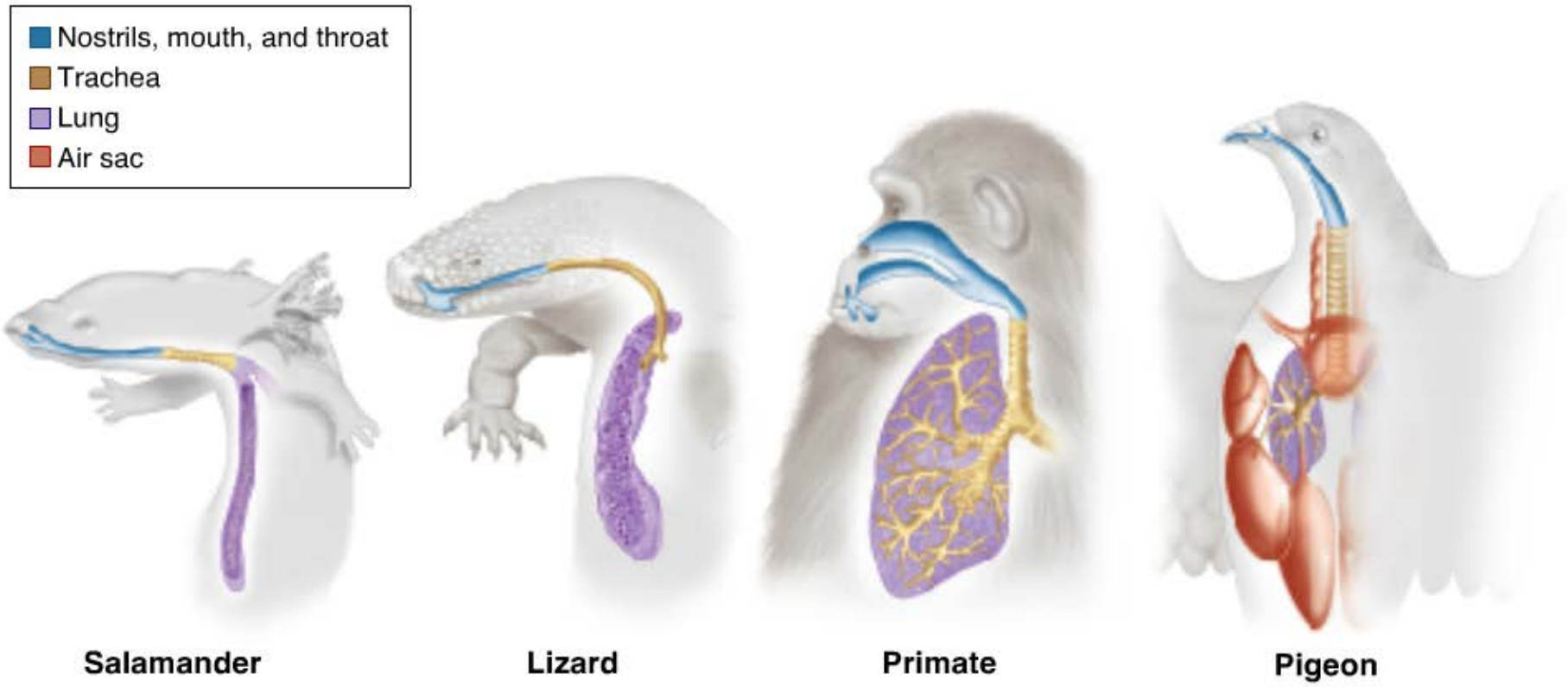
•As water passes over the gill filaments, oxygen molecules diffuse into blood in tiny blood vessels called capillaries. At the same time, carbon dioxide diffuses from blood into the water.



Form and Function in Chordates

Respiration

• Unlike most aquatic chordates, **land vertebrates**—like salamanders, lizards, birds, and primates—**use lungs** to breathe. A few aquatic chordates, such as sea turtles and marine mammals, use lungs as well.



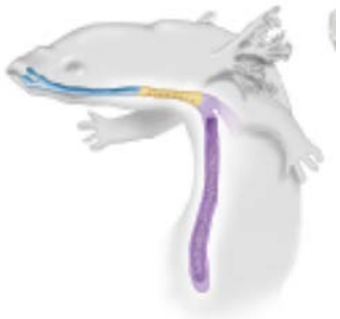
Form and Function in Chordates

Respiration

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

Respiration

• The typical amphibian lung is little more than a sac with ridges.



Salamander

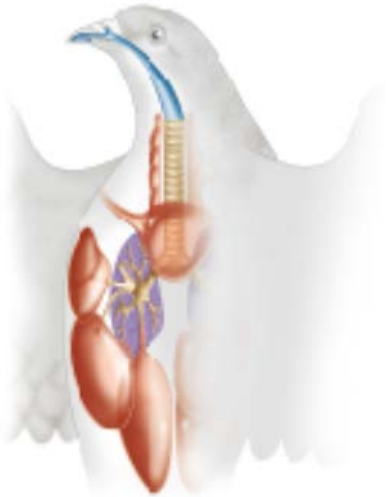
•Reptilian lungs are often divided into a series of large and small chambers that increase the surface area available for gas exchange.

Lizard

Respiration

• In the lungs of birds, air flows in only one direction. A system of tubes in a bird's lungs, plus air sacs, enables this one-way air flow.

• Thus, gas exchange surfaces are constantly in contact with fresh air that contains a lot of oxygen. This supply of oxygen enables birds to fly at high altitudes, where there is less oxygen in the atmosphere than at lower altitudes.



Pigeon

Respiration

• In mammals, the lungs branch extensively, and their entire volume is filled with thousands of bubblelike structures called **alveoli**. Alveoli provide an enormous surface area for gas exchange.

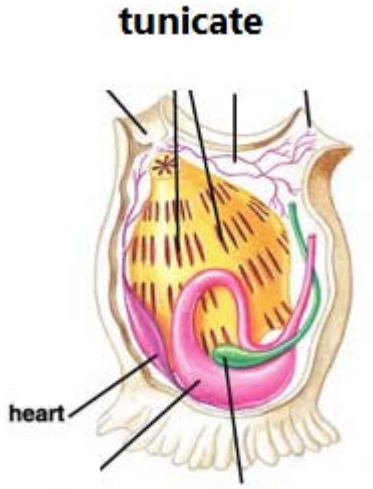
Primate

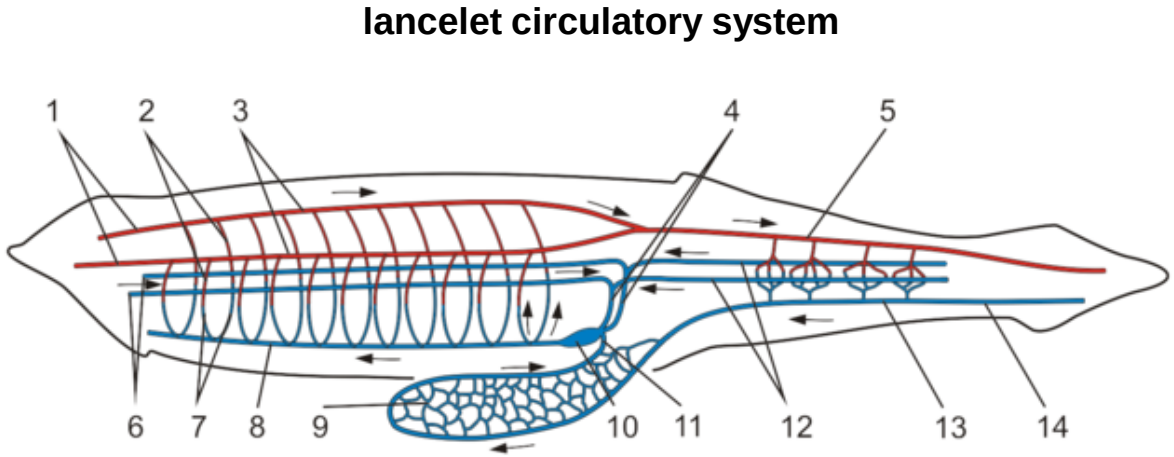
Circulation

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

•Tunicates have short, tubelike hearts with a simple pump but no true chambers.

•Lancelets have a fairly well-developed circulatory system but no specialized heart.

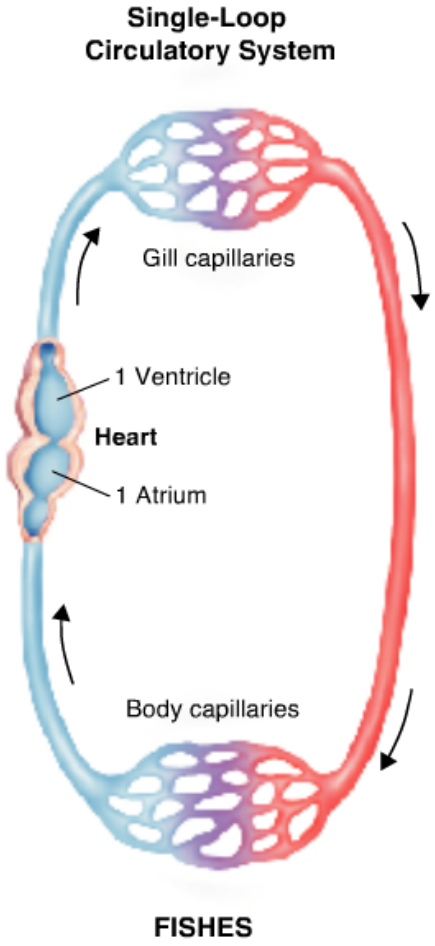




Circulation

- **Single-Loop Circulation**

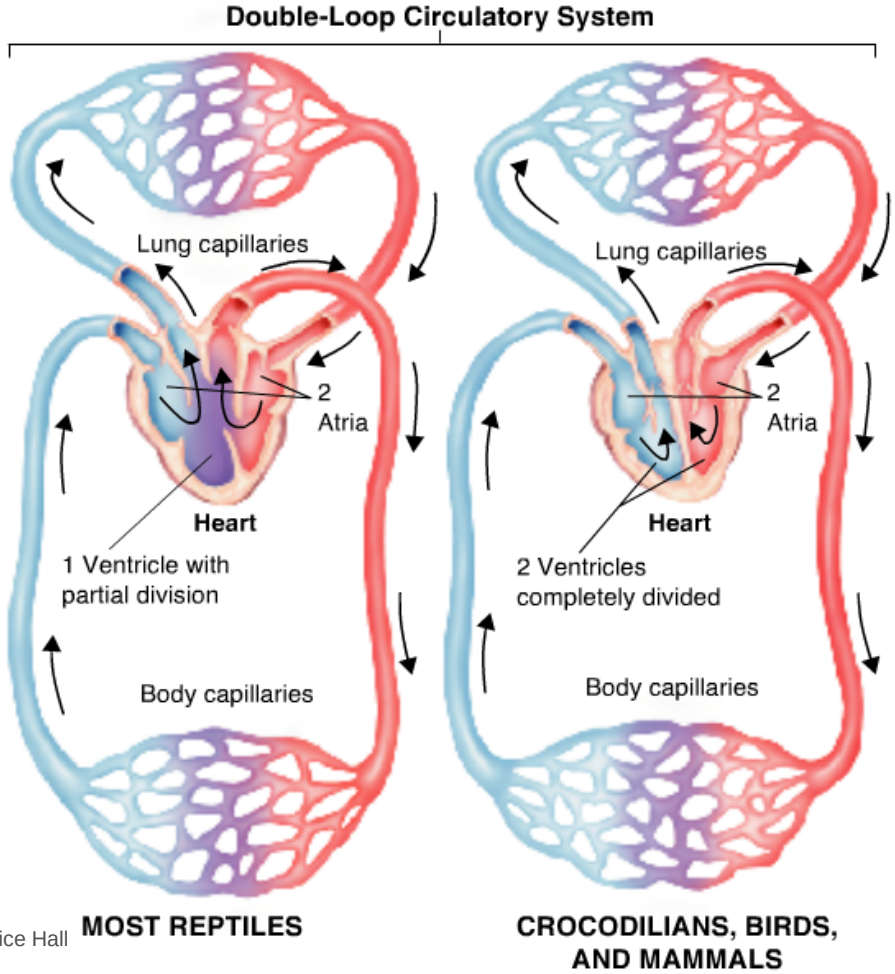
Those that use gills for respiration have a single-loop circulatory system. In this system, blood travels from the heart to the gills, then to the rest of the body, and back to the heart in one circuit.



Circulation

- **Double-Loop Circulation**

Vertebrates that use **lungs** for respiration have a **double-loop circulatory system.** The first loop carries blood between the heart and lungs. Oxygen-poor blood from the heart is pumped to the lungs, while oxygen-rich blood from the lungs returns to the heart. The second loop carries blood between the heart and the body. Oxygen-rich blood from the heart is pumped to the body, while oxygen-poor blood from the body returns to the heart.

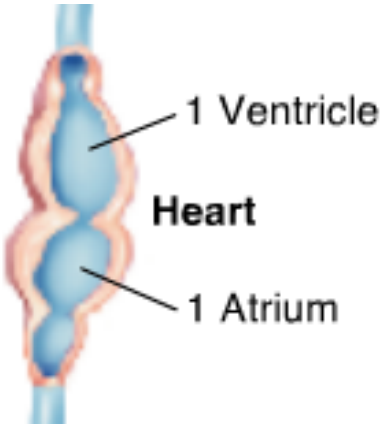


Circulation

- **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.

- **In vertebrates that use gills for respiration**, such as fishes and larval amphibians, **the heart consists of two chambers**: an atrium that receives blood from the body, and a ventricle that pumps blood to the gills and then on to the rest of the body.

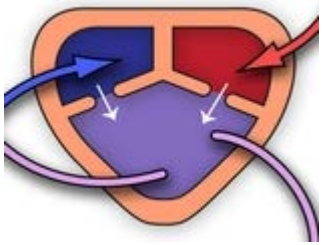


Circulation

- **Heart Chambers**

- The hearts of **most amphibians have three chambers**: two atria and one ventricle.

- 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. There is some mixing of oxygen-rich and oxygen-poor blood in the ventricle.

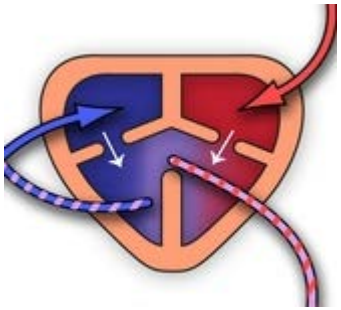


Circulation

- **Heart Chambers**

- **Most reptiles have a three-chambered heart**, some have four chambers.

- However, unlike amphibians, most reptiles have a partial partition in their ventricle. Because of this partition, there is even less mixing of oxygen-rich and oxygen-poor blood than there is in amphibian hearts.

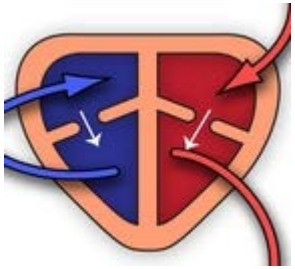


Circulation

- **Heart Chambers**

- **Birds, mammals, and crocodilians have hearts that are completely partitioned into four chambers**.

- One pump moves blood through the lung loop and the other moves blood through the body loop. The two loops of the circulatory system are completely separated. There is no mixing of oxygen-rich and oxygen-poor blood.



Excretion

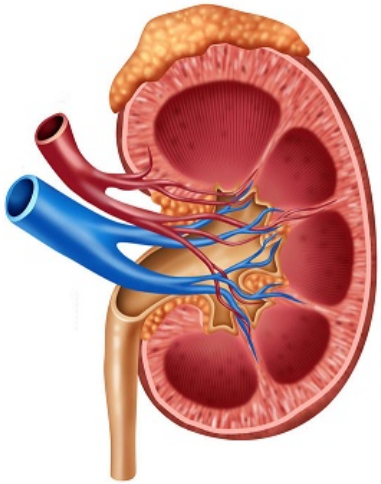
• Nitrogenous wastes—formed from the breakdown of proteins—are first produced in the form of **ammonia**.

• **Ammonia is a highly toxic compound** that must quickly be eliminated from the body or changed into a less poisonous form.

• In tunicates, ammonia leaves the body through the outflow siphons. Other waste byproducts, such as uric acid, are stored within the tunicate's body and released only when the animal dies.

•Aquatic amphibians and most fishes also excrete ammonia directly from the gills into the surrounding water through simple diffusion.

Excretion



- **In mammals, land amphibians, and cartilaginous fishes, ammonia is changed into urea, a less-toxic compound**, before it is excreted.

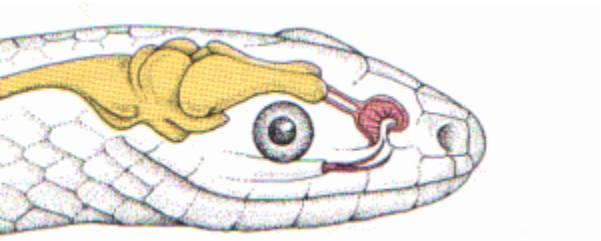
- **In most reptiles and birds, ammonia is changed into uric acid.**

- Besides filtering wastes, vertebrate kidneys help maintain homeostasis by regulating the amounts of water, salt, and other substances dissolved in body fluids.

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.



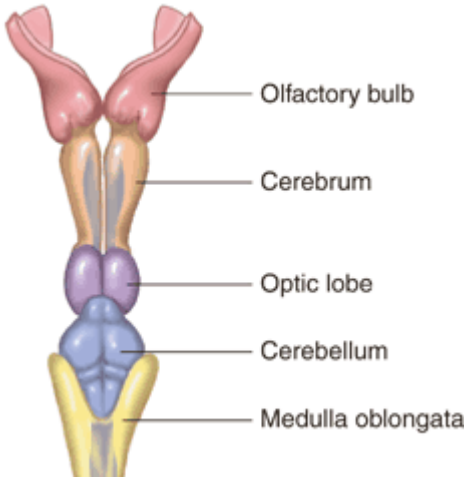
Response

- Tunicates have sensory cells in and on the siphons and other internal surfaces may help control the amount of water passing through the pharynx.

- Lancelets—which have a more defined head region—have a small, hollow brain with a pair of eyespots that detect light.

Response

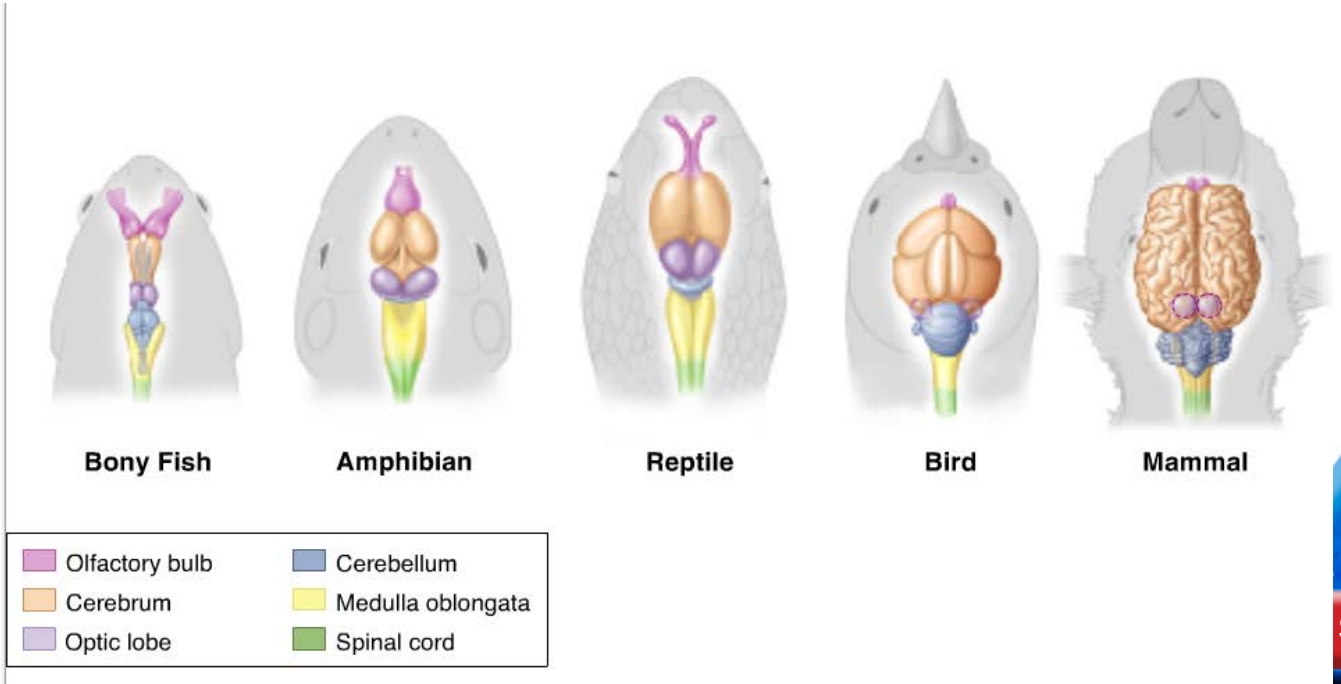
• Vertebrates head contains a well-developed brain, which is situated on the anterior end of the spinal cord. The vertebrate brain is divided into several parts, including:



The medulla oblongata controls the functioning of many internal organs. The optic lobes are involved in vision and the olfactory bulbs are involved in the sense of smell.

Response

- In **fishes, amphibians, and reptiles**, the cerebrum is relatively small.
- In **birds and mammals**, especially primates, the cerebrum is greatly enlarged and may contain folds that increase its surface area. The cerebellum, which coordinates movement and controls balance, is also most developed in birds and mammals.



Movement

- Unlike most other chordates, nonvertebrate chordates lack bones. They do, however, have muscles.
- Lancelets and larval tunicates swim with a fishlike movement of their muscular tails.
- Some adult tunicates use their siphons to swim by jet propulsion.
- However, most adult tunicates lose their tails and attach to a hard surface on the ocean floor for life.

Movement

- The skeletal and muscular systems **support** a vertebrate's body and make it possible to control **movement**.
- With the exception of hagfishes, all vertebrates have an internal skeleton of bone or, in the case of certain fishes, cartilage.

Movement

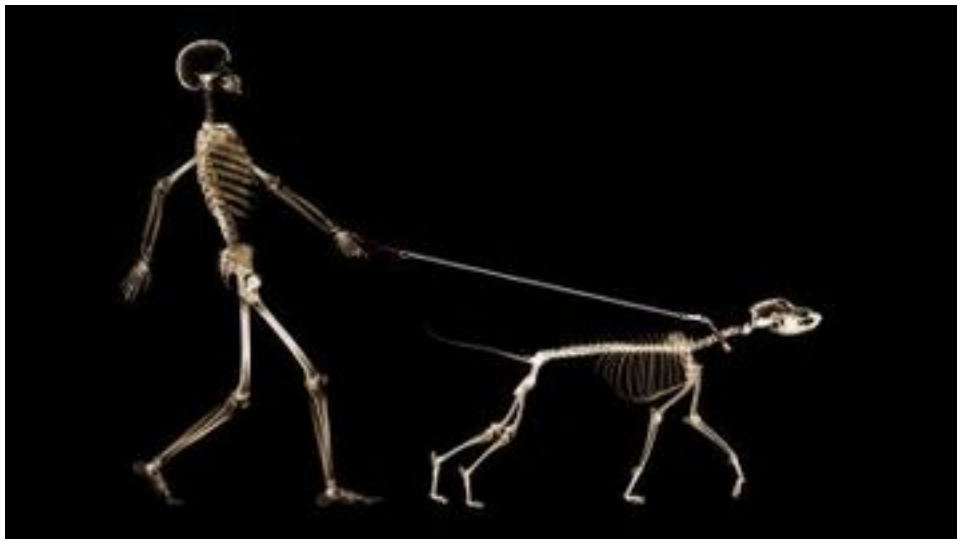
• In many fishes and snakes, the main body muscles are arranged in blocks on either side of the backbone.

•In many amphibians and reptiles, the limbs stick out sideways from the body.

Movement

• Most mammals stand with their legs straight under them, whether they walk on two legs or on four.

•In this position, the legs can support the body weight efficiently.



Reproduction

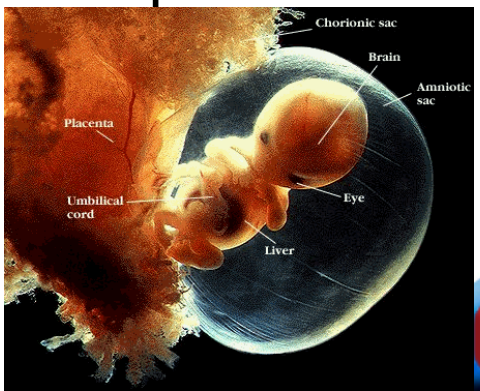
- Almost all chordates reproduce **sexually**.
- The **eggs** of most nonvertebrate chordates—and many fishes and amphibians—are **fertilized externally**.
- The **eggs** of reptiles, birds, and mammals are **fertilized internally.**

Reproduction

- In **oviparous** species, which include most fishes and amphibians and all birds, the eggs develop outside the mother's body.

- In **ovoviviparous** animals, such as sharks, the eggs develop within the mother's body and the embryos receive nutrients from the yolk in the egg. The young of ovoviviparous species are born alive.

- The developing embryos of **viviparous** species—including most mammals, some sharks—obtain nutrients directly from the mother's body. The young of viviparous species are born alive.



Reproduction

- Some vertebrates, such as most amphibians, produce many offspring but give them little or no care.
    - This reproductive strategy is successful in circumstances favoring populations that disperse and grow rapidly.
- Mammals and birds, in contrast, usually care for their young but produce few of them.
    - This helps young survive in crowded, competitive environments