

# Derived Characters of Vertebrates

- **Vertebrates** have the following derived characters:
  - Vertebrae enclosing a spinal cord
  - An elaborate skull
  - Fin rays, in the aquatic forms.

# Gnathostomes are vertebrates that have jaws

- **Gnathostomes** include sharks and their relatives, ray-finned fishes, lobe-finned fishes, amphibians, reptiles, birds, and mammals.

## Derived Characters of Gnathostomes

- **Genome duplication**, including duplication of *Hox* genes.
- An enlarged forebrain associated with enhanced smell and vision.
- In aquatic gnathostomes, the **lateral line system**, which is sensitive to vibrations

- During the mid-Devonian, these organisms adapted to life on land and gave rise to vertebrates with limbs and feet, **called tetrapods—a lineage that includes humans.**

# Derived Characters of Tetrapods

- Tetrapods are gnathostomes that have limbs.
- **Tetrapods** have some specific adaptations:
  - 4 limbs, and feet with digits
  - A neck, which allows separate movement of the head
  - Fusion of the pelvic girdle to the backbone
  - The absence of gills (except some aquatic species)
  - Ears for detecting airborne sounds

# Amphibia

- *Amphibian* means “both ways of life,” referring to the metamorphosis of an aquatic larva into a terrestrial adult.
- **Amphibians** are represented by about 6000 species of organisms in 3 orders.
- Most amphibians have a moist skin that complements the lungs in gas exchange.
- Fertilization is external in most species, and the eggs require a moist environment. **Amphibian eggs lack a shell and dehydrate quickly in dry air.**
- Many species hibernate in winter.

# Amniotes are tetrapods that have a terrestrially adapted egg

- **Amniotes** are a group of tetrapods whose living members are the reptiles (including birds), and mammals.
- Amniotes are named for the major derived character of the clade, the ***amniotic egg***, which contains membranes that protect the embryo; **An adaptation for reproduction on dry land.**
- Amniotes have other terrestrial adaptations, such as **relatively impermeable skin** and the ability to use the **rib cage** to ventilate the lungs.



# Reptiles

The **reptile** clade includes the tuataras, lizards, snakes, turtles, crocodilians, birds, and the extinct dinosaurs.

Unlike amphibians, reptiles have **scales** (that contain the protein keratin) which create a **waterproof barrier**.

Most reptiles are **ectothermic**, absorbing external heat as the main source of body heat.

- Birds are **endothermic**, capable of keeping the body warm through metabolism. Unlike amphibians, reptiles **do not have an aquatic larval stage**.

## Aves: Birds - reptilian anatomy modified for Flight

Aves (birds) are - feathered, winged, bipedal, warm-blooded, egg-laying, vertebrate animals. They share evolutionary origins with the reptiles. The taxon was treated as equal to fish, amphibia, reptiles and mammals, but in order to make classifications reflect evolutionary history, they are now regarded under the group: Reptilia.

There are about 10,000 species of birds in the world. Like crocodilians, birds are **archosaurs**, but almost every feature of their anatomy has been modified in their **adaptation to flight**.

A bird's most obvious adaptations for flight are its wings and feathers. Feathers are made of the protein  $\beta$ -keratin, **which is also found in the scales of other reptiles**.



## Derived Characters of Birds:

Many characters of birds are adaptations that facilitate flight:

- wings with keratin feathers
- lack of a urinary bladder
- small gonads, females with only one ovary
- loss of teeth.

(**weight loss**)

# Mammalia

- Mammals are a clade of endothermic amniotes distinguished from reptiles and birds by the possession of a **neocortex** (a region of the brain; sight and hearing), **hair, middle ear bones** and **mammary glands**.

- Mammals include the largest animals on the planet, the great blue whales, as well as some of the most intelligent, such as elephants, primates and cetaceans.
- The basic body type is a terrestrial **quadruped**, but some mammals are adapted for life at sea, in the air, in trees, underground or on two legs (**bipedalism**).
- Mammals, are represented by more than 5,300 species.

# Derived Characters of Mammals

- ***Mammals have***

- *Mammary glands, which produce milk*
- *Hair*
- *A larger brain than other vertebrates of equivalent size*
- *Differentiated teeth.*

- By the early Cretaceous, the three living lineages of mammals emerged: **monotremes, marsupials, and eutherians.**



**Monotremes** are found only in Australia and New Guinea and are represented by 1 species of platypus and 4 species of echidnas.

**Monotremes lay eggs.**

Like all mammals, monotremes have hair and produce milk, but they **lack nipples.**

Milk is secreted by glands on the belly of the mother.

After hatching, the baby sucks the milk from the mother's fur.

# Marsupials

- Opossums, kangaroos, and koalas are examples of the group called **marsupials**.
- They have higher metabolic rates and **nipples that provide milk**, and **they give birth to live young**.
- The embryo develops inside the uterus of the female's reproductive tract. The lining of the uterus and the extraembryonic membranes that arise from the embryo form a **placenta**, a structure in which nutrients diffuse into the embryo from the mother's blood.

- A marsupial is born **very early** in its development and completes its embryonic development while nursing. In most species, the nursing young are held within a maternal pouch called a ***marsupium***.

# Eutherians - Placental Mammals

- Compared with marsupials, ***eutherians = placental mammals*** have a longer period of pregnancy. Their placenta is more complex than those of marsupials.
- **Young eutherians complete their embryonic development within the uterus**, connected to their mother by the **placenta**. The eutherian placenta, provides an intimate and long-lasting association between the mother and her developing young.