

Chordate Animals

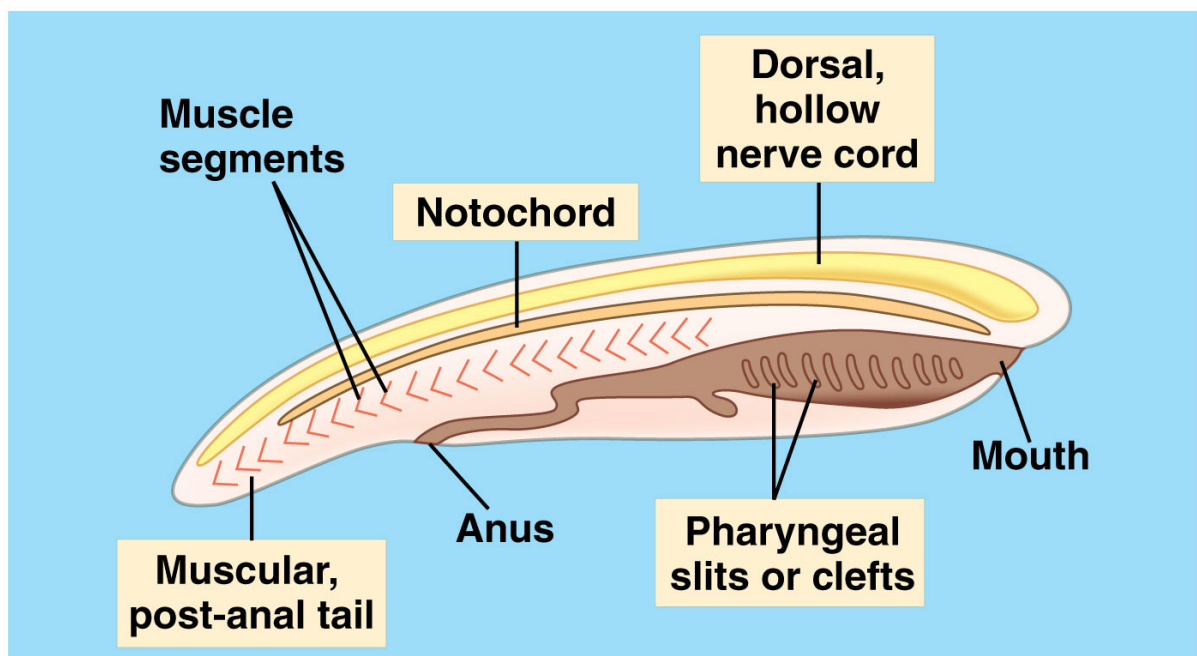
Objectives:

- Be able to identify the four traits shared by chordates: **notochord, dorsal hollow nerve cord, pharyngeal gill slits/pouches, post-anal tail.**
- Be able to map the following traits on a phylogeny of the chordates: **Notochord, head (cranium), vertebral column, jaws, lungs, lobed fins, limbs with digits, amniotic egg, and milk.**
- Be able to identify to which of the major taxonomic groups an animal belongs, among the **taxa** featured in this lab.
- Be able to describe important features of the animal taxa covered in this lab.

For any given chordate you should be able to identify to which major clade or taxon it belongs. You should also be able to describe important features of these animals.

Chordate characteristics

The figure below illustrates the 4 traits that chordates have in common: **notochord, dorsal hollow nerve cord, pharyngeal gill slits, and a post-anal tail.** They do not necessarily possess all of these traits at all stages of their life cycle, but all chordates have these four traits at some point during their life cycle.



Phylum Hemichordata (acorn worms and pterobranchs)

The Hemichordata are a small phylum that shares certain characteristics with the Chordata. Acorn worms have pharyngeal gill slits, and all Hemichordata have a dorsal, hollow nerve chord. Structures exist that may be homologous to the notochord, but these homologies are disputed.

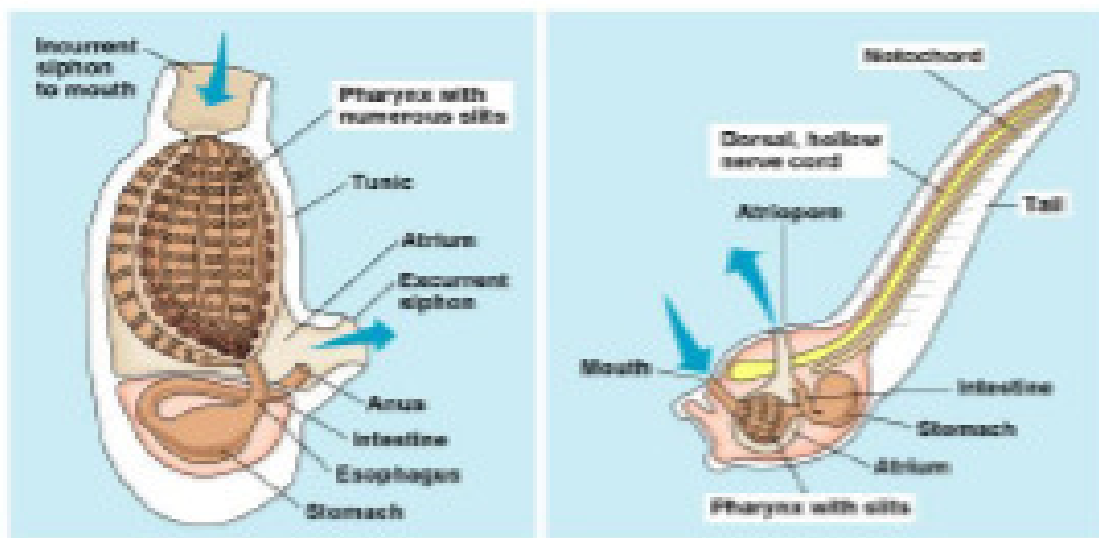
The Hemichordata are now usually treated as a separate phylum closely related to the Chordata and to the Echinodermata. (Larval acorn worms and larval echinoderms are remarkably similar!) All Hemichordata are filter-feeders. In addition to the free-living acorn worms, the Hemichordata include the tube-building Pterobranchs, as well as an extinct group called Graptolites. Both pterobranchs and graptolites feed using feathery ciliated tentacles that resemble a lophophore. The acorn worms pass currents of water through their gill slits and use their gills as a feeding apparatus.

Examine and draw a preserved specimen of an acorn worm. Label the **gill slits** and the muscular **proboscis** used in burrowing.

Phylum Chordata

Subphylum Urochordata (tunicates or sea squirts)

Adult tunicates are sessile (attached) organisms that pump water through a seive-like gill basket with hundreds of gill slits. They filter feed by straining tiny food particles out of the water using this gill basket. Their actively swimming larval stage has a notochord, a dorsal hollow nerve chord, a series of segmentally organized swimming muscles, and a strong post-anal tail, but these larval features are lost or greatly diminished in the adult. Observe and draw an adult tunicate. Also, examine a slide of a larval tunicate if one is available.



(a)

(b)

Subphylum Cephalochordata (sea lancets)

Sea lancets such as *Amphioxus* are active swimmers that filter feed by passing water through their many gill slits and straining out tiny food particles. Their adult stages are in many ways comparable to a larval tunicate. Examine *Amphioxus* again and review these similarities.

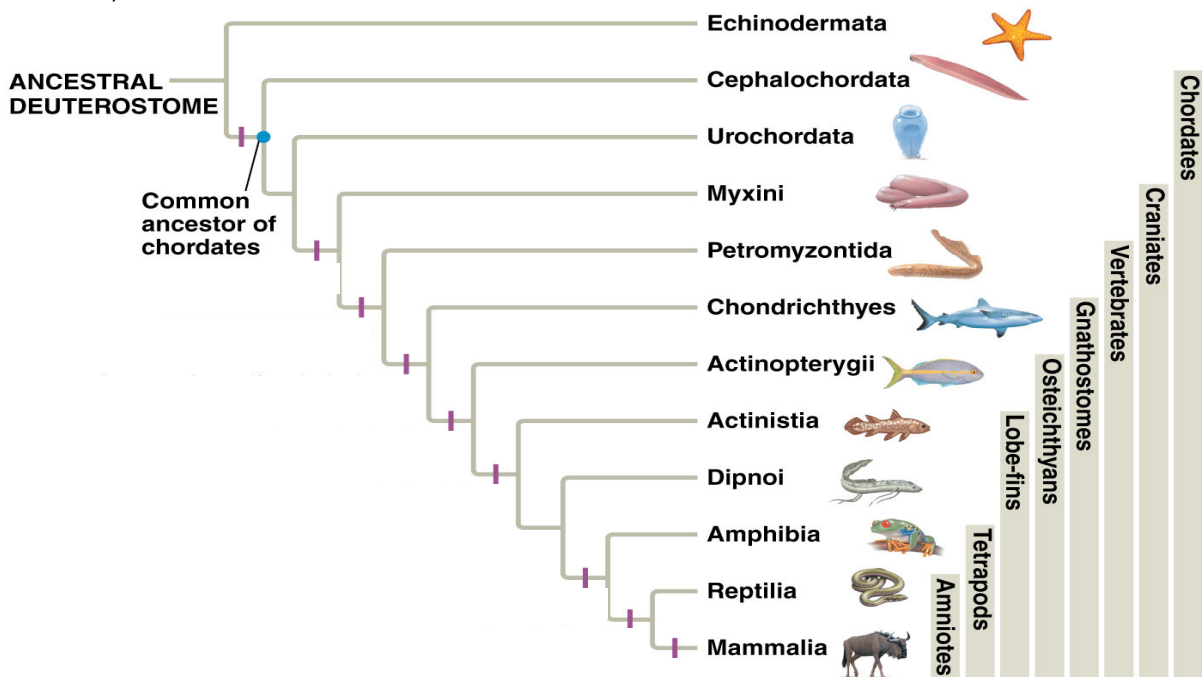
- **Observe *Amphioxus* (a Cephalochordate).** Draw *Amphioxus* on your own paper, and label the notochord, dorsal hollow nerve cord, pharyngeal gill slits, and post-anal tail.

Subphylum Vertebrata (vertebrates)

Vertebrates are Chordata in which the notochord is partly or fully replaced in the adult stages by a **vertebral column (backbone)**, consisting of a series of **vertebrae**. The vertebral column allows the axis of the body to bend sideways but not to shorten; this permits undulatory swimming movements by rhythmic contractions of muscles on one side, then the other, alternately. All fishes swim this way.

Chordate Phylogeny

In the following phylogeny label the following traits: **Lungs, Limbs with digits, vertebral column, Amniotic egg, Notochord, Jaws, Lobed fins, Milk, Head (cranium).**



Class Agnatha (jawless fishes)

The Agnatha are a paraphyletic group that contains the hagfishes (Myxini), lampreys (Petromyzontida), and several extinct groups. Examine preserved specimens of both lampreys and hagfish, locating the mouth and gill slits in each case. Examine the round mouth of the adult lamprey, with its embedded teeth.

Class Placodermi (extinct, armored fishes with jaws)

The placoderms were the first **Gnathostomes** (fishes with jaws). They varied in size from a few inches long to terrifying creatures up to 30 feet (10 meters).

Class Chondrichthyes (cartilaginous fishes, including sharks, skates, and rays)

The Chondrichthyes have a skeleton made entirely of cartilage. Their skin contains thousands of small, embedded **placoid scales**. Most Chondrichthyes are predators. Their gill slits are externally visible, and they have no lungs or lung homologues.

Class Osteichthyes (bony fishes with jaws)

The Osteichthyes, or bony fishes, include the vast majority of fish species alive today. Their sizes, shapes, and lifestyles vary greatly, but they all share two important traits:

- a body flap (**operculum**) covering and protecting the external gill slits, and
- a **lung** or similar gas-filled, sac-like structure. In various primitive fishes, and in modern lungfish, these sacs function as lungs, but, in a majority of bony fishes, they have been converted into a **swim bladder**, filled with gas, that helps control the depth at which the fish swims.

The Osteichthyes are subdivided into two groups:

- **Subclass Actinopterygii** (bony fishes with flat fins supported by bony rays). This group includes the majority of fishes alive today.
- **Subclass Sarcopterygii** (bony fishes with thick, lobe-like fins that include strong muscles). This group may be further subdivided into the **Actinistia** (or Crossopterygii) and **Dipnoi** (lungfishes).

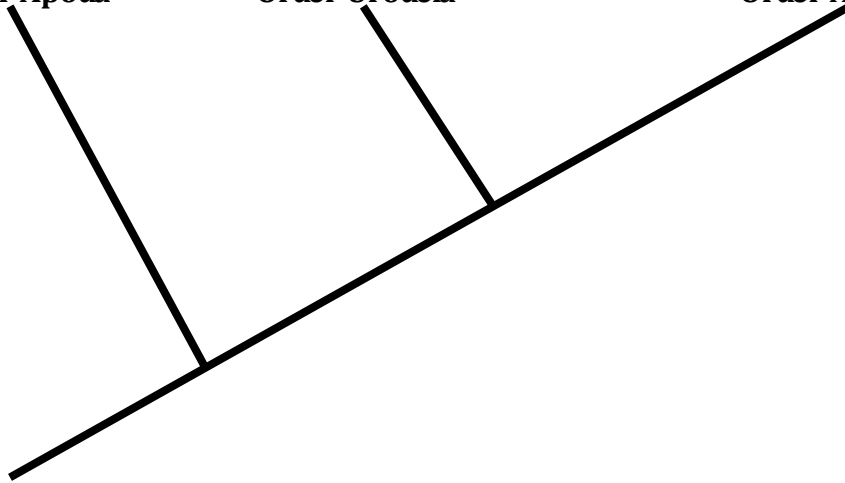
The Tetrapod Move onto Land

When Tetrapods made the move onto land, they faced many of the same challenges that plants had when they made the big leap onto land.

- **What were some of these challenges?**
- **What adaptations permitted the transition from water to land?**
- **In what way are amphibians still to aquatic habitats?**
- **Why is the amniotic egg considered a key innovation?**

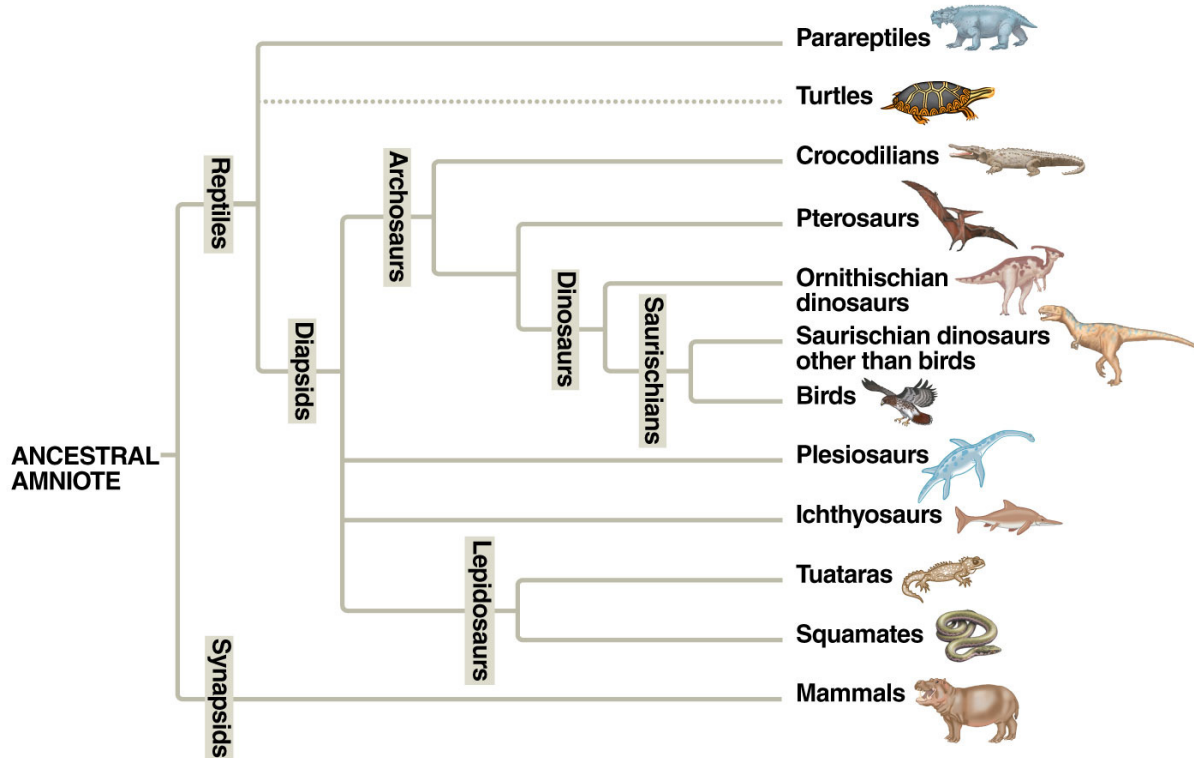
Class Amphibia:

The Amphibia are vertebrates with aquatic, gill-breathing larvae that undergo metamorphosis into lung-breathing adults. What adaptation do amphibians lack, that requires them to stay near a body of water? The posture of amphibian limbs is sprawling, with the body resting on its ventral surface when not in motion; this posture is best seen in salamanders (**Urodela** or **Caudata**). In addition to salamanders, modern amphibians include two other groups: the legless caecilians (**Apoda**) and the frogs and toads (**Anura**). The class Amphibia also includes a number of extinct groups that flourished in the Devonian through Triassic periods.

**Order Apoda****Order Urodela****Order Anura**

Amniotes:

On the phylogenetic tree shown here, please note that **Birds** are also called **Aves**. The **Saurischians** can be subdivided into **Sauropodomorpha** (long-necked herbivores) and **Theropoda** (predators like *T. rex*); **Aves** belong within the **Theropoda**.



Class Reptilia:

Reptiles are amniotes that are in most cases covered in epidermal scales and cold-blooded (body temperature variable, usually closely following the temperature of the environment). Among the reptiles are the following groups:

- **Testudines** (turtles and tortoises)
- **Plesiosauria** (extinct marine reptiles with paddle-like limbs)
- **Ichthyosauria** (extinct marine reptiles with fishlike body shapes)
- **Sphenodontia** (the tuatara of New Zealand, and its ancient relatives)
- **Squamata** (lizards and snakes, the largest living group)
- **Crocodylia** (alligators and crocodiles)
- **Pterosauria** (extinct flying reptiles)
- **Ornithischia** (dinosaurs with a "birdlike" hip)
- **Saurischia** (dinosaurs with a "lizardlike" hip, including the ancestors of birds)

Reptiles were once a very diverse group, especially during the Mesozoic Era, but only a few reptile groups survive today.

Below is a family tree of **dinosaurs**, including the orders Ornithischia and Saurischia. We have many models on display in lab, and even more out in the hall. Notice that the group shown here is monophyletic and includes the birds. If the birds were excluded, the group would be paraphyletic. If we added various other large extinct reptiles (such as ichthyosaurs, plesiosaurs, and ancient crocodiles), such a group would be polyphyletic.



Birds:

Birds are warm-blooded vertebrates covered in feathers, and most of them fly. They were traditionally recognized as **Class Aves**, but, since they evolved from a group of saurischian dinosaurs, a growing number of zoologists now place them within the Class Reptilia. Examine several birds and notice their adaptations for flying.

Class Mammalia:

Mammals are warm-blooded vertebrates with a fully divided (four-chambered) heart that nourish their young with milk. Living mammals can be divided into a few egg-laying species (the **Monotremes**, including the platypus and echidna), the pouched mammals (**Marsupials**, including opossums, kangaroos, koalas, and others), and the placental mammals (**Eutheria**).

Placental mammals (Eutheria)

The vast majority of mammals are placental mammals in which the young develop inside the mother's uterus and are born alive. While in the uterus, the young are nourished through a

placenta, an intimate connection of maternal and fetal blood vessels. Placental mammals include the following orders:

- **Leptictida**, an extinct group thought to be ancestral to all the rest
- **Lipotyphla (or Insectivora)**, including moles, shrews, hedgehogs, etc.
- **Chrysochlorida**, the golden moles of South Africa
- **Dermoptera**, the colugo or "flying lemur"
- **Chiroptera**, the bats
- **Scandentia**, the tree shrews
- **Primates**, the tarsiers, lemurs, monkeys, apes, and humans
- **Rodentia**, the gnawing mammals (squirrels, porcupines, beavers, rats, mice, and others; the largest and most diverse of all mammalian orders)
- **Lagomorpha**, the rabbits
- **Carnivora**, the dogs, cats, bears, racoons, weasels, hyenas, civets, etc.
- **Pinnipedia**, the seals, sea lions, and walruses
- **Pholidota**, the pangolins
- **Tubulidentata**, the armadillos
- **Cetacea**, the whales (including porpoises and dolphins)
- **Artiodactyla**, the even-toes hoofed mammals (pigs, hippos, camels, giraffes, deer, goats, sheep, cattle, antelopes, gazelles, etc.)
- **Perissodactyla**, the odd-toed hoofed mammals (rhinoceroses, tapirs, horses)
- **Hyracoidea**, the hyraxes
- **Proboscidea**, the elephants, mammoths, and mastodonts
- **Sirenia**, the manatees and dugongs
- **an additional two dozen orders that are extinct**