

1. Phylum Hemichordata

Phylum Hemichordata is a small group of marine invertebrates that share certain features with both **echinoderms** and **chordates** (the phylum that includes vertebrates). The name **Hemichordata** comes from the Greek words *hemi* (half) and *chordate*, referring to the presence of a structure resembling a **notochord** (a key feature of chordates) in some species.

Key Characteristics of Hemichordata:

1. Body Structure:

- Hemichordates have a **tripartite body** (divided into three sections): the **proboscis**, **collar**, and **trunk**.
- The **proboscis** is an anterior extension that is used for feeding and locomotion.
- The **collar** surrounds the mouth and contains various sensory and feeding structures.
- The **trunk** is the posterior portion of the body, which houses most of the digestive and reproductive organs.

2. Presence of a Notochord-like Structure:

- Hemichordates have a structure called the **notochord-like cord** or **stomochord**, which is located in the proboscis. This structure is similar to the notochord of chordates but is not homologous (i.e., it is not directly related to the chordate notochord). The stomochord is thought to help in feeding and possibly play a role in the animal's stability.

3. Nerve Cord:

- Like chordates, hemichordates have a **dorsal nerve cord**, although it is not as well developed as the nerve cord in true chordates. This nerve cord runs along the length of the body and is involved in coordinating movement and responses to environmental stimuli.

4. Gill Slits:

- Hemichordates possess **pharyngeal gill slits** (also called **branchial slits**) that are a key characteristic of chordates. These slits are used for filter feeding and respiration.
- The presence of gill slits is a shared feature between hemichordates and chordates, making them important for understanding the evolutionary relationships between these groups.

5. Open Circulatory System:

- Hemichordates have an open circulatory system, which means their blood (or coelomic fluid) is not confined to blood vessels but flows freely within the body cavity (coelom).

6. Sexual Reproduction:

- Hemichordates typically reproduce sexually, with separate sexes in most species. Fertilization is external, and many species release their eggs and sperm into the surrounding water. Some species are hermaphroditic, meaning they have both male and female reproductive organs.

7. Marine Habitat:

- Hemichordates are exclusively marine organisms. They are found in a wide range of marine environments, including shallow coastal waters, muddy bottoms, and deep-sea habitats.

Major Classes of Hemichordata:

Hemichordata is divided into three main classes, which have different body structures and lifestyles:

1. Class Enteropneusta:

- **Enteropneusts** are commonly known as **acorn worms** due to the shape of their body. They are burrowing, worm-like animals that live in shallow marine environments. Acorn worms have a long, cylindrical body divided into three distinct regions: proboscis, collar, and trunk.
- **Examples:** *Balanoglossus* and *Saccoglossus* are common examples of acorn worms.

2. Class Pterobranchia:

- **Pterobranchs** are a smaller group of hemichordates that are colonial and live in tubes, unlike the solitary acorn worms. These organisms are typically found in deeper marine environments.
- Pterobranchs have a body that is divided into three regions similar to the acorn worms (proboscis, collar, and trunk), but they are more specialized for a sedentary, colonial lifestyle.
- **Examples:** *Rhabdopleura* and *Cephalodiscus* are examples of pterobranchs.

3. Class Planctosphaeroidea :

- This class contains extinct species of hemichordates that are known from fossil records. These creatures are thought to have been planktonic and were important for understanding early hemichordate evolution.

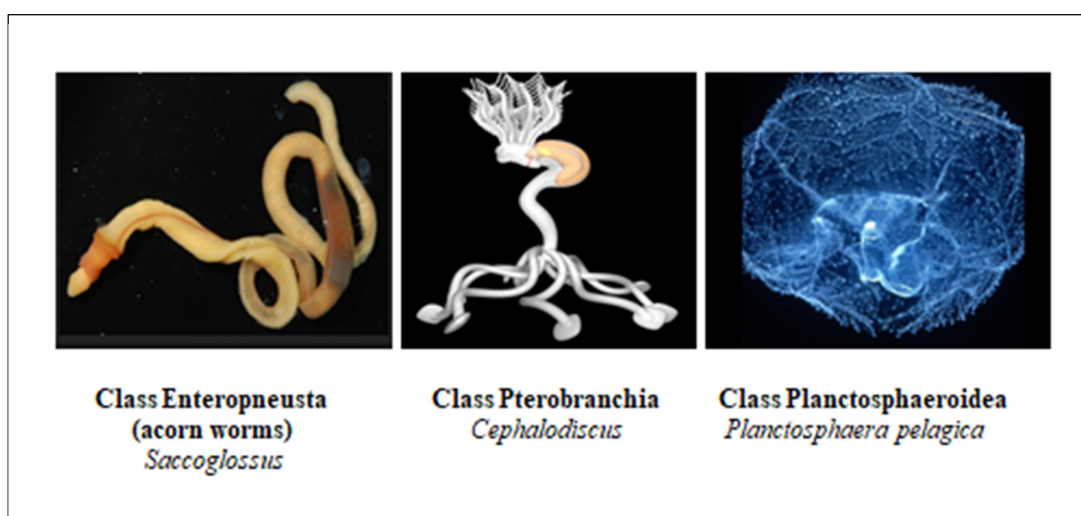


Figure 01: Major Classes of Hemichordata

2. Phylum Chordata

Phylum Chordata is one of the most important and diverse groups in the animal kingdom, encompassing species ranging from simple marine organisms like tunicates to the highly complex and diverse vertebrates, including humans. The members of this phylum share a set of defining characteristics, particularly during their embryonic development that set them apart from other animal phyla.

Key Characteristics of Chordates:

All members of Phylum Chordata share the following five key features at some point in their life cycle (though some may only exhibit these traits during early development):

1. Notochord:

- The **notochord** is a flexible, rod-like structure that provides support and serves as the primary skeletal structure during early development. In most vertebrates, the notochord is replaced by the vertebral column (spine), but it is retained in some invertebrate chordates like *lancelets* and *tunicates*.
- In vertebrates, the notochord plays a role in signaling during the development of the nervous system.

2. Dorsal Hollow Nerve Cord:

- The **dorsal nerve cord** is a tube-like structure located above (dorsal to) the notochord. It develops into the central nervous system: the brain and spinal cord in vertebrates.
- This nerve cord is hollow, unlike the solid ventral nerve cords found in many invertebrates.

3. Pharyngeal Slits (or Pouches):

- These are openings or slits in the pharynx (the region behind the mouth) that allow water to exit the body. In aquatic chordates, pharyngeal slits are often used for filter feeding or respiration (as gills).
- In vertebrates, these slits may be modified into structures such as gills (in fish) or parts of the ear and throat (in tetrapods, including humans).

4. Post-Anal Tail:

- The **post-anal tail** is an extension of the body that extends beyond the anus. It provides mobility and is present in many chordates during some stage of their life cycle. In many vertebrates, this tail is reduced or absent in the adult stage, but it remains a key feature in the embryos of species such as humans (e.g., the embryonic tail) and is more prominent in animals like fish and some amphibians.

5. Endostyle (or Thyroid Gland):

- The **endostyle** is a ciliated groove in the pharynx that secretes mucus and helps with filter feeding in primitive chordates like lancelets and tunicates. In vertebrates, the endostyle becomes the **thyroid gland**, an important endocrine gland that regulates metabolism and growth.

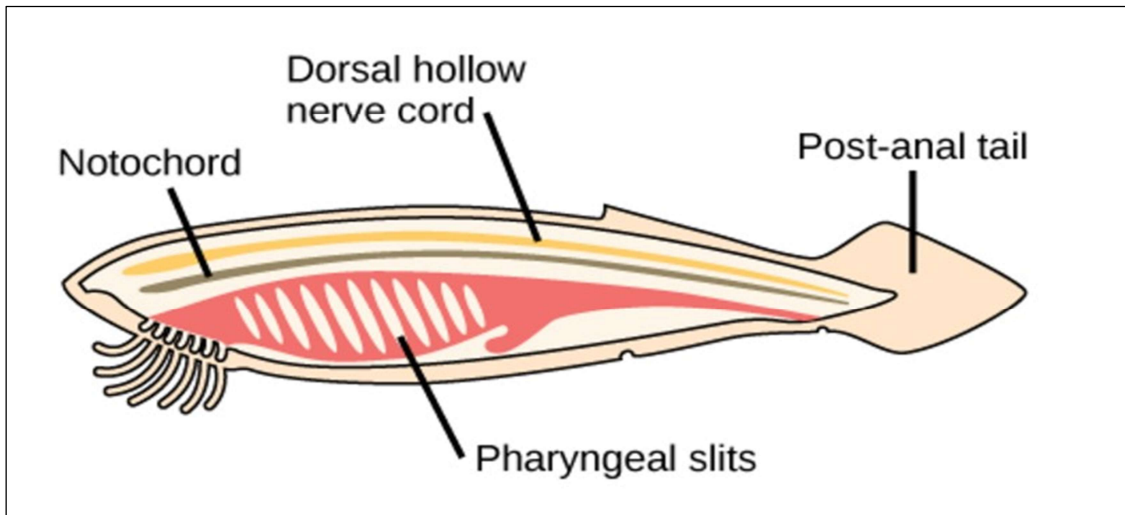


Figure 2: In chordates, four common features appear at some point during development: a notochord, a dorsal hollow nerve cord, pharyngeal slits, and a post-anal tail.

Major Subphyla of Chordata:

Chordata is divided into three subphyla: **Urochordata**, **Cephalochordata**, and **Vertebrata**. The subphyla represent key evolutionary divergences within the phylum.

1. Subphylum Urochordata (Tunicates or Sea Squirts):

- **Tunicates** (also known as **sea squirts**) are marine animals that are often found attached to rocks or other surfaces. They are typically sessile as adults, but their larvae are free-swimming and possess all the characteristic features of chordates (notochord, nerve cord, pharyngeal slits, post-anal tail).
- Adult tunicates retain the pharyngeal slits, which are used for filter feeding, but they lose the notochord, tail, and nerve cord.
- **Examples:** *Ciona*, *Clavelina*.

2. Subphylum Cephalochordata (Lancelets):

- **Lancelets** (or **amphioxus**) are small, fish-like organisms that live in shallow marine waters, typically buried in sand. Lancelets retain all the features of chordates throughout their entire life, including a notochord, dorsal nerve cord, pharyngeal slits, post-anal tail, and endostyle.

- They are important for studying the early evolution of chordates because they exhibit many of the basic features that were present in the common ancestor of all chordates.
- **Examples:** *Branchiostoma* (also called amphioxus).

3. **Subphylum Vertebrata (Vertebrates):**

- **Vertebrates** are the most complex and diverse group within the phylum Chordata. They are characterized by a **vertebral column** (or backbone) that replaces the notochord in adults. This is one of the defining features of vertebrates and provides structural support and protection for the spinal cord.
- Vertebrates also have a well-developed brain, a complex nervous system, a closed circulatory system, and an internal skeleton.
- Vertebrates include **fish, amphibians, reptiles, birds, and mammals**.

Major Classes of Vertebrates:

Within **Subphylum Vertebrata**, there are several classes, each representing a distinct evolutionary group:

1. **Class Agnatha (Jawless Fish):**

- Agnathans are primitive fish that lack jaws. They are characterized by their cylindrical bodies, and they have a cartilaginous skeleton.
- **Examples:** Lampreys (*Petromyzon*) and hagfish (*Myxine*).

2. **Class Chondrichthyes (Cartilaginous Fish):**

- Cartilaginous fish have a skeleton made of cartilage rather than bone. They have jaws, paired fins, and a well-developed nervous system.
- **Examples:** Sharks, rays, skates, and chimaeras.

3. **Class Osteichthyes (Bony Fish):**

- Bony fish are characterized by a bony skeleton, as opposed to the cartilage of sharks and rays. They have a wide range of adaptations for aquatic life, including gills for respiration and fins for locomotion.
- This class is divided into two subclasses: **Ray-finned fishes** (e.g., salmon, tuna) and **Lobed-finned fishes** (e.g., coelacanths, lungfish).

4. **Class Amphibia (Amphibians):**

- Amphibians are vertebrates that typically start their life cycle in water (as larvae with gills) and then move to land as adults (with lungs and legs). They

are ectothermic (cold-blooded) and often have moist skin that helps with respiration.

- **Examples:** Frogs, toads, salamanders, and caecilians.

5. Class Reptilia (Reptiles):

- Reptiles are ectothermic vertebrates that have scaly skin and lay eggs with leathery shells. Most reptiles have well-developed lungs and are adapted for life on land.
- **Examples:** Snakes, lizards, crocodiles, turtles, and dinosaurs (extinct).

6. Class Aves (Birds):

- Birds are endothermic (warm-blooded) vertebrates with feathers, beaks, and a high metabolic rate. Birds are adapted for flight, although some species are flightless.
- **Examples:** Eagles, sparrows, penguins, ostriches.

7. Class Mammalia (Mammals):

- Mammals are endothermic (warm-blooded) vertebrates that possess hair or fur and **mammary glands**, which produce milk to nourish their young. Mammals have a highly developed brain and specialized teeth for feeding.
- **Examples:** Humans, whales, dogs, cats, elephants, and bats.

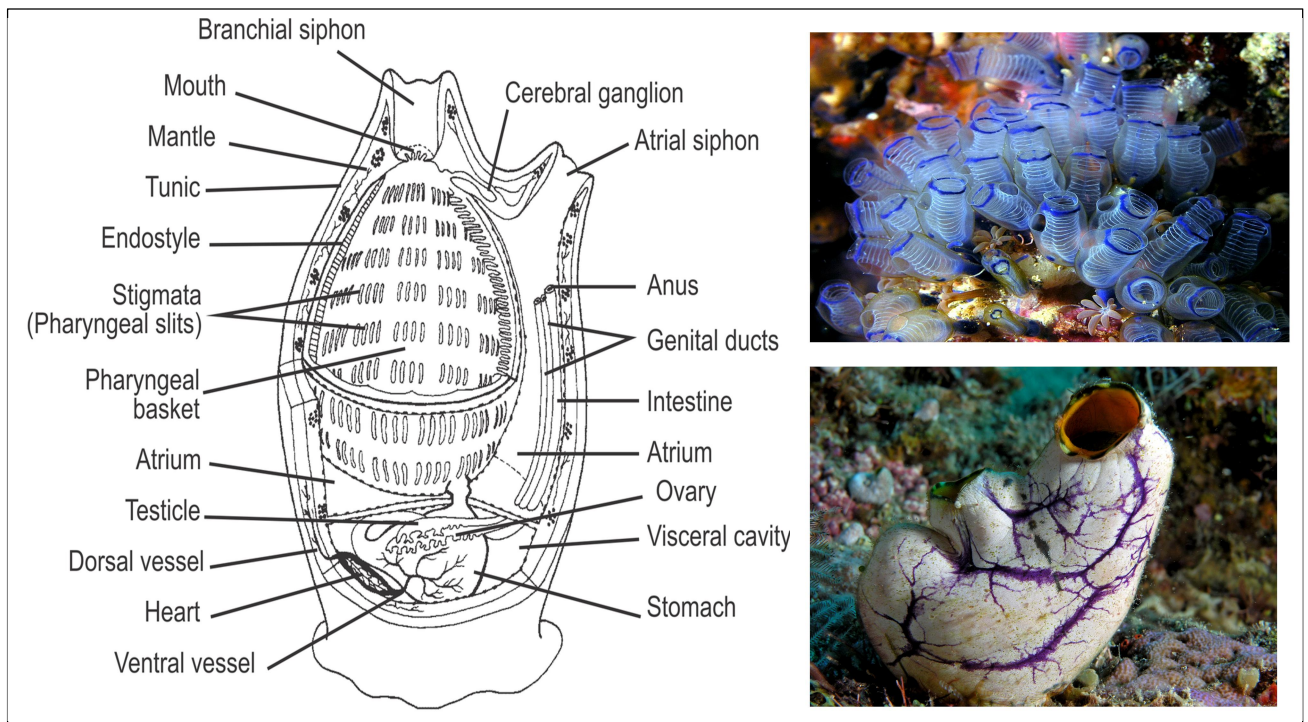


Figure 03: Subphylum Urochordata (Tunicates or Sea Squirts)

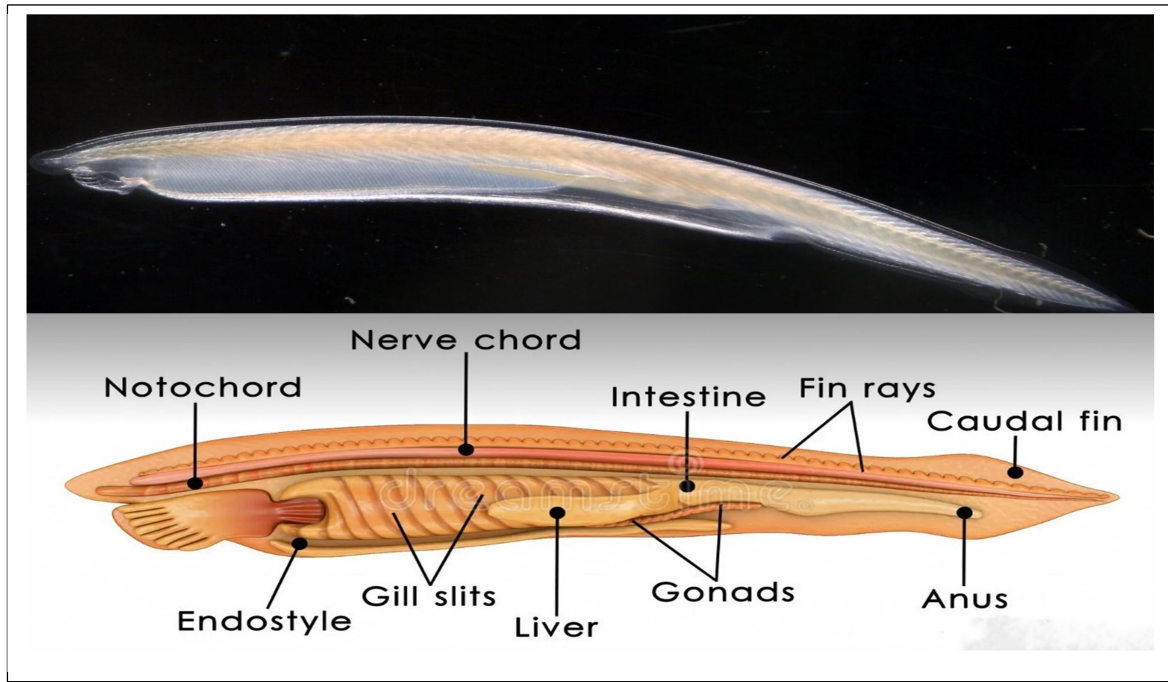


Figure 04: Subphylum Cephalochordata (Lancelets)

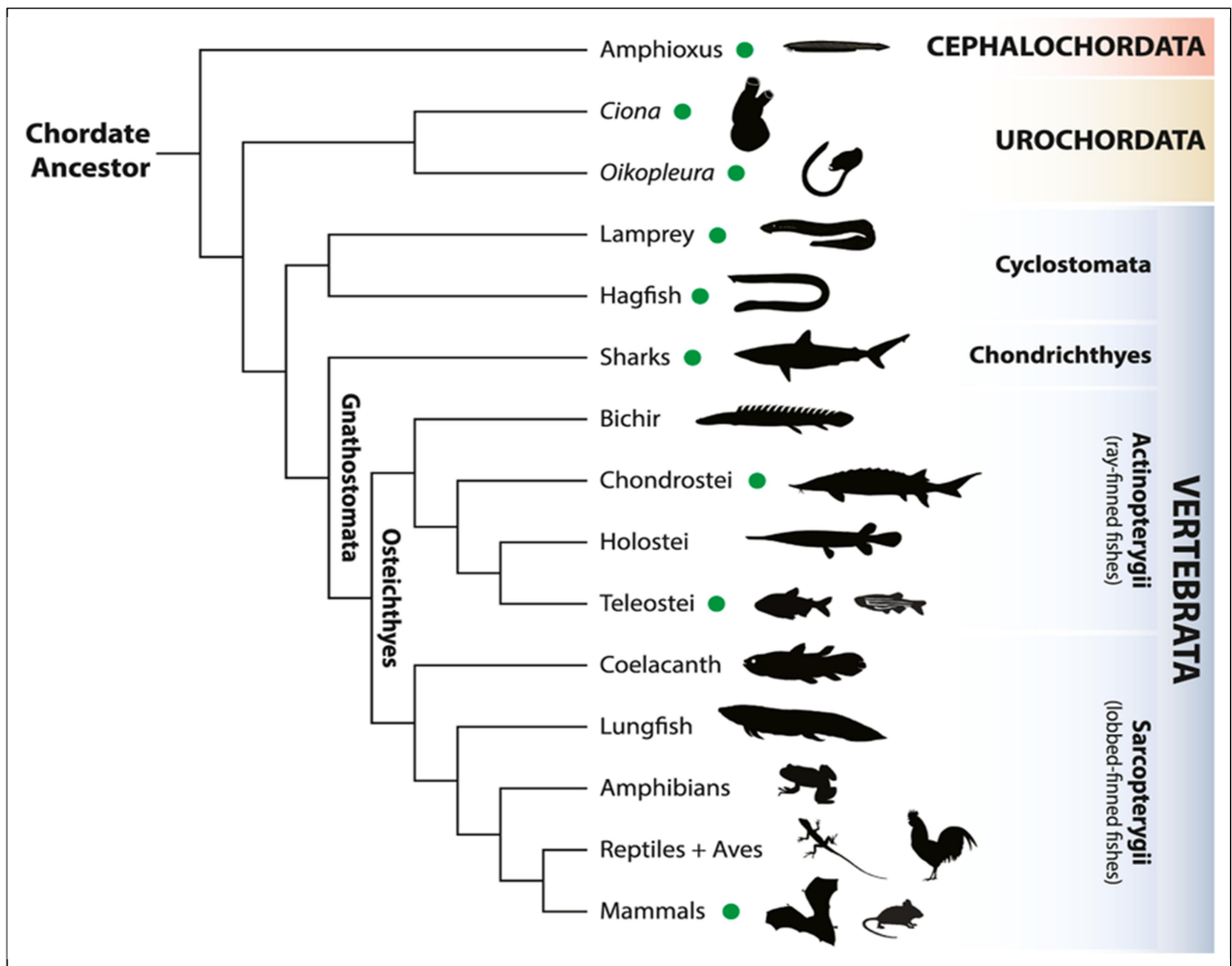


Figure 05: Simplified-phylogenetic-tree of cephalochordates; urochordates and vertebrates.