Chapter 34A:
The Origin & Evolution of Vertebrates I

1. Overview of the Chordates
2. Invertebrate Chordates
1. Overview of Chordates
Phylogeny of Chordates

ANCESTRAL DEUTEROSTOME

Common ancestor of chordates

Notochord

Vertebrates

Jaws, mineralized skeleton

Lungs or lung derivatives

Lobed fins

Limbs with digits

Amniotic egg

Milk

Vertebrates

Gnathostomes

Osteichthyes

Lobe-fins

Tetrapods

Amniotes
Derived Characters of Chordates

All chordates have the following derived characteristics at some point in their life cycle*:

- **NOTOCHORD**
- **PHARYNGEAL SLITS OR CLEFTS**
- **MUSCULAR POST-ANAL TAIL**

- **DORSAL HOLLOW NERVE CHORD**

*In many species these characters are only apparent during embryonic development.
The notochord is a longitudinal, flexible rod between the ventral digestive tube and the dorsal nerve cord.

- provides structural support throughout the length of the chordate body
- develops into some of the “backbone” structures in most adult vertebrates, thought remnants of the notochord may be retained
The nerve cord of chordate embryos develops from a plate of ectoderm that folds inward forming a **neural tube** dorsal to the notochord.

- the neural tube will develop into the central nervous system – the **brain** and **spinal cord**
Pharyngeal Slits or Clefts

In most chordates the pharyngeal slits open to the outside of the body and can have the following functions:

- filtering food from water in suspension feeders
- gas exchange in non-tetrapod vertebrates
- in tetrapod vertebrates develop into structure of the jaw, head & neck
Muscular Post-Anal Tail

All chordates have some sort of tail posterior to the anus:

• may be greatly reduced during embryonic development in some species (e.g., *Homo sapiens*)

• contains skeletal and muscle elements that may play a role in propulsion (aquatic species) or balance & support (terrestrial species)
2. Invertebrate Chordates
2 Groups of Invertebrate Chordates

In invertebrate chordates, the notochord is retained into adulthood to provide longitudinal support, thus there is no vertebral column or “backbone”.

There are two groups of invertebrate chordates:

CEPHALOCHORDDATA – the lancelets

UROCHORDDATA – the tunicates
Cephalochordata (Lancelets)

- The lancelets are basal chordates
- They are suspension feeders named for their blade-like shape

Cephalochordata
- Urochordata
- Myxini
- Petromyzontida
- Chondrichthyes
- Actinopterygii
- Actinistia
- Dipnoi
- Amphibia
- Reptilia
- Mammalia
Urochordata (Tunicates)

Tunicates are more closely related to vertebrate chordates than the lancelets.

- Tunicates draw water into an *incurrent siphon* and expel water through an *excurrent siphon*, filtering out food particles in the process.
- When threatened, they shoot water out the excurrent siphon, hence their common name – “sea squirts”.

![Phylogenetic tree](image-url)
Tunicate Structure

(a) A tunicate larva

(b) An adult tunicate

(c) An adult tunicate

- Notochord
- Dorsal, hollow nerve cord
- Tail
- Muscle segments
- Intestine
- Stomach
- Atrium
- Pharynx with slits
- Water flow
- Incurrent siphon
- Excurrent siphon
- Incurrent siphon to mouth
- Excurrent siphon
- Atrium
- Pharynx with numerous slits
- Tunic
The Hox genes responsible for the formation of the lancelet nerve cord (e.g., BF1, Otx & Hox3) also play a key role in the organization of the vertebrate central nervous system and are expressed in the same general pattern.

- Vertebrates have more Hox genes than lancelets and tunicates due to gene duplication and subsequent mutation.
- (i.e., paralogous genes)