

Vertebrate Biology – Lecture Notes



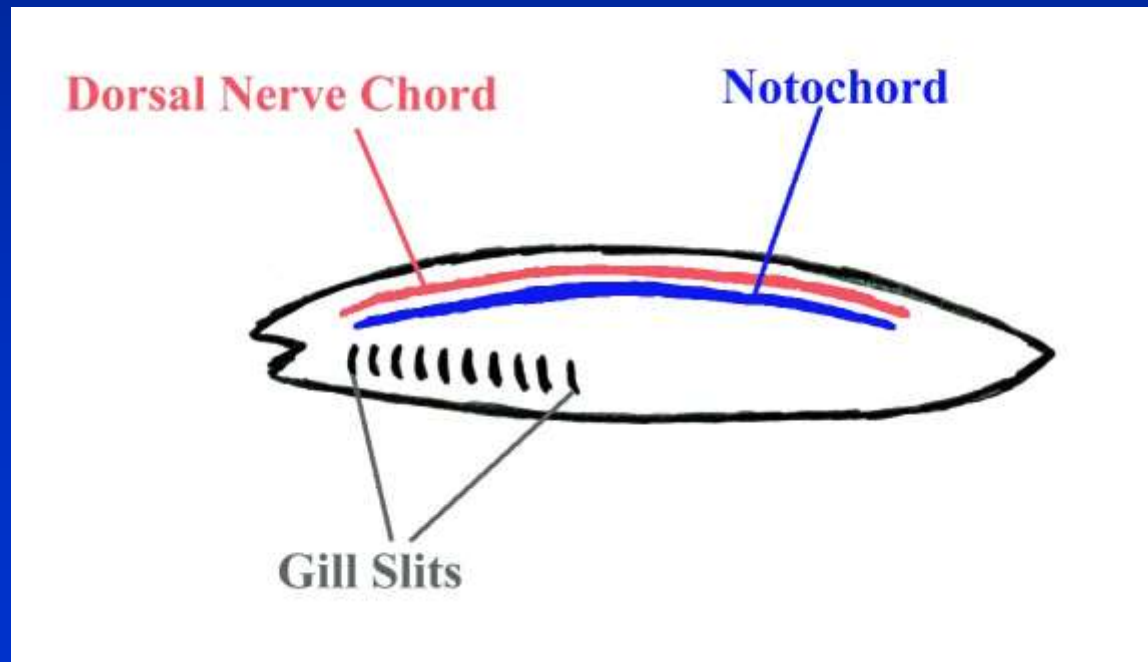


The Phylum Chordata

Vertebrates belong to the Phylum Chordata

- these are animals that, at one stage or another of their life cycle possess the following three characteristics:

1. Flexible, rod-like notochord representing the primitive axial skeleton
 - in most vertebrates, present only in embryos
2. Dorsal, hollow nerve chord
3. Pharyngeal gill slits or pouches
 - Also absent in many adult vertebrates, especially terrestrial ones.



Classification

Phylum Chordata

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graph TD; A[Phylum Chordata] --> B[Subphylum Urochordata]; A --> C[Subphylum Cephalochordata]; A --> D[Subphylum Vertebrata]; B --> E[tunicates]; C --> F[lancets]; D --> G[Agnathans]; D --> H[Fish]; D --> I[Sharks]; D --> J[tetrapods];
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**Subphylum
Urochordata**

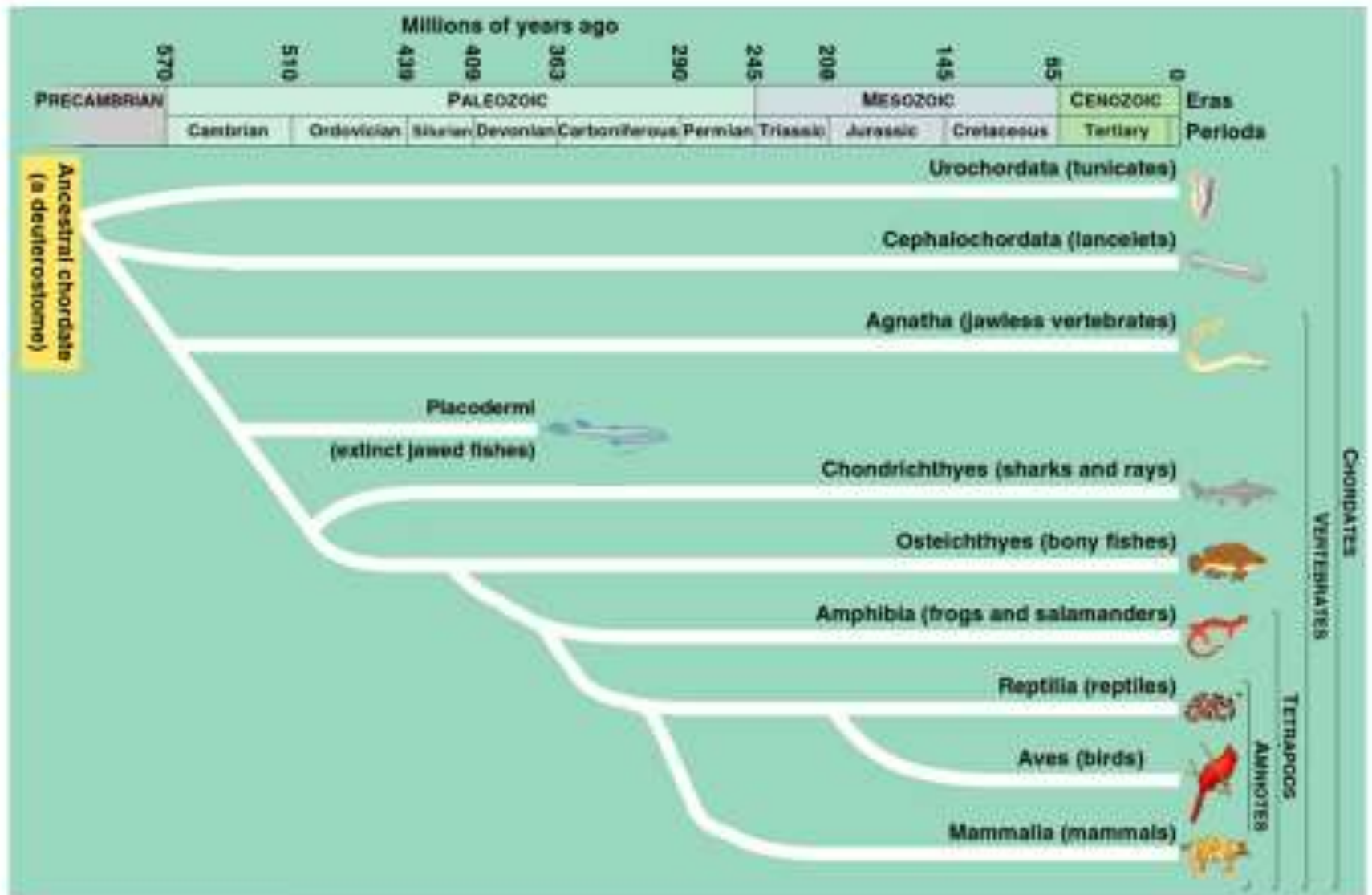
tunicates

**Subphylum
Cephalochordata**

lancets

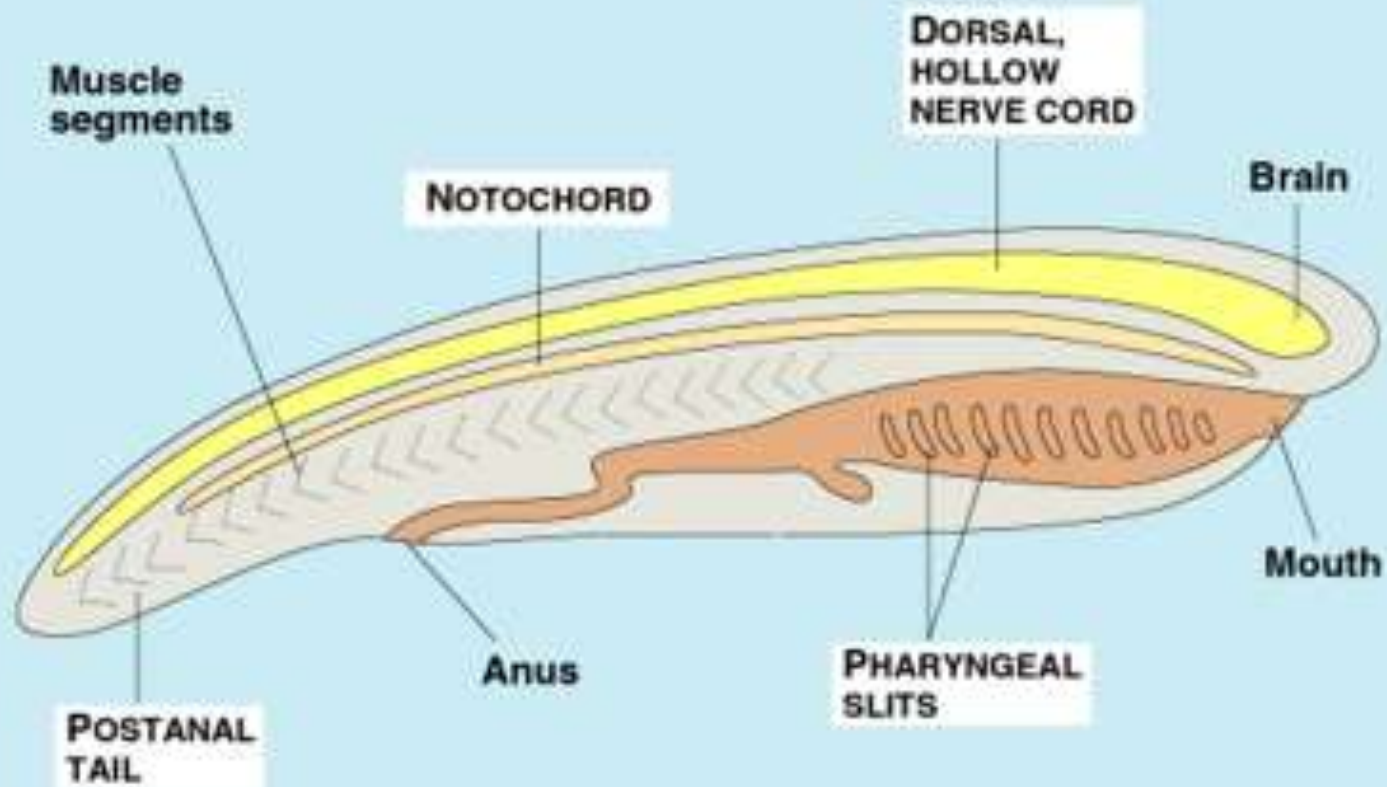
**Subphylum
Vertebrata**

Agnathans
Fish
Sharks
tetrapods



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Chordate Characteristics

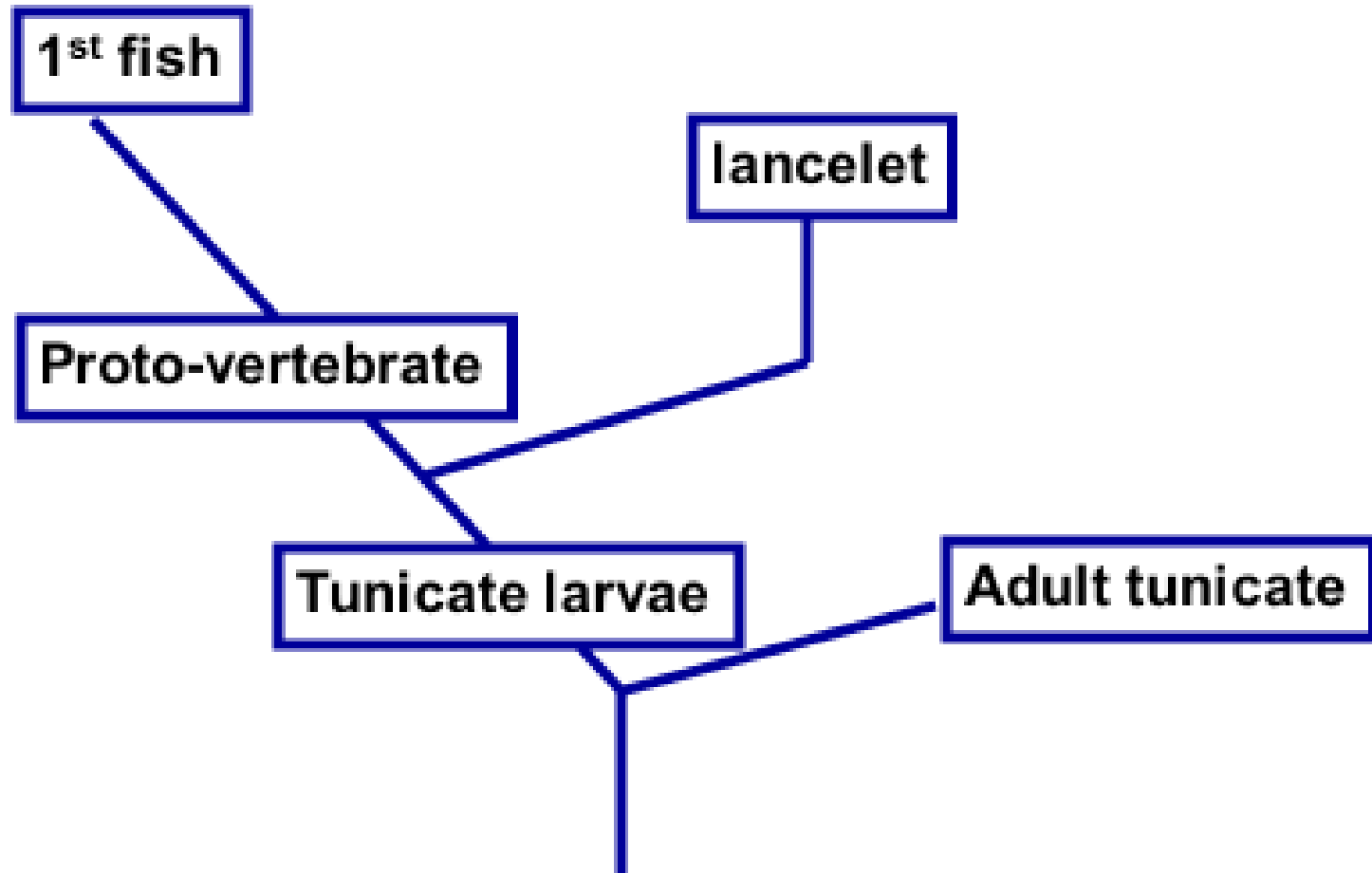


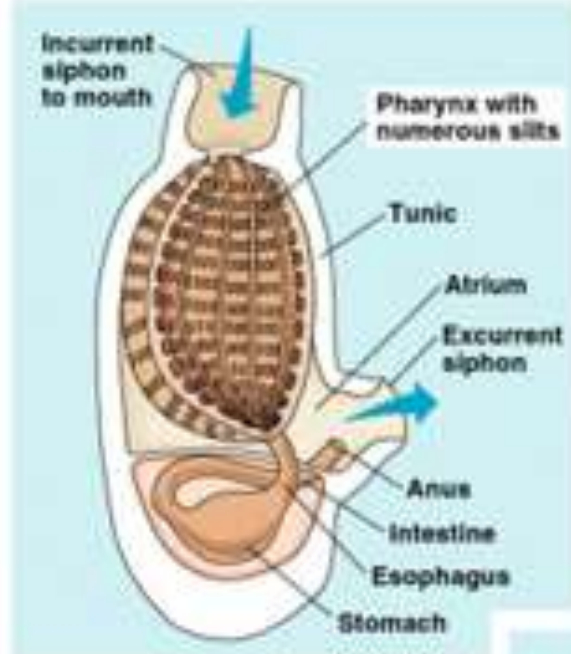
Burgess Shale Fauna (540 MYBP)



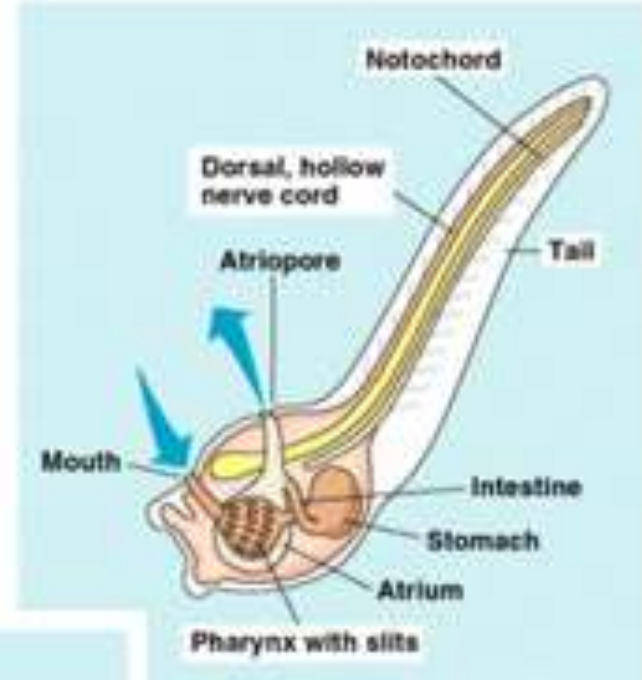
Pikaia- earliest known chordate

Possible evolution of 1st fish

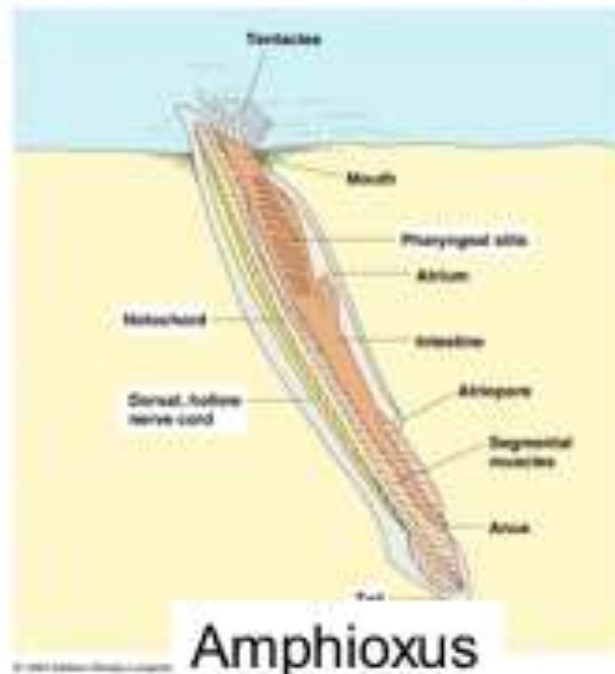




(b)
© 1998
Adult tunicate



Larval tunicate



Amphioxus

Geologic Time Scale Millions of Years

PHANEROZOIC	CENOZOIC	QUATERNARY		0	HOLOCENE
		TERTIARY	NEOGENE	1.65	PLEISTOCENE
					PLIOCENE
			PALEOGENE	23.8	MIOCENE
				OLIGOCENE	
			EOCENE		
			PALEOCENE		
	MESOZOIC	CRETACEOUS		65	
		JURASSIC		144.8	
		TRIASSIC		200	
	PALEOZOIC	PERMIAN		251	
		CARBONIFEROUS		300	
		DEVONIAN		355	
		SILURIAN		418	
		ORDOVICIAN		441	
		CAMBRIAN		490	
		EDIACARAN		544	
		570			
PRECAMBRIAN			4000+		

end of dinosaurs

1st dinosaur

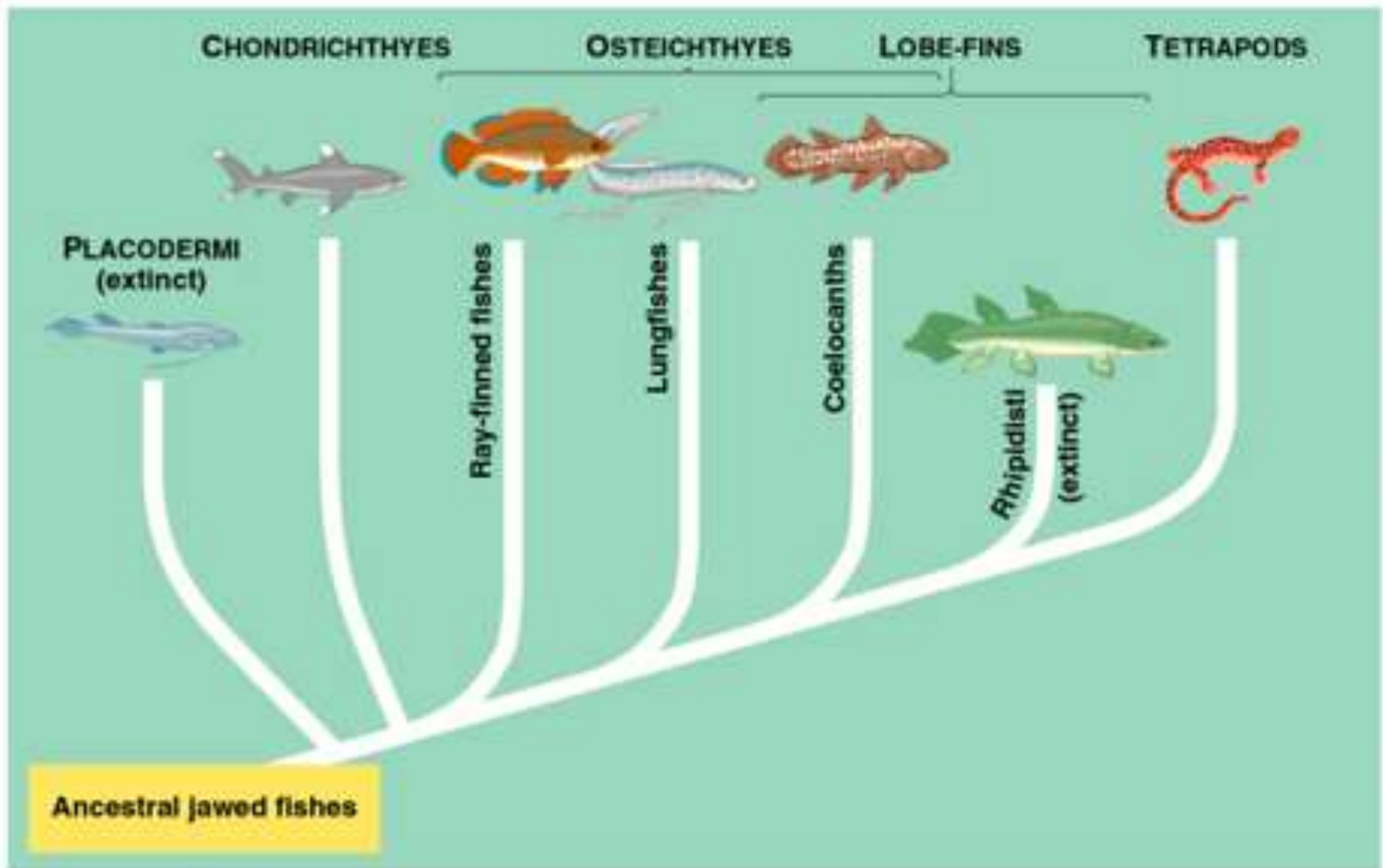
1st reptiles

1st amphibians

1st land plants

1st fish

1st invertebrates



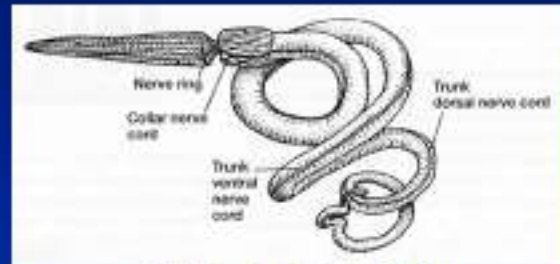
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Chordate Subphyla

Three or four subphyla are recognized depending on the authors.

1. Hemichordata

- also known as acorn worms



(Illustration from Kardong, 2002)

-Hemichordates are no longer considered to be chordates by taxonomists

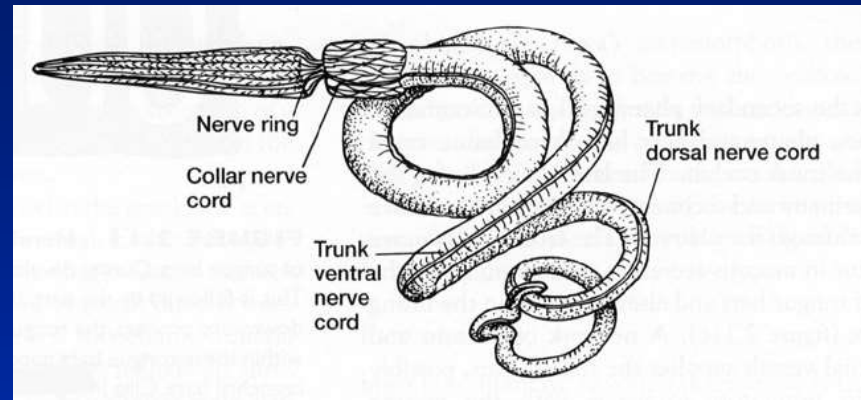
- a sister group to the echinoderms
- these are worm-like marine organisms found on tidal flats where they live in tunnels in mud and sand.

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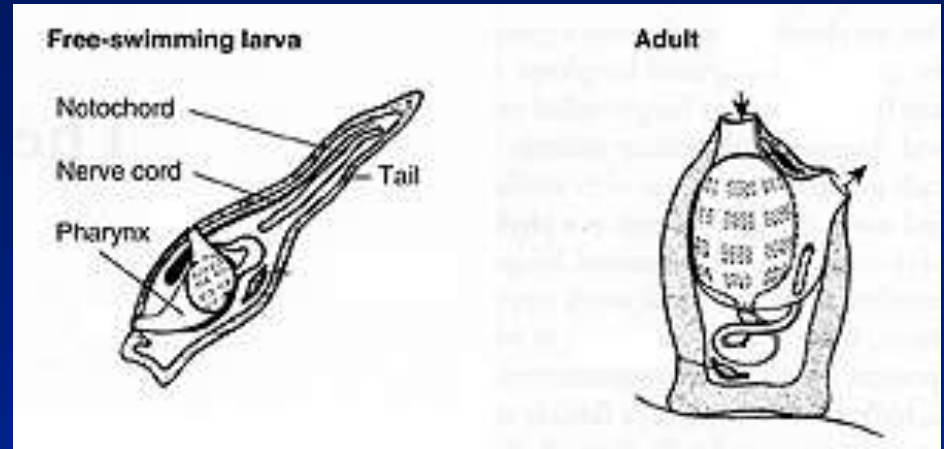
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2. Subphylum Urochordata

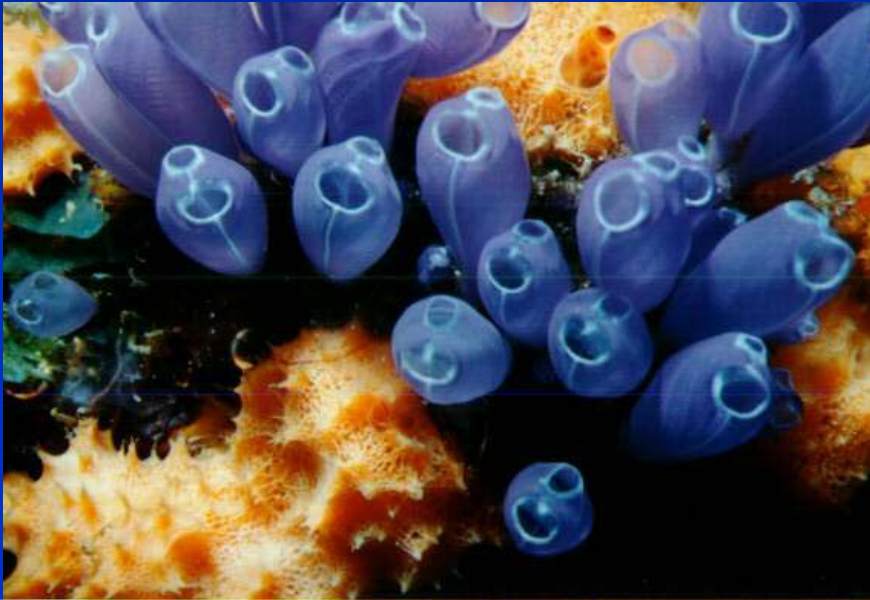
-also known as Tunicates or
Sea Squirts.

-these are marine organisms
that are Free-floating or sessile.

-chordate features are most evident in the free-swimming larvae



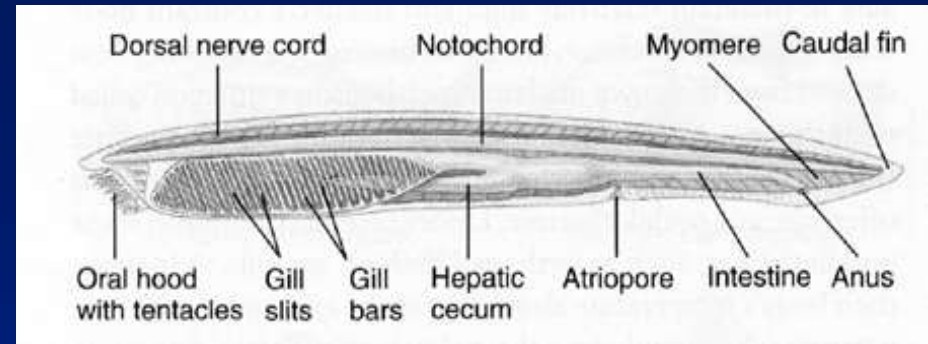
(Illustration from Linzey, 2001)



3. Subphylum Cephalochordata

-aka Amphioxus or Sand Lance

- marine, in sand in shallow water.
- mature individuals possess all chordate features



(Illustration from Linzey, 2001)



Cephalochordates resemble vertebrates and are traditionally viewed as ancestral to vertebrates

- Supported by recent fossils and evaluation of developmental genes

However, other DNA studies suggest that Urochordates are ancestral to vertebrates

This issue remains hotly debated among vertebrate paleontologists

4. Subphylum Craniata (heads with bony or cartilagenous skeleton)

Craniata = Infraphylum Myxinoidea (hagfish) + Infraphylum Vertebrata

-all three chordate features are typically simultaneously evident only during development

- embryonic vertebrates:

- have a notochord.

- all vertebrates have a dorsal nerve chord

- embryonic vertebrates have gill pouches (pharyngeal clefts)

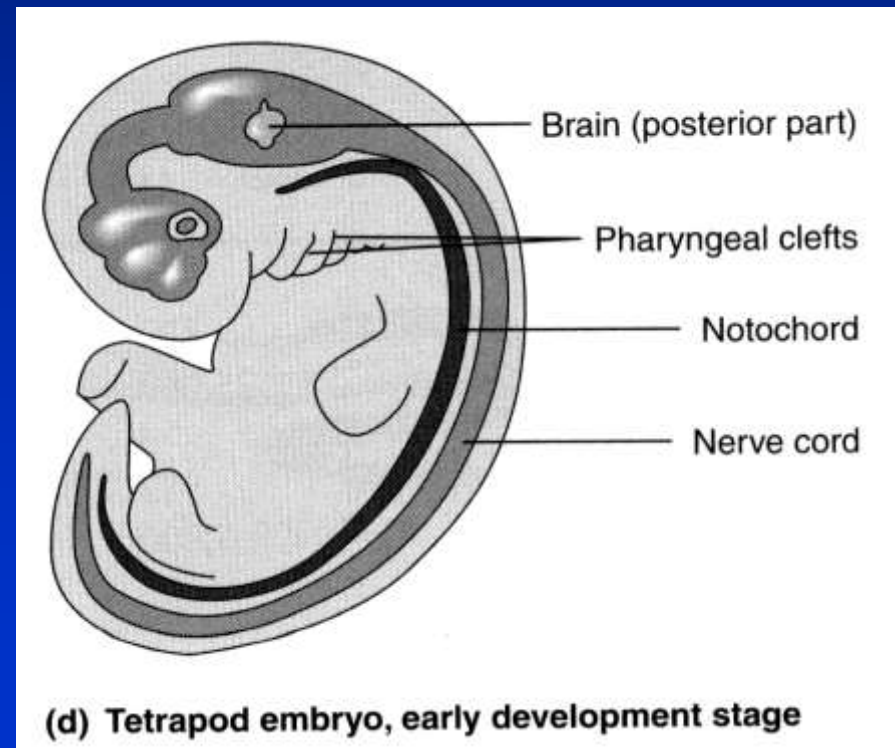


Illustration from Linzey 2001

- Vertebrates differ from all other Chordates in one important respect
- in adults the notochord is usually either rudimentary or absent and is replaced by a cartilaginous or bony vertebral column or backbone.
- outgrowths of the vertebral column extend dorsally and serve to protect the dorsal nerve chord.

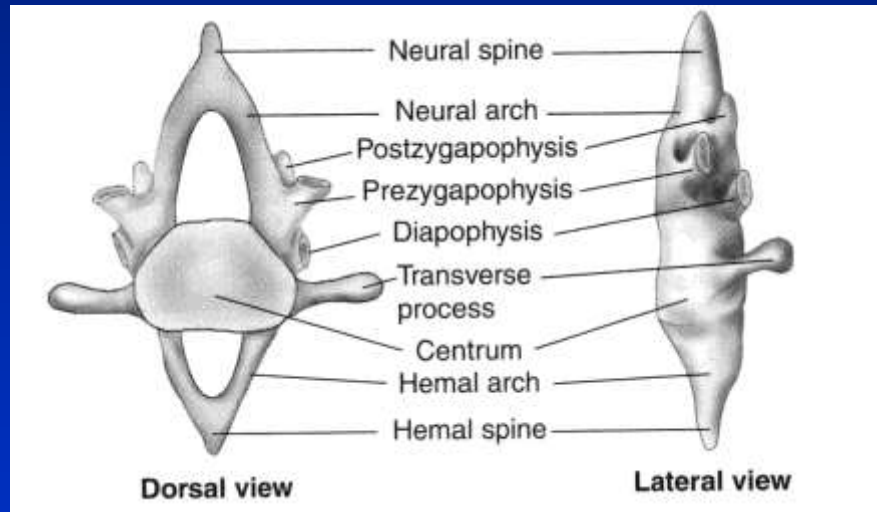


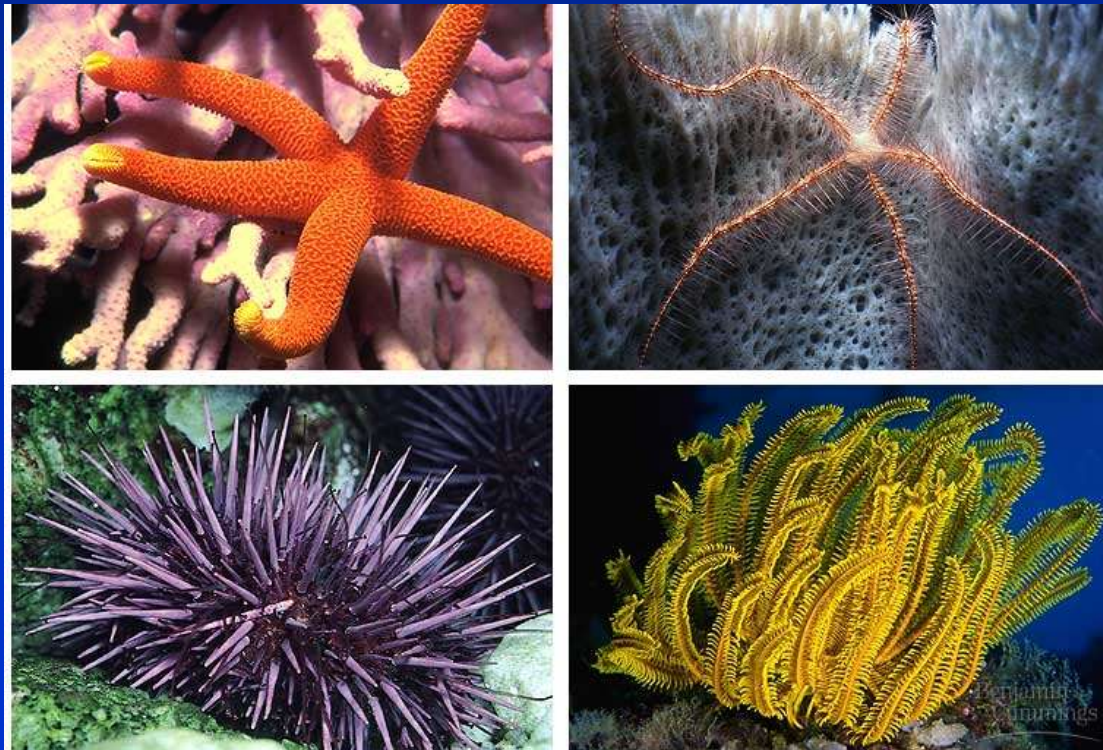
Illustration from Linzey 2001

Note that Myxinoidea (hagfish) are not vertebrates because they lack true vertebrae.

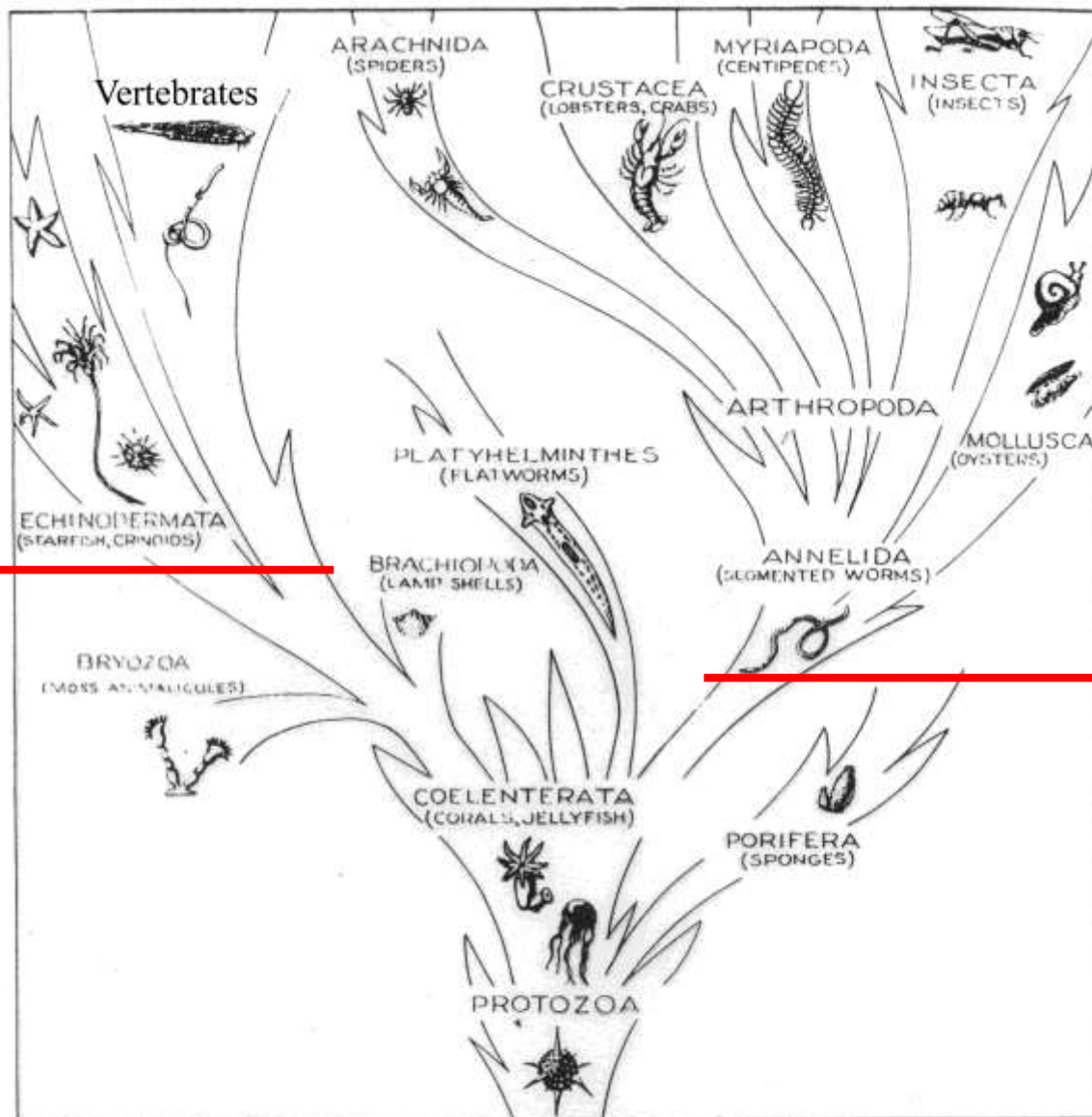
Vertebrate Origins

What is the ancestral origin of the Chordates?

- no fossil record, therefore much speculation
- one popular hypothesis puts the chordates as possibly descendant from echinoderms or from a common ancestor to echinoderms



Deuterostomes



Protostomes

Figure 10. A simplified family tree of the animal kingdom, to show the probable relationships of the vertebrates. (After Romer, Man and the Vertebrates, University of Chicago Press.)

From Romer and Parsons 1977

The justification for this phylogeny can be summarized as:

1. Vertebrates and all invertebrates above the level of coelenterates have 3 embryonic tissue layers (ectoderm, mesoderm, endoderm)
2. The higher invertebrates can be divided into two lineages based on **coelum formation**, the fate of the blastopore, and cleavage type
3. Only the lineage containing Echinoderms and Chordates share the following features:
 - three embryonic tissue layers
 - body cavity that arises from pouches of mesoderm growing outward from gut wall
 - radial cleavage, deuterostomes (blastopore becomes anus)

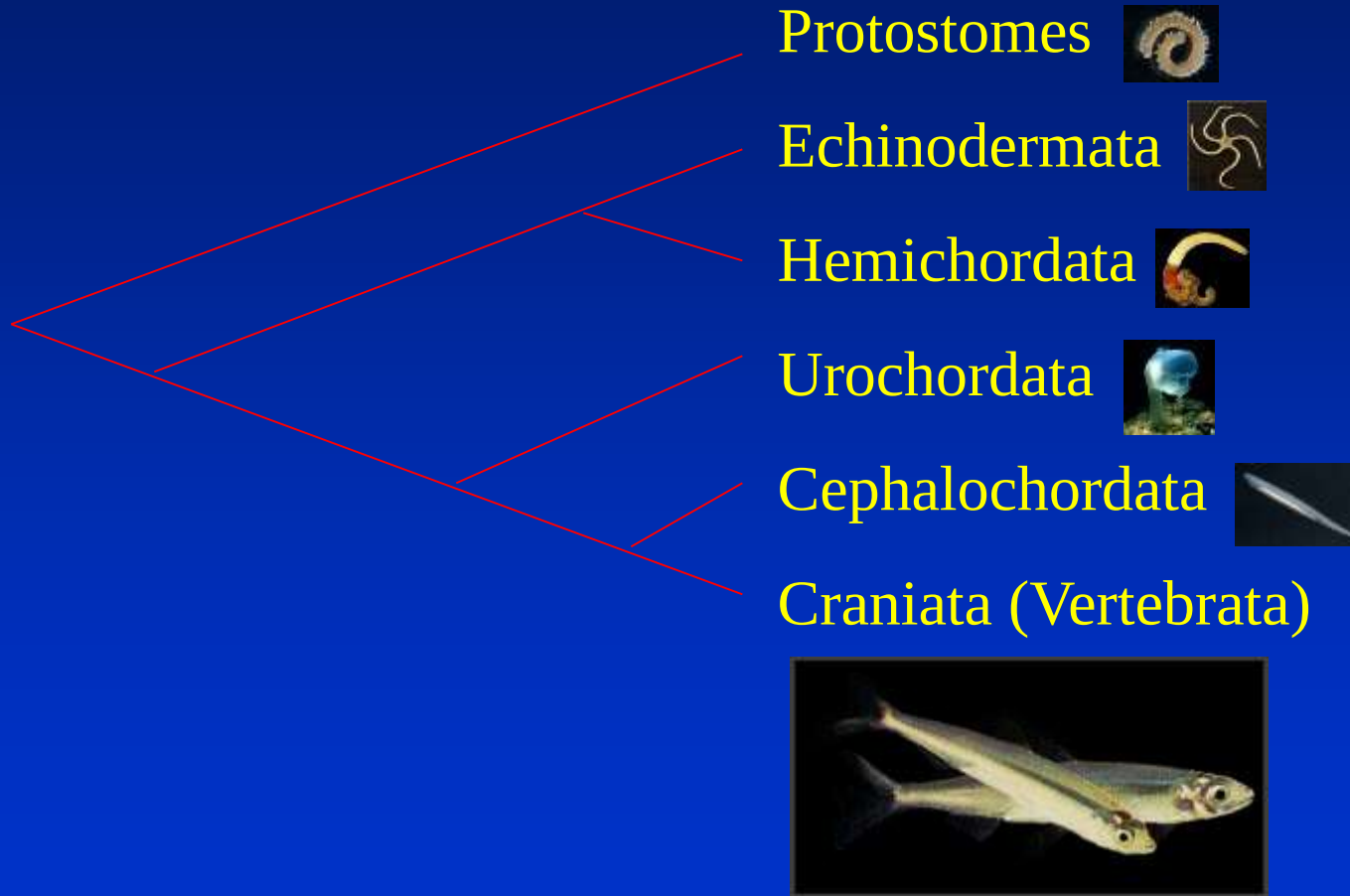
In addition:

Echinoderms and chordates (vertebrates) share some of the same blood serum proteins (not found in other groups)

These comparisons suggest that echinoderms and chordates are closely related and may share a common ancestor.



The current accepted phylogeny is:



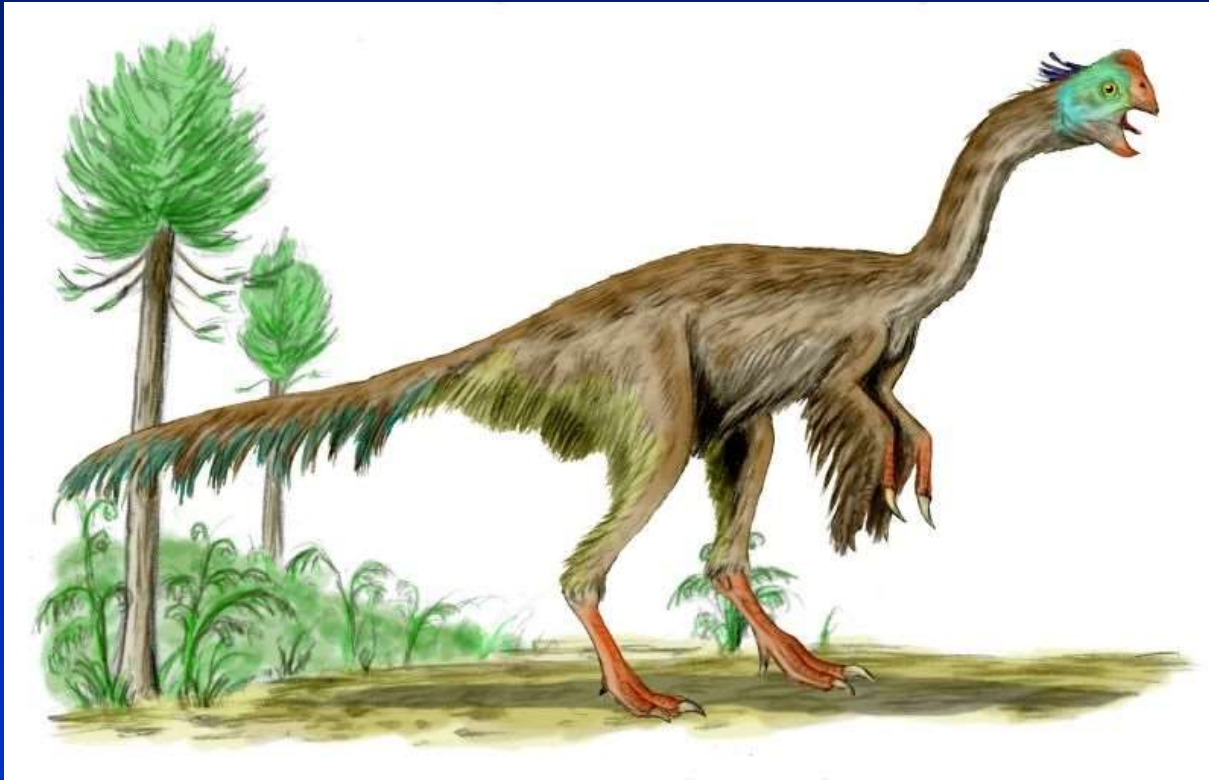
Vertebrate Classification

<u>Class</u>	<u>Common Name</u>			
Agnatha	Jawless fishes	}	Superclass Pisces	Anamniotes
Chondrichthyes	Cartilaginous fishes			
Osteichthyes	Bony fishes			
Amphibia	Amphibians	}	Superclass Tetrapoda	Amniotes
Reptilia	Reptiles			
Aves	Birds			
Mammalia	Mammals			

The classes identified above represent the traditional classification scheme. Other schemes exist, particularly with regard to how the various fishes are grouped and whether or not birds are included with the reptiles.

In addition, all vertebrates above the level of Agnatha are sometimes referred to as Gnathostomes (jawed vertebrates)

Many paleontologists and taxonomists combine birds and reptiles into a single Class Sauropsida and refer to Mammals as Theropsida



Many taxonomists also recognize an extinct group of fishes as the Class Placodermi

A Phylogenetic Classification of the Chordates

FROM: http://users.tamuk.edu/kfjab02/Biology/Vertebrate%20Zoology/b3405_ch01.htm

PHYLUM CHORDATA

Subphylum UROCHORDATA

Subphylum CEPHALOCHORDATA

Subphylum CRANIATA

Infraphylum MYXINOIDEA

Infraphylum VERTEBRATA

Order PETROMYZONTIFORMES

GNATHOSTOMATA

Class CHONDRICHTHYES

Subclass Holocephali

Subclass Elasmobranchii

Class OSTEICHTHYES

Subclass ACTINOPTERYGII

Brachiopterygii

Unnamed taxon

Order Chondrostei

Order Neopterygii

Lepisosteus

Unnamed taxon

Amia

Teleostei

Note that this classification recognizes petromyzontiformes but does not assign them to a class

AGNATHA = Hagfish & Lampreys
(aka CYCLOSTOMATA)

Class OSTEICHTHYES

Subclass SARCOPTERYGII

Order ACTINISTIA

Order DIPNOI

Division RHIPIDISTIA

Eusthenopteron, Panderichthys, etc.

EOTETRAPODA

Ichthyostega and other primitive "amphibians"

TETRAPODA

Class AMPHIBIA

Gymnophiona

Batrachia

Anura

Urodela

AMNIOTA

SYNAPSIDA

Class MAMMALIA

Monotremata

Theria

Marsupialia

Eutheria

Class REPTILIA

Testudines

Sauria

Lepidosauria

Sphenodontia

Squamata

Archosauria

Crocodylia

Class AVES

The above phylogeny reflects the evolutionary history of vertebrates

