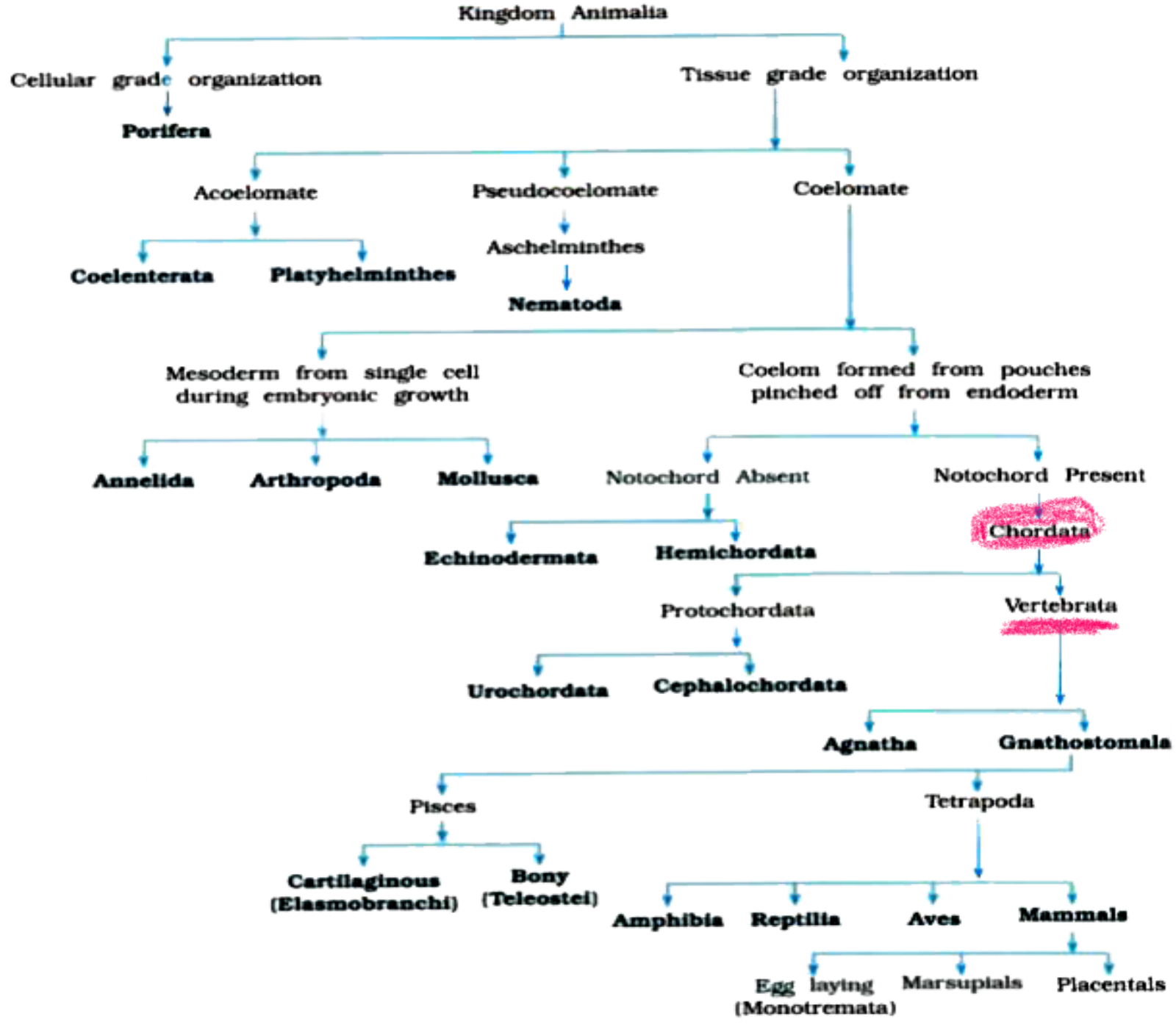
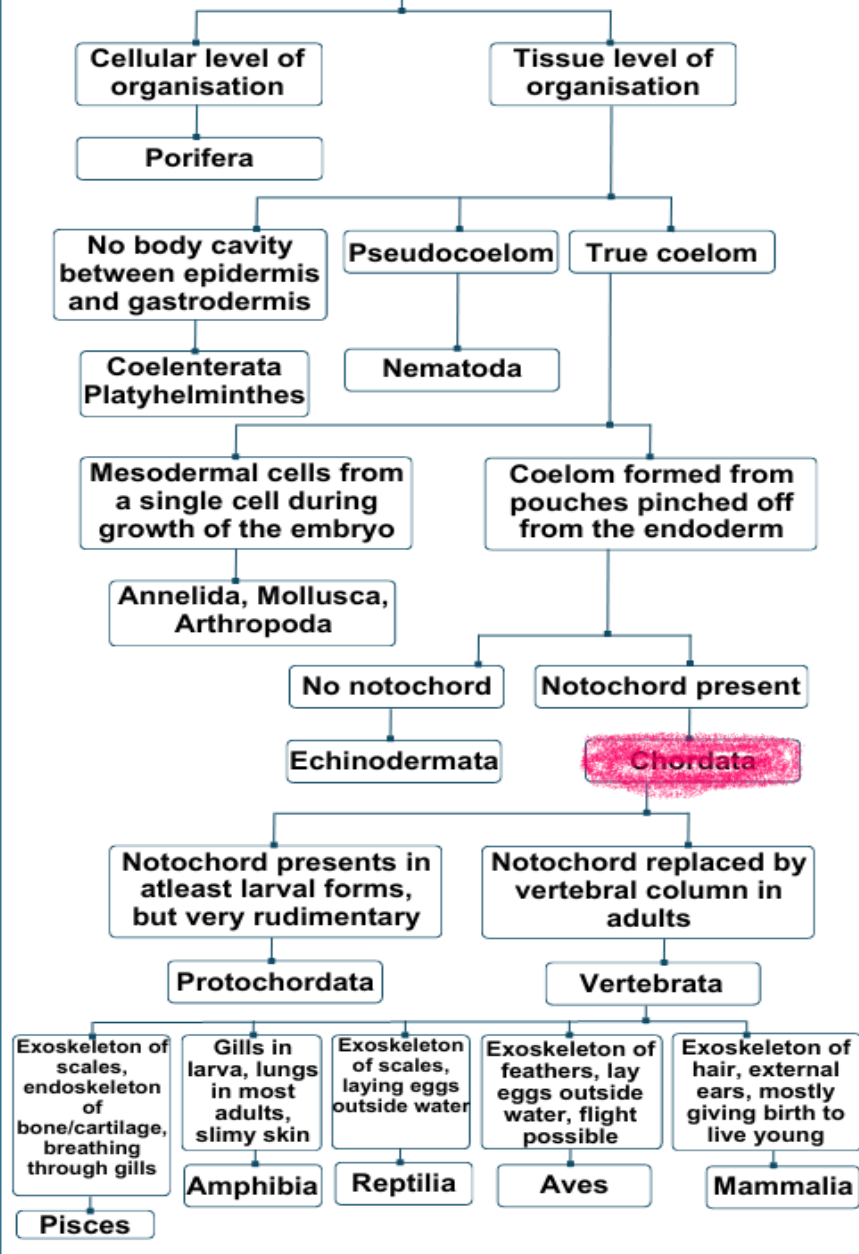
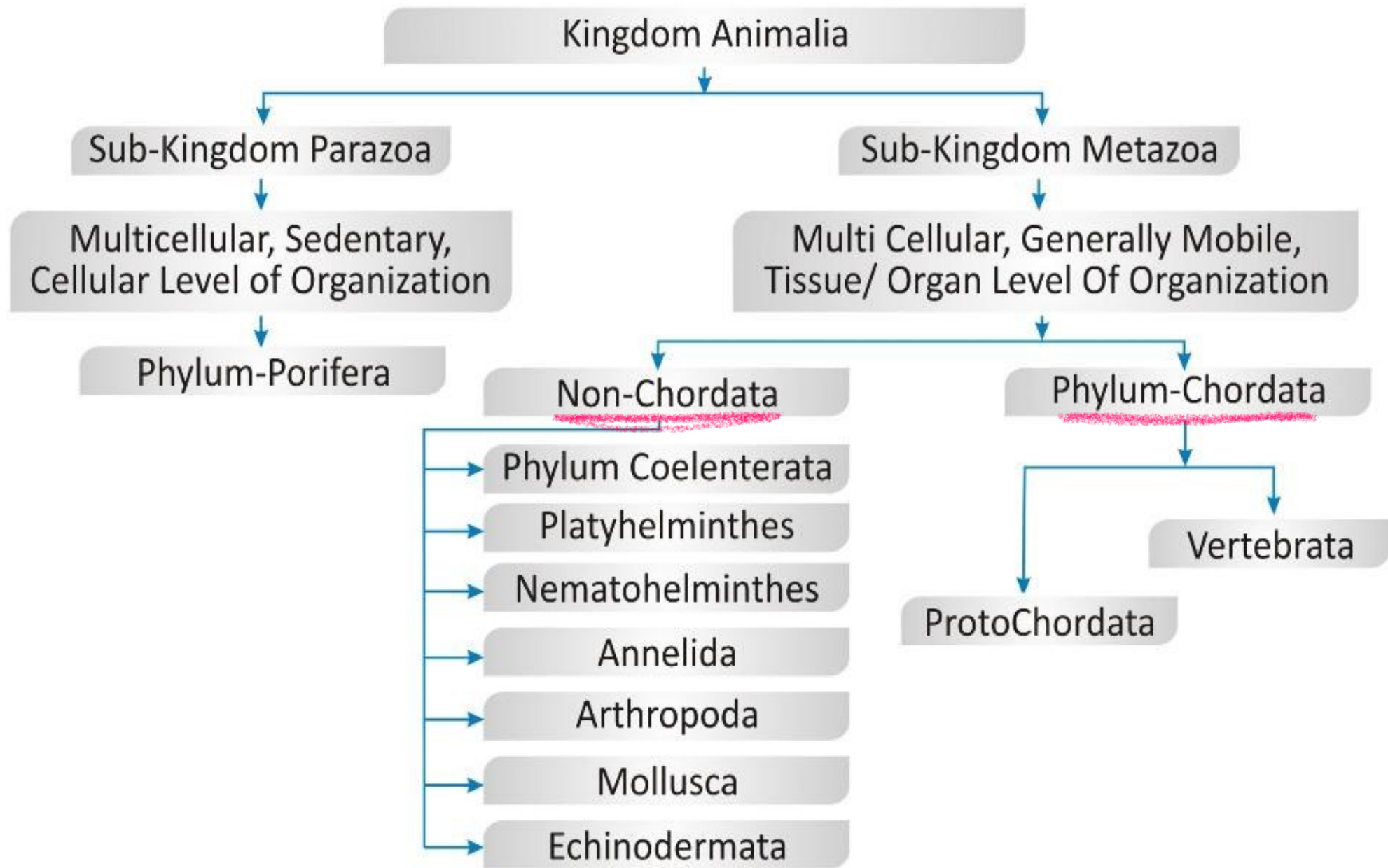


ANIMAL KINGDOM

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Classification of Animal Kingdom





What is Chordata?

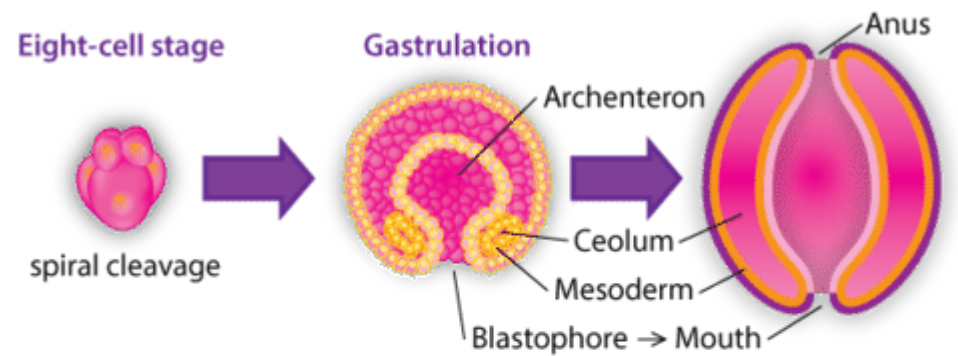
In the scheme of classification, the Animal Kingdom is divided first into several major animal groups called *phyla* (singular, *phylum*). There are approximately 30 animal phyla currently recognised. The last major group of the Animal Kingdom is known as phylum *Chordata*. It was created by Balfour in 1880. The name of this phylum is derived from two Greek words, the *chorde* meaning a string or cord, and *ata* meaning bearing. The reference is to a common characteristic feature in the form of a stiff, supporting rod-like structure along the back, the *notochord* (Gr., *noton*, back; L., *chorda*, cord), which is found in all the members of the phylum at some stage of their lives. Thus, chordates are animals having a cord, i.e., notochord. The animals belonging to all other phyla of the Animal Kingdom are often termed 'the non-chordates' or 'the invertebrates' since they have no notochord or backbone in their body structure.

Chordate Animals

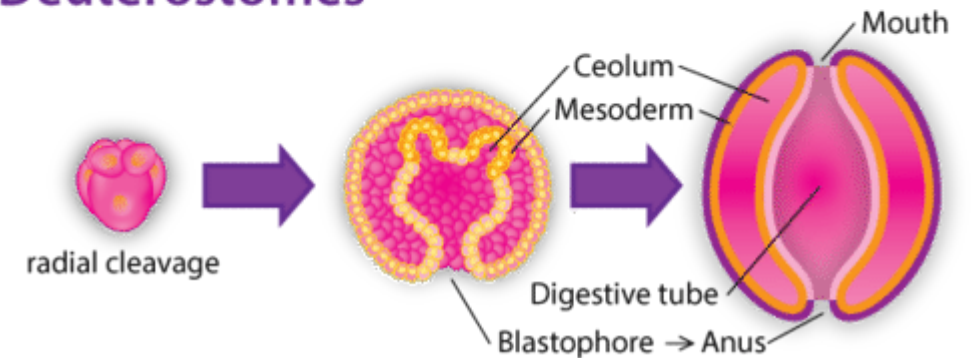
Phylum Chordata is the largest of the deuterostome phyla. It is the highest and the most important phylum comprising a vast variety of living and extinct animals including man himself. Most of the living chordates are the well known familiar vertebrate animals such as the fishes, amphibians, reptiles, birds and mammals. Besides, they include a number of marine forms such as the tunicates and lancelets, that are less well known.

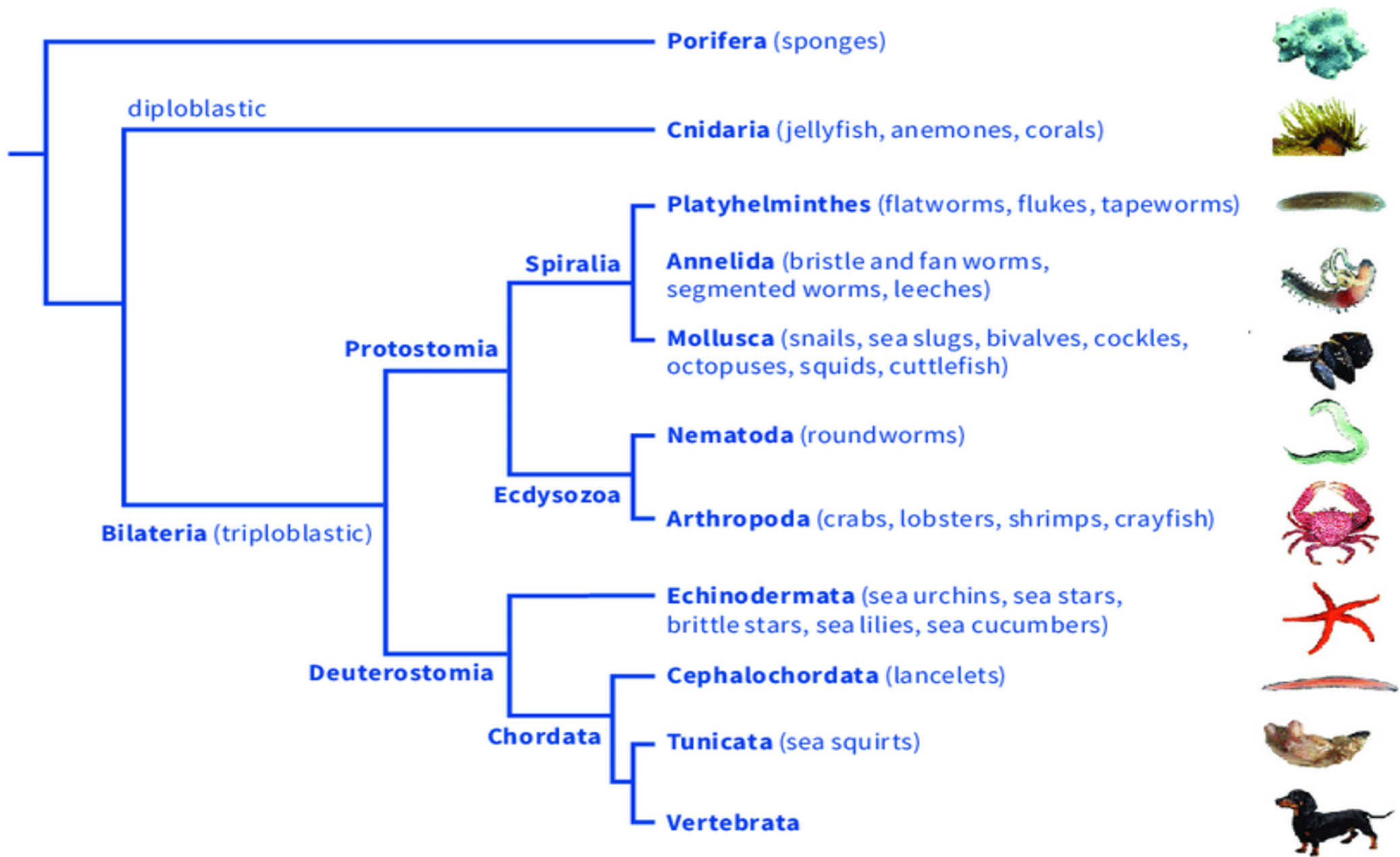
Protostomes and deuterostomes are two groups of animals that are classified based on their early embryonic development.

Protostomes



Deuterostomes





Diversity of Chordates

The chordates exhibit an astonishing diversity of form, physiology and habit.

Numerical strength. The number of chordate species is not unusually large. About 49,000 species are on record which are only half of the living species of molluscs, and less than one-tenth those of arthropods. The two subphyla Urochordata and Cephalochordata claim for nearly 2,500 species. The subphylum Vertebrata includes 46,500 species; of these, fishes are the most numerous with approximately 25,000 species. It is commonly assumed that amphibian species number about 2,500, reptiles 6,000, birds 9,000 and mammals 4,500.

Size. Despite their modest number of species, the chordates make a disproportionate contribution to the biomass of the earth. Nearly all of them are medium to large in size. The vertebrates, in particular, are considerably large and many of them are among the largest of living animals. The gigantic blue whale (*Balaenoptera musculus*), which grows to 35 meters long and 120 tons in weight, is the biggest known animal. The whale shark (*Rhineodon typus*) reaches a length of 15 meters and is the second biggest vertebrate after whales. The smallest fish is a Philippine goby (*Pandaka*) measuring only 10 mm long.



Ecology. The chordates are not only the largest animals in existence today, but ecologically they are among the most successful in the Animal Kingdom. They are able to occupy most kinds of habitats and they have adapted themselves to more modes of existence than any other group, including the arthropods. They are found in the sea, in freshwater, in the air, and on all parts of land from the poles to the equator. Birds and mammals have been able to penetrate cold climate because they have a constant body temperature, something no other animals have.

All lower chordates are marine, fishes are aquatic and higher chordates are predominantly terrestrial. Saltwater amphibians are unknown. No bird lives permanently in water, while some amphibians, reptiles and mammals occur as permanent residents of waters. While most tunicates are sessile, all chordates are free-living and none is strictly parasitic.

The chordates are probably the most conspicuous and the best-known group in the entire animal kingdom, partly because of their large size and partly because of the important role they perform in their ecosystems. They are of primary interest because man himself is a member of the group. From a purely biological viewpoint also the chordates are interesting because they illustrate so well the broad biological principles of evolution, development and relationship.

Characters Common to Chordates and Higher Nonchordates

There are a number of features in which the chordates resemble the higher nonchordates or invertebrates.



PHYLUM CHORDATA

Three Fundamental Chordate Characters

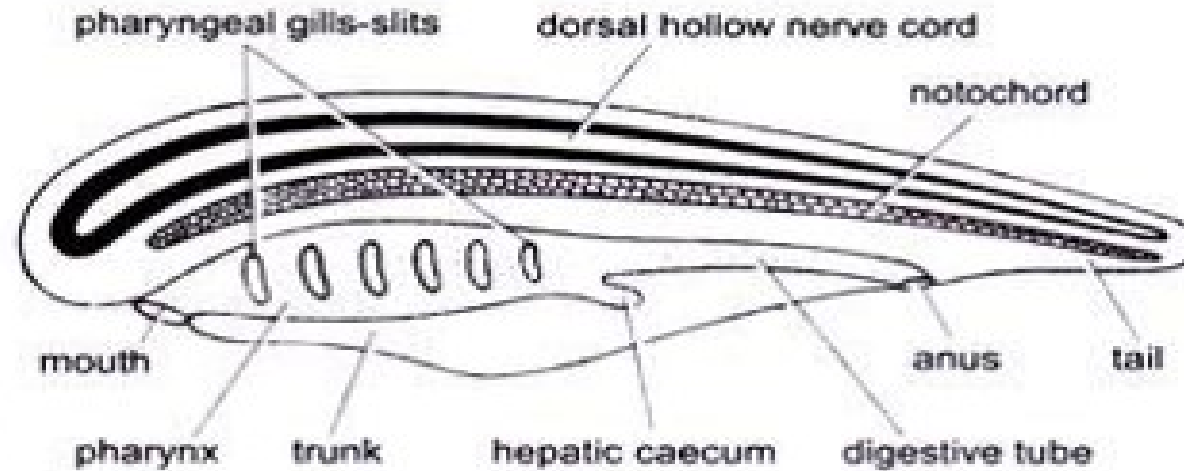
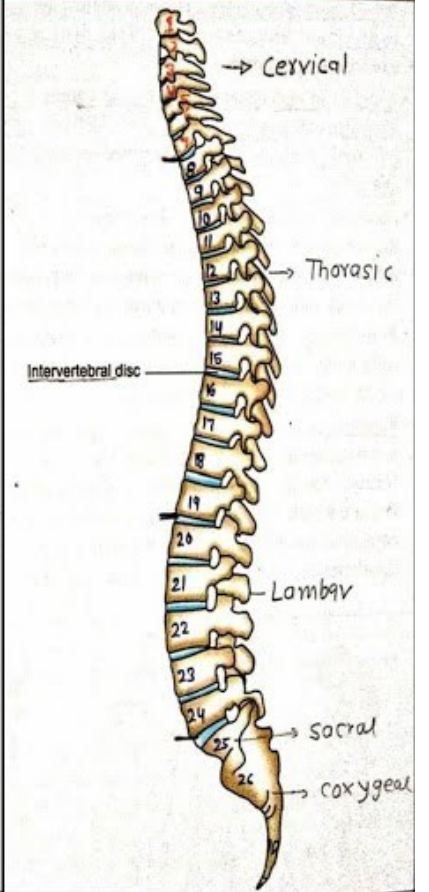
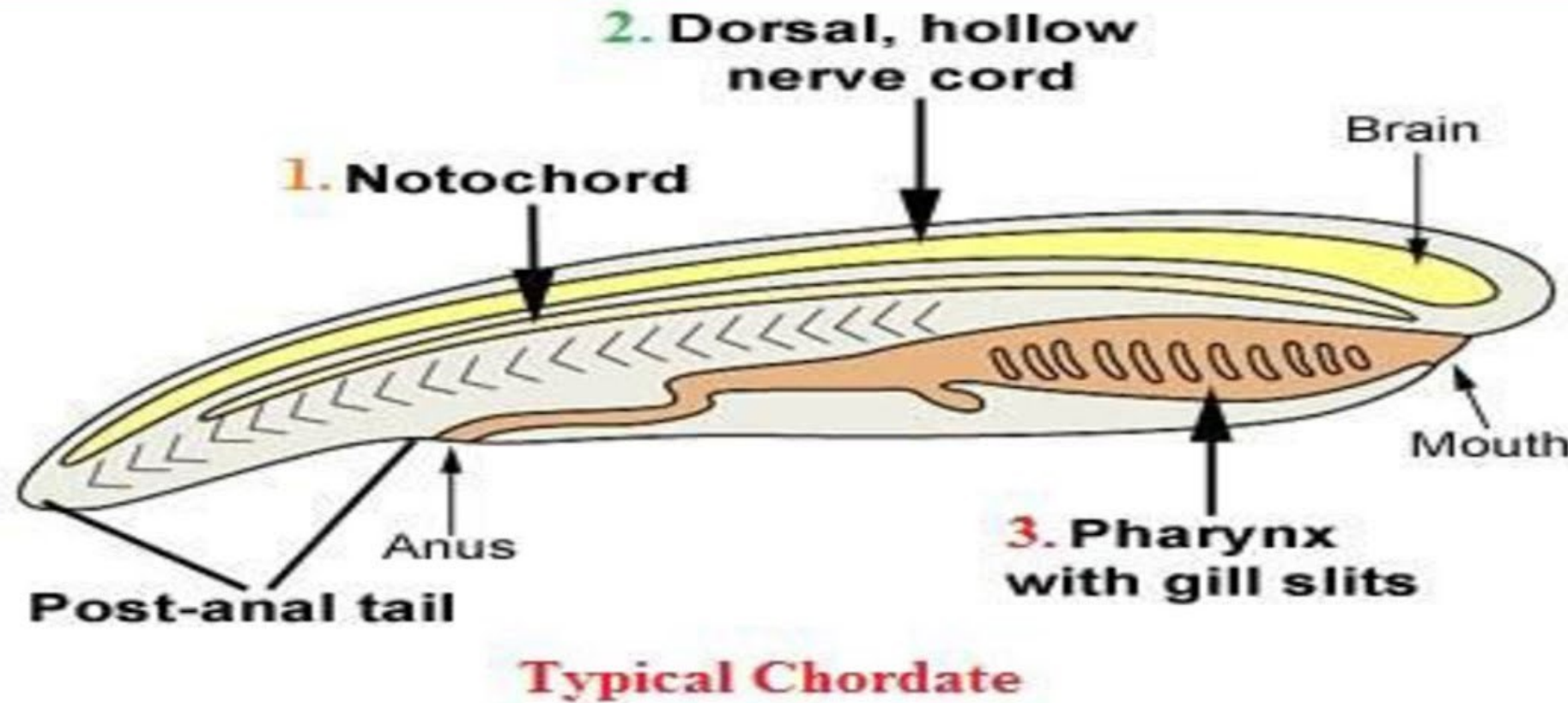


Fig. 1.1. Diagrammatic side view of a chordate showing three fundamental chordate characters.

All the chordates possess three unique characteristics at some stage in their life history. These three distinctive features, set chordates apart from all other phyla. These three fundamental morphological features include:

Phylum- Chordata:

Primary Chordates characters

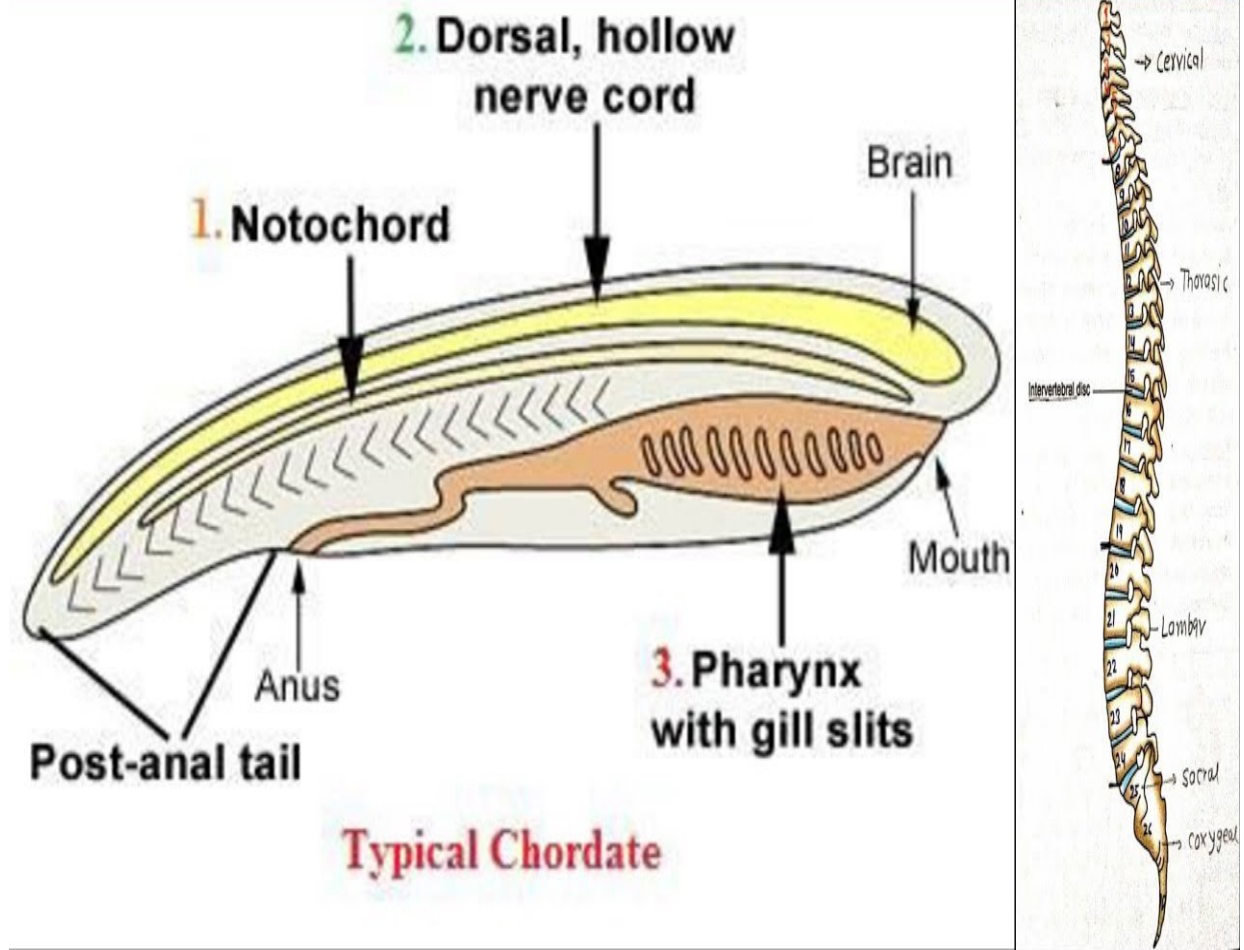


Phylum- Chordata:

Primary Chordates characters

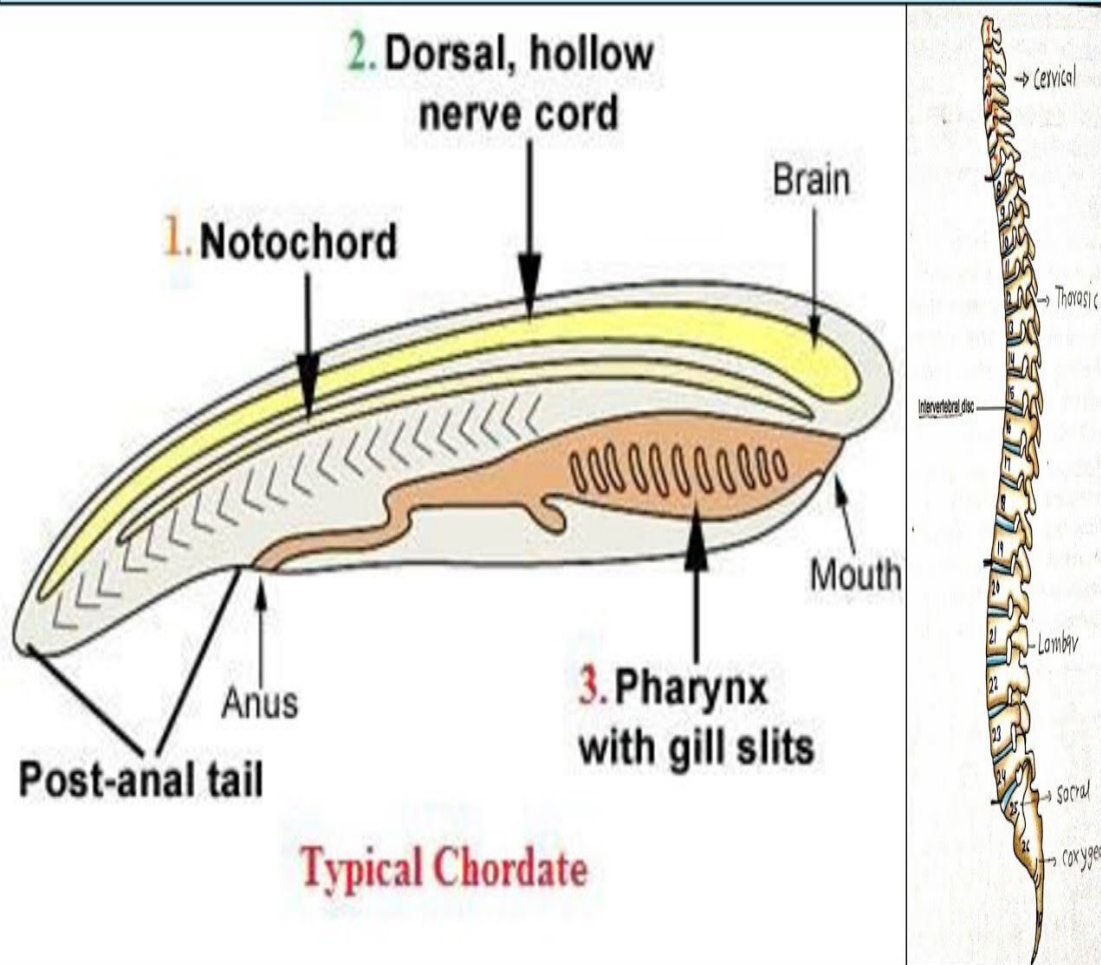
(1) **A dorsal hollow or tubular nerve cord:** The central nervous system of the chordates is present dorsally. It is in the form of a longitudinal, hollow or tubular nerve cord lying just above the notochord and extends lengthwise in the body. It is derived from the dorsal ectodermal neural plate of the embryo and covers a cavity called **neurocoel**. The nerve cord serves for the integration and coordination of the body activities.

In vertebrates, the anterior region of nerve cord is specialized to form brain which is covered by cranium. The posterior part of nerve cord becomes the spinal cord and protected within the vertebral column.



Phylum- Chordata:

Primary Chordates characters



(2) **A longitudinal supporting rod-like notochord:** The notochord is an elongated rod-like flexible structure present in entire length of the body. It is present immediately beneath the nerve cord and just above the alimentary canal, providing skeletal support to the body. It originates from the endodermal roof of the embryonic archenteron. Structurally, it is composed of large vacuolated notochordal cells containing a gelatinous matrix and surrounded by an outer fibrous and an inner elastic sheath.

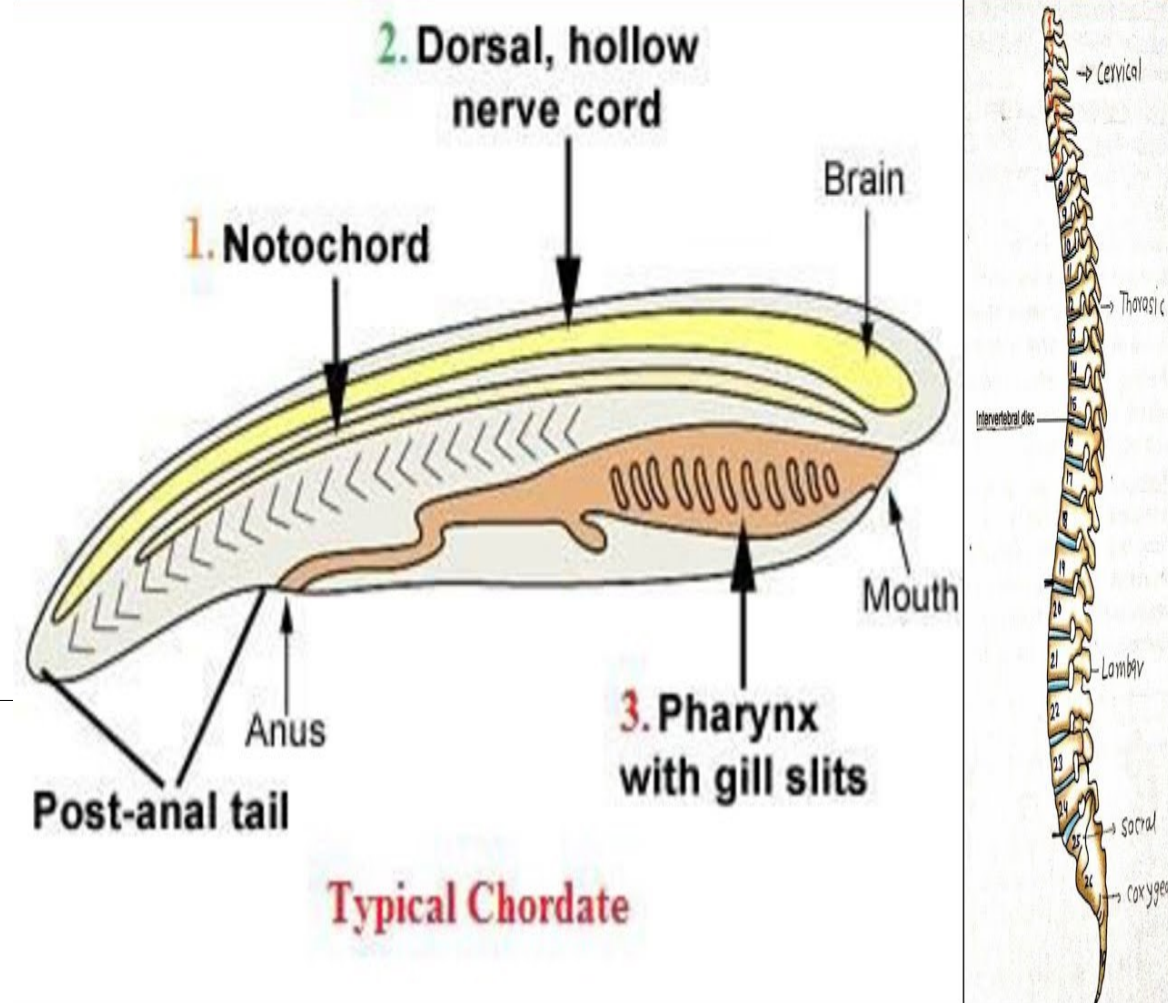
In adult vertebrates, it is replaced by the vertebral column.

Phylum- Chordata:

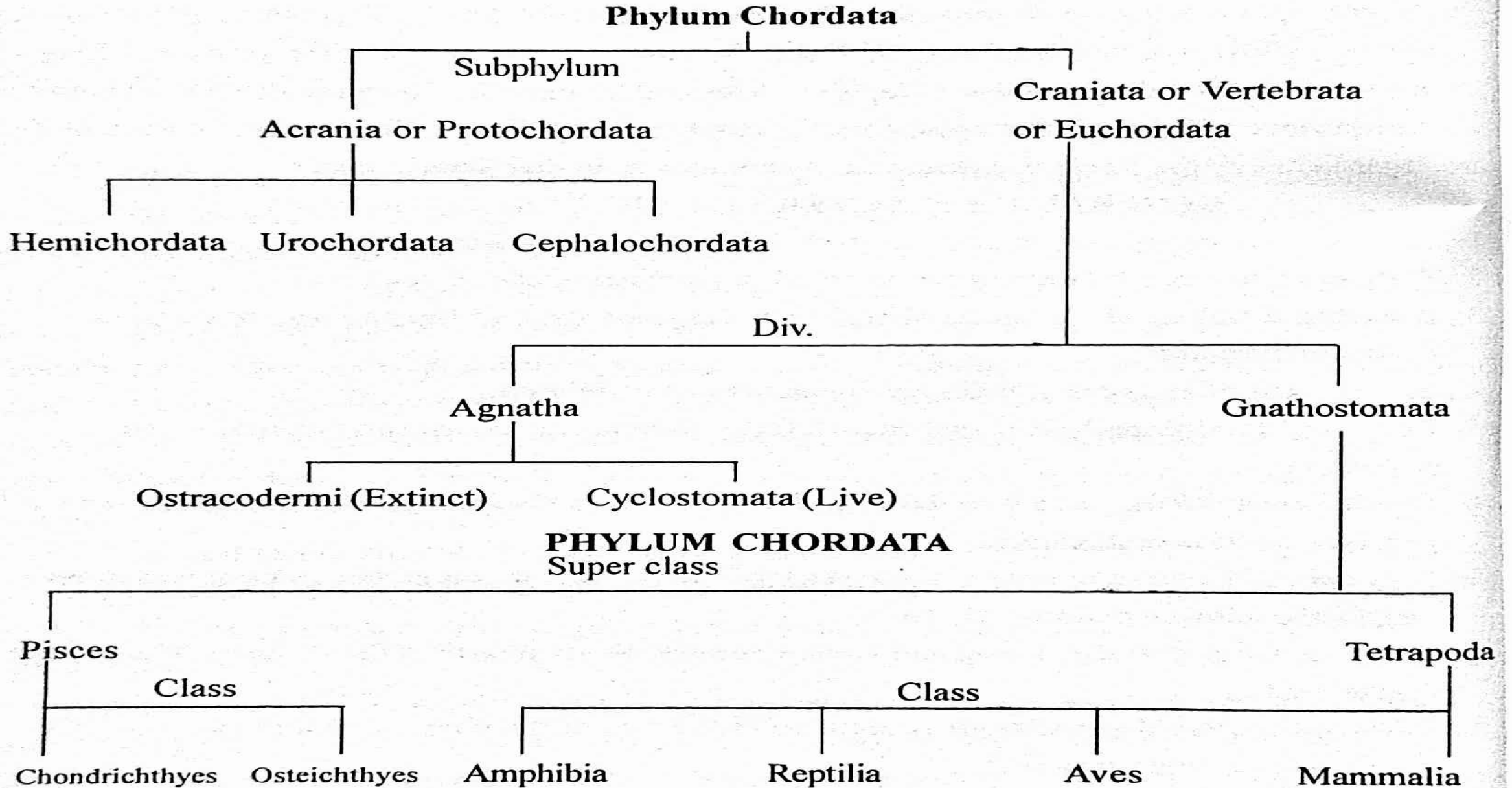
Primary Chordates characters

(3) **A series of pharyngeal gill slits:** In all the chordates, at some stage of their life history, a series of paired lateral gill clefts or gill slits (openings) present in the pharynx (the region just posterior to mouth) that extend to the outside environment. They serve primarily for the passage of water from the pharynx to outside, thus bathing the gills for respiration and also assist in filter feeding by retaining food particles in the pharynx.

In protochordates and lower aquatic vertebrates, the gill slits are functional throughout life. But, in higher vertebrates, they disappear or become modified in the adult. In vertebrate fishes, the pharyngeal gill slits develop into gill arches-the bony or cartilaginous gill supports. In most terrestrial animals, pharyngeal gill slits are present only during embryonic development, which develops into the jaw and inner ear bones.



OUTLINE CLASSIFICATION OF PHYLUM CHORDATA.



GENERAL CHARACTERISTICS OF CHORDATES

- Aquatic, aerial or terrestrial. All **free-living** with no fully parasitic forms.
- Body **small to large**, complex-organ system level of organization.
- **Bilaterally symmetrical** and metamerically segmented.
- A **postanal tail** usually projects beyond the anus at some stage and may or may not persist in the adult.
- **Exoskeleton** often present; **well developed** in most vertebrates.

Different species of chordates illustrating their diversity and vast size range.



A **tunicate** approximately one inch in length. Notice the tiny fish (also a chordate) swimming in front of the tunicate.



A **white rhinoceros** weighs approximately 6600 pounds (3000 kg).



A kangaroo and joey.



A great white shark.



A double-crested cormorant bird.



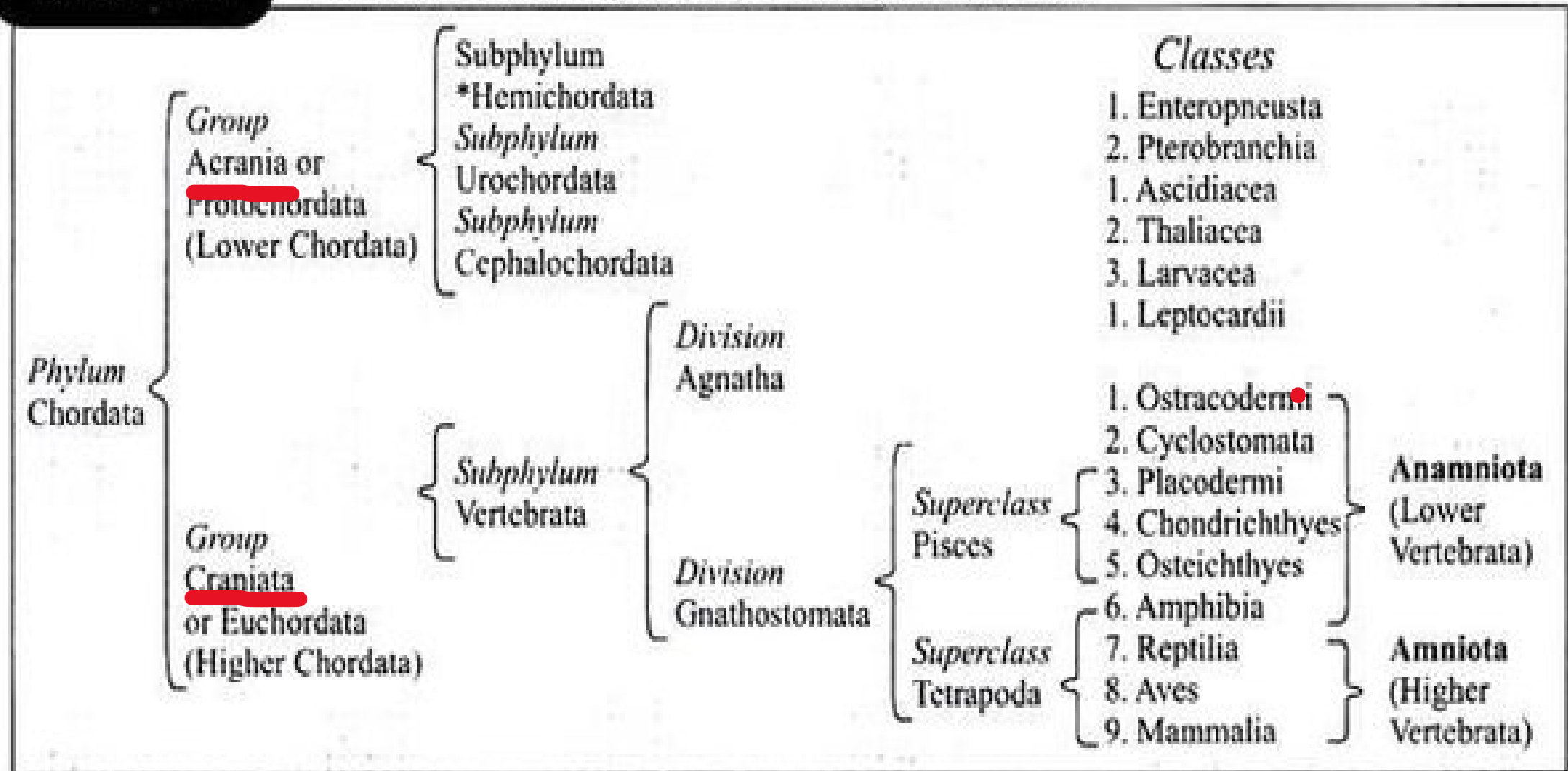
A blue whale.

- Body wall **triploblastic** with 3 germinal layers
- **Coelomate animals** having a true coelom-enterocoelic or schizocoelic in origin.
- A skeletal rod, the **notochord, present** at some stage in life cycle.
- A **cartilaginous or bony**, living and jointed **endoskeleton** present in the majority of members (vertebrates).
- **Pharyngeal gill slits** present at some stage; may or may not be functional.
- Digestive system **complete** with digestive glands.

- Blood vascular **system closed**. Heart ventral with dorsal and ventral blood vessels.
- **Special organs for respiration-** gills and lungs
- Excretory system comprising **proto-or meso-or meta-nephric kidneys**.
- **Nerve cord dorsal** and tubular. Anterior end usually enlarged to form brain.
- **Sexes separate**. Development **indirect in some**.

TABLE 1.2.

OUTLINE CLASSIFICATION OF PHYLUM CHORDATA.



*Subphylum Hemichordata is now considered to be an invertebrate group.

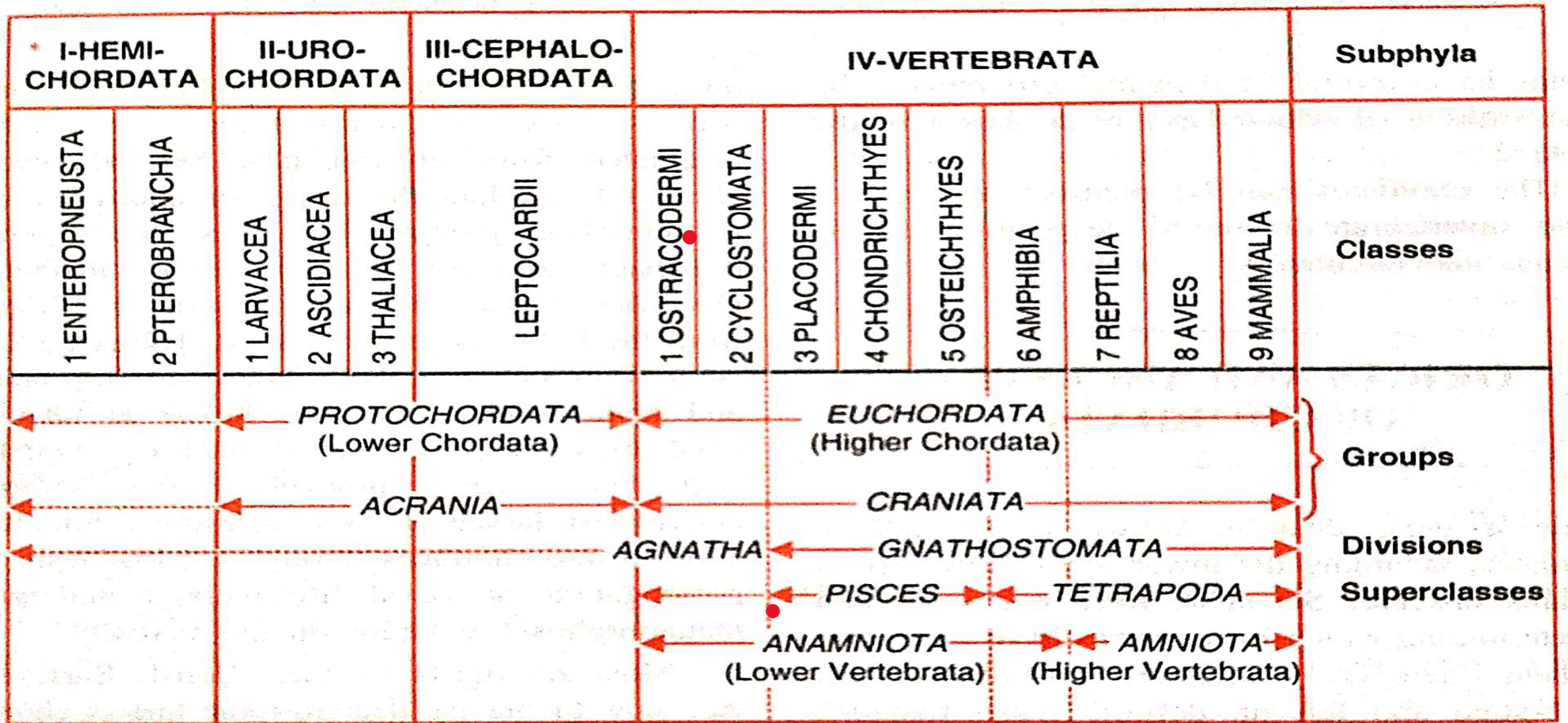


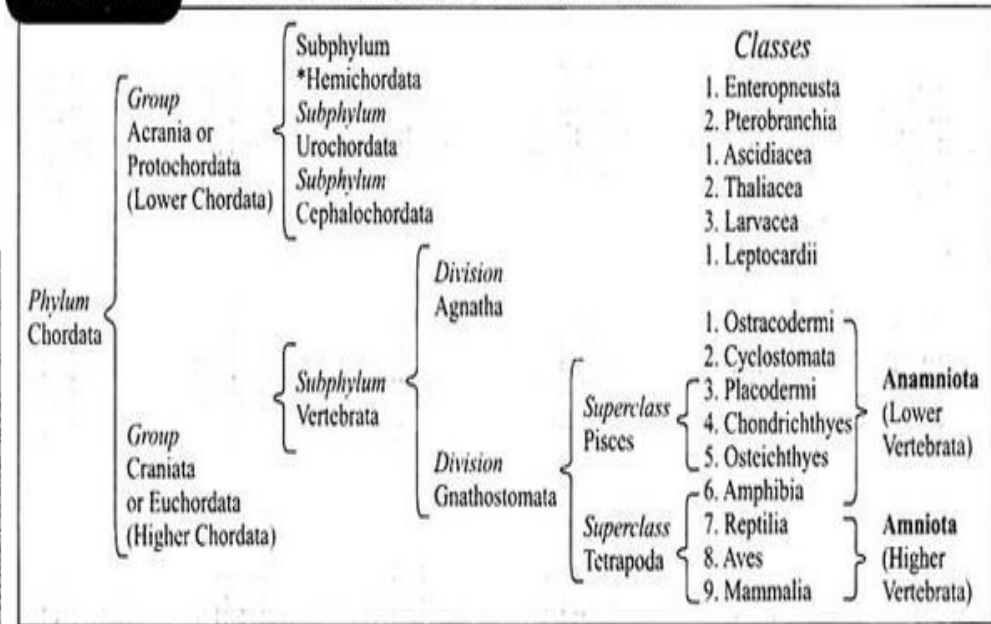
Fig. 4. Subdivisions of the phylum Chordata.

FOLLOWING TERMINOLOGY INCLUDES MAJOR DIVISION OF PHYLUM CHORDATA

Table 3. Contrasting characters of Protochordata and Euchordata.

Group A. Acrania (Protochordata) or Lower Chordata	Group B. Craniata (Euchordata) or Higher Chordata
1. Exclusively marine, small-sized chordates.	1. Aquatic or terrestrial, mostly large sized vertebrates
2. No appendages, cephalization and exoskeleton.	2. Usually 2 pairs of appendages, well-developed head and exoskeleton present.
3. Coelom enterocoelic, budding off from embryonic archenteron.	3. Coelom schizocoelic, arising by splitting of mesoderm.
4. Notochord persistent. No skull, cranium and vertebral column.	4. Notochord covered or replaced by a vertebral column. Skull and cranium well developed.
5. Pharynx with permanent gill-clefts. Endostyle present.	5. Pharyngeal gill-clefts persist or disappear. Endostyle absent.
6. Heart chamberless when present. No red blood corpuscles in blood.	6. Heart made of 2,3 or 4 chambers. Blood contains R.B.C.
7. Kidneys protonephridia.	7. Kidneys meso- or metanephridia.
8. Sexes separate or united. Reproduction asexual as well as sexual. Gonoducts usually absent.	8. Sexes separate. Only sexual reproduction, Gonoducts always present.
9. Development indirect with a free-swimming larval stage.	9. Development indirect or direct, with or without a larval stage.

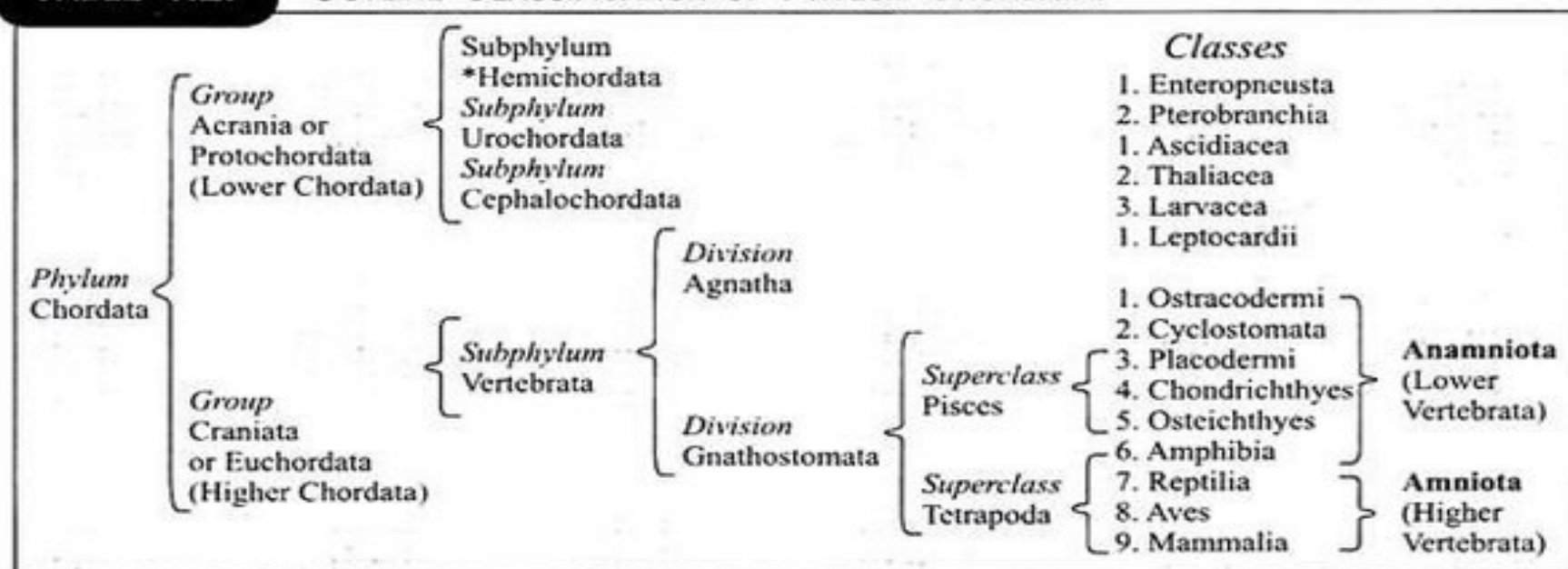
TABLE 1.2. OUTLINE CLASSIFICATION OF PHYLUM CHORDATA.



*Subphylum Hemichordata is now considered to be an invertebrate group.

TABLE 1.2.

OUTLINE CLASSIFICATION OF PHYLUM CHORDATA.

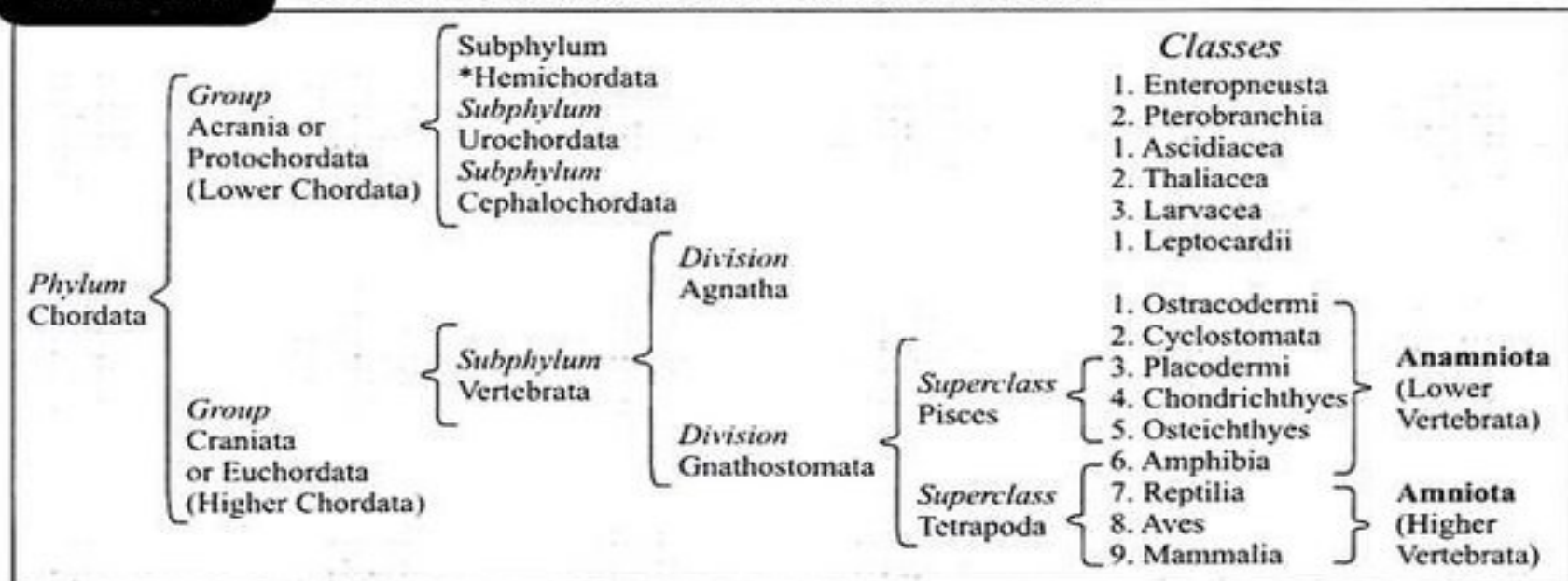


*Subphylum Hemichordata is now considered to be an invertebrate group.

Division I. Agnatha	Division II. Gnathostomata
1. Without true jaws.	1. True jaws present.
2. Paired appendages absent.	2. Appendages paired (pectoral & pelvic).
3. Inner ear with 2 semi-circular canals.	3. Inner ear with 3 semi-circular canals.
4. Notochord persistent in adults.	4. Notochord persists or replaced by vertebrae.

TABLE 1.2.

OUTLINE CLASSIFICATION OF PHYLUM CHORDATA.



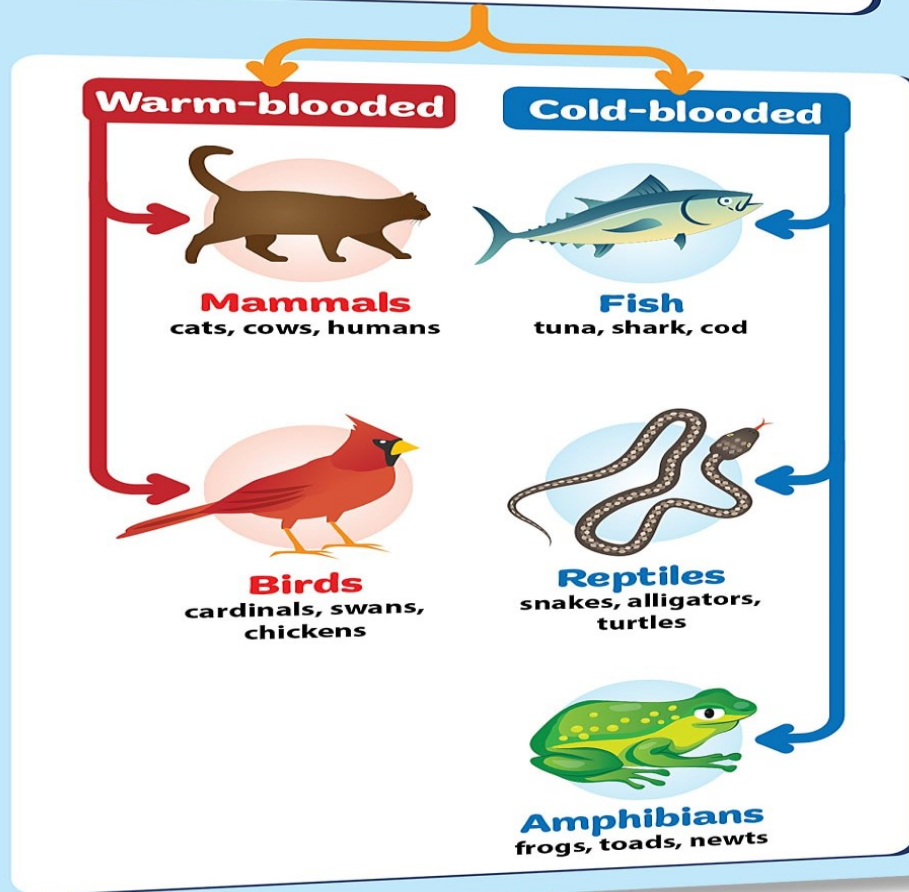
*Subphylum Hemichordata is now considered to be an invertebrate group.

Superclass 1. Pisces	Superclass 2. Tetrapoda
1. Exclusively aquatic gnathostome vertebrates.	1. Aquatic or terrestrial. Some arboreal and aerial.
2. Paired limbs, if present, as fins.	2. Paired pentadactyle limbs present.
3. Median fins present.	3. Median fins absent.
4. Skin usually moist and scaly.	4. Skin usually dry and cornified.
5. Respiration aquatic, by gills.	5. Respiration aerial, by lungs.
6. Sense organs functional in water.	6. Sense organs functional in air.

Classifying Animals (KINGDOM Animalia)

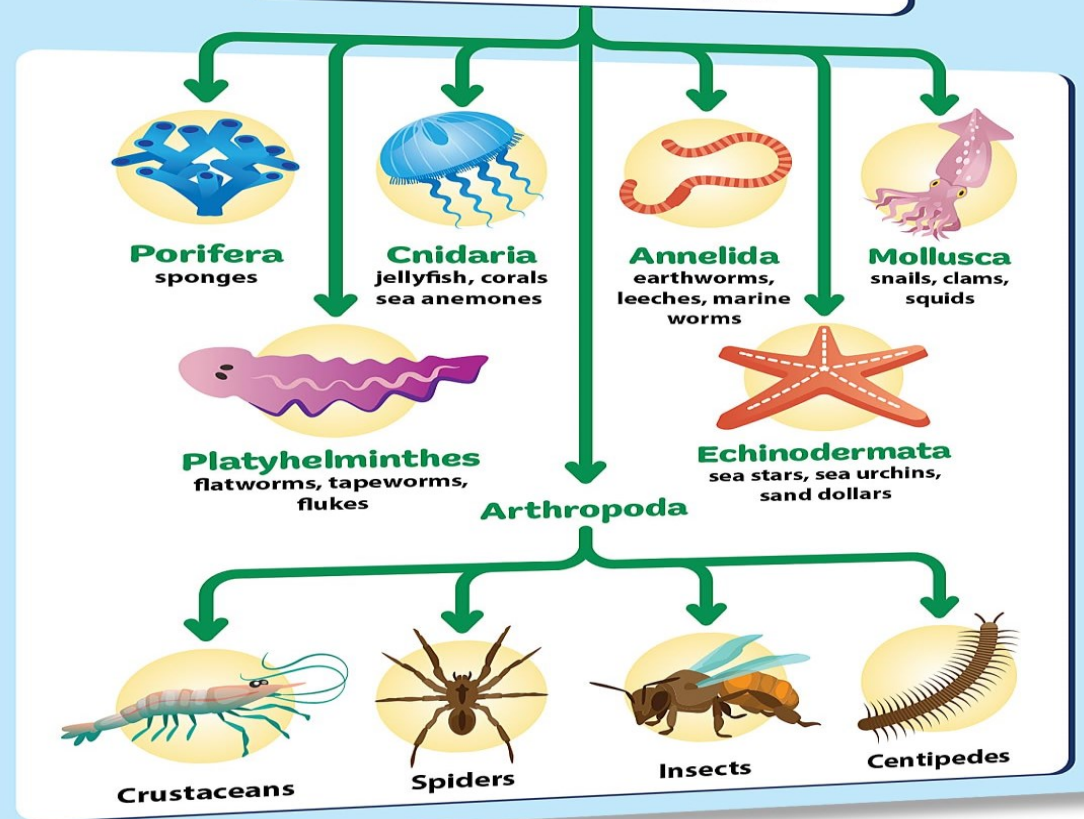
VERTEBRATES

Vertebrates **have a backbone**, are usually larger and faster than invertebrates, have a developed brain (in a skull), and have a complex nervous system.



INVERTEBRATES

Invertebrates **do not have a backbone**, are usually small and slow-moving, do not have a well developed brain, and have a simple nervous system.



Cold-Blooded Animals or Ectothermic animals (Poikilothermic)-Their body temperature changes with the environment.
Warm-Blooded Animals or Endothermic animals. (Homeothermic)- They maintain a constant body temperature, regardless of the environment.

Difference between Vertebrates and Invertebrates

Vertebrates	Invertebrates
1.They have an internal skeleton.	1.Internal skeleton is absent.
2.A backbone is present	2.Backbone is absent
3.A tail is usually present.	3.Tail is absent.
4.Heart is on the ventral side of the body.	4.Heart, when present is on the dorsal side of the body.
5.Nerve cord is dorsal and hollow	5.Nerve cord is ventral and solid
6.They have two pairs of limbs	6.They have three or more pairs of limbs, if present
7.Haemoglobin is present in red blood cells.	7.Haemoglobin, if present, is dissolved in blood.

DIFFERENCE BETWEEN CHORDATES AND NON-CHORDATES

Features	Chordata	Nonchordata
1. Symmetry	Bilateral	Radial, biradial, bilateral or lacking
2. Metamerism	True metamerism	True or pseudometamerism or lacking
3. Post-anal tail	Usually present	Lacking
4. Grade of organization	Organ-system	Protoplasmic to organ-system
5. Germ layers	3, triploblastic	2 (diploblastic), 3 (triploblastic) or lacking
6. Coelom	Truly coelomate	Acoelomate, pseudocoelomate or truly coelomate
7. Limb derivation	From several segments	From same segment
8. Notochord	Present at some stage or replaced by a backbone made of ring like vertebrae	Notochord or backbone lacking
9. Gut position	Ventral to nerve cord	Dorsal to nerve cord
10. Pharyngeal gill-slits	Present at some stage of life	Absent
11. Anus	Differentiated and opens before the last segment	Opens on the last segment or absent
12. Blood vascular system	Closed	Open, closed or absent
13. Heart	Ventrally placed	Dorsal, lateral or absent
14. Dorsal blood vessel	Blood flows posteriorly	Blood flows anteriorly
15. Hepatic portal system	Present	Absent
16. Haemoglobin	In red blood corpuscles	In plasma or absent
17. Respiration	Through gills or lungs	Through body surface, gills or tracheae
18. Nervous system	Hollow	Solid
19. Brain	Dorsal to pharynx in head	Above pharynx or absent
20. Nerve cord	Single, dorsal, without ganglia	Double, ventral, usually bearing ganglia
21. Roots of segmental nerves	Dorsal and ventral separate	Dorsal and ventral roots not separate
22. Reproduction	Sexual reproduction predominant	Asexual reproduction predominant
23. Regeneration power	Usually poor	Usually good
24. Body temperature	Cold or warm-blooded	Cold-blooded

1. Answer the following

- a) Members of acricanata group have no head but vertebral column present--- True or False
- b) limbs are characteristics of which group of animals---- a) Pisces
b) Tetrapoda
- d) The nerve cord or neural tube encloses a cavity called _____
- e) In protochordates and lower aquatic vertebrates, the gill slits are functional throughout life---- True or False

2. Answer the following

- a. Explain briefly the fundamental chordate characters.
- b. Differences between Chordates and Non Chordates
- c. Write the general characters of Phylum Chordata

References:

Kotpal- Modern Textbook of Zoology Vertebrates
Fundamentals of Zoology by Ghosh Manna