Chordata

INTRODUCTION:

- There are nearly 30 recognised animal phyla in which the phylum chordata is the last major group.
- The largest deuterostome, enterocoelomate phylum is CHORDATA.
- The animals of phylum Chordata exhibit **diversity in form, physiology and habit.**
- Phylum Chordata was established by Balfour in 1880. (*Chorde* – string or cord and *ata* – bearing).

CHORDATA CHARACTERISTICS:

- In all chordates there are three outstanding characteristics viz., **notochord, nerve cord, pharyngeal gill slits and Post anal tail.**

1. Notochord or chorda dorsalis :

- The Stiff, elastic, supporting rod – like structure on the dorsal side is **Notochord.**
- Notochord is derived from the chorda – mesoderm of the embryo.
- The notochord is made up of vacuolated cells, covered by an outer elastic membrane and an inner fibrous sheath.
- The notochord is persistent in lower chordates like *Amphioxus*
- In higher vertebrates notochord is seen in embryonic condition and is replaced by a vertebral column in the adults.
- The thickenings of vestigial notochord in the centre of the intervertebral discs of adult mammals are called **nuclei pulposi**.

2. Dorsal tubular nerve cord:

- In chordates the nerve cord is single, dorsal, tubular fluid filled and non ganglionated, whereas in Invertebrates the nerve chord it is ventral, solid and double.
- The nerve cord is located dorsal to the notochord and is derived from the ectoderm. This is differentiated into an anterior brain and a posterior spinal cord in vertebrates.
- The nerve cord controls and coordinates the body activities.
- Nerve chord is degenerated in adult Urochordates.

Pharyngeal gill slits or Bronchial clefts

- In the lower aquatic chordates, the pharyngeal wall is perforated by gill slits meant for the exit of the water current from pharyngeal cavity.
- The gill slits as such are persistent in protochordates, fishes and agnaths. They are functional in amphibian larvae.
- In the transition from aquatic to the land life the function of gill slits is shifted to lungs. Consequently in land vertebrates the gill slits became vestigial and non-functional and are restricted to embryonic stages only.
- The gill slits are developed from the inpouchings of ectoderm and their fusion with the corresponding out pouchings of the endoderm of pharynx.

Post Anal Tail:

- The posterior prolongation of the body is called tail.
- Tail has no coelom, and no viscera, but it has muscles, nerve cord and notochord. The tail in chordates is behind the anus.

Other Characteristics of Chordata

- **Symmetry:** Chordates are bilaterally symmetrical like the other phyla like Annelida, Arthropoda.
- **Metamerism:** The body exhibits segmental organisation or metamerism. In chordates segmentation is internal as evident from the musculature, arrangement of vertebrate and nerves.
- **Coelom:** The coelom of chordates is enterocoel as in Echinodermata.
- **Skeleton:** To permit movements of the body many chordates have an endoskeleton made up of bone or cartilage.
- **Heart:** In most chordates the circulation of blood is maintained by muscular heart. Heart is ventral in position, and is **myogenic**. Unlike in nonchordates the flow of blood in dorsal blood vessel is from anterior to posterior and in the ventral blood vessel it is from posterior to anterior end, which is opposite to that of invertebrates.
- **Hepatic Portal vein:** The blood vessel called hepatic portal vein collects the blood containing amino acids, glucose from the digested food from the alimentary canal and opens into the liver through capillaries.
- **Muscle Phosphogen:** The muscle phosphogen in the chordates is **creatine phosphate**.
- **Blastopore:** Blastopore formed during gastrulation develops into an anus. This condition is called **deuterostomate** condition.
- **Cleavage:** Cleavage is **radial** and **indeterminate**. In addition they exhibit characters like cephalisation and triploblastic condition.

ANCESTRY OF CHORDATES AND VERTEBRATES:

- The geological records firmly establish the origin of chordates prior to **Cambrian period.**

I. Evolution of chordates:

1. Echinoderm ancestry: Garstang suggested that probably the free-swimming auricularia larva of echinoderms became sexually mature and later this neotenic larva gave rise to the chordates.

- Chordates resemble echinoderms in the cleavages, fate of balstopore, coelom formation, mesodermal endoskeleton, serum proteins and creatine phosphate as muscle phosphagen.

2. Common Ancestry for Deuterostomate

- Proposed by Romer, Berrill, Barrimgton.

- According to them Echinodermates, pterobranches, hemichordates and chordates show common ancestry.

a) Embryological evidences: Radial and indeterminate cleavage, Blastopore forms the anus, Coelom formation is enterocoelomate, suggest the common ancestry of the three phyla. Echinodermata, Hemichordata and Chordata.

b) Biochemical evidences :

- All deuterostomes have creatine phosphate as muscle phosphogen, while the invertebrates have arginine phosphate.
- Hemichordates and Echinoderms have both arginine and creatine phosphate.
- These facts show that hemichordates are connecting link between chordates and non chordates.

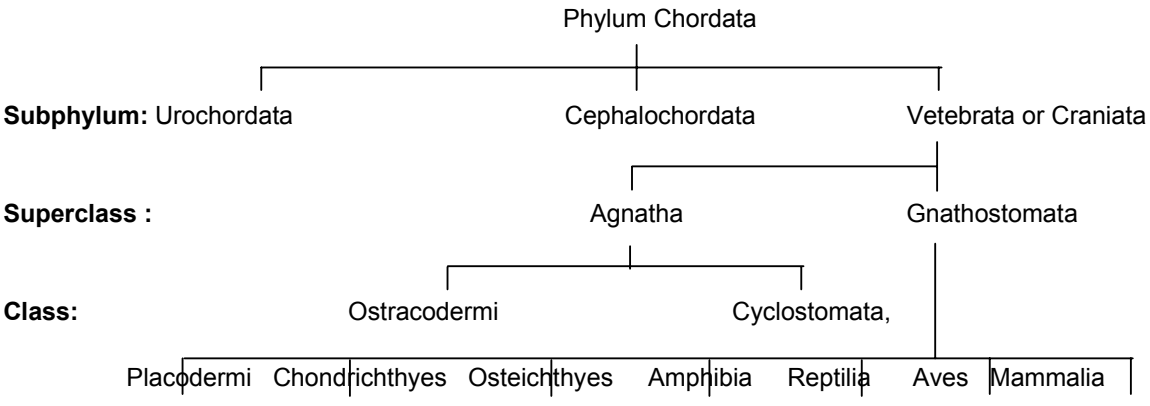
c) Serological evidences: Serological tests show that proteins of the three deuterostome phyla, Echinodermata, Hemichordata and Chordata are more closely related.

- Hyman concluded that all these might have a common ancestor, probably an arm feeder ancestor.
- Echinoderms and pterobranchs branched off from a common evolutionary line as arm feeders.
- A shift from arm-feeding to gill-feeding produced the primitive gill-feeders from which hemichordates and primitive ascidians branched off.

Urochordate ancestry of vertebrates:

- This theory is advocated by **Garstang (1928)** later elaborated by **N.J.Berrill** (1955) and **Romer** (1959).
- According to them the adult ascidians reflect the primitive filter feeding condition of chordates.
- According to this theory the tadpole larva failed to metamorphose into adults but became neotenous and developed into the paedomorphic adult
- Paedomorphosis allowed chordate characters of larval tunicates to be passed on to succeeding generations of adult animals.
- The principal drawback of this theory is that it considers sessile urochordates to be ancestors of chordates.

OUTLINE CLASSIFICATION OF PHYLUM CHORDATA:



SUBPHYLUM – I:

***UROCHORDATA (Uro*–TAIL, *Chorda*–NOTOCHORD)**

- Sedentary or pelagic marine animals.
- Adult body is usually **degenerate.**
- There is a **tunicin similar to cellulose** covering the body. Hence referred as *tunicata.*
- **Notochord is present only in Larval Tail**, hence the name Urochordata.

- On the ventral side of pharynx **Endostyle** is present.
- Blood vascular system is open. Flow of blood is periodically reversed. The blood pigment is vanadium. Heart is **tubular**.
- Pharynx is surrounded by **ectoderm lined cavity** called **atrium.**
- Development is indirect, with a tailed free swimming larva.
- Adults lack notochord, tail and nerve chord. **Well developed chordata feature in adults** is the pharynx with **pharyngeal gill slits**.
- Sub Phylum Urochordata is divided into 3 classes.
  1. Ascidiacea, 2. Thaliacea 3. Larvacea.

Class 1: Ascidiacea

- Solitary or colonial, bottom living.
- Ascidians are called **sea squirts** as the water inside the body is expelled out like jets, when they are disturbed.
- Body is enclosed in permanent test
- Adults are usually sessile. Larva is free swimming.
- The larval notochord, nerve cord and tail are lost and brain is reduced into a solid ganglion during metamorphosis. **This phenomenon is called retrogressive metamorphosis.**
- E.g. *Herdmania,* - Marine, solitary and sedentary tunicate inhabiting temperate seas. It has a terminal bronchial aperture and an atrial aperture.
- *Botryllus* – Sedentary colonial ascidian found in European seas.

Class 2: Thaliacea

- Adults are free swimming and pelagic.
- Tunic is permanent transparent with muscular bands arranged with incomplete rings (e.g. Salpa) complete (eg: Doliolum).
- Life history of some shows alternation of generations.
- e.g. (i) *Pyrosoma*: Bioluminescent colonial form. *Pyrosoma* emits the strongest light among the marine organisms.
  (ii) *Salpa* & (iii) *Doliolum:* These are cosmopolitan marine pelagic forms. They exhibit alternation of generations.

Class 3: Larvacea

- Small, solitary and free swimming.
- Neotenic forms with a persistent tail, notochord, nerve cord and brain.
  E.g. *Oikopleura.* It is a neotenic, free swimming, pelagic, tiny and solitary form.

SUBPHYLUM-II: CEPHALOCHORDATA

- Marine, Sedentary animals.
- Body fish like and transparent.
- Notochord rod like, persistent and extend from tail to rostrum.
- The name cephalochordata is derived from the fact that the **notochord extends forwards inside rostrum even beyond the so-called brain.**
- Gills are useful in filter feeding.
- **Respiratory pigment is absent in the blood**. Heart is absent.
- Excretory organs are protonephridia with Solenocytes.
- Development is indirect.
  E.g. *Branchiostoma* (*Amphioxus*)
- It is a marine animal found commonly in shallow waters.
- It is found buried in the sand in an upright condition.
- It is a typical ciliary feeder and feeds mainly on microorganisms brought along with respiratory-cum-food current.
- The cephalochordates and urochordates together called acraniates because of the absence of cranium.

SUB PHYLUM – III: VERTEBRATA

- This subphylum is also called Craniata due to the presence of cranium which covers the brain.
- Locomotory organs are fins (or) limbs. Fins are paired (lateral fins) and unpaired fins (median).
- 6 pairs of aortic arches and seven pairs of visceral arches are present in the embryonic condition.
- Heart is two to four chambered. Paired sensory organs like optic, auditory and olfactory are present on the head.
- The subphylum vertebrata is divided into 2 super classes: 1) Agnatha and 2) Gnathastomata.

Superclass: Agnatha

- Agnatha includes jawless fishes, found from Ordovician rocks.
- Visceral arches are unmodified. They are divided into two classes.
  Ostracodermi – extinct
  Cyclostomata – living

Class 1 – Ostracodermi :

- They were quite abundant in upper Silurian and Devonian periods in the bottom sediments of fresh water streams.
- The head is enclosed in a shield made up of bony dermal plates, while the rest of the body is covered by smaller plates. This leads to their name 'Ostracoderms' or 'armoured fishes'. Paired fins are present. In some agnaths single nostril is present (**Monorhina**) e.g. *Cephalaspis*. Others have two nostrils (**Diplorhina**).
- Paired fins are present. E.g. *Cephalaspis*

Class 2 – Cyclostomata :

- Body elongate and eel like.
- Paired fins are absent, tail **diphycercal**.
- Endoskeleton fibrous and cartilaginous.
- Mouth ventral suctorial and circular.
- Gills are 5-16 pairs.
- Heart is two chambered. Renal portal system is not developed.
- Semicircular canals in the internal ear are one or two.
- Gonoducts are absent
- Lampreys and hag fishes are included in this class. Lampreys are freshwater and marine forms.
- Hagfishes are marine in habitat.
  E.g. **Petromyzon**
- It is commonly called lamprey.
- Both marine and fresh water forms.
- Suctorial buccal funnel with many horny teeth. Gill slits are 7 pairs.
- Ear with 2 semicircular canals.
- It exhibits sanguivorous habit, rasp away flesh and suck out blood from sharks. Thus they lead an ectoparasitic life.
- It exhibits anadromous migration, ascending fresh water rivers and streams for spawning.
- Larva is **Ammocoetes**.

Myxine:

- This is called **Hag fish**.
- Hag fishes are exclusively marine.
- Body soft, scale less, elongated and eel like.
- There are sensory tentacles around the mouth
  6 pairs of gill pouches.
- Ear with a single semi circular canal.
- *Myxine* produces enormous quantity of slime; hence they are called **slime eels**. They feed on dead fish. (Necrophagous)

Superclass : Gnathostomata

- Vertebrates with well developed mouth between two jaws.
- The paired fins or appendages are present.
- Ear with 3 semi circular canals.
- Gonads open into gonoducts.
- Exoskeleton is usually present.
- The super class Gnathostomata is divided into 7 classes.
  1. Placodermi, 2. Chondrichthyes, 3. Osteichthyes, 4. Amphibia, 5. Reptilia, 6. Aves and 7. Mammalia.

FISHES :

- Includes Placodermi, Chondrichthyes and Osteichthyes.
- They are aquatic, gill breathing with paired fins.
- Placodermi are extinct fishes while Chondrichthyes and Osteichthyes are living.
- They study of fishes is called **Ichthyology.**

AMIPHIBIA :

- Amphibians are vertebrates with no exoskeleton. They are the first tetrapods.
- Their early development is in water and in adult stages they are lung breathing and amphibious.
- Frogs and Toads are included in this group.
- The classes of amphibians and fishes are together included under *Ichthyopsida* or *Anamniota.*
  e.g. Frogs, toads, salamanders, newts, caecilians etc.

REPITILES :

- These are first terrestrial animals with Keratin in their skin.
- They lay their eggs on land.
- They are the first amniotes.

- Study of reptiles is **Herpetology.**
  e.g. Lizards, Turtles, Crocodiles and Snakes.

AVES :

- Bipedal, aerial vertebrates.
- The study of birds is **Ornithology.**
- Birds and reptiles together included in a group called ***Sauropsida***.

MAMMALS :

- These are highly advanced intelligent group of vertebrates.
- They feed their young ones with the milk produced by the mother.
  e.g. Man, Elephant.
- Reptiles, Birds and Mammals are studied under **amniota** due to presence of extra embryonic membrane called amnion.