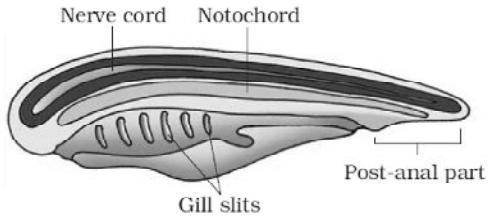
CHAPTER 00 | ANIMAL KINGDOM - PHYLUM CHORDATA

Most advanced animal phylum, over 50,000 living species. They are bilaterally symmetrical, triploblastic, coelomate with organ-system level of organisation. All the chordates possess some diagnostic features either in the embryonic stage or throughout life.

Chordate characteristics



Notochord - The name chordata refers to a common feature in the form of stiff rod like structure along the back, called notochord. It is a primary axial supporting skeleton laid during the embryonic stage. It persists throughout life in some primitive chordates but, in majority it occurs only during embryonic stage, as it is replaced in adult by a cartilaginous or bony vertebral column.

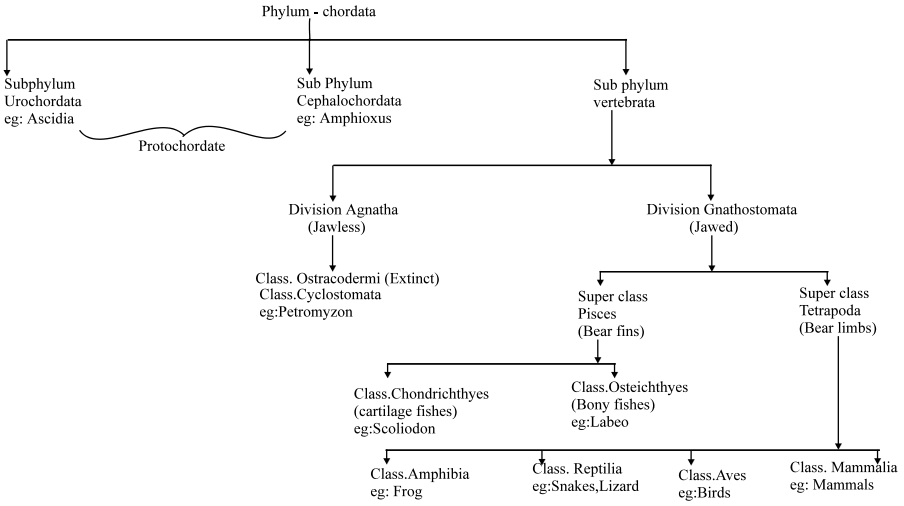
Nerve cord - Single, dorsal, hollow / tubular and non-ganglionated fluid filled nerve cord lie mid dorsally above the notochord. In most chordates its anterior part enlarges to form a brain while the remaining part forms the spinal cord, both together forms the CNS.

Pharyngeal gill slits - Paired lateral openings leading from the pharynx to the exterior, primarily for respiration. They serves for the passage of water from the pharynx to the outside, thus bathing the gills for respiration. In protochordates and lower aquatic vertebrates, the gill slits are functional throughout life.

Post and tail- Posterior prolongation of the body beyond anus. It has no coelom and viscera but has extensions of muscle, nerve cord, notochord etc.

In addition to these fundamental features, chordates also possess - ventral heart, closed circulation, metameric segmentation, enterocoelom, deutero-stomous condition, mesodermal endoskeleton, well marked cephalization etc.

Classification of phylum chordata upto class.

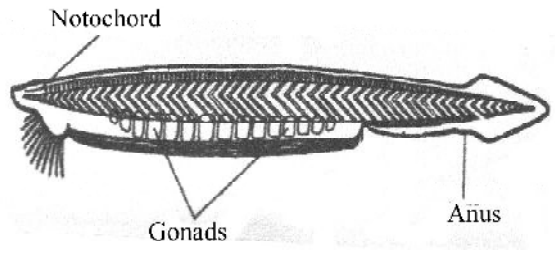


Urochordata

- Exclusively marine, mostly sessile, solitary or colonial primitive chordates
- Notochord is present only in the larval tail and disappears in the adult
- Adult body is covered by a protective leathery test or tunic composed of tunicin, a cellulose like substance. Hence the name tunicata.
- Dorsal tubular nerve cord is found in larva. It is replaced by a dorsal ganglion in the adult.
- Pharynx is perforated by numerous gill slits.
- Ventral heart and open circulation
- Mostly hermaphrodites, external and cross fertilization.
- Indirect development with tailed ascidian tadpole larvae.
- Larvae undergoes retrogressive metamorphosis.

eg. Ascidia, Salpa, Doliolum, Pyrosoma, Herdmania

Cephalochordata



- Exclusively marine, small fish like burrowing protochordate.
- Notochord extends from head to tail region and persists throughout life.
- Blue print of chordates - members of this group are the first complete chordate animals because all the primary chordate characters are present even in the adult stage.
- Ciliary filter feeding animal. They possess an arterior wheel organ which helps in the ingestion of food by producing circular current of water.
- Numerous pharyngeal gill slits - branchial basket.
- Closed circulation.
- Protonephridia with solenocytes for excretion.
- Unisexual, external fertilization and indirect development.

  eg. Branchiostoma (Amphioxus or Lancelet).

Verteberata

- Notochord is present in embryos and it is replaced by bony or cartilaginous vertebral column in adult.
- All vertebrates are chordates but all chordates are not vertebrates.
- Nerve cord in embryo is differentiates as brain and spinal cord.
- Advanced chordates with cranium around brain, called craniates.
- High degree of cephalization
- Exoskeleton may be scaly, feathery, hairy etc.
- Endoskeleton may be cartilage, bone, cartilage and bone.
- Striped, unstriped and cardiac muscles
- Enterocoelom
- Aerobic respiration - lungs, gills, skin, buccopharyngeal.
- Closed circulation - blood vascular system and lymphatic system.
- Ventral muscular myogenic heart with 2/3/4 chambers
- Presence of Hb in RBC
- Paired kidneys for excretion and osmoregulation
- Well developed sense organs.
- Chemical co-ordination through endocrine glands.

- Sexes are usually separate, fertilization may be external or internal, development may be direct or indirect.

Agnatha - cyclostomata

- The mouth is devoid of jaws and hence the name Agnatha.
- Sucking and circular mouth without jaws.
- Elongated, eel like body, devoid of scales and paired fins.
- Generally ectoparasites on the fishes.
- Cranium and vertebral column are cartilaginous.
- Notochord persists throughout life.
- 6-15 pairs of gill slits for respiration.
- Closed circulation with 2 chambered heart.
- Migrate to fresh water for spawning - anadromous migration.
- After spawning within a few days, they die.
- Ammocoete larvae, after metamorphosis return to ocean.

eg. Petromyzon and myxine.

Pisces

- Most abundant and first true jawed vertebrates -gnathostomes.
- Aquatic animals with stream lined body.
- Poikilothermic or ectothermic and anammiotes
- Body is covered by dermal scales such as placoid, cycloid or ctenoid
- Paired pectoral and pelvic fins.
- Unpaired fins or median fins like dorsal, ventral and caudal fins.
- Eye without eyelids, well developed nictitating membrane
- Branchial respiration, 4 to 7 pairs of gill slits.
- Heart is 2 chambered, known as venous heart, because it contains only deoxygenated blood.
- Mesonephric kidney for excretion
- Only internal ear, external and internal ear are absent.
- Lateral line sense organs are present, which can detect vibrations and electric field.

- Sex separate, mostly external fertilization and oviparous, direct development.

Chondrichthys - Cartilaginous fishes.

- Marine fishes with skeleton made up of cartilages.
- Notochord is persistent throughout life.
- Tough skin and minute placoid scales cover the body.
- Large ventral mouth.
- Predaceous animals with powerful jaw.
- Teeth are modified placoid scales which are backwardly directed.
- Caudal fin mostly heterocercal.
- 5 - 7 pairs of gills, gill slits are separate and without operculum.
- Air-bladder is absent and animals have to swim constantly to avoid sinking.
- Ureotelic mode of excretion
- Presence of cloaca and cloacal aperture.
- Unisexual, internal fertilization with the help of claspers attached to the pelvic fins of male.
- Mostly viviparous or ovo-viviparous.

Eg:-Scoliodon/dog fish, Carcharadon/great white shark.

Pristis - Sawfish, saw like rostrum which bears tooth like denticles, it is used for prey capture, digging, offence and defence.

Trygon - Sting ray, tail is whip like bearing a spine.

Torpedo - Electric ray, a pair of electric organs are situated on the dorsal side of the trunk, generate electric current.

Osteichthyes - Bony fishes

- It includes both marine and fresh water fishes with bony endoskeleton.
- Notochord is present only in embryos and replaced by vertebral column.
- Large cycloid / ctenoid scales cover the body.
- Mouth is small and mostly terminal
- Homocercal caudal fin
- 4 pairs of gills which are covered by an operculum.

- Swim bladder regulates buoyancy.
- Nitrogenous waste matter is mostly ammonia - ammonotelism.
- Separate anal and urinogenital opening.
- Fertilization is generally external and mostly oviparous.

  eg: **Fresh water fishes**- Labeo (Rohu), Catla (Katla), Clarius (Magur/cat fish), Etroplus-pearl spot, Anabas - Climbing perch
- **Aquarium fishes** - Betta (fighting fish), pterophyllum (Angel fish)
- **Marine fishes** - Exocoetus (Flying fish), Hippocampus (Sea horse).

  Echeneis - sucker fish, Anguilla - eel, Mackeral, Sardine,

  Chimera - Cartilaginous fish with operculum, connecting link between cartilaginous and bony fish.

  Latimeria - Coelocanth, living fossil - connecting link between fishes and amphibians.

  Amphibia
- First vertebrate to invade land.
- Dual mode of life; can live in aquatic and terrestrial habitat.
- First tetrapods with 2 pairs of limbs - generally pentadactyl.
- Digits are without claws, and often have webs.
- Poikilothermic and show hibernation and aestivation.
- Body is divided into head and trunk, and tail is present in some forms.
- Skin is moist, smooth, glandular and scaleless.
- Ear consists of internal and middle ear. Tympanum directly receives sound waves.
- Eyes with movable lower eyelids and nictitating membranes.
- Carnivorous animals with protrusible tongue.
- Dentition - Homodont, polyphyodont and acrodont.
- Alimentary canal, urinary and reproductive tracts open into a common cloacal chamber that opens to the outside through cloacal aperture.
- Respiration is by lungs on land, by skin while in water and by gills in tadpoles.
- Trilocular heart with 2 auricles and a single ventricle.
- Incomplete double circulation

- Accessory heart chambers are sinus venosus and conus arteriosus.
- RBC is oval, biconvex and nucleated.
- Well developed renal and hepatic portal system.
- Kidneys are mesonephric.
- Mostly urieotelic (Frogs and toads), but amphibian tadpoles and tailed amphibians are ammonotelic.
- Sexes are separate; animals are oviparous with external fertilization. Development involves a tadpole larva.

Class amphibia is divided into 3 orders

1. **Anura** - tailless but limbed amphibians - Frogs and Toads.

eg: - Rana tigrina -Indian bull frog, Bufo-common toad

Hyla - tree frog, Rhacophorus - flying frog, Alytes - midwife toad.

2. **Apoda** - limbless amphibians

• Primitive amphibians with scales

• Blind, worm like and burrowing

eg : - Ichthyophis, Uraeotyphlus

3. **Urodela** - tailed amphibians

• lizard like amphibians with a distinct tail.

eg. Salamanders, newts etc.

Seymouria - a fossil amphibian, believed to be the connecting link between amphibia and reptilia.

Reptilia

- First true land animals and amniotes.
- Creeping and crawling mode of locomotion.
- Mostly terrestrial and carnivorous animals
- Body is divided into head, neck, trunk and tail.
- Skin is dry without glands and body is covered by dry and cornified skin, epidermal scales or scutes.
- Snakes and lizards shed their scales as skin cast.

- Trunk bears two pairs of pentadactyl limbs with clawed digits.
- Tympanum represents ear
- Alimentary canal terminates into a cloacal aperture.
- Pulmonary respiration throughout life.
- Heart is 3 chambered or incompletely four chambered, having two auricles and a partly divided ventricle.
- Crocodiles have a completely 4 chambered heart and complete double circulation.
- Metanephric kidney for excretion and mostly uricotelic.
- Unisexual, internal fertilization, oviparous, direct development.

Eg: - **Chelonians** → Chelone (Turtle), Testudo (Tortoise)

Lizards → Chameleon (Tree lizard), Calotes (garden lizard), Hemidactylus - wall lizard, Draco - flying lizard

sphenodon- Tuatara, Varanus - monitor lizard (largest living lizard).

Snakes

Poisonous snakes → Naja, Bangarus - Neurotoxic venom

Viper, rattle snake - Haemotoxic venom

Non-poisonous snakes → Python, Natrix, Ptyas.

Crocodilians → Crocodile, Alligator, Gavialis

Aves

- Flying vertebrates with feathery exoskeleton.
- Most of them can fly (carinatae), except flight less birds (Ratitae).
- Boat shaped and stream lined body.
- Body is divisible into head, neck, trunk and tail.
- Body temperature is regulated (Homeothermy) and high.
- Skin is dry without glands, except the oil gland/preen gland
- Jaws are modified into beak, which lacks teeth.
- Forelimbs are modified into wings for flight.
- Bipedal locomotion
- Hind limb have scales, which indicate reptilian ancestry.

- Hind limbs are modified for walking, swimming and perching.
- Endoskeleton is fully ossified (bony).
- Long bones are pneumatic, hollow with air cavities.
- Alimentary canal has crop for storing food and gizzard for grinding food, digestive tract exit out through cloacal aperture.
- Pulmonary respiration, lungs are spongy and elastic.
- Mostly 9 air sacs are connected with lungs to provide buoyancy and to supplement respiration.
- Heart is completely 4 chambered and there is double circulation.
- Sound produced by sound box, called syrinx.
- Kidneys are metanephric, excretory matter is chiefly uric acid.
- Many bones are fused to acquire strength, which helps in flight

  Synsacrum $\rightarrow$ sacral vertebrae fused together with some other vertebrae

  Furcula $\rightarrow$ Clavicle and interclavicle together form a wish bone.

  Pygostyle / urostyle $\rightarrow$ fusion of some caudal vertebrae

  Keeled sternum $\rightarrow$ Keel is a ridge on the sternum which provide place for the attachment of flight muscles.

  eg : -Flightless birds $\rightarrow$ Ostrich, Emu, Kiwi, Rhea, Cassowary, Penguin

  Flying birds $\rightarrow$ Corvus, columba, Psittacula, Pavo, Nephron.
- Unisexual, internal fertilization, oviparous, cleidoic egg, direct development.

Mammalia

- Most advanced and most dominated animal group
- Found in diverse habitats - forests, deserts, mountains, grasslands, polar ice caps, dark caves etc.
- Primarily terrestrial animals, some of them adapted to fly (Chiropterans) or live in water (Cetaceans).
- Most unique mammalian feature is the presence of milk producing mammary glands to feed their young ones.
- Hairy exoskeleton, which conserve body heat - homeothermic
- Skin pocess sweat glands (sudoriferous) and oil glands (Sebaceous)
- Two pairs of pentadactyl limbs, variously adapted for walking running, climbing, burrow-

ing, swimming, grasping, flying etc.

- External ears or pinnae are present.
- Endoskeleton mainly bony.
- Skull is dicondylic; has two occipital condyles.
- Cervical vertebrae are seven in number.
- Acoelous / Amphiplatyan vertebrae
- Bicephalic ribs - ribs articulate with vertebrae by 2 articulation points.
- Muscular diaphragm divide coelom into anterior thoracic cavity and posterior abdominal cavity.
- Dentition - Heterodont, Thecodont, Diphyodont
- Pulmonary respiration; lungs are spongy and elastic.
- Tetralocular heart and complete double circulation.
- RBCs are circular, biconcave and non-nucleated.
- Kidneys are metanephric type and ureotelic mode of excretion.
- Anus and urino-genital openings are separate.
- Well developed brain; large cerebrum and cerebellum.
- Corpus callosum connects the two cerebral hemispheres.
- 12 pairs of cranial nerves.
- Sex separate, sexual dimorphism, internal fertilization, mostly viviparous, extra abdominal testis, copulatory organ, direct development, parental care.
- Amnion, chorion, allantois and yolk sac surrounds the developing embryo.

Prototheria $\rightarrow$ primitive egglaying mammals, considered as the connecting link between reptiles and placental mammals.

Animal without placenta, pinna, scrotum, corpus callosum etc.

eg: - Ornithorhyncus (platypus), Tachyglossus (Echidna).

Metatheria $\rightarrow$ Pouched mammals, females have a marsupium/brood pouch for rearing young ones.

eg:-Macropus, opossum, wombat, Koala, Tasmanian wolf etc.

Eutheria $\rightarrow$ True placental mammals; complete development inside the uterus.

eg : - Balaenoptera, Delphinus, Pteropus, Macaca, Camelus, Elephas, Equus, Felis, Canis, Rattus, Panthera tigris, panthera leo etc.