CHAPTER 6

ANIMAL KINGDOM (CHORDATES)

Topics Discussed

NTRODUCTION

HYLUM CHORDATA

Acraniata or Protochordata Craniata or Vertebrata

1. Introduction

The organisms are classified in five kingdoms. Animal kingdom is the biggest one in terms of class and sub class. Echinodermata and Hemichordata are studied in previous chapter, now Chordata are discussed in details here. Chordates are largest existing animals now and are most successful in terms of ecology in this kingdom. The organisms show diversity in habitat, physiology, and form. The name of this phylum is a Greek word.

This chapter is detailed discussion of this phylum with its class, sub class and super class.

Objectives of this chapter

At the end of this chapter, you will be able to:

- Evaluate the phylum class and sub class.
- Locate the mammals in the kingdom
- Realise the extent of diversity in once thought to be similar animals.

2. Phylum Chordata

- Chordate is two words of Greek language as '*Chorda*' 'a thick string' and the '*Ata*' 'to have' and thus chordate animals have notochord.
- Notochord is the support for the body structure of these animals which is present in the organisms at all the stage in the life.



Figure 6.1: Amphioxus structure

- Animals that lack notochord, are called as non-chordates.
- According to taxonomists, from the total number of organisms present on earth, 90-95% animals are non-chordates and 3-5% animals are chordates.
- In chordates, Pisces group includes maximum species while minimum animals is in the Amphibia group.

Three Fundamental Characters of Chordates

Chordate animals have some specific characters in life span, called as the fundamental chordate characters.

These are as follows:

(i) Presence of notochord / *Chorda dorsalis* – Embryonal chordate animals have a solid stick-like structure (located below the CNS, above alimentary canal), called as the notochord.

- Notochord is located at the dorsal surface in the body and extends between anterior ends and posterior ends.
- Notochord has mesodermal origin and forms a primary endoskeleton supporting the central nervous system (CNS) and the muscles.
- Protochordata has notochord throughout the life span. Vertebrata has modified notochord in the form of back bone or vertebral column, which surrounds spinal cord and cranium around the brain.

(ii) Presence of dorsal tubular nerve cord

- Nervous system is present at the dorsal surface of the body in chordate animals.
- A hollow tubular structure is present just beneath the body wall and just above the notochord.
- Nerve cord has ectodermal origin (formed from the ectoderm in the embryo).
- Non-chordates have solid and double nerve cord which is situated at mid ventral side of the body E.g. in Annelids and Arthropods.
- Chordates lack Ganglia in the nerve cord.

(iii) Presence of pharyngeal gill - clefts

- Chordate animal have paired, lateral gill clefts present in the pharynx walls that are used for respiration throughout life.
- Chordate animals have pharyngeal gill clefts which are only in the embryonal stages, disappear in adults.
- Aquatic chordates (Pisces) have pharyngea gill clefts that is used for respiration throughout their life span.
- Terrestrial chordates have lungs as the main respiratory organ.

(iv) Post anal tail – It is the post anal part of the body. Tail is reduced or absent in many adult chordates. It is considered as fourth character of chordates.

2.1 General Characters of Chordate

- Aquatic, terrestrial or aerial habitats are common and are free living.
- Bilateral symmetry of the organisms.
- Triploblastic i.e. made from the three germinal layers ectoderm, mesoderm and endoderm.
- Arrangement of muscles in embryonic stages and in adults, vertebrae and ribs is due to metamerism.
- True coelom of enterocoelous type is present. (Deuterostomous animals)
- Alimentary canal is complete. Digestive system, digestive glands are present which complete the digestion extracellularly.
- Heart is located below the alimentary canal at the ventral side of the body, and the blood flows from the anterior to the posterior side in dorsal blood vessel.
- Blood vascular system is of the closed type. Respiratory pigment is haemoglobin in the RBCs
- Hepatic portal system is common among all. Also renal portal system is present in the chordates (not in birds and mammals).
- Exoskeleton is highly developed among the vertebrates.

- In chordates, endoskeleton is found which is made up of cartilage and bones.
- Embryonic stages show presence of a muscular tail called as post anal tail which gets reduced later in some of the chordates E.g. man, apes.
- Proto, meso and metanephric kidneys constitute the excretory organs.
- Sexual reproduction is most dominant. Sexes are separate.
- Metamorphosis or development of embryo is direct i.e. without any larval stage (few exceptions).
- Chordates may be cold blooded (Poikilothermous) E.g. Amphibians, Reptiles and fishes or warm blooded (homeothermous) E.g. Birds and Mammals.

2.2 Classification of Chordata

Phylum chordate has diversity in the cranium, vertebral column and paired appendages. This is the basis for division into two groups– Acraniata or Protochordata and Craniata or Vertebrata

3. Acraniata or Protochordata

- Small, marine animals.
- Respiration is by gills.
- Pharyngeal gill clefts are present in embryonic as well as adult stages.
- Notochord stays throughout the life, and completely lack skull, brain and vertebral column.
- Notochord does not replaces vertebral column.
- Also they lack exoskeleton, head and paired appendages.
- Acrania group is divided into two sub-phylum:
 - o Subphylum 1- Urochordata
 - o Subphylum 2- Cephalochordata

3.1 Sub-Phylum – Urochordata or Tunicate

- Marine, freely swimming larva while adults remain attached to the rocks.
- Notochord exists in the tadpole larva tail which reduces during metamorphosis. Chordate characters exists in the tadpole larva tail, which gives the name Urochordata to this subphylum.
- Adults have leathery test all over their body which is tunicin made of the tunic (like cellulose) naming the group as tunicate.
- Food is taken with the ciliary help.
- A ciliary glandular slit around the ventral surface of pharynx is called as endostyle. The main work is to absorb iodine from marine water.

- Endostyle is similar to the mammalian thyroid gland.
- Blood vascular system is of the open type. Heart is at ventral side of the body. Respiratory pigment is vanadium in the blood stored in the purple blood corpuscles which is called as vanadocytes.
- Excretion occurs through supra neural gland, pyloric gland and nephrocytes.
- Dorsal tubular nerve cord exists only in larval stage in the nervous system. Adults when matured the nerve cord gets modified into a neural ganglion.
- Sexes are separate in animals (bisexual).
- External cross fertilisation.
- A free swimming larval stage, like tadpole of the frog, is present called as tadpole larva.
- "Retrogressive metamorphosis" is common in animals where a well-developed free swimming larva develops into under developed, fixed adult. The larval stage is more developed than the adults.
- Only pharyngeal gill clefts (chordate charcter) is found in adults.
- E.g. Herdmania Sea potato or sea- squirts.

Ascidia

Ciona

Botryllus

Pyrosoma – Biolumniscence is found. (Strongest light among marine organism)

Doliolum – Barrel shaped.

Salpa

Oikopleura – Shows pseudomorphism – A gelatinous sheet envelops the animal. Which has emergency back door to escapes.

3.2 Sub-Phylum – Cephalochordata

- Shallow sea water dwellers.
- Burrows in sand are made in which they grow coming out only in night (nocturnal).
- Body is laterally compressed like fish, and is segmented.
- Body is divided into trunk and tail without head.
- Paired appendages is replaced by unpaired fins.
- Alimentary canal is complete. Buccal cavity has cover on all four sides of oral hood. "Wheel organ" or "Ciliated organ of Muller" is present below it. This organ ingests food after producing circular currents in water.





Figure 6.2: Structure of Herdmania

Test or

Tunic

Branchial

aperture

Atrial

aperture

Foot

- Ciliary feeders feeding on the diatoms and microbes.
- Circulation system is of closed type without heart and respiratory pigment.
- Hepatic portal system is present for excretion.
- Protonephredia are present as flame cells or solenocytes. Hatschecks nepheridium (single) helps in the excretion.
- Nervous system is in dorsal position, is tubular and hollow nerve cord.
- Notochord and nerve cord extend from one end to the other end in the body.
- Fundamental chordate characters persists throughout life.
- Unisexual animals. External fertilisation.
- Development is indirect via. Larval stage.
- Members of this group have developed to be the first complete chordate animals.
- E.g. Branchiostoma or Amphioxus (Lancelet). Also called a typical chordate.

4. Craniata or Vertebrata

- These animals are known as higher chordates due to the presence of highly developed/ advance characters.
- These characters include prominent head, vertebral column, jaws and cranium.
- Only one subphylum Vertebrata is included in this phylum chordate.

4.1 Sub-Phylum - Vertebrata

- In these animals, notochord is completely or partially replaced by cartilaginous or bony vertebral column.
- Brain is covered by a protective covering. It is made up of bones or cartilage, it is called cranium.
- There is a prominent head and a well-developed and complicated brain. Nerve cord remains enclosed within the vertebral column.

4.1.1 Agatha

• Group Agnatha is divided into two classes

Ostracodermi

Cyclostomata

Class (A) - Ostracodermi

- All the members are extinct which belonged to this class. The animals were freshwater fishes which were the first complete vertebrates.
- Their body had a protective covering of hard scales.







TRY IT YOURSELF

- 1. Which of the following is not a character of chordates?
 - (A) Notochord is present
 - (B) A post-anal metamerically segmented tail
 - (C) Pharynx perforated by gill slits
 - (D) Heart is dorsal in position
- 2. In which of the following animal the notochord is replaced by bony vertebral column in the adult?

(A) Ascidia	(B) Branchiostoma			
(C) Petromyzon	(D) Labeo			

3. In the sub-phylum (i) notochord is present only in the larval tail, while in (ii), it extends from head to tail region and is persistent throughout their life. In (iii) class of vertebrata notochord is replaced by cartilaginous vertebral column and (iv) class of vertebrata the notochord is replaced by bony vertebral column. Select the option is correct for all (i) – (iv) blanks

(A) (i) – Cephalochordata	(ii) – Urochordata
(iii) – Agnatha	(iv) – Osteichthyes
(B) (i) – Protochordata	(ii) – Urochordata
(iii) – Agnatha	(iv) – Osteichthyes
(C) (i) – Urochordata	(ii) - Cephalochordata
(iii) – Chondrichthyes	(iv) – Osteichthyes
(D) (i) - Urochordata	(ii) –Cephalochordata
(iii) - Agnatha	(iv) –Gnathostomata
Pancreas is absent in	
(A) Cyclostomata	(B) Chondrichthyes
(C) Osteichthyes	(D) Gnathostomata



4.

Class – (B) Cyclostomata

- The fishes are parasites and scavengers (feeding on plant and animal dead bodies).
- Jaws were absent in the fishes (flase-fishes).
- Body is long, thin, and tubular in shape with a flat tail.
- Skin is soft, smooth and without scales.
- Mouth is round, sucker-like and capable of biting or eating.
- Three eyes: on the head, one median pineal eye along with two lateral eyes.
- Gill clefts range from 6 to 15 pairs.
- Digestive system lacks stomach.
- Notochord as well as vertebral column are present. Cartilage forms the basis of vertebral column and cranium. They lack bones.
- Heart is two chambered, called as venous heart.
- Protonephric or mesonephric kidneys.
- Paired fins are absent. Instead dorsal median and tail fin is present.
- Protocercal tail with extended notochord at the last end and the tail fin has two equal dorsal and ventral lobes.
- Unisexual animal, external fertilization, no larval stage. Larva is present in the development of Petromyzon except Ammocoete.
- Marine animals, some migrate in fresh water for spawning. After spawning they die within few days. After metamorphosis larva returns to the ocean.

E.g.

- Petromyzon or Lamprey It is a living fossil. It is an ectoparasite (Sanguivorous) on true fishes. Many teeth are found in mouth and it shows anadromous migration. Larva Ammocoete is considered as connecting link between Cephalochordata and Cyclostomata.
- Myxine or Hag fish- It has wrinkled lips just like an old woman. It usually remain attached with the gills of host.

4.2 Gnathostomata

Agnatha		Gnathostomata		
•	Lacks Jaws around mouth.	•	Jaws circle the Mouth.	
•	Notochord is in cartilaginous vertebrae.	•	Vertebral column is completely developed.	
•	Paired appendages are present (fins or limbs)	•	Paired limbs are absent.	
•	Only one nostril is present (monorhynous)	•	Paired nostrils are present (Dirhynous)	
•	Two semi – circular canals are found in internal ear.	•	3 Semi-circular canals are found in internal ear.	
•	Two lateral eyes on head along with one pineal eye in middle is present.	•	Pineal eye is absent and only pair of lenses are present.	

Table 6.1: Difference between Agnatha and Gnathostomata

 It is classified into two super classes on the basis of locomotory organs, respiratory organs, and heart and blood vascular system. Super Class – Pisces and Tetrapoda

4.2.1 Super Class – Pisces

- "Devonian period" is called as the "Golden period of fishes"
- True fishes constitute this super class.
- Aquatic habitats found both in fresh water or marine water.
- Body is long, boat shaped, stream lined, with well differentiated head, trunk and tail and without neck. There are slime glands in the skin.
- Body has dermal scales as cover. Exceptions: Cat fish, *Torpedo* and *Wallagonia* fish are without scales.
- Paired fins is used for swimming. E.g. Pectoral and pelvic fins. There are unpaired fins present on the body E.g. mid dorsal fin and caudal fin.
- Teeth are Acrodont type.
- Presence of internal ear (no ossicle or tympanum).
- Respiration is with gills, which are 4 to 7 pairs which can be naked or have a cover operculum.
- Unidirectional blood flow with two chambered heart, called as "venous heart", as it has impure blood,
- Circulatory system also has sinus venosus, renal and hepatic portal systems.
- Bones or cartilage make the endoskeleton.
- Vertebrae in fishes are amphicoelous, which has concave centrum at both the surfaces.
- One occipital condyle is present in the skull of fishes, thus the skull is called as monocondylar type.

- Cranial nerves are in pairs of 10.
- Body has lateral line receptor system, with many receptor organs to detect vibrations (Rheoreceptor) and electric field.
- Kidneys are mesonephric type.
- Excretion is without urinary bladder.
- Cartilaginous fishes urea, marine bony fishes trimethylamine oxide and fresh water fishes ammonia.
- Fishes are unisexual.
- Fertilisation can be either internal or external. Metamorphosis is direct without larval stage.
- These are cold blooded or poikilothermic vertebrates (Exception Tuna fish, Sword fish which they are endothermic).
- Small fishes (Bony fishes) are called as Fry or Hatchling.
- Fishes migrate in a particular season.
 - o Catadromous migration : from fresh water to marine water, E.g. Anguila
 - o Anadromous migration : from marine water to fresh water, E.g. Salmon, Sturgeon and Hilsa

- *Petromyzon*, though marine, goes to fresh water for spawning, i.e., anadromous. After spawing within a few days, they die.
- Larva *Ammocoete* is hatched out from the eggs in about 14-21 days. The larval period may prolong from three to seven years.
- Ammocoete is the connecting link between Amphioxus and the cyclostomes.
- Lingual cartilage in the tongue is also a part of skeleton, that supports it (lingual = related to tongue.)
- Typhlosole is a fold of epithelium in the intestine. It prevents the rapid flow of food in the intestine and increases the absorptive surface area.
- Super class pisces is classified into three classes Placodermi, Chondrichthyes and Osteichthyes.

Class A – Placodermi

- Extinct fishes (Fossil fish) are included that were the first fresh water true fishes which lived from Devonian period to Permian period. Their body had bony plates cover called as "Armoured fishes"
- E.g. Climatius First jawed fish, Dinichthyes

- Types of caudal fin
 - Diphycercal or protocercal: Most primitive kind of tail fin. The tail is symmetrical, both externally and internally as in protocercal, but it is secondary symmetrical.
 - Heterocercal/hypocercal tail: Epicaudal and hypocaudal lobes are of unequal sizes.
 - o Homocercal: Identical lobes. Externally symmetrical and internally asymmetrical.
- Endothermic fishes: Although most fishes are ectothermic, a few species such as blue fish tuna and swordfish are able to maintain a body temperature higher than the temperature of the water that surrounds them. Genetic studies of these endotherms have revealed that the ability to maintain high body temperature gives these fishes an adaptive advantage by allowing them to hunt in much colder waters than their competitors.
- Fish taken out of water dies of suffocation due to the lack of oxygen. This is because the gill filaments stick together when taken out of water, thereby reducing the surface area.

Freshwater Species	Marine Species
Labeorohita (Rohu)	Harrpodon (Bombay duck)
Labeocalbasu (calbasu)	Anguilla (Eel)
Catla catla (Catla/cat fish)	Sardinella (Salmon)
Gyprinus carpio (Carp)	<i>Hilsa</i> (Hilsa)

Table 6.2: Examples of Fresh Water and Marine Water Species.

Some air-breathing fishes used their paired fins to move on land and gave rise to the first land vertebrates. A living fossil of this group is Latimeria, a lobe-finned fish.

Class B – Chondrichthyes or Elasmobranchi

- Cartilaginous marine fishes which had cartilage endoskeleton.
- Notochord is present throughout life.
- Exoskeleton has placoid scales originated from skin dermis are like denticle. Teeth are in backward direction modified placoid scales.
- 5-7 pairs of gills open outside the body through gillslits. Operculum is normally absent in these fishes.
- Mouth with jaws and teeth are at the ventral surface of head. Jaw suspensorium is of the hyalostylic type. Jaws are very powerful which makes the animals predaceous.
- Intestine has a spiral valve or scroll valve to increase surface area for absorption.
- Cloacal aperture is present in which the genital ducts open.



- "Ampulla of Lorenzini" is at the dorsal head which works as thermoreceptor.
- Liver is bilobed.
- Tail is heterocercal type.
- Internal Fertilisation. Male fishes have inner edges of pelvic fins that develop the copulatory organs "Claspers".



Figure 6.6: Structure of Electric ray Torpedo

• Many of them are Viviparous.



Figure 6.7: Structure of Pristis (saw fish)

- Scoliodon Dog fish –sense of smell is like a dog. It is also known as Indian shark viviparous
- Carcharodon Great white shark
- Pristis Saw fish
- Trygon Sting ray dorsal fin has poisonous spines.
- *Torpedo-* Electric ray –electric organ is a modified muscle that gives a shock of about 100 volts. It lacks exoskeleton.
- Sphyrna/zygaena Hammer headed shark
- Stegostoma Tiger Fish/ Zebra shark
- Rhinobatus Guitar Fish.
- *Rhineodon* Whale shark It is the largest true fish. Its length is 13-14 meters.
- *Chimaera* "Rat fish" or "King of herrings" or Ghost fish. Connecting link between bony and cartilaginous fish. Operculum present. Cartilage fish with operculum is placed under holocephali group.

- Stone fish is the most poisonous fish
- Gambusia fish (larvivorous) was introduced into several tropical regions to control malaria.
- Catadromous fishes live in fresh water and go down to sea for breeding, E.g., Anguilla (European eel). When fishes migrate from rivers to sea, it is called catadromous migration.
- *Hilsa* is the only Indian fish that migrate from sea to rivers for breeding.
- Most primitive fish (fossil) is *Climatius* (placodermi).
- Anabas (climbing perch). It has accessory respiratory organs for breathing atmospheric air which enables the fish to take long overland excursions in search of earthworms.
- Pomfret is the most widely eaten fish in India.



Figure 6.8: Various types of vertebrae in animals

- *Dipnoi* has incompletely divided three-chambered heart.
- Urinary bladder is absent in fishes.
- Some elasmobranches retain urea in blood to maintain hypertonicity.
- Ampulla of Lorenzini is a thermoreceptor.
- Electric organs of electric ray are modified muscles.
- Bioluminescent fishes: *Anamalops*, *Porichthyes*, etc.; sound-producing fishes: *Mola*, *Batistes*.

- Poisonous glands are found in sting ray, eagle ray, *Chimaera*, *Diodon*, and *Tetrodon*.
- Fish byproducts are fish meals and fertilisers; fish flour, fish proteins, fish oil, steaming, fish glue, leather, artificial pearls, etc.
- Weberian ossicles were discovered by Waber (1820). These connect air bladder with internal ear.
- The commercial name of integument of Scoliodon "shagreen".
- Typical trunk vertebrate of fish are amphicoelous, centrum peculiar as is supported by four wedge-shaped calcified fibrocartilages forming a "Maltese cross" and leaving uncalcified area.
- The study of fish is called ichthyology.
- The study of skates, rays, and sharks is called torpedology.
- Crossopterygians (Rhipidistia, Osteolepis genus) gave rise to amphibia.
- Parental care is well developed in Hippocampus.
- Isinglass is a gelantinous product obtained from the air bladder of certain fishes such as carps, salmons, cat fishes, etc. It is used for making cements, jellies, and for clarification of wines and beers.

Class C – Osteichthyes or Teleostomi

- Bony fish found in fresh water as well as marine water.
- Endoskeleton is made up of bones, hence the name "bony-fishes".
- Their exoskeleton is made up of scales, which maybe cycloid or ctenoid or ganoid type. Placoid scales are absent.
- Respiration by 4-pairs of gills. These are covered by operculum at each side of body.



Figure 6.9: Structure of Exocoetus

- Mouth, jaws with teeth can be terminal or subterminal, Supensorium of jaw is autostylic.
- Helping respiratory organs "air bladders" are present. Lung fishes respire through air bladders. In other fishes these air bladders are hydrostatic i.e. help in maintaining balance of body and provide buyoncy.
- Cloacal aperture is replaced by anus.
- Liver is trilobbed

- Tail is normally homocercal type, rarely diphycercal type.
- Genital ducts via separate apertures open outside the body.
- External fertilisation, male fishes lack claspers.
- Fishes are oviparous however some may be oviparous or viviparous.



Figure 6.10: Structure of Labe



Figure 6.11: Structure of *Hippocampus*

Examples –

- *Hippocampus* "Sea horse" or "Pregnant male" It swims in sea water in its vertical position. Abdomen of male fishes is pouch like known as "Brood-pouch" to collect the eggs. Secondary vivipary and parental care is found in hippocampus.
- *Exocoetus* Flying fish- long dorsal fin that can glide over 400 metres in sea water.
- Labeo "Rohu" or "Indian carp" It is a fresh water fish.
- *Clarias* "Cat fish" or Magur (Fresh water)



Mystus (Cat Fish)

Figure 6.12: Diagram of Mystus (Cat fish)

- Catla Katla (Fresh water)
- Betta Fighting Fish (Aguarium fish)
- *Pterophyllum* Angel fish (Aguarium fish)

- Wallagonia Lachi (scale less)
- Heteropneustis Singhi
- Channa Lata Fish
- Lophius Angler Fish
- Anabas Climbing perch.



Figure 6.13: Structure of Anabas testudineus (Climbing perch)

- Sardinella Salmon
- Acipensor Sturgeon Endoskeleton is cartilaginous
- Anguila Eel Snake like, migrate to sea for spawing. Young eel (Ever) migrate back to fresh water.
- Solea Flat fish
- Harpodon Bombay Duck
- Amia- Bow fish
- Echeneis (Remora) Suker fish. Shows commensalism with shark and whales. Dorsal fin modified into sucker.
- Mystus Sanghara
- Sirrhina Mrigal
- Latimeria or coelacanth Living fossil fish –the oldest living vertebrate that belongs to group Crossopterygii.



Figure 6.14: Latimeria structure

- Chenocephalus Ice fish Only vertebrate without haemoglobin.
- Opsanus Toad fish
- Synancejahorrida- Stone fish- the most poisonous fish.
- Gambusia (Top minnow) Larvivorous fish.

Lung fishes – Fishes of dipnol group are called as "uncle of amphibia" as they have air bladder which help in respiration. They have:

- Three chamberd heart.
- Both external and internal nares (nostrils).
- Their tail is heterocercal type. Scale is placoid type.

E.g. *Protopterus* – African lung fish- living fossil fish.

• These all are freshwater bony fishes.

Lepidosiren – South American lung fish. Neoceratodus – Australian lung fish.



Paddle-like paired fins

Figure 6.15: *Neoceratodus* structure



Figure 6.16: Various types of scale on fishes

6.18



Shagreen is dried skin of Cartilaginous fish.
Cod liver oil is rich in Vitamin D, Shark liver oil is rich in Vitamin A
Maltase sugar is found in vertebra of Shark for supporting the vertebrae.
Mermaid's purse refers to egg capsule of Shark.
Smallest fish *Mystichthyes* – Goby fish – *Pandaka* (8-10mm)

DID YOU KNOW

Ichthyology: the science that deals with the study of fishes.

Pisciculture: the rearing of fishes in different waters: artificial or natural water bodies.

Marine Bony fishes: E.g. Exocoetus (Flying fish) and Hippocampus (Sea horse).

Other fresh-water bony fishes: E.g. *Cyprinus, Ophiocephalus* (Channa), and *Anguilla* (Eel).

Gold fish has variety of shapes, size and colours and thus is maintained in aquaria for decorative purposes.

Hippocampus (Sea horse fish) shows sexual dimorphism. Male has a brood pouch to carry fertilised eggs deposited by female hence it is commonly called as pregnant male.

Carcharodon (Great white shark): Most aggressive shark with white belly and is commonly called as man-eating shark.

Protopterus (Lung fish): A connecting link between bony fishes (presence of fins, lateral line an operculum) and amphibians (has lungs and 3-chambered heart).

4.2.2 Superclass – Tetrapoda

- Members are aquatic and terrestrial.
- 2 pairs of pentadactylous limbs are locomotory organs.
- Embryonic stage have gills while adults have lungs.
- Heart is three or four chambered with double circulation.
- Kidneys are either mesonephric or metanephric type.

- Middle ear is present even in birds and mammals.
- Superclass Tetrapoda is divided into four classes
 - o Class [A] Amphibia
 - o Class [B] Reptilia
 - o Class [C] Aves
 - o Class [D] Mammalia

Class A – Amphibia

- Devonian Origin and carboniferous period is the phase of amphibians
- Animals which can live in water and on land are called amphibious animals.
- The first chordate animals to come out of the water however they found difficulties to live on land permanently as they required water for their reproduction. Their eggs lack protective covering.
- Body has head and trunk with tail in some.
- Skin is smooth without scales, if scales are present are embedded in the skin E.g. Ichthyophis.
- Numerous glands in the skin that moisturise the skin.
- Pigment cells that colour the skin are called as chromatophore. Few amphibians contract and expand which changes the colour of pigment cells. This phenomenon is known as metachrosis.



Figure 6.17: Common Amphibians: A. Salamander, B. Ichthyophis, C. Leopard frog,D. Tropical tree toad and E. Mudpuppy

- Swimming or travelling is with two pairs of limbs. Forelimbs have four fingers and hindlimbs have five fingers.
- Their digits do not have nails or claws at all.
- Mouth is bigger in size with different teeth on upper or both the jaws. Suspensorium of jaws is autostylic. These are pleurodont, homodont and polyphyodont. (Frog- Acrodont)
- Digestive system has a well-developed and complete alimentary canal with digestive glands that secrete enzymes and acids for digestion (Salivary glands are absent in frog).
- Cloaca have openings of alimentary canal, urinary bladder and genital ducts.
- Respiration is through gills, skin, lungs and buccopharyngeal cavity.
- Heart is three chambered into two auricles and one ventricle (arteriovenous). Sinus venosus and truncus arteriosus is present to give electric currents to it.
- RBCs are respiratory pigment that are biconvex, oval and nucleated.
- Renal portal system and hepatic portal system are present in the kidneys.
- Bones are the endoskeleton, however cranium is cartilaginous.
- Skull has two occipital condyles, with which it is connected by first vertebra of vertebral column i.e. Atlas. This skull is called as the dicondylic skull.
- Ribs are absent, except in some animals where it is not attached to sternum.
- Vertebrae are procoelus type, where anterior of the centrum is concave while posterior is convex.
- Middle and internal ear make the ear where middle has ear-ossicle called as columella (stapes). Tympanum is on the surface of ear. Eyelids cover the eyes.
- Cranial nerves are 10 pairs.
- Excretory organ is a pair of kidneys which are mesonephric or opisthonephric type. These animals are ureotelic however some tailed animals and larvas are ammoniotellic.
- Cold blooded or poikilothermal animals.
- Hibernation or aestivation is a process used by animals to prevent themselves from extreme temperatures and overcome unfavourable conditions.
- Unisexual animals where rarely males have copulatory organs. Animals go back in water from land for their reproduction.
- External fertilisation inside the water, some animals fertilise internally.
- These are oviparous, eggs are laid in water.
- Indirect Development i.e. tadpole larva In Frog, Axolotle larva In Salamander
- This class is divided into three orders.
 - Gymnophiona or Apoda
 - Caudate or Urodela
 - Anura or salientia

(a) Order – Gymnophiona or Apoda

- Their body is worm like. These are primitive amphibians burrowing in nature.
- Their body is limbless.

E.g.

- o Ichthyophis (Caecilian) Limbless blind worm without tongue.
- o Scales on body.

(b) Order – Caudata or Urodela

• Body is distinctly divided into head trunk and tail. Tail may have caudal fin.

E.g.

- Salamandra It is viviparous. Its larva is called Axolotl larva. It sometimes show neoteny. (Longest gestation period -36 months)
- Proteus Cave salamander (Blind)
- Ambystoma Tiger salamander (Axolotl larva)
- o Triton Newt
- Necturus Water dog or mud puppy Gills in adult also. It shows permanent neoteny.
- o Amphiuma Congo- eel Largest RBC is present.
- o Siren Mud eel
- o *Cryptobranches* Hell Bender Largest Amphibian, Fully aquatic.

(c) Order – Anura or salientia

- These are specific animals, where tail is absent in adult stage.
- All the forgs and toads are included in this order.
- Vertebral column small, in which only 5-9 vertebrae are found. Last vertebra is stick like urostyle.
- Eyes with lids, tear glands present. (Lower lid movable and upper immovable).
- Maxillary teeth are present in the upper jaw (absent in toad).
- Middle ear and tympanic membrane present.

E.g.

- o Bufo Common toad (Poision glands are modification of parotid gland.
- o Hyla Tree Frog
- Ranatigrina Indian bull frog. Mentomechanial bone is found (Tip of the lower jaw).
- o Rhacophorus Flying frog
- o Alytes Midwife toad- Parental care is well developed in them. Male toads carry eggs in their

limbs.

- o Pipa americana Surinam toad carries eggs, Secondary vivipary. (Tongue absent)
- Ranagoliath Largest frog
- Phyllobates Smallest frog (found in Cuba)
- Discoglossus or Bombinator Fire bellied toad, Xenopus African toad.

KNOWLEDGE BUILDER

- Amphibian (amphibians): first land vertebrates,
 - Evolved from lobe which have fins and bones,
 - o Skin nakes and moist that helps in respiration,
 - o Have four limbs, where digits are without claws,
 - o Sac- like lungs, 3-chambered heart,
 - o Undergoes metamorphosis,
 - o Embryonic membranes are not formed.
- Some frogs develop in amazing ways which does not allow their eggs from dying out. The female *Surinam* toad of South America carries her eggs in the back skin pits/pockets. 60 young ones grow from the tadpole stage still embedded in the back and then emerge as small frogs.
- External ears are absent, only tympanum present. Frogs have a tympanic membrane on the surface of both sides of their head. The tympanic membrane of a human are called eardrums and each is protected inside ear canal.
- Word roots and origins
 - o Caudata: From Latin, Caudata meaning "tail".
 - o Nictitating: From Latin, *nictate* meaning to "wink".
- Seymouria is a connecting link between amphibia and reptiles.
- Paedogenesis: Development of gonads and/or production of young ones by immature or larval forms, E.g., salamander (*Ambyostoma*).
- Total neoteny is shown by Necturus, Siren, and Proteus.
- Toads are used in Chinese medicines. The skin of toad secretes a substance that increases the blood pressure when injected into humans.
- The skin of tadpole also secretes an enzyme, diastase.



- The upper jaw of frog is derived from quadrate cartilage, whereas the lower jaw is derived from meckel's cartilage.
- First toe is called as hallux.
- Jaw suspension is autostylic; urostyle is the last component of vertebral column.
- The shape of second to seventh vertebrae is procoelocus (typical); eighth vertebra: amphicoelous; ninth vertebra: acoelous.
- Amphiuma has the largest RBCs among vertebrates.
- At the time of metamorphosis, tadpole does not feed.
- Blind worms (limbless amphibians) are unusual amphibians as only one species lives in water. All the other burrow underground and are rarely seen on the surface. Many do not even need water to breed.
- Carboniferous period is known as the age of amphibians.
- Arrow poison frogs secrete a powerful poison from the skin which can cause instant death.
- The most poisonous frog-*Golden dart* poison frog-is from South America. One adult frog contains enough poison to kill 200 people.

	Tr	Y IT YOURSELF							
	1.	1. In which of the following fish the skin is tough containing minute placoid							
		(A) Exocoetus	(B) Hippocampus	s (C) Sco	liodon	(D)) Labeo		
	2.	Which of the following is not a characteristic features of cartilaginous fish?							
		(A) Internal fertilisation							
		(B) Viviparous							
<u>_</u>		(C) Pelvic fins males bear claspers							
		(D) Gills are covered by an operculum on each side							
	3.	A teleost fish can be differentiated externally from an elasmobranch by							
		(A) Endoskeleton	(B) Exoskeleton	l				
		(C) Operculum	(D) Stream line	body				



TRY IT YOURSELF

- 4. Body fishes can stay at a particular depth in water without beating their pectoral and pelvic fins due to the presence of
 - (A) Pneumatic bones
 - (B) Lateral line sense organs (Neuromast organs)
 - (C) Air bladder
 - (D) Streamlined body
- 5. Which of the following is mismatching?
 - (A) Torpedo : Electric organs, modified muscles supplied with nerves
 - (B) Trygon: Dorsal fin is modified into a poison string
 - (C) Exocoetus : Pectoral fin becomes large by which it can leap into air
 - (D) *Hippocampus* : Female bears a brood pouch
- 6. Ampulla of Lorenzini in Scoliodon act as
 - (A) Neuromast organs (B) Thermoreceptors
 - (C) Electric organs (D) Rheoreceptors

Class B - Reptilia

- Mesozoic era is the Golden age of Reptile.
- The branch of biology which deals with the study of reptiles is known as "Herpetology".
- Class reptilla's animals are the first successful terrestrial animals.
- First reptiles are called Stem reptiles or Cotylosaurs.
- Class name refer to creeping or crawling mode of Locomotion.

General Characters

- There are, mostly, terrestrial animals, but some animals are aquatic in nature also.
- Body is divided into head, neck, trunk and tail.
- Their skin is dry, cornified, rough, non-glandular (femoral gland in male lizard). Snakes and Lizard shed their scales as skin cast.
- In these animals, each limb has five digits. Each digit has incurved nails.

- Their exoskeleton is made up of horny epidermal scales or bony scutes or bony plates.
- A complete alimentary canal is found in these animals, which opens into cloaca.
- Teeth are homodont, polyphyodont and mostly pleurodant.
- Respiration in these animals is by lungs, throughout the life.
- In these animals, heart is incompletely four chambered (NCERT-3 chambered) but it is four chambered in Crocodiles. Right and left both systemic arches are present.
- Sinus venosus is ill developed and trunkus arterious is absent.
- Skull is monocondylic (one condyl).
- Ribs are present in neck and thorax Ribs of thoracic region make true sternum.
- Centrum of vertebrae are procoelous type.
- A chevron bone is found in caudal vertebrae of these animals.
- They do not have external ear opening. Tympanum represents the ear.
- One pair of metanephric kidneys help in excretion.
- These animals are uricotelic for water conservation.
- There are 12- pairs of cranial nerves in these animals.
- At the roof/ceiling of buccal cavity Jacobson's organ (olfactory) is present.
- Genital aperture is not separate from anus. Ureters, genital ducts and alimentary canal open into a single cloacal aperture.
- These are unisexual animals. Fertilization is internal.
- One or two penis (Hemipenis) is found in male animals as copulatory organ
- These are mostly oviparous, but some animals are viviparous also.
- Eggs are Megalecitheat (with large amount of yolk) and cleidoic, i.e. eggs are covered by a shell made up of CaCO₂
- leidoic eggs is an adaptation for terrestrial habitat. Eggs are leathery.
- Embryonic membranes like amnion, chorion, allantois and yolk sac are present in the embryo. So this class is grouped under Amniota group. (Fishes and amphibians were anamniotes)
- Development direct i.e. larva stage is absent.
- Parental care is often marked.
- These are Cold blooded, Poikilothermal animals. Their body temperature varies according to climate.
- Class Reptilia is classified on the basis of presence or absence of temporal fossae in the temporal region of skull and on their number.

(i) Subclass – Anapsida

- Temporal fossae are absent in the temporal region of the skull i.e. roof of skull is complete.
- Limbs are strong.

(a) Order – Cotylosauria

E.g. Seymouria: Connecting link between Amphibia and Reptilia (Extincted).

(b) Order – Chelonia

- Body is broad and oval.
- They are terrestrial, marine and fresh water animals.
- Whole body is covered by firm bony shell. Exoskeleton of dorsal region of body is called carapace and skeleton of ventral region of body is called plastron.
- Jaws are horny and teeth less, beak like jaws are found.
- Scales are found on neck, limbs and tail.
- All these three organs can be pushed into the carapace.
- Thoracic vertebrae and ribs are attached with carapace.
- Cloacal aperture is vertical and it helps in respiration.

E.g.

- Testudo Land tortoise
- *Trionyx* Fresh water (Terrapins (Edible))
- Chelone Marine tortoises (Turtles)
- Kachhugatactum



Figure 6.18: Image of A. Tortoise and B. Turtle

DID YOU KNOW

- Snakes and some lizards lack the secondary limbs.
- Reptile and birds, cloaca is three chambered that is for conservation of water.
- Aquatic reptiles E.g., Turtles are ureotelic in excretion.
- Tortoise when disturbed withdraws all the body parts in a tortoise shell.
- Tortoise is the symbol of long life span (200 years).
- Crocodile is the largest amphibious reptile. It has certain mammalian characters.
- Eudynamis (Koel): commonly called as Indian Nightingale.
- *Tyto* (Owl) is nocturnal bird of prey. It has keenest eyesight at night and has binocular vision. It is important in biological control of rats in the fields.
- In hedgehog, hair of dorsal side of trunk are modified into spines for defence.
- Insectivores are simplest true placental mammals.

(ii) Sub – Class – Diapsida

• One pair superior and one pair inferior temporal fossae are found in the temporal region of skull.

(a) Order – Rhynchocephalia

- Most of the species are extinct and found as fossils. Long living with 100 years of age possible.
- Only Sphenodonpunctatum species is alive in New Zealand.
- A functional third eye or pineal eye is present in the head region.
- Teeth are of the acrodont type.

E.g. Sphenodonpunctatum – Tuatara (living fossil) it is found only in New Zealand.

(b) Order – Squamation

- Limbs if present are clawed, snakes and some lizards lack limbs.
- Skin has horny scales.
- Copulatory organs are paired in males (Hemipenis).



Figure 6.19: Reptiles: A. Chameleon B. Crocodiles C. Chelone D. Naja



Suborder Lacertilian

- Members are "Lizards"
- The science that deals with the Study of lizards is called "Saurology"
- Limbs and girdles are well developed.
- Eyelids are movable with nictitating membrane in the eye.
- Auditory aperture or auditory opening (ears) and tympanum is present.
- Urinary bladder is present.
- Foramen of Piazza is present in the heart of lizard.
- Pair of lungs are equally well-developed.

E.g.

- *Hemidactylus* Common lizard, wall lizard. It can shed its own tail at the time of emergency. It is called autotomy. Power of regeneration is well marked.
- Calotes Blood sucker, Garden lizard (Girgit). It can change its colour according to environment.
- Draco Flying lizard. Its body skin expands in the form of 2 wings or patagia. With the help of these patagia, it can glide from one tree to another tree or its branches. It cannot fly.
- Chameleon Arborial lizard (Viviparous) (Girgit)
- Varanus Goh, Monitor lizard. Varanus komodoensis Ferocious Dragon Largest living lizard.
- Ophiosaurus It is limbless lizard. It is also called glass snake.
- Burkudia limbless lizard found in south India.
- *Heloderma* Gila- monster, Hela monster. It is the only poisonous lizard. Its poison glands are modified sublingual glands.
- Mobuya Viviparous lizard.
- *Phrynosoma* Horned toad (viviparous)
- Uromastix Sand lizard or Sanda



KNOWLEDGE BUILDER

Architeuthis (the giant Atlantic squid) is the largest and heaviest animal in all the invertebrates, with 55 feet long body. *Nautilus* is the only *Cephalopod* that has external shell and no ink glands. The colour change in *Cephalopods* occurs due to chromatophores.

Suborder Ophidia

- Members of this suborder are normally called "Snakes".
- The study of snakes is called ophiology or serpentology.
- Body long, thin, smooth and limbeless.
- Eyelids are immovable and nictitating membrane in eyes are absent.
- Girdles, sternum and urinary bladder absent.
- Auditory opening and tympanum absent. No middle ear.
- Tongue thin, long and bifid and sensitive to odour and vibration.
- Left lung is ill developed.
- Leathery shell is found on egg of Snakes.

Non-Poisonous Snakes

- Python mourus Azgar. It is the largest snake, its length is about 25 feet. Rudiments of hind limbs are found on the body.
- *Ptyas mucosus, Zamenis mucosus* or Rat snake. It is commonly called Dhaman. It feeds on rats, so it is also called "Friend of farmers".
- *Eryx johni* Sand boa. It is also called Dumuhi snake.
- *Typhlops* Blind snake.

Poisonous Snakes

- *Hydrophis* Marine. Deadly poisonous. Tail is laterally compressed. It is viviparous.
- Naja Indian corbra. Poisonous snake. Its poison is neurotoxic.
- Naja bungarus or N. hannah King cobra, poisonous snake. It is the largest snake among poisonous snakes (Head with one or two circular mark).
- Bangarus Krait : Poisonous (neurotoxic) snake
- Vipera Viper snake: Head is differentiated from body. Poisonous snake (viviparous). Its venom is haemotoxic / Cardiotoxic. Loreal pit is found is a thermoreceptor. Largest viper is Russel viper (V mark on head).
- *Micrurus* Coral snake.
- *Crotalus* Rattle snake: It produces a characteristic rattling sound of "Rate rate rate", so it is called snake. It is poisonous and ovoviviparous snake.





Characteristic features of poisonous snakes

- Hood or head have small scales.
- Marine snakes have laterally compressed tail.
- Ventral scales present in the body are broad.

- Two teeth marks the snake to be poisonous. (V-shaped Non-poisonous)
- Poisonous snakes have poison glands which are modified labial glands. Probably these glands are homologous to parotid salivary glands of mammals.
- Poisonous teeth (fangs) are modified maxillary teeth.
- Antivenom dose treats the poisonous snake bite. Antivenom is produced in India at Central Research Institute Kausalya Shimla and Offline Institute, Mumbai.
- Biggest serpentorium is located in India in Chennai.

Snake Charming

- Contrary to general belief, the snake charmer's cobra does not dance the tune of the flute.
- Rather it follows the movement of the tip of the flute and the swaying body of its master, who really moves with the rhythm of the music.
- Raising its head and spreading its blood, the cobra gets ready to strike the moving flute tip. The charmer knows the striking distance and adjusts himself so that the snake orients towards the waving flute but keeps beyond the strike distance.

Rattle Snake Muscles

- Rattle snakes have the quickest moving skeletal muscles in the animal world.
- Their tail muscle allows them to shake their rattle 90 times each second.
- Most muscles would quickly tire from this kind of energetic activity, but the rattle snake can shake its tail for long periods of time.
- The muscle's ability to use ATP in an efficient manner allows it to sustain a high level of activity.

(c) Order - Crocodilia or Loricata

- Crocodiles, alligator etc. are common examples of the order.
- Amphibious animals that live in lakes or rivers and on land.
- Largest modern reptiles.
- Bony scutes are covering the skin.
- Body is solid with massive long snout with external nares are situated at the distal end of snout and nares have cover also.
- Urinary bladder is absent.

- Special features are -
 - Heart is four chambered, where ventricle has two chambers and auricle has two chambers.
 - Teeth are of the thecodont type.
 - o Diaphragm is present.

E.g.

- o Crocodilus / Crocodilus (Crocodile) It is only found in Indian subcontinent.
- *Gavialis* Gharial. Snouth very long.
- Alligator Maxican crocodile.



Figure 6.21: Differences among mouth of A. Crocodile, B. Alligator and C. Gavalis

(d) Order – Saurischia

- Dinosours were the most dangerous or terrible lizards (Fossils).
- Origin of Dinosours began in the Triassic period and they got extinct in Cretaceous period in the Mesozoic era.

E.g.

Brontosaurus - Thunder lizard. Largest Dinosaurs (Herbivorous)

Stegosaurus

Tyrannosaurus – Tyrant lizard. King of Dinosours.

- Reptilian (reptiles): Dry scaled waterproof skin,
- Digits of all the four limbs have the claws,
- Well-developed lungs for respiration,
- Incomplete 4-chambered heart is common,
- Males have copulatory organs,
- Eggs have amniotic fluid and are laid on the land,
- Fertilisation is internal without the larval stage.

Class C – Aves

- End of Jurassic period in the Mesozoic era was a start for the birds along with the modernisation in cretaceous factor.
- The science which has study of birds is termed as "Ornithology"



Figure 6.22: Shape of Furcula

- Dr. Salim Ali was the great ornithologist of India and thus called as "Birdman of India"
- Study of eggs laid by bird are known as Oology.
- Study of the nest that bird builds is known as Nidology.
- Huxley called birds as glorified reptiles.
- Birds have wings arranged on the body which is known as Pterylosis.

Main Characters -

- This class accommodates all the types of birds.
- Body has shape similar to a boat which has head, neck, trunk and tail. Neck is long and flexible to lift and move the mouth or beak for food.

- Soft feathers (derivative of stratum corneum) cover the body of all the birds, called as "plumage"
- Birds are warm blooded or homeothermic or endothermic animals.



Figure 6.23: Various types of beaks in birds

- Hind limbs have scales.
- Skin is dry as it lacks glands that secrete oil and softens it. However oil glands or preen glands are present on the base of tail or uropygium.
- Birds are feathered bipeds. Exoskeleton is the soft feathery covering all over the body (except on the hind limbs).
- Forelimbs (have three digits) are developed into wings, which are used in flying and in conserving the heat. Four claws have digits are found on hind limbs. The limbs are best suited so that the bird can sit on branches of trees, perch, walk on land, or swim in water.
- Crop, an oesophagus modification that quickly ingests and stores food and gizzard crush the food which is then swallowed unmastigated. Pigeon milk is produced and secreted from males and females (Crop product). Gall bladder is absent.
- Cloaca is three chambered.
- Jaws lack teeth and are modified into horny beak. Beak has an epidermal horny sheath, which is called as Ramphotheca.



Figure 6.24: Various types of claws in birds

- Respiration is through spongy lungs which have air sacs. Air sac is connected to the lungs for supplement respiration.
- Sound producing (vocal) organ is at the junction of trachea and bronchi of birds called as syrinx.
- Heart is four chambered, which has only right aortic arch.
- Hepatic portal system is well developed in birds, but renal portal system is ill developed. Sinus venosus is absent.
- Endoskeleton is fully ossified (bony). Long bones are hollow, in which air is filled having air cavity these bones are called pneumatic bones. These make the body light in weight and help in flying.
- Skull has a single occipital condyl.
- Centrum of the vertebra is heterocoelous.
- Some vertebrae of the posterior body join together to form synsacrum.
- Last 4 or 5 caudal vertebrae are fused together to form pygostyle.

6.36
- Sternum is large which has a swollen basal part called as "Keel". This keel creates a joint plane for the flight muscles present in the flying birds.
- Ribs of birds are bifid with uncinate processes.
- Exoskeleton is in the form of soft feathers all over the body (except hind limbs)
- Pectoral girdle has foramen of triosseus.
- Two bones: clavicle and interclavicle are fused to form a V shaped furcula or wish bone or merry thought bone. It acts as a spring between the two girdles.
- Kidneys are metanephric (Trilobbed). Ureters are connected to the cloaca.
- Aves are always uricotelic (uric acid producing).
- Uric acid is a semisolid substance. Excreta of marine birds is known as guano.
- Most of the birds do not have urinary bladder and copulatory organ.
- Brain is large, smooth, highly developed. Cerebellum is well developed for aerial mode of life.
- Cranial nerves are 12- pairs.
- The skin around the nostrils is sensory in birds that is called "Cere".
- Eyes are large and well developed which are surrounded by rings made up of bony plates known as Sclerotic ossicles.
- Eyes are large and nictitating membrane is present in eye. Vision is monocular.
- A specific comb like structure pecten is found in the eyes of all birds except kiwi's eyes. Pecten helps in accommodation of eye and provides nutrition to eye balls. It also controls the pressure of liquid present in eye. Acute vision and telescopic vision of birds is due to pecten.
- External ears are preent but ear pinnae are absent. Columella bone (Stapes) (one ossicle) is found in middle ear. Cochlea (not coiled) is present in internal ear.
- Olfactory organs are less- developed.
- Birds are monodelphic i.e. only left ovary and left oviduct is functional in females. Birds are oviparous vertebrates.
- Birds are unisexual. Sexual dimorphism is well marked. Copulatory organ usually absent in males.
- Fertilisation is internal.
- They are egg lying i.e. oviparous.
- Eggs are large, megalecithal and cleidoic. Shell is perforated.
- Embryonic development is direct. Embryonic membranes are present, so birds are included under group amniota.

• All the birds form nests. Parental care is well marked.



Figure 6.25: Aves: A. Neophron, B. Struthio, C. Psittacula and D. Pavo

Та	ble 6.3: List of f	lightless birds
Common Name	Genus	Distribution
African ostrich	Struthio	Africa and Arabia
South American ostrich	Rhea	South America
Cassowary	Casuarius	Australia and New Guinea
Emu	Dromaius	Australia
Tinamou	Tinamus	South America
Kiwi	Apteryx	New Zealand

Table 6.4: Difference between Super orders Ratite and Carinatae

Character	Super order III (Palaeognathae or Ratitae)	Super order IV (Neognathae or Carinatae)	
Distribution	Restricted, discontinuous. Not found in India	Cosmopolitan, found all over the world	
Habitat	Terrestrial	Arboreal, terrestrial, or aquatic	
Locomotion	Flightless running birds	Flying birds	
Wings	Vestigial or absent	Well developed	
Legs	Large cursorial	Variously adapted	
Feathers	Without interlocking mechanism, brab-free	Barbs interlocked due to brabules and barbicels	
Downfeathers	Absent	Present	
Horny sheath of break or marnphotheca Divided in several pieces		Undivided	
Oil gland	Usually absent	Present	
Sternum Plat, raft-like due to vestigial or no keel		Well-developed mid-ventral keel	
Clavicles Small or absent, no furcula		Both clavicles and interclavicle fused to form a V-shaped furcula	
Pectoral muscles	Poorly developed	Well developed	
Syrinx	Usually absent	Present	
Air sacs	Poorly developed	Well developed	
Eggs	Thick and hard shell. Pore canal branched	Shell thin, fragile; pore canal unbranched	
Examples Struthio (ostrich), Aptenodytes (penguin)		<i>Corvus</i> (crow), <i>Columba</i> (pigeon), <i>Psittacula</i> (parrot), <i>Pavo</i> (peacock), <i>Neophron</i> (vulture)	





Figure 6.26: Different types of feathers: A. and B. Quill, C. Contour, D. Filoplume, E. Down, F. Rictal bristle

Class Aves is divided into 2 subclasses -

Subclass (a) Archaeornithes and Subclass (b) Neornithes.

(i) Subclass – Archaeornithes

- Primitive "Lizard like birds", which belong to Jurassic period. All the members have become extinct.
- Wings are ill developed, i.e. capacity of flying was very less.
- Pygostyle and keel in sternum were absent.
- 3-3 clawed digits in the forelimb were at the free edges of wings.
- Lacked uncinate processes on ribs.
- Teeth are attached to the jaws of the skull.
- Subclass is the connecting link between the reptiles and the birds.

E.g.

- Archaeopteryz Lizard bird. (Extinct in Cretaceous period) Its fossil was discovered by Andrea Wagner in 1861 from Bavaria (Germany).
- Archaeornis

- Largest bird: *Struthiocamelus* 8 feet height, 300 lbs weight.
- Smallest bird: *Mellisuga helenae* 5.5 cm long.
- Smallest egg of bird: *Mellisuga* (humming bird)
- The humming bird is the only bird which can fly backward as well as forward.
- Largest egg of bird: *Struthio* 1.5- L capacity.
- Largest sea bird: Diomedea epomorphora (royal albatross); wing stretch 200 375 cm.
- Deepest diver bird: Aptenody testorsteri (emperor penguin)
- Fastest swimmer bird: *Pygoscelis papua* (penguin)
- Fastest runner bird: Struthio 60 km/h speed.
- Heaviest bird of prey: Vulture gryphus.
- Fastest flying bird: Swift rarely touches the earth.
- Second largest bird is *Emu* (*Dromaeus*) as is the most primitive living bird.
- Recently extinct bird is *Dodo* (passenger birds) of Mauritius.
- The incubation period of a hen's egg at 102° F (38.8° C) is 21 days.
- Though polygamy is common in birds, emu is strictly monogamous.
- Penguins are flightless birds found in Antarctica; wings are paddle-like; act as flippers during swimming; and are covered by scale-like feathers.
- T.H. Huxley said "birds are glorified reptiles". The feathers are highly modified reptilian scales. Birds have scales on their legs. Their eggs resemble reptilian eggs in general but have a calcareous shell.
- Among the Indian birds, the smallest are sun birds.
- The bursa fabrici is a blind sac which has much lymphoid tissue in the cloaca of some young birds. It produces lymphocytes (a type of white blood corpuscles). It is also called "cloacal thymus".
- Columbia has the world's richest diversity of birds.
- Uropygium (tail): The projecting terminal portion of a bird's from which the tail feathers arise.
- Swifts use saliva for binding nest materials.
- Kiwi lays the largest egg in proportion to its own size.





- Himalayan bearded vulture is the largest Indian bird. Previously, the Sarus was considered the largest Indian bird.
- Ostrich has the largest eyes of any land animal.
- Kiwi is the only bird known to use the sense of smell for finding food on the ground.
- Indonesia has the most bird species facing extinction.
- *Red-billed Quelea* (*Quelea quelea*) of Africa are the most abundant birds. Previously, the house sparrow was considered the most abundant species of birds.
- Jatinga is a village in Assam where a mass suicide of birds occurs.
- The owl rotates its head through an angle of 270° as its eyes do not rotate in their sockets. Each eye is fixed like a car headlight.
- Copulatory organ (true penis) is present in ostrich duck, swan, and gose.
- Dr Salim Ali is a famous Indian ornithologist.
- The national bird of India is Pavo cristatus (peacock).

(ii) Sub Class – Neornithes

- Live animals and extinct animals that were present after the Jurassic period.
- Birds fly with the wings that are well developed (except in some birds)
- Last few vertebrae in the birds fuse to form pygostyle.
- Sternum is bigger and also has keel.
- Thoracic ribs end up in the uncinate processes.
- Lack teeth except some species (extinct ones).

This subclass is classified under four superorders.

Super order – Odontognathae

- These are extinct animals that had teeth.
- Lack pygostyle and keel in the sternum.

E.g. - Hesperornis

Super order – Impennae

- Aquatic birds which have modified fore limbs into flippers.
- Limbs are webbed.

- Teeth are absent.
- Sternum is without keel.
- E.g.
- Spheniscus Penguin It is also called "sea bird of Antarctica"
- - Aptenodytes Penguin

Super order – Palaeognathae or Ratitae

- Large massive birds lack the flight ability in nature, however running ability is enhanced.
- Wings as are not used are usually reduced, rudimentary, can be either vestigial or absent.
- Caudal vertebrae are free and lacks pygostyle.
- Sternum does not have a keel and is similar to raft.
- The ribs are without uncinate processes.
- Lack the oil glands or preen glands.
- Sound producing organ syrinx is absent.
- Usually urinary bladder and penis are present.

E.g.

- Struthio African ostrich or Camel-bird It is the largest living bird of modern period. It is almost 8 feet in height. Polygamous, male incubate the eggs (Largest egg).
- Rhea American ostrich
- *Apteryx* Kiwi It is National bird of New Zealand. It has hair like feathers all over its body. It is smallest flightless bird.
- Dromaeus Emu It is a monogamous bird in which only males look after their young ones and eggs.
- Aepyornis Elephant bird.
- Casuarius Casswary (found in new Guina)/ Austrails

Super order – Neognathae or Carinatae

- Small sized flight birds which are present in this time. Wings are light weight which help in the flying of birds.
- Pygostyle is present.
- Keel present in the sternum is well developed and have crop glands that secrete pigeon milk.
- Uncinate processes are present in the ribs which are well marked.
- Oil glands or preen glands are found in the back near end of the tail.
- Beak lacks the teeth.
- Sound producing vocal organ is called as syrinx are located in the base of trachea.

E.g.

- Pavo cristatus Peacock It is the national bird of India.
- Psittacula krameri Indian parrot. (Upper jaw movable Psittaciformes)
- Columbalivia Blue rock pigeon Its crop glands secrete pigeon milk (Columbiformes)
- Streptopelia Dove
- Passerdomesticus Sparrow It shows commonsalism with man.
- Corvus splendens Crow
- Molpaster Bulbul
- Anas Duck
- Cygnus Swan Aquatic bird having webbed limbs
- Bobo Bubo or owl or "Ill of oman"
- Cuckoo It lays its eggs in the nest of other birds (Crow)
- Eudynmis Indian Koel
- Phoenicopterus Flemingo
- Alcedo King fisher
- *Raphusdidus* Dodo (Mauritian extinct bird in 17th centuary)
- Dinopium Wood pecker Kathphorva
- Diomedea Albatross Marine bird with largest wings in flying birds.
- *Milvus* Kite (Predatory birds)
- Flaco Falcon (Predatory birds)
- Neophron Vulture (Scavenger bird)
- Choriotis nigriceps Great Indian bustard. It is also called Gondavan. It is the state bird of Rajasthan.
- *Helena* Humming bird. It is also called sunbird. It feeds on nector of flowers. It is the smallest bird. It is found in Cuba. It can fly in forward and backward both the directions. It can fly like helicopter. Its size is about 3 to 4 cm.
- *Ploceous* Weaver bird (Baya)
- *Micropodus* Pitohui/pathua- It is the only one poisonous bird, which is found in Newguinea.
- Swift spine tailed Fastest flying bird, it is found in Japan.
- Poor bill Bird which shows sleeping stage and undergoes hibernation.

DID YOU KNOW

Migratory Birds

- Pluvialis dominica It is an American bird which migrates from south to north and from north and from.
- Scolopax rusticola It migrates from hill area to planes.
- Himalyan partridge It can fly over 6000 miles.
 - o Stera paradisaea Champion bird Arctic to Antarctic and back.

KNOWLEDGE BUILDER

Types of feathers

- Quills: large feathers found in wings and tail. It has a central axis called as the shaft. Small proximal part of the shaft is hollow, translucent, and cylindrical and is termed as calamus. The long-distal, solid, and opaque part of the stem is known as rachis. An umbilical groove extends all along the ventral side of rachis. A small hole on the proximal end of calamus is known as inferior umbilicus; the hole on the distal end of calamus is known as superior umbilicus. Each vane is composed of parallel filaments, the barbs. Each barb bears many barbules. The distal barbule have small hook lets. Emu birds have an after shaft as long as the main shaft.
- Coverts: small feathers in the wings and tail. They fill the gaps between the bases of the quills. Short calamus in comparison to quills.
- Contours: cover the body and give its shape. They resemble the quills, but their barbs are weakly joined which can be separated easily.
- Filoplums: Occur beneath contour feathers; very small in size made of the long rachis that bear few weak free barbs with barbules at the tip.
- Down feathers/ nestling downs: They cover the newly hatched bird. They consist of short calamus, reduced rachis bearing flexible barbs with short barbules. They are found beneath contours.
- Bristles: Short calamus, a long rachis bearing a few vestigial barbs at its base. Bristles occur near the mouth in fly catchers. The first digit of the hand (thumb or pollex) bears a tuft of small feathers known as bastard wing or ala spuria or false wing.





Aves (birds) have thin dry skin convered with the feathers that do not allow body heat to be lost, forelimbs are modified into wings, fingers lack claws, toes are armed with the claws, spongy little elastic lungs have air – sacs opening into them, the bifurcation of trachea into bronchi has a voice box called as syrinx, heart has 4-chambers, eggs are amniotic, fertilisation is internal without larval stage, endothermic which generate the body heat through rapid metabolism, Nest building where parental care is common and migratory behaviour.

TRY IT YOURSELF

- 1. Which of the following set of animals are amniotes?
- (A) Pisces and amphibian
- (B) Amphibians and reptiles
- (C) Reptiles, birds and mammals
- (D) Amphibians, reptiles and birds

2. Which of the following is not a character of reptiles?

- (A) Body covered by dry and cornified skin
- (B) They are poikilotherms
- (C) Fertilisation is external
- (D) Heart is three chambered but four chambered in crocodiles
- 3. Which of the following lizard shows camouflaging and has prehensile tail?

(A) Hemidactylus	(B) Calotes	(C) Chameleon	(D) Heloderma
4. Which of the followi	ng in non-poisono	ous snake?	
(A) Naja	(B) <i>Bunganus</i>	(C) Vipera	(D) Python
5. Carapace is presen	t in		
(A) Toad		(B) Birds	
(C) Testudo (tortoise)		(D) Alligator	

Class D – Mammalia

- Mammals evolved in the Triassic period of Mesozoic era. Coenozoic era is golden era for the development of mammals.
- The science that deals with the Study of mammals is called as Mammology.

Main Characters -

- The members of this class are omnipresent and found in a numerous areas polar ice cap, deserts, mountains, forest, and grasslands and even in dark caves. Some of them have ability to fly or swim and survive in air or water.
- Body has well differentiated head, neck, trunk and tail.
- A horizontal, diaphragm between the thorax and abdomen in the body cavity is commonly found in all the members of this class.
- Diaphragm plays active role in respiration, defaecation, micturition and parturition.
- The body of almost all the mammals is covered with a coat of hair (made of α Keratin), called pelage.
 Some may have many hair like monkey while some may have less like a man.
- The mammals have skin which is thick, water proof, glandular. There are many types of glands in the skin like sweat glands, oil glands or sebaceous glands and mammary glands.
- Mammary glands (Modified sweat glands) are common in females which takes care for baby feeding, which gives the class mammalian its name.
- If present, horns are located at the head, nails at the end of fingers and toes, claws or hoof are found, which provide protection.
- Two pairs of limbs are attached in the trunk. Limbs are pentadactyle that aids swimming, walking running etc. Hind limbs are absent in Cetacea and Sirenia.
- Alimentary canal is complete, with its proximal end as mouth and sital end as anus. Anus and urinogenital openings are different. Cloaca is absent (Exception members of Prototheria have cloaca)
- Teeth are fixed in sockets called as gums in the buccal cavity, hence the teeth are called as thecodont.
- Teeth are of four different types and such different types of teeth are called as heterodont teeth.
- Teeth comes twice for most of the animals in a life span and thus animals are also called as diphyodont teeth.
- The jaws suspensorium is of the craniostylic type.
- Lower jaw consists of dentary bone.
- Respiration is through a pair of lungs which is enclosed in the pleural cavity.
- Larynx or sound creating organ is present in the neck region which produces sound.
- Heart is four chambered which has double circulatory system is present in the thoracic cavity. Only left side has aortic (systemic) vessel.

- RBCs are small, circular and non-nucleated when they mature, except: Family Camilidae Lama and Camel which contain nucleus in RBCs.
- Endoskeleton is bony, skull is dicondylic.
- Vertebrae are accelous or amphiplatyan type i.e. centrum is flat at both the sides. Cartilagenous pads are found at the edges of centrum that are called epiphysis.
- Neck is made up of 7 cervical vertebrae except: Bradypus / Sloth which has 9 or 10 cervical vertebrae and Sea cow/ Mantees which has 6 cervical vertebrae.
- Ribs are bifid and joined to sternum.
- Excretion is through one pair of metanephric kidneys situated in the abdominal cavity.
- Excretory product is mainly urea and hence these animals are ureotelic.
- Brain is larger with a skull covering it and is highly developed.
- Cerebrum and Cerebellum are the brain parts that are very complex in structure and are highly developed.
- A special structure connects both the right and left cerebral hemispheres of brain that is called as corpus callosum. (Absent in *Monotermes* and *Marsupial*)
- There are four optic lobes which are solid and collectively called as corpora quadrigemina.
- Cranial nerves are 12 pairs.
- External ear called as ear pinna is present.
- Middle ear has three ear ossicles called as Malleus, Incus and stapes.
- High spiral coiling of cochlea of internal ear.
- Mammals are unisexual animals. Testes in males are outside the body present in the scrotal sacs. Copulation is through the distinct penis.
- Ovaries and a reduced penis called as clitoris are found in females.
- Fertilisation is in the fallopian tubes.
- Eggs are developed into zygote in the uterus. Embryonic membranes are amnion, chorion and allantois and yolk sac present in the embryo and hence these animals are classified under group Amniota.
- Embryo gets the nourishment from the mother through the uterus by placenta, which is why these animals are also called as placental animals.
- Mostly mammals are viviparous.
- Parental care specificity of the mammals. Mother feeds the child through the milk which is secreted by her mammary glands and looks after her child.
- Mammals are warm blooded with homeothermic or endothermic nature.
- Livings mammals are classified into two subclasses.

(i) Subclass – Prototheria

- In this subclass primitive egg laying mammals are included.
- Eggs are large, yolky and shelled.(Megalecithal)
- Mammary glands are without nipples
- Gynaecomastism is found in these animals i.e. male and female both feed their child. Mammary glands are functional in males and females both.
- Cloaca is present.
- Testes in males are situated inside the body (Abdominal cavity)
- Pinnae are absent and cochlea is less coiled.
- Corpus callosum is absent in the brain.
- A toothless horn like beak is found in adult animals, however child has teeth.
- Partially homeothermic animals.
- Animals are found in Australia, Newguine and Tasmania.
- This subclass has only one order.



Figure 6.27: Mammals: A. Ornithorhynchus anatinus, B. Tachyglossus, C. Macropus

(a) Order – Monotremata

Connecting links between the reptiles and mammals.

E.g.

- Ornithorhynchus or Duck billed platypus poison secreting glands in male platypus.
- Tachyglossus or Echidna or spiny ant eater.

(ii) Subclass – Theria

- Viviparous animals.
- Embryo is attached with uterus of mother through placenta to nourish it.
- Mammary glands with developed Nipple.
- Cloaca is absent.
- Testes are situated in the scrotal sacs.
- Pinnae are present and cochlea are much coiled
- Teeth are present.
- Teeth are found in adults as well as children.
- Subclass Theria is further subdivided into two infra classes:

Infraclass – Metatheria or Marsupials

- An abdominal pouch where young immature offspring are developed until their maturity is called as marsupium is found.
- Mammary glands along with nipples are found, situated in the marsupium.
- Two vagina with two clitoris and two different uteri each for a vagina are present in a female animal and bifid (two openings) penis present in a male.
- Yolk sac and placenta are found.
- Cochlea is more coiled in the internal ear.
- Adults have teeth, which are monophyodont and heterodont type.
- Corpus callosum is absent.
- Infraclass is divided in one order:

(a) Order – Marsupialia

- Characters are like metatheria
- Animals are oviparous

E.g.

- Macropus Kangaroo- Found in Australia only. Saltatorial locomotion (tail to use as body balance
- Didelphys Opossum Found in North America. Shortest gestation period (12-13 days).
- Dasyurus Tiger cat.

- Benadryl is used as an antidote to counteract the effect of hemotoxins.
- Seymouria is considered as the connecting link between amphibians and reptiles.
- Mesozoic era is known as "age of reptiles".
- Loreal pit of pit viper is a thermoreceptor organ.
- Reptiles without urinary bladder are snakes, crocodiles and alligators.
- Many sea snakes are viviparous. Pit vipers are also mostly viviparous.
- The oldest living animal in any Indian zoo is the Algebra giant tortoise.
- Rattle snake's tail emits a frightening sound which scares away the enemy.
- The king cobra of India is the only snake in the world that builds a nest.
- Largest snake is python; smallest snake is thread snake.
- Largest lizard is Komodo dragon; smallest lizard is two species of dwarf gecko.
- Longest dinosaur is Diplodocus; smallest dinosaur is Compsognathus.
- Heaviest dinosaur is *Brontosaurus*.
- Largest living reptiles are python, crocodile, and Komodo dragon.
- *Hemidactylus* or wall lizard (gecko) is swift runner on smooth vertical surface due to the presence of vaccum pads.
- Draco is a flying lizard but it actually does not fly.
- Heloderma is a poisonous lizard (gila moster).
- Ophiosaurus is known as "glass snake". "Blind worm". Or "slow worm", limbless lizard.
- Anguis is also known as blind worm and is limbless.
- Most poisonous snake of the world is peninsular tiger snake.
- Poisonous sea snake: *Hydrophis*.
- Biggest flesh eater dinosaur is *Tyrannosaurus*.
- Horned dinosaur: Stegosaurus.
- Monitor lizard (*Varanus*) is the largest living lizard. *Varanus* is commonly called "Goye" or "monitor"; semi-aquatic; slightly laterally compressed tail.
- Carapace is hard shield like structure present on the dorsal surface of tortoise and turtle.
- Reptiles arose in the lower carboniferous time, from labyrinthodont amphibia.

- *Phrynosoma* is found in deserts; called "horned toad", skin hygroscopic; takes water in the form of dew; exudes red blood like stream from eyes, whenever, terrified.
- *Iguana* is 5-6 feet long; body and tail laterally compressed; arboreal in habit; herbivorous found in tropical America.
- Sphenodon is the only living genus of Rhynchocephalia. It is commonly called Tuatara. It is found only in New Zealand. It is called living fossil as it resembles with Hanaesaurus of Jurassic age.
- Largest living carnivorous reptile is *Crocodilus*.
- Thermomorpha is a group of reptiles which are considered to be the ancestors of mammals.
- Hedonic glands present in males secret a sticky substance which hardens structures such as spine and helps to hold the mate firmly.
- In Uromastyx, cloaca possesses a pair of copulatory organs called hemipenes.
- Russel's viper is the largest Indian viper.
- Hafkine Institute of Bombay is the main center where antivenom is produced.
- The limbs of Chameleon show syndactyly (fusion of digits) as an adaption to arboreal life to form opposable finger to hold the twigs.

Infra Class – Eutheria

- True mammals who give birth to a mature child. A true placenta is found, which is of the Allanto chorionic type.
- Mammary glands have well developed and marked Nipples.
- Only one uterus and only one vagina are present in a female. Penis is single present in male.
- Cochlea is highly coiled in shape to fit in the body.
- Corpus callosum is present in brain.
- Entirely endothermic animals.
- Infraclass Eutheria is further divided into 16 orders as follows:

(a) Order 1: Insectivora

• These are burrowing nocturnal and insectivorous animals.

E.g.

- Erinaceous - Jhau - Chuha / Hedge Hog

- Sorex Shrews: smallest mammal's size is about 3 inches: Chhachhunder
- Talpa Mole

(b) Order 2: Chiroptera

- Bats which can fly in air. These are true flying mammals.
- Skin between the forelimbs and hindlimbs are expanded in a way to form patagium, which helps in flying.
- Testes are inside abdomen.
- Echolocation (Radar system) is the sensory system.

E.g.

- *Pteropus* Flying fox, a fruit eater animal.
- Vespertilo Insectivorous bat, also called filtter mice.
- Desmodus Vampire bat, a sanguivorous animal

DID YOU KNOW

- Small bats have claw on first digit of the fore limb and have a tail. Bats hang downward from tree branches because they are unable to stand erect.
- Lion in India is found in Gir forests of Gujrat. Male is polygamous with a mane, the digits have retractile claws.
- Monkeys are quadrupedal, tailed, with equal sized limbs and ischia callosities, while apes are bipedal, tailless, with longer force limbs but without ischia callosities.
- African elephant is larger in size, has depressed back, large sized pinnae and large sized tusk only in males.
- Elephant is largest terrestrial animal. Indian elephant has tusks in both the sexes.
- Turkish camel is a two-humped camel found in Gobi desert of Central Asia, while Arabian camel is one-humped camel found in North Africa to India.
- Camels are characterized by hump (store house of fat), water cells in stomach (to store metabolic water), pads beneath two digits, dense hair growth near eyes and nostrils, and nucleated RBCs. It is called ship of desert.
- Baleen is a set of hanging plates in the buccal cavity of blue whale.



(c) Order 3: Rodentia

- The biggest order in mammals
- These are small, terrestrial, can be either herbivore or omnivore.
- Incisor teeth grow continuously, canines are absent, which leaves empty space between teeth called as diastema

E.g.

- Funambulus Squirrel
- Rattus Rat
- Hystrix Porcupine =Sehi = Body hair are modified into quills.
- Cavia Guinea Pig.
- Dipodomys Kangaroo rat Desert rat (Never drink water)
- Beavers Aquatic Rodents

(d) Order 4: Edentata (Ant-eaters)

• The only mammal which has bony plates and horn like scales as exoskeleton.

E.g.

- Myrmecophaga Giant anteater.
- Dasypus or Armadillo It shows polyembryony (4-8 embryoes)
- Bradypus Slowest animal

(e) Order 5: Pholidota – (Scaly anteater)

- Two pairs of incisors teeth are present in the upper jaws and one pair in lower jaw.
- Are similar to rodents except the teeth
- Fore limbs are shorter than hind limbs.

E.g

- Manis/ pangolin - Scaly anteater.

(f) Order 6: Lagomorpha

- Similar to rodents
- Complete herbivore mammals
- · Canines are absent and diastema is present

E.g.

- Oryctolagus - Rabbit

Figure 6.28: Pteropus (Indian flying fox)

- Lepus Hare
- Ochotona Pika (Tail less)

(g) Order 7: Carnivora

- Canines are well developed.
- Smart, strong, carnivorous animals.
- Upper last premolar and lower first molar teeth tear the flesh of prey and these teeth are called as carnassials teeth.
- Digitigrades locomotion.
- Terrestrial carnivorous animals are called as Fissipedia and Marine carnivores are called as Pinnipedia.

E.g.

- o Canisfamiliaris Domestic dog.
- o Felisdomesticus Domestic cat.
- Panther leopersica Lion Lions in India are found only in Gir forests of Kathiawar of Gujrat state.
- o Panther pardus Tendua Panther.
- Panther tigris Tiger It is the National animal of India.
- Acinonyx Cheetah It is the extinct animal of India.
- Vulpes bengalnesis Fox.
- o Zalopus Sea lion.
- o Phoca Seal.
- o Odobenus Walrus.
- o Herpestes Mangoose.
- o Ursus Bear.
- o Canis lupus Wolf.

(h) Order 8: Cetacea

- Fish like marine mammals
- Hind limbs are absent.
- Hairs and pinnae are absent.
- Testes are found inside abdomen.

• A thick heat resistant layer of adipose tissue just beneath the skin is called as blubber.

E.g.

- Balaenopteramusculus Blue whale Found in Antarctic Ocean. A Horny sheed called as the Baleen plate (for filtration) is found in upper jaw and not in teeth. Milk is squirited to the baby by the muscle contraction of the mother. Retea mirabile helps in underwater respiration is found in thoracic region.
- o Phocaena porpoise Small whale
- o Orcinus Killer whale
- o Caparea Pigmy whale.
- *Physeter* Sperm whale –stomach secretes Ambergris which is used in making perfumes.
- Platanistagangatica Dolphin –in Ganga River.
- o Delphinus Common Dolphin.

(i) Order 9: Sirenia

- Herbivorous aqatic animals.
- Hind limbs are absent.
- Pinnae are absent.
- A transverse fin on the tail.
- Big tusk is present in male.

E.g.

- o Rhytina Sea cow.
- o Trichechus Manatee
- o Halicore Dugong

(j) Order 10: Proboscidia

- Largest and heaviest present day terrestrial animals.
- Upper incisors are long, tubular form as tusks. Canine teeth are absent.
- Molar teeth are lophodont type.
- Hair less, Testis is found in the abdomen.

E.g.

- o Elephas Indian elephant
- o Loxodonta African elephant, it is largest living land animal

(k) Order 11: Artiodactyla

• Stomach is divided in four chambers, which helps these animals in rumination (Cud-chewing). All animals are ruminent except Sus and Hippopotamus (Nonruminent). Even toed ungulate animals.

E.g.

- o Bos indicus Cow
- o Bubalus Buffalow
- o Camelus Camel (RBC nucleated)
- o Sus Pig.
- o Capra Goat
- o Ovis Sheep
- o Bos mutus /Poephagus Yak
- o Cervus Dear
- o Cameloparadelis Girrafe
- o Moschus moschiferus Musk dear (Smallest RBC)

KNOWLEDGE BUILDER

How many vertebrae do giraffes have in their neck? Most of the vertebrates, including giraffes and camel, have seen cervical (neck) vertebrates. At almost 6 m (20 ft) tall, the giraffe is the tallest of all vertebrates and its seven cervical vertebrae are greatly elongated

Exception: three-toed sloth (*Bradypus*) with nine cervical vertebrae and *Manatee* is with six neck vertebrae.



Armadillos: The nine-banded armadillo (*Dasypus*) is one of the few mammalian species whose range is expanding. In late 1800s, they lived only as far north as central Texas. Leprosy bacteria is cultured in the armadillos (*Dasypus*).

Humans remain plantigrade at rest or during locomotion; use only the toes for running. Thus, is called sub-plantigrade.

The color of human skin is yellow to orange due to carotene pigment in the cells of stratum corneum and subdermal fat cells. Melanin is found in melanocytes.

In humans, sweat glands are absent at lip borders, clitoris, glans penis, nail beds, under surface of prepuce.

Sweat or sudoriferous glands secrete sweat. Sweat comprises 95% water and 5% metabolic waste.

Spiny ant eater, scaly ant eaters, moles, cetaceans, sirenians, and some edentates do not possess sweat glands.

- Tusks of elephants are two incisors of upper jaw which constantly grow throughout life.
- Primates such as monkeys, man, apes, etc., acquired three-dimensional vision due to their most evolved motor understanding of visual sensation.
- Deer, amongst vertebrates, proportionately to their body size, possess largest eyes.
- Carnassial teeth: Special shearing teeth in carnivores for cracking bones fourth premolar of upper jaw and first molar of lower jaw.
- Milk-producing male mammal: Spiny ant eater/Echidna.
- Monotreme: With a single aperture of cloaca for urinogenital and digestive tracts.
- Largest land animal: Loxodonta africana (African elephant). Height 3.5 m and weight 7 tonnes.
- Tallest land mammal: Giraffe, up to 6 m.
- Mouse and Rat have first molar bigger than combined second and third molars.
- Stripes of no two zebras are alike.
- Fastest mammal: Acinonyx jubatus (Cheetah) (extinct from India present in Africa). Speed up to 100 km/h.
- Slowest terrestrial mammal: three-toed sloth (Bradypus), Tridactylus, 100-150 m/h.
- Slowest aquatic mammal: Sea otter, 10 km/h.
- Longest gestation period in mammal: 609 days/20 months in *Elephas maximus*.
- Shortest gestation period in mammal: Opossum, 12-13 days.
- Panthera tigris is the national animal of India (declared in 1973).
- Today marsupials are found mainly in Australia except a few marsupials such as the American opossum are found outside that continent.
- Plantigrade mammals are those whose palm and sole touch the ground when moving from one place to another, E.g., bears and certain insectivores
- Rabbit is digitigrade because it moves on digits.



Figure 6.29: A. Plantigrade, B. Digitigrade, and C. Unguligrade feet of mammals.

- Unguligrade mammals are those whose only the tips of one or two fingers and toes remain in contact with the ground both at rest and locomotion. These are fastest running terrestrial mammals, E.g., horses, deers, cows, donkeys, etc.
- Hides are prepared from the dermis of animals skin.
- Seals and wheals have scanty hairs because heat insulation is done by blubber.
- The horns of rhinoceros, scales of scaly ant-eater, and spines of porcupine are derivatives of hairs.
- The retina of owls contains only rods (suitable for nocturnal habit). Also, the same occurs in shrews, hedgehog, rodents, bats, etc.
- The retina of fowls contains only cones (suitable for diurnal habit). Squirrels also have only cones.
- Wheals, mice, shrews, and also some other mammals, but not rabbit and man, possess Harderian gland like that of the frog.
- The scrotum of mammals contains testes in most of the mammals; it acts as a thermostatic chamber. Testes lie outside the abdominal cavity because sperms cannot develop in body temperature. Thus, these become close, if the temperature falls more than C or come apart from the body, if temperature rises more than C of the body temperature.
- In insectivores, chiroptera, and rodentia, scrotum is formed only during breeding season. It later moves to abdominal cavity, E.g., bat, otter.
- Insectivores, edentates, proboscidians (elephants), cetaceans (wheals) always have their testes inside the body cavity.

(I) Order 12: Perissodactyla

- Limbs are long with 1 or 3 digits with hooves. These are fast running animals.
- Odd toed animals.

E.g.

- Equus caballus Horse
- o Equus asinus Donkey
- o Equus hemionus Indian Donkey
- o Equus zebra Zebra
- o Rhinoceros unicornis Rhino Single horn Genda. It is found in Kaziranga National Park Jorhat,



Assam. Rhino possess keratin horn over snout.

(m) Order 13: Primates

- Most developed mammals. It includes wise or most intelligence animals E.g. man, monkeys, lemur, apes, gibbons, gorilla chimpangi etc.
- Cerebrum highly advanced.
- Prosimians

E.g.

- Nycticebus Lemur
- Loris Loris (tail less)
- Tarsius Tarsier
- Simians
- Macaca mulalta Rhesus monkey (Monkey of old world catarrhint)
- Semnopithecus Baboon (Langur)
- Atles Spider monkey Monkey of modern world. (Platrrhini)
- (Prehensile tail)
- Hylobates Gibbon Smallest ape. (found in India)
- Only ape found in India Hoolock gibben
- Gorilla Largest ape.
- Pan Chimpanze Most intelligent in apes.
- Orangutan Man of forest (found in Indonesia)
- Homo Sapiens Man

KNOWLEDGE BUILDER

Mammalian (mammals):

Skin with sweat and milk glands,



- Hairy coat that conserves body heat,
- Four limbs that have digits along with claws, nails or hoofs,
- Buccal cavity is with thecodont, heterodont, diphyodont teeth,
- Spongy elastic lungs,
- Heart is 4 chamered,
- Cerebral hemispheres are connected together with the corpus callosum,
- Optic lobes are divided into four corpora quadrigemina,

• External ear is often accompanied with pinna,



- Males have copulatory organ,
- Eggs are amniotic, fertilization is internal, without larval stage,
- Viviparous animals
- Diaphragm between thorax and abdomen, endothermic.

Animal Kingdom (Chordates)

EXERCISE

TRY IT YOURSELF

- 1. Which of the following is most unique character of mammals and is without any exception?
- (A) They are viviparous
- (B) Presence of external ears or pinnae
- (C) Presence of mammary glands
- (D) Presence of seven cervical vertebrae
- 2. Which of the following mammal is oviparous?
- (A) Macropus (B) Pteropus
- (C) Ornithorthynchus (D) Delphinus
- 3. All mammals, without any exception, are characterised by
- (A) Biconcave red blood cells
- (B) Extra-abdominal testes and four chambered heart
- (C) Heterodont teeth and twelve pairs of cranial nerves
- (D) A muscular diaphragm
- 4. Besides bats, echolocation sonar mechanism also occurs in
- (A) Primates
- (B) Felis (cat)
- (C) Wheals and dolphins
- (D) Macropus (Kangaroo)

Summary



Flowchart 6.1: Animal Kingdom and its Division

- Phylum Chordata: all animals with a notochord in their body in either some of the life part or throughout the life. There are common features in all the chordates which are the dorsal, hollow nerve cord and also the paired pharyngeal gill slits.
- Some of the vertebrates lack jaws (Agnatha) while most of the vertebrates have jaws (Gnathostomata). Agnatha includes the class Cyclostomata. They are the most primitive chordates and are ectoparasite on fishes.
- Gnathostomata is further divided into two super classes: Pisces and Tetrapoda. Class Chondrichthyes and Osteichthyes are parts of pisces that bear fins for locomotion. The Chondrichthyes include marine fishes that have cartilaginous endoskeleton and Osteichthyes class includes all the bony fishes.
- Super class Tetrapoda has Classes Amphibia, Reptilia, Aves and Mammalia. They share lists of similarities major one is two pairs of limbs. The amphibians have ability to survive and grow on land

and in water. Reptiles have dry and cornified skin. Snakes lack limbs. Fishes, amphibians and reptiles all are Poikilothermous (cold-blooded). While Aves are warm-blooded animals that have feathers as covering on their bodies and forelimbs are modified into wings used in flying. Hind limbs have the ability to walk, swim, perch or clasp. The unique features among all the mammals are their mammary glands and hairs on the skin. They commonly exhibit viviparity with few exceptions.

Objective Type Questions

Q.1 Notochord persists in the adult of

(A) Protochordates	(B) Agnatha
(C) Chondrichthyes	(D) Osteichthyes

Q.2 In which of the phylum stomochord is present instead of true notochord?

(A) Chordates	(B) Hemichordates
(C) Protochordata	(D) Urochordata

Q.3 Which of the following group of characters is present in all chordates in some or other stage in their life?

- (A) Mammary glands, hairs and gill slits
- (B) Notochord, gill slits and dorsal tubular nervous system
- (C) Notochord. Scales and dorsal tubular nervous system
- (D) Gill slits, vertebral column and notochord
- Q.4 Retrogressive metamorphosis occurs in
 - (A) Balanoglossus (Tornaria larvae)
 - (B) Amphioxus
 - (C) Ascidian tadpole larva of Herdmania
 - (D) Glossobalanus
- Q.5 Vertebral column is a modified
 - (A) Nerve cord (B) Notochord
 - (C) Umbilical cord (D) Urochordata
- Q.6 In chordates, basically the pharynx
 - (A) Perforated (B) Non-perforated
 - (C) Present in the gut of the larva
- (D) A source of thyroxin which controls metamorphosis

Q.7 Which of the following larvae after metamorphosis migrates from river to ocean?

- (A) Ammocoete larvae of lampreys (cyclostoma)
- (B) Trochophore larvae of molluscs
- (C) Ascidician tadpole larva of Herdmania
- (D) Dipleura larva

Q.8 Petromyzon belongs to the class

- (A) Chondrichythes (B) Cyclostomata
- (C) Osteichthyes (D) None of these
- **Q.9** Which of the following is ectoparasite vertebrate in which stomach is absent and a functional pineal eye is present?
 - (A) Agnatha (Petromyzon) (B) Shark
 - (C) Torpedo (D) Remora
- **Q.10** In which of the following fish electric organs are present which are modified musculature between eye and nostrils?
 - (A) *Torpedo* (electric ray) (B) *Scoliodon* (dog fish)
 - (C) *Trygon* (sting ray) (D) *Pristis* (saw fish)
- **Q.11** Gill slits in chondrichthyes are
 - (A) Uncovered (B) Covered by operculum
 - (C) Absent (D) Only sometimes covered

Q.12 Scales in cartilaginous fishes are

(A) Cycloid	(B) Ctenoid	(C) Placoid	(D) Leptoid
Q.13 Which of the following i	s viviparous and bring f	orth their young alive?	
(A) Hippocampus	(B) Shark	(C) Anabas	(D) Trygon
Q.14 Air bladder is present ir	1		
(A) Cartilaginous fishes	(B) Bony fishes	(C) Star fish	(D) Electric Ray
Q.15 Lateral line organs do r	not occur in		
(A) Cartilaginous fishes	(B) Bony fishes	(C) Amphibian larvae	(D) Reptiles

Q.16 In fishes, the neuromast c	organs are				
(A) Chemoreceptors		(B) Gu	statoreceptors		
(C) Olfactoreceptors		(D) Rh	eroceptors		
Q.17 Peculiarity of fish heart is	that it has				
(A) All venous blood		(B) All	arterial blood		
(C) Partly venous and partl	y blood	(D) No blood at all			
Q.18 Heterocercal tail, placoid	scales are found	in one	of the following		
(A) Rohu	(B) Neoceratod	lus	(C) Scoliodon	(D) Anguilla	
Q.19 Mermaid purse is					
(A) A colony of skates and	rays	(B) A I	ovely fish		
(C) Egg case of skate fishes		(D) A brood pouch of male sea horse for carrying eggs			
Q.20 Gambusia is a					
(A) Pest on fishes		(B) Pa	thogenic fish		
(C) Parasitic fish		(D) Fish predator of mosquito larvae			
Q.21 One of the following fish d	loes not belong to	o class	osteichthyes		
(A) Hippocampus	(B) Labeo		(C) Torpedo	(D) Exocoetus	
Q.22 In which of the following fitter the air, as the fish leaps out	sh the pectoral fi t?	in is lar	ge and modified to use	for gliding several meters in	
(A) Exocoetus	(B) Anabas		(C) Echeneis	(D) Labeo	
Q.23 In which fish male shows	parental care and	d has a	brood pouch?		
(A) Anabas	(B) Labeo		(C) Hippocampus	(D) Synaptura	
Q.24 In fishes, the locomotion is	s due to				
(A) Caudal fins		(B) Fin	s without fin rays		
(C) Paired fins		(D) Pa	ired and unpaired fins		

Q.25 The intestine of dogfish	is characterized by	/ the presence of	
(A) Scroll valve	(B) Typhlosole	(C) Maltase cross	(D) Cartilage
Q.26 The oldest living fish is			
(A) Anabas	(B) Coelacanth	(C) Diodon	(D) Sturgeon
Q.27 Which one of the following	ng is most venome	ous fish?	
(A) Electric fish	(B) Saw fish	(C) Stone fish	(D) King of Herrings
Q.28 Fishes have kidney of			
(A) Pronephric type		(B) Mesonerphic type	
(C) Metanephric type		(D) Nephridial type	
Q.29 Which one of the following	ng is a true fish?		
(A) Cray fish	(B) Cuttlle fish	(C) Flying fish	(D) Jelly fish
Q.30 An anadromous fish mig	rates from		
(A) Rivers to sea eg. Ang	uilla	(B) Rivers to estuary	
(C) Sea to rivers eg. Hilsa	a, Salmon	(D) Deep sea to surface waters	
Q.31 A catadromous fish migr	ates from		
(A) Rivers to sea		(B) Rivers to estuary	
(C) Sea to rivers		(D) Deep sea to surface waters	
Q.32 Which one of the following	ng is a catadromo	us fish?	
(A) Anguilla	(B) Hilsa	(C) Salmon	(D) Yellow eel
Q.33 One of the following is a	limbless amphibia	an	
(A) Salamandra (Urodela)	(B) Lchthyophis (Apoda)	
(C) Necturus (Urodela)		(D) <i>Hyla</i> (Anura)	
Q.34 Which of the following m	atch is incorrect		
(A) Alytes – Male midwife	toad	(B) Necturus – Mud puppy or w	ater dog

(C) Bombinator – Fire-bellied toad

(D) Hyla arborea – Flying frog

Q .3	5 Which is the largest amph	nibian?				
	(A) Amphiuma	(B) Crytobranchus		(C) Necturus	(D) Proteus	
Q.3	6 Fire bellied toad is					
	(A) Salamandra	(B) Discogloss	us	(C) Rhinoderma	(D) Amphiuma	
Q.3	7 Salamandra is					
	(A) Tailed amphibian		(B) Tail-less ar	nphibian		
	(C) Limbless amphibian		(D) Reptile			
Q.3	8 The excretory product of r	newly hatched ta	idpole of frog is			
	(A) NH ₃		(B) Uric acid			
	(C) NH_3 and urea	H_3 and urea		(D) Urea, amino acids and $\rm NH_3$		
Q.3	9 Which one of the following	g, is a poisonous	amphibian?			
	(A) Bufo marinus (B		(B) Hyla verscicolour			
	(C) Ichthyothis		(D) Rana tirina			
Q.4	0 A frog lives in water or ne	ar water becaus	е			
	(A) It can get its food easily in water					
	(B) Its hind limbs are webbed and help in swimming					
	(C) It lays eggs in water					
	(D) It can see through its tr	ansparent eye li	ds while swimmi	ng		
Q.4	1 The larva of Ambyostoma	is				
	(A) Ascidian	(B) Axolotl		(C) Tadpole	(D) Trochophore	
Q.4	2 Male frogs can crock loud	er than females	because being/h	naving		
	(A) Larger in size		(B) Larger sou	nd box		
	(C) Stronger		(D) Vocal sacs			

Q.43 The success of reptiles as truly land animals was due to

(A) Development of internal fertilisation						
(B) Presence of amino, embryonic membrane which encloses the embryo and provides watery environment for development						
(C) Respiration only throu	(C) Respiration only through lungs, which is improved by the development of ribs					
(D) All of these						
Q.44 Which of the following a cranial nerves?	are poikilothermal	animals	s with single occipital	condyle and twelve pairs of		
(A) Aves	(B) Reptiles		(C) Mammals	(D) Amphibia		
Q.45 Which is the only poison	ous lizard of the w	vorld?				
(A) Ophiosaurus	(B) Varanus		(C) Heloderma	(D) Draco		
Q.46 The largest sized lizard is	S					
(A) Chameleon	(B) Heloderma		(C) Ophiosaurus	(D) Varanus		
Q.47 Which one is a viviparous lizard?						
(A) Chameleon	(B) Hemidactyl	us	(C) Mabuya	(D) Uromastix		
Q.48 The urinary bladder is ab	osent in					
(A) Chameleon	(A) Chameleon (B) Snake					
(C) Snake and crocodile		(D) Wa	(D) Wall lizard			
Q.49 Study of snakes is called	I					
(A) Ichthyology	(B) Serpentolog	ЭУ	(C) Herpatology	(D) Entomology		
Q.50 The reptiles without teeth	n is					
(A) Lizards	(B) Heloderma		(C) Chelonia	(D) Alligators		
Q.51 Which one of the followir	ng is non-poisonoi	us snake	e?			
(A) Cobra (<i>Naja naja</i>) (B) Aigar (<i>Pvthon</i>)						
(C) Krait (Bungarus)	(D) Viper (Viper russelli)					
Q.52 Which of the following is	not a true snake?	,				
(A) Tree snake		(B) Gla	iss snake			
(C) Blind snake		(D) Sea snake				
--	-----------------------------------	------------------------------------	-------------------------	--		
Q.53 The cobra (Naja naja) can	ı be distinguished	d by the presence of				
(A) Agile habit		(B) Black colour				
(C) Hood		(D) Hood and III largest supra l	labials			
Q.54 Which one of the following	g pair of snakes i	s viviparous?				
(A) Krait and Viper		(B) Cobra and Krait				
(C) Hydrophis and Vipera r	(C) Hydrophis and Vipera russelli					
Q.55 Benadryl and antisera are	used to					
(A) Control malaria		(B) Counteract the effect haem	otoxins			
(C) Cure sleeping sickness		(D) Counteract the bite of mad dog				
Q.56 The largest Indian poison	ous snake is					
(A) Blue Krait	(B) Cobra	(C) King cobra	(D) Python			
Q.57 Which one is the longest s	snake?					
(A) Cobra	(B) Krait	(C) Python	(D) Rat snake			
Q.58 Krait (<i>Bungarus</i>) can be d	ifferentiated from	n other snakes by its				
(A) Hairy body		(B) Size				
(C) Shield like scales on the	e head	(D) Vertebralscales				
Q.59 Crocodile, fish and frog, o	n one hand and	squirrel and crows on the other	differ in the following			

- (A) The former have four appendages, the latter have only two
- (B) The body temperature of the former changes with environmental temperature, the temperature of the latter remains more or less constant.
- (C) The former undergo metamorphosis, the latter do not
- (D) The former are oviparous the latter are viviparous
- **Q.60** Which of the following group of animals are homeothermal, single occipital condyle, twelvepairs of cranial nerves, pneumatic bones and found chambered heart?

	(A) Amphibia	(B) Aves		(C) Reptilia	(D) Mammalia
Q.6	1 Feathers of the birds are v	vaterproof due to	the onl	y secretion of	
	(A) Cutaneous gland	(B) Preen gland	ł	(C) Sudorific gland	(D) None of these
Q.6	2 Pneumatic bones occur in				
	(A) Amphibians	(B) Reptiles		(C) Birds	(D) Mammals
Q.6	3 Right ovary, right oviduct a	and urinary blade	der have	atrophied in one of the	following
	(A) Kiwi	(B) Pigeon		(C) Kingfisher	(D) All of these
Q.6	4 Air sacs are found only in				
	(A) Aquatic birds	(B) Ground bird	S	(C) All birds	(D) No bird
Q.6	5 A pigeon in the absence o	f down feathers	will not t	be able to	
	(A) Fly for long distance				
	(B) Protect against ectopara	asite			
	(C) Exhibit secondary sexu	al dimorphism			
	(D) Keep the body warm				
Q.6	6 Which of the following bor	ies in present on	ly in biro	ds?	
	(A) Axis vertebra		(B) Atla	as vertebra	
	(C) Ear ossicles		(D) Fur	cula	
Q.6	7 The beak in birds is toothe	ed in			
	(A) Ostrich	(B) Kiwi		(C) Archaeopteryx	(D) Pelican
Q.6	8 Which one of the following	ı birds, has recer	ntly beco	ome extinct?	
	(A) Archaeopteryx		(B) Arc	haeornis	
	(C) Dodo		(D) Gre	eat Indian Bustard	
Q.6	9 The largest living bird is				
	(A) Struthio (Ostrich)		(B) Apt	enodytes (Penguin)	
	(C) Phoenicopterus (Flamir	ngo)	(D) Aeµ	oyornis (Giant elephant b	bird)

Q.70 Which of the following statement is incorrect about birds?

(A) The two clavicles and one interclavicle forms a 'V'-shaped bone called as furcula

- (B) The eyes of birds are peculiar due to the presence of Pecten
- (C) Carinatae or flying birds have sternum with keel
- (D) In birds the left ovary and oviduct is atrophied

Q.71 Which one of the following is a metatheria mammal?

(A) Echidna	(B) Kangaroo	(C) Shrew	(D) Pangolin
Q.72 Ungulates or odd-toe	d mammals (Horse, Ass a	nd Zebra, belong to the	order
(A) Artiodactyla	(B) Perissodactyla	- (C) Lagom _{ິດ} rnha	(D) Edentata
Q.73 Which one of the follo	owing characters is not typ	ical of the clas، الم	lia?
(A) Thecodont dentitio	n (B),	Alveolar lungs ⁵	
(C) Ten pairs of crania	I nerves (D)	Seven cervical vertebrae	9
Q.74 Which of the following	a animals has a diaphragn	between the thorax and	d abdomen?
(A) Frog	(B) Lizard	(C) Pigeon	(D) Whale
Q.75 In one of the following	g orders of class mammilla	ı, the animals can fly	
(A) Lagomorpha	(B) Chiroptera	(C) Rodentia	(D) Cetacea
Q.76 The tusks of elephant	tare		
(A) Incisors	(B) Canines	(C) Molars	(D) Premolars
Q.77 Testes are internal, c	anines and premolars are	absent in which one of t	he following?
(A) Rabbit	(B) Elephant	(C) Whale	(D) Goat
Q.78 Which is the most inte	elligent ape among the foll	owing?	
(A) Gibbon (Hylobates) (B)	Gorilla	
(C) Pongo	(D)	Chimpanzee (Pan)	
Q.79 Sea cow (Halicore) is	a member of order		
(A) Cetacea	(B) Lagomorpha	(C) Carnivora	(D) Sirenia

			Anima	I Kingdom (Chordates)	
0.8	0 Which one of the following	uis a tailless orin	nate?		
Q.0	(A) Tarsier	(B) Lemur	(C) Rhesus monkey	(D) Gorilla	
		(_) _0	(0) •	(2) 201110	
Q.8	Q.81 The largest spiny mammal out of the following is				
	(A) Hedge hog (Erinaceus)		(B) Opossum (Didelphis)		
	(C) Porcupine (Hystrix)		(D) Spiny ant eater (Tachyglossus)		
Q.8	2 Elephant is an inhabitant of	of hot climate. Th	nis is suggested by		
	(A) Huge size		(B) Fleshy feet		
	(C) Almost hairless skin		(D) Small eyes		
Q.8	3 Gynaecomastism conditior	n (males have fun	nctional mammary glands to feed young o	ones) is best seen in	
	(A) Duck-billed Platypus		(B) Didelphys		
(C) Scaly ant eater		(D) Hedge hog			
Q.8	4 In one of the following, cellulose.	stomach is com	plicated with several chambers in wh	ich bacteria digest	
	(A) Flying fox	(B) Goat	(C) Porcupine	(D) Hedge hog	
Q.8	5 Monotreme is a group of a	animals which inc	cludes		
	(A) Fishes with single gill a	perture	(B) Insects with a single pair of cloaca		
	(C) Mammals with a single	cloaca	(D) Protozoa with a single flagellum		
Q.8	6 Milk glands are found in				
	(A) All vertebrates		(B) All mammals		
	(C) All placental mammals		(D) All prototherians only		
Q.8	7 The largest life span in an	imals is of			
	(A) Tortoise	(B) Snake	(C) Parrot	(D) Gorilla	

Q.88 Whale is a mammal because

6.76

- (A) Heart has four chambers
 (B) It is aquatic with stream lined body
 (C) It lays egg and produces milk
 (D) Diaphragm is found between thorax and abdomen

 Q.89 Very large with a single nostril is

 (A) Blue whale
 (B) Physeter
 (C) Python
 (D) Tortoise

 Q.90 Eggs of egg laying mammals are

 (A) Macrolecithal
 (B) Alecithal
 (C) Mesolecithal
 (D) Telolecithal
- **Q.91** Within the lamellae of gills, the blood circulation is arranged so that blood is carried in the opposite direction to the movement of water. The functional significance of this arrangement is that
 - (A) It helps to maintain the temperature of the organism equal to the water temperature, thus enhancing diffusion.

(B) It ensures a continuous gradient concentration difference between the blood and the water, so that diffusion continues all along the gill.

(C) It increases the surface area for diffusion.

- (D) It allows some kinds of fishes to continue to get oxygen even if they are not moving.
- **Q.92** The graph below shows changes in air temperature and changes in the body temperature of a lizard. Use the graph below to answer the question that follows graph.



In order to raise its internal temperature, it must do which of the following?

- (A) Rest in shade
- (B) Bask in sunrise
- (C) Increase its internal temperature through metabolism
- (D) Decrease its internal temperature through activity.
- **Q.93** The following diagrams show five parts of the amniotic egg indicated by latters, 1, 2, 3, 4 and 5. Choose the correct option for the name and function of each part.



	1	2	3	4	5
(A)	Amnion, prevents desiccation	Allantois respiration and excretion	Embryo forms new individual	Chorion, protection	Yolk sac, encloses food
(B)	Amnion, prevents desiccation	Embryo, forms new individual	Allantois, respiration excretion	Chorion, protection	Yolk sac, encloses food
(C)	Allantois respiration and excretion	Amnion, prevents desiccation	Embryo forms new individual	Chorion, protection	Yolk sac, encloses food
(D)	Allantois respiration	Amnion provides watery environment	Chorion, protection	Embryo forms new individual	Yolk sac, encloses food

Q.94 Study the two skulls. Which is more like a mammal skull? Choose correct answer for A and (B)

- (A) A is like a mammalian skull and B is like an avian skull
- (B) A is like an avian skull and B is like a reptilian skull
- (C) A is like a reptilian skull and B is like a mammalian skull
- (D) A is like a mammalian skull and B is like a reptilian skull

Previous Years' Questions

Q.1 In which sub-phylum notochord extends from head to tail region and persistent throughout their life? (*HP PMT 2011*)

(A) Cephalochordata	(B) Urochordata	
(C) Both (A) and (B)	(D) None of the above	
Q.2 The three fundamental character	s of all chordates are	(Manipur 2006)
(A) Dorsal tubular nerve cord, diaphra	agm, notochord	
(B) Notochord, diaphragm, gill slits		
(C) Gill slits, diaphragm, dorsal tubula	ar nerve cord	
(D) Notochord, gill slits, dorsal tubular	r nerve cord	
Q.3 The postanal tail is present in		(Karnataka CET 2007)
(A) Chordates	(B) Vertebrates	
(C) Invertebrates	(D) In all of them	
Q.4 In which of the following animals	notochord is not present	(Orissa JEE 2007)
(A) Adult tunicate	(B) Herdmania	
(C) Myxine	(D) Balanoglossus	
Q.5 Paired appendages are not found	d in	(AFMC 2008)
(A) Hemichordates	(B) Urochordates	
(C) Cephalochordates	(D) All of these	
Q.6 Which one of the following state other three are correct?	ments is totally wrong about th	e occurrence of notochord, while the (CBSE PMT Mains 2011)
(A) It is present only in larval tail in As	scidians	
(B) It is replaced by a vertebral colum	in in adult frog	

- (C) It is absent throughout life in humans from the very beginning
- (D) It is present throughout life in Amphioxus
- Q.7 In some chordates, the notochord is modified as the vertebral column. Such animals are called vertebrates. Which one of the following statements make sense? (*Karnataka CET 2011*)
- (A) All chordates are vertebrates but all vertebrates are not chordates
- (B) All vertebrates are chordates and all chordates are vertebrates
- (C) All vertebrates are chordates but all chordates are not vertebrates

(D) Chordates are not vertebrates and vertebrates are not chordates

Column I (Animal)	Column II (Maximum life span)
I. Carp	(a) 102 years
II. Cobra	(b) 47 years
III. Turtle	(c) 152 years
IV. Giant Tortoise	(d) 28 years
V. Swan	(e) 123 years

Q.8 Match the items in column I with column II and choose the correct alternatives. (Kerala PMT 2007)

(A) I - b, II - d, III - e, IV - c, V - a

(B) I - a, II - d, III - c, IV - e, V - b

(C) I - b, II - c, III - d, IV - e, V - a

(D) I - a, II - c, III - b, IV - e, V - d

(E) I - c, II - d, III - e, IV - b, V - a

Q.9 Which one of the following is not a characteristic feature of the sub-phylum vertebrata?

(A) Dorsal tubular nerve cord(B) Ventral muscular heart

(C) Presence of notochord in the adult

(D) Presence of kidneys

(E) Two pairs of lateral appendages fins or limbs

Q.10 Which one of the following is correctly matched?

(A) *Trygon* - Monitor

(B) Ichthyopis - Crow

(C) Varanus - Stingray

- (D) Corvus Limbless amphibian
- (E) *Pristis* Sawfish

Q.11 Placoid (tooth-shaped) scales are found in

(A) Reptiles (B) Bony fishes (C) Cartilaginous fishes (D) Amphibians

(Kerala PMT 2007)

(Kerala PMT 2007)

(BHU 2008)

Q.12 In Sharks, which one of the following is absent?			(J&K CET 2008)
(A) Claspers		(B) Placoid scales	
(C) Cartilaginous endos	skeleton	(D) Air bladder	
Q.13 Which of the follow	wing fish injures its prey'	?	(AFMC 2008)
(A) Clarius	(B) Gambusia	(C) Heterpneustes	(D) Salsa
Q.14 Which of the follow	wing has exoskeleton of	scales and paired copulatory or	gans or penes? (UPCPMT 2008)
(A) Sharks	(B) Lizards	(C) Urochordates	(D) Urodela
Q.15 Sea horse is			(Chhatisgarh PMT 2009)
(A) A bird	(B) A mammal	(C) An amphibian	(D) A fish
Q.16 Ampullae of Lorer	nzini are present in		(DUMET 2009)
(A) Fish	(B) Lizard	(C) Frog	(D) Rabbit
Q.17 Which one of the	following pairs of animal	s comprises jawless fishes?	(CBSE 2009)
(A) Guppies and hag fis	shes	(B) Mackerals and rohu	
(C) Lampreys and eels		(D) Lampreys and hag fishes	
Q.18 Connecting link be	etween cartilaginous and	bony fishes is	(BHU 2009)
(A) Catla	(B) Chimaera	(C) Protopterus	(D) Torpedo
Q.19 Sharks and Rays	belong to class		(Chandigarh CET 2009)
(A) Osteichthyes	(B) Chondrichthyes	(C) Cyclostomata	(D) Amphibian
Q.20 Which one is commonly known as flying fish?			(HP PMT 2010)
(A) Betta	(B) Exocoetus	(C) Hippocampus	(D) Pterophyllum
Q.21 Which one of the following groups of animals is correctly matched with its characteristic feature without any exception? (AIPMT (Prelims) 2011)			

- (A) Reptilia : possess 3-chambered heart with an incompletely divided ventricle
- (B) Chordata : possess a mouth with an upper and a lower jaw
- (C) Chondrichthyes : possess cartilaginous endoskeleton
- (D) Mammalia : give birth to young ones

(AIPMT (Prelims) 2011)

Q.22 What will you look for to identify the sex of the following?

(A) Male Frog — a copulatory pad on the first digit of the hind limb.

(B) Female cockroach — anal cesci

(C) Male Shark — Claspers born on pelvic fins

(D) Female Ascaris — Sharply curved posterior end

Q.23 Match list I with list II and choose the correct option.

(Kerala PMT 2011)

List I	List II		
a. Pacific salmon fish	1. Verhulst-Pearl Logistic growth		
b. $N_t = N_o e^{rt}$	2. Breeds only once in lifetime		
c. Oyster	3. Exponential growth		
d. dN/dt = rN $\left(\frac{K-N}{K}\right)$	4. A large number of small sized offspring		

(A) a - 4, b - 3, c - 1, d - 2	(B) a - 3, b - 4, c - 1, d - 2	
(C) a - 3, b - 1, c - 4, d - 2	(D) a - 2, b - 3, c - 4, d - 1	(E) a - 2, b - 4, c - 3, d - 1

Q.24 Which of the following animals sows discontinuous distribution?(DUMET 2011)(A) Green muscle(B) Bats(C) Lung fish(D) Pacific salmon

Q.25 Consider the following four statements about certain desert animals such as Kangaroo rat;

I. They have dark colour and high rate of reproduction and excrete solid urine

- II. They do not drink water, breathe at a slow rate to conserve water and have their body covered with thick hairs
- III. They feed on dry seeds and do not require drinking water
- IV. They excrete very concentrated urine and do not use water to regulate body tem perature

Which two of the above	(DUMET 2011)		
(A) II and III	(B) III and I	(C) I and II	(D) II and IV
Q.26 Which one is co	mmonly known as Saw fis	h?	(HP PMT 2011)
(A) Bette	(B) Exocoetus	(C) Pristis	(D) Trygon

- Q.27 Which one of the following categories of animals, is correctly described with no single exception in it? (CBSE Mains PMT 2012)
- (A) All reptiles possess scales, have a three chambered heart and are cold blooded (poikilothermal)

(B) All bony fishes have four pairs of gills and an operculum on each side

(C) All sponges are marine and have collared cells

(D) All mammals are viviparous and possess diaphragm for breathing

Q.28 Jaw of shark contains (AMU 2012) (A) Thecodont teeth (B) Aacrodont teeth (C) Pleurodont teeth (D) None of these Q.29 Pin rot of fish is caused by (West Bengal JEE 2012) (A) Aeromonas (B) Pseudomonas (C) Branchiomyces (D) Xenoplylla Q.30 Which one of the following pairs of animals are similar to each other pertaining to the feature stated (CBSE Main PMT 2012) against them? (A) Pteropus and Ornithorhyncus - viviparity (B) Garden lizard and crocodile - three chambered heart (C) Ascaris and Ancylostoma — metameric segmentation (D) Sea horse and flying fish — cold blooded (poikilothermal)

Q.31 In fish, Catla catla the specific name is identical with the generic name, thus it is an example of

(A) Antonym	(B) Tautonym	(C) Synonym	(D) Homonym

Q.32 In chondrichthyes, claspers are seen on

(A) Pelvic fins of male

(B) Pelvic fins of females

(C) Operculum of both sexes

(D) Around jaws

Q.33 Match the following

Column I	Column II
I. Euplectella	(a) Sea pen
II. Physalia	(b) Pinworm
III. Pennatula	(c) Venus flower basket
IV. Enterobius	(d) Midwife toad
V. Alytes	(e) Portuguese man of war

(Kerala PMT 2007)

(AMU 2012)

(HP PMT 2012)

Choose the correct choice

(A) I - e, II - d, III - c, IV - b, V - a	(B) I - e, II - c, III - d, IV - b, V - a
(C) I - d,.II - e, III - a, IV - b, V - c	(D) I - c, II - e, III - a, IV - b, V - d
(E) I - b, II - a, III - c, IV - d, V - e	

Q.34 The largest RBC's have been seen in

(Karnataka CET 2007)

(A) Elephant (B) Whale (C) Amphibia (D) Man

Q.35 Which of the following features is not common between newt and *Hemidactylus?* (UPCPMT 2009)

- (A) Body is divisible into head, neck, trunk and tail
- (B) Head with pair of eyes and tympanic membrane
- (C) Trunk has 2 pairs of limbs for locomotion
- (D) Heart is 3-chambered
- Q.36 Which one of the following the genus name, its two characters and its class/phylum are correctly matched? (CBSE AIPMT 2011)

Genus	Two characters	Class/phylum	
(A) Salamandra	(I) A tympanum represents ear	Amphibia	
(A) Salamanura	(ii) Fertilisation is external	Amphibia	
(P) Diaranua	(i) Skin possesses hair	Mammalia	
(B) Fleropus	(ii) Oviparous	Wallinalia	
(\mathbf{C}) Aurolia	(i) Cnidoblast	Coolonterate	
(C) Aurena	(iii) Organ level of organization	Coelenterata	
(\mathbf{D}) Apparia	(i) Body segmented	Appolido	
	(ii) Males and females distinct	Arineliua	

Q.37 The number of cranial nerves in frog are

(HP PMT 2012)

(A) Ten (B) Twelve (C	C) Twelve pairs	(D) Ten pairs
-----------------------	-----------------	---------------

Q.38 If the scales on the belly of a snake are small, but the tail is laterally compressed, then it is a

(Chhatisgarh 2009)

(A) Cobra	(B) Viper	(C) Sea snake	(D) Krait
Q.39 Which one of	the following indicates	s the reptilian ancestry of the birds?	(CBSE PMT 2008)
(A) Eour obomboro	dboort		

(A) Four chambered heart

(B) Two special chambers, crop and giz zard in their digestive tract

(C) Eggs with a calcareous shell

(D) Scales on their hind limbs

Q.40 An animal which	has both exoskeletal and	d endoskeletal structures i	s (Karnataka PMT 2009)
(A) Frog	(B) Jelly fish	(C) Fresh water mussel	(D) Tortoise
Q.41 The sea snakes h	nave		(Haryana PMT 2009)
(A) Cylindrical tail		(B) Dry horny scale at ta	ail end
(C) Laterally compress	ed tail	(D) Dorso-ventrally flatte	ened tail
Q.42 The snake eating	snake is		(J&K CET 2009)
(A) Black cobra	(B) King cobra	(C) Rattle snake	(D) Anaconda
Q.43 Venom of viper a	ffects		(Manipal 2009)
(A) Nervous system		(B) Circulatory system	
(C) Respiratory system	I	(D) None of these	
Q.44 Animals of which epidermal scales	class are mostly terres or scutes?	strial and their body is co	overed by dry and comified skin, <i>(HP PMT 2010)</i>
(A) Ayes	(B) Amphibia	(C) Reptilia	(D) Mammalia
Q.45 Four chambered	heart is characteristic of	this poilkilotherm	(HP PMT 2012)
(A) Psittacula	(B) Hemidactylus	(C) Pteropus	(D) Crocodilus
Q.46 Renal portal syste	em is absent in		(BHU 2008)
(A) Reptiles	(B) Amphibians	(C) Reptiles and Amphil	pians (D) Birds
Q.47 Which one of the	following in birds indicat	es their reptilian ancestry	? (CBSE 2008)
(A) Two special chamb	ered crop and gizzard in	their digestive tract	
(B) Eggs with a calcare	eous shell		
(C) Scales on their hind	d limbs		
(D) Four chambered he	eart		
Q.48 Which of the follo	wing is a flightless bird?		(UP CPMT 2011)
(Δ) Ostrich	(B) Emu	(C) Kiwi	(D) All of these

6.86			Animal Kingdom (Chordates)
Q.49 Which one of the	following is not Poikiloth	er mous?	(HP PMT 2011)
(A) Fishes	(B) Amphibians	(C) Reptiles	(D) Aves
Q.50 If a water body is o	contaminated with a toxica	ant, its biomagnification w	ill be more marked in (AMU 2012)
(A) Water	(B) Planktons	(C) Small fishes	(D) Birds
Q.51 What is common	between Parrot, Platypus	s and Kangaroo?	(CBSE PMT 2007)
(A) Functional post ana	ıl tail	(B) Oviparity	
(C) Homoiothermy		(D) Toothless jaws	
Q.52 Identify the odd co	ombination of the habitat	and the particular anima	Il concerned. (CBSE PMT 2007)
(A) Periyar	- Elephant		
(B) Rann of Kutch	- Wild Ass		
(C) Dachigam	- National Park		
(D) Sunderbans	- Bengal Tiger		
()			
Q.53 Species going to	extinct due to low reprod	uctive rate is	(MP PMT 2007)
(A) Lion	(B) Bald eagle	(C) Giant panda	(D) Island species
Q.54 Indian rhinoceros	are protected in		(MP PMT 2007)
(A) Gir Forest		(B) Kaziranga National	Park
(C) Bandipur National F	Park	(D) Ranthambore Natio	nal Park
()			
Q.55 Statement A : All	Metatherian are placenta	al mammals.	(Karnataka CET 2007)
Statement B : All place	ntal mammals have men	strual cycle.	
(A) Statement A is true	and statement B is false	9	
(B) Statement B is true	and statement A is false)	
(C) Both the statements	s A & B are true		
(D) Both the statements	s A & B are false		
Q.56 Longest loop of H	enle is found in		(UPCPMT 2007)
(A) Kangaroo rat	(B) Opposum	(C) Rhesus monkey	(D) all of these

_

ANSWER KEY

Objective Questions

Q.1 A	Q.2 B	Q.3 B	Q.4 C	Q.5 B	Q.6 A
Q.7 A	Q.8 B	Q.9 A	Q.10 A	Q.11 A	Q.12 C
Q.13 B	Q.14 B	Q.15 D	Q.16 D	Q.17 A	Q.18 C
Q.19 C	Q.20 D	Q.21 C	Q.22 A	Q.23 C	Q.24 D
Q.25 A	Q.26 B	Q.27 C	Q.28 B	Q.29 C	Q.30 C
Q.31 A	Q.32 A	Q.33 B	Q.34 D	Q.35 B	Q.36 B
Q.37 A	Q.38 A	Q.39 B	Q.40 C	Q.41 B	Q.42 D
Q.43 D	Q.44 B	Q.45 C	Q.46 D	Q.47 A	Q.48 C
Q.49 B	Q.50 C	Q.51 B	Q.52 B	Q.53 D	Q.54 C
Q.55 B	Q.56 C	Q.57 C	Q.58 D	Q.59 B	Q.60 B
Q.61 B	Q.62 C	Q.63 D	Q.64 C	Q.65 D	Q.66 D
Q.67 C	Q.68 C	Q.69 A	Q.70 D	Q.71 B	Q.72 B
Q.73 C	Q.74 D	Q.75 B	Q.76 A	Q.77 B	Q.78 D
Q.79 D	Q.80 D	Q.81 C	Q.82 C	Q.83 A	Q.84 B
Q.85 C	Q.86 B	Q.87 A	Q.88 D	Q.89 B	Q.90 A
Q.91 B	Q.92 B	Q.93 C	Q.94 C		

Previous Years' Questions

Q.1 A	Q.2 D	Q.3 A	Q.4 A	Q.5 D	Q.6 C
Q.7 C	Q.8 A	Q.9 C	Q.10 E	Q.11 C	Q.12 D
Q.13 C	Q.14 D	Q.15 A	Q.16 D	Q.17 A	Q.18 D
Q.19 B	Q.20 A	Q.21 B	Q.22 B	Q.23 C	Q.24 C

Animal	Kingdom	(Chordates))
	J		e

Q.25 B	Q.26 C	Q.27 D	Q.28 D	Q.29 C	Q.30 B
Q.31 B	Q.32 B	Q.33 D	Q.34 B	Q.35 A	Q.36 D
Q.37 C	Q.38 D	Q.39 A	Q.40 D	Q.41 C	Q.42 D
Q.43 D	Q.44 D	Q.45 C	Q.46 B	Q.47 B	Q.48 C
Q.49 D	Q.50 D	Q.51 D	Q.52 D	Q.53 C	Q.54 C
Q.55 C	Q.56 B				

6.88