

ANIMAL KINGDOM

Contents

2. ANIMAL KINGDOM

2.1 Introduction

2.2 Definition

2.3 Basis of Classification

- 2.3.1 Levels of Organisation
- 2.3.2 Patterns in Organ-System
- 2.3.3 Symmetry
- 2.3.4 Diploblastic and Triploblastic Organisation
- 2.3.5 Coelom
- 2.3.6 Segmentation
- 2.3.7 Notochord

2.4 Classification of Animals

- 2.4.1 Phylum Porifera
 - 2.4.2 Phylum Coelenterata
 - 2.4.3 Phylum Ctenophora
 - 2.4.4 Phylum Platyhelminthes
 - 2.4.5 Phylum Asclehelminthes
 - 2.4.6 Phylum Annelida
 - 2.4.7 Phylum Arthropoda
 - 2.4.8 Phylum Mollusca
 - 2.4.9 Phylum Echinodermata
 - 2.4.10 Protochordata
 - 2.4.10.1 Phylum Hemichordata
 - 2.4.10.2 Urochordata
 - 2.4.10.3 Cephalochordata
 - 2.4.11 Phylum Chordata
 - 2.4.11.1 Division- Agnatha
 - 2.4.11.1.1 Class-Cyclostoma
 - 2.4.11.2 Division- Gnathostomata
 - 2.4.11.2.1 Super Class- Pisces
 - 2.4.11.2.1.1 Class-Chondrichthyes
 - 2.4.11.2.1.2 Class- Osteichthyes
 - 2.4.11.2.2 Super Class- Tetrapoda
-

2.4.11.2.2.1 Class- Amphibia

2.4.11.2.2.2 Class- Reptilia

2.4.11.2.2.3 Class-Aves

2.4.11.2.2.4 Class-Mammalia

2.5 Points to Remember

2. ANIMAL KINGDOM

2.1 Introduction

- Animal Kingdom includes only multicellular eukaryotes.
- Animalia contains only multicellular animals.
- Whales and Giant Squids are macroscopic and multicellular animals.
- They differ from plants in absence of cell wall, plastids, vacuoles and centrosome in their cells.
- Plants are mostly fixed but animals move in search of food and shelter.
- The important groups represented by the Kingdom are protozoa, sponges, Coelenterates, worms, Annelids, Arthropods, Molluscs, Star Fishes, Fishes Amphibians, Reptile, Birds and Mammals.

2.2 Definition

"Animals are a major group of mostly multicellular, eukaryotic organisms of the kingdom Animalia **or** Metazoa."

- Their body plan eventually becomes fixed as they develop, although some undergo a process of metamorphosis later on in their life.
- Most animals are motile, meaning they can move spontaneously and independently.
- All animals are also heterotrophs, meaning they must ingest other organisms for sustenance.

2.3 Basis of Classification

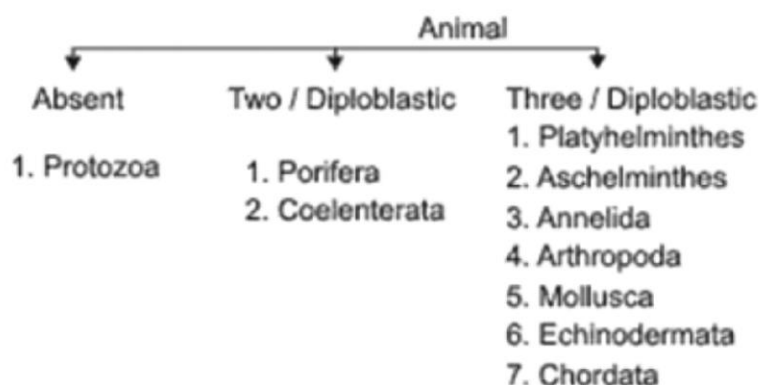
- In spite of differences in structure and form of different animals, there are fundamental features common to various individuals in relation to the arrangement of cells, body symmetry, and nature of coelom, patterns of digestive, circulatory or reproductive systems.
- These features are used as the basis of animal classification and some of them are discussed here.

2.3.1 Levels of Organisation

- Although all members of Animalia are multicellular, all of them do not exhibit the same pattern of organisation of cells.
 - Based upon the levels of organisation the animals are classified into three groups-
 - i. Sponges which have retained a cellular grade of organization.
 - Their cells are arranged as loose cell aggregates.
 - ii. Coelenterates (Metazoa) are multicellular animals having epithelial, connective, muscular and nervous tissues with 'division of labour.'
 - Here the cells performing the same function are arranged into tissues, hence is called **tissue level** of organisation.
 - iii. Organ system level found in multicellular animals having tissues organs and systems e.g. flat worms, roundworms, annelids, mammals etc.
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❖ Multicellular ,heterotrophic animals have following types of structural organisation:-

- Protoplasmic or Acellular Level- Found in protozoa, the organisms are made of single cells.
- The organisation is at level of protoplasm in these organisms.
- Cellular Level – Body consists of many cells that are not organized into the tissues. These are of two types:
 - Cellular Colony Level: The cells are similar as in Volvox and Cellular slime moulds.
 - Cellular Aggregate Level: The cells are of different types as in sponges (Porifera).
- Tissue Level (Cell Tissue Level)- Body is multicellular and cells are organized into definite tissues. E.g. Gastrodermis and epidermis in coelenterates (Cnidaria and Ctenophora).
- The tissues are organized into organs e.g. some Platyhelminthes.
- Organ Level (Tissue Organ Level)- Body of multicellular animals posses cells organized into tissues. E.g. Gastrodermis and epidermis in Platyhelminthes.
- The cells are grouped into tissue, tissues into organs and organs into organs system; e.g. in Platyhelminthes, Aschehelminthes and other higher level animals belonging to Annelida, Arthropoda, Mollusca, Echinoderms and Chordates.



2.3.2 Patterns in Organ-System

The complexity of organ systems act as good useful criteria to classify animals e.g. the circulatory system may be of two types:

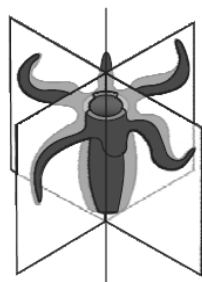
- Open type** in which the blood is pumped out of the heart and the cells and tissues are directly bathed in it or
- Closed type** in which the blood is circulated through a series of vessels of varying diameters (arteries, veins and capillaries).

2.3.3 Symmetry

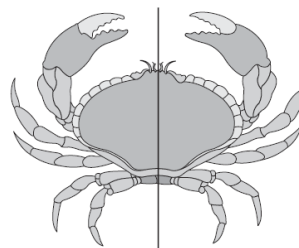
“Symmetry is defined as the arrangement of body parts which are similar on the sites of the body.”

- Some animals are asymmetrical i.e., any plane that passes through the centre does not divide them into equal halves e.g. Sponges.

- When any plane passing through the central axis of the body divides the organism into two identical halves, it is called radial symmetry. Coelenterates, ctenophores and echinoderms have this kind of body plan.

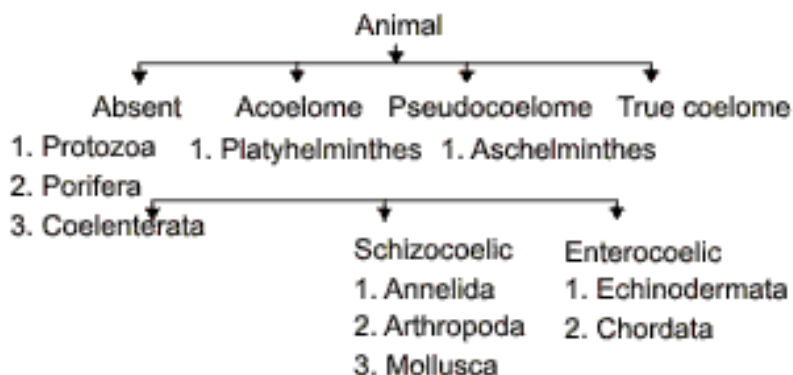


Radial symmetry



Bilateral symmetry

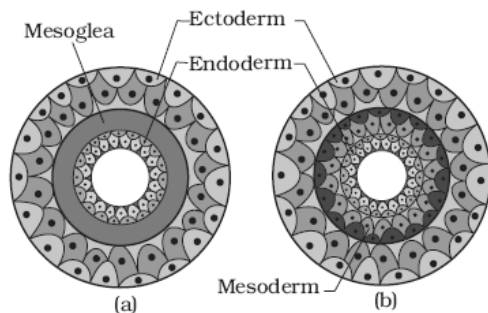
- Animals like annelids, arthropods, etc., where the body can be divided into identical left and right halves in only one plane, exhibit bilateral symmetry.



2.3.4 Diploblastic and Triploblastic Organisation

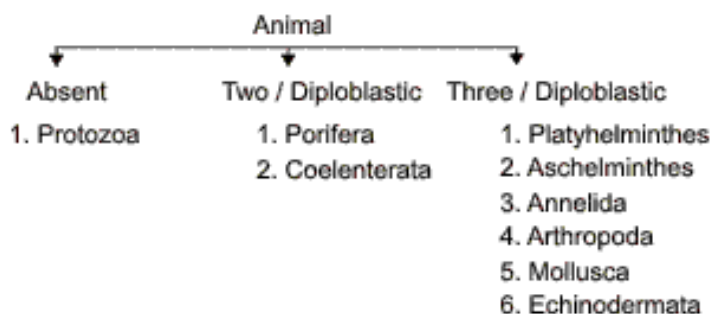
"Animals in which the cells are arranged in two embryonic layers, an external **ectoderm** and an internal **endoderm**, are called **Diploblastic** animals, e.g., coelenterates."

An undifferentiated layer, mesoglea, is present in between the ectoderm and the endoderm.



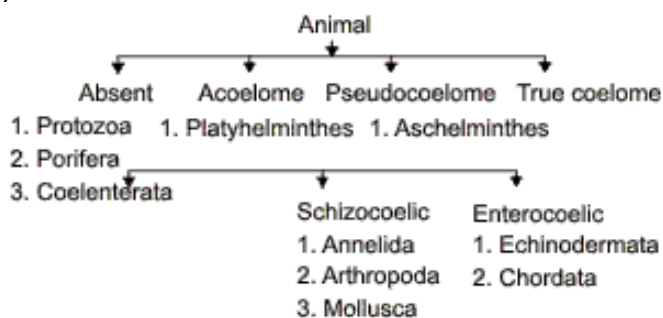
Showing germinal layers- (a) Diploblastic (b) Triploblastic

"Those animals in which the developing embryo has a third germinal layer, **mesoderm**, in between the ectoderm and endoderm, are called **triploblastic** animals (platyhelminthes to chordates)."

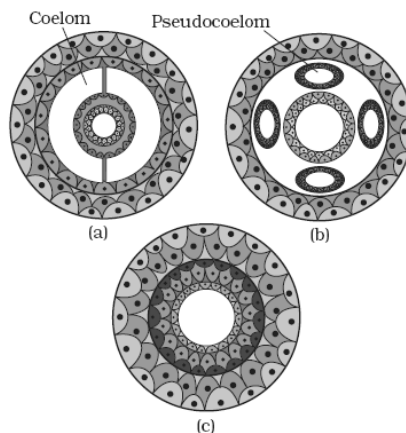


2.3.5 Coelom

Coelom is the body cavity. Coelom is defined as "the space between body wall and alimentary canal but lined by mesoderm."



- Presence or absence of a cavity between the body wall and the gut wall is very important in classification.
- Animals possessing coelom are called **coelomates**; they have true coelom e.g., Annelids, Molluscs, Arthropods, Echinoderms, Hemichordates and Chordates.
- In some animals, the body cavity is not lined by mesoderm, instead, the mesoderm is present as scattered pouches in between the ectoderm and endoderm.
- Such a body cavity is called pseudocoelom and the animals possessing them are called pseudocoelomates, e.g., Aschelminthes
- The animals in which the body cavity is absent are called acoelomates, e.g., Platyhelminthes.



Diagrammatic sectional view of (a) Coelomate (b) Pseudocoelomate (c) Acoelomate

2.3.6 Segmentation

- The body of earthworm has many segments.
- It shows serial repetitions of parts in the segments.
- It is known as metameric segmentation.
- This process is termed as metamerism.
- Pseudometamerism is observed in Platyhelminth e.g. *Taenia*.

2.3.7 Notochord

- Notochord is a mesodermally derived rod-like structure formed on the dorsal side during embryonic development in some animals.
- Animals with notochord are called chordates and those animals which do not form this structure are called non-chordates, e.g., Porifera to echinoderms.

2.4 Classification of Animals

- The animals are divided into two major groups on the basis of absence or presence of backbone-

Invertebrates (without backbone)

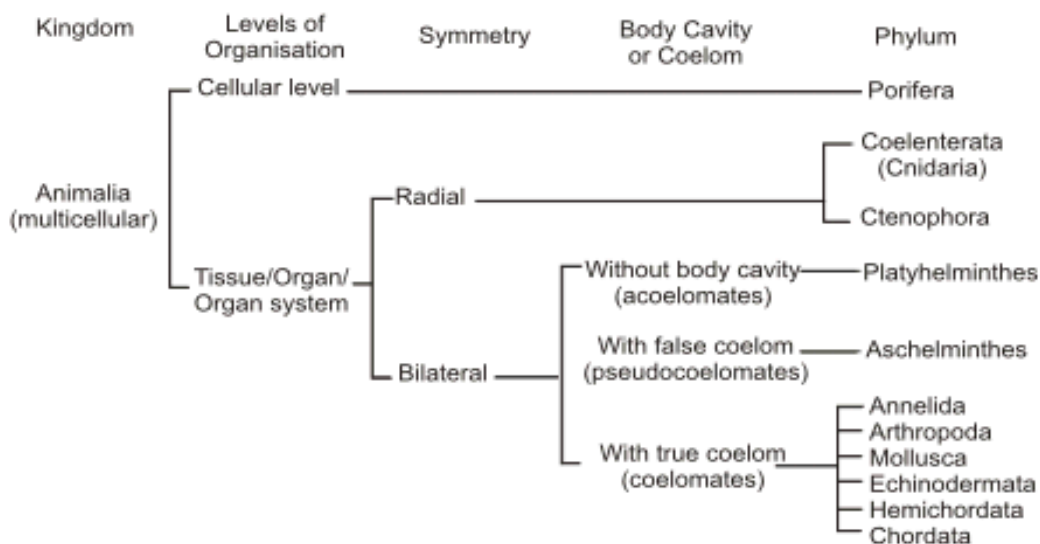
Vertebrates (with backbone)

- Almost 99% of animals are invertebrates and the remaining represents the vertebrates.
- On the basis of absence or presence of notochord at some stages in their life, animals are divided into two major groups-

Non-Chordates (without notochord)

Chordates (with notochord)

- In total there are eleven phyla of Animalia. The broad classification of Animalia based on common fundamental features.



Broad classification of Kingdom Animalia based on common fundamental feature

2.4.1 Phylum Porifera

- It is the Smallest Phylum. Robert Grant & Ellis proved them as animals.
 - These are commonly known as 'sponges'. Animals are sessile or sedentary.
 - They are mostly marine and generally asymmetrical animals.
 - Cells are loosely arranged.
 - Outer wall is pinacoderm made up of pinacocyte cells.
 - These are primitive multicellular animals and have cellular level of organisation.
 - Sponges have a water transport or canal system.
 - Sponges are called pore bearing animals which have retained a cellular grade of organization.
 - Water enters through minute pores (ostia) in the body wall into a central cavity, spongocoel, from where it goes out through the osculum.
 - Ostia may be one or more in number, small in size, controlled by porocyte cells and equal to mouth.
 - Osculum one or few in number, large in size, controlled by meucocytes and equal to anus.
 - Power of regeneration is more. Endoskeleton present, secreted by scleroblast cells.
 - This pathway of water transport is helpful in food gathering, respiratory exchange and removal of waste.
 - Choanocytes or collar cells line the spongocoel and the canals.
 - Inner wall is choanoderm made up of choanocyte cells or collared flagellated cells.
 - Digestion is intracellular in choanocyte cells.
 - Choanocyte cells function to transfer sperms to ovum.
 - Between these two layers mesenchyma present in which amoebocyte cells are there. Central cavity is spongocoel or peragastric cavity.
 - Digestion is intracellular. The body is supported by a skeleton made up of spicules or sponging fibres.
 - Sexes are not separate (hermaphrodite), i.e., eggs and sperms are produced by the same individual.
 - Sponges reproduce asexually by fragmentation and sexually by formation of gametes.
 - Respiration & excretion through general body surface by diffusion.
 - Parenchymula & amphiblastula larva present.
 - In body spicules are present, may be mega scleres or micro scleres. Spicules are formed by actinoblast cells.
 - Spicules are of monoaxon to polyaxon type (diaxon absent).
 - Fertilisation is internal.
 - The development is indirect including a larval stage which is morphologically distinct from the adult.
 - They are included in sub-kingdom Parazoa.
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- Examples: *Sycon* (Scypha), *Spongilla* (Fresh water sponge) and *Euspongia* (Bath sponge).
- Animals of this phylum are maximum active in animal kingdom.
- Nutrition is holozoic.
- Chromatocytes cells present.
- Food is stored in thesocyte cells.
- Olyanthus is ancient sponge, present in life cycle of most of the sponges.
- Water canal system is of three types –

(a) Ascon type

(b) Sycon type

(c) Leucon type

- Phylum Porifera is divided into three classes on the basis of endoskeleton –

1. Calcaria

2. Hexetinillida

3. Demospongia

2.4.1.1 Calcaria

- Their Endoskeleton is made up of calcium carbonate.
- Endoskeleton is secreted by calcoblast.
- They are marine in habitat.

Examples – Scypha – sycon, crown sponge

Leucosolinia – most simplest sponge

2.4.1.2 Hexetinillida

- Their Endoskeleton is made up of silica.
- Endoskeleton is secreted by silicoblast.
- **Their** Habitat is marine.

Examples – Pheronema is also called bowl sponge or bird's nest sponge.

Hyalonema also called as glass rope sponge

Euplectella is known as Venus flower basket [It shows unity until death, symbiotic with shrimps (one pair shrimp spongiocola remains in sponge) and it is used as bridal gift in Japan.

2.4.1.3 Demospongia

- Their Endoskeleton is made up of silica & spongin fibres.
- Silicoblast & spongioblast cells secrete endoskeleton.
- Animals are marine & few are fresh water.

Examples -Spongilla is fresh water sponge.

Euspongia is called as common bath sponge, it is unisexual & found in Mediteranian Sea. In olden time it was used for the cure of throat diseases.

Cliona is also called red boring sponge or sulphur sponge. It is Sea boarer. It causes damage to pearl industry.

Chalina is called mermaid's gloves.

Hippospongia is also known as horse sponge, horny sponge. It is commercial sponge.

2.4.2 Phylum Coelenterata

- Coelenterates or Cnidarians are fresh water and mostly marine, sessile or free-swimming, radially symmetrical animals.
 - Some of them show polymorphism e.g. *Physalia*.
 - They show a blind sac body plan and radial symmetry.
 - They have a coelenterons and nematocysts e.g. *Hydra*, *Obelia*.
 - The name cnidaria is derived from the cnidoblasts or cnidocytes (which contain the stinging capsules or nematocytes) present on the tentacles and the body.
 - Cnidoblasts are used for anchorage, defense and for the capture of prey.
 - Cnidarians exhibit tissue level of organisation and are diploblastic. They have a central gastro-vascular cavity with a opening (single oral aperture), hypostome.
 - Digestion is extracellular and intracellular.
 - Central cavity is coelenteron or gastrovascular cavity, helpful in nutrition & circulation. Trembley & Leeuckart named Coelenterata.
 - Hetscheck named it Cnidaria. Stinging cells or nematoblast or cnidocytes present for offence & defence.
 - Some of the cnidarians, e.g., corals have a skeleton composed of calcium carbonate.
 - Outer layer is epidermis, inner layer is gastrodermis, between them mesoglea present. Mouth is meant for ingestion & egestion.
 - Digestion is inter-cellular & intra-cellular both.
 - Respiration through general body surface.
 - Nervous system is diffused type, nerves absent & brain absent.
 - Asexual reproduction by budding.
 - Fertilization is external. Development is indirect/direct.
 - Planula larva is common. Sex ducts absent.
 - Metagenesis present i.e. asexual reproduction is alternated by sexual reproduction.
 - Cnidarians exhibit two basic body forms called polyp and medusa.
 - The Polyp is a sessile and cylindrical form like *Hydra*, *Adamsia*, etc.
 - Polyp is Test tube like, Sedentary & colonial, Hollow, Mesoglea is thin, Statocyst are absent, Asexual bodies. Polyp is of following types
 - i. gastrozoid (nutrition)
 - ii. gonadozoid (reproduction)
 - iii. dactylozoid (offence & defence).
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- The medusa is umbrella-shaped and free-swimming like *Aurelia* or jelly fish.
- Medusa is Umbrella shaped, Free swimming & solitary, Velum present/absent, Mesoglea thick, Stotocyst present, Mainly sexual body. Medusa is of following types
 - i. nectophore (swimming zooids)
 - ii. pneumatophore (floating)
 - iii. phylozoid
 - iv. gonophore
- Those cnidarians which exist in both forms exhibit alternation of generation (Metagenesis), i.e., polyps produce medusae asexually and medusae form the polyps sexually (e.g., *Obelia*).

Examples: *Physalia* (Portuguese man-of-war), *Adamsia* (Sea anemone), *Pennatula* (Sea-pen), *Gorgonia* (Sea-fan) and *Meandrina* (Brain coral).

- Gonads are ectodermal / endodermal in nature. Coral or sea foam may present.
- Coral reefs (coral + algae) are of 3 types
- Fringing reefs – extend from shore upto 400 m deep in sea.
- Barrier reefs – non parallel to shore, seperated from shore by a water body called lagoon.
- Atoll – it is circular coral reef surrounded by lagoon. It is called coral island. Atoll is largest barrier reef of 1920 kms. long in Australia.
- Phylum Coelenterata is divided into three classes on the basis of polymorphism

1. Hydrozoa

2. Scyphozoa

3. Anthozoa or Actinozoa

2.4.2.1 Hydrozoa

- Polyp & medusa both forms present.
- Animals are found in fresh water & sea water.
- Gonads are ectodermal.
- In coelenteron septa are absent.
- Velum present on corner of medusa i.e. crespedote.

Examples – *Hydra* is freshwater animal with radial symmetry.

Obelia also called sea fur. Its tentacle are solid.

Millepora is stinging coral or fire coral .

Porpita is disc shaped. It is also known as blue button.

Vallela is called little sail. It has canaria larvae.

Physalia is commonly known as Portuguese man of war. Polymorphism is maximum developed.

2.4.2.2 Scyphozoa

- Medusa form present.
 - Marine habitat.
 - Gonads endodermal.
 - Septa in coelenteron are few.
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- Tetramerous radial symmetry.
- Tentaculocytes present for balancing.

Examples – *Aurelia* is commonly called jellyfish or moon jelly. In India it is abundant in Tamil Nadu coast. Its larvae are scyphistome, ephyra & hydratuba.

Rhizostomum has many mouth.

Cyanea is a sea blubber. It is called sun jelly. It is largest jelly fish. Its diameter 2 meter. Its tentacles are 40 meters long.

2.4.2.3 Anthozoa

- Only polyp form present.
- Marine habitat.
- Gonad endodermal.
- In coelenteron many septa.
- Mostly in coral forms.
- **Examples** – Pteoides is called sea feather.

Metridium is commonly known as sea anemone.

Adamsia is also called sea anemone.

Gorgonia is commonly known as sea fan.

Pinnatula is a sea pen.

Renilla is called sea penzy.

Cavernularia known as sea stick.

Helliopora is blue coral.

Coralium is red coral.

Antipathos is black coral.

Medrepora is stag horn coral.

Tubipora is organ pipe coral.

Fungia is also called mushroom coral.

Astrea is a star coral.

Meandrina is also called brain coral.

Alcyonium is dead man's finger. It is softest coral.

Favea is called stony coral.

2.4.3 Phylum Ctenophora

- The word Ctenophora was given by Eschschbolte.
 - Ctenophores, commonly known as sea walnuts or comb jellies are marine with transparent, flat or oval body shape.
 - Only marine & pelagic. On aboral end statocyst present for balancing.
 - They are radially symmetrical, diploblastic organisms with tissue level of organisation.
 - They are devoid of cnidoblasts or Nematoblast cells. When tentacles are present in them, they contain colloblast cells.
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- They move by cilia. They have special sense organs. E.g. *Beroe*, *Hormiphora* and *Ctenophora*.
- Tentacles are oppositely placed. On tentacles comb plates present. which help in locomotion.
- Digestion is both extracellular and intracellular.
- Lasso cells present for offence & defence.
- Colloblast or glue cells present.
- Bioluminescence (the property of a living organism to emit light) is well-marked in ctenophores.
- Sexes are not separate i.e. they are Bisexual. Biradial symmetry. Stomodium present.
- Asexual reproduction absent. Metagenesis absent. Gonads endodermal.
- Reproduction takes place only by sexual means.
- Fertilisation is external with indirect development.
- Cydipid larvae present.

Examples: *Pleurobrachia* and *Ctenoplana*.

Ctenophora is divided into 2 classes on the basis of tentacles

1. Tentaculata 2. Nuda

2.4.3.1. Tentaculata has tentacles.

Examples –*Pleurobranchi* is called sea gooseberry.

Cestum is also known as venus girdle or venus belt.

Tjelfiella is viviparous.

2.4.3.2 Nuda does not possess tentacles.

Examples –*Baroe* is known as sea mitres or swimming eyes of cat.

2.4.4 Phylum Platyhelminthes

- Platyhelminthes includes the flatworms. They are named by Gegenberg.
 - They have dorso-ventrally flattened body, hence are called flatworms.
 - These are mostly endoparasites found in animals including human beings.
 - Flatworms are bilaterally symmetrical, triploblastic and acoelomate animals with organ level of organisation.
 - Muscles present in the form of bundle.
 - Digestion is intercellular. They are generally parasites.
 - Mainly anaerobic respiration occurs.
 - Hooks and suckers are present in the parasitic forms.
 - Some of them absorb nutrients from the host directly through their body surface.
 - Specialised cells called flame cells help in osmoregulation and excretion.
 - They have some kind of nervous system. Nervous system is ladder shape.
 - Ganglions are formed for the first time.
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- Sexes are not separate i.e. they are bisexual. Sex ducts present.
- Power of fertility is more.
- Fertilisation is internal and development is through many larval stages.
- Vitelline glands give nourishment to zygotes & also helpful to give out zygotes out of uterus.
- Polyembryony present i.e. from one zygote many embryos are formed. Epidermis is syncytial.
- Development is indirect. Life cycle is complicated. They are digenetic.
- Some members like *Planaria* possess high regeneration capacity.
- *Examples: Taenia* (Tapeworm), *Fasciola* (Liver fluke).
- Phylum platyhelminthes is divided into 3 classes

1. Turbellaria

2. Trematoda

3. Cestoda

2.4.4.1 Turbellaria

- Their body is ciliated & unsegmented.
- They are free living / parasite.
- They are commonly known as eddy worms.
- Their digestive system is developed.
- Their development is direct.
- Chemoreceptor rhabdites are present.
- Muller organs are present.

Examples – *Convoluta*, *Catenula*

Microstomum is known as enemy of hydra.

Bipallium is free living.

Ectoplana is parasite on book lungs of limulus.

Dugesia is called planaria. It is free living, eyes present. It is used in experiments of regeneration. In *Dugesia* cannibalism present.

2.4.4.2 Trematoda

- Their body is non ciliated and unsegmented.
 - Animals are ecto & endo parasite.
 - They are commonly known as 'flukes'.
 - Their digestive system is less developed.
 - Suckers are present in them.
 - Flukes suck blood, cell fragments and tissue fluids from their hosts.
 - Intestine is inverted 'Y' shaped.
 - Mahlis gland are present to form egg shell.
 - Mostly monoecious, development is indirect in endoparasites and direct in ectoparasites with alternation of generation.
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- Laurer's canal functions as vagina.

Examples – *Fasciola hepatica* is called liver fluke, primary host sheep. Its secondary host snail. Their larvae are Miracidium (infective stage in secondary host).

Sporocyst

Radia

Cercaria

Metacercaria (infective stage in primary host)

Schistosoma is called blood fluke, blood sucker. It is unisexual and shows haemotria i.e. male keeps female in gonophore tube of his body. Muller larva present.

2.4.4.3 Cestoda

- Commonly called 'Tapeworms' parasites without cilia and sense organs, body segmented (pseudo-metamerism).
- Segmentation is external only i.e. strobilization.
- Single segment is strobilus or proglotid.
- They are Endoparasite.
- Digestive system is absent, absorbs predigested nutrients from the host's gut through their general body surface.
- Development is indirect.
- Head is scolex with rostellum.
- Body is ribbon shaped.
- Life cycle is complicated.

Examples –

Taenia solium also called pork tapeworm. Its length is 5 meter. Its life span 30 yrs. Its neck is unsegmented, known as zone of proliferation. In *Taenia* falling of last segments is apolysis. There is only one tapeworm present in one host. In it fertilization is self. On the body of *Taenia* microtrichous or villi are present to absorb digested food. Its larvae are onchosphere or hexacanth (infective stage in pig). It has cysticercus or bladder worm (infective stage in man).

Echinococcus is also known as dwarf tapeworm or dog tapeworm.

Taenia segineta is beef tapeworm.

2.4.5 Phylum Asclehelminthes

- It is known as Nematohelminthes or Nematoda.
 - The word Nematoda was given by Gegenburg.
 - They are also called roundworms because their body is circular in cross-section,
 - They may be free living, aquatic and terrestrial or parasitic in plants and animals.
 - Roundworms have organ-system level of body organisation.
 - Pseudocoelome is present.
 - They are bilaterally symmetrical, triploblastic and pseudocoelomate animals.
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- Alimentary canal is complete with a welldeveloped muscular pharynx.
- An excretory tube removes body wastes from the body cavity through the excretory pore. Excretory organs are coelomoducts.
- Sexes are separating (dioecious), i.e., males and females are distinct. Females are longer than males. (Unisexual. Monogenetic.)
- Nervous ring is formed in Nervous system.
- Fertilisation is internal and development may be direct (the young ones resemble the adult) or indirect.
- *Examples: Ascaris* (Round Worm), *Wuchereria* (Filaria worm), *Ancylostoma* (Hookworm).
- Maximum adapted for parasitism.
- Cleavage is spiral and determinate.
- Eutyly present i.e. number of cells are fixed & show increase in size only (auxatic growth).
- In aschelminthes only one class nematoda is there, divided into 2 sub-classes.

2.4.5.1 Aphasmda or Enoplea (Gr. Enoplos=arms)

- Amphids generally well developed ,pocket-like ,five or more oesophageal glands.
- In Aphasmda phasmid is absent.
- Excretory system lacking lateral canals ,mostly free-living , some parasitic on plants and animals.
- Most of them are free living marine animals.

Examples –*Desmoscolex, Trilobus, Trichenella and Trichuris.*

2.4.5.2 Phasmida or Rhabditea (Gr. Rhabdos= a rod)

- Amphids ventrally coiled, three oesophageal glands.
- Both free-living and parasitic forms.
- Phasmid is present in them.
- They are Endoparasite.

Examples –*Ascaris*

Trichuris is also called whip worm / serpent worm.

Trichenella is trichina worm.

Enterobius is known as pin worm / thread worm

Ancylostoma is first discovered nematode. It is also called hook worm. Its larva is filariform.

Dracunculum is known as guinea worm. It's vector is cyclop. It causes naru or bala diseases.

Loa loa is an eye worm.

Metastrongylus is called lung worm.

Waucheria brankofti is filarial worm. It causes filariasis or elephantiasis diseases. It is viviparous. Its vector female culex. Its larvae are microfilarial & rhabitiform.

2.4.6 Phylum Annelida

- The body surface of Annelids is distinctly marked out into segments or metameres (Latin annulus= little ring)so it is called Annelida. Lamarck named it Annelida.
- Segmentation is external by annuli. Segmentation is internal by coelosepta.
- True coelome is present. Schizocoelic. Protostomia.
- They may be aquatic (marine and fresh water) or terrestrial; free-living, and sometimes parasitic.
- They exhibit organ-system level of body organisation and bilateral symmetry.
- They are triploblastic, metamerically segmented and animals.
- They possess longitudinal and circular muscles which help in locomotion. Locomotary organ are setae (in leech suckers present).
- Aquatic annelids like *Nereis* possess lateral appendages, parapodia, which help in swimming.
- Digestion is intercellular.
- Respiration by body wall / gills / parapodia.
- A closed circulatory system is present.
- Nephridia (sing. nephridium) help in osmoregulation and excretion.
- Neural system consists of paired ganglia (sing. ganglion) connected by lateral nerves to a double ventral nerve cord. Nerve ring present.
- *Nereis*, an aquatic form, is dioecious, but earthworms and leeches are monoecious.
- Reproduction is sexual.
- Animals are bisexual / unisexual.
- Fertilization is external.
- Development is indirect.
- Trochophore larva present in most of the animals.
- Haemoglobin or erythroquorine is desolved in plasma.

Examples: *Nereis*, *Pheretima* (Earthworm) and *Hirudinaria* (Blood sucking leech).

- Phylum Annelida is divided into following classes –

1. Archiannelida

2. Polychaeta

3. Oligochaeta

4. Hirudinea

2.4.6.1 Archiannelida

- Animals are Unisexual.
 - Setae are absent.
 - Parapodia are absent.
 - They are primitive Annelid.
 - External segmentation is not clear.
-

- They are present in salt water.
- Trochophore larva is present.

Examples –*Polygordius* is connecting link between Annelida & Mollusca.

Dinophilus

2.4.6.2 Polychaeta

- Almost all are marine and occur in greatest abundance near the seashore.
- The body segments bear cirri or branchiae or both.
- Locomotory structures are parapodia. Their setae present on parapodia.
- They have indefinite segments.
- Their head is distinct with eyes, palps and tentacles.
- Clitellum or cingulum is absent.
- They are unisexual.
- Trochophore during development which undergoes metamorphosis to reach the adult stage.

Examples –*Nereis* is called as rag worm or sand worm or clam worm. Their gonads temporary. Heteronereis is sexual stage differentiated into anterior atoke (small parapodia) & posterior epitoke (large parapodia).

Aphrodite is a sea mouse. It is biluminescent. Its colour changes from gold to peacock blue during locomotion.

Arenicola is commonly called lug worm / lobe worm.

Polynoe is scale worm.

Eunica is palalo worm.

Chaetopterus is paddle worm.

Terebella has branched gills.

Sabella has branched gills. It is also called peacock worm.

Serpula is fan worm.

Glycer is soft blood worm.

Chaetogaster is smallest annelid.

Sipunuculus is peanut worm.

Polybranchia is bearded worm.

2.4.6.3 Oligochaeta

- Commonly called 'Earthworms', mostly terrestrial, some in freshwater.
 - Setae are present on body wall.
 - Parapodia absent in them.
 - They have indefinite segments.
 - Their Head is not clear.
 - Clitellum is present. Its main function is cocoon formation.
-

- They are bisexual.
- Development is direct, no larval stage and therefore no metamorphosis.
- They are commonly known as earthworms.

Examples – *Pheretima* is north Indian earthworm.

Eutyphoeus is **north** Indian earthworm.

Drawida is south Indian earthworm.

Megascoles is south Indian earthworm. It is largest earthworm (3 meter).

Lumbricus is North American earthworm or European earthworm.

Enchytreus is white earthworm.

Perionyx is aquatic earthworm.

Tubifex is also called liver worm or blood worm. It is biological indicator. It is fresh water animal.

Nias

Dero

2.4.6.4 Hirudinea

- Commonly called 'Leeches', ectoparasites, body with fixed number of segments, 33.
- Each segment is sub-divided into annuli.
- Parapodia and setae are absent, with two suckers.
- Suctorial mouth, Sanguivorous (feeding on blood).
- Clitellum is present in breeding season only.
- They are Bisexual.
- In coelome mesodermal botryoidal tissue is present which stores fat.
- Leeches secrete anticoagulant 'Hirudin' from salivary glands.
- 10 pairs of crop present to store blood.
- They have 'Open circulatory system'.
- Locomotion by looping and swimming, there is no larval stage or metamorphosis.
- The embryos develop inside a well-formed cocoon.
- Fertilization is internal in them.
- Development is direct.
- Saw like chitinous teeth are present.

Examples –

Hirudinaria is common leech. It is ecto parasite. It has 6 pairs pre testicular nephredia & 11 pairs testicular nephredia. It has 11 pairs of testes. It has 1 pair ovary.

Hirudinaria medaconalis is medicinal leech of Europe.

Pontobdella is marine leech.

Acanthobdella is connecting link between oligochaeta & herudinea.

Haemopsis is horse leech.

Bonellia if larva sits on proboscis of female & enters into the body turn into male. If larva sits in mud turn into female. It is marine leech Its body unsegmented.

2.4.7 Phylum Arthropoda

- This is the largest phylum of Animalia which includes insects.
- Van Sebold named Arthropoda.
- Over two-thirds of all named species on earth are arthropods.
- They have jointed appendages (arthros-joint, poda-appendages).
- They have organ-system level of organisation.
- Hemocoel represents the body cavity. Protostomia.
- They are bilaterally symmetrical, triploblastic, segmented and coelomate animals.
- The body consists of head, thorax and abdomen.
- Exoskeleton is made up of chitin. Endoskeleton is present.
- The body of arthropods is covered by chitinous exoskeleton.
- They have open type of Circulatory system .
- Respiratory organs are gills, book gills, book lungs or tracheal system.
- Sensory organs like antennae, eyes are compound or simple, statocysts or balance organs are present.
- Excretion takes place through malpighian tubules/ green glands or antennary glands / coxal gland.
- Brain is present.
- They are mostly dioecious i.e. they are unisexual.
- Fertilisation is usually internal. They are mostly oviparous.
- Development may be direct or indirect.
- In most of animals (except insect) haemocynine is dissolved in plasma.
- Cilia totally absent. Ecdysis / moulting / exuviae is common.

Examples: Economically important insects – *Apis* (Honey bee), *Bombyx* (Silkworm), *Laccifer* (Lac insect) Vectors – *Anopheles*, *Culex* and *Aedes* (Mosquitoes) Gregarious pest – *Locusta* (Locust) Living fossil – *Limulus* (King crab).

- Phylum Arthropoda is divided into 4 classes on the basis of legs –

1. Onchophora

2. Crustacea

3. Insecta

4. Arachnida

5. Myriapoda

2.4.7.1 Onchophora

- It is the connecting link between Annelida & Arthropoda.
 - Their Excretory organs are nephridia.
 - They are Nocturnal in nature, insectivorous.
 - Unsegmented legs are present.
 - They are Viviparous.
-

- Body worm-like, claw bearing appendages (unjointed), the most primitive arthropods.
- Examples –*Peripatus* is walking worm.

2.4.7.2 Crustacea

- They have 12 – 19 pairs of legs present.
- Body is divided into cephalothorax & abdomen.
- Exo skeleton of cephalothorax is carapace.
- Fenestra absent in them.
- They have 2 pairs of Antennae.
- Their Respiration is by gills, respiratory pigment haemocyanin dissolved in plasma with metallic base copper.
- Haemocyanin becomes light blue on combining with oxygen, stalked compound eyes, common examples are prawns, lobsters and crabs.
- Excretory organs are green glands.
- Biramous appendages are present.
- Telson is last part of body.

Examples –*Astacus* is called cray fish.

Apus is a tadpole fish.

Daphnia is called water flea.

Cypris is also called water flea.

Cyclop is also called water flea. It is husband of hundred wives. Also named giant of one eye.

Peanus is marine prawn. It has mysis larva.

Palaeomon is commonly known as prawn. It has nauplius larva present.

Lepas is called goose barneckel.

Balanus is called acorn barneckel.

Hippa is called mole crab or coconut crab.

Eupagarus is commonly called hermit crab. It has ovotestes. It is bisexual. It has glucothoea larva.

Cancer is also called crab. It has zoea, megalopa larva.

Spongicola is commonly known as shrimp.

Sacculina is most degenerated parasite on abdomen of crab. It does not have appendages. Its body is thread like. It causes parasitic castration.

2.4.7.3 Insecta

- In Insecta 3 pairs of legs are present. So they are also called Hexapoda.
 - With over 7, 50,000 species grouped in 26 orders.
 - Insects form, the largest class of animals living on the land and air.
 - Respiration by trachea in them.
-

- Their body is divided into head (6 segments), thorax (3 segments) & abdomen (11 segments).
- Fenestra is single pair.
- Antennae are also one pair.
- Their Excretory organs are malpighian tubules.
- Winged insects grouped in pterygota.
- Wingless insects grouped in apterygota.
- Aposition / superposition images are formed.

Example- *Glossina* is commonly called Tse–Tse fly.

Xenopsylla is rat bug. It is vector of plague.

Lepisma is called silver fish. It is wing less insect.

Photinus is called glow worm. It is fire fly.

Cicadas has 16 yrs. sleep out of 17 yrs, loudest insect.

Locuste is commonly called grass hoper.

Shistocerca is also called grass hoper.

Ranatra is called water scorpion.

Nepa is water scorpion.

Laccifer lacca is also called lac's insect.

Tachardia is commonly called lac's insect.

Musca is common house fly. Its mouth parts are spongy.

Apis is called honey bee, social useful insect. From *Apis* honey & wax are obtained.

Their honey is neutral. Their mouth parts are siphoning type. *Apis* workers are sterile, sting is modified ovipositor.

Bombax morai is called silk moth. From cocoon (pupae) of *Bombax* silk is obtained.

Mantis is called Praying mentis. Their female eats male after copulation.

Phyllium is called leaf insect. It shows mimicry.

Belostoma is known as giant water bug.

Pediculus is called lice. Its eggs are nits.

Cimex is known as bed bug. It causing relapsing fever.

Drosophilla is commonly called fruit fly. They have gynandromorph condition.

Gryllus is called house cricket.

Gryllotalpa is known as mole cricket.

Anopheles is Malaria causing mosquito. Johnston's organs present in antennae. Its larvae wriggler, pupae tumbler, active. It is vector of *Plasmodium vivax*.

Culex is mosquito. It is vector of important diseases such as West Nile virus, filariasis, Japanese encephalitis, St. Louis encephalitis and avian malaria.

Ades is vector of important diseases dengue causing mosquito.

2.4.7.4 Arachnida

- Terrestrial or aquatic, with 6 pairs of appendages.
- They have 4 pairs of legs or they are Octopoda.
- Their respiration is by book lungs.
- Their body is differentiated into prosoma & ophisthosoma.
- They have 4 pairs of Fenestra.
- Their antennae are 1 pair is converted into chalcarea.
- Their excretory organs are coxal gland.
- They include Scorpions , spiders, mites and ticks.
- Mites and ticks are often ectoparasites on other animals.
- Most spiders spin webs to trap and capture prey.
- The web is made of silk produced by spinneret present in the posterior part of the abdomen.
- **Examples** –*Limulus* is called as king crab. It is living fossil.
Palameneus is commonly known as scorpion. They have pecten which is thigmoreceptor. They are viviparous. They are cannabolic, carnivorous. In them matting dance is present.
Archaeranea is spider. It is called black widow. They have web gland on last part of abdomen, it is in the form of spinnerets.
Ixodes is commonly called as ticks, true head absent, spread rocky mountain fever.
Choriotes are mites.

2.4.7.5 Myriapoda

- Their legs are indefinite. Diplopoda is thousand legers usually 70 to 100 pairs of legs, 2 pairs legs per segment, herbivorous, poisonous claws are absent, simple eyes, harmless coil into a tight spiral when disturbed, commonly known as millipede, genital pore present on 3rd segment i.e. progoniata.
 - Chilopoda is hundred legers usually 10 to 30 pairs of legs, 1 pair leg per segment, carnivorous , poisonous claw is present, simple eyes ,capable of a painful often poisonous bite, commonly known as centipede, the body is divided into head and trunk, thorax is absent, genital pore in hind part of body i.e. ophisthogniata.
 - Respiration by trachea in them.
 - Their body is differentiated into head, thorax & abdomen.
 - Fenestra absent in them.
 - Excretory organs are malpighian tubules.
 - They are commonly known as wire worms.
 - Myriapoda is divided into diplopoda & chilopoda.
- Examples** –*Scolopendra* is centipede. *Julus* is millipede.
-

2.4.8 Phylum Mollusca

- The Molluscs have soft body surrounded by an external calcareous shell.
- Mollusca word was given by Johnston.
- This is the second largest animal phylum.
- Molluscs are terrestrial or aquatic (marine or fresh water) having an organ-system level of organisation.
- They are bilaterally symmetrical, triploblastic and coelomate animals.
- Body is unsegmented with a distinct head, muscular foot and visceral hump (mass) and mantle. They are Protostomia i.e. their mouth is formed first. The anterior head region has sensory tentacles.
- The mouth contains a file-like rasping organ for feeding, called radula.
- A soft and spongy layer of skin forms a mantle over the visceral hump.
- The space between the hump and the mantle is called the mantle cavity in which feather like gills are present.
- Mantle is helpful in respiration, secretion of shell. Study of shell is conchology.
- The shell is made up of Calcium carbonate. In shell conchalin protein present.
- Torsion and detorsion may present i.e. twisting of viscera around axis, so animals become asymmetrical.
- Intercellular digestion. Hepatopancreas present.
- Respiration occurs in them by Gills, lungs or through body surface.
- Circulatory system is open. In heart 1–2 auricles & 1 ventricle present.
- Haemocoel is present. Coelome is reduced maximum.
- Muscular foot is present.
- Excretion by coxal gland / renal gland / keber's gland / metanephridia / coelomoduct / organ of bajonus.
- They are usually dioecious and oviparous with indirect development.
- Brain present. They are Unisexual. Fertilization external. Development indirect.
- Balancing organs are statocyst. Ospharidium is chemoreceptor. Kidney is sac like. Cleavage is spiral & determinate.

Examples: *Pila* (Apple snail), *Pinctada* (Pearl oyster), *Sepia* (Cuttlefish), *Loligo* (Squid), *Octopus* (Devil fish), *Aplysia* (Seahare), *Dentalium* (Tusk shell) and *Chaetopleura* (Chiton).

- Phylum Mollusca is divided into following classes on the basis of foot

1. Monoplacophora

2. Aplacophora

3. Polyplacophora

4. Scaphopoda

5. Gastropoda

6. Pelecypoda

7. Cephalopoda

2.4.8.1 Monoplacophora

- 'A living Fossil', they are connecting link between annelida & Mollusca.
- Body and foot oval, single dorsal shell, only Mollusca having segmentation or metamerism.

Examples – *Neopelina* is a living fossil.

2.4.8.2 Aplacophora

- They do not have Shell.
- Body worm-like, calcareous spicules buried in cuticle.
- Foot is also absent in them.

Examples – *Neomenia*, *Chaetoderma* is worm like and marine.

2.4.8.3 Polyplacophora

- Their Shell is made up of 8 plates.
- Dorso-ventrally flattened body, small head radula, mantle, foot and external gills present.
- Mantle cavity posterior.
- Respiration by mentle.

Examples – *Chiton* is sea mica and living fossil.

2.4.8.4 Scaphopoda

- They are commonly called tusk shells.
- Their body within a tubular shell open at both ends.
- Their foot is conical.
- Head & eyes absent in them.
- They have mouth with tentacles.
- Radula present, no gills.

Example- *Dentalium* is known as tusk shell. Its respiration is by mental.

2.4.8.5 Gastropoda

- Gastropoda is the largest class of molluscs comprising whelks, periwinkles, limpets, slugs, snails, etc.
 - These animals are fresh water or terrestrial or amphibious.
 - Their foot is large and flat.
 - Their development indirect.
 - Velliger / trochophore larvae are present.
 - Their head is distinct with eyes and tentacles.
 - They have Radula.
 - Torsion & detorsion present in them.
 - Shell is present or absent, univalve and usually coiled.
-

- Monopectinate gills are present.
- They are generally bisexual.

Examples – *Pila* is apple snail. It has stalked eye. Its stalk is ommatophore.

Helix is garden snail.

Patella is sea mice.

Aplysia is called sea hare, parapodia present.

Doris known as sea lemon.

Limex is grey slug.

2.4.8.6 Pelecypoda

- Pelecypoda includes clams, mussels, oysters, scallops and related bivalve molluscs.
- Body laterally compressed and enclosed in a bivalve.
- No head, tentacles, eyes, jaws and radula.
- These animals are fresh water & marine.
- Foot is plough shaped.
- Mostly filter-feeding.
- Development indirect.
- Dioecious, Velliger or Glochidium larva is present.
- Gills are W-shaped.

Examples – *Unio* is fresh water mussel. Its alimentary canal passes through heart.

Mytilus is marine mussel.

Teredo is ship worm.

Oyster is pearly oyster. The pearl is secreted by nacreous layer of mantle in 7 yrs.
Its larvae spat.

Pinctada is called Indian pearl oyster.

Pecten is known as scallops.

Solen is also called razor shell or razor fish.

2.4.8.7 Cephalopoda

- Cephalopoda contains the most specialized molluscs, including squids, octopods, cuttlefish and nautiloids.
 - Most active molluscs, the foot is located on the head modified in the form of oral arms.
 - Nautilus has an external shell, but in others the shell has been reduced and enclosed within the body or lost entirely.
 - Head is distinct and large with well developed eyes.
 - Head is surrounded by a ring of tentacles.
 - Part of the foot forms, a funnel-shaped siphon.
 - Locomotion is by expelling water in jet through siphon.
-

- Ink glands in some squids for offence and defence. When squid is attacked, it emits a cloud of inky fluid through its siphon. This 'smoke screen' interferes with the visual and chemoreceptors of the predator and thereby helps the squid to escape.
- These animals are large sized and are exclusively marine.
- Their foot is converted into excurrent siphon or arms.
- Development is direct in them.
- Larva is absent but Radula is present.
- Their Nervous system is advanced.
- Eyes are chordate like.
- Circulatory system is closed.
- Chromatophores are present.

Examples - *Octopus* is known as devil fish, octopoda, shell absent. They have ink gland. The ink is ejected through anus to form cloud in water. In male 3rd arm is spoon shaped. *Loligo* is called squid. The ink gland is present. Its shell is internal. They are decapoda. They are sea arrow, because lateral fins combined posteriorly.

Sepia is also called cuttle fish. Its shell is internal. They are decapoda. The ink gland present.

Nautilus or pearly nautilus is living fossil. Its shell is spiral & chambered. Animal present in last chamber, siphuncle or living tube present as a special feature.

Tethys is called sea fly. It is largest snail.

Architeuthis is called giant squid. Its weight is about 5 tones. Its length is 18 meter, diameter 6 meter. It has largest eyes in animal kingdom (15 inch). **It is** largest & heaviest invertebrate.

2.4.9 Phylum Echinodermata

- Echinodermata animals have an endoskeleton of calcareous ossicles and, hence, the name Echinodermata (Greek – echinos= hedgehog; dermos= skin) or Spiny bodied.
 - Jacob Klein gave the name Echinodermata.
 - Commonly known as 'swimming pebbles'.
 - They are exclusively marine with organ-system level of organisation.
 - The adult echinoderms are radially symmetrical but larvae are bilaterally symmetrical.
 - They are triploblastic and coelomate animals.
 - The Echinoderms have spiny skin with calcareous plates. They possess long, movable spines, a mouth on the lower side and an anus on the upper side.
 - Echinoderms are distinctly different from other metazoans, body unsegmented.
 - Echinoderms are uncephalized (head absent), the oral-aboral axis is perpendicular to the pentamerous plane.
 - An outstanding characteristic of the echinoderm is their complex coelom and its derivatives; the water vascular system perivisceral coelom and haemal system.
 - They do not have proper circulatory system.
-

- Digestive system is complete with mouth on the lower (ventral) side and anus on the upper (dorsal) side. With straight or coiled alimentary canal.
- Their most distinctive feature is the presence of water vascular system which helps in locomotion, capture and transport of food and respiration.
- Locomotion by tube feet. Respiration by tube feet / dermal papillae / bursae.
- An excretory system is absent and it is done partly by diffusion through the body & partly by amoeboid cells in the coelomic fluid. Excretion by water vascular system. Water vascular system consists of Teidmann's bodies and S-shaped stone canals.
- Brain is absent.
- In Echinoderms sexes are separate i.e. Unisexual and they have five pairs of sex organs.
- Reproduction is sexual.
- Fertilisation is usually external in open water.
- Development is indirect with free-swimming larva. Pinnaria / bipinnaria / oricularia / echinopluteus larvae are present.
- Covering of body is echinocardium.
- Examples: *Asterias* (Star fish), *Echinus* (Sea urchin), *Antedon* (Sea lily), *Cucumaria* (Sea cucumber) and *Ophiura* (Brittle Star.)
- Phylum Echinodermata is divided into following classes on the basis of tube feet –

1. Asteroideae

2. Crinoideae

3. Ophiozoidea

4. Echinozoidea

5. Holothurozoidea

2.4.9.1 Asterozoidea

- They have 5 tube feet with sucker.
- Pedicellaria present as organ of defence.
- Madreporite is present.
- Excretory material mainly ammonium compounds.

Examples – *Pentaceros* is sea star. It is star fish. It is carnivorous. It creates damage to pearl industry. It has autotomy i.e. breaking of tube feet.

Haliostira is sea pentagon.

***Asterias* is a star fish, stomach comes out during feeding.**

2.4.9.2 Crinozoidea

- It has more than 5 tube feet.
 - Their tube feet without suckers.
 - Pedicellaria are absent.
 - Madreporite are absent.
 - Central disc is calyx.
 - Mouth and anus both are on same surface.
-

Examples – *Antedon* is sea lily, appearance is like a small herbaceous plant. It is living fossil. It is fixed echinoderm, for fixation stalk is cirri. It has doliolaria larva.

Neometra is stalked echinoderm. It is also called as feather star.

2.4.9.3 Ophiozoidea

- It is commonly known as serpent star.
- They are most successful animals.
- Their larva is ophiopluteus.

Examples – *Ophioderma* is called brittle star. It can creep & swim. Jointed arm are present.

2.4.9.4 Echinozoidea

- Animals are hedge hog like in appearance.
- Commonly known as sea urchins or sand dollars.

Examples – *Echinus* is sea urchin. It has echinopluteus larvae. Aristotle's lantern present for grinding food.

Clypeaster is sea biscuit.

Echinorchinus is sand dollar, arms are absent.

2.4.9.5 Holothurozoidea

- They do not have arms.
- Respiration by cloacal tubule.

Examples – *Cucumberia* is called sea cucumber.

Holothuria is sea cucumber, respiratory tree or bursae present. At the time of anger animal throws its viscera, again regenerated, this phenomenon is known as Evisceration.

Synapta is fresh water animal.

Thyone **R.B.C.** are present.

2.4.10 Protochordata

- These are primitive chordates, vertebrae and paired appendages are absent.
- All protochordates are marine.
- Protochordates are also called non-vertebrate or invertebrate chordates.
- On the basis of location of notochord, protochordates are divided into 3 subphyla-
 1. Hemichordata
 2. Urochordata
 3. Cephalochordata

2.4.10.1 Phylum Hemichordata

- Hemichordata (Hemi= half; chorda= rod) was earlier considered as a sub-phylum under phylum Chordata.
 - But now it is placed as a separate phylum under non-chordata.
 - They are burrowing animals. Burrows are U-shaped.
 - This phylum consists of a small group of worm-like marine animals with organ-system level of organisation.
-

- They have *Notochord* in head region in larva & adult both. Notochord is known as buccal diverticulum or stomochord.
- They are bilaterally symmetrical, triploblastic and coelomate animals.
- Body is divided into proboscis, collar & trunk.
- Locomotion is present in them.
- Their circulatory system is of open type.
- They respire through gills.
- Excretory organ is proboscis gland.
- Their sexes are separate i.e. they are unisexual. Gonads are many pairs.
- Fertilisation is external.
- Their development is indirect.
- Tornaria larva is present.
- Metamorphosis is progressive type.
- The protochordates do not have a backbone or vertebral column so they are also called Non-vertebrate Chordates.

Examples- *Amphioxus*, *Herdmania*

Balanoglossus is also called acorn worm or tongue worm. It has colourless blood

Saccoglossus is connecting link between Echinodermata & chordata.

Protoglossus, *Discoglossus*, *Cephalodiscus*, *Rhabdopleura*

2.4.10.2 Urochordata

- Notochord present in tail part in larva only.
- Commonly known as tunicata or ascidian.
- Their body covering is tunic, made up of tunicin (animal cellulose).
- Their body is sac like.
- Locomotion is absent. They are sessile (few are free living).
- They are Bisexual. Gonads are one pair.
- Larva is ascidian tadpole.
- Metamorphosis is retrogressive type.
- Excretion by supraneural gland or pyloric gland or nephrocyte.
- It is Neotenic form.
- Coelome is replaced by arterial cavity.
- Pharynx sac like having many gill slits.
- Vanedocytes present to take out venidium (green pigment).
- Typhlosole is present.

Examples – *Herdmania* is called sea potato, sea squirt.

Ciona is known tube sea squirt.

Botryllus is a colonial animal.

Doliolum is known as sea drum.

Salpa is free swimming, viviparous, sea drum.

Pyrosoma is colonial, free swimming, fire flames, and Maximum light in sea animals.

Oikopleura, Molgulla

2.4.10.3 Cephalochordata

- Notochord present in complete length in embryo & adult both.
- Their body is Lense shaped.
- Body covering is absent.
- Commonly known as lanceolate.
- Locomotion is present, caudal fin is present.
- They are Unisexual. Larva stage is absent.
- Gonads are many pairs.
- Metamorphosis is progressive type.
- For excretion brown funnel or solenocyte or protonephridia or Hetscheck's nephridia present.
- Their body is transparent.
- Heart and brain is absent.
- Respiratory is pigment absent.
- Vellum or wheel organ is present near mouth for feeding.

Examples– *Branchiostoma* is Amphioxes, typical chordate
Asymetron

2.4.11 Phylum Chordata

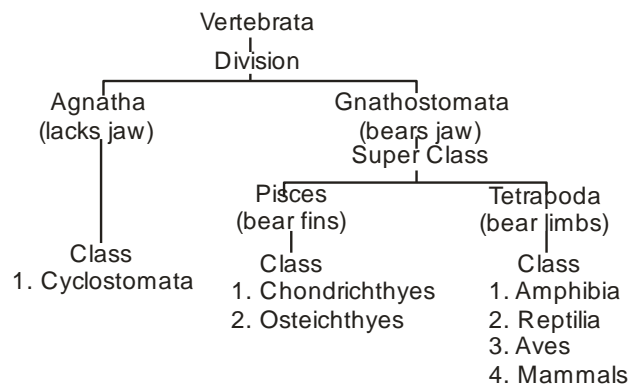
- Chordates (Chorda= rod) possess a notochord either throughout or during early embryonic life.
 - The fundamental features of Chordates are the presence of a dorsal hollow nerve cord, paired pharyngeal gill slits and a notochord.
 - These are bilaterally symmetrical, triploblastic, and coelomate with organ-system level of organisation.
 - They possess a post anal tail and a closed circulatory system.
 - Phylum Chordata is divided into three subphyla: Urochordata or Tunicata, Cephalochordata and Vertebrata.
 - Subphyla Urochordata and Cephalochordata are often referred to as protochordates and are exclusively marine.
 - In Urochordata, notochord is present only in larval tail,
 - In Cephalochordata, it extends from head to tail region and is persistent throughout their life.
-

Examples: Urochordata – *Ascidia*, *Salpa*, *Doliolum*; Cephalochordata – *Branchiostoma* (Amphioxus or Lancelet).

Comparison of Chordates and Non-chordates

CHORDATES	NON-CHORDATES
Notochord is present.	Notochord is absent.
Central nervous system is dorsal, hollow and single.	Central nervous system is ventral , solid and double.
Pharynx perforated by gill slits.	Gill slits are absent.
Heart is ventral.	Heart is dorsal if present.
A post-anal tail is present.	A post-anal tail is absent.
Mouth is generally in first segment.	Mouth is generally after first segment.
Anus is generally in last segment.	Anus is generally before last segment.
Liver is present.	Liver is absent.
Flow of blood – On dorsal Anterior to posterior On ventral Posterior to anterior	Flow of blood -On dorsal, posterior to Anterior On ventral, anterior to Posterior
R.B.C are present	R.B.C are absent.
Circulatory system is closed.	Circulatory system is Open/ closed/ absent.
Position of alimentary canal is Ventral to nerve cord.	Position of alimentary canal is Dorsal to nerve cord.
Symmetry is Bilateral.	Symmetry is of all types.
Grade is Organ system.	Grade is of all types.
Body wall is Triploblastic.	Body wall is Diploblastic / triploblastic.
Coelome is Enterocoelic.	Coelome is of all types.
Reproduction is mainly asexual.	Reproduction is mainly sexual.
Larvae are generally absent.	Larvae are generally present.
Regeneration is less.	Regeneration is more
Temperature - Animals are cold blooded or warm blooded.	Temperature - Animals are cold blooded.
Total animals are 3-5%	Total animals are 95- 97 %

- The members of subphylum Vertebrata possess notochord during the embryonic period.
- The notochord is replaced by a cartilaginous or bony vertebral column in the adult.
- Thus all vertebrates are chordates but all chordates are not vertebrates.
- Besides three basic chordate characters, i.e. presence of a dorsal hollow nerve cord, paired pharyngeal gill slits and a notochord, vertebrates have a ventral muscular heart with two, three or four chambers, kidneys for excretion and osmoregulation and paired appendages which may be fins or limbs.
- They respire by gills or lungs and have endocrine system etc.
- The subphylum Vertebrata is further divided as follows-



2.4.11.1 Division- Agnatha

- Agnatha is the division of vertebrates which do not have jaws (a= without; Gnatho= jaws).
- They are the most primitive living vertebrates that are superficially fish-like but do not have paired fins.
- The few living species of Agnathans are collectively called as cyclostomes (meaning round mouthed).e.g. Myxine & Petromyzon.
- The skin is smooth, slimy and without scales and the skeleton consists of a notochord and various small cartilages.
- The feeding apparatus consists of a powerful sucker and a protusible rasping tongue, which the animal uses as a substitute for jaws.
- Lampreys spawn in the river water and die.
- The larva called ammocoete has a worm-like appearance and totally unlike the adult. This stage lasts for 3 to 5 years and is followed by metamorphosis which takes 2 months. It then moves to the sea to take up the adult mode of life.
- Agnatha is divided into two classes

1. Ostracodermi 2. Cyclostomata

2.4.11.1 .1 Class Ostracodermi

- They are first vertebrate.
- Their body is heavily armoured.
- They are all fossils.

Examples – *Cephalospis*

2.4.11.1.2 Class-Cyclostoma

- Cyclostoma (Cycle = circle; stoma = mouth) are most primitive vertebrates .
- All living members of the class Cyclostomata are ectoparasites on some fishes.
- Their Body is eel like. Their mouth is sucker like. On tongue horny teeth present.
- They have an elongated body bearing 6-15 pairs of gill slits for respiration.
- Cyclostomes have a sucking and circular mouth without jaws.
- Pineal eyes are present.
- Their body is devoid of scales and paired fins.
- Unicellular shin glands are present.
- They are Sanguivorous.
- Cranium and vertebral column are cartilaginous.
- Circulation is of closed type. Cyclostomes are marine but migrate for spawning to fresh water.
- After spawning, within a few days, they die.
- Their larvae, after metamorphosis, return to the ocean.

Examples: Petromyzon is lamprey, lampredin present. They have 7 pairs of gills. Their larva is ammocoete for 7 years. They are living fossil.

Myxine is Hag fish. Its lips are like old lady. They are bisexual. Their development direct.

2.4.11.2 Division- Gnathostomata

- Gnathostomata are the vertebrates provided with jaws (Gnatho= jaws; stoma= mouth) and two pairs of appendages.
- Skin is provided with exoskeletal structures.
- Gnathostomata is divided into 2 super classes

1. Pisces 2. Tetrapoda

2.4.11.2.1 Super Class – Pisces

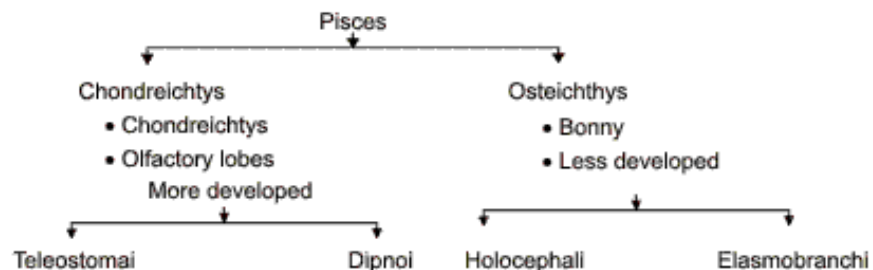
- Pisces is the Latin word for "fish" (plural). Age of fishes is devonian period.
 - The term "fish" most precisely describes any non-tetrapod craniate (i.e. an animal with a skull and in most cases a backbone) that has gills throughout life and whose limbs, if any, are in the shape of fins. Skull is monocondylic.
 - Fishes are a paraphyletic collection of taxa, including hagfishes, lampreys, sharks and rays, ray-finned fishes, coelacanth, and lungfishes. They are Aquatic animals.
 - A typical fish is ectothermic, has a streamlined body for rapid swimming, extracts oxygen from water using gills or uses an accessory breathing organ to breathe atmospheric oxygen, has two sets of paired fins, usually one or two (rarely three) dorsal fins, an anal fin, and a tail fin, has jaws, has skin that is usually covered with scales, and lays eggs.
 - Teeth are pleurodont or acrodont. Jaw suspensorium is autostylic.
 - Rheoreceptor is neuromast. Galvanoreceptor is mormyromast.
-

- Dermal scales (originate from mesoderm) present (in Silurian e.g. cat, fish scales absent). Scales may be placoid, cycloid, ganoid, and ctenoid.
- **Lateral line system is present.**
- Endo skeleton is cartilagenous / bonny.
- In some fresh water fishes anterior vertebrae are modified to form a chain of bone **webbrian's ossicles** connect internal ear to air bladder.
- For locomotion, myotomes muscles are present. Fins are helpful in locomotion. Migration may present.

Anadromous (sea → river) e.g. Salmon, lamprey, hilsa & sturgeon.

Catadromous (river → sea) e.g. Anguilla (eel).

- Digestion is intercellular.
- Gills are respiratory organs. For brachial respiration water enters in pharynx through mouth.
- RBC is spherical & nucleated.
- Heart is 2 chambered veinous heart or brachial heart (in dipnoi 3 chambered). Circulation is single type.
- They are Cold blooded animals.
- Kidney is mesonephric. Excretory material may be ammonia / urea / TMO (Trimethyl amine oxide) mainly ureotelic.
- Only internal ear is present. Clasper may present.
- Cranial nerves are 10 pairs.
- Animals are unisexual.
- They may be Oviparous or viviparous.
- Fertilization may be internal or external.
- Development may be internal or external.
- Young ones are called fry.
- Anamniota i.e. embryonic membranes are absent.
- They are Aplacental. Parental care may present.



2.4.11.2.1.1 Class-Chondrichthyes

- They are marine animals with streamlined body and have cartilaginous endoskeleton.
- Mouth is located ventrally. Notochord is persistent throughout life.
- Gill slits are separate and without operculum (gill cover).
- The skin is tough, containing minute placoid scales.
- Teeth are modified placoid scales which are backwardly directed.
- Their jaws are very powerful.
- These animals are predaceous.
- Due to the absence of air bladder, they have to swim constantly to avoid sinking.
- Heart is two-chambered (one auricle and one ventricle).
- Some of them have electric organs (e.g., *Torpedo*) and some possess poison sting (e.g., *Trygon*).
- They are cold-blooded (poikilothermous) animals, i.e., they lack the capacity to regulate their body temperature.
- Sexes are separate. In males pelvic fins bear claspers.
- They have internal fertilisation and many of them are viviparous.
- *Examples: Scoliodon* (Dog fish), *Pristis* (Saw fish), *Carcharodon* (Great white shark), *Trygon* (Sting ray).

2.4.11.2.1.1.1 Teleostomai

- They are usually bonny fishes.
 - They have 4 pairs Gills.
 - Operculum is present.
 - Spiracle (reduced fish gill slit) are absent.
 - Accessory respiratory organ present as swim bladder, air bladder, air sac.
 - Scales are cycloid, genoid, ctenoid.
 - Cartilagenous / bonny rays present in fins.
 - Clasper is absent.
 - They are mostly aquatic.
 - Their tail is homocercal.
 - Cloaca is absent.
 - Their Liver has 3 lobes.
 - Cones in retina are present.
 - Their vision is at far range.
 - Their Gills are with reduced septum.
 - Cerebellum is small.
 - They are not colour blind.
-

- Olfactory lobes less developed.

Example – In *Sword tail* sexual dimorphism is more clear

Periophthalmus is fish with glasses on eyes. The respiration is conducted by skin.

Salmon (trout) are larvivorous fishes. They feed on larvae of mosquito.

Gambusia are another larvivorous fishes. They feed on larvae of mosquito.

Minnow are larvivorous fishes. They feed on larvae of mosquito.

2.4.11.2.1.1.2 Dipnoi

- They are commonly known as lung fishes.
- Internal nares present in them.
- They have Lungs and gills.
- Their Heart is 3 chambered.
- They have cycloid scales.
- They are fresh water animals.
- Their tail is heterocercal.
- Caudal fin is diphyccercal.
- Pinkus organ is present.
- Commonly known as uncles of amphibian.

Example – *Neoceratodus* is found in Australia (Marry & bernet river).

Ceratodus is found in Australia (Marry & bernet river).

Lepidasiren is found in Tropical South America (Amazon river) .

Protopterus is found in Tropical Africa (Nile river), lobe finned fish, living fossil.

2.4.11.2.1.2 Class- Osteichthyes

- It includes both marine and fresh water fishes with bony endoskeleton.
- Their body is streamlined. Mouth is mostly terminal.
- They have four pairs of gills which are covered by an operculum on each side.
- Skin is covered with cycloid/ctenoid scales. Air bladder is present which regulates buoyancy.
- Heart is two chambered (one auricle and one ventricle).
- They are cold-blooded animals.
- Sexes are separate. Fertilisation is usually external.
- They are mostly oviparous and development is direct.

Examples: Marine – *Exocoetus* (Flying fish), *Hippocampus* (Sea horse); Freshwater – *Labeo* (Rohu), *Catla* (Katla), *Clarias* (Magur); Aquarium – *Betta* (Fighting fish), *Pterophyllum* (Angel fish).

2.4.11.2.1.2.1 Holocephali

- Operculum present.
 - Anterior calasper present on head.
-

Example – Callorhynchus is called elephant shark.

Chaimera is known as rat fish or rabbit fish or king of herming or ghost shark or spook shark .It gives one egg in one time, schooling habitat present.

2.4.11.2.1.2.2 Elasmobranchi

- They are Cartilagenous fishes.
- They have 5–7 pairs of Gills.
- Operculum is absent.
- Sphiracle (reduced fish gill slit) is present.
- Accessory respiratory organ are absent. (They have to move continuously to neutralize gravitation pull).
- Their scales are placoid. They have claspers.
- Fins horny fin rays present.
- Marine (Nephron are urea absorbing segment, so about 2.5% of urea is retained in blood to make it isotonic).
- Their tail is heterocercal. Cloaca is present.
- Stomach is J-shaped. Scroll valve present in intestine.
- Rectal glands are present.
- Liver has 2 lobes.
- Their vision is at close range.
- Ampullae of lorenzini on snout is present as thermo receptor.
- Gills with long interbranchial septum i.e. lamelli form.
- Cerebellum is large.
- They are colour blind. Olfactory lobes are more developed. Cones in retina are absent.
- Commonly known as Shark, Rays, and Skates.

Examples – *Scoliodon* is dog fish. It has placenta. Its teeth are homo & polyphyodont.
Garcarodon is great white shark and is man eater.

Lamna is also called Mackerel shark. The name is given on bursting of clouds.

Raja is also known as skate.

Sphyrna is hammer headed fish.

2.4.11.2.2 Super Class –Tetrapoda

- They are cold blooded vertebrates, freshwater in habit, capable of living on land and in water.
 - They are conspicuous by their absence in marine habitat.
 - The skin is glandular, devoid of scales.
 - The forelimbs and hind limbs possess digits devoid of claws.
 - The heart has two auricles and single ventricle; there are 3 aortic arches, carotid trunk, systemic trunk and pulmocutaneous trunk.
-

- Aerial respiration with lungs, external nostrils opening into buccal cavity by in many cutaneous respiration also takes places.
- About 30-35 % of total gaseous exchange takes place through cutaneous respiration. The adult kidney is mesonephros.
- Cranial nerves are ten in number.

2.4.11.2.2.1 Class- Amphibia

- Amphibian (*Gr., Amphi* =dual; *bios* = life) as the name indicates, amphibians can live in aquatic as well as terrestrial habitats. Age of amphibia is carboniferous period.
 - Amphibian is **s**mallest class. They have minimum vertebrae.
 - At the larval stage these are fish-like and swim in water using their tail. Not marine.
 - The adults live on the land and move about using two pairs of limbs.
 - Body is divided into head and trunk. Keratinization absent.
 - Exo skeleton absent due to cutaneous respiration. Ribs are absent. Skull is dicondylic.
 - Neck is absent. Tail may be present in some.
 - The skin is moist with unicellular mucous glands and without scales.
 - The eyes have eyelids. Their teeth are acrodont.
 - A tympanum represents the ear. Middle and internal ear present. In middle ear, MIS combine to form collumella auris.
 - Jacobson's organ (smell) present first of all.
 - Centrum is procoelus / amphicoelus / acoelus.
 - They are Tetrapoda, pentadactyle limbs, claws absent.
 - Larynx is present in them. Vocal cords became active first of all.
 - Alimentary canal, urinary and reproductive tracts open into a common chamber called cloaca which opens to the exterior.
 - Respiration is by gills, lungs and through skin. In tadpole gills also present.
 - In Amphibians Sternum was formed first of all.
 - In brain optic lobes are 2 (corpora bizemini). Cranial nerves are 10 pairs.
 - The heart is three chambered i.e. two auricles and one ventricle.
 - Trunchus arteriosus & sinus veinosus are present. Circulation is incomplete double.
 - RBC is biconvex and nucleated.
 - They are cold-blooded animals.
 - Their Kidney is mesonephric. They are Ureotelic.
 - Sexes are separate. Copulatory organ is absent.
 - Fertilisation is external.
 - Development is external. Development indirect i.e. tadpole present. Anamniota. Aplacental.
 - They are oviparous and development is direct or indirect.
-

Examples: *Bufo* (Toad), *Rana* (Frog), *Hyla* (Tree frog), *Salamandra* (Salamander), *Ichthyophis* (Limbless amphibia).

Order I. Apoda or Cecaelian or Hymnophiona

- Limbless, blind elongated worm-like, burrowing, dermal scales embedded in skin.
- Male have protrusible copulatory organ.
- Left lung rudimentary.
- Maximum vertebrae.
- Legs absent. In Apoda & Urodela fertilization is internal.

Example – *Ichthyophis* is Apodon. It is burrowing, blind worm. It has scales. Its eyes rudimentary.

Ureotyphlous is found in Cochin & Malabar.

Typhlonectes is a South American viviparous aquatic form.

Order II. Urodela or Caudata

- Commonly called as 'newts' and 'Salamanders', lizard-like with a distinct tail.
- Tympanum absent, gills permanent or lost in the adult.
- Males without copulatory organs.
- Their fore limbs & hind limbs are equal.
- They have tail.
- Larva is axolotl.
- It shows neoteny or paedogenesis.
- Retention of larval characters even after sexual maturity is called neoteny.

Example – *Proteus* is blind salamander. They have permanent Neotenic larvae.

Salamander atra has longest gestation period (36 month). They can swim with tail.

In their oviduct 15 embryos present. They are viviparous.

Plethodon is called slimy salamander. In these animals lungs are absent.

Megalobatrachus is longest amphibian (5 feet).

Cryptobranchus is the largest amphibian (114 cms), hell blender,

Ambystoma is found in USA.

Order III. Anura or Salientia

- Commonly called as frogs and toads, tailless, adult without gills, eyelids well formed, and tympanum present.
 - Fore limbs small, hind limbs large.
 - Skin loosely fitting, scale-less, mandibles toothless.
 - Exoskeleton as scales is not found in frogs. A diaphragm is not found in frog.
 - *Bufo marinus* is a poisonous amphibian. In midwife toad, male is smaller without vocal sacs. Males show parental care.
 - *Bombinator* is famous for warning colouration.
-

- *Rana goliath* is the largest frog of West Africa, 30 cm long.
- A frog differs from a toad in the absence of warts.
- Male frog can croak louder than female with the help of vocal sacs.
- A frog has ears but no pinnae.
- A frog has 4 fingers on hands , and five toes on leg.
- The glands present in the skin of frog are mucous and poisonous.
- Frog is ureotelic.
- Functional kidney of frog tadpole is pronophros.
- Frog aestivates during summer and hibernates during winter.
- Neck is absent in a frog, this helps the frog in jumping on the ground.
- Poison gland of a toad is modified parotid gland.
- 'Horned Toad' is a lizard living in desert, it is not an amphibian.
- *Hyla* is an arboreal frog, adapted for life in trees. It is green in colour. Terminal bones of digits are claw-shaped and swollen basally into glandular adhesive discs which enable them to climb trees.
- *Rhacophorus* has characteristic large webs developed between the much elongated digits. Webs and flattened body serve as a parachute in gliding from higher elevation to a lower ones, so they are designated 'flying frogs'.
- *Xenopus laevis* is the African clawed toad, it lacks tongue, eyelids and distinct tympanum.
- *Xenopus* is used as a test in diagnosis of human pregnancy.
- *Phylllobates limbatus* is the smallest frog found in Cuba. It is hardly 12.5mm long.

Example –*Rana tigrina* is Indian bull frog. Its lower eye lids more moveable. It has mantomekeline bone.

Rana pipens is called leopard frog.

Rana concirona is found in salty lake, marine.

Bufo is a toad .Bufonin & bufotelin is secreted by its parotid gland.

B. marinus or cocoi frog is poisonous amphibian, maximum lethal in all animals.

Xenopus is an African clawed toad. Their eye lids and tongue are absent .

Rhacophorus is also called flying frog.

Rehobtrachus is the frog which gives babies from mouth.

Hyla is a tree frog. It has adhesive pad. Their skin is hygroscopic.

Alytes is a mid wife frog, male care egg between hind legs.

Pipa is surenam toad, tongue, teeth eye lid absent. Its female cares eggs on her back.

Phlobatus is smallest frog.

Bombinator is also called fire belied toad.

Ascappus is African bull toad. It has cloacal projection Their fertilization is internal.

Hyla vasta is the largest tree frog of West Indies.

Pigmo tree frog is the smallest tree frog.

Microphyla are narrow mouthed frog.

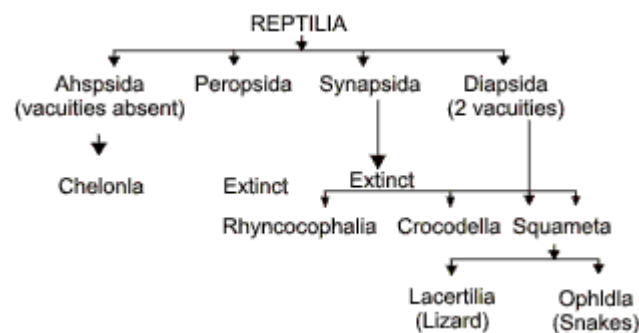
Gestrotheca is Morsupial frog.

Astylosternus is hairy African frog.

2.4.11.2.2.2 Class- Reptilia

- Reptilia (*Latin, repere or reptum, to creep or crawl*) the class name refers to their creeping or crawling mode of locomotion.
 - They are mostly terrestrial animals, carnivorous, vertebrates.
 - They are Tetrapoda, claws present.
 - The body is divisible into four regions namely head, neck, trunk and tail.
 - Their body is covered by dry and cornified skin, epidermal scales or scutes. The skin is dry and nonglandular.
 - Exoskeleton is made up of scales (squamata), bony scutes (crocodilia), carapace & plastron (chelonia). Exo skeleton is epidermal or dermal.
 - Endoskeleton is maximum complicated, bony. Ribs present. Skull monocondylic.
 - T-shaped interclavicle present.
 - Centrum heterocoelus (saddle shaped).
 - In caudal vertebrae chaveron bone present. Ribs are helpful in locomotion.
 - Cranial nerves are 12 pairs.
 - Teeth acrodant, homodont.
 - They do not have external ear openings. Tympanum represents ear. Middle and internal ear present.
 - Limbs, when present, are two pairs.
 - Heart is usually three-chambered, but four-chambered in crocodiles.
 - Sinus venosus reduced.
 - Two systemic arches are present.
 - Erythrocytes are oval and nucleated.
 - Jacobson's organ (vomeronasal organ) in the roof of buccal cavity concerned with smell, well developed in snakes and lizards.
 - Respiration by lungs. Circulation incomplete double.
 - Kidney metanephric. Uricotelic.
 - They are cold blooded animals or poikilotherms.
 - Snakes and lizards shed their scales as skin cast.
 - Sexes are separate. Copulatory organ is hemipenis.
 - Eggs are cleidoic, eggs covered with leathery shells.
 - Fertilization is internal.
 - Eggs Macrolecithal, telolecithal of yolk.
-

- Cleavage meroblastic ,extra-embryonic membranes are present (Amniota).
- Development is direct, no metamorphosis and no parental care.
- Ecdysis is present. Ceacum is formed first of all.
- The two features which make reptiles truly land animals are internal fertilisation and presence of a special membrane around the developing embryo i.e. they are amniotes.
- They are oviparous and development is direct.
- **Examples:** *Chelone* (Turtle), *Testudo* (Tortoise), *Chameleon* (Tree lizard), *Calotes* (Garden lizard), *Crocodilus* (Crocodile), *Alligator* (Alligator). *Hemidactylus* (Wall lizard), Poisonous snakes – *Naja* (Cobra), *Bangarus* (Krait), *Vipera* (Viper).
- Classification of reptiles is based on temporal fossa on skull.
- The Class reptilia is first divided into 5 subclasses-
 - i. Anapsida
 - ii. Euryapsida-Extinct
 - iii. Peropsida - Extinct
 - iv. Synapsida -Extinct
 - v. Diapsida
- Out of 5 sub-classes only two have living reptiles Anapsida and Diapsida.



2.4.11.2.2.2.1 Anapsida

- Primitive reptiles with a solid skull roof.
- No temporal opening.
- It has only one order- Chelonia.

Order I - Chelonia

- Commonly called turtles, tortoise and terrapins.
 - Body encased in two shell plates , dorsal carapace and ventral plastron.
 - Their Exo skeleton is dermal.
 - Limbs clawed, webbed or paddle-like.
 - Sternum is absent.
 - Jaws with horny sheath. They do not have teeth.
-

- In their eyes mineral secretion glands are present.
- They have a single Penis.
- Certain aquatic turtles perform cloacal respiration ,but all other reptiles respire with lungs.
- The giant land tortoise ,*Testudo abingdoni* of Galapagos Islands is the largest Chelone, 100 kg wt., life span 200 to 400 years.

Example –*Trionyx* is fresh water tortoise.

Testudo is marine turtle.

Chelone is present in Indian sea.

Dermochelys is marine leathery turtle.

Chelonia mydes is green turtle or sea buffalo.

2.4.11.2.2.2 Diapsida

- It has living reptile.
- It is divided into 3 orders- Rhynchocephalia, Crocodelia and Squamata.

Order I - Rhynchocephalia

- All are extinct except a living species *Sphenodon punctatum*.
- They are lizard-like reptiles that includes only one living genus.
- Despite its current lack of diversity the Rhynchocephalia or Sphenodontia at one time included a wide array of genera in several families.
- They represent a lineage stretching back to the Mesozoic Era.

Example – *Sphenodon punctatum* is burrowing, carnivorous and nocturnal in habits.

Sphenodon punctatum is called tuatara.

It is living fossil. It is found in New Zealand.

An interesting feature of *Sphenodon punctatum* is the presence of pineal or parietal or third eye. It has 3 eye and penis absent.

It resembles to jurrasic homeocerus, viviparous.

It has maximum gestation period in reptiles, and age is 100 yrs.

Order II - Crocodelia

- They are commonly called crocodiles, alligators and gharials.
 - These are large sized, carnivorous and aquatic reptiles.
 - Tail long, strong and laterally compressed.
 - Skin thick with scales , bony plates and scutes.
 - Teeth are thecodont, heterodont.
 - Their heart is 4 chambered.
 - The Lung cavity of crocodile is separated from rest of the body cavity by a muscular diaphragm, analogous to that of mammals.
 - Pineal gland is absent in crocodiles.
 - Crocodiles show affinity with Dinosaurs.
-

- The largest of all crocodiles is the salt water *Crocodylus porosus* of South Eastern Asia, which is about 8 to 9 meters long.
- *Gavialis gangeticus* lives in Ganges and Brahmaputra rivers and grows to 8 meters.
- Both crocodiles and alligators have respiratory organs to breathe in air.
- Internal nares open in pharynx.
- Gizzard stomach like.
- Herdarian glands open in nasal path, so known as crocodile tears.
- They have single penis.
- Cochlea in internal ear present.

Example- *Crocodile* has musc gland present

Alligator

Gavalis is found only in India

Crocodyllus is the largest crocodile, marine, weight 1100 pond, found in South East Asia.

Order II – Squameta

- Commonly called lizards or snakes.

1. Lizards

- Lizards have four well developed clawed pentadactyl limbs.
 - Limbs are absent in lizards like *Ophiosaurus*, *Anguis*, *Rhineura* and *Barkudia*.
 - A limbless lizard can be distinguished from true snake by the presence of movable eyelids and external ear opening which snakes lack.
 - Lizards are mostly carnivorous, but a herbivorous lizard is Iguana from South and Central America.
 - The largest living lizard in the world is the ferocious Dragon, *Varanus komodensis*, found in Malaya Archipelago. Length 2 to 3 meters, weight 70 to 100 kg.
 - The tail of most lizards is easily broken off when threatened or seized by a predator. This ability is known as autotomy. Autotomy is voluntary breaking tail to confuse enemy. A new tail is soon regenerated which however, does not possess vertebrae.
 - Girdles are present.
 - Tympanum is present.
 - Their eye lids are movable.
 - Nictitating membrane is present.
 - Most lizards are oviparous; two viviparous lizards are *Phrynosoma* and *Chameleon*.
 - Eggs are covered by calcareous shell.
 - Femoral glands are present on thigh of male, which is helpful in copulation.
 - Urinary bladder is also present.
 - Scales are of uniform size.
 - Zygosphenes & zygantra in vertebrae are absent.
-

- Both lungs are equally developed.
- Jaw bones are of fixed type.
- Cotylosaures are stem reptiles Reptiles + aves = sauropsida.

Example – *Hemidactylus* is a wall lizard. Its breaking of tail is autotomy for defence. It shows heteromorphism i.e. regenerated tail lacks vertebrae. It produces sound by striking tongue against palate.

Heloderma is only poisonous lizard, sublingual gland is poisonous. It is also called gila monster or beaded lizard of Mexico.

Gecko is commonly known as geko.

Phineura is limbless lizard.

Ophiosaurus is also limbless lizard. It is also called glass snake.

Anguis is known as limbless lizard or glass snake or herbivorous.

Phrynosoma is found in USA & Mexico. It is also called horned toad. It is viviparous. It throws red fluid at the time of danger from eyes.

Draco is flying lizard of Indo–Malaya region. It has petagium.

Uromastix is called sand lizard.

Chameleon or girgit has air sacs .Its tongue length is equal to body's length. It has helmet like head. It is syndactyly in digits. It can be move both eyes independently of each other.

Varanus komodensis is the monitor or largest lizard.

Calotes is called garden lizard or blood sucker.

Amblyrhincus is marine lizard. At most of the time remains on land i.e. Galapagos island.

2. Snakes

- Snakes are the most specialized animals in the world.
 - Snakes are limbless. Limbs were degenerated during evolution.
 - Girdles absent.
 - Sternum, pectoral girdle, urinary bladder and tympanum absent.
 - Eye lids immovable.
 - Nictitating membrane absent.
 - Eggs covered by leathery shell.
 - Femoral glands absent.
 - Scales differentiated in plates & shields.
 - Zygosphenes & zygantra present.
 - Left lungs are reduced. Jaw bones moveable.
 - Snakes may be poisonous (10%) and non poisonous.
 - Snakes have ability to swallow preys several times of its own diameter.
 - Parotid salivary glands are poisonous.
 - Snake has long, slender and bifid tongue which is sensitive to both odours and vibrations.
 - Snake has no middle ear. It perceives sound through skin.
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- Snakes shed scaly epidermis of skin periodically usually in one piece. This process is termed moulting or Ecdysis. Ecdysis of cornified cells of skin.
- Locomotion of snakes is helped by ribs and large ventral scutes.
- There are two types of snakes – Poisonous and Non-poisonous.
- Most snakes are not poisonous to human. Majority of snakes are beneficial to man as they destroy harmful rodents and insects.
- Poisonous teeth or phages are maxillary teeth.

Examples – *Naja hannah* is called king cobra which is largest poisonous snakes (2m). It forms nest and feeds on other snakes.

Ophiophagus is also king cobra and largest poisonous snake (2m). It forms nest and feed on other snakes

Naja naja is cobra, venom is neuro & cardiotoxic. Its antivenom injections are prepared at Hoffkin's Institute Bombay & Central Research Institute, Kausuali. The hood is formed by expansion of cervical vertebrae. The most poisonous snake of India.

Penincular tiger is South Australian, most poisonous terrestrial snake of world.

Hydrophis is marine poisonous and viviparous tail flat.

Bungarus is commonly known as krait.

Crotalus is also called rattle snake. It is viviparous. It has a chain of scale of last end tail part gives rattle. It creates a voice to frighten enemies.

Viper is called pit viper and Russell's viper. It is viviparous.

Eryx johani is called dumai or sand boa.

Typhlina is double mouthed snake and long tailed blind snake. It is smallest snake of India.

Python reticulatus is the largest snake.

Calliophis is known as coral snake.

Dryophis is called whip snake or green vine snake.

Dendrophis is called a tree snake.

Typhlops is blind snake.

Ptyas is rat snake.

Trimeresurus is pit viper. Its pit is thermoreceptor.

Leptotyphlops is smallest snake of world. It is also called thread snake.

Anaconda is the longest reptilia (40 feet). It is also called water boa.

Chrysopelea is known as flying snake.

2.4.11.2.2.3 Class Aves

- The Aves (birds) are characterised by the presence of feathers and most of them can fly except flightless birds (e.g., Ostrich). Feathers are modified epidermal scales, their arrangement is pterolysis. Quill feathers on wings are remiges.
 - Tail feathers (rectices) form steering.
 - Body is boat shaped.
 - They possess beak .Teeth are absent. Beak is covered by a horny sheath rhamphotheca.
 - Their forelimbs are modified into wings. Some birds are flightless e.g. Ostrich, Kiwi.
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- Their hind limbs generally have scales and are modified for walking, perching, swimming or clasping the tree branches. Bipedal locomotion.
- Perching mechanism present. In it gastrocnemius muscle is helpful.
- Skin dry only uropygial or preen gland (at the joint of belly & tail) present. Endoskeleton is fully ossified (bony) and the long bones are hollow with **air** cavities (pneumatic). Ribs are bifid with uncinata process.
- Skull is monocondylic. Centrum heterocoelus. Pneumatic or papery or hollow bones present. Skull bones are fused. V shaped furcula or wish bone present (made up of clavicle and interclavicle).
- Posterior thoracic, lumbar & anterior caudal vertebrae fused to form synsacrum.
- Few posterior caudal vertebrae fused to form pygostyle (plough shaped).
- Tebiotarsus present. Tarso metatarsus present. Tetrapoda, claws present.
- The digestive tract of birds has additional chambers, the crop and gizzard. Heart is completely four chambered.
- They are warm-blooded or homoiothermous animals, i.e., they are able to maintain a constant body temperature. They have maximum temperature.
- Middle and internal ear present. In eye, pecten is attached to blind spot. Sclerotic ring present. Strong eye sight.
- The heart is four chambered. Right systemic arch is present. Circulation is double. RBC are spherical & nucleated.
- Respiration is by lungs. Lungs spongy i.e. alveoli large, air sacs 9, helpful in double respiration. Air sacs connected to lungs supplement respiration.
- Kidney metanephric and Uricotelic. Kidney is 3 lobed. Renal portal system is less developed. Faeces of sea birds contain phosphorus so known as guano.
- Gall bladder is absent.
- In brain optic lobes are two. Cerebellum maximum developed. Cranial nerves 12 pairs.
- Sexes are separate. Fertilisation is internal. Development is external.
- Ureter and genital duct open in urodeum. Ecolocation present.
- They are oviparous and development is direct. Migration may present, stimulated by light.
- Copulatory organ absent. Birds with copulatory organs are duck, swan, goose & ostrich. Originated from diapsida.
- Cloacal projections present. Amniota. Aplacental. Left ovary present. Urinary bladder absent. Cloaca is 3 chambered.
- Parental care is present.
- In cloaca bursa fabricii lymph gland present functional as cloacal thymus.
- Syrinx is sound producing organ.

Examples: *Corvus* (Crow), *Columba* (Pigeon), *Psittacula* (Parrot), *Struthio* (Ostrich), *Pavo* (Peacock), *Aptenodytes* (Penguin), *Neophron* (Vulture).

1. Coprodium

2. Urodium

3. Proctodium

2.4.11.2.2.3.1 Archaeornithes

- They are all extinct Jurassic birds of Mesozoic Era.
- Wings primitive with little power of flight.
- Tail long, lizard-like with two lateral rows of retrices.
- Hand with clawed fingers.
- Skull with teeth in both jaws.

Example – Archaeopteryx is connecting link between reptile & aves. It has beak. It also has teeth. V-shaped forcula are present. It is known as lizard bird or jurrasic bird. Its first fossil found in Babena (German) discovered by Andreas Wagner. This fossil is preserved in British museum London & Berlin museum German.

2.4.11.2.2.3.2 Neornithes

- Modern as well as extinct post-Jurassic birds.
- Wings well developed and adapted for flight.
- Tail short and reduced.
- Teeth absent except in some fossil birds.
- Sternum with keel or crania.
- There are 4 super orders in this sub-class-

Super-Order I Odontognathae

Super-Order II Palaeognathae

Super-Order III Impennae

Super-Order IV Neognathae

2.4.11.2.2.3.2.1 Odontognathae

- *Hesperornis* (with teeth) extinct.

2.4.11.2.2.3.2.2 Palaeognathae or ratittae

- Non flying or flightless birds.

Example – *Struthio* is also called African ostrich or camel bird or Arabian ostrich. Its height is 275 cm, weights is 300 ponds and speed is 80 kms/ hr. It is the largest bird. It has penis. It has 2 toes. It also has urinary bladder and male incubates eggs.

Rhea is South American ostrich. It has urinary bladder.

Cassowary is an Australian ostrich. It has helmet on head. It has penis.

Apteryx is kiwi of New Zealand. It is the smallest non flying bird. It is runner bird. It has nasal pores on beak. It has the largest egg in ratio of body weight. It is the living fossil.

Dinornis is also called moa. It is found in New Zealand.

Aepyornis is commonly known as elephant bird.

Emu is the IInd largest bird. Its male incubates egg. It is found in Australia.

Spheniscus is commonly called as penguin. It is an amphibian bird. It is found in southern hemisphere . It has sub cutaneous fat layer blubber.

Pygoscelis papua is Gentoo penguin is the fastest swimmer bird.

Aptenodytes forsteri or Emperor penguin is the deepest diver bird.

2.4.11.2.2.3.2.3 Palaeognathae or ratittae

- Penguins (Aptenodytes) are found in Antarctica (South Pole).
- They have paddle-like wings and cannot fly.
- Penguins are marine and lay eggs in ice.

2.4.11.2.2.3.2.4 Carinatae or Neognathae

- Flying birds.

Example –*Podiceps* is unable to walk on land. It is an aquatic bird.

Motacilla is also called wag tail. It is Siberian bird.

Ploceus is commonly called weaver bird.

Apus is mostly air born bird 9 months in year.

Pitohui dichrous is a poisonous bird.

Scolopax is the slowest flying bird.

Sterna is the longest flying bird (40,000 km/yr.)It is world champion bird.

Ana is also called dabbling duck.

Columba is known as pigeon

Corvus is commonly called as crow.

Passer is called as house sparrow.

Bubo is also called horned owl or Tuto owl. It has binocular vision eyes cannot be rotated so head is rotated it is regarded as symbol of ill Oman.

Albatros largest sea bird wing's span 5 metre.

Mellisuga helanae is called bee humming bird of Cuba. It is the smallest bird. It is 5 cm long and its weight is less than 10 paisa coin. It is smallest egg back mover.

Gallus is known as cock or jungle fowl.

Sun bird is also called suck nector. It is the smallest bird of India.

Psittacula is known as parrot. Its upper jaw is movable. It do not have oil glands.

Dinopium or flame backs or golden backs is commonly called as wood pecker.

Pavo cristatus is our national bird it is also called peacock.

Milvus is commonly called as kite.

Falco is also called falcon.

Neophron is known as vulture.

Raphus dodo is latest extinct bird. The of Moritius extinct in 17th century.

Eudynamys is known as Cuckoos. It has 2 toes forward and 2 toes backward. It gives eggs in crow's nest i.e. nest parasitism.

Streptopelia is commonly called as dove.

Ardeotis nigriceps is known as Indian bustard.

Choriotis nigriceps is known as the great Indian bustard or State bird of Rajasthan.

Ardeotis or *Otis* is known as bustard.

Lophophorus impejanus or Monal is the state bird of H.P.

Coracias is commonly called as Neel kanth.

Cygnus or swan. It is the highest flier bird (27,000 feet).

Orthotomus is known as tailor bird.

Grus or sarus is called as crane.

Grus antigone is called as sarus or crane.

Black partridge is state bird of Haryana.

Micropodus swift, fastest flying bird.

Tyonalba is has external ear like structure.

Halcyon is known as king fisher.

Petrels is a sea bird.

Loon is also a sea bird.

2.4.11.2.2.4 Class-Mammalia

- The Mammals are found in a variety of habitats – polar ice caps, deserts, mountains, forests, grasslands and dark caves.
 - Some of them have adapted to fly or live in water.
 - The body is divided into Head, neck, trunk and tail.
 - Diaphragm is present. Skin is rich in glands.
 - Exo skeleton present in the form of scales / hoofs / horns / hair (hair absent in whale).
 - Ribs are bifid. Skull is dicondylic. Centrum is acoelus or amphipalatin.
 - Intervertebral disc or epiphysis present.
 - Lower jaw is made up of only one bone dentary. Cervical vertebrae 7. (8 in rat, 6 in sea cow).
 - Turbinal bones present in nasal chambers. Tetrapoda, claws present.
 - Jaw craniostylic. Teeth heterodont, thecodont & diphyodont. Larynx is present.
 - The other important features include body covered with hair, presence of external ear (pinnae), presence of milk producing glands (mammary glands) by which the young ones are nourished and the foetus (embryo) being nourished by the mother through placenta; corpus Callosum in brain; heart is four chambered and lungs are well developed.
 - Pinnae, middle & internal, ear present. In internal ear cochlea present.
 - Optic lobes 4, i.e. corpora quadrigemina. Optic lobes are solid. Cerebral hemispheres are maximum developed. Pons varoli present. Cranial nerves are 12 pairs.
 - The muscular diaphragm separates the chest cavity from the abdomen.
 - Heart is 4 chambered. Left systemic arch present. Circulation double, warm blooded.
 - They have two pairs of limbs, adapted for walking, running, climbing, burrowing, swimming or flying.
 - RBC is biconcave and nucleus is absent (in camel & lama nucleus is present).
 - They are homoiothermous.
 - Respiration is by lungs. Kidney metanephric. Renal portal system absent. Urinary bladder is allantoic type.
-

- Parental care present. Unisexual. Viviparous. Internal fertilization. Internal development. Copulatory organ is penis. Amniota Placental. Testes are extra abdominal i.e. in scrotal sac.
- Sexes are separate and fertilisation is internal.
- They are viviparous with few exceptions and development is direct.

Examples-Oviparous-Ornithorhynchus (Platypus)

Viviparous - *Macropus* (Kangaroo)

Pteropus (Flying fox), *Camelus* (Camel)

Macaca (Monkey)

Rattus (Rat)

Canis (Dog)

Felis (Cat)

Elephas (Elephant)

Equus (Horse)

Delphinus (Common dolphin)

Balaenoptera (Blue whale)

Panthera tigris (Tiger)

Panthera leo (Lion)

2.4.11.2.2.4 .1 Prototheria

- Prototherians are primitive mammals. They are confined to Australian region.
- They are connecting link between reptiles and mammals.
- Young ones are fed on milk from mammary glands without nipples.
- Body temperature is low 25 to 28 ° C.
- In Prototheria pinnae is absent.
- Gynecomastia condition is present.
- Corpus callosum is absent.
- Testes are intra abdominal.
- Oviparous, eggs megalecithal & disolecithal.
- Commonly called monotreme as single cloaca present.
- They are partially homeothermal or warm-blooded animals.
- Urinary bladder is absent in them.
- Penis and urethra are absent in them.
- Marsupial bones present.
- Found in Australia, New Guinea & Tasmania.
- There is only one order under this subclass- Monotremata.

Example -Tachyglossus is called echidna or spiny ant eater. It is the living fossil. It is the connecting link between Reptilia & Mammalia. Teeth are absent in adults.

Zaglossus is also called as spiny ant eater.

Ornithorhynchus anatinus is commonly called as duck bill platypus. It is fresh water animal. It is living fossil. It is connecting link between Reptilia & Mammalia. In male poison gland present with horny spur.

Order I- Monotremata

- Mammals with single opening or cloaca.
- No external ear pinna.
- Testes abdominal, penis conducts only sperms.
- Uterus and vagina absent.

Example –Echidna (*Tachyglossus*) spiny anteater found in Australia, New Guinea and Tasmania.

Ornithorhynchus, Duckbilled Platypus found in Australia and New Zealand. Aquatic, found in rivers. Mammary glands are functional in both male and female. This is the only poisonous mammal.

2.4.11.2.2.4.2 Theria

- Subclass Theria is divided into two infraclasses-Metatheria and Eutheria.

Infraclass I- Metatheria

- Pinnae is present. It has teats.
- Corpus callosum is absent in them.
- Testes extra abdominal.
- They are Ovo–viviparous. Vagina & uteri double.
- Marsupium present so known as marsupials.
- Monophyodont i.e. they have only one set of teeth.
- In pelvic girdles marsupial bones present.
- Placenta present (true placenta absent).
- Clitoris present.
- More than 44 teeth present.

Example - *Macropus* is commonly known as kangaroo. It has red sweat.

Opossum is also called American didalphys. It has maximum teeth 50. It has conjugated sperm. It has smallest gestation period in mammal (12–13 days)

Perameles or long- nosed bandicoot.

Infraclass II- Eutheria

- They are Viviparous animals.
- **It is having 16 orders** –

Order 1. Insectivora

- Smallest and most primitive eutherian.

Example-*Talpa* (Mole), *Erinaceus* (hedge hog).

Order 2. Dermaptera

- Gliding mammals with patagium.
Example - Galaeopithecus (flying lemur).

Order 3. Chiroptera

- Nocturnal, true flying mammals capable of echolocation, a type of radar system.
- Commonly called bat.
Example- Pteropus (Flying Fox) fruit eating , Frugivorous, Rhinolophus (Horse Shoe Bat) insectivorous, Desmodus (Vampire Bat) sanguinivorous.

Order 4. Edentata

- Teeth absent or reduced to molars, without enamel.
Example – *Dasyus* (Armadillo), *Myrmecophaga* (Giant anteater), *Bradypus* (Sloth).

Order 5. Pholidata

- Body covered with large overlapping horny scales ,no teeth , tongue and protrussible , eat on ants.
Example- *Manis* (Pangolin or scaly anteater).

Order 6. Rodentia

- Largest order of mammals in number of species, small gnawing mammals.
- Each jaw with one pair of long rootless chisel-like incisors growing throughout life.
- No canines.
Example- *Rattus*(rat), *Mus*(mouse), *Funambulus* (Squirrel), *Cavia* (Guinea pig), *Hystrix* (porcupine), *Dipodomys spectabilis* (Kangaroo rat).

Order 7. Legomorpha

- Herbivorous with a second pair of upper incisors , no canines.
- Rabbit eats its own faeces.
Example- *Oryctolagus* (rabbit), *Lepus* (Hare), *Ochotona* (Pika).

Order 8. Carnivora **Example** – Panthera, dolphin, porpoise

- Predatory flesh-eating mammals.
- i. Fissipedia-Terrestrial carnivores.**
- Mongoose is an enemy of snakes.
- Lions are found in India and Africa.
- In India, lions are found in Gir Forests of Gujarat.
- Tiger is the "National Animal of India".
- Cheetah is the fastest animal on four legs, speed 70 km.p.h.
- Cheetah became extinct in India early in the present century.

Example- *Canis familiaris* (dog), *Felis domestica* (Cat), *Panthera leo* (Lion), *Panthera*

tigris (Tiger), *Acinonyx jubatus* (Cheetah), *Lutra* (Otter), *Herpestes* (Mongoose), *Ursus arctos* (Bear).

ii. Pinnipedia-Marine carnivores.

- Streamlined body, reduced tail, limbs modified into flippers.

Example- *Odobenus* (Walrus), *Phoca* (Seal), *Zalopus* (Sea-Lion).

Order 9. Cetacea

- Aquatic mammals breathe by lungs, blubber or subcutaneous fat present which helps in heat conservation, skin glands absent, forelimbs modified into paddle-like flippers, no hind limbs, no external ears, testes abdominal.
- Hairs only on snout, nostrils on the top of the head, teeth often lost, eyes very small, bones spongy, mostly gregarious and carnivorous.
- *Balaenoptera musculus* is the largest animal ever lived. Length 35 meters, weight 150 tonnes, feeds in arctic and Antarctic waters on microscopic animals or plankton.
- It is the largest animal in the world living upon the smallest organisms.
- In Whales, the milk is squirted down to the throat of baby by muscular contraction of mother.

Example- *Phocaena* (Porpoise), *Orcinus* (Killer Whale), *Delphinus* (Common Dolphin), *Platanista* (Ganges Dolphin), *Physeter* (Sperm Whale), *Balaenoptera musculus* (The Blue Whale).

Order 10. Sirenia

- Herbivorous aquatic mammals with paddle-like forelimbs, no hind limbs, no external ears, no pinna, blubber present, testes abdominal.
- *Manatus australis* is a sea cow having six cervical vertebrae.

Example- *Rhytina* (Sea cow), *Trichechus* (Manatee), *Halicore* (Dugong), *Manatus australis*

Order 11. Tubulidentata

- With tubular mouth, tongue slender protrusible, no incisor or canines, limbs clawed and adapted for digging ant and termite nests..

Example- *Orycteropus* (aardvark or Cape anteater of South Africa).

Order 12. Proboscidea Example – elephant

- Largest land living animals.
 - Hairless skin, nose and upper lip modified into proboscis.
 - Two upper incisors modified as tusks.
 - Hairless skin is adaptation for hot climate.
 - Ivory is obtained from the tusk of elephant. Mammoths and Mastodons were extinct elephants.
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Example- *Loxodonta africana* (African Elephant), *Elephas maximus* (Indian or Asiatic Elephant), *Funambulus* (Squirrel), *Cavia* (Guinea pig), *Elephas cyclotis* (Pigmy African Elephant).

Order 13. Hyracoidea

- Small, guinea-pig like mammals distantly related to elephants.
- Snout, ears and legs short. 4 toes on front foot, 3 on hind foot.
- Commonly called 'African conies'.

Example- *Hyrax* from South Africa, Syria and Arabia.

Order 14. Parissodactyla

- Odd-toed hoofed animals, incisors present in both jaws.
- Stomach simple.
- A mule is a hybrid between male ass (jack) and female horse (mare).
- A hinny is hybrid between male horse (stallion) and female ass.
- In India, Rhinos are found in Kaziranga National Park in Jorhat, Assam.
- Asiatic wild ass *Equus hemionus* is an endangered species, found in little Rann of Kutch (Gujarat).
- Tibetan wild asses are found inhabiting Ladakh and nearby regions.

Example- *Equus caballus* (Horse), *Equus asinus* (Ass), *Equus zebra* (Zebra), *Rhinoceros unicornis* (Indian Rhinoceros), *Diceros bicornis* (African Rhinoceros) and *Tapirus indicus* (Malayan tapir).

Order 15. Artiodactyla

- Even toed hoofed animals, incisors and canines in upper jaw usually absent.
- Stomach 4 chambered.
- All except pig ruminates or chew their cud.
- Many with antlers or horns.
- Term 'bovine' is associated with Artiodactyla.
- Hippopotamus is called 'Horse of the river' found in Nile river of Tropical Africa.
- Camels are well adapted for desert life and they are known as 'Ships of the desert'.

Example- *Hippopotamus amphibius* (Hippopotamus), *Camelus dromedarius* (Arabian Camel), *Cervus* (Red Deer), *Giraffa camelopardalis* (Giraffe), *Sus scrofa* (Wild Boar), *Bubalus bubalis* (Water buffalo).

Order 16. Primate

- Highest development of brain, most intelligent mammals, mostly arboreal, first digit usually opposable, an adaptation for grasping.
 - Eyes typically large and turned forward.
 - Primates include lemurs, lorises, tarsiers, monkeys, apes and man.
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- *Gibbon* is the smallest man-like ape.
- *Mandrillus* is the African dog-like monkey.
- Chimpanzee is the most intelligent ape.
- *Gorilla* is the most powerful ape and is the largest living primate.
- *Ateles* is found in South America, it has a prehensile tail which can be used as an extra limb to hang from trees, as a sensitive probe or to pick up an object.

Example- *Ateles paniscus* (Spider monkey), *Macaca mulatta* (Rhesus monkey), *Macaca silenus* (Lion-tailed Macaque), *Macaca mulatta* (Guinea pig), *Hylobates lar* (Gibbon), Papio (Baboon), Presbytis (Langur), Pongo (Orangutan), Pan (Chimpanzee).

Example – *Bradypus* is known as sloth, 9 or 10 cervical vertebrae. They do not have incisors. They are the slowest mammals.

Petaurista is also called flying squirrel.

Manis is commonly called as pangolin or scaly ant eater. They do not have teeth. They are most primitive placental animals.

Ateles is also called as spider monkey.

Cebus is known as capuchian monkey.

Presbytis is also known as langur.

Rhesus Macaque is rhesus monkey

Macaca mulatta has rh factor.

Cavia is known as guinea pig.

Pan is known as chimpanzee.

Hylobates is called as gibbon, primitive ape, smallest ape. It is the only ape found in India.

Loris is the smallest primate.

Lemur is the most primitive mammal. It is found in Madagascar. mammalian ghost with long tail. It has patagium present.

Papio is known as baboon. It is dog mouth shaped monkey.

Gorilla is the largest ape. It is found in Africa, height 1.8 m, wt. 250 kg.

Pongo is known as orangutan. It is called as man of forest. It is found in Indonesia.

Rhinopoma or *Pteropus* is commonly called bat or flying fox. Teeth are present in embryo.

It has sonar system. It is vampire bat.

Desmodus is blood sucking vampire bat. It is found in America.

Funambulus is commonly called squirrel.

Sus is commonly called pig.

Aardwark is known as earth pig or cap ant eater.

Mus commonly called as chuhia.

Rattus is also called rat.

Sorex is known as shrew. It has high metabolic rate. It has poisonous saliva

Sorex hoyi is called pigmy shrew (smallest).

Kitti's hog nosed bat. Its weight is 1.5 gms.

Erinaceus is commonly called hedge hog, jhau chuha. It is rarest animal. They use metabolic water. They become round in danger. They have hibernation.

Bisons are found in Kaziranga sanctuary.

Dasyopus is nine banded armadillo. It shows poly embryony. They have one zygote, 4-8 embryo.

Oreinus is called killer whale.

Delphinus is sea dolphin.

Platanista is Ganges dolphin. The tail with 2 lobed flukes.

Phocaena is porpoise. In them skin's glands absent.

Monodon is single toothed whale.

Belenoptera is commonly blue whale. It is 35 m length and 209 tones in weight.

It largest & heaviest mammal & animal. It has blubber. It dies on earth due to its own wt.

It is homodont. It fin whale, whale bone whale. It is balene or plated jaws present.

Physeter is sperm whale, spermaceti oil is obtained

Zalopus is sea lion.

Camelopardalis is giraffe, tallest mammal (16 feet height) It has head 3 horns like structure present. It is dumb, vocal cords are absent. Its tongue long, found in Savanna

Manatee is known as sea cow.

Puffin is sea parrot

Phoca is earless seal. It can imitate human laughter.

Walrus is seal like with tusk modified upper canine which is helpful in locomotion.

Luther is known as otter.

Canis lupus is commonly known as wolf.

Canis domesticus is also known as dog, carnassial teeth present .Upper Jaw : last molar, Lower Jaw : first molar.

Vulpes is known as fox.

Hyena is called Indian hyena.

Felis is known as cat.

Panthera leo is babbur sher (Junagarh).

Panthera tigris is called as tiger. It is our national animal.

Panthera pardus is called leopard.

Acionyx is cheetah, at verge of extinct, disappeared from India.

Ailuropoda is panda.

Equus is horse.

E. zebra is zebra.

E. sinuatus is called donkey.

Hippopotamus is called horse of river. It has red sweat. The sweat gland are on tip of pinnae. It is found in Assam. It is poikilothermal.

Rhinoceros unicornis is single horned genda .Its horn is stiff hair.

Camelus is camel. It has elongation of cervical vertebrae. Its hump is made up of fat.

It has R.B.C. round & nucleated. It is uricotelic.

Lama is mountain dweller. Its R.B.C. nucleated

Capra is called goat.

Ovis is known as sheep.

Bos indicus is cow. Their hoofs are unpaired.

Bubalus is known as buffalo. Its horns are hollow.

Talpa is called as mole.

Elphus maximus is Indian elephant. Its lungs are undeveloped. Its tusks are modified upper incisors. It has largest gestation period in mammal 609 days.

E. loxodonta is African elephant, largest mammal on land.

Cervis is also called deer.

Gazella is Rajasthan state animal. It is also known as Chinkara.

Antelope is called **black** deer.

Moichus is called musk deer. It has smallest R.B.C. in mammal

Axis is called cheetal

Cervis unicolour is sabher deer. It is largest deer.

Dipodomys is kangaroo rat, never drinks water.

Oryctolagus is rabbit.

Pika is tail less rabbit.

Hystrix is known as seyahi or sehali parcipine.

Herpestis is called mongoose.

Ursus is known as bear

Salient Features of Different Phyla in the Animal Kingdom

Phylum	Level of Organisation	Symmetry	Coelom	Segmentation	Digestive System	Circulatory System	Respiratory System	Distinctive Features
Porifera	Cellular	Various	Absent	Absent	Absent	Absent	Absent	Body with pores and canals in walls.
Coelenterata (Cnidaria)	Tissue	Radial	Absent	Absent	Incomplete	Absent	Absent	Cnidoblasts present
Ctenophora	Tissue	Radial	Absent	Absent	Incomplete	Absent	Absent	Comb plates for locomotion.
Platyhelminthes	Organ & Organ-system	Bilateral	Absent	Absent	Incomplete	Absent	Absent	Flat body, suckers,
Aschelminthes	Organ-system	Bilateral	Pseudo Coelomate	Absent	Complete	Absent	Absent	Often worm-shaped, elongated.
Annelida	Organ-system	Bilateral	Coelomate	Present	Complete	Present	Absent	Body segmentation like rings.
Arthropoda	Organ-system	Bilateral	Coelomate	Present	Complete	Present	Present	Exoskeleton of cuticle, jointed appendages.
Mollusca	Organ-system	Bilateral	Coelomate	Absent	Complete	Present	Present	External skeleton of shell usually present.
Echinodermata	Organ-system	Radial	Coelomate	Absent	Complete	Present	Present	Water vascular system, radial symmetry
Hemichordata	Organ-system	Bilateral	Coelomate	Absent	Complete	Present	Present	Worm-like with proboscis, collar and trunk.
Chordata	Organ-system	Bilateral	Coelomate	Present	Complete	Present	Present	Notochord, dorsal hollow nerve cord gill slits with limbs or fins.

2.5 Points to Remember

- The basic fundamental features such as level of organisation, symmetry, cell organisation, coelom, segmentation, notochord, etc., have enabled us to broadly classify the animal kingdom.
- Besides the fundamental features, there are many other distinctive characters which are specific for each phyla or class.
- Porifera includes multicellular animals which exhibit cellular level of organisation and have characteristic flagellated Choanocytes.
- The coelenterates have tentacles and bear cnidoblasts.
- They are mostly aquatic, sessile or free-floating.
- The ctenophores are marine animals with comb plates.
- The platyhelminthes have flat body and exhibit bilateral symmetry.
- The parasitic forms show distinct suckers and hooks.

- Aschelminthes are pseudocoelomates and include parasitic as well as non-parasitic round worms.
 - Annelids are metamerically segmented animals with a true coelom.
 - The arthropods are the most abundant group of animals characterised by the presence of jointed appendages.
 - The molluscs have a soft body surrounded by an external calcareous shell.
 - The body is covered with external skeleton made of chitin.
 - The echinoderms possess a spiny skin.
 - Their most distinctive feature is the presence of water vascular system.
 - The hemichordates are a small group of worm-like marine animals.
 - They have a cylindrical body with proboscis, collar and trunk.
 - Phylum Chordata includes animals which possess a notochord either throughout or during early embryonic life.
 - Other common features observed in the chordates are the dorsal, hollow nerve cord and paired pharyngeal gill slits.
 - Some of the vertebrates do not possess jaws (Agnatha) whereas most of them possess jaws (Gnathostomata). Agnatha is represented by the class, Cyclostomata.
 - They are the most primitive chordates and are ectoparasites on fishes.
 - Gnathostomata has two super classes, Pisces and Tetrapoda.
 - Classes Chondrichthyes and Osteichthyes bear fins for locomotion and are grouped under Pisces.
 - The Chondrichthyes are fishes with cartilaginous endoskeleton and are marine.
 - Classes, Amphibia, Reptilia, Aves and Mammalia have two pairs of limbs and are thus grouped under Tetrapoda.
 - The amphibians have adapted to live both on land and water.
 - Reptiles are characterised by the presence of dry and cornified skin.
 - Limbs are absent in snakes. Fishes, amphibians and reptiles are poikilothermous (coldblooded).
 - Aves are warm-blooded animals with feathers on their bodies and forelimbs modified into wings for flying.
 - Hind limbs are adapted for walking, swimming, perching or claspings.
 - The unique features of mammals are the presence of mammary glands and hairs on the skin. They commonly exhibit viviparity.
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