4 Animal Kingdom

TOPICS

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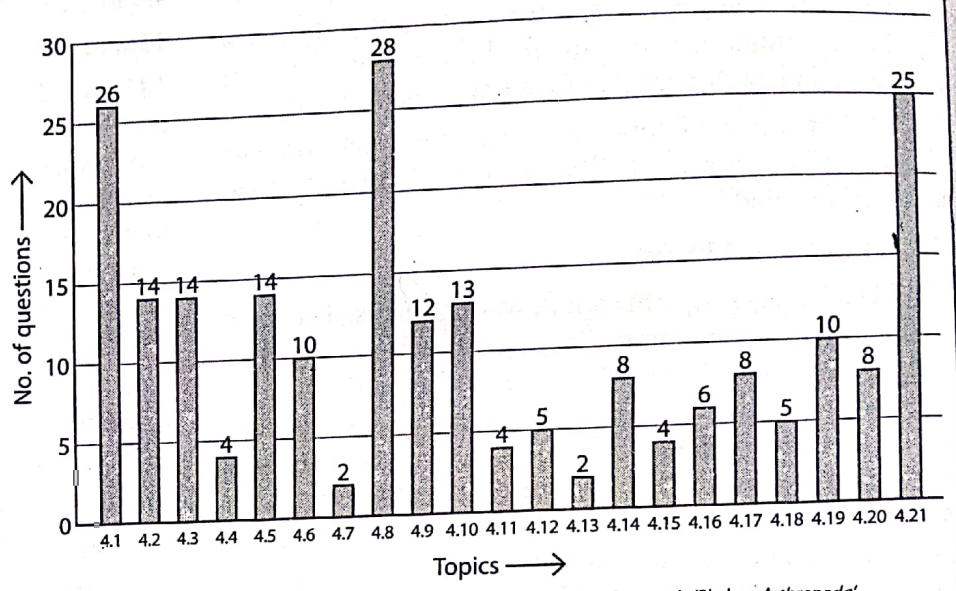
Topicwise analysis of last 10 years (2019-2010) questions



Note : *This graph shows that maximum number of questions appeared from topic 'Phylum-Arthropoda'.*

- Animal kingdom includes eukaryotic and multicellular organisms. It is classified into several phyla according to some basic features such as:
  - (i) **Level of organisation :** Animals show three different levels of organisation *i.e.,* cellular level (*e.g.*, Sponges), tissue level (*e.g.,* Coelenterates) and organ system level (*e.g.*, higher invertebrates and all vertebrates).
  - (ii) **Body symmetry:** Body symmetry is the similarity of parts in different regions and directions of the body. It is of three types: **asymmetry** (body cannot be divided into equal halves by any plane *e.g.*, some sponges), **radial symmetry** (body can be divided into equal halves by any plane from top to bottom *e.g.*, coelenterates and echinoderms) and **bilateral symmetry** (single, median longitudinal or sagittal plane can divide the body into two halves *e.g.*, many invertebrates and all vertebrates).
- ***Embryonic organisation:*** The embryos of poriferans and coelenterates have two germinal layers, the **ectoderm** and **endoderm**. These animals are called **diploblastic**. An undifferentiated layer, **mesogloea**, is present in between the ectoderm and endoderm. The embryos of all other animals (from Phylum Platyhelminthes to Phylum Chordata) have three germinal layers - the **ectoderm**, **mesoderm** and **endoderm**. These animals are called **triploblastic animals**.
- ***Body cavity:*** A **body cavity** can be any internal space, or a series of spaces present inside body. On the basis of body cavity, animals can be of three types :
  - (i) **Acoelomates:** Body cavity is absent *e.g.*, platyhelminthes.
  - (ii) **Pseudocoelomates:** Body cavity is pseudocoelom *i.e.*, not lined by mesoderm, instead, the mesoderm is present as scattered pouches in between the ectoderm and endoderm *e.g.*, aschelminthes.
  - (iii) **Coelomates:** Body cavity is lined by mesoderm *i.e.*, true coelom. *E.g.*, annelids, molluscs, arthropods, echinoderms, hemichordates and chordates.

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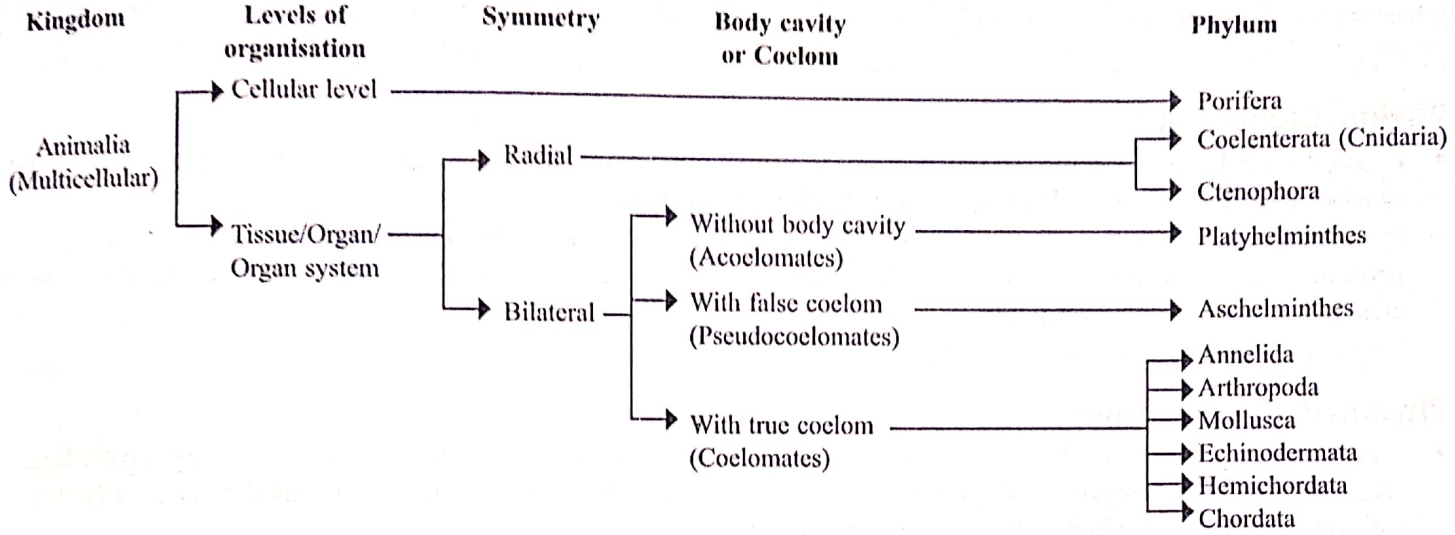
- **Segmentation:** Segmentation is division or differentiation of the body into distinct portions called segments. It is of two types:
  (i) **Metameric segmentation** (Metamerism): Body externally and internally divided into segments with a serial repetition of atleast some organs *e.g.*, Annelida, Arthropoda and Chordata.
  (ii) **Pseudometamerism:** Body segmented only externally *e.g.*, tapeworm.
- **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 Echinodermata.

Classification of Animals



Phylum Porifera

- **Porifera** contains most primitive multicellular animals, called **sponges** referred to as **'pore bearers'**, as their body walls contain tiny pores (**ostia**) that are basic structures in their functional activity.
- All aquatic, mostly marine, few freshwater. Solitary or colonial, **sessile**. Body form vase-like, cylindrical, tubular, cushion-shaped, branched, etc. **Symmetry** radial or no symmetry.
- Body wall with outer **pinacoderm** (dermal epithelium), inner **choanoderm** (gastral epithelium) made of choanocytes or flagellated collar cell (**characteristic of porifers**) and gelatinous non-cellular **mesenchyme** in between.
- Cells loosely arranged and do not form definite layers, hence **not regarded truly diploblastic**.
- Ostia, canals and chambers serve for the flow of water. This system of ostia and canals is called **canal system**.
- The central body cavity of sponges is called **spongocoel** or **paragastric cavity**.
- Skeleton if present may be of **calcareous** or **siliceous spicules** or of protein **spongin fibres**, or of both.

Classification

TABLE: Phylum Porifera is divided into three classes

Class	Skeleton	Examples
Calcarea	Calcareous spicules	*Leucosolenia, Sycon* (Scypha)
Hexactinellida	Siliceous spicules with six rays	*Euplectella* (The venus flower basket), *Hyalonema* (The glass rope sponge)
Demospongiae	Skeleton of spongin fibres or spongin fibres with siliceous spicules	*Euspongia* (bath sponge), *Cliona* (boring sponge), *Spongilla* (fresh water sponge)

Phylum Coelenterata (Cnidaria)

- It is a phylum of **acoelomate**, lower invertebrates. Symmetry **radial** or **biradial** about a longitudinal oral-aboral axis.
- Tissue level of body organisation. Cells mostly scattered and specialised for different functions. Some cells form tissues like **nerve net** or **nervous tissue**. **Exoskeleton** chitinous (called perisarc) or calcareous (*e.g.*, corals).
- Body wall diploblastic with two cellular layers–outer **epidermis** and inner **gastrodermis** - with a gelatinous acellular **mesogloea** in between. In advanced types, mesogloea is with cells and connective tissue, hence they are **triploblastic**.
- One or both body layers have peculiar stinging cell organelles or **nematocysts**, which serve for adhesion, food capture and offence and defense. A single internal cavity, lined with gastrodermis, called **gastrovascular cavity** or **coelenteron** present into which mouth opens.

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- Two body forms occur, attached **polyps** and free-swimming **medusae**. Some species are notable for **polymorphism** or **variety of forms**. Polymorphic forms exhibit **alternation of generation (metagenesis)**, *i.e.*, polyps produce medusae asexually and medusae form the polyps sexually, *e.g.*, *Obelia*.

Coelenterata

Divided into three classes on the basis of dominance of medusoid or polypoid phase in the life cycle.

Hydrozoa
Only polypoid or both polypoid and medusoid stages present. *E.g.*, *Hydra, Obelia*

Scyphozoa
Medusoid stage dominant. Polypoid stage either reduced or absent. *E.g.*, *Aurelia*

Anthozoa
Only polypoid stage is present. Medusoid stage is absent. *E.g.*, *Adamsia*

Phylum Ctenophora

- Ctenophora (Gk. *Ktene* - comb, *phors* - bearing) is a small phylum of solitary, pelagic, free-swimming and **exclusively marine** animals, commonly known as **sea walnuts** or **comb jellies**.
- Reproduce **only sexually**. Monoecious (= hermaphrodite or bisexual). **Power of regeneration** is well marked. **Bioluminescence** is well-marked. Comb like eight ciliary plates called **comb plates** are present on the body, hence, ctenophores are called **comb jellies**.

  Examples: *Pleurobrachia* and *Ctenoplana*.

Phylum Platyhelminthes

- It includes primitive, worm-like animals, commonly known as **flatworms**. Free-living, commensal or parasitic forms. **Organ grade of organisation**. **Triploblastic**, bilaterally symmetrical, dorso-ventrally flattened body usually with a well-defined ventral surface bearing mouth and gonopore.
- Body **unsegmented** (except in class Cestoda). **Acoelomate** spaces between various organs are filled with special mesodermal tissue, the **mesenchyme** or **parenchyma**. **Digestive system** branched and incomplete without anus.
- Adhesive structures like **hooks, spines** and **suckers**, and **adhesive secretions** are common in parasitic forms.
- Excretory system includes lateral canals and protonephridia. Absent in some primitive forms. Nervous system primitive, ladder-like. Sense organs simple. Eye-spots or photoreceptors in free living forms.
- Mostly monoecious with complex reproductive system. Fertilisation internal, may be cross or self. Development direct or indirect (common in endoparasites).

Phylum Platyhelminthes

Divided into three classes on the basis of mode of life

Turbellaria
- Free-living flatworms.
- *E.g., Dugesia* (Planaria)

Trematoda
- Ecto or endoparasitic worms (flukes).
- *E.g., Fasciola* (Liver fluke), *Schistosoma* (Blood fluke)

Cestoda
- Endoparasites of vertebrates.
- *E.g., Taenia solium* (Pork tapeworm), *Echinococcus* (Dog tapeworm)

Phylum Aschelminthes

- Their body is slender, unsegmented, **bilaterally symmetrical and triploblastic** with **organ system level** of body organisation. They are **pseudocoelomates**.
- **Digestive tract** is complete with mouth, specialised muscular pharynx, straight non-muscular intestine and posterior anus. **Circulatory, respiratory and skeletal systems are absent**. The excretory system consists of gland cells, or of canals or of both. **Nervous system** consists of a **circumpharyngeal nerve ring** (surrounding the pharynx) and four peripheral longitudinal nerves. Mostly **dioecious** (sexes are separate). Males usually smaller than females **(sexual dimorphism)**.
- Examples : *Ascaris* (Round worm), *Wuchereria* (Filarial worm), *Ancylostoma* (Hookworm).

Phylum Aschelminthes — Class

Aphasmidia
- Phasmids are absent.
- Amphids are of various types.
- *E.g.*: *Trichinella, Trichuris.*

Phasmidia
- Phasmids are present near hind end of body.
- Amphids are present near anterior end.
- *E.g.*: *Ascaris, Enterobius, Wuchereria.*

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Phylum Annelida

- Annelids are **mostly aquatic**, some terrestrial. Burrowing or **tubicolous**. Some commensal and parasitic. Body elongated, bilaterally symmetrical, **triploblastic**, showing **metamerism**.
- Locomotory organs are segmentally repeated chitinous bristles, called **setae** or **chaetae**, embedded in skin. May be borne by lateral fleshy appendages or **parapodia**. True **coelom** (schizocoelous), **digestive system** straight and complete, digestion entirely extracellular.
- **Blood vascular system is of closed type**. Respiratory pigments either **hemoglobin** or **erythrocruorin** dissolved in blood plasma. Respiration by moist skin or gills of **parapodia** and head.
- **Excretory system** consists of metamerically disposed coiled tubes, called **nephridia**. **Nervous system** with a pair of cerebral ganglia (brain). Sensory organs include tactile organs, taste buds, statocysts, photoreceptor cells and sometimes eyes with lenses in some.
- **Hermaphrodites** or sexes separate, reproduction is sexual, cleavage spiral and determinate. Larva, when present, is a **trochophore**. Regeneration common.

Classification

Phylum Annelida

Divided into 4 main classes on basis of presence or absence of parapodia, setae, metameres.

Polychaeta
- Well developed parapodia with numerous setae.
- Indirect development. *E.g.*, *Nereis*

Oligochaeta
- Few setae without parapodium.
- Direct development. *E.g.*, *Pheretima* (Indian earthworm)

Hirudinea
- Parapodia and setae are absent.
- *E.g.*, *Hirudinaria* (Blood sucking leech)

Archiannelida
- Parapodia and setae absent.
- External segmentation faint but internally complete. *E.g.*, *Polygordius*

Phylum Arthropoda

- The **largest phylum** of the animal kingdom, comprising more than 9,00,000 species in all habitats which constitute about 80% of all the known species of animals.
- **Organ-system level** of body organisation. Body bilaterally symmetrical, **triploblastic** and **metamerically segmented. Appendages jointed**, usually one pair to a somite, and with varied functions as jaws, gills, legs, etc.
- **Exoskeleton** of dead chitinous cuticle that is shed in intervals, called ecdysis or moulting, for growth and development. Body divisible into head, thorax and abdomen. Head and thorax often fused to form a cephalothorax.
- True coelom reduced and largely replaced by a blood-filled haemocoel.
- Muscles mostly striated, usually capable of rapid contraction.
- **Digestive system** complete with mouth and anus. **Mouth parts** adapted for various modes of feeding. **Circulatory system** open with many chambered heart, arteries and blood sinuses of haemocoel. **Respiration** by general body surface, gills, tracheae or book-lungs.
- **Excretory organs** are coxal glands or Malpighian tubules (green glands). **Nervous system** typically annelidan type, with a dorsal brain connected with a nerve ring to a double ventral nerve cord. **Sensory organs** comprise of eyes (**simple** and **compound**), chemo-and tactile receptors and balancing and auditory organs.
- Sexes usually separate (**dioecious**). **Reproductive organs and ducts paired**. Fertilisation usually internal. Oviparous or ovoviviparous. Development direct or indirect with one to many larval stages. **Parthenogenesis** present in some.

Classification

TABLE: The Phylum Arthropoda is divided into seven classes

Class	Body Division	Appendages	Examples
Crustacea	Body divisible into cephalo-thorax and abdomen.	2 pairs of antennae and a pair of stalked compound eyes.	*Palaemon* (Prawn)
Chilopoda	Body divisible into head and trunk.	Single pair of antennae. Each trunk segment bears a pair of legs. First pair of legs are modified into poison claws.	*Scolopendra* (Centipede)

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Diplopoda	Body is divided into head, thorax and abdomen.	Single pair of antennae. Each thoracic segment bears a pair of legs (except first segment). Each abdominal segment has two pairs of legs.	*Julus* (Millipede)
Insecta	Body is divided into head, thorax and abdomen.	A pair of antennae and a pair of compound eyes. Thorax has 3 segments with 3 pairs of legs and 2 pairs of wings.	Silver fish, cockroach, bed bug, wasp etc.
Arachnida	Body divisible into cephalo-thorax and abdomen.	Cephalothorax bears simple eyes and 6 pairs of appendages (one pair of chelicerae, one pair of pedipalpi and four pair of legs). **Antennae are absent.**	Scorpion, spider, tick, mite
Merostomata	Body divided into cephalo-thorax and abdomen.	5-6 pairs of abdominal appendages with book gills.	*Limulus* (King crab) living fossil
Onychophora		Single pair of antennae, eyes and jaws.	*Peripatus* (Connecting link between Annelida and Arthropoda)

Phylum Mollusca

- **Triploblastic, coelomate** with **organ system level of body** organisation. Body is **bilaterally symmetrical** and **unsegmented.** In some molluscs such as *Pila* (Gastropoda), due to **torsion (twisting)** during growth, the adults become asymmetrical.
- Mouth contains a **rasping organ** for feeding, called **radula. Mantle** or **pallium** more or less covers the body and secretes a shell made up of **calcium carbonate.**
- **Blood vascular system is of open type** (except cuttle fish). **Excretory organs** are one or two pairs of sac-like kidneys. Gills are also excretory in function.
- **Nervous system** comprises of paired ganglia, joined by the nerve connectives and commissures. In many molluscs, eyes and tentacles are present on the head. **Statocysts** (balancing organ) may be present.
- **Osphradium** is present in some molluscs for testing chemical and physical nature of water. They are usually **dioecious** and **oviparous.** When the **development is indirect**, it includes a characteristic larva, namely, **veliger**, **trochophore** or **glochidium.**

Phylum Mollusca
Divided into six classes

Monoplacophora
(*monas*- one, *plax*-plate, *pherein*-bearing)
The shell is cup or spoon-shaped. *E.g., Neopilina.*

Scaphopoda
Tubular shell, open at both ends. *E.g., Dentalium.*

Cephalopoda
Head and foot regions are combined and modified into structure cephalopod or head foot having eyes and eight tentacles. Shell may be external (*Nautilus*), internal (*Sepia*) or absent (*Octopus*).

Amphineura
Non-ganglionated nerve ring present around mouth with two pairs of interconnected nerve cord. *E.g., Chaetopleura* (Chiton).

Gastropoda
Shell made up of one piece. The early embryo is symmetrical but during development, the body twists showing torsion, so that the body becomes asymmetrical. This class includes largest number of molluscs. *E.g., Pila, Doris, Limax, Limnaea, Patella, Helix.*

Pelecypoda or Bivalvia
Shell is made up of two halves. *E.g., Unio, Mytilus* (Sea mussel), *Teredo* (Shipworm), *Pinctada* (Pearl oyster).

Phylum Echinodermata

- Echinodermata literally means **"spiny or prickly skinned"**. (Gr., *echinos*, hedgehog; *derma*, skin) and refers to the conspicuous spines possessed by their test or skin. Some are **pelagic** and a few are **sessile.**
- **Symmetry bilateral in larvae** and **pentamerous radial in adults.** Body unsegmented with globular, star-like, spherical, discoidal or elongated shape. Endoskeleton of dermal calcareous ossicles with spines, covered by the epidermis.
- **Water-vascular system** of coelomic origin, including podia or tube feet for locomotion and usually with a madreporite present. Coelom is **enterocoelous.**
- **Respiratory organs** include **dermal branchiae, tube feet, respiratory tree** and **bursae. No excretory organs. Nervous system** without a brain and with a circumoral ring and radial nerves. Poorly developed sense organs.

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- Usually **dioecious**, fertilisation external; development indirect through free-swimming larval forms. Phenomenon of autotomy and regeneration is present.

Classification

Phylum Echinodermata
Divided into five classes

Asteroidea (Star fishes or sea stars)
Body star like, five arms not sharply marked off from central disc. Larval forms are **Bipinnaria** and **Brachiolaria**. *E.g., Asterias* (Starfish), *Pentaceros*.

Ophiuroidea (Brittle stars)
Star like body, arms sharply marked off from central disc. Ambulacral grooves and pedicellariae are absent. **Ophiopluteus larva.** *E.g., Ophiothrix, Ophiura.*

Echinoidea (Sea urchins)
Globular or disc like body. Biting and chewing apparatus with teeth called **Aristotle's Lantern** is present. Ambulacral grooves are absent. **Pluteus** and **Echinopluteus** larva. *E.g., Echinus* (Sea urchin), *Clypeaster* (Cake urchin).

Holothuroidea (Sea cucumbers)
Elongated and cylindrical body. Ambulacral grooves, spines and pedicellaria are absent. Larval forms are **Auricularia** and **Doliolaria.** *E.g., Holothuria, Cucumaria.*

Crinoidea (Sea lilies)
Body has central disc, which is attached to substratum. Spines, pedicellariae and madreporite are absent. **Doliolaria larva.** They are commonly called feather stars or sea lilies. *E.g., Antedon* (Feather star).

Phylum Hemichordata

- Hemichordata was earlier considered as a subphylum under phylum Chordata. They are vermiform, solitary or colonial **coelomate** animals having intra-epidermal nervous system and a pre-oral gut with or without gill-slits and without typical nephridia.
- Coelom **enterocoelous**, usually divided into protocoel, mesocoel and metacoel, corresponding to 3 body regions. Foregut gives out a hollow buccal diverticulum into proboscis, earlier considered as "notochord". Ciliary filter feeders.
- **Circulatory system** simple and open, including a dorsal heart and two longitudinal vessels, one dorsal and one ventral. Sexes usually separate. **Fertilisation external** in sea water. Development direct or indirect with a free-swimming **tornaria larva.**
- Examples: *Balanoglossus* and *Saccoglossus*.

Phylum Chordata

- Chordates are fundamentally characterised by the presence of a **notochord**, a **dorsal hollow nerve cord** and **paired pharyngeal gill slits**. These are **bilaterally symmetrical, triploblastic, coelomate** with organ-system level of organisation. They possess a post anal tail and a **closed circulatory system.**

Phylum Chordata

- **Subphylum Urochordata** *e.g., Herdmania*
- **Subphylum Cephalochordata** *e.g., Amphioxus*
- **Subphylum Vertebrata or Craniata**
  - Section **Agnatha** Jawless vertebrates
    - **Class Ostracodermi** (Extinct)
    - **Class Cyclostomata** *e.g., Petromyzon, Myxine*
  - Section **Gnathostomata** Jawed vertebrates
    - **Superclass Pisces** (True fishes)
      - **Class Placodermi** All fossils had protective scales or plates *e.g., Climatius*
      - **Class Osteichthyes** Bony fishes, *e.g., Labeo*
      - **Class Chondrichthyes** Cartilaginous fishes, *e.g., Scoliodon*
    - **Superclass Tetrapoda** (Typically four limbs)
      - **Class Amphibia** *e.g., Uraeotyphlus, Salamander,* Frog
      - **Class Reptilia** *e.g.,* Tortoise, Lizards, Snakes
      - **Class Aves** *e.g.,* Birds
      - **Class Mammalia** *e.g.,* Mammals

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Sub-Phylum Urochordata

This sub-phylum is also called **Tunicata**, because the adult body is enclosed within leathery **test** or **tunic** formed of cellulose like substance **tunicin**. The notochord and dorsal tubular nerve cord are found only in larval stage. The larva is motile and undergoes retrogressive metamorphosis *i.e.*, change from better developed larva to less developed adult. *E.g.*, *Herdmania* (Sea squirt), *Ascidia, Doliolum, Salpa.*

Sub-Phylum Cephalochordata

- The notochord and tail persist throughout the life. Pharyngeal gill slits are more numerous and better developed. Shows progressive metamorphosis. *E.g.*, *Branchiostoma, Amphioxus.*

Sub-Phylum Vertebrata or Craniata

- Have cranium around brain. Notochord present only in embryonic stage and is replaced by vertebral column in adult forms. Nervous system consists of CNS, PNS and ANS. No asexual reproduction.

Class Cyclostomata

- The cyclostomes (Gk. *cyclos* – circular; *stome* – mouth) or round mouthed fishes are aquatic vertebrates. Mouth is circular and jawless. It has **suctorial tongue** which possesses horny teeth. Body is eel like, tail is compressed. **Endoskeleton** is cartilaginous. Notochord persists throughout life. Larva is **ammocoetes**. Examples: *Petromyzon* (Lamprey), *Myxine* (Hagfish).

Super Class Pisces (Bears fins)

True fishes

- Fishes are cold blooded (poikilothermic or ectothermic).
- Heart is 2 chambered (one auricle and one ventricle).
- Most forms are oviparous or ovoviviparous.

TABLE: Characteristics of fishes

Characteristics	Chondrichthyes (Cartilaginous fishes)	Osteichthyes (Bony fishes)
Habitat	Mostly marine	Both marine and freshwater
Scales	Placoid scales	Cycloid, ctenoid and ganoid scales
Caudal fin	Heterocercal-asymmetrical	Homocercal-symmetrical
Mouth	Ventrally placed. Digestive tract leads into the cloaca.	The mouth is terminal. Digestive tract leads into anus, cloaca is absent.
Fertilisation	Internal	External
Chief nitrogenous waste	Urea	Ammonia
Examples	*Torpedo* (Electric ray), *Trygon* (Sting ray), *Scoliodon* (Dog fish).	*Labeo rohita* (Rohu), *Exocoetus* (flying fish), *Anguilla* (fresh water eel)

Class Amphibia

- The amphibians were the **first vertebrates to invade** land, but they have not fully adapted to terrestrial life.
- **Pigment cells** (chromatophores) present. **Exoskeleton** absent. **Endoskeleton** mostly bony. Notochord does not persist. Skull with **2 occipital condyles**.
- **Respiration** by lungs, skin and mouth lining. Larvae with external gills which may persist in some aquatic adults.
- Heart **3-chambered** (2 auricles+1 ventricle). **Sinus venosus** present. Renal and hepatic portal systems well developed. **Poikilothermous**. Kidneys **mesonephric**. Excretion **ureotelic**. Brain poorly developed. 10 pairs of cranial nerves.
- **Sexes separate**. Male without copulatory organ. Fertilisation mostly external. Females mostly oviparous. Development indirect. Larva is a tadpole which metamorphoses into adult.

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Classification

Amphibians
Divided into three orders

- **Apoda**
  - Blind worms
  - Limbless, scales present. *E.g., Ichthyophis*
- **Urodela**
  - Tail present
  - *E.g., Necturus, Salamandra*
- **Anura**
  - Tail absent
  - *E.g., Rana, Hyla, Bufo, Xenopus*

Class Reptilia

- Reptiles are **first vertebrates fully adapted for life on dry land**. Predominantly terrestrial, **creeping** or **burrowing**, mostly carnivorous, air-breathing, cold-blooded, oviparous and **tetrapodal vertebrates**. **Skin dry**, cornified and devoid of glands.
- **Alimentary canal** terminates into a cloacal aperture. Heart usually 3-chambered, **4-chambered in crocodiles**. Cold-blooded. Kidneys **metanephric**. Excretion uricotelic. Lateral line system absent. **Jacobson's organ** present in the roof of mouth.
- Sexes separate. Direct development. Internal fertilisation.

Classification

Reptiles

- **Sub-class Anapsida**
  Order Chelonia
  E.g., Chelone (Turtle), *Testudo* (Tortoise)
- **Sub-class Diapsida**
  Order
  - **Rhynchocephalia**
    E.g., Sphenodon (living fossil)
  - **Squamata**
    Sub-order
    - **Lacertilia**
      E.g., Lizards: *Calotes* (Garden lizard), *Hemidactylus* (Wall lizard)
    - **Ophidia**
      E.g., Snakes: *Naja* (Cobra), *Bungarus* (Krait)
  - **Crocodilia**
    E.g., Crocodilus, Alligator

Class Aves

- It include birds which are **unique in having a coat** of feathers and in resting on the hindlimbs alone. Birds are often described as **"glorified reptiles"** because of their resemblance with and origin from the reptiles.
- The body is **boat-shaped** and **streamlined**. With forelimbs modified into flight wings. Legs bear **horny epidermal scales**. Skin is dry except for the presence of an oil or preen gland or **uropygeal gland at the base of short tail or uropygium**. Sweat glands are absent.
- The **endoskeleton** is bony, but delicate and light. Skull is **monocondylic**. Bones are **pneumatic**, *i.e.*, contain air cavities to reduce weight. **Bone marrow** is absent. The last 3 or 4 fused tail vertebrae form a structure called **pygostyle**. The **forked** bone furcula formed by the fusion of two clavicles and interclavicle is called **wish bone**. **Synsacrum** is formed by the fusion of posterior thoracic, lumbar, sacral and anterior caudal vertebrae.
- A system of thin-walled air sacs lying among the viscera is associated with the lungs. Most of the birds have **9 major air sacs**. Voice box lies at the junction of the trachea and bronchi. It is called **syrinx** (characteristic feature). The larynx does not act as a sound box.
- The heart is relatively large and fast beating for quick supply of adequate amount of blood during flight. Heart is **4-chambered**, having two auricles and two ventricles. Kidneys are **metanephric**. Excretion **uricotelic**. **Urinary bladder absent**. Development is direct. The birds are **homoiotherms**, and spend a lot of energy to keep warm. Examples: *Corvus* (crow), *Columba* (pigeon), *Psittacula* (parrot), *Struthio* (ostrich), *Pavo* (peacock), *Aptenodytes* (penguin), *Neophron* (vulture).

Class Mammalia

- Mammals are primarily terrestrial homeothermic vertebrates. The **skin** is glandular and mostly covered by a horny epidermal exoskeleton of hair, which conserve body heat. The **skin** glands are multicellular, and include **sweat** glands, oil glands, wax glands and milk glands.

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- **Endoskeleton** is bony. The mouth is relatively small and has movable lips. Buccal cavity has true **salivary glands**. Teeth occur in both the jaws.
- **Respiration** occurs only by lungs. The heart is 4-chambered, having two auricles and two ventricles. **Sexes** are often distinguishable externally.
- **Fertilisation is internal**. Except egg-laying monotremes, mammals are mostly viviparous. Development is direct.

Classification of mammals

Sub-class

Prototheria

- Ear without pinna.
- No nipples (mammae).
- No corpus callosum.
- Testes abdominal, no scrotum.
- Digestive and urinogenital tracts open out through cloaca and cloacal aperture.
- No marsupial pouch.
- Oviparous.
- No placenta.
- Examples : *Ornithorhynchus anatinus* (Duck-billed platypus), *Tachyglossus* (Spiny anteater)

Theria (Infraclass)

Metatheria

- Ear with pinna.
- Nipples abdominal.
- Corpus callosum feebly developed or absent.
- Scrotum in front of penis.
- Digestive and urinogenital tracts open out by separate apertures that are controlled by a common sphincter muscle.
- Marsupial pouch often present.
- Viviparous.
- Placenta small, intrauterine development brief, young extremely small and helpless, brought up in marsupial pouch, if present.
- Examples : *Macropus* (Kangaroo), *Didelphis* (Opossum).

Eutheria

- Ear usually with pinna.
- Nipples abdominal or thoracic.
- Corpus callosum present.
- Scrotum behind penis.
- Digestive and urinogenital tracts open out by separate apertures, each with its own sphincter muscle.
- No marsupial pouch.
- Viviparous.
- Placenta large, intrauterine development prolonged, young advanced and fully formed.
- Examples : *Rattus* (Rat), *Equus* (Horse)

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