

ANIMAL KINGDOM

- Animal is an animated, moving, perceiving and reacting being with ingestive feeding, determined growth and remarkable and characteristic patterns of behaviour. The word animal is derived from the Latin '*anima*' which means 'air' or 'breath' or 'soul'. Animals have different structures and different form, yet there are common fundamental features in relation to body symmetry, arrangement of cells, nature of coelom, patterns of physiology, etc.
- Animals show four different grades of organization.
 - **Protoplasmic grade** : Life activities are confined within the limits of a single plasma membrane *e.g.*, protozoans.
 - **Cellular grade** : Only cells exhibit division of labour for performing specialized functions *e.g.*, sponges, mesozoans.
 - **Tissue grade** : This is of two types; cell-tissue grade *e.g.*, coelenterates and tissue - organ grade, *e.g.*, platyhelminthes.
 - **Organ system** : Organs join in a system to perform basic functions *e.g.*, higher invertebrates and all vertebrates.
- **Symmetry**: Body symmetry is the similarity of parts in different regions and directions of the body. When the body is divisible into equal halves by any plane it is called **asymmetrical** or **asymmetric** as found in *Amoeba* and some sponges.
- **Radial symmetry**: All the lines passing through the longitudinal axis, in any plane, will divide the body into equal halves or **antimeres**. In the animal kingdom, radially symmetrical phyla are **porifera**, **coelenterata**, **ctenophora** and **echinodermata**.
- **Bilateral symmetry**: There is a single plane, the median longitudinal or sagittal plane, through which the body can be divided into two similar right and left halves. *e.g.*, platyhelminthes.

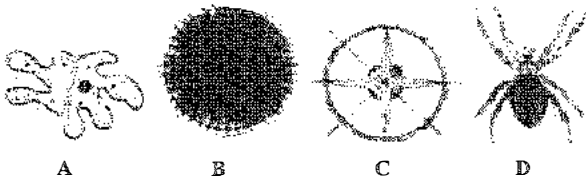


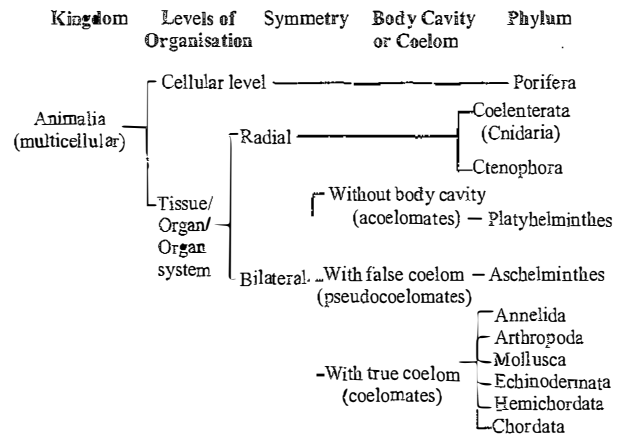
Fig.: A. Asymmetry in *Amoeba*; B. Spherical symmetry in *Volvox*; C. Radial symmetry in jelly fish; D. Bilateral symmetry in spider.

- **Diploblastic and triploblastic 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**.
- **Coelom**: A **body cavity** can mean any internal space, or a series of spaces present inside body. The body cavity, which is lined by mesoderm is called **coelom**. Animals

possessing coelom are called **coelomates** *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.

- **Segmentation**: Segmentation is division or differentiation of the body into distinct portions called segments. It is of two types: **metameric segmentation** and **pseudometamerism**. *e.g.*, earthworm, shows metameric segmentation and the phenomenon is known as **metamerism**. Pseudosegmentation as found in tapeworms is external only. The body is not internally divided.

CLASSIFICATION OF ANIMALS



PHYLUM PORIFERA

- **Porifera** contains the most primitive of multicellular animals, called **sponges**. They are usually referred to as '**pore bearers**', as their body walls contain tiny pores that are basic structures in their functional activity. The study of sponges is known as **parazoology**.
- Multicellular organisms with cellular level of body organization. No distinct tissues or organs. Mostly marine, few freshwater, all aquatic. Solitary or colonial, **sessile**.
- Body form vase-like, cylindrical, tubular, cushion-shaped, multi-branched, etc. Symmetry radial or no symmetry. Body wall with outer pinacoderm (dermal epithelium), inner choanoderm (gastral epithelium) and gelatinous non-cellular mesenchyme in between.
- Choanoderm is mainly made of choanocytes. The cells (choanocytes) are characteristic of porifers. Cells loosely arranged and do not form definite layers, hence **not regarded truly diploblastic**.
- Body with many pores (**ostia**), canals and chambers that serve for the flow of water. One or more water exits or **oscula** present. This system of pores and canals is called canal system. **Choanocytes** or **flagellated collar cells**

usually line special chambers. Sponges are the only metazoans having choanocytes. The central body cavity of sponges is called **spongocoel** or **paragastric cavity**. Skeleton of **calcareous** or **siliceous spicules** or of protein **spongin fibres**, or of both, or absent.

- Digestion **intracellular**. No respiratory or excretory organs. Therefore, respiration and excretion occur by **diffusion** through general body surface. **Excretory matter is mainly ammonia**. **Contractile vacuoles** in some freshwater forms. **Primitive nervous system**.
- All sponges **hermaphrodite** but **cross-fertilization** is the rule. Asexual reproduction by **buds** or **gemmules**. Sexual reproduction by **ova** and **sperms**. Cleavage **holoblastic**. Development indirect through a free-swimming ciliated larva, the **amphiblastula** or **parenchymula**.
- Examples: *Sycon* (Scypha), *Spongilla* (Fresh water sponge) and *Euspongia* (Bath sponge).

PHYLUM COELENTERATA

- **Coelenterata** or **cnidaria** is the phylum of acoelomate and radially symmetrical lower invertebrates.
- All aquatic, some freshwater (*Hydra*), mostly marine. Solitary or colonial. Sedentary or free-swimming. Symmetry **radial** or **biradial** about a longitudinal oral-aboral axis.
- Body organization of **cell-tissue grade**. Cells mostly scattered and specialized for different functions. Some cells form tissues like **nerve net** or **nervous tissue**. Exoskeleton chitinous (perisarc) or calcareous (**corals**). Body wall **diploblastic** with two cellular layers—outer epidermis and inner **gastrodermis** - with a gelatinous acellular **mesogloea** in between. In advanced types mesogloea with cells and connective tissue are present, hence are called **triploblastic**.
- Two types of individuals occur, attached polyps and free-swimming medusae. Some species are notable for polymorphism or **variety of forms**.
- A single internal cavity, lined with gastrodermis, called **gastrovascular cavity** or **coelenteron**, into which mouth opens. **Anus is absent**. Digestion is **intracellular** as well as **extracellular**. One or both body layers with peculiar **stinging cell organelles** or **nematocysts**, which serve for adhesion, food capture and offence and defense.
- 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 *Madrina* (Brain coral).

PHYLUM CTENOPHORA

- Ctenophora (*Gk. Ktens* - comb, *phors* - bearing) is a small phylum of marine animals, which are commonly known as **sea walnuts** or **comb jellies**. Exclusively **marine**. Solitary and pelagic and free swimming animals. Carnivorous and feed on plankton. They swim by cilia. Reproduce

only sexually. **Power of regeneration** is well marked. **Bioluminescence** (the property of living organism to emit light) is well-marked in ctenophores.

- Comb like eight ciliary plates called **comb plates** are present on the body. The cilia of these plates help in swimming. Since comb like plates are present, ctenophores are called **comb jellies**. Digestion is both **extracellular** and **intracellular**. Monoecious (= hermaphrodite or bisexual). Fertilization is generally external. Asexual reproduction is lacking. Paedogenesis is common.
- Examples: *Pleurobrachia* and *Ctenoplana*.

PHYLUM PLATYHELMINTHES

- It includes primitive, bilaterally symmetrical and acoelomate worm-like animals, commonly known as 'filaments'. Free-living, commensal or parasitic forms. **Tissue-organ grade of organization**.
- Triploblastic, bilaterally symmetrical, **dorso-ventrally flattened**. Usually with a well-defined ventral surface bearing mouth and gonopore. Body **unsegmented** (except in class Cestoda). Acoelomate. Spaces between various organs filled with special mesodermal tissue, the **mesenchyme** or **parenchyma**.
- Adhesive structures like **hooks**, **spines** and **suckers**, and **adhesive secretions** are common in parasitic forms. **Digestive system** branched and incomplete without anus. Skeletal, respiratory and circulatory systems are wanting. **Excretory system** includes **lateral canals** and **protonephridia (flame cells)**. Absent in some primitive forms. **Nervous system** primitive, ladder-like. **Sense organs** simple. Eye-spots or photoreceptors in free living forms.
- Mostly **monoecious (hermaphrodite)** with complex reproductive system. **Fertilization** internal, may be cross or self. **Development** direct or indirect. Usually indirect in endoparasites.
- Examples: *Taenia* (Tapeworm), *Fasciola* (Liver fluke).

SUPERPHYLUM ASCHELMINTHES

- According to some zoologists such as Hyman (1951), Aschelminthes is regarded as a distinct phylum and the various groups included in it as classes. However, others treat different groups as separate phyla and the name of Aschelminthes as a superphylum or without any taxonomic rank.
- Mostly aquatic, free-living or parasitic. Body slender, vermiform, unsegmented, flat or cylindrical, **bilaterally symmetrical** and **triploblastic**. Organ system grade of body organization. Musculature includes mostly longitudinal fibres.
- Body cavity a pseudocoel not lined by mesoderm. Digestive canal complete with mouth, specialized pharynx, straight non-muscular intestine and posterior anus. No circulatory and respiratory systems. Excretory system of **protonephridia** (in some) and **canals**. Cloaca present in some. Nervous system of **cerebral ganglia** or of circumenteric nerve ring with anterior and posterior nerves.

- Mostly **dioecious**. Male usually smaller than female. Development usually direct with no larval stages, or indirect with a complicated life history.
- Examples : *Ascaris* (Round Worm), *Wuchereria* (Filaria worm), *Ancylostoma* (Hookworm)

PHYLUM ANNELIDA

- Mostly aquatic, some terrestrial. Burrowing or tubicolous. Some commensal and parasitic. Body elongated, bilaterally symmetrical, triploblastic, truly coelomate and metamericly segmented into similar metameres.
- Locomotory organs are segmentally repeated chitinous bristles, called setae or chaetae, embedded in skin. May be borne by lateral fleshy appendages or **parapodia**.
- **Coelom**, true, schizocoelous. Mostly well-developed except in leeches. Digestive system straight and complete. Digestion entirely extracellular. **Blood vascular system closed**. Respiratory pigments either haemoglobin or erythrocrorin dissolved in blood plasma. Respiration by moist skin or gills of **parapodia** and head.
- Excretory system consists of metamericly 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. **Hermaphroditic** or sexes separate, Reproduction is sexual, cleavage spiral and determinate. Larva, when present, is a **trochophore**. Regeneration common.
- Examples : *Nereis*, *Pheretima* (Earthworm) and *Hirudinaria* (Blood sucking leech)

PHYLUM ARTHROPODA

- Phylum Arthropoda is 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 organization.
- Body bilaterally symmetrical, triploblastic and metamericly 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 dorsal often many chambered heart, arteries and blood sinuses of haemocoel.
- Respiration by general body surface, gills, tracheae or book-lungs.
- Excretory organs are green glands or Malpighian tubules.

- Nervous system typically annelidan, with a dorsal brain connected with a nerve ring to a double ventral nerve cord.
- Sensory organs comprises of eyes (**simple and compound**), chemo-and tactile receptors, and balancing and auditory organs.
- Sexes usually separate (**dioecious**). Reproductive organs and ducts paired. Fertilization usually internal. Oviparous or ovoviviparous.
- Development direct or indirect with one to many larval stages. Parthenogenesis in some.
- **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 MOLLUSCA

- Phylum Mollusca includes **soft bodied** invertebrate animals such as snails, slugs, mussels, clams, oysters, tusk-shells, squids, octopods and nautili, etc.
- Mollusca is the second largest phylum after Arthropoda. Mostly marine, however, some freshwater and terrestrial forms are also available. Unsegmented (except Monoplacophora) with a distinct head, **muscular foot** and **visceral hump**. Triploblastic, coelomate with organ system grade of body organisation. Body is bilaterally symmetrical. In some molluscs such as *Pila* due to **torsion (twisting)** during growth, the adults become asymmetrical.
- A thin fleshy fold or outgrowth of dorsal body wall more or less covers the body. This fold is called mantle or pallium. It encloses a space, the **mantle** or **pallial cavity** between itself and the body. The mantle usually secretes the shell. It is made up of **calcium carbonate**. Coelom reduced and represented mainly by **pericardial cavity** (space around heart), **gonadial cavity** (space around testes and ovaries) and small space within kidney. Spaces amongst the viscera (soft organs) contain blood and form **haemocoel**.
- **Digestive system** complete with a digestive gland or liver (hepatopancreas) and **rasping organ**, the radula with transverse rows of teeth. Exchange of gases usually takes place through **gills** called ctenidia, but may occur by **mantle** (*Dentalium*) and in semi-terrestrial forms like *Pila* by **pulmonary sac** or **lung**. The **circulatory system** is **mostly open**. Blood often has a copper-containing, blue respiratory pigment called **haemocyanin**. The cephalopods have closed circulatory system.
- The **excretory system** includes kidneys, which open into the mantle cavity. The excretory matter is ammonia or uric acid. Gills are also excretory in function. In many molluscs, eyes and **tentacles** are present on the head. **Statocysts** may be present. **Osphradium** is present in some molluscs for testing chemical and physical nature of water.
- The sexes are generally separate but some are hermaphrodite. **Fertilization** may be external or internal. **Oviparous**. The development is either direct or indirect (metamorphosis). When the development is indirect, it includes a characteristic larva, **veliger**, **trochophore** or **glochidium**.

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

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. **Marine**. They generally live at sea bottom. Some are **pelagic** and a few are **sessile**.
- Organ-system grade of body organization. Triploblastic and coelomate.
- **Symmetry bilateral in larvae and pentamerous radial in adults**. Body unsegmented with globular, star-like, spherical, discoidal or elongated shape. Head absent; body surface is marked by five symmetrically radiating areas (ambulacra) and five alternating interradial (inter-ambulacra).
- Body bears spines and pincer-like pedicellariae. The spines are protective in function. The pedicellariae keep the body surface clear of debris and minute organisms. Endoskeleton of dermal calcareous ossicles with spines, covered by the epidermis. Ambulacral (water vascular) system of coelomic origin, including a madreporite (perforated plate) and podia or tube-feet present. These feet also help in locomotion. Coelom **enterocoelous**.
- **Digestive tract is complete**. Vascular system is of open type and includes **haemal** and **perahaemal** systems. There is no heart. 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. Usually **dioecious**, fertilization external; development indirect through free-swimming larval forms. Phenomenon of **autotomy** and **regeneration** is present.
- Examples: *Asterias* (Star fish), *Echinus* (Sea urchin), *Antedon* (Sea lily), *Cucumaria* (Sea cucumber), and *Ophiura* (Brittle star).

PHYLUM HEMICHORDATA

- Hemichordata was earlier considered as a sub-phylum under phylum Chordata. But now it is placed as a separate phylum under non-chordata. Alliance with the chordates was based on the presence of gill slits and the so called notochord. Hemichordates are vermiform, solitary or colonial enterocoelous coelomate animals having intra-epidermal nervous system and a pre-oral gut with or without gill-slits and without typical nephridia.
- Exclusively marine, solitary or colonial, mostly **tubicolous**. Body soft, fragile, vermiform, unsegmented, bilaterally symmetrical and triploblastic. Coelom **enterocoelous**, usually divided into protocoel, mesocoel and metacoel, corresponding to 3 body regions. Digestive tube complete, straight or U-shaped. Foregut gives out a hollow buccal **diverticulum** into proboscis, earlier considered as “notochord”.

- Dorso-lateral pharyngeal gill-slits, when present, one to several pairs. **Ciliary filter feeders**. Circulatory system simple and open, including a dorsal heart and two longitudinal vessels, one dorsal and one ventral. Excretion by a single **proboscis gland** or **glomerulus** connected to blood vessels. Nervous system primitive consisting mainly of a subepidermal nerve plexus.
- Reproduction mainly sexual. Sexes usually separate. **Fertilization external** in sea water. Development direct or indirect with a free-swimming **tornaria larva**.
- Examples: *Balanoglossus* and *Saccoglossus*.

PHYLUM CHORDATA

- Animals belonging to phylum Chordata 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.

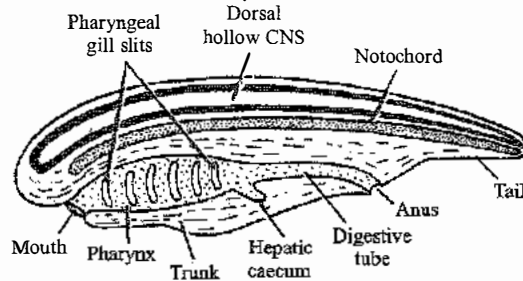
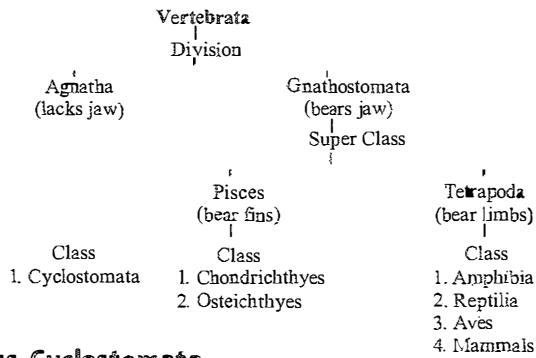


Fig.: A generalized chordate

Table: Comparison of Chordates and Non-chordates

	Chordates	Non-chordates
1.	Notochord present.	Notochord absent
2.	CNS is dorsal, hollow and single.	CNS is ventral, solid and double.
3.	Pharynx perforated by gill slits.	Gill slits are absent
4.	Heart is ventral.	Heart is dorsal (if present).
5.	A postanal part (tail) is present.	Postanal tail is absent.

- 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, while 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).
- 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 the basic chordate characters, 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.



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, skin is smooth, without scales and has mucous glands. Endoskeleton is **cartilaginous**. Notochord persists throughout life.
- The heart is **two chambered** with a conus arteriosus anteriorly. Kidney is mesonephric. 8-10 pairs of cranial nerves. Fertilization is external. Larva is **ammocoetes**.
- **Examples** : *Petromyzon* (The Lamprey), *Myxine* (Hagfish).

Class Chondrichthyes

- All chondrichthyes fishes are **marine**. Body laterally compressed or dorsoventrally flattened. It consists of head, trunk and tail. They have two dorsal fins. Median and paired fins are supported by horny fin rays. Pelvic fins bear claspers in male. They have **heterocercal** tail fin.
- Mouth is **ventral**. Intestine has **scroll valve**, to increase absorptive surface. Endoskeleton is cartilaginous and dermal **placoid** scales are present. They have 5-7 pairs of lamelliform gills. Gills are not covered by opercula (exception *Chimaera*). Swim bladder is absent.
- Heart is **two chambered**. Sinus venosus and conus arteriosus are present. Renal portal system is well developed. Kidneys are **mesonephric** ureotelic. Only **internal ear** is present, have 3 semicircular ducts, **lateral line sense organs** are well developed.
- Sexes are distinguishable externally. Fertilization is internal. Most forms are ovoviviparous or oviparous or some are viviparous. Some of them have **electric organs** (e.g. *Trygon*). They are cold-blooded (**poikilothermous**) animals, i.e., they lack the capacity to regulate their body temperature.
- Examples: *Scoliodon* (Dog fish), *Pristis* (Saw fish), *Carcharodon* (Great white shark), *Trygon* (Sting ray).

Class Osteichthyes

- Osteichthyes includes all members of lung fishes, the ray finned and lobe finned fishes. The bony fishes occur in all sorts of water, fresh, brackish, salt, warm and cold. Body is often spindle shaped. Body has 3 regions; head, trunk and tail. Tail is **homocercal**.
- Scales of 3 types ; **ganoid**, **cycloid** or **ctenoid**. Placoid scales are absent. Endoskeleton is chiefly of bone (exception - *Sturgeon*). Mouth terminal or subterminal, jaws usually with teeth.
- Respiration by 4 pairs of gills covered by a common operculum. Swim bladder present in few fishes (e.g., lung fishes). Heart two chambered. **Sinus venosus** and **conus arteriosus** present.

- Kidney is **mesonephric**. Excretion is ureotelic or ammonotelic
- 10 cranial nerves are present. Well developed **lateral line** system is present. Sexes separate. Gonads paired. Fertilization is external. 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).

Class Amphibia

- The amphibians were the **first vertebrates to invade land**, but they have not fully adapted to terrestrial life so they live on land and aquatic environment. This dual mode of life is expressed in their name (*amphi* = two; *bios* = life). **Aquatic** or **semiaquatic** (fresh water), air and water breathing, carnivorous, cold-blooded, oviparous, **tetrapod vertebrates**. Head distinct, trunk elongated. Neck and tail may be present or absent.
- Limbs usually 2 pairs (**tetrapod**), some limbless. Skin soft, moist and glandular. **Pigment cells** (chromatophores) present. **Exoskeleton** absent. Digits clawless.
- Endoskeleton mostly bony. Notochord does not persist. Skull with **2 occipital condyles**.
- Mouth large. Upper or both jaws with small homodont teeth. Tongue often protrusible. **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. Cranial nerves **10 pairs**. Sexes separate. Male without copulatory organ. Fertilization mostly external. Females mostly oviparous. Development indirect. Larva is a tadpole which metamorphoses into adult.
- Examples: *Bufo* (Toad), *Rana* (Frog), *Hyla* (Tree frog), *Salamandra* (Salamander), *Ichthyophis* (Limbless amphibia).

Class Reptilia

- Reptiles represent the first class of vertebrates fully adapted for life in dry places on land. The class name refers to the mode of locomotion (L; *reperere* or *reptum*, to creep or crawl), and the study of reptiles is called **herpetology** (Gr. *herpeton*, reptiles).
- Predominantly terrestrial, **creeping** or **burrowing**, mostly carnivorous, air-breathing, cold-blooded, oviparous and **tetrapodal vertebrates**. Body bilaterally symmetrical and divisible into 4 regions-head, neck, trunk and tail. Limbs 2 pairs, pentadactyl. However, limbs **absent** in a few lizards and all snakes. Exoskeleton of horny epidermal scales, shields, plates and scutes. **Skin** dry, cornified and devoid of glands.
- Alimentary canal terminates into a cloacal aperture. Heart usually 3-chambered, **4-chambered in crocodiles**. Cold-blooded. Respiration by **lungs** throughout life. Kidneys **metanephric**. Excretion uricotelic. Lateral line system absent. **Jacobson's organ** present in the roof of mouth.
- Sexes separate. Male usually with a muscular copulatory organ. Fertilization internal. Mostly oviparous. **Embryonic membranes** appear during development.

No metamorphosis. Young resemble adults. **Parental care** usually absent.

- 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).

Class Aves

- The class aves include birds. The birds 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**. It is divisible into head, neck, trunk and tail. **Beak** is present, which **lacks teeth**.
- There are two pairs of limbs. The forelimbs are modified into wings for flight. The hindlimbs or legs are large and variously adapted for perching, walking, hopping, wading and swimming. 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**. The secretion of this gland is used for dressing the feathers. Sweat glands are absent.
- **Oil gland is absent in ostrich and parrot.**
- 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.
- Alimentary canal contains **crop** for storing and softening of food and **gizzard** for crushing it. Respiration takes place only by **lungs**. 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. It is **4-chambered**, having two auricles and two ventricles.
- Kidneys are **metanephric** Excretion **uricotelic**. **Urinary bladder absent**.
- There may be **sexual dimorphism**. Female has a **single functional left ovary and oviduct**. Fertilization is internal. All birds are **oviparous**.
- 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 vertebrates. Some have gone back to water, *e.g.*, whales. They occur in all sorts of habitats. 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.
- There are two pairs of pentadactyl limbs. These are variously adapted for walking, running, jumping, climbing, burrowing, swimming, or flying. **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.
- **Fertilization is internal**. Except egg-laying monotremes, mammals are mostly **viviparous**. Development is direct. The body temperature is regulated (homeothermy).
- 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).

	Features	Amphibia	Reptilia	Aves	Mammalia
1.	Skin	Rich in mucous glands, respiratory.	Lacks glands, not respiratory.	Lacks glands, except single oil gland on tail, not respiratory.	Contains many types of glands, no mucous glands, not respiratory.
2.	Exoskeleton	Mostly absent	Mainly of horny epidermal scales.	Mainly of horny epidermal feathers.	Mainly of horny epidermal hair.
3.	Digits	Unarmed.	Armed with claws.	Fingers unarmed, toes armed with claws.	Armed with claws, nails or hoofs.
4.	Occipital condyles	Two	One	One	Two
5.	Heart	3-chambered	Incompletely 4-chambered	4-chambered	4-chambered
6.	Erythrocytes	Oval, biconvex, nucleated	Oval, biconvex, nucleated	Oval, biconvex, nucleated	Circular, biconcave, denucleated
7.	Lungs	Sac-like	Sac-like	Spongy	Spongy
8.	Cranial nerves	Ten pairs	Twelve pairs	Twelve pairs	Twelve pairs
9.	Body temperature	Variable (poikilothermous)	Variable (poikilothermous)	Fixed (homoiothermous)	Fixed (homoiothermous)
10.	Breeding	Most forms oviparous	Most forms oviparous	All oviparous	Most forms viviparous

