

Patterns in Life Diversity and Classification

Chapter Out Line

- ✧ Taxonomy
- ✧ Hierarchy
- ✧ Nomenclature
- ✧ Classification
- ✧ Kingdom Monera
- ✧ Kingdom Protista
- ✧ Kingdom Plantae
- ✧ Kingdom Animalia



Octopus



Bat



Panthera tigris

INTRODUCTION

Every organism of this living world, whether an animal, a plant or a microorganism (true bacteria, cyanobacteria, protozoans, etc.) is **unique** in itself. The uniqueness (or the special diagnostic features of the particular organism) is the basis of the **diversity** (or species richness) in life forms, which is the most important aspect of the biological world. Diversity simply means variety of forms. Thus, **Biodiversity means different forms of living organisms or a variety of life forms found in a particular region.**

Each and every living organism possesses a distinct form that distinguishes it from others. In other words, each organism has its own identifying characters that make it to identify and differentiate from others.

Different places in different parts of the world have their own distinct types of organisms. They vary in their shapes, sizes, colours, external appearance, longevity and behaviour. For example, some microscopic bacteria measure only a few micrometers in size whereas blue whales are more than 30 metres long and red wood trees of California are more than 100 metres tall. Some pine trees live for thousands of years whereas, mosquitoes die within a few days. Some organisms are colourless or hyaline whereas, others have beautiful colours. This clearly indicates that the **extent of biodiversity is endless.**

– Boost your knowledge

- ☛ “**Biodiversity**” is a concise form of “**Biological Diversity**” and was coined by **Walter G. Rosen** in 1986.
- ☛ The warm and humid tropical regions of the earth between the tropic of Capricorn and the tropic of Cancer, are rich in diversity of plant and animal life. This is called the region of “megadiversity” (12 centres in the world).

TAXONOMY

(Gr. Taxis-arrangement, nomos-law). The functional branch of biology dealing with the identification, classification and nomenclature of living organisms is called taxonomy. “Carolus Linnaeus” (1707-1778) is known as “**Father of taxonomy**”.

Taxon : Plant groups or animals groups included in categories are called taxon. e.g. Pisces, Insecta

Family - Brassicaceae

Genus - Raphanus

Species - sativus

Here FAMILY is a category in which brassicaceae group is a taxon.

Taxonomic Hierarchy:

- “Hierarchy” means ordering of living creatures according to their growing similarities. It includes the following pattern of classifying any living one.
The hierarchial order of classifying organisms is :
- Kingdom → Phylum/ Division → Class → Order → Family → Genus → Species

S.No	Categories	Features
1.	Kingdom	It is the highest category of taxonomic studies. All animals are included in kingdom Animalia and all plants are included in kingdom Plantae.
2.	Phylum (or Division)	Many Classes with some common characters are included in Phylum.
3.	Class	Similar orders are place together in a class.
4.	Order	A number of families having common characters are placed in order.
5.	Family	A number of genera having several common characters form a family.
6.	Genus	It is a group of closely related species with common ancestry.
7.	Species	A group of organisms capable of interbreeding to produce offspring.

– Boost your knowledge

- ☛ Biodiversity “hotspots” are areas of the world with a high number of endemic species (that is, species found only in that place).
- ☛ Taxonomists--biologists who specialize in identifying and classifying life on the planet have named approximately 1.7 million species about 13,000 more species are added to the list of known organisms. (National Wildlife Magazine)

(a) Identification : Correct description of an organism is known as identification and nomenclature is only possible when we describe organism correctly.

(b) Classification :

The method of arranging organisms into groups on the basis of similarities & differences is called classification.

(I) Significance of Classification :

- It establishes hierarchy of groups of organisms on the basis of their common features.
- It makes the systematic study easier.
- It is essential to understand the inter-relationship amongst different groups of organisms.
- It serves as a base for the development of other biological sciences as well as different fields of applied biology like public health, environment etc.

(II) System of Classification :

- Artificial system :** Biological classification in early times were based upon single arbitrarily chosen character suiting the convenience of taxonomist.
e.g. On the basis of habitat and ability to fly.
- Natural system :** It was based on morphological and anatomical similarities and differences.
- Phylogenetic system :** It was based on evolutionary sequence as well as genetic relationship amongst the organisms. Charles Darwin showed that living organisms evolved by the process of descent with modifications.

(c) Nomenclature :

- It is the system of naming an individual.
- Nomenclature is done on the basis of a set of rules stated in the ICN i.e. International code of Nomenclature.
- **Binomial nomenclature :** Proposed by Carolus Linnaeus in his book Systema Naturae who is also called father of taxonomy.
According to this system of nomenclature, each scientific name of an animal or plant has two components : the first one is the generic name and the second one is the name of the specific epithet.

Nomenclature have some universal rules as follows:

- Scientific name are generally in Latin or Latinized and written in Italics.
- The first word represents the genus and second denotes species.
- Hand written scientific name are separately underlined Mangifera indica.
- Generic name always start with capital letter and specific name with small letter.
- Name of the author or inventor or discoverer should be written in abbreviated form after the species.
Eg.

Mangifera indica Linn. It indicates that this species was first described by Linnaeus.

CLASSIFICATION OF ORGANISMS

Two kingdom system : It was given by Carolus Linnaeus in 1758. Organisms were divided into Plant Kingdom and Animal Kingdom. Fungi, Bacteria and Euglena could not find an appropriate position.

Three kingdom system : It was given by Ernst Haeckel (1894). In this Kingdom Protista was also included along with plant kingdom and animal kingdom.

Four kingdom system : It was given by Copeland. Kingdom Monera was also included in this system of classification.

Five kingdom system : It was given by Robert Whittaker (1959). According to him organisms were divided into five kingdoms.

These five kingdom are:

- (a) Monera (b) Protista (c) Fungi (d) Plantae (e) Animalia

Basis of five kingdom Classification :

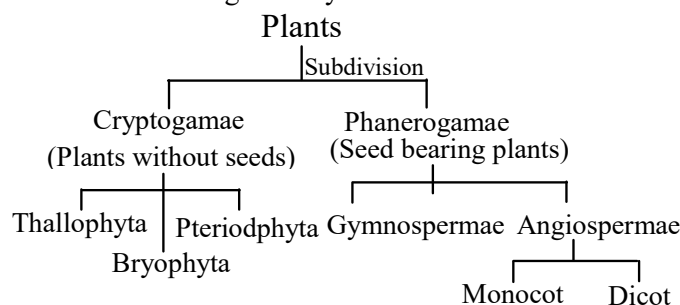
- Complexity of structure
- Mode of nutrition
- Level of organization

CHARACTERISTICS OF FIVE KINGDOMS

1. **Kingdom - Monera** : All the prokaryotic unicellular organisms are included in monera.
Prokaryotic nature : The genetic material is not organised into a nucleus. It lies directly inside the cytoplasm and is called nucleoid. Membrane bound cell organelles like mitochondria, Golgi apparatus, plastids, lysosomes, are absent.
Unicellular nature : Monerans are basically unicellular. In filaments and colonies, the cells are similar and independent.
Mode of nutrition is either autotrophic (Blue-green algae) or heterotrophic (Mycoplasma and most bacteria). Some organisms have cell wall (in bacteria and blue-green algae) while other lacking (in Mycoplasma).
 e.g. Blue Green Algae (Cyanobacteria) – Anabaena, Nostoc.
 Bacteria – (Vibrio cholerae, Clostridium botulinum, Escherichia coli)
 Mycoplasma – (Produces diseases in humans, animals and plants).
 2. **Kingdom - Protista**
 Organisms are unicellular which have eukaryotic organization.
 There is a true nucleus and membrane bound other cell organelles.
 Some protists are covered with cell wall (most photosynthetic protists) while others do not possess it (e.g., protozoan protists).
 Mode of nutrition is either autotrophic (algae and diatoms) or heterotrophic (protozoans). Some organisms have hair like cilia (e.g. Paramecium) ; whip like flagellum (e.g. Euglena) and pseudopodia (e.g. Amoeba) for locomotion.
 e.g. Unicellular algae – Chlamydomonas, Chlorella
 Diatoms
 Dinoflagellates
 Protozoa – Amoeba, Plasmodium, Euglena, Paramecium
 3. **Kingdom - Fungi**
 These are non-green (lacking chlorophyll) eukaryotic, organisms. They may be unicellular (e.g. Yeast) or Multicellular (most fungi). Heterotrophic mode of nutrition is found. Food is gained either saprophytically (from dead organic matter) or parasitically (from other living tissues). Cell wall is made up of Chitin. Reserve food material is Glycogen.
 e.g. Yeast, Rhizopus (Bread mould), Penicillium, Mucor, Mushroom (Agaricus), Smut (Ustilago).
Lichen : Symbiotic association between algae (mostly blue green algae or cyanobacteria) and fungi is known as lichen. The alga manufactures food not only for itself but also for the fungus. Fungus provides protection to alga, helps in fixation and absorption of water as well as minerals. Lichens can be seen as the slow growing large coloured patches on the bark of trees. They are a source of essences, dhup, havan samagri and some medicines.
 e.g. Rhizocarpon, Parmelia and Usnea
 4. **Kingdom - Plantae**
 Plants are multicellular, eukaryotes with cellulosic cell wall.
 They are autotrophs i.e. prepare own food by photosynthesis by using chlorophyll.
 5. **Kingdom - Animalia**
 Animals are multicellular, eukaryotes without cell walls.
 They are heterotrophic.
- Carl Woese (1977) modified the five kingdom classification by dividing the Monera into Archaeobacteria (or Archaea) and Eubacteria (True Bacteria). This is known as **six kingdom classification**.

PLANT KINGDOM

Plant kingdom was divided into two sub kingdoms by Eichler.



(a) Sub kingdom Cryptogamae :

(Cryptos = hidden gamous = marriage) : It includes lower plants which do not bear flower or seeds. The reproductive organs are hidden.

(i) Division Thallophyta :

- They are commonly called as **algae**.
- They are most primitive and simple kind of plants.
- Plant body is not differentiated into root, stem and leaves.
- Xylem and phloem are absent. i.e. vascular system is absent.
- These are aquatic or terrestrial, fresh water or marine. Autotrophic, photosynthetic containing various pigments like chloro-phyll, carotenoids, xanthophylls etc.
- Unicellular, colonial, filamentous & multi- cellular.
- Cell wall of cellulose and stored food is starch.
- Reproductive organs are single-celled and there is no embryo formation after fertilization.
- e.g. Blue green algae (*Nostoc*), *Anabaena* Green algae (*Ulothrix*, *Chara*, *Cladophora*, *Ulva*, *Spirogyra*) Brown algae(*fucus*), Red algae(*gelidium*, *gracilaria*) etc.

(ii) Division Bryophyta

- The division **Bryophyta** (Greek word *Bryon* = moss ; *phyton* = plant) includes the simplest and primitive plant.
- Xylem and phloem are absent that's why it is non – vascular.
- They are also known as **amphibians of plant kingdom** because they required water for the completion of their life cycle.
- Plant body is not differentiated but root like structure present called as **Rhizoids**.
- Sex organs are multicellular. The male sex organs are **antheridia** and female sex organs are **archegonia**.
- An **embryo** is formed upon fertilization. Sporophyte lives as a parasite over gametophyte.
- Examples Liverworts (*Riccia*, *Marchantia*), hornworts (*Anthoceros*) and Mosses (*Funaria*, *Polytrichum*).

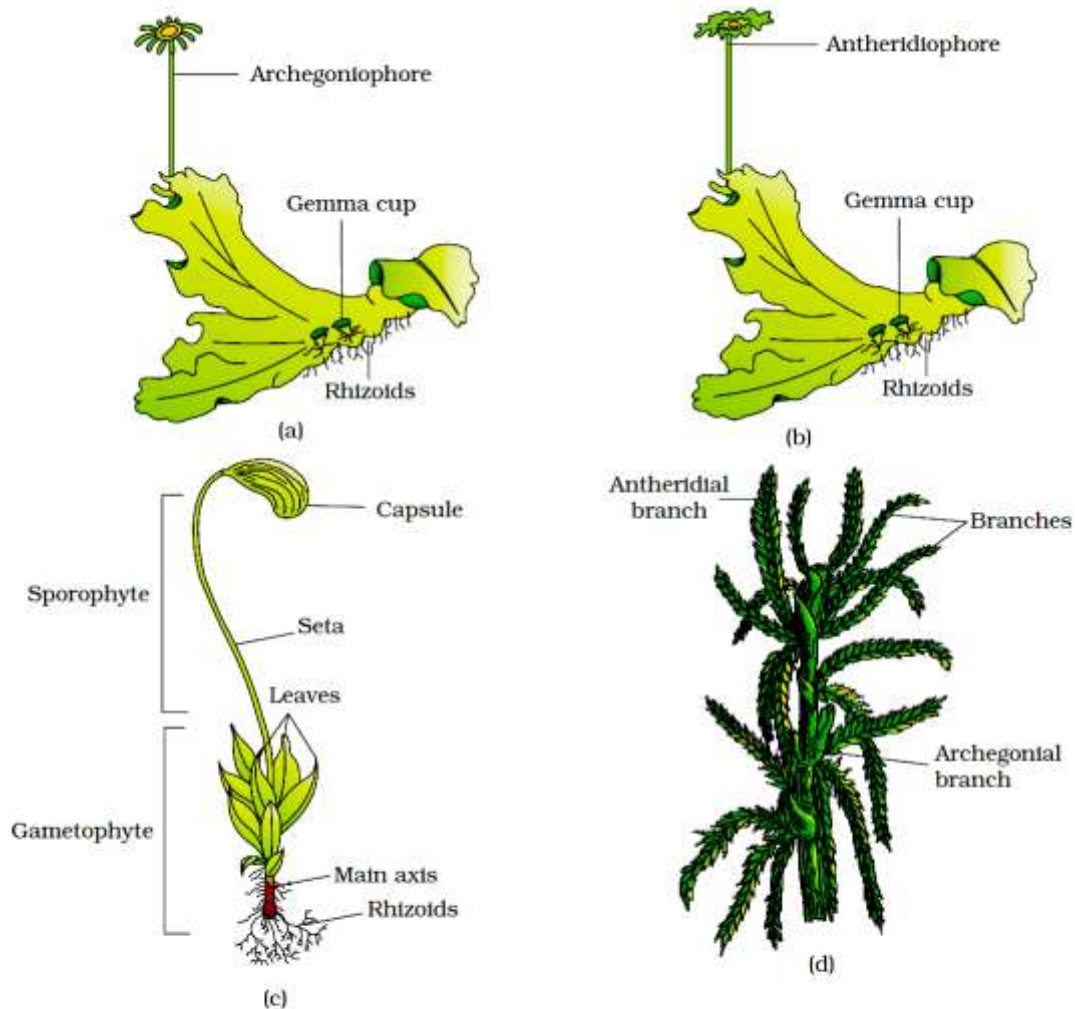


Figure Bryophytes: A liverwort – *Marchantia* (a) Female thallus (b) Male thallus Mosses – (c) *Funaria*, gametophyte and sporophyte (d) *Sphagnum* gametophyte

(iii) Division Pteridophyta

Characters :

- Plants body is differentiated into root, stem and leaf.
- Vascular tissues ie xylem and phloem are present and are called **vascular cryptogams**.
- These plants have no flowers and do not produce seeds.
- These produce spores in sporangia.
- Sex organs are multicellular and jacketed by sterile cells.
- Club mosses - *Selaginella*, *Lycopodium* (“ground pine”); horsetails - *Equisetum*; and ferns - *Marsilea*.

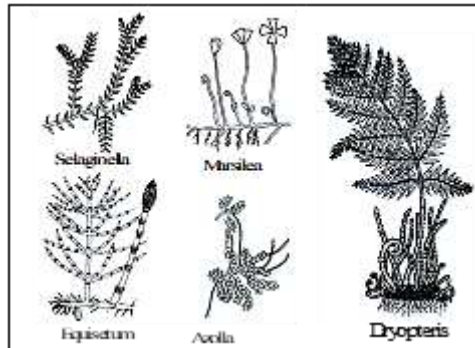


Fig. Pteridophyta

(b) Sub Kingdom : Phanerogamae :

(Phaneros = visible : gamous = marriage.)

This is the highest group of plants which includes flowering and seed bearing plants. They reproduce sexually by means of seeds. These plants are of two types :

(i) Gymnosperms (ii) Angiosperms

(i) Gymnosperms -

(Gymno = naked and Sperma = seed)

- The seeds produced by these plants are naked and are not enclosed within fruits.
- They have well developed vascular system but xylem lacks vessels and phloem lacks companion cells.
- Plants are commonly tall trees or shrubs.
- The flowers are represented by unisexual cones, often both cones are present on the same plant.

Ex :- *Cycas*, *Pinus*, *Ginkgo*

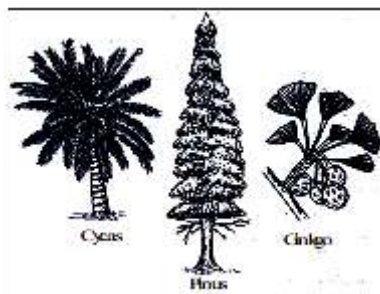


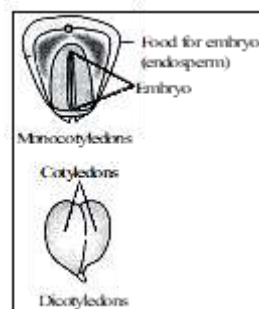
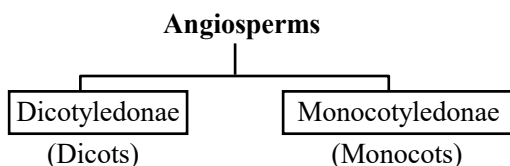
Fig. Gymnosperms

– Boost your knowledge

- Bryophytes like mosses provide food for herbaceous mammals, birds and other animals. Species of *Sphagnum*, a moss, provide peat that have long been used as fuel, and because of their capacity to hold water as packing material for trans-shipment of living material.

(ii) Angiosperms :

- Angiosperms are highly evolved plants and they produce seeds that are enclosed within the fruit.
- These are represented by trees, herbs, shrubs.
- It is the dominant group on the earth which ranges from the microscopic plant *Wolffia* to tall trees like *Eucalyptus* over 100 m.
- It provides food, fodder, fuel, medicine and several other things for commercial use.
- The reproductive organs are aggregated in a flower.
- Flower consists of stamen as male reproductive organs and pistil as female reproductive organs.
- Flowers may be unisexual or bisexual. Pollination occurs by wind, water and animals.
- They have highly developed vascular system. Seeds remain enclosed in ovary. Plant embryos in seeds have structures called cotyledons. cotyledones are called “seed leaves”.
- It is divided into two classes on the basis of number of cotyledons.



(1) Dicot

- The seeds produced by these plants have embryos with two fleshy leaves, the cotyledons.
- Their leaves have reticulate venation, with a network of veins.
- The root system has a prominent tap root.

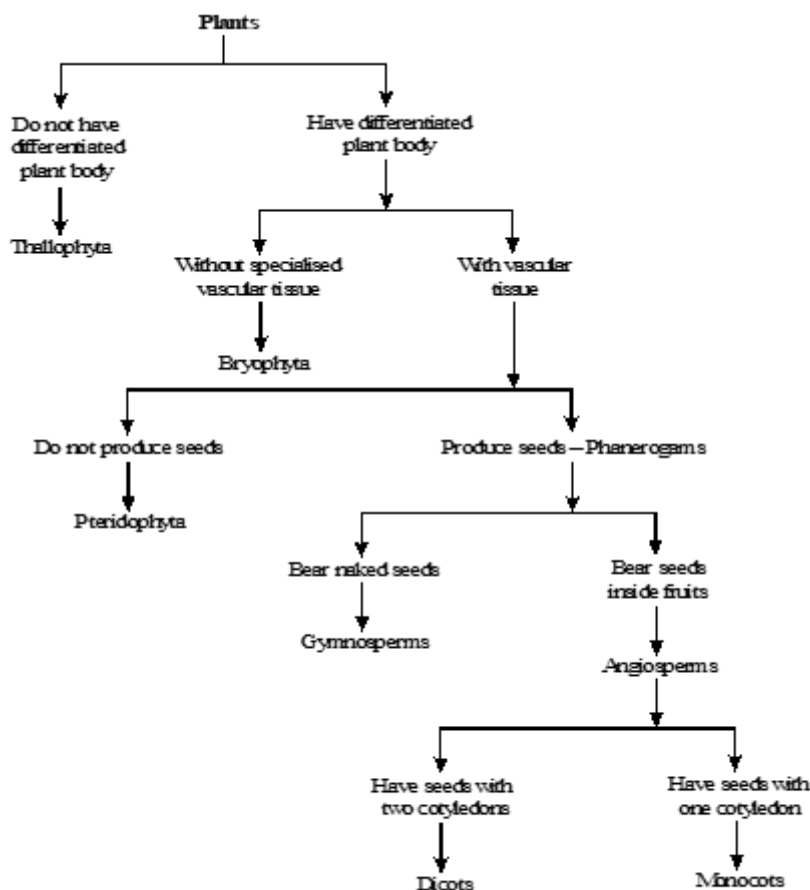
Examples : Pea (*Pisum sativum*), potato (*Solanum tuberosum*), sunflower (*Helianthus annuus*), rose (*Rosa indica*), banyan (*Ficus religiosa*), neem (*Melia indica*), apple (*Malus silvestris*).

(2) Monocot :

- The seeds of these plants have only one cotyledon.
- Their leaves have parallel venation.
- The root system consists of similar fibrous roots.
- The vascular bundles are scattered and closed (i.e. lack cambium). Secondary growth does not occur.

Examples : Maize (*Zea mays*), Wheat (*Triticum vulgare*), rice (*Oryza sativa*), onion (*Allium cepa*), sugarcane (*Saccharum officinarum*), barley (*Hordeum vulgare*), banana (*Pandanus*), Coconut and grasses.

SOME DISTINGUISHING CHARACTERS OF DICOTS AND MONOCOTS.			
S.No.	Plant organ	Dicots	Monocots
1.	Root	Tap, Adventitious or both.	Only adventitious.
2.	Stem	Vascular bundles arranged in ring with central pith.	Vascular bundles scattered.
3.	Leaves	Mostly with reticulate venation.	Usually parallel venation.
4.	Cotyledons	Two	One
5.	Floral parts	Five or multiple of 5, rarely 4.	Three or multiple of 3, rarely 4.



Classification of plants

ANIMAL KINGDOM

Basis of Classification :

- Organization and differentiation of cells to form tissues and organs.
- Body symmetry.
- Formation of body cavities and blood vascular system.
- Features of embryonic development.

(a) Level of Organisation in living beings :

It is structural differentiation of animal body.

- Cellular level of Organisation :** Tissues do not differentiate. Different types of cells are present, e.g., porifera (sponges).
- Tissue Level of Organisation :** Multicellular body cells organised into tissues but organs are absent e.g., Coelenterates.
- Organ Level of Organisation :** Cells are organised into tissues and tissues into organ but organ systems are absent, e.g., Platyhelminthes.
- Organ System Level of Organisation :** Cells are organised into tissues, tissues into organs and organ into organ systems e.g., Annelids, Arthropodes, Chordates.

(b) Body Symmetry :

It is similarity in arrangement of parts. Absence of repetition or similarity is called asymmetry. Symmetry is of two types, radial and bilateral.

- Radial Symmetry :** The body is cylindrical or discoid when similar parts occur all around the central axis. Any vertical plane passing through, the central axis will divide the body into two equal halves, e.g., ctenophore, coelenterates and echinodermites.
- Bilateral Symmetry :** The body has a head. Organs and limbs are paired. They are arranged laterally. Body is divisible into two equal halves by only one plane (mid-sagittal plane). Bilateral symmetry is found in Platyhelminthes, Nematoda, Annelida, Mollusca, Arthropoda and chordata.

– **Boost your knowledge**

☛ **Cephalization :** It is development of head in the anterior part of the animal body.

(c) Germ or Germinal Layers :

- A germ layer is group of cells in an embryo that interact with each other as the embryo develop and contribute to formation of all organs and tissue.
- Germinal layers can be two or three in number. On this basis, the animals are of two types, Diploblastic and Triploblastic.
- (i) **Diploblastic Animals :** Animals having two germinal layers, outer **ectoderm** and inner **endoderm**. Mesoderm is absent e.g. Porifera, Coelenterata.
- (ii) **Triploblastic Animals :** Animals having three germinal layers-outer **ectoderm**, middle **mesoderm** and inner **endoderm**, e.g., Platyhelminthes to Chordates.

(d) Coelom (Body Cavity):

It is mesoderm lined fluid filled space that occurs between alimentary canal and body wall. Depending upon the absence or presence of coelom animals are of three types **acoelomate**, **pseudocoelomate** and **eucoelomates**.

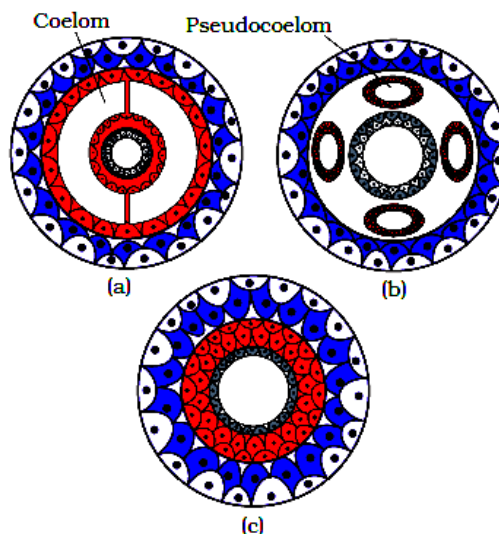


Figure Diagrammatic sectional view of :
(a) Coelomate (b) Pseudocoelomate
(c) Acoelomate

- (i) **Acoelomate** : Coelom is absent e.g., Porifera, Coelenterata, Platyhelminthes. In Platyhelminthes a mesoderm is present but it does not form cavity.
- (ii) **Pseudocoelomate** : A cavity called **pseudocoelom** is present which is not lined by mesoderm. It is generally endodermal in origin. Mesoderm occurs but forms small separate pouches e.g., aschelminthes.
- (iii) **Coelomate or Eucoelomate** : A true coelom lined by mesoderm is present.
e.g. Annelids to Chordates
- (e) **Notochord** is a mesodermally derived rod-like structure formed on the dorsal side during embryonic development in some animals. On the basis of presence or absence of notochord animals are of two types :
 - (i) **Chordates** : Animals with notochord are called chordates, e.g. Amphibians, Reptiles, Aves, Mammals.
 - (ii) **Non Chordates** : Animals which do not have notochord are called non-chordates, e.g, porifera to echinoderms.

– **Boost your knowledge**

- ☛ In some animals, the body is externally and internally divided into segments with a serial repetition of at least some organs. For example, in earthworm, this phenomena is known as **metamerism**.
- ☛ Annelids are the first animal to develop true body cavity or coelom.
- ☛ Cnidarians is the first phylum to organized at tissue level organization and platyhelminthes is the first to organized at organ system level of organization but it lacks well developed organs due to absence of coelom.

NON CHORDATES

(a) Phylum Porifera :

Characters :

- Also called as **sponges**.
- Aquatic, mostly marine.
- Sessile (stalk-less) and sedentary asymmetric or with radial symmetry.
- Simplest multicellular, diploblastic animals.
- Have organisation at cellular level. Thus, cells are loosely held together and do not form tissues.
- Mostly asymmetrical. Sponges may be vase-like, rounded, sac-like branched.
- Body contains a cavity called as **spongocoel**.
- Body is perforated by numerous pores, the **ostia** that open into a canal system having canals and chambers lined with collar flagellated cells or **choanocytes** and have a large water outlet called **oscula**.
- Endoskeleton is made of needle like spicules made of calcium carbonate and silica or spongin.
- Hermaphrodite, asexual reproduction by budding.

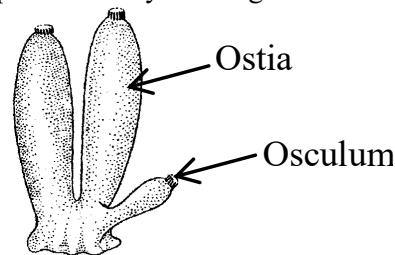


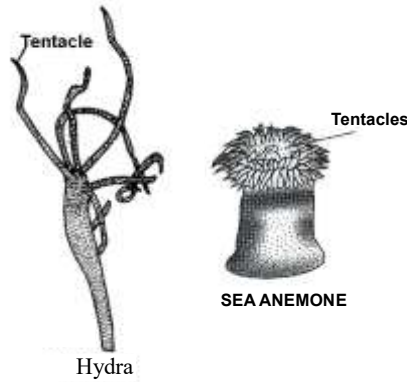
Fig- Sycon

Examples - Sycon, Euplectella, (Venus flower basket), Spongilla (Fresh water sponge).

(b) Phylum - Cnidaria (Coelenterata) :

Characters :

- Aquatic, mostly marine, a few such as *Hydra* are fresh water solitary or colonial forms.
- Cnidarians or coelenterates are multicellular, diploblastic animals with tissue grade of organisation.
- Body cavity (coelom) act as gastrovascular cavity ie coelenteron.
- Body shows radial symmetry.
- Posses specialized cells (cnidoblasts or cnidocytes) bearing stinging capsules called **nematocysts** present on tentacles and body. Nematocysts serve the functions of paralysing the prey by injecting poison or to hold the prey.
- Exhibit the phenomenon of polymorphism (Ex- Physalia).
- Body shows two main forms, the polyps and the medusae.
- Asexual reproduction by budding and sexual reproduction by gametes.



Examples - Hydra, Obelia (sea fur) , Aurelia (jelly fish), Metridium (sea anemone), Physalia (Portuguese man of war)

(c) Phylum Ctenophora :

Characters :

- Marine, solitary and free swimming.
- Body is transparent with radial symmetry.
- They possess comb plates that are ciliated and 8 in number. These help in locomotion. They also possess tentacles.



Figure Example of Ctenophora (Pleurobrachia)

Examples : *Cestum*, *Ctenoplana*, *Pleurobrachia*.

– Boost your knowledge

- ☛ The body of porifera supported by a skeleton made up of **spicules** or **spongin fibres**.
- ☛ The cnidarians which exist in both forms that is polyp and medusae exhibit alternation of generation called as **Metagenesis**.
- ☛ **Bioluminescence** is the property of a living organism to emit light is found in ctenophores.

(d) Phylum - Platyhelminthes :

Characters :

- Bilaterally symmetrical, Acoelomate and dorsoventrally flattened animals, hence are also called as **flatworm**.
- Body thin, soft, leaf-like or ribbon-like.
- Triploblastic, with organs system level of organization.
- Digestive cavity (when present) with a single opening, the mouth (anus is absent).
- Suckers and hooks are usually present.
- Circulatory and respiratory system and skeleton are absent.
- Excretory system occurs through specialized cells called **flame cells**.
- They are hermaphrodite.

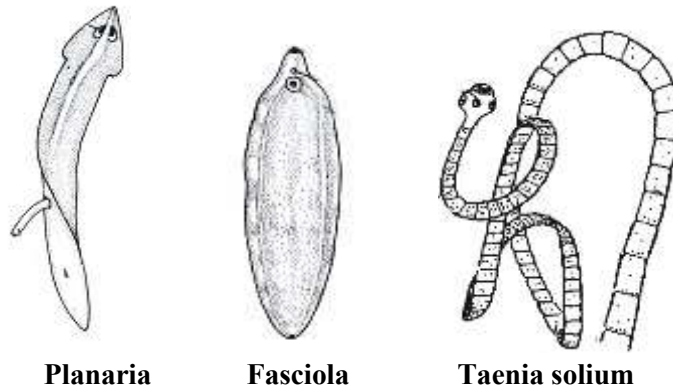


Fig. Platyhelminthes

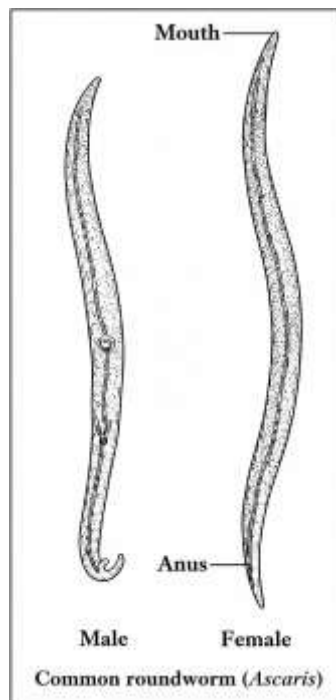
Examples : *Dugesia* (Planaria), *Fasciola* (liver fluke), *Schistosoma* (Blood fluke), *Taenia solium* (Pork Tape worm).

(e) Phylum - Aschelminthes or Nematoda

Characters :

- Also called as **round worms**.
- They are parasitic or free-living.
- They are triploblastic, unsegmented and show bilateral symmetry.
- Body cavity is not a true coelom, Pseudocoelomate animal
- Alimentary canal is complete.
- Sexes are separate. Female ascaris is longer than male ascaris it has curved tail.
- Reproduction is sexual.

Examples : *Ascaris* (Round worm), *Enterobius* (Pin worm), *Wuchereria* (filaria worm)



(f) Phylum - Annelida :

Characters :

- Also called as **segmented worms**.
- They occur in moist soil, fresh water and sea.
- They are elongated, with segmented body and bilateral symmetry.
- Triploblastic animals.
- First animals with true body cavity (coelom).
- Body bears lateral appendages for locomotion in the form of chitinous **setae** or **parapodia**.
- Well developed alimentary canal is present.
- Excretion by nephridia.
- Nervous system has dorsal brain.
- Reproduces sexually.

Examples : *Nereis* (sand worm) *Aphrodite* (sea mouse), *Pheretima* (earthworm), *Hirudinaria* (Cattle leech)

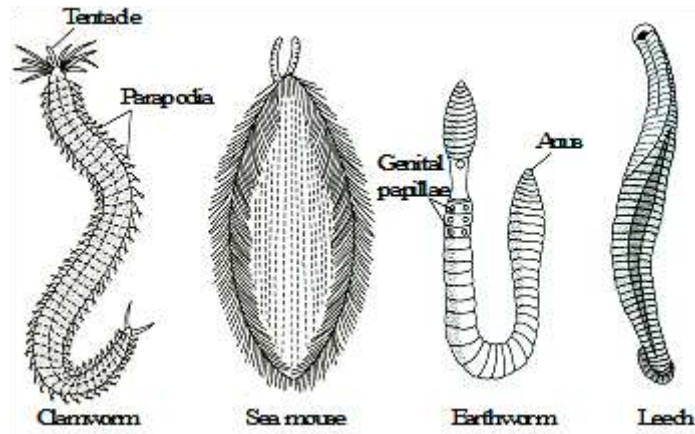


Fig. Common Annelids

(g) Phylum - Arthropoda :

Characters :

- These are the organisms with jointed appendages.
- This is the largest phylum in animal kingdom.
- Triploblastic, bilaterally symmetrical and metamerically segmented animals.
- Body cavity (coelom) is reduced.
- Body is covered with a thick chitinous covering.
- Respiration through general body surface, by gills, air tubes (tracheae) or book-lungs.
- Excretion by coelom ducts, malpighian tubules, green glands.
- Body segments are grouped into two regions-cephalothorax (head and thorax together and abdomen, or three regions-head, thorax and abdomen.
- Each body segment usually bears paired lateral and jointed legs or appendages.
- Sexes are separate.

Example : *Palaemon* (Prawn), *Daphnia* (water flea), *Limulus* (King crab), *Palamnaeus* (Scorpion)

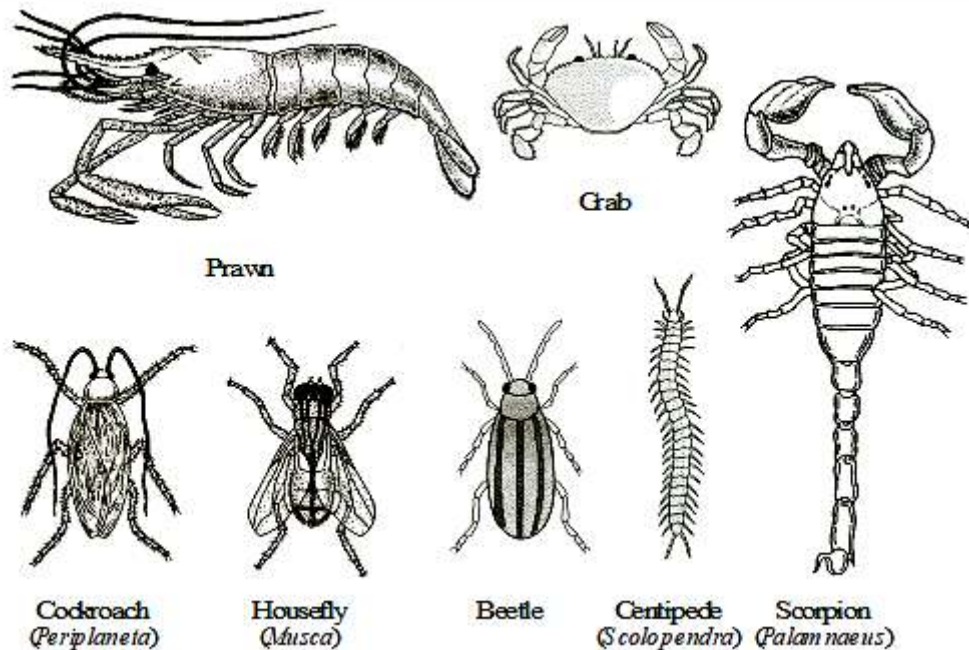


Fig. Common Arthropods

– Boost your knowledge

- ☛ Planaria is hermaphrodite animal (an animal that contains both male and female reproductive organs).
- ☛ Arthropoda is largest Phylum of animal kingdom.
- ☛ Sensory organs like antennae, eyes (compound and simple), statocysts or balance organs are present in arthropoda.
- ☛ Blood in annelids is red due to presence of haemoglobin.

(h) Phylum - Mollusca (Mollusca = soft) :

Characters :

- It is the second largest group of animals.
- They have soft, unsegmented body.
- Bilaterally symmetrical, triploblastic, Coelomate and having organ system level of organization.
- Body is divided into three regions (head, visceral mass and ventral foot).
- Outer surface is covered by a hard calcareous shell.
- Respiration is by gills or **ctenidia**.
- Circulatory system is of open type. Blood contains **haemocyanin** (blue colour pigment).
- Excretion by metanephridia near heart.
- The sexes are usually separate.

Examples : *Chiton*, *Pila* (Snail), *Unio* (Fresh water mussel), *Octopus* (Devil fish).

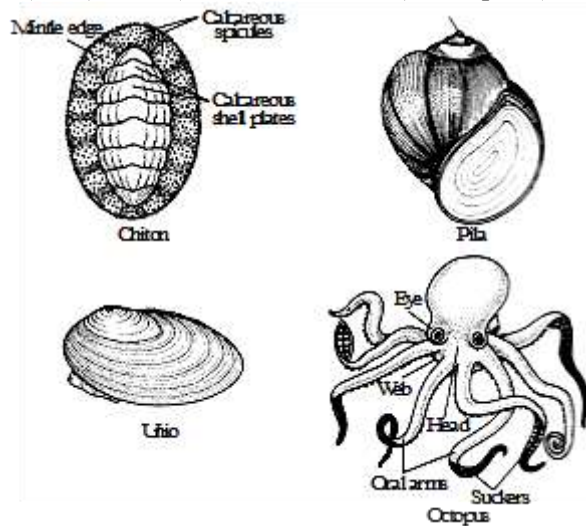


Fig. Molluscs

(i) Phylum - Echinodermata (Echinos = Spines, Derma = Skin):

Characters :

- Also called as **spiny skinned animals**.
- Radially symmetrical, triploblastic, coelomate animal with organ system level of organization.
- They are marine, gregarious (live in groups) and free-living animals.
- Shape may be star-like, spherical or elongate.
- Body surface is covered all over by calcareous spines.
- Their symmetry is radial in adults but bilateral in larvae.
- These are unsegmented.
- Body cavity is modified into a **water-vascular system** or **ambulacral system** with tube like outward extension for locomotion, called **tube feet**

Examples : *Asterias* (Star fish), *Echinus* (Sea urchin), *Holothuria* (Sea cucumber), *Antedon* (Feather star)

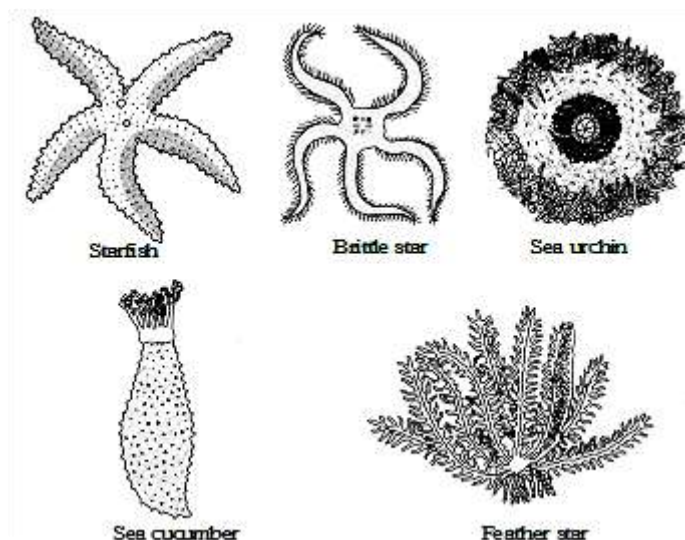


Fig. Echinodermata

◆ Hemichordata

Characters :

- Triploblastic, coelomate animal with organ system level of organization.
- They are placed in between nonchordates and chordates as they possess some characters of both.
- They include worm like, unsegmented, bilaterally symmetrical animals which are exclusively marine.
- Their body is divided into three regions proboscis, collar & trunk.
- Hemichordates have a notochord like structure called as **Buccal diverticulum** or **Stomochord** in proboscis.
- They possess gill slit or gill cleft which is meant for respiration.
- They possess nerve cord in collar region but it is not a true dorsal nerve cord.

Examples : *Balanoglossus* (tongue worm), *saccoglossus*.

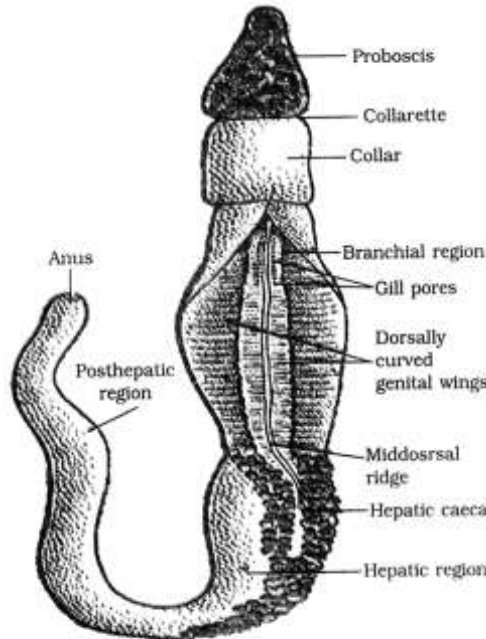


Fig. : *Balanoglossus*

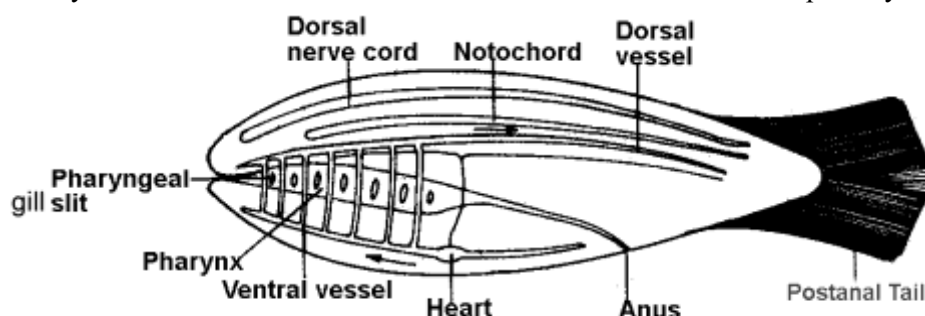
– Boost your knowledge

- ☛ Nerve chord is solid strand of nervous tissue forming a part of central nervous system.
- ☛ Difference between nerve chord and notochord is that notochord leads to form vertebral column while nerve chord leads to form spinal chord.

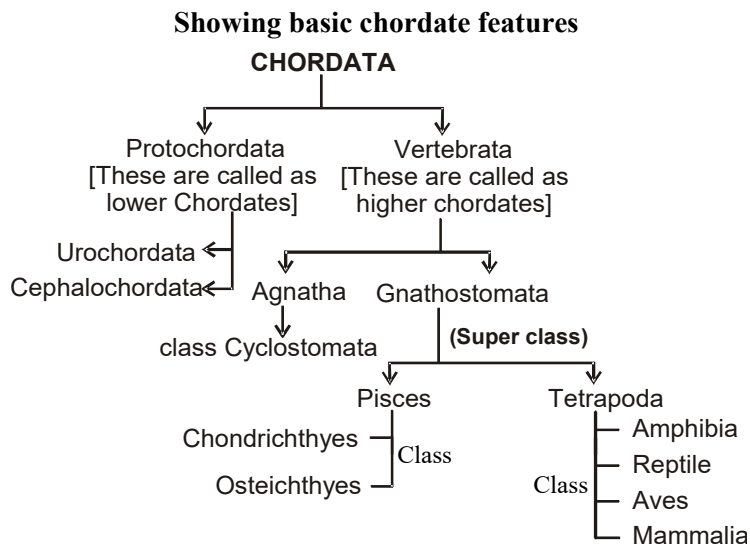
◆ Phylum Chordata

Characters :

- This is the most advanced group of animals.
- Notochord is present at some stages of life, supported by a tubular hollow dorsal nerve cord.
- In higher chordates i.e. vertebrates, the notochord is replaced by vertebral column.
- A set of gill slits is also present at certain stage of life, also called as pharyngeal gill clefts.
- Tail is also present behind the anal aperture that is post anal tail.
- They also possess a proper circulatory system.
- **Notochord** : It is solid unjointed of vacuolated cells, present on dorsal side between alimentary canal and nervous system in some animal. It is derived from mesoderm and act as primary axial skeleton.



Dig: Showing basic chordate features



(a) Subphylum : Protochordata

Characters :

- They are termed as lower chordates.
- They do not possess brain, cranium, vertebral column, jaw and paired appendages.
- Notochord is present at least in some stages along with other diagnostic chordate characters (dorsal hollow nerve cord, gill slits, post anal tail).
- They are triploblastic, bilaterally symmetrical, coelomic, organ system level organization.
- They are marine animals.



Fig. Ascidia

Protochordates are further divided into two groups :

(i) Urochordata

Characters :

- They are commonly known as tunicates.
- The notochord is present in the tail of the larva and disappears in the adult.
- The larva (tadpole) undergoes retrogressive metamorphosis, i.e., changes from a better developed larva to a less developed adult.

Examples : *Herdmania* (sea squirt), *Doliolum*, *Pyrosoma*.

(ii) Cephalochordata

Characters :

- Animals are fish like without a head.
- A notochord which extends upto the entire length of the body and persists throughout the life.
- A post anal tail is present throughout life.

Examples : *Branchiostoma* (Amphioxus ; Lancelet.)

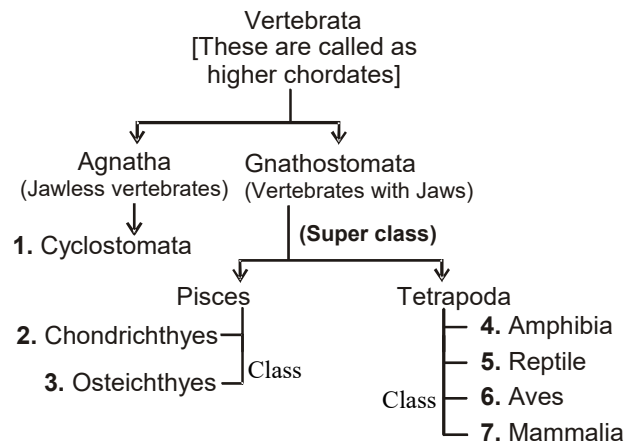
S. No.	Vertebrates	Invertebrates
(1)	They have an internal skeleton.	No internal skeleton.
(2)	A backbone is present.	Backbone is not present.
(3)	Heart is on the ventral side of the body.	Heart, when present, is on the dorsal side.
(4)	Nerve cord is dorsal and hollow.	Nerve cord is ventral and solid.
(5)	Haemoglobin in red blood cells.	Haemoglobin, if present, is dissolved in plasma.

(b) Subphylum : Vertebrata or Craniata

Majority of chordates are included in this phylum.

Characters :

- They are advanced animals, having a cranium (brain box) around the brain. Nervous system is well developed.
- Notochord is replaced by a vertebral column (backbone) in the adults. Endoskeleton is highly developed.
- There are two pairs of limbs or appendages.
- Head is well differentiated.
- The heart is situated ventrally. The circulatory system is closed consisting of blood vascular system and lymphatic system. Red coloured pigment haemoglobin is present in red blood corpuscles.
- Respiratory organs may be gills (in aquatic animals), skin, buccopharyngeal cavity (in amphibians) or lungs (in land animals).
- Excretion occurs through kidneys.
- Sexes are separate.
- This subphylum is subdivided into seven classes. They are :



I. Agnatha :

(1) Class Cyclostomata :

(Gr. Cyclos = circular, Stome = mouth ; the circular mouthed fishes)

These are the most primitive vertebrates.

Characters :

- These animals are jawless and possess a circular mouth.
 - They are ectoparasites on fish and use mouth to stick to fish ; the mouth is therefore suctorial.
 - Notochord is present in the form of a cylindrical rod.
 - Head and brain are poorly developed.
 - Cartilagenous endoskeleton is present.
 - Respiration occurs through gills contained in pouches.
 - Heart is two-chambered consisting of one auricle and one ventricle.
 - Gonad is single and fertilization is external.
- Example:. *Petromyzon* (lamprey), *Myxine* (hag fish).



II. Gnathostomata :

(1) Super Class Pisces

Characters:

- True fishes are included in the class
- They respire through gills.
- Their body is stream lined and covered by scales / plates.
- They have muscular tail and fins for movement.
- Endo skeleton is either made up of cartilage or bone.
- They are unisexual and lay eggs.
- They are **cold blooded or poikilothermous** animals ie their body temperature is not constant and changes with atmospheric temperature.
- Heart is 2 chambered.

Fishes are of two types based on the nature of their endoskeleton.

1. Cartilaginous fishes
2. Bony fishes

Cartilaginous fishes

e.g. Scoliodon – Dog fish, Trygon – Sting ray, Torpedo – Electric ray, Rhineodon – Whale shark, Chimera – ghost shark.

Bony fishes

e.g. Labeo rohita – Rohu or Indian carp, Anabas – Climbing perch, Caulopharyne jordani - Angler fish, Hippocampus – Sea horse, Pterois volitans - Lion fish, Exocoetus – Flying fish, Synchiropus splendidus - Mandarin fish

S.NO.	CHONDRICHTHYES	OSTEICHTHYES
1.	Mouth ventral.	Mouth terminal.
2.	Tail fin asymmetrical (heterocercal).	Tail fin symmetrical (homocercal).
3.	5-7 pairs of gills are present.	4-5 pairs of gills are present.
4.	Gills are naked.	Gills are covered by operculum.
5.	Cloacal aperture is present.	Anus and urinogenital apertures are separate.
6.	No swim bladder.	Swim bladder usually present.
7.	Fertilization is internal.	Fertilization is external.
8.	e.g. Scoliodon – Dog fish, Trygon - Sting ray, Torpedo - Electric ray, Rhineodon - Whale shark.	e.g. Labeo rohita - Rohu or Indian carp, Anabas - Climbing perch, Caulopharyne jordani- Angler fish, Hippocampus-Sea horse, Pterois valitans -Lion fish, Exocoetus - Flying fish.

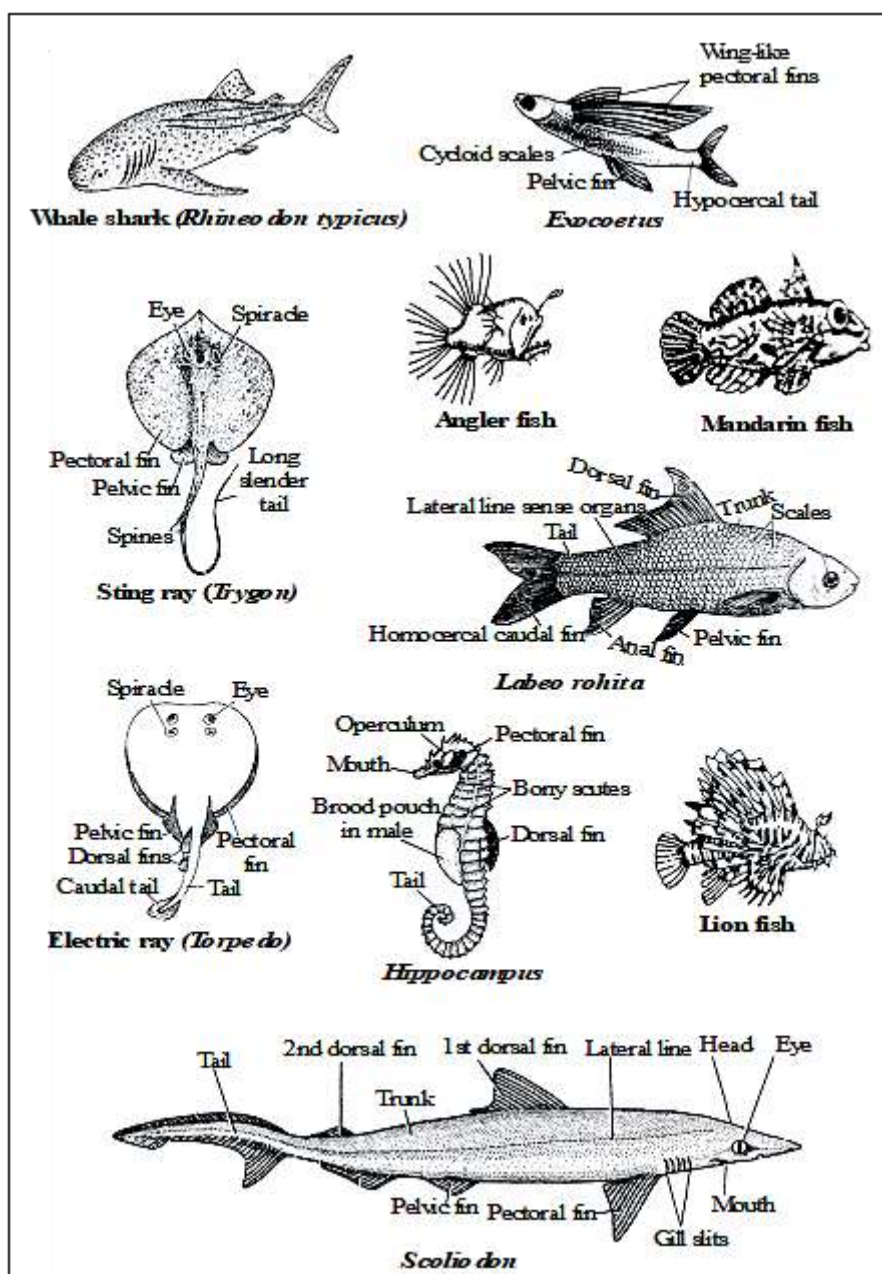


Fig.: Fishes

(2) Super Class Tetrapoda :

• **Class Amphibia :**

(Greek, *amphi* = both, *bios* = life, the vertebrates leading two lives / dual life)

Characters :

- They can live on land as well as in water.
- Skin is smooth or rough, rich in glands which keep it moist ; skin with pigmented cells, i.e. chromatophores.
- Body is without scales.
- Endoskeleton is mostly bony, notochord does not persist in adults.
- Head and trunk are distinct ; neck and tail may or may not be present.
- Limbs tetrapods (four – limbed), digits without nails
- Respiration occurs by lungs, skin or buccal lining, gills are present at least during larval stage for respiration.
- They are cold blooded animals.
- Excrete either ammonia (by tadpole) or urea (by adults).
- Heart three chambered with two auricles and a ventricle, red blood corpuscles are large, biconvex, oval and nucleated.
- Brain is not much developed, cranial nerves are 10 pairs.
- Sexes are separate, i.e., dioecious, male without copulatory organ.
- Eggs with gelatinous covering, usually laid in water.
- Fertilization is external.
- Development is indirect with a tadpole larva which undergoes metamorphosis to become adult.

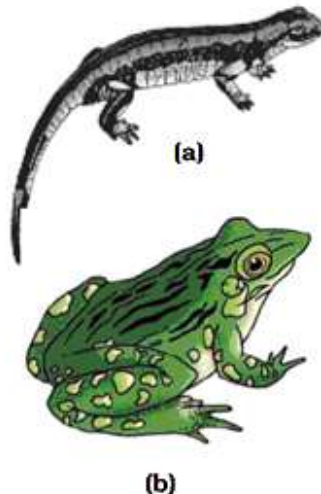


Figure Examples of Amphibia :
(a) *Salamandra*
(b) *Rana*

Example : Salamanders, frogs & toads. *Salamandra* (Salamander), *Necturus* (mud puppy), *Triturus* (newt), *Rana* (frog), *Bufo* (toad).

• **Class Reptilia :**

Characters :

- Two pairs of pentadactyl limbs are present ; but in snakes limbs are reduced or absent.
- Body is covered with epidermal horny scales.
- Skin is dry, impermeable and devoid of glands.
- Respiration takes place by lungs only. Gills are absent.
- They are cold blooded animals.
- Heart is incompletely four – chambered, having two auricles and incompletely divided ventricle. In crocodile, heart is completely four chambered.
- Sexes are separate.
- Fertilization is internal (characteristics of land animals).

Examples: *Testudo* (tortoise), *Chelone* (turtle) *Draco* (flying lizard), Chameleon, *Hemidactylus* (wall lizard), *Naja* (cobra) etc.

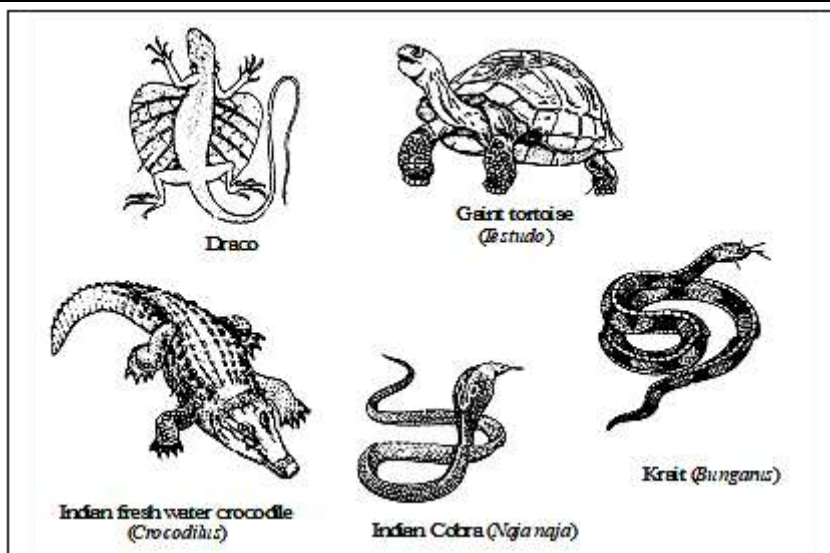


Fig. Reptiles

– **Boost your knowledge**

- ☛ Limbless amphibian called Ichthyophis.
- ☛ Reptiles do not have external opening. Tympanum represent ear.

• **Class Aves : (L. Aves = birds)**

The birds are described as ‘feathered reptiles’ that have developed the power of flight.

Characters :

- The body is covered with soft feathers (feathery exoskeleton). called Plumage
- The body is divisible into head, neck, trunk and tail.
- There are two pairs of limbs. The fore limbs are modified to form wings (in flying birds) or are reduced (as in non-flying birds). Hind limbs are strongly developed for perching, walking.
- Endoskeleton is light. The bones have air cavities (Pneumatic bones). This makes the bird light.
- Jaws are modified to form a strong beak.
- Teeth are absent.
- Respiration is by lungs only. Lungs have additional bag like membranous extensions called as air sacs.
- They are **warm blooded** animals i.e. their body temperature is constant and does not change with atmospheric temperature.
- Heart is completely four chambered.
- Sexes are separate.
- Birds are oviparous, i.e. egg laying.
- Fertilization is internal. Fertilized eggs are laid with a yolk (stored food) and with a hard calcareous shell.
- Like reptiles and mammals, they have the embryonic membranes namely the amnion, chorion, yolk – sac and allantois.
- High degree of parental care is exhibited.
- There is no larval stage in development.

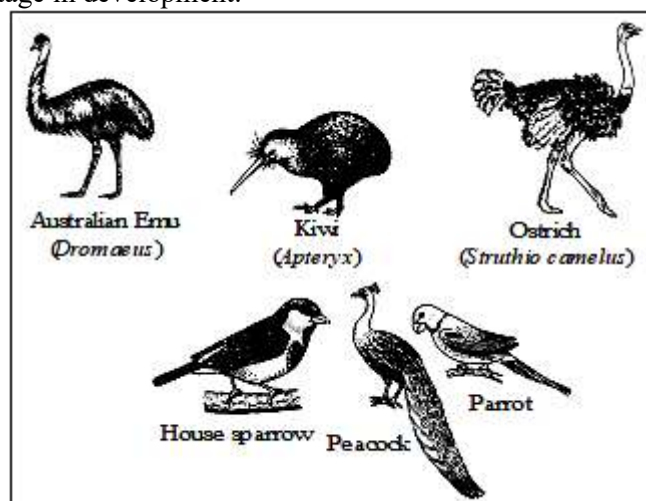


Fig. Birds

Examples: *Columba* (pigeon), *Pavo* (peacock), *Corvus* (crow), *Passer* (sparrow). *Struthio camelus* (ostrich), *Kiwi* and *Penguin* are flightless birds. White Stork (*Ciconia ciconia*) Male Tufted duck (*Aythya fligula*)

• **Class Mammalia :**

(**L. mamma = breast ; the mammals**)

- Mammalia is the most evolved group of organisms and are found in diverse habitats ranging from deserts, polar ice caps, oceans, mountains, forests and grasslands.
- They are named mammals as all of them possess mammary glands (milk producing glands). Mammals are the only animals which feed their young ones with milk.

Characters :

- Skin is covered with an exoskeleton of hair. Hair are provided with sweat glands which help in the regulation of body temperature. In aquatic mammals, hair being negligible, the subcutaneous layer of fats provides insulation.
- Mammals have two pairs of pentadactyl limbs.
- The body cavity is unequally divided into two parts by a muscular partition called as diaphragm.
- Eyes are provided with movable lids.
- Ears have fleshy external ears or pinnae.
- Teeth are embedded in sockets (thecodont). Two sets of teeth develop in the life time of a mammals Milk teeth and permanent teeth (diphyodont).
- Teeth are of different types (heterodont).
- Respiration occurs by lungs.
- Heart is four chambered. R.B.Cs are non nucleated and usually circular.
- Sexes are separate. Gonads are paired. Testes lie commonly in the scrotal sacs outside the abdomen.
- Fertilization is internal. Eggs are small, microscopic without shells and are retained in uterus of female for development.
- Embryonic membranes (amnion, chorion, yolk sac and allantois) present.
- They give birth to living young ones and are called as viviparous.
- The young ones are fed on milk from mammary glands.

Important Groups of Mammals : Mammals are divided into three main groups.

- (1) **Egg-laying mammals (monotremes) :** These mammals show characters of both reptiles and mammals. They lay hard shelled eggs (oviparous)

Example : Spiny ant eater, Duck – billed platypus

- (2) **Marsupial mammals (pouched mammals):**

- Pouched or marsupial mammals (Latin marsu-pium = pouch) They are viviparous.
 - The young ones, when born, are cared in pouch called marsupium present on the mother's abdomen.
 - In the pouch, they feed on the mother milk
- Example : *Kangaroo* (*Macropus*), Kola bear.

- (3) **Placental mammals (true mammals) :** These mammals with true placenta.

- The embryo is retained in the uterus.
 - These are the very successful group of land animals, occurring in diverse climatic conditions.
- Example : Mole, bat, lion, tiger, camel, giraffe, whale, dolphin, monkey, humans etc.

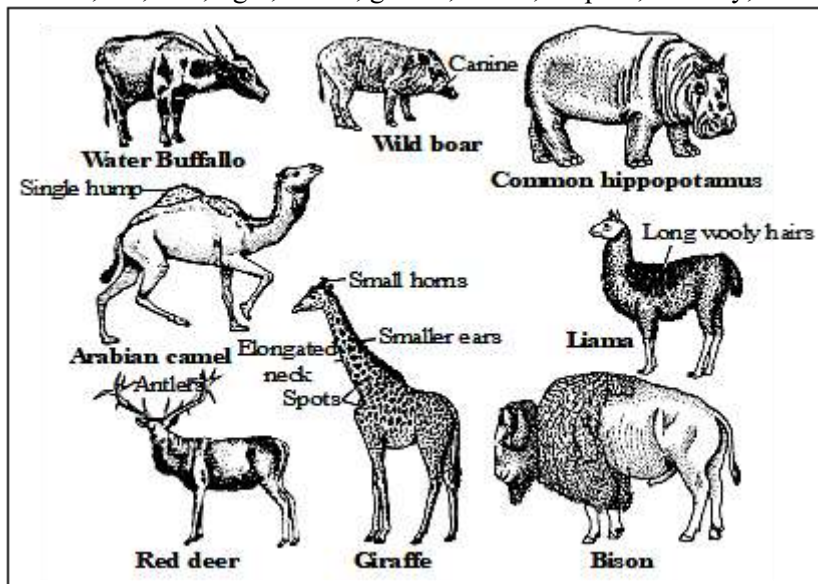
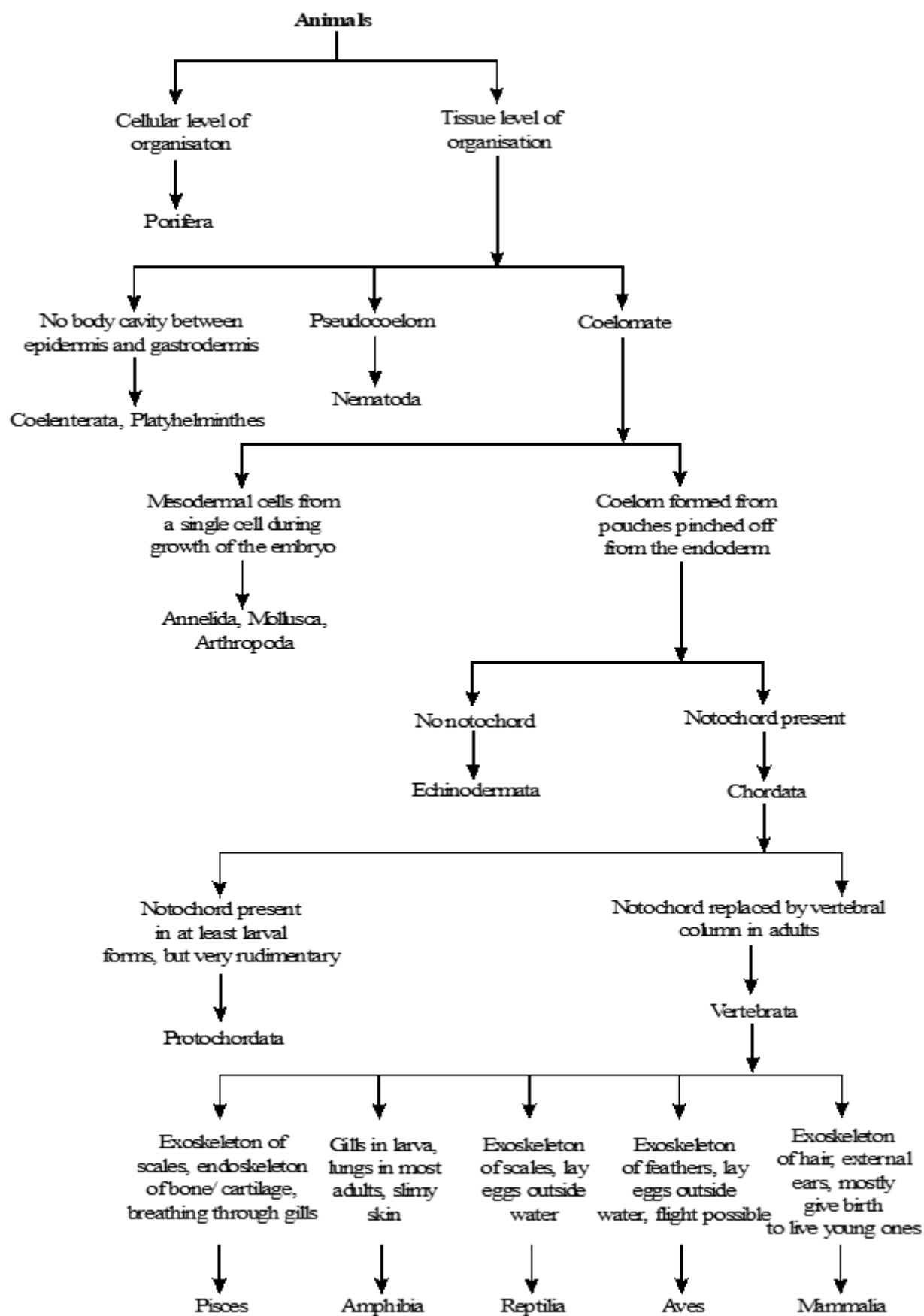


Fig. Mammals

– **Boost your knowledge**

- Blue whale & dolphin are the only mammal that lives in water.
- Mammals maintain fixed body temperature therefore they are called **warm blooded animals**



Classification of animals