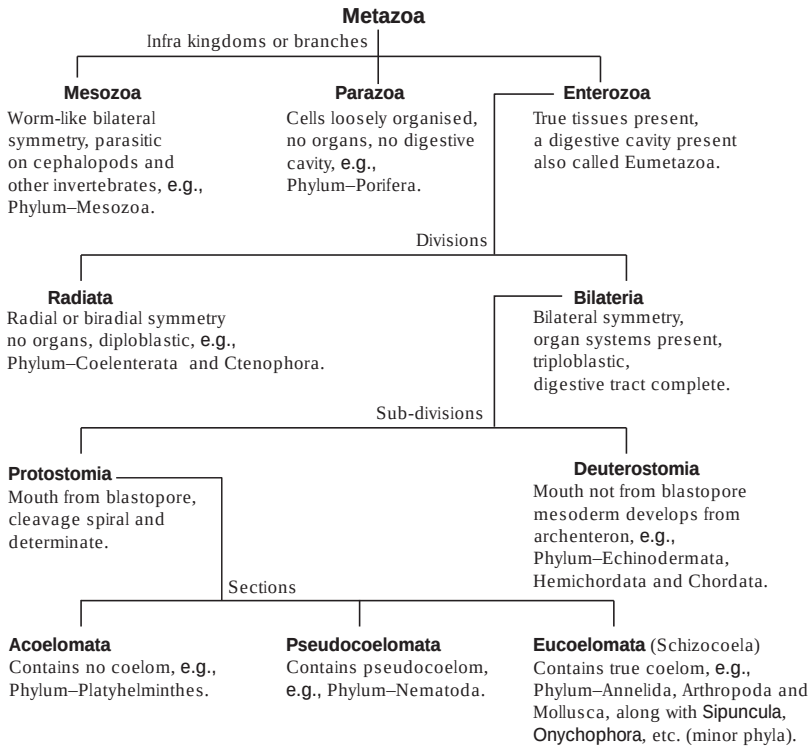
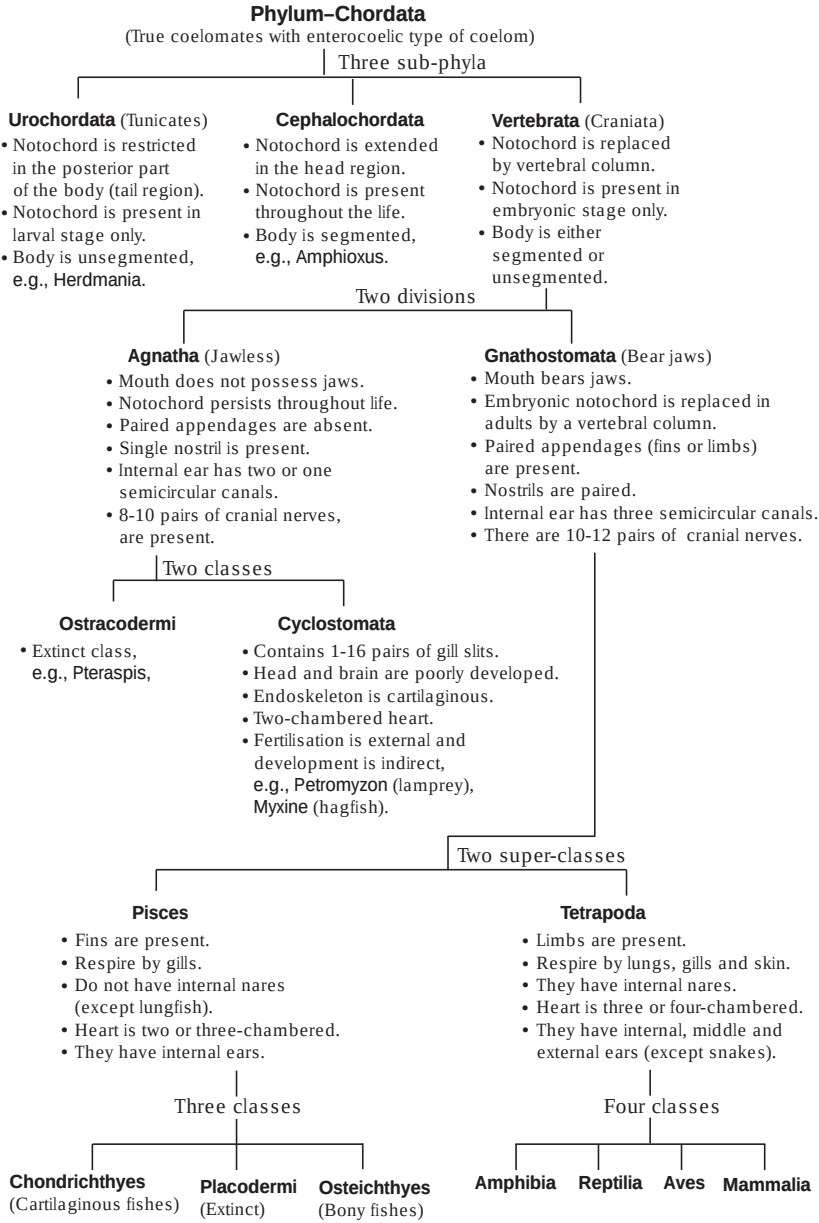
4

Animal Kingdom

Kingdom Animalia is characterised by multicellular, eukaryotic animal forms. It is also known as **Metazoa**. It includes around 1.2 million species of animals from sponges to mammals (other than protozoans).



Classification of Metazoa



Classification of Phylum Chordata

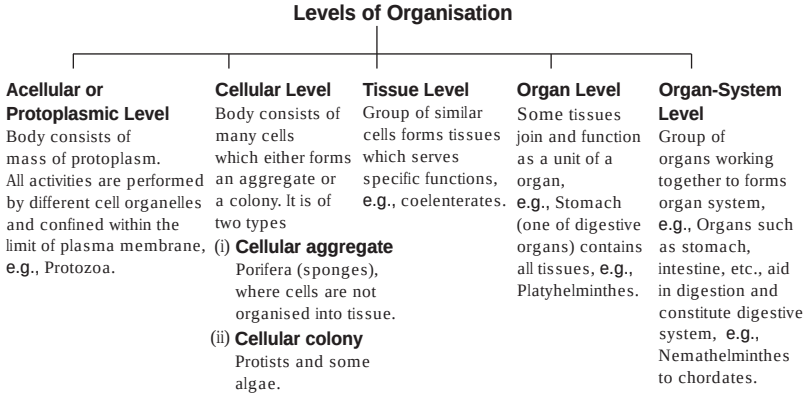
Basis of Classification

There are few fundamental common features to various animal groups, which form the basis of classification. **These features are as follows**

1. Level of Organisation

Though, all the members of kingdom–Animalia are multicellular, yet all of them do not exhibit the same pattern of cellular organisation.

Different levels of organisation are discussed below



2. Symmetry

It refers to the correspondence of body parts in all major respect like size, shape, position, etc., with the parts on opposite side when divided from the central axis.

Types of symmetry found in animals are

(i) **Radial symmetry** In radial symmetry, the animal gets divided into two '**identical halves**' when any plane passes through the central axis, **e.g.,** coelenterates, echinoderms.

(ii) **Bilateral symmetry** In bilateral symmetry, body is divided into two '**identical halves**' only when a plane passes through the median longitudinal axis, **e.g.,** annelids, arthropods, etc.

3. Germ Layers

These are the groups of cells behaving as a unit during early stages of embryonic development. On the basis of number of germ layers, animals are placed in two groups, **i.e.,** diploblastic and triploblastic. These groups are divided at the gastrulation stage.

(i) Diploblastic

Embryo is two-layered consisting an outer ectoderm and inner endoderm, **e.g., Hydra,** jellyfish, etc.

(ii) Triploblastic

Embryo is three-layered consisting of an outer ectoderm, middle mesoderm and inner endoderm, **e.g.,** humans.

4. Coelom

It is a large fluid-filled space or cavity lying between the outer body wall and inner digestive tube.

Types of Coelom

Internal body cavity separates digestive tract from outer body wall

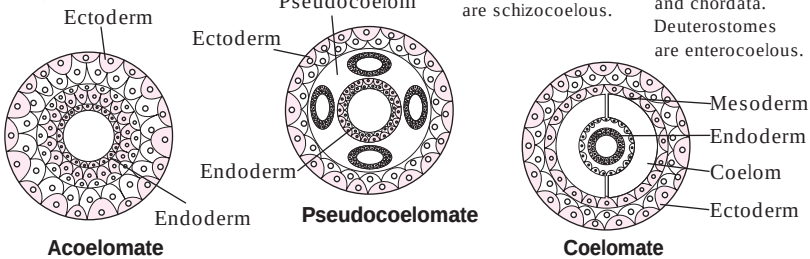
Acoelom
There is no body cavity. Region between the ectodermal epidermis and the endodermal digestive tract is completely filled with mesoderm in the form of a spongy mass of space filling cells called **parenchyma**. e.g., Porifera, Coelenterata, Ctenophora and Platyhelminthes.

Pseudocoelom
The presence of false coelom or perivisceral cavity. Coelom is not lined by mesoderm and directly connected to archenteron. Developmentally, pseudocoelom is the persistent blastocoel of blastula stage, e.g., Rotifera, Aschelminthes and Nematoda.

Eucoelom or True Coelom
True body cavity develops entirely lined with the mesoderm, e.g.,higher invertebrates (Annelida, Echinodermata and Chordata).

Schizocoel
Developed as a split in the mesoderm sheet, e.g., Annelida to Arthropoda. Protostomes are schizocoelous.

Enterocoel
Formed from the pouches of the archenteron or primitive gut. e.g., Echinodermata and chordata. Deuterostomes are enterocoelous.



Digrammatic sectional view of coelom

5. Segmentation

It is the serial repetition of similar parts along the length of an animal.

It is of two types

(i) **Pseudosegmented** (strobilisation) Body is divided into number of pseudosegments (proglottids) which are independent of each other, **e.g.,** tapeworms.

(ii) **Metameric** Linear repetition of body parts (somites), **e.g.,** annelids, arthropods and chordates.

6. Notochord

It is a rod-like structure present on the dorsal side of the animal body. It is derived from the embryonic mesoderm. Based on its presence and absence, animals are non-chordates (phylum–Porifera to Echinodermata) and chordates (phylum–Chordata).

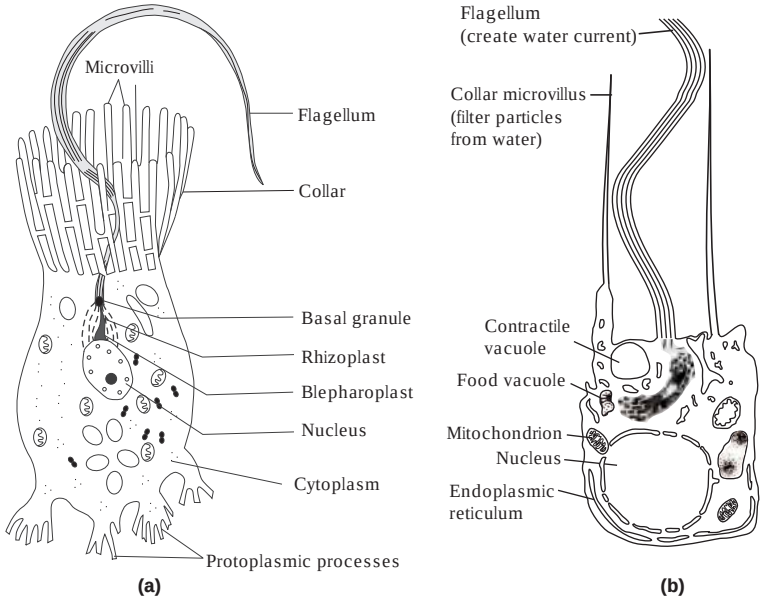
Major differences between Chordata and Non-Chordata are as follows

Chordata	Non-Chordata
Bilaterally symmetrical.	Asymmetrical, radially symmetrical or bilaterally symmetrical.
True metamerism.	Non-segmented, false segmented or true metamerically segmented.
True coelomates.	Acoelomate, pseudocoelomate or true coelomates.
Post-anal tail usually present.	It is usually absent.
Triploblastic animals.	Cellular, diploblastic or triploblastic animals.
Alimentary canal is always ventrally placed to nerve cord. Heart is ventrally placed.	It is always dorsally placed to the nerve cord. Heart is dorsal or absent.
Central nervous system is hollow, dorsal and single.	Central nervous system is ventral, solid and double.
Pharynx is perforated by gill slits.	Gill slits are absent.

Phylum–Porifera

Poriferans bear numerous minute pores called **ostia** on the body wall, which leads into a central cavity called **spongocoel** or **paragastric cavity**. The spongocoel opens to outside by **osculum**.

Majority of poriferans (sponges) are marine and sedantry. They are diploblastic animals and contain an outer dermal layer of pinacocytes and inner gastral layer of choanocytes.



Choanocyte : (a) Light microscopic view
(b) Electron microscopic view

Canal System (Aquiferous system)

It is a system of interconnected canals through which water circulates and helps in a number of metabolic activities of a sedentary sponge. In sponges, canal system is of three types, **i.e.**, asconoid, syconoid and leuconoid.

Different Types of Canal System

Asconoid Canal System	Syconoid Canal System	Leuconoid Canal System
Simplest type with thin walls.	Complex type with thick walls.	Much complex type with highly folded thick walls.
Spongocoel is large and spacious.	Spongocoel is narrow.	Spongocoel is either reduced or absent.

Asconoid Canal System	Syconoid Canal System	Leuconoid Canal System
Choanocytes form the gastral layer and lines the whole spongocoel.	Choanocytes are restricted in radial canals only.	Choanocytes are confined in the flagellated chambers which are formed by the evagination of radial canals.
Route of water is Outside water → (Dermal) Ostia → Spongocoel → (Osculum) Outside **e. g., Leucosolenia.**	Route of water is Outside water → (Dermal) Ostia → Incurrent canal → (Prosopyle) Radial canal → (Apopyle) Excurrent canal → (Gastral) Ostia → Spongocoel → (Osculum) Outside **e.g., Grantia.**	Route of water is Outside water → (Dermal) Ostia → Hypodermal spaces → Incurrent canals → (Prosopyle) Flagellated chambers → (Apopyle) Excurrent canal → (Osculum) Excurrent spaces → Outside, **e. g., Plakina.**

Reproduction

In sponges, reproduction occurs by both asexual and sexual means.

(i) **Asexual reproduction** Mainly occurs by budding and gemmules.

(ii) **Sexual reproduction** Occurs with the help of amoebocyte or archeocytes or sometimes through choanocytes.

Classification of Porifera

Phylum–Porifera

Three classes

Calcispongiae or Calcarea
- Skeleton of calcareous spicules.
- Large choanocytes.
- Small-sized species.

Hyalospongiae or Hexactinellida
- Skeleton of siliceous spicules.
- Small choanocytes.
- Moderately-sized species.

Demospongiae
- Skeleton of spongin fibres or may be absent.
- Very small choanocytes.
- Large-sized species.

Common and Scientific Names of Some Members of Porifera

Common Species of Porifera	Scientific Name	Common Species of Porifera	Scientific Name
Glass rope sponge	**Hyalonema**	Venus flower basket	**Euplectella**
Bath sponge	**Euspongia**	Bowl sponge	**Pheronema**
Freshwater sponge	**Spongilla**	Dead man's finger sponge	**Chalina**
Urn sponge	**Scypha**	Boring sponge	**Cliona**

Economic Importance

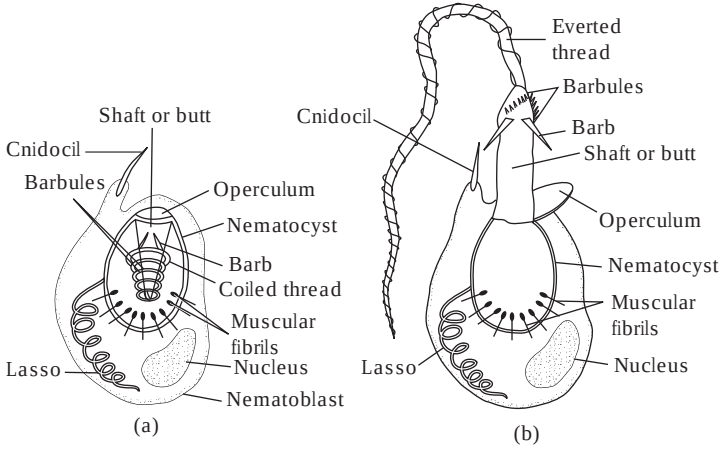
- They are used commercially for bathing/cleaning sponges.
- They help to clean-up the ocean floor by boring into dead shells and corals releasing chemicals to break them down.

Phylum–Coelenterata (Cnidaria)

Coelenterates are the animals bearing a special body cavity called **coelenteron** (gastrovascular cavity). They exhibit dimorphism and display two major forms namely polyp (sedentary) and medusa (swimming). They also exhibit trimorphism (**e.g., Siphonophora**) and polymorphism (**e.g., Porpita**).

Body Wall

They are diploblastic animals and their body wall contains several types of cells, **e.g., stinging cells** (cnidoblast/nematocyst)**, interstitial cells** (totipotent cells)**, sensory cells, nerve cells,** etc.



Cnidoblast Cells : (a) Undischarged (b) Discharged

Skeleton

In coelenterates, skeleton may be endoskeleton, exoskeleton or absent.

- **Endoskeleton e.g.**, **Alcyonium** (fleshy mesogloea), **Pennatula** (axial rod of calcified horn).
- **Exoskeleton e.g.**, **Millipore** (coenosteum), **Gorgonia** (gorgorin), **Madrepora** (corallum).
- **Absent e.g.**, sea anemones.

Metagenesis

It is like the alternation of generations between the sexual (medusa) and asexual (polyp) forms. In contrast to alternation of generation in metagenesis, it is difficult to distinguish between asexual and sexual forms as both individuals are diploid.

Reproduction

It occurs both by sexual and asexual means.

(i) **Asexual reproduction** By external budding.

(ii) **Sexual reproduction** By sexual medusae. The development is usually indirect which occurs through ephyra, planula and hydrula larvae.

Classification of Coelenterata

Phylum–Coelenterata

Three classes

Hydrozoa
- Both polyp and medusa present. Polyp stage dominant, medusa stage reduced or absent.
- Velum is present.
- Gonads are epidermal in origin.
- Larva hydrula, planula,

Scyphozoa
- Medusa form is dominant. Polyp represented as scyphistoma stage.
- Pseudovelum is present.
- Gonads are endodermal in origin.
- Larva ephyra.

Anthozoa (Actinozoa)
- Medusa form is absent.
- Velum is absent.
- Gonads, if present are endodermal in origin.
- Corals and sea anemone.

Common and Scientific Names of Some Coelenterates

Common Names of Coelenterates	Scientific Name	Common Names of Coelenterates	Scientific Name
Sail-by-wind	**Valella**	Organ-pipe coral	**Tubipora**
Portuguese man of war	**Physalia**	Stag horn coral	**Madrepora**
Stinging coral	**Millipora**	Mushroom coral	**Fungia**
Sea anemone	**Metridium**	Star coral	**Astraea**
Dead's man finger coral	**Alcyonium**		

Economic Importance

- They take part in the formation of coral reefs, **e.g.**, **Millipora** (stinging coral).
- Their skeleton has medicinal value, **e.g., Tubipora** (organ-pipe coral).
- They have ornamental value, **e.g**., **Astraea** (star coral).

Phylum–Ctenophora

The members of this phylum are generally marine, solitary, free-swimming or pelagic. They are diploblastic animals and acoelomates.

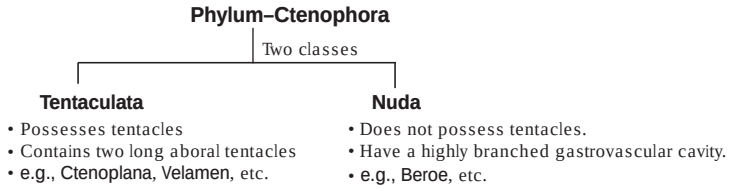
Peculiar Characteristics

A gelatinous mesoglea is present between epidermal and gastrodermal tissue layers. They are also called **comb plates. Colloblast cells** are the sensory and adhesive cells.

Reproduction

Sexes are not separate. All are hermaphrodites. Gonads develop from endosperm. Fertilisation is internal. Development is indirect through **cydippid** larva.

Classification of Ctenophora



Common and Scientific Names of Some Ctenophores

Common Name of Ctenophores	Scientific Name
Venus Girdle	**Velamen**
Sea walnut	Pleurobrachia
Swimming eye of cat	Beroe

Economic Importance

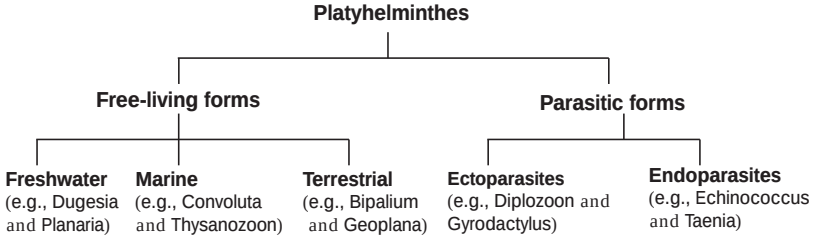
- They reproduce quickly and are good predators.
- They can bring down an ecosystem.

Phylum–Platyhelminthes

They are dorsoventrally flat animals having either unsegmented and leaf-like (**e.g.**, flukes) or segmented and ribbon-like (**Taenia**) body. They are the first animals to have bilateral symmetry and to undergo **cephalisation**.

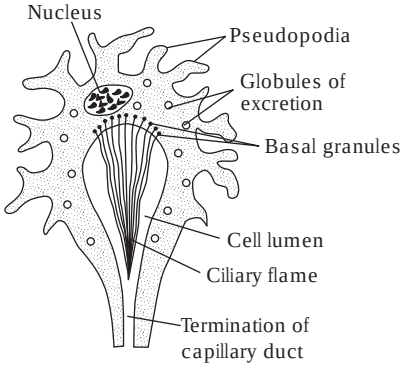
Habitat

They are mostly found as free-living forms, but few of them are parasitic in their habitat.



Peculiar Features

These are the first animals with **triploblastic layers** in body wall and **organ system organisation**. They are **acoelomates** due to the presence of a mesodermal connective tissue, **parenchyma**, in between the visceral organs. These animals have ladder-type nervous system and peculiar cells called **flame cells or protonephridia for excretion**. These cells are modified mesenchymal cells.

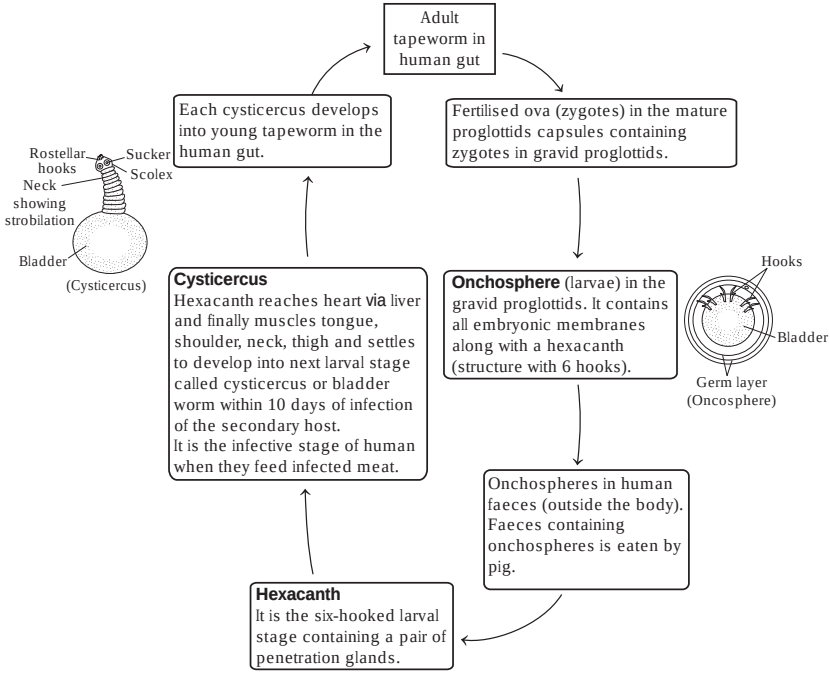


Flame cell (Solenocyte)

Reproduction

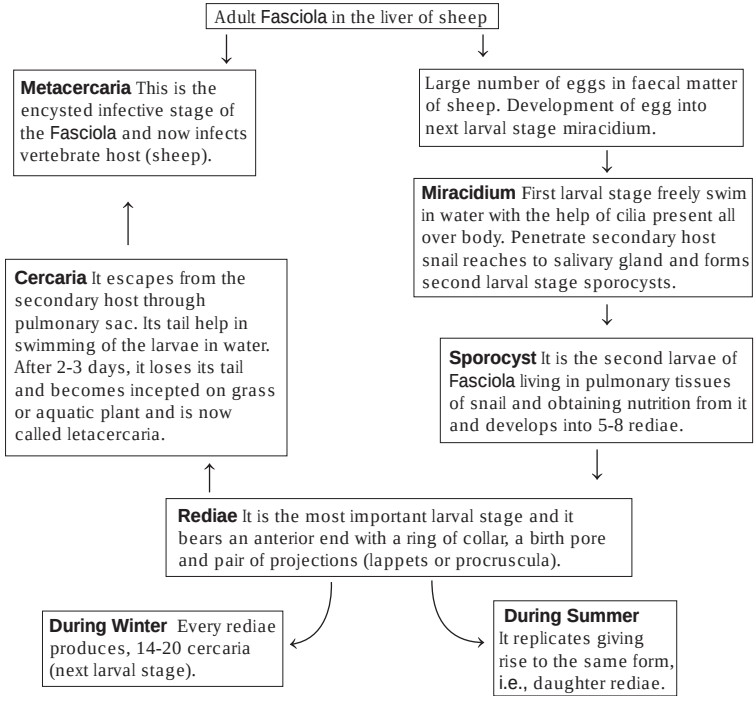
These animals are generally bisexual. **Cross- fertilisation** occurs in trematodes, while **self-fertilisation** occurs in cestodes. Fertilisation is always internal. Turbellarians reproduce by **transverse fission.**

Life Cycle of Taenia solium



The graphical representation of life cycle of Taenia solium depicting different larval stages and adult form in the primary and secondary hosts

Life Cycle of *Fasciola hepatica*



Graphical representation of life cycle of Fasciola hepatica depicting polyembryony along with different larval stages

Classification of Plathelminthes

Phylum–Platyhelminthes

Three classes

Turbellaria

- Mostly non-parasitic and free-living.
- Unsegmented and flat leaf-like. Body wall contains
- syncytial epidermis with rod-shaped rhabditis, e.g., Planaria.

Trematoda

- Ecto or endoparasites.
- Unsegmented and flat leaf-like.
- Body wall contains cuticular spines, e.g., Fasciola.

Cestoda

- Exclusively endoparasites
- Segmented and ribbon-like.
- Body wall is lined by microvilli. e.g., Taenia.

Common and Scientific Names of Some Platyhelminthes

Common Names of Platyhelminthes	Scientific Name	Common Names of Platyhelminthes	Scientific Name
Liver fluke	**Fasciola hepatica**	Pork tapeworm	**Taenia solium**
Planarian	**Dugesia**	Hydatid worm or dog tapeworm	**Echinococcus granulosus**

Economic Importance

- **Fasciola** causes **fascioliosis** or **liver rot** which is characterised by hepatitis.
- **Echinococcus** causes hydatid disease which is characterised by enlargement of liver.

Phylum–Aschelminthes

They are long, cylindrical, unsegmented and thread-like animals with no lateral appendages, so these are commonly called **roundworms**, **bagworms** or **threadworms.**

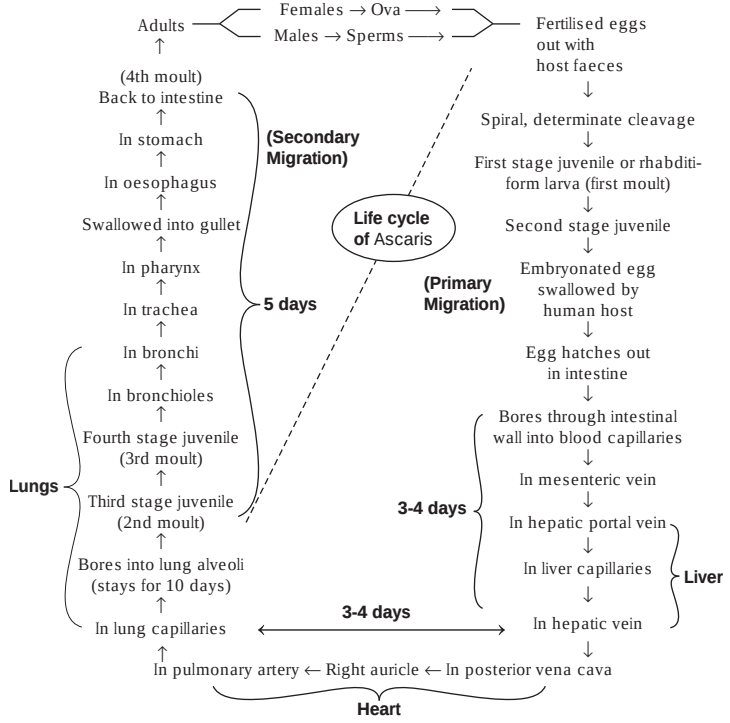
Peculiar Features

Body wall of these pseudocoelomate animals is composed of complex cuticle, syncytial epidermis and only longitudinal muscles. They have **tube-within-tube plan of digestive system**.

They have fixed number of cells in every organ of the body (eutylic condition). Excretory system is H-shaped and contains **rennete cells**.

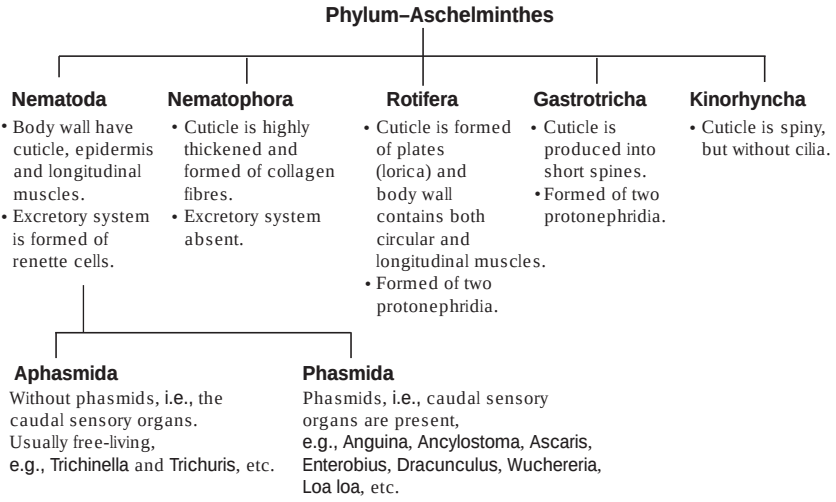
Reproduction

Sexual dimorphism is present and males are smaller than females. Fertilisation is internal and it may be direct or indirect.



A graphical representation of life cycle of Ascaris

Classification of Aschelminthes



Common and Scientific Names of Some Aschelminthes

Common Names of Aschelminthes	Scientific Name	Common Names of Aschelminthes	Scientific Name
Roundworm	**Ascaris lumbricoides**	Guinea worm	**Dracunculus medinesis**
Root-knot eel worm	**Meloidogyne marioni**	Pinworm	**Enterobius vermicularis**
Filarial worm	**Wuchereria bancrofti**	Whipworm	**Trichuris trichiura**
Eye worm	**Loa loa**		

Economic Importance

- **Ascaris** causes ascariasis in humans.
- **Meloidogyne** is a harmful phytoparasitic nematode.

Phylum–Annelida

Annelids are segmented worms with an elongated body possessing triploblastic layers. Their musculature is formed of only smooth muscle fibres of two types, **i.e.,** longitudinal (inner) and circular (outer) muscles.

Peculiar Features

- These animals show **metameric segmentation**, **i.e.**, the external division of the body by annuli corresponds to internal division of coelom by septa.
- These are the first animals to have circulatory system.
- Locomotory organs are minute rod-like chitinous **setae** or **suckers** which are embedded over **parapodia**.
- A characteristic **circumoesophageal ring** is present in the anterior part of CNS.
- Special structures called **nephridia** are present for excretion.

Reproduction

Asexual reproduction By fragmentation is seen in some polychaetes.

Sexual reproduction Sexes are either united (**e.g.,** oligochaetes) or separate (**e.g.,** polychaetes). Fertilisation is internal (**e.g., Hirudinaria**) or external (**e.g.,** earthworm). Development is direct in monoecious form and indirect in dioecious form involving a free-swimming **trochophore** larva.

Classification of Annelida

Phylum–Annelida

Three classes

Polychaeta
- Marine, fossorial or tubicolous.
- Distinct head bearing tentacles, palps and eyes.
- Bristle-like setae and parapodia for locomotion
- Clitellum is absent.
- Unisexual, e.g., Aphrodite and Chaetopterus.

Oligochaeta
- Terrestrial, freshwater
- Distinct head with eyes (palps and tentacles are absent).
- Locomotion by peristalsis, parapodia is absent.
- Permanent clitellum is present.
- Bisexual, e.g., Pheretima and Tubifex.

Hirudinea
- Mostly freshwater, few marine.
- No cephalisation
- Locomotion by anterior and posterior suckers.
- Clitellum appears during breeding season.
- Bisexual, e.g., Hirudinaria and Acanthobdella.

Common and Scientific Names of Some Annelids

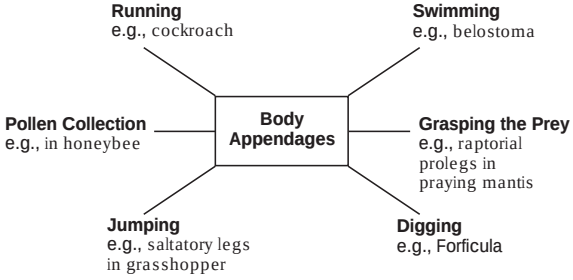
Common Names of Annelids	Scientific Names	Common Names of Annelids	Scientific Names
Earthworm	**Pheretima posthuma**	Paddle worm	**Chaetopterus**
Clam worm	**Nereis**	Blood worm	**Glycera**
Polalo worm	**Eunice**	Skate sucker	**Pontobdella**
Sea mouse	**Aphrodite**	Lung worm	**Arenicola**

Economic Importance

- Earthworms are used as fish-baits and for improving the soil fertility.
- **Polynoe** shows bioluminescence and this phenomenon is used in self-defence.
- **Tubifex** has putrefaction ability and is grown in filtre beds of sewage disposal plants.
- **Pontobdella** causes huge food loss to man when present in large number.

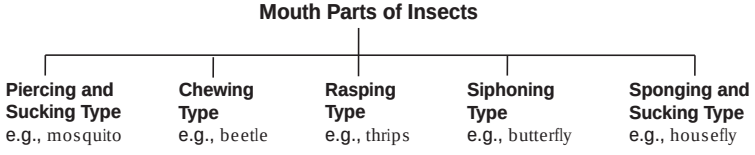
Phylum–Arthropoda

It is the largest phylum of Animalia which includes insects with jointed legs and sclerotised exoskeleton. Their body is divided into three parts or tegmata, **i.e., head**, **thorax** and **abdomen**. They are haemocoelomates, **i.e.,** true coelom is replaced by haemocoel (pseudocoel with blood). The body appendages are variedly modified in different arthropods to perform various functions.

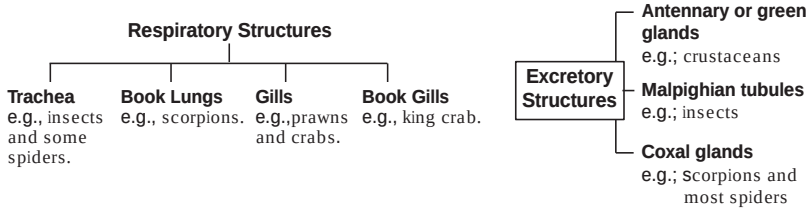


Peculiar Features

- They are the first animals to have an **endoskeleton** and **voluntary muscles** in their body wall.
- They have well-developed sensory organs which include antennae, sensory hair, simple or compound eyes, auditory organs and statocyst.
- They have well-developed **endocrine system** containing glands like corpora cardiaca, corpora allata, etc.
- Mouth is always surrounded by mouth parts of different types in different animals.



Arthropods have special respiratory and excretory structures as follows



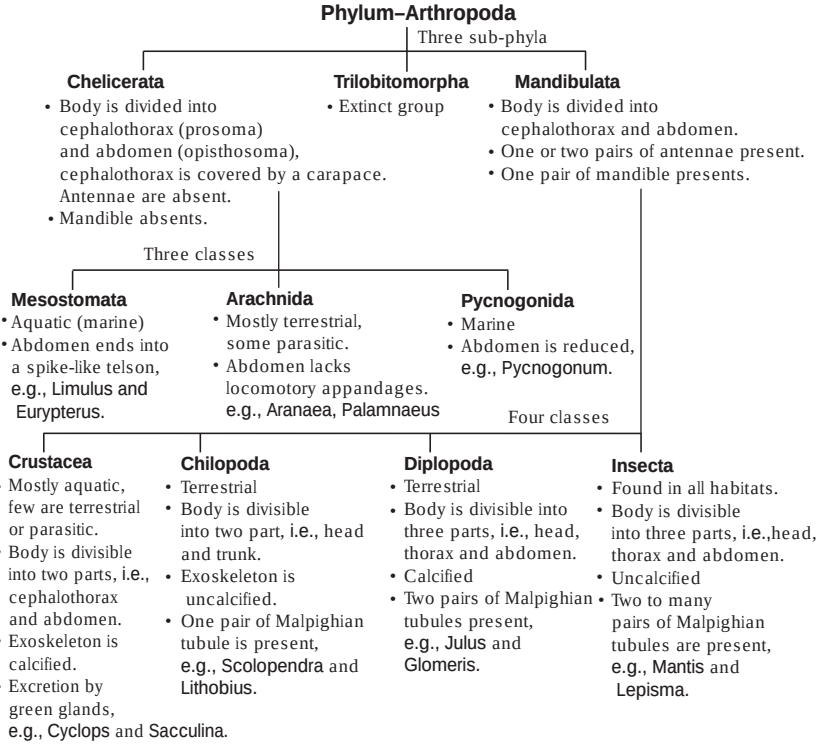
- Their nervous system possesses all the three types, **i.e., central**, **peripheral** and **autonomic**.

Reproduction

Sexes are separate and fertilisation is internal. These animals are generally oviparous or ovoviviparous.

Development may be direct (**e.g.,** cockroach) or indirect. Some arthropods undergo parthenogenesis, **e.g.,** drones of honeybee.

Classification of Arthopoda



Common and Scientific Names of Some Arthropods

Common Names of Arthropods	Scientific Name	Common Names of Arthropods	Scientific Name
Walking worm	**Peripatus**	Grasshopper	**Poecilocercus**
Prawn	**Palaemon**	House cricket	**Gryllus**
Spiny lobster	**Palinurus**	Praying mantis	**Mantis religiosa**
Brown crab	**Cancer**	Earwig	Forficula
Root-headed barnacle	**Sacculina**	Dragon fly	**Sympetrum**
Hermit crab	**Eupagurus**	Silkmoth	**Bombyx mori**
Goose-barnacle	**Lepas**	Yellow wasp	**Polistes**
Rock barnacle	**Balanus**	Honeybee	**Apis indica**
Silverfish	**Lepisma**	Millipede	**Thyroglutus**
Cockroach	**Periplaneta**	Centipede	**Scolopendra**
Desert locust	**Schistocerca**	Horseshoe crab	**Limulus**

Economic Importance

- **Limulus** is a living fossil.
- Honeybee produces wax and honey.
- **Peripatus** acts as a connecting link between Arthropoda and Annelida.
- Prawn and lobster are used as food in many countries.
- **Microtreme** (white ant-termite) causes loss to furniture and other wooden articles.

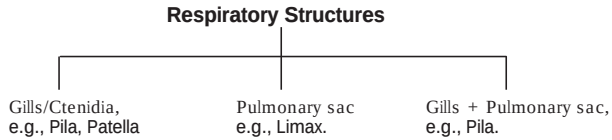
Phylum–Mollusca

Phylum–Mollusca is the second most abundant phylum which contains soft-bodied animals usually protected by a calcareous shell and a ventral muscular foot. The study of molluscs is called **Malacology**, while study of molluscan shell is called **Concology**.

Peculiar Features

- They generally have an exoskeleton of calcareous shell which may be internal or absent.
- Body is divisible into three parts, **i.e.,** head, foot and mantle cavity.
- A glandular fold called **mantle** or **pallium** is present in the body wall.
- A rasping organ called **radula** is present in buccal cavity of most of molluscs.
- A peculiar sense organ called **osphradium** check the quality of water.

Respiration occurs by the following structures



Excretion occurs by 1 or 2 pairs of metanephridial tubules called **kidneys** or **organs of Bojanus**. Pelecypods also have a large, reddish-brown **Keber's organ** in front of pericardium for excretion. Nervous system is formed of 3-paired ganglia, **i.e.,** cerebral, pedal and visceral ganglia.

Reproduction

Sexes are usually dioecious, but some are hermaphrodite, **e.g., Doris, Limax**, etc. Most forms are oviparous, but only a few are viviparous (**e.g., Pecten**). Fertilisation is external (**e.g., Patella**) or internal (**e.g., Pila**).

Development is either direct (**e.g.,** all pulmonates and cephalopods) or indirect including **trochophore**, (**e.g., Chiton**) or **glochidium** (**e.g., Unio**) or **velliger** (**e.g., Dentalium**) larvae.

Classification of Mollusca

Scaphopoda
- Tusk-like shell opens at both sides.
- Head is absent.
- Radula is present.
- Foot is conical-shaped for digging.

e.g., Dentalium.

Monoplacophora
- Limpet-shaped shell formed of single value.
- Head bears tentacles, but eyes are absent.
- Radula is present.
- Foot is broad and flat and has 8 pairs of pedal retractor muscles,

e.g., Neopilina.

Phylum–Mollusca

Pelecypoda (Bivalvia)
- Two-valved shell.
- Head is absent.
- Radula is absent.
- Foot is wedge-shaped and muscular for creeping or burrowing.
- Absent in sedentary forms.

e.g., Pecten.

Amphineura
- Shell is formed of 8 plates.
- Head is reduced and lacks tentancles and eyes.
- Radula is usually present.
- Foot is large, flat and muscular.
- Absent in some forms,

e.g., Chiton.

Gastropoda
- Spirally coiled shell, but absent in pulmonates.
- Head bears both eyes and tentancles.
- Radula is present.
- Foot is large and flat for creeping and attachment,

e.g., Pila.

Cephalopoda (Siphonopoda)
- Externally spiral shell.
- Well-developed, internal or absent.
- Head bears a pair of large complex eyes.
- Radula is present.
- Foot is partially modified into 8-10 suckers and partially into siphon or funnel.

e.g., Octopus.

Common and Scientific Names of Some Molluscs

Common Names of Molluscans	Scientific Name	Common Names of Molluscans	Scientific Name
Sea mussel	**Mytilus**	Sea lemon	**Doris**
Edible oyster	**Ostrea**	Grey slug	**Limax**
Cockle	**Cardium**	Squid	**Loligo**
Rock-borer	**Pholas**	Cuttlefish	**Sepia**
Razor clam	**Solen**	Devil fish	**Octopus**
Scallop	**Pecten**	Pearly nautilus	**Nautilus**
Ear shell	**Haliotis**	Tusk shell	**Dentalium**
True limpet	**Patella**	Coat of mail shell	**Chiton**
Sea hare	**Aplysia**		

Economic Importance

- Molluscans like oyster, squid and cuttlefish are used as food in many countries.
- Shell of many molluscans is of ornamental value.
- **Dentalium** is used as decorative piece.
- **Sepia** ink has medicinal value.

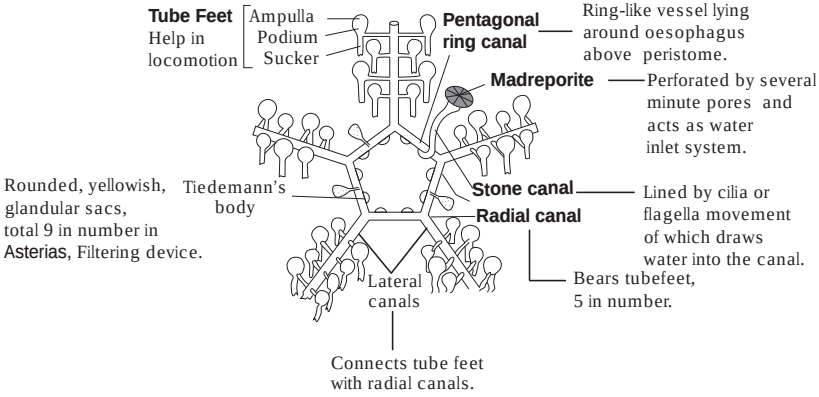
Phylum–Echinodermata

It is a group of exclusively marine, spiny-skinned animals. These triploblastic animals form the only phyla (except Chordata) which contains true endoskeleton (mesodermal origin).

Peculiar Features

- Adults with pentamerous radial symmetry, while larval forms with bilateral symmetry.
- Great power of **autotomy** and **regeneration**.
- Body surface of five symmetrical radiating areas or ambulacra and alternating between interambulacra. Ambulacra have tube feet for locomotion, respiration, etc.

- The presence of water vascular system of coelomic origin.



Water vascular system in Asterias

Degenerate Characters

- Head, respiratory pigment and excretory organs are absent.
- Sense organs are poorly developed.
- Nervous system is formed of nerve plexi.
- Circulatory system is of open type.

Classification of Echinodermata

Phylum–Echinodermata

Five classes

Asteroidea
- Star-shaped body with pentagonal disc.
- 5-50 arms are present.
- Bipinnaria larva, e.g., Asterias.

Ophiuroidea
- Star-shaped body with rounded disc.
- 5-7 arms are present.
- Pluteus larva, e.g., Ophiothrix.

Echinoidea
- Spherical, oval or heart-shaped body.
- Arms are absent.
- Echinopluteus larva, e.g., Echinus.

Holothuroidea
- Elongated and cylindrical body.
- Arms are absent.
- Auricularia larva, e.g., Holothuria.

Crinoidea
- Contains mostly extinct forms, e.g., Antedon.

Common and Scientific Names of Some Echinoderms

Common Names of Echinoderms	Scientific Name	Common Names of Echinoderms	Scientific Name
Starfish	**Asterias**	Basket star	**Gorgonocephalus**
Sea urchin	**Echinus**	Feather star	**Antedon**
Brittle star	**Ophiothrix**		

Economic Importance

- **Antedon** is supposed to be a living fossil.
- Eggs of sea urchin are used for embryological studies.
- Sea cucumber is used as food in many countries.

Phylum–Hemichordata

It includes acorn worms or tongue worms. These are commonly called **half chordates** or **pre-chordates**. They are exclusively marine, mostly tubicolous, primitive chordates. They are bilaterally symmetrical, triploblastic and enterocoelic true coelomates.

Peculiar Features

- Body is divided into three regions, **i.e.,** proboscis, collar and trunk.
- Their foregut gives out a thick and stiff outgrowth called **stomochord** or **buccal diverticulum**.
- Excretion occurs by a proboscis gland or glomerulus present in the proboscis in front of heart.
- Nervous system is of primitive type containing sub-epidermal nerve plexus.

Reproduction

They mainly reproduce by sexual reproduction. Sexes are usually separate and number of gonads varies from one to several pairs.

Fertilisation is external. Development is direct or indirect with a free-swimming tornaria larva.

Economic Importance

They show affinities with annelids, echinoderms and chordates.

Phylum–Chordata

Animals belonging to phylum–Chordata are characterised by the presence of **notochord**, **dorsal tubular nerve cord**, **gill-clefts** and **post-anal tail**. These four structures are found in the embryological stages of all chordates.

Notochord

It serves as a primitive internal skeleton. It may persist throughout life, as in cephalochordata, cyclostomata and some fishes. It may be replaced partially or completely by a backbone or vertebral column.

Dorsal Tubular Nerve Cord

It lies above the notochord and persists throughout life in most chordates, but in a few it degenerates before maturity.

Gill Clefts

They appear during the development of every chordate, but in many aquatic forms, they are lined with vascular lamellae which form gill for respiration.

Post-anal Tail

An extension of the body that runs past the anal opening.

In terrestrial chordates which never breathe by gills, traces of gill clefts are present during early development, but disappear before adult life.

Classification of Chordata

The various sub-phyla and divisions are already explained in the chapter starting.

Major classes of Chordata are discussed below

Pisces

Three classes

Chondrichthyes

- Cartilaginous endoskeleton.
- Exoskeleton is of placoid scales (dermal origin).
- Mouth is placed ventrally.
- External nares are ventral to head.
- Caudal fin is heterocercal.
- 5-7 pairs of gills are present.
- Swim bladder is absent.
- Gills are not covered by operculum.
- Electric organs (e.g., Torpedo) and poison sting (e.g., Trygon) are present.
- Mostly viviparous, e.g., Scoliodon (dog fish), Pristis (saw fish), Trygon (sting ray), Carcharodon (great white shark), Chimaera (rabbit fish) and Rhinobatos.

Osteichthyes

- Bony endoskeleton.
- Exoskeleton comprises cycloid, ctenoid or ganoid scales (mesodermal origin).
- Mouth is terminal.
- External nares are dorsal to head.
- Caudal fin is homocercal.
- Four pairs of gills are present.
- Swim bladder is present.
- Gills are covered by operculum.
- Electric organs all absent
- Mostly oviparous, e.g., Labeo (rohu), Clarias (magur), Pterophyllum (angel fish), Betta (fighting fish), Catla and Exocoetus (flying fish).

Placodermi

- Includes earlier fossils
- Body is with an external protective armour of bony scales or plates
- Jaws are primitive with teeth, e.g., Climatius, Palaeospondylus.

Tetrapoda

Four classes

Amphibia

- Cold-blooded.
- Skin is smooth . and glandular.
- Heart is with two auricles and one ventricle.
- Respiration occurs by lungs, buccopharyngeal cavity, skin and gills.
- RBCs are nucleated.
- They have largest RBCs of animal kingdom.
- Two pairs of limbs, each with five-toes.
- Skull is dicondylic.
- Fertilisation is external, oviparous.

Reptilia

- Cold-blooded.
- Skin is cornified and covered with scales.
- Heart consists of two. auricles and partly divided ventricle.
- Respiration occurs by lungs.
- RBCs are nucleated.
- Two pairs of pentadactyl limbs, each with 5 digits bearing claws corneoscutes. In snakes, limbs are absent.
- Skull is monocondylic.
- Thecodont teeth.
- Fertilisation is internal, oviparous.

Aves

- Warm-blooded.
- Skin is covered by feathers,
- Heart contains two auricles and two ventricles.
- Respiration occurs by lungs provided by air sacs.
- RBCs are nucleated.
- Forelimbs are modified to wings and hindlimbs are modified for walking, swimming and pearching.
- Hindlimbs bear claws and scales.
- Skull is monocondylic.
- Teeth are absent and upper and lower jaws are modified into beak.
- Fertilisation is internal, oviparous.

Mammals

- Warm-blooded.
- Skin is covered by epidermal hairs.
- Heart contains two auricles and two ventricles.
- Respiration occurs by lungs.
- RBCs are enucleated.
- Quadruped limbs whose digit ends with claws or nails or hooves.
- In whales and dolphins, limbs are absent.
- Skull is dicondylic.
- Thecodont, heterodont and diphyodont teeth.
- Fertilisation is internal,both oviparous and viviparous.

Amphibia

Class-Amphibia consists of two sub-classes, **i.e.**, **Stegocephalia** (extinct) and **Lissamphibia** (modern living amphibians). In contrast to Stegocephalia whose skin bears scales and bony plates, Lissamphibians do not possess bony dermal skeleton.

Lissamphibia is further divided into three orders as follows

Lissamphibia

Three orders

Apoda/Gymnophiona/Caecillians

- Also called **limbless amphibians**.
- Long worm-like, burrowing, dermal scales present in skin.
- Tail short or absent, cloaca terminal.
- Skull compact, roofed with bone.
- Males have protrisible copulatory organ.
- Larva has 3 pairs of external gills, gills also present in adult stage.
- e.g., Ichthyophis (blindworm), Ureotyphus.

Urodela/Caudata

- Also called **tailed amphibians.**
- **L**izard-like, limbs two pairs of weak and equal size.
- Commonly called newts and salamanders.
- Skin devoids of scales and tympanum.
- Possesses largest RBC.
- Gills permanant or lost in adults. (Necturus, Proteus, Siren and Axolotl larva have external gills). Fertilisation is internal.
- Larva aquatic, adult-like with teeth,
- e.g., Nectunes, Salotrandra and Ambystoma.

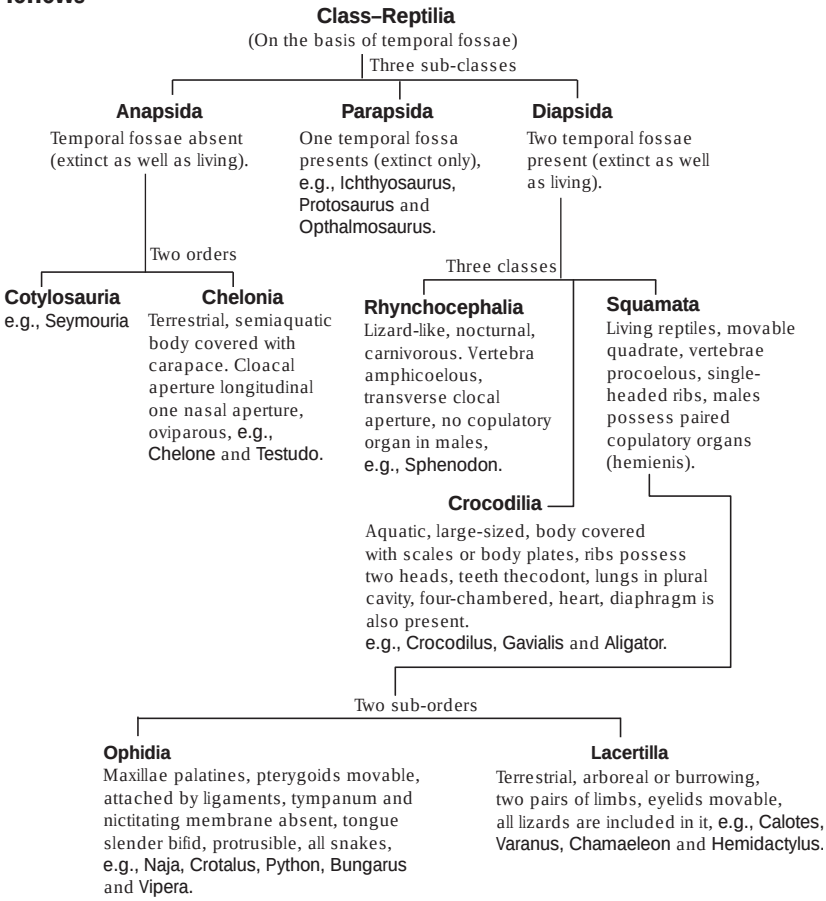
Anura/Salientia

- Also called tail-less amphibians.
- Commonly includes frogs and toads.
- Forelimbs shorter than hindlimbs.
- Adults without gills.
- Skin loosely fitting, scaleless, teeth present only on upper jaw or absent.
- Vertebral column very small of 5-9 procoelous.
- Vertebrae and a slender urostyle.
- Fertilisation always external.
- Full metamorphosis without neotenic forms e.g., Rana, Bufo, Hyla and Rhacophorus.

Reptilia

On the basis of the presence of **temporal fossae**, class–Reptilia is sub-divided into three sub-classes, **i.e.**, Anapsida, Parapsida and Diapsida.

These sub-classes are further divided into orders and sub-orders as follows



Aves

Class–Aves possesses various peculiar characteristics which are not found in other animal groups. They possess long bones with air cavities, **i.e., pneumatic** bones which reduce their body weight and hence, helpful in flight. Their bones also lack bone marrow.

Their sternum is large and bears a keel for the attachment of flight muscles. They do not possess skin glands except the cutaneous oil glands or **green glands** (or uropygial glands) that are located at the root of the tail. These glands are absent in parrot and ostrich.

Class–Aves is further divided into sub-classes and orders as follows

Class–Aves

Two sub-classes

Archaeornithes

(Gk. archios–ancient;ornithes–bird)

Includes extinct (in Mesozoic era) birds, homodont (same type of teeth) teeth in both the jaw, long tapering tail, weak, vertebrae are amphicoelous, keeled sternum, non-pneumatic bones, hand with clawed fingers wings are primitive with little power of flight, e.g., Archaeopteryx lithographica (ancient or lizard bird) and Archaeornithes.

Neonithes

(Includes extinct as well as living birds) Teeth absent except in some fossil birds, wings are well-developed and adapted for flight, tail short and reduced, fingers of the wings are without claw.

Four super-orders

Odontognathae

(Extinct cretaceous birds), jaw bears teeth for catching fish. e.g., Hesperornis, Ichthyornis.

Palaeognathae

(Flight less running birds)

- Wings vestigial or rudimentary, feathers without any interlocking mechanism.
- Oil gland is absent except in Tinamus and kiwi.
- Sternal keel is vestigial, flat or raft-like.
- Pygostyle is penis or reduced.
- Syrinx is absent.
- Male has a penis, e.g., Struthio camelus (African ostrich), Rhea americana (American ostrich), Dromaeus (emu), Casurarius (cassowary) Apteryx (kiwi), Tinamus (tinamou).

Impennae

- The super-order includes modern aquatic flightless birds with paddle-like wings or flippers.
- Feet are webbed.
- The skeleton is solid, air sacs are absent.
- The integument is a fatty insulating layer, e.g., Aptenodytes (emperor penguin), Eudyptes (rock hopper penguin).

Neognathae (Carinatar)

- Modern flying birds, with well-developed wings and feathers with interlocking mechanism.
- Sternum with developed keel.
- Males have no copulatory organ.
- Some important order of flying birds are **Gaviiformes,** e.g.,divers. **Procellariiformes,** e.g., albatross. **Anseriformes**, e.g.,swans, geese and ducks. **Falconiformes,** e.g.,vultures, eagles, hawks and falkons. **Gruiformes**. e.g., pheasants. **Columbiformes**, e.g., pigeons. **Psittaciformes**, e.g., parrots. **Cuculiformes**, e.g.,cuckoo. **Coraciiformes**, e.g., kingfishers. **Passeriformes**, e.g., crow and thrashers.

Flight Adaptation in Birds

In birds almost every system is modified to support flight as given under

- The feathers constitute very smooth covering over the body to reduce the friction of air. Due to non-conducting nature of these, body temperature is maintained. Feathers of tail (rectrices) form fan-like structure and steer the body during flight.
- Wings (remiges) act as main organ of flight with association of feathers. They are responsible for supporting the bird during the flight. Remiges are attached by ligament or directly to the bone.
- The bones are light, hollow and provide more space for the muscle attachment.

Types of Feathers

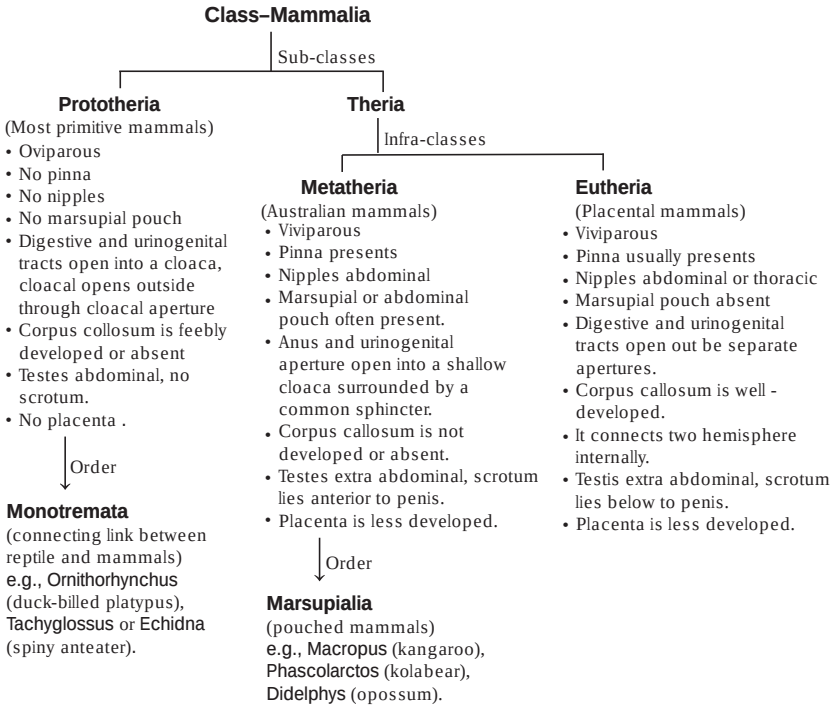
Body in birds is covered by feathers made up of keratin protein. An arrangement of feathers on the body of birds is called **pterylosis**. **An outline of these feathers are as follows**

1. **Contour feathers** These are small feathers that cover the body, wings and tail. Each contour feather has a central axis and a vane.
2. **Flight feathers or Quills These are useful in flights and can be of following types**
   (i) **Remiges These are large wing feathers and further categorised to**
      (a) **Primaries** which are attached to the bones of the hand.
      (b) **Secondaries** which are attached to the bones of the forearm.
      (c) **Tertiaries** which are attached to the humerus of upper arm bone.
   (ii) **Retrices** These are large tail feathers.
   (iii) **Coverts** These are found at the edge of remiges and rectrices.
3. **Filoplumes** These are hair-like feathers scattered over body surface and lie between the contour feathers. These act as sensory organs, registering pressure and vibration.
4. **Bristles** Modified filoplumes found in certain birds near nostrils and eyes. These are used as a touch sensor or funnel that makes the bird reflexively snap up food.
5. **Down feathers** Found only in the newly hatched birds. These form their first feathery covering, which provides insulation.

Mammalia

Class–Mammalia is considered to be superior of all animal groups. This class is further divided into two sub-classes.

The detailed classification of class–Mammalia is as follows



Comparative Analysis of Various Phyla of Animal Kingdom

Phylum	Porifera	Coelenterata	Ctenophora	Platyhelminthes	Aschelminthes
Organisation level	Cellular level	Tissue level	Tissue level	Organ and organ system level	Organ system level
Symmetry	No clear symmetry	Radial symmetry	Radial symmetry	Bilateral symmetry	Bilateral symmetry
Coelom	Absent	Absent	Absent	Absent	Pseudocoelomate
Segmentation	Absent	Absent	Absent	Absent	Absent
Digestive system	Absent	Incomplete	Incomplete	Incomplete	Complete
Circulatory system	Absent	Absent	Absent	Absent	Absent
Respiration	Absent	Absent	Absent	Absent	Absent
Distinctive feature	Pores and canal system	Cnidoblast cells	Comb plate for movement	Suckers, flat body and hooks.	Elongated worm-like
Example	**Sycon**, **Spongilla** and **Euspongia.**	**Physalia, Adamsia** and **Pennatula.**	**Ctenoplana** and **Pleurobrachia.**	**Taenia** and **Fasciola.**	**Ascaris, Wuchereria** and **Ancylostoma.**

Comparative Analysis of Various Phyla of Animal Kingdom

Annelida	Arthropoda	Mollusca	Echinodermata	Hemichordata	Chordata
Organ system level	Organ system level	Organ system level	Organ system level	Organ system level	Organ system level
Bilateral symmetry	Bilateral symmetry	Bilateral symmetry	Radial symmetry	Bilateral symmetry	Bilateral symmetry
Coelomate	Coelomate	Coelomate	Coelomate	Coelomate	Coelomate
Present	Present	Present	Absent	Absent	Present
Complete	Complete	Complete	Complete	Complete	Complete
Present	Present	Present	Present	Present	Present
Absent	Present	Present	Present	Present	Present
Segmented body	Joint appendage and exoskeleton	Shell present on body	Radial body with water vascular system	Worm-like body with proboscis, collar and trunk	Notochord, nerve cord, gills and lungs.
Nereis, Pheretima and **Hirudinaria.**	**Apis, Bombyx, Anopheles** and **Locusta.**	**Pila, Sepia** and **Octopus.**	**Asterias, Echinus, Cucumaria** and **Ophiura.**	**Balanoglossus** and **Saccoglossus.**	Fish, birds, amphibians, reptiles and mammals.