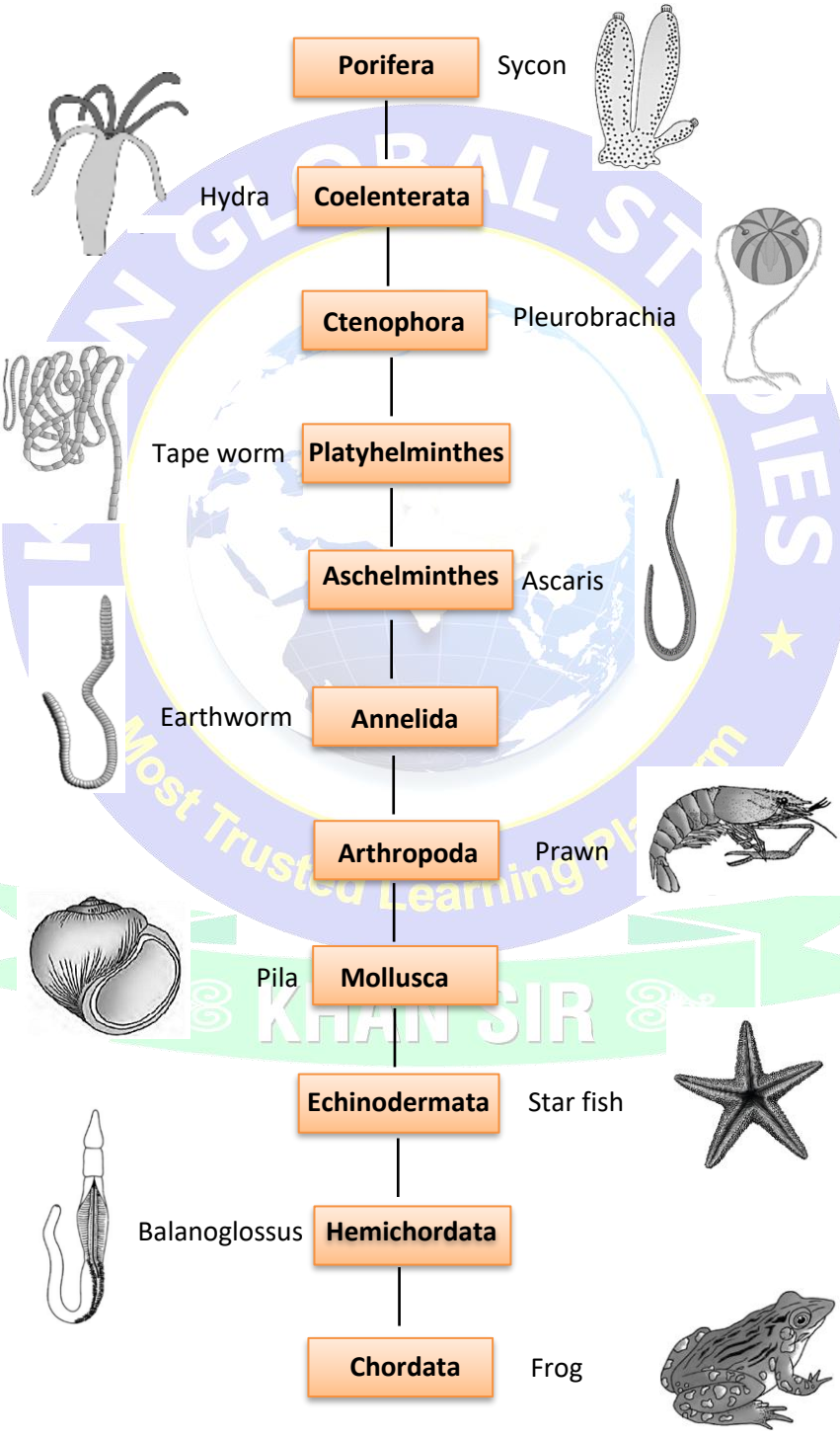
Chapter 01

ANIMAL KINGDOM

IMPORTANT PHYLA:



BASIS OF CLASSIFICATION:

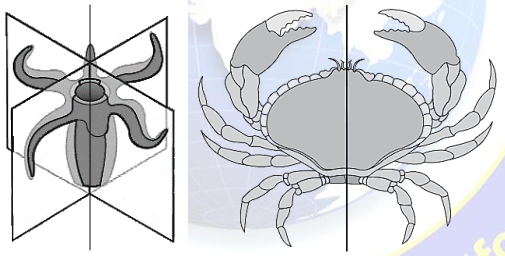
1. Level of body organization:

- **Cellular level** → Cells are arranged as loose cell aggregates and minor division of biological activity occurs among cells (Tissues absent). E.g. Porifera
- **Tissue level** → A group of cells performing the same function are arranged into tissues (Organs absent). E.g. Cnidaria, Ctenophora
- **Organ level** → Similar Tissues are grouped together to form organs. E.g. Platyhelminthes
- **Organ system level** → In higher animals, organs further organised to form organ systems E.g. Aschelminthes to Chordata.

2. Symmetry :

(a) Asymmetry : When any plane that passes through the centre does not divide the body of animals into two equal halves. Example: Most of sponges.

(b) Radial symmetry : When any plane passing through the central axis of the body divide the animal into two identical halves. Example : Coelenterates, Ctenophores and Echinoderms (adult)



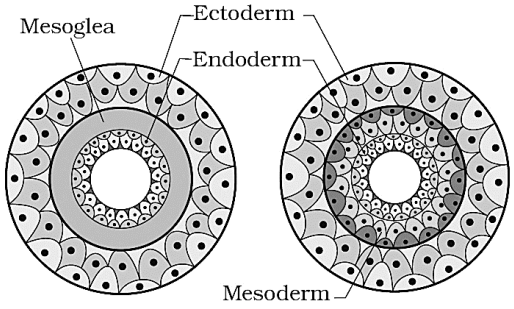
Radial symmetry **Bilateral symmetry**

(c) Bilateral symmetry: When the body can be divided into identical left & right halves in only one plane. Example : Platyhelminthes to Chordates.

3. Germinal layers : -

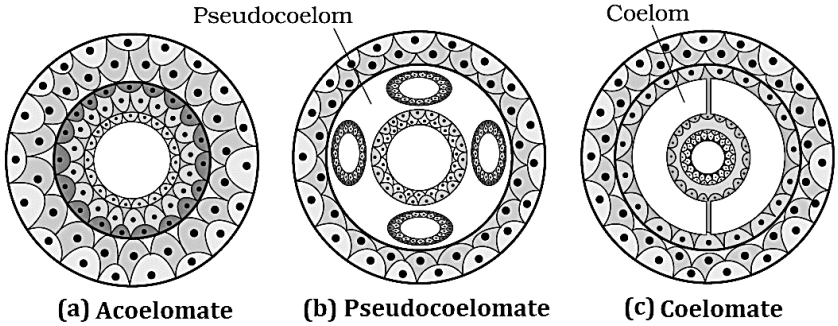
(a) Diploblastic : Animals in which the cells are arranged in two embryonic layers ectoderm and endoderm with an intervening undifferentiated mesoglea, Example : Sponges, Coelenterates and Ctenophores.

(b) Triploblastic : Those animals in which the developing embryo also has a third germinal layers- **Mesoderm** in between the ectoderm and endoderm. Example : Platyhelminthes to Chordates.



(a) Diploblastic **(b) Triploblastic**

4. **Body Cavity or Coelom :** Presence or absence of a body cavity or coelom between the body wall and gut wall is very important in classification.
   ☞ The body cavity which is lined by mesoderm is called coelom.



   (a) Acoelomates: Animals in which the body cavity or coelom is absent. Example: Platyhelminthes (Flat worms).
   (b) Pseudocoelomates: Animals in which 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. Example: Aschelminthes (round worms).
   (c) Coelomates: Animals possessing coelom i.e. the body cavity which is lined by mesoderm on all sides. Example : Annelida to Chordata.

5. **Digestive System :**
   (a) Incomplete :- Digestive tract has only single opening to the outside of the body that serves as both mouth and anus. Example: Coelenterates to Platyhelminthes
   (b) Complete :- Digestive tract with separate opening mouth and anus. Example: Nemathelminthes to Chordates

6. **Segmentation:**
   When body is externally and internally divided into segments with a serial repetition of at least some organs, this is called **metameric segmentation** (true) and the phenomenon is known as **Metamerism.**
   It is found in - Annelida, Arthropoda chordata.

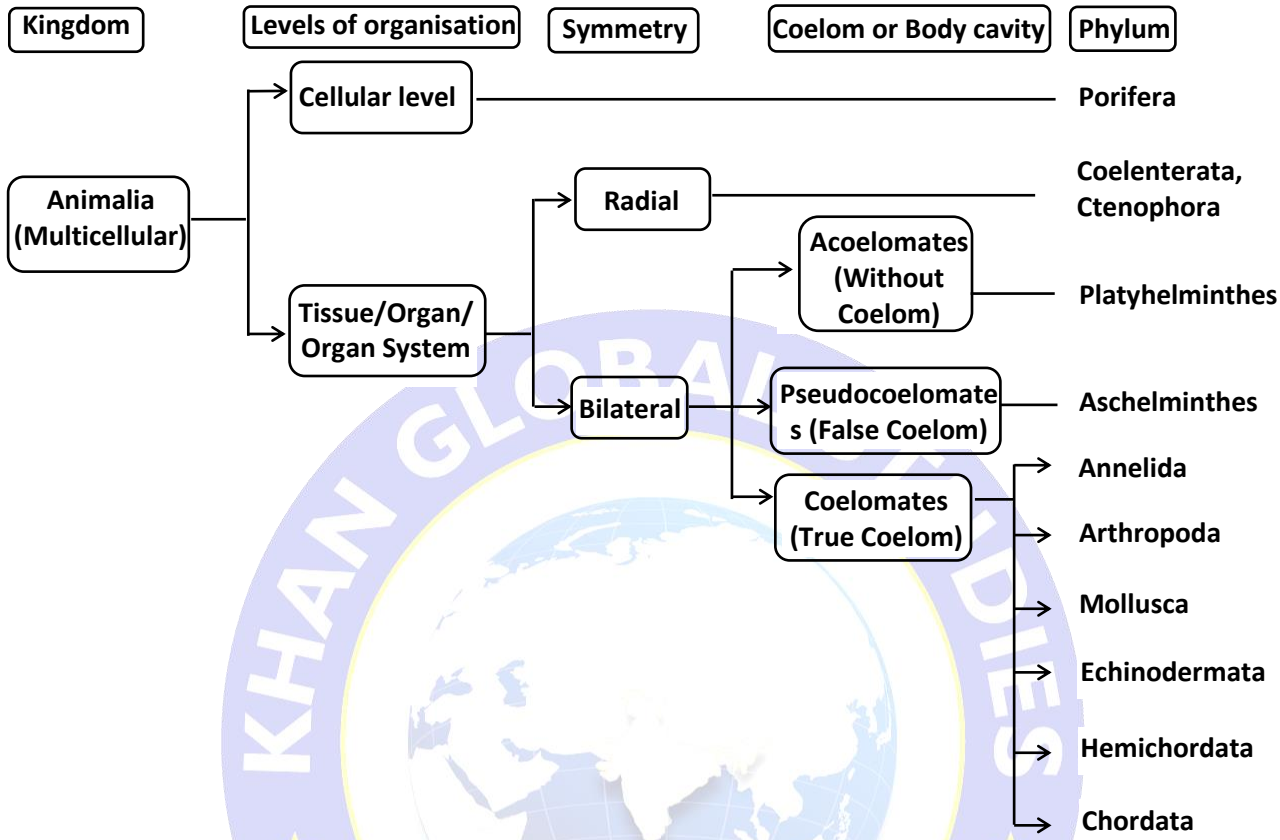
7. **Notochord :** It is a mesodermally derived rod-like structure formed on the dorsal side during embryonic development in some animals.
   (a) Non-chordates- Animals without notochord. (Eg : Porifera to Hemichordata)
   (b) Chordates : Animals with notochord.

8. **Circulatory system:**
   (a) Open type - In which the blood remains filled in tissue spaces (blood sinuses) or body cavity (haemocoel) due to absence of blood capillaries. Example : Arthropods, Molluscs, Echinoderms, Hemichordates and some lower Chordates like tunicates.
   (b) Closed type : In which the blood is circulated through a series of vessels of varying diameters i.e. arteries, veins and blood capillaries. Example : Annelids, Giant molluscs (Octopus) and Vertebrates.

9. **Embryonic Development**
   Some animals have an intermediate stage called larva, which is quite different from its adults in morphology and some other features. Transformation of larva into adults is called **metamorphosis.**
   (a) Direct development - If larval stages are absent
   Examples : Earthworm, Cockroach, Fishes, reptiles, birds and mammals.
   (b) Indirect development - If larval stages are present

Examples : most of non-chordates, lower chordates and amphibians.

Classification of kingdom Animalia based on fundamental features



PHYLUM-PORIFERA

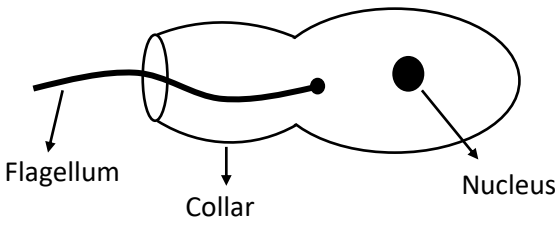
1. Members of this phylum are commonly known as **"Sponges".**
2. All are **aquatic and sessile,** mostly **marine** but few are found in **fresh water (Spongilla)** also. They are **solitary** or **colonial.**
3. Entire body with pores i.e. numerous small **Ostia** for entry and one large opening **Osculum** for exit of water.
4. Central cavity of sponges is known as **spongocoel**.
5. Most of them have irregular shaped body and are **Asymmetrical.**
6. Sponges are most primitive multicellular animals and have **cellular level** of organisation with two germ layers i.e. **Diploblastic.**
   - ☞ Body wall consists of
     - (i) ***Ectodermal layer :*** **-** Consists of flat cells called Pinacocytes.
     - (ii) ***Endodermal layer :*** **-** Consists of **flagellated collar cell** or **choanocytes.**
     - (iii) Between these two layers gelatinous material **Mesenchyme** is present.

DETECTIVE MIND

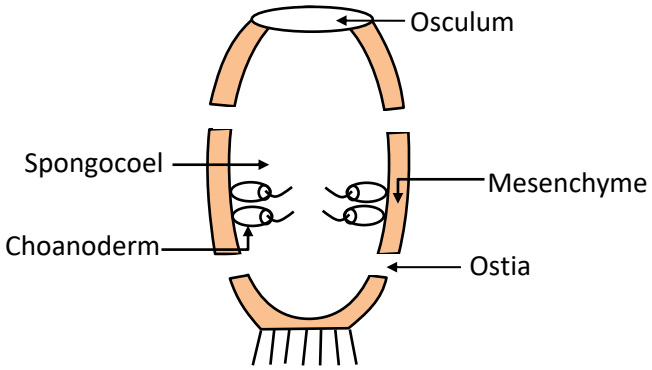
Mesenchyme contains certain Amoebocytes cells like:

(i) Scleroblast – For formation of skeleton elements. (spicules or spongin fibres)

(ii) Archaeocytes – Totipotent cells responsible for High power of regeneration, formation of ova & spermatozoa



Choanocyte cell



7. Unique Features :-

(i) Presence of choanocytes : Choanocytes forms lining of Spongocoel and canals. Continuous beating of flagella helps in maintaining flow of water current.

(ii) Canal system or water transport system: Sponges have a continuous flow of water current through their body, water enters through **ostia** of the body wall into **spongocoel** and goes out through **osculum.** This pathway of water transport is helpful in **food gathering** (Nutrition), **respiratory exchange** (Respiration) and **removal of wastes** (excretion).

8. **Digestion** is **intracellular** and occurs in food vacuoles of choanocytes.

9. Endoskeleton is made up of **spicules (Calcareous or Siliceous) or spongin protein fibre** located in mesenchyme.

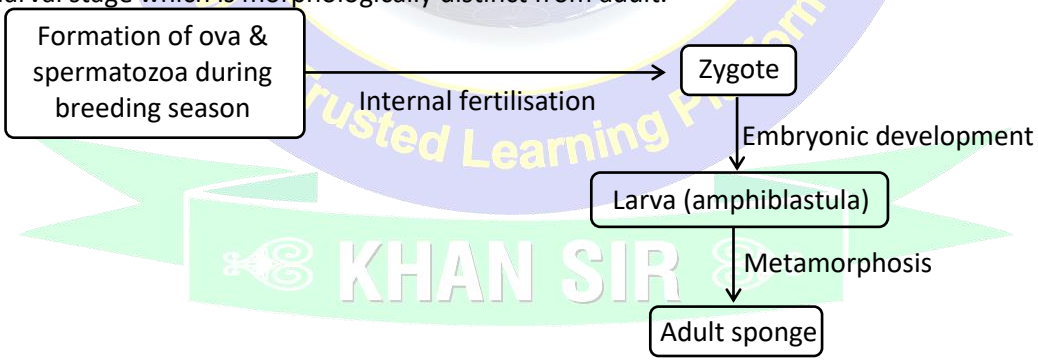
10. Respiration and Excretion takes place **by diffusion** of gases through **body surface**. Excretory matter is Ammonia.

11. **Reproduction**:

(A) **Asexual -** By budding, Fragmentation and Special cell mass **Gemmules** containing Archaeocytes.

☞ Endogenous buds of asexual reproduction in sponge are known as Gemmules (In unfavourable condition).

(B) **Sexual** – Sexes are not separate **(Hermaphrodite). Fertilization is internal and cross** because female gamete (Ovum) get matured earlier then male gametes (sperms) and **development is indirect** having a larval stage which is morphologically distinct from adult.



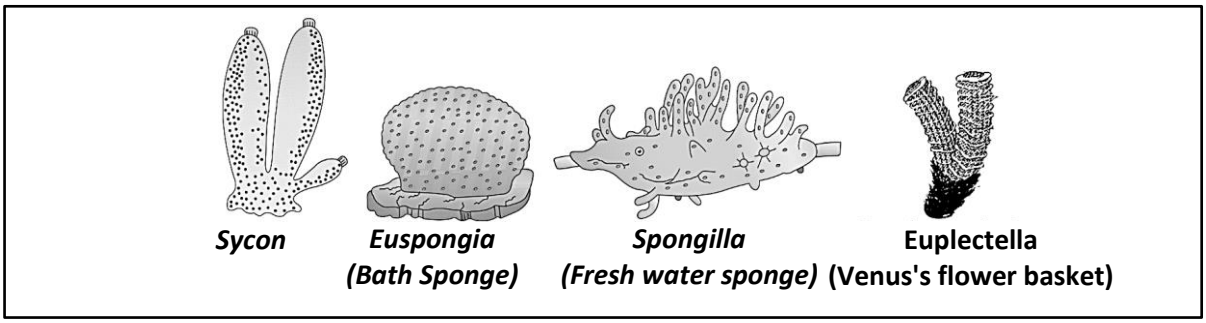
Examples:

(1) ***Sycon*** *or Scypha* (Urn sponge)

(2) ***Spongila*** (Fresh water sponge)

(3) ***Euspongia*** - (Bath sponge) : - used for rubbing skin while bathing because it has only spongin fibres (Spicules are absent)

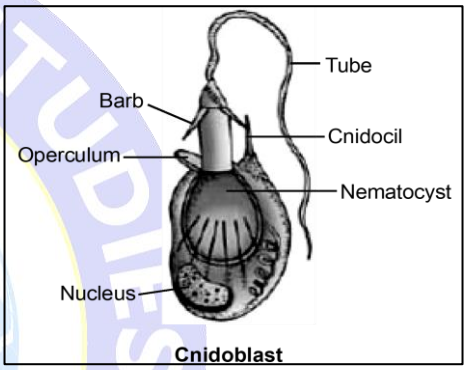
(4) ***Euplectella*** (The Venus flower basket) - Used as Bridal gift (Marriage gift) in Japan



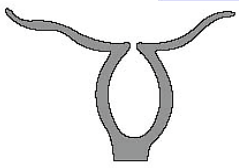
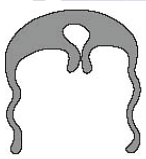
PHYLUM-CNIDARIA (COELENTERATA)

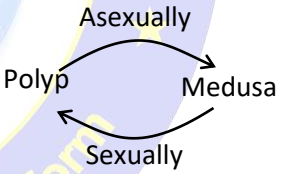
- Coelenterates are also known as **Cnidarians** due to presence of stinging cells called **Cnidoblast** or **Cnidocytes.**

1. Mostly **marine**, **few are found in fresh-water** *(Hydra),* Carnivorous, sessile or free floating.
2. **Radial symmetry**
3. **Tissue level of organisation.**
4. They are **Diploblastic.** They develop from two germinal layers (1) Ectoderm (2) Endoderm and mesoglea between two layers.
   - ☞ Body of some coelenterates may be covered by **calcareous exoskeleton** (Eg: Corals).
5. Cnidoblast or Cnidocyte (contain stinging capsule as Nematocyst) present on the tentacles and Whole body
   - Cnidocyte are Unique to coelenterate and used for anchorage (Attachment), defence and for the capture of Prey (Offence).



6. Coelenterates have **two basic or morphological forms** (Dimorphic).

(1) Polyp	(2) Medusa
- Cylindrical and sessile form - Mouth directed upward - Asexual form - Like - Hydra, Adamsia	- Umbrella shaped and free swimming - Mouth directed downward - Sexual form - Like – Aurelia
 Adamsia (Polyp)	 Aurelia (Medusa)



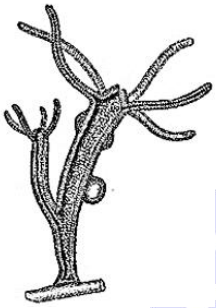
Metagenesis
e.g: Obelia

   - ☞ They are represented either by only polyp or medusa or both forms in their life cycle.
   - ☞ If both forms are found in a species, they never exist together, Polyps produce medusae asexually and medusae form the polyps sexually, this alternation of generation is called **Metagenesis (**eg : **Obelia).**
7. They have a large central cavity called **Coelenteron** with single aperture, i.e. **Incomplete digestive tract,** mouth is located on conical structure called **hypostome.**
   - ☞ Coelenteron is also responsible for distribution of food besides partially digesting it. Therefore coelenteron is also known as **Gastrovascular** cavity.
8. **Digestion** is partially **extracellular** and partially **Intracellular** i.e. takes place in **gastrovascular cavity** as well as in food **vacuole of cells.**
9. **Respiration** and **Excretion** takes place by simple diffusion through **general body surface**, Excretory matter is **Ammonia.**
10. **Nervous system** diffused type and consist of **non-polar** neurons (Nerve net).
11. **Reproduction: -**
    - ☞ Asexual reproduction occurs by **budding**
    - ☞ Sexual by production of gametes

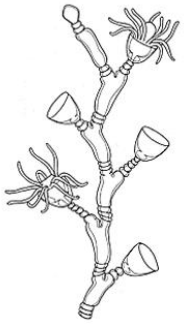
- ☞ Fertilization is **external**
- ☞ Development is **indirect** with larval stages

Examples :

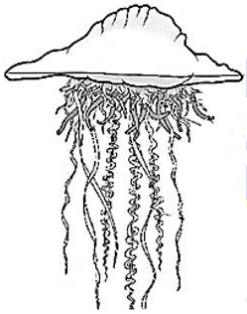
1. ***Hydra*** - Fresh water polyp.
2. ***Obelia*** - Sea fur, Shows metagenesis
3. ***Physalia*** - Portuguese man of war
4. ***Aurelia*** - Jelly fish,
5. ***Adamsia*** : Sea Anemones
6. **Corals** (Only coelenterate with calcareous exoskeleton)
   (i) ***Pennatula*** - Sea pen (ii) ***Gorgonia*** – Sea-fan (iii) ***Meandrina*** - Brain coral



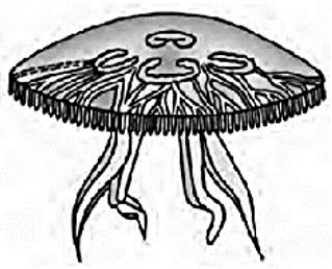
Hydra



Obelia
(Sea fur)

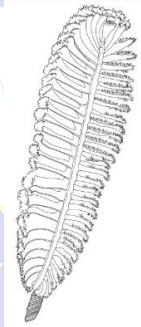


Physalia
(Portuguese man of war)



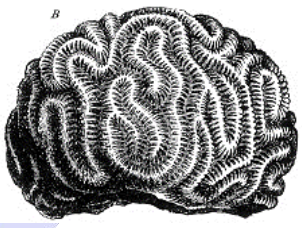
Aurelia
(Jelly fish)

Adamsia
(Sea anemone)



Pennatula
(Sea Pen/ Feather)

Gorgonia
(Sea Fan)

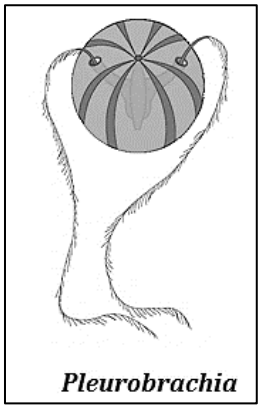


Meadrina
(Brain coral)

PHYLUM- CTENOPHORA

1. **Ctenophorans** are known for their beauty and delicate nature. In sunlight their comb-plate give the effect of a rainbow. Body is soft transparent jelly like. They are commonly known as "**Comb-jellies**".
2. They are exclusively **marine.**

3. They are **radial symmetrical, Diploblastic animals** with **tissue level** of body organisation.
4. **Bioluminescence** (The Property of a living organism to emit light) is well marked**.**
5. They have **8 ciliary comb plates** on the body surface for swimming (locomotion).
6. **Digestion** is both extracellular and intracellular.
7. **Respiration** and excretion occurs by simple diffusion.
8. Nematoblasts are absent, so they are also called **"acnidarians".** They have one pair of long and weak tentacles which have some adhesive cells for capturing of prey.
9. Sexes are not separate. Reproduction takes place only by **sexual means.** Fertilization is **external.**
10. Development is of **indirect type**. Life cycle involves a free swimming larva.
    Example: ***Pleurobrachia (Sea gooseberry)***
    : Ctenoplana
    : ***Beroe*** (Swimming eye of cat)


Pleurobrachia

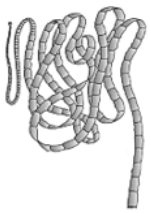
SPOT LIGHT

Ctenophorans have been separated from coelenterates due to absence of stinging cells, polyps and medusa forms, and presence of ciliary comb plates & bioluminescence property to protect themselves during night. Otherwise they are similar to coelenterates in general features.

PHYLUM- PLATYHEMINTHES

1. They have dorso–ventrally flattened body hence are called **flat worms.**
2. These are **mostly endoparasites** found in animals including human being but some are **Free living** (aquatic).
3. They are **first Bilaterally symmetrical, Triploblastic animal** and with **organ level** of body organisation.
4. Locomotory organs are absent in these animals but **adhesive organs** like **suckers**, **hook** etc. are present in parasitic form.
5. Parasites have **thick cuticle,** which protect them from digestive enzymes of host.
6. These are **acoelomate**. Space between body wall and digestive tract is not filled with fluid but have solid mesodermal tissue.
7. **Digestive system incomplete** and without anus but in Tapeworm digestive system is completely absent. They absorb nutrients from the host directly through their body surface.
8. **Anaerobic** respiration in internal parasites.
9. **Excretion** occurs through specialised cells called **flame-cells or Solenocytes** (protonephridia). They also help in **osmoregulation.**
10. **Skeleton, respiratory** and **circulatory** systems are absent.
11. Nervous system is **ladder like**, consist of a **nerve ring** and two main longitudinal **nerve cords.**
12. **They are Bisexual.** Reproductive system is **complex** and well-developed. **Fertilization** is **internal**. Development **indirect** through many larva stages.
13. Some members like **Planaria** have high regeneration capacity.
    Example :
    (1) ***Planaria*** **:** Free living fresh water flatworm, shows high power of regeneration.
    (2) ***Taenia solium*** **(Pork tapeworm) :**
    (3) ***Fasciola hepatica*** **(Liver fluke)**


Planaria


Tape worm (Taenia)


Liver fluke (fasciola)

DETECTIVE MIND

- ***Fasciola* (liver fluke) :-** It is digenetic (2 hosts), Causes **"Liver rot/fascioliasis"** disease in sheep/goat (primary host) and carrier host is pond snail.
- ***Taenia* (Tapeworm) :-** Digenetic parasite, Causes digestive disorder **"Taeniasis"** in humans (primary host), Carrier host is pig. Human acquire infection by eating infected pork.

PHYLUM - ASCHELMINTHES (NEMATHELMINTHES)

1. They have long, **Cylindrical and unsegmented** body with tapering ends.
2. They appears circular in cross section, therefore popularly called **round worms.**
3. **Nematodes** are mostly parasite in plants and animals, but some are free living.
4. They are bilateral symmetric, triploblastic animals with organ system level of body organisation.
5. They are **Pseudocoelomate animals,** they have body cavity between body wall and digestive tract which is not lined by mesodermal epithelium, therefore called **Pseudocoel** (Unique to nematodes)
6. **Body wall** consist of
   (i) **Cuticle** – Non-living, thick and resistant to digestive enzymes of host.
   (ii) **Epidermis** - **Syncytial** (multinucleated).
   (iii) **Muscle layer** - Only Longitudinal muscle fibres present, help them to resist peristalsis of host intestine (circular muscle absent).
7. **Skeleton** is absent but fluid pressure in the pseudocoelom maintains body shape. It is called **Hydrostatic-skeleton**.
8. **Digestive tract** is **complete** with mouth, muscular pharynx, intestine & anus.
   ☞ Muscular **Pharynx** is used to suck the liquid food from host intestine
9. Parasites respires **anaerobically.**
10. **Excretory system** is H-shaped and consists of **excretory canals** (Protonephridia) which removes body wastes from body cavity through excretory pores. They develop from an embryonic **"Renette cell"**. Excretory matter is **ammonia**.
11. Skeletal, respiratory and Circulatory systems are absent.
12. **Nervous system** comprises of a nerve ring (Brain) and longitudinal nerve cords.
13. **Reproduction -** sexes are separate **(Dioecious) and also exhibit sexual dimorphism.**
    ☞ Female are usually longer than males.
    ☞ Fertilization is **internal** and development may be **direct** or **indirect.**

    Examples :

    (1) ***Ascaris*** (Roundworm) – Monogenetic, found in human small intestine and Causes **"Ascariasis disease".**
    Mode of infection - by contaminated food and water.

    (2) ***Ancylostoma*** (Hookworm)- Monogenetic, intestinal parasite that causes **severe anaemia** (Ancylostomiasis)

    (3) ***Enterobius*** (Pin worm) - in large intestine and causes anal itching **(churne).**

    (4) ***Wuchereria*** (Filarial worm)- digenetic parasite, causes "**Filariasis** or **elephantiasis**" in human host, carrier hots is a female culex mosquito.

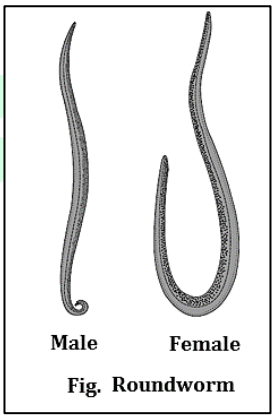


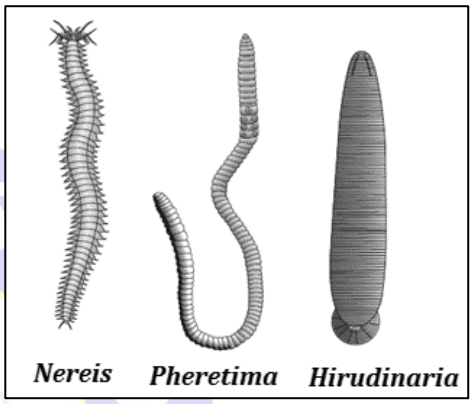
Fig. Roundworm

DETECTIVE MIND

- Nematod females are mostly **oviparous,** lays eggs after copulation that passes through faeces from the body of human host, But *trichinella* and *Wuchereria* are viviparous.

PHYLUM – ANNELIDA

1. Mostly free living found in moist soil, fresh water or sea but few are parasitic.
2. Body is Soft elongated, cylindrical divided into **segments** or **metameres. (Latin, Annulus → Little rings).**
3. They are bilaterally symmetric, Triploblastic and have organ-system level of organisation
   - They are **metamerically segmented** and **coelomate** animals.
4. They have Chitinous Setae (Eg. Earthworm) or lateral muscular appendages called **Parapodia (Eg. Nereis)** for locomotion.
5. **Body wall** consist of:
   (1) **Cuticle** - moist and elastic.
   (2) **Epidermis** - Living layer that secretes dead cuticle outside.
   (3) **Muscle layer** – Well developed and Contains both **circular** and **longitudinal muscles** which help in Locomotion.



6. **Body cavity** is **true coelom** lined by mesodermal epithelium. **(First coelomate).** It is filled with coelomic fluid that serves as a hydrostatic skeleton.
7. **Digestive tract** is complete, (tube within tube), Digestive glands are developed for the first time in Annelida.
8. **Respiration** mainly occurs through **moist skin (Cutaneous respiration)**.
9. **Circulatory system is closed** type and pulsatile heart present.
   ☞ The blood is red with **haemoglobin** which remain dissolved in plasma **(RBCs absent).**
10. Excretion occurs through highly coiled microscopic tubules called **Nephridia** (sing. Nephridium). Also help in osmoregulation.
    Excretory matter: (1) **Ammonia** in aquatic form (2) **Urea** in land form
11. **Nervous system** consists of a **nerve ring (Brain)** and a solid, double and **ventral nerve cord.**
12. Reproduction is sexual, Nereis is **dioecious** but earthworms and leeches are **monoecious**.
    ☞ Development is **direct** (Eg. Earthworm and leeches) **or indirect** with free swimming ciliated **trochophore** larva. (Eg. Nereis).

Examples:
(1) ***Nereis*** (Sand worm)
(2) ***Pheretima*** (North Indian Earthworm)
(3) ***Hirudinaria*** (Fresh water or cattle leech)

DETECTIVE MIND

- **Leeches** – They are ectoparasitic and blood sucking, saliva contains "**Hirudin**" as anticoagulant. locomotion by swimming & looping method through muscle contraction.
- During course of evolution **metameric segmentation**,
  True coelom, **closed circulatory system** and the both **circular** and **longitudinal muscles** in body wall appeared first in annelids.

PHYLUM - ARTHROPODA

(Arthros = Joint, Poda = appendages)

1. Arthropoda is **the biggest phylum** of kingdom animalia which includes over two-third of total known species on earth.
2. They may be **aquatic** (marine and fresh water) or **terrestrial**, free living and sometimes parasitic.
3. Body is **Bilateral symmetric**, **Triploblastic** with **organ system level** of organisation
4. They are **metamerically segmented** and **coelomate** animals.
5. Body is divided into three region **Head, thorax** & **abdomen**, but in some head and thorax fused to form cephalothorax.
6. **Unique features**
   (i) They have **jointed appendages** for different function hence named arthropoda (arthro- joints, poda - foot/appendages).
   (ii) The body of Arthropods is covered by **Chitinous exoskeleton**.
7. **Digestive Tract** is complete and they can feed upon all kind of food substances.
8. RESPIRATION
   - In aquatic
     - By gills (Eg. Prawn)
     - Book gills (Eg. King crabs)
   - In Terrestial
     - Tracheal system (Eg. Insects)
     - Book lungs (Eg. Scorpion)
9. **Circulatory system** is **Open** type i.e. blood remains filled in open tissue spaces and hoemocoel. Blood is colourless called **Haemolymph**. Respiratory pigment absent.
10. **EXCRERTION**
    - In aquatic – By Green or Antennary gland (Eg. Prawn)
    - In terrestial – By Malphigian tubule (Eg. Insects)
11. **Nervous system** comprises of a **nerve ring (brain)** and a **double**, **solid and ventral nerve cord** bearing **ganglia.**
12. Sensory organs like **Eyes** (Simple or compound) **antennae** and balancing organ "**statocyst**" are found.
13. They are **mostly dioecious** and also exhibit sexual dimorphism. Fertilization is **usually internal** but few aquatic forms has external fertilization. Females are **mostly oviparous** (Shelled eggs).
14. Development may be **direct** or **indirect**.

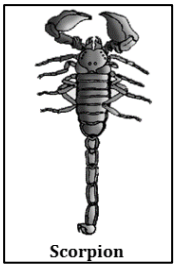
DETECTIVE MIND

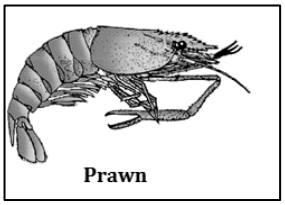
Insects are physically & metabolically active animals, So they need more energy or oxygen but have open blood circulation & blood has no role in transportation of respiratory gases. Therefore, They have a dense network of air filled tubules called tracheal system that carries environmental oxygen directly up to the level of tissues.

Examples :

(1) **Arachnids** (Octapods) - Four pair legs/Eight legs
- Respiration by book lungs
  Examples : **Scorpion, Spider**

(2) ***Crustacea***(aquatic) -
- Respiration by - Book gills


Scorpion


Prawn

- Excretion by - Green gland/Antennary gland
  Examples : ***Palaemon*** *(Prawn)*, ***cancer*** (crab)

(3) *Insecta* (Haxapoda) -

- All insects have three pairs of legs.
  Respiration by tracheal system and excretion by Malpighian tubules.

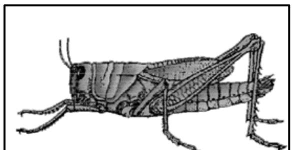
Examples :

(i) Economically important insects – ***Apis*** (Honey bee) used for apiculture, ***Bombyx*** (Silkworm) used for sericulture, ***Laccifer*** (Lac insect) used for commercial production of Lac.

(ii) Vectors – Female mosquitoes sucks blood and spread disease. ***Anopheles*** *(Malaria)*, ***Culex*** *(Elephantiasis)* and ***Aedes*** (Dengue)

(iii) Gregarious pest – ***Locusta*** (Locust)

(iv) ***Periplaneta*** (Cockroach)


Locust


Butterfly

SPOT LIGHT

Limulus (King crab)-respires through book gills and have fossil like character as of now, therefore, considered as **"living fossil".**

PHYLUM – MOLLUSCA

1. It is **second largest** Phylum which includes **"Soft bodied and shelled"** animals.
2. They are mostly aquatic **(marine or fresh water)** or terrestrial.
3. They are **bilaterally symmetrical, triploblastic** and coelomate animals with **Organ system** level of organisation.
4. Body is Soft, slimy and unsegmented and covered with **calcareous** shell.
5. Body is divisible into three parts:
   (i) **Head -** distinct with Eyes and sensory Tentacles.
   (ii) Dorsal **visceral mass/ hump –** main body containing all visceral organ of body.
   (iii) Ventral **muscular foot** for locomotion.
6. Soft and spongy layer of dorsal skin form a **mantle** over the visceral hump or body.
   - The space between hump and mantle is called **mantle cavity.**
   - The mantle usually secretes an external **calcareous <u>shell</u>. (Calcium carbonate).**
7. **Digestive tract** is complete. Buccal cavity contains a **file-like rasping organ** for feeding called <u>**Radula**</u>, with transverse row of teeth. Anus opens into the mantle cavity.
8. **Respiration** is usually by **feather like gills,** located in the mantle cavity which also helps in excretion.
9. **Circulatory system** is **open**. Haemocoel is present.
   - Blood or haemolymph usually has a copper containing respiratory pigment called **haemocyanin (Blue or green)**.
10. **Excretory system** includes 1 or 2 pairs of **kidneys** known as **Keber's organs** or **Organ of Bojanus**. Excretory matter is **ammonia** or **uric acid.**
11. **Nervous system** comprises 3 or 4 pairs of ganglia and connective nerves**.**
12. **Statocyst** present in the foot is the sensory organ for body balancing.


Chaetopleura


Dentalium

13. They are mostly **dioecious,** and **oviparous**. Fertilization is usually **external.**

☞ Development is - Usually **indirect**. **Trochophore** is very common larva of Mollusca**.**

Examples :

(1) ***Chaetopleura*** (Chiton)

(2) ***Dentalium*** (Tusk shell animal)

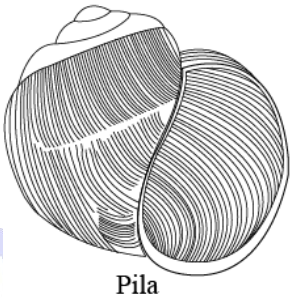
(3) ***Pila*** (Apple snail)

(4) ***Aplysia*** (Sea-hare)

(5) ***Unio*** - Fresh water mussel

(6) ***Pinctada*** (Pearl oyster)

(7) ***Sepia*** (Cuttlefish)
(8) ***Loligo*** (Squid)
(9) ***Octopus*** (Devil fish)
→ Giant Molluscs


Pila


Octopus

DETECTIVE MIND

(1) ***Neopilina*** - Living fossils, Connecting link between annelida and mollusca, only mollusca with segmented body.

(2) **Giant molluscs –** They have close circulatory system, foot divided into 8 or 10 arms with suckers and **ink gland** present for offence and defence.

PHYLUM – ECHINODERMATA

1. They are exclusively **Marine.** Generally live at **bottom** of the sea and are slow moving.

☞ Body may be **star like**, **cylindrical** or **cucumber like, disc-like**, **Lilly plant like**.

2. The adult Echinoderms are **radially symmetrical** but larvae are **bilaterally symmetrical.**

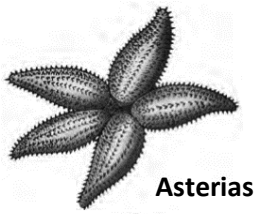
3. They are **triploblastic** and **coelomate** animals with **organ - system level** of body organisation.

4. Skin of echinoderms is rough and spiny, it contains **calcareous spines**, and endoskeleton of **calcareous plate (dermal ossicles).**

DETECTIVE MIND

➢ Minute pincer like structure **pedicellariae** comes out through skin.
They keep the skin clean of debris and minute organisms.

5. The most distinctive feature of echinoderm is presence of water Transport system called **water vascular system** which helps in locomotion, capture and transport of food, excretion and respiration.



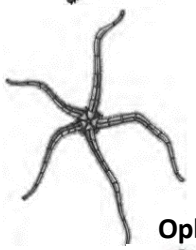
Asterias

6. A perforated plate **madreporite** permits entry of water into **water vascular** system which finally reaches into **tube feets** located on ventral side of each arms. Pressure of water helps in maintaining shape of tube feet. All tube feets have suckers for attachment of the arms (locomotion).

7. **Digestive tract** is **complete**, with mouth on lower side (ventral) and anus on the upper side (dorsal).

8. **Respiration** takes place by body surface or **minute gills** (dermal branchiae).

9. **Circulation** system is reduced and open type. Heart absent and blood colourless.



Ophiura

10. **Excretory system absent,** Nitrogenous waste (ammonia) diffuses out through body surface.

11. **Nervous system** is simple and less developed, includes a **Nerve ring** and **radial nerves** with simple sense organ. They don't have distinct head and brain.

Cucumaria

12. **Reproduction is sexual**, sexes are separate **(dioecious)** and mostly oviparous.

13. Fertilization is **external** and development is **indirect** with free swimming larva **(Bipinnaria)**.

SPOT LIGHT

Echinoderms have great power of **regeneration**. Star fishes have an ability of voluntary breaking of their arms for defence. This phenomenon is known as **Autotomy**.

Examples:

(1) ***Asterias*** (Star fish)
(2) ***Ophiura*** (Brittle star)
(3) ***Echinus*** (Sea urchin): have masticating organ called **Aristotle's Lantern**
(4) ***Cucumaria*** (Sea cucumber)
(5) ***Antedon*** (Sea lily)

DETECTIVE MIND

- Echinoderms are headless, brainless and heartless animals but still Considered more advance than Arthropods & molluscs due to presence of some chordate like characters **enterocoelic** coelom, **mesodermal** skeleton and **deuterostomic** embryonic development.

PHYLUM – HEMICHORDATA

1. Hemichordata was earlier considered as a sub-phylum of Chordata. But now it is placed as a separate phylum under non-chordata.

2. They are exclusively marine and worm like animals.

3. They are **bilateral symmetrical, triploblastic** and **coelomate animals (Enterocoelomate)** with organ system level of organisation.

4. The body is cylindrical, unsegmented and divided into **three parts**: -

☞ Anterior **proboscis,** middle **collar** and a posterior long **trunk.**

5. They have a rudimentary structure in the collar region called **stomochord**, a structure similar to notochord. Stomochord is not considered as true notochord. Therefore, they have to be shifted from chordates to non-chordates.
6. Digestive tract is complete.
7. Respiration takes place through **gills.**
8. Circulatory system is **open type.** Blood is colourless and Heart is situated **dorsally (just like in non-chordates).**
9. **Excretion** occurs through a **proboscis gland.**
10. **Central nervous system** consists of Nerve ring and ventral nerve cord **(just like non-chordates).**
11. **Reproduction** is sexual and Mostly animals are **unisexual.**
    - ☞ Fertilization is **external**.
    - ☞ **Development** is **indirect** with tornaria larva.

Example :

- ***Balanoglossus***: Tongue worm or Acorn worm
- ***Saccoglossus***

➢ **Hemichordata is a connecting link between Non-chordata & Chordata.**

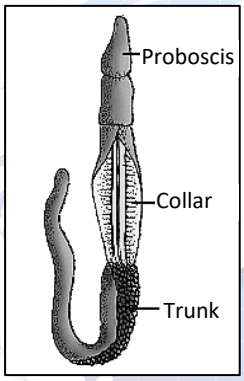


Figure: *Balanoglossus*

COMPARATIVE CHART : NON-CHORDATES

Characters	Porifera (Sponges)	Coelenterata and Ctenophora	Platyhelminthes (Flat worms)	Nemathelminthes (Round worms)	Annelida	Arthropoda	Mollusca	Echinodermata	Hemichordata	Chordata
Level of organisation	Cellular	Tissue	Organ	Organ system	Organ system	Organ system	Organ system	Organ system	Organ system	Organ system
Germ layers	Diploblastic	Diploblastic	Triploblastic	Triploblastic	Triploblastic	Triploblastic	Triploblastic	Triploblastic	Triploblastic	Triploblastic
Symmetry	Asymmetric	Radial	Bilateral	Bilateral	Bilateral	Bilateral	Bilateral	Bilateral + Radial	Bilateral	Bilateral
Coelom	Acoelomate (Without body cavity or coelom)			Pseudocoelomate (With pseudocoel)	Coelomates (with true coelom)					
Segmentation	Absent	Absent	Pseudometameric in Tapeworm	Absent	Metameric Segmentation		Absent		Absent	Metameric Segmentation
Digestion	Intracellular	Intracellular and extra cellular	Extracellular (takes place in digestive tract)							
Respiration	General body surface (Respiratory Organs are absent)		Parasites respires anaerobically		Moist skin (cutaneous)	Gills or Book gills or Book lungs or Tracheal system	Gills	Gills or Body Surface	Gills	Gills or Lungs
Excretion	General body surface (Excretory Organs are absent)		Flame cells or Solenocytes or Protonephridia	Renette cells or Excretory canals	Nephridia	Malpighian tubule or Green glands	Keber's organs or Organs of Bojanus	Absent	Proboscis gland	Kidneys
Circulatory system	Absent				Closed type	Open type				Closed type
Development	Indirect	Indirect	Indirect	Both	Both	Both	Indirect	Indirect	Indirect	Direct/ Indirect
Distinctive feature	– Body with pores, Choanocytes and Canal system	–Singing cells (Cnidoblast –Polyp and Medusa form in coelenterates	– Flat body – Resistant cuticle – Hooks and Suckers in parasites	– Round body – Pseudocoel present	– True coelom, – Metameric seg. – Closed type circulatory system	– Chitinous exoskeleton, – Jointed appendages, Haemocoel	– Mantle, Calcareous Shell and Radula in buccal cavity	– Spines on body – Tube feet for locomotion – Water vascular System	– True notochord absent, Ventral nerve cord present	– Presence of Notochord, Dorsal nerve cord and Pharyngeal gill slits.

PHYLUM – CHORDATA

- The term Chordata is originated by the two words of Greek language the '**Chorda'- Thick string** and the **'Ata'- Bearing** and over all meaning of Chordata is **animals having notochord** at any stage of their life.

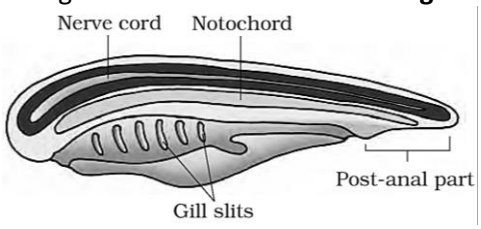


Figure: Chordata characteristics

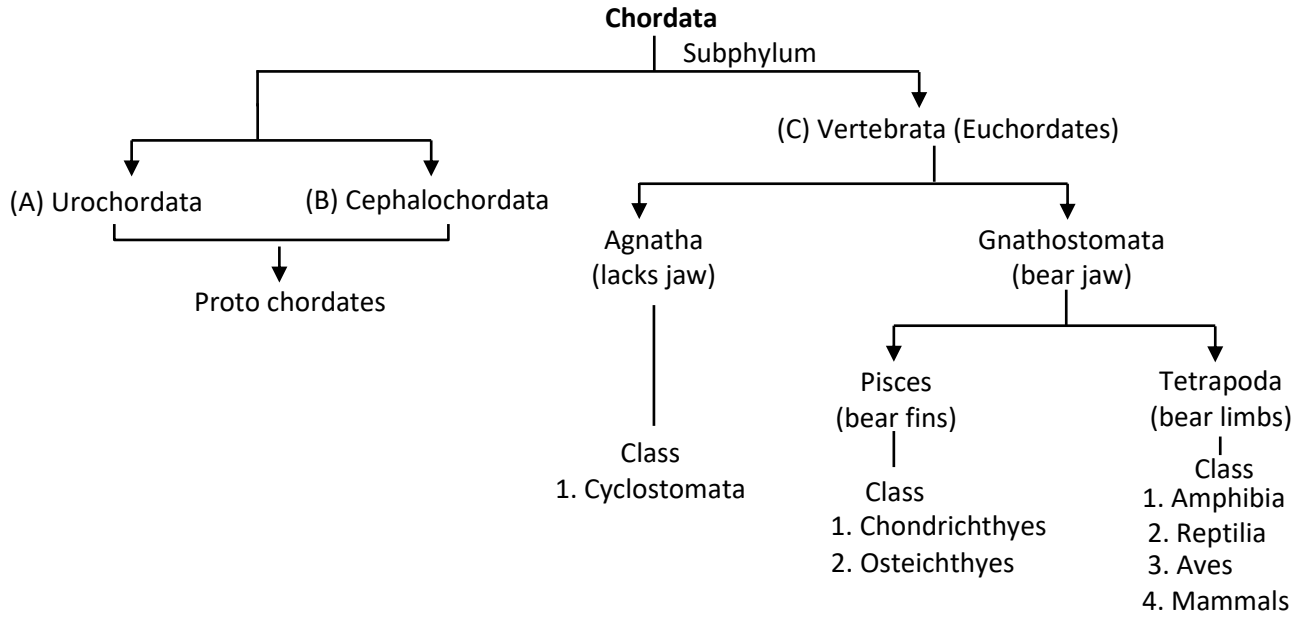
- Chordates are bilaterally symmetrical, triploblastic, coelomate with organ system level of organisation. They have a closed circulatory system.

Fundamental Characters of Chordates:

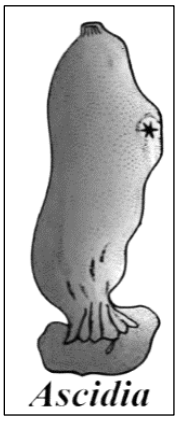
1. **Presence of notochord :–** In the embryonal stage of all chordate animals there is a solid rod like structure (Just below the central nervous system and above the alimentary canal), this is called **notochord**.
   - **Notochord** is extended from anterior end to posterior end of the body at the dorsal surface.
   - It is **mesodermal** in origin and provide support to body.
     In lower chordates **(Protochordates)** notochord is present through out the life but in higher chordates **(vertebrates)**, it is replaced by **vertebral column or back bone in adults.**
2. **Presence of Dorsal Tubular Nerve Cord:**
   - In chordate animals, **nervous system** is situated at the **dorsal surface** of body.
   - In these animals, a hollow, tubular nerve cord is situated just beneath the bodywall and just above the notochord.
   - Nerve cord is ectodermal in origin.
3. **Presence of pharyngeal gill slits:**
   - All chordates have paired, lateral **gill slits** in the walls of pharynx for **respiration** in any stage of their life.
   - In **aquatic** and **lower chordates**, pharyngeal gill slits remain persistent **throughout their life.**
   - In **terrestrial chordates**, gill slits are found only in embryonic stage and are replaced by lungs in adults.
4. **Post anal tail :–** Tail if present is the post anal part of the body.

S.No.	Chordates	Non-Chordates
1.	Notochord present	Notochord absent
2.	Central nervous system is dorsal, hollow and single.	Central nervous system is ventral, Solid and double.
3.	Pharynx perforated by gill slits.	Gill slits are absent.
4.	Heart is ventral in position.	Heart is dorsal or lateral in position. (if present).
5.	A post-anal part (tail) is present.	Tail if present is pre-anal part of body. (Post-anal tail is absent)

Classification of Chordata:



(A) SUB–PHYLUM – UROCHORDATA OR TUNICATA:



- They are exclusively marine, adults are mostly sessile, attached with rocks.
- All the adult members have test all over their body, made up of a **cellulose like** substance called **tunicin**. so these animals are also called **tunicates.**
- **Notochord is found only in tail of tadpole larva** which is lost during metamorphosis. So the name **Urochordata** was given to this subphylum. (Uro-tail, chord-Notochord)
- All chordate characters are found in larva. Only one chordate character is found in adults i.e. **pharyngeal gill slits.** Therefore metamorphosis is called **Retrogressive.**
- Circulation is **open type** and heart is **ventral** in position.
- Most of the animals are **hermaphrodite**.
- Fertilisation is **external.**
- Development **Indirect** A free swimming tadpole larva present**.**

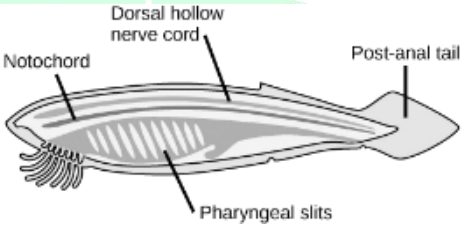
Example :

(i) ***Herdmania***- (Sea Potato or sea squirts). (ii) ***Ascidia***

(iii) ***Doliolum*** (iv) ***Salpa***

(B) SUB-PHYLUM - CEPHALOCHORDATA:

- They are also exclusively marine.
- Notochord and nerve cord remain extended from tail to head, therefore, called cephalochordates (**cephalo**-head, **chord-notochord**)
- All fundamental chordate characters persists throughout the life. Therefore, they are considered as **first complete or typical chordates.**
- Excretion by **solenocytes** or **Vascular flame cells.**
- Circulation is closed but blood is colourless.
- These are **unisexual** animals.
- Fertilisation is **external.**
- Development is **indirect.**



Amphioxus

Example : **Amphioxus (The Lancelet) or *Branchiostoma* .**

(C) SUB PHYLUM - VERTEBRATA :

- Vertebrates are higher chordates which possess notochord only during the embryonic period and is replaced by a cartilaginous or bony **vertebral column** in the adult. Thus, **all vertebrates are chordates but all chordates are not vertebrates.**
- Vertebrates have a ventral muscular heart with two, three or four chambers.
- Kidneys for excretion and osmoregulation
- Paired appendages which may be fins or limbs.
- **Sub-phylum Vertebrata is further divided into two divisions:**

(1) Agnatha – Jaw absent (2) Gnathostomata – Jaw present

↓ Class

Cyclostomata (living)

CLASS – CYCLOSTOMATA

- This class includes all living "**Jaw less or round mouthed fishes"**. They are not true fishes.
- Most of the members of this class are marine but migrate for spawning to fresh water. After spawning within few days, they die. Their larvae, after metamorphosis, return to Ocean.
- They are mostly ectoparasites on true fishes.
- They have elongated body bearing **6–15 pair** of gills slits for respiration.
- They have a circular mouth **without jaws,** adapted for sucking blood.

- **Scales** and **paired fins (pectoral and pelvic fins)** are also absent**.** Swimming by **unpaired fins** like dorsal, ventral & caudal fins**.**
- Notochord and vertebral column both are present. Cranium and vertebral column are cartilaginous. Bones are absent.
- Circulation is closed type, Heart is two - chambered. It is called **Venous - heart.**
- Animals **unisexual**, fertilization **external**, development direct and indirect.

Examples :

(1) ***Petromyzon* or Lamprey**: It is an ectoparasite on true fishes (shark). Shows migration for breeding Ammocoete larva returns back into sea after metamorphosis**.**

(2) ***Myxine* or *Hag fish*** → No migration , No larva.

COMPARATIVE CHART: Vertebrates

Character	Pisces	Amphibians	Reptiles	Aves	Mammals
Habitat	Aquatic	Amphibius	Terrestrial		
Respiratory organs	Gills	Mainly skin & lungs	Lungs		
Exoskeleton	Dermal scales	Usually absent	Epidermal scales	Feathers	Hair, Nails
Body Temperature	Variable (Poikilothermic/Cold blooded)			Constant (Homeothermic or warm blooded)	
Teeth	Homodont and polyphyodont			Absent	Heterodont, diphyodont and Thecodont
	(Acrodont)	(mostly pleurodont)			
Kidneys	Mesonephric		Metanephric		

Excretory product	Urea/NH_3	Mainly urea	Uric acid		Urea
Heart chambers	2 (venous heart)	3	3 (except crocodiles)	4	
Circulation	Single	Mixed double circulation		Complete double circulation	
Hepatic portal system	Present	Present	Well developed		
Renal portal system	Well developed		Reduced	Absent	Absent
Ear	Only Internal	Internal + Middle + Tympanum		Ear Canal also present	Complete with Ear pinna

SUPER CLASS – PISCES

It includes "**true fishes**" exclusively aquatic, body is streamlined and covered by scales, both paired & unpaired fins present for swimming.

[A] CLASS – CHONDRICHTHYES

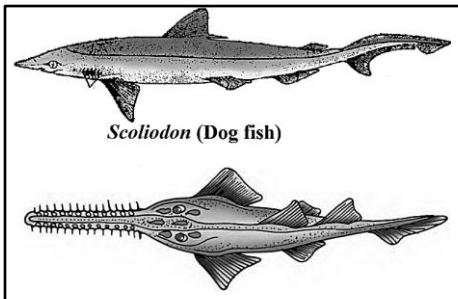
- They are exclusively **marine**.
- Endoskeleton is made up of exclusively **cartilage.** So, these are called **"Cartilaginous fishes".**
- Notochord is persistant throughout the life to support cartilaginous vertebral column.
- They are poikilotherms/cold blooded.
- Exoskeleton over the skin is made up of **placoid** scales (Tooth like).
- These fishes are predaceous, Jaws are very power full, mouth is present at the ventral surface of head and teeth are backwardly directed and formed by modification of placoid scales.
- In these fishes, **5 - 7 pairs** of gills are present, which open direct outside the body by gill slits.
- operculum is normally absent in these fishes.
- Due to absence of air - bladder they have to swim constantly to avoid sinking.
- Cloacal aperture is present. Genital ducts open into cloacal aperture.
- They are **ureotelic** (excretory product-urea)
- Male fishes have "**Claspers**" as copulatory organs, which are developed on pelvic fins.
- They have internal fertilisation and many of them are **Viviparous.**

SPOT LIGHT

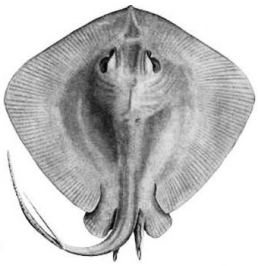
- Animals, lack capacity to regulate body temperature are called cold **blooded/poikilotherms** (fishes, amphibians & Reptiles) and animals have capacity to regulate body temperature are known as warm blooded/ homeotherms. (eg. Birds & mammals)

Examples:

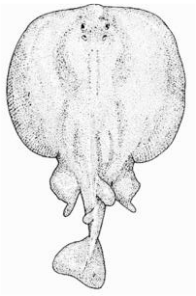
1. ***Scoliodon*:** Dog fish or common **Indian shark,** Dog like sense of smell. It is **viviparous**
2. ***Pristis*** (Saw - fish)
3. ***Trygon*** (Sting ray) - Its dorsal fin has poisonous spines for protection.
4. ***Torpedo* (Electric ray) - In this fish** an electric organ is found which is a modified muscle, it can give shock of about 100 volts (Scaleless fish).
5. ***Carcharodon*:** Great white shark
6. ***Chimaera*:** (Rat fish" "King of herrings" Ghost fish :– Connecting link between bony & cartilagenous fish. Operculum present and cloaca absent like in bony fishes.



Pristis (Saw fish)



Trygon (Sting ray)



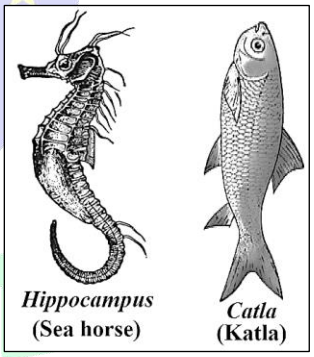
Torpedo (Electric ray)

[B] CLASS – OSTEICHTHYES

- They are found in fresh water as well as marine water.
- **Endoskeleton**-made up of **bones**, so these fishes are called "**bony - fishes**". Notochord is perfectly replaced by bony vertebral column.
- **Exoskeleton**-made up of **cycloid scale** or **ctenoid scales.**
- Respiration by **4 - pairs** of gills. These gills are covered by **operculum** at each side of body.
- Mouth is terminal.
- An air filled bag like structure **"air bladder"** is present. Which help in maintaining balance of body and provide **Buoyancy.**
- **Cloaca absent**, anus and genital ducts open outside the body through separate apertures.
- They are ammoniotelic (NH_3).
- Fertilization is **usually external**, **claspers** are absent in male fishes.
- They are mostly **oviparous.**

Examples :

1. ***Hippocampus*** – **(Sea – horse)** - It swims in sea water in its vertical position.
2. ***Exocoetus*** (Flying fish) - Its **dorsal fin** is long, it can fly (glide) over 400 metre in sea water with the help of enlarged pectoral fin. Which is modified into wing like structure.
3. ***Labeo*** **:-** "Rohu"or "Indian carp" ┐ Fresh water food
4. ***Clarias*** **:- "Cat fish"** or **Magur** ┘ fishes
5. ***Catla*** – Katla
6. ***Betta*** – Fighting Fish ┐ Aquarium fish
7. ***Pterophyllum*** – Angel Fish ┘
8. ***Latimeria or coelocanth*** – **Living fossil**
9. ***Gambusia*** – Larvivorous fish, feeds on mosquito larva.
10. ***Protopterus***: (African lung fish): Lung fishes have some amphibian characters like lungs for aerial breathing and 3 chambered heart. Therefore, considered as connecting link between fishes & amphibians.



DETECTIVE MIND

Some fishes show **migration** for breeding in a particular season.

[A] **Catadromous migration:** Migration of fishes from fresh water to marine water (River to ocean)
Example: Larva of Petromyzon, Anguilla (Fresh water Eel)

[B] **Anadromous migration:** Migration of fishes from marine water to fresh water (Ocean to river)
Example: Adult Petromyzon, Hilsa

Superclass – Tetrapoda

Includes terrestrial vertebrates, lungs and 2 pairs of limbs present, each limb is Pentadactylas (with 5 digits).

CLASS - AMPHIBIA

- They are amphibious animals (amphi-both, bios-life) which can live on both the places at ease i.e. under water and on the land. (No marine amphibian)
- These are **poikilothermal** or cold blooded animals.
- These animals undergo **hibernation** (winter sleep) or **aestivation** (summer sleep) to prevent themselve from extreme cold and heat and to overcome unfavourable conditions.
- Body is divided into **head** & **trunk**. Tail may be present in some. Neck is totally absent.
- Most of them have **two pairs of limbs**. Forelimbs have four fingers and hindlimbs have five fingers.
- Skin is **moist, smooth** and **scale less**.
- Numerous **mucus glands** are found in skin which help in moisturing the skin. So these animals respire through moist skin **(Cutaneous respiration).**
- Alimentary canal, urinary bladder and genital ducts open into a common chamber called **cloaca**, which opens to the exterior.

Respiration (Eg: Frog)
- In larva – By gills
- In adult
  - Mainly by moist skin
  - By Lungs
  - By Bucco-pharyngeal epithelium

- Heart is **three chambered,** 2 auricles and 1 ventricle.
- 1 pair of **mesonephric kidneys** are present (Henle's loop absent). They are mostly **Ureotelic** but tailed amphibians and larvae are **Ammonotelic.**
- Tympanum represent the ear. Eyes have eyelids.
- Sexes are separate.
- Fertilization is usually **external**.
- These are mostly **oviparous**.
- Development is **indirect through larva.**

Salamandra (Salamander)

Rana (Frog)

SPOT LIGHT

When frog is present under water or during winter/summer sleep, it respires through skin only. When it is present on land then respires through both skin and lungs.

Eg : Tadpole larva in frogs & Toads (Gills and tail disappear during metamorphosis)
: **Axolotl larva** in newt & salamanders (No metamorphosis)

Examples :

(A) Limbless amphibian

(i) ***Ichthyophis* (blind or deaf worm) :-** Long cylindrical worm like body without limbs. Eyes covered by skin and tympanum absent.

(B) Tailed amphibian

(i) ***Salamandra*: –** It is viviparous.

(ii) ***Amphiuma* -** Largest RBC is present.

(C) Tailless amphibian

(i) ***Rana tigrina*** – Indian bull frog.

(ii) ***Hyla*** – Tree frog

(iii) ***Bufo*** – Common toad: Poison glands are found in skin which are modification of parotid salivary gland.

(iv) ***Alytes*** (The Mid wife toad) : - Male show parental care

DETECTIVE MIND

Tailed Amphibians (eg: Salamander) lives in caves, valleys where water is deficiet of Iodine, Therefore, their larva doesn't undergo metamorphosis due to deficiency of thyroxin/ thyroid hormone and retains larval traits like gills & tail throughout the life. This phenomenon is called **neoteny.**

CLASS – REPTILIA

- Class name refer to creeping or crawling mode of locomotion. (Latin reptum - To creep or Crawl)
- These are **Cold blooded/Poikilothermal animals**.
- Reptiles were the **first successful terrestrial** vertebrates because they don't depend on water for breeding.
- Body is divided into **head, neck, trunk and tail.**
- Skin is dry, cornified, rough and non-glandular.
- Exoskeleton is made up of horny **epidermal scales** (snakes & Lizards) or **bony scutes** (Eg. Crocodiles)**.**
- Snakes & Lizard shed their scales as skin cast.
- Limbs, when present are **two pairs.**
- Respiration occurs exclusively through **lungs. (Pulmonary respiration)**
- Heart is usually **3 chambered** (**4 chambered** in crocodiles) and have mixed double circulation of blood.
- They do not have external ear opening. **Tympanum represent ear.**
- Ureters, genital ducts and alimentary canal open into a **single cloacal aperture.**
- These are unisexual animals, Females are mostly **oviparous,** eggs are cledoic (shelled). Fertilization is **internal.** Development is **direct**.

SPOT LIGHT

Amphibians were first vertebrates that invaded on land but they need water for eggs covered by soft Jelly coat & fertilization (external), on the other hand, Reptilian eggs are shelled and fertilization is internal, therefore, they are completely adapted for land habitat.

Examples :

(1) Tortoise & Turtles: Body is covered by two bony plates.

Testudo – Land tortoise

Chelone – Marine Turtles

(2) <u>Lizards:</u>

(i) ***Hemidactylus*** (Common lizard, **wall lizard**) : – It can shed its own tail at the time of emergency. It is called **autotomy**. Power of regeneration is well marked.

(ii) ***Calotes*** **(Garden lizard/Blood sucker/Girgit) : –** It can change its colour when get irritated.

(iii) ***Chameleon*** **(Tree lizard): –** It is viviparous.

(iv) ***Heloderma*** **(Gila-monster) : –** It is the **only poisonous lizard**.

(3) <u>Snakes:–</u> Limbless and tympanum/ Ear absent

(a) Non-poisonous snakes

(i) ***Python*** (Ajgar) – largest **non-poisonous snake**.

(b) ***Poisonous snakes***

(i) ***Naja naja*** – **Indian cobra**.

(ii) ***Naja bungarus*** or ***N. Hannah*** **(King cobra) : –** largest poisonous snake.

(iii) ***Bangarus*** **(Krait)**

(iv) ***Vipera*** **(Viper) : –** Viviparous

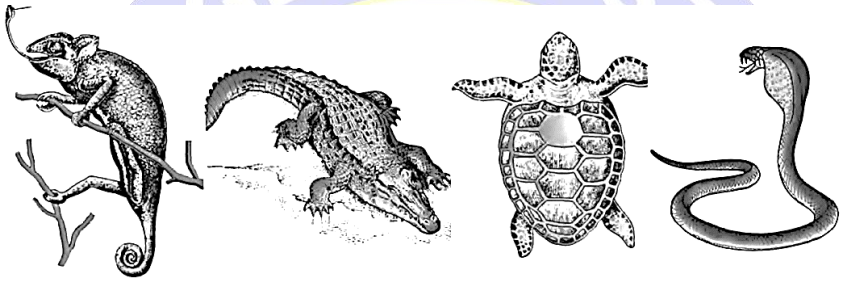
(v) **Hydrophis (Sea snake) –** Viviparous

(4) Crocodiles & Gharials: They are the largest/heaviest living reptiles and have some mammal like features –Diaphragm, Thecodont teeth and 4 chambered heart.

(i) ***Crocodilus (Asian Crocodile)***

(ii) ***Alligator*** – Maxican crocodile.

(iii) ***Gavialis*** – Gharial



Chameleon **(Tree** | *Crocodilus* **(Crocodile)** | *Chelone* **(Turtle)** | *Naja* **(Indian cobra)**

DETECTIVE MIND

- Sphenodon :- Tuatara of Newzeland is an example of living fossil, It is famous for having functional pineal eye (3rd eye)
- Poisonous snakes have two poisonous teeth associated with poison glands (Modified Salivary gland).
- Venom of most of snakes is **neurotoxic** (affects nerve impulse conduction) but venom of viper is **haemotoxic** causes haemolysis or Bursting of RBCs.

CLASS – AVES

- Includes truly flying vertebrates or glorified reptiles which are popularly called "**birds**".
- They are **Homeothermous (warm blooded)** i.e. They are able to maintain a constant body temperature.
- Body is stream lined. It is divided into **head**, **neck**, **trunk** and **tail**. Neck is long and flexible.
- **The most unique features of birds is presence of feathers all over the body.**
  - Feathers keep them warm and also makes body weight light.
- **Most of them can fly except flightless bird (Ostrich).**
- Skin is **dry and without glands.** But some oil glands or **Preen glands** are found in tail region, which lubricates feathers.
- Forelimbs are modified into wings, which help in flying.

- Hind limbs are adapted for clasping the branches of trees or for walking or swimming. Scales are found only on hind limbs.
- Jaws are modified into beak which is **toothless.**
- Digestive tract has additional chambers - the **crop** (for food storage) and **gizzard** (for grinding of food)
- A three chambered **cloaca** is present in the birds.
- **Spongy lungs** are present for respiration. Air sac connected to lungs supplement respiration.
- Air sacs are non-vascular but stores air to increase efficiency of respiration.
- Heart is four **chambered**, consist of two auricles and two ventricles. Complete Double circulation of blood is found.
- Endoskeleton is **fully ossified (bony)**. Long bones are hollow with air cavity, So, these bones are called **pneumatic bones**. These make the body light in weight which helps in running or flying.
- **External auditory openings** are present but ear pinnae are absent.
- Birds are **unisexual** and also exhibit **Sexual dimorphism**.
- Fertilization is **internal.** They are **oviparous** (shelled eggs)and development is direct.
- Most of the birds do not have urinary bladder and copulatory organ.

Examples :

(A) **Flightless Birds:–** Wings are reduced, unable to fly but are fast runner.

(i) ***Struthio*** - African ostrich

(ii) ***Apteryx*** (Kiwi) : - It is National bird of New Zealand.

(B) **Flying Birds:**– All flying adaptations present, wings are well developed.

(i) ***Pavo cristatus*** (Peacock) - It is the national bird of India.

(ii) ***Psittacula*** - Indian parrot.

(iii) ***Columba*** - Blue rock pigeon

(iv) ***Neophron*** - Vulture (Scavenger bird)

(v) ***Corvus*** - Crow

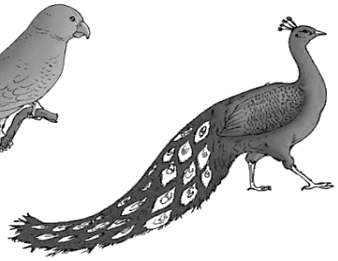
(vi) ***Passer domesticus***- Sparrow

(C) ***Aptenodytes*** (Penguin):- also called **"Sea bird of Antarctica",** forelimbs modified into flippers for swimming.

Struthio
(Ostrich)

Neophron
(Vulture)

Psittacula
(Parrot)



Pavo
(Peacock)

DETECTIVE MIND

In flying birds, some caudal vertebrae fused to form **pygostyle,** which helps in wagging movement of tail to provide propulsion force for flying, Sternum has a Ventral projection "**keel**" for attachment of flight muscles & preen glands (Oil) also present to lubricate feathers on tail region.

CLASS - MAMMALIA

- The members of this class are **cosmopolitan** (worldwide) and found in a variety of habitats - polar ice cap, deserts, mountains, forest, grasslands and dark caves. Some of them adapted to fly or live in water.
- Mammals are **warm blooded** and **homeothermic.**
- Body is divided into **head**, **neck**, **trunk** and **tail.**
- The most unique mammalian characteristic is the presence of milk producing "**Mammary glands**" by which the young ones are nourished. **Diaphragm** between thoracic and abdominal cavity is also unique and found in all mammals.
- The skin of mammals is unique in possessing **hair**, minimizes heat loss during winter.
- Skin of mammals is thick, and glandular. So many types of glands are present in the skin as **sweat glands, sebaceous glands** and **mammary glands**. (modified sweat gland).
- Two pairs of limbs are present in trunk. Limbs are **pentadactylous** which help in swimming, walking running etc. **Hind limbs** are **absent** in some aquatic mammals (Whale, dolphin).
- Respiration is by one pair of **lungs,** diaphragm also helps in breathing.
- Double circulatory system is present. Heart **four chambered**.
- Mature **RBCs are biconcave & enucleated** in mammals. (Except Camel and llama)
- Neck is having **7 cervical vertebrae -** Number of cervical vertebrae remain same in almost all mammals, they do not depends on length of their neck.
- External ear is present in the form of **ear pinnae** and middle ear has **3 ossicles (malleus, incus, stapes).**
- Mammals are **unisexual** animals.
- Fertilization is **internal.**
- Mostly mammals are **viviparous.** (give birth to baby)
- Embryo is attached to the uterus of mother with a temporary structure called **placenta** during pregnancy.

Examples:

(A) Egg laying mammal:

- Lays reptile like shelled eggs
- Connecting link between reptiles and mammals.
  Eg. Ornithorhynchus (Duck billed platypus)

Ornithorhynchus (platypus)

(B) Marsupials or Pouched mammals of Australia:

- An abdominal pouch called marsupium is found in females, in which immature young ones are kept after delivery **(Viviparous)**
  Eg. *Macropus* (Kangaroo)

Macropus (kangaroo)

(3) True placental mammals: **Viviparous** and give birth to a mature baby. A true placenta is found, which provides both attachment and nutrition to baby.

- **Pteropus (Flying fox):** It is Frugivorous bat. These are true flying mammals.(Radar system present).
- ***Rattus*** (Rat),
- ***Canis*** (Dog), ***Felis*** (Domestic cat), ***Panthera leo*** (Lion)
- ***Panthera tigris***- Tiger (National Animal of India)
- ***Delphinus*** (Common dolphin), ***Balaenoptera*** (Blue whale),
- ***Elephas*** (Indian elephant)
- ***Equus*** (Horse)
- ***Camelus*** (Camel)
- ***Macaca*** (Monkey)

Pteropus (Flying fox)

Balaenoptera
(Blue whale)

SPOT LIGHT

Aquatic mammals (Whale, Dolphin) don't have Ear Pinna, body hair and hind limbs. They have a thick adipose tissue layer "**Blubber**" Just below the skin, Which also helps in Thermoregulation.