ANIMAL KINGDOM

Animals are **multicellular** and **heterotrophic** organisms **without cell wall** and **chlorophyll.**

Kingdom Animalia includes 11 major phyla:

1. Porifera
2. Cnidaria
3. Ctenophora
4. Platyhelminthes
5. Aschelminthes
6. Annelida
7. Arthropoda
8. Mollusca
9. Echinodermata
10. Hemichordata
11. Chordata

BASIS OF CLASSIFICATION

1. Levels of organization

Based on this, animals are grouped into four levels:

a. **Cellular level of organization:** Here, the cells are arranged as loose cell aggregates. E.g. Porifera.

b. **Tissue level of organization:** Here, the cells are arranged into **tissues.** E.g. Cnidarians and Ctenophores.

c. **Organ level of organization:** Here, tissues are arranged into **organs.** E.g. Higher animals (Platyhelminthes to chordates).

d. **Organ system level of organization:** Here, organs are associated to **organ system.** Each system performs a specific physiological function. E.g. Higher animals.
Organ systems of various animals show complexities. E.g. **Digestive system** is 2 types:
   - **Incomplete:** It has only a single opening that acts as mouth & anus. Seen in Cnidaria and Platyhelminthes.
   - **Complete:** It has 2 openings (mouth & anus).

Circulatory system is 2 types: **open** & **closed.**

2. Body symmetry

It is the arrangement of similar body parts on 2 sides of main axis of the body. Based on symmetry, animals are 2 types: Asymmetrical and Symmetrical.

a. **Asymmetrical:** Here, body cannot be divided into 2 equal halves. E.g. Most Poriferans, Snails etc.

b. **Symmetrical:** Here, body can be divided into 2 equal halves. It is 2 types.
   - **Radial symmetry:** Here, body can be divided into 2 equal halves in **any vertical plane** along **central axis** (oral-aboral axis) of the body. E.g. some Poriferans, Cnidarians, Ctenophores and Echinoderms (adult).
   - **Bilateral symmetry:** Here, body can be divided into **right & left halves** in only **one plane.**
     E.g. Platyhelminthes to Chordata (except adult Echinodermata).

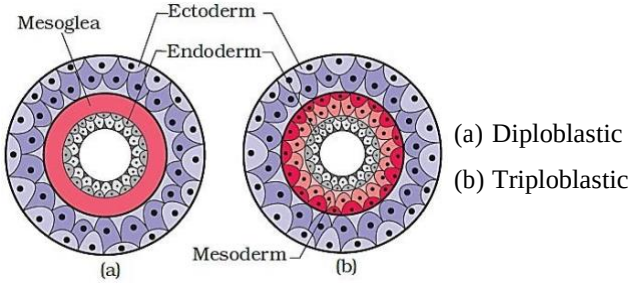
The body of bilaterally symmetrical animal has a **dorsal side** (upper), a **ventral side** (lower), left & right **lateral sides**, **anterior** (cephalic) side and **posterior** (anal or tail) side.

3. Germinal layers (Embryonic layers)

These are layers of embryo from which all the body organs are formed. Based on the number of germ layers, animals are 2 types- Diploblastic and Triploblastic.

a. **Diploblastic animals:** 2 germ layers- outer ectoderm and inner endoderm. In between these layers, an undifferentiated jelly-like layer called **mesoglea** is present. E.g. Cnidaria & Ctenophora.

b. **Triploblastic animals:** 3 germ layers- Outer ectoderm, middle mesoderm and inner endoderm. E.g. Platyhelminthes to Chordata.



(a) Diploblastic
(b) Triploblastic

4. Coelom (body cavity)

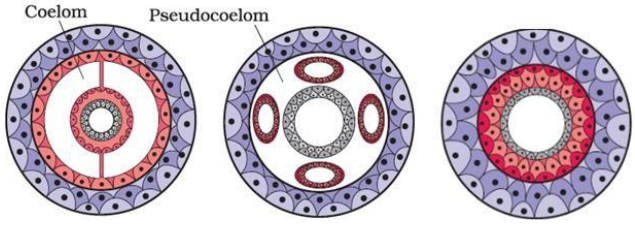
It is the cavity lined by mesoderm. It is seen between body wall and gut wall. Coelom separates the muscles of gut and body wall.

Based on the nature of coelom, animals are 3 types:

a. **Acoelomate:** No coelom. The space between body wall and digestive cavity is filled with matrix (parenchyma). E.g. Porifera to Platyhelminthes.

b. **Pseudocoelomate:** False coelom. Here, the body cavity is not lined by mesoderm. Mesoderm is scattered pouches. E.g. Aschelminthes.

c. **Coelomate**: True coelom. Here, the coelom arises from the mesoderm. Coelom is lined by peritoneal layer and filled with coelomic fluid. E.g. Annelida to Chordata.



Coelomate *Pseudocoelomate* *Acoelomate*

Functions of coelom:

- It accommodates visceral organs.
- Coelomic fluid reduces friction between visceral organs.
- It acts as shock absorber.

5. Metamerism (segmentation)

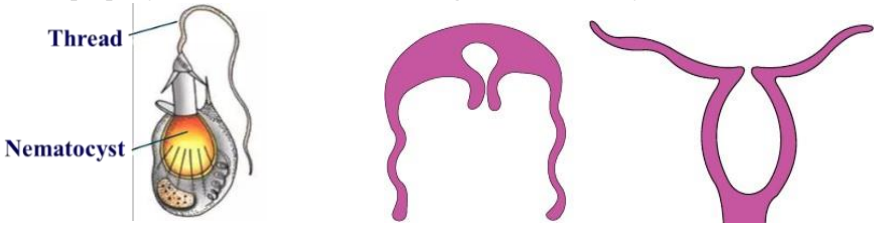
It is the phenomenon in which the body or organs is externally and internally divided into **repeated segments (metameres).** E.g. Annelids (earthworm etc.), Arthropods.

6. Notochord

It is a **mesodermally derived supporting rod** formed on the dorsal side during embryonic development in some animals. Animals with notochord are called **chordates** and those without notochord are called **non-chordates.**

Features	Porifera (Sponges)	Cnidaria (Coelenterata)	Ctenophora (Comb jellies or Sea walnuts)
Grades of organization	Cellular	Tissue	Tissue
Symmetry	Asymmetrical. Some are radial.	Radial	Radial
Germ layers	-	Diploblastic	Diploblastic
Coelom	Acoelomate	Acoelomate	Acoelomate
Habit and habitat	Aquatic (mostly marine). Sedentary. Solitary/colonial.	Aquatic (mostly marine). Sessile/free swimming. Solitary/colonial.	Exclusively marine. Solitary & pelagic
Digestive system	Absent. Intracellular digestion.	Incomplete. Intracellular & extracellular digestion.	Incomplete. Intracellular and extracellular digestion.
Respiratory system	Absent	Absent	Absent
Circulatory system	Absent	Absent	Absent
Reproduction	Asexual **(fragmentation)** & Sexual. Hermaphrodite. Internal fertilization. Development is indirect.	Polyp reproduces asexually (budding) and medusa sexually. Most are separate sexes. External fertilization. Development is indirect.	Only Sexual. Hermaphrodite. External fertilization. Development is indirect.
Unique features	**Water canal (water transport) system.** Millions of **ostia (pores).** **Spongocoel** & canals are lined with **choanocytes** (collar cells). Body is supported by **spicules** and **spongin** fibres.	**Tentacles** with **cnidoblasts.** **Gastro-vascular cavity (coelenteron)** with an opening (mouth) on **hypostome.** **Polyp** & **Medusa** forms are seen. Some shows **alternation of generation.** **Corals** have skeleton ($CaCO_3$).	Locomotion is by **8** vertical external rows of ciliated **comb plates**. Tentacles present. Shows **Bioluminescence.**
Examples	*Sycon (Scypha),* *Spongilla* (fresh water sponge), *Euspongia* (Bath sponge)	*Hydra, Obelia, Aurelia, Physalia* (Portuguese man of war), *Adamsia* (Sea-anemone), *Pennatula* (Sea pen), *Gorgonia* (Sea fan), *Meandrina* (Brain coral)	*Ctenoplana, Pleurobrachia*

1. **Water canal system:** Here, water enters through minute pores **(ostia)** in the body wall into a central cavity **(spongocoel),** from where it goes out through **osculum.** Canal system is used for food gathering, gas exchange and removal of wastes.
2. **Hermaphrodite (Monoecious):** Male and female sex organs are seen in same individual.
3. **Tentacles:** Finger-like structures which surrounds the mouth of coelenterates. Used for food capture & defense.
4. **Cnidoblasts (Cnidocytes):** These are stinging cells (present on the tentacles and the body) with a poison-filled capsule called ***nematocyst***. Cnidoblast is used for **anchorage, defense** and to **capture prey.**
5. **Polyp & Medusa:** 2 types of body forms in cnidarians.
   Polyp is tubular attached asexual form, with upwardly directed mouth & tentacles. E.g. *Hydra, Adamsia.*
   Medusa is umbrella like, free-swimming sexual form, with downwardly directed mouth & tentacles. E.g. *Aurelia* (Jelly fish).
6. **Alternation of generation (Metagenesis):** The phenomenon in which polyps produce medusae asexually and medusae form the polyps sexually. E.g. *Obelia.*
7. **Bioluminescence:** It is the property of some animals to emit light from the body.



Features	Platyhelminthes (Flatworms)	Aschelminthes (Roundworms)	Annelida (Segmented or Ringed worms)	Arthropoda (Joint-legged animals)
Grades of organization	Organ & Organ system	Organ system	Organ system	Organ system
Symmetry	Bilateral	Bilateral	Bilateral	Bilateral
Germ layers	Triploblastic	Triploblastic	Triploblastic	Triploblastic
Coelom	Acoelomate	Pseudocoelomate	Coelomate	Coelomate
Habit and habitat	Mainly aquatic. Endoparasites. Some are free-living.	Aquatic and terrestrial. Free living or parasitic in plants & animals.	Terrestrial, fresh water or marine. Free living or parasitic.	Cosmopolitan
Digestive system	Incomplete	Complete. Tubular alimentary canal with well-developed muscular pharynx.	Complete	Complete
Respiratory system	Absent	Absent	**Cutaneous** respiration. Some have **branchial (gill)** respiration.	**Gills/ book gills/ trachea/book lungs**
Circulatory system	Absent	Absent	Closed type	Open type
Reproduction	Asexual (fragmentation) and Sexual. Hermaphrodite. Internal Fertilization. Development is indirect. Many larval stages.	Dioecious. Sexual reproduction. Internal fertilization. Development is direct or indirect.	Sexual. Earthworms & leeches are monoecious. *Neries* is dioecious. Development is direct or indirect.	Mostly dioecious. Usually internal fertilization. Mostly **oviparous.** Development is direct or indirect.
Unique features	**Unsegmented, dorso-ventrally flattened body** (except tape worms). Excretion and osmo-regulation by **Flame cells (protonephridia).** Parasites have **Hooks** & **suckers.** Some absorb nutrients from the host through their body surface.	Body is circular in cross section. **Syncytial** epidermis. Thick cuticle. An excretory tube to remove body waste through excretory pore. **Sexual dimorphism** (females are longer than males).	Segmentation like rings. **Longitudinal and circular muscles** help in locomotion. Locomotory organs are **setae** (in earthworm) or **parapodia** (in *Neries*). Excretion by **Nephridia.** Paired ganglia connected by lateral nerves to a double ventral nerve cord.	**Jointed appendages**. Body has 3 regions: **head, thorax** & **abdomen.** Body is covered by **chitinous cuticle (exoskeleton).** Excretion by **Malpighian tubules.** **Sensory organs** are **antennae, compound** & **simple eyes, statocysts (balance organs)**.
Examples	*Taenia solium* (Tape worm), *Fasciola* (Liver fluke), *Planaria* (shows high regeneration capacity).	*Ascaris* (Roundworm), *Ancylostoma* (Hookworm), *Wuchereria* (Filarial worm).	*Pheretima* (earthworm), *Hirudinaria* (blood sucking Leech), *Neries* (aquatic. Parapodia for swimming).	Spider, Scorpion, Crab, Prawn, Insects etc. **Economically important insects:** *Apis, Bombyx, Laccifer*. **Vectors:** Mosquitoes (*Anopheles, Culex & Aedes*), Housefly etc. **Gregarious pest**: *Locusta*. **Living fossil:** *Limulus* (King crab)

1. **Dioecious:** Sexes are separate.
2. **Sexual dimorphism:** Morphological differences between male and female.
3. Arthropoda is the largest phylum. Over two-thirds of all named species are arthropods.

GENERAL CHARACTERS OF DIFFERENT PHYLA (NON-CHORDATES)

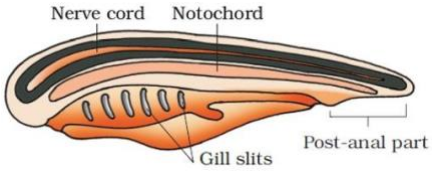
Features	Mollusca (Soft-bodied animals)	Echinodermata (Spiny-skinned animals)	Hemichordata
Grades of organization	Organ system	Organ system	Organ system
Symmetry	Bilateral	Adults radial. Larvae bilateral.	Bilateral
Germ layers	Triploblastic	Triploblastic	Triploblastic
Coelom	Coelomate	Coelomate	Coelomate
Habit and habitat	Aquatic. Few are terrestrial.	Exclusively marine.	Exclusively marine.
Digestive system	Complete	Complete. Ventral mouth and dorsal anus.	Complete
Respiratory system	**Gills** in aq. forms and **pulmonary sac** in terrestrial forms.	**Dermal branchiae (skin gills** or **papulae)** and **tube feet.**	**Gills**
Circulatory system	Open type	Open type	Open type
Reproduction	Dioecious. Oviparous. Development is direct or indirect.	Dioecious. External fertilization. Development is indirect. Ciliated free-swimming larva.	Dioecious. External fertilization. Development is indirect.
Unique features	Body has **head, visceral mass (visceral hump)** & muscular **foot.** Head has **sensory tentacles.** Calcareous shell. Feather-like gills for respiration & excretion. **Mantle** & **radula** are seen.	They have an endoskeleton of calcareous **ossicles** (Spiny bodied). Head absent. **Water vascular system** present. Excretory system absent. Shows **autotomy** & **regeneration.**	Worm-like cylindrical body formed of anterior **proboscis, a collar** and a long **trunk.** Collar bears **stomochord** (a rudimentary structure similar to notochord). Excretion by **Proboscis gland.**
Examples	*Pila* (Apple Snail), *Pinctada* (Pearl Oyster), *Sepia* (Cuttlefish), *Loligo* (Squid), *Octopus* (Devil fish), *Aplysia* (Sea Hare), *Dentalium* (Tusk shell), *Chaetopleura* (Chiton)	*Asterias* (Starfish), *Echinus* (Sea Urchin), *Echinocardium,* *Antedon* (Sea Lily), *Cucumaria* (Sea Cucumber), *Ophiura* (Brittle Star)	*Balanoglossus* (Tongue worm), *Saccoglossus*

1. **Mollusca** is the second largest phylum.
2. **Mantle (Pallium):** The membrane which covers visceral mass. Space between the hump and mantle is called ***mantle cavity.***
3. **Radula:** File-like rasping organ present in the mouth of molluscs. It is used for feeding.
4. **Water vascular (ambulacral) system:** In this system, sea water enters through a porous plate called ***madreporite*** and reaches the radiating canals and ***tube feet (podia).*** Its functions are locomotion, respiration, capture & transport of food and excretion.
5. Hemichordata was earlier considered as a sub-phylum of Chordata. Like chordates, it has pharyngeal gill slits.

PHYLUM CHORDATA

It includes animals with notochord, dorsal tubular nerve cord and pharyngeal gill slits.
Notochord is a flexible rod located in the mid dorsal line between the alimentary canal and the nerve cord in the embryo.

Differences between Chordata and Non-Chordata

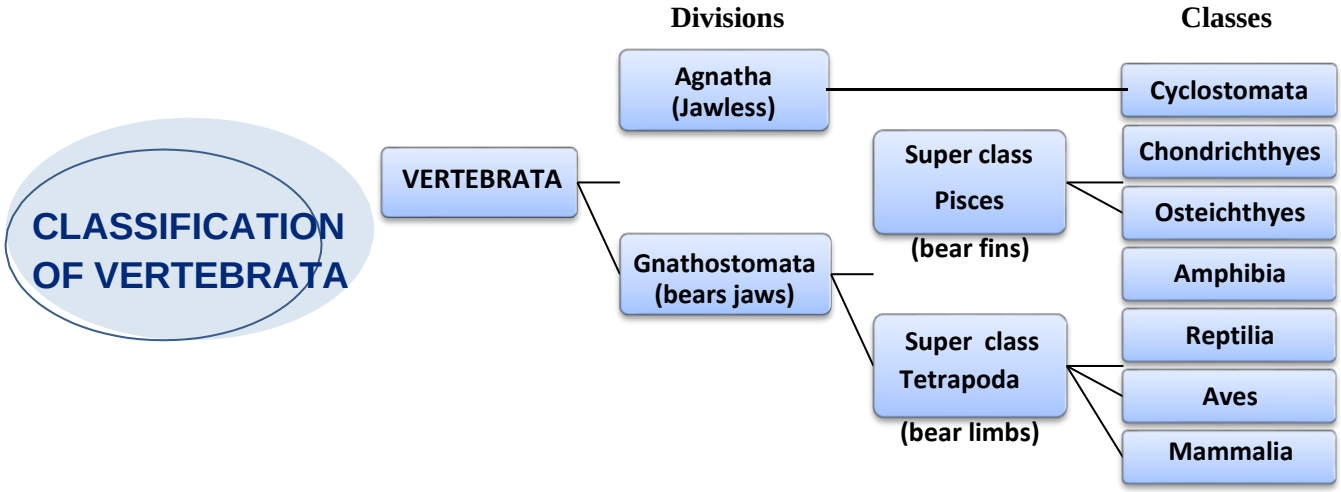


Chordata characteristics (Body plan)

Chordata	Non-Chordata
1. Notochord is found in the embryonic stage	Absent
2. Central nervous system is dorsal, hollow and single	Ventral, solid and double
3. Pharyngeal gill slits present	Absent
4. Ventral heart	Dorsal heart (if present)
5. A post-anal part (tail) is present	Absent

Phylum Chordata is classified into 3 subphyla: **Urochordata, Cephalochordata & Vertebrata.**

PROTOCHORDATA (ACRANIATA)		VERTEBRATA (CRANIATA)
Urochordata (Tunicata)	**Cephalochordata**	
• **Notochord** present only in larval tail. • Body is covered by **test** made up of **tunicin.** • Exclusively marine. • Hermaphrodite. • E.g. *Ascidia, Salpa, Doliolum.*	• Notochord from head to tail region and is persistent throughout the life. • Fish-like body. • Exclusively marine. • Sexes are separate. • E.g. *Branchiostoma* (Amphioxus or Lancelet).	• Possess notochord during the embryonic period. • Notochord is replaced by a cartilaginous or bony **vertebral column** in the adult. • **Ventral** muscular **heart.** • **Kidneys** for excretion & osmoregulation • **Paired appendages** (fins or limbs).



CLASS CYCLOSTOMATA

- All are ***ectoparasites*** on some fishes.
- Elongated body without scales and paired fins.
- 6-15 pairs of ***gill slits*** for respiration.
- Sucking and circular mouth ***without jaws.***
- Circulation is ***closed*** type.
- Marine, but migrate for ***spawning*** to fresh water. After spawning, they die. Their larvae, after metamorphosis, return to ocean.
- ***Cartilaginous cranium*** and ***vertebral column.***
- E.g. *Petromyzon* (Lamprey) and *Myxine* (Hagfish).

SUPERCLASS PISCES (FISHES)

Class Chondricthyes (Cartilaginous fishes)	Class Osteichthyes (Bony fishes)
Marine. Stream-lined body. Predaceous.	Marine & fresh water. Stream-lined body.
Cartilaginous endoskeleton. **Notochord** is **persistent** throughout life.	**Bony endoskeleton.**
Ventral mouth.	Terminal mouth.
Gill slits without operculum. Powerful jaws.	4 pairs of **gills** covered by **operculum** on each side.
Skin with **placoid scales.** Teeth are modified placoid scales which are backwardly directed.	Scales are **Cycloid, ctenoid** etc.
No air bladder. So, they have to swim constantly to avoid sinking.	**Air bladder** for buoyancy.
Poikilotherms (cold-blooded).	**Poikilotherms** (cold-blooded).
Two-chambered heart (one auricle and one ventricle).	**Two-chambered** heart (one auricle and one ventricle).
Sexes are separate. In males, pelvic fins bear **claspers.** Internal fertilization. Many of them **viviparous.**	Sexes are separate. External fertilisation. Mostly **oviparous.** Development is direct.

Examples	**Examples**
Scoliodon (Dogfish), *Pristis* (Saw fish), *Carcharodon* (Great white shark), *Trygon* (Sting ray- has poison sting), *Torpedo* (Electric ray- has ***electric organ).***	**Marine:** *Exocoetus* (flying fish), *Hippocampus* (seahorse) **Fresh water:** *Labeo* (Rohu), *Catla* (Katla), *Clarias* (Magur). **Aquarium:** *Betta* (Fighting fish), *Pterophyllum* (Angel fish).

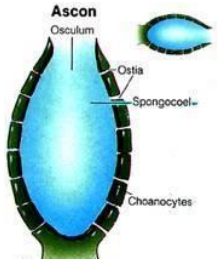
SUPERCLASS TETRAPODA

Class Amphibia	Class Reptilia	Class Aves (Birds)	Class Mammalia
They live in aquatic & terrestrial habitats and need water for breeding.	Dry & cornified skin, epidermal ***scales*** or ***scutes***.	Presence of ***feathers*** and ***beak.*** Forelimbs are modified into ***wings.***	Presence of ***mammary glands*** (milk producing glands).
Body has head & trunk. Some have tail. ***Moist skin*** without scales. Most have 2 pairs of limbs.	Snakes and lizards shed their scales as ***skin cast***. Limbs- 2 pairs (if present). Crawling mode of locomotion.	Dry skin without glands except the ***oil gland*** at the base of tail. Hind limbs have ***scales*** and are modified for walking, swimming or clasping tree branches. Hollow & pneumatic long bones.	Skin with ***hair.*** 2 pairs of limbs for walking, running, climbing, burrowing, swimming or flying.
Tympanum represents ear.	***Tympanum*** represents ear.	***Tympanum*** represents ear.	External ear ***(Pinnae).***
3-chambered heart (2 auricles + 1 ventricle).	***3-chambered*** heart (but a septum partially separates ventricle). Heart is ***4-chambered*** in **crocodiles.**	***4-chambered*** heart.	***4-chambered*** heart.
Poikilotherms	***Poikilotherms***	***Homoiotherms***	***Homoiotherms***
Alimentary canal, urinary & reproductive tracts open into a ***Cloaca*** which opens to exterior.	Well-developed alimentary canal.	Digestive tract has additional chambers, the ***crop*** & ***gizzard***.	Well-developed alimentary canal. Dentition is ***Heterodont, thecodont & diphyodont.***
Respiration is by ***gills*** (in larva), ***lungs*** & ***skin***	Respiration by ***lungs.***	Double respiration. ***Air sacs*** connected to lungs.	Respiration by ***lungs.***
Sexes are separate. External fertilisation. ***Oviparous***. Development is indirect.	Internal fertilisation. ***Oviparous.*** Development is direct.	Internal fertilisation. ***Oviparous.*** Development is direct.	Sexes are separate. Internal fertilisation. ***Viviparous*** (except *Echidna* and *Platypus*). Development is direct.
Examples *Bufo* (Toad), *Rana* (Frog), *Hyla* (Tree frog), *Salamandra* (Salamander), *Ichthyophis* (Limbless amphibia)	**Examples** *Chelone* (Turtle), *Testudo* (Tortoise), *Chameleon* (Tree lizard), *Calotes* (Garden lizard), *Crocodilus* (Crocodile), *Alligator*, *Hemidactylus* (Wall lizard). **Poisonous snakes**: *Naja* (Cobra), *Bangarus* (Krait), *Vipera* (Viper) etc. **Non-poisonous snakes:** *Python* etc.	**Examples** *Corvus* (Crow), *Columba* (Pigeon), *Psittacula* (Parrot), *Struthio* (Ostrich), *Pavo* (Peacock), *Aptenodytes* (Penguin), *Neophron* (Vulture) etc.	**Examples** *Ornithorhynchus* (Platypus), *Macropus* (Kangaroo), *Pteropus* (flying fox), *Camelus* (Camel), *Macaca* (Monkey), *Rattus* (Rat), *Canis* (dog), *Felis* (Cat), *Elephas* (Elephant), *Equus* (Horse), *Delphinus* (Common dolphin), *Balaenoptera* (blue whale), *Panthera tigris* (Tiger), *Panthera leo* (lion)

- **Poikilotherms (Cold-blooded animals):** Animals that lack the capacity to regulate their body temperature.
- **Homoiotherms (warm-blooded animals):** Animals having ability to maintain a constant body temperature.

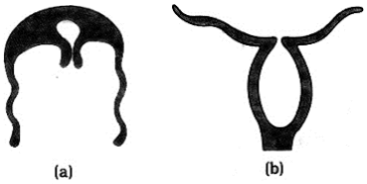
MODEL QUESTIONS

1. Observe the diagram showing the water canal system of sponges and complete the given flow chart.



Surrounding sea water ⟶ **A** ⟶ **B** ⟶ **C** ⟶ Surrounding sea water

2. Observe the diagram and answer the following questions:



   a. Identify the two forms.
   b. Name the phylum in which this phenomenon is seen.
   c. Mention any two differences between them.
   d. Of these, which is more advanced? Give reason.

3. Note the relation between first two words and suggest a suitable word for the fourth place

a.	Annelida	: Nephridia	Platyhelminthes	: ……..
b.	Platyhelminthes	: Acoelomates	Pseudocoelomate	: ……..
c.	Fish	: Gills	Insects	: ……..

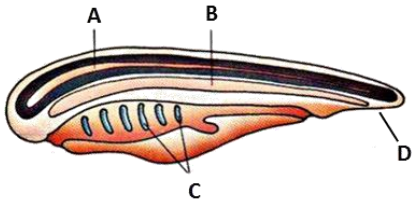
4. Odd man out and give reason
   a. Ascaris, Wuchereria, Ancylostoma, Limulus
   b. Earthworm, hookworm, roundworm, filarial worm
   c. Flying fish, Sea horse, Hag fish, Angel fish

5. Match the following related things from B and C with column A

A	B	C
Jelly fish	Sepia	Annelida
Cuttlefish	Hirudinaria	Echinodermata
Sea urchin	Aurelia	Mollusca
Leech	Echinus	Cnidaria

6. Find out the corresponding phylum with an example from the following general characters
   a. They are multicellular with a tissue grade of organisation, all are aquatic, radially symmetrical, diploblastic and mouth is encircled by finger like tentacles with stinging cells.
   b. They are bilaterally symmetrical, vermiform animals, triploblastic, exhibit true metamerism.
   c. They are exclusively marine, triploblastic, spines on the skin and radially symmetrical in the adult and bilaterally symmetrical in the larval stage.

7. Observe the following diagram.



   a. Identify the diagram.
   b. Copy the diagram and label A, B, C & D.

8. Give reasons for the following statements
   a. All vertebrates are chordates but all chordates are not vertebrates.
   b. Shark has to swim continuously, otherwise it will sink down.

9. Study the following facts by connecting with the features of tetrapoda and answer the following

- Aq. larval life & terr. adult life
- Bear limbs
- Heterodont dentition
- Heart is 4-chambered
- Pneumatic bone
- Mammary glands
- Presence of feathers
- Caudal fin
- Bony endoskeleton
- Operculum
- Poikilotherms
- Oviparous
- Skin with hair
- Dry and cornified skin
- Notochord present

   a. Select the common features of all tetrapods.
   b. Select the unique features of different tetrapods.
   c. Mention the features which are not suitable for tetrapods.