Classification of Animals

Kingdom Animalia - Invertebrata

Can you divide these animals into different groups along with the reasons for each division?

The animals can be grouped as follows:

1. **Fish and seahorse**: They are exclusively water-inhabiting animals. They breathe through gills.

2. **Chimpanzee and monkey**: They have mammary glands and produce young ones.

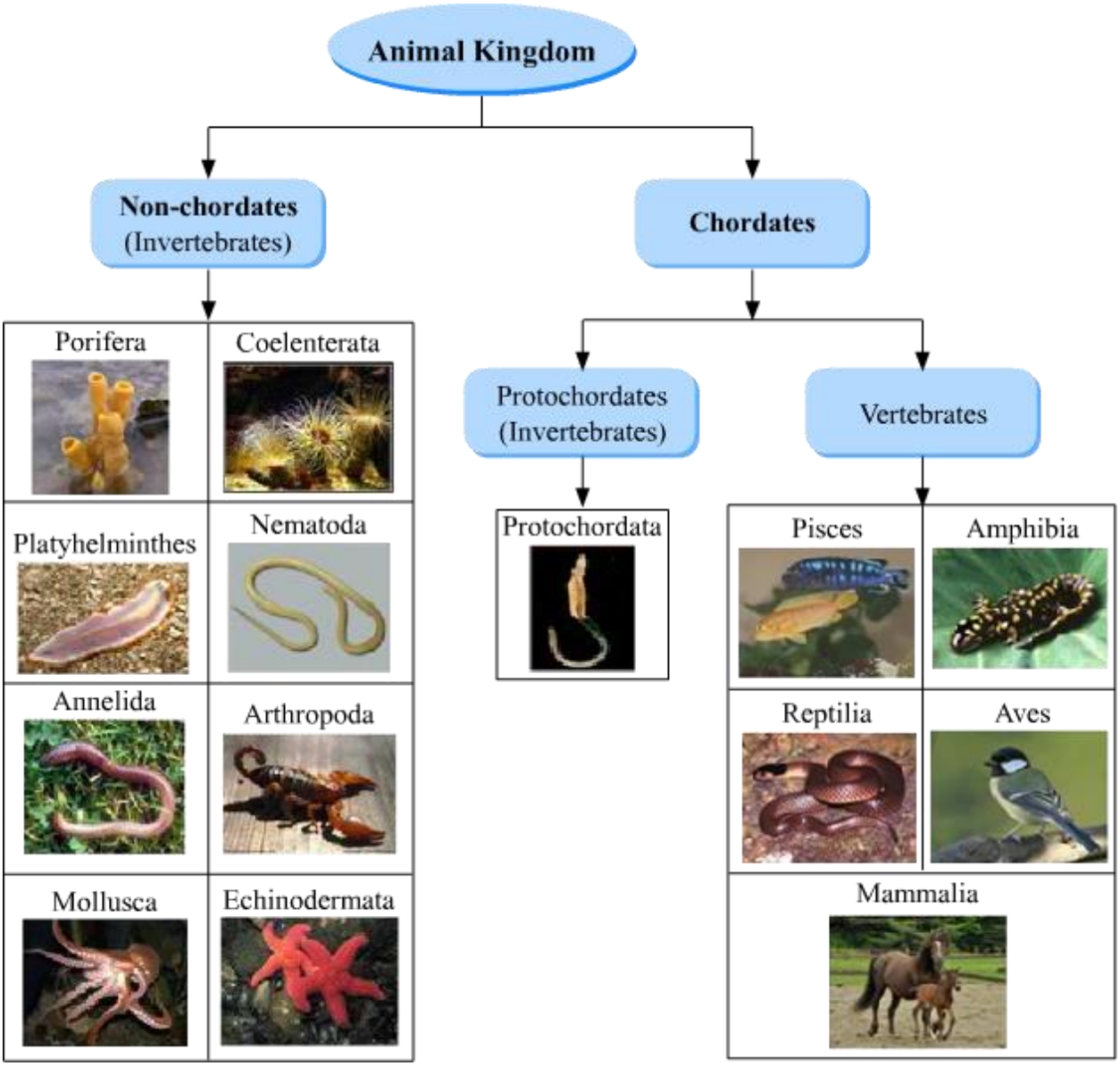
3. **Pigeon and sparrow**: They are warm-blooded animals. They lay eggs and have feathers on their bodies.

4. **Lizard and snake**: They are cold-blooded animals. They lay eggs and have scales on their bodies. They breathe through lungs.

What do we learn from the above activity?

We learn that characteristics can be compared to discover the similarities between various organisms, and then these organisms can be classified into groups based on the similarities.

Classification of the Animal Kingdom



The two broad divisions—non-chordates and chordates—are made on the basis of the presence or absence of the notochord. These groups are then further divided into sub-groups on the basis of other features of body organization.

Let us study in detail about the various characteristics used for classifying the organisms in the animal kingdom.

Bases of Animal Classification

Certain fundamental features that are common to various organisms in the animal kingdom are used as the bases for classifying them. These are as follows:

- Level of organization
- Symmetry
- Diploblastic and triploblastic organization
- Coelom
- Segmentation
- Notochord

Levels of organization

Though all members of kingdom Animalia are multicellular, all of them do not exhibit the same pattern of organisation of cells. The different levels of organization are as follows:

- Cellular level of organization (Example: Porifera)
- Tissue level of organization (Example: Coelenterata)
- Organ level of organization (Example: Platyhelminthes)
- Organ system level of organization (Examples: Nematoda, Annelida, Arthropoda, Mollusca, Echinodermata and chordates)

Bases of Animal Classification

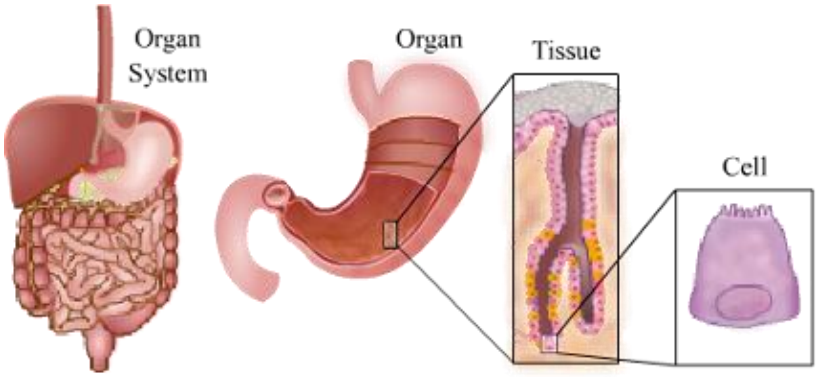
Levels of organization

- **Cellular level of organization**: It is a loose aggregation of cells in which the cells are functionally different from one another.

- **Tissue level of organization**: In this, different cells performing similar functions are arranged into tissues.

- **Organ level of organization**: Here, different tissues are organized into organs and each organ is specialized for a particular function.

- **Organ system level of organization**: At this level, organs associate to form functional systems and each system is concerned with a specific physiological function.



Two types of circulatory systems are found in the organ system level of organisation.

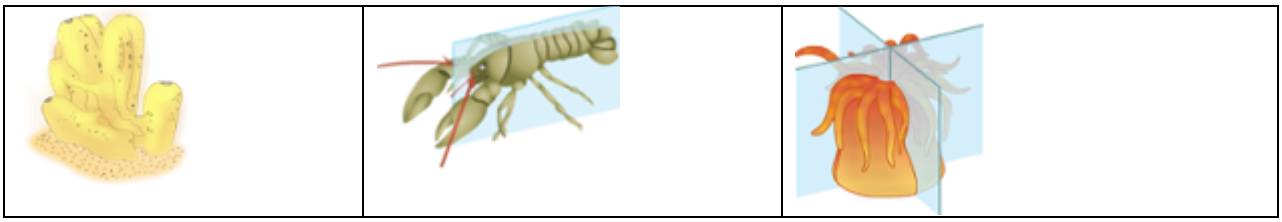
- **Open type**: Blood vessels are absent in this circulatory system. Blood is pumped out of the heart and the cells and tissues are directly bathed in it.
- **Closed type**: In this circulatory system, blood is circulated through vessels of varying diameters (arteries, veins and capillaries).

Bases of Animal Classification

Symmetry

Symmetry is defined as balance between distribution of duplicate body parts and shapes. On the basis of body symmetry, animals can be categorised as: Asymmetrical, bilaterally symmetrical or radially symmetrical

Asymmetrical organisms	Bilaterally symmetrical organisms	Radially symmetrical organisms
These organisms do not show any body symmetry. Any plane passing through the centre does not divide them into two equal parts.	These organisms show bilateral body symmetry. In their case, the body can be divided into two equal parts by only one plane. The two parts are approximately identical and mirror images of each other.	These organisms show radial body symmetry. In their case, the body can be halved when cut anywhere along the central axis. In this type of body plan, there is a regular arrangement of body parts in the body around the central axis. So, we can divide body into halves in many ways.
Examples : Sponges	Example : Platyhelminthes & chordates	Examples : Coelenterates and echinoderms

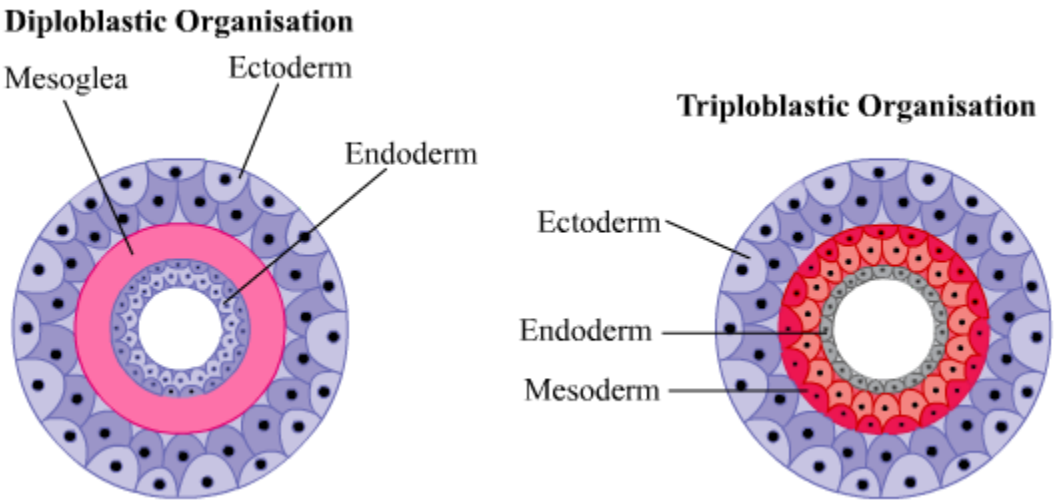


Bases of Animal Classification

Diploblastic and triploblastic organization

The animals in which cells are arranged in two embryonic layers—an external ectoderm and an internal endoderm—are called **diploblastic animals**. In these animals, an undifferentiated mass of tissue called mesoglea fills the space between the ectoderm and the endoderm. Coelenterates are diploblastic animals.

The animals in which the developing embryo has three germinal layers, viz. the ectoderm, the mesoderm and the endoderm, are called **triploblastic animals**. Platyhelminthes and all chordates are triploblastic animals.

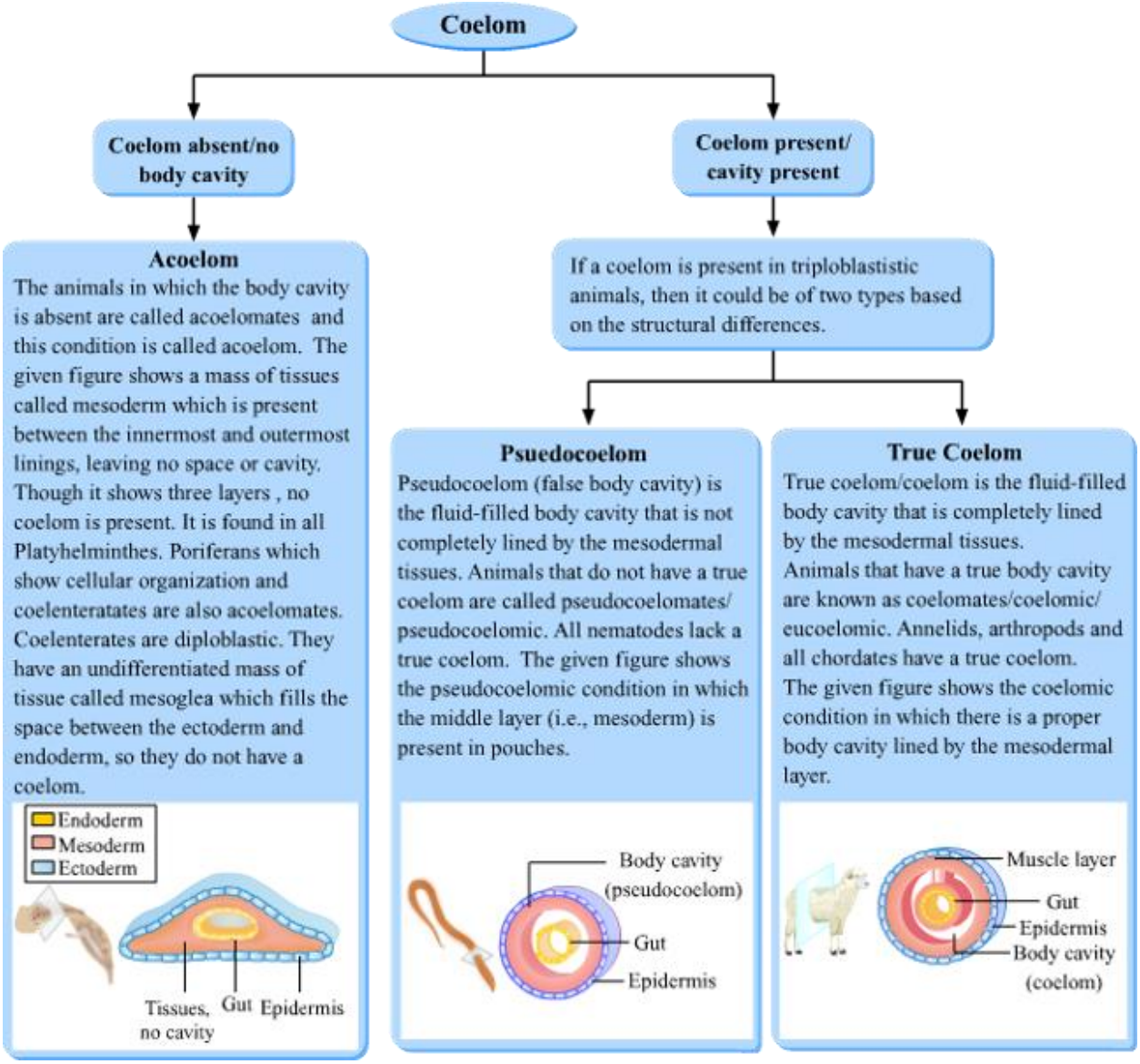


Bases of Animal Classification

Coelom

The presence or absence of a cavity called coelom is very important in the classification of animals. Coelom is the space or cavity between the body wall and the gut wall where the internal organs are suspended. Although body cavity can also include any space inside the body (such as the space inside internal organs), it is the coelom which is used for the purpose of classification.

Coelom is the space enclosed by the mesodermal cell. Thus, only triploblastic animals can have a coelom. However, not all triploblastic animals actually show this characteristic. Hence, there can be two conditions with respect to coelom.



Know More

True coelom can be categorized further as schizocoelom and enterocoelom on the basis of developmental differences.

Schizocoelom

Schizocoelom arises from mesodermal split. This body cavity is formed from blocks of mesoderm around the gut which enlarge and hollow out. Animals belonging to the phyla Annelida, Mollusca and Arthropoda display this type of true coelom.

Enterocoelom

Enterocoelom arises from outpocketing of the embryonic gut (endoderm). This body cavity is formed by outpocketings of the primitive gut which break off and form the coelom. Animals belonging to the phyla Echinodermata and Chordata display this type of true coelom.

Bases of Animal Classification

Segmentation

Certain animals have a body that is externally and internally divided into segments, with a serial repetition of at least some organs. Such segmentation is called metameric segmentation and this phenomenon is known as **metamerism**. For example, the body of an earthworm shows metameric segmentation.

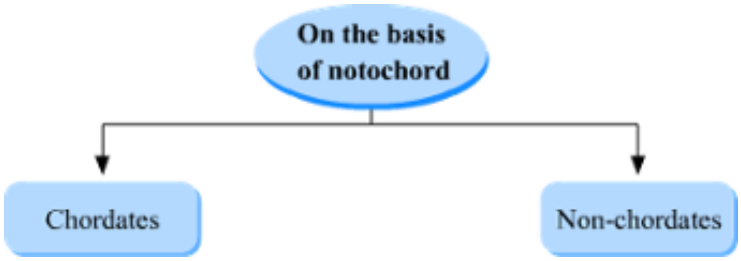
Earthworm

Notochord

Notochord is a rod-like structure consisting of vacuolated cells. It originates from the mesoderm. It is formed on the **dorsal** side in some animals. It separates the nervous system from the gut and also acts as a support.

Based on the presence or absence of the notochord, animals are categorized as chordates and non-chordates.

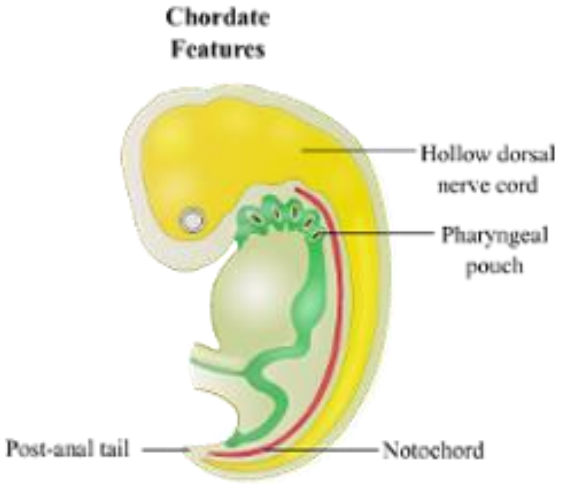
Bases of Animal Classification



Non-chordates: These organisms do not have a notochord. Animals belonging to the phyla Porifera, Coelenterata, Platyhelminthes, Nematoda, Annelida, Arthropoda, Mollusca and Echinodermata are all non-chordates.

Chordates: These organisms have a notochord. *Amphioxus*, *Herdmania* and all vertebrates (of the classes Pisces, Amphibia, Reptilia, Aves and Mammalia) are chordates.

The given figure shows the embryo of a chordate along with the location of the notochord.



Non-Chordates

Let us now study about the characteristic features of the first eight phyla of kingdom Animalia, i.e., Porifera, Coelenterata, Platyhelminthes, Nematoda, Annelida, Arthropoda, Mollusca and Echinodermata.

Phylum Porifera

The word ‘Porifera’ means ‘organisms with holes’. These organisms are commonly called sponges.

General features of poriferans

- They are mostly marine organisms except *Spongilla*.
- They are non-motile and found attached to rocks.
- They show cellular level of organization and minimal differentiation.
- Majority of sponges are asymmetrical.
- Their bodies are porous. The holes or pores are called ostia. These pores lead to the canal system which allows the circulation of water throughout the body. The pores enable food and oxygen to enter the body.
- These animals have a hard-outside layer or skeleton.
- Examples of poriferans: *Sycon*, *Spongilla*, *Euspongia*, *Euplectella*

Sycon

Euspongia

Spongilla

Did You Know?

- There are approximately 5000 different species of sponges.
- A sponge can contain around 16000 other animals inside itself.
- One of the first anti-cancer drugs was isolated from a sponge. In 1959, the anti-cancer drug called cytosine arabinoside was extracted from a sea sponge named *Cryptotethya crypta.* Recently, sponges have received much attention from pharmaceutical companies as the many chemicals produced by these organisms help fight infections, inflammations, diabetes and gastrointestinal ailments.

[[//mn:know]]

Non-Chordates

Phylum Coelenterata

The word ‘Coelenterata’ means ‘hollow gut’. This phylum is also known as Cnidaria.

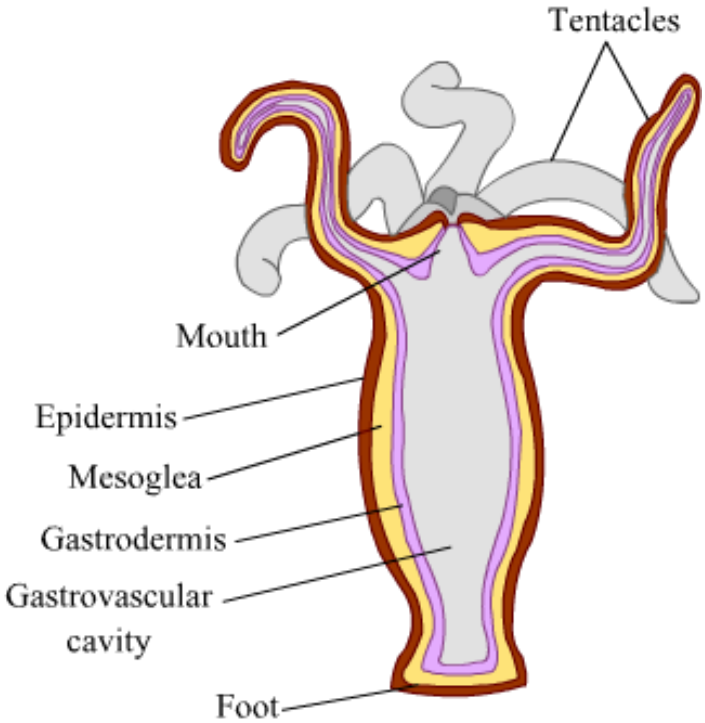
General features of coelenterates

- They are exclusively marine animals.
- They have a tissue level of organization, and lack organs and organ systems.
- Most of these animals have radial symmetry.
- The body of a coelenterate consists of two cell layers—the ectoderm (the outer layer) and the endoderm (the inner layer). Hence, it is the first diploblastic animal.
- Since a coelenterate is diploblastic, the body cavity called coelom is absent. (The coelom is found between the gut wall and the body wall of triploblastic animals.) Its body

has a sac-like body cavity with a single opening to the outside for ingestion and egestion.
- Some of the coelenterate species live in colonies (e.g., corals), while others have a solitary life span (e.g., *Hydra*).

Non-Chordates

- Examples of coelenterates: *Hydra*, *Obelia*, *Aurelia* (jellyfish), *Metridium* (sea anemone)



Hydra

Did You Know?

- There are more than 2000 coral reefs in the world.
- The Great Barrier Reef is the world's largest coral reef. It is composed of around 3000 individual corals extending to around 2600 km.

Non-Chordates

Phylum Platyhelminthes

Another name for platyhelminthes is ‘flatworms’. This is because their bodies are dorsoventrally flattened, and so they have a leaf-like or ribbon-like appearance.

General features of platyhelminthes

- They are mostly parasitic (e.g., tapeworms, liver flukes). However, some may be free-living (e.g., *Planaria*).
- They show an organ level of organization.
- They show bilateral symmetry.
- The body of a platyhelminth consists of not only the ectoderm and the endoderm but also the mesoderm (the layer of cells found between the outer and inner layers). Therefore, it is the first triploblastic animal.
- True body cavity or coelom is absent.
- Examples of platyhelminthes: *Planaria, Fasciola* (liver fluke), *Taenia solium* (tapeworm).

Planaria

Liver fluke

Tapeworm

Solved Examples

Medium

Example 1:

Do you know what causes liver rot disease?

Solution:

Liver fluke found in the liver and bile ducts of sheep and goats causes the complete breakdown of liver cells. This is known as liver rot disease. It is a serious disease in animals and can be fatal.

Example 2:

Why are fully developed organs not found in platyhelminthes?

Solution:

A platyhelminth has three layers of cells from which differentiated tissues can be made, which is why it is called triploblastic. This allows the outer and inner body linings to be

made along with some organs. Thus, there is some degree of tissue formation. However, there is no true internal body cavity or coelom in which well-developed organs can be accommodated. Hence, platyhelminthes do not have fully developed organs.

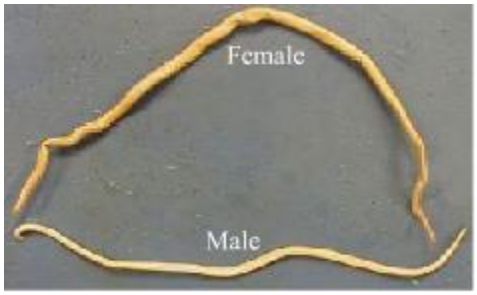
Non-Chordates

Phylum Nematoda

Another name for nematodes is ‘roundworms’.

General features of nematodes

- They are parasitic animals which cause diseases such as elephantiasis (filarial worms) and usually live in the intestine.
- A nematode has a cylindrical body with tapering ends.
- Nematodes have an organ system level of organization, but no real organs are formed due to the absence of a true coelom.
- They are bilaterally symmetrical and triploblastic.
- A false body cavity or pseudocoelom is present.
- Examples of nematodes:*Ascaris*, *Wuchereria* (filarial worm), *Ancylostoma* (hookworm)



Ascaris

Wuchereria

Non-Chordates

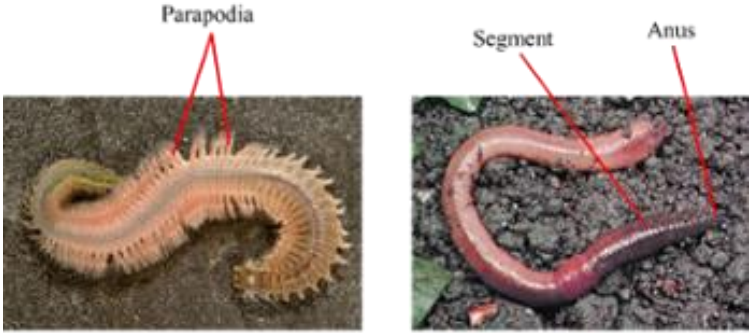
Phylum Annelida

Annelids are commonly called segmented worms.

General features of annelids

- They occur in both terrestrial and aquatic environments. They may be free-living or parasitic.
- They have an organ system level of organization.
- They are bilaterally symmetrical.
- An annelid possesses true organs inside its body structure.

- They are triploblastic animals. They are the first animals to possess a true body cavity or coelom (schizocoelom).
- They have metameric segmentation with extensive organ differentiation. The segments of the body are lined up one after the other from head to tail. Some of them have appendages called parapodia that help in locomotion.
- Examples of annelids: *Pheretima* (earthworm), *Hirudinaria* (leech), *Nereis*



Nereis Earthworm

Did You Know?

- Earthworms do not have eyes, but they have light receptors to sense light. These receptors help them differentiate between light and darkness.
- Earthworms are only found in humid conditions because they respire through their skin. They have a covering of mucus which allows dissolved oxygen to move into blood.

Non-Chordates

Phylum Arthropoda

The word ‘Arthropoda’ means ‘animals with jointed legs’. It is the largest phylum of the animal kingdom and includes more than 900000 species.

General features of arthropods

- They are found everywhere on Earth.
- An arthropod has a segmented body like that of an annelid. The body is divided into three regions—the head, the thorax and the abdomen.
- The body is covered by an exoskeleton made of chitin.
- Arthropods have an organ system level of organization.
- They show bilateral symmetry. They are triploblastic animals. Schizocoelom is present.
- They have certain advanced features.
- A distinct head is present. There are jointed legs for moving around.
- An open circulatory system is present, i.e., blood does not flow in well-defined blood vessels. Thus, their coelomic cavity is filled with blood.
- Examples of arthropods: crab, *Palaemon* (prawn), insect, spider, scorpion, centipede, millipede, cockroach, housefly, mosquito

Cockroach Butterfly Housefly Prawn

Non-Chordates

Phylum Mollusca

It is the second largest phylum after arthropods. Its members are commonly called soft-bodied animals.

General features of molluscs

- Though mostly present in seas, they may be found in freshwater or on land as well.
- The body of a mollusc is unsegmented like those of an annelid and an arthropod.
- They have an organ system level of organization.
- They show bilateral symmetry.
- A mollusc has an open circulatory system and possesses kidney-like organs for excretion.
- Molluscs are triploblastic animals.
- The coelomic cavity (schizocoelom) is reduced to a cavity called haemocoel, through which the hemolymph (function similarly as blood of vertebrates) circulates.
- The body is divided into an anterior head, a ventral muscular foot and a dorsal visceral mass.
- The soft body is covered by a hard shell.
- A mollusc has a distinct foot for moving around.
- Examples of molluscs: *Octopus*, *Pila* (freshwater snail), *Unio* (freshwater mussel), *Sepia* (cuttlefish), *Loligo* (squid)

Chiton *Octopus* *Pila* *Unio*

Non-Chordates

Phylum Echinodermata

The word ‘Echinodermata’ is derived from two Greek words: ‘echinos’ which means ‘hedgehog’ and ‘derma’ which means ‘skin’. They are commonly called spiny-skinned animals.

General features of echinoderms

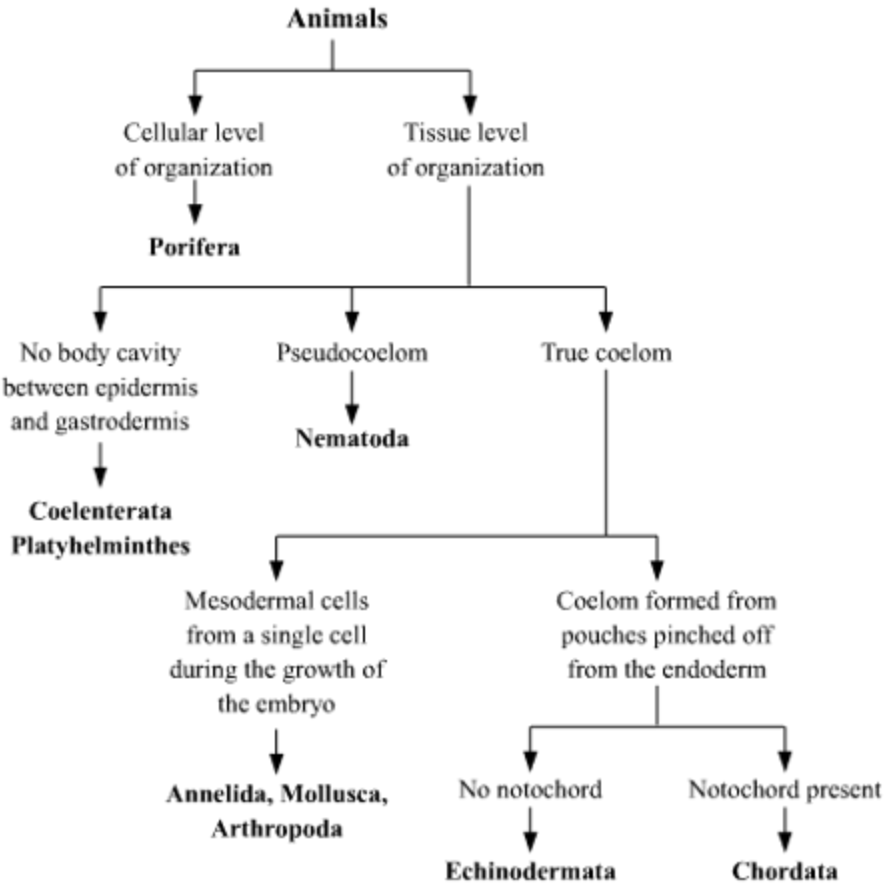
- They are exclusively free-living marine animals.
- They may be globular or cylindrical in shape.
- They have an organ system level of organization.
- They are triploblastic animals.
- They are coelomates and possess an enterocoelom.
- In the larval stage, they have bilateral symmetry and as adults, they have radial symmetry.
- The body of an echinoderm has a spiny outer covering made up of calcium carbonate.
- Echinoderms use a powerful water-driven tube system for moving around.
- Examples of echinoderms:*Asterias* (starfish), *Echinus* (sea urchin), *Holothuria* (sea cucumber), *Ophiura* (serpent star), *Antedon* (feather star)

Sea urchin

Starfish

Ophiura

Summary of Classification



Kingdom Animalia – Vertebrata

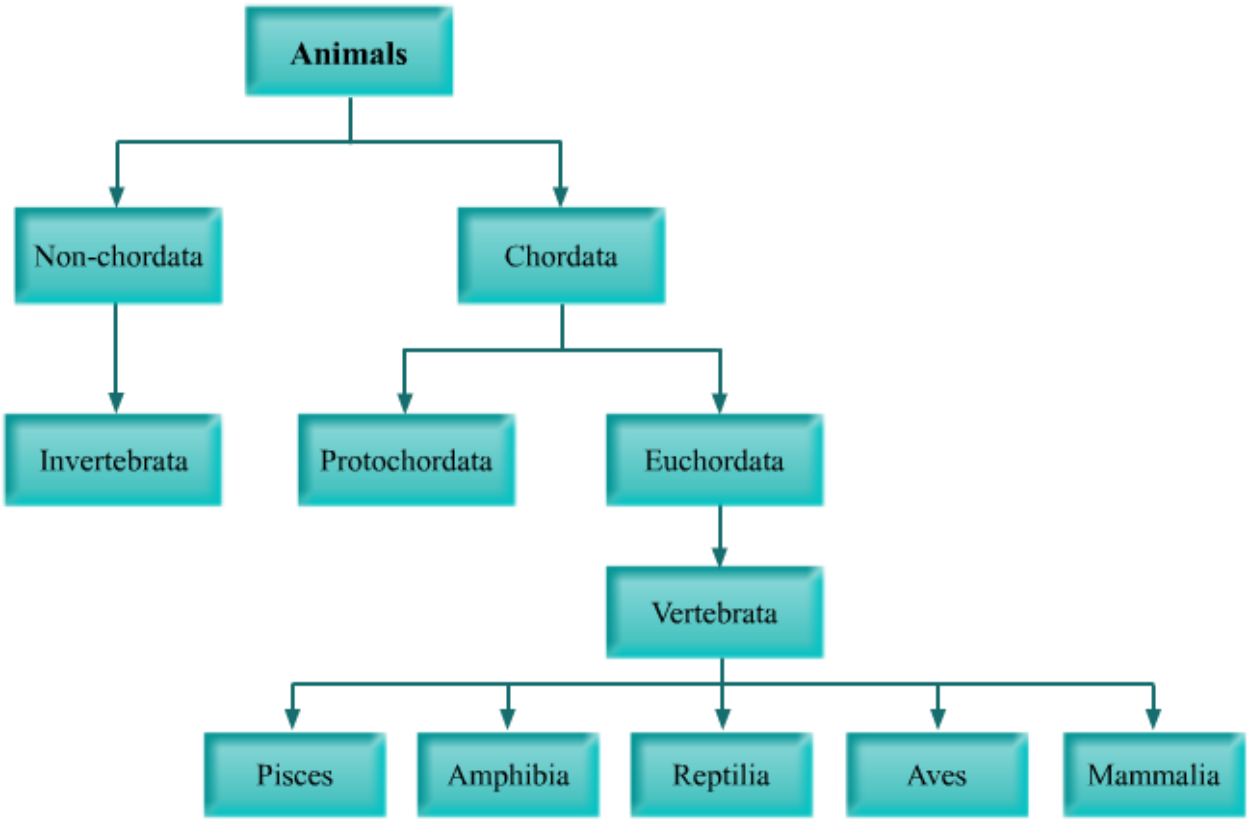
Phylum Chordata

We know that kingdom Animalia is divided into chordates and non-chordates based on the presence or absence of the **notochord**.

General features of chordates

- They have a notochord.
- They have a dorsal nerve cord.
- They are bilaterally symmetrical and triploblastic.
- They possess a true coelom (enterocoelom).
- They have paired gill pouches.

Phylum Chordata is sub-divided into the sub-phyla **Protochordata** and **Vertebrata** based on the developmental features of the notochord.



Sub-phylum Protochordata

This group includes animals that have a notochord. This feature may not be present at all stages of their life cycle. Further, the notochord may not run the entire length of a protochordate's body. The word 'proto' means 'primitive'. This indicates that protochordates are the ancestors of the modern-day chordates.

General features of protochordates

- They are exclusively marine animals. They often live in burrows.
- They show an organ system level of organization and are triploblastic.
- The body cavity is enterocoelom.
- The body of a protochordate is not segmented and is bilaterally symmetrical.
- A notochord is present in some or all stages.
- Examples of protochordates: *Amphioxus*, *Herdmania*, *Balanoglossus*

Amphioxus

Balanoglossus

Interesting Facts

- In *Herdmania,* the notochord appears only in the tail of the larva and disappears in the adult.
- In *Amphioxus,* the notochord extends until the anterior end of the body and is present throughout its life.

Sub-Phylum Vertebrata

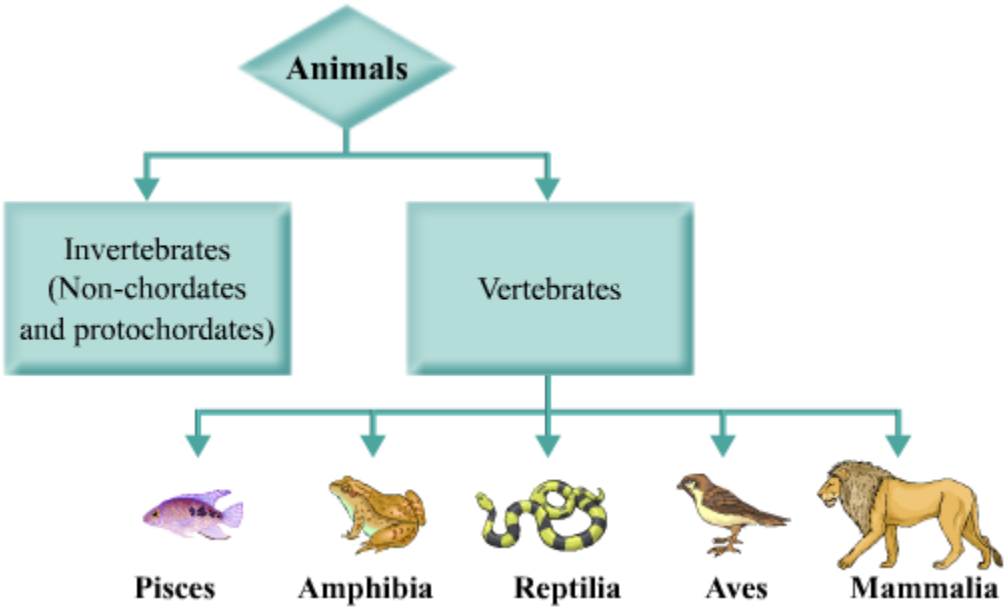
The members of sub-phylum Vertebrata are advanced chordates.

General features of vertebrates

- A notochord is present only in the embryonic stage.
- In an adult vertebrate, the notochord is replaced by a vertebral column consisting of ring-like bones called vertebrae.
- An internal skeleton is present along with the vertebral column. This allows for a completely different distribution of muscle attachment points to be used for movement.
- Vertebrates have a muscular heart with two, three or four chambers.
- They are bilaterally symmetrical and triploblastic.
- Examples of vertebrates: fishes, amphibians, reptiles, birds and mammals

Concept Builder

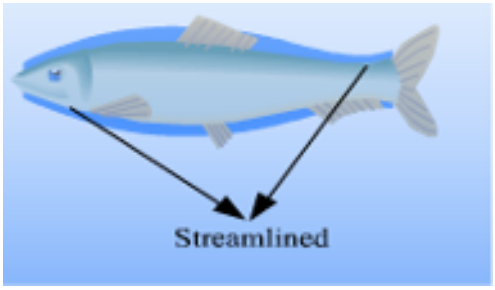
Invertebrates and Vertebrates



Class Pisces

Class Pisces includes fishes.

General features of fishes



They are exclusively aquatic animals. They have special adaptive features to live in water, like a streamlined body and a tail for movement.

Fins are present but limbs are absent. The skin of a fish is covered with scales. Fishes obtain oxygen dissolved in water with the help of gills.

They are **cold blooded** animals and are also called ectotherms/pokiliotherms. They have a two-chambered heart.

They lay eggs.

Examples of fishes: *Scoliodon* (dogfish/shark), Tuna, *Rohu*.

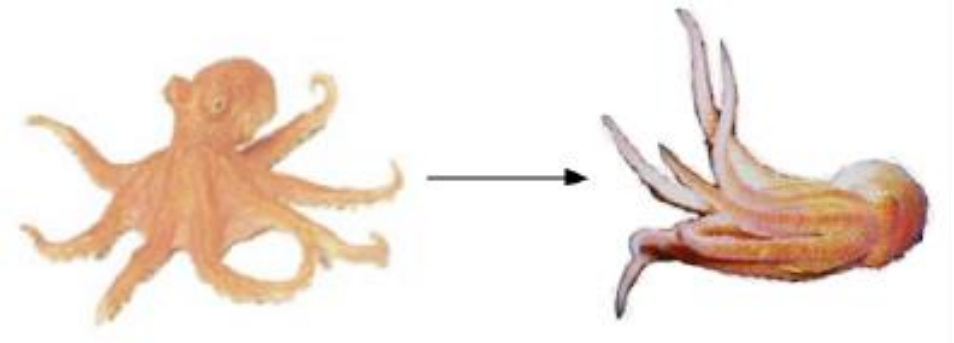
Shark Rohu

The skeletons of some fishes (e.g., shark, ray) are made entirely of cartilage. These fishes are called **cartilaginous fishes**.

The skeletons of some fishes (e.g., *Rohu*, *Catla*) are made of both bone and cartilage. These fishes are called **bony fishes**.

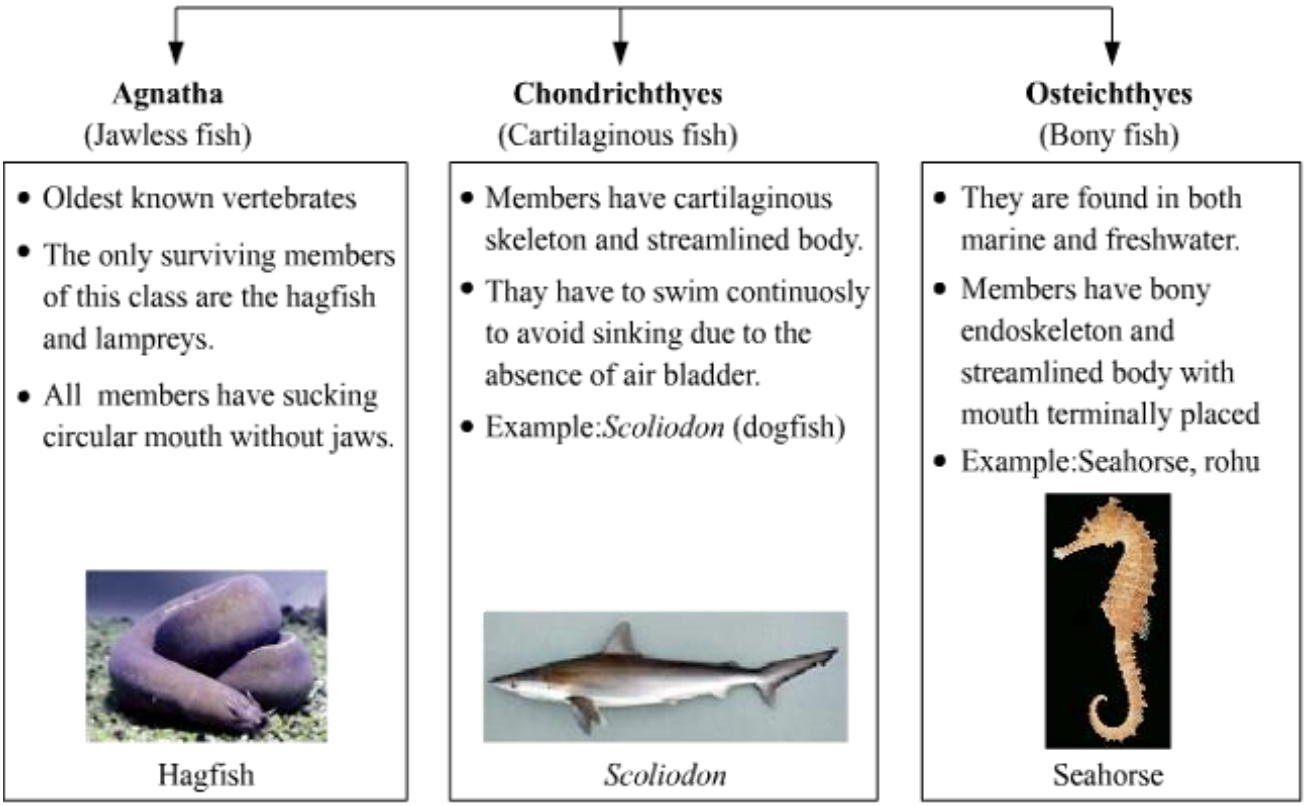
Whiz Kid

An octopus is capable of streamlining its body while swimming.



Know More

Pisces is further divided into three classes:



Class Amphibia

The word ‘Amphibian’ can be understood by breaking it into two parts: ‘amphi’ which means ‘two’ or ‘both’ and ‘bios’ which means ‘life’. So, amphibians are animals that can live both on land and in water.

General features of amphibians

- The adults are terrestrial. They were the first vertebrates to occupy land.
- They live in damp places.
- The adults respire through lungs or skin, while the larvae respire through gills.
- They lay eggs in water.
- They are cold blooded animals.
- They have a three-chambered heart.
- The skin of an amphibian has mucus glands. Scales are absent.
- Examples of amphibians:toad, frog, salamander

Toad

Frog

Salamander

Solved Examples

Medium

Example 1:

Why are toads, frogs and salamanders called amphibians?

Solution:

The word ‘amphibian’ is derived from the Greek words ‘*amphi*’ which means ‘two’ or ‘both’ and ‘*bios*’ which means ‘life’. Thus, amphibians are animals that have a dual mode of life, which is the case with toads, frogs and salamanders.

Their dual modes of life are as follows:

- The larval stage is fish-like since they are aquatic. The larva has a tail, which aids it in swimming. Also, it has gills for respiration.
- The adult stage is terrestrial. The adult moves with limbs and respires through lungs and skin.

Example 2:

What is the difference between a toad and a frog?

Solution:

Toad	Frog
It has a rough, dry and warty skin.	It has a smooth and moist skin and this makes it look ‘slimy’.
It has a wider body.	It has a narrower body.
It has lower, ball-shaped eyes.	It has higher, rounder and bulgier eyes.
It has shorter, less powerful hind legs.	It has longer, more powerful hind legs.
It runs or takes small hops rather than jump.	It takes long high jumps.

Class Reptilia

Reptiles are called so because they creep or crawl on land.

General features of reptiles

- The body of a reptile is divisible into the head, the neck and the trunk. The tail is well-developed in some and reduced in others.
- Limbs are present, but are reduced or absent in case of snakes.
- The skin is covered with scales.
- Reptiles are cold-blooded animals.
- Most of them have a three-chambered heart, except crocodiles which have a four-chambered heart.
- They respire through lungs only.
- They lay eggs on land.
- Examples of reptiles: lizard, snake, turtle, chameleon

Snake

Turtle

Chameleon

Did You Know?

- The king cobra is the largest venomous snake in the world. It is approximately 12 feet long.
- Most snakes swallow their prey alive. However, a poisonous snake kills its prey with its venom before swallowing it.

Class Aves

Class Aves includes all birds.

General features of birds

- Most of them have feathers.
- They possess a beak.
- Forelimbs are modified into wings for flight.
- Hind limbs are modified for walking and clasping.
- Bones are hollow.
- They are **warm blooded** animals and are also called endotherms/homeotherms.
- The heart is four-chambered.

- Respiration occurs through lungs only.
- They lay eggs.
- Examples of birds: sparrow, parrot, crow, pigeon

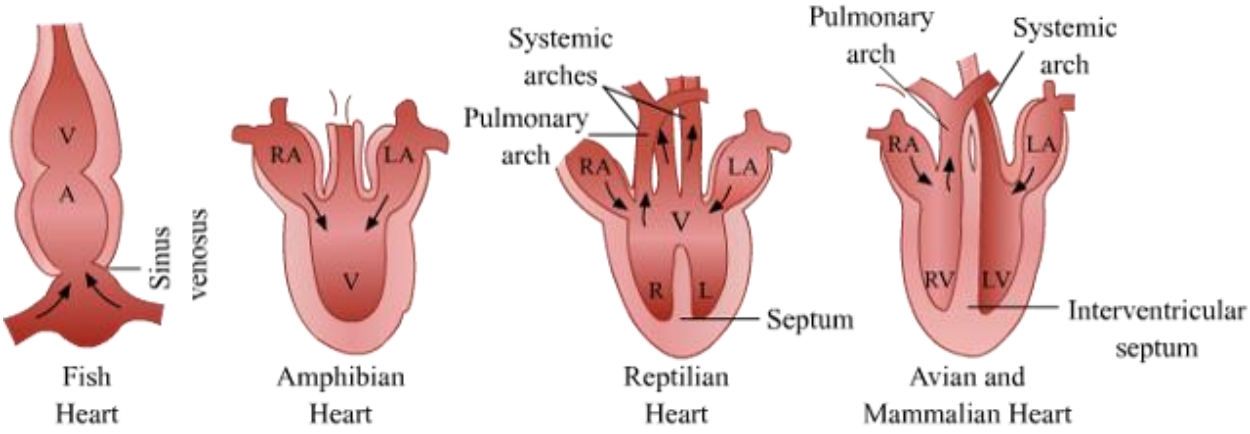
Sparrow

Parrot

Crow

Know More

The Heart in Different Vertebrates



Solved Examples

Medium

Example 1:

What is the difference between cold-blooded and warm-blooded animals?

Solution:

A cold-blooded animal does not have a definite body temperature. It alters its body temperature in tune with that of the outside environment. Fishes, amphibians and reptiles are cold blooded. A warm-blooded animal, on the other hand, has a definite body temperature. This temperature does not alter according to the outside temperature. Birds and mammals are warm-blooded.

Class Mammalia

Class Mammalia includes a variety of animals that have milk-producing glands (mammary glands) to nourish their young ones.

General features of mammals

- They are found in a variety of habitats like deserts, forests, mountains, etc.
- Some of them can fly.
- They have two pairs of limbs for walking, running or flying.
- The skin of a mammal has hair as well as sweat glands. The hair protects it in winters and the sweat glands keep its body cool in summers. These features are of particular importance as a mammal is a warm-blooded animal.
- Mammals respire through lungs.
- They have a four-chambered heart.
- They give birth to young ones and, so, are called **viviparous**. There are some mammals that lay eggs, e.g., Platypus, Echidna.Such mammals are called **oviparous mammals**.
- Two sets of teeth—milk teeth and permanent teeth—develop in the lifetime of a mammal. The teeth are of different types, i.e., heterodont.
- Examples of mammals:human, bat, whale, rat, cat

Bat

Whale

Rat

Solved Examples

Medium

Example 1:

How do bats locate their prey?

Solution:

Bats locate and catch their prey by the mechanism called echolocation. While hunting, a bat produces a constant stream of high-pitched sounds. When these sound waves hit an insect or another animal, the echoes bounce back to the bat. The echoes guide it to the prey. The time interval between the sounds and the echoes helps the bat to determine its distance from the prey.

Example 2:

Why are bats not placed under class Aves?

Solution:

Bats are not placed under class Aves in spite of their capability to fly. This is because they possess many characteristics that are specific to the animals belonging to class Mammalia. These include: the presence of hair and mammary glands, and the condition of being viviparous (i.e., giving birth to their young ones).