8 Five Kingdom Classification

Syllabus : A brief outline of the five Kingdom classification :

Main characteristics of each kingdom with suitable examples Monera, Protista, Fungi, Plantae (Thallophyta, Bryophyta, Pteridophyta and Spermatophyta). Animalia — (Non-chordates from Porifera to Echinodermata and Chordates-all five Classes).

There are millions of different types of organisms starting from single-celled microorganisms like bacteria to large-sized plants like mango or pine trees and the huge-sized animals like elephants and whales. The range of size is not so surprising but it is the complexity of structure that is most significant (Fig. 8.1).

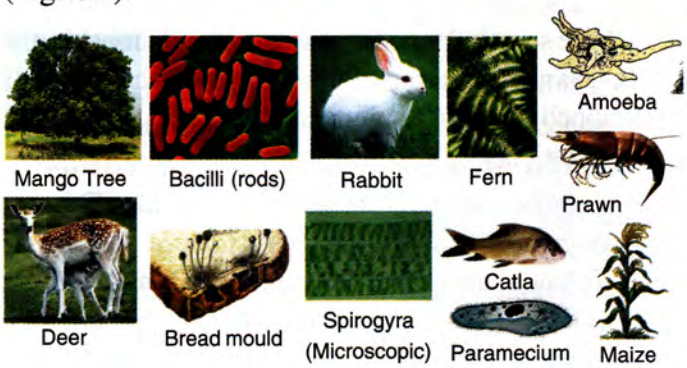


Fig. 8.1 Diversity in organisms (A sample)

For studying diversity in living organisms, these are grouped according to the increasing similarity and from the less complex to more and more complex types.

Before we talk of Diversity in Organisms on a broad scale, we should first get familiar with the category levels of diversity, namely : Species, Genus, Family, Order, Class, Phylum and Kingdom.

Let us start with the lowest category *i.e.*, species.

8.1 WHAT IS SPECIES ?

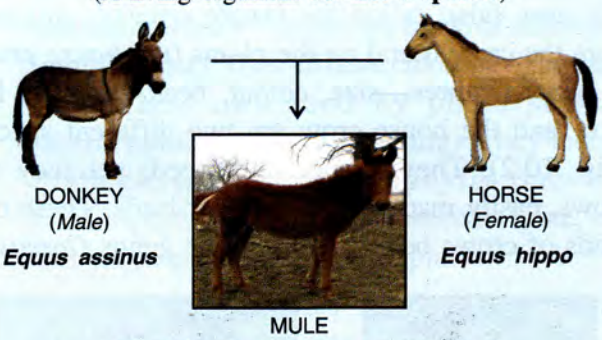
Species means an organism of a particular kind whose members can *interbreed* among themselves to produce fertile young ones.

All individuals of a species can **normally breed among themselves**. Individuals of a particular species differ from all other living beings. All house cats of the world belong to one species ; they may have some differences among themselves such as colour, height and the length of tail, yet they can all interbreed. So, the house cat is one species (*Felis domesticus*). Similarly, there may be quite a few differences in the body features of the people of different countries or races, yet there can be a marriage between them with normal children. So, all mankind today belong to a single species (*Homo sapiens*). Similarly, all 'peepal' trees, and all mango trees belong to their respective species.

Horse and Donkey are two different species, and both have their numerous breeds. All breeds of a horse and those of a donkey can interbreed among themselves to produce fertile young ones but a cross between a horse and a donkey, though possible, does

MULE

(A living organism but **not** a **species**)



It is neither a horse nor a donkey !

Mule is a cross (hybrid) between a donkey (male) *and a* mare (female horse). *It resembles the male parent (donkey) in the size and shape of ears, legs and hooves, the shape of the tail and the shortness of the mane and is similar to the female parent (horse) in height, shoulder, etc.*

Mule is sterile and cannot reproduce.

(A cross between a horse (male) *and a* jenny (female donkey) *produces HINNY* which also is incapable of breeding)

not produce a fertile "mule". Humans have been practising producing mules for centuries, but several new types of crosses have been successfully tried in modern times.

SOME OTHER EXAMPLES OF CROSSES BETWEEN TWO DIFFERENT SPECIES

- Zebra mated with donkey produces **"Zenkey"** with ears and back like those of donkey and striped legs and hips like the zebra. Zenkey is sterile.

A male baby zenkey with his donkey mother

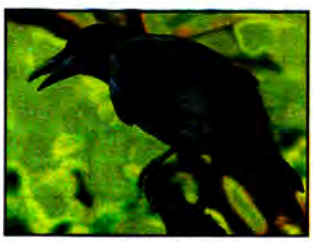
- Tiger mating with a female lion produces **"Tigon"** (sterile).
- **"Geep"** is the product of a goat and a sheep, again sterile.
- **Pomato** is a combination that produces potatoes underground and tomatoes above ground, but it produces no seeds.

Such crossing or interbreeding can occur only between two very closely related species, and the offspring are invariably sterile.

8.2 CATEGORIES HIGHER THAN SPECIES

GENUS. Similar species constitute the next higher category called **genus** (plural : genera). Let us take an example. We have crows around our homes. The hill crow (also called the ***jungle crow***) is different from the crow found on the plains (the ***house crow***) in many features—size, colour, beak, etc. The hill crow and the house crow are two different species (Fig. 10.2). They cannot interbreed; yet they are crows, easily made out from other birds. These two kinds of crows belong to the same genus ***Corvus***.

HOUSE CROW
(*Corvus splendens*)



JUNGLE CROW
(*Corvus macrorhynchos*)

Fig. 8.2 Two common and closely related species of crow found in India.

FAMILY. A group of genera with certain common characteristics form a **family.** Take an example. Lion (*Panthera leo*) and tiger (*Panthera tigris*) are different species but they belong to the same genus. This genus (*Panthera*) and another genus (*Felis*) which includes the domestic cat, also share some common characteristics. Therefore, there is the larger cat-family **(Felidae)** which includes the genus of lion and tiger, and the genus of the domestic cat.

ORDER. A group of related families make an **order.** *For example*, the cat family Felidae (lions, tigers and cats) and the dog family Canidae (dogs, foxes, jackals, etc.) possess some common features and so they make an **order.** In the example cited here the order is "Carnivora".

CLASS. Related orders make a **class.** *For example*, the orders of different animals like those of dogs, cats, bats, whales, monkeys and even humans, etc., have some common features such as hairy skin and milk-glands. The particular **class** of the animals mentioned here is "Mammalia".

PHYLUM. A ***phylum is the largest division*** in the classification of plants and animals. Related classes constitute a phylum. *For example*, the classes of different animals like the mammals, birds, reptiles, frogs, fishes, etc., together constitute the phylum **Chordata** which have a notochord or a backbone.

KINGDOM. The kingdom is the largest division of living beings.

8.3 DRAWBACKS OF THE OLD TWO KINGDOM CLASSIFICATION

According to the old classification as was given by Linnaeus (1707-1778) the entire world of living organisms was divided into two kingdoms: Kingdom **Plantae** (including all plants) and Kingdom **Animalia** (including all animals). But this scheme had several **drawbacks**. *For example*, how do we say that

- "Bacteria and fungi are plants" — they have no chlorophyll and do not carry out photosynthesis.
- Some single-celled organisms such as *Euglena* cannot be exclusively called plant or animal — they have chloroplasts like the plants, have cell mouth to feed like animals and possess contractile vacuole for excretion.
- Bread mould, *etc.*, are multicellular, but they

have nothing like roots, stem, and leaves and they do not bear any flowers or seeds and they have no chlorophyll.

So, the above three groups of organisms are now recognised as distinct kingdoms (*Monera, Protista and Fungi*), and these together with the two other kingdoms, the plants (*Plantae*) and animals (*Animalia*), now constitute what is called the Five Kingdom classification, as is given below.

8.4 FIVE KINGDOM CLASSIFICATION

The *five* kingdoms under the recent scheme of classification are : 1. *Monera,* 2. *Protista*, 3. *Fungi*, 4. *Plantae* and 5. *Animalia*.

1. Kingdom **MONERA** (unicellular & prokaryotic) — It mainly includes bacteria (Fig. 8.3), blue-green bacteria and some unicellular algae.

- These are single-celled organisms
- They have no **organized nucleus.**
- The nuclear material (DNA) is distributed in the cell without being enclosed in a nuclear membrane. This condition of the cell is called **prokaryotic** (*pro :* **primitive,** *karyon :* **nucleus).**
- They are also devoid of membrane-bound organelles like mitochondria and chloroplasts.

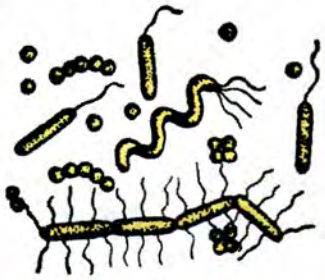


Fig. 8.3 Bacteria. Three common shapes — rods, spirals and spheres (singly, in groups, or in chains)

2. Kingdom **PROTISTA** or more appropriately **PROTOCTISTA**. (Unicellular & eukaryotic) — These are single-celled organisms having a **well-defined nucleus** with a nuclear membrane (**eukaryotic**). They include both the unicellular green autotrophic organisms (*e.g. Chlamydomonas*) as well as unicellular non-green heterotrophic organisms (e.g. *Euglena, Amoeba, Paramecium*) (Fig. 8.4), and also some of their multicellular photosynthetic descendants like *Pandorina*.

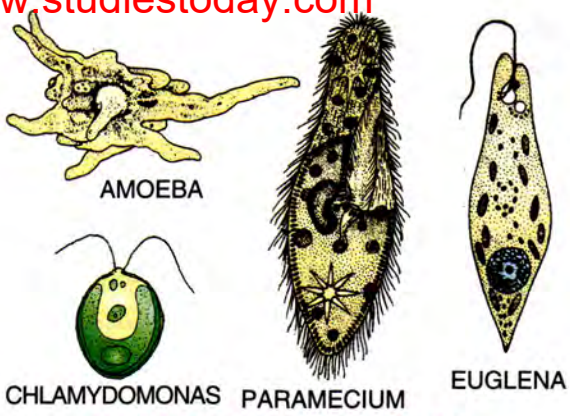


Fig. 8.4 Four very common Protists

3. Kingdom **FUNGI** (multicellular, eukaryotic and saprophytic)— Most fungi are made up of thread-like hyphae rather than cells, and there are many nuclei distributed in the continuous cytoplasm. *Examples :* Bread mould, Toadstool, Yeast, Penicillium (Fig. 8.5)

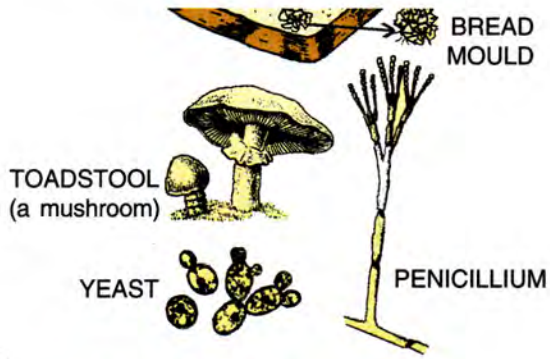


Fig. 8.5 Four very common Fungi

4. Kingdom **PLANTAE** (multicellular, eukaryotic and autotrophic) — These are made of many cells (multicellular). They all have chlorophyll and they make their own food by photosynthesis (**autotrophic *i.e.* self nourishing**). They include **thallophyta** (algae), **bryophytes** (mosses), **pteridophytes** (ferns), **gymnosperms** (pine, *etc*), and **angiosperms** (flowering plants).

Thallophyta : Includes all algae e.g. chlamydomonas, volvox etc. Thallophytes are autotrophic as they contain chlorophyll. They have a thallus like body, *i.e.* the plant body cannot be distinguished into roots, stem or leaves. They are primarily aquatic.

Bryophyta : *e.g.* mosses and liverworts plants belonging to this group have a plant body

that has false root like structures called rhizoids, and leaf like structures. They are autotrophs.

Pteridophytes : Includes all ferns.
Plants belonging to this group have a plant body that can be distinguished into root, stem, and leaves.The leaves are often made of leaflets bearing spores on the underside. They are non-flowering plants.

Gymnosperms : *e.g.* cycas, pine, fir etc.
The plants belonging to this group bear naked seeds, *i.e.* the seeds are not enclosed in fruits. They may be either trees or shrubs. They bear both male and female flowers. They are of two types cycads and conifers.

Angiosperms : Includes all flowering plants.
Plants belonging to this group have a highly developed plant body, which can be differentiated into root, stem, leaves, flowers and fruits. The seeds are enclosed in a fruit. They are further divided into monocots and dicots.

Monocots : The plant belonging to this group bear seeds having only one cotyledon, the leaves have parallel venation, and the root system is fibrous, *e.g.* maize, rice, grass etc .

Dicots : The plants belonging to this group bear seeds with two cotyledons, the leaves have reticulate venation, and a tap root system. *e.g.* pea, potato, apple, sunflower, rose etc.

5. Kingdom **ANIMALIA** (Multicellular, eukaryotic and heterotrophic) — These are multicellular organisms without cell wall, without chlorophyll, usually mobile, and obtaining food by eating or sucking, etc. (**heterotrophic** *i.e.*, differently nourished).

Of all the living organisms we are generally most familiar with plants *(Plantae)* and animals

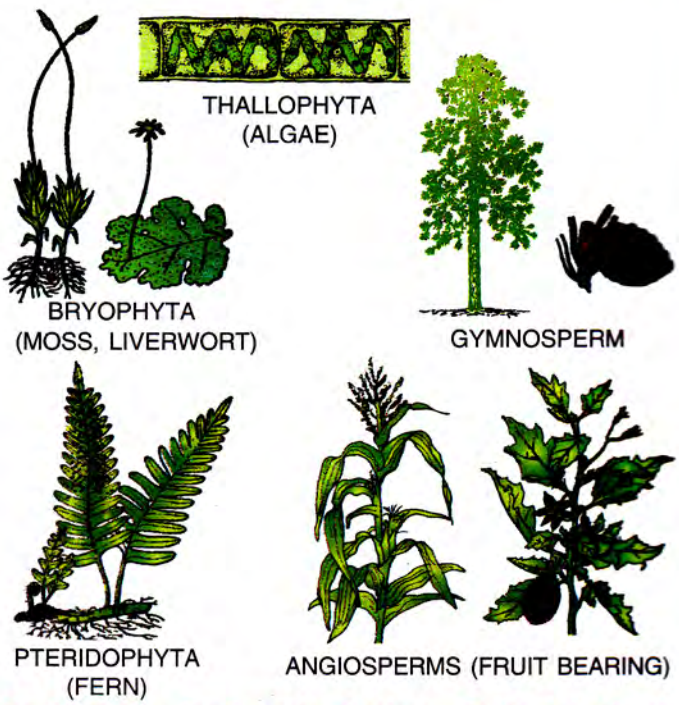


Fig. 8.6 Plantae - The five major divisions — Thallophyta (algae), Bryophyta (mosses), Pteridophyta (Fern), Gymnosperms (pine, etc.) Angiosperms — Flowering plants (monocots and dicots).

General scheme of five kingdom classification

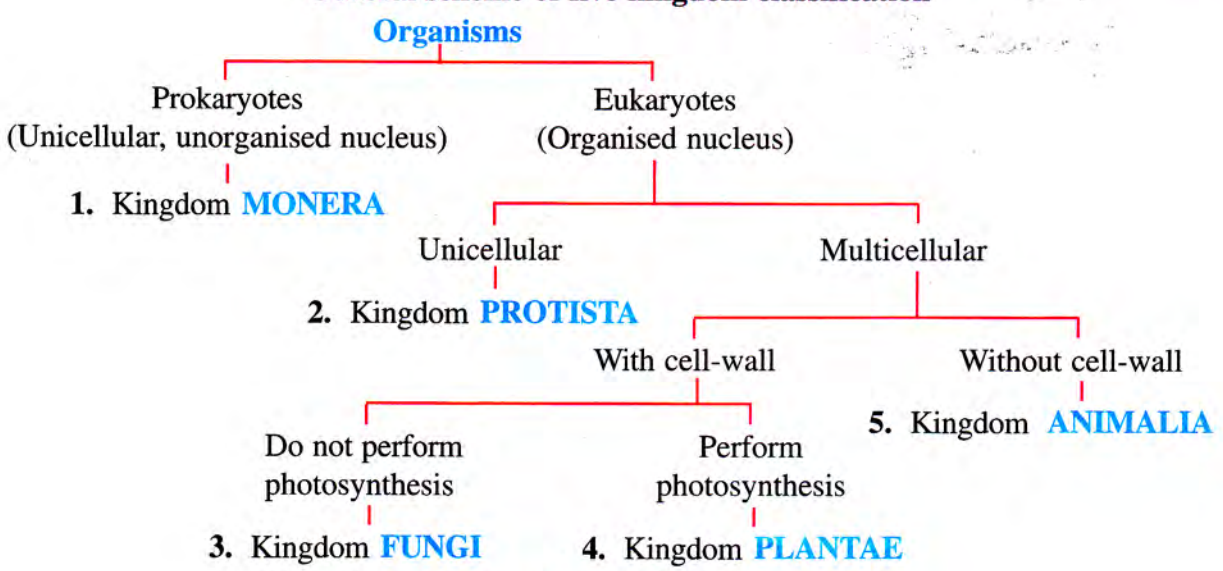


Fig. 8.7 The five Kingdom classification

(Animalia). Therefore, it will be worth understanding the most distinct differences between these two (Table 8.1 page 77).

8.5 NAMING AN ORGANISM (extra information, useful to know).

Common names are variable and sometimes confusing. We know animals and plants by the common names used for them in a particular locality. Can you think of any plant or animal which in India is known by several names? Pumpkin and custard apple could be good examples. Pumpkin in the local languages is known as, ***"sitaphal", "kashiphal", "kumhra." "petha", "kaddu"*** and so on.

Sometimes, a certain common name is not enough to indicate the particular species. There are different kinds of frogs, earthworms, or grasses. Talking of crows again, if you have to distinguish between the two kinds of crows, you have to use some adjectives such as the hill or **jungle crow** and the plain or **house crow**. But it does not mean that the jungle crow cannot come to the plains and the plain crow cannot go to the hills. What is most important is that these two crows *cannot interbreed*, and so they are *different species*.

Scientific names. In science, people from different countries with different languages have to read about each other's research work. So, it was found necessary to eliminate any possible confusion in using local names by substituting them with names specially given in scientific language. The present practice is to use a *two part* name for each species. *For example*, our hill crow is *Corvus macrorhynchos* and the house crow is *Corvus splendens*. The first part in these names is the genus which is the same "*Corvus*" for both, and the second part is the name of the particular species of the genus. This method of naming the organisms is called the **binomial nomenclature** (*bi* : two, *nomen*: name), and was first introduced by Linnaeus (1707-1778).

Table 8.1 : General differences between plants (Plantae) and animals (Animalia)

PLANTS	ANIMALS
1. Have a green pigment **chlorophyll**	1. Do not have chlorophyll.
2. Usually **fixed** into the soil and cannot move about freely, at the most can only bend.	2. Can **move about freely** from place to place (except the fixed sponges, corals, etc.)
3. Can make their own food using carbon dioxide and water in sunlight. **(Photosynthesis)**	3. Cannot make their own food and so have to **feed** on plants or on other animals.
4. Have no special digestive organs because they synthesise their own food.	4. Have **special digestive organs** because they have to digest and absorb the ingested readymade food.
5. Plant cells have a firm **cell wall** made of cellulose on the outside of the cell membrane.	5. **No cellulose cell wall.** Only the cell membrane is present.
6. Plant cells usually have **large vacuoles** containing sap.	6. Animal **cells have no vacuoles**; if present, they are small and temporary, concerned with excretion or secretion.
7. Plants have relatively a low level of organization with only two organ-systems — root system and shoot system	7. Animals have a **high level of organization** with **definite organ systems** like the digestive, respiratory, nervous, reproductive systems, etc.
8. Keep growing throughout life **(indeterminate growth)**	8. Growth stops after a definite body shape and size are established although body cells are replaced from time to time **determinate growth.**
9. Growth confined to apices of root and shoot **(localized growth).**	9. **Growth is uniform** and proportionate affecting all parts of the body.
10. Their bodies are of **spreading type** in order to have large surfaces for absorption of gases, water and sunlight.	10. Have **compact bodies** in order to be able to move.
11. They **respond slowly** to external stimuli, such as light, gravity, touch, etc.	11. They **respond quickly** to external stimuli.

A SAMPLE CLASSIFICATION OF LIVING BEINGS

You have now learnt that there are different levels of classification of living beings from the highest level of the Kingdom to the lowest level of Species. Let us take a few examples as follows :-

Example → Grouping ↓	Modern Man 	House Cat 	Tiger 	Dog 	Mango 
Kingdom	Animalia	Animalia	Animalia	Animalia	Plantae
Phylum	Chordata (Vertebrata)	Chordata (Vertebrata)	Chordata (Vertebrata)	Chordata (Vertebrata)	Spermatophyta
Class	Mammalia	Mammalia	Mammalia	Mammalia	Angiospermae
Order	Primates	Carnivora	Carnivora	Carnivora	Sapindales
Family	Hominidae	Felidae	Felidae	Canidae	Anacardiaceae
Genus	*Homo*	*Felis*	*Panthera*	*Canis*	*Mangifera*
Species	*sapiens*	*domesticus*	*tigris*	*familiaris*	*indica*

Rules in scientific names. Two main rules to write scientific names are as follows :

1. Scientific names are always written in the Roman script and when in print they are always in ***italics***. When hand-written they should always be **underlined**.
2. The first letter of the genus-name should be a Capital letter, while the species-name (*i.e.* the second part) should begin with a small letter.

Scientific names of some common organisms

ANIMALS	
Man	*Homo sapiens*
Cat	*Felis domesticus*
Dog	*Canis familiaris*
Honeybee	*Apis indica*
Housefly	*Musca domestica*
Peacock	*Pavo cristatus*
Cobra	*Naja naja*
Hoopoe	*Upapa epops*
PLANTS	
Peepal	*Ficus religiosa*
Mango	*Mangifera indica*
Potato	*Solanun tuberosum*
China rose	*Hibiscus rosa-sinensis*
Okra (Bhindi)	*Hibiscus esculentus*
Pineapple	*Ananas comosus*
Pigeon pea ('Arhar')	*Cajanus cajan*
Lentil ('Masur')	*Lens esculenta*

You have learnt about animals (Kingdom Animalia) as different from plants (Kingdom Plantae). Here you will know about the diversity in animals.

Till today, more than 1,000,000 species of the living animals are already identified and every year some new species are reported. All these animals are classified into different groups and subgroups.

8.6 MAJOR GROUPS OF ANIMALS

The animal kingdom is divided into nine major phyla :

Phylum 1. Porifera
Phylum 2. Cnidaria
Phylum 3. Platyhelminthes
Phylum 4. Nematoda
Phylum 5. Annelida
Phylum 6. Arthropoda
Phylum 7. Mollusca
Phylum 8. Echinodermata
Phylum 9. Chordata

10.7 INVERTEBRATA AND VERTEBRATA

The phyla (1-8) mentioned above, from Porifera to Echinodermata are grouped together under the category **Invertebrates**, *i.e.* animals without a backbone. The last phylum **Chordata** includes all such animals which have some kind of a backbone and these are popularly called the **Vertebrates**.

Thus, **Invertebrata** are those animals which have no backbone and **Vertebrata** are those that have a backbone. This classification is only a matter of convenience but not formal. Table 8.2 below gives the major differences between vertebrates and invertebrates.

Table 8.2 Major differences between vertebrates and invertebrates

VERTEBRATES	INVERTEBRATES
1. They have an internal skeleton.	1. No internal skeleton.
2. A backbone is present.	2. Backbone is not present.
3. A tail is usually **present**.	3. Tail is **absent** (anus at the tip of the back end of the body).
4. Heart is on the ventral side of the body.	4. Heart when present, is on the dorsal side of the body.
5. Nerve (spinal) cord is dorsal, and hollow.	5. Nerve cord is ventral and solid.
6. They have two pairs of limbs.	6. They have three or more pairs of limbs, if present.
7. Haemoglobin in red blood cells.	7. Haemoglobin, if present, dissolved.

PROGRESS CHECK

1. Rearrange the following categories of animal grouping in a sequence starting from the highest downward to the lowest.
   Class _____
   Phylum _____
   Species _____
   Genus _____
   Kingdom _____
2. Tick-mark the features that characterise vertebrates.
   (i) Dorsal nerve cord
   (ii) Haemoglobin dissolved
   (iii) Three or more pairs of limbs
   (iv) A tail behind the level of the anus
   (v) Dorsal heart

8.8 INVERTEBRATE PHYLA – PORIFERA TO ECHINODERMATA

1. Phylum **Porifera** – the pore-bearers (Sponges)

Porifera are the simplest multicellular animals. Their body consists of a hollow tube. There is no single mouth but many pores or canals are present in the body wall, through which water enters the body. From this water the sponges capture their food. A single large opening on the top is the exit for water. The sponges usually have a skeleton of microscopic spicules or elastic spongin fibres. Except one or two fresh water sponges, all are found in sea. *Examples* : *Sycon* and bathsponge, (Fig. 8.7).

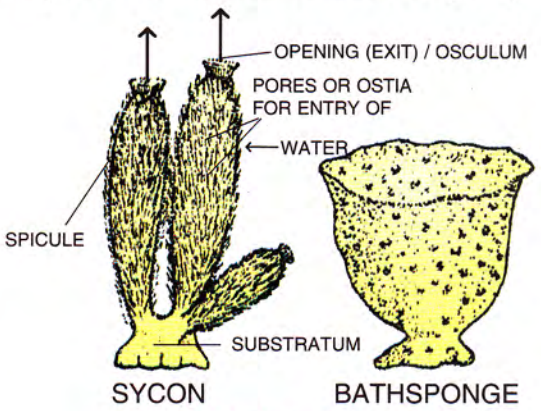


Fig. 8.7 Porifera—two examples

2. Phylum **Cnidaria / Coelenterata** (Sac-like animals). ***Examples*** **: Hydra, jellyfish, sea anemone, corals (Fig. 8.8).**

In cnidarians a two-layered body wall encloses a single cavity in which digestion takes place. The cavity opens by a mouth at one end only. There are tentacles to catch food organisms. The cnidarians are found in water (mostly in sea, very few in fresh water). Corals develop hard skeletons made up of calcium carborate from their secretions (but these are not bones).

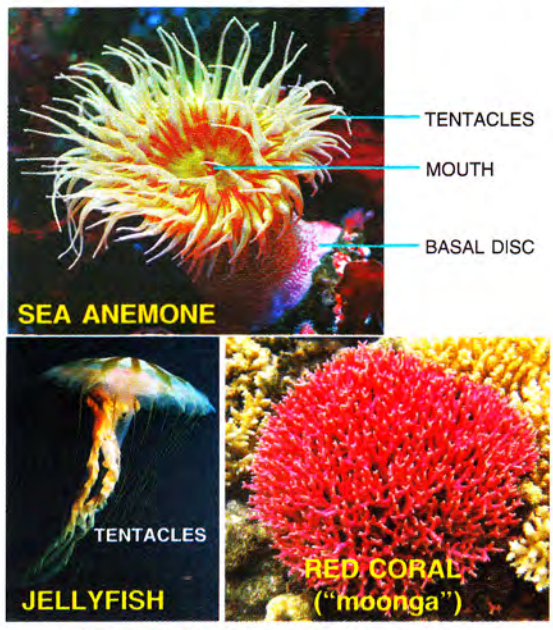


Fig. 8.8 Cnidaria—three examples

NEXT THREE PHYLA - THE WORMS

The next three phyla Platyhelminthes, Nematoda and Annelida include the animals which may collectively be called "worms". This is a term commonly used for *crawling or creeping animals with relatively soft bodies.*

3. Phylum **Platyhelminthes** (Flatworms)

These are small, soft, flattened, unsegmented worms without a body cavity. The alimentary canal has only one opening, the mouth. Most of the flatworms live on or inside other animals as parasites, but a few are free, living in the sea or fresh water. *Examples* : Parasites—Liverfluke, Tapeworm ; free living—Planarian (Fig. 8.9). You will learn more about a tapeworm in Chapter 16 (p. 163).

Fig. 8.9 Platyhelminthes, two examples

4. Phylum **Nematoda** (Roundworms)

They are long, cylindrical and unsegmented, without a body cavity. The alimentary canal opens at the two ends, mouth and anus. They are mostly parasitic but some live free in the soil. *Examples*: Hookworm and *Ascaris* in humans, eelworms in potato plants (Fig. 8.10). You will read more about *Ascaris* in Chapter 16.

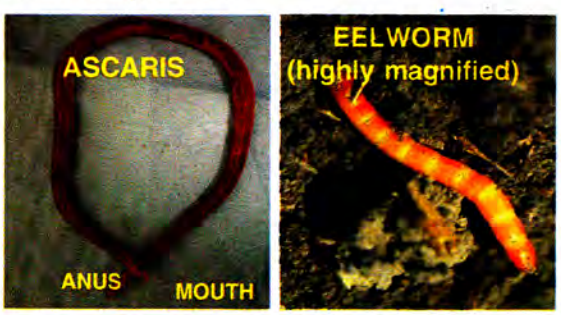


Fig. 8.10 Round worms, two examples

5. Phylum Annelida (Segmented or ringed worms). *Examples* : Earthworms, Leeches and *Nereis* (Fig. 8.11).

The body of an annelid worm is cylindrical and divided into ringlike segments. An annelid worm has a well-developed digestive system with the alimentary canal open at both ends, with a mouth and anus. They have a true body cavity, the coelom.

Earthworm. All earthworms live in burrows in damp soil. They make these burrows by eating through the soil. The soil is eaten in large quantities and is passed out through the other end of the body in the form of castings. The soil contains organic matter in the form of humus and broken bits of leaves.

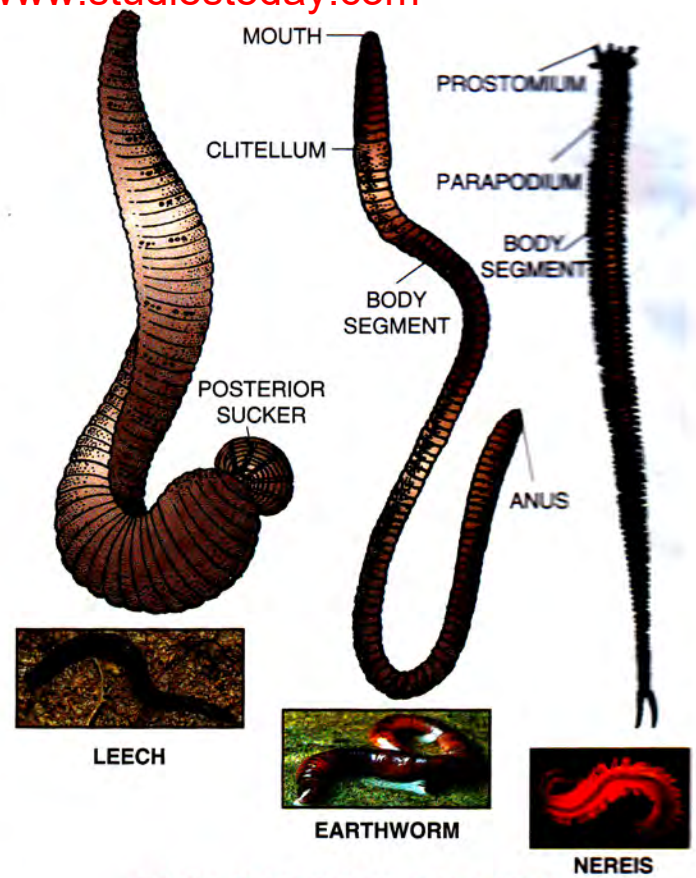


Fig. 8.11 Three representative annelids.

Earthworms avoid light. They are **nocturnal.** They crawl up on the surface of the ground at night for feeding and mating.

Dry soil is unsuited for earthworms. Their skin has to be kept moist for respiration.

The common Indian earthworm *Pheretima posthuma* (Fig. 8.11) has a long cylindrical body which is divided into a series of 80-100 ring-like segments. There is no head and there are no appendages (legs), no eyes and no tail. The **mouth** is a simple opening at the front end. There are no jaws. The **anus** is located at the extreme hind end. In a mature worm, a short cylindrical band of thick glandular skin **(clitellum)** surrounds the body like a belt in the segments 14-16 which is about one-third distance of the body from the front end. This clitellum serves in reproduction.

The lighter coloured ventral (lower) side bears a few important openings and structures close to the clitellum. These are concerned with reproduction.

Economic importance. The earthworm is highly **useful in agriculture.**

(i) It loosens up and **aerates the soil** as it burrows. This helps in the respiration of the roots of plants and makes them grow well and penetrate deeper.

(ii) The earthworms keep interchanging the top soil with the lower layer thus increasing the fertility of the soil.

(iii) The earthworm's excreta is rich in nitrogenous matter which is required for plant growth.

(iv) Presently, earthworms are being used in vermiculture for producing high-quality manure.

(v) Many people use earthworms as **baits** in catching fish.

6. Arthropoda (Jointed-legged animals) *Examples :* Crayfish, crabs, millipede, centipede, insects, scorpions, spiders, *etc.*

This phylum has the largest number of species in the animal kingdom.

These animals have jointed limbs, one pair each on some or on all body segments. There is an exoskeleton made of chitin. They cast off their exoskeleton during growth in early life, which is regrown. The casting off and the regrowing of the exoskeleton is collectively called **moulting.**

Extra : Beyond syllabus

Arthropods are further divided into four classes (useful to know but **not in syllabus**) (Fig. 8.12).

(i) Crustacea
(ii) Myriapoda
(iii) Insecta
(iv) Arachnida

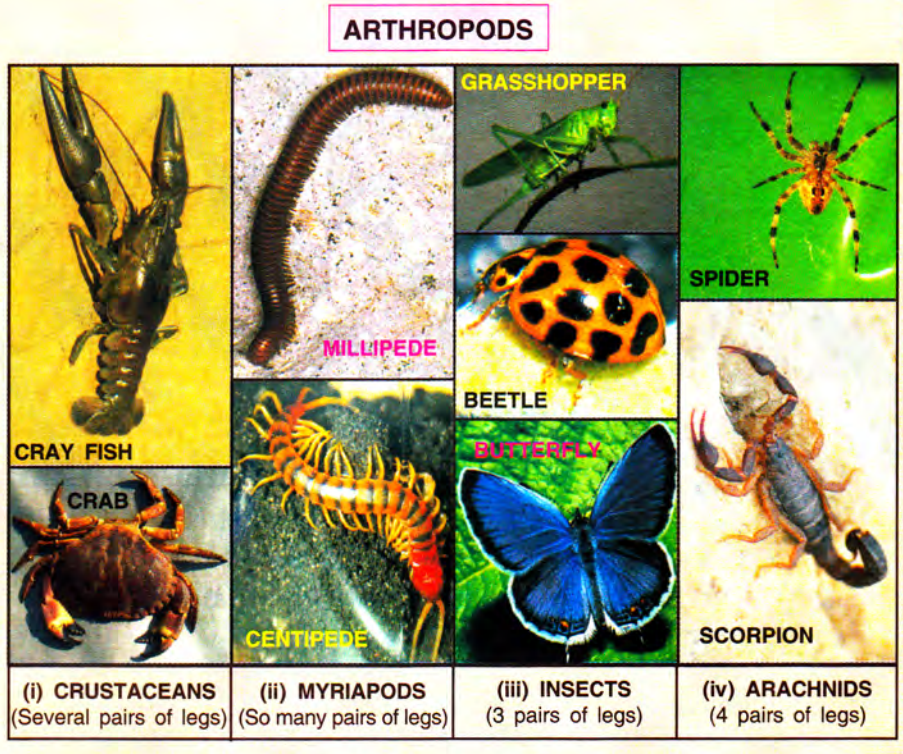


Fig. 8.12 Four classes of arthropods

(i) Class **Crustacea.** *Examples* : crayfish, crabs. Crustaceans are primarily aquatic animals. They have a hard chitinous exoskeleton. The body is divided into head, thorax and abdomen, but the head and thorax are fused together. Many appendages for various purposes, such as feeding, walking, running and swimming.

(ii) Class **Myriapoda.** *Examples :* centipede and millipede. These animals have many segments. Each segment has one or two pairs of limbs. The trunk is not divided into thorax and abdomen.

(iii) Class **Insecta.** *Examples :* silverfish, housefly, mosquito, beetle, grasshopper, locusts, cockroach, *etc.* The distinguishing characteristics of insects are as follows :

(1) The body is divided into ***head, thorax*** and ***abdomen.***

(2) Thorax has ***three pairs of jointed legs.***

(3) Usually two ***pairs of wings,*** sometimes a single pair or no wings at all.

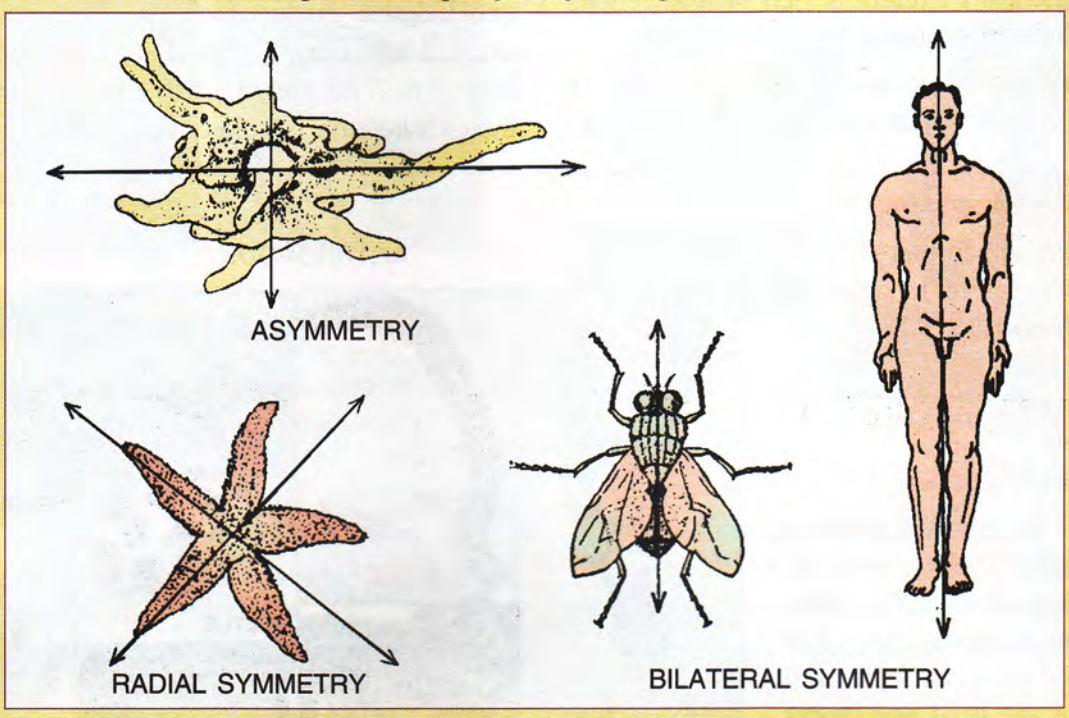
(iv) Class **Arachnida.** *Examples* : spiders, scorpions, mites, ticks. Arachnids have their body divided into two parts, the front part consists of the head and thorax fused together and the hind part consists of the abdomen. They have four pairs of jointed legs. They lack wings and antennae.

Table 8.3 Differences among flatworm, roundworm and ringed worms

Flatworm (Platyhelminthes)	Roundworm (Nematoda)	Ringed worms (Annelida)
1. Flat ribbon like unsegmented body	1. Soft, round, cylindrical body	1. Soft, cylindrical ring like the segmented body
2. Body cavity absent	2. False body cavity present	2. True body cavity present
3. Alimentary canal has one opening, serves both as mouth and anus.	3. Alimentary canal has a separate opening mouth and anus.	3. Alimentary canal opens at two ends.

BODY SYMMETRY

Look at the general shape of the four organisms shown below



A straight line with arrow heads at both ends represents the manner in which we may try to cut the organism into two equal halves. What will you find ?

Amoeba — No matter how you cut it, the two halves will never be similar to each other. Thus amoeba is *asymmetrial* (*i.e.* shows no symmetry).

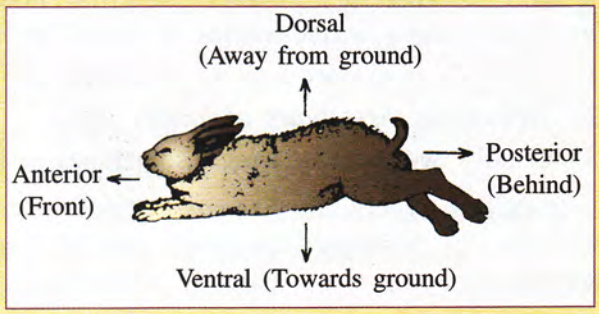
Starfish — Any line passing through the centre (*i.e.* along any radius) will divide the body into two similar halves. The starfish is, therefore, *radially symmetrical.*

Housefly — The body can be divided into two similar halves only along one plane, *i.e.* along the middle axis. The housefly is *bilaterally symmetrical* (*i.e.* two sideward halves are similar).

Human — Human body also shows *bilateral symmetry.* (Almost all the vertebrates and a large number of invertebrates are bilaterally symmetrical)

BODY DIRECTIONS

Anterior : Towards the front
Posterior : Towards the hind end
Dorsal : Relating to the back or the upper side of the body
Ventral : Belonging to the lower or underside of the body.
Lateral : Sides (right or left)



7. Phylum **Mollusca** (Fig. 8.13). ***Examples*** **: snail, slug, oyster, mussel, clam, squid and octopus.**

These animals have a soft, unsegmented body, with a hard, calcareous shell to protect the soft body. They have a muscular foot to help locomotion and also to act as a weapon in some cases.

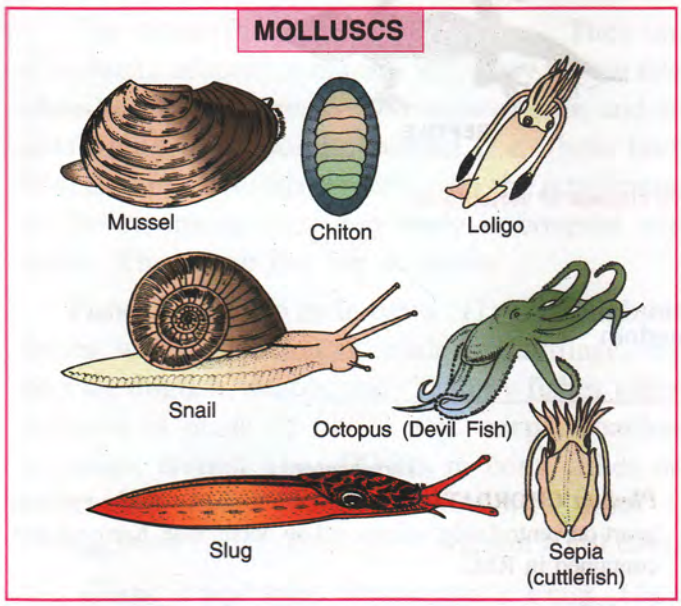


Fig. 8.13 Mollusca, some common examples.

8. Phylum **Echinodermata.** (Spiny-skinned animals) (Fig. 8.14). ***Examples*** **: Starfish, brittle-star, sea-urchin and sea-cucumber.**

Echinoderms are unsegmented, marine animals. They have an exoskeleton and a spiny surface. They move by means of tube-feet. They are radially symmetrical, *i.e.* they have similar parts (usually five) arranged regularly around a central point.

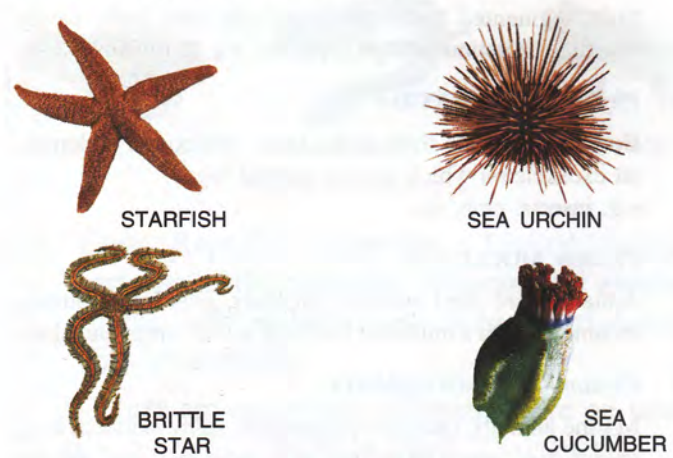


Fig. 8.14 Echinodermata, four examples.

PROGRESS CHECK

1. Mention the name of the phylum against the following characteristics

(i) No single mouth but numerous pores as water inlets _____

(ii) Jointed appendages. _____

(iii) Unsegmented body with a protective calcareous shell _____

(iv) Locomotion by tube feet _____

(v) Long, cylindrical and unsegmented body _____

(vi) Small flat unsegmented worms _____

2. Name the phylum of each of the following invertebrates.

	Animal	Phylum
(i)	Leech	_____
(ii)	Hydra	_____
(iii)	Tapeworm	_____
(iv)	Sea cucumber	_____
(v)	Sponge	_____
(vi)	Roundworm	_____
(vii)	Scorpion	_____
(viii)	Slug	_____
(ix)	Centipede	_____
(x)	Butterfly	_____

8.9 PHYLUM CHORDATA (Vertebrata)

All chordates possess a **notochord** which is a rod-like structure present in the mid-dorsal axis of the body. Except a few primitive forms in which the notochord persists throughout life, in all others it is replaced by a backbone (vertebral column). All vertebrates, including humans, have a notochord in embryonic life.

The chordates which possess a backbone are called **Vertebrates.** Vertebrates have a well-developed vertebral column forming the main axis of their internal skeleton, which may be of bones or cartilage. These animals have a head, a trunk and two pairs of appendages. Gill slits are present at some time in their life. Vertebrates are divided into five classes comprising fishes, frogs, lizards, birds and hairy quadrupeds (Fig.8.15).

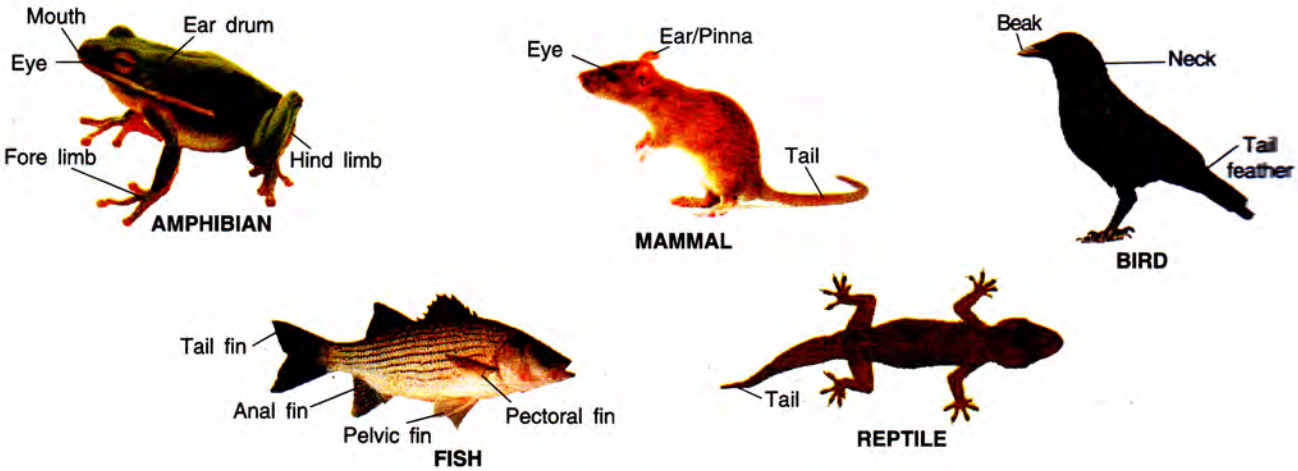


Fig. 8.15 Representatives of five classes of vertebrates

CLASSIFICATION OF ANIMAL KINGDOM

Animal kingdom

Invertebrates

Nerve cord present on ventral side, heart on dorsal side, haemoglobin dissolved in blood

Vertebrates

9. ***Phylum* CHORDATA :** Notochord/Vertebral column present, heart on ventral side, nerve cord on dorsal side, haemoglobin contained in RBC.

Cellular level

1. ***Phylum* PORIFERA :** pore bearers, aquatic fixed type, spongy fibres for protection, *e.g.* sponges and sycon

Tissue level

2. ***Phylum* CNIDARIA :** two layered body wall, radially symmetrical epidermis, and gastrodermis present, have tentacles and stinging cells, bisexual *eg.* Hydra and Coral

Organ & organ system level

***Acoelomata* (No body cavity)**

3. ***Phylum* PLATYHELMINTHES**

Bilateral symmetry, free living as well as parasitic, flat, unsegmented worms, body cavity absent, bisexual, one opening, *e.g. Planaria*—free living (Liver-fluke, Tapeworm) Parasitic

4. ***Phylum* NEMATODA**

Soft, cylindrical, unsegmented body, two openings, parasitic *e.g.* Ascaris, eel worm and filaria worm

***Coelomata* (body cavity present)**

5. ***Phylum* ANNELIDA**

Soft, segmented body, two openings, true body cavity bisexual, excretion through nephridia. *e.g.* Earthworm, leech

6. ***Phylum* ARTHROPODA**

Body divided into three parts, head, thorax and abdomen, an exoskeleton which moults, jointed legs.
e.g. insects, crab, etc.

7. ***Phylum* MOLLUSCA**

Aquatic, hard shell protects soft body, gills for breathing, locomotes with a muscular foot. *e.g.* oyster, slugs and clam.

8. ***Phylum* ECHINODERMATA**

Marine animals, radially symmetrical, spiny skinned, head absent, five arms, locomotes with tube feet. *e.g.* starfish and brittle star.

8.9.1 VERTEBRATE CLASSES

(i) **Pisces** (Fishes)
(ii) **Amphibia** (Frog)
(iii) **Reptilia** (Lizards)
(iv) **Aves** (Birds)
(v) **Mammalia** (Hairy quadrupeds)

(i) Class Pisces

The class Pisces includes fishes. They are completely adapted to aquatic life. They have a ***two-chambered heart***, breathe by means of ***gills***, and are ***cold-blooded*** or poikilothermal (*i.e.* their body temperature fluctuates directly with the temperature of the environment). Their body is covered with *scales*. They have *fins* but no limbs.

Fishes are of two main types : (1) **Cartilaginous fishes** whose skeleton is made of cartilage, e.g. **sharks, dogfish, skates,** and (2) **Bony fishes** whose skeleton is made of bones, e.g. **carps, roaches, herrings, trouts.** The gill-slits in bony fishes are concealed under a gill-cover, while those in cartilaginous fishes are exposed without a gill cover.

(ii) Class Amphibia. *Examples* : Frog, toad, salamander and newt.

Amphibians live **partly on land** and **partly in water**. Eggs are laid in water. In early stages of life (larvae), they breathe by means of ***gills***. But their adults breathe by means of ***lungs***. They have a smooth, non-scaly moist, ***slimy skin***. The ***eardrum*** (tympanum) lies on the surface of the skin. They have ***five fingered*** (pentadactyl) limbs, and a three-chambered heart. They are cold-blooded.

Fig. 8.16 Amphibians

(iii) Class Reptilia. *Examples* : Lizard, snake, tortoise, turtle, crocodile, alligator and gharial (found only in the rivers of India, Malaysia and Myanmar).

Reptiles are completely adapted to life on land. Their eggs have a **leathery shell**. They breathe by means of **lungs** right from birth. They have rough, **horny scales** on the skin, and a **three-chambered heart** in which the **ventricle is partially divided**. The eardrum (tympanum) lies at the bottom of a tubular depression. They are **cold-blooded**.

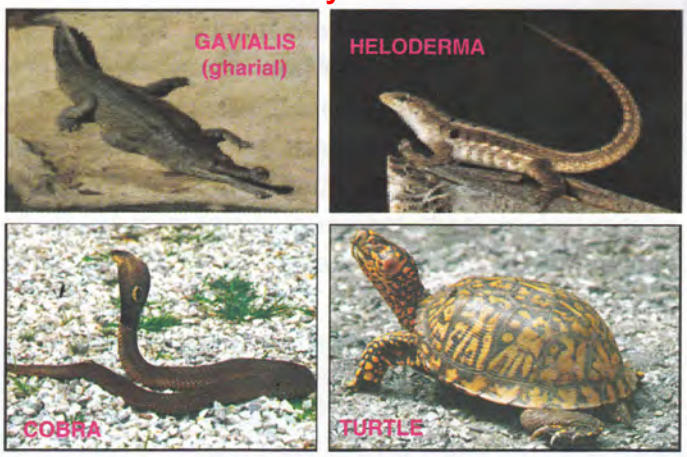


Fig. 8.17 Reptiles

(iv) Class Aves. *Examples* : Pigeon, sparrow, crow, duck, owl, penguin, ostrich, emu, *etc*.

All birds belong to this class. They breathe by means of **lungs**. They have an **exoskeleton of**

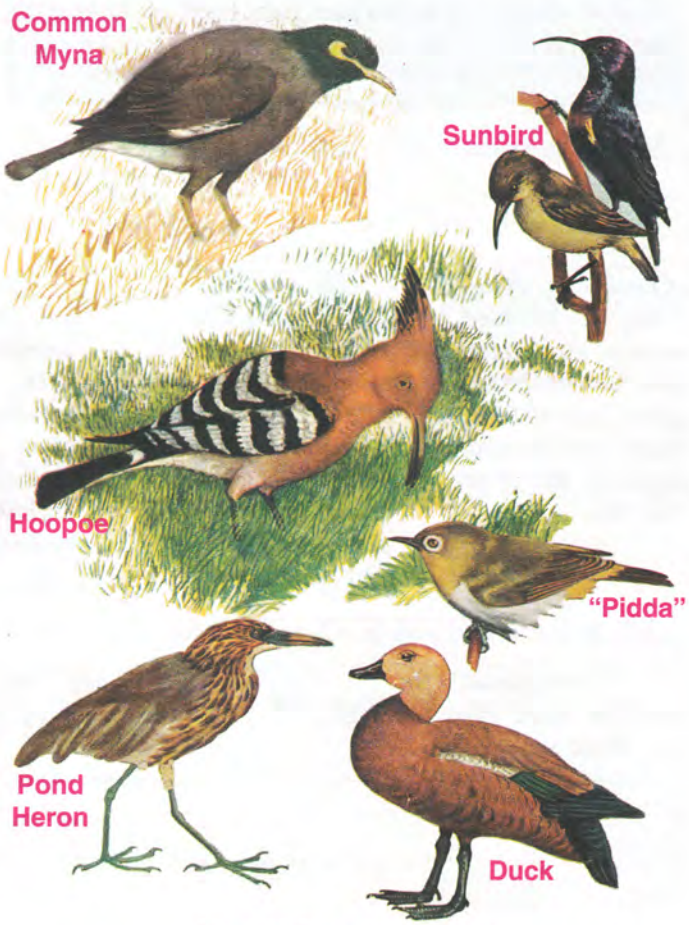


Fig. 8.18 Some Indian Birds

feathers. Their fore-limbs are modified into wings. They have **scaly legs** and a **four-chambered heart**. Their body is streamlined and the skeleton is light to facilitate flying. They are **warm-blooded** or **homeothermal** (*i.e.* they maintain an almost constant, relatively high body temperature irrespective of the temperature of the environment). They lay **eggs with calcareous shells**.

TO BELIEVE OR NOT TO BELIEVE!

The truth about some birds is as follows :

Cuckoo ("Koel") – It is the black coloured **male** that sings (koo-oo-koo-oo), the brownish white-patched female produces only a dull broken call (kuk ... kuk ...). It lays eggs in **crow's nest**, the crow incubates them.

Hawk cuckoo ("Papiha") lays its eggs in **'seven-sisters' nest.**

Swan ("Hans") has no capacity "to drink just milk and leave behind the water mixed in it!" It also has no lust for eating pearls.

Chakor (Indian red-legged partridge) may love moonlight but it neither "flies into the moon," nor does it "eat burning charcoal."

(v) Class Mammalia. *Examples* : Cat, dog, cow, sheep, rat, bat, seal, monkey, apes, man, etc.

Mammals are the most highly developed animals for life on land, although some of them, such as whales and porpoises live in water and bats fly in air. They **give birth to living young ones** (viviparous) with two exceptions of the Australian spiny ant-eater (Fig. 8.19) and duckbilled platypus which lay eggs. They suckle the young ones by means of mammary glands. They have **hair on their skin**. They are warm-blooded. They have a **muscular diaphragm** separating the thorax and abdomen internally. They have a **four-chambered heart** and breathe by means of **lungs**. As a rule, they have a pair of **external ears** (pinnae) and **external testes** contained in a scrotum (testicles).

Fig. 8.19 Spiny ant-eater of Australia—an egg laying mammal. (Do not confuse this with the hedgehog which gives birth to young ones.)

SUMMARY OF CLASSIFICATION OF VERTEBRATES

Classes* - (i) *Pisces

Cold blooded, aquatic slimy, scaly skin, breathe through gills, 2-chambered heart, fertilization external, locomotes with fins

- ***Cartilaginous Fish*** — Skeleton made up of cartilage, *e.g.* Shark and dogfish
- ***Bony Fish*** — Skeleton made up of bones, *e.g.* Trout and rohu.

(ii) *Amphibia*

Cold blooded, Live in water and on land, slimy skin; gills, skin and lungs for respiration, 2 pairs of limbs, 3-chambered heart, external fertilization *e.g.* frog and salamander

(iii) *Reptilia*

Cold blooded, land animals, dry scaly skin, lungs for breathing, two pairs of limbs, 3-chambered heart, lay leathery eggs. *e.g.* snake and lizard

(iv) *Aves*

Aerial, warm blooded, forelimbs in the form of wings, feathery skin, lungs for breathing, lay calcareous eggs, 4-chambered heart, *e.g.* Parrot, crow and duck

(v) *Mammalia*

Warm blooded, all sort of habitat, hairy skin, lungs for breathing, two pairs of limbs, 4-chambered heart, give birth to young ones, mammary glands secrete milk, external ears or pinnae, *e.g.* Whale, Dolphin, Bat, Dog, Cat, humans, etc.

PROGRESS CHECK

1. Listed below are eleven characteristics (i-xi) in Column I and the five classes (a-e) of Chordata in Column II. Match at least two characteristics with each class.

Column I (Characteristics)	Column II (Classes)
(i) Three chambered heart	(a) Pisces
(ii) Feathers	_____
(iii) Two-chambered heart	_____
(iv) Eardrum in a pit	(b) Amphibia
(v) Scales	_____
(vi) External ears	_____
(vii) Gills	(c) Reptilia
(viii) Moist skin	_____
(ix) Horny scales on skin	_____
(x) Homeothermal	(d) Aves
(xi) Testes in scrotum	_____
	_____
	(e) Mammalia
	_____
	_____

2. Mention the class of vertebrates against each.

(i) Crocodile _____
(ii) Penguin _____
(iii) Toad _____
(iv) Shark _____
(v) Whale _____
(vi) Bat _____
(vii) House lizard _____

POINTS TO REMEMBER

- *Linnaeus introduced the modern method of naming living organisms, called binomial nomenclature*
- *The scientific name of an organism consists of the generic name and a specific name.*
- *A species consists of such individuals which have basically the same characteristics and they can normally breed among themselves.*
- *Species is the lowest level in biological classification.*
- *Ranks higher than species are genus, family, order, class, phylum and kingdom.*
- *In classifying the organisms one starts with the highest category, Kingdom, and then step by step to the lowest level, Species.*
- *The five major kingdoms are Monera (unicellular, unorganised nucleus), Protista (unicellular, organised nucleus), Fungi (multicellular, eukaryotic, saprophytic), Plantae (autotroptic, eukaryotic, multicellular) and Animalia (eukaryotic, multicellular, heterotrophic).*
- *Animals are mainly grouped under two categories — vertebrates and invertebrates.*
- *Invertebrates consist of a wide variety of animals consisting of several phyla.*
- *Protozoa are single-celled eukaryotic Protista.*
- *Sponges are fixed aquatic animals with numerous pores for entry of water and one large pore for its exit.*
- *Cnidarians have a two-layered body with tentacles surrounding the mouth.*
- *Platyhelminthes have a flat body, and an alimentary canal with a single opening*
- *Nematoda are round worms with openings at both ends of the gut.*
- *Annelids have a segmented body and usually without limbs.*
- *Arthropoda have a segmented body and a varying number of jointed appendages.*
- *Arthropoda are divided into four classes — Crustacea (with head and thorax fused and an abdomen, and with many pairs of appendages), Myriapoda (each body segment with paired appendages), Insecta (body divided into head, thorax and abdomen, 3 pairs of jointed legs, and usually two pairs of wings), Arachnida (head and thorax fused and four pairs of jointed legs).*
- *Mollusca have soft unsegmented body usually enclosed in a shell.*
- *Echinodermata have unsegmented radially symmetrical body.*
- *Vertebrates consist of five classes — Pisces, Amphibia, Reptilia, Aves and Mammalia.*

REVIEW QUESTIONS

A. MULTIPLE CHOICE TYPE

1. The animals (Kingdom Animalia) are mainly grouped under two categories
   (a) bilaterally symmetrical **and** radially symmetrical
   (b) coelomate **and** acoelomate
   (c) aquatic and terrestrial
   (d) vertebrates **and** invertebrates
2. Which one of the following examples does not come under the particular group ?
   (a) Mushroom, yeast, fern — **Fungi**
   (b) Paramecium, Euglena, sponge — **Protista**
   (c) Starfish, Cuttlefish, Dogfish — **Pisces**
   (d) Bat, Parrot, Oyster — **Vertebrates**
3. Which one of the following is an example of **binomial scientific name** ?
   (a) Green alga (b) Snow leopard
   (c) *Rana tigrina* (d) China-rose
4. Which one of the following is the ***correct*** statement about the respective animal(s) ?
   (a) **Donkey** and **horse** should be considered one single species because they can successfully mate and produce an offspring.
   (b) **Donkey** and **horse** are two different genuses.
   (c) **Mule** is a separate species.
   (d) **Mule** is neither a donkey nor a horse.

B. VERY SHORT ANSWER TYPE

1. Who had introduced the binomial system of naming living beings ?
2. Which ***two*** characters out of (a)-(e) given below are common to dog, humans, squirrel, bat, camel and monkey ?
   (a) scales on the skin.
   (b) wings.
   (c) external ears.
   (d) give birth to young ones.
   (e) a functional tail.
3. **Match the items** in Column I with as many as possible and even repeatedly from Column II.

Column I	Column II
1. Pine	(i) Fungi
2. Earthworm	(ii) Monera
3. Bread mould	(iii) Prokaryote
4. Amoeba	(iv) Gymnosperm
5. Moss	(v) Plantae
6. Bacteria	(vi) Animalia
	(vii) Protista
	(viii) Bryophyta

C. SHORT ANSWER TYPE

1. Rearrange the following categories of classification in their proper sequence starting with the highest. **species, family, genus, class, order, phylum.**
2. Give the **scientific names** of man, domestic cat, and peepal tree.
3. **Why** are scientific names of living beings considered better than their common names?
4. Mention any **two drawbacks** in classifying organisms under the old two kingdom classification.
5. All humans on earth today may differ widely in their **facial features, colour, height,** etc. Yet, they belong to a single species *Homo sapiens.* Give *one* reason why they are not considered belonging to different species.
6. Rewrite the following scientific names **correctly**. ficus religiosa (peepal), zea Mays (maize) and Bombyx Mori (silk moth).
7. Name the five kingdoms according to the new classification.
8. What are the **group names** of the following categories of animals ?
   (a) Animals with a backbone .....
   (b) Animals with a hairy skin .....
   (c) Animals with three pairs of legs .....
   (d) Animals with feathers .....
9. Which ones of the following animals are **invertebrates** ? Housefly, silverfish, trout, jellyfish, whale, penguin, lizard and sponge.
10. Give any *one* difference between each of the following:
    (a) Protozoa and Metazoa,
    (b) Vertebrate and Invertebrate,
    (c) Insecta and Arachnida,
    (d) Flatworm and Roundworm,
11. Given below is a list of ten animals each followed by three terms or features. **Underline the term** which *does not* match with the animal.
    (i) **Amoeba** — Nucleus, tentacle, food vacuole.
    (ii) **Hydra** — Invertebrata, Cnidaria, Crustacea.
    (iii) **Fish** — Gills, paired fins, ear drum
    (iv) **Earthworm** — Invertebrata, Annelida, Insecta.
    (v) **Grasshopper** — Wings, trachea, proboscis.
    (vi) **Butterfly** — Insecta, Invertebrata, Mollusca.

(vii) **Whale** — Gills, mammary glands, fat under the skin.

(viii) **Pigeon** — Feathers, wings, hair.

(ix) **Monkey** — External ear, sweat glands, lateral line.

(x) **Bat** — Aves, Mammalia, Chordata.

12. Explain the meaning of the terms cold-blooded and warm-blooded (homeothermal).

13. Name *three* animals (belonging to different classes) which breathe by means of lungs but have no external ears (pinnae).

D. LONG ANSWER TYPE

1. Mention any *one* major **similarity** and *one* major **difference** in the following pairs of animals :
   (a) insects and birds
   (b) whales and fishes
   (c) snakes and earthworms
   (d) bat and pigeon
   (e) cuttlefish and dogfish
   (f) wall lizard and frog

2. **Match** the names of animal groups in Column I with the names of animals in Column II.

Column I (Group)	Column II (Animal)
Annelida	Pigeon
Porifera	Snake
Mollusca	Earthworm
Reptilia	Sponge
Amphibia	Octopus
Pisces	Trout
Mammal	Rabbit

Which names are **left out** that do not match and why ? _____

_____

E. STRUCTURED/APPLICATION/SKILL TYPE

TYRANNOSAURUS

(One of the extinct animals which lived on the Earth about 100,000,000 years ago)

Tyrannosaurus ***was about six metres long and it preyed upon other animals. What do you think about its classification—was it an amphibian, a reptile or a mammal ?***

Can you call it a relative of Kangaroo ? **Yes/No**

Give reason .....

.....

Laughter — One of the hundreds of common features between a human and human's nearest biological relatives the apes (here an Orangutan).

Geckos (the common wall lizards) stick to walls not by any vacuum but by innumerable microscopic "**hairs**" called spatulae (like the bristles of a tooth brush) projecting from the setae growing on the rows of plates on the underside of the feet. These spatulae produce an attraction force at atomic level to stick to tiny rough parts on the surface of the walls.

A total myth "Sarp Mani"

Contrary to popular belief there is no jewel (*mani*) in the cobra's head. If jewels were found in snakes, the snake-catchers would be maharajahs, not just poor snake catchers. This simple insert is a glass piece "glued" in the head to deceive people.

Snake-keeping is now banned.