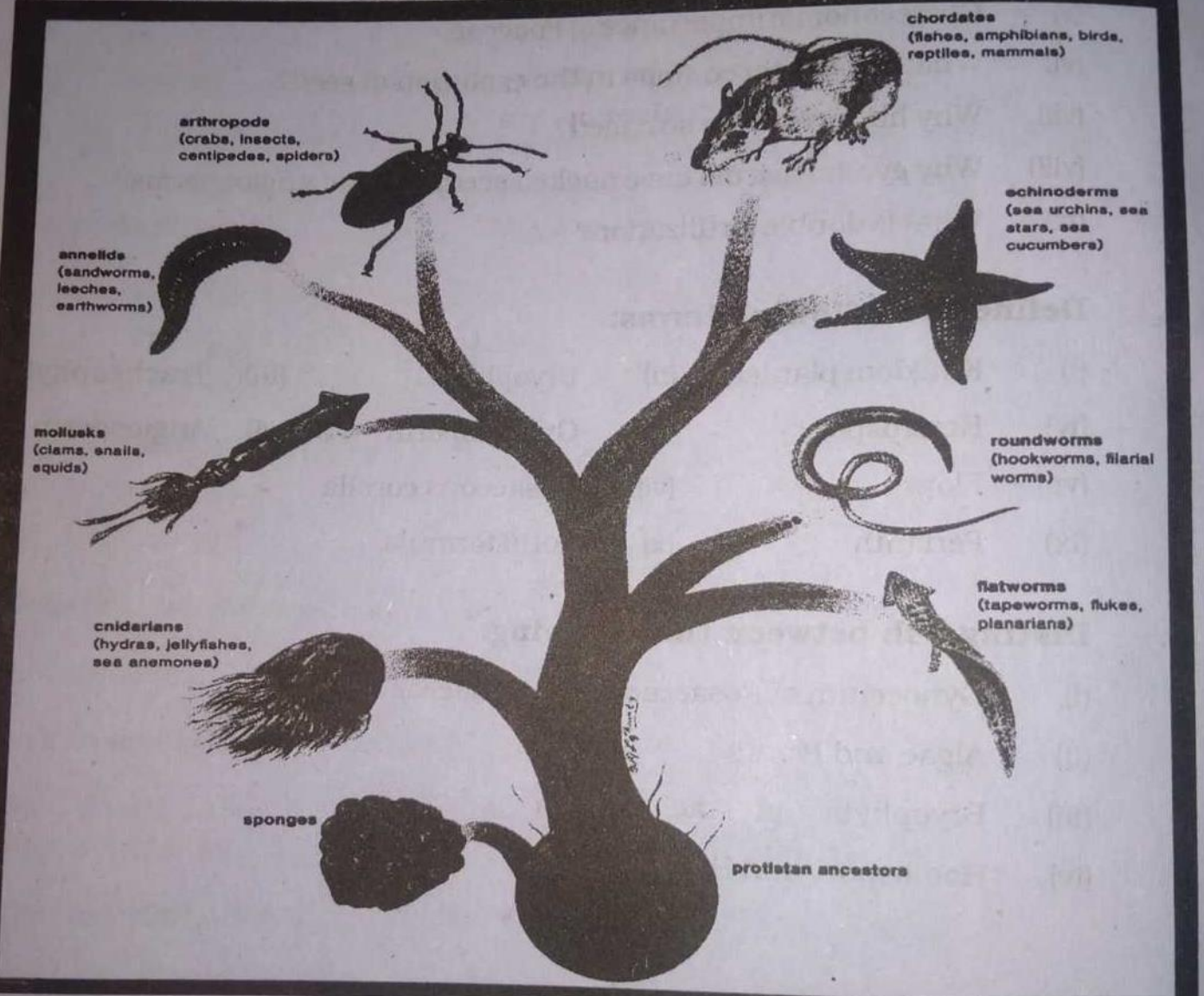
CHAPTER 10

THE KINGDOM ANIMALIA



In this chapter we trace the long evolutionary history of the animals; in it we encounter the simplest members of this kingdom — sponges, jellyfish and several kinds of worms. These animals are important ecologically and they illustrate the advent of the major characteristics that are important in the more advanced animal phyla. These characteristics include the development of tissues and organs, the use of internal digestion, the appearance of radial and then bilateral body organization and the appearance of internal body cavities.

DIVERSITY AND COMPLEXITY

Animals, the members of this kingdom are the most conspicuous living organisms in the world around us. As individuals, animals are greatly out numbered by plants, bacteria and even fungi. Yet there are more kinds of animals than any other type of organism. A total of about 1.3 million species of animals are included in this kingdom. It constitutes around 75% of the total known species of living organisms.

An organism is a complete living being.

Animals range in size and complexity from a merely microscopic parazoan **Trichoplax** to the giant blue whale **Balaenoptera** that reaches a length of nearly 40 meters and weighs more than 160,000 Kilograms (Fig. 10.1). Between these extremes is an immense diversity of animals that differs a great deal not only in size, appearance and habitat but also in having virtually no organs to a highly specialized organ system. The members of most of the phyla are found in shallow water or moist soil. True land dwelling forms are found in phylum Arthropoda and Chordata.

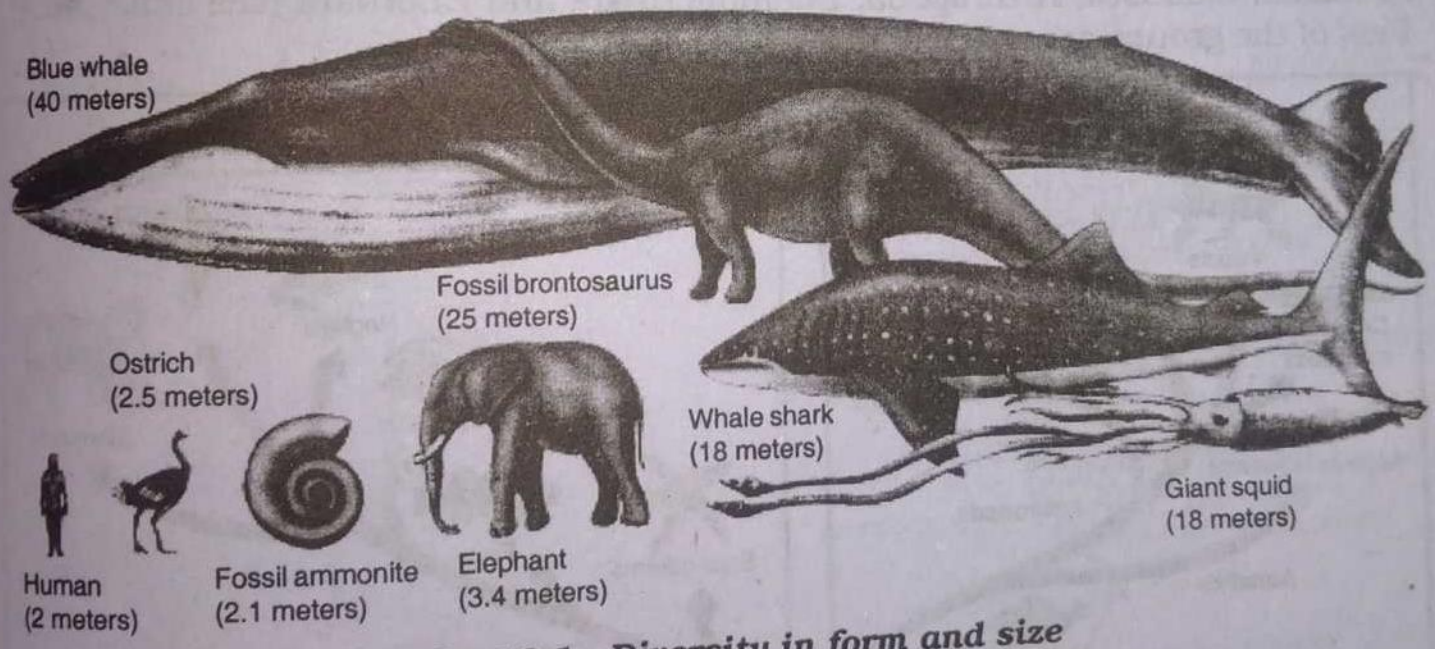


Fig. 10.1 Diversity in form and size

Such a diversified group of animals is thought to had arisen from an ancestral colonial, probably volvox like protist (protoctist) as a result of division of labour among their aggregated cells. Some cells became specialized for movement, others for nutrition and still others differentiated into gametes. These co-ordinated groups of cells evolved into larger and more complex organisms that we now call animals. Multicellular animals have arisen from the protists at least three times. The sponges (phylum Porifera), cnidarians (phylum Cnidaria), and flat worms (phylum Platyhelminthes) probably represent the three separate evolutionary lines. The other animal phyla probably evolved from a flatworm or flatworm like ancestor.

10.1 ANIMAL CLASSIFICATION

In order to better understand such a large number of organisms, it is necessary to arrange them in groups. This arrangement presents a great deal of information in an orderly way. In the traditional two-kingdom system of classification (not followed these days) the multicellular animals were referred to as Metazoa to distinguish them from one-celled Protozoa. In modern five kingdom classification scheme, the Protozoa belongs to kingdom Protoctista whereas the true animals are placed in kingdom Animalia. A true animal is now defined as "a eukaryotic, multicellular, heterotrophic (ingestive mode of feeding) organisms which are diploid and developed from an embryo formed by the fusion of two different haploid gametes, a larger egg and a smaller sperm". Most of animals are motile, a few, however, are sessile.

The kingdom Animalia is divided into 33 groups called phyla, out of which we will deal with only nine major ones. Each of these groups include a sufficient number of species and individuals which play an important role in an ecological community. These major phyla are Porifera, Cnidaria, Platyhelminthes, Nemathelminthes, Annelida, Mollusca, Arthropoda, Echinodermata and Chordata (see chart No.1). Rest of the groups are called minor phyla.

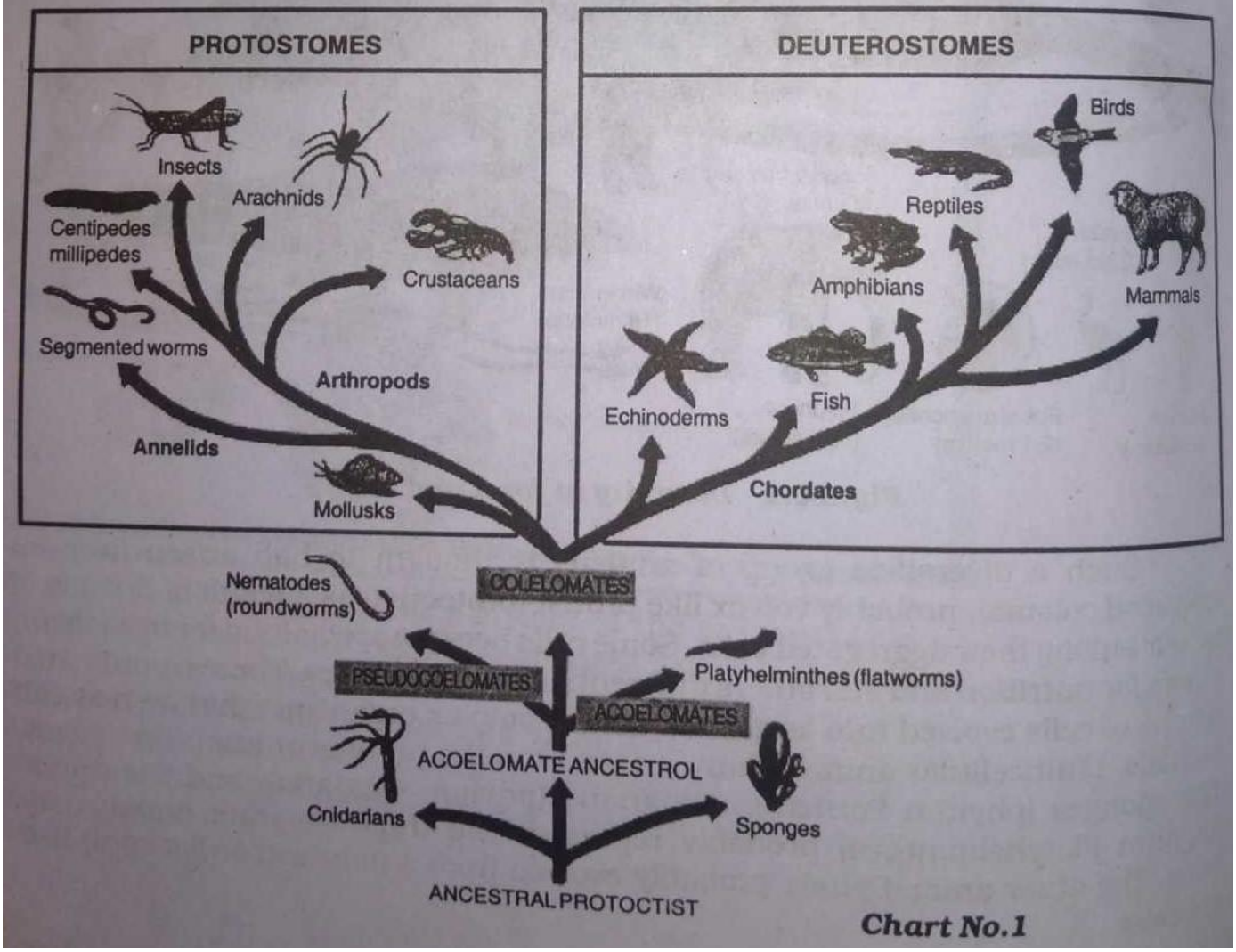


Chart No.1

This classification or grouping of animals is called Taxonomy or Systematics. It is carried out primarily on the basis of their evolutionary relationships. Clues to these relationships are found in (i) the comparative study of their morphology (general appearance) and (ii) their internal architecture which includes their cellular organization, symmetry and the embryological developmental pattern of their coelom and blastopore etc. The structure of DNA and the study of their comparative biochemistry and physiology also help in tracing their relationships.

10.1.1 Developmental Patterns:

An animal starts its life as a **zygote**, which is a diploid cell, formed as a result of fertilization. It develops by a sequence of mitotic division, called ***cleavage***, into a multicellular structure, first a solid ball of cells the ***morula*** and then a hollow ball of cells the ***blastula***. In most of the animals the blastula invaginates i.e. folds

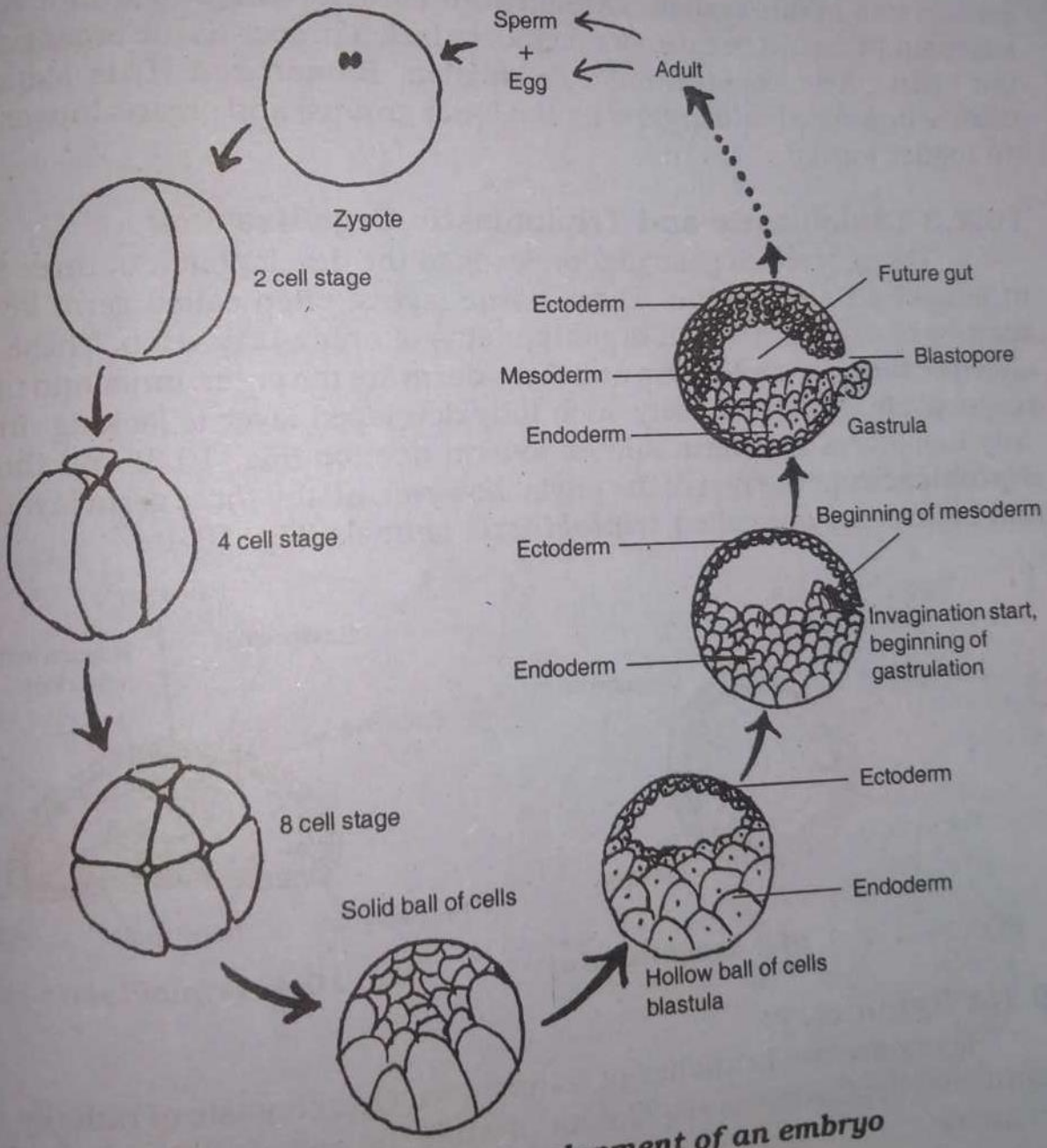


Fig. 10.2 Initial stages of development of an embryo

inwards, at a point to form ***gastrula***, has a hollow sac having an opening called ***blastopore*** (Fig. 10.2). Further development and movement of cells produce a hollow digestive system called an **enteron** if it is open at one end only and a **gut**, if it has developed a second opening.

The details of further embryonic development differ widely from phylum to phylum but are fairly constant within each phylum. Such developmental details provide very important criteria for determining relationship between the phyla.

10.1.2 Cellular Organization:

Animal phyla described in the next pages are in approximate order of increasing complexity. All the animals are multicellular and their cells are eukaryotic. These cells are joined together into tissues, tissues into organs and organs into organ-system. One phylum Porifera, is grouped in a separate sub-kingdom ***Parazoa*** because its members lack a proper tissue organization. Rest of the eight phyla constituting sub-kingdom ***Eumetazoa*** (True Metazoans) have tissues organized into organs (in the lower groups) and organs into organ systems (in higher forms).

10.1.3 Diploblastic and Triploblastic Organization:

The process of gastrulation leads to the development of three tissue layers in almost all ***eumetazoa***. These tissue layers, often called germ layers, are the masses of cell from which organ systems of animals develop. These germ layers called ***ectoderm***, ***endoderm*** and ***mesoderm*** are the outer, inner and middle layers, respectively. In Porifera any such fully developed layer is lacking. In Cnidarians only two layers ectoderm and endoderm develop (Fig. 10.3) and they are called ***diploblastic***. In the rest of the phyla, however, all the three germ layers are formed and hence they are called ***triploblastic*** animals (Fig. 10.4).

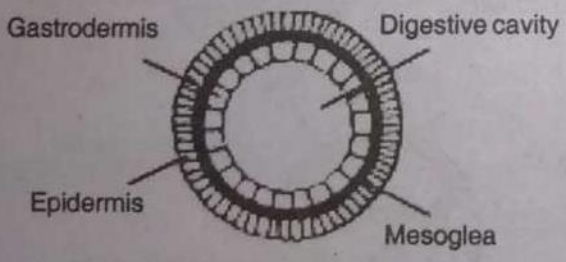


Fig. 10.3 T.S. of a coelenterate

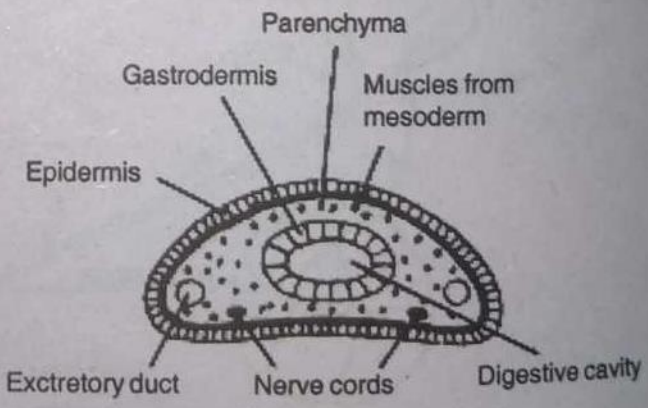


Fig. 10.4 Triploblastic animal

10.1.4 Symmetry:

There are two branches of Eumetazoa. One consists of radially symmetrical organisms, the Coelenterata (Cnidaria) while the rest of all the phyla show bilateral symmetry.

What is symmetry? Symmetry is the overall shape of an animal body. All the symmetrical animals can be divided, along at least one plane, into two identical halves. Animals that have no plane of symmetry are said to be **asymmetrical** e.g. sponges. A body with **radial symmetry** has one main axis around which body parts are arranged and the organism can be divided into identical halves by any plane that passes through the main axis. Cnidarians and Echinoderms are the examples of radially symmetrical animals. A **bilaterally symmetrical** animal can be divided into identical right and left halves only by a cut through the mid-line of its body (Fig. 10.5).

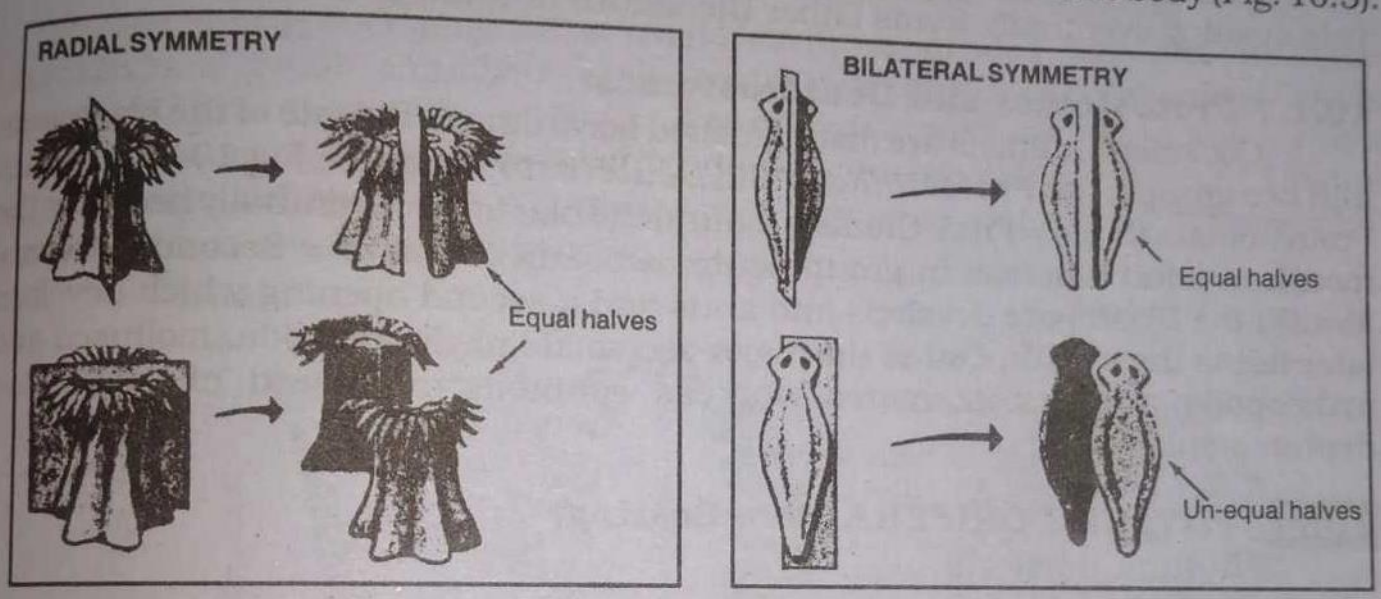


Fig. 10.5

10.1.5 Coelom:

The bilaterally symmetrical animal phyla may be divided into three groups: ***Acoelomata*** (Platyhelminthes) are those which lack a body cavity; ***Pseudocoelomata*** (Nematodes) are those which develop a body cavity but lack a true coelom. The ***Coelomata*** (from Annelida to Chordata) are all those which develop a true coelom (Fig. 10.6 and chart No.1). In coelomates the meso-dermal layer splits open to contain a space that widens and eventually

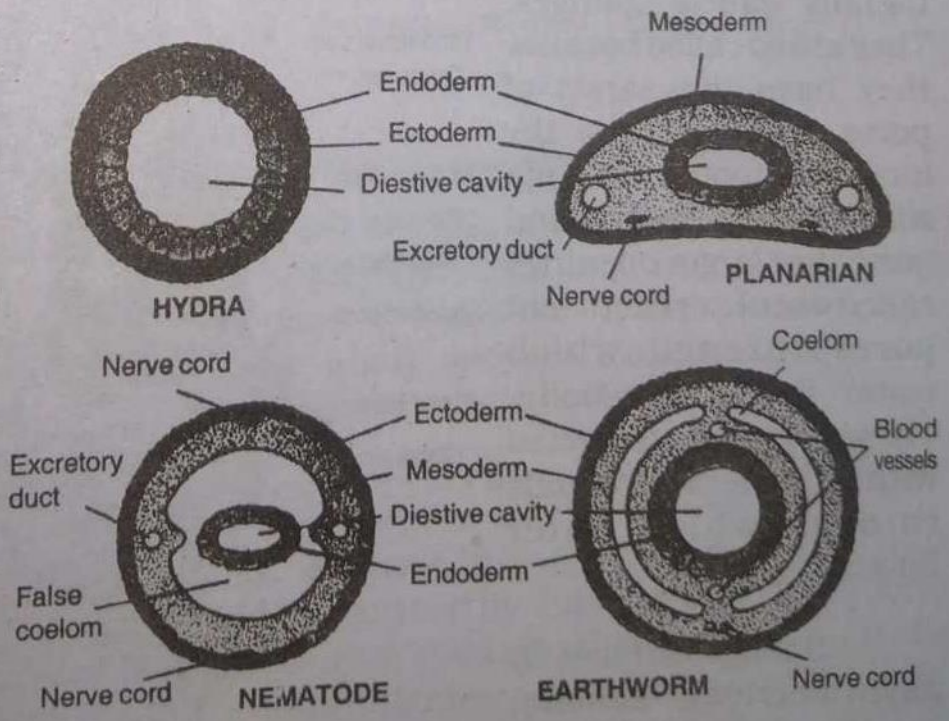


Fig. 10.6

forms a body cavity in which digestive, repro-ductive and other organs develop and are suspended. This true body cavity, being lined by mesodermal layers, is called the ***coelom***. A pseudocoelom is though a body cavity which also encloses the intestine but it is not formed by the splitting of mesoderm. Acoelomate animals have no such body cavity at all.

10.1.6 Fate of Blastopore:

Blastopore is the opening which develops in an embryo at the gastrula stage. This opening eventually forms either the mouth or anus of the animal.

10.1.7 Protostomes and Deuterostomes:

Coelomate animals are distinguished according to the fate of the blastopore into two groups, the ***Protostomata*** and ***Deuterostomata*** (see Fig. 10.2). In group Protostomata (Proto = First; Stoma = Mouth) the blastopore eventually becomes the mouth of adult whereas in group deuterostomata (Deutero = Second; Stoma = Mouth) the blastopore develops into anus and a second opening which develops later forms the mouth. Out of the major coelomate phyla annelida, mollusca and arthropoda are protostomates whereas echinodermata and chordata are deuterostomates.

10.2 PHYLUM PORIFERA (Pore Bearing)

Phylum porifera which includes about 5,000 species are the simplest living animals usually called sponges. They are so called because they have thousands of pores called ***ostia*** or the incurrent pores through which water enters and one or few larger openings called ***oscula*** or excurrent pores through which water leaves the body. These pores are connected with a system of canals through which water flows.

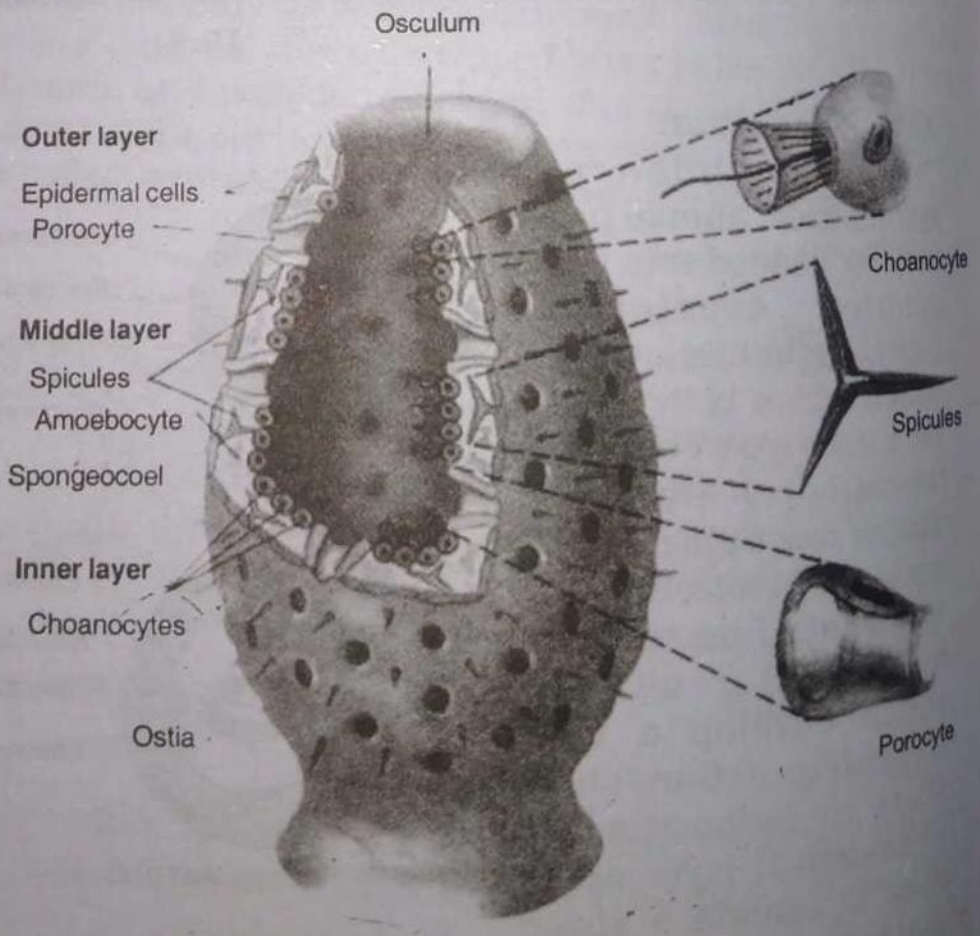


Fig. 10.7 Spongocoel

Sponges are usually asymmetrical, sessile, aquatic organisms. Most of them are marine

whereas about 150 types live in fresh water. They lack mouth, intestine, respiratory, excretory and nervous systems. Oxygen diffuses in through the body wall and food is filtered out from water which flows through their body. Waste particles and fluids simply diffuse out of the body or flow out through oscula.

A sponge may be described as an assemblage of loosely organized cells rather than a well defined multicellular organism. The ***pinacocytes*** are the contractile flattened cells forming the epidermis, ***porocytes*** form the pores whereas ***choanocytes*** are flagellated cells lining the inner hollow cavity the ***spongocoel*** (Fig. 10.7).

The spongocoel may be a single cavity or divided and redivided into thousands of small chambers and canals thus increasing the surface area available. Three types (Fig. 10.8) i.e. ***Ascon type*** (spongocoel single cavity, not divided), ***Sycon type*** (spongocoel divided into secondary chambers) and ***Leucon type*** (spongocoel divided and redivided into secondary and tertiary chambers) of canal systems are found in sponges.

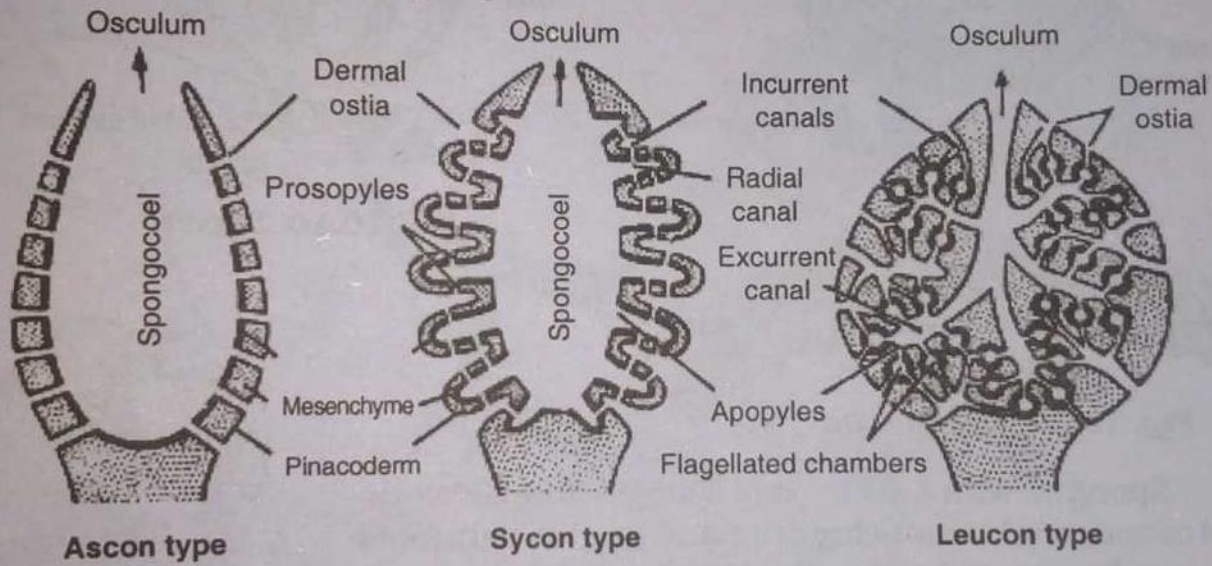


Fig. 10.8 Canal system of sponges

Between pinacocytes and choanocytes is a gelatinous mesenchyme which consists of ***amoebocytes*** and ***spicules***. Spicules which may be ***calcareous*** or ***siliceous*** consititute the skeleton of sponges. The skeleton of bathroom sponges, however, is a network of ***spongin fibres***. Many sponges look coloured due to symbiotic algae or due to the presence of pigments in amoebocytes.

A 10 cms sponge filters more than 20 litres of water everyday.

Most sponges are hermaphrodite whereas in a few sexes are separate. During sexual reproduction eggs and sperms formed by amoebocytes. The sperms are carried out by water current to neighbouring sponges where fertilization takes place. The fertilized egg develops into a multicellular free swimming ***Amphiblastula*** larva which settles to the bottom and grows into an adult.

Asexual reproduction takes place either by regeneration of fragments of sponges or by spore like ***Gemmule*** formation. Gemmules (Fig.10.9) are actually nutrient laden amoeboid cells surround by layers of epithelial cells. Gemmule is resistant to drought or winter and when conditions become favourable it grows into a new sponge. Sycon (Fig. 10.10), Euplectella (Fig. 10.11) and Euspongia (Fig. 10.12) are the common examples of this phylum.

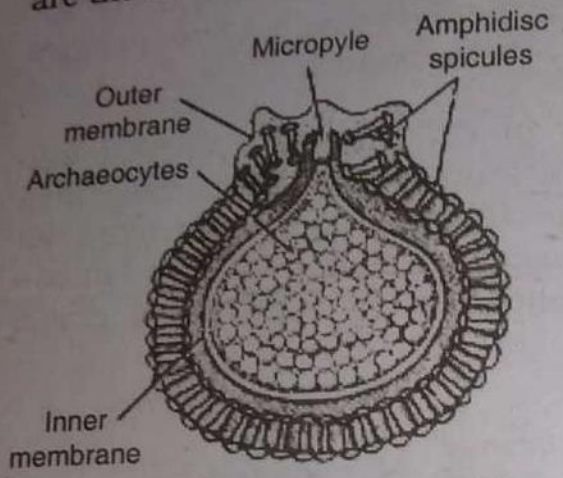


Fig. 10.9 Gemmule

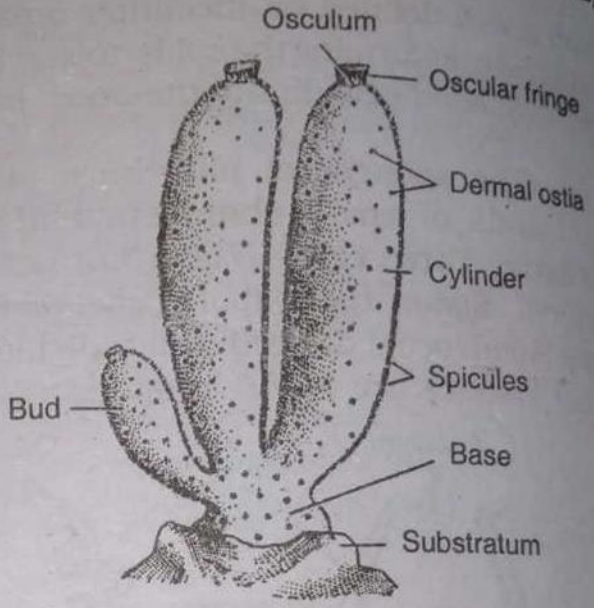


Fig. 10.10 Sycon

Fig. 10.11 Euplectella

Fig. 10.12 Bath sponge

Sponges, with a skeleton of spongin fibre network, are of commercial value being dried and used as bathroom sponges. Sponge fishing and sponge culture was very common in the past though in the recent years it has been very much replaced by the artificial sponges.

Three classes on the basis of skeleton are:

i) ***Calcarea:*** Skeleton of needle shaped lime-crystals e.g. Ascon, Sycon.

ii) ***Hexactinellida:*** Spicules silicious (glass material) with six rays e.g. e.g. Euplectella.

iii) ***Demospongiae:*** Skeleton of proteinacious fibers (spongin fibers) either with or without spicules. e.g. Spongilla, etc. Spicules when present are siliceous but never six rayed.

10.3 PHYLUM CNIDARIA (With Nematocytes)

Phylum Cnidaria which includes about 9000 species is also commonly called Coelenterata (with hollow enteron). This group of morphologically least

complex metazoa includes the common Hydras, Jelly fishes, Sea Anemones and the microscopic animals responsible for building coral reefs. Cnidarians are all aquatic, majority of them are marine whereas a few live in fresh water. They are radially symmetrical and diploblastic. Their body wall encloses a hollow cavity the gastro-vascular cavity or ***coelenteron***, hence the name coelenterata (Fig. 10.13). Coelenteron which serves as a rudimentary gut opens to the exterior through just one opening which serves both as mouth and anus. The development of an enteron and a rudimentary network of nerves in cnidarians is the first evolutionary step towards formation of organ system. The cnidarians have no respiratory, excretory or circulatory system because all the cells of the body are close enough to the external medium so that respiration and excretion occur directly by diffusion through the cell membranes.

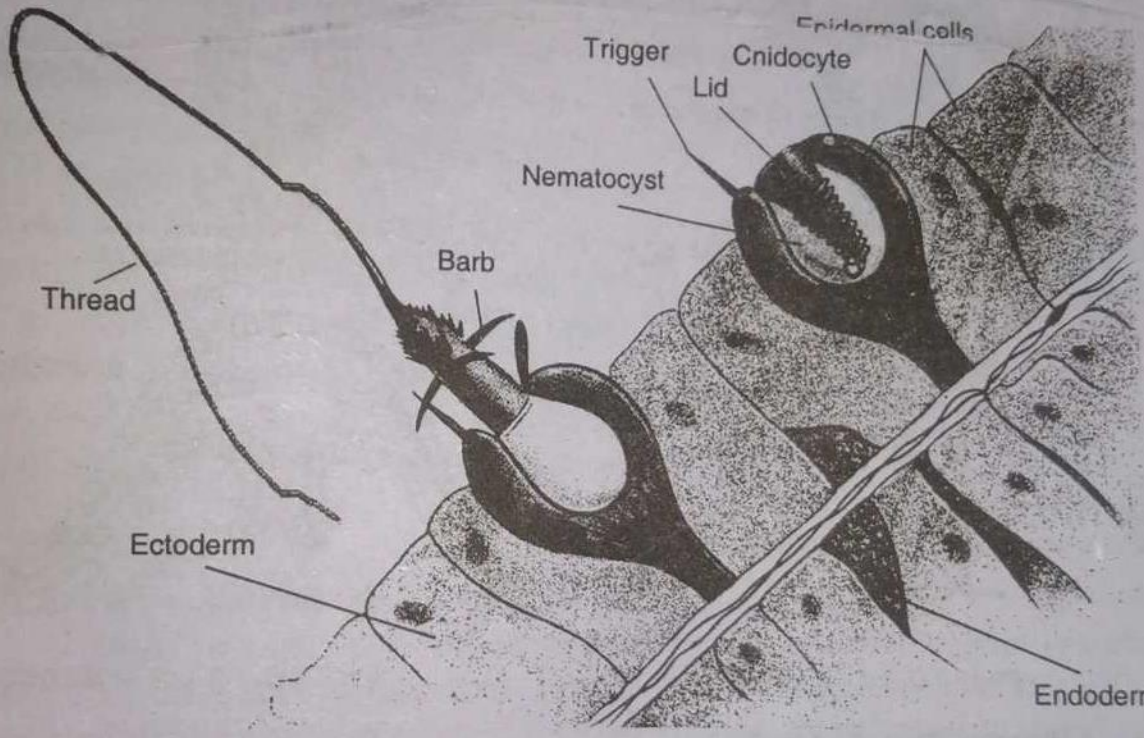


Fig. 10.13 Cnidocytes and Nematocysts

All cnidarians are carnivorous. They paralyse or kill their prey with the help of special stinging cells called ***cnidocytes*** (Fig. 10.13), hence the name cnidaria.

10.3.1 Diploblastic Organization:

Cnidarians are called diploblastic animals because their body wall is composed of two cellular layers, an outer ectoderm and an inner endoderm (Fig. 10.14). In between these two cellular layers is a plate of non-cellular gelatinous mass called ***mesogloea***. The cellular layers in cnidarians are more complex than those in porifera and consist of cells whose activities are co-ordinated to form tissues. Thus cnidaria are considered to have evolved to tissue grade of organization but lack true organs.

As a group cnidarians have two distinct body forms, ***Polyp*** and ***Medusa***. Polyps are cylindrical with mouth and tentacles situated at the upper end. Medusae, on the other hand are umbrella shaped whose mouth and tentacles are on the lower surface (Fig. 10.15). Hydra, Sea anemone and Corals occur only in polyp form being adapted to sessile life style whereas Jelly fish occurs only in medusa form and are adapted to a free-living, motile life style.

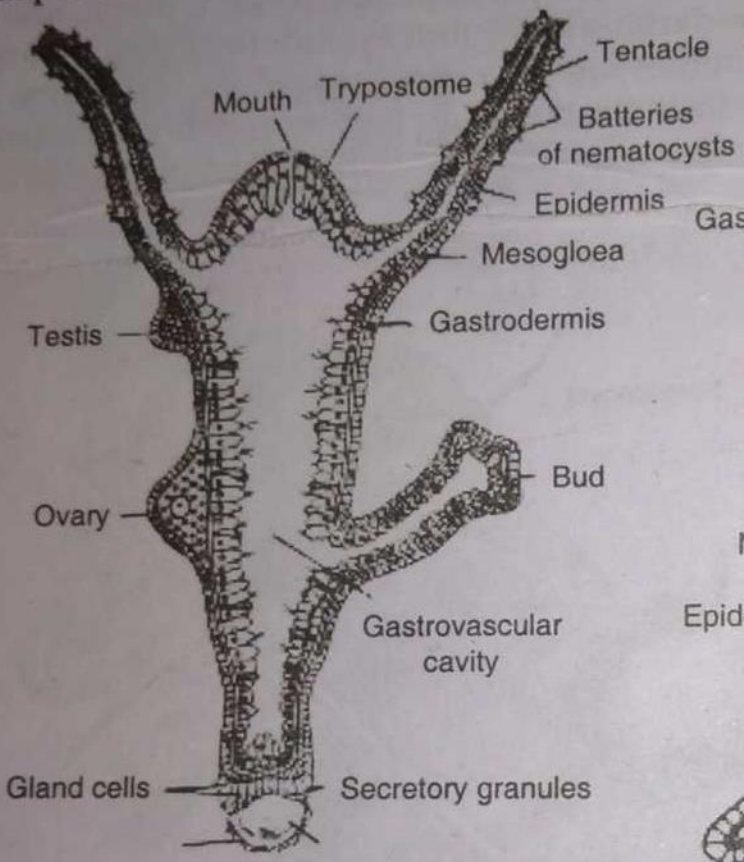


Fig. 10.14 **L.S of Hydra**

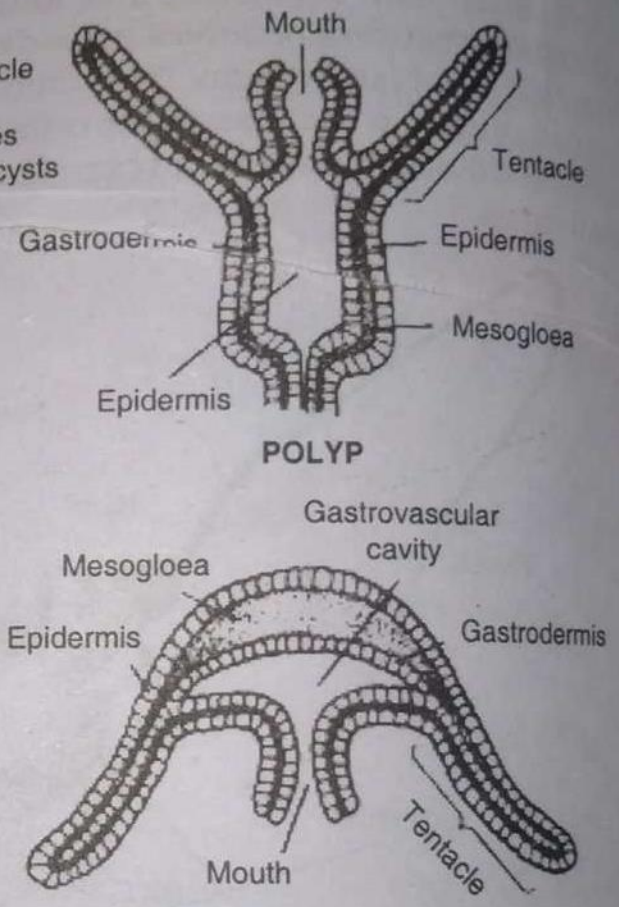
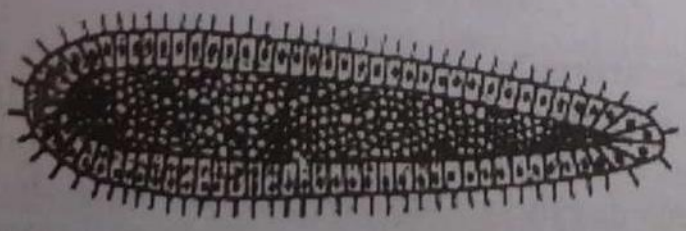


Fig. 10.15 **L.S of MEDUSA**

10.3.2 Alternation of Generation:

Some cnidarians alternate between two body types during their life cycles. In

Fig. 10.16 (a) Planula Larva



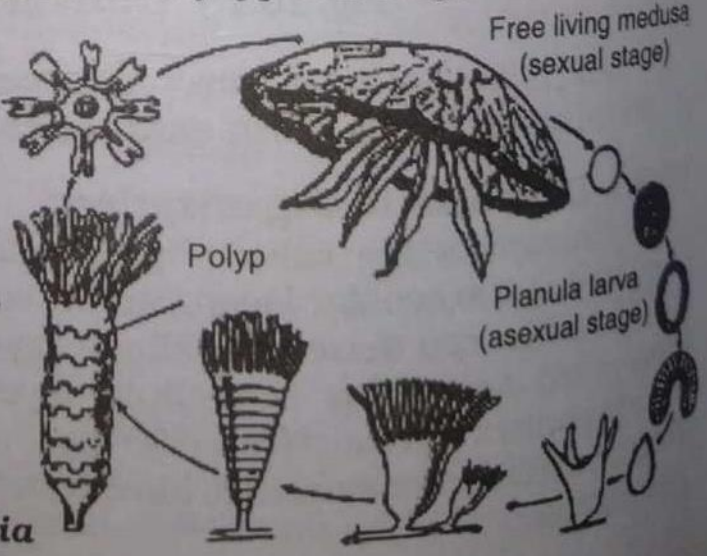


Fig. 10.16 (b) Life Cycle of Aurelia

these species the asexual polyp produces male or female medusae which as a result of sexual reproduction form zygote which transforms into a ***planula larva*** (Fig. 10.16-a) which eventually develops into a new asexual polyp. This phenomenon of producing asexual form by sexual form and vice versa is called ***Alternation of Generation*** (Fig. 10.16-b).

10.3.3 Polymorphism:

Many cnidarians live as a part of a large colony in which many individuals become physically attached to one another and occur in many different forms or zooids. These zooids are interdependent and perform special function for whole of the colony. This ensures an efficient division of labour. It is a common feature of hydrozoan colonies. The occurrance of a species in two or more structurally and functionally different kind of zooids is known as ***Polymorphism***. Physalia (Fig. 10.17) is a common example of a polymorphic colony in which many types of polypoid and medusoid forms live together, in a colony, and perform specific functions.

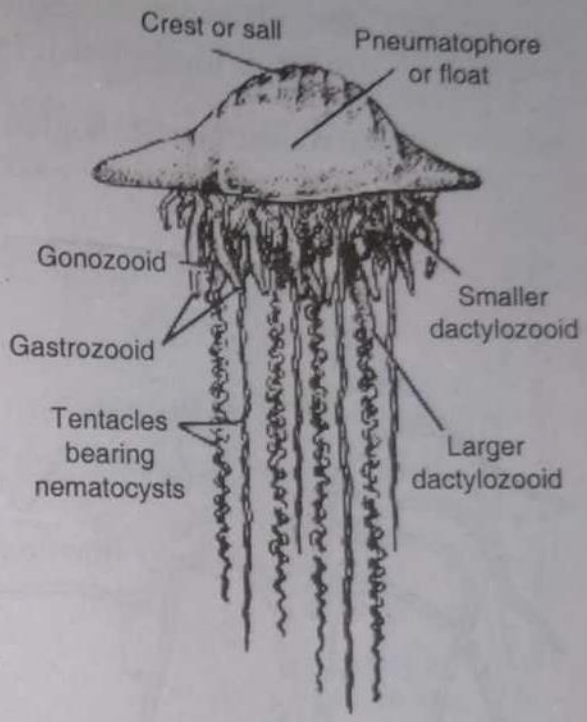


Fig. 10.17 Physalia (A colony)

10.3.4 Corals and Coral reefs:

Many polypoid cnidarians secrete certain chemicals which form a hard but dead protective covering around them. These coverings are of various shapes, sizes and chemical composition and are called ***corals***. ***Coral reefs*** are underwater lime-stone ridges near the surface of the sea. These are usually formed by the combined secretions of several species of coelenterates and other carbon precipitating protoctist organisms. Coral reefs which are usually restricted to warm shallow waters provide a heaven to a large number of marine species. ***Great Barrier Reef*** of Australia's eastern coast is spread over hundred of miles. Jewellery and other decorative items are carved from the red corals. Red coral by the name of 'MARJAN' is used by Hakeems in preparing eastern medicines.

10.3.5 Phylogeny:

Phylogenetically it is believed that the cnidarians have evolved along one of the three evolutionary lines from protoctista. No other phylum of animals is thought to have evolved from cnidaria.

There are following three classes based upon the dominnant phase.

i) ***Hydrozoa:*** Mesoglea noncellular, both polypoid and medusoid phases showing alternation of generation e.g. Hydra, Obelia, Physalia (portuguese man of war).

ii) ***Scyphozoa:*** Mesoglea cellular; predominatly medusoid e.g. Aurelia (Jelly fish). Polyp occurs during development.

iii) ***Anthozoa:*** Mesoglea fibrous, polpoids forms only e.g corals, sea-anemone.

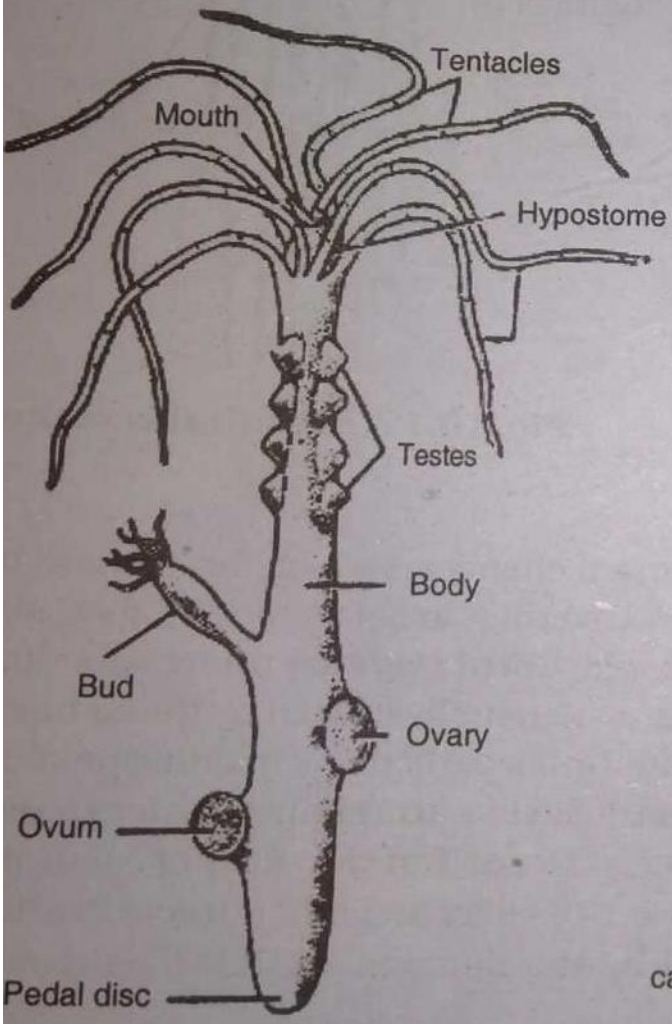


Fig. 10.18 Hydra

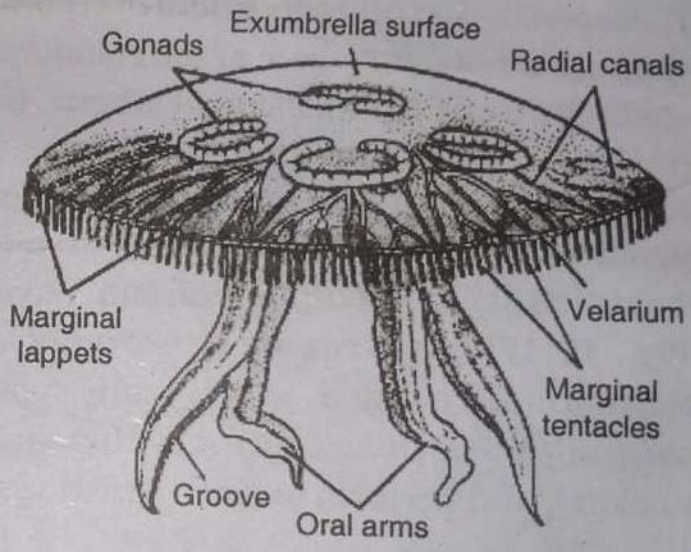


Fig. 10.19 Aurelia

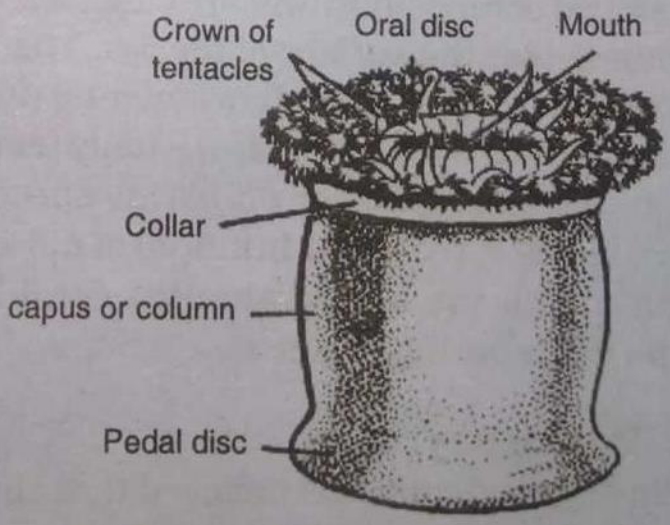


Fig. 10.20 Sea anemone

10.4 PHYLUM PLATYHELMINTHES (Flat worms)

There are found about 15000 species of Platyhelminthes. They are soft bodied flat or ribbon shaped worms thought to have evolved from a coelenterate like worm which resembled a planula larva. Of all the animals that have a head, platyhelminthes are the least complex. They have a mouth which opens into a gut but no anus. They are acoelomate, bilaterally symmetrical, triploblastic animals with organs and organ systems. They have a much branched intestine and a network of excretory tubule with a large number of ciliated protonephridia. These moving cilia look like a flickering flame hence called ***flame cells***. A rudimentary nervous system is also present whereas circulatory and respiratory systems are not needed hence absent.

Flat worm are mostly hermaphrodite with complex life cycles which may include many larval stages. They are mostly external or internal parasites of animals to which they remain attached by their special adhesive organs, the hooks and suckers (Fig. 10.21). These parasitic flat worms complete their life cycle in one or two hosts hence called ***Monogenic***, when one host is involved and ***Digenic***, when two animal hosts are involved.

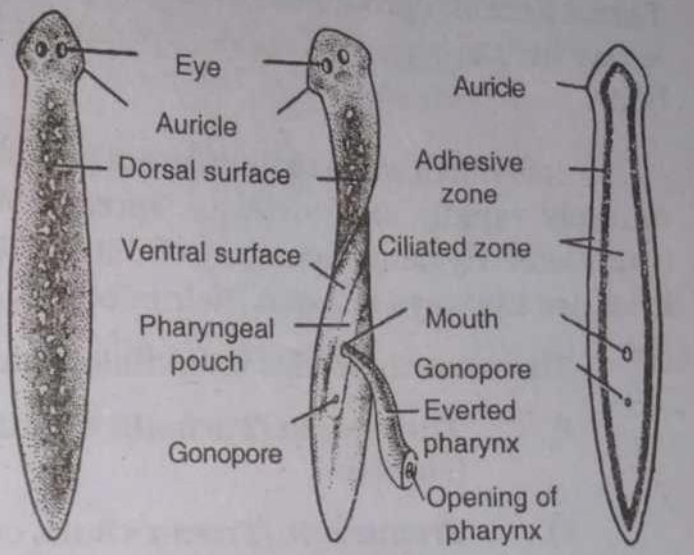


Fig. 10.21 Dugesia

Common examples of Platyhelminthes are ***Dugesia*** (Planaria Fig.10.21), ***Fasciola*** (Liver fluke Fig. 10.22) and ***Taenia saginata*** (Tape worm Fig. 10.23).

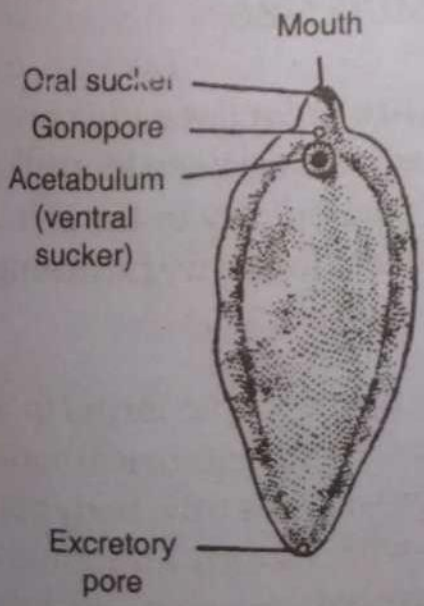


Fig. 10.22 Fasciola hepatica (Liver fluke)

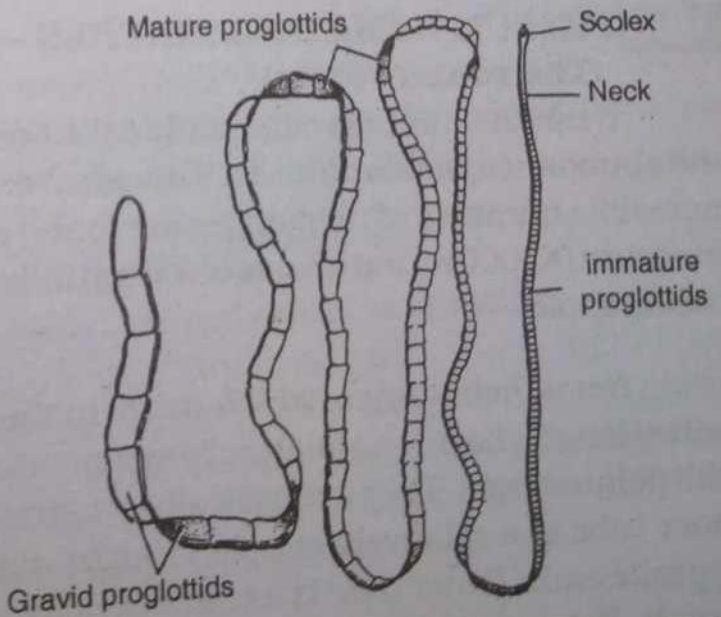


Fig. 10.23 Taenia saginata (Tape worm)

10.4.1 Parasitic Adaptations:

Platyhelminthes have developed a number of adaptations which made them suitable for their parasitic mode of life. Their thick body covers protect them against defence mechanisms of host body. The spines, suckers and hooks developed for attachment and have replaced the locomotory organs which are not needed by parasitic animals. Alimentary canal is reduced, even absent as in Taenia, because of the availability of digested food from host. Neurosensory organs are not developed due to their passive mode of life. Reproductive system is very much developed. In Taenia a set of reproductive organs is present in almost every segment. Fertility rate is very high to cope with chances of danger from the defence mechanism of the host body.

It is worth while to be aware of parasitic worms because they cause diseases, multiply rapidly and are wide spread. Many are spread due to poor sanitary conditions. Hygienic living, careful inspection of edibles and thorough cooking of meat are the ways to avoid their infection.

There are three classes in this phylum, according to their mode of living.

i) ***Turbelaria (Turbella = A little sting):*** Free living, e.g.Dugesia (Planaria).

ii) ***Trematoda (Trema = hole, cavity of sucker):*** Ecto or endoparasites; alimentary canal bifurcated. e.g. Fasciola hepatica (sheep liver - fluke).

iii) ***Cestoda (Kestos = ribbon, eidos = like):*** Exclusively endo parasite; alimentary canal absent, body ribbon shaped e.g.Taenia saginata (Beef tape - worm).

10.5 PHYLUM NEMATHELMINTHES — ASCHELMINTHES (The roundworms):

Nemathelminthes commonly called round worms are the most wide spread and abundant animals on earth. Though about 20,000 species have been identified. incredible numbers of nematodes are found every where particularly in the soil. In one count 90,000 round worms of several different species were found within a single rotting apple.

Nemathelminthes, which range in their size, from microscopic forms to a 9 meters length, have long bilaterally symmetrical, triploblastic and cylindrical bodies with pointed ends. They are basically constructed as a tube within a tube body plan. Inner tube is a relatively simple straight digestive tract with mouth and anus at opposite ends. Outer tube is a complex body wall being covered over by a non-living cuticle. Between the tubes is a fluid filled body cavity, the pseudocoel.

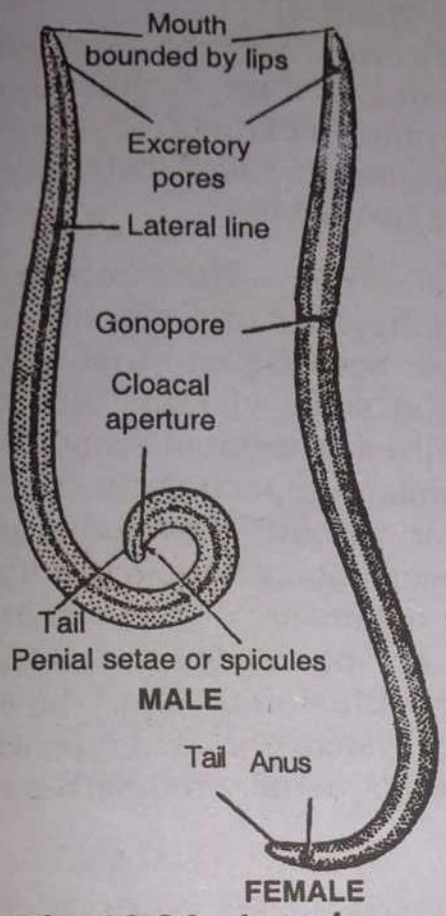


Fig. 10.24 Ascaris

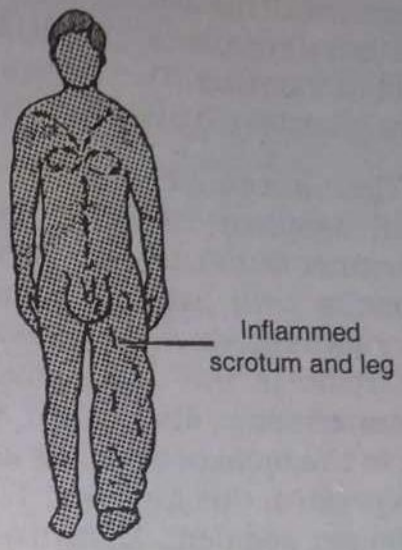


Fig. 10.25
Elephantiasis

Round worms have a varied mode of existence from free living scavengers to predators and parasitic on animals and even plants. At least 50 different species of round worms can inhabit the human body. Millions of human beings in the world are infected with **Ascaris** (Fig. 10.24) alone. It is the most common human round worm and lives as an endoparasite in the intestine of man. They, like other nematodes, are sexually dimorphic, males being shorter than females. Enormous number of eggs are produced by females. Their eggs containing the developing embryo enter the human body with contaminated food or water.

A female Ascaris may produce as many as 2,00,000 eggs every day.

The thread worm like ***Wuchereria*** transmitted by blood sucking mosquitoes inhabit the lymphatic vessels of many animals including man where it produces a disease called ***Filariasis*** causing excessive inflammation of legs, arms and scrotum a condition called ***Elephantiasis*** (Fig. 10.25). Another common nematode parasite **Ancylostoma,** the Hook worm whose larva can penetrate through the skin of man to reach the intestine where it matures and sucks the blood.

10.6 PHYLUM ANNELIDA (Segmented Worms)

Annelida, commonly called segmented worms, have the most complex body structures of all the worms. They are distinguished by their ring like (Annulus: little ring) external segments. They look like a large number of rings put on and arranged one behind the other. These rings or external segments, called metameres, coincide with the internal partitions called *septa* of the body cavity.

There are about 15000 species of annelida known. They are all triploblastic, bilaterally symmetrical coelomates with an organ system level of body organization. Their segmentation is said to be metameric because external segmentation corresponds with internal segmentation and some of their organs such as excretory and reproductive organs are repeated in each segment. Another important characteristic is the development of coelomic compartments in their body. Chitinous chaetae also called setae with or without parapodia are usually present in the most of annelids and help in locomotion whereas in some annelids suckers perform this function. The excretory organs are a pair or more, tubular nephridia per segment. Digestive, excretory, nervous and reproductive systems are well developed. Respiration takes place by diffusion through the moist skin. Annelida is the first group to have a circulatory system of closed type with definite blood vessels and many pulsatile hearts. Blood is usually red with haemoglobin dissolved in it.

Annelids live on land, in moist soil, in fresh water or in sea. Many annelids are active free swimming predators, some are aquatic filter feeder living in tubes burried in mud whereas leeches are ectoparasites and suck the blood of their host. There are also many type of burrowing forms called the earthworms, which feed upon dead organic matter.

Polychaetes, the most ancient annelids, are supposed to have evolved from a primitive flat worm like ancestor in the sea. Oligochaetes evolved from polychaetes whereas leeches evolved from oligochaetes.

Phylum Annelida is divided into three classes mainly on the basis of number and type of setae.

Class Polychaeta (With many setae):

Polychaetes are usually free living active swimmers or sedentary filter feeding tubuculous forms. They are mostly marine having a pair of lateral flap like fleshy lobes the parapodia on each segment of the body. Each parapodium has a bundle of bristles called setae or chaetae. Sexes are usually separate. Development passes through a ***Trochophore*** larval stage. Common examples are Sabella (Peacock worm) and Nereis (Clam worm) (Fig. 10.26).

Class Oligochaeta (Few Setae):

Oligochaeta are usually terrestrial, free living, burrowing forms without

parapodia but with a few setae per segment arranged in a ring. All are hermaphrodite. Common example is **Pheretima** the common earthworm (Fig. 10.27).

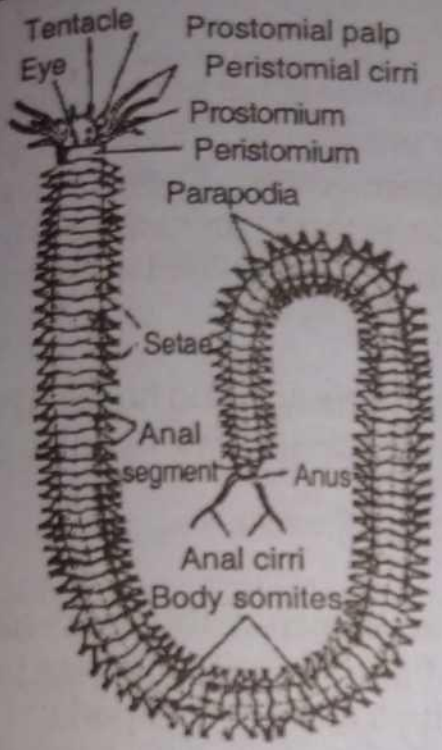


Fig. 10.26 Nereis

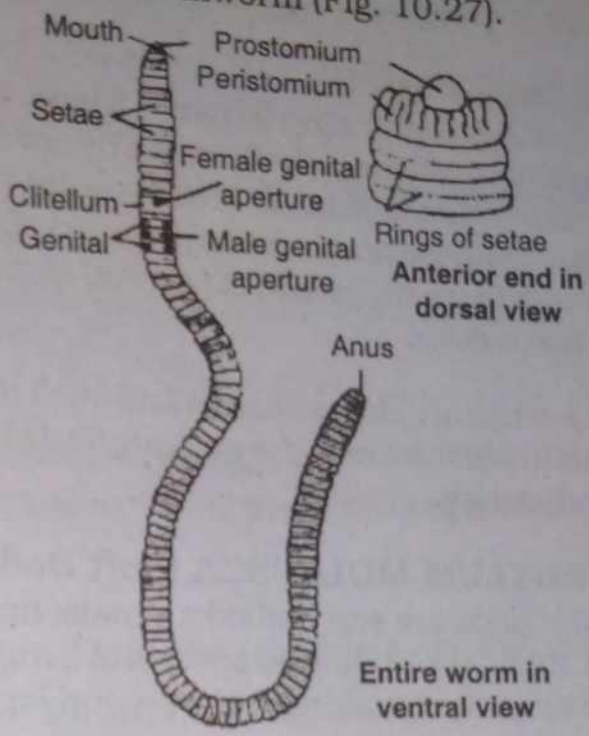


Fig. 10.27 Pheretima

Class Hirudinea (Leeches):

This group of annelids includes the leeches, in which setae and parapodia both are absent instead an anterior and a posterior suckers are present for blood sucking and attachment. Some are free living predator whereas others are ectoparasite of verte-brates and invertebrates. They live usually in fresh water and are all hermaphrodite. Common example is **Hirudinaria** (Fig. 10.28) the common Indian leech.

> A substance in a leech's saliva called hirudin prevents blood from clotting.

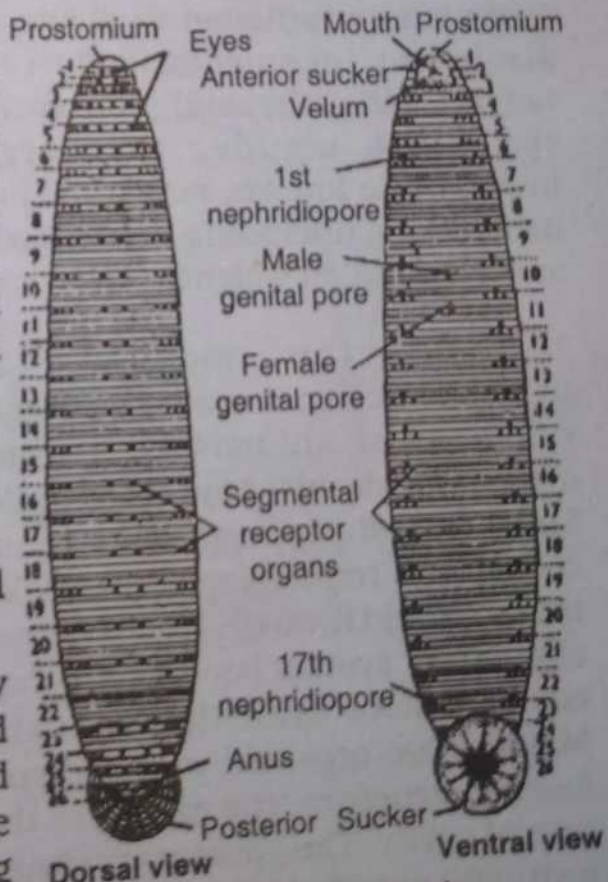


Fig. 10.28 Hirudinaria (Leech) — External features

10.6.1 Advantages of Segmentation and Coelom:

Segmentation increases flexibility allowing various parts of the body to bend independently of the other parts. Increased flexibility enhances locomotory power. The coelom improves swimming or burrowing activities of the annelids by serving as a hydrostatic skeleton. In many annelids coelom

collects metabolic wastes discharged by excretory organs. It also provides space for maturation of eggs and sperms.

10.6.2 Importance:

Earth-worms being farmer is friend, are one of the most beneficial animals for the mankind. They help the farmers by continuously ploughing the soil and adding nitrogenous wastes into it, thus making the soil more fertile. They are used by Chinese, Japanese and Indians in preparation of various fancy medicines. They are also used as fish bait, as food of fish and also in laboratories for dissections and other research activities.

Leeches are ectoparasites and suck the blood of their aquatic hosts. They are also used in remote areas, for sucking foul blood from a patient. A few are also carrier of some diseases.

10.7 PHYLUM MOLLUSCA (Soft Bodied)

Mollusca are soft bodied animals; most have an external and some have an internal shell. About 50,000 species of living and 35,000 of fossil mollusca have so far been described making it the second largest phylum after Arthropoda.

As a group mollusca underwent one of the most remarkable of animal evolutionary radiation in shape and also in size. The smallest molluscs are not bigger than the sand grain whereas the giant squids, the largest invertebrate known, may grow to 18 meters long (including the tentacles) and 1800 Kg. in weight.

All the molluscs are triploblastic, coelomate, bilaterally symmetrical animals with organ-system grade of body organization. They are mostly unsegmented. Though coelom has reduced to a few pockets the large fluid filled cavities of the open circulatory system become the major component of hydrostatic skeleton. Majority are provided with a rasping feeding structure, the radula in their buccal cavity. The alimentary canal is a straight or coiled tube, with a mouth and anus at the opposite ends.

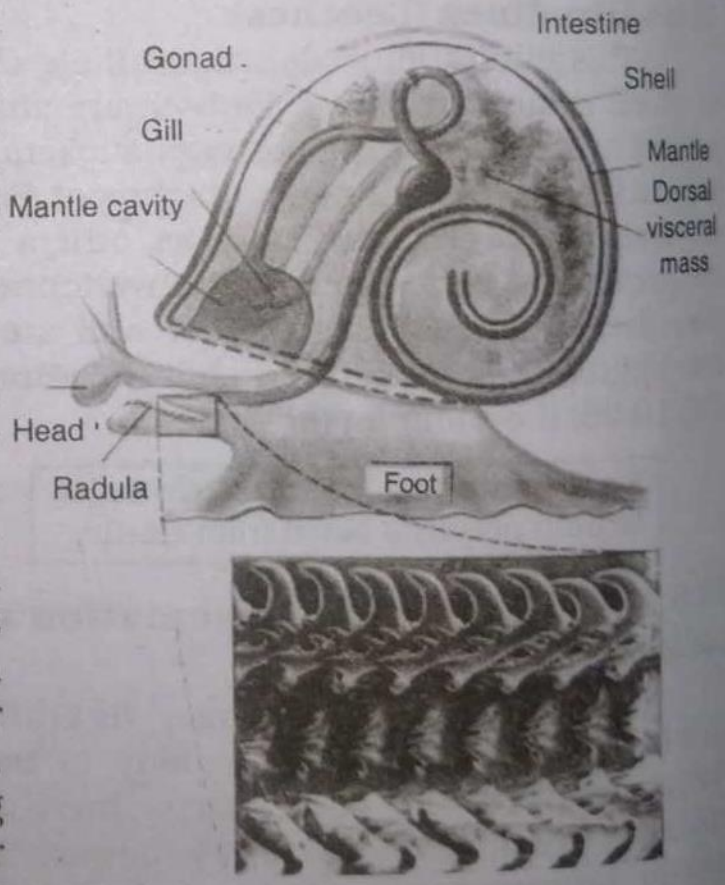


Fig. 10.29 A generalized Mollusc showing basic characters

Excretory and nervous systems are also well developed. Respiration takes place by gills in aquatic form and by a rudimentary lung in terrestrial forms.

Though molluscs have most varied body forms yet they share at least three common characters (Fig. 10.29).

(i) A head-foot portion primarily concerned with sensation, feeding and locomotion.
(ii) A dorsal visceral mass that includes the major organs.
(iii) A mantle, which is a fold of delicate tissue, surrounding the entire body.

In most of the molluscs sexes are separate and fertilization takes place in water. They all pass through a ***trochophore*** larva stage. As the animals of phylum annelida also have a trochophore larval stage it is believed that segmented worms and molluscs are related.

Although phylum mollusca is usually divided into six classes; Monoplacophora, Amphineura, Scaphopoda, Gastropoda, Bivalvia and Cephalopoda, only the last three classes will be discussed here.

Class Gastropoda (Foot on visceral mass):

This is the largest class of mollusca which includes whelks, snails and slugs. They are mostly marine, though some live in fresh water and still others are terrestrial. Many of them become, secondarily, asymmetrical by the twisting of visceral mass at 180° by a phenomenon called ***torsion***. They have a prominent head and a broad muscular foot developed on the visceral mass. External shell may be present or absent, whenever present it is usually spirally coiled e.g. Pila (Fig. 10.30).

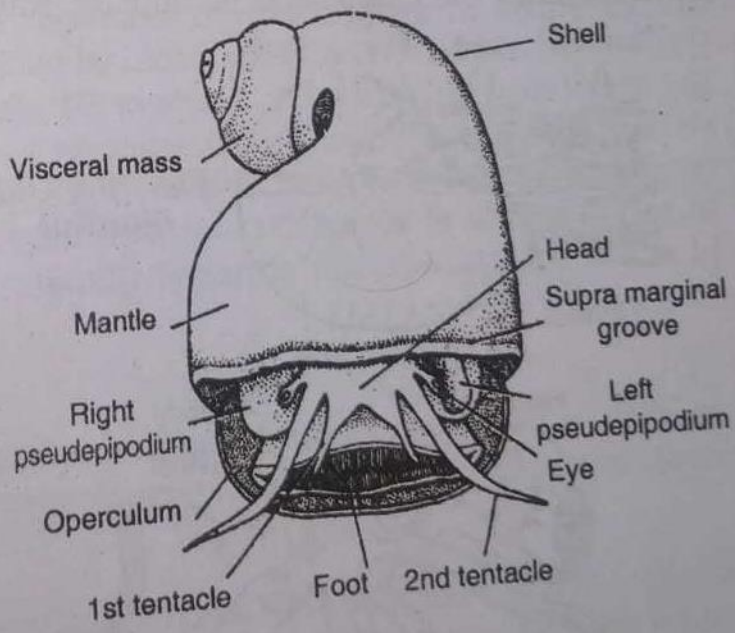


Fig. 10.30 Pila

Class Bivalvia (Shell with 2 halves):

This group is the second largest class of phylum Mollusca. They are called ***Bivalvia*** because their bodies are enclosed in a shell which consists of a right and a left piece. These pieces called valves are movably hinged together. The muscular foot is ventral and laterally compressed suited for creeping and burrowing in the soft mud or sand. Bivalves are both marine and fresh water forms. Common examples of this class are Unio (Fig. 10.31-a), Mytilus and Pearl Oysters (Fig. 10.31-b).

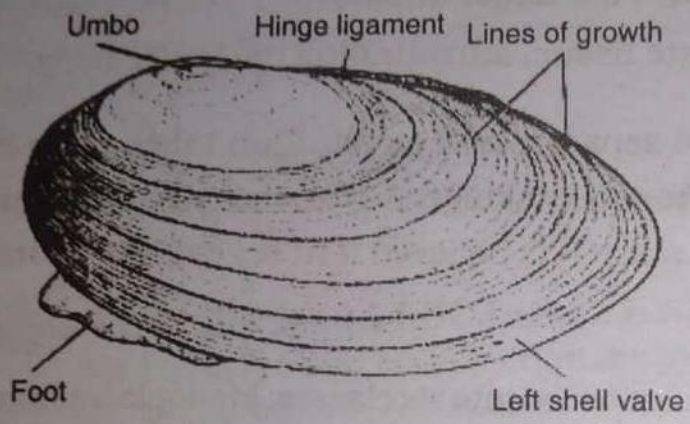


Fig. 10.31 (a) Unio

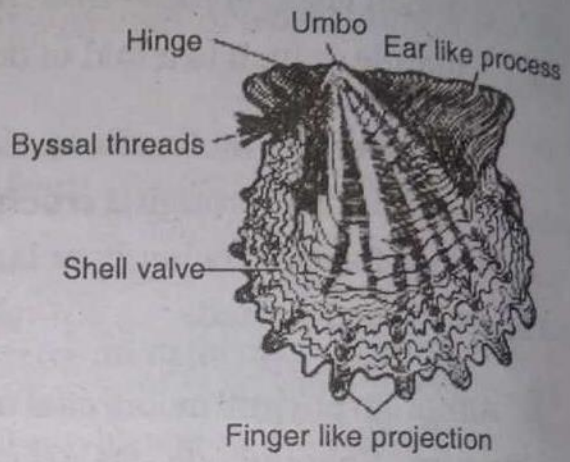


Fig. 10.31 (b) Pearl Oyster

Class Cephalopoda (Foot on the head):

Cephalopods are all marine and exhibit a high degree of development. Foot in cephalopods is transformed into suckers bearing tentacles and arms. It is present in a ring around the mouth. Nautilus, Sepia (cuttle fish), Loligo (Squids) and Octopus (devil fish) are the common cephalopods. Nautilus (Fig. 10.32-a) has an external

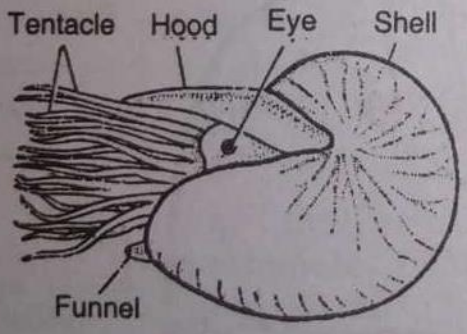


Fig. 10.32 (a) Nautilus

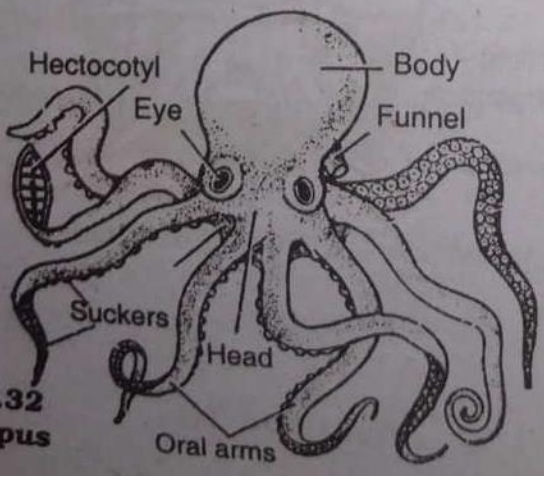
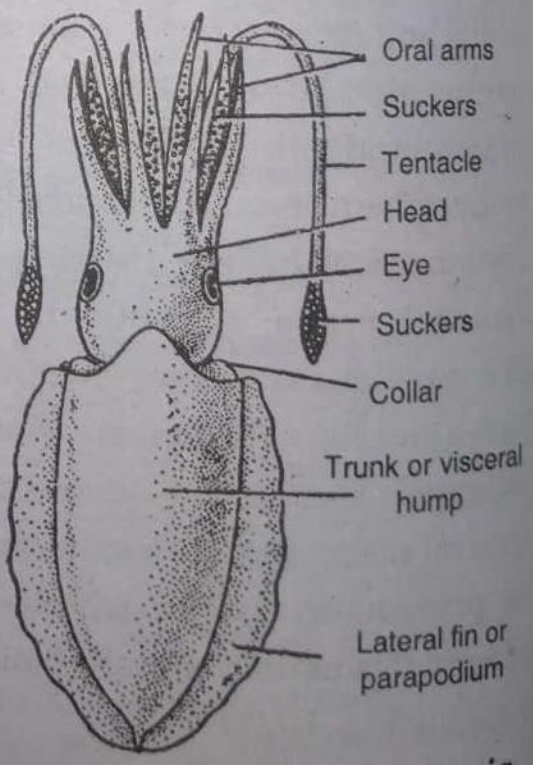


Fig. 10.32 (c) Octopus



shell, Sepia (Fig. 10.32-b) and Loligo have developed an internal one whereas Octopus (Fig. 10.32-c) has none.

Squids are the largest invertebrates.

10.7.1 Economic Importance:

Since the earliest recorded time molluscs have been used by human beings. They are important in palaentological studies and as index fossils to underlying oil deposits. A variety of molluscs called shell fish, together with crustaceans, are still an important source of food. Their shells are decorative and their inner lustrous layer which is a mixture of calcium carbonate and proteins is called ***Necre*** or mother of pearl. In some bivalve molluscs, called ***Pearl Oyster***, concentric layer of necre are deposited around any foreign particle that comes to lie between the mantle and the shell. This particle transforms into the most beautiful and precious jewellery item, the pearl. Pearl culture industry is being successfully run in Japan and China by artificially introducing the fragment of man made particles, of a variety of shapes, in pearl oysters.

10.8 PHYLUM ARTHROPODA (Jointed legs)

Arthropoda is the largest phylum of the animal kingdom, and includes about one million species. They are found everywhere on the earth wherever the life is possible, even in the oil wells. Arthropods are bilaterally symmetrical, triploblastic and metamerically segmented animals. The bodies of the most of arthropods are divided into a head, a thorax and an abdomen. Coelomic space in arthropoda is called ***haemocoel*** because it is occupied by blood sinuses of the open circulatory system. Respiration takes place through gills in aquatic forms, by tracheae in insects and by book-lungs in scorpions. Alimentary canal is well developed and assisted by jaws. Excretory organs are mostly malpighian tubules. Nervous system is developed and of annelidan type. Compound eyes with mosaic vision is also a factor of advantage in arthropods. Sexes are usually separate and metamorphosis is of common occurrence.

10.8.1 Metamorphosis:

It is a set of changes which transforms a larva into its developed adult form. A larva is a creature which in some animals, comes out of the egg in an immature and undeveloped stage.

Metamorphosis is said to be ***complete*** when a larva hatches out of the egg and develops into a resting stage the ***pupa*** which in turn transforms into an adult. ***Incomplete metamorphosis***, on the other hand is that in which a tiny, immature but adult like creature called ***nymph*** comes out of the egg and grows directly, into an adult.

10.8.2 Advantages of exoskeleton, jointed appendages and wings:

A significant advancement in this group is their jointed appendages, hence the name Arthropoda. These appendages serve many functions which include walking, swimming, food capture, copulation and sensory perceptions.

Another important features of Arthropoda is their exoskeleton which covers, externally, whole of the body and appendages. This exoskeleton is water proof and made up of chitin. It is non-living and as the animal outgrows it is shed and a new one is formed. This mechanism of regular changing over of exoskeleton and formation of the new one is called ***Moulting*** or ***Ecdysis***.

The evolution of exoskeleton and jointed legs are the most important features which made the distribution of arthropods that much diversified so as to make them the most successful group of animals. Exoskeleton not only protects the body organs but also provides sites for muscle attachment which together with the advantage of developed jointed appendages resulted in efficient swimming in water and running on land. Further more the development of wings made possible their invasion into the atmosphere (Fig. 10.33).

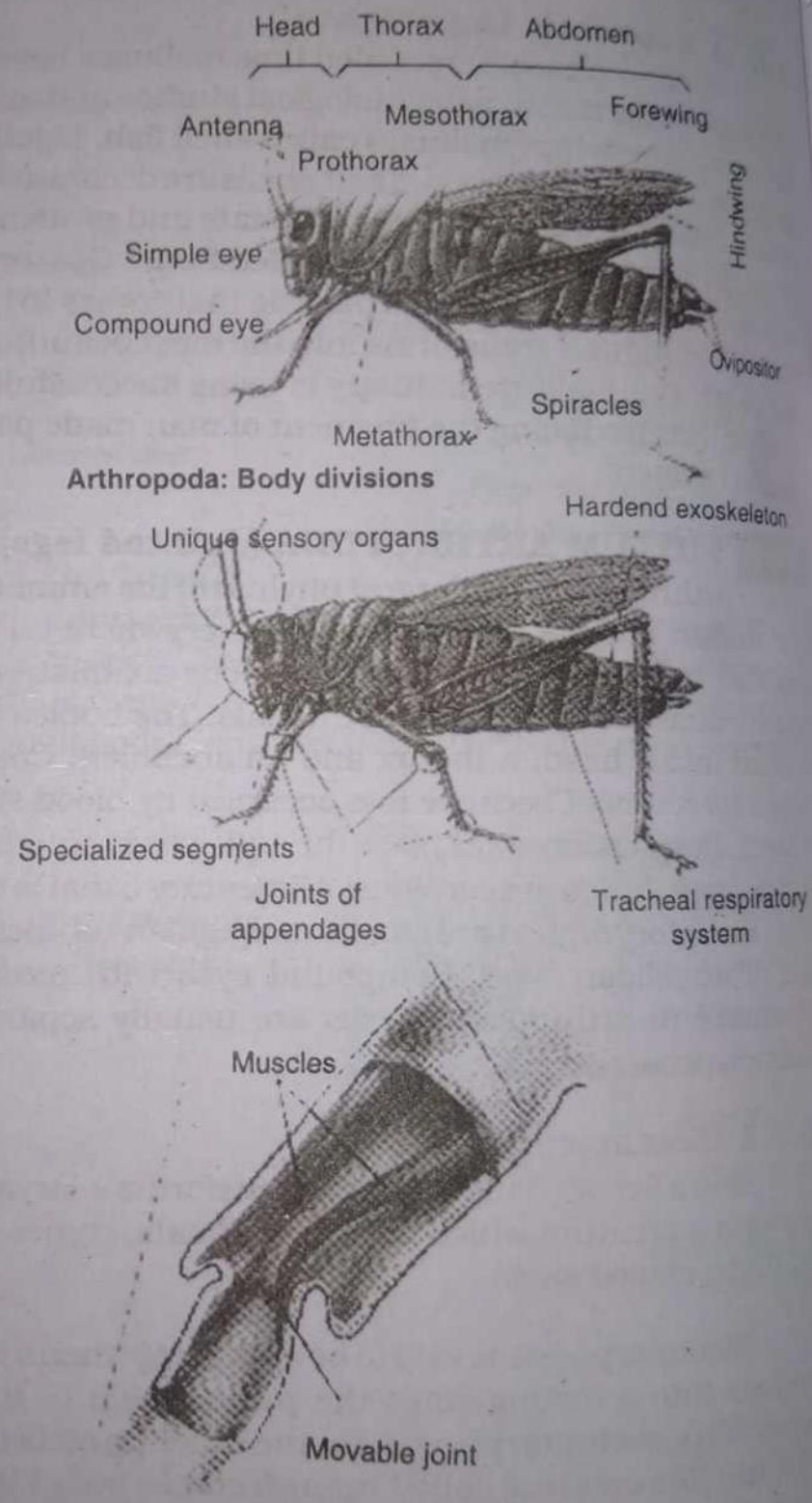
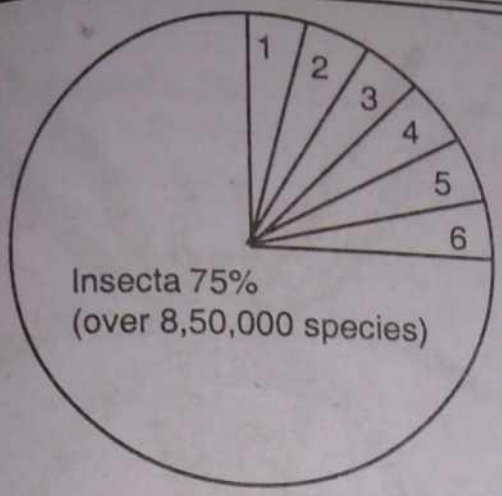


Fig. 10.33 The arthropod body plan

Arthropoda has the largest kinds of animals but Nematoda has the largest number.



1.	Other Arthropoda	8.0%
2.	Chordata	4.0%
3.	Echinodermata	0.5%
4.	Mollusca	8.0%
5.	All Worms	3.0%
	Annelida	0.75%
	Nematoda	1.5%
	Platyhelminthes	0.75%
6.	Porifera and cnidaria	1.5%

About 80% of the animal species are arthropods and 90% of the arthropods are insects.

10.8.3 Economics Importance:

Arthropods are of great economic importance. The predominant group of arthropoda, the insects, not only helps in pollination but also predates on plant pest. Many cause diseases, in plant and animals, by transmitting bacteria and viruses. In human beings they are responsible for the transmission of ***Trypanosoma, Plasmodium*** and **germs of cholera** etc. Arthropods are an important source of food for many animals and carnivorous plants. Sea food, that is not fish or mollusc, is generally arthropods. Farming of honey bees called ***apiculture*** and those of silk worms called ***sericulture*** are being carried out at a large scale and are of great economic importance to mankind. Phylum Arthropoda is divided into following five classes.

Class Merostomata (mouth plates):

It is a small group of marine arthropods in which mouth is surrounded by many small plates. It includes ***Limulus*** (Fig. 10.34) the King Crab which is considered a living fossil.

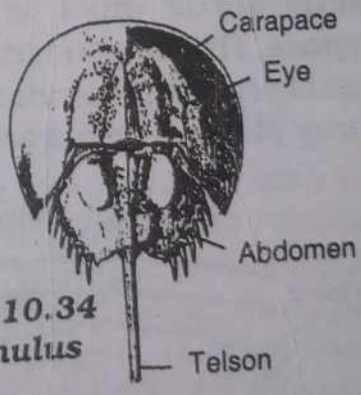


Fig. 10.34 Limulus

Class Arachnida (spider like):

It is a group of terrestrial arthropods with four pairs of walking legs. They respire by the help of book lungs, tracheae or general body surface. The most well known examples are scorpions (Fig. 10.35-a). They are comparatively large and possess a sting at the end of their narrow segmented posterior abdomen. The largest number of species of arachnids are spiders (Fig. 10.35-b). They are predators. They possess silk glands which secrete a protein that on exposure to air forms silk threads used in building nest and webs for trapping the preys.

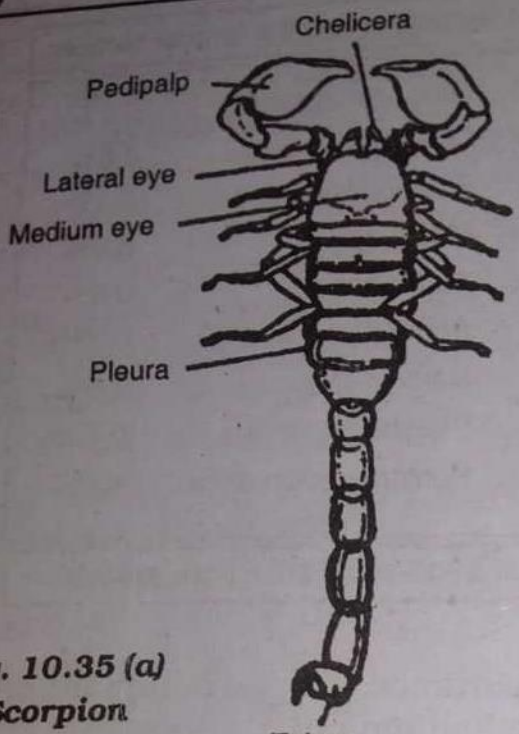


Fig. 10.35 (a) Scorpion

Fig. 10.35 (b) Spider

Class Crustacea (with carpaee):

Prawns, shrimps, lobsters, crabs and many other arthropods belong to this class. They are marine, fresh water and even terrestrial creatures. Crustaceans possess two pairs of antennae, a pair of mandibles and two pairs of maxillae around their mouth. The body is divided into head, thorax and abdomen. In many cases, e.g. prawn (Fig. 10.36-a), crab (Fig. 10.36-b), head and thorax become fused to form ***cephalothorax*** which is covered over by a single plate of exoskeleton called ***carapace***. Their appendages are modified for walking, swimming, feeding, respiration and as accessory respiratory structures. There are usually five pairs of walking legs. Majority of crustaceans are free living whereas a few e.g. ***Sacculina*** are parasite.

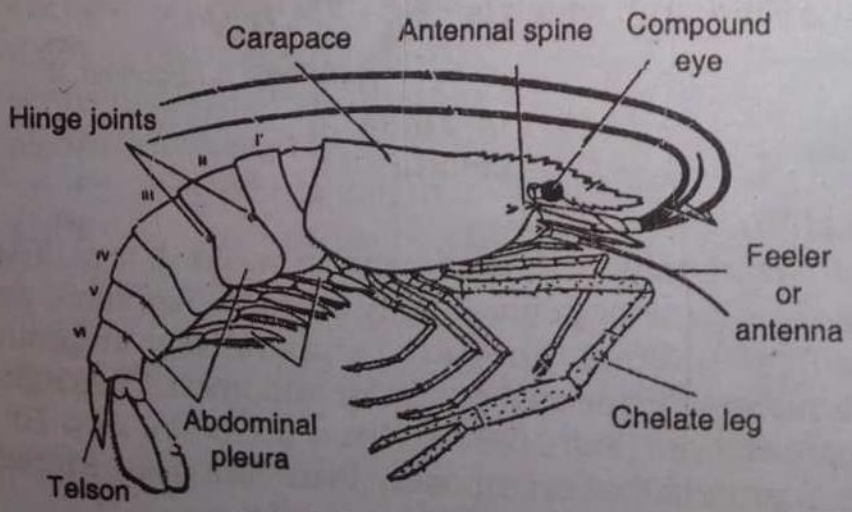


Fig. 10.36 (a) Prawn

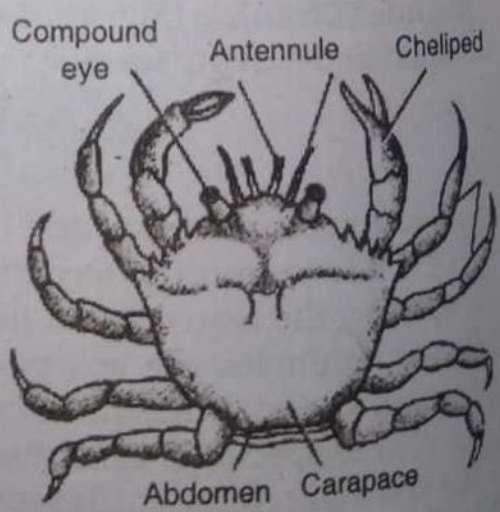


Fig. 10.36 (b) Crab

Daphnia and cyclops are the common microscopic fresh water forms. Economically important crustaceans being used as food are prawns, shrimps and lobsters.

Class Myriapoda (many legs):

These are terrestrial arthropods leading a hidden life in the soil. Their body consists of a head and a very long trunk consisting of many similar segments. The head bears a pair of antennae and trunk is provided with paired lateral appendages. This class includes Centipedes (Fig. 10.37-a) with one pair and Millipede (Fig. 10.37-b) with two pairs of appendages per segment.

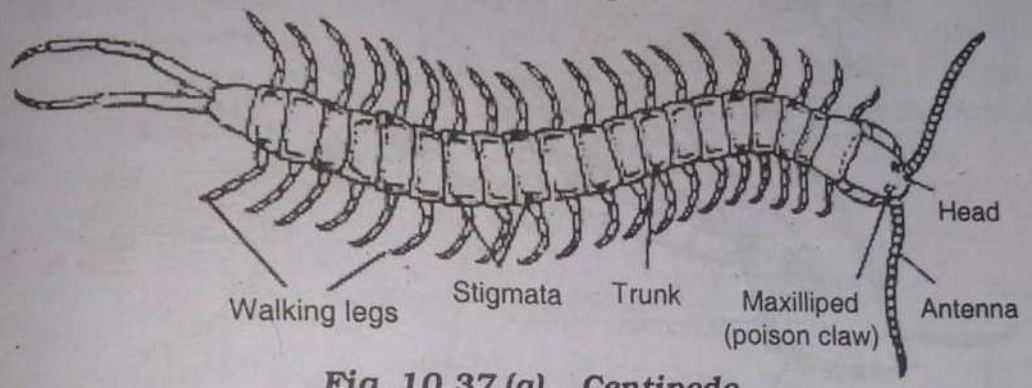


Fig. 10.37 (a) Centipede

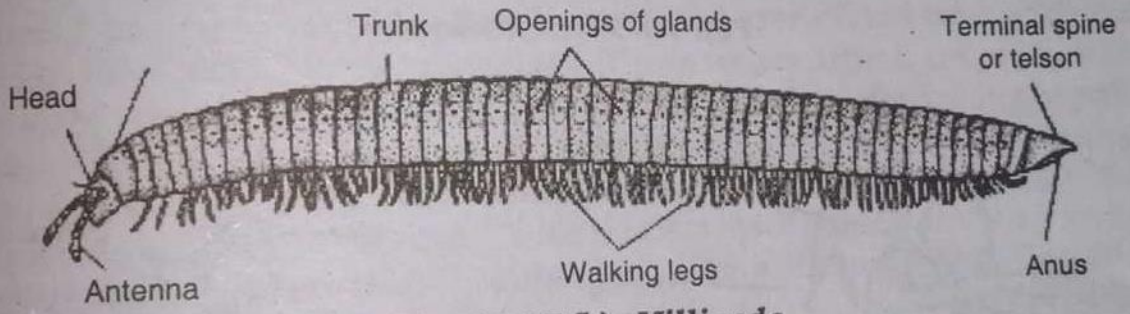


Fig. 10.37 (b) Millipede

Class Insecta or Hexapoda (six legs):

This is the largest class of the animal kingdom. It includes more than 90% of the arthropod species. Members of this large group are called insects and their study is called ***entomology***. Insect body is divided into head, thorax and abdomen. This class is also called Hexapoda because they possess on their thorax three pairs of walking legs. They are found in all types of habitats but majority are terrestrial. The success of insects can partly be attributed to the development of flight. In flying insects one or two pairs of wings develop dorsally on thorax. The group of insects with wings is called ***Pterygota*** whereas the group without wings is called ***Apterygota***. A pair of antennae on head is also a characteristic of insects. Insects have developed many types of specialized mouth parts to suit their mode of feeding. They may be **biting and chewing** type as in cockroach, **piercing and sucking** type as in mosquito, **chewing and lapping** type as in honey bee, **sponging** type as in house fly and **siphoning** type as in butter fly. They mostly lead an independent life; a few ants, termites and honey bees live in large colonies, with a marked division of labour, and are called **social**

insects. Flies and mosquitoes (Fig. 10.38-a) are involved in transmission of many diseases e.g cholera, dysentery and malaria. Fleas are ectoparasite on many warm blooded animals whereas rat fleas are involved in the transmission of a deadly human disease the Plague. Grasshoppers, moths, butter flies and beetles are regarded as pest of plants. Cockroaches (Fig. 10.38-b) are very common in warm damp places including our kitchens and bath rooms whereas silver fish (Fig. 10.38-c), actually an insect, is found in the book shelves.

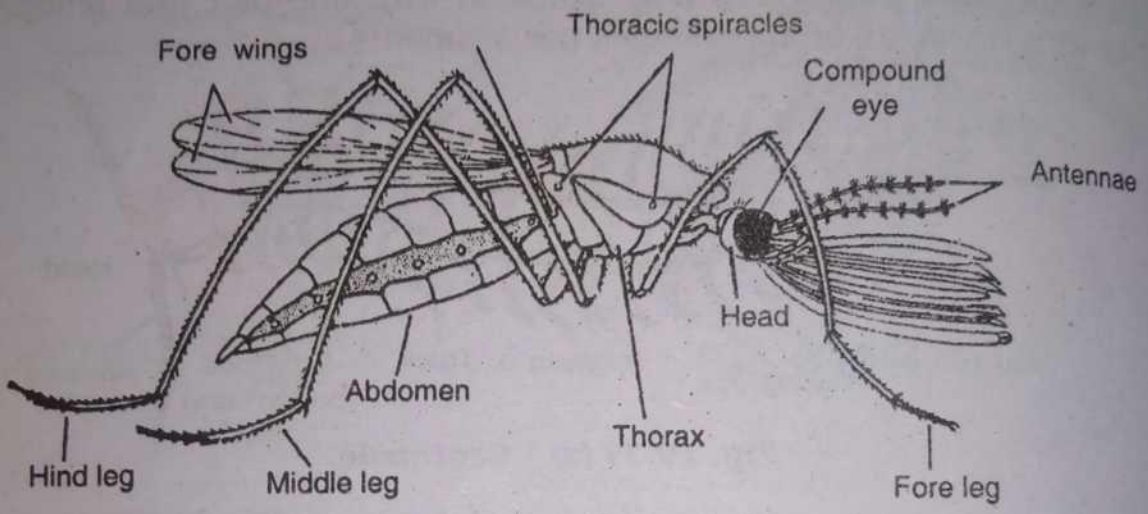


Fig. 10.38 (a) Mosquito

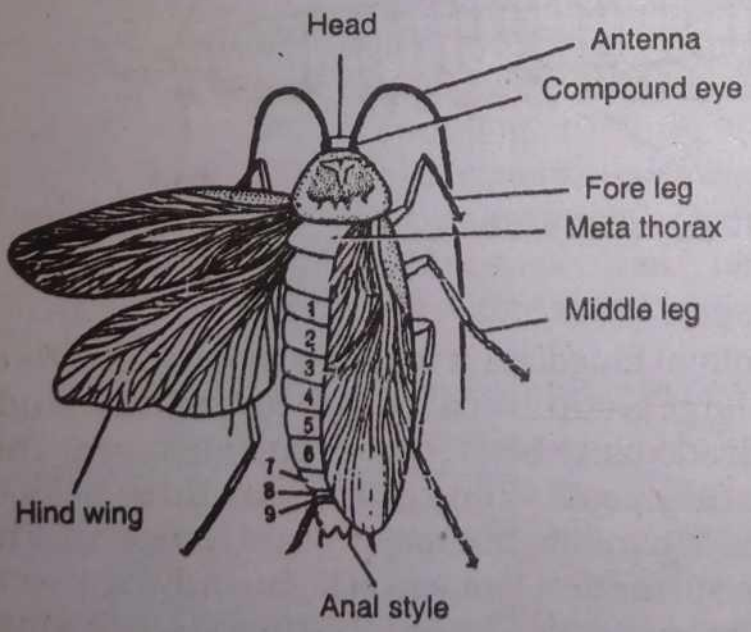


Fig. 10.38 (b) Cockroach

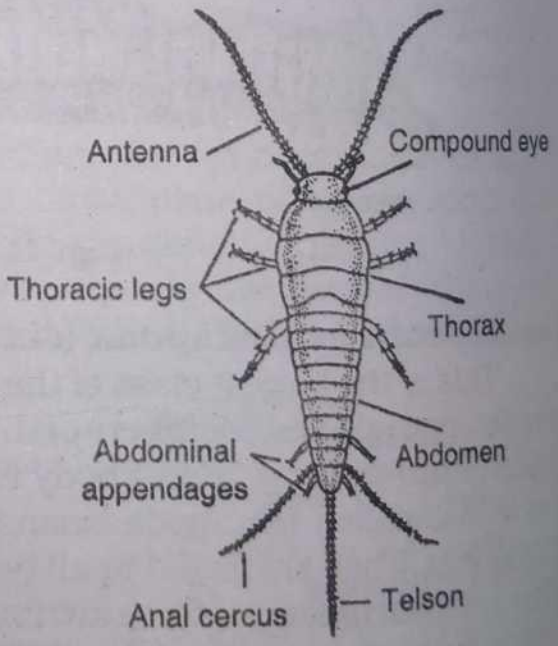


Fig. 10.38 (c) Silver fish

10.8.4 Insects — a successful group:

Insects are found everywhere in the world from low land upto the tops of Himalaya and from hot springs to Antaratican temp: of — 65°C. They are even found in the oil wells. This great diversity of habitats has become possible due to various structural and physiological modifications and social adaptations the insects have

undergone. Structural modifications include developed brain and sense organs, developed mouth parts in accordance with the requirements of food available, a protective exoskeleton, development of wings and jointed appendages. Physiological modifications include the production of a variety of digestive enzymes, high reproductive potential and metamorphosis which have collectively increased their chances of survival even in the extreme environments. As social insects, they live in a co-ordinated society which increases the adaptability to the environment and enhances the chances of their survival.

10.9 PHYLUM ECHINODERMATA (Spiny Skinned)

Echinodermata is a group of about 6000 species of exclusively marine animals. They begin their lives as free swimming bilaterally symmetrical larvae but as adults they have radially symmetrical bodies. As the bodies of most of the echinoderms have five symmetrically radiating parts or arms they are referred to as Pentaradial (Pentamerous).

None of the Echinoderms lives out of the sea.

Adult echinoderms though lack head, brain and segmentation; are triploblastic, coelomate deuterostomes with organ-system grade of body organization. The body is covered over by a delicate epidermis stretched over a firm endoskeleton of fixed or movable calcareous plates with spines. These spines, which are present all over the body may be long as in Sea Urchin or short as in sand dollars. These spines are the characteristic of this group and inspired the name Echinodermata. The calcareous plates covering the body are perforated over certain areas through which special organs the tube feet project out. These thousands of **tube feet** are a part of a unique **water vascular system** (Fig. 10.39) which is also a characteristic of echinodermata.

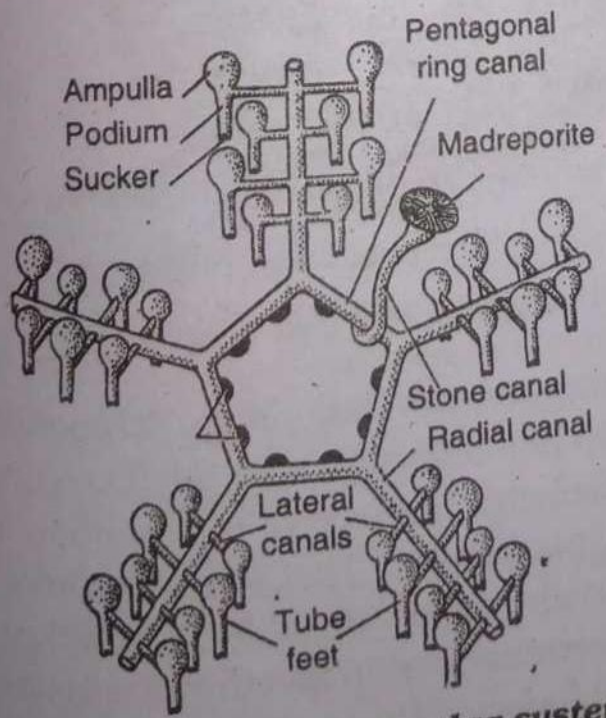


Fig. 10.39 Water vascular system

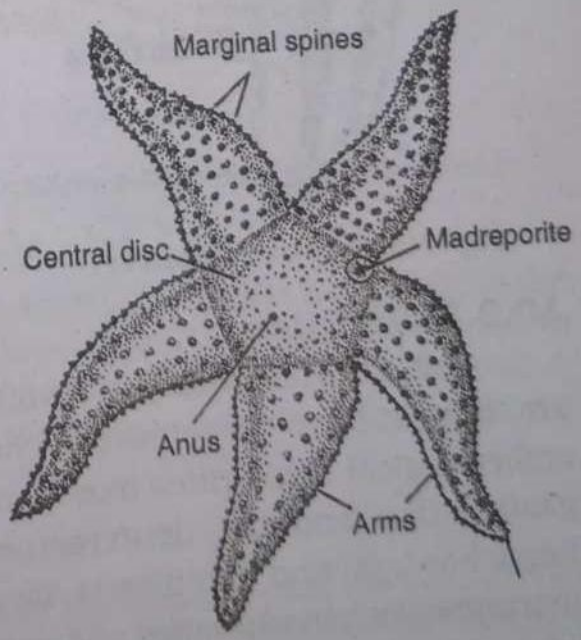


Fig. 10.40 Star fish

These tube feet serve for locomotion, holding of food and respiration. Most echinoderms exhibit the remarkable power to regenerate their lost parts. Reproduction is usually sexual. In some cases, however, it is asexual. Development is indirect passing usually through a ***bipinnaria*** larval stage. Common echinoderms are star fish (Fig. 10.40), brittle star (Fig. 10.41), sea cucumber (Fig. 10.42) and sea urchin (Fig. 10.43).

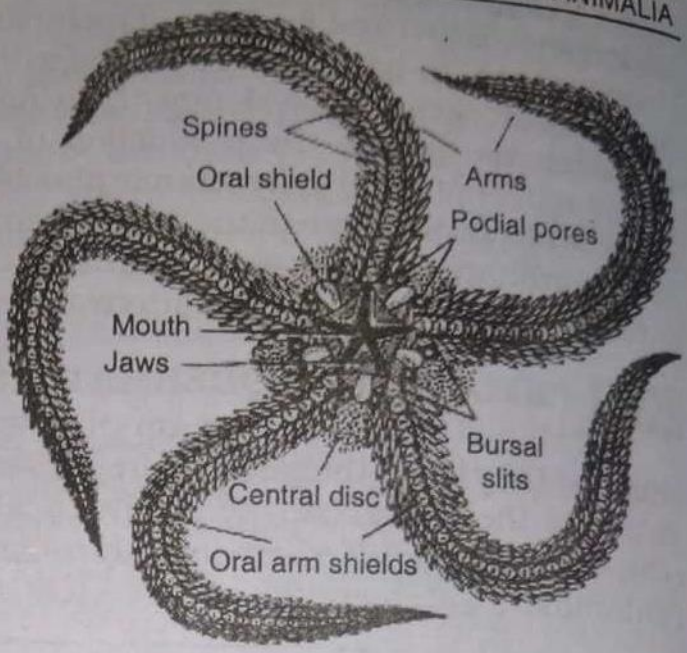


Fig. 10.41 Brittle star

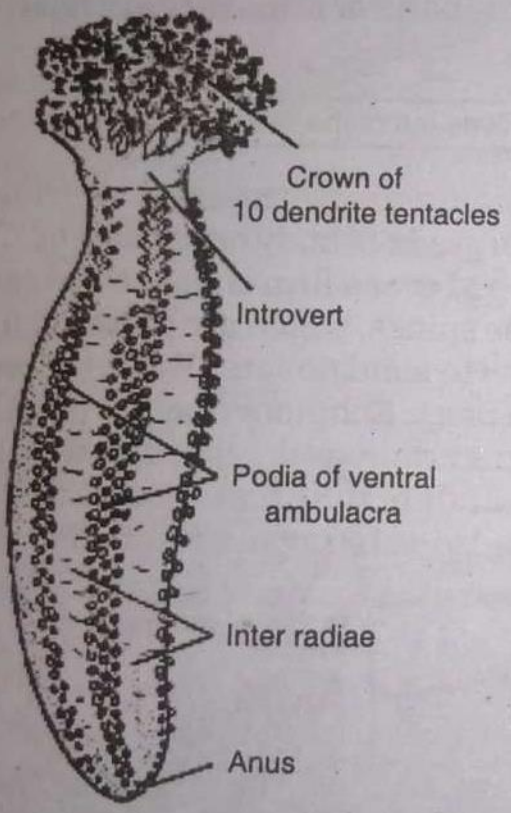


Fig. 10.42 Sea cucumber

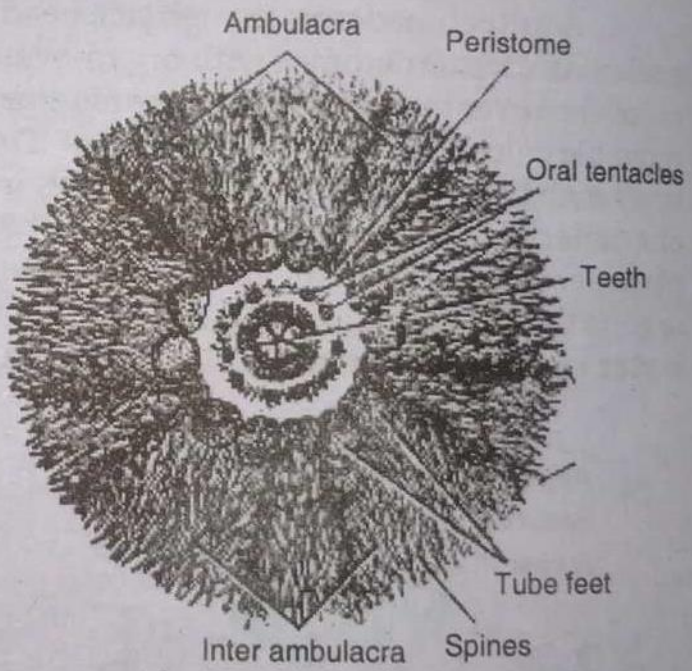


Fig. 10.43 Sea urchin

10.9.1 Affinities:

Affinities mean similarities of characters suggesting relationship. Echinoderms are thought to be the relative of chordates and hemichordates on the basis of the embryological similarities like their style of cleavage, pattern of blastulation and gastrulation and the deuterostomy of the blastopore. The tornaria larva of hemichordata and bipinnaria larva of echinodermata has a large number of morphological, biochemical and anatomical resemblances. In fact the tornaria larva when first discovered was mistaken as an echinoderm. These affinities have led to

the conclusion that echinoderms evolved as a side branch from a common *Dipleura* like ancestor which also gave rise to hemichordata and chordata.

HEMICHORDATA (Half Notochord):

Phylum Hemichordata is a small group of animals which includes about 90 species. They are all soft bodied animals which usually live in shallow 'U' shaped burrows in the sandy or muddy sea bottom. These cylinderical or vase shaped animals are bilaterally symmetrical and lack any segmentation. They may be solitary or colonial and usually range between a few millimetre and 250 centimetres in length. **Balanoglossus gigas**, however, may reach a length of 1.5 meters. Their circulatory system is open and coelom is divided into three chambers. A dorsal and a ventral nerve cord are present being connected together by transverse rings.

Sexes are separate in hemichordate though no sexual dimorphism is seen. As the blastopore of the embryo develops into anus hemichordates are deuterostomes.

Embryological studies of tornaria larva of hemichordata, however, reveal a close and fundamental resemblance with bipinnaria larva of echinodermata. Hence, it is believed that echiondermata, hemichordata and chordata are closely related and might have evolved from a common ancestor.

10.10 PHYLUM CHORDATA (Forms with notochord)

Members of this phylum, are the best known of all the animals. They include about 45000 species including many animals of major economic importance. All the chordates show all or at least any one of the following three fundamental characters (Fig. 10.44).

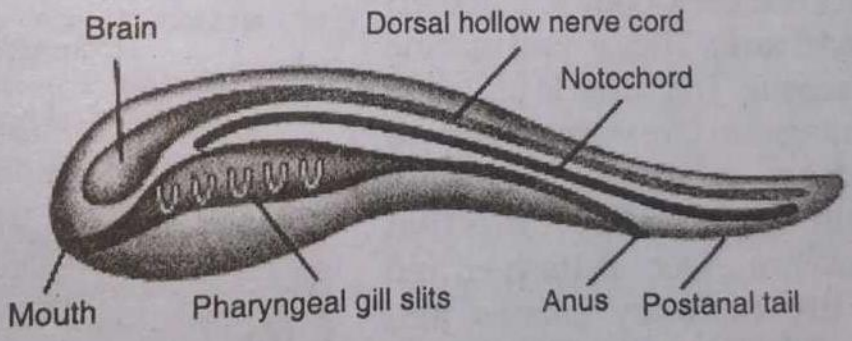


Fig. 10.44 A generalized chordate showing fundamental chordate characters

1. Notochord:

It is a flexible cartilagineous skeletal rod which forms in the early stage in the embryos of all the chordates in the mid-dorsal line, dorsal to the gut but ventral to the nerve cord. It extends the length of the body and persists in a few chordates, throughout their life whereas in most of them it is surrounded and replaced by a vertebral column.

2. Hollow, dorsal, tubular nerve cord:

In all the chordates a hollow, tubular, fluid filled, nerve cord always develop in the mid-dorsal line. In the group craniata it becomes differentiated into brain and spinal cord.

3. Pharyngeal gill slits:

In all the chordates, in an early embryonic stage, walls of pharynx become perforated. In aquatic forms these pharyngeal slits develop gills whereas in terrestrial forms they close and disappear.

Chordates, in general, are bilaterally symmetrical, triploblastic, deuterostome, animals having a complete digestive tract with a mouth and an anus. Coelom is well developed and internal organs are suspended in the coelomic cavity by a thin membranous tissue called mesentery. They all, as a rule, reproduce sexually. A majority have a post-anal tail.

According to the recent classification Phylum Chordata is divided into two groups (i) Acraniata or Protochordata and (ii) Craniata or Vertebrata.

Group: Acraniata or Protochordata (First chordates; without brain box):

Protochordates or Acraniates as their name indicates are the first or simple chordates in which brain box (Cranium) is absent and hence brain is not prominent. In this group of chordates notochord does not transform into vertebral column. Protochordata or Acraniata is divided into two sub phyla Urochordata and Cephalochordata.

Sub-phylum: Urochordata (Notochord in the Tail)

Urochordates are also called Tunicata because their body is enclosed in a sac called ***Tunic***. They are all marine and mostly sessile. The tunic is provided with two openings, an ***incurrent*** or ***buccal siphon*** and an ***excurrent*** or ***Atrial siphon***. It is through these openings that water currents bring food and oxygen and take away the excretory wastes and gametes. An adult Ascidia (Fig. 10.45) shows little chordate characters. It is actually its motile larva, which resembles a tadpole, and exhibits chordate characters. It contains a nerve cord and a short notochord in its tail only, hence the name Urochordata. As the larva reaches maturity it attaches to the sea bottom and undergoes ***retrogressive metamorphosis*** by losing its tail and most of the chordate characters. Many species of ***Herdmania*** are found in our seas.

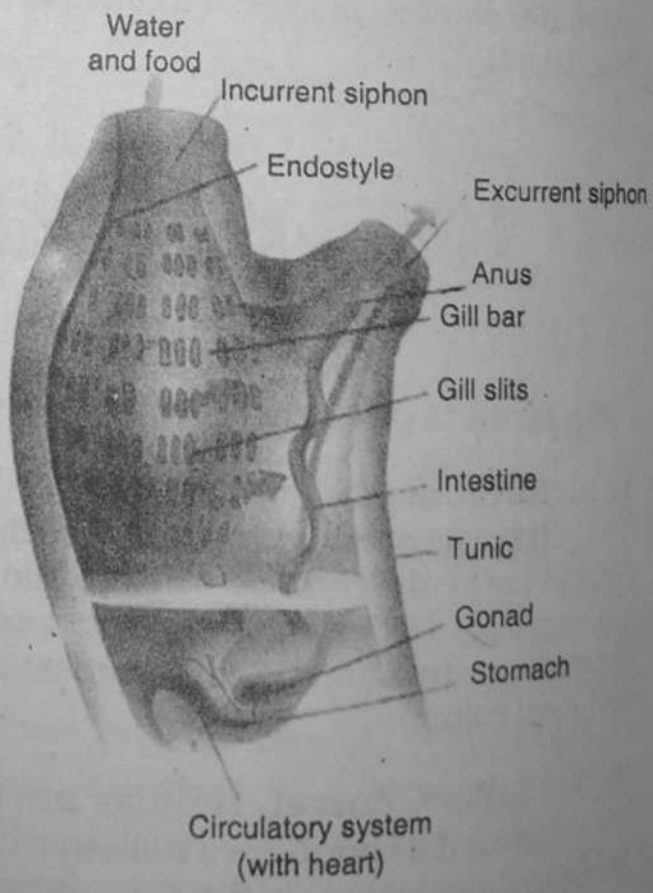


Fig. 10.45 Ascidia

Sub-Phylum: Cephalochordata (Notochord from head to tail)

This is a small group and includes ***Branchiostoma*** which is commonly called Amphioxus (Fig. 10.46). It is a small marine animal with its both ends pointed. It lives burried in sand in shallow water with its anterior end protruded out. Though a small animal it is a typical chordate and exhibits, quite clearly, all the fundamental chordate characters i.e. a hollow dorsal nerve cord, a number of pharyngeal gills slits and a notochord which extends right in the mid dorsal line from anterior to posterior tip of the body. Out of only two genera found around the world ***Branchiostoma*** is found on our coasts.

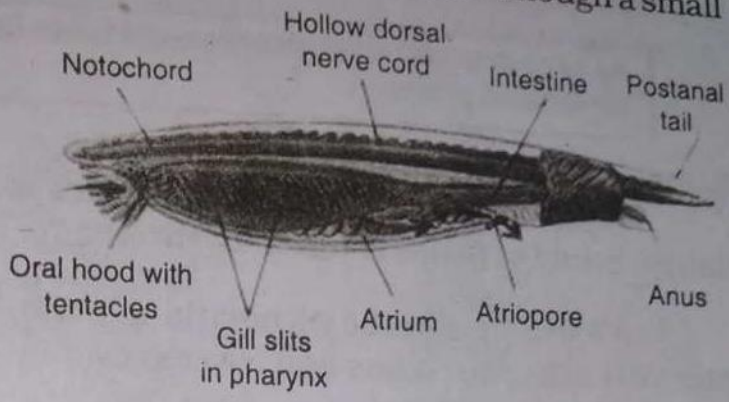


Fig. 10.46 Amphioxus

Group: Craniata or Vertebrata (With cranium and vertebral column):

These are the chordates in which brain is protected inside a skeletal brain box called ***cranium***. They are also called vertebrates because in the members of this group notochord is replaced by a vertebral column. This group is divided into two sub-phyla (i) Agnatha and (ii) Gnathostomata.

Sub-Phylum: Agnatha (Mouth with out jaws):

This is a small group of vertebrates which includes only one class Cyclostomata hence Agnatha are also commonly called cyclostomes. As the members of this group superficially resemble the fishes but lack the jaw they are often known as Jawless Fishes. This group includes Hag Fish and Lamprey (Fig. 10.47-a,b). They are elongated eel like animals without jaws, scales or paired fins. They have a rounded suctorial mouth with many rings of teeth. Both are parasites.

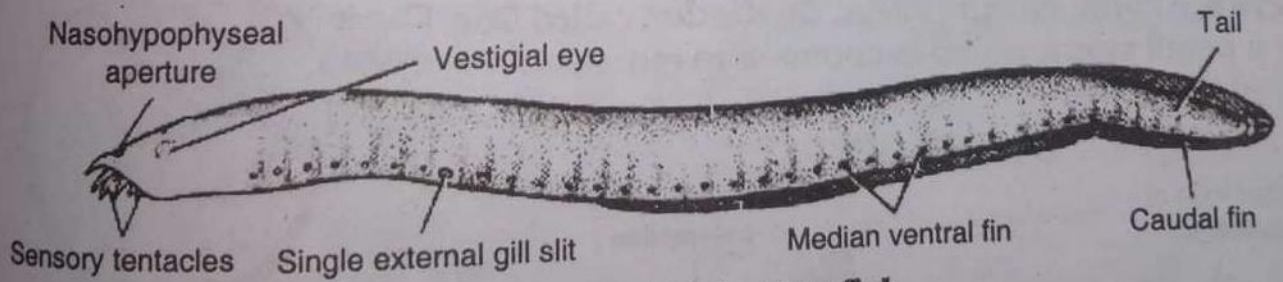


Fig. 10.47 (a) Hag fish

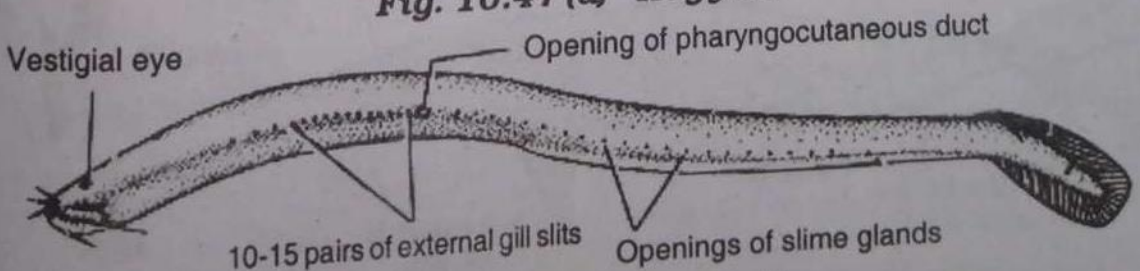


Fig. 10.47 (b) Lamprey

Sub-Phylum: Gnathostomata (Mouth with Jaws)

This is a large group of vertebrates in which both upper and lower jaws are present though teeth may be present or absent. Gnathostomata are divided into two super classes Pisces and Tetrapoda.

> As more than half of the chordates are fishes hence they are in grouped is a super class called pisces.

Super Class Pisces (Fish):

This is the largest group of chordates which includes about 25000 species of fishes. Study of fishes is called ***Ichthyology***.

A fish is an aquatic gill breathing gnathostomates whose streamlined body is provided with paired fins and covered over by dermal scales.

Super class Pisces is divided into two classes: (i) Chondrichthyes and (ii) Osteichthyes.

Class Chondrichthyes (Cartilagineous fishes):

This group also called class ***Elasmobranchi*** comprises of marine fishes whose endoskeleton is made up of **cartilages** while their skin contain an enormous number of tiny sharp enamel coated denticles called ***placoid scales*** (Fig. 10.48) which form their exoskeleton. Their wide mouth is ventral in position and their tail fin is ***heterocercal***. There are present many usually **5 exposed gill** slits on each side which are not covered over by a gill cover the operculum. This group includes sharks (Fig. 10.49-a), skates and rays including shock producing Electric ray-Torpedo (Fig. 10.49-b). Many types of skates and rays are found on our coasts. ***Scoliodon*** called Dog fish is a small shark which is common in our seas.

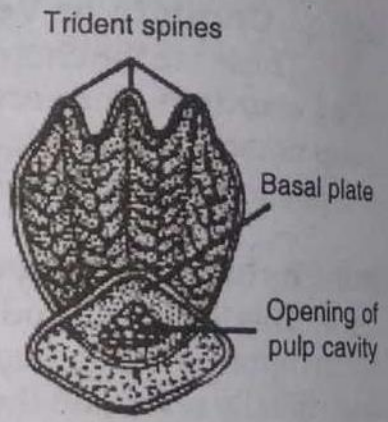


Fig. 10.48 Placoid scale

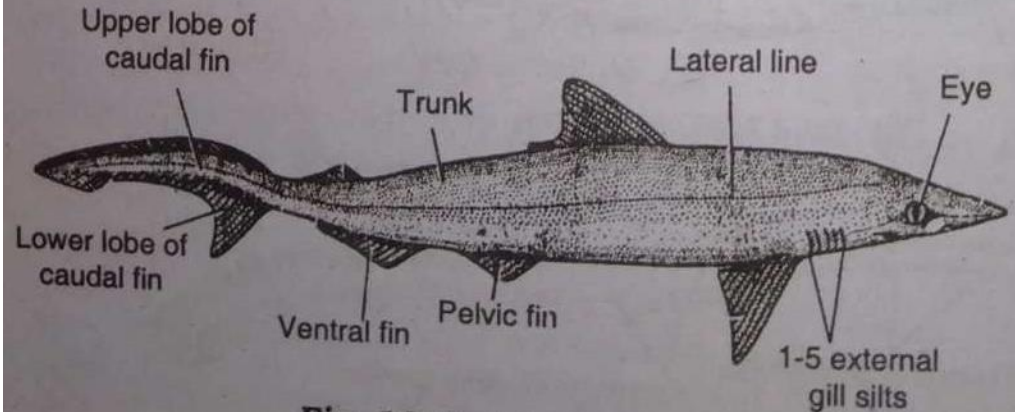


Fig. 10.49 (a) Shark

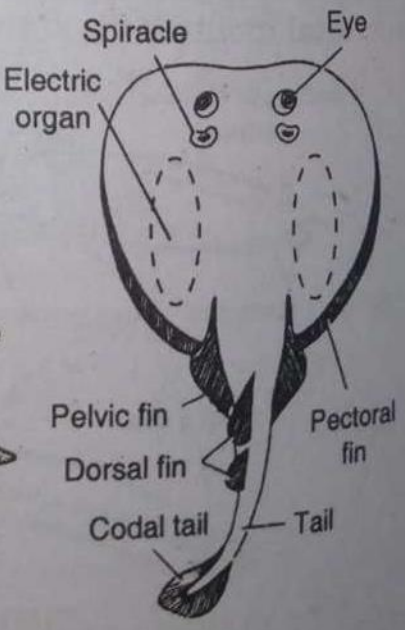


Fig. 10.49 (b) Torpedo

Class Osteichthyes (Bony Fishes):

This group also called ***Teleostomi*** is actually the largest class of chordates. They are marine and fresh water fishes in which mouth openning is present at the anterior tip. The endoskeleton in these fishes is **bony** and the exoskeleton which is made up of thin bony plates which are called ***cycloid*** (Fig. 10.50-a) or ***ctenoid*** (Fig. 10.50-b) scales according to whether their outer edge is smooth or spiny. The gills

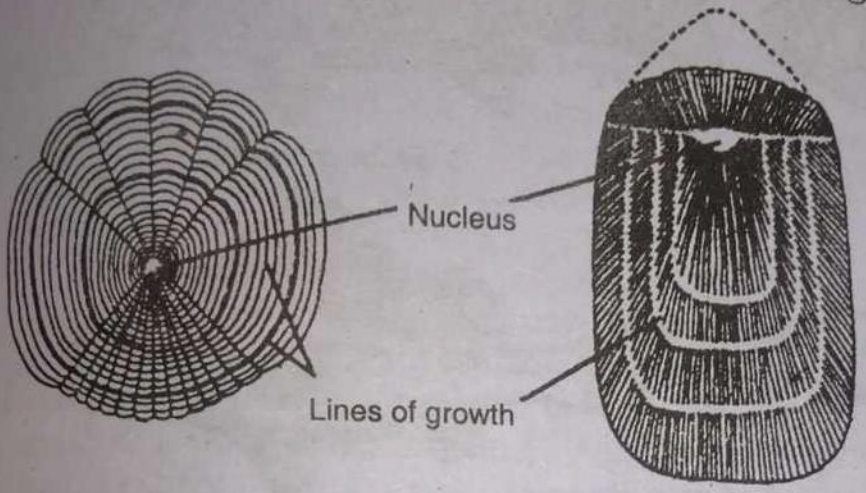


Fig. 10.50 (a) Two shapes of cycloid scales

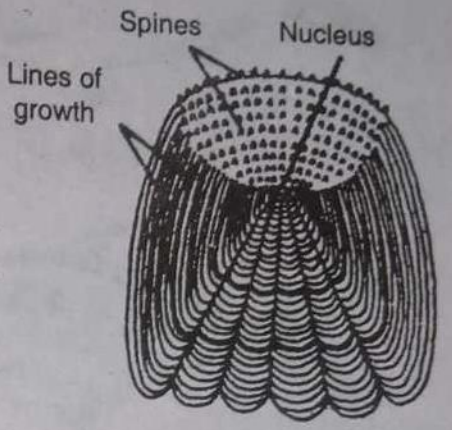


Fig. 10.50 (b) Ctenoid scale

are covered over on each side, by a gill cover called ***operculum***. Most of these fishes have an air bladder which acts as a hydrostatic organ. Tail fin is usually ***homocercal*** or ***diphycercal***. This group includes Eel (Fig. 10.51-a), Sea horse (Fig. 10.51-b), Flying fish (Fig. 10.51-c), Globe fish (Fig. 10.51-d) etc.

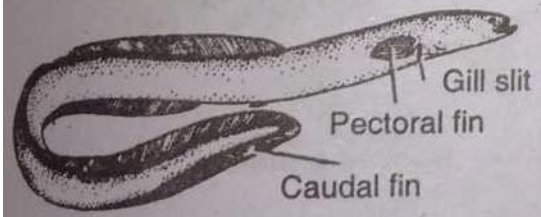


Fig. 10.51 (a) Eel

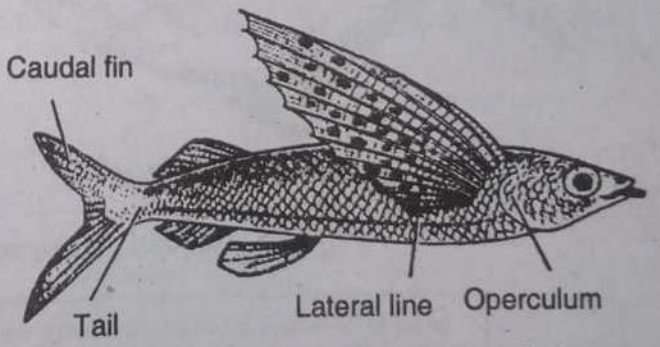


Fig. 10.51 (c) Flying fish

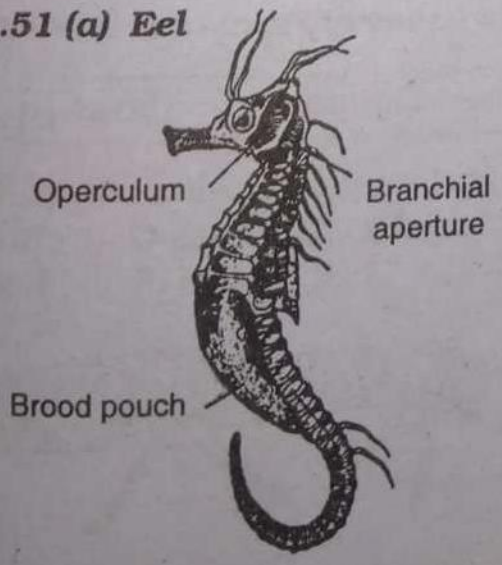


Fig. 10.51 (b) Sea horse

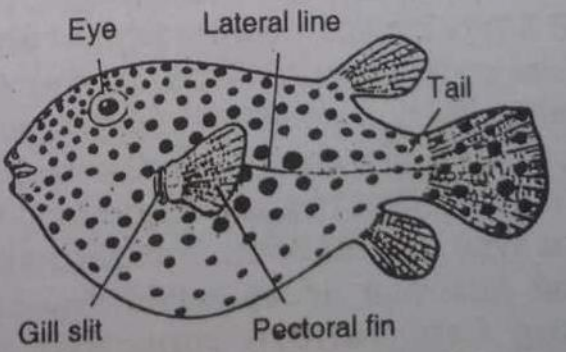


Fig. 10.51 (d) Globe fish

Most of the delicious edible fishes also belong to this group. The commonly liked edible fishes of Pakistan (Fig. 10.52) are Perches (Pomfret), Hilsa (Pallah), Carps (Rohu), Mackrels (Surmai), Cat fishes (Khagga), and Salmon (Trout).

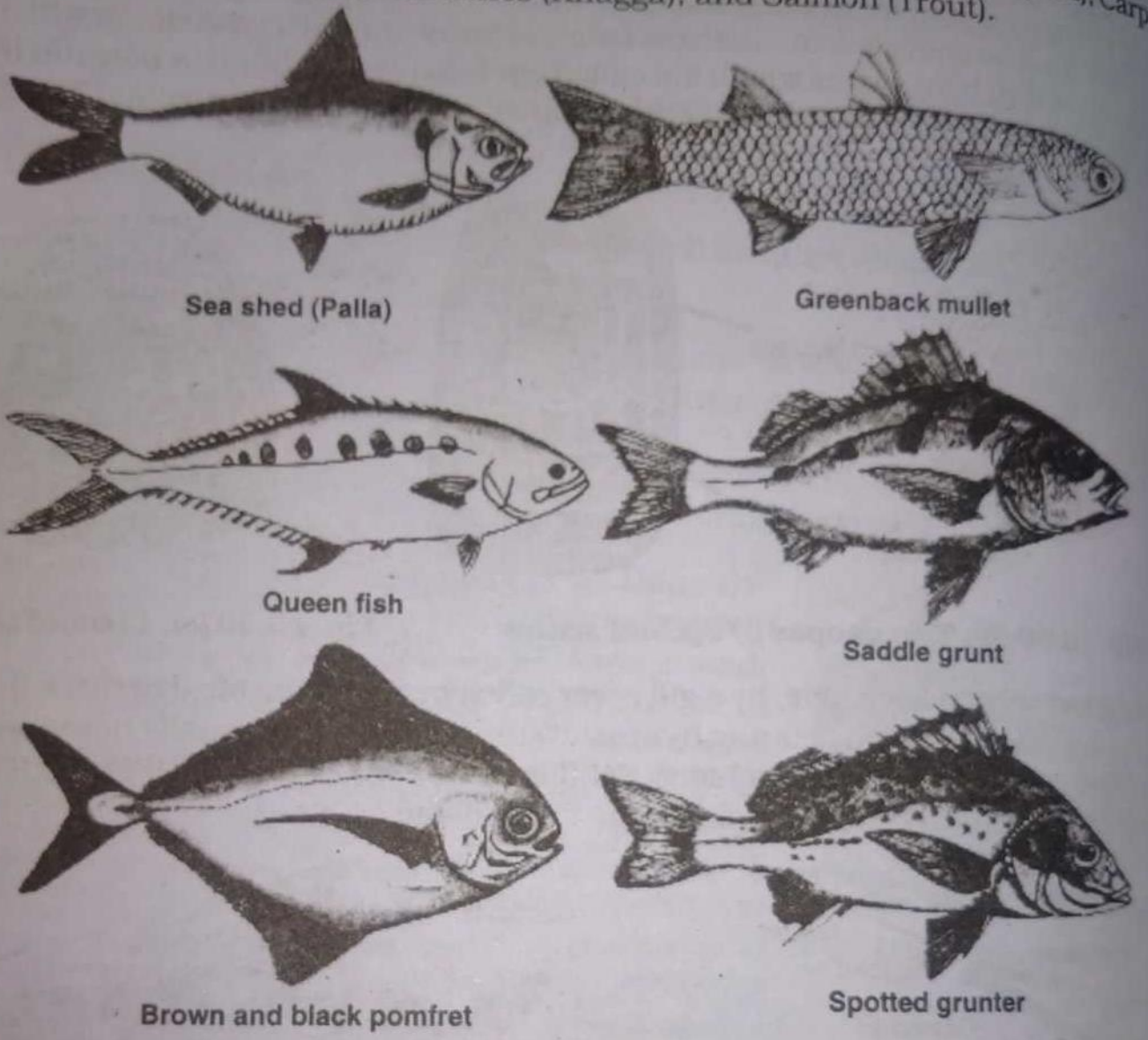


Fig. 10.52 Common edible fishes of Pakistan

Some fishes travel thousands of kilometres to their spawing areas.

A small group of zoogeographically important fishes called ***Lung fishes*** (Fig. 10.53) belonging to order ***Dipnoi*** are also included in the Class Osteichthyes. Only three genera of such fishes are found in the world. They respire by the help of gill as well as, at times during drought period, by lungs which are actually the modified air bladders. They are found isolated, one type each in South America, Africa and Australia hence called American lung fish, African lung fish and Australian lung fish respectively.

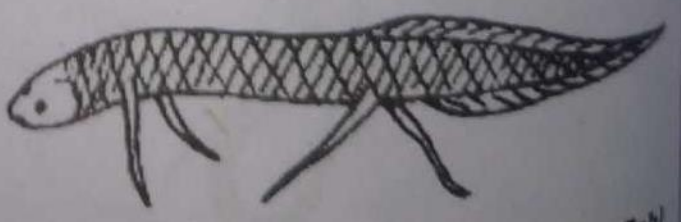


Fig. 10.53 Protopterus (African lung fish)

10.10.1 Adaptations for an Aquatic life:

The fishes are well adapted to aquatic life due to their streamlined body shape, which is helpful in swimming, by the presence of paired and unpaired fins and tail for balance and propulsion, by losing hard armour and developing air bladder for bouncy and by developing the gills for aquatic respiration. To overcome the deficiency of sense of hearing and sight in water their sense of smell has developed remarkably.

Super class Tetrapoda (Four legs):

This is the group of vertebrates which have developed two pairs of pentadactyl limbs for walking, running, flying or for offence and defence. This group of Gnathostomates is divided into 4 classes (i) Amphibia (ii) Reptilia (iii) Aves and (iv) Mammalia.

Class Amphibia (Living at both places; water and land):

This is a comparatively small group of tetrapod comprising of about 2000 species. This is the only group of vertebrates which lacks any sort of exoskeleton. Hence their naked skin is soft and moist. They respire by lungs, gills, skin and lining of buccal cavity. They lay eggs in water where they spend at least their early life. Hence, they have become partially aquatic and partially terrestrial. Their name amphibia also indicates this double mode of life.

Amphibians are poikilothermic vertebrates; they cannot maintain their body temperature at a constant level. To avoid extremes of temperature they undergo **hibernation** in winter by burrying themselves in the mud to avoid low temperatures of the environment. In hot summers they do so again; the process is called ***aestivation***.

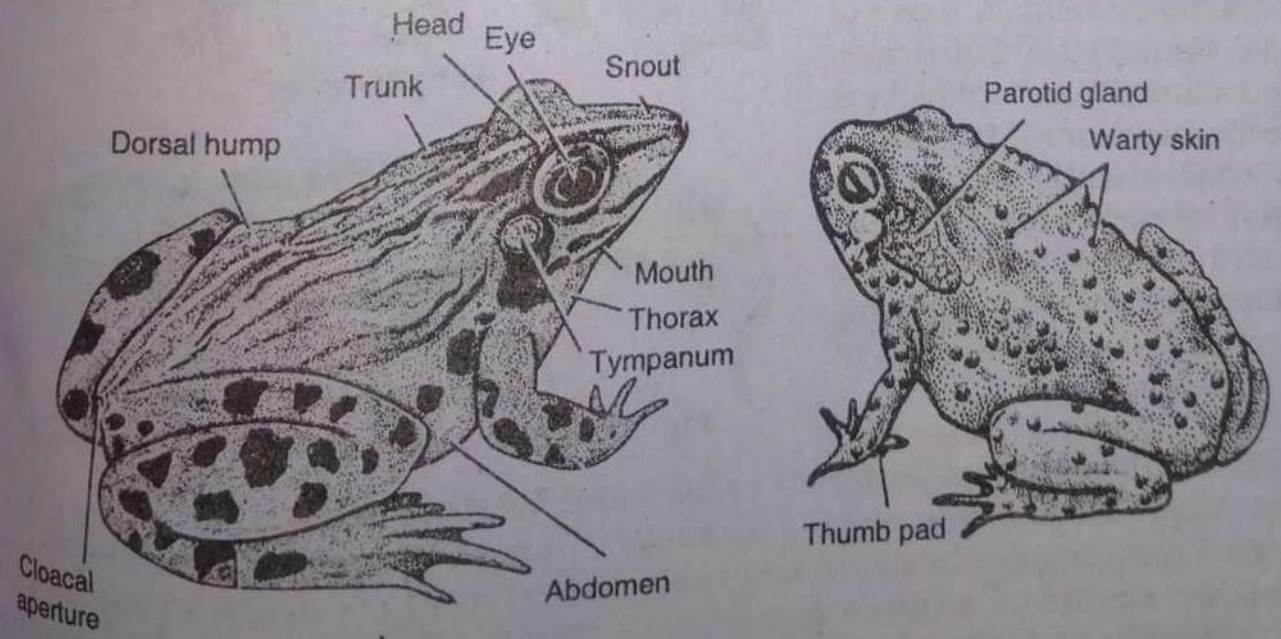


Fig. 10.54 Frog and toad

The common amphibians are the limbless worm like caecilians, lizard like salamanders with limbs and tail and frog like creature with limbs but no tail. Frogs and toads (Fig. 10.54) are common in Pakistan.

> A number of aquatic amphibian called permanent larval forms, do not metamorphose at all.

10.10.2 Trends towards a land habitat:

The greatest event in the phylogenic history of animals was a transition from aquatic to terrestrial mode of life. Amphibians were the first animals to attempt it though failed to adapt it completely. The most important adaptation was the development of lungs for breathing air in terrestrial habitat. Another important factor was the modification of fins into legs for walking on the land.

10.10.3 Origin of Amphibia:

An ancient bony fish called ***Rhipidistian*** (lobe finned fishes) lived some 350 million years ago when the land was covered over by shallow, swampy bodies of stagnant water which often become warm and oxygen deficient. The rhipidistian were adapted to these conditions due to the presence of lungs in their body that could inhale oxygen from the air. They also had fleshy lobed fins with bony endoskeleton. These fins were probably used to support the bodies as they pushed their head out of water for a breath of air or dragged their bodies from one shrinking pond to another. This practice made these animals more and more adapted to terrestrial life. The first amphibian known from the fossil record was primarily aquatic and fish like but with four legs. The limb bones of these early amphibians were remarkably similar to those of rhipidistians (Fig. 10.55). Hence, it is concluded that rhipidistians were the ancestors of amphibian and consequently of all four legged vertebrates. A near relative of rhipidistian are ***coelocanth*** fishes still surviving, as living fossil in the sea, in small numbers.

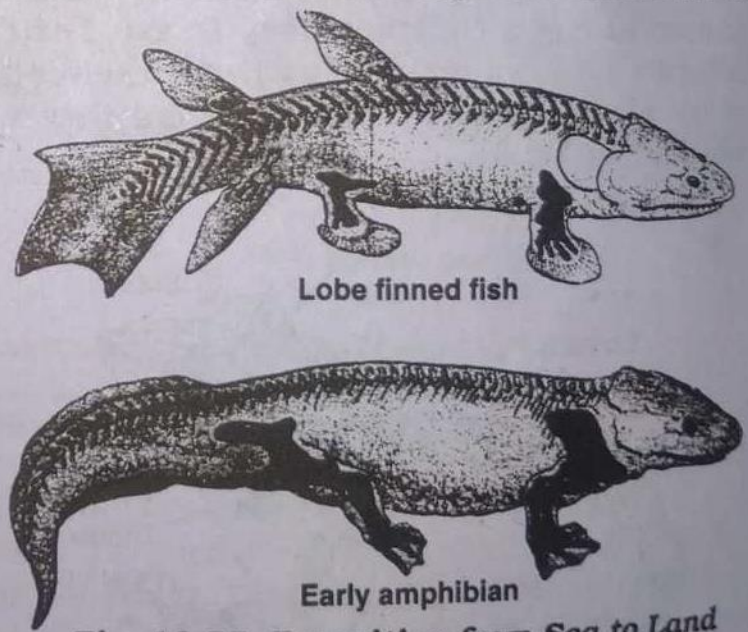


Fig. 10.55 Transition from Sea to Land

10.10.4 Amphibia as Unsuccessful Land Vertebrates:

Amphibia is a diminishing group of animals. The number of amphibian species is reducing day by day and is subjected to recent researches. They are said to be unsuccessful land vertebrates because they failed to adapt completely to the land environment. As they are cold blooded and do not possess any exoskeleton they

cannot cope with the extremes of temperature which has restricted their distribution, around the water bodies. Their thin naked skin cannot prevent the continuous loss of water and hence makes them vulnerable to desiccation. Their eggs are small and without a shell and external fertilization is a rule. Being endangered to desiccation amphibian eggs are laid in water. Because the quantity of yolk in the egg is not sufficient enough for the complete development of the embryo, the larva hatches out at an early stage and undergoes metamorphosis which passes through an aquatic gill breathing larval stage. It is, therefore, evident that to live, to mate and to propagate amphibians are always in need of water but unfortunately their physique did not allow them to invade the sea.

Class Reptilia (To crawl and creep):

Reptilia is a group of about 5000 vertebrate species with dry skin which is covered over by epidermal scales. They are terrestrial and crawl on land with the help of two pairs of limbs which are pentadactylous and provided with horny claws. Snakes, however, have no limbs.

Reptiles are poikilothermic (cold blooded). They lay eggs on land which are covered over by leathery shells. The embryo develops on the large quantity of yolk and albumen present in the egg. Due to the presence of a protective membrane called ***amnion*** in the egg the three groups of higher vertebrates i.e. Reptiles, Birds and Mammals are called ***Amniota***. The vertebrates without it i.e. Fishes and Amphibian are called ***Anamniota***.

10.10.5 Past History:

Though reptiles evolved much earlier, the mesozoic era, 225-70 million years ago was the time when reptiles dominated the earth. This era was ruled by the best known giant reptiles called the Dinosaurs which mean "Terrible Lizards". Ancestors of the present day reptiles also appeared during the same period. About 70 million years ago when mesozoic era came to an end and Cenozoic Era started the dinosaurs perished.

Brontosaurs 82 ft. long and 16 ft. high was the largest whereas ***Tyranosaurs*** 60 ft. long and 20 ft. high with both of its powerful jaws containing a large number of almost one foot long powerful teeth, was the most terrifying creature ever to roam the earth.

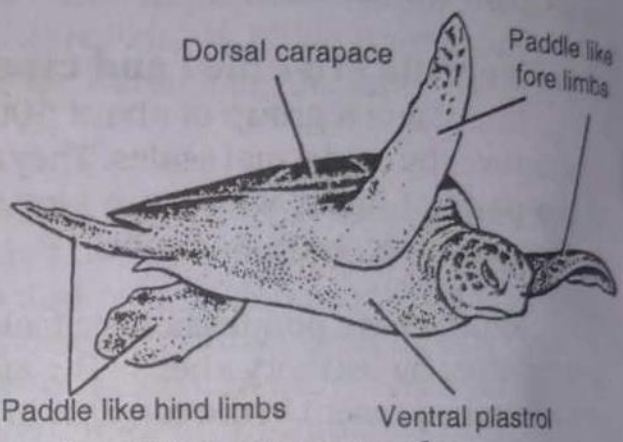
10.10.6 Successful Land Vertebrates:

Reptilia is the first group of vertebrates fully adapted for life on dry places on land. Unlike amphibians they do not have to go to water to reproduce. Key to their success on land is their internal mode of fertilization and the amniotic egg with a leathery shell which is relatively impermeable to water but permeable to gases. The ability to sustain the frequent temperature changes on land and to slow down the loss of the body water was brought about by the development of an exoskeleton of horny

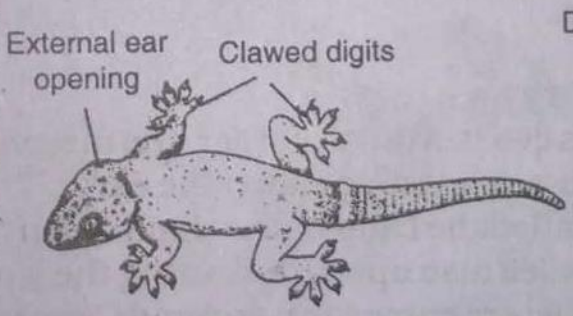
scales and plates on the skin. This was supplemented by much more developed kidney to retain enough water and excrete concentrated urine. Their developed limbs and appearance of claws made them fit not only to move, dig and climb but also to defend themselves against the predators and last but not the least their developed lungs and heart made possible the increased supply of oxygen for much higher muscular activity needed for a more active life on the land.

The common reptiles found around the world are tortoise and turtles, lizards and snakes crocodiles and alligators. ***Sphenodon*** a living fossil, the only reptile of its kind, is restricted to Newzealand only.

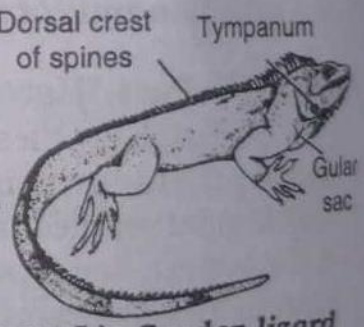
Many species of tortoises and turtles including the endangered green turtle the ***Chelone mydas*** (Fig. 10.56) are found in Pakistan. Among the lizards wall lizard, garden lizard (Fig. 10.57-a,b), and Uromastix are common. Snakes are the limbless reptiles which creep on land by the undulating movement of their body. Some of the snakes are poisonous. Their poison called ***Venom*** which may be haemotoxic or neurotoxic is injected into the body of the prey by the help of specially designed sharp and curved teeth called ***Fangs***. Cobra (Fig. 10.58-a), Viper, Krait, Python and many types of sea snakes (Fig. 10.58-b) are common in Pakistan.



10.56 Green turtle



10.57 (a) Wall lizard



10.57 (b) Garden lizard

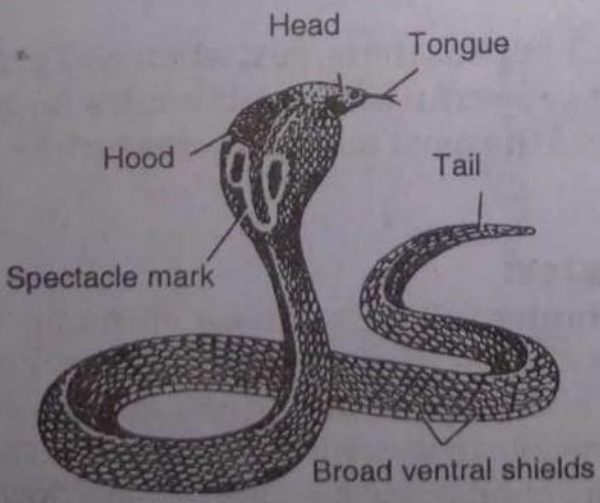


Fig. 10.58 (a) Cobra

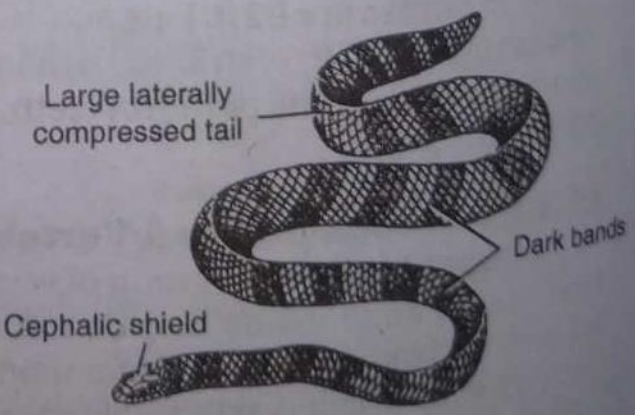


Fig. 10.58 (b) Sea snake

- Snakes have no limbs, no eyelids and no ears.
- Green turtle lays eggs on the same coast where it was born.

Among the larger reptiles Crocodiles (Fig. 10.59) are present in Pakistan in small numbers.

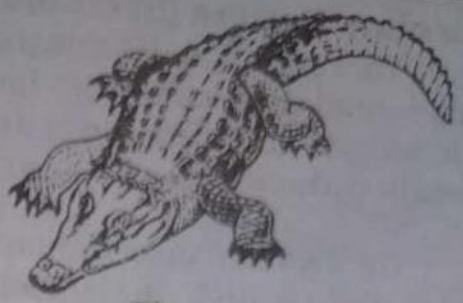


Fig. 10.59 Crocodile

Class Aves (Birds):

Birds are the most beautiful animals in the world. They attract the people because of their flight, colourful plumage (feathers), spring-time songs, strange migrations, parental care and considerable economic value in respect of food and as game animals.

There are about 9000 species of birds and their study is called ***Ornithology***. They are among the most successful vertebrates due to their enormous number, adaptation to a variety of environment and their distribution throughout the world. The variation in size is also remarkable. They range from a 2 gms West Indian humming bird to a 150 kg Ostrich.

A bird can be defined as a feather covered bipedal flying vertebrate possessing wings. Feathers which cover the body all over constitute a unique and basic identifying character of birds. It not only serves as a protective insulating garment but is directly involved in two most important aspects of avian biology: Endothermy and Flight. Endotherms or Homeotherms are the animals whose body temperature remain constant irrespective of the temperature of the environment they are living in. Flight that gives the birds an unmatched freedom among the vertebrates is brought about by the modification of its fore-limbs into wings and an astonishing reduction of its skeletal weight owing to its hollow construction (Pneumatic bones).

Though the birds are present in large numbers and live in very different habitats, they all have a compact spindle shaped body, reduced number of bones, large eye ball with keen eye sight and a large, powerful, four chambered heart. They have a sound producing sac, the syrinx instead of larynx present in other vertebrates. They have a tooth less beak. The shape of beak and type of its feet and claws tell about the habit and habitat of a bird. Fertilization is internal and eggs are large, amniotic and covered over by hard calcareous shells.

A bird's respiratory system delivers a plentiful supply of oxygen to its flight muscles

The modern birds are divided into two group i.e. Ratitae and Carinatae.

Sub class Ratitae (Sternum raft like):

This sub class of birds includes the modern big sized flightless birds. These birds cannot fly because they have comparatively heavy weight (Ostrich about 150 Kg in weight) and their wings are either vestigial or rudimentary. They have a flat sternum without keel and accordingly their flight muscles are poorly developed.

The distribution of ratitae is also restricted. None of them is found in Pakistan. Ostrich (Fig. 10.60-a), the largest bird is found in Arabian countries and Africa. Rhea is found in South America. Emu and Cassowary in Australia and Kiwi (Fig. 10.60-b) is restricted to Newzealand only. Penguin another unique aquatic flightless bird is confined to the frozen shores of Antarctica.

Fig. 10.60 (a) Ostrich

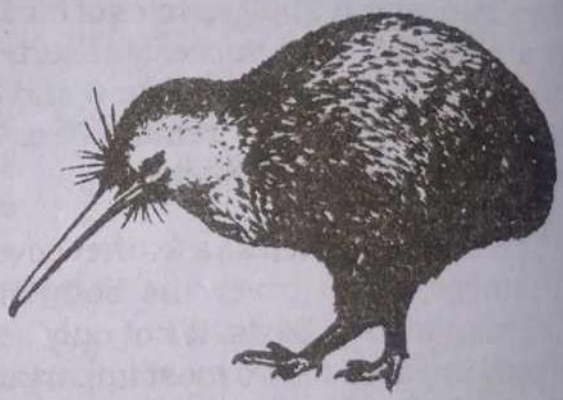


Fig. 10.60 (b) Kiwi

Sub class Carinatae (Sternum with keel):

Almost all the modern flying birds are included in this sub class. They are usually small, light weight birds whose wings are highly developed and feathers of their wings have an interlocking mechanism. Their sternum is provided with a crest like keel to accommodate the highly developed pectoral flight muscles. The flying birds are distributed all around the world.

Pakistan is a zone with rich avifauna and enjoys the presence of a large variety of resident and visiting migratory birds. The common birds of Pakistan are sparrow, pigeons (Fig. 10.61-a), myna, bulbul, hoopoes, crow (Fig. 10.61-b), doves, parrots (Fig. 10.61-c), fowls, cuckoo and ducks. Kites, falcon and owl (Fig. 10.61-d) are the common birds of prey. Ducks, Sea Gulls Terns and Cranes are common migratory birds. ***Peacock*** (Fig. 10.61-e) and ***Houbara*** are among the most beautiful birds of Pakistan.

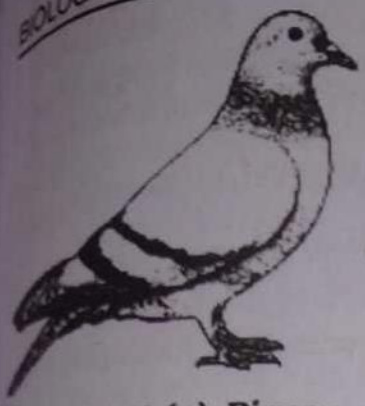


Fig. 10.61 (a) Pigeon

Fig. 10.61 (b) Crow

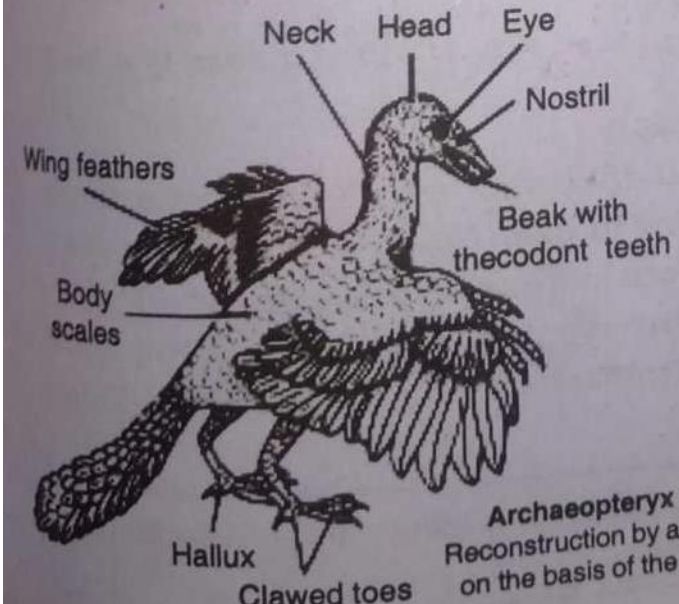
Fig. 10.61 (c) Parrot

Fig.10.61 (d) Owl

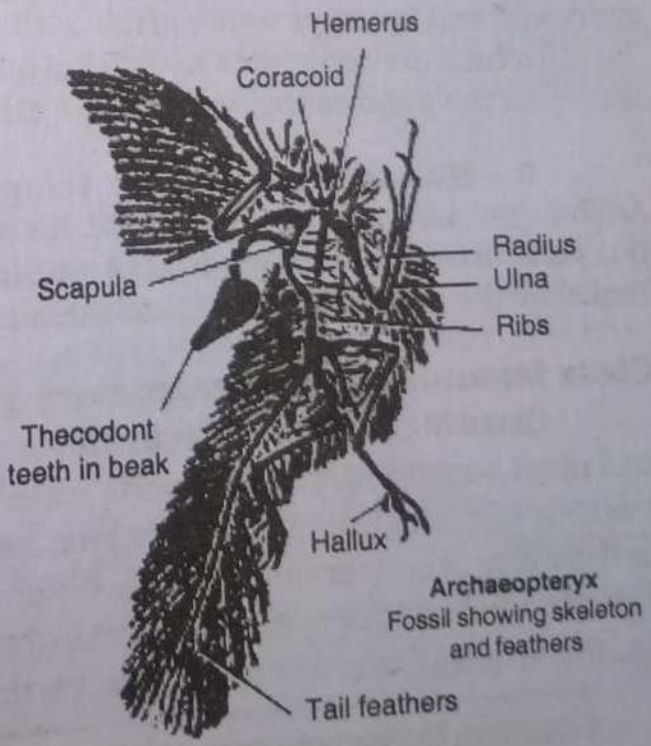
Fig. 10.61 (e) Peacock

10.10.7 Origin of Birds:

Birds are often called glorified reptiles because they have evolved from this group and have many characters in common but show a much more



Archaeopteryx
Reconstruction by an artist on the basis of the fossil



Archaeopteryx
Fossil showing skeleton and feathers

Fig. 10.62 Archaeopteryx

specialization and a marked superiority over reptiles. They are also called feathered dinosaurs because of their evolution some 200 million years ago from a small and bipedal insect eating lizard called ***Thecodont*** which also gave rise to dinosaurs.

Archaeopteryx (Fig. 10.62) is thought to be the earliest bird whose fossils have been found from the rocks 150 million years old.

10.10.8 Flight Adaptations:

The birds have undergone a number of adaptations which helped them to meet the requirement of a perfect flying animal.

1. Shape of the body: The streamlined compact, spindle shaped body which offers least resistance to air is the primary requisite of flight.

2. Loss of weight: The hollow bones are light, strong and pneumatic (air filled). Teeth are lost and so are the tail vertebrae. The urinary bladder and an ovary and an oviduct have also disappeared.

3. Wings: Fore limbs are modified into wings which are moved up and down by strong flight muscle keeping the body afloat.

4. Energy requirement: It is brought about by a rich oxygen supply to the tissues by a powerful heart and an extra-ordinary respiratory system made efficient by the presence of many air sacs (Fig. 10.63) which are connected with lungs on one side and with the pneumatic bones on the other.

5. Maintenance of Body temperature: Active muscular activity tends to rise the temperature of body which is kept within normal limits by the ventilating action of the air sacs.

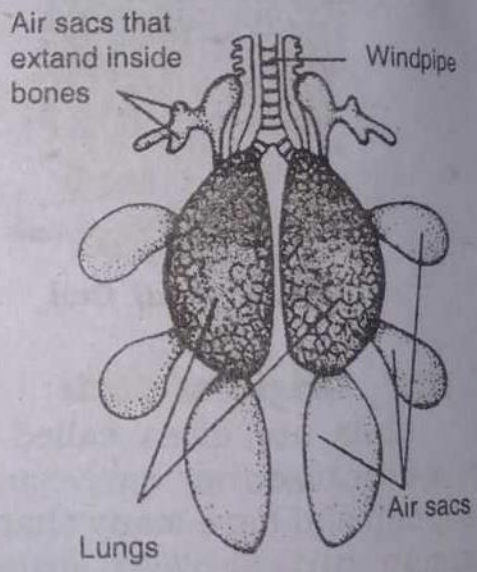


Fig. 10.63 Air sacs of a bird

Class Mammalia (With mammary glands):

Class Mammalia which includes about 4500 species are the most complex and most successful group of vertebrates living to-day. They are adapted for life in a variety of ecological niches from land and trees to water and even in the air. As far as their size is concerned they range from a tiny pygmy shrew weighing only about 2 gms to a blue whale which measures upto 40 meters long and weighs upto 160,000 Kg, the largest living animal on the earth.

> Human beings are also animals being included in class mammalia and given the scientific name **Homo sapiens**.

Two important mammalian characters which distinguish them from other vertebrates are **hair** and **mammary glands**. All the mammals have a protective and insulating hair cover on their skin. It is luxuriant in most of the species, reduced to patches in humans and restricted to sensory whiskers on snout in whales and dolphins.

Mammals are unique among animals in suckling their youngs with a nutritive fluid, the milk, secreted by special mammary glands.

Other important mammalian characters include the presence of a muscular transverse partition the **diaphragm** which divides the body cavity into a thoracic and an abdominal compartment. Presence of seven cervical (Neck) vertebrae, and internal mode of fertilization are also among the important mammalian characters. Teeth though few are ***thecodont*** (lodged in sockets of the jaws) and ***heterodont*** (of different shapes) being differentiated into 4 types i.e. incissors, canines, premolars and molars. All of them with the exception of egg laying mammals are ***viviparous*** that is they give birth to live young ones because the embryo develops in the uterus inside the body of mother.

10.10.9 Origin:

Mammals appeared in the early part of the Mesozoic era as a branch of the now extinct order ***Therapsida*** of class reptilia. Ancient mammals were small no bigger than rat and mouse. They were nocturnal and burrowing or arboreal forms. Thus co-existed with dinosaurs and other reptiles for 150-200 million years and when the large reptiles and dinosaurs disappeared, at the close of mesozoic era, the mammals increased dramatically in numbers, diversity and size.

Class Mammalia is divided into three sub classes Prototheria, Metatheria and Eutheria, on the basis of the mode and developmental conditions of their new born babies.

Sub-Class Prototheria (Egg laying mammals):

This sub class contains the most primitive mammals being grouped in a single order Monotremata, hence also called ***monotremes***. They are represented by just 2 genera which include only three species being found only in Australia and

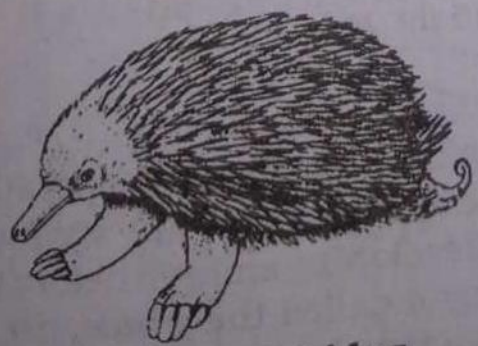


Fig. 10.64 (a) Echidna (spiny anteater)

Fig. 10.64 (b) Duck billed platypus

New Guinea. These mammals are the Echidna, the spiny anteater (Fig. 10.64-a) and duck-billed Platypus (Fig. 10.64-b). Like their reptilian ancestors they are oviparous hence, called ***egg laying mammals***. Like reptiles they have a cloaca (common rectal and urinogenital opening) and also lack an external ear (Pinna) but like mammals they possess hair and produce milk on which they nourish their youngs when they hatch out of egg. They are, hence, considered to be a connecting link between reptiles and true mammals.

Sub-Class Metatheria (Pouched mammals):

It is also a relatively small group of mammals which contains a single order Marsupialia represented by about 250 species, most of which live in Australia. A few, however, are found in South America and North America. Marsupials are ***viviparous***. They give birth to live young ones. Their eggs are not laid but retained and fertilized inside the body of the female. As the eggs do not contain enough yolk to feed the embryo for the entire period of development, hence marsupials are born in an immature form. The rest of the development of the new born tiny marsupial occurs outside the uterus in a special bag like pouch, that contains openings of mammary glands. Each baby attaches itself to a nipple of mammary gland by its mouth. This pouch is called the ***marsupium*** and hence the metatherians are commonly known as ***pouched mammals*** or ***marsupial mammals***. Examples include Kangaroo (Fig. 10.65-a), Koala bear (Fig. 10.65-b) and Opossum.

Fig. 10.65 (a) Kangaroo

Fig. 10.65 (b) Koala bear

Sub-Class Eutheria (Placental mammals):

This group includes about 95% of the mammals which are wide spread and adapted to almost each and every habitat on the earth. They are viviparous placental mammals because the nourishment of the developing embryo before birth takes place, in the uterus of mother, by a special organ called the ***placenta***. The placenta is a connection between the mother and its developing young. Embryo receives oxygen and food from the mother's circulation and discharges the wastes

into her blood through the placenta. Embryo of placental mammals is much more secure in the uterus where all the essentials of life are guaranteed hence they are born in a far more advanced and almost completely developed form.

Hedge hogs (Fig.10.66-a), shrews, rats. squirrels, rabbits (Fig. 10.66-b) and ant-eater are small Eutherians. Ungulates, the hoofed mammals which includes sheeps, goats, cows, boars, deers (Fig.10.66-c), camels (Fig.10.66-d), giraffe, horses, donkey (Fig. 10.66-e), zebra, rhinoceros (Fig. 10.66-f) and hippopotamus are all herbivores and most of them are very useful to mankind. Small and big cats are a group of carnivores. Bear is an omnivore. Primate, the most evolved and intelligent group of animals includes lemurs, monkeys, apes, gorilla and man himself.

Fig. 10.66 (a) Hedgehog

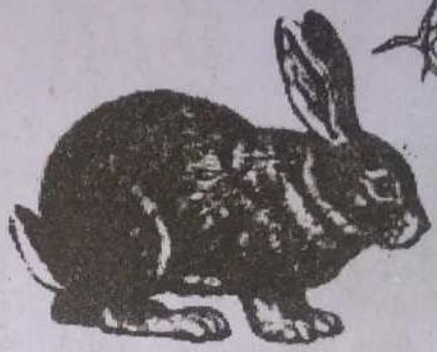


Fig. 10.66 (b) Rabbit

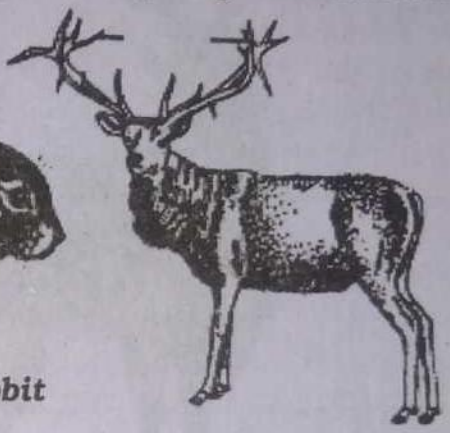


Fig.10.66 (c) Deer

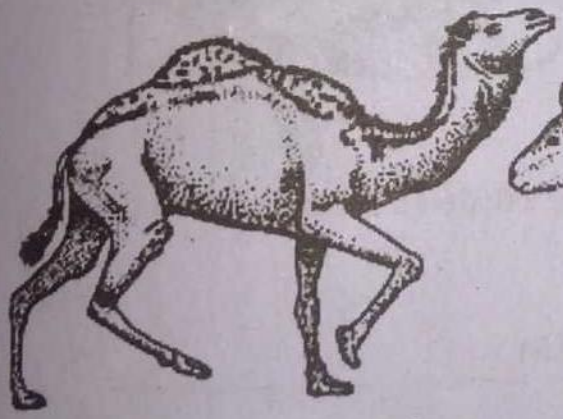


Fig. 10.66 (d) Camel

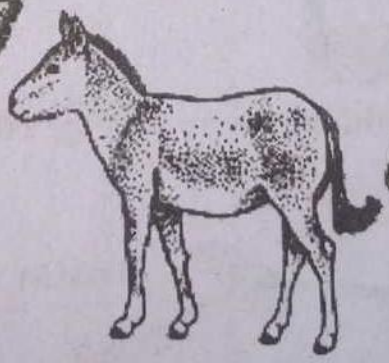


Fig. 10.66 (e) Donkey

Fig.10.66 (f) Rhinoceros

Among the large placental mammals elephants (Fig. 10.66-g) are terrestrial whereas whale the largest of all the animals are aquatic. Bats (Fig. 10.66-h) are the only flying mammals.

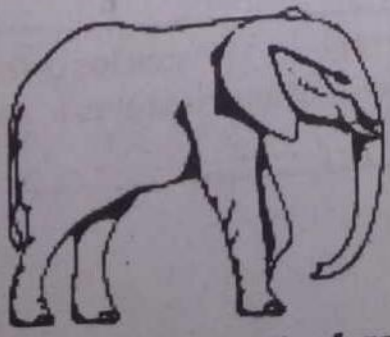


Fig. 10.66 (g) Elephant

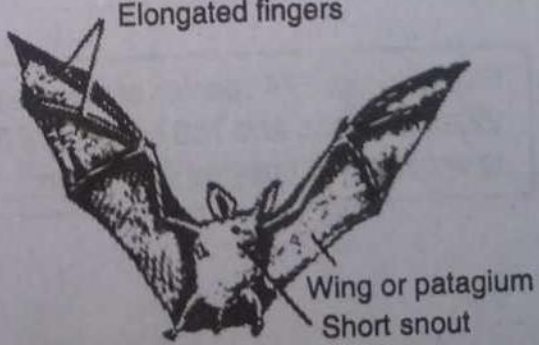


Fig. 10.66 (h) Bat

Pakistan has a large number of Bats and small placental mammal and a large variety of beautiful and useful ungulates. Goats, Buffalo and Donkey are found only in Pakistan and a few neighbouring countries. Markhor (wild goat) (Fig. 10.66-i), of which many varieties are found in our country, is the national animal of Pakistan. Rhesus monkey (Fig. 10.66-j) is a native of Pakistan whereas the beautiful snow leopard, of our northern areas, is an endangered species. Among the aquatic mammals blind dolphin (Fig. 10.66-k) still persists in small numbers in our river Indus.

Fig. 10.66 (i) Markhor (wild goat)

Fig. 10.66 (j) Rhesus monkey

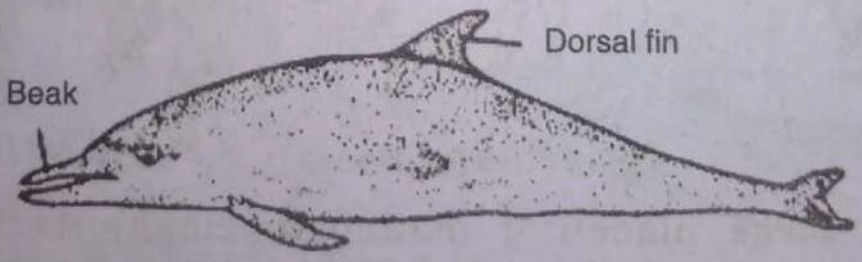


Fig. 10.66 (k) Indus dolphin

Pakistan has 174 species of mammalia, 670 species of birds, 177 species of reptiles, 22 amphibians and 788 species of fishes, 1182 species of invertebrates in addition to around 500 species of insects.

SUMMARYOF CHARACTERISTICS OF MAJOR ANIMAL PHYLA

Sr. No:	Name of Phylum and Approx. number of Spp.	Common Name	Cellular Organization	Symmetry	Fate of Blastopore	Digestive System and Bodycavity	Examples	Distinguishing Characteristics
1	Porifera 5,000 Spp.	Sponges	No tissue No cellular layer	Asymmet-rical	Protostome	None Acoelomate	Sycon,Euplectella, Bath sponge.	Choanocytes, Porocyte, Aquatic Filter, Canal System.
2	Cnidaria 9,000 Spp.	Coelenterates	Tissues, Diploblastic	Radial	Protostome	Coelenteron Acoelomate	Hydra, Jelly Fish Sea Anemone.	Cnidocytes, Polymorphism, Alternation of generation.
3	Platyhelminthes 15,000 Spp.	Flat worms	Organs, System Triploblastic	Bilateral	Protostome	Much branched enteron with mouth only acoelomate	Planaria, Liver-fluke, Tape worm.	Flat dorso-ventrally with head lobes, Suckers and Hooks, Free living or parasite.
4	Nemathehelminthes 20,000 Spp.	Round worms	Organ system Triploblastic	Bilateral	Protostome	Pseudocoele. Intestine with mouth & anus	Ascaris, Thread worm, Hook worm.	Cylinderical with tapering end. Male shorter. Usually parasite.
5	Annelida 15,000 Spp.	Segmented worms	Advanced organ system Triploblastic	Bilateral	Protostome	Coelomate. Developed gut	Nereis, Leech, Earth worms.	Metameric segmentation, Setae, Parapodia or suckers.
6	Mollusca 85,000 Spp.	Molluscs	Organ system Triploblastic	Bilateral	Protostome	Coelomate. Developed gut	Unio, Pila, Sepia, Squid, Oyster, Octopus, Nautilus.	Mantle, Radula, Shell, Foot.
7	Arthropoda 10,00,000 Spp.	Arthropods	Advanced organ system Triploblastic	Bilateral	Protostome	Coelomate. Developed gut	Prawn, Crab, Insects, Centipedes, Millipedes.	Exoskeleton Chitinous, Jointed appendages Haemo-coel, Sense organs developed, Mouth parts specialized, Ecdysis.
8	Echinodermata 6,000 Spp.	Echinoderms	Organ system Triploblastic	Pentaradial	Deuterostome	Coelomate. Developed gut	Sea star, Brittle star, Sea urchin, Sea cucumber.	Water vascular system, Bony plates, Tube feet, Skin spiny, Larvae many types.
9	Chordata 45,000 Spp.	Chordates	Most advanced organ system triploblastic	Bilateral	Deuterostome	Coelomate. Developed gut	Fish, Frog, Snake, Bird, Rat, Cat, Cattle, Monkey, Ape, Man.	Notochord, Pharyngeal gill, Hollow dorsal nerve cord, Cranium, Post anal tail etc.

KEY POINTS

- Animals the members of kingdom Animalia are eukaryotic, multicellular heterotrophs which reproduce sexually and are usually motile.
- Animalia is the most diversified group as far as number of species is concerned. They range in size from microscopic to very huge organisms.
- They vary from simplest to most complex individuals.
- Animals are thought to have evolved from a volvox like protoctist.
- Kingdom Animalia is classified into about 33 major groups called phyla, on the basis of their phylogenic relationship.
- Phylogeny is traced on the basis of comparative study of their body plan and their developmental patterns.
- Most animals have a recognizable symmetry, either radial or bilateral. Sessile animals usually exhibit radial symmetry whereas motile animals are usually bilaterally symmetrical.
- All animals but sponges have a digestive cavity. Most animals have a body cavity (a pseudocoelom, coelom or haemocoel) between their body wall and digestive tube.

Protostome and deuterstomes differ in early embryological development and fate of blastopore. In protostomes blastopore forms the mouth whereas in deuterostomes blastopore transforms into anus.

Sponges are aquatic animals circulating water in the canals present in their bodies to trap the food and discharge wastes and gametes.

Cnidarians are aquatic, radially symmetrical diploblastic animal with two body forms polyp and medusa. They are equipped with special stinging cells the cnidocytes.

Platyhelminthes, commonly called flatworms are thought to be ancestors of most of the phyla except porifera and cnidaria.

Some flatworms are free living but most are endoparasites. They are bilaterally symmetrical with well developed organ systems. They exhibit beginning of cephalization.

- Round worms of phylum Nemathelminthes are the most abundant animals. Most of them are free living whereas many are parasites. They are bilaterally symmetrical, cylinderical organisms with a fluid filled pseudocoelom.
- Annelids are bilaterally symmetrical, segmented worms with a true coelom and well-developed head and organ systems.
- Mollusca are bilaterally symmetrical, non-segmented coelomate animals whose body can be divided roughly into a head-foot, a visceral mass and a mantle. A teeth bearing redula is a unique molluscan structure as is the shell.
- Arthropoda constitute the most diverse phylum. They are bilaterally symmetrical, segmented animals that are covered over by a chitinous exoskeleton and are equipped with jointed appendages. The coelom is reduced whereas a fluid filled body cavity the haemocoel is prominent.
- Insects evolved wings and became the first animals to fly.
- Echinoderms are radially symmetrical pentramous animals with a unique water vascular system. Body is covered over by spiny calcareous plates and thousands of tiny multipurpose tube feet.
- Hemichordata, once considered true chordates, are now classified as a small separate phylum, between invertebrata and chordata.
- Chordata, the most advanced phylum includes a small number of invertebrate protochordates and the vertebrates (Fishes, Amphibians, Reptiles, Birds and Mammals).
- All chordates are bilaterally symmetrical animals that are characterized by a notochord, a hollow dorsal nerve cord and pharyngeal gill slits. Many have post-anal tail.

EXERCISE

1. Encircle the correct choice:

(i) True animals are:

(a) Non-cellular (b) Unicellular
(c) Multicellular (d) Prokaroytic

(ii) Annelids are:

(a) Acoelomate (b) Pseudocoelomate
(c) Coelomate (d) Haemococoelomatic

(iii) Group deuterostomata includes phylum:

(a) Chordata (b) Annelida
(c) Arthropoda (d) Deuterostomes

(iv) Insects have:

(a) 3 pairs of legs (b) 4 pairs of legs
(c) 5 pairs of legs (d) 6 pairs of legs

(v) Largest fishes are:

(a) Whales (b) Sharks
(c) Cuttle fish (d) Jelly fish

(vi) Farming of honey bees is called:

(a) Agriculture (b) Apiculture
(c) Sericulture (d) Culture

(vii) Which one of these is a fish:

(a) Star fish (b) Jelly fish
(c) Sea horse (d) Cuttle fish

(viii) A characteristic feature of Echinoderms is:

(a) Water vascular system (b) Canal system
(c) Tracheal system (d) None of them

(viii) Lamprey has:

(a) No jaws (b) No tongue
(c) No teeth (d) No vertebra

(ix) Chondrichthyes have an exoskeleton of:

(a) Placoid scales (b) Cycloid scales
(c) Ctenoid scales (d) Epidermal scales

(xi) Skin in amphibia is:

(a) Naked (b) Covered by scales
(c) Covered by hair (d) Calcareous plates

(xii) Sound producing organ in birds is:

(a) Syrinx (b) Tongue
(c) Larynx (d) Pharynx

(xiii) Teeth in mammals are:

(a) Homodont (b) Heterodont
(c) Acrodont (d) Polyphydont

(xiv) Kangaroo is:

(a) An egg laying mammal (b) Marsupial mammal
(c) A placental mammal (d) Oviparous

(xv) Bat is:

(a) A bird (b) An insect
(c) A mammal (d) A reptile

Write detailed answers of the following questions:

(i) Discuss the basic factors which help in classification of animals.

(ii) Describe the important characters of phylum Cnidaria. Also discuss diploblastic organization, polymorphism and alternation of generation.

(iii) Discuss the parasitic adaptations in worms. Name three parasitic nematodes and their pathogenicity.

(iv) Write down the important characters of phylum Annelida. Give the names, characters and examples of its classes.

(v) Write down the basic characters of phylum Arthropoda and three of its classes. Give examples.

(vi) Classify mollusca upto classes. Give characters and examples of each class.

(vii) Discuss the salient features of class Insecta. What structural and physiological modifications they have undergone to become the most successful group of animals.

(viii) Discuss the important characters of Echinodermata and its affinities.

(ix) How did reptiles become fully adapted for a complete terrestrial life? Name some important reptiles of Pakistan.

(x) What are mammals? Name its sub-classes. Give the characters and examples of each sub-class.

3. Write short answers of the following questions:

(i) Name various types of canal system in Porifera. What are its functions?

(ii) Define the terms alternation of generation and polymorphism.

(iii) What features made the arthropods a successful group?

(iv) What is coelom, pseudocoelom and heamocoel?

(v) What are the three most common characters of molluscs?

(vi) Name various types of mouth parts present in insects. Give one example of each.

(vii) Describe the three basic Chordate characters.

(viii) How would you differentiate between a bony and a cartilagineous fish?

(ix) Name the common groups of edible fishes. Mention their common names.

(x) What are lung fishes? What is their importance?

(xi) Differentiate between hibernation and aestivation.

(xii) Archaeopteryx is a connecting link between reptiles and birds. Prove.

(xiii) What adaptations made the birds capable of flight?

(xiv) What is a placenta? What are its functions?

(xv) Define diploblastic and triploblastic.