CHAPTER 1

Biology and Living Things

Science is the systematic study of natural phenomena in our environment. It consists of the accumulated knowledge of any subject and the methods by which discoveries are made. Biology, one of the basic sciences, can be defined as the study of living things – plants and animals. Biology is often divided into many branches. That is, botany, the study of plants; zoology, the study of animals; anatomy, the study of the structure of organisms and physiology, the study of how organisms function.

Methods of inquiry in biology

Biology, like any other natural sciences, is concerned with the search for knowledge using the five senses. All scientific investigations or inquiries usually start with observations. These lead to the identification and statement of a problem. The scientist forms an hypothesis (scientific guess) or a tentative answer. The hypothesis is tested by carrying out **experiments**. During an experiment, the scientist carries out many activities such as measurement, classification, controlling variables, interpreting data, inference, generalization and prediction.

The **results** of scientific experiments, including biology experiments, are usually recorded and can be used to show whether the hypothesis is true or false. If subsequent experiments show that the hypothesis is true, it will become the basis of a scientific theory, which may be accepted as a natural law. However, if a hypothesis is proved to be false, the scientist has to think again. This sequence of events, which forms the scientific method of inquiry, is shown is Fig. 1.1.

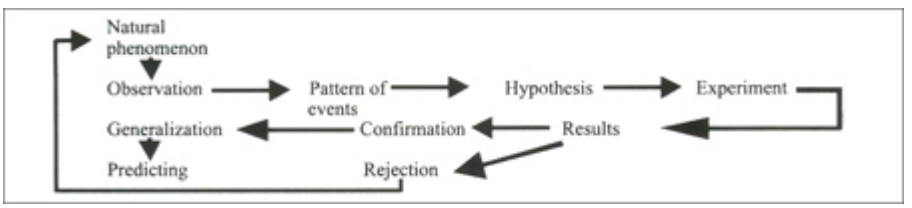

Fig. 1.1 Main stages in the scientific method of inquiry

Control in scientific experiments

All scientific experiments must be performed under controlled conditions. In fact, controls are widely used in biology experiments.

The â€˜controlâ€™ is that part of an experiment in which the organism being observed is not deprived of the factor being investigated. For example, in an experiment to demonstrate that light is necessary for photosynthesis, one **de-starched**, potted plant is placed in a dark cupboard and another one is kept in sunlight. The one placed in sunlight is the control, the former is the experimental plant. The variable being investigated is the effect of light. Thus, the experimenter can be sure that any observed change is caused by the presence of light in one situation and its absence in the other.

In learning biology, it is common to observe the structures of organisms in relation to their functions. We also compare and contrast the features of organismsâ€™ physiological and physical processes.

Furthermore, in performing and reporting any biological experiment, you must always include a control. Conclusions drawn from biology experiments without reference to controls are considered as invalid and inconclusive. Besides, when such reports are presented in examinations, the conclusion drawn thereof does not carry any score.

In reporting any experiment, always ensure that you include the following features:

1. **Aim:** State the purpose of the experiment.
2. **Apparatus:** List the apparatus used.
3. **Method:** Describe in detail every step you take in performing the experiment including any precautions you have taken.
4. **Observation:** Record all reactions or all that happened from the beginning to the end of the experiment.
5. **Conclusion:** Draw conclusions from the results you obtained and your observations.

Usefulness of Science

Science has been found to be of utmost importance in every facet of life and our daily living.

1. *Healthy living and improved way of life:* The knowledge of science has made man aware of the various components of his body and how to use them to best advantage. Technology which is the application of science has led to the discovery of many useful home appliances that make life more comfortable and make doing household chores easier and interesting. The invention of home appliances such as cookers, toilet facilities, washing machines, microwave ovens, refrigerators and freezers are good examples.
2. *In agriculture*, science has found ways of doing more work in a shorter time using less labour and getting higher yield through mechanization. Knowledge of science has also led to the discovery of better crop grades through hybridisation, using knowledge of genetics.
3. The importance of *communication* in every day life can not be

overemphasized. Science has so much improved commmunication networks that the world has become a global village, with news and information reaching extreme ends of the poles in minutes through phones, fax, internet – computer, e-mail, etc.

4. *Medically*, science has helped in the discovery of drugs to cure various ailments; thus reducing death rates. It has also helped in providing ways and means of avoiding diseases through preventive medicine and enlightening/educating people on how to live in clean and healthy environments.
5. *Transportation:* Distances have become shortened and risks to life reduced due to improved means of travelling and construction of good roads.

Characteristics of living things

All organisms except viruses can be classified into two groups: **living and non-living things**. The following are the activities which living things normally perform but which non-living things cannot perform.

1. *Movement* – Animals can move from place to place of their own accord for protection or in search of food and mates. Higher plants only move certain parts of their body in response to growth or external stimuli (tropism and nastic movement). Some organisms e.g. *Euglena* which have both animal and plant features can move about.
2. *Respiration* – To be able to perform the numerous processes of life, living things need plenty of energy which they can only obtain when they respire. In the mitochondria of every living cell, energy is liberated from food substances all the time. This is done with the help of different enzymes whether or not oxygen is present.
3. *Nutrition* – While green plants can manufacture their own food using simple inorganic materials like CO_2, water and sunlight (autotrophic nutrition), all animals depend on plants directly or indirectly for their food (heterotrophic nutrition).
4. *Irritability* (sensitivity) – This is the ability of living things to respond to stimuli (e.g. hunger, thirst or pain) in order to survive. stimuli could be external, e.g. heat, light, water, sound and chemical substances, or internal, e.g. hunger, thirst, pain.
5. *Growth and repair* – When organisms are young, they tend to increase rapidly in length or size and in mass. They use food for this purpose. Part of the blood is also used to repair or replace the damaged or old parts of their bodies.
6. *Excretion* – Waste products are always produced from the various chemical reactions going on in living cells. To ensure the proper functioning of the body of organisms, poisonous waste products and other unwanted substances have to be eliminated or excreted.
7. *Reproduction* – At maturity, living things usually produce new or young ones (offsprings). It occurs either sexually or asexually.
8. *Death* – Every organism has a definite and limited period of existence. Death occurs when conditions are unfavourable for life

processes. In general, life has five main stages: origin (birth), growth, maturity, decline and death.

9. *Competition* – Living things tend to struggle for many of the necessities of life in order to survive. Hence, organisms usually compete for natural resources such as food, light and space.
10. *Adaptation* – In order to survive, every organism possesses the ability to adapt to changes in its environment. The inability of an organism to do so leads to its extinction.

The main differences between plants and animals are shown as follows:

Table 1.1 Differences between plants and animals

Plants	Animals
1. Green plants photosynthesize (autotrophic), non-green, plants cannot (heterotrophic).	They cannot photosynthesize (heterotrophic)
2. Usually fixed or stationary	Usually mobile (can move about).
3. Have no fixed number of parts and continue branching	Have fixed number of parts and usually compact.
4. Growth is lateral, apical and intercalary and continues throughout life.	Growth occurs throughout the body (intercalary) and stops at adulthood.
5. Responses to stimuli are usually slow.	Responses to stimuli are usually fast.
7. Store carbohydrates as starch except fungi which store carbohydrates as glycogen.	Store carbohydrates as glycogen.
8. Cell has rigid, non-living cellulose cell wall	Cell has thin, flexible, living cell membrane.
9. Reproduction is both sexual and asexual	Reproduction is sexual

The Case of Viruses

Viruses are microscopic organisms exhibiting the characteristics of living and non living things. Thus they can not be classified as either. A virus is made up of an acid (i.e. Ribonucleic acid RNA or deoxyribonucleic acid DNA) enclosed in a protein coat.

The characteristics of viruses include

(1) the ability to grow and reproduce inside a host cell.
(ii) the ability to transmit its genetic material from parent to offspring.
(iii) the possession of nucleic acid.

Viruses are considered non living because:

(i) they do not respire, excrete or carry out irritability;
(ii) they do not reproduce outside the host;
(iii) they have no nucleus and no cytoplasm;
(iv) they can exist in form of cysts.

Some non-living things would appear to carry out some of the characteristics described of living things. For example, a car moves, feeds on petrol, a crystal of copper sulphate $CuSO_4$ increases in size (grows); a computer reacts to impulses. These do not make them to be living as they do not carry out all the processes. Moreover, these processes are innate to living things.

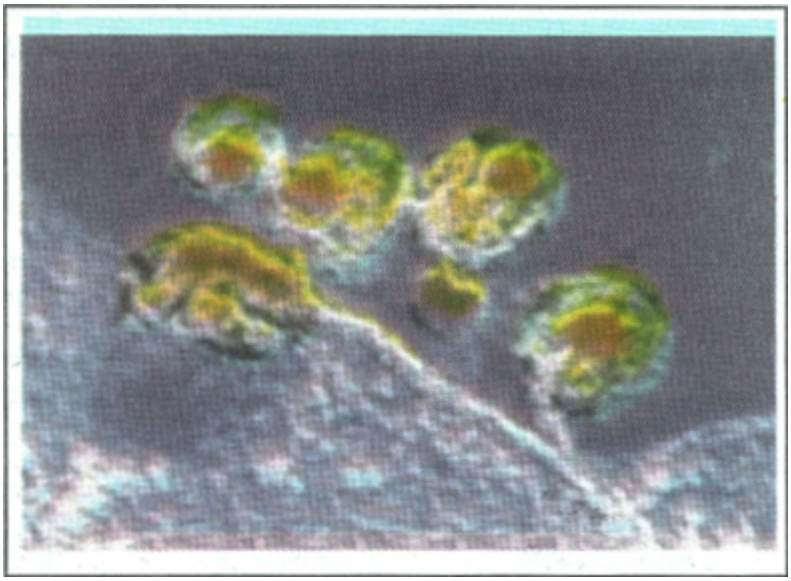

Fig. 1.2 Human Imunno Deficiency Virus (as seen under an electron microscope)

Classification of living things

Since there are many different kinds of organisms on earth, scientists have devised a way of classifying them. A classification is merely an arrangement into groups. Each group is then split into smaller groups. The members of each group have certain features in common which distinguish them from other groups.

Organisms are first split into kingdoms such as the Monera, Protista, Fungi, Plantae and Animalia. The kingdoms are split into a large number of smaller groups called phyla (singular: phylum). All the members of a phylum have certain features in common. Each phylum is broken down into classes, classes into orders, orders into families, families into genera (singular: genus); genera into species. Each of these groups contain fewer types of organisms. Hence, while a phylum contains a wide variety of organisms, which have certain fundamental differences among them, the organisms that belong to a genus are all very similar.

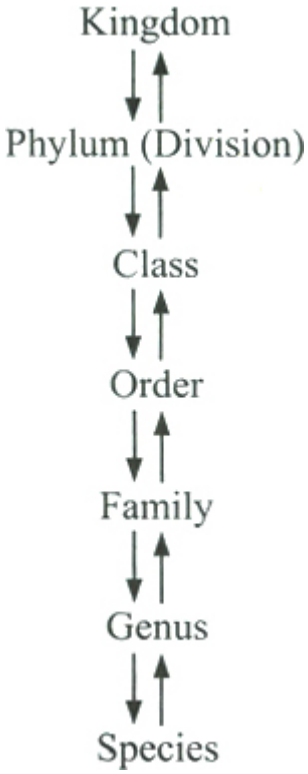

Fig. 1.3 Classification of Living things

Table 1.2 Major groups in biological classification using humans and dogs

	Human	**Dog**
Kindgom	Animalia	Animalia
Phylum or Division*	Vertebrata	Vertebrata
Class	Mammalia	Mammalia
Order	Primata	Carnivora
Family	Hominidae	Canidae
Genus	Homo	Canis
Species	*H. sapiens*	*C. Familiaris*

**Division is usedfor plants and phylum for animals*

Species is the smallest natural category of organisms. All members of a species can cross breed but a member of a specie cannot cross breed with a member of another species. For instance, humans *(H. sapiens)* cannot cross-breed with dogs *(C. familiaris)*.

Every species is usually given two names: a generic name and a specific name. This is a Binomial system developed by the Swedish biologist, Carl Von Linnaeus (1707 – 1789). The generic name is common to all the species in a genus.

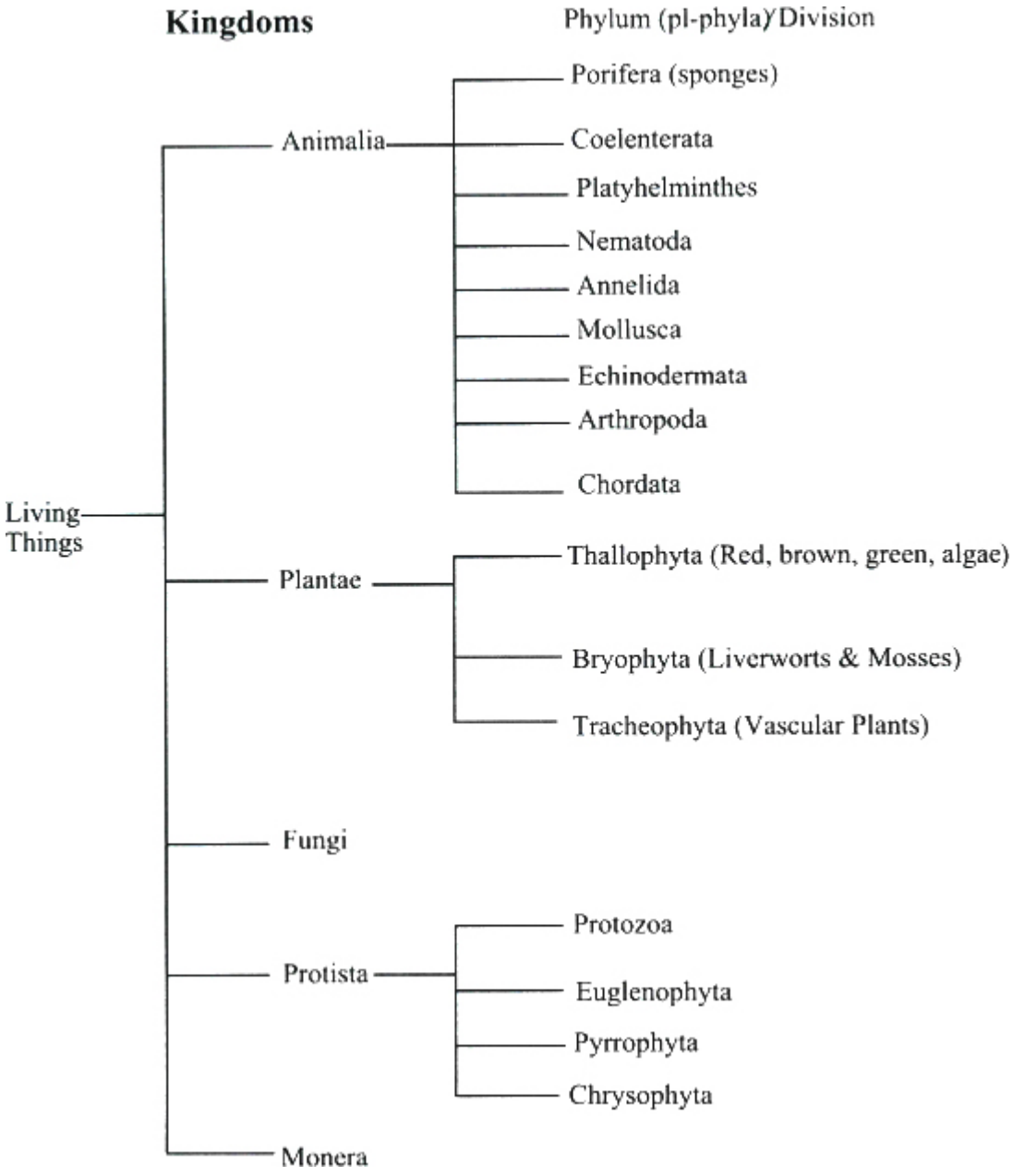

Fig. 1.4: Major groups of Living things

For instance, *Canis lupus* (Wolf), Canis *latress* (the Coyote) and *Canis aureus* (the golden jackal) are different species belonging to the same genus.

The generic name is always written first using a capital letter. Scientific names are always underlined when written and in italics when printed. Whenever we refer to numerous species that belong to the same genus, we only need to write the generic name in full for the first organism e.g. *Canis familiaris, C. lupus* and C. *aureus.*

Let us now examine the major groups of organisms. Before going into details, look at *Fig. 1.4*. This shows you, at a glance, the major groups into which organisms are divided. This is but only one of the classifications commonly used. We will then briefly examine each group of living things shown in *Fig. 1.4*.

Kingdoms of Living Things

In the earliest classification made by scientists, living things were grouped into two kingdoms namely:

Kingdom Plantae

Kingdom Animalia

This was found to be highly limiting as more organisms were discovered that could not be classified as either plants or animals. **A** third kingdom — **Protista**, was created for micro organisms. The realisation that putting fungi in the plant kingdom was inappropriate led to the creation of a separate kingdom, as fungi lack cell walls made of cellulose which is a primary feature of plants. Rather, they have cell walls made of chitin. The fifth Kingdom, **Monera**, consists of organisms that are prokaryotic, e.g. blue, green, algae.

Kingdom Monera

This kingdom consists of two main phyla. The phylum schizophyta (the bacteria) and the phylum cyanophyta (the blue-green algae). They have the following characteristics:

(i) They are unicellular.

(ii) They are prokaryotic, i.e. their cells lack definite nucleus.

(iii) Their cells lack cell organelles such as mitochondria, chloroplasts and endoplasmic reticulum.

(iv) Reproduction is asexual, i.e. by binary fission in schizophytes and cell division in cyanophytes.

Kingdom Protista

There are four phyla in this kingdom namely:

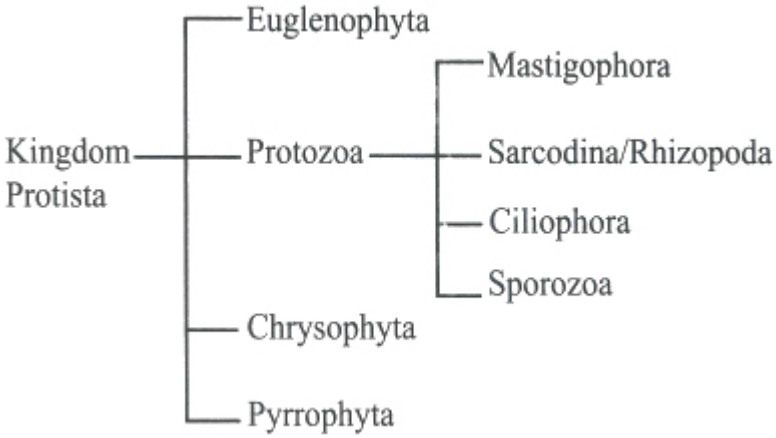

Fig. 1.5: Classification of Kingdom Protista

Protozoa, euglenophyta, chrysophyta and Pyrrophyta. They are microscopic, unicellular and eukaryotic organisms. They are the first set of organisms to show motility by posessing various forms of locomotory organelles such as cilia, (small needle-like structures), pseudopodia and flagella. This is a form of advancement over the kingdom Monera. In addition asexual reproduction is observed in some protists, e.g. Paramecium (class ciliophora) by fusion of gametes.

Phylum Protozoa e.g. Amoeba, Paramecium, Sporozoa and Zooflagellates: There are four classes under this phylum based on the presence or absence of locomotory organs. Most protozoans are aquatic or endoparasitic, unicellular and microscopic.

Class Sarcodina/Rhizopoda e.g. Amoeba

1. They possess pseudopodia as organs of locomotion (see Fig. 1.6).
2. Most species of amoeba live in fresh water, some live in the sea and others in damp soil.
3. A few species of amoeba are parasitic and may cause diseases such as amoebic dysentery.
4. Reproduction is asexual, i.e. by binary fission.
5. By forming the pseudopodia which they use for locomotion and to capture food, amoeba is constantly changing its shape thereby making it irregular in shape.

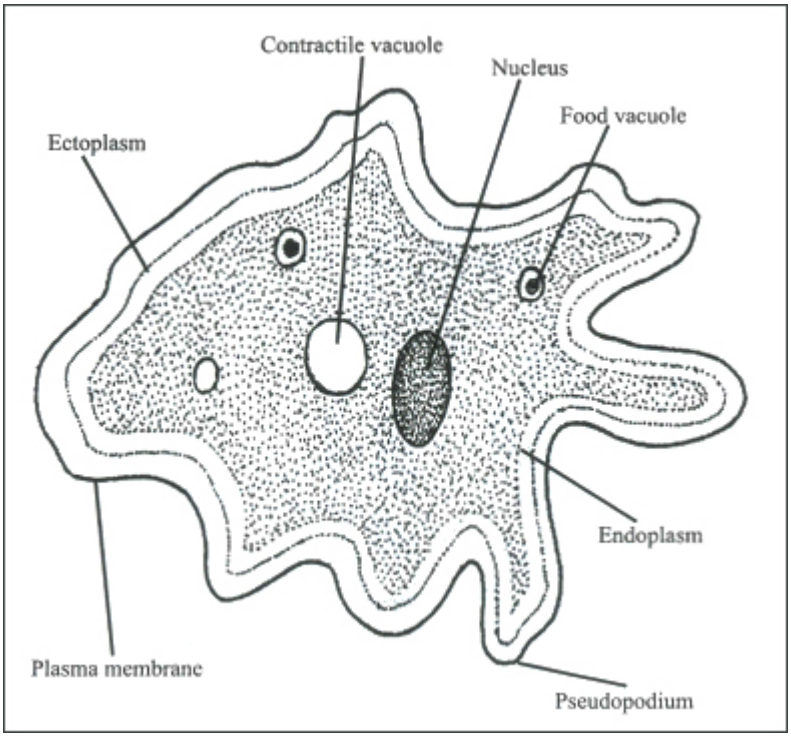

Fig. 1.6 Amoeba

Class Mastigophora e.g. Trichonympha Trypanosoma (see Fig. 1.7)

1. They are classified by the posession of flagella for locomotion.
2. The trichonympha is a symbiont, living in the intestine of termites helping them to digest wood while Trypanosoma is an endoparasite living in the blood stream of wild antelopes. Trypanosomones are transmitted through the bites of tsetse flies to cause sleeping sickness in man and a disease called â€˜naganaâ€™ in cattle.

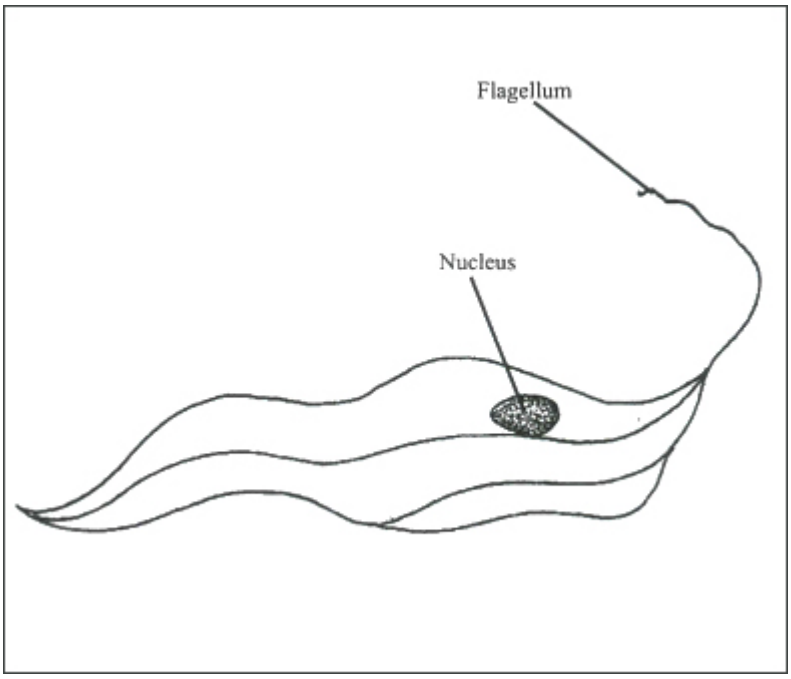

Fig. 1.7 Trypanosoma

3. The phytomastigophorans are plant-like and feed holophytically while the Zoomastigophorans feed holozoically.
4. Reproduction is asexual by binary fission.

Class Sporozoa e.g. (i) Plasmodium
(ii) Monocystis (see Fig. 1.8)

1. All members of this class lack locomotory organelles.
2. They are all parasitic.
3. At one stage or the other in their life histories they form resistant spores.
4. Reproduction is sexual and asexual.

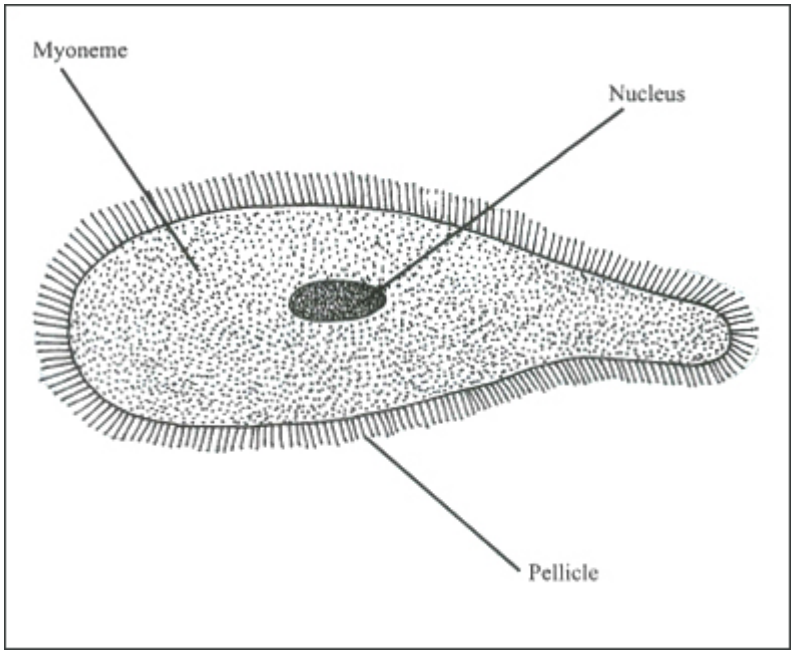

Fig. 1.8 Monocystis

Class Ciliophora e.g. Paramecium (see Fig. 1.9) and vorticella.

1. This class contains the most advanced/ complex protozoans.
2. They possess cilia for locomotion and feeding.
3. They possess two nuclei; a macronucleus for controlling cell activities and a micronucleus which is important in sexual reproduction.

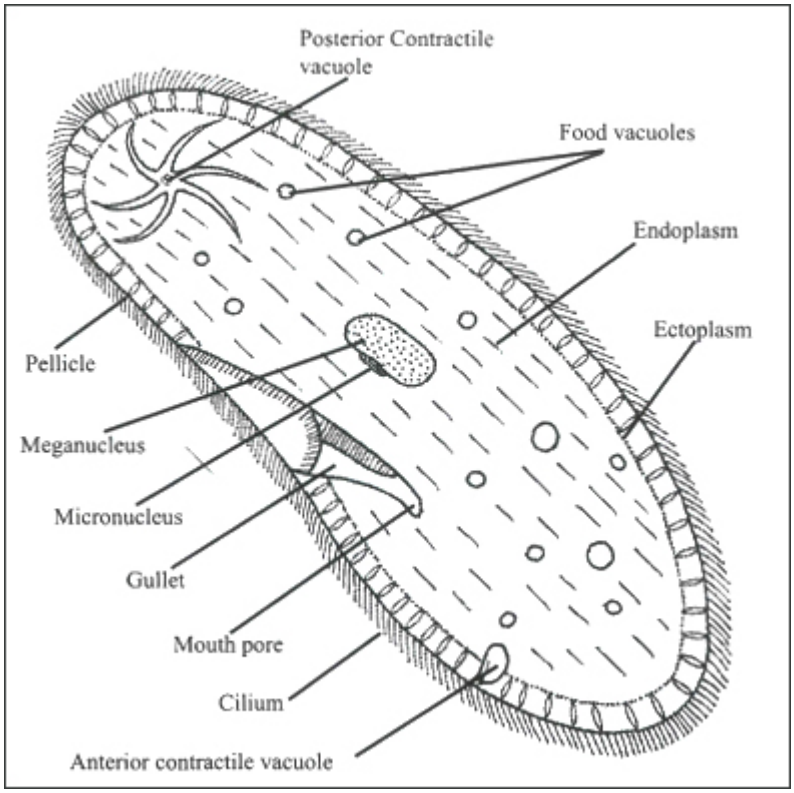

Fig. 1.9 Paramecium

4. Some members have two contractile vacuoles placed, anteriorly and posteriorly.
5. Reproduction is asexual by longitudinal division, sexual by fusion of gametes.

Phylum Euglenophyta and Pyrrophyta

Members of the phyla Euglenophyta and Pyrrophyta are similar because:

1. They possess one or two flagellae which are whiplike structures for locomotion and feeding.
2. They are both unicellular and aquatic.
3. They both possess plant-like features, e.g. the Euglena — a euglenophyte has chlorophyll while the dinoflagellate has a cellulose cellwall.

They differ in the possession of pellicle, in the case of Euglena in place of cellwall. Euglena possesses feature of plants and animals.

Plant features of Euglena

1. Possession of chloroplasts which contain chlorophylls â€˜aâ€™ and â€˜bâ€™
2. Asexual reproduction.
3. Storage of excess starch in form of paramylum granules.

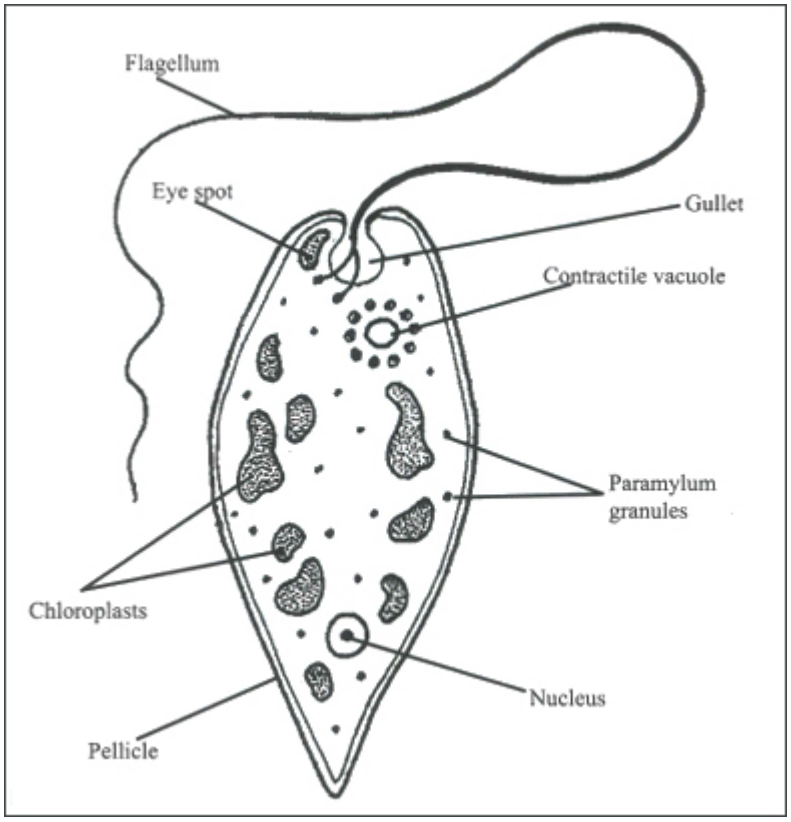

Fig. 1.10 Euglena

Animal features

1. Possession of eye spot for light detection.
2. Possession of pellicle in place of cell wall.
3. Possession of flagellum for locomotion.

Phylum Chrysophyta (Diatoms)

Diatoms are aquatic organisms that vary in shape and colour.

1. They are usually brownish or brownish-green. Some species possess yellow carotenoid to give a golden colour.
2. They possess rigid cell walls which lack cellulose but are fortified with silicon compounds.
3. They possess no visible means of propulsion but move along slowly with the current.

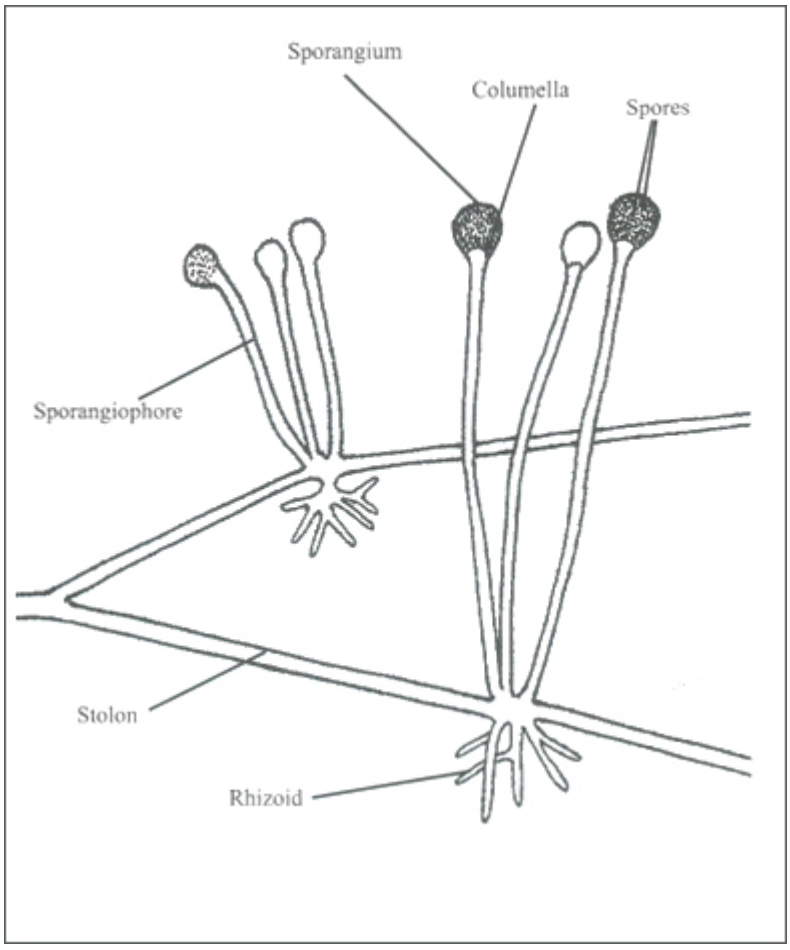

Fig. 1.11 Rhizopus

Kingdom Fungi

Fungi are not plants because:

1. They have no roots, stems or leaves.
2. They lack chlorophyll and are unable to photosynthesize. Rather, they are heterotrophic. Some feed saprophytically on complex organic substances, some are parasitic, some are symbiotic.
3. Their cell walls are not composed of cellulose but chitin.
4. Their bodies are built of long thread like filamentous processes called **hyphae** which form a mass of **mycelium.**
5. They store excess food in form of glycogen.
6. Fungi reproduce asexually by formation of spores and some sexually by conjugation.
7. They possess root-like structures called **rhizoids** and stem-like structures called **stolon** (see Fig. 1.11)
8. They are of economic importance. This is because they bring about the decay of dead organic matter thereby recycling nutrients in nature.
9. Examples of fungi include moulds (bread mould or Rhizopus), mucor, mildews,yeasts, mushrooms and toadstools.

Suggested Practical Work

Take a slice of bread, moisten it with water. Leave it exposed in a warm, dark place. Examine it at intervals over a period of one week Note your observations.

Plant Kingdom

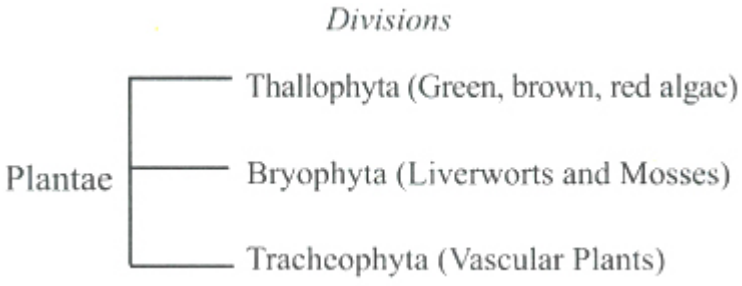

Fig. 1.12 Classification of Plant Kingdom

The plant kingdom consists of three main divisions (phyla).

Divison (Algae) Thallophyta

These can be further subdivided into Rhodophyta (red algae) chlorophyta (green algae) and phaeophyta (brown algae).

Algae are simple aquatic plants which do not have true roots, stems or leaves. They are either, unicellelular and microscopic e.g. chlamydomonas or multicellular e.g. spirogyra. They are mainly seaweeds and may be green (e.g. volvox), brown e.g. kelp or red depending on the pigment they contain which gives them their colouring.

In addition to chlorophyll, the brown algae which are usually large, contain fucoxanthin, while the red algae contains the pigment phycoerythrin.

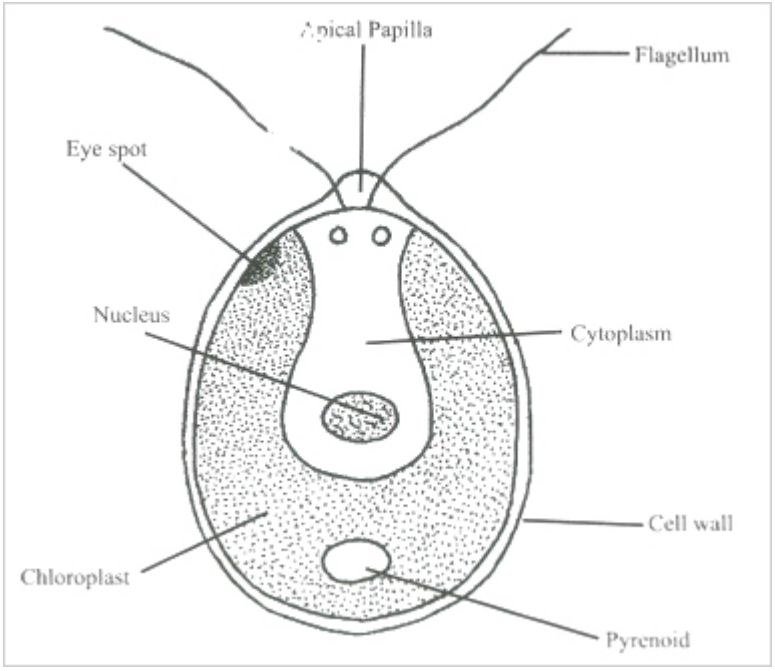

Fig. 1.13 Chlamydomonas

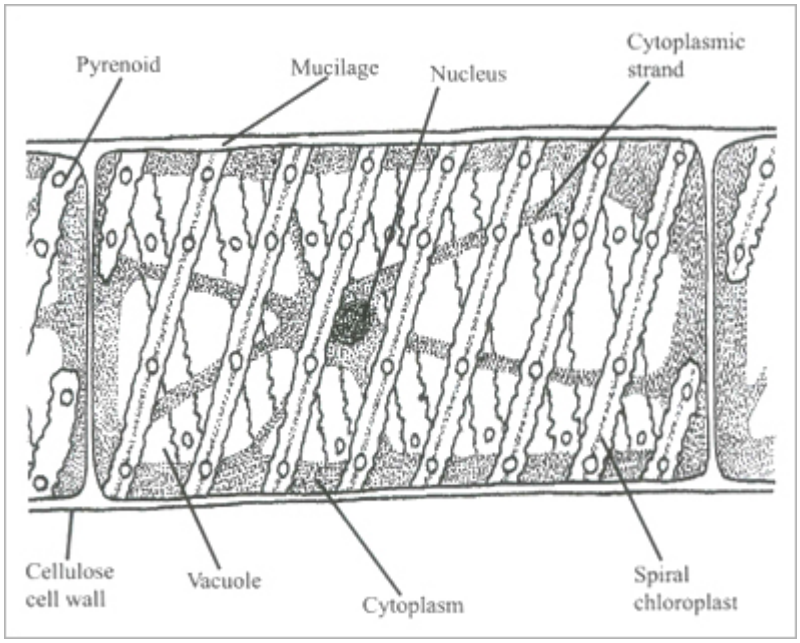

Fig. 1.14 Spirogyra

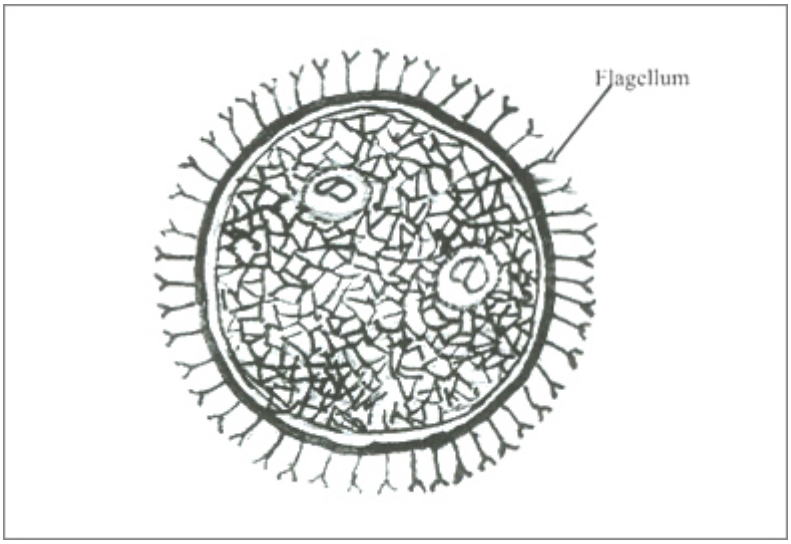

Fig. 1.15 Volvox

Of the three divisions, the green algae are the most primitive. They can exist as single free living like chlamydomonas (see Fig. 1.13) or in form of filaments, e.g. spirogyra (see Fig. 1.14) or in colonies, e.g. volvox (see Fig. 1.15).

Suggested Practical Work

From ponds, ditches and slow moving waters in your area collect specimens for identification. Were you able to identify spirogyra?

Division Bryophyta

Bryophyta are multicellular, non vascular plants. They lack true roots, stems and leaves. They possess chlorophyll and are found in moist places. Their structure is intermediate between the algae and the pteridophytes. Bryophytes do not grow singly, but in clumps or mats. They possess hair-like structures called rhizoids which penetrate the

soil, absorb water and anchor the plant. These differ from true roots in their lack of woody conducting cells. They have large, disc-shaped chloroplasts.

Bryophyta has two classes, namely: (i) Musci (Mosses) and (ii) Hepaticae (Liverworts)

They reproduce asexually by formation of spores and sexually by gametes.

Liverworts are more dependent on water and may be found along banks of streams and shady damp places, e.g. Marchantia. Mosses are found on tree trunks, walls of open drains, sides of ponds.

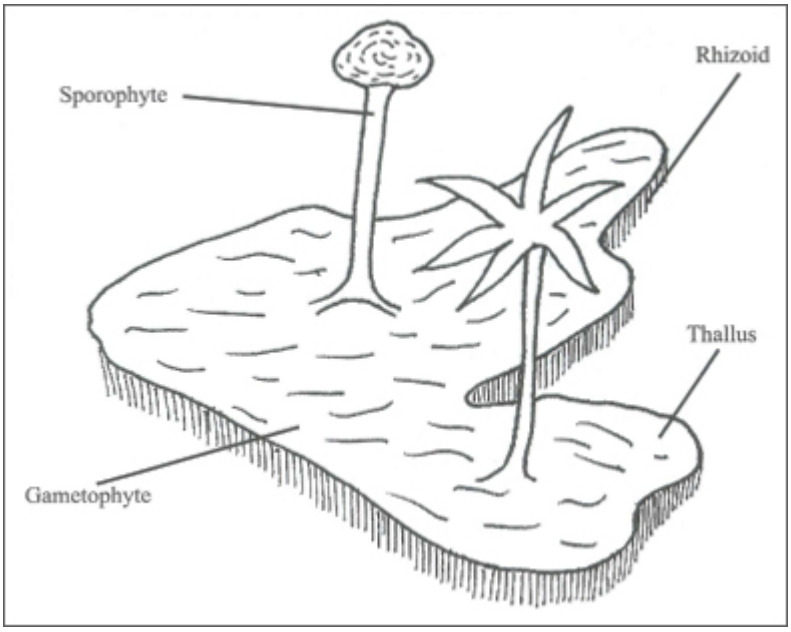

Fig. 1.16 Marchantia a liverwort

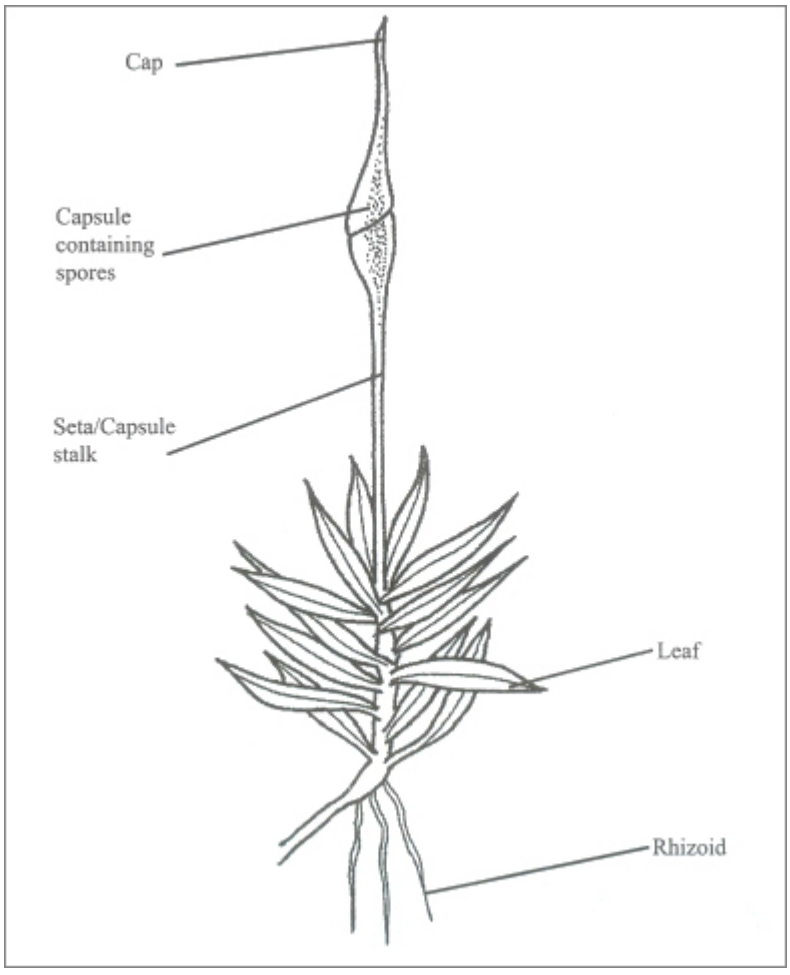

Fig. 1.17 Moss

What you can do

Gently scrap bryophytes off any damp place or tree trunk. Separate individual plants from a clump. Wash away any soil clinging. Examine their structures. Note the presence of the simple leaves and the rhizoids. How would you describe them? Did you get any with a capsule attached? What is the function?

Division Tracheophyta (Vascular Plants)

The division includes subdivisions **Pteridophyta, Gymnospermae** and **Angiospermae**. They have conducting vessels for food and water. They possess chlorophyll and they photosynthesize. Important members are:

1. *Class Filicinae (ferns)*: Ferns are multicellular plants with true roots, stems and leaves. They reproduce sexually by formation of spores which are borne in **sporangia**. The sporangia are grouped together in **Sori** found on the underside of leaflets as â€œbrown spotsâ€ They have large and feathery leaves.

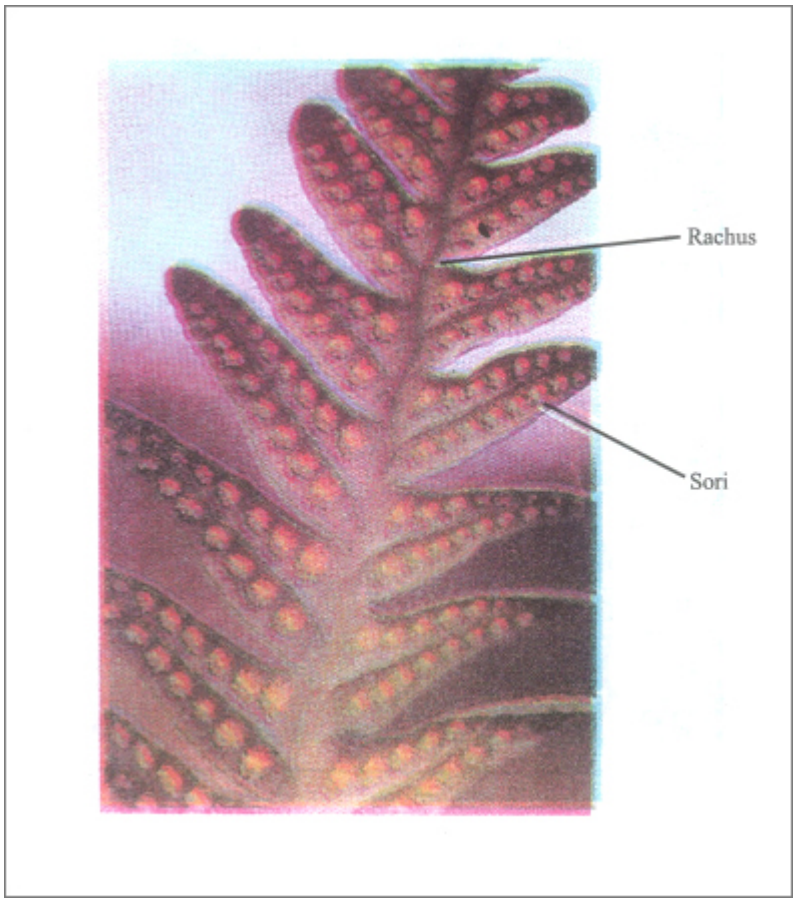

Fig. 1.18 Dryopteris (A fern)

2. Classes Coniferinae and cycadinae
   (i) They are mostly trees and shrubs.
   (ii) Conifers have thin needle-like leaves while Cycadsâ€™ leaves are large and fan like.
3. Their seeds have one integument and are borne naked in cones e.g. are Pinus and Cycas.
4. They are commonly called Gymnosperms.

Class Angiospermae (Flowering Plants)

These are terrestrial, multicellular green plants with well-developed vascular tissues. They have true roots, true stems and true leaves. They produce flowers, seeds and fruits but their most distinctive feature is the production of flowers. Their seeds are borne in fruits. They have a wide range of forms ranging from small herbs to large trees.

Angiosperms are further subdivided into Monocotyledons and Dicotyledons: Gymnosperms and Angiosperms are collectively called **Spermatophytes**. Examples of Monocotyledons include maize while those of Dicotyledons include orange, hibiscus.

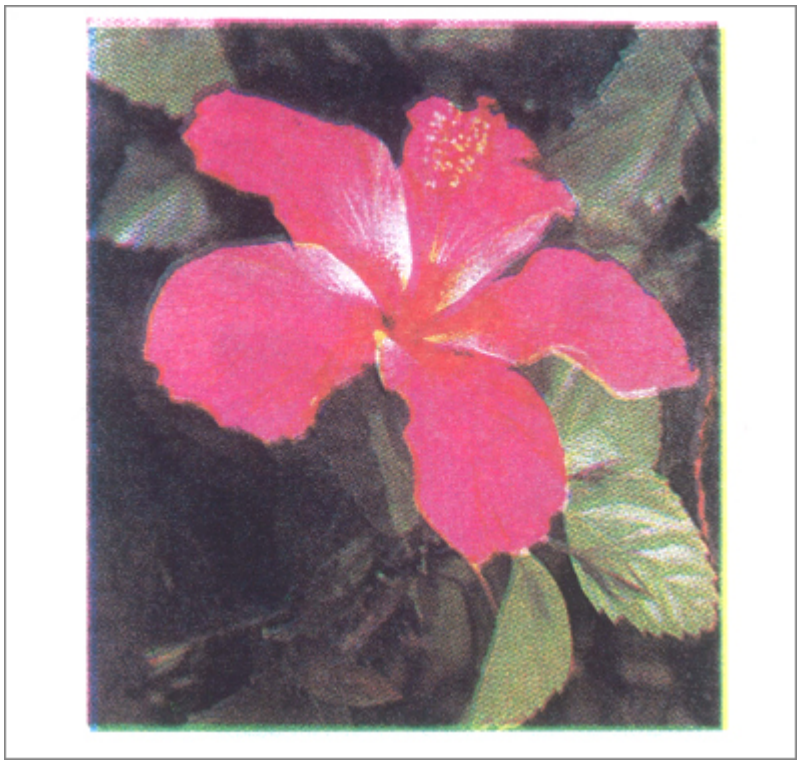

Fig. 1.19 Hibiscus

Animal Kingdom

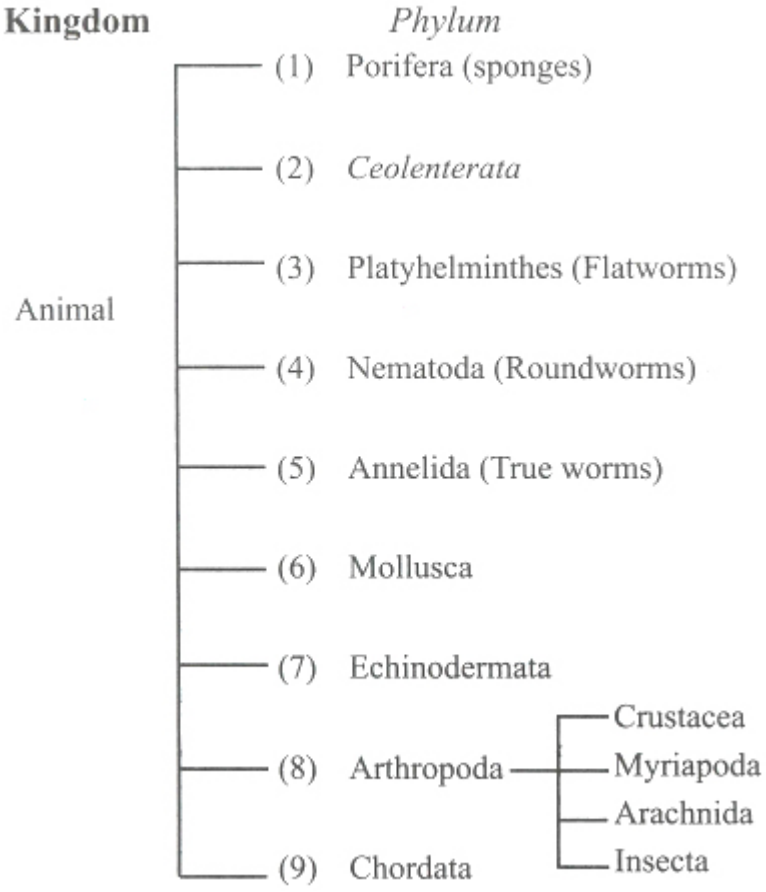

Fig. 1.20 Major groups of the Animal Kingdom

The first 8 phyla of the animal kingdom belong to the sub-phylum invertebrates, i.e. they are animals without backbone and internal skeletons while the phylum Chordata belong to the phylum Vertebrata, i.e. animals with backbone and internal skeleton

1. *Phylum Porifera* (sponges)

They are the most primitive group in the Kingdom Animalia. They are multicellular, sessile (they are moved by water current) aquatic organisms. Their body which is full of holes through which water is continually streaming is composed of two cell layers. Reproduction is asexual, i.e. by budding.

2. *Phylum Coelenterata*

These are multicellular animals with two layered bodies surrounding a central hollow cavity (enteron). They possess tentacles and sting cells. Most of them are aquatic. Examples are *Hydra* (see Fig 1.21b), jelly fish, sea anemone (see Fig 1.21a), and coral.

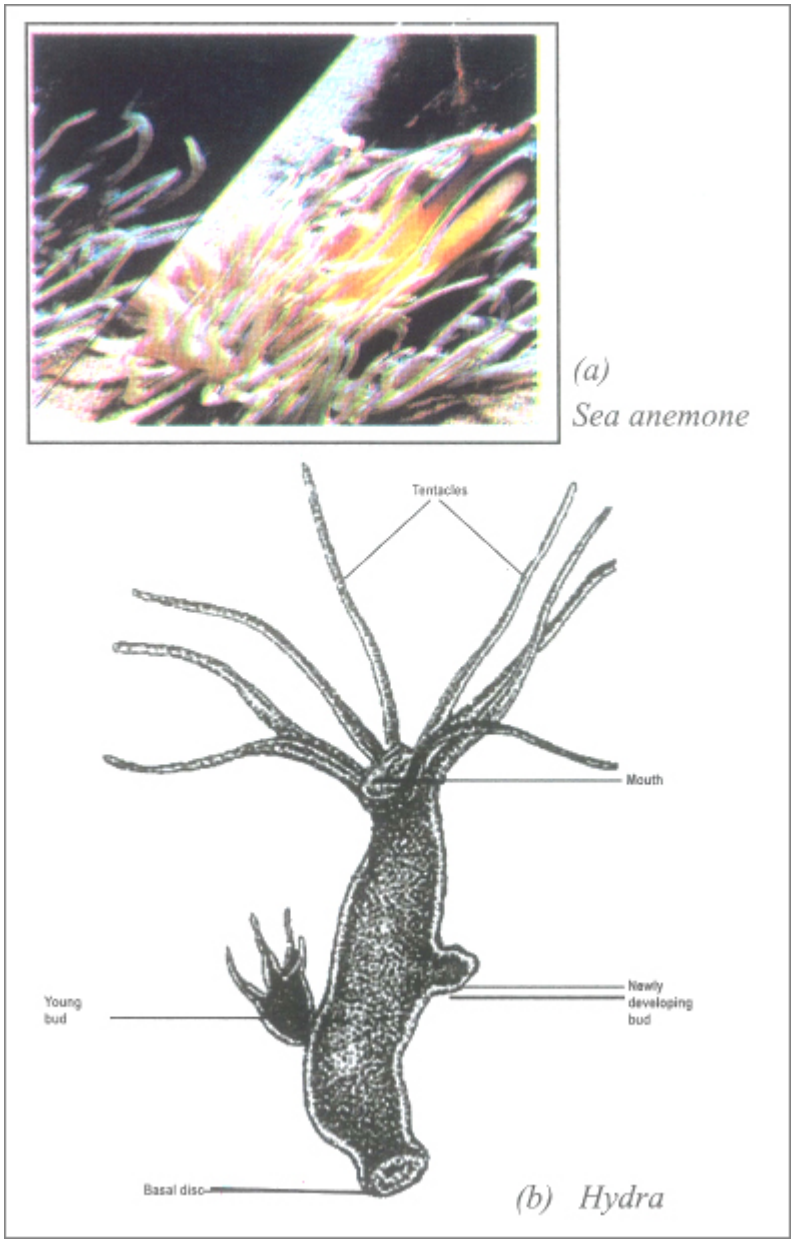

Fig. 1.21 Ceolentrates

3. *Platyhelminthes* (flatworms)

These are tiny, flat, elongated animals without a body cavity. They however, have alimentary canal. Some live in ponds and streams e.g. *Planaria*, while others are parasites e.g. flukes and tapeworms.

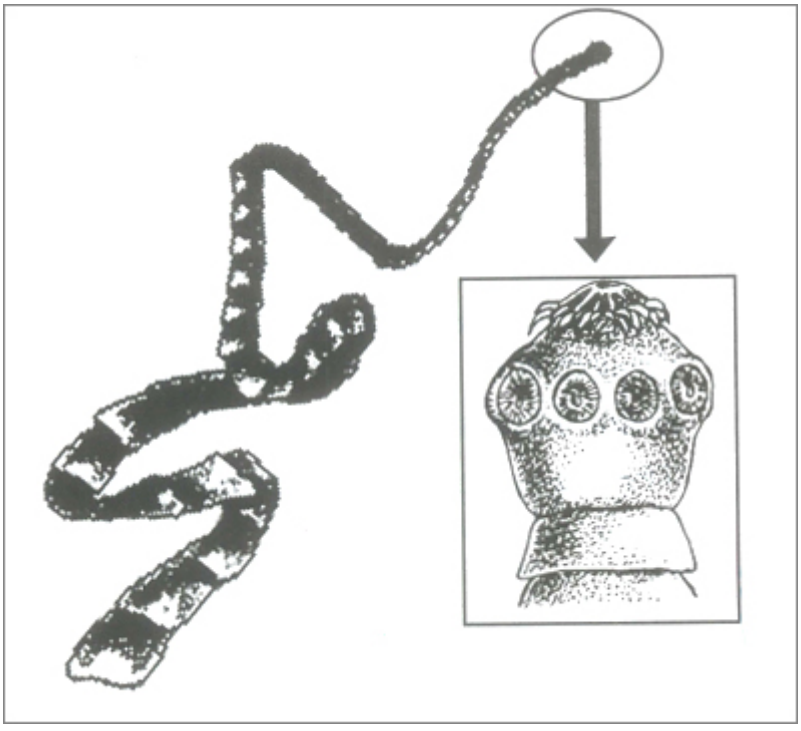

Fig. 1.22 Platyhelminthes

4. *Nematoda*

These are round, thread-like, cylindrical worms without body cavity. Their alimentary canal has two openings: the mouth and anus. Many of them are parasites, e.g. roundworms, hookworms, threadworms and guinea worms. Others are saprophytes.

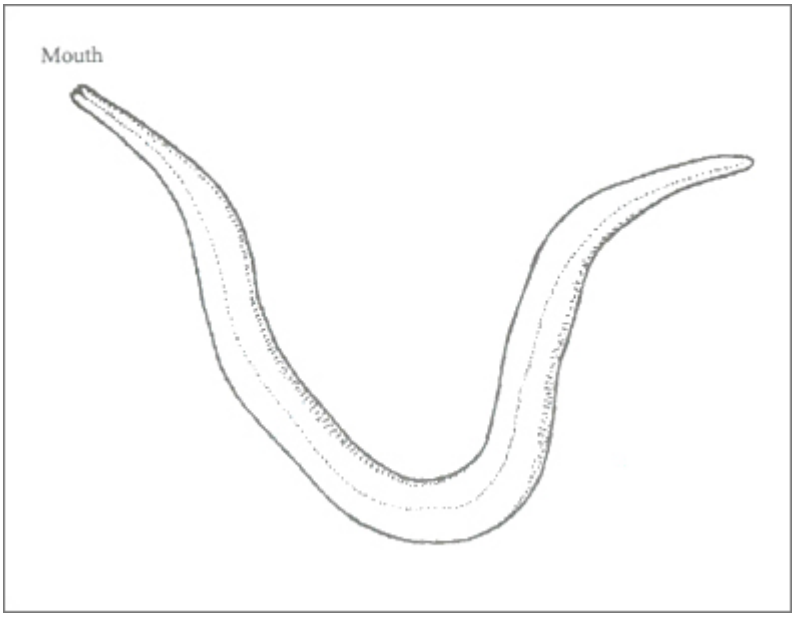

Fig. 1.23 Ascaris

5. *Annelida*

The annelids are animals with segmented bodies. They are segmented both externally and internally (metameric segmentation). Many of them are aquatic. Examples include earthworms, leeches, ragworms and tubeworms.

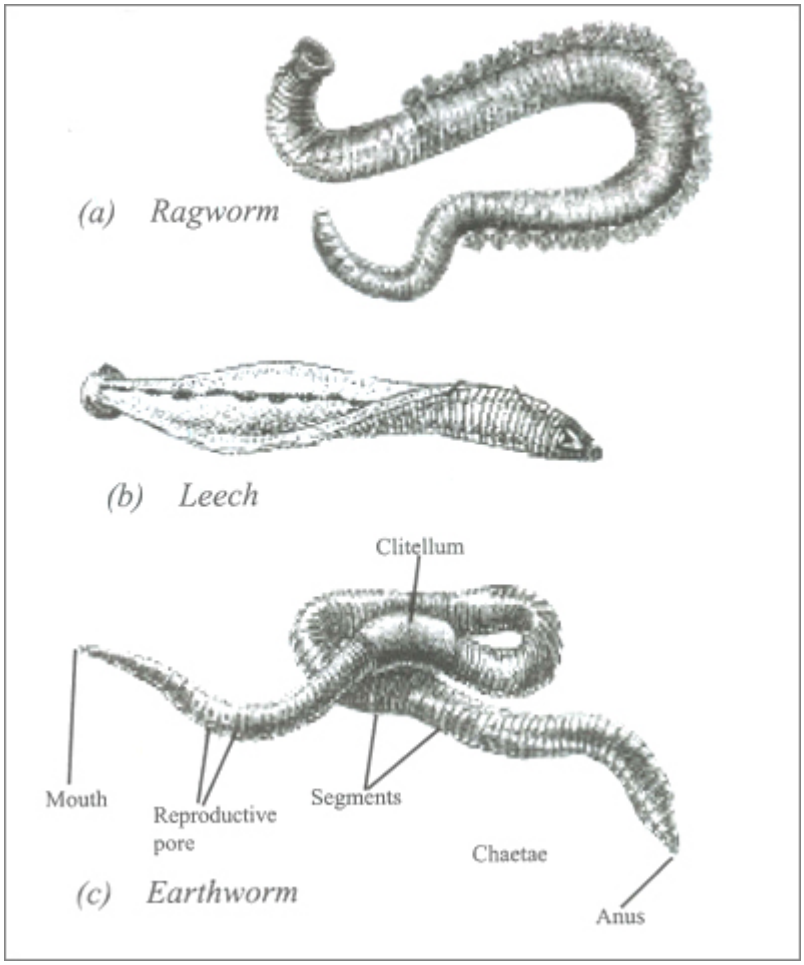

Fig. 1.24 Annelids

6. *Mollusca*

Molluscs posses soft, non-segmented bodies with tentacles. Some have shells e.g. snail, mussel and squids, while others have no shells e.g. octopus and slug.

(a) squid

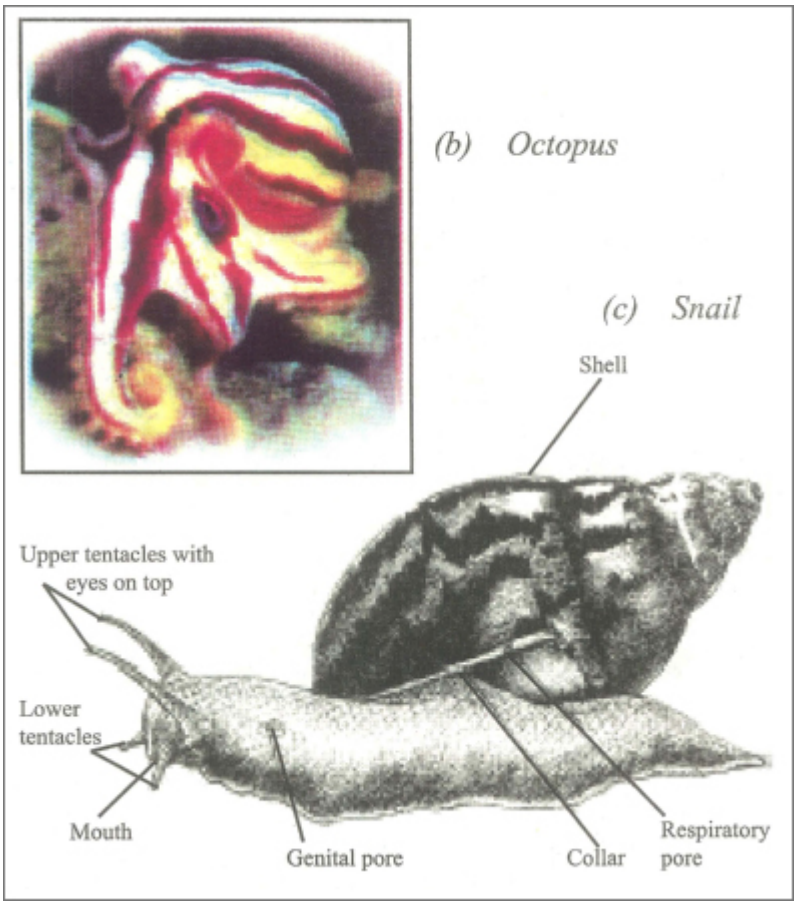

Fig. 1.25 Mollusca

7. *Echinodermata*

Echinoderms have spiny skin. Most of them are radially symmetrical and star-shaped. All are aquatic, e.g. starfish, brittle star, sea urchin, and sea cucumber.

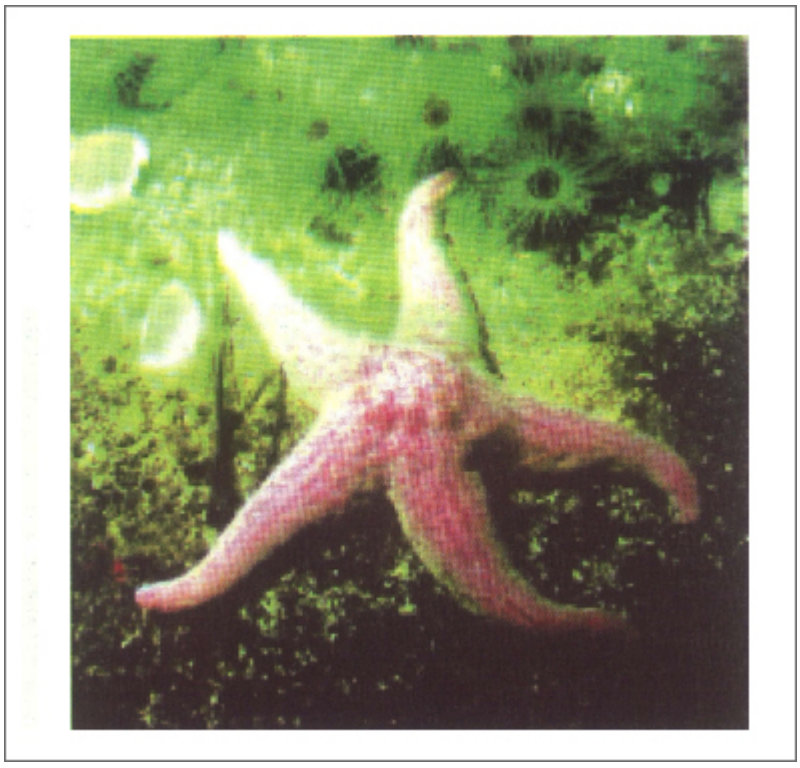

Fig. 1.26 Echinoderm (star fish)

8. *Arthropoda*

Arthropods are animals possessing segmented bodies, chitinous exoskeleton, and jointed legs. Examples are crustaceans e.g. shrimps, crab and prawn, arachnids e.g. mite, spider and scorpion; myriapods e.g. millipede and centipede and insects, e.g. grasshopper and ant.

Class Crustacea

1. They are all aquatic.
2. Their bodies are divided into two, namely cephalothorax and abdomen.
3. They have their head and thorax fused into the cephalo - thorax under a carapace.
4. Respiration is by means of gills.
5. They have a pair of stalked compound eyes borne on top of the head.

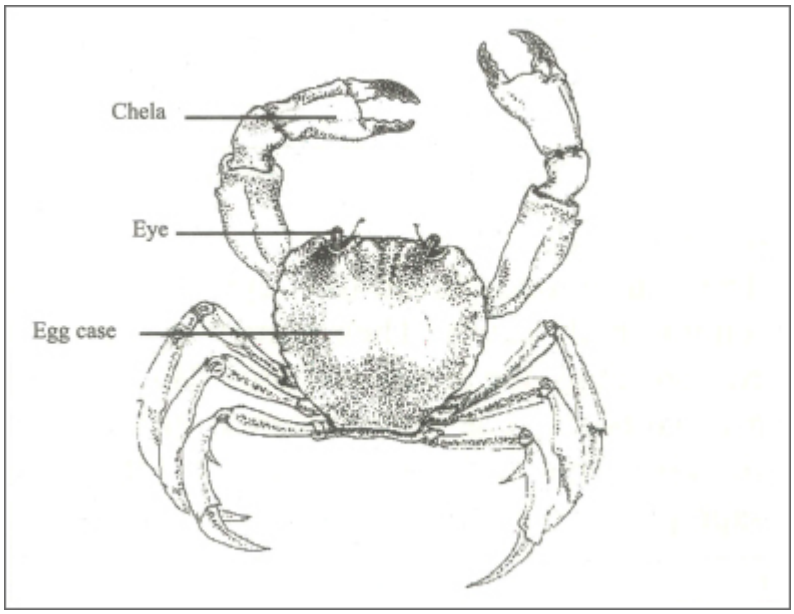

Fig. 1.27 Crustacean (Crab)

Class Myriapoda

They are subdivided into subclass: Chilopoda (centipedes) and Diplopoda (millipedes). The chilopods bear a pair of walking appendages on each body segment.

They are carnivorous and bear poison claws.

Diplopods bear two pairs of walking legs on each body segment. They are herbivores.

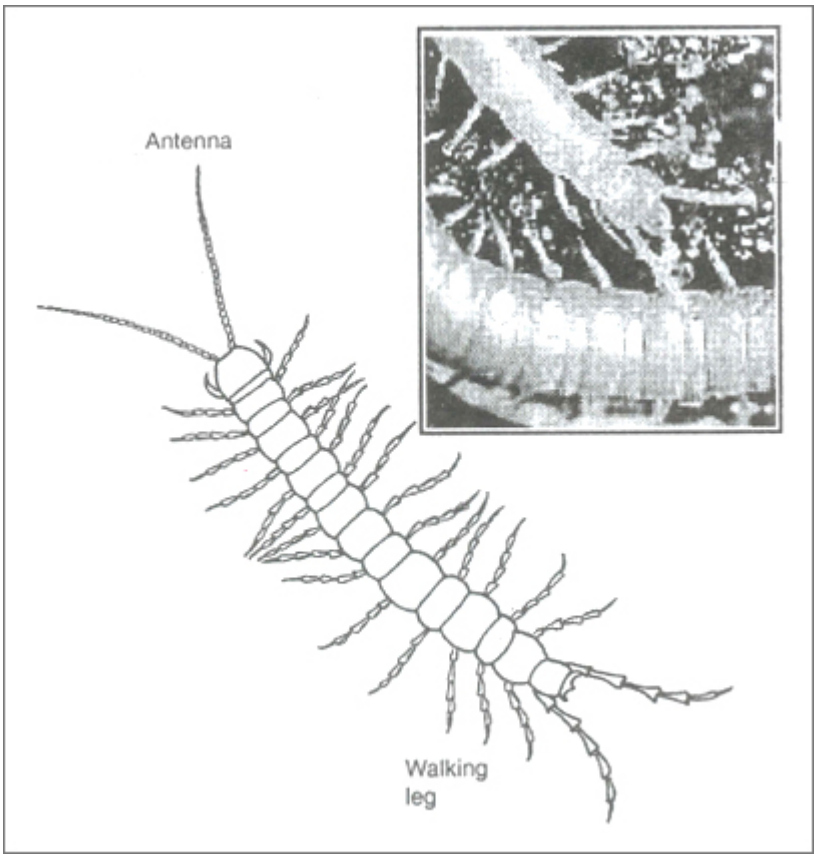

Fig. 1.28 Myriapoda (Centipede)

Class Arachnida

1. Their bodies are divided into Prosoma and the opisthosoma.
2. They possess spinnerets for web spinning.
3. They have four pairs of walking legs.
4. Some possess poison claws.

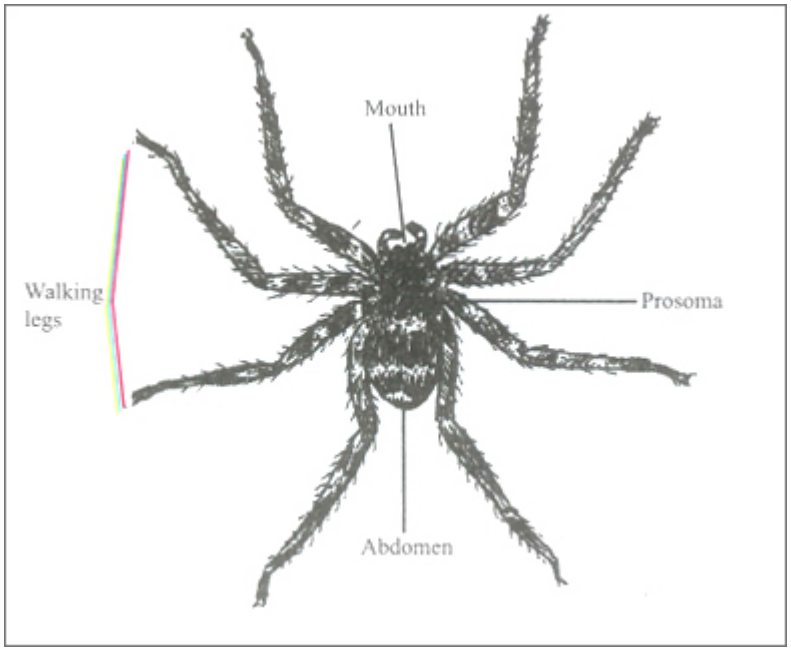

Fig. 1.29 (Arachnida) Spider

Class Insecta

1. They have three body divisions namely head, thorax and abdomen.
2. The head bears a pair of jointed antennae, a pair of compound eyes and mouth parts for feeding.
3. The thorax has three segments namely pro, meso and metathorax.
4. Each segment of the thorax bears a pair of legs and may also have two pairs of wings.
5. The abdomen is segmented and bears no appendages.
6. Respiration is by means of tracheal tubes.
7. Insects undergo metamorphosis which may be complete or incomplete.

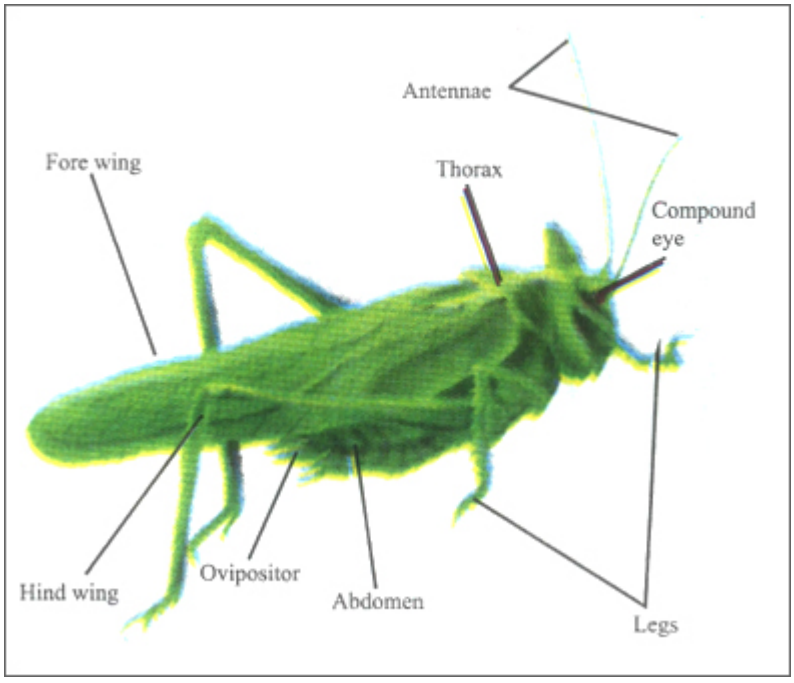

Fig. 1.30 (Insecta) Grasshopper

9. Chordata

This phylum includes invertebrate sub-phyla such as the Hemichordata (acorn worms), the Urochordata (sea squirt) the cephalochordata (Amphioxus) and the Craniata or Vertebrate animals. This sub-phylum is divided into 5 classes.

At some time in their life history, all chordates possess:

(i) a number of gill slits in the pharynx.
(ii) a dorsal skeletal rod called the notochord.
(iii) a tubular, dorsal, central nervous system.

Subphylum Craniata or Vertebrata.

Members of this subphylum have the following characteristics.

(i) A brain housed within a skull or cranium
(ii) The notochord is replaced by a bony or cartilaginous set of

strctures called vertebrae.

(iii) A ventral heart

(iv) A post-anal tail.

This subphylum is divided into five classes as follows:

Class Agnatha

These are the most primitive vertebrates. They are a very ancient fossil group that contains the modern lampreys. The lampreys are of biological interest because they are â€œliving fossilsâ€ and one of the very few parasitic vertebrate animals.

Class Pisces (Fishes)

This class is usually considered and treated as the first class under the subphylum:

(i) Fishes are aquatic vertebrates.

(ii) They possess fins and a tail modified for swimming.

(iii) The fins are of two main types — paired, i.e. pectoral and pelvic and unpaired — that is, caudal, dorsal and ventral fins.

(iv) They tend to have a streamlined shape.

(v) They have gills housed in gill chambers covered by operculum for gaseous exchange.

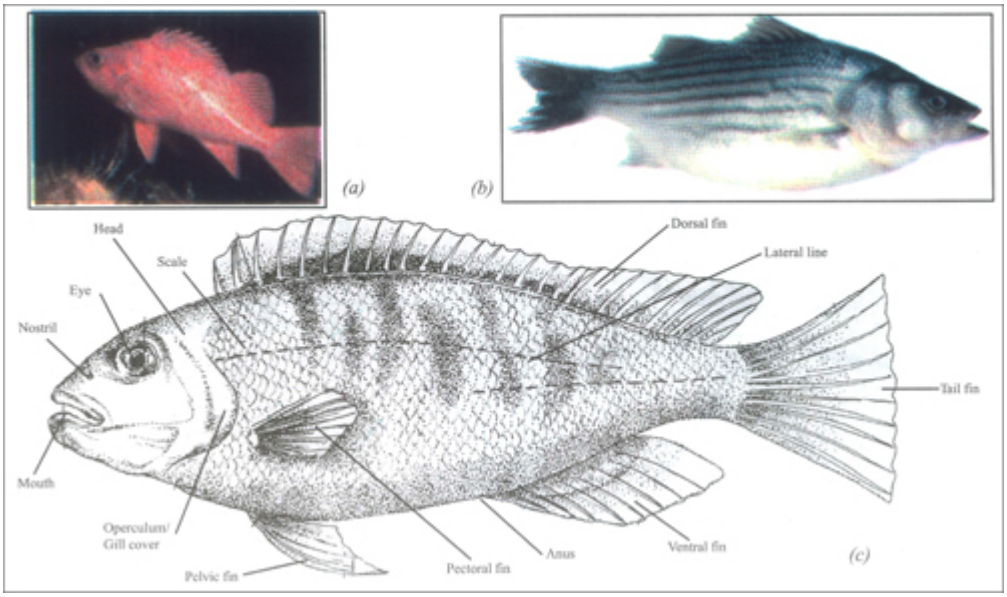

Fig.1.31 (a) and (b) shows two different fishes while (c) shows the lateral view of Tilapia

(vi) Most have their bodies covered with scales for protection. The scales may be placoid or cycloid.

(vii) A lateral line is present for detecting low frequency vibrations.

(viii) Fishes are further subdivided into bony fishes, e.g. tilapia and cartilagenous fishes e.g. dogfish.

(ix) Fishes lay eggs, i.e. they are oviparous.

(x) They are poikilothermic, i.e. cold blooded. Their temperature changes with that of their environment.

2. Class Amphibia

Amphibians are oviparous, poikilothermic animals with moist skin. They spend most of their time on land but breed in water. They have fish-like tadpoles as larva which change into adult, e.g. frog, toad and newt.

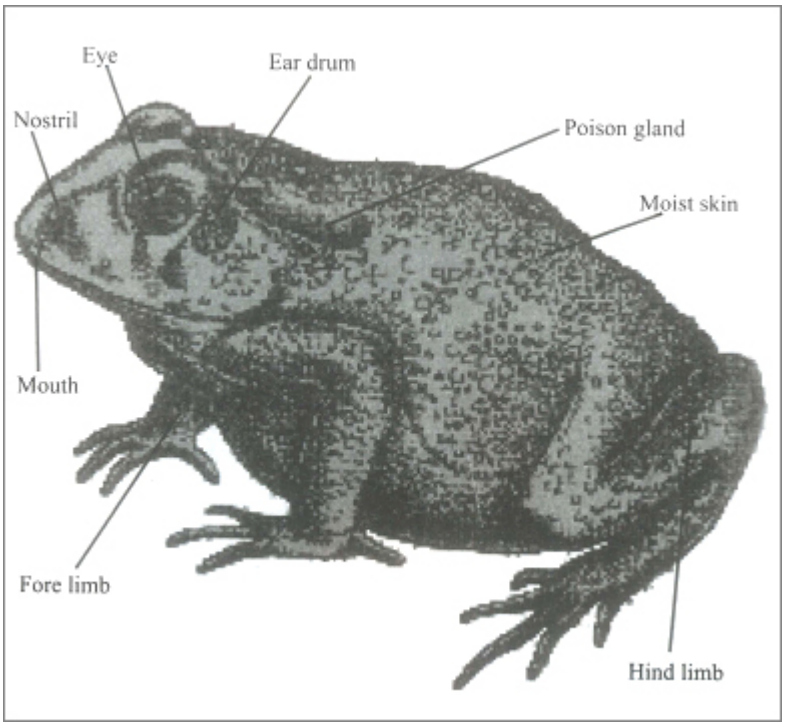

Fig.1.32 (Amphibian) Toad

3. Class Reptilia

Reptiles are poikilothermic, homodont (i.e. having the same type of teeth) animals. Their bodies are covered with dry scales or bony plates. Their eggs have soft, leathery shells and are laid on land. Some are aquatic, e.g. crocodiles and turtles. Others include lizards, geckos, tortoises and snakes which are terrestrial.

(a) Crocodile

(b) Snake

(c) Tortoise

Fig. 1.33 Reptiles

4. Class Aves

These are popularly referred to as birds. They are homoiothermic (i.e. the body temperature remains constant irrespective of changes in external temperature) animals. Their bodies are covered with feathers. They have wings for flight and beaks for picking food. They have scaly legs and lay hard-shelled eggs. Examples are sparrow, pigeon and duck.

(a) Heron

(b) Vulture

(c) Ostrich

(d) Parrot

Fig. 1.34 Aves

5. Class Mammalia

Mammals are homoiothermic, heterodont, i.e. possessing different types of teeth and mainly viviparous vertebrates. They have hair, pinna, diaphragm and mammary glands which produce milk in adult females. Examples are bat, dog, rat and whale. A few lay eggs (oviparous) e.g. echnidna and the duck-billed platypus.

(a) Bear

(b) Anteater

(c) Weasel

(d) Lion and Lioness

Fig. 1.35 Mamalia

Organization of life

The simplest form of plant and animal life exists as a single, independent cell. The four main levels of organization of life in organisms are, the cell, tissue, organ and system.

1. *Cell* As you will learn in Chapter 1 of Book 2, all organisms are made up of units called cells. The bodies of some organisms are composed of only a cell. One-celled animals are called prostists, e.g. *Amoeba, Paramecium, Plasmodium, Trypanosome, Euglena. Chlamydomonas* is a plant, a green algae of the division chlorophyta. These are unicellular organisms. The single cell in each of them performs all the activities of living things by means of organelles. These activities are done by specialized parts of multicellular organisms.

Some single cells, living together in a colony, e.g. *Pandorina* and *Volvox (Fig. 1.15)*, are capable of moving about. Each of these animals function independently in the colony. In some cases, a group of independent cells are joined together in form of a filament, e.g. *Spirogyra.*

2. *Tissue A tissue* is a group of structurally similar cells which work together to perform a function in multicellular organisms. Examples are the mesophyll layer of leaves that manufacture food, muscle tissue in humans used for movement, and nervous tissue for the perception and transmission of nerve impulses.

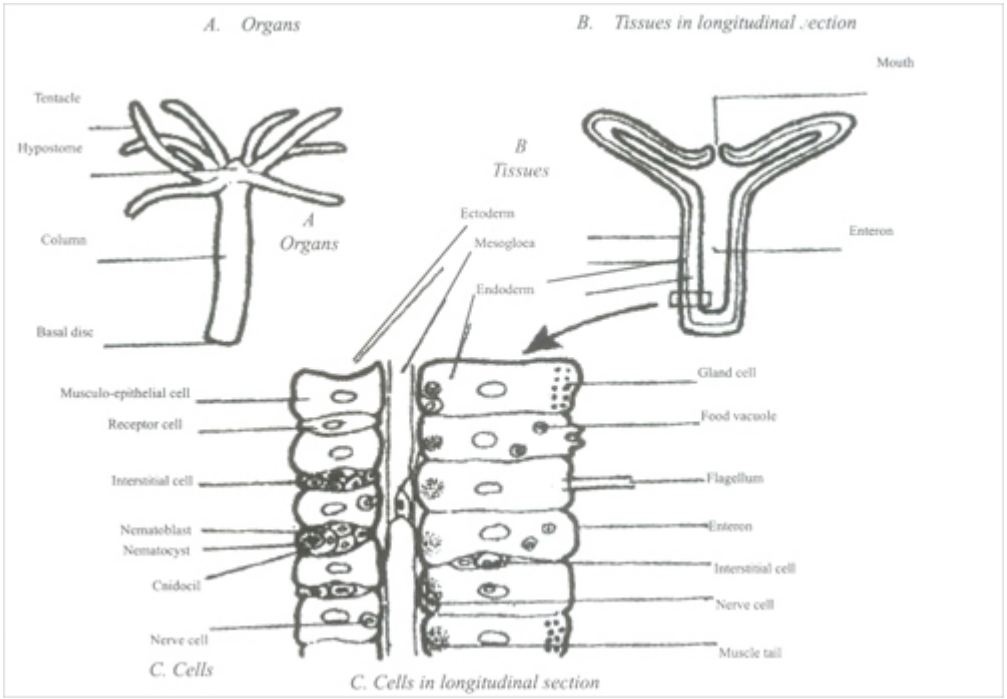

Fig. 1.36 Interdependence of parts of Hydra

In *Hydra*, the ectoderm and endoderm are tissues. Hence, *a Hydra* is composed essentially of tissues *(Fig. 1.36)*.

3. *Organs* Groups of different tissues that work together to perform a particular function are called *organs*. Examples of organs of plants are the roots, stems, leaves, flowers, fruits and seeds, bulbs (e.g. onion) and rhizomes, e.g. canna lily. *(Fig. 1.37)*. Examples of animal organs are the heart, lung, liver, kidney, brain, eye and ear which perform specific functions.

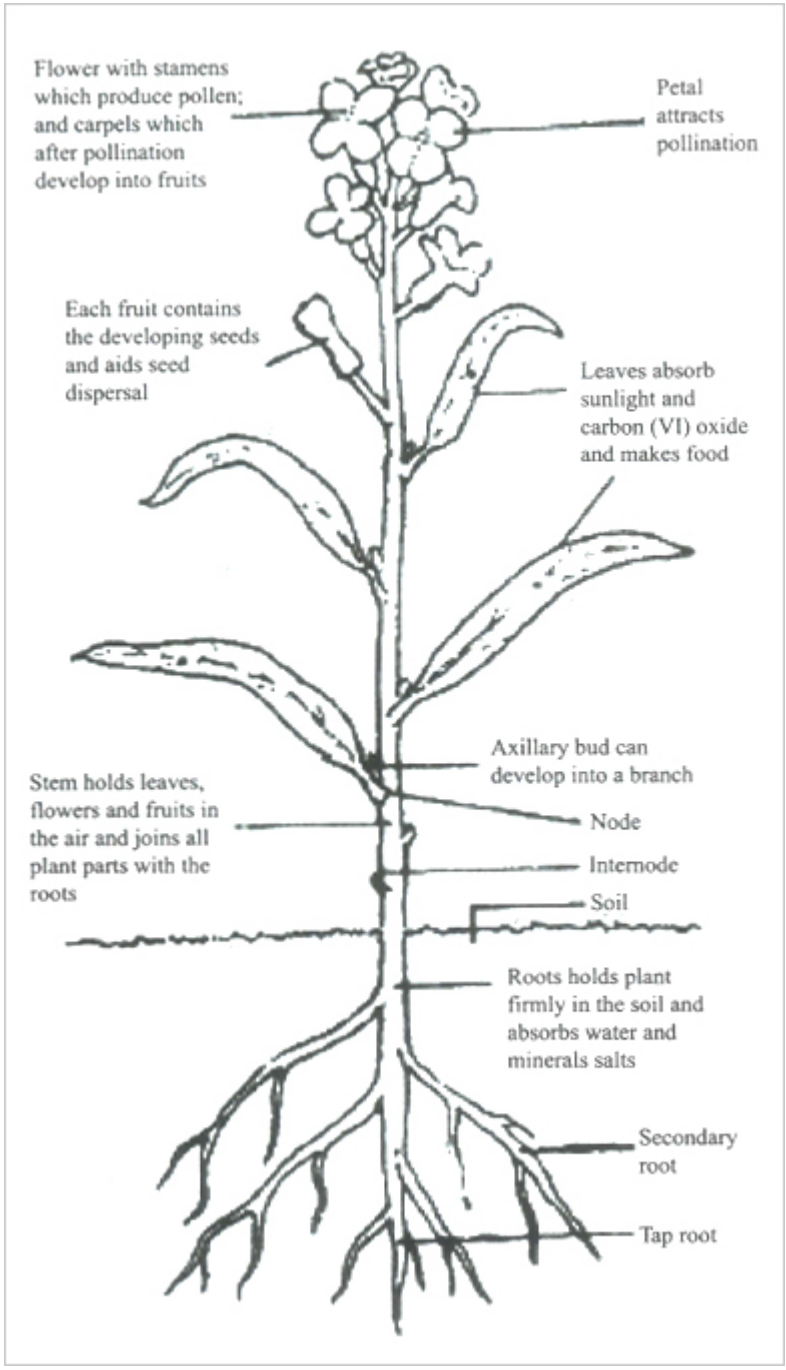

Fig. 1.37 Plant organs.

4. *Systems* Different organs that work together in multicellular organisms form a *system* or *systems*. For example, a flowering plant consists of a shoot system and a root system. All the bones and cartilages in our bodies form the skeletal system. The various systems of an animal body, including the digestive, circulatory, excretory, locomotory, nervous and respiratory systems, function together to produce a total, normal organism. Thus, the normal functioning of an organism depends on the normal functioning of all its parts – every cell, tissue, organ and system.

Table 1.3 *Functions of some human organs and systems*

Name	Type of Structure	Main functions
Skin	Organ	Protection, support, irritability, body temperature regulation.
Lung	Organ	Exchange of gases containing oxygen, carbon (IV) oxide, etc. between the body and the atmosphere.
Spinal cord	Organ	Reception and interpretation of, and response to stimuli.
Digestive System	System	Ingestion, digestion, absorption, egestion.
Reproductive System	System	Production of offspring.

Complexity of organization in higher organisms

Organisms are either unicellular or multicellular. All processes of life in unicellular organisms occur within the cell. In such organisms, different parts of the protoplasm are specialized to perform different functions. In multicellular organisms however, different functions are carried out by specialized tissues, organs or systems.

(A) Advantages of complex organization

Among the advantages of the complex nature of multicellular organisms are the following:

1. Often, multicellular organisms tend to increase in size and complexity to a very great extent. As a result, many of their cells become specialized for particular functions leading to a division of labour.
2. For efficient division of labour, specialized tissues, organs and systems develop in such organisms.
3. Because various processes are performed by different organs or systems, efficiency is increased and maintained in the functioning of the organism.
4. Specialized organs, and systems possessed by multicellular organisms enable them to live and survive in different habitats.

(B) Disadvantages of complex organization

Among the disadvantages of the complexity of multicellular organisms are the following:

1. Specialization of cells as tissues, organs and systems, results in division of labour which makes different parts of the organism interdependent.
2. Unicellular organisms have a large surface area to volume ratio, while multicellular organisms have a small surface area to volume ratio. Thus, while movement of substances by diffusion is efficient in unicellular organisms, it is inefficient in multicellular organisms. To overcome this, complex organisms have developed transport systems. However, if there is any defect in this system, the organism may be endangered.

3. The proper coordination of the activities of the various tissues, organs and systems is necessary in multicellular organisms. Such organisms cannot function well if the coordination is poor or impaired.
4. If an organ or a system in a multicellular organism is damaged or does not function properly, the other organs and systems might not function properly or might be damaged as well.

Suggested Practicals

Characteristics of Organisms

1(a) Look at the list of the characteristics of life given in this chapter.
(b) Look closely at the various organisms provided by your teacher.
(c) For each organism, write down the particular characteristic of life you can see that it actually has. Do not write down the characteristics you do not see.
(d) How can you discover if an organism possesses a characteristic of life which cannot really be seen?

2(a) Get a potted specimen of the sensitive plant, *Mimosa pudica.*
(b) Gently touch the top side of a leaf with a needle or a pencil. What happens?
(c) Gently, touch the other parts of the plant including the stem and the underside of the leaves.
(d) Describe what happens in each case.
(e) Put a drop of water on to one of the leaves with a pipette. What happens?

3(a) Collect as many organisms as possible, try and classify them into kingdoms, phylum/ division, class, etc.
(b) Classify the preserved specimens in your laboratory. Exchange this classifications with your friend. How correct are you?

Summary

1. All scientific investigations always begin with observations.
2. We commonly use control in biology experiments. A control is that part of an experiment in which the organism under observation is not deprived of the factor being investigated.
3. Living things differ from non-living things because they move, respire, feed, are sensitive to stimuli, grow and repair worn out parts of their body, excrete waste products, reproduce, have definite life span and die. Non-living things cannot perform any of these life processes.
4. The major kingdoms into which living things are classified are Monera, Protista, Fungi, Plantae and Animalia.
5. The major groups of animals are sponges, coelenterates, platyhelminthes, nematodes, annelids, molluscs, echinoderms, arthropods and chordates.
6. Classes under the subphylum vetebrata include pisces, amphibia,

reptilia, aves and mammalia.

7. The main divisions of the kingdom Plantae are Algae, Thallophyta, Bryophyta and Tracheophyta.
8. The parts of living things are organized at four levels: the cell, tissue, organ and system.
9. Organisms are either unicellular or multicellular. Some unicellular organisms live separately while others live in colonies.
10. The complexity of multicellular organisms has advantages and disadvantages. One advantage is that there is division of labour because of the presence of specialized organs and systems. One disadvantage is that an efficient system is necessary.

Objective Questions

1. An organism that is one-celled is likely to be a
   A. coelenterate
   B. mollusc.
   C. protozoan.
   D. nematode.
   E. platyhelminthes.

2. An organism that is metamerically segmented is probably
   A. a hydra.
   B. a tapeworm
   C. an echinoderm
   D. an annelid
   E. an arthropod.

3. Which of the following is not **true** about the differences between animals and plants?
   A. Plants are stationary, while animals are mobile.
   B. Animals show apical growth, while plants show inter-calary growth.
   C. Green plants are autotrophic, while animals are hetetrophic.
   D. Animals have fixed number of parts, while plants continue to grow throughout life.
   E. Animals have limited growth while plantsâ€™ growth is unlimited.

4. Which of the following organisms usually lays its eggs on land?
   A. Reptile
   B. Bird
   C. Amphibian
   D. Fish
   E. Mammal

5. Hard-shelled eggs are characteristic of
   A. reptiles.
   B. some mammals
   C. birds

D. newt
E. *Tilapia*

Essay Questions

1. To what kingdom, phylum or class does each of the following organisms belong: cat, centipede, *Euglena*, fern, guinea worm, *Hydra*, mushroom, snail, snake and star fish?

2(a) What are the charasteristics that distinguish living things from non-living things?

(b) State five differences between animals and plants.

3. Briefly describe the main distinguishing characteristics of the following groups of organisms.

(a) protozoa.
(b) arthropoda
(c) echinodermata
(d) pteridophyta
(e) gymnosperms

4. Write the name of a plant which

(a) causes a disease;
(b) lacks chlorophyll;
(c) is coloured green;
(d) produces seeds in cones; and
(e) reproduces by means of flowers