THE GOVERNMENT OF THE REPUBLIC OF THE UNION OF MYANMAR
MINISTRY OF EDUCATION

BIOLOGY
GRADE 9

BASIC EDUCATION CURRICULUM, SYLLABUS AND
TEXTBOOK COMMITTEE

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FOREWORD

Grade 10 Biology is the foundation course for the beginners to make them aware of the actual meaning of biology that deals with living things (organisms). Jelly-like substance, protoplasm is the origin of living things. The context of the text clarify that living things include both plants and animals, including man. Close association of biology with other sciences and applied sciences are simplified and clearly presented in addition to two main fields of biology (Botany, and Zoology) and various fields of biology. Scientific ethics and Binomial Nomenclature given in the text are vital important factors in the study of biology.

Cells, the basic units of living things (plants and animals), tissues, organs, variety of organisms given in evolutionary trend are supported by relevant diagrams. Explanation of the structure of living organisms is incomplete without the support of diagrams. Practical classes would aid them in practicing simple one-line drawings. The learners need to be familiar with the terminology used in biology. Drilling is the most effective mean of remembering and understanding.

A subject becomes interesting with systematic learning methods. It is thus greatly depend on the deliverers, who must prepare each lesson carefully in order to draw the interests of the receivers. Suggested teaching methods to attract the attention of the students given in Grade 10 Teachers' Guide would be of aid while teaching. Deliverers are solely responsible since the concerned team who has prepared the text had taken great care to simplify the context in the text as far as possible.

CONTENTS

CHAPTER I

THE SCIENCE OF BIOLOGY

Biology is the study of living things. A large variety of living things exist on the land, in the water and in the air. Living things (organisms) include both plants and animals. Thus, biology deals with the study of all plants and animals that live or have ever lived on the earth.

Biology is very fundamental and important science dealing with all about plants and animals, including man; their structures and functions associated with one another in their respective environments.

Biology is closely related with the methods and findings of other sciences such as physics, chemistry, and mathematics in order to understand more about organisms. Biophysics and biochemistry are most common borderline branches of sciences. Application of physical laws to biology is termed as biophysics. Biochemistry deals with the chemical constitution, the breakdown, and synthesis of plant and animal products. Biology also contributes to, and receives information from geology, sociology, anthropology, and psychology. Biology is basic to many applied sciences such as medicine, animal husbandry, agriculture, and forestry (Fig 1.1).

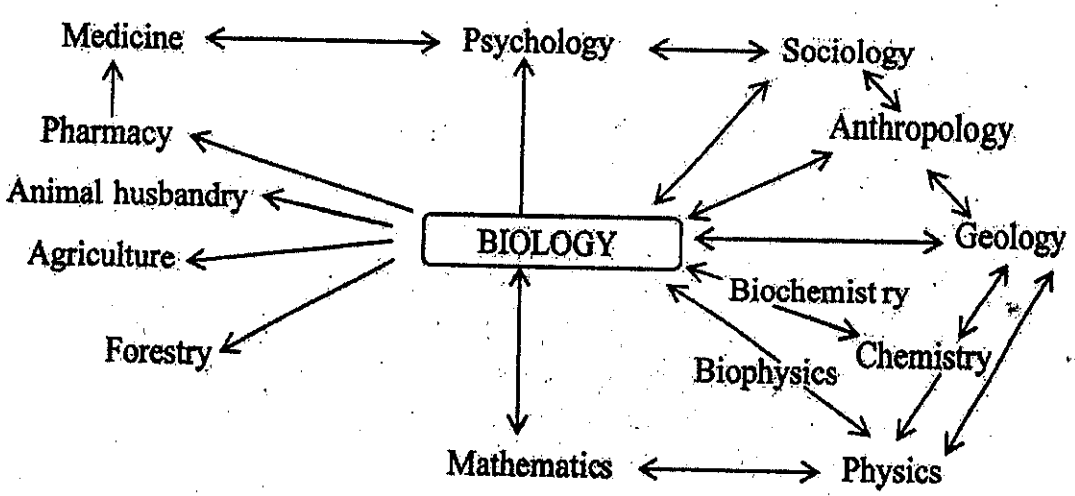


Fig 1.1 Relations of biology

HOW BIOLOGY IS STUDIED

Some biologists study plants and animals in nature. A ruler, a collecting bottle, a hand lens, and a field book are simple requirements to study the organisms in nature. Other biologists investigate life processes such as respiration, nutrition, reproduction etc. They often need complicated apparatus and a laboratory where they can carry out their experiments. However, requirements for the successful study of biology are generally simple. They are:

(1) Ability to observe carefully and to report accurately, that which is seen,

(2) Absolute honesty in all work - a prime requirement in all branches of science,

(3) Clear thinking to arrive at dependable deductions from observations, and

(4) Ability to analyze the relative values of conflicting evidences for appropriate conclusions.

DIVISIONS OF BIOLOGY

Two main branches of biology distinguished based on the nature of organisms are:

(1) Botany (study of plants) and

(2) Zoology (study of animals)

The branches of biology distinguished based on the methods of studying organisms in different ways are as follows.

Morphology : study of form and structure of organisms

Anatomy : study of gross internal structures

Histology : study of microscopic structure of tissues

Cytology : study of cells

Physiology : study of living processes or functions of the various parts of organisms

Embryology : study of early development of organisms

Palaeontology	: study of fossils (the remains of organisms that lived millions of years ago; now preserved in rocks)
Taxonomy	: study on classification of organisms
Ecology	: study of the relationships of organisms to their environments
Evolution	: study of the origin and differentiation of organisms
Genetics	: study of heredity and variations
Microbiology	: study of microscopic organisms

SUMMARY

Biology, the study of living things (organisms) is fundamental and important science. It deals with structures and functions associated with one another of living things in their respective environments. The basic theme of biology is the knowledge about an understanding of human beings since living things include plants and animals, including human beings. Human beings cannot understand themselves unless they understand other living things. All organisms face the same problems, but through the evolutionary process, they solve these problems differently.

Biology is closely related to methods of other sciences. It is also basic to many applied sciences. Figure 1.1 in this chapter shows the relations of biology to other sciences and applied sciences. Students should find it feasible to understand the overview of this topic.

Naturalists study plants and animals in nature. They do not require complicated equipment. Biologists that study life processes in laboratory need equipment to analyze the obtained data. In any case, all scientists are to abide by the four rules given in this chapter in order to maintain scientific ethics. The science world would be lost without scientific ethics.

Botany (study of plants) and Zoology (study of animals) are the two main branches of biology. Branches of biology based on the methods of studying organisms are simplified to serve as basic knowledge for beginners taking biology as their subject of study.

CHAPTER II

LIFE AND ITS CHARACTERISTICS

It is not difficult to distinguish most living things from the non-living but it is not easy to define life. It is however easier to consider the characteristics of living things.

The main characteristics of living things are their **cellular structure, metabolism, growth, movement, irritability, reproduction,** and **adaptability.**

Cellular Structure

All living things consist of the living substance called protoplasm; organized into units called cells. They contain a molecule that carries biological information-DNA. Cells of plants and animals are organized into tissues, and tissues are in turn organized into organs and systems to carry out the various life processes.

Metabolism

Various life processes taking place all the time in all living things is termed as **metabolism.** The two aspects of metabolism are **anabolism** and **catabolism.** The food material is made into a part of the organism in the process of anabolism. The food material when broken down with the release of energy and the formation of waste products is termed as catabolism. The important metabolic processes that take place in organisms are **nutrition, respiration,** and **excretion.**

Growth

The growth of an organism is due to increase in size, weight, and development.

Movement

All living things show some kinds of movement. This is more obvious in animals since they have organs of movement or locomotion. Movements in plants mainly take place inside the cells.

Irritability

Living things respond to stimuli, which is sensitive to any changes in the environment (light, sound, touch, temperature etc.).

Reproduction

Reproduction is the production of a new generation of offspring. Two types of reproduction are **asexual** reproduction and **sexual** reproduction. In asexual reproduction, the new individual may be produced by a part of the old one. The new individual is produced by the fusion of two cells formed from two individuals of the same species in sexual reproduction.

Adaptability

Living organisms are able to adjust and adapt themselves to changes in their environment. Adaptability increases their chances of survival and the production of their own species. For instance, a change of seasons or a shortage of food may cause certain birds to migrate to another place where the conditions are more favourable. A plant may grow very straight and upright to be above the plants around it. This enables them to get enough sunlight.

SUMMARY

Life can be recognized by certain common characteristics although life is difficult to define. Living things are made up of cells; maintain their structure by taking chemicals and energy from the environment, respond to external stimuli, and reproduce. As species, living things evolve, change, and adapt themselves to changes in their environment.

The characteristics of living things simplified under sub-headings: cellular structure, metabolism, growth, movement, irritability, reproduction, and adaptability in this chapter. The value of life would be clearly defined after completing this chapter.

CHAPTER III

THE PLANTS AND ANIMALS

CELLS

Cells are units of living substance, which can be seen only under high magnification, and consisting of jelly-like substances called protoplasm. The basic features of cells are as follows.

(a) **Nucleus** - is a round or oval body containing a number of thread-like chromosomes. The chromosomes contain materials inherited from the parents. Nuclei (plural) are important in cell division and controlling the life processes of cells.

(b) **Cytoplasm**- is a grayish jelly-like living substance, which contains the nucleus, and many specialized structures called organelles. Numerous chemical reactions take place in the cytoplasm. The following structures are some important organelles found within the cytoplasm.

(i) **Mitochondria**

These are small rod-shaped structures that control the release of energy within the cell.

(ii) **Ribosomes**

Ribosomes are tiny structures found along a network of tubules called endoplasmic reticulum. Their function is to manufacture proteins.

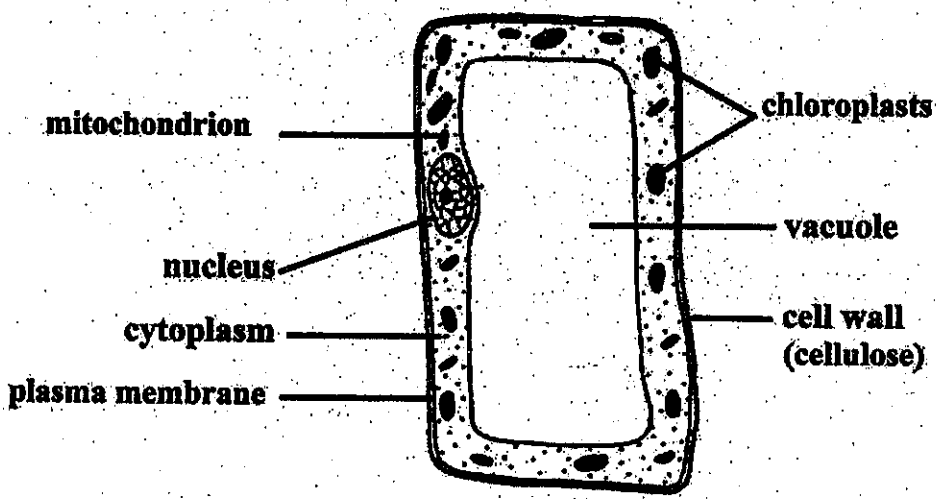
(iii) **Centrioles**

They are a pair of tiny structures found near the nucleus. They take part in cell division.

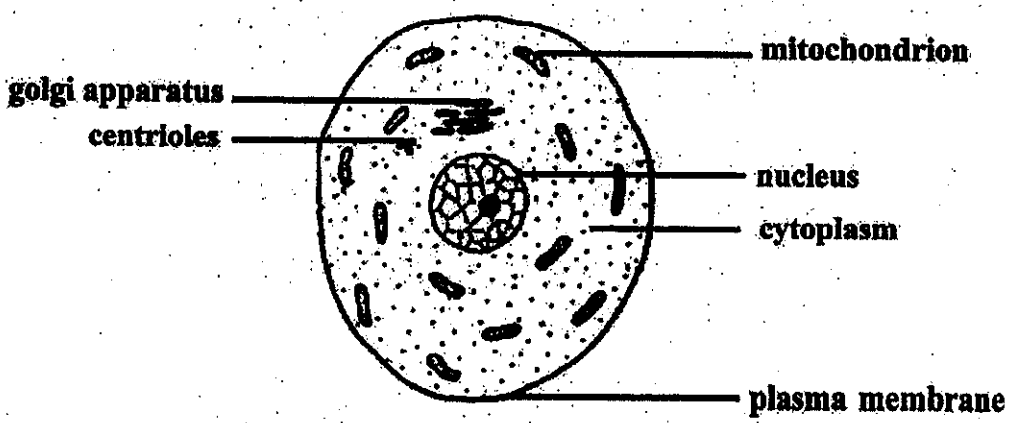
(iv) **Golgi apparatus**

It consists of stacks of flattened membranous sacs and vesicles involved in secretion.

(c) **Cell or plasma membrane** – is a thin, delicate, and protective structure surrounding the cell. It is selectively permeable and controls the passage of substances into and out of the cell.



Typical plant cell



Typical animal cell

Fig. 3.1 Cells

Table 3.1 Comparison of animals and plants

		Animal	Plant
1.	Cell wall	Absent	A rigid **cell wall** often composed of **cellulose** that surrounds the cell and supports the plant
2.	Chlorophyll	Absent	Green pigments found in the green parts of plants
3.	Vacuoles	Usually absent, but, if present, are small and numerous	Usually large and few in number, contain watery fluid called **cell sap**
4.	Centrioles	Present	Absent in cells of higher plants
5.	Food storage	Excess glucose stored as **glycogen granules** in the body cells, particularly in the liver, **fat** stored beneath the skin and around internal organs, fat, beneath the skin keeps the body warm	Excess glucose is stored as **starch,** or sometimes as oil or complex in sugar, in the cytoplasm of the cells of **roots,** stems or leaves
6.	Method of feeding	**Heterotrophic** - feed on ready-made organic food	**Autotrophic** - makes its own organic food by utilizing the sun's radiant energy to build complex organic substances from carbon dioxide and water by **photosynthesis**
7.	Movements	Organs of locomotion present in most animals	Plants do not possess any organ of locomotion. The only visible movements are growth movements, e.g. shoots growing towards light etc.
8.	Scheme of Growth	Usually stops growing at a certain age, but repair and renewal of cells continue throughout life	Usually continues to grow throughout life

		Animal	Plant
9.	Sensitivity	Usually has well-developed sense organs and nervous system to react immediately to any stimuli, e.g. light, smell etc.	Growth is usually the only response to any external stimuli

CLASSIFICATION OF PLANTS AND ANIMALS

Everyone must be able to identify objects and to relate their observations to other people. Most people are familiar with some of the common forms of plants and animals. However, since there are so many different kinds of plants as well as animals, the word 'plant' or 'animal' is not sufficient for identification.

Linnaeus (1707-1778), a Swedish student, studied and gave scientific names to thousands of plants and animals. He introduced the **Binomial System of Nomenclature** in the year 1753. Each plant or animal is given a two-word name by this system. The first name is the **genus** and the second is the **species.** The name of the genus is always written with a capital letter, and the name of the species with a small letter. These two names constitute the scientific name of the organism. For example, the scientific name of man is *Homo sapiens,* and that of paddy plant is *Oryza sativa.*

DIVERSITY OF PLANTS AND ANIMALS

The majorities of plants are green and can make their own food. Plants may be divided into two main groups:-

(A) Plants which do not flower (non-flowering plants) and

(B) Flowering plants

A. Non-flowering plants

The following are groups of non-flowering plants.

1. **Algae (Division – Thallophyta)** possess chlorophyll and may be single-celled or many-celled. They are commonly found in ponds, lakes, and puddles and on damp soil and tree trunks. Seaweeds are also algae.

2. **Fungi (Division – Thallophyta)** do not possess chlorophyll and are therefore unable to make their own food. They depend on other plants and animals, or decaying organic matter for their source of food. The fungi include moulds, toadstools, mushrooms, and bracket fungi.

3. **Liverworts (Division – Bryophyta)** are small, flat, green leaf-like plants found in clusters in moist shady places, stream banks and in garden beds.

4. **Mosses (Division – Bryophyta)** have a distinct stem-like structure with small green leaf-like outgrowths. Many of them grow on damp rocks, on the barks of trees, and in dense stands on the soil producing soft velvet-like green carpets.

5. **Ferns (Division – Pteridophyta)** are of many kinds and most of them are garden plants. They grow chiefly in shaded moist places. A fern consists of roots, stem and leaves, but does not produce flowers or seeds.

6. **Coniferous trees (Division – Gymnospermae)** like pines, cedars, firs and cypresses are woody plants, which bear seeds. The seeds of these plants are not produced within the fruit but are borne on leaf-like structures. These plants grow in many parts of the world. Some are found in the tropics, but most of them are common in the cool parts of the temperate zones.

B. Flowering plants

Flowering plants are the most widely distributed of all green plants on the earth's surface. They can be divided into two groups.

1. **Monocotyledons** — plants with only one cotyledon (seed leaf) in the seed like grasses, orchids, cereals, bananas, gladiolus, etc.

2. **Dicotyledons** — plants with two cotyledons in the seed like mango, padauk, roses, sunflowers, etc.

The animal kingdom consists of **Invertebrates** (animals without a backbone) and **Vertebrates** (animals with a backbone).

A. Invertebrates

The invertebrates include the following groups:

1. **Single-celled animals (Phylum – Protozoa)** are the lowest form of animals and microscopic. They are free-living in water and soil or parasitic in bodies of larger animals.
2. **Sponges (Phylum – Porifera)** are the lowest and simplest of all multicellular (many-celled) animals. Their bodies are with pores. Most sponges are marine forms and a few fresh water forms.
3. **Coelenterates (Phylum – Coelenterata)** are those animals with a tubular body or a gelatinous body of umbrella shape. They live either separate or in colonies. Some are free-living forms and others attached to rocks or other objects in fresh and salt water.
4. **Flatworms (Phylum – Platyhelminthes)** are flat-bodied animals including flukes and tapeworms. They are parasitic in many animals. Some are free living.
5. **Segmented worms (Phylum – Annelida)** are worms, which have bodies made up of ring-like segments. Segmentation is clear both on the outside and inside. They live in moist soil, sand, or mud, in marine or fresh water. Few of the worms are parasitic.
6. **Soft-bodied animals (Phylum – Mollusca)** have soft bodies covered by a thin fleshy mantle. A shell commonly protects their bodies entirely or in part. They are mostly marine forms. Some are found in fresh water and few on lands.
7. **Joint-footed animals (Phylum – Arthopoda)** segmented body covered with an outer covering, the exoskeleton. They bear paired jointed appendages.
8. **Spiny-skinned animals (Phylum – Echinodermata)** bodies covered with long or short spines. They are strictly marine forms.

B. Vertebrates

The vertebrates consist of the following groups:

1. **Fish (Class – Pisces)** are aquatic animals of both fresh and salt water. They possess fins for swimming and most fish breathe by means of gills.

2. **Amphibians (Class – Amphibia)** are animals that spend part of their life in water and part on land. They breathe by gills in water and by lungs on land. They possess four limbs to be able to move on land.

3. **Reptiles (Class – Reptilia)** are those animals with a dry skin covered with scales or bony plates. Most of them are landforms and few are aquatic. Like fish and amphibians, reptiles are cold-blooded animals.

4. **Birds (Class – Aves)** are warm-blooded animals having bodies covered with feathers. Their fore limbs are in the form of wings for flight. Some birds cannot fly.

5. **Mammals (Class – Mammalia)** are also warm-blooded animals. Their bodies are covered with hair. Mammals feed their young with milk from milk glands. Mammals are land animals although a few are aquatic.

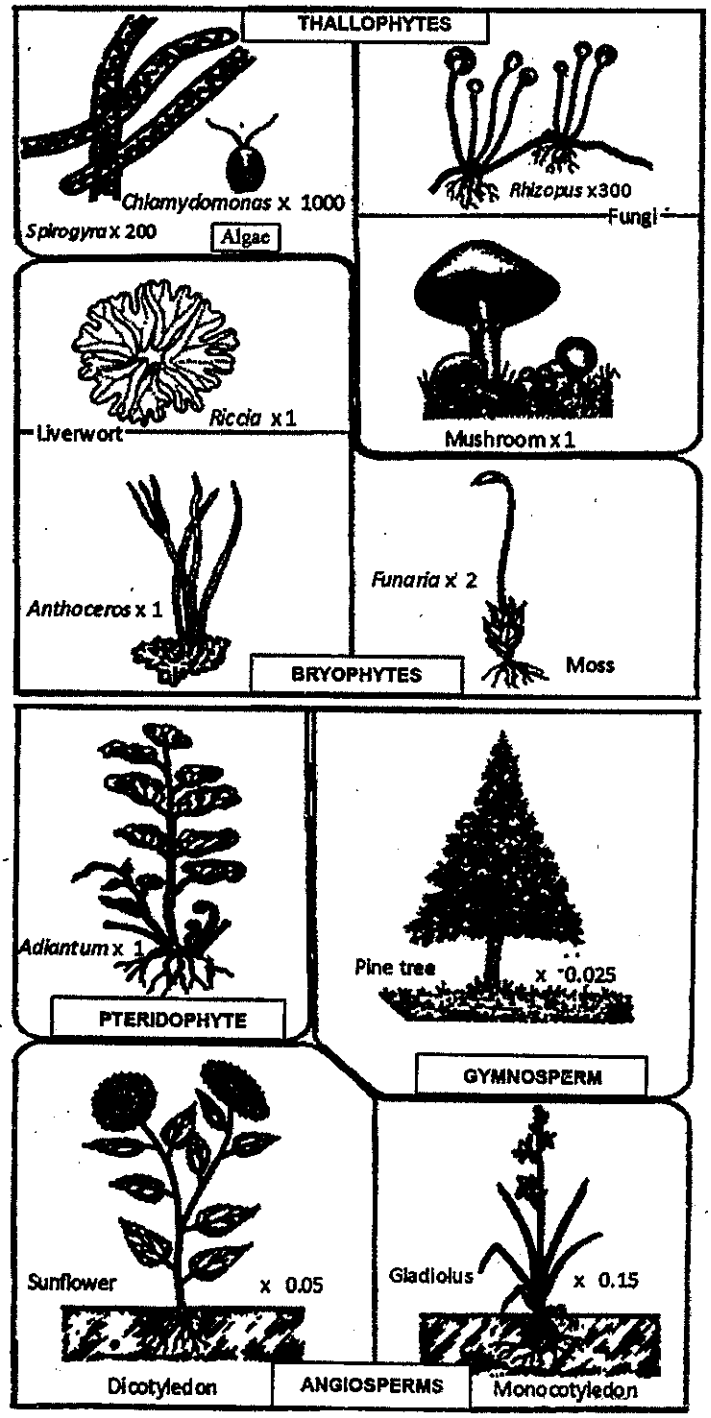


Fig. 3.2 Diversity of plants

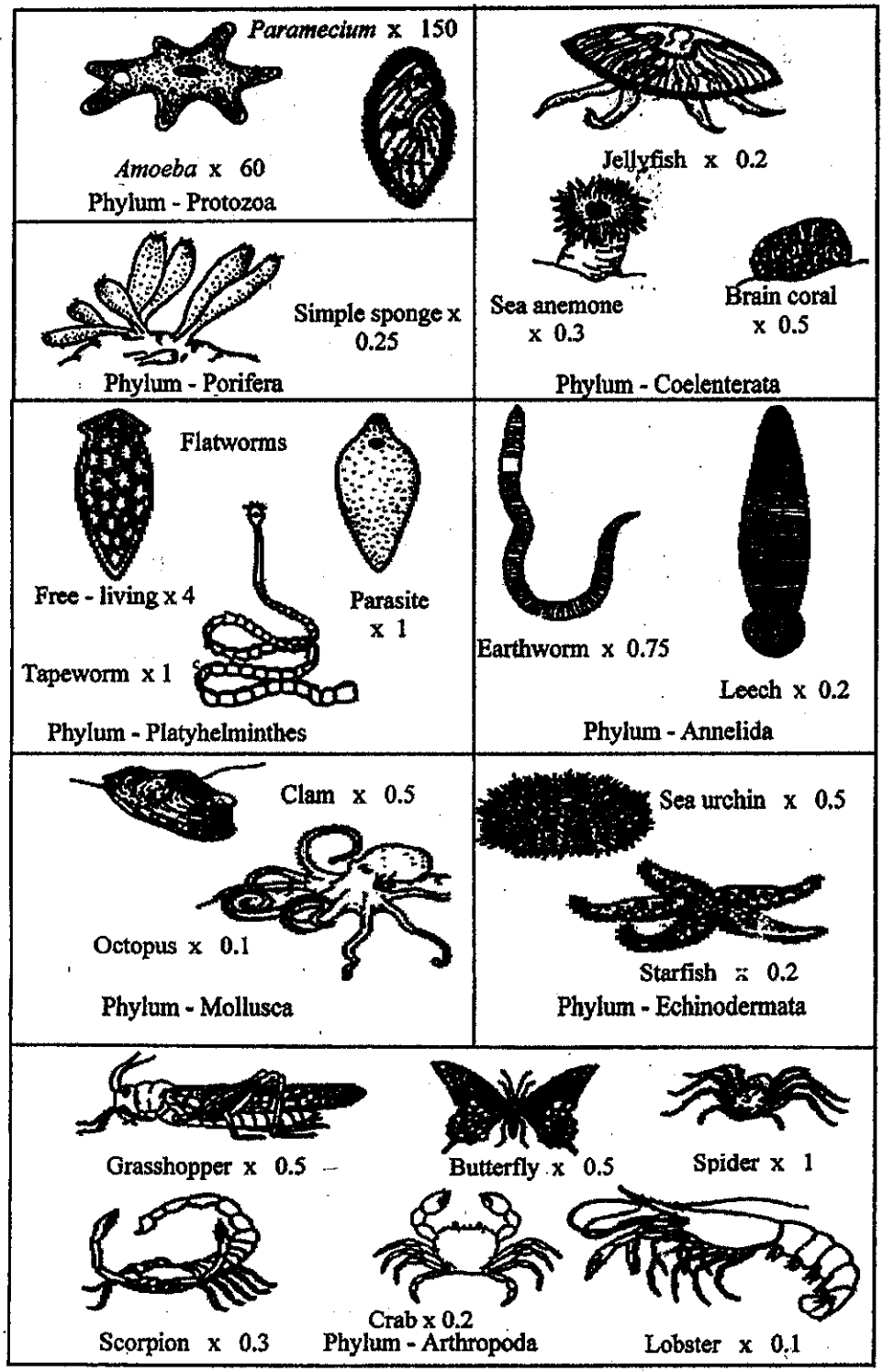


Fig. 3.3 Diversity of animals (Invertebrates)

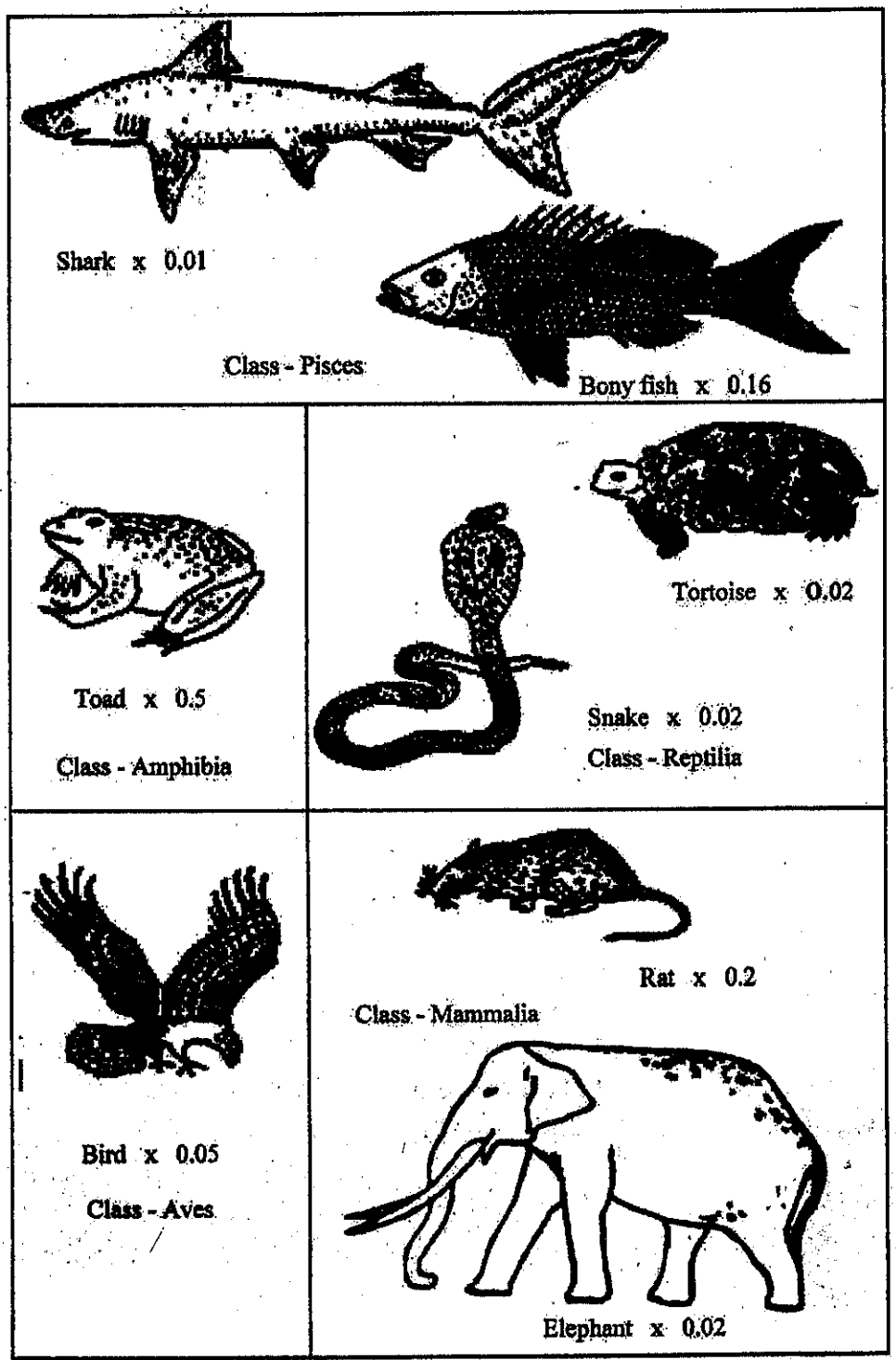


Fig. 3.4 Diversity of animals (Vertebrates)

SUMMARY

The cell is the smallest unit of living things and all the characteristics of life are found here. An understanding of cell structure, physiology and biochemistry serves as a foundation to an understanding of multicellular forms. All living cells consist of jelly-like substance called protoplasm. Cells are usually divided into two groups: prokaryotic cells and eukaryotic cells. Prokaryotic cells evolved before eukaryotic cells and they lack a true nucleus. A membrane bound the nuclear materials of a true nucleus. Eukaryotic cell possesses a true nucleus. Prokaryotic cell possesses nuclear materials but lacks a nuclear membrane.

The plant and animal cells given in this chapter are eukaryotic cells. An outer cell membrane (plasma membrane) bounds the cytoplasm, the substance of the cell outside the nucleus. Various organelles, small bodies with special structures and functions are also found in the cytoplasm. Plant cell has a cell wall in addition to the plasma membrane. Cell wall is absent in animal cell. Differences between plants and animals are summarized in tabulated form for easy understanding.

Many different kinds of plant and animal exist on this earth. The name referred to particular plant differs between the nations. Scientific name thus become essential as the common factor for all scientists to understand the referred plant or animal. Linnaeus in the year 1753 invented Binomial System of Nomenclature. This basic knowledge will serve as the important factor in identification of plants and animals.

The plant kingdom is simply divided into flowering and non-flowering plants mentioning the respective groups with diagnostic features. Similarly, the animal kingdom is categorized into invertebrates (animals without a backbone) and vertebrates (animals with a backbone). Various groups of invertebrates and vertebrates are given with simple diagnostic features. This would serve as basic knowledge to understand the evolutionary trends of plants and animals.

CHAPTER IV

PLANT AND ANIMAL TISSUES

Some plants and animals are unicellular while others are multicellular. In unicellular organisms, the single cell performs all the life functions, such as nutrition, respiration, excretion, and reproduction. In multicellular organisms, different cells from various parts of the body perform different functions. All new cells are derived from the preexisting ones. A fertilized egg divides and increases in size and eventually becomes a multicellular individual. The maturing cells gradually become diversified in appearance. The process by which a cell changes from its immature form to mature form is termed as **differentiation.**

Groups of mature cells having the same shape are capable of performing a particular function, and are termed as tissues. **A tissue** is a group of cells, usually similar in both structure and function arising from a common origin.

Ordinarily the bodies of multicellular organisms are organized based on tissues, organs, and systems. **An organ,** in turn, is composed of various tissues (not necessarily similar) grouped together into a structural and functional unit. Similarly, a system is a group of interacting organs that 'cooperate' as a functional complex in the life of the organism.

PLANT TISSUES

Two main types of tissues are:

A. Meristematic tissue and

B. Permanent tissue

A. Meristematic Tissues (Meristems)

Meristematic tissues consist of undifferentiated cells that are capable of dividing repeatedly. The cells are small, thin-walled, with dense granular cytoplasm, and minute scattered vacuoles. The nucleus looks comparatively large since the cells are small. The cells are closely packed with no intercellular spaces between them. Meristems may commonly be grouped based on their position in the plant body.

(1) **The apical meristems** lie at the tips or apices (singular-apex) of stems and roots. They are responsible for the growth in length of stem and root.

(2) **The intercalary meristems** are those that are found in the internodes and leaf sheaths of most grasses.

(3) **The lateral meristems** lie parallel to the sides of the organ in which they occur. They are responsible for the growth in girth of stems and roots, e.g. vascular cambium.

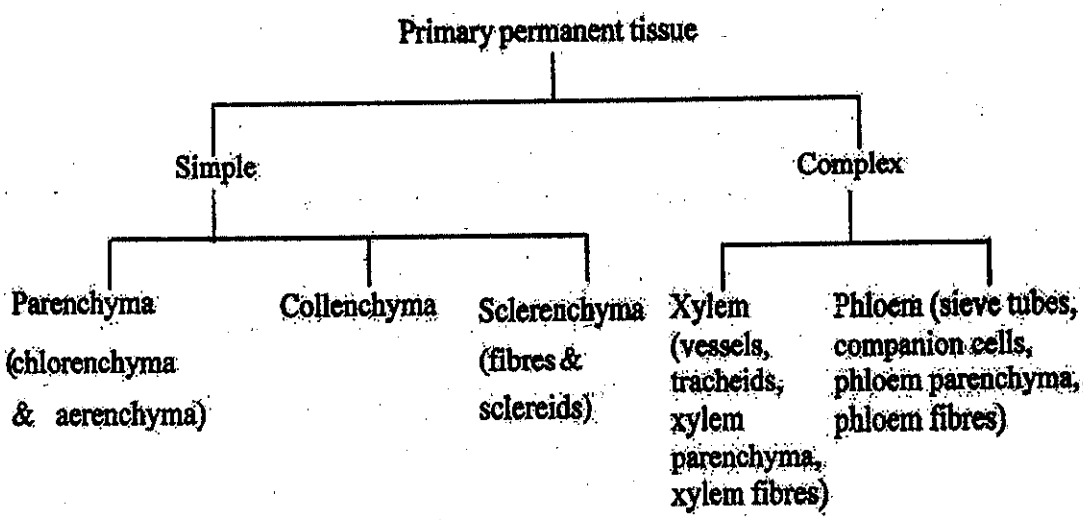
B. Permanent tissues

Permanent tissues consist of cells, which are completely differentiated to perform a particular function. They are usually incapable of further cell division. These tissues may be grouped into **primary permanent** and **secondary permanent** tissues. The primary permanent tissues are derived from apical meristems, and secondary permanent tissues from the lateral meristems.

Primary permanent tissues

Based on the composition, the primary permanent tissues may further be differentiated into two groups. (1) simple tissues, made up of only one type of cells, and (2) complex tissues, composed of two or more types of cells.

Primary permanent tissue may be simply classified as shown in the diagram below.



1.Simple Tissues

No	Types	Structure	Location	Functions
(a)	Parenchyma	least specialized living spherical columnar or irregular cells with thin cell walls composed of cellulose	soft portions of plants	storage of food materials
	Chlorenchyma	contain chloroplasts	green leaves and green stems	manufacture sugars and starch
	Aerenchyma	cells with intercellular spaces	aquatic plants	buoyancy
(b)	Collenchyma	more specialized living cells, spherical or polygonal in cross section, elongated in longitudinal section , wall thickened at the corner due to cellulose and pectin	hypodermis of some stems	mechanical support
(c)	Sclerenchyma	most highly specialized dead cells, secondary walls of cellulose and lignin		
	(i) fibres	long, narrow, thick-walled, lignified cells, tapering at both ends, length 1 to 3 mm, 20 to 550 mm in flax and hemp (fibre yielding plants)	in patches or definite layer	mechanical support
	(ii) sclereids	variable in shapes but not elongated, walls strongly lignified	flesh of pears, guavas	

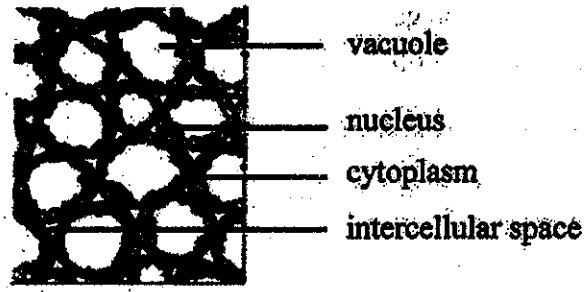


Fig. 4.1 Parenchyma

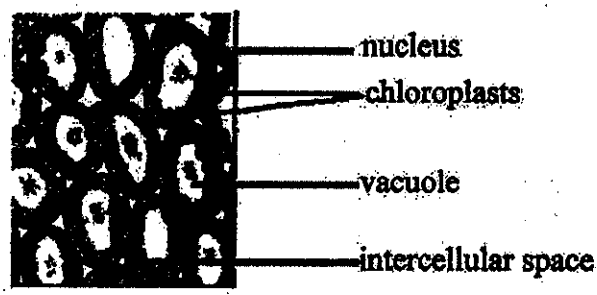


Fig. 4.2 Chlorenchyma

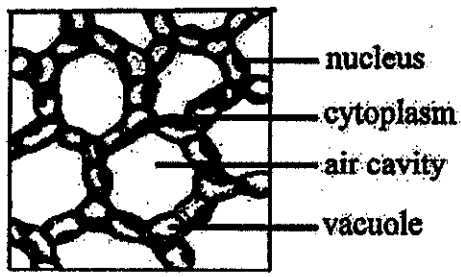
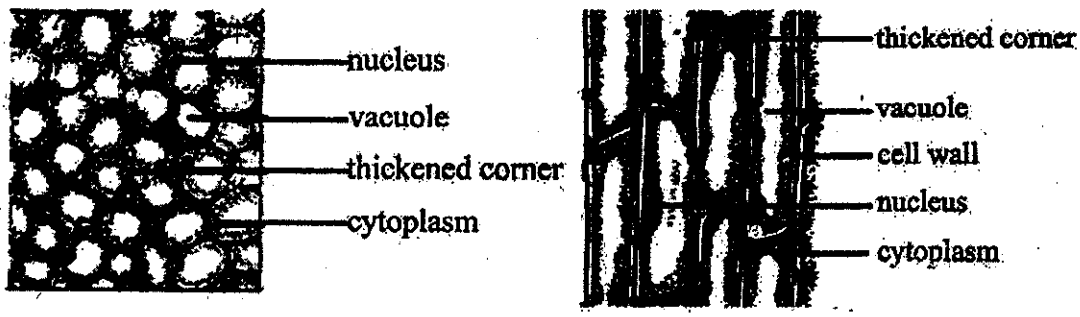


Fig. 4.3 Aerenchyma



Transverse section **Longitudinal section**

Fig. 4.4 Collenchyma

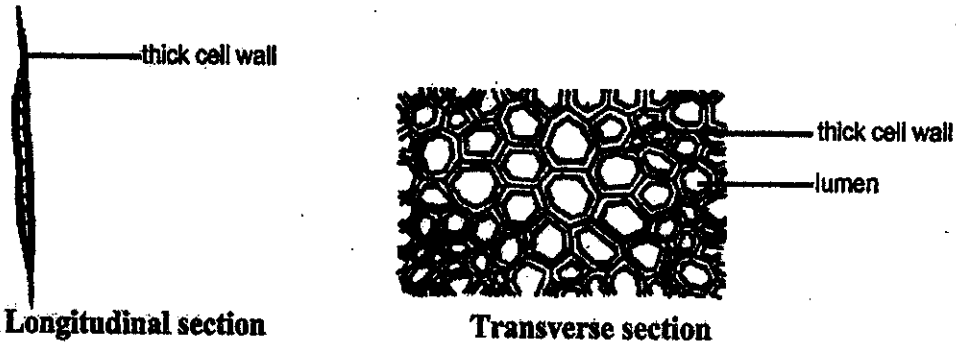


Fig. 4.5 Fibre

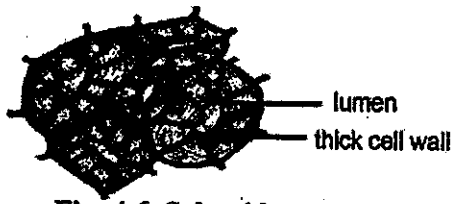


Fig. 4.6 Sclereid

2. Complex tissues

No	Types	Structure	Location	Functions
(a)	Xylem (wood)	different living or non-living cells with cell walls lignified in various patterns forming pits	vascular tissue of plant body	transport water and dissolved substances from the root to the leaves, mechanical support
	Composed of: -Tracheids	long and empty overlapping tubes near the tapering portions with cross wall at each end		
	-Vessels	more or less elongated, hollow tube-like drum-shaped cells joined end to end, transverse or end-walls with one or more openings	only in flowering plants	
	-Xylem parenchyma	living parenchymatous cells	associated with xylem	assist in conduction of water, storage of starch and fat
	-Xylem fibres	sclerenchymatous cells	in association with xylem	mechanical support

Fig. 4.7 Tracheids showing various kinds of thickenings

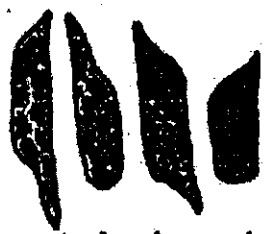
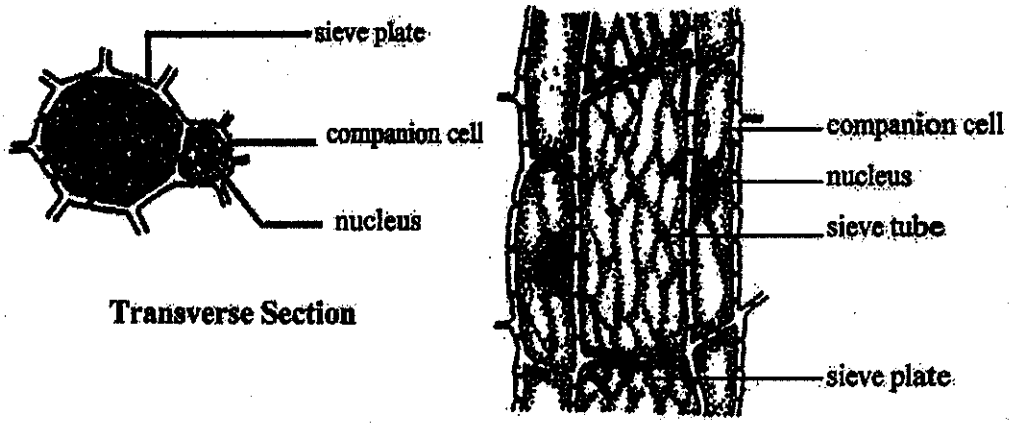


Fig. 4.8 Vessel elements showing various kinds of thickenings

No	Types	Structure	Location	Functions
(b)	Phloem (bast)	mostly living tissue	vascular tissue of plant body	conduct food materials from the leaf to the storage organs, then to the growing regions
	Composed of -Sieve tubes	thin walled, elongated tube-like cells placed end to end -transverse walls perforated by pores, like sieves (sieve plates)		food materials pass through sieve plates
	-Companion cells	thin-walled narrowly elongated cells with nucleus and mitochondria	with sieve tubes in flowering plants	
	-Phloem parenchyma	living cylindrical parenchymatous cells	together with phloem	
	-Phloem fibres	sclerenchymatous cells	absent in primary phloem, usually present in secondary phloem	



Transverse Section

Longitudinal Section

Fig. 4.9 Phloem tissue

ANIMAL TISSUES

Four major groups of animal tissues include:-

A. Epithelial or covering tissue,

B. Connective or supporting tissue,

C. Muscular or contractile tissue, and

D. Nervous tissue

A. Epithelial or Covering Tissue (based on form and structure)

No	Types	Structure	Location	Functions
1.	Simple squamous epithelium	thin flat cells, like tiles in a pavement	peritoneum lining of the body cavity	protection
	Stratified squamous epithelium	many layers of cells, the outermost being squamous cells	outer layer of the skin of man and higher animals lining of the mouth and nasal cavities	protection
2.	Cuboidal epithelium	Cuboidal or cube- like cells	salivary glands and kidney tubules	protection
3.	Columnar epithelium	cells rather taller than wide	lines the stomach and intestinal walls of vertebrates	protection

No	Types	Structure	Location	Functions
4.	Ciliated epithelium			
	Cuboidal ciliated epithelium	cuboidal cells with short hair-like protoplasmic processes (cilia) on the outer surface of each cell	sperm ducts of earthworms	protection
	Columnar ciliated epithelium	columnar cells with cilia on the outer surface of each cell	lines intestine of earthworms and air passages (trachea) in land vertebrates	protection
5.	Flagellated cell	slender whip-like processes (flagella) on the outer surface of the cell	digestive cavity of *Hydra*	protection

Fig. 4.10 Simple squamous epithelium

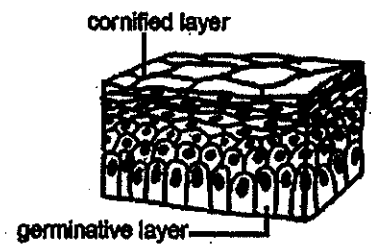


Fig. 4.11 Stratified squamous epithelium

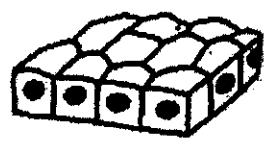


Fig. 4.12 Cuboidal epithelium

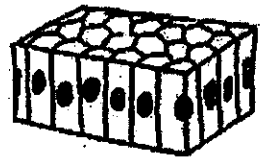


Fig. 4.13 Columnar epithelium

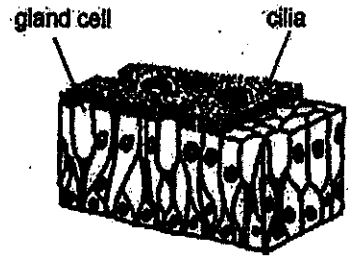


Fig. 4.14 Columnar ciliated epithelium

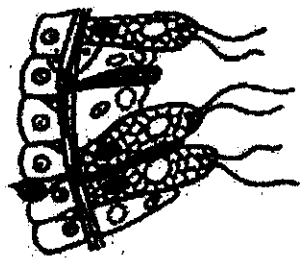
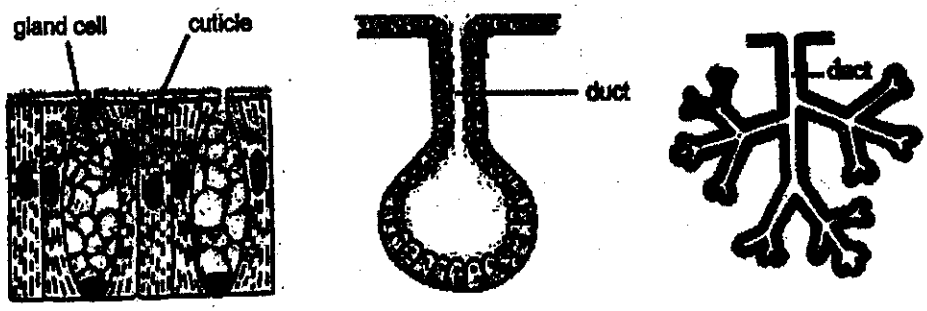


Fig. 4.15 Flagellated epithelium

Epithelial or Covering tissues (based on function)

No	Types	Structure	Location	Functions
1.	Protective epithelium	one layered in many invertebrates, stratified in land vertebrates	cuticle of earthworms body covering of arthropods nails and claws (special groups of epithelial cells)	guards animals from external injury or infection
2.	Glandular epithelium	- unicellular gland cells of columnar type - multicellular cuboidal cells	external surface of earthworms and in the intestinal epithelium of vertebrates. salivary glands of man and other mammals	specialized for secreting substances necessary for the use of the animals
3	Sensory epithelium	-	the epidermis of earthworms and on the tongue and nasal passage of man	specialized to receive certain kinds of external stimuli



(a) Unicellular (earthworm) (salivary gland) (b) Sac-like (frog skin) (c) Compound alveolar

Fig. 4.16 Types of glandular epithelial tissue

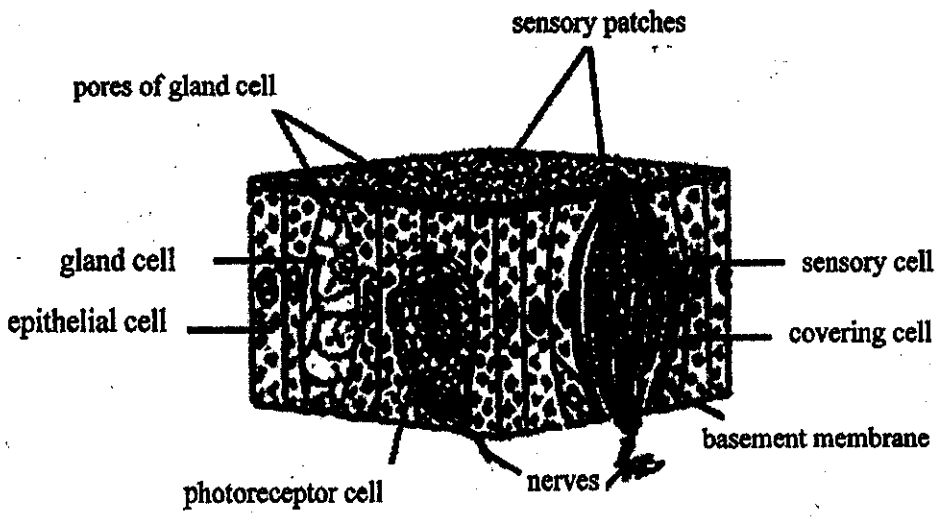
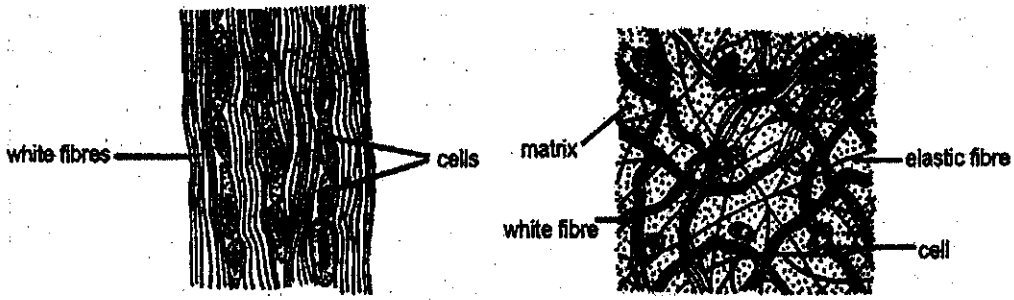


Fig. 4.17 Sensory epithelium of earthworm

B. Connective or supporting tissue

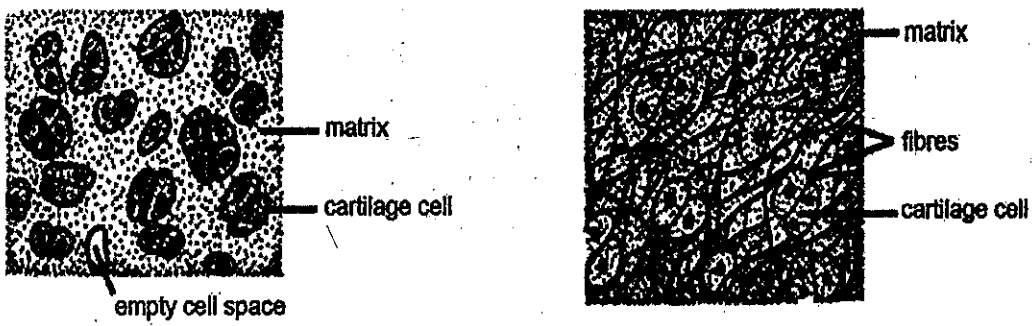
No	Types	Structure	Location	Functions
1.	Fibrous connective tissue	rounded or branched scattered cells		
	(a) white fibres	pale bundles, crossed or interlaced but not branched	tendons, around muscles and nerves	bind and hold together other cells and tissues of the body and give support

No	Types	Structure	Location	Functions
	(b) elastic fibres	sharply defined, straight, bent or branched	walls of larger blood vessels	bind the skin to the underlying muscles, attach many other tissues and organs to one another
2.	Cartilage connective tissue	rounded cartilage cells embedded within the elastic matrix	embryonic stages of all the vertebrates, surfaces of joints and the end of ribs in adults nose, tracheal rings and external ears of mammals	support
3.	Bone or osseous tissue	dense organic matrix with deposits of minerals in between the bone cells, marrow cavity large in the centre of the bone, contains yellow marrow (fat) or red marrow, to produce blood cells, concentric rings (lamellae)around each Haversian canal form the cell matrix, the bone cells embedded in the cavities of the lamellae periosteum, a thin fibrous covering of the bone	occur only in the skeleton of bony fish and other higher vertebrates	resilient when young and brittle in old age, support the body, act as levers for muscles, protects the delicate internal organs
4.	Fat or adipose tissue	rounded or polygonal cells with thin cell walls containing droplets of fat which may form larger globules, nucleus displaced to one side matrix, usually with white and elastic fibres	deep layer of the skin, abdominal region, around organs	
5.	Blood or vascular tissue	fluid plasma with erythrocytes, leucocytes and platelets	heart and blood vessels	transports the digested nutrients to all parts of the body, bring oxygen to cells for producing heat and energy, removes the waste materials of cell activities



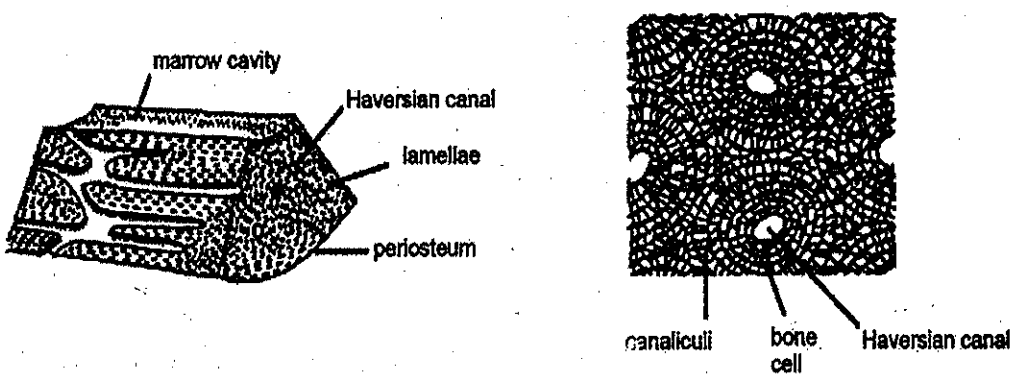
a. Fibrous tissue of a tendon b. Elastic tissue

Fig. 4.18 Fibrous connective tissue



a. Hyaline b. Fibrous

Fig. 4.19 Cartilage



a. Bone cut open to show marrow cavity b. Microscopic structure of bone

Fig. 4.20 Bone tissues

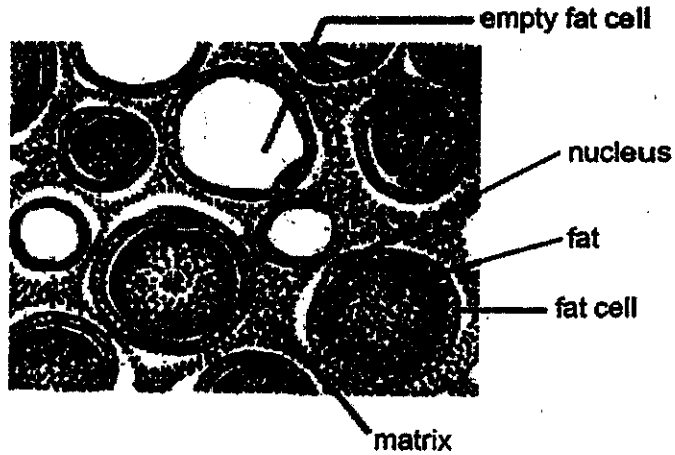
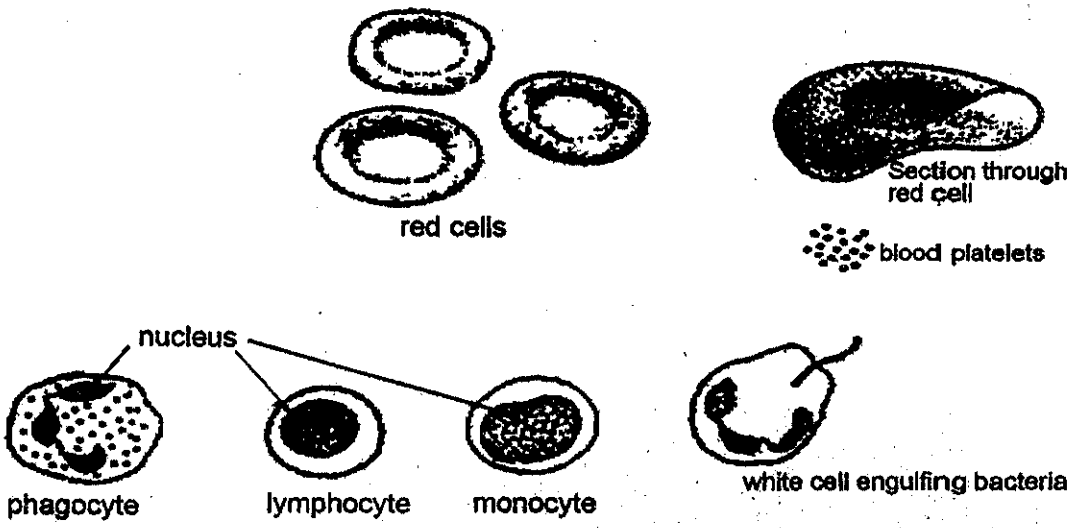


Fig. 4.21 Fat tissue



three types of white blood cells

Fig. 4.22 Blood cells

C. Muscular or Contractile tissue

No	Types	Structure	Location	Functions
1.	Muscular or contractile tissue	long and slender cells, contain minute contractile fibres called myofibrils	—	perform movements by contraction by getting shorter and thicker
	(a) Striated muscle (or) Skeletal muscle (or) Voluntary muscle	cylindrical with distinct dark and light cross bands or striations , each cell contains many nuclei and is covered by a delicate membrane (sarcolemma)	biceps of the upper arm	contraction
	(b) Smooth muscle (or) Non-striated muscle (or) Involuntary muscle (or) Visceral muscle	slender spindle-shaped cells each containing a single oval nucleus, no striation	internal organs of the vertebrate body (digestive tract, blood vessels)	contraction
	(c) Cardiac muscle (or) heart muscle	faintly striated and branched	heart	contraction

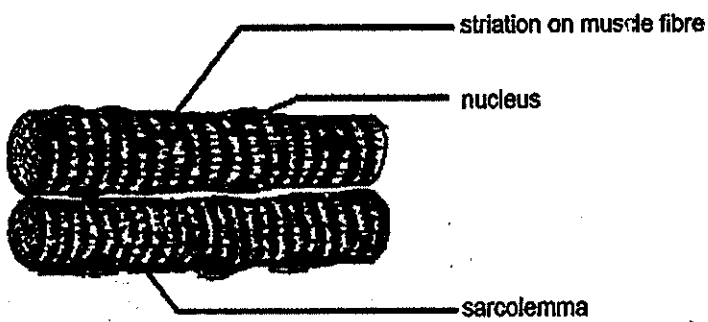


Fig. 4.23 Striated muscle

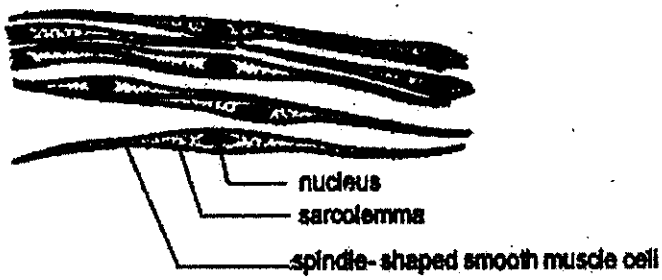


Fig. 4.24 Smooth muscle

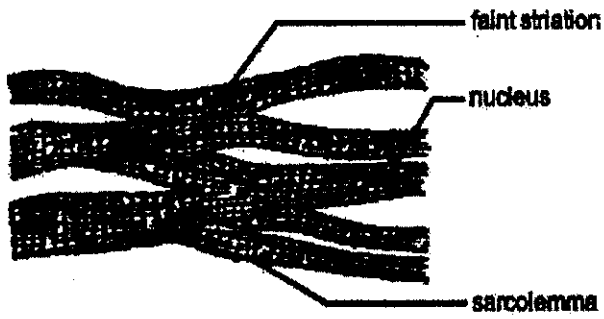


Fig. 4.25 Cardiac muscle

D. Nervous tissue

No	Types	Structure	Location	Functions
1.	Nervous tissue	nerve cells or neurones **Neurone** large cell body with a conspicuous nucleus and two or more protoplasmic processes **Protoplasmic processes** (dendrites and axon) **dendrite** transmits stimuli to cell body	all parts of the body	specialized for conducting impulses throughout the body

No	Types	Structure	Location	Functions
		axon carries the impulses away from the cell body **Nerve** a group of nerve processes or fibres bounded together by connective tissue		

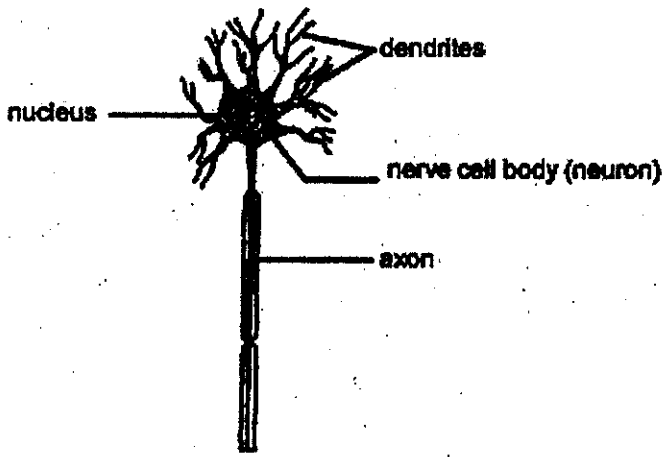


Fig. 4.26 A neurone

SUMMARY

A single cell that can perform all the life processes is termed as unicellular organism. Unicellular organisms exist in both plant and animal kingdoms. The well-known organisms however are multicellular. Different cells from various parts of the body perform different functions. Groups of mature cells having the same shape are capable of performing a particular function. A group of cells usually similar in both structure and function arising from a common origin is termed as a tissue. The bodies of multicellular organisms are organized based on tissues, organs, and systems.

Simple explanations of groups of plant and animal tissues supported by associate diagrams can easily be understood. In addition, extracted structures, locations, and functions of tissue types are presented in table forms to aid in remembering the essential facts. The basic knowledge of tissues would serve as an important foundation for Grade 11 Biology.

CHAPTER V

VARIETY OF LIVING ORGANISMS

A BACTERIAL CELL

Bacteria are very small organisms, visible only under high power microscope with the size ranging from 1 - 5 μm. However, they are larger than viruses.

Different shapes and groupings of bacteria

Bacterial cells distinguished and named according to their shapes are **bacilli** (rod-shaped), **spirilla** (spiral-shaped), **vibrio** (comma-shaped), **cocci** (spherical in shape). The cocci based on types of grouping subdivided into **diplococci** (bacteria grouped in twos), **streptococci** (in chains), **staphylococci** (in irregular collections), and **sarcina** (grouped in fours).

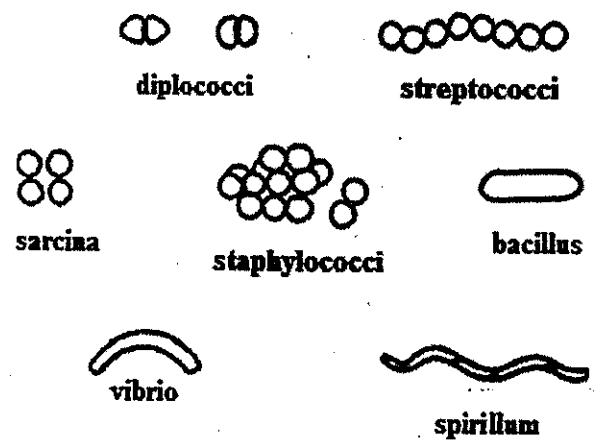


Fig. 5.1 Shapes and groupings of bacteria.

Structure

Bacteria are **unicellular.** They can exist singly or in colonies. Each cell consists of :

(a) **Cell wall** – made up of polysaccharides linked with amino acids (unlike plant cell walls, which are made of cellulose without amino acid). The cell wall determines the shape of the bacteria.
(b) **Cell membrane** – encloses the cytoplasm.
(c) **Nucleus**- absent

(d) **Deoxyribonucleic acid (DNA)** –DNA is not enclosed in a nuclear membrane. Nuclear materials in bacterial cell are not membrane bound. This type of cell is termed as **prokaryotic cell,** i.e. cells without a membrane system. Nuclear materials in plant and animal cells are membrane bound. They are termed as **eukaryotes.**

(e) **Cytoplasm** – contains granules of **glycogen** and lipids but no starch.

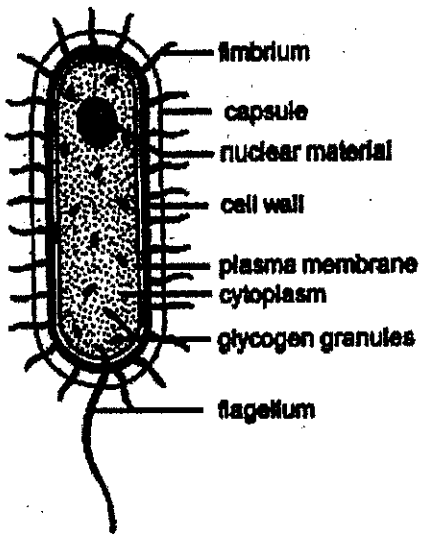


Fig. 5. 2 Structure of a generalized bacterial cell

In addition to a cell wall, a slimy capsule enclosed many bacteria, which gives them additional protection. Disease-causing bacteria are often encapsulated. The capsule prevents host cells from destroying the invading bacteria. Many bacilli and spirilla have **flagella,** which are used for locomotion.

Life functions of bacteria

1. **Nutrition**

(a) **Autotrophic bacteria** – produce food from simple inorganic compounds.

(i) **Photosynthetic bacteria** – have pigments that enable them to absorb light and use inorganic compounds to carry on photosynthesis (e.g. sulphur bacteria use hydrogen sulphide instead of water).

(ii) **Chemosynthetic bacteria** – use energy from oxidizing inorganic compounds (e.g. nitrifying bacteria use energy obtained from bacterial oxidation of ammonia to nitrites and nitrates).

(b) **Heterotrophic bacteria** –obtain ready-made food from the environment.

(i) **Saprophytic bacteria** – free-living, feed on remains of plants and animals. They secrete enzymes into organic matter and absorb some of the products as food leaving the rest in the environment. This process of bacterial breakdown of organic matter is termed as **decay**.

Decomposers – most are saprophytic bacteria. Chemicals released from the remains of plants and animals recycle in the environment by the activities of saprophytic bacteria.

Food spoilage – spoilage occurs when bacteria contaminate food and multiply rapidly. The food becomes spoilt and unfit for eating. The growth of bacteria retarded by refrigeration and freezing of food.

Food production – some saprophytic bacteria are important in industrial processes.

Lactobacillus spp. **(lactic acid bacteria)** – live in milk. Their activities change the sugars in milk into acid and responsible for production of milk products such as cheese and yoghurt. The bacterial action on cream produces butter.

Other bacteria produce vinegar through acid fermentation of alcohol.

Another group of bacteria is responsible for production of antibiotics (e.g. streptomycin, neomycin).

(ii) **Parasitic bacteria** – live on or in living organisms and feed on the host. They damage the host cells and secrete toxin.

Syphilis and **gonorrhoea** are sexually transmitted diseases caused by parasitic bacteria.

2. **Respiration**

(a) **Aerobes** – most bacteria are aerobic; require free oxygen for cellular respiration.

(b) **Anaerobes** – some bacteria can live without oxygen; a few grow slowly or even killed by oxygen, e.g. ***Clostridium botulism*** (cause food poisoning in improperly canned food), ***Clostridium tetani*** (cause tetanus -lockjaw).

3. **Reproduction**

Asexually by fission – under favourable condition, each bacterial cell can divide once every twenty minutes. The DNA replicates followed by cell

division. Two equal daughter cells result. Bacteria survive by forming **endospores** when the environment is unfavourable. A coat around each cell protects the bacterium during inactive spore formation. The spore is resistant to adverse conditions, such as drought or extreme temperature.

CYANOBACTERIA

SPIRULINA

Occurrence

Cyanobacteria can live almost anywhere: in fresh or salt water; on damp rocks, soil, and tree trunks; and in hot, cold, or dry climates.

Structure

Spirulina is also called blue green algae, which is a multicellular, filamentous blue green microalga (bacterium). It consists of cylindrical cells. The filaments are motile and can grow rapidly, reaching high filament densities in warm, shallow brackish lakes.

Fig. 5.3 ***Spirulina***

Economic importance

It is highly nutritious serving as a source of a total food for human nutrition. Human can survive with ***Spirulina*** and water without taking any other food. It is a pure natural food without chemical or synthetic supplement and free from pathogenic microorganism. Chlorophyll in ***Spirulina*** prevents wound infection and is effective in the treatment of ulcers and digestive deformation.

A FILAMENTOUS GREEN ALGA

Algae belong to the division **Thallophyta**. The characteristic features of algae are:

1. The plant body is simple and not differentiated into true stem, leaf and root. It may be unicellular or multicellular. Such a plant body is termed as a thallus.
2. They do not possess a vascular system.
3. They contain chlorophyll and are able to synthesize their own food.
4. Most of the algae grow in water, on damp soil, on wet rocks and on tree trunks. Some of them may even grow in hot springs and snow.
5. They may reproduce vegetatively by fragmentation, asexually by the formation of spores and sexually by the formation of gametes.
6. There is no formation of embryo after the fusion of gametes.

SPIROGYRA

Occurrence

Spirogyra species are filamentous green algae. They are commonly found in ponds, ditches, streams, etc. Numerous filaments grow together forming a slippery mass.

Plant body and cell structure

The plant body of ***Spirogyra*** is a simple unbranched filament consisting of a row of cylindrical cells joined end to end. A thin gelatinous sheath covers each filament.

The cell of ***Spirogyra*** is similar to that of higher plants. It has a distinct cell wall. The protoplasm is clearly differentiated into cytoplasm and a nucleus. The cytoplasm forms a thin layer enclosing a large central vacuole. One or more large spiral ribbon-shaped chloroplasts present along the periphery of the cell, occupying the entire length of the cell. The margin of the chloroplast may be smooth or serrated. Several small rounded bodies, known as **pyrenoids** are found in it. A large nucleus lies in the centre of the cell suspended in the central vacuole by thin cytoplasmic strands extending from the pyrenoids of the chloroplast.

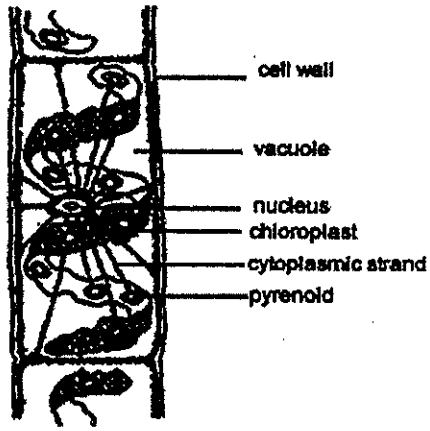


Fig. 5.4 Vegetative cell of *Spirogyra*

Reproduction

Spirogyra can reproduce vegetatively and sexually. Asexual reproduction by any kind of spores does not commonly occur.

(a) **Vegetative reproduction**

Vegetative reproduction is by means of fragmentation of filaments.

(b) **Sexual reproduction**

Sexual reproduction in ***Spirogyra*** takes place by **conjugation.**

PROTOZOA

Protozoans belong to the phylum **Protozoa.** General characteristics of Protozoa are:

1. Protozoans are usually one-celled and microscopic in size.
2. The shape is usually constant, but sometimes changes with environment or age.

3. Nucleus and other organelles are present. Organs or tissues are absent.
4. Locomotion is by flagella, cilia, pseudopodia, or by movement of the cell itself.
5. Some species have protective coverings, while many species produce resistant cysts or spores.
6. They may be free-living or parasitic.
7. Nutrition is by subsisting on other organisms, or on dissolved substances in their surroundings; or on dead animal matter; or by producing food by photosynthesis as in plants; or by combining two of the above methods.
8. Asexual reproduction is by fission or budding and sexual by fusion of gametes or by conjugation.

Members of protozoa are all microscopic one-celled organisms.

1. They are all **eukaryotes.** The cells contain a distinct membrane- bound nucleus and many different types of cytoplasmic organelles.
2. There are both autotrophic forms (e.g. ***Euglena*** - a single-celled organism with chloroplasts and flagellum), and heterotrophic forms (e.g. ***Amoeba*** - a single-celled organism that moves by forming pseudopodia (false feet) to obtain food). Some members are parasitic (e.g. ***Plasmodium*** - a parasite in man and mosquito that can cause malaria).
   Plasmodium is a member of the Class Sporozoa. Sporozoans are parasites. They obtain food from the host in which they live. During its life cycle, a sporozoan produces many spores, hence its name sporozoa.

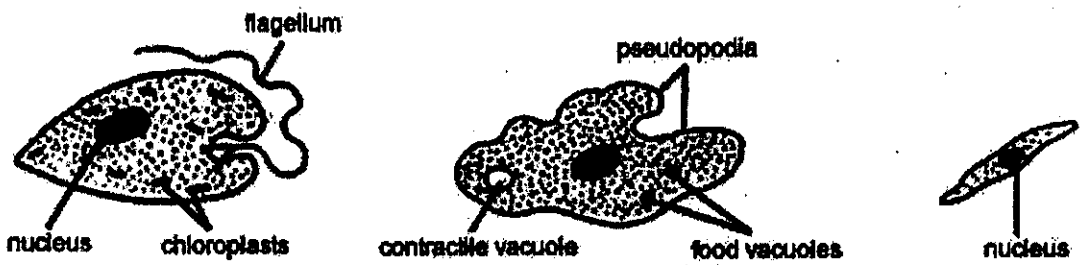


Fig. 5.5 Protozoa

AMOEBA

Habitat

Amoeba is free living and inhabit slow-moving fresh water, or on vegetation and mud at the bottom of ponds.

Structure

The living ***Amoeba*** is a small mass of jelly-like protoplasm completely covered by a semipermeable plasma membrane. It is flexible and irregular in shape. It changes its shape frequently due to the formation of temporary false feet, **pseudopodia.** The protoplasm consists of a nucleus and cytoplasm. The cytoplasm is distinguishable into the outer thin **ectoplasm** and the inner **endoplasm.** The latter contains a disc-like nucleus, a **contractile vacuole,** one or more **food vacuoles** of various sizes, crystals, oil globules and other cell inclusions.

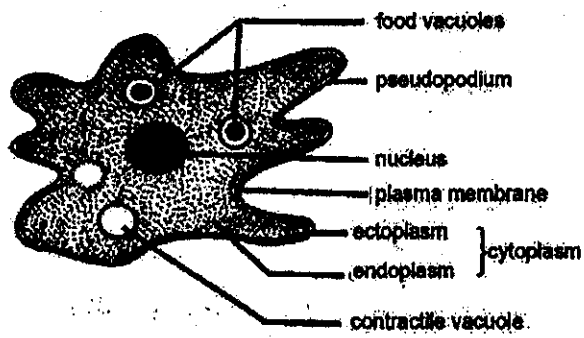


Fig. 5.6 Structure of *Amoeba*

Movement

The endoplasm of ***Amoeba*** exists in two different states. Just inside the ectoplasm is a region of firm jelly, **plasmagel.** Internal to this is a more fluid region, **plasmasol.** The two states can be changed from one state to the other. Transformation of plasmagel to plasmasol and plasmasol to plasmagel takes place at the same time, while the protoplasm gradually flows in one direction, forming the pseudopodia. This process is termed as **amoeboid movement.**

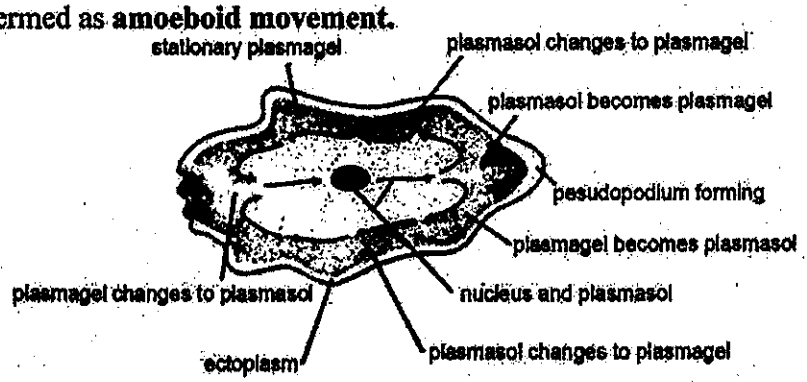


Fig. 5.7 Amoeboid movement

Nutrition

Amoeba feeds on food particles including bacteria, algae and other types of protozoa. Chemicals from the food particle diffuse into the water. ***Amoeba*** senses the chemicals and forms pseudopodia in the direction of the food. The food is surrounded by the pseudopodia and captured. The food, together with a drop of water forms a vacuole inside the ***Amoeba***. This process is **ingestion.** The protoplasm secretes enzymes into the food vacuole and **digestion** takes place. The digested food is absorbed by the surrounding protoplasm and is incorporated into it. This process is **assimilation.** Finally, the *Amoeba* performs the process of egestion by moving away and leaving undigested materials in the water.

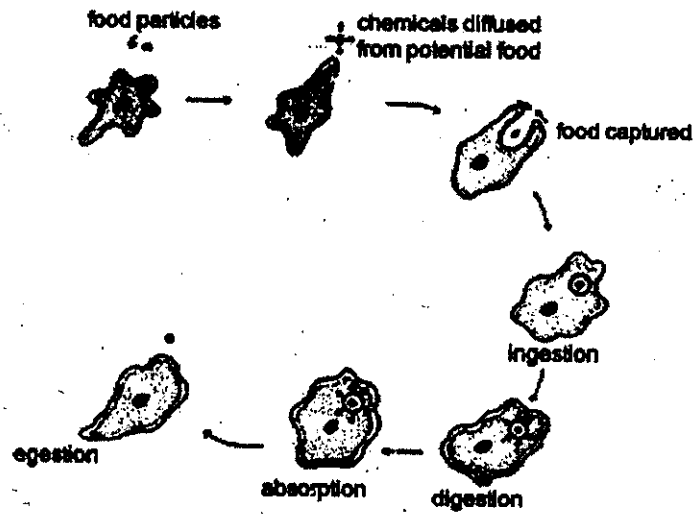


Fig. 5.8 Stages of nutrition in *Amoeba*

Respiration

The concentration of dissolved oxygen in the water is high and that in the body of ***Amoeba*** is low since the oxygen is used up as soon as it enters the cell body. Hence, inward **diffusion** of dissolved oxygen takes place from high concentration to low concentration. This diffusion takes place all over the surface through the semipermeable plasma membrane. Waste products of oxidation, e.g. carbon dioxide diffuse out through the same route.

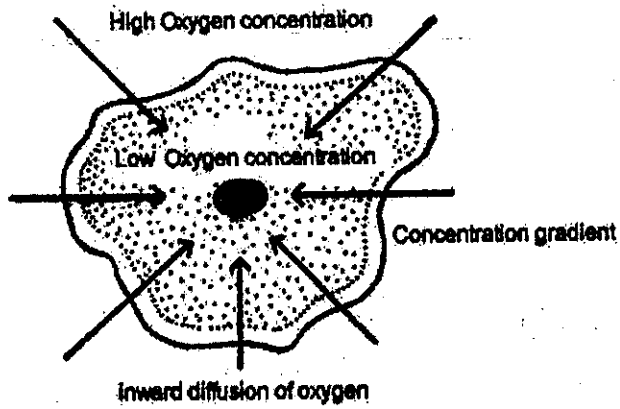


Fig. 5.9 Respiration in *Amoeba*

Excretion

Concentration of waste, such as, carbon dioxide and urea is high in the protoplasm owing to the production of waste by the living cell. Dispersal of waste in the surrounding water maintains low concentration. Removal of waste, **excretion,** thus takes place by the outward diffusion of dissolved carbon dioxide and waste nitrogenous compounds all over the surface of the ***Amoeba***. The contractile vacuole probably serves in part for excretion.

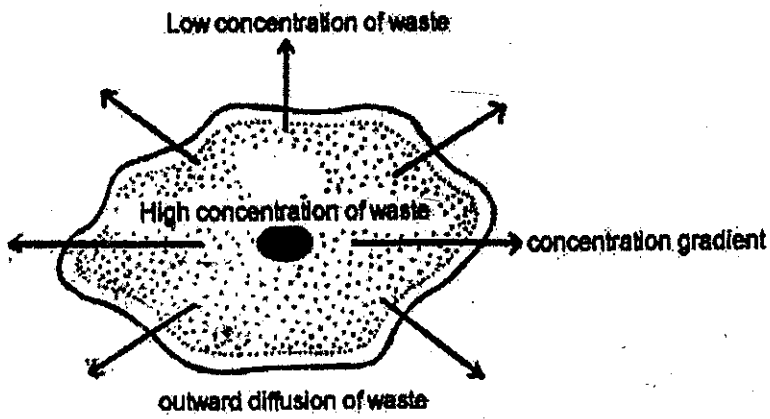


Fig. 5.10 Excretion in *Amoeba*

Osmoregulation

Regulation of the water content of the cell body, **osmoregulation,** is the principal function of the contractile vacuole. The concentration of dissolved substances in the protoplasm is higher than that in the surrounding water, so the water passes inwards by osmosis through the semipermeable membrane. The contractile vacuole collects the excess water in the cell body and enlarges. Then it moves to the

surface of the cell body and discharges the collected water with some dissolved waste substances into the surrounding water.

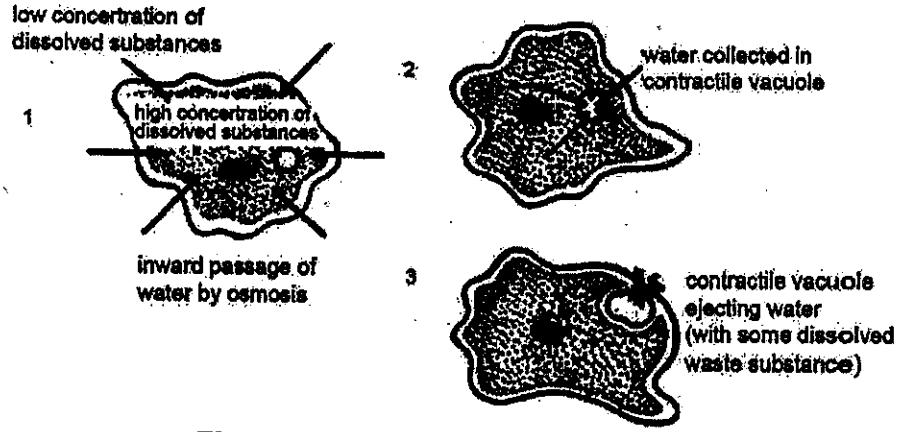


Fig. 5.11 Osmoregulation in *Amoeba*

Irritability

Amoeba responds to stimuli or changes in its environment in various ways. It responds negatively to unfavourable stimuli like irritant chemicals, or unpleasant touch with a needle or a strong light, and moves away. However, it responds positively to the chemicals diffused from the food particles into the water, and moves towards them.

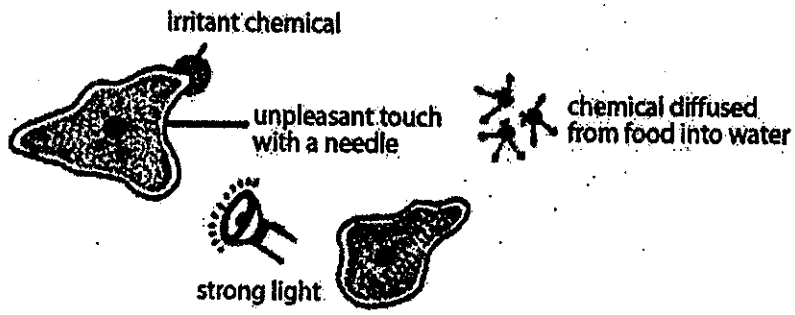


Fig. 5.12 Irritability in *Amoeba*

Reproduction

When the volume of the cell body becomes too large in relation to the surface area, *Amoeba* reproduces asexually by **binary fission.** *Amoeba* stops moving, rounds off and the nucleus divides into two. The cytoplasm also divides and final splitting of the cytoplasm gives rise to two daughter **amoebae.** This division of one cell into two cells is termed as binary fission.

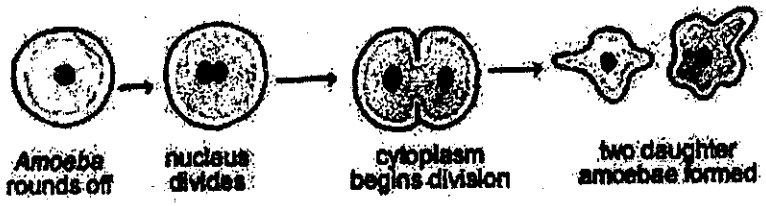


Fig. 5.13 Binary fission in *Amoeba*

Dormancy and dispersal

Under unfavorable conditions, the protoplasm of some species of ***Amoeba*** secretes a surface material, which hardens and forms a **cyst.** The cyst is resistant to drought and extreme temperature, and ***Amoeba*** remains **dormant** in the cyst through the unfavorable period. The cyst may be dispersed by wind or by animals. The cyst breaks open and ***Amoeba*** emerges when it reaches a favorable place. In some species of ***Amoeba,*** the nucleus breaks down and separate portions are formed. Each portion, containing a nucleus and a small part of cytoplasm, forms a cyst. The parent ***Amoeba*** disintegrates and the cysts are dispersed. Under favorable situations, each cyst breaks open releasing a daughter ***Amoeba.***

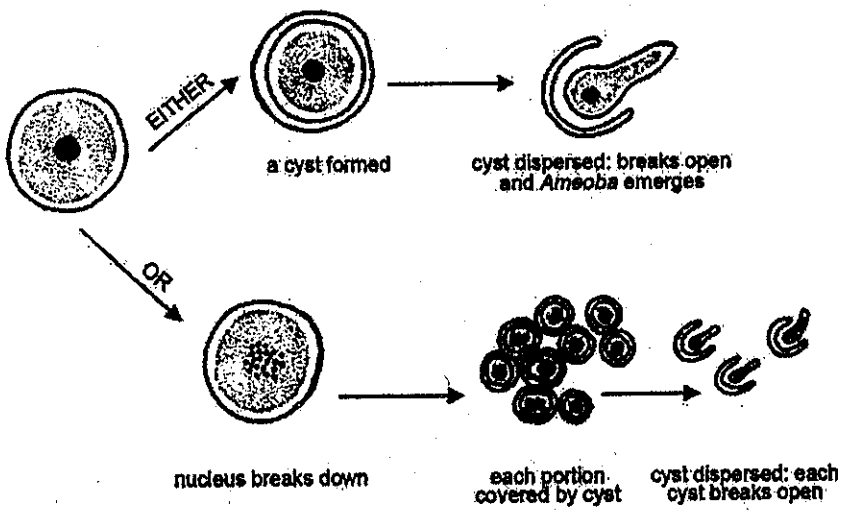


Fig. 5.14 Dormancy and dispersal in *Amoeba*

FUNGI

Fungi form a large subgroup of **Thallophyta.** Lack of chlorophyll distinguishes the fungi from higher plants and algae.

The characteristic features of fungi are:

1. The fungi possess a simple kind of plant body called a thallus. They may be unicellular or in the form of a multicellular filament. A single thin thread-like filament is termed as a **hypha (plural-hyphae),** which may be **septate** (with a dividing wall) or **aseptate** (without a dividing wall). A collection of hyphae forming the vegetative part of the fungi is termed as **mycelium (plural-mycelia).**
2. A vascular system is absent.
3. They have a definite cell wall, made up of chitin or cellulose and a well-defined nucleus.
4. They do not possess chlorophyll and are unable to carry out photosynthesis. Therefore, they depend on others for food.
5. They grow as **parasites** on other plants and animals or as **saprophytes** on decaying organic matter in the soil and water.
6. They reproduce vegetatively, asexually, or sexually.

Fungi are non-green organisms. Most of them consist of many cells. Fungi include moulds, yeast, mushrooms, and bracket fungi.

RHIZOPUS

Plant body

The plant body of *Rhizopus* consists of fine thread-like hyphae. The hyphae are freely branched, aseptate and multinucleate. They intertwine to form a dense white mass, the mycelium. The mycelium when mature is differentiated into three types of hyphae; stolon, rhizoid and sporangiophore.

The hyphae that grow horizontally over the surface of the substratum are the **stolons.** Their tips then bend down into the substratum to form a tuft of **rhizoids.** Rhizoids are repeatedly branched hyphae, which penetrate into the substratum to absorb nourishment for the whole plant. **Sporangiophores** are unbranched erect hyphae, which arise in tufts at the point where the rhizoids are produced.

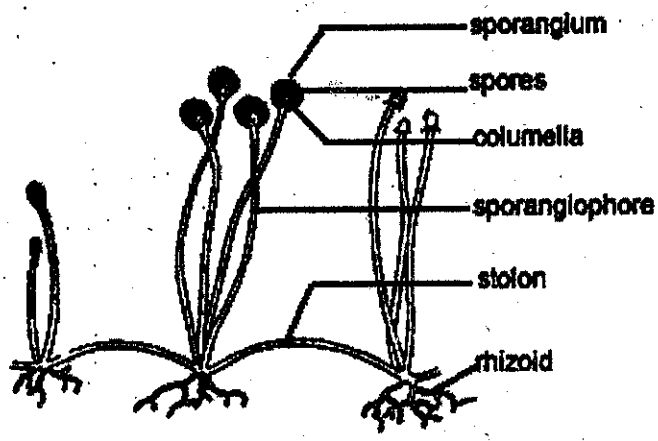


Fig. 5.15 The mycelium of *Rhizopus*

MUSHROOM

The plant body

Highly branched hyphae constitute the plant body of the mushroom. The branched hyphae unite at their points of contact and form a network known as the mycelium.

The aerial portion of the mushroom constitutes the fruiting body, the **basidiocarp.** This consists of a stalk-like portion, the **stipe** (a thick cylindrical fleshy structure), which supports a broad umbrella-shaped cap, the **pileus.** The stipe is usually broader and swollen at the base. The pileus is more or less rounded and convex. When young, the basidiocarp is spherical in shape and known as the button stage. A thin membranous covering called the **veil** or **velum** completely covered the basidiocarp. The velum remains in the form of a ring, the **annulus** as the button grows and enlarges into the pileus and stipe.

Numerous thin, vertical plate-like structures hanging from the underside of the pileus are termed as the **gills** or **lamellae** (singular-lamella). The gills extend from the margin of the pileus towards the stipe.

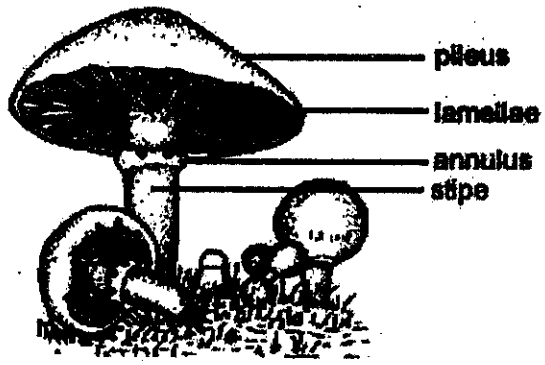


Fig. 5.16 Mushroom, basidiocarp

Nutrition

Most fungi are saprophytes, living on dead organic matter. Other fungi are parasitic, infecting plants or animals. The hyphae spread into the substrate in which they are growing, secrete enzymes to break down the complex molecules into simpler ones before finally absorbing them by diffusion. Food is stored as glycogen.

Reproduction

Fungi reproduce asexually by means of spores. The black dots of bread mould are sporangia that produce spores. The familiar mushrooms are actually the visible spore-producing parts of the club fungi. The cap of the mushroom consists of many hyphae fused together. Yeast reproduces asexually by budding and by spore formation.

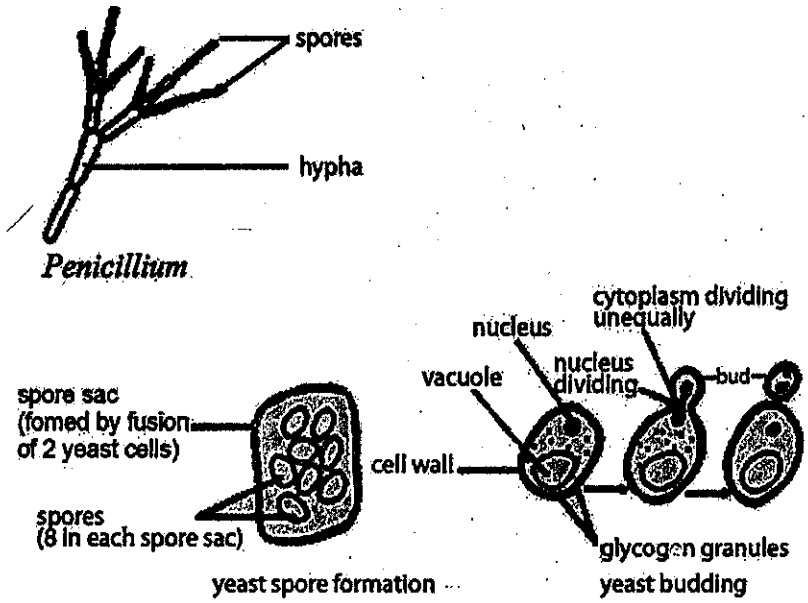


Fig. 5.17 Fungi

Economic importance

1. **Decomposers**

   Together with bacteria, fungi are responsible for recycling the chemicals in the remains of organisms to the environment.

2. **Fermentation**

   Yeasts are useful in industry for their fermentation products such as alcohol, alcoholic beverages, and bread. Production of alcohol and carbon dioxide occur during respiration in the absence of oxygen.

   $$\text{Sugar} \xrightarrow{\text{enzyme (secreted by yeasts)}} \text{Alcohol} + \text{Carbon dioxide}$$

   This reaction is termed as **alcoholic fermentation**. Yeasts on feeding upon the carbohydrates in dough, liberate carbon dioxide and cause the dough to rise.

3. **Food**

   Many species of mushrooms are edible and serves as a source food. A species of *Penicillium* produces cheese with a distinctive flavour. Another species of *Penicillium* produces the antibiotic called penicillin.

4. **Disease agents**

   Parasitic fungi penetrate and spread their hyphae throughout the host tissues,

eventually killing the cells. Rusts and mildews are examples of fungal diseases on crop plants, (e.g. white rust on leaves of vegetables), and ringworm, a skin infection, is an example of a fungal disease in man.

A TAPEWORM

Tapeworms belong to the phylum **Platyhelminthes.**

General characteristics of Platyhelminthes are:

1. The body is usually flat without true segmentation.
2. Organs and tissues are present. Epidermis is soft and ciliated or covered by cuticle.
3. Digestive system is incomplete, having a mouth but no anus.
4. Body cavity is absent. Loose parenchyma fills the space between internal organs.
5. Skeletal, circulatory, and respiratory systems are absent. The excretory system consists of flame cells connected to excretory ducts.
6. Nervous system consists of a pair of anterior ganglia or a nerve ring connecting to longitudinal nerve cords with transverse commissures.
7. Sexes are usually united. Fertilization is internal. Development is either direct or with larval stages. Some species reproduce asexually.

Taenia solium (The pork tapeworm)

It is an **obligate parasite**, that is, it dies if deprived of a host. It is also called an **endoparasite**, since it lives inside the body of its host. It is very well adapted to life in its peculiar habitat.

Structure

The adult *Taenia solium* lives in the small intestine of man, the **primary host.** The body, which is narrow, flat, and elongate, resembling a tape, may be about 5 meters long. It is covered with cuticle, beneath which is a layer of epidermis. In the body are muscles, nerves, flame cells, excretory canals, and parenchyma. The parenchyma is a loose network of cells filling the interstices. The body cavity is absent. The tapeworm is attached to the internal lining of the intestine, by a small

"head" or **scolex**, which has four suckers and a circle of hooks on a crown-like portion or **rostellum.** The body consists of as many as 1000 segment-like **proglottids.** The proglottid becomes broader towards the unattached end.

A newly formed proglottid is immature. As it becomes pushed further away from the scolex it develops male organs and then female organs. About halfway of the tapeworm is a region of hermaphroditic proglottids. Fertilization occurs in this region. Beyond this, the male organs and later the female organs degenerate and disappear. The proglottids in the terminal region are ripe and each consists entirely of a single uterus, filled with fertilized eggs or zygotes.

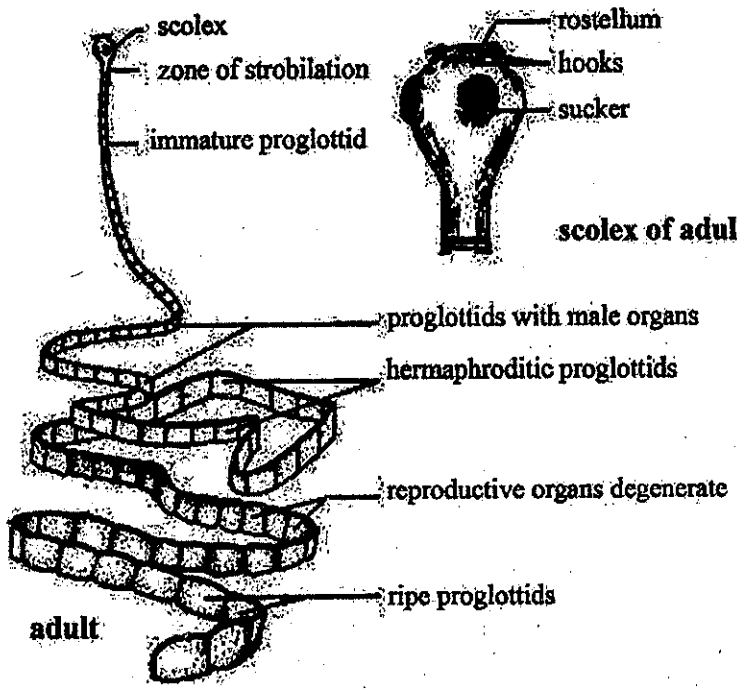


Fig. 5.18 ***Taenia solium***

Life cycle

The ripe proglottids of the terminal part of the tapeworm finally drop off into the intestinal cavity of the host. The ripe proglottids pass out with the faeces of the host onto the soil. Within the uterus of the tapeworm, the zygote, which is inside its shell, develops into a solid ball of cells with six hooks. This is the **hexacanth larva.**

On the soil, the proglottids break open and the hexacanths are liberated. The protective shells of the larvae resistant to drought and temperature protect the larvae

inside. When a pig, the secondary host, ingests the larva, it passes into stomach, where the shell is digested and the larva is set free. The hexacanth larva attaches to the stomach wall and then bores through it into a blood vessel. The blood to the muscle of the pig carries it. Here the hexacanth changes into a bladderworm (**cysticercus**). This is a cyst, which is a fluid-filled bladder with an inturned **proscolex.** When man ingests raw or partly cooked pork, the cyst is digested in the intestine and the proscolex is turned out to attach to the intestinal wall. Then the bladder is cast off and growth takes place by **strobilation** (production of new proglottids) begins.

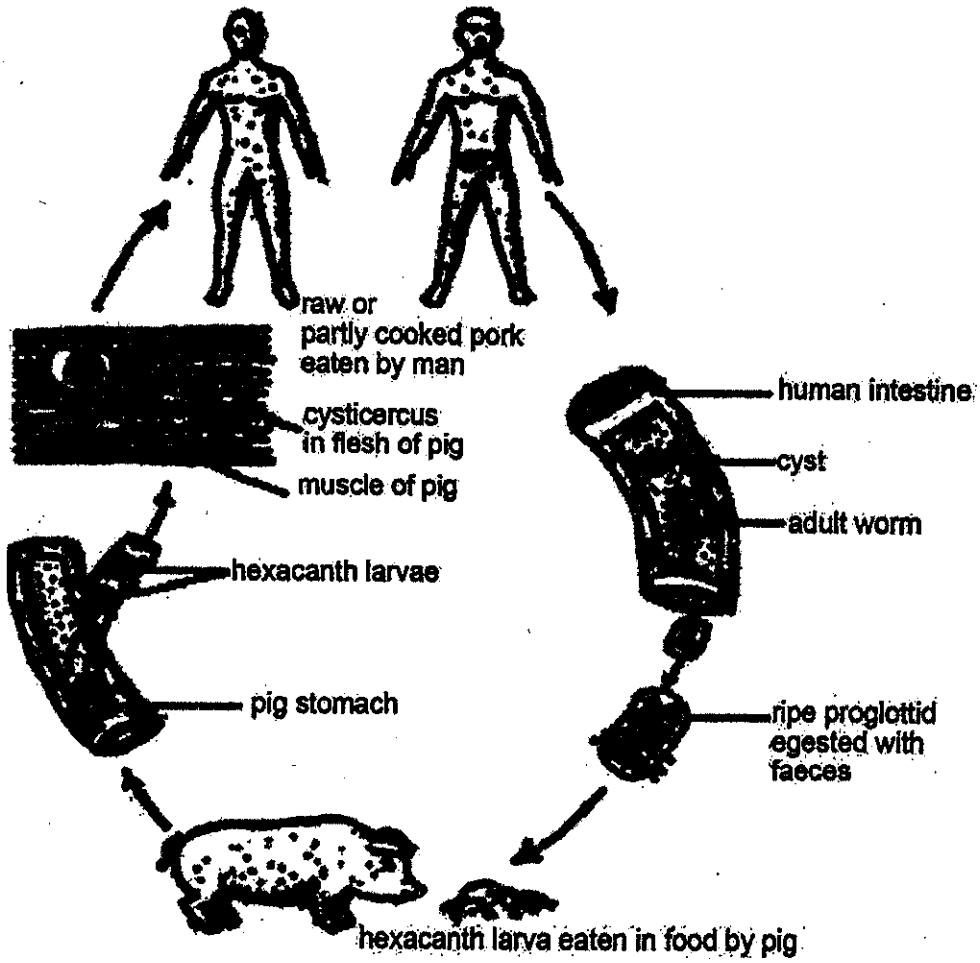


Fig. 5.19 Life cycle of *Taenia solium*

Effect of tapeworm infection on the health of man

1. Tapeworm infection causes abdominal pains, vomiting and nervous disorder in man.
2. The effect is usually serious in children.
3. It is also serious in adults already weakened by some other condition.
4. Once infected, the adult tapeworm is able to live in human hosts for more than twenty years.

LIVERWORTS AND MOSSES

The bryophytes are regarded as the most primitive land plants. They include two main groups, **liverworts,** and **mosses.** Most of them grow on damp and shaded soil.

The characteristic features of bryophytes are:

1. Liverworts commonly have a forked thallus-like body and mosses have a small stem bearing tiny leaves. Both liverworts and mosses are attached to the soil by means of thread-like structures called **rhizoids.**
2. The plant bodies have no vascular system. They are composed mainly of parenchymatous tissue.
3. The sex organs are multicellular. A layer of sterile cells surrounds the gametes and spores.
4. There is formation of an embryo after fertilization, which takes place in the presence of water.
5. The life cycle of bryophytes shows two distinct phases. One of them is the green **thalloid** or leafy plant, which reproduces sexually by production of gametes. Based on the nature it is termed as a **gametophyte.**

The zygote, which is formed by the fusion of gametes, does not grow into a gametophyte but forms an embryo, which gives rise to a **sporogonium.** The sporogonium produces spores. This stage is termed as the **sporophyte.** The spore, on

germination grows into the gametophyte. The two generations thus regularly alternate with each other in a single life cycle. This is called "**alternation of generations**". In bryophytes, the gametophyte is the conspicuous and independent generation, whereas the sporophyte is borne on the gametophyte and is dependent on it.

A LIVERWORT

RICCIA

Occurrence

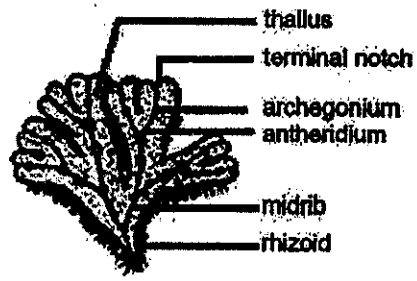
Riccia is a common liverwort, which grows as green patches on moist ground. It usually grows more abundantly when there is plenty of moisture.

A. Gametophyte

Structure

Riccia has a dorsiventral thallus, which is small, flat and ribbon-like. It is prostrate and branches dichotomously to form a rosette. A terminal notch exists at the tip of each branch in which lies the growing point. The thallus is thickest in the middle and gradually becomes thinner towards the margins. The middle portion is termed as the midrib. On the upper surface of the thallus, there is a median groove or furrow. The lower surface bears numerous unicellular rhizoids and tiny brown multicellular scales. There are two kinds of rhizoids; smooth-walled and tuberculate. The tuberculate rhizoids possess peg-like outgrowths projecting inward from the wall and serve to absorb water. The smooth rhizoids serve for anchorage.

thallus in the form of rosette



single thallus

Fig. 5.20 *Riccia* gametophyte

Reproduction

Riccia reproduces both by vegetative and sexual methods. In vegetative reproduction, the lobes of the thallus become separated due to the death of older parts. The separated lobes grow into new plants.

Sexual reproduction is by means of the male and female sex organs, known as **antheridium** (plural-antheridia) and the **archegonium** (plural-archegonia).

B. Sporophyte

The mature sporophyte consists only of the capsule, which is a spherical sac-like structure. It remains embedded in the thallus and is entirely dependent upon it for food and water. The sporophyte produces a large number of tiny spores. These spores are liberated after the death and decay of the capsule wall and thallus. Under favourable conditions, the spore germinates into a small green filament, which subsequently grows into a new plant.

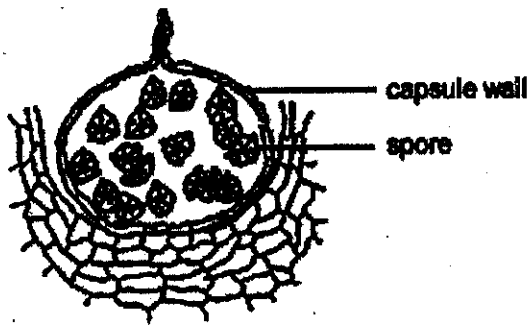


Fig. 5.21 Longitudinal section of *Riccia* sporophyte

A MOSS

FUNARIA

Occurrence

Mosses are higher bryophytes. They usually grow on old damp walls, tree trunks and on damp soil during the rainy season. Wherever they grow, they form patches or soft velvet-like green carpet. The most commonly found moss is *Funaria*. Although it looks quite different from a common liverwort e.g. *Riccia*, *Funaria* has the same type of life cycle. The leafy plant body is the gametophytic generation and the sporophyte is borne on the gametophyte.

A. Gametophyte

Structure

The plant body is small and consists of a short stem bearing spirally arranged small green leaves. The stem may be branched or unbranched. The rhizoids, which arise from the base of the stem, serve to anchor the plant in the soil and to absorb water and mineral salts. Because of the presence of the stem, leaves and rhzoids, *Funaria* looks like a small flowering plant. However, the stems and leaves are not similar to those of higher plants, since they do not have any vascular system.

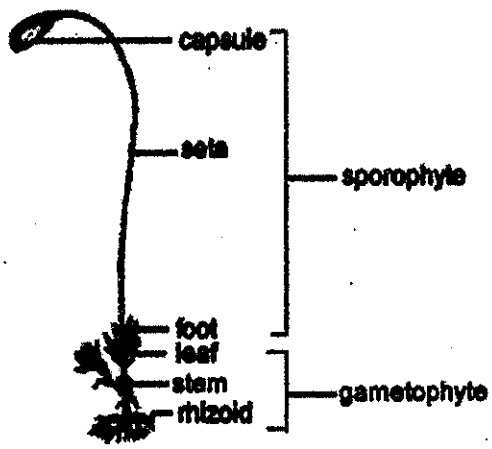


Fig.5.22 A moss gametophyte (bearing mature sporophyte)

Reproduction

In sexual reproduction, clusters of antheridia and archegonia develop at the tips of the branches. They may be borne together on the same plant or on separate plants.

B. Sporophyte

The sporophyte of moss is more complex than that of *Riccia*. It is composed of three parts: the foot, seta, and capsule. The lower conical part called the foot is embedded in the apex of the gametophyte from where it absorbs food. The middle portion, the **seta** or stalk, usually stands out above the leafy shoot. It conducts water and food from the foot to the capsule. The upper portion or **capsule** is a complex body. The main body of the capsule consists of three regions. The solid central region is the **columella**. Next to the columella is the **spore sac** consisting of a large number of tiny spores. The outermost region is the highly differentiated **capsule wall**.

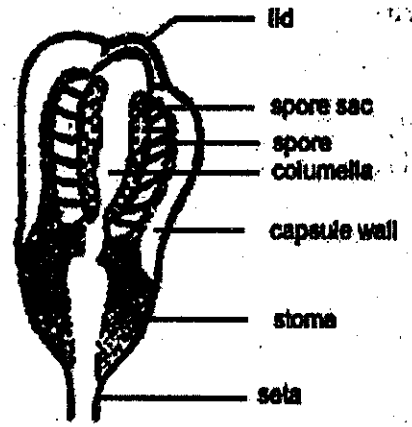


Fig. 5.23 Longitudinal section of the capsule of moss

When the spores are mature, a small lid at the tip of the capsule opens liberating the spores. The spores are dispersed by wind. Dispersed spores germinate to form a green-branched filament called the **protonema.** It subsequently gives rise to a number of gametophytes when environmental conditions are favourable.

A FERN

The ferns belong to the sub-group **Pteridophyta.** The pteridophytes are land plants, more advanced than bryophytes. They have certain similarities with bryophytes on the one hand and to spermatophytes on the other, and thus they occupy a position between the bryophytes and spermatophytes in the plant kingdom.

The characteristics of pteridophytes are:

1. The sporophyte is the independent generation, differentiated into stem, leaf and root.
2. A well-developed vascular system extends throughout the plant body.
3. Reproduction is by means of spores and not by seeds.
4. There is embryo formation after fertilization, which usually occurs in the presence of water.
5. The life cycle of pteridophytes shows distinct alternation of generations. The sporophyte is the conspicuous and independent generation.

ADIANTUM (Walking fern)

Occurrence

Adiantum is a widely distributed plant. It grows abundantly in damp shaded localities of the tropical and subtropical regions of the world.

A. Sporophyte

Structure

Adiantum has a long creeping or a short erect underground stem or **rhizome,** bearing **pinnately compound leaves.** The coiled young leaf is like a spring and it unrolls from the base towards the apex **(circinate vernation)** and gradually grows into a large compound leaf. It has a shining dark brown or black petiole. The petiole and rachis are hard. Roots grow in clusters from the underside of the rhizome. The stem and root possess both parenchymatous and vascular tissue.

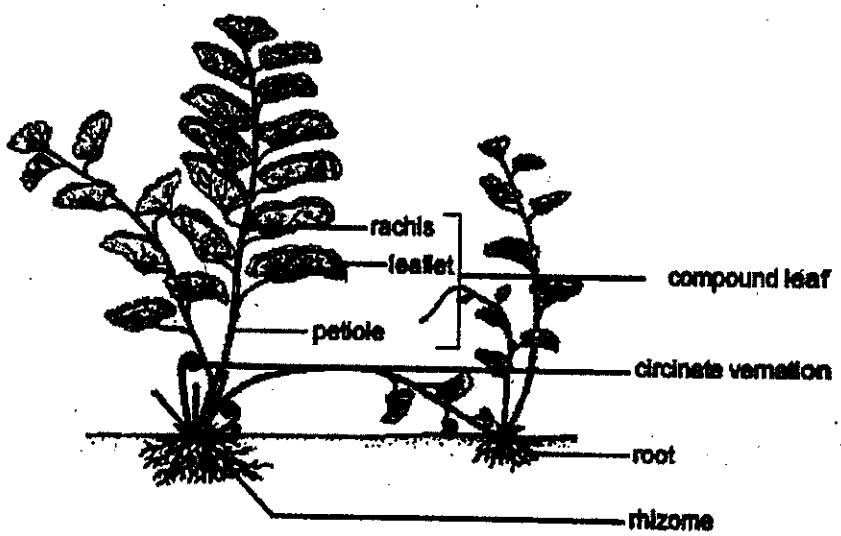


Fig. 5.24 A mature sporophyte of *Adiantum*

Reproduction

The sporophytes of *Adiantum* reproduce vegetatively and asexually. Roots produced from the tips of long spreading leaves when they touch the ground at some distance from the parent plant. A new plant soon develops from each rooted tip of the leaf.

B. Gametophyte

Structure

The light spores are easily dispersed by the wind. Under favourable environmental conditions, the spore may germinate to form a short green filament, which soon grows into a gametophyte called the **prothallus.**

The prothallus is a thin, green, flat, heart-shaped body with a conspicuous notch and fixed to the soil by root-like rhizoids borne on its undersurface.

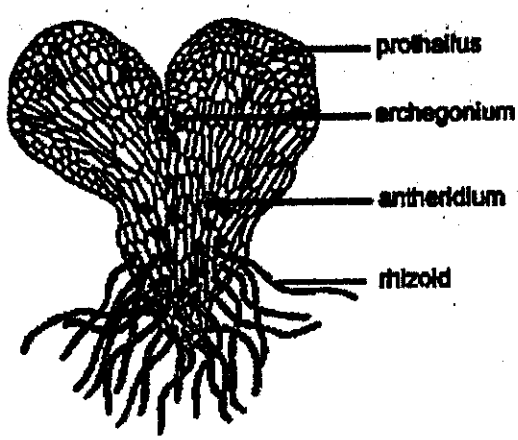


Fig. 5.25 Prothallus of *Adiantum*

Reproduction

The gametophyte of *Adiantum* reproduces sexually. Antheridia and archegonia are usually borne on the undersurface of the same gametophyte.

AN EARTHWORM

Earthworms belong to the phylum **Annelida.** Characteristics of the phylum are:

1. The body is elongate and usually segmented both externally and internally.
2. Appendages are small rod-like setae, or fleshy tentacles on the head and the setae borne on lateral parapodia.
3. Thin moist cuticle covers the body. Under the cuticle is the epidermis containing gland cells and sensory cells.
4. Coelom is well developed and is divided by septa.

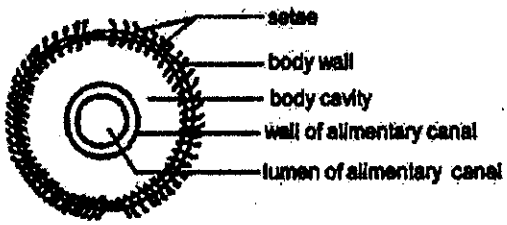
5. The digestive system is complete with mouth and anus.
6. The circulatory system is a closed system of longitudinal blood vessels with lateral branches in each segment.
7. Respiration is by the epidermis, or by gills in some species.
8. The excretory system consists of nephridia, which remove wastes from the coelom and blood stream.
9. The nervous system consists of a pair of cerebral ganglia with connectives to a solid ventral nerve cord. Sensory cells and organs for touch, taste and light perception are present.
10. Sexes are united and development is direct or sexes are separate with larval stage. Some species reproduce asexually by budding.

PHERETIMA

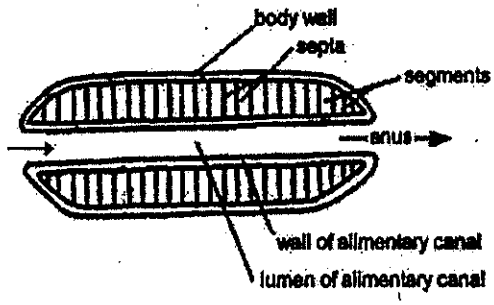
Earthworms live in moist soil, which may be loose or compact. They are usually not found in too clayey or acidic soil. They are found on the surface of the ground at night or after their burrows have been flooded by heavy rain.

Body plan and external features

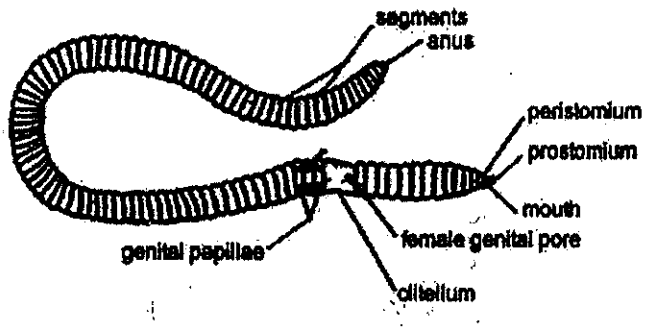
The body of *Pheretima* is tubular, consisting essentially of two tubes, one inside the other. The tubular alimentary canal lies inside the tubular body wall and the space between them is the fluid-filled body cavity or **coelom,** divided by septa into segments. The body consists of 100-120 segments, the external segmentation corresponding with the internal segmentation. The mouth lies in the first segment or **peristomium.** Overhanging the mouth is fleshy lobe, the **prostomium.** The anus is in the last segment. In *Pheretima,* segments 14 to 16 form a glandular girdle-like thickening known as the **clitellum.** Across the middle of each segment are a number of chitinous needle-like structures, the **setae.** Along the mid-dorsal line is a series of openings, the dorsal pores. A single female genital pore lies on the ventral side of segment 14. Four pairs of **spermathecal pores** present on the ventro-lateral sides between segments 5/6, 6/7, 7/8 and 8/9. A pair of male genital pores is located on the ventral side of segment 18, and a pair of genital papillae in each of segments 17 and 19.



Transverse section



Longitudinal section



External features of the earthworm

Fig. 5.26 ***Pheretima***

The ecological role of earthworms

In nature, the long-time effects of earthworms have certain practical values. In many soils, thousands are present per acre.

1. The burrows made by earthworms permit the entrance of air into the soil, improve drainage, and allow the roots of plants to penetrate more easily.
2. The soil from below the surface of the ground is brought up giving a tilling effect to the land.
3. The castings consist of the finest soil particles mixed with broken down vegetative tissues forming a high quality of humus.
4. In dry weather, the castings fall to powder, which is spread by the wind to form a new layer of tilled earth.
5. Organic remains dragged into their burrows mix with the soil and decomposed more quickly by soil bacteria serving as plant food.

6. Excretory matter from the earthworms adds manure to the soil and helps the activity of soil bacteria.

INSECTS

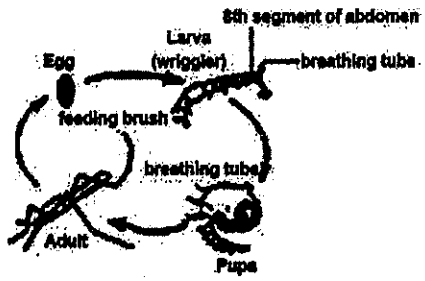
Insects belong to the class **Insecta** of the phylum **Arthropoda.** External characteristics of insects are:

1. The body of an insect is differentiated into head, thorax and abdomen.
2. One pair of antennae is present on the head.
3. Eyes may be simple or compound.
4. The mouthparts are for chewing, sucking or lapping.
5. The thorax has three pairs of jointed legs and two pairs of wings.
6. Small paired spiracles, the openings of the respiratory system, are present on the sides of thorax and abdomen.
7. Sexes are separate, usually with a single sex opening at the end of the abdomen.

Some insects undergo **complete metamorphosis,** that is a complete change during their life cycle,e.g. mosquito and housefly. Others develop gradually through **incomplete metamorphosis**,e.g. cockroach, grasshopper.

(a) Mosquito ----- complete metamorphosis

1. Eggs laid in stagnant water.



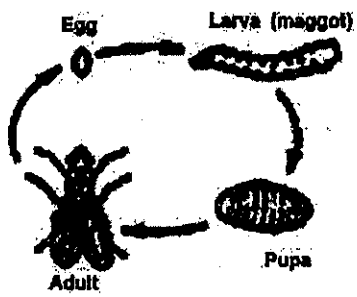
2. Larva feeds on decay vegetation, breathes air through tube, and grows by molting.

3. Pupa is the non-feeding stage. Adult tissues,e.g. wings and legs develop.

4. Adult has piercing mouthparts (proboscis) and feeds on blood or plant juice.

(b) Housefly ----- complete metamorphosis

1. Eggs laid on decay organic matter.

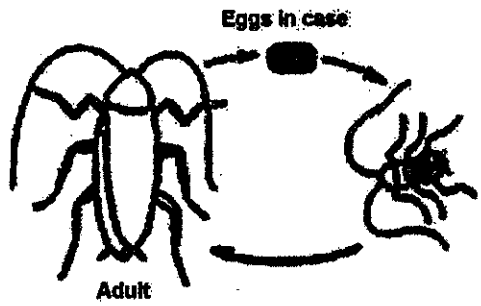


2. Larva feeds on decaying matter, breathes through spiracles at anterior and posterior ends and grows by molting.

3. Pupa is the non-feeding stage. Adult tissues develop within pupa case.

4. Adult has sucking proboscis secretes digestive juice on food; and sucks up dissolved food.

(c) Cockroach —— incomplete metamorphosis



Nymph resembles the adult lives in the same habitat and grows by molting.

Fig. 5.27 Life cycles of insects

Economic importance

1. **Agents of pollination**

   Some insects, e.g. butterfly and bee, visit flowers to collect nectar and pollen for food. In the process, they transfer pollens from one flower to the next and thus serving as agents for pollination.

2. **Vectors of diseases**

   Some insects carry disease-causing organisms.

   (a) Insects may transmit intestinal diseases, e.g. typhoid, cholera and dysentery, through contaminating the food we eat.

   (b) Other insects transmit disease organisms directly into our body by biting or piercing through our skin, e.g. malaria (*Anopheles* female mosquito) and dengue fever (*Aedes* mosquito).

A BONY FISH

Bony fish belong to the phylum **Chordata.**

Characteristics of a bony fish are as follows:

1. Skin of the bony fish has mucous glands and bony dermal scales. Some bony fishes are naked, i.e. **scaleless.** Median and paired fins are present.

2. Mouth is usually terminal and jaws are well developed. Two olfactory sacs are usually not connected to the mouth cavity. Eyes are usually well developed but without eyelids.
3. Skeleton is chiefly of bone.
4. Heart consists of two chambers, viz, one **atrium** and one **ventricle.**
5. Respiration is by gills at each side of the pharynx, covered by an **operculum.**
6. Ten pairs of cranial nerves are present.
7. The bony fishes are cold-blooded, i.e. their body temperature varies according to that of the environment.
8. Reproductive organs are typically paired. Fertilization is external.

External Features

The body of bony fish is spindle-shaped for easy passage through water. The three regions of the body are head, trunk, and tail. The head is from the tip of the snout to the hind edges of the **opercula**, the **trunk** from these edges to the anus and the region behind the anus is the **tail.** The mouth is large and terminal. The jaws are distinct and bear fine teeth. On the snout are two pairs of nostrils. The eyes are lateral and without eyelids. Behind each eye, covering four comb-like gills is a thin gill-cover, the operculum with free edges posteriorly and ventrally. Just anterior to the anal fin are the anus and the urogenital aperture.

An epidermis covering the entire fish is soft and produces mucus. The latter protects the body against injury and from entry of pathogenic organisms. Thin rounded dermal scales arranged in longitudinal diagonal rows on the trunk and the tail. Along either side of the body is the lateral line, which is a row of small pores connected along a tubular canal under the scales.

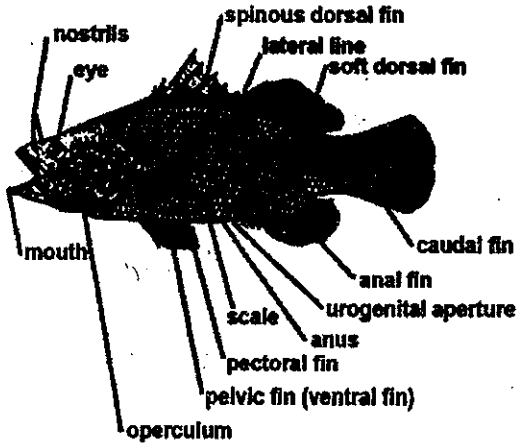


Fig. 5.28 External features of a bony fish

Median and paired fins are present. The median are the two **dorsals** on the back and **caudal** on the tail, and the **anal** behind the anus. The paired or lateral fins are the **pectorals** and the **ventrals**. The pectoral fins lie behind the opercula and the ventrals close below.

Muscular system

The trunk and the tail of the fish consist mainly of segmental muscles, called **myomeres**. They alternate with the vertebrae and produce swimming and turning movements by their coordinated contractions along the length of the body.

Swim Bladder

The swim bladder (air bladder) is a large thin-walled sac in the dorsal portion of the body cavity filled with oxygen, nitrogen, and carbon dioxide. It acts as a **hydrostatic** organ to adjust the specific gravity of the fish to that of the water at different depths. The fish makes this adjustment slowly as it moves from one depth to another by secreting or absorbing gases through the blood vessels in the wall of the swim bladder.

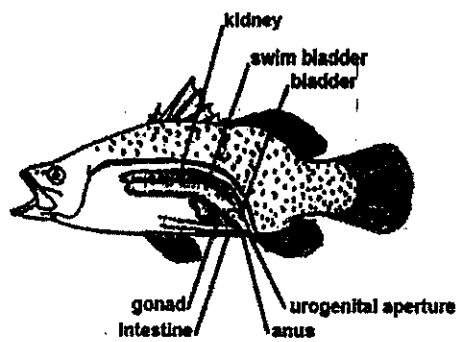


Fig. 5.29 General structure of a bony fish, showing swim bladder and kidneys

Digestive system

The digestive system of the fish consists of a complete digestive tract and its associated glands, the liver and the pancreas.

The mouth is large with distinct jaws that bear many small conical teeth. The mouth leads into the pharynx, followed by a short oesophagus. In the pharynx are the pharyngeal and gill raker teeth. The teeth on the jaws grasp the food and those in the pharynx help in holding and crushing it. The tongue is small, attached to the floor of the mouth cavity. It may aid in respiratory movements.

The oesophagus leads into the recurved stomach, which in turn leads into the intestine. A pyloric valve separates the stomach and intestine. Attached to the intestine are three tubular pyloric caecae for secretion and absorption. The intestine forms a few folds in the coelom extending towards the anus anterior to the urogenital opening.

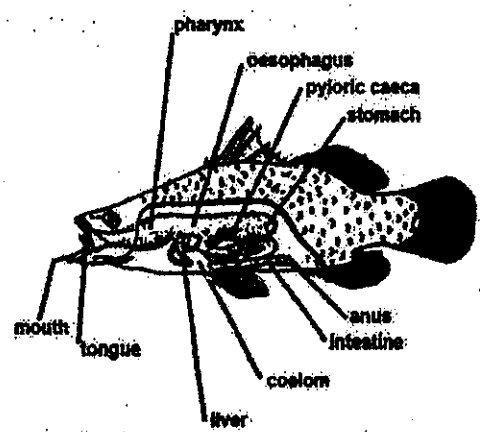


Fig. 5.30 Digestive system of a bony fish

Circulatory system

Circulation in the fish is a single circuit, the blood passing through the heart only once in a complete circulation. The heart is tubular and two chambered consisting of an atrium and a ventricle. It lies ventral to the pharynx in the pericardial cavity in the anterior portion of the coelom.

Deoxygenated blood from the whole body returns by the main veins, the paired **anterior cardinals** and **posterior cardinals**, and unpaired **hepatic portal system.** It passes through the sinus venosus to the thin-walled atrium and then to the muscular ventricle. Valves separating the chambers of the heart prevent the reverse

flow of blood. The ventricle contracts rhythmically and forces the blood to flow through the conus arteriosus and the short ventral aorta into the four pairs of **afferent branchial arteries**. Thus, the blood in the capillaries of the gill filaments is oxygenated. The corresponding paired **efferent branchial arteries** collect the blood from the capillaries in the gills and flow into the dorsal aorta. The latter, having many branches, distributes blood to various parts of the head and the body.

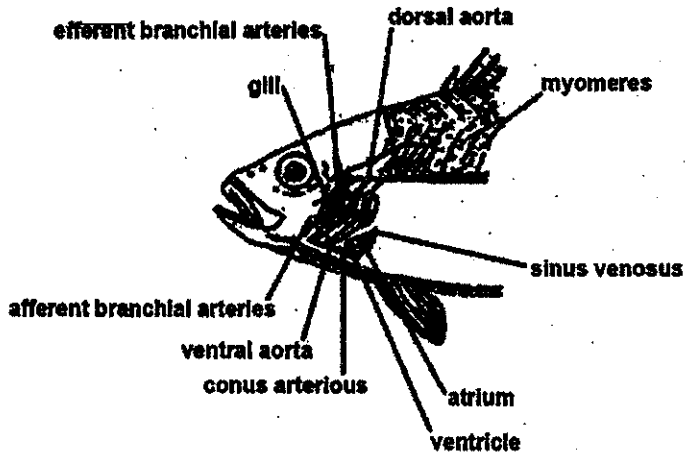


Fig. 5.31 Arterial system of a bony fish

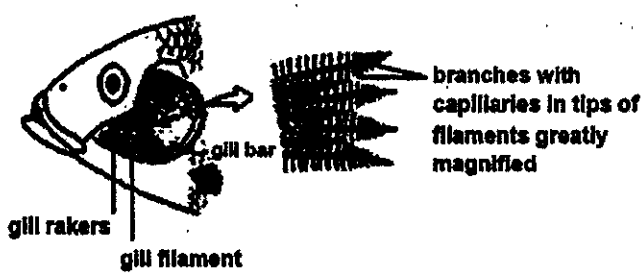


Fig. 5.32 Gills of a bony fish (The gill cover has been cut away to show the gills)

Respiratory system

Respiration in the fish is by means of gills. On each side of the pharynx are four gills located in a common gill chamber beneath the operculum. Each gill consists of a double row of gill filaments, bearing many minute transverse plates **(lamellae)** covered with a thin epithelium. Each plate contains afferent and efferent brachial arteries, with capillaries between them. A cartilaginous gill arch supports each gill. The inner border of the gill bears expanded gill-rakers, which prevent the food from passing through the gill slits.

Excretory system

The two elongate dark kidneys are the main excretory organs of the fish. They lie between the swim bladder and the vertebrae. The two tubular ureters, one from each kidney, join the urinary bladder, which opens to the exterior through the urogenital sinus.

Nervous system

The brain of the bony fish is short and consists of the **olfactory lobes, cerebral hemisphere, diencephalons, optic lobes, cerebellum, and medulla oblongata.** There are ten pairs of cranial nerves. Neural arches of the vertebrae protect the nerve cord. Paired **spinal nerves** to each body segment emerge between the neural arches of successive vertebrae. Organs of special sense are (a) the dorsal olfactory sacs of the snout, (b) the taste buds in and around the mouth, (c) the large eyes, (d) the internal ear and (e) the lateral line system, including the lateral line.

Reproductive system

The male reproductive system consists of two testes. A **ductus deferens** runs from each testis to the urogenital aperture. In the female, there are two united ovaries, connected with the urogenital aperture through the oviducts.

AN AMPHIBIAN

Amphibians are members of the class **Amphibia** of the phylum **Chordata.**

Characteristics of the Amphibians are:

1. The skin is moist and glandular. External scales are absent.
2. They possess two pairs of limbs for walking or swimming. The toes may be four to five or fewer in number. In some species, there are no limbs and in some others, there are no hind limbs at all.
3. They have two nostrils connected to the mouth cavity. The eyes are with movable lids. The eardrums are external. The mouth is usually with fine teeth and tongue is usually protrusible.
4. The skeleton is largely bony. The skull is with two occipital condyles.
5. The heart is three- chambered having two auricles and one ventricle. Number of aortic arches may be one or three.

6. Respiration is by gills, lungs, skin or the mouth lining.
7. They possess ten pairs of cranial nerves.
8. The body temperature is variable, i.e. they are cold-blooded animals.
9. Fertilization is external or internal. They usually have an aquatic larval stage with metamorphosis.

***Duttaphrynus melanostictus*(Schneider, 1799)**

Synonym - ***Bufo melanostictus*** **(The toad)**

Duttaphrynus melanostictus is a common species of toad in Myanmar. They live in damp shady places hiding under logs and stones during the day and wander about in search of food at night. They take to water during the rainy season only to breed.

External Features

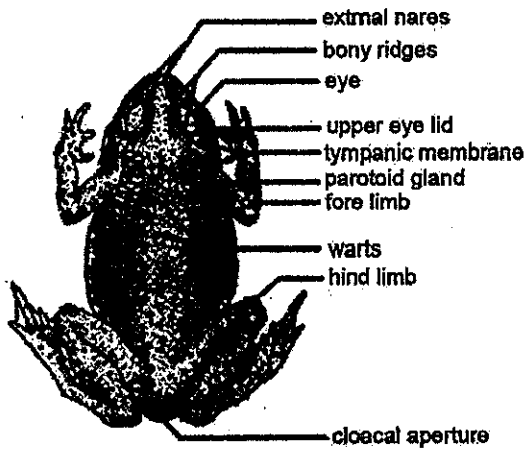


Fig. 5.33 External features of the toad

The body of the toad is short, stout, and depressed. The male toads are generally smaller than the females. The body is divisible into the head and the trunk. The neck region is absent. The head has distinct bony ridges. The eyes are prominent, each having two eyelids: the thick movable upper eyelid and the thin, semipermeable **nictitating membrane**, which can cover almost the whole eye. Behind each eye is a distinct oval **tympanic membrane**, from the upper edge of which runs the **parotoid gland**, a concentration of poison glands in the skin. At the anterior end of the head is the wide mouth. On the dorsal surface of the snout are two openings, the external nares, leading into the nasal chamber, and the buccal cavity.

In the trunk region are a pair of fore and hind limbs. In between the two hind limbs is the cloacal aperture, a common passage for faeces, urine, and genital products. The skin of the toad is very rough and warty due to the presence of the poison glands.

Skeletal system

The jointed internal skeleton of the toad supports the body and protects the vital organs. It affords attachment of muscles that aid in movement or locomotion. It consists of the **axial skeleton** and the **appendicular skeleton.** The skull, vertebral column and the sternum comprise the axial skeleton, and the bone of the limbs and the girdles form the appendicular skeleton.

Muscular system

The muscular system consists mainly of the skeletal or voluntary muscles attached to the bones. They produce movement or locomotion under the willful control of the animal. The muscles of the internal organs of the body, as in the walls of the gut, respiratory passages, blood vessels, urinary and genital organs are visceral in nature. These muscles act together in coordination, directed by the nervous system.

Digestive system

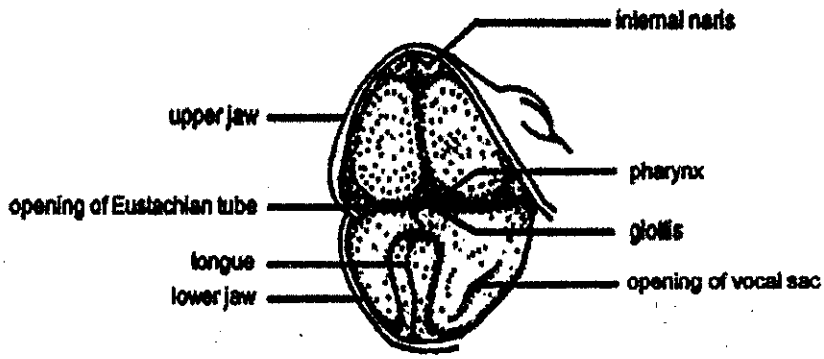


Fig. 5.34 Buccal cavity of the male toad

The digestive system includes the alimentary canal and its associated glands. The alimentary canal starts from the mouth and ends at the cloacal aperture. The wide mouth leads into the buccal cavity. In the roof of the cavity are two rounded bulges of the eyes. Anterior to these are two small rounded openings, the internal nares. Near

each angle of the jaw is a small opening of the **Eustachian tube**, leading towards the **tympanic cavity**. The tongue is flat and oblong with a narrow anterior end attached in front to the lower jaw and below to the hyoid cartilage. The broader posterior end with a rounded margin is free enabling it to flip out and catch the prey. In the male, there is usually a single slit-like opening of the **vocal sac** in the floor of the buccal cavity. The roof and floor of the buccal cavity converge posteriorly to form the pharynx. On the ventral side of the pharynx is a vertical slit-like opening, the glottis leading to the lungs.

The pharynx leads to a short esophagus, which suddenly widens to form a thick- walled stomach followed by a thin-walled **duodenum**, separated, from it by the pylorus. The duodenum lies almost parallel to the stomach and turns backward as the **ileum**. This opens into a wide rectum, followed by a short cloaca ending in a **cloacal aperture.**

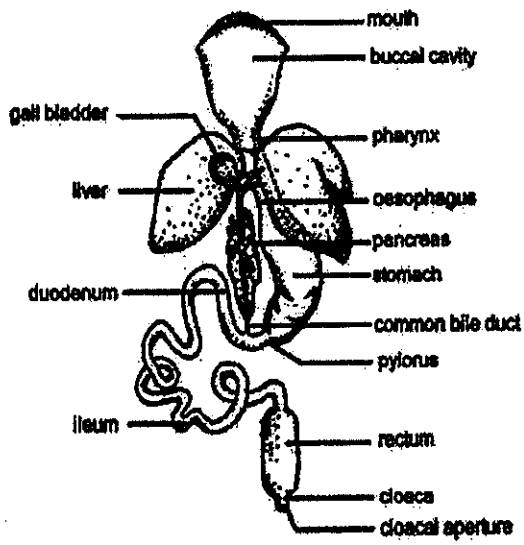


Fig. 5.35 Digestive system of the toad

The associated glands are the liver and the pancreas. The liver is a large dark red organ, consisting of three lobes. Ventral to the median lobe is a green rounded **gall bladder.** The **pancreas** is a cream-coloured irregular body situated between the stomach and the duodenum. A common bile duct carries bile produced from the liver and the pancreatic juice secreted from the pancreas into the duodenum.

Circulatory system

The circulatory system of the toad consists of the heart, arteries, veins and capillaries. The heart consists of the sinus venosus, two auricles, the ventricle and the **truncus arteriosus**. The sinus venosus receives deoxygenated blood brought back to the heart through the anterior **venae cavae** and the posterior **vena cava**. It opens ventrally into the right auricle. The pulmonary vein brings oxygenated blood from the lungs and opens into the left auricle. The two auricles communicate with the ventricle, which pumps out the mixed blood from the heart through the truncus arteriosus and the three arterial arches to the various parts of the body. The arches are **carotid**, the **systemic**, and the **pulmonary.**

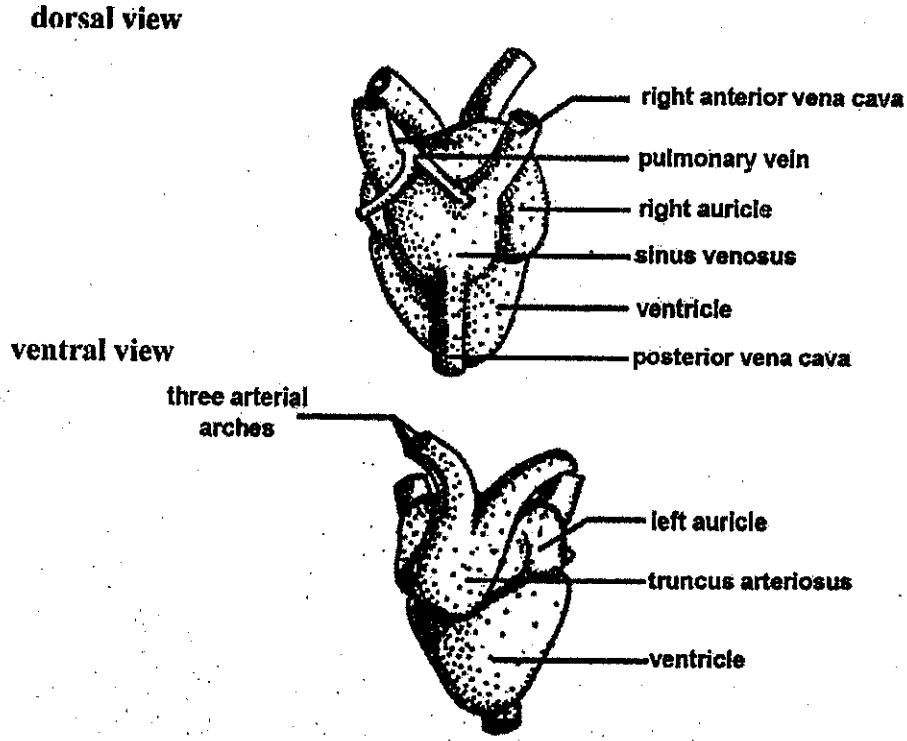


Fig. 5.36 Heart of the toad

The arteries are thick-walled elastic blood vessels, which transport blood away from the heart. The veins are thin- walled blood vessels that carry blood back to the heart. The capillaries are thin microscopic blood vessels, which connect the arteries with the veins. Food and oxygen pass through their thin walls to all the tissues of the body.

Respiratory system

The respiratory organs of the toad consist of the lungs, buccal cavity, and skin.

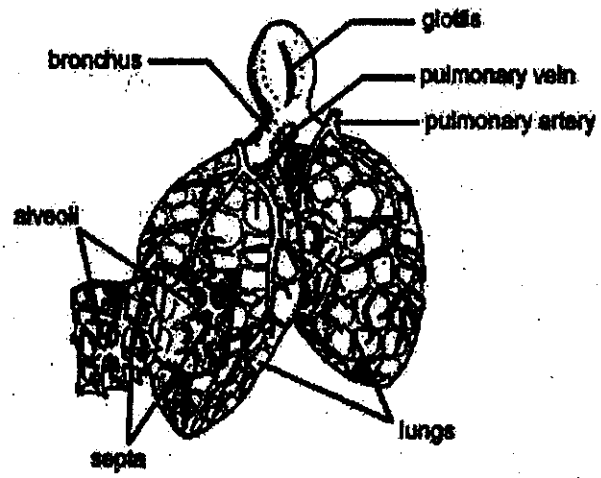


Fig. 5.37 Lungs of the toad, the right lung cut open to show the inner surface (ventral view)

The lungs are a pair of greatly distensible sacs, communicating with the buccal cavity by way of the glottis. A network of septa, which form a number of small chambers or **alveoli,** increases the internal surface of the lungs. The walls of the alveoli are supplied with blood capillaries and a single layer of epithelial cells lines the surface. The walls of the lungs consist of connective tissue containing blood and lymph vessels and non-striated muscle cells. The outer surface is covered by the **peritoneum.**

Pulmonary respiration, i.e., respiration by means of the lungs, takes place when the toad is very active.

Buccal respiration, i.e., respiration by the lining of the buccal cavity takes place on land when the toad is relatively inactive. The lining of the buccal cavity is moist with secreted mucus and exchange of gases takes place readily. Respiratory movements are externally visible as gentle pulsations of the floor of the mouth.

Cutaneous respiration, i.e., respiration by the skin takes place all the time but especially in the water. The skin of the toad is moist with the mucus secreted by the mucous glands. Vertical section of the skin shows a thin layer of epidermis for rapid diffusion of gases. The **dermis** contains the blood capillary network, which reaches close to the skin surface. Dissolved oxygen in mucus diffuses inward into the blood. Carbon dioxide passes out in a similar manner.

Nervous system

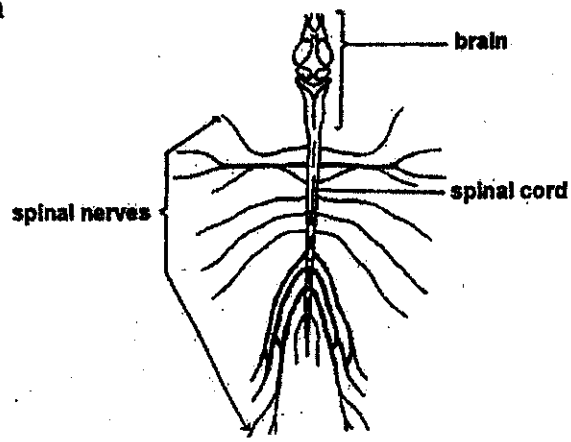


Fig. 5.38 Central nervous system and the spinal nerves of the toad (dorsal view)

The nervous system is composed of three divisions: - the central nervous system, the peripheral nervous system, and the sympathetic nervous system. The central nervous system consists of the brain and spinal cord; the peripheral nervous system comprises the cranial and spinal nerves; and the sympathetic nervous system consists of two nerves chains, ganglia and many fibres connecting to the brain, spinal cord and viscera.

Excretory system

The most important organs of excretion are the two dark red elongate kidneys. Each is a compact mass of numerous renal corpuscles bound together by connective tissue. Each renal corpuscle consists of the **glomerulus, Bowman's capsule,** and **uriniferous tubule.** The uriniferous tubules open into the **collecting tubules,** which join the ureter. The latter is a fine white tube arising from the kidney and extending posteriorly to open into the cloaca. The urinary bladder is a bilobed thin-walled sac connected with the ventral wall of the cloaca opposite the openings of the ureters.

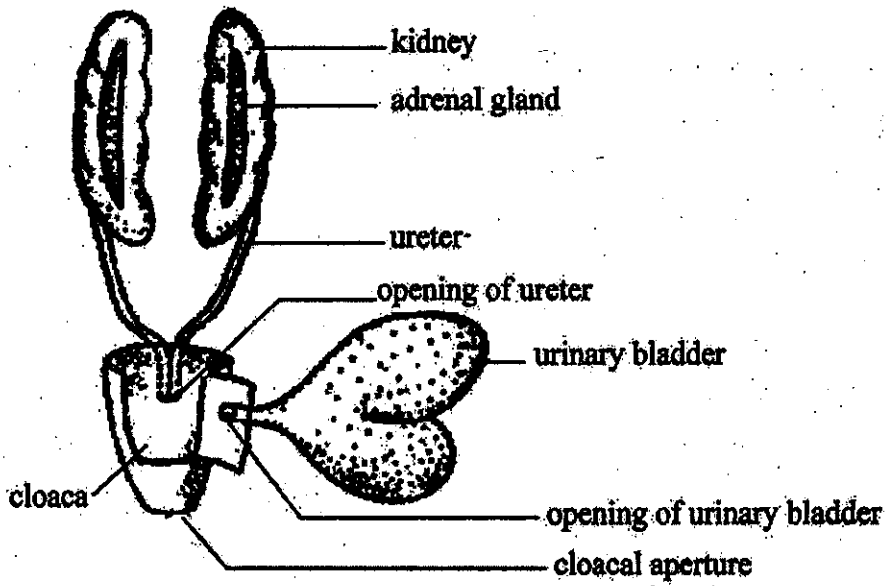


Fig. 5.39 Excretory system of the toad

Reproductive system

Male reproductive system

In the male toad, the kidneys are closely associated to the genital organs. Each whitish elongate testis lies ventral to the kidney. The spermatozoa are carried by the **vasa efferrentia** from the testes through the kidneys to the ureters, which also serve as **vasa deferentia.** Thus, ureters are termed as urogenital ducts. The ureters widen into the seminal vesicle just before opening into the cloaca.

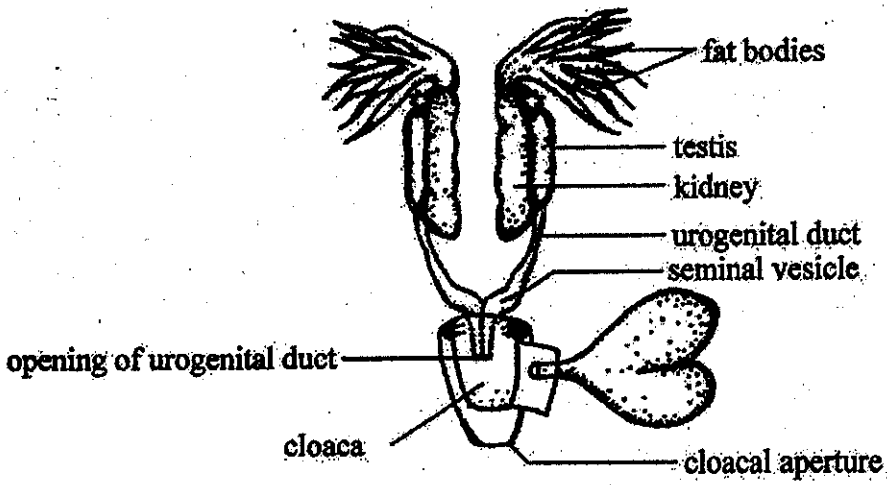


Fig. 5.40 Urogenital system of the male toad

Female reproductive system

The female organs are two sac-like lobed ovaries. In adult females, they contain thousands of small black eggs. The oviducts are paired whitish convoluted ducts each having a wide ostium just at the base of the lung. Each enlarges to form the distensible egg sac near the posterior end. The two egg sacs join and open into the cloaca.

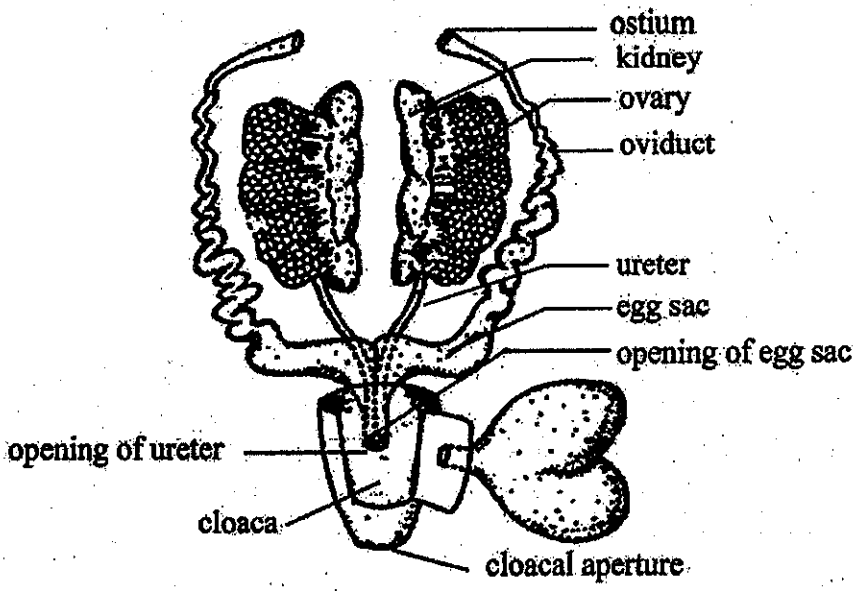


Fig. 5.41 Urogenital system of the female toad

SUMMARY

This chapter deals with all living organisms starting from prokaryote to higher forms. The account of a bacterial cell (a prokaryote) includes structure and its life processes. Plants and animals are presented in evolutionary trend: from unicellular organisms to higher multicellular forms. Economic importance is given after the account of each plant and animal given as examples. Most of the examples given are familiar ones. The students would understand the complex life of plants and animals, as they get higher in the plant and animal kingdoms.

Green plants are the producers while fungi and animals are consumers. Among animals, some are parasites and some transmit diseases to human beings. Some on the other hand benefit human beings. The accounts of these animals are included in this chapter. The students would become more familiar with plants and animals after completion of this chapter. Furthermore, the concept of this chapter would be foundation for Grade 11 Biology.