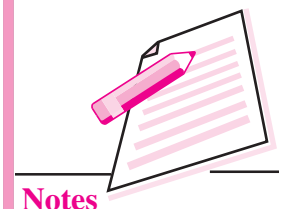


5

TISSUES AND OTHER LEVELS OF ORGANIZATION

You have just learnt that cell is the fundamental structural and functional unit of organisms and that bodies of organisms are made up of cells of various shapes and sizes. Groups of similar cells aggregate to collectively perform a particular function. Such groups of cells are termed "tissues". This lesson deals with the various kinds of tissues of plants and animals.

OBJECTIVES

After completing this lesson, you will be able to :

- *define tissues;*
- *classify plant tissues;*
- *name the various kinds of plant tissues;*
- *enunciate the tunica corpus theory and histogen theory;*
- *classify animal tissues;*
- *describe the structure and function of various kinds of epithelial tissues;*
- *describe the structure and function of various kinds of connective tissues;*
- *describe the structure and function of muscular tissue;*
- *describe the structure and function of nervous tissue.*

5.1 WHAT IS A TISSUE

Organs such as stem, and roots in plants, and stomach, heart and lungs in animals are made up of different kinds of tissues. **A tissue is a group of cells with a common origin, structure and function.** Their common origin means they are derived from the same layer (details in lesson No. 20) of cells in the embryo. Being of a common origin, there are similar in structure and hence perform the same function. Several types of tissues organise to form an **organ**.

Example : Blood, bone, and cartilage are some examples of animal tissues whereas parenchyma, collenchyma, xylem and phloem are different tissues present in the plants. The study of tissues is called **histology**.

A group of cells with similar origin, structure and function is called **tissue**. e.g. bone, and muscle in animals and meristem in tips of root and shoot in plants

5.2 THE PLANT TISSUES

The plant tissues are mainly of two catagories:

1. Meristematic (Gk. meristos : dividing)
2. Permanent (non-dividing)

1. **Meristematic tissues**
   - Composed of immature or undifferentiated cells without intercellular spaces.
   - The cells may be rounded, oval or polygonal; always living and thin-walled.
   - Each cell has abundant cytoplasm and a prominent nucleus in it.
   - Vacuoles may be small or absent.

Table 5.1 Types of meristematic tissue

Types	Location	Function
Apical Meristem	Root tip and shoot tip.	Growth in length of plants and their branches.
Intercalary Meristem	At the bases of leaves or at the bases of internodes.	Internodal growth, in monocots growth of leaf lamina in grasses.
Lateral Meristem	Cambium between xylem and phloem and cork. cambium in the cortex of dicot plants.	Growth in thickness of the plant body (secondary growth).

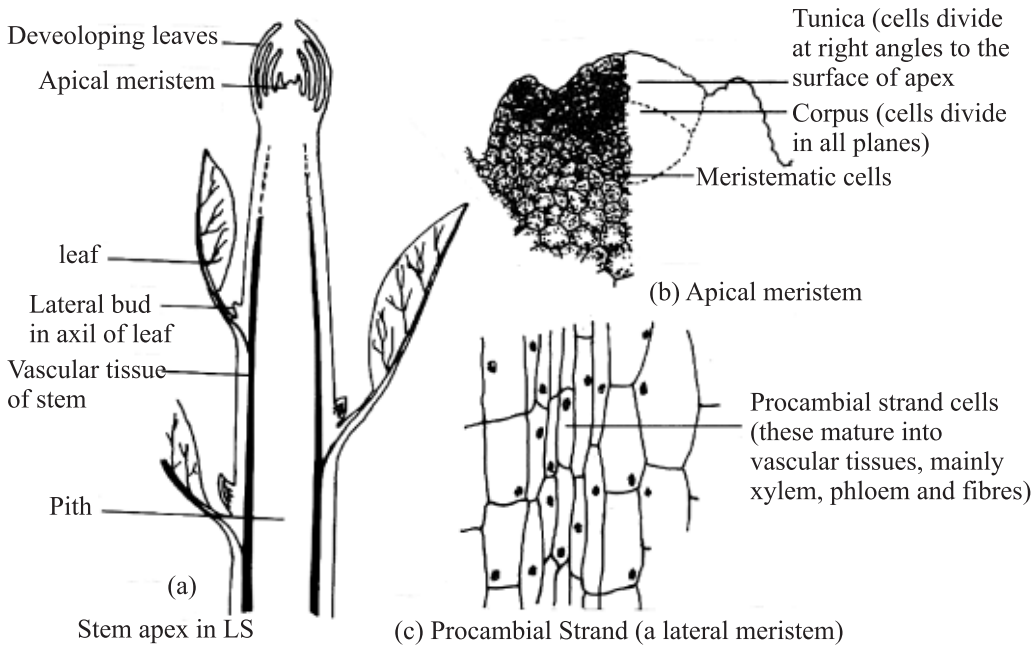
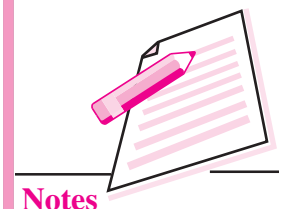


Fig. 5.1 Location of the meristematic tissues in an angiospermous plant



2. **Permanent tissues**
   - Permanent tissues are those in which growth has stopped either completely or for the time being.
   - Cells of these tissues may be living or dead; and thin-walled or thick-walled.
   - Thin-walled permanent tissues are generally living whereas the thick-walled tissues may be living or dead.

Types of permanent tissues

(i) **Simple tissues :** A simple tissue is made up of only one type of cells. Common simple tissues are parenchyma, collenchyma and sclerenchyma (Fig. 5.2, 5.3 and 5.4).

(ii) **Complex tissues :** A complex tissue is made up of more than one type of cells working together as a unit. Common examples are xylem and phloem (Fig. 5.5 and 5.6).

The structure, function and distribution of simple plant tissues is given in Table 5.2.

INTEXT QUESTIONS 5.1

1. Define a tissue.

   .....

2. Give one word equivalent for the following :
   (i) A plant tissue that consists of cells which continue to divide to produce more cells.

   .....

   (ii) The meristematic tissue responsible for the increase in thickness of the stem of a tree.

   .....

   (iii) The kind of plant tissues which consists of all similar cells.

   .....

   (iv) The category of plant tissues in which the cells do not divide.

   .....

3. What do you mean by "cells of a tissue have similar origin"?

   .....

4. Name that branch of Biology in which tissues are studied?

   .....

5. What is a complex tissue?

   .....

6. Mention any **two** special features of the meristematic cells.

   .....

Notes

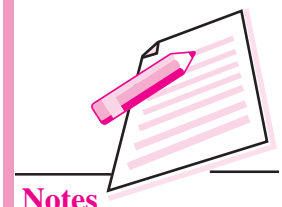
5.2.1 Simple Plant Tissues

There are three types of simple plant tissues (Fig. 5.2, 5.3 and 5.4)

1. Parenchyma (Chlorenchyma and Aerenchyma)
2. Collenchyma
3. Sclerenchyma

Table 5.2 Structure, Function and Distribution of simple tissues

Tissue	Living or Dead	Structure	Function	Distribution
1. Parenchyma	Living	(i) Oval or round, thin-walled with sufficient cytoplasm. (ii) Has prominent nucleus and intercellular spaces (iii) Wall made up of cellulose	(a) They make large parts of various organs in most plants. (b) Act as storage cells. (c) Chlorenchyma carries out photosynthesis. (d) Turgid, parenchyma gives rigidity to the plant body.	1. Pith and cortex of stem and root. 2. Mesophyll of leaves. 3. Endosperm of seed. 4. Xylem and phloem parenchyma in vascular tissue. 5. Occur in leaves and stems of aquatic plants
(a) Chloren-chyma	Living	Parenchyma containing chloroplasts.		
(b) Aeren-chyma	Living	Parenchyma with large air spaces or intercellular spaces.		
2. Collenchyma (Gk. collen : glue)	Living	(i) Elongated cells with thick primary walls. Thickenings more in the corners of the cells. (ii) Wall material is cellulose and pectin (iii) Intercellular sapces present.	Gives mechanical support to the plant body. Specially in many dicot leaves and green stems	Occurs in the peripheral regions of stems and leaves.
3. Sclerenchyma (Gk. scleros = hard)	Dead	Sclerenchyma consists of thick walled cells, walls uniformly thick with lignin.	Sclerenchyma is mainly a supporting tissue, which can withstand strains and protect the inner thin-walled cells from damage.	• Fibres occur in patches or continuous bands in various parts of stem in many plants. • Sclereids occur commonly in fruits and seeds. Present in some leaves in large numbers.
(a) Fibres	Dead	Elongated cells with pointed ends. Walls are thick with lignin.		
(b) Sclereids	Dead	Irregular in shape. Cell wall very thick making the cell cavity very small.		



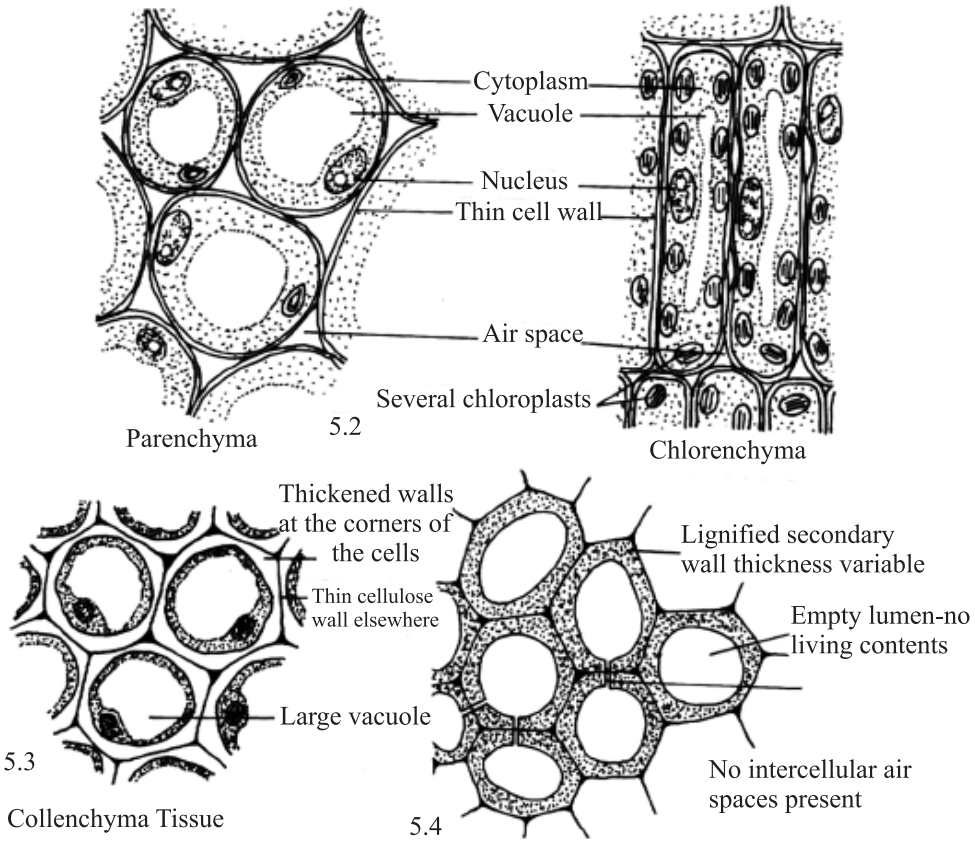


Fig. 5.2, 5.3, 5.4 Various types of simple tissues

5.2.2. Complex tissues

Complex tissues are mainly of two types :

(i) Xylem

(ii) Phloem

– Xylem and phloem form a continuous system inside the plants, that is from the roots through the stem and leaves.

– They are known as vascular tissues and form vasular bundles in roots and stems.

Xylem (Greek xylo = wood)

– Xylem is a conducting tissue which conducts water and salts upward from roots to leaves.

– Xylem is composed of (a) Tracheids, (b) Vessels (c) Fibres and (d) Xylem Parenchyma (Fig. 5.5)

Phloem

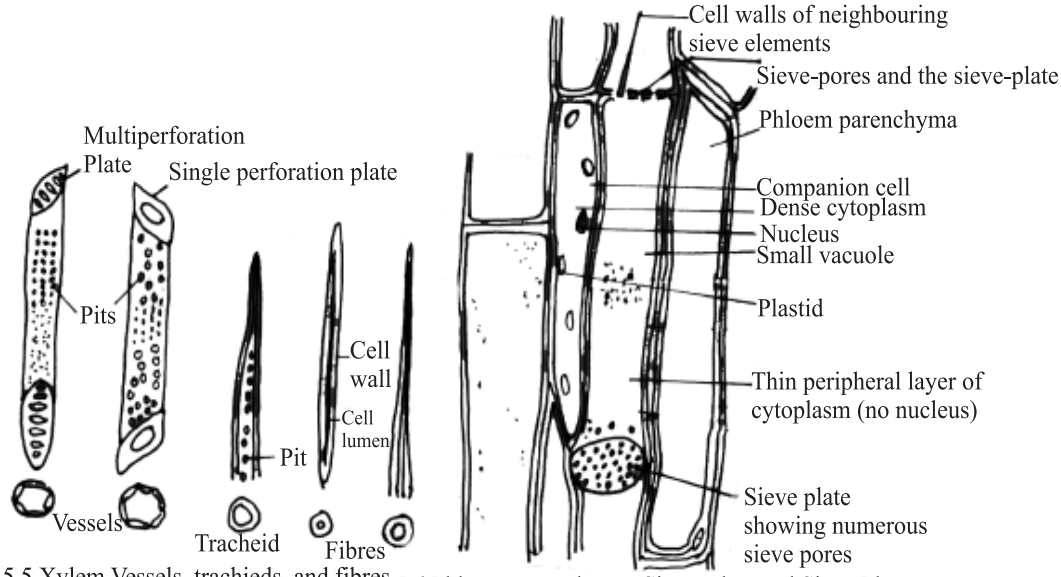
– Phloem too is a conducting tissue which conducts the metabolites (food) food synthesised in the leaves to different parts of the plant.

– Phloem is composed of (a) Sieve tube element (b) Companion cells (c) Phloem fibre and (d) Phloem Parenchyma (Fig. 5.6)

The structure, and function of the complex plant tissues is given in Table 5.3.

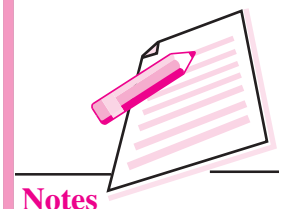
Table 5.3 Structure and function of the components of xylem and phloem

Tissues	Living or Dead	Structure	Function
Xylem			
1. Tracheids	Dead	Long cells with pointed ends. Walls thick with lignin. Have pores on the walls	All of them function as a unit to conduct water and minerals upward from root to leaves.
2. Vessels	Dead	Cells shorter and broader than tracheids. Walls thick with lignin and have pores. End walls open and the cells join to form a long tube.	
3. Xylem Fibres	Dead	Long cells with very thick lignin deposition on the walls, no pores on the walls.	
4. Xylem Parenchyma	Living	Small thin walled cells with cellulose walls.	
Phloem			
1. Sieve tube	Living	Elongated sieve elements join to form sieve tubes; cell wall of cellulose. End walls of the cells have perforations on them, which give them the name (sieve).	All of them function as a unit to translocate food assimilated in the leaves by photosynthesis to different parts of the plant.
2. Companion cell	Living	Long, rectangular cells associated with seive cells. Cell wall made of cellulose.	
3. Phloem fibre	Dead	Very long cells with thick lignified walls	
4. Phloem parenchyma	Living	Elongated cells. Cell walls thin and made of cellulose.	



5.5 Xylem Vessels, trachieds and fibres 5.6 Phloem parenchyma, Sieve tubes and Sieve Plate

Fig. 5.5, 5.6 Various types of complex tissues



5.2.3 Theories explaining growth of the plant at its shoot apex and root tip

There are two important theories that explain the growth of a plant at the extremities of shoot and root. These are (i) the Tunica corpus theory and (2) the Histogen theory.

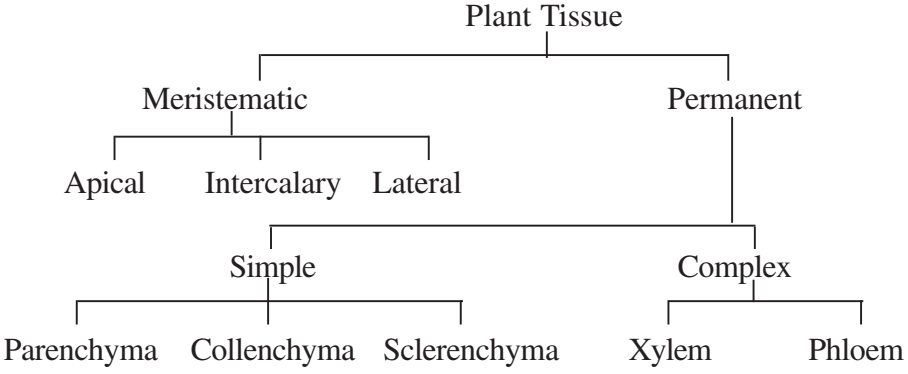
Tunica Corpus Theory :

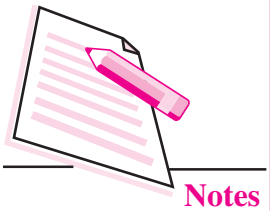
- Tunica corpus theory was developed for vegetative shoot apex.
- According to this theory, there are **two** zones of tissues in the apical meristems **the tunica** (Tunic = cover) consisting of one or more layers of peripheral layers of cells, and the **corpus** (corpus = body) a mass of cells enclosed by the tunica.
- According to the theory, different planes and rates of cell division and methods of growth in the apex set apart two regions.
- The layers of tunica show anticlinal (perpendicular to periphery) divisions and bring about surface growth.
- In the corpus, cell division is irregular and at various planes resulting in grwoth in volume of the mass.
- Tunica gives rise to the epidermis and cortex. Corpus gives rise to endodermis, pericycle, pith and vascular tissue.

Histogen Theory

- According to this theory, the apical meristem of stem and root are composed of small mass of cells which are all alike and divide fast (meristematic)
- These meristematic cells form promeristem, which differentiates into three zones **dermatogen, periblem** and **plerome**.
- Each every zone consists of a group of initials called a **histogen** (tissue builder).
  - (i) The dermatogen gives rise to epidermis of stems and epiblema of roots.
  - (ii) Periblem (middle layer) gives rise to cortex of stems and roots.
  - (iii) Plerome gives rise to the central meristematic region – pericycle, pith and vascular tissue.

Classification of plant tissues-at a glance





Notes

INTEXT QUESTIONS 5.2

1. Give Two characteristics and one example of the location of the given tissues in plants in the following table:

S.No.	Tissue	Characteristics	Example of location
(i)	Parenchyma	.....	.....
(ii)	Collenchyma	.....	.....
(iii)	Sclerenchyma	.....	.....

2. Name the plant tissues which
   (i) conduct water .....
   (ii) conduct food metabolites. .....

5.3 ANIMAL TISSUES

As in plants, tissues in animals are also of various types which perform different functions. See the flow-chart given below

Animal Tissues

- **Epithetial tissue** (Protection by covering, secretion, and absoption)
- **Connective Tissue** (Binding, support, transport)
- **Muscular tissue** (Movement and Locomotion)
- **Nervous Tissue** (Control and co-ordination)

5.3.1 Epithelial Tissue

Structural Characteristics : The cells forming epithelial tissue –

(i) are closely packed with no intercellular spaces in between.

(ii) arise from a non-cellular basement membrane.

(iii) are not supplied with blood vessels.

Function : Epithelian tissues line the surfaces, help in absorption, secretion, and also bear protoplasmic projections such as the cilia. (See Table 5.4 and Fig. 5.7)

Table 5.4 : Types of epithelial tissue

Type	Structure	Location	Function
1. Squamous Epithelium	Flattened cells with a centrally placed nucleus. Have irregular margins.	Lining of air sacs in the lungs.	For exchange of O_2 and CO_2.
		Lining of Kidney tubules.	For absorption.
		Lining of blood capillaries.	For exchange of materials.

2. Cubodial Epithelium	Cube like cells with a centrally placed nucleus, Cells appear polygonal.	Lining of salivary and pancreatic ducts.	For absorption.
		In sweat and salivary glands.	For secretion
3. Ciliated Epithelium	Have cilia at free ends.	Lining of kidney tubules.	For flow of nephric filtrate.
4. Columnar epithelium	Long column-like cells, each with nucleus at the basal end	Lining of stomach, instestine	Secretion and absorption
5. Ciliated Columnar Epithelium	Cilia at free ends	Lining of trachea	Flow of fluids in a particular direction
6. Brush bordered Columnar Epithelium	Numerous folds at free ends—folds looking like bristles of a brush.	Lining of intestine	Increasing the surface area for absorption

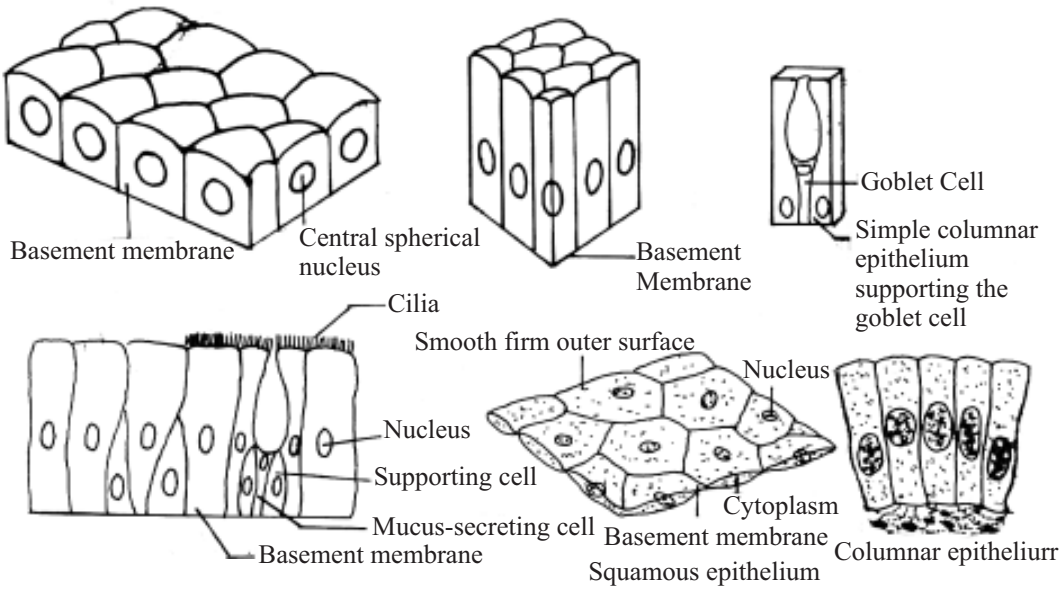
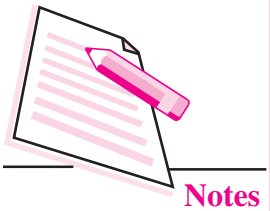


Fig. 5.7 The structure of different kinds of epithelial tissues

If the epithelial cells are in a single layer, they form simple eptihelium. If the epithelial cells are arranged in many layers, they form compound epithelium or stratified epithelium (many layers). Stratified eptihelium is present in the body, where there is lot of wear and tear. For example the skin and inner lining of cheeks.



Notes

INTEXT QUESTIONS 5.3

1. List the different types of animal tissues

   .....

2. Match the items in Column I with those in Column II by writing the corresponding serial number within brackets.

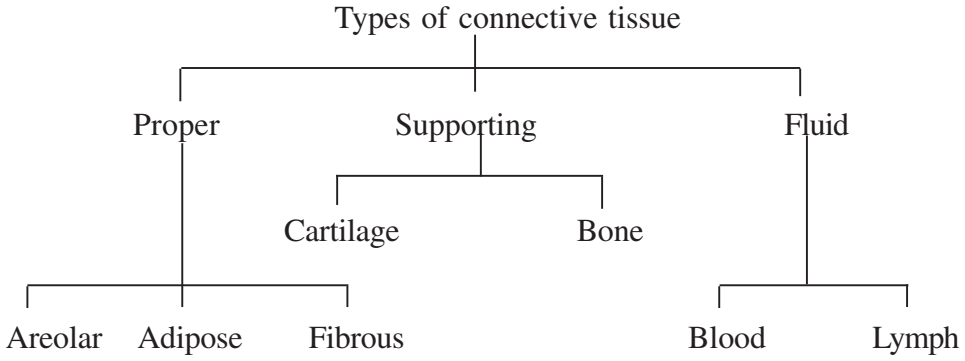
Column I		Column II
(a) Compound Epithelium	( )	(i) Epithelial tissue
(b) Basement membrane	( )	(ii) For increasing the surface area
(c) Brush-bordered epithelium	( )	(iii) Lining of trachea
(d) Salivary gland	( )	(iv) Skin
(e) Ciliated Epithelium	( )	(v) Cuboidal epithelium

5.3.2 Connecitve tissue

The connective tissue has two components :

(a) matrix, the ground substance and (b) cells

The matrix and cells are different in different connective tissues (Fig. 5.8).



A. Proper Connective Tissue

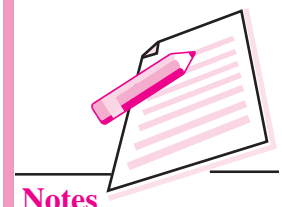
1. Areolar : Most widely spread connective tissue.

The cells forming the tissue are :

(i) **Fibroblasts**-which form the yellow (elastin) and white (collagen) fibres in the matrix.

(ii) **Macrophages**-which help in engulfing bacteria and micro-pathogens.

(iii) **Mast cell**-which secretes heparin, that helps in clotting of blood.



2. Adipose tissue : It has specialized cells which store fat and provide help in forming paddings.

3. Fibrous : It is mainly made up of fibroblasts. It forms tendons and ligaments.

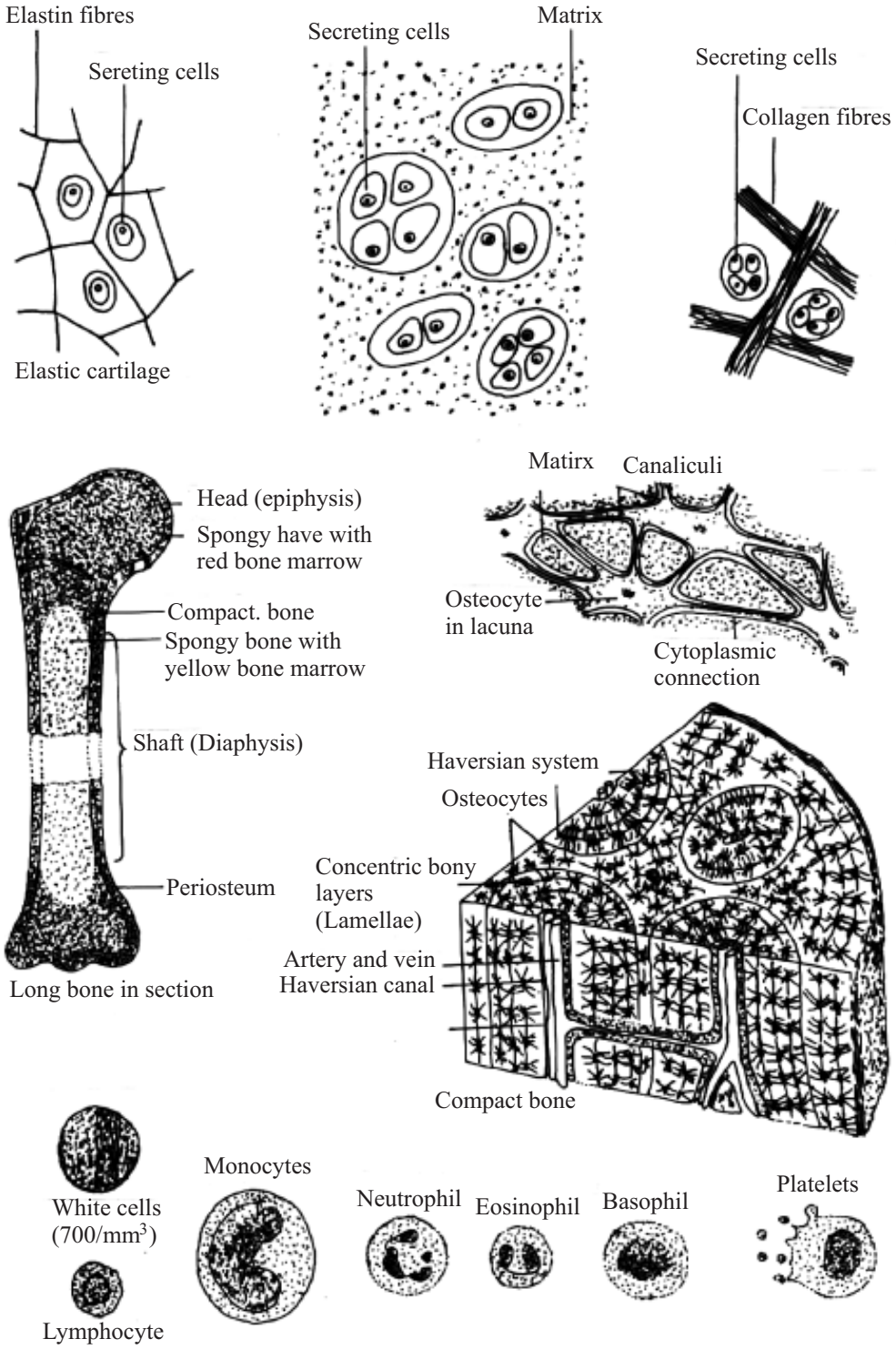


Fig. 5.8 Some representative types of connective tissues.

B. Supporting Connective Tissue

Supporting Connective Tissue

Cartilage	Bone
1. Matrix is composed of **chondrin.** The cells lie in the matrix singly or in groups of two or four surrounded by fluid-filled spaces. The cartilage may be elastic whose matrix has yellow fibres as in the pinna of the ear.	1. Matrix is composed of **ossein.** Matrix also contains salts of calcium, phosphorus and magnesium. Matrix in mammalian long bones (such as the thigh bone) is arranged in concentric rings. The **osteocyte**s (bone cells) lie on the lamellae (concentric rings in the matrix.) Osteocytes give out branched processes which join with those of the adjoining cells. Some bones have a central cavity which contains a tissue that produces blood cells. The substance contained in the bone cavity is called **bone marrow.**
2. The cartilage is a flexible and strong type of connective tissue in most of the vertebrates usually occurring as part of their endoskeleton.	2. Bones are of two types : **Spongy** and **Compact**. In a spongy bone, the bone cells are irregularly arranged. Such bones are found at the ends of the of long bones.
3. The cartilage can be calcified where calcium salts are deposited in the as in head of long bones.	3. In the compact bones, cells are arranged in circles or lamellae around a central canal- the Haversian canal.

C. Fluid connective tissue

Blood and Lymph are the two forms of fluid connective tissue.

Blood : It is a complex of blood cells and plasma. Plasma forms the matrix.

The blood cells are :

1. Red Blood Cells (Erythrocytes)-Transport O_2 and CO_2
2. White blood cells (Leucocytes)-Function in defence against bacteria, viruses and other invaders.
3. Platelets (Thrombocytes)-help in the clotting of blood.

Plasma is the extracellular fluid matrix in the ground substance. It contains a large number of proteins such as Fibrinogen, Albumin, and Globulin to be transported to various parts of the animal body for various purposes.

5.3.3 Muscle tissue

This is composed of long excitable cells containing parallel microfilaments of contractile proteins, as in actin, myosin, troponin and tropomysin. Because of its elongated shape, muscle cell is called a muscle fibre. The muscle fibres of vertebrates are of three different types (i) Striated (ii) Unstriated and (iii) Cardiac (Fig. 5.9) according to the shape and functions as mentioned in Table 5.5 and Fig. 5.9.

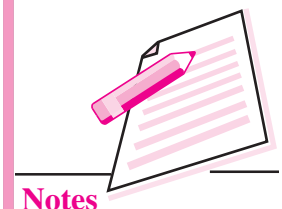
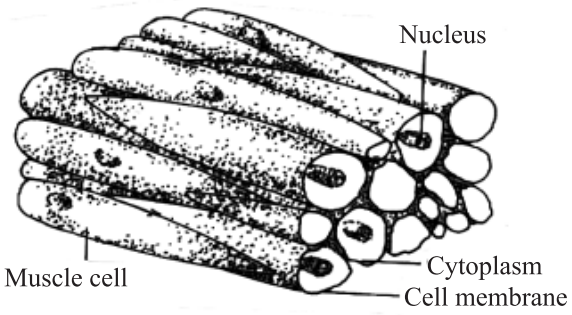
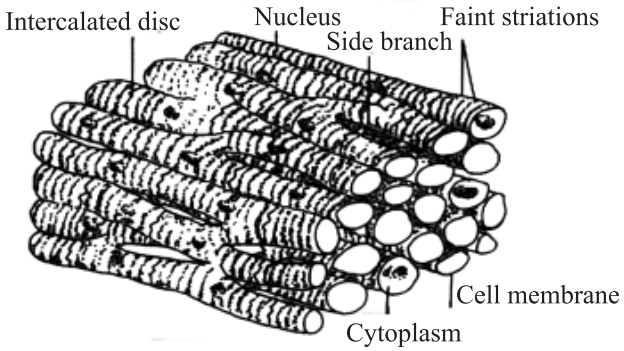


Table 5.5 Types of Muscle Fibres

Striated/Voluntary/Skeletal	Unstriated/ Involuntary	Cardiac
Location		
1. Attached to the skeleton like head, limbs, face etc.	In the walls of body organs like stomach, intestines.	Walls of heart.
Shape		
Elongated, cylindrical, unbranched fibres	Spindle shaped, tapering.	Elongated, cylindrical, branched.
Myofibrils so arranged in the cytoplasm, that there are striations seen.	No such striations seen as myofibrils are not uniformly arranged .	Striations (stripes) seen.
Sarcolemma		
Thin and tough membrane sarcolemma of the fibre (cell).	Thin cell membrane, no sarcolemma.	Thin
Nucleus		
Multi nucleated, Peripheral nuclei.	Uninucleated, centrally placed.	One nucleus in each unit, centrally placed.
Blood Supply		
Rich	Poor	Rich
Intercalate Discs		
Absent	Absent	Present
Voluntary (Contracts at will)	Involuntary	Involuntary



Smooth muscle fibres



Cardiac muscle fibres

Fig. 5.9 Types of Vertebrate Muscle Tissue

The muscle fibres have the following characteristics:

(i) Excitability, (respond to stimulus)
(ii) Extensibility, (stretch)
(iii) Contractility, (contract)
(iv) Elasticity, (move back to the original position)

INTEXT QUESTIONS 5.4

1. Name the different types of cells found in the different types of connective tissue.
.....

2. Match the item in Column I with those in Column II, by writing the corresponding serial number within brackets:

Column I		Column II
a. Unstripped muscles	( )	(i) multinucleate
b. Myofibrils	( )	(ii) run parallel to each other in a striped muscle
c. Sarcolemma	( )	(iii) cardiac muscles
d. Striped muscle	( )	(iv) outer tough membrane of a striped muscle fibre
e. Branched myofibrils	( )	(v) involuntary

5.3.4 Nervous Tissues

Nervous tissues has two kinds of cells i.e. **neurons and neuroglia cells**

Neurons

Neuron is the functional unit of nervous tissue. Neurons are also called nerve cells. Nervous tissues constitute the brain, spinal cord, nerves and the sensory cells and sense organs.

A single neuron has a generalised appearance as shown in the Fig. 5.10.

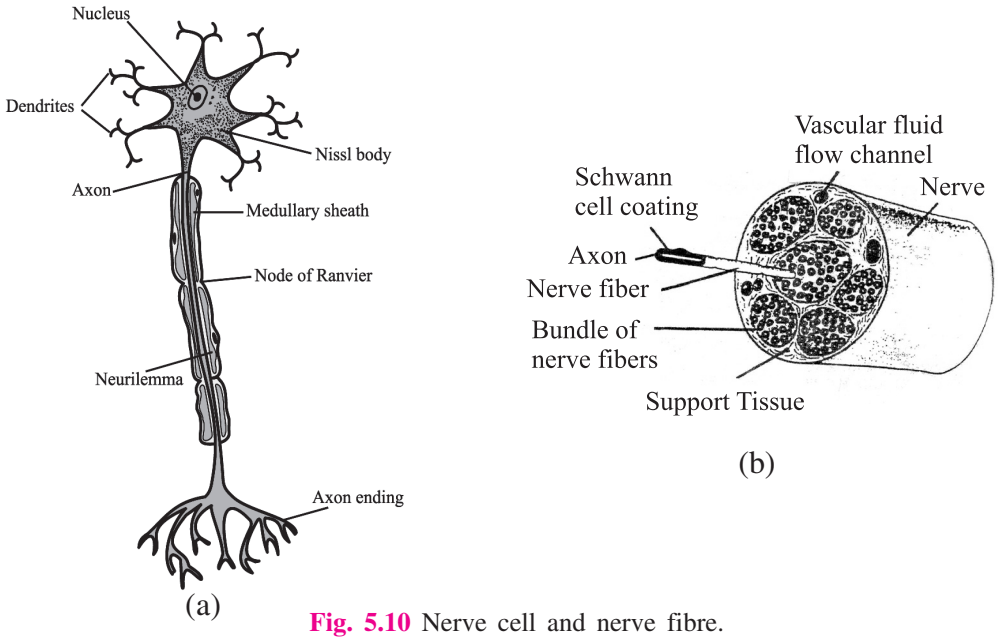
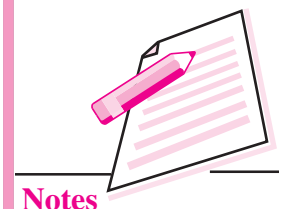


Fig. 5.10 Nerve cell and nerve fibre.



Like any other cell of the body, the nerve cell or neuron has the main cell body called **cyton** from which project out a varying number of processes –one of which is usually very long. This long fibre is called the **axon**.

The smaller branching processes of the cyton are called the **dendrites** (GK dendros = tree). The cells bounded by plasma membrane, possess a nucleus and other organelles like mitochondria.

The cyton also contains dark granules called **Nissi** bodies. These are made of RNA and Protein.

Transmission of nerve impulse – The branching dendrites receive the stimulus and transmit it through the cyton to the axon, which finally transmits it through its variously branched ends into either a muscle (to order it to contract) or to a gland (to order it to secrete). The axon constitutes the nerve fibre. The nerve fibre may or may not be covered by an extra sheath called **medullary sheath** secreted by sheath cells. It is made of **myelin** a lipid like substance. Accordingly, the nerve fibre is termed **medullated** and **non-medullated.** The medullary sheath is not continuous and is broken at **nodes of Ranvier** (Fig. 5.10).

INTEXT QUESTIONS 5.5

1. What is the function of the nervous tissue?

   .....

2. What is the direction of the "flow of impulse" within a nerve cell from its dendrites to its axon end or from its axon end toward its dendrites?

   .....

3. What are the following parts in a nerve cell?

   (i) Cyton .....

   (ii) Dendrite .....

   (iii) Axon .....

   (iv) Medullary sheath .....

   (v) Node of Ranvier .....

5.4 LEVELS OF ORGANISATION – CELL TO ORGANISM

We started the lesson by talking about the smallest unit of life in any living organism i.e. the cell. The cell has a very complex system of its organelles, each organelle concerned with a particular task or activity, and each activity contributing to the total performance of the cell. Thus there is a division of labour at the cellular level. As evolution progressed and larger and larger organisms appeared with enormous number of cells in the body, it became necessary that the bodily functions are distributed among different groups of cells or tissues even among groups of tissues. Such higher and higher stages or groupings are known as the levels of organization. These levels are as follows:

(i) **Cellular Levels of Organization**– The organization of the activities by different organelles in a single cell. Example, white blood cells or a green cells of a leaf.

(ii) **Tissue Level**– The aggregates of cells of same origin and having same function, example, the surface epithelium of our skin or the dividing cells at the root cap of a plant.

(iii) **Tissue System**– Generally seen in plants where two or more different cell types combine to perform a particular activity. Example – Vascular tissue e.g. veins of a leaf, consisting of xylem and phloem, for transport of water and food materials.

(iv) **Organ Level–** A distinct recognizable part of the body, composed of a variety of tissues and performing one or more special functions which contribute to the well being of the organism. Example : Liver in animals and leaf in plants.

(v) **Organ System-** Combination of a set of organs all of which are usually devoted to one general function. Example : respiratory system (consisting of lungs, trachea, and diaphragm) in man or the shoot system (consisting of leaves, stem and branches) in a plant.

(vi) **Organism–** The complete individual made of different organ systems. Examples: man, monkey, or a mustard plant.

INTEXT QUESTIONS 5.6

1. Rearrange the following levels of organizations in their correct sequences:- tissue, cell, organ, organism, organ system.

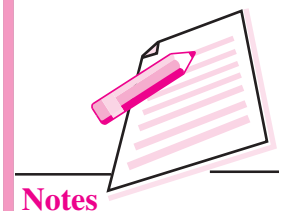
   .....

2. Complete the following Table by giving one example of each of the following in an animal and plant.

Level of Organisation	Examples	
	Animal	**Plant**
Cell	.....	.....
Tissue	.....	.....
Organ	.....	.....
Organ system	.....	.....
Organism	.....	.....

WHAT YOU HAVE LEARNT

- A tissue is a group of cells which are essentially of the same kind and of the same origin and performing similar function.



- In plants there are, first of all two major categories of tissues- meristematic (dividing and undifferentiated) and permanent (specialized) tissues.
- Meristematic tissue is located at all growth points.
- Permanent tissue consists of the simple tissue (parenchyma, collenchyma and sclerenchyma) and complex tissue (xylem and phloem).
- The animal tissues consist of epithelium (closely packed cells usually on surfaces,) connective tissue which primarily support, connect or bind the body parts together (bones blood etc.), the contractile muscular tissue (different muscles,) and nervous tissue consisting of nerve cells adapted for conducting the message (brain cells,)
- The various tissues in both plants and animals are grouped together to form an organ. The different organs together form the organ system and the various organs systems together constitute the organism or the individual. Thus there are different levels of organization with increasing complexity and specialization from cell to organism.

TERMINAL EXERCISES

1. What is a tissue?
2. State one main structural characteristic and the special activity of the following tissue:

   meristem, sclerenchyma, xylem, phloem, epithelium, muscle, nervous tissue.
3. In what way do the following tissues differ from the one stated:-
   (i) Connective tissue from epithelial tissue
   (ii) Bone from blood
   (iii) Phloem from xylem
   (iv) Squamous epithelium from columnar epithelium
   (v) Tracheids from wood fibres
4. Name the different levels of organizations in animals (such as humans) giving one example of each.

ANSWERS TO INTEXT QUESTIONS

5.1 1. a group of cells with similar origin, structure and function

2. (i) Merisematic;
   (ii) Lateral meristem
   (iii) Simple
   (iv) Permanent
3. arising from same embryonic layer of cells

4. histology
5. composed of more than one type of cells all cooperating in performing common function

5.2 1.

S.No.	Tissue	Characteristics	Example of location
1.	Parenchyma	1. Round cells 2. Living	1. Root, stem and leaves
2.	Collenchyma	1. Polygonal cells with thickening at corners 2. Living	1. Petiole and Mid-rib of leaves
3.	Sclerenchyma	1. Elongated or irregular in shape 2. Dead and thick walled	1. Woody Stems

2. xylem, phloem

5.3 1. Epithelial, connective, muscular, nervous

2. a-iv, b-i, c-ii, e-iii

5.4 1.

Firbroblasts	-	areolar
Macrophages	-	areolar
Mast cells	-	areolar
Cartilage cells/chondrocyte	-	chondrocyte-cartilage
Bone cells/osteocyte	-	bone
Blood cells/WBC RBC	-	blood

2. a (v); (b) (ii); c (iv); d (i); e. (iii)

5.5 1. sensory

2. Dendrite to the axon

3. (i) cell-body (ii) thin processes of cyton (iii) sensory fibre (iv) medullary layer (v) interruptions in medullary sheath

5.6 1. Cell, tissue, organ, organ system, organism

2. refer to text subsection 5.4

MODULE - II
FORMS AND FUNCTIONS OF PLANTS AND ANIMALS