

CHAPTER – 13



Tissue

In the previous chapter, it is learnt that all living organisms are made of cells. In unicellular organisms (e.g. *Amoeba*, *Paramecium*, etc.), there is only a single cell in its body, i.e. a single cell performs all basic functions of the organism. For example, in *Amoeba*, a single cell carries out its movement, intake of food and respiratory gases (O_2), intracellular digestion, metabolism, respiration and excretion. However, in multicellular organisms (e.g. a human being) there are millions of cells. Most of these cells are specialised to carry out a few functions efficiently. These functions are taken up by different groups of cells. So, we can say that there is a division of labour in the multicellular organisms. For example, in human beings, muscle cells contract and relax to cause movement, nerve cells carry messages, blood flows to transport oxygen, food, hormones and waste material (CO_2) and so on. In the same way, in plants, vascular tissues conduct food from leaves and water from roots to the other parts of the plant. Thus, we know that cells, which are specialised in one function, are grouped together and form a **tissue**. A tissue is arranged and designed in such a way that it provides the highest possible efficiency of function. Blood, phloem, muscle etc. are all examples of tissues.

A group of cells similar in structure and work together to perform a particular function forms a tissue.

13.1 Why are Plants and Animals made of different Types of Tissues?

Plants and animals are two different types of organisms. They are distinctly different in their structures and functions. Plants can manufacture their own food by the process of photosynthesis. Therefore, plants are also known as **autotrophic organisms**. Plants are stationary or fixed – they don't have to move from one place to another to look for their food. Since they don't expense or require much energy, most of the tissues of the plants are supportive, as they provide them only structural strength. Most of these tissues such as xylem, Sclerenchyma etc. are dead tissue; they provide mechanical strength as they do not contain living protoplasm.

Animals, on the other hand, are **heterotrophic** as they depend on others for their food. They have to move around in search of food, mates and shelter. Hence, they consume more energy as compared to plants. Most of the tissues they have, are living i.e. they contain protoplasm.

Another difference between animals and plants is in the pattern of growth. The growth in plants is limited to certain regions, while this is not so in animals. There are some tissues in plants that divide throughout their life. These tissues are localized in certain regions. Based on the dividing capacity of the tissues, various plant tissues can be classified as **growing** or **meristematic tissue** and **permanent tissue**.

In contrast to plants, growth in animals is more uniform. So, there is no such demarcation of dividing and non-dividing regions in animals.

The fundamental difference between the two major groups of organisms is structural organisation of organs and organ system is more specialised and localized in complex animals than complex plants.

13.2 Plant tissues

13.2.1 Meristematic (*Meristos* = divided) tissue

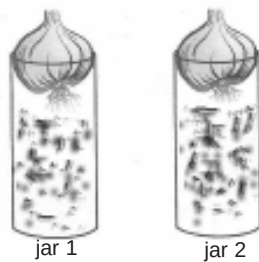


Fig.13.1: Observation of growth of roots in onion bulbs

Activity 13.1

Let us take two glass jars and fill them with water. Now, take two onion bulbs and place one on each jar. Observe the growth of roots in both the bulbs for a few days. Measure the length of roots on day 1, 2 and 3. On day 4 cut the root tips of the onion bulb in jar 2 by about 1 cm. After this, observe the growth of roots in both the jars and measure their lengths each day for five more days and record the observations in tables, like the table below.

Length \	Day 1	Day 2	Day 3	Day 4	Day 5

From the above observations, answer the following questions:

1. Which of the two onion bulbs has longer roots? Why?
2. Do the roots continue growing even after you have removed their tips?
3. Why would the tips stop growing in jar 2 after you have cut them?

Meristematic tissues are made up of dividing cells. They help in increasing the length and girth of the plant. Meristematic cells are similar in structure and have uniform thin cellulose cell wall. They are spherical, oval, polygonal or rectangular in shape. They are compactly arranged i.e. no intercellular spaces present between them. They possess dense or abundant cytoplasm with prominent nuclei (Fig.13.2). Vacuoles are absent in them; if present, small in size and many in number.

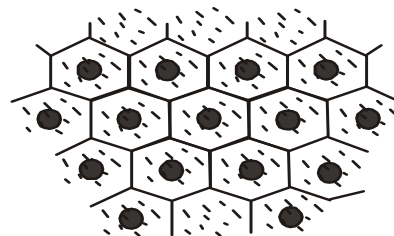


Fig. 13.2: Meristematic tissue

Meristematic tissues, depending on the region where they are present, are classified as **apical**, **intercalary** and **lateral**.

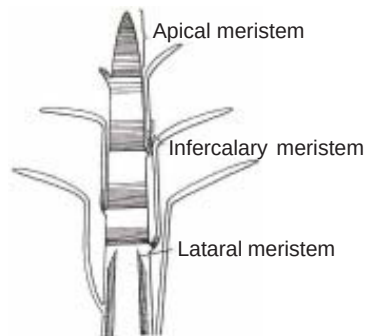


Fig.13.3: Different types of meristems on the basis of position in plant body.

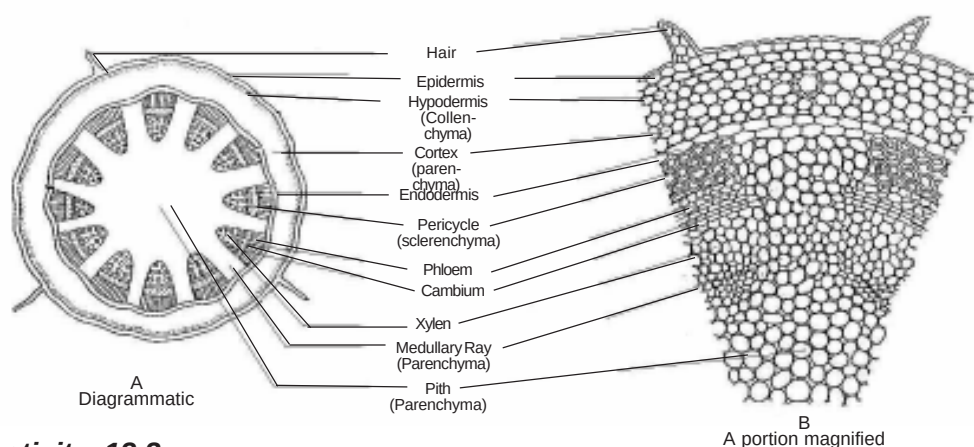
Apical meristem tissues are situated at the growing tips of stems and the root i.e. at shoot apex and root apex. These tissues are also present at the apices of leaves. They bring about the elongation of the roots and stems, resulting in increase in height of the plants.

Intercalary meristem is the meristem found at the base of the leaves or internodes, e.g. stems of grasses and other monocots. Their main function is to increase the length of organ in which they occur.

Lateral meristem tissues are situated along the sides of the stem and roots. These tissues are responsible for the growth in thickness. **Cork cambium** (found beneath the bark) is an example of lateral meristems.

13.2.2 Permanent tissue

The cells formed by meristematic tissue take up a specific role and lose the power to divide and ultimately attain their definite form. Consequently, they form a permanent tissue. This process of taking up a permanent shape, size, and a function is called differentiation. Permanent tissues are classified into two types – simple and complex.



Activity 13.2 Fig. 13.4 : Section of a Dicot stem (Sunflower)

Let us take a few cm. long sunflower stem and with help of your teacher cut into very thin cross sections or slices. Now, stain the sections with safranin and wash in water. Place one neatly cut section on a slide, and put a drop of glycerine. Cover with a cover-slip and observe the various types of cells and their arrangement. Compare it with (Fig. 13.4.)

Now, answer the following on the basis of your observation:

1. Are all cells similar in structure?
2. How many types of cells can be seen?
3. Can you think of reasons why there would be so many types of cells?

You can also try to cut sections of sunflower roots. You can even try cutting sections of roots and stem of different plants.

(1) Simple permanent tissue

The simple tissues consist of a group of similar type of cells forming uniform structures and performing the same functions. The common simple tissues found in plant bodies are **parenchyma**, **collenchyma** and **sclerenchyma** and these names are derived from the cell types of which these are composed.

Parenchyma is the basic packing tissue formed by a few layers of cells. They are found present in all the soft parts of the body. viz, root, stem, leaves, flowers, fruits etc. They are living cells having thin cell walls. There are spaces between cells (intercellular spaces) in this tissue, so they are loosely packed, [Fig.13.5]. Parenchyma cells have living protoplasm containing nucleus and surround a large central vacuole. They have the capability of cell division even though they are permanent tissues. When parenchyma contains chlorophyll, it is known as **chlorenchyma** and performs photosynthesis. A parenchyma is called **aerenchyma** when there is a large air cavity in between cells to give buoyancy to the aquatic plants and help them float. The function of parenchyma is to store food and water.

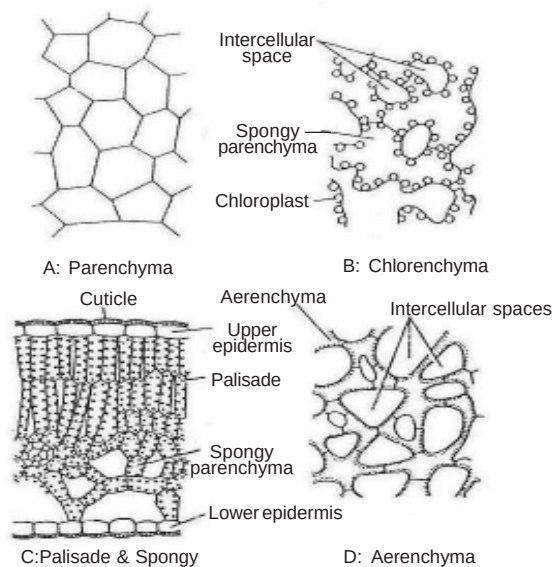


Fig. 13.5: Different kinds of parenchyma

Collenchyma provides the flexibility and mechanical support in plants. It allows easy bending in various parts of a plant (leaf, stem) without breaking. It shows many features similar to parenchyma but there is deposition of extra cellulose and pectin at the corners of the cells in collenchyma. The cells of this tissue are living, elongated and irregularly thickened at the corners. There is very little intercellular space. There are three types of collenchymatous tissues in different plants namely, **Angular**, **Lacunar** and **Lamellar** (Fig.13.6). They are found in dicot stem and leaf stalks just below the epidermis.

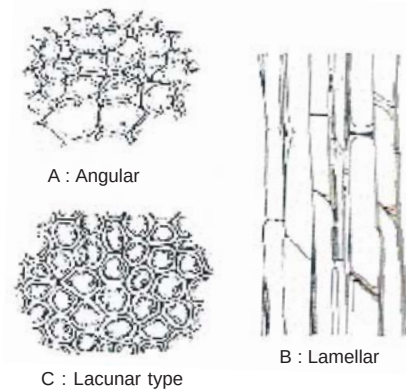


Fig.13.6: Different types of collenchyma

Sclerenchyma is the tissue which makes the plant hard and stiff. We have seen the husk of a coconut. It is made of sclerenchymatous tissue. Sclerenchyma cells are dead cells and do not contain protoplasm. The cell walls are regularly thickened with lignin. The cells are long and narrow, hence called **fibres** (Fig.13.7 (ii)).

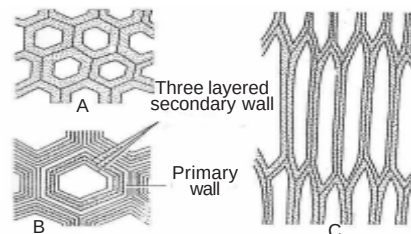


Fig.13.7: (i) A & B Transverse section and C. Longitudinal section of Sclerenchyma

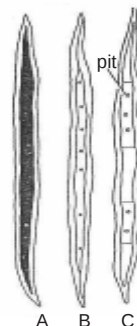


Fig.13.7: (ii) Sclerenchymatous Fibres

Due to thickened cell walls, there is no inter cellular space between the cells (Fig.13.6). They are located in stems, around vascular bundles, in the veins of leaves and in the hard covering of seeds and nuts. They provide strength to the plant parts.

The outermost layer of cells that you observed in Fig.13.4 is called **epidermis**. The epidermis is usually present in the outermost layer of the plant body such as leaves, flowers, stem and roots. It is formed by a single layer of cells. The epidermis may be thicker in some plants found in very dry habitats, since protection against water loss is significant. Epidermal cells on the aerial parts of the plant often secrete a waxy, water-resistant chemical substance known as **cutin** which is deposited to form a definite layer on their outer surface called **cuticle**. This aids in protection against loss of water, mechanical injury and invasion by parasitic fungi. Cells of epidermal tissue form a continuous layer without intercellular spaces since it has a protective role to play. Most epidermal cells are relatively flat. The main function of the epidermis is to protect the plant from desiccation (loss of water from plant body), infection and mechanical injury.

In roots, the outer most layer is called **epiblema**, not epidermis of stems. This is because their outer walls are not thickened with cuticle. The epiblema cells of roots usually bear long hair like structures known as **root hairs** that help the plants to absorb water from the soil.

The epidermis of leaf is not continuous. There are small pores here and there. These pores are called **stomata** (Fig.13.7). A Stoma is bounded by the two kidney or bean shaped, specialised epidermal cells, known as **guard cells**. The inner wall of guard cells are thicker than the outer walls. A guard cell contains chloroplasts, a unique feature which differentiate it from other epidermal cells. In the day time stomata remain open and close at night. Its opening and closing of stomata are due to turgidity and flaccidity of the guard cells. They are concerned with transpiration (loss of water in the form of water vapour) as well as with the gaseous interchange between the atmosphere and the internal tissues of plants during photosynthesis and respiration of plants.

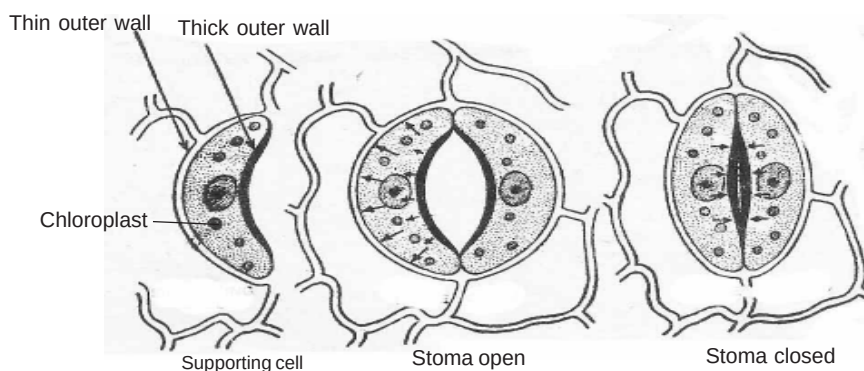


Fig.13.8: Opening and closing of stomata

As plants grow older, the outer protective tissue (epidermis) undergoes certain changes. A strip of secondary meristem, called **phellogen** or **cork cambium** replaces the epidermis of the stem. The layer of the cells which is cut off by cork cambium on the outer side ultimately becomes the several-layer thick cork or the bark of the tree. Cells of cork are dead and compactly arranged without intercellular spaces (Fig.13.6). The cells of the cork are heavily thickened by the deposition of a chemical (fatty acid) called **suberin** in their walls that makes them impervious to gases and water.

(2) COMPLEX PERMANENT TISSUE

We have discussed the different types of tissues which are all made of one type of cells. They look like each other. Such tissues are called Simple permanent tissues. However, there is another type of permanent tissue known as complex tissue. Complex tissues are made of more than one type of cells. All these cells coordinate to perform a common function. Complex tissues transport water, mineral salts (nutrients) and food material to various parts of plant body. The only Complex tissues of great importance are **xylem** and **phloem**. They are both conducting tissues and constitute a vascular bundle. They are also known as **vascular** or **conductive tissue**, which is a distinctive feature of the higher plants. It is the one feature that has made possible their survival in the terrestrial environment. Can you see different types of cells in the vascular bundle in Fig.13.4 showing a section of stem?

Xylem is composed of cells (elements) of four different types: tracheids, vessels, xylem parenchyma, and xylem fibres (Fig.13.9). All xylem elements have thick lignified walls, and are dead cells except xylem parenchyma. Tracheids and vessels are tubular structures but vessels are shorter and wider than tracheids. Tubular structures of both tracheids and vessels allow them to transport water and minerals vertically. The parenchyma stores food and helps in the lateral conduction of water. Fibres are mainly supportive in function. The main function of xylem is to carry water and mineral salts upward from the root to different parts of the plants. It also provides mechanical strength to the plant body because of lignified walls of tracheids, vessels and sclerenchyma of xylem.

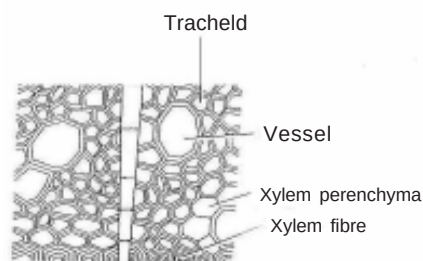


Fig.13.9: (i) T.S. of xylem showing its components

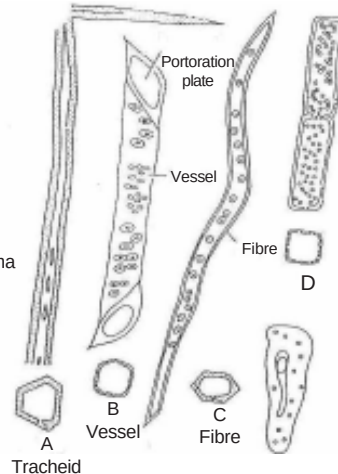


Fig.13.9: (ii) Elements of xylem

Phloem contains tubes like xylem but has no mechanical function. Phloem is composed of four types of elements: **sieve tubes**, **companion cells**, **phloem sclerenchyma** and **phloem parenchyma** (Fig.13.10). Sieve tubes are tubular cells with walls perforated by numerous pores (sieve plates or sieve pores). All the phloem cells are living cells except for phloem sclerenchyma. Phloem sclerenchyma is also known as bast fibres which provide mechanical support to the plant. Phloem transports photosynthetically prepared food materials from leaves to other parts of the plants.

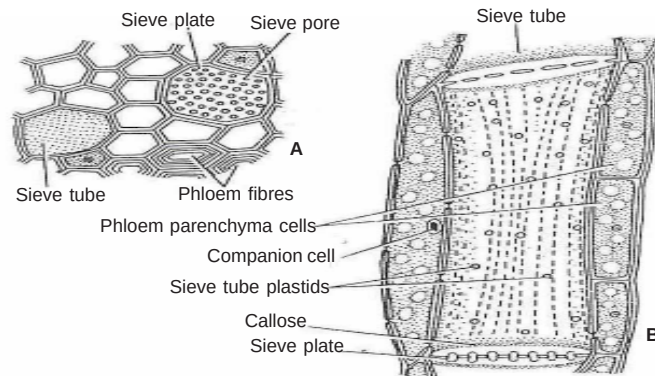


Fig.13.10: A. T.S. of phloem showing its elements B. L.S. of phloem

Try to answers the questions

1. What is a tissue?
2. Name the simple tissues of plants.
3. Classify meristems on their position in the plant body.
4. What is the function of Apical meristem?
5. What are the constituent elements of xylem and phloem?
6. How do stomata open?

13.3 ANIMAL TISSUES

While breathing, we can actually feel the movement of our chest. How do and what makes this body parts move? We have specialised cells in our body called muscle cells, to perform this life activity. The contraction and relaxation of these muscle cells result in movement.

During breathing we inhale oxygen gas along with air. Where does this oxygen go? It goes to our two lungs and then is transported to all cells of the body through blood. Can you imagine why cells need oxygen? Mitochondria present in the cells, utilize the oxygen in the generation of energy in the form of ATP molecules. Blood flows and connects different parts of the body. It carries oxygen and food to all cells. It also collects metabolic wastes (e.g. carbon dioxide) from all parts of the body and carries them to the liver and kidney for disposal.

Thus, blood and muscles are both examples of tissues found in our body. Animal tissues can be classified, on the basis of functions they perform in the body, as **epithelial tissue**, **connective tissue**, **muscular tissue** and **nervous tissue**. Muscle forms muscular tissue and blood is a type of connective tissue

13.3.1 EPITHELIAL TISSUE

Epithelial tissue is the simplest tissue. It is the covering or protective tissue in the animal body (as epidermis of plants). Cells of these tissues are tightly packed and form a continuous sheet. They indeed contain a small amount of cementing material between them and almost no intercellular spaces. It covers most organs and cavities

within the body. It also forms a barrier to keep separately different body system. The skin, the lining of the mouth, the lining of the blood vessels, lung alveoli and kidney tubules are all made of epithelial tissue. Various epithelial cells play an important role in regulating the exchange of materials between the body and the external environment and also between different parts of the body. An extracellular fibrous basement membrane separates epithelium from underlying tissue.

Epithelial tissue may be simple, i.e. composed of a single layer of cells, or stratified, i.e. made up of several layers of cells.

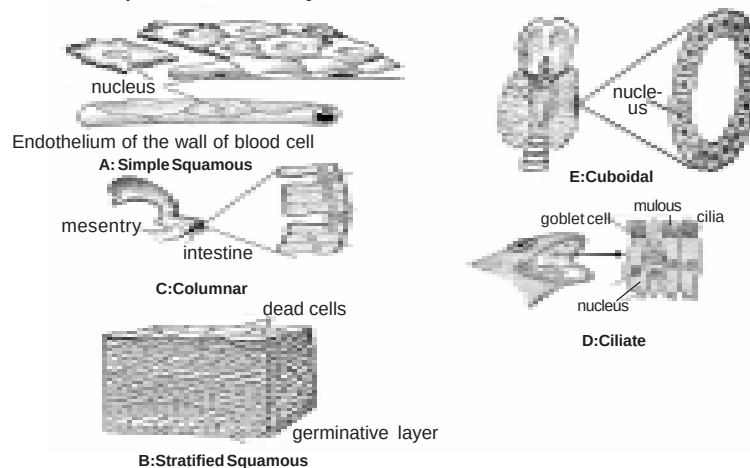


Fig. 13.11: Types of epithelial tissues

Epithelial cells form an outer layer of the skin and protect the underlying cells from drying and injury. It helps in absorption of water and nutrients and also helps in elimination of waste products.

Epithelial tissue can be classified depending on the structures and function they perform, as squamous epithelium, columnar epithelium, ciliated epithelium, cuboidal epithelium and glandular epithelium.

Squamous epithelium can be further divided into two types such as simple and stratified squamous epithelium. Simple squamous epithelial cells are extremely thin, flat and irregularly shaped cells (Fig.13.11 A). It forms a delicate lining of blood vessels, and cavities found in alveoli, oesophagus, mouth etc. it forms a selectively permeable surface through which transportation of substances occur. Stratified squamous epitheliums are arranged in patterns of layers as found in skin where epithelial cells are arranged in many layers to prevent wear and tear (Fig.13.11 B). This epithelium is highly resistant to mechanical injury and is water proof.

Columnar (meaning 'pillar-like') epithelium is tall epithelial cell having nucleus towards the base. It is present in the inner lining of the stomach and intestine, where absorption and secretion occur. It facilitates movement across the epithelial barrier.

Certain columnar epithelial tissue has cilia, which are hair-like projections on the outer surfaces of epithelial cells. Such type epithelium is ciliated columnar epithelium (Fig.13.11 D). It is found in the respiratory tract. The movement of cilia pushes the solid particles (e.g. mucus) forward to clear it.

Cuboidal epithelium consists of the cube – like (cubical) cells (Fig.13.11 E). It is found in the lining of kidney tubules and ducts of salivary glands, where it provides mechanical support. It also helps in the absorption, excretion and secretion.

Epithelial cells often acquire additional specialization as gland cells, which can secrete substances at the epithelial tissue folds inward, and a multicellular gland is formed. This is glandular epithelium.

13.3.2 CONNECTIVE TISSUE

The cells of connective tissues are widely separated from one another, with a large amount of intercellular substances between them (Fig.13.12). The intercellular substances are the matrix which may be jelly like, fluid, dense or rigid. The nature of matrix will be different depending on the function of the particular connective tissue.

Take a drop of blood on a slide and observe different cells present in it under a microscope and compare them with Fig.13.12.A.

Blood is a fluid connective tissue. It has a fluid or liquid matrix called plasma. The plasma contains blood corpuscles or cells such as red blood cells (RBCs), white blood cells (WBCs) and platelets. It contains proteins, salt and hormones. Blood flows and transports gases, digested food, hormones and waste materials to different parts of the body. Different blood cells perform different functions such as, RBCs carry oxygen to the tissues for oxidation, WBCs fight diseases and platelets help in clotting of blood.

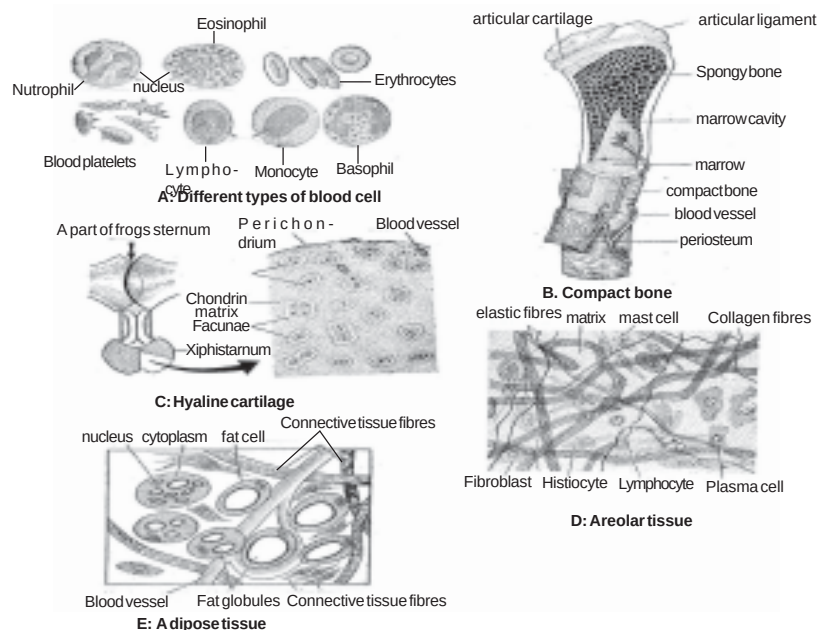


Fig.13.12: Different types of connective tissue

Bone is a connective tissue that provides shape and support to the body. It also protects the main organs of the body and anchors the muscles. It is a strong and nonflexible tissue. Bone cells are embedded in a hard matrix that is composed of calcium and phosphorus compounds that are responsible for its hardness.

Ligament is also a connective tissue that connects bones to bones. This tissue

is highly elastic and has considerable strength but contains very little matrix. Tendons are also another connective tissue that connects muscles to bones. They are fibrous and inelastic tissue with great strength but its flexibility is limited.

Another type of connective tissue is cartilage. It has widely spaced cells. The solid matrix is composed of proteins and sugars. It provides support and flexibility to the body parts. It makes bone surfaces smooth at joints. It is present in the nose, ear, trachea and larynx. The cartilage of the ears can be folded, but the bones in our arms cannot be bended.

Areolar connective tissue is a loose tissue found between the skin and muscles, around blood vessels and nerves and in the bone marrow. It fills the space inside the organs, supports internal organs and helps in repair of tissues after injury.

Adipose tissue is a type of loose connective tissue that is specialised to store fats. It is found below the skin and between internal organs. The cells of this tissue are filled with fat globules. Storage of fats also lets it act as an insulator and reduces the loss of heat from body.

13.3.3 MUSCULAR TISSUE

Muscular tissues are made of muscles cells. Muscles cells are elongated and large-sized. They are also called muscles fibres (Fig.13.12). Muscles contain special proteins called contractile proteins, which is responsible for movement in our body by contracting and relaxing.

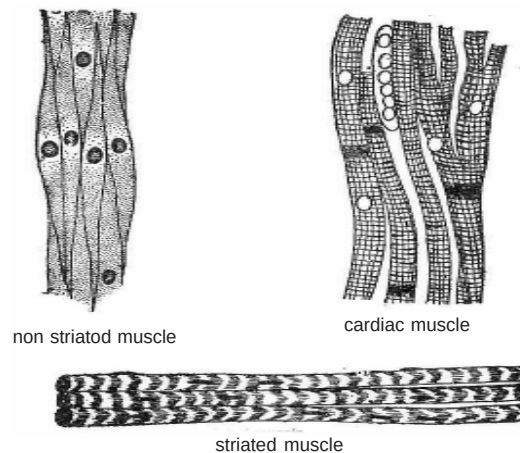


Fig.13.13: Different types of muscle fibres

There are three types of muscles fibres depending on their location, structure and function they perform: **striated muscles**, **smooth muscles**, **cardiac muscles**

Striated muscles show alternate light and dark bands or striations. The cells of this tissue are long, cylindrical, unbranched and multinucleate (having many nuclei). Striated muscles are also known as voluntary muscles. Since we can move muscles present in our limbs when we want them to, and stop when we so decide. These muscles are also called skeletal muscles since they are mostly attached to bones and are responsible for body movement.

Smooth muscles do not move at our will so they are also called as **involuntary muscles** like the movement of food in alimentary canal or the contraction and relaxation of blood vessels. Smooth muscles control such movements. The cells are long with

pointed ends (spindle-shaped) and uninucleate (having a single nucleus). They are also found in the iris of the eye, in ureters and in the bronchi of the lungs. They are also called unstriated muscles because they do not bear any bands, stripes or striation across the muscles.

Cardiac muscles are involuntary, striated and nonfatigued fibres. They are cylindrical, branched and uninucleate. The muscles of the heart show rhythmic contraction and relaxation throughout life. The contraction and relaxation of the heart muscles help to pump and distribute blood to various parts of the body.

Now, you can compare the structures of different types of muscular tissues and note their shape, number of nuclei and position of nuclei within the cell.

13.3.4 NERVOUS TISSUE

Cells of the nervous tissue are the most highly specialised cells for being stimulated and then transmitting the stimulus very rapidly from one place to another within the body. The brain, spinal cord and nerves are all composed of the nervous tissue. Nerve cells or neurons are the highly specialised cells present in the nervous tissue (Fig.13.13). A neuron consists of a cell body, dendrites and axon. A cell body or cyton contains a nucleus and cytoplasm. Dendrites are long thin hair-like parts arising from cell body. Axon is a single long part. An individual nerve cell may be up to a metre long.

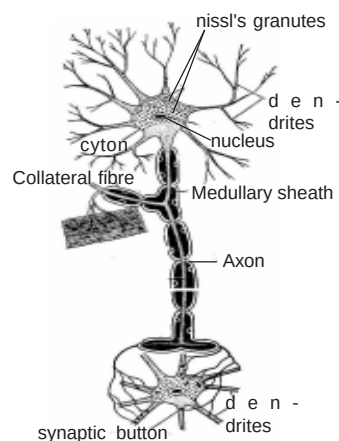


Fig.13.14: A neuron cell in the nervous tissue.

The functional combination of nerve and muscle tissue is fundamental to most animals as this combination enables animals to move rapidly in response to stimuli.

Try to answer the questions

1. What are the four main types of animal tissues?
2. Name the tissue responsible for movement in our body.
3. Name the type of epithelial tissue present in the inner lining of stomach and intestine.
4. What is the function of WBC?
5. What are the functions of areolar tissues?
6. What does the neuron look like?

POINTS TO REMEMBER

- * Tissue is a group of cells similar in structure and function.
- * Plant tissues are of two main types – meristematic and permanent.
- * Meristematic tissue is the dividing tissue present at the growing regions of the plant. They are meant for growth of an organ.
- * Permanent tissues are derived from meristematic tissue till they lose the ability to divide. They are classified as simple and complex tissue.
- * Three types of simple tissues are parenchyma, collenchyma and sclerenchyma. Xylem and phloem are types of complex tissues.
- * Animal tissues can be epithelial, connective, muscular and nervous tissue.
- * Epithelial tissue is classified as squamous, cuboidal, columnar, ciliated and glandular, depending on shape and function
- * The different types of connective tissues in our body include blood, bone, tendon, ligament, cartilage, areolar tissue and adipose tissues.
- * Striated, unstriated and cardiac are three types of muscle tissues. They perform movement by contraction and relaxation.
- * Nervous tissue is made of neurons that receive and conduct impulses.
- * An impulse is the passage of electrical activity along the axon of a nerve cell.

EXERCISES

1. *Define tissue.*
2. *What is the utility of tissues in multicellular organisms?*
3. *Name types of simple tissue.*
4. *Where is apical meristem found?*
5. *Which tissue makes up the husk of coconut?*
6. *What are the constituents of phloem?*
7. *What are the elements that make up the xylem tissue?*
8. *Differentiate simple tissue and complex tissue of plants.*
9. *Differentiate between parenchyma, collenchyma and sclerenchyma on the basis of their cell walls.*
10. *What are the stomata and what are the functions of stomata?*
11. *Name the tissue responsible for movement in our body.*
12. *What does a neuron look like?*
13. *Give three features of cardiac muscles.*
14. *What are the functions of areolar tissue?*
15. *Diagrammatically show the difference between the three types of muscle fibres.*
16. *What is the specific function of the cardiac muscle?*
17. *Differentiate between striated, unstriated and cardiac muscles on the basis of their structures and site/ location in the body.*

18. Draw a labelled diagram of a neuron.
19. Name the following.
- Tissue that forms the inner lining of our mouth.
 - Tissue that connects muscle to bone in humans.
 - Plant tissue that transports food.
 - Tissue that stores fat in our body.
 - Connective tissue with a fluid matrix.
 - Tissue present in the brain.
20. Identify the type of tissue in the following: skin, bark of tree, bone, lining of kidney tubule, vascular bundle.
21. Name the regions in which parenchyma tissue is present.
22. What is the role of epidermis in plants?
23. How does the cork act as a protective tissue?
24. Complete the table:

