Tissues

SYLLABUS : Structure and functions of animal and plant tissues (four types in animals, meristematic and permanent tissues in plants)

DIVISION OF LABOUR

All living organisms are made up of cells. In unicellular organisms, like Amoeba all life processes are carried out within a single cell. The cell also performs other organismic level activities like movements, intake of food, exchange of gases, irritability, excretion, reproduction, etc. In multicellular organisms there are millions of cells. At organismic level, they show division of labour where different components of the body take up different functions like movements through contraction and relaxation of muscles, conduction of messages by nerves, transport of oxygen, food, hormones and waste materials by blood in animals or conduction of water and food by vascular tissues in plants. Division of labour has been made possible by specialisation of cells and their grouping with each specialized cellular cluster occupying a definite place in the body and performing a particular function. Specialisation is achieved due to differentiation whereby cells come to have a definite shape, size, structure and function. Group of cells having a common origin, similar or related structure which work together to perform a common function is called tissue (Fr. tissue—woven). Study of tissues is called histology (Gk. histos—tissue, logos—study).

Importance of Tissues. (i) Formation of tissues has brought about division of labour in multicellular organisms, (ii) Tissues become organized to form organs and organs into organ systems. This higher organisation has further increased efficiency of multicellular organisms, (iii) Workload of individual cells has decreased, (iv) Due to improved organisation and higher efficiency, multicellular organisms have higher survival.

ARE PLANTS AND ANIMALS MADE OF SAME TYPES OF TISSUES

Both plants and animals have similar life processes. However, they do not have similar types of tissues because of the differences in their organisation, mode of living and life style.

1. Mobility. Plants are stationary or fixed. They require more of supportive tissues for obtaining structural strength. Most of their tissues are dead. The dead tissues provide more mechanical strength. They also require less maintenance.

Animals are mobile. They move about in search of food, mate and shelter. Most of their tissues are living. The living tissues require more energy for their maintenance.

2. Growth. Plants continue to grow throughout their life. Animals stop growing after becoming mature. For continuing growth, plants possess meristematic tissues in specific regions of the body. They have, therefore, two basic types of tissues, meristematic and permanent. Meristems are absent in animals.

3. Structural Organisation. In having organ and organ systems, structural organisation of animals is far more specialied and localised as compared to plants. It is due to mobility and different feeding methods of animals.

Plant Tissues	Animal Tissues
1. Abundance. Dead supportive tissues are more abundant as compared to living tissues.	Living tissues are more common as compared to dead tissues.
2. Maintenance Energy. They require less maintenance energy.	Animals require more maintenance, energy.

3. Basic Nature. There is differentiation of meristematic and permanent tissues.	Such a differentiation is absent.
4. Organisation. It is simple.	Organisation is complex with the development of more specialised and localised organs and organ systems.
5. Purpose. Tissue organisation is towards stationary habit.	Tissue organisation is towards high mobility.

Very Short Answer Questions

1. What types of functions does the single cell of unicellular organism like Amoeba perform
Ans. The single cell of unicellular organism like Amoeba performs both vital life activities (e.g., respiration, metabolism, repair, assimilation) and organismic level activities (e.g., intake of food, exchange of respiratory gases, excretion, reproduction).

2. What types of functions does a single cell of multicellular organism perform ?
Ans. All vital life activities and one specific function as a part of a tissue.

3. What is tissue ?
Ans. Tissue is a group of cells having a common origin and a common function.

4. Name the two basic types of tissues found in plants.
Ans. Meristematic and permanent.

5. Name a basic tissue present in plants but absent in animals.
Ans. Meristematic

6. What is division of labour ?
Ans. Division of labour is the distribution of different functions among different components of the body which, therefore, get specialised for the same.

7. Which types of tissues are more common in plants ?
Ans. Tissues with dead cells.

8. Why do animals consume more energy as compared to plants ?
Ans. Animals require more energy as they have to move from place to place and posse living tissues for their activity.

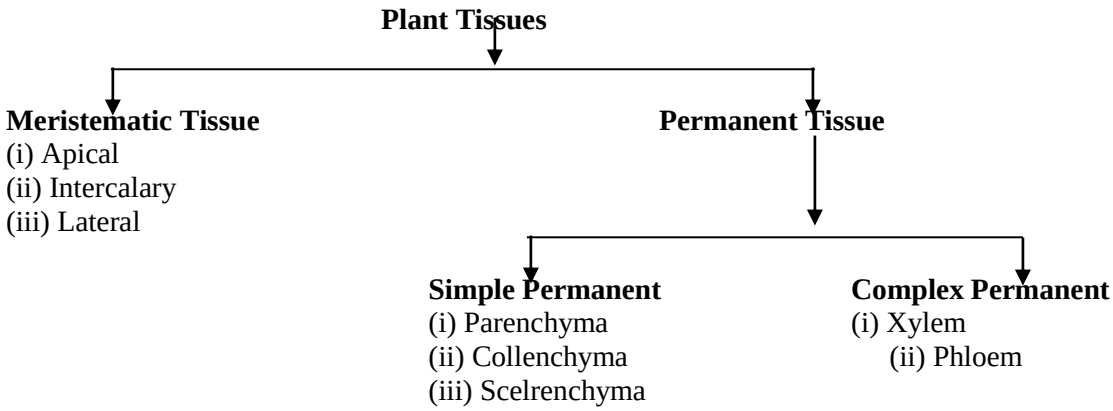
9. What contributes most to the difference in organ system design of plants and animals ?
Ans. Active locomotion in animals and sedentary habit of plants.

Short Answer Questions

10. Why do plants and animals possess different types of tissues ?
11. What is the importance of tissues ?
12. Tabulate differences between plant and animal tissue.

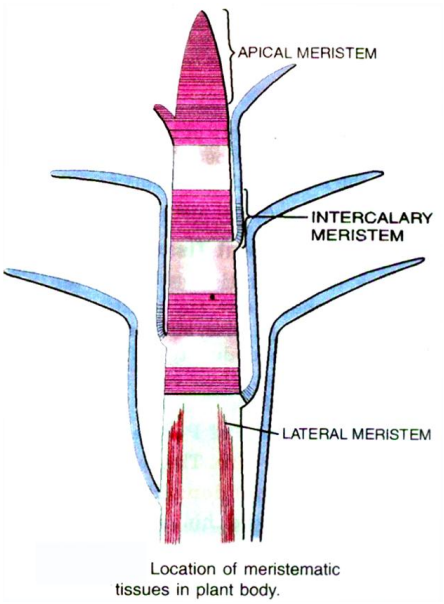
PLANT TISSUES

Plant tissues are of two types, meristematic and permanent. Permanent plant tissues have two subtypes, simple and complex.



MERISTEMATIC TISSUE (GK. MER/STOS—DIVIDED)

It is a plant tissue of thin-walled compactly arranged immature cells that have the potential to divide and form new cells. Meristematic tissue is also called meristem. Its cells are called meristematic cells. The region where meristem is present can function as growth region. New cells produced by a meristem are initially like meristematic cells. Slowly, they grow, differentiate and mature into components of various permanent tissues.



Location of meristematic tissues in plant body.

CHARACTERISTICS OF MERISTEMATIC CELLS

1. Shape and Size. The cells are small, spherical or polygonal in outline.
2. Cell Wall. It is thin and elastic.
3. Intercellular Spaces. They are absent. The cells are compactly arranged.
4. Cell Contents, (a) Nucleus is large (b) Cytoplasm is dense (c) Vacuoles are absent or very small.
5. Activity, (a) Respiration is rapid, (b) There is high synthetic activity, (c) Food supply is high but food is not stored, (d) Meristematic cells grow and divide repeatedly.

FUNCTIONS

1. Growth. Meristematic tissue takes part in growth by formation of new cells.
2. New Organs. Plants continue to produce new leaves, stem branches, flowers, fruits, root hairs and root branches. They are formed by meristematic cells.
3. Injury. The place of injury is healed up by the formation of new cells.
4. Lodging. The shoots lodged or bent by wind are made to grow upright by activity of intercalary meristem.

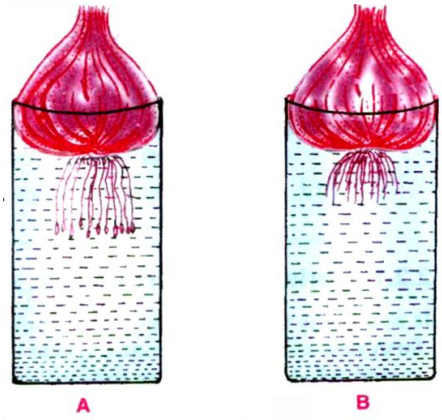
LOCATION OF MERISTEMS

On the basis of position in the plant body, meristems or meristematic tissues are of three types—apical. intercalary and lateral.

1. Apical Meristem. It occurs at the growing tips of stems and roots. Depending upon its occurrence at root or stem tip, it is called root apical meristem and stem or shoot apical meristem. Apical meristem produces growth in length of root and stem. Intercalary meristem is left out part of the apical meristem.

2. Intercalary Meristem. It occurs in intermediate position at the base of leaves, base of the internodes (e.g., Grasses) or below the nodes (e.g., Mint). Intercalary meristem helps in growth of leaves and internodes. Upward bending of lodged shoots is due to activity of intercalary meristem.

3. Lateral Meristem. It occurs on the sides both in stem and root. Lateral meristem is of two types, vascular cambium and cork cambium. Vascular cambium produces secondary vascular tissues, secondary phloem and secondary xylem. Cork cambium (phellogen) produces a protective cork on the outside. Lateral meristem increases girth of stem and root.



Growth of roots in Onion. A, with intact apical meristem.
B, with apical meristem removed on fourth day.

APICAL MERISTEM CAUSES GROWTH IN LENGTH

Apparatus. Two glass jars, two onion bulbs, scale, scissors or scalpel, water.

Working. Take two glass jars. Fill them with water. Place an onion bulb over the mouth of each jar in such a way that stem base of the bulb dips in water. Observe daily. Roots develop from the base of the bulbs in both the jars. Measure the length of the roots daily. On fourth day, remove 1 cm long apical portion of the roots of bulb 2. Measure /he lengths of the roots in both the bulbs on fifth and sixty day.

Observation :

Average Length of Root.	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Jar 1	–	–	–	–	–	–
Jar 2	–	–	–	–	–	–

It is seen that of bulb 1 continue to grow on fifth and sixth day. They stop growing in case of bulb 2. The difference between the two jars is that in bulb 1, the root apical meristems are intact while in bulb 2, the root apical meristems have been removed.

Conclusion. Apical meristem is responsible for growth in length of the root.

PERMANENT TISSUES

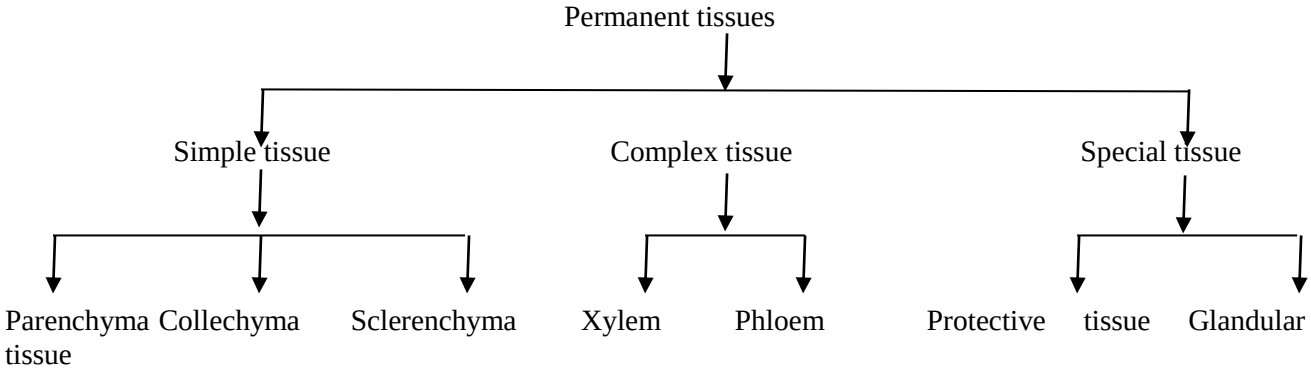
They are plant tissues where the cells have lost the ability to divide, and have assumed a permanent shape, size and function. They are derived from meristematic cells. The process of taking up a definite shape, size, structure and function is called differentiation. Different types of permanent tissues are formed due to differences in their specialisation. Permanent tissues may be simple, complex or special. Their cells may be living or dead, thin-walled or thick-walled. Thickening may be regular or irregular.

CHARACTERISTICS OF PERMANENT TISSUES

1. Shape and Size. The cells have attained a definite shape and size which do not alter afterwards.
2. Specific Functions. Permanent cells come to have specific functions.
3. Wall. It can be thin or thick. The thickening may be regular or irregular.
4. Division. Permanent cells normally do not divide.
5. Life. They may be living or dead.

Meristematic Tissue	Permanent Tissue
1. Nature. The cells are small isodiametric and undifferentiated.	The cells are large differentiated with different shapes.
2. Spaces. Intercellular spaces are absent.	Intercellular spaces are often present.
3. Vacuoles. They are absent.	Large central vacuole occurs in living permanent cells.
4. Wall. Cell wall is thin.	Cell wall is thin or thick.
5. Divisions. The cells undergo regular divisions.	The cells do not normally divide.
6. Tissue. Meristematic tissue is a simple tissue.	It can be simple, complex or special.
7. Metabolism. Rate of metabolism is high.	Metabolic rate is comparatively slower.
8. Organelles. Cell organelles are simple.	Cell organelles are well developed.
9. Crystals. Cells do not contain crystals and other inclusions.	Cells possess crystals and other inclusions.

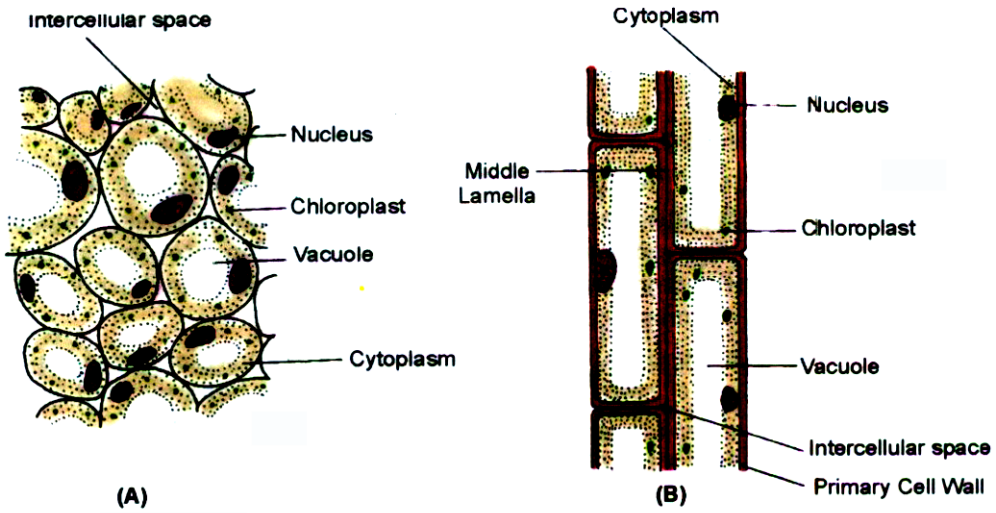
Differences Between Meristematic Permanent Tissues



(i) Simple Permanent Tissues

They are those permanent tissues in which the permanent cells are similar in structure, origin and function. Simple permanent tissues are of three types–parenchyma, collenchyma and sclerenchyma.

Parenchyma (Gk. para–beside, enchyma–filing,)



Parenchyma. A, transverse section. B, longitudinal section.

It is a simple permanent tissue of thin walled relatively unspecialised, isodiametric (all sides equal) living cells which forms the basic packing tissue of plant body lying in between specialised tissues. It is the most abundant tissue of plants. Parenchyma is found in all nonwoody parts of plant like stem, root, leaves, flowers, fruits, etc. The cells are oval, spherical or polygonal in outline. The thin cell wall is made of cellulose. There is a central vacuole and peripheral cytoplasm containing the nucleus. The cells are loosely packed with small and large intercellular spaces occurring in between cells.

Functions. (i) Storage. Parenchyma cells store food and water. In storage tissues, parenchyma cells are especially enlarged to store nutrients and water.

(ii) Support. The cells of the tissue remain turgid and provide rigidity or support to softer parts.

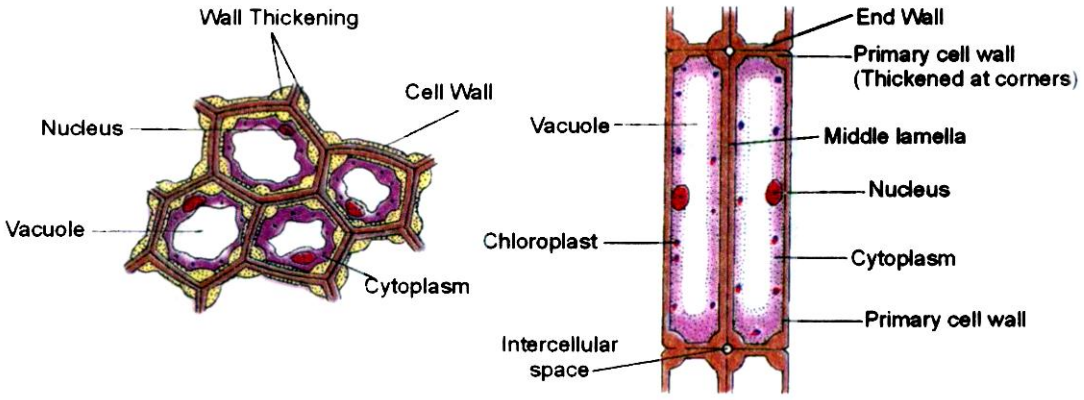
(iii) Gaseous Exchange. Presence of intercellular spaces in between parenchyma cells allows movement of gases and gaseous exchange.

(iv) Waste Products. Certain parenchyma cells store waste products like tannins, resins, gums, crystals, etc.

(v) Slow Transport. Parenchyma present in xylem and phloem takes part in slow lateral movement of materials.

(vi) Chlorenchyma. Parenchyma containing chloroplasts is called chlorenchyma. Chlorenchyma is present in the leaf interior as well as outer cortex of young stems. It is the seat of photosynthesis or manufacture of organic food.

(vii) Aerenchyma. It is modified parenchyma found is hydrophytes or aquatic plants. Aerenchyma consists of a network of parenchyma cell which enclose large air cavities. Air cavities store gases and provide buoyancy to aquatic plants.
(viii) Epidermis. It is specialised parenchyma present on the surface of the plant organs.
* Collenchyma (Gk. kolla- glue, enchyma- tissue. Figure 2.4)



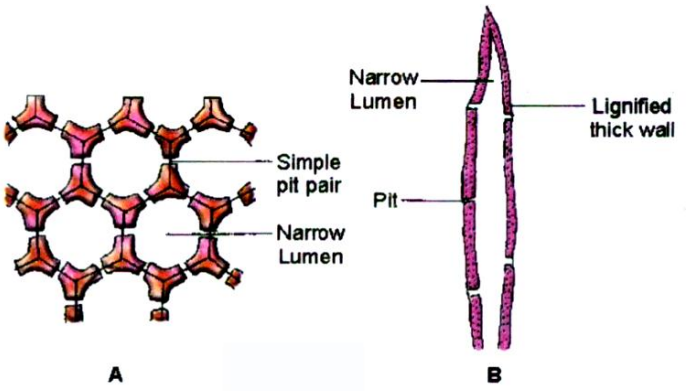
Parenchyma. A, transverse section. B, longitudinal section.

It is a simple permanent tissue of living cells which provides flexibility to soft aerial parts (e.g., leaves, young stems) that can bend without breaking. The cells possess uneven thickenings of pectocellulose, generally at the corners. Intercellular spaces are little. The cells are elongated but appear oval, circular or angular in transverse section. Collenchyma occurs below the epidermis in leaf stalks, leaf mid ribs and herbaceous dicot stems. It is absent in monocots.
Functions. (i) Strength. Collenchyma is a living mechanical tissue which provides both mechanical strength as well as flexibility. Because of collenchyma, plant organs can bend without breaking.
(ii) Growth. Collenchyma allows growth and elongation of organs.
(iii) Storage. Being living tissue, collenchyma stores food.
(iv) Photosynthesis. Collenchyma cells may contain chloroplasts and take part in photosynthesis.

Difference Between Parenchyma and Collenchyma

Parenchyma	**Collenchyma**
1. Shape. Cells are isodiametric.	Cells are elongated.
2. Wall. Cell wall is thin.	Cell wall is unevenly thickened generally over the comers.
3. Strength. Parenchyma provides rigidity to softer organs.	It provides both mechanical strength as well as flexibility.
4. Occurrence. It forms the packing tissue of all plant organs. .	It occurs hypodermally in dicot stems and leaves only.

Sclerenchyma (Gk. scleros—hard, enchyma—tissue.
It is a simple permanent tissue of dead highly thick-walled cells with little lumen. The thickening is generally made of lignin which functions as cement and hardens the cells. The walls contain certain unthickened areas called pits. Sclerenchyma is of two types, fibres and sclereids. Sclerenchyrma fibres are made of spindle shaped, long and narrow cells that reach a length of 1-550 mm. They generally occur in sheets or bundles. Sclereids are short and broad highly thick-walled Sclerenchyma cells which occur single or in small groups.



Sclerenchyma fibres. A, transverse section. B, longitudinal section.

Difference between Sclerenchyma Fibres and Sclereids

Sclerenchyma Fibres	Sclereids
1. Shape. They are elongated spindle shaped thick-walled dead cells.	They are broad thick-walled dead cells.
2. Aggregation. They are arranged in bundles, nets and cylinders.	Sclereids occur singly or in small groups.
3. Covering. They do not form covering of any plant organ.	They form hard covering of nuts and seeds.
4. Function. Sclerenchyma fibres provide mechanical strength.	Sclereids provide stiffness.

Sclerenchyma occurs in the stem as hypodermis in monocot stems, around vascular bundle, inside xylem and phloem, hard covering of seeds and nuts, husk of Coconut, grit of Apple, Pear and Guava.

Functions. (i) Mechanical Strength. Sclerenchyma ia the chief mechanical tissue of plants which provides them strength and enables them to bear various stresses.

(ii) Protection. It forms a protective covering around seeds and nuts.

(iii) Commercial Fibres. Sclerenchyma fibres of some plants are commercially exploited, e.g., Flax, Hemp, Jute, Coconut.

Difference Between Collenchyma and Selerenchyma

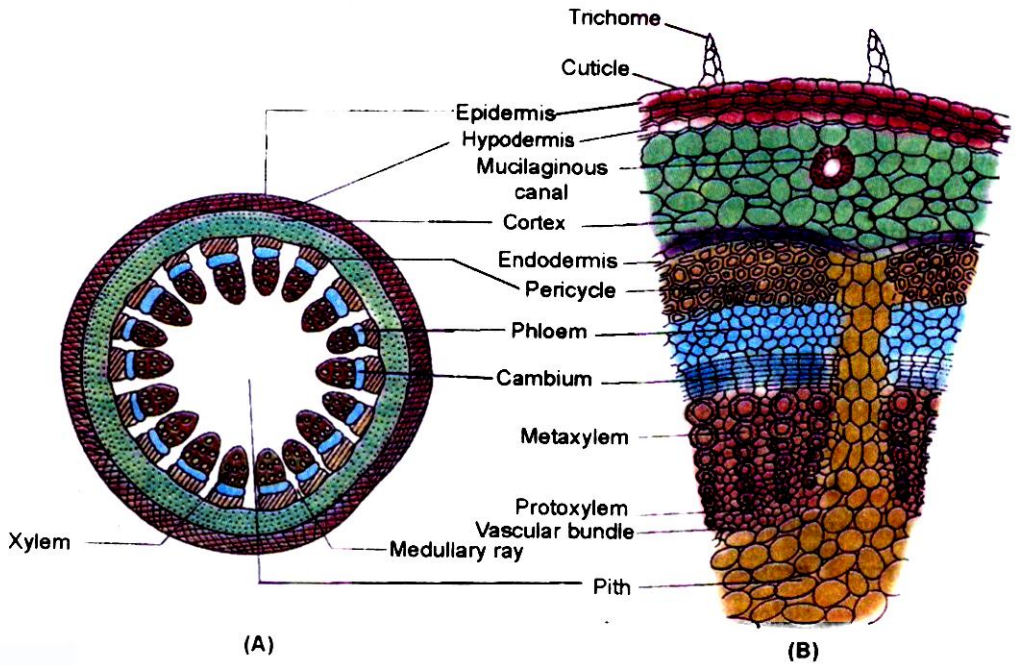
Collenchyma	Sclerenchyma
1. Tissue. It is living mechanical tissue.	It is dead mechanical tissue
2. Evenness of Thickening. Wall thickening is uneven.	Wall thickening is uniform.
3. Chemical Nature. Wall thickening is of pectin and cellulose.	Wall thickening is of lignin.
4. Lumen. Lumen or cell cavity is wide.	Lumen or cell cavity is narrow.
5. Food. Collenchyma manufactures as well as stores food.	Sclerenchyma has no such function.
6. Hardness. It keeps the organs soft.	It provides hardness.
7. Major Function. Collenchyma provides flexibility as well as strength.	Sclerenchyma provides mechanical strength for facing various stresses.

STUDY OF STEM TISSUES

Apparatus. Stem segment of Sunflower, Potato cylinders, razor or new blade, safranine, watch glasses, brush, clean slides, cover slip, needle, microscope, glycerine, dropper.

Working. Take a rectangular or cylindrical piece of Potato tuber. Scoop a narrow hole in it. The stem segment is embedded in potato. It is held in vertical position in between the fingers and thumb. Wet the razor and plant material and give horizontal cuts to the material with single jerks. Float the section in water. Complete and fine sections are picked up with the help of fine brush and dipped in safranine dye for 2-3 minutes. Take out the sections and wash in water twice. Select a clean slide. Place a drop of dilute glycerine over it. Take the stained section and dip in the drop of glycerine over the slide. Place a clean cover slip over the section. Observe the slide under the microscope.

Observation. Observe that the section is circular in outside. There is a single layered epidermis on the outside. At places epidermis bears fine slomata and multicellular hair. Epidermis is followed by 3–4 layers of collenchymatous hypodermis and then a few layers of rounded thin walled parenchymatous general cortex. Mucilage and oil ducts occur at places in the cortex. The innermost layer of cortex is



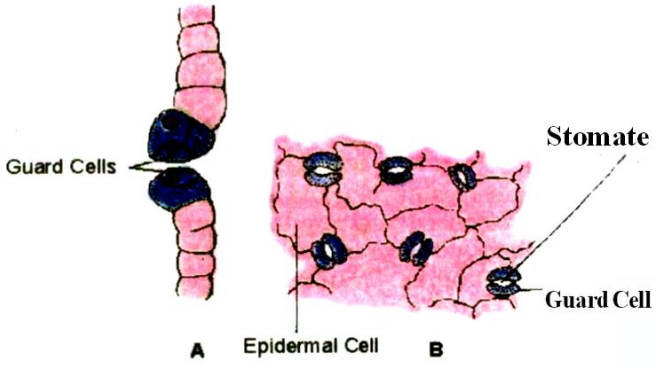
T.S. Stem. A, diagrammatic. B, part of transverse section showing details of tissues.

wavy. It is called starch sheath. There are then a few layers of pericycle. Pericycle is alternately sclerenchymatous and parenchymatous. Sclerenchymatous pericycle occurs as bundle caps on the of vascular bundles. Vascular bundles are wedge-shaped in outline. Each vascular bundle has on the outer side and xylem on the inner side with a strip of vascular cambium in between the two. Xylem has differentiation of metaxylem on the outer side and protoxylem (smaller elements) on the inner side. Such a xylem is called endarch. Parenchymatous areas called medullary rays occur in between the vascular bundles. The centre of stem contains parenchymatous area called pith.

PROTECTIVE TISSUE

It is an outer layer of cells that covers plant parts (stem, root, leaves, flowers, fruits, etc), providing protection against adverse environmental factors and pathogens besides performing' specialised functions like exchange of gases. Protective tissue is of two types, epidermis and cork.

1. Epidermis (Gk. epi—upon, derma—skin). It is the outermost protective layer of plant organs. Epidermis is commonly single layered with the exception of some xerophytic plants (e.g., Oleander, Banyan). Cells of epidermis are elongated and closely packed. Intercellular spaces do not occur between them. The cells are generally thickened on their outer and radial sides and thin-walled on inner side. In aerial parts, the outer thick walls are also covered by a layer of water impermeable fatty substance called cutin. Cutin and wax also form a separate noncellcular coating called cuticle. Cuticle is quite thick in xerophytic plants. It is thin in plants of mesophytic habitats. In grasses the epidermal cells of aerial parts also possess a deposition of silica. Silica stiffness and protection against grazing.



Epidermis showing stomata. A, late... B, surface view.

At places the aerial parts bear minute pores called stomata. Each stoma or stomate is enclosed by a pair of specialised epidermal cells called guard cells. Guard cells are kidney-shaped (reniform) in dicots and dumb-bell shaped in monocots. They are thicker on the inner side and thinner on the outer side. As the guard cells become turgid they create a pore in between their thick inner walls. The pores are helpful in exchange of

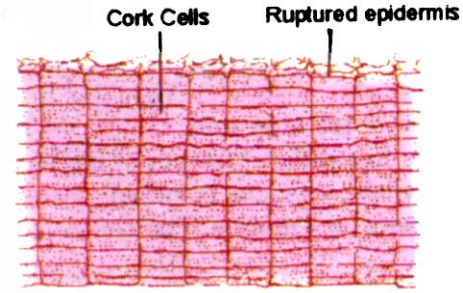
gases. They are also the seat of transpiration (loss of water in vapour form). In xerophytic plants, the stomata are often sunken to reduce the rate of transpiration. Transpiration helps in keeping the plant surfaces cool even in hot weather.

In many plants, the aerial surfaces also bear cutinised hair over their epidermis. They are trichomes. Aerial hairs help in developing an insulating stationary layer of air over the surface in order to reduce the rate of transpiration as well as impact of solar radiations.

In roots the younger parts are covered by uncutinised layer of epidermis called epiblema. Some of the epiblema cells give rise to tubular outgrowths called root hairs. Root hairs increase the absorptive surface area of the root. They pass into soil interspaces for absorbing water and mineral salts.

Functions, (i) Protection. Epidermis is the outer protective layer of the plant that prevents entry of pathogens and pests, (ii) Water Loss. By presence of cuticle, it checks the rate of water loss from aerial parts. (iii) Hair. Occurrence of epidermal hair produces an insulating stationary layer of air. (iv) Stomata. They regulate exchange of gases. Stomata are also the seat of major loss of water in transpiration. Transpiration keeps the aerial parts cool. (v) Epiblema. Epiblema or epidermis of the root alongwith its root hairs takes part in absorption of water and minerals.

2. Cork (Figure 2.8). It is outer protective tissue of older stems and roots. Cork is formed by a secondary lateral meristem called cork cambium or phellogen. Cork cambium produces secondary cortex on the inner side and cork on the outer side. Cork cells are rectangular in outline. Thy are arranged compactly in several layers. Intercellular spaces are absent. Older cells become dead and filled with tannins, resins andair. Their walls become impermeable due to deposition of suberin. At places cork possesses small aerating pores called lenticels. Commercial cork is obtained from the stem surface of Quercus suber (Cork Oak).



Protective tissue of cork.

Functions. (i) Protection Against loss of Water. Multilayered impervious cork prevents loss of water by evaporation.

(ii) Protection from Microbes. Cork protects the interior of plant from entry of harmful micro-organisms.

(iii) Insulation. Cork provides protection against mechanical injury, extremes of temperature, fire and browsing animals.

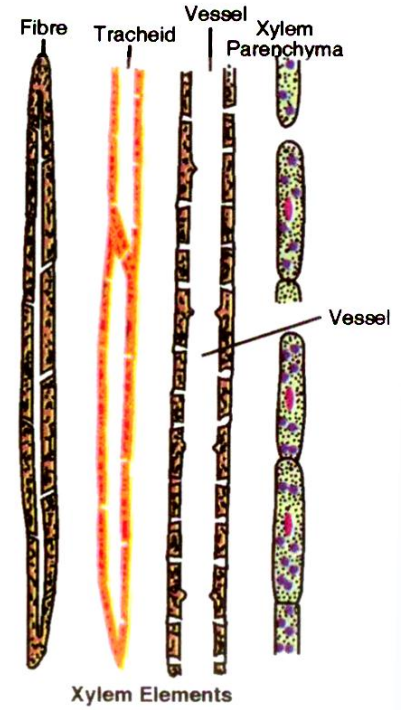
(iv) Commercial Uses. Cork is light, impervious, compressible, non-reactive and insulating. It is used commercially in manufacture of stoppers for bottles, insulation boards, shock absorbers, linoleum, sport goods, etc.

STUDY OF EPIDERMIS

Apparatus. Fresh leaf of Rheo, petri dish, water, safranin, needle, glass slide, glycerine, drop cover slip, microscope.

Working. Take a freshly plucked leaf of Rheo (= Rhoeo, Tradescantia). Stretch and give an oblique jerk to break it. A coloured peel would be found attached to the broken ends. Remove the peel and put it in a petri dish filled with water. Add a few drops of safranine. Wait for 2—3 minutes. Pour a drop of glycerine over a clean slide. Transfer the peel over the slide. Place a cover slip over the peel. Observe under microscope.

Observation. The peel contains many large parenchymatous cells. They are epidermal cells. At places the strip contains small oval-oblong structures called stomata. Each stomate contains two small kidney-shaped guard cells. A pore or stoma is present in between the two guard cells. Stomata are seats of gaseous exchange and transpiration.



Elements of Xylem.

COMPLEX PERMANENT TISSUES

They are those permanent tissues which are made of more than one type of cells which work together to perform a particular function. Common complex permanent plant tissues are conducting or vascular tissues of

two types, xylem and phloem. They join together to produce vascular bundle. Vascular or conducting tissues have made possible the survival of plants in the terrestrial environment as they can carry materials to long distances inside the plant.

Xylem - xylem—wood,

Xylem is a complex permanent plant tissue which takes part in conduction of water and mini-nil salts inside the plant. Additionally it provides mechanical strength. Xylem is also called wood. It consists of four types of elements : tracheids, vessels, xylem fibres and xylem parenchyma.

1. Tracheida. They are long, tubular dead cells with lignified walls and tapering ends. Tracheids possess various types of thickenings for mechanical strength. The unthickened areas help in movement of water from one tracheid to another.

2. Vessels (Tracheae). They are very long tubes which are formed by end to end union of a large number of dead empty cells where the transverse walls break down completely. The walls are lignified. They generally possess pits. Vessels and tracheids are conducting or tracheary elements of xylem. Vessels are more efficient than tracheids. They occur in flowering plants.

3. Xylem Fibres. They are sclerenchyma fibres found in xylem. Xylem fibres have tick pitted walls, narrow lumen and tapering ends. They provide only mechanical strength.

4. Xylem Parenchyma. It consists of living cells present inside the xylem. Cells of xylem parenchyma store food. They also help in slow lateral conduction.

Functions, (i) Conduction of Sap. Xylem conducts sap (water and minerals) from roots to the top of plants. The movement is generally unidirectional as the major force develops in the leaves.

(ii) Mechanical Strength. Xylem provides mechanical strength to the plant because of the occurrence of thick walled lignified components.

(iii) Wood. It is mostly made of xylem.

Difference Between Tracheid and Vessel

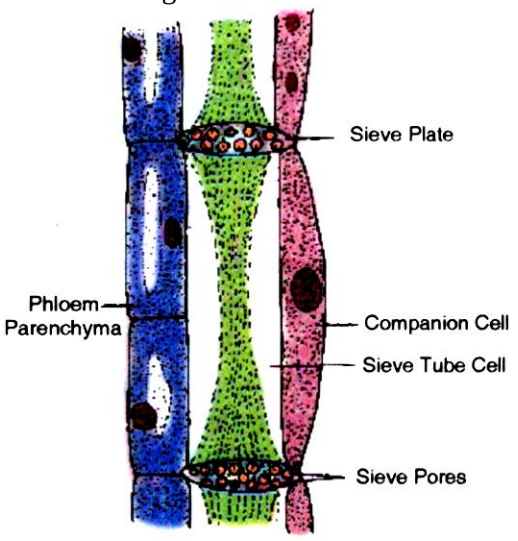
Tracheid	Vessel
1. Cells. It is formed from a single cell.	A vessel is formed by a large number of cells.
2. End Wall. The ends of individual cells remain intact,	The ends or transverse walls of individual cells get dissolved to form a vessel.
3. Length. A tracheid reaches a length of upto 1 mm.	A vessel reaches a length of several centimetres.
4. Tips. Tracheidal ends are tapering.	Vessel ends are rounded.
5. Wall. Wall is comparatively thick while the lumen is narrow.	The wall is comparatively less thickened while the lumen is wide,
6. Efficiency. It is less efficient in conduction of water.	It is more efficient in conduction of water.

PHLOEM (GK. PHLOEIS—INNER BARK.)

It is a complex permanent plant tissue which takes part in conduction of organic food inside the plant. Phloem is called living conducting tissue as its transport channels are made of living cells. It is also called bast. Phloem is made of four types of elements—sieve tubes, companion cells, phloem parenchyma and phloem fibres.

1. Sieve Tubes. They are elongated tubular living conducting channels of phloem. A sieve tube is formed of a large number of thin walled sieve tube cells, placed end to end in linear row. The transverse end walls between adjacent sieve tube cells are perforated. They are called sieve plates. Sieve plates are slightly bulged out. Sieve tube cells have vacuolated cytoplasm. Nucleus degenerates. Cytoplasmic strands are continuous between adjacent sieve tube cells through the pores of sieve plates.

2. Companion Cells. They are thin-walled cells which lie on the sides of sieve tube cells. Companion cells are connected to the sieve tube cells through compound plasmodesmata. The cells have dense cytoplasm and prominent nucleus. They



Living elements of pholem.

maintain a proper pressure gradient in the sieve tube cells for conduction of food
Companion cells and sieve tube cells are sitter cell* as they develop from the same mother cell. Despite having lost nucleus in the mature state, sieve tube cells remain living. Their activity is controlled by nucleus of the companion cell.

3. Phloem Parenchyma. It is parenchyma present in the phloem. Cells of phloem parenchyma are thin-walled and living. They have two functions, storage and slow lateral conduction of food.

4. Phloem Fibres. They are the only nonliving components of phloem. Phloem fibres are thick walled elongated spindle-shaped dead cells which possess narrow lumen. They provide mechanical strength to the tissue.

Functions. (i) Conduction of Food. Phloem conducts organic food throughout the plant. Unlike xylem, conduction occurs both in upward and downward directions from leaves to storage organs and from storage organs to growing organs.

(ii) Phloem Fibres. Phloem or bast fibres of some plants are source of commercial fibres, e.g.. Jute. Hemp, Flax.

Difference Between Xylem and phloem

Xylem	Phloem
1. Conduction. It conducts water and minerals.	Phloem conducts organic solutes or food materials.
2. Direction. Conduction is mostly unidirectional. .	Conduction can be bidirectional.
3. Channels. Conducting channels or tracheary elements are tracheids and vessels.	Conducting channels are sieve tubes.
4. Components. Xylem consists of tracheids, vessels, xylem parenchyma and xylem fibres.	Phloem consists of sieve tubes, companion cells, phloem parenchyma and phloem fibres.
5. Dead/Living Parts. Three of the four elements of xylem are dead (viz., tracheids, vessels and fibres). Only xylem parenchyma is living.	Three of the four elements are living (viz., sieve tubes, companion cells and phloem parenchyma). Only phloem fibres are dead.
6. Mechanical Strength. In addition of conduction, xylem provides mechanical strength to the plant.	There is no mechanical Function of phloem.

Very Short Answer Questions

1. Give one example of (i) Apical meristem and (ii) Lateral meristem.
Ans. One example of Apical meristem— Shoot apex and Lateral meristem— Cambium.

2. Where do you find meristematic tissues in plants ?
Ans. In apical, intercalary and lateral positions in plants.

3. Define permanent tissues.
Ans. Group of cells which have lost their ability to divide and have assumed a definite form and size is known as permanent tissue.

4. Define simple tissues.
Ans. A collection of similar cells that carry out the same function is known as simple tissue.

5. What is the main function of parenchyma ?
Ans. The main function of parenchyma is to store food.

6. Which chemical is deposited at the corner of cells in collenchyma ?
Ans. Pectin and cellulose are deposited at the corner of cells in collenchyma.

7. Which chemical is deposited on the cell wall of sclerenchyma ?
Ans. Lignin is deposited in the cell wall of sclerenchyma.

8. Give one main function of collenchyma.
Ans. Collenchyma provides tensile strength to the plant body.

9. Define complex tissue.
Ans. Complex tissue consists of more than one type of cell and they work together to perform a particular function.

10. Name the complex tissue which helps in ;
(a) Conduction of water and minerals (b) Conduction of food.
Ans. (a) Xylem (b) Phloem

11. What is the common name of :
(a) Xylem (b) Phloem ?
Ans. (a) Wood (b) Bast.

12. Name the cell which is attached to the lateral side of sieve tube.
Ans. Companion cell is attached to the lateral side of sieve tube.

13. Which type of simple tissue is used for making ropes ?
Ans. Sclerenchyma is used for making ropes.

14. Give one example of protective tissue in the plant.
Ans. Cork is the protective tissue in the plants.

Short Answer Questions
15. Write a short note on intercalary meristem.
16. Write one main function of
(a) Apical meristem (b) Lateral meristem.
17. What are simple tissues ? Explain their three different types.
18. Draw a well labelled diagram of parenchyma and collenchyma.
19. Draw a well labelled diagram of xylem.
20. Draw a well labelled diagram of phloem.
21. Why intercellular spaces are absent in collenchyma ?
22. Give two functions of collenchyma.
23. Write a short note on sclerenchyma.
24. Distinguish between xylem and phloem.
25. Distinguish between vessels and tracheids.
26. Explain the different types of cells present in phloem.
27. What are tracheary elements ? Describe their functions.
28. Write the functions of collenchyma, parenchyma and sclerenchyma.
29. What is the difference between parenchyma and collenchyma ?
30. What is the difference between sclerenchyma and collenchyma ?
31. How many types of elements are present in the phloem ?
32. Name the different types of elements found in the xylem.
33. What is the function of phloem ?
34. What is the function of xylem ?
35. What are different types of tissues in plant ?
Long Answer Questions
37. Define simple tissue. Classify and explain its different types with suitable diagram.
38. Define complex tissue. Classify and explain its different types with suitable diagrams.

ANIMAL TISSUES

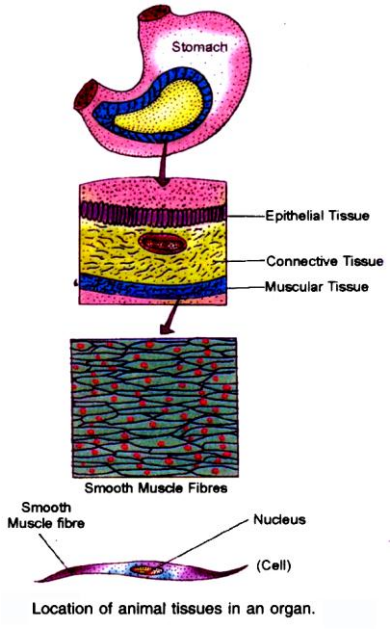
They occur in multicellular holozoic organisms or animals. The working of an animal body is controlled by tissues and organs formed from them. For example, breathing is due to contraction and relaxation of certain muscles. In breathing inhalation provides oxygen to blood inside lungs. Carbon dioxide contained in blood

passes into air to be exhaled. Blood carries oxygen and food to all cells. Waste products produced by cells are picked up by blood to be disposed by liver and kidneys. Blood is a component of connective tissue while muscles constitute muscular tissue. On the basis of their structure and functions, animals have four principal types of tissues—epithelial, connective, muscular and nervous.

Animal Tissues

Epithelial tissue | Connective tissue | Muscular tissue | Nervous tissue

EPITHELIAL TISSUE OR EPLTHELLUM (GK EPL—UPON, THELE—NLPPLE)



Location of animal tissues in an organ.

It is a fundamental animal tissue which forms a continuous sheet of closely packed cells that covers all external and internal surfaces of the animal body. Intercellular spaces are nearly absent. The cells are tightly held together by various types of junctions and small amount of cementing materials. Epithelium rests over a extra-cellular layer of collagen fibres and dense matrix called basement membrane.

Basement membrane connects the epithelial tissue to the underlying connective tissue. A direct vascular supply is absent.

Epithelium forms a barrier for separating the different body systems. Anything entering the body must cross atleast one layer of epithelium. Permeability of cells of various epithelia determines passage of substances between different body parts and between body and external environment. Epithelial tissue occurs over the skin, lining of mouth and other parts of alimentary canal, lung alveoli, lining of respiratory tract, nasal membrane, kidney tubules, urinary tract, reproductive tract, blood vessels and different types of glands.

Functions. (i) Protection. Surface epithelium lying over the skin protects the body from drying up, microbes, chemicals and injury. A similar function of protection is carried out by epithelium lining mouth, nasal tract and alimentary canal.

(ii) Absorption. Some epithelia have become specialised for absorption e.g., intestinal mucosa.

(iii) Excretion. Epithelium lining, the different parts of unmferous tubules, takes part in ultrafiltration, secretion and reabsorption to produce urine.

(iv) Exchange of Gases. Epithelium forming the lung alveoli allows diflfusion of gases between blood and alveolar air.

(v) Movement. Epithelia having cilia help in movement of various types of materials, e.g., dust particles and mucus in respiratory tract, primary urine in uriniferous tubule, ovum in oviduct, etc.

(vi) Secretion. Glandular epithelium produces secretions, e.g,, tears, mucus, gastric juice, intestinal

(vii) Germinal Epithelium. It produces male and female sex cells.

(viii) Sensations. Sensory epithelium is specialised to receive sensations, e.g., nasal epithelium, taste buds.

TYPES OF EPITHELIA

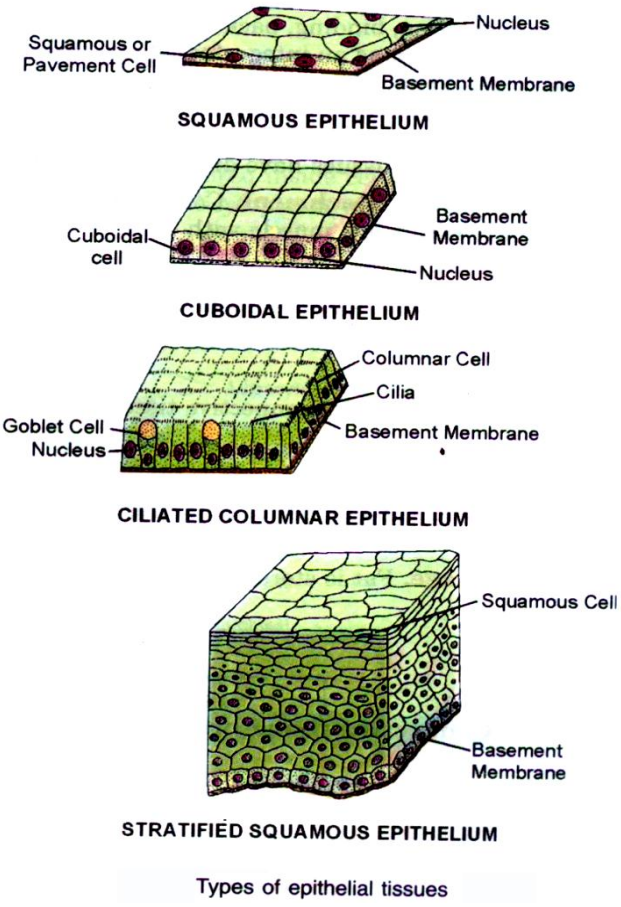
Epithelia (plural of epithelium) are classified one the basis of arrangement of layers, cell shapes and functions.

EPITHELIUM

Arrangement of layers	Cells Shape	Function
1. Simple epithelium	1. Squamous epithelium	1. Function
2. Stratified epithelium	2. Cuboidal epithelium	2. Germinal epithelium
	3. Columnar epithelium	3. Ciliated epithelium
		4. Galndular epithelium

ON THE BASIS OF ARRANGEMENT OF LAYERS

1. Simple epithelium—Cells of the tissue are arranged in a single layer.
2. Stratified epithelium— Cells of the tissue are arranged in more than one layer.



Types of epithelial tissues

ON THE BASIS OF CELL SHAPES

1. Squamous Epithelium. It is also called pavement epithelium because its cells fit together like the tiles of a floor. The cells are thin, flat, polygonal with central bulgings having flat nuclei.The margins may be smooth or wavy (tesselated). Simple squamous epithelium occurs in lung alveoli, Bowman's capsules, blood capillaries, etc. It functions as a selectively permeable barrier, allowing diffusion, filtration and secretion. Stratified squamous epithelium occurs in areas where there is regular wear and tear, e.g., buccal cavity, pharynx, oesophagus, skin. The basal layer lying in contact with basement membrane continues to add new cells as the older surface cells are torn away.
2. Cuboidal Epithelium. The epithelium is made up of compactly arranged cells which appear squarish in vertical section and polygonal in surface view. The nucleus is rounded and centrally placed. Simple cuboidal epithelium occurs in uriniferous tubules, .thyroid vesicles, small salivary and pancreatic ducts. The epithelium takes part in secretion, excretion and absorption. Stratified cuboidal epithelium is found on the inner surface of the large ducts, e.g., salivary, pancreatic, sweat, mammary gland ducts. It provides mechanical support.
3. Columnar Epithelium. The epithelium consists of tall columnar or pillar-like compactly arranged cells. Nucleus is oval and lies near the base. Simple columnar epithelium occurs in the lining layer of stomach, intestine and their glands. Modified columnar epithelium occurs in the nasal tract. The tissue takes part in absorption of digested material, secretion of mucus and enzymes. Stratified columnar epithelium forms covering layer of epiglottis.

ON THE BASIS OF SPECIFIC FUNCTION

1. Sensory Epithelium (Neuroepithelium). It consists of special columnar cells which possess sensory hair on their free surface. The epithelium picks up external stimuli with the help of its hair, e.g.. olfactory epithelium, taste buds.
2. Germinal Epithelium. It occurs in gonads (testes, ovaries). The epithelium consists of cuboidal cells. It forms gametes.
3. Ciliated Epithelium. It is columnar or cuboidal epithelium where the cells bear cilia on their free surface. Ciliated cuboidal epithelium occurs in sperm ducts and uriniferous tubules. Ciliated columnar epithelium is found in lining layer of respiratory tract and oviducts. Cilia produce a current in liquid medium. It pushes the ovum in oviduct. The respiratory tract is cleared of mucus having trapped dust particles and microbes.
4. Glandular Epithelium. The epithelium is often infolded to form multicellular glands. Glands secrete chemical substances, e.g,, sweat (sweat glands), oil (oil glands), enzymes (digestive glands), hormones (endocrine glands).

CONNECTIVE TISSUE

It is a fundamental animal tissue having scattered living cells embedded in an abundant matrix that helps in connecting, binding, packing and supporting different structures of the animal body. This enables the body to function as an integrated whole. It is, therefore, the most abundant tissue of the animal body. The matrix is generally secreted by the living cells of the connective tissue (exception blood). It can be jelly-like, fluid or

solid. On the basis of nature of matrix, connective tissue is of three types—connective tissue proper (matrix jelly-like), skeletal tissue (matrix solid) and vascular tissue (matrix fluid). Different types of connective tissues have different types of living cells.

Functions. (i) Attachment. Connective tissue binds different structures of the body, e.g., bone with bone, muscle with bone, muscle with skin.

(ii) Packing. It forms the packing material in different organs.

(iii) Sheaths. Various organs of the body are covered by protective sheaths of connective tissue.

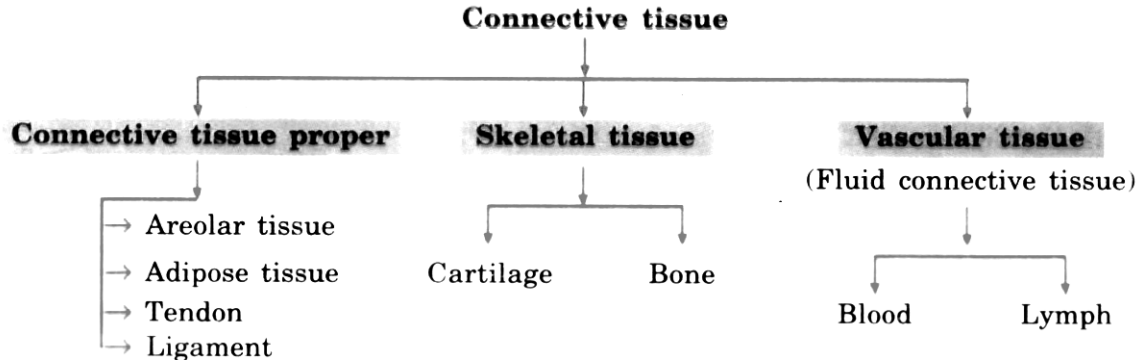
(iv) Cushion. Connective tissue forms shock absorbing cuahions around several organs, e.g., eye, heart, kidneys.

(v) Support. Skeletal connective tissue (bones, cartilages) forma supportive framework of the body.

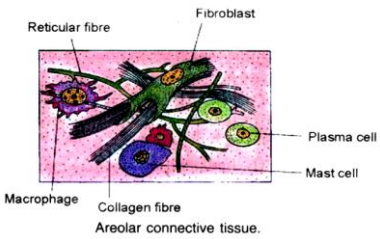
(vi) Transport. Vascular tissue (fluid connective tissue) forms an internal transport system of the body.

(vii) Defence. A number of cells present in the connective tissue provide protection against microbes and toxins.

(viii) Storage. Fat is stored in connective tissue called adipose tissue.



CONNECTIVE TISSUE PROPER



It is connective tissue having jelly-like matrix made of complex chemicals (glycoproteins, mucopolysaccharides) and three types- of fibres— white collagen, yellow elastin and reticular fibres. Living cells include fibroblasts (secrete fibres and matrix), mast cells (secrete matrix, anticoagulant heparin, inflammation producing histamine and blood vessel constrictor serotonin), plasma cells (antibody producing), macrophages (destruction of microbes and toxins) and immunocytes or lymphocytes. Connective tissue proper is of two types, loose and dense. Loose connective tissue proper has fewer fibres and more of matrix, e.g.. areolar, adipose. Dense connective tissue proper has abundant fibres and smaller amount of matrix, e.g., ligaments, tendons.

AREOLAR TISSUE

It is simple and typical connective tissue having semifluid jelly-like matrix, white collagen and yellow elastic fibres, fibroblasts, mast cells, plasma cells, macrophages and immunocytes. Areolar tissue occurs inside organs, around blood vessels, muscles and nerves, below the skin as subcutaneous tissue and joining various structures like muscles with skin.

Functions. (i) Packing. Areolar tissue provides packing material in various organs.

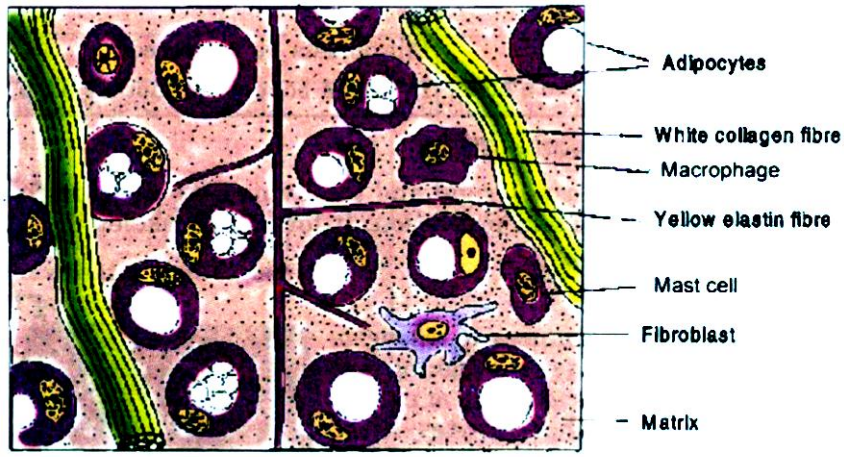
(ii) Binding. It binds various structures with one another in such a way as to prevent their dislocation while allowing limited movement.

(iii) Repair. The tissue provides materials for repair of injury.

(iv) Defence. It has cells that feed on microbes, produce antibodies and other chemicals to combat them.

•ADIPOSE TISSUE

it is a connective tissue which is specialised to store fat. Fat is stored inside cells called adipocytes. They are large cells with one or more globules of fat and a peripheral cytoplasm with nucleus at one end. Adipose tissue is otherwise similar to areolar tissue in having soft matrix, living cells (fibroblasts, macrophages, plasma cells, mast cells, etc.) and two types of fibres (collagen and elastin fibres). Adipose tissue may show partitions to form lobules.



Adipose connective tissue.

Adipose tissue occurs in subcutaneous region, cushion around eyes, heart, kidneys, blood vessels and inside yellow bone marrow.

Functions. (i) Storage. Adipose tissue is a storage tissue where fat is kept in reserve for use when required.

(ii) Shock Absorption. It forms shock abriorbing cushions around important organs.

(iii) Insulation. Adipose tissue forms an insulating layer below the skin. Animals living in cold areas have thick subcutaneous fat in order to prevent heat loss. The insulating fat body present in Whale is called blubber. Hump of Camel is also rich in adipose tissue.

(iv) Body Shape. It rounds off body contours and provides shape to various body parts.

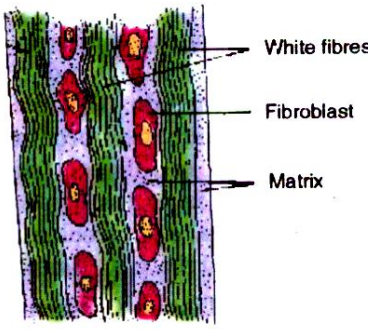
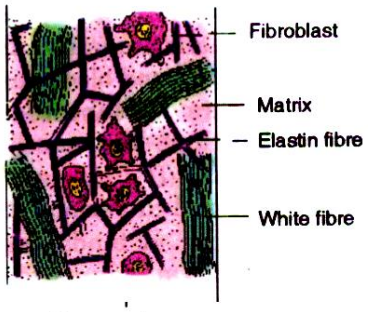


Figure 2.15. Tendon.



Ligament.

Tendon (L. tendere—to stretch)

It is a small cord-like dense fibrous connective tissue of great strength but limited flexibility. Tendon contains parallel bundles of white collagen. Tendon. fibres with rows of flat elongated fibroblasts or tendinocytes in between them. A layer of areolar tissue occurs on the outer side. Tendon joins a skeletal muscle to a bone. It helps in moving the bone on contraction and relaxation of the muscle.

"Ligament (L. ligamentum—band)

It is a cord-like dense fibrous connective tissue of considerable strength and high elasticity. A ligament is made up of a number of yellow elastin fibres, bundles of white collagen fibres arranged variously and fibroblasts scattered in between the fibres. Ligament binds a bone with another bone. Because of its flasticity, a ligament allows bonding and rotation movements over a joint. Sometimes a ligament gets overstretched. It causes sprain.

Differences Between Tendon and Ligament

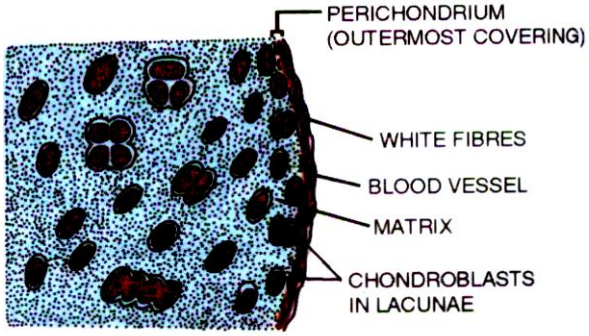
Tendon	Ligament
1. Nature. It is tough and inelastic.	It is strong but elastic.
2. White Fibres. Thedon contains parallel bundles of white collagen fibres.	Ligament has bundles of white collagen fibres arranged in various directions.
3. Yellow Fibres. Yellow elastin fibres are absent.	Yellow elastin fibres occurs in good number.
4. Fibroblasts. They occur in rows.	Fibroblasts lie scattered.
5. Function. It connects a muscle to a bone.	It joins a bone with another bone.

SKELETAL TISSUE (SUPPORTIVE CONNECTIVE TISSUE)

It is a connective tissue in which matrix is rigid and the living cells occur in fluid filled spaces called lacunae. Skeletal tissue provides support and protection. It forms endoskeleton. Skeletal tissue is of two types, cartilage and bone.

CARTILAGE

It is a firm but flexible supportive connective tissue in which the solid matrix has fluid filled lacunae having 1—4 living cells called chondrocytes. Matrix is made up of protein complex chondrin which is secreted by chondrocytes. Blood supply is restricted to outer covering of cartilage called perichondrium. A layer of cartilage forming cells called chondroblasts occurs below the perichondrium. Lacunae are smaller and more abundant towards periphery. They become larger and fewer towards the interior. Chondrocytes are similarly smaller and irregular towards the outer side and larger and rounded towards the inner side.



Cartilage in transverse section.

Cartilage occurs in nasal septum, pinna, epiglottis, larynx (voice box), rings of trachea and bronchi, sternal ends of ribs, intervertebral discs and tips of several bones. In some fishes (e.g. Sharks), the whole skeleton is made of cartilage.

Functions. (i) Support. Cartilage provides support and flexibility to various body parts. Because of its flexibility, pinna can be folded without breaking.

(ii) Friction. It prevents frictional wear and tear of bone tips by forming their articular surfaces.

(iii) Cushions. Intervertebral discs of cartilage function as cushion against stresses.

BONE

It is hard, rigid, strong and non-flexible skeletal tissue which consists of a solid matrix with fluid filled lacunae having osteocytes or bone cells. Unlike cartilage, blood vessels and nerves pass into the interior of bone. Matrix consists of protein complex ossein (30-40%) and mineral matter (60-70%) mainly made of phosphate and carbonate of calcium and magnesium. Hardness is due to deposition of mineral matter. Osteocytes or bone cells occur in concentric rings or lamellae around nutrient filled Haversian canals. Osteocytes occur singly in fluid filled spaces called lacunae. Each lacuna has a number of fine canals or canaliculi having cytoplasmic processes of the osteocytes. Many bones contain soft special connective tissue called red bone marrow. It produces blood cells. Sheath of bone is called periosteum. A layer of osteoblasts or bone forming cells occurs below it. A similar but nonactive layer occurs around the bone marrow. It is called endosteum.

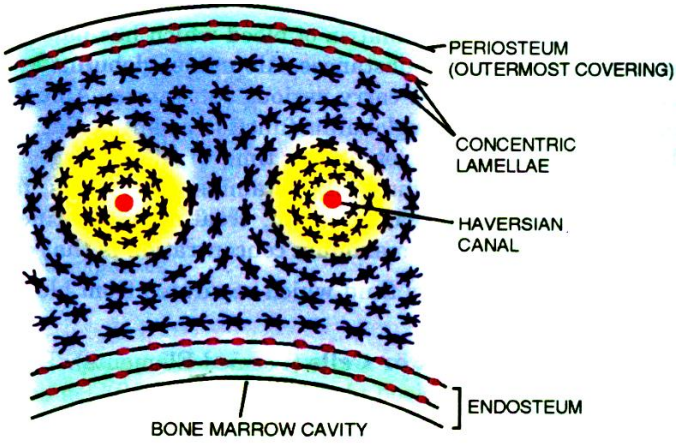
Bone forms the endoskeleton of animal body.

Functions. (i) Framework. The bony endoskeleton forms the supportive frame work of the body.

(ii) Protection. It provides protection to vital organs like brain, heart, lungs, etc.

(iii) Movements. By having joints with attached skeletal muscles, bony skeleton takes part in body movements including locomotion.

(iv) Blood Cells. They are formed in red bone marrow of the bones.



Bone in transverse section

Different Between Bone and Cartilage

Bone	Cartilage
1. Nature. It is hard and inflexible.	Cartilage is comparatively soft and flexible.
2. Matrix. Matrix is made up of protein complex ossein.	Matrix is formed of protein complex chondrin.
3. Mineral Matter. Matrix possesses abundant quantity of mineral salts, especially phosphates and carbonates of calcium and magnesium.	Deposition of minerals is rare.
4. Blood Supply. Blood supply passes into the interior of bone through Haversian canals.	Blood supply is restricted the outside. Haversian canals are absent
5. Marrow Cavity. A marrow cavity is often present in the interior.	A marrow cavity is always absent.
6. Lamellae. Matrix shows concentric lamellae.	Matrix is homogeneous.
7 Lacunae. Lacunae have branched canaliculi.	Canaliculi are absent.
8. Cells, Bone cells occur singly.	Cartilage cell8 occur singly, in twos or fours.

VASCULAR OR FLUID CONNECTIVE TISSUE

It is mobile connective tissue which constitutes the transport system of animals. Instead of fibres the matrix contains fibrinogen that can produce fibres as during coagulation. Matrix is also not produced by the contained cells. Vascular tissue is of two types, blood and lymph.

Blood. It is reddish coloured vascular tissue that flows inside blood vessels by means of pumping activity of heart. pH is 7.4. Colour is bright red in oxygenated form and purple in deoxygenated form. Blood has two parts, fluid plasma (55%) and blood cells (45%).

Plasma. It is liquid matrix of blood which has pale yellow colour. 90—92% is water. 8-10% consists of organic and inorganic substances. Albumins, globulins and fibrinogen are major types of soluble proteins. Albumins and globulins carry various substances. Albumins produce osmotic pressure of blood. A type of globulins called gamma globulins function as antibodies. They are also called immunoglobulins. Fibrinogen helps in formation of clot at the time of blood coagulation. Other organic components of plasma are nutrients (glucose, amino acid, vitamins, fatty acids, fat drops), anticoagulant heparin, hormones and excretory products (urea, uric acid, creatinine, creatine). Almost all types of inorganic substances are present in plasma. The maximum concentration is that of Na^+ and CI^-

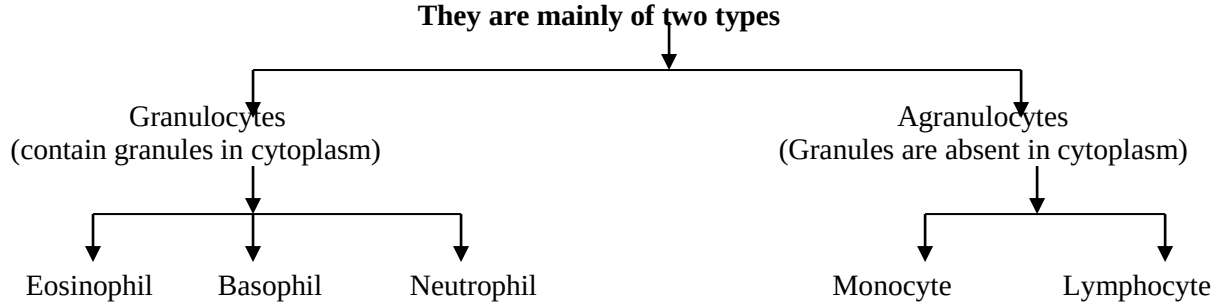
Serum. It is watery fluid which separates from blood when the latter coagulates. It does not contain fibrinogen.

Blood Corpuscles or Cells (Formed Elements). They are of three types—red blood corpuscles, white blood corpuscles and blood platelets (Figure 2.19).

1. Red Blood Corpuscles (Erythrocytes). They are biconcave disc-shaped enucleate (without nucleus) coloured living cells which provide red colour to blood. The number is very large, 4.5—5.0 million/mm^3 30—35% of red blood cells consist of iron containing reddish protein pigment called haemoglobin.

Haemoglobin is respiratory pigment which takes part in transport of oxygen. It can also carry small amount of CO_2.

2. White Blood Corpuscles (Leueocytea). They are colourless nucleated cells which can change their shape like Amoeba. Number is 6000-8000/mm^3.



Granulocytes have irregular polymorphic nuclei and a number of large granules with specific staining properties. They are of three types—neutrophils (3—7 lobed nucleus, 55—60% of all leucocytes, phagocytic), basophils (S-shaped nucleus, upto 1%, release histamine, heparin and serotonin), and eosinophils (two lobed nucleus, 2—3%, detoxicative, number increases in worm infection.)

Agranulocytes do not have large sized cytoplasmic granules. Nucleus is not lobed. Agranulocytes are of two types—monocytes (largest leucocytes, bean shaped nucleus, 3-8%, phagocytic) and lymphocytes (large rounded nucleus, 30-35%, immunity).

3. Blood Platelets (Thrombocytes). They are non-nucleated, small, oval or rounded colourless cell fragments with a number of 2,00,000—4,00,000/mm^3. On exposure to air the blood platelets burst and release chemicals (e.g., thromboplastin) for coagulation of blood at the place of injury.

FUNCTIONS OF BLOOD

(i) Transport. The major function of blood is to transport substances from one part to another inside the body. This includes nutrients (e.g., glucose, amino acids, fatty acids), metabolic wastes (e.g., urea, uric acid), hormones, gases (O_2 and CO_2).

(ii) Body Temperature. Blood conducts heat and regulates body temperature.

(iii) pH. It has buffers for regulating pH.

(iv) Tissue Fluid. It leaks out tissue fluid and keeps the tissues moist.

(v) Immunity. White blood corpuscles fight foreign microbes by eating them up (phagocytosis), producing antitoxins and antibodies.

(vi) Maintenance of Osmotic concentration. Blood is important in maintaining a proper concentration round cells, inside tissues and organs.

(vii) Clotting. Blood prevents its own loss by plugging the place of injury through formation of clot in the process of blood coagulation.

LYMPH

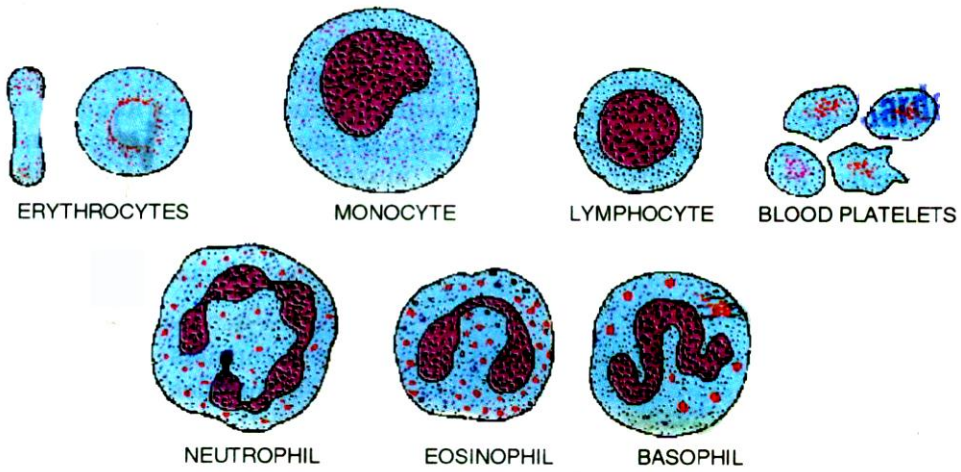
It ia light yellow fluid connective tissue which is formed from tissue fluid and filtered out blood. Lymph is devoid of red blood corpuscles and blood platelets. Proteins are fewer. So are white blood corpuscles. However, lymphocytes are most abundant. Lymph flows through lymph capillaries and lymph vessels. All places they pass through lymph nodes and lymph organs where lymphocytes multiply and mature. They are also sites for entrapping microbes. Lymph is ultimately passed into blood. Most of the organs and tissues pour their secretions and excretions into lymph instead of blood.

Functions. (i) Middleman. Lymph is middle man between tissues and blood. It brings CO_2 and wastes from tissues to blood and nutrients, oxygen, hormones, etc. from blood to tissues.

(ii) Blood Volume. Lymph helps in maintaining blood volume by removing or adding excess plasma.

(iii) Microbe Traps. Lymph nodes and lymphoid organs function as traps for microbes where they can be effectively destroyed.

(iv) Lacteals. They are special lymph vessels present in intestinal villi for absorption of fat and fat soluble vitamins from intestine.

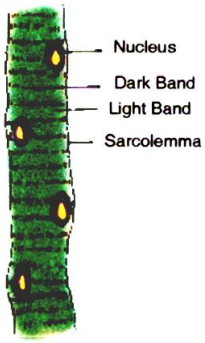


Blood corpuscles.

MUSCULAR TISSUE

It is contractile tissue which possesses contractile proteins inside cells held together by connective tissue. A matrix is absent. Cells of the muscular tissue are elongated. They are called muscle fibres. In a muscle fibre or muscle cell plasma membrane may fuse with basement membrane to form sarcolemma. Cytoplasm (= sarcoplasm) contains endoplasmic reticulum (= sarcoplasmic reticulum) that can store calcium. Nervous, electrical and other stimuli cause the muscles to contract. Calcium is essential for muscle contraction. The contraction is 1/2 to 1/3 of the original length. Contractile elements of muscle fibres are called myofibrils. Each myofibril has two types of protein filaments, thicker myosin and thinner actin. Their overlapping in parallel series produces striations. Striations are absent where they are arranged obliquely (smooth muscle fibres).

Muscular tissue occupies nearly 40% of total weight of the body. It consists of groups of muscle fibres called muscles. Contraction and relaxation of muscles produces movements. Muscle fibres are of three types-striated, smooth and cardiac.



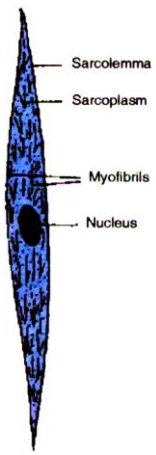
Striated muscle fibre

1. Striated Muscle Fibres (Striped, Skeletal or Voluntary Muscle Fibres,). They are long, cylindrical unbrahced muscle cells which bear striations in the form of alternate light and dark bands. Ends are blunt. A number of oval nuclei occur peripherally in each cell below the sarcolemma. Striated muscle fibres work under the control of will. They are, therefore, voluntary. They occur in arms, legs, hands, feet, neck, face, body wall, tongue, pharynx, diaphragm, upper part of oesophagus, etc.

Skeletal and Visceral Striated Muscles. Striated voluntary muscles attached to bones are called skeletal muscles. The ones attached to other internal parts of the body are known as visceral striated muscles, e.g.

voluntary muscles of tongue, pharynx, diaphragm, etc.

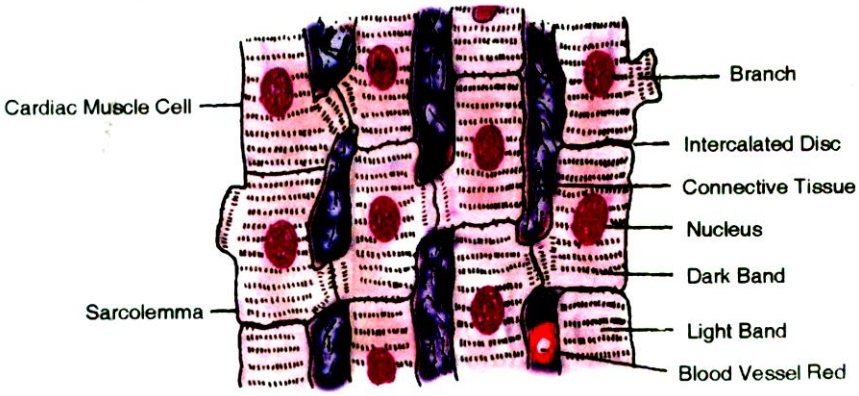
Striated muscles can contract rapidly and powerfully. However, they get fatigued very soon due to accumulation of lactic acid (formed in anaerobic respiration).



Smooth muscle fibre.

2. Smooth or Unstriated Muscle Fibres. (Nonstriated, Visceral Involuntary Muscle Fibres,). They are spindle shaped, unbranched muscle cells which are called smooth muscle fibres because they do not bear striations. Smooth muscle fibres occur in bundles or sheets. Each muscle fibres contains a centrally placed single oval or spindle-like nucleus. Myofibrils occur but they do not run vertically or parallel to one another. Instead they run obliquely so that their contraction results in shortening of the muscle fibre. Unstriated or smooth muscle fibres are not under the control of will. They are, therefore, involuntary (They work under stimulation of autonomic nervous system). Smooth muscle fibres are slow to contract but can remain contracted for long periods without becoming fatigued. They occur in various visceral organs of the body, e.g., posterior oesophagus, stomach, intestine, ureter, bronchii, lungs, urinary bladder, iris etc. Temporary rhythmic movements called peristaltic movements occur in the digestive tract due to smooth muscles that help in pushing the food.

3. Cardiac Muscle Fibres (Figure 2.22). They are involuntary, striated and nonfatigued muscle fibres which occur in the wall of heart performing rhythmic contractions and relaxations continuously. The fibres are cylindrical but shorter than skeletal muscle fibres. They develop small lateral branches. Cardiac mucle fibres form a highly interconnected network that helps in quick spread of impulses. The cells are uninucleate. The are rich m glycogen and mitochondria. Striations of light and dark bands occur as in striated muscle fibres. Cross connections or oblique bridges occur between adjacent fibres with the help of lateral branches. In the area of union between two adjacent cells, zig-zag junctions ions or intercalated discs occur. The cell membranes are specialised in the region of intercalated discs to function as impulse boosters. Spaces in between the cardiac fibres are filled with loose connective tissue which is richly supplied with blood capillaries. Cardiac muscle fibres continue to contract and relax tirelessly throughout life. The movement is not under the control of will. Fatigue is absent as the fibres do not produce lactic acid.



Cardiac muscle fibres.

Difference Amongst Striated, Smooth and Cardiac Muscle Fibres

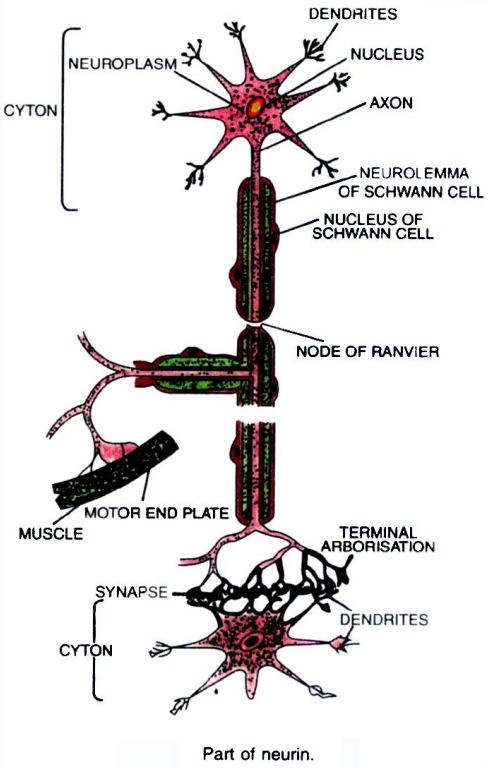
Striated Muscle Fibres	Smooth Muscle Fibres	Cardiac Muscle Fibres
1. Cells. They are long cyhndrical cells.	The fibres are elongated and spindle-shaped.	The cells are small and cylindrical.
2. Ends. The fibres have blunt ends.	The fibres have pointed ends.	The fibres have broad ends.
3 Striations. They possess striations or alternate light and dark bands.	Striations or light and dark bands are absent.	Striations are present but they are fainter than those of striated muscle fibres.
4. Intercalated Discs and Cross Connections. They are absent.	Intercalated discs and cross-connections are absent.	Intercalated discs and cross-connections are present.
5 Nucleus. The muscle fibre is multinucleate. Nuclei are oval in outline. They occur peripherally below the sarcolemma.	Smooth muscle fibre is uninucleate. Nucleus is centrally placed, oval or elongated.	The cells are uninucleate. Nucleus in oval-rounded. It is centrally placed.
6. Occurrcnce. Striated muscle fibres occur in limbs, hands, feet, body wall, tongue, pharynx and upper part of oesophagus.	The fibres occur in dermis, urinogenital tracts, digestive tract, lungs, iris, blood vessels, etc.	The muscle fibres occur only in the wall of heart.
7. Nature. They are voluntary.	They are involuntary.	They are involuntary.
8. Activity. They are able to perform fast and powerful contractions but soon get fatigued.	They perform slow but prolonged contractions without getting fatigued.	Cardiac muscle fibres perform powerful, rhythmic contractions without ever getting fatigued.

NERVOUS TISSUE

It is tissue specialised in reception, integration and transmission of stimuli or impulses to various parts of the body. The ability to respond to stimuli is present in all living cells. However, integration and long distance rapid transmission of stimuli is possible with the help of nervous system only. Nervous system is devoid of a

matrix. Its cells are surrounded by special connective tissue cells. They aggregate to form brain, spinal cord and nerves. Individual cells of nervous tissue are called nerve cells or neurons. They are the longest cells of the body reaching upto a metre in length. Each neuron is made of two parts. cell body and neurites. Neurites are of two types, dendrites and axons.

1. Cell Body (Cyton). It is polygonal, broader and nucleated part of neuron. Cell body has all types of cell structures but a centriole is absent. Two special structures present in cyton are neurofibrils and Nissl granules. Neurofibrils are very fine fibrils probably involved in transmission of impulses. Nissl granules are ribosome containing structures.



Part of neurin.

2. Dendritcs. They are small, tapering, branched protoplasmic outgrowths of cell body. The large dendrites are also called dendrons. Like cyton, dendrites possess neurofibrils and Nissl granules. Dendrites pick up impulses and transmit the same towards cyton.

3. Axon. It is a long fibre-like process of uniform thickness that generally arises singly from the cell body of a neuron. Axon is devoid of Nissl granules. It, however, contains neurofibrils. It carries impulse away from the cell body. Axon is surrounded by a sheath (= neurolemma) of special connective tissue cells. The ensheathed axon is called nerve fibre.

Nerve fibres are of two types, whitish medullated and greyish nonmedullated. Medullated nerve fibres have an additional medullary sheath. At places the sheath is absent. They are called nodes of Ranvier. The extra sheath as well as nodes of Ranvier are absent in nonmedullated nerve fibres.

Axon is divided terminally into fine branches called terminal arborisations. The latter have knobbed ends in contact with muscles, glands, skin and other structures for providing an impulse for activity. At places terminal arborisations are connected with dendrite branches of an adjacent neuron. Each such junction is called synapse. It is meant for transmission of impulse from one neuron to the next. Transmission of impulse is generally carried out with the help of a neurotransmitter chemical, e.g. acetylcholine.

Difference Between Axon and Dendrite

Axon	Dendrite
1. It is long uniformly thickened fibre–like process of a neuron.	1. It is a short tapering process of a neuron.
2. It is always ensheathed.	2. A sheath is absent.
3. Nissl granules are absent. Neurofibrils are however, present.	3. Both Nissl granules and neurofibrils are present.
4. It carries impulses away from the cell body.	4. It carries impulses towards the cell body.

Types of Neurons/ a neuron can be sensory or motor but not both the impulse is transferred from sensory to motor neuron or vice versa with the help of third king of neuron called interneuron

1. Sensory or Afferent Neurons. They carry impulses from sense organ to brain or spinal cord.
2. Motor or Efferent Neurons. The neurons carry message from brain or spinal cord to muscles, glades and other effect or organs.
3. Interneuron's (Connector Neurons). They transit message from a sensory neuron to motro neuron and vice versa.

Review Problems

VERY SHORT ANSWER QUESTIONS

Q.1. Which tissue protects the entire body ?
Ans. Epithelial tissue protects the entire body.

Q.2. Classify epithelial tissues on the basis of arrangement of layers.
Ans. Epithelial tissue is classified into two types, on the basis of arrangement of layers-simple and stratified epithelium.

Q.3. Give one example each of :
(a) Squamous epithelium
(b) Columnar epithelium.
Ans. (a) Lung alveoli (b) Alimentary canal.

Q.4. Which type of epithelium (on the basis of function) is present in :
(a) Sweat gland (b) Testis ?
Ans. (a) Glandular epithelium
(b) Germinal epithelium.

Q.5. Which type of epithelium is present in the organs where exchange of substances takes place ?
Ans. Squamous epithelium is present in the organs where exchange of substances takes place.

Q.6. Which type of tissue is most abundant in animals ?
Ans. Connective tissue is most abundant in animals.

Q.7. Give one example of connective tissue in which matrix is solid.
Ans. In bone, matrix is solid.

Q.8. Which type of connective tissue is present in hump of camel and blubber of whale ?
Ans. Adipose tissue is present in hump of camel and blubber of whale.

Q.9. Which tissue is commonly known as "Packaging tissue" ?
Ans. Areolar tissue is commonly known as packaging tissue.

Q.10. Which connective tissue connects bone to another bone ?
Ans. Ligament connects bone to another bone.

Q.11. Give two examples of cartilage.
Ans. Tip of the nose and external ear (pinna) are two examples of cartilage.

Q.12. Which type of skeletal tissue contains chondrin and ossein respectively ?
Ans. Chondrin is present in cartilage whereas ossein is present in bone.

Q.13. Which type of connective tissue has fibreless matrix ?
Ans. Blood has fibreless matrix.

Q.14. What is serum ?
Ans. When fibrinogen is taken out of the plasma, it is known as serum.

Q.15. What is the function of WBC.
Ans. WBC provides immunity to the body by protecting the body against infections.

Q.16. What is the main function of RBC.
Ans. RBC contains haemoglobin, which helps in transport of oxygen and carbon dioxide.

Q.17. What is the main function of blood platelets ?
Ans. Blood platelets help in clotting of blood at the site of injury.

Q.18. Mention two differences between blood and lymph.
Ans. (a) Blood contains blood cells (RBC, WBC and Platelets) as well as plasma whereas lymph contains plasma and leucocytes (lymphocytes are most abundant).
(b) Blood has more proteins, calcium and phosphorus whereas plasma has few proteins and less calcium and phosphorus.

Q.19. Which type of WBC is most abundant in lymph ?
Ans. Lymphocytes are most abundant in lymph.

Q.20. Name any one structure in our body which bears ciliated epithelium.
Ans. Respiratory tract bears ciliated epithelium.

Q.21. Name the following :
(a) Multinucleate muscle fibre
(b) Spindle shape muscle fibre.
Ans. (a) Skeletal muscle fibre
(b) Smooth muscle fibre.

Q.22. Name the muscle, which gets fatigued very soon.
Ans. Skeletal muscle gets fatigued very soon.

Q.23. Name the muscle of heart.
Ans. Cardiac muscle is the muscle of heart.

Q.24. What are the two types of striated muscle fibres ?
Ans. Skeletal and cardiac muscles are two types of striated muscle fibres.

Q.25. Name the muscle which is found in visceral organs.
Ans. Smooth muscle is found in the visceral organ.

Q.26. Name the muscle fibre which contains intercalated discs.

Ans. In cardiac muscle, intercalated disc is present.

Q.27. Name of the following :
(a) Neurons which carry impulses towards brain.
(b) Process of neuron which carries impulses from cyton.
Ans. (a) Sensory neuron (b) Axon

SHORT ANSWER QUESTION

28. What is the function of bone, cartilage, ligament and tendon ?
29. Distinguish between ligament and tendon.
30. Name the following :
(a) Tissue which stores fat.
(b) Epithelium which lines lung alveoli.
31. Name any one bone and the part in it where blood cells are formed.
32. Write the four types of animal tissues based on location and function.
33. Distinguish between cartilage and bone.
34. Name three different types of blood cells. Explain their structure and function.
35. Give three functions of blood.
36. Give two functions of lymph.
37. What are the different types of tissues in animals ?
38. Distinguish between striated and unstriated muscles.
39. Draw a well-labelled diagram of striated muscle.
40. Draw a well-labelled diagram of neuron.
41. Describe the structure of neuron.
42. Classify neurons on the basis of their nature (function).
43. Explain the structure of neuron with the help of labelled diagram.
44. Distinguish between dendrite and axon.

LONG ANSWER QUESTIONS

45. Describe the structure and functions of epithelium.
46. Classify connective tissue and give one example of each.
47. Write short notes on :
(a) Connective tissue proper
(b) Skeletal tissue.
48. Describe the composition and functions of blood.
49. Define muscular tissue. Classify and explain different types of muscles with the help of suitable diagram.
50. Diagrammatically show the difference between three types of muscle fibres.
51. Draw labelled diagram of a neuron.

Quick Revision Of The Chapter

1. A group of similar cells that perform or help to perform a common function and have a common origin is called a tissue.
2. Plant tissues are of two main types— Meristematic tissues and Permanent tissues.
3. A group of cells that are preparing to divide, or are in the process of multiplication or have the capacity to divide is known as meristematic tissue.
4. Meristematic tissues can be classified on the basis of their position into— apical (shoot and root apex), lateral (cambium, cork cambium) and intercalary meristems.
5. Permanent tissues can be of three types—
simple tissues, complex tissues and special tissues.
6. Simple tissues are made up of one type of cells and they perform the same function whereas complex tissues are made up of more than one type of cells and they work together to perform a particular function.
7. Parenchyma cells are made thin with intercellular spaces. They store food.
8. Collenchyma consists of thin walled cells but at the corners of cells pectin and cellulose are deposited. It gives tensile strength to the body.
9. Sclerenchyma consists of dead cells which have deposition of lignin. It provides mechanical strength.
10. Xylem conducts water and minerals. It is also known as wood. It consists of trachieds, vessels, xylem fibres and xylem parenchyma.
11. Phloem conducts foods materials. It is also known as best. It consists of sieve tubes, companion cells, phloem fibres and phloem parenchyma.
12. Animal tissues are of four different types depending upon their structure and functions. They are - epithelial, connective, muscular and nervous tissues.
13. Epithelial tissue covers the entire body externally as well as internally.
14. In simple epithelium, cells are arranged in a single layer whereas in stratified epithelial cells are arranged in more than one layer.
15. Squamous epithelium is made up of flat cells; cuboidal epithelium is made up of cubical cells whereas columnar epithelium is made up of column (oblong) like cells.
16. On the basis of their function epithelial tissues may be sensory (eye, ear), germinal (testis, Over), ciliated (respiratory tract), glandular (sweat gland).
17. Connective tissue is filled with a non-living matrix. It is the most abundant body tissue.
18. Areolar tissue is commonly known as packaging tissue; Adipose tissue stores fat; Tendon connects muscle to a bone whereas ligament connects bone to bone.
19. Cartilage is semi-rigid and flexible whereas bone is solid, rigid with deposition of inorganic salts (like calcium and phosphorus).

20. Fluid connective tissue has fibreless matrix. Blood consists of plasma and blood cells.

21. RBC transports O_2 and CO_2; WBC provides immunity to the body whereas blood platelets help in blood coagulation.

22. Lymph is like plasma, but it lacks RBC and blood platelets. It contains large number of lymphocytes.

23. Muscles are capable of contraction and relaxation in response to chemical stimuli. They may be striated - cylindrical, unbranched. multinucleate, attached to skeleton ; smooth - spindle shaped uninucleate ; or cardiac—striated, cylindrical, uninucleate with intercalated discs.

24. Nervous tissue is specialised for receiving and transmitting impulses. It is made up of neurons. Neuron consists of expanded cell body and processes like dendrites and axon.

25. The region of union of the axon endings of one neuron with the dendrite of another neuron is called synapse.

Text Book Questions

In-Text Questions

Q.1. What is a tissue ?
Ans. Tissue is a group of related cells that have a common origin and perform a common function.

Q.2. What is the utility of tissues in multicellular organisms ?
Ans. (i) Division of Labour. Tissues bring about division of labour in multicellular organism increases efficiency.
(ii) Higher Organisation. Tissues become organised to form organs and organ systems. (iii) Individual Cells. Work load of individual cells has decreased.
(iv) Higher Survival. Because of division of labour, higher efficiency and organisation, multicellular organisms have high survival.

Q.3. Name types of simple tissues.
Ans. Three— parenchyma, collenchyma and sclerenchyma. (Meristematic tissue is also a simple tissue).

Q.4. Where is apical meristem found ?
Ans. Apical meristem occurs at root and stem tips.

Q.5. Which tissue makes up the husk of coconut ?
Ans. Sclerenchyma.

Q.6. What are the constituents of phloem ?
Ans. Sieve tubes, companion cells, phloem parenchyma and phloem fibres.

Q.7. Name the tissue responsible for movement of our body.
Ans. Muscular tissue.

Q.8. What does a neuron look-like ?
Ans. A miniature tree with thin hair like parts arising from its ends.

Q.9. Give three features of cardiac muscles.
Ans. (i) Cells/Fibres. They are small, cylindrical, uninucleate striated with short lateral branches.
(ii) Intercalated Discs. In the area of union between the two adjacent cardiac muscle fibres develop zig-zag junctions called intercalated discs. They function as impulse boosters.
(iii) Rhythmic Contractions. The muscles are involuntary and no fatigued which continue to contract and relax tirelessly throughout life.

Q.10. What are the functions of areolar tissue.

Q.11. Define the term ''tissue''?
Ans. See question no. 1.

Q.12. How many types of elements together make up the xylem tissue ? Name them.
Ans. Xylem tissue is formed of four types of elements. They are tracheids, vessels, xylem parenchyma and xylem fibres.

Q.13. How are simple tissues different from complex tissues in plants ?

Ans. Difference between Simple and Complex Tissues

Simple Tissues	Complex Tissues

1. Cells. A simple tissue is formed of only one type of cells. **2. Activity.** All the cells perform the same function. **3. Types.** There are three types of simple plant tissues— parenchyma, collenchyma and sclerenchyma. **4. Function.** They form primary structure of the plant.	A complex tissue is made of more than one type of cells. The different cells perform different fractions of a function. There are two types of complex plant tissues— xylem and phloem. They form transport system of the plant.

Q.14. Differentiate amongst parenchyma, collenchyma and sclerenyma on the basis of the cell wall.
Ans.

Parenchyma	Collenchyma	Sclerenchyma
1. The cell wall is thin. 2. It is smooth. 3. Wall is formed of cellulose.	It is thickened. It is unevenly thickened. The thickening is pectocellulosic.	It is thickened. The wall is uniformly thickened. The thickening is generally of lignin,

Q.15. What are the functions of stomata ?
Ans. Functions of Stomata. (i) Gaseous Exchange. Stomata are sites where exchange of gases (carbon dioxide and oxygen) occurs between the plant interior and external environment.
(ii) Transpiration. Major part of transpiration occurs through stomata. Transpiration removes excess water and keeps plant surfaces cool even in bright sun.
(iii) Regulation. They regulate both gaseous exchange and transpiration.

Q.16. Diagrammatically show the difference amongst three types of muscle fibres.

Q.17. What is the specific function of cardiac muscle ?
Ans. Rhythmic contraction and relaxation simultaneously throughout life without getting

Q.18. Differentiate amongst striated, unstriated and cardiac muscles on the basis of their structure and site/location in the body.

Q.19. Draw a labelled diagram of a neuron.

Q. 20. Name the following :
(a) Tissue that forms the inner lining of our mouth.
(b) Tissue that connects muscle to bone in humans.
(c) Tissue that transports food in plants.
(d) Tissue that stores fat in our body.
(e) Connective tissue with a fluid matrix.
(f) Tissue present in the brain.
Ans. (a) Epithelial tissue (b) Tendon
(c) Phloem (d) Adipose
(e) Blood (f) Nervous tissue.

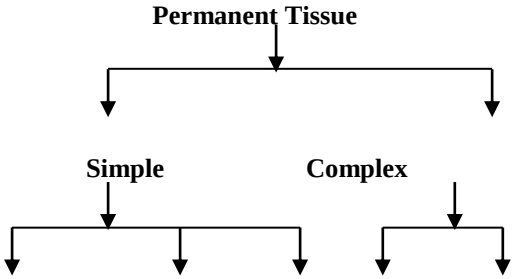
Q.21. Identify the types of tissue in the following : skin, bark of tree, bone, lining of kidney tubule, vascular bundle.
Ans. (a) **Skin—** Epithelial tissue
(b) **Bark of Tree—** Cork (Protective tissue)
(c) **Bone—** Connective tissue with solid matrix
(d) **Lining of Kidney Tubule—** Epithelial tissue
(e) **Vascular Bundle—** Complex or vascular tissues, xylem and phloem.

Q.22. Name the regions in which parenchyma tissue is present.
Ans. It occurs in almost all nonwoody parts of the plants— cortex, pith, medullary rays of stem, cortex and pith of root, chlorenchyma of leaves, flowers, pith of fruits, etc. Epidermis is special type of parenchyma.

Q. 23. What is the role of epidermis in plants ?
Ans. (i) Protection,
(ii) Regulation of transpiration.
(iii) Formation of insulating stationary air layer with the help of hair.
(iv) Exchange of gases.

Q.24. How does the cork act as a protective tissue ?
Ans. Cork acts as a protective layer because its cells are dead, filled with tannins, resin and air, impermeable due to deposition of suberin over the cell walls and absence of intercellular spaces, It is insulating (heat proof), fire proof, shock proof, water proof and repellent to microbes and animals.

Q.25. Complete the table :



(i) Collenchyma (ii) Xylem (iii)
Ans. (i) Parenchyma (ii) Sclerenchyma
(iii) Phloem fatigued.

Multiple Choice Questions

1. Which meristem helps in increasing girth of the plant ?
(A) Apical meristem
(B) Lateral meristem
(C) Intercalary meristem
(D) Both A and C.
2. What constitutes thickening in collenchyma ?
(A) Lignin (B) Cellulose
(C) Pectin (D) Both Rand C.
3. Cork is impervious to water because it has deposition of
(A) Lignin (B) Pectin
(C) Suberin (D) All of these.
4. Which of the following conducts water and minerals in plants ?
(A) Xylem (B) Phloem
(C) Fibres (D) Both A and B.
5. Squamous epithelium is found in
(A) Lung alveoli (B) Trachea
(C) Alimentary Canal (D) Oviduct.
6. Large intercellular spaces are present in
(A) Epithelial tissue (B) Connective tissue
(C) Muscular tissue (D) Nervous tissue.
7. Ligament connects
(A) Bone to muscle
(B) Bone to bone
(C) Organ to bone
(D) Blood vessels to adipose tissue.
8. Fibrinogen is absent in
(A) Blood (B) Serum
(C) Plasma (D) Both B and C
9. Intercalated disc is present in
(A) Striated muscle (B) Smooth muscle
(C) Cardiac muscle (D) Both B and C.
10. The efferent part of neuron is
(A) Axon (B) Dendrite
(C) Cyton (D) Both A and B
11. Heart muscles are
(A) Voluntary and striated
(B) Involuntary and striated
(C) Voluntary and multinucleate
(D) Involuntary, striated and uninucleate.
12. Tongue is made up of
(A) Striated muscle (B) Smooth muscle
(C) Cardiac muscle (D) Both A and B.
13. Haversian canals are present in
(A) Cartilage (B) Ligament
(C) Bone (D) Tendon
14. Which of the following is non-vascular ?
(A) Epithelial tissue (B) Connective tissue
(C) Muscular tissue (D) Nervous tissue.
15. Which of the following is a dead cell ?
(A) Sieve tube (B) Companion cell
(C) Parenchyma (D) Tracheid.

ANSWERS ZONE

1. (B) **2.** (D) **3.** (C) **4.** (A) **5.** (A) **6.** (B) **7.** (B) **8.** (B) **9.** (C)
10. (A) **11.** (D) **12.** (A) **13.** (C) **14.** (A) **15.** (D)