

Syllabus : Tissues : Types of plant and animal tissues.

A brief understanding of their location, basic structure and functions, with examples. A brief understanding of their role in different physiological processes in plants and animals.

A single cell working on its own would achieve very little inside an animal or a plant. So, many many **similar cells** lying side by side work together as a team to perform the same function. Such groups are called **tissues**. We will describe here only the more common plant and animal tissues.

3.1 TISSUES — “The Teams of Workers”

A tissue is a group of similar cells performing a specific function.

Most plants and animals possess a tissue system. The human body, *for example*, has an epithelial tissue covering the skin, the muscular tissue made up of muscle cells which by contraction bring about movements. In a plant, the conducting tissue conducts water upwards from the soil to the aerial parts and food prepared from the leaves to the lower parts.

Relationship between tissue, organ, organ system and organism. Several tissues together contributing to some specific function inside the body, constitute an **organ** (such as tongue having epithelial cells, nerve cells, muscle cells, etc.). Many organs acting together to perform a specific life process constitute an **organ system** (such as the digestive system). Organ systems together constitute the organism (e.g. the root system and the shoot system constitute the plant, an organism).

3.2 PLANT TISSUES

Plant tissues are basically of *two* types—

- Meristematic tissue (cells can multiply to produce new cells) (Gk. *meristos*; divided).
- Permanent tissue (non-dividing cells and specialised).

A. Meristematic tissue or Meristem

- Found at all growing points of a plant, such as the tips of roots, stems and branches (Fig. 3.1).

- Also present between the bark and the wood of trees where it leads to growth in the diameter of the stem.

Chief characteristics of meristematic tissue :

- (1) Cells are small.
- (2) Cells are usually cubical.
- (3) Cell wall is thin.
- (4) Nuclei are large.
- (5) Vacuoles almost absent.
- (6) Cells tightly packed with almost no intercellular spaces.
- (7) The cells actively divide adding new cells to the plant.
- (8) New cells thus produced are transformed into mature permanent tissues.

The meristematic tissue can be classified into two categories : *Apical meristem* and *Cambium* or *lateral meristem*.

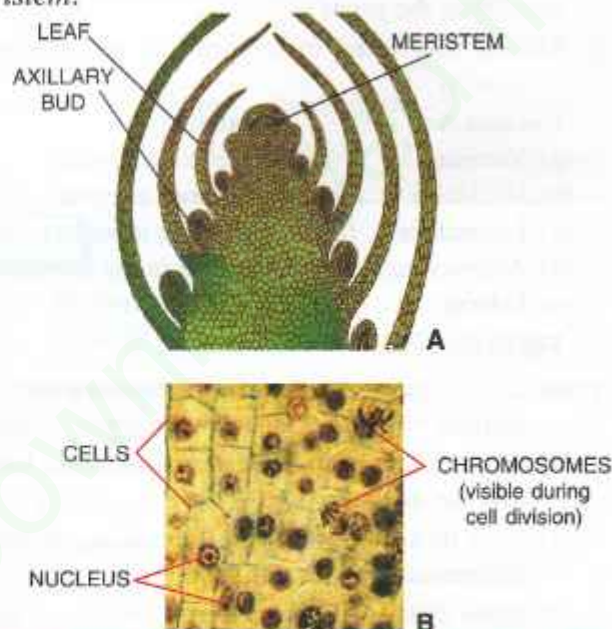


Fig. 3.1 A- Longitudinal section of stem tip, together with the differentiating leaves and the axillary buds. **B-** Meristematic cells undergoing cell division in the root tip of an onion.

of roots and stems and also in the growing young leaves near the tips of stems, as well as on the tips of axillary buds.

- (ii) **Cambium or Lateral meristem.** This is situated below the bark and is responsible for increase in the diameter of the stem.

B. Permanent tissues are made up of cells which have lost their ability to divide. They take a permanent shape to perform some permanent function. They may be living (nucleus present) or dead (nucleus absent).

According to the function performed the permanent tissues are of three types : **Protective, Supporting and Conducting.**

1. Protective tissue

- cells with thick walls.
- found on the surface of roots, stems and leaves.

Examples : Epidermis of leaves which secretes a waxy water-proof material. Cork cells in the barks contain another strong water-proof material.

2. **Supporting tissue** is of several types. The three most important ones are (a) parenchyma, (b) collenchyma, and (c) sclerenchyma.

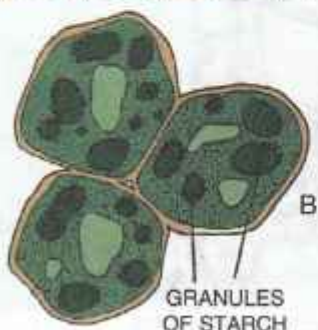
(a) Parenchyma

- large **thin walled** cells, oval, circular or polygonal in shape.
- usually a **single large vacuole** (Fig. 3.2A)
- found in soft parts of plants, such as in the cortex (outer region) and in the pith (central region)
- may **store food** as in potatoes (Fig. 3.2B)
- provide **temporary support** to the plant



A

From cortex of root
• thin walled
• single large vacuole



B

From potato
• small vacuole
• store starch granules

Fig. 3.2 Parenchyma cells

Some parenchymatous cells, particularly in the leaf, contain chloroplasts and are termed **chlorenchyma** (*chloros* : green). Chlorenchyma helps the leaf to produce food by photosynthesis.

(b) Collenchyma (*collen* : glue)

- Made up of cells which are elongated and the **cell wall is thickened at the corners**. (Fig. 3.3). It is found in the leaf stalks and below the epidermis of stems. The tissue helps to support the parts of a plant.

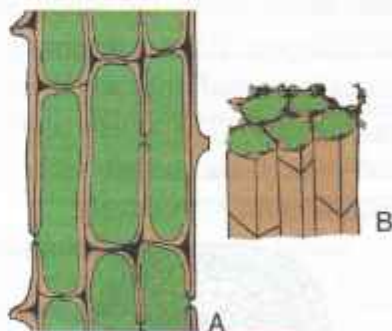


Fig. 3.3 Collenchyma.

A—Longitudinal view, B—Cross section.

(c) Sclerenchyma (*scleros* : hard)

- Composed of long, narrow cells, which have become dead; these cells develop very thick walls due to the deposition of lignin. This tissue provides strength to plant parts. It is found in stems and veins of the leaves (Fig. 3.4).

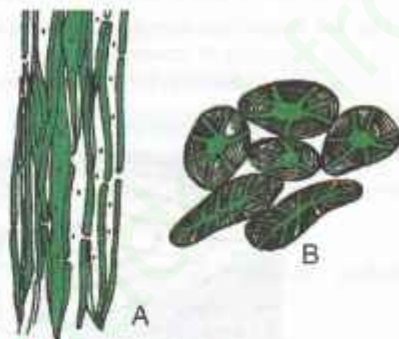


Fig. 3.4 Sclerenchyma.

A—Longitudinal section; B—Cross section.

The above three categories namely, parenchyma, collenchyma and sclerenchyma, are grouped as **simple tissues**, each being made up of one type of cell.

Fibres and "stones"

Ropes, mats and certain textiles are made from plant fibres such as those of linen and hemp. These fibres are the sclerenchyma cells.

The hard walnut shells and the gritty masses in the skin and the pulp of pears are made up of sclerenchyma cells, here known as stone cells.

tissue, provides a passage for water and dissolved materials to move up and down in the plant. The xylem and phloem are the two types of conducting tissues.

(a) **Xylem** cells are elongated and thick-walled. These cells are somewhat in the form of tubular passages (Fig. 3.5). They provide for upward movement of water and dissolved materials absorbed from the soil by the roots to other parts of the plant. Older xylem (*xyl*o : wood) tissue forms the wood and does not participate in transport. You can determine the age of a tree by counting its annual rings which actually are the xylem rings (Fig. 3.6). The xylem tissue consists of tracheids and vessels, also called tracheary elements, and xylem parenchyma respectively.

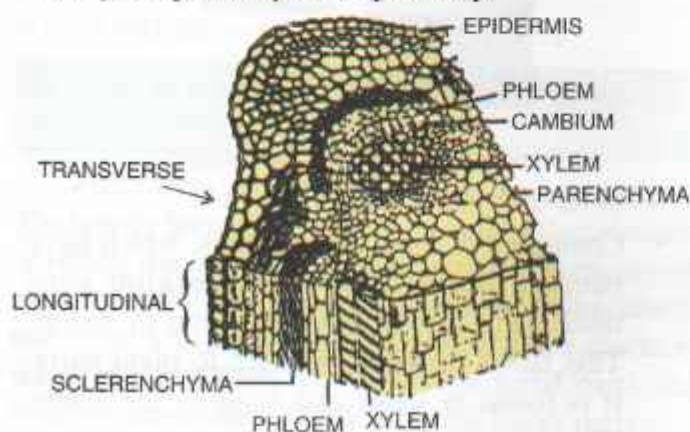


Fig. 3.5 Magnified portion of a stem representing a herb and showing in transverse and longitudinal views, several typical plant tissues

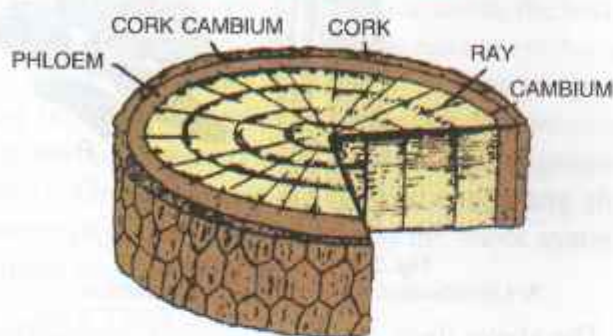


Fig. 3.6 Diagrammatic sketch of the cross-section of a 3-year-old woody stem. Note the three concentric rings of xylem indicating age.

- **Tracheids** are made up of elongated dead cells with large cavities without any contents. The cells are placed end to end forming a long tube. They have highly lignified cell walls. They provide mechanical support by developing various types of thickenings in their walls.

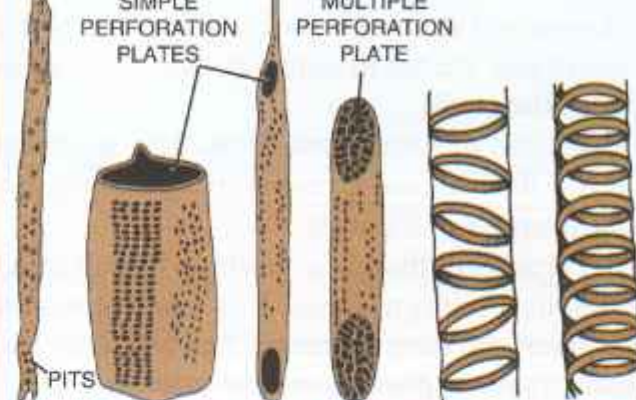


Fig. 3.7 A variety of shapes of tracheids (xylem elements)

- **Xylem Vessels** or **tracheae** are long tube-like structures meant for transporting water, and dissolved minerals. They are made up of elongated cells placed end to end. Their cell walls are quite hard, thick and lignified. Transverse walls get dissolved and make a continuous water pipe.
- **Xylem parenchyma** consists of living parenchyma cells associated with the xylem. These cells serve for the storage of food (sugars and starch), and also help in the conduction of water and minerals.

(b) **Phloem** cells (*phlo*os : bark) provide a passage for the **downward movement of food manufactured in the leaves** to various parts of the plant. They also provide for the upward movement of the prepared food towards the growing new leaves. The phloem consists of sieve tubes, companion cells, phloem parenchyma cells and phloem fibres (Figs. 3.5, 3.8).

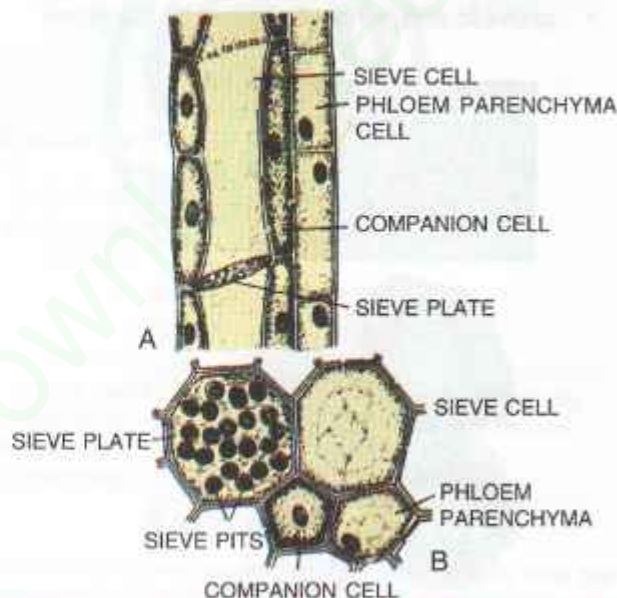


Fig. 3.8 Phloem cells. A-Longitudinal section, B-Cross-section.

• **Sieve Tubes** : Made up of elongated cells placed end to end forming a long tube. The transverse walls are perforated and called sieve plates. They help in the transport of food from leaves to storage organs and other parts of the plant.

- **Companion cells** : Living parenchyma cells closely associated with sieve tube cells. They help in the functioning of the sieve tube cell.
- **Phloem parenchyma** : Parenchymatous tissue found associated with phloem. Mainly concerned with storage of starch, fat and other organic food material.
- **Phloem Fibres** : Sclerenchymatous tissue found associated with phloem. They mainly provide support.

The xylem and phloem collectively form the vascular bundles. The veins of leaves are examples of vascular bundles. They are in continuity with the conducting tissues of stem and root.

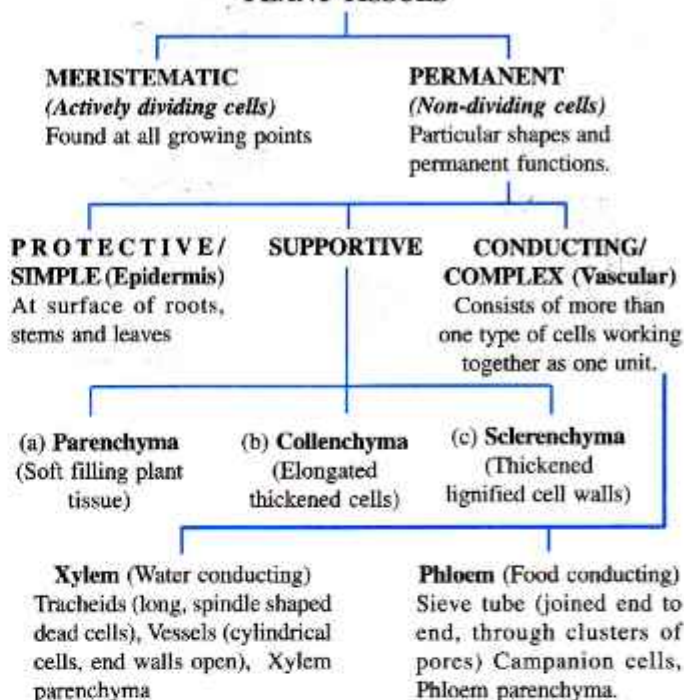
The above two tissues, xylem and phloem, are also termed **complex tissues** being made of more than one type of cells working together as a unit.



PROGRESS CHECK

- What are the two basic types of plant tissues?
- Give the technical terms for the following:
 - The category of plant tissues that have lost their ability to multiply
 - The kind of plant cells with thin walls and usually a single large vacuole
 - Elongated cells which are thickened at the corners
 - The two types of tissues which provide the upward movement of water and dissolved materials from the roots to other parts of the plant.
- Mention if the following statements are **true (T)** or **false (F)**
 - Phloem cells carry manufactured food from leaves to other parts.
 - Veins of leaves have both xylem and phloem.
 - The older xylem tissue does not participate in transport.
 - The sclerenchyma consists of actively dividing cells.

PLANT TISSUES



3.3 ANIMAL TISSUES

The main kinds of animal tissues are as follows:—

- Epithelial tissue
- Connective tissue
- Muscle tissue
- Neural tissue

1. **EPITHELIAL TISSUE** is a thin, protective continuous sheet of cells.

Location : It covers the surface of the body and lines the various body cavities and internal organs, including the blood vessels. *Examples* : The outermost layer of skin and the lining surfaces of the mouth, nose, lungs, stomach, etc.

Shape : Epithelial cells may be *flat*, *cuboidal* or *columnar* in shape.

In all cases the cells of the epithelial tissue fit tightly together leaving no space between the cells.

Function : The epithelial tissue functions for *protection* (as on skin), *absorption*, *secretion* (as in intestine), *sensory perception*, etc. Its five structurally distinct categories are as follows :

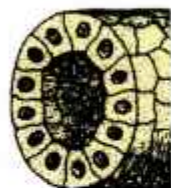
(a) **Squamous epithelium (Fig. 3.9 A)** is composed of cells, which are thin, flat with prominent nuclei closely packed. *Examples* : Found lining the



A—Squamous epithelium
(Flat, irregular shaped cells)



(several layered cells)
Here, upper layers are squamous, lowermost layer is cuboidal



C—Cuboidal epithelium



D—Columnar epithelium



E—Ciliated columnar epithelium

Fig. 3.9 Different kinds of epithelial tissue in the animal body

mouth and nasal cavities, blood vessels and lymph vessels.

The squamous epithelium protects the underlying parts from mechanical injury, germs, harmful chemicals, and drying up.

(b) Stratified epithelium (Fig. 3.9 B) : Found in the skin and the cornea. It is composed of several layers (strata) of the same or different kinds of epithelial cells.

(c) Cuboidal epithelium (Fig. 3.9 C) is found in some parts of kidney tubules and in some glandular ducts such as those of salivary glands, pancreatic duct.

(d) Columnar epithelium (Fig. 3.9 D) contains vertically arranged cylindrical or brick-like cells. These cells are usually tall in size. Columnar epithelium is generally found in the inner lining of the stomach and intestines.

(i) Ciliated columnar epithelium (Fig. 4.9 E): At some places in the body, such as in the lining of the trachea (wind pipe), the columnar epithelium is ciliated. The cells of **ciliated epithelium** have thread-like protoplasmic projections called **cilia**, at their free ends.

The cilia constantly keep lashing and move the materials which enter these regions.

(ii) Glandular epithelium (also a kind of columnar epithelium) contains some large cells which secrete certain chemical substances. Such cells are common in the lining of the stomach and the intestine. At certain places in the body the glandular epithelium is folded

example, the sweat glands, tear glands or the liver.

2. CONNECTIVE TISSUE

The connective tissue binds one tissue with another, and also connects various organs, keeping them in proper place. It has three characteristics :

- Abundance of intercellular substance — the **matrix**
- Fewer cellular elements, and
- Fibres

The connective tissue is classified as follows :

- Connective tissue proper** — serves for packing and binding the organs
- Supportive connective tissue** — gives support (cartilages and bones)
- Fluid connective tissue** — blood and lymph

I. Connective tissue proper — its three subcategories are as follows:

(a) Areolar (packing) tissue — It is most widely spread, occurring beneath the epidermis of skin. It makes the skin elastic and helps it to withstand pulling strain.



(b) Adipose (fat) tissue — It has specialized cells which store fat. This tissue forms padding under the skin and around kidneys, eye ball, etc. Padding under skin acts as an insulation for retaining the body heat.

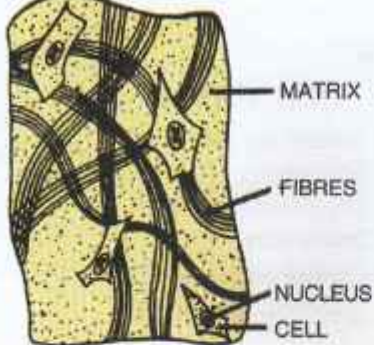
(c) Fibrous connective tissue — It is mainly formed of fibre forming cells which form **tendons** (connecting muscles to bone) and **ligaments** connecting one bone to another bone).

II. Supportive connective tissue

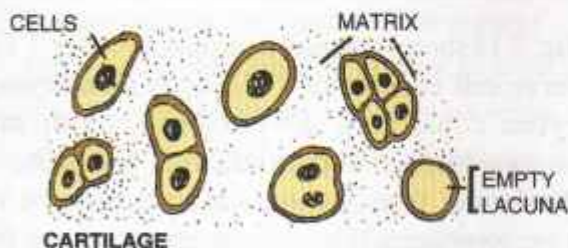
(a) Cartilage is a non-porous tissue. It has a thickened intercellular substance (**matrix**). It has no blood vessels or nerves. Cartilage is **semi-transparent** and **elastic**. Cartilages are found in the tip of the nose, external ears, trachea and bronchial tubes, between vertebrae, and at the ends of long bones.

(b) Bone is a hard **porous** tissue. It has a good supply of blood vessels and nerves. It consists of both living cells called **osteoblasts** and a rigid mass of inorganic salts.

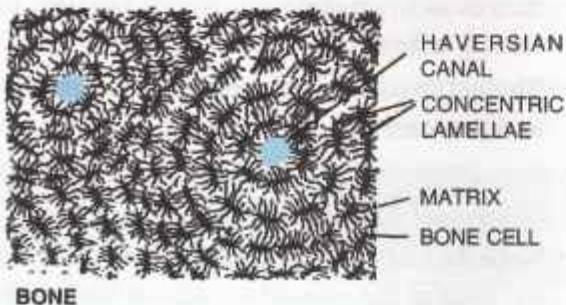
FIBROUS CONNECTIVE TISSUE



2.



3.



BONE CELL

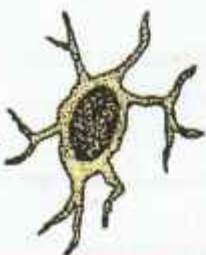


Fig. 3.10 Types of connective tissue. 1. Fibrous (with non-living matrix which contains scattered cells and fibres), 2. Cartilage, and 3. Bone (with one bone cell enlarged).

III. Fluid connective tissue (blood and lymph)

(a) **Blood.** Blood is composed of :

- The liquid part **plasma** and
- The cellular part **red blood cells, white blood cells and platelets** (Fig. 3.11).

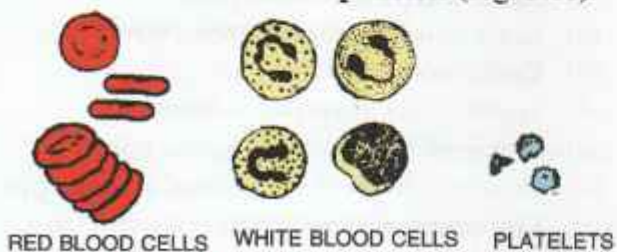


Fig. 3.11 Three kinds of blood cells in humans.

(b) **Lymph** is the fluid surrounding the body cells. It is essentially the blood plasma that has oozed out of the blood vessels. It contains white blood cells and not the red blood cells.

Both blood and lymph are mainly concerned with **transportation** and also with **immunity** (protection against diseases).

3. MUSCLE TISSUE

Forms the muscles of the body. Muscles can contract and relax. Thus they help the body in its movements.

Three kinds of muscles (Fig. 3.12) are :

- striated** (skeletal, striped, or voluntary) muscles
- unstriated** (smooth, unstriped, or involuntary) muscles and
- heart** or **cardiac** muscles.

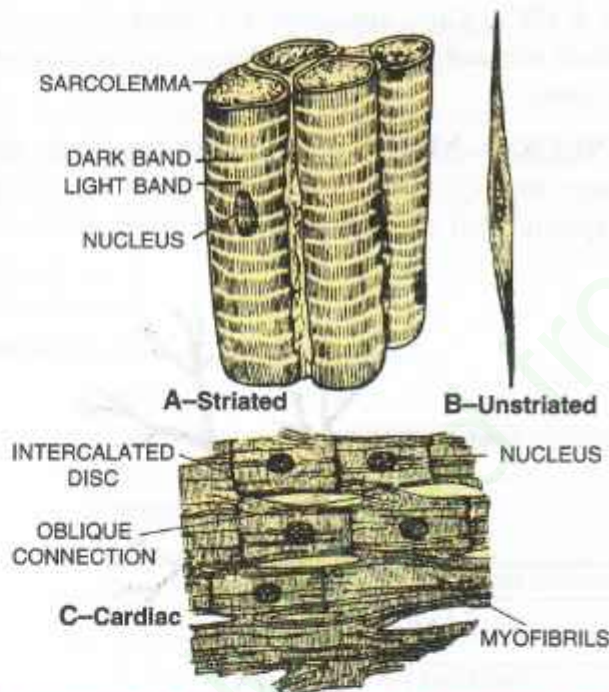


Fig. 3.12 Kinds of muscles. A-Striated; B-Unstriated; C-Cardiac.

(a) **Striated muscles** are under the control of the will. They are made of long fibres (cells) which are nucleated and striated – light and dark bands run across the fibres. (Fig 3.12A). This muscle moves only when you want it to. They constitute about 50% of the body weight. These muscles are found in the arms, legs, face, neck, etc.

(b) **Unstriated muscles** are not under the control of the will. They are made up of spindle shaped/slender

ANIMAL TISSUES

EPITHELIAL

(Thin protective)

- (i) Squamous
- (ii) Stratified
- (iii) Cuboidal
- (iv) Columnar
- (v) Ciliated columnar
- (vi) Glandular

CONNECTIVE

- (i) Fibrous connective (Tendons, ligaments, fascia, adipose)
- (ii) Cartilage
- (iii) Bone
- (iv) Fluid (Blood & lymph)

MUSCULAR

- (i) Striated (or striped), Voluntary
- (ii) Unstriated (unstriped), Involuntary
- (iii) Cardiac (striated, branched), Involuntary

NEURAL

Neurons (axons of the neurons form nerve fibres)

tapering cells which are uninucleated. (Fig 3.12B). They are found in the walls of the intestine helping in the passage of food, muscles of the iris of the eye, skin, lining of blood vessels, urinary bladder, uterus etc.

(c) **Cardiac muscles** are involuntary in function and found only in the walls of the heart. The fibres of cardiac muscle are striated, uninucleated and branched. (Fig 3.12C). They are relatively short. They can contract without outside stimulation and do not get tired soon.

4. **NEURAL NERVOUS TISSUE** constitutes the nervous system. This tissue is made up of specialised elongated cells called neurons.

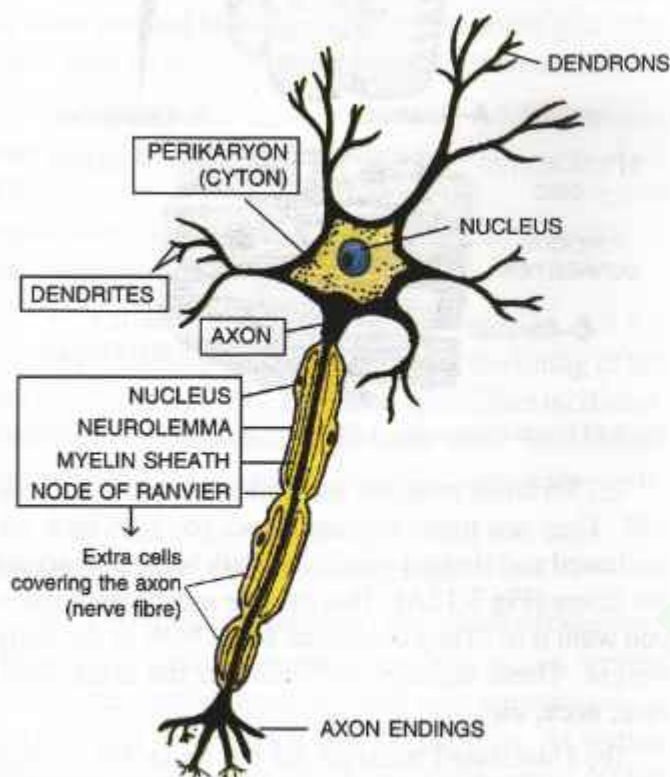


Fig. 3.13 A nerve cell (neuron)

Fig. 3.13 shows a typical neuron or nerve cell. Each nerve cell consists of a cell body **perikaryon** or **cyton** containing the nucleus, one or more elongated hair-like extensions (dendrites or **dendrons**). One of these, the **axon**, may be very long, sometimes as long as one metre, or even three metres as in an elephant. Axons bundled together form a **nerve**.

The nerve tissue is concerned with the perception and responses of animals.



PROGRESS CHECK

- Name the kind of animal tissue in which
 - Cells are flat, cuboidal or columnar, forming protective layer.
 - Cells produce and pour out chemical substances.
 - Cells can contract and relax.
 - Cells can conduct impulses.
- Give one example of each of the following tissues where they are located.
 - Ciliated columnar epithelium
 - Elastic cartilage
 - Unstriated muscles
- Write one speciality each of the following :

(i) Cartilage	(ii) Bone
(iii) Striated muscle	(iv) Cardiac muscle
- Mention if the following statements are **true (T)** or **false (F)**
 - Axons of nerve cells are very long.
 - Dendrons bundled together form a nerve.
 - Cardiac muscles get tired soon.
 - Epithelial cells leave space in between.
 - Perikaryon is the nucleus of a nerve cell.
 - Muscles of the iris of the eye are of voluntary type
 - Cartilage has no blood vessels or the nerves in it.

Analogies can never be perfect comparisons. However, these are often helpful in understanding.

Can we compare the following and if so, how ?

- | | |
|--|--|
| 1. Blood vessels – rivers | 2. Capillaries – canals |
| 3. Red blood cells – ships | 4. White blood cells – anti-terrorist squad |
| 5. Urinary system – drainage | 6. Kidneys – aquaguards |
| 7. Liver – thrifty house-keeper | 8. Nerves – land lines (telephonic) |
| 9. Plant leaves – agriculture farms | |

POINTS TO REMEMBER

- *Similar cells packed together form a tissue*
- *Different tissues arranged together form an organ*
- *Related organs together constitute an organ system.*
- *ANIMAL TISSUES comprise of epithelial, connective, muscular and nerve tissues*
 - *Epithelial tissue consists of squamous epithelium, cuboid epithelium, columnar epithelium, ciliated epithelium, and glandular epithelium.*
 - *Connective tissue consists of fibrous connective tissue (tendon, ligament, adipose), cartilage, bone, fluid connective tissue (blood, lymph).*
 - *Muscle tissue consists of striated (voluntary), unstriated (involuntary), and cardiac muscles*
 - *Neural tissue consists of neurons whose long axons are bundled together to form nerves.*
- *PLANT TISSUES are of two main types — meristematic (actively dividing cells) and permanent.*
 - *Permanent tissues include protective tissue (e.g. epidermis), supporting tissue (parenchyma, collenchyma, sclerenchyma) and conducting tissue (xylem, phloem)*

REVIEW QUESTIONS

A. MULTIPLE CHOICE TYPE

1. In potato starch is stored in :
(a) Sclerenchyma (b) Collenchyma
(c) Parenchyma (d) Chlorenchyma
2. **Tendons** and **ligaments** are examples of
(a) Fibrous connective tissue
(b) Cartilage
(c) Muscular tissue
(d) Adipose tissue.
3. Which one of the following pairs is **correctly matched**?
(a) Meristem – Actively dividing cells
(b) Xylem – Transport of food
(c) Phloem – Transport of water
(d) Sclerenchyma – Storage of starch.
4. Parenchyma containing chloroplasts is known as :
(a) Parenchyma (b) Aerenchyma
(c) Collenchyma (d) Chlorenchyma
5. Annual rings are the number of :
(a) Internodes in a stem
(b) Rings of vascular bundles in a monocot stem.
(c) Barks layers in a woody stem.
(d) Layers of Xylem in a stem.
6. Which of the following cells in plants are said to be nonliving ?
(a) Meristem (b) Parenchyma
(c) Collenchyma (d) Sclerenchyma.
7. Which of the following connects a muscle to a bone ?
(a) Cartilage (b) Ligament
(c) Tendon (d) Interstitial fluid.
8. Cardiac muscle is :
(a) Involuntary
(b) Smooth
(c) Striated
(d) Involuntary and Striated.

- Name** the kind of tissue found
 - at the tip of plant roots.
 - at the lower surface of leaf.
 - in the inner lining of intestine.
 - at the joint between two long bones.
 - in the walls of the veins of leaves.
 - as gritty masses in the skin of pears.
- Where** is the least specialized tissue located in plants?
- Write one word** for each of the following :
 - A group of similar cells performing a specific function.
 - Cells least specialized in the plants.
 - Cells responsible for increase in diameter of the stem and root of dicot plants.
- Name one place** each in living organisms where the following tissues are located :

(a) Meristematic tissue	(b) Cartilage
(c) Squamous epithelium.	(d) Sclerenchyma
(e) Ciliated epithelium	(f) Ligament
- Name the kinds** of cells found in the following places:
 - Surface of the human skin
 - Salivary gland
 - Brain
 - Inner lining of the wind pipe

C. SHORT ANSWER TYPE

- Name any one** body part where ciliated epithelium is found in humans ? What is its function ?
- What is the difference** between the nervous *tissue* and the nervous *system* ?
- List** the tissues found in the human heart?
- Can you consider a cluster of eggs as a tissue? **Why?**
- Name** the three kinds of muscles found in the human body. In each case, name one region in the body where they are found.

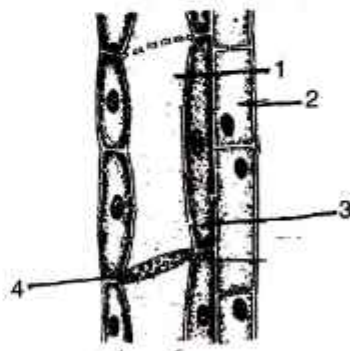
D. LONG ANSWER TYPE

- What is the **difference** between
 - cell and tissue ?
 - organ and organism ?
 - organ and organelle ?
 - organ and organ system ?

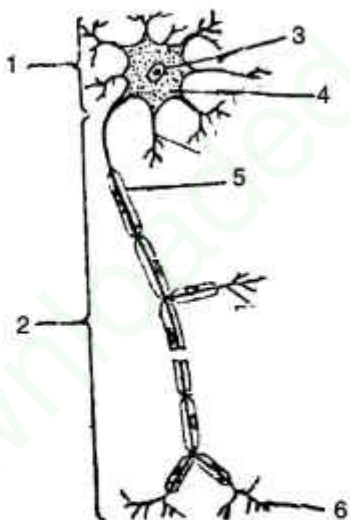
- Parenchyma and collenchyma
- Meristematic tissue and permanent tissue
- Sclerenchyma and parenchyma
- Cells of involuntary and voluntary muscle
- Fibres of voluntary muscle and cardiac muscle.

E. STRUCTURED/APPLICATION QUESTIONS

- Study the diagram given below and then answer the questions that follow :



- Identify the tissue and give a reason to support your answer.
 - Name the parts labelled 1, 2, 3, and 4.
 - Where is this tissue likely to be found in the plant ?
 - State the function of the parts labelled 1, 2, 3 and 4.
- Study the diagram given below and then answer the questions that follow :



- Identify the cell.
- Name the parts labelled 1, 2, 3, 4, 5, and 6.
- Where is this cell likely to be found in the human body and what is its function ?