Definition of tissue
Tissues are group of similar cells, having the same origin and performing a specific function.

Definition of organ
A group of tissues that contribute to perform a specific function is called an organ.

Definition of organ system
A group of organs which perform a specific function is called an organ system. Several organ systems together form an organism.

CLASSIFICATION OF PLANT TISSUES

MERISTEMATIC TISSUE
This type of tissue is made up of immature, small and similar cells, which are constantly dividing. As a result of cell division, new cells are constantly being added to the plant. Hence these tissues play an important role in the growth of the plant.
Depending on the location, Meristematic tissue can be grouped into three types- apical meristem, lateral meristem and the intercalary meristem.

1. **Apical (terminal) meristem:**
   - It is located at the growing tips or apices of the roots and stems. This tissue is responsible for the increase in the length of the roots and stems.

2. **Lateral meristem:**
   - Found beneath the bark of trees as **cork cambium.** It is called **cambium** when it is seen in the vascular bundles of dicot stems and roots. This tissue is responsible for the increase in the diameter or girth of the stem.

3. **Intercalary meristem:**
   - It is located at the base of the nodes and internodes. This tissue produces an increase in the length of the organ.

#### Location of meristematic tissue in a plant body

**SIMPLE PERMANENT TISSUE**

This group of tissues is mainly supportive in function, yet they also perform other functions. They are grouped into three types: **parenchyma, collenchyma and sclerenchyma**
## Characteristics of Simple, Permanent Tissue

<table>
<thead>
<tr>
<th></th>
<th>Parenchyma</th>
<th>Collenchyma</th>
<th>Sclerenchyma</th>
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</thead>
</table>
| **Structure**      | Generally oval or spherical  
                    | Thin cellulose cell wall  
                    | Elongated cells  
                    | Cellulose cell wall, unevenly thickened at the corners  
                    | Vacuole small  
                    | Nucleus present  
                    | Nucleus present  
                    | Intercellular spaces present  
                    | Intercellular spaces absent  
                    | Spindle shaped cells  
                    | Cell wall is evenly thickened with lignin  
                    | Vacuole absent  
                    | Nucleus absent  
                    | Intercellular spaces absent  |
| **Location**       | Seen in the soft parts of stems, roots, leaves, flowers  
                    | In leaf stalks (petiole). Below epidermis of leaves. Stems of herbaceous, dicot plants.  
                    | Found in veins of leaf. Hard covering of seed and nuts. (sclereids) In and around the xylem and phloem of stems.  |
| **Function**       | Storage of food. Forms the ground tissue of plants. When chlorophyll is present it is called  
                    | Provides mechanical support. If chloroplasts are present, performs photosynthesis.  
                    | Fibres provide mechanical strength, rigidity and flexibility to the plant body. The sclereids or stone  |
**Diffences between sclerenchyma fibres and sclereids.**

<table>
<thead>
<tr>
<th>Fibres</th>
<th>Sclereids or stone cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Elongated cells, tapering at both ends.</td>
<td>• Spherical or irregular cells</td>
</tr>
<tr>
<td>• Occur in bundles.</td>
<td>• Found scattered</td>
</tr>
<tr>
<td>• Gives mechanical strength.</td>
<td>• Gives hardness to seed coat.</td>
</tr>
<tr>
<td>• Used for making ropes, mats (coir, jute) and textile materials such as linen and hemp.</td>
<td>• The presence of stone cells in walnut shells, almond shells make them hard.</td>
</tr>
<tr>
<td></td>
<td>• The gritty nature of pulp of pears and guava is also due to the sclereids present in them.</td>
</tr>
</tbody>
</table>

**COMPLEX PERMANENT TISSUE**

The complex tissue consists of more than one type of cells which work together as a unit. This tissue is also known as **conducting tissue** or **vascular tissue** as their main function is to transport water, mineral salts and food materials. The two types of complex permanent tissue are:

1. Xylem or wood
2. Phloem or bast

Xylem and phloem together form **vascular bundles.**

<table>
<thead>
<tr>
<th>Xylem</th>
<th>Phloem</th>
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</thead>
<tbody>
<tr>
<td>1. It consists of tracheids, vessels, xylem parenchyma and xylem fibres.</td>
<td>1. Phloem tissue comprises of the sieve tubes, companion cells, phloem parenchyma and phloem fibres.</td>
</tr>
<tr>
<td>2. Mainly made up of dead cells.</td>
<td>2. Mainly made up of living cells.</td>
</tr>
</tbody>
</table>
3. It conducts water and dissolved minerals from the roots to the aerial parts in an upward direction.  

3. It translocates food from the leaves to the storage organs of the plant.

**Note:** The rings present in the trunk of an old tree are the xylem rings. By counting the number of rings, we can determine the age of a tree.

**PROTECTIVE TISSUES**

These tissues include: 1. Epidermis  2. Cork

1. **Epidermis:** forms one cell thick outermost layer of the organs of plants, such as, leaves, flowers, stems and roots. This layer of cells is covered from the outside by the **cuticle**.

2. **Cork:** is made up of dead cells with thick walls, with no intercellular spaces, found in older stems and roots of dicot plants. As the dicot plants get older, the single layer of epidermis is replaced by a multi-layer cork cells.

The L.S. of a leaf showing the epidermal cells and the cuticle.
The T.S of a stem showing the different tissues

QUESTION BANK ON PLANT TISSUES

1. Differentiate between the following tissues based on the point given in brackets:
   a. apical meristem and lateral meristem (location)
   b. parenchyma and collenchyma (cell wall)
   c. collenchyma and sclerenchyma (shape of cell)
   d. xylem and phloem (function)
   e. intercalary meristem and apical meristem (function)

2. State one area of the plant where the following tissues are located:
   a. Xylem
   b. Sclereids
   c. Cambium
   d. Parenchyma
   e. Collenchyma
   f. Sclerenchyma fibres

ANIMAL TISSUES:
• In multi cellular animals there are the following four main types of tissues: Epithelial Tissue, Connective Tissue, Muscular Tissue, Nerve Tissue.

• These are further differentiated as shown in the chart below:

  ANIMAL TISSUE
  
  EPITHELIAL TISSUE  |  CONNECTIVE TISSUE  |  MUSCULAR TISSUE  |  NERVE TISSUE
  Squamous          |  Areolar            |  Skeletal         |  Cardiac
  Columnar and glandular |  Tendon            |  Smooth           |  Cartilage
  Cuboidal          |  Ligament           |  Cardiac          |  Bone
  Ciliated          |  Adipose            |  Cartilage        |  Blood
  Skeletal          |  Fluid              |  Fluid            |  Lymph

• **EPITHELIAL TISSUE**
  
  ✓ Is a thin, protective continuous sheet of cells leaving no space between them.
  ✓ It covers the surface of the body and lines the various body cavities and internal organs including the blood vessels. Examples – outermost layer of skin, lining surface of mouth, lungs etc.
  ✓ The main function is protection, absorption, secretion, sensory perception etc.
  ✓ The distinct categories are

<table>
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<tr>
<th>TISSUE</th>
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<th>OCCURRENCE</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SQUAMOUS EPITHELIUM</strong></td>
<td>Compact, flat plates like cells with no inter cellular spaces.</td>
<td>Lining the skin and cavities of ducts. Whenever it forms a lining as that of blood vessels, it is</td>
<td>Protects underlying parts from injury, entry of germs, chemicals</td>
</tr>
<tr>
<td>COLUMNAR AND GLANDULAR EPITHELIUM</td>
<td>Cells are taller than broad with nucleus towards the base. Certain cells adapted for secretion.</td>
<td>Intestinal lining, sweat gland, tear gland, salivary gland, kidney tubules.</td>
<td>Gives mechanical strength, concerned with secretions.</td>
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<tr>
<td>CUBOIDAL EPITHELIUM</td>
<td>Cube like cells which are square in section but the free surface appears hexagonal.</td>
<td>Kidney tubules, salivary glands, inner lining of the cheek.</td>
<td>Gives mechanical strength.</td>
</tr>
<tr>
<td>CILIATED EPITHELIUM</td>
<td>Cuboid or columnar cells with protoplasmic outgrowth called cilia.</td>
<td>Lining of trachea of vertebrates, kidney tubules and oviduct.</td>
<td>Keeps out unwanted particles.</td>
</tr>
</tbody>
</table>

- **CONNECTIVE TISSUE**

  ✓ It binds one tissue with another and also connects various organs, keeping them in proper place.
3 characteristics are abundance of intercellular substance the matrix, fewer cellular elements, fibres.

The connective tissue is classified as follows –

<table>
<thead>
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<th>OCCURRENCE</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Areolar connective</strong> (PACKING)</td>
<td>Consists of white and yellow fibres with irregular cells scattered in the matrix.</td>
<td>Fills spaces inside organs found around muscles, blood vessels and nerves.</td>
<td>Joins skin to muscles, supports internal organs, and helps in the repair of tissues.</td>
</tr>
<tr>
<td><strong>Tendon</strong></td>
<td>Consists of collagen bound together by areolar connective. Inelastic.</td>
<td></td>
<td>Connects muscles to bones.</td>
</tr>
<tr>
<td><strong>Ligament</strong></td>
<td>Consists of elastic fibres bound together by areolar connective. Elastic.</td>
<td></td>
<td>Connects bones to each other.</td>
</tr>
<tr>
<td><strong>Adipose tissue</strong> (FAT)</td>
<td>Oval or rounded cells filled with fat droplets.</td>
<td>Below skin, between internal organs, yellow bone marrow.</td>
<td>Storage of fat, conserves heat.</td>
</tr>
<tr>
<td><strong>Skeletal tissue</strong></td>
<td><strong>Cartilage</strong></td>
<td><strong>Bone</strong></td>
<td><strong>Points to Note:</strong></td>
</tr>
<tr>
<td>----------------------</td>
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</tr>
<tr>
<td><strong>Non porous tissue, intercellular matrix composed of proteins, slightly hardened by calcium salts. Blood vessels absent.</strong></td>
<td>Ear pinna, nose tip, epiglottis, intervertebral disc of mammals. Rings of trachea.</td>
<td>Internal skeleton.</td>
<td>Provides support and flexibility to body part.</td>
</tr>
<tr>
<td><strong>Hard porous tissue with phosphates and carbonates of calcium and magnesium. Blood vessels present.</strong></td>
<td><strong>Points to Note:</strong> Protects internal delicate organs, provides attachment for muscles, helps in locomotion, bone marrow makes blood cells.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Fluid tissue</strong></th>
<th><strong>Blood</strong></th>
<th><strong>Lymph</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Consists of a fluid – plasma and formed elements erythrocytes (RBC) , leucocytes (WBC) and platelets. Dissolved in plasma are proteins, salts, hormones and enzymes.</strong></td>
<td><strong>In blood vessels circulating throughout the body:</strong></td>
<td><strong>In lymph vessels:</strong></td>
</tr>
<tr>
<td><strong>Straw coloured fluid similar to blood in composition but devoid of RBC’S and proteins.</strong></td>
<td><strong>Transports oxygen, nutrients, hormones to tissues and organs. Leucocytes fight diseases. Platelets help in clotting of blood.</strong></td>
<td><strong>Transports nutrients into the heart. Forms the defence system of the body.</strong></td>
</tr>
</tbody>
</table>

**POINTS TO NOTE:**
1. The connective tissue is concerned with **connecting** the parts of the body. As such it can connect bones to each other, muscles to bones, bind tissues and give support to the various parts of the body by forming a packing around organs so that they do not get displaced by body movements.

2. Fluid tissues connect the different parts and also maintain a continuity within the body.

3. Blood platelets are not cells but pieces of certain giant cells of the bone marrow. They are rounded, colourless, bi-convex and non-nucleated. They disintegrate at the site of injury and help in other clotting of blood.

**ANIMAL MUSCLE TISSUE**

All types of movements are brought about in the body with the help muscular tissue.

Classification of muscular tissue:

The muscular tissue is of three types:

i) Striped or striated or skeletal or voluntary muscle.

ii) Unstriped or non-striated or smooth or visceral muscle.

iii) Cardiac muscle.

---

**i) Skeletal or voluntary muscle:**
They are striated, multinucleated, unbranched fibres. The muscle fibres are bounded by an elastic but tough covering called sarcolemma. Bounded by the sarcolemma is a clear fluid called sarcoplasm which contains contractile fibrils called myofibrils. The myofibrils show alternate dark and light bands giving a characteristic striped or striated appearance. These muscles can get tired and need rest.

**Location:** Attached primarily to bones.

**Function:**
- Striated muscles help in bringing about all voluntary movements of the body.
- Provide the force for locomotion.

**ii) Smooth or Involuntary muscle:**
They are non-striated, uni–nucleated, spindle shaped fibres.
- The nucleus is in the centre and the ends of the cell may branch.
- Myofibrils do not show alternate dark and light band. Hence, they are smooth or non-striated muscles.
- The muscle fibres lack sarcolemma but several fibres are joined together in bundles by loose connective tissue.

**Location:** They are found in the walls of hollow organs like stomach, intestine, urinary bladder; blood vessels, iris, erector muscle in skin.

**Function:**
- Unstriated muscles cause slow and prolonged contractions which are involuntary i.e. not under the control of the will.
- Peristaltic contractions in the alimentary canal are brought about by the smooth muscles. These contractions push the food ball in the alimentary canal.

**iii) Cardiac muscle:**

Cardiac muscles are striated, uni–nucleated, branched fibres.
- They show characteristics of both unstriated and striated muscles.
- Each fibre is surrounded by sarcolemma and has sarcoplasm.
- They have a centrally located nucleus.
- Their contractions are rapid but rhythmic and involuntary throughout life.
- Cardiac muscles do not get tired.
Location: They are found in the walls of heart.

Function: The contraction and relaxation of heart helps to pump blood and distribute it to various parts of the body.

NERVOUS TISSUE
Nervous tissue is a highly specialised tissue due to which the animals are able to perceive and respond to any change in the environment. The fundamental unit of nervous tissue is called nerve cell or neuron.

STRUCTURE OF NEURON:

Each neuron consists of three parts:

i) Cyton or cell body or perikaryon: It is star shaped having a single nucleus in the centre.

ii) Dendrons: The dendrons are short processes arising from the cyton and further branching into thin dendrites. They carry impulse towards the cell body.

iii) Axon: It is a single, long, cylindrical process arising from cyton which branch terminally. It carries message away from cyton. In most neurons, the axon is surrounded by a white sheath called medullary or myelin sheath. The medullary sheath is not continuous throughout the length, the gaps left are called Nodes of Ranvier. The medullary sheath of the axon acts like an insulation and prevents mixing of impulses in the adjacent axons.
Neurons enclosed in sheaths form a nerve fibre and nerve fibres bound together in parallel bundles form a nerve.

**Location:** Neurons are found in the brain and spinal cord.

**Function:** Nerve tissue is concerned with the perception and responsiveness of animals.

**QUESTIONS:**

1. Mention the general characteristics of the epithelial tissue.
2. Differentiate between
   (i) RBC and WBC.
   (ii) Blood and lymph.
   (iii) Bone and cartilage.
   (iv) Tendon and ligament.
3. Why is blood regarded as a connective tissue?
4. Name any one body part where ciliated epithelium is found in humans? What is its function?
5. Differentiate between Skeletal muscle, smooth muscle and cardiac muscle.
6. Mention one similarity between smooth muscle and cardiac muscle.
7. Mention one similarity between skeletal muscle and cardiac muscle.
8. State the location and function of the following:
   a) Skeletal muscle.
   b) Smooth muscle.
   c) Cardiac muscle.
   d) Nerve cell.
9. Draw a neat, labelled diagram of a neuron.
10. Differentiate between an Axon and Dendron.