1 Tissue systems and their functions:

06

1.1 Epidermal Tissue System

1.2 Secretary Tissue System

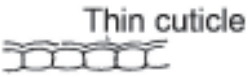
1.3 Mechanical Tissue System

Definition:

A group of tissues performing a common function irrespective/ regardless (different) of their position and origin is called as epidermal tissue system.

Epidermal tissue system is also known as, 'dermal tissue system'. It is made up of

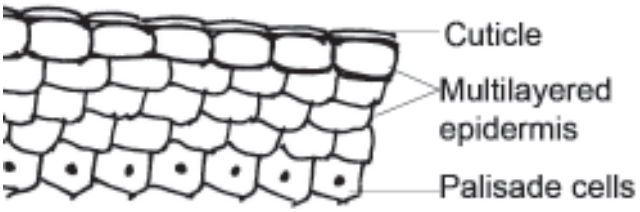
1. Epidermis
2. Cuticle
3. Stomata
4. Trichomes



1. Epidermis: This word is derived from Greek word epi- upon, derma- skin. Epidermis consists of single layer of cells covering all organs of plant body, like stem, root, flower, leaf, fruit and seeds. It is continues layer except small pores called stomata and lenticels.

According to histogen theory it is derived from dermatogen or proderm or from apical meristem.

Multiple Epidermis –



Multilayered Epidermis

Epidermis with many layers is called as multiple epidermis. Many layered epidermis is found in the leaves of plants like Opuntia, Ficus, and Nerium. It is made up of 3-5 layers of cells. In Ficus species multilayered epidermis prevents heating of the mesophyll cells below and helps to reduce transpiration.

2. Cuticle:

It is a layer of waxy substance known as cutin, on the outer wall of the epidermis. It is present on the epidermis of all aerial parts of plant body. Cutin layer means closely applied to the outer wall forming a continuous layer. It is probably secreted is liquid from by the epidermal cells and reaching outer wall, which becomes tough and hard. The cuticle is impermeable to water.

Function –

Prevent loss of water from inner cells. The cuticle is very thin in shady plants and those growing in moist plants. In xerophytes the cuticle is thick. In some leaves there is a coating of oil an epidermis e.g.Nymphea. It prevents welting of leaf.

3. Stomata:

The stomata are minute pore which occur in the epidermis of plant. They are found on all aerial parts and are absent in roots. Stomata are made up of two guard cells, having an opening between them known as stomatal aperture. Generally the term stomata is applied to the stomatal opening and guard

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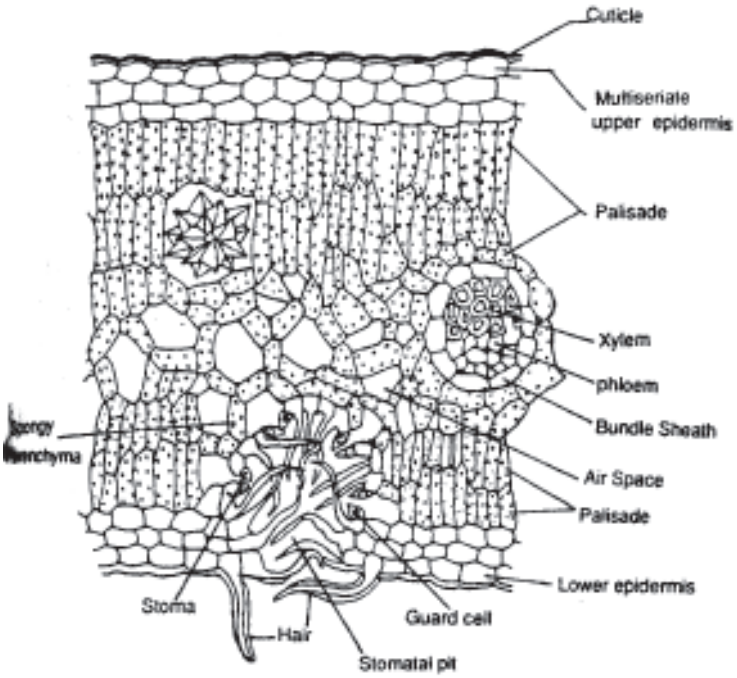
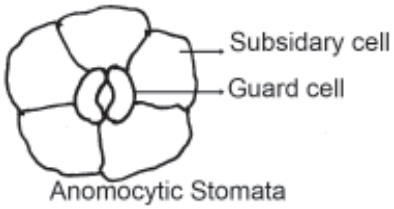


T.S. of ***Nerium*** leaf showing multiseriate epidermis and sunken stomata

cells. There is a respiratory cavity below the stomata which allows gaseous exchange. The guard cells are living and contain chloroplast. Usually in the leaves of dicotyledons stomata are scattered where as the leaves of monocotyledons the stomata are in parallel rows, from this we an identify monocot and dicot plants. Number of stomata varies from few thousands to 100's of thousand per square cm or cm^2. Stomata occur on both upper and lower surface of leaf. But mostly they are found on lower surface. Stomata remain closed in night and it remain open during day time.



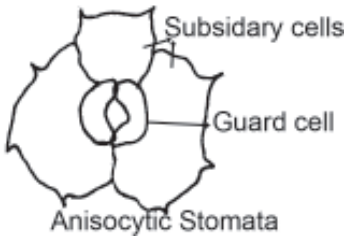
Anomocytic Stomata

Types of Stomata:

The stomata are classified into 5 types on the basis of their morphology.

a. Ranunculous/Anomocytic type – (Anomocytic – regular celled)

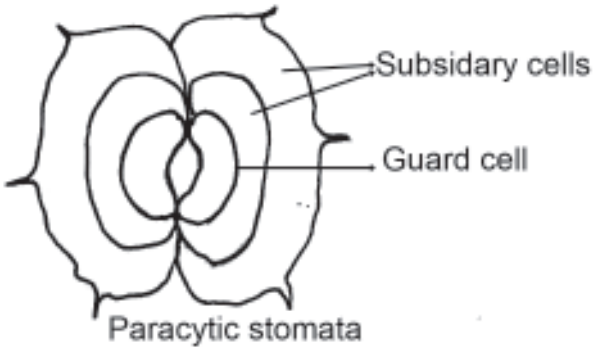
Here stomata is surrounded by a limited number of subsidiary cells which are quite alike the remaining epidermal cells. The subsidiary cells are five in number.



Anisocytic Stomata

b. Cruciferous/ Anisocytic type – (Anisocytic- unequal celled)

Stomata is surrounded by there accessory cells of which one is distinctly smaller than the other two. e.g. Petunia.



Paracytic stomata

c. Rubiaceous/Paracytic type – (paracytic-parallel celled)

In this type stomata is usually surrounded by two subsidiary or accessory cells which are parallel to the long axis of the pore and guard cells. E.g. Phaseolus.

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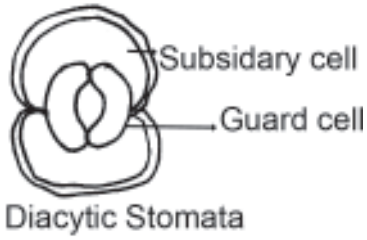
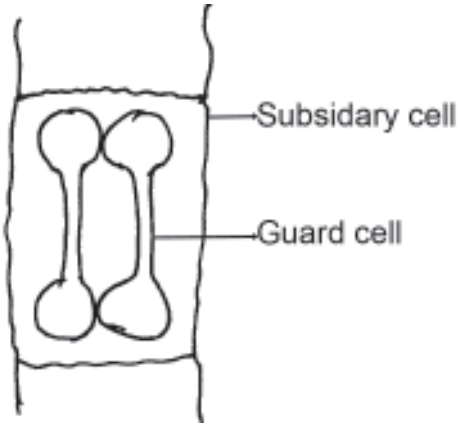
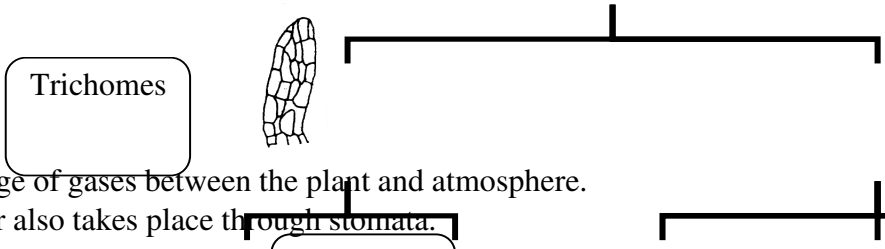


d. Caryophyllaceous/Diacytic type- (Diacytic- cross celled)
Stomata is surrounded by a pair of subsidiary cells whose common wall is at right angles to the guard cells.



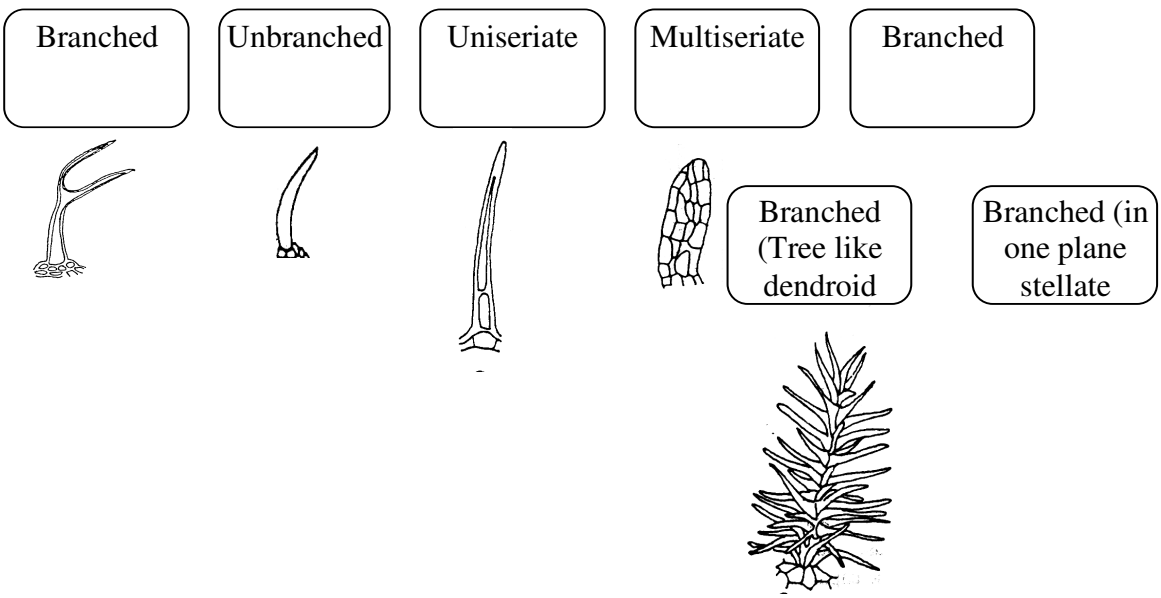
e. Graminaceous type –
This type of stomata is found in monocots like family Graminae. In this type of stomata guard cells are dumbbell shaped e.g. Cyperaceae, Graminae.



Functions:

1. They help in exchange of gases between the plant and atmosphere.
2. Evaporation of water also takes place through stomata.

Trichomes:



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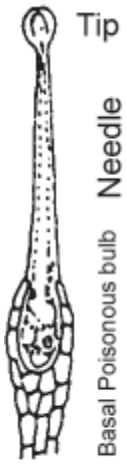

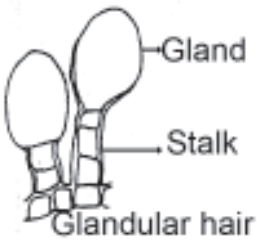

plants there are present various types of simple and complex hairs as follows.

i. Stinging hairs.
ii. Mucilage hair.
iii. Non-glandular hairs
iv. Glandular shaggy hairs
v. Stellate hairs
vi. Cup shaped peltate hair
vii. Uniseriate hairs

i. Stinging Hairs –

These are most interesting type of hairs. It consists poisonous liquid/acidic sap in the basal bulb like structure from which cylinder of pointed structure is given out. The tip of such pointed needle like structure penetrates into the body of animal. When animal come in contact with such hairs the acidic sap secreted by the gland is injected into the skin of animal and causes irritation.

ii. Glandular Hairs –

Many plants possess glandular hairs. These hairs may secrete oil, resin, mucilage, poisonous acidic substances. Typical glandular hair posses stalk and elongated terminal portion which may be referred as gland. They may be uniseriate or multiseriate.

iii. Scales/Peltate Hairs-

It is common type of trichome (shield like). The scale consists of disc shaped plates or cells.

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Development of Trichomes/Hairs-

Trichomes are nothing but the protuberances or outgrowths of epidermal cells. These protuberances or outgrowths elongates and develops into multicellular structure.

Trichomes and Taxonomy –

On the basis of different types of Trichomes, we can classify different genera and species of plants.

Functions of Trichomes –

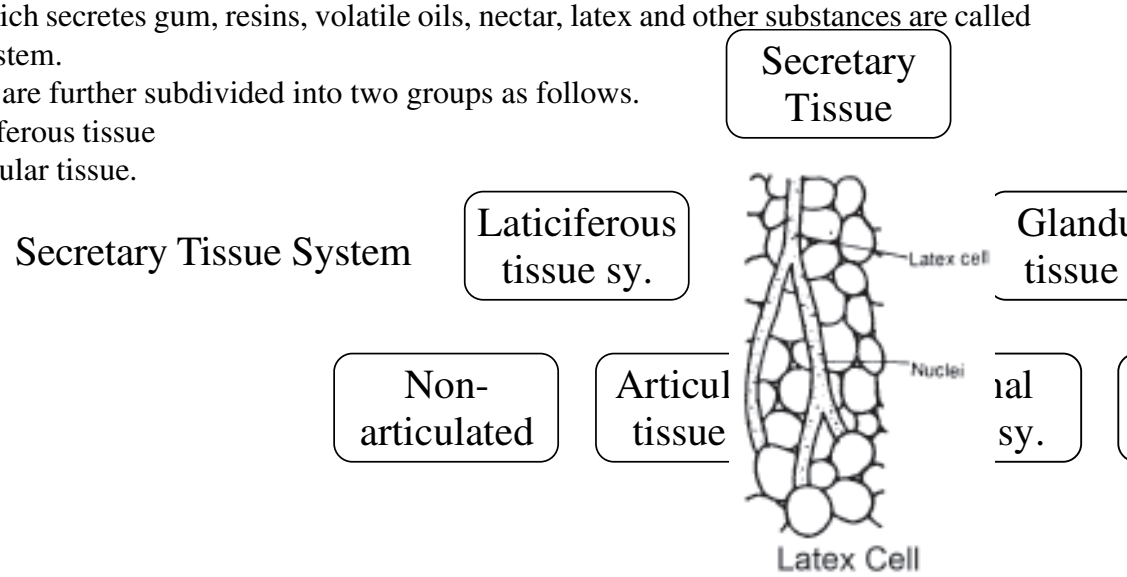
Generally dense covering of Trichomes controls the rate of transpiration. They also reduce the heating effect of sunlight. They protect the plant body from outer injuries, agencies like insects and animal. Glandular hair performs secretary and excretory functions.

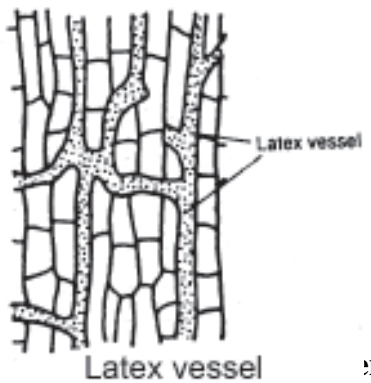
Secretary Tissue System

The tissue which secretes gum, resins, volatile oils, nectar, latex and other substances are called as secretary tissue system.

These tissues are further subdivided into two groups as follows.

1. Laticiferous tissue
2. Glandular tissue.





Latex vessel

ɛm –

It is made up of long branched or unbranched tubes or cells called the latex tubes or latex cells. They contain a colourless, milky or coloured fluid called the latex. The latex contains stored organic materials in the form of starch grains, alkaloids, tannins, enzymes, proteins, mucilage, rubber etc. The

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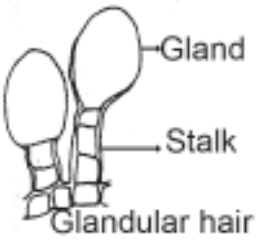
latex producing plants are mainly xerophytes. e.g. *Nerium*, *Euphorbia*, *Calatropis*, *Argemone*. It is of two types.

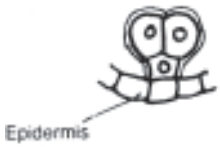
a. Latex Cells/Non-articulated Latex Ducts –

They are single cells that elongate and become tube like. The nuclei in the cells divide but are not separated by transverse walls. So these cells become multinucleate or Coenocytic. These cells may be branched or unbranched. They never form a network. The cells are full of latex e.g. *Nerium*, *Euphorbia*, *Ficus*, *Cannabis* etc.

b. Latex Vessels or Articulated Latex Ducts –



Glandular hair of ***Gerenium***



Glandular hair of ***Ocimum***

in The transverse walls of cells placed one above the oher a single row get dissolved to from a long vessel or a tube. This is called a latex vessel. It is full of latex. Adjoining latex tubes become interconnected by transverse or oblique rows of cells whose end walls also dissolve to form a latex tube that connects two longitudinally running vessels. These vessels may also become branched at a later stage. They are also called **syncyts**. e.g. *Argemone*, *Achrus*, *Havea*, Banana etc.

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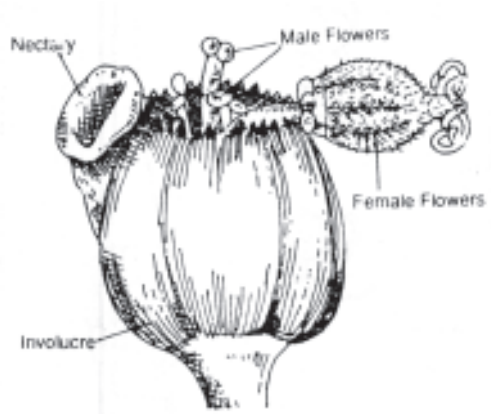
Nectory-disc in ***Citrus***



Cyathium with nectory in ***Euphorbia***

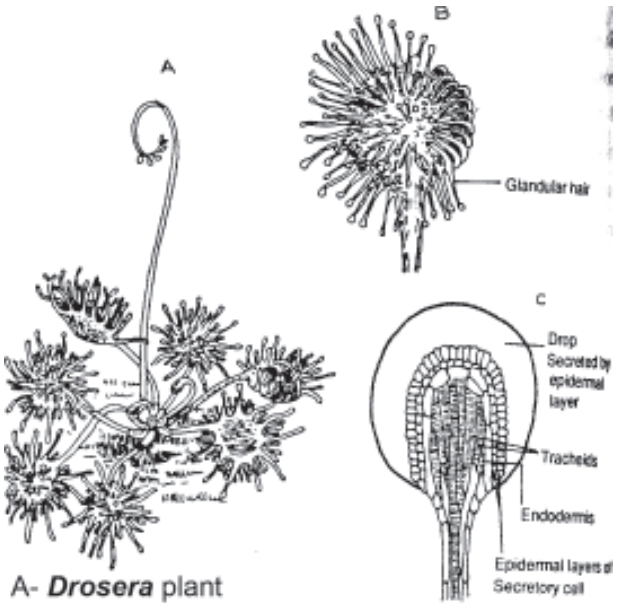
Glandular Tissue System:

Glandular tissue includes groups of cells or tissues concerned with secretion or excretion form the plant body. These tissues mainly consist of glands. These are various types of glands such as digestive glands which secrete digestive enzymes, nectar is secreted by nectarines. The glands are of two types.

A. External Glands
B. Internal Glands.

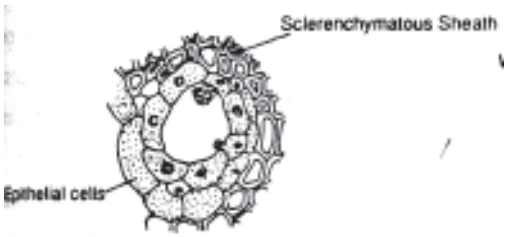
A. External Glands – They occur as glandular outgrowths on the epidermis of stems, leaves, fruits and flower. They are again of three types.

i. Glandular Hair –



A- ***Drosera*** plant
B -***Drosera*** leaf with glandular hair
C - Digestive gland in sectional view

These are multicellular hair that grow from epidermal cells and secrete products that may be mucilage (*Nymphea*), oil (*Geranium*) and poisonous acidic substances (*Utrica*). These hairs have a multicellular stalk and a globular head which secretes the products.

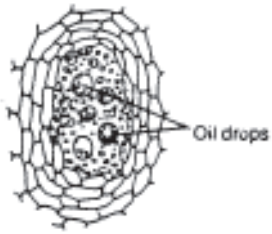


A - Resinduct of ***Pinus*** stem

also present on the leaves.

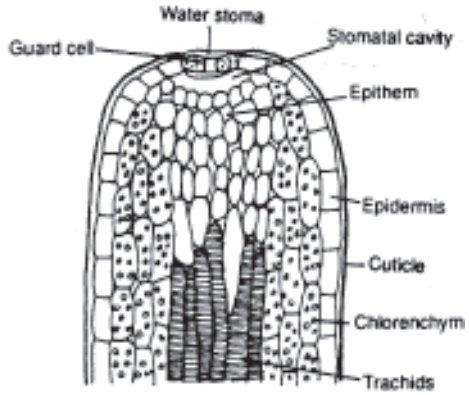
ii. Nectaries or Nectar Secreting Glands –

Nectaries are special structure that secrete nectar and are present on various organs of lower e.g. petal (Ranunculaceae), in the form of a disc below the ovary (Rutaceae) at the base of stamens (Brassica). They are



Oil duct from peel of ***Citrus*** fruit

iii. Digestive Glands –



Hydathode in L.S.

In certain insectivorous plants there are digestive glands which secrete a protein, digestive enzymes. These enzymes acts upon insect body and entire body of insect is broken down for absorption of the plant.

B.. Internal Glands –

There are many plants that possess glands embedded in the various tissues of roots, stems, leaves, flowers and fruits.

a. Resin duct - In Sunflower and Pinus there are resin ducts. In sunflwoer stem resin canals are found in the cortex. In Pinus the resin ducts are also found in the cortex, the

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secondary xylem of the stem and mesophyll of the leaf. The resin ducts are fromed schizo-genously (8) and having a lining of peripheral layers of parenchyma cells wit hdense protoplast which excrete resin.

b. Oil ducts- The plants belonging to the families Apiaceae, Asteraceae, Myrtaceae and Rutaceae possess oil ducts in the stem. the leave of Eucalyptus have oil ducts that secrete aromatic oils. the leaves and petals of Rutaceae also possess oil ducts.

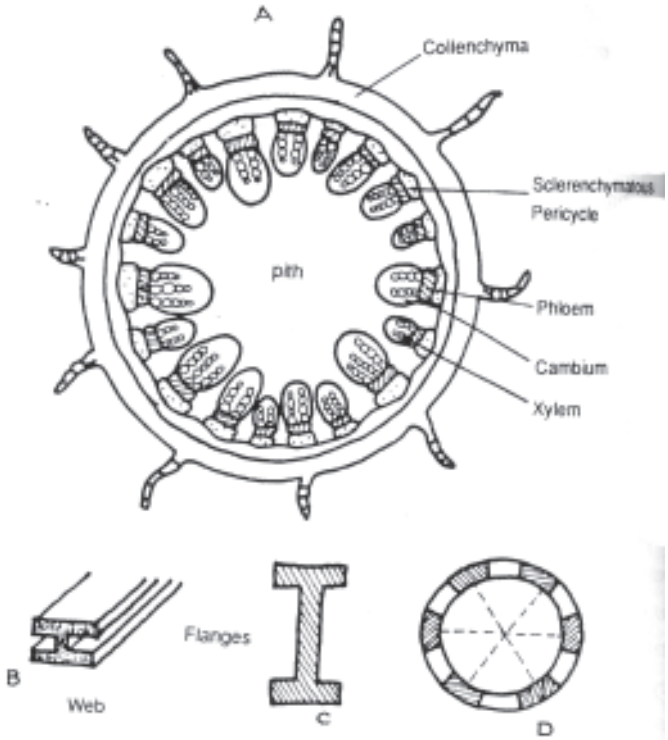
The characteristic oil glands present on the rind of citrus, lemon and organe fruits and in the leaves of Eucalyptus are formed lysigenously. The cavities remain filled up wit hessential oils due to disorganization of tissue. Oil ducts are spherical in shape and has a peripheral layer of thin walled and living secretory cells that secrete oil into a central cavity.

Hydathodes –

These are also called water stomata through which water exudes in the form of drops. They are found in the leaves of herbaceous angiosperms that generally grow in humid places. Hydathode occurs at the tips of leaves of some grasses or along the margins. The opening is called as water pores or water stomata, which differ from ordinary air stomata in their position at the ends of the veins, and is always remains open and their large size. Hydathodes have and aperture guarded by guard cells. Below the aperture is an air cavity, below which is loose tissue called epithem. Under beneath epithem there are tracheids.

Mechanical Tissue System

Definition: The group of cells or tissue which performs the function of mechanical support are called as stereome/mechanical tissues.



A-T.S.of Stem showing collenchymatous hypodermis and sclerenchymatous pericycle
B&C - 'I' girder
D - Cylinder formed by 'I' girders

Various organs of plant body are subject to mechanical injury from the forces of nature. Stems of herbaceous plants are subject to horizontal pressure on one side and compression on the other due to high winds. Woody trees have to bear the weights of massive branches and the crown of leaves. The roots are subject to radial pressure and are pulled up when the stem is shaken by high velocity of winds. Leaves are subject to pressure at right angles to the surface and the lamina is likely to be torn by winds. Massive branches are subject to bending pressure due to their own weight. To guard against there various injuries plants have developed a mechanical tissue system.

Mechanical tissue system is made up of four types of cells.

1. **Collenchyma**
2. **Phloem fibres**
3. **Sclerenchyma fibres**
4. **Sclereids**

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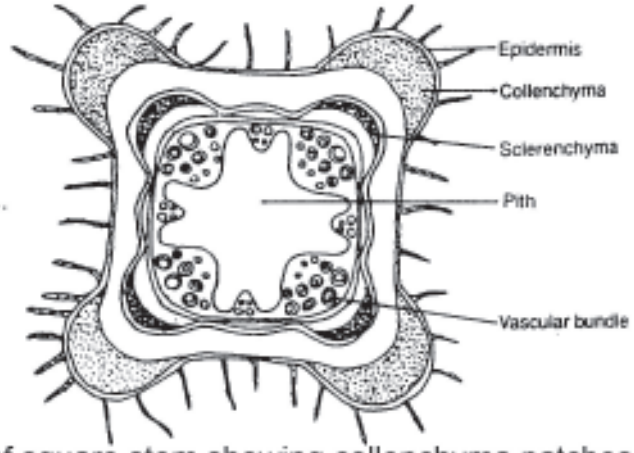
Lignified cells of the xylem tissue also give mechanical strength to the organ in which they are situated. A characteristic feature of these cells is they have their walls very much thickened due to cellulose or lignin and give rigidity to the organ in which they are developed.



T.S. of square stem showing collenchyma patches at the corners

Mechanical Tissues in Stem

A) In Herbaceous stem- The principle mechanical elements in herbaceous stems are the strands of sclerenchyma known as hard bast. Two strands of hard bast on opposite sides of the axis with intervening cells form 'I' shaped girders of mechanical tissue. The upper and lower flanges o the girders are formed by hard bast and the intervening cells from its web. Such girders can resist bending in a single plane.

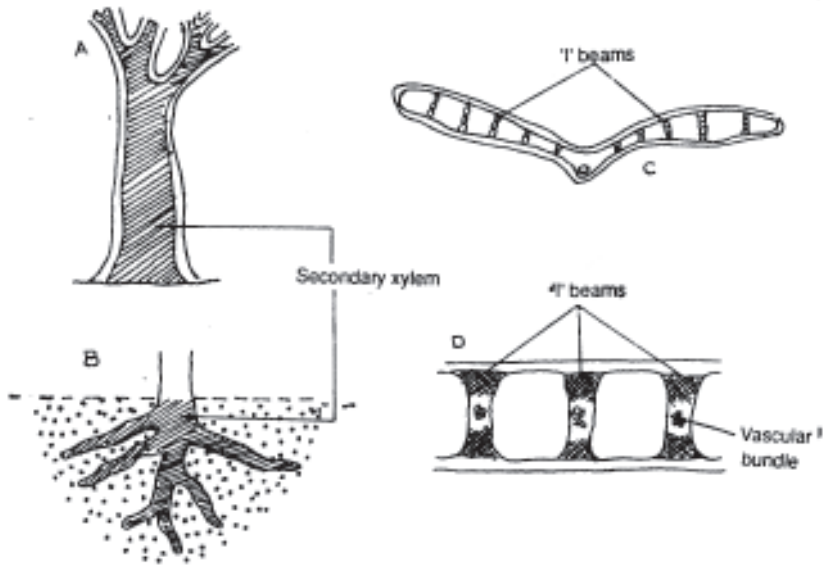


Fig. 3C·3
A Pillars of mechanical tissue in tree trunk. B Central cable like mass of secondary xylem in roots. C T. S. of *Pandanus* leaf showing 'I' beams of mechanical tissue. D T. S. of Hemp leaf showing the same.

B) In Square stem- Square stems are subject to greater pressure of wind and rain at the angles. They possess strands of mechanical tissue at the four corners. Thus in ***Torenia*** there are strands of collenchyma at the angles. Square stems are common in the family Labiatae. In angular stems there are patches of collenchyma as in the African marigold ***Tagetes & Cucurbita***. These vertical strands of mechanical tissue prevent bending and give strength to the axis.

In several plants patches of sclerenchyma are present on the outside of the vascular bundles. Such sclerenchymatous patches again represent flanges of a girder.

C) In Woody shrubs and trees- The main tree trunk has to bear the weight of its own massive branches and heavy crown of leaves, which may be compared to putting a load at the top of the cylindrical axis. Here the tree trunk is subjected to longitudinal compression. Longitudinal pressure of this sort requires columnar strength. Threes also suffer from horizontal pressure of winds. Thus the trunk of trees is

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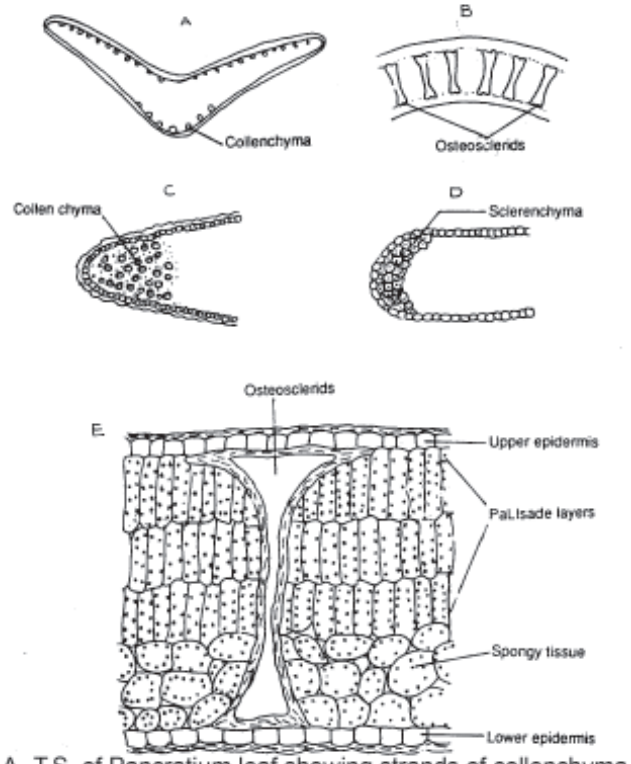
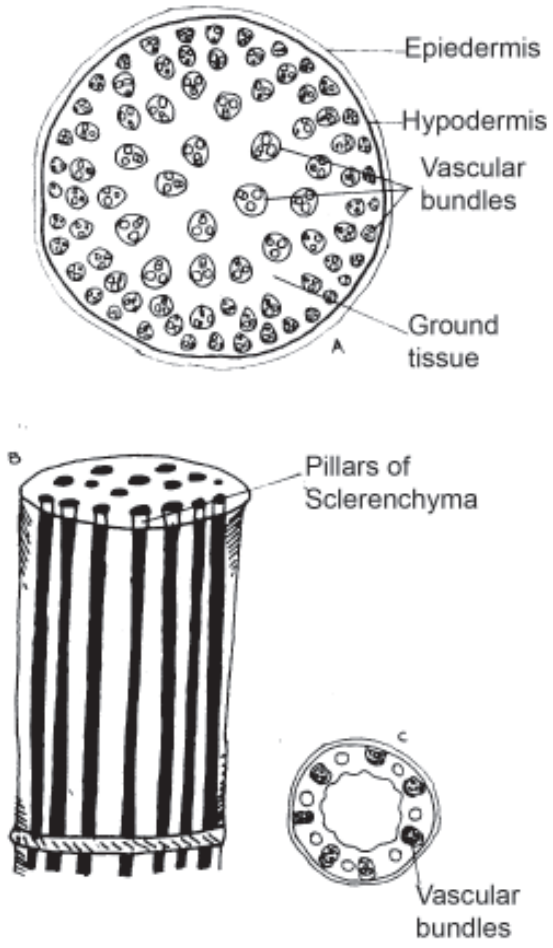
subject to both longitudinal and horizontal pressure. Their mechanical tissues are effe3ctively aggregated at the central portion which serves as a solid column for withstanding longitudinal compression. The central portion of tree trunk is made up of dead cells of secondary xylem with thick and lignified \walls. It is comparable to pillars of re-enforced concrete used in building construction. The mechanical tissue enables the trees to resist the pressure of winds and flood water and support weight of massive branches. Woody shrubs also have their mechanical tissue of secondary xylem.



A- T.S. of Pancratium leaf showing strands of collenchyma
B& E- Osteosclerids in Hakea & Osmanthus leaf resp.
C- Collenchyma at the margin of Pancratium leaf
D- Sclerenchyma in Eucalyptus

D) In Roots- the weights of the stem are uniformly distributed over the root system and are subjected to longitudinal compression. Roots are generally subject to considerable tension especially when the stems sway in the high velocity of winds and roots are pulled upwards. Thus they are subject to pull along the long axis. When the trees are uprooted due to shaking of the stem in high winds they suffer from radial pressure of the soil in which they are firmly fixed. In summer season roots are subjected to radial pressure due to contraction of the soil on losing its moisture by evaporation. In young roots the peripheral mechanical cylinder is most effective means of resisting radial pressure. The mechanical tissues of old roots are made up of central cable like mass of secondary xylem. The cable like mechanical tissue enables the roots to resist both longitudinal and radial pulls.

E) In Leaves – The leaves are generally prone to transverse flexion at right angles to their surface because by they are bilateral organs. They are also prone to tearing and cutting effects by high winds. Leaves can resist these injuries by peculiar mechanical elements. The frame work of mechanical tissue is formed in leaf lamina by the midrib, secondary veins and vein-lets. The midrib and secondary veins possess hypodermal collenchyma and veinlets are mostly made up of lignified xylem vessels and tracheids. This vein skeleton of mechanical tissue enables the lamina to resist the pressure of winds at the surface. Leaves have special arrangement for protection by increased



A - T.S. of Maize stem showing sclrenchymatous hypodermis and vascular bundles.
B - Monocot stem showing pillars of sclerenchyma
C - T.S. of Cyperus stem