UNIT - II :⇒ Tissue System In Plants

Introduction :⇒

Meristematic tissue divides, redivides and adds new cells continuously in plant body. These new cells retain their meristematic activity but some of the cells stop dividing and acquire certain changes. Those cells which can't divide further are called "parmanent cells" and group is called as "parmanent tissue".

"The process in which meristematic tissue changes into parmanent tissue is called as differentiation".

There are three types of parmanent tissues those are as follows :

1) Simple tissues
2) Complex tissues
3) Secretory tissues

1) Simple tissues :⇒

→ These are the group of parmanent tissues of same origin, structure and function.

→ simple tissues are of three types such as -

ⓐ Parenchyma
ⓑ Collenchyma
ⓒ Sclerenchyma

ⓐ Parenchyma :

→ These are the most common simple tissues found in all plant parts

→ These are parmanent and living tissue.
→ These are composed of thin walled, isodiametric cells having intercellular spaces inbetween them.
→ These tissues are different in their shapes such as oval, spherical, rectangular, stellate or cylindrical.
→ These tissues occurs in cortex, medullary rays, mesophyll and fruit pulp.
→ These are the most fundamental and ground tissue.
→ In plant body most of the specialized tissues are derived from parenchyma.
→ The main functions of parenchyma are manufacture of food material and slow conduction of food material.
→ These parenchyma are again differentiated into following types :-

i) Palisade parenchyma
ii) Spongy parenchyma
iii) Chlorenchyma
iv) Storage parenchyma
v) Aerenchyma
vi) Stellate parenchyma

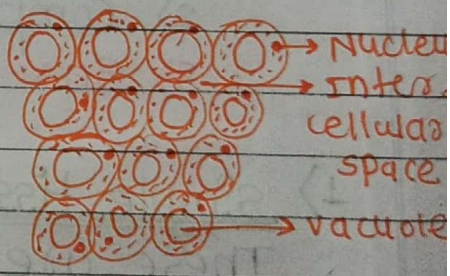


Fig. Parenchyma tissue

i) Palisade parenchyma :⇒

It is a group of compactly arrenged elongated or columnar cells which are rich in chloroplast.
→ Palisade parenchyma present below the epidermis.

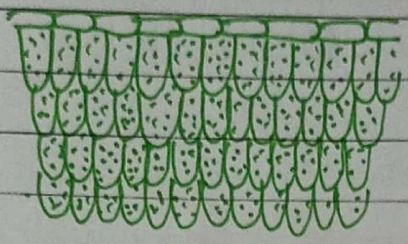


Fig. Palisade Parenchyma

ii) Spongy Parenchyma :⇒

"A group of parenchymatous cells with irregular shape and size are called as spongy parenchyma."

→ These spongy parenchyma has intercellular spaces inbetween them.
→ These are rich in chloroplast.
→ Generally spongy parenchyma are present in mesophyll layer of leaves.

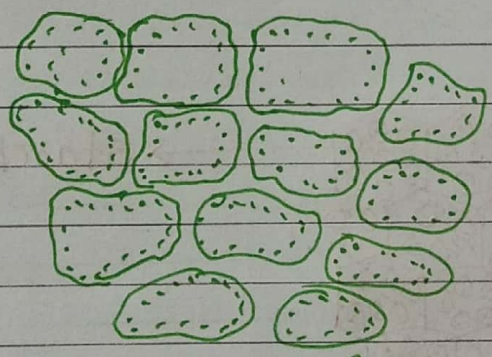


Fig. Spongy Parenchyma

iii) Chlorenchyma :⇒

"These are the parenchymatous cells which are rich in chloroplast."

→ These are present in green parts of the plant.
→ Main function of chlorenchyma is photosynthesis.

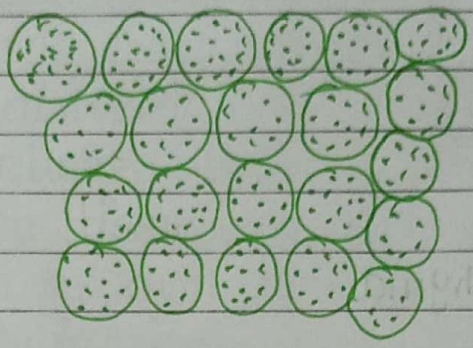


Fig. Chlorenchyma

iv) Storage parenchyma :⇒

" A group of parenchymatous cells which store starch grains in large amount are called storage parenchyma".

→ These parenchyma are found in stem modifications. e.g. stem tubers, rhizomes, corms.

→ These are also found in root tubers like sweet potato.

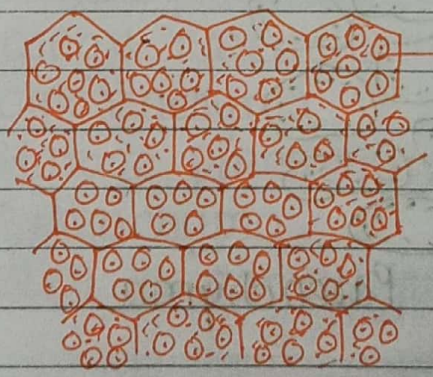


Fig. Storage parenchyma

v) Aerenchyma :⇒

"Parenchymatous cells which has large air spaces or ~~air~~ cavities which are filled with airs."

→ It is common in aquatic plants.
→ With the help of aerenchyma plants floats in water.
e.g. Lotus, Marsilea, etc.

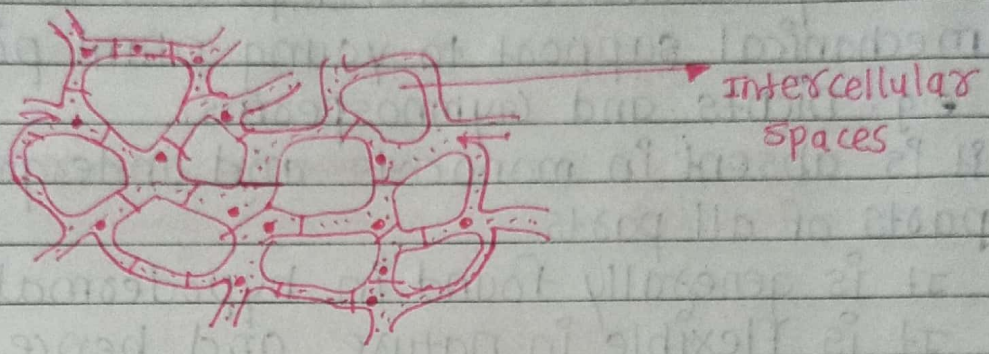


Fig. Aerenchyma

vi) Stellate Parenchyma :⇒

"A group of star-shaped parenchymatous cells are called stellate parenchyma".

→ These are commonly foun

Fig. Stellate Parenchyma

(b) Collenchyma :⇒

→ These are simple, thick walled parenchymatous cells.
→ These are living tissues.
→ These are more or less elongated in cross section.
→ cells are thick due to additional deposition of cellulose, hemicellulose and pectin.
→ Primary function of collenchyma is to give mechanical support to young plant parts.
e.g. Dicots and Gymnosperms.
→ It is absent in monocots and underground parts of all parts.
→ It is generally found in hypodermal region.
→ It is flexible in nature and hence plant will be protected by bending and pulling actions of wind.

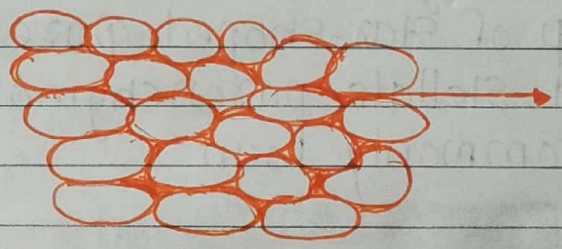


Fig. Collenchyma

→ Collenchyma are compactly arrenged without intercellular spaces.
→ These cells are also founds in the margin and petiole region of leaf, due to which leaves are not damaged during high wind.

→* Based on deposition of pectin/cellulose/Hemicellulose on wall, 3 types of collenchym are there :⇒

1. Lamellar collenchyma
2. Angular collenchyma
3. Lacunar collenchyma

(1) Lamellar Collenchyma :⇒

→ These are also called as plate collenchyma.
→ Pectin is deposited on tangential walls i.e. tangential walls are thick as compare to radial walls.

e.g. Raphanus

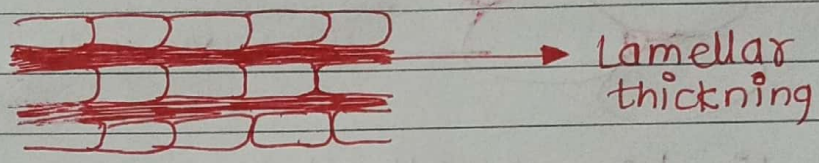


Fig. Lamellar collenchyma

(2) Angular Collenchyma :⇒

Thickning occurs at the corners or angles of cells due to which collenchyma forms thick compact nature.

e.g. Datura, Lycopersicon

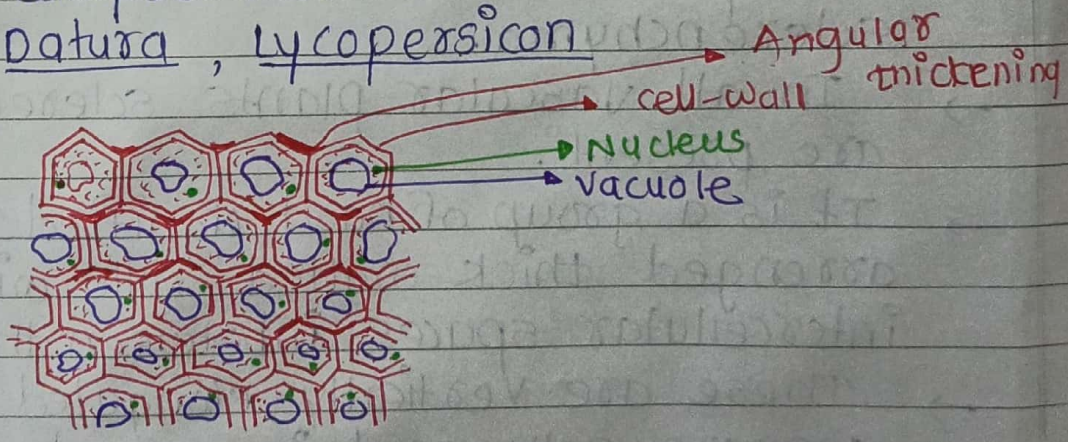


Fig. Angular collenchyma

(3) Lacunar collenchyma :⇒

→ These are also called as tubular collenchyma.
→ Thickning is restricted to the walls of regions bordering air spaces.
→ They have thick intercellular spaces.
→ These are also called as "Lacunate" parenchyma.

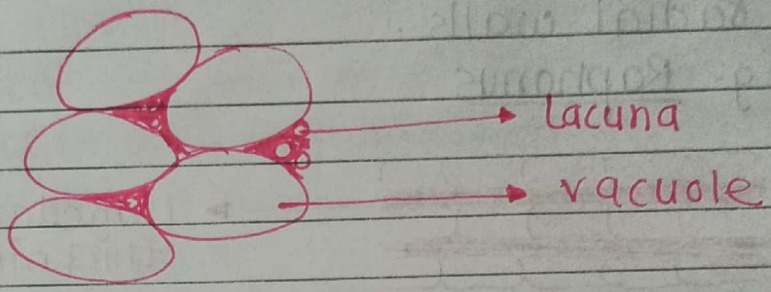


Fig. Lacunar collenchyma

(C) Sclerenchyma :⇒

→ These are simple parmanent tissue.
→ These are dead tissues.
→ Protoplasmic content is absent in sclerenchyma.
→ In all vascular plants sclerenchyma are present.
→ It is a group of hard lignified, compactly arrenged thick-walled cells without intercellular spaces inbetween them.
→ These are vertically elongated and appears polygonal in cross section.
→ The main function of sclerenchyma is to give mechanical support to plant.

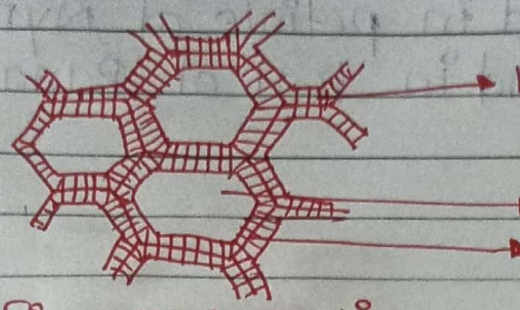


Fig. cross-section of sclerenchyma

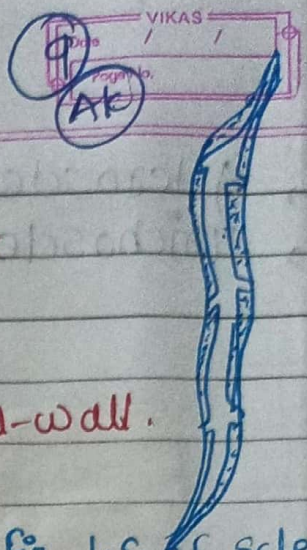


fig. L.S. of sclerenchyma.

Sclerenchyma are of two types which are as follows :

1) Sclereids
2) Fibres

(1) Sclereids :⇒

→ Sclereids are thin walled spherical, oval or some are stellate shaped.
→ These have hard walls.
e.g. endocarp of coconut, seed coat of pea and bean.
→ They have simple / branched pits.
→ Sclereids are isodiametric and elongated in shape.
→ These are also called as stone cells.
→ Sclerieds are of different types such as Brachysclereids, macrosclerieds, osteosclereids, Asterosclereids, Trichosclereids.
→ Brachysclereid's are found in fleshy edible part of fruit.
→ Macrosclerieds are found in epidermal cells of seed coat.
→ Osteosclereids found in seed coat.

→ Asterosclerieds found in petiole of Nymphea.
→ Trichosclerieds found in leaf of Banana.

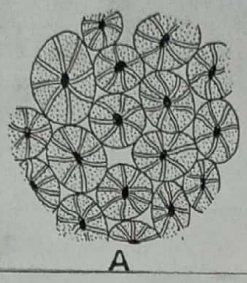


Fig. T.S. of Sclereids

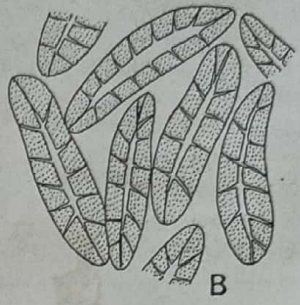


Fig. L.S. of sclereids

② Fibres :⇒

→ Fibres are long, narrow, elongated with pointed ends.
→ They have simple pits.
→ They gives mechanical support/strength and provide rigidity to plant organs.
e.g. stem, roots, vascular bundles.

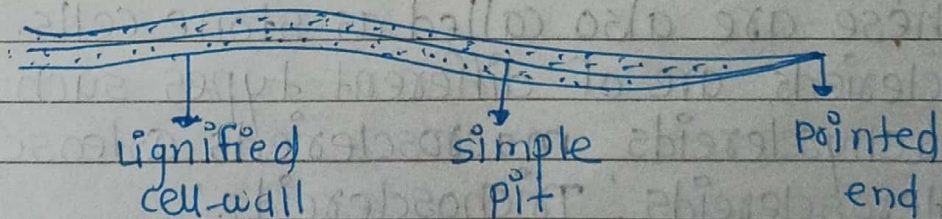


Fig. A fibre

PHLOEM:

Phloem is a living complex vascular or conducting tissue. It is also called as bast because the phloem fibres of some plants are used in binding purposes. It is heterogenous in nature. The primary function of the phloem is the conduction of food material in dissolved form generally from the green leaves to the storage organs and growing tips of the plant body.

It is composed of four different kinds of constituent elements called the phloem elements such as

1. Sieve tubes
2. Companion cells
3. Phloem fibres
4. Phloem parenchyma

Sieve Tubes:

The sieve tube is slender, tubular, structures made up of elongated, thin walled cells placed end to end in several vertical rows. The sieve tubes have many transverse walls in their structure. The transverse walls are perforated and are called as sieve plates. The sieve plates are oblique or horizontal in position. The sieve tubes contain a stream of protoplasm with dissolved food material which passes through the perforated sieve plates. The sieve tubes are mainly concerned with the longitudinal transportation of soluble food material.

Companion Cells:

The elongated, thin walled cells in association with the sieve tubes are called the companion cells. The companion cells contain vacuolated protoplasm and elongated nucleus. These cells help the sieve tube in the conduction of food material.

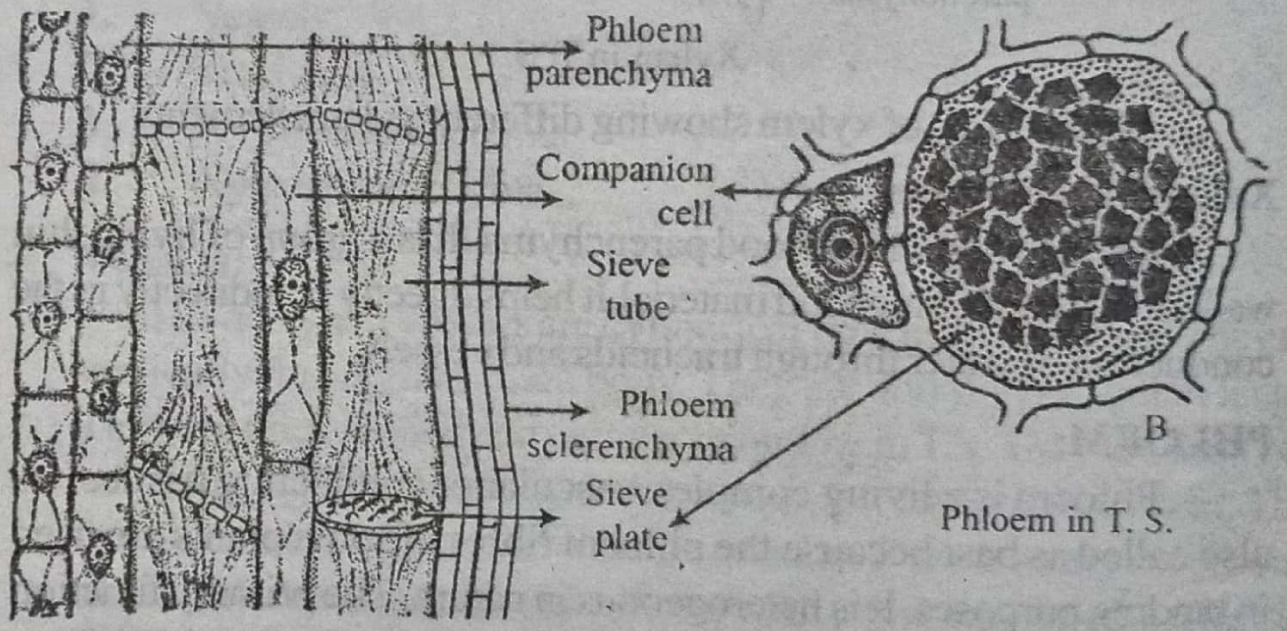


Fig.2.5 (A-B). L.S. and T.S. of phloem showing different phloem elements

Phloem Parenchyma:

These are the short, cylindrical, thin walled cells. They usually store the food material and help in the conduction of the same. These are absent in monocots.

Phloem Sclerenchyma:

These are narrow, dead, thick walled cells with narrow lumen

(cavity). These are also known as phloem fibres or bast fibres (fibres used in binding the material)

SECRETORY TISSUES

Many plants contain certain isolated, special groups of cells which secret certain substances, secrete some waste material as a results of their metabolic activities called the secretory tissues. The secretory tissues are metabolically more active than the normal tissues. The secretory tissues are of two types such as

1. Laticiferous tissues
2. Glandular tissues

Laticiferous Tissues:

A group of special cells which secrete a juice called latex or some other substances like starch, proteins, tannins, enzymes etc. is called the laticiferous tissuses. The cells of this tissue are thin walled, elongated, tubular and embeded in the ground tissuse of the plant body. The laticiferous tissue are very common in the members of family ***Euphorbiaceae, Apocynaceae, Asclepiadaceae, compositae*** etc. These tissues secrete the latex (juice) of different colours such as milky, white, yellow, some are colourless etc.

The laticiferous tissues protect the plants from the attack of animals. They may also serve as the reservior of various substances. It is also believed that, they may act as the transporting system inside the plant body. The laticiferous tissue is of two types.

1. Latex cells
2. Latex vessels

Latex cells:

Latex cells are tubular, branched or unbranched, independent, uninucleate and unicellular. They become multinucleate due to the free nuclear divisions. These cells never fuse with each other. They protect the plants from the attack of animals. They are very common in *Calotropis, Euphorbia* and *Nerium* etc.

Latex vessels:

These are composed of latex cells which are placed end to end

with their transverse wall. They may be simple or branched. They form a sort of network by fusion at various places. These are more common

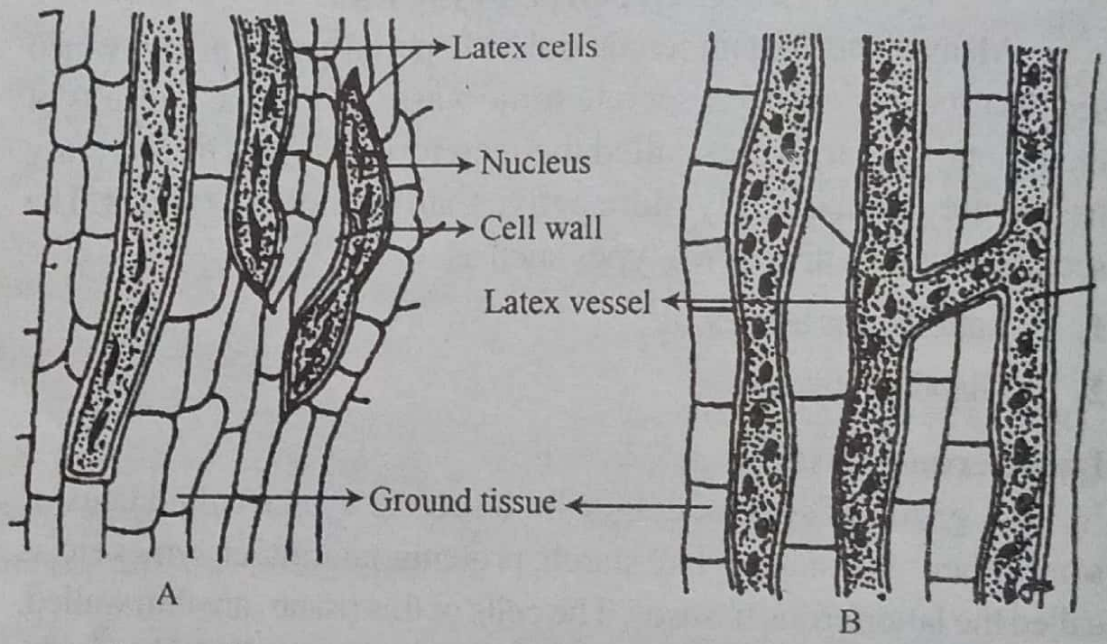


Fig.2.6 (A-B). Types of laticiferous tissues

in *Argemone, Manihot, Hevea, Opium* etc. They store starch as a food. Some time it is poisionous to protect the plant from grazing animals. Latex of ruber (Hevea) yields ruber of commerce.It is of great industrial importance.

Glandular Tissues or Glands:

The secretory tissues present in the form of glands are called the glandular tissues.The glands are the specialised groups of cells having capacity to secrete certain products by cytoplasm. The secretion includes gums, honey etc. On the basis of position, the glands are classified into two types such as

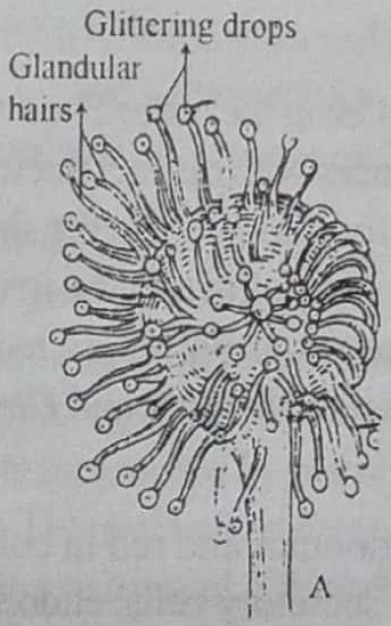
1. External glands
2. Internal glands

External glands:

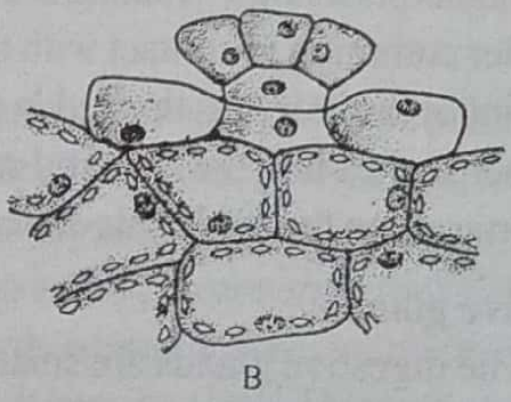
The glands occuring externally on the plant organs as an outgrowth are called the external glands. The common external glands are such as

1. Glandular hairs

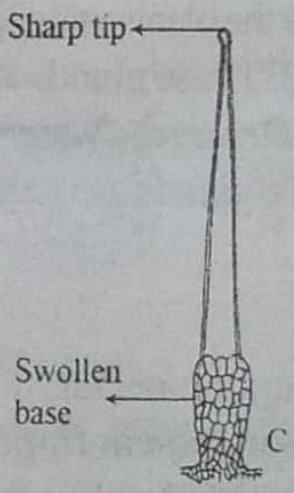
2. Stinging hairs
3. Digestive glands
4. Nectary glands



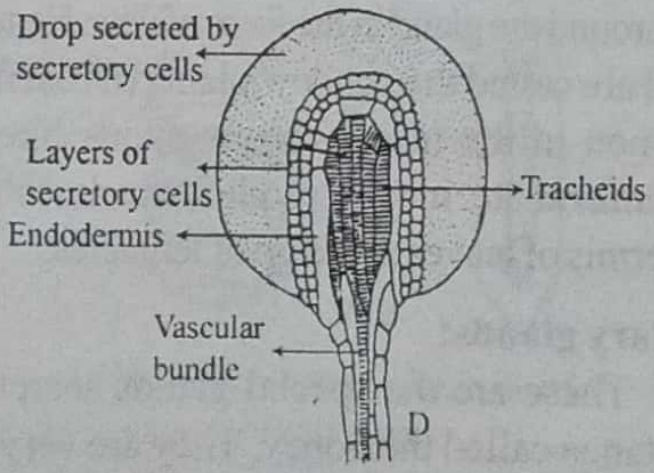
Leaf of Drosera Showing glandular hairs



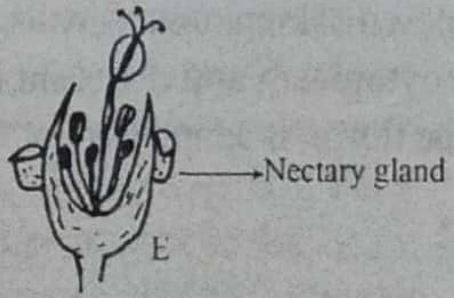
Glandular hair of Pinguicula



Stinging hair



A digestive gland of Drosera



Cyathium infloroscence with nectaries

L.S. of nectary gland

Fig.2.7 (A-F). Types of external glands

Glandular hairs:

They are present on epidermal region as an outgrowth. They are unicellular and multicellular, thick walled, living and with distinct nuclei.

Stinging hairs:

They are stiff, unicellular and swollen at the base. The swollen base contains poisonous, irritating substances with distinct nuclei. The hairs after comming in contact with the foregion bodies the sharp or stiff point of the hair gets thersed in the body skin and the irritating substance rushes into the skin and causes irrtation. These hairs are very common on the epidermis of plants like ***Mucuna*** and ***Utrica.***

Digestive glands:

The digestive glands are small, globular and red in colour.A digestive gland is composed of layer of secretory cells, endodermis and terminus of vascular supply. The cells of the secretory layer secrete the digestive juice containing digestive enzymes. This juice is collected in or around the gland in the form of dew. Hence the plants with digestive gland are called the sundew plants (Drosera). These glands are very common in the insectivorous plants like ***Drosera***, ***Nepenthous, Utricularia*** etc. in mereus plant the digestive glands are part an the epidermis of leaves at the tip of tentacles.

Nectary glands:

These are the special glands secreting the nectar, a sugary substance called the honey. They are very common in ***Euphorbia.*** The nectary glands are well developed, yellowish, cup like structure present externally on the outer surface of involucre of the cyathium inflorescence. The glands composed of longitudinal, palisade like layer of secretory cells with dense cytoplasm and different nucleus, the presence of nectary glands in the flower is adaptation for the attraction of insects for pollination.

Internal glands:

The glands occuring internally in the plant body are called the internal glands. The oil glands, resin ducts and hydathodes are some common internal glands.

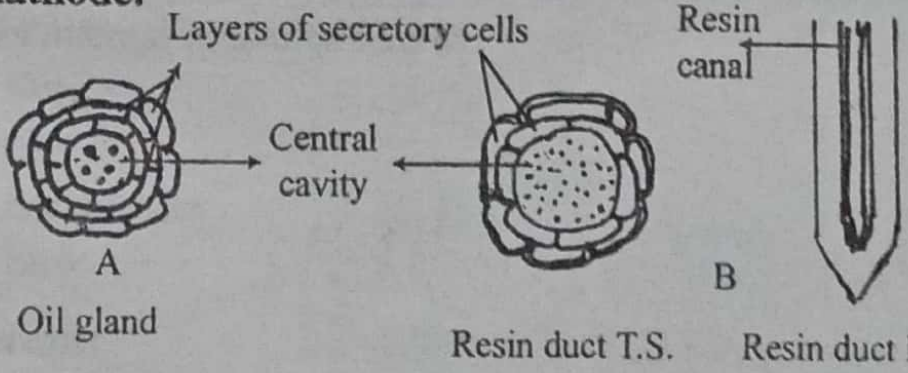
Oil glands:

The oil glands are composed of many layered thin walled living secretory cells and a central cavity. The secretory cells secrete a volatile oil which is stored in central cavity. The oil glands are spherical in outline and they are very common in the members of ***Rutaceae, Myrtaceae, Asteraceae, Apiaceae*** etc.

Resin ducts:

Resin ducts are resin secreting glands. These are present in the form of longitudinal canals passing from root to stem through the cortical and pith region. The ducts are very common in Gymnosperm. Each duct is surrounded by one or two layers of secretory cells which secrete resin. This resin secreation directly poured into the central cavity. Resin is yellowish liquid. When drys, it becomes hard. Due to the hard resin the plant gets mechanical strength and the wood becomes durable. The resin is used in the manufacture of perfumes, soaps and medicines.

Hydathode:



It is also called as water stomata. They are generally found in grass leaves along the margin at the end of veinlet in the form of circular deperation. They are special organs through which exudation of water mixed with salts takes place. They are generally present at the tip or margin of leaves of plants growing in moist place. Generally water drops are seen along the margin on the leaves and indicate position of the

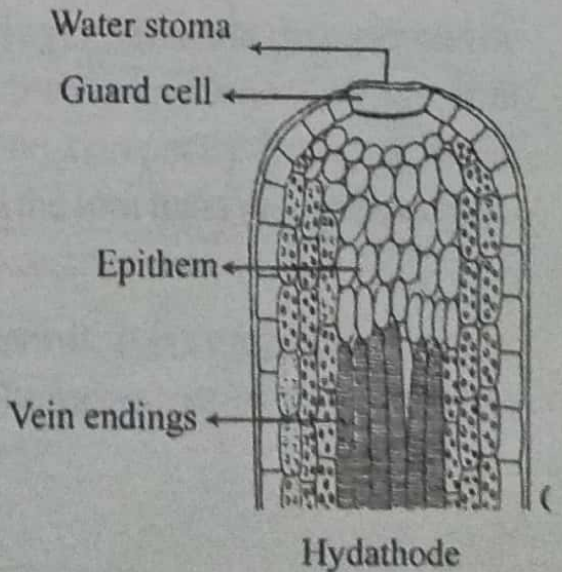


Fig.2.8 (A-C). Types of internal glands

hydathodes. Each hydathode has a mass of loosely arranged cells with large intercellular spaces called epithem. The epithem lies above the vein ending and is connected with external atmosphere through a pore in the epidermis called as water stomata. The water stomata are garded by colourless cells called the guard cells. The guard cells of water stomata are small and devoid of chloroplast.

***

Epidermis is made up of two Greek words—Epi = **upon** and derma = **skin**.

It is a system of cells, constituting the outer covering of the primary plant body and is variable in structure and function. Epidermis is the tissue, originated from the protoderm. The epidermis of roots, according to some workers, differs from that of the shoot in origin, structure and function. It has, therefore, been given a separate name **epiblema**, **rhizodermis** or **piliferous layer**. In broader sense, however, the term epidermis is used to represent the superficial layer of cells of the primary plant body—root, stems, leaf, flower, fruit and seed etc. Due to the presence of many types of hairs, stomatal guard cells and several other specialized cells, the epidermal cells are not uniform in morphology and function.

Cutin is a fatty substance synthesized in living protoplast and migrate to the surface through the cell wall. It is usually present in the outer wall of the epidermal cells, and constitute a layer called **cuticle**. The process of impregnation with cutin is called **cutinization** (cutin formation = cuticularization). Cutin stains red with Sudan IV. Cuticle is absent from the actively growing parts of roots. It is of varying thickness in different plants, and is thicker normally in those plants growing in dry habitats. The surface of cuticle may be smooth, rough, ridged or furrowed. Deposits of wax in the form of granules *e.g.*, in *Brassica*, *Dianthus* or in shape of **rods** as in *Saccharum* or may be in the form of a continuous layer *e.g.*, in *Thuja*, may be present outside the cuticle. In *Agave*, a **wax layer**, is found below the cuticle.

Urticaceae, Cucurbitaceae, etc. In Cruciferae, **myrosin**—sac like secretory cells containing the enzyme, are present. They stain red in **Millon's** test.

2. Stomata

(Stoma = singular; stomata = plural)

Stomata are the minute units of the epidermal tissue system. These are the openings (stomatal pores or apertures) in the epidermis, limited by two specialized cells termed the **guard cells**. The guard cells together with the opening form **stoma**.

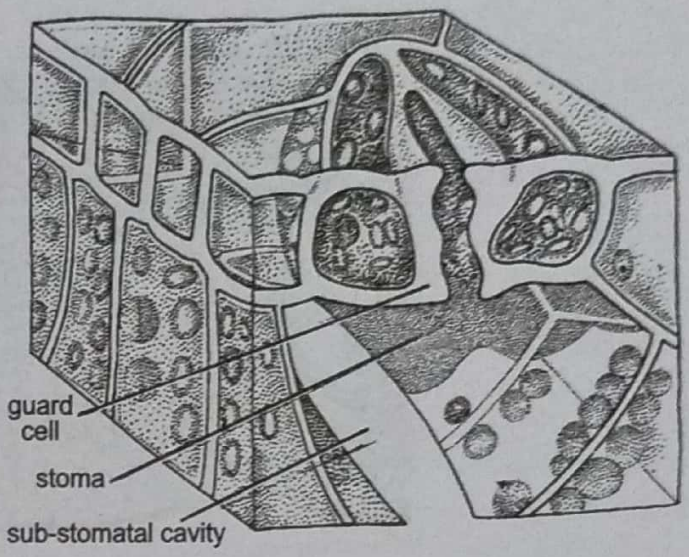


Fig. 3. Stoma.

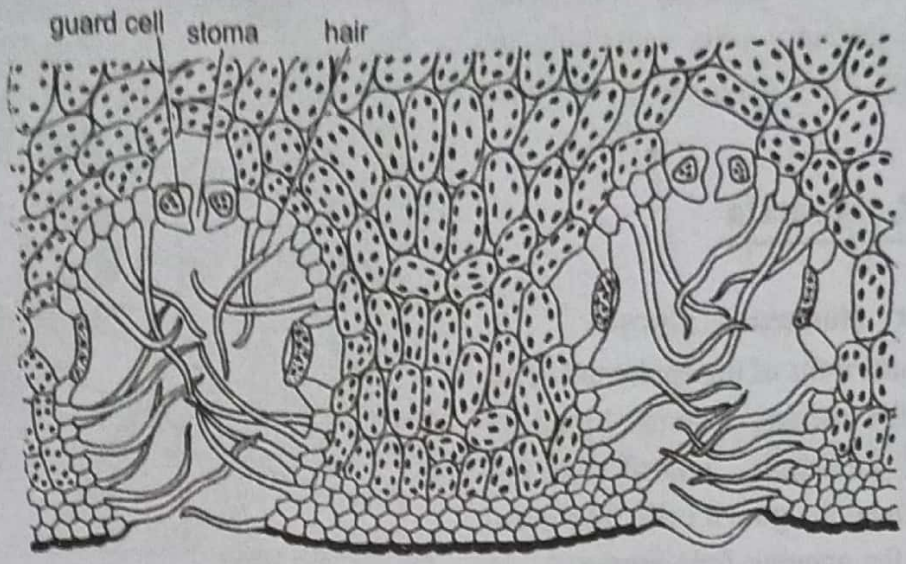


Fig. 4. Sunken stomata in the leaf *Nerium*.

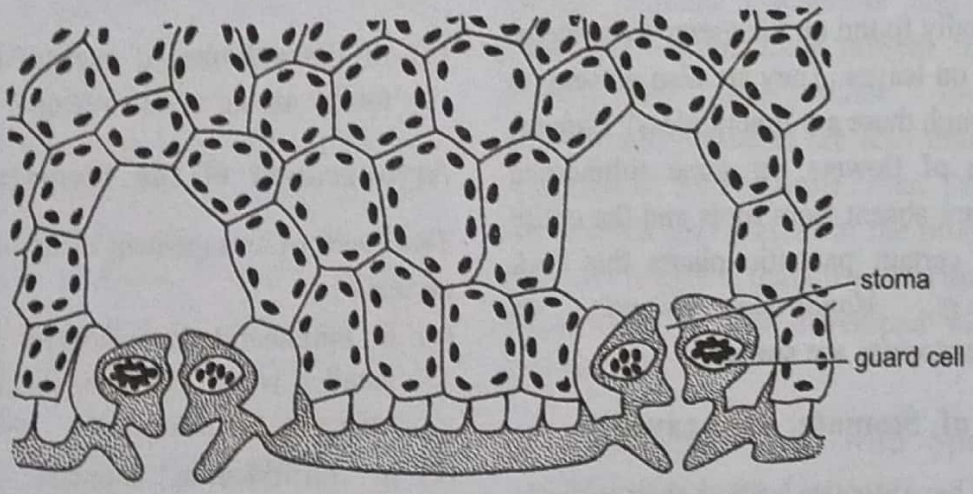


Fig. 5. Sunken stomata in the leaf of *Agave*.

Structure of the Stomata

A stoma consists of a pore surrounded by two guard cells. The epidermal cells adjoining the guard cells often differ in size or arrangement from the rest of the epidermal cells and are called the **subsidiary cells**. The stomata together with the subsidiary cells, is sometimes termed as **stomatal complex**.

Functions of guard cells. Due to the unevenly thick walls, the guard cells are helpful in the opening and closing of the stomata.

Types of Stomata

On the basis of number and arrangement of the subsidiary cells, **Metcalfe** and **Chalk** (1951) found the following types of stomata :

1. Anomocytic. (Irregular celled or Ranunculaceous according to Solereder). The surrounding cells or subsidiary cells are **indefinite in number** and do not differ from the other epidermal cells. *e.g.*, Ranunculaceae, Malvaceae and Papaveraceae, etc.

2. Anisocytic. (Unequal celled or Cruciferous type according to Solereder). Usually 3 subsidiary cells surround the stoma, one cell being considerably smaller or larger than the other two *e.g.*, Cruciferae, *Solanum* and *Nicotiana*, etc.

3. Diacytic. (Cross celled or Caryophyllaceous type according to Solereder). Two subsidiary cells surround the stoma with their common walls at right angels to the guard cells, *e.g.*, Caryophyllaceae, Acanthaceae.

4. Paracytic. (Parallel celled or Rubiaceous type-according to Solereder). One or more (often 2) subsidiary cells are present with their longitudinal

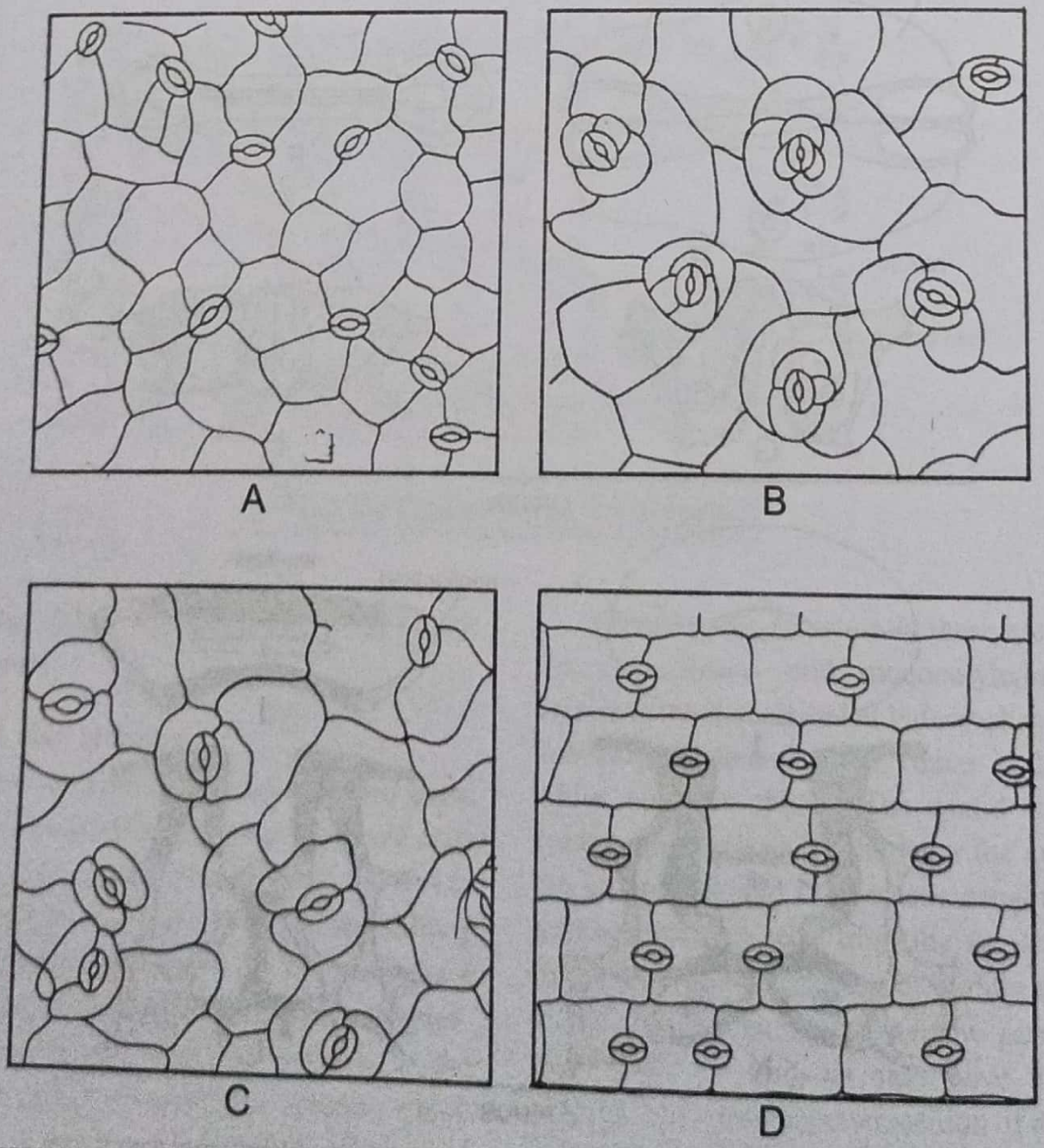


Fig. 7. Epidermis in surface views illustrating patterns formed by guard cells around neighbouring cells. **A.** *Citrullus*, anomocytic, **B.** *Sedum*, anisocytic; **C.** *Vigna*, paracytic, **D.** *Dianthus*, diacytic.

axis parallel to the guard cells, *e.g.*, Rubiaceae, Magnoleaceae.

5. Antinocytic. Four or more subsidiary cells, elongated radially to the stoma, *e.g.*, in Araceae, Commelinaceae, Musaceae.

6. Cyclocytic. Four or more subsidiary cells, arranged in a narrow ring around the stoma *e.g.*, Palmae, Pandanaceae, Cyclanthaceae (Fig. 7).

On the basis of ontogeny three categories are formed :

1. Mesogenous. The subsidiary cells have a common origin with guard cells. *e.g.*, *Thunbergia* (Fig. 9).

2. Perigenous. The subsidiary cells do not have a common origin with the guard cells, *e.g.*, *Avena sativa* (Fig. 10).

3. Mesoperigenoas. At least one of the subsidiary cells have a common origin with the guard cells but the others are not.

Haplocheilic and syndetocheilic stomata (Stomata of gymnosperms). These both types of stomata were described by **Florin** (1951) for Gymnosperms. The subsidiary cells may or may not be related to the guard cells ontogenetically.

Haplocheilic type. The subsidiary cells are not related to the guard cells. (This type corresponds to perigenous type but this term now-a-days is not used) *e.g.*, *Cycads, Conifers, Ginkgo*.

Syndetocheilic type. The subsidiary cells have a common origin with guard cells. A protodermal cell divides into a guard mother cell and two lateral cells, each of which either becomes a subsidiary or cell gives rise to subsidiary cell by divisions *e.g.*, *Gnetum, Welwitschia*.

Functions of stomata. (i) Interchange of gases between atmosphere and the plant body. (ii) These are meant for transpiration.

3. Epidermal Appendages

The outgrowths are present on the epidermis, termed as **epidermal appendages**. These are of two types :

1. Trichomes. All unicellular and multicellular appendages of the epidermis are designated by the term Trichomes.

2. Emergences. More massive structure, such as warts and spines. *e.g.*, thorn of rose consisting of epidermal as well as subepidermal tissues are called emergences.

Trichomes

The four more common types of trichomes are : **hairs, collectors, water vesicles** or **bladders** and **root hairs**.

1. Shoot hairs. Hairs form the chief appendages of the epidermis. These may be unicellular or multicellular. A unicellular hair may be unbranched *e.g.*, *Salvia plebia* or branched *e.g.*, *Aerua* sps. or stellate *e.g.*, *Sida* sps. A multicellular hair commonly have foot embedded in the epidermis and a body projecting out. Hairs are present on stem, root, leaves, gynaecium and androecium, etc. The wall of the hairs is made up of cellulose. Hairs are of great use in Taxonomy. On the basis of the hair structure several plants may be

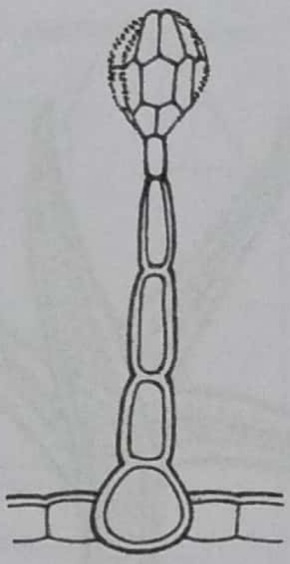


Fig. 12. Colleters of *Ononis matrix.*

classified. The hairs may be glandular or non-glandular. The **glandular hairs** consist of a **head** and a **stalk** and secreting a sticky substance. Such types are mainly present on the insectivorous plants. Shoot hairs may be either branched or unbranched.

2. Colleters. Glandular trichomes which secrete a sticky substance and which usually consist of a multicellular stalk and head, are termed as colleters. Such trichomes are mainly found on budscales and stipules, *e.g.*, *Rosa* and on the calyx *e.g.*, *Plumbago.*

3. Water vesicle or bladder. The epidermal cell becomes much enlarged to reserve the water (Fig. 13). These are also known as **vesiculate hairs** *e.g.*, *Atriplex.* When the vesicle dries out during maturation, the salt content remains on the leaf surface as a white, powdery layer.

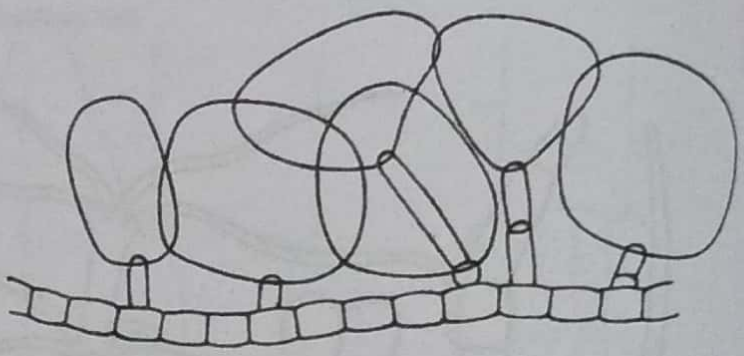


Fig. 13. Vesiculate hairs of *Atriplex* sps.

4. Root hairs. Root hairs are developed from any cell of the epidermis or a particular group of cells. The root hairs are thin walled, short lived, unicellular, meant for absorption of water from soil.

Functions of trichomes. (1) Hairs on leaves are helpful in reducing the transpiration and the intensity of illumination.

(2) Hairs present on stigma are helpful in pollination.

(3) When present on seeds these are helpful in dispersal.

(4) Glandular hairs give secretory or excretory products which protect them from enemies.

(4) Hairs present on insectivorous plants give enzymes.

Emergence

Spines, scales and warts are .the epidermal emergences.

Scales. These are made up of discoid plate of cells which are usually situated on a short stalk, *e.g.*, *Salvia.*