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PLANT TISSUES

A mature **vascular plant** (any plant other than mosses and liverworts), contains several types of differentiated cells. These are grouped together in tissues. Some tissues contain only one type of cell. Some consist of several.

Meristematic

The main function of meristematic tissue is mitosis. The cells are small, thin-walled, with no central vacuole and no specialized features.

Meristematic tissue is located in

- the **apical meristems** at the growing points of roots and stems.
- the **secondary meristems** (lateral buds) at the **nodes** of stems (where branching occurs), and in some plants,
- meristematic tissue, called the **cambium**, that is found within mature stems and roots.

The cells produced in the meristems soon become differentiated into one or another of several types.

Parenchyma

The cells of parenchyma are large, thin-walled, and usually have a large central vacuole. They are often partially separated from each other and are usually stuffed with plastids.

In areas not exposed to light, colorless plastids predominate and food storage is the main function. The cells of the white potato are parenchyma cells.

Where light is present, e.g., in leaves, chloroplasts predominate and photosynthesis is the main function.

Sclerenchyma

The walls of these cells are very thick and built up in a uniform layer around the entire margin of the cell. Often, the cell dies after its cell wall is fully formed. Sclerenchyma cells are usually found associated with other cells types and give them mechanical support.

Sclerenchyma is found in stems and also in leaf veins. Sclerenchyma also makes up the hard outer covering of seeds and nuts.

Collenchyma

Collenchyma cells have thick walls that are especially thick at their corners. These cells provide mechanical support for the plant. They are most often found in areas that are growing rapidly and need to be strengthened. The **petiole** ("stalk") of leaves is usually reinforced with collenchyma.

Xylem

Xylem conducts water and dissolved minerals from the roots to all the other parts of the plant.
In angiosperms, most of the water travels in the **xylem vessels**. These are thick-walled tubes that can extend vertically through several feet of xylem tissue. Their walls are thickened with secondary deposits of cellulose and are usually further strengthened by impregnation with **lignin**. The secondary walls of the xylem vessels are deposited in spirals and rings and are usually perforated by pits.

Xylem vessels arise from individual cylindrical cells oriented end to end. At maturity the end walls of these cells dissolve away, and the cytoplasmic contents die. The result is the xylem vessel, a continuous nonliving duct.

Xylem also contains **tracheids**. These are individual cells tapered at each end so the tapered end of one cell overlaps that of the adjacent cell. Like xylem vessels, they have thick, lignified walls and, at maturity, no cytoplasm. Their walls are perforated so that water can flow from one tracheid to the next. The xylem of ferns and conifers contains only tracheids.

In woody plants, the older xylem ceases to participate in water transport and simply serves to give strength to the trunk. Wood is xylem. When counting the annual rings of a tree, one is counting rings of xylem.

Phloem

The main components of phloem are

- **sieve elements** and

- **companion cells**.

Sieve elements are so-named because their end walls are perforated. This allows cytoplasmic connections between vertically-stacked cells. The result is a **sieve tube** that conducts the products of photosynthesis.

Companion cells move sugars, amino acids and a variety of macromolecules into and out of the sieve elements. In "source" tissue, such as a leaf, the companion cells use transmembrane proteins to take up - by active transport - sugars and other organic molecules from the cells manufacturing them. Water follows by osmosis. These materials then move into adjacent sieve elements through plasmodesmata. The pressure created by osmosis drives the flow of materials through the sieve tubes.

In "sink" tissue, the sugars and other organic molecules leave the sieve elements through plasmodesmata connecting the sieve elements to their companion cells and then pass on to the cells of their destination.

Epidermal Tissue System of Plants

Epidermis:

This system solely consists of the outermost skin or epidermis of all the plant organs beginning from the underground roots to the fruits and seeds.

This layer represents the point of contact between the plants and the outer environment and, as such exhibits diversities in structure.

It is primarily a protective tissue, which protects the internal tissues against excessive loss of water by transpiration and mechanical injury. Subsidiary functions like storage of water, mucilage, secretion and, though rarely, even photosynthesis, may also be carried on.

But for stomatal and lenticular openings the epidermis is a continuous layer. Normally it is uniseriate—typically consisting of one layer of cells. It derives its origin from the protoderm of the meristematic region.

The protoderm cells divide anticlinally and in course of time uniseriate epidermis is formed. Many-layered or multiseriate epidermis, usually called multiple epidermis, is found in some organs like roots of orchids, leaves of Ficus spp., Nerium, Peperomia, etc.

Normally it may be assumed that these layers have originated from the protoderm by periclinai divisions. The outermost layer of multiple epidermis is similar to ordinary uniseriate one. The inner layers are different from other tissues in absence of chlorophyll.

The epidermal cells are living with lining layer of protoplast around large central vacuole. The plastids are normally small and colourless. Chloroplasts are present only in the guard cells of the stomata in case of organs exposed to sunshine, but they occur in the epidermal cells of aquatic plants and plants growing in moist and shady situations. Mucilage, tannins and crystals may occasionally be present.

Anthocyanins may occur in the cell-sap of the vacuoles. Epidermal cells retain the potentiality of cell division. During normal course of development or due to external stimuli they may divide and produce new cells.

Epidermal cells exhibit wide diversities as regards their size, shape and arrangement. But they may be said to be essentially tabular in shape compactly set, so that a continuous layer without intercellular spaces is formed. Only in the petals of some flowers intercellular spaces are found, but they remain covered by outer cuticle. In surface view they are more or less isodiametric in shape.

In the leaves and petals of flowers they may have irregular shapes, often with teeth and flanges which remain peculiarly interlocked with one another. In monocotyledonous stems and leaves with parallel venation the epidermal cells are rather elongated in the direction of the long axis, so much so that in extreme cases they may be fibre-like in appearance.

Epidermal cells have unevenly thickened walls, the outer and radial walls being much more thick than the inner walls. In some cases they may be so massive that the central lumen is almost obliterated. The walls are strongly cutinised, what is very important for protection against mechanical injuries and prevention of loss of water.

The fatty substance cutin is found in the wall—in interfibriller and intermicellar spaces of the cellulose and forms the cuticle occurring all over the outer wall of the epidermal cells. It remains as a separate layer and in some cases it may be removed as a whole. The cuticle is often found to project into the radial walls as peg-like bodies Cuticle is absent only in the epidermis of roots and some submerged aquatic plants. The thickness of the outer walls of the epidermal cells depends on the environmental conditions of the plants. It is quite thin in plants with adequate water supply, and it is unusually thick in plants growing in dry situations. The surface of the cuticle may be smooth or may possess ridges and cracks. The cutinised portion of the walls, the portion lying beneath the cuticle, has been found to consist of alternating layers of cutin and pectic materials. Waxy matters are often deposited on the cuticle in form of rods and grarules. The so-called 'bloom' of many fruits and glaucous characters of many stems and leaves are due to these deposits. Lignification is rather rare in epidermal cells. It occurs in the pine needles in cycad, in grass leaves outside the sclerenchyma patches and in a few dicotyledons. Deposition of silica is common in the epidermal cells of horse-tails (Equisetum) and grasses. It is really interesting to find long epidermal cells having corrugated margin associated with two kinds of short cells—the silica cells and cork cells in grasses. The silica cells contain silicon oxide and cork cells with suberised walls contain organic materials.

In some dicotyledonous families like Malvaceae, Rutaceae, etc., the epidermal cells individually or in groups undergo mucilaginous changes, particularly in the seeds. Special sac-like cells remain scattered in the epidermis of some members of family Cruciferae.

These are idicblastic cells resembling the lati ciffers, but they contain an enzyme, myrosin, and so they are called myrosin cells. Dicotyledonous families like Urticaceae, Moraceae, possess cystoliths.

The cystolith-containing cells of epidermis are referred to a lithocysts. The epidermis is often made up of a layer of sclereids, as found in the seed-coats of Pisum and Phaseolus of family Leguminosae and in the scales of garlic—Allium sativum of family Liliaceae.

In organs with distinct secondary growth in thickness epidermis continues till cork cells are formed. In leaves, flowers and fruits, it persists as long as the organs do. In roots the epidermis with a part of cortex becomes dead, lignified or suberised after the root hairs are destroyed.

Bulliform Cells:

In the leaves of monocotyledons, excepting a few families, a peculiar type of comparatively larger, highly vacuolate and thin-walled cells occur in the epidermis. These are called bulliform (meaning, bubble-like) cells.

In transverse section they appear as a fan-like band because the median cell is usually the largest in size. They may be present on both sides of a leaf, but are more common on the upper side running parallel to the veins.

They either cover large areas or remain restricted to the grooves. These are mainly water-containing cells with no chlorophyll. The walls are usually thin, but the outer walls may be thick and cutinised like other epidermal cells, often filled with silica.

Stomata

The continuity of the epidermis of aerial organs is interrupted by the presence of some minute pores or openings on it. These pores are called the stomata, through which exchange of gases takes place between the internal tissues and the outer atmosphere. A stoma has a small slit or pore and two specialised epidermal cells, called guard cells, on the two sides. Often other epidermal cells adjacent to the stoma undergo modifications.

They differ from other epidermal cells and become associated with the stoma functionally. These are referred to as subsidiary or accessory cells. Though gaseous interchange actually occurs through the pore, called stomatal aperture or opening, the term stoma includes the whole thing, the pore, guard cells and subsidiary cells, when present.

In surface view the guard cells look cresent or kidney-shaped in appearance, being attached to each other at the margin of the concave side with the aperture lying in between them. They may be easily distinguished from ordinary epidermal cells, because they possess dense cytoplasm, prominent nuclei, chloroplasts, and even starch grains.

A cavity is present just beneath the stoma, what is called sub-stomatal chamber or cavity. It is in communication with the intercellular space system of the internal tissues. The walls of the guard cells are unevenly thickened, the wall along the aperture being strongly built and that away from the aperture being thin and extensible. The guard cells have cutinised outer walls with a layer of cuticle which extends through the aperture and joins the inner wall.

The guard cells, due to uneven thickening of the wall, what is really an outstanding character, can regulate the opening and closing of the stomatal aperture. Normally stomata remain open in daytime and close up with nightfall. The opening is influenced by the changes in the turgor of the guard cells. With increase of turgor the thinner walls of the guard cells get stretched and the thicker walls become more concave, thus the gap becomes wide. In the grass and sedge families the guard cells of the stomata are peculiarly dumb-bell- shaped where the middle portion is straight and strongly thickened and the two ends are swollen or bulbuous and thin-walled.

Epidermal Outgrowths:

Outgrowths of diverse forms, structures and functions develop from the epidermis. All these appendages which are epidermal in origin, are referred to as trichomes.

Thus they are different from the emergences like the prickles of roses, as the latter are formed by epidermis and a part of cortex. Trichomes may occur on all parts of the plant body. Some of them persist throughout the life of the organs, whereas many of them are ephemeral bodies. They may remain alive or become dead and continue as such.

Trichomes have been put into a number of groups on the basis of their morphological characters.

(a) Hairs:

Hairs constitute a very common type of trichome. They may be unicellular or multicellular. Unicellular hairs are often simple unbranched elongated bodies or they may be branched.
Some of them are very much elongated and twisted, so that they have woolly appearance . Multicellular hairs may be formed of one row of cells or of many layers as found in the base of petiole of Portulaca. Often these hairs branch in very peculiar fashions; some of them assume dendroid or tree-like appearance, or the branches come out in one plane giving it stellate or star-like shape. They are also called stellate hairs, A multicellular hair has usually two parts, the basal part which remains embedded in the epidermis is the foot and the other which projects out is the body. An initial cell divides periclinally into two parts, of which the outer one forms the body and the inner one, the foot.

(b) Scales or Peltate hairs:

These hairs consist of disc-like plate of cell put on a short stalk or directly attached to the foot.

(c) Colleters:

These are glandular trichomes. Some hairs have multicellular stalk and head, the latter is composed of glandular cells. Sticky exudations present on the surface of certain leaves and buds are secreted by colleters.

Salt-secreting glands as found in Tamaricaceae and calcium- secreting glands of Plumbaginaceae are really interesting.

(d) Water vesicles or bladders:

They form a very interesting type of trichome where some epidermal cells become greatly distended and serve as water reservoir. They occur in the so-called 'ice-plant' (*Mesembryanthemum crystallinum* of family Aizoaceae) where the surface of the leaves and young stems appear to be covered by ice-beads. Those occurring in Artiplex, also called vesiculate hairs, dry up with maturity and persist as a white layer on the leaf surface. The walls of trichomes are commonly of cellulose covered by cuticle. They sometimes remain impregnated with silica and calcium carbonate. Trichomes other than glandular ones have highly vacuolated protoplast. The cotton fibres, which are really hairy outgrowths from the seeds, have secondary walls of almost pure cellulose. The stinging hairs of nettle (Urtica dioica) possess a peculiar type of wall structure for releasing the contents of the gland. The hair resembles of fine capillary tube with silicified upper end and calcified lower end. The base remains embedded in the epidermal cells. Coming in contact with the skin the tip breaks at a predetermined point and the sharp edge penetrates into the skin when the contents (histamine and acetycholine) are injected, so to say, to the wound.

Root-hairs:

Root-hairs are not outgrowths or appendages, but they are prolongations of the epidermal cells. During the formation of root-hairs, growth in length of the epidermal cells is checked.

PROBABLE QUESTIONS :

1. What is Trichome ?
2. What do you mean by Bulliform cell and where it can be seen?
3. What is stomata? Mention its function.
4. Mention simple and complex permanent tissue?

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