Plant tissues. Cover, excretory and basic tissues

Plan

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Dermal tissues (surface tissues)

Dermal tissues (surface tissues) are plant tissues located on the border with the external environment, and consisting of tightly closed cells.

The functions of the dermal tissues are all functions related to the interaction of the plant with the environment:

1. protection from adverse environmental influences: a sharp change in temperature, drying up, chemical and physical influences, eating by animals, etc.
2. gas exchange
3. transpiration
4. absorption of water and substances dissolved in it
5. excretion of excretory substances and chemical protection substances

In addition, the dermal tissues can sometimes perform other functions:

6. synthesis of substances
7. accumulation of water and nutrients

All the dermal (surface) tissues are complex. This is due to the large number of functions performed. As a rule, the dermal tissues have several groups of cells adapted to perform a particular function.

Primary dermal tissues are formed from apical meristems (protoderma), secondary is as a result of the activity of phellogen. The primary ones are the **epiblem (rhizodermis)** and **epidermis**, the secondary ones are the **periderm**. In a number of tree species, the periderm is subsequently replaced by a **rhytidome**.

The epidermis is the primary dermal tissue (surface tissues) covering the leaf, petal flowers and young stems. The epidermis is a complex tissue. The plant epidermis consists of three main cell types: **pavement cells**, **guard cells** and their **subsidiary cells** that surround the stomata (stomata complex) and **trichomes**, otherwise known as leaf hairs.

The pavement cells are tightly closed together, the outer tangental walls are usually thicker than the lateral (radial) and internal ones, there are no intercellular places. The walls of the pavement cells are sinuous.

The epidermal cell walls may undergo cuticulation, which consists in the deposition of a layer of fat-like substance, cutin, called cuticle, on the outer wall of the cell by the protoplast. The cuticle can be smooth and folded by the nature of its surface.

A characteristic feature of the epidermis is the presence of **stomata**, through which gas exchange and water evaporation take place. Stomata are pores in the plant epidermis surrounded by two **guard cells** that control the opening and closing of the opening. These guard cells are in turn surrounded by **subsidiary cells** that play an auxiliary role to the guard cells.

The guard cells contain chloroplasts, a nucleus, and several vacuoles. Between the guard cells is the stomatal slit. Below the stomatal slit there is usually an air cavity. The epidermal (pavement) cells adjacent to the guard cells, which are more or less different in shape from the epidermal cane cells, are called their subsidiary cells. Subsidiary cells play an important role in the opening and closing of the stomata. Through them, water is loaded and drained into the guard cells of the stomata. Subsidiary cells are usually different in shape and size from pavement cells. Usually in the leaves of dicotyledons the stomata remain scattered whereas in the leaves of monocotyledons they are arranged in parallel rows. There are several types of stomatal apparatus:

1. **Anomocytic** — (from Greek. Anomos — disorderly) or ranunculoid, in which the subsidiary cells do not differ from the other cells of the epidermis (Buttercup, geranium).
2. **Anisocytic** — (from Greek. Anisos — unequal) or cruciferoid, in which the presence of three subsidiary cells is noted, one of which is noticeably larger or smaller than the other two (kalanchoe, Brassicaceae).
3. **Paracytic** — (from Greek. Pair — side by side) or rubiaceoid, which is characterized by the presence of two subsidiary cells located parallel to the stomatal fissure (Fabaceae).
4. **Diacytic** — (from Greek. Dia — through, across) or karyophylloid there are two subsidiary cells, and they are perpendicular to the stomatal fissure (Lamiaceae).
5. **Actinocytic** — (from the Greek aktis — ray) or radial-cellular — the stomata is surrounded by several side subsidiary cells, the long axes of which are located radially with respect to the guard cells (Ferns, Monocotyledons).
6. **Tetracytic** — stomata are surrounded by four subsidiary cells, two of them are located parallel, and two are perpendicular to the stomatal fissure (Fabaceae), possibly a lateral arrangement of all cells — two on each side (Commelinaceae).
7. **Cyclocytic** — there are more than six subsidiare cells, and they are located either in a ring or without a certain order (Buxáceae, Monocotyledones).

There are other types of stomatal apparatus.

This slide shows other types of stomata: hypocytic, pericytic, desmocytic, polocytic, staurocytic. In total, more than 40 types of stomata are known.

Trichomes are external outgrowths of epidermal cells, sometimes subepidermal layers take part in their formation. They distinguish of a great variety, and at the same time they are stable and typical for individual species, genera and families. Therefore, the external signs of the trichome structure are systematic and diagnostic feature. Trichomes are divided into **glandular** and **non-glandular (covering)**.

Glandular trichomes form and secrete essential oils. They consist of a stalk and a secretory head which, in turn, can consist of a different number of cells. Depending on this, the glandular trichomes (hairs) and glandulars are separated. In hairs, the stalk is usually long, and the secretory head consists of a small number of cells. The stalk may be short or longer, and the secretory head may be just a single cell or a group of several cells. In the glandulars, the stalk is short or absent, and the head is multicellular in the glands. Secretory cells of the head secrete a secret on the surface of the shell under the cuticle. The secretory product may simply accumulate inside the central vacuole of the secretory cells, or it may instead accumulate between the cell wall and the cuticle (the cuticle here is too thin to see).

Covering trichomes have different structures, they can be unicellular, multicellular, branched, non-branched, stellate, scaly, etc. But they always have a basal cell and cells surrounding it, which differ in shape and size from the actual epidermal cells. The covering trichomes in some cases remain alive for a long time, in others they quickly die and fill with air. They often form a thick cover on plants, reflect some of the sun's rays and reduce the heating of the leaves, as a result of which they reduce transpiration.

More massive formations are called emergencies which consist not only of epidermis but also inner tissues. These involve: prickles (rose, raspberry), glandules (in ash tree or chestnut shoots), or nectaries in flowers.

In the region of the root, layer of epidermidis is called the **epiblem.** The **epiblem (rhizodermis)** is the primary dermal tissue of the root in the matiration zone (root hair zone). It is the outermost layer of cells with a large number of unicellular root hairs. The rhizoderm consists of a single layer of living cells with a thin wall consisting of cellulose and pectin substances. The protoplast is pressed against the cell wall by a vacuole. The cell juice is characterized by an increased concentration. It has weak cell walls, it is less water and gas resistant, it swell when wet, it has no cuticles or stomata. The rhizodermis produces acids and exoenzymes that disturb the substrate and nutrients.

The main function of the rhizoderm is the absorption of water and mineral salts from the soil. The absorption capacity is increased by root hairs, which are outgrowths of rhizoderm cells. Mature root hairs has a length of up to 2 mm. The length of all root hairs of one plant on average reaches 3-4 km. Due to the formation of root hairs, the total surface of the root increases ten or more times.

Root hairs, like the entire rhizoderm as a whole, function for a few days, and die at a distance of 2-3 cm from the tip of the root, although in some plants the rhizoderm can function for weeks and months. As the rhizoderm dies off, it is replaced by periderm at dicotyledonous plants. At monocotyledonous plants, the protective function of the rhizoderm after its death passes to the exoderm of the root.

The periderm is a complex, multilayered tissue consisting of three different layers the fellema (cork), which performs the main protective functions, the phellogen (cork cambium) — the secondary meristem responsible for the prolonged growth of the periderm in thickness, and the phelloderm, which performs the function of feeding the phellogen. The walls of the cork cells are impregnated with a fat-like substance — suberin, which does not pass gases and water. The protoplast of cork cells is dying. The connection of tissues with the external environment occurs through the lenticels. Lenticels are special formations that serve for gas exchange and transpiration. The lenticels has the appearance of a small bump on the surface of the shoots of trees and shrubs. Lenticels are lenticular or circular structures protruding from the surface of the stems and roots. They are formed most often in the place of stomata. Lenticels are formed together with the first periderm is in those areas where the cork cambium is more active. As the periderm is grows thicker, new lenticels are produced. Lenticels function as passages for the gas exchange. At the site of the formation of the lenticels, the phellogen deposits parenchymal cells (lenticel filling tissue) instead of the phellema. They're alive. These cells press on the cork, and first lift it, and then tear it, forming a tubercle. In autumn, in preparation for the winter period, the phellogen deposits one (closing) layer of cork cells in the lenticels, which is again broken through by parenchymal cells in the spring with the resumption of phellogen activity. They have a pore and underlying parenchyma showing thin primary walls that leave intercellular spaces.

The activity and lifetime of phellogen greatly varies from species to species. The old phellogen gets crack and gradually dies out as a result of an increasing radial pressure by newly developed annual rings. In deeper primary cortex tissues, later on even in life phloem, new phellogen is formed. They give rise to new layers of periderm under dead outer layers. The repetition of dying and the formation of new phellogen is a unique complex here dead layers of primary cork meet layers of periderm, and, later on, dead layers of phloem meet deeper and deeper formed periderm. This complex of cover tissues is called rhytidome or bark. When it is peeled off, the older non-functional layers of phloem are peeled, too. This could be macroscopically observed as a coarse, deeply cracked bark, which varies according to species (trunk base of old pines, birches etc.).

In the **rhytidome or bark**, as well as in the periderm, there are lenticels. In the rhytidome, they are located at the bottom of cracks.

Ground (Fundamental, basic) tissue

In the Russian and English botanical schools, the concept of "ground tissues" is interpreted differently. In Russian botany, the term "ground tissues" means only living parenchymal tissues. However, in most English textbooks on botany, in addition to parenchyma, sclerenchyma and collenchyma are also referred to as the ground tissues. In the Russian botanical school, sclerenchyma and collenchyma are separated into a separate group called mechanical (or reinforcing)(or supporting) tissues.

The parenchymal tissues are poorly specialized tissues that occupy areas between other permanent tissues in all organs. By origin, the parenchymal tissues can be both primary and secondary. They are parenchymal in shape, with thin walls. The cytoplasm is pressed against the walls by vacuoles. Lignification and suberinization (corkiness) of the walls usually does not occur.

There are four types of parenchymal tissues, depending on the function they perform:

1. **Assimilative parenchyma (Assimilative parenchyma (chlorenchyme) (palisade tissue, mesophyll)** is a living tissue that contains chloroplasts, performs photosynthesis. The bulk of this tissue is concentrated in the leaves, a smaller part in the young green stems of shoots, where it lies directly under the transparent epidermis is a living tissue that contains chloroplasts, performs photosynthesis. The bulk of this tissue is concentrated in the leaves, a smaller part in the young green stems of shoots, where it lies directly under the transparent epidermis.
2. **The storage parenchyma** is a tissue in which excess metabolic products are deposited during this period of plant development: proteins, fats, carbohydrates, etc. Usually these are living thin-walled cells, but sometimes the cell shells of the storage tissues can thicken, they have a mechanical function.
3. **The water-bearing** parenchyma is a tissue that stores water. It is thin - walled, large-celled, there are mucous substances in the vacuoles of cells that contribute to moisture retention. It is found in the stems and leaves of succulents (cacti, agaves, aloe), plants of saline places (Salicornia perennans), leaves of cereals.
4. **The air-bearing parenchyma — (aerenchyma, air-space parenhyma)** is a tissue with highly developed intercellular cells. The purpose of aerenchyma is to supply tissues with oxygen, in some cases-to supply leaves with carbon dioxide (CO_2) and to ensure the buoyancy of plants. It is well developed in various organs of aquatic and marsh plants, but it is also found in land species.
5. **The core parenchyma** is also different sometimes. It consists of living poorly specialized cells, which has a large vacuole and often does not contain chloroplasts. Its function is to fill in the gaps between other permanent tissues and bind them into a single whole.

Excretory (secretory) tissues

Excretory tissues or structures are called tissues (structures) that are able to secrete and either bring out or actively isolate various secrets inside the plant body (essential oils, resins, mucus, tannides, latex, calcium and magnesium oxalates, etc.)

Excretory (secretory) tissues are divided into two groups: **internal secretions structures and external secretions structures.** The internal excretory structures, respectively, isolate the secrets inside the plant body, the external ones-bring the secrets and the final products of metabolism out.

Internal secretory structures include schizogenous and lysigenous cavities idioblasts, and latex tubes cells.

Schizogenous cavities arise as a result of the accumulation of secretions in the intercellular places. With an increase in the number of secretions, the cells move apart, forming receptacles. An example of such a container is a resin passage.

Lysigenous cavities arise as a result of the dissolution of the cell walls of nearby cells by accumulating secretions (for example, the essential oil receptacle of citrus peel).

Schizogenous and lysigenous cavities surround living parenchymal cells. They contribute to the transport of secretions. Such cells are called epithelial cells and contain a granular cytoplasm with a large nucleus.

The laticifers (latex tubes) are located between the parenchymal cells in various parts of the plant and form a complex intertwined network. The milky juice (latex) is located in the latex tubes. Its chemical composition is diverse. It is an emulsion of various spare substances and final products of metabolism. The structure of the laticifers can be non-segmented (formed from a single cell) (non-articulate laticifers) and segmented (formed from many cells, between which the walls are destroyed (articulate laticifers)). Laticifers may be divided into:

Articulated laticifers, i.e., composed of a series of cells joined together, or

Non-articulated laticifers, consisting of one long coenocytic cell.

Idioblasts (**secretory cells**) are scattered in the other tissues, and differ in size from the surrounding cells. Secretory cells are classified according to their contents: oil cells, myrosine cells, mucus cells, crystal-cavity cells and others.

External excretory structures

Stinging hairs are formed by the epidermis and the tissues lying under it. For example, a stinging nettle hairs is large unicellular head on a multicellular stalk. The top cell of the stinging hairs is large, elongated, narrowed to the top, ends with a pin-shaped tip. The base of the top cell is expanded and immersed in the multicellular stalk. The large vacuoles of the cell contain formic acid. If you carelessly touch the head of the hair breaks off, the tip of the hair pierces the skin, a liquid with acid is poured into the resulting wound, causing local irritation.

Essential oil glandulars. They are similar in structure to trichomes and are often considered as their variations. Among the essential-oil glandulars, simple and peltate are distinguished. They have a certain shape and a certain number of cells. Peltate glandulars are multicellular, and as such a glandular develops, some of the cells dissolve under the influence of the secretions stored in them, as in lysigenous cavities and it is difficult to determine the number of cells of the peltate gland. Such glandulars are found in currants.

Water-removing structures include hydatodes and water bubbles.

- **Hydatodes (water stomata)** — represent the stomata, under which there is an epithem — a group of loose cells of the mesophyll of the leaf. A small conducting vessel bundles is suitable for the epithem, through which water enters the hydatode. The xylem part of the conducting vessel bundles is in contact with the epithem — mainly the tracheids.
- **Water bubbles** are formed as a result of stretching of the epidermal cells, and are filled with water. This water is used by the plant when there is a lack of moisture.

Salt-removing structures include salt glandulars and salt cells.

- **Salt cells** are bubble-shaped, located above the epidermis. It is type trichome. Salts are storage in the central vacuole. After the destruction of the walls of the trichomes, salts are deposited on the surface of the leaf.
- **Salt-removing glandulars** are a complex of cells, some of which are secretory, others are basal. The secreted salt exits through the pores in the surface layer of the cells.

The digesting glandulars of the leaves of insectivorous plants produce mucopolysaccharides and proteolytic enzymes, thanks to which insects are digested. In these glandulars, there is a differentiation of cells for functions (irritation, perception, isolation).

Nectaries are the most complex excretory structures that secrete a sugary liquid - nectar. Often nectaries are modified organs (for example, the petals of buttercups, or the stamens of rosaceae)

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