Plant tissues. Meristems, the process of plant cell division.

Plan

The concept of plant tissue.
Principles of classification of plant tissues.
The meristems. The concept, features of the structure, functions.
The process of plant cell division.
Classification of Meristems.

Plant tissue is a group of cells that are structurally and functionally interconnected with each other and, usually, similar in origin.

Tissues consisting of cells, all of whose linear dimensions are approximately the same, are called parenchymal. Tissues whose cells have a length several times greater than the width and thickness are called prosenchymal.

Tissues consisting of one type of cells are called simple, from several types of cells — complex. As a rule, simple tissues perform one specific function, for example, assimilation parenchyma. And complex tissues have several functions, and each type of cell is responsible for performing its function.

The cells of the meristematic tissue are constantly dividing and differentiating into cells of other tissues. Permanent (long lasting) tissue perform one of the functions necessary to maintain the vital activity of the plant. Therefore, they have a name match for the function they perform.

Primary and secondary tissues are distinguished by origin. Primary tissues are formed by primary meristems, secondary tissues are formed by secondary meristems.

Meristematic tissue (Meristems)

A meristem is a specialized tissue whose cells divide and give rise to new cells that form permanent tissues. Meristems ensure the growth of the plant in length and thickness, form new organs and tissues, provide the orientation of the plant in space, as well as wound healing.

Meristems are simple tissue. Their cells are usually parenchymal in shape. They are small, tightly clamped do not have intercellular space. They contain a thick granular cytoplasm and a large nucleus. Vacuoles are so small that they are not visible in a light microscope. Plastids are also very small and are represented by proplastids. There are no ergastic substances. The main feature of meristematic cells is that these cells continuously divide by mitosis. After that, some of the cells continue to divide, and some grow and differentiate into cells of permanent tissues.

Mitosis (from the Greek mítos - thread), karyokinesis, indirect cell division, the most common method of reproduction of cells, ensuring the identical distribution of genetic material between daughter cells and the repeatability of chromosomes in a number of cell generations. The biological significance of

Mitosis is determined by the combination of the doubling of chromosomes in it by their longitudinal splitting and uniform distribution between daughter cells.

The cell cycle is a set of phenomena between two consecutive cell divisions or between its formation and death. The cell cycle includes mitotic division itself and interphase - the interval between divisions.

In the process of mitosis, several stages or phases are destined. There are prophase, metaphase, anaphase and telophase.

In prophase, when examined under a light microscope, chromosomes begin to appear, which are then shortened, isolated and arranged in a more orderly manner. At the end of prophase, the nuclear envelope and the nucleolus disappear.

In the metaphase, the chromosomes finally separate and assemble in one plane - the equatorial (or metaphase) plate, at the site of the former nucleus. Chromatids begin to separate from each other, remaining connected only in the region of the centromeres. Microtubules at this time form a series of filaments located between the poles of the nucleus like a spindle (mitotic spindle).

In anaphase, the centromeres are divided, each chromosome is divided into two independent chromatids, which become daughter chromosomes and move to the poles with the help of spindle threads.

By the time of telophase, the daughter chromosomes reach the poles of the cell, the spindle disappears, the chromosomes swell, lengthen and gradually become indistinguishable again, taking the form of chromatin filaments. At the same time, nucleoli and a nuclear shell appear around two new nuclei, each of which enters an interphase. The second half of the chromosomes is completed already in the interphase nucleus. The average duration of mitosis is 1-2 hours.

So, during mitosis, a cell goes through a series of successive phases, as a result of which each daughter cell receives the same set of chromosomes as it was in the mother cell. The biological significance of mitosis consists in the strictly identical distribution of reduplicated chromosomes between daughter cells, which ensures the formation of genetically equivalent cells and preserves continuity in a number of cell generations.

After mitosis, the cell itself divides. It is called cytokinesis. During cytokinesis, a median plate consisting of pectin substances is formed between two daughter cells. Initially, the median plate, or fragmoplast, has the shape of a disk growing towards the walls of the mother cell due to polysaccharides delivered by Golgi vesicles. Daughter cells are half the size of the mother, but then they grow, reach a certain size and can divide again, passing an unlimited number of cell cycles in meristematic tissues, or begin to specialize and lose the ability to divide.

By origin, primary and secondary meristems are distinguished. The beginning of the primary meristems is given by the initial cells formed during the formation of the plant embryo from a fertilized egg. Secondary meristems are formed from cells that have lost the ability to divide (in other words, any permanent tissue, and less often - from primary meristems).

There are two ways of growth of the plant.

1) Primary growth: It is controlled by shoot or root apical meristems and other prymary meristems, which are normally found in the tips of the plants, and is responsible for the elongation of the plant

2) Secondary growth: It is controlled by the secondary lateral meristems such as vascular cambium and cork cambium and is responsible for the plant's thickness.

The plane of meristematic tissue division and its growth pattern is essential to control the mode of growth. The plane of meristematic tissue division and its growth pattern is essential to control the mode of growth.

Based on the mode of growth, tissues can be classified into three types, namely:

a) Mass meristem

b) Rib or file meristem

c) Plate meristem

Mass meristem:

They are also known as block meristem. In this type of meristem, cell divisions occur in all possible planes, which will increase the plant body's volume. In meristems of cortex and pith, we can observe this kind of plane division.

Rib meristem:

It is also known as file meristem. The cells divide only one plane and forms rows or columns of cells. In the formation of filaments in algae, we can observe this kind of plane division.

Plate meristem:

These cells divide in two planes resulting in an increase in the area of an organ. During this division, plate-like structures are formed. Formation of leaf blade takes place by the activity of this meristem.

Depending on the position in the plant, the meristems are divided **into apical, lateral, insertion, wound.**

The most important meristems in the plant are the apical meristems. They are formed during the division of a fertilized egg and retain their activity throughout the life of the plant. These meristems are cones of growth of the stem and root. Only the apical meristems contain initial cells and that is why they never lose the ability to divide.

Apical meristem, region of cells capable of division and growth in the root and shoot tips in plants. Apical meristems give rise to the primary plant body and are responsible for the extension of the roots and shoots. Unlike most animals, plants continue to grow throughout their entire life span because of the unlimited division of these and other meristems.

The functions of apical meristems are the growth in length of the roots and stems of the plant, the formation of new organs, the formation of primary dermal tissues and the formation of lateral and intercalary primary meristems. In plants, the formation of organs occurs earlier than the formation of their tissues.

Therefore, the young organs of the plant consist of primary integumentary tissues and a complex of various primary meristems, from which the primary structure of the organs is later formed.

The lateral meristems are located parallel to the surface of the axial organ of the plant. Lateral meristems are primary (**protoderma, pericycle and ground meristem, procambium**) and secondary (**phellogen** and **cambium**).

Primary lateral meristems are short-lived, they are formed from apical meristems and form the primary structure of stems and roots, providing at this stage the growth of axial organs in thickness. At the end of their existence, the pericycle and procambium completely differentiate into cells of permanent tissues. In young axial organs, the pericycle is located in the peripheral part, and the cambium is located in the central part. All the tissues formed by these meristems are primary in origin.

The ground meristem and pericycle, as a rule, forms the tissues of the primary cortex (collenchyma, assimilating parenchyma (mesophyll), endoderm in the stem, exoderm, mesoderm and endoderm in the root) and develops centripetally. In the stem, the pericycle quickly loses its ability to divide, and completely differentiates into parenchyma or sclerenchyma cells (ground tissues), forming a closing layer on the border of the primary cortex and the Central axial cylinder. In the root, the pericycle retains meristematic activity longer, partially participates in the formation of the secondary structure, and lateral roots are formed from it.

Procambium forms the primary tissues of the central axial cylinder. These can be parenchyma, primary phloem and primary xylem. The primary phloem is usually formed centrifugal, and its development is somewhat ahead of the development of the primary xylem. The primary xylem develops centripetally.

Together, the pericycle and procambium form the primary structure of the axial organs. Procambium forms the primary tissues of the central axial cylinder. These can be parenchyma, primary phloem and primary xylem. The primary phloem is usually formed centrifugal, and its development is somewhat ahead of the development of the primary xylem. The primary xylem develops centripetally.

Together, the pericycle and procambium form the primary structure of the axial organs.

So the primary dermal tissue is formed due to the activity of the apical meristem (protoderma), the cortical tissue – the ground meristem, and the tissue of the central axial cylinder – the pericycle and the procambium.

Insertion (intercalary) meristems are located at the base of internodes, leaves, their petioles, pedicels. They are always primary in origin. They are formed from apical meristems. These meristems provide additional growth in length (stretching), and allow the plant to change the position of the leaves relative to the light. The growth of lateral organs (leaves, flowers) and the formation of their internal structure is carried out thanks to these meristems. They remain active for quite a long time, but they do not have initial cells, and at the end of their existence they completely differentiate into cells of permanent tissues. Intercalary meristem cells can differentiate into cells of any primary permanent tissues, except for the dermal ones.

During the formation of the secondary structure, the pericycle and procambium are replaced by secondary lateral meristems **cambium (vascular cambium)** and **phellogen (cork cambium)**. The cells of secondary meristems differentiate from the cells of primary meristems in that they are more similar in shape to the cells of the tissue that gave them origin. Thus, cambium and phellogen cells contain chloroplasts. The cambium cells are elongated along the axis of the organ and are similar in shape to the phloem and xylem cells. Phellogen cells are parechymal.

The vascular cambium is formed in the central axial cylinder and provides a long-term growth of the axial organs of the plant in thickness, forming vascular tissues and tissues of the vascular (pith) rays.

Phellogen is formed in the peripheral part of the axial organs and forms secondary dermal tissues — the periderm and the rhytidome.

Cells of the cork cambium or phellogen show the typical features of meristematic cells, although they may contain functional chloroplasts. Cork cambium arises from dedifferentiation of parenchyma or collenchyma cells located at the outermost layer of the cortex, after the secondary xylem and phloem formation is started. Sometimes, the first meristematic cells are differentiated from primary phloem or from the epidermis. The first cork cambium of the plant may last for several years depending on of the species (for instance, more than 20 years in the apple tree). Later, sometimes after several years, cork cambium are originated in deeper areas of the stem and from different cells like parenchymatic cells of the secondary phloem. In the roots, cork cambium is originated from the pericycle. Cork cambium usually shows a seasonal activity.

Cork meristematic cells are elongated and form a continuous cylinder in the cortex or are arranged in strands or plates at different depths from the surface. These cells undergo periclinal divisions (they divide in planes parallel to the surface of the organ; see figure) and give rise to phellem, commonly known as cork, outward and phelloderm inward. The three structures, phellem (cork), phellogen (cork cambium) and phelloderm constitute the periderm, a protective tissue that replaces epidermis in stems and roots, which increase in diameter when secondary growth occurs. Cork cambium produces more cork layers than phelloderm layers.

Both phellogen and vascular cambium can be formed many times during the life of the plant. An example of repeated formed of vascular cambium can be the structure of a beet root crop, where rings similar to yearly ones are formed by additional layers of this tissue, which are formed during one growing season. With repeated laying of vascular cambium in the same place, annual rings are formed in the trunks of trees. This is because in the spring, during the sap flow, the vascular cambium begins to actively divide, and closer to autumn its activity gradually decreases and by winter it stops altogether.

As phelloderm usually has seasonal activity, dead cork of the outer layers detaches from the surface anually. As a result of repeated phellogen (cork cambium) deposition, a secondary integumentary tissue - the outer bark containing dead cork, and sometimes some phloem, is known as rhytidome.

There are also **wound meristems** in the plant, which are formed at the site of the wound of the plant. Wound meristems are always secondary in origin. As a result of the activity of these meristems, a special parenchymal tissue is formed. It is called the callus, which gradually completely closes the wound. Callus is a very unusual plant tissue. Very active processes occur in it and a lot of hormones accumulate. As a result, initial cells may form again here and an apical meristem may arise, which may lead to the formation of a new organism. This property of callus is used in the vegetative reproduction of plants, as well as in the reproductive of plants by "tissue culture"

Zemlyanskaya I.V.