Tissues

Tissue: a group of cell, of similar shape and size, which all have the same function. plant organs usually have several different kinds of tissue. e.g. leaves have epidermal cell mesophyll and vascular tissue.

Organ: a group of cell of tissue forming part of an organism, with a special function e.g. a leaf, a stamen

Permanent Tissues

The meristematic cells gradually divide and get differentiated to form permanent tissue which are composed of such cells in which growth has stopped either completely or for the time-being. sometime, they again become meristematic partially or wholly. the cells of these tissues may be living or dead; thin walled or thick-walled the primary meristematic tissue from the primary permanent tissues and the secondary permanent tissues are derived from secondary or lateral meristems or cambial-layers. In dicots and gymnosperms, the cambium is present, which in most of the monocots, cambium is absent and therefor, there is no secondary growth. All the permanent tissues can be categorized in two main groups according to complexity.

1- Simple tissues this one included

   I-parenchyma t.

   II-collenchyma t.

   III-sclerenchyma t.

2- Complex tissues also this one included

   I-xylem t.

   II-phloem t.

   simple –tissues

   These are composed of similar cells and have homogenous nature.

   these are:(i) parenchyma (ii) collenchyma(iii) sclerenchyma

(i) Parenchyma:

is the most common unspecialized morphologically and physiologically simple tissue

Origin: as regard their origin the parenchyma tissue of the primary body, that is the parenchyma of the cortex and pith of the mesophyll of leaves and of the floral parts (flower-parts), get differentiated from the ground meristem. The parenchyma associated with the primary and secondary vascular tissues is formed by the pro-cambium and vascular cambium respectively pro-cambium parenchyma associated with the secondary vascular tissue

Vascular cambium-parenchyma associated with the secondary vascular tissue.

During secondary growth, the also arise from the phellogen (cork-cambium) as secondary cortex or phelloderm.

Distribution: parenchyma cells may be associated with other types of cells in morphologically heterogeneous tissue.

Generally, they occur in the pith and cortex of stems and roots, the photosynthetic tissue, mesophyll of leaves, the fleshy part of succulent fruits, the endosperm of seed etc.

The also occur in tissues like xylem and phloem as vascular rays. Besides these tissues, certain specific tissues are also parenchymatous in nature like scleroids, laticiferous tissue, sieve-tubes and certain glandular tissue

Structure: (i) shape- the parenchyma cells are usually isodiametric or polyhedral in shape. Many kinds of parenchyma become elongated. prosenchyma cells (elongated cell with tapering ends) parenchyma of mesophyll tissues are variously lobed, folded and armed. In ordinary parenchyma cells are homogenous, with small spaces or non, shaped parenchymatous cells are isodiametric or polyhedral or with -14- sided tetrakaidecahedron. In Pinus mesophyll parenchyma are folded with in internal ridges.

(ii) cell-well parenchyma cells have usually thin wall composed of cellulose, with primary pit fields. In storage-organs parenchyma walls may be considerably thick due to deposition of hemicellulose e.g., in the endosperm of seeds of date palm (Phoenix dactylifera) in secondary walls.

(iii) cell-arrangement: mature parenchyma cells are either closely packed or with short intercellular spaces while storage parenchyma of fleshy fruits bear larges and numerous intercellular spaces, but endosperm as a food storage tissue does not have large spaces which may be absent also.

(iv) cell-contents: the cell contents are widely variable and are intimately related to the activities of the cell, e.g. photosynthetic cells contain numerous chloroplasts, and starch; non-chlorophyll on parenchymatous cells are highly vacuolated and contain leucoplasts; also in many parenchyma cells accumulate tannin, as phenol derivatives and store mineral substances.

(v) Nucleus: Generally, the parenchyma cells are unincleate and nucleus may be either in center or near the wall of the cell

Function:

1- parenchyma cell are centers of many essential physiological activities like photosynthesis depend on the living protoplast

2- parenchyma cells of xylem and phloem in form of traches and sieve element respectively help in upward and downward conduction of water and dissolved food materials
3- these cells are also helpful in wound healing and regeneration
4- parenchyma with thin cellulose wall can also serve as supporting tissue
5- cutinized parenchyma of epidermis are protective in function
6- parenchyma of cambial cell divides and form secondary tissue
7- parenchyma cells of meristems are helpful in formation of adventitious roots and buds
8- parenchyma cells which store air (aerenchyma) give buoyancy to the aquatic plants to float easily in or on the water.
9- In succulent plants these cells store water and mucilaginous substances

<u>Specialized parenchymatous cells</u>

Parenchyma cells of mesophyll tissue of leaves and green stems of xerophytic plants (succulent plants) contain chlorophyll pigments. These are known as chlorenchyma. Chlorencymatous cells are photosynthetic in function. Parenchyma of aquatic plant have large and abundant intracellular spaces. As a result, they often become star like or stellate in shape. These are called as aeranchyma. The air spaces give buoyancy to the plants.

(ii) Collenchyma tissue

These are living tissues composed of more or less elongates cells with thick primary non-lignified walls.

Origin: the derivatives of apical meristems are differentiates into protoderm, procambium and ground meristem.

Cortical collenchyma and procambium originate from a common meristem.

Structure: collenchyma cells are not much variable in structure

(i) cell shape: these cells are considerably elongated with oblique, slightly rounded or tapering ends.

The shorter collenchyma cells are prismatic – like many parenchyma cells. They are usually polygonal in cross section

(ii) cell wall: the most distinctive feature of collenchyma cells is the nature of cell walls which are unevenly thickened.

Three types of collenchyma have been recognized on the basis of manner or deposition of secondary cell – wall materials i.e. cellulose impregnated with pectin.

A- Angular: here the deposition is localized to the junction between the cells. The cells are irregularly and compactly arranged with little or no intracellular spaces, e.g. in Solanum lycopersicum, Datura, Morus, Vitis and Ficus. The degree of deposition varies in different plant species (Fig.)

Specialized parenchymatous cells which produce and store tannins, oil and crystals, of calcium-oxalate are known as idioblasts.

A- Ordinary **B-** Stellate in Canna indica **C-** Folded-parenchyma in Pinus

D- Thick-parenchyma **E-** Endosperm of of endosperm Diospyrus Phoenix dactynfena (Date)

F- Aerenchyma of Elodia stem **G-** Polyhydral- parenchyma Telrakaidecahedro

Different types of parenchyma

B- Lamellar (Plate-like)

Here the thickening occurs chiefly on the tangential walls. e.g. Sambucus due to thickening the cells appear like-plates, bonds or lamellae.

C- Lacunar (Tubular)

Here the cells are with large intercellular spaces, and the thickening occurs on the walls facing the intercellular spaces e.g. in Salvia, Malva etc.

The cell wall of all the types of collenchyma is composed of cellulose and pectin with high percentage of water. The thickening to great extent is determined by the environmental factors.

Cell-contents:

The cells of collenchyma tissue are living with vacuolated protoplast. Chloroplast may also present. They are always uninucleate. The structures of collenchyma are sometimes modified for doing specific functions. These tissue have a considerable tensile strength with flexibility and plasticity. Thus the older tissues are harder than the younger ones.

Distribution:

Collenchyma is found below the epidermis in herbaceous dicots

like sunflower, they occur either as homogeneous layer e.g. in sunflower or in patches e.g. in ribs of Cucurbita stem. In leaves they are present on both sides of the veins or along the margins. This tissue is normally absent in underground stems, roots and stems and leaves of monocots.

Functions:

1- It is effective mechanical tissue and give support to the growing organs.
2- It gives tensile strength to the growing organs during their development.
3- It protects the vascular bundles of leaves by forming cap or bundle sheath like structures.
4- If chloroplasts are present, then it may preform little photosynthetic function also.

A- Lamellar- Collenchyma in <u>Sumbucus</u> Stem, x thickening mainly on tangential walls

B- Angular-Collenchyma in <u>Cucrbita</u>
Stem thickening in the anglers

C- Lacunar- Collenchyma in <u>Lactuca</u>, Stem
show numerous intracellular space
indicated by arrows and the most prominent
thickening locating next to there

(iii) Sclerenchyma:

It is also a simple tissue mainly adapted for mechanical function. A sclerenchyma a tissue in considerably thick walled and lignified, with simple pits in its wall, sclerenchyma cells show. Much variation in form structure origin and development and the different type of cells are placed in to two group. v.z. fibers and scleroids.

<u>**1- Fibers**:</u>

fibers are very much elongated usually with pointed needle like ends and are dead in nature.

Classification: fiber is divided in to two large groups i.e. xylary fibers or wood fibers (intraxylary) and phloem fibers (extraxylary fibers) besides these fibers in cortical and pericycle

These last two types of fiber included fibers placed outer of the primary phloem in dicot stems and also the fibers placed hypodermal in some monocot stem these fibers are originated from ground meristems the xylem or wood fibers are sub-divided in to two main groups i.e. fiber-tracheid

1- libriform fibers: (derived from inner bark i.e. phloem)

structure extra xylary fibers or phloem fibers are long spindle like with acute or acaminate or blunt ends. Generally primary extra xylary are longer than the secondary the cell wall is quiet thick with simple or slightly bordered pits few extra xylary fibers bear lignified walls (monocots) and others are non-lignified. At maturity these fibers lose protoplasm and become dead.

<u>Wood fibers or xylem fibers</u>

Have strongly lignified secondary walls they vary in size, shape, thickness of wall and frequency of pitting. The pits may be small round or slit-like in appearance. Sometimes the secondary wall is so much thickened and lignified that the central lumen is almost obliterated. Some fibers may bear gelatinous sheath. The tracheids fibers and libriform fibers both are septate-fibers also show overlapping or interlocking nature at their ends.

Distribution: fiber occur as groups as sheets or as cylinders in the cortical and vascular region (in xylem and phloem) as bundle sheath or bundle cap in stems of dicots, fibers occur in the outermost part of the primary phloem e.g. in linum and nerium. In monocot stems fibers have been observed as bundle sheath e.g. in zea mays. The primary and secondary xylem and phloem tissues of roots also bear fibers. Gymno sperms usually have no fibers in primary phloem but may have them in secondary phloem.

Functions:

These are the most important type of mechanical cells their great strength, flexibility and elasticity serve to enable plant organs to develop resistance against gravitational tension and strains.

Economic fibers:

Flax, temp, jute, and ramie fibers are obtained from phloem and are used for preparing carpets, ropes etc. the commercial fibers are separated in to hard and soft fibers. The hard fibers are monocot stems and leaves with heavily lignified walls e.g. musa textilis the soft fibers e.g. cannabis sativa (hemp) etc.

2-sclereids:

These develop from the derivatives of procambial and cambial cells stone cells embedded in cork originate from phellogen. Macrosclereids of seed coat are protodermal in origin. Sclereid may get branched during their developmental period. Normally sclereid become deal with maturity.

Structare:

The secondary walls of the sclereids vary in thickness and are typically lignified in many sclereids the lumina are almost filled with massive wall deposits and secondary walls show ramiform canal like pits.

Classification

Sclereids are classified on the basis of their size, shape, nature of cell-wall and mode of deposition of secondary cell wall materials.

1- Brachysclereids (stone-cell):

Isodiametric short, resemble parenchyma cells and occur in cortex pith of stem and flesh of fruits as in fruits of pyrus communis (pear)

2- Macrosclereide:

these are rod-shape, elongated cells form palisade like epidermal layer on the seed coat in species of phaseolus and pisum (pea) etc.

3- Osterosclereide: (bone-shaped sclereids)

These are bone like in shape columnar cells enlarged at the ends. They occur in the leaves of some dicots and seed-coat of pea.

4- Astrosclereids: (star-shaped sclereids)

these are star or stellate shaped and occur in the leavers of some dicots such as nympheae (water lily)

5- Trichoseclerids: (filiform sclereids)

These are long slender and hair-like as L or Y shaped they occur in leaves mesophyll of olive-plant

Function:

1- They give firmness to parts where they are present
2- Sclereids, because of their lignification in the secondary wall, give mechanical support to a particular part by producing a hard texture, e.g. seed coats endocarp of fruits etc.

The vascular tissue system conducts water, mineral, and food

The vascular tissue system a continuous system of tissues that conduct water, minerals, and food-consists of two complex tissues; xylem and phloem.

Xylem: brings water and minerals nutrients from the root to the rest of the plant. Phloem; moves sugars and other organic nutrient from the leaves to the rest of the plant in other words (phloem carries the food produced by photosynthesis the contents transported by xylem and phloem are known as sap. So that the plants are divided in two groups:

- **A)** plants including xylem and phloem called as vascular plants (Trachophyta)
- **B)** plant without (xylem and phloem) called as non-vascular plants

the xylem: has four elements such as;

1- Tracheid's
2- Vessels
3- Xylem fibers
4- Xylem-parenchyma

The xylem of all vascular plant contains tracheid's which are long cells with tapered end. In transection the cell appears either circular, polygonal and typically the only type of water conducting cell in ferns, conifers and most other non-flowering plants tracheid align with each other to form a continuous water-conducting system. The secondary cell wall of tracheid has thinner region called pits in which only the primary wall is present. Pits in adjacent tracheid are usually aligned, allowing water and minerals to flow from one tracheid to another one, below, or next to it. In some plants, pits are often bordered by bulges in the secondary cell walls which strengthen the opening and also make it narrow, slowing down the flow. Fig.1. shows how the pit membrane, consisting of porous primary cell-walls and the thin middle lamella, regulates the flow through bordered pits. In conifers and some primitive angiosperms, the middle of the pit membrane is a thicker area called a torus that acts like a valve. If the membrane moves to the side. The torus blocks the pit opening there by slowing the flow.

Function of xylem:

Due to present of central lumen and thick hard elastic and highly lignified wall, they are well adapted for trans port of water and solutes from root to stem and leaves. They also give a slight mechanical support. The secondary walls in tracheid's are deposited which may be annular, spiral, scalar form, reticulate and pitted.

2- vessel elements:

In addition to tracheid, the xylem of most flowering plants and a few gymnosperms contains other water-conducting cells called vessel-elements which transport water and minerals more rapidly than tracheid. like tracheid, vessel elements are dead at maturity, with the cell walls forming hollow tubes, but vessel elements are generally wider, shorter, and less tapered than tracheid. They have the largest diameters of all conducting cells-up to 100 micrometers (Mm), compared with 10 Mm for tracheid and can carry about 10 Mm as much water and mineral as tracheid. Vessel elements lose some or most of their cell wall at each end, leaving perforation-plates that allow water to flow through while still providing support. In this way. Vessel elements are joined to form a continuous pipe or vessel-vessel elements also have pits, which allow lateral flow vessel to vessel. The secondary wall layers are deposited a sin tracheid (annular, spiral, scalar form, reticulate and pitted). Fig.2.

Function:

The vessel due to presence of thick lignified walls are much adapted for easy transport of water and solutes from roots to stem and also give mechanical support.

3- xylem fibers:

Sclerenchymatous fibers associated with xylem are known xylem fibers these are long, slender, pointed and dead cell, two main types of xylem fibers are reported from primary and secondary xylem tissue

A) fiber-tracheids

B) libriform fiber

4-xylem parenchyma:

Living parenchyma associated with xylem are called as xylem-parenchyma. The xylem parenchyma store food reserve in form of starch and fat, tannins, crystal and various other substance may also occur in these cells.

According to similarity in function of tracheid and vessels so that there is a general term is using as tracheary elements

Phloem: food-conducting tissue

It is another complex vascular tissue, which transport food. The phloem is composed of sieve elements (sieve-cell and sieve-tube), companion cells, phloem parenchyma and some fibers. The elements of phloem originate from the pro cambium of opical meristem or vascular cambium (through the primary and secondary growth)

1- **<u>sieve- elements:</u>** these are two type

a) the less specialized sieve-cells and the more specialized sieve-tubes.

b) Sieve-cells: in nonflowering vascular plants (lower plants and gymnosperms) such as ferns and conifers

Phloem consists of a more primitive type of water conducting cell called a sieve cell. Rows of sieve cells function much like sieve tube members, but the ends of sieve cells lack sieve plates. This difference is somewhat like the difference between the over lapping tracheid and the continuous tube of vessel elements like sieve-tube members.

Sieve cells lack a nucleus when they are mature. Each sieve cells have an associated albuminous cell, which has a nucleus and appears to serve the same function as the companion cell dose for a sieve-tube member. (fig. 3.).

B) sieve-tube: these are long tube like slender bodies placed end to end the cells are arranged in longitudinal series where the end walls are perforated in a sieve-like manner.

These are called as sieve-plates, through which cytoplasmic connection are established between adjacent cells the perforations are called as sieve-area, in inclined position sieve-plate is called simple if it has only one sieve area or compound if it has several sieve areas arranged in scalariform, reticulate or other manners.

Origin: the sieve-elements originate from the same meristematic cells from which companion cells originate.

Occurrence: the lower vascular plants and the gymnosperms bear sieve cells and angiospermic plants have sieve-tube.

Function: the main function of sieve-elements is the longitudinal transmission of prepared food materials, proteins and carbohydrate from the leaves to the storage organs.

Companion cells: these are specialized parenchymatous cells which are closely associated with sieve elements in origin position and function. These cells occur only in angiosperms. They are formed by same meristematic cell which form sieve elements (fig. 3)

3- phloem parenchyma: the phloem tissue contains variable number of parenchyma cells. The main function of these parenchyma is to store organic food materials and other substances like starch, fat, resins etc.

4-phloem fiber: fibers occur both in primary and secondary phloem and are called as phloem, giber have much commercial importance used for the manufacture of clothes, ropes.

Primary structure of a plant

The xylem and phloem present in the primary growth are called as primary xylem and primary phloem respectively.

A) primary xylem: it is composed of two types of cells:

1- proto xylem: these are first formed xylem tissue which appears at the beginning of vascular differentiation and occupy particular position in the primary vascular system of plant organ. Thus in system it occurs near the pith and in root it is located farthest from the center the proto xylem has trachieds, vessel and parenchyma, the fiber being usually absent.

The primary cell walls are of cellulose while secondary material are deposited in the form of annular and spiral thickening. The proto xylem elements are narrower than the metaxylem vessels.

2-metaxylem: the lately formed xylem is called at the metaxylem it consists of tracheids, vessels, parenchyma and fibers. It more complex them protoxylem and possess more of tracheary elements.

B) primary phloem: it is composed of two types of tissue:

1- proto-phloem: the first phloem is called as proto-phloem which develops directly from procambium. It is composed of sieve elements viz. sieve-tubes in angiosperms and sieve-cells in gymnosperms and pteridophytes companion cells are scarce or lacking.

2- metaphloem: the meta phloem elements are differentiated after growth in length of the organs is completed. It is composed of sieve elements, parenchyma and fibers. The sieve elements are longer and wider with more destinet sieve areas, companion cells are typically present in meta-phloem in stems, the xylem occurs to words the center and phloem towards the periphery.

In root, both these tissues are arraigned in alternate manner. In leaves phloem is toward the lower epidermis and xylem is towards the upper epidermis.

Secondary structure of plants

The secondary growth in plants takes place by the vascular-cambium in stellar region and by cork-cambium in to extra stellar region. The cork cambium forms the secondary cortex and cork and vascular cambium forms.

The secondary xylem and secondary phloem: The secondary xylem and secondary phloem tissue differ from primary tissues in having additional strictures. They form a complete ring around the central core.

Questions:

1- write short notes on the following:

a-companion cells

b-sieve-plat, albuminous cells

2- what is the function of xylem ? sketch various types of elements found in xylem approximately the same size throughout the growth ring. But the ring-porous wood in which the vessels of the early (spring) wood are large in comparison to these of the late (summer) wood.

Bark القلف

Some-notes summary:

Bark: all tissues outside the vascular cambium the part of a stem or root surrounding the wood.

Bark: has two distinct regions on inner bark and on outer bark.

A) inner bark: tissue consisting of living secondary phloem, dead phloem between the vascular cambium and the currently active innermost cork cambium and any remaining cortex.

But outer bark consists of dead tissue including dead secondary phloem and all the layers of periderm outside of the most recent cork cambium. Bark, the outermost layers gradually crack and peel off in patterns that vary from species to species (figs. 5&6).

The periderm البشرة المحيطة

Periderm is a protective tissue of secondary origin it replaces the epidermis when the axis is increased in girth and the epidermis is destroyed. Periderm formation is a common phenomenon in stems and roots of dicotyledons and gymnosperms that increase in thickness by secondary growth. Structurally the periderm consists of three part:

1- the phellogen or cork cambium and phloem

2- cork, produced by the phellogen (cork-cambium) toward the outside

3- phelloderm a tissue that resembles cortical parenchyma and consists the inner derivatives.

Bark is applied most commonly to all tissues outside the vascular cambium of the axis in either a primary or secondary state of growth. It is also used more specifically to designate the tissue that accumulates on the surface of the plant axis as a result of phellogen (cork-cambium) activity.

Lenticels العديسات

The suberin in the cell walls of cork cells blocks the passage of oxygen in to the stem or root however stem and roots have lenticels small openings in the outer bark where the cork layer is then and there is enough space between cells to allow for exchange of gases. As new cork cambium arises new lenticels develop that are aligned with the outer lenticels providing a continuous pathway for oxygen in trees with smooth bark lenticels are easily observer usually appearing as short streaks, slits or raised dots on the surface of twigs, branches, trunk and roots. In addition to appearing in stems and root lenticels can be seen as spots and streak on the surface of some fruits such as apples and pear (Figs. 7&8).

Summary:

Lenticel: a porous swelling in a woody stem that develops when the epidermis is replaced by periderm facilitates the exchange of gases between the stems interior and the atmosphere.

Anatomy of dicot stem تشريح ساق ذوات الفلقتين

Young stem of sunflower (helianthus) in a transvers section the stem appears circular or slightly wavy in outline. The tissues are arranged as follows:

1- Epidermis البشرة

It is the outer most uniseriate layer composed of parenchymatous cells which are tabular is shop flattened tangentially and attached end- to- end along their radial wall without inter-cellular space. In young stem, chloroplasts may be observed and covered by cuticle material it checks the loss of water. Stomata are present and also a large number of multicellular hairs are also present.

2-cortex القشرة

It lies below the epidermis and is differentiated inti following zones:

A) Hypodermis: طبقة تحت البشرة

this layer is immediately below the epidermis and is composed of 3 to 4 layers of thick collenchymatous cells. The corners or angles are thickened due to deposition of lignin or pectin or cellulose. The cells are living and may contain few chloroplasts. This layer forms a continuous band of exteral cortex which provides mechanical support to the peripheral portion of the stem.

B) General cortex: القشرة الاعتيادية

it consists of thin walled, large oval or rounded living parenchymatous cells, having conspicuous intercellular spaces, the cells of this layers may contain some chloroplast they may function as assimilatory cells and they also serve for storage of food.

C) Endodermis: القشرة الداخلية

it is the inner most layer of the cortex and separates the cortex from stele. The cells are somewhat barrel shaped compactil arranged having no intercellular spaces and are parenchymatous they contain numerous starch grains, the layer is therefore, referred to as a starch sheath. The radial and the inner walls are thickened due to deposition of lignin forming casparian strips (characteristic feature of endodermis).

3- stele: الاسطوانة المركزية

it includes of following

1- Pericycle الدائرة المحيطية
2- vascular bundles الحزم الوعائية
3- pith (النخاع) اللب
4- pith-rays (medullary-rays) الاشعة اللبية

1- pericycle:

It lies below the endodermis and is composed partly of parenchymatous and partly of sclerenchymatous tissues. The sclerenchyma is form bundle-cap it which outside the phloem and separated the vascular-bundle from the cortex. It hard-bast, because they give mechanical support to the plant parts.

2- vascular-bundles

These are conjoint collateral open, wedge-shaped and arranged in a ring around the central pith. The size of the bundles varies in different species. Each bundles have a patch of xylem towards the Centre of phloem toward the periphery and strip of cambium in between them.

3- pith

The center of the stem is known as pith or medulla it is composed of parenchymatous cells. The cells are rounded or polygonal, thin walled with conspicuous intercellular spaces food is stored in this region

4- pith-rays

The pith extends in between the adjacent vascular bundle to form elongated structure called as pith-rays or medullary rays. The cells are thin-walled, parenchymayous and polygonal or radially elongated. The pith rays store the food materials and also help in internal translocation of water and other substances.

Anatomy of monocot stem

In monocot stems there is no secondary growth. The stems bear only primary permanent structures which are formed due to the activity of the apical meristem only. We are discussing here the anatomy of zea mays stem. It can be distinguished in the following regions.

1- Epidermis: البشرة

It is single outermost layer composed of small, thin walled somewhat barrel-shaped parenchymatous cells which are tightly packed without intercellular spaces. A thick-cuticle is present on the outer surface here and there in the epidermis few stomata are present usually the trichomes or hairs are lacking (fig.12.)

2-cortex: القشرة

The cortex is not well differentiated into distinct regions it is composed of the following regions:

a) hypodermis الطبقة تحت البشرة

it lies just below the epidermis comprising few layers of thick-walled lignified scleerenchymatous cells without inter-cellular spaces.

b) ground tissue النسيج الاساسي

it is a continuous mass of thin-walled, parenchymatous tissues which lies below the hypodermis. The inter-cellular spaces are profusely present. The cells are rounded or polygonal in shaped. There is no differentiation of general cortex, endodermis, pericycle, pith and pith-rays, vascular bundles are irregularly embedded in this region

3- stele: الاسطوانة المركزية

Absent the vascular bundles are irregularly scattered in the cortex.

c) vascular bundles:

the vascular bundles are conjoint, collateral, closed, without cambium, irregularly scattered in the ground tissue. The bundles present in the peripheral region are smaller in size and compactly arranged while those towards the central region are larger in size and widely placed.

All the vascular bundles have similar structure it has xylem towards the centre and phloem toward the periphery it is oval in shape and surrounded by a sheath bundle of sclerenchymatous tissues, more numerous on upper and lower side. Xylem it is y-shaped bearing two large meta xylem vessels with wider cavities and pitted thickening at the two lateral arms. The proto xylem vessels are only one or two smaller with narrow cavities having annular or spiral thickening at the base. Below the protoxylem vessels is a large water containing cavity formed lysigenously by disintegration or breaking of some cells of parenchyma tissue and rarely protoxylem vessels. Then walled xylem parenchyma are present around the protoxylem vessels.

Phloem: it lies outside thy xylem and is partly present near the metaxylem vessels. It is composed of sieve-elements and companion cells. In a mature bundle the protophloem cells get crushed just below the sheath so the inner portion is the metaphloem. The sieve-tubes appear polygonal in shape in transverse section having internally situated companion cells. (fig.11&12).

<u>Anatomy of dicot root</u>

Absorption of water and dissolved mineral from the soil is carried out by roots, therefore cuticle in roots is absent. The non cutinised outer layer of the root is called as <u>epiblema</u> or <u>rhizodermis</u>. In general outline, the transverse section appears circular. Following tissues are visible

1- <u>epiblema</u> (rhizodermis) بشرة الجذر

It is the outermost uniseriate layer composed of thin-walled, closely packet, parenchymatous cells without inter cellular spaces. Unicellular root hairs are present. The cuticle and stomata are absent. The root hairs absorb water and dissolved mineral salts from the soil.

<u>2- cortex</u> القشرة

It extends from just below the epiblema up to the stele

A) <u>Exodermis</u> القشرة الخارجية

It lies immediately below the epiblema composed of one layer is closely packed. In some cases, it is short-lived and outer most cortical cells bear thin cuticle and become corky. These perform the function of protection. This layer is called as exodermis.

b) <u>general cortex</u> القشرة الاعتيادية

it composed the largest layers of thin-walled loosely arranged cells bear conspicuous inter-cellular spaces. The cells contain leucoplasts for storage of starch grains

c<u>) endodermis</u> القشرة الخارجية

it occurs inner to the general cortex around the stele and is composed of barrel-shaped, parenchymatous cells without inter-cellular spaces. Usually the radial and inner tangential walls of these cells are thickened due to deposition of suberin and lignin due to deposition strip-like structure are formed these are known as casarian strips.

The cells of the endodermis lying opposite thin the protoxylem elements are thin-walled and known as passage-cells because they aloe the passage of water from root to the xylem. The endodermis acts as a water-tight jacket around the stele. (fig. 13)

3-stele الاسطوانة المركزية

It is tetrarch as there are four xylem bundles alternating with four phloem bundles. It consists of following parts:

a) pericycle الدائرة المحيطية

it lies internal to the endodermis and forms a single, uniseriate layer of thin-walled parenchymatous cells containing abundant protoplasm.

b) vascular bundles

these are arranged in ring but xylem and phloem are placed on different radil (pl. of radius)

having equal number of patches. They are alternate in position.

c) pith

it is a central small region or absent in the dicot root. (fig. 13)

Anatomy of monocot root

the internal structure of monocot root comprises following parts:

1- epiblema: it is similar to epiblema of dicot roots.

2- cortex: it lies inner to epiblema. It is similar in structure to that of dicot.

3-endodermis: it lies below the cortex around

The central stele.

4- stele: it is comprising following parts:

a) pericyle

b) vascular bundles

there are a large number of radial bundles arranged in a ring around the central pith

c: pith:

it is the central portion and widely than in dicot root. (fig. 14)

Differences between anatomy of root and stem

الاختـــلاف بيـن تشــريح الجــذر والســاق

Root الجذر	**Stem الساق**
1-root has unicellular hairs with thin walls, without cutich	1-stem bears multicellular hairs with cuticle
2-cuticle and stomata are absent in outermost layer i.e. epiblema	2- cuticle and stomata are present in outermost epidermis
3- epiblema is absorptive in function	3- epidermis is protective in function
4- cortex is broad? Why	4- cortex is narrow
5-Outermost layer of cortex i.e. exodermis is sometimes protective in function	5- outermost layer of cortex is hypodermis, it may be collenchymatous or sclerenchymatous and is protective in function

6-endodermis is general distinct with thick radial walls. it form A water tight jacket around the Stele	6-endodermis may or may not be distinct it cells generally bear starch and thus the layer known as Starch sheath.
7-passage cells are present	7- passage cells are absent.
8- pericycle is single layered Composed of thin walled parenchymatous cell	8- pericycle is multilayered composed of sclerenchyma Or partly parenchymatous
9- vascular bundles are radial i.e. xylem and phloem are separate.	9-vascular bundles are conjoint collateral and either closed or open
10- xylem exarch i.e. proto xylem is towards periphery	10- xylem is endarch i.e. protoxylem is towards center
11-lateral branches are endogenous in origin	11- lateral branches exogenos in origin.