Unit-2
1st chapter

STEM

SHOOT APICS

→ The aireal portation of seedling is generally known as the shoot system.
→ The main axis of the shoot is the stem which bears leaves and at matured stage in its ontogeny to the stem also bear flower and fruit
→ Stem is terminated by cell perepting population of small isodermic repetly deviding cell known as shoot apical meristem.
→ It is the part of the shoot and give rise to leaf premordia and produce the tissue that contribute to the increase in length of the stem.
→ The apical meristem has one of the outstanding characterestic is that as a center of most embryonic development.
→ It function as a organizes. It determinate the fats of its own derivative & in this process to continous to produce leafs and floral meristem through out the life of the plant thus the shoot apical meristem is capable of intermidiate growth.

Organisation of shoot apex

→ The shoot apex or shoot apical meristem is a grove of meristematic cell present at the tip of meristematic cell present at the tip of the stem.
→ It is the region of initiation of primary organization of the shoot where growth process occu
→ The sc. Wolf in 1759 through most like these important maney theory have good provided explan the organization of shoot apex.

The theory are 1) Apical cell theory
2) Histogen theory
3) Tunica corpus theory
4) Histogenetic layer theory
5) Annuaeare initial & meristem & etent theory
6) Cytological zonation theory
7) Newmans theory.

1) APICAL CELL THEORY

1) Apical cell theory was the first theory 1759 recognized to explain the apical organization in plant.

2) proposed by Nageli 1858 (~~1878~~)

3) According to this theory The single apical cell constitutes the growing point in most of the cryptogams. This single cell is called Apical cell

4) Each single apical cell leads to the development of the complete plant body.

5) Nageli proposed that the shoot apex of Gymnosperms and Angiosperms also consisted of a single apical cell.

6) However later studies rejected the apical cell theory because the single celled apical organization is limited only to cryptogams such as algae, fungi, bryophytes & pteridophytes

7) This theory is not aplicable for gymnosperm and Angiosperm.

2) Histogen theory

→ proposed by J. Hanstein in 1868 explained by sc. Derman in 1947. 1870

→ Hanstein proposed the histogen theory based on two consideration.

a) The plant body does not originate from a single superficial cell, but from a mass of meristematic cell.

b) This meristematic zone consist of three distinct zones called as Histogens. that contribute to the primary growth of the plant body.

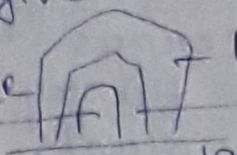
① Dermatogen

② periblem

③ plerome

a) Dermatogen
→ The outermost layer of Apical meristem.
→ This layer devide Anticlinal division and give rise to Epidermis layer.

b) periblem
→ Located inner to the dermatogen, consist of a few layer of isodiametric cell
→ Each cells are devided and give rise to cortex and ground tissue system.



c) plerome
→ Inner to the periblem plerome layer is present it is central zone of the shoot apex.
→ It give rise to vascular tissue, medulary ray, and pith region.

According to this theory each plant parts originates from a group of initials
→ The histogen theory is now rejected. This is because recent studies have shown that there is no strict zonal differentiation betn the histogens in the shoot apex meristem.
* periblem and plerome from each other in apical region we can not differentiation.

③ TUNICA CORPUS THEORY
→ proposed by Schmidt in 1924. This theory is aplicable only shoot apex & not to the root apex.
→ According to this theary two distinct tissue zones occur in the apical region of the sheet. They are

a) Tunica
→ consist of one or more peripheral layer of cells
• Smaller then corpus
• show Anticlinal division
• They assist in increasing surface area.
→ If tunica is more then one layer the outer most layer form the Epidermis
inner layer - cortex
pericycle
vascular tissue
pith

Anatomy of Dicot stem

Internal structure of a typical dicot stem sunflower

Epidermis

→ It is the outermost layer of stem. Composed thin walled parenchymatous cell arranged in compact
→ On the outer side it is covered by cuticle
→ The epidermis exhibits several unbranched multicellular hair present surface of cuticle.
→ Stomata are also seen

Cortex

→ This layer is extends (present) immediately beneath the epidermis.
→ It is differentiated in to hypodermis, general cortex, and endodermis.

a) HYPODERMIS

→ In dicot stem Hypodermis is composed of few (3-4) layer of living collenchymatous cell.
→ Chloroplast is present this cell.
→ Provide mechanical support to the young stem
→ They also perform the fun of photosynthesis

b) General cortex

→ It is present bet^n the hypodermis (outer) and inner endodermis.
→ composed of loosely arranged parenchymatous cell. with intracellular space.
→ The cells are isodiametric in shape and contain chloroplast. Hence these cells are also known as chlorenchyma or assemmelatory parenchy

→ In aquatic plant the cortex region develops aerenchyma with large intracellular space which provides bouncy.
→ Resin duct (oil duct) or reservoir of waste product are usually found in cortex region
→ The function is storage of food materials also known as food storage region.

→ It help to the photosynthetic process with provide mechanical support to the tissue of the stem.

c) Endodermis

→ It is the innermost layer of cortex which separates the stele from cortical cell.

→ It is uniseriate wavy layer composed of barrel shaped elongated cell in vertically.

→ starch grains are found in this layer & hence it is called as starch sheath.

Pericycle

→ This layer is occurs inner to the endodermis

→ composed of both sclerenchymatous & parenchymatous cells present in alternate patches.

→ sclerenchyma patches are found just outer to the vascular bundle. also provides mechanical support

→ The parenchymatous cells are act as storage of food.

vascular system

→ A number of vascular bundles arranged in ring. The vascular bundle are may be various type such as conjoint, collateral & open (Amphicribal) type with endarch protoxylem.

primary medullary rays

→ The ground tissue found in between the vascular bundle is known as Medulary rays.

→ composed of thinwalled parenchymatous cell connect the pith with pericycle

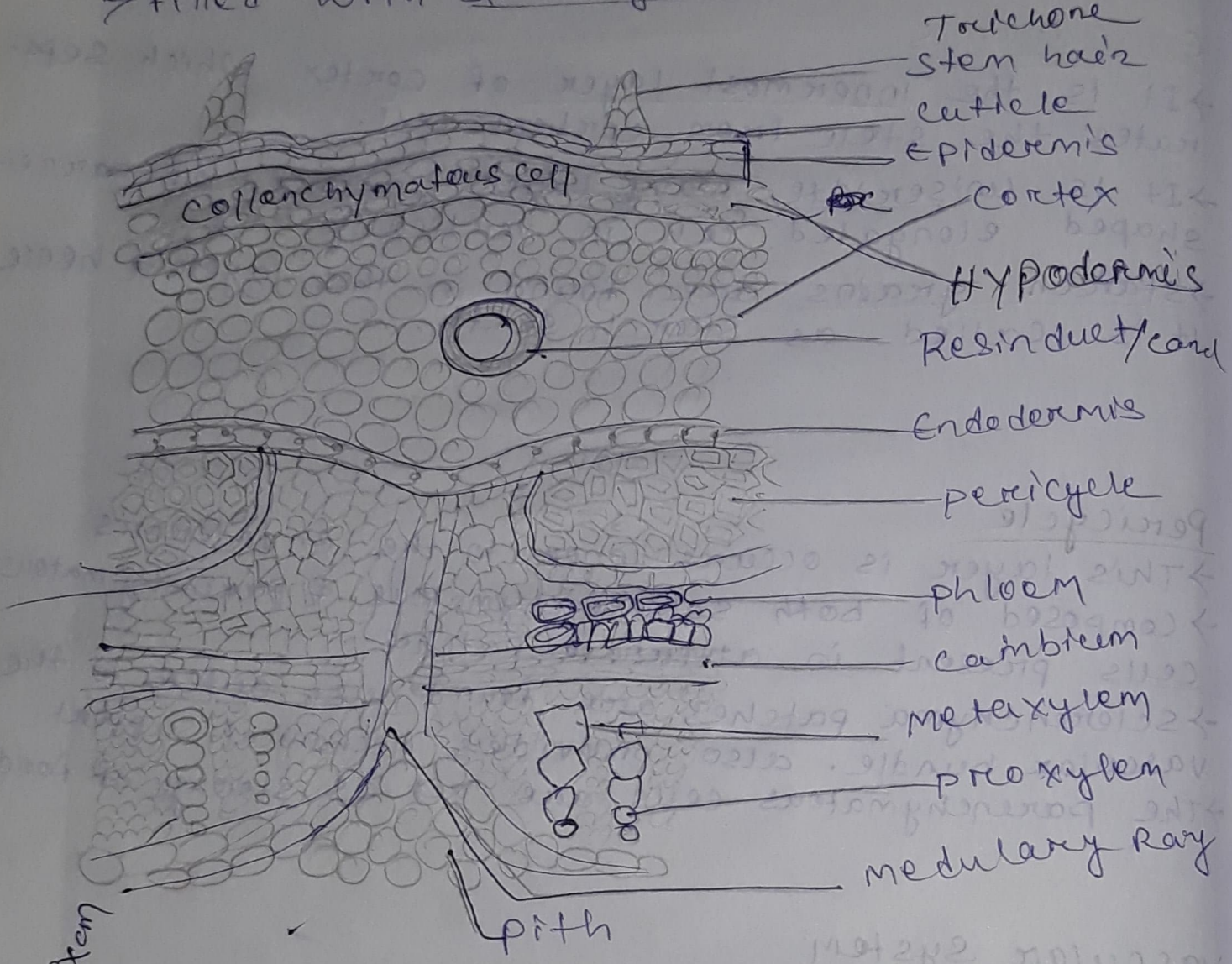
→ The medulary rays are involved in radial conduction of food & water.

Pith or Medulla

→ pith is present at the centre is large and composed of parenchymatous cells

→ present intra-cellular space

→ filled with starch grains & other foods.



Anatomy of Monocot stem

A transverse section of monocot stem ie Maize stem is differentiated in to

Epidermis
Hypodermis
vascular bundles

(maize, Rice, Wheat / graminaceae family (Coconut)

1) Epidermis

1→ outermost Single layer, composed of rectangular cell

2→ The outer wall of the cell forming a thick wall. Cuticle

3→ Lack of epidermal hair (Trichomes)

2) Hypodermis

1→ present below the epidermis layer

2→ composed of 2-3 layered of sclerenchymatous cell.

3) Ground tissue

2← composed of parenchymatous cell with thin walled.

1- present below the hypodermis to the centre.

3→ The cells are loosely arranged with intra-cellular space

4← The vascular bundles are embedded in this region

5← It is not differentiated into ; cortex, endodermis; pericycle, pith

4) vascular system

1- The vascular bundles present scattered (face 2 face) in the ground tissue. to the periphery

2→ They are numerous and present closer then in the centre.

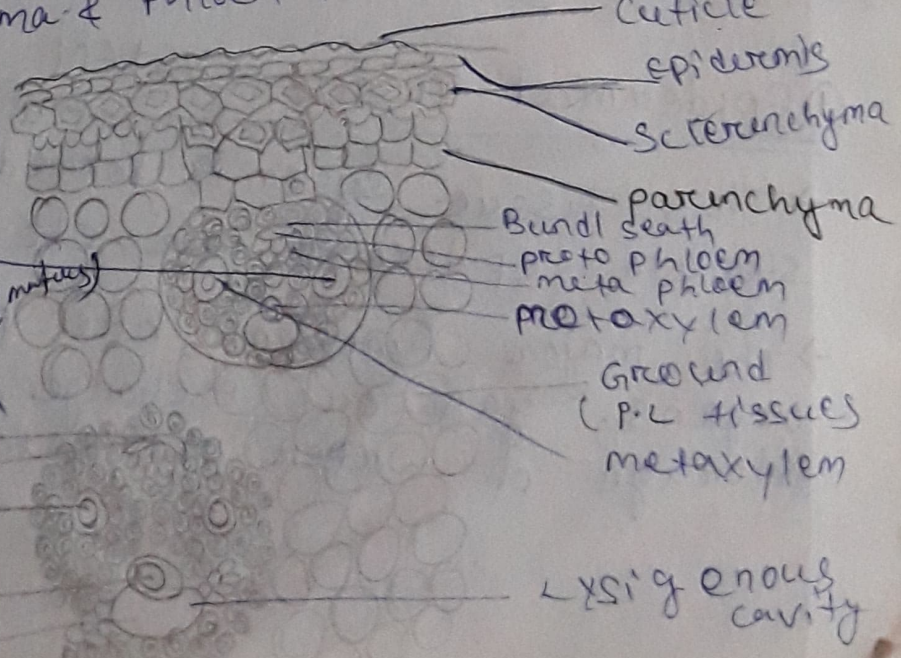
3→ The vascular bundle are generally oval, covered by a sclerenchymatous sheath.

4→ The bundle are conjoint collateral & closed. due to absent of V.C

5→ protoxylem is endarch and a lysigenous cavity (water containing cavity) is present just below the protoxylem.

6→ phloem parenchyma & phloem fibres are absent in vascular bundles

7→ Do not occurs secondary growth



Structure of Dicot and Monocot stem

→ The shoot system of the flowering plant which develop from the plumule each consist of an axis the stem bearing lateral organ

→ Leaf characterestic by determinate growth & usually have dorsiventral symmetric and buds by potentially intermidiate growth an have radially radial symmetry

→ HOW ever the reproductive phage the stem produces flower or influrecence which are bud laterally on terminally and in both position.

→ HOW ever the reproductive phage the stem produces flower or influrecence which

The stem is devids in to

① Node

② Internode.

→ The parts of the stem one or more leaf are attached are called node & the region bet' to successive node known as internode.

Primary structure of stem

The primary str of stem may be distinguish into three tissue stystem.

① Epidermal

② Ground

③ vascular.

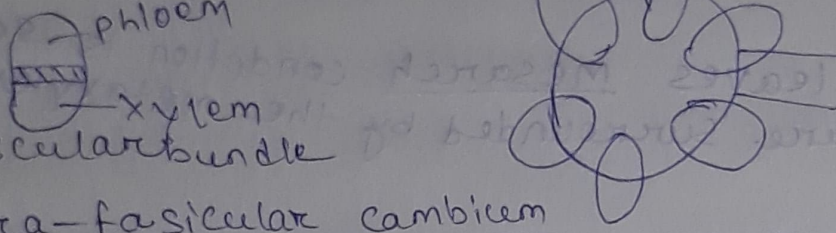
① Epidermal Tissue system

→ This tissue system is formed by the epidermis, stomata, epidermal hair etc

→ The major function are protection of intern organs, gaseoous exchange, transpiration and storage of water and metabolic products

Cambicum

Helps in secondary growth mostly present in
① Dicot (Angiesperm)
② Gymnosper
But cambium is absent in monocot plant
Based on cambicum position they are 2 types.
① Inter fasicular cambicum
② Intrafasicular cambicum



Intra-fasicular cambicum
present in betn xylem & phloem or cender/inside the vascular bundle

Inter-fasicular bundle
present in betn two vascular bundle form a Ring str for secondary growth.

Vascular Cambicum
→ The vascular cambicum is a lateral meristem that provids secondary vascular tissue.

Origin - vascular cambicum develop from procambicum in the vascular bundle (region) the procambium tissue differentiate to form primary vascular tissue Then it undergoes division to form secondary vascular tissue

Cambium

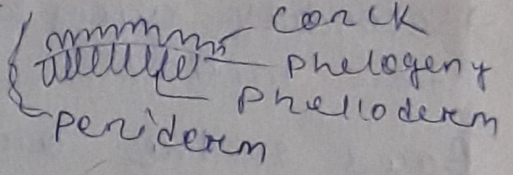
→ Group of meristematic cell
→ They are parallel to one another and encircle the stem of a plant.
→ cambium a cellular plant tissue from which phloem, xylem or cork grows by division resulting develope secondary growth of plant.
origin- Develop from procambium

There are several kind of cambium found in plants stem and roots

① Cork cambium (phallogen (pericambium) Bark
② unifacial cambium
③ vascular cambium (Bifacial /wood & main cambium)

Cork Cambium

→ Responsible for the development of periderm.
→ cells that grow inwards from there are formed, phelloderm and cells that develop outwards are termed as phellem or cork.



unifacial cambium

→ Such cambium produces cells to the interior of its cylender. These cells differentiate in to xylem tissue.

Vascular cambium

→ It is a plant tissue located betn xylem & phloem in the stem & roots of vascular plants
→ Give rise secondary vascular tissue.
→ It is the source of both secondary xylem growth inward the pith & (2ndary Phloem) growth outwards to the bark.
→ It found in dicot & gymnosperm but not monocot
→ Intra-f-c- present betn primary xylem & phloem (open) of vascular bundle
→ Intere-f-c- present in betn vascular bundle

Structure

Vascular cambium is usually composed of two basic types of cell

① Ray initial

② Fusiform initial

a) Ray initial

→ It give rise to parenchymatous vascular ray.
→ They are isodiametric & flattening structure.
→ These are not tapering

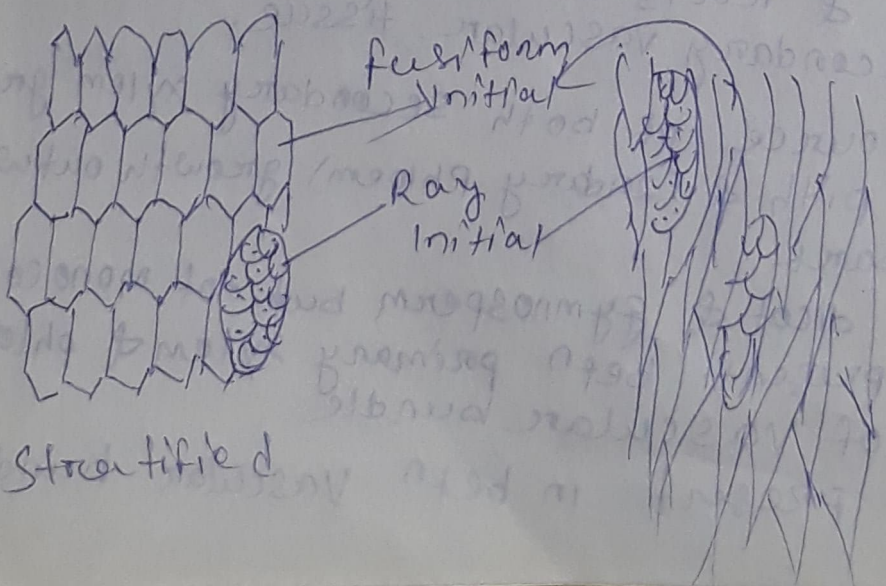
b) Fusiform initial

→ cells are considerably long with tapered end and spindle shape.
→ Secondary xylem and phloem differentiate from this initial

Based on the arrangement of fusiform cells they are devids in to two types of V-C.

Stratified

→ Arranged in regular horizontal row in such away that their end and are approximately at the same levele
ex- found in Dalbergia sissoo
Grewia oppositifolia



Non-stratified vascular cambium

→Here the fusiform initial partialy overlap to each other

ex- Based on division cambia two types

Steroid - Radial division

Non-steroid - obliquely radial (pseudo transverse division)

→The cambial cells are highly vaculated & thin peripheral cytoplasm.

→The wall of cambial cell have primary pits with plasmodesmata

Function

→provides layers of xylem and phloem in a woody plant thereby growing the diameter of the stem.

→In healing for injured plant life

→The corck cambium is responsible for secondary growth that replace the epidermis in roots & stem.

Seasonal Activity of cambium

→Activity of cambium is under the influence of several environmental factor such as season

→Trees growing in the tropics show more or less uniformity in the size or dimension of their vessel elements

→These growing in temperate climets show clear Morphological variation summer & winter wood.

*Summer - vessels are wider

*winter - vessels are narrow

→According to wetmore R. Rier (1963)

- Low con. of sugar - xylem differentiation
- High con of sugar - phloem differentiation

Secondary growth of stem

→ The growth of the roots & stem in length with the help of apical meristem is primary growth

→ Apart from primary growth the most dicotyledon plant exhibit an increase in girth. (growth of lateral meristem)

→ This increase is called secondary growth.

secondary growth are two types

Lateral Meristem
- (i) Vascular cambium
- (ii) Cork cambium (periderm)

- Occcurs in all woody dicots, some herbaceous dicots and gymnosperm. some monocot plant like Dracaena, Aloe, Yucca etc.

Secondary growth in Dicot stem

→ main secondary growth occurs in stelar region by the help of vascular cambium. which is called stelar secondary growth.

→ extra-stelar region - secondary growth occurs by the help of cork cambium which is called extrastelar secondary growth.

→ This leads to formation of periderm.

STELAR SECONDARY GROWTH

Formation of cambium Ring

Intrafascicular cambium- cambium present in bet^{n} xylem and phloem of the vascular bundle

Interfascicular cambium- cambium develop in the parenchyma (medullary ray) cell in between the vascular bundle.

→ fasicular and intrafasicular cambium patches join end to end and form a complete ring called cambium ring.

Activity of Cambium Ring

→The cambium consist of elongated spindle-shaped cell called fusiform initial cell & small isodiametric cells are called ray initial

→fusiform initials towards the inner side differentiate in to secondary xylem. These cell on outer side differentiate in to secondary phloem element

→Ray initials produces parenchyma cell arranged in radially from secondary medullary rays which pass through secondary xylem & phloem

→Cambium ring is more active on the inner side then the outer side producing more amount of xylem & phloem

→Resulting, a pressure is used pushing the cambium phloem & other surrounding tissues outwards

→But the primary xylem remains intact at the centre.

→secondary growth, The main bulk of the plant body is formed by secondary xylem

Formation of annual ring

→The cambium ring also shows seasonal variations in its activity. It become more active in spring producing more amount of xylem vessels & with wider lumen.

→During winter cambium ring becomes less active

→secondary xylem elements formed during spring are large, thin & broad as compared to these formed during autmn which are small, narrow & thick

Spring - spring wood or early wood.

Autumn - autumn wood or late wood.

→Two types of woods appear in the form of distinct concentric circles called annual rings.

→Dendrochronology - deals with determining the age of a tree.

SAPWOOD AND HEARTWOOD

Sapwood / alburnum

- secondary xylem, present towards periphery
- Conduction & food storage.
- It is living and ~~minerals~~ lighter in colour
- conduct water and mineral

→The older wood of annual rings in the centre becomes stained due to deposition of aromatic substances, oils, resins, gums, tannins etc

Heartwood or duramen

→The cavity of Heart wood are often clogged with deposits of gummy materials and outgrowths of adjacent cell which enter through the pits called tylosses.
→water conduction stop in heartwood & it helps mostly in mechanical support.
→Heart wood is generally commercially more valuable then sapwood.
→Heart wood is more resistant to micro-organisms & insects then sapwood.

EXTRA-STELAR secondary growth

Formation of cork cambium

→Occurs outside the vascular bundles or stelar region is called extrastelar secondary growth.
→such secondary growth leads to the formation of periderm
→ e-s-g: encircle phellem or cork, phallogen or cork cambium, & phelloderm / 2ndary cortex.
→phellogen / cork cambium
present below the epidermis become secondary lateral meristem
outer cell phellem / cork
-cells are rectangular, arranged in radial row
phelloderm / 2ndary cortex
present inner to the cork cambium.
→Lenticels develop on phellem. It formed due to over activity of cork cambium at this region.
→Resulting overlying cells are pushed outwards and epidermis is ruptured.
→The cells are loose thin walled parenchymatous intra cellular space are called complementary cell.
→They often project slightly above the outer surface of the stem.
→phellem, phellogen & phelloderm togather constitute the periderm.

Internal str of LEAF

on the basis of nature of mesophyll & exposure to sunlight the leaves are of two types

1) **Dorsiventral Leaf** seen in Dicotyledon.
flattened & mesophyll tissue differentiated into palisade parenchyma & spongy parenchyma

2) **Isobilateral leaf**
Found in Monocotyledon.

1) **Dorsiventral leaf**

Upper epidermis ~~epidermis~~ or adaxial epidermis:-
- composed of single layer of parenchyma cell compactly arranged.
→ possess a thick cuticle on the outer surface
stomata are absent in upper surface.
→ Generally hypostomatic (stomata more in number on lower surface)
some are amphistomatic (stomata same on both surface.

Mesophyll

present in betn upper and lower epidermis the chloroplast containing photosynthetic tissue called mesophyll.

Mesophyll is differentated into
(i) palisade parenchyma
(ii) spongy parenchyma

palisade parenchyma

→ present below the upper epidermis
→ These cells are arranged vertically & parallel to each other & contain more chloroplast.
→ The fun of P.P is photo synthesis.

2- spongy parenchyma

→ It is present below the palisade tissue.
→ cells are loosely arranged irregularly shaped cell
→ present intra-cellular space.
→ contact with atmosphere through stomata of lower surface • chloroplast less then palisade tissue.

vascular system

→ A number of vascular bundle are present in a row of which the one represents the mid-vein is the largest.
→ each vascular bundle is surrounded by a thin layer of parenchymatous cells called Bundle sheath.
→ each vascular bundle is conjoint, collateral, and closed type with xylem towards upper epidermis and phloem towards lower epidermis.

Lower epidermis Abaxial epidermis

→ composed cutinised as the upper epidermis. But possesses a number of stomata with prominent guard cells.

ISOBILATERAL LEAF Monocot (maize) vertical section

UPPER EPIDERMIS (adaxial)

→ Thickness of cuticle and presence of stomata are same in both side. (amphistomatic)
- possesses cuticle on outer wall
- not contain chloroplast.

→ present large, thin walled and empty bulliform cell containing water.
- stomata are also present in this layer.

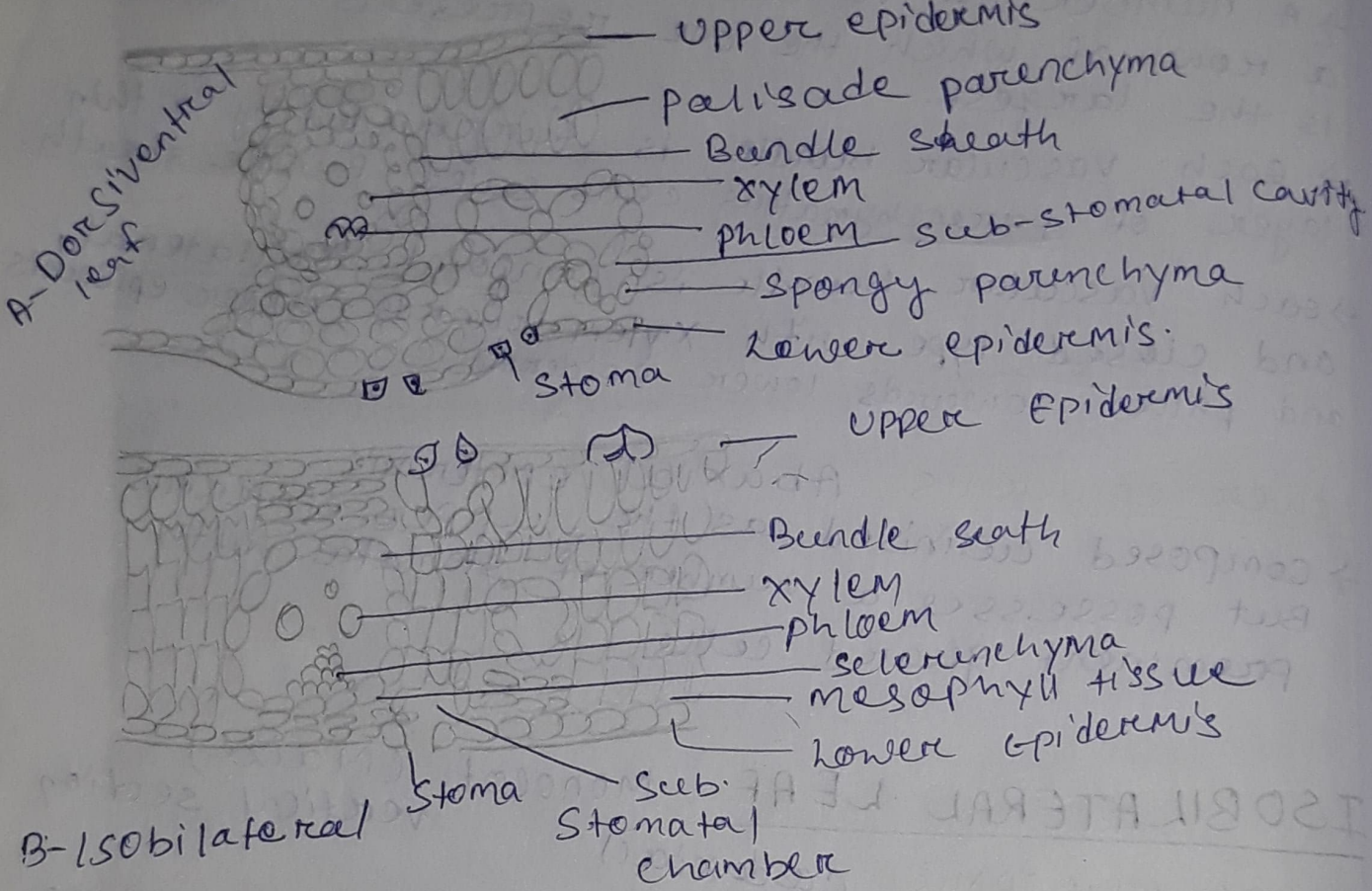
vascular bundle

→ conjoint & closed
→ Arranged in a row having xylem towards upper side & phloem on the lower side
→ They are encircled by bundle seath

→A large vascular bundle appears in the centre
→The sclerenchymatous patches are found at both ends of large vascular bundle

LOWER EPIDERMIS

→Single layered composed of parenchyma cells
→Having a large number of stomata as compared to the upper epidermis.



DORSIVENTRAL

→stomata are absent in ~~lower~~ upper epidermis
Hypostomatic
→Mesophyll tissue is devide into spongy & pallisade parenchyma.
→Bundle seath extensions are seen
→Vaiscular bundle are irregularly spaced and are diff^n size
→Bulliform cells are absent

ISOBILATERAL

-Leaves are Amphistomatic
→Mesophyll tissue is not differentiated & mostly consist of spongy parenchy
→Bundle s-e is not seen.
→V.B are distributed Regularly & are approximately of same size
→Bulliform cells are occures in upper epide

KRANZ ANATOMY

→ The word kranz means "wreath" or "Ring"

Kranz anatomy is a specialized structure in C4 plants where the mesophyll cells are clustered around the bundle-sheath cells in a ring-like fashion

→ The number of chloroplast in the bundle sheath cells is more then that in the mesophyll cell

→ This is found in C4 grasses such as maize and a few dicot.

The kranz anatomy is developed in 3 diffⁿ steps

- Initiation of procambium.
- Bundle sheath & mesophyll cell specification
- chloroplast development & integration of the C4 cycle.

KRANZ ANATOMY in C4 plant.

→ The light-dependent reaⁿ and the calvin cycle are separated in the C4 plants.

→ The calvin cycle occures in the bundle-sheath cell and the light-dependent reaⁿ occures in the mesophyll cell

→ The atmospheric oxygen is fixed first to form 4-carbon compound oxaloacetate in the mesophyll cell catalyzed by PEP carboxylase.

→ oxaloacetate is converted to malate which is transported to the bundle-sheath cell.

→ malate dissociates in the bundle-sheath cell to release carbon di-oxide.

→ Rubisco fixes the carbon dioxide and converts it in to sugars.

→ carbon dioxide is constantly pumped into the bundle sheath cell by the mesophyll cell. The carbon dioxide concentration around Rubisco is always higher.

→ This reduce photorespiration.

→ In the majority of plants, carbon dioxide is fixed into a 3 carbon compound by the enzyme of Ribulose bisphosphate carboxylase oxygenase (Rubisco.

→ Rubisco can also catalyze a reaction with oxygen giving a wasteful process known as photorespiration.

→ To overcome this, the C4 pathway fixes atmospheric carbon dioxide using the enzyme phosphoenolpyruvate carboxylase.

→ Carbon dioxide is then released for refixation by Rubisco.

→ In C4 grasses such as maize, the mesophyll cells surround the bundle sheath cells and the bundle sheath cells surrounds the vein.

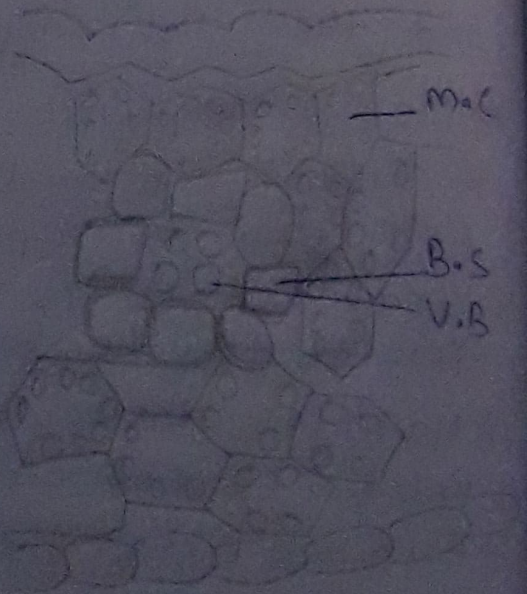
KRANZ ANATOMY

→ C4 plant show Kranz anatomy

→ Mesophyll is not differentiated into palasid & spongy tissue

→ vascular bundle surrounded by bundle sheath cell.

→ In mesophyll cell contains Grandular chloroplast small size more in number



→ Bundle sheath - contains

A - grandular chloroplast

ex - Sugarcane, jawar, maize

Anatomy of Angiosperm

No-1 1×10 = 10

1- Tunica corpus theory was proposed by _____.
2- The vascular bundles originate from _____.
3- Xylem and phloem are _____ tissue.
4- In root _____ type of vascular bundle are found.
5- The cambium is absent in vascular bundle, this type of vascular bundle are called _____
6- The Dicotyledon leaf is also called as _____.
7- The monocotyledon leaf is also called as _____
8- mesophyl tissue divisible in to _____ and _____ parenchyma
9- Epidermis layer of stem is developed from _____.
10- Vascular bundle is developd from _____ layer of cell/short note.

No-2 3×5 = 15

1- Apical cell theory
2- What is Histogen
3- Periblem
4- Tunica corpus theory.
5- inter-fasicular cambium

No-3 long question exs. 40

1- Describe the str & distribution of vascular cambium.
2- Anatomy of Dicotyledon stem.
3- Anatomy of monocotyledon stem.
4- secondary Growth in stem.
5- Kranz anatomy.