Anatomy of flowering Plants (2-3 Q)

Basic intro:-

cell → tissue → organ

① type of tissue:-
- i) Meristematic
- ii) permanent — simple, complex

② Tissue system:-
- i) Epidermal tissue
- ii) Vascular bundle
- iii) Ground tissue

③ transverse sections
- Dicot – root, stem, leaf
- monocot – root, stem, leaf

④ secondary growth

Defn:- anatomy:- study of internal structure

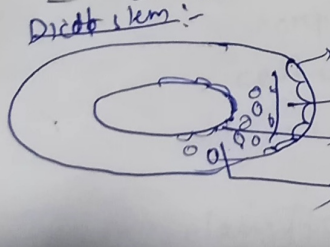
tissue:- Groups of cells have common origin & similar function

Type:-
on the basis of ability to divide
- → Meristematic tissue
- → permanent tissue
  - simple permanent (only 1 type of cell) → parenchyma, collenchyma, sclerenchyma
  - complex permanent (more than 1 type of cell) → xylem, phloem
- cell growth → stop, performing particular function

xylem tissue
- ↳ xylem fibre
- ↳ " parenchyma
- ↳ Vessel
- ↳ tracheids

Example of complex permanent other than xylem & phloem:-

Dicot stem:-



cortex tissue = 1 + 2 + 3
- ↳ collenchyma + parenchyma

{ Complex permanent tissue }

Type of tissue → Meristematic
→ permanent tissue
→ simple permanent
→ complex permanent

① Meristimatic Tissue :-

Meristem → group of dividing cells.

features of meristimatic tissue :-

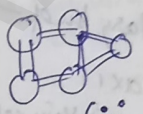
→ small size

→ cellwall thin (1° cellwall)

→ vacuole absent / very small (because it is feature of permanent cell)

→ dense cytoplasm.
(represents activities is going on i.e. protein synthesis or RNA synthesis)

→ cell have multiple plasmodesmatic connection.



(∵ plants doesnot have neuron, plasmodesmata help them to communicate with eachother)

→ cellwall
→ P.M.

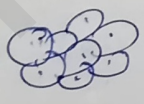
shape - oval or round

→ n/c ratio high

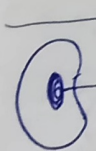
n/c volⁿ (low)

→ n/c volⁿ → high

→ n/c volⁿ



meristem or (meristematic tissue) → no intercellular space (absent)



(seed)

embryo (dividing cell) → (1° meristem) → dividing cell (derived from embryo) (present from start)

(differentiation)

permanent cells (1° tissue)

(de-differentiation)

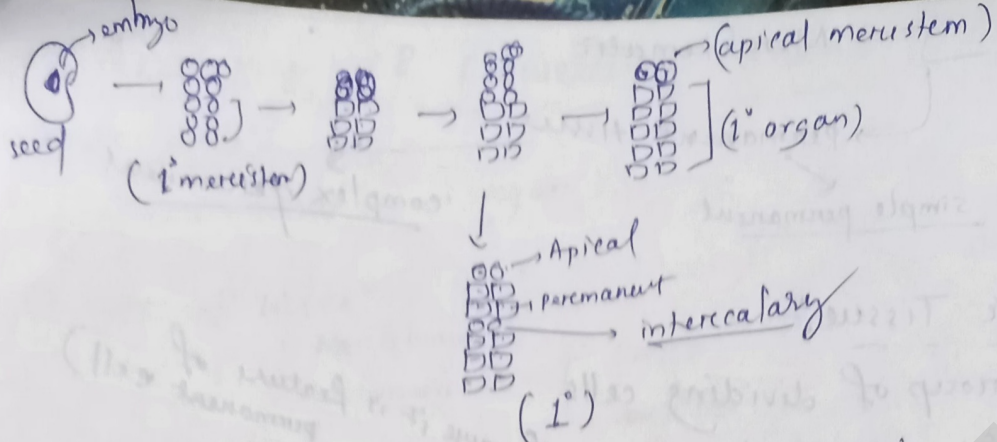
(1° organ) → (leaf), (stem), (root)

re-differentiation

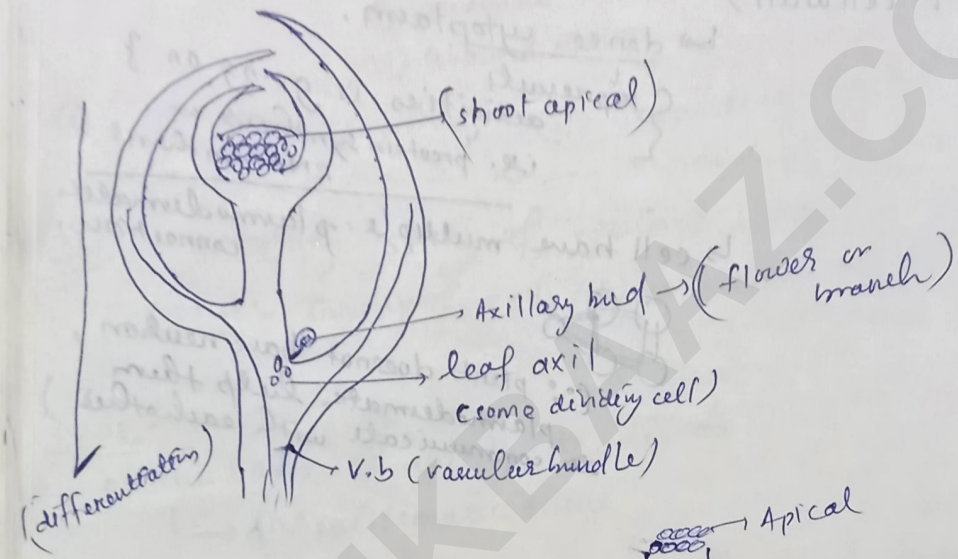
(2° tissue) → secondary xylem/phloem

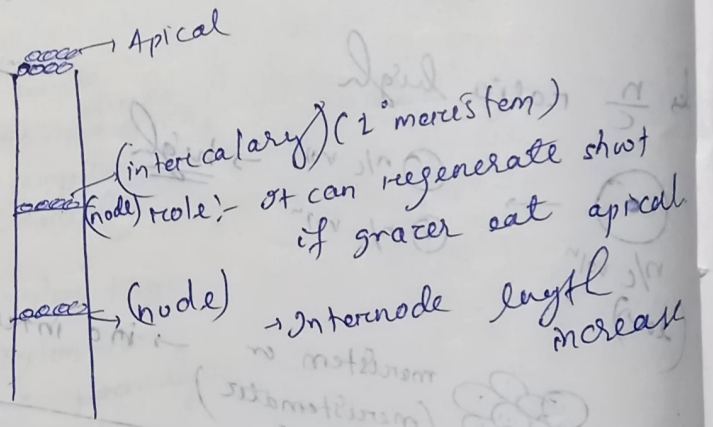
permanent (from 2° meristem)

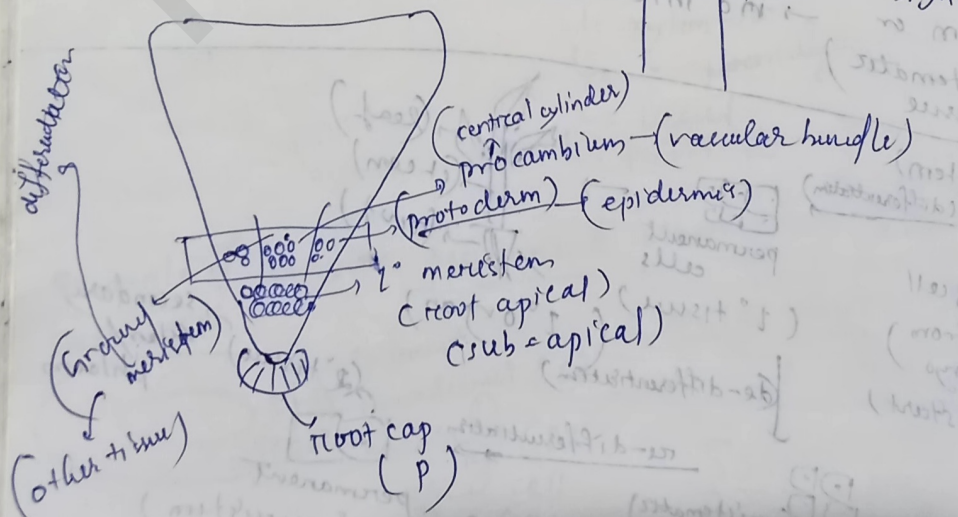
(2° meristem) (vascular cambium / cork cambium) ← (meristematic cell)

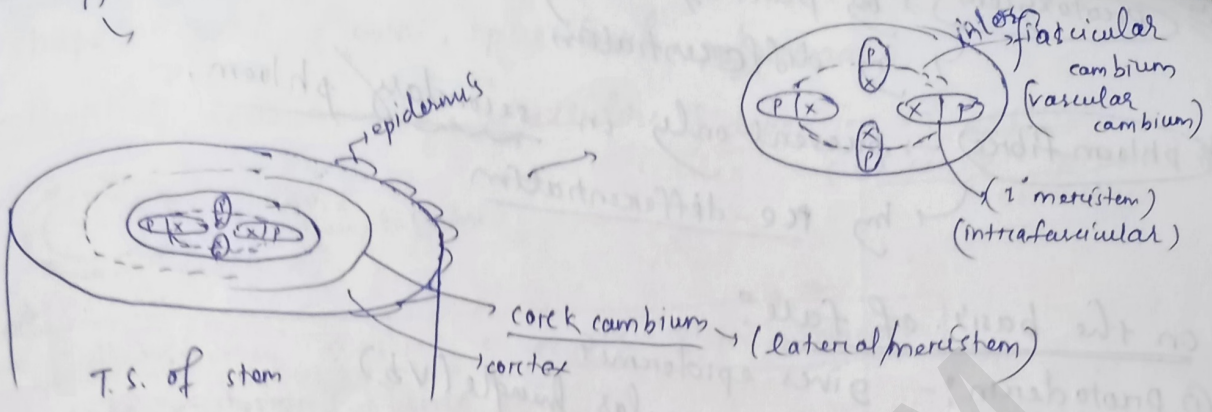


Type of meristem :- on the basis of location









* 2 lateral meristem
  i) cork cambium (secondary meristem)
     ↳ derived from de-differentiation of cortex
  ii) vascular cambium → (not completly 2°)
     → (½ primary + ½ secondary)
     (intrafascicular cambium) (fascicular cambium (from medullary rays))

Eg.
On the basis of origin:-
a) primary - present since origin (e.g. Apical & intercalary)
b) secondary - derived from de-differentiation of permanent cell.
   e.g. cork cambium (from cortex)
   vasular cambium (from medullary rays)

On the basis of location:-
a) Apical - on shoot tip & root tip
b) intercalary - separated from apical by permanent
c) lateral - present in mature tissue (root / stem)

Q Name one primary meristem which is lateral?
→ intrafascicular is part of V.C.
position - lateral
but origin → primary

N.b. // (Protoxylem) → ~~by~~ part of 1° xylem
↳ by differentiation

(Phloem fibre) → present only in secondary phloem.
↳ by re-differentiation

* On the basis of fate:
① Protoderm :- gives epidermis
② Procambium :- gives vascular bundle (Vb)
③ Ground meristem :- form ground tissue

① Simple Permanent Tissue :-
a) parenchyma
b) collenchyma
c) sclerenchyma

a) Parenchyma:
* shape :- mainly isodiametric or oval round, polygonal spherical.
→ Elongated (अगर aise shape hue → protection मे kaam ayega)

* cell wall :- mainly cellulose.
* intercellular space can be present.
* parenchyma → space filling tissue } most abundant tissue. **
(e.g. pith, cortex)

Role :-
→ storage, photosynthesis, secretion.
→ No role in mechanical support.

photosynthetic parenchyma :→ Chlorenchyma
↳ leaf cell → mesophyll cell
in dicot leaf → (spongy + palisade)
↳ mesophyll cell

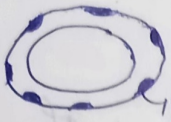
Aerenchyma :- (aquatic plants) ~~pro~~
↳ provide buoyancy
↳ air space present betⁿ parenchyma cells.

→ storage : e.g. (xylem & phloem parenchyma)

Collenchyma :-

shape :- O S P (oval, spherical, polygonal)

cellwall :- cellulose, hemicellulose & deposition of pectine (at certain place) (corners)

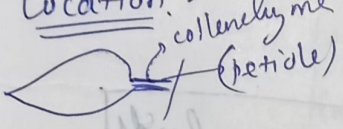


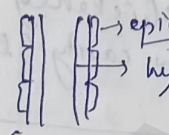
→ Collenchyme absent in roots & in monocots.

- intercellular space absent

Role :- That living cell which can act → mechanical support
→ photosynthesis

Location :-





(Dicot stem)

→ present in that part → which is soft but provide hardness.

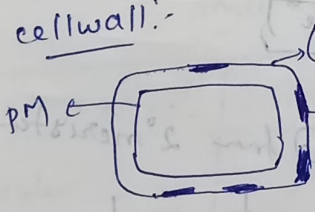
Imp. Note :- All epidermal cell (green part) lack chloroplast except Guard cell

collenchyma may be present as → complete layer (homogenous layer)
or
→ in patches

Sclerenchyma :-

① shape :- long narrow, polygonal, highly thickened wall.

cellwall :-



→ Dead & lignified role → mechanical support.

pit → locations where deposition of lignin is absent.

1° cellwall → permeable & in dead cell → plasma membrane absent.

So, water can move easily through pit.

pits found in → Fibre, vessels, tracheids, sclereids

* Sclerenchyma is 2 types on the basis of (F, O, S, D) form, origin, structure, & development

fibre

- → Elongated, pointed end.
- → lignified
- → dead (no protoplasm)
- → Lumen (hollow)
- → organs help in mechanical support

location:- → xylem fibre,
- phloem fibre,
- pericycle of (dicot stem)
- → hypodermis of (monocot stem)

sclereids

- → polygonal

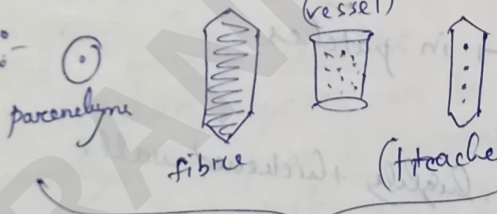
- → few organs like fruit
  - ex:- → Brachysclereids → pulp of pear sapota guava (Gritiness)
- * legume seed coat - Epidermis & hypodermis
- * tea leaf
- → More thickened wall.
- → very narrow cavity (lumen)

Deposition of lignin found at :- vessel, fibre, sclereids, tracheids

Complex Permanent Tissue:-

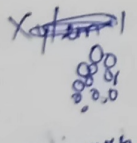
Xylem (Hadrome):-

Xylem:-



role of xylem:-
- → conduct of water & mineral.
- → some hormone can move.
- → unidirectional.

Tissue:- group of cell having common origin & similar function



→ Xylem tissue (primary xylem)

if xylem formed from 2° meristem → secondary xylem.

if ano. cells present → xylem bundle.

Evolution:-

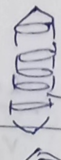
primary meristem — differentiation → i) xylem parenchyma — [storage → starch, oil, tannin ; → radial conduction]

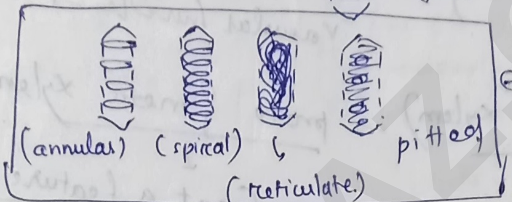
→ xylem fibre (sclerenchyma)

(dead) elongated, tappering, lignified highly thickened.
- → present in group
- obliterated lumen (lumen में भी lignin है) closed lumen
- septate or aseptate

→ vessel member

→ tracheids — endwall → close (pit)





tracheary elements ↓ (vessel + tracheids)

similarity in vessel & tracheid:-
- a) dead
- b) lignified - mechanical role
- c) Apoplast conduction
- d) pitted

Difference:-

tracheids	vessels
- imperforation	- perforation
- narrow lumen	- wide lumen
- single member	- multimember

Name of cell	Living	lignified	mechanical	conducting	(non-porous) Gymnosperm	(porous) Angiosperm
i) xylem parenchyma	✓	✗	✗	✓ ←||→ (radial conduction)	✓	✓
ii) xylem fibre	✗	✓	✓	✗	✗	✓
iii) tracheids	✗	✓	✓	✓	✓	✓
iv) vessels	✗	✓	✓	✓	✗	✓

Wood → xylem

vessel present → porous wood - angiosperm

absent → Gymnosperm Exceptⁿ :- Gnetum, ephedra.

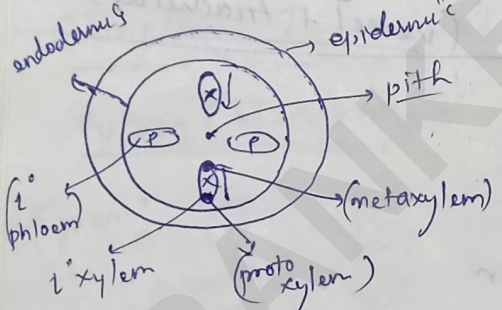
Type of xylem → primary
→ secondary → develope from secondary meristem (present in dicot stem & root)

1° meristem → primary xylem

(1° meristem) → plant → protoxylem → (annular tracheid) (early xylem)
→ metaxylem - late form xylem
vascular bundle → full size

(feature of only 1° xylem) → proto & meta xylem.
(not a feature of 2° xylem)

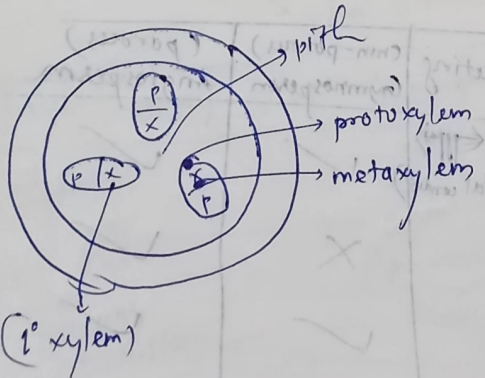
T.S. of root:-



metaxylem → towards pith
protoxylem → towards outside
(exarch)

Development → centripetal. (outside to inside)

T.S. of stem



protoxylem → towards pith
metaxylem → towards outside
(Endarch)

Development - Centrifugal
(inside to outside)

Phloem :- (Leptome) :-

→ phloem parenchyma (living)
→ companion cell (living)
→ sieve tube (living)
→ phloem fibre → (dead)

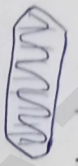
Role :-
→ conduction of food, mineral, hormones. (Cold leaf → young leaf)

Evolution :-

(Meristem) → differentiation → Permanent cell → phloem parenchyma
storage
→ Resin, mucilage, gum

Elongated, cylindrical, thick wall, dense cytoplasm (plasmodesmata connection with other cell.)

differentiation → phloem fibre

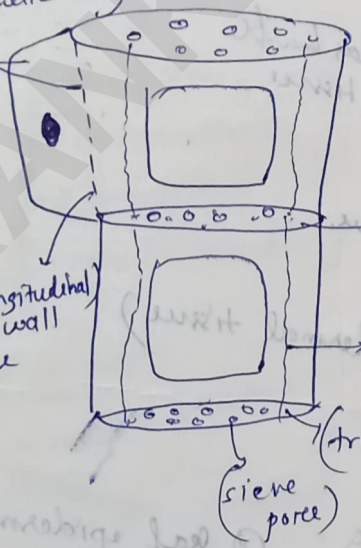


→ Elongated
→ dead, lignified
→ use as commercial fibre
Jute, flax, hemp

differentiation → Companion cell & sieve tube

* sieve tube & companion cell share wall, function & origin.

pit fields :- (plasmodesmatic connection at their longitudinal wall)



companion cell
• living
• nucleated
→ control activity of sieve tube
→ Maintain pressure gradient of sieve tube.

→ sieve tube element
* central vacuole, periferal cytoplasm
* Enucleated
* perforation present → (on transverse wall)
→ sieve plate
(longitudinal wall)
(P-protein) (phloem protein / cytoplasmic strand)
(transverse wall)
(sieve pore)

In Gymnosperm :- sieve cell & albuminous cell (in place of companion cell)

T.S / V.S

1. Dicot stem } secondary growth
2. Dicot root }
3. Dicot leaf } no secondary growth
4. Monocot stem
5. Monocot root
6. Monocot leaf

* Phloem fibre → absent in primary phloem
present in secondary phloem
↓
secondary growth

i.e. phloem fibre absent in
(3+4+5+6)

* phloem parenchyma absent in Monocot.

Q. T.S/V.S which lack phloem fibre but have phloem parenchyma
a) Dicot stem
b) " root
c) " leaf
d) Monocot stem

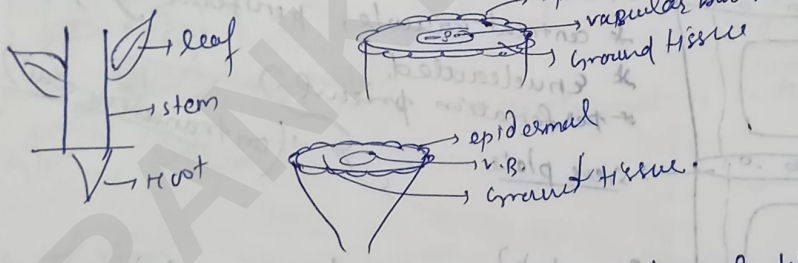
Q. both phloem fibre & parenchyma absent.
→ Monocot.

Q. phloem fibre absent in
a) primary phloem
b) protophloem c) metaphloem
d) all

Primary phloem → protophloem
↳ metaphloem

secondary phloem

Tissue System :-



Ground tissue = T.S - (V.B. + Epidermal tissue)

Tissue System :-

① Epidermal tissue :- Epidermis
① root epidermis ② stem epidermis ③ leaf epidermis.

General feature :
→ made up of parenchyme cell.
→ single layer
→ No intercellular space
→ large vacuole, less amount of cytoplasm.
→ Many appendages & modification
→ cell shape - elongated

→ present in primary plant body.

(a) Root Epidermal tissue → (Epiblema)

cell → parenchyma
→ Root hair present (unicellular outgrowth, unbranched)

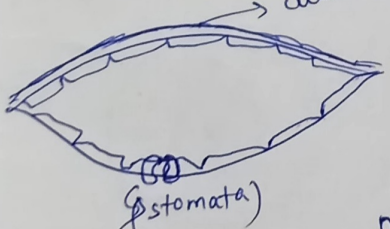
Root hair :- (in all type of root)
→ cuticle absent in root
→ No stomata
(***) → Lenticels → (product of secondary growth)
(in Dicot root)
(pore like structure for resp^{n} in root)

(b) Stem Epidermis :-

→ root hair ✗
→ cuticle ✓ (aerial part) Jitna jada cutin protein hoga utna thick cuticle hoga.
→ stomata ✓ (Green stem)
→ lenticel (Dicot stem) ✓
→ hair like structure → trichome (hair like, soft or stiff)
(***)
→ multicellular, branched or unbranched.
→ can be secretory.
→ prevent transpiration

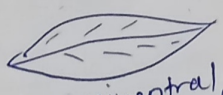
Root hair	trichome
→ Unicellular	→ multicellular
→ Unbranched	→ branched
→ Absorptive	→ can be secretory

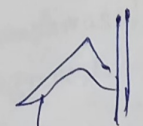
(c) Leaf Epidermis :-



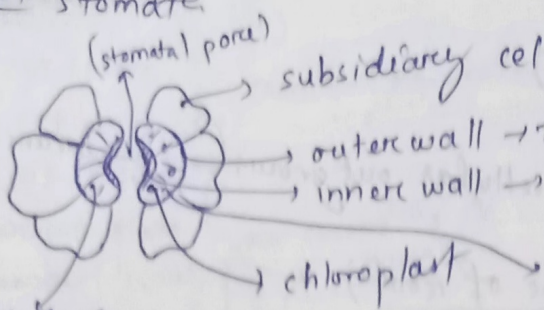
→ cuticle (upper surface → more amount)
- lenticel (✗) absent.
- cuticle ✓
- trichome ✓ (some leaf)
- stomata ✓

Dicot leaf



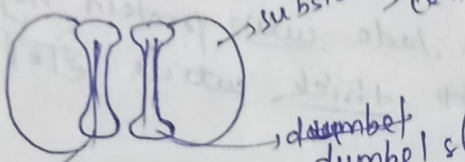


Dicot stomata



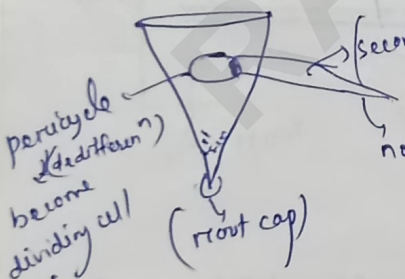
stomatal apparatus = subsidiary cell + Guard cell + stomatal pore

Monocot stomata



Why secondary root have no root cap ??

(2° root develop from pericycle.)

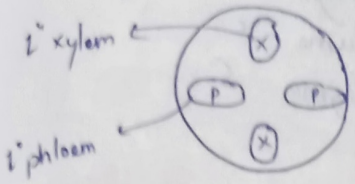


stem, branch → (exogenous)
surface se ho.

(11) Vascular Bundle :-

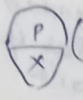
- Xylem bundle + phloem bundle → vascular bundle
- on the basis of arrangement of (X) & (P), different type of V.B..

a) Radial bundle (root) (both dicot & monocot)

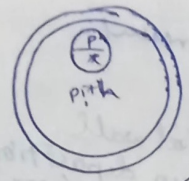


- xylem & phloem is alternate at different radius.

b) conjoint :- (stem & leaf) xylem & phloem is together & it is present in same radius.

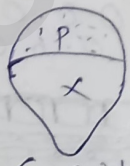


(collateral) (phloem outside, xylem inside)



(cambium)

intrafascicular / fascicular (conjoint, collateral, open)



(conjoint collateral closed)

↓ divide to form 2° phloem & 2° xylem.

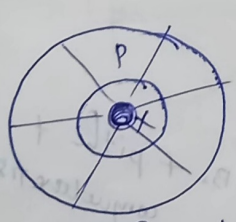
* Dicot root, Monocot root → Radical

Dicot stem → open conjoint collateral

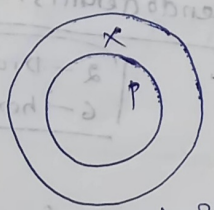
Monocot stem, Monocot leaf, Dicot leaf → close conjoint collateral.

Evolution

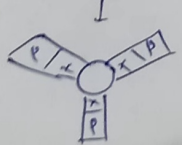
gymnosperm



(concentric & amphihadral) (Hadrocentric)



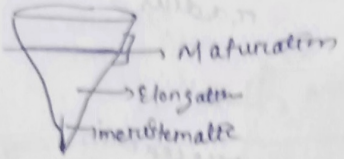
(concentric & amphivasal) (leptocentric)

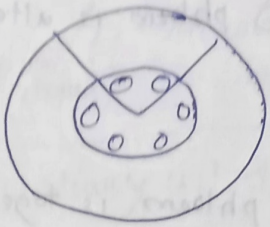


(III) Ground tissue :-

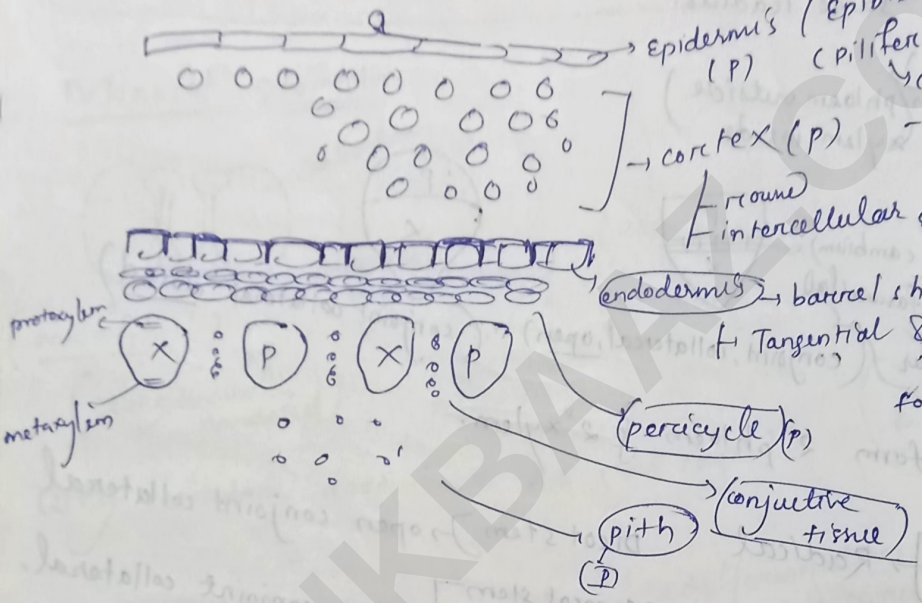
Ground tissue = transverse section − (Epidermal + Vascular bundle)

T.S. of Dicot root :- (tap root)





parenchyma − P
collenchyma − C
sclerenchyma − S



Pericycle :- parenchymatous cells under endodermis.
(Parenchyma)

Pericycle $\xrightarrow{\text{de-differentiate}}$ dividing cell $\xrightarrow{\text{re-diff}^n}$ secondary root.

also help in secondary growth

N.B
* inner to cortex → pericycle
* innermost layer of cortex → endodermis.

V.B. → radial, 2-4,6 exarch.

2 − Diarch
6 − hexarch

pith → inconspicuous.

stele :- all tissue inner to endodermis ((pericycle + V.B. + pith + conjuctive tissue)

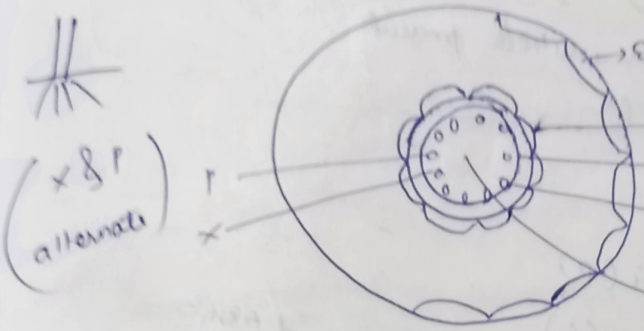
Ground tissue :- T.S. − (Epidermis + V.B.)
= cortex, endodermis, pericycle, pith, conjuctive tissue

* Ground tissue of dicot root have only parenchyma

Q tissue - which is part of stele not ground tissue → V.B.

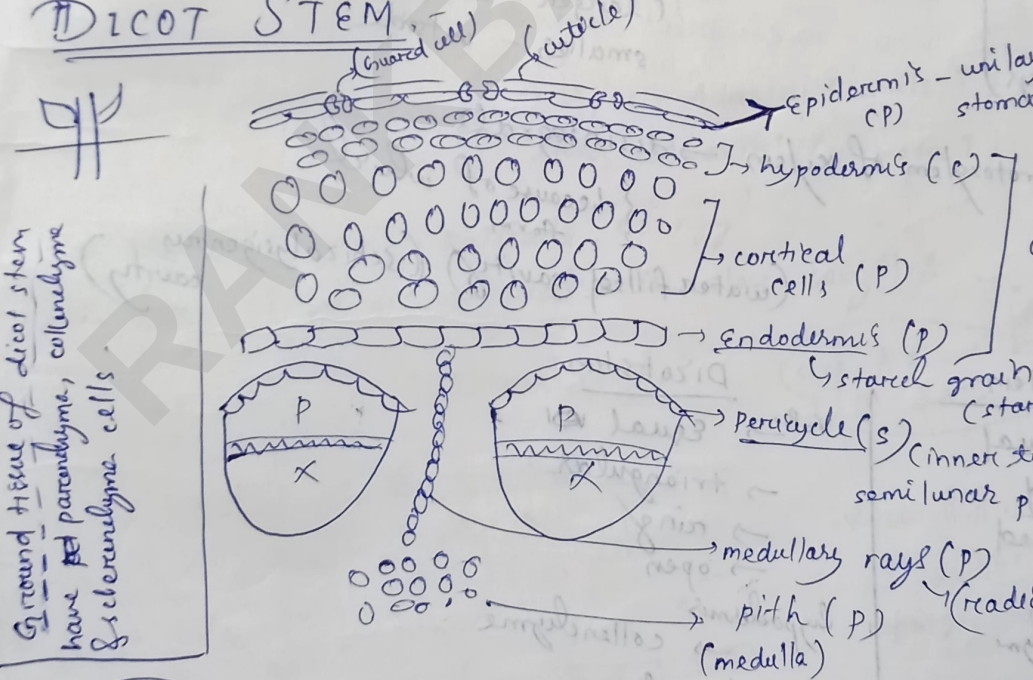
Q tissue - which is part of Ground tissue not stele → cortex

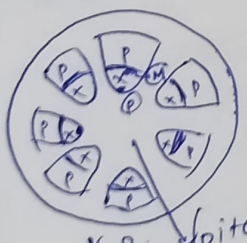
T.S. of Monocot Root (Fibrous root)



Monocot root	Dicot root
- Polyarch	→ 2 - 4, 2-6
- large pith	→ inconspicuous pith
- no 2° growth	→ occur 2° growth

DICOT STEM





V.B. conjoint, collateral, open (cambium - fascicular cambium)

Ring shaped → Eustele

wedge shape → Δ triangular

Equal size

endarch

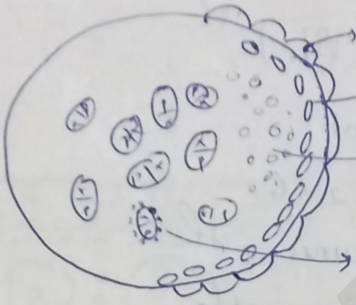
Dicot root

- → Ground tissue → parenchyma
- → Radial
- → exarch
- → pericycle → dedifferentiation → cambium
- → Root hair
- → cuticle absent
- → pith inconspicuous

Dicot stem

- → Ground tissue (P, C, S)
- → conjoint
- → endarch
- → Medullary rays d-d → cambium
- → trichome, cuticle present
- → pith large

Monocot stem



- → Epidermis (P)
- → hypodermis (S)
- → large parenchymatous cell (Ground tissue)
- → Bundle sheath (S) → part of Ground tissue

V.B.
- → unequal size
- → scattered (Atactostele)
- (larger - centre)
- smaller - outside

- → cortex
- → pith
- → endodermis
- → pericycle
- → Medullary rays

→ absent

sometime, protoxylem of xylem → disintegrate → because of which form (water filled cavity) ((schizolysigenous cavity)

Monocot stem

- → V.B. → unequal
  - → round
  - → scattered
  - → close
- hypodermis → sclerenchyma
- * water filled cavity
- * 2° growth absent

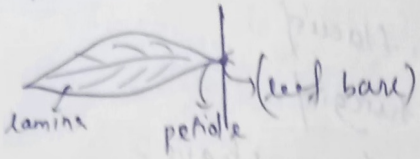
Dicot stem

- V.B. → Equal
  - → triangular
  - → ring
  - → open
- hypodermis → collenchyma
- → Absent
- → present

V.S. of leaf:-

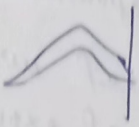
Dicot leaf

Dorsiventral leaf

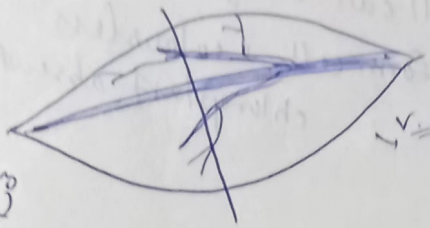


Monocot leaf

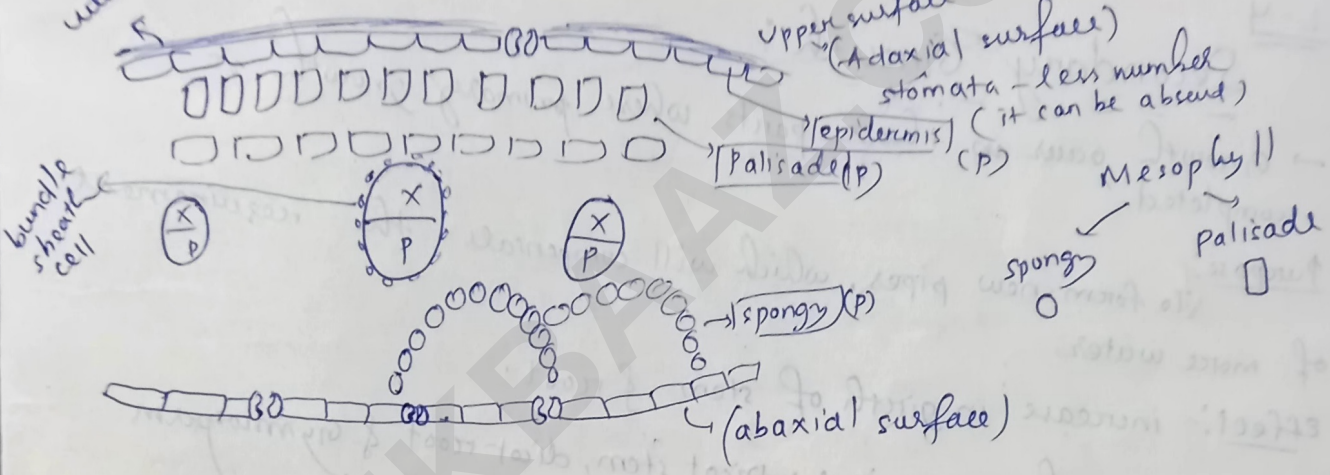
Isobilateral leaf



Dicot leaf:



photosynthetic cell of leaf → Mesophyll cell (P)



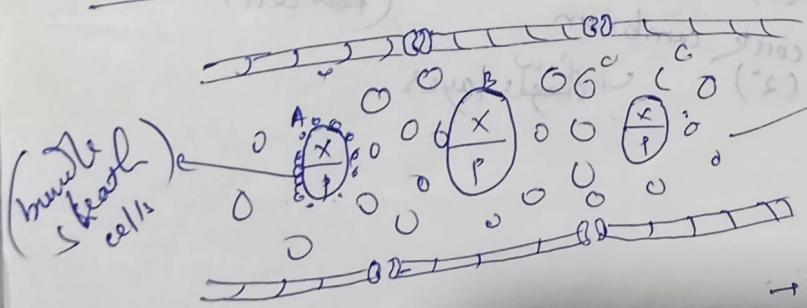
Dicot leaf:-

2 epidermis → Upper - Adaxial (cuticle ↑)
lower - Abaxial (stomata ↑)

* Mesophyll cell → palisade, spongy
* vascular bundle → unequal size, close, conjoint.

Monocot leaf:- (isobilateral leaf):-

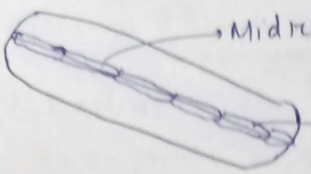
size A = C → due to parallel venation
B → large size



* Mesophyll cell
No distinction between spongy & palisade parenchyme

→ Equal no. of stomata on both the surface.

Special feature of monotot leaf:



Bulliform cells (Grass leaf upper surface) Adaxial (no chloroplast)

leaf curling when flaccid
leaf expose when turgid

→ Both Guard cell & bulliform cell can change their shape
→ Guard cell → coloured chloroplast present
bulliform cell → colourless chloroplast absent

L-4

Secondary Growth:

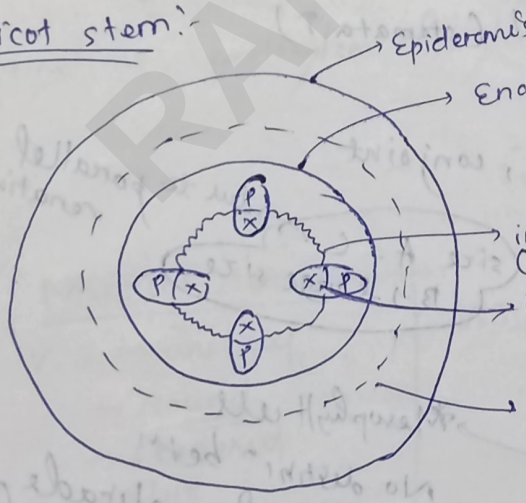
→ Growth occur in those parts where primary growth is completed.

Purpose:- To form new pipes, which will compensate the requirement of more water

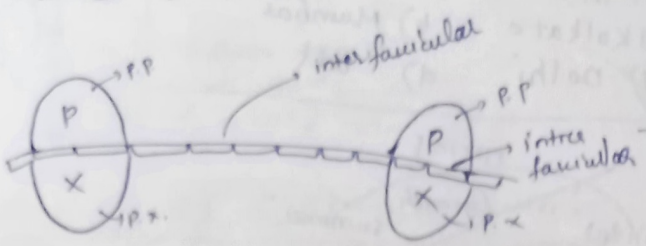
Effect:- increase in girth of stem & root.

secondary growth occurs in :→ Dicot stem, dicot root & Gymnosperm

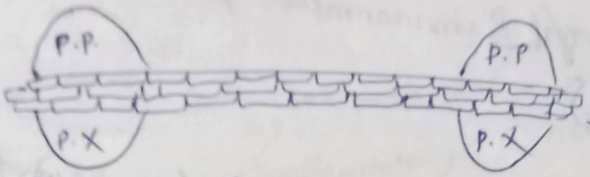
Dicot stem:-

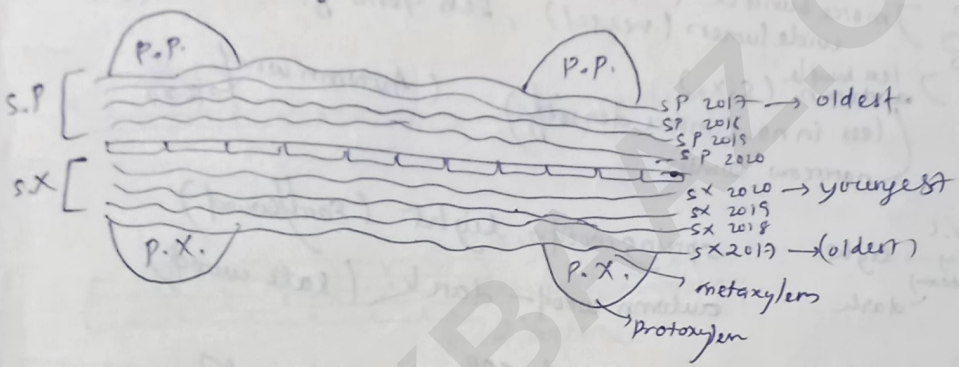


Activity of vascular cambium:

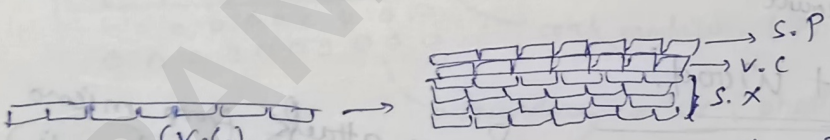


↓ V.C. Divide (cut off to give layer) periclinal division





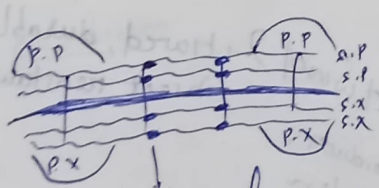
* Oldest 2° xylem is close to 1° xylem & youngest is close to vascular cambium.



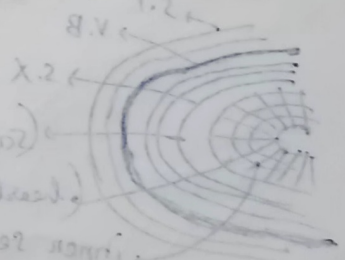
V.C. is more active towards inner side & produce more secondary xylem as compare to 2° phloem.

In each division vascular cambium move outward, so some secondary phloem & primary phloem get crushed.

So, to count age → secondary xylem required.

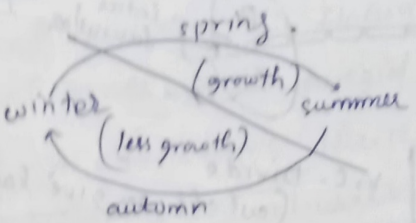


ray parenchyma → form → 2° medullary rays

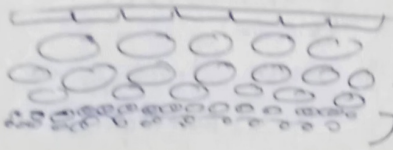


Spring Wood & Autumn Wood :

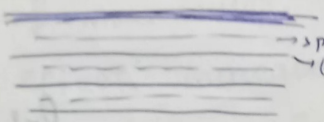
Ring of S.X is used to count age in:-
a) Kolkata b) Mumbai
c) Delhi d) all



V.C. is in control of - physiological & environmental factors.
V.C. is more active in spring.



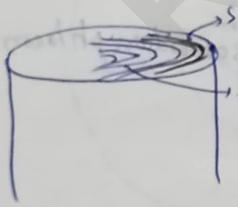
more bundle (S.X.), wide lumen (vessel), less density (spring wood) (S.X.)
less bundle (S.X.) (less in no., more dense, narrow lumen) (Autumn wood) (S.X.)



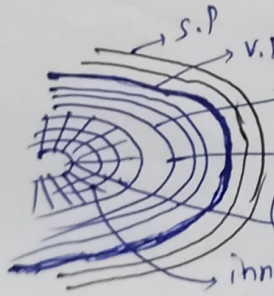
spring wood - light (Early/Sarad)
autumn wood - dark (late wood)

We use alternate light & dark, to count age.
(Dendrochronology) (only where season present)
↳ science of age count

Sap wood & Heart Wood:

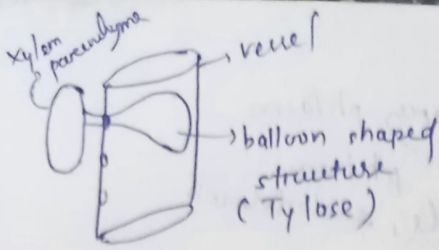


SP → To prevent infection & any attack from micro organism. (fungi - Basidiomycetes → मशरूम खाने वाली & bacteria & insect → (25% are phytophagous).



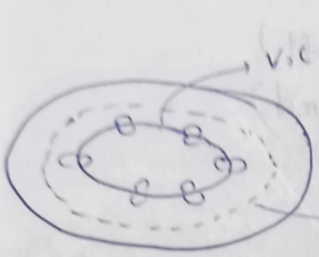
dead → (non-conducting) → by blocking by: → resin, tannin, oil, gum, essential oil / vessel

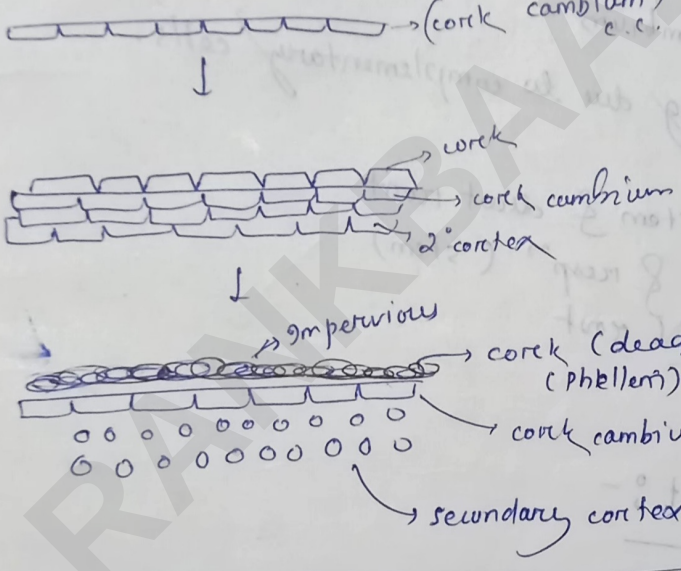
(Heart wood) → Hard, durable, insect resistant
non-conducting xylem



conducting wood → sapwood (living)

Activity of cork cambium:-



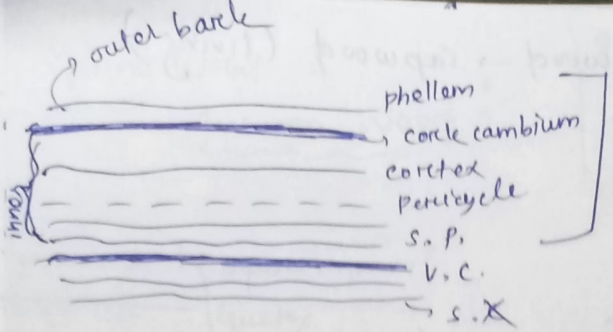


periderm = phellem + phellogen + phelloderm

Bark - early and late:-

cork cambium → moving outside (outer layer sloughed off)

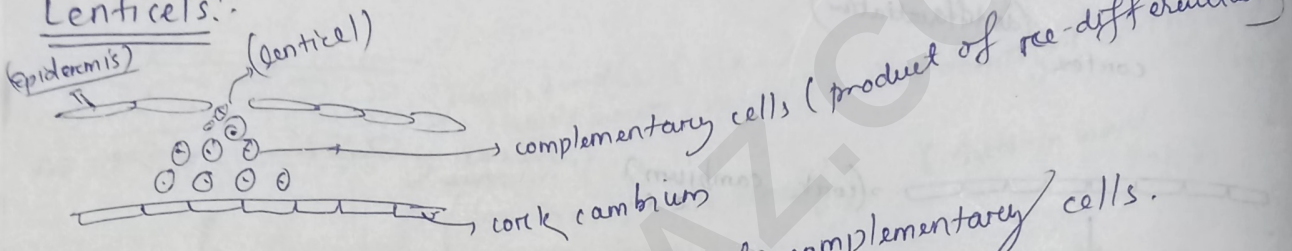
Bark is non-technical term for all tissue external to vascular cambium



Bark → secondary phloem
primary phloem
pericycle, endodermis
cortex
cork cambium
phellem

Bark formed in spring season → early bark (soft)
" autumn " → late bark (hard)

Lenticels:-



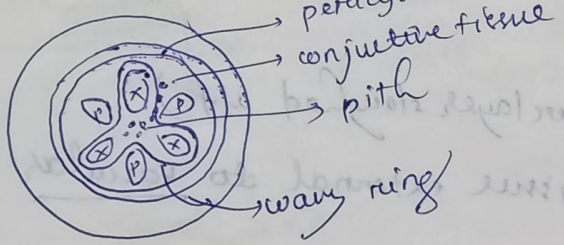
lenticel :→ lens shaped opening due to complementary cells on epidermis.

Lenticel found in → Dicot stem & dicot root

func^{n} :- Transpiration & resp^{n} (stem)
only resp^{n} (root)

↓
mainly gaseous exchange

Secondary Growth in root :-



vasular cambium → from → pericycle + conjuctive tissue of pith.