PLANT ANATOMY

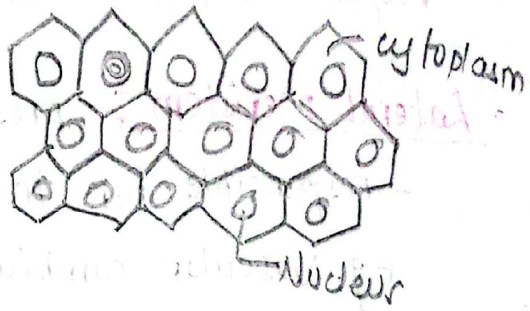
→ tissue basic unit.

- **Anatomy:** Study of internal structure.

- **Plant tissue:** Group of cells → similar or dissimilar structure performing more or less common function with common origin.

  - Father of plant anatomy → N. Grew
  - Plant tissue term was given by → N. Grew

** Meristematic Tissue



- Termed by Nageli
- Having maximum power of division.
- Cells are thin, living and isodiametric.
- No intercellular space, dense cytoplasm.
- No reserve food material (high amount of salts), conspicous nucleus.

* Types of meristem on the basis of origin

- **Pro-meristem:-** Earliest and youngest meristematic cells present in embryonic stage.
- **Primary meristem:-** Arises from embryo and responsible for primary growth. eg. Intrafascicular cambium
- **Secondary Meristem:-** After differentiation primary meristem changed into primary permanent tissue and these permanent tissue goes dedifferentiation and forms secondary meristem. e.g. Interfascicular cambium & cork cambium
  - Wound healing in plants is due to secondary meristem.

* Types of meristem on the basis of position

- **Apical Meristem:-** present in apices of root and shoot.
  - increase in length
  - axillary and terminal buds are derived from apical meristem.
  - Absent in monocot and grasses.

zoology | Botany | Physics
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cell division

Note:- Root tip is subterminal as root is covered by root cap, behind root tip where is meristem.

- **Intercalary meristem:** present in base of nodes and internodes, base of leaves.
  - derived from apical meristem.
  - Grasses grow by the activity of intercalary meristem.
  - responsible for increase in length.

- **Lateral Meristem:-** present laterally.
  - responsible for increase in diameter or girth.

  eg. Vascular cambium.

Q. A plant is labelled (M+F) 2m above the ground, after two years what will happen to the labelling?

(a) increases (b) decreases ✓ (c) remains constant

(d) increases and then decreases

* **Types of meristem on the basis of function:-**

- **Protoderm:** forms epidermal tissue system (E.T.S) i.e. epidermis, hair cap, etc.
- **Ground Meristem:-** forms ground tissue system (G.T.S) i.e. hypodermis, cortex, pith, etc.
- **Procambium:-** forms vascular tissue system (V.T.S) i.e. xylem & phloem.

Histogen Theory

→ given by Hanstein

→ applicable in both shoot and root apex.

→ Three histogens i.e. dermatogen, periblem, pleurome.

→ **Dermatogen:-** forms epidermal tissue system

→ **Periblem:-** forms ground tissue system

→ Pleurome :- forms vascular tissue system

Note: In dicot, root cap is formed by dermatogen @DD but in monocot, root cap is formed by calyptrogen @MC.

Quiescent Theory

→ given by Clowes.
→ applicable in root apex.
→ Inactive centre in root apex is quiescent centre (crescentic shape)
→ There is → low DNA, low RNA, cell division slow, cell remain in G0 stage. in quiescent centre.
↳ Repairment of damaged meristem.

Q. Paritive geotropism in root is due to:-
(a) Gravity (b) Starch grain (c) both a & b (d) Protein matter
↳ due to presence of golgi body in quiescent centre.

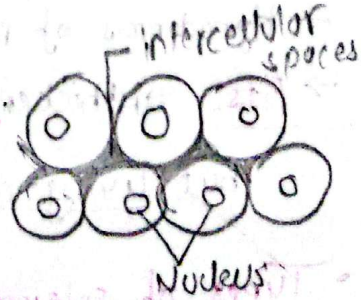
Tunica corpus theory

→ given by Schmidt.
→ For shoot apex.
→ Outer tunica :- divides anticlinally (perpendicular) → forms E.T.S.
→ Inner corpus :- divides by both anticlinal and periclinal (parallel) i.e. forms G.T.S and V.T.S.
→ widely accepted theory.

Permanent Tissues :- loss the power of division, it may be living or dead.

① Simple permanent tissues :- having similar types of cells.

(a) Parenchyma :-
→ universal plant tissue.
→ living, isodiametric, thin walled with intercellular space.
→ Ground tissue is mainly parenchymatous.
→ cell wall made of cellulose and calcium pectate.
→ function: storage of food.



• Modification of Parenchyma

i) Prosenchyma :- long cells with tapering ends, found in pericycle.
↳ can help in mechanical support.

ii) Aerenchyma :- having air sacs.
→ well developed in hydrophytes.

iii) Chlorenchyma :- having chloroplast.
→ found in leaf.

iv) Idioplast :- parenchyma storing cell inclusions / ergastic substances.

(b) Collenchyma :-

→ living mechanical tissue. V.V.I
→ Hypodermis of dicot stem.
→ Deposition of pectin and cellulose (pectocellulose) in intercellular space.
↳ more
→ Functions as support and flexibility.
→ Due to presence of pectin, it can stores water.
↳ hydrophillic

@ MSDC
Hypodermis
→ Monocot → sclerenchyma
→ Dicot → collenchyma

• Types of collenchyma

(i) Angular collenchyma is found in members of solanaceae family.
(ii) Lamellate collenchyma is found in sunflower. (sheet जैसा)
(iii) Lacunar collenchyma is found in cucurbits. (tubular जैसा)

(c) Sclerenchyma

→ Dead, main mechanical tissue.
→ Hardest plant tissue.
→ Cell wall is thick and lignified.
→ Hypodermis of monocot stem.
→ Pits :- unthickened area, two dead cells are interconnected through pits.
but living cells are connected through plasmodesmata

[Hardest plant substance
↳ Sporopollenin]

• Types of sclerenchyma

(i) Sclereids :- shorter, highly thickened.

ii) Brachysclereids ~~(stone cells)~~ :- endocarp of drupe fruit, Gritness in seeds.
Stone cells

(iii) Macrosclereids :- rod shaped, found in epidermal covering of legume seeds.

(iv) Astrosclereids :- star shaped, found in petioles of lotus.

(v) Osteosclereids (prop cells) :- bone shaped.
→ found in sub epidermal covering of legume seeds.

(vi) Sclerenchymatous fibres → long elongated tapering ends, helps in mechanical support.

- Xylem / wood fibres → hard, mechanical
- Phloem / bast fibres :- flexible, commercial fibres.
  → obtained from secondary phloem.
  e.g. Corchous (Jute), Crotolaria (sun hemp)

- Bast fibres of connabis is obtained from pericycle called perivascular fibres.
  ↳ Hemp fibres

- Cotton fibres :- False fibres, surface fibres, cellulosic fibres, epidermal seed hair.

- Coir fibres (Coconut) :- obtained from mesocarp.

Q. Pure cellulose is obtained from :-
(a) root hair (b) stem hair (c) Seed hair (d) all

(2) Complex Permanent Tissue

→ heterogenous (different cells मिलेर बनेको हुन्छ)

(a) Xylem / Hadrome / wood

→ Hadrome → Xylem - Xylem fibres
→ Helps in conduction of water and minerals → unidirectional (upward)

*** Components of Xylem**

- Tracheids
- Vessels
- Xylem parenchyma
  ↳ only living component of xylem
- Xylem fibres

Note :- Tracheids and vessels are together called : Tracheary elements. (conduction गर्ने)

• Tracheids :- found in all vascular plants.
→ Main conducting tissue in case of gymnosperms & pteridophytes.
→ Thickening → more thickened, narrow lumen.
→ Tapering ends.

Different types of thickenings

· Annular :- ring like
· Spiral :- spring like
· Scalariform: ladder like
· Reticulate :- Net like
· Pitted :- Pit like
· Simple thickening → annular and spiral.
· Advanced thickening → scalariform, reticulate, pitted.

• Vessels :- Main conducting elements in angiosperms.

Some exceptions :-
Gymnosperms having vessel → Genetum, Ephedra, Welwitschia @GEW
Pteridophytes having vessel → Selaginella, Equisetum

→ Longest vessels is found in Eucalyptus
→ Vessels have wider lumen, less thickenings than tracheids.
→ Produced due to end to end arrangement of many elongated cells in which transverse wall dissolved.
→ Vessels are also known as endless tracheids, pipeline.

• Xylem parenchyma :- only living component, thin walled, helps in storage and lateral conduction of water and minerals.

• Xylem fibres :- Sclerenchymatous fibres related to xylem, responsible for mechanical support.

* Based on origin, xylem may be :-

① Protoxylem :- first formed.
· Smaller vessels with annular and spiral thickenings.

② Metaxylem :- later formed.
· Wider vessels with reticulate and scalariform thickenings.

* Based on the position of protoxylem:-

① Exarch / centripetal:- outer protoxylem (towards pericycle)
inner: metaxylem (towards pith)
→ found in both dicot and monocot roots.

② Endarch / centrifugal:- inner: protoxylem
outer: metaxylem
→ found in stems.

③ Mesarch :- Protoxylem is surrounded by metaxylem on both sides.
→ found in leaf, fern.

* Tyloses :- Ballon like ingrowth of xylem parenchyma into the vessels.
· Xylem vessels are blocked by tyloses.

ⓑ Phloem / leptome

→ function:- bidirectional translocation of food materials.
→ leptome (functional part) → phloem – phloem fibres.
→ phloem fibres is only dead component and other all are living

* Components of phloem

· Sieve tube
· Companion cells
· Phloem parenchyma
· phloem fibres.

· Sieve tubes & companion cells
→ Sieve ~~tubes~~ cells are present in gymnosperms and pteridophytes instead of sieve tubes.
→ Albuminous cells are present in gymnosperms and pteridophytes instead of companion cells.
→ Sieve tube and companion cells are sister cells arise from same mother cell
→ Sieve tube and companion cells are only present in angiosperms.
→ P proteins ~~and~~ are present in sieve tube.
→ Sieve pore is blocked by callose (carbohydrate deposition) in winter.
→ RBC is analogous to sieve tube.

- Phloem Parenchyma

→ Helps in storage and lateral conduction.

→ It is absent in monocots.

Specialized tissues/ Secretory Tissues

→ Special types of cell having properties of secreting specific chemicals.

① Glandular Tissue

(a) External glands:- present in epidermis of stem, leaves usually in the form of outgrowth. e.g. Hydathode, stinging hairs, digestive glands, nectaries.

(i) Hydathode:- occurs in leaves tip (e.g. Colocassia) or margin. secretes water drops and cause guttation, it is supported by thin walled cells known as epitheum.

(ii) Stinging hairs:- Secretes poisonous albuminoid substances for protection. It cause irritation and blisters in skin. e.g. Urtica

(iii) Digestive glands:- present in insectivorous plants which contain proteolytic enzymes.

(iv) Nectaries:- secretes sugary substances associated with different parts of flower.

(b) Internal Glands:- deeply located inside tissues.

(i) Mucilage glands:- mucilage secreting glands. e.g. piper betel.

(ii) Resin glands:- resin secreting glands. e.g. Pinus

(iii) Oil glands:- present in citrus.

* Secretion storing cavity

- Lysigenous cavity:- Formed by disintegration of cells.
  e.g. oil cavity of citrus.
- Schizogenous cavity:- Formed by separation of cells.
  eg resin duct of pinus.

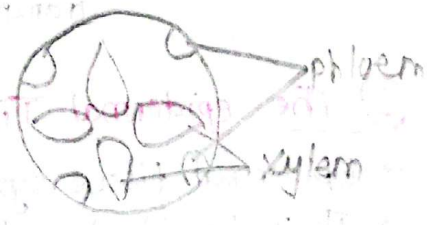
- Schizolysigenous cavity:- Formed by both above process.
  e.g. Water cavity of maize.

* Lactiferous tissues:- Mainly composed of long branched thin walled, tube like that contains milky juice: latex.

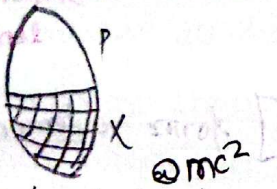
Latex cells	Latex vessels
• Single cells, unbranched or branched.	• Many cells, branched.
• Without anastomosis.	• Presence of anastomosis.
• Non articulated.	• Presence of network.
• e.g. Nerium, Euphorbia.	• e.g. Papover (opium)
	• papain is latex of papaya.
	• Para rubber:- from Hevea brasiliensis
	• Indian rubber:- Ficus elastica
	• Chewing gum:- from Achras zapota.

Vascular tissue System

① Radial V. bundles:- found in both roots.
→ alternating patches of xylem and phloem.
→ Don't touch each other, in different radii.



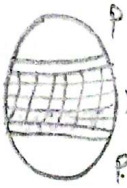
② Conjoint Vascular bundles:-



@ mc²
Collateral closed
↳ monocot stem



Collateral open @ DSC.
↳ dicot stem



Bicollateral
↳ @ BSC ↳ solanaceae, cucurbitaceae.

→ Collateral means phloem towards pericycle and xylem towards pith, closed means without cambium & open means having cambium.
→ Vascular bundle in monocot stem: conjoint collateral and closed.
→ Vascular bundle in Dicot stem: conjoint collateral and open.
→ Bicollateral V. Bundle: phloem is present in both inside and outside. It is always open. Xylem is sandwiched between phloem.
↳ It is present in family Cucurbitaceae, Solanaceae & convulaceae

Plant Tissue System

→ A group of tissue performing a similar function, irrespective of its position in the plant body, is called a tissue system.

→ Julius Von Sachs recognized three tissue system in plants:-

1. Epidermal Tissue system
2. Fundamental Tissue system / ground tissue system
3. Vascular or fascicular tissue system

	Types and characters of Tissue systems			
Sl. No.	Types / characters	Epidermal Tissue system	Ground or Fundamental Tissue system	Vascular or conduction Tissue system
1.	formation	Forms the outermost covering protoderm.	forms the ground meristem	forms the procambial bundles.
2.	Components	epidermal cells, stomata and epidermal outgrowths.	Simple permanent tissues → parenchyma and Collenchyma.	Xylem and phloem
3.	functions	Protection of plant body; absorption of water in roots, gas exchange for photosynthesis & respiration, transpiration in shoots.	Gives mechanical support to the organs; prepares and stores food in leaf & stem.	conducts water and food; gives mechanical strength.

(1) The epidermal Tissue system

→ Epidermal tissue system is the outermost covering of plants.

→ It is in direct contact with external environment.

→ It consists of epidermis derived from protoderm and its appendages. (stomata, hairs, lenticels)

* Epidermis

→ Epidermis [Epi' means upon and 'derma' means skin] forms outer covering of plants.

→ It is made up of single layer of parenchyma cells which are arranged compactly without intercellular spaces.

→ Multilayered and dead epidermis (velamen) is present in epiphytic roots of Vanda.

→ Epidermal cells donot contain chloroplast except gaurd cells.

* Gaurd cells differs from other epidermal cells in having chloroplast. [I.E 2008]

→ Epidermal cells may have deposition of cutin or suberin.
→ Root epidermis is termed as epiblema or rhizodermis or piliferous layer, which develop unicellular root hairs in the zone of maturation.
→ Epiblema does not have cuticle.

• Epidermis structures:-

(a) Bulliform (bubble-like) cells → Highly ~~vascularized~~ vacuolated cell on epidermis of grass leaf. [BP-2002]
↳ Rolling of leaf → ↓SA → ↓H_2O loss.

(b) Stomata:- Minute, aperture in epidermis (↳ mainly leaf). Each epidermis is bounded by two kidney shaped cells, called gaurd cells. Stomata are absent in roots.

(c) Epidermal outgrowths:- The unicellular or multicellular appendages that originate from the epidermal cells are called trichomes.
→ Trichomes may be branched or unbranched and are one or more one celled thick.
→ Prickles → Epidermal emergences with no vascular supply. They are stiff and sharp in appearance. e.g. Rose
→ Root hairs → unicellular, speciliazed for H_2O absorbtion.
→ stem hairs → Multicellular, protective in function, & cutinized.

(2) Ground (Fundamental) Tissue system

→ The ground or Fundamental tissue system constitute the main body of the plants.
→ It includes all the tissues except epidermis and vascular tissues.
→ In monocot stem, ground tissue system is a continous mass of parenchymatous tissue in which vascular bundles are found scattered. Hence, ground tissue is not differentiated into cortex, endodermis, pericycle and pith.
→ In dicot stem, ground tissue system is generally differentiated into three main zone → cortex, pericycle & pith.
→ It is classified into extrastelar ground tissue (e.g. → cortex and endodermis) and intrastelar ground tissue (e.g. pericycle, medullary ray and pith).

b. Hypodermis
→ one or more layered continuous tissue below the epidermis.
→ In dicot stem → Collenchyma
→ In grasses and xerophytic stems → Sclerenchyma
→ Absent in → Roots and leaf

c) Cortex :-
→ It may be few to many layered in thickness.
→ Made up of → parenchyma.
→ Functions → storage of food.

d. Endodermis (starch sheath) — only dicot stem.
→ border between cortex & medulla.
→ cells of endodermis → single layered, living (parenchyma), barrel shaped and tightly arranged.
→ Casparian strip → Thin band of suberin, cutin & lignin in tangential and radial wall of endodermis. (+nt in root endodermis).
→ A distinct endodermis is a constant feature of Root (dicot, monocot).
→ Absent in monocot stem but in dicot stem (+nt) — starch sheath.
→ Passage cells or transfusion cells → Thin walled cell opposite to protoxylem.
→ Functions :- Biological checkpoint, Form water tight layer inside root.

V.V.I Endodermis is a part of cortex.

e. Pericycle :-
→ It is the outermost layer of stele. [IOM 2008]
→ cells → may be living (parenchyma) or may be dead (sclerenchyma).
→ Heterogenous pericycle → Bora type → Sunflower.
→ Functions → Form root branch / 2° root / lateral root (endogenous origin). Larise

f. Medulla or Pith :-
→ It occupies the central part in dicot stem and dicot & monocot roots.
→ well developed in monocot root & dicot stem but absent in dicot roots and monocot stem.
→ Cells → parenchymal cells.
→ Functions → storage of foods

multi dimension → chemical bonding

3) Vascular (fasciculor) Tissue system

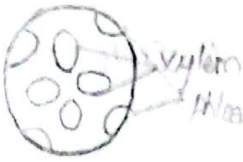
→ Central cylinder of the shoot or root surrounded by cortex is called stele. The varying no. of vascular bundles formed inside the stele constitute vascular tissue system.

→ Each vascular bundle is made up of xylem and phloem with or without cambium.

→ Vascular bundles in dicotyledonous stem and in roots of dicots as well as monocots are arranged in a ring while in monocotyledonous stem they are scattered in general ground tissue.

* Types of Vascular bundles:-

(a) **Radial**:- Separate and alternate strands of phloem and xylem present on different radii.



• Present in Roots → @[Radial = Root] ☺

(b) **Conjoint**:- Xylem and phloem are united and are present on the same radius. e.g. Stem

(i) **Collateral**: Xylem lies towards the inner side & phloem lies towards the periphery.

• **Open type**:- Cambium is present between xylem and phloem.
e.g. Dicot stem

• **Closed type**:- Cambium is absent. e.g. Monocot stem

(ii) **Bicollateral**:- There are two patches of phloem one on each side of xylem. e.g. Stem of cucurbitaceae. [JoM 2007, Ku 2008]

(c) **Concentric**:- Either xylem surrounds the phloem or phloem surrounds the xylem.

(i) **Amphicribal**:-(Hadrocentric) → The xylem is surrounded by phloem.
e.g. Hydrilla, Rhizome of ferns. @ Amphicribal - phloem bahira

(ii) **Amphivasal**:-(leptocentric) → The phloem is surrounded by xylem.
e.g. Stems of Dracaena and Yucca. @ Amphivasal - phloem vitra

Internal structure of Dicot and Monocot stem

Characters	Dicot stem	Monocot stem
1. Epidermis	Multicellular hairs present, cutinized.	Hairs absent, cutinized
2. Hypodermis	Collenchymatous	Sclerenchymatous
3. Ground tissue system	Differentiated - hypodermis, general cortex, endodermis, pericycle, pith, etc	Not differentiated into cortex endodermis and pith
4. Stele	Dictyostele or Eustele	Actinostele (Mucor as varied type)
5. Vascular bundles	Conjoint, collateral and open type.	Conjoint collateral and closed type
6. Pith	Present	Absent
7. Secondary growth	Present	Absent except Yucca, Agave, Aloe

Internal structure of root :-

- Some important characters of both dicot & monocot roots -
  - → Vascular bundle is radial with exarch xylem.
  - → Distinct endodermis & passage cells.
  - → Lateral roots arise opposite the protoxylem points from pericycle i.e. endogenously.

Q. Grafting is impossible in monocots - • Lack of cambium • closed V.B

Q. Ringing / Girdling exp is impossible in monocot as Scattered V.B

Differences between anatomy of dicot and monocot root are:-

Characters	Dicot Root	Monocot Root
1. Cortex	Narrow	Very wide
2. Cork	Epiblema, cortex and even endodermis are peeled off and replaced by cork.	Cork not formed, epiblema is peeled off, cortex and endodermis persist.
3. Endodermis	Less thickened and casparian stripes are more prominent.	Casparian stripes are visible only in young root.
4. Pericycle	Produce lateral roots, cork cambium, vascular cambium.	Produces lateral roots only.
5. Vascular bundles	Xylem and phloem bundles are diarch to hexarch (i.e 2-6)	Xylem and phloem bundles are polyarch. (i.e. ≥8)
6. Pith → dicot stem, Monocot root stem	Small or absent	Well developed
7. Secondary growth	Present	Absent.

Differences between Anatomy of roots and stem:-

Characters	Stem	Root
1. Epidermis	→ Have outer cutinized walls. → Protective in function. → Stomata are present. → Stem hairs:→ → Do not arise as outgrowth of epidermal cells. → Generally multicellular. → Spreads all over the stem. → Heavily cutinized. - Reduce loss of water	→ Functional epiblema is without any cuticle or cutinized over walls. → Absorbtive in function → Absent → stomata. → Root hairs: - Arise as tubular outgrowth of epidermal cells. - Unicellular - Found in clusters in root hair zone - Not cutinized. - Helps in absorbtion.

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chemistry
→ chemical bonding

2. Hypodermis	• Collenchymatous (dicot) or sclerenchymatous (monocot). Hypoderma present	• Hypodermis absent. In some cases, thick walled exodermis present.
3. Cortex	Cortex is narrow	Cortex is broad
4. Pericycle	Pericycle when present is usually multilayered. • Does not take part in the formation of branches and secondary growth.	Pericycle is commonly 1-2 layered. - Takes part in the formation of root branches and secondary growth.
5. Vascular bundles	conjoint and collateral. - Xylem is exarch	→ radial - Xylem is exarch
6. Secondary growth	- secondary growth when present is by cambium which is mostly intrafascicular.	- Secondary growth when present arises from conjuctive parenchyma & pericycle.

Anatomy of leaf

→ In dicots is dorsiventral and monocot → isobilateral.

→ leaf has upper & lower epidermis, mesophyll and vascular bundle.

Character	Dicot leaf	Monocot leaf
1. Epidermis	Deposition of cuticle is thicker in upper than in lower epidermis. - Bulliform or motor cells absent. - Hypostomatic, i.e. no. of stomata are maximum in lower surface & few on upper surface → Stomata guarded by kidney shaped guard cells. (chloroplast present)	• Deposition of cuticle is same in both surfaces. → Bulliform or motor cells present. [BPKCHS, NEET] → Amphistomatic i.e. no. of stomata are equal on both surface. → Stomata guarded by dumb bell shaped guard cells.
2. Mesophyll Tissue	• Divided into upper tightly packed palisade (photosynthesis) parenchyma & lower loosely arranged spongy (gas exchange) parenchyma. • Bundle sheath cells are colorless	• Not differentiated into spongy & palisade parenchyma. • Bundle sheaths are green & helps in C4 cycle. This type of is known as Kranz Anatomy.

Secondary Growth

→ Increase in diameter (girth) of the axis (shoot and root) due to formation of new tissues as a result of activity of lateral meristems, i.e. intrastelar cambium (= vascular cambium) and extrastelar cambium (= cork cambium / phellogen) is called secondary growth.

→ Present in dicots & gymnosperms. (stem & root)

→ Absent in monocot (due to lack of vascular cambium), however, abnormal secondary growth takes place in some monocot stems. e.g. Dracaena, Yucca, Agave

→ stelar secondary growth results in the formation → secondary xylem and phloem.

→ cortical secondary growth results in the formation of protective periderm.

* Secondary growth in dicot stem

* Stellar Secondary Growth :-

· Formation of cambium ring :-

→ A typical dicot stem has conjoint collateral, open vascular bundles arranged in ring.

→ Fascicular or intrafascicular cambium is present in between the xylem & phloem.

→ some medullary rays cells become active forming inter fascicular cambium. (NEET 2013)

→ Inter fascicular and intra fascicular cambium join together forming a ring of cambium.

· formation of secondary tissues by stelar cambium [= vascular cambium]

→ A. primary structure, B. formation of cambial rings.

C. formation of secondary xylem & secondary phloem. (NEET 2016)

- cambial cells are of two types: fusiform initials and ray initials.

→ fusiform initials form vascular elements i.e. tracheids, vessels, fibres, sieve tubes.

→ Ray initials give rise to parenchyma cells, all are most of which elongate in the horizontal direction forming vascular rays, which extended both inwards (xylem rays) and outwards (phloem rays).

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classif of animals | cell biology | 1D & 2D | chemical bonding
protozoa | cell division

→ Of the two cells formed in this way one daughter cell remains meristematic while the other daughter cell becomes permanent.
→ Permanent cell formed on the outer side will develop into secondary phloem and inner side will develop into secondary xylem. [NEET 2017]
→ Cambium ring is more active towards inner side so more secondary xylem cells are formed towards the centre due to which the cambium ring moves towards the periphery.
→ Due to newly formed secondary xylem and secondary phloem, the 1° xylem and 1° phloem which were near to one another earlier get separated far apart.

* Annual rings (growth rings) :-

→ There is a marked difference in activity of cambium with change in season.

Spring wood	Autumn wood
– woods elements are larger in size.	→ woods elements are smaller in size.
– more in no.	→ more in number
→ wider lumen	→ narrow lumen.

→ Spring woods + Autumn woods of a year constitute annual rings.
→ Annual rings are conspicuous in temperate (cold) regions. [TOM 2012]
→ The age of a tree can be counted by counting annual rings in oldest or basal portion of tree trunk. Calculation of age of the tree by counting annual rings is called Dendrochronology. [NEET 2013]
→ In some woody trees, e.g. Tilia, Dalbergia sisoo the vessels in the spring woods are large and arranged in a ring & narrow vessels of the autumn wood are scattered such as wood is said to be ring porous.
→ In Eugenia Jamboling and Rose, the vessels are more or less uniformly distributed throughout the spring wood and autumn wood. Such woods is called diffuse porous wood.

Q. When bark is removed from tree → Root dies first
└ conduction Iphloem x.
Q. When lenticels are removed from tree → Shoot dies first.
└ transpiration ↓↓↓

Q. In hollow hearted trees → Tree never dies.
Q. King of wood → Tectona Grandis (Teak wood)

Genetics Bacteria

Quick Digest

- With the passage of time & addition of new outer rings of secondary xylem more rings of the sap wood are changed into heart wood whereas the sap wood remains of about the same thickness. [MOE 2056, BP 2001]
- Tyloses are ballon like structure which are produced due to ingrowth of adjacent xylem parenchyma cells into the lumen of xylem vessels through pits. [IOM 2005]

→ Bark of ~~co~~ cinchona is source of Quinine (antimalarial drug).
→ Heart wood of Hematoxylan is source of Hematoxylin (a nuclear dye).
→ Heartwood of Acacia Catechu is source of catch (Katha) used in coloring ~~co~~ clothes and paan.
→ Conduction function of heart woods stop due to formation of tyloses in vessels and hence heart woods is mechanical in function. [NEET 2017]

Cortical secondary growth

→ As a matter of fact cortical secondary growth is the consequence of stelar secondary growth because latter causes ruptore epidermis & hence periderm formation become essential.

- Periderm is made up of 3 tissues:

① Phellogen (cork cambium):- It a secondary lateral meristem that may orise from hypodermis or cortex. [IE 2008]
→ Composed of a single layer of meristematic cells.
→ Divide in a tangential plane cutting cells towards its inner as well as outer face.

② Phellem (cork):- These cells are formed as a result divisions of phellogen cells towards the outer face. [IE 2009, NEET 2017]
→ cell walls become thick due to deposition of suberin. [BPKIHS 2004]
→ It is impervious to water.
→ commercially obtained from Quercus (oak)

③ ~~Bark~~ Phelloderm (secondary cortex):- layers of thin walled cells cut-off towards the inner side of the phellogen from phelloderm.

* Bark :- All tissues outside the vascular cambium constitute the bark.
→ Bark is a loose term & is used to define all the tissues, outside vascular cambium.
→ Bark = Periderm + cortex + Pericycle + Primary & secondary phloem.
→ Rhytidome (outer bark) consists of ~~outer~~ outer, dead portion of bark outside the cork cambium.