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SECONDARY GROWTH IN PLANTS

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BOTANY: SEM- IV, PAPER: GE4T:PLANT ANATOMY AND EMBRYOLOGY:UNIT-3:SECONDARY GROWTH

• CHAPTER OUT LINE-

- 1. Overview of secondary growth
- 2. Growth patterns in wood and bark
- 3. Commercial Uses of wood and bark

CHAPTER OBJECTIVES-

Students should have an idea of;

1. How wood and bark develop
2. How stems and roots become thicker and stronger
3. Commercial benefits of wood and bark of a plant with secondary growth

SECONDARY GROWTH-

Cambial

1.Vascular cambium

a)Fusiform Initials (Vertically oriented)

Secondary Xylem

Secondary Phloem

b)Ray Initials (Horizontally oriented)

Vascular Rays

Xylem rays

Phloem ray

2.Cork cambium (Phellogen)

Periderm

Phellem (Cork cells)

Phelloderm (Cork Parenchyma)

SECONDARY GROWTH: AN OVERVIEW-

- Secondary growth is an increase in girth (width) of a plant initiated by cell divisions in lateral meristems
- Primary and secondary growth happen simultaneously but in different parts of a woody plant
- Secondary growth adds width to older areas of the stems and roots that are no longer growing in length
- Typically, stems have much more secondary growth than roots

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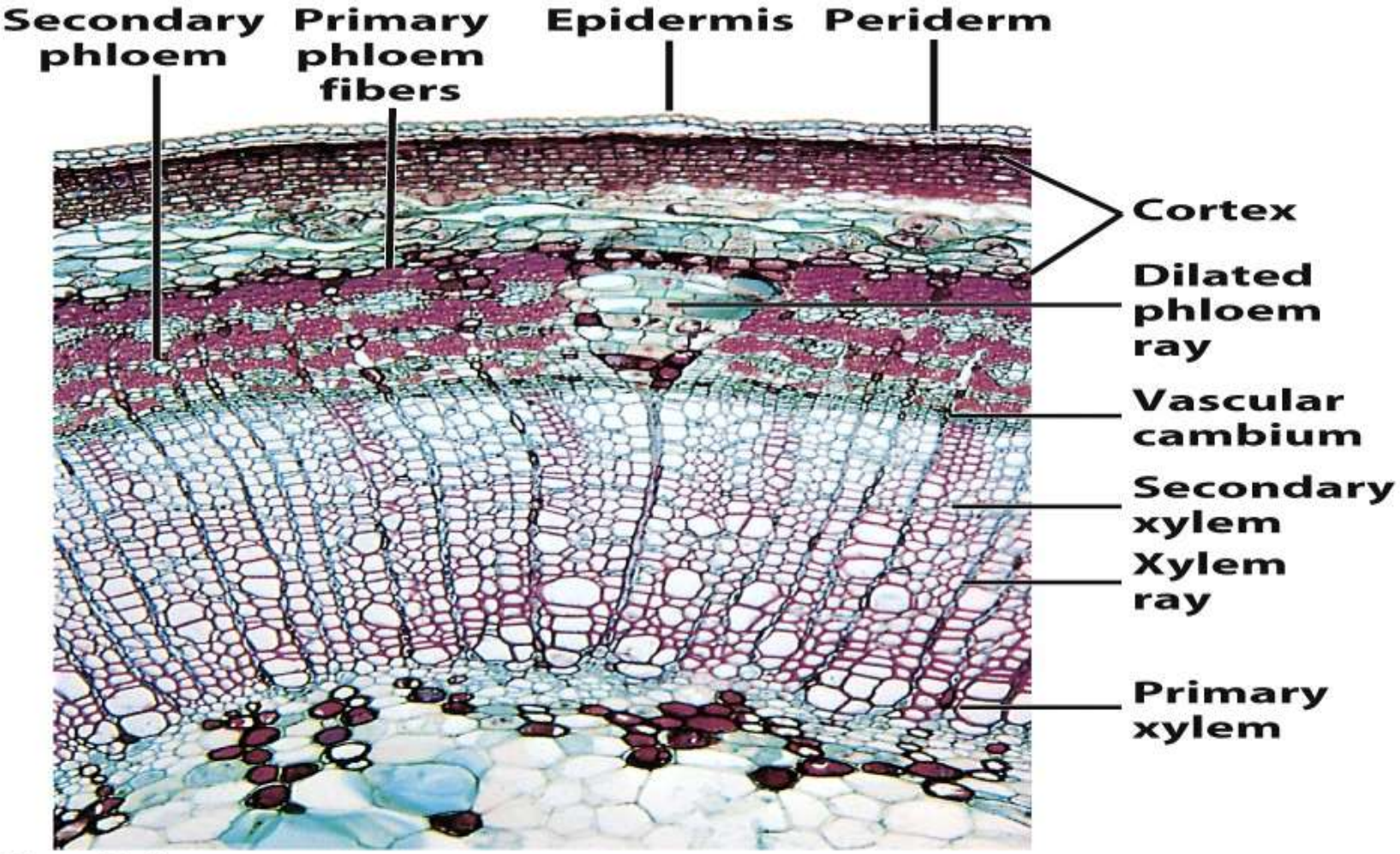

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- Making stems and roots thicker rather than longer involves quite different process

- Secondary growth in plants are produce by lateral meristems

- Instead of growth in length, secondary growth is radial- increasing the diameter of a stem or root as dividing cell produce lateral or sideways growth

- In lateral meristem, new cells are added internally, toward the center and toward the surface of the stem or root

- Secondary growth arises in regions of a woody plant where primary growth has ceased.

- This usually occurs during the first or second year of the plant's growth
- The process starts when differentiated cells revert to become undifferentiated cells, forming 2 lateral meristems called; Vascular cambium and cork cambium
- Cambium cells are cells that have exchange their previous roles for a new role of dividing repeatedly to produce new growth

1.Vascular cambium produces vascular tissues which are called secondary xylem and secondary phloem

- The vascular cambium itself forms from cells in the cortex and procambium
- In roots, pericycle cells are also involved

2. **Cork cambium** (phellogen) forms initially from parenchyma cells in the cortex and sometimes in the primary phloem

- **Cork cambium** produces new dermal tissues which eventually replaces the **epidermis** formed by the **protoderm**

- In a three-dimensional (3D) view, the vascular bundles of a plant form a cylinder
- secondary growth in dicots and conifer stems begins when vascular cambium cells arise from residual procambium cells between the primary xylem and phloem
- Vascular cambium's cells are existing cells that becomes meristematic at different times, under the influence of the hormone auxin, until eventually they form a complete cylinder
- This cylinder **runs** through the middle of each vascular bundle

VASCULAR CAMBIUM-

In roots, the arrangement of primary xylem and phloem prevents the vascular cambium from initially forming in a circular configuration

- Within a year or so, different rates of cell division in the vascular cambium result in the formation of a cylinder

- Secondary xylem expands the plant's capacity to carry water and minerals up from the roots and adds structural support

- Secondary phloem increases transport of food from the leaves

- As the stem or root grows in thickness, the mature primary xylem and phloem tissues are pushed farther apart.

VASCULAR CAMBIUM-

- Secondary xylem is what we commonly call wood.
- Secondary xylem consists largely of dead cells
- Only the more recently formed layers of secondary xylem conduct water and minerals
- Similarly, only the more recently formed layers of living secondary phloem conduct food
- Old phloem cells no longer conduct because they are stretched and broken when new cells produced by vascular cambium push them outward.
- Older xylem cells no longer conduct because an increasing number of vessels have broken columns of water and an increasing number of tracheids contain air.

CORK CAMBIUM-

- Secondary growth maintain the two basic functions of vascular tissue: Conduction and Support
- There are basically two types of dermal tissue in vascular plants: Epidermis and Periderms
- Epidermis and cortex form during primary growth
- They are replaced by the periderm in plants that have secondary growth
- Periderm is produce by the cork cambium
- It consist of; cork, phelloderm, and cork cambium cells
- Cork (phellem) forms to the outside of the cork cambium

- It consists of dead cells when mature.
- Phelloderm is a thinner layer of living parenchyma cells that forms to the inside of each of the many cork cambia
- Unlike the vascular cambium, cork cambium does not grow in diameter
- Every year, or sometimes less frequently, a new cork cambium forms inside the old one, creating another layer of periderm inside the old periderm
- In a stem, the first cork cambium arises from parenchyma cells in the outermost layers of the cortex
- Each new cork cambium arise from cortex tissue to the inside until eventually the cortex is used up in this manner

As the diameter of the stem expands due to the action of the vascular cambium, the cortex expands.

- Since no cell division occurs in the cortex, the expansion eventually causes the cortex to break apart and fall off the stem
- Subsequent cork cambia then arise from the secondary phloem to the inside
- In roots, the initial cork cambium forms after changes in the endodermis and pericycle

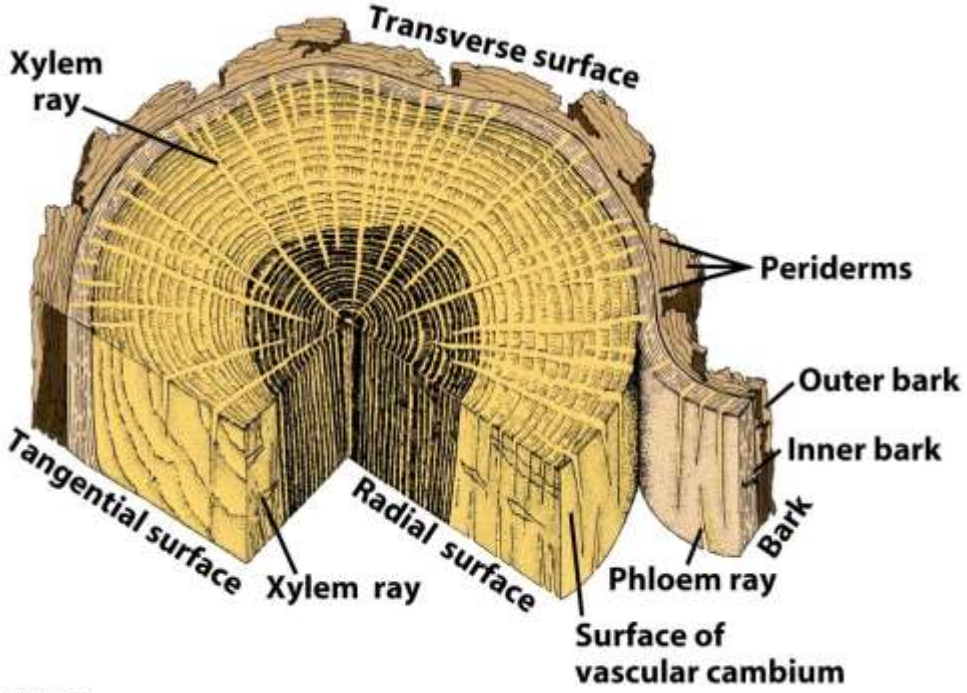
- Endodermis is no longer needed since H2O and minerals are no longer absorbed
- Pericycle no longer give rise to branch roots but instead widens as it is pushed towards the outside
- From the outer layers of this enlarged pericycle emerges the first cork cambium, which forms a layer of periderm.
- The outermost layers of the root – endodermis, cortex and epidermis – become stretched and eventually rupture and peel off
- leaving the periderm as the outer covering

SECONDARY GROWTH-BARK:

- Bark is the part of a stem or root surrounding the wood.
- Bark has two distinct regions: –Inner bark –Outer bark
- Inner bark consist of living secondary phloem, dead phloem but the vascular cambium and the innermost cork cambium, and remaining cortex.
- Outer bark consists of dead tissue – including dead secondary phloem and all the layers of periderm outside of the cork cambium

As the periderm layer builds up in the outer bark, the outermost layers gradually crack and peel off

- Bark is typically much thinner than the woody portion of a stem or root.
- The rough texture of the bark is due to the splitting of older layers of periderm
- Outer bark dead tissues provides protection whiles the inner bark secondary phloem helps to transport sugar and organic molecules



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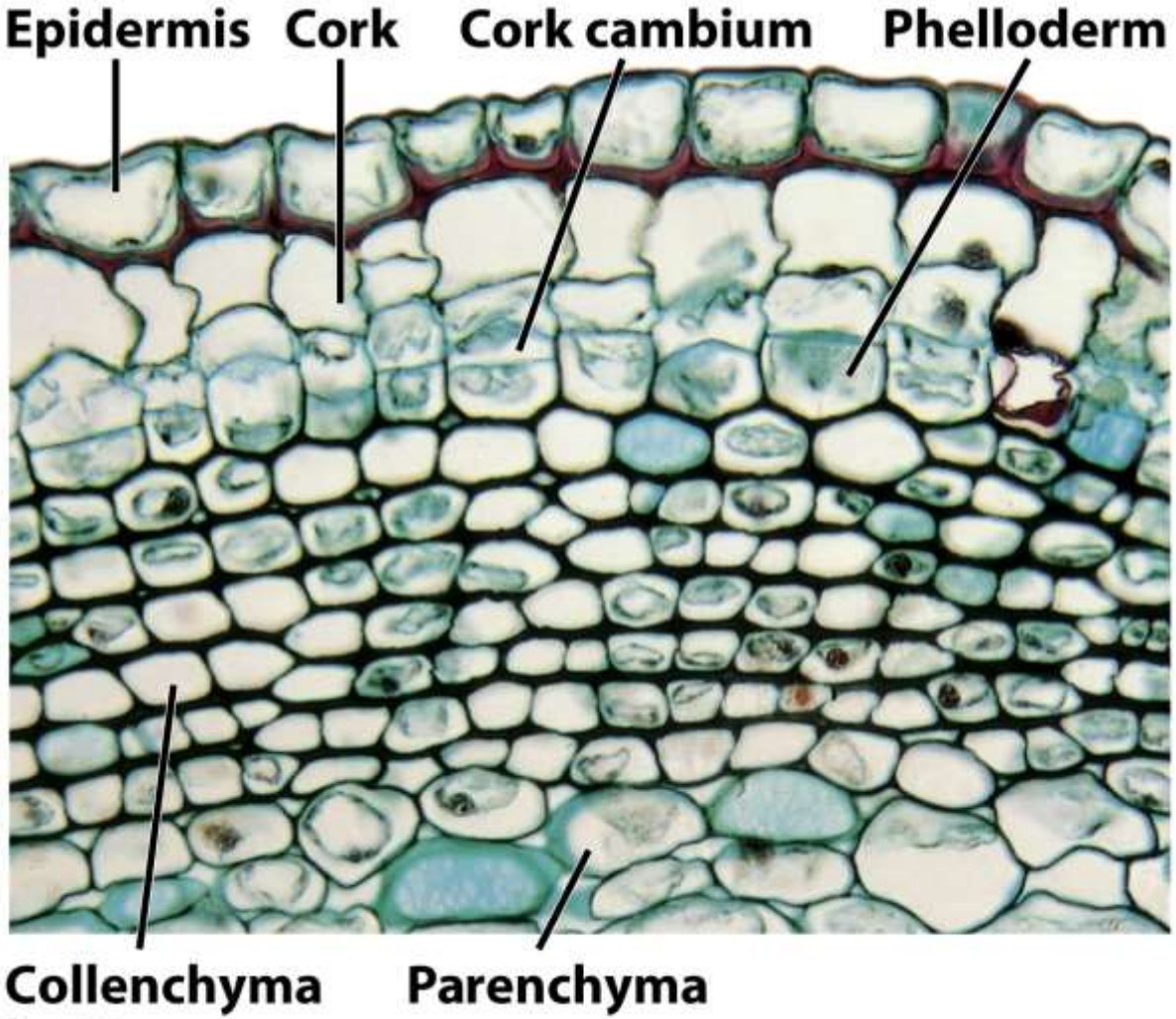

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GROWTH PATTERN IN WOOD AND BARK-

- The continue source of wood in a tree is due to the presence of vascular cambium
- Vascular cambium produce the secondary phloem that conducts food within the inner bark
- Two types of meristematic cells form the vascular cambium: – Fusiform initials – Ray initials
- These initials undergo periclinal and anticlinal cell division.
- Periclinal cell divisions add to the length of a stem or root
- Anticlinal cell divisions increase the diameter of the vascular cambium.

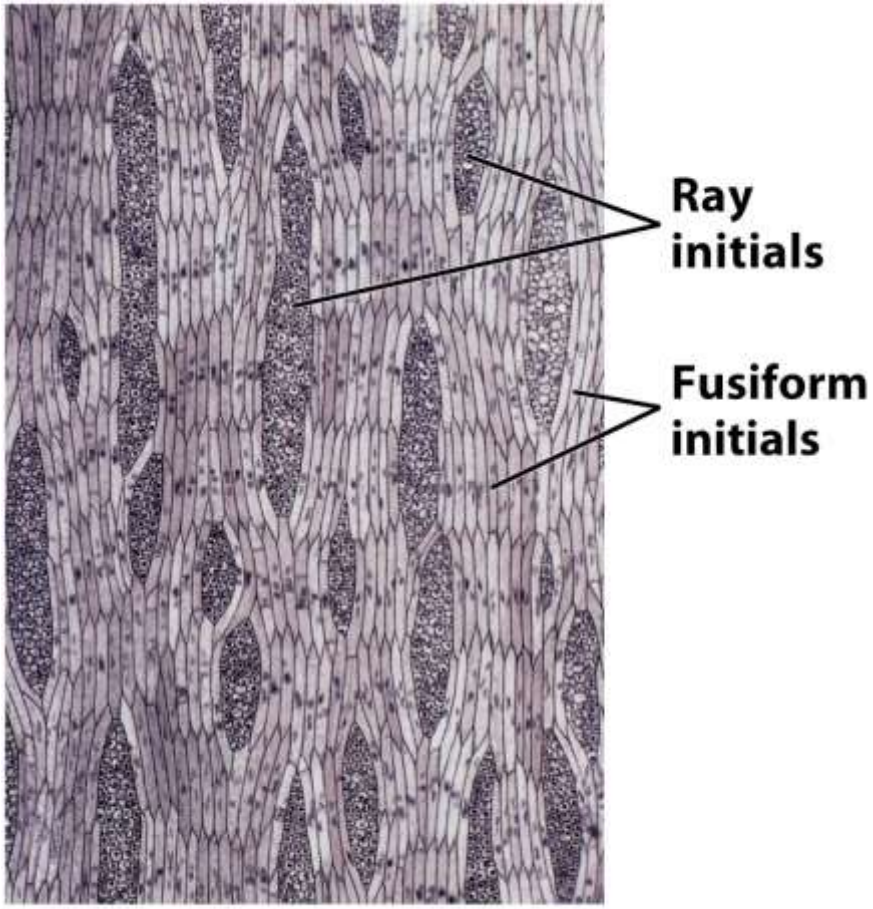
FUSIFORM INITIALS-

From Latin fusus, “spindle”

- Elongated spindle shape cells arranged in vertical row
- Arise within the vascular bundles and produce new vascular tissue
- Xylem inside and phloem outside
- Fusiform initial divides so that one daughter cell becomes either xylem or phloem
- A fusiform initial can also divide to produce two fusiform initials that remain within the vascular cambium
- Fusiform initials and conducting cells are aligned lengthwise parallel to the surface of the stem or root.

Cell divisions of the fusiform initials typically produce more xylem than phloem

- Growth of the xylem is visible each year as a ring
- the ring formation is due to the different size of the new cells every season
- Xylem ring accumulate year after year, but the innermost rings no longer conduct water and minerals.
- Phloem current cells conduct water



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RAY INITIALS-

- Horizontal arranged cells in the vascular cambium
- Helps in producing phloem rays and xylem rays
- Ray initials arise but the vascular bundles and are often cubical cells
- They produce cubical parenchyma cells
- These cells serve mainly for storage and also sideways transport
- Ray initials division leads to the formation of daughter cells and parenchyma cells
- Rays are common in dicots, where they are often more than one cell wide

WOOD-

- Wood is the secondary xylem of seed-plants.
- A tree trunk is composed of the following basic parts, listed in order beginning with the outer layer:
- The bark is dead tissue; and its function is to protect the tree from weather, insects, disease, fire, and injury.
- The phloem is a thin layer comprised of living cells, and its basic function is to transport food around the tree.
- The cambium is living tissue. This very thin layer of a tree produces both new phloem on one side and new xylem on the other.
- The largest part of a trunk is the xylem, which is composed of both sapwood and heartwood.

SAP WOOD-

Also referred to as “Alburnum”

- It is the living, outermost portion of a woody stem, branch or root of a plant where sap flows
- It is usually light in color
- Cells contain more water and lack darkly staining chemical substances commonly found in heartwood
- Sapwood performs two functions: – Adding support to the tree – Transportation of nutrients and xylem sap

SAPWOOD

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HEART WOOD-

Also referred to as “Duramen”

- Heartwood is the dead, inner wood of a stem, branch or root of a plant.
- Cell contain substances that make it dark in colour. Eg: Tannins, resin, gums etc
- It is mechanically strong, resistant to decay

–The main function of the heartwood is to support the tree.

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COMPONENTS OF WOOD-

- Plant consist of a complex mixture of substances that support, protect, retain its durability etc
- These substances are produced by the cells of plants
- They are suspended in a watery medium where other substance are dissolved.
- Among these components of wood are; Latex , Gums , Rosin ,Sap, Oils, Fats and Waxes.

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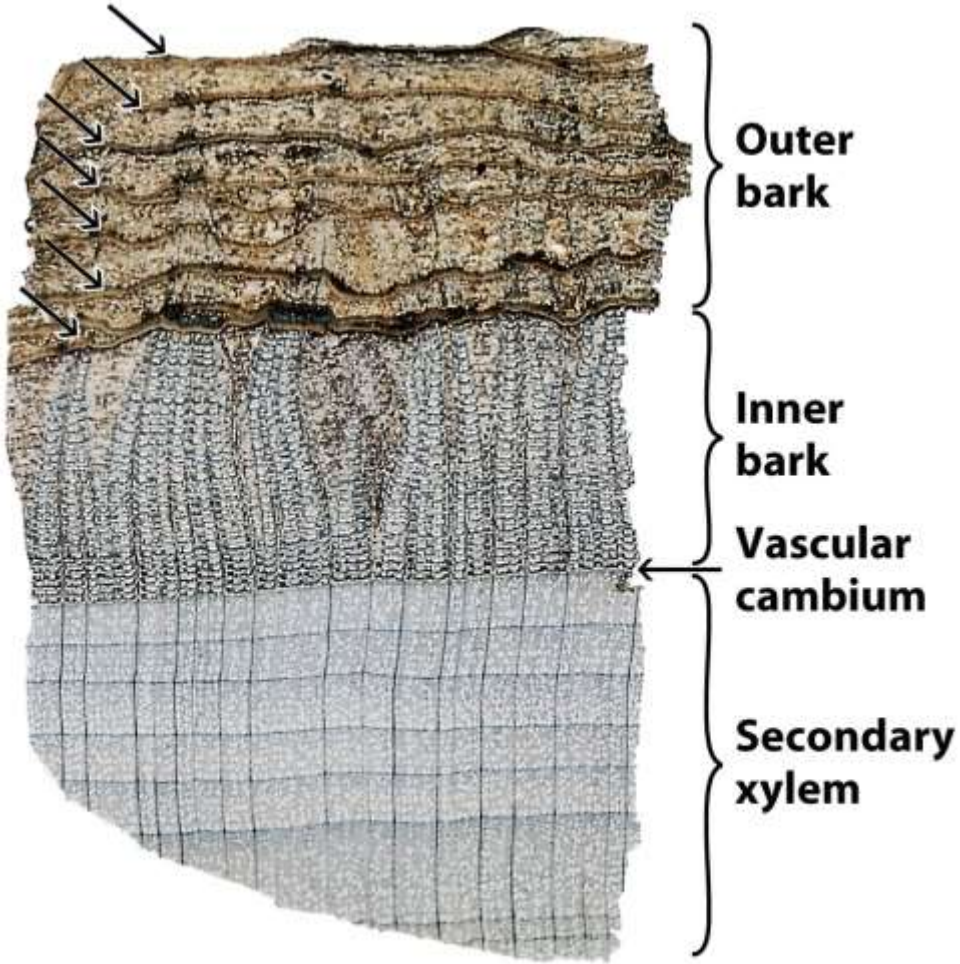

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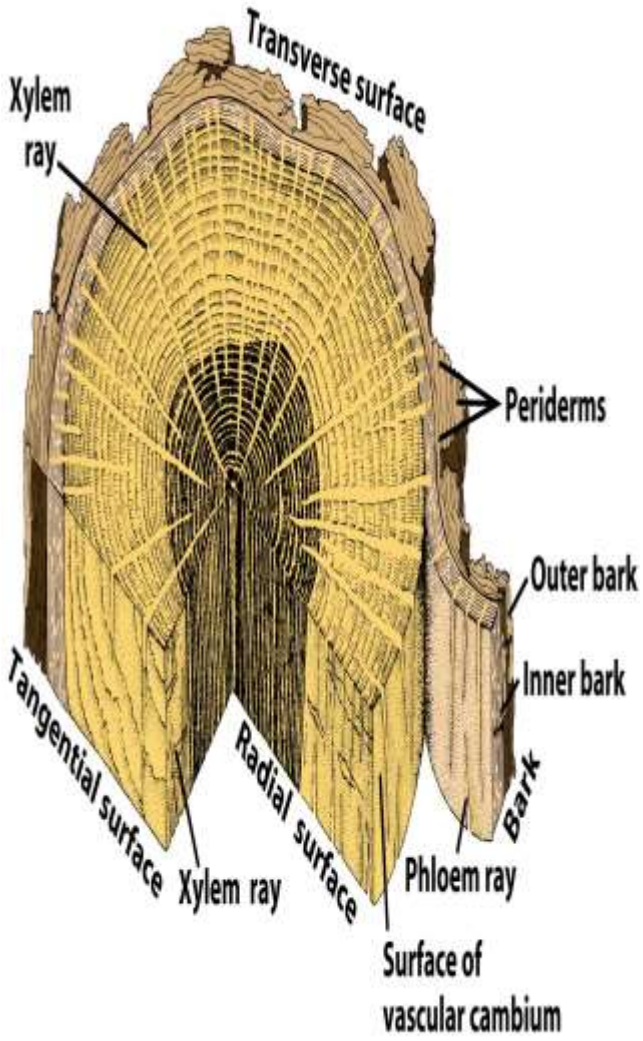

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LATEX-

- Latex is a thick, creamy white, milky fluid in about 10% of all flowering plants
- Usually white, but some yellow, orange or scarlet latex
- Produces in special cells called Laticifers
- It contain compounds that prevent the growth of fungi and bacteria –Complex mixture of proteins, alkaloids, starches, sugars, oils, tannins, resins, and gums –These substance coagulated on exposure to air –Usually exuded after tissue injury

FUNCTION-

- It blocks the entry of disease-causing organisms and insects through wounds sites
- Latex of many species can be processed to produce many materials;

– Latex is used in clothing – Natural rubber (Mattresses, gloves, condoms, catheters, balloons) – Synthetic latex is used in coatings (eg; latex paint) – Latex from the chicle and jelutong tree is used in chewing

RESINS-

- Resin is a sticky substance that flows through canal in secondary xylem and phloem
- Yellowish – brown in colour
- They are transparent or translucent
- Soluble in organic solvents but insoluble in water
- Harden when expose to air
- They are exuded from trees, especially pines and firs wind, fire, lightning or other cause
- They are mixtures of compounds, including flavonoids, terpenoids, and fatty substances

FUNCTION-

–Help in the healing of wounds after injury in plants

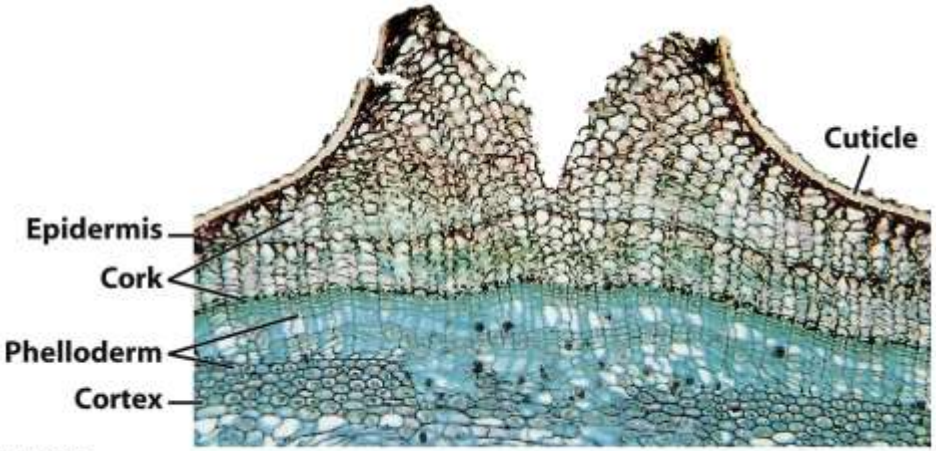
–Valued for the production of varnishes, adhesives etc

–Used as raw materials for synthesizing other organic compounds. Eg Perfume, incense

– synthetic resin can be use for the production of Epoxy glue- by the conversion of bisphenol, a diglycidyl ether to epoxy upon the addition of a hardener

–Production of silicones from silicone resins.

Lenticel- spongy regions on the cork surfaces of stems, roots, and other plant parts that allow for gas exchange.



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