Cambium and its activity

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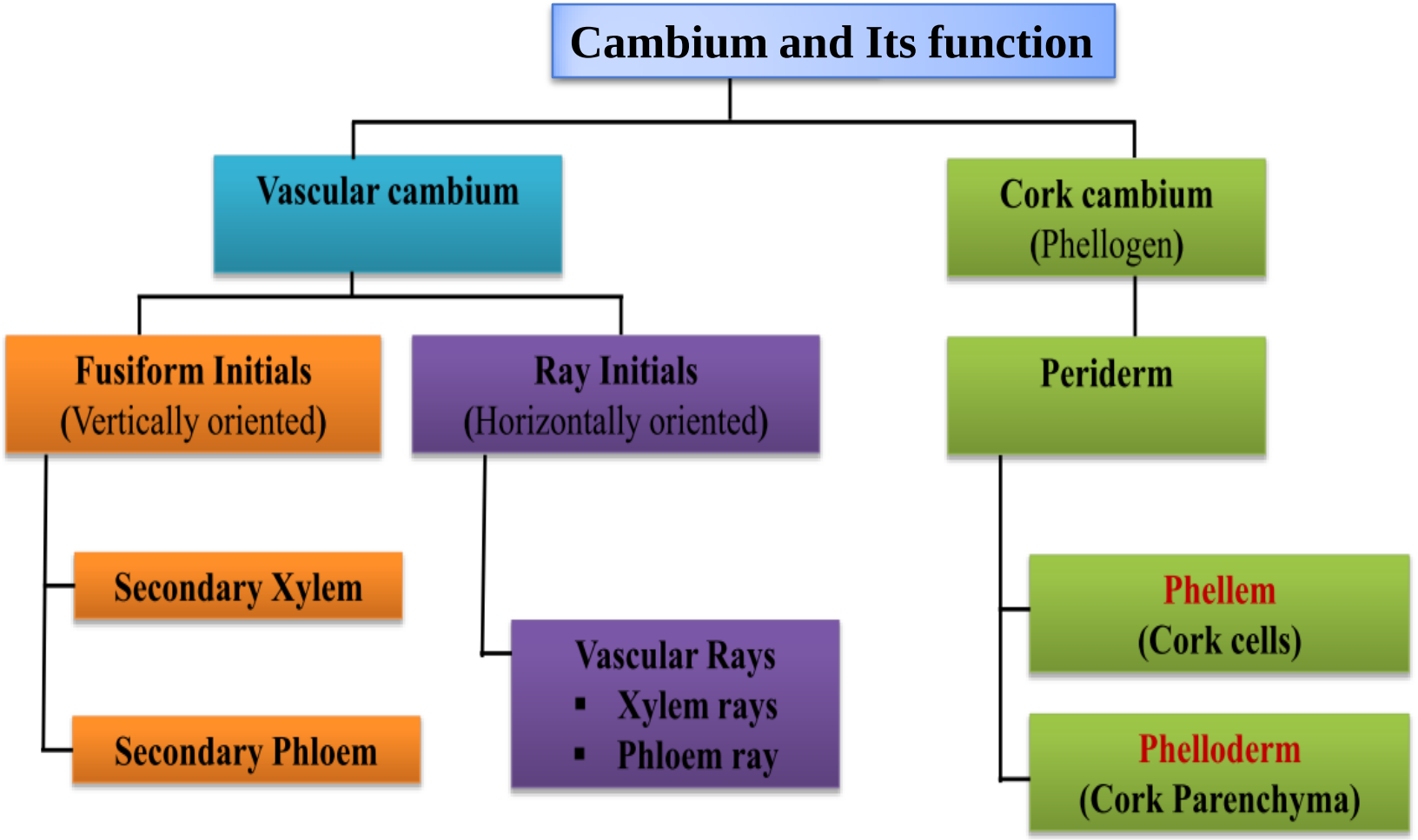

Cambium and Its function
Vascular cambium
Cork cambium
(Phellogen)
Fusiform Initials
(Vertically oriented)
Ray Initials
(Horizontally oriented)
Periderm
Secondary Xylem
Secondary Phloem
Vascular Rays
Xylem rays
Phloem ray
Phellem
(Cork cells)
Phelloderm
(Cork Parenchyma)

SECONDARY GROWTH: 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

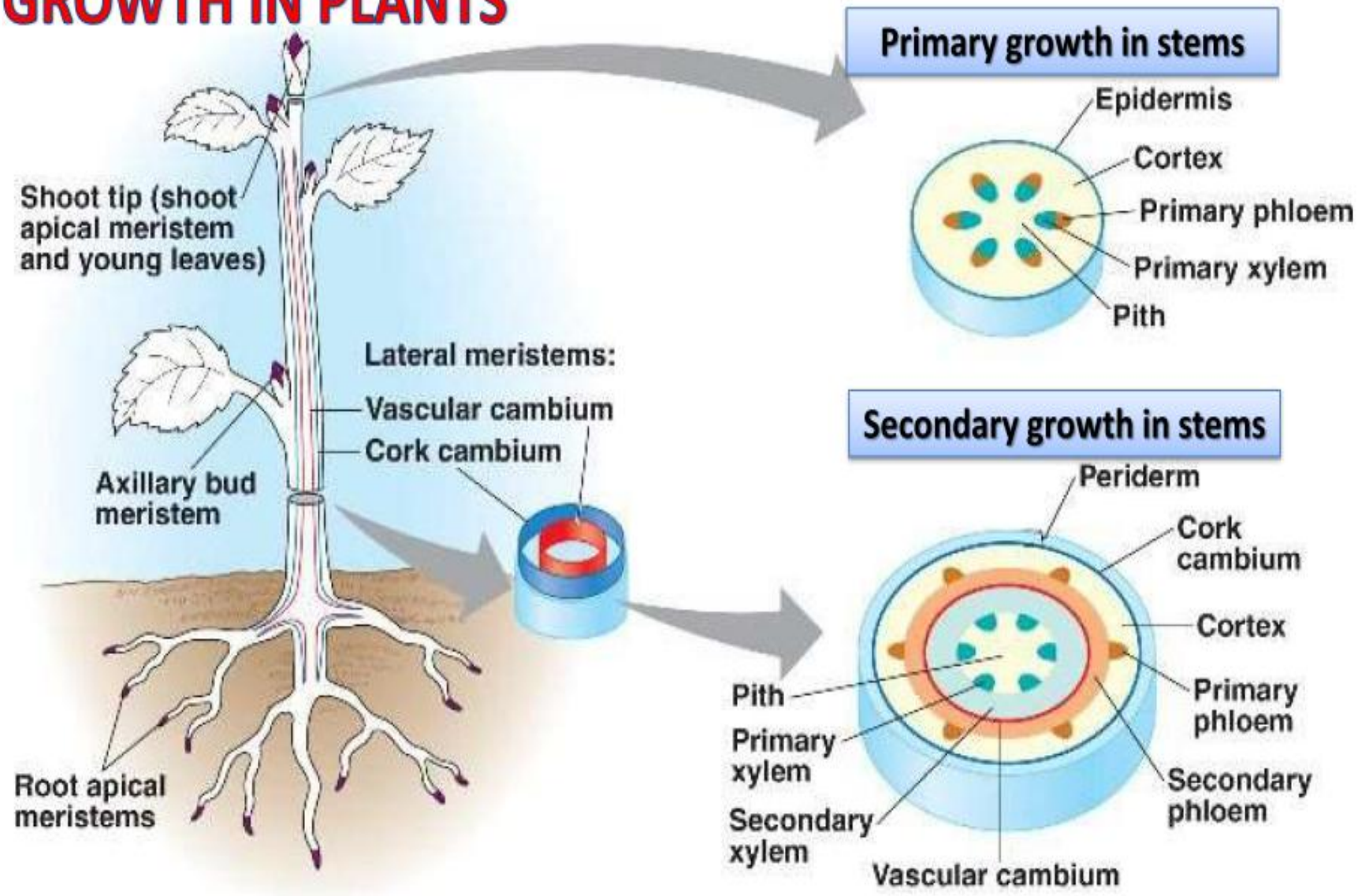
SECONDARY GROWTH: Overview

- 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: Overview

- 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

GROWTH IN PLANTS



SECONDARY GROWTH: Overview

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

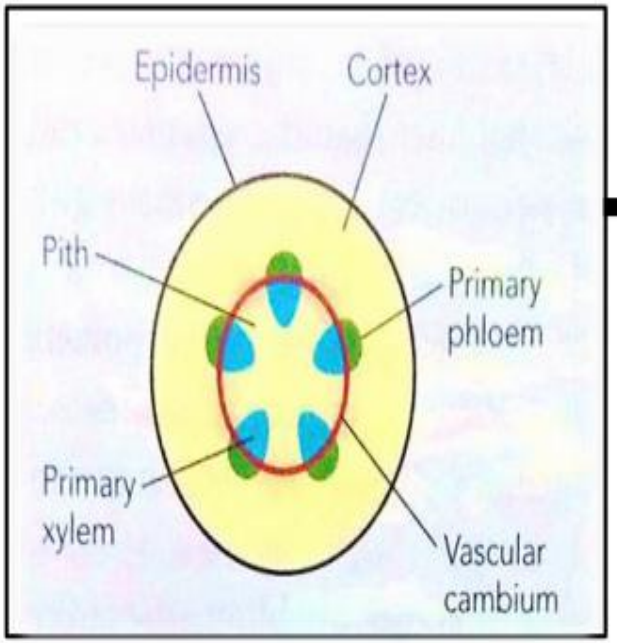
- Cork cambium produces new dermal tissues which eventually replaces the epidermis formed by the protoderm

1. VASCULAR CAMBIUM IN STEM

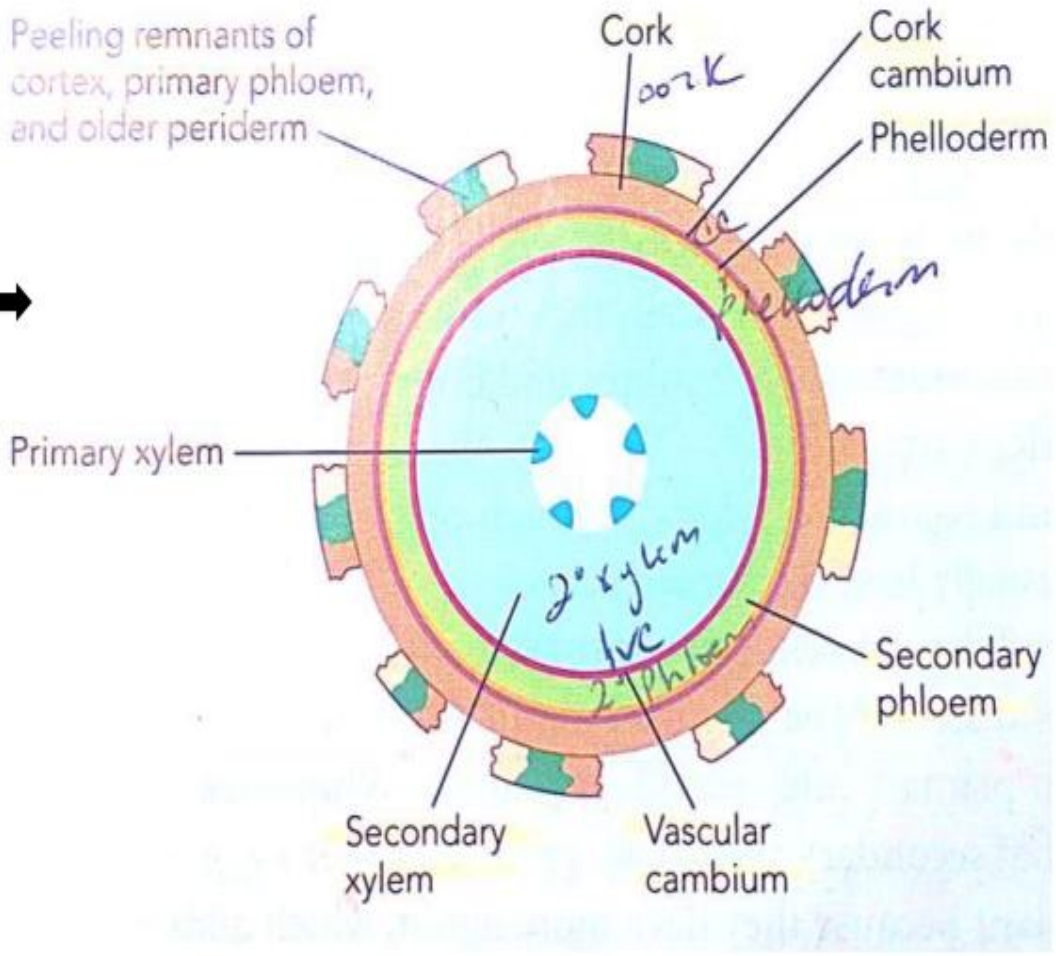
- In a three-dimensional (3D) view, the vascular bundles of a plant form a cylinder
- secondary growth in dicots and conifer stems begins when vascular cambium cells arise from **residual procambium** cells between the primary xylem and phloem
- **Vascular cambium's cells are existing cells that becomes 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 FORMATION IN A STEM

Initial formation



Growth after several yrs

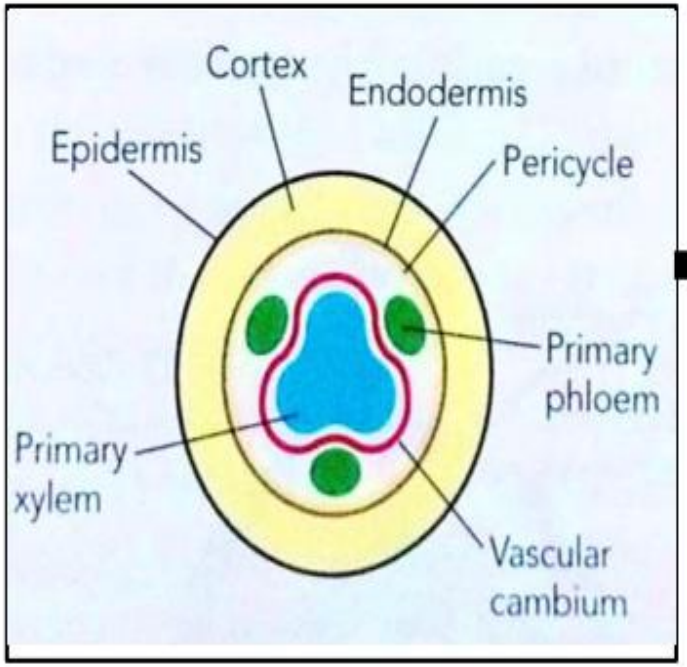


1. VASCULAR CAMBIUM

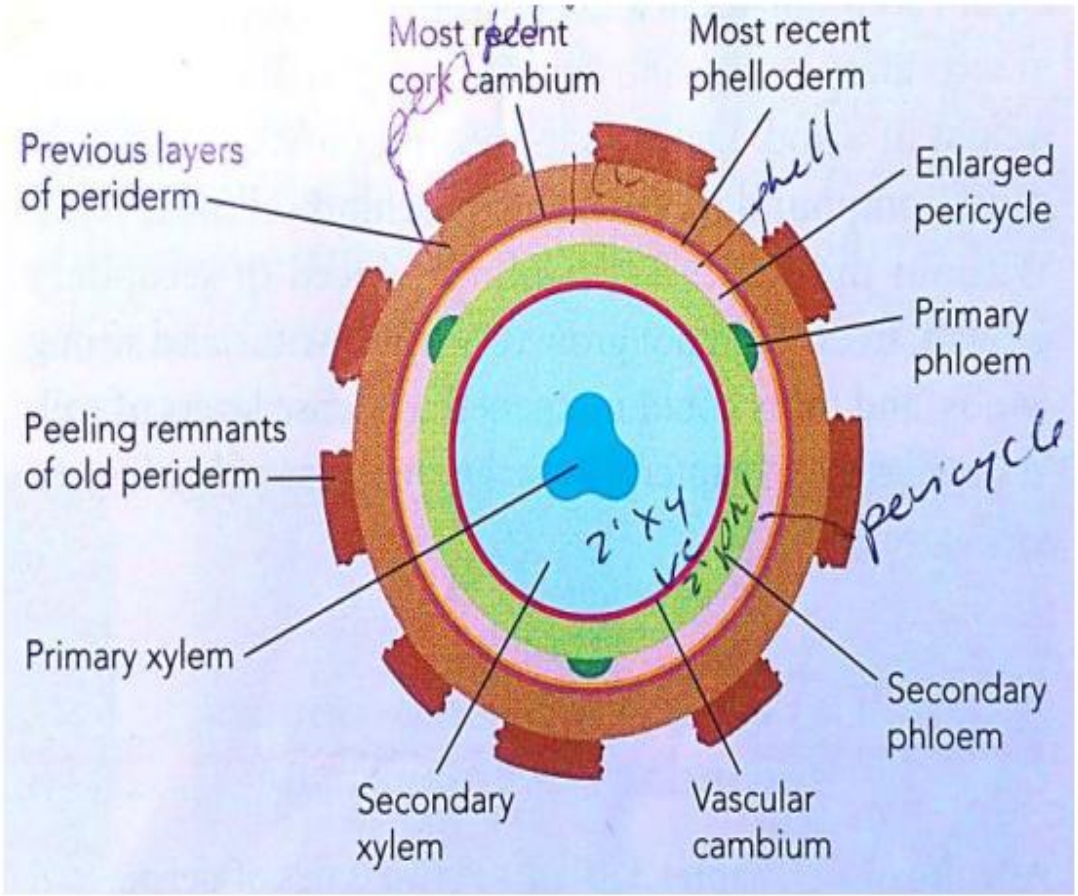
- In roots, the arrangement of primary xylem and phloem prevents the vascular cambium from initially forming in a circular configuration
- Within a year or so, different rates of cell division in the vascular cambium result in the formation of a cylinder
- **Secondary xylem** expands the plant's capacity 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 FORMATION IN A ROOT

Initial formation



Growth after several yrs



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 CAMBIUM

- **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

CORK CAMBIUM

- 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

CORK CAMBIUM

- In roots, the initial cork cambium forms after changes in the endodermis and pericycle
- Endodermis is no longer needed since H_2O 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

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** b/t 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

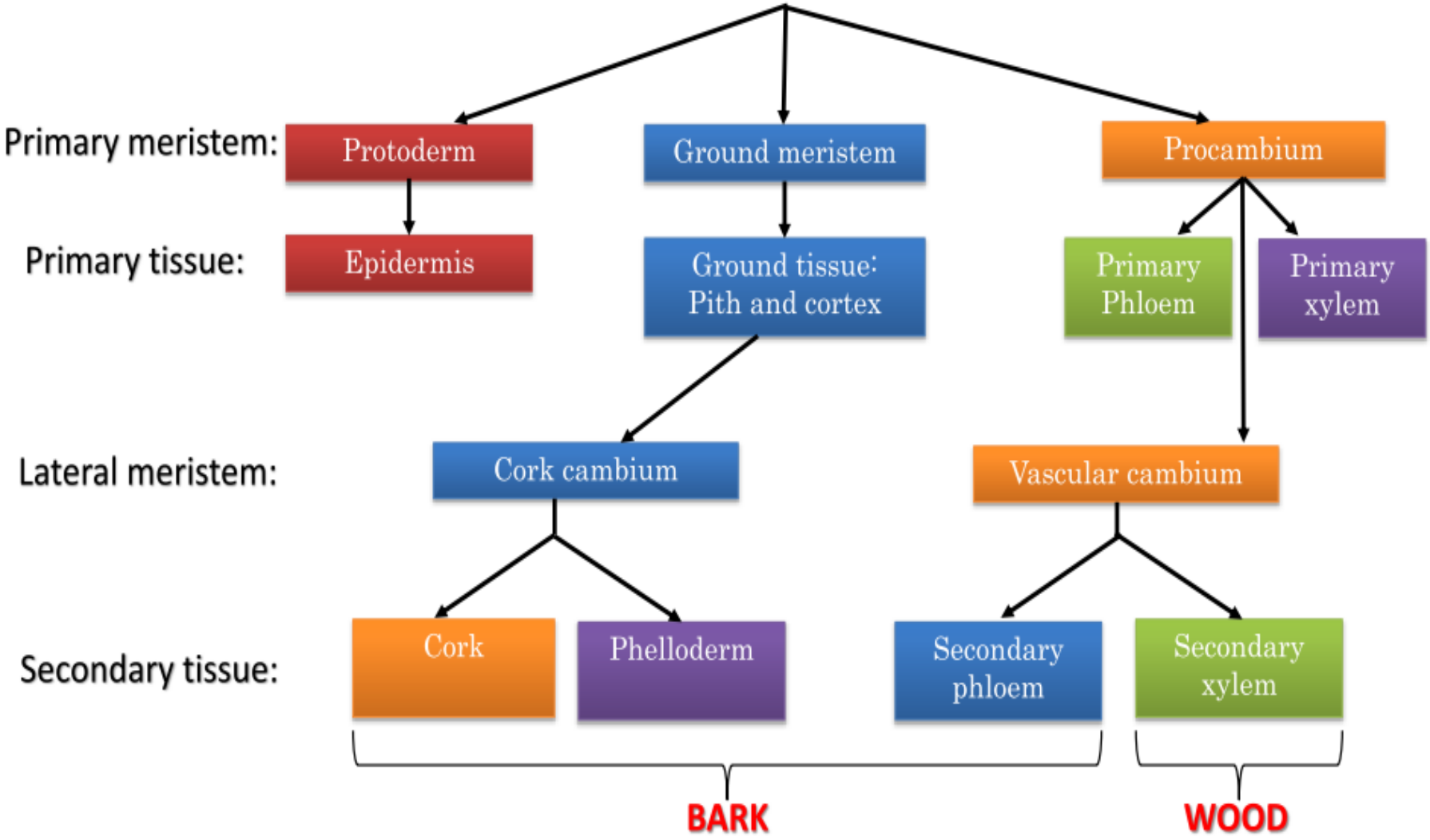
BARK

- 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**

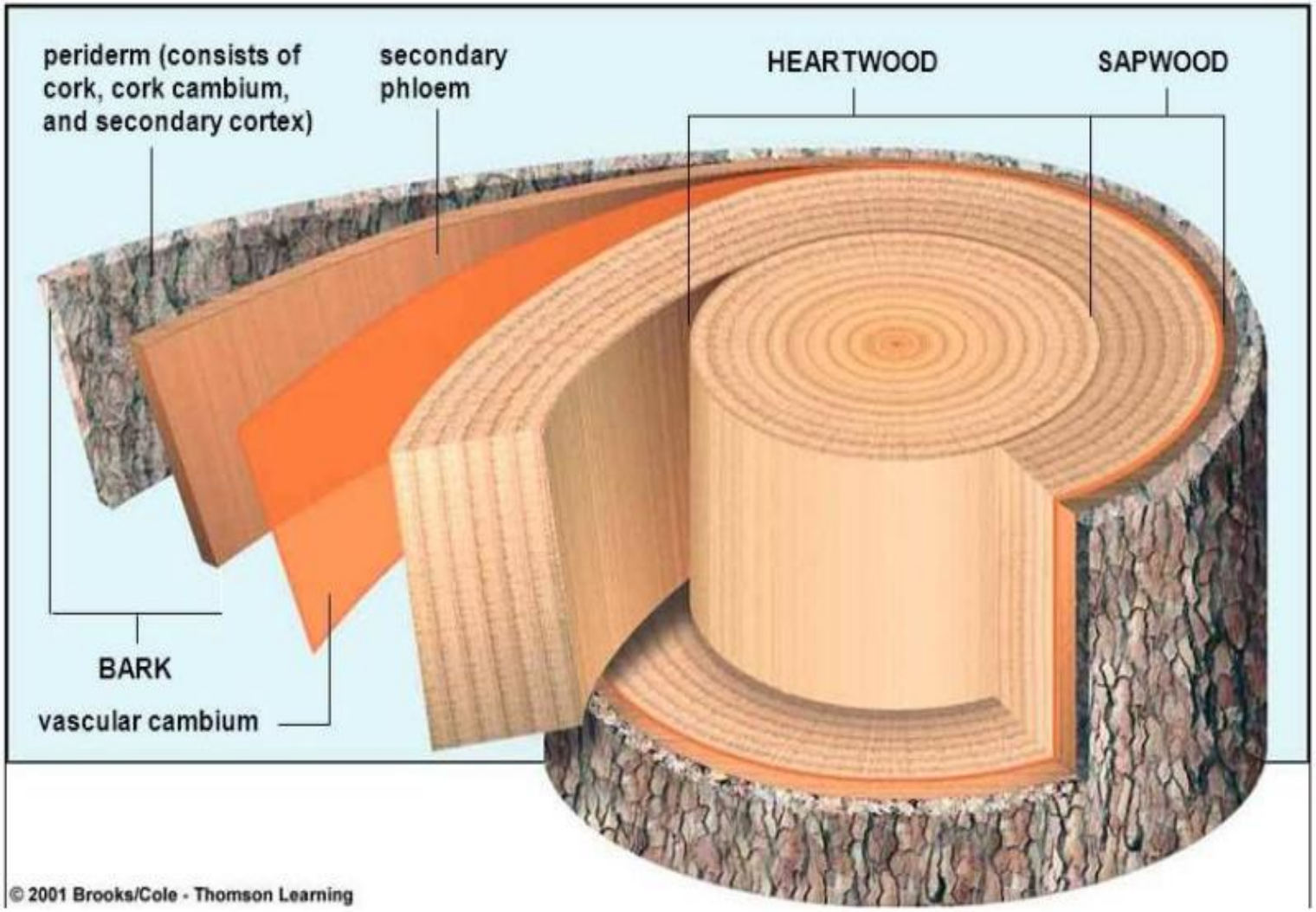
WOOD

- **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.

APICAL MERISTEM



WOODY STEM


periderm (consists of cork, cork cambium, and secondary cortex)
secondary phloem
HEARTWOOD
SAPWOOD
BARK
vascular cambium
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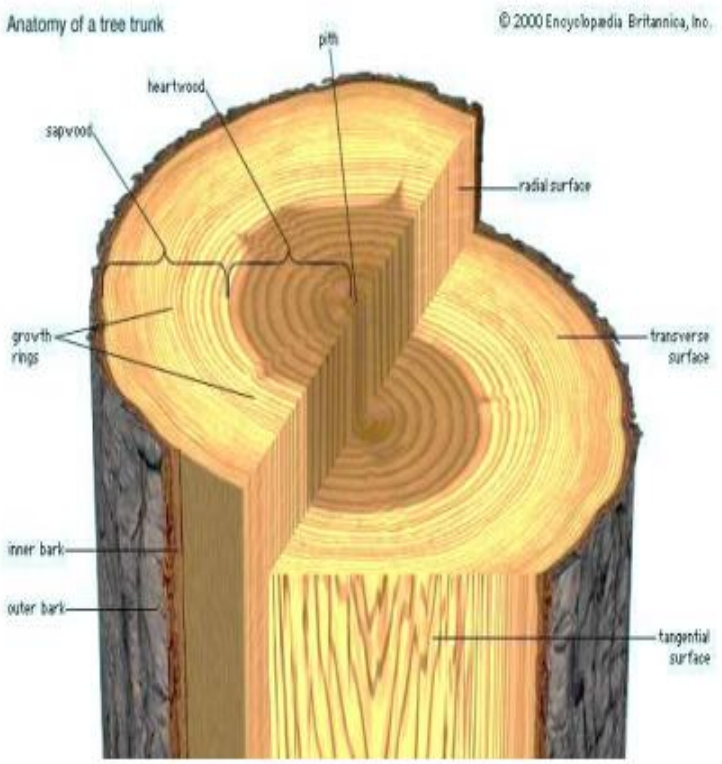
SAPWOOD

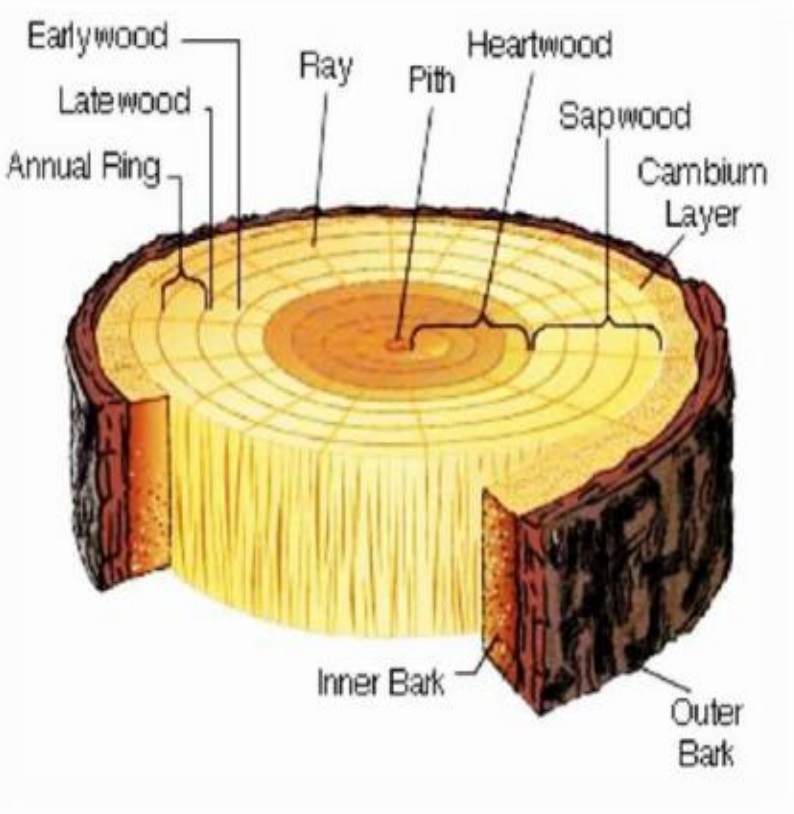
- Also referred to as "***Alburnum***"
- It is the living, outermost portion of a woody stem, branch or root of a plant where sap flows
- It is usually light in color
- Cells contain more water and lack darkly staining chemical substances commonly found in heartwood
- Sapwood performs two functions: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



HEARTWOOD

- 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.**



COMMERCIAL USES OF WOOD AND BARK

- Variation in growth pattern and other physical characteristics of wood and bark provides important implications for human uses.
- Wood has two main uses worldwide;
  - **Fuel & Paper production**
- About the same amount is also used to make paper, a thin film of cellulose made from **wood pulp**
- Wood pulp is a solution of water and crushed wood
- Paper is usually made from **White spruce** (***Picea glauca***)

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**
  - **Rosin**
  - **Oils and Fats**
  - **Gums**
  - **Sap**
  - **Waxes**

THANK YOU