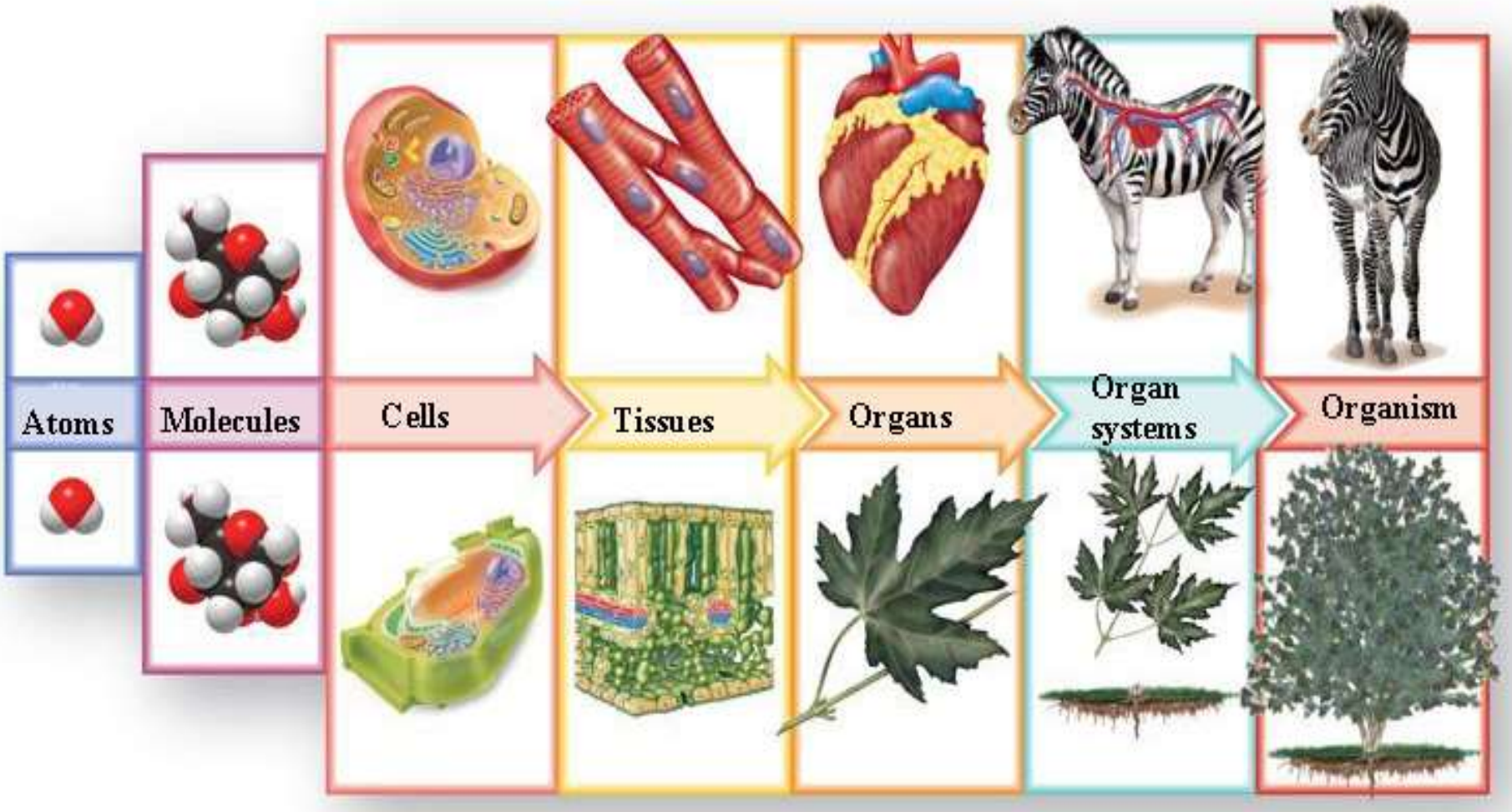

PLANT ANATOMY

# What is plant anatomy

## PHYTOTOMY

- Branch of biology concerned with the study of internal structure of plant and their parts.

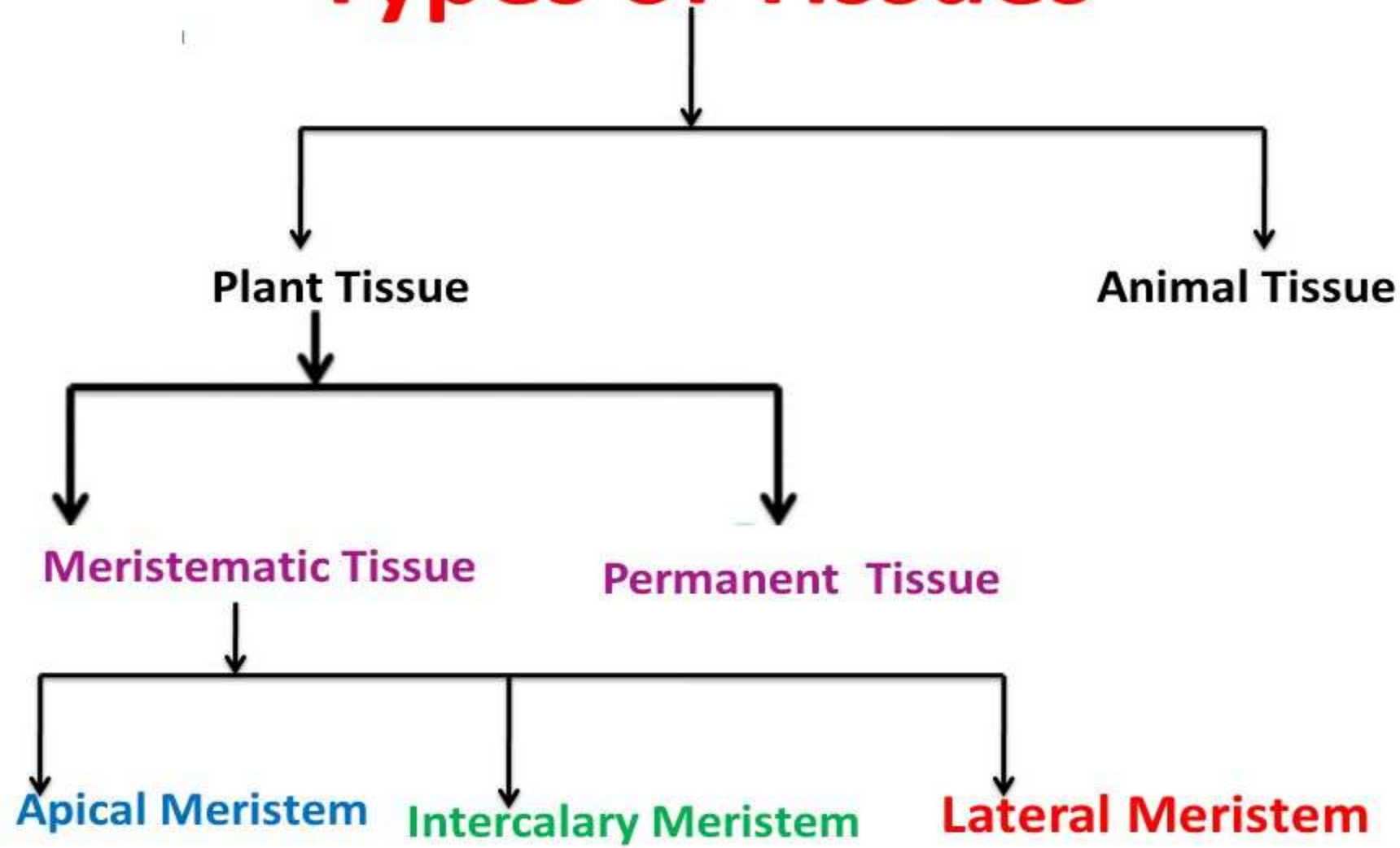
# Level of organization



# What is Tissue

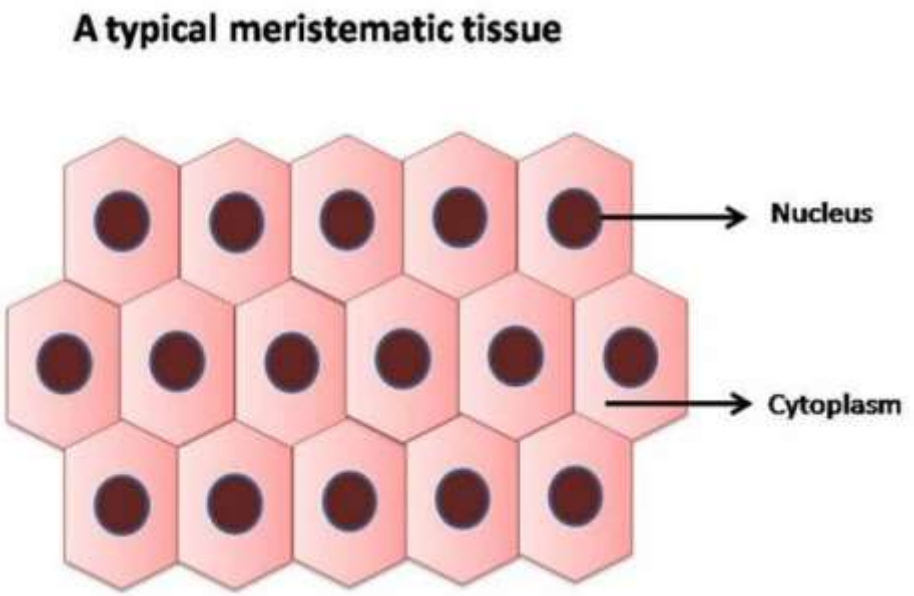
- Histology - Study of tissues
- A group of cells that are similar in structure and funtion.

# Types of Tissues



# Meristematic tissue characterstics

- Small cells
- Dense cytoplasm
- Thin cell wall
- Large nuclei
- No vacuoles
- No intercellular spaces



# Where are found?

- Based on which position or region of the plant meristematic tissue are found 3 types

1. Apical meristem
2. Intercalary meristem

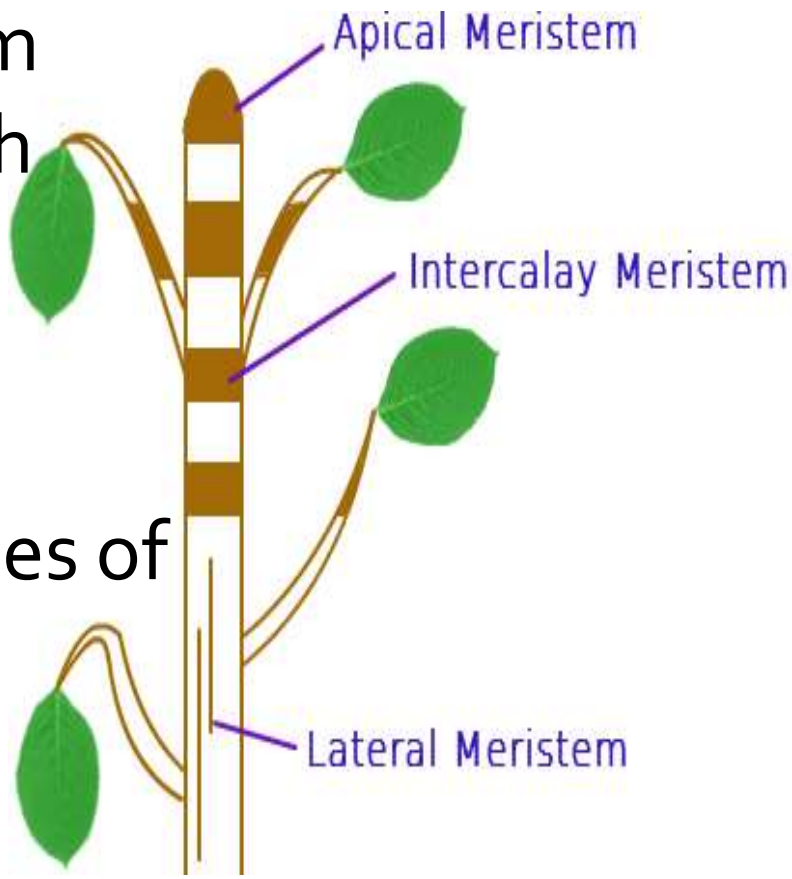
} Primary meristem

3. lateral meristem - secondary meristem

# TYPES OF MERISTEM

- **Apical meristem**
  - present tips of root & stem
  - help to increase the length of Root & stem

- **Intercalary meristem**
  - base of leaves & internodes of twigs



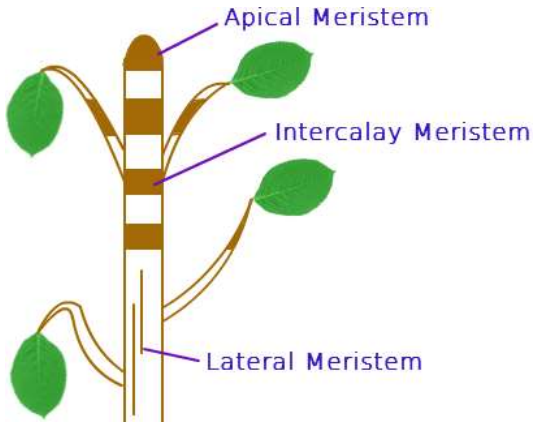
# TYPES OF MERISTEM cont.

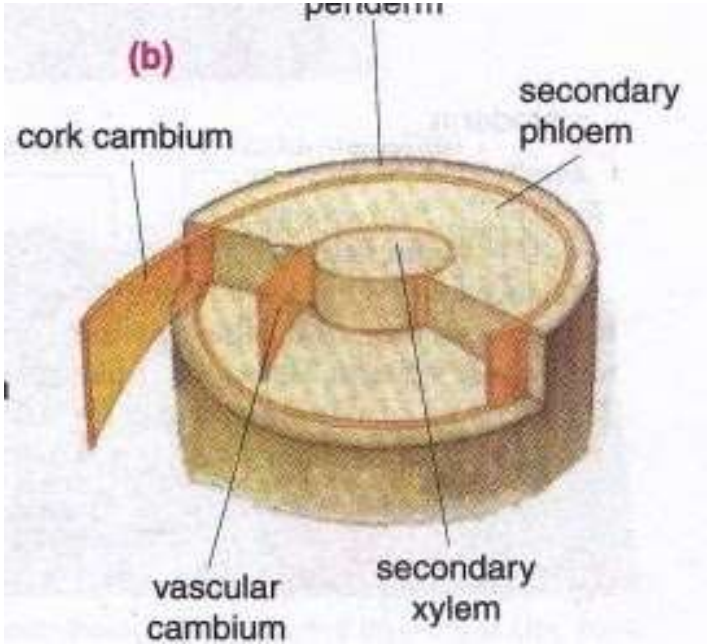
- **Lateral meristem (cambium)**

  - Root / stem girth

  - Vascular cambium

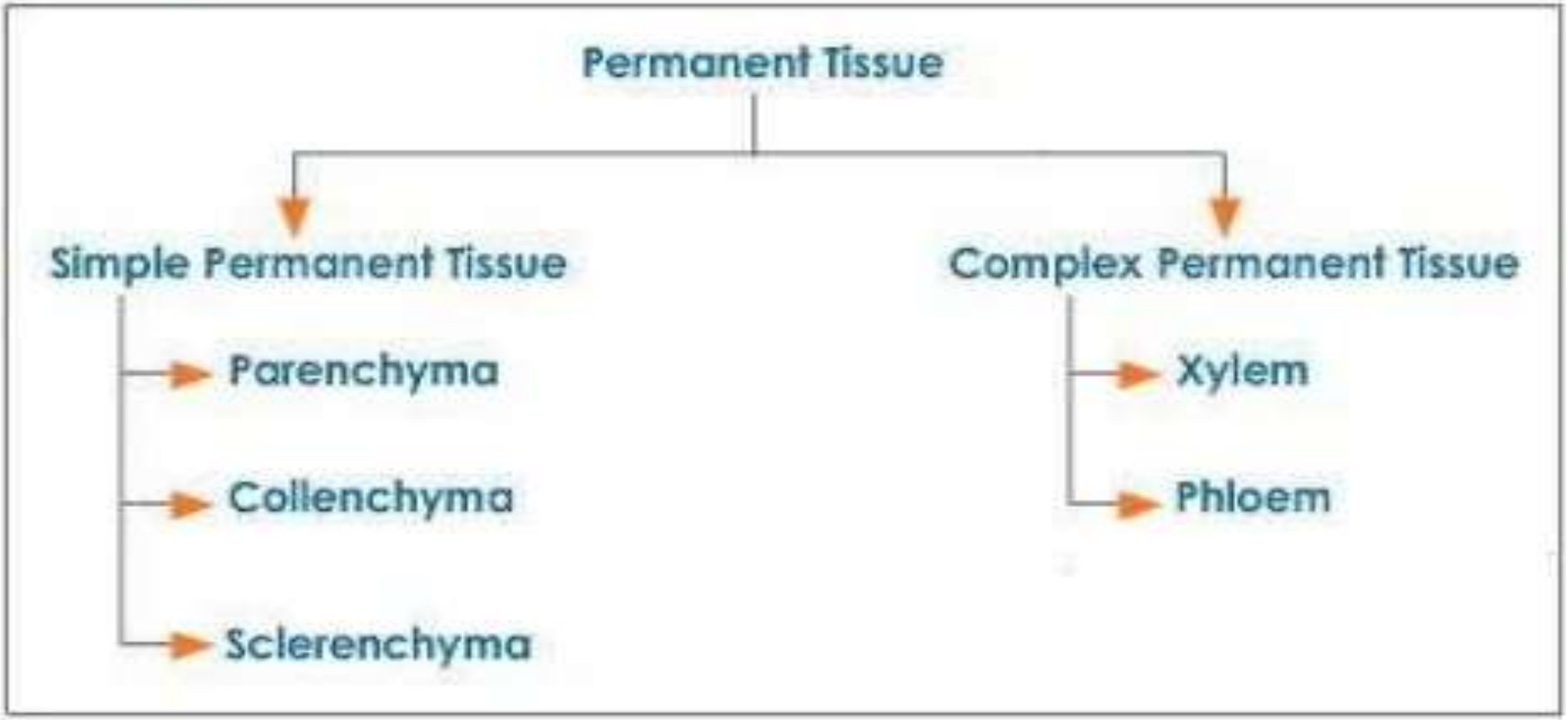
  - Cork cambium



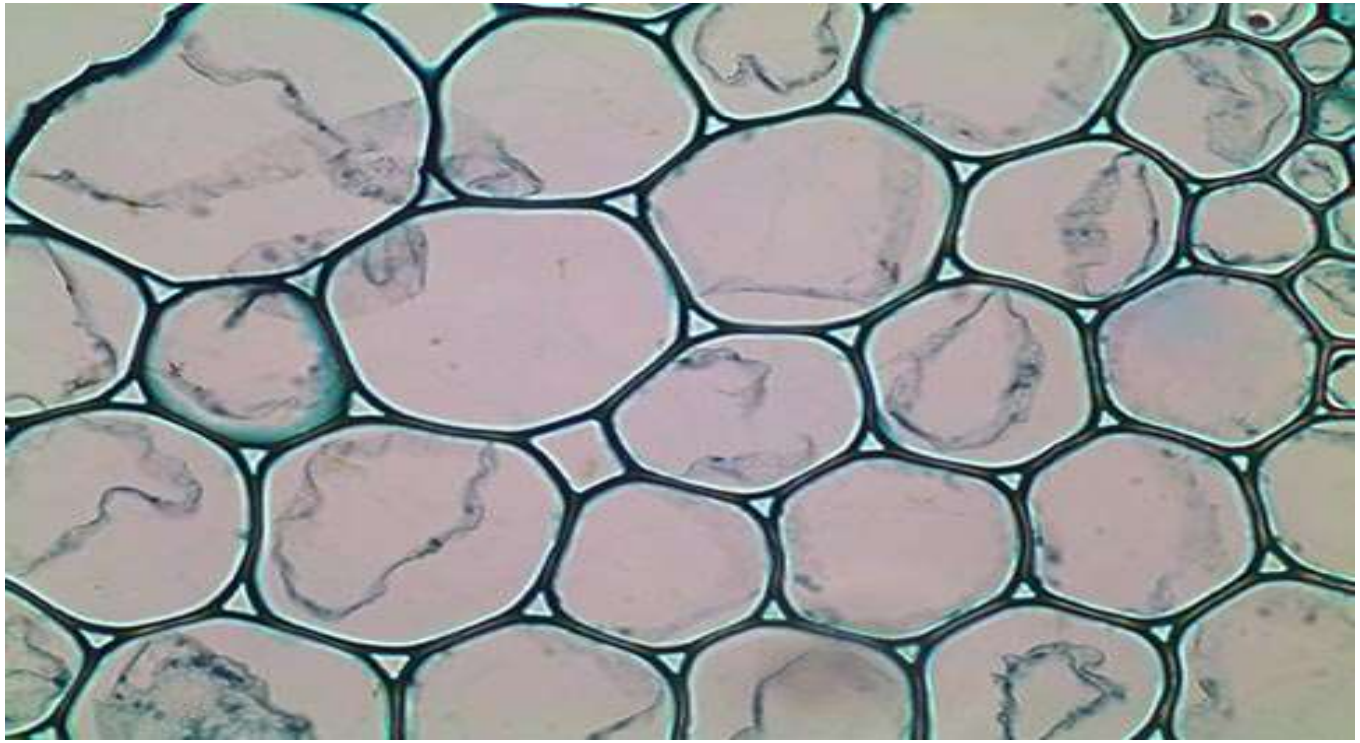
# PERMANENT TISSUE

- Perform specific function
- No ability to divide
- Termed as "permanent tissue" as they have permanent shape, size and function
- Process by which cells formed by meristematic tissue become a permanent tissue is called **"Differentiation"**


Permanent Tissue
Simple Permanent Tissue
Complex Permanent Tissue
Parenchyma
Collenchyma
Sclerenchyma
Xylem
Phloem

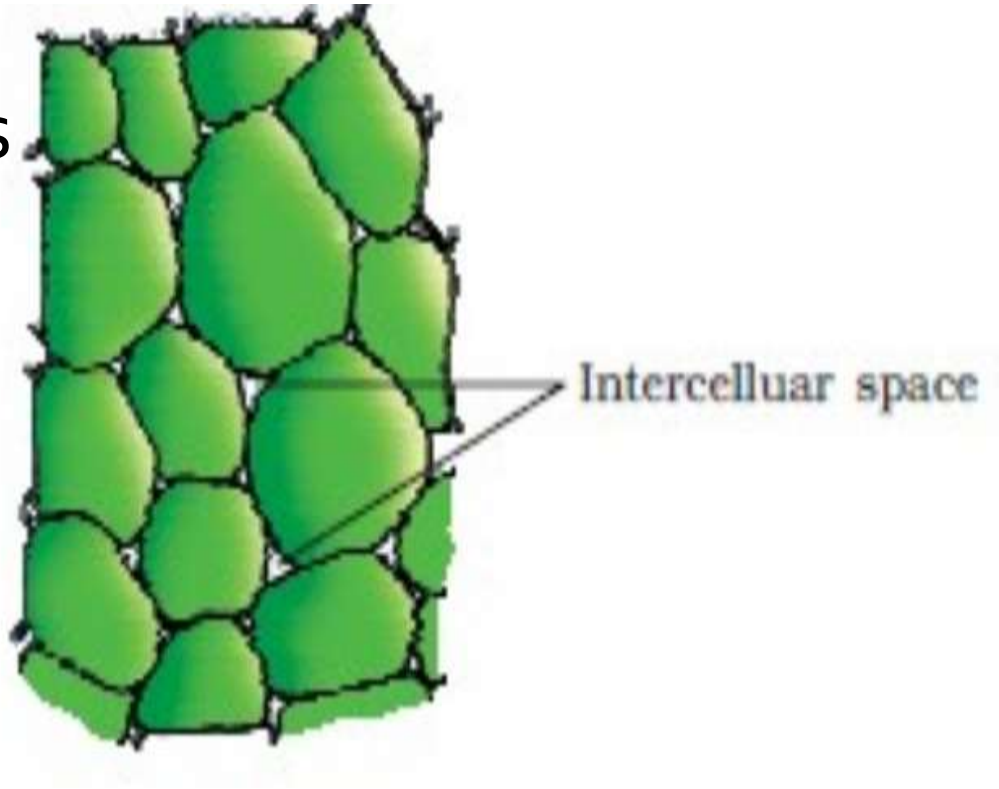
# Simple permanent tissue

- Tissue which are made up of similar type of cells



# Parenchyma

- Basic packing tissue
- Unspecialized live cells
- Thin cell walls
- Intercellular spaces present



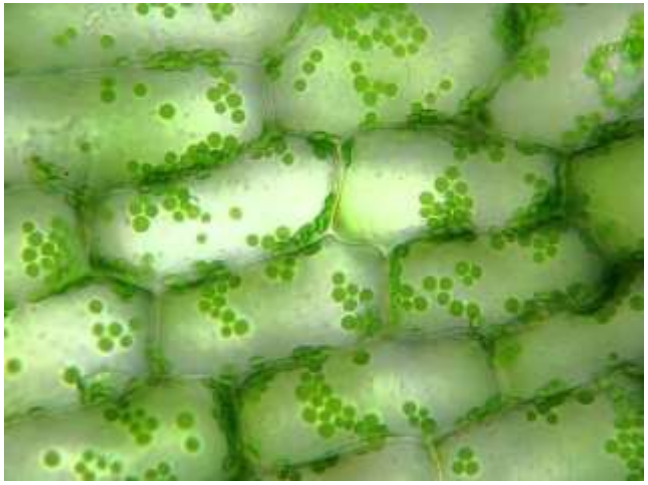

**Function:**

- Support to plants
- Store food
- Stores nutrients &water

# Parenchyma types

- Chlorenchyma

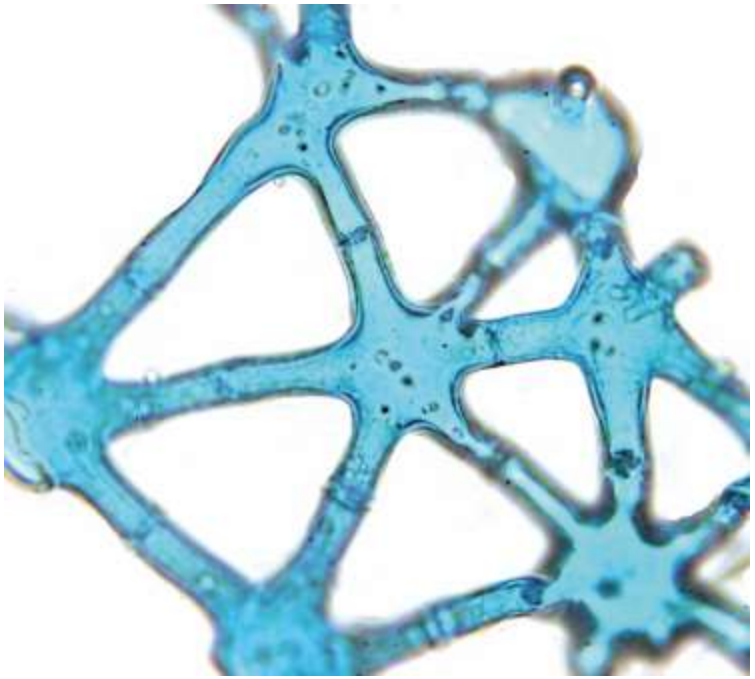
  parenchyma with chlorophyll
  Helps in photosynthesis



- Aerenchyma

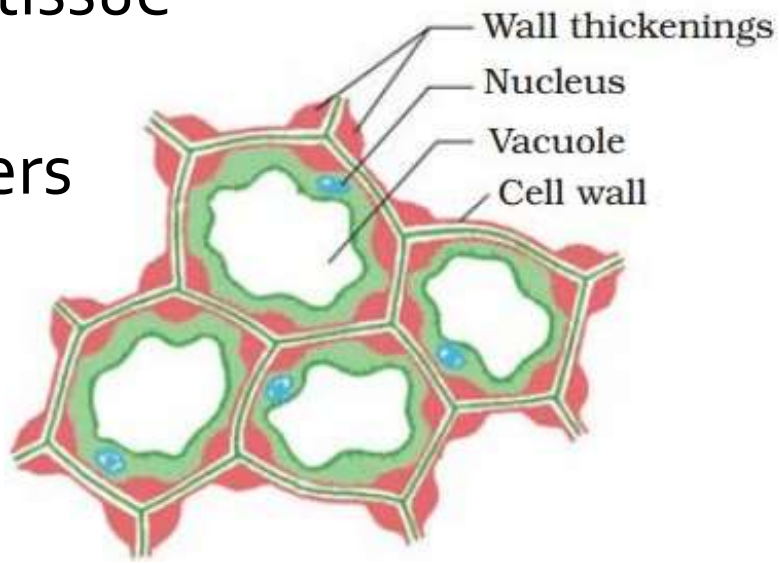
  parenchyma with air
  cavities in aquatic plants
  help in floating

# Stellate parenchyma



# Collenchyma

- Tissue responsible for flexibility in plant.
- Supporting & strengthening tissue
- Elongated cells
- Irregularly thickened at corners
- Less intercellular spaces
- **<u>"Living mechanical tissue"</u>**




Functions:

- Allow bending of stem, leaves without breaking

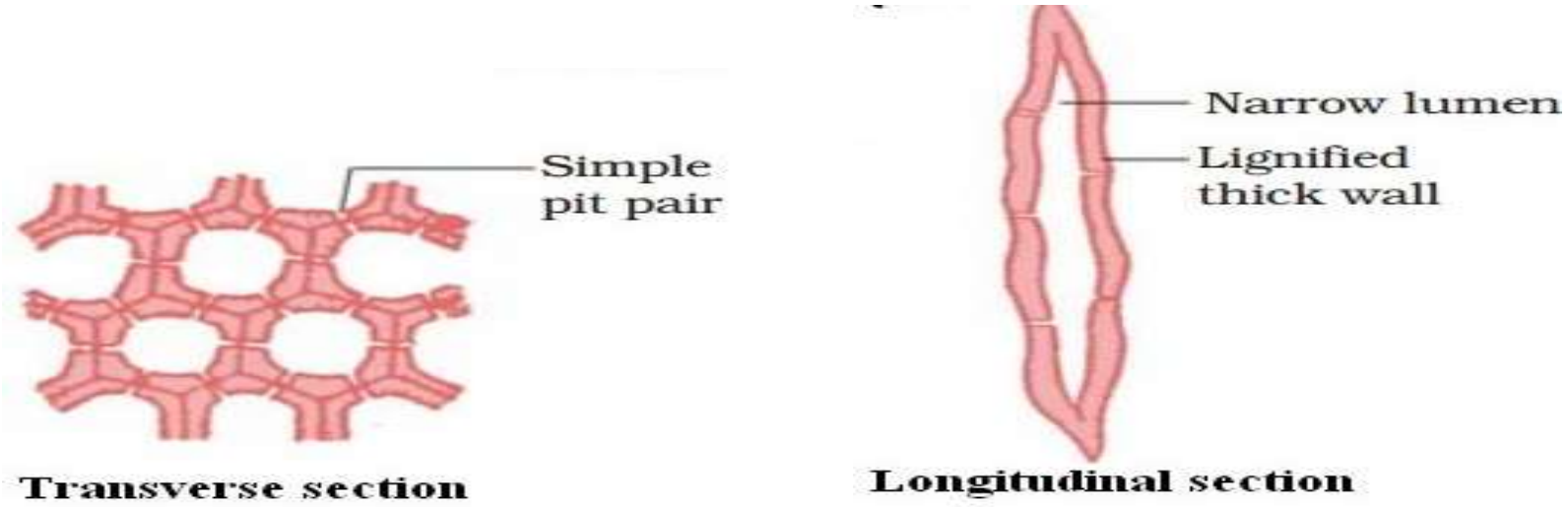
# Sclerenchyma

- Tissue responsible for stiffness in plant
- Long, narrow & dead cells
- Thickened cell walls made of cellulose impregned with Lignin
- Simple pits are present in thickened cell walls
- No intercellular spaces
- 2 forms of sclerenchyma:
  - Sclereids
  - Fibres

# Sclereids

- spherical / cylindrical in shape
- Highly thickened dead cell
- Narrow lumen
- Found in fruits & seeds

# Fibres




- Elongated needle-shaped with pointed tips
- Thick-walled cells
- Narrow lumen

# Where are they found?

- Hard covering of seeds & nuts
- Veins of leaves
- Stems around vascular bundles

Functions

- Provide strength to plant parts
- Provide mechanical support

# Parenchyma vs. Collenchyma vs. Sclerenchyma

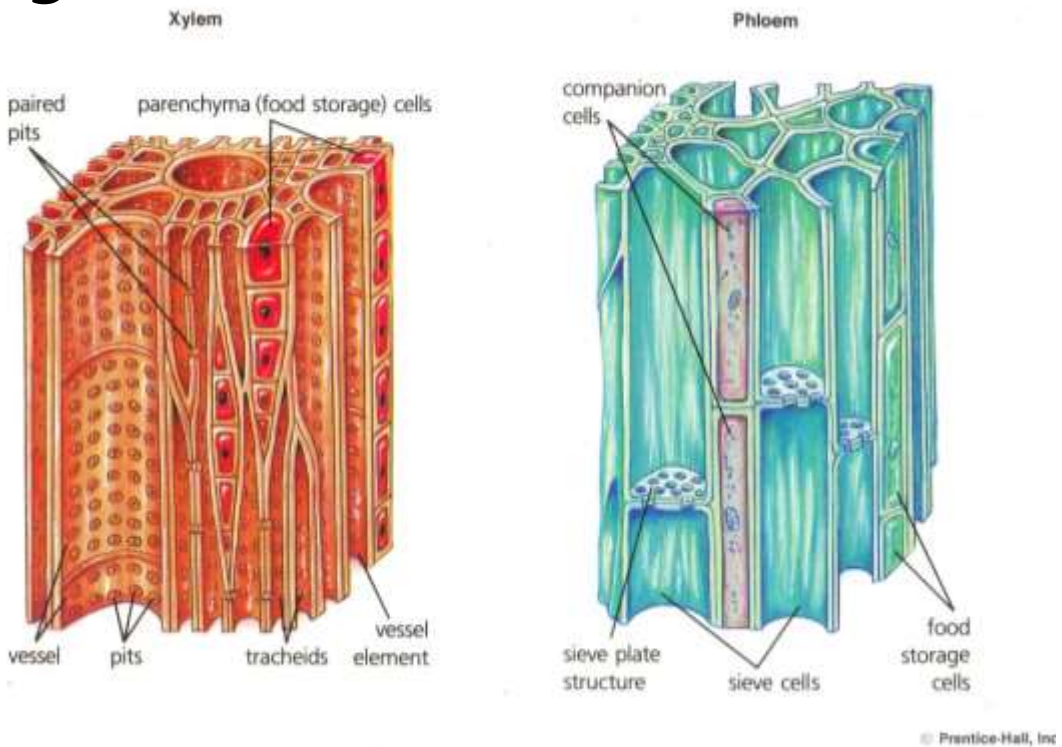
| | Parenchyma | Collenchyma | Sclerenchyma |
|---|---|---|---|
| Cells | Living | Living | Dead on maturity |
| Intercellular spaces | Less | Lesser | Absent |
| Cell walls | Thin | Irregularly thickened at corners | Thickened with lignin |
| Function | Packing tissue<br>Photosynthesis in leaves & storage of food | Flexibility | Stiffness<br>Support & protection |

# Complex permanent tissue

- Tissue made up of many type of cells
- Cells co-ordinate to perform a specific / common function
- E.g
  xylem
  phloem

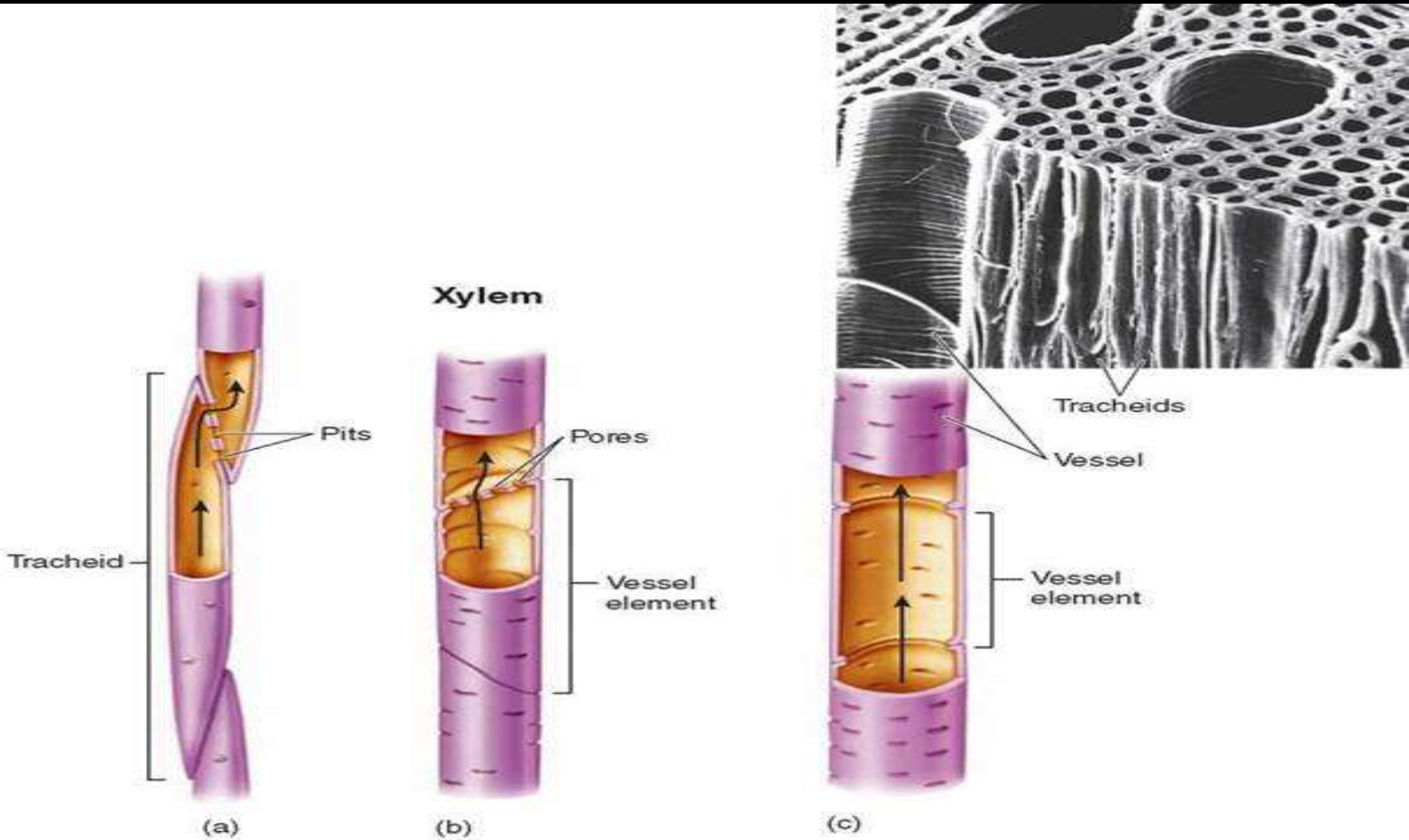
# Complex permanent tissue

- Xylem and phloem together constitute **vascular bundle**
- Conducting tissues



# XYLEM

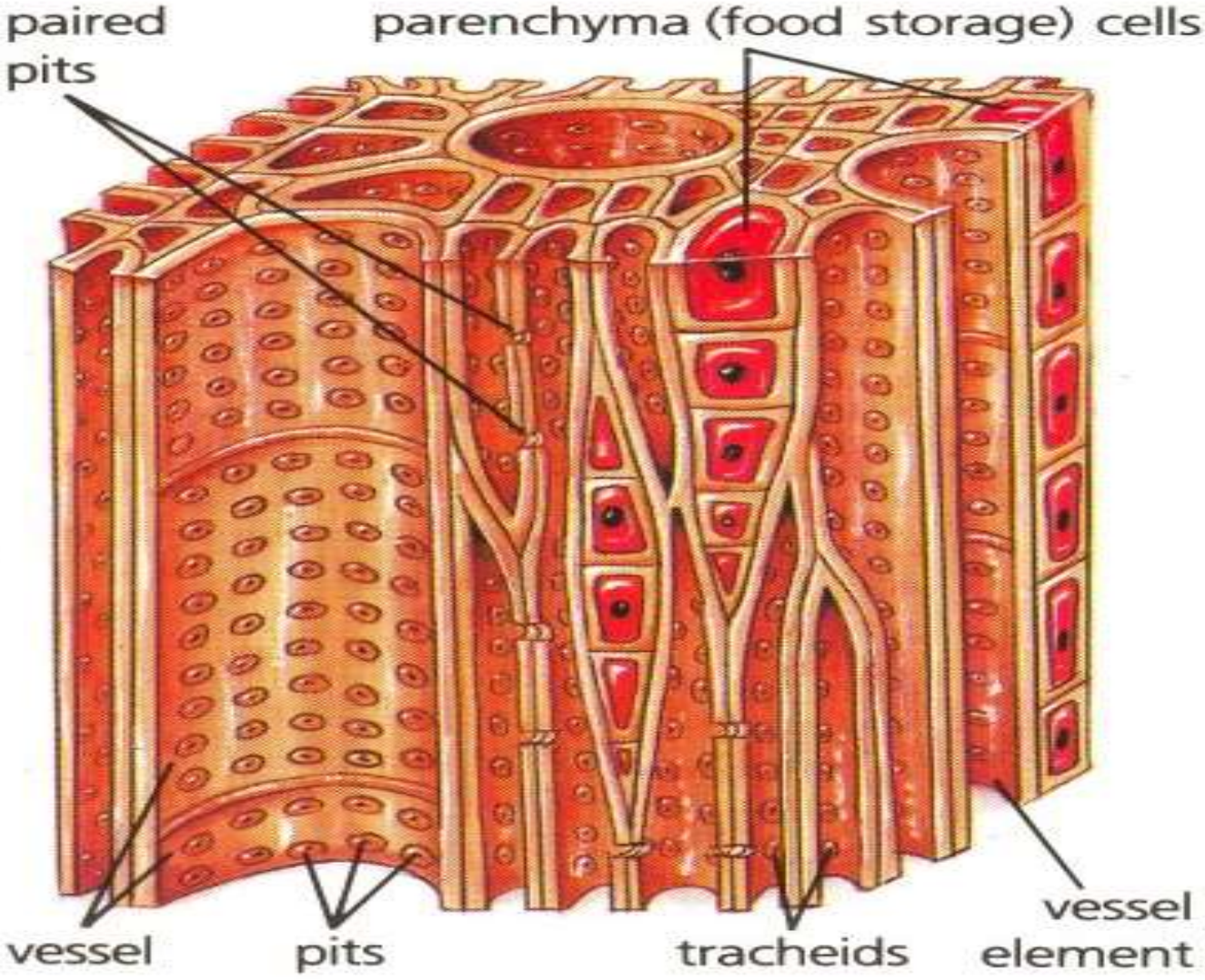
- Mostly dead cells
- Conducting water and minerals from roots to stem & leaves
- Elements is made up of:
  1. Tracheids
  2. Vessels
  3. xylem parenchyma
  4. xylem fibres


Xylem
Pits
Tracheid
Pores
Vessel element
Tracheids
Vessel
Vessel element
(a)
(b)
(c)

# XYLEM

- TRACHEIDS
  - tubular structures
  - conduct water & minerals vertically
  - Dead cells without protoplasm
- VESSELS
  - Tubular cells with tapering ends
  - lignified walls without protoplasm
  - perforation present
  - gymnosperms lack vessels

# Xylem


paired pits
parenchyma (food storage) cells
vessel
pits
tracheids
vessel element

# XYLEM

- XYLEM PARENCHYMA
  - Thin walled living cells
  - store food
  - conduct water sideways
- XYLEM FIBRES
  - Support
  - dead cells

# PROTO- & META-XYLEM

- PROTOXYLEM
  - first formed primary xylem
  - smaller lumen

- METAXYLEM
  - later formed primary xylem
  - larger lumen

- Arrangements:

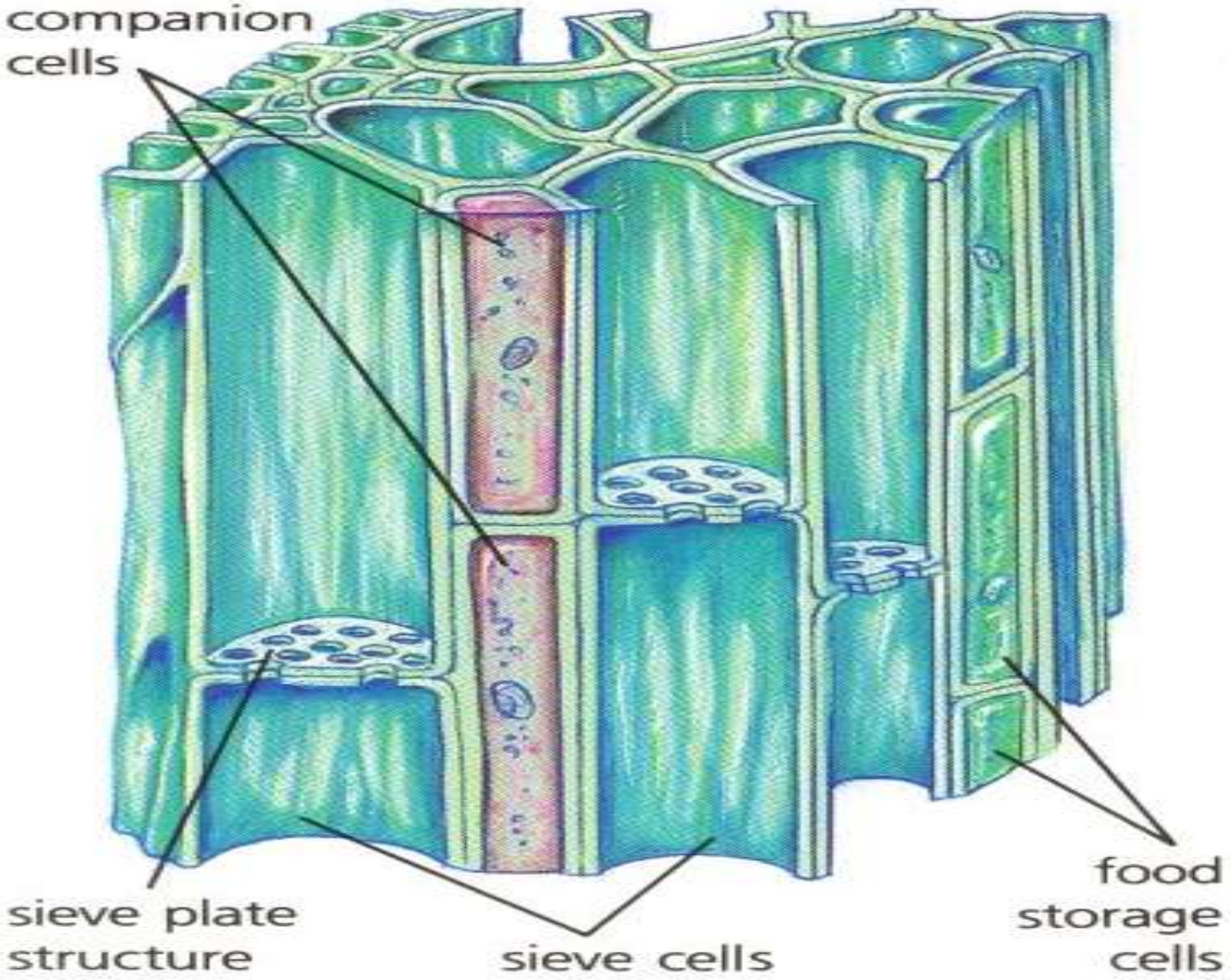
  - Endarch = protoxylem inside the metaxylem

  - Exarch = protoxylem outside the metaxylem

# PHLOEM

- Transport food materials from leaves to other plant parts
- Living cells except phloem fibres
- Elements it is made up of:
  1. Sieve tubes
  2. Companion cells
  3. Phloem parenchyma
  4. phloem  fibres

# Phloem



# PHLOEM

- SIEVE TUBES

  -Tubular cells with perforated walls

  - Sieve tube elements:

    - large vacuole
    - no nucleus
    - peripheral cytoplasm
    - fusion of sieve cells called **syncystes**

- COMPANION CELLS
  - Specialized parenchyma cells
  - regulates metabolic activities of sieve tube element
  - no campanion cells in gymnosperms (albuminous cells)

- PHLOEM PARENCHYMA
  - elongated cylindrical
  - support sieve tubes & also stores like starch
  - absent in most monocot

# PHLOEM

- PHLOEM FIBRES
  - Sclerenchymatous dead cells
  - extremely thick cell wall
  - gives mechanical support

# Proto- & meta-phloem

- Protophloem
  - first formed primary phloem
  - narrow sieve tubes

- Meta xylem
  - later formed primary phloem
  - bigger sieve tubes

# Xylem vs. Phloem

| Xylem | Phloem |
| --- | --- |
| Unidirectional transport | Bidirectional transport |
| Transport water & minerals from roots to aerial plant parts | Transport food & nutrients from leaves to different plant parts |
| Dead tissues at maturity | Living tissues |
| Occurs at centre of vascular bundle | Occurs on outer side of vascular bundle |

# Simple tissue vs complex tissue

## Simple tissue

- Only one type of cell
- Occur in all part of plant
- Perform variety of fucntion
- Parenchyma, collenchyma & sclerenchyma

## Complex tissue

- Different type of cells
- Occur in vascular region
- Mainly perform conduction
- Xylem, phloem

# Plant tissue system: Types

- Based on function:

1. epidermal tissue system

2. ground tissue system

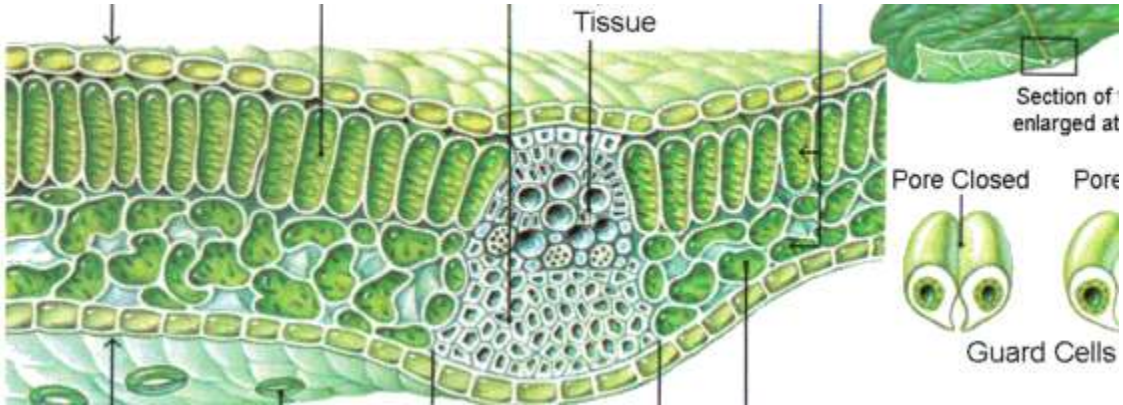
3. vascular tissue system

# EPIDERMAL TISSUE SYSTEM

- Outermost covering of plant body
- Ensure protection
- Components:
  1. epidermis
  2. stomata
  3. epidermal appendages (trichomes & hairs)

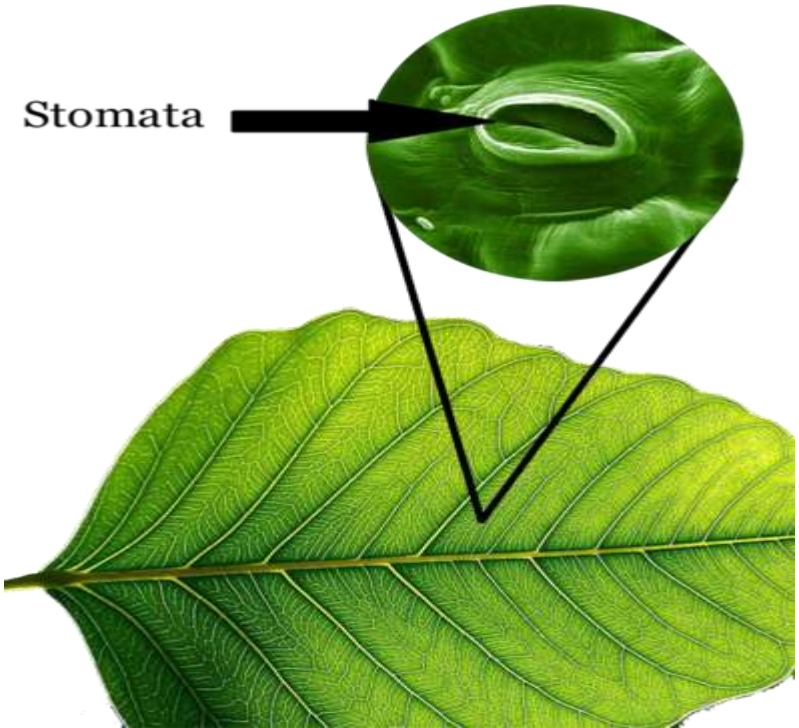
# EPIDERMIS

- Single continuous layer of compactly arranged cells.
- Prevent water loss
- Cells are parenchymatous
- Large vacuole with less cytoplasm
- Cuticle, a waxy thick outer layer is present

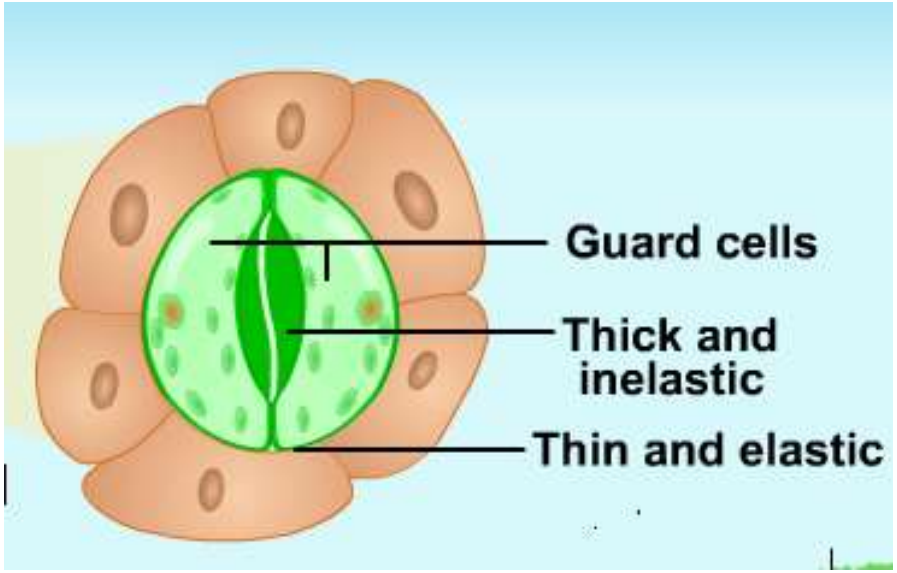


# STOMATA

- Pores present on the surface of the leaves
- Regulate the exchange of gases & water vapor between external  air & interior of the leaf



# Structure of stomatal apparatus




- Pore is surrounded by a pair of kidney shaped cells, **Guard cells**
- Outer thin wall inner thick wall
- Control opening & closing stomata

# EPIDERMAL APPENDAGES

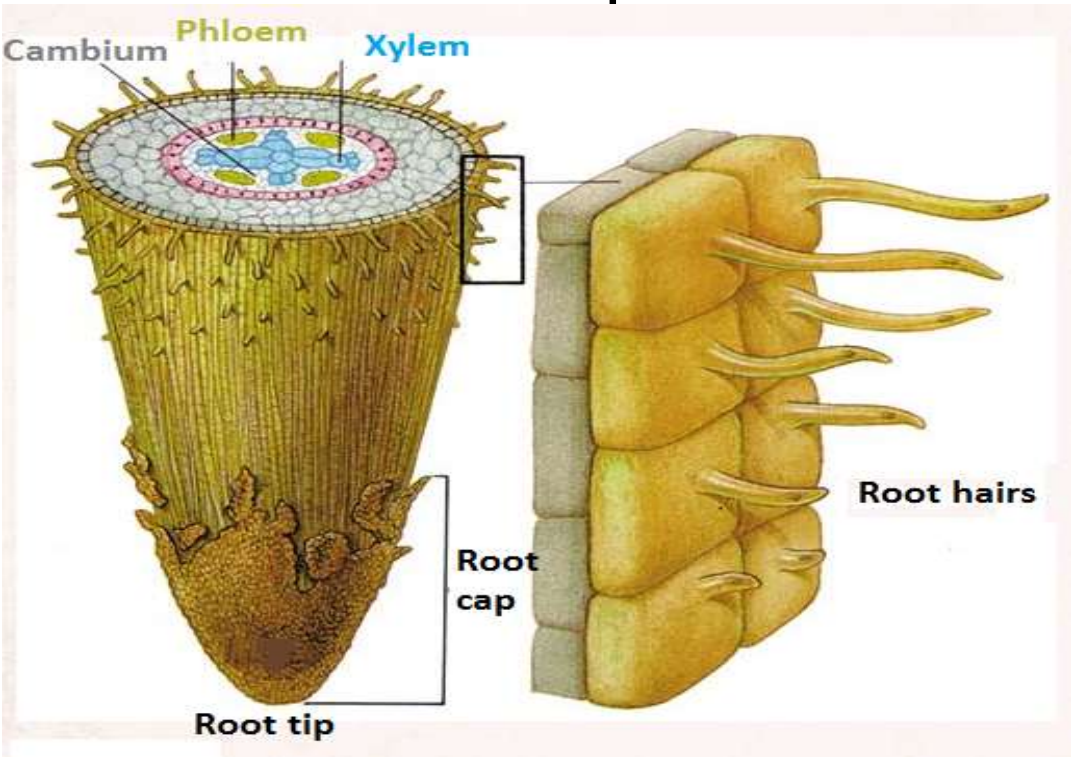
- Outer growth from epidermal cells
- Epidermal hairs

  - root hairs

  - trichomes

# Roots hairs

- Unicellular elongation of the epidermal epidermal cell in roots
- Help in water & minerals absorption from soil



# trichomes

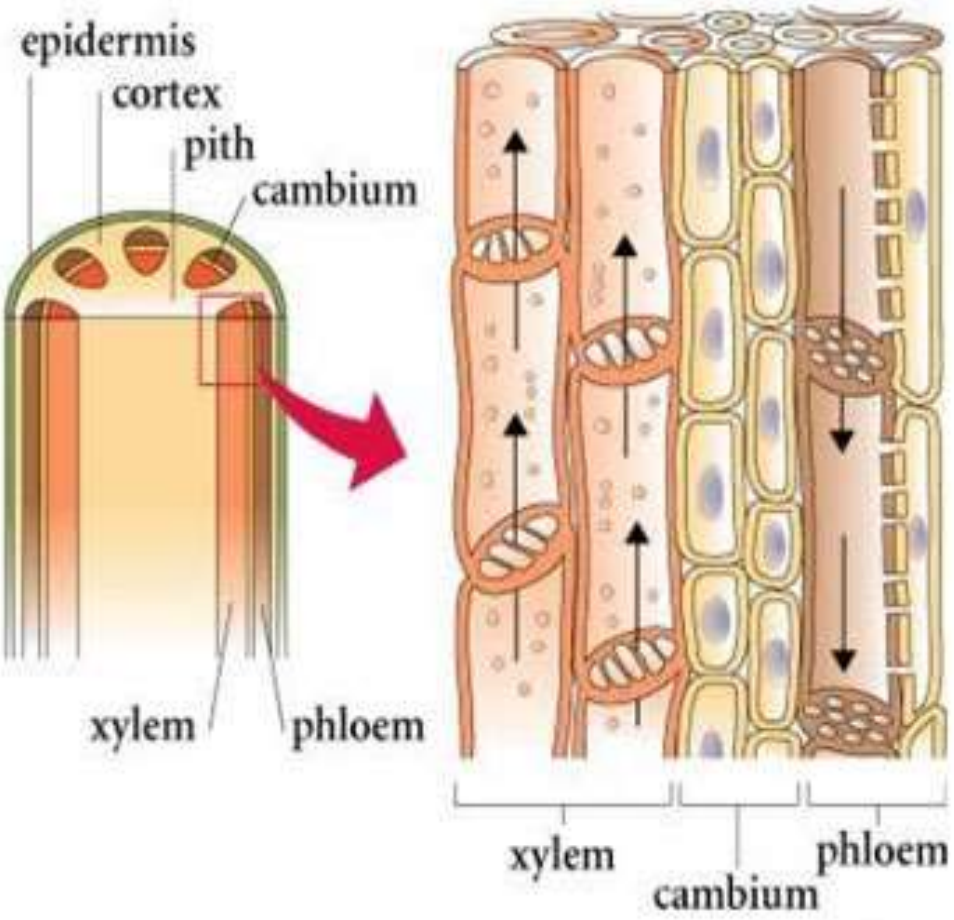
- Multicellular elongation of epidermis cell in shoot system
- Help in preventing waterloss

# Ground tissue system

- All tissue that are **neither dermal nor vascular**
- Parenchyma
- Collenchyma
- sclerenchyma

# VASCULAR TISSUE SYSTEM

- Xylem and phloem together constitute **vascular bundle**
- Conducting tissues


epidermis
cortex
pith
cambium
xylem
phloem
xylem
cambium
phloem

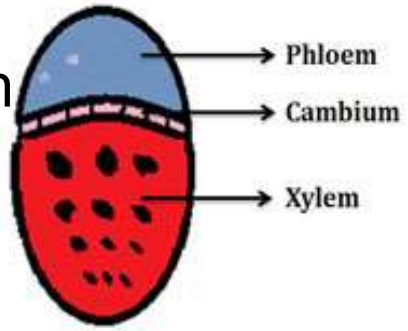
# VASCULAR TISSUE SYSTEM

- **Open vascular bundles**

  - cambium is present between xylem & phloem

  - secondary xylem & phloem tissue are formed

  - seen in dicot stems



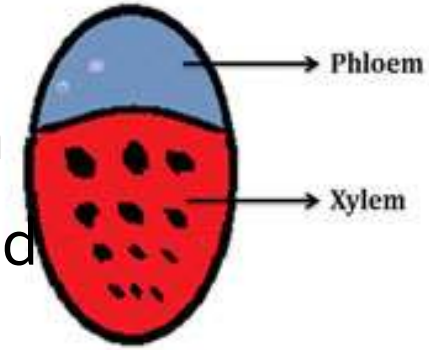
Open Vascular Bundle

- **Closed vascular bundles**

- cambium is absent between xylem & phloem

- secondary xylem & phloem tissue are formed

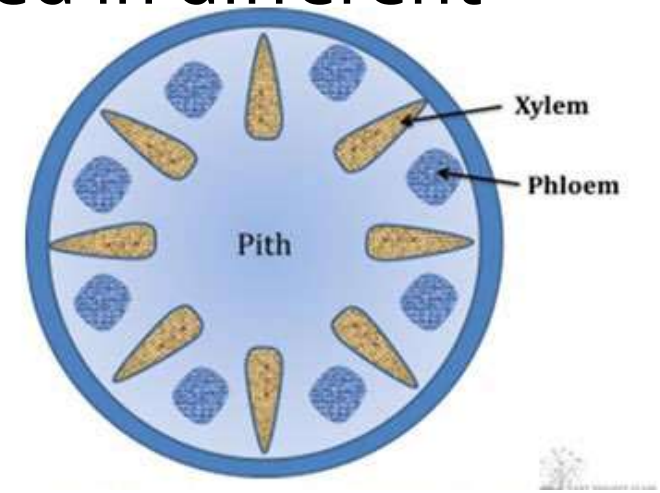
- seen in monocot stems



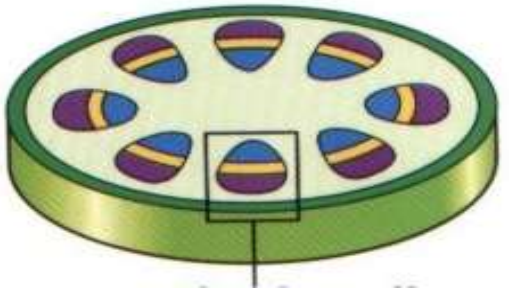
Closed Vascular Bundle

# Radial & conjoint vascular bundles

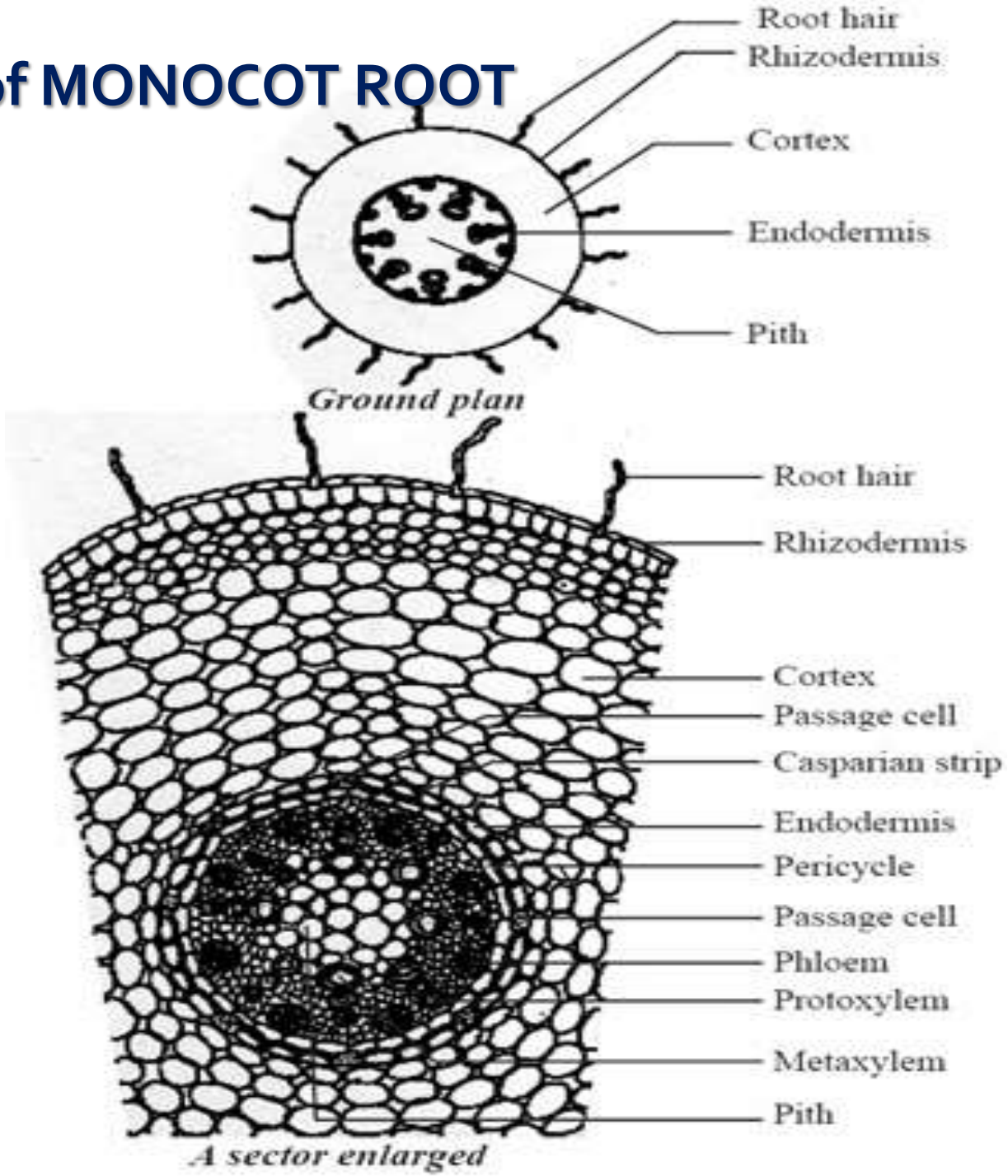
- Radial vascular bundles
  - xylem & phloem are arranged in different radii
  - Seen in roots




- conjoint vascular bundles
  - xylem & phloem are arranged in same radii
  - Seen in leaves and stems



# T.S of MONOCOT ROOT



# MONOCOT ROOT

- **Epidermis**
- **Cordex**
- **Parenchyma cells**

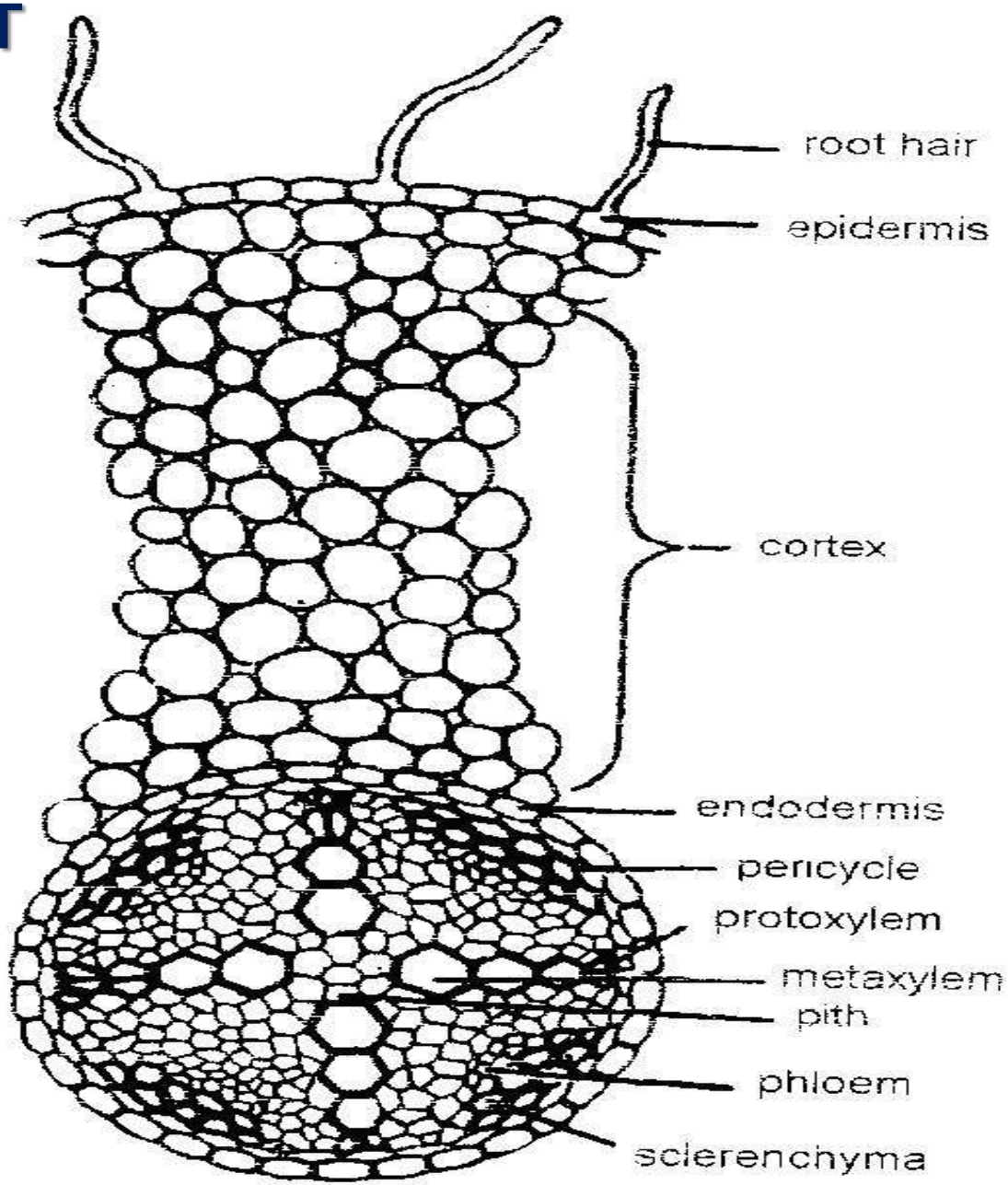
  - thin walled with intercellular spaces
- **Endodermis**

  - no intercellular spaces
- **Casparian strips**

  - waxy layer prevents water leakage
- **Pericycle**

  - few layers of thick walled parenchyma cells
- **Vascular cylinder**

# T.S of DICOT ROOT



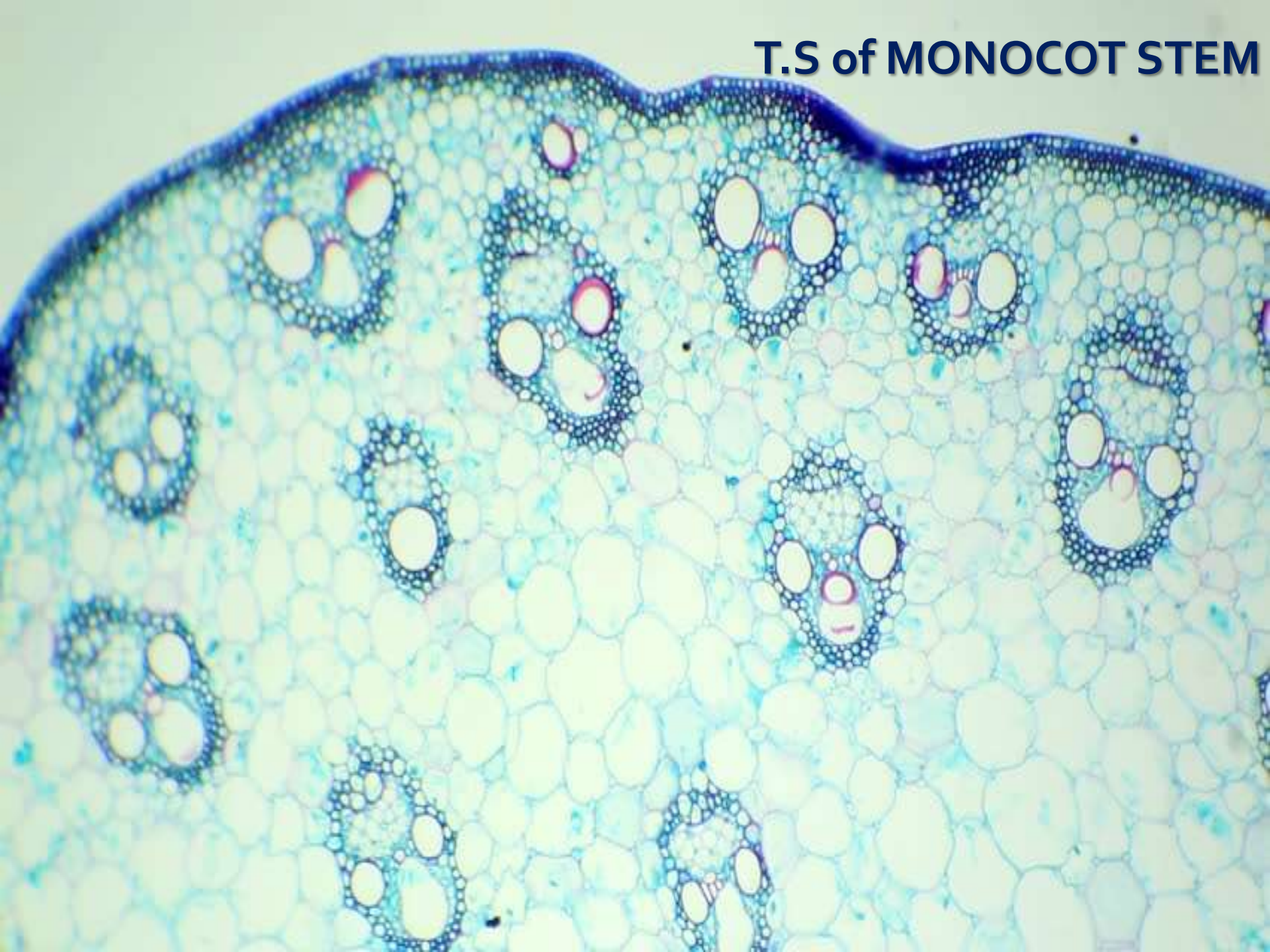
# DICOT ROOT

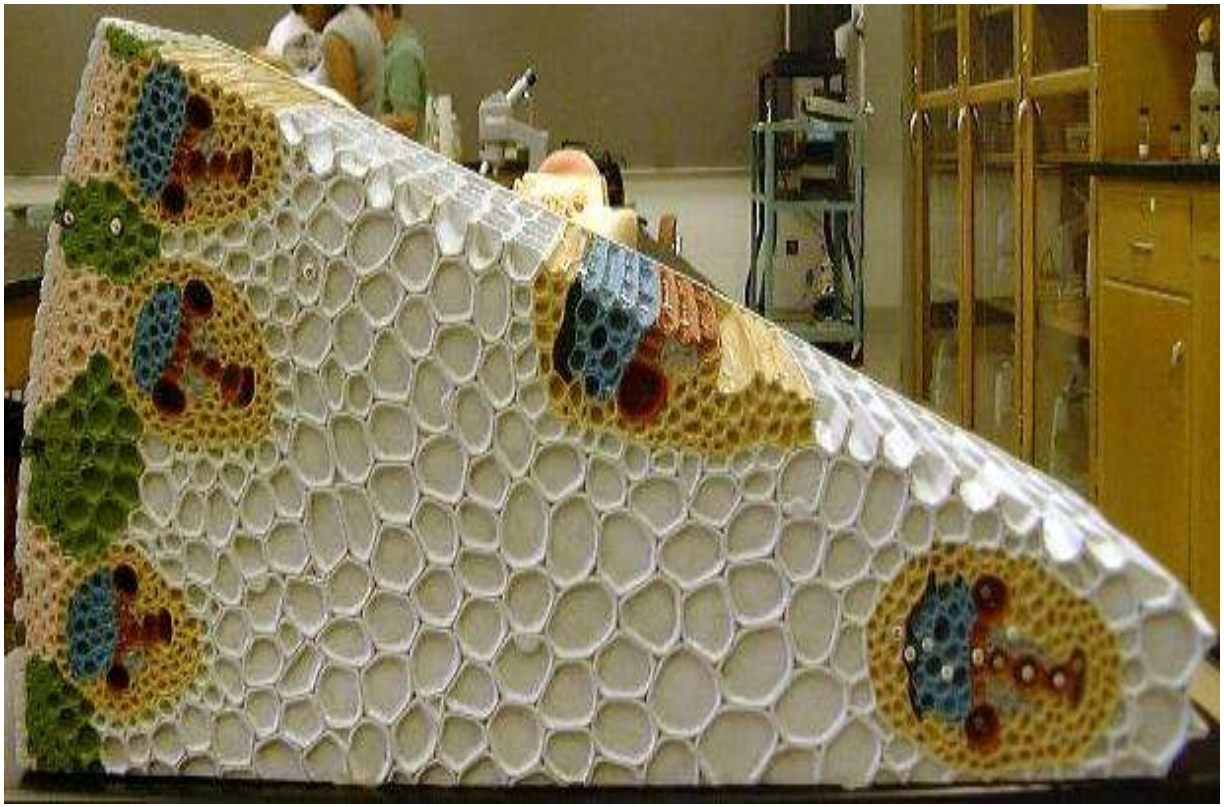
- **Epidermis**
- **Cordex**
- **Parenchyma cells**
  - thin walled with intercellular spaces
- **Endodermis**
  - no intercellular spaces
- **Casparian strips**
  - waxy layer prevents water leakage
- **Pericycle**
  - few layers of thick walled parenchyma cells
  - secondary growth initiates in these cells
- **Pith**
- - smaller when compared to monocot root
- **Vascular cylinder**
- **Conjunctive tissues**
  - parenchymatous tissue between xylem & phloem

# Monocot root vs dicot root

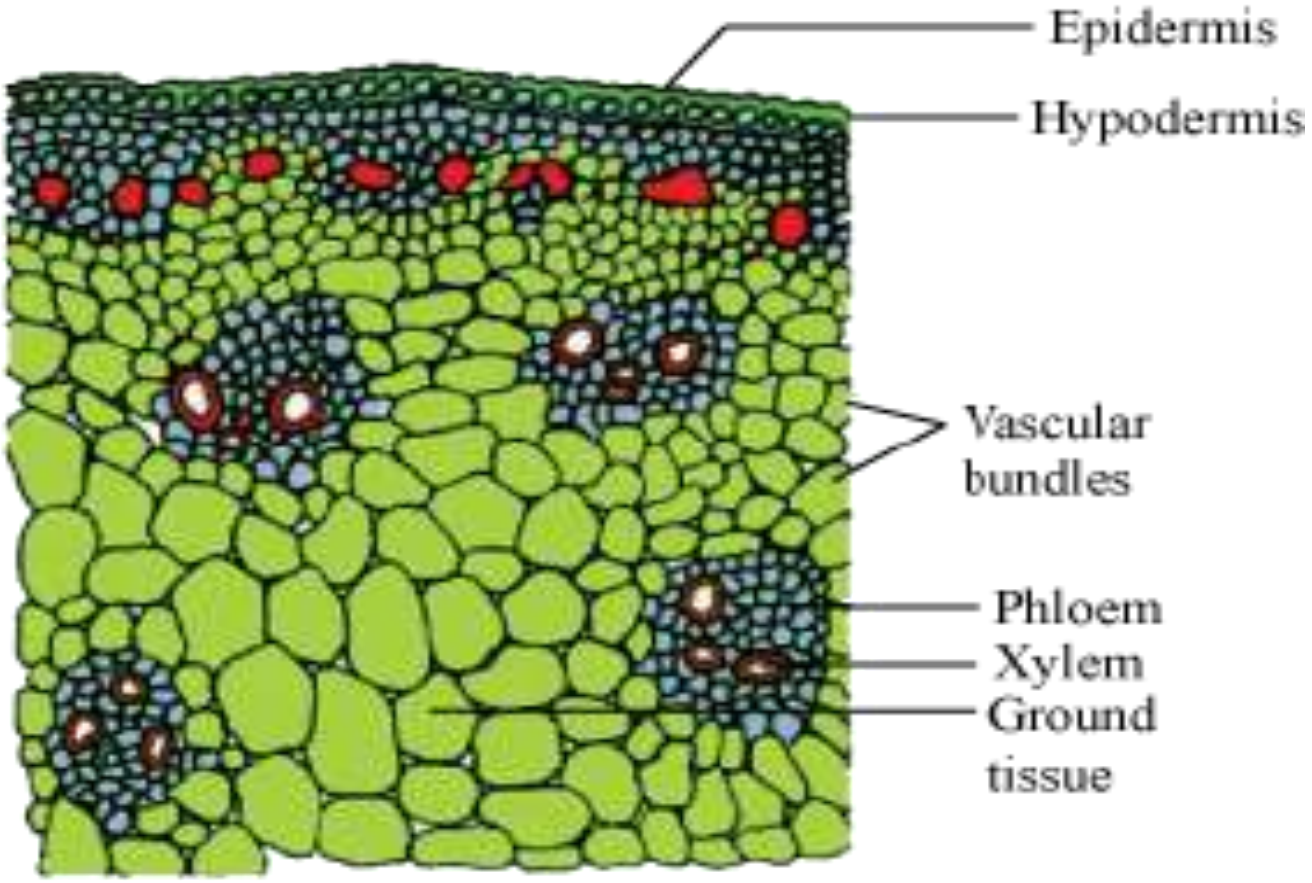
| MONOCOT | DICOT |
| --- | --- |
| Pith is well developed and large | Pith is smaller |
| More xylem bundles | Fewer xylem bundles |
| No sec. growth occur | Sec. growth occur |
| Conjunctive tissue are mostly sclerenchymatous | Conjunctive tissue are mostly parenchymatous |

# T.S of MONOCOT STEM





# T.S of MONOCOT STEM



# MONOCOT STEM

- **Epidermis**
- **Hypodermis**
  - sclerenchymatous cell
- **Vascular bundles**
  - scattered, conjoint, closed
  - surrounded by sclrenchymatous bundle sheath
- **Parenchymatous ground tissue**

# T.S of DICOT STEM

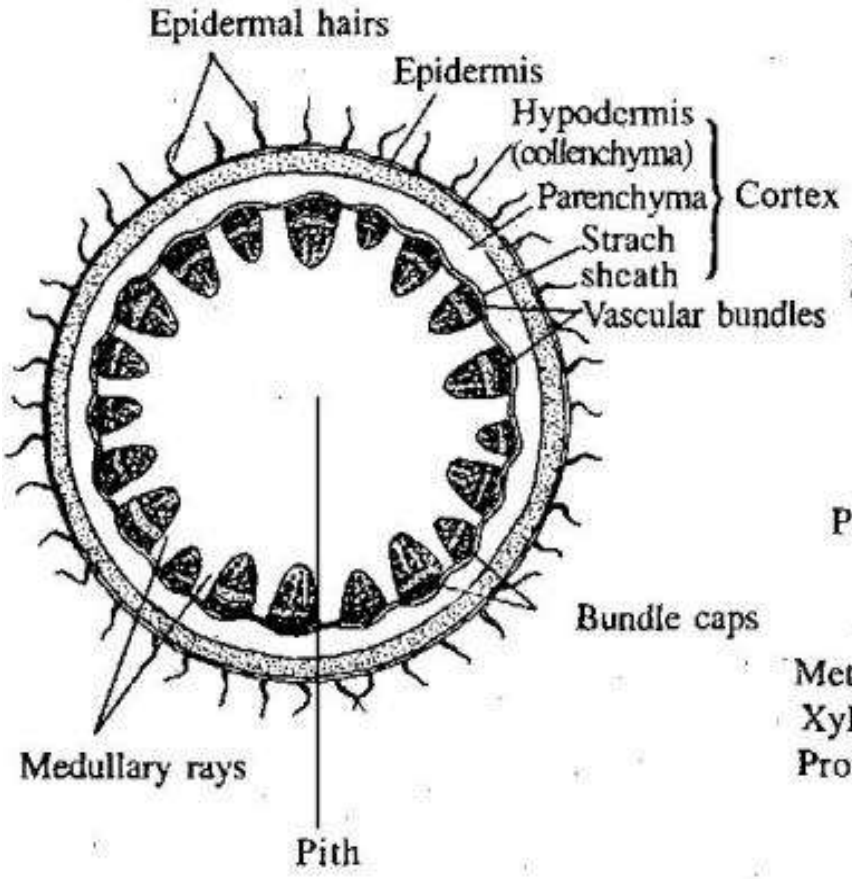



**Fig. 3.5.1 :** T.S. of young dicot stem (Sunflower) ground plan

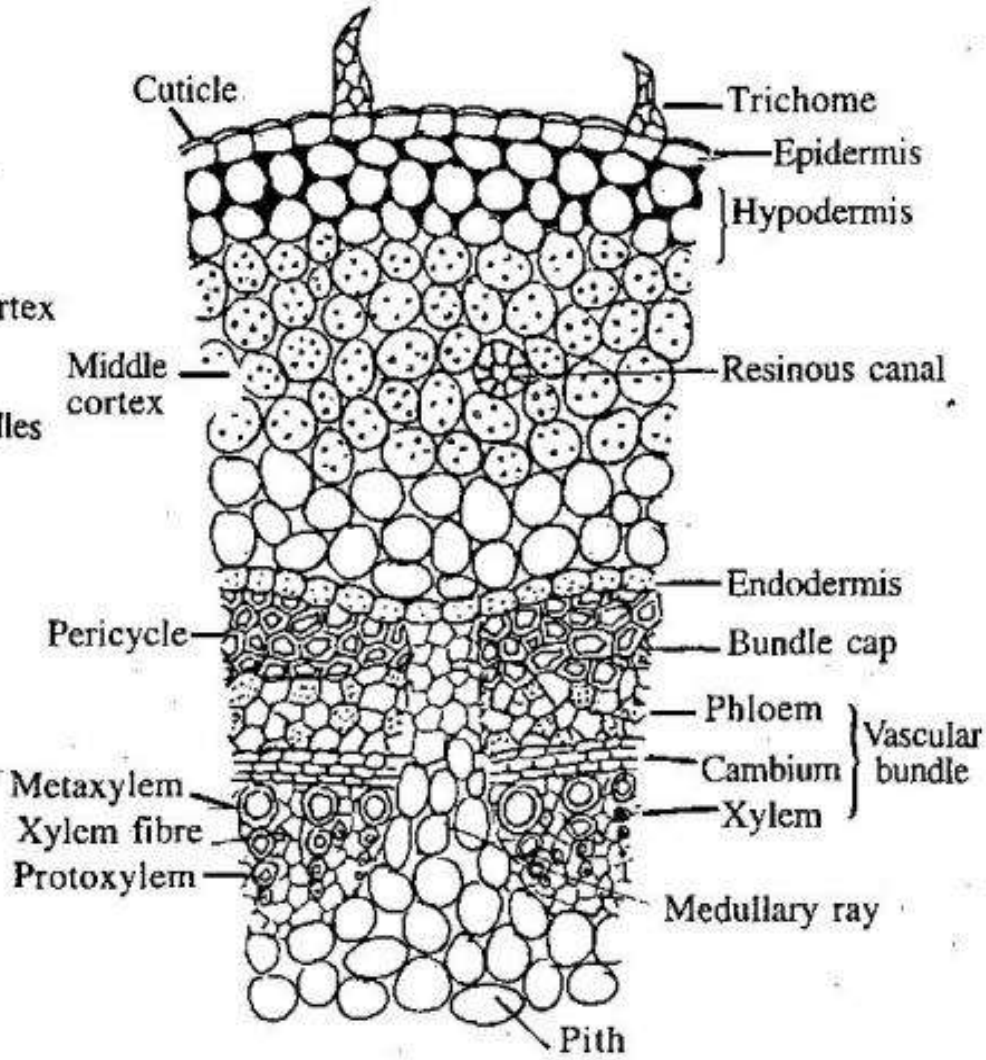



**Fig. 3.5.2 :** T.S. of young dicot stem (Sunflower) - A sector enlarged

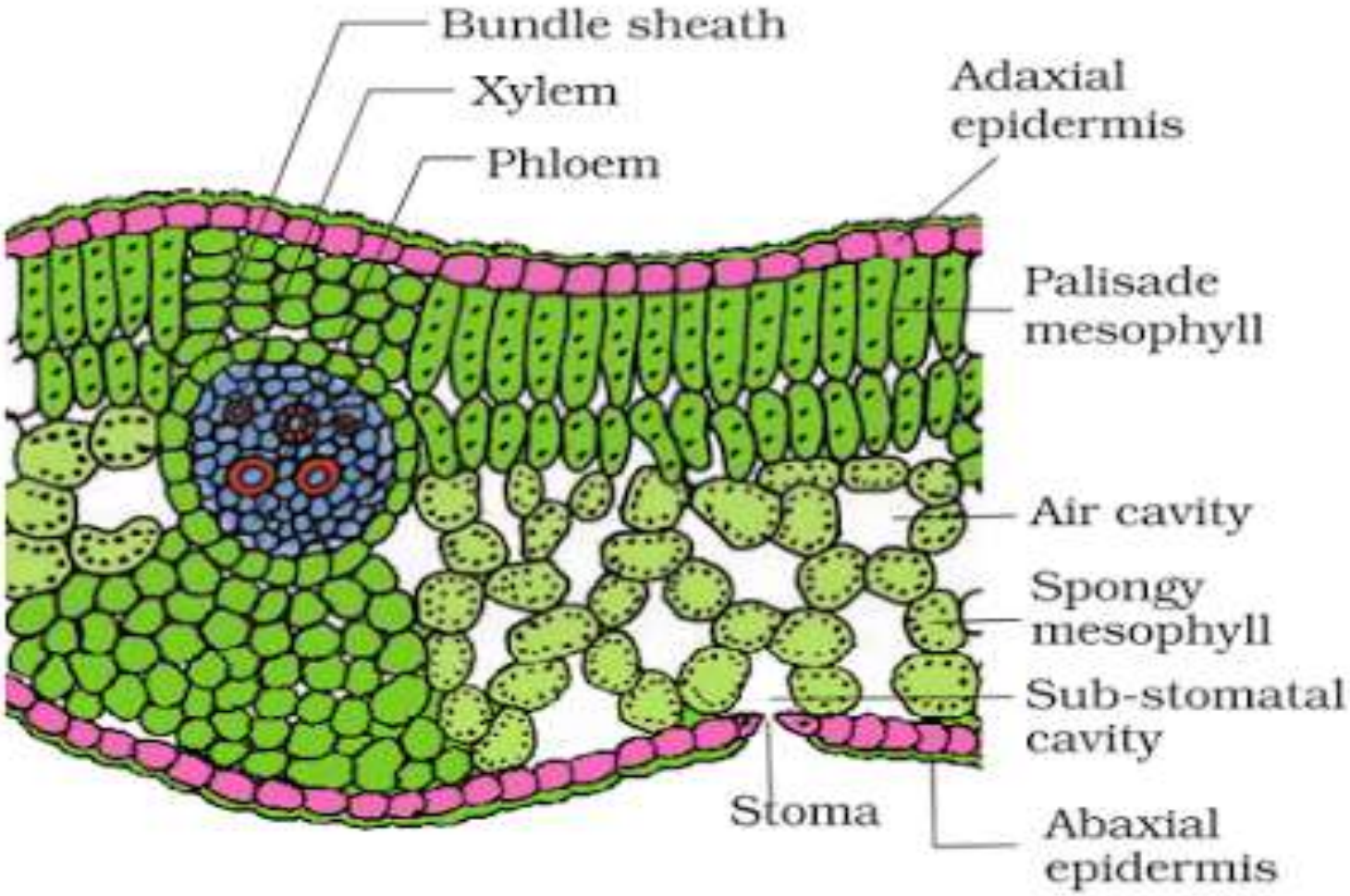
# DICOT STEM

- **Epidermis**
- **Hypodermis**
  - collenchyma cells to provide strength
- **Cortex**
- **Parenchyma cells**
  - Thin walled with intercellular spaces
- **Endodermis**
- **Pericycle**
  - patches of sclerenchyma cells
- **Vascular bundles**
  - conjoint, open
  - ring arrangement
  - vascular cambium is present

# Monocot stem vs. Dicot stem

| Monocot stem | Dicot stem |
|---|---|
| Epidermal hairs are absent | Epidermal hairs are present |
| Hypodermis is schlerenchymatous | Hypodermis is collenchymatous |
| Bundle sheath is present | Bundle sheath absent |
| Not much differentiation in Ground tissue | Well differentiated into hypodermis, cortex, endodermis, pericycle & pith |
| Vascular bundles are conjoint, closed | Vascular bundles are conjoint, open |
| Phloem parenchyma is absent | Phloem parenchyma is present |
| Secondary growth doesn't occur | Secondary growth occurs |

# T.S of DICOT LEAF



# DICOT LEAF

- Epidermis
  - adaxial epidermis: upper surface of leaf
  - abaxial epidermis: lowersurface of leaf
  - More stomata on abaxial epidermis
- Mesophyll
  - made up of parenchyma cells

  Palisade parenchyma
  - Elongated cells arranged parallel to each other

  Spongy parenchyma
  - round cells with large spaces & air cavities
- Vascular bundles
  - seen in vein & midrib
  - surrounded by thick walled bundle sheath cells

# A Typical Leaf

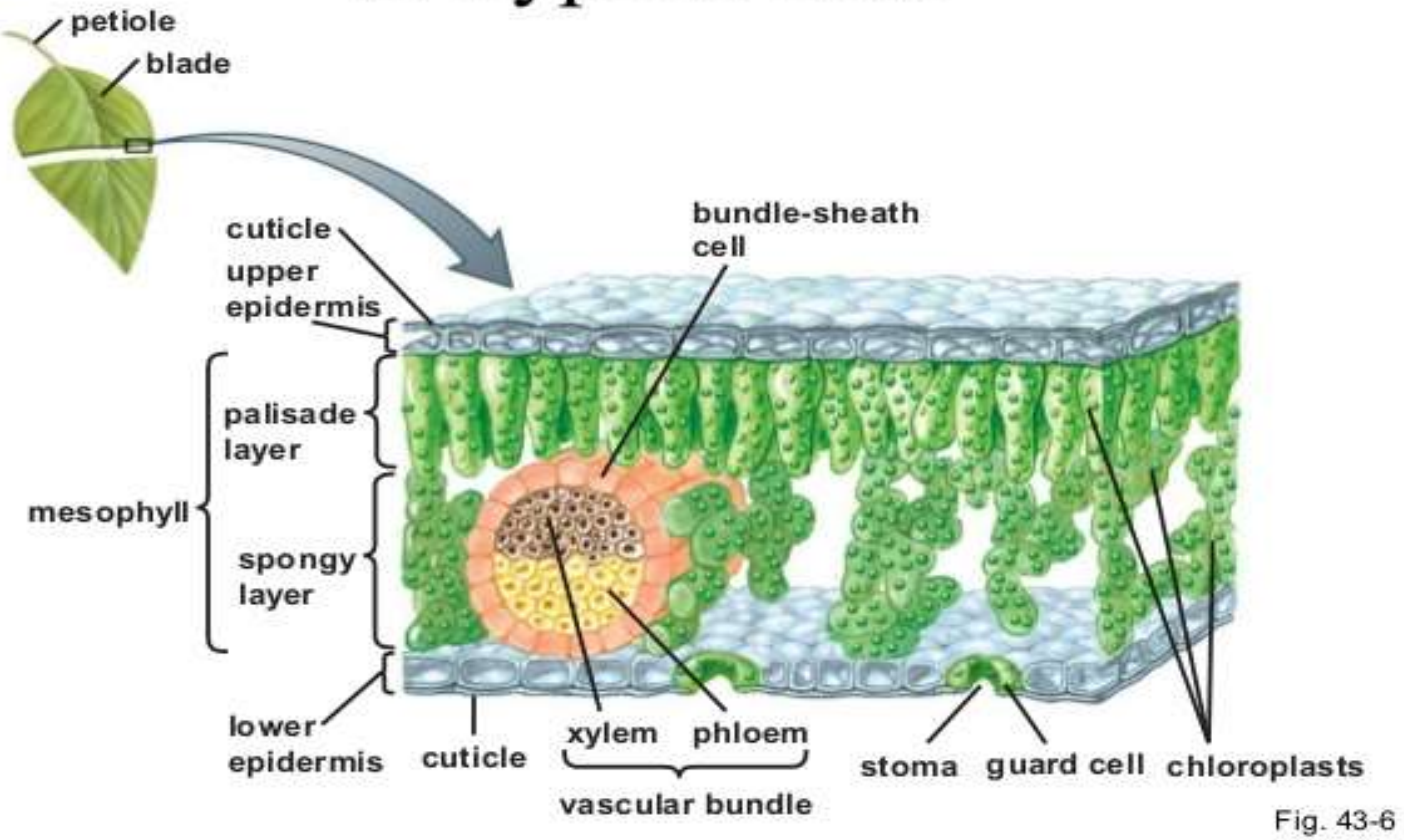
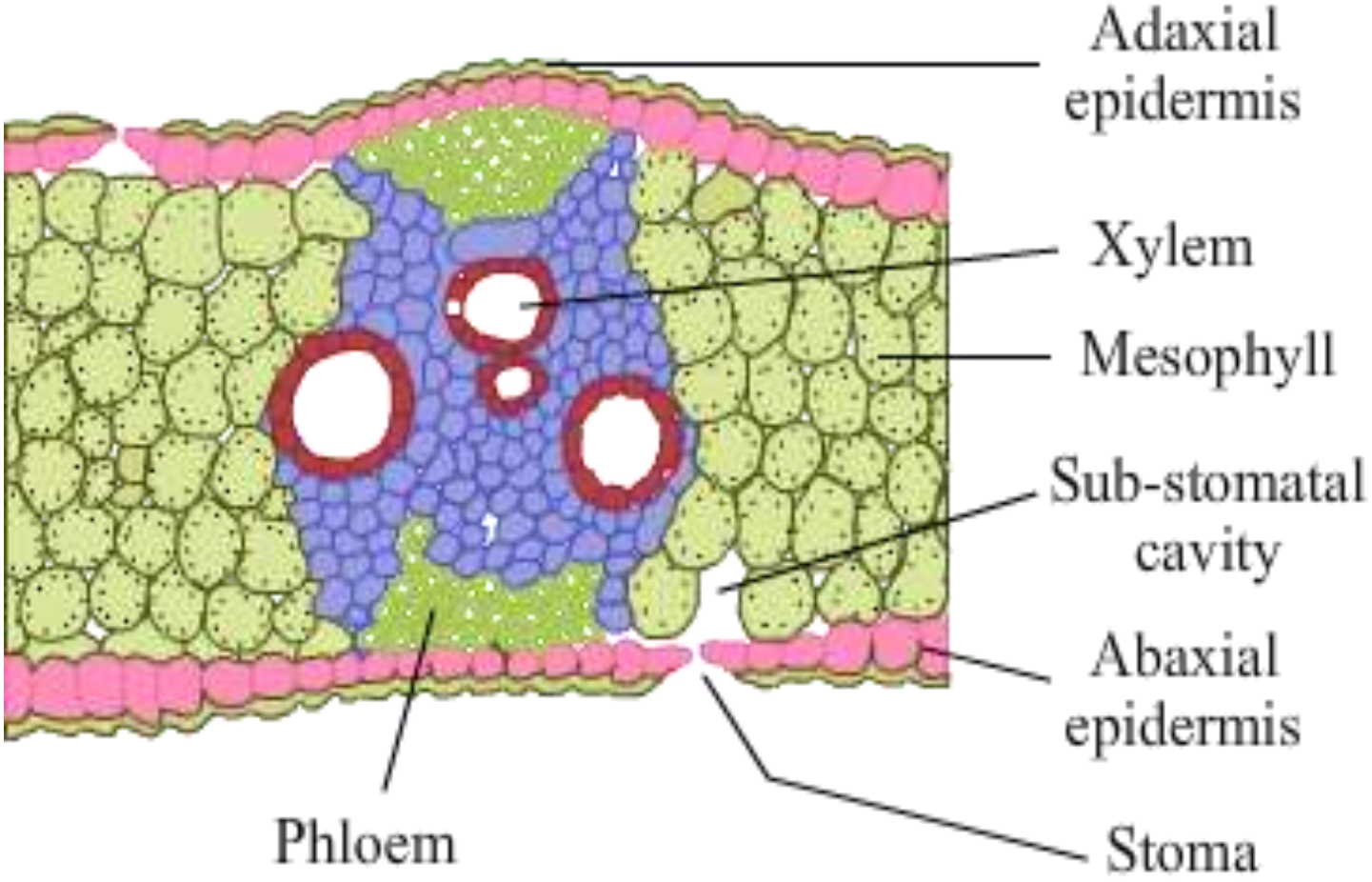



Fig. 43-6

# T.S of MONOCOT LEAF



# MONOCOT LEAF

- Epidermis
  - stomata on both adaxial & abaxial epidermis
- Mesophyll
  - not differentiated into palisade & spongy parenchyma
- Vascular bundle
  - seen in veins & midrib
  - surrounded by thick walled bundle sheath cells

# MONOCOT VS DICOT

| MONOCOT | DICOT |
| --- | --- |
| Stomata equally distributed on both upper & lower surfaces | Stomata on lower surface |
| Bulliform cells may be present on upper surface | Bulliform cells are absent |
| Mesophyll not differentiated | Mesophyll differentiated into palisade & spongy parenchyma |

# Secondary growth

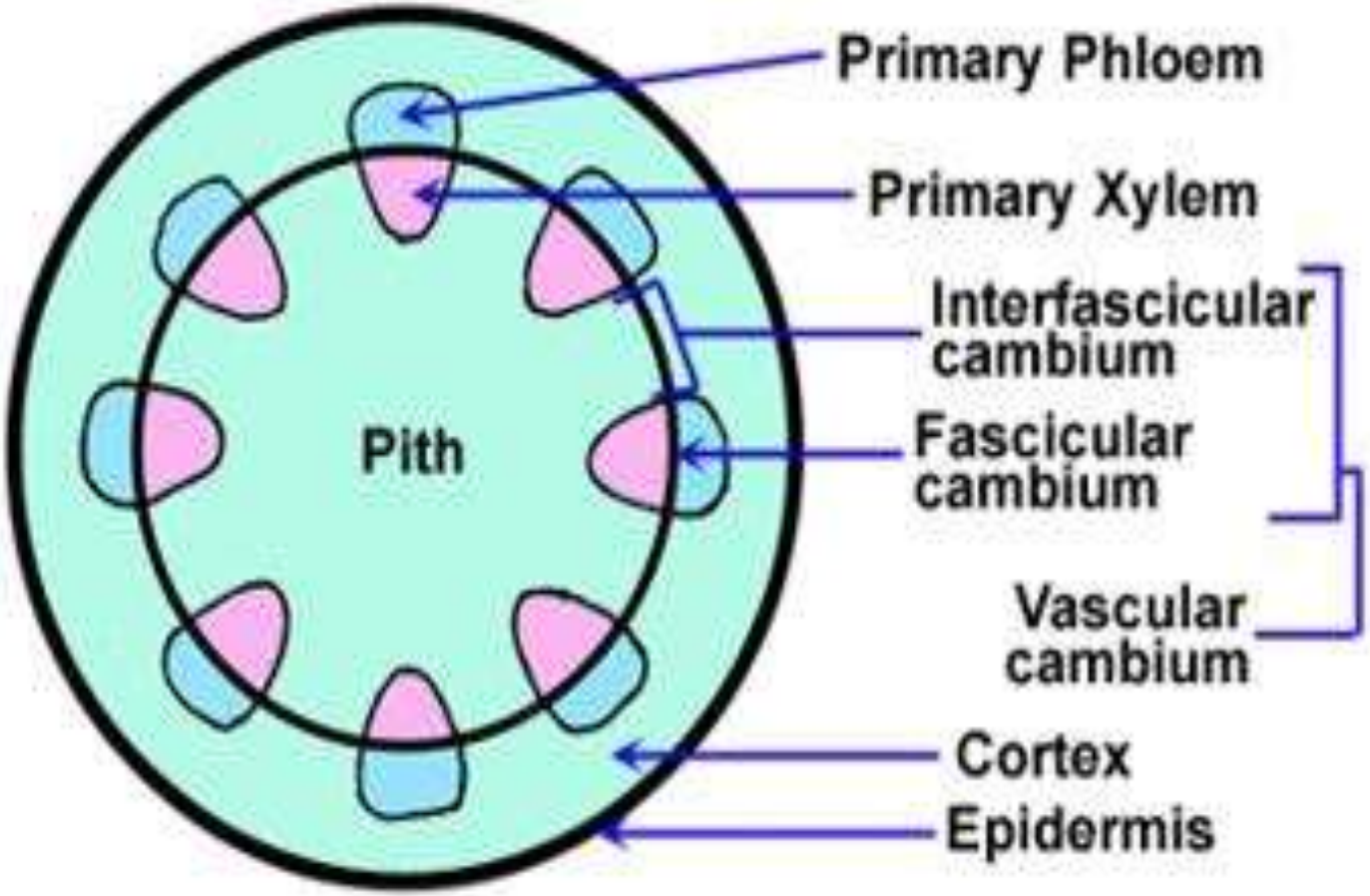
# Primary vs secondary

- Primary growth
  - growth of roots & stem lengthwise
  - apical meristems cause primary growth

- Secondary growth
  - growth of roots& stem girthwise
  - lateral meristems cause secondary growth

# Secondary growth

- Lateral meristem cause secondary growth
- Vascular cambium
- Cork cambium


Primary Phloem
Primary Xylem
Interfascicular cambium
Fascicular cambium
Vascular cambium
Pith
Cortex
Epidermis

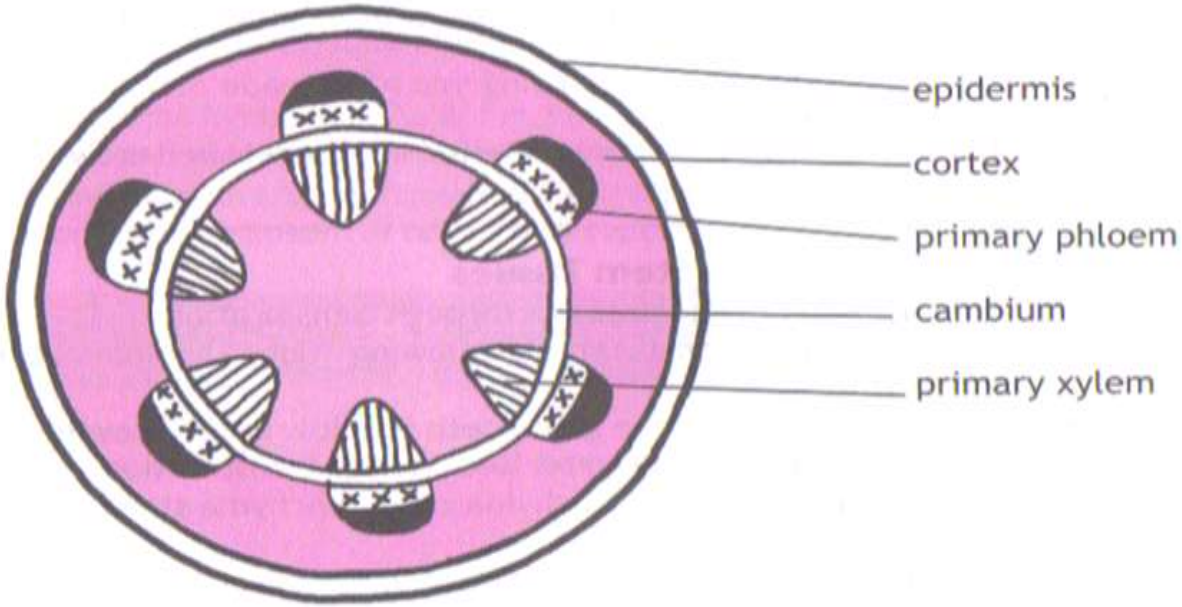
# Vascular cambium

- Meristematic layer
- Exists as a layer between primary xylem & primary phloem
  - **intrafascicular cambium**
    - cambium present between pri. xylem & pri. Phloem
  - **interfascicular cambium**
    - medullary cells, adjoining the intrafascicular cambium

# Vascular cambium

**Formation of cambial ring**

- a continuous ring of cambium



# Vascular cambium

- **Formation of Secondary phloem**

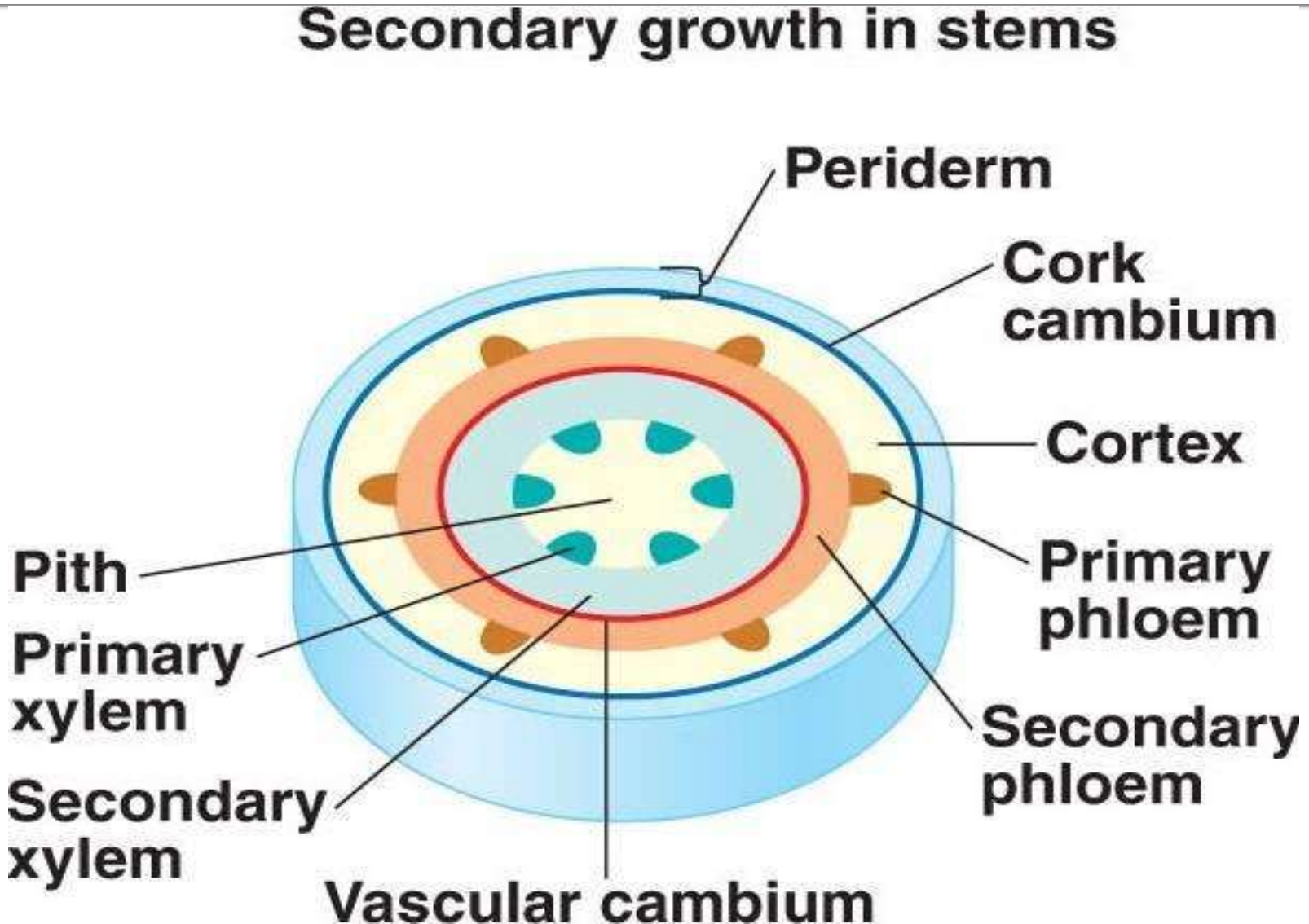
  - cells on the outer side of cambial ring differentiate into sec. phloem

- **Formation of Secondary xylem**

  - cells on the inner side of cambial ring differentiate into sec. xylem

  - sec. xylem produced more than sec. phloem

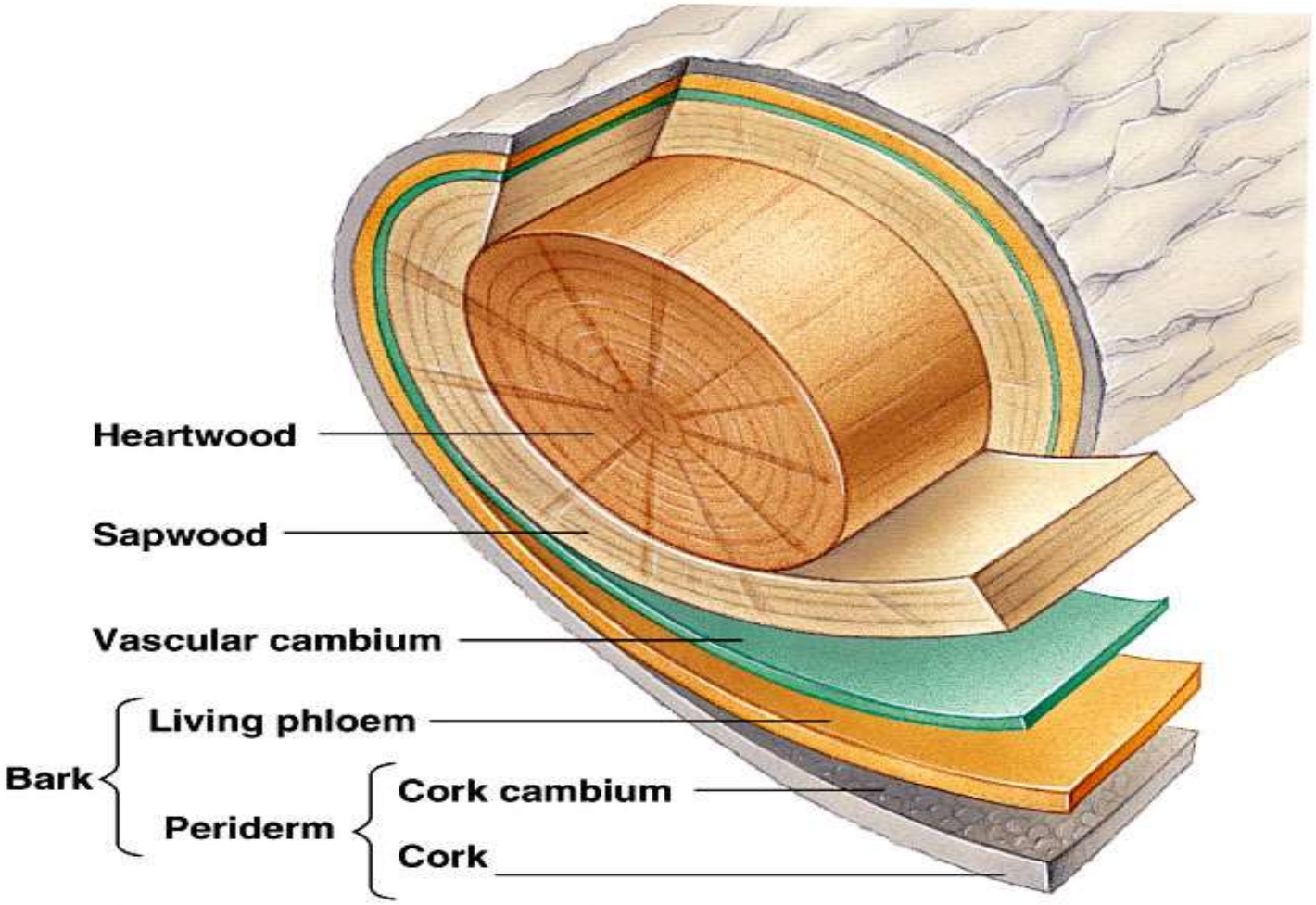
# CORK CAMBIUM



# Cork cambium

- A layer of meristematic tissue which develops around the cortex region

- Replace the broken epidermis during sec. growth
  - cells on the outer side differentiate to form cork
  - cells on the inner side give rise to sec. cortex



# Bark

- All tissues exterior to the vascular cambium, therefore including sec. phloem

- Cell layers constituting bark:
  - sec. phloem
  - periderm


Thank You !!

Interfascicular cambium develops from the cell of

a. Xylem parenchyma
b. Endodermis
c. Pericycle
d. Medullary rays

Lenticels are involved in

a. Gaseous exchange
b. Food transport
c. Photosynthesis
d. Transpiration

Casparian strips are present in the____ of the root

a. Epiblema
b. Cortex
c. Pericycle
d. endodermis

Which of the following pairs is an example for lateral meristem?

a. Phellogen and Phelloderm
b. Phellogen and fascicular cambium
c. Procambium and phelloderm
d. Interfascicular cambium and phellem

- Hydrophytes are characterized by

a. Presence of sclerenchyma
b. Presence of aerenchyma
c. Absence of aerenchyma
d. Presence of root nodules

- Which of the following is dead, but work efficinetly?

a. Sieve tube
b. Companion cells
c. Vessels
d. Both (b) and (c)

- Which of the following plant tissue provides mechanical strength to plants?

a. Parenchyma
b. Collenchyma
c. Sclerenchyma
d. Aerenchyma

- The age of tree by counting annual rings is called

a. Dendrochronology
b. Ageing
c. Chronology
d. Countrology

- Jute is mainly composed of

a. Xylem
b. Secondary bast fibre
c. Phloem
d. cortex

- Which one of the following is not a lateral meristem?

a. Intrafascicular cmbium
b. Interfascicular cambium
c. Phellogen
d. Intercalary meristem

- Cork tissue arises from

a. Periderm
b. Phellogen
c. Pelloderm
d. Phellum

- Cambium is most active in

a. Summer
b. Winter
c. Rainy season
d. Snow areas

- Meristematic tissues are

a. Premature having ability of division
b. Mature does not have ability of division
c. Premature not having ability of division
d. Complex differentiation in xylem, phloem and cambium