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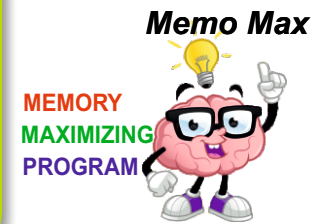
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UNIT  
**04**

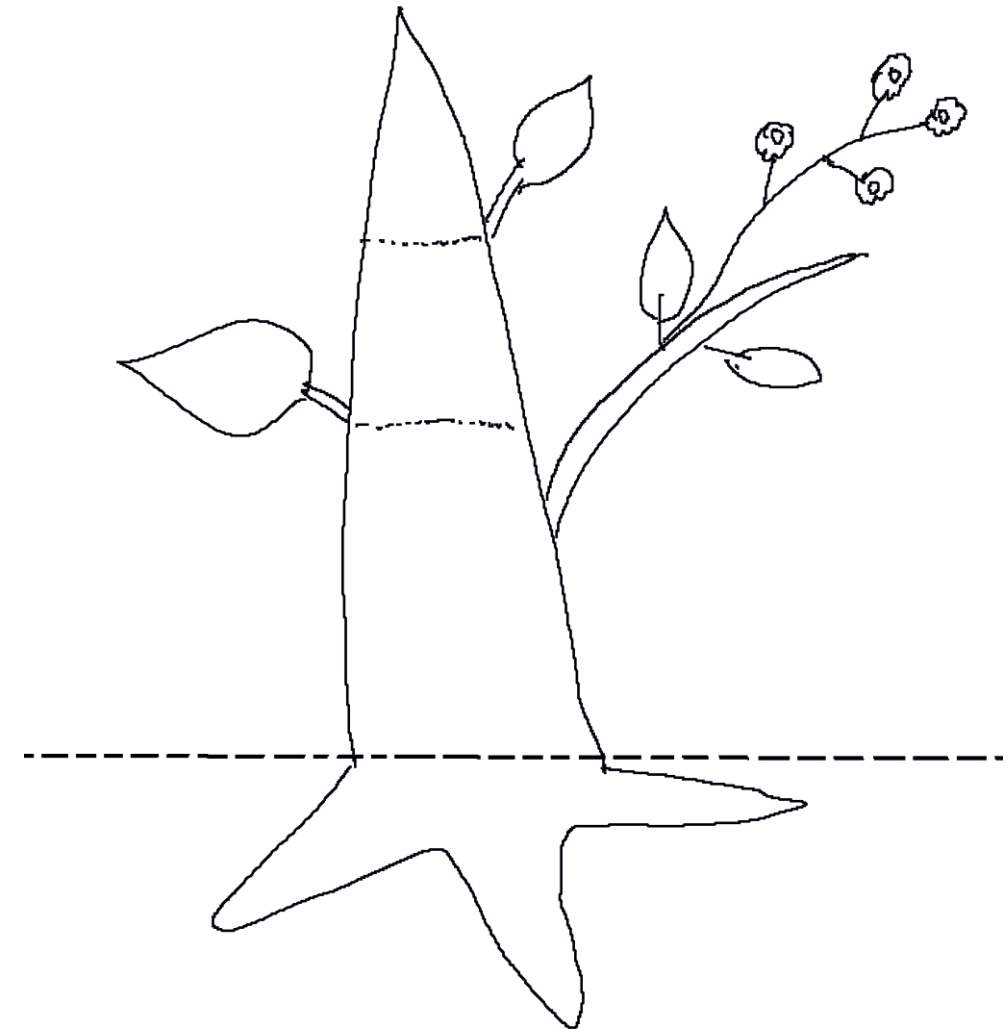
Plant form and Function  
4.0.1: Plant Tissues

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### 4.1.1. Structure, Growth and Development of Plants

The main focus of this unit is on structure, growth and development of vascular plants. Plants consist of a root system and a shoot system and roots and shoots grow at their tips, which are with meristematic properties and called as apices, buds or meristems.

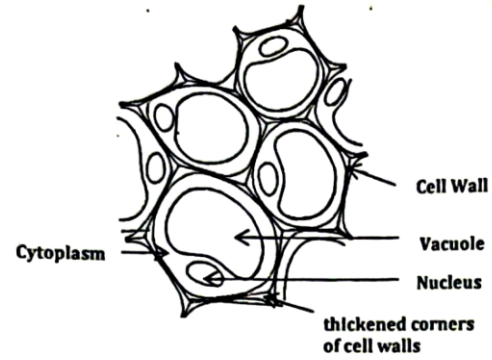


Types of plant tissues, structure-function relationship

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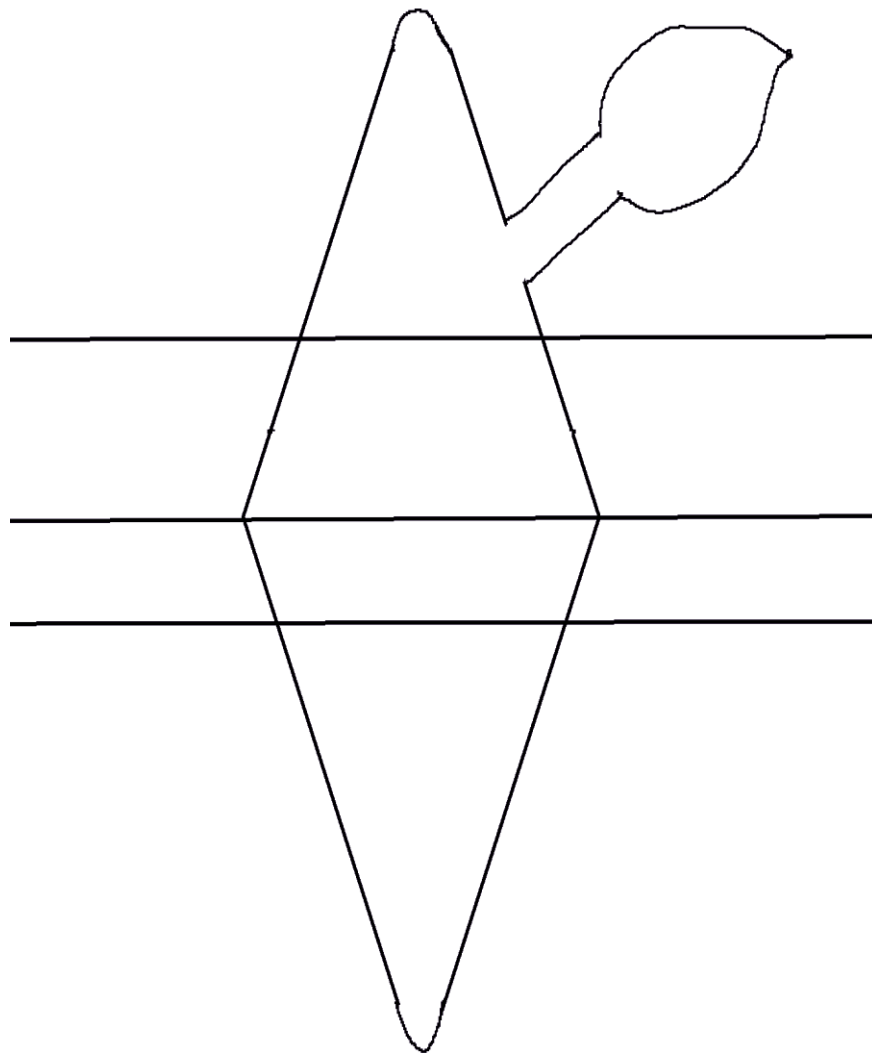


- Diagram of Collenchyma cells : 6 marks
- Fully labelled correct diagram : 6 marks
- Partially labelled correct diagram : 3 marks
- Unlabelled diagram : no marks



Correct diagram of T.S. of sclereids : 2 marks

- Any 34 points × 4 marks = 136
- Diagram of parenchyma cells = 6 marks
- Diagram of collenchyma cells = 6 marks
- Diagram of T.S. of sclereids = 2 marks
- Total = 150 marks**

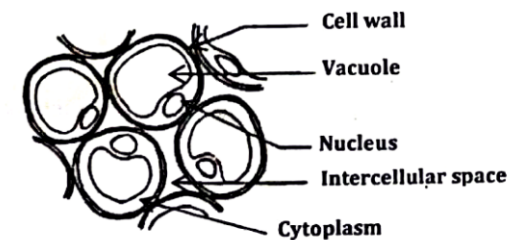


Ground tissue consists of three main types of cells;

1. Parenchyma cells,
  2. Collenchyma cells and
  3. Sclerenchyma cells.
  4. Parenchyma cells have primary cell walls,
  5. which are thin
  - 6, 7 They contain a large, central vacuole
  8. Some contain plastids /leucoplasts/chloroplasts.
  9. Collenchyma cells are (generally) elongated and
  10. have primary cell walls,
  - 11 which are thicker than those of parenchyma cells and
  - 12 unevenly thickened.
  13. Sclerenchyma cells have secondary cell walls,
  - 14, 15. which are thickened by large amount of lignin.
- Two types of sclerenchyma cells,
16. sclereids and
  17. fibers.
  - 18: Sclereids are irregular in shape,
  - 19, 20. shorter and wider than fibers.
  21. Fibers are long,
  - 22, 23. slender and tapered.

#### Functions

24. Fills the gap between dermal tissue and vascular tissue.
- 25, 26. Forms cortex and pith.
27. Photosynthesis.
28. Short distance transport (of substances).
29. Parenchyma cells carry out metabolic functions
30. such as synthesis of organic substances /products,
31. storage (of substances) and
32. wound repair.
33. Collenchyma cells provide (mechanical) support
- 34, 35. Sclerenchyma cells / sclereids / fibers provide support and strength.



- |                                    |   |          |
|------------------------------------|---|----------|
| Diagram of Parenchyma cells        | : | 6 marks  |
| Fully labelled correct diagram     | : | 6 marks  |
| Partially labelled correct diagram | : | 3 marks  |
| Unlabelled diagram                 | : | no marks |





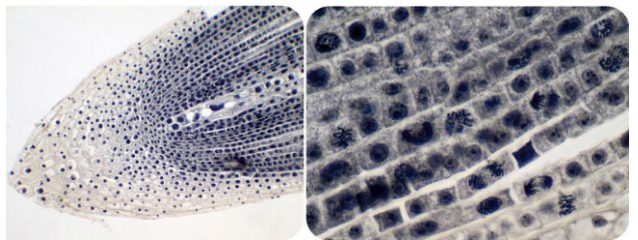
### Meristems, Locations and Role in Plant Growth

Plants have ..... tissues called meristems, consisting of cells which constantly ..... under suitable conditions and produce new cells. Some of these cells then ..... and ..... to produce new tissues of the plant body and others remain as ..... Meristems may have ..... periods. Due to the action of meristem new cells are added. Subsequently these cells get differentiated and therefore plant growth occurs by making new plant tissues.

#### Characteristics of Meristematic Cells

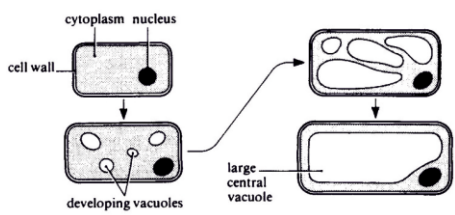
All cells in the meristems have common characteristics. They;

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- In meristem there are three overlapping zones of cells consisting of cells at successive stages of

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There are three types of meristems based on Location. They are;

- 18. Parenchyma tissue is inefficient in?  
(1) Protection (2) Storing of water (3) Storing of food (4) Maintain air spaces  
(5) Conduction
- 19. Which of the following is directly related to primary growth of plants?  
(1) Apical meristem. (2) Intercalary meristem. (3) Interfascicular cambium.  
(4) Cork cambium (5) Fascicular cambium. (AL/2011 Old)

#### Essay

1. Briefly describe the structure and function of ground tissues of plants. (2021 AL)

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7. Sclerenchyma,  
 (1) Cells are absent in xylem tissue. (2) Cells are absent in ferns.  
 (3) Cells have lignified secondary cell walls. (4) Tissue is made of live cells.  
 (5) Abundant intercellular spaces.
9. Which of the following statement is incorrect regarding phloem?  
 (1) Photosynthetic products are conducted within the phloem as glucose.  
 (2) Presence of parenchyma cells and companion cells imply the need of energy for translocation.  
 (3) Sieve cells are present in gymnosperm phloem.  
 (4) Conduction of molecules is bidirectional (5) Fiber cells are present in phloem.
10. Which of the following statements is incorrect regarding collenchyma cells?  
 (1) It's a dead cell (2) They have abnormally thickened non lignified cell walls  
 (3) They are considered as the mechanical tissue of non-woody plants  
 (4) Normally absent in root (5) Intercellular spaces may present
11. Which of the following statements is incorrect regarding mature xylem vessel element?  
 (1) It's a dead cell (2) Lignified thick cell walls present  
 (3) They store water and photosynthetic products.  
 (4) Provide mechanical support to plant.  
 (5) Fusion of several vessel elements forms a vessel.
12. Which statement is incorrect regarding phloem?  
 (1) It's a live tissue (2) Fibers present. (3) Conduction of food required metabolic energy.  
 (4) Main conduction product within the phloem is sucrose.  
 (5) Food translocation within the phloem takes place in night.
13. Which of the following statement is true about collenchyma tissue?  
 (A) Secondary cell wall is absent. (B) Corners are thickened with cellulose.  
 (C) Large intercellular air spaces are present. (D) Vacuoles are absent  
 (E) Present in xylem tissue
14. Which of the following is absent within phloem?  
 (1) Sucrose (2) Water (3) Starch (4) Inorganic ions (5) Suberin
15. Which of the following statements is true?  
 (1) The primary function of xylem fibers is conduction.  
 (2) Lignified cells are important in paper industry  
 (3) Pits are present in vessel elements but absent in fibers.  
 (4) Fibers are elongated cells with thickened cell walls, present only in vascular tissues.  
 (5) Fibers and sclereids are sclerenchyma cells.
16. Which of the following contribute/s significantly to the mechanical strength of the leaf?  
 (A) Sclerenchyma (B) Xylem vessel (C) Guard cell (D) Collenchyma  
 (E) Xylem tracheids (AL Bot/92)
17. Lignin is abundant in  
 (1) Mature sclerenchyma cells (2) Young stone cells (3) Vessels elements (4) Fibers  
 (5) Collenchyma cells

**Apical meristems**

These meristems are located at root tips and shoot tips. They add new cells that enable increase in length. This process is known as primary growth.

**Lateral meristems**

..... and ..... cambium are lateral meristems. They are found in woody plants and involve in the .....growth in increasing ..... of roots and stems. The vascular cambium produces secondary ..... and secondary ..... The cork cambium produces thick and tough ....., replacing epidermis.

**Intercalary meristems**

**Primary growth of Roots/2007 AL**

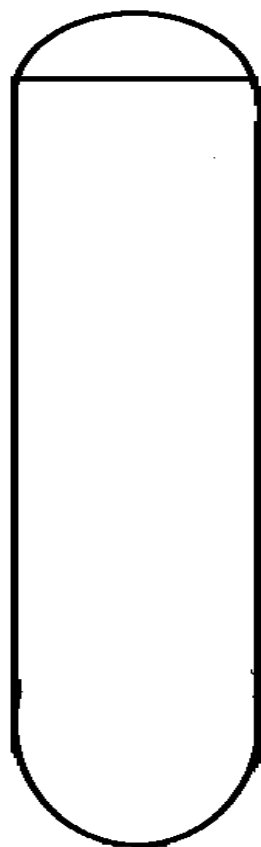
Elongation of root due to the activity of primary meristems located on ..... is called ..... of the root. During the growth three processes take place.

- i. .... - due to mitotic division.
- ii. ....
- iii. .... - due to differentiation.

These stages are found in three overlapping regions starting from meristems.

The zone of cell division includes the ..... meristem and its ..... In this region, new cells are produced to ..... Cells produced outward to the apical meristem are differentiated to form ..... which prevents damaging the root apical meristem from friction when grows through soil.

Cells produced inward to the meristem undergo elongation, in the zone of cell elongation. Root cells ....., sometimes to more than ..... times their original length. Hence the root is pushed forward through soil. In the zone of ....., the cells begin specializing in structure and function where cells complete their differentiation and become ..... mature. Primary structure of the root is formed as a result of primary growth.



Name the two major tissues involved in the transport of materials in plants and indicate their constituent cell types and substances transported.

Tissue	Constituent cell types	Substance transported
.....	.....	.....
.....	.....	.....
.....	.....	.....

State two major features of collenchyma.

.....  
 .....  
 .....

**MCQ**

- Which of the following statements is **incorrect** regarding collenchyma cells?
  - (1) They are living at maturity. (2) They have primary cell walls only.
  - (3) They are capable of further cell division.
  - (4) They are found in both primary & secondary plant bodies.
  - (5) They have unevenly thickened cell walls. (A/L 2000)
- Which of the following is incorrect regarding xylem vessels?
  - (1) They are non-living tissues at maturity. (2) They have lignified thick walls.
  - (3) The lumen of each vessel is continuous with that of adjacent ones.
  - (4) They conduct both water and synthesized food.
  - (5) They give mechanical support to the plant. (A/L 2000)
- Which of the following statement is true about collenchyma tissue?
  - (1) Live cells, cell walls are mainly thickened with cellulose.
  - (2) Live cells, cell walls are mainly thickened with lignin.
  - (3) Live cells, cell walls are mainly thickened with hemicellulose.
  - (4) Dead cells, cell walls are mainly thickened with cellulose.
  - (5) Dead cells, cell walls are mainly thickened with lignin.
- Which of the followings is present in primary tissues but absent in secondary tissues?
  - (1) Parenchyma (2) Collenchyma (3) Sclerenchyma (4) Tracheids (5) Vessel elements
- Which of the followings is absent in angiosperm root?
  - (1) Ground tissue (2) Parenchyma Cells (3) Vascular tissue (4) Sclerenchyma cells (5) Collenchyma cells
- What statement is correct regarding the sclerenchyma cells?
  - (1) Cell walls are not uniformly thickened.
  - (2) Cells appear tetragonal in a longitudinal section.
  - (3) Intercellular spaces are abundant.
  - (4) They are present in the peripheral region of the plant organs.
  - (5) Live and sometimes bears chloroplasts.



(a) Name the parts labelled (a) - (d) on side B.

(b) Indicate on side A of the diagram the position of the following zones using double brackets {}.

- (i) zone of cell division
- (ii) zone of cell elongation and cell enlargement
- (iii) zone of tissue differentiation

(c) How does the L.S. of a shoot apex as shown in the diagram above differ from that of a root apex of a dicotyledon?

**Shoot apex**

**Root apex**

- (i) .....
- (ii) .....
- (iii) .....
- (iv) .....

2. A (i) State four differences seen between a xylem vessel element and a sieve tube element.

Xylem Vessel element	Sieve tube element

A (i) Name the supporting cells of plants.

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 .....

(ii) State the major chemical constituents which determine the rigidity of each of the supporting cells stated in A (i)

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**Primary growth of the shoot**

- Elongation of shoot is due to the activity of primary meristem located in shoot apex, and is called primary growth of the shoot.
- A shoot apical meristem is a dome-shaped mass of dividing cells located at the shoot tip.
- Leaves develop from leaf primordia, finger-like projections along the sides of the apical meristems.
- Normally these primordia cover the shoot apical meristem.
- Shoot apical meristem produces new cells only towards the stem, due to mitosis.
- After cell elongation, cell differentiation takes place.
- Then the primary tissues of the stem are formed due to cell differentiation.
- Therefore, the height of the stem is increased due to primary growth.

**Shoot Apex**

*Fig. Shoot apical meristem*

Shoot apex	Root apex

Fig. Differences Between Shoot Apex and Root Apex

**Plant tissue systems**

The new cells ..... from the meristems are ..... to perform ..... functions and form a plant tissue system. During differentiation process, they undergo changes in ....., ..... and ..... Therefore, several types of plant cells can be recognized according to their structure and function. A tissue consists of group of ..... or ..... cell types which carries out specialized function (s). Vascular plants have three main tissue systems. They are;

1. ....
2. ....
3. ....

**Dermal tissue system**

This is the outer protective covering of plants.

Eg. Epidermis

- Protective layer in the stems and roots of the primary plant body and leaves
- Tightly packed single cell layer
- Normally covered by a cuticle which is a waxy epidermal coating in aerial parts
- Specialized cells such as guard cells, trichomes and root hairs are also found in epidermis

**Functions of Epidermis:**

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B. (i) Name the types of cells present in the xylem tissue and give one function of each type of cell.

**Type of cell**

**Function**

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(ii) Name the types of cells present in phloem tissue and give one function of each type of cell.

**Type of cell**

**Function**

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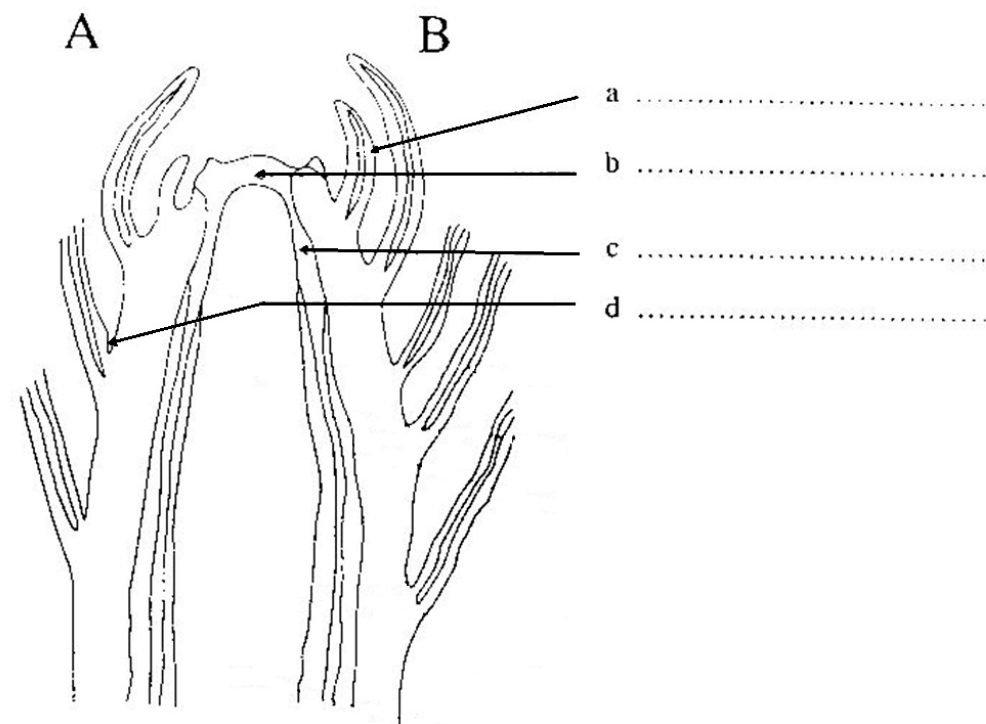
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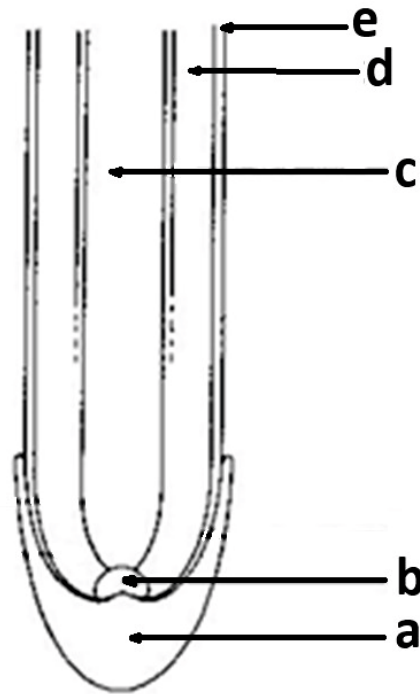
**2000 AL**

1. Figure given below is a line diagram of a longitudinal section of a shoot apex of a dicotyledon.



**Structured Essay**

1. A. (i) The diagram represents longitudinal section of a dicotyledonous root apex. Name the



Parts labeled as a, b, c, d, and e.

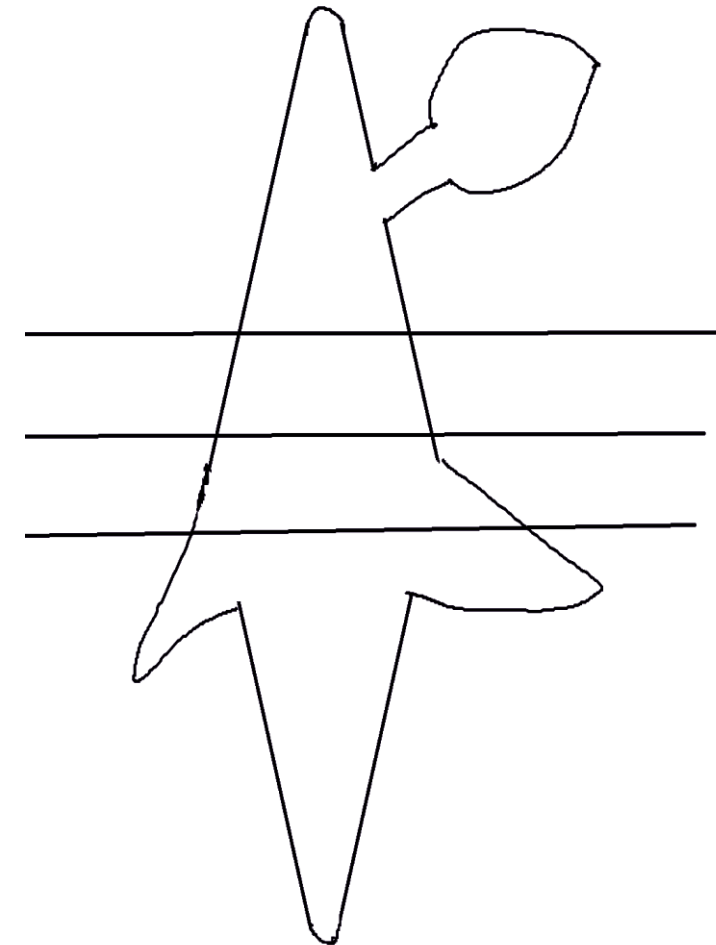
- a .....
- b .....
- c .....
- d .....
- e .....

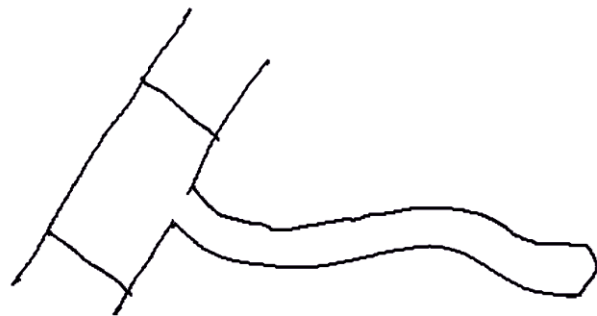
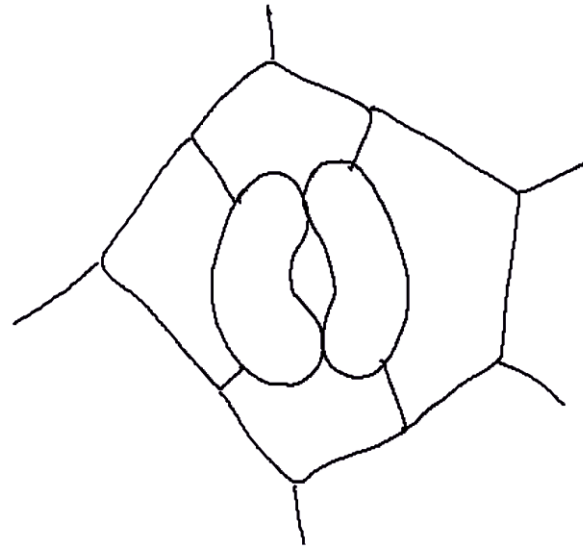
(ii) From which of the above parts do the following structures originate?

- Xylem .....
- Root cap .....
- Lateral roots .....

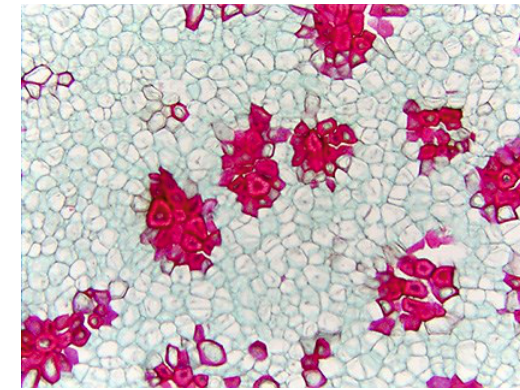
(iii) Give one function of each of the parts labeled as a, b, and c in the diagram.

Part	Function
a	.....
b	.....
c	.....





### Sclereids of Pear (Pyrus) fruits/Guava/Anona

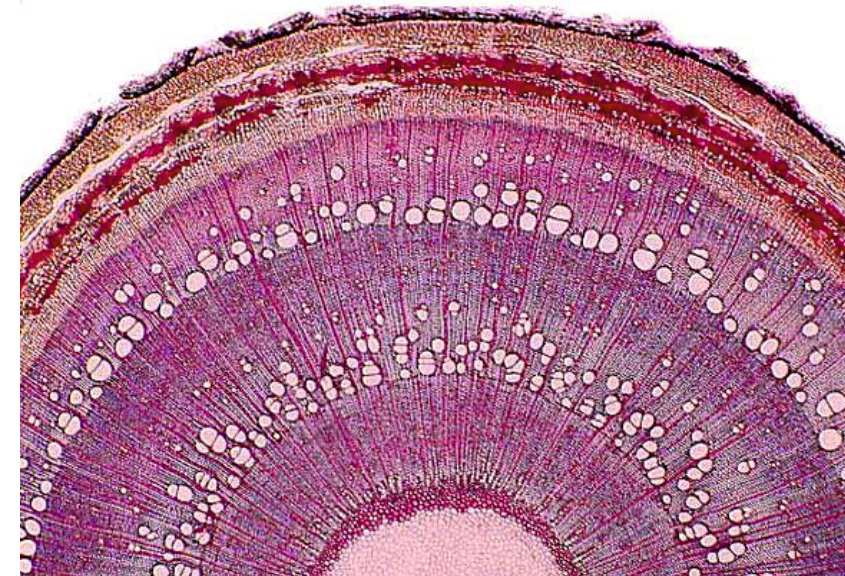


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### Wood of Stem cuttings

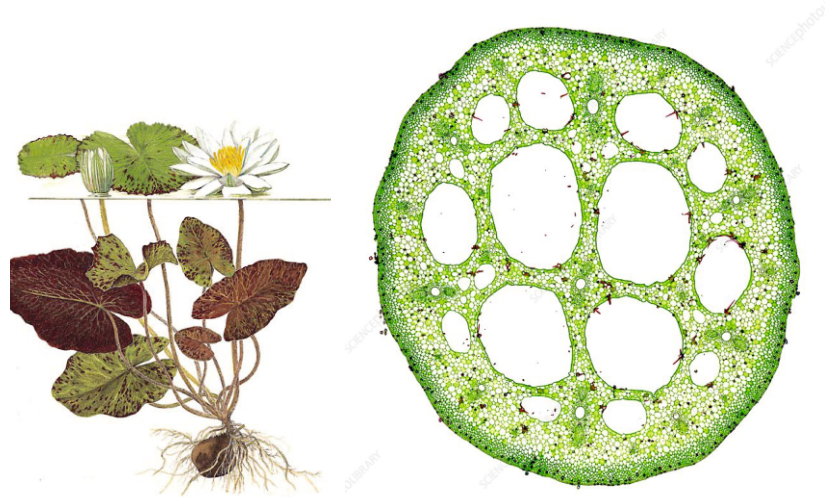


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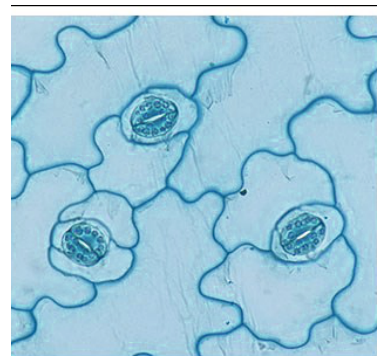
*Nymphaea* leaf petiole



*Nymphaea* plant

*Nymphaea* leaf petiole

Leaf Epidermis



Ground tissue system

- ..... mainly consists of cortex (outer to vascular tissue) and pith (inner to vascular tissue).
- The ground tissue includes cells specialized for functions such as ....., ....., and ..... transport.
- Three main types of cells are present in ground tissue. They are;
  1. Parenchyma cells
  2. Collenchyma cells
  3. Sclerenchyma cells

Parenchyma cells

- Living even at functional maturity
- Mature cells have ..... which are relatively ....., ..... and most of the cells lack secondary walls

- They have a large central vacuole

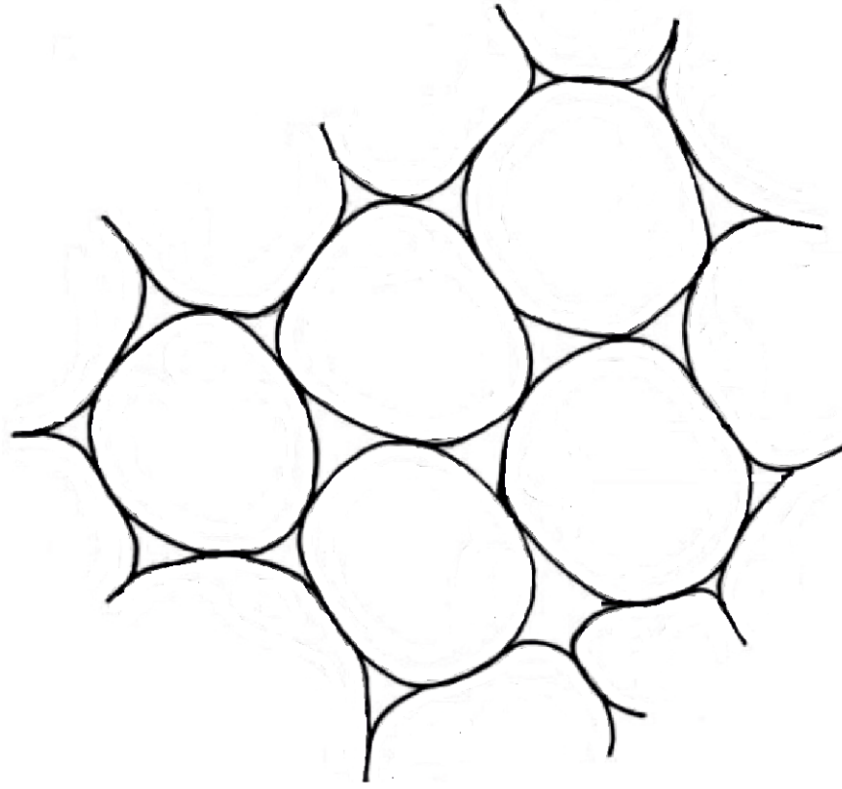


Diagram of typical parenchyma cells

**Functions**

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**PRACTICAL NO.16**

**Identification of special characters of cell types of plant tissues using light microscope**

**Objectives**

- Students should be able to

  1. identify plant tissues namely parenchyma, collenchyma, sclerenchyma (sclereids, fibers), xylem and phloem using light microscope,
  2. draw suitable diagrams of observed plant tissues as seen through the light microscope proportionately,
  3. differentiate the plant tissues according to the characters of each tissue.

**Materials and equipment**

- Light Microscopes
- Prepared slides of cross sections of stem, root and leaf of *Helianthus*
- Other suitable prepared slides containing major plant tissues (cross section of *Nymphaea* leaf petiole, leaf epidermis of monocot and dicot, material macerated from flesh of Guava/ Annona fruits, and wood of stem cuttings, etc.)
- Slides and cover-slips (If prepared slides are not available make suitable wet mounts in the classroom.)

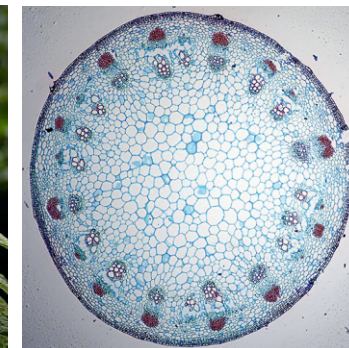
**Instructions**

- Allow students to examine the slides under low power of the microscope.
- Direct them to identify the areas /zones which show the distribution of different tissues.
- Let students identify the characteristics of each tissue under medium and high powers.
- Provide students with other suitable prepared slides for further identification of a variety of plant tissues.
- Let students make suitable diagrams to show the observed characteristics of the tissues.

***Stem of Helianthus***



*Helianthus*



*Helianthus stem (T.S)*

### Sieve tube elements

- Sieve tube elements lack nucleus, ribosomes, a distinct vacuole, and cytoskeletal elements-
- Cytoplasm reduced into a thin peripheral layer.
- Absence of these allow passing of nutrients more freely
- Chains of sieve tube elements are aligned to form sieve tubes
- The end walls between sieve tube elements contain porous plate called sieve plate.
- Sieve plate allows movement of fluid from one sieve element to the next.

### Companion cells

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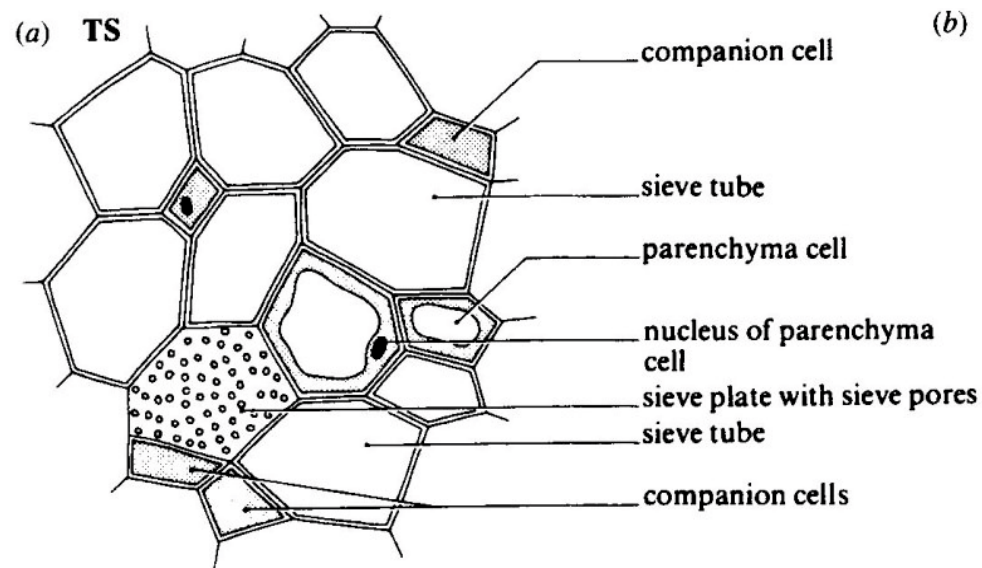
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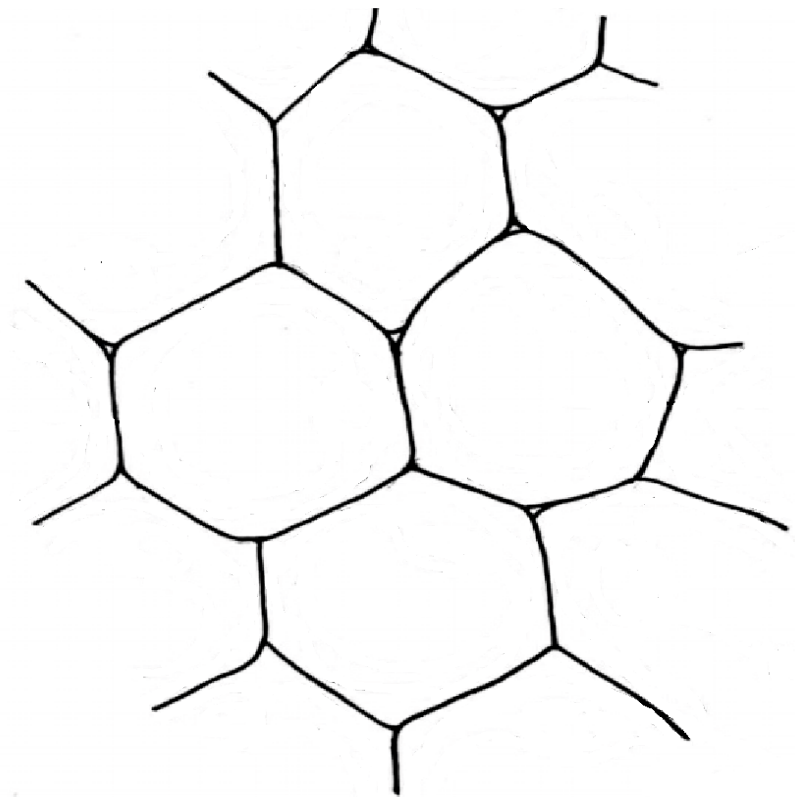
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- This ability is important in wound repair. These abilities also make it possible to multiply and differentiate cells even from a single parenchyma cell in tissue culture practices.

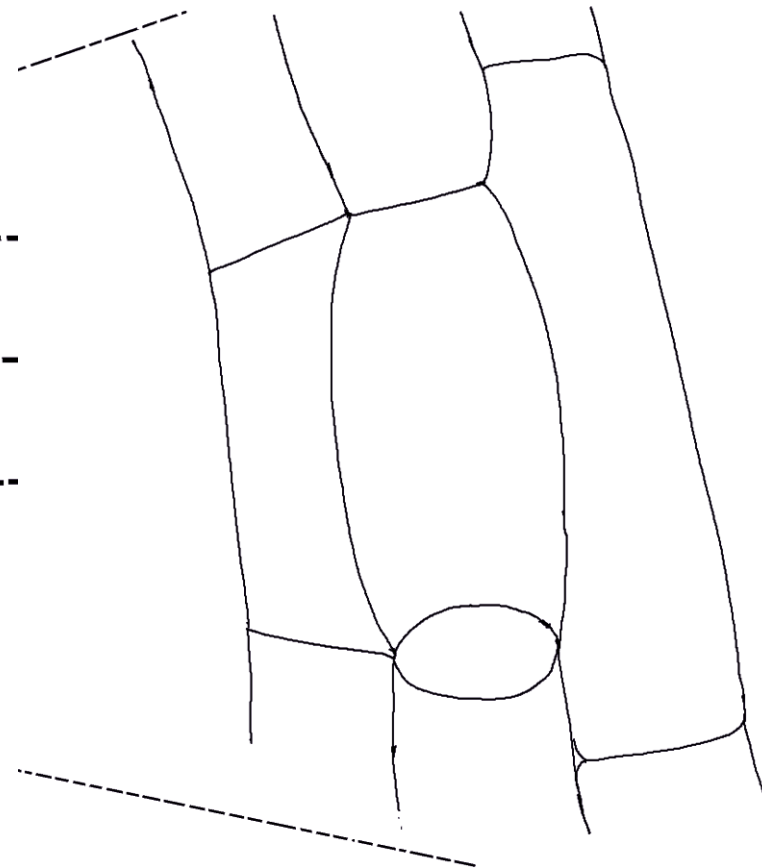
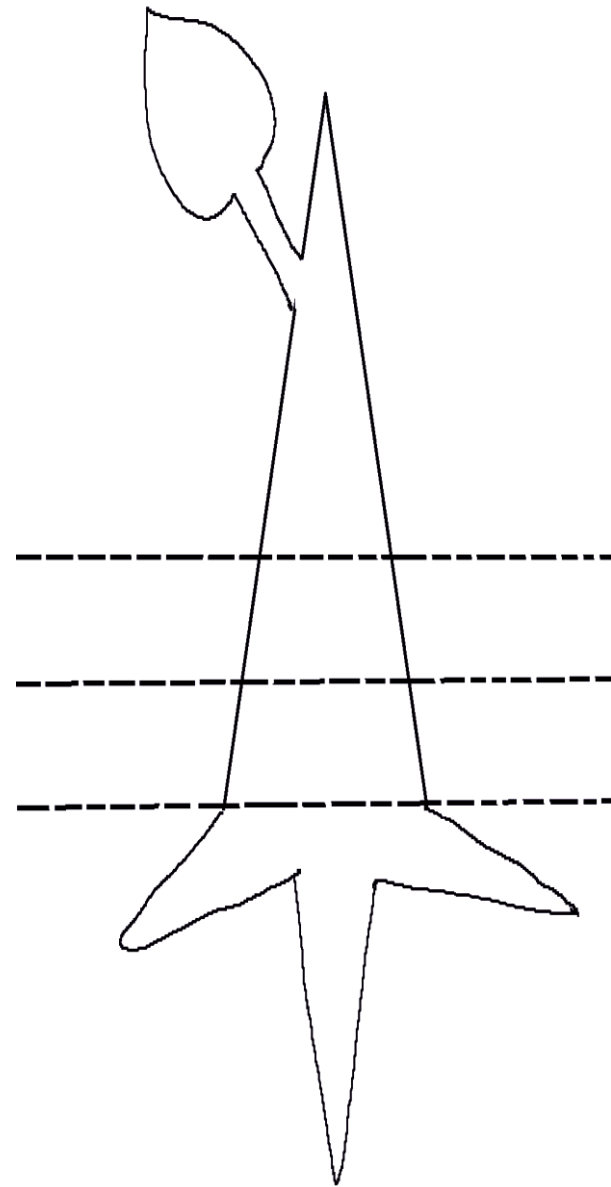
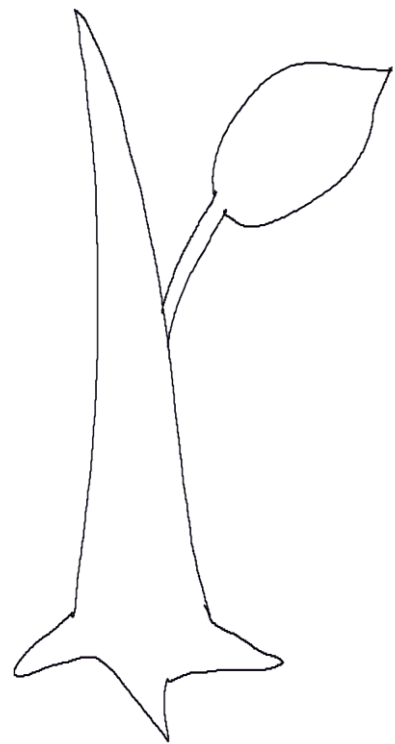
### Collenchyma cells

- They are generally elongated
- They have thicker primary walls than parenchyma cells
- Their walls are unevenly thickened
- Young stems and petioles often have strands of collenchyma cells just below the epidermis
- Even at functional maturity they are living, flexible and elongating with stems and leaves they support

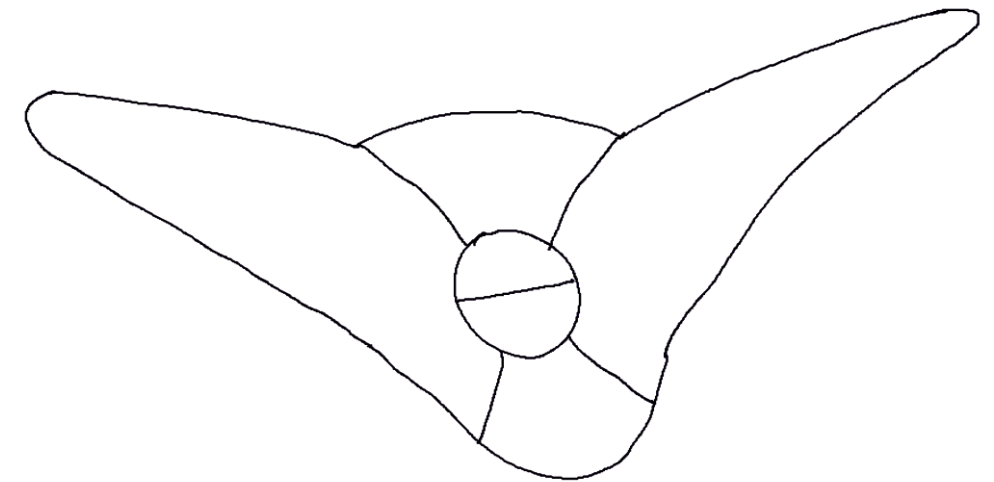
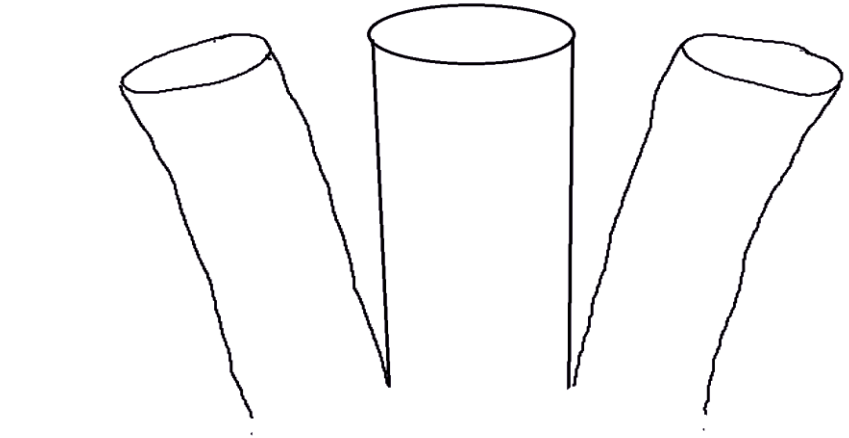
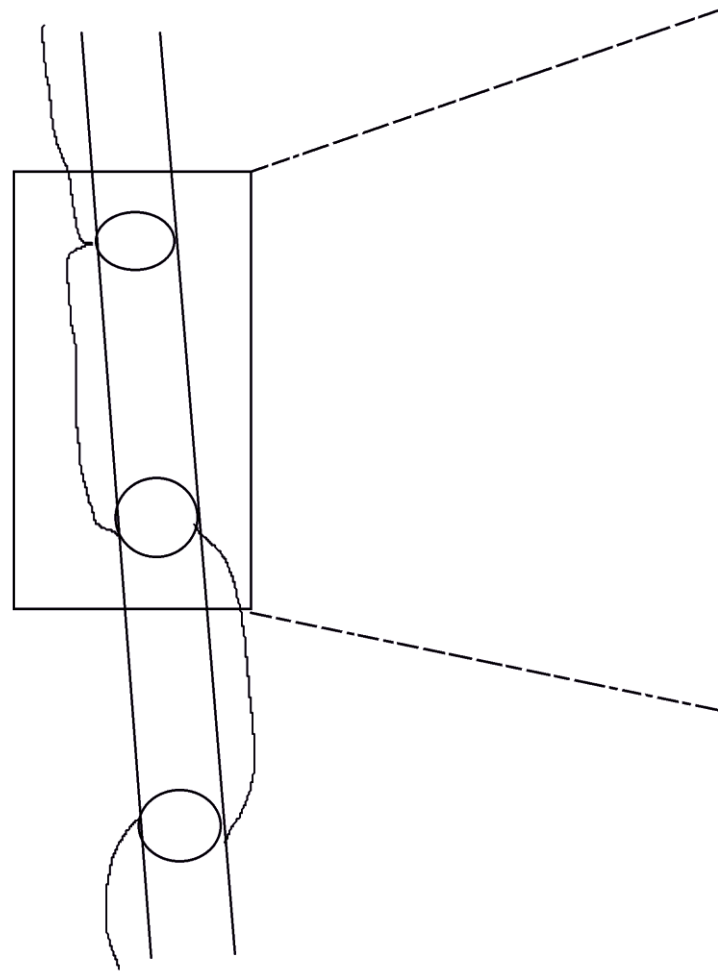
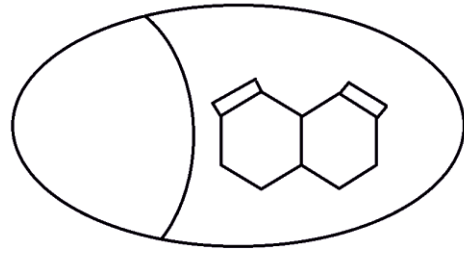
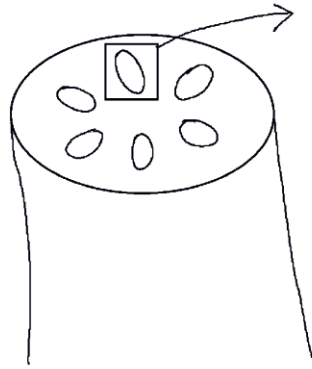
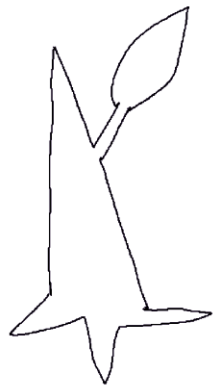


### Sclerenchyma cells

- Secondary cell walls are produced after cell elongation



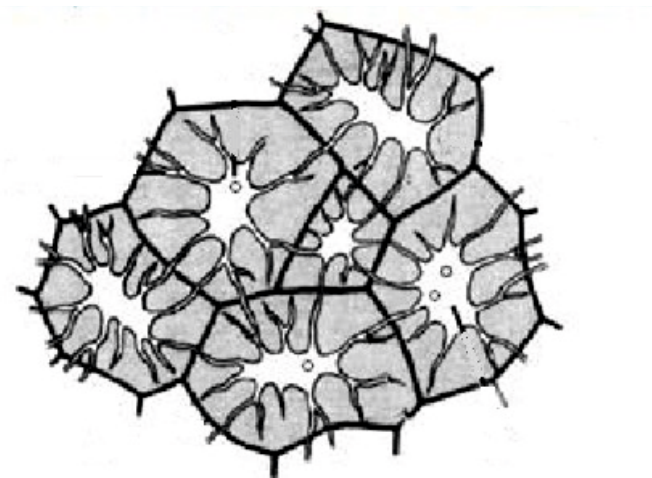




**Functions**

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- They have secondary cell walls thickened by large amount of lignin
- They are dead cells at maturity
- There are two types of sclerenchyma cells;
  1. Sclereids
  2. Fibers



**Sclereids**

- Sclereids are shorter and wider than fibers and irregular in shape.
- They have very thick lignified secondary cell walls.
- They are found in places where growth has stopped  
Eg. nut shells, seed coats and flesh of coarse fruit.

**Fibers**

- Fibers are usually grouped in strands.
- They are long, slender and tapered.
- Used commercially to obtain fibers.  
Eg: coconut husk fiber, hemp fibers

**Functions**

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**Phloem Tissue/AL 2003/AL 2012**

- It consist of sieve tube elements, companion cells, parenchyma cells and fibers in angio-sperms
- Except fibers other phloem cells are living cells
- In seedless vascular plants and gymnosperms sieve tube elements and companion cells are absent. Instead of sieve tube elements, long narrow cells called sieve cells are present in these plants.

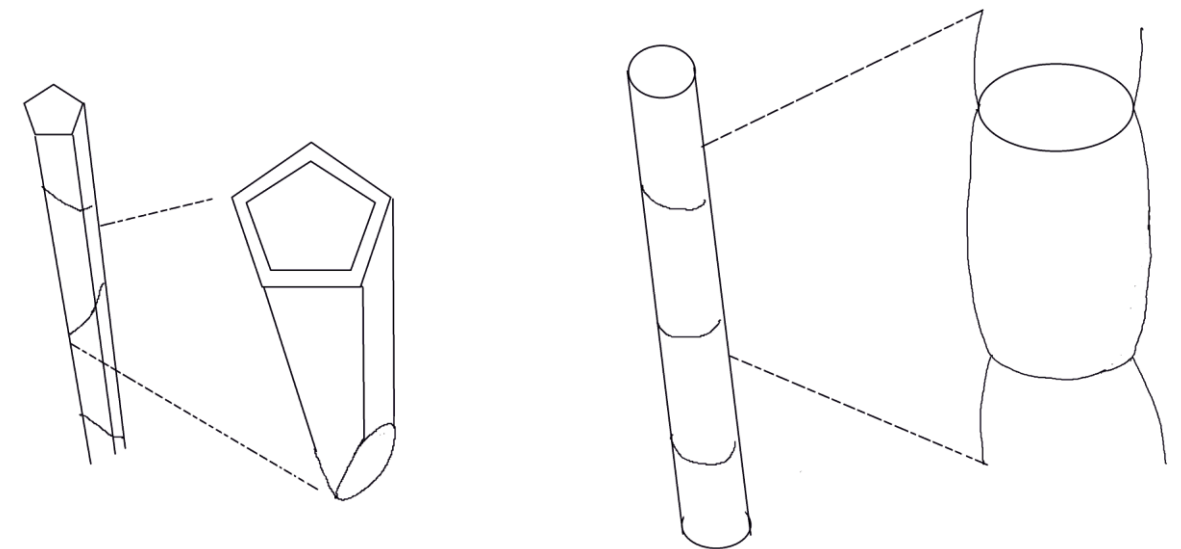
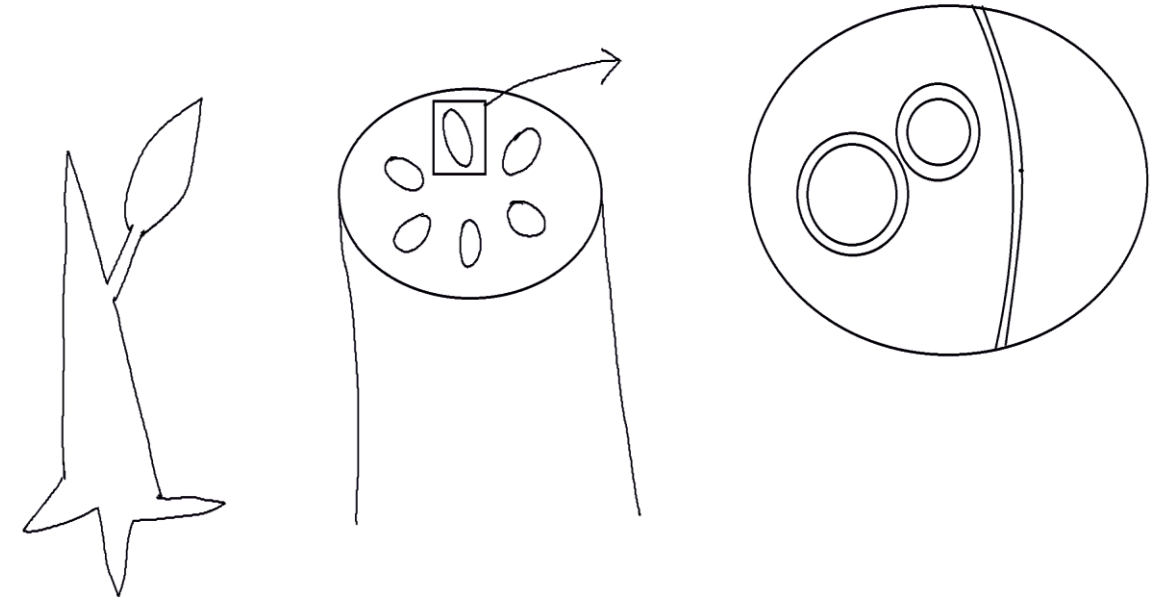
## Vessel elements

- Perforation plates are present at end walls of vessel elements. Other walls are interrupted by pits
- They form xylem vessel by aligning end to end with perforation plates
- Water flows freely through perforation plates

## Tracheids

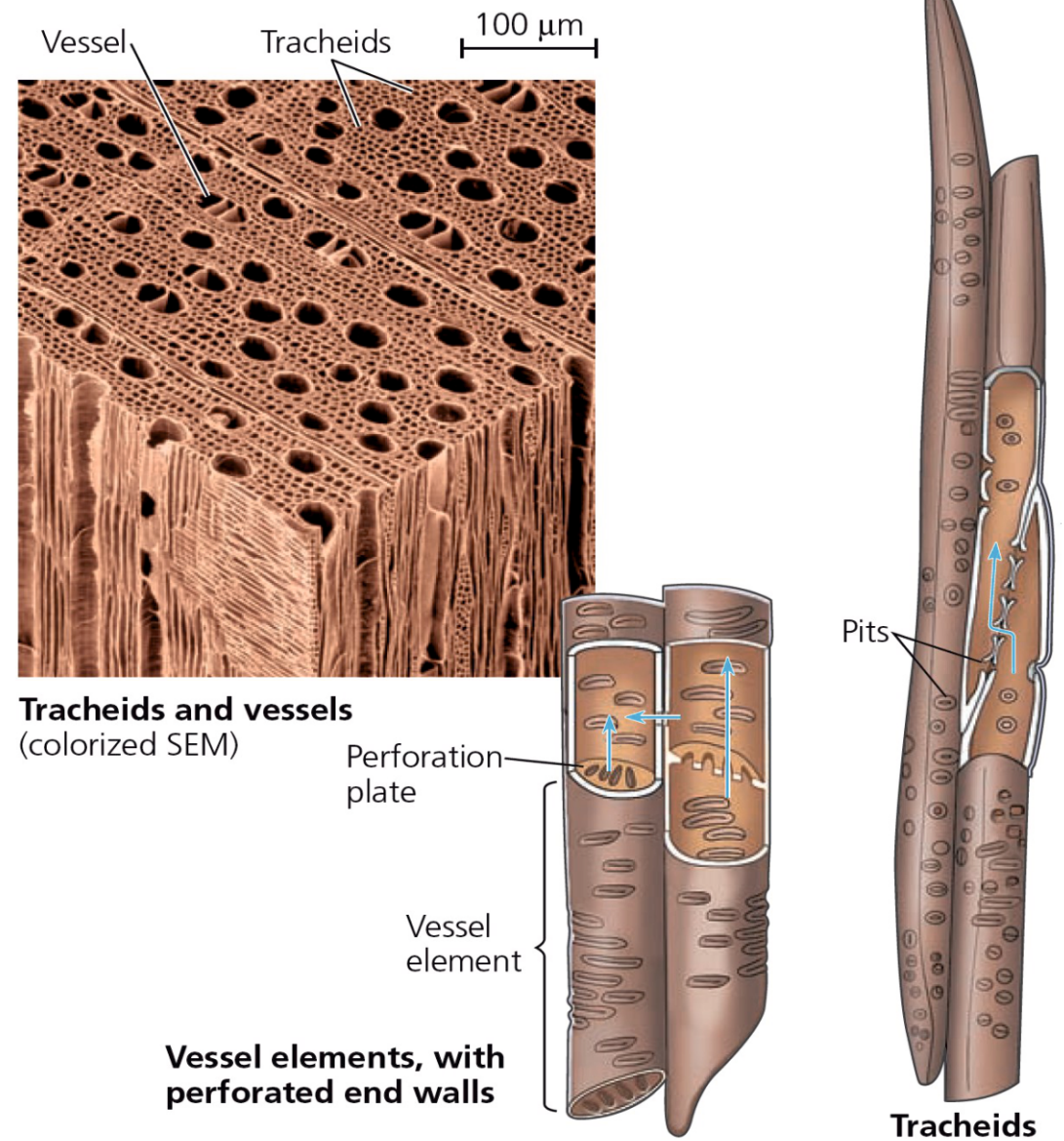
## Ascent of Sap

- Movement of water and dissolved minerals from roots to shoot through the xylem is called as ascent of sap.



## Vascular tissues - Xylem and phloem

### Xylem tissue



- It consists of vessel elements, tracheids, fibers and parenchyma cells in angiosperms and some of the gymnosperms.
- Vessel elements and tracheids mainly conduct water.
- They are dead at functional maturity.
- Fibers give mechanical strength.
- Parenchyma functions in storage and in radial transportation.