

BOTA

****PLANT ANATOMY****

PRACTICAL Sem 2; CC3

- 1) Types of Stomata, Sclerides ,Raphides (Colocasia), Cystolith(Ficus) leaf, Starch grains, Aleurone grains, Laticiferous Ducts; Oil Glands..... (Part 1) . .
- 2) Study of anatomical details through permanent slides ;- Monocot & Dicot Roots; Monocot & Dicot Stem; Monocot & Dicot Leaf.....(Part 2).
- 3) Study of Anomalous Secondary Structures in Stem of Boerhaavia; Bignonia; Tecoma; Dracena; & Root of Tinospora.....(Part 3)
- 4) Study of Adaptive Anatomical features:- Hydrophytes (Nymphaea petiole); Xerophyte (Nerium leaf).....(Part 3)

**STUDY of ANATOMICAL DETAILS
Through PERMANENT SLIDES.
MONOCOT & DICOT
ROOTS , STEMS , LEAVES
Part -2**

✓4. **Safranin**—Dissolve 1 gm. safranin in 70% alcohol 100 c. c. and filter. It is a good stain for lignified tissue.

✓5. **Light green**—Dissolve light green 1gm. in absolute alcohol 5 c. c. and clove oil 75 c. c. It is a good stain for non-lignified tissue.

✓6. * **Haematoxylin (Delafield's method)**—Dissolve 1gm. haematoxylin in 6 c. c. absolute alcohol and add this solution drop by drop to 100c. c. saturated solution of Ferric Ammonium Sulphate (Ferric Alum) in a flask. Keep it in exposed air and light for 1 week. Filter and add 2·5 c. c. glycerine and 2·5 c. c. methyl alcohol. Allow to ripen at least 2 months. Filter as needed. It is a good stain for non-lignified tissue.

✓7. * **Haematoxylin (Ehrlich's improved method)**—Mix haematoxylin 1 gm., glacial acetic acid 5 c. c., glycerine 50 c. c., absolute alcohol 50 c. c., dist. water 50 c. c. and potassium aluminium sulphate in excess in a flask. Keep it well stoppered and wrap the flask with black paper for 2 weeks. Then filter it and use the stain after one month.

✓ 6. Alcohol—Alcohol is used for dehydrating the tissues. As the absolute alcohol is costly, alcohol grades should be prepared from rectified spirit (95% Alcohol). The chart is as follows—to prepare 90%—mix 90c. c. (95%) alcohol and 5c. c. dist. water; for 80%—80c. c. alcohol and 15c. c. dist. water; for 70%—70c. c. alcohol and 25 c. c. dist. water; for 50%—50 c. c. alcohol and 45 c. c. dist. water.

✓ 7. Xylol—It acts as a clearing agent.

✓ 4. Canada Balsam—It dissolved in xylol. It is prepared from an exudation of a Gymnosperm—*Abies balsamea*. In this medium tissues remain undamaged. Besides the optical properties, Canada Balsam allows a clear vision through the material.

SLIDE PREPARATION OF STEM AND ROOT

Aim: To prepare temporary stained glycerine mounts of transverse sections of stem and root of Dicot and Monocot plants.

Material required: Sharp razor, brush, dropper, needles, watch glass, microscopic slides, cover-slips, safrannin, glycerine and compound microscope.

Technique:

- Take 2-3cm long pieces of the material.
- Hold the material between thumb and first finger of your left hand.
- Hold the razor in the right hand with edge of the blade facing you and handle at right angle to it.
- Dip the top of the material in water.
- Then start cutting transverse sections as fast as possible in a watch glass containing water.

- Then start cutting transverse sections as fast as possible in a watch glass containing water.
- Select the thinnest section of the material with the help of a delicate brush.
- Take a clean watch glass with water, transfer thin sections of the material.
- Put a few drops of saffranin stain in the watch glass with water.
- Leave it for 3-5 minutes.
- Drain off stain and wash with water if necessary.
- Put the thinnest section in the centre of the slide.
- Put a drop of glycerine over the material.
- Cover it with a coverslip with the help of needle.
- Observe it under a compound microscope after staining and mounting.

CHAPTER VIII

STAINING METHODS FOR ANATOMICAL STUDIES

To study the anatomical structures of plant organs a fine section of the same should be selected and stained with suitable dye. Staining of tissue is done for clear observation and easy identification of the same. Different types of tissue may be stained with one particular dye (single staining) or they may be differentiated with two selective dyes (double staining). For soft materials single staining is suitable. For woody materials double staining method is adopted with combination of two dyes (one acidic and the other basic) of contrasting colour distinguishing lignified tissue from non-lignified one.

IV. Procedure of double staining with Safranin (in 70% alcohol) and Light green (in clove oil).

1. Cut thin sections and put them in water.
2. Transfer the sections in 30% alcohol and keep there for 3 minutes.
3. Transfer in 50% alcohol for 3 minutes.
4. Transfer in 70% alcohol for 3 minutes.
5. Stain with Safranin for 20-30 minutes.
6. Wash in 70% alcohol to remove excess stain.
7. Transfer in 80% alcohol for 3 minutes.
8. Transfer in 90% alcohol for 3 minutes.
9. Transfer in 95% alcohol for 3 minutes.
10. Transfer in absolute alcohol for 3 minutes.
11. Give change in absolute alcohol for another 3 minutes.
12. Transfer in clove oil for 5 minutes.
13. Stain in dilute Light green for 2 minutes.
14. Wash in clove oil to remove excess stain.
15. Transfer in xylol or omit it.
16. Mount in a drop of Canada Balsam on a glass slide and cover it with a cover slip.
17. Label the slide.

N. B. Function of alcohol is dehydration ; Clove oil and Xylol are clearing agent ; Safranin stains very suitable the lignified tissue elements ; Bismark Brown, Hematoxylin, Light green etc. stain nonlignified soft thin walled tissues ; Euparal, Canada Balsam and Glycerine-jelly are mounting media.

Study under the microscope: Focus the slide under lower of microscope and then change to high power if needed

Precautions:

- Safranin is to be used to stain only the lignified tissues, over staining can be removed by washing in water.
- Air bubbles must be avoided in the sections.
- Use only brush to transfer or to handle the sections. Do not use needles for this purpose.
- Discard the incomplete and oblique sections.

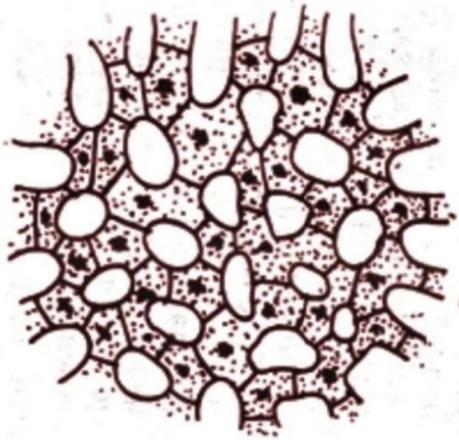
A. Temporary slide preparation of Dicot stem

Identifying characteristics-

- Multicellular hair present on the epidermis.
- Hypodermis collenchmatous.
- Xylem endarch (metaxylem towards periphery and protoxylem towards centre)
- Vascular bundles are arranged in a ring.
- Vascular bundles conjoint, collateral and open.(cambium present)

Inference: The given specimen is the section of dicot stem.

TISSUE TYPES



Aerenchyma

Parenchyma which contain large air cavities are called as aerenchyma. The aerenchyma help in buoyancy.

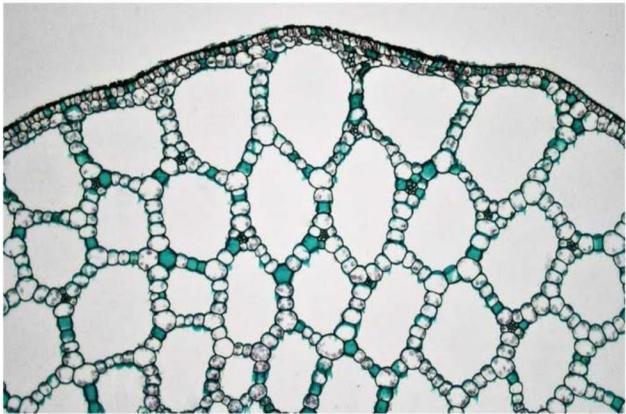
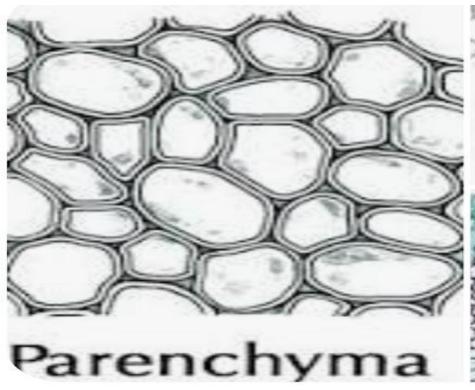
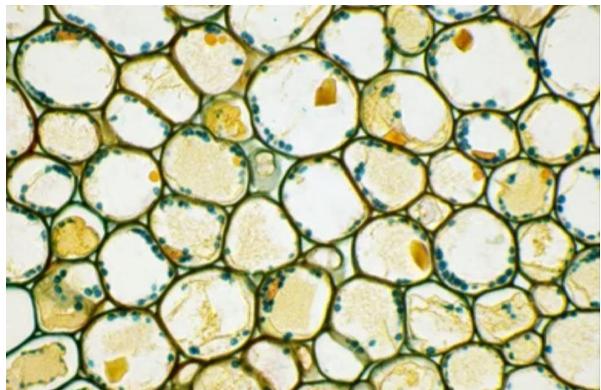
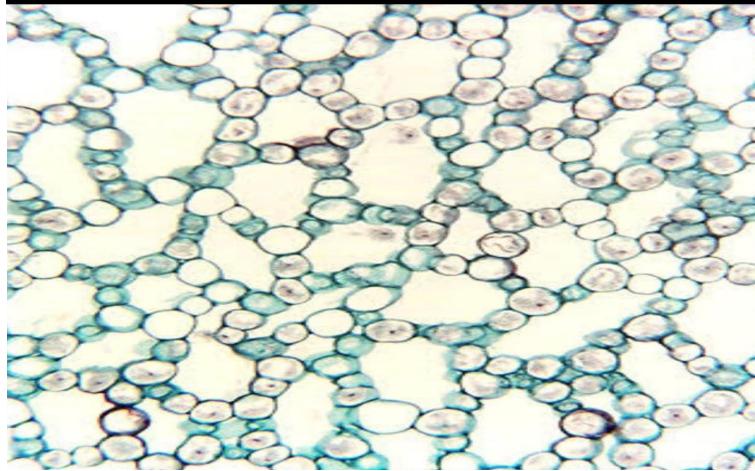
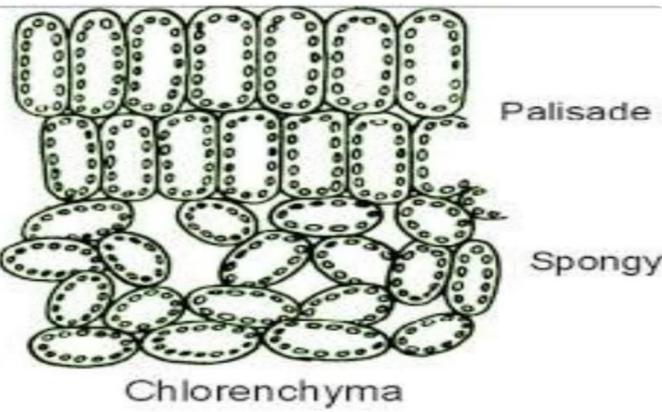


Figure 2.4. Aerenchyma in the stem of the aquatic monocot *Potamogeton*. Large air spaces can be seen between

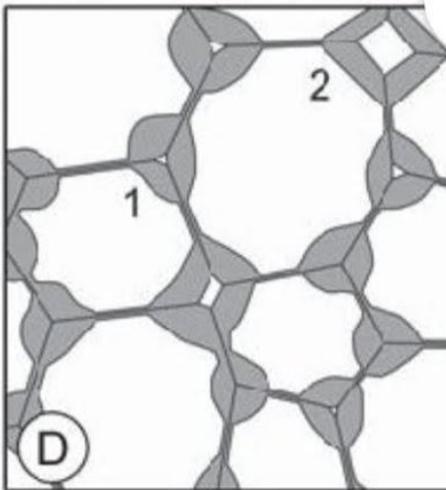
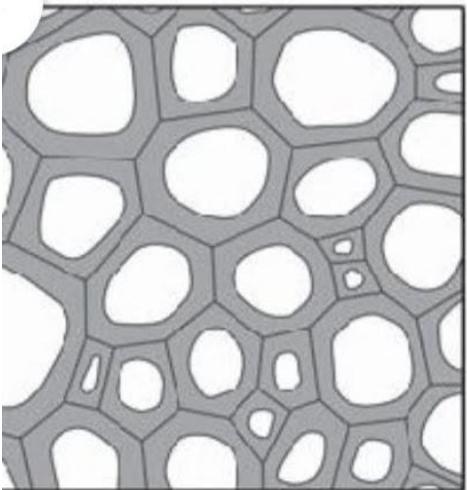
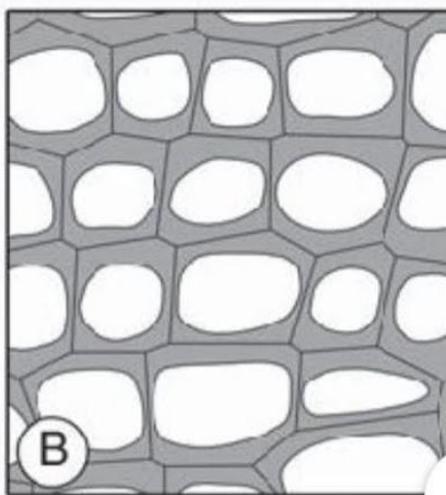
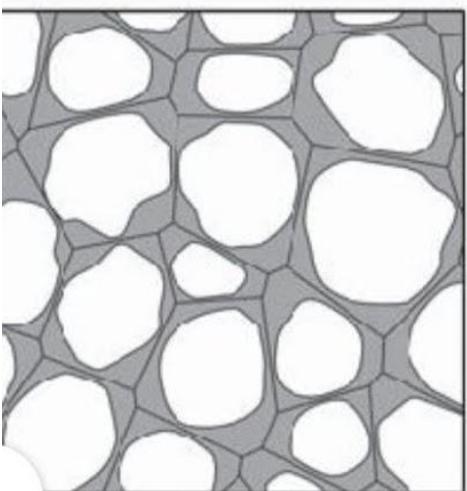


Parenchyma



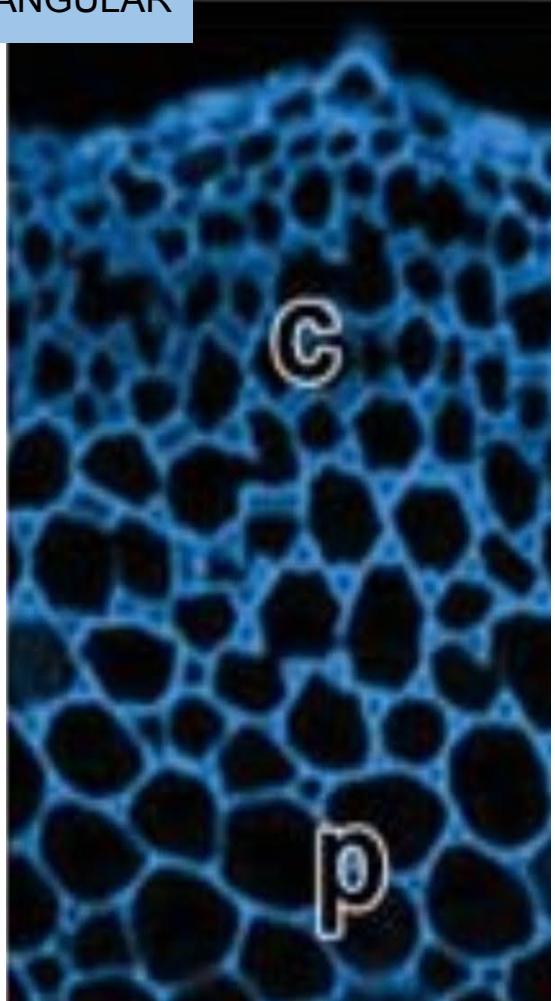
Chlorenchyma

Parenchyma containing chloroplasts are called as chlorenchyma. The chlorenchyma help in photosynthesis.

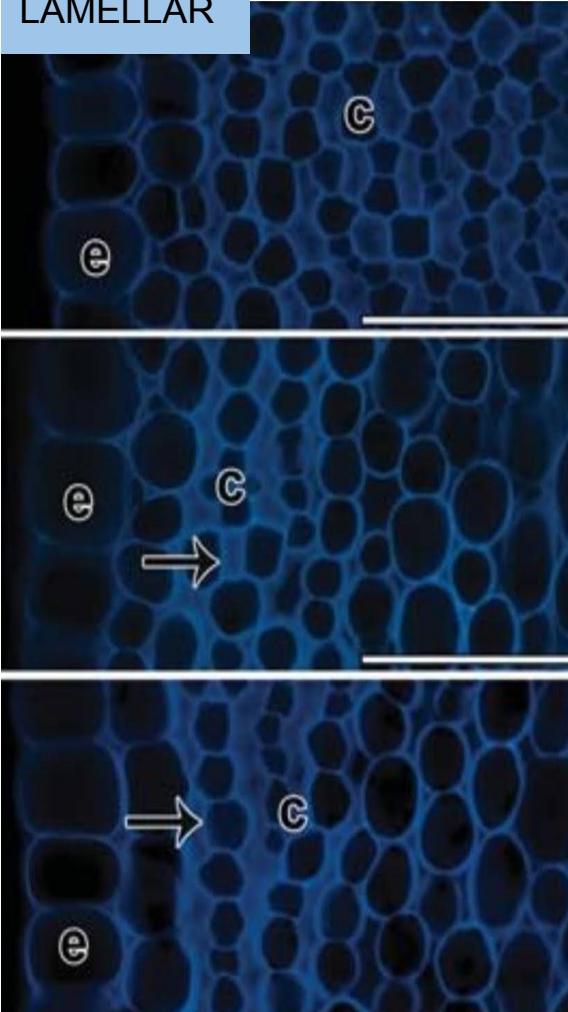


Schematic drawings of the most common types of collenchyma. (A) Angular collenchyma. (B) Tangential collenchyma. (C) Annular collenchyma. (D) Lacunar collenchyma. This type often occurs as an intermediate type with angular and lamellar collenchyma, in which the size of the intercellular spaces can vary from minute spaces (1) to large cavities surrounded by collenchymatous walls (2).

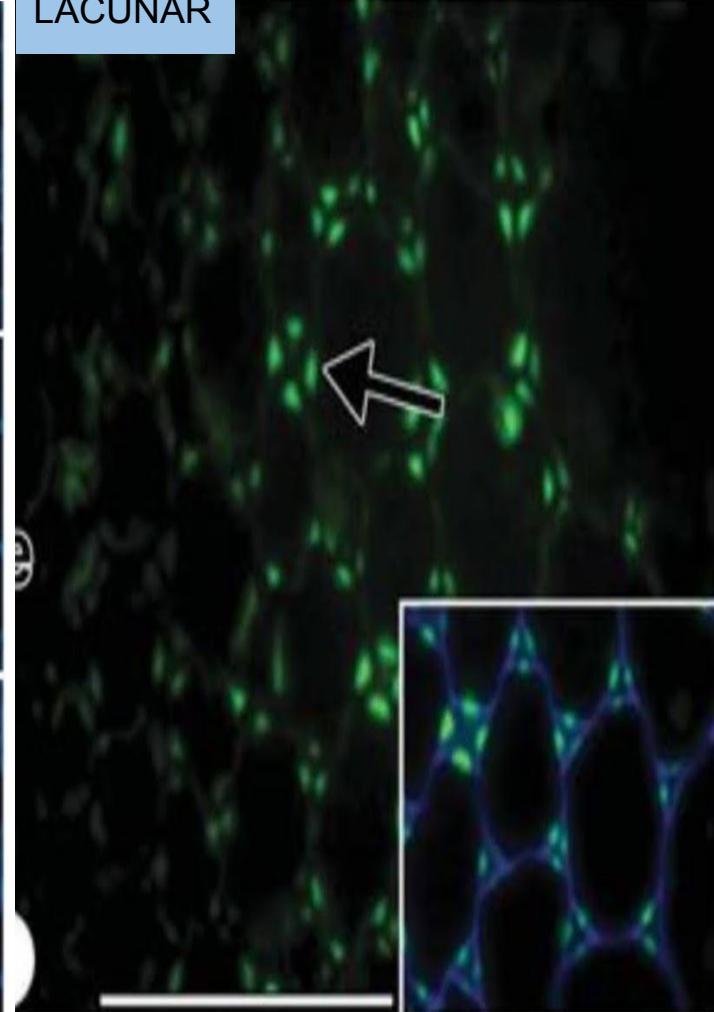
ANGULAR

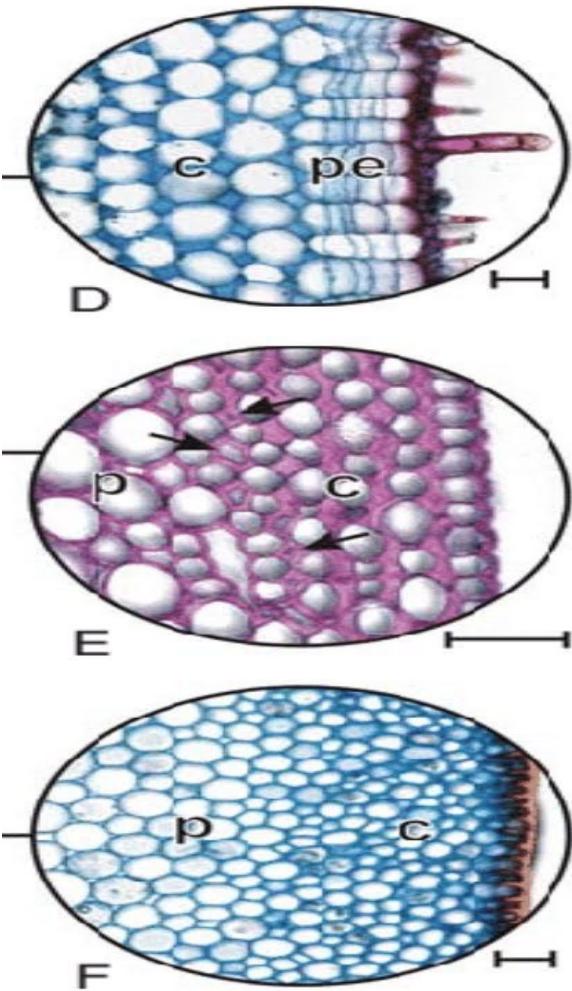


LAMELLAR



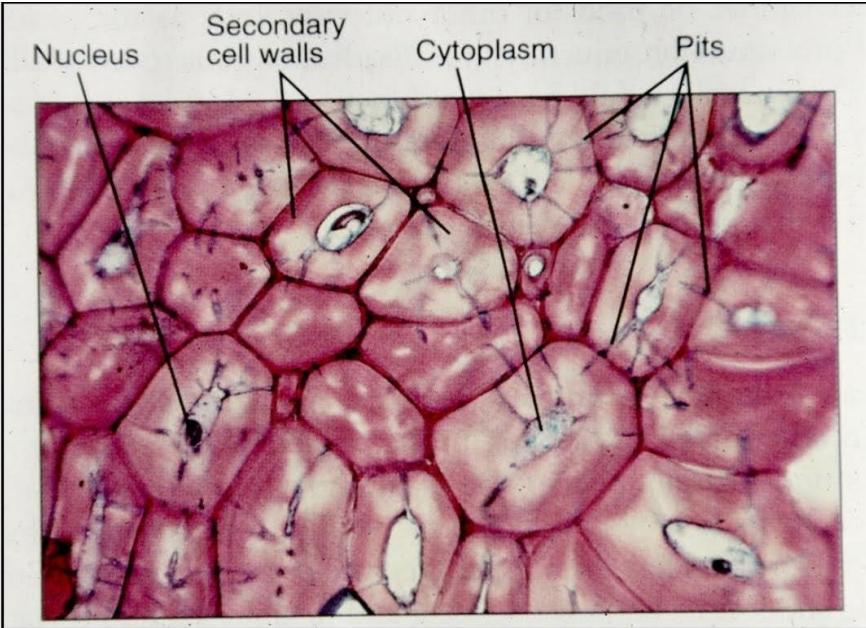
LACUNAR



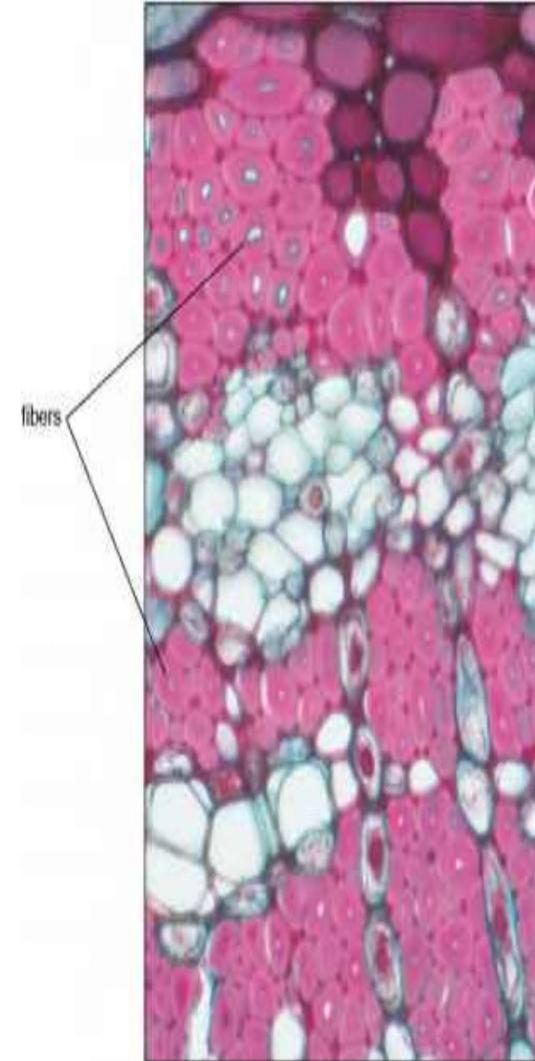
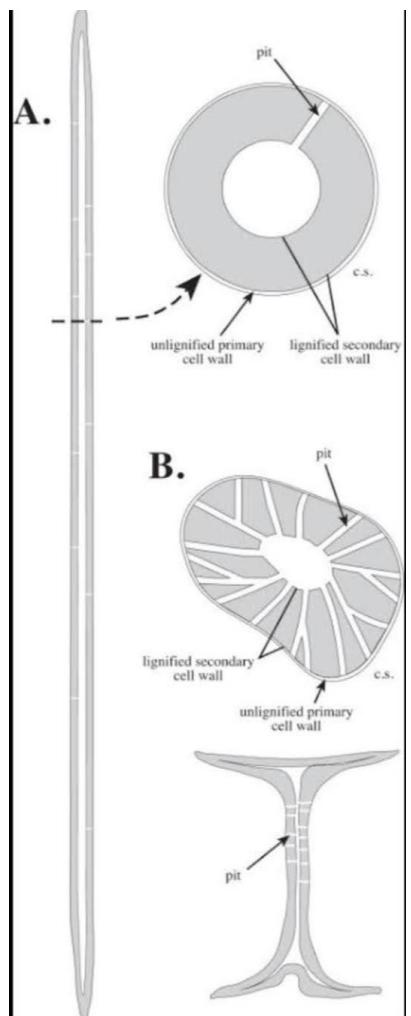


(C). (D) Angular collenchyma in *Plectranthus fruticosus* (Lamiaceae, eudicots). Note the sub-epidermal periderm tissue. (E) Intermediate type between tangential and lacunar collenchyma in *Geranium sobolifolium* (Geraniaceae, eudicots). Note the many intercellular spaces (arrows). (F) *Peperomia* sp. (Piperaceae, basal angiosperms) with annular collenchyma.

5. Two types of sclerenchyma occur
—fibers (which are long and tapering)
and **sclereids** (which are short in
length); both types have thick walls
and are usually dead at maturity.



Despite their thick walls, these sclereids remain living and they are interconnected by pits.



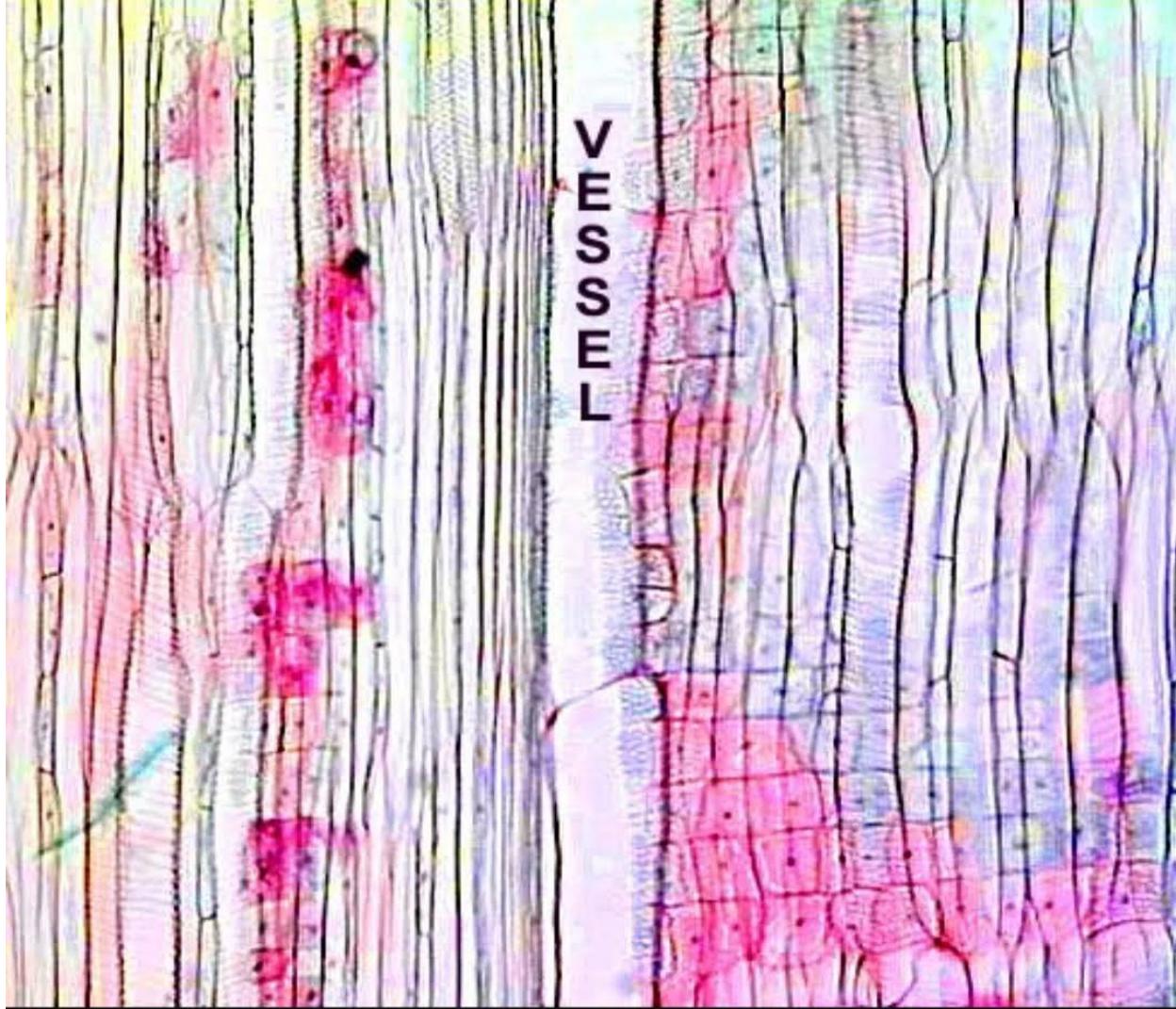


Figure 4. Q Spiral thickenings on the inside wall of a tra-cheid, x400.

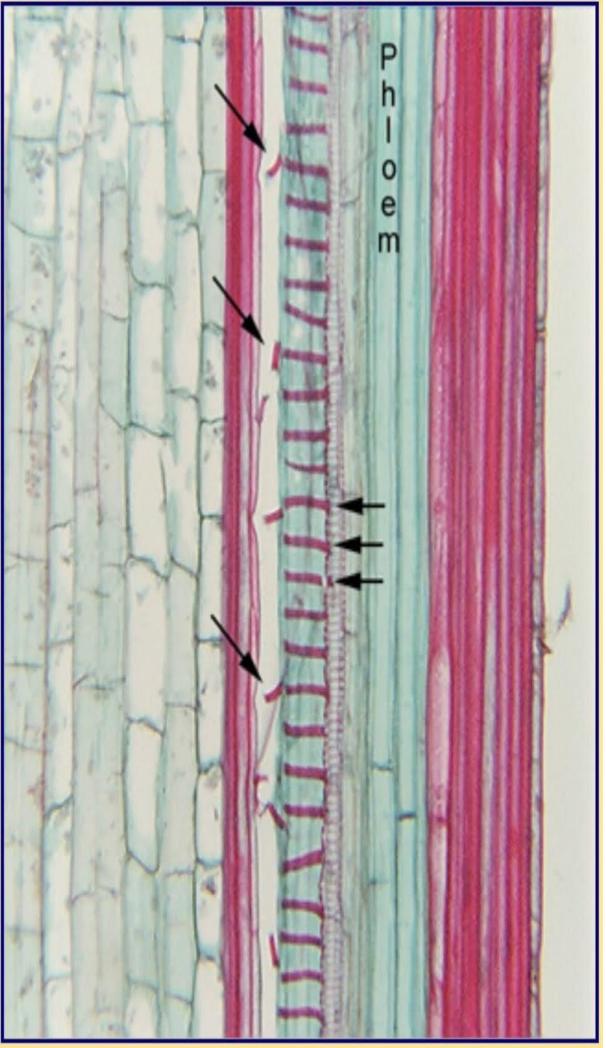
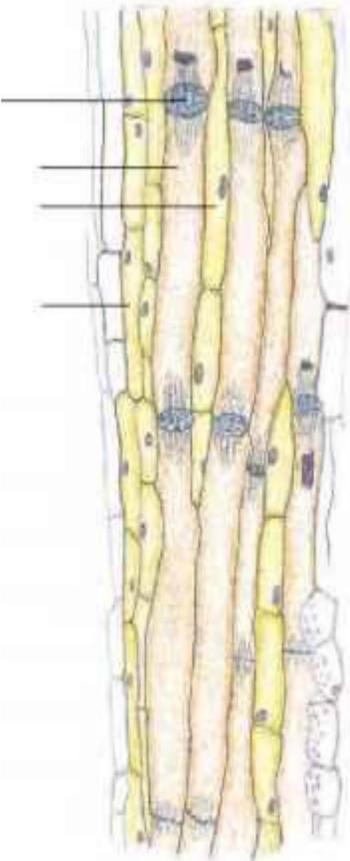
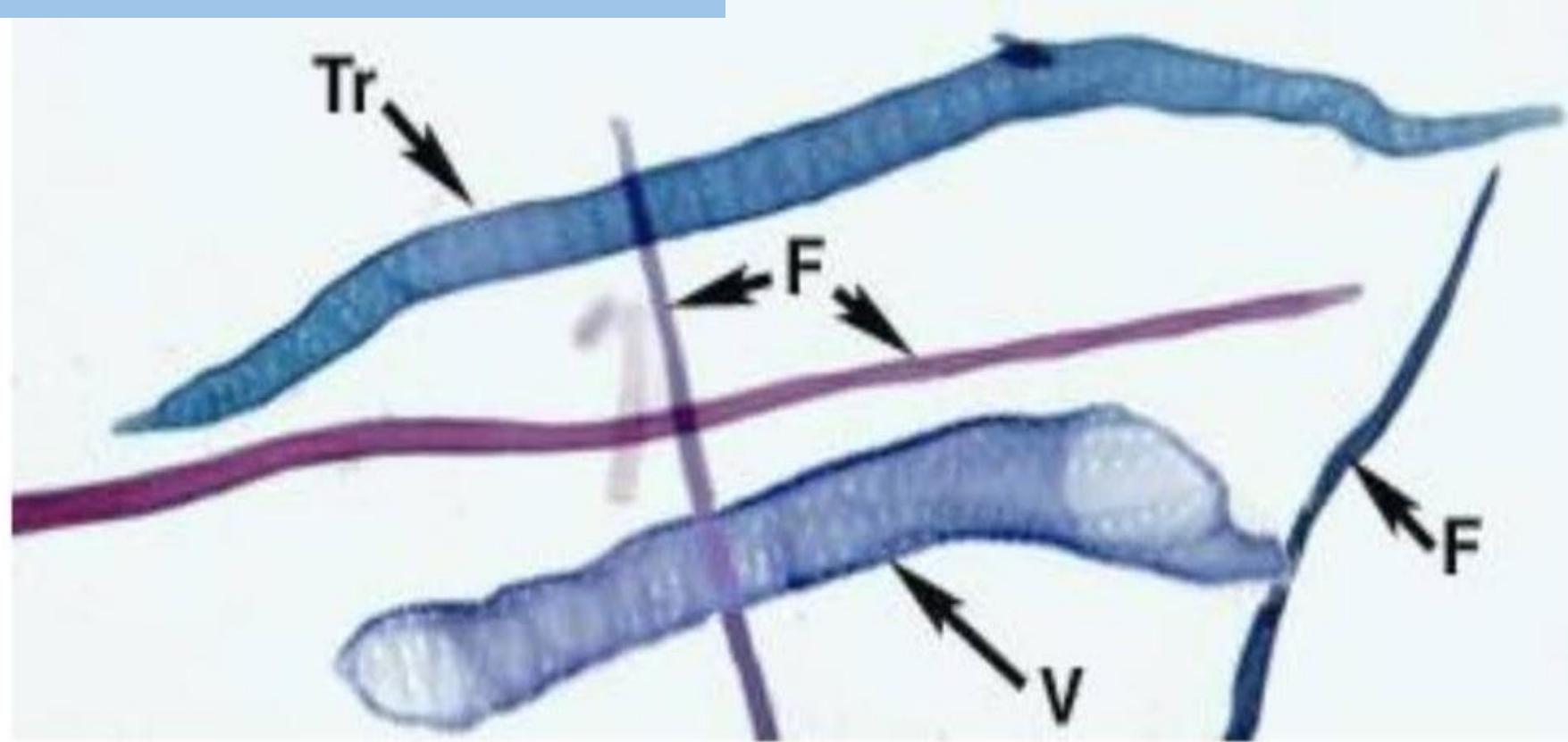


Figure 4.10 Longitudinal view of part of the phloem of a black locust tree (*Robinia pseudo-acacia*), x1,000.



Phloem parenchyma
sieve plate
sieve tube member
companion cell
Phloem parenchyma

MACERATED WOOD/ CONDUCTING TISSUE



Macerated Wood of Oak – Vessel Element. (V), Tracheid (Tr), Fibre

MACERATED WOOD



Figure (4): *S. aegyptiaca*. 1. Vessel member, very short with both ends transverse, 2 and 3. Vessel members of more or less transverse end walls, 4. Vessel member with one end wall transverse and the other oblique, 5. Vessel member with both ends oblique, 6. A very primitive vessel member with the both end walls steeply sloped, 7. Different types of libriform fibers, 8. Distal fiber portions showing different types of dentitions.

MACERATED WOOD : VESSEL MEMBERS,FIBER TRACHEID,& FIBRE

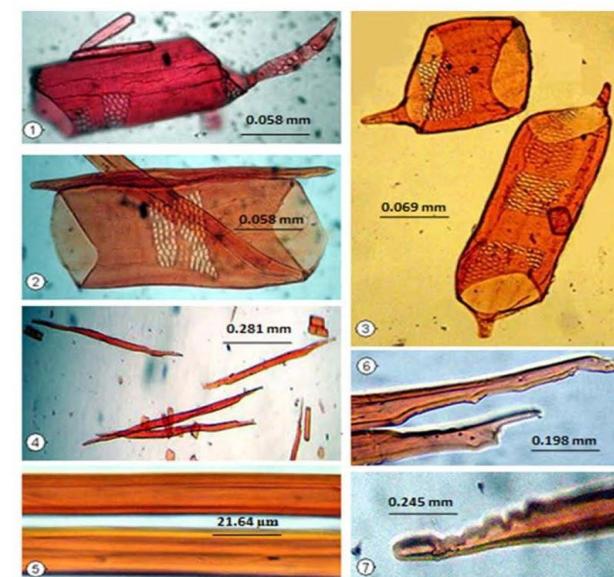


Figure (5): *S. purpurea*. 1. Vessel member with one end oblique and the other transverse, 2. Vessel member both end walls transverse, 3. Two vessel members, one (above) with mixed end walls, the other (below) with both end walls slightly oblique, 4. Libriform fibers, 5. Fiber cell wall thickness and cell lumen, 6 and 7. Two types of distal portions showing variable kinds of dentitions.

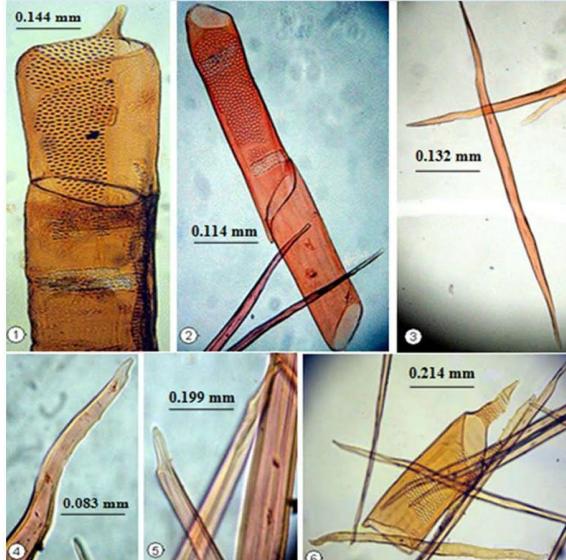


Figure (2): *S. acromphylax*. 1. Two ends by end connected vessel elements, both with two end transverse, 2. Two ends by end connected vessel elements, both with two ends oblique (140x), 3. Typically, straight-shaped libriform fiber, 4. Distal part of a fiber showing minute irregular dentitions, 5. Fiber cell wall and lumen with a fiber tip, 6. An irregular-shaped libriform fiber (below), Vessel member and numerous variously shaped libriform fibers (above).

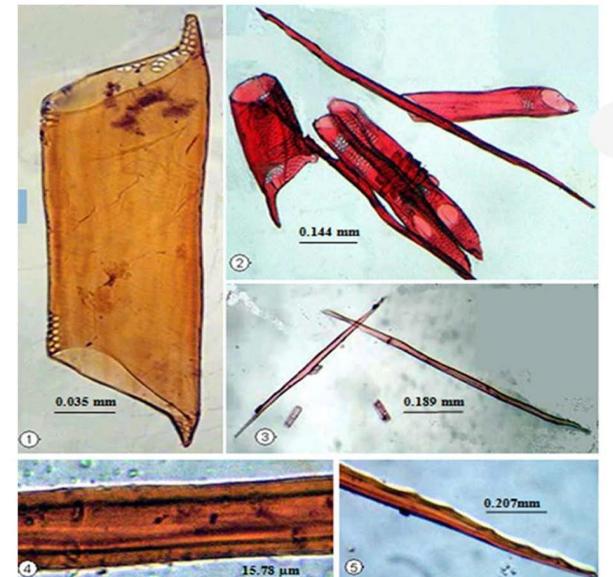


Figure (1): *S. alba*. 1. Vessel element, both ends slightly oblique, inter-vessel near adjoining vessels, 2. Vessels of variable ends and areas of pitting, 3. libriform fibers, 4. Medium part of a libriform fiber showing cell wall thickness and cell lumen, 5. Distal part of a libriform fiber showing dentitions on one side of the fiber.

A. Study of Anatomical structure of the Stem : DICOTYLEDONOUS STEMS

Characteristic feature of a dicotyledonous stem on the basis of anatomy—

- (i) There is a differentiation of ground tissue into cortex, endodermis, pericycle, hypodermis etc.
- (ii) The multicellular shoot hairs are normally present above the epidermal layer. ; Presence of well defined cuticle
- (iii) Mostly a multilayered collenchymatous hypodermis is present below the epidermis, termed as hypodermis.
der region is demarcated from the cortical region by the endodermis or starch
- (iv) The vascular bundles are always conjoint, collateral and open i.e. cambium is present. xylem endarch .
towards centre & metaxylem towards periphery.
- (v) The vascular bundles are arranged in a ring.
- (vi) Medullary rays present in between vascular bundles.
- (vii) Presence of definite pith.

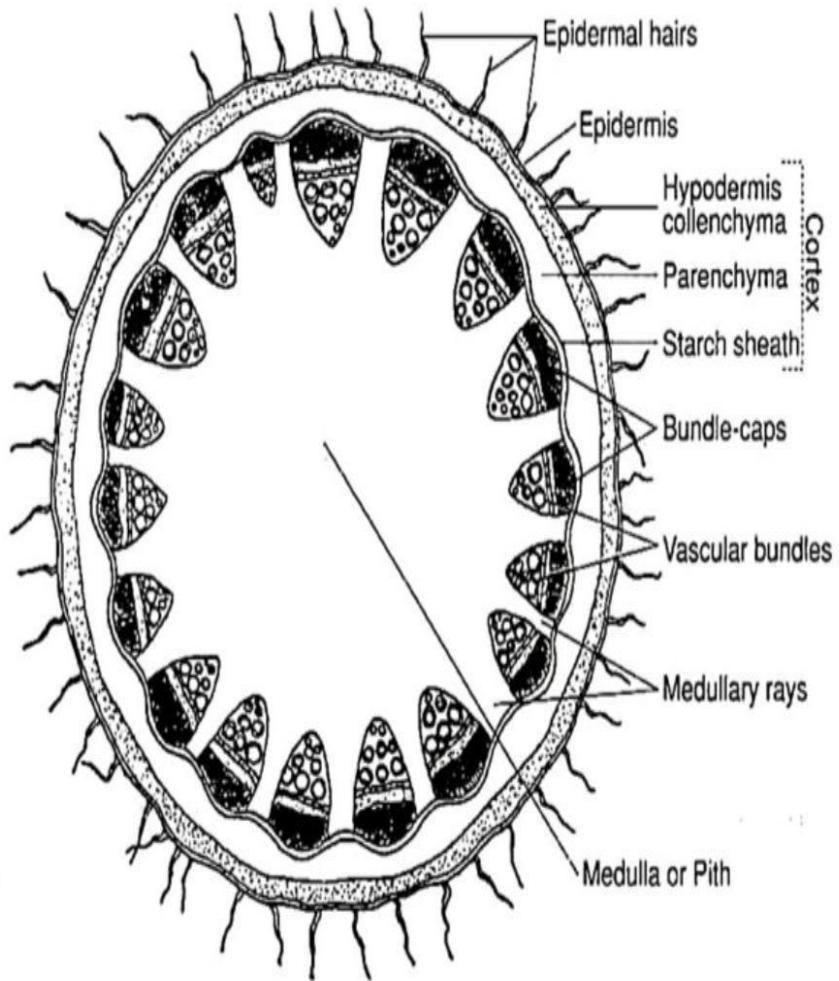


Fig. 5.86 : Diagrammatic anatomical view of young stem of sunflower in transverse section

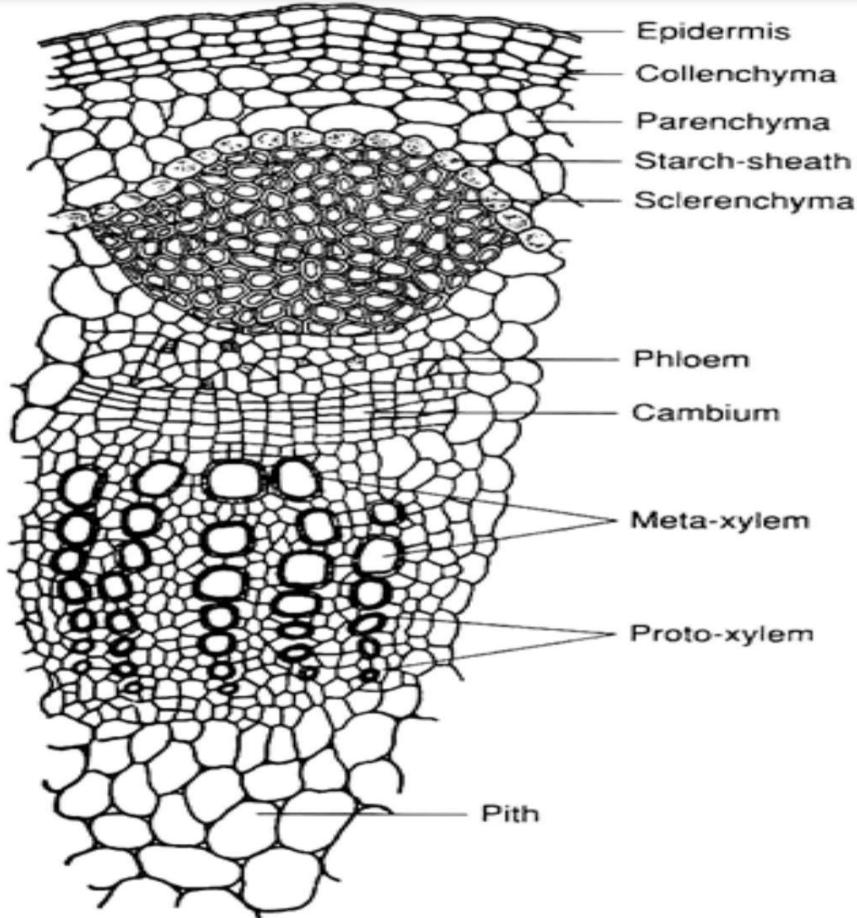


Fig.5.87 : A portion of the transverse section of young stem of sunflower showing the tissue distri-

~~1. Structures of the stem of HELIANTHUS (Sunflower) -~~
~~in T. S.~~

T. S. shows the following structures :—

1. **Outline**—Circular.
2. **Cuticle**—A well defined cuticle is present.
3. **Epidermis**—Single layered, barrel-shaped parenchyma cells, interrupted by stomata; multicellular epidermal hairs are present.
4. **Cortex**—It is differentiated into an outer collenchymatous hypodermis and inner parenchymatous region containing a number of secretory canals.

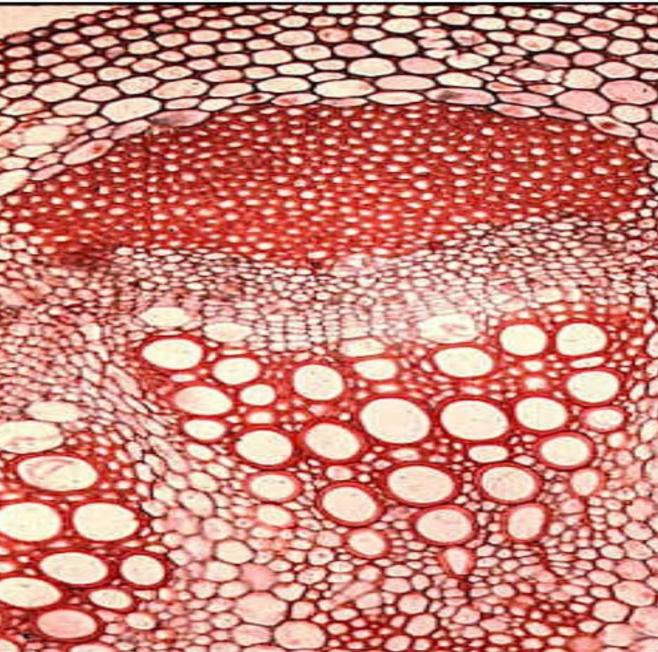
5. **Endodermis**—A uniseriate wavy well-defined layer of barrel-shaped parenchymatous cells containing starch grains.

6. **Pericycle**—It is in the form of crescent-shaped sclerenchymatous patches interrupted by parenchyma.

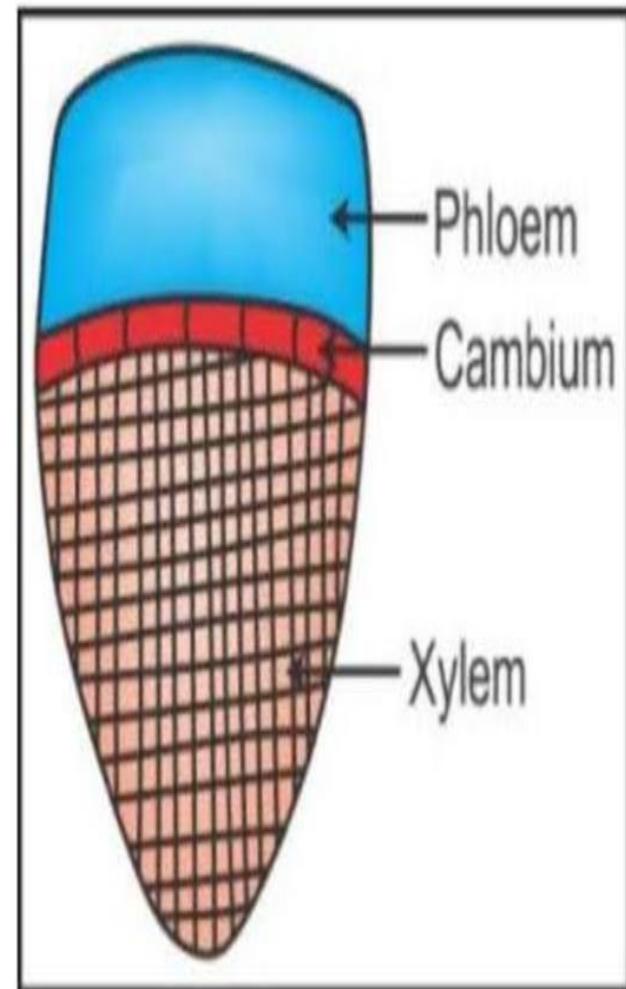
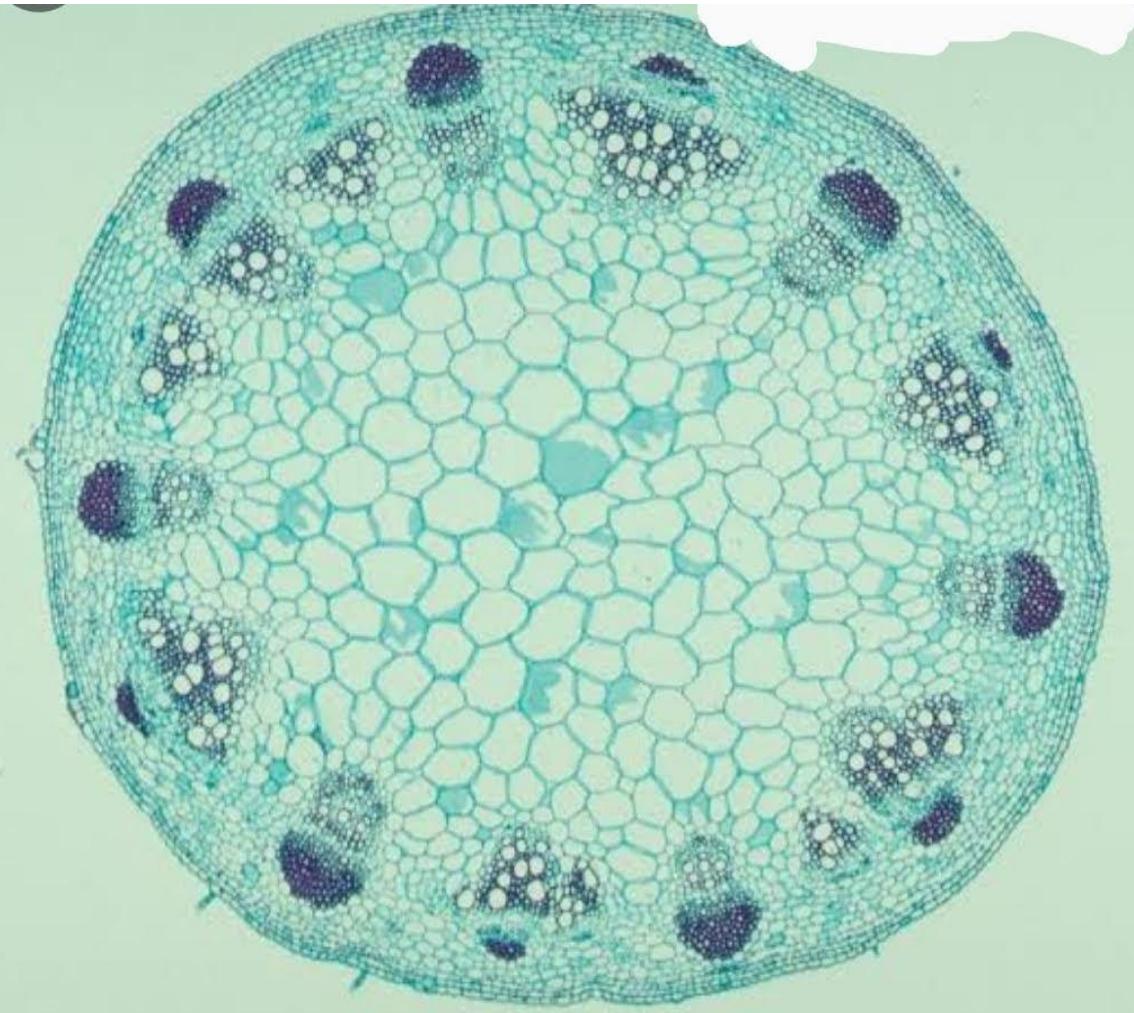
7. **Vascular region**—Bundles are collateral, endarch, open and arranged in a ring. Protoxylem is endarch. Medullary rays are prominent.

8. **Pith**—A parenchymatous pith is present in the centre.

Comment—It reveals a typical dicot. stem with a ring of open, collateral, endarch, bundles forming a dissected siphonostele. Pith is large and parenchymatous. Sclerenchyma patches form bundle caps.

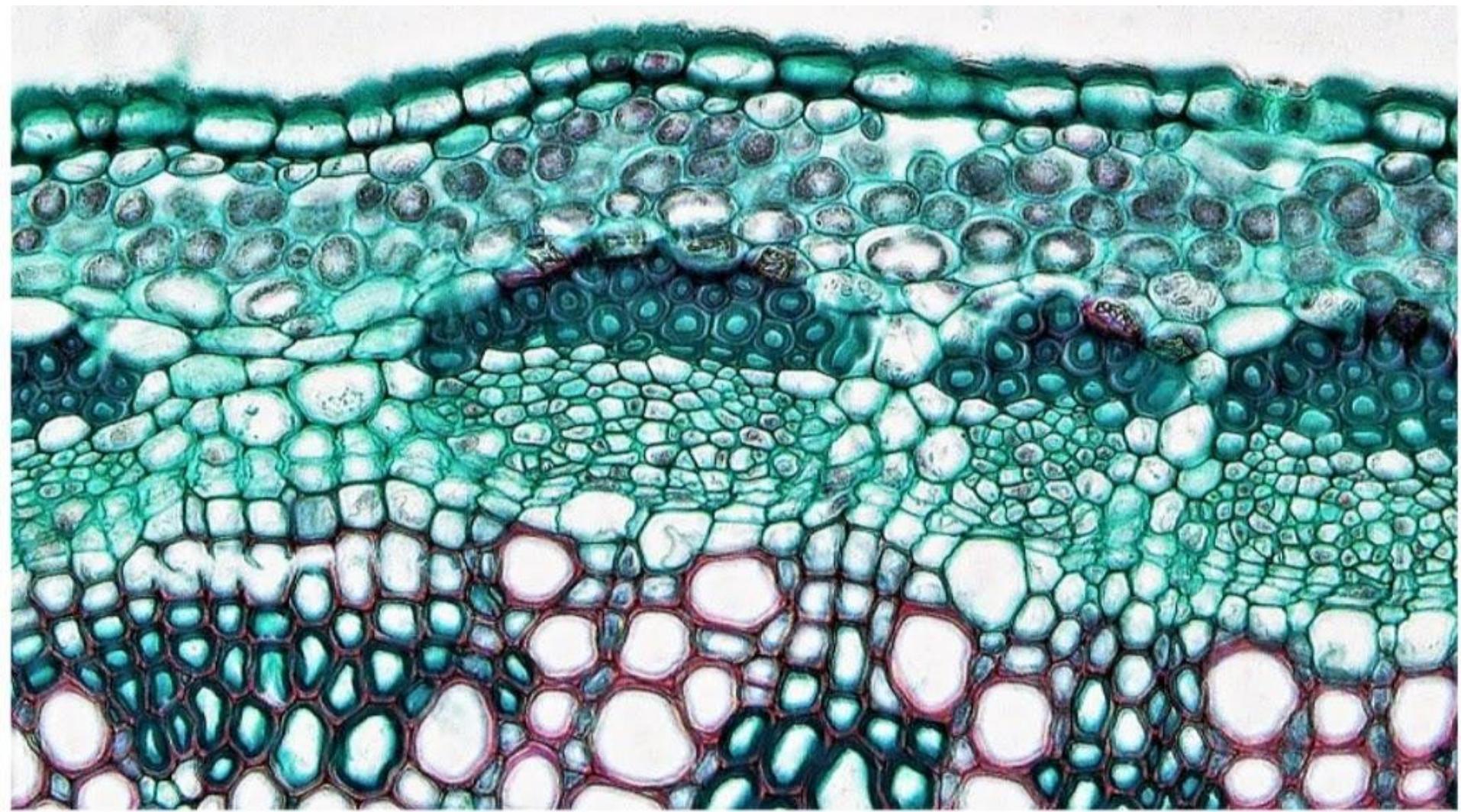


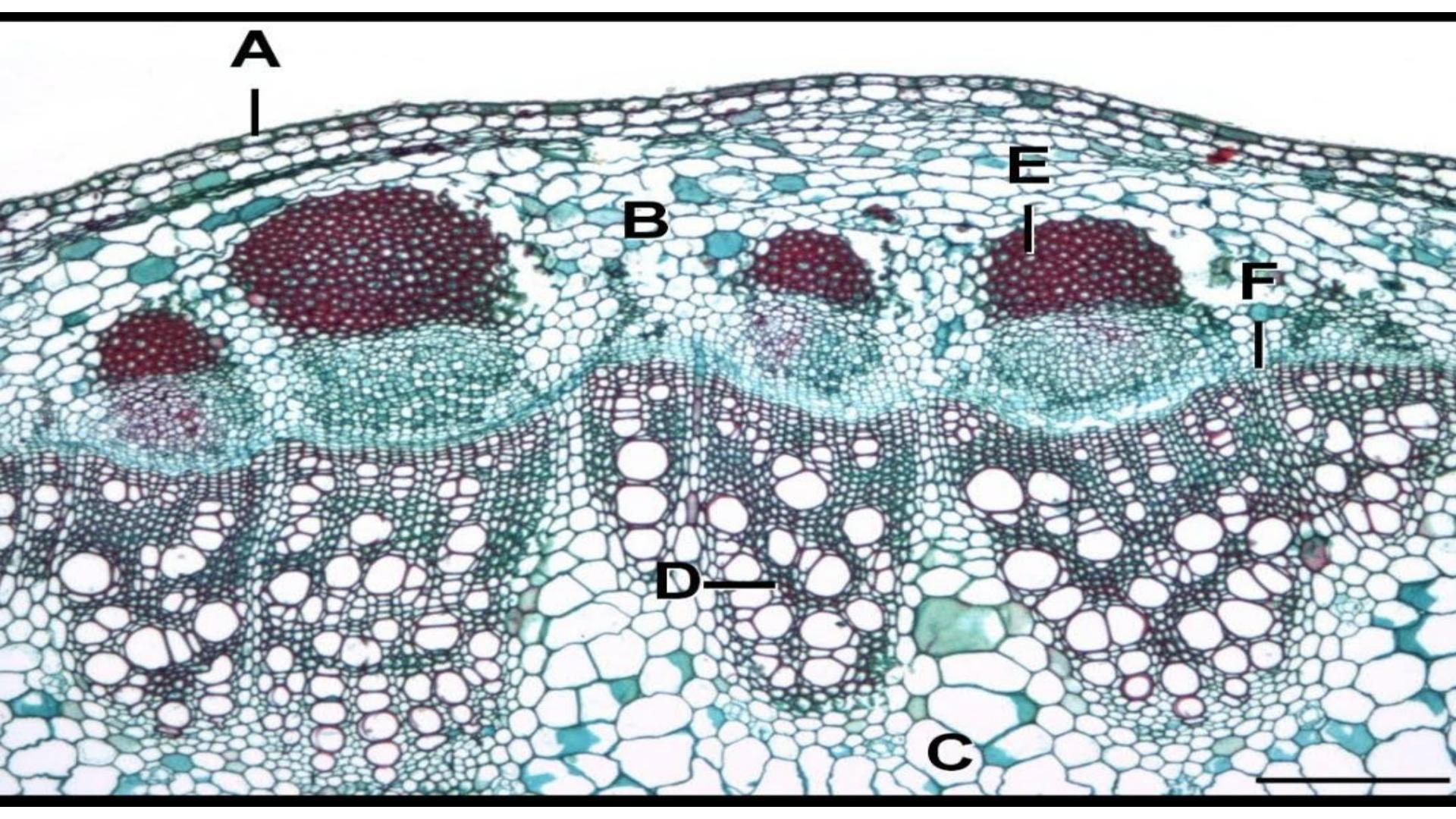
a) Open collateral : In this type, in between phloem and xylem strands lie a strip of lateral meristem called cambium (fascicular cambium). This is a characteristic feature of dicotyledonous stem.(A)

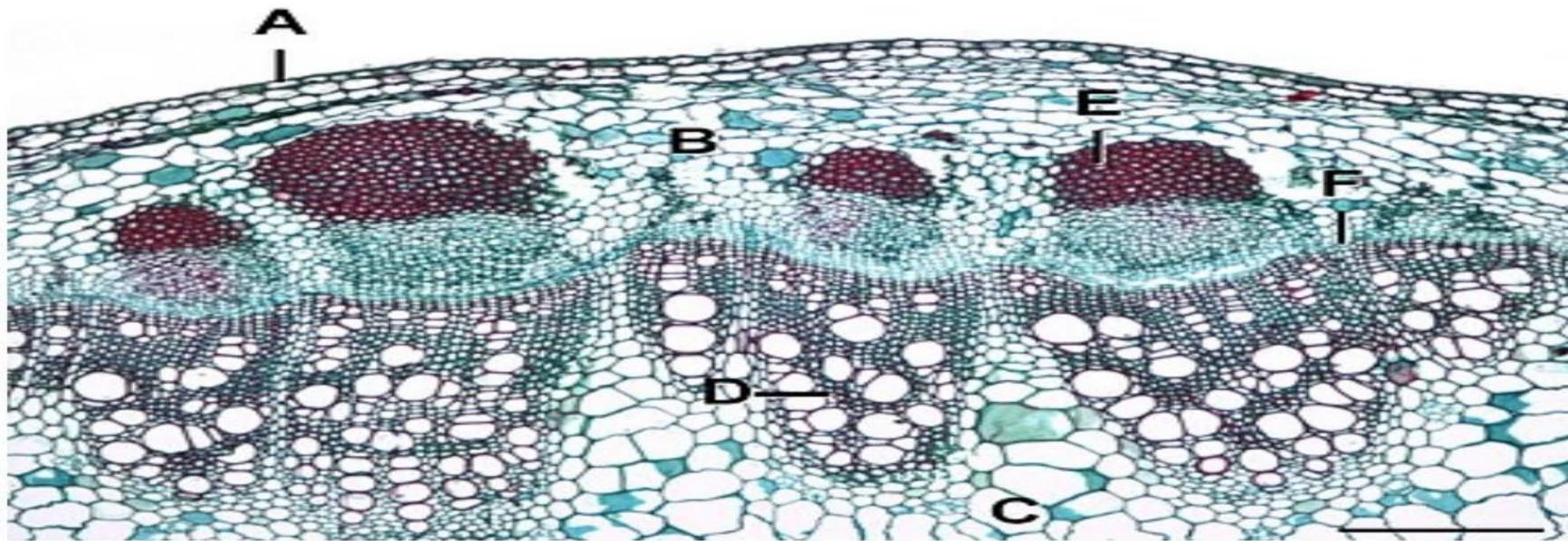


Sunflower Stem CS 40X 3dham.com

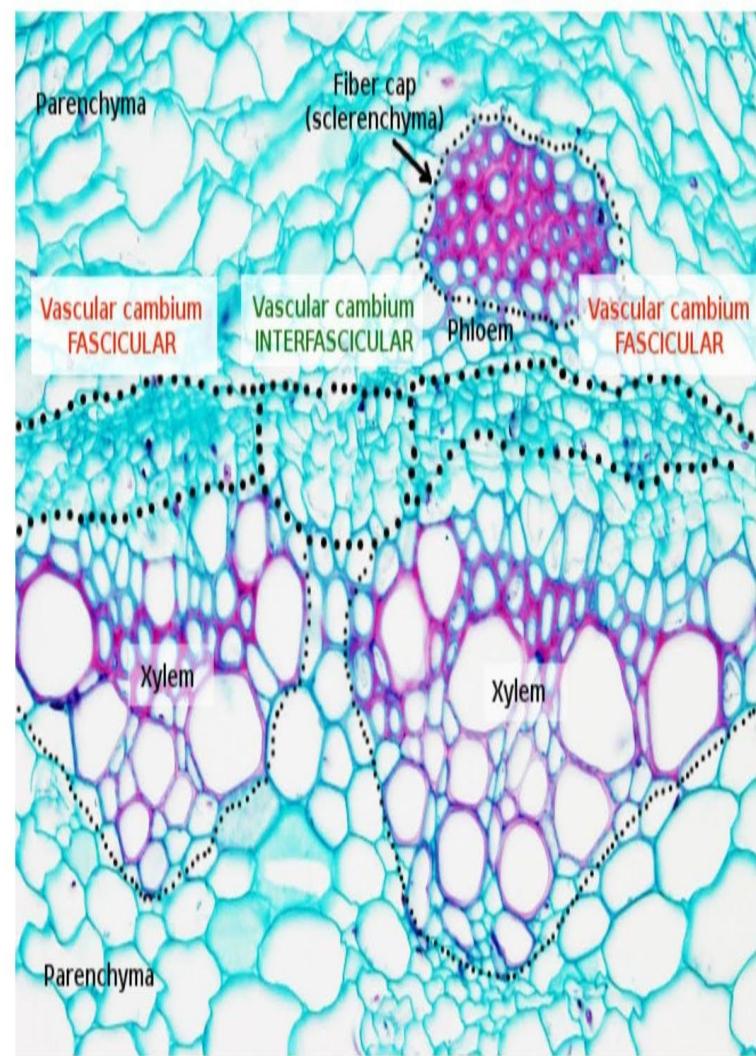
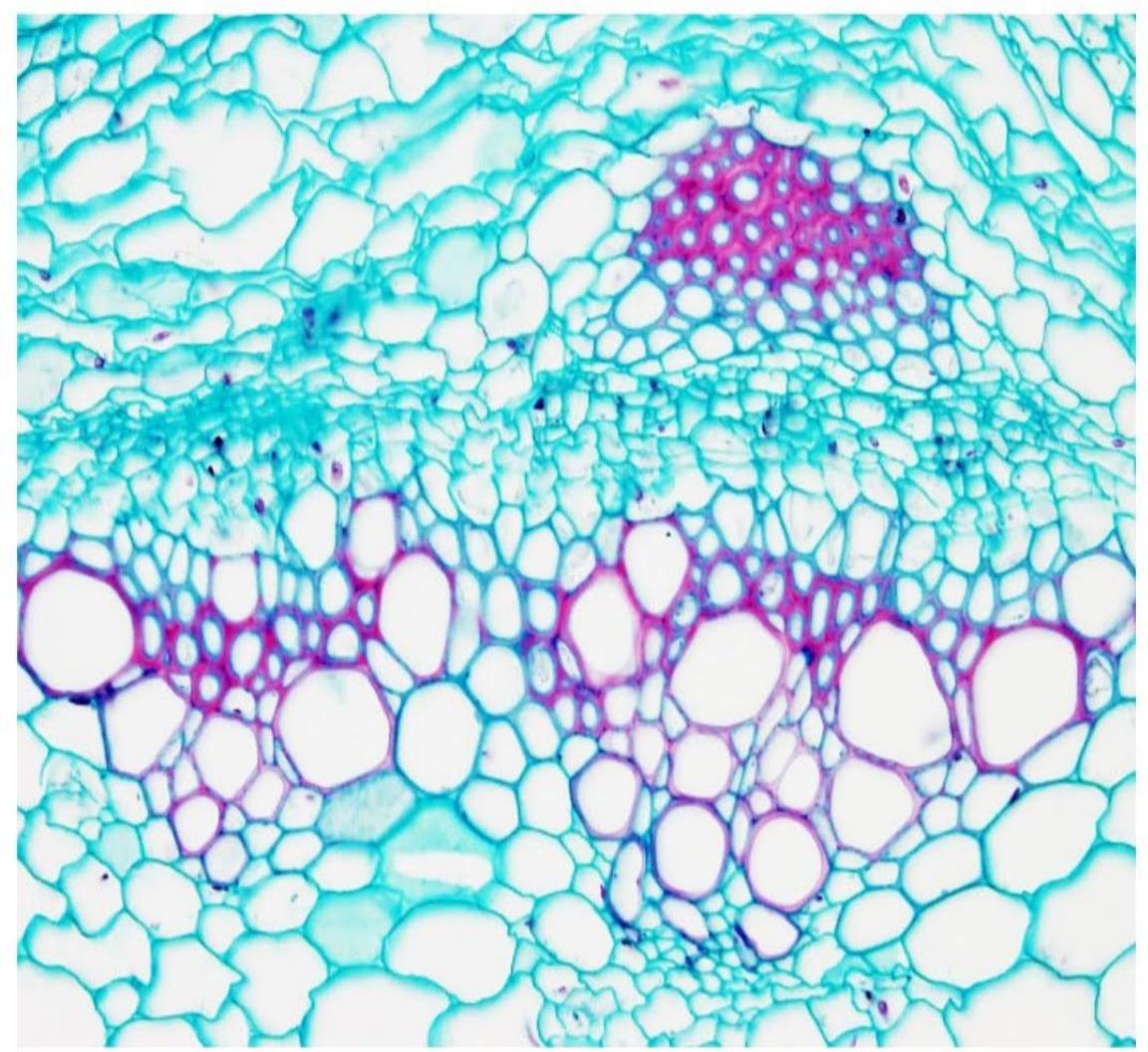


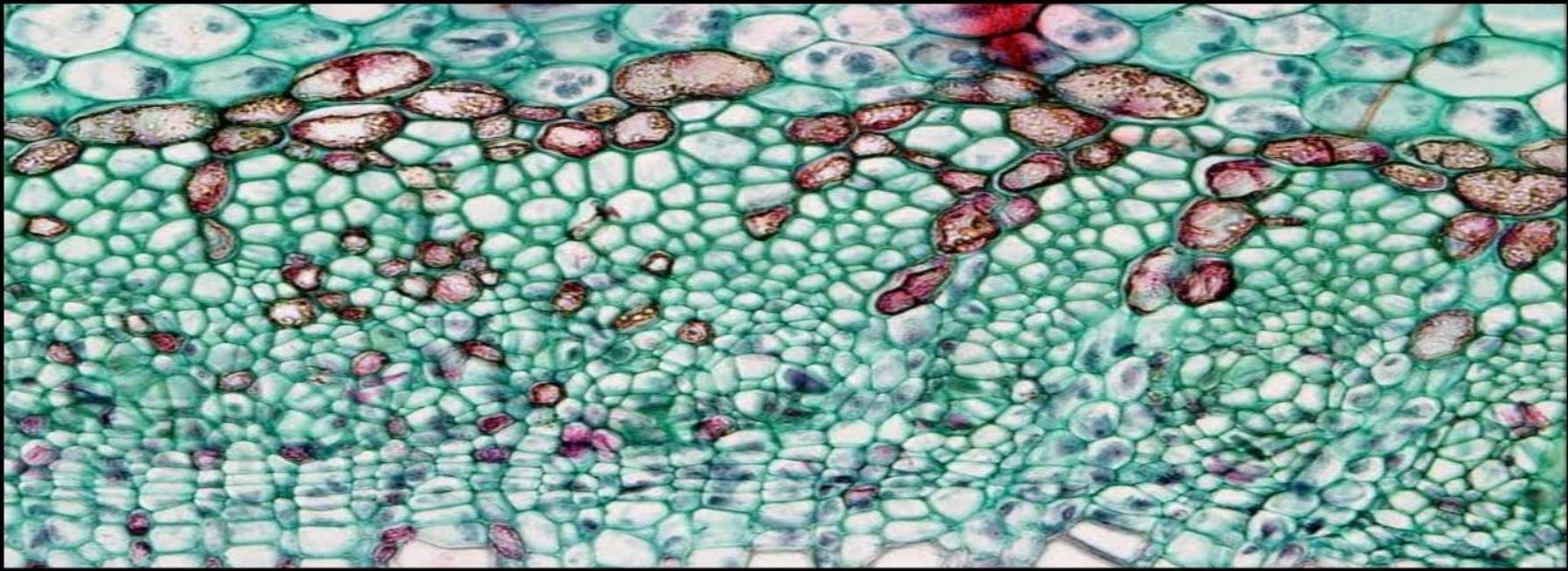






Helianthus stem in section. The cells of the vascular cambium (F) divide to form phloem on the outside, located beneath the bundle cap (E), and xylem (D) on the inside. Most of the vascular cambium is here in vascular bundles (ovals of phloem and xylem together) but it is starting to join these up as at point F between the bundles.





- Wikimedia Commons

**File:Woody Dicot Stem
Starch Sheath in Early Firs...**

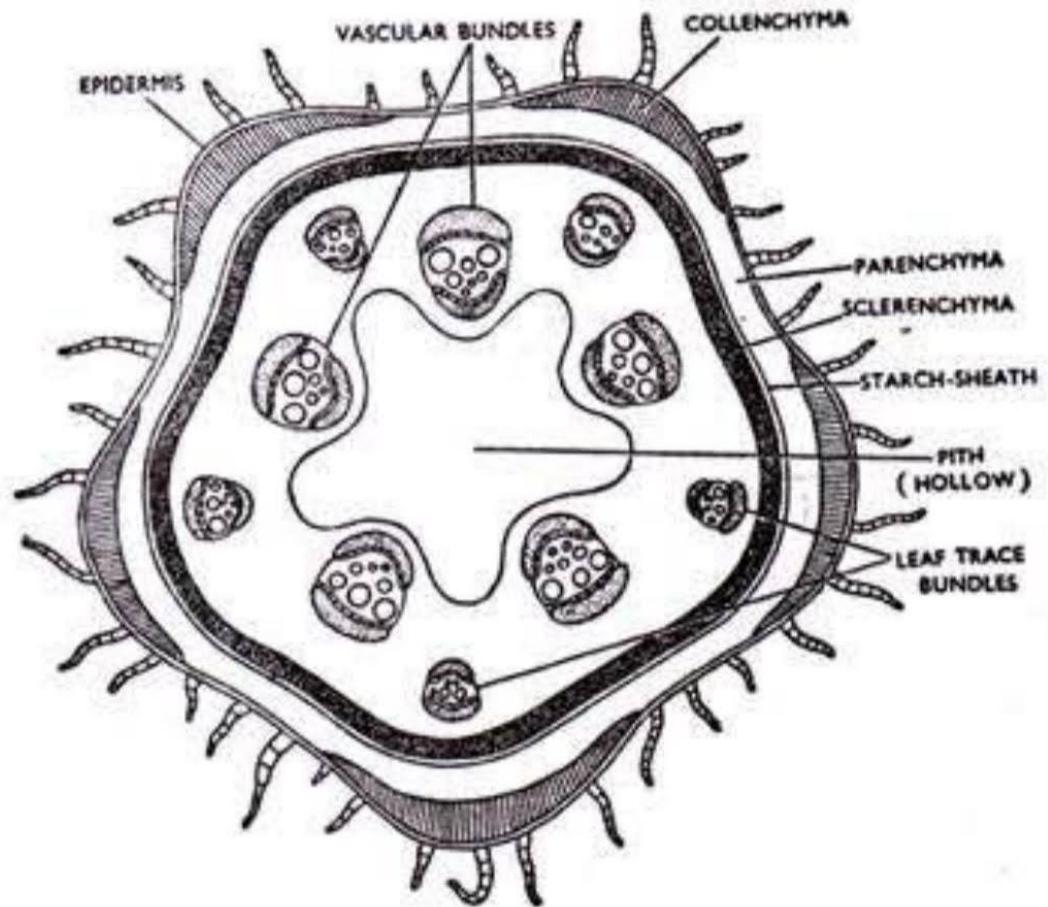
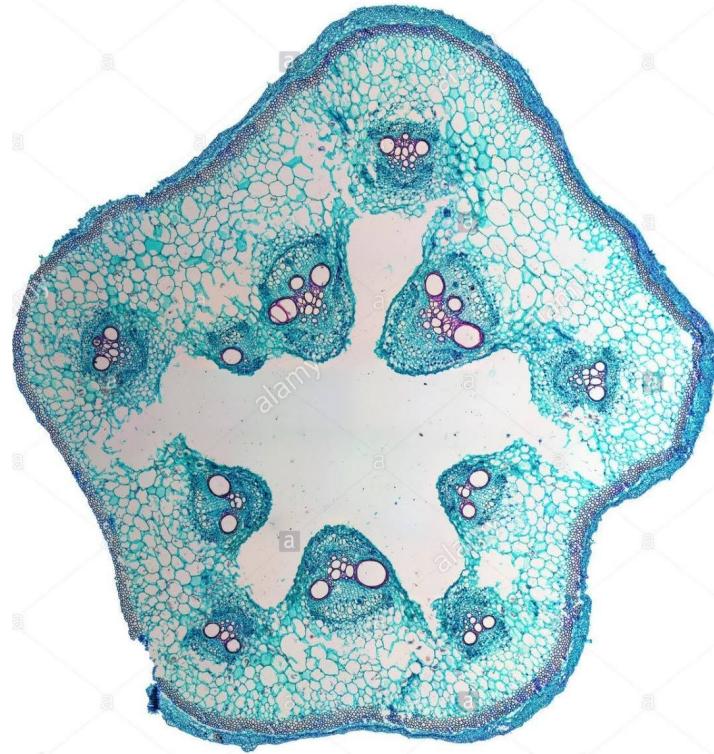


FIG. 584. Transverse section of a young stem of *Cucurbita* (diagrammatic).



✓ 2. Structures of the stem of CUCURBITA in T. S.

T. S. shows the following structures :—

1. **Outline**—Ridged and furrowed.
2. **Cuticle**—A thin layer of cutin covers the epidermis.
3. **Epidermis**—Single layered with multicellular hairs and stomata in furrows.
4. **Cortex**—Differentiated into two zones—outer hypodermis with collenchyma cells and inner general cortex with chlorenchyma cells.
5. **Endodermis**—Single layered, barrel-shaped cells with starch.
6. **Pericycle**—Sclerenchymatous, continuous, a few layered.
7. **Ground tissue**—Parenchymatous within which two rings of vacular bundles are present.
8. **Vascular bundles**—Bicollateral, endarch. The outer smaller correspond to ridges and the inner bigger correspond to furrows.
9. **Pith**—Hollow.

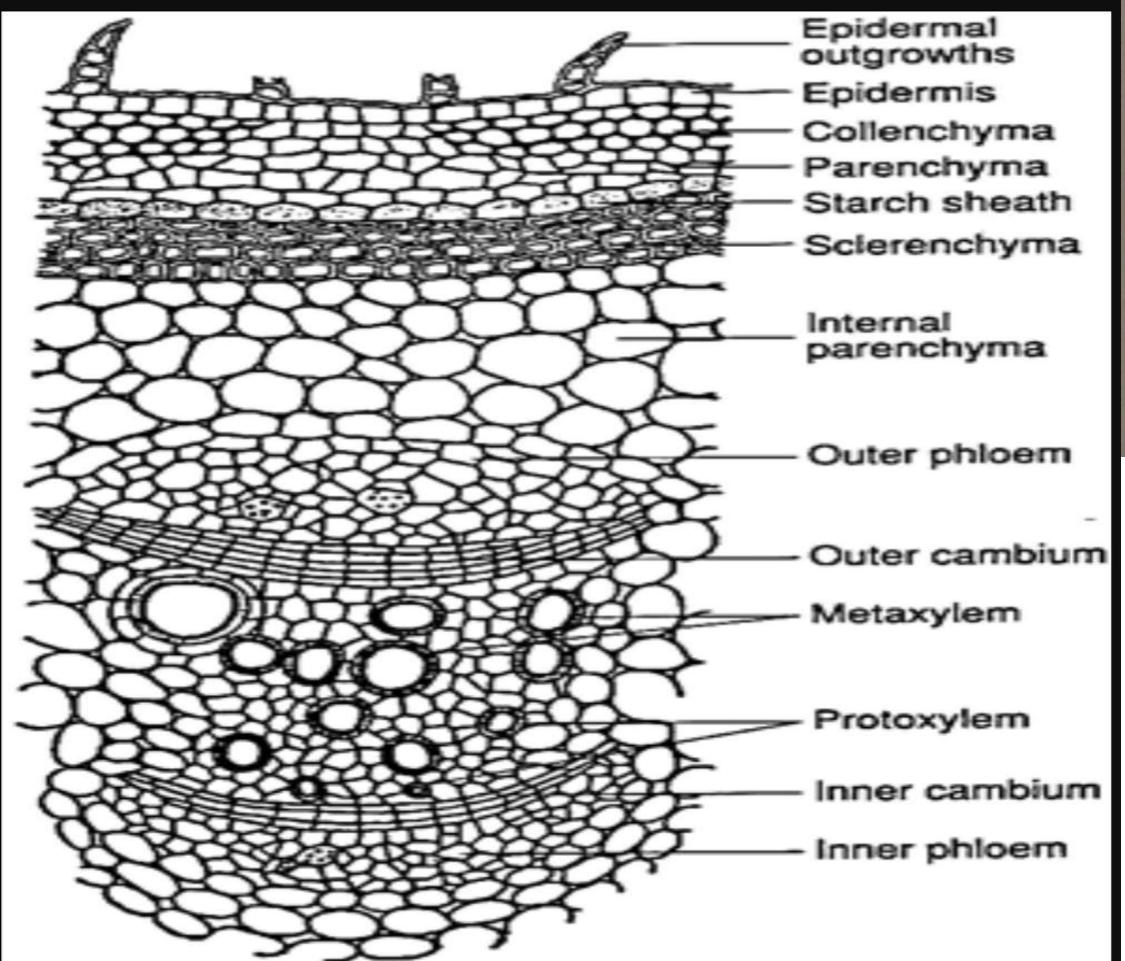
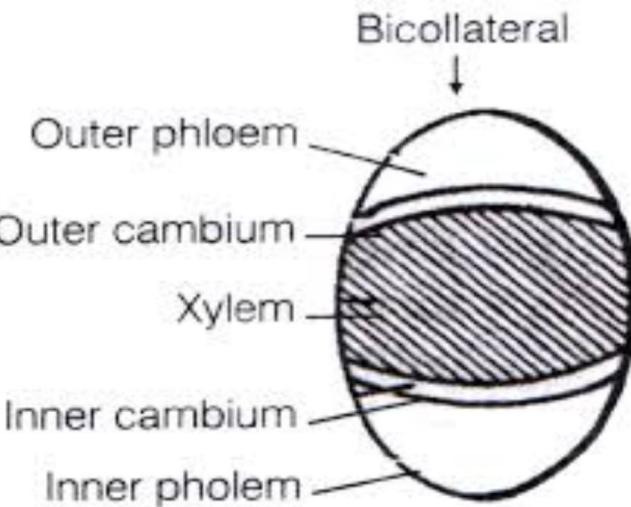
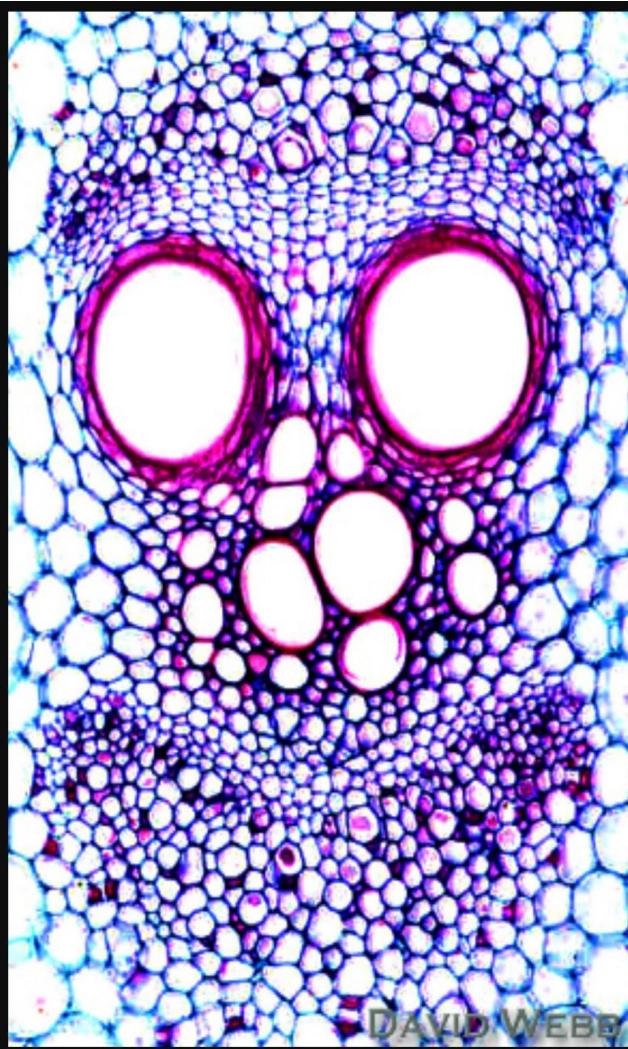
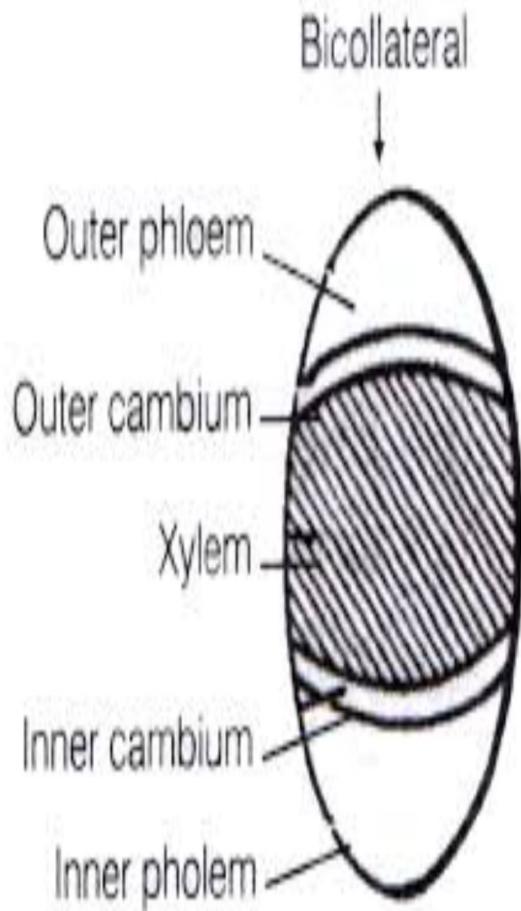


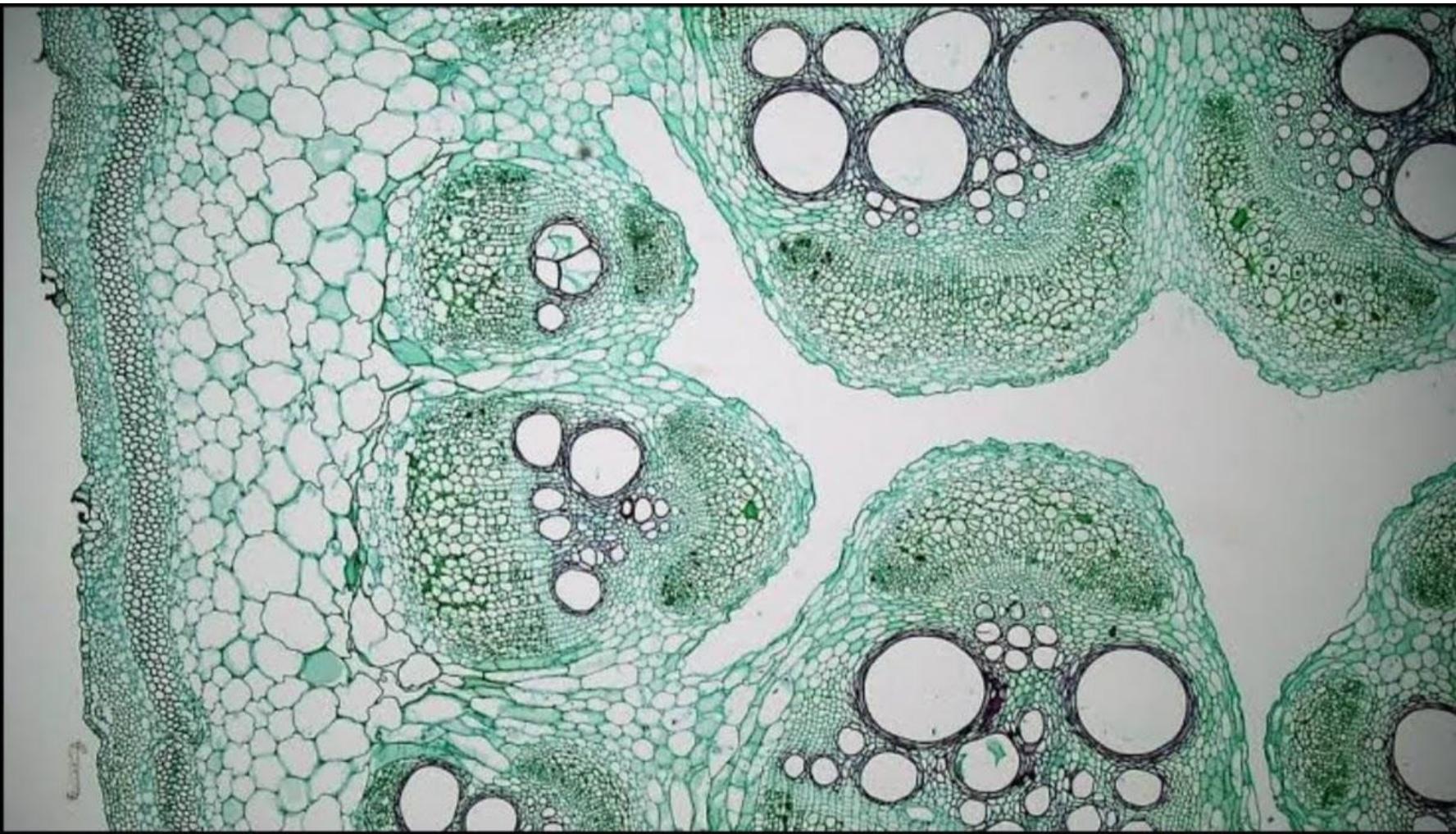
Fig. 5.89 : The cellular diagram of a portion of young *Cucurbita* stem in T.S. to show the tissue distribution

Comment—It reveals a typical dicot. stem with open, bicollateral, endarch vascular bundles occurring in two rings. Smaller bundles are alternating with larger ones. Outline of the structure is wavy. Pericycle is continuous and pith hollow. Metaxylem is very large.





2. Bicollateral bundle - If the xylem tissue is situated in the middle and the phloem tissue is present on the both outer and inner sides separated from the xylem by strips of cambia in between is termed to be as a bicollateral bundle.(C)



2.2.2 Collenchyma

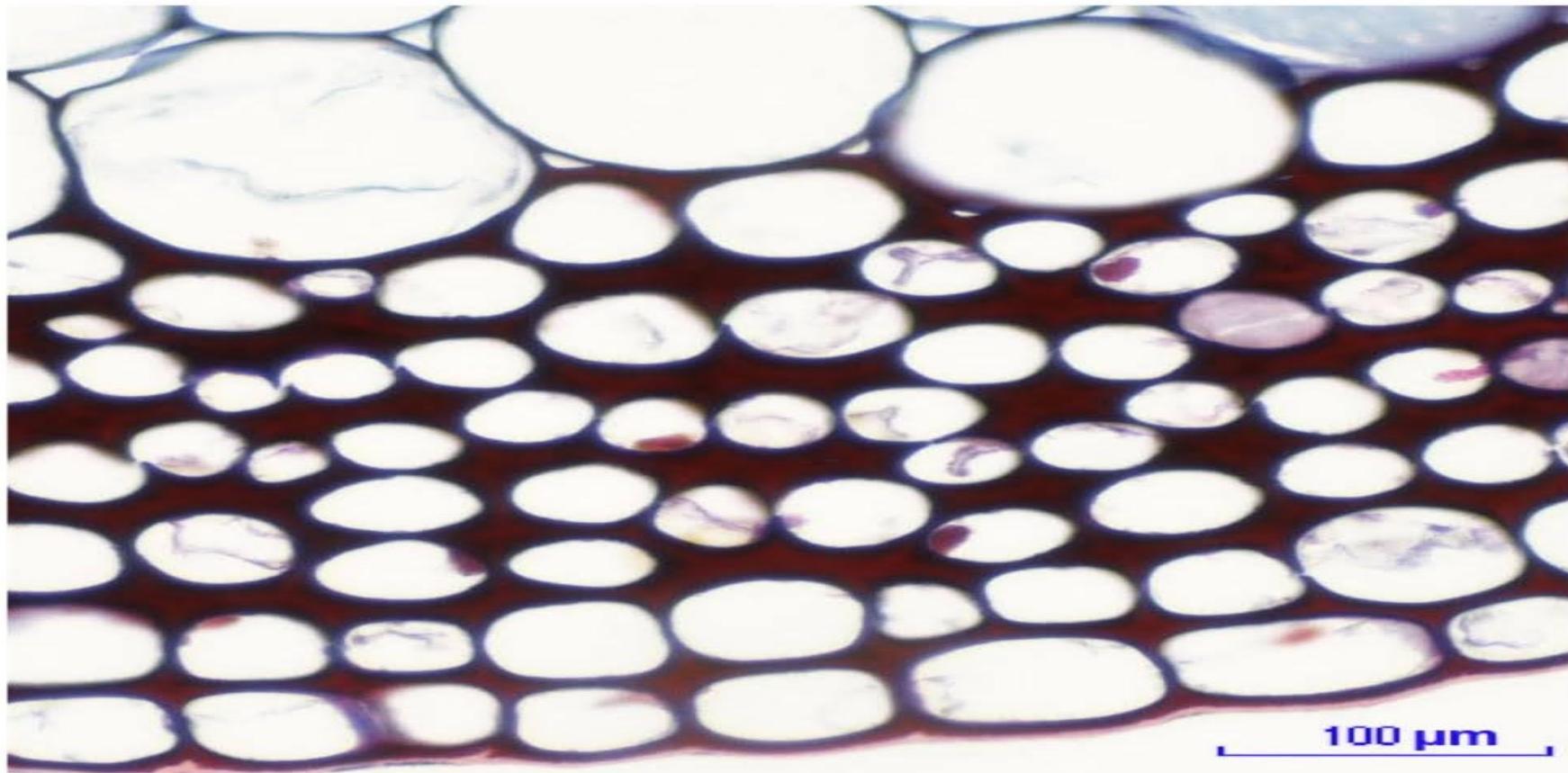
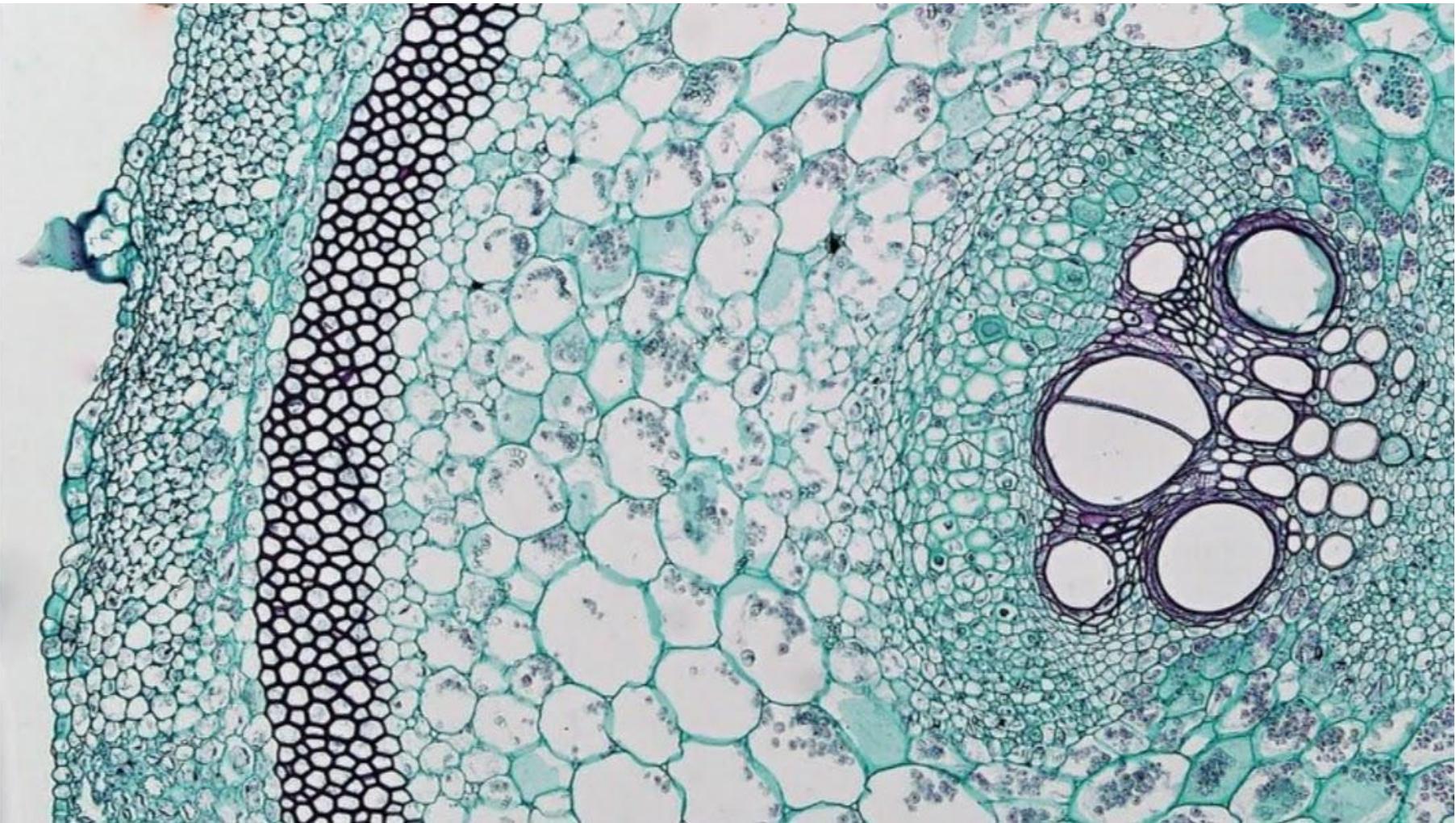
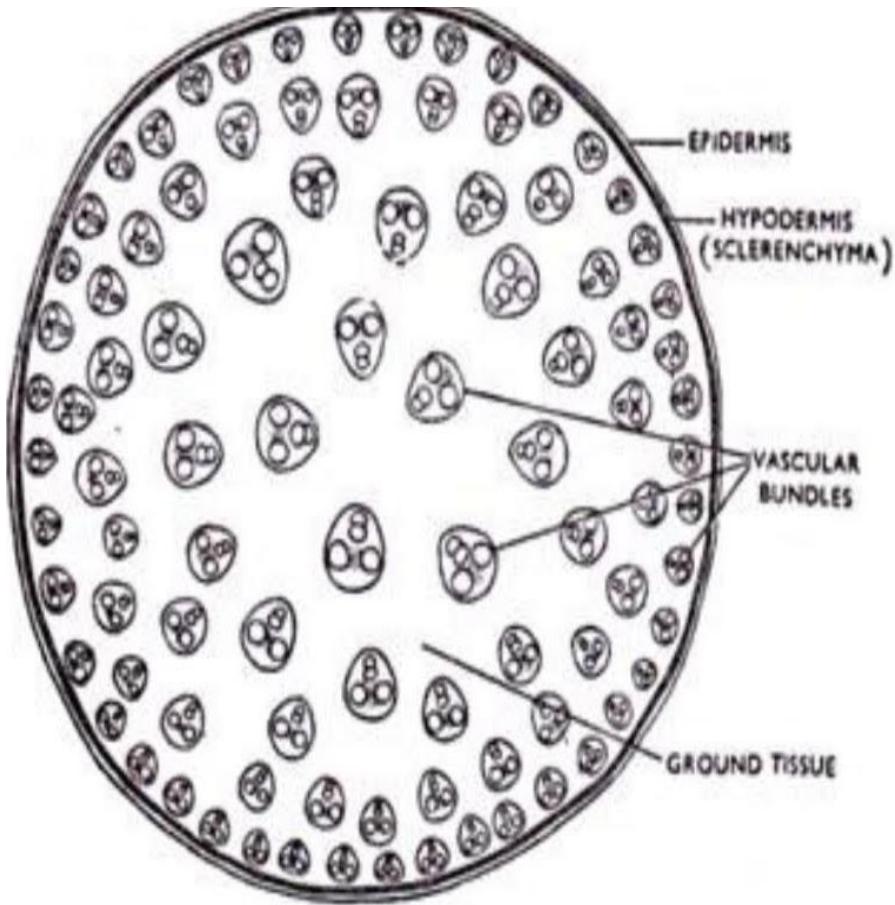


Figure 2.5.a. Collenchyma cells of





590. Transverse section of stem of *Zea mays* (maize) [diagrammatic]

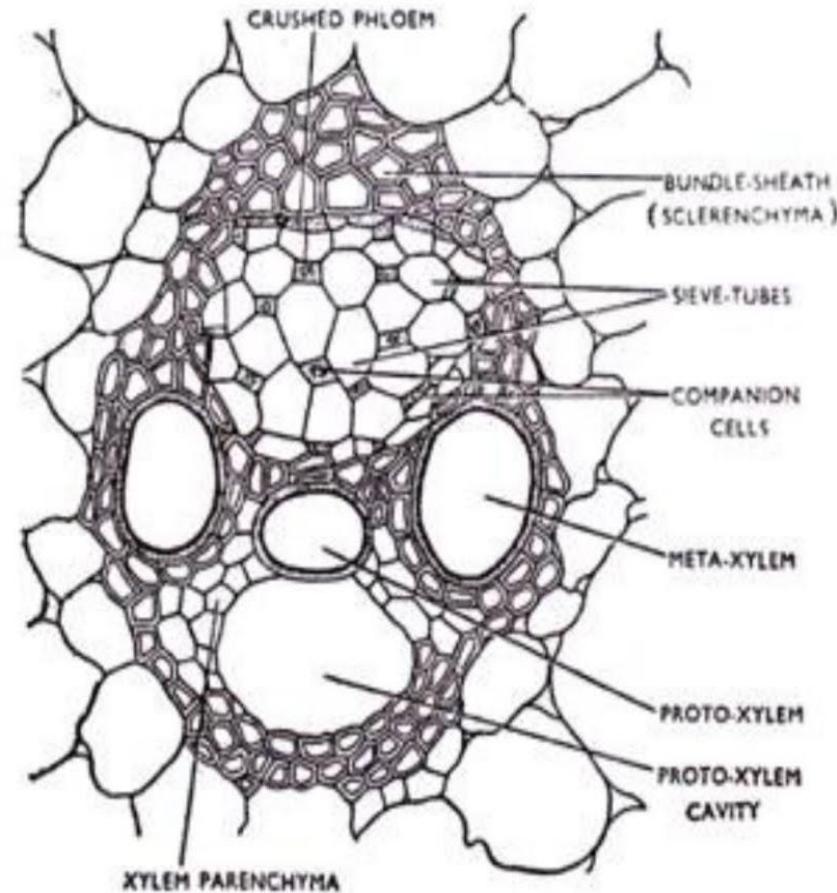


FIG. 592. A vascular bundle of stem of *Zea mays* (maize) [magnified].

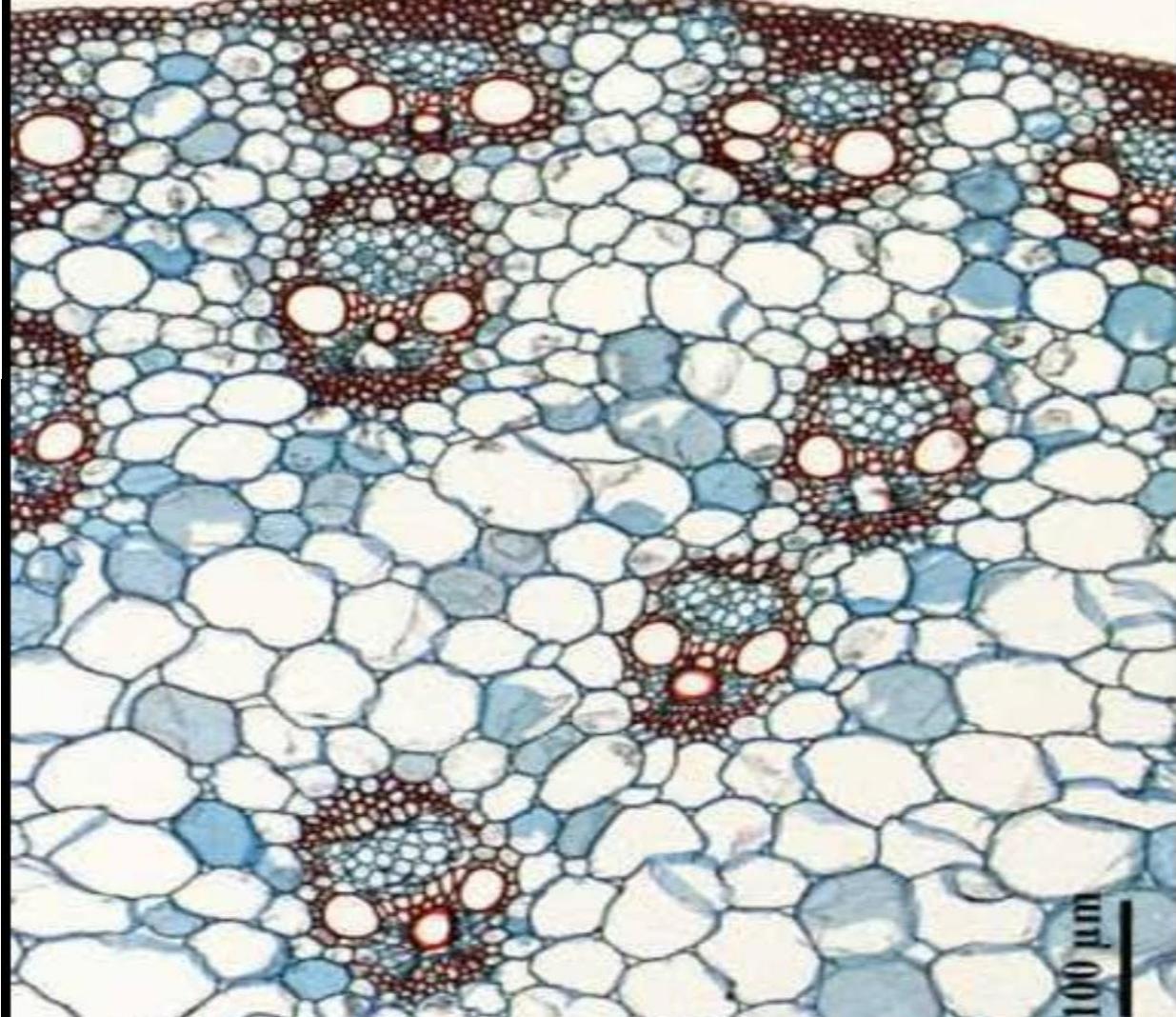
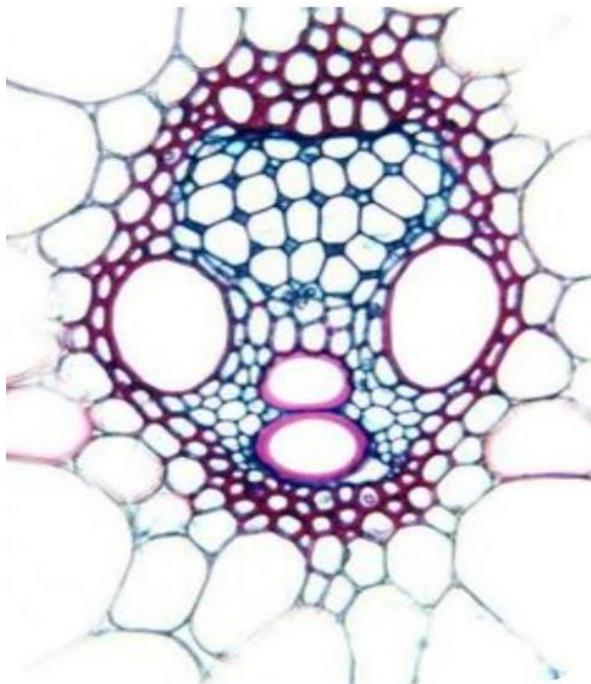
MONOCOTYLEDONOUS STEMS

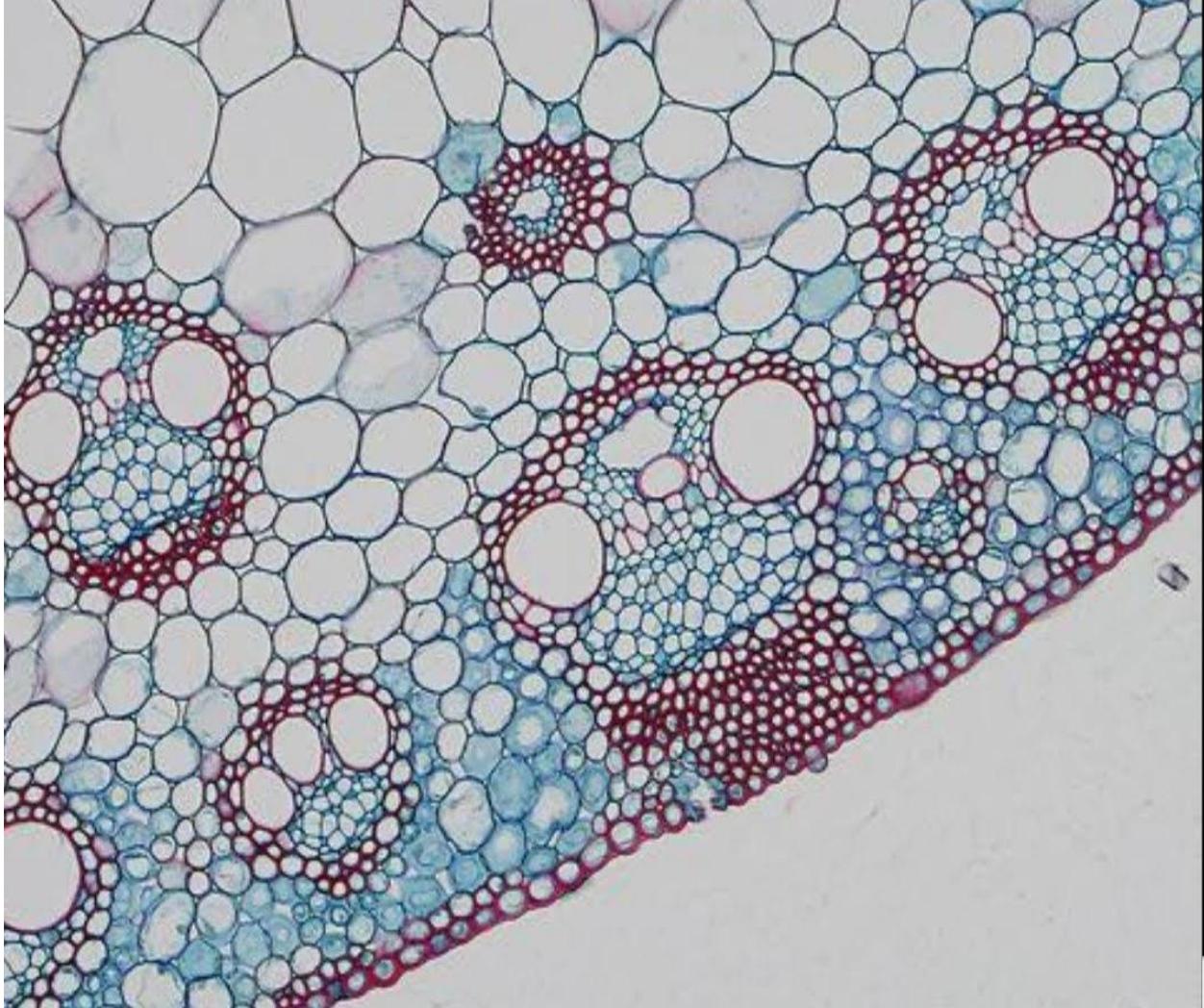
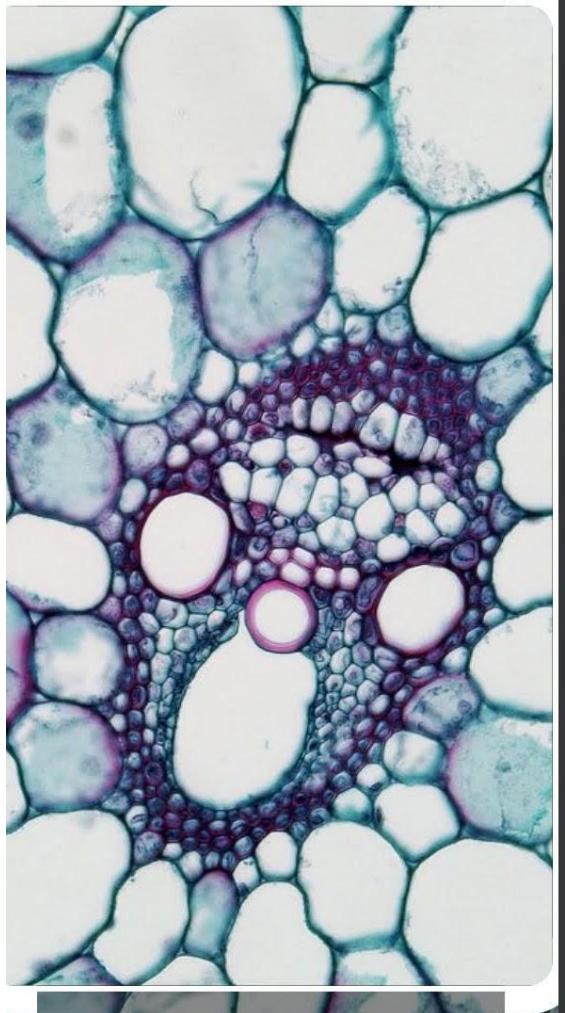
The most distinctive and characteristic anatomical features of a monocotyledonous stem on the basis of anatomy are as follows :—

- (i) The absence of shoot hairs on the outer side of epidermis.
- (ii) The hypodermis is sclerenchymatous.

- (iii) No further differentiation of ground tissue i.e. cortex, endodermis, pith, etc.
- (iv) The vascular bundles are lying scattered ^{all over} in the ground tissue and are many in number.
- (v) The vascular bundles are collateral and closed i.e. there is no cambium. ^{with each xylem}
- (vi) The vascular bundles remain surrounded by a sclerenchymatous sheath.
- (vii) Pith and medullary rays are absent.

b) Closed collateral : In this type, cambium is absent between xylem and phloem. This type is characteristic feature monocotyledonous stem.(B)





15. Structures of the MAIZE stem in T. S.

T. S. shows the following structures :—

1. **Outline**—Round.
2. **Cuticle**—A thick cuticle present.
3. **Epidermis**—A uniseriate layer of barrel-shaped parenchymatous cells without any hairs.
4. **Hypodermis**—Few layers thick and sclerenchymatous.
5. **Ground tissue**—Thin walled parenchymatous with intercellular spaces.
6. **Stele**—Atactostele.
7. **Vascular bundles**—Numerous, oval shaped, conjoint, collateral, endarch and closed. These are scattered in the ground tissue. The bandles towards the periphery are smaller in size whereas the inner bundles are larger in size. Each bundle is surrounded by a sheath of sclerenchymatous fibres.

Xylen—Composed of four circular vessels arranged in the form of a 'Y'. Lysigenously formed water cavity is seen close to protoxylem on the lower side.

Phloem—Composed of sieve tubes and companion cells only.

Comment—It is a typical nonocot. stem showing scattered, collateral and closed vascular bundles, each of

which is encircled by sclerenchymatous sheath. Small bundles towards the periphery and larger ones towards the centre. Xylem arranged in the form of 'Y'. Hypodermis is sclerenchymatous. Ground tissue is not hollow.

DICOT & MONOCOT ROOTS

B. Study of Anatomical structures of the Root

DICOTYLEDONOUS ROOTS

Distinctive anatomical features of the dicotyledonous root :—

- (i) The vascular bundles are radial i.e., they are radially arranged.
- (ii) The xylem is exarch i.e., protoxylem is towards the periphery and metaxylem towards the centre.
- (iii) Presence of unicellular root hairs on the outside of epiblema.
- (iv) The xylem bundles vary from two to six in number.
- (v) The pith is normally reduced. *or absent*
- (vi) There is no cambium but secondary cambium arises. *at a later period of growth*
- (vii) Presence of secondary growth.

20. Structures of the root of CICER (gram) in T. S.

T. S. shows the following structures :—

1. Outline—Circular.
2. Epiblema—Outermost single layered with unicellular root hairs. Cuticularised.
3. Cortex—Simple, homogeneous, parenchymatous with intercellular spaces.
4. Endodermis—Single layered. Composed of barrel shaped cells, with casparyan thickenings.

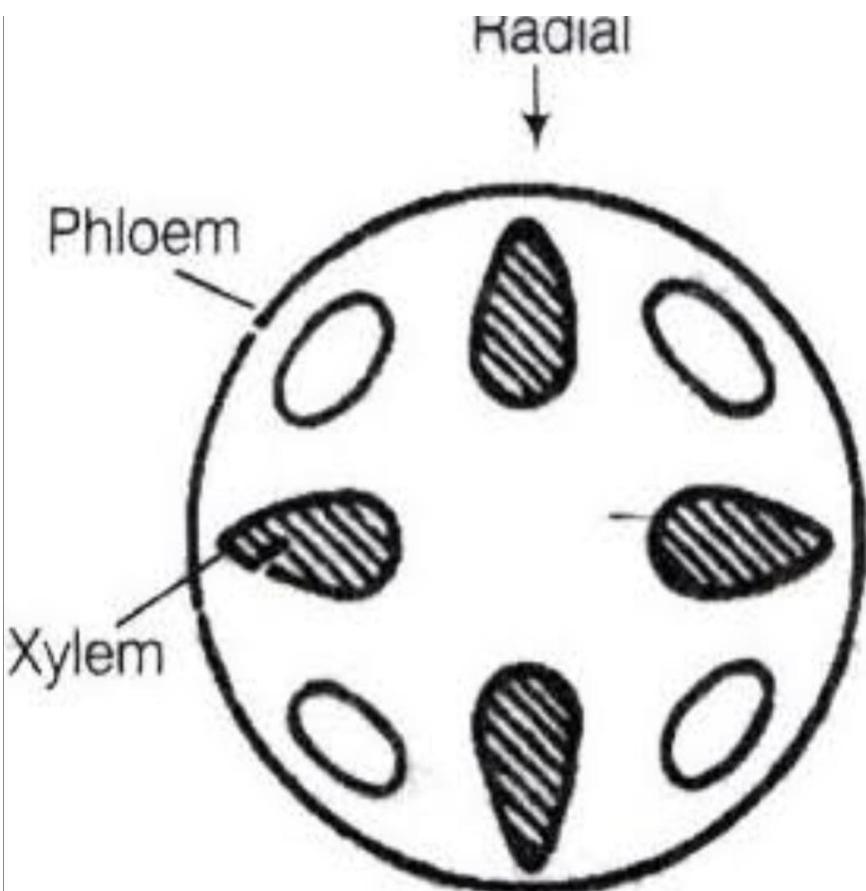
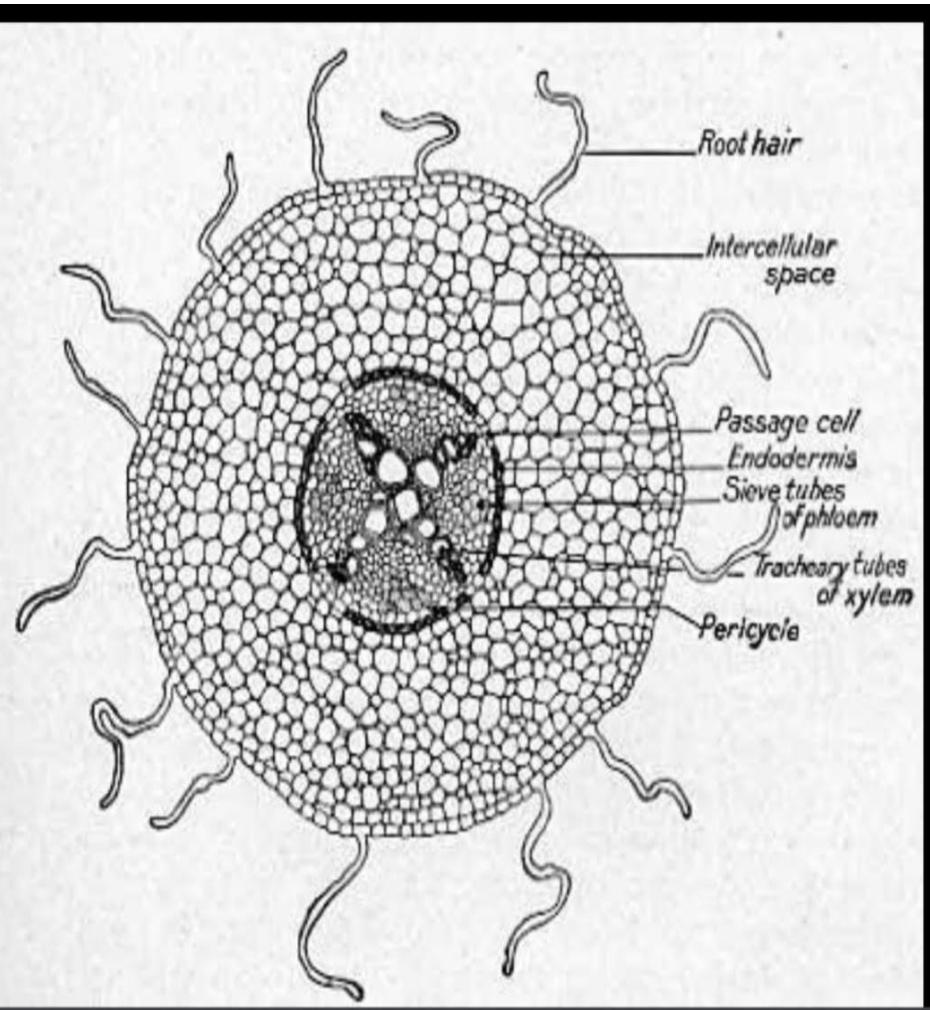
5. **Pericycle**—One layer of pa'echymatous thin walled cells.

6. **Vascular region**—Bundles are radially arranged. They are exarch and tetrach. Sclerenchyma patches with phloem alternate with xylem patches. Parenchymatous conjunctive tissue is present between xylem and phloem.

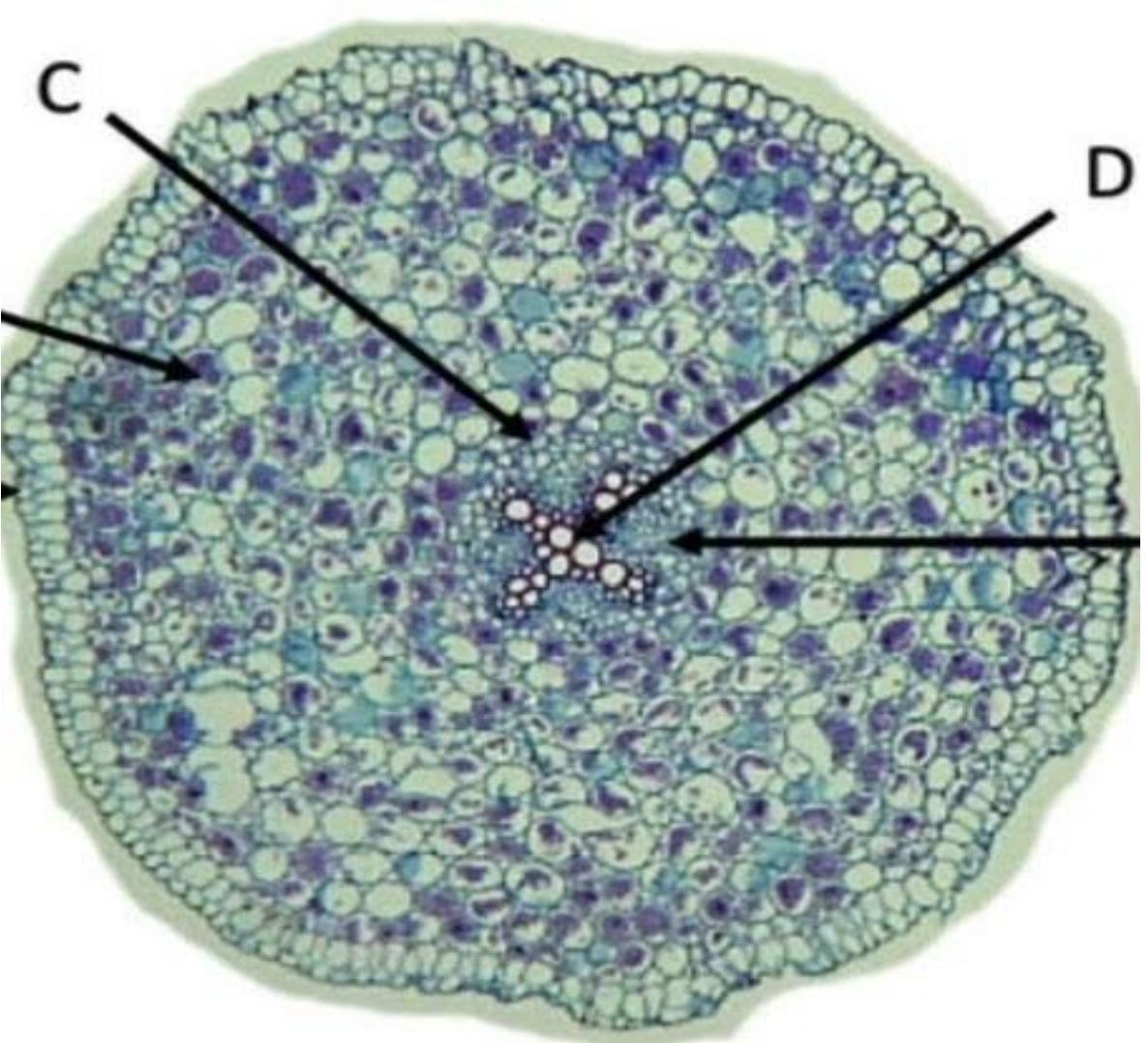
7. **Pith**—Almost absent.

Comment—The section reveals the typical dicotyledo-

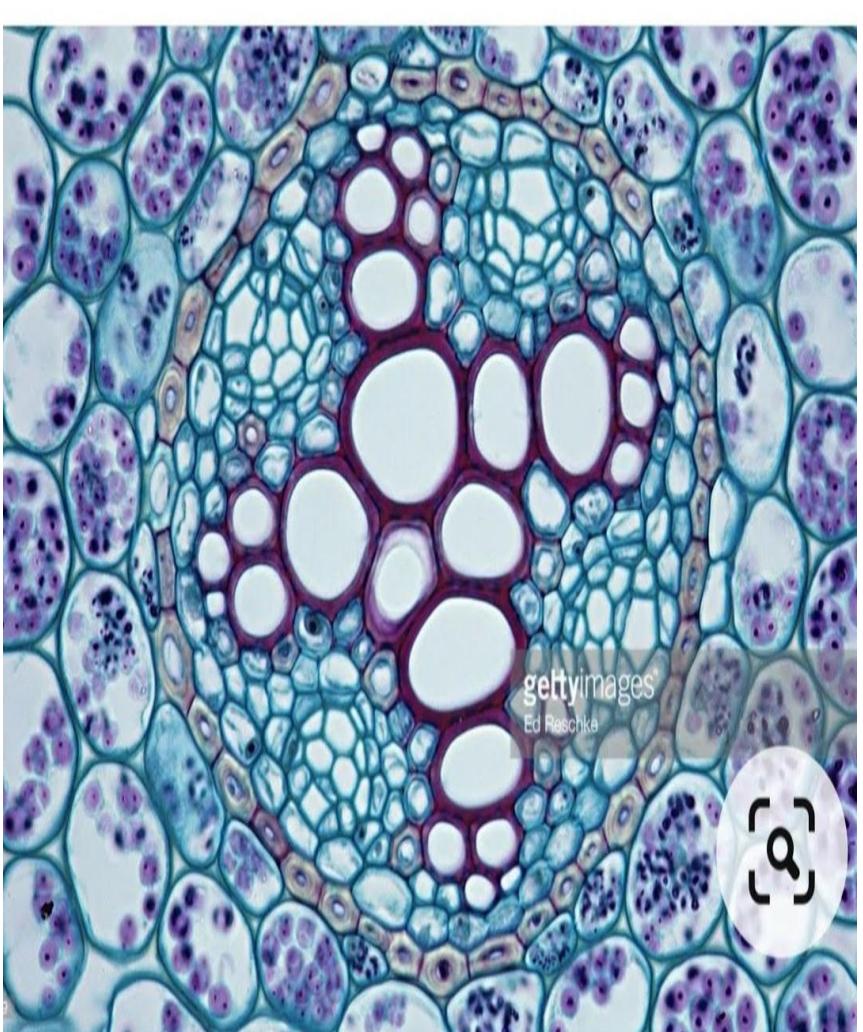
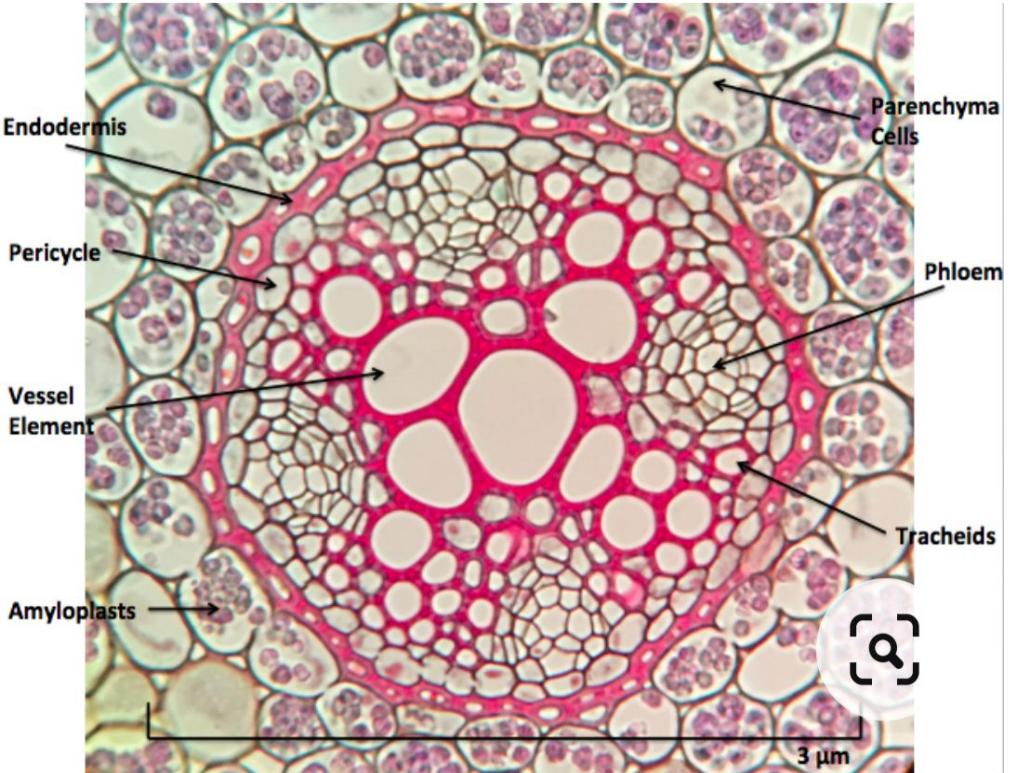
nous root structure having homogeneous parenchymatous cortex and a radially arranged tetrach vascular bundles. Protoxylem is exarch. Sclerenchyma patches with phloem alternate with xylem patches. Epiblema with unicellular hairs. Pith is almost absent.



Radial vascular bundle



4. Radial type - In this type, the phloem and xylem strands occur circularly in different patches on alternate radii from the centre and are separated by non-conducting tissue. This type is characteristic feature of roots .(F)

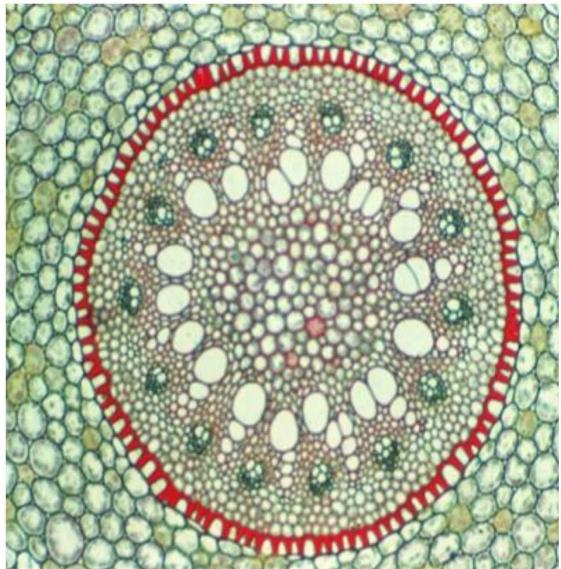


From en.wikipedia.org

Root - Wikipedia

Internal Structure of Monocotyledon Root

Internal Structure of Monocotyledon Root



The internal structure of a typical monocotyledon root is similar to dicotyledon root:

MONOCOTYLEDONOUS ROOTS

~~Distinctive anatomical features of the monocotyledonous root :-~~

- (i) The vascular bundles are radial.
- (ii) The xylem is exarch.
- (iii) Presence of unicellular root hairs.
- (vi) The xylem bundles are numerous and vary from eight to twenty in number.
- (v) The pith is large and well-developed.
- (vi) There is no cambium.
- (vii) There is no secondary growth.

Cortex is delimit by endodermis

24. Structures of the root of COLOCASIA (Arum) in T. S.

T. S. shows the following structures :—

1. **Outline**—Rounded.
2. **Epiblema**—Outermost single layered, composed of tubular cells, with unicellular root hairs.
3. **Cortex**—Large parenchymatous with intercellular spaces.
4. **Endodermis**—Single layered, composed of barrel shaped cells with casparyan strips.
5. **Pericycle**—Single layered, made of thin walled parenchymatous cells.
6. **Vascular region**—Bundles are radially arranged. They are exarch and polyarch. Small conjunctive tissue is present in between xylem and phloëm patches.
7. **Pith**—The central part of the stele is occupied by a fairly large pith.

Comment—It reveals the typical monocotyledonous root. Epiblema with unicellular root hairs. The cortex is fairly large. Vascular bundles are radial, exarch and poly-arch. Pith is very large.

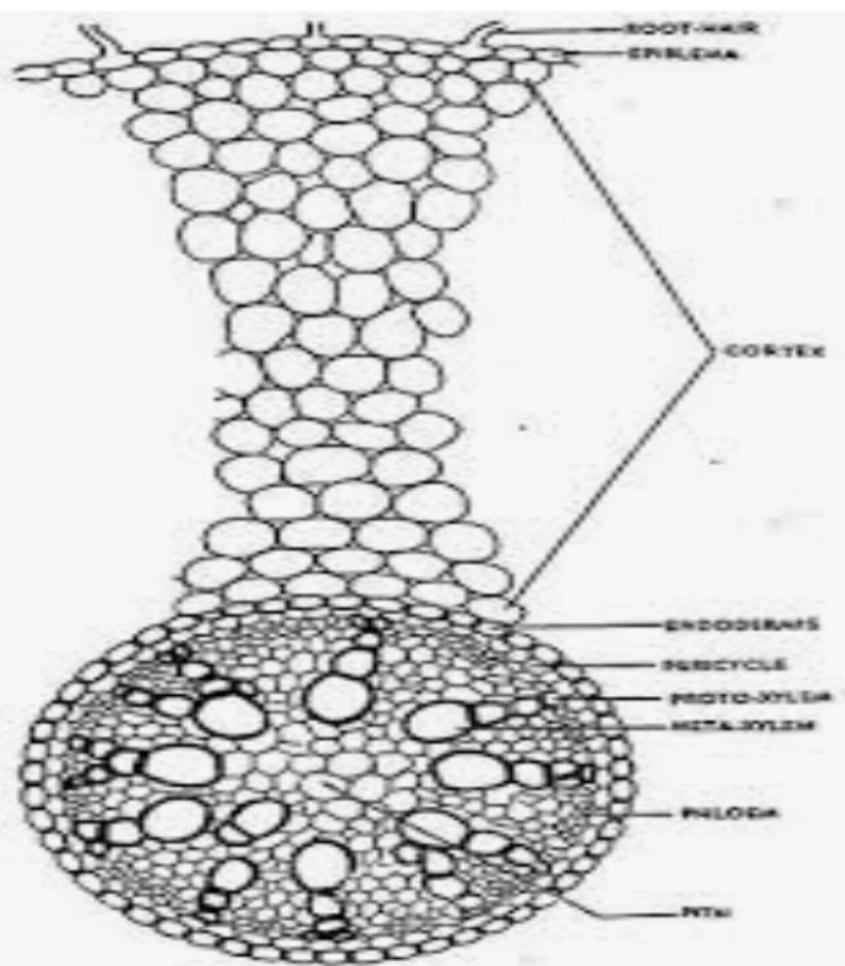


Fig. 156. Portion of transverse section of a monocotyledonous root (*Amarum*) showing the plan of arrangement of tissues.

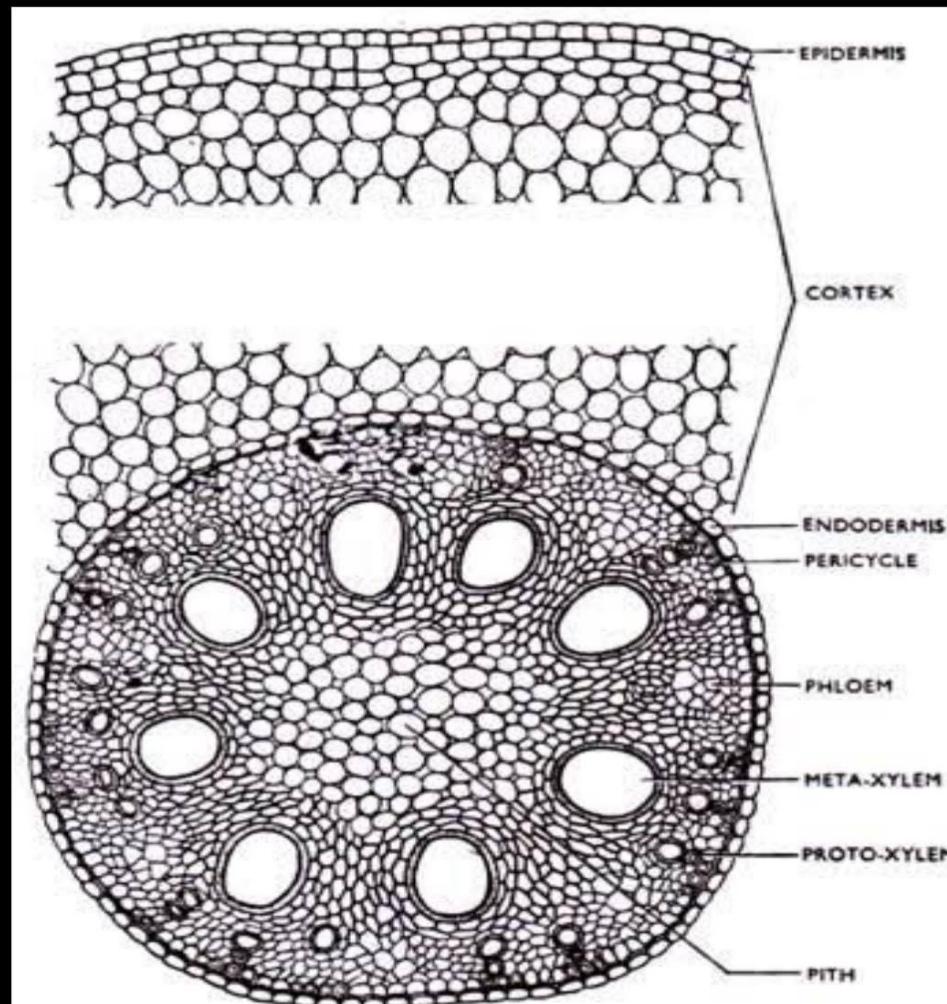
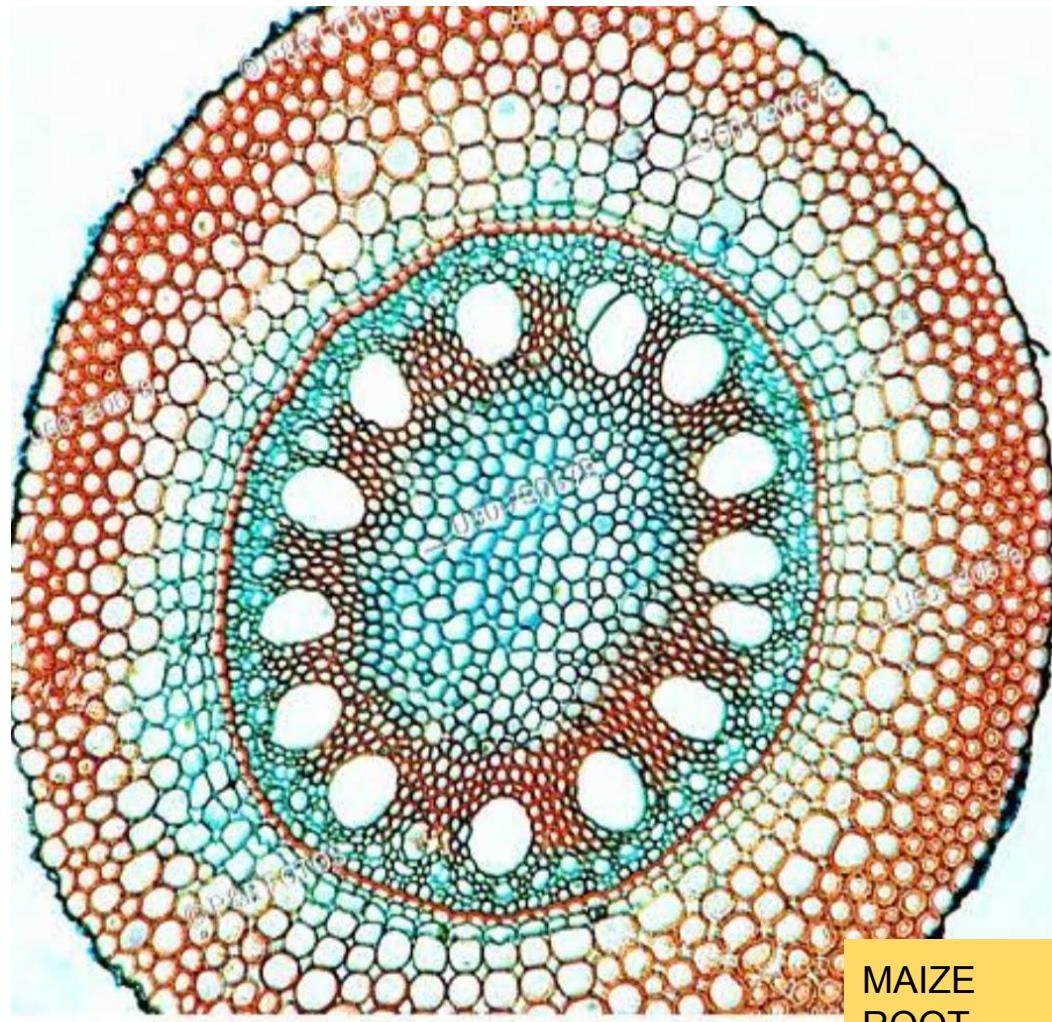
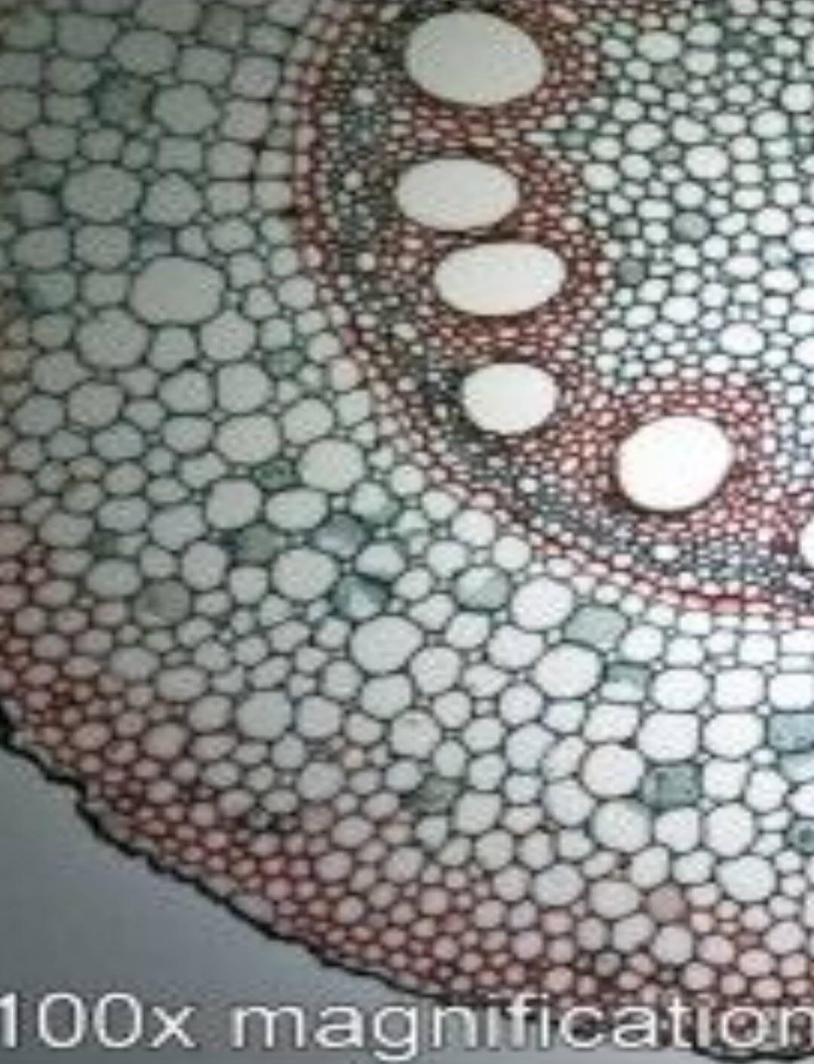


Fig. 605. A portion of root of *Zea* (maize) in transverse section.

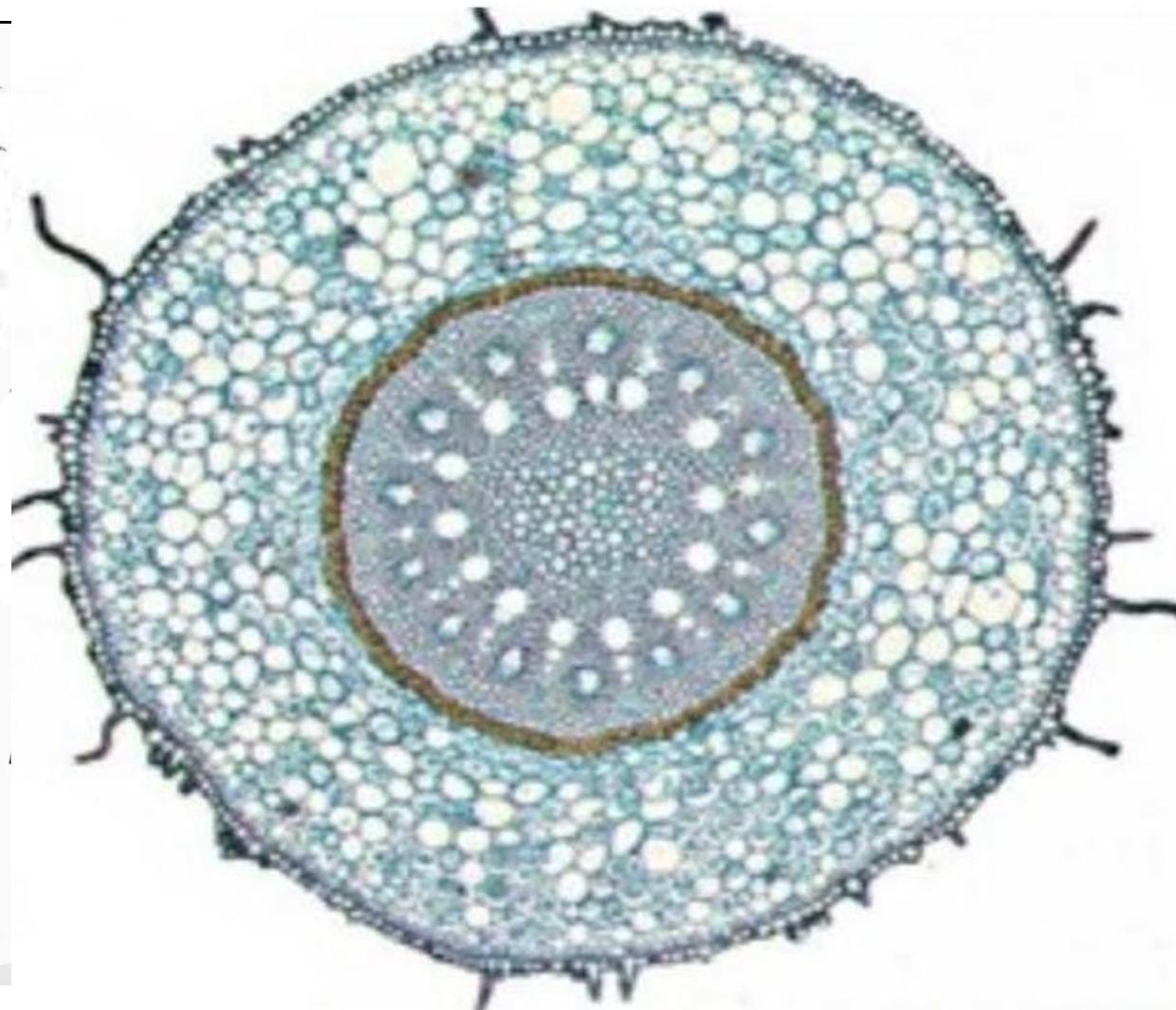
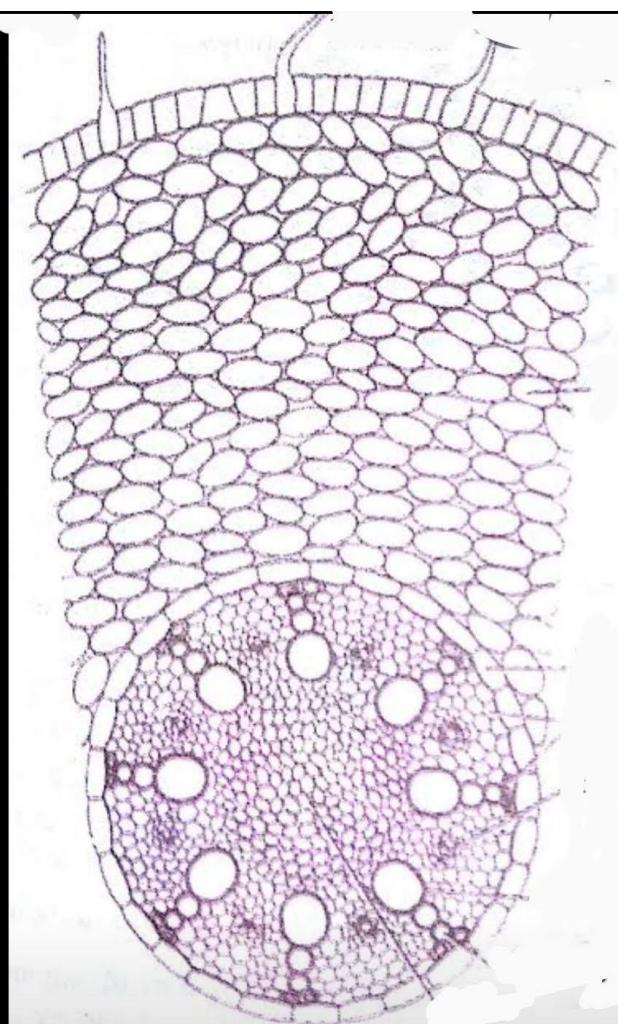


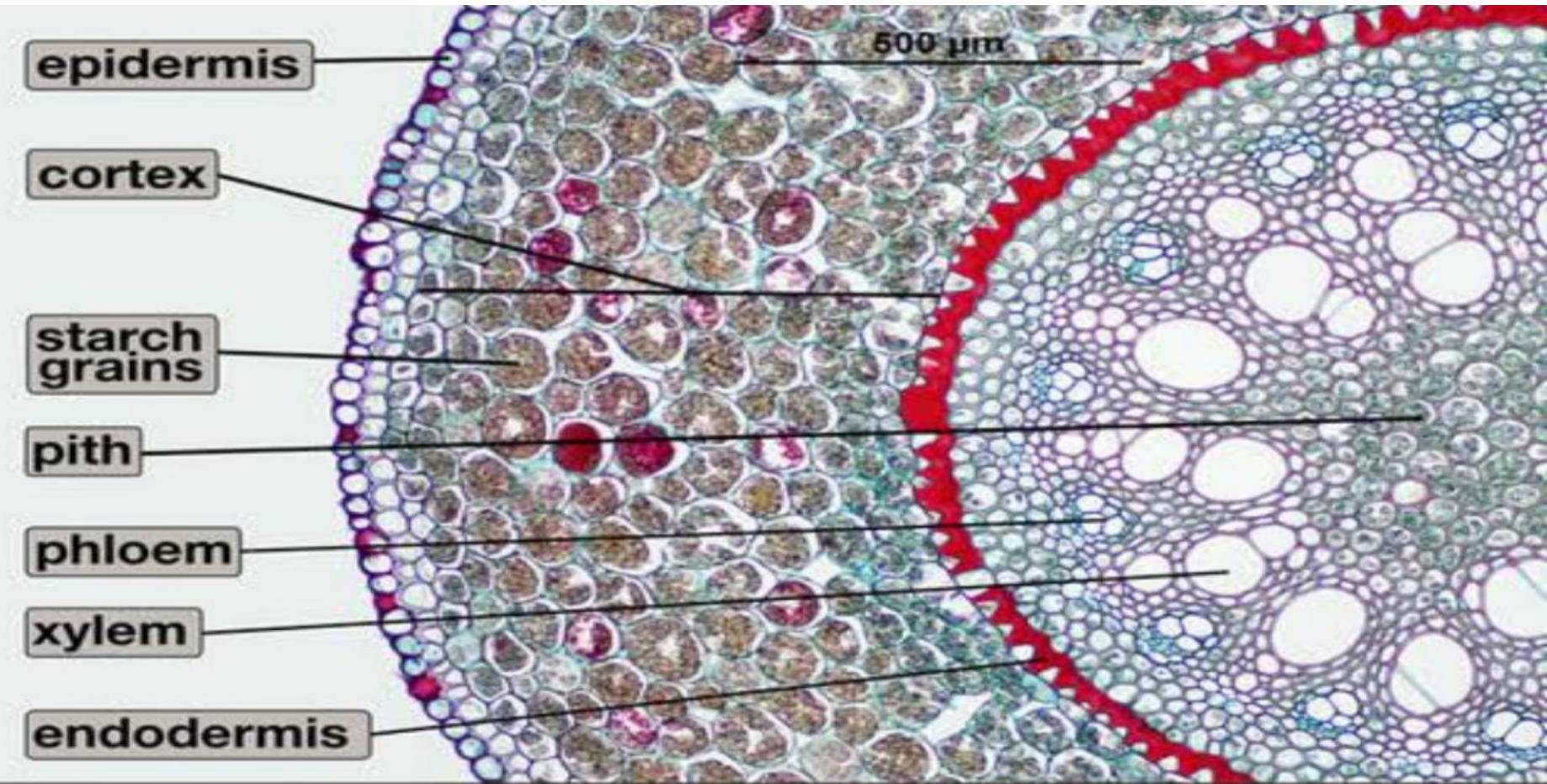
25. Structures of the root of ZEA (Maize) in T. S.

T. S. shows the following structures :—

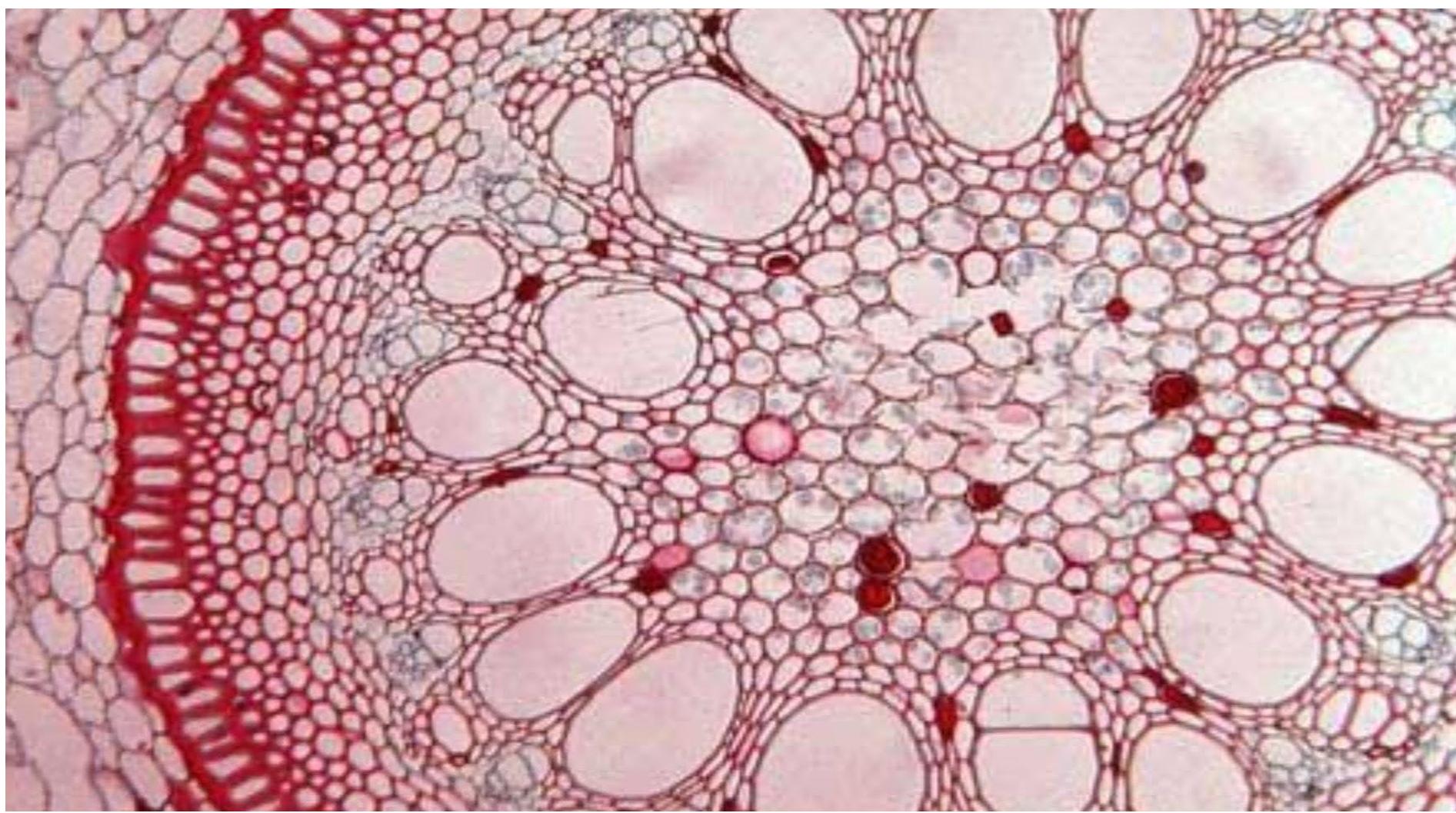
1. Outline—Circular.
2. Epiblema—A uniseriate compact layer of barrel-shaped parenchymatous cells from which arise unicellular root hairs.
3. Cortex—Broad, composed of loosely arranged thin walled parenchymatous cells enclosing intercellular spaces.
4. Endodermis—Uniseriate, composed of thick walled cells.
5. Pericycle—Uniseriate, parenchymatous but partly sclerenchymatous.
6. Vascular bundles—Polyarch, exarch and radial.
7. Xylem—Radial pear-shaped bundles.
8. Phloem—Crescent-shaped bundles and alternate with those of xylem bundles.
9. Pith—A large parenchymatous pith occupies the centre.

Comment—The section reveals a typical monocotyledonous root structure having fairly large cortex and a radially arranged polyarch vascular bundles. Protoxylem is exarch. Pericycle is partly sclerenchymatous. Metaxylem is large and circular. A large parenchymatous pith occupies the centre. Uniseriate epiblema with unicellular root hairs.

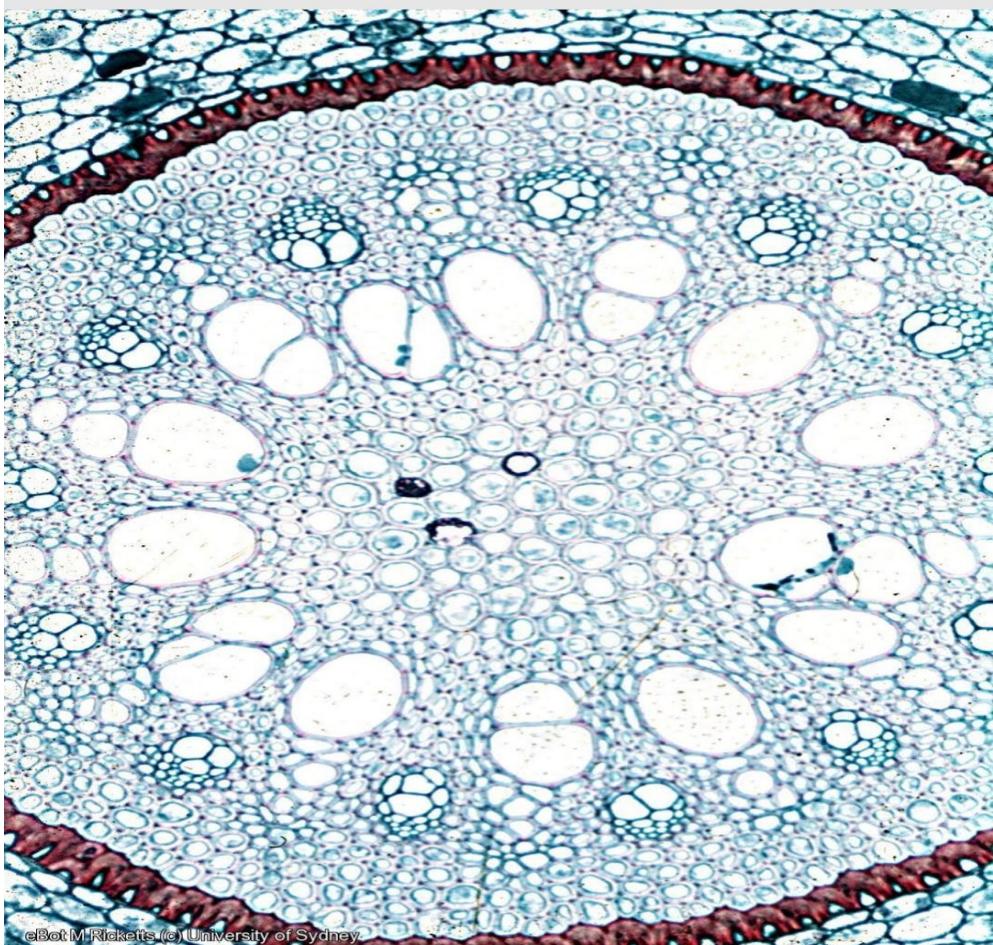




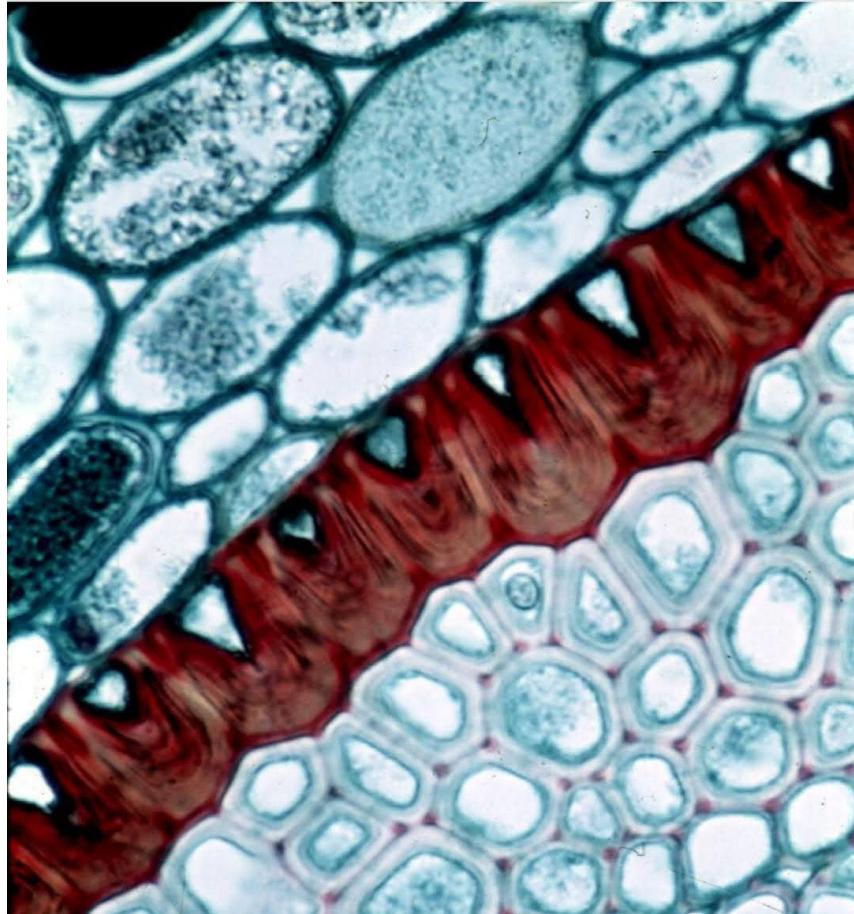
Smilax root c.s.

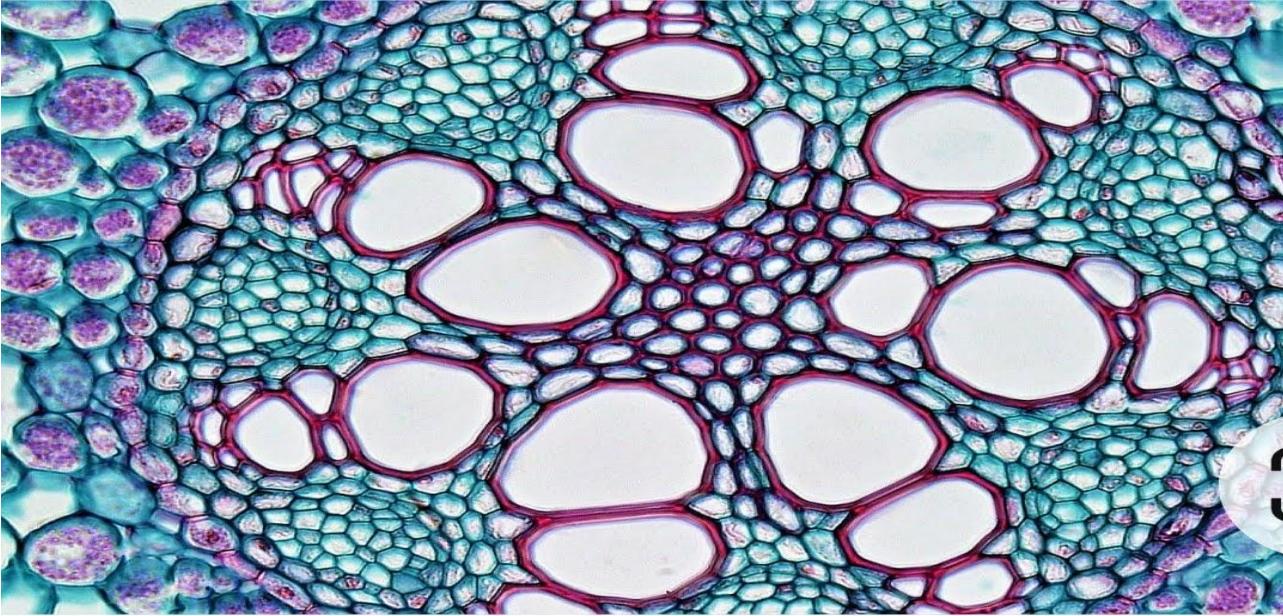


TS Smilax root stele



TS Smilax root endodermis





Monocot Root: Caspary Strip

26. Structures of the root of VANDA (Orchid) in T. S.

T. S. shows the following structures :—

1. Outline—Circular.
2. Velamen—Few layered, composed of radially elongated somewhat polygonal cells. The outermost layer is limiting layer.
3. Exodermis—Single layer of thick walled cells

which contains few passage cells. It limits cortex from the velamen.

4. **Cortex**—Few layers of thin walled parenchymatous cells with air chambers.

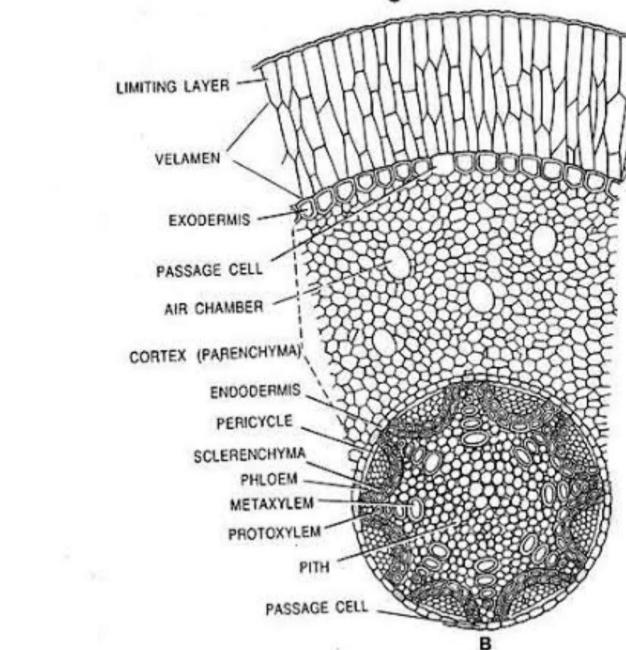
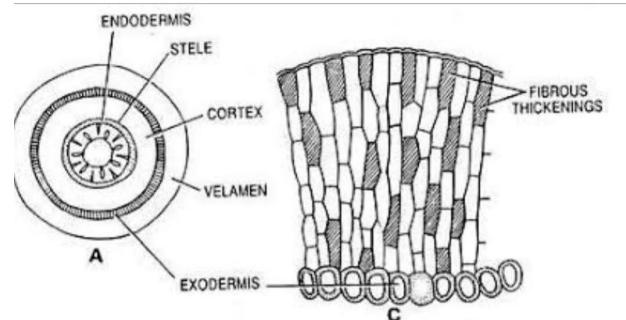
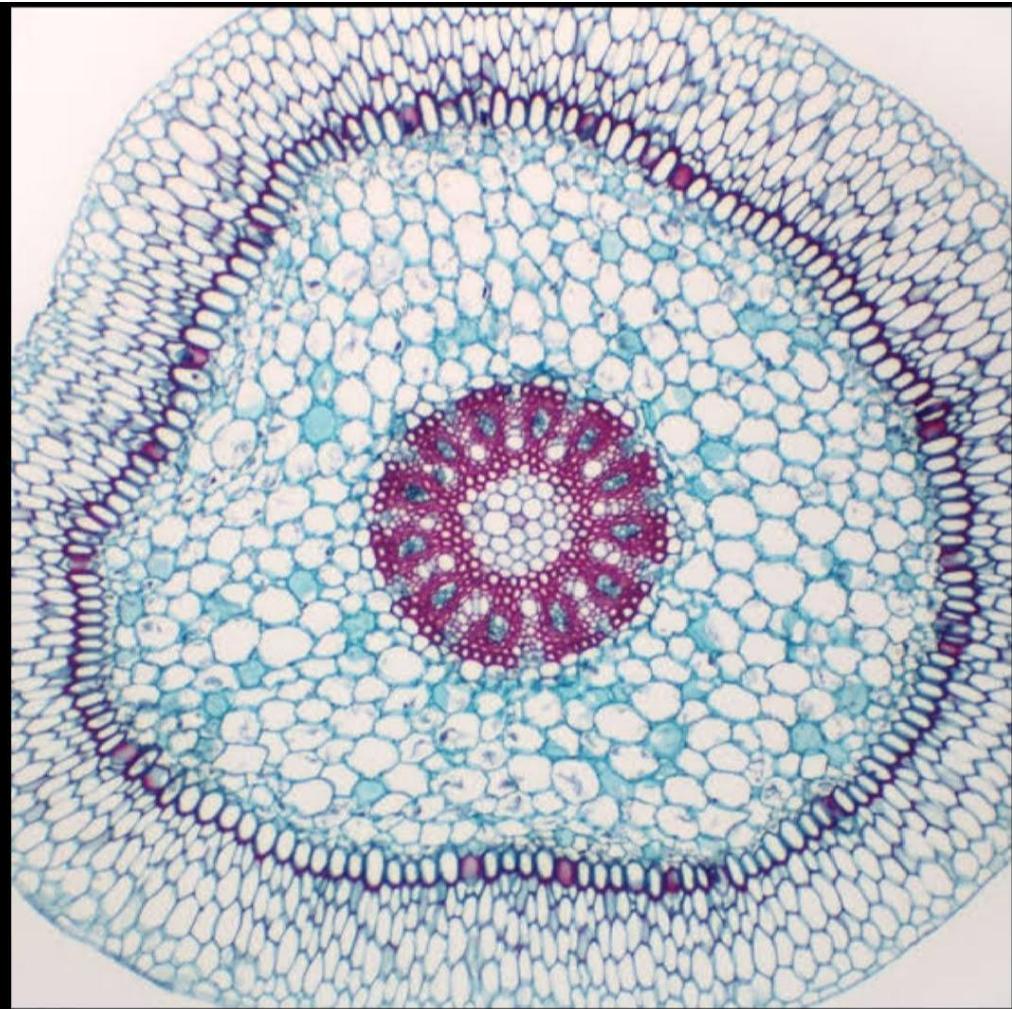
5. **Endodermis**—It is single layered with thickened inner tangential walls. The passage cells are present opposite to the protoxylem.

6. **Pericycle**—Uniseriate, sclerenchymatous and is parenchymatous opposite to the protoxylem.

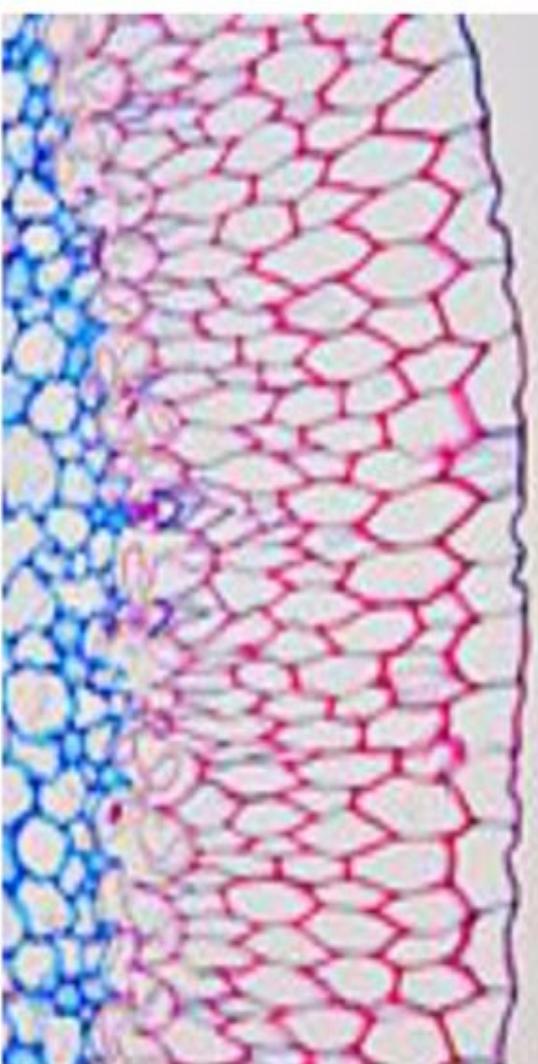
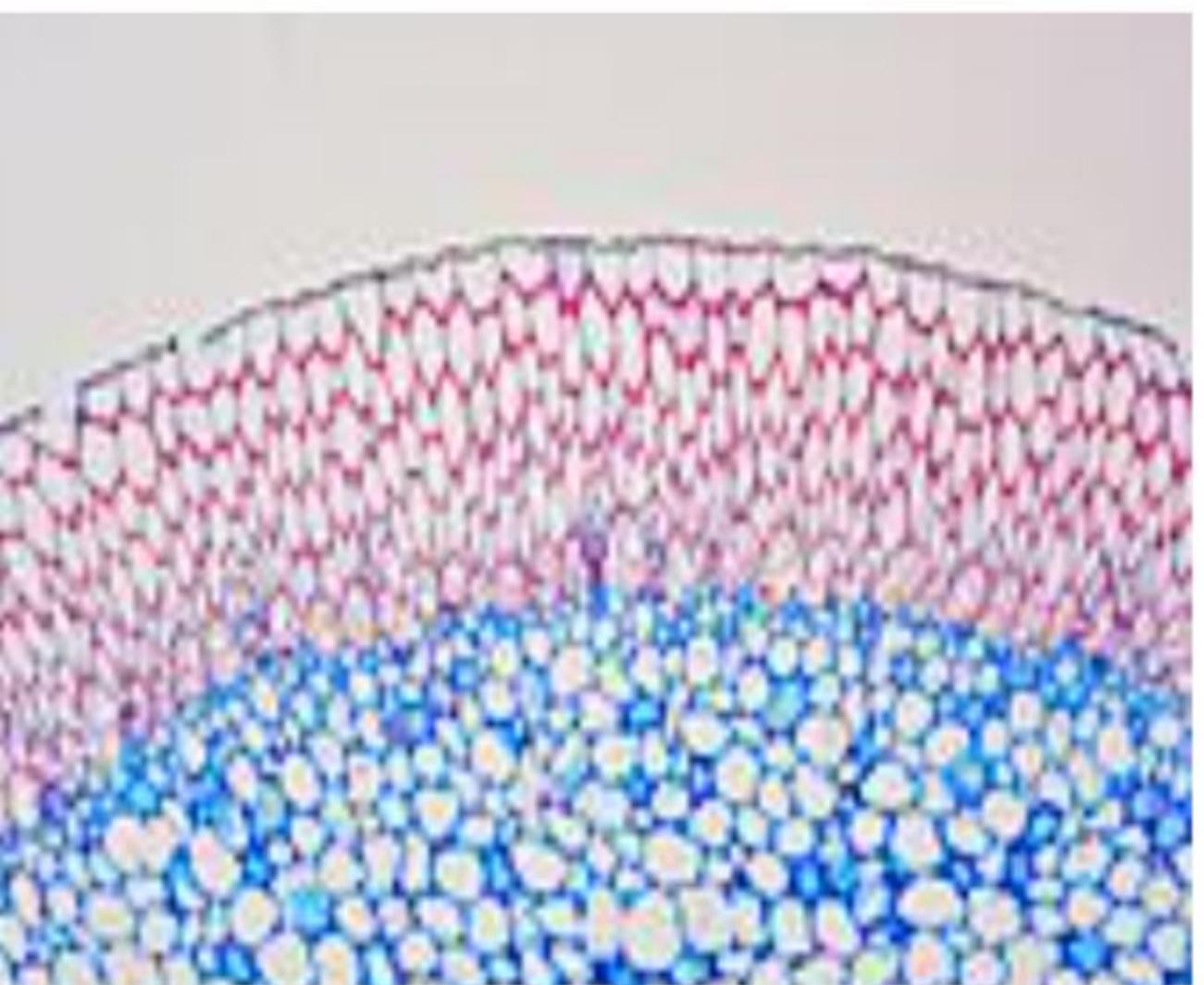
7. **Vascular bundles**—Radial, polyarch and exarch. Sclerenchymatous conjunctive tissue surrounding the phloem.

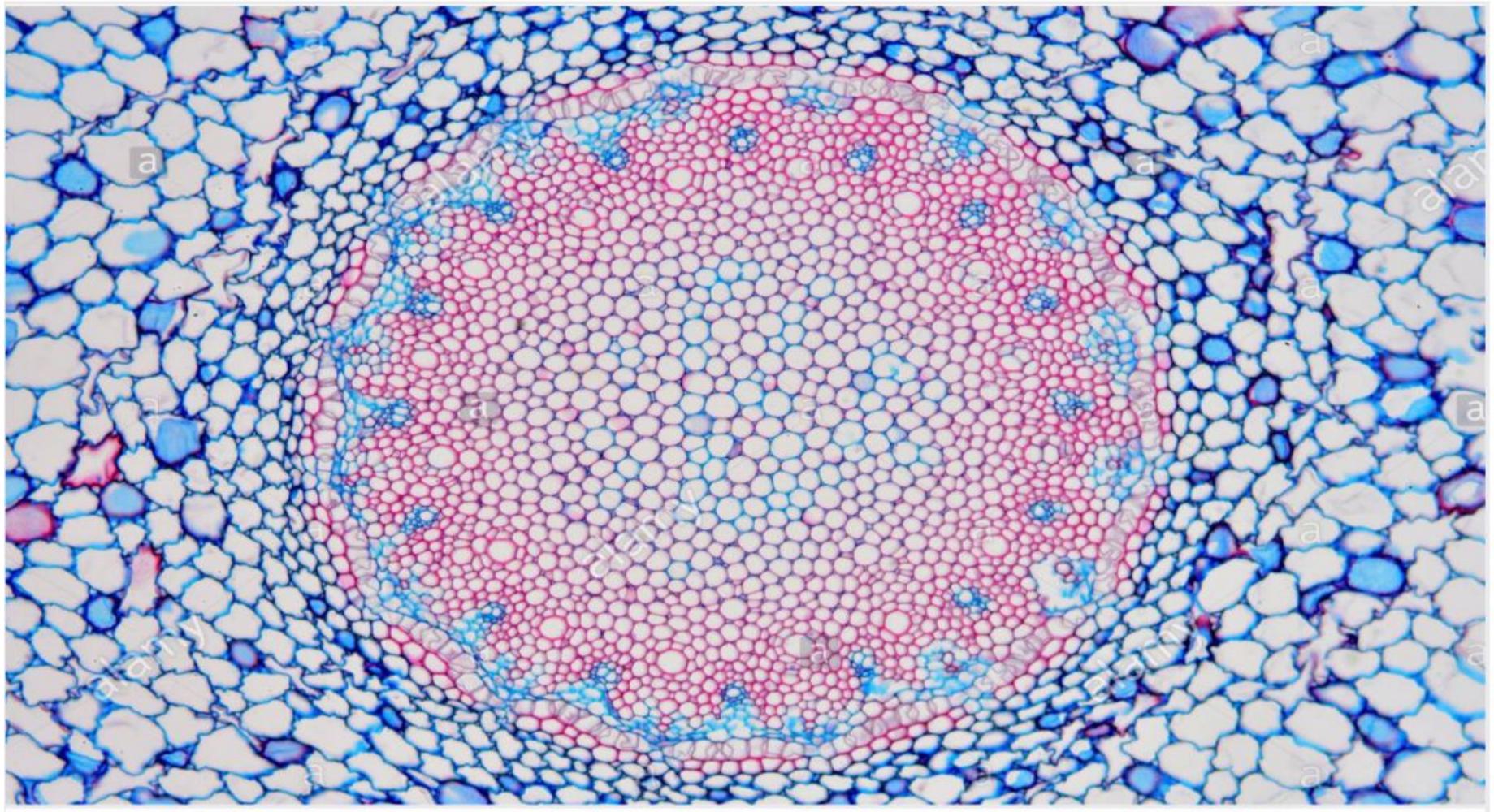
8. **Pith**—Parenchymatous and large.

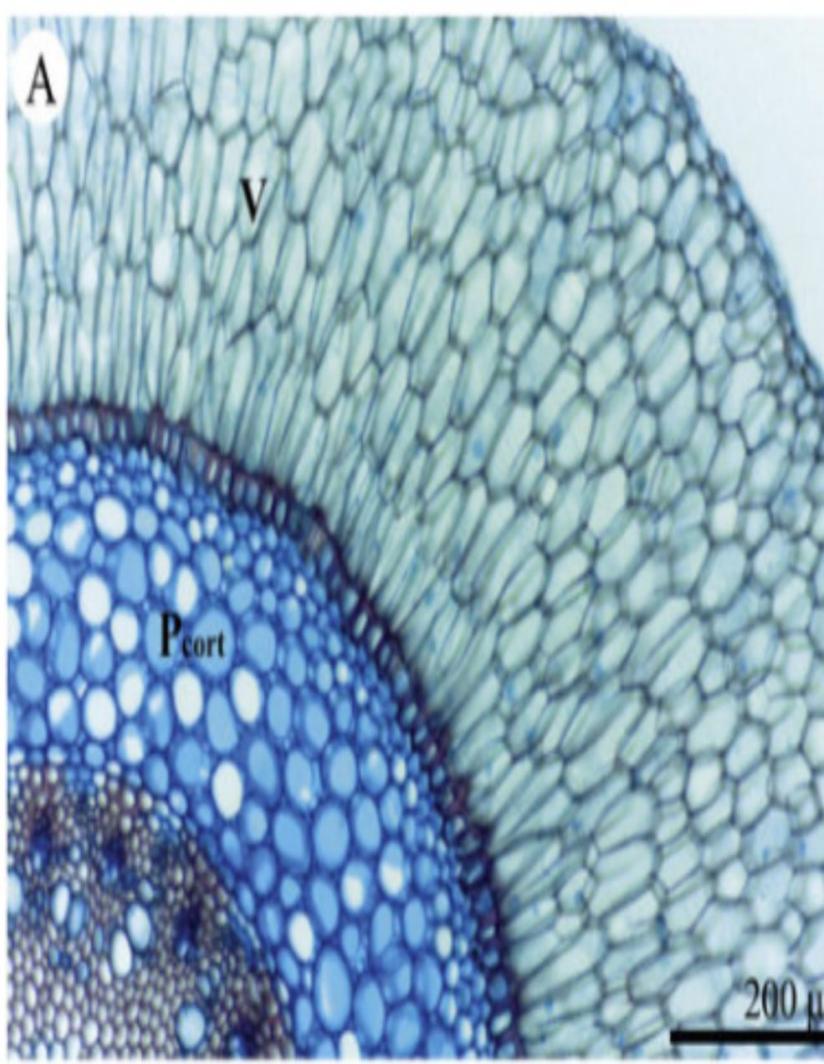
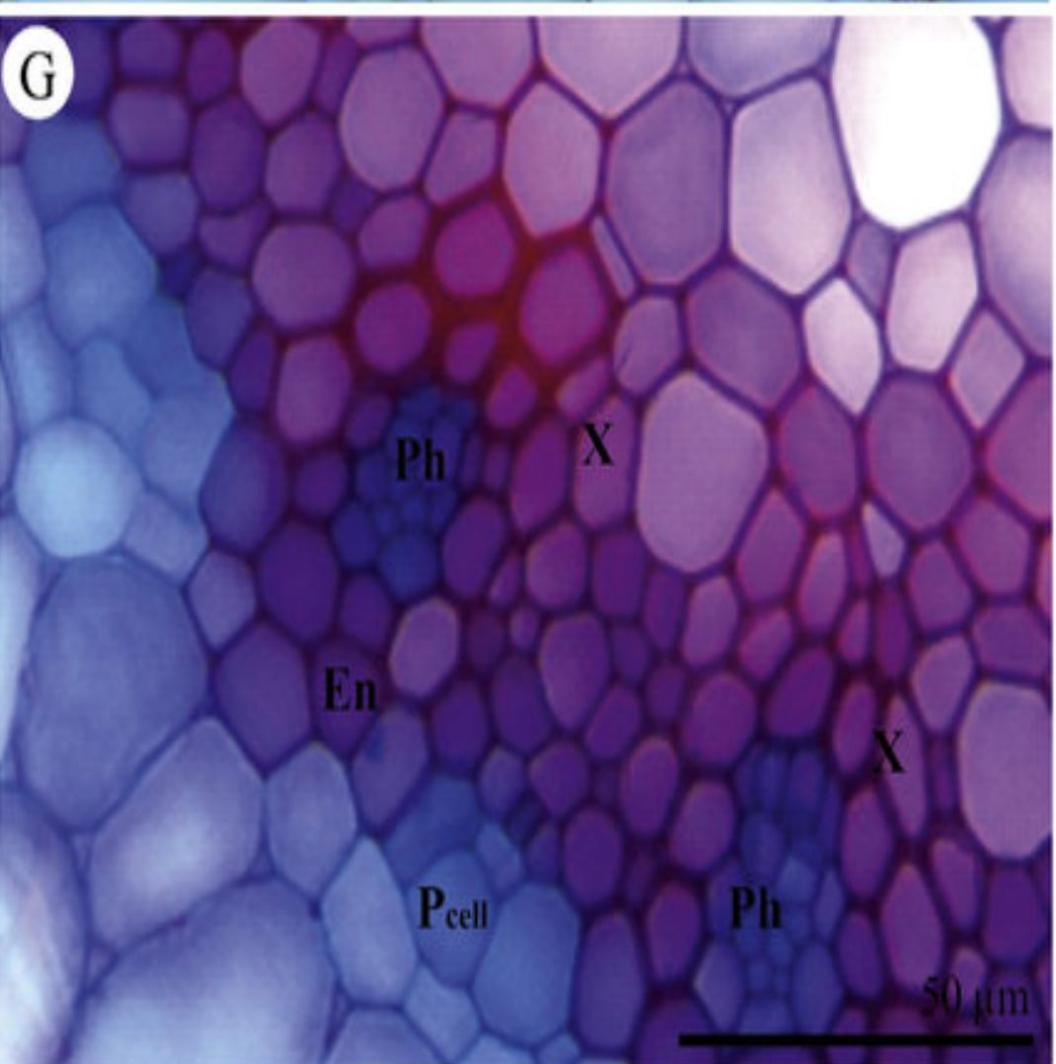
Comment—It reveals a monocot. root showing epiphytic nature with moisture absorbing tissue, velamen and exodermis with passage cell just next to limiting layer. Exodermis separates velamen outside and cortex inside. Parenchymatous cortex with air chambers. Vascular bundles are typically radial, exarch and polyarch. Sclerenchymatous conjunctive tissue surrounding the phloem. Pith is fairly large.

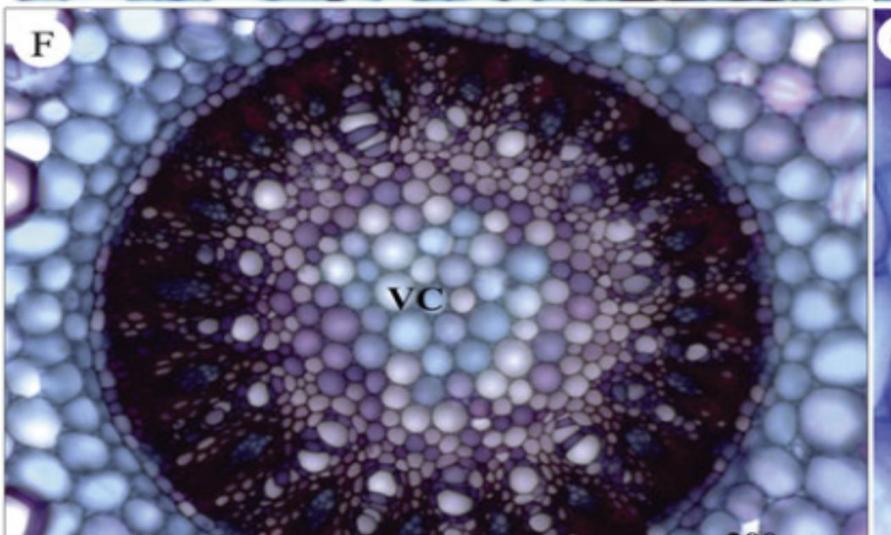
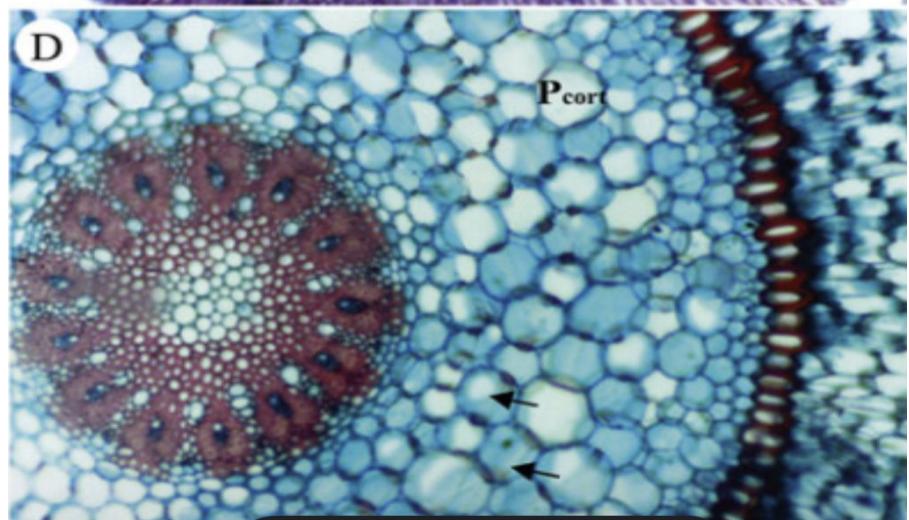
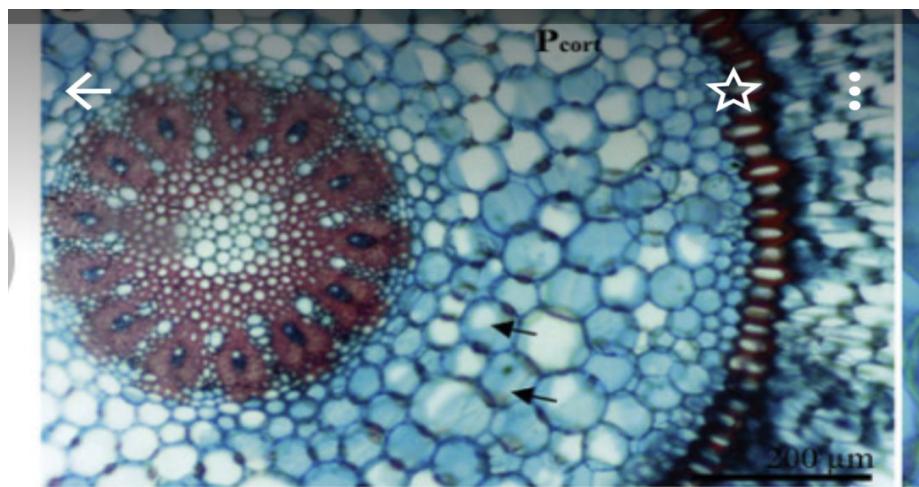
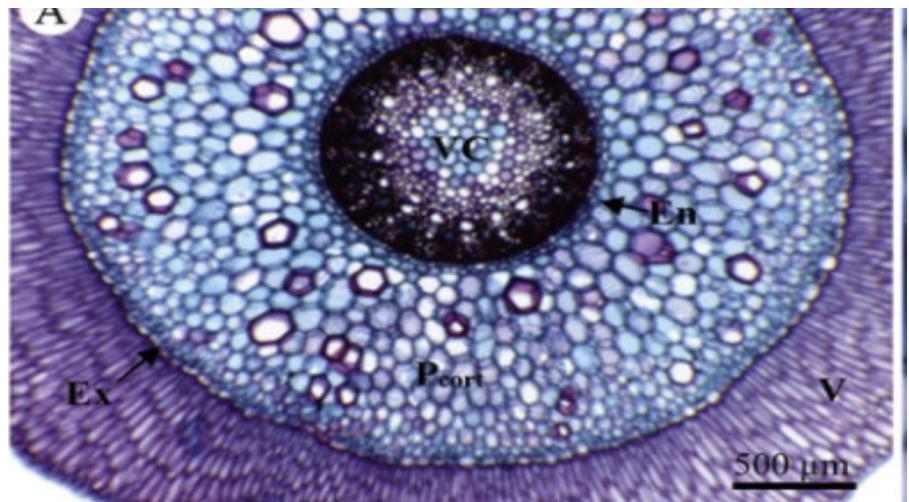


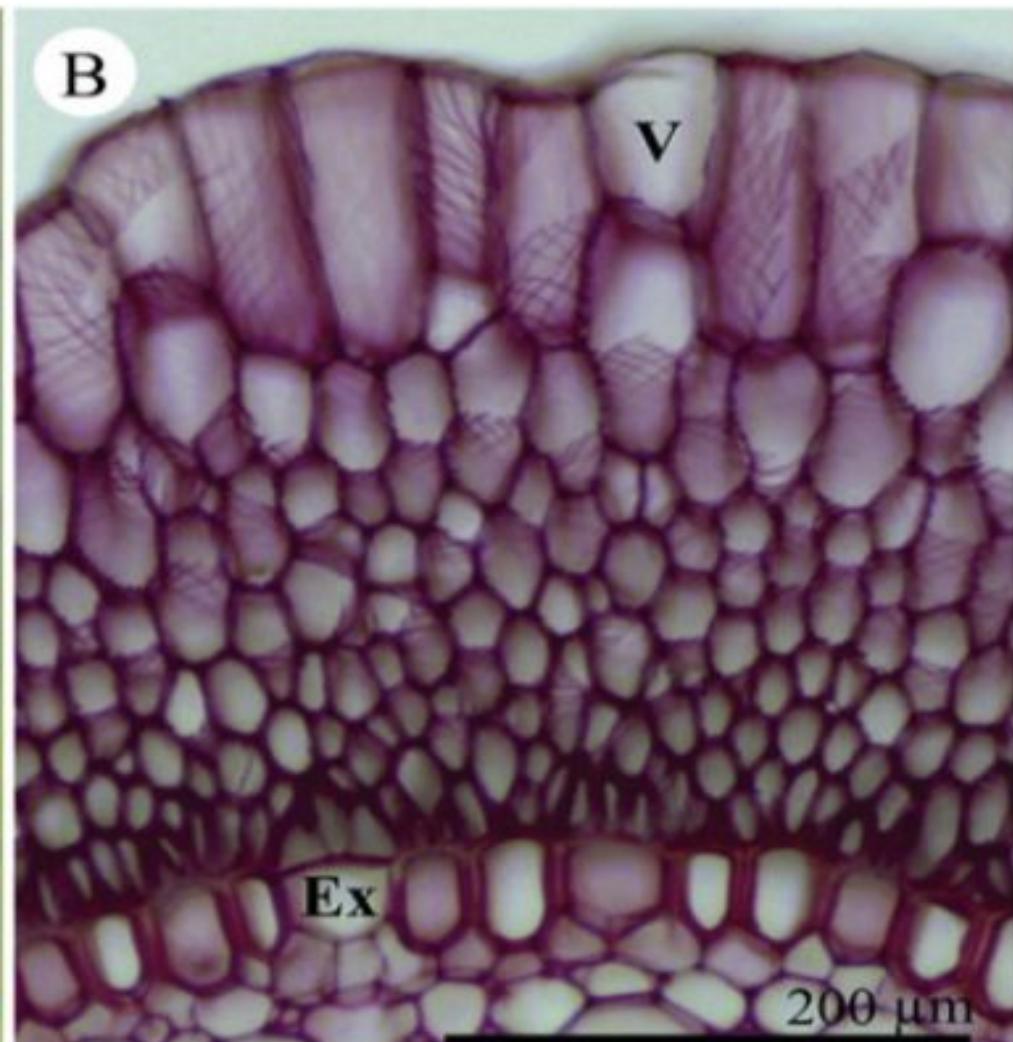
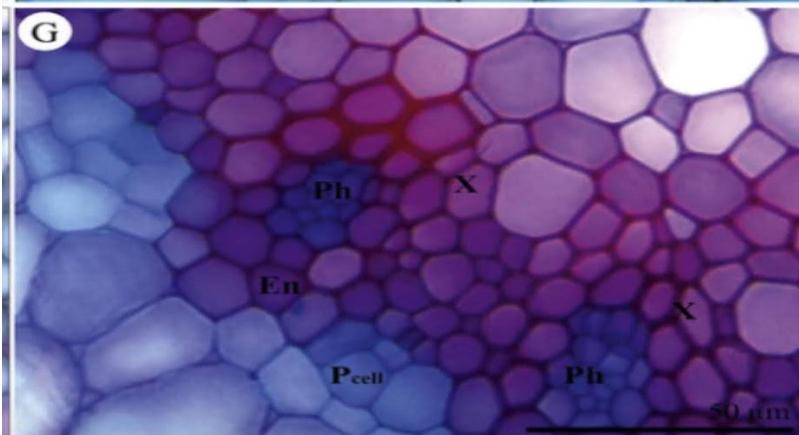
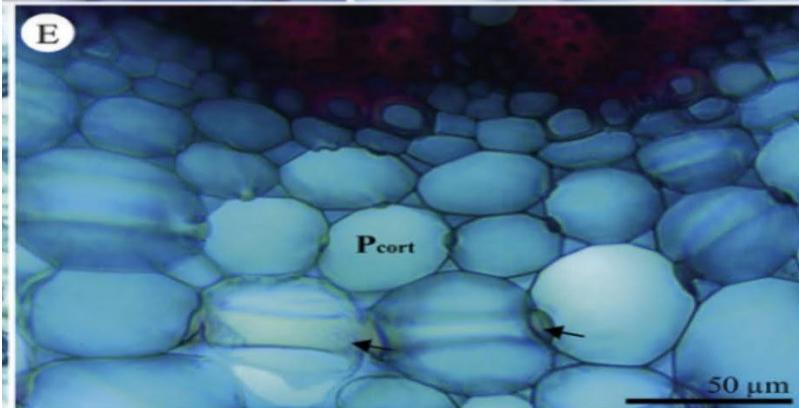
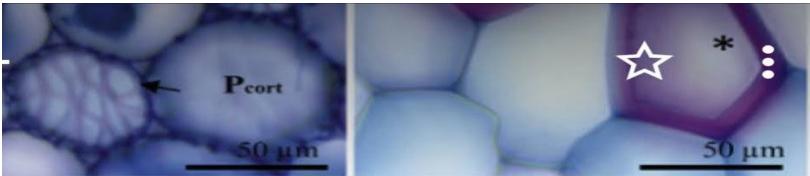
L. 42.33. Anatomy of Orchid root (Monocot—Orchidaceae)—A, T.S. of root (diagrammatic) and exodermis enlarged; B, T.S. of *Dendrobium* (orchid) root showing detailed struc-



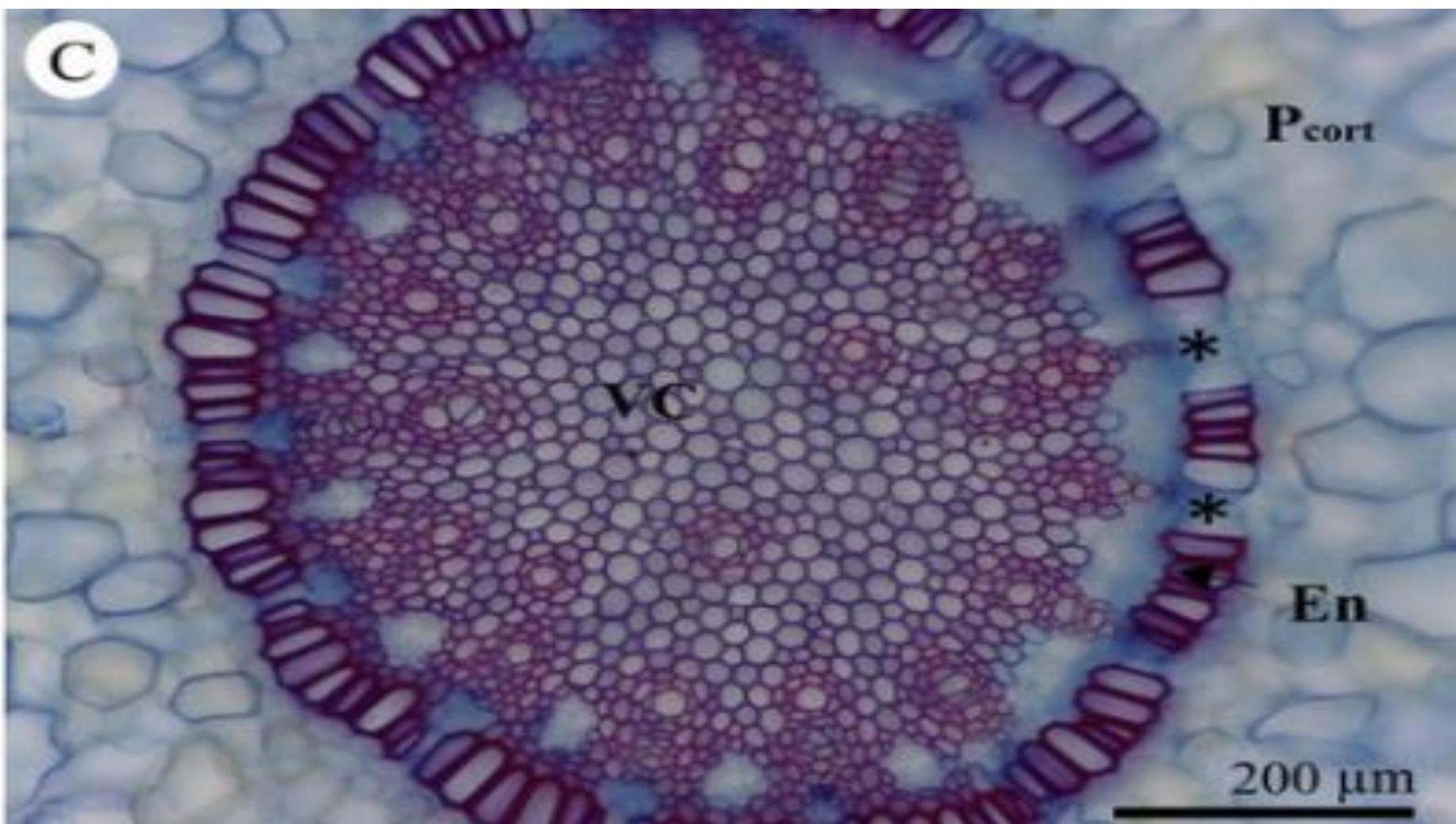








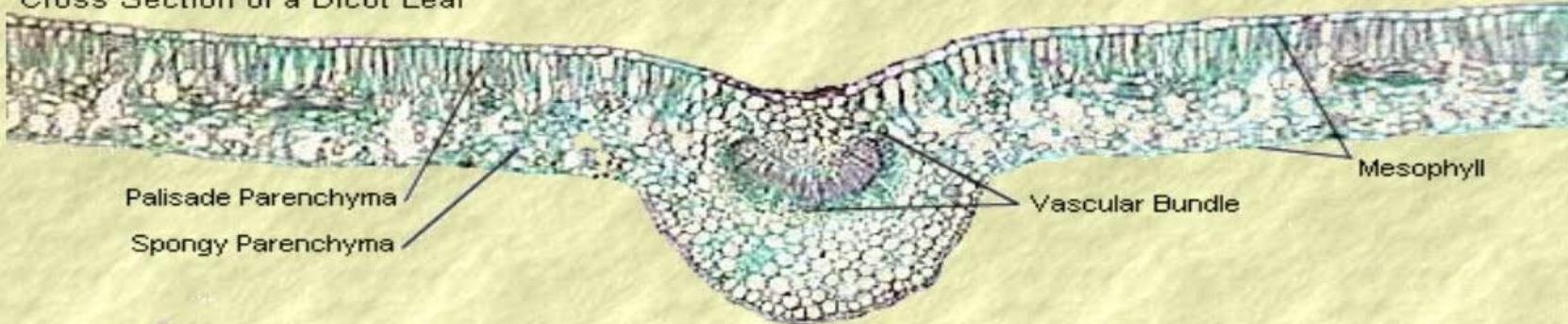
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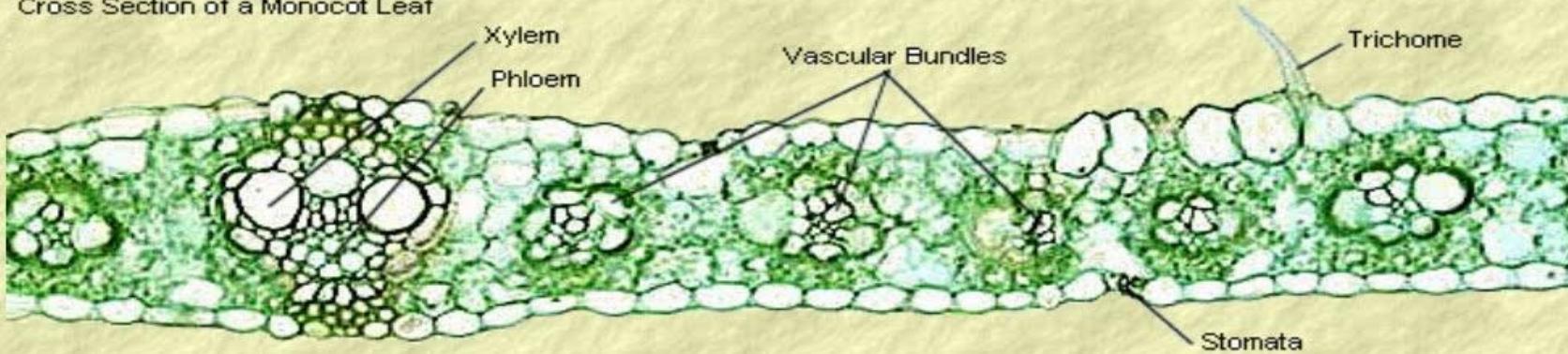
DICOT AND MONOCOT LEAF

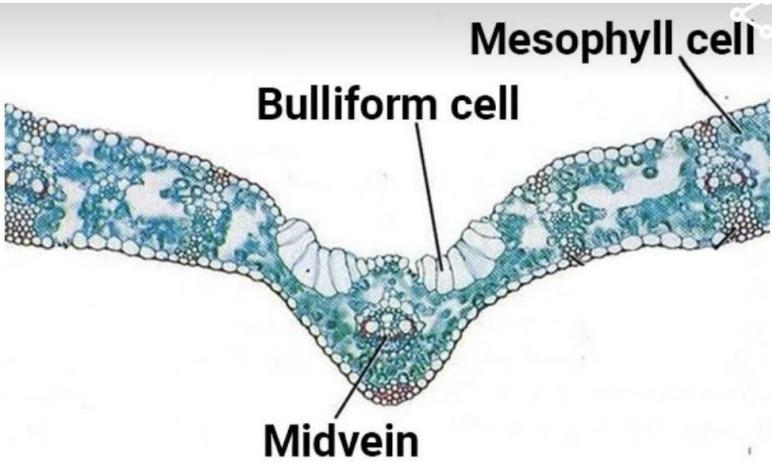
Leaf Anatomy:

Cross Section of a Dicot Leaf



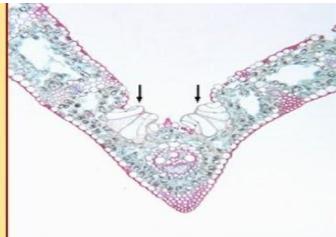
Cross Section of a Monocot Leaf





In grasses, some upper epidermis cells are modified into large cells called as 'Bulliform cells'.

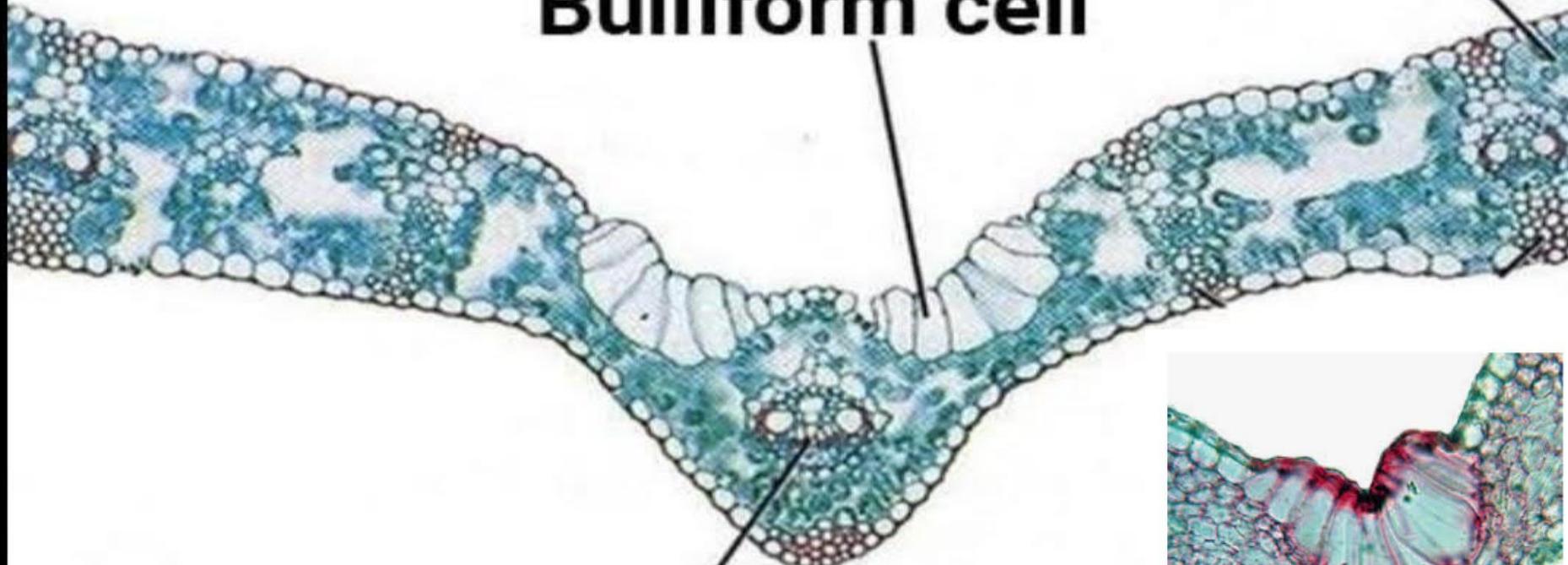
section of grass leaf (Poa praetense). During drought, many grass leaves close as the two sides of the blade fold up toward each other. Once adequate water is available, the leaves open again. When folded, the leaves are less exposed to sunlight, so they are heated less. **This movement is due to water being absorbed or lost by very large epidermis cells, called bulliform cells** (see pages 194 and 195 in Plant Anatomy [Mauseth]). The bulliform cells (arrows) are located near the midrib. This species only has the two sets of bulliform cells, each set running the length of the midrib. In other species of grasses, there may be many sets of bulliform cells, allowing the leaf blade to curl or roll up rather than merely fold.



Mesophyll cell

Bulliform cell

Midvein



Bulliform Cells |

ISOBILATERAL LEAVES

Distinctive anatomical features of the isobilateral leaves :—

- (i) Presence of two epidermis - upper and lower.
- (ii) Both of them are cuticularised.
- (iii) Stomata distributed on both the surfaces.
- (iv) Mesophyll tissue is uniformly alike.
- (v) Vascular bundles are conjoint, collateral, closed and mesarch.

1. Anatomy of Zea mays - Leaf (Family - Graminae):

T. S. reveals the following structures:

Epidermis:

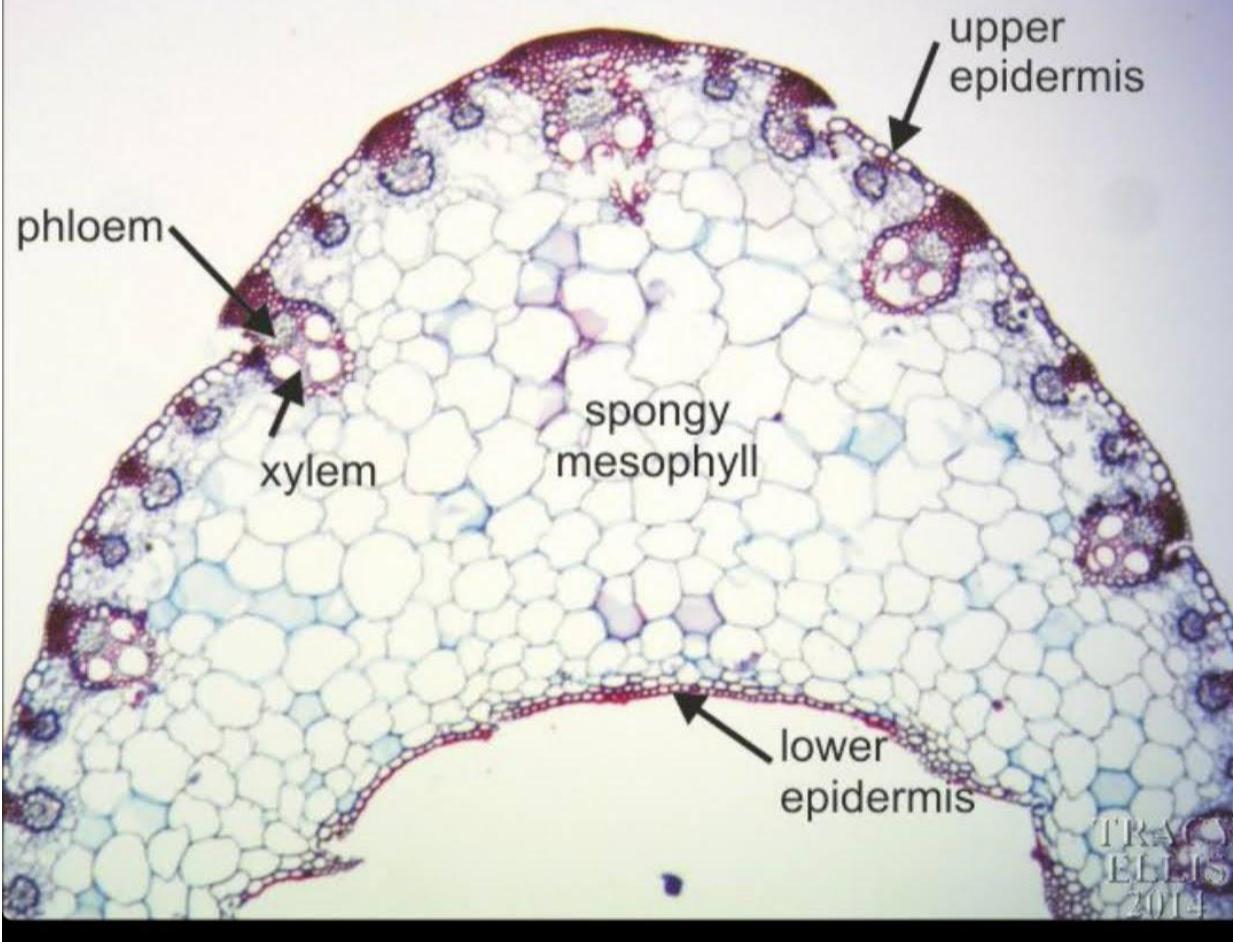
1. A single layer is present on the upper as well as lower surfaces of the leaf.
2. Both the epidermal layers, i.e., upper as well as lower, contain stomata.
3. A thick cuticle is present on both the epidermal layers.
4. Some cells of upper epidermis are larger in size. These are called bulliform cells or motor cells.

Mesophyll:

5. In between the epidermal layers is present the region of chlorophyll containing cells called mesophyll.
6. It is not differentiated into palisade and spongy parenchyma.
7. The cells are spherical or angular with only a few or no intercellular spaces.
8. The cells of this region are arranged compactly.

Vascular bundles:

Zea mays (Corn) Leaf 40x



Vascular bundles:

9. Many small and large bundles are present.
10. Vascular bundles are collateral and closed.
11. Each vascular bundle is surrounded by a layer of thin walled, parenchymatous cells called bundle sheath.

12. The cells of the bundle sheath contain starch and plastids.

13. On both the ends of large vascular bundles are present patches of sclerenchyma which extend upto the upper and lower epidermal layers.

14. In the large bundles, xylem and phloem elements are more visible than small bundles.

15. Xylem is present towards the upper epidermis and phloem towards the lower epidermis in the large vascular bundles.

16. Xylem consists of vessels, tracheid's and xylem parenchyma.

17. Metaxylem is represented by two large oval vessels and the protoxylem by a water cavity called lysigenous cavity.

18. Phloem consists of sieve tube and companion cells.

19. Smaller vascular bundles consist of less developed xylem and phloem surrounded by a bundle sheath.

Xerophytic Points:

(a) Presence of thick cuticle.

(b) Presence of patches of sclerenchyma.

(c) Presence of motor cells.

(d) Presence of stomata.

Identification:

(a) 1. Presence of expanded portion or blade.

2. Upper and lower epidermal layers are present.

3. Presence of mesophyll.

4. Presence of bundle sheath.
(Leaf)

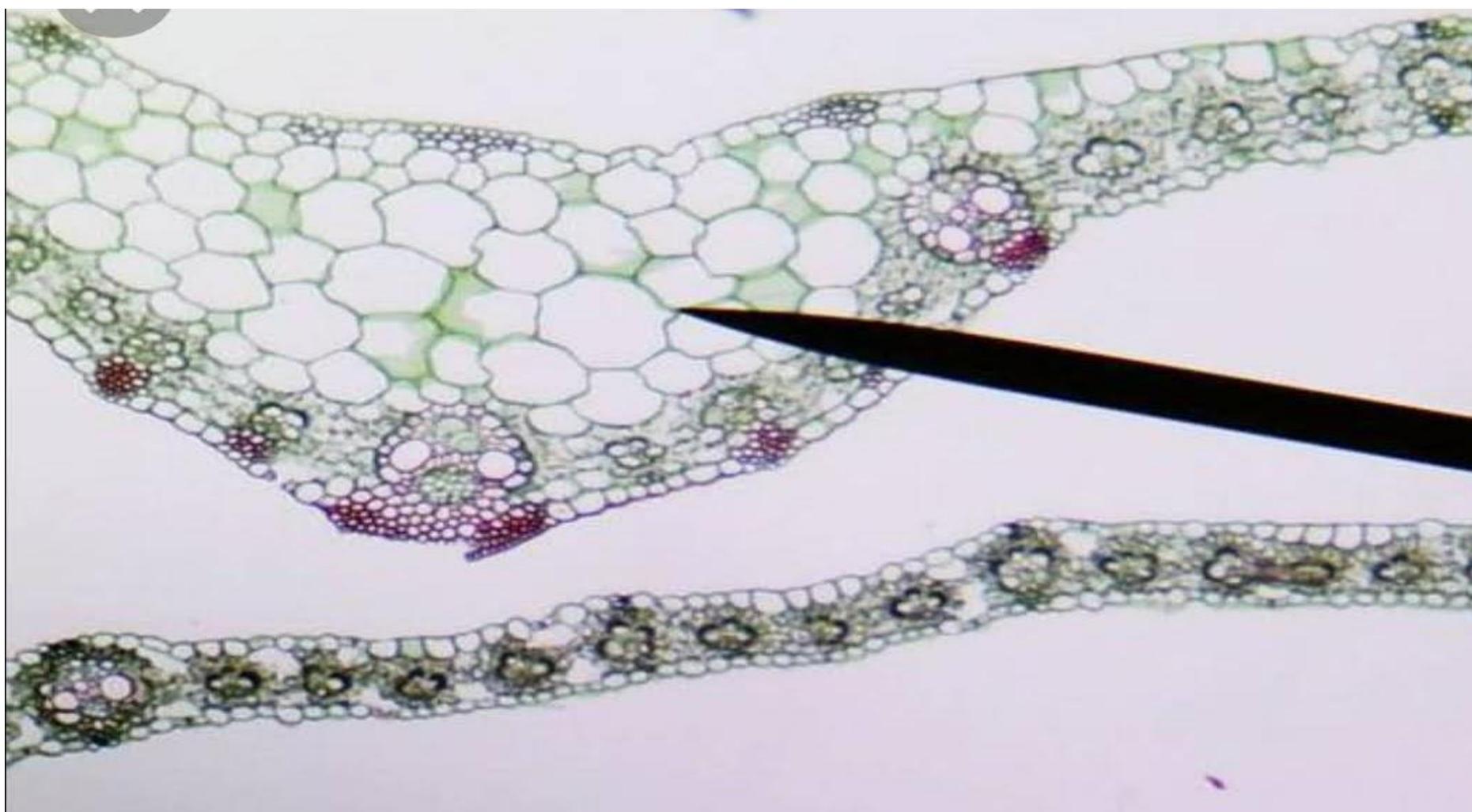
(b) 1. Many vascular bundles are arranged parallaly.

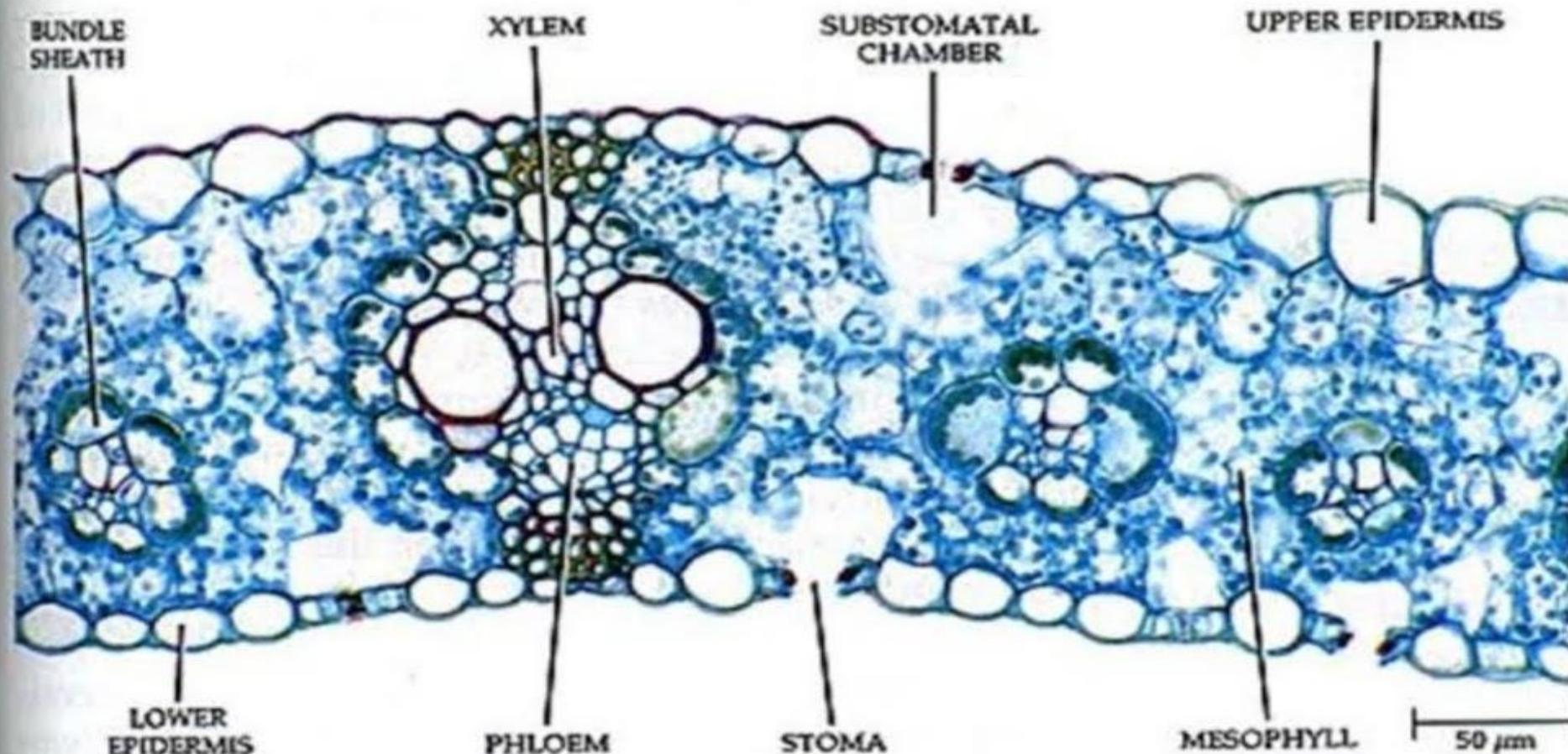
2. Absence, of cambium.

3. Presence of stomata on both the surfaces.

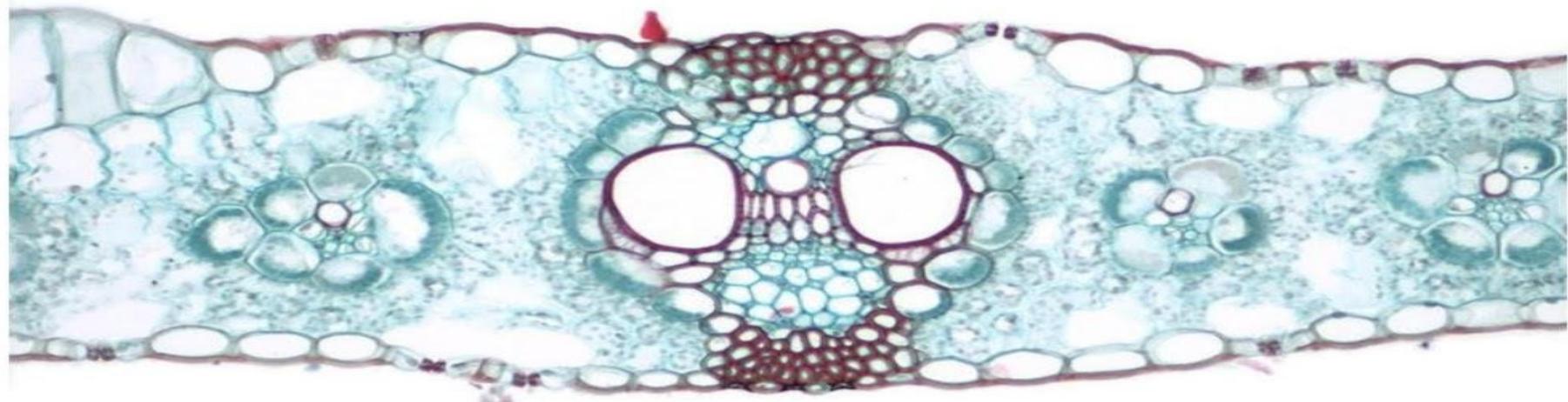
4. Vascular bundles are collateral and closed.

5. No differentiation of palisade and spongy parenchyma in mesophyll. (Isobilateral, monocot leaf)

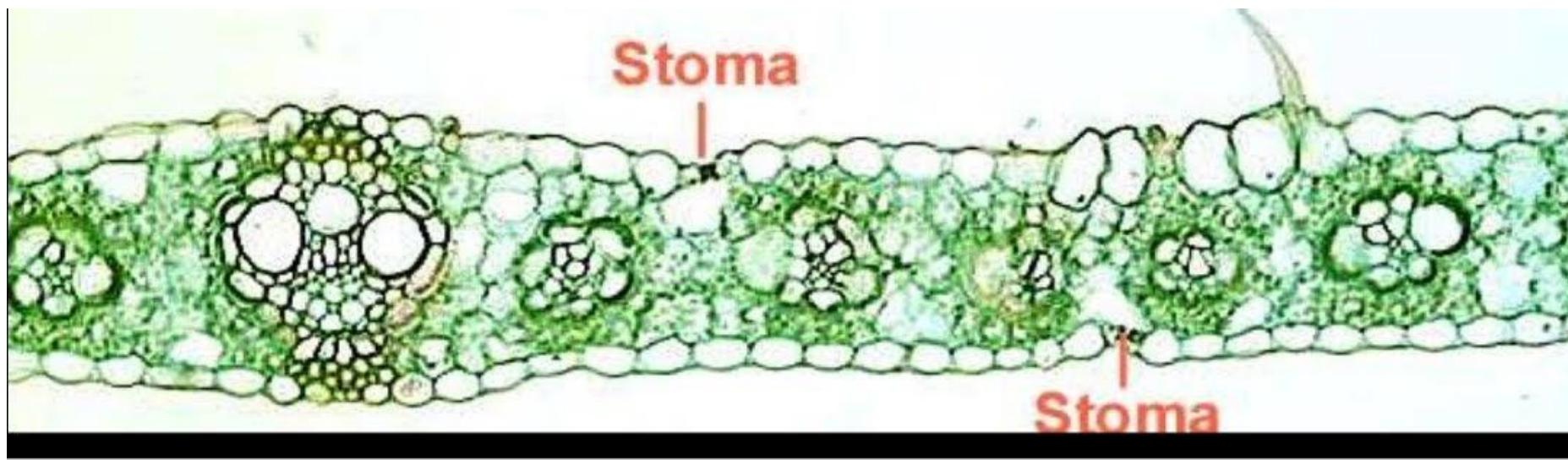




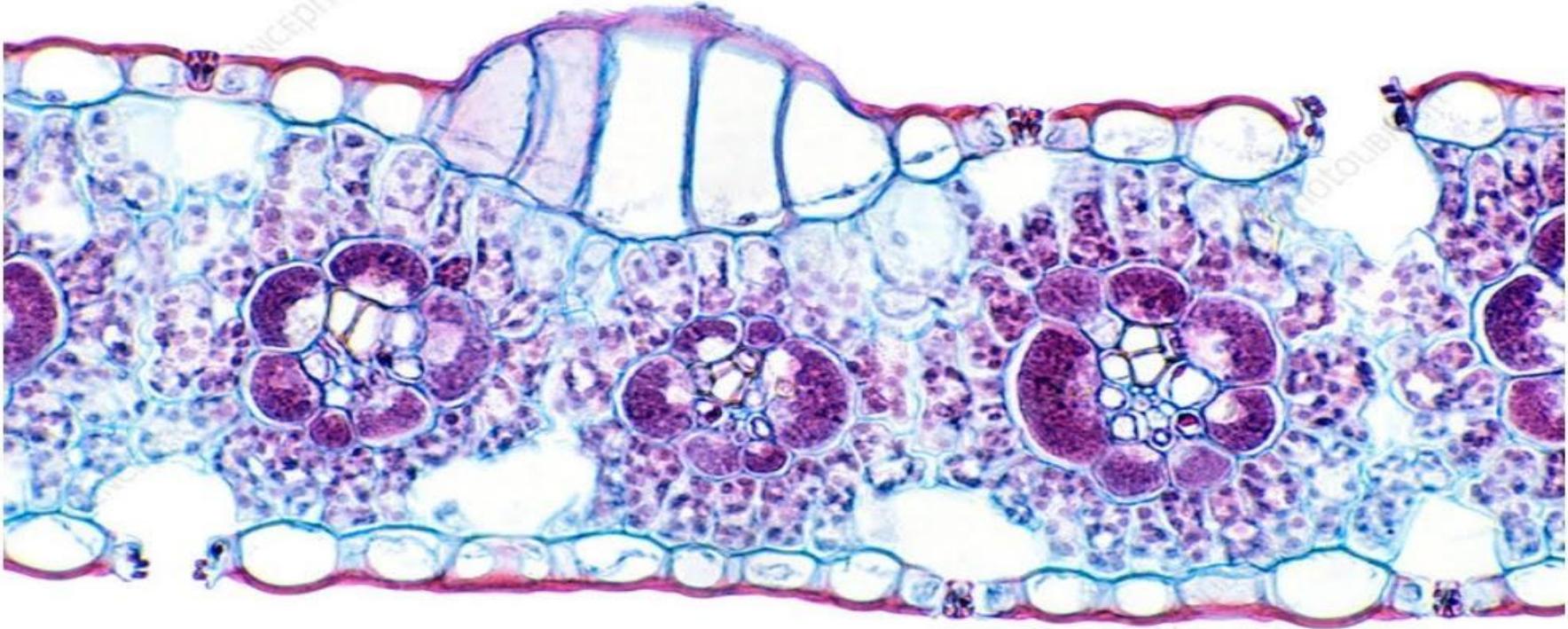
Cross section of corn leaf



Stoma



Stoma

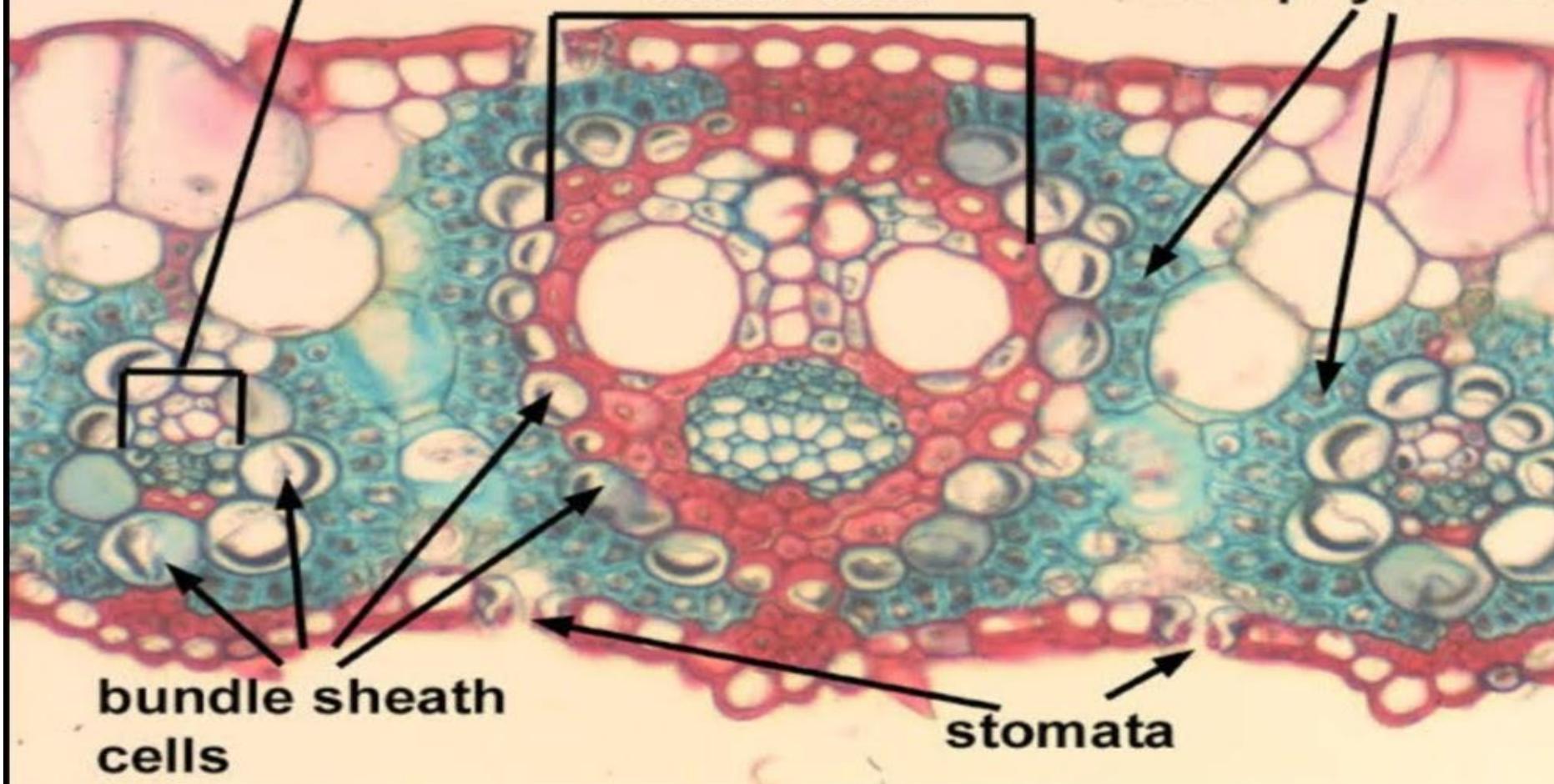


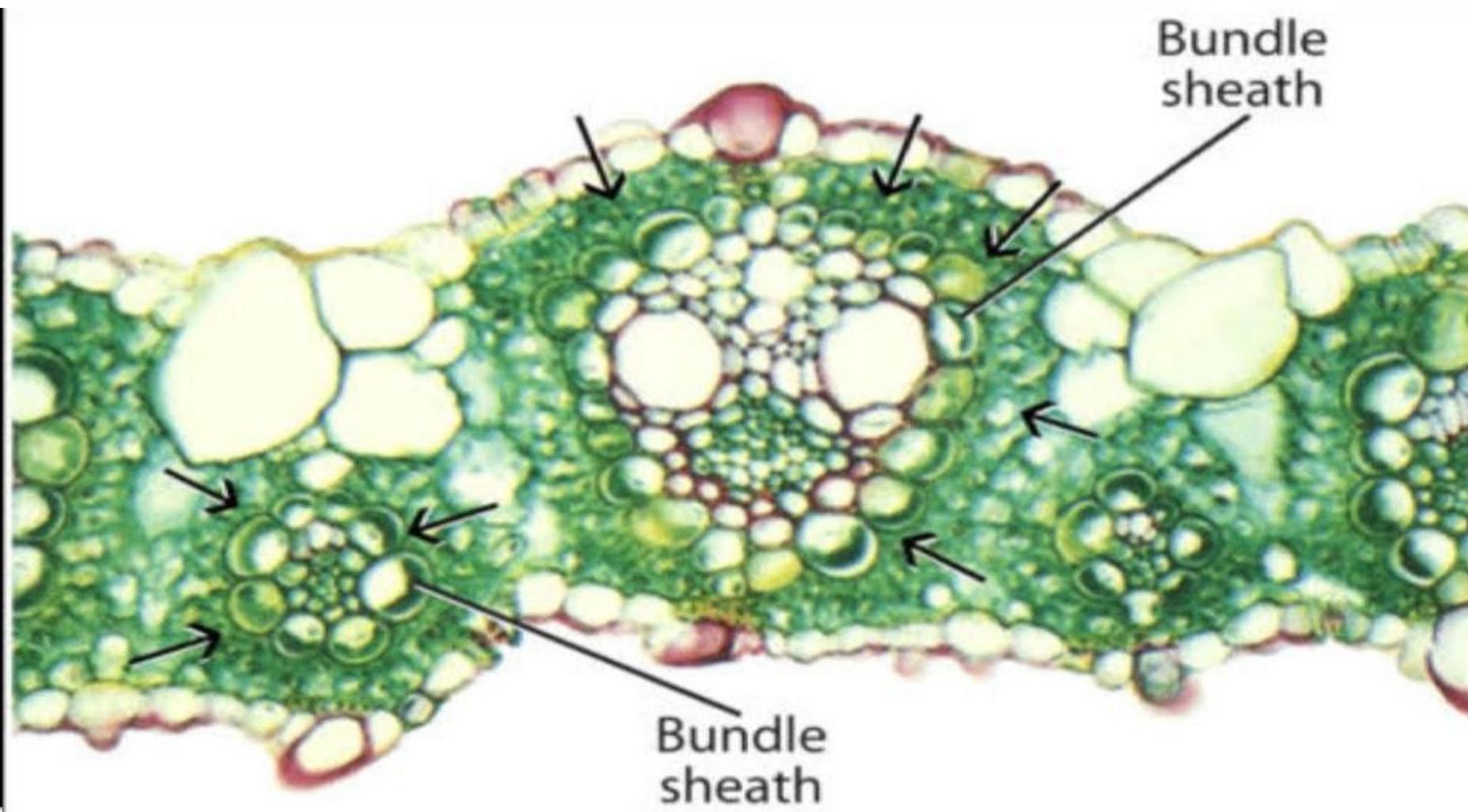
Corn (*Zea mays*) monocot leaf

small vein

main vein

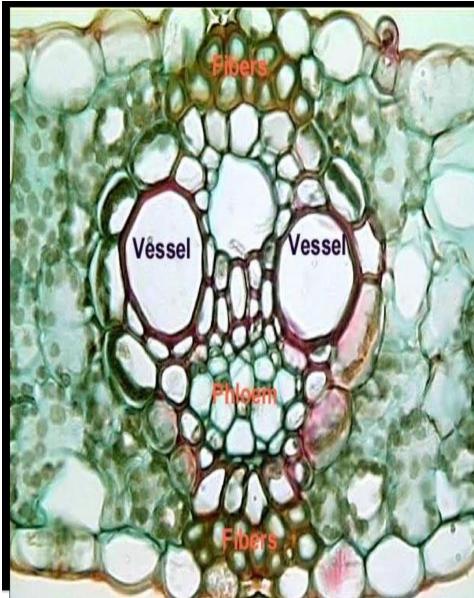
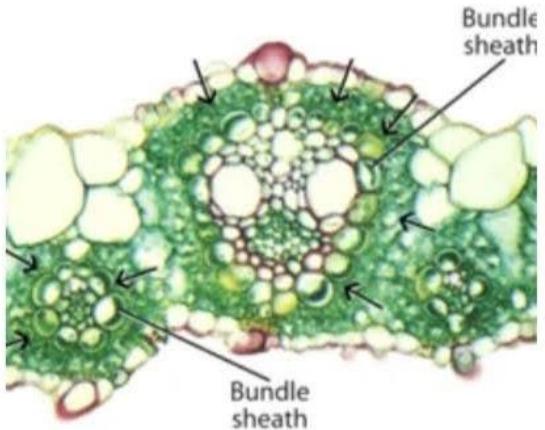
mesophyll cells





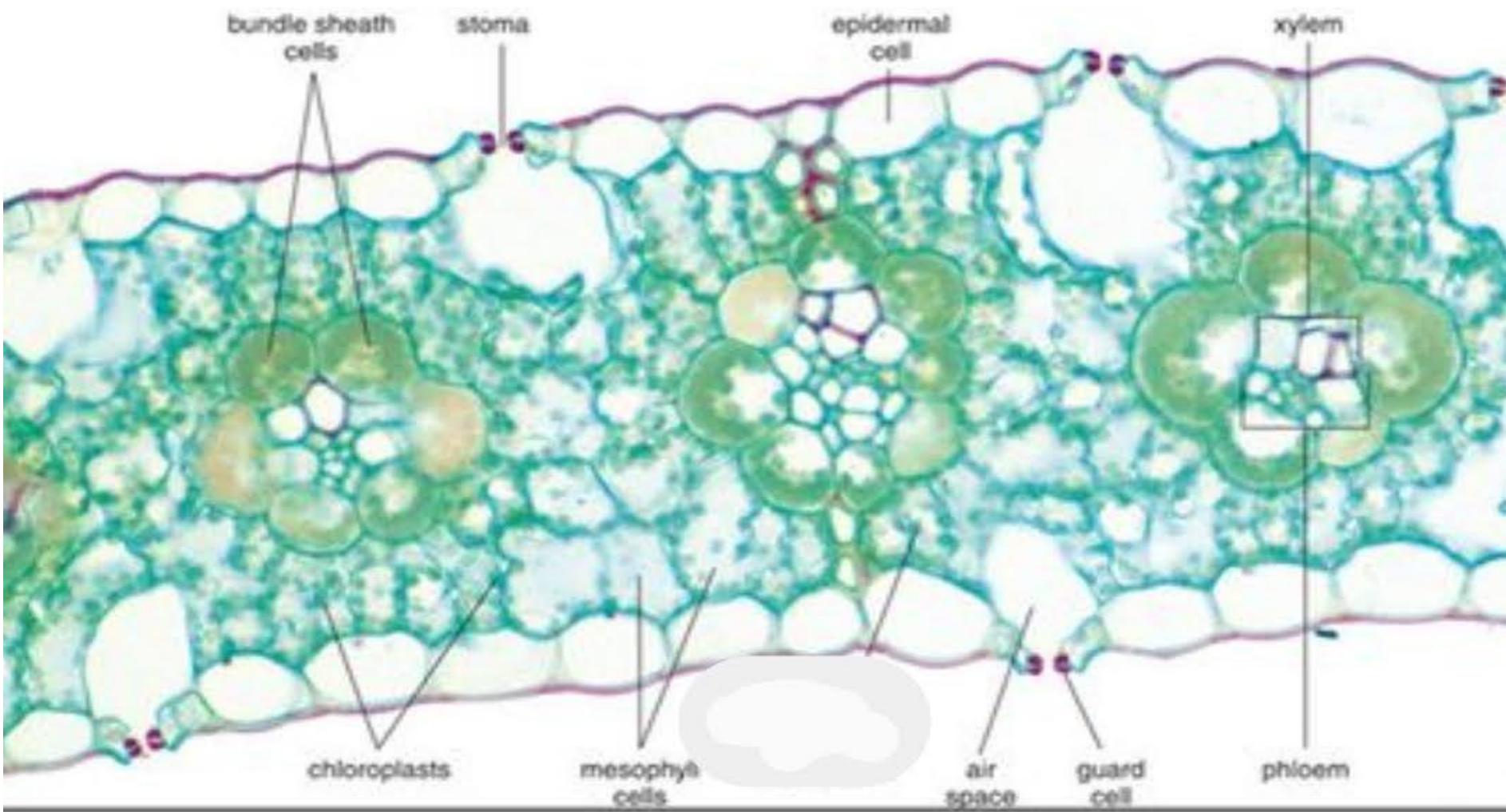
Concentric arrangement of the mesophyll and bundle sheath layers

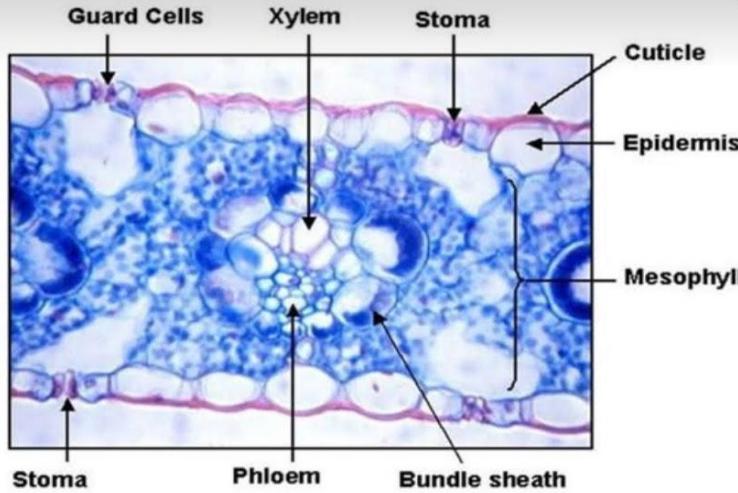
Kranz anatomy



Corn leaves show Kranz anatomy

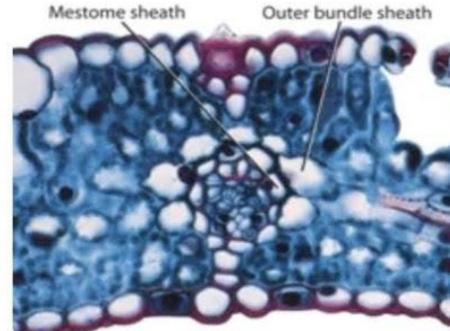
This arrangement of mesophyll cells is known as 'Kranz Anatomy'.

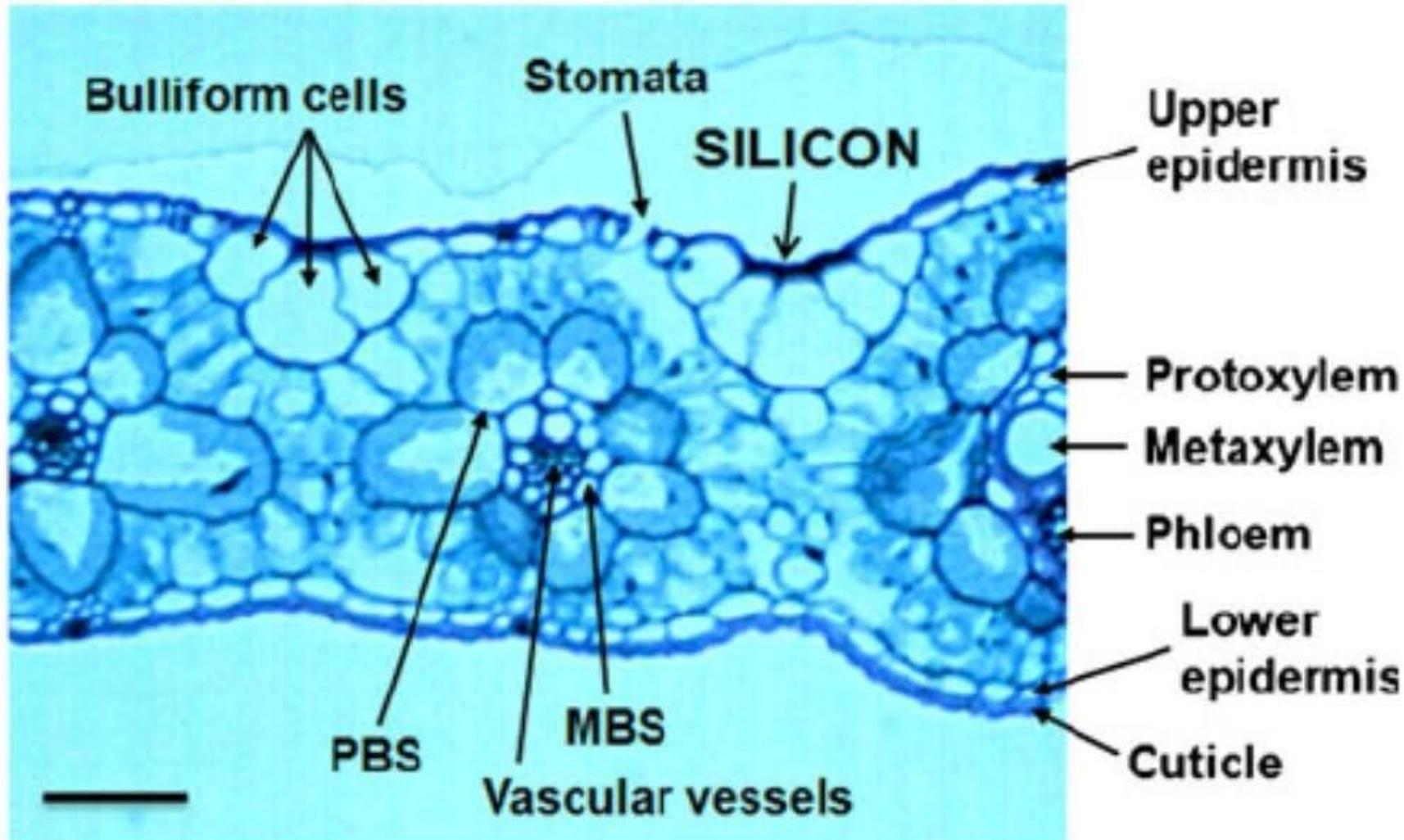


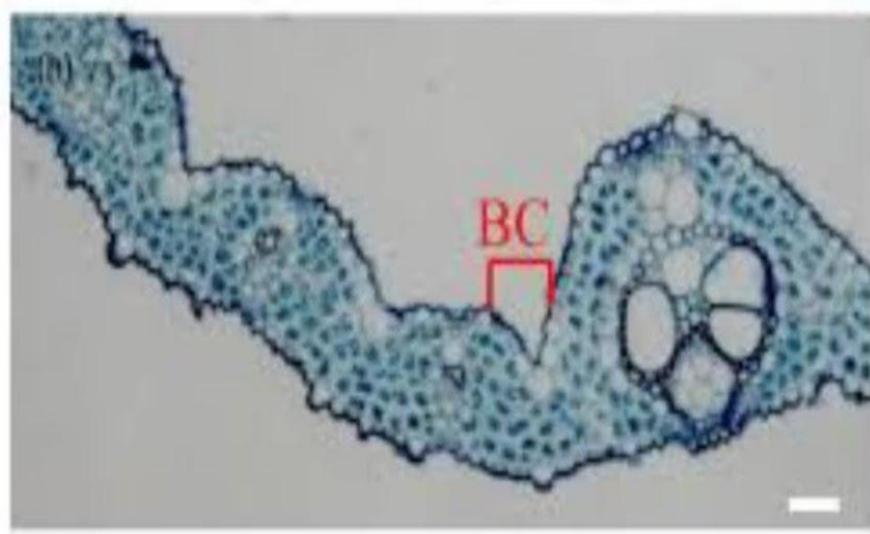
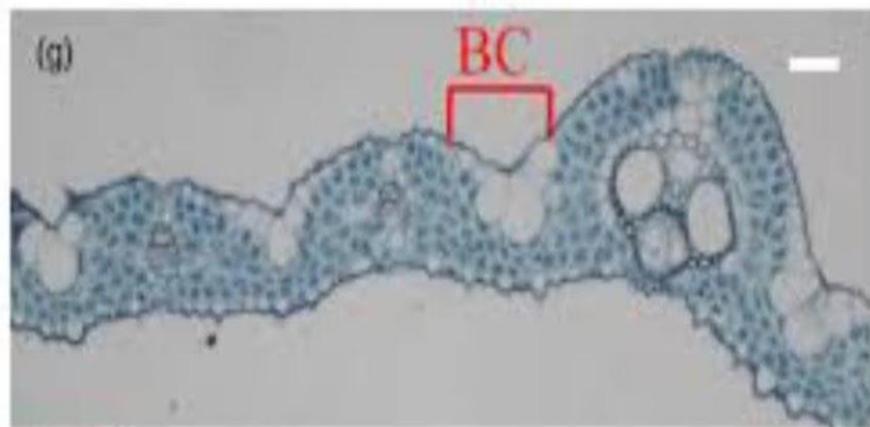
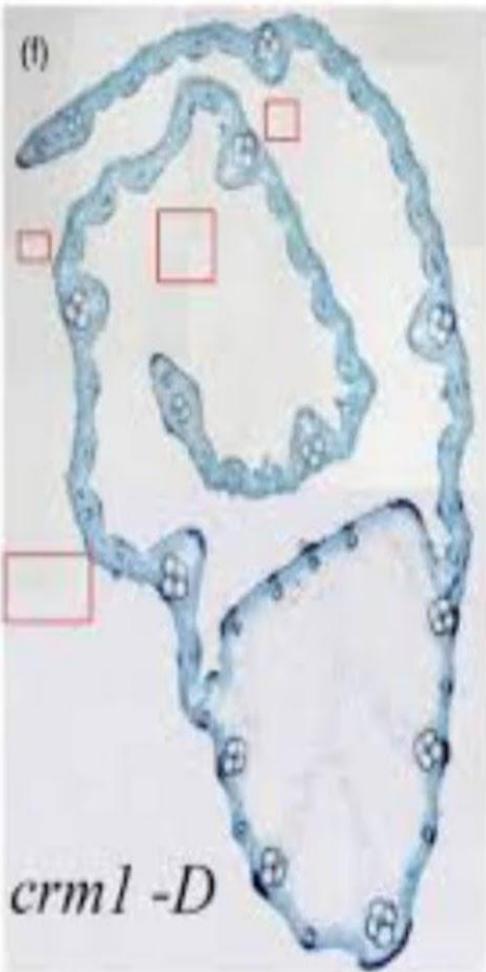


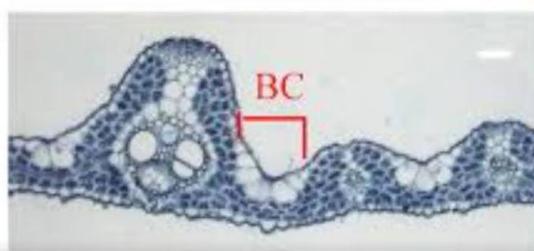
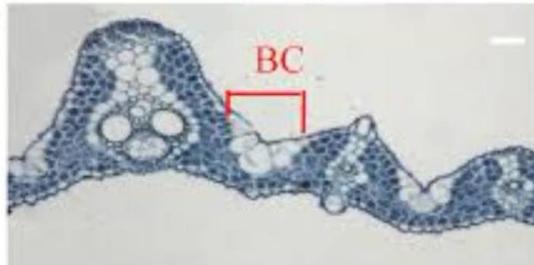
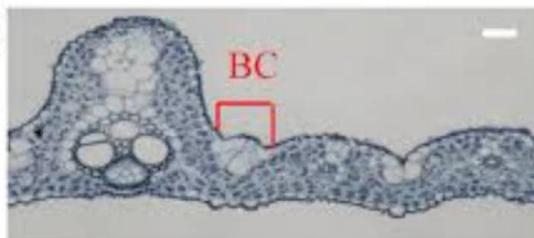
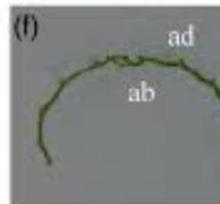
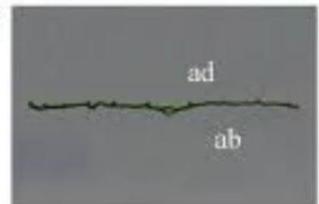
The vascular bundle has xylem towards the upper surface and phloem towards the lower.

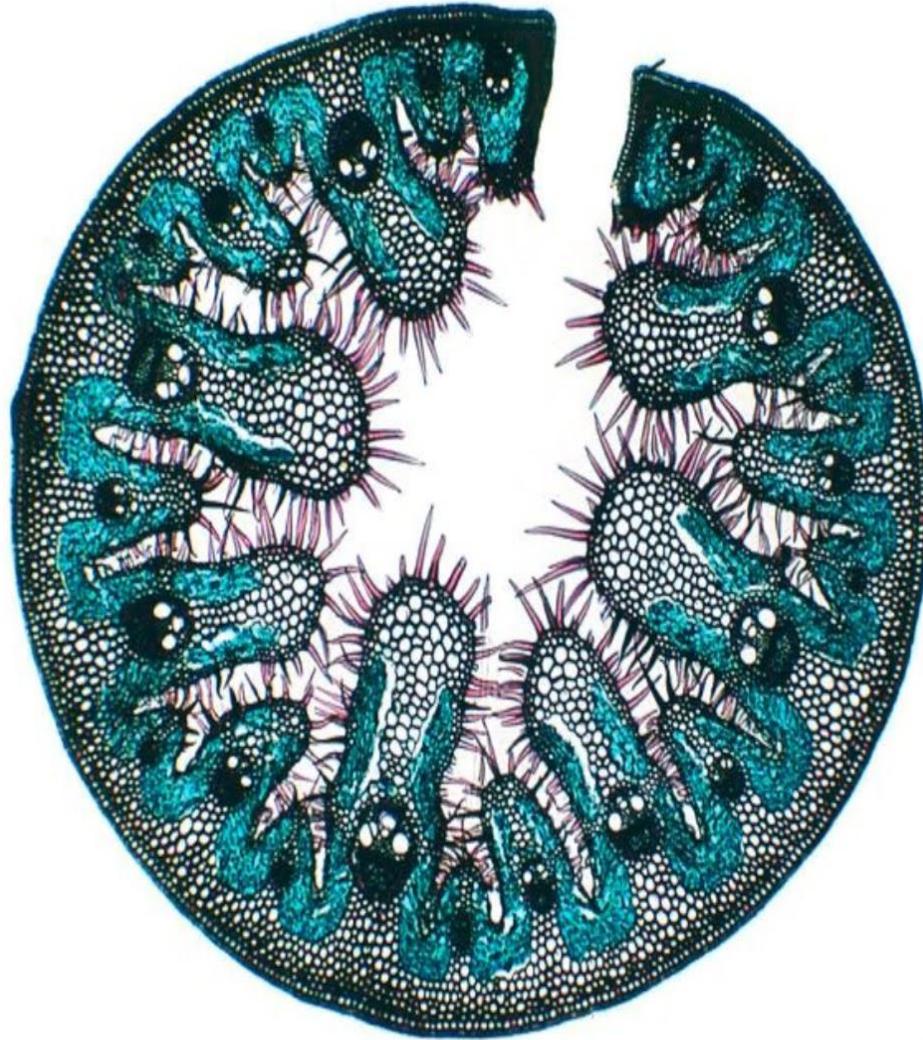
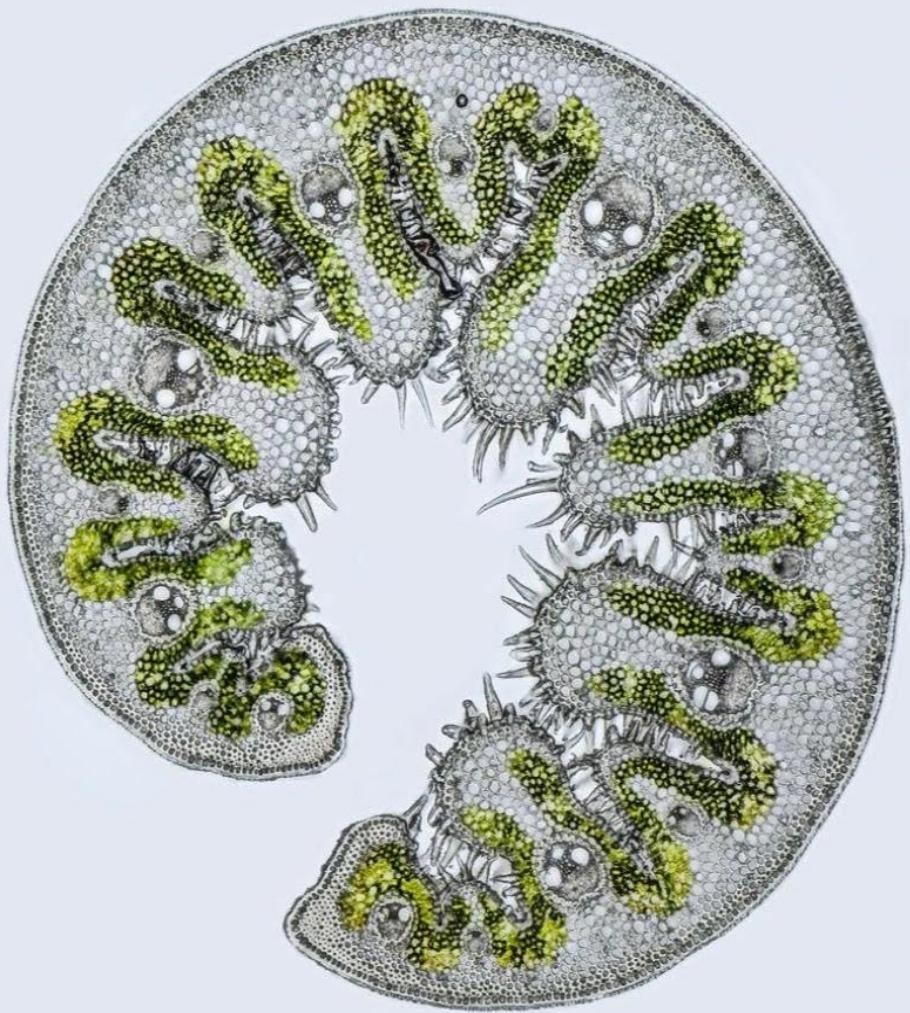
C3 - mesophyll cells and bundle sheath are non concentrically arranged, small cells of parenchyma with small chloroplast that are empty and clear. also an inner, thick walled sheath also present

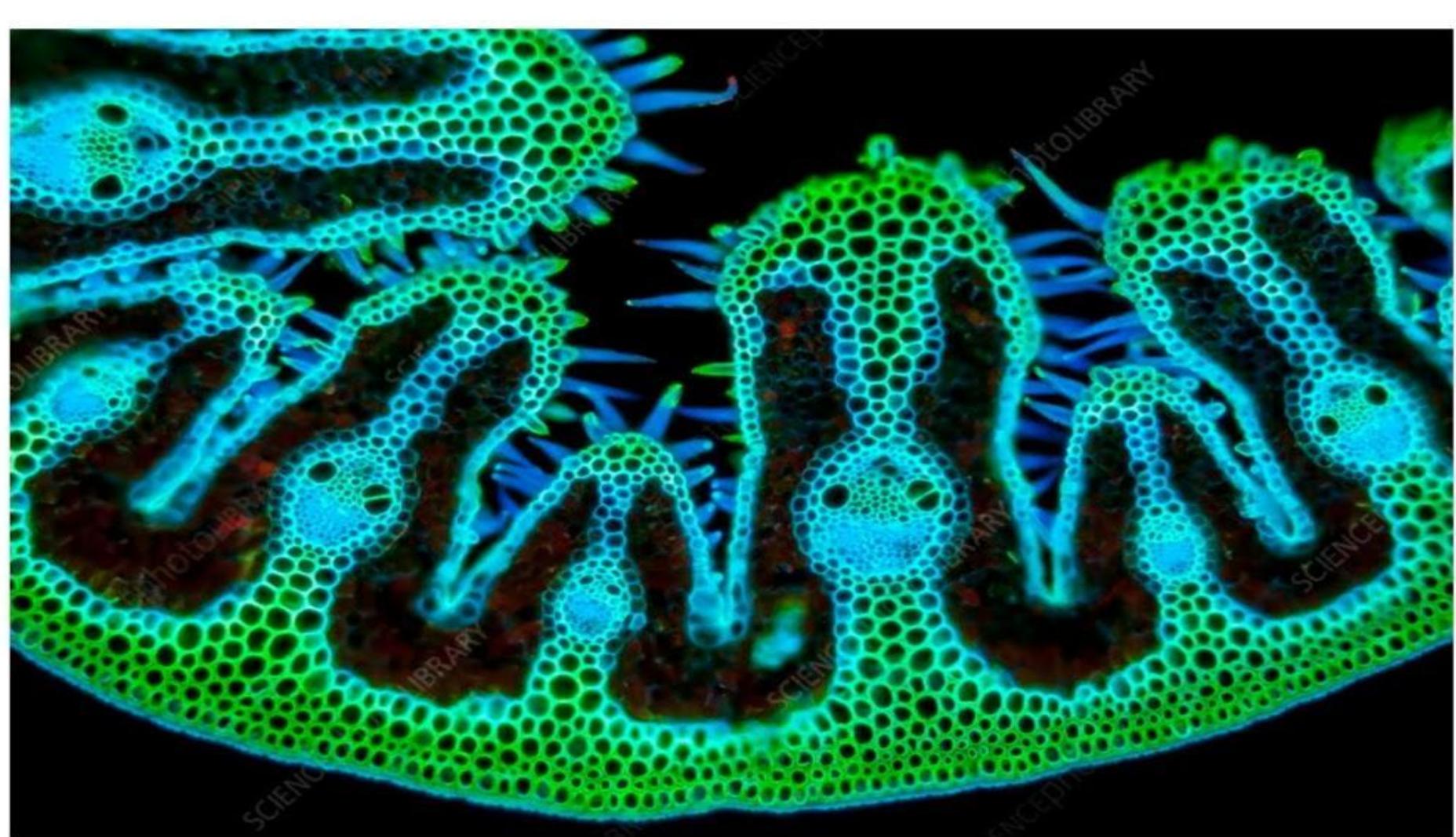


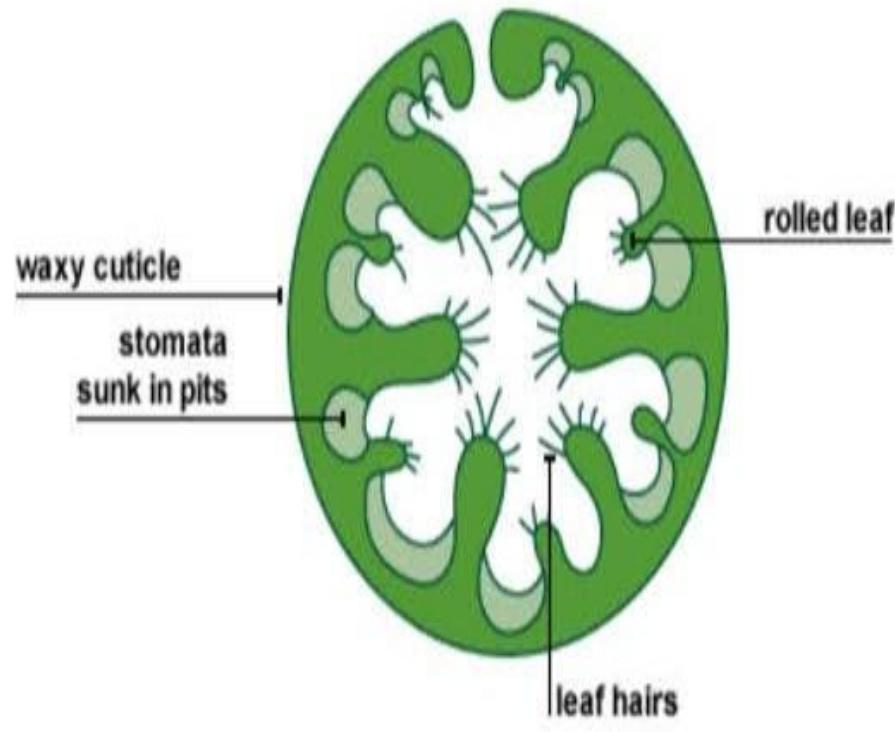
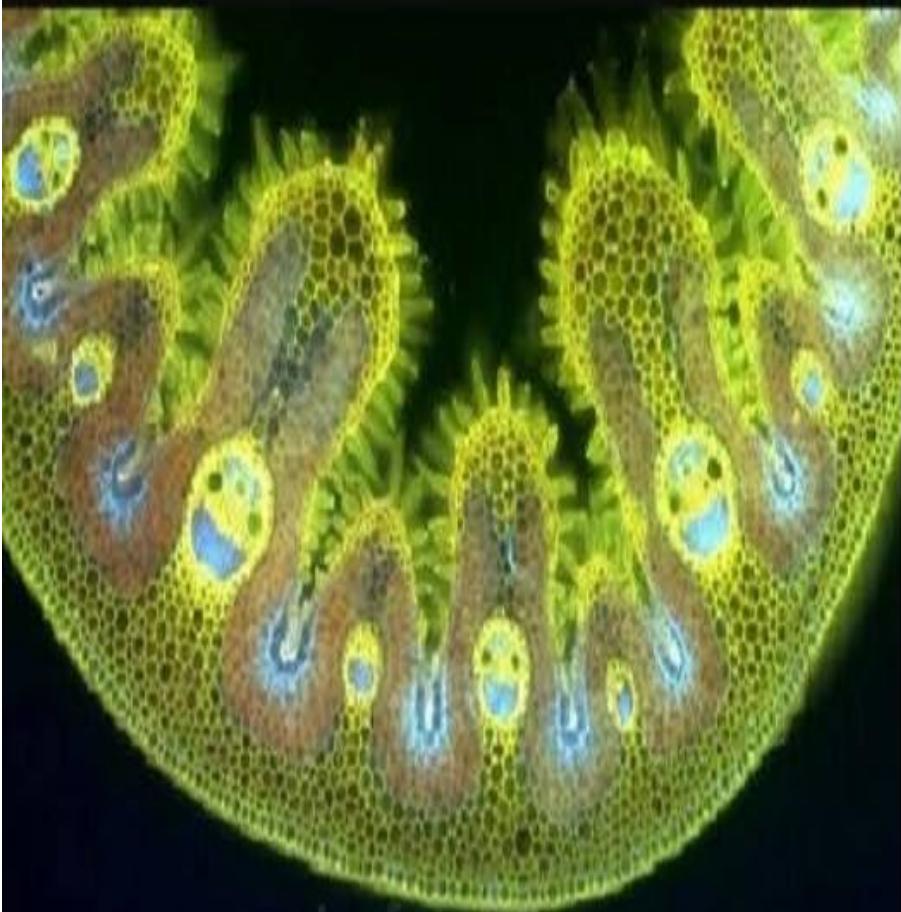








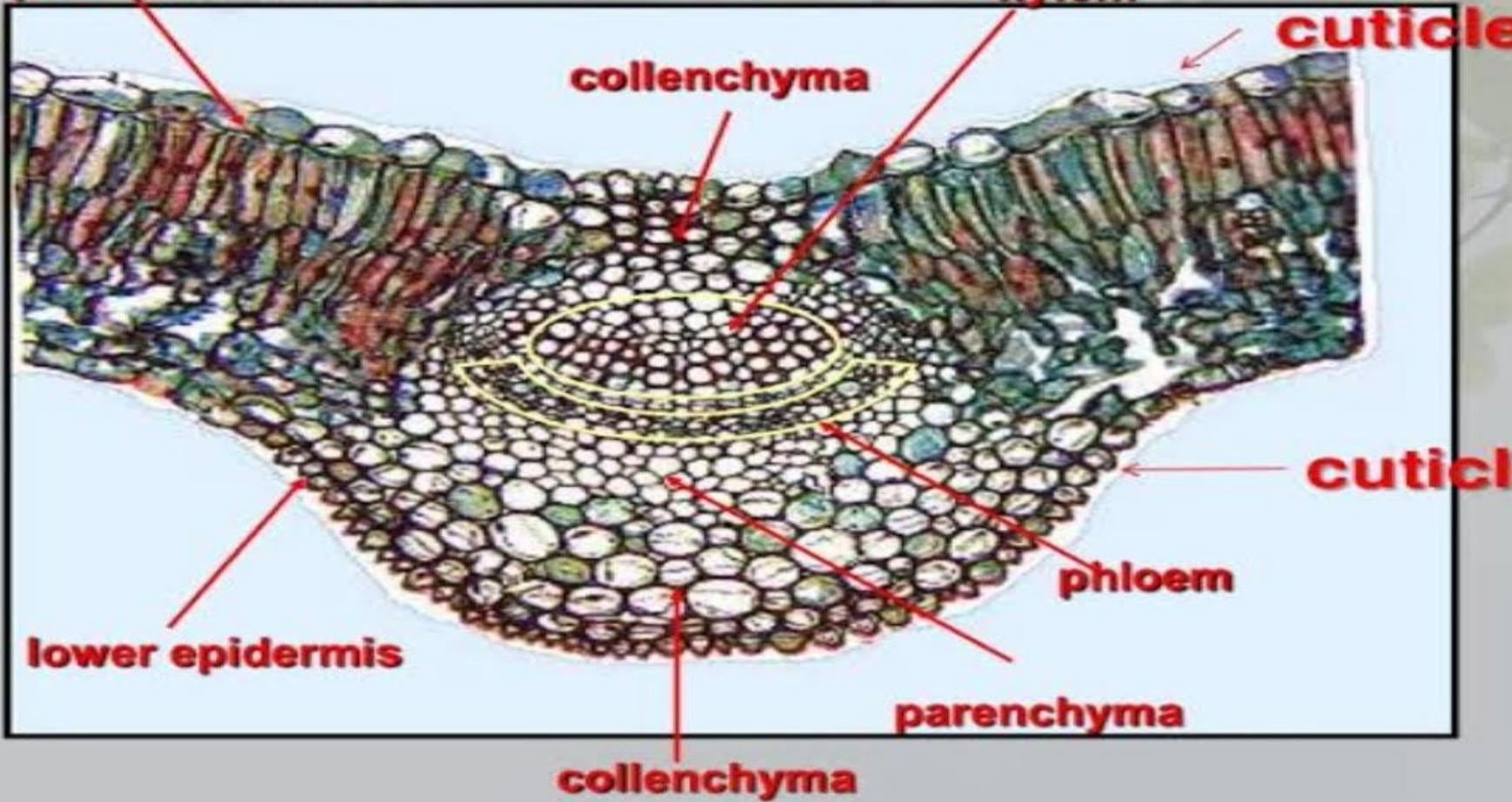




DORSIVENTRAL LEAVES

Distinctive anatomical features of the dorsiventral leaves :—

- (i) Presence of two epidermis - upper and lower.
- (ii) Both of them are cuticularised.
- (iii) Stomata distributed to the lower surface only.
- (iv) Mesophyll tissue differentiated into palisade and spongy parenchyma.





Angiosperm Morphology: The Mesophytic Dicotyledonous Leaf

T. S. Shows the following structures :—

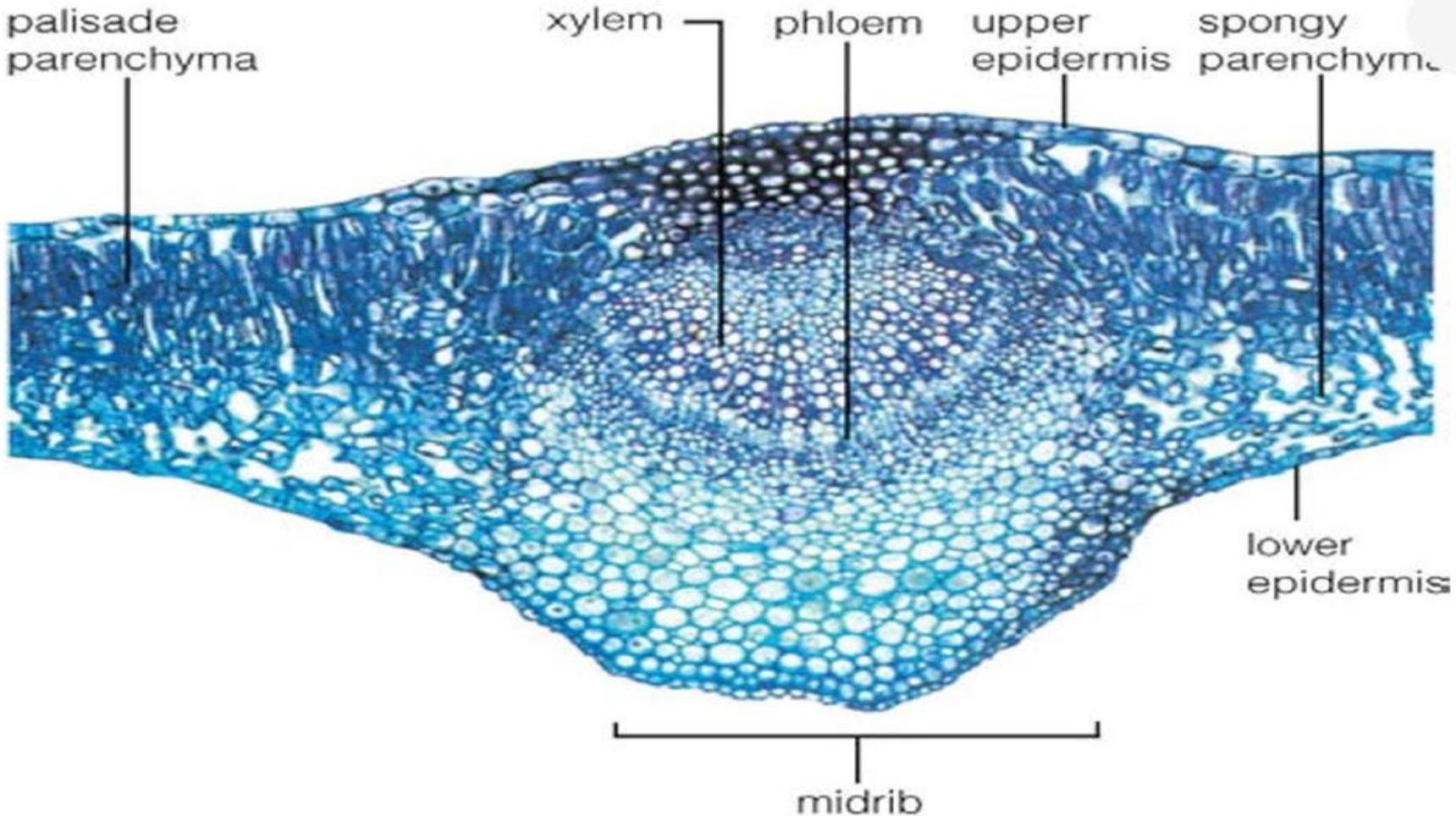
1. Outline—Dorsiventrally flattened.
2. Cuticle—Thick on the upper side and thinner on the lower side.
3. Epidermis—Single layered, consisting of thin walled tubular cells. Upper epidermis continuous, lower epidermis with stomata.
4. Mesophyll—Differentiated into upper palisade tissue and lower spongy tissue.

Palisade—Two layered, parenchymatous columnar cells with scanty intercellular spaces and contain chloroplast.

Spongy—Parenchymatous, loosely arranged with conspicuous intercellular spaces and contain less chloroplast.

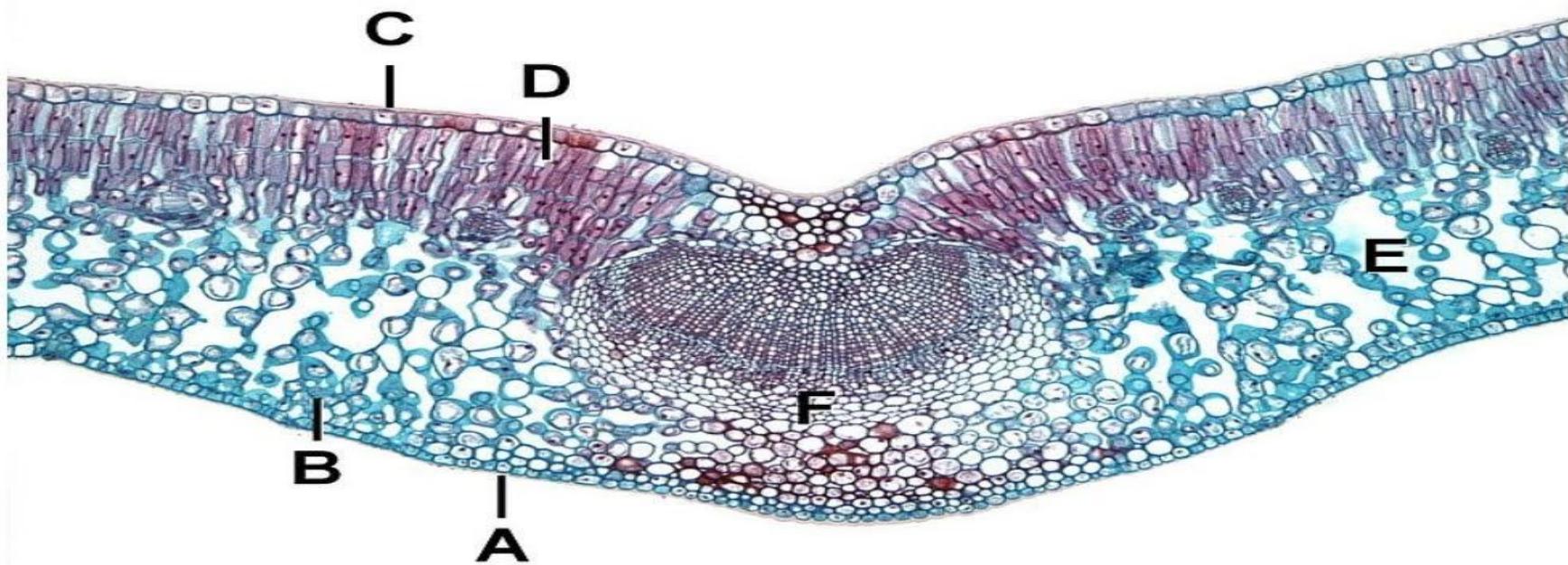
5. Vascular bundles—They are conjoint, collateral and closed. Bundles are of various sizes. Each bundle is enclosed by a colourless band of parenchymatous cells. On both upper and lower sides of the bundle two patches of collenchyma tissues are present.

Comment—It reveals a typical dorsiventral leaf. The section is dorsiventrally flattened in outline. Each epidermis is cuticularised. Upper epidermis continuous, lower epidermis with stomata. Mesophyll tissue is differentiated into upper palisade and lower spongy parenchyma. The bundles are conjoint, collateral and closed. Each bundle is enclosed by a bundle sheath.



File:Dicot leaf

文A



Dicot leaf - midrib section + vascular section

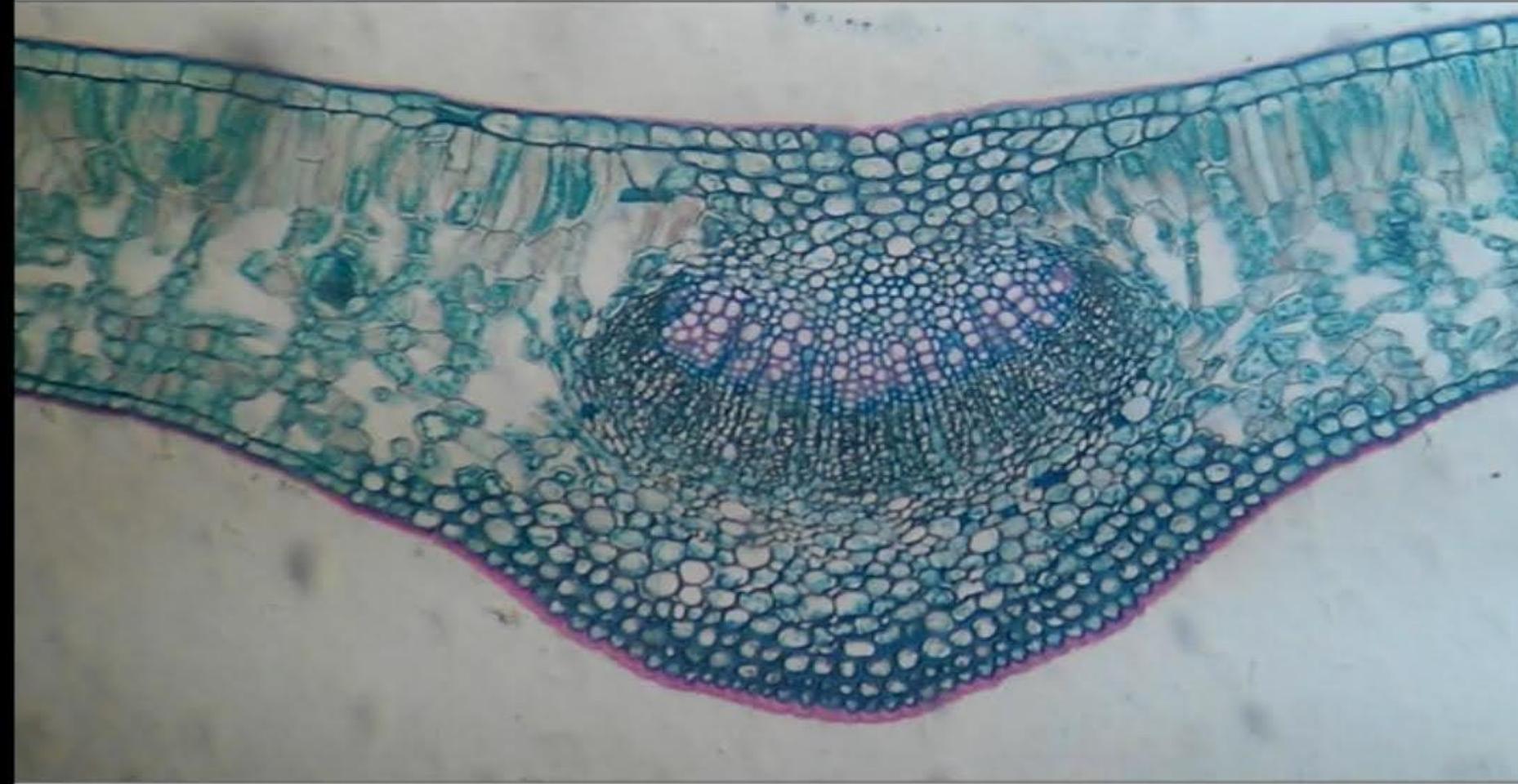
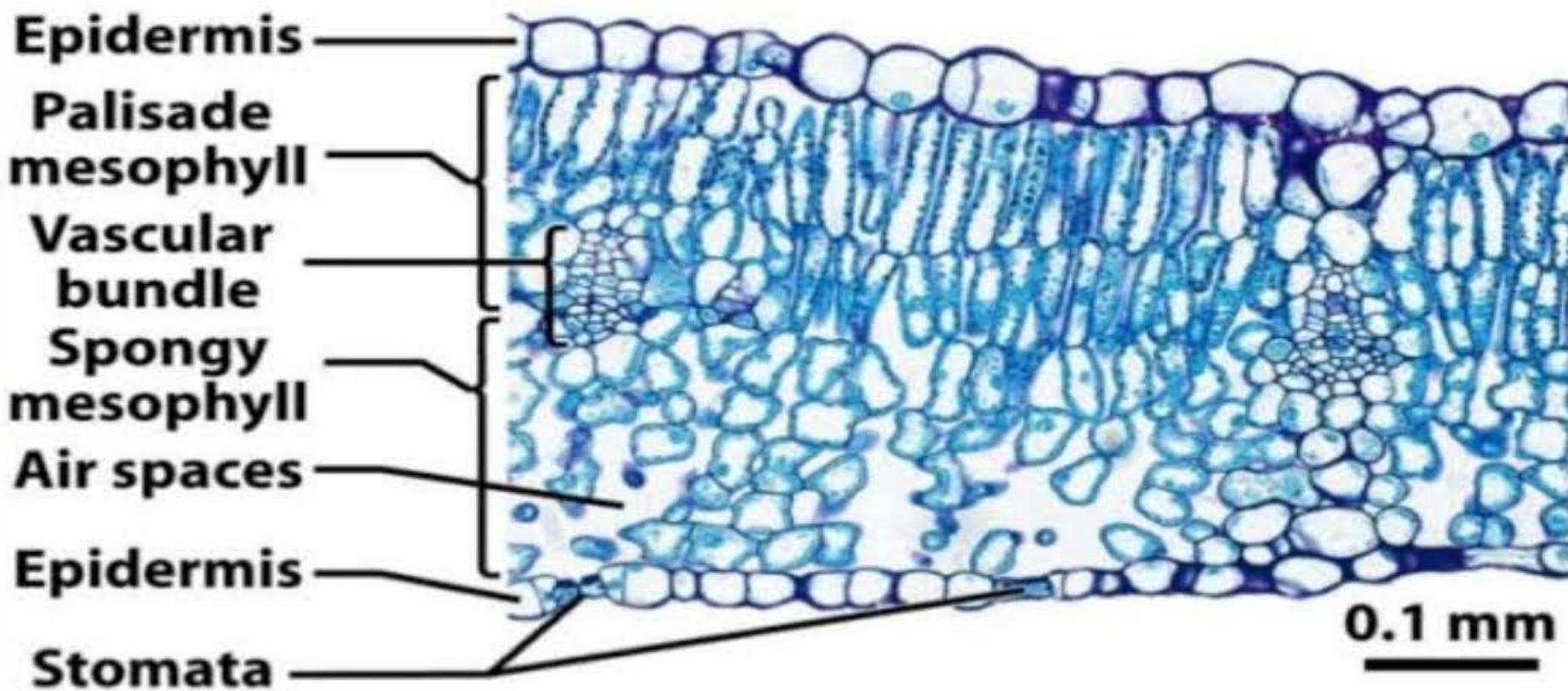
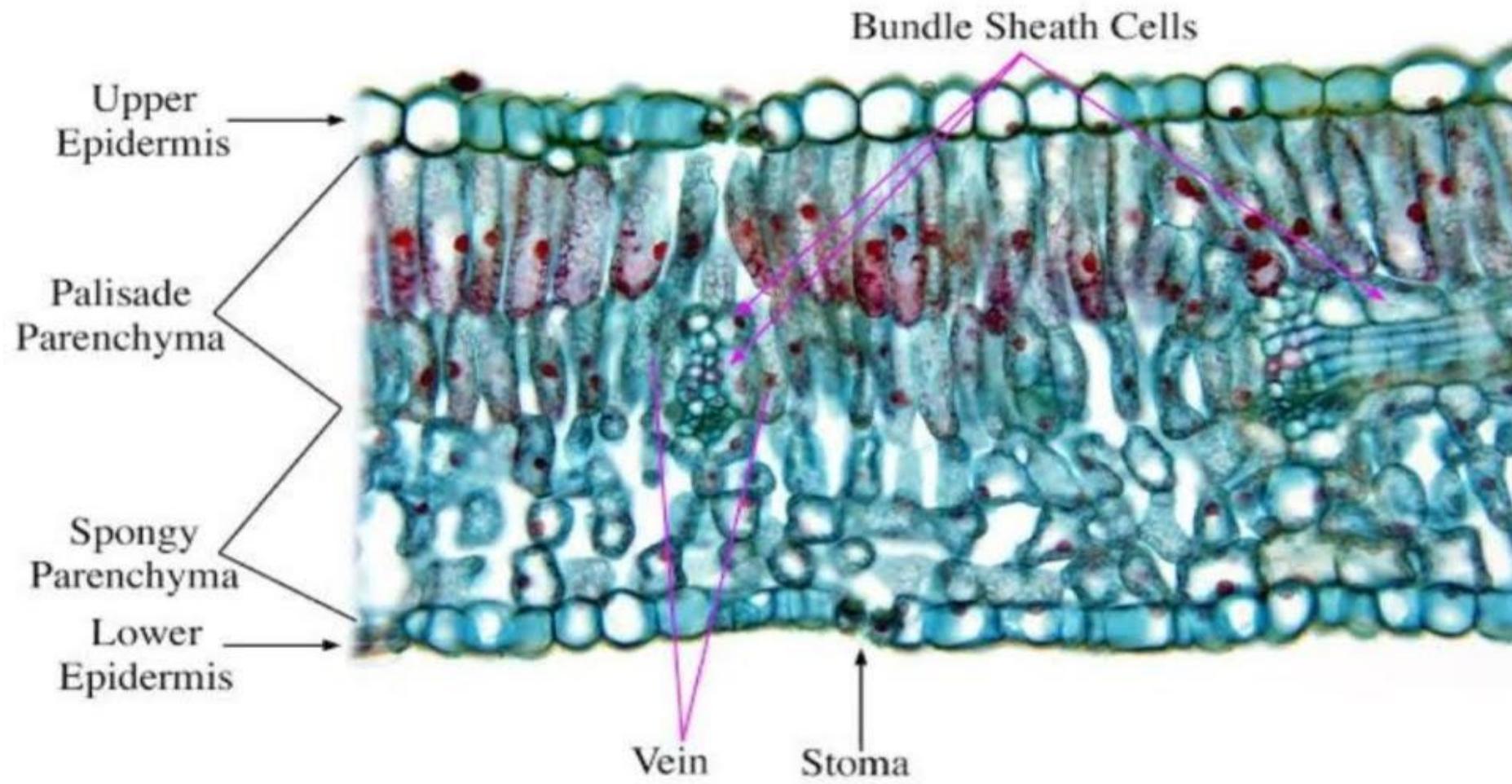
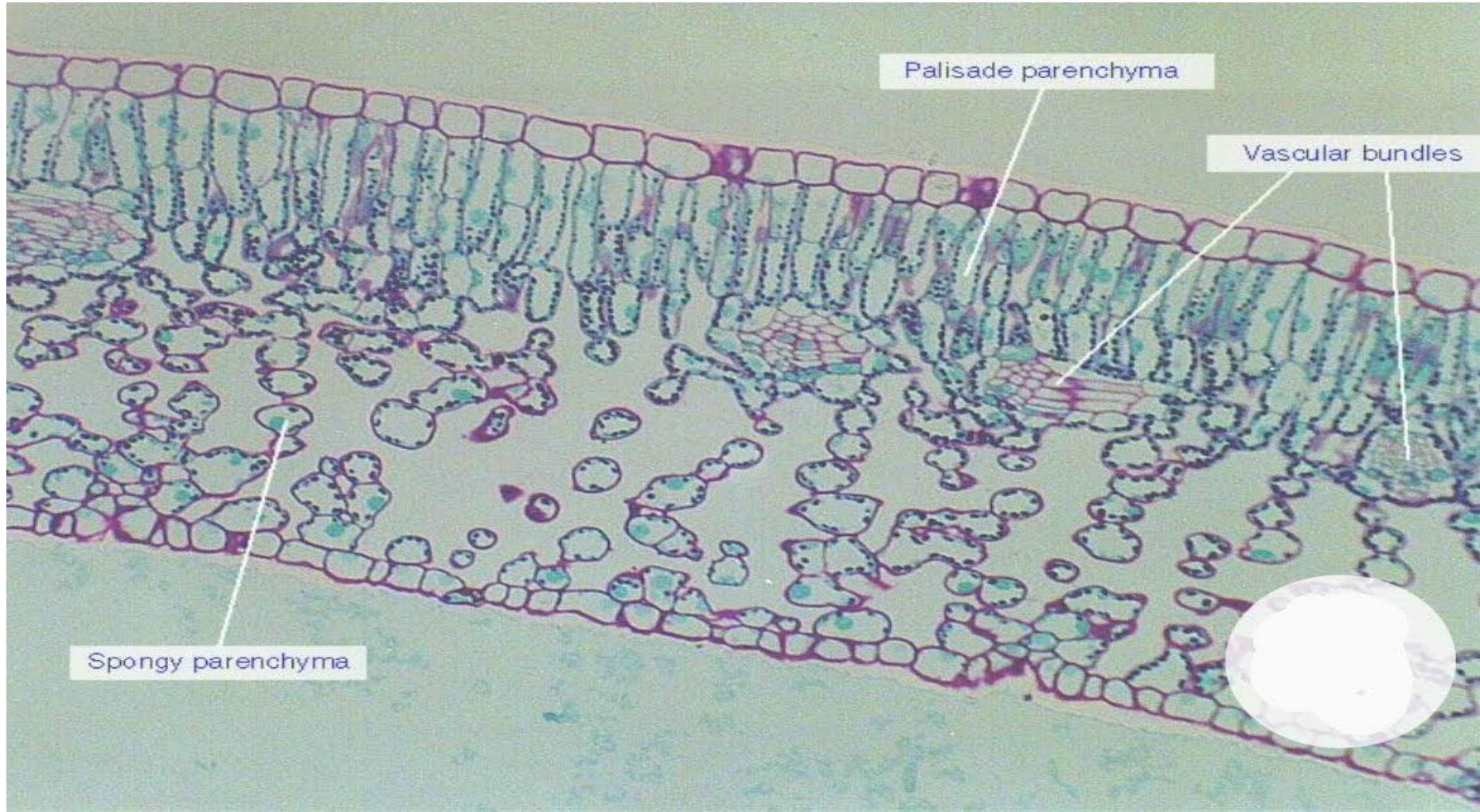


Diagram of Dicot Leaf

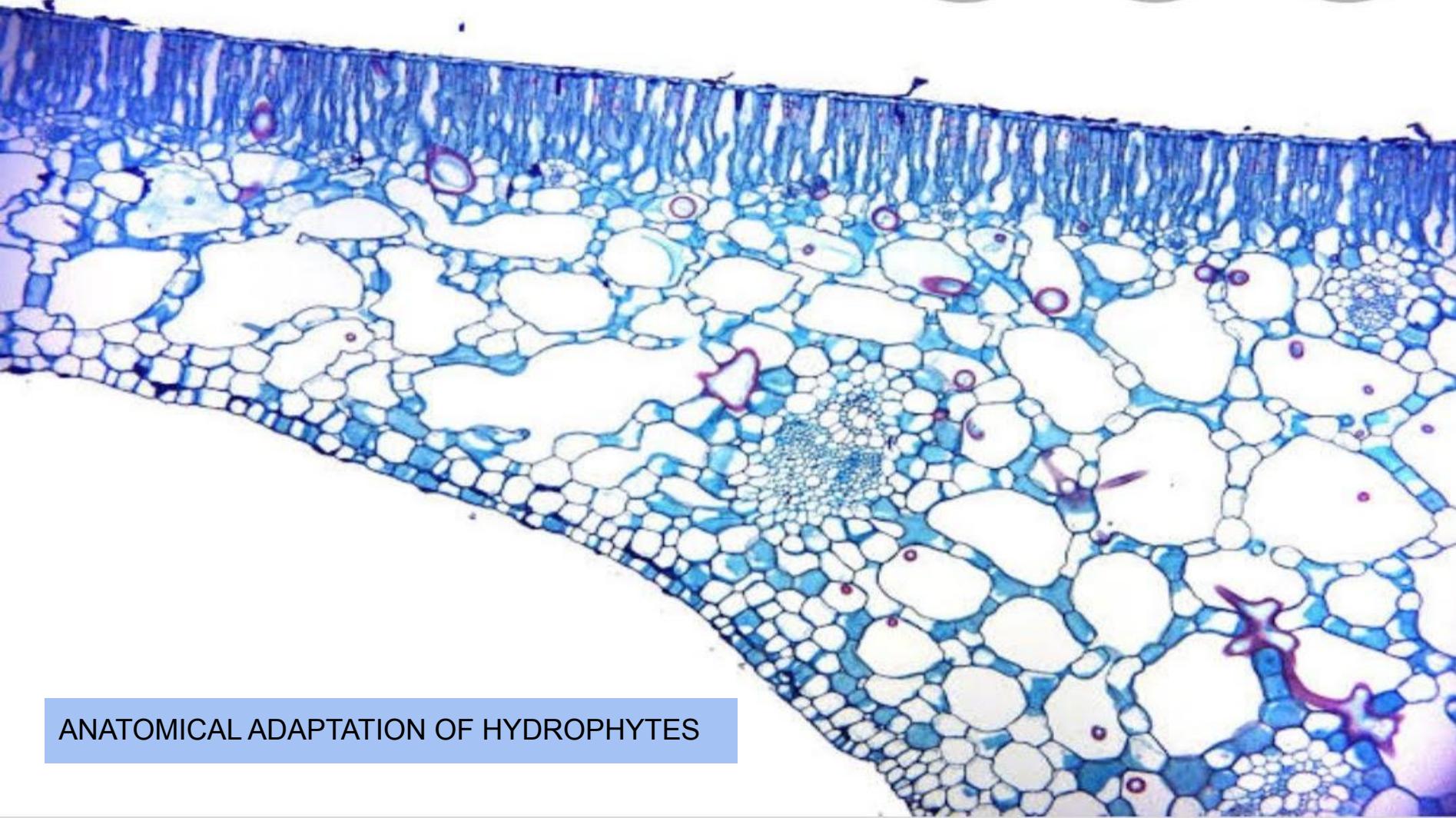




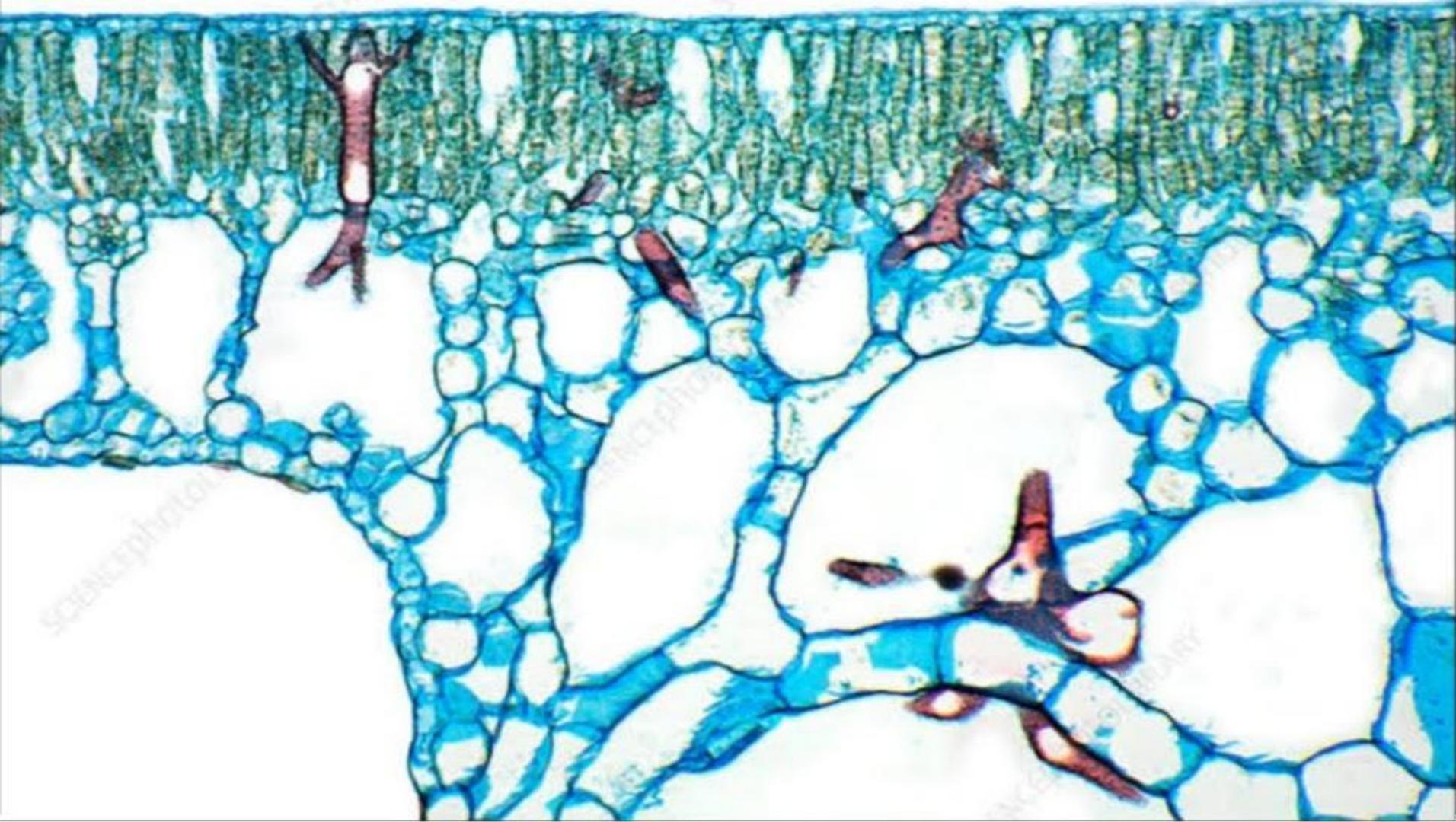


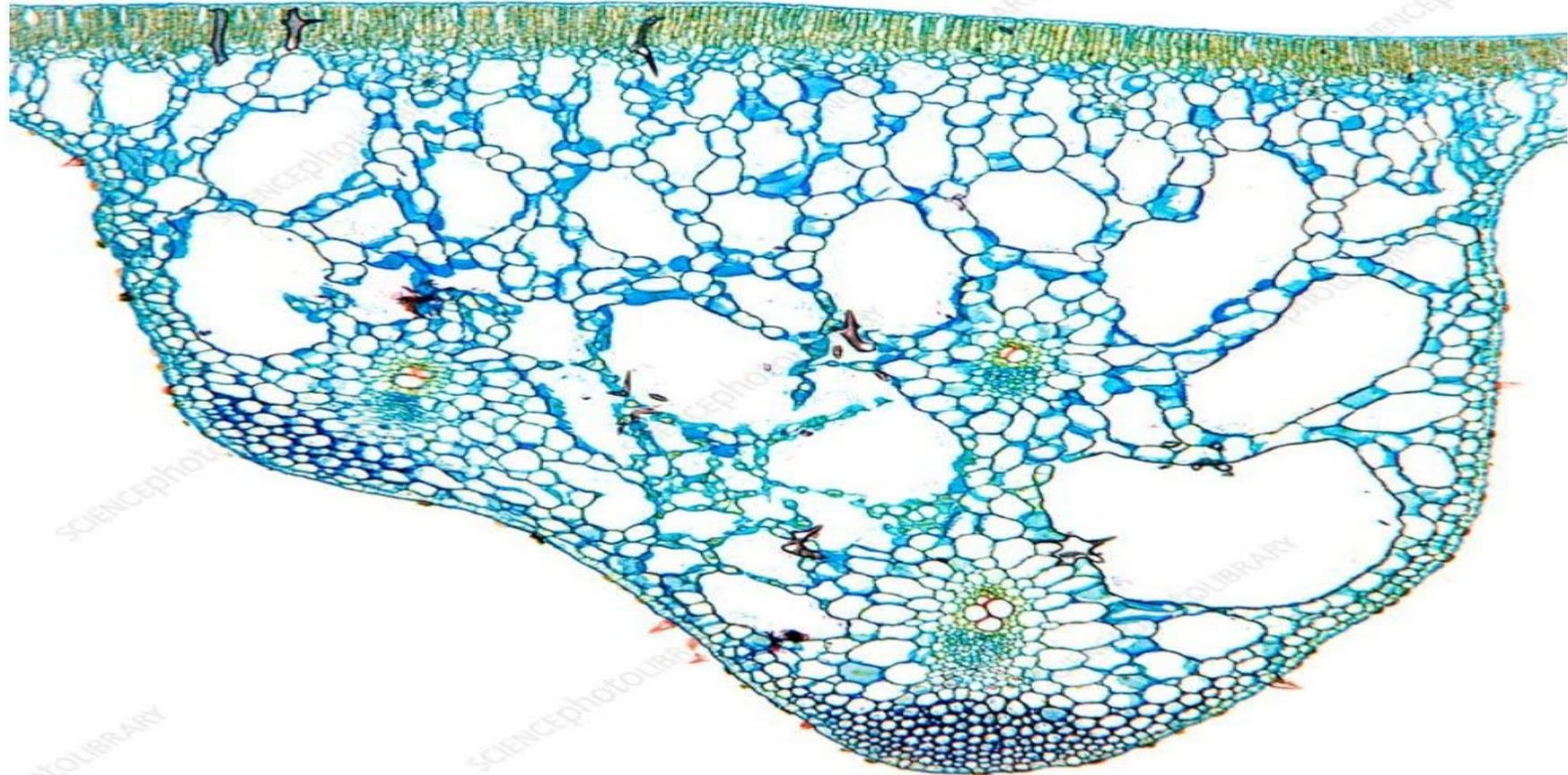


Water lily leaf, light micrograph



ANATOMICAL ADAPTATION OF HYDROPHYTES





Water lily leaf, light micrograph



Stomatal pit

Nerium leaf (T.S)

29. Structures of the leaf of NERIUM (Oleander) in T. S.

T. S. shows the following structures :—

1. **Outline**—Dorsiventrally flattened with **planoconvex shape** in the region of the midrib.

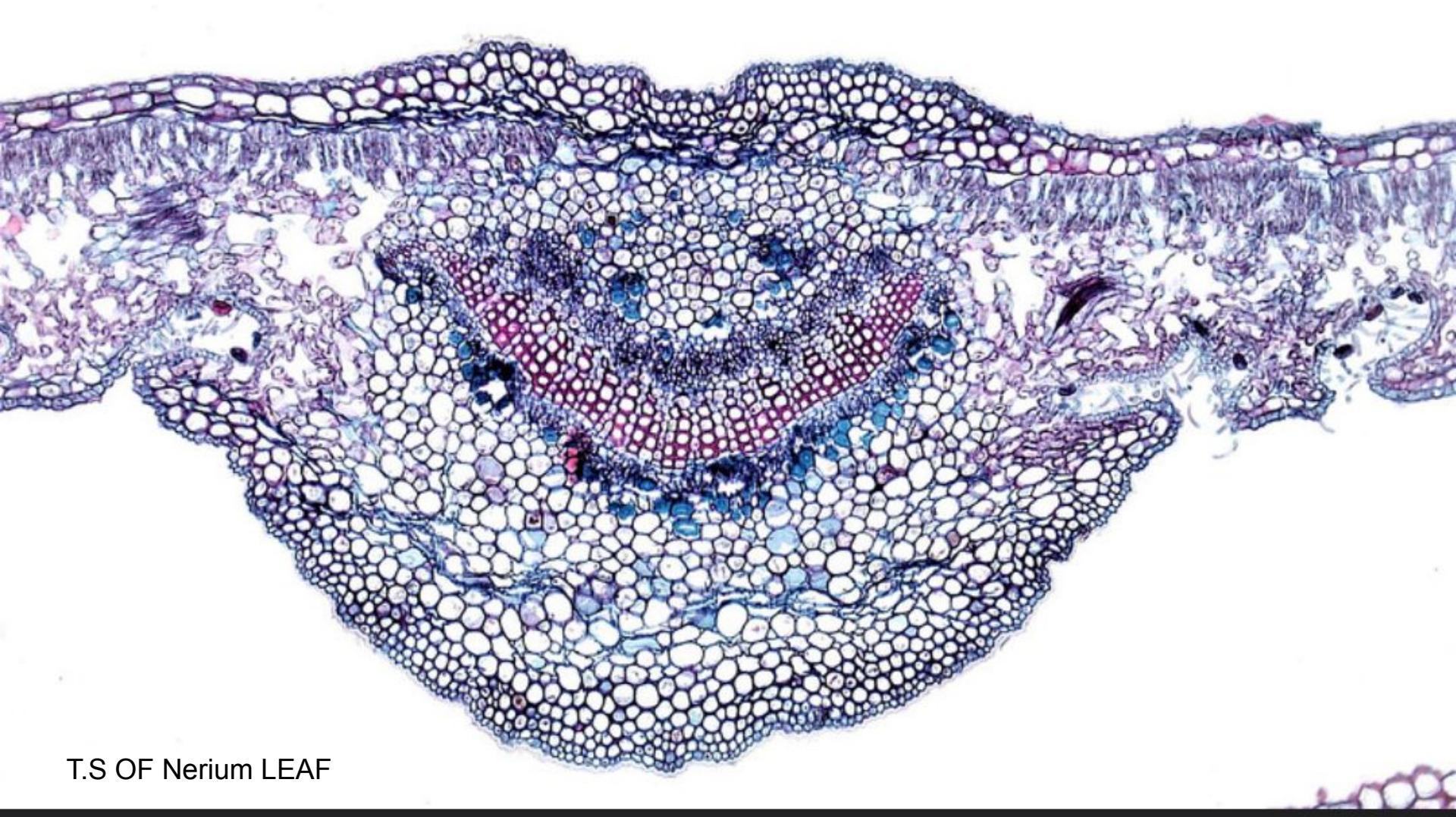
2. **Cuticle**—Thick on the upper side and thinner on the lower side.

3. **Epidermis**—Multilayered on both sides. Sunken stomata are present on the lower epidermis in stomatal pits which are gurded by trichomes developed from the cells bordering the pits.

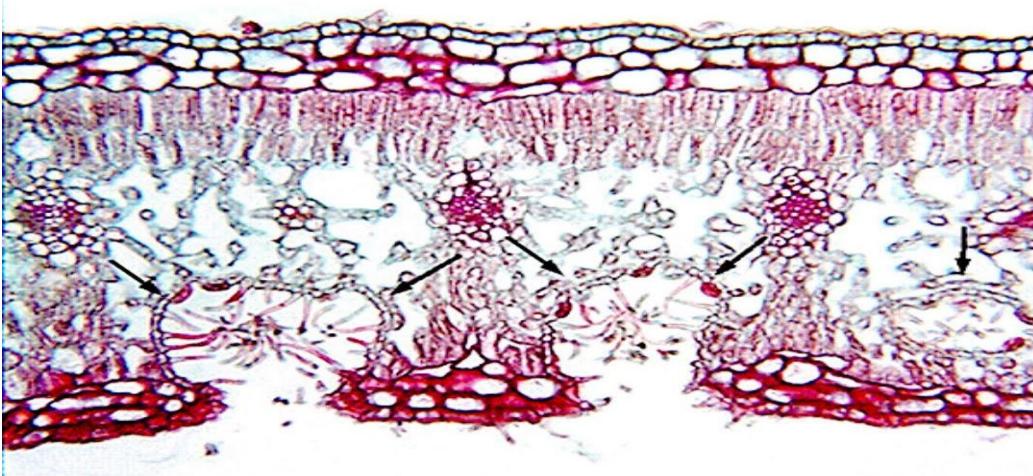
4. **Mesophyll**—It consists of palisade and spongy cells. Palisade parenchyma occurs both towards upper and lower epidermis and spongy cells are located in between them. Spaeoraphides are present here and there.

ones with xylem on the upper and phloem on the lower sides. They remain surrounded by parenchymatous sheath. Presence of intraxylary phloem close to protoxylem.

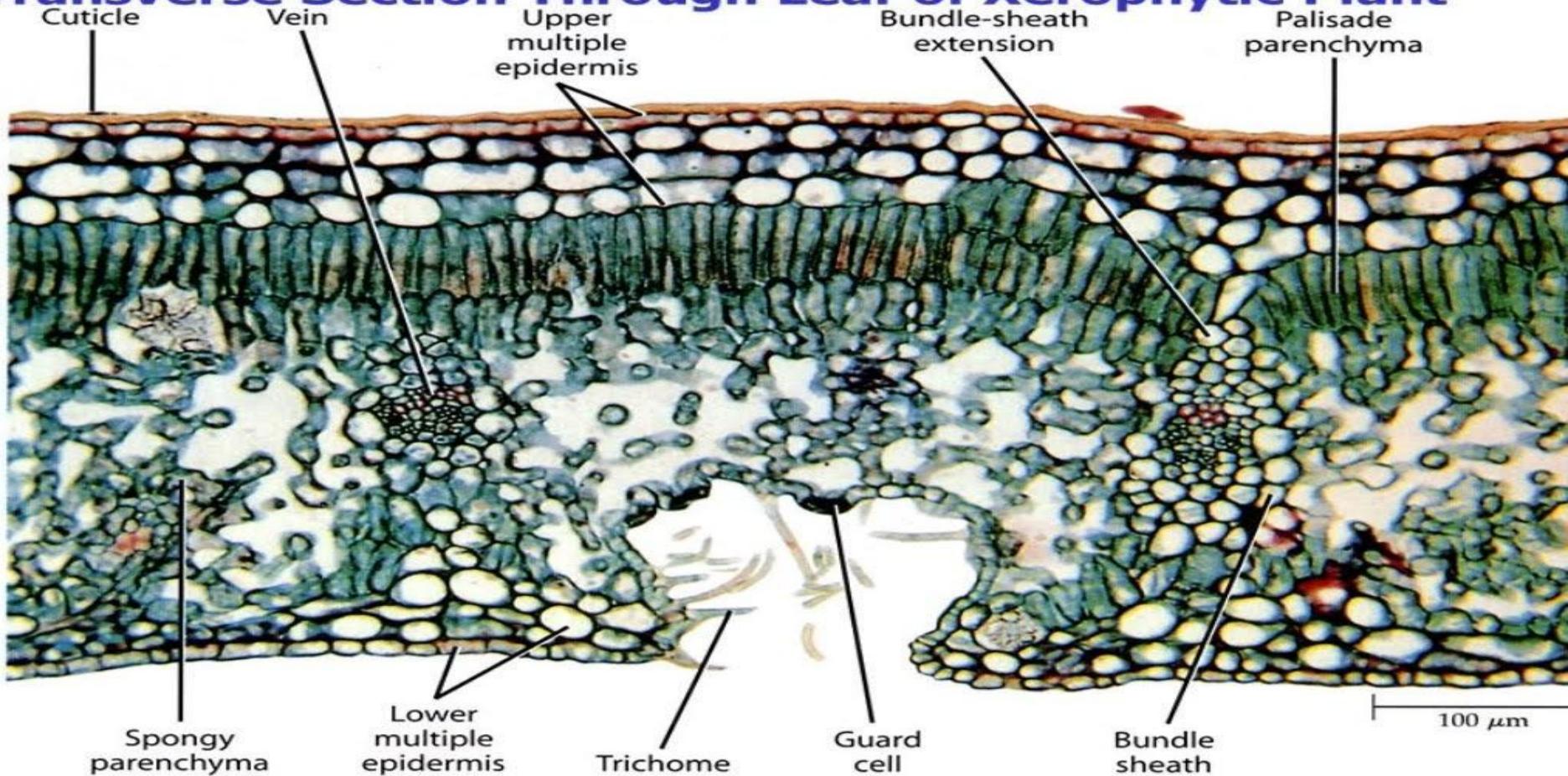
Comment—It reveals a dicotyledonous xerophytic leaf having multiple, heavily cuticularised epidermis; sunken stomata in the stomatal pit with hairs on the lower epidermis; well developed palisade parenchyma on both sides and spongy parenchyma in the middle. Vascular bundles are collateral and closed with bundle sheath. Presence of intraxylary phloem is an anomalous structure.

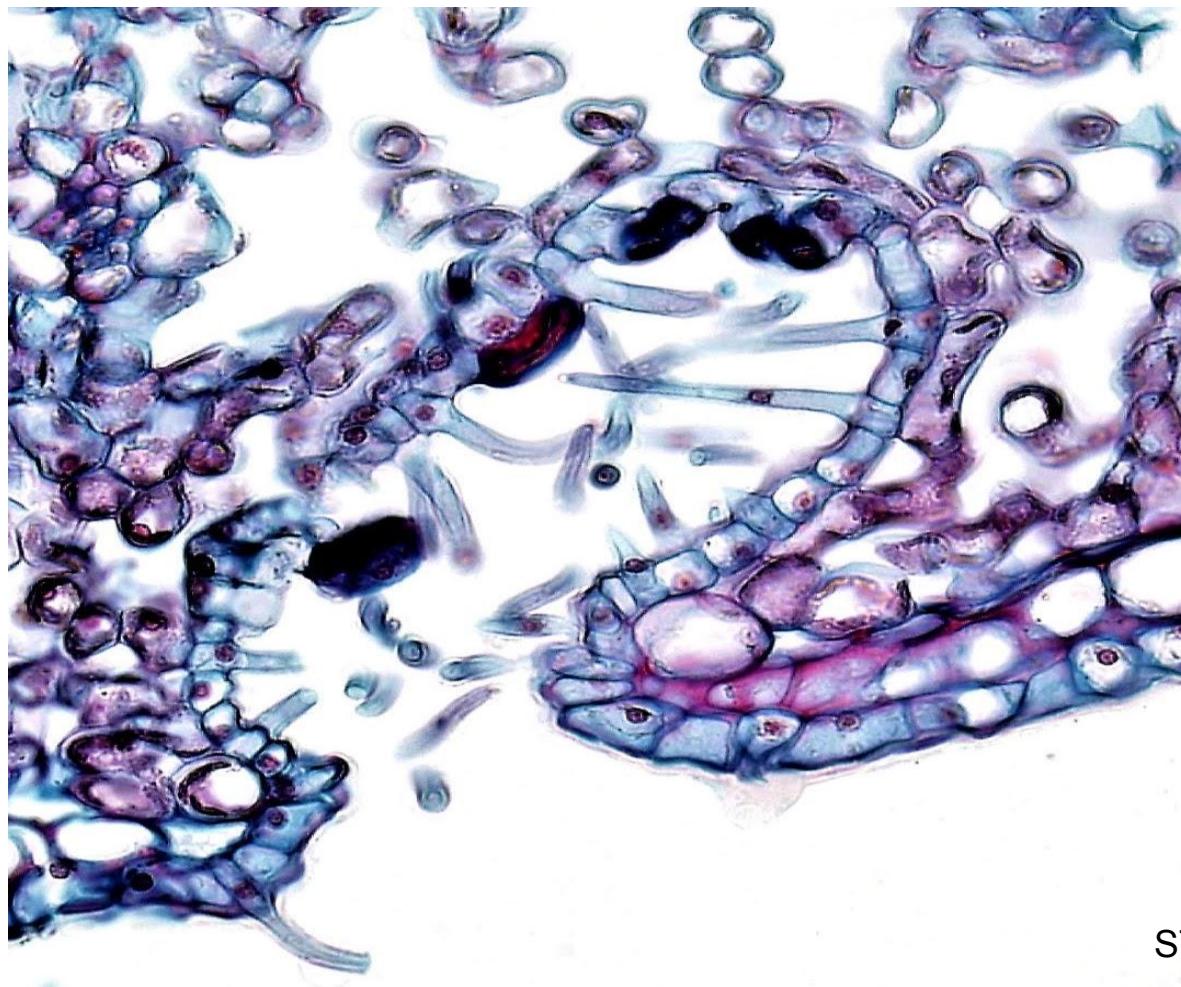


T.S OF *Nerium* LEAF



Transverse Section Through Leaf of Xerophytic Plant





STOMATAL PIT OF NERIUM LEAF

END OF PART TWO