TELANGANA UNIVERSITY, NIZAMABAD
DEPARTMENT OF BOTANY
M. Sc. – I-Year II SEMESTER
Paper – III Developmental Anatomy and Palynology
QUESTION BANK - INTERNAL ASSESSMENT TEST -1
Unit – I

I. Multiple Choice Questions:

1. The root cap is made up of. (a)
a) Parenchyma b) Sclerenchyma c) Collenchyma d) Chlorenchyma e) All of these
2 . In general the root is. (a)
a) exarch b) endarch c) Mesarch d) Endoexarch e) None of these.
3. Schizogenous oil glands are found in (b)
a) *Citrus* b) *Eucalyptus* c) *Calotropis* d) *Ricinus* e) None of these.
4. In general, the stem is (b)
a) exarch b) endarch c) Mesarch d) Endoexarch e) All of these.
5. An example of C_3 Plants is (a)
a) *Mangifera indica* b) *Sacharam officianaram* c) *Zea mays* d) *Oriza sativa* e) *Tridax procumbens*
6. The Tunica – Corpus theory was proposed by (a)
a) Schmidt b) Clowes c) Derman d) Han-Stein e) New man
7. The stem develops from (a)
a) Embryo b) pollen c) root d) Primary phloem e) Primary xylem
8. The major function of the leaf. (c)
a) Respiration b) Conduction c) Absorption d) Photosynthesis e) All of these
9. The root develops from (a)
a) Embryo b) pollen c) stem d) Primary phloem e) Primary xylem
10. An Example of C_4 Plant is (c)
a) *Mangifera indica* b) *Cajanus cajan* c) *Zea mays* d) *Azadirachta indica* e) *Ricinus communis.*
11. The main function of the mesophyll tissue is (a)
a) Manufacture of food material b) Manufacture of alcohol c) Manufacture Of water
d) Manufacture of Latex. e) All of these
12. The vascular bundles in C_3 plants are (b)
a) Small b) Large c) Big d) Huge e) None of these
13. The Kranz anatomy is observed in (e)
a) Graminae b) Amaranthaceae c) Cyperaceae d) Euphorbiaceae e) All of these
14. CAM Plants generally are. (e)
a) Mesophytes b) Halophytes c) Hydrophytes d) Saprophytes e) Xerophytes
15. The main function of Cortex is (e)
a) Storage of food b) Storage of water c) Storage of mineral d)Storage of Air e) All of these
16. The Sunken stomata are observed in. (e)
a) Mesophyte s b) Halophytes c) Hydrophytes d) Saprophytes e) Xerophytes
17. Lysigenous oil glands are found in . (b)
a) *Citrus* b) *Eucalyptus* c) *Calotropis* d) *Nerium* e) All of these
18. The Apical Cell theory was proposed by (e)
a) Schmidt b) Clowes c) Derman d) Han-Stein e) Nageli
19. The aerenchyma is found in (a)
a) cortex b) pith c) epidermis d) xylem e) phloem
20. The Structure of Quiescent Center is. (a)
a) cup shaped b) dumbbell shaped c) round d) pyramidal e) None of these
21. The Root cap is made up of a meristamatic tissue known as (a)
a) Calyptrogen b) Dermatogen c) Periblem d) Pleurome e) None of these.
22. The apical meristem is made up of. (a)
a) Meristematic tissue b) Intercallary tissue c) Basal tissue d) Lateral tissue.
e) None of these.
23. Bulliform cells are observed in. (a)
a) Leaf b) Stem c) Root e) Flower e) All of these
24. The Concept of Quiescent Center was proposed by. (b)
a) Schmidt b) Clowes c) Derman d) Han-Stein e) New man.
25. The Collenchyma is present in. (e)
a) Lea b) Stem c) Pedicel d) Fruits e) All of these.
26. Sclerenchyma is deposited with. (b)
a) Pectin b) Lignin c) Cutin d) Mutin e) All of these
27. The Korper- Kappe theory was proposed by. (b)
a) Schmidt b) Schuepp c) Derman d) Han-Stein e) New man.
28. In Dicotyledons the guard cells are (a)
a) Kidney shaped b) Dumbbell shaped c) Round d) Rectangular shaped e) None of these.
29. In Monocotyledons the guard cells are (b)
a) Kidney shaped b) Dumbbell shaped c) Round d) Rectangular shaped e) None of these.
30. The term "Continuing meristematic residue" was termed by. (e)
a) Schmidt b) Schuepp c) Derman d) Han-Stein e) New man.
31. The Quiescent center in *Zea mays* comprises of. (d)
a) 100 cells b) 300cells c) 400cells. d) 500cells e) 1000 cells.
32. Rubber is Produced from. (a)
a) Laticiferous tissue b) Lysegenous tissue c) Schizogenous d) Epidermal tissue
e) None of these
33. The cells are siliceous in (c)
a) *Mangifera indica* b) *Cajanus cajana* c) *Sacharam afficinaram* d) *Azadirachta indica* e) *Ricinus communis.*
34. Root apex of higher plants differ from the apex in having. (c)
a) Periblem b) Phloem c) root cap d) dermatogens e) None of these
35. There is tunica corper organization in the shoot apex of green and higher plants of angiosperms. one to five layers tunica have been observed in (b)
a) Monocotyledons b) Dicotyledons c) Pteridosperms d)Gymnosperms e) All of these
36. Mantle core concept of shoot apex organization was put forth by (b)
a) Wallksman b) Dermen c) Nawaschin d) Hanstein e) Korper and kapee

37. The Lateral meristem is chiefly meant for (a)
a) Growth in thicknes b) Growth in cortex c) Growth in length d) Growth in parenchyma
e) All of these.
38. Korper- kapee theory regarding root apex was given by (b)
a) Korper and kapee b) Schenpp c) Dermen d) Nawaschin e) Henstein
39. Those tissues whose cells are thin walled and more or less isodiametric and have inter cellular spaces are termed. (a)
a) Parenchyma b) Sclerenchyma c) Collenchyma d) Chlorenchyma e) Cortex
40. The periclinal divisions which initiate a leaf primordium are responsible for the formation of a lateral prominence on the side of the (b)
a) root apex b) shoot apex c) leaf apex d) root and shoot apex e) All of these
41. As the leaf primordium grows upward from the buttresses which of the following meristems again becomes like a small mound ? (c)
a) Lateral meristem b) Intercalary meristem c) Aapical meristem d) All of these.
42. Epidermis of root without cuticle is called as (b)
a) Epiderm b) Epiblema c) Endoderm d) Parenchyma e) Cortex
43. The major function of the stomata (a)
a) respiration b) absorption c) transpiration d) conduction e) None of these
44. The cuticle layer and stomata is absent in (c)
a) Stem b) Leaf c) Root d) Petiole e) All of these
45. In general vacuoles are absent in (a)
a) Meristematic tissue b) Sclerenchyma c) Collenchyma d) Chlorenchyma
e) All of these
46. Cambium is usually present in (a)
a) Dicots b) Monocots c) Algae d) fungi e) None of these
47. Salt glands are found in (d)
a) *Tabernaaemontana* b) *Viola* c) *Urtica dioica* d) *Avicennia* e) None of these
48. Stomata size in *Zea mays* (c)
a) 7×3µ b) 38×8µ c) 4×26µ d) 5×25µ e) None of these
49. Clowes observed Quiscent zone in (c)
a) *Mangifera indica* b) *Cajanus cajana* c) *Zea mays* d) *Azadiricta indica* e) *Ricinus communis.*
50. Example for latex oozing plants (e)
a) *Heava* b) *Ficus* c) *Achras* d) *Carica* e) All of these

Unit – II

1. Simple living tissue composed of thin walled cells [c]
(a) Collenchyma (b) Sclerenchyma (c) Parenchyma (d) Mesenchyma (e) All of these
2. Which one of the following is mechanical tissue [c]
(a) Parenchyma (b) Collenchyma (c) Sclerenchyma (d) Aerenchyma (e) None of these
3. Phloem is a vascular tissue & consists of [e]
(a) Sieve elements (b) Companion cells (c) Phloem fibers (d)Phloem parenchyma (e) All of these
4. Companion cells are not found in [c]
(a) Gymnosperms only(b) Vascular Cryptogams only (c)Gymnosperms and vascular cryptogam
(d)Angiosperms (e) None of these
5. Histogen theory was proposed by [c]
(a) Schmidt (b) Schuepp (c) Hanstein (d) Nageli (e) None of these
6. Epidermis originated from [a]
(a) Dermatogen (b) Periblem (c) Pleurome (d) Periblem& Pleurome (e) None of these
7. Cystolith is encrusted with [a]
(a) Calcium Carbonate (b) Calcium Oxalate(c) Calcium bicarbonate (d) Calcium Silicate (e) None of these
8. Paracytic type of stomata is observed in members of [b]
(a) Cruciferae (b) Rubiaceae (c) Graminae (d) Caryophyllaceae (e) None of these
9. In which of the following type three accessory cells are present out of which one is smaller than the other two [c]
(a) Paracytic (b) Diacytic (c) Anisocytic (d) Anomocytic (e) None of these
10. The outermost protective covering of the plant body [c]
(a) Cortex (b) Endodermis (c) Epidermis (d) Stele (e) None of these
11. Water secreting glands in plants are [c]
(a) Nectaries (b) Digestive glands (c) Hydathodes (d) Epithelium cells (e) None of these
12. Hydathodes are [c]
(a) Pores in the bark (b) Pores through which transpiration takes place
(c) Special openings in the leaf though which liquid water is forced out (d) Pores in the root (e) None of these
13. Multiple Epidermis is found in [b]
(a) Banyan leaf (b) Nerium leaf (c) Maize leaf (d) hibiscus leaf (e) Paddy leaf
14. Root hair arises from [a]
(a) Pericycle (b) Endodermis (c) Cortex (d) Epiblema (e) None of these
15. Epidermal outgrowths are known as [c]
(a) Stomata (b) Leaves (c) Trichomes (d) Flower buds (e) All of these
16. Plant cells without nuclei are [c]
(a) Cambium (b) Root hairs (c) Companion cells (d) Vessels (e) Transfer cells
17. Angiosperms have [b]
(a) Tracheids (b) Vessels (c) Tubes (d) Plates (e) All of these
18. The chief functions of sieve tube is [a]
(a) To translocate the organic materials manufactured by leaves (b) To conduct dyes
(c) To transport water from root to leaves (d) To help the plant in forming wood (e) All of these
19. Guttation takes place through [c]
(a) Stomata (b) Chloroplast (c) Hydathodes (d) Lenticels (e) Epidermis
20. The term phloem was coined by [a]
(a) Nageli (b) Strasburger (c) Haberlandt (d) Sachs
(e) Schmidt
21. The secondary walls of phloem fibres chiefly consists of [b]
(a) Cellulose (b) Lignin (c) Pectin (d) Hemicellulose (e) Callose
22. Phloem parenchyma is characterized by [e]
(a) Presence of Cellulose cell walls (b) Presence of primary pit fields in cell walls
(c) Storage of food materials (d) Radial conduction of food material (e) All of these

23. Phloem fibres are called [c]
(a) Libriform fibres (b) Fibre trachieds (c) bast fibres (d) Idioblasts (e) All of these
24. Sieve cells are [a]
(a) Long and elongated with tapering ends (b) Long and elongated with broader ends
(c) Short cells formed from a row of cells (d) Long and tube-like cells formed from a row of cells
(e)None of these
25. The secondary walls of fibres of flax (linum) are made up of [c]
(a) Lignin (b) Pectin (c) Cellulose (d) Suberin (e) All of these
26. Who classified tissue systems into three main types [b]
(a) Strasburger (b) Sachs (c) Bower (d) Von Mohl (e) Newman
27. The guard cells differ from epidermal cells [c]
(a) In presence of Chloroplasts (b) In presence of unevenly thickened walls
(c) In presence of Chloroplasts & unevenly thickened walls (d) In presence of Chromoplasts (e) None of these
28. Transfusion tissue is [c]
(a) Special type of mesophyll (b) Secretory tissue
(c) Special type of conducting tissue (d) Guard tissue of leaf (e) None of these
29. Periderm includes [a]
(a) Cork Cambium, Cork, Secondary cortex (b) Cork Cambium, Cork
(c) Cork (d) Cork and Secondary cortex (e) None of these
30. The function of cuticle is [e]
(a) To help in exchange of gases (b) To protect the inner tissues
(c) To check the transpiration (d) To ensure the transpiration (e) All of these
31. When Xylem is surrounded by Phloem, that vascular bundle is called [c]
(a) Collateral (b) Radial (c) Amphicribal (d) Amphivasal
(e) None of these
32. Vascular bundles having protoxylem towards periphery is called [b]
(a) Endarch (b) Exarch (c) Radial (d) Collatera (e) None of these
33. The primary tissue of stem separating Xylem and Phloem is called [b]
(a) Procambium (b) Fascicular cambium (c) Cork cambium (d) Interfascicular cambium (e) None of these
34. When Xylem and Phloem alternate each other, it is called [b]
(a) Conjoint (b) Radial (c) Collateral (d) Concentric (e) None of these
35. Growth rings are formed by the activity of [a]
(a) Cambium (b) Xylem (c) Phloem (d) Both Xylem & Phloem (e) None of these
36. In leaves stomata may occur on both sides, then termed as [c]
(a) Epistomatous (b)Hypostomatous (c)Amphistomatous (d)Peristomatous (e) None of these
37. The age determination of trees by counting the annual growth rings is known as [c]
(a) Dendrology (b) Chronology (c) Dendrochronology (d) Dendropenology (e) None of these
38. In secondary Phloem [d]
(a) Sieve tubes are abundant (b) Phloem parenchyma is abundant
(c) Phloem fibres are abundant (d) Phloem parenchyma & Phloem fibres are abundant (e) None of these
39. The cells of the cork are impermeable to water and gases due to presence of [c]
(a) Cutinised walls (b) Lignified walls(c) Suberised walls (d) Chitinised walls
(e) None of these
40. Lenticel is filled with [c]
(a) Parenchymatous cells (b) Collenchymatous cells (c) Complimentary cells (d) Lock cells (e) None of these
41. In stem of Acer cuticle is [a]
(a) Thick (b) Thin (c) Absent (d) Irregular (e) regular
42. Nectar secreting discs are present in [e]
(a) Leaves (b) Stem (c) Roots (d) buds (e) All of these
43. Epidermal outgrowths [e]
(a) Hair (b) Wax (c) Cuticle (d)Cutin (e) All of these
44. Group of cells exhibiting meristematic activity [a]
(a) Meristemoids (b) Epithem (c) Bulliform cells (d) Hydathodes (e) All of these
45. Radial micellation play an important role in [a]
(a) Stomatal movements (b) Photosynthesis (c)Nitrogen Metabolism
(d)Lipid Metabolism (e) None of these
46. Cellulosis micro fibrils arranged within the guard cells of stomata [a]
(a) Radial micellation (b) Elongate fibres (c) Central cells
(d) Radial micellation & Elongate fibres (e) None of these
47. When turgidity of guard cells increase [a]
(a) The stoma open (b) The stoma close (c) The stoma open & close (d) The Stoma Rotate (e)None of these
48. Neighbouring or subsidiary cells do not have common origin with guard cells are termed as [a]
(a) Perigenous (b) Mesogenous (c) Mesoperigenous (d) Epigenous (e)Hypogenous
49. Glandular trichomes are called as [a]
(a) Salt glands (b) Secretary glands (c) Nectary glands (d)Oil glands (e) All of these
50. Parenchymatous cells associated with sieve cells in gymnosperms are [a]
(a) Albuminous cells (b) Companion cells (c) Resin cells (d) Plasmodesrmata cells (e) All of these

1. The tunica is commonly two or three cells deep with layers, from the outside in, referred to as L1, L2, and L 3
2. The inner layers of the tunica give rise to the corpus and eventually the ground tissue and cells that differentiate into vascular tissue.
3. The root system of a plant begins its development from the radicle of the embryo.
4. The radicle grows out of the seed after the seed has absorbed sufficient amounts of water; it then continues to grow as the primary root of the new plant.
5. The tip of the root is covered by a collection of parenchymatous cells that constitute the root cap.
6. Root cap cells function in growth regulation (such as gravity perception) and in the production and secretion of abundant mucilage.
7. The root cap originates from the activity of the root apical meristem and consists in some roots of centrally positioned, longitudinally aligned columella cells and outer peripheral cells.
8. Columella cells are distinguished by their elongate shape and by containing dense aggregations of starchy amyloplasts that sediment to lower sides within the cell in response to gravity.
9. The peripheral cells of the root cap secrete enormous quantities of a mucilage called mucigel.

10. This slimy substance benefits the plant by protecting and lubricating the growing root apex and aiding in water and nutrient absorption.
11. The concept of a quiescent center refers to a hemispherically shaped aggregation of mitotically and metabolically inactive cells that are positioned just behind the root cap.
12. The number of cells composing the quiescent center range from as few as 2 to 4 in *Alectra vogelii, Striga gesnerioides,* and *Arabidopsis* to over 1000 cells in very large apices such as *Zea mays.*
13. Leaves of angiosperms are initiated as groups of cells on the flanks of the shoot apical meristem.
14. Primordial cells can originate as discrete mounds of undifferentiated tissue on the sides of the apex, or they can arise as a raised structure that completely encircles the meristem
15. The period of early primordium growth in monocotyledons is followed by the establishment of a basal leaf meristem
16. Carnauba wax is derived from the wax palm *Copernicia cerifera;* thick wax forms on the undersurface of the leaves
17. Bayberry wax is derived from the fruit of *Myrica*
18. Stoma consists of a pore and pair of guard cells, and the total stomatal complement is most commonly restricted to the lower surface of the lamina is hypostomatous
19. Stomata occasionally are located on both the upper and lower epidermis is amphistomatous, or they can be confined to the upper surface is epistomatous.
20. Xylem is responsible for the transpiration of water from the soil to the leaves
21. Phloem translocates the products of photosynthesis from leaves to the rest of the plant
22. Tracheid: function in conduction of water and minerals, densely covered with circular bordered pits, lack a perforation plate
23. Imperforate tracheary elements: long, narrow, tapered at ends, lack a perforation plate
24. Perforate tracheary elements: possess a perforation plate, short, wide, connected end-to-end to form a vessel
25. Girdling was used by Marcello Malpighi in 1686 to demonstrate that sugars moved through the phloem and water through the xylem
26. Libriform fiber: function in support, largely nonconductive, may be alive at maturity, containing a few simple pits, pits often slit-shaped
27. Vestured pits are bordered pits containing tiny outgrowths that project into the pit cavity from the secondary wall that surrounds the pit
28. In angiosperms, the long-distance transport of phloem sap takes place via the sieve tube elements (STE)
29. Companion cells (CC) and phloem parenchyma (PP) provide metabolic support for the STE and are involved in the loading and unloading of the molecules to be translocated
30. Gymnosperm phloem tissue has sieve cells and phloem parenchyma, but lacks companion cells and phloem fibers
31. In the early development of angiosperms, primary phloem is first formed as a growth from procambium parenchyma cells from the apical meristem in what will become the mid vein site through extension. These are termed protophloem cells
32. The mechanism of phloem translocation was first described by the German botanist Ernst Münch in 1926 called the Münch pressure flow hypothesis

Patterns of leaflet morphogenesis
German botanist Wilhelm Troll described three patterns of leaflet morphogenesis that are characteristic of compound leaves. These are (1) basipetal, the oldest leaflets near the primordium tip forming and developing first; (2) acropetal, the oldest leaflets near the primordium base forming first; and (3) divergent, leaflets initiated first in one direction and then in both acropetal and basipetal directions

Principal tissue systems
Three principal tissue systems can be recognized. These are: (1) dermal (includes the primary epidermis and secondarily produced cork layers); (2) fascicular (contains the conducting xylem and phloem of primary and secondary origin); and (3) fundamental (includes the primary pith, cortex, and mesophyll).

Epidermis
The epidermis comprises the mature, typically uniseriate surface layer of the entire primary plant body. It is derived from the protoderm and by definition encompasses a variety of cell types, including ordinary epidermal cells, guard cells, subsidiary cells, trichomes or emergences, and various idioblasts.

Multiple epidermis
Multiple epidermis of two or more layers in thickness. A multiple epidermis is visible in plants belonging to a number of dicotyledonous families, such as Begoniaceae, Bombacaceae, Malvaceae, Moraceae, and Piperaceae, as well as many monocotyledons. The multiple epidermis is thought to function as a water storage tissue, at least in some plants. During secondary growth of the stem and root, the epidermis is most often sloughed off and replaced by periderm.

Epidermal features
The plant surface has been subdivided into four recognizable categories of epidermal features. These are: (1) cellular arrangement or pattern; (2) shape of the epidermal cells ("primary sculpture"); (3) relief of the outer epidermal cell walls caused primarily by cuticular striations and visible wall thickenings ("secondary sculpture"); and (4) epicuticular wax secretions ("tertiary" sculpture").

Cuticle
The outer walls of cells covering the aerial organs are characteristically overlaid by a structurally complex waxy layer, the cuticle, that is largely impervious to liquids and gases. It represents one of the major adaptations of plants to life on land. Based on the stage of development, some individuals have employed the terms "primary" and "secondary" cuticle. The primary cuticle forms while epidermal cells are in the process of expansion. This stage is followed by the development of secondary cuticle after epidermal cells have reached their full size. The cuticle, or "cuticular membrane" as it is sometimes referred to, is chiefly composed of cutin, a fatty substance that becomes oxidized and polymerized on the outer cell surface by a process known as cuticularization. By contrast, the process of impregnation of the cell wall with cutin is called cutinization. In addition to cutin, epidermal cells can have lignin, silica, waxes, or a mixture of other materials in or on the walls.

Specialized Epidermal Cells
A diverse collection of epidermal cell types can occur on the young stems and foliar organs of different angiosperms. For example, large, thin-walled, and highly vacuolated bulliform (balloonlike) cells are present in the leaves of many monocotyledons, where they are thought to function in the rolling up or unrolling of leaves following the loss or uptake of water. The cells of various taxa form complex stalked, irregularly shaped mineral depositions of calcium carbonate (termed cystoliths), which are deposited over an internal cellulosic framework. These can completely fill a cell. Cystoliths occur in the parenchymatous cells of various parts of the plant, but they are most frequently found in the epidermis, in hairs, or in greatly enlarged cells (termed lithocysts). Surface cells with distinctly papillate outer walls are found in diverse genera. Although a perfectly smooth or nonsculptured epidermal surface occurs in many plants, a large number of species show a well-developed

indumentum composed of hairs or trichomes. Diverse types of trichomes, or hairs, commonly arise from the surface of many plants. Included in this diversity are various unicellular and multicellular types, as well as grandular hairs that produce essential oils, resulting in a distinctive odor or secretion.

Stomata
The epidermis of all aerial organs such as leaves, stems, floral parts and fruits are typically provided with specialized openings called stomata. The pores are surrounded by a pair of specialized and often reniform epidermal cells, the guard cells, which open or close the stomatal opening by changing the turgor pressure, thereby regulating the rate of transpiration and gaseous exchange between the atmosphere and the internal air spaces. Guard cells possess starch-accumulating chloroplasts, whereas ordinary epidermal cells generally lack plastids or have only rudimentary plastids. Following an increase in internal pressure, the structure of the pectin-rich guard cell walls allows for expansion only along the direction of the curved longitudinal axis. This results in the opening of the pore. Two or more morphologically distinct subsidiary cells may surround the guard cells. The pore, guard cells, and subsidiary cells collectively are sometimes referred to as the stomatal apparatus or stomatal complex. Subsidiary cells store large amounts of water and ions, and because no functional plasmodesmata occur between mature guard cells, subsidiary cells, and ordinary epidermal cells, these materials must move through the apoplast.

Angiosperm stomata types based on origin of subsidiary cells
Depending upon the manner of origin of subsidiary cells, angiosperm stomata can be categorized into three main types. Mesogenous stomata have subsidiary cells that arise from the same initial as the guard cells. Perigenous stomata have subsidiary cells that do not have a common origin with the guard cells, but are formed from cells lying around the guard cell initial. Mesoperigenous stomata have subsidiary cells of mixed origin.

Xylem
Xylem is a complex tissue containing multiple cell types, each with a specific structure and function. Xylem cell types include tracheary elements (tracheids and vessel elements which are dead at maturity) and parenchyma (which are alive at maturity). With their thick secondary cell walls, tracheary elements conduct water and provide support. Tracheary elements are divided into two classes. Imperforate tracheary elements are long, narrow, and tapered at the ends. As their name suggests, they lack a perforation. They include tracheids in gymnosperms and tracheids, fiber tracheids, and libriform fibers in angiosperms. Perforate tracheary elements are short and wide and are connected end-to-end via perforations (large holes at the ends of the cell) to form a vessel.

Tracheids in gymnosperms and angiosperms
Tracheids are imperforate tracheary elements and the sole water conductors in gymnosperms. Gymnosperms tracheids serve the dual role of water conduction and support. Their tapered ends overlap and water movement between tracheids is via pits in the side walls.
Angiosperm tracheids, *fiber tracheids*, *and libriform fibers represent a continuum of imperforate tracheid design and function.* Angiosperm imperforate tracheary elements serve mostly for support, although water-conducting tracheids are not uncommon. The three imperforate cell types differ in the number and shape of side wall pits. Tracheids have circular bordered pits. Fiber tracheids have fewer and slit-like pits. Libriform fibers have the least pitting, and those pits are simple. Numerous examples exist of intermediate morphologies. All three cell types are collectively called xylary fibers. Angiosperm wood has a lower percentage of imperforate tracheary elements than gymnosperm wood. To manufacture paper, xylary fibers are digested from angiosperm and gymnosperm wood and formed into thin sheets.

Phloem
Phloem is a complex tissue with multiple cell types, each with a specific structure and function. Primary phloem develops from the procambium; secondary phloem develops from the vascular cambium. Angiosperm phloem consists of sieve tube elements, companion cells, fibers, and parenchyma. Gymnosperm phloem only has sieve cells and phloem parenchyma. In almost every instance, phloem and xylem always occur together, because they are derived from the same, bifacial meristems. Phloem is to the outside, abaxial to the xylem.

Translocation
Phloem's main function is the long-distance transport of sugars and other photosynthates from the source (mature leaves), or reserves (the cotyledons of germinating seedlings) toward the sinks, e.g., roots, developing reproductive structures (flowers, fruits, and seeds), meristems, and young leaves. The process is called translocation,

Phloem cell types and their functions in angiosperms and gymnosperms

Phloem cell type	Function	Angiosperm	Gymnosperm
Sieve tube elements	Translocation of sugars, amino acids and hormones	Yes	Yes
Companion cells	Metabolic support, phloem loading/unloading	Yes	No, but contain albuminous cells
Fibers	Support/protection	Yes	No
Parenchyma	Storage/synthesis	Yes	Yes