Botany and Microbiology Department

Practical lessons in

Botany 3

“ Plant anatomy and physiology”

Prepared by

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First term

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Practical physiology

Determination the osmotic suction force by curvature the Ricinus petioles

Tools:

Ricinus petioles- knife or scalpel, NaCl solution (concentrated), distilled water, petri-dishes, different concentrations.

Procedures:

1- Cut the Ricinus petioles with knife
2- Put some of these petioles in 3 petri dishes
3- One of the petri dish contain distilled water , the second contain concentrated solution of NaCl
4- Put different concentrations of NaCl in petri dishes
5- Observe the curvature of Ricinus petioles in each petri dish.

Observation

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Determination the osmotic suction force by weighing method using potato tubers

Tools:

Potato tuber, knife or scalpel, NaCl solution, distilled water, petri-dishes.

Procedures:

1-Cut potatoes into six groups of small, uniform cubes measuring 1/2 cm by 1/2 cm.

2-Make four different solutions of NaCl: 0.0N,0.2 N, 0.4N ,0.6 N,0.8N and 1N

3-Weigh each group, on a mass balance, before immersing it in the appropriate NaCl solution for half an hour.

4-After immersion, weigh each group again and calculate the changes in the potato masses.

Observation

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Comment

Recognition some organic compounds in the plant cell

1- Carbohydrates

a- Detecting monosaccharide

Tools:

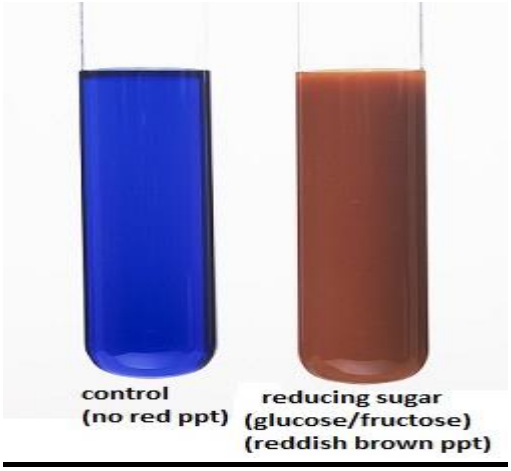
Glucose soln.- Fehling reagent – test tubes – water bath 100℃

Procedures:

1- Take 5ml of Glucose soln.in clean test tube.

2-Add 5ml of Fehling reagent (blue color)

3-Put the tube in water bath at 100℃ for 15 min.



Observation

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b- <u>Detecting disaccharide</u>

Tools:

Sucrose soln.- Fehling reagent – test tubes – water bath 100℃ , 40℃- invertase

Procedures:

1- Take 5ml of sucrose soln.in two clean test tubes.

2-Add 2ml of invertase in one tube and let the other tube without addition

3-Put the tubes in water bath at 40℃ for 30 min.

4-Add 5ml of Fehling reagent in the two test tubes.

5- Put the tubes in water bath at 100℃ for 15 min.

Observation

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Comment

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c- Detecting of polysaccharides (Starch)

Tools:

Starch soln.- Fehling reagent – chines plate – water bath 100℃ , 40℃- diastase- iodine soln. -

Procedures:

1- Take 3 test tubes and add 5ml of starch soln.in three test tubes.

2-Add 2ml of diastase in two tubes and let the third one without addition

3-Put the tubes in water bath at 40℃ for 30 min.

4- After 15 min. take drops of the mix. In the chines plate which contain iodine soln. to detect the complete conversion of starch to simple sugar.

4-Add 5ml of Fehling reagent in the two test tubes (the tube contain diastase and the tube without diastase).

5- Put the tubes in water bath at 100℃ for 15 min.

Observation

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2-Proteins

a- **<u>Yellow protein test (Xanthoproteic Test)</u>**

Tools:

Egg albumin (protein sample)- concentrated nitric acid – test tube – NaOH

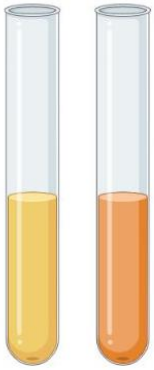
Procedures:

2- Take 5ml of egg albumin in clean test tube.

2-Add 1ml of concentrated nitric acid (white ppt.)

3-Heat in water bath

4- Add 2ml of NaOH (40%) and cooling under tap water.



Xanthoproteic Test Positive

Presence of aromatic amino acids (tyrosine and tryptophan)

Presense of the dark yellow or orange color

Observation

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Comment

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b- Biuret test

Biuret test is a general test for compounds having a peptide bond.

Tools:

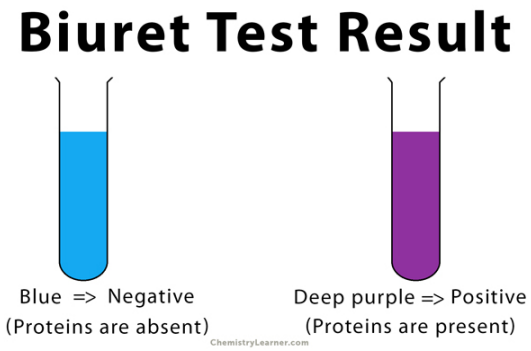
Egg albumin- NaOH – test tube – $CuSO_4$

Procedures:

3- Take 5ml of egg albumin in clean test tube.

4- Add 1ml of NaOH (40%)

5- Add 1ml of $CuSO_4$(10%)



Observation

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Comment

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3-Pigments

Tools:

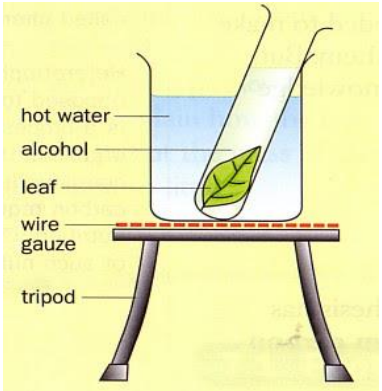
Green leaves- ethyl alcohol or ethyl alcohol (conc.) – test tubes - water bath

Procedures:

1- Take the green leaves in clean test tube

2- Add 5 ml of concentrated ethyle or methyle alcohol

3- Put the test tube in water bath at 60C.



Observation

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Comment

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4-Fats and oils

Tools:

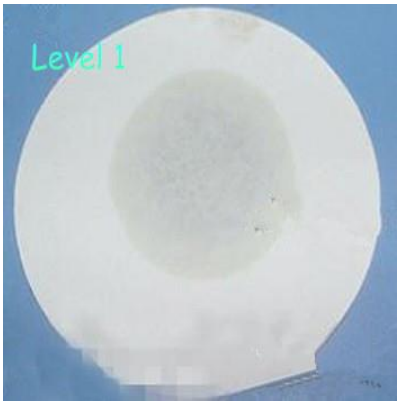
Filter paper- oil or butter– distilled water –

Procedures:

1- Take the filter paper

2- Add drops of oil or butter on the filter paper.

3- Add drops of water on another filter paper .



Observation

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Factors affecting on diffusion in the plant cell

1- pH

Tools:

Beet roots – test tubes– solutions of different pH(2,4,6,8) –

Procedures:

1-Cut the beet roots to small pieces

2-Put an equal amount in each test tube

3-Add 5 ml of different pH(2,4,6,8)solutions in each tube.

Observation

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2- Temperature

Tools:

Beet roots – test tubes–distilled water – water bath at(0,20,50,70C)

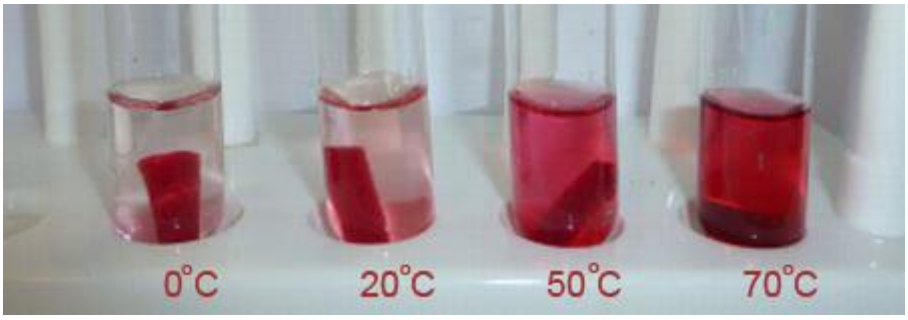
Procedures:

1-Cut the beet roots to small pieces

2-Put an equal amount in each test tube

3-Add 5 ml of distilled water in each tube.

4-Put each tube in different water bath



Observation

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3-Ethyl alcohol

Tools:

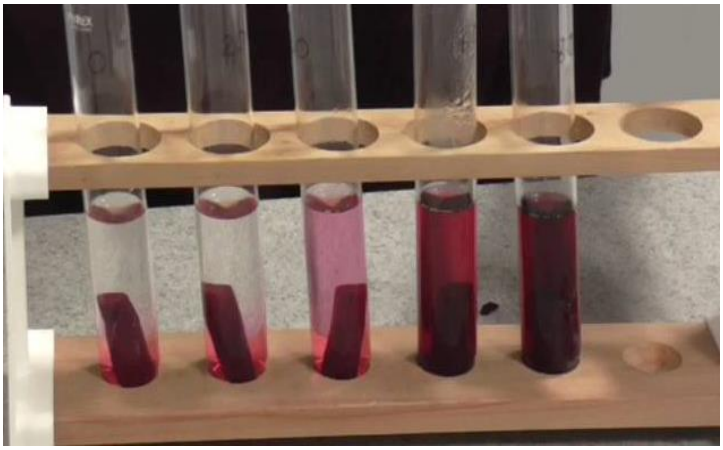
Beet roots – test tubes–different concentration of ethyl alcohol –

Procedures:

1-Cut the beet roots to small pieces

2-Put an equal amount in each test tube

3-Add 5 ml of different concentration of ethyl alcohol.



Observation

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Comment

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Determination of some plant minerals in plant extract

- **Determination of calcium (Ca^{2+}) and magnesium (Mg^{2+})**

Tools:

Plant extract – Muroxide indicator – versine – distilled water- conical flask – burette – E.C.BT indicator.

Procedures:

1- Put known amount of plant extract in the conical flask
2- Add drops of E.C.BT indicator in the conical flask (the color become purple red).
3- Fill the burette with versine (0.1N)
4- Titrate the mix in the conical flask against versine untile the color turned to blue.
5- Calculate the volume consumed from versine
6- Calculate the concentration of calcium and magnesium together (V1)

For determination the calcium (Ca^{2+}) only

7- Put known amount of plant extract in the conical flask
8- Add trace amount of Muroxide indicator in the conical flask (the color become red).
9- Fill the burette with versine (0.1N)
10- Titrate the mix in the conical flask against versine untile the color turned to purple.

11- Calculate the volume consumed from versine

12- Calculate the concentration of calcium only (V2)

13- Subtract V2 from V1 to calculate the concentration of magnesium Mg^{2+}

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- **Determination of Chlorine (Cl^-) in plant extract**
- **Tools:**
- Plant extract –$AgNO_3$ – distilled water- conical flask – burette – $K_2Cr_2O_4$ indicator
- **Procedures**

1- Put known amount of plant extract in the conical flask

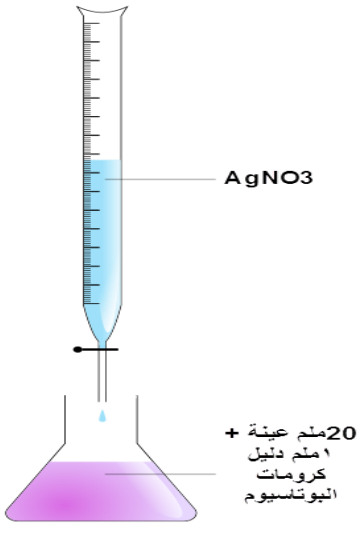
- 2-Add drops of $K_2Cr_2O_4$ indicator in the conical flask (the color become yellow).

3-Fill the burette with $AgNO_3$ (0.01N)

4-Titrate the mix in the conical flask against AgNO3 untile the color turned to red.

5-Calculate the volume consumed from $AgNO_3$

6- Calculate the concentration of Cl^-



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Transpiration

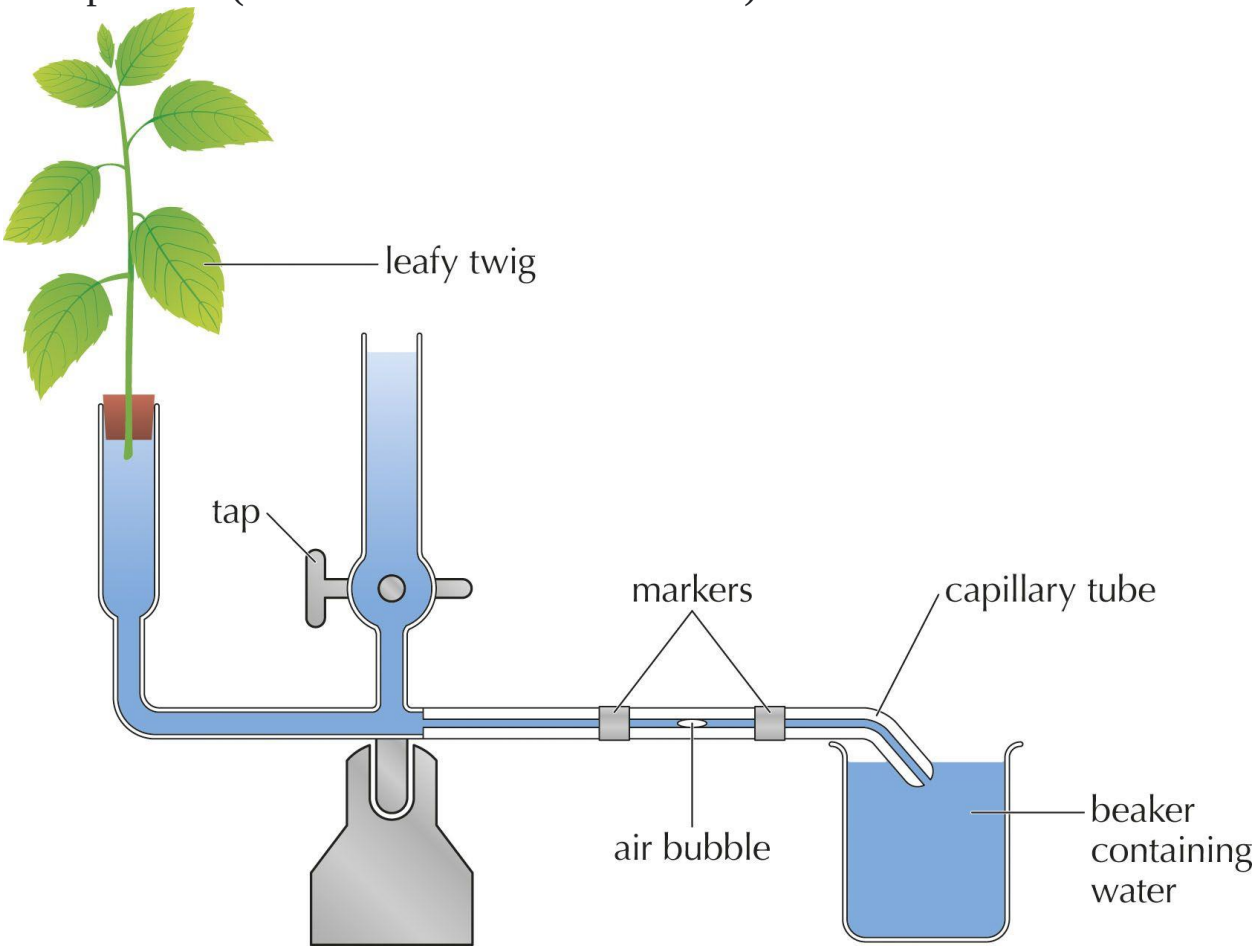
3-Potometer

- **Uses**

It is used to measure the rate of transpiration

- **The idea of its work**

It is based on the idea that the rate of absorption (the rate at which water plants acquire) almost equals the rate of transpiration (the rate at which water is lost)



Mechanism of work and the law

The plant that we want to measure transpiration rate for it is fixed in part designated for it inside the device, and the leaf surface area for this plant is estimated

There are two ways to measure the rate of transpiration

1-The gravimetric method for estimating the rate of transpiration

The apparatus is filled with water and branch of plant is fixed in its appropriate place, then the apparatus is weighted before beginning the experiment and weighted after the end of the experiment, the amount of lost water is calculated as the difference between the two weights

W1 = weight before beginning the experiment

W 2 = weight of the apparatus after the end of the experiment

$$\text{Transpiration rate} = \frac{\text{Weight of water lost (W1-W2)}}{\text{Leaf area (cm) x time (hours)}}$$

g / cm2 / hour

Methods for determining leaf area

1-By graphing

The paper is placed on a graph paper, then its dimensions are drawn with bullets and the number of squares taken is calculated, where each square represents 1 cm through the number of squares The area of the paper is approximately calculated

1- Weighted method

Draws a square with known dimensions, length and width, on a filter paper, and let its area be (A 1), then cut it and weight it

(W1) .on the same type of filter paper draw the leave that you want to find its area and let its area A2 and weight it lets its weight W2

W1/ A1= W 2 /A 2

A2 = A1 x W2/W1

Leaf area = number of leaves x area of one leaves

If the stomata are found on two surfaces, the area of the leaves *2

Determining the effect of environmental conditions on transpiration rate

Aim

To determine the effect of environmental conditions on transpiration rate using a simple potometer.

1-Wind velocity

Tools:

Soft green leafy shoot – conical flasks – distilled water-

Procedures:

1-fill the two conical flask with 250ml distilled water

2-fix the Soft green leafy shoot in the conical flask.

3-weight the two conical flask (W1, W2)

4-leave one conical flask expose to wind for 48 hr. and leave the other without exposure.

5-after 48 hr. weigth the frist conical flask exposed to wind W3 and the second (does not exposed to wind) W4.

6-Calculate the rate of transpiration in the two conical flasks.

Observation

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2-Effect of salts (NaCl)

Tools:

Soft green leafy shoot – conical flasks – distilled water- NaCl soln.

Procedures:

1-fill one of the conical flask with 250ml distilled water and the other with 250 ml NaCl soln.

2-fix the Soft green leafy shoot in the conical flask.

3-weight the two conical flask (W1, W2)

4-after 48 hr. weigth the frist conical flask (contain dist.water)= W3 and the second (contain NaCl soln.) =W4.

6-Calculate the rate of transpiration in the two conical flasks.

Observation

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Comment

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Practical anatomy

Plant Cell

- Living contents
  - It is include nucleus, mitochondria, Plastides (chloroplasts; spiral, cup-shaped, Star shape and discoid)

Spiral shape

Discoid

Cup shape

Star shape

Chromoplast

Non-living contents; includes:

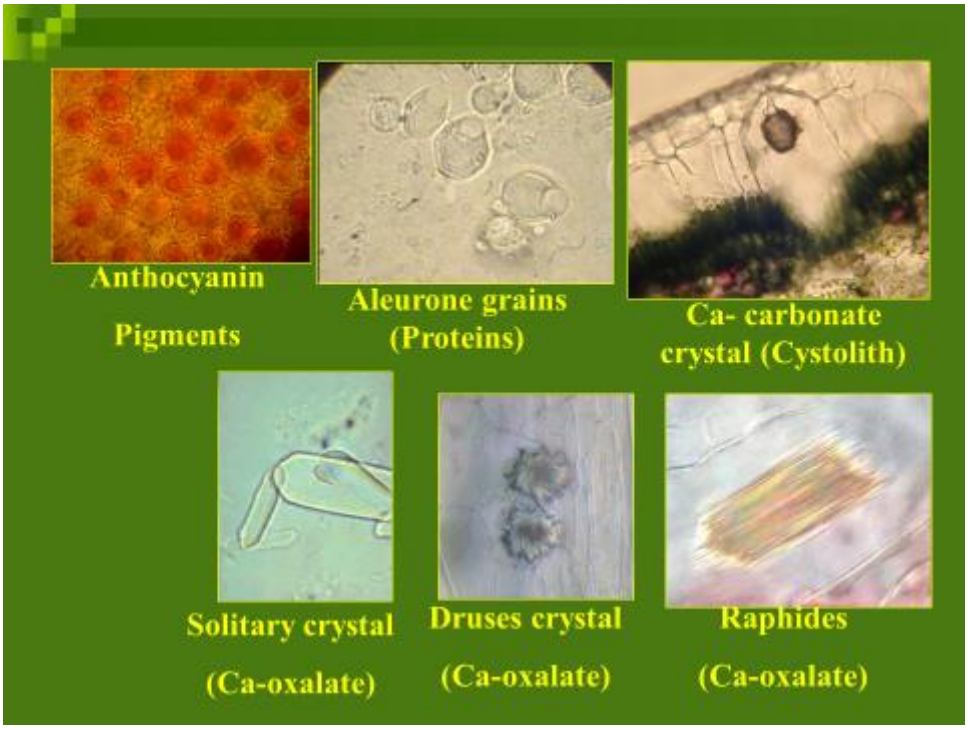
- Starch grains
- Aleurone grains
- Crystals
- Pigments

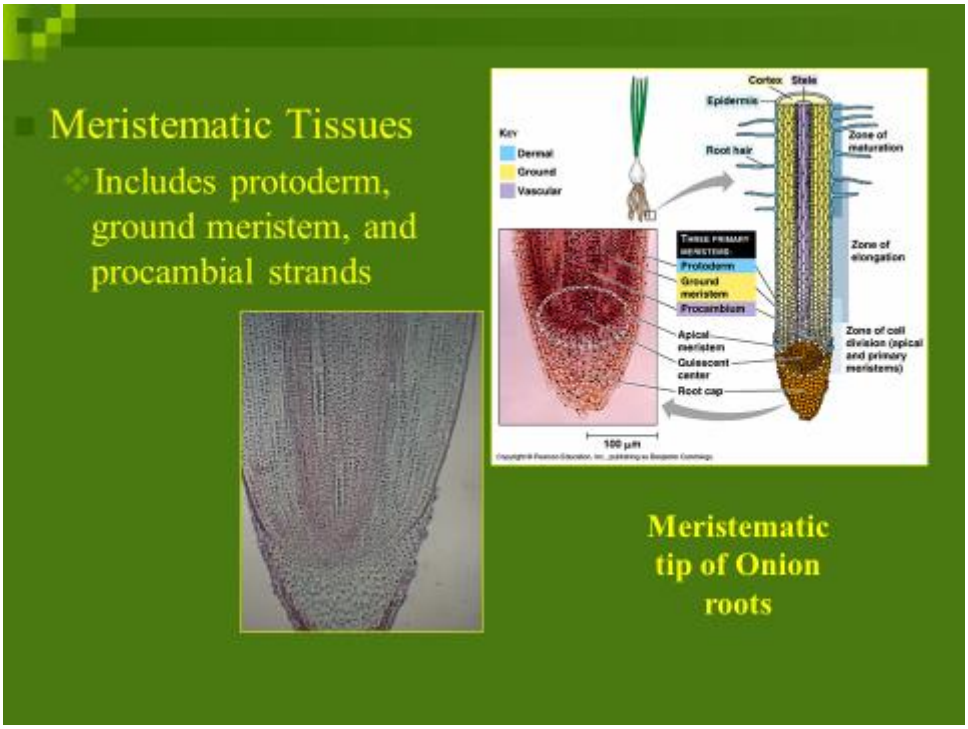
Potato starch

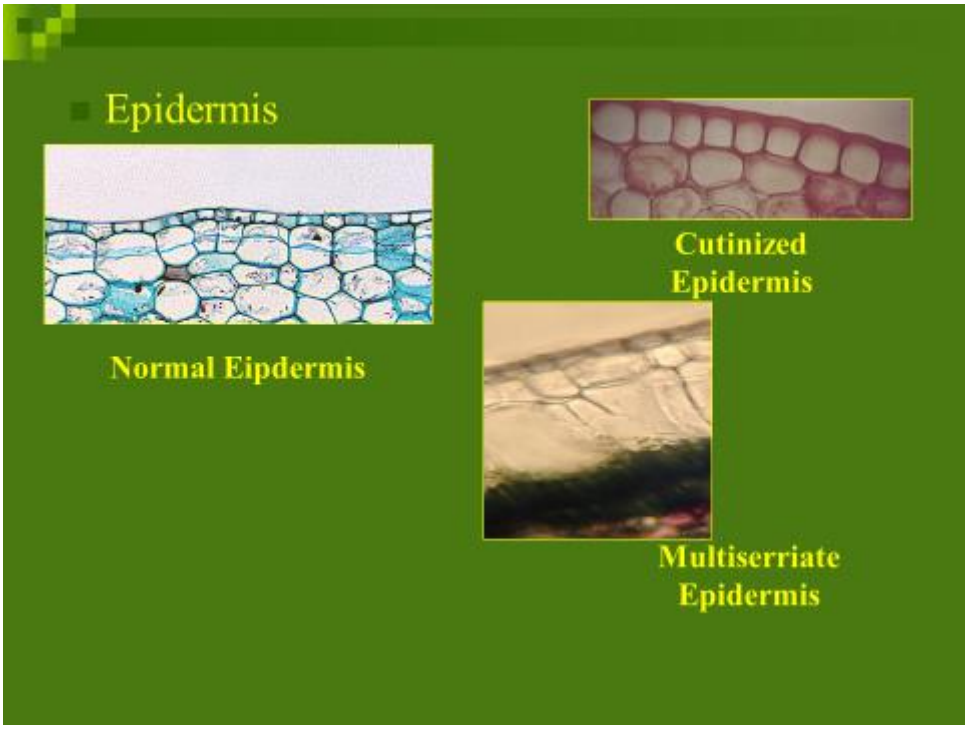
Wheat starch

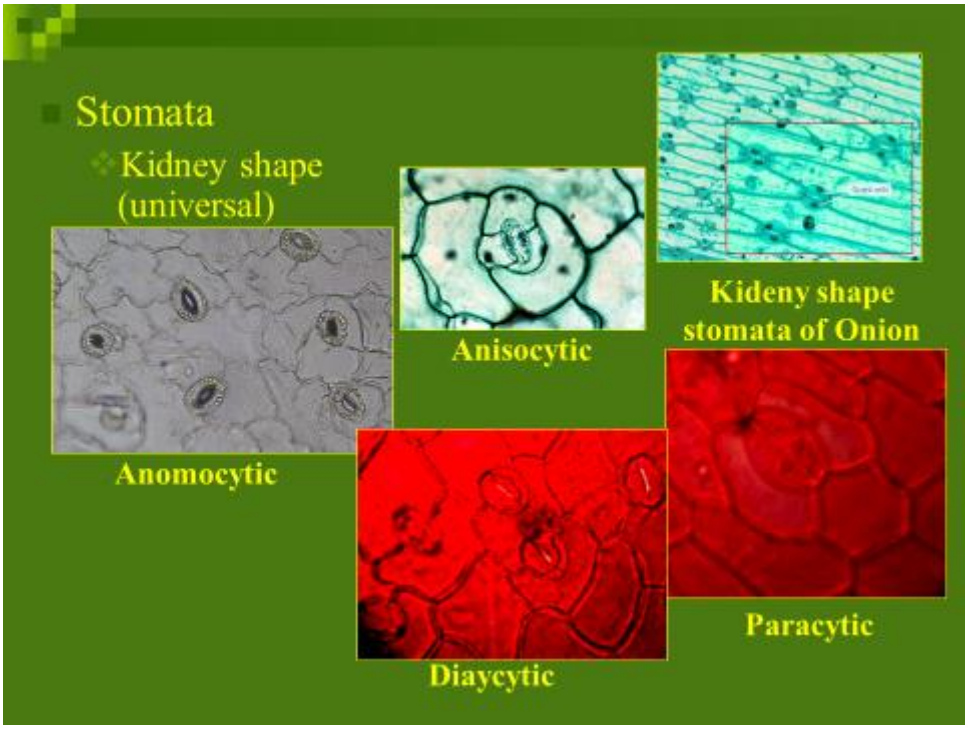
Phaseolus starch

Rice starch


Anthocyanin
Pigments
Aleurone grains
(Proteins)
Ca- carbonate
crystal (Cystolith)
Solitary crystal
(Ca-oxalate)
Druses crystal
(Ca-oxalate)
Raphides
(Ca-oxalate)


Meristematic Tissues
Includes protoderm, ground meristem, and procambial strands
Cortex
Stele
Epidermis
Key
Dermal
Ground
Vascular
Root hair
Zone of maturation
Zone of elongation
Protoderm
Ground meristem
Procambium
Apical meristem
Quiescent center
Root cap
Zone of cell division (apical and primary meristems)
100 µm
Meristematic tip of Onion roots


Epidermis
Normal Eipdermis
Cutinized Epidermis
Multiserriate Epidermis


Stomata
Kidney shape (universal)
Anomocytic
Anisocytic
Kideny shape stomata of Onion
Diaycytic
Paracytic

- Dumb-bell shape stomata
  - in Families Cyperaceae and Gramineae.

- Sunken stomata

Sunken stomata

Sunken stomata with hairs

- Hairs and Trichomes

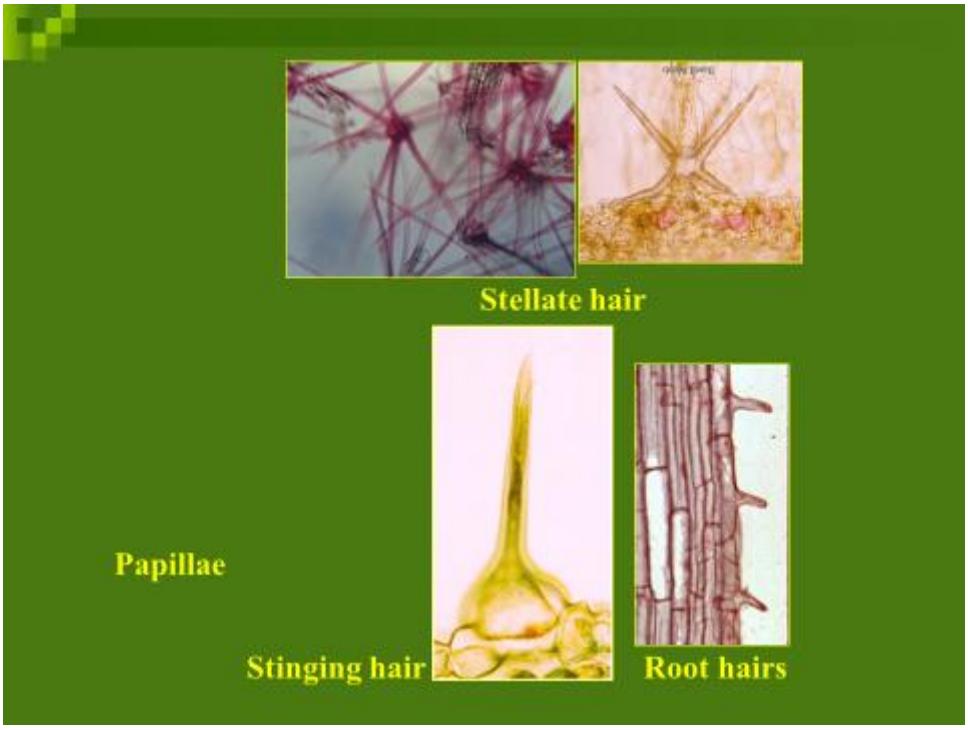
Simple hair

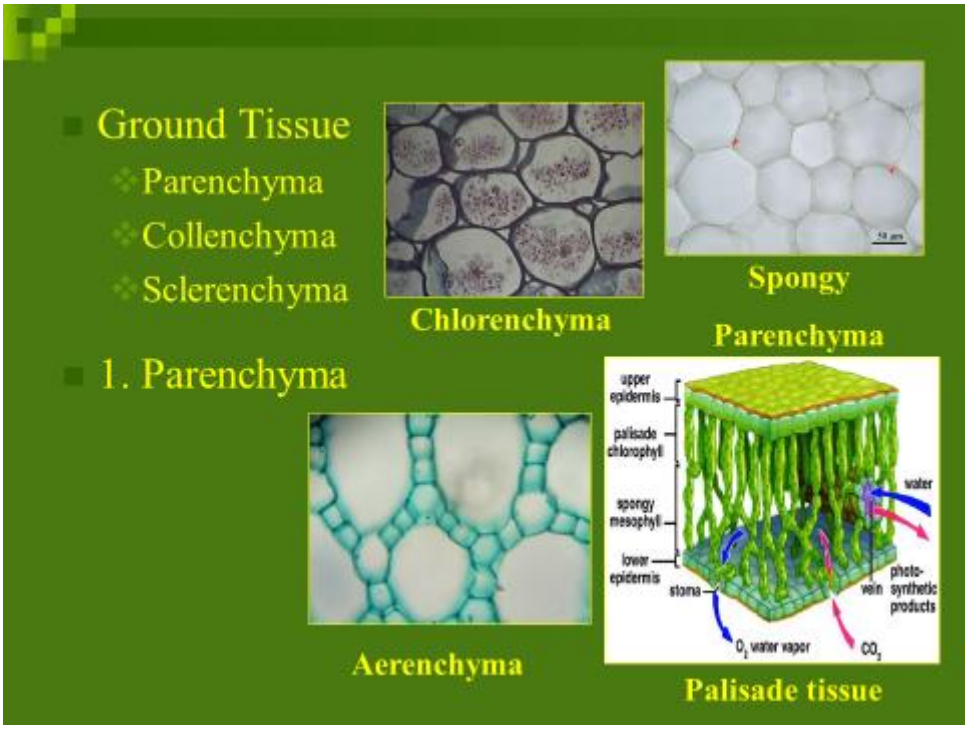
Compound hairs

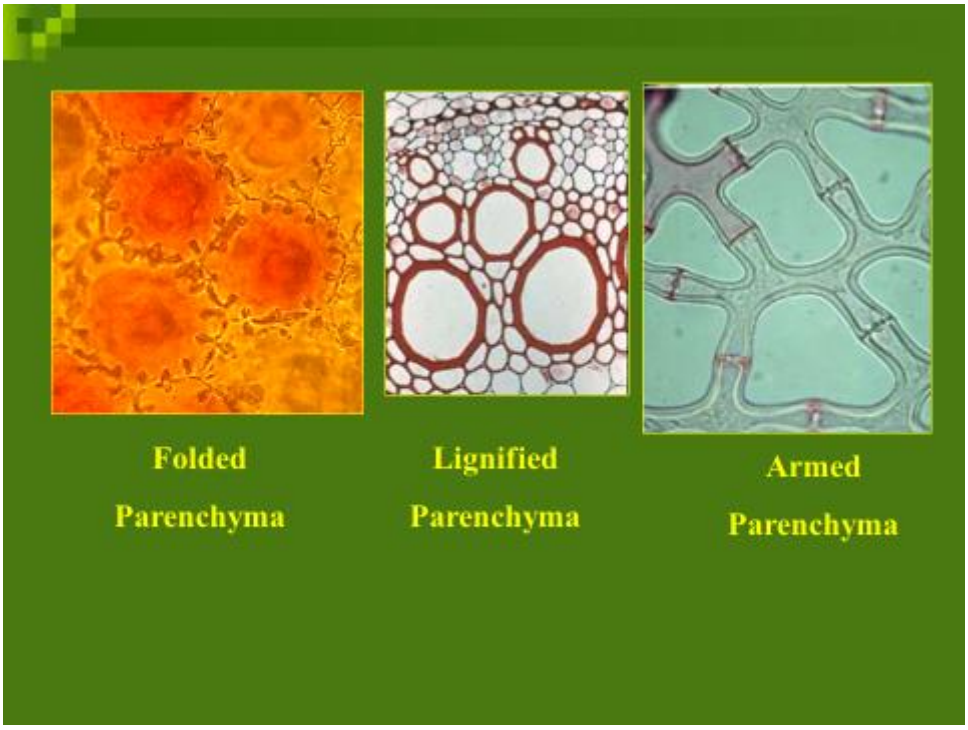
Glandular hairs

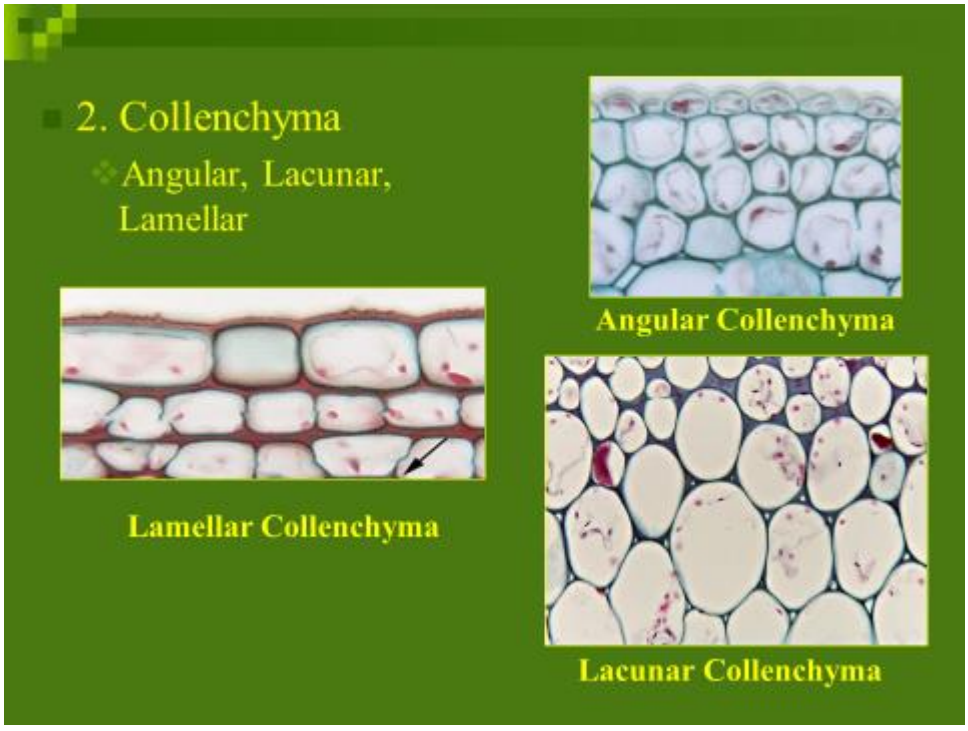
Peltate hair

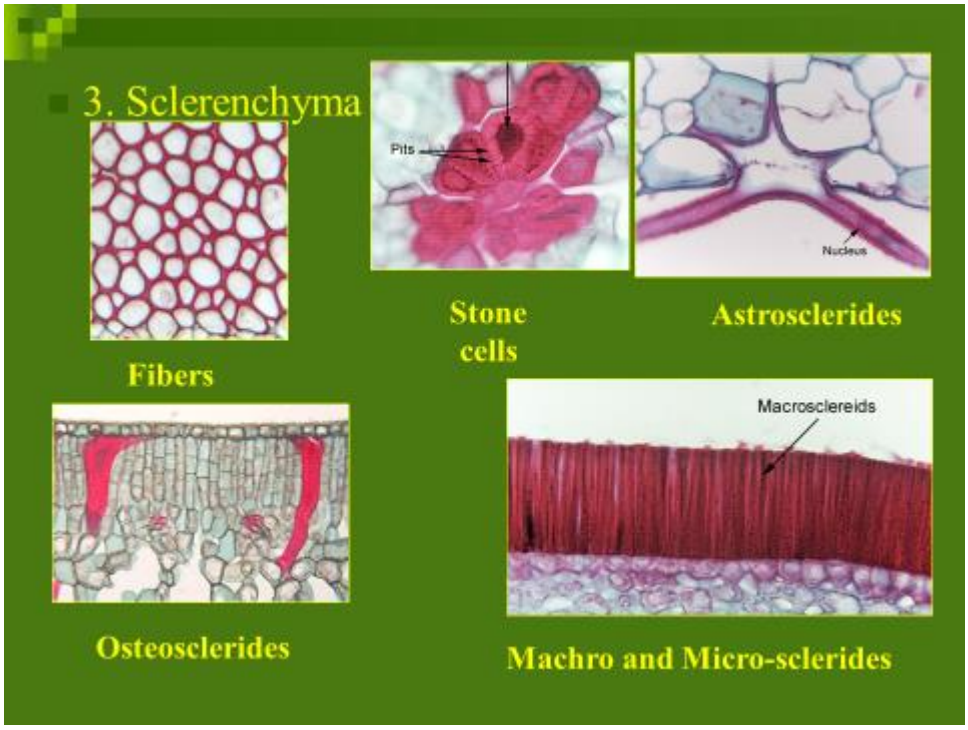
Branched-unicellular hair

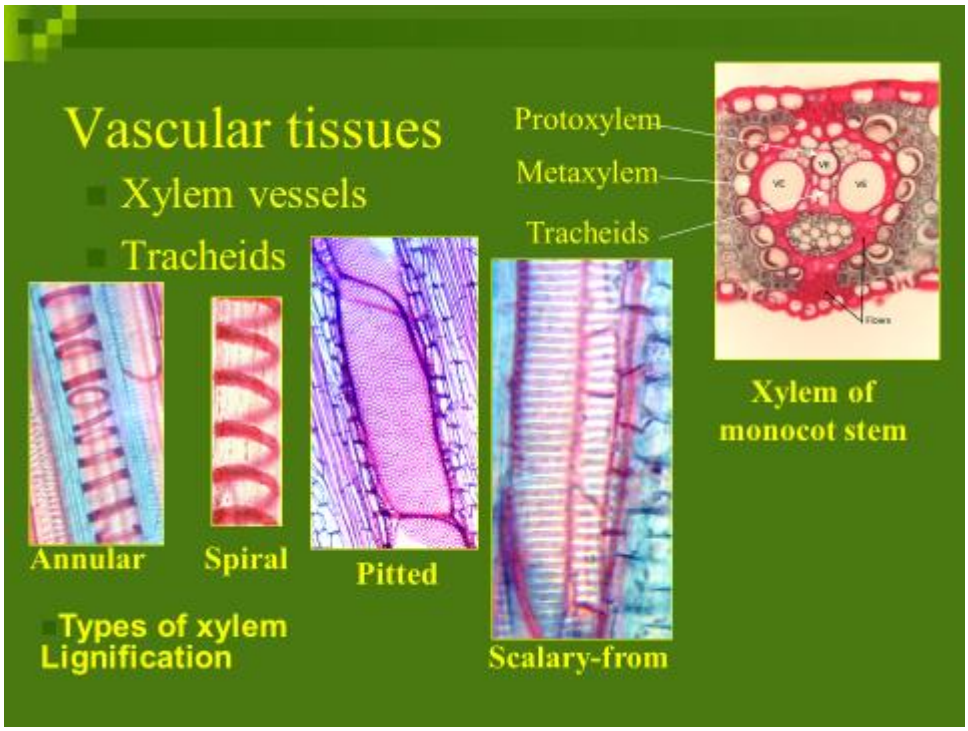

Stellate hair
Papillae
Stinging hair
Root hairs


Ground Tissue
Parenchyma
Collenchyma
Sclerenchyma
Chlorenchyma
Spongy
Parenchyma
1. Parenchyma
Aerenchyma
upper epidermis
palisade chlorophyll
spongy mesophyll
lower epidermis
stoma
water
vein
photo-synthetic products
O2 water vapor
CO2
Palisade tissue


Folded
Parenchyma
Lignified
Parenchyma
Armed
Parenchyma

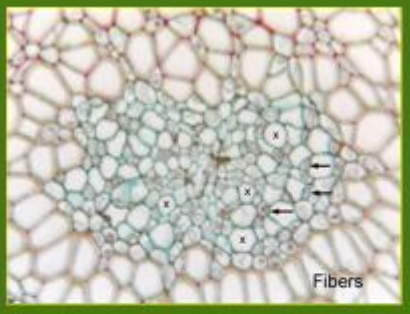

2. Collenchyma
Angular, Lacunar, Lamellar
Angular Collenchyma
Lamellar Collenchyma
Lacunar Collenchyma


3. Sclerenchyma
Pits
Nucleus
Fibers
Stone cells
Astrosclerides
Macrosclereids
Osteosclerides
Machro and Micro-sclerides

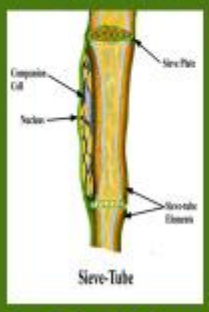

Vascular tissues
Xylem vessels
Tracheids
Protoxylem
Metaxylem
Tracheids
Xylem of monocot stem
Annular
Spiral
Pitted
Types of xylem Lignification
Scalary-from

Phloem

Regular Phloem in monocots

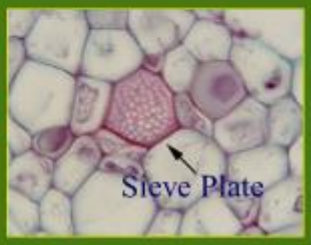


L. S. in Phloem



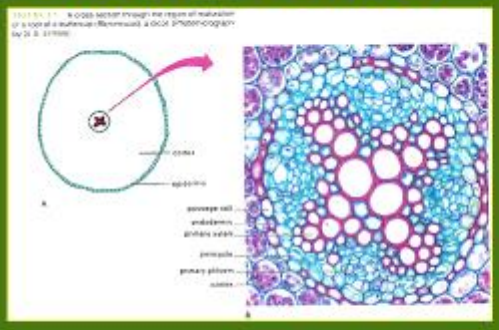
L. S. in Phloem

Irregular Phloem in monocots

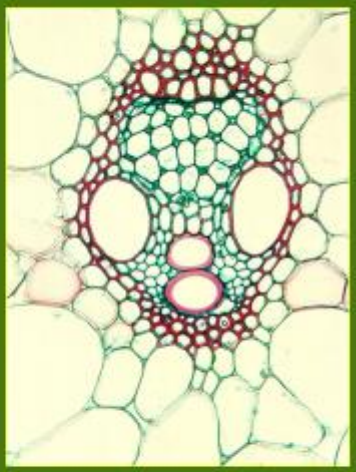


T. S. in Phloem

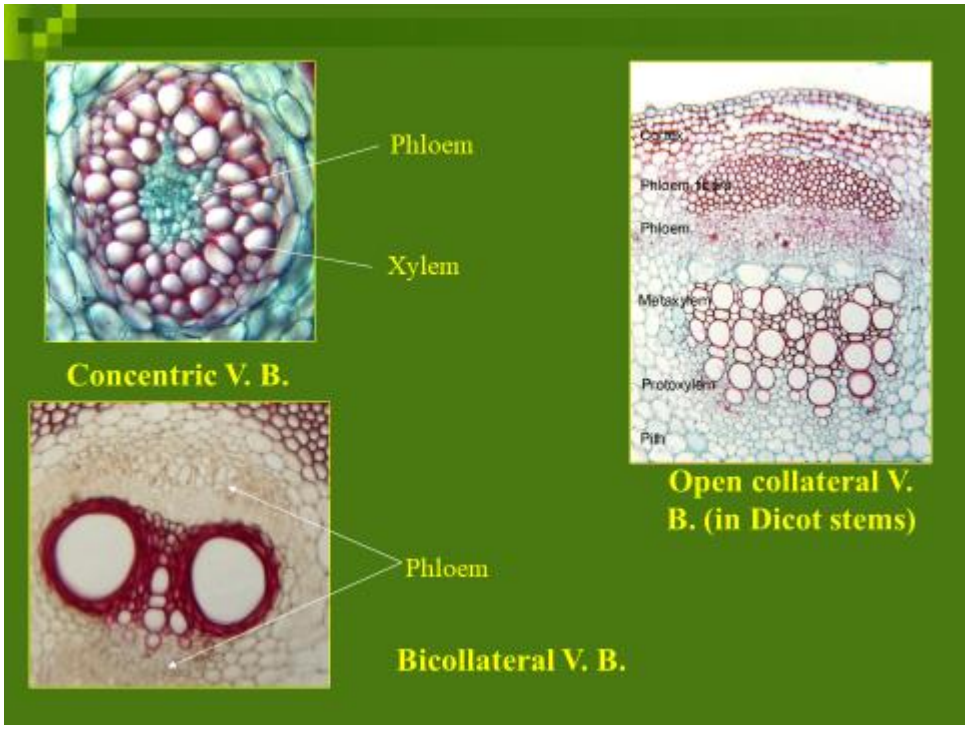
Vascular Bundles



Radial Vascular Bundle (in Roots)



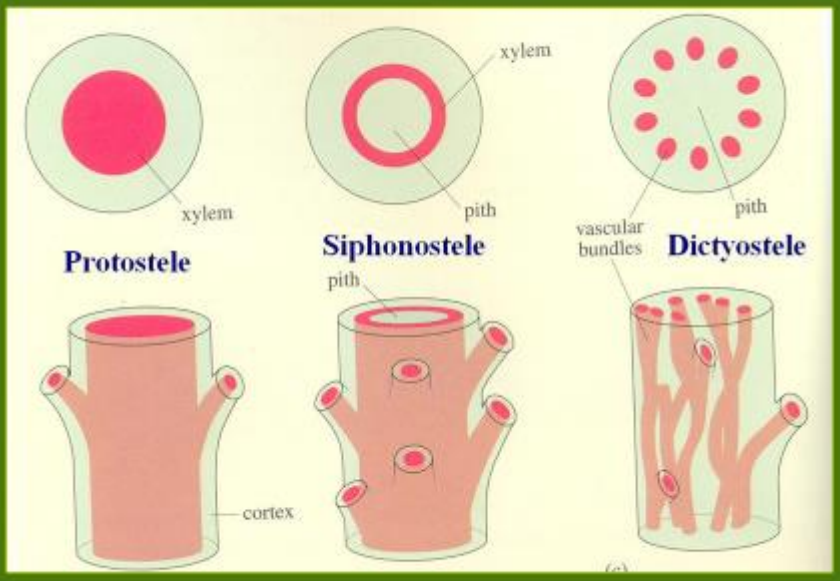
Closed collateral V. B. (in Monocot stems)

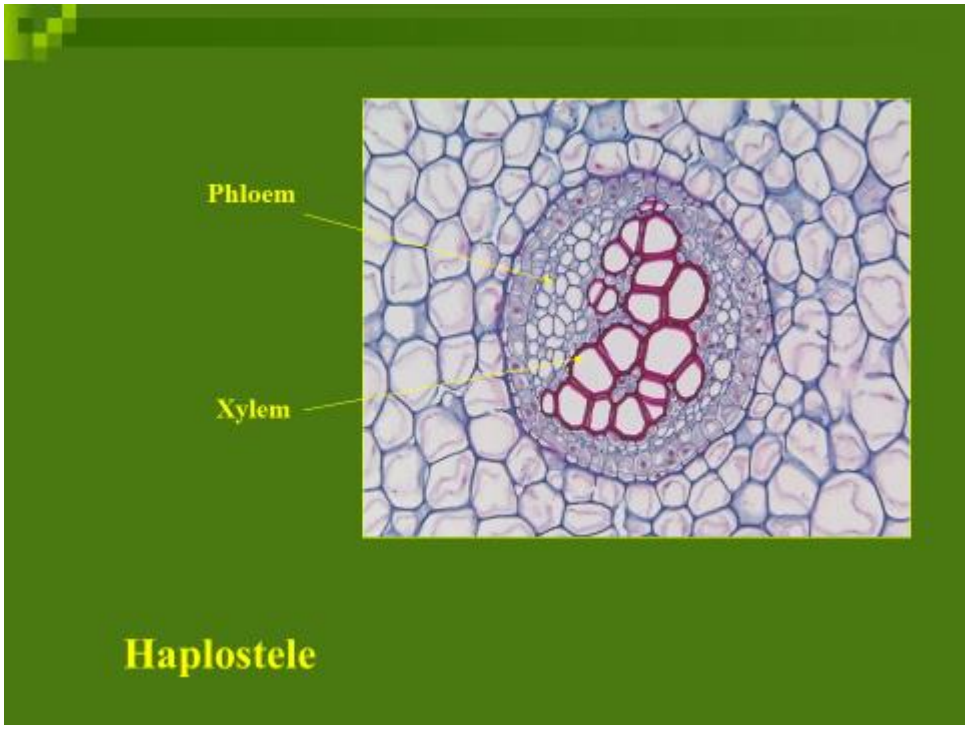

Phloem
Xylem
Concentric V. B.
Phloem
Bicollateral V. B.
Open collateral V. B. (in Dicot stems)

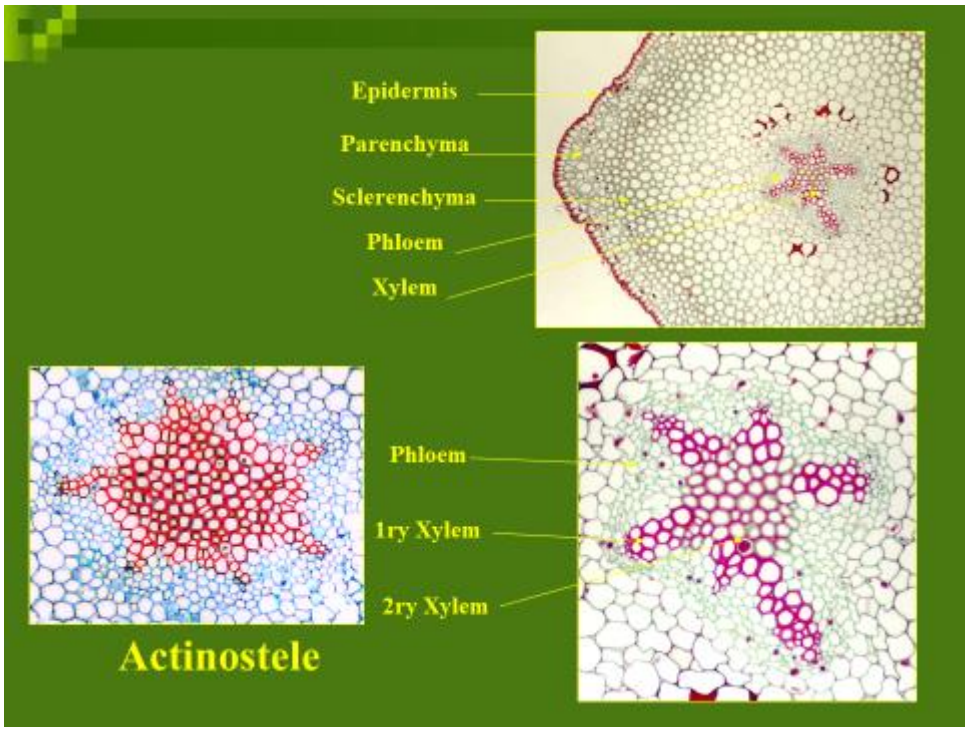

Secretory Tissue
Schizogenous gland
Digestive gland
Lizogenous gland

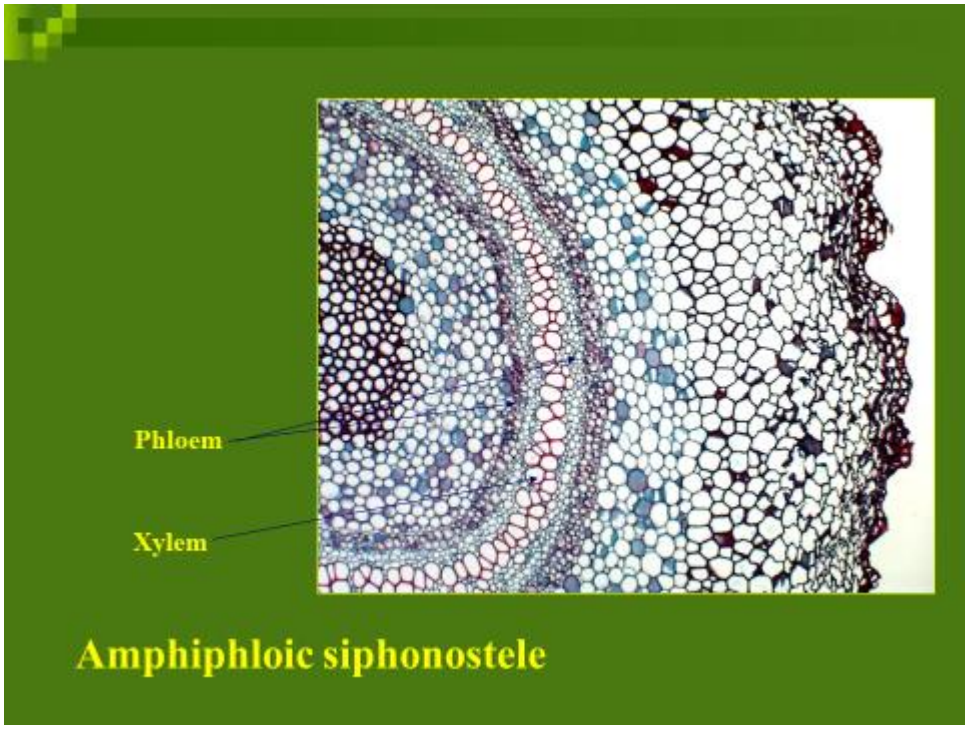
Vascular Skeleton (The Stele)

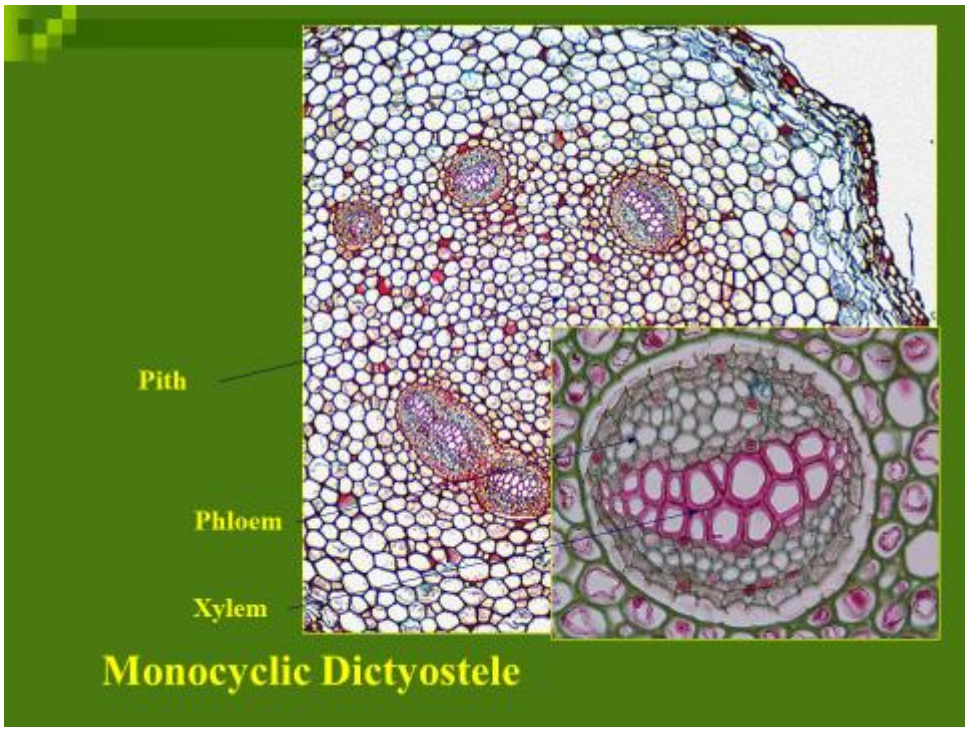
- Protostele
  - Haplostele
  - Actino]stele
  - plectostele
- Siphonostele
  - Ectophloic siphonostele
  - Amphiphloic siphonostele
- Dictyostele (monocyclic, polycyclic)
- Atactostele in monocots
- Eustele in dicots

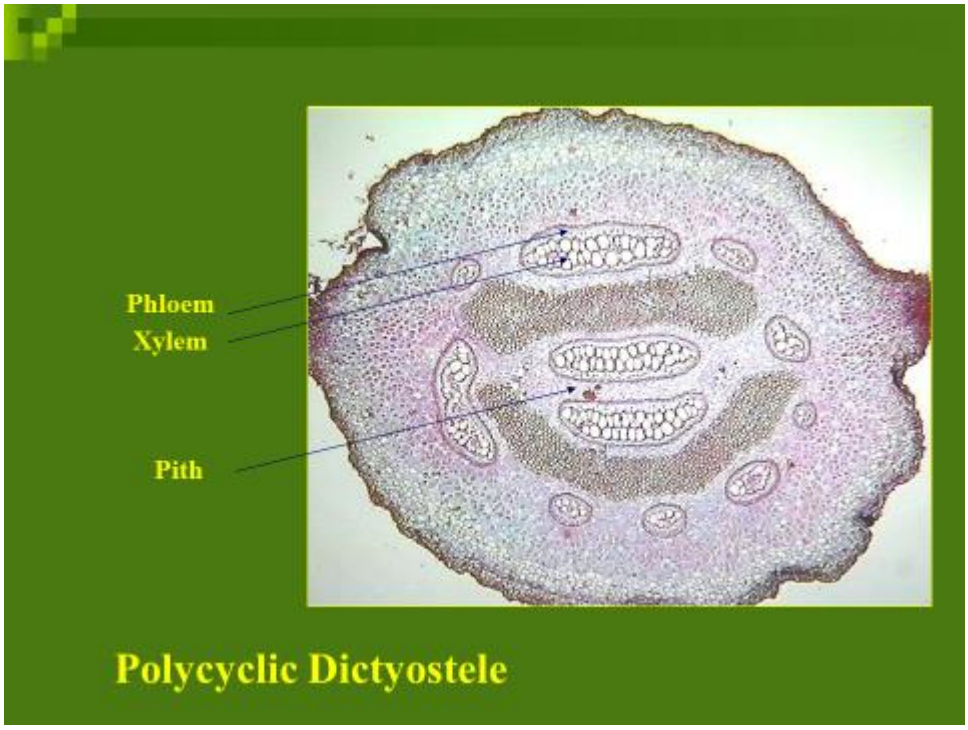



Phloem
Xylem
Haplostele


Epidermis
Parenchyma
Sclerenchyma
Phloem
Xylem
Phloem
1ry Xylem
2ry Xylem
Actinostele

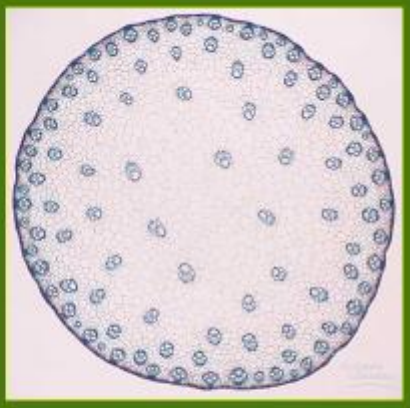

Phloem
Xylem
Amphiphloic siphonostele


Pith
Phloem
Xylem
Monocyclic Dictyostele



Polycyclic Dictyostele

Eustele



Atactostele

Anatomy of Plant Organs

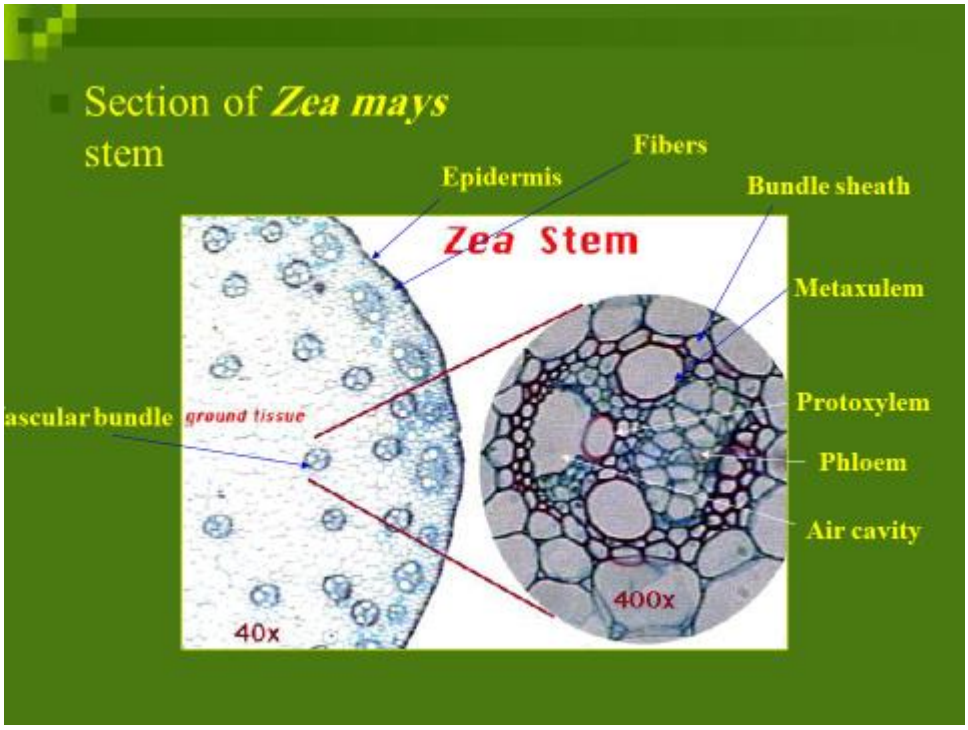
- The Stem

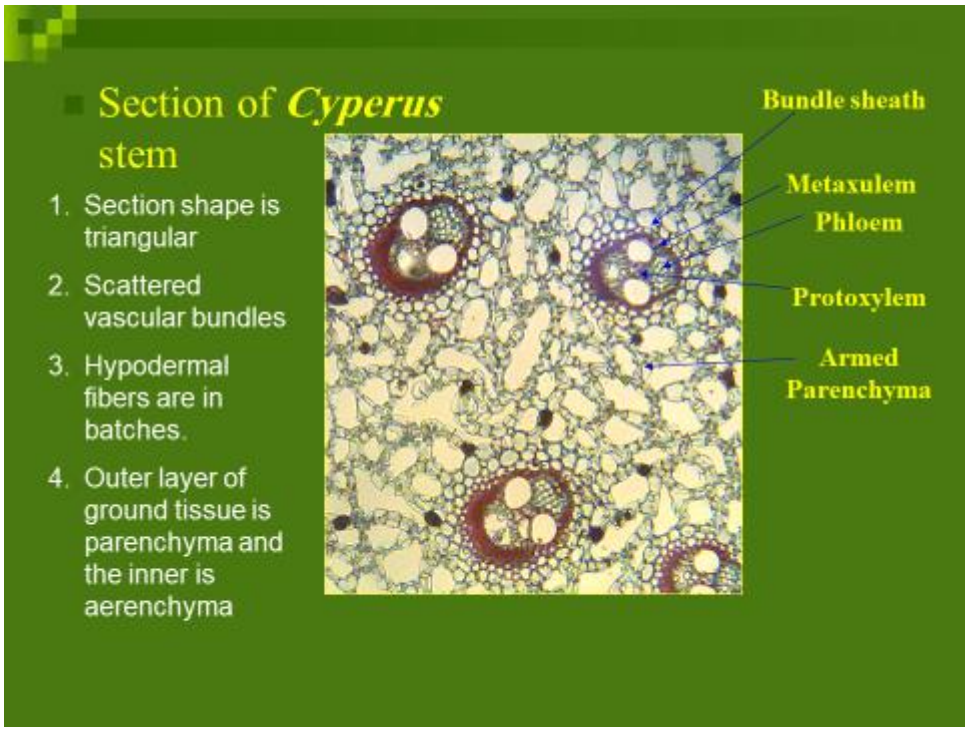
Stem is Characterized by:

1. The vascular bundles are collateral.
2. The xylem is endarch
   - Monocot stems
     - ***Zea, Cyperus, Triticum, Asphodelus, Ruscus, Phoenix, Canna.***

Monocot stem is characterized by:

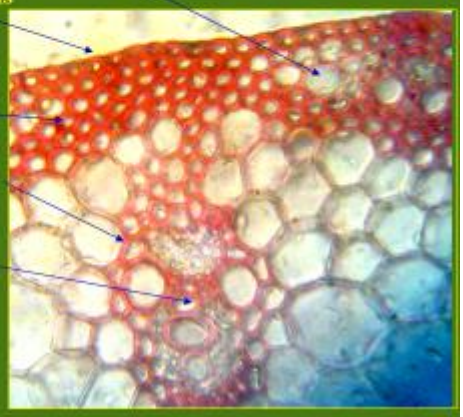
1. The supporting tissues under the epidermis is fibers.
2. Vascular bundles are scattered.
3. Ground tissue undifferentiated into cortex and pith.
4. Xylem vessels arranged in V- or Y- shape.
5. Vascular bundles are closed collateral.
6. The phloem is regular.


Section of Zea mays stem
Fibers
Epidermis
Bundle sheath
Zea Stem
Metaxulem
ascular bundle
ground tissue
Protoxylem
Phloem
Air cavity
400x
40x


Section of Cyperus stem
1. Section shape is triangular
2. Scattered vascular bundles
3. Hypodermal fibers are in batches.
4. Outer layer of ground tissue is parenchyma and the inner is aerenchyma
Bundle sheath
Metaxulem
Phloem
Protoxylem
Armed Parenchyma

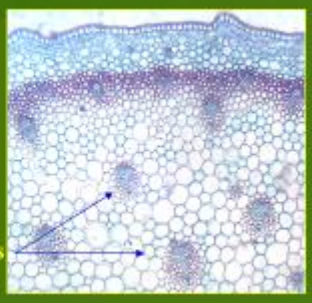
Section in *Triticum* stem

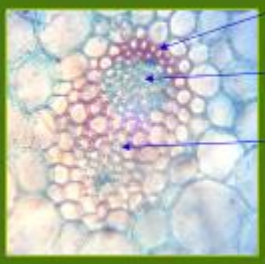
1. Hypodermis is a continuous layer of Fibers
2. vascular bundles are arranger in two rows
3. The outer smaller bundles are embedded in the hypodermal fibers
4. Xylem shape is V-shape
5. The stem is hollow

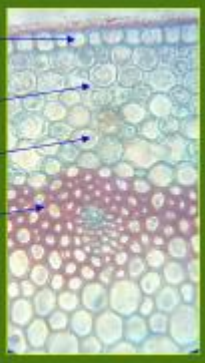


Section in *Ruscus* stem

1. vascular bundles are scattered
2. The cap fibers is present on each vascular bundle

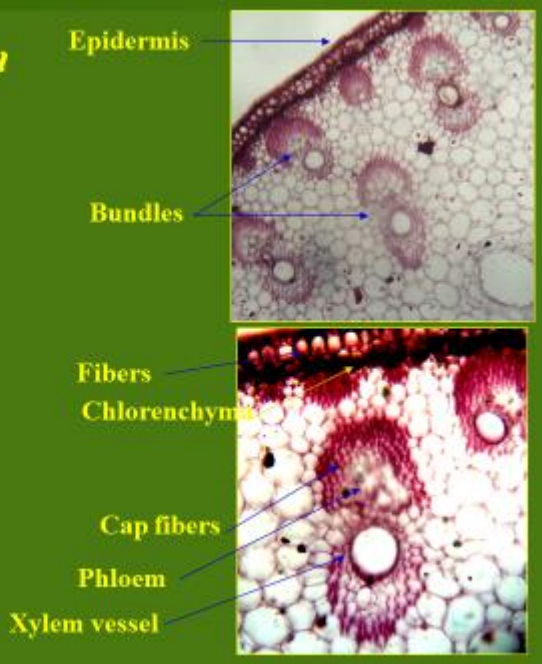






Section in *Canna* stem

1. The epidermis is followed by chlorenchyma layer
2. Hypodermal fibers are in batches.
3. The xylem shape is made of one vessel only.



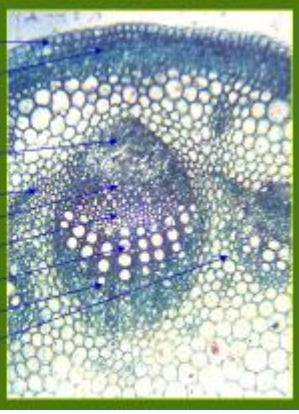
Dicot Stems

- Dicot stems are characterized by:
  - The supporting tissue under the epidermis is collenchyma.
  - Vascular bundles are arranged in one ring.
  - Ground tissue differentiated into cortex and pith.
  - Xylem vessels arranged in parallel rows.
  - Vascular bundles are open collateral V.B.
  - The phloem is irregular.
  - Fibers present over the V.B. forming pericycle.

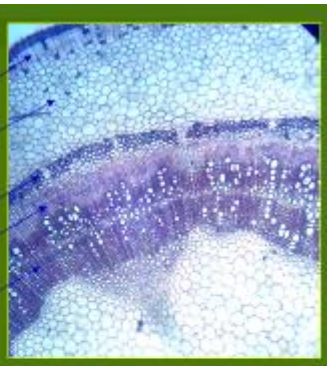
- **Dicot stems may be young or old;**
  - Young if there is no secondary tissues, and the medullary rays are very wide.
  - Old if the secondary tissues are present.
- **Dicot stem may be herbaceous, vines or woody;**
  - Herbaceous when the vascular bundles are clearly separated by wide interfascicular regions, and 2ry xylem and phloem are very limited.
  - Vines when the primary medullary rays are very narrow and presence of secondary meduulary rays.
  - Woody when the secondary tissues form a continuous cylinder and the intervascicular regions are very narrow, secondary xylem and phloem are much large.

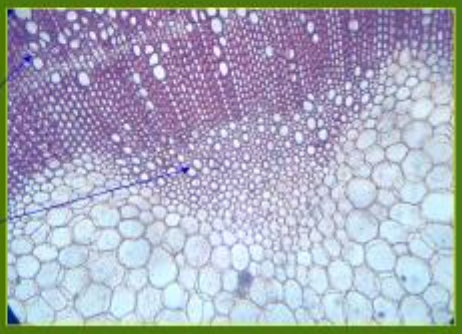
- Section of ***Helianthus*** stem (young dicot herbaceous stem)

1. The supporting tissue under the epidermis is collenchyma (lamellar).
2. The medullary rays are very wide.



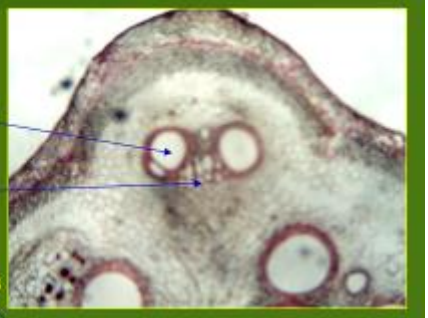
- Section in ***Pelargonium*** Old dicot herbaceous stem

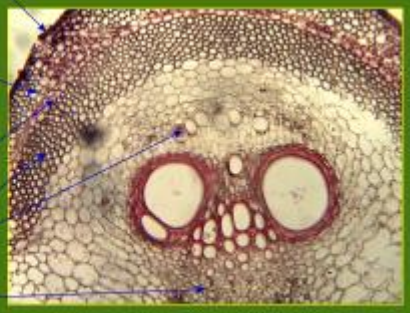




- Section in ***Luffa*** Old herbaceous dicot stem

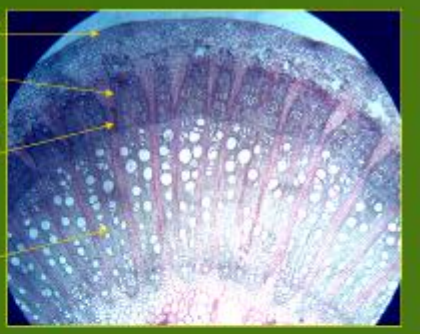
1. The supporting tissue under the epidermis is collenchyma (angular).
2. The V.B. are arranged in two rows.
3. Bundles are bicollateral.
4. No cambium between the xylem and inner pohloem





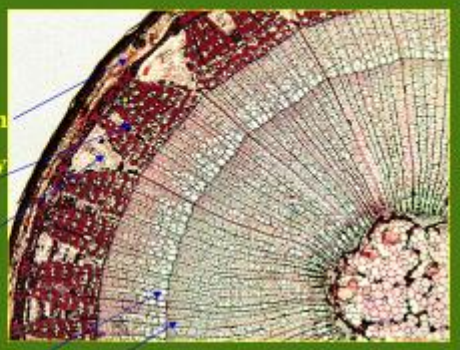
Section in *Vitis* Old dicot vine stem

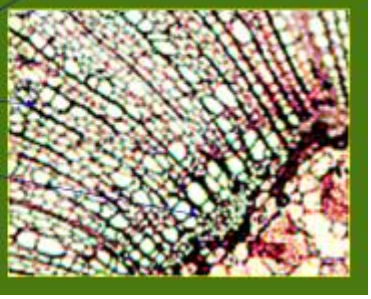
1. Primary and secondary xylem are on the same radius.
2. Medullary rays are numerous and narrow (2ry vascular tissues appear to consists of strand.
3. Secondary xylem and phloem are large.



Section in *Tilia* Old Dicot Woody Stem

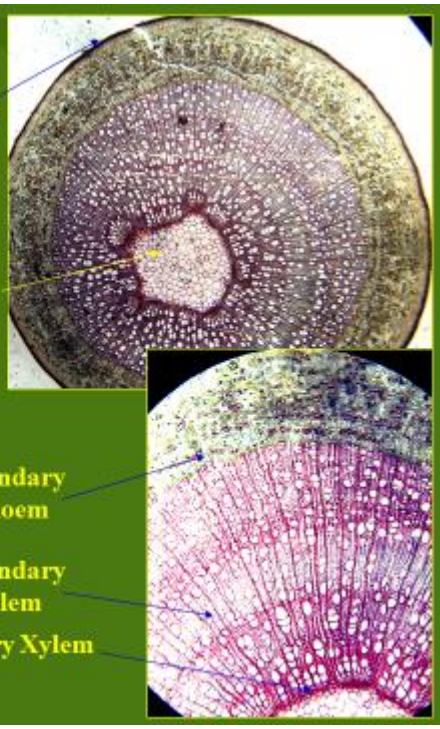
1. Presence of periderm.
2. Secondary phloem contains fibers.
3. Large amounts of 2ry xylem differentiated into spring and autumn wood forming annual rings.





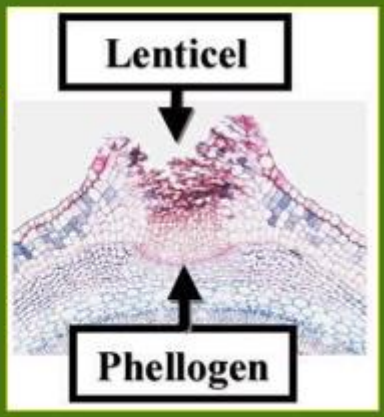
Section in Old Dicot Woody Stem (*Salix*)

1. The supporting tissue under the epidermis is collenchyma.
2. The secondary tissues form a continuous cylinder and the interfascicular regions are very narrow.
3. Large amounts of 2ry xylem and secondary phloem.



Periderm and Lenticels

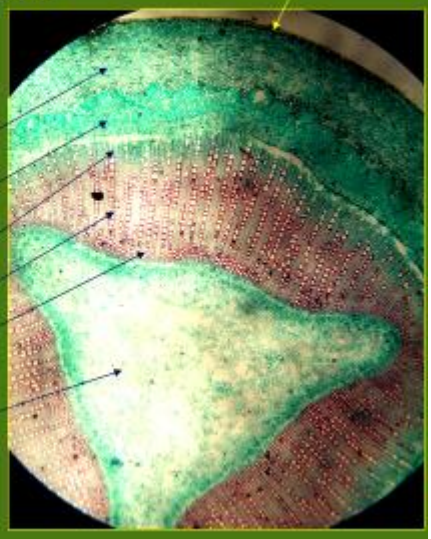
Periderm



Abnormal Old Dicot Stems

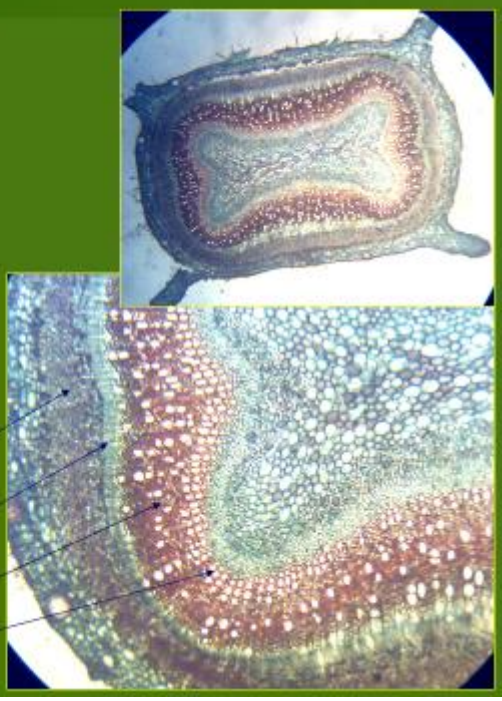
- ***Nerium*** stem:

1. The cambium is normal in its position (between xylem and phloem).
2. The cambium is abnormal in its activity (form equal amounts of secondary phloem but unequal amounts of xylem).



- ***Jacaranda*** stem:

1. The cambium is normal in its position (between xylem and phloem).
2. The cambium is abnormal in its activity (form equal amounts of secondary phloem but unequal amounts of xylem).

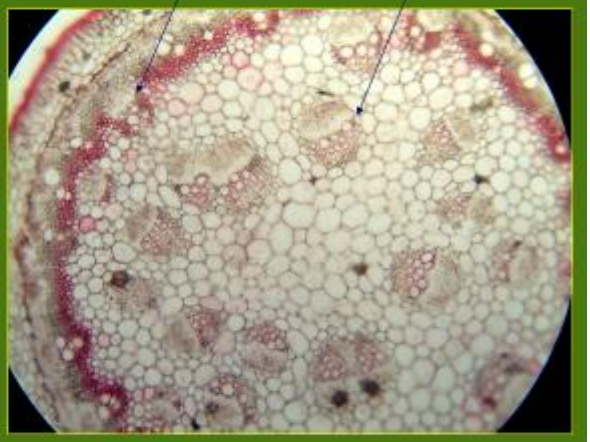


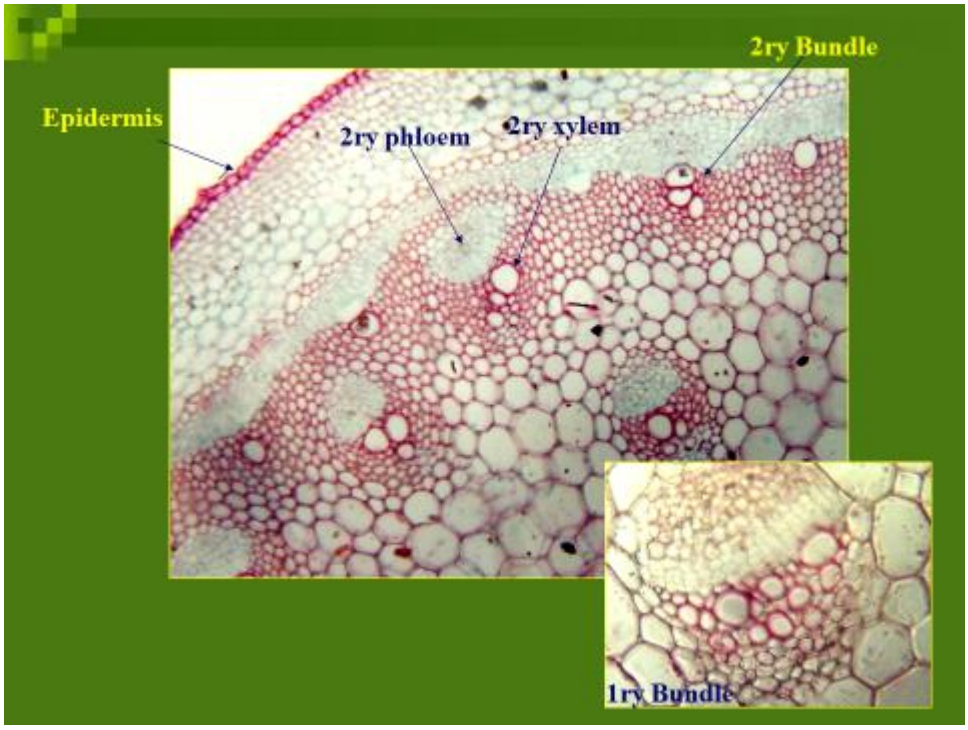
Jacaranda stem:

1. The cambium is normal in its position (between xylem and phloem).
2. The cambium is abnormal in its activity (form equal amounts of secondary phloem but unequal amounts of xylem).

Bougainvillea stem:

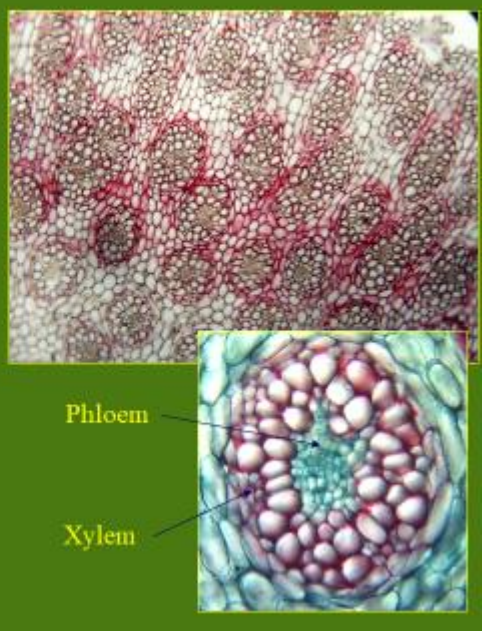
1. The vascular cambium is formed normally in position and activity, but it become inactive.
2. A new cambium formed just outside the primary bundles (abnotmal in position).
3. The new cambium (accessory cambium) is abnormal in activity (give separate 2ry bundles to the inside surrounded by conjunctive tissue and parenchyma cells to the outside)



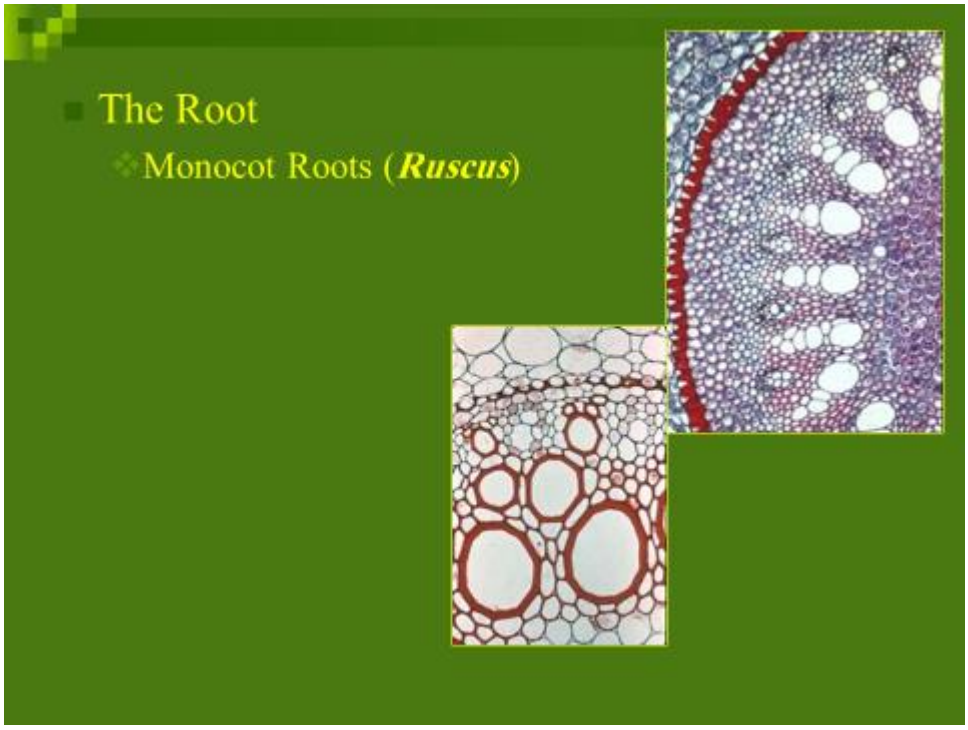

2ry Bundle
Epidermis
2ry phloem
2ry xylem
1ry Bundle

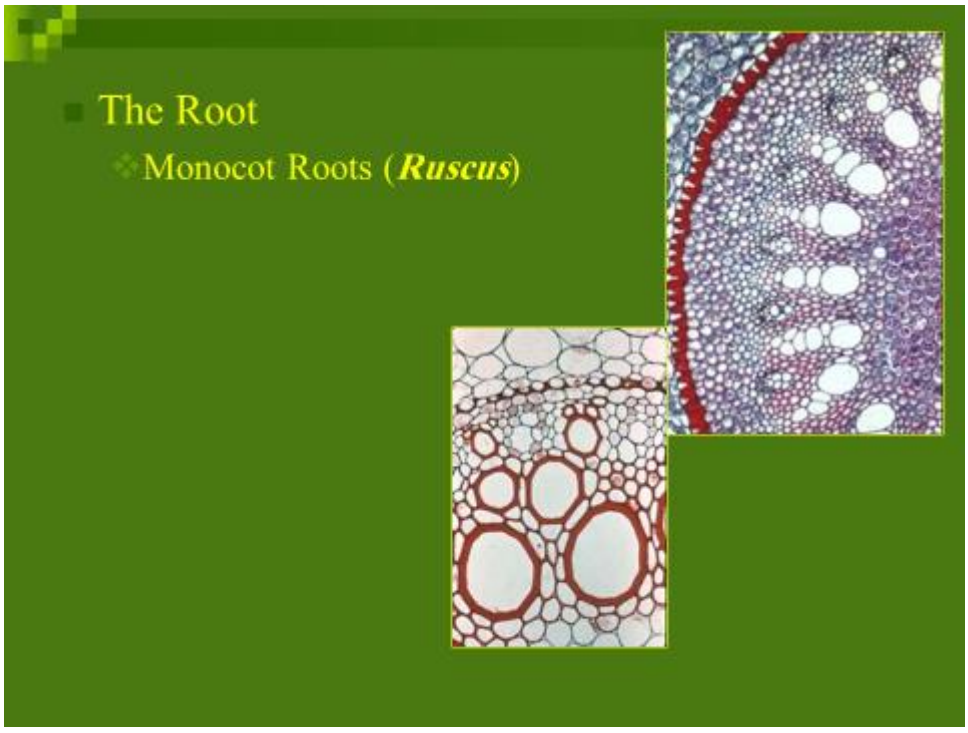

Leptadinia stem:

- ***Drocera*** stem

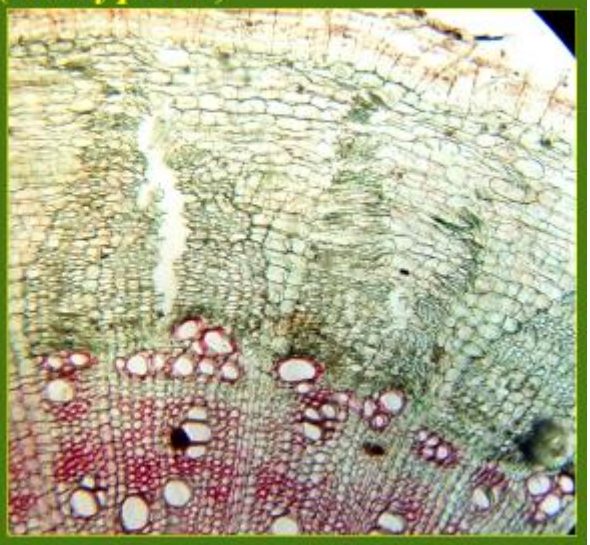


Pinus (Conifers) stem


The Root
Monocot Roots (*Ruscus*)


The Root
Monocot Roots (*Ruscus*)

- Old Dicot Root (***Gossypium***)



- Old Dicot Root (***Ficus***)

- Abnormal Old Dicot Root (***Beet*** Root)

- Monocot leaf

Dicot leaf