

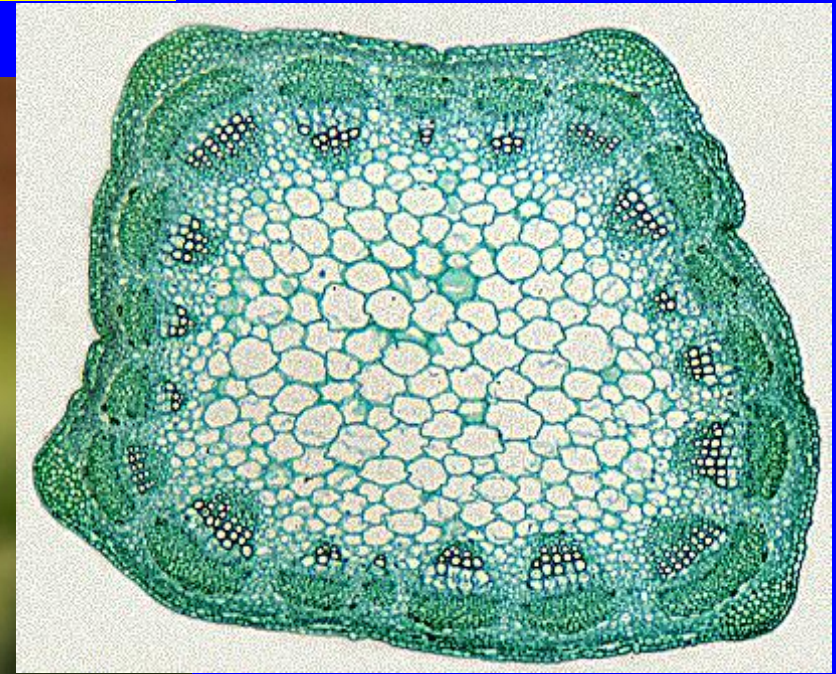
### IV. Primary Structure of Stem

#### (I) Primary structure of dicotyledon stem

##### 1. Epidermis

It is developed from procuticle, consists of a single layer of living cells, does not contain chloroplast and contains anthocyanidin in some cases. Cells are in a shape of rectangular prism and have developed vacuoles, the major diameter is parallel with the vertical axis, bioplast clings to cell wall, the outer tangential wall is thick and cutinized and has cuticle, wax in some cases. There are stomata usually, which sometimes are differentiated into hairy appendages.

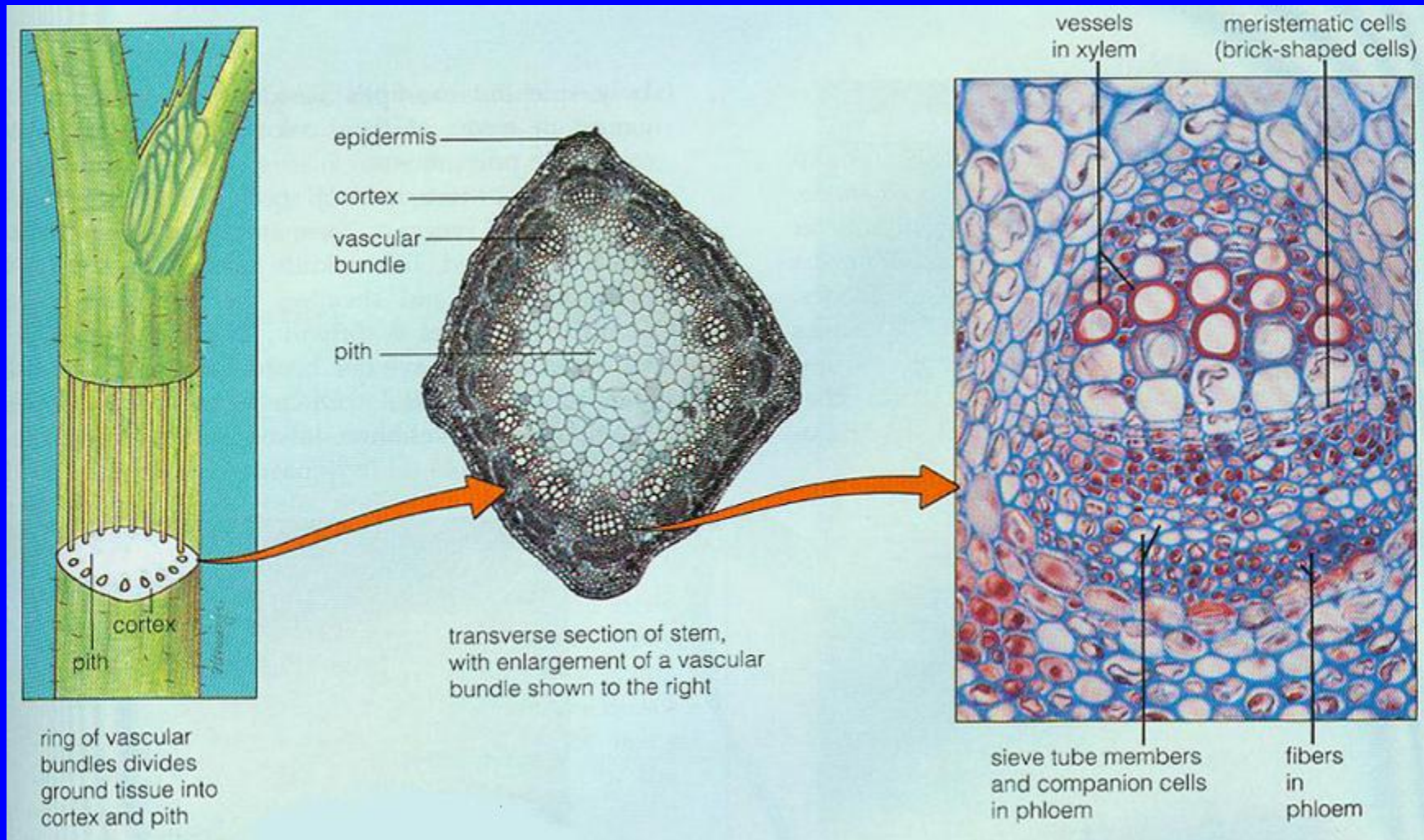




**Vascular bundles from *Medicago* stem**

**Cross section of celery stalk, showing vascular bundles, which include both phloem and xylem.**

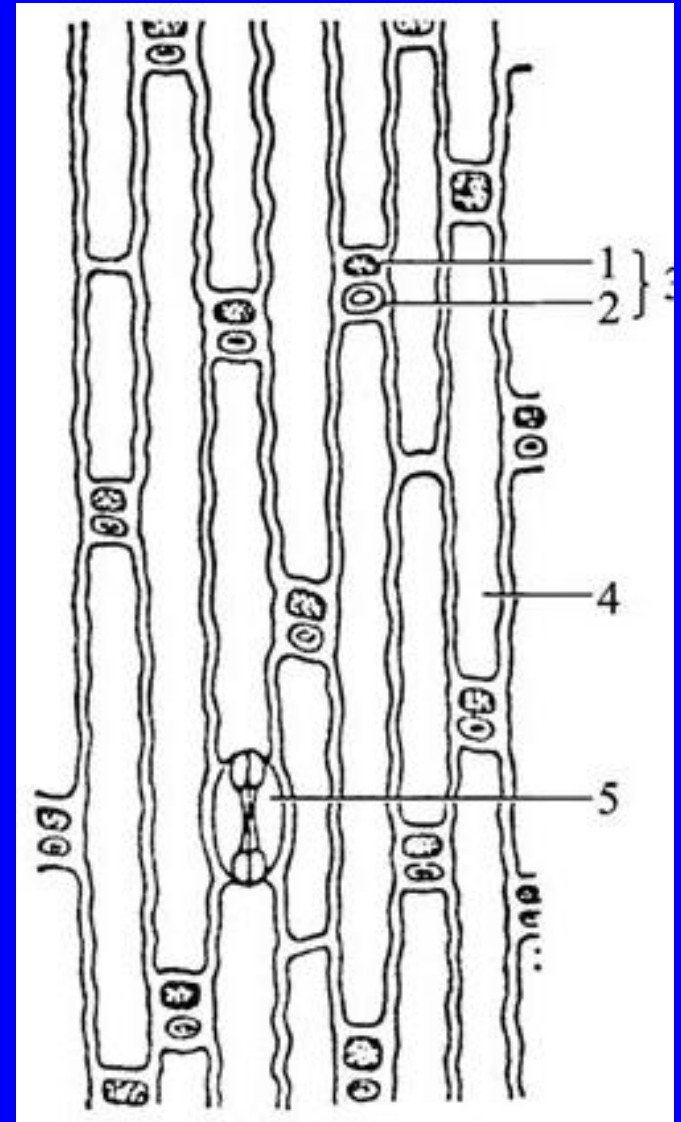
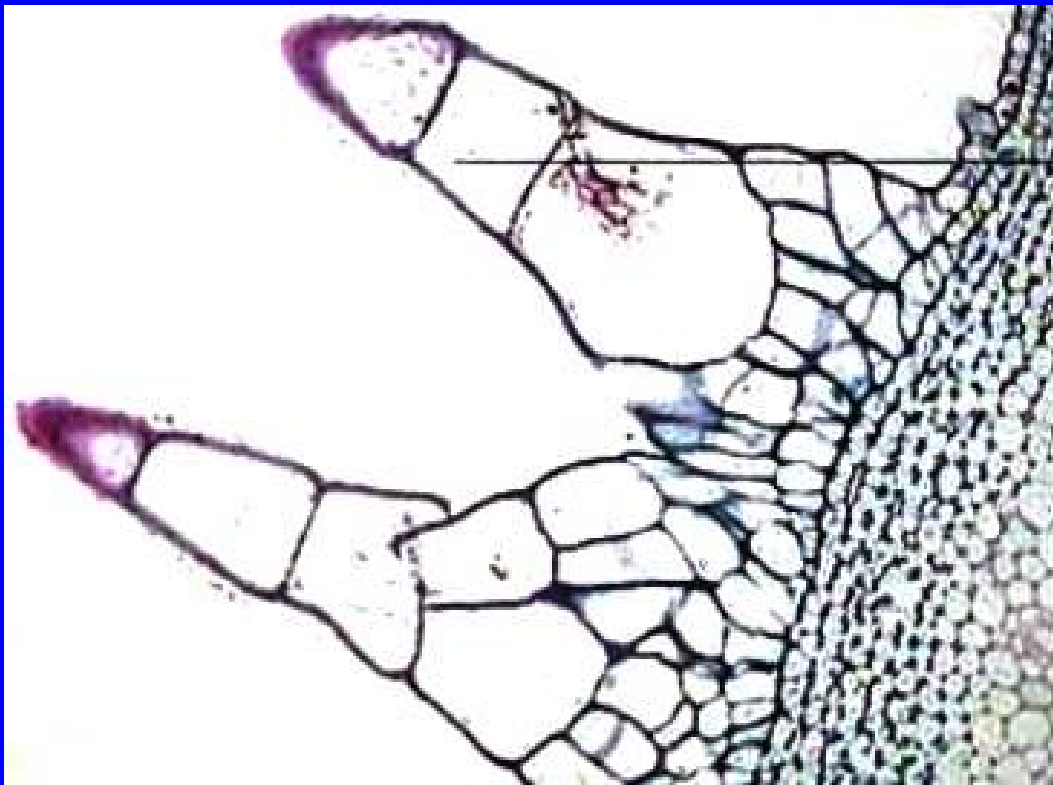
# Chapter IV Vegetative Organs of Seed Plants – The Stem



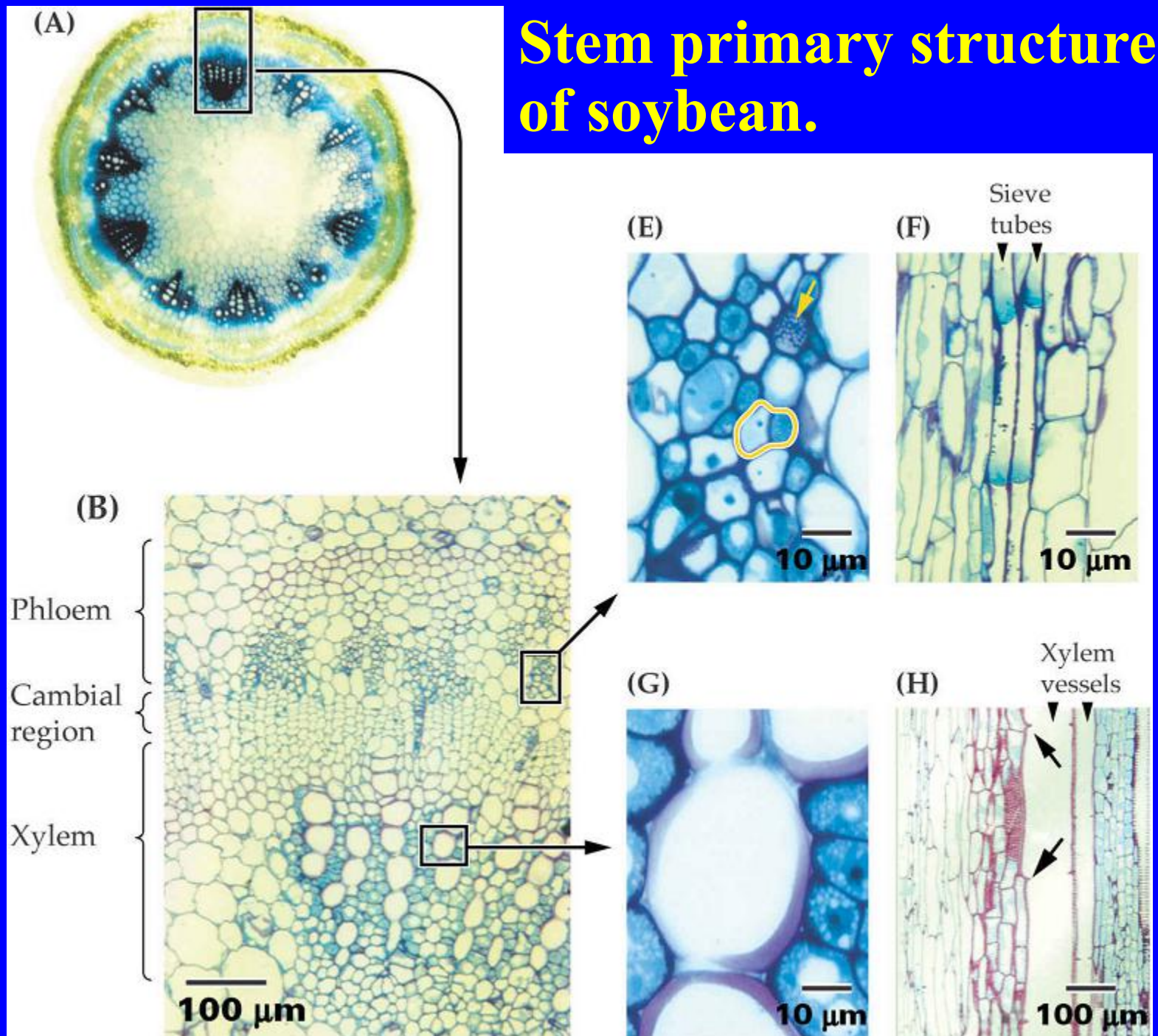
## Stem primary structure of alfalfa.



# Epidermal hair and stoma



# Stem primary structure of soybean.



### 2. Cortex

It is on the inner side of epidermis and generated from differentiation of fundamental meristem and contains multiple layers of cells and multiple tissues dominated by parenchymal tissue. The cells are living cells with thin wall and intracellular space. On the transverse section, the cells are isodiametric. The cells of young stems near epidermal cells contain chloroplast and usually also store nutrient substances.

One ~ a few layers of cortex cells clinging to the inner side of epidermal cells are often differentiated into collenchyma tissue, in continuous layers or scattered bundles. They play a role of support and some of them contain fiber or lithocyte.

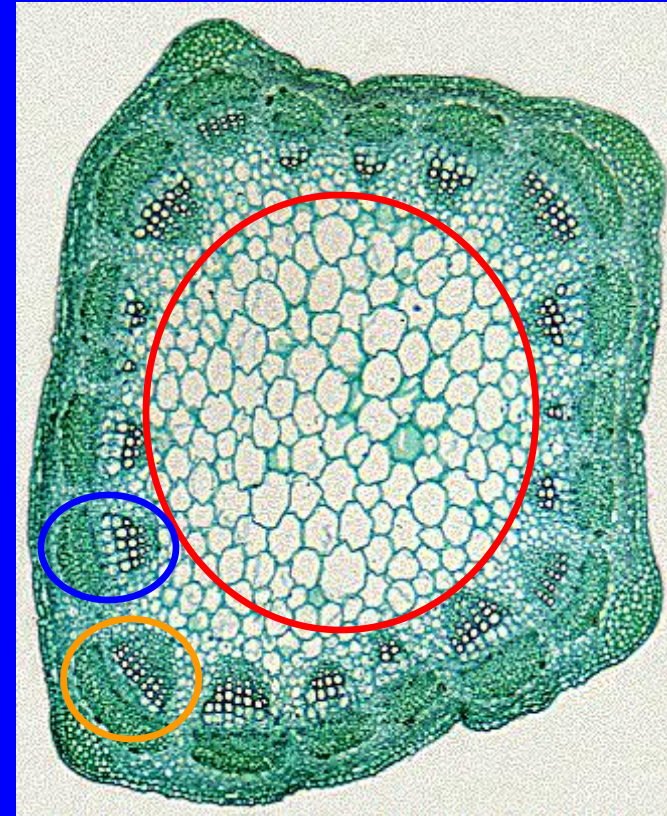
The innermost layer of cortex is mostly not significant, sometimes has endodermis, and exists universally among water plants or underground stems. The cells of the innermost layer of cortex in some plants are rich in starch grains, which constitute a starch sheath.

### 3. Vascular cylinder

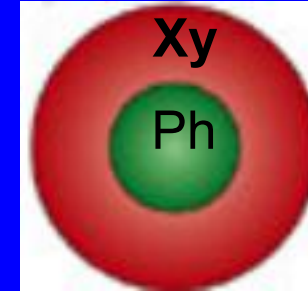
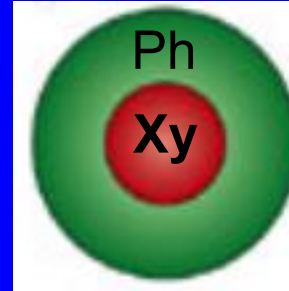
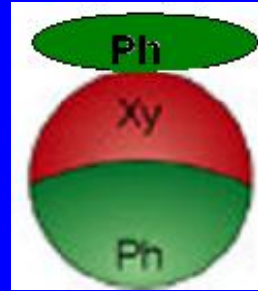
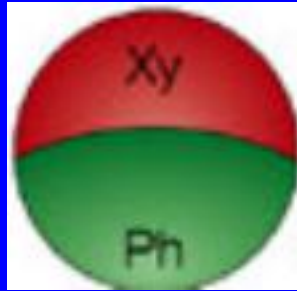
It consists of vascular bundle, pith and pith ray and does not have significant endodermis and pericycle. The vascular bundles are generated from differentiation of procambium and are in one circle of separately arranged bundle structure.

#### (1) Classification of vascular bundles

- ① { Open vascular bundle: There is a cambium between xylem and phloem.  
Closed vascular bundle: No cambium between xylem and phloem.



## Chapter IV Vegetative Organs of Seed Plants – The Stem



Collateral vascular bundle: Primary phloem is on the outer side and primary xylem is on the inner side. A majority of plants, such as pear, sunflower and clover.

② Bicollateral vascular bundle: Primary phloem exists both inside and outside primary xylem. Between internal phloem and xylem, there isn't a cambium. Cucurbitaceae, Convolvulaceae, Solanaceae, etc.

Ampicribral vascular bundle: Primary xylem is at the center and externally surrounded by primary phloem. Fern, rheum officinale and garden sorrel.

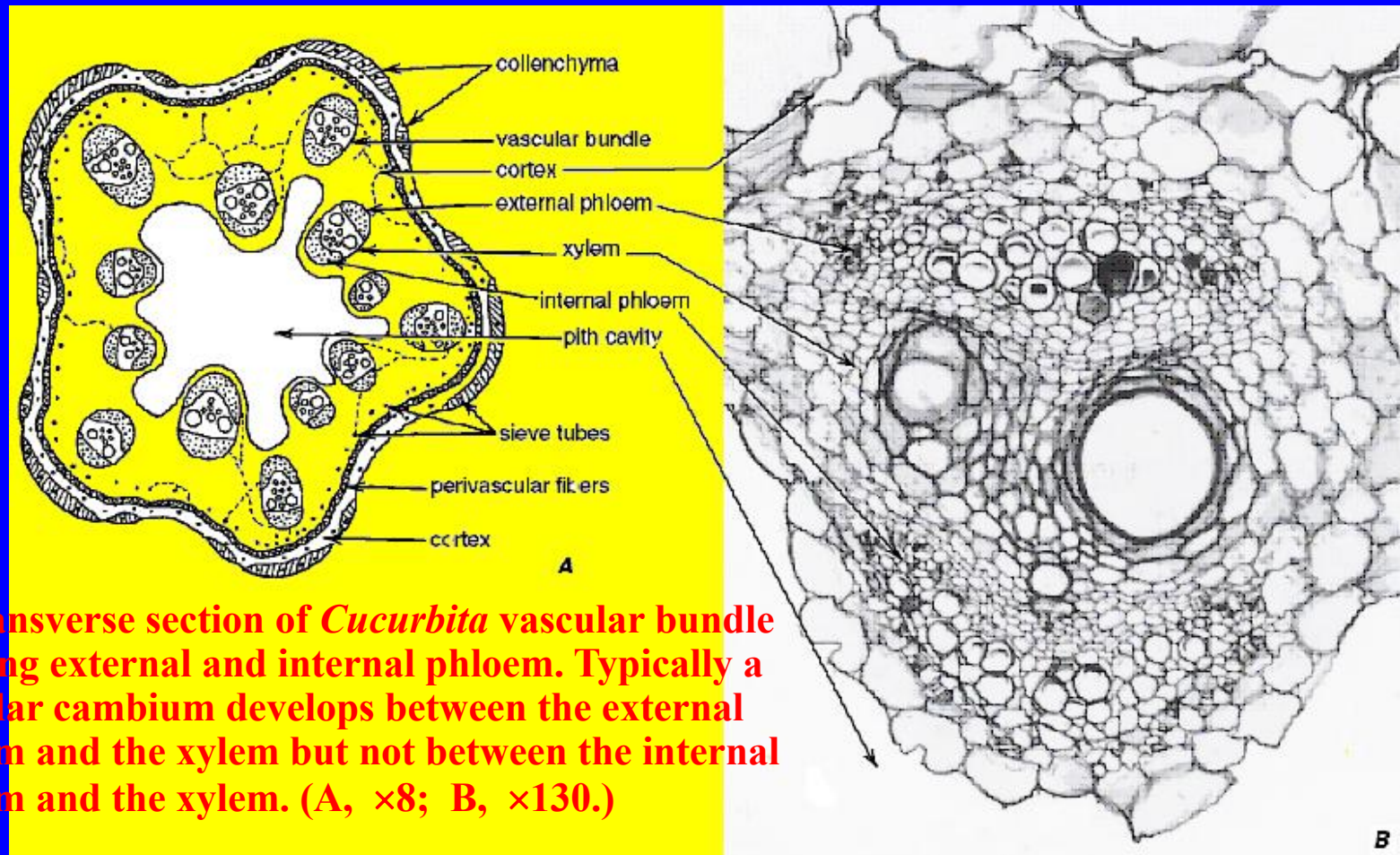
Amphivasal vascular bundle: Primary phloem is at the center and externally surrounded by primary xylem. Bulrush, *Iris tectorum Maxim*, Polygonaceae and Piperaceae.





## Chapter IV Vegetative Organs of Seed Plants – The Stem

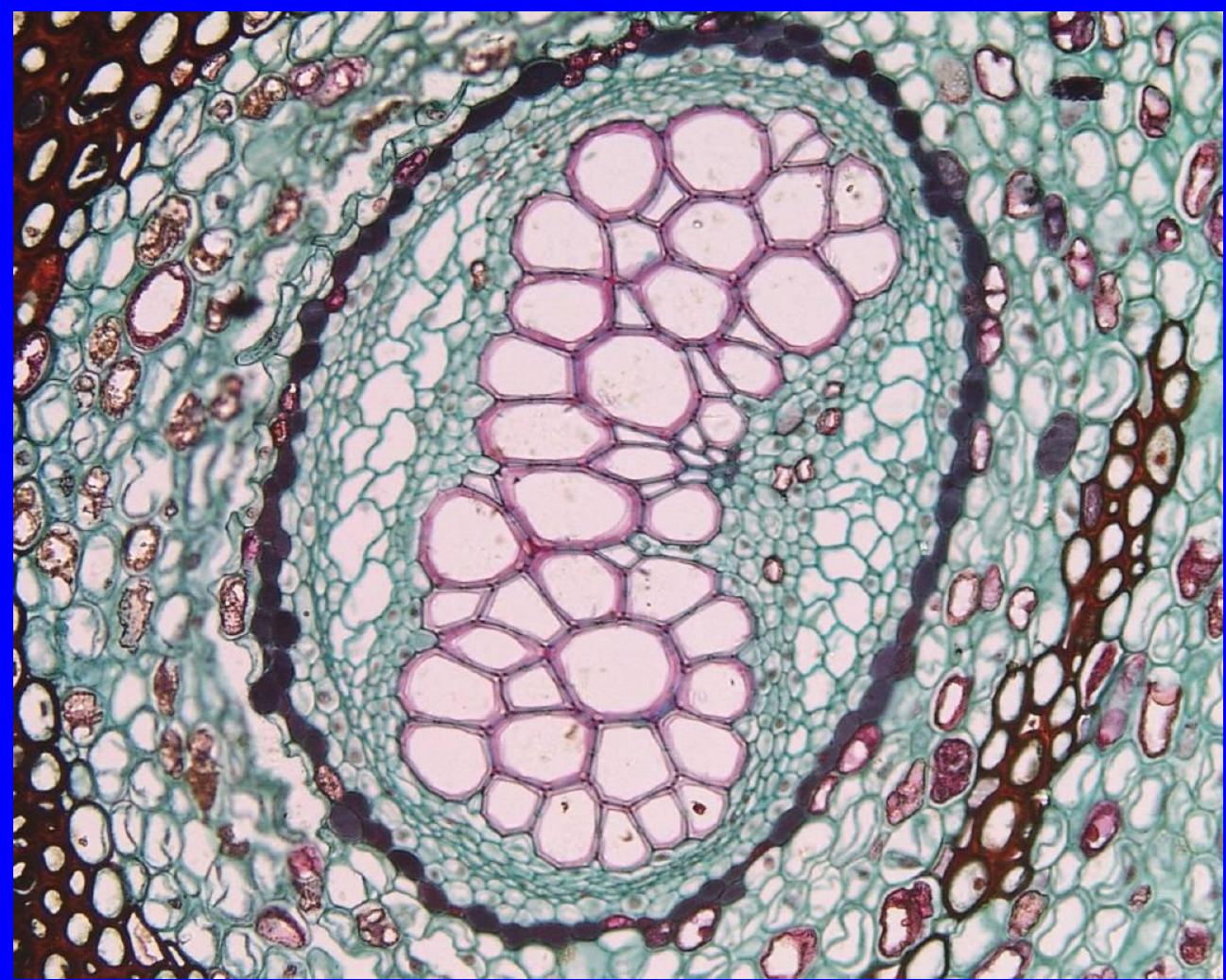
**A, transverse section of a *Cucurbita* stem. Herbaceous vine with discrete vascular bundles, each having phloem on opposite sides of the xylem (bicollateral bundles). The vascular region is delimited on the outside by sclerenchyma (perivascular fibers). The cortex is composed of parenchyma and collenchyma. There is an epidermis. A cavity has replaced the pith. Small strands of extrafascicular sieve tubes and companion cells traverse parenchyma of the vascular region and cortex.**



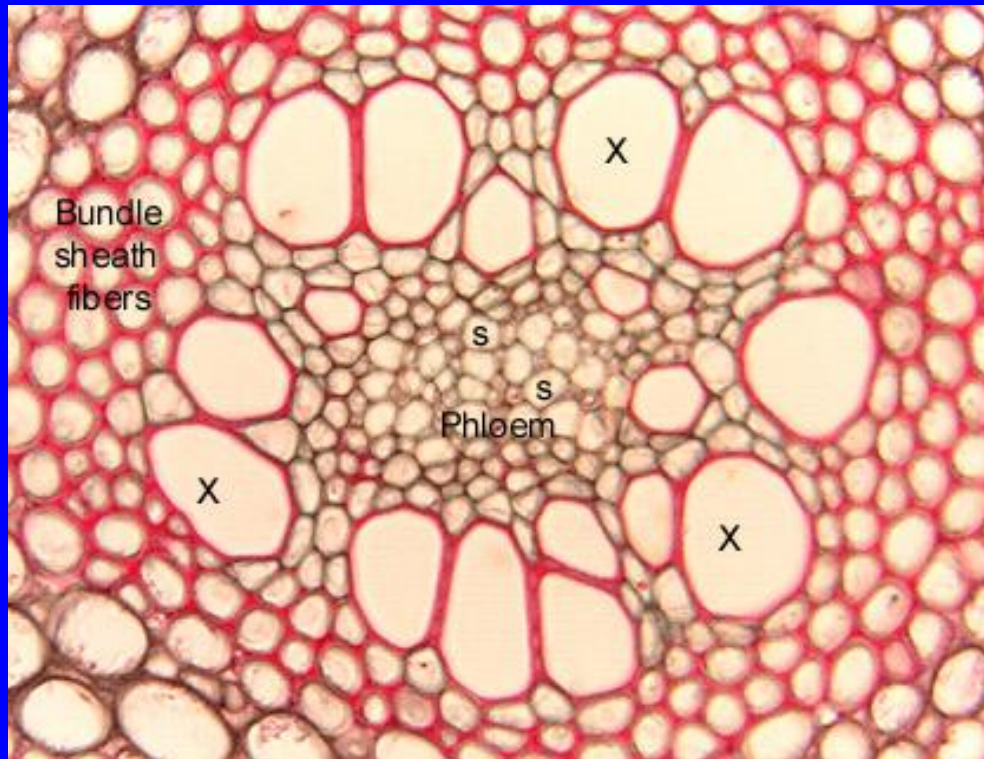
**B, transverse section of *Cucurbita* vascular bundle showing external and internal phloem. Typically a vascular cambium develops between the external phloem and the xylem but not between the internal phloem and the xylem. (A,  $\times 8$ ; B,  $\times 130$ .)**



An *Osmunda*  
amphicribal  
vascular  
bundle view  
showing the  
darkly stained  
endodermis.



## Chapter IV Vegetative Organs of Seed Plants – The Stem



**Transverse section of stem of rush (*Juncus*). This is an amphivasal vascular bundle: one in which the phloem is surrounded by xylem. The Xs mark just three of the many xylem elements, which are large enough here that we have no trouble distinguishing them from the fibers of the bundle sheath (in many species, it can be difficult to be certain if a cell is a wide sheath fiber or a narrow tracheary element). In the phloem, two of the many sieve tube members have been marked with “s”.**

## Chapter IV Vegetative Organs of Seed Plants – The Stem

### (2) Primary xylem (endarch )

Protoxylem: On the inner side, annular or spiral, with a small vessel diameter. Many wood parenchyma cells, a storage role.

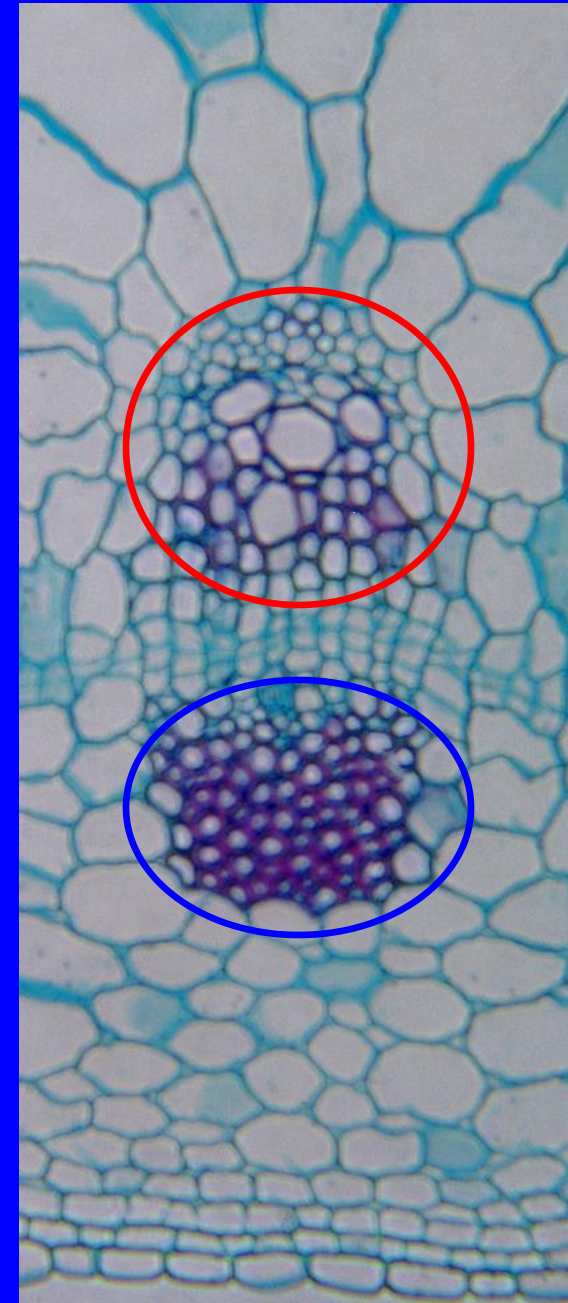
Metaxylem: On the outer side, scalariform, reticulate or pitted, with large vessel diameter. Much xylon, a supporting role.

### (3) Primary phloem (exarch )

Parenchyma cells are scattered and larger than compaion cells; phloem fibers are often arranged in bundles outside primary phloem.

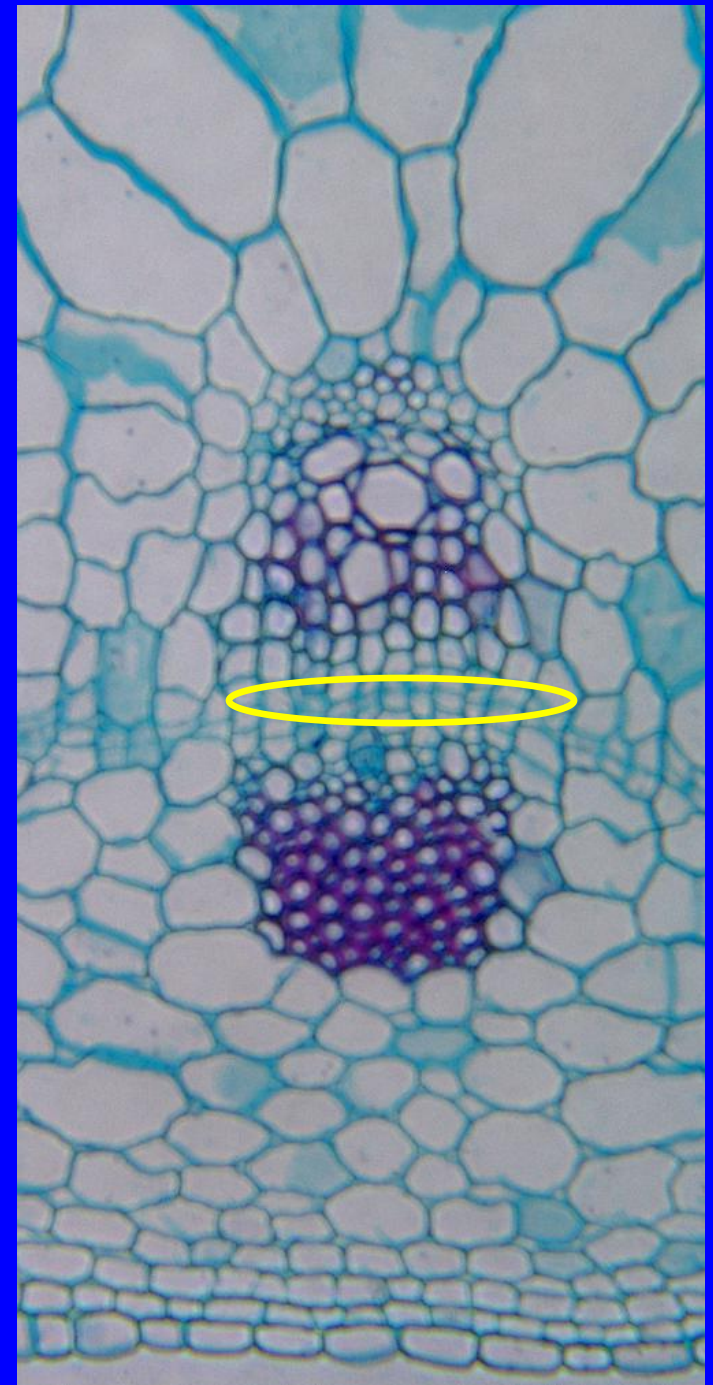
Protophloem: Outer side

Metaphloem: Inner side



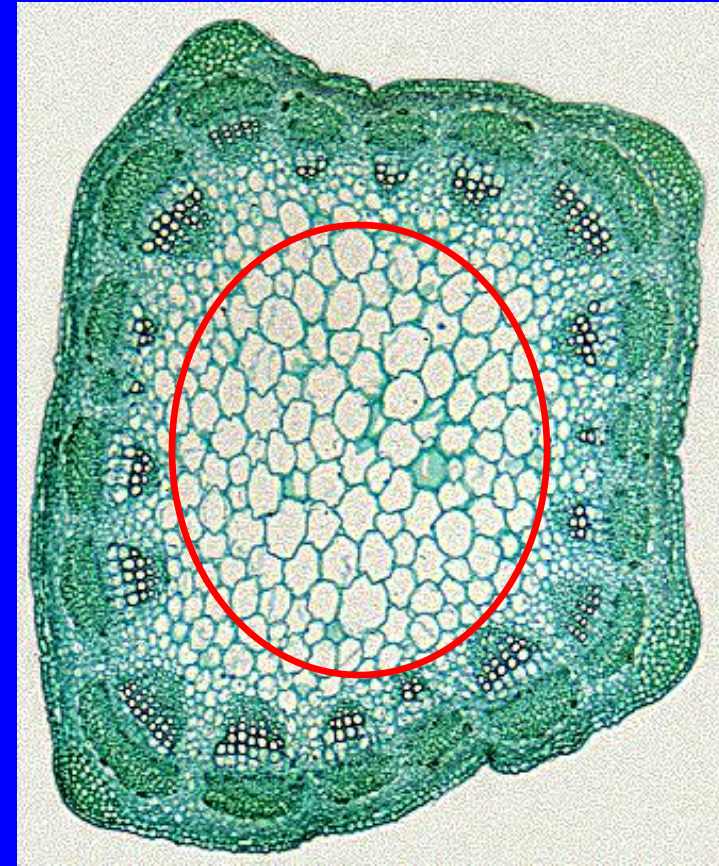
### (4) Vascular cambium

It is a potential meristem left by procambium during differentiation of primary vascular bundles and appears between primary xylem and primary phloem. It is a narrow strip as thick as 1~2 layers of cells.



### (5) Pith and pith ray

- ① Pith: It is a central part formed by parenchymal tissue and generated by fundamental meristem. Some contain lithocyte (camphor), some have a perimedullary zone (bass) and some piths are damaged under a full to form pulp cavities (Cucurbitaceae and Umbelliferae).
- ② Pith ray: Refer to the parenchymal tissue between vascular bundles. It is located between cortex and pith, generated by fundamental meristem and in a radiant form on transverse section and transversely transports and stores nutrient substances.



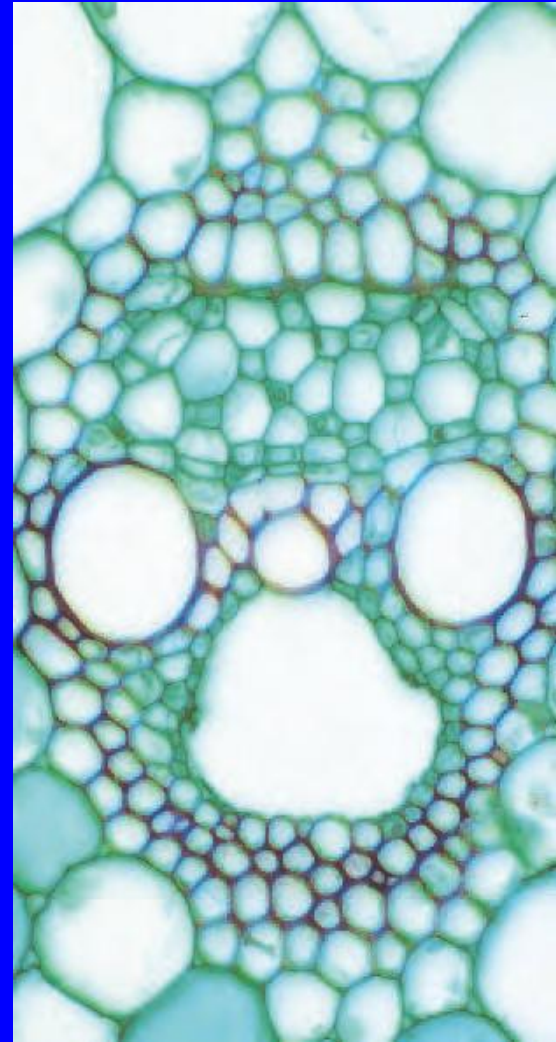
### (II) Features of primary structure of monocotyledon stem

- 1 The stems of most monocotyledons only have a primary structure. The vascular bundles are closed and collateral .
- 2 The two pitted vessels of metaxylem inside the vascular bundle and the annular or spiral vessels arranged in line inside protoxylem form a V-shaped structure.
- 3 Vascular bundles are arranged in two forms:

They are scattered irregularly and increased gradually from the center to the outside. Cortex and pith are hardly identifiable (corn and sugar cane).

They are scattered regularly, in two circles in general, with a pith at the center. After grow-up, the pith is broken into a pulp cavity (paddy and wheat).

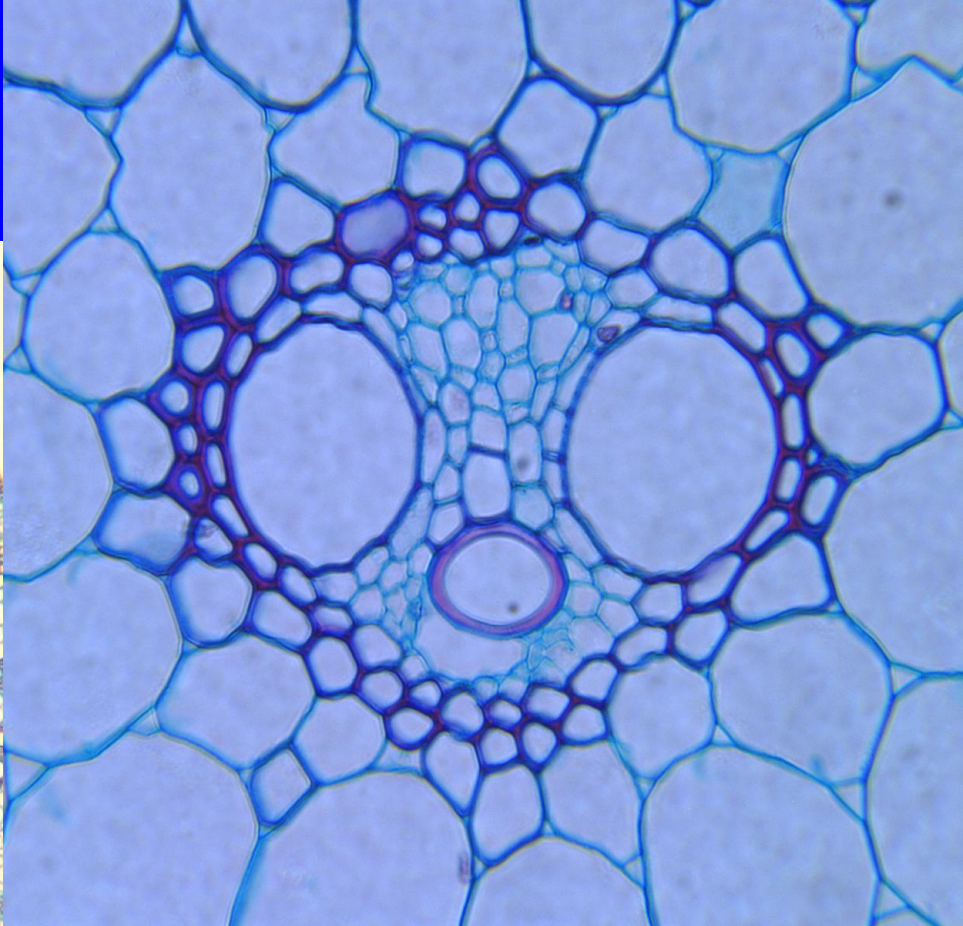
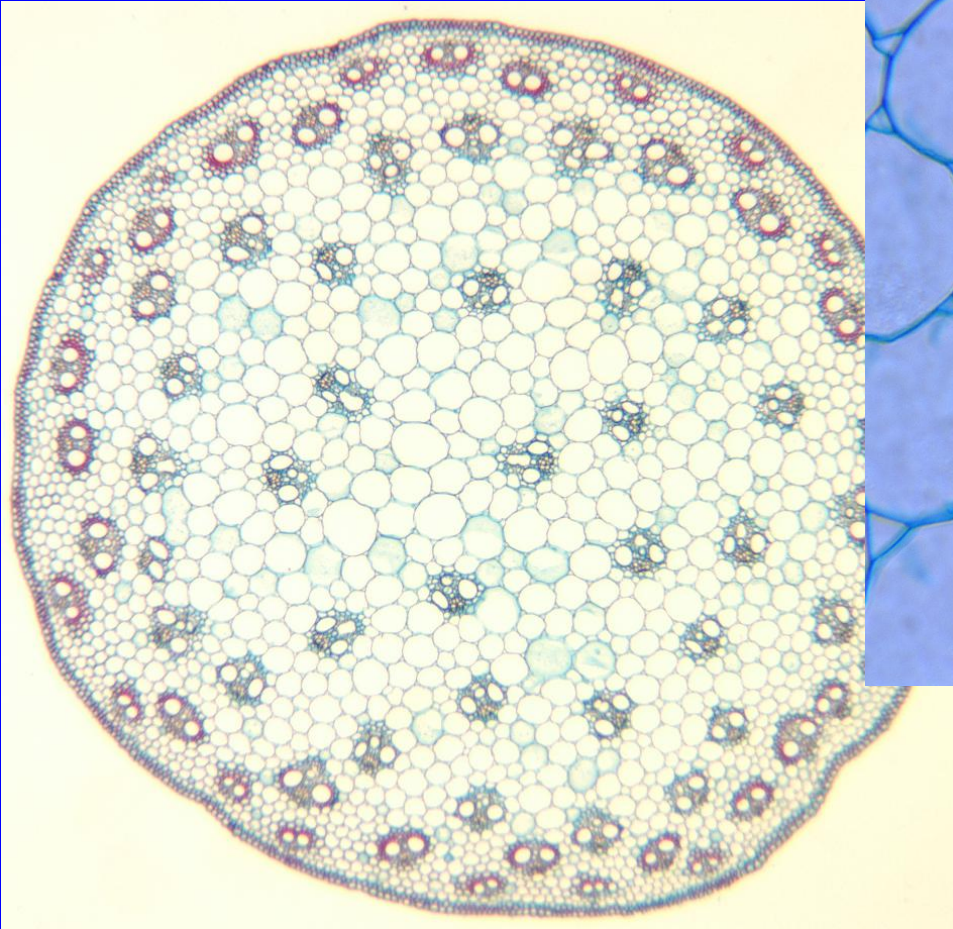




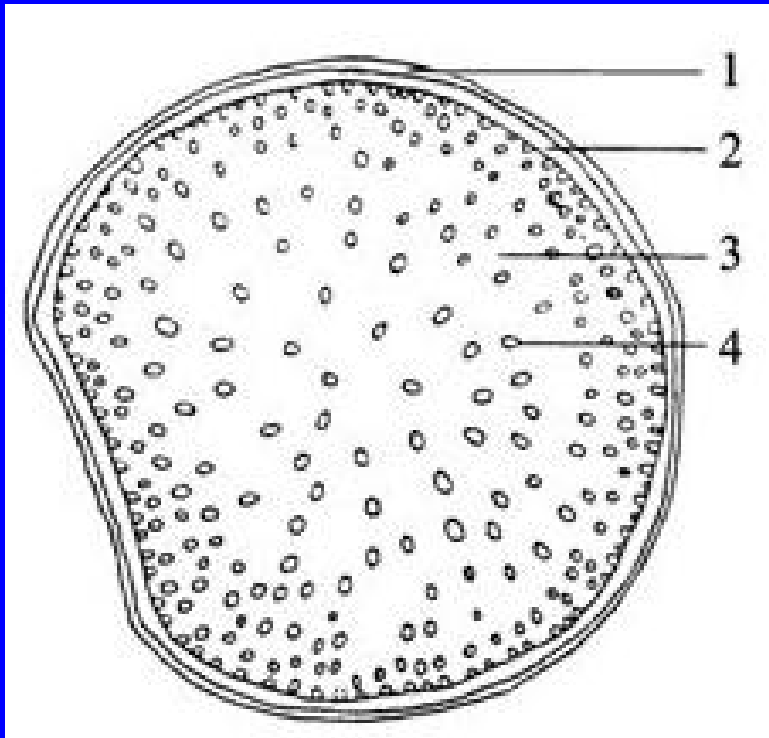
**Stem primary structure of corn.**



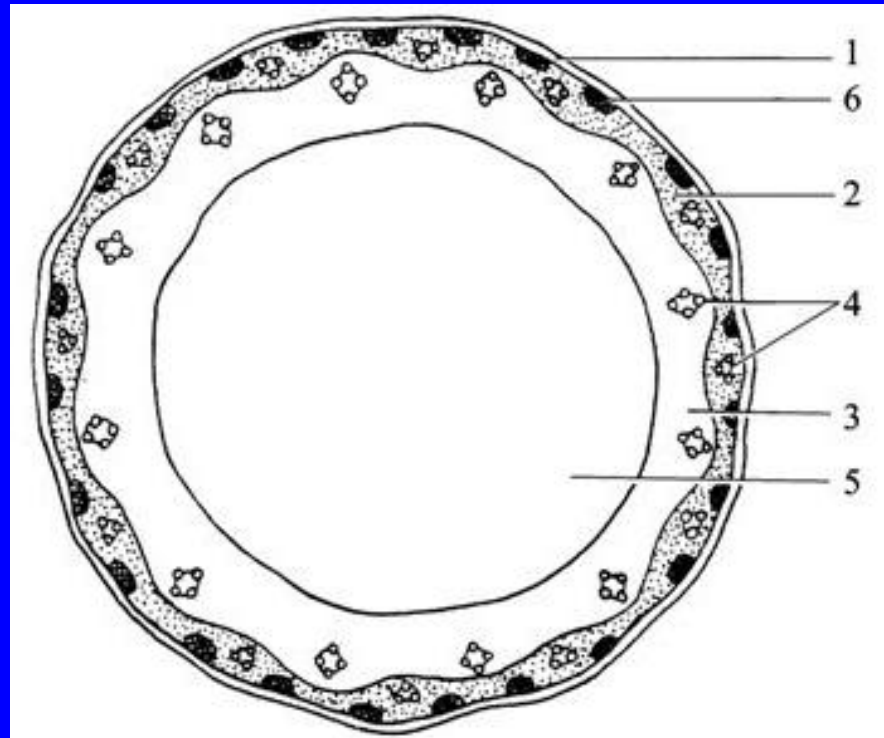
# Stem primary structure of corn.



# Chapter IV Vegetative Organs of Seed Plants – The Stem

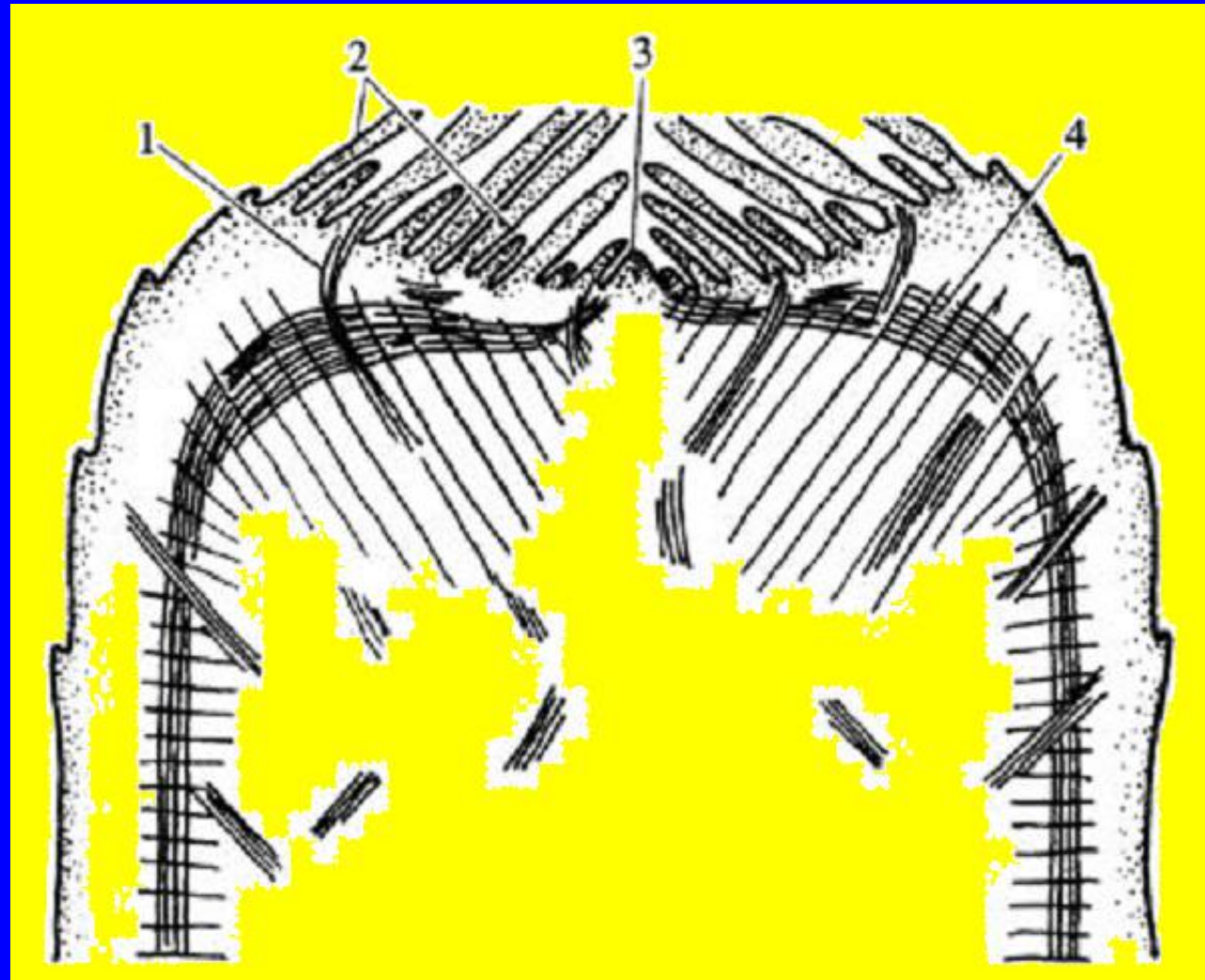


**Outline of corn internode**



**Outline of transverse section of wheat stalk**

The longitudinal section of corn stem apex shows primary thickened meristem



### (III) Features of the primary structure of gymnosperm stem

1. Cortex contains a secretory structure - resin canal;
2. Xylem consists of tracheids. Protoxylem consists of annular or single-spiral tracheids. Metaxylem consists of multi-spiral or scalariform tracheids;
3. Phloem consists of sieve cells;
4. There isn't herbaceous stem staying in the stage of primary structure.

## Assignments

- Compared with the primary structure of root, what characteristics does the primary structure of stem have?