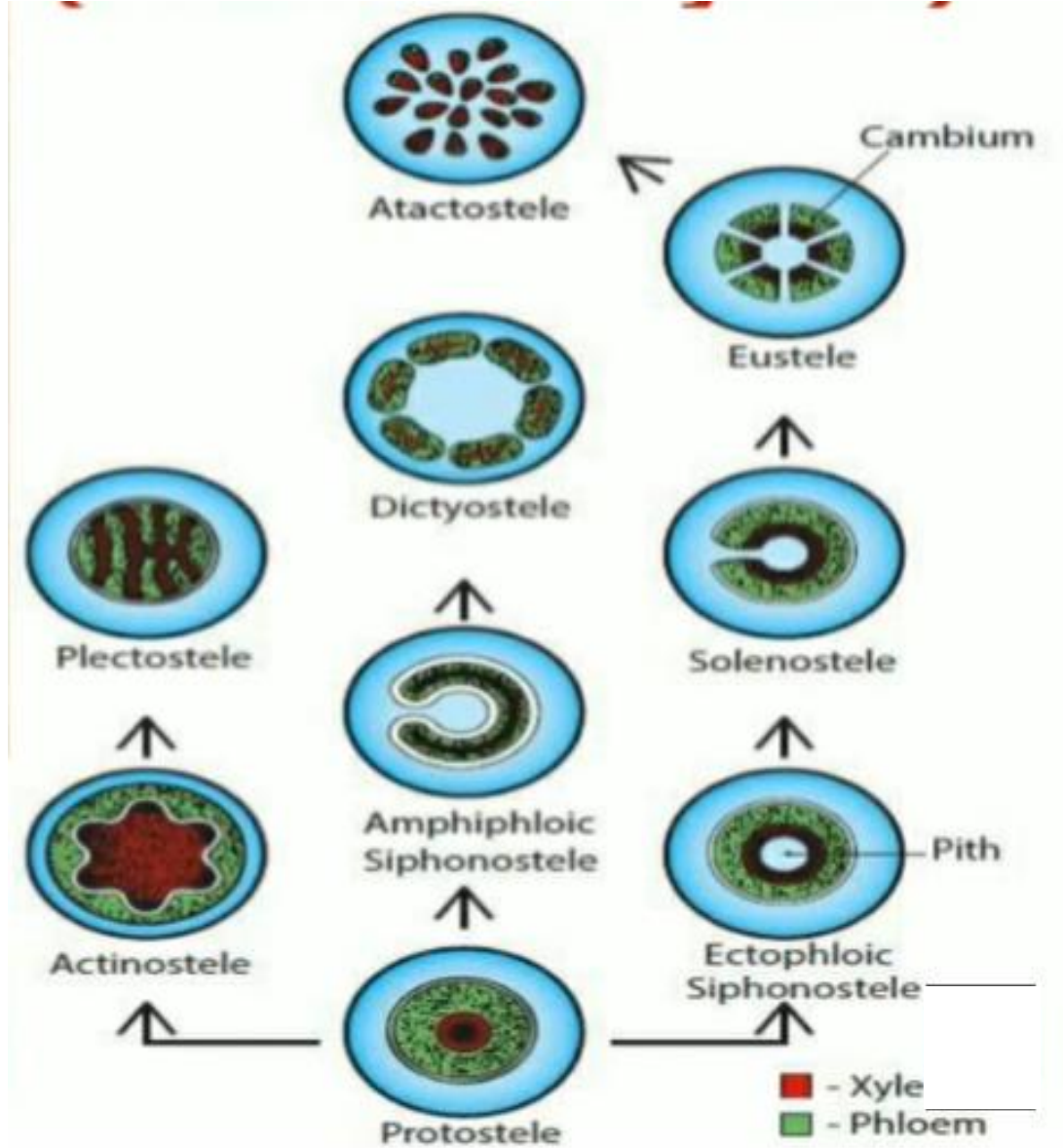


STELAR SYSTEM IN PTERIDOPHYTES



Learning objectives:

- What is 'stele'?
- Stellar Theory
- Components of Stele
- Different types of Steles in plants
 1. **Protostele:** definition, classification and examples
 2. **Siphonostele:** classification and examples
 3. **Solenostele:** classification and examples
- Stellar evolution in land plants (Pteridophytes)

What is Stele?

Vascular plants are those plants which contain vascular tissues like xylem and phloem. The vascular plants are represented by pteridophytes, gymnosperms and angiosperms.

Plant organs are composed of three tissue systems: dermal, vascular, and ground

Each organ of a plant has three tissue systems: the dermal, vascular, and ground tissue systems.

- Each system is continuous throughout the plant body.

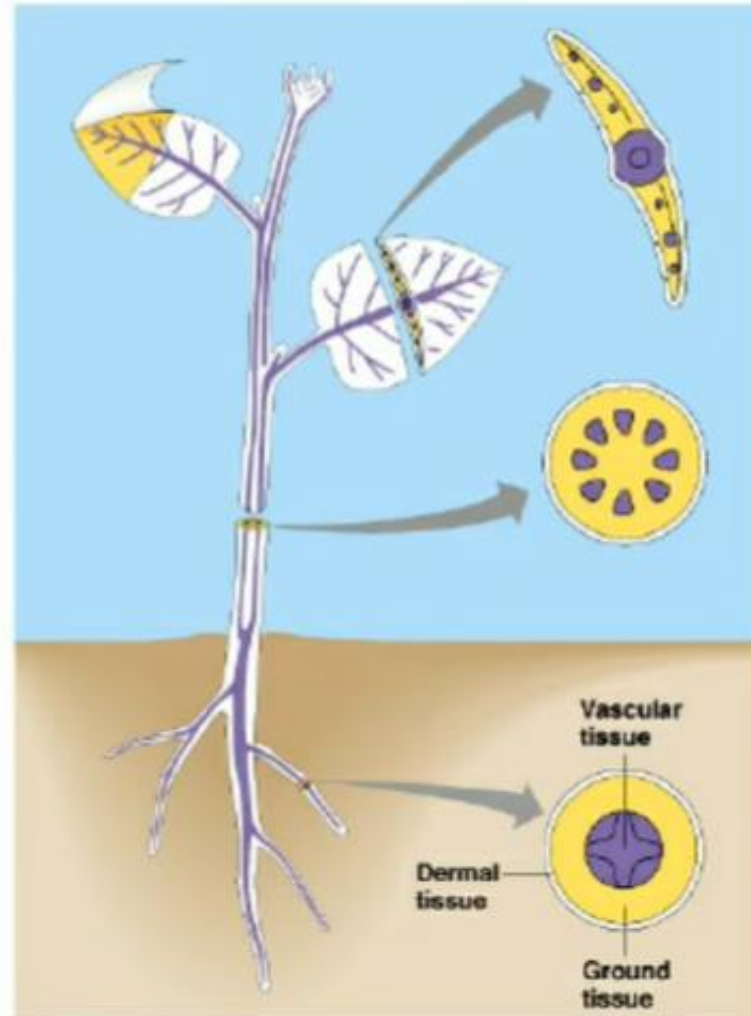
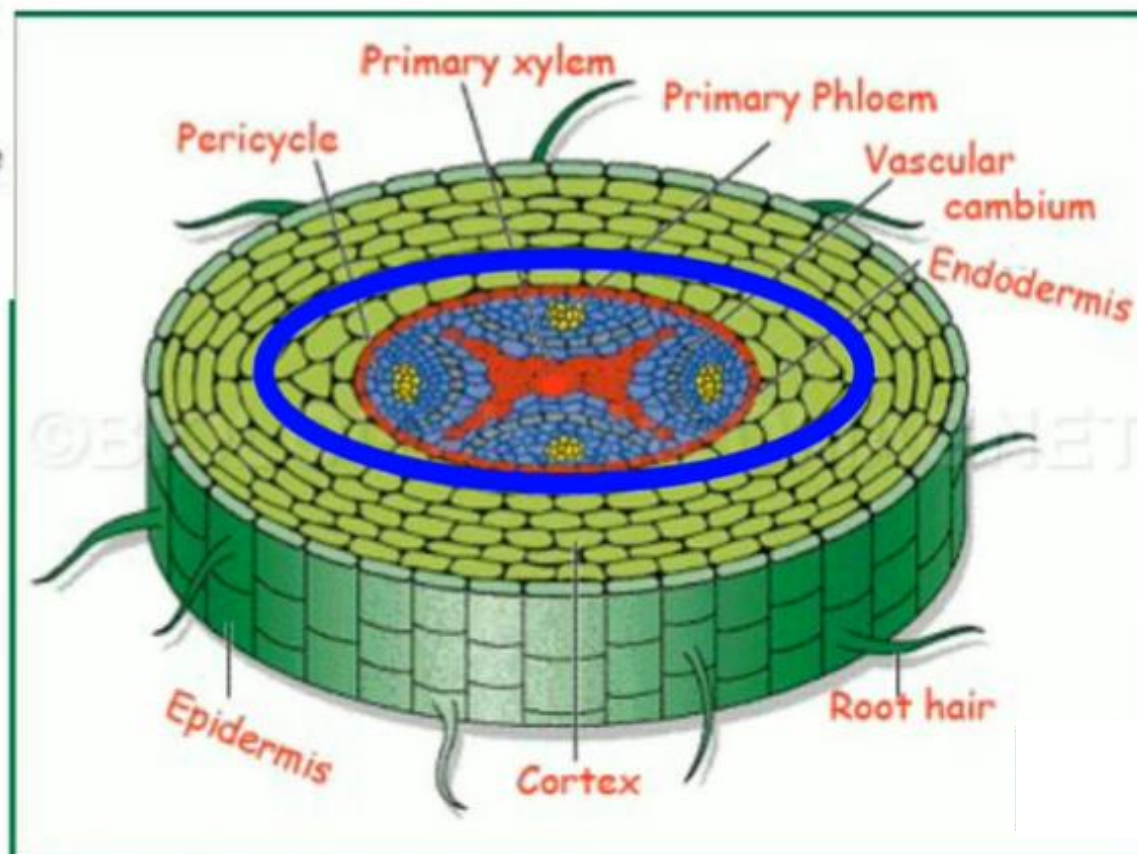
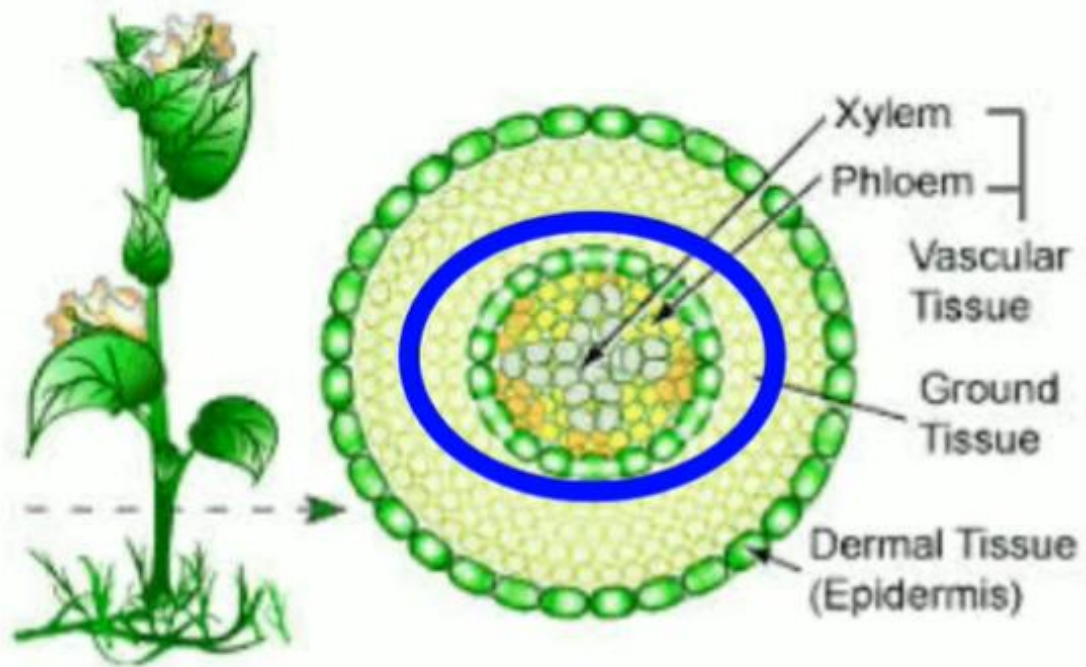


Fig. 35.7



What is stele? What are the components of stele?

■ *Stele is the central cylinder or core of vascular tissue in higher plants*

■ *Stele consists of:*

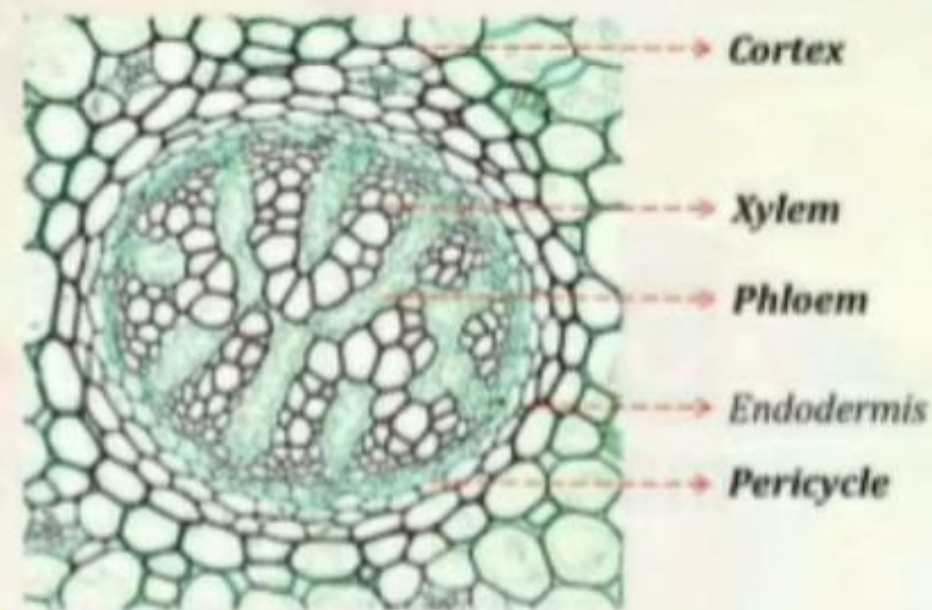
➤ **Xylem**

➤ **Phloem**

➤ **Pericycle**

➤ **Medullary (if present) (Pith)**

■ *Term 'stele' used by Van Tieghem and Douliot (1886) in 'Stelar Theory'*



A Pteridophyte Stele
Lycopodium

Definition: Stele

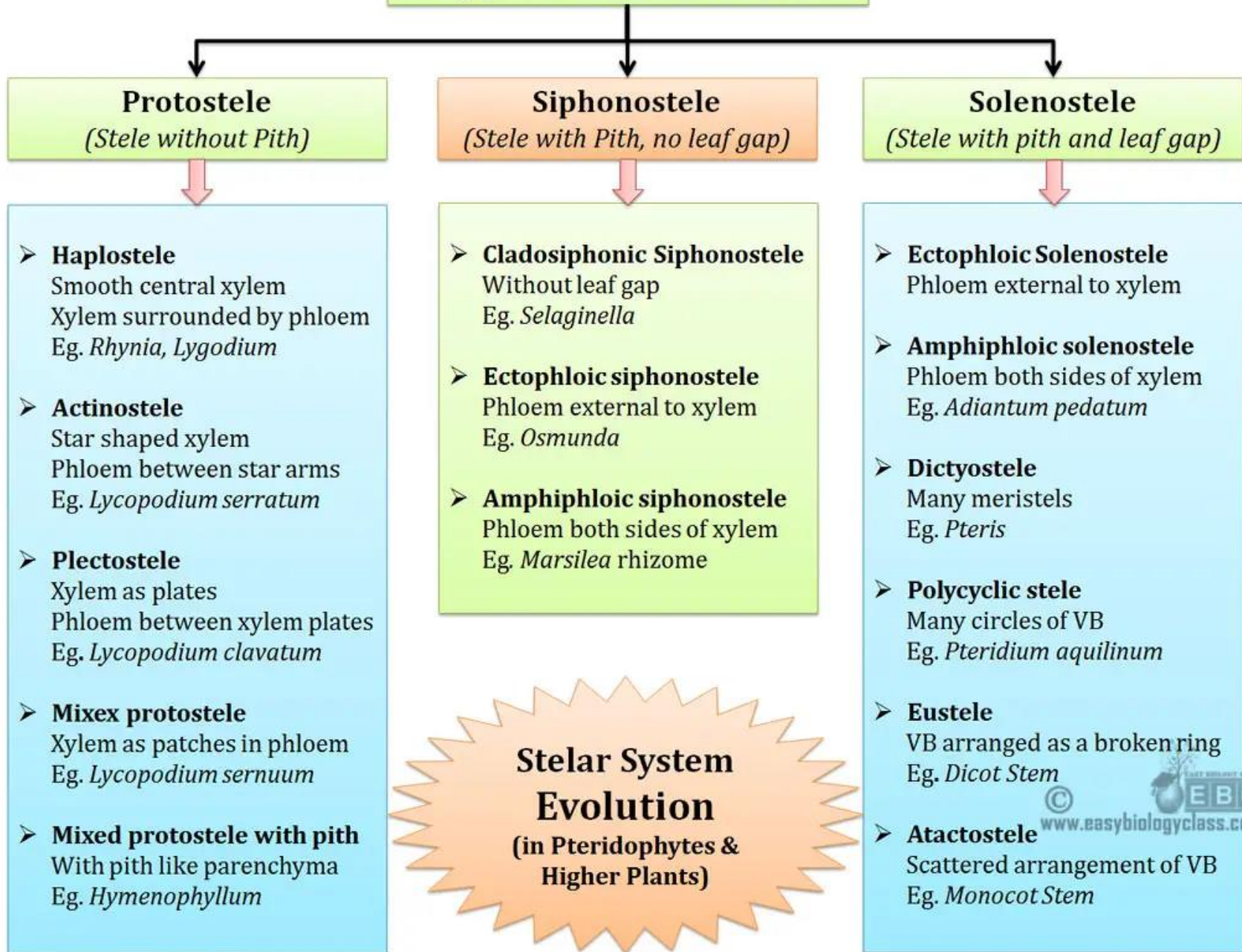


- The stele is defined as a central vascular cylinder, with or without pith and endodermis separating it from cortex.

What is 'stellar theory'?

- Proposed by **Van Tieghem** and **Douliot** (1886)
- Major highlights in stellar theory are:
 - *Stele is a real entity and present universally in all higher plants*
 - *Cortex & stele are two fundamental parts of a shoot system*
 - *Stele and cortex are separated by the endodermis*
 - *Main components of stele - xylem and phloem*
 - *Pericycle, medullary rays and pith are also the components of stele*

Types of Stele in Plants



(1). Protostele

i

- A stele with a **solid core of xylem at the centre** and it is surrounded by phloem, pericycle and endodermis
- **Pith** is absent
- The simplest stellar organization
- Considered as the most primitive stellar organization in plants
- Majority of Pteridophytes show protostelic condition in their rhizome, stem or roots

(1). Protosteles

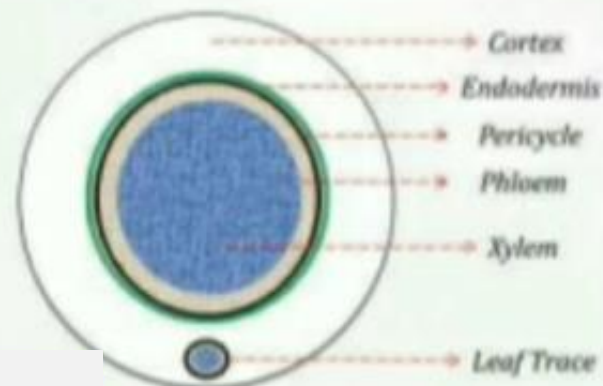
- **FIVE** types of protosteles in Pteridophytes:
 - a) **Haplostele**
 - b) **Actinosteles**
 - c) **Plectosteles**
 - d) **Mixed protosteles**
 - e) **Mixed protosteles with pith**

(a). Haplostele

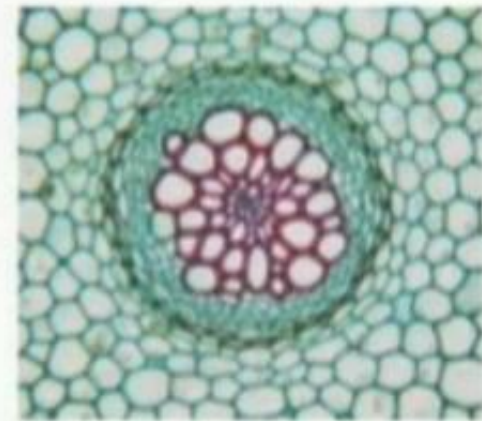
- A protosteles with a **smooth core of xylem** surrounded by uniform layers of phloem
- Named by Brebner in 1902
- Most primitive type of protosteles
- Usually present in fossil genera (*Rhynia* and *Horneophyton*)
- Example (living): *Selaginella*, *Gleichenia* and *Lygodium*



Selaginella



Haplostele



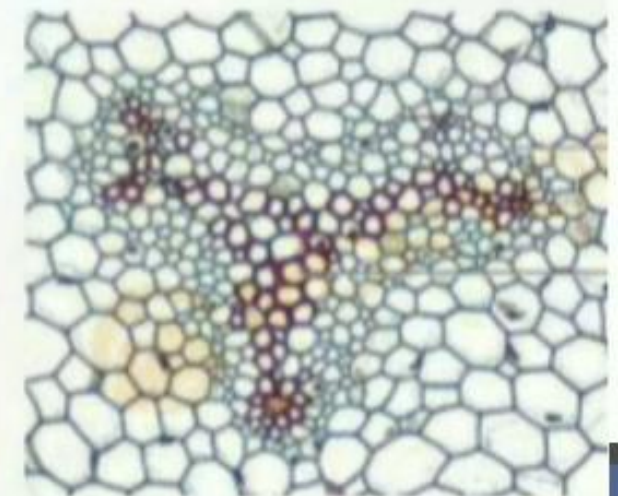
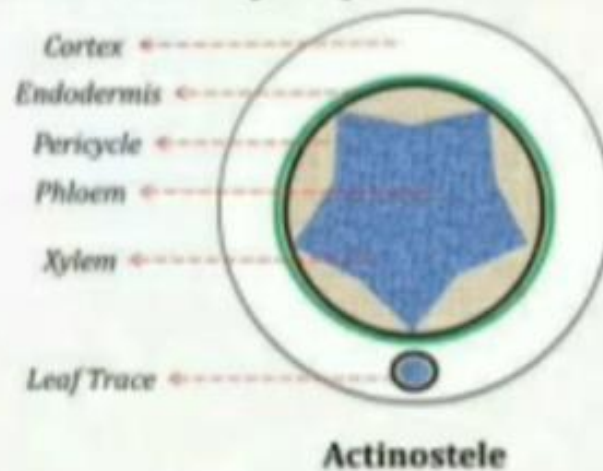
Selaginella Stem

(b). Actinostele

- Protostele with xylem core having radial ribs or arms
- **Xylem is star shaped** or stellate, hence the name
- Phloem is **NOT** present in a continuous manner
- Phloem occurs as separate patches between the arms of xylem
- Named by Brebner in 1902
- Example: *Asteroxylon*, *Psilotum*, *Lycopodium serratum*



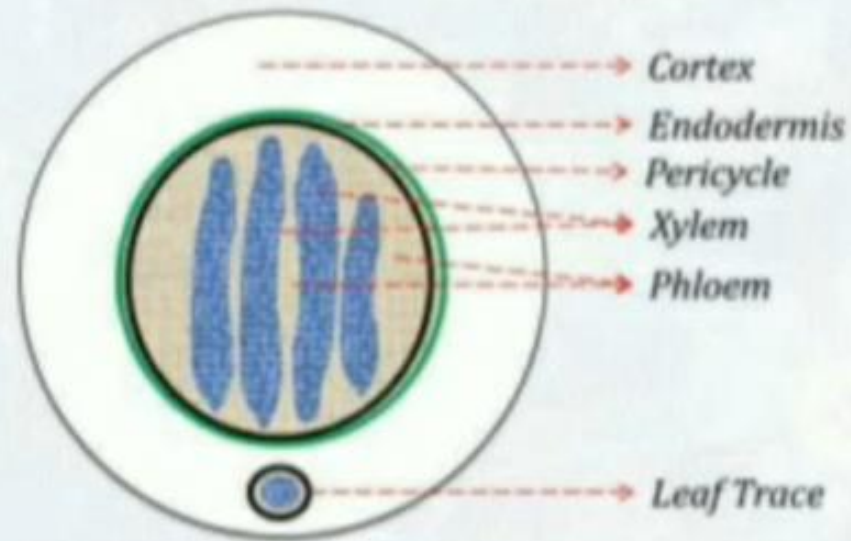
Psilotum



Psilotum Stem 11

(c). Plectostele

- Xylem occurs as **several plates** which are more or less parallel to each other
- Xylem plates are alternated with phloem patches
- Named by Zimmermann in 1930
- Example: *Lycopodium clavatum*



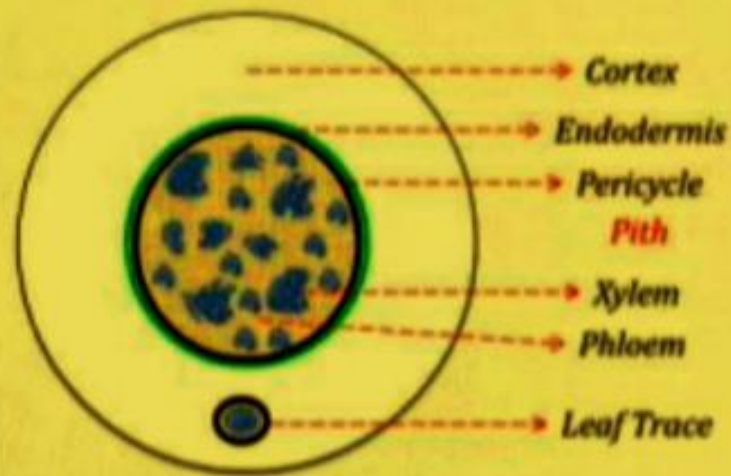
Plectostele



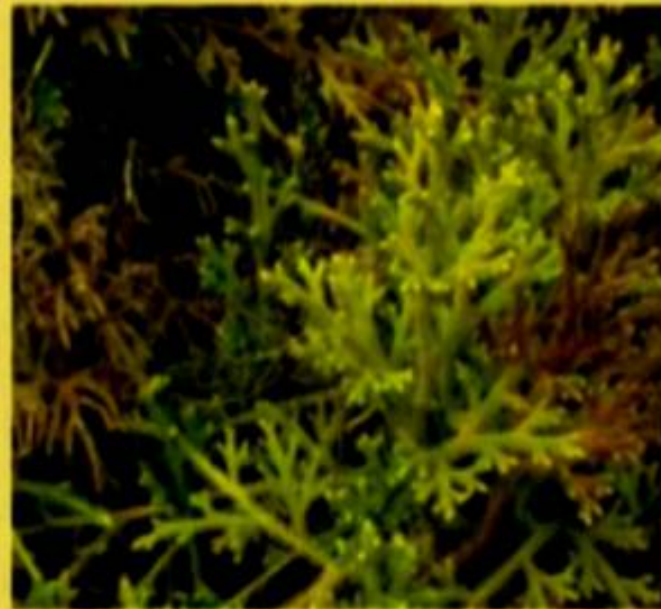
Plectostele
(*Lycopodium clavatum*)

(d). Mixed protosteles

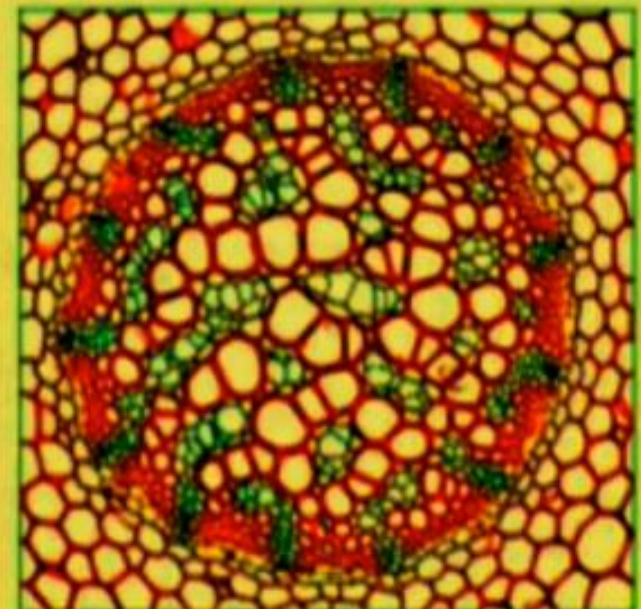
- Xylem is divided into **several units** or groups
- Each xylem units are scatteredly arranged inside the ground mass of phloem
- Example: *Lycopodium cernuum*



Mixed Protosteles



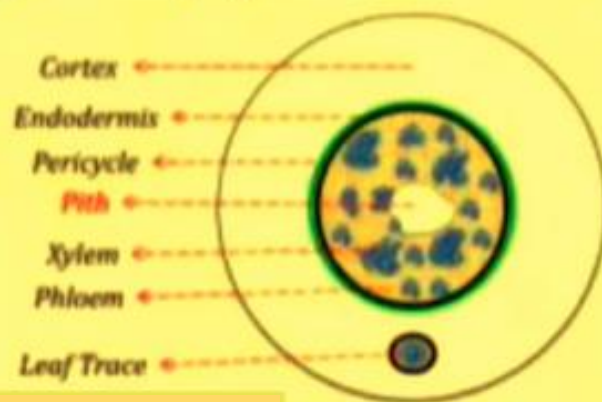
Lycopodium cernuum



Mixed Protosteles
(*Lycopodium cernuum*)

(d). Mixed protosteles with pith

- Advanced type among protosteles
- Formation of **pith** started here for the first time in evolution
- Stele is similar to mixed protosteles
- Patches of parenchymatous region occur in association with xylem
- Considered as a connecting link between protosteles and siphonosteles
- Example: *Hymenophyllum demissum*, *Lepidodendron selaginoides*



d Protosteles with Pith



(2). Siphonostele

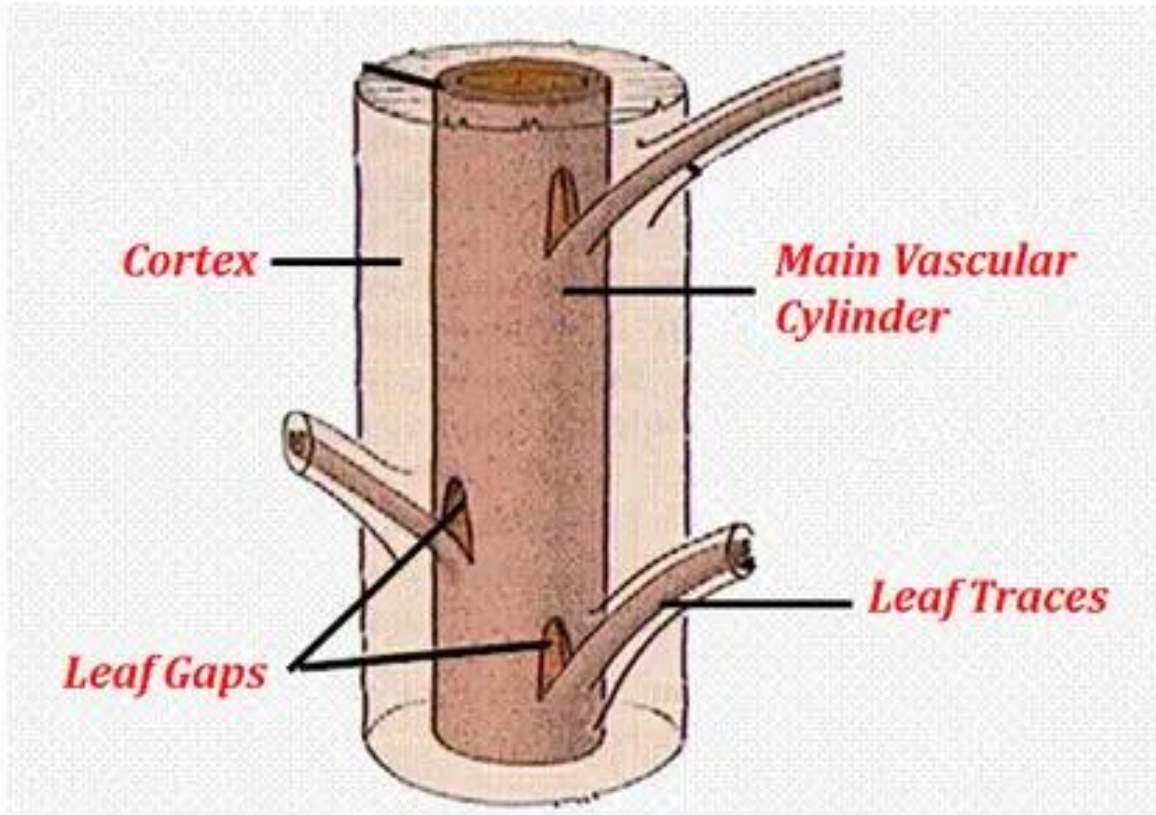
- A stele with **pith** (medulla) at the centre
- Central core of pith is surrounded by xylem
- Advanced type than protostele

Different types of siphonosteles

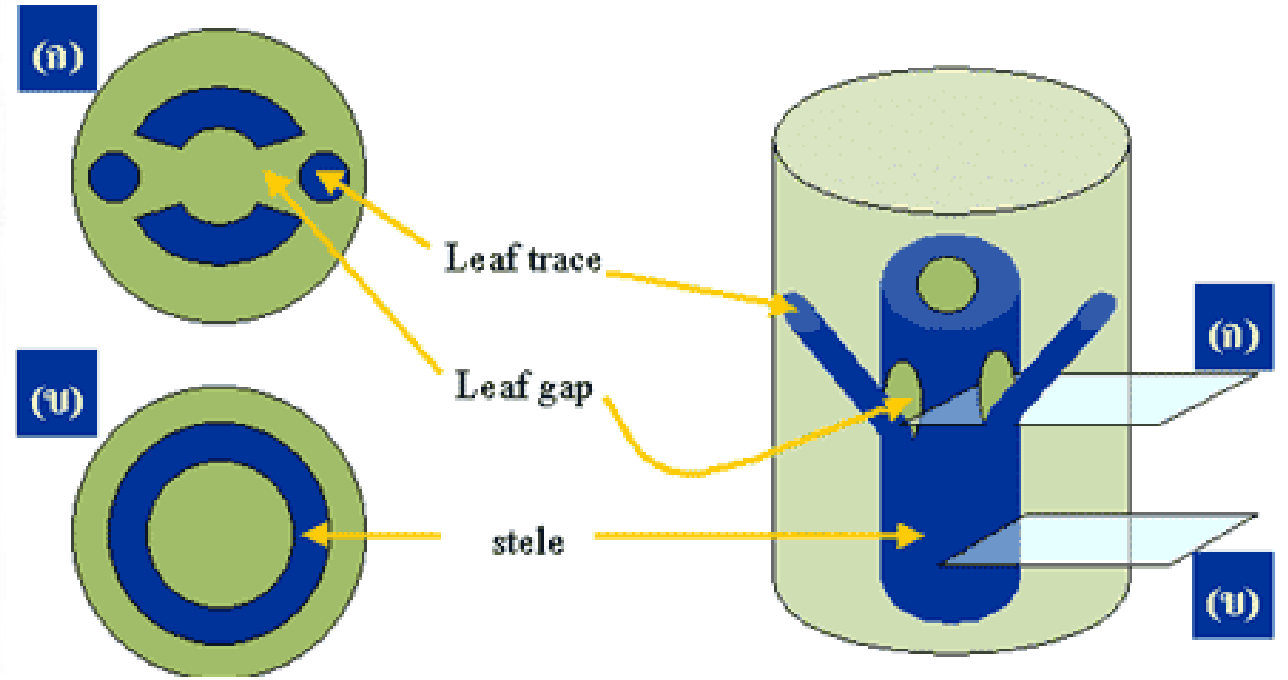
- TWO types of siphonostles based on the position and distribution of phloem
 1. *Ectophloic siphonostele*
 2. *Amphiphloic siphonostele*

The **siphonostele without leaf gap** is known as **cladosiphonic siphonostele** (Jeffery, 1910) e.g., *Selaginella*.

Phyllosiphonic siphonostele: A siphonostele with smaller or larger leaf gaps is called phyllosiphonic siphonostele e.g., *Filicophyta*.

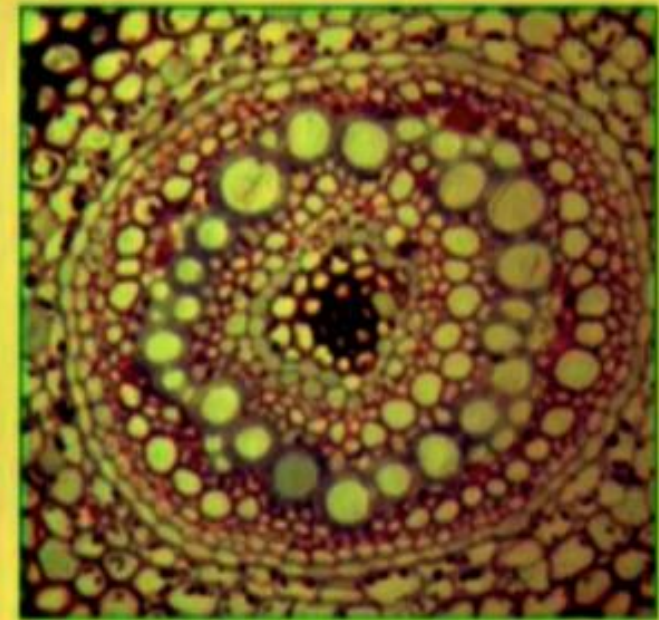


Leaf Gaps and Leaf Traces



(a). *Ectophloic siphonostele*

- Phloem present only on the **external** side of the xylem
- Pith is at the central position
- Phloem is externally surrounded by pericycle and endodermis
- Leaf traces present, but leaf gap absent
- Example: *Osmunda*, *Schizaea*

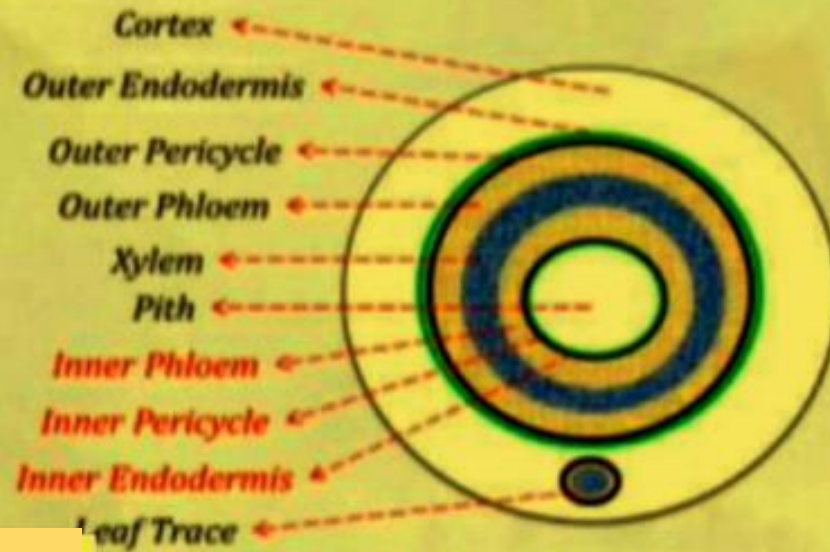


Ectophloic Siphonostele
(*Osmunda*)

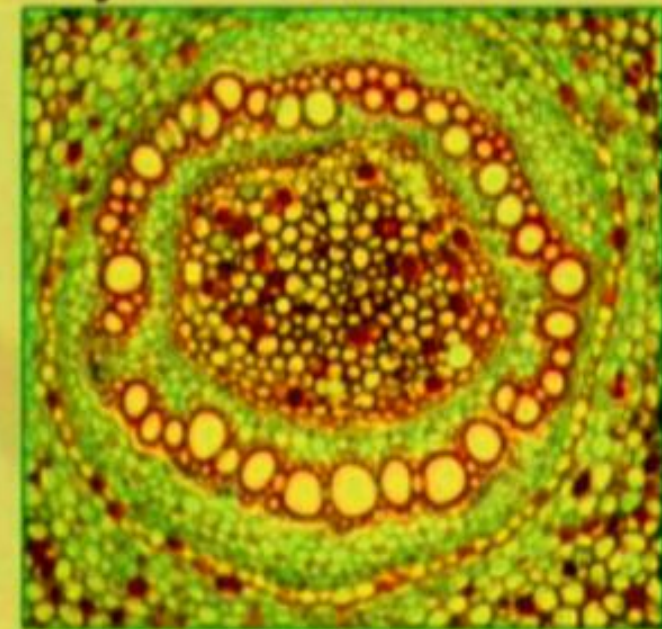
hloic Siphonostele

(b). Amphiphloic siphonostele

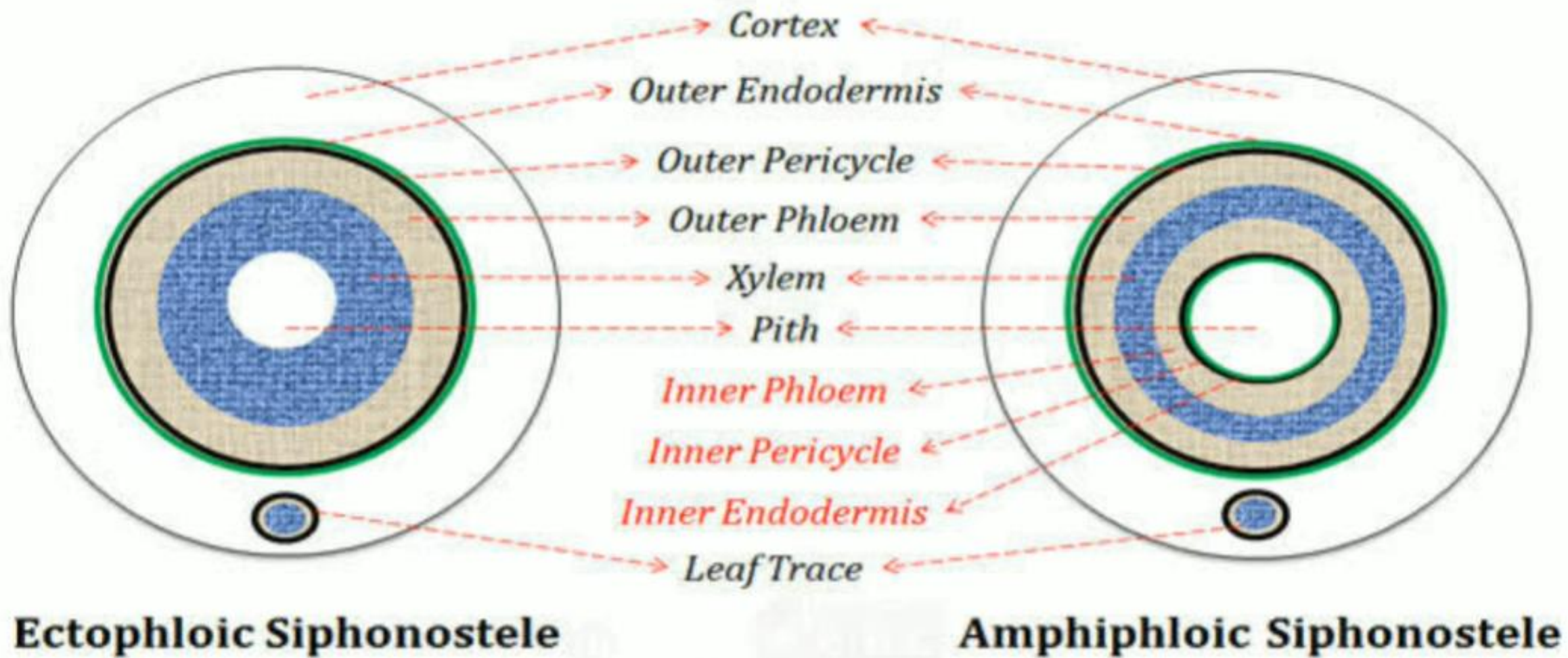
- Phloem is present on **both sides** of the xylem
- Central portion of the stele is occupied by pith
- Xylem on inner side: surrounded by inner phloem, pericycle & endodermis
- Xylem on outer side: surrounded by outer phloem, pericycle & endodermis
- Example: *Marsilea*, *Adiantum*



Amphiphloic Siphonostele



Amphiphloic Siphonostele
(*Marsilea Rhizome*)



(3). Solenostele

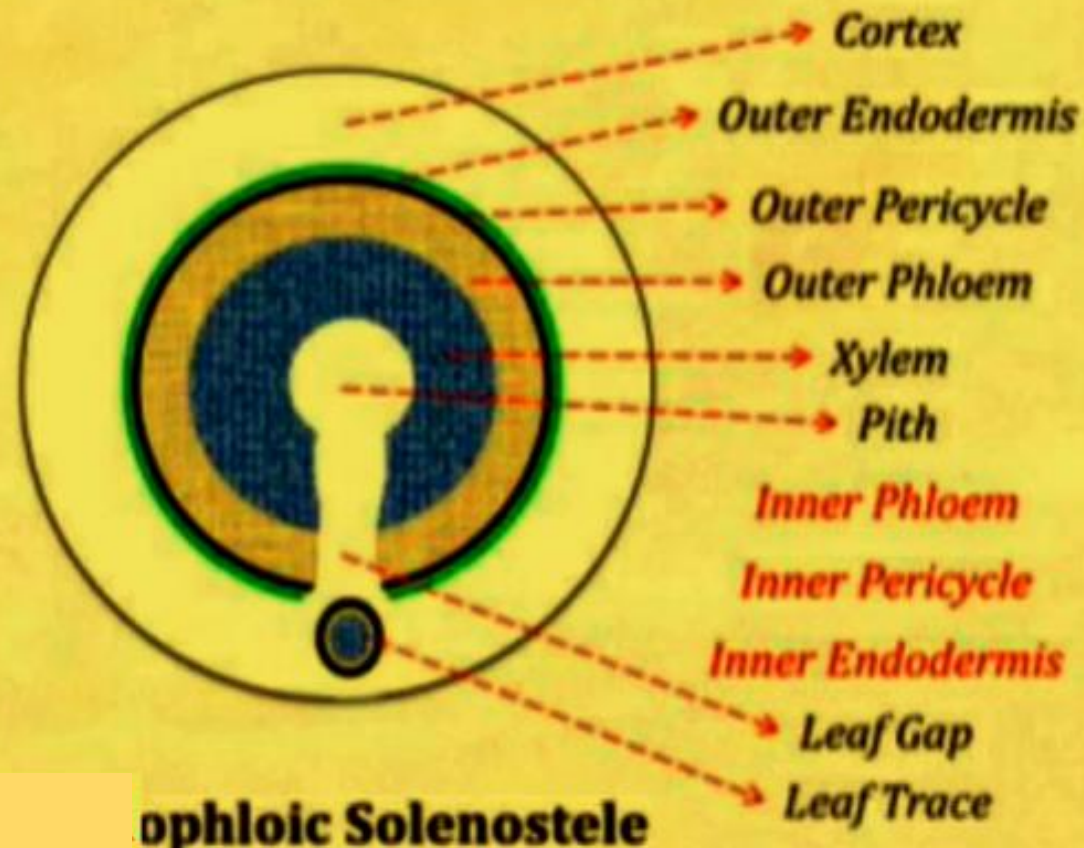
- Solenostele is actually a sub category of siphonostele
- Siphonostele which is **perforated at the place of origin** of leaf trace is called solenostele
- In simple, asiphonostele with **leaf gap** is called solenostele

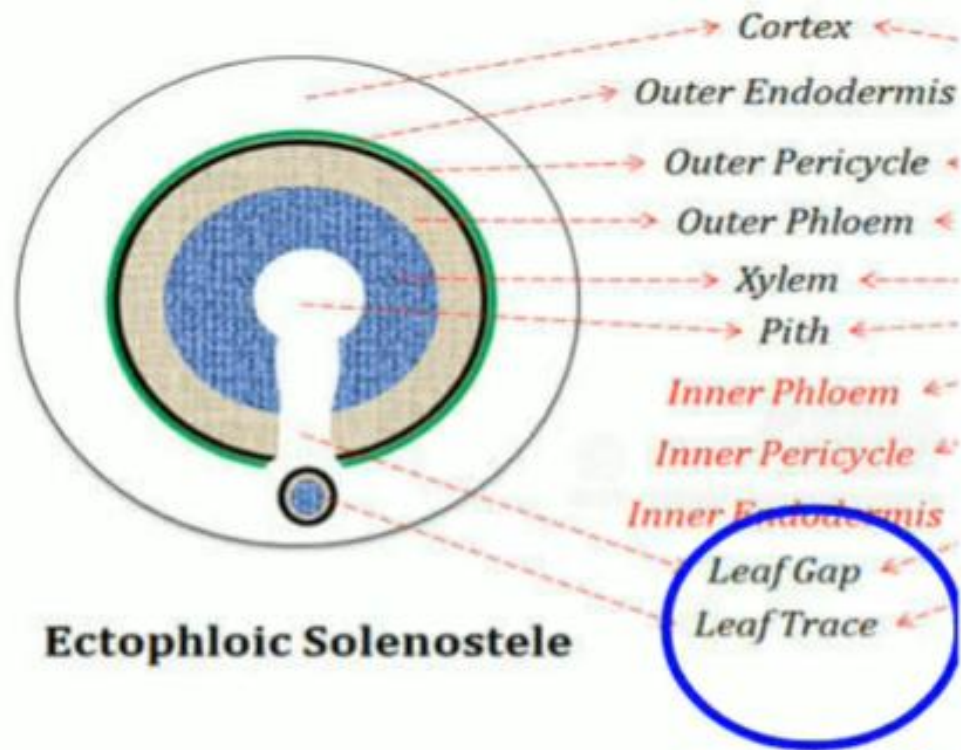
Different types of Solenostele

- Six different types of solenosteles (among plant kingdom)
 - a) ***Ectophloic solenostele***
 - b) ***Amphiphloic solenostele***
 - c) ***Dictyostele***
 - d) ***Eustele***
 - e) ***Atactostele***

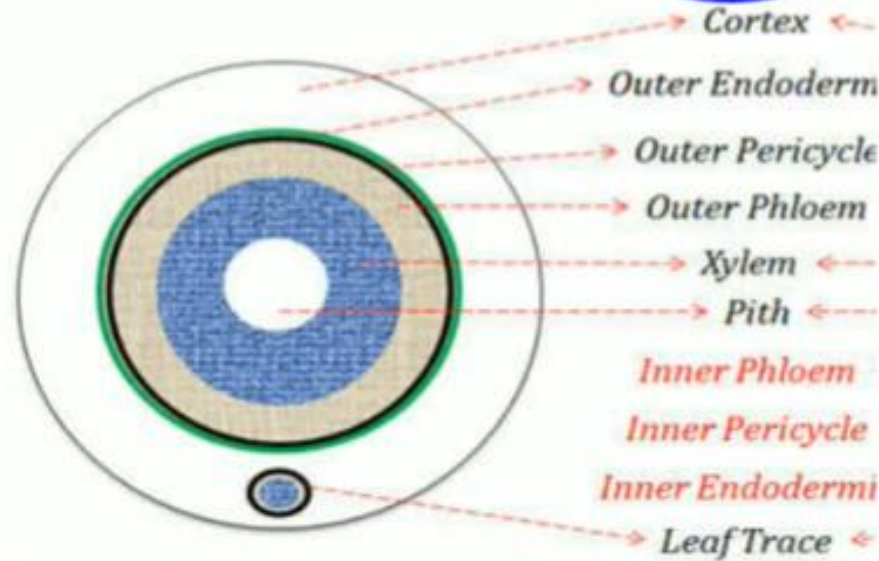
(a). Ectophloic solenostele

- Derived from ectophloic siphonostele
- Thus phloem is present only on the outer side of the xylem





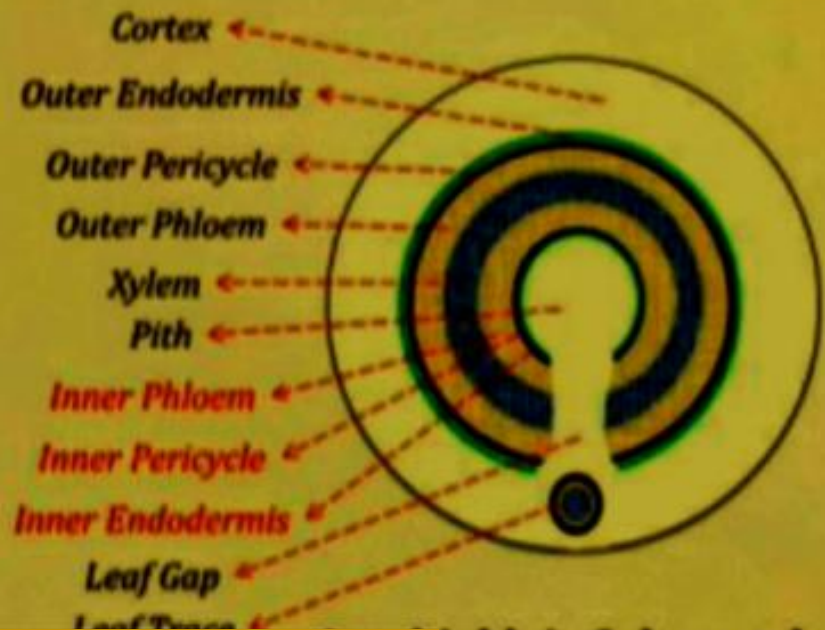
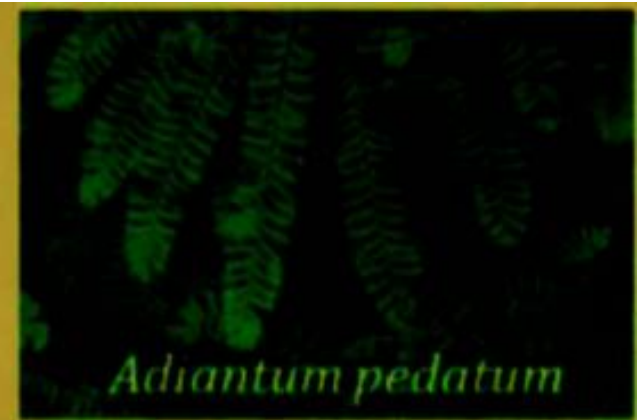
Ectophloic Solenostele



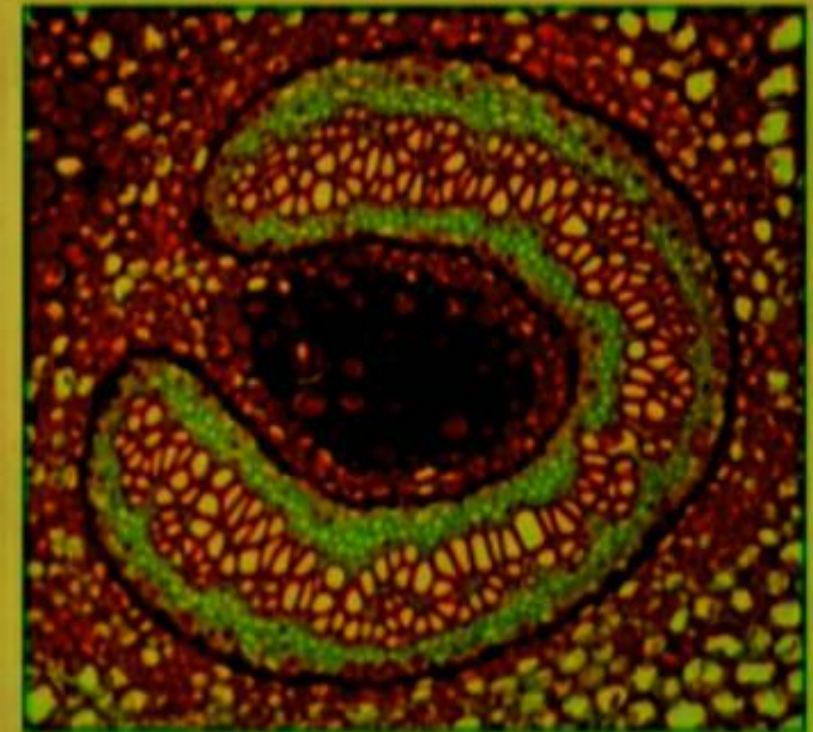
Ectophloic Sinuostele

(b). Amphiphloic solenostele

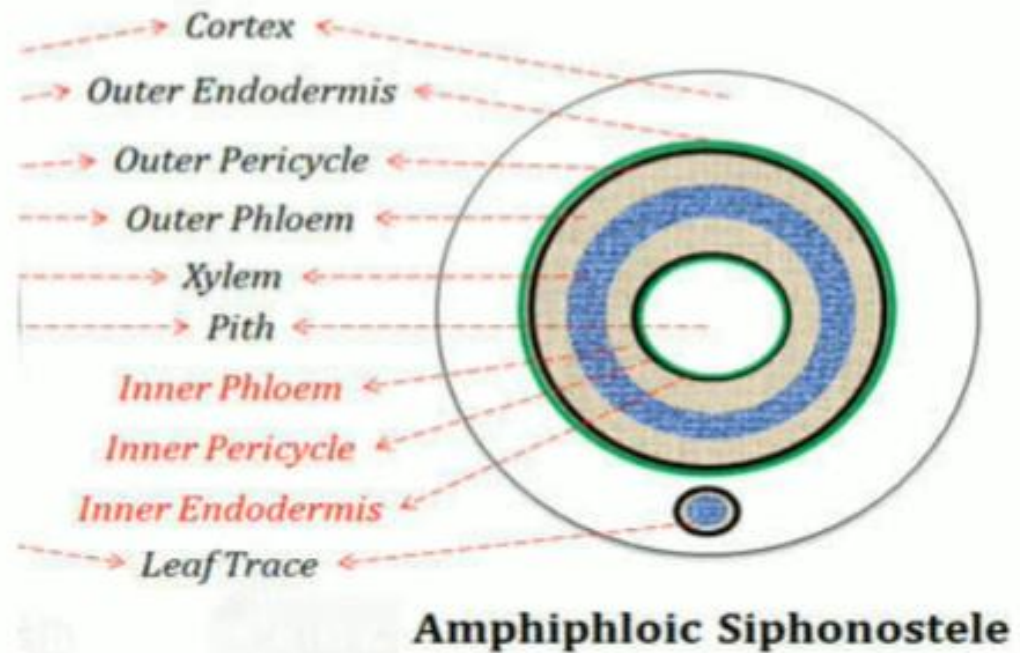
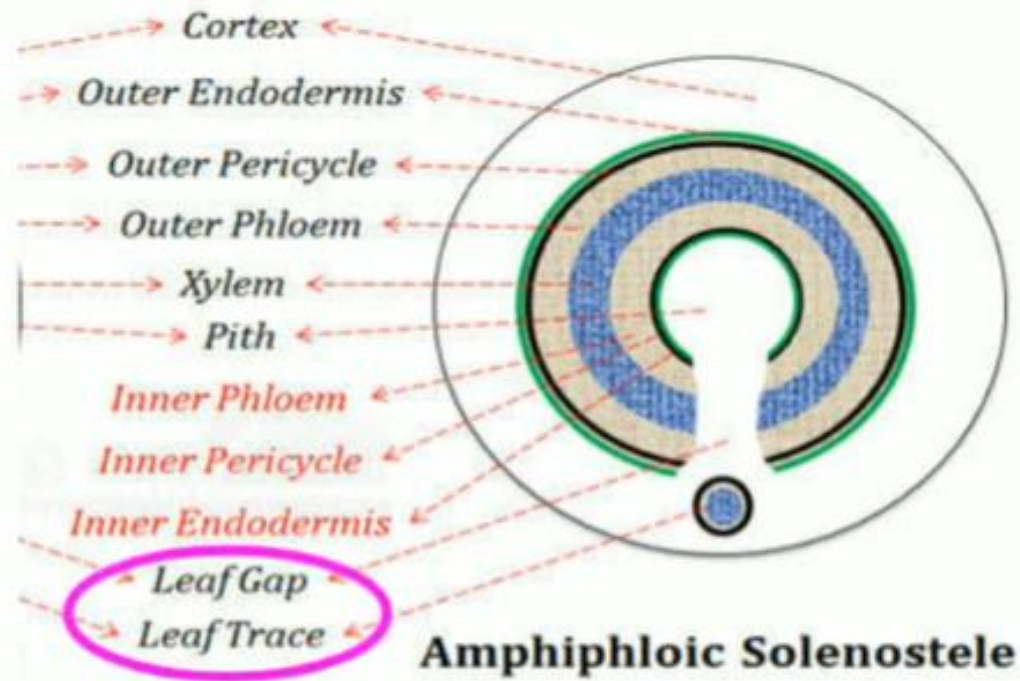
- Derived from amphiphloic siphonostele
- Phloem is present on both sides of the xylem
- Phloem in both sides is intern surrounded by pericycle and endodermis
- Example: *Adiantum pedatum*



Amphiphloic Solenostele

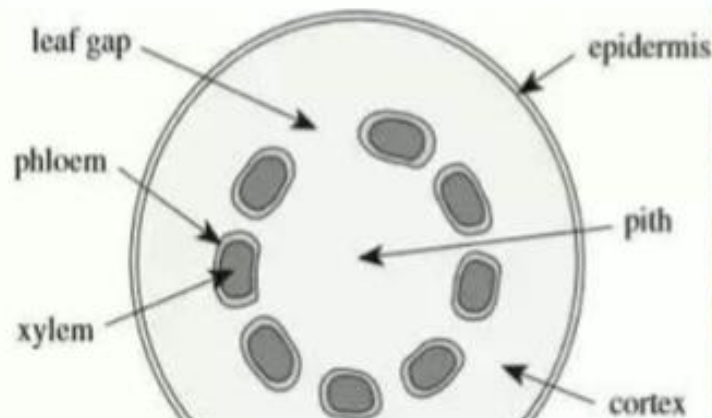


Amphiphloic Solenostele
(*Adiantum pedatum*)



(c). *Dictyostele*

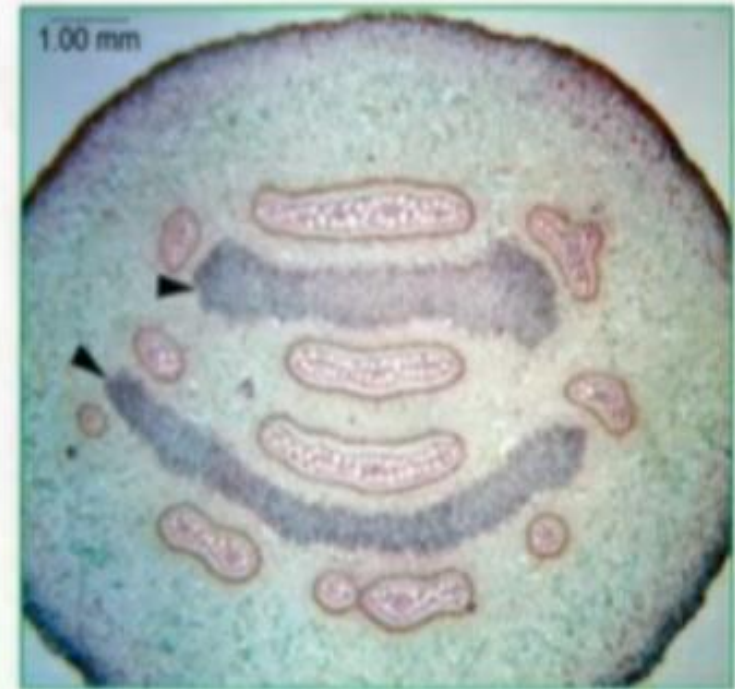
- Solenostele that is broken into a network of separate vascular strands
- This is due to the presence of large number of leaf gaps
- Each such separate vascular strand is called **meristele**
- Example: *Pteris*, *Adiantum capillus-veneris*



Dictyostele



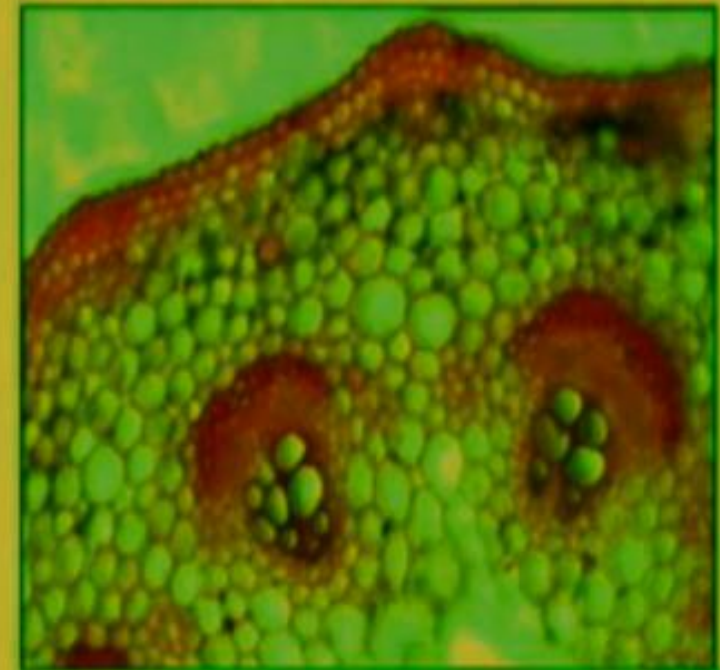
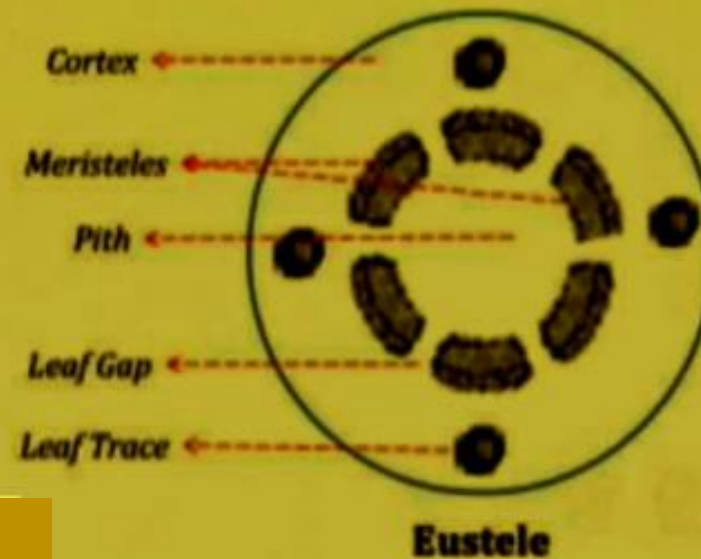
Pteris



Dictyostele
(*Pteris*)

(d). Eustele (stele in higher plants)

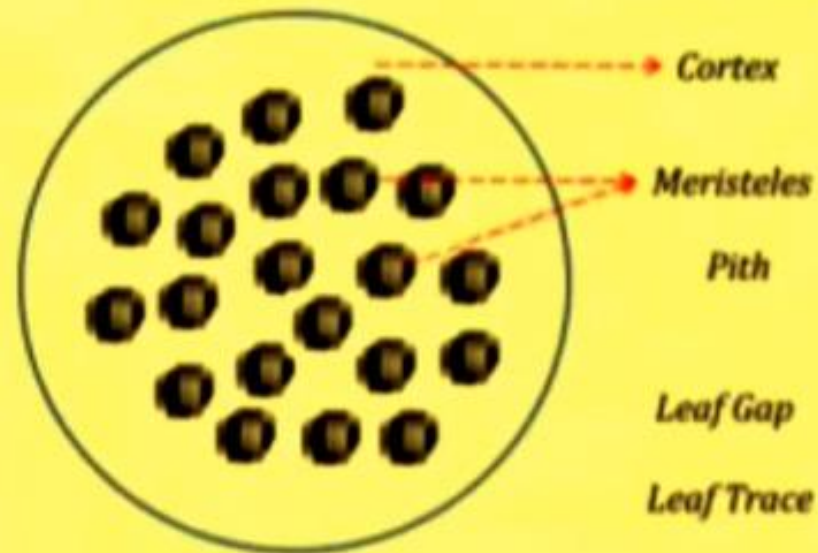
- If stele is split into distinct collateral VB, then it is called eustele
- It is a modified ectophloic siphonostele
- Splitting takes place due to the overlapping of large number of leaf gaps
- Individual VB in the eustele are arranged as broken ring in the ground tissue
- Example: dicot stem primary structure



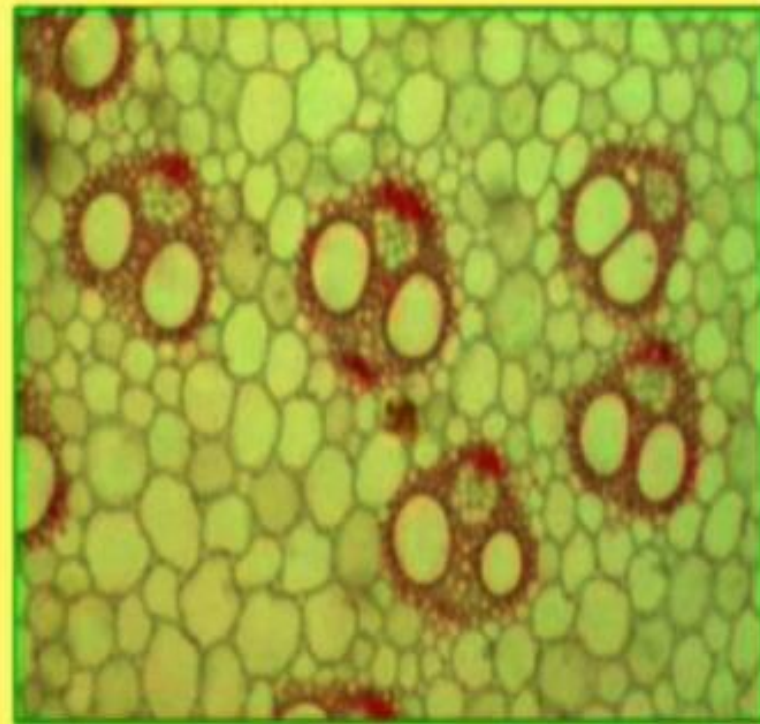
Eustele (Dicot Stem)

(e). Atactostele (stele in higher plants)

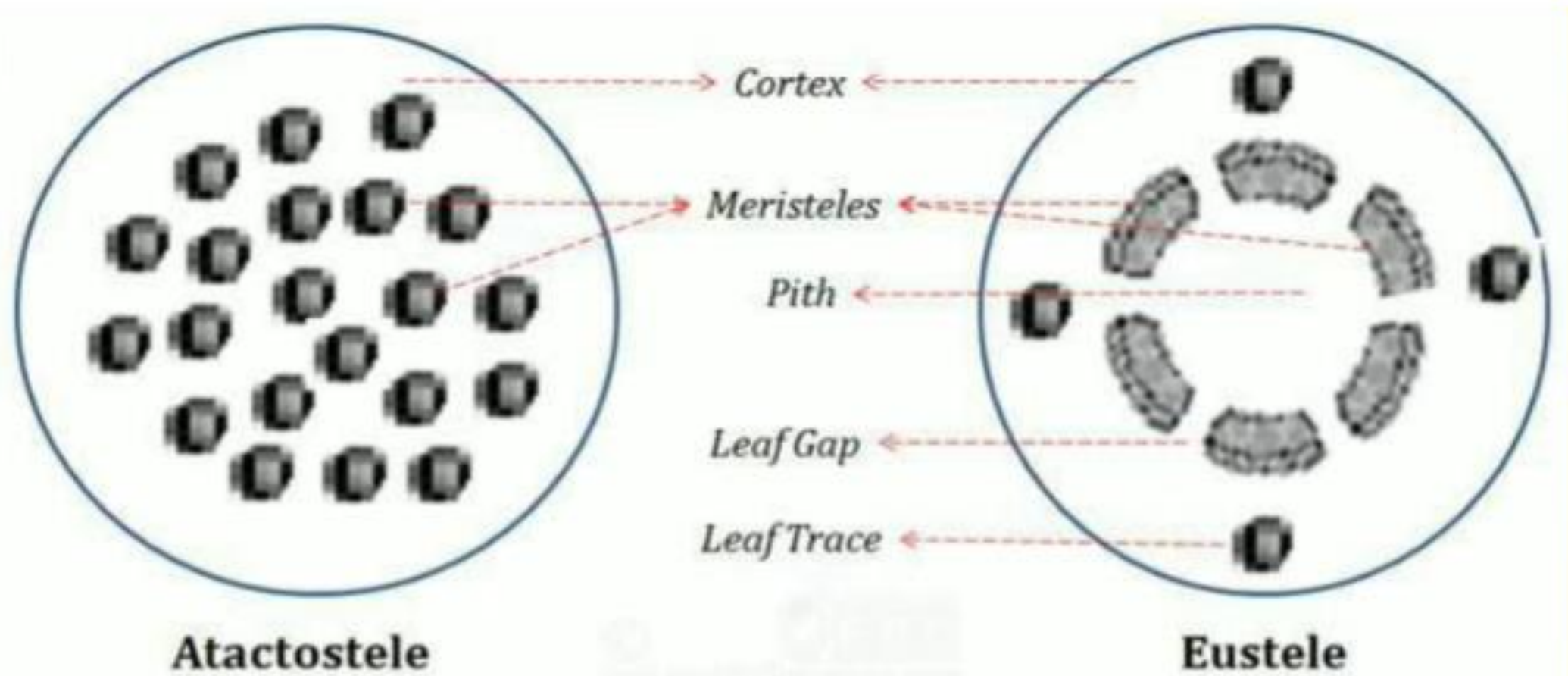
- Similar to eustele
- But the individual vascular bundles are scatteredly distributed in the ground tissue
- Example: monocot stem



Atactostele



Atactostele (Monocot Stem)



(d). Poly-cyclic stele

- Ø Here the stele is present as two or more concentric cylinders.
- Ø Poly-cyclic stele will be always solenostelic in nature.
- Ø Poly-cyclic stele may be polycyclic solenostele or polycyclic dictyostele

Key Questions:

1. What is stelar theory?
2. Define stele
3. Who proposed the stelar theory?
4. What are the main points in stelar theory?
5. Name the three major categories of steles in vascular plants.
6. What is meant by protosteles?
7. Describe different types of protosteles with examples.
8. Differentiate actinostele and haplostele.
9. What is meant by siphonostele?
10. Describe different types of siphonosteles with examples.
11. Define meristele.
12. What is actactostele and Eustele
13. Write an essay on stelar evolution in Pteridophytes with examples.

THANK YOU