

Stelar System of Plant: Definition and Types

Definition of Stelar System:

According to the older botanists, the vascular bundle is the fundamental unit in the vascular system of pteridophytes and higher plants. Van Tieghem and Douliot (1886) interpreted the plant body of vascular plant in the different way.

According to them, the fundamental parts of a shoot are the cortex and a central cylinder, is known as stele. Thus the stele is defined as a central vascular cylinder, with or without pith and delimited the cortex by endodermis.

The term stele has been derived from a Greek word meaning pillar. Van Tieghem and Douliot (1886) recognized only three types of steles. They also thought that the monostelic shoot were rare in comparison of polystelic shoots.

It is an established fact that all shoots are monostelic and polystelic condition rarely occurs. The stele of the stem remains connected with that of leaf by a vascular connection known as the leaf supply.

Types of Steles:

1. Protostele:

Jeffrey (1898), for the first time pointed out the stelar theory from the point of view of the phylogeny. According to him, the primitive type of stele is protostele. In protostele, the vascular tissue is a solid mass and the central core of the xylem is completely surrounded by the strand of phloem. This is the most primitive and simplest type of stele.

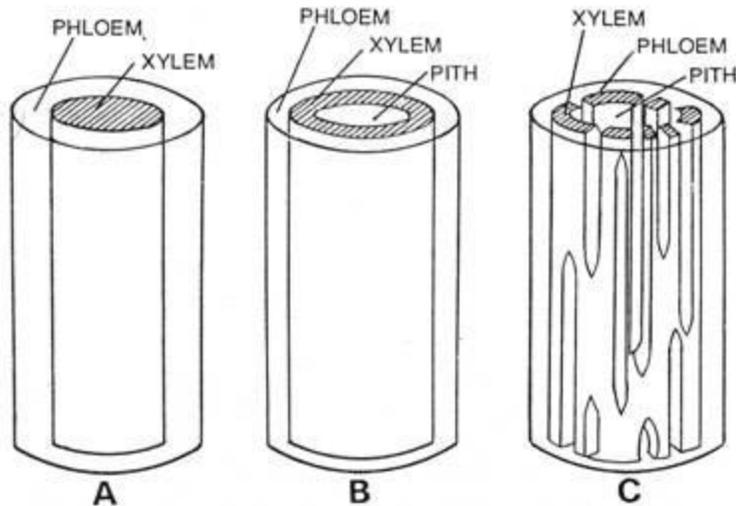


Fig. 37.42. Types of arrangements of vascular tissues in steles. A, protostele; B, siphonostele; C, dictyostele.

There are several forms of protostele:

(a) Haplostele:

This is the most primitive type of protostele. Here the central solid smooth core of xylem remains surrounded by phloem (e.g., in Selaginella spp.).

(b) Actinostele:

This is the modification of the haplostele and somewhat more advanced in having the central xylem core with radiating ribs (e.g., in Psilotum spp.).

(c) Plectostele:

This is the most advanced type of protostele. Here the central core of xylem is divided into number of plates arranged parallel to each other. The phloem alternates the xylem (e.g., in Lycopodium).

(d) Mixed-pith stele:

Here the xylem elements (i.e., tracheids) are mixed with the parenchymatous cells of the pith. This type is found in primitive fossils and living ferns. They are treated to be the transitional types in between true protosteles on the one hand and siphonosteles on the other (e.g., in Gleichenia spp. and Osmunda spp.).

2. Siphonostele:

This is the modification of protostele. A stele in which the protostele is medullated is known as siphonostele. Such stele contains a tubular vascular region and a parenchymatous central region. Jeffrey (1898) interpreted that the vascular portion of siphonostele possesses a parenchymatous area known as a gap immediately above the branch traces only or immediately above leaf and branch traces.

On the basis of these branch and leaf gaps Jeffrey (1910), distinguished two types of siphonosteles. In one type, however, the leaf gaps are not found and they are known as cladospiphonic siphonosteles. In the other type both leaf and branch gaps are present and they are known as phyllosiphonic siphonosteles.

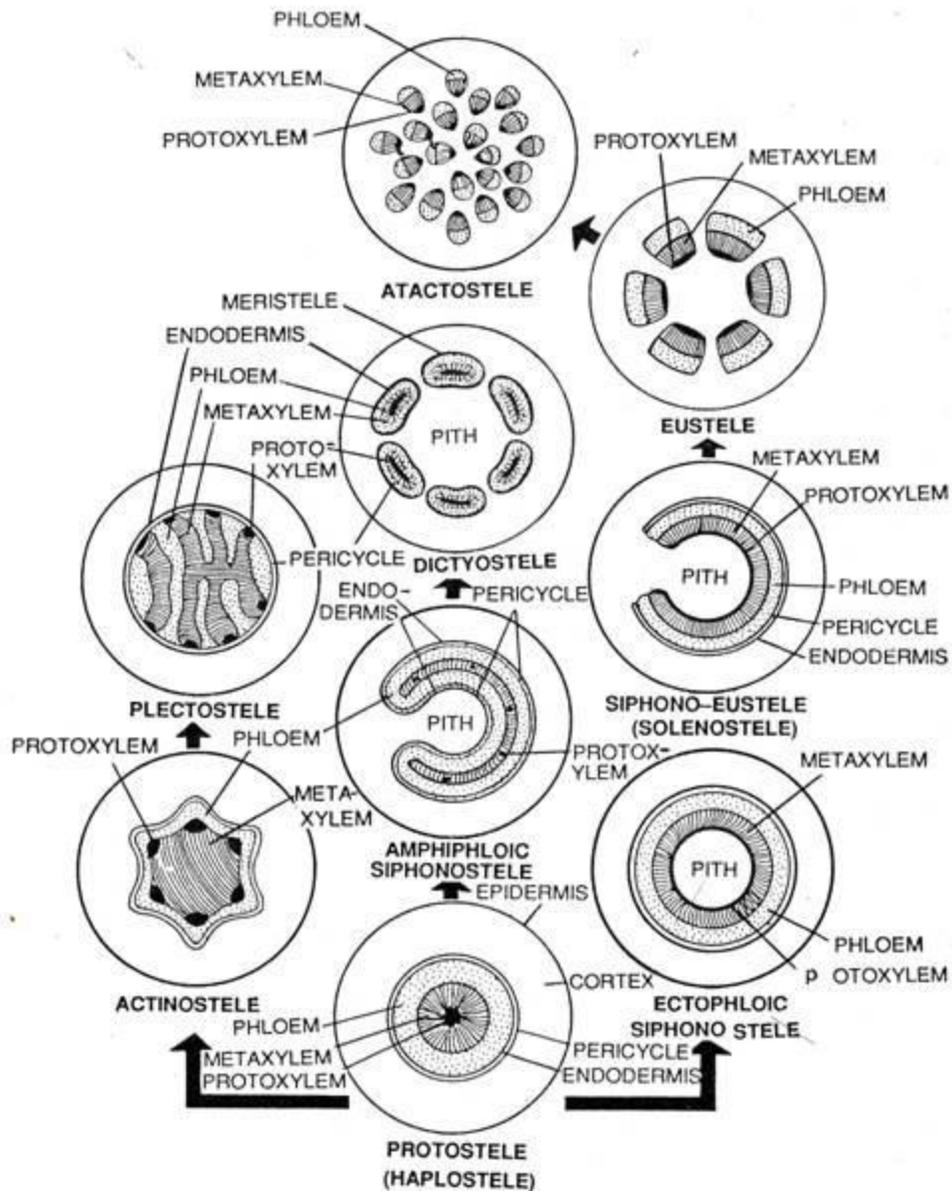


Fig. 37.43. The stele system. Different types of steles arranged in evolutionary sequence.

Jeffrey (1902, 1910, and 1917) interpreted the evolution of the siphonostele from the protostele as follows. He supported that the parenchyma found internal to the phloem and xylem has been originated from the cortex.

The supporters of this theory believe that the inner endodermis found to the inner face of the vascular tissue and the parenchyma encircled by this endodermis have been originated from the cortex. According to Jeffrey and other supporters of this theory the siphonosteles with

internal endodermis are more primitive than those without an internal endodermis.

The siphonosteles which do not possess the inner endodermis are believed to have been originated by disintegration of inner endodermis during evolution.

According to the theory proposed by Boodle (1901), and Gwynne Vaughan, the siphonostele has been evolved from the protostele by a transformation of the inner vascular tissue into parenchyma.

A siphonostele may be of the following types:

(a) Ectophloic:

In this type of siphonostele, the pith is surrounded by concentric xylem cylinder and next to xylem the concentric phloem cylinder.

(b) Amphiphloic:

In this type of siphonostele the pith is surrounded by the vascular tissue. The concentric inner phloem cylinder surrounds the central pith. Next to the inner phloem is the concentric xylem cylinder which is immediately surrounded by outer phloem cylinder (e.g., in Marsilea).

3. Solenostele:

The vascular plants have been divided into two groups on the basis of the presence or absence of the leaf gaps. These groups are— Pteropsida and Lycopsidea. The ferns, gymnosperms and angiosperms are included in Pteropsida, whereas the lycopods, horse-tails, etc., are included in Lycopsidea.

The simplest form of siphonostele has no gaps, such as some species of Selaginella. However, among the simplest siphonostelic Pteropsida and siphonostelic Lycopsidea, the successive leaf gaps in the stele do not overlap each other and are considerably apart from each other.

According to Brebner (1902), Gwynne-Vaughan (1901) such siphonosteles which lack overlapping of gaps are known as

solenosteles. They may be ectophloic or amphiphloic. Some authors (Bower, 1947; Wardlaw, 1952; Esau, 1953) however, interpret the solenostele as an amphiphloic siphonostele.

4. Dictyostele:

In the more advanced siphonosteles of Pteropsida, the successive gaps may overlap each other. Brebner (1902) called the siphonosteles with overlapping gaps as dictyosteles. In such cases the intervening portion of the vascular tissue between lateral to such leaf gaps is known as meristele. Each meristele is of protostelic type. The dictyostele with many meristeles looks like a cylindrical meshwork.

5. Polycyclic Stele:

This type of stelar organization is the most complex one amongst all vascular cryptogams (pteridophytes). Such type of steles are siphonostelic in structure. Each such stele possesses an internal vascular system connected with an outer siphonostele. Such connections are always found at the node.

A typical polycyclic stele possesses two or more concentric rings of vascular tissue. This may be a solenostele or a dictyostele. Two concentric rings of vascular tissue are found in *Pteridium aquilinum* and three in *Matonia pectinata*.

6. Eustele:

According to Brebner (1902), there is one more modification of the siphonostele known as eustele. Here the vascular system consists of a ring of collateral or bicollateral vascular bundles situated on the periphery of the pith. In such steles, the inter-fascicular areas and the leaf gaps are not distinguished from each other very clearly. The example of this type is *Equisetum*.

Origin of siphonostele

There are different views among the scientists regarding the origin of siphonostele. But they all agreed that, the siphonostele is originated from

protostele by formation of pith in the center. Here, the centrally placed xylem core is replaced with parenchymatous pith.

Different stages of changing protostele to siphonostele can be observed in the T.S at different levels in *Gleichenia*, *Osmunda* and *Anemia*.

There are two views regarding the origin of pith in the siphonostele.

According to this theory, the pith is formed as a result of the invasion of cortical parenchymatous cells into the stele. The invasion of pith occurs through the leaf gap or branch gap.

Thus pith and cortex are homogeneous structures according to this theory.

This theory is not accepted by most of the authors since in many pteridophytes there is stele without leaf gaps but having siphonostele.

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