QUICK REVISION NOTES
For NEET
BIOLOGY CLASS 11

Meristematic Tissue Definition

"Meristematic tissue is the plant tissue that has the ability to divide actively throughout its life."

What is Meristematic Tissue?

Carl Wilhelm von Nägeli coined the term "meristem." Meristematic tissue contains undifferentiated cells, which are the building blocks of the specialized plant structures.

Meristematic tissues contain living cells with varied shapes. They possess a large nucleus devoid of the vacuole. The cells have no intercellular space. The zone where these cells exist is known as meristem.

The cells of the meristematic tissue divide actively to form specialized structures such as buds of leaves and flowers, tips of roots and shoots, etc. These cells help to increase the length and girth of the plant.

Let us have a detailed look at the characteristics and types of meristematic tissue.

Characteristics of Meristematic Tissue

The characteristics of meristematic tissue are as follows:

1. The cells of these tissues are commonly called meristems.
2. The meristematic tissue has the quality of self-renewal. Every time the cell divides, one cell remains identical to the parent cell, and the others form specialized structures.
3. They have very small and few vacuoles.
4. The meristematic tissue is living and thin-walled.
5. The protoplasm of the cells is very dense.
6. The meristematic tissues heal the wounds of an injured plant.
7. The cells of the meristematic tissue are young and immature.
8. They do not store food.
9. They exhibit a very high metabolic activity.
10. They possess a single, large and prominent nucleus.

Types of Meristematic Tissue

The meristematic tissue is of the following types:

Meristematic Tissue On the basis of Origin

Promeristem

- The earliest and youngest meristematic tissue.
- It originates from the embryo.

- The primary meristem arises from the promeristem.
- It is found in the root and the shoot tips.

Primary Meristem

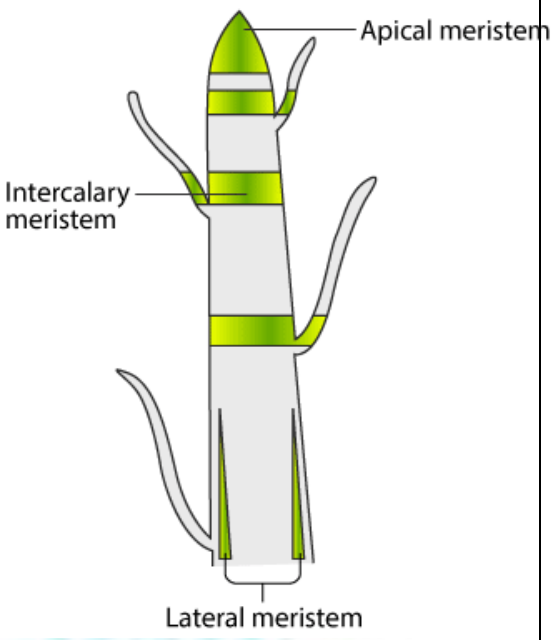
- It arises from the promeristem.
- Cells divide actively.
- It is present below the promeristem and forms the permanent tissue.

Secondary Meristem

- It originates from the primary meristem.
- The permanent tissue forms from the secondary meristem.

Meristematic Tissue On the Basis of Position

Meristematic Tissue – Based on Occurrence



Apical Meristem

- These are present at the tips of the roots and shoots and helps in the increase of the height of the plants.
- Various cell divisions facilitate the growth of the cells in the roots and shoots and help in cellular enlargement.
- Apical meristem is divided into-promeristem zone, which contains actively dividing cells, and the meristematic zone, which contains protoderm, procambium and ground meristem.

Intercalary Meristem

- It is located in the leaves and internodes at the intercalary position.
- These help to increase the length of the internode.
- It is found in grass, monocots and pines.
- It is a part of apical meristem and adds to the height of the plant.

Lateral Meristem

- It is located in the stems and roots on the lateral side.
- It increases the thickness of the plant.
- Vascular cambium and cork cambium are the two lateral meristems.
- These divide preclinically or radially and give rise to secondary permanent tissues.

Meristematic Tissue On the Basis of Function

Protoderm

- It is the outermost plant tissue and forms the epidermis.
- It protects the plants from any mechanical shocks.

Procambium

- It is the innermost tissue and gives rise to xylem and phloem.
- It helps in the transport of water and nutrients to different parts of the plant.

Ground Meristem

- The cells are large with thick walls.
- It forms the cortex, pericycle and pith.

The meristematic tissue is usually found in the apices of the root systems and the shoots and is in a continuous state of division.

BOTANY: STELE TYPES

In a vascular plant, the stele is the central part of the root or stem containing the tissues derived from the procambium. These include vascular tissue, in some cases ground tissue (pith) and a pericycle, which, if present, defines the outermost boundary of the stele. In other words, vascular bundle or the stele consists of three tissues: the pericycle, the xylem, and the phloem.

Outside the stele lies the endodermis, which is the innermost cell layer of the cortex.

Below you will find a useful outline if various stele types.

Lecture 11 — Botany 313Stele types – The arrangement of xylem and phloem instems, rooots, and axes
1.

Recap of Lecture 102.

Definition of steles3.

How to tell stem steles from root steles (positions of protoxylem and phloem)4.

Protosteles
(haplostele, actinostele, plectostele, medullated protostele)5.

Siphonosteles
(solenostele, dictyostele; ectophloic and amphiphloic)6.
Eusteles
(eustele, atactostele)

QUICK REVISION NOTES
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Lecture 10

1.Finish pine life cycle as typical gymnosperm2.Compare seed plants to non-seed plants3.Angiosperm reproductive characters4.Angiosperm life cycle

Stele
1.

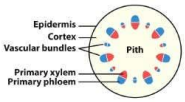
Tissues inside the endodermis(of roots and some stems)1.

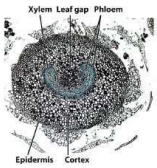
Recognized by the configuration of vascular tissuesin transverse section (=cross section)2.

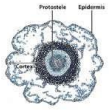
Recognized by the configuration of the xylem intransverse section3.

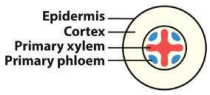
Stele terms are used for stems and roots todescribe the vascular system4.

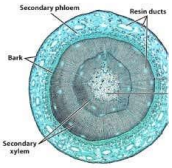
There are three basic stele types in vascular plants





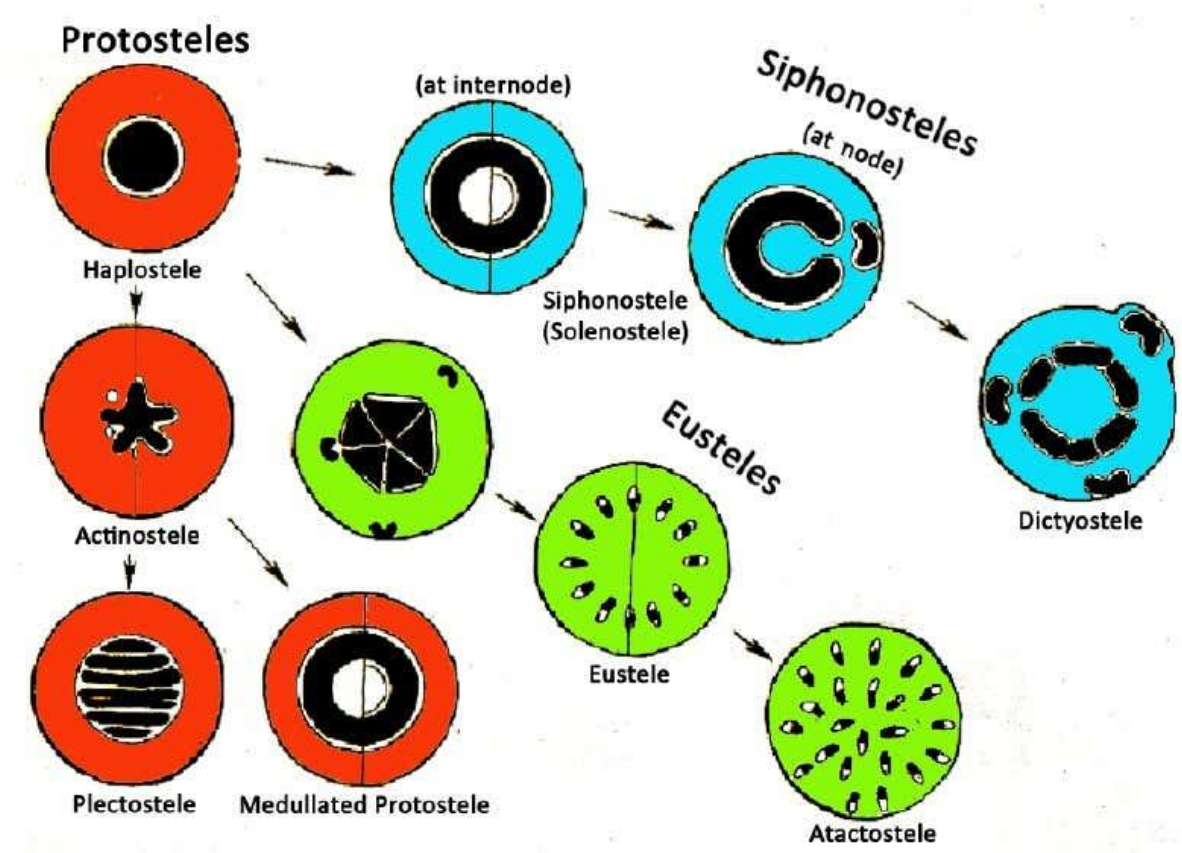






1.Protostele =
core of xylem, has
no leaf gaps2.Siphonostele =
hollow cylinder of xylem,has pith, has
leaf gaps3.Eustele =
xylem and phloem arrangedas a ring of vascular bundles. Bundles formsympodia. Typically has pith. No true leaf gaps.
Basic stele types in vascular plants

Evolution of Stele Types



Distribution and Features of Protosteles
1.

In roots.2.

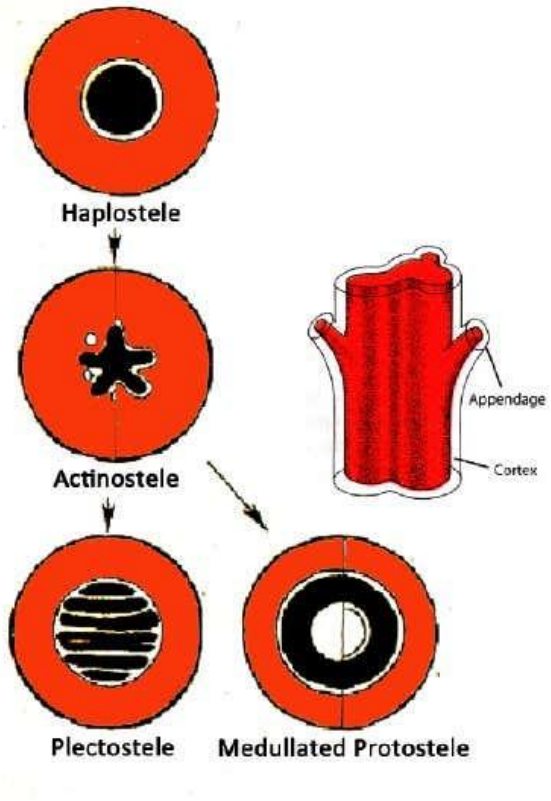
In stems of lycopods, some ferns and seedplants, and axes of Psilotum.
3 . N o l e a f g a p s
in stems.•

Haplostele – circular in outline•

Actinostele – star-shaped stele •

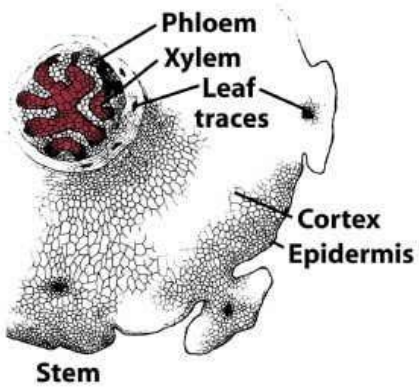
Plectostele – plates of xylem•

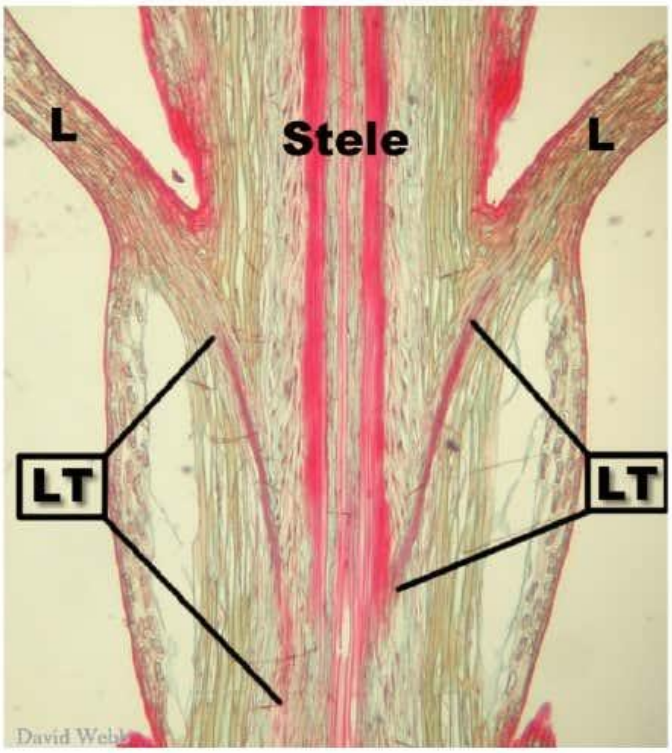
Medullated Protostele(fossilsand some lycopods) – has apith but no leaf gaps



Lycopodium

Stem in l.s.Showing leaftracesplectostele
No Leaf Gaps!





Examples of Protosteles
•

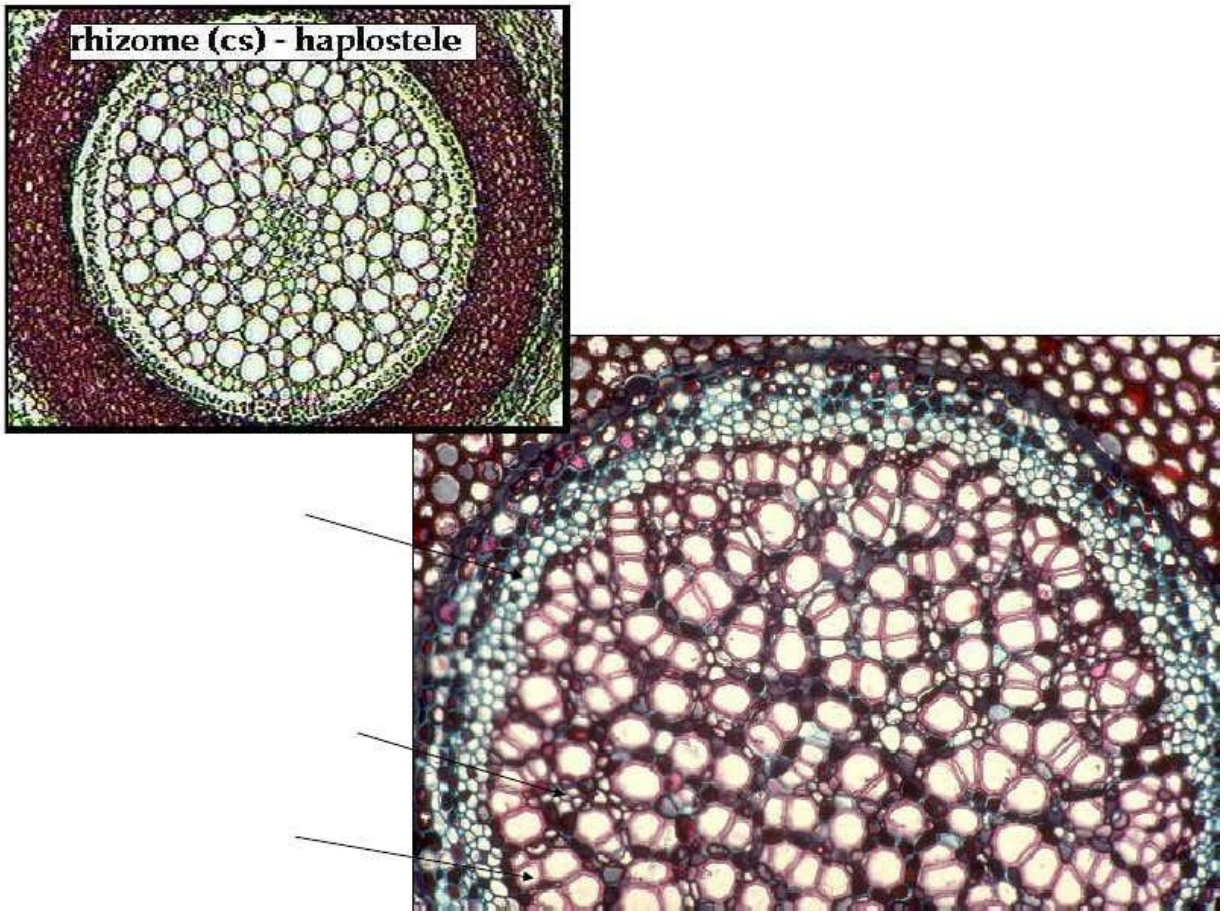
Haplostele
– found in stems of some ferns (fossiland living), also in roots of higher plants (seedplants)•

Actinostele
– found in roots of higher plants andstems of lycopodsNote: when in roots the phloem is located inbetween the xylem arms•

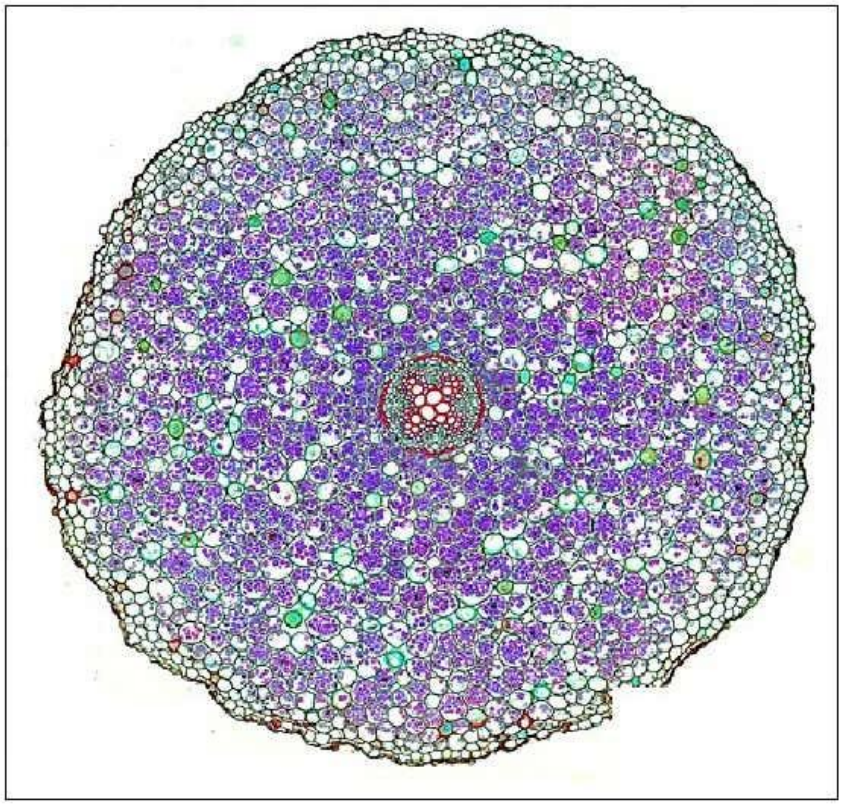
Plectostele
– found in stems of lycopods

Gleichenia
– a fern stem(=rhizome) with a haplostele

Mixed protostelehas parenchymamixed with xylemtracheidsPhloem sieve cells

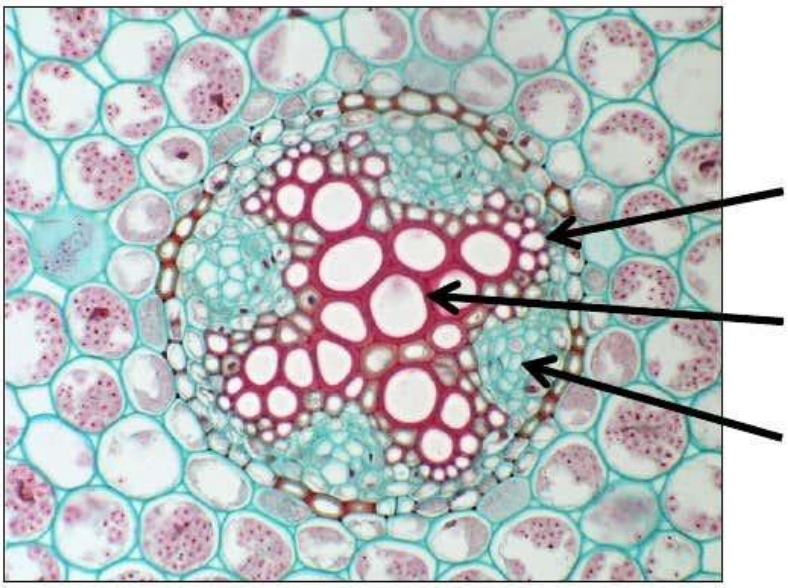


Actinostele
Star-shapedsteleFound in rootsof dicots andgymnosperms
Ranunculus
root x.s.

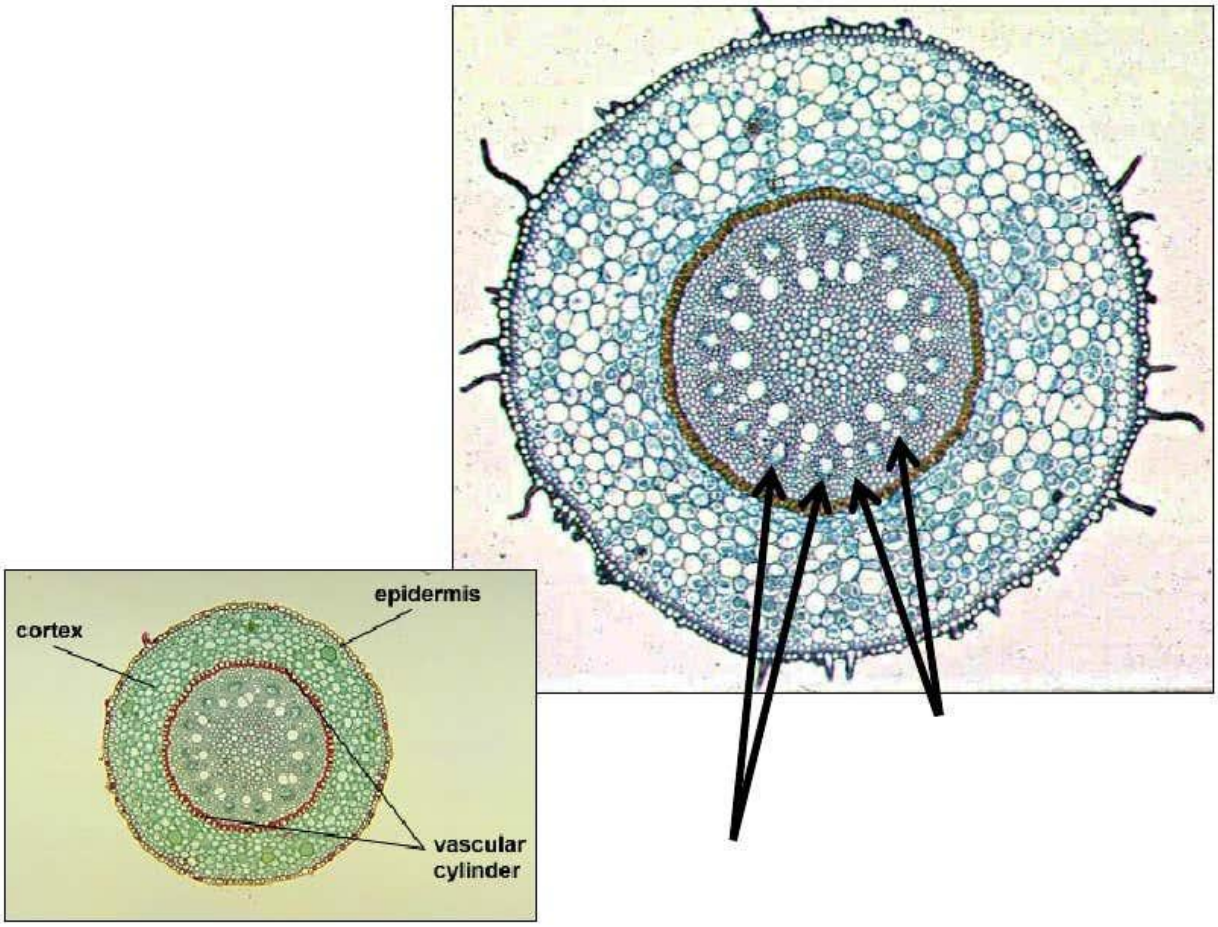


Actinostele
Ranunculus
(buttercup) root x.s.

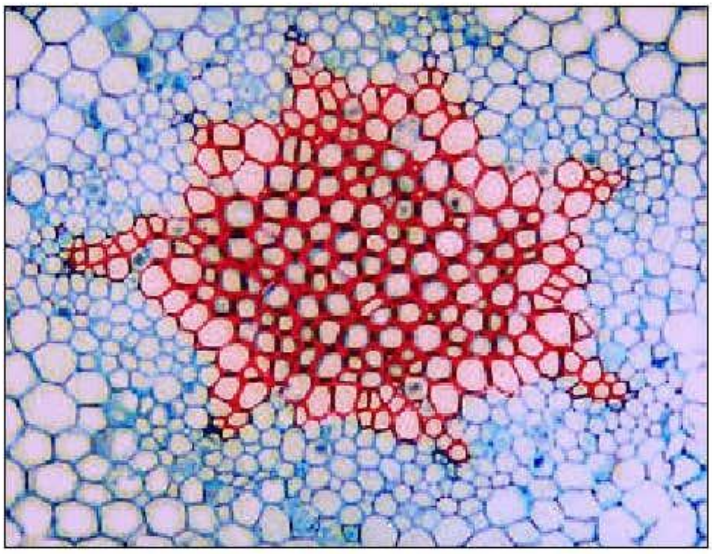
Protoxylem(Exarch)MetaxylemPhloem



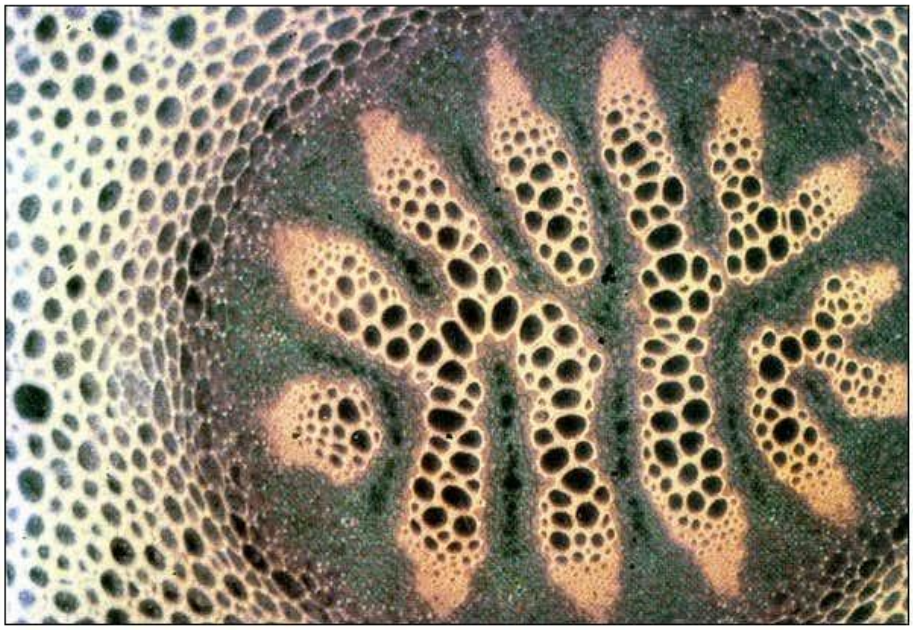
MedullatedProtostele
Found in rootsof monocotsExarch XylemPhloem



Actinostele
Psilotum
axis

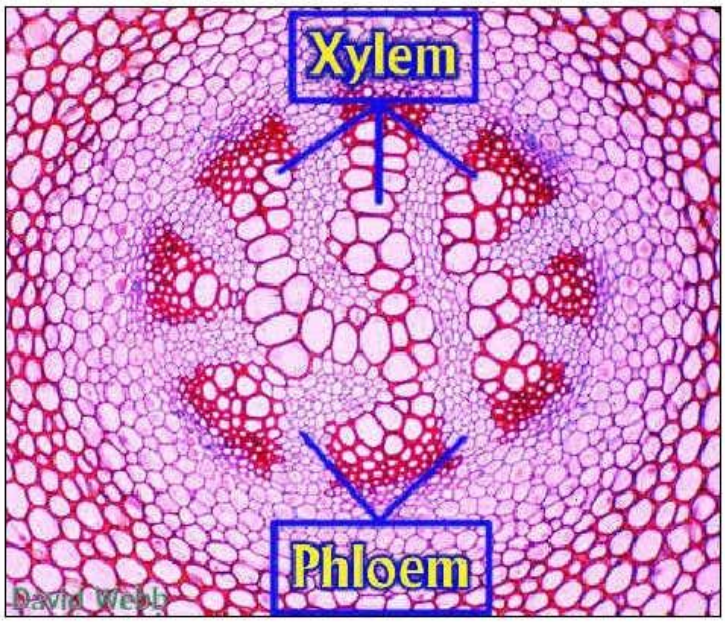


Plectostele
Lycopodium
stem x.s.



Lycopodium
stem x.s.

Steles can change at different stem levels



Siphonosteles
1. Solenostele= simple siphonostele with fewgaps (e.g., one at a time) stem produces fewleaves or one leaf at a time2. Dictyostele= highly dissected siphonostele(e.g., one producing several leaves at atime, therefore, many gaps
These stele types are common in ferns (stems)

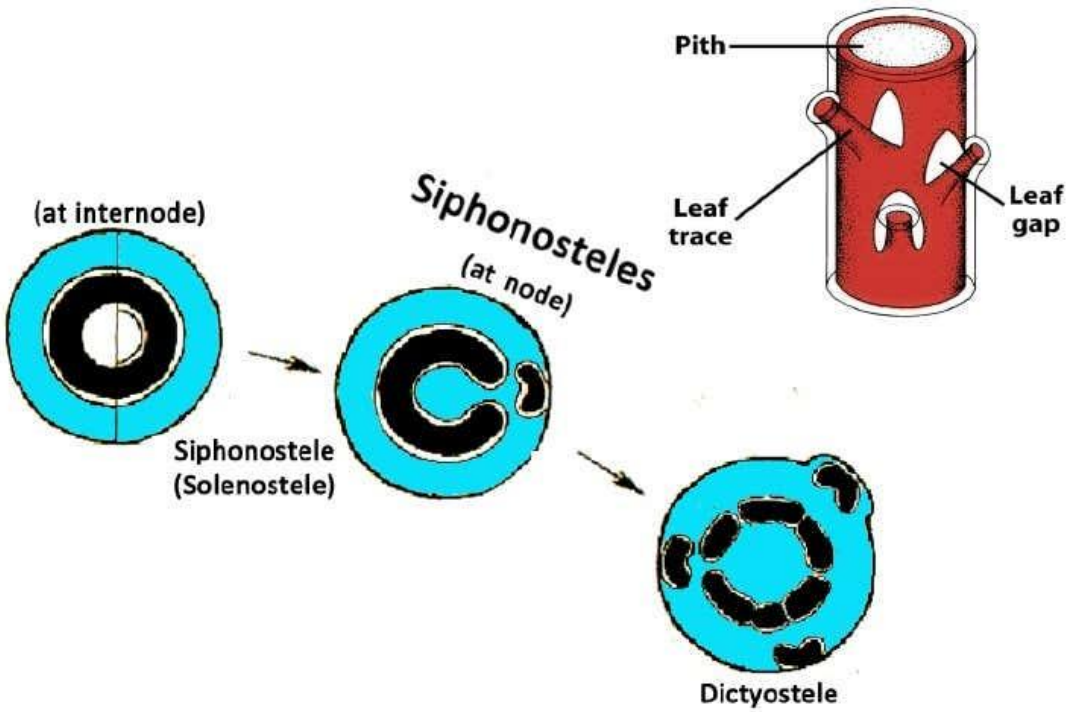
Distribution and Features Siphonosteles
1.

In stems of ferns

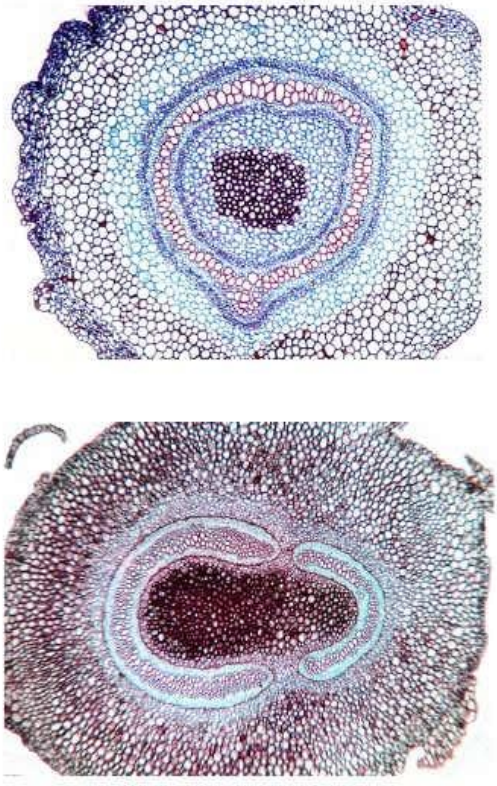
2 . L e a f g a p s
in vascular cylinder•

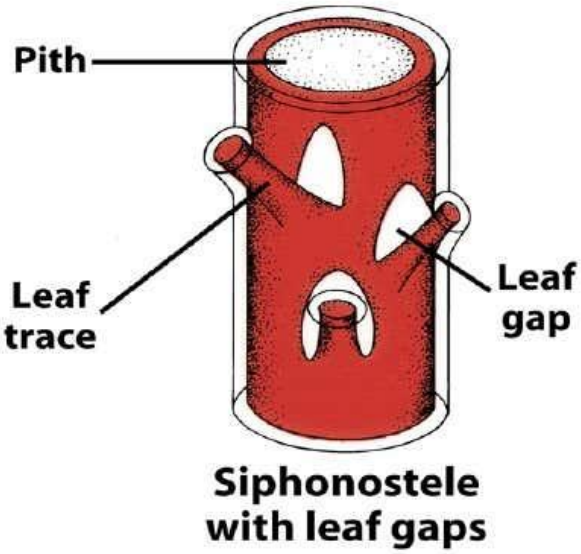
Solenostele – only one leafgap in a single cross section.•

Dictyostele – two or more leafgaps in a single cross section

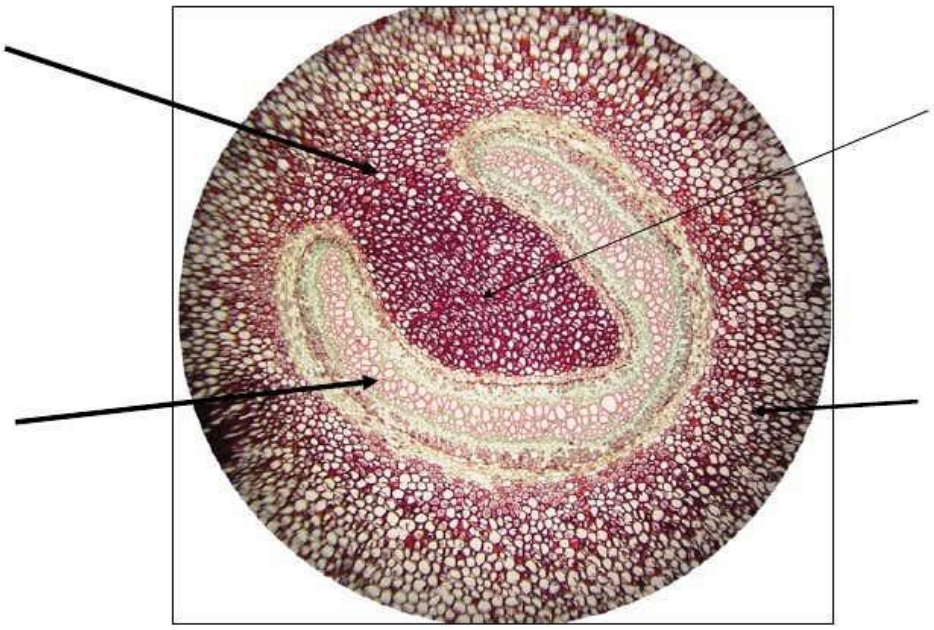


Adiantum
fern solenostele with leaf trace
internodenode

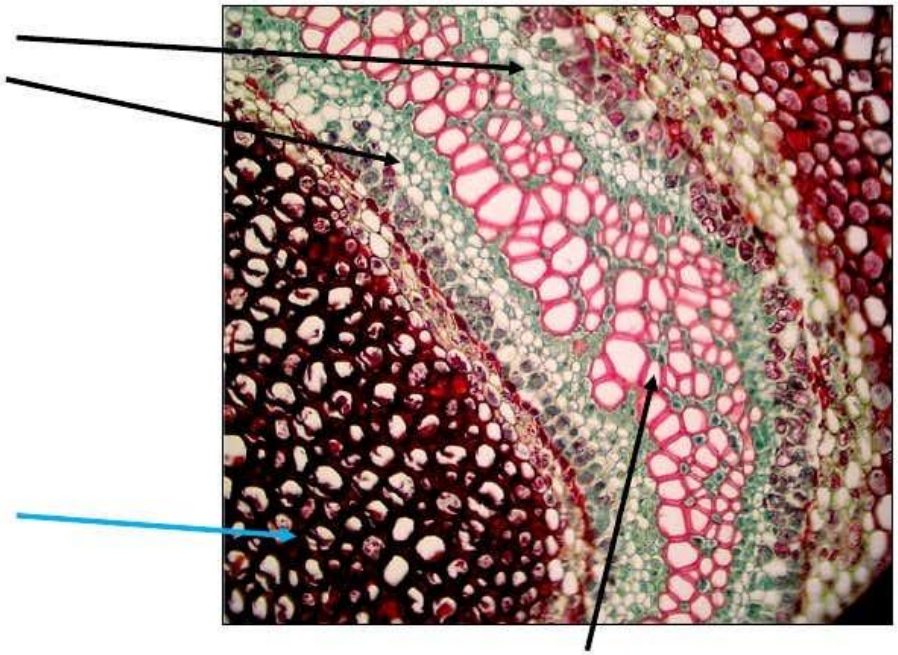




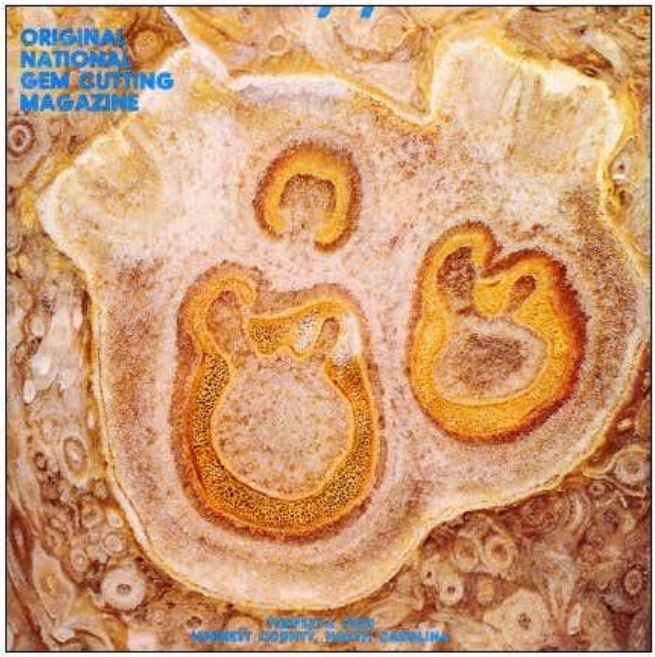
Solenostele
Adiantum
(fern) rhizome x.s.
Leaf gapstelepithcortex

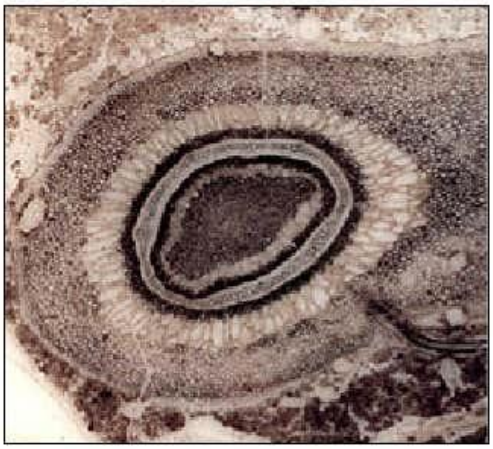


pith
x
phloem
Adiantum –
Amphiphloic solenostele
xylem
= phloem on both theoutside and the theinside of the xylem



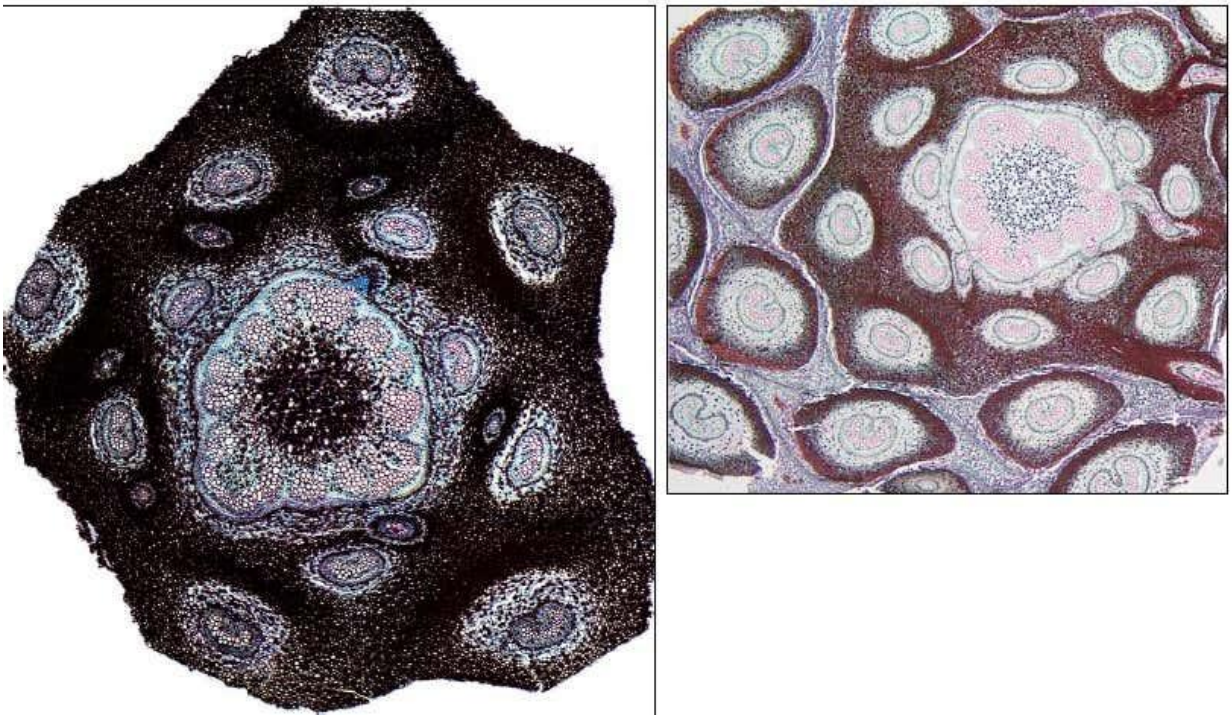
Fossil solenosteles
DennstaedtiopsisTempskya



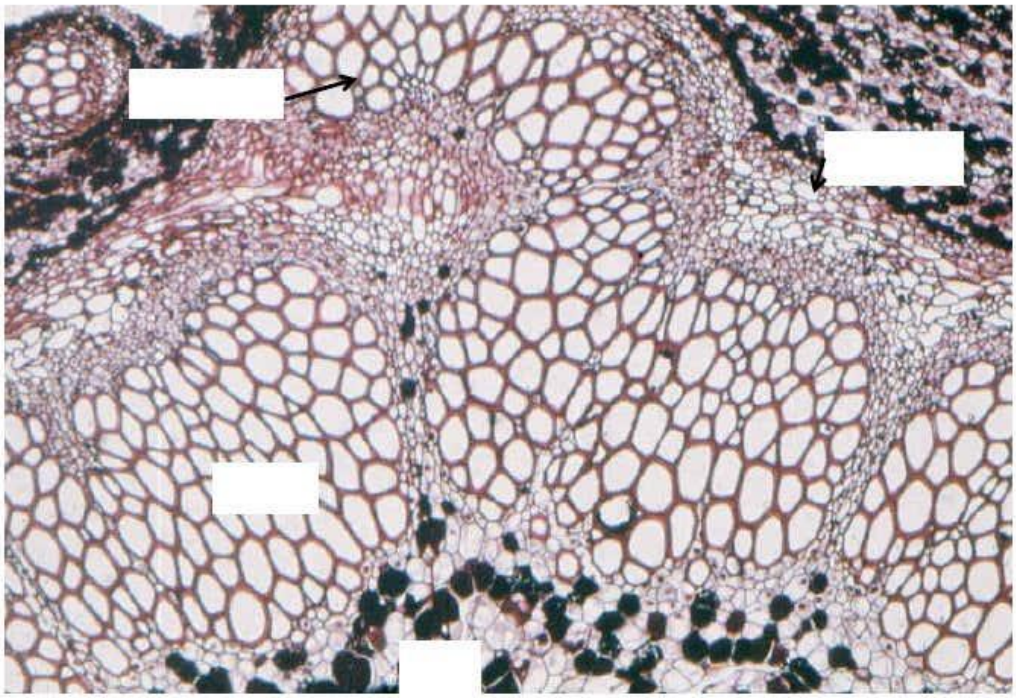


Osmunda
rhizome

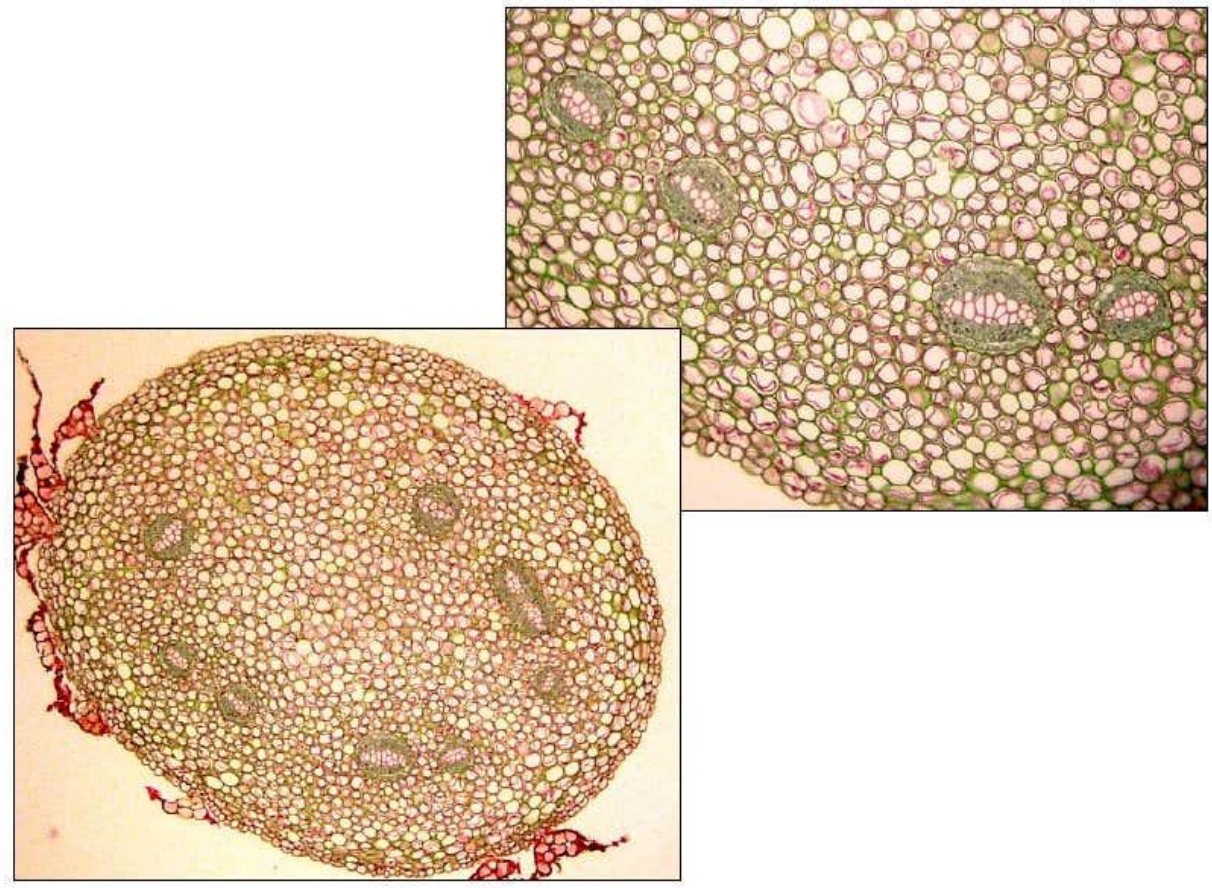
Dictyostele



Osmunda -
Ectophloic dictyostele
= phloem on the outside of the xylem only
pithphloem
xylemleaf gapleaf trace



Polypodium
(fern)rhizome(=stem
)
Dictyostele



Distribution and Features Eusteles
1.

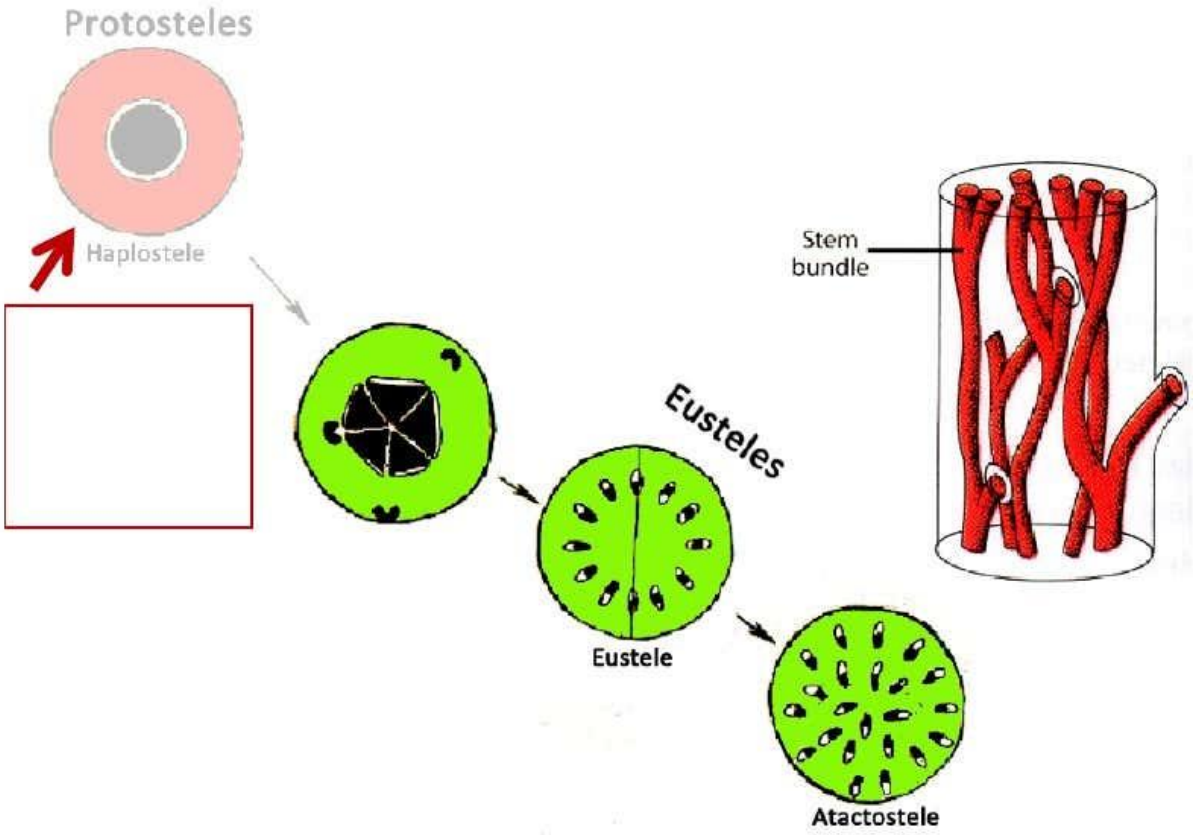
In stems of seed plants

2.

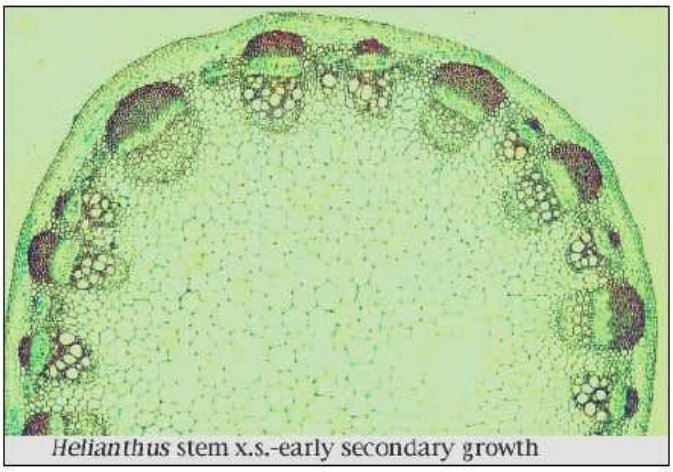
No true leaf gaps•

Eustele – one recognizablering of stem (cauline) bundles,pith present.•

Atactostele – Complexeustele. Bundles look random,no pith present. Eusteles haveevolved fromprotosteles bylongitudinaldissection.



Eustele
Found in dicot stems (a group of flowering plants)
pithe.g.,
Helianthus
(sunflower)
Has NO true leaf gapshas a series of vascularbundles or strands


Helianthus stem x.s.-early secondary growth

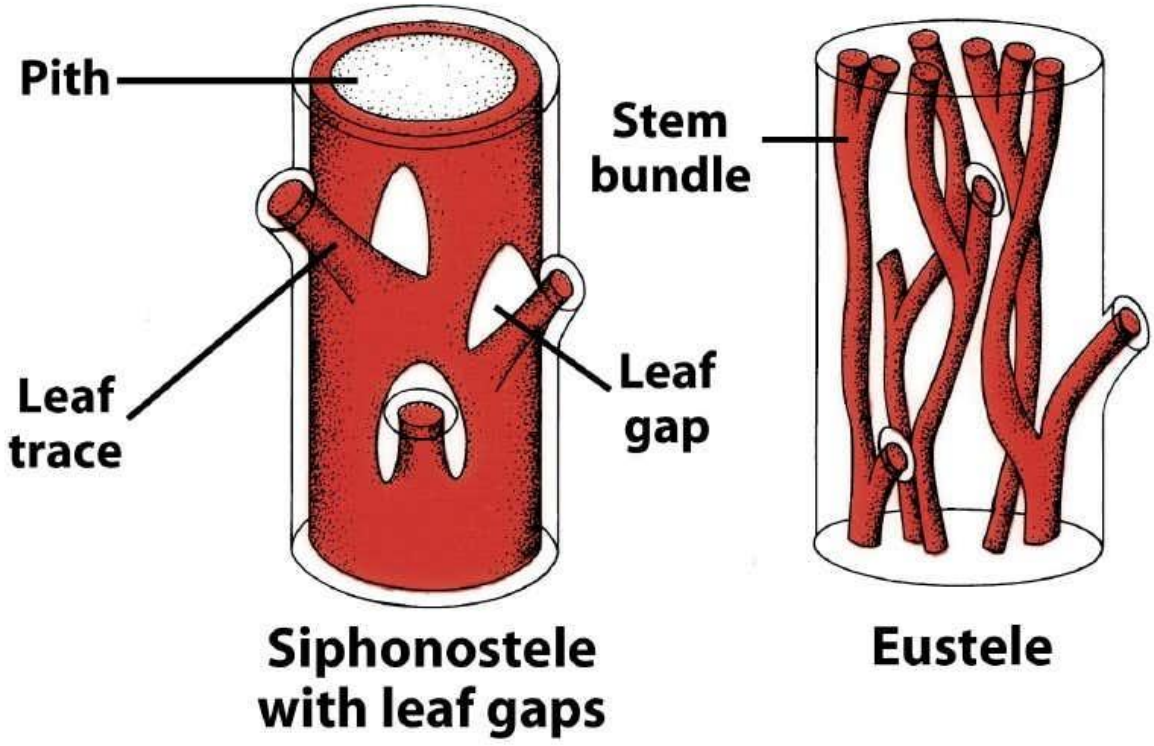
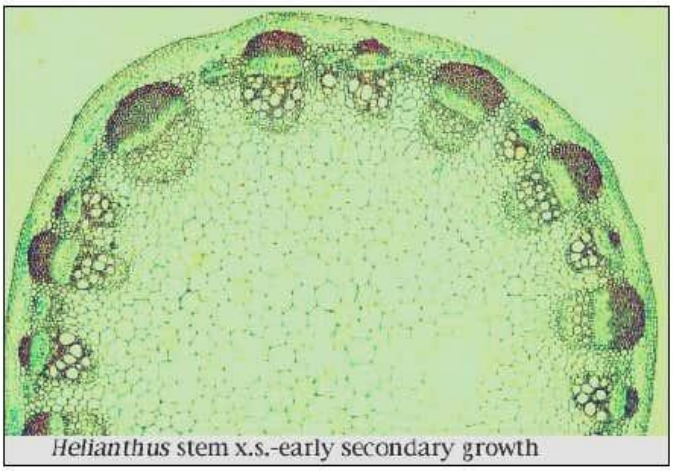
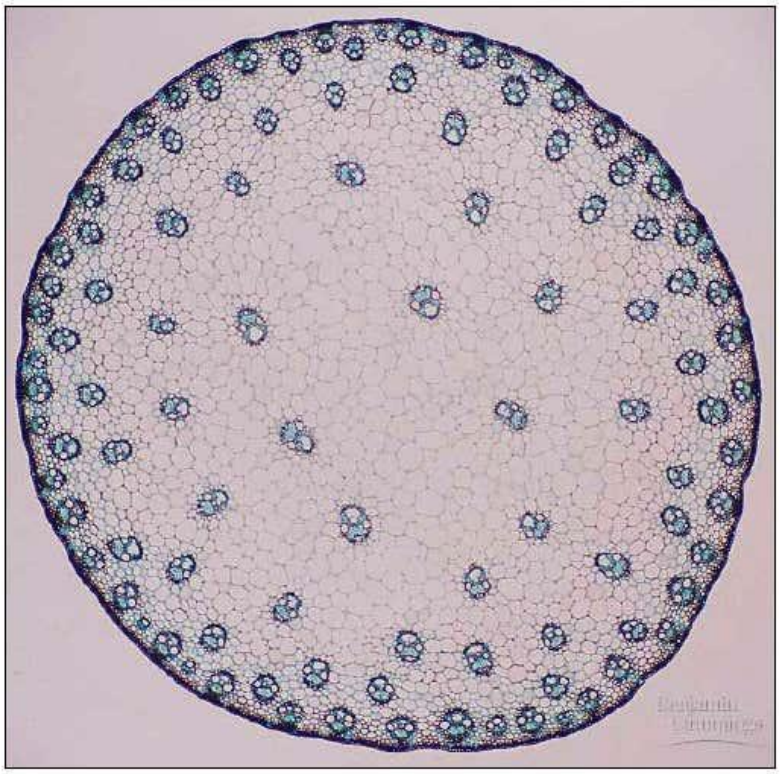


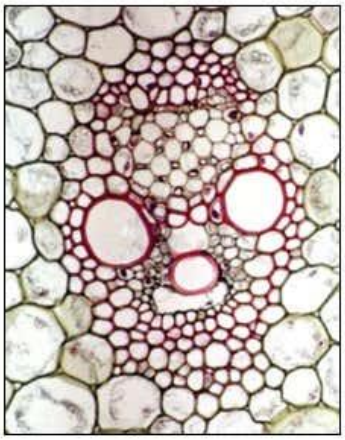
Figure 17-5 part 1
Biology of Plants, Seventh Edition

Eustele
Found in dicot stems (a group of flowering plants)
pithe.g.,
Helianthus
(sunflower)
Has NO true leaf gapshas a series of vascularbundles or strands

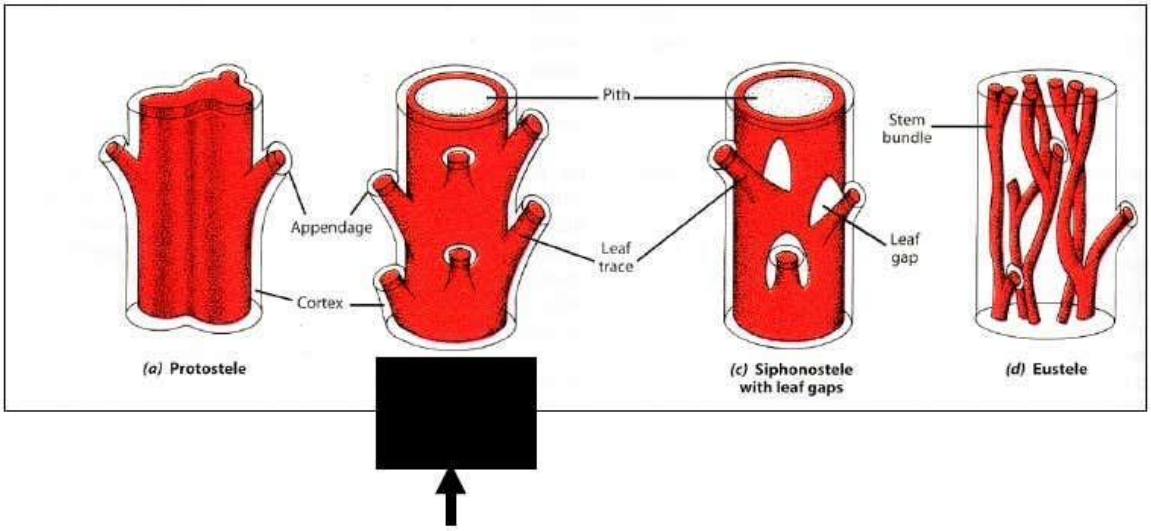

Helianthus stem x.s.-early secondary growth

Atactostele
Corn
Zea mays
stem

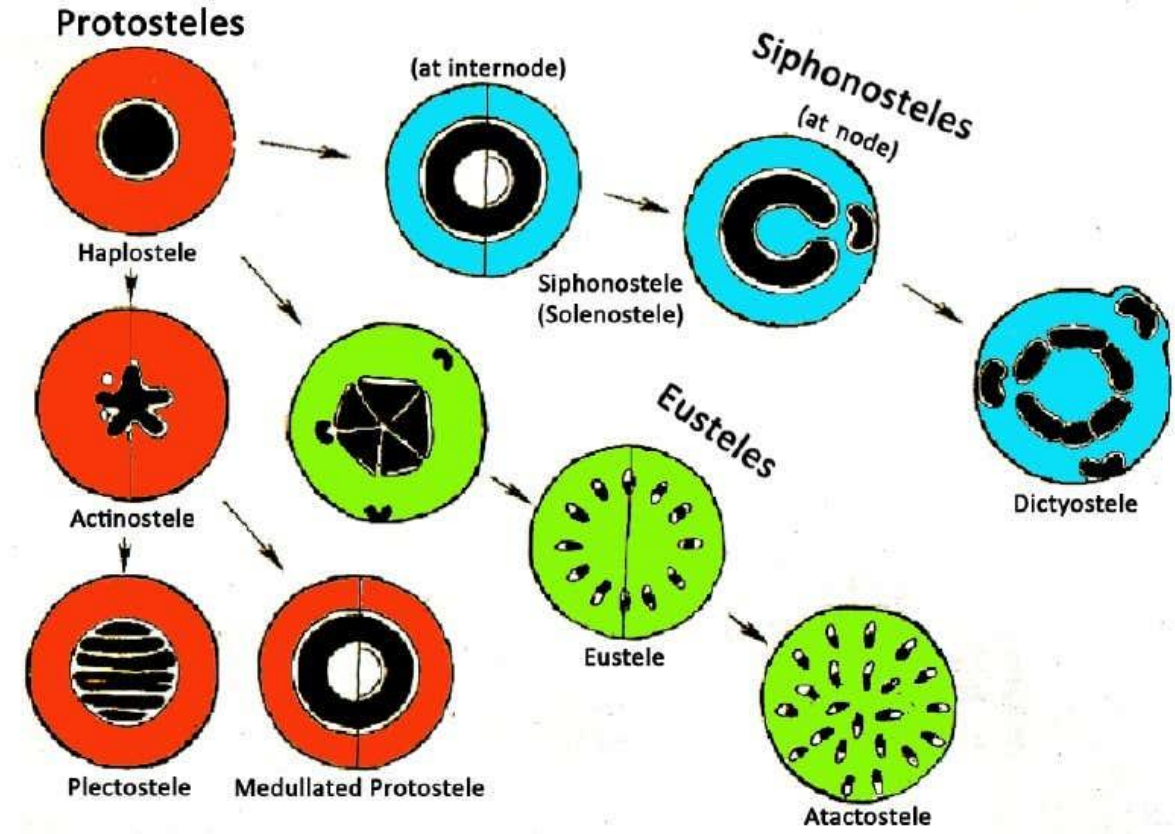


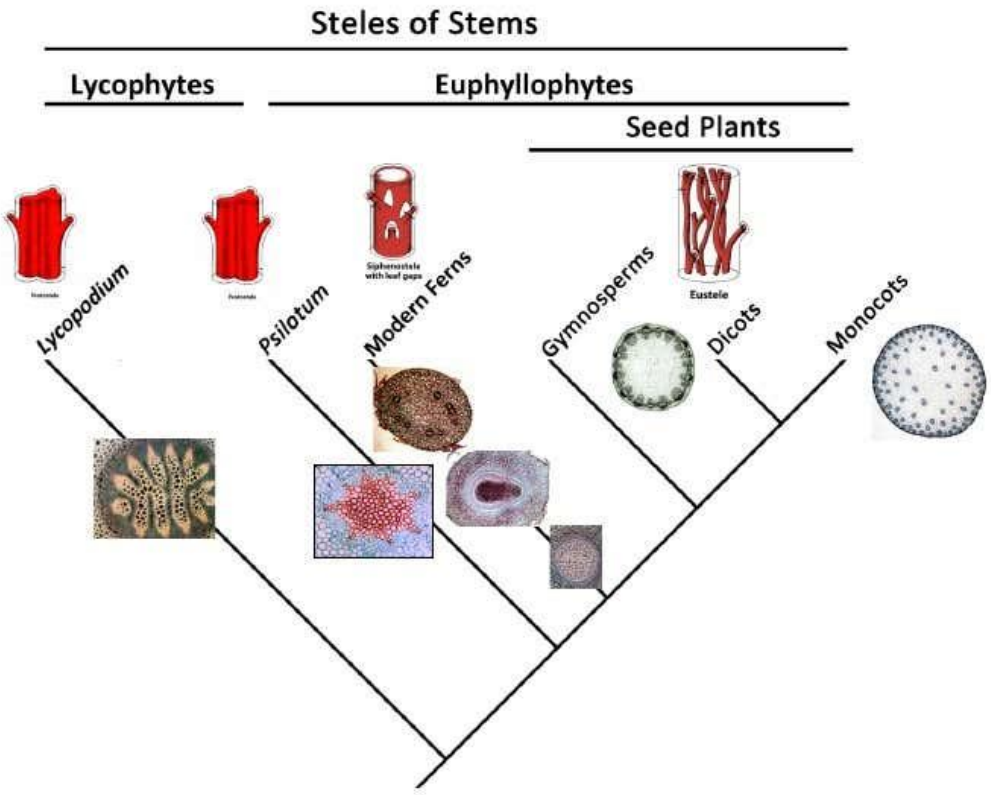


Vascular plant steles
MedullatedProtostele***
***Note: this is a mistake in your textbook(should be as on this slide)



Evolution of Stele Types




Steles of Stems
Lycophytes
Euphyllophytes
Seed Plants
Lycopodium
Psilotum
Modern Ferns
Gymnosperms
Dicots
Monocots
Eustele

3

Morphology of Flowering Plants – Important Points, Summary, Revision, Highlights

Morphology of Flowering Plants

The Root

- **Tap root:** Primary root is formed by elongation of the radicle and it bears secondary and tertiary roots, present in dicot plants, e.g. gram, mustard, etc.
- **Fibrous root:** found in monocotyledons. A large number of roots originate at the base of the stem, e.g. rice, wheat, etc.
- **Adventitious root:** Primary root is not formed from the radicle, e.g. grass, banyan tree, maize, etc.

Modification of the Root

- **For storage:** taproots- carrot, turnip; adventitious roots- sweet potato
- **For support:** Prop roots of Banyan tree, that arise from branches; stilt root of maize and sugarcane, that comes out of lower stem nodes
- **For aeration:** pneumatophores present in mangroves help them in respiration as it grows in swampy areas. These roots grow upwards above the ground, e.g. *Rhizophora*
- **For nitrogen fixation:** root nodules of leguminous plants

The Stem

- Plumule develops into stem
- The part of the stem which bears leaves is called a node and the part between two nodes is known as internode

Modification of the Stem

A. **Underground Stem:** They help plants sustain unfavourable conditions for growth
    1. **Rhizome-** runs parallel to the ground and has nodes, internodes, buds, e.g. ginger, banana
    2. **Tubers-** the end part gets swollen as in potato
    3. **Corm-** it grows vertically below the ground, e.g. colocasia, etc.
    4. **Bulb-** stem is reduced and surrounded by scaly leaves, e.g. garlic, onions
B. **Stem Tendrils:** these are a coiled structure that supports tender stem of the plant and help in climbing, e.g. grapes, cucumber, pumpkin
C. **Thorn:** axillary bud gets modified into pointed thorns and protects plants from grazing animals, e.g. Bougainvillea, citrus
D. **Subaerial Weak Stem**

1. **Offsets-** internode of lateral branches decreases resulting in the rosette of leaves, e.g. Eichhornia, Pistia
2. **Suckers-** lateral branches arise from the underground portion of the stem, e.g. chrysanthemum, banana, pineapple
3. **Runners-** stem run horizontally above the ground and roots arise at nodes, e.g. grasses, strawberry
4. **Stolon-** lateral branches arise normally but then bend down and touch the soil where the root grows and the new daughter plant arises, e.g. mint

E. **Aerial modification-** The stem is completely metamorphosed for various adaptations, e.g. **Phylloclade** of xerophytic plants. The stem becomes fleshy and green having photosynthetic pigments to prepare food as leaves are reduced to thorns to check water loss by transpiration, e.g. Euphorbia, Opuntia

The Leaf

- Leaves originate from the apical meristem of a shoot
- Normally a leaf consists of three parts; leaf base, lamina and petiole
- Leaf base attaches to stem and may have two small leaf-like structures known as stipule

Types of venation:

1. **Reticulate-** present in dicotyledons, there is a network of veins present, which are irregularly distributed
2. **Parallel-** present in monocotyledons, veins are parallel to each other

Types of Leaves:

1. **Simple-** lamina is complete and incision doesn't reach midrib
2. **Compound-** incision touches midrib, that divides a leaf into a number of leaflets
    - **Pinnately compound-** the leaflets are present on the common axis, i.e. midrib, called the **rachis**, e.g. Neem
    - **Palmately compound-** leaflets are attached at the petiole tip, e.g. silk cotton

Phyllotaxy: pattern of arrangement of leaves around the stem

1. **Alternate type-** single leaf present at each node, e.g. *Hibiscus, Brassica*
2. **Opposite type-** each node bears a pair of leaves, e.g. *Psidium guajava, Calotropis*
3. **Whorled type-** more than two leaves arise at the node to form a whorl, e.g. *Alstonia*

Modification of Leaves

- **Tendrils-** leaves modified to form a long thread-like structure, it gives support to climbers, e.g. peas
- **Spine-** in xerophytic plants to reduce water loss, e.g. cactus, aloe
- **For storage-** e.g. garlic, onion
- **Phyllodes-** petiole gets modified to form a leaf-like structure and function, e.g. Acacia

- Pitcher in pitcher plant is a modified leaf which traps insects inside

Inflorescence

- The arrangement of the flowers around the floral axis
- The two main types of inflorescence are
    1. **Racemose:** the main axis grows indefinitely, flowers are present laterally in acropetal succession i.e. older flowers at the bottom and the younger ones at the top. Types of racemose inflorescence: raceme, spike, umbel, capitulum, corymb, catkin, spadix, etc.
    2. **Cymose:** the main axis terminates in flower and has limited growth. Flowers are borne in a basipetal order i.e. older flowers are at the top and new flowers are at the bottom. Types of cymose inflorescence: monochasial cyme, dichasial cyme, etc.
- **Special types of Inflorescence**
    1. **Verticillaster:** sessile flowers arranged in dichasial cyme, e.g. Ocimum, Salvia
    2. **Cyathium:** involucre of bracts form cup shape structure, single female flower is surrounded by numerous male flowers, e.g. Euphorbia
    3. **Hypenthodium:** both male and female flowers are present in a cavity with an apical opening called ostiole, e.g. Fig

The Flower

- A flower has four whorls; calyx, corolla, androecium and gynoecium. These are attached to the swollen terminal of pedicel called the thalamus
- **Flower symmetry:**
    1. **Actinomorphic-** radially symmetrical flowers, e.g. chilli, datura, mustard
    2. **Zygomorphic-** when a flower can be divided into two equal parts in only one vertical plane, e.g. *Cassia,* pea, etc.
- Flowers can be trimerous, tetramerous or pentamerous depending on the multiple of floral appendages present 3, 4 or 5
- Types of flowers depending on the presence or absence of bracts (reduced leaf present at the base of pedicel); **Bracteate or Ebracteate**
- Types of flowers based on the position of the ovary:
    1. **Hypogynous-** gynoecium occupies the highest place, above all the other parts. The ovary is known as **superior**, e.g. brinjal, china rose, mustard
    2. **Perigynous-** gynoecium is present at the same level as the rest of the parts of a flower. The ovary is known as **half inferior,** e.g. peach, plum, rose
    3. **Epigynous-** thalamus encloses the ovary completely and other parts are present above it. The ovary is known as **inferior**, e.g. ray florets of a sunflower, guava, cucumber

Parts of a Flower

Calyx: A flower's outermost whorl is made up of leaf-like structures called **sepals**

Gamosepalous- sepals united

Polysepalous- sepals free

Corolla: made up of bright coloured petals. Present after sepals

Gamopetalous- petals united

Polypetalous- petals free

Aestivation: It is the mode of arrangement of sepals and petals. The main types of aestivations are:

- **Valvate-** sepals or petals just touch each other and don't overlap in a whorl, e.g. *Calotropis*
- **Twisted-** sepal or petal overlaps the next sepal or petal and the same continues in a whorl, e.g. cotton, china rose, lady's finger
- **Imbricate-** margins of sepal and petals overlap each other randomly and not in one direction, e.g. Gulmohar, *Cassia*
- **Vexillary-** the largest petal overlaps two petals (wings) present laterally on both the sides and that overlaps the two anterior petals (keel) in the same way. It is also called papilionaceous, e.g. beans, peas

Androecium: It is a male reproductive part. It consists of stamens. Each stamen is made up of filament and anthers.

- **Staminode-** sterile stamen
- **Epipetalous-** stamens are attached to petals
- **Polyandrous-** stamens are free
- **Monadelphous-** stamens are united and present as one bundle
- **Diadelphous-** stamens are united and present in two bundles
- **Polyadelphous-** stamens are united and present in more than two bundles

Gynoecium: It is a female reproductive part. It consists of carpels. Each carpel has three parts; stigma, style and ovary.

- **Apocarpous:** more than one carpels present, which are free, e.g. rose, lotus
- **Syncarpous:** more than one carpels present, which are united, e.g. tomato, mustard

Placentation: The specific arrangement of ovules in the ovary is called placentation. Types of placentation:

1. **Marginal-** e.g. pea
2. **Axile-** e.g. lemon, china rose
3. **Parietal-** e.g. *Argemone,* mustard
4. **Free central-** e.g. *Primrose, Dianthus*
5. **Basal-** e.g. marigold, sunflower

The Fruit

It is a matured and ripened ovary after fertilisation.

- **Parthenocarpic fruit: the fruit** formed without fertilisation, it makes seedless fruits, e.g. pineapple
- Seed and pericarp make a fruit. The fleshy pericarp is made up of three layers; epicarp, mesocarp and endocarp

The Seed

After the fertilisation, the ovule develops into a seed.

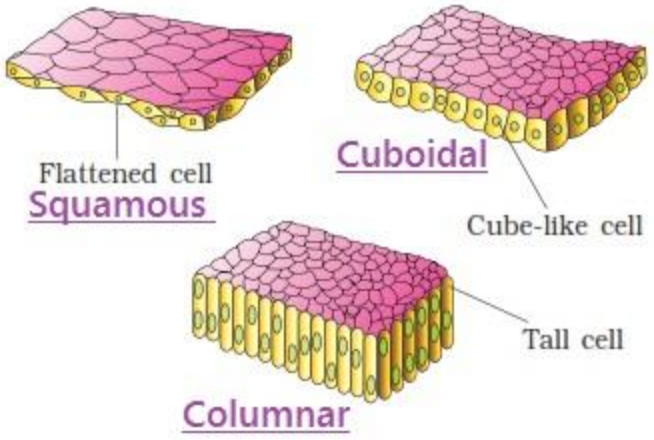
- A seed has a seed coat and an embryo. An embryo is made up of radicle, embryonal axis and one or two cotyledons in monocotyledons (maize, wheat) and dicotyledons (pea, gram) respectively.

Dicotyledonous seed	**Monocotyledonous seed**
The seed coat is made up of two layers; outer **testa** and inner **tegmen** There is a scar present through which the seed was attached to the fruit while developing, it is called the **hilum** **The micropyle** is a pore above the hilum	The seed coat is fused to the fruit wall and membranous
The embryo consists of an embryonal axis and two cotyledons	The embryo consists of one large cotyledon known as **scutellum**
Cotyledons store food	The endosperm is bulky and stores food
Mostly non-endospermic seeds. In castor, an **endospermic seed** is present- endosperm is formed due to double fertilisation and stores food	Mostly endospermic seeds. Some seeds like orchids are non-endospermic. **Aleuron** (a proteinaceous layer), is the outermost layer of endosperm, which separates the embryo
Radicle and plumule are present at the two ends of the embryonal axis	Plumule is enclosed in **coleoptile** and radicle is enclosed in **coleorhiza**

STRUCTURAL ORGANISATION IN ANIMAL

Epithelial Tissues

- An epithelium is a tissue composed of one or more layers of cells that cover the body surface and lines its various cavities.
- It serves for protection, secretion and excretion.
- The word 'epithelium' was introduced by *Ruysch*.
- Epithelial tissue evolved first in animal kingdom.
- It originates from all the three primary germ layers. *e.g.* Epidermis arises from ectoderm, Coelomic epithelium from the mesoderm and epithelial lining of alimentary canal from the endoderm.
- **Types of Epithelium**



Glands

- Multicellular exocrine glands are classified by structure, using the shape of their ducts and the complexity (branching) of their ducts system as distinguishing characteristics.
- Shape include tubular and alveolar (Sac like).
- Simple exocrine glands *e.g.* intestinal glands, mammalian sweat glands, cutaneous glands of frog etc. have only one duct leading to surface.
- Compound exocrine glands have two or more ducts *e.g.* liver, salivary glands etc.
- **Structural classification of exocrine glands:**

Type	Example
Simple tubular	Intestinal glands, crypts of Lieberkuhn in ileum.
Simple coiled tubular	Sweat glands in man
Simple branched tubular	Gastric (stomach) gland, and Uterine gland.
Simple alveolar	Mucous gland in skin of frog, Poison gland of toad and seminal vesicle.
Simple branched alveolar	Sebaceous glands

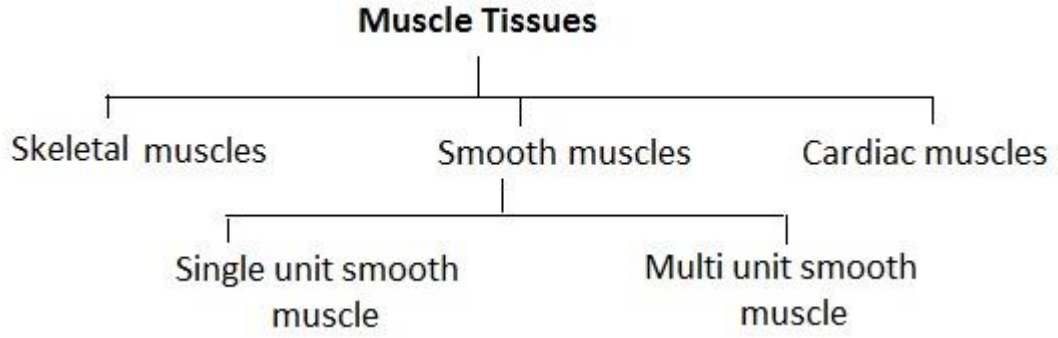
Compound tubular	Brunner's gland, bulbourethral gland and liver.
Compound alveolar	Sublingual and submandibular parotid salivary gland
Compound tubulo alveolar	Parotid salivary glands, Mammary gland and Pancreas.

Important Tips

- Study of tissue outside the body in a glass tube is known as in vitro, while study of living tissues in situ is known as in vivo.
- Among epithelia, simple epithelia were first to evolve.
- Transitional epithelium also called plastic epithelium or urothelium. It lacks basement membrane
- False epithelium derived from mesenchyma a diffuse network of tissue derived from embryonic mesoderm) and lining the synovial cavities.
- Mammary glands without teats are present in prototheria.
- A malignant tumour arising from an epithelium is called a carcinoma. If it arises from a squamous epithelium it is a squamous cell carcinoma and if it arises from glandular epithelium it is called an adenoma.
- The epithelial lining of brain ventricles and central canal of spinal cord is known as ependyma.
- Stereocilia are elongated membrane outgrowths found in certain parts of male reproductive tract.

Muscle Tissues

- Muscle cells are highly contractile (contracting to 1/3 or 1/2 the resting length).
- Muscle cells lose capacity to divide, multiply and regenerate to a great extent. Study of muscle is called myology.
- About 40% to 50% of our body mass is of muscles.
- The muscle cells are always elongated, slender and spindle-shaped, fibre-like cells, These are, therefore called muscle fibres.
- These possess large numbers of myofibrils formed of actin and myosin.



(f) **Difference between three types muscle fibres**

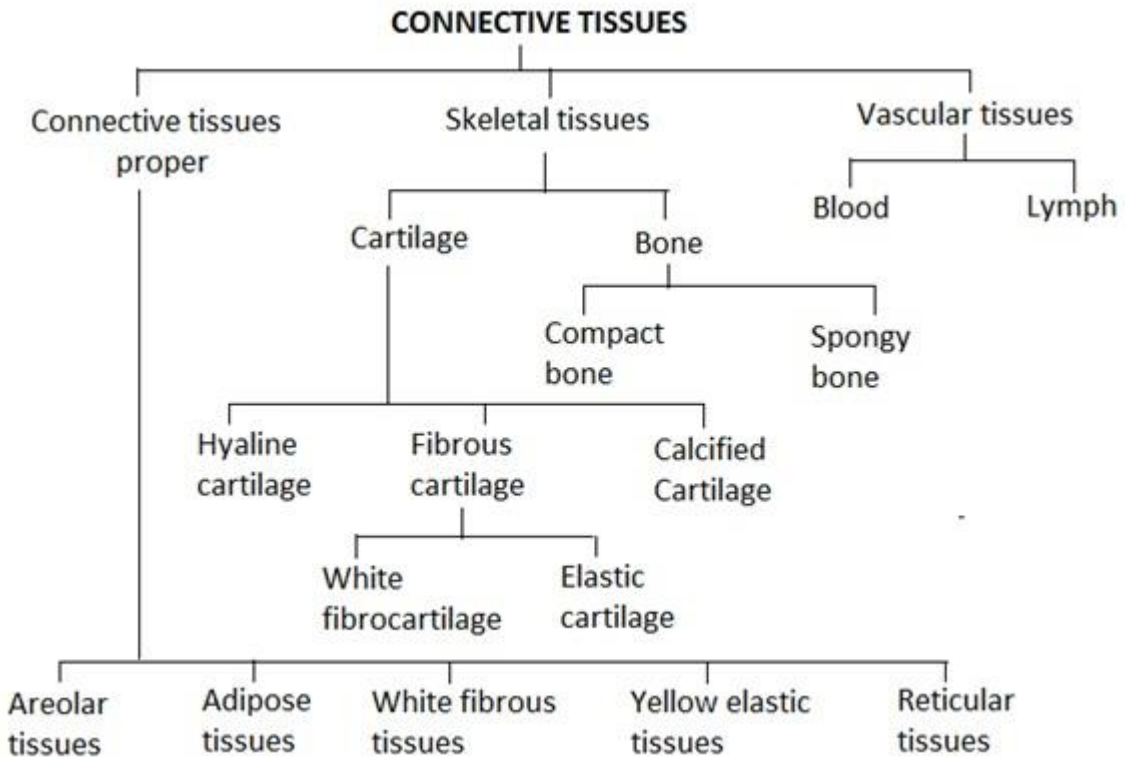
S.No.	Feature	Striated or Striped or Skeletal or Voluntary muscle fibres	Non-striated or Unstriped or Smooth or Visceral or	Cardiac muscle fibres

			Involuntary muscle fibres	
1.	Shape	Long cylindrical	Fusiform (thick in middle tapering at ends) (0.02 nm to 0.2 nm long)	Network of fibres
2.	Stripes	Dark A bands and light I bands present	Absent	Present
3.	Nucleus	Many (syncytial) at periphery	Single at the centre of each cell	Many nuclei between successive end plates central position
4.	Unit	Sarcomeres, cylindrical long myofibrils placed end to end forming cylindrical myofibrils	Fusiform cells with inconspicuous borders	Oblique cross-connecting fibres make this muscle an interconnected bundle of myofibrils
5.	Attachment	To bones	To soft organs or viscera	Not attached to other organs except major blood vessels which are isolated and covered by pericardium
6.	Sarcolemma	Distinct	Absent	Absent
7.	Sarcoplasmic Reticulum	Well developed	Less extensive	Poorly formed
8.	Blood supply	Rich	Poor	Rich
9.	Contraction	Quick, fatigue fast	Slow, sustained contraction	Rhythmic, contractions originate in heart (pace maker immune to fatigue)
10.	Location	Generally peripheral, tongue, proximal part of oesophagus	Central, in hollow visceral organs, iris of the eye, dermis of the skin	Only in heart
11.	Intercalated discs	Absent	Absent	Present
12.	T-tubule system	Well developed	Lacking	Well developed
13.	Innervated nerves	Motor nerves from central nervous system (neurogenic)	Nerves from autonomic nervous system (neurogenic)	Nerves from central and autonomic nervous system (myogenic)
14.	Fibres	Unbranched	Unbranched	Fibres join by short oblique bridges
15.	Action	Voluntary	Involuntary	Involuntary

Connective Tissues

- It connects and supports all the other tissues, the intercellular element predominating.
- The cellular element is usually scanty. In function this tissue may be mechanical, nutritive and defensive.
- It is a tissue made up of matrix (abundant intercellular substance or ground substance) and living cells that connects and support different tissues.

- Connective tissue was called mesenchyme by Hertwig (1893).
- Types of connective tissues



(1) **On the basis of their texture:**

The bones are divided into two categories spongy or cancellous or tubecular bones and compact or periosteal bones

Bone	**Cartilage**
1. Matrix is composed of a tough, inflexible material, the ossein.	**1.** Matrix is composed of a firm, but flexible material, the chondrin.
2. Matrix is always impregnated with calcium salts.	**2.** Matrix may be free or impregenated with calcium salts.
3. Bone cells lie in lucunae singly.	**3.** Cartilage cells lie in lacunae singly or in groups of two or four.
4. Osteocytes are irregular and give off branching processes in the developing bone.	**4.** Chondroblasts are oval and devoid of processes.
5. Lacunae give off canaliculi.	**5.** Lacunae lack canaliculi.
6. There are outer and inner layers of special bone forming cells, the osteoblasts, that produce new osteocytes, which secrete new lamellae of matrix.	**6.** There are no special cartilage-forming cells. Cartilage grows by division of all chondroblasts.
7. Matrix occurs largely in concentric lamellae.	**7.** Matrix occurs in a homogenous mass.

8. Bone is highly vascular.	**8.** Cartilage in nonvascular.
9. Bone may have bone marrow at the centre.	**9.** No such tissue is present.

(2) **On the basis of origin of bone:**

Ossification or osteogenesis is the process of bone formation. A bone is classified into four categories.

Characters	**Spongy bone**	**Compact bone**
Arrangement of lamellae	There is no regular Haversian system so have spongy texture.	Have regular Haversian system
Occurrence	In skull bones, ribs, centrum of vertebrae and epiphyses of long bones	In the shaft (diaphysis) of long bones
Marrow cavity	Broad	Narrow
Type of bone marrow	Red marrow in the spaces between lamellae	Yellow marrow in marrow cavity
Function	Marrow forms RBCs and Granular WBCs	Marrow stores fats

(3) **On the basis of treatment:**

These are of two types :-

Characters	**Dried bone**	**Decalcified bone**
Type of treatment	Subjected to high temperature.	Subjected to dilute solution of *HCl*.
Nature of matter left	With only mineral matter.	With only organic matter.
Marrow cavity	Empty.	With bone-marrow.
Fate of cells	Periosteum, endosteum, osteoblasts and osteocytes are absent being killed by high temperature.	Periosteum, endosteum, osteoblasts and osteocytes all are present.
Lacunae	Lacunae present.	Lacunae absent.

(6) **Number of RBC:** The number of RBCs is counted by instrument haemocytometer. The total number of RBC per cubic mm of blood is called RBC count. RBC count is slightly lower in women than a man and number of RBC is more in people who live on mountains because there is less oxygen. RBC are absent in cockroach.

S.No.	**Organism**	**Number of RBCs**
1.	Male	5 – 5.4 million / cubic mm of blood
2.	Female	4.5 – 5 million / cubic mm of blood
3.	Infants	65 – 70 lacs/ cubic mm of blood
4.	Embryo	85 lacs/ cubic mm of blood
5.	Rabbit	70 lacs / cubic mm of blood
6.	Frog	4 lacs / cubic mm of blood

(7) **Life span of RBC:** The life span of red blood corpuscles circulating in the blood stream varies in different animals. RBCs have longest life span in blood. The mammalians RBC have short life span due to absence of nucleus, which is disappeared during development.

S.No.	Organism	Life span of RBCs
1.	Mammals and Human	120 days or 4 months
2.	Rabbit	80 days
3.	Frog	100 days
4.	New born	100 days

(8) **Function of RBCs:** The major function of erythrocytes is to receive O_2 of respiratory surfaces and then transport and readily deliver it to all cells of body. This important function is performed by haemoglobin which has a great ability to combine loosely and reversibly with O_2 and is, hence, called "respiratory pigment". Haemoglobin, in annelids, is dissolved in the plasma because of absence of red blood corpuscles. In mollusc and some arthropods, etc., a different respiratory pigment, haemocyanin is found dissolved in the plasma. This pigment is bluish due to presence of copper in place of iron.

(9) **Comparison Between Blood and Lymph**

Blood	Lymph
1. Red corpuscles present.	**1.** These are absent.
2. White corpuscles fewer, neutrophils most numerous.	**2.** White corpuscles more; lymphocytes most numerous.
3. Soluble proteins more than insoluble proteins.	**3.** Insoluble proteins more than soluble proteins.
4. Amount of nutrients and O_2 comparatively more.	**4.** Amount of nutrients and O_2 comparatively less.
5. Amount of CO_2 and metabolic wastes normal.	**5.** Amount of these much more.

Important Points

- Argentaffin cells which produce a precursor of serotonin, a potent vasoconstrictor hormone, occurs in intestinal cells.
- The brown adipose tissue in human is restricted till third month of post natal life.
- White fibres yield gelatin on boiling and are digestible with enzyme pepsin but yellow (elastic) fibres are not digestible by enzyme trypsin.
- The fat in the globules is stored in the form of triglycerides.
- The Cytoplasmic granules basophils contain histamine.
- Sprain – Excessive pulling of ligaments.
- Plasma cells are also called as "Cart wheel cells".
- Collagen constitutes about 33% of total body protein.

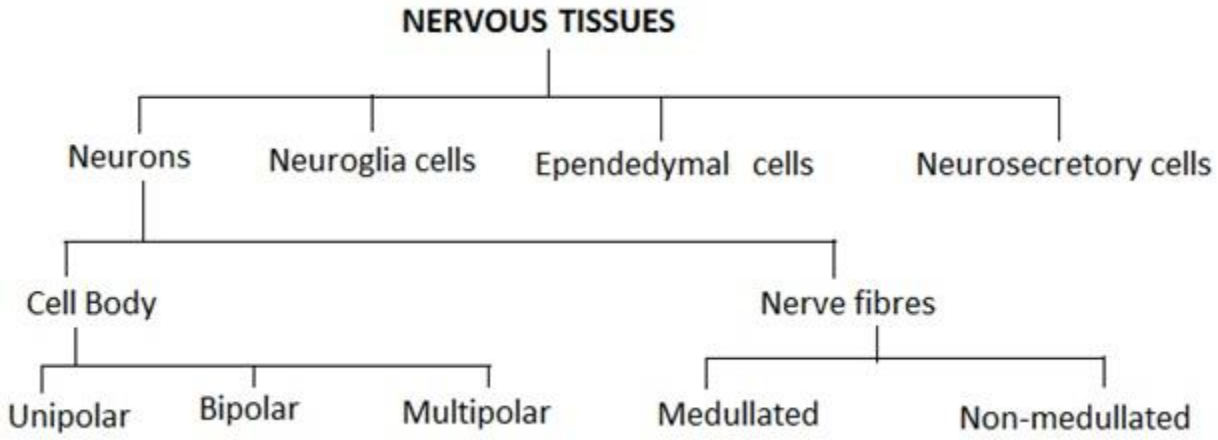
Nervous Tissues

- A most complex tissue in the body, composed of densely packed interconnected nerve cells called neurons (as many as 10^{10} in the human brain).
- It specialized in communication between the various parts of the body and in integration of their activities.
- Nervous tissue is ectodermal (from neural plate) in origin.

- Difference between axon and dendron

Characters	Axon	Dendron
1. Number	Always single	May be one or more in number
2. Structure	Formed of neuroplasm with only neurofibrils but no Nissl's bodies.	Formed of neuroplasm with both neurofibrils and Nissl's bodies
3. Size	Long sized processes	Small sized processes
4. Direction of new impulses	Always away from the cell body	Always towards the cell body
5. Nature	Efferent	Afferent
6. Branching	Generally absent	Generally present

- **Classification of nervous tissues**



Connective Tissue

A group of cells along with intercellular substances that perform a specific function is called tissue.

There are mainly four different types of tissues present in our body.

1. Epithelial- provides covering or lining
2. Muscular- helps in movement
3. Neural- responds to stimuli
4. Connective- supports, links and cushions

What is Connective Tissue?

Connective tissues, as the name implies, support and connect different tissues and organs of the body. They are widely distributed in every part of the body. They originate from the mesoderm (the middle germinal layer of the embryo).

Connective tissue is made up of a few cells present in the intercellular framework of protein fibres secreted by the cells, known as collagen or elastin. The cells also secrete a thin gel of polysaccharides, which together with fibres make matrix or ground substance.

The elasticity, flexibility and strength of the connective tissues are due to fibres. The function and types of connective tissues depend on the nature of the intercellular substance present.

Connective tissues contain three types of fibres: collagen, elastic and reticular

Collagen fibres are the most widespread and made up of fibrous protein, collagen. Collagen fibres are flexible and have high tensile strength (comparable to steel).

Elastic fibres form a network and can be stretched like a rubber band. They are made up of protein elastin. They retain their original shape and size once the force is removed.

Reticulate fibres consist of collagen and glycoproteins. They are thin and form a delicate network. They join connective tissues to neighbouring tissues.

There are various kinds of cells present in different types of connective tissues. They secrete different types of fibres and matrices. Fibroblasts or adipose cells are **stationary** and macrophages, mast cells, monocytes, lymphocytes are **migrating** cells.

Fibroblasts are found in developing tissues and play an important part in wound-healing. They are spindle-shaped and present between collagen fibres. They secrete tropocollagen and other substances found in the matrix.

Macrophages are also known as scavenger cells. They wander through connective tissues, clean up debris and remove bacteria and other antigens by phagocytosis.

Also see: Types of Epithelial Tissue

Types of Connective Tissue

Connective tissues are divided into three groups:

Loose Connective Tissue

Loose connective tissues are present all over the body, where support and elasticity both are needed. Blood vessels, nerves and muscles, all have a loose connective tissue wrapping. They form the subcutaneous layer under the skin along with adipose tissues, attaching muscles and other structures to the skin.

The fibres and cells are loosely arranged in the semi-fluid matrix. They are found between many organs as a filling and act as a shock absorber and reservoir for salt and fluid.

Areolar Tissue: It is present under the skin and supports epithelium. It contains randomly distributed fibres, fibroblasts, mast cells and macrophages. It supports the organs present in the abdominal cavity, fills the space between muscle fibres and wraps around blood and lymph vessels.

Adipose Tissue: They are present under the skin and store fat. It acts as a shock absorber and helps in maintaining body temperature in colder environments.

White adipose tissues protect kidneys and are also found at the back of the eye, in the hump of camels, blubber of whales, etc.

Brown adipose tissue is found in infants, polar bears, penguins and other animals found in cold regions. It contains more mitochondria and generates 20 times more heat as compared to the other fat. It releases metabolic heat.

Reticular Connective Tissue: It is made up of reticular fibres. It supports the internal framework of organs such as liver, lymph nodes and spleen.

Dense Connective Tissue

In the dense connective tissue, fibroblast cells and fibres are compactly packed. Their main function is to support and transmit mechanical forces. They are somewhat less flexible than loose connective tissue. On the basis of the arrangement of collagen fibres, they are divided into two types:

Dense regular tissue: In this type of tissue, the orientation of fibres are regular. The collagen fibres are present between the parallel running bundles of fibres. The regular arrangement enhances tensile strength and poses resistance to stretching in the direction of the orientation of fibre. Examples of dense regular tissue are tendons and ligaments.

Tendons and Ligaments: Tendons attach bones to skeletal muscles. Ligaments attach two bones together.

Dense irregular tissue: There are many fibres including collagen, which are oriented irregularly or randomly. The irregular arrangement gives uniform strength in all directions. Fibres may form a mesh-like network. This type of tissue is present in the dermis of the skin.

Specialised Connective Tissue

Other than these, there are supportive connective tissues, that help in maintaining correct posture and support internal organs, e.g. cartilage and bone.

Blood and lymph are fluid connective tissues that circulate in the body and help in interaction and communication among all the organs.

Cartilage: Cartilage is mostly present in the embryonic stages and works as a supporting skeleton. Most of the cartilage is replaced by bones in adults, however, it supports some structures in adults too. In humans, cartilage is present between the bones of the vertebral column, in the external ear, nose and hands.

The cartilage consists of **chondrocytes** cells, which are enclosed in a hard, rubbery matrix, secreted by them. They secrete collagen fibres also, which provide additional strength. Chondrocytes lie in the cavities known as **lacunae,** in a group of 2-4 cells or singly. Cartilage possesses elasticity, but is firm too. They lack nerves, blood and lymph vessels.

Bones: Bone is the hardest connective tissue and helps in maintaining the shape and posture of the body, it protects internal organs. They are rich in collagen fibres and calcium, which give strength.

The cells of the bone are known as **osteocytes.** They are present in lacunae and secrete the matrix. There is substantial blood supply in bony tissues. The cytoplasmic extension of osteocytes makes tiny channels known as **canaliculi.** These channels help in communication among osteocytes and capillaries.

Spongy bone is present in the core surrounded by the compact bone. **Osteons** is the spindle-shaped unit present in the compact bone. Osteocytes are present in the concentric layers of the matrix in each osteon, called **lamellae.** Capillaries and nerves pass through a central channel known as **Haversian canals.** Haversian canals are surrounded by lamellae.

There is a central marrow cavity made up of spongy tissues (marrow). The yellow marrow contains fat, whereas red marrow produces blood cells.

Blood: Blood is made up of various cells present in the plasma. The blood contains red blood cells (RBCs), white blood cells (WBCs) and platelets.

RBCs have haemoglobin and transport oxygen.

WBCs form a defence system and protect from foreign antigens.

Platelets are important for blood clotting.

Plasma contains proteins, water, hormones, salts, etc. to transport to different parts of the body.

Lymph: Lymph drains into the blood and transports absorbed fat to the blood, which cannot enter the bloodstream directly. Lymph has white blood cells in the liquid matrix. They help in getting rid of toxins and waste materials. They contain WBCs, which help in fighting infection.

Connective Tissue Disorder

Connective tissue disorders may be due to mutation of genes or by inherited faulty genes. The two genetic disorders of connective tissue are epidermolysis bullosa (EB) and Marfan syndrome.

Marfan syndrome is due to defective genes producing a protein fibrillin-1. The disease is characterised by a very thin and long body. Fingers and toes are spider-like.

EB is characterised by skin oversensitivity.

The other type of connective tissue disorder is autoimmune. When the immune system of the body starts attacking healthy tissues, it is known as an autoimmune disorder.

Some of the autoimmune diseases of connective tissue are the following:

The systemic lupus erythematosus (SLE) – It is an inflammatory disorder of the skin and internal organs. The immune system of the body starts attacking its own tissues. Symptoms include fever, swollen and painful joints, mouth ulcers, hair loss, butterfly rash, etc.

Rheumatoid arthritis (RA) – It leads to the damage in joints and deformities. RA is due to the immune system attacking synovium, the membrane between joints.

Scleroderma- It is characterised by thickening and hardening of the connective tissue. It may be localised, only affecting a part of the skin or systemic, impacting vital organs.