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Structure of Dicot Stem

STEM :

- Shoot system is an aerial and erect part of plant body which grows upwards.
- It isusually above the soil and develops from **plumule** of the embryo.

Characteristics of Stem:

i. Arises as a prolongation of plumule (one end of an embryo).

ii. Grows and bends towards light **(positively phototropic)** and away from gravity **(negatively geotropic).**

iii. Divided into **nodes** (point of attachment of leaf) and **internodes** (regions between two nodes).

iv. Bears leaves, branches and flowers on nodes.

v. Bears **vegetative buds** which could be terminal (apical bud) for plant to grow upwards or axillary (bud in the axil of leaf) which give rise to lateral branches.

vi. Bears **floral buds** (terminal or axillary) that grow into flowers.

Differences between stem and root:

STEM	ROOT
A. Develop from plumule.	A. Develop from radicle.
B. Young stem is green coloured because of chlorophyll.	B. No green because of chlorophyll is absent.
C. Divided into nodes and internodes.	C. Not divided into nodes and internodes.
D. Bears leaves, vegetative and floral buds.	D. Absent.
E. No cap present at the apex	E. Root cap is present at the apex.
F. Positively phototropic and negatively geotropic	F. Negatively phototropic but positively geotropic.
G. Origin of lateral branches is exogenous (originating from outer layers).	G. Origin of lateral roots is endogenous (originating from inner layers).

Functions of stem:

A. Primary functions:

i. **Support and orient the leaves** in a manner that they are exposed to maximum sunlight and for efficient gaseous exchange during photosynthesis and respiration

ii. **Conduct water and minerals** from roots to leaves and manufactured **food** from leaves to different parts of the plant.

iii. Bear flowers and fruits.

B. Secondary Functions:

i. **Storage -** Stems store food and water in plants e.g. potato

ii. **Perennation -** The underground stems help tide over the unfavourable growing periods e.g. ginger.

iii. **Vegetative propagation -** Stem can be a means of vegetative propagation e.g. rose, sugar cane.

iv. **Photosynthesis-** in certain plants like xerophytes (desert plants) where leaves are reduced, the stem takes up the function of photosynthesis. These stems posses chlorophyll e.g. *Opuntia*

v. **Protection-** In some plants the axillary bud modifies into thorn and protects the plants from animals e.g. citrus, D*arranta.*

vi. **Climbing -** Tendrils or hooks are modified branches or buds. They coil around the support and help the plant to climb e.g. grape vine

- **Internal (anatomical) structure of stem**
- The internal structure can be studied if you cut the stem transversely and observe
- it under a compound microscope.

A. Internal structure of dicot stem (e.g., Sunflower)

- In a transverse section of a young dicot stem we will see the following structure :

- **Epidermis -** Outermost single layered, covered with cuticle, bears multicellular hairs, protective function.
- **Cortex** - Inner to epidermis, there are three regions.

1) **Hypodermis -** 4-6 layers of collenchyma for mechanical support.
2) **Middle layers -** Few layers of parenchyma.
3) **Endodermis -** Innermost layer of cortex, has barrel shaped cells. As cells contain starch grains, it is also called **starch sheath.**

- **3. Stele -** All the tissues lying internal to endodermis constitute the stele.

A. **Pericycle -** Inner to endodermis, multilayered, parenchymatous with patches of sclerenchyma.

B. **Vascular bundles -** Arranged in a ring each vascular bundle is :-

✓**Conjoint** (xylem and phloem together in one bundle),

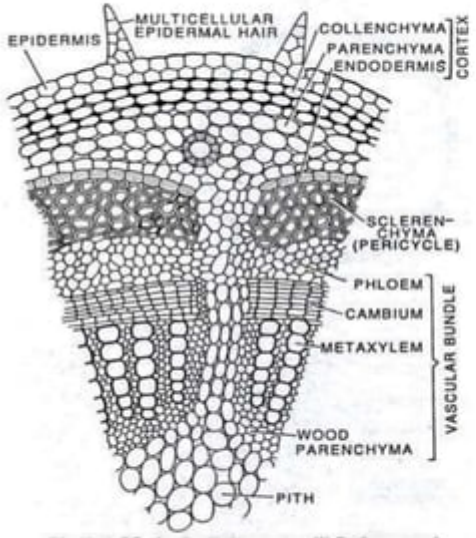
✓**Collateral** (xylem and phloem on the same radius with phloem towards the periphery)

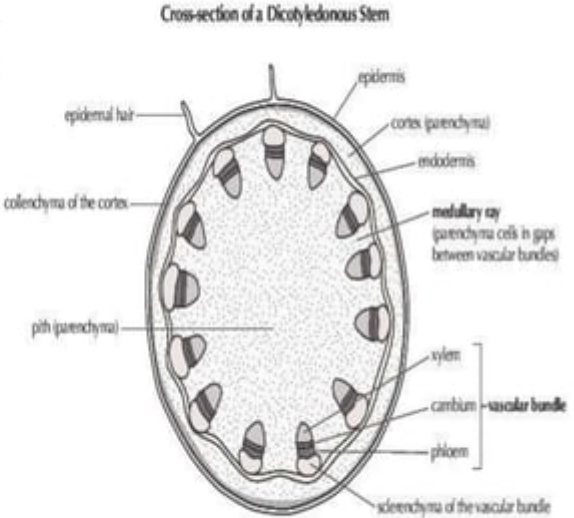
✓ **Open type**(cambium present in between xylem and phloem).

- Xylem is **endarch** (protoxylem towards Centre and metaxylem towards periphery).

C. **Medullary rays -** Narrow regions of parenchymatous cells in between the vascular bundles.

D. **Pith -** The central parenchymatous zone with intercellular spaces.


EPIDERMIS
MULTICELLULAR EPIDERMAL HAIR
COLLENCHYMA
PARENCHYMA
ENDODERMIS
CORTEX
SCLEREN-CHYMA (PERICYCLE)
PHLOEM
CAMBIUM
METAXYLEM
VASCULAR BUNDLE
WOOD PARENCHYMA
PITH


Cross-section of a Dicotyledonous Stem
epidermis
epidermal hair
cortex (parenchyma)
endodermis
collenchyma of the cortex
medullary ray
(parenchyma cells in gaps between vascular bundles)
pith (parenchyma)
xylem
cambium
vascular bundle
phloem
sclerenchyma of the vascular bundle

B. Internal structure of monocot stem (e.g., maize):

- A transverse section of monocot stem reveals the following structure :-
- **Epidermis** - Single layered, covered with cuticle, stem hairs absent.
- **Ground tissue-** A mass of parenchymatous tissue.
- Only a few peripheral layers below epidermis are sclerenchymatous called **hypodermis.**
- **Vascular bundle-** Numerous, scattered in the ground tissue each enclosed by sclerenchymatous bundle sheath. Each bundle is

(a) cotlateral and **(b) closed** (no cambium strip between xylem and phloem) with **(c) endarch** xylem. Xylem occurs in the form of letter 'Y' and innermost protoxylem disintegrates to form a water cavity.

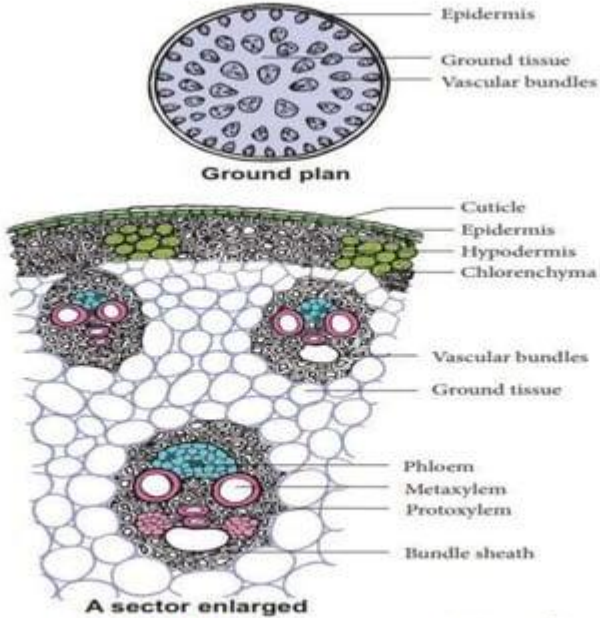


Figure 12.5 Transverse section of Monocot stem

- **Differences between monocot stem and dicot stem**

CHARACTERS	DICOT	MONOCOT
1. Epidermal hairs	Present	Absent
2. Hypodermis	Collenchymatous	Sclerenchymatous
3. Ground tissue	Differentiated into cortex, endodermis, pericycle, pith and medullary rays.	Undifferentiated
4. Vascular bundles	i. Number not very large. ii. Uniform in size. iii. Arranged in a ring. iv. Open. v. Bundle sheath absent. vi. Xylem vessels arranged in a radial row. vii. Water cavity absent.	i. Numerous in number. ii. Smaller near periphery, bigger in the centre. iii. Scattered. iv. Closed. v. Bundle sheath present. vi. Xylem vessels arranged in shape of letter "Y". vii. Water cavity present.
5. Secondary growth	Present	Mostly absent.

Anatomical differences between stem and root

Characters	Stem	Root
1. Cuticle	1. Present.	1. Absent.
2. Hairs	2. Multicellular.	2. Unicellular.
3. Ground tissue	3. Differentiated.	3. Differentiated.
4. Cortex	4. Narrow (dicot) or undifferentiated (monocot).	4. Wide.
5. Pericycle	5. Many layers of sclerenchymatous and parenchymatous cells.	5. Single layered of parenchymatous cells only.
6. Vascular bundle	6. Many conjoint and collateral.	6. Fixed number, radial.
7. Xylem	7. Endarch	7. Exarch

Secondary growth in stem:

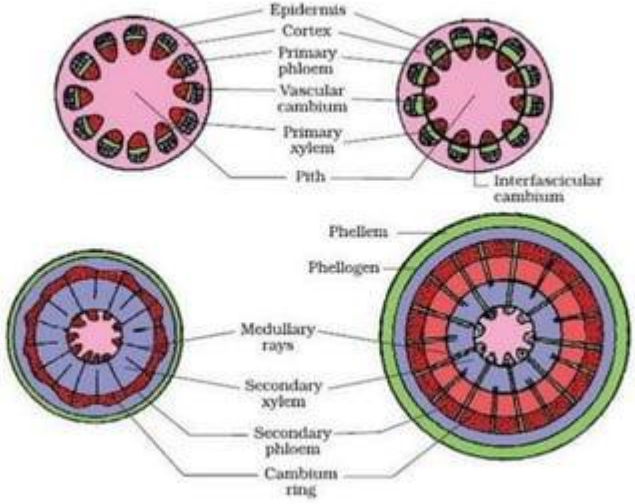
- Growth in thickness in stem becomes possible due to the formation of new tissues entirely by the activity of two lateral meristems - (i) Vascular cambium (ii) Cork cambium.
- These tissues thus formed are known as secondary tissues and growth in girth is referred as secondary growth.

1. **Activity of vascular cambium** -Forms secondary vascular tissue as follows:-

- The strip of cambium present in the vascular bundle is called **Fascicular Cambium.**
- The cells of medullary rays adjoining the strip of vascular (Fascicular) cambium become meristematic and form **interfascicular cambium.**
- Both fascicular and inter-fascicular cambium join to form a continuous **cambium ring.**
- Cambium divides and adds cells on internal side (towards pith) which mature into **secondary xylem** and cells added towards external side (periphery) mature into **secondary phloem**.
- Amount of secondary xylem produced is more than secondary phloem

2. **Activity of cork cambium**-Forms periderm as follows :

- Cork cambium or **phellogen** develops in the cortex.
- **Phellogen** divides and adds cells on both the inner and the outer side.
- The inner cells differentiate into **phelloderm** or **secondary cortex** while outer cells into **phellem** or **cork**.
- Cork cells are compactly arranged and become dead and suberized (deposition of suberin) except in regions of **lenticels,** where cells are loosely arranged **(complimentary cells)** and non-suberized.
- It is through the lenticels that woody branches and tree trunks can undergo gaseous exchange.
- Phellogen, phelloderm and phellem together constitute the **periderm**.Due to internal increase in thickness, periderm replaces the epidermis, becomes protective in function.
- All the dead cells lying outside the active phellogen constitute the **bark.**


Epidermis
Cortex
Primary phloem
Vascular cambium
Primary xylem
Pith
Interfascicular cambium
Phellem
Phellogen
Medullary rays
Secondary xylem
Secondary phloem
Cambium ring