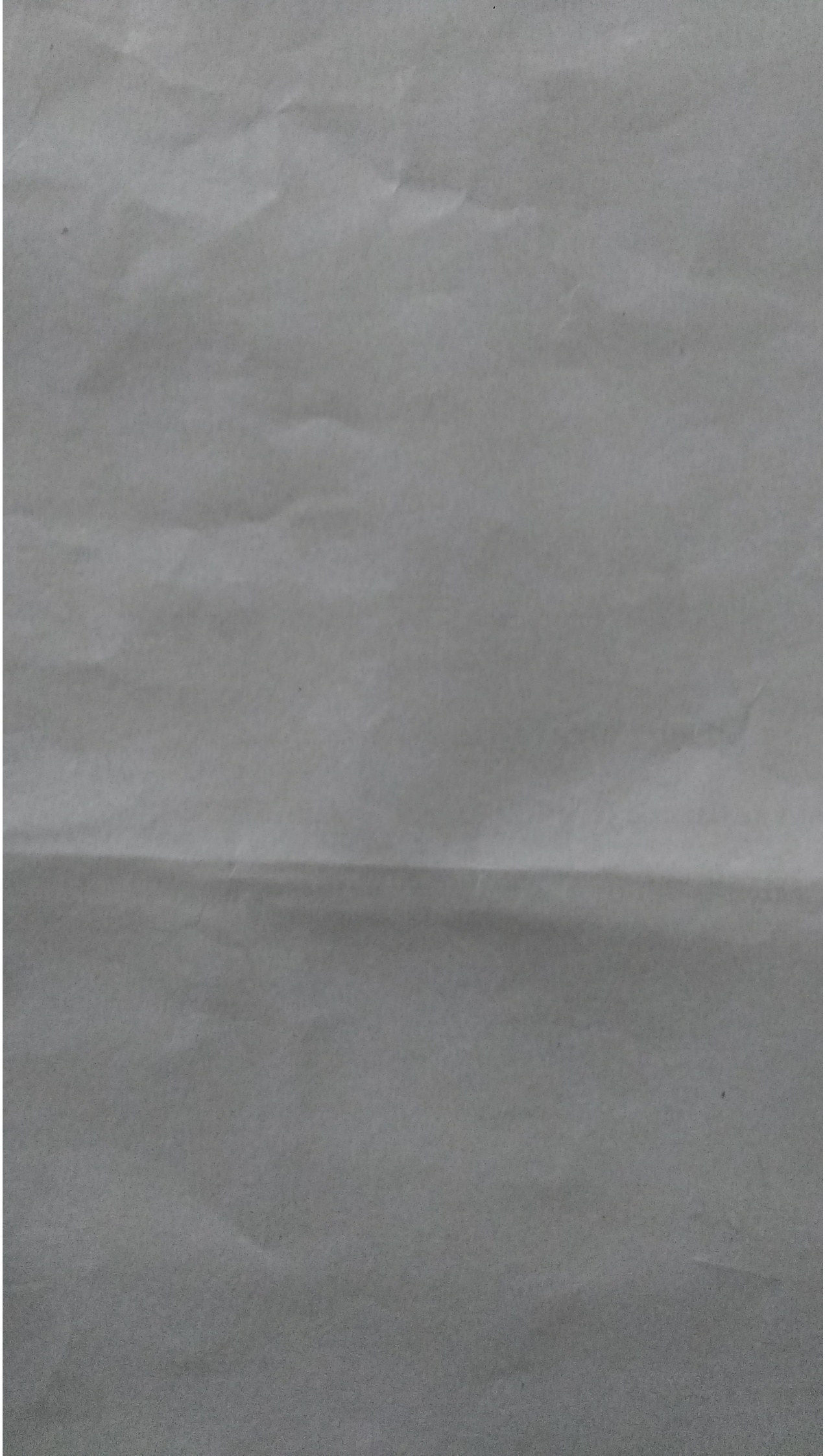

THE TISSUE

A group of similar or dissimilar cells which perform a common function and are similar in their origin and structure, is called a tissue.

✪ Term 'tissue' was coined by **N. Grew.**

The internal structure of most of the plants is complex with the exception of some lower plants. These cells are in groups and perform definite functions.

The tissues are grouped into two main types:

1. Meristematic tissue (Already described).

2. Permanent tissue.

PERMANENT TISSUE

Permanent tissues are formed due to division and differentiation in meristematic tissue. The cells of these tissue may be **living** or **dead, thin-walled** or **thick-walled.** The thin walled tissues are generally **living** whereas the thick-walled tissues may be **living** or **dead.**

The permanent tissues are further of 2 types:

(A) Simple permanent tissue.

(B) Complex permanent tissue.

(A) Simple permanent tissues

The simple permanent tissue is made up of **one type** of cells which form a uniform system of cells and perform a common function. These simple tissues are of three main types:

(a) Parenchyma; (b) Collenchyma; (c) Sclerenchyma.

(a) Parenchyma

Term 'parenchyma' is made up of two Greek words–

para – beside + *en-chein* – to pour, *i.e.*, some semi-liquid substance poured beside other solid tissues (ancient concept of parenchyma).

The parenchymatous cells are **isodiametric** and **thin-walled,** which may be oval, spherical or polygonal in shape with well developed **intercellular spaces.** In pericycle of some plants, parenchymatous cells become long and taper at both ends, called **prosenchyma.** (Fig. 18.6)

Functions of parenchyma

(i) The main function is **storage of food.** The storage parenchyma develop thick walls, *i.e.*, the endosperm of *Phoenix dactylifera* (date palm), *Coffea arabica* (coffee).

(ii) In fleshy stems and leaves, these cells act as **water storage tissue,** *e.g.*, *Opuntia, Euphorbia, Aloe, Agave*, etc.

(iii) In hydrophytes, the parenchyma develop air spaces and such parenchyma with air cavities is known as

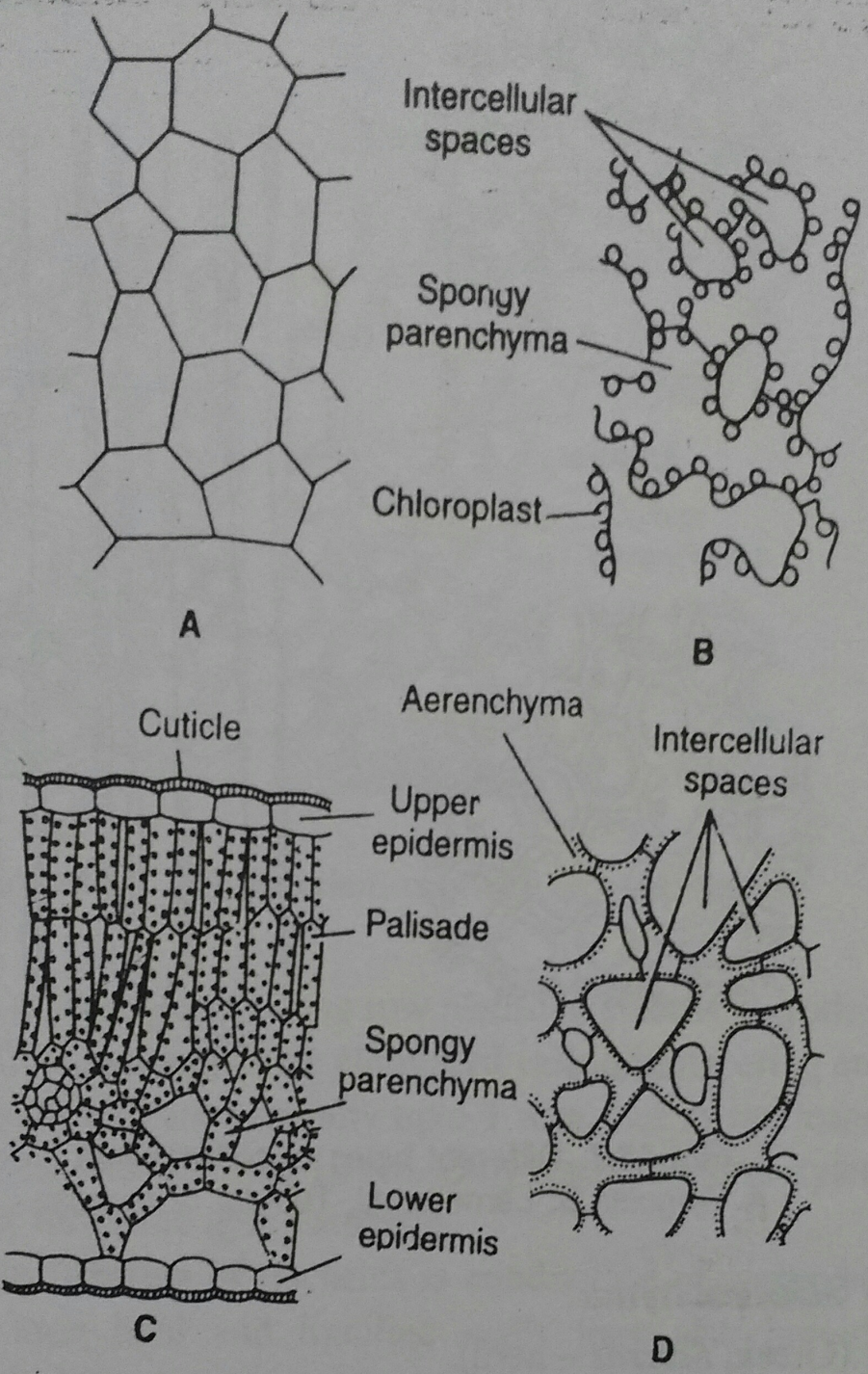

Fig. 18.6. Different types of parenchymatous tissues **A.** Parenchyma **B.** Chlorenchyma **C.** Palisade and spongy parenchyma **D.** Aerenchyma

aerenchyma, which help in floating or buoyancy, *e.g.*, *Eichhornia.*

(iv) Some times chloroplasts are developed in parenchyma cells which are called **chlorenchyma.**

(v) In some cases, the parenchyma cells develop the capacity of cell division or become cambium like, *e.g.*, **cork cambium** and **root cambium,** which help the plant in secondary growth and formation of cork.

(b) Collenchyma

Collenchyma is made of **thick-walled cells,** which are **living.** The thickenings are of **cellulose** and **pectin.** Further the intercellular spaces in this tissue are absent. There are 3 types of collenchyma with respect to arrangement of cells:

(i) Angular type : Here the cells are **irregularly arranged** and thickenings are present at angles. **This is most common type** of collenchyma, *e.g.*, in *Ficus, Vitis, Polygonum, Morus, Canabis.*

(ii) Lamellar type : Here the thickenings are **plate like.** *e.g.*, in *Rheum, Eupatorium*, etc.

(iii) Tubular type : In this type, the intercellular spaces are present, *e.g.*, in *Salvia, Malva, Althaea,* etc.

Functions of collenchyma : The chief function of this tissue is to provide **mechanical support** to the organs. Further, when the chloroplasts are present, it takes part in photosynthesis process.

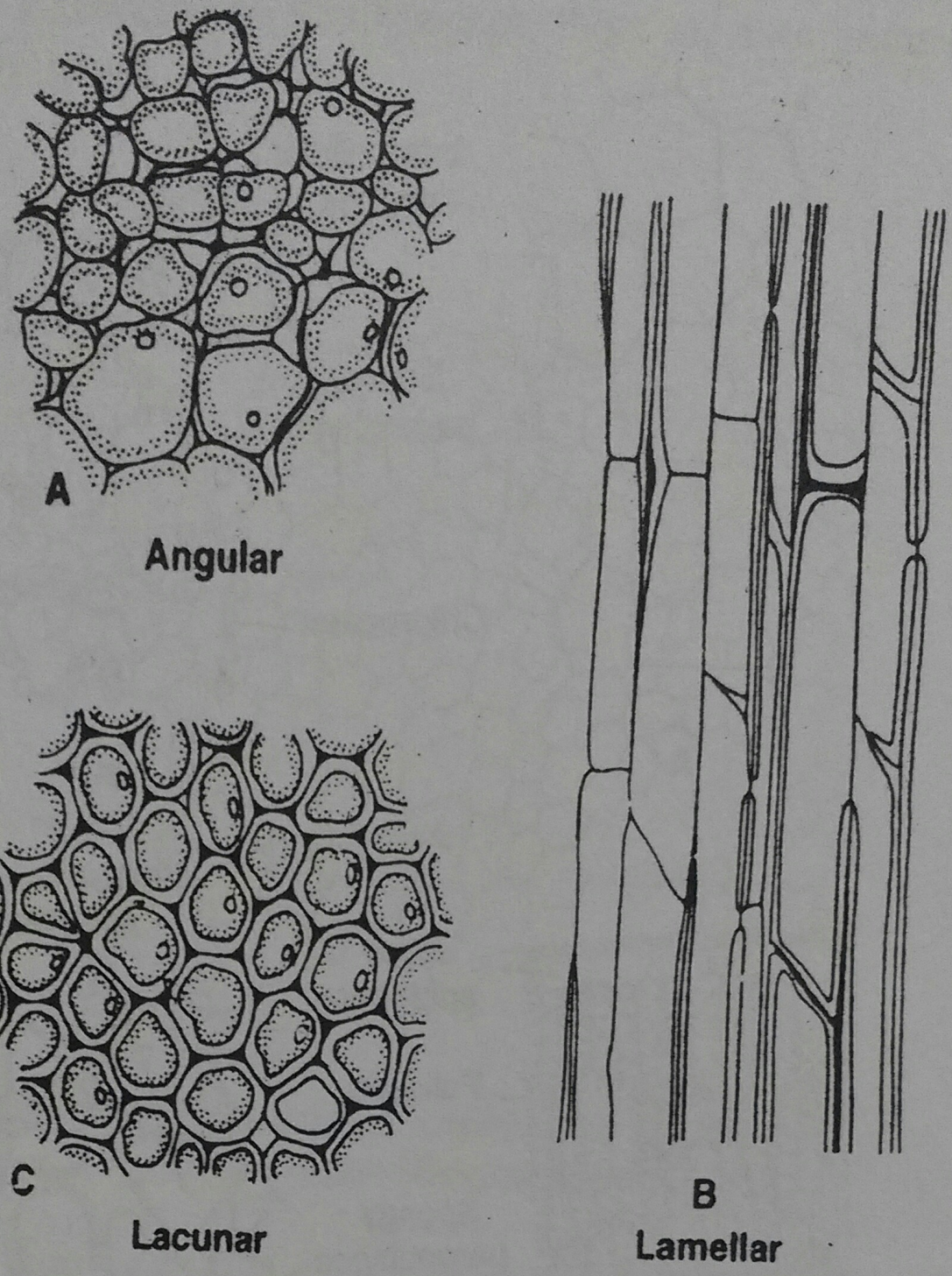

Fig. 18.7. Different types of collenchyma
A. Angular B. Lamellar C. Tubular or lacunar

(C) Sclerenchyma

(Greek; *Scleros* – hard).

Sclerenchyma is **thick – walled tissue** which has depositions of **lignin** on their cell walls (**lignified**).

✪ These are **dead cells.**

Sclerenchymatous tissue is of 2 types:

(i) Sclerenchymatous fibres.

(ii) Sclereids or stone cells.

(i) Sclerenchymatous fibres : These are **thick-walled** elongated cells with tapering or pointed ends. These have

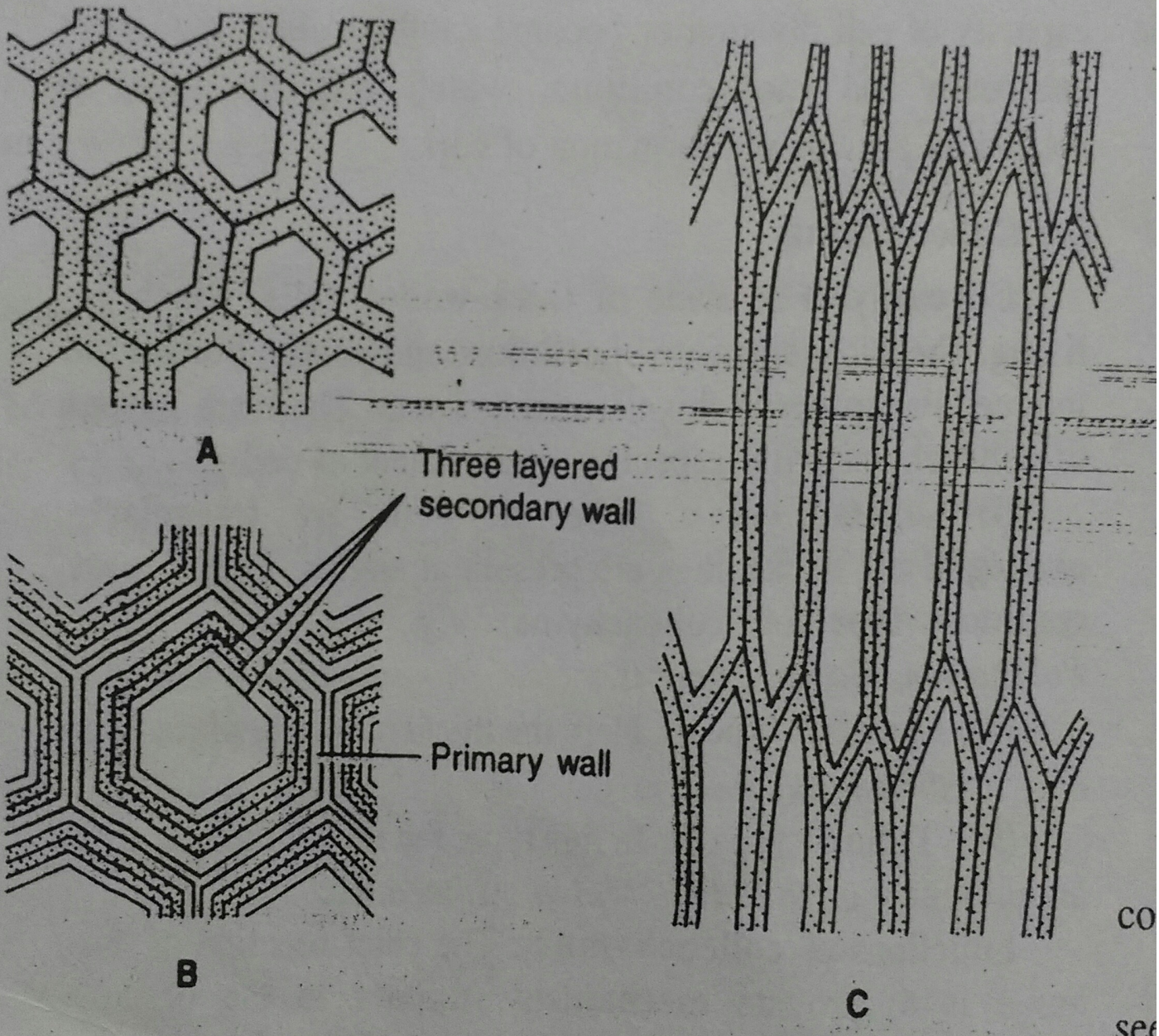

Fig. 18.8. Sclerenchyma **A and B.** T.S. **C.** L.S.

thickenings of lignin and have very narrow lumen. These are **dead** and **mechanical** in function. Generally **length of the** fibres is **upto 3 mm** but in some cases like **jute** (*Corchorus capsularis*), **flax** (*Linum*) and **hemp** (*Canabis*), fibres are upto **20 to 550 mm** in length.

Fibres are of two types:

(a) Xylem fibres or Xylary fibres : These arise from **same meristematic cells** from which other xylem cells arise.

(b) Extraxylary fibres or Bast fibres : *e.g.*, **phloem fibres** (originate in phloem), **cortical fibres** (originate in cortex) and **perivascular fibres** (*e.g.*, pericyclic fibres).

(ii) Sclereids or Stone cells : These are not much longer than their breadth. They have also **extremely thick wall of lignin** with narrow lumen. These are isodiametric but some are elongated also.

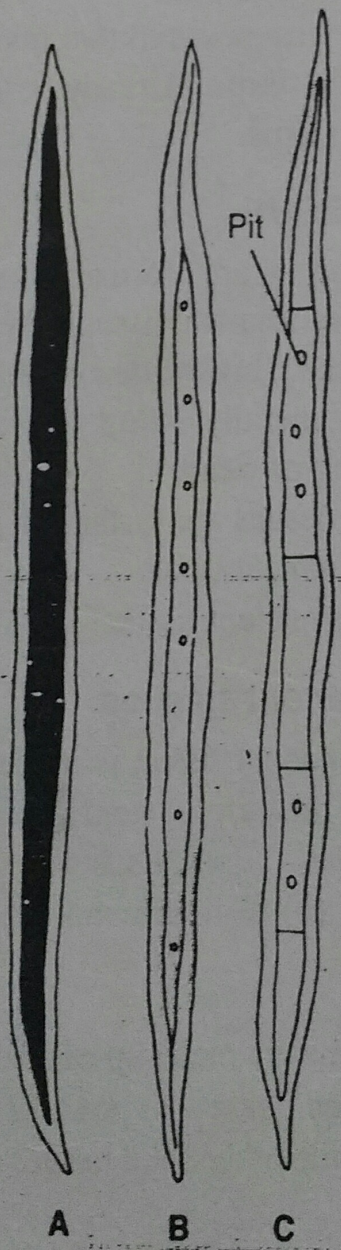

Fig. 18.9. A–C. Sclerenchymatous fibres

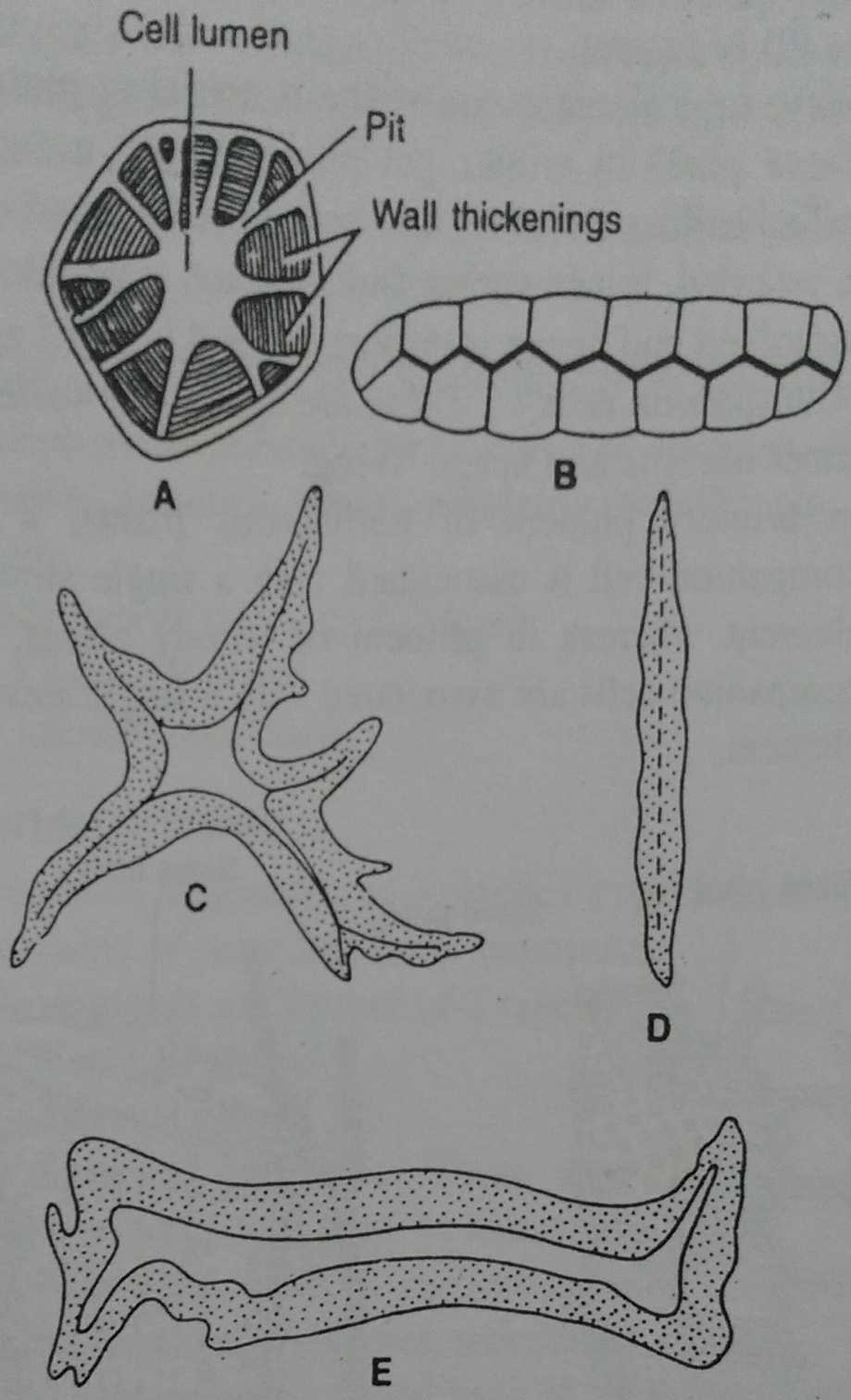

Fig. 18.10. Types of stone cells or sclereids
A. Brachysclereid **B.** Macrosclereid **C.** Asterosclereid
D. Filiform **E.** Osteosclereid

(c) **Osteosclereids** (bone shaped) : Found in hypodermal layers of many seeds and fruits.

(d) **Asterosclereids** (star shaped) : Found in intercellular spaces of leaves and stems of hydrophytes.

(e) **Filiform.**

- Function of sclereids is **mechanical.**

(B) Complex permanent tissues

A group of **different types** of cells which perform common function, is called **complex tissue.**

Important complex permanent tissues are:

(a) Xylem

Xylem is known as **water conducting tissue.** It is also known as **hadrome.** It is associated with conduction of water and minerals from roots to top of plants.

Xylem is having 4 types of cells or elements:

(i) Tracheids,

(ii) Vessels or tracheae,

(iii) Xylem parenchyma and

(iv) Xylem fibres.

(i) Tracheids : These are elongated cells with tapering ends and are **dead** because of deposition of **lignin** and thickenings in wall may be **scalariform** or **annular** or **reticulate** or **pitted.**

- Tracheids are generally with bordered pits.

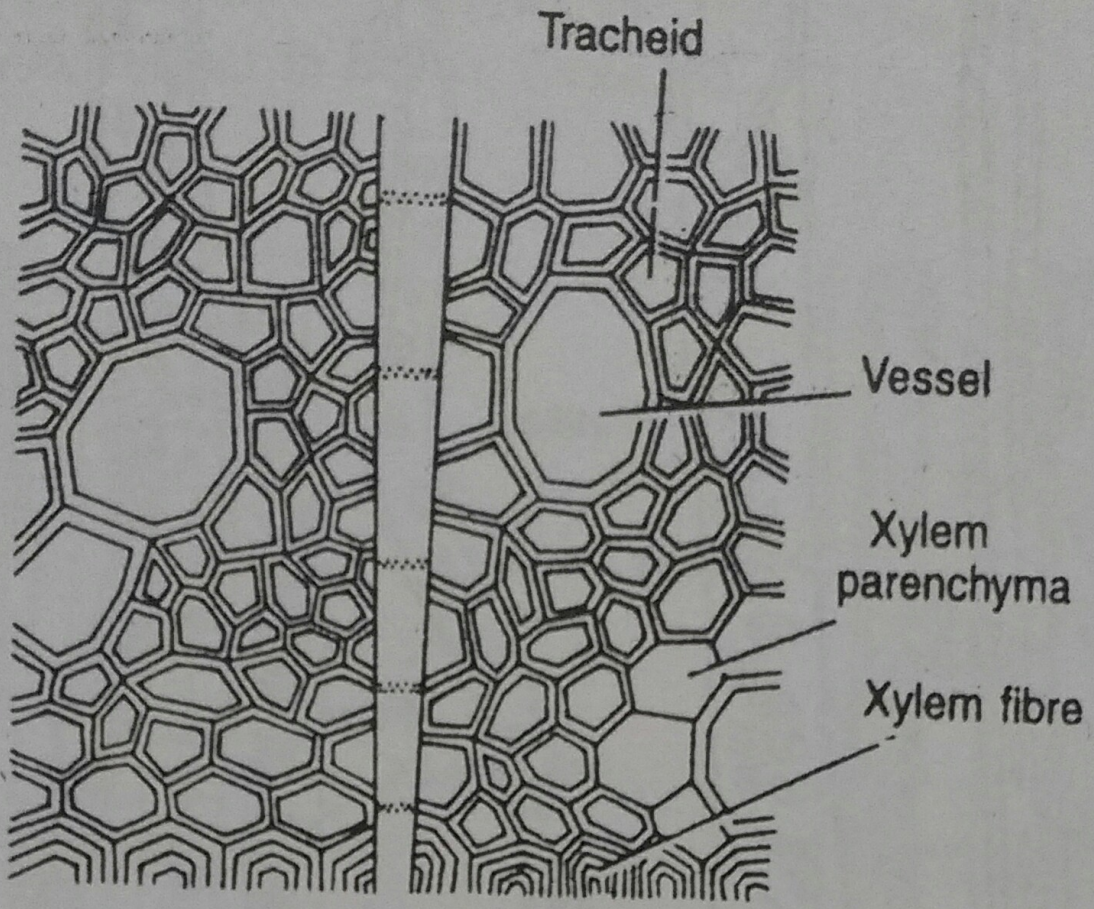

Fig. 18.11. T.S. of xylem showing its components

- Tracheids form a long row placed one above the other.
- Tracheids are **single elongated cells** with tapering end walls and are generally upto **1 mm,** but in rare cases these may be upto **12 cm.** Only tracheids form xylem of **ferns** and **gymnosperms.**

Main function of tracheids is **conduction of water** but due to their hard and lignified walls they also provide **mechanical** support.

(ii) Vessels or Tracheae : Vessels are different from tracheids in being cell fusion (*i.e.*, **composite structure**) as these are formed by dissolution of end walls of row of cells, *i.e.*, **vessel elements.**

- Vessels are generally upto **10 cm** in length but longest vessels are found in *Eucalyptus* and **oak** (*Quercus*), which are from **2 metre to 5 metre** in length.
- The walls of vessels are **lignified** but not so thick. The thickenings may be **annular** or **spiral** or **scalariform** or **reticulate,** etc.
- Usually diameter of vessels is much greater than tracheids. In most advanced types, vessels are **drum-shaped** with large diameter. The openings in vessel element walls are called **perforations,** which may be **simple perforations** (with single opening) or **multiple perforations** (two or more openings).

Vesselless angiosperms : Although vessels are characteristic features of angiosperms but there are certain angiosperms where **vessels are absent.** Such vesselless angiosperms belong to families:

1. **Winteraceae** (*e.g.*, *Wintera*).
2. **Tetracentraceae** (*e.g.*, *Tetracentron*).
3. **Trochodendraceae** (*e.g.*, *Trochodendron*).

Besides, vessels are absent in stem and leaves of *Yucca* and *Dracaena.*

- There are some **non-angiosperms** where vessels are present, *e.g.*, some species of *Selaginella,* two species of *Pteridium,* (**pteridophytes**) and order **Gnetales** of

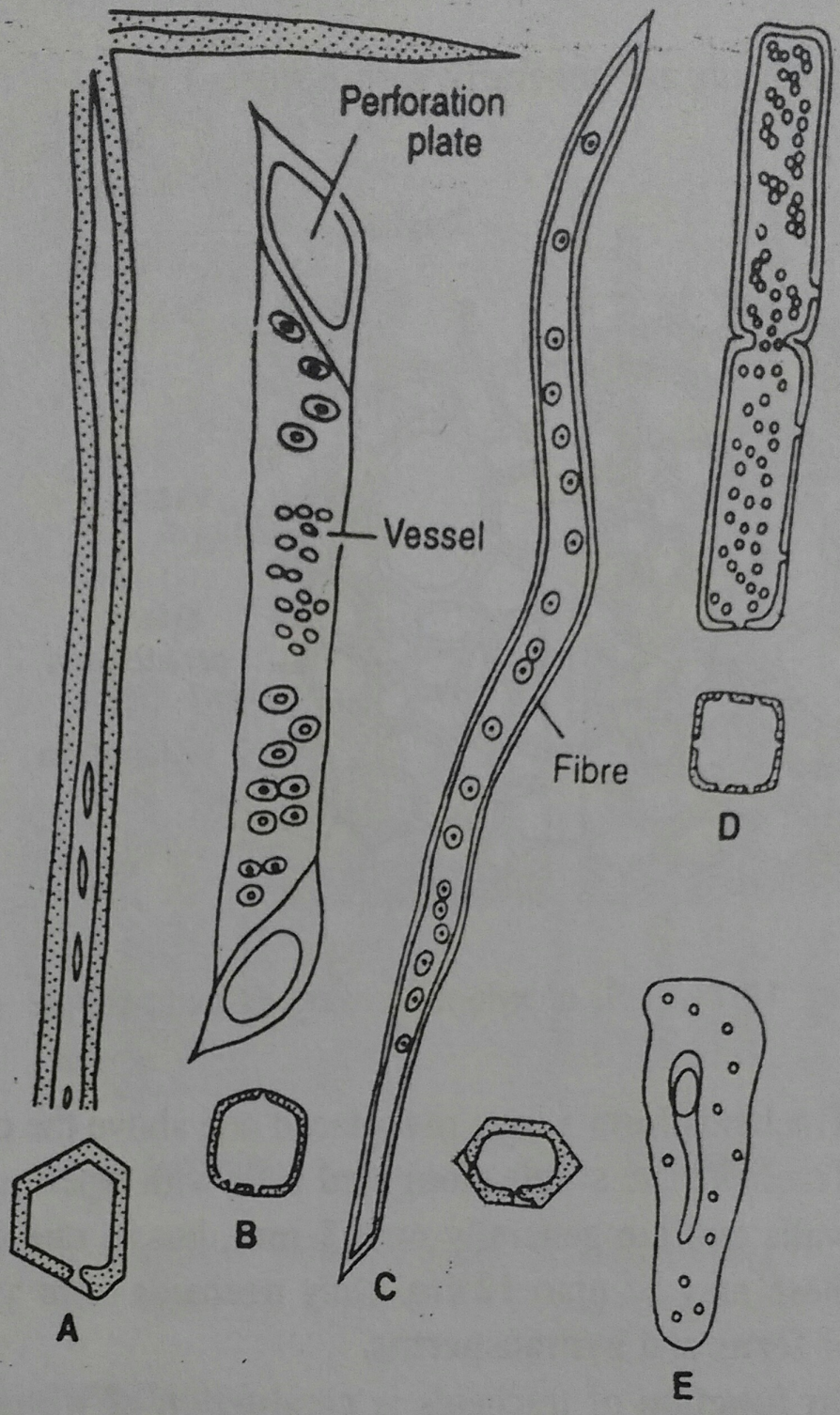

Fig. 18.12. Xylem elements **A.** Tracheid **B.** Vessel **C.** Fibre **D—E.** Parenchyma

gymnosperms (*e.g., Gnetum, Welwitschia* and *Ephedra*).

✪ At maturity **nucleus is absent** in vessels.

(iii) Xylem parenchyma : These are thin-walled **living cells** and they store food materials. They also help in conduction of water.

(iv) Xylem fibres or Wood fibres : They are **lignified** fibres found in xylem and provide **mechanical support.**

(b) Phloem or Leptome

Conducting tissue responsible for **transport of organic food** is **phloem.**

- In pteridophytes and gymnosperms, phloem is made of only **sieve cells** and **phloem parenchyma,** although in rare gymnosperms, phloem fibres are also present.
- In angiosperms phloem is made of **sieve tube elements, companion cells, phloem parenchyma and phloem fibres.** Although in many or most of the monocots, phloem parenchyma is absent.

(i) Sieve tube elements : These are conducting elements of phloem. These are arranged end to end in linear rows with septa (**sieve plate**) between two sieve tube elements. In the sieve plate, there are present **sieve pores.** In **pteridophytes** and **gymnosperms,** these are not arranged in linear rows and hence called **sieve cells.**

Sieve tube elements have **thin cellulosic walls** and hence they are **living,** although in some plants, **extremely thick wall (nacre wall)** is present.

- ✪ Sieve tube elements are **without nuclei at maturity.**
- ✪ Sieve pores in winter get plugged with a substance called **callose** (soluble) and hence the transport of food is retarded. But in spring and summer, this callose gets dissolved and hence transport of food is rapid again.

(ii) Companion cells : These are again thin-walled cells with distinct nucleus and hence **living.**

- ● In primary phloem of herbaceous plants, a single companion cell is associated with a single sieve tube element whereas in phloem of woody plants, many companion cells are associated with a single sieve tube element.

- The sieve tubes and companion cells are connected **through pits.**
- Companion cells are **absent** in phloem of **pteridophytes** and **gymnosperms.**
- The companion cells help in transport of food along with sieve tubes.

(iii) Phloem fibres : These are commonly known as **bast fibres** or **bass.** These are thick-walled sclerenchymatous cells with tapering ends with simple pits. They provide **mechanical support.**

(iv) Phloem parenchyma : These are simple thinwalled parenchymatous cells (living) which are intermixed with sieve tube elements. They store food material and also help in conduction of food.

- Phloem parenchyma is absent in most of the monocots and few dicots like *Ranunculus*.