

B.SC. SEMESTER-II

BOTANY PAPER-II

(MORPHOLOGY OF ANGIOSPERM AND FLORICULTURE)

UNIT III: (Carpel and Fruit)

Gynoecium: Parts, Cohesion, Adhesion and Placentation.

Fruit: Definition, Pericarp, Types of fruits: Simple (Dehiscent, Schizocarpic, Dry Indehiscent, Fleshy Indehiscent), Aggregate (Etaerio) fruits, Composite Fruits (Sorosis and Syconus).

Gynoecium: Parts, Cohesion, Adhesion and Placentation.

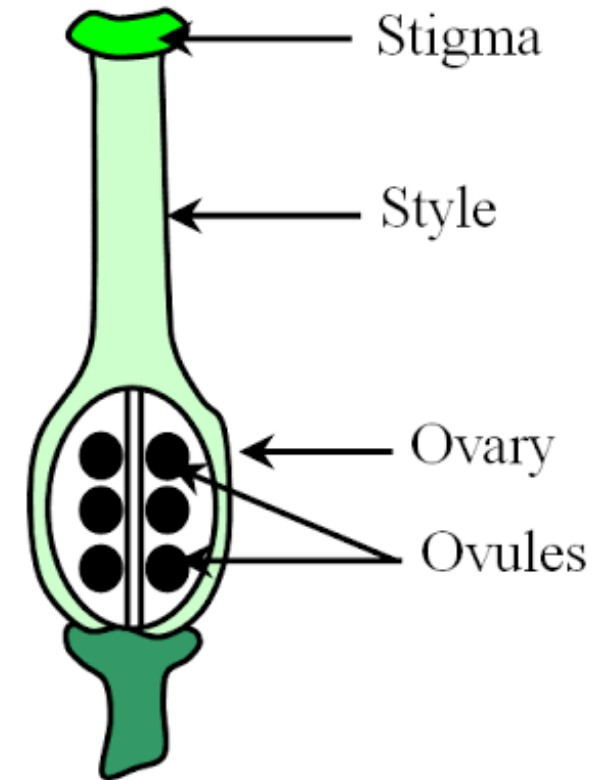
Gynoecium:

- Gynoecium, the female reproductive whorl of flower, consists of carpels(megasporophylls).
- A carpel is differentiated into 3 parts- Stigma, Style and Ovary.
- When gynoecium is sterile or underdeveloped, it is called pistillode.

Gynoecium may be classified broadly into two types:

(a) Simple or Monocarpellary:

It is composed of only one carpel, e.g., pea, all legumes.



Structure of carpel

(b) Compound or Multi-capillary:

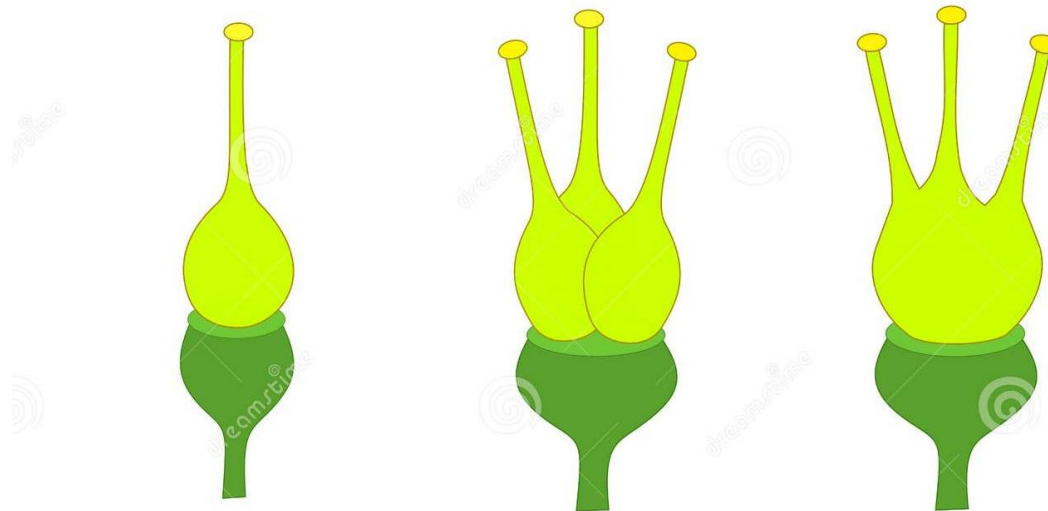
It comprises more than one carpel. Such a type of gynoecium occurs in majority of seed plants. Again, it may be of following two types: –

Apocarpous:

Each carpel is free from the other forming a separate gynoecium, e.g., *Ranunculus*, *Clematis*, etc.

Syncarpous:

All the carpels are fused with one another forming a compound gynoecium, e.g., Brassica (mustard), *Hibiscus* (China rose), *Solanum* species etc.



Monocarpous

Apocarpous

Syncarpous

2. Number of Carpels:

Depending upon the number of carpels, a syncarpous gynoecium may be of the following types:

(i) **Bicarpellary:** Comprises two carpels, e.g., *Sonchus*, *Coriandrum*, *Mussaenda*.

(ii) **Tricarpellary:** With three carpels, e.g., *Allium cepa* (onion), etc.

(iii) **Tetracarpellary:** With four carpels, e.g., *Duranta*, *Berberis*, etc.

(iv) **Pentacarpellary:** With five carpels, e.g., *Hibiscus* (China rose) etc.

(v) **Multicarpellary:** With more than five carpels, e.g., *Papaver*.

3. Stigma:

It is the terminal part of pistil meant for receiving pollens at the time of pollination.
On the basis of shape, stigma may be

Capitate or round: *Hibiscus, Citrus*

plumose or feathery: grasses

Fid or Forked: *Tridax*

Discoid: *Melia*

Dumb-bell shaped: *Thomoea*

Hood-Like: *poppy*

Funnel-shaped: *Crocus*

Striated: *Argemone*

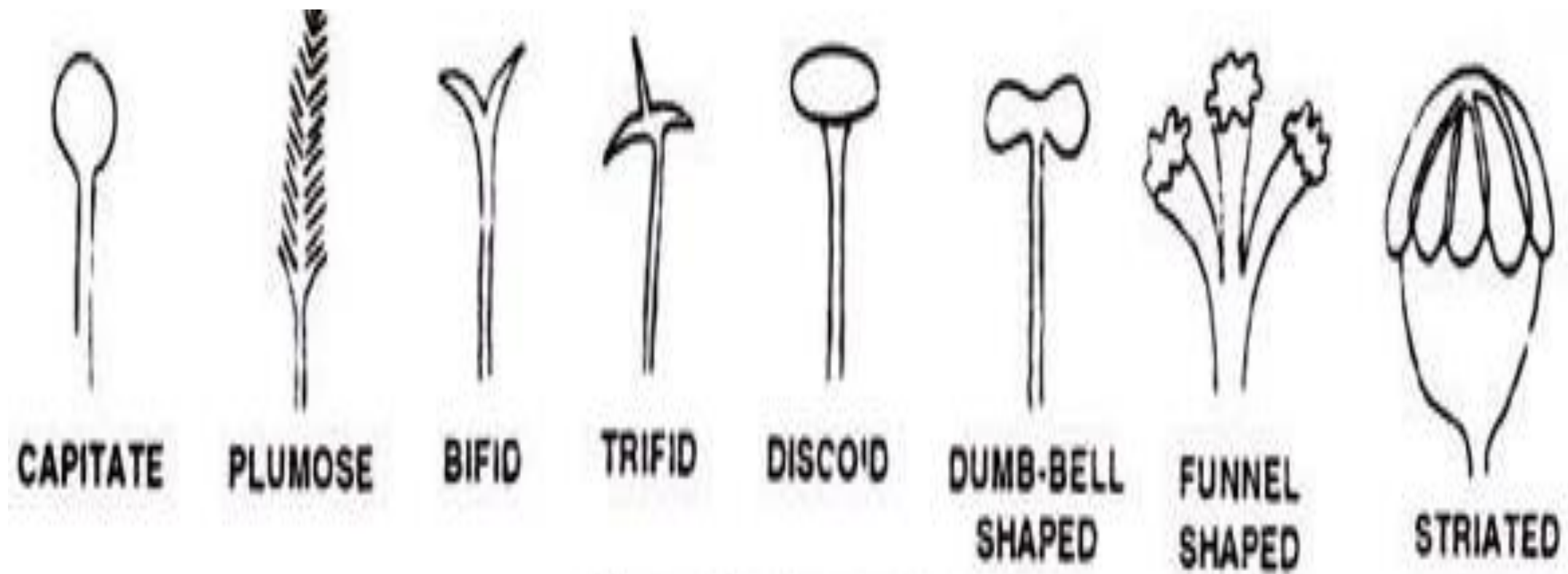


Figure 6.13. Types of Stigma

4. Style:

It is the tubular stalk that connect stigma with ovary.

It may be of following types-

(a) Terminal or Apical:

When style lies in the same straight line with the ovary, e.g., *Hibiscus*, *Dianthus*, etc.

(b) Lateral:

When style appears to be arising from the side of the ovary, such as in strawberry, mango, etc.

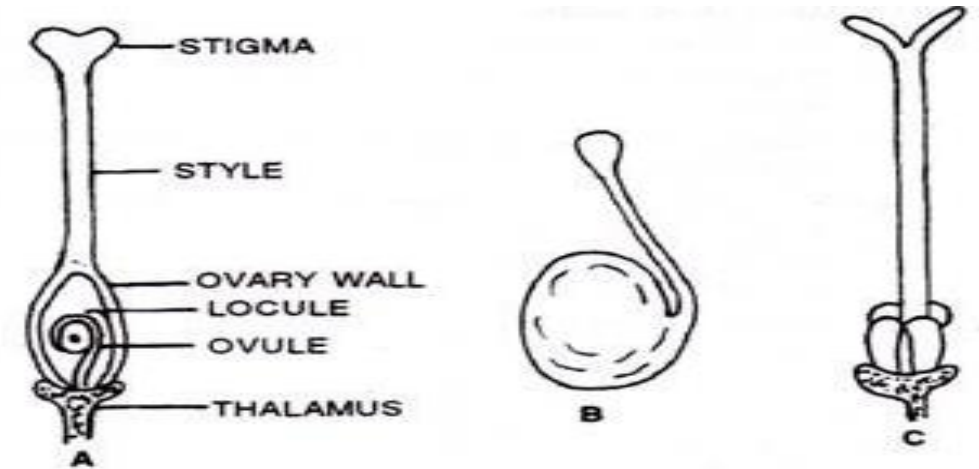


Figure 6.14. A. Pistil with terminal style (ovary cut open), B. Lateral style C. Gynobasic Style

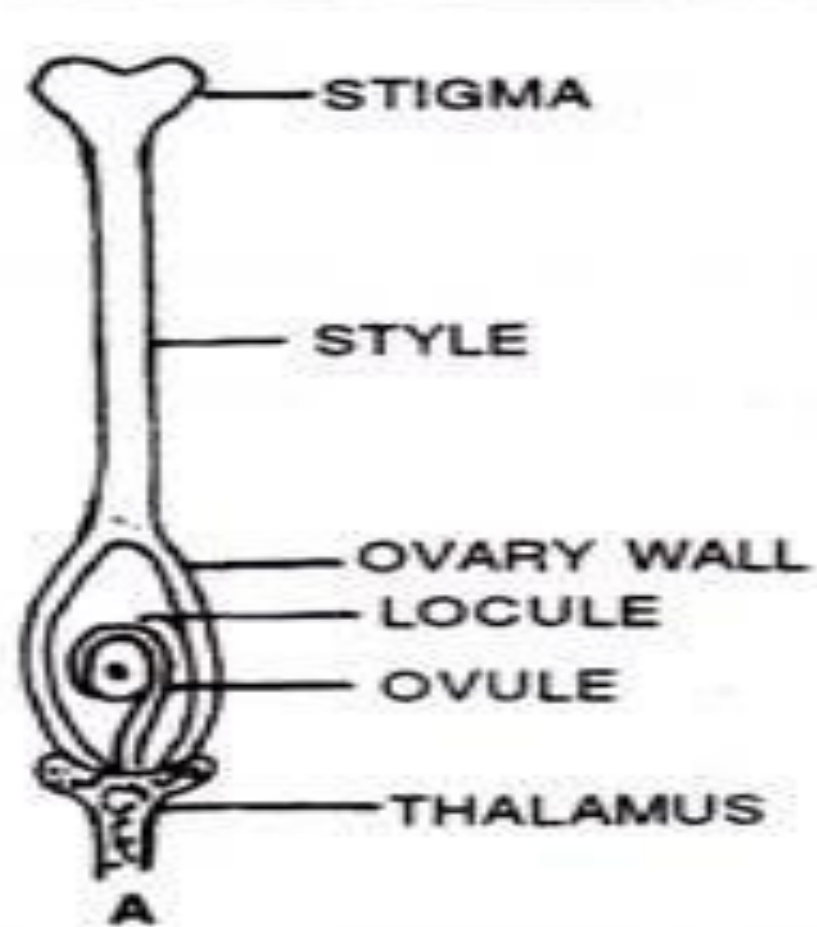


Figure 6.14. A. Pistil with terminal style (ovary cut open), B. Lateral style C. Gynobasic Style

5.Position of the ovary on thalamus:

In relation with other floral whorls, the ovary may occupy any of the following positions:

(i) Superior Ovary:

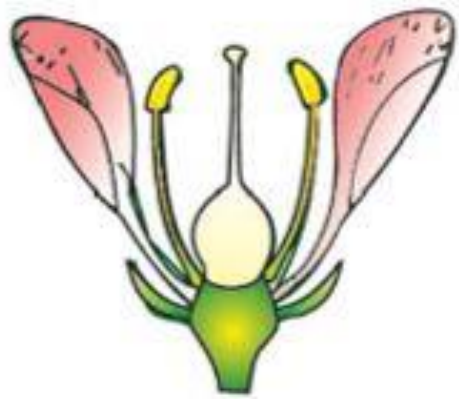
When Ovary occupies the highest position on thalamus, and the three other whorls (viz., sepals, petals and stamens) are successively inserted below it, the ovary is called superior, e.g., *Citrus* (lemon), *Hibiscus*, *Brassica*, etc.

(ii) Semi-inferior:

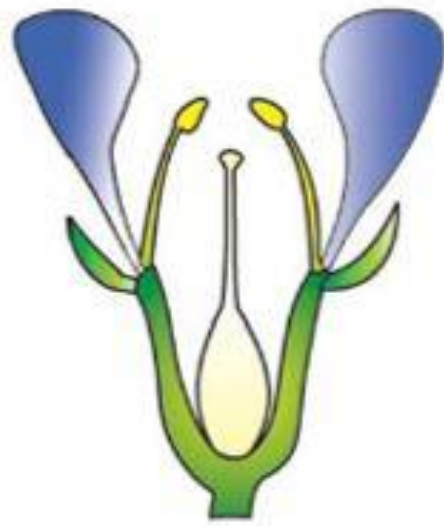
Here the thalamus grows around the ovary to form a cup, and bears sepals, petals and stamens on the rim of the cup e.g., *Rosa* (Rose), *Prunus*, etc.

iii) Inferior:

In this type, the thalamus completely covers the ovary and fuses with it. Sepals, petals and stamens emerge from the top of the ovary e.g., *Coriandrum*, *Mussaenda*, *Cucurbita*, etc.



Hypogynous



Perigynous



Perigynous



Epigynous

Chambers (locules) of the Ovary:

- Depending upon the numbers of locules, following types of ovaries can be recognized.
- Mostly the number of locules corresponds to the number of carpels, but this is not the rule, because sometimes the number of locules may be more than the number of carpels due to the formation of false septa or less due to dissolution of septa.

i) Unilocular:

Ovary with a single chamber, e.g., *Pisum* (pea).

(ii) Bilocular:

Ovary with two chambers, e.g., *Solarium*, *Murraya*, etc.

(iii) Trilocular:

Ovary with three chambers, e.g., *Asphodelus*, *Euphorbia*, *Musa* (Banana), etc.

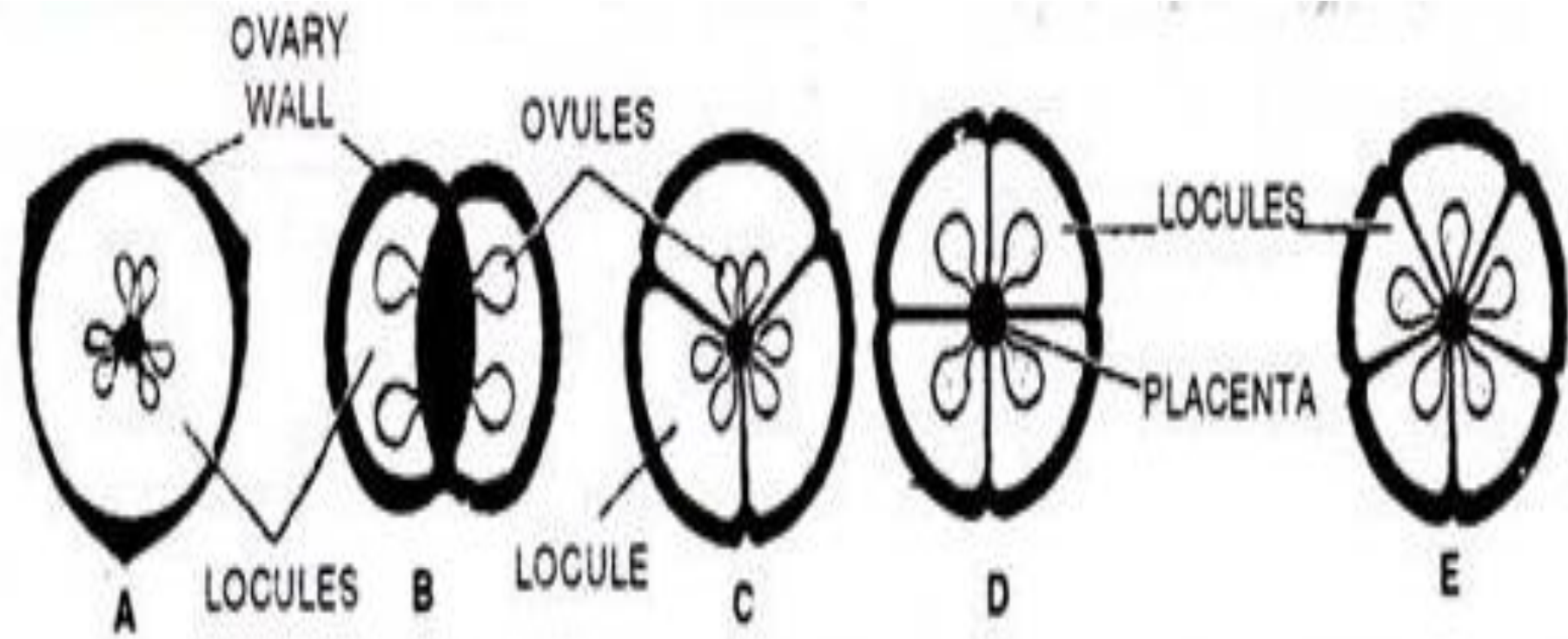


Figure 6.15. T.S. of gynoecium showing number of locules—A. Unilocular, B. Bilocular, C. Trilocular, D. Tetralocular, E. Pentalocular.

6. Placentation:

- The ovary of flower possesses one or more ovules which later on develop into seeds after fertilization.
- The ovule bearing region of the carpel is called placenta.
- The mode of arrangement of placentae and ovules within the ovary is called placentation.

It may be of following types

(a) Marginal:

When the gynoecium is monocarpellary apocarpous, the placentae bearing ovules are borne on the ventral suture, where the margins of the ovary wall fuse, e.g., family Leguminosae.

(b) Axile:

Ovary multilocular and ovules borne on central placenta, e.g., *Hibiscus*, *Citrus*, *Solanum*, *Allium*, tomato, etc.

(c) Parietal:

Ovary is unilocular but pistil is syncarpous. The ovules are borne on peripheral fused margins of carpels, e.g., *Brassica*, *Papaya*, *Gourd* etc.

(d) Free central:

Ovary is unilocular and ovules borne on a central column which is not connected to the ovary wall by any septum, e.g., *Dianthus*, *Silene*, *Primula* etc.

(e) Basal:

Ovary is unilocular and a single ovule is borne at the base of the ovary.

(f) Superficial (Laminar):

Ovary is multilocular and the ovules are borne on septa as well as all over the inner surface, e.g., *Nymphaea*.

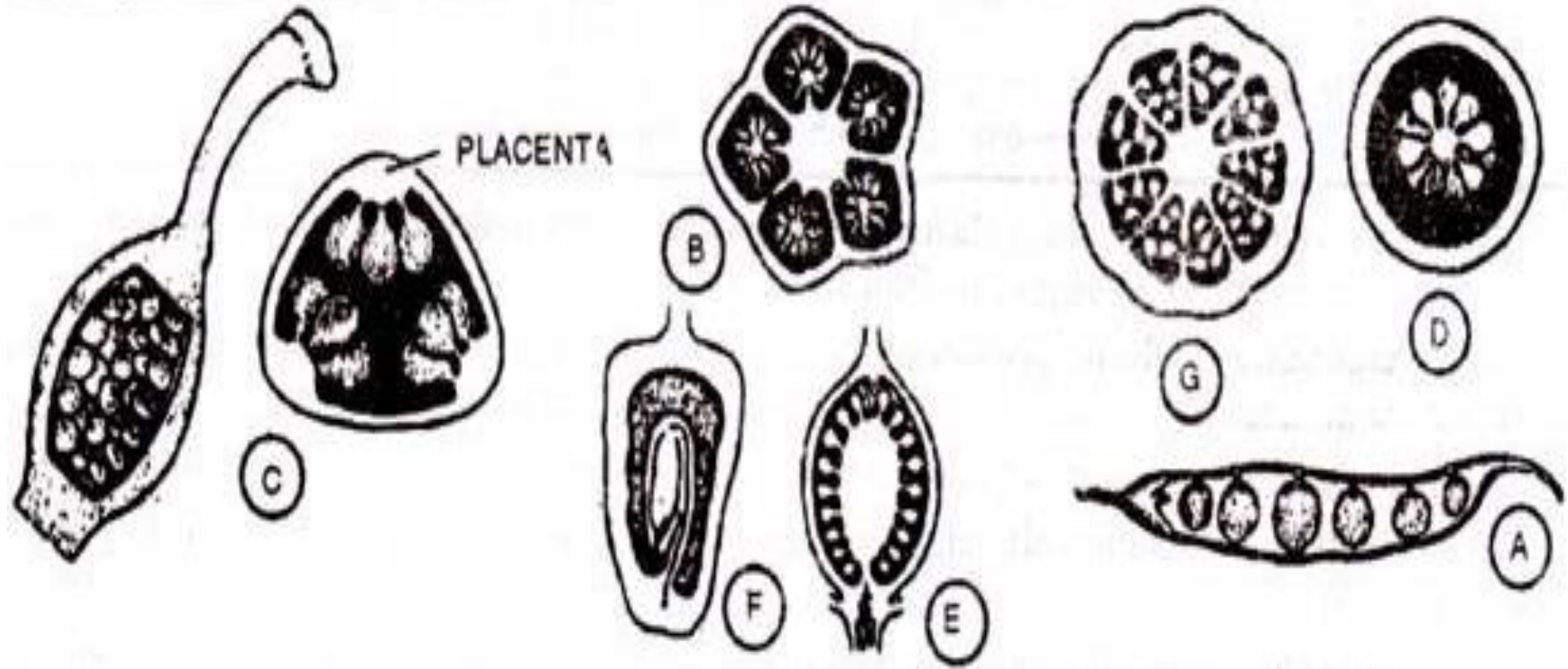


Figure 6.16. Various kinds of placentation. (A) Marginal; (B) Axile ; (C) Parietal ; (D-E) Free-central ; (F) Basal ; (G) Superficial or Lamellate.

Fruit:

fruit develops from a ripe ovary or any floral parts on the basis of floral parts they develop, fruits may be true or false.

i) True Fruits:

A true fruit or eucarp is a mature or ripened ovary, developed after fertilization, e.g., Mango, Maize, Grape

ii) False Fruits:

A false fruit or pseudo-carp is derived from the floral parts other than ovary, e.g., peduncle in cashew-nut, thalamus in apple, pear, gourd and cucumber; fused perianth in mulberry
Jack fruit and pine apple are also false fruits as they develop from the entire inflorescence.

False fruits are also called spurious or accessory fruits.

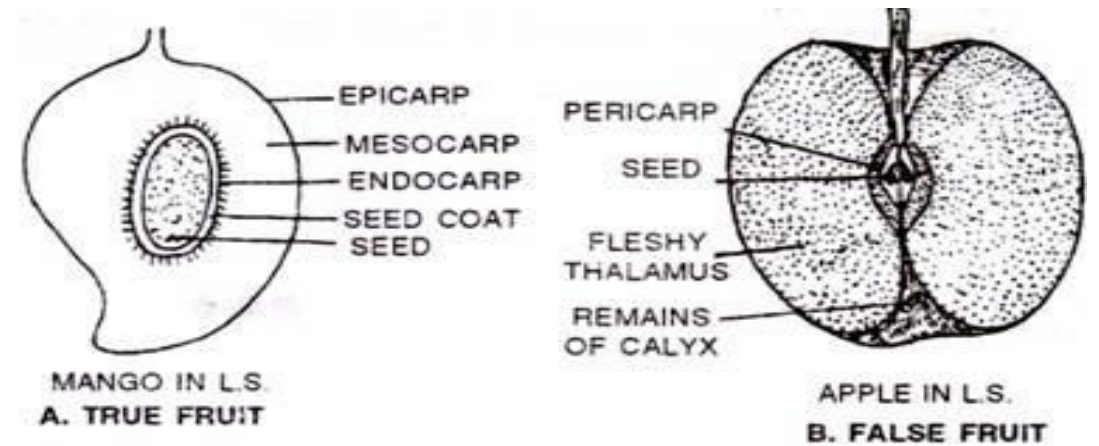
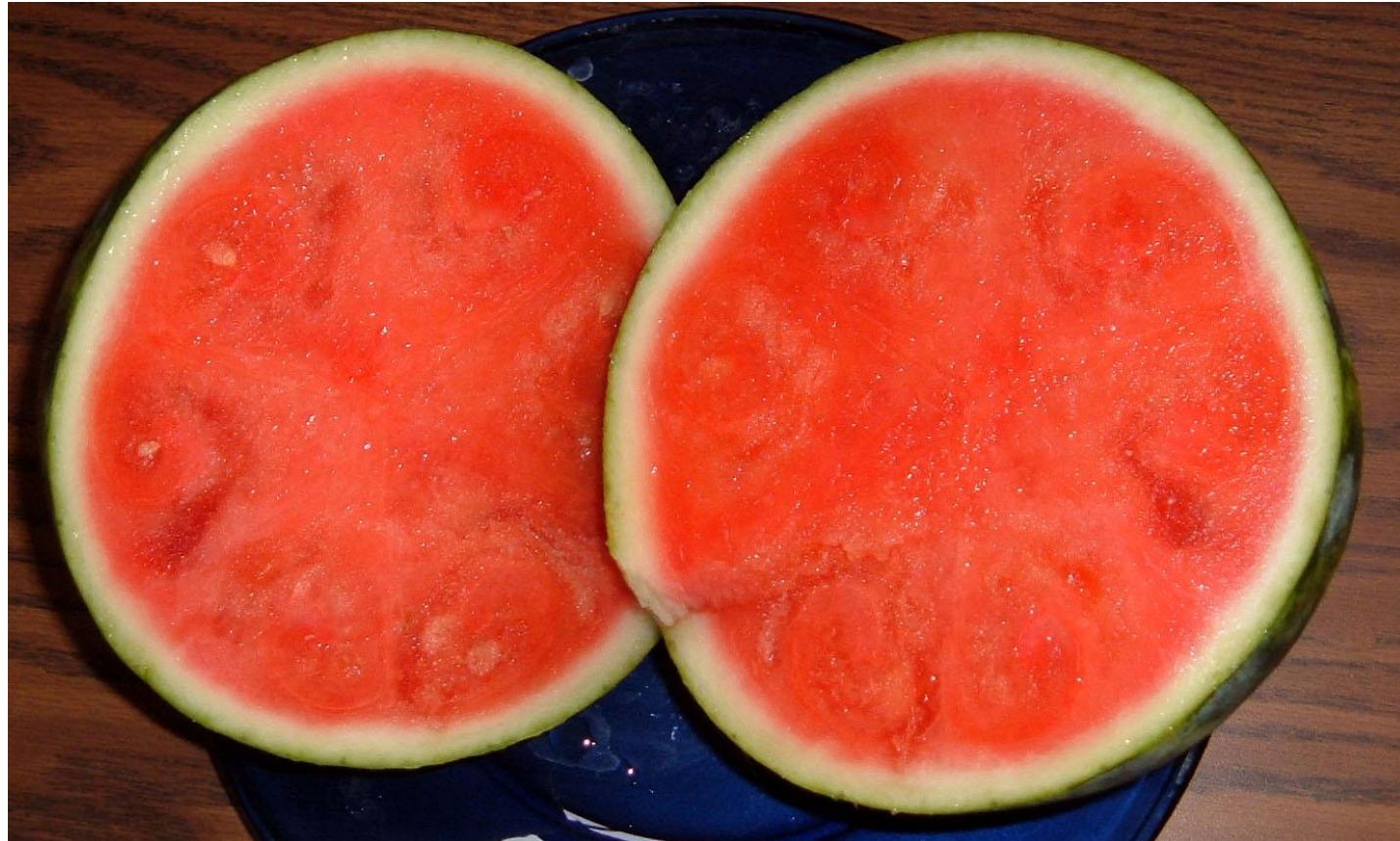


Figure 7.1. Morphology of True and False fruits.

iii) Parthenocarpic fruits:

These are seedless fruits that are formed without fertilization, e.g., Banana. Now a day many seedless grapes, oranges and water melones are being developed by horticulturists. Pomology is a branch of horticulture that deals with the study of fruits and their cultivatio



Morphology of a Typical Fruit:

- A fruit consists of pericarp and seeds.
- Seeds are fertilized and ripened ovules.
- The pericarp develops from the ovary wall and may be dry or fleshy.
- When fleshy, pericarp is differentiated into outer epicarp, middle mesocarp and inner endocarp.

Types of Fruits:

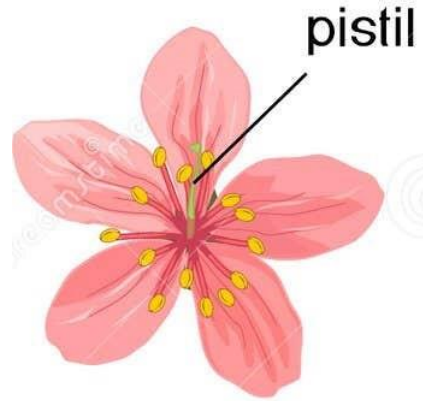
On the basis of the above mentioned features, fruits are usually classified into three main groups:

(1) Simple,

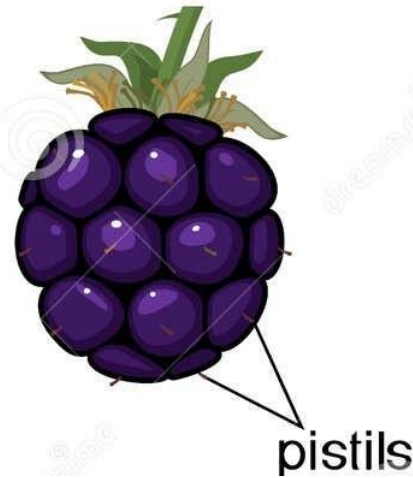
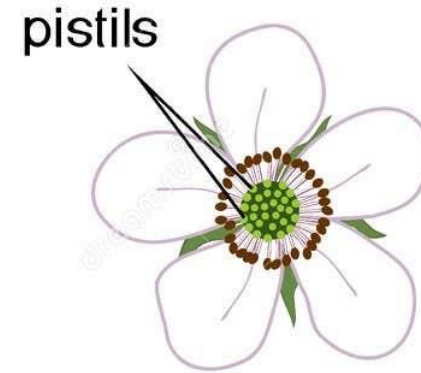
(2) Aggregate and

(3) Composite or Multiple fruits.

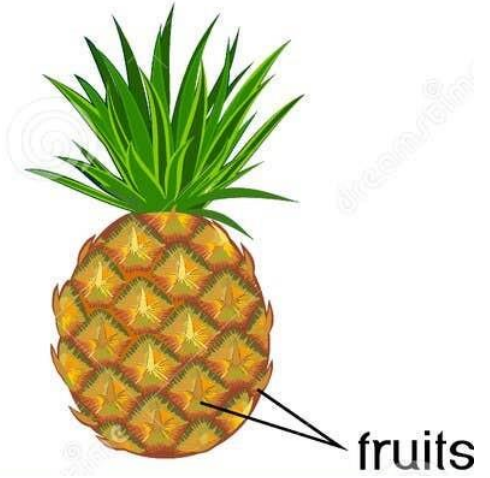
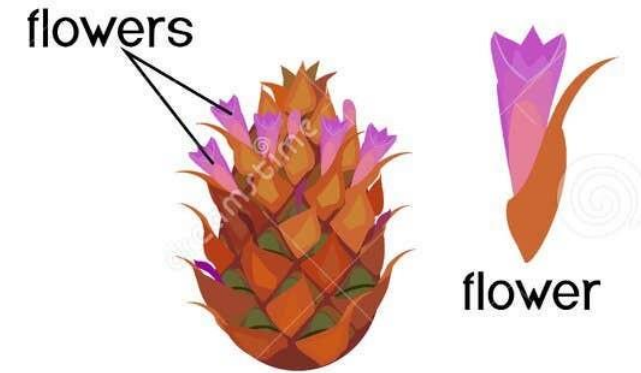
Simple fruit



Aggregate fruit



Multiple fruit



1. Simple Fruits:

When a single fruit develops from a single ovary of a single flower, it is called a simple fruit.

The ovary may belong to a monocarpellary simple gynoecium or to a polycarpellary syncarpous gynoecium. There are two categories of simple fruits—dry and fleshy.

Simple fruits are of two types:

1. Dry Fruits:

These fruits are not fleshy, and their pericarp (fruit wall) is not distinguished into three layers.

2. Succulent Fruits (Fleshy fruits):

In these fruits pericarp is distinguished into epicarp, mesocarp and endocarp.

Mesocarp is fleshy or fibrous. These fruits are indehiscent, and seeds are liberated after the decay of the flesh.

1. Dry Fruits:

Three types of dry fruits are distinguishable:

(A) Dehiscent Fruits (Capsular Fruits):

Characteristic of these fruits is that their pericarp ruptures after ripening and the seeds are disseminated.

(B) Indehiscent Fruits (Achenial Fruits):

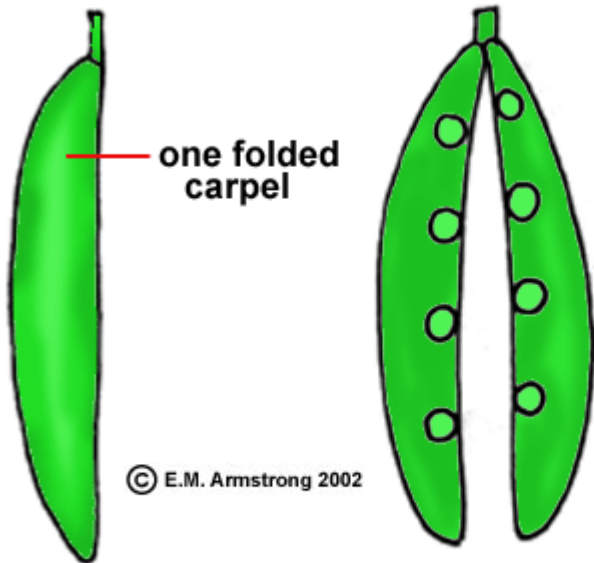
As their name indicates, pericarp of such fruits does not rupture on ripening and the seeds remain inside.

1. Legume or Pod:

Legume develops from a superior, monocarpellary, unilocular ovary. At maturity, the fruit dehisces along both the sutures i.e. ventral as well as dorsal. It is characteristic of family Leguminosae (Pea, Gram etc).

2. Follicle:

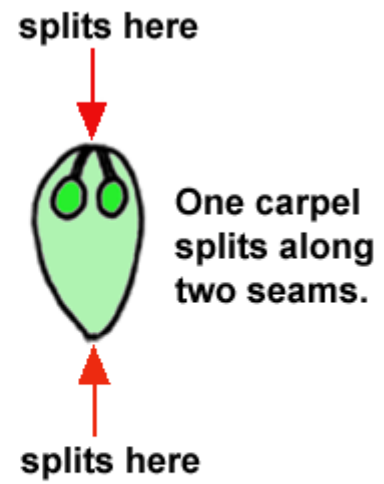
It is similar to legume but it dehisces only along the ventral suture, e.g. *Larkspur*, *Calatropis*, *Michelia*, *Vinca*.



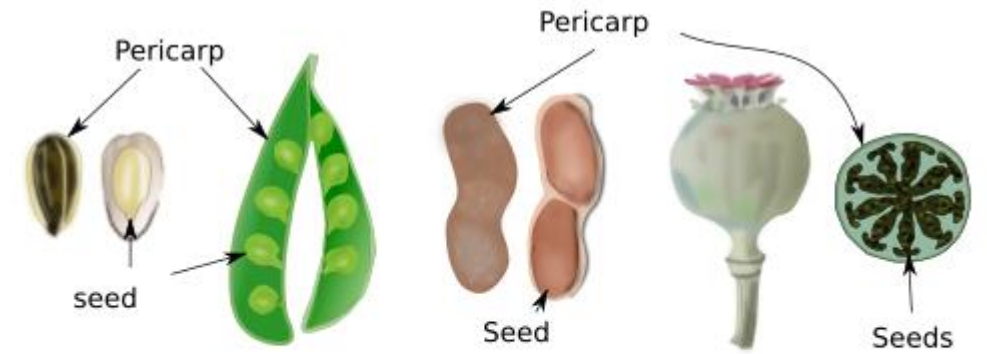
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Unopened Legume
(e.g. Pea Pod)

Legume Split Open
(1 Carpel, 2 Seams)



Cross Section
of a Legume



Cypsela

Shell

Follicle

Capsule

Indehiscent fruit | _____ | Dehiscent fruits | _____ |

3. Siliqua:

Siliqua develops from a bicarpellary, syncarpous, superior ovary which is unilocular but becomes bilocular due to a false septum called replum.

It is an elongated fruit in which dehiscence occurs along both the sutures from base to apex and the seeds attached to the replum get exposed. Example-Brassica (Mustard).

4. Silicula:

A short and flattened siliqua is called silicula. It is almost as broad as long. Examples: *Iberis amara* (Candytuft), *Capsella bursa-pastoris* (Shepherd's purse).

5. Capsule:

It is a simple dry many seeded dehiscent fruit developing from a multi-carpellary syncarpous ovary.

On the basis of dehiscence capsules are of the following types:

(i) Porocidal:

The dehiscence occurs through pores as in Poppy (*Papaver*)

(ii) Pyxis:

This is a special name given to a capsule when the dehiscence is transverse so that the top comes off as a lid as if exposing a box of seeds, e.g., *Celosia* (Cock's comb), *Amaranthus*, *Chaffweed*

iii) Loculicidal:

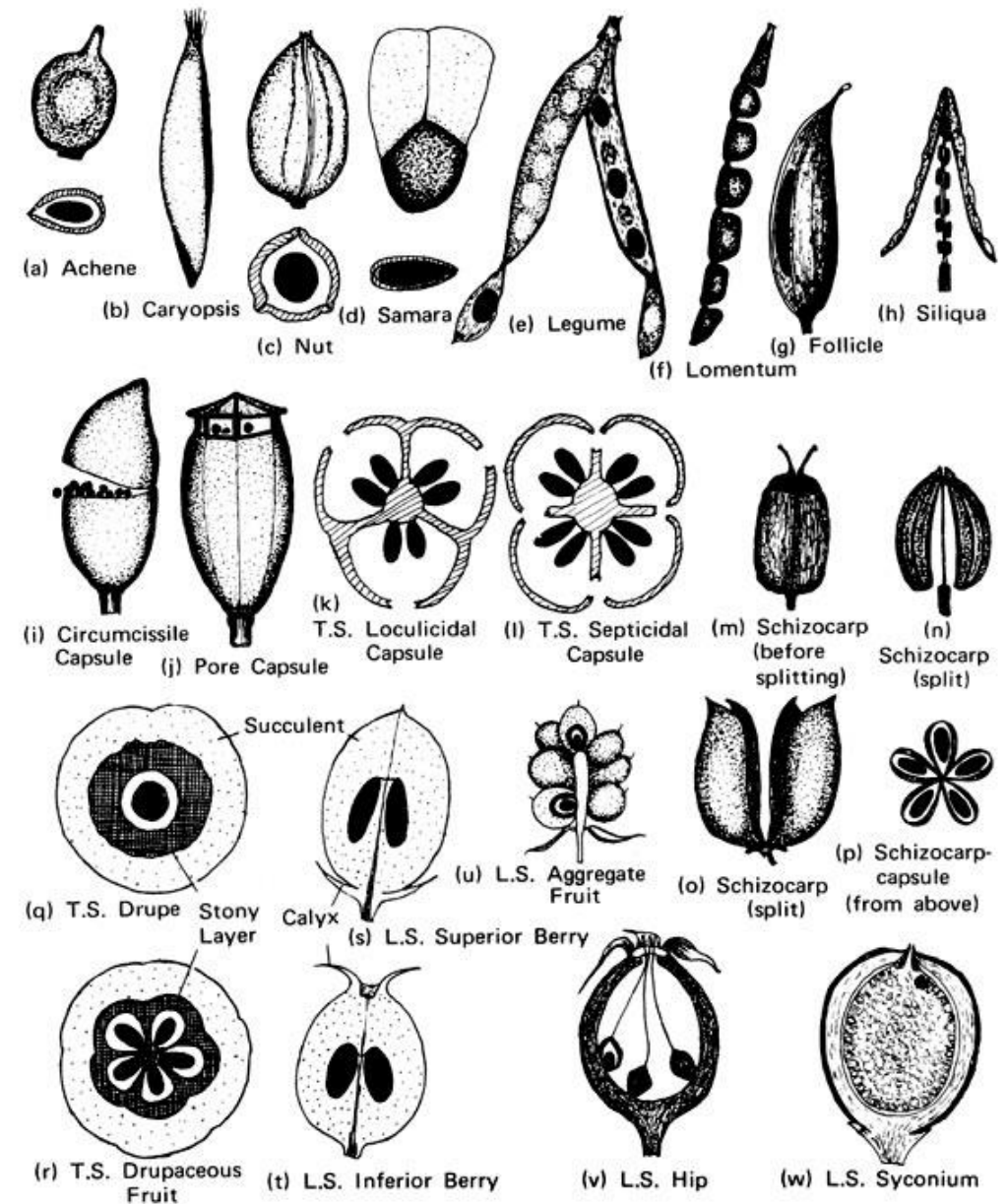
The dehiscence occurs by longitudinal slits which open into the loculi, e.g., lily's finger (*Abelmoschus*)

(iv) Septicidal:

The dehiscence line appears along the septa, e.g., Linseed, Cotton to the central axis, e.g. *Datura*.

(v) Senticidal:

Thin-broken parts separate exposing the seeds attached to the central axis, e.g. *Datura*



B) Indehiscent or Achenial Fruits:

Achenial fruits are simple, indehiscent, single seeded having a thin, dry, woody or leathery pericarp.

There are five common types of achenial fruits:

1. Achene:

The pericarp of the fruit is free from the testa of the seed. The seed is attached to the pericarp only at one point.

It develops from superior monocarpellary pistill having unilocular and uniovuled ovary,

e.g., *Mirabilis jalapa*, but more commonly achenes occur in the form of aggregate fruits as in *Ranunculus* and *Clematis* etc.

2. Caryopsis.

It is similar to achene except that in this case pericarp and testa are inseparably fused as in cereals. It is a characteristic feature of family Gramineae.

e.g.—Wheat, Maize etc.

3. Cypsela:

It is a characteristic feature of family Compositae.

The fruit wall is free from testa and a typical feature of the fruit is the presence of a pappus having a crown of hair like processes which helps in wind-dispersal.

The fruit develops from bicarpellary, syncarpous, inferior ovary having a single basal ovule, e.g., *Sonchus*, *Dandelion* etc.

4. Samara:

- It develops from a monocarpellary pistil with a superior, unilocular and uniovuled ovary. The pericarp is expanded in the form of wings which help in dispersal. Example *Holoptelea* and Elm.

5. Nut:

- The pericarp is harder and leathery or woody. It may develop from a simple or compound pistil with superior or inferior, uniovuled ovary.
- Examples *Quercus* (Oak), Litchi and Cashew nut *Trapa* etc.
- In case of Litchi pericarp is hard and leathery.
- The edible part is aril which is an outgrowth of testa from the micropylar end and becomes juicy.

C) Schizocarpic or Splitting Fruits:

- These fruits maybe considered intermediate between achenial (being indehiscent) and capsular (being many seeded) fruits.
- The fruit breaks up into a number of indehiscent single-seeded segments called mericarps from which seeds are liberated only when pericarp gets rotten.
- In some cases one- seeded parts of the fruit are dehiscent and are called Cocci.

Schizocarpic fruits are of following 5 types:

1. Lomentum:

- The fruit is constricted between the seeds and usually breaks up into segments containing one or more seeds, e.g. *Mimosa*, *Acacia arabica*.
- In case of radish, the fruit is lomentaceous siliqua.

2. Compound Samara:

- This is a type of two or more-chambered fruit derived from a syncarpous (i.e., compound) ovary.
- The pericarp is extended in the form of wings and at maturity the fruit breaks up % into single seeded mericarps. e.g., EIm (Holooptelea), maple.

3. Cremocarp:

- This is a two-seeded fruit derived from bicarpellary, syncarpous, inferior, bilocular and uniovuled ovary.
- It is a typical fruit of family umbelliferae.
- The two mericarps split along the central axis or carpophore to which they remain attached.
- Persistent style and stylopodium are present e.g. Coriander.

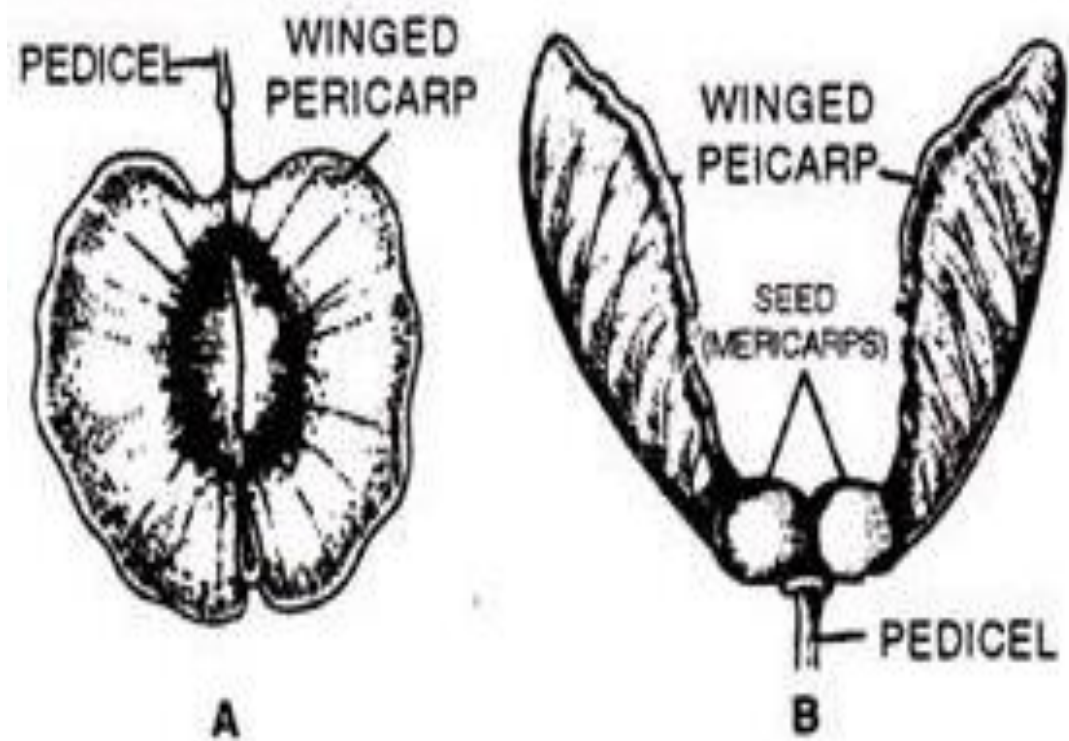


Figure 7.7. Compound Samara
A. Holoptelea, B. Acer (Maple)

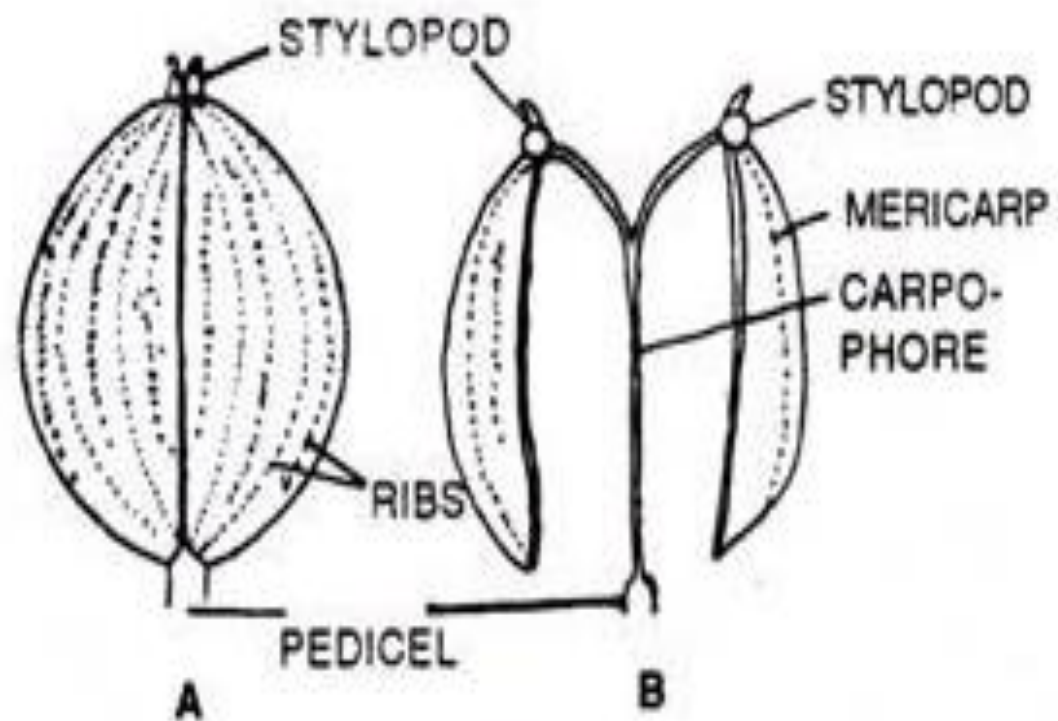


Figure 7.8. Cremocarp of Coriander
A. Complete B. Mericarps Separated

4. Carcerulas:

- This fruit is derived from superior, syncarpous pistil, multilocular with axile placentation. The fruit splits into many mericarps. e.g. Hollyhock (*Althaea rosea*), *Salvia*, *Ocimum*

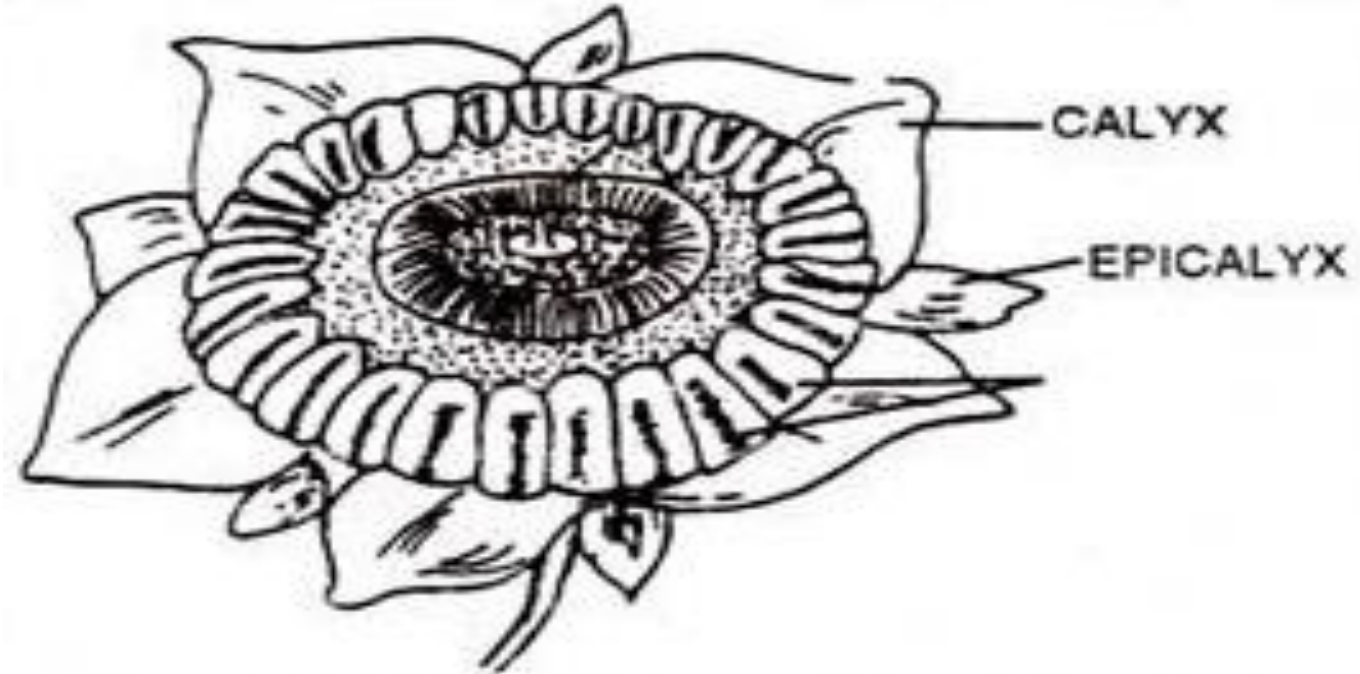


Figure 7.9. Carcerulus of *Althaea* (Hollyhock).

5. Regma:

- It is derived from polycarpellary pistil which splits into as many Cocci (dehiscent segments) as there are carpels.
- Regma of castor breaks up into three cocci as it is derived from tricarpellary syncarpous pistil.
- Similarly, regma of Geranium breaks into five cocci as it is derived from five carpels

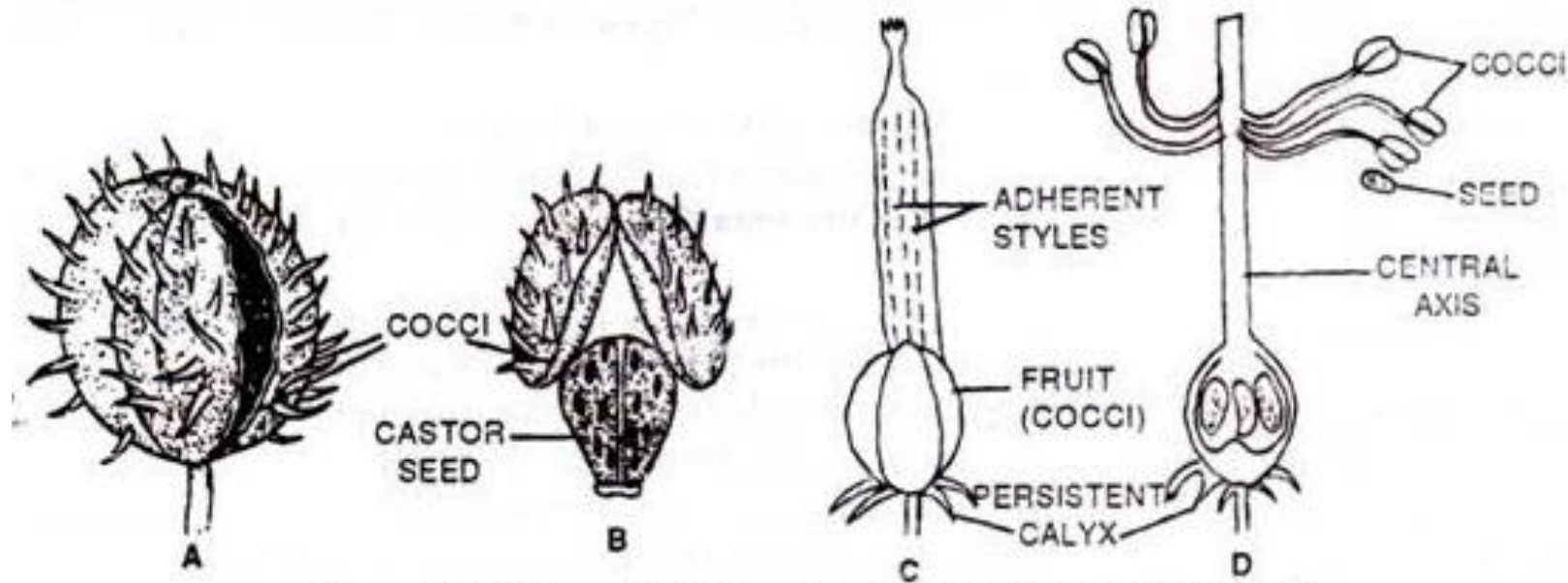


Figure 7.10. Regma A. Regma of castor breaking into three cocci, B. Coccus releasing a seed, C. Regma of Geranium. D. Dehisced Regma of Germanium

2. Succulent or Fleshy Fruits:

These are simple fruits with fleshy pericarp. The simple succulent fruits are of 3 types – drupe, pome and berries.

1. Drupe:

- The pericarp or fruit wall is differentiated into thin epicarp (skin) fleshy mesocarp and stony endocarp. Hence, it is also called as stone fruit
- e.g., Mango, Coconut, Peach, Almond, Trapa etc. In mango, mesocarp is juicy and edible.
- In coconut mesocarp is fibrous and edible part is endocarp.
- In almond, epicarp and mesocarp get peeled off and only hard endocarp can be seen in marketed fruits. The edible part is cotyledons

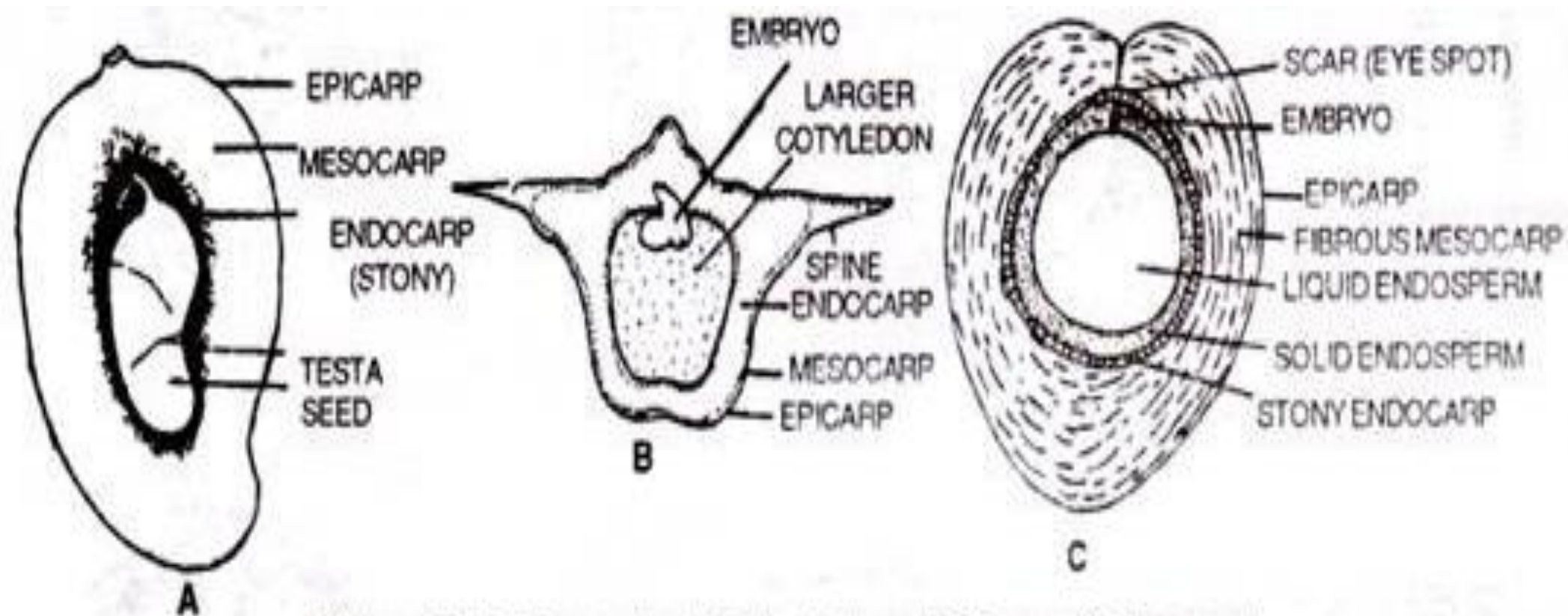


Figure 7.11. Drupes in L.S. A. Mango, B. Trapa, C. Coconut

2. Pome:

It is a simple, fleshy but false fruit as it is surrounded by a fleshy thalamus which is edible while actual fruit lies within, e.g., apple, pear, etc.

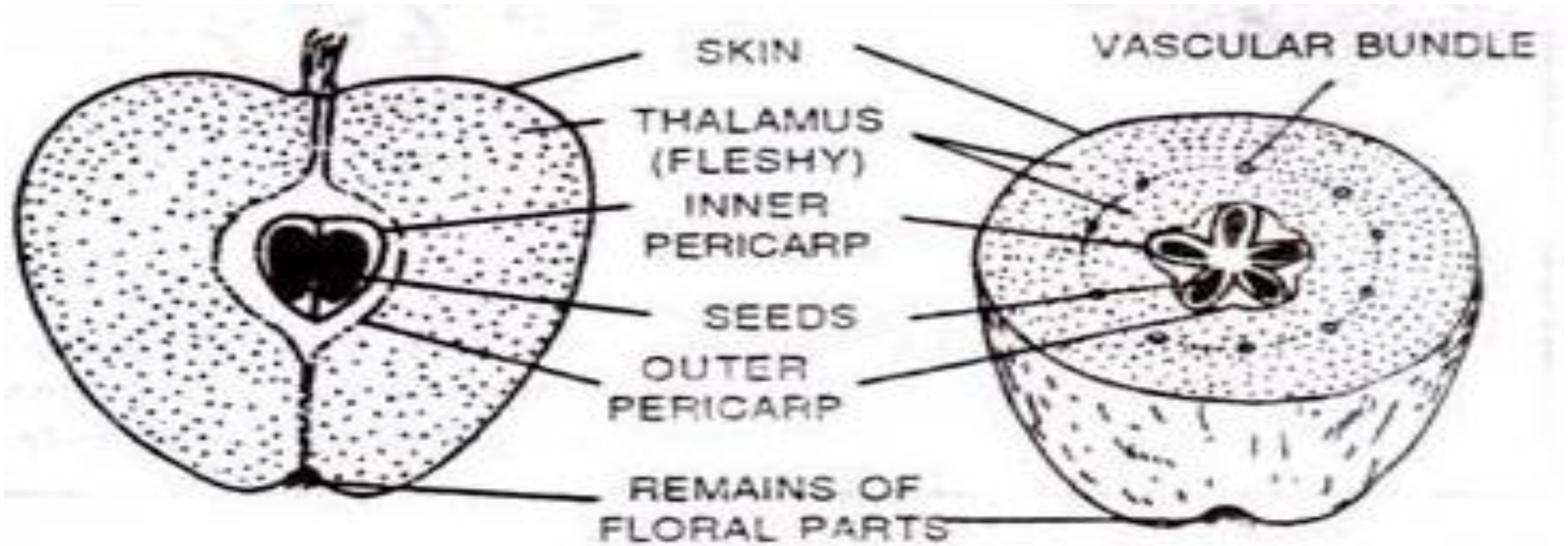


Figure 7.12. Pome of Apple A. L.S., B. T.S.

3. Berry and Bacca:

- Berry is a fleshy fruit in which there is no hard part except the seeds. Pericarp may be differentiated into epicarp, mesocarp and endocarp.
- One or other of these layers may form pulp in which seeds are embedded which generally gets detached from the placenta.
- The fruits derived from superior ovary are called superior or true berries as in brinjal, grape, tomato.
- False berries are derived from inferior ovary and thalamus and pericarp are fused as in banana and guava etc.
- In case of banana, epicarp and thalamus are peeled off, mesocarp and endocarp with embedded unripe seeds forms the edible part.
- In case of Date, epicarp and mesocarp are edible while papery and thin endocarp is thrown away along with the seed.

There are some fruits which show variations from the normal berry:

(i) Pepo:

- This develops from inferior ovary which is unilocular or falsely trilocular having parietal placentation.
- The seeds remain attached to placenta. The outer ring is very hard as in Cucurbits

ii) Hesperidium:

- It develops from polycarpellary, syncarpous, superior, multilocular ovary with axile placentation.
- Epicarp forms the leathery peeling, mesocarp is in the form of fibres while the endocarp projects inwards forming distinct chambers from which juicy ingrowths in the form of hairs arise which form the edible part, eg. *Citrus* (Orange, Lemon)

iii) Amphisarca:

- It is derived from polycarpellary, syncarpous, multilocular and superior ovary. In this case, epicarp is woody.
- The placenta and inner layers of pericarp become pulpy and edible in which the seeds are scattered. The testa is mucilaginous,
- e.g., *Aegle marmelose*

iv) Balusta:

- It is a berry with an outer hard rind formed of epicarp and a part of mesocarp. The inward foldings of mesocarp form chambers.
- Each chamber is lined by papery endocarp which encloses a group of seeds.
- The seeds are covered by edible juicy testa. e.g., Pomogranate

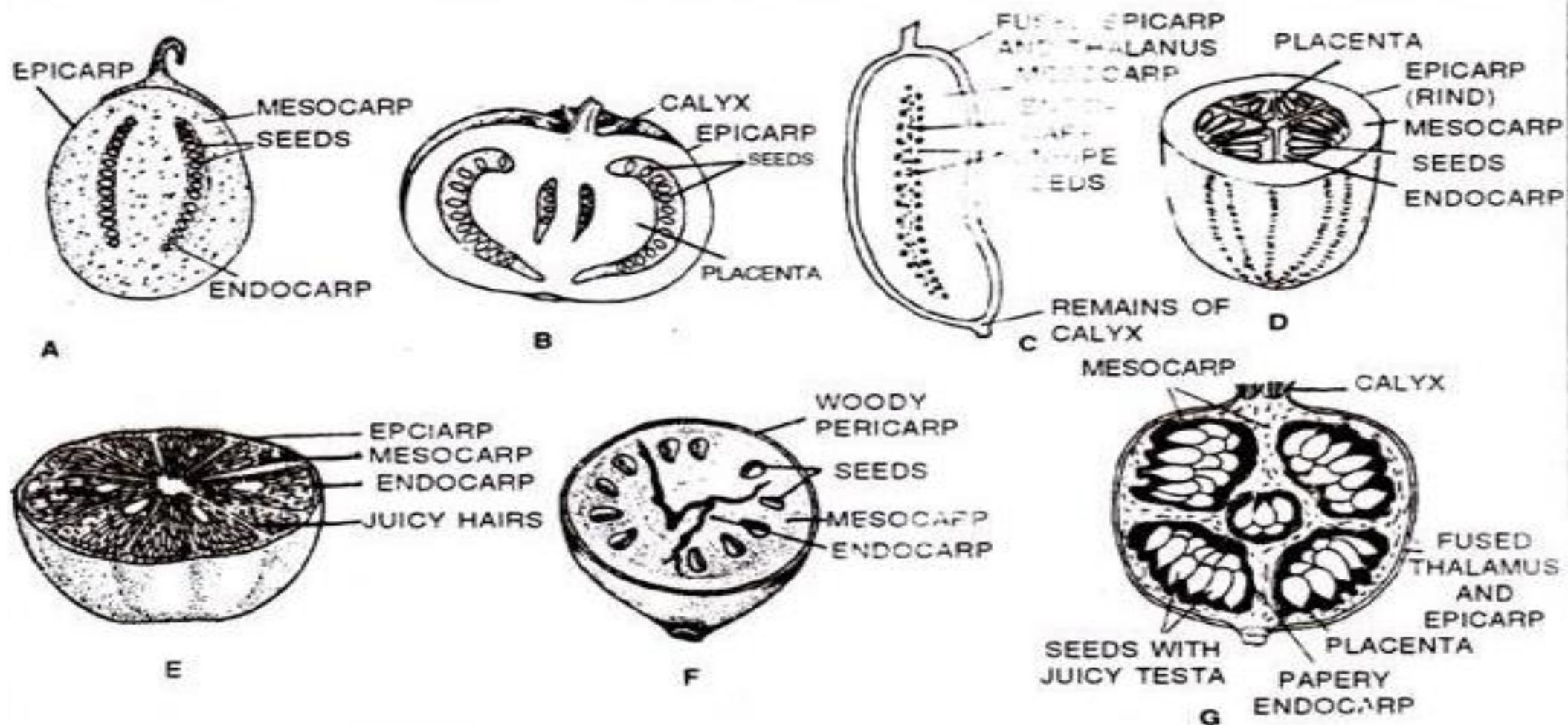


Figure 7.13. Berries or baccate fruits. A. Berry of brinjal in L.S., B. L.S. berry of tomato, C. L.S. berry of banana, D.T.S. pepo of cucumber, E.T.S. Hesperidium of Lemon, F.T.S. amphisaraca of wood apple (Aegle), G.L.S. balusta of Pomegranate

II. Aggregate Fruits:

- Flowers with polycarpellary and apocarpous gynoecium give rise to a number of fruitlets as there are a number of free ovaries, each giving rise to one fruitlet.
- Sometimes, these fruitlets coalesce together appearing to be a single fruit but in many other cases, the fruitlets remain free from one another forming etaerio of fruitlets.
-
- An aggregate fruit is named according to the nature of fruitlets.

1. Etaerio of achenes:

- Aggregate of achenes are found in *Fragaria* (strawberry), Rose, *Ranunculus*, *Nelumbium* (lotus) etc. Here each fruitlet is an achene; and achenes are hairy.
- In rose (*Rosa*), many achenes are present on a saucer (cup) shaped thalamus. In lotus (*Nelumbium*), thalamus becomes spongy and some achenes are embedded in it.
- In strawberry [*Fragaria*), the thalamus is fleshy and becomes red on maturation and is the edible part

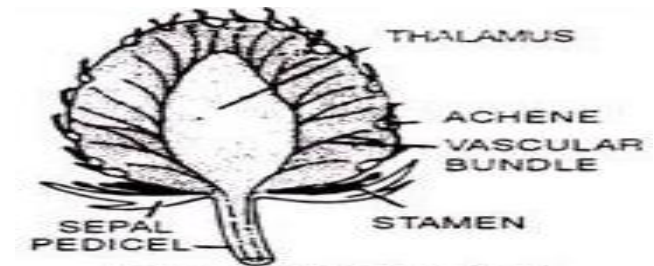


Figure 7.14 Etaerio of achenes of strawberry.

2. Etaerio of follicles:

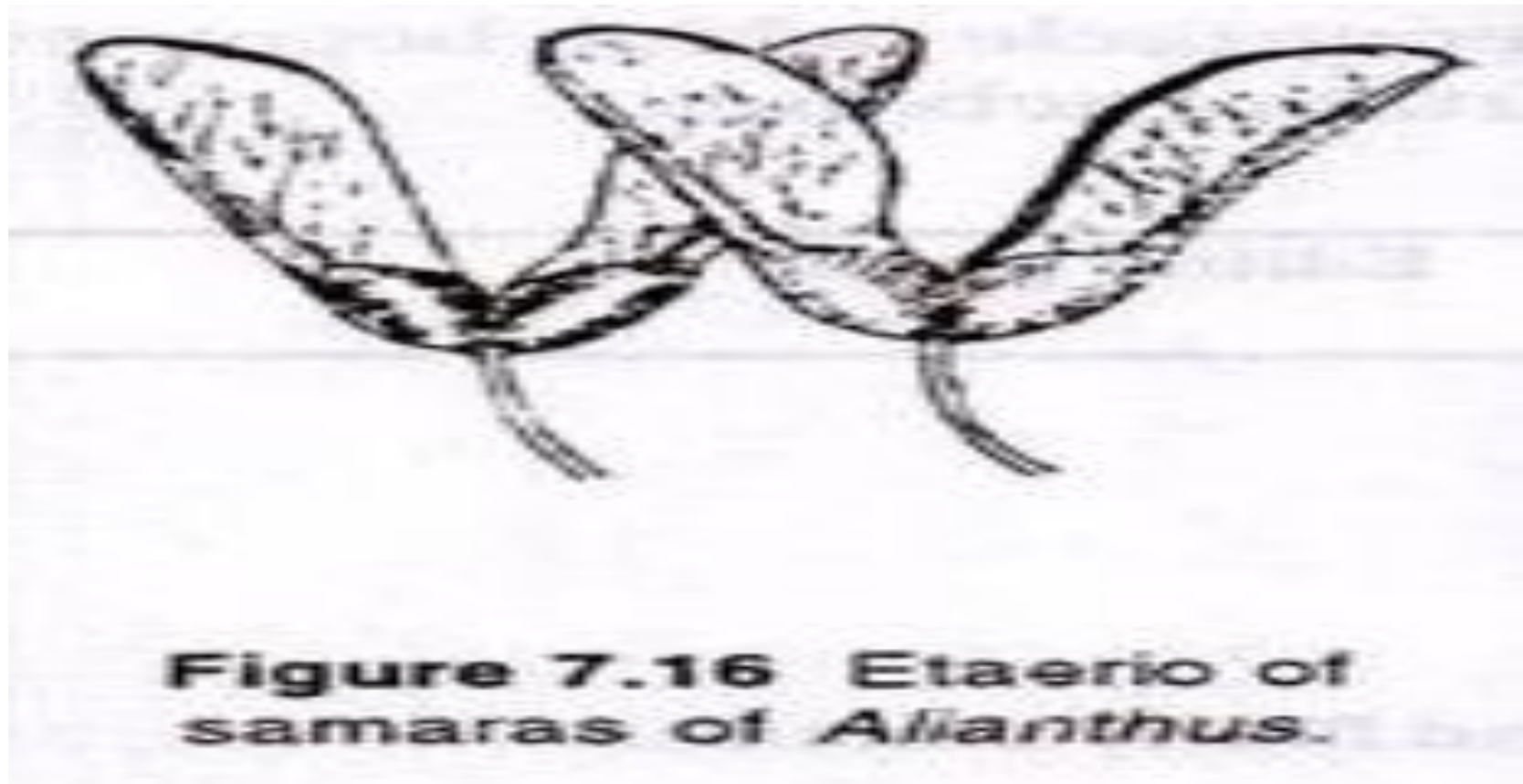
- Etaerio of follicles can be seen in *Aconitum*, *Catotropis*, *Cryptostegia* etc.
- In *Aconitum* three fruitlets from each flower while two fruitlets (follicles) develop from one flower in *Calotrois*, *Cryptostegia* and *Michelia*



Figure 7.15 Etaerio of follicles of *Michelia*.

3. Etaerio of samaras .

It can be studied in *Ailanthus* where many winged samaras develop from one flower.



4. Etaerio of berries:

- In *Artabotrys* berries occur in a bunch.
- In *Anona squamosa* (Custard apple) the berries become very fleshy and being crowded together on a thick thalamus form a complex single fruit.
- The apices of berries fuse together forming something like a common rind.

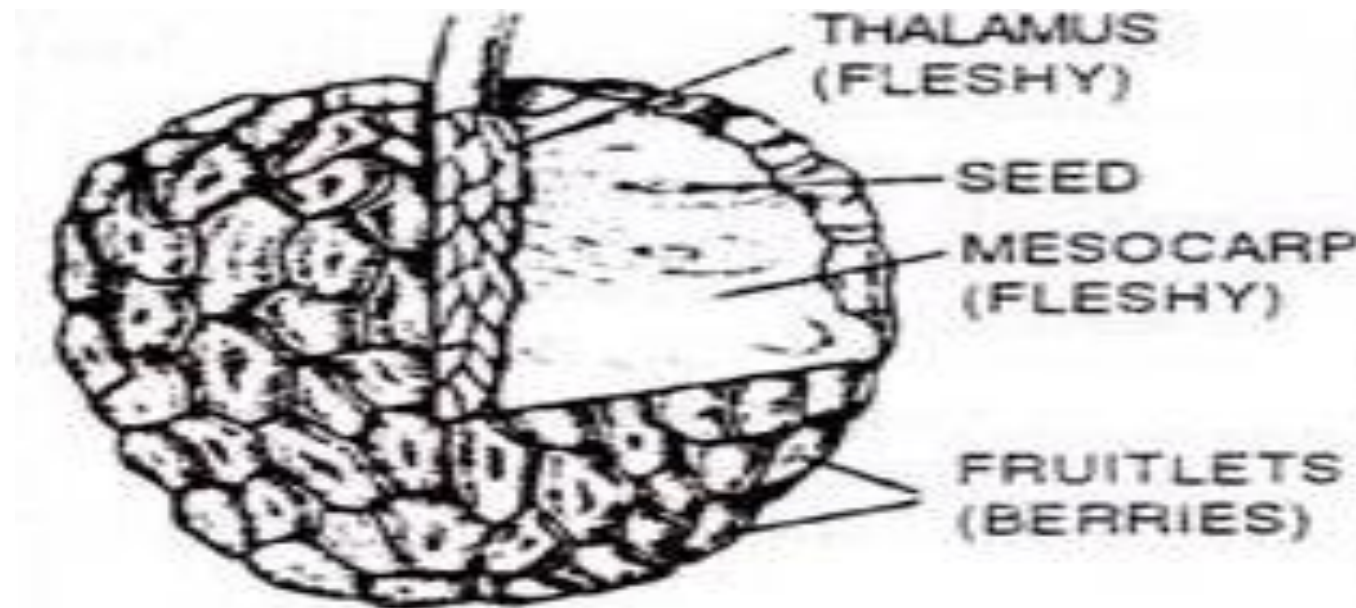


Figure 7.17 Etaerio of berries of custard apple.

5. Etaerio of drupes .

It is an aggregate of small drupes or drupelets developing from different carpels of a flower, and arranged collectively on fleshy thalamus, e.g. *Rubus idaeus*.

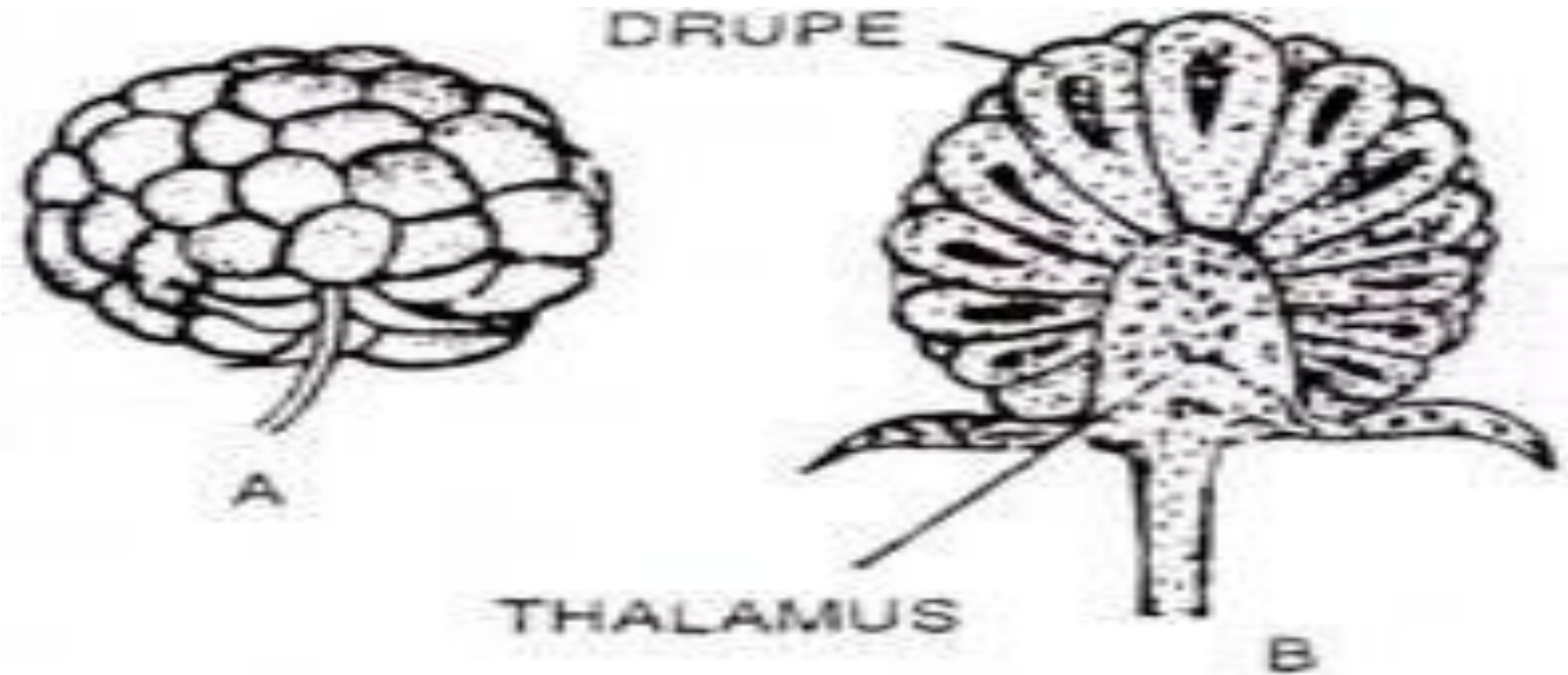


Figure 7.18 A. Etaerio of drupes of *Rubus* (Raspberry). B. Section of the same.

III. Composite Fruits:

A fruit developing from a complete inflorescence is called a multiple or a composite fruit.

There are two main types of composite fruits:

1. Sorosis:

- This type of fruit is found in Mulberry, Pineapple and Jack fruit (kathal). These fruits are derived from catkin, spike and spadix type of inflorescence.
- Mulberry (*Morus indica*) fruit develops from catkin in which fleshy perianth encloses dry achenes.
- Jack fruit, thick club-shaped peduncle has the flowers arranged on it.
- The fertile fruits have juicy, edible perianth lobes and the bracts form more or less juicy chaffs around them.
- The spines on the tough rind represent the stigmas of the carpels. Each seed is covered by a membranous testa.
-
- In Pineapple (*Ananas sativus*), the ovaries are not so conspicuous, edible portion being formed by peduncle, perianth and bracts. Each polygonal area on the surface represents a flower. This fruit develops from an intercalary spike.

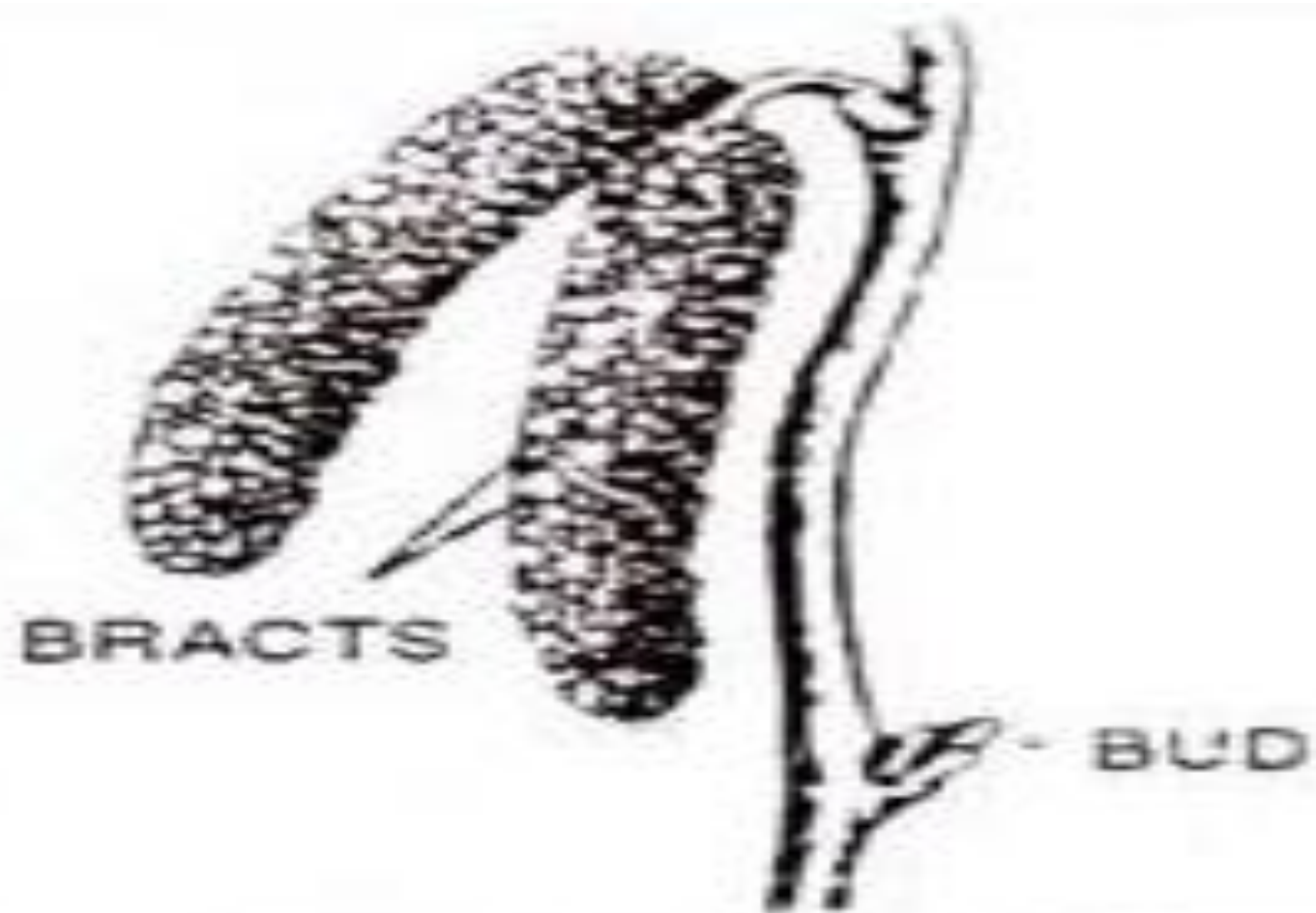


Figure 7.19 Sorosis of Mulberry

2. Syconus:

- This fruit develops from the hypanthodium type of inflorescence and is characteristic of *Ficus*.
- female flowers within the closed receptacle (which becomes fleshy) of the inflorescence develop into achenes giving rise to a multiple fruit of achenes.

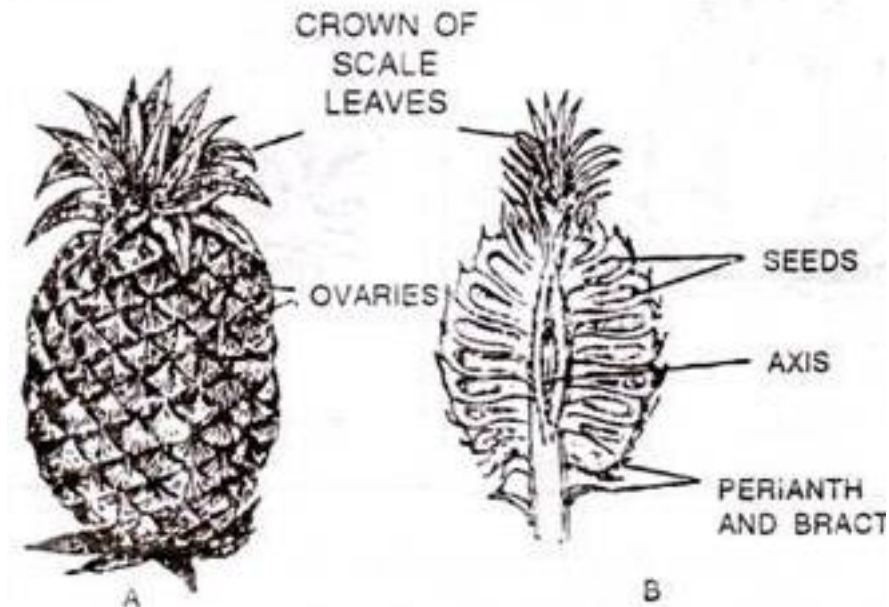


Figure 7.20. A. Sorosis of pine-apple, B. V.S. of the same.

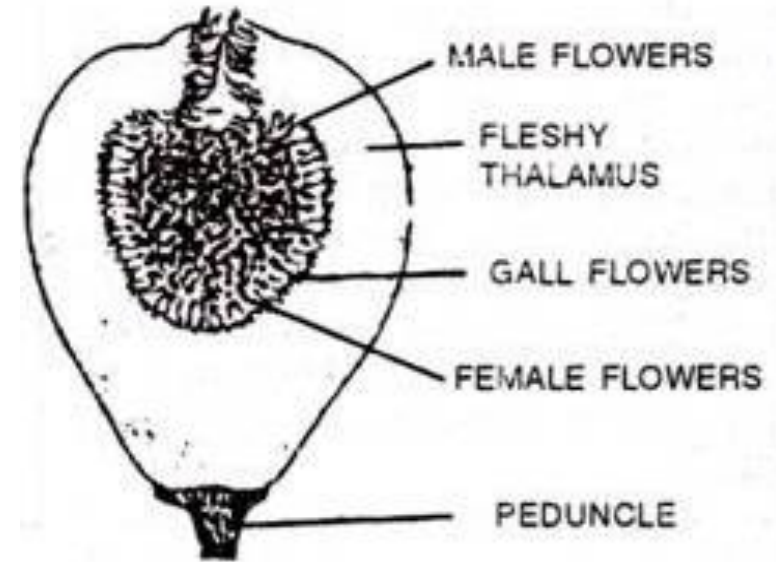


Figure 7.21 Syconus of fig.

THE END