(A)

AR – 7164

M.Sc. (Second Semester) Exam.: 2013

BOTANY

(Floral Morphology and Embryology of Angiosperms)

(LBC – 804 / LBT – 204)

Model Answers

Q. 1.

(i) b (Anatropus)

(ii) b (Micropyle lie near the funiculus)

(iii) c (Axile)

(iv) a – (Polygonum type)

(v) b – (Present)

(vi) c – (Integumentary Tapetum)

(vii) a – (Anemophily)

(viii) b – (Hyphydrophily)

(ix) a – (Perisperm)

(x) a – Cocos nucifera

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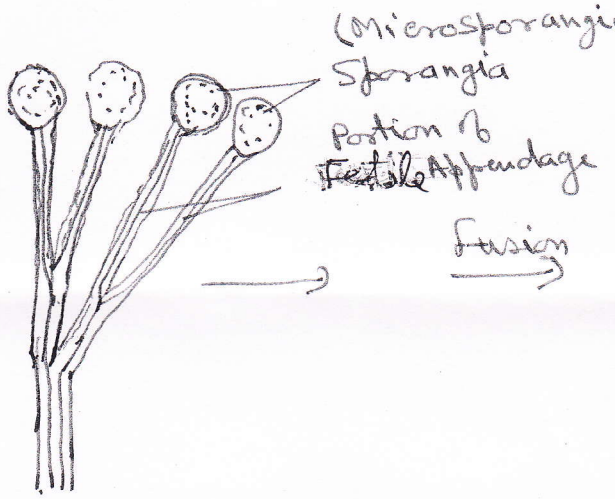
J. Lahat
15/5/13

Section - B

The primitive stamen was leaf like or foliar structure. According to Wilson (1937, 1942, 1953) on the basis of vascularization of stamen, the stamen can be interpreted as fertile telome.

On this view the modern angiospermous stamen with its slender filament and compact anther was derived from the fusion of dichotomously branched system with terminal sporangia.



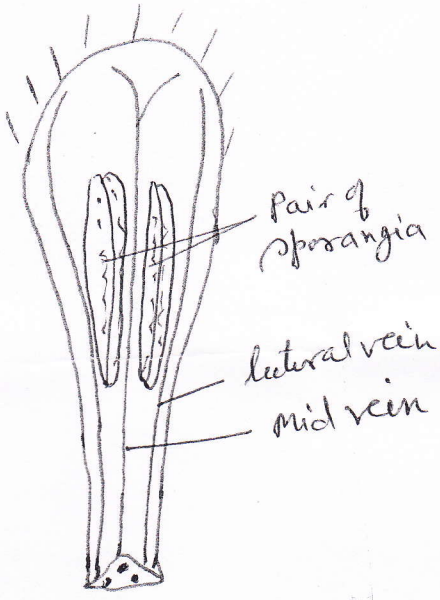
Stamen with four Microsporangia

The number of microsporangia was reduced to four and the modern anther morphologically is a synangiate structure consisting of four microsporangia

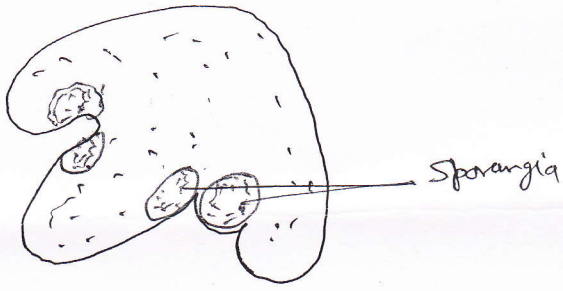
However, Bailey (1954) studied some primitive angiosperms like Degeneria (native of Fiji) which provides primitive structure of stamen i.e.

(1) The stamen not differentiated into filament, anther and connective but in a

foliaceous, three veined sporophyll which developed four slender, elongated microsporangia deeply embedded in its abaxial surface.

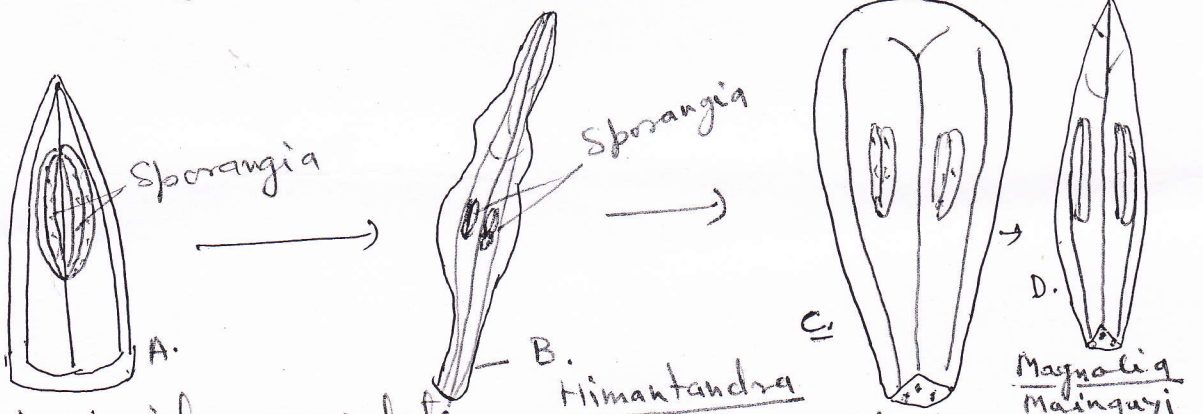


Degeneria vitiensis
Abaxial view showing a pair of sporangia between lateral and mid vein.



T.S. of stamen of Degeneria vitiensis showing 4 sporangia embedded in Abaxial surface.

Phylogeny of Stamen –



Austrobaileya maculata
Adaxial surface with sporangia at each side of mid vein

Himantandra baccata - Abaxial surface showing sporangia and branched veination

Degeneria vitiensis
Abaxial surface with sporangia

Magnolia Mainguyi

Q. 3. Tapetum is the nutritive layer of anthers of angiosperms. It provides nutrition to the developing microspores and play an important role in the fertility of plants.

Among angiosperms two types of tapetum is present —

(i) Amoeboid or Invasive or Periplasmodial tapetum –

(ii) Secretory or glandular tapetum

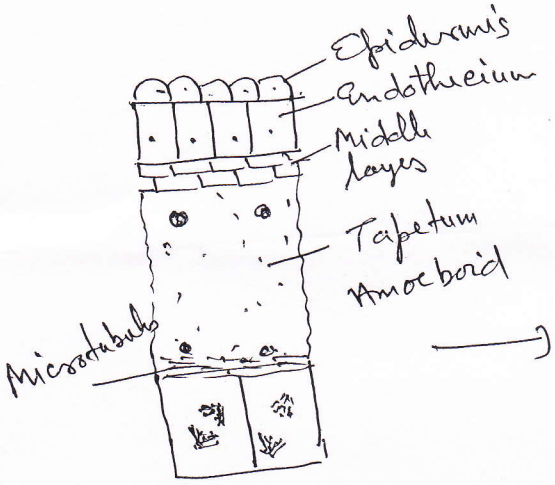
(i) Amoeboid tapetum is characterised by an early breakdown of the inner and radial walls of the cells. The protoplast masses move into anther cavity. This is followed by the fusion of protoplast to form a tapetal Periplasmodium closely surrounding the pollen mother cells or microspores

e.g. It is found in Arum, Butomus, Trachscantia Typha, Helianthus, Alisma and Mahonia etc.

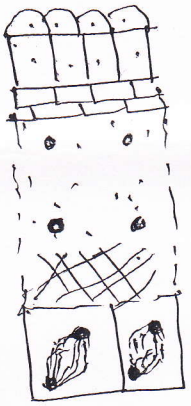
At meiosis-I Anaphase the microtubuls starts to accumulate near the dividing meiocyte. At the Telophase stage of Meiosis-I when tetrad formation takes place

of monads takes place due to the action of Callase enzyme which is secreted by the tapetum.

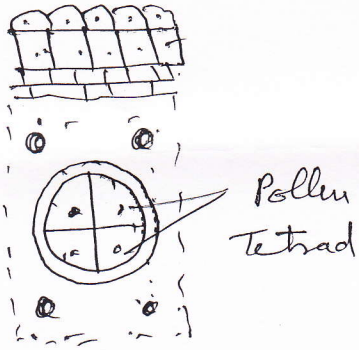
The microtubules help in the formation of pollen walls.



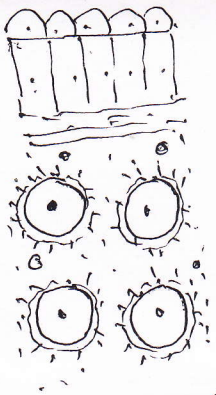
Meiosis-I-Anaphase



Meiosis-I Telophase



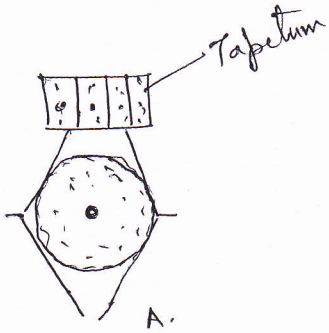
Tetrad Stage



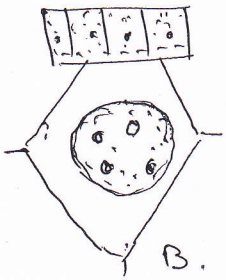
Uninucleate pollen grains with intine & Exine

Glandular tapetum – This is of common occurrence in the angiosperms. The cells of this type of tapetum remain intact throughout the development of the microspores and their breakdown occur when pollen grains reach at maturity. e.g. Cucurbita pepo.

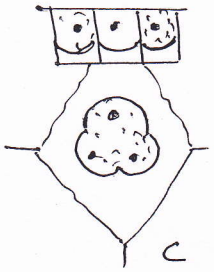
Ciampalini etal (1993) reported 12 Stages of tapetum pollen development in Cucurbita pepo -



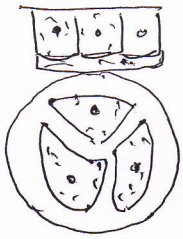
A.
Late prophase



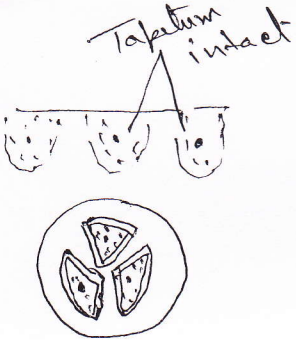
B.
Telophase of second meiotic division.



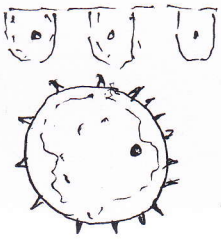
C
Meiotic Cleavage



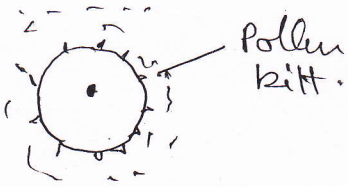
D.
Early Tetrad stage.



Late tetrad Stage

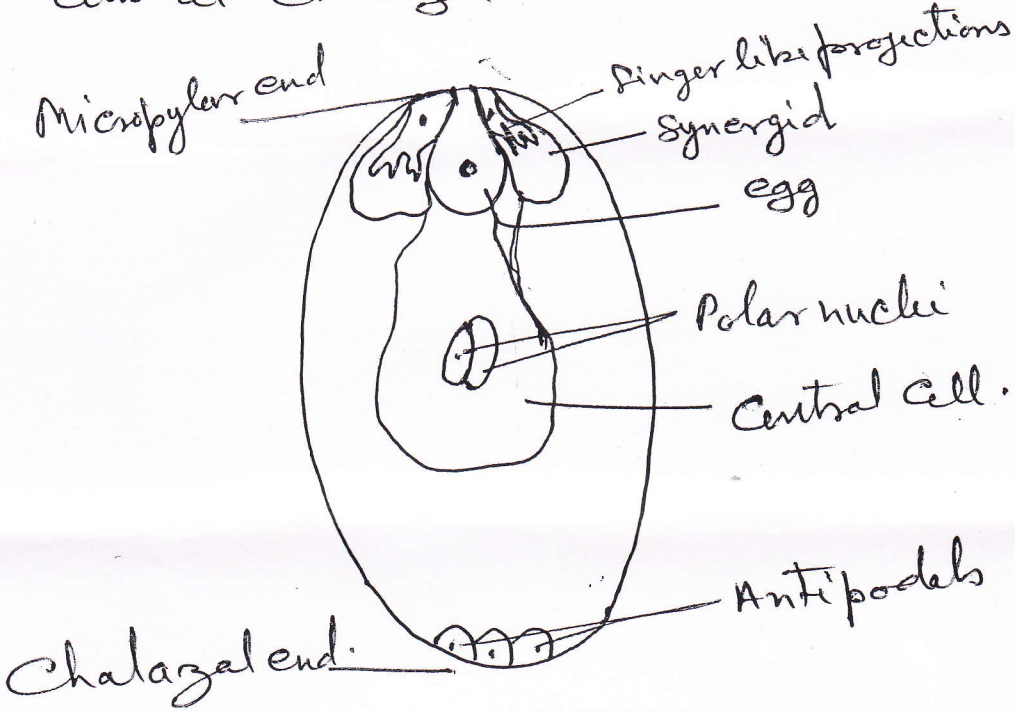


Late microspore stage.
unicellular



Q. 4.

Embryo sac is a seven celled Eight nucleate structure and also known as female gametophyte. The Embryo-sac generally consists of an egg apparatus at micropylar end with one egg cell and two synergids, two polar nuclei in the central cell and three antipodal cells at Chalazal end.



There is a large central cell with two polar nuclei which later fuse to form the secondary nucleus.

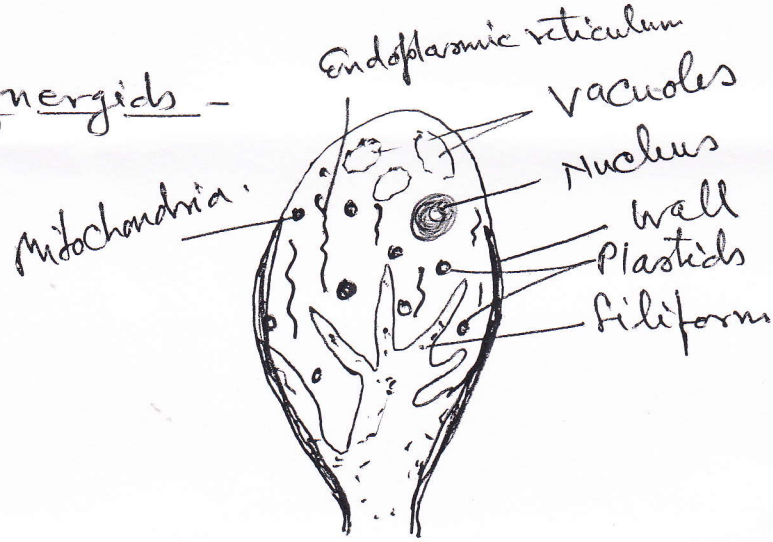
The micropylar end of the central cell is occupied by the egg apparatus, comprising an egg cell and two synergids and at its Chalazal end three antipodal cells are present. The cells of egg apparatus and the

antipodal cells are uninucleate and haploid whereas the central cell is binucleate or diploid.

The Polygenum type of embryosac is most comm among plants. The occurrence of egg is univers Except for Plumbago and Plumbegella type the egg is always associated with two (rarely one, as in Peperomia type) synergids.

The antipodals are almost always present except in oenothera type.

Synergids -



A mature, Cotton, Synergid (Diagrammati

Functions of Synergids

(1) Play role in directing the pollen tube growth by secreting some Chemotropically active substances

(2) The degenerating synergid forms the seat for pollen tube discharge in the embryo sac

(3) Jensen (1965) suggested that the filiform apparatus may be aiding the synergid in the absorption and transportation of materials into the embryo sac from the nucellus. However, many workers have expressed doubts regarding the nutritive role of the synergids. The presence of cuticle over the micropylar wall of the embryo sac in Jasione support this view.

The currently prevailing view is that the entry of metabolites into the embryo sac is mainly through its chalazal end.

Egg. - It shows common wall with the synergids and the central cell. The wall of egg is thicker towards micropylar end but thinner towards chalazal end.

Physiologically, the egg cell at maturity remain poorly active because the mitochondria show only a few cristae.

In Plumbago capensis many finger like projections arise at the micropylar end of the egg cell (Cass - 1972). They resemble with the filiform apparatus of the synergids. Because synergids are absent in this plant, the egg cell seems to have taken over the role of synergid in addition to its own gametic function.

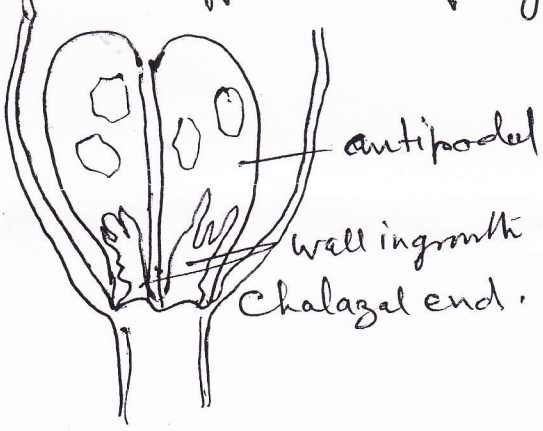
Antipodals

Usually antipodals are present at the Chalazal end and disappear just before or after fertilization. In Sapotaceae (except Mimusops) and Thismiaceae the antipodal nuclei degenerate even without organizing into cell.

In Caltha palustris they persist upto octant stage of the proembryo.

The highest number of antipodal cells known is 300 in Sasa paniculata. Zea mays has about 20 antipodals and each with 1–4 nuclei due to incomplete wall formation between cells resulting multinucleate protoplasm or syncytium.

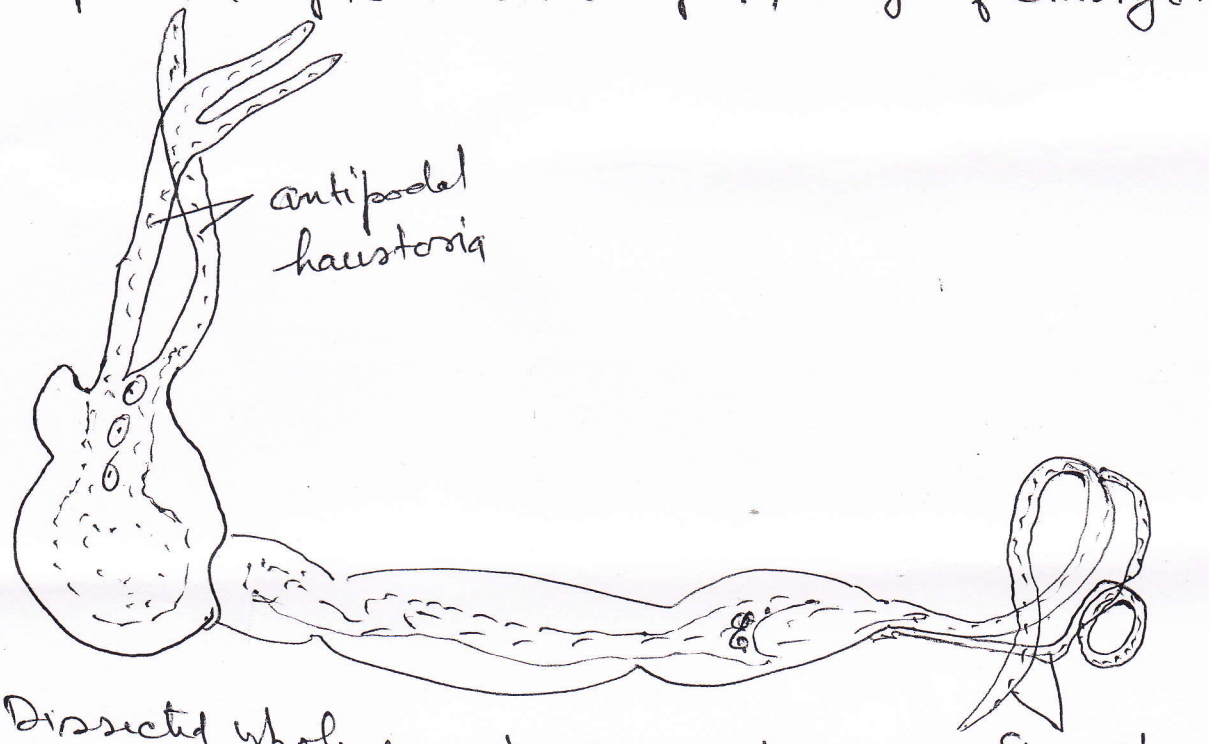
Antipodals of Aquilegia, Poppy and rice show presence of finger like cut growth similar to filiform apparatus of synergids



Aquilegia vulgaris
Chalazal part of Embryo-sac
Showing two antipodals with
wall ingrowths.

In Grindelia, Haplopappus and Quinchamalium the antipodal cells behave like haustorial cells.

In Argemone mexicana the antipodal cells are much larger than either the egg or the synergids. After fertilization they continue to enlarge and persist upto heart shaped stage of Embryo.



Dissected whole mount of a mature Embryo sac of Quinchamalium chilense showing antipodal and synergid haustoria.

Functions of antipodal cells - 3 main functions have been attributed to the antipodal cells —

(1) They functions as nutritive cells, especially when they are persistant.

(2) They show similarity with glandular tapetum and integumentary tapetum in having the nutritive functions.

(3) The wall projection of maize, rice & Poppy gives them appearance

suggest that antipodal cells may be associated with the nutrition of Embryo sac

(2) They functions as store cells of starch, lipids and proteins which are utilized by the developing endosperm and Embryo.

(3) Antipodal cells produce and secrete some substances that control the growth and development of endosperm.

Central Cell

It is the largest cell of the Embryo sac and the mother cell of the endosperm.

The enlargement of the Embryo sac after the last nuclear division is due to the enlargement of the vacuole in the central cell. The vacuole in the ~~central~~ central cell functions as reservoir of sugars, amino acids and inorganic salts.

The nuclei of the central cell are called polar nuclei and are very large with conspicuous nucleolus.

The two polar nuclei fuse before or during double fertilization to form the secondary nucleus.

The presence of cell wall projections in the micropylar and Chalazal region shows that central cell draws nutrition from the surrounding nucellus or integument.

Ans. 5. (i) Hydrophily with Examples

The pollination through the agency of water is called 'Hydrophily'. Hydrophily is of two types -

(a) Hyphydrophily (b) Ephydrophily

Hyphydrophily - When the flowers are pollinated below the surface of water. In such plants the female flowers remain suspended in to ~~the~~ water and the density of pollen grains is ~~same~~ equal to the density of water.

e.g. Ceratophyllum sp.

5. (ii) Ornithophily - (i) The pollination through the agency of birds is known as 'Ornithophily'

(ii) The flowers open during day time i,e. anthesis takes place during day. Flowers are of various shades of Red colour.

(iii) Flowers do not emit odour for attraction.

(iv) Flowers are tubate or tube like and hanging.

(v) Flowers walls are hard, filaments of stamen are hard and/or united. Ovaries are well protected.

(vi) Nectar is abundant but well concealed as

(viii) The birds possess long beak and long tongue to take

nectar from the flowers. Hence, the bird pollination takes place during the foraging visits of the birds on the flowers. e.g.

Bird pollinated flowers are Bombax malabaricum, Camptsis radicans, Erythrena indica, Aloe sp., Strelitzia sp., Spathodea campanulata etc.

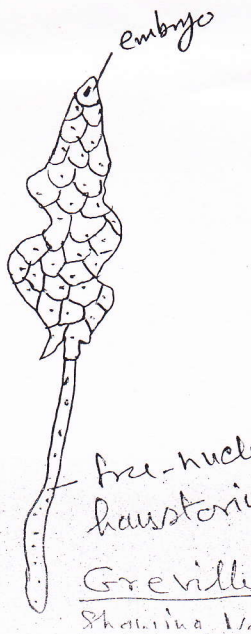
However, recently some orchids have also been reported as ornithophilous. e.g. Genus Disa.

Q. 6. Short notes

(1) Endosperm haustoria and their functions-

Endosperm is the post fertilization product among angiosperms. It is commonly triploid structure. The main function of Endosperm is to provide nourishment to the developing Embryo. However, in some plants the endosperms exhibit extra appendages like structures. These are called Endosperm haustoria.

For the first time Kausik (1941) reported the presence of a vermiform appendage at the chalazal end of the endosperm in Grevillea robusta. This is known as endosperm haustorium. Since then endosperm haustoria have been reported in several members of family Cucurbitaceae, Legeminosae and Proteaceae.



Grevillia endosperm
Showing Vermiform haustorium

In Lomatia polymorpha numerous single celled finger like projections are present all over the endosperm. This increases the absorbing surface of the endosperm.

P.T.O.

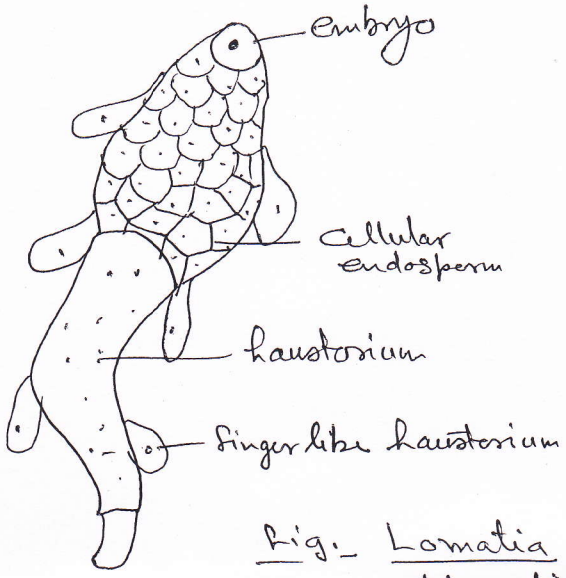
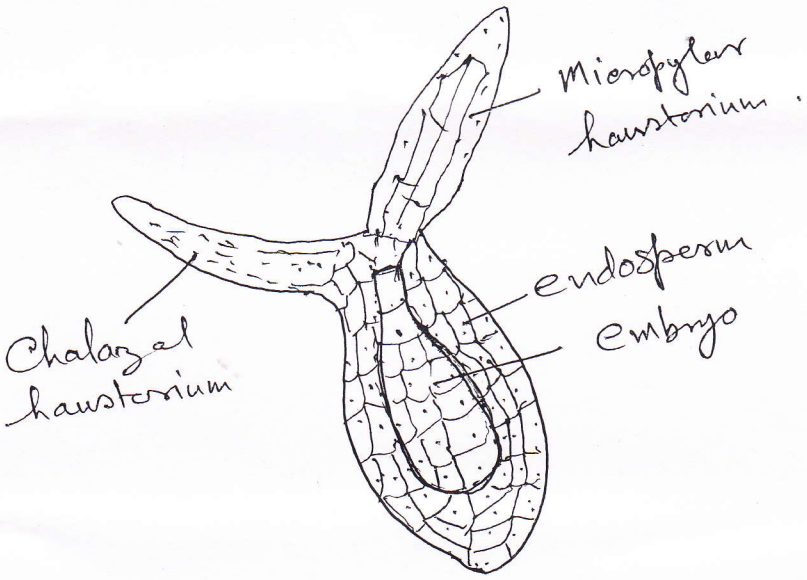


Fig.- Lomatia polymorpha with fingerlike haustoria

In family Acanthaceae both micropylar and chalazal haustoria have been reported e.g. Barleria cristata.

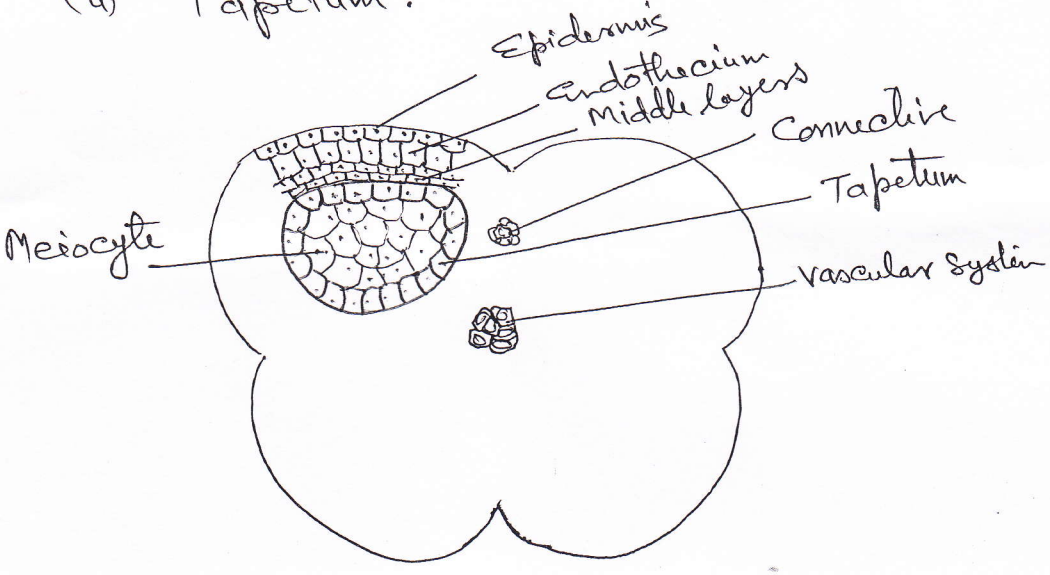


Barleria cristata-Endosperm showing micropylar and chalazal haustoria

Q.7. Wall layers of angiosperm anthers

The transverse section of angiospermous anther exhibit following layers

(1) Epidermis (2) Endothecium (3) Middle layers (4) Tapetum.

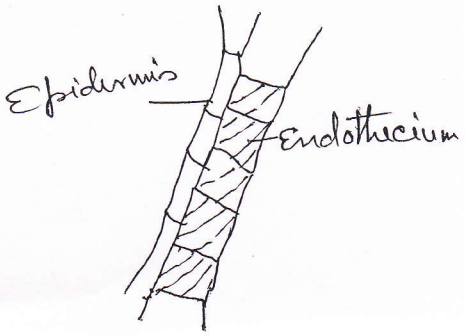


T.S. of Angiospermous Anther - A portion (Cellular) Showing anther wall layers.

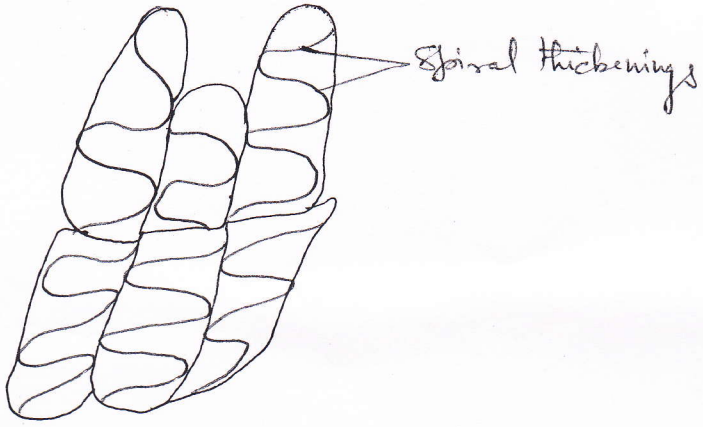
Epidermis - It is originated from protoderm layer. This is the outermost layer of the anther. At maturity it disrupted in most of the taxa but in some taxa of family Amaryllidaceae, Magnoliaceae, Liliaceae the epidermis remains well difined. In Arceuthobium the epidermis develops fibrous bands.

Endothecium - It originates from parietal layer. The cells are radially elongated and attain its maximum development at the time of anther dehiscence. Generally, it is single layered but multilayered endothicium has been reported in Datura alba, Capsicum annuum etc. In Brassica and Allectra the thickening developed in Endothecium layer on the tangential walls. However

fibrous thickenings are absent in members of family Hydrocharitaceae, Cleistogamous forms and in plants exhibiting anther dehiscence by pores. (e.g. Erica).



Melothria sp.
L.S. part of mature anther wall showing epidermis and endothecium



Momordica Charantia
Endothecium in surface view showing spiral thickenings

Reticulate thickenings have been reported in Magnolia stellata (Kapil and Bhandari, 1964)

Endothecial cells of Senecio speciosus exhibit thickenings on the longitudinal walls near the connective.

Senecio speciosus
Single endothecium cell with thickenings.

de Fossard (1969) reported that the endothecial thickenings contain a high proportion of α-Cellulose. However, Pectin and lignin have also been reported in Pisum and Lens (Biddle, 1979).
→ The endothecium helps in dehiscence of anther.

Middle layers - Below the endothecium usually one or two middle layers are present but in Hippeastrum and Lilium 2-5 middle layers persist until anther dehiscence.

Sometimes middle layers in Costus, Agave and Argemone also develops thickenings.

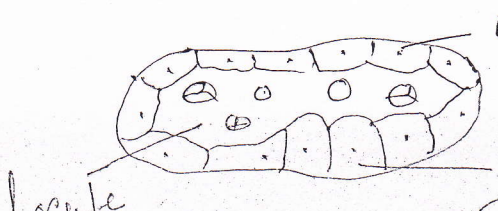
Tapetum -

This is the most important layer of anther. It provides nutrition to the developing microspores and help in the separation of monad pollens from the Tetrad by producing the callase enzyme. The malfunctioning of the Tapetum layer leads to the male sterility of the plant.

Artificial male sterility can be achieved by the deactivating the gene responsible for the development of meiocyte by introducing bacterial gene ~~Barnase~~ BARNASE and the fertility can be recovered by introducing BARSTAR gene.

Generally the tapetum is single layers but biseriate tapetum has been reported in Tecoma and Pyrostegia. ~~and~~ However, multiseriate condition is known in Oxystelma.

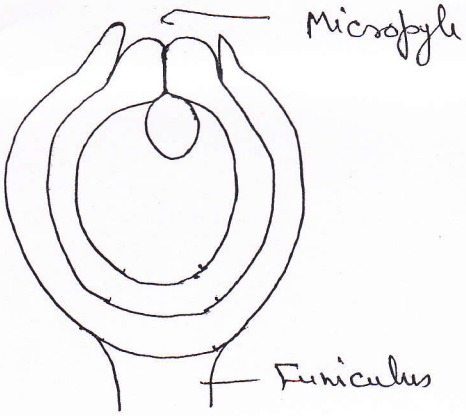
The Dimorphic tapetum has been reported in Antigenon and Alectra ~~sp~~ thomsonii



Dimorphic tapetum of Alectra thomsonii

8. Structure and function of ovule of angiosperms —

Ovule among spermatophytes is known as megasporangium. Ovule at the initial stage consists of a nucellus surrounded by integuments. Among angiosperms following five types of ovules have been reported —

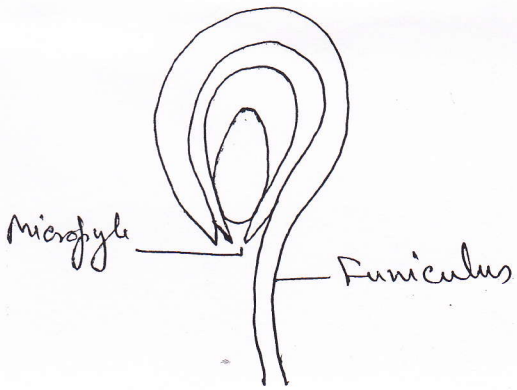


Orthotropus ovule

(Micropyle and funiculus lie in one line)

20 families of Angiosperms exhibits this type of ovule

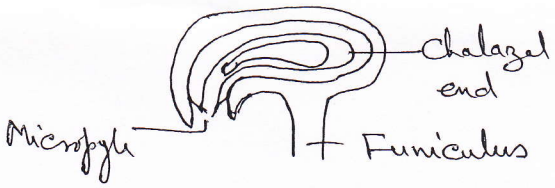
e.g. (Polygonaceae, Piperaceae)



Anatropus ovule

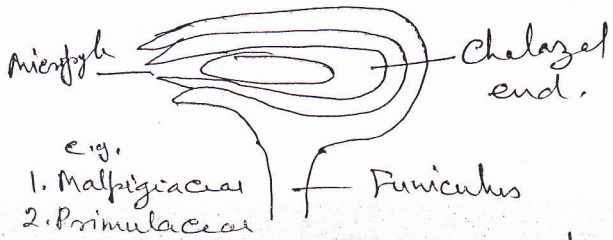
1. Micropyle lie near the funiculus due to the unilateral growth of ovule.
2. Most common type of ovule. 82% of Angiosperms show this type of ovule.

204 families of Angiosperms exhibit this type of ovule.



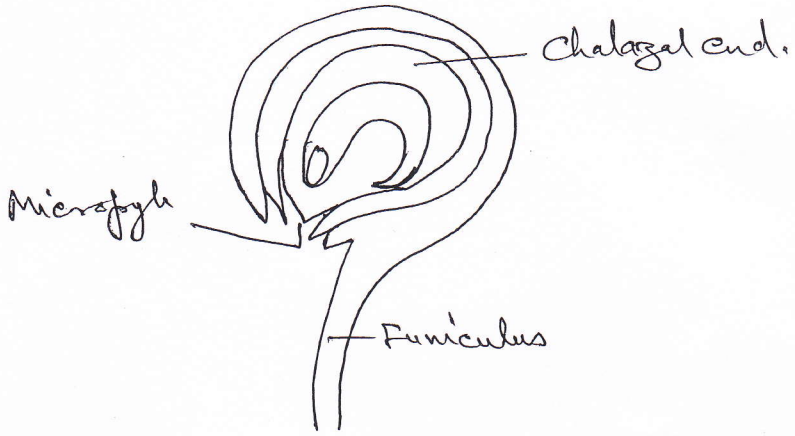
— the curvature of ovule is less and micropyle come parallel to funiculus and the chalazal end remain horizontal. 5 families exhibit such ovules.

e.g Chenopodiaceae Capparidaceae



e.g.
1. Malpighiaceae
2. Primulaceae

When micropyle and chalazal end lie at the right angle of funiculus. (13 families exhibit



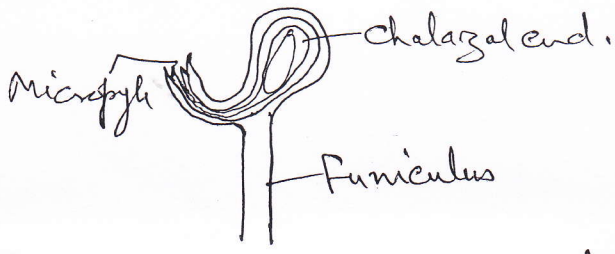
Amphitropus ovule

When the curvature of ovul is so much that the nucellus becomes horse shoe shaped it is called amphitropus ovule.

4 families exhibit this type of ovule.

e.g. Crossosomataceae and Leitneriaceae

In family cactaceae a spicial type of ovule is found and called circinotropus. Here the micropyle pointed out towards upward.



Circinotropus ovule

The function of ovule is to develop female gametophyte and to ~~prepare~~ develop the egg apparatus for fertilization and embryo development.

The mature fertilized ovule is known as seed.

Q.-9. Pollination.

The pollination is a phenomenon which occurs only among the members of Spermatophyta. i,e. Angiosperms and Gymnosperms.

Pollination can be defined as "the transfer of pollen to the stigma of the same or different flower. Pollination can be of two types – (a) Self Pollination (Autogamy) (b) Cross or Allogamy. The Cross Pollination may be of following types –

(1) Zoophily – Pollination by biotic factors like animals
(2) Anemophily – Pollination by wind
(3) Hydrophily – Pollination by water

Zoophily – may be further categorised as follows –

(1) Entomophily – Pollination by insects
(2) Bird pollination or Ornithophily – Erythrina, Bombax, Campsis
(3) Bat Pollination – Cheiropterophily e.g. Bassia, Madhuca, Haplophragma, Kigelia etc.

Entomophily further divided into following types –

(i) Beetle Pollination – Pollination by beetle known as Cantharophily e.g. Stapeliads etc
(ii) Fly pollination – Myophily (Sapromyophily) – Thunbergia, Ipomoea and many others.
(iii) Antpollination – Myrmecophily – Most of the angiosperm plants
(iv) Bee Pollination – Melittophily

(v) Butterfly pollination — Psychophily - Lantana, Plantago etc.

(vi) Moth pollination — Phalaenophily - Phlox, Verbena.

(vii) Snail / Slug pollination — Malacophily e.g. Rhodea japonica.

4. Rain Pollination — (Ombrophily)

e.g. Ranunculus sp. (Butter cup)

Narthecium ossifragum (Bog Asphodel)

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