Embryology of Angiosperms

DATE / /
PAGE NO.

Structure of Anther

(1) **Epidermis** :- Single layered and protective in function.

(2) **Endothecium** :- has radial elongated cells.
- (α-cellulose + suberin + lignin)
  - more. — less
  - causes fibrous thickening

→ Fibrous thickening makes endothecium hygroscopic in nature.

→ Hygroscopic nature of endothecium play key role in Dehiscence (फटने) of anther wall.
- → Liberation of pollen grain.

Note:- The site of dehiscence of anther → stomium

(3) **Middle layer**:- 2-3 layered. (Multilayered)
- → ephemeral cells (short lived). & degenerate at maturity.
- → Nutritive in function.

(4) **Tapetum**:- Innermost layer of anther wall.
- → Tapetal cells → Multinucleated cells / polyploidy.
- → Polyploidy in a cell is due to endomitosis.

Function:- (i) Nourishment of PMC & pollen grain.
(ii) Enzymes & Harmones production.
(iii) produce Ubisch granules.
- makes sporopollenin — makes exine of pollen grain.
- hardest biological substance.

(iv) Secrete pollen kit.
- Found in entomophilus plant.

DATE / /
PAGE NO.

Microsporogenesis :- Process of formation and differentiation of microspores.

Microsporangium (2n) —mitosis→ sporogenous tissue (2n) —mitosis (II)→ sporogenous (2n)
↳ microspore mother cell
(n) Microspore tetrad ←meiosis II— microspore dyad (n) ←meiosis I
↓ differentiation / maturation
Microspore / pollen grain (n)
(4 microspores)

→ In family, Asclepediceae & Orchidaceae, pollen grain of one anther lobe are united and packed in a ballon like structure called pollinium. [BP]

→ Process of formation of more than 4 microspores are called polyspory.
. commonly seen in cuscuta. [TOM]

* Structure of pollen grains :-
→ Study of pollen grain → Palynology
→ study of pollen grain with honey bee → Melitopalynology V. Imp
→ First cell of male gametophyte → Pollen grain

* Microspore : 2 distinct wall

• Pollen grain (V. I.)
  - outer wall : exine → Thick & hard
    ↳ due to sporopollenin
  - Inner wall : intine → Thin & elastic
    ↳ due to cellulose & pectin
    commonly → pectocellulose

• Sporopollenin :- Hardest plant substance.
→ pollen grains ~~reversed~~ remain preserved ~~due~~ in fossils due to sporollenin.

*

DATE / /
PAGE NO.

- **Pectocellulose:-** Intine is thin & elastic in nature due to pectocellulose.
→ Intine gives rise to pollen tube - during germination.

- **Pollen Grain:-** is best defined as partially ~~divi~~ developed male gametophyte.
→ Pollen grain with pollen tube → fully developed male gametophyte / Germinating pollen grain.
→ pollen grains have one or three or many weak points → Germ pore.

At germ pore:
exine → Thin / absent

→ Pollen tube emerges from → Germ pore
- → Monocot (1)
- → Dicot (3)

Q. The exine of pollen grains composed of:-
(a) cellulose (b) Sporopollenin (c) pectin (d) None

Microgametogenesis:- The process of formation of male gametophyte from functional pollen grains.

Microspore (Haploid) —Mitosis (unequal)→
- → smaller: Generative cell (Genetically active)
- → larger:- Vegetative cell (metabolically active)

→ In angiosperm, pollen grains are shed from anther mostly at 2celled stage & rarely at 3 celled stage.

→ In cycas → 3 celled stage (C=3)
→ In pinus → 4 celled stage → (2 prothelial cell + 1 generative cell + 1 tube cell.)
- Male gametophyte of angiosperm has no prothelial cell.

DATE / /
PAGE NO.

Special points :-

pollen grain at pollinating stage → 2 nucleus

Vegetative nucleus
Siphogenic or tube nucleus
→ ~~pollen~~ directs the growth of pollen tube towards embryosac
→ Acts as torch [IOM/KU]

Generative nucleus
[Mitosis]
2 non-motile male gametes.
1st male gamete (smaller)
2nd male g (larger)

→ In entomophilous plants :— Insect loving plants.
pollen grain → protective layer of yellow sticky substance called pollen kit.
(Lipid + carotenoids)
secreted by Tapetum

Female Reproductive part / Gynoecium

→ Gynoecium is composed of carpel / pistil.
eqv. to megasporangium.

→ Carpel / pistil (3 parts) → stigma, style, ovary
ovary contains ovules
eq. to megasporangium of gymno

✱ Ovule :- Ovule is integumented megasporangium. [IOM]
→ Main body of ovule is formed by Nucellus.
→ Nucellus is surrounded integument.
→ Opening of ovule is called micropyle.

→ Base of ovule is called chalaza.
└ or origin centre of integuments.

→ Placenta:- ovary is ~~attached~~ attached with ovule. with the help of:
→ Bulged part of ovule → Raphe
→ The point of attachment of body of ovule to funicle :- Hilum.
→ Ovules are attached with ~~the~~ placenta with the help of funicle

* Types of Ovule:-

① Orthotropous :- Primitive and simple type of ovule.
→ Micropyle, chalaza, Funicle → lie in the same straight line.
→ Chalaza → Base मा, Micropyle → Tip मा
→ also called ~~Antr~~ Atropous / straight ovule.
→ e.g. Gymnosperm, except pinus anatropous @PAN

② Anatropous :- Most common type type of ovule.
→ Body of ovule is completely inverted - so that micropyle & funicle are parallel. & very close to each other.
→ commonly called inverted ovule.
e.g. Angiosperm, Pinus @ PAN.

③ Amphitropous :- Both body of ovule & embryosac are curved.
→ Horse shoe shaped.
→ e.g. Papaveraceae.

④ Hemianatropous :- Body of ovule is right angle to funicle.
→ also called Hemitropous / Transverse ovule.
→ eg. Ranunculus.

DATE / /
PAGE NO.

(5) Campylotropous:- only body of the ovule is curved.
e.g. Leguminoseae, Cruciferae.

(6) Circinotropous:- funicle is exceptionally long and forms complete circle around ovule
e.g. Cactaceae (Opuntia)

Some specific structures associated with Ovule:-

(i) Endothelium:- specialized nutritive tissue formed by integuments.

(ii) Orburator:- Ovular structure that directs the growth of pollen tube towards ovule.

(iii) Carunde:- Develops from outer integuments. e.g. Castor (Ricinus)

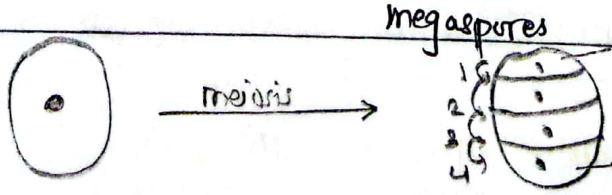
(iv) Perisperm:- Remnant of nucellus. e.g. Zingiber

(v) Fleshy Aril:- Develops from funicle of ovule.
e.g. Litchi Chinensis [TUM]

Q. Edible part of litchi is:- Fleshy Aril.

Megasporogenesis:- formation of megaspores from megaspore mother cell.

→ single cell of nucellus → Archesporial cell → Megaspore mother cell → linear tetrad of Haploid megaspores (Meiosis)

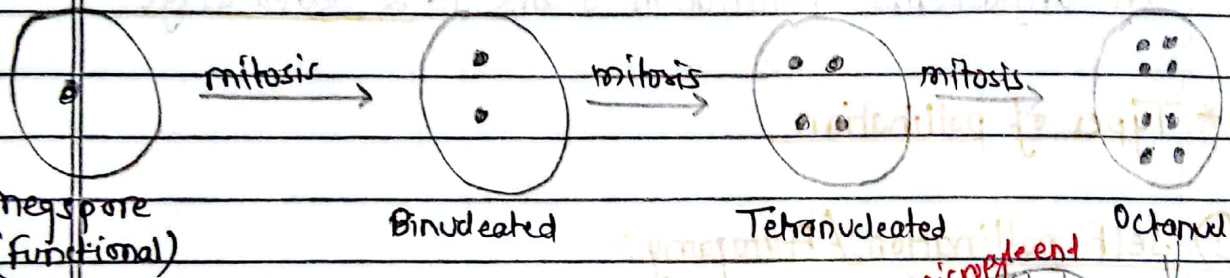


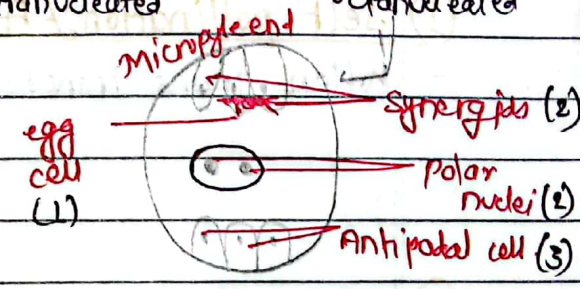
DATE / /
PAGE NO.

VT → Functional megaspore is 1st from chalaza and 4th from micropyle

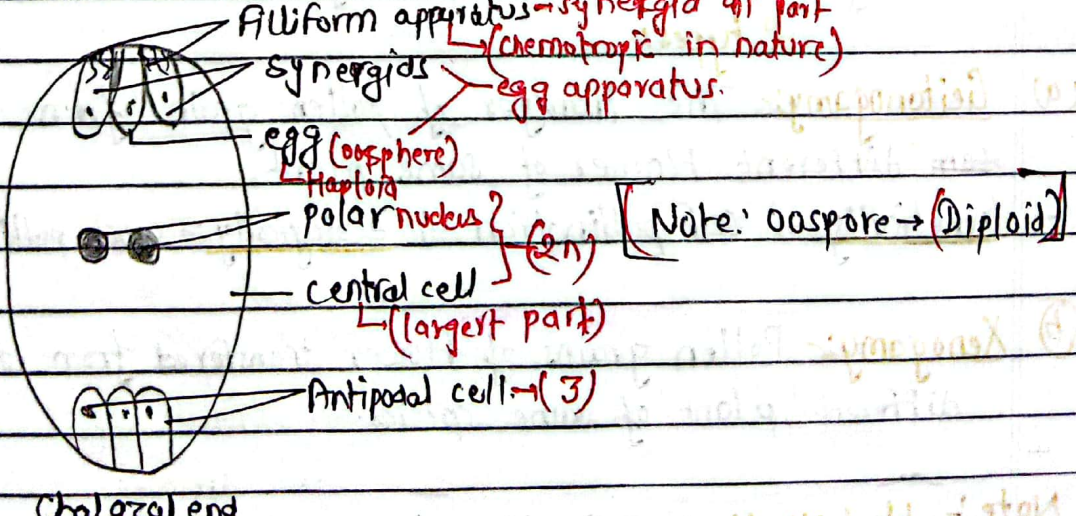
Q. Functional megaspore in an angiosperm develops into:—
— Embryo sac

Megagametogensis:- Formation of female gametophyte (Embryosac) from (Functional ~~micro~~ megaspore) chalazal end मा हुन्छ।
— A fully developed female gametophyte is 7 celled and 8 nucleated.
— Most common, simple and normal type of Embryosac is polygonum type.
— Functional megaspore (3 mitosis) → female gametophyte.





Embryo sac:- fully developed female gametophyte.
— 7 celled & 8 nucleated.



[Note: oospore → (Diploid)]

— Polar nucleus is only diploid others are all haploid.

DATE / /
PAGE NO.

→ Most common type of Embryo sac → Polygonum
→ Only diploid nucleus of embryo sac → Secondary / Definitive / central / polar nucleus
→ largest cell of embryo sac → central cell
→ Constant feature of embryosac → egg cell
→ Filliform apparatus is feature of Synergid
→ Egg aparatus = egg cell + Syngergid
→ Pollen tube finally discharges gametes in Synergid.
→ Growth of pollen tube towards embryosac is ~~then~~ chemotropic.

Pollination :- The transfer of pollen grains from anther to stigma is called pollination.
→ In angiosperms, pollination occurs at 2-celled stage

* Types of pollination

(1) Self pollination / Autogamy :-
- Pollen grains transfer to stigma of same flower.

(2) Cross pollination / Allogamy :-
- Pollen grains transfer to stigma of different flower.

2 types :-

(a) Geitonogamy :- The transfer of pollen grain from stigma of ~~same~~ different flower of same plant.
- Genetically → self pollination ; ecologically :- cross pollination

(b) Xenogamy :- Pollen grains of flower transfered from stigma of different plant of same species.

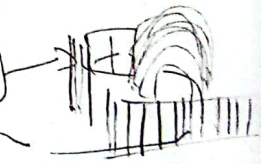
Note :- Hybridization : Pollination between flowers of different species.

* Contrivances or adaptations for Self pollination @BHC

(i) Bisexuality:- self pollination always occurs in bisexual flower

(ii) Homogamy:- Androecium and Gynoecium mature at same time.

(iii) Cleistogamy:- Closed Flower
→ Flowers that never open at maturity.
e.g. Commelina, Arachis Hypogeae (Ground nut), केराक (अरंड)
↳ cleistogamy is due to geocarpy: ↳ product of fruit underground



Commelina Benghalensis
⇓
Chasmo-cleistogamous

→ Aerial Flower
- opens at maturity → Chasmogamous [TOM]
- cross pollination

→ Underground flower
- Donot open at maturity :- Cleistogamous
- Self pollination

* Contrivances or adaptations for cross pollination :-

(V.I) (i) Dicliny / Unisexuality :- Allogamy is best favoured by Dicliny.
→ cross pollination always occurs in unisexual plant.

(ii) Heterostyly :- Flowers with different length of stamen and style.
Diff. Stamen style

(V.I) (iii) Herkogamy :- Physical / Mechanical barrier that prevents self pollination.
→ Best herkogamy is seen in Calotropis.

(iv) Self sterility:- Pollen grains fail to germinate.

(v) Pollen preoptency:- quicker growth of pollen tube.

Mode of Pollination:

- Anemophily:- wind pollination. eg. Graminae, Gymnosperm @G (versatile anther is present)
  - → Typical cross pollination occurs in Maize.
  - → Anemophilous plant → small and inconspicious flower.
  - → Pollen grain:- small, light, smooth and dry
  - → Stigma :- sticky, leathery

- Entomophily:- Insect pollination.
  - → Most common and most effective pollination.
  - → Chief pollinator:- Bees
  - → Flower :- Brightly coloured, with ~~se~~escent and nectar.
  - → Pollen grain:- sticky, rough, & large. [TOM]

- Hydrophily:- water pollination.
  - (i) Epihydrophily:- submerged dioecius plant. @EVa Vallisneria
  - (ii) Hypohydrophily:- @ZNC eg. Zostera, Naja, Ceratophyllum.

- Ornithophily:- Bird pollination.
  - @ 4B eg. Bombax, bottle brush, Bignonia, Butea Monosperma (Flame of forest)

- Chiropterophily:- Bat pollination.
  - e.g. Kigelia Pinnata (sausage tree)

- Malacophily:- Snails pollination.
  - eg. Lemna, Colocasia

DATE / /
PAGE NO.

- **Ophiophily:-** also known as serpentophily.
  → pollination by snakes.
  e.g. Arisaema (snake plant) or (cobra plant)

- **Zoophily:-** Pollination by animals.
  e.g. Rafflesia by elephant
  Myth → Largest Flower Rafflesia is pollinated by largest animal elephant. 2nd pers.
  Truth → Rafflesia emit → odour of rotten animal flesh
  ↓attracts
  carrion flies. 1st priority.

Entry of pollen tube into ovule:-

- **Porogamy:-** Entry of pollen tube through micropyle.
  - most common mode of entry.

- **Chalazogamy:-** Entry of pollen tube through chalaza or base of ovule.
  → also known as basigamy.

- **Mesogamy:-** Entry of pollen tube through integuments or Funicles.
  e.g. Cucurbitaceae. (v.I)

Post pollination change in pollen grain

- **Pollinating stage:-** Pollen grain has 2 nuclei.

Vegetative nucleus	Generative nucleus
- also known as siphonogenic nucleus / Tube nucleus.	↓mitosis
→ acts as a torch. ↓ directs the growth of pollen tube towards embryo sac.	2-non-motile male gametes 1st → smaller 2nd → larger

Zoology | Botany | Physics | Chemistry

DATE / / PAGE NO.

- Germination of pollen tube is promoted by Boron & Calcium @BoCa

Double Fertilization

→ Pollen tube $\xrightarrow[\text{embryo sac}]{\text{enters}}$ at micropylar end.

→ Filliform apparatus of synergids $\xrightarrow[\text{chemicals}]{\text{release}}$ to attract pollen tube.

→ First male gamete (n) + egg cell (n) $\xrightarrow[\text{fertilization}]{\text{True}}$ zygote (2n)

→ 2nd male gamete (n) + secondary nucleus (2n) $\xrightarrow[\text{fusion}]{\text{Triple}}$ Endosperm (3n) or primary end. nucleus.

→ Fusion of 1st male gamete with egg cell and fusion of 2nd male gamete with 2ndary nucleus is called Double fertilization.

→ Double Fertilization ⇒ Syngamy + Triple Fucion.

→ Double fertilization was discovered by S.G. Nawaschin in fritilaria.

→ No. of nuclei involved in double fertilization ⟶ 5

→ No. of Gametes involved ⟶ 3

→ Significance → production of viable seeds.

- Double fertilization is the characteristics features of Angiosperm.

Endosperm in:-

① Angiosperm → Triploid (3n)
↳ formed after fertilization.

② Gymnosperm → Haploid (n)
↳ formed before fertilization

→ Endosperm is suppressed in Trapaceae, Orchideaceae, Podostomaceae.

@Top

Abishek singh

* **Post fertilization change in the ovary**

Ovary	Fruit
Ovary wall	Pericarp (fruit wall)
Ovule	Seed
Funicle	Stalk of the seed
Hilum of ovary	Hilum of seed
V.I.P Nucellus	Perisperm
Micropyle of ovule (pollen tube का entry)	Micropyle of seed (water entry का लगेगा)
Outer integument	Testa
inner integument	Tegmen

- Antipodal cells and synergids → Degenerate

* **Special points:-**

- **Endosperm:-** The nutritive tissue for developing embryo.
  In angiosperm, free nuclear division occurs at the endosperm formation.
- Most common type of endosperm → Nuclear endosperm.
- **Coconut milk:-** Free nuclear degenerative multinucleated liquid endosperm. [IOM]
  → Rich in cytokinin. [IOM]
- Endosperm of Maize contains → Zeatin [IOM]
- **Xenia:** Effect of pollen grain on endosperm.
  e.g. Maize
- **Metaxenia:** Effect of pollen grain on structure outside endosperm i.e. seed coat, or fruit wall.
- **Polyembryony:-** The process of development of more than one embryo in seed is called polyembryony.
  → common in Gymnosperms.
  → Discovered in Angiosperm (Citrus). [MOE]