LECTURE 1

STRUCTURE OF SEEDS AND THEIR STORAGE

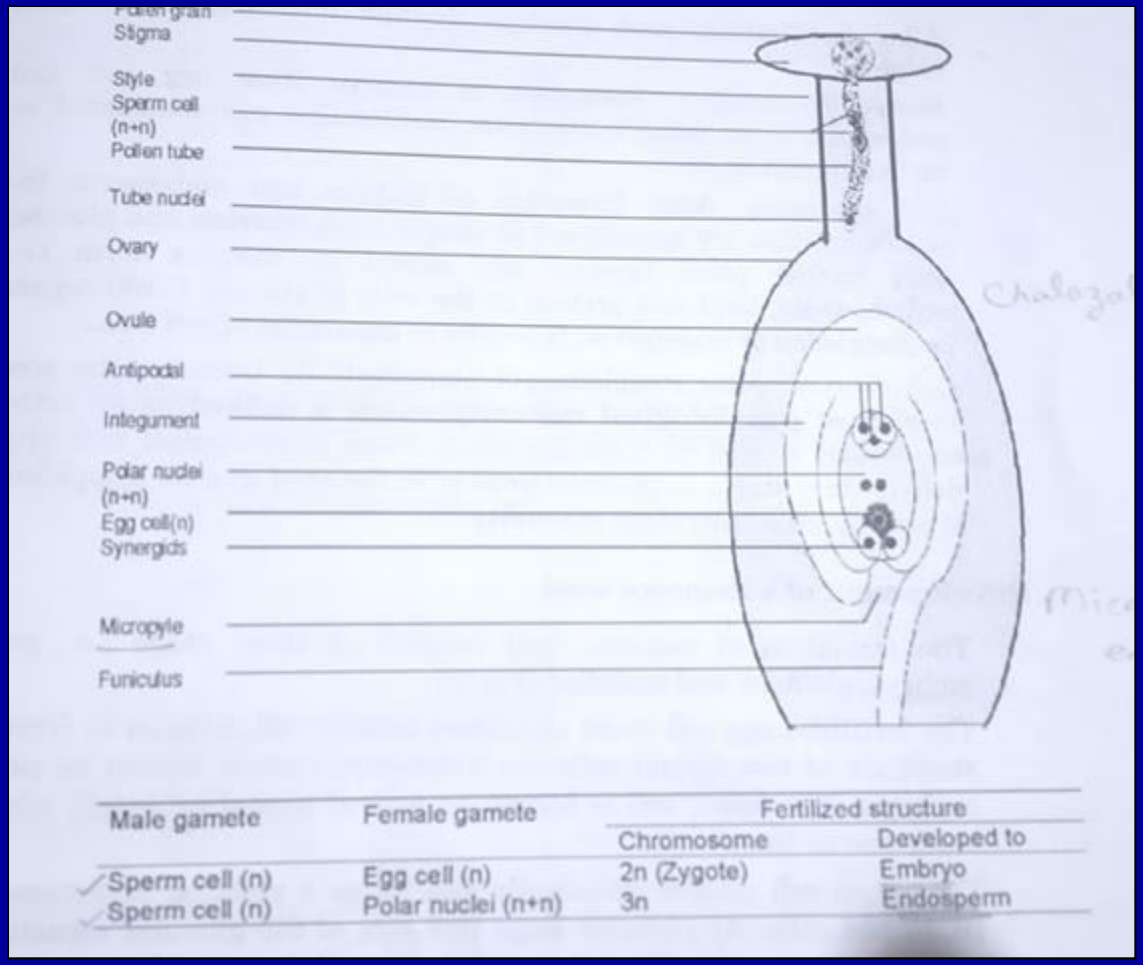
Seed is a ripened ovule containing an embryo in arrested state of development, usually with food reserve and a protective coat.

In the term of seed technology, the part of the plant use for sowing purpose to raise the crop is considered as seed.

Every seed consists of

- Embryo
- Storage tissue
- Protective other covering

Fertilization and pollination



Male gamete	Female gamete	Fertilized structure	
		Chromosome	Developed to
Sperm cell (n)	Egg cell (n)	2n (Zygote)	Embryo
Sperm cell (n)	Polar nuclei (n+n)	3n	Endosperm

Fig. Process of fertilization.

Fertilization and pollination

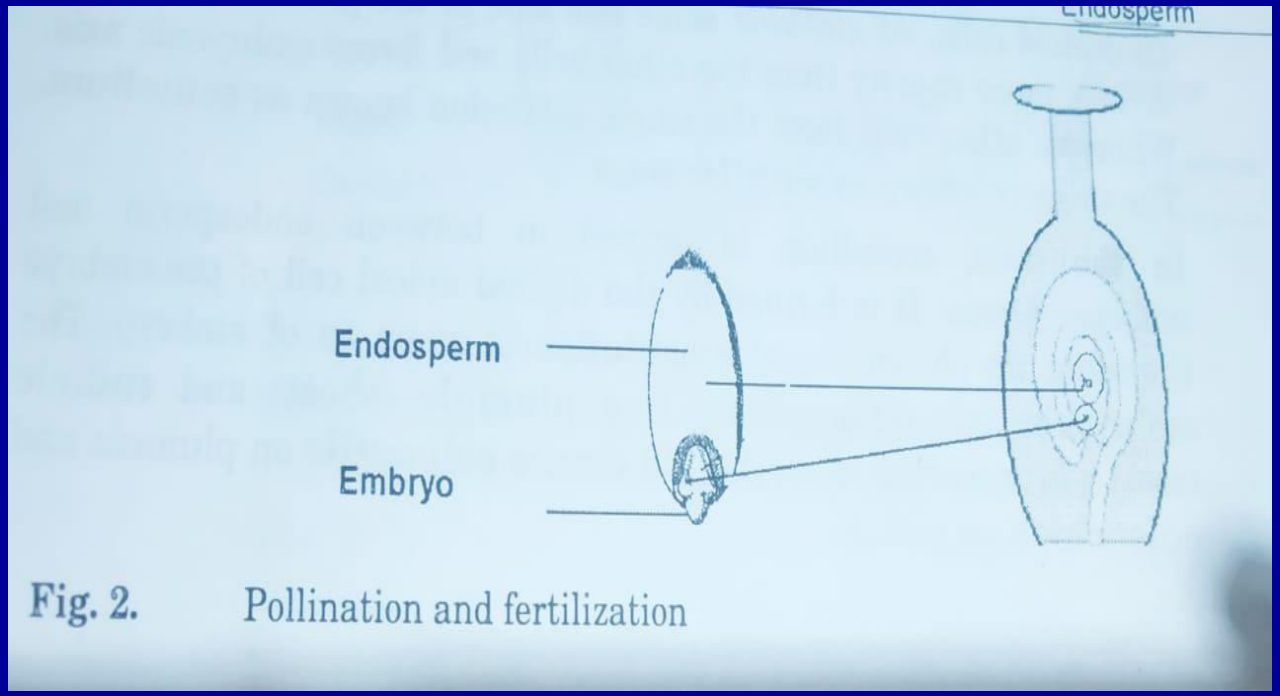


Fig. 2. Pollination and fertilization

Relation between flower tissues and subsequent parts of the fruit and seed; typical for angiosperms

Ovary	Grows Into Fruit tissue
Ovule	Mature Seed
Embryo Sac	Inner Part of the seed
Polar nuclei	Along with generative nucleus becomes the endosperm
Egg cell	Fuses with one generative nucleus to form embryo
Integuments	Layers of seed coat (testa)

Seed developmental patterns and source of assimilates for seed development

After fertilization seeds develop through following physiological stages histo-differentiation, cell expansion and maturation drying.

Stage I: Formation of embryo from egg cell and endosperm from polar nuclei after fertilization are considered as histo-differntiation

Stage II: After formation of embryo and endosperm the photosynthates are transferred in simple form (sucrose and glucose from mother plant (source) and stored in complex form i.e., Carbohydrate, lipid and protein in the cells of storage organs i.e., Cotyledon or endosperm. It result in increase in seed size, for food reserves deposition.

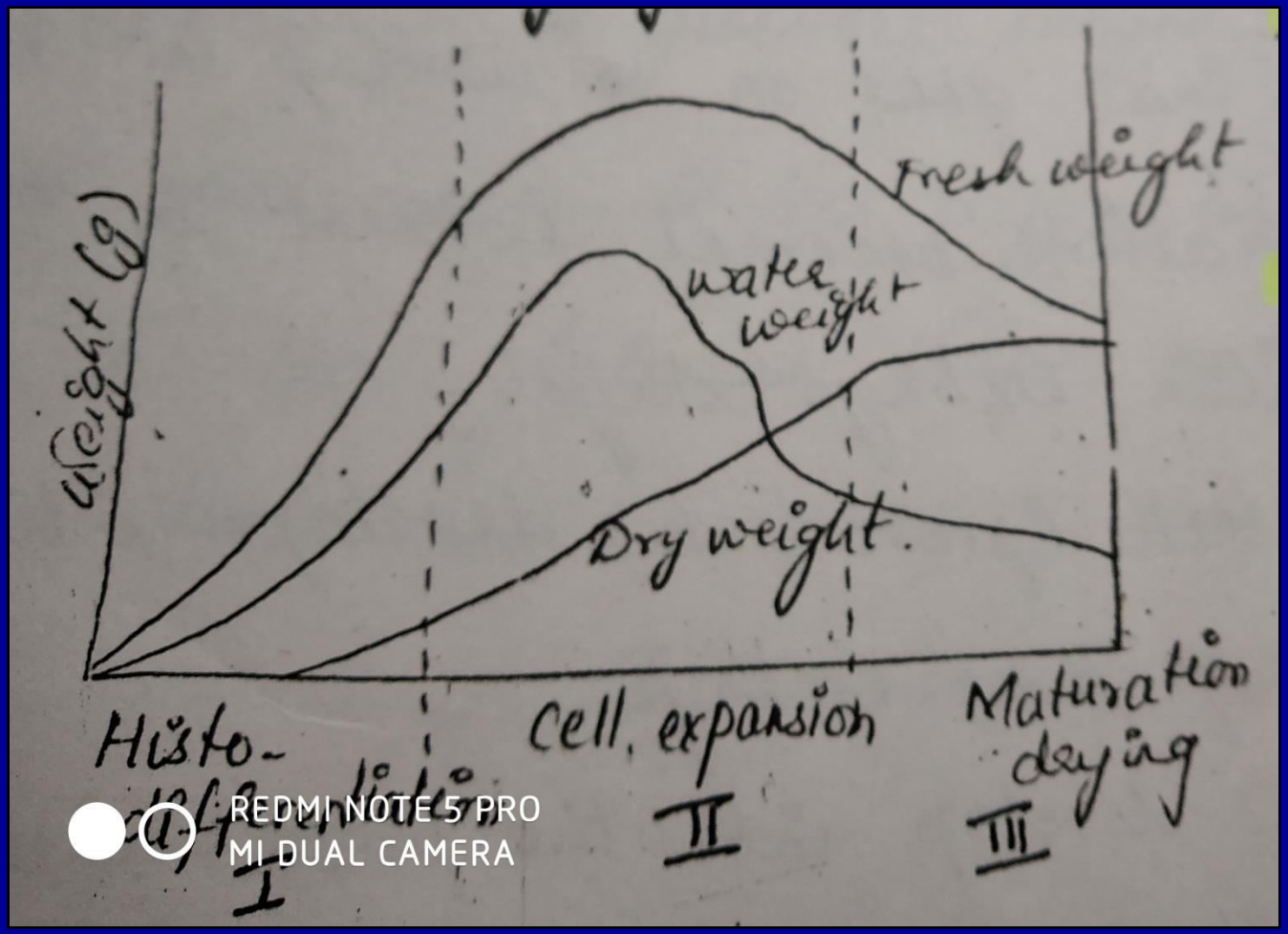


Fig:. Three physiological stages of seed development

Stage I: Histo differentiation / Embryo differentiation

Dicots

Characteristics stages of development include the proembryo, globular, heart, torpedo and cotyledon stage.

- Following fertilization, a proembryo is initiated by a transverses cell division to form an apical and basal cell.
- Apical cell forms the suspensor; while basal cell forms the embryo.
- Suspensor is usually a column of single or multiple cells, it functions to push the proembryo into the embryo sac cavity and to absorb and transmit nutrients to the proembryo.

- Basal derivatives in the globular embryo form the hypophysis, that goes on to develop into radicle.
- Tissue differentiation becomes evident in the 16-celled globular embryo stage.
- Outer layer of cells (Protoderm) develops into the epidermal cells of the embryo.
- Inner cell layers develop into the procambium and ground meristem.
- Cotyledon primordium is evident in the heart shaped stage
- Elongation of primordial cell gives rise to a typical torpedo stage embryo: which has an apical meristem, radicle, cotyledon and hypocotyl..

Monocots

- Characterisitics development stage include proembryo, globular, scutellar and coleoptilar stages.
- Following fertilization, apical and basal cell is visible that initiates the proembryo stage.
- Proembryo and globular stages similar to dicots but suspensor is less differrentiated.
- In the late globular stage, outer epidermal layer is evident and a group of cells on one side of the embryo
- Cotyledonary remnants are visible in the scutellar stage.
- Monocots have a single modified cotyledon termed as the scutellum which is the conductive tissue between endosperm and embryo axis

- During coleoptilar stage, the embryo axis differentiatesa into plumule (shoot) and radicle (root).
- Embryo axis has specialized tissue surrounding the shoot (coleoptile) and root (coleorrhiza).

Stage II: Cell expansion/ Seed filling

- Rapid cell enlargement due to accumulation of food reserves
- Food reserves ensure survival of the germinating seedling and also essential food for human and animals

Stage III: Maturation drying

- Physiological maturity is the time prior to maturation drying where the seed (embryo) has reached maximum dry weight
- At this stage, seeds show high germination potential, as measures by seed viabilty and vigour.
- Rapid water loss.

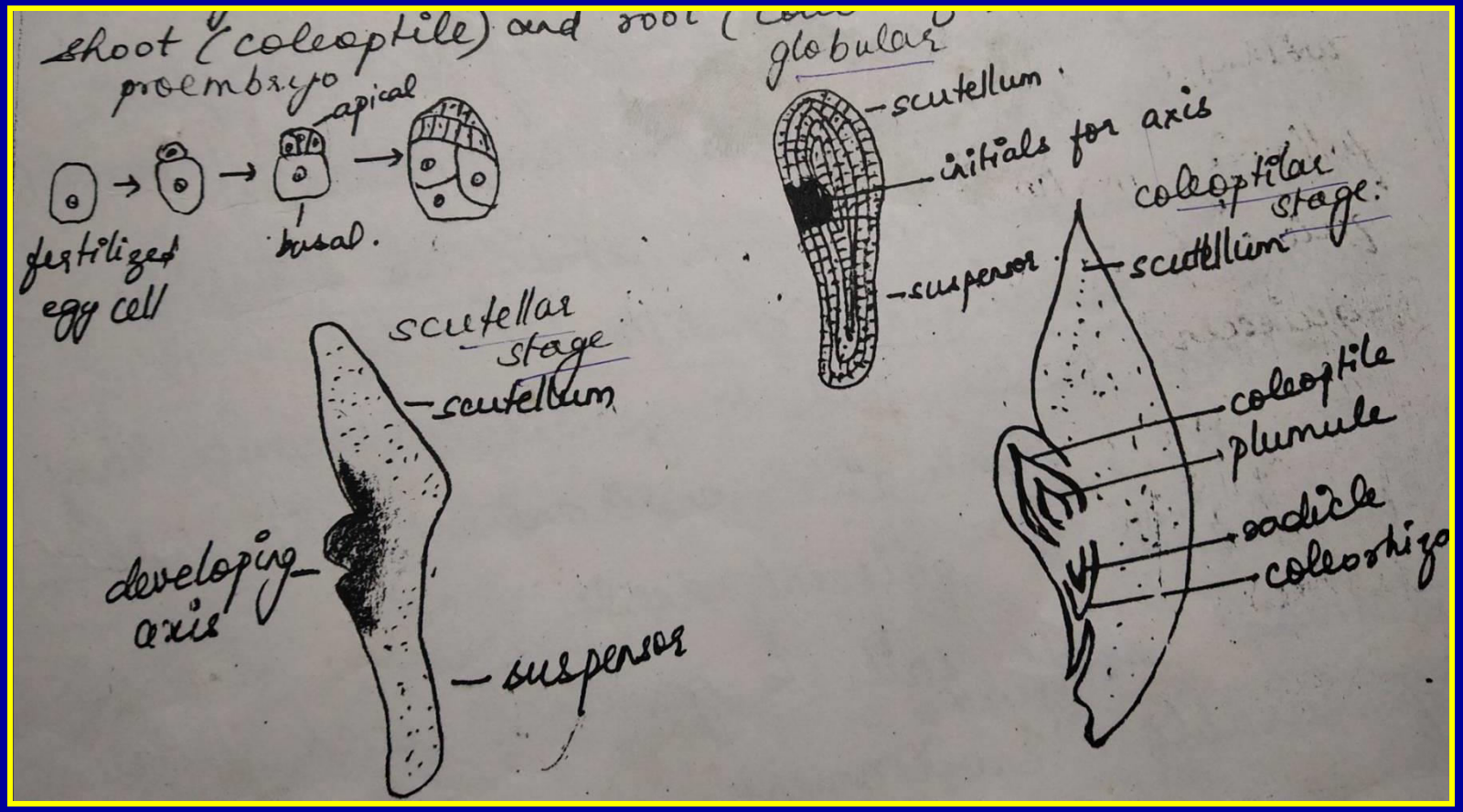


Fig:. Histo-differentiation and embryo formation in Monocot

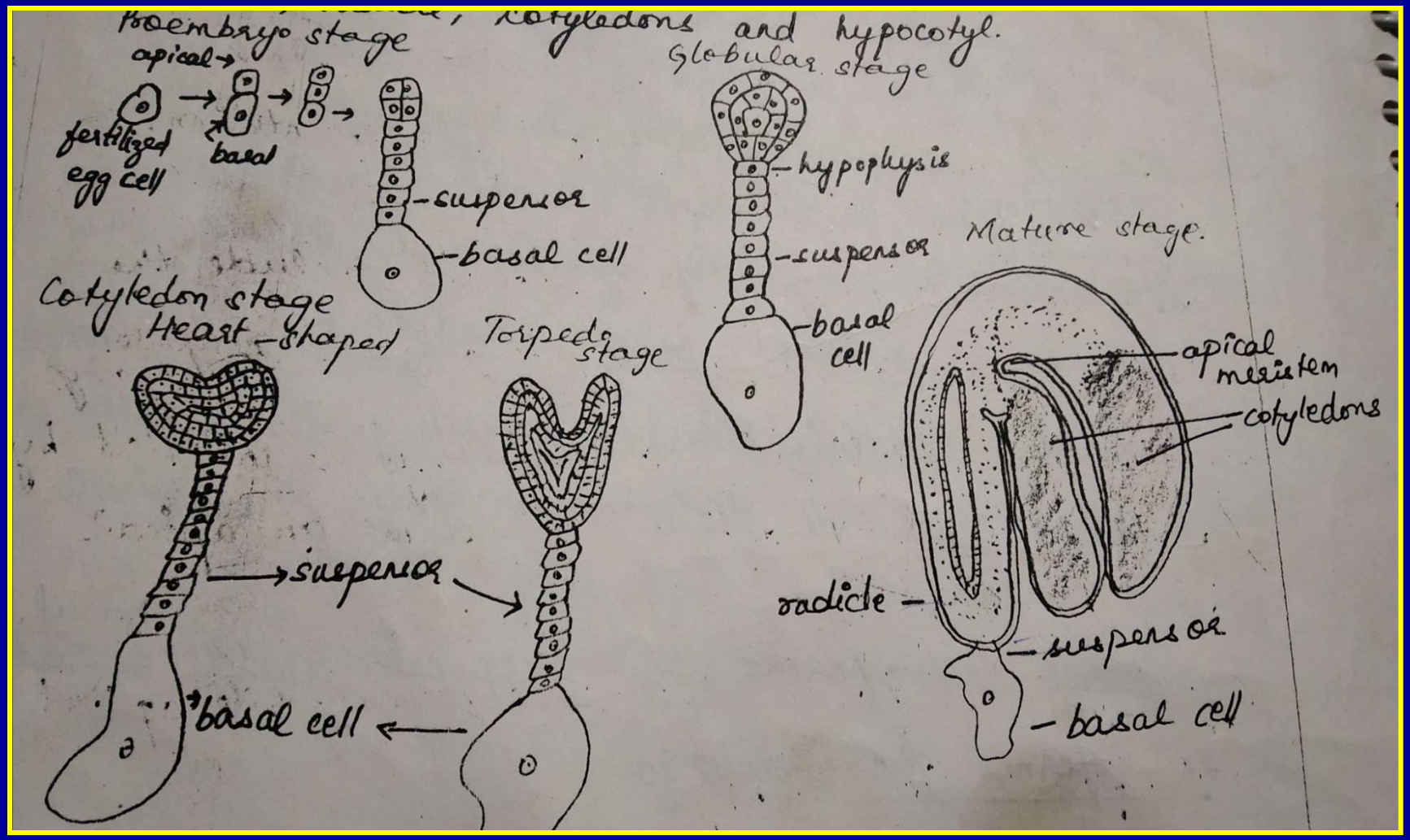


Fig:. Histo-differentiation and embryo formation in dicots

- There is no longer a vascular connection with the mother plant through funiculus.
- The area where seed coat and the funiculus was attached is the hilum
- Hilum is the valve that allows water to leave the seed completing the dessication process
- Seeds that germinate prematurely on the plantwithout dessication drying are called viviparous germination
- Following maturation drying seeds are either in quiescent or dormant condition.
- Quiescent seeds seeds fail to germinate because they are dry, favourable environment will induce germination in quiscent seeds.
- Dormant seeds fail to germinate even under favourable environment.

Embryo

- Embryo is the new plant resulting from union of male and female gamete during fertilization.
- it has an embryo axis with growing points at each end, one for shoot, one for root.
- One or more cotyledons are attached to the axis
  single cotyledon - monocots (coconut, grasses)
  two cotyledon - dicots (bean, peach)
  many (15) cotyledon - gymposperms (pine, ginkgo)

Storage tissue

- Initially provides energy for embryo growth during seed development.
- Later on used by embryo during germination.
- In angiosperms – perisperm (nucellus), endosperm or cotyledons.
- In gymnosperms – female gametophytic endosperm.
- With respect to their relative embryo development or type of storage tissue, seeds are separated into three basic types: non endospermic, endospermic (or) unclassified.

Non endospermic

- Rapid initial growth in the endosperm of dicot species that digests the enclosing nucellus.
- Followed by embryo expansion through cell division at the periphery of the cotyledons that digests the endosperms.
- Thus, endosperm/nucellus is reduced to a remnant between the embryo and integuments (seed).
- Cotyledons function as the major storage tissues.

Endospermic seeds

- Cotyledon growth is arrested, such that the embryo may be only one-third to one-half size of the seed when it is ripe.
- Remainder of the seed cavity contains large amount of endosperm or perisperm (nucellus).

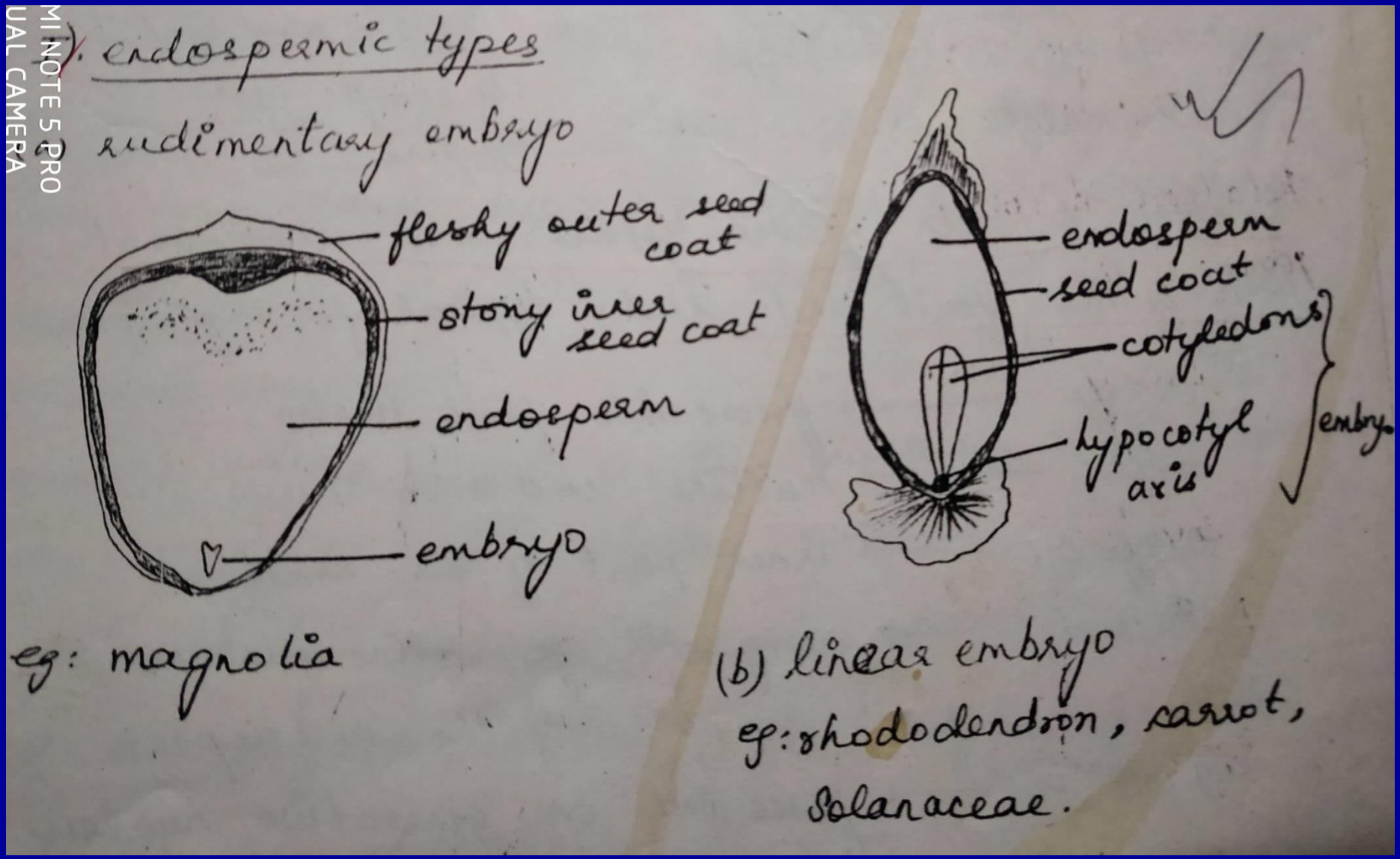


Fig:. Endospermic type of seed

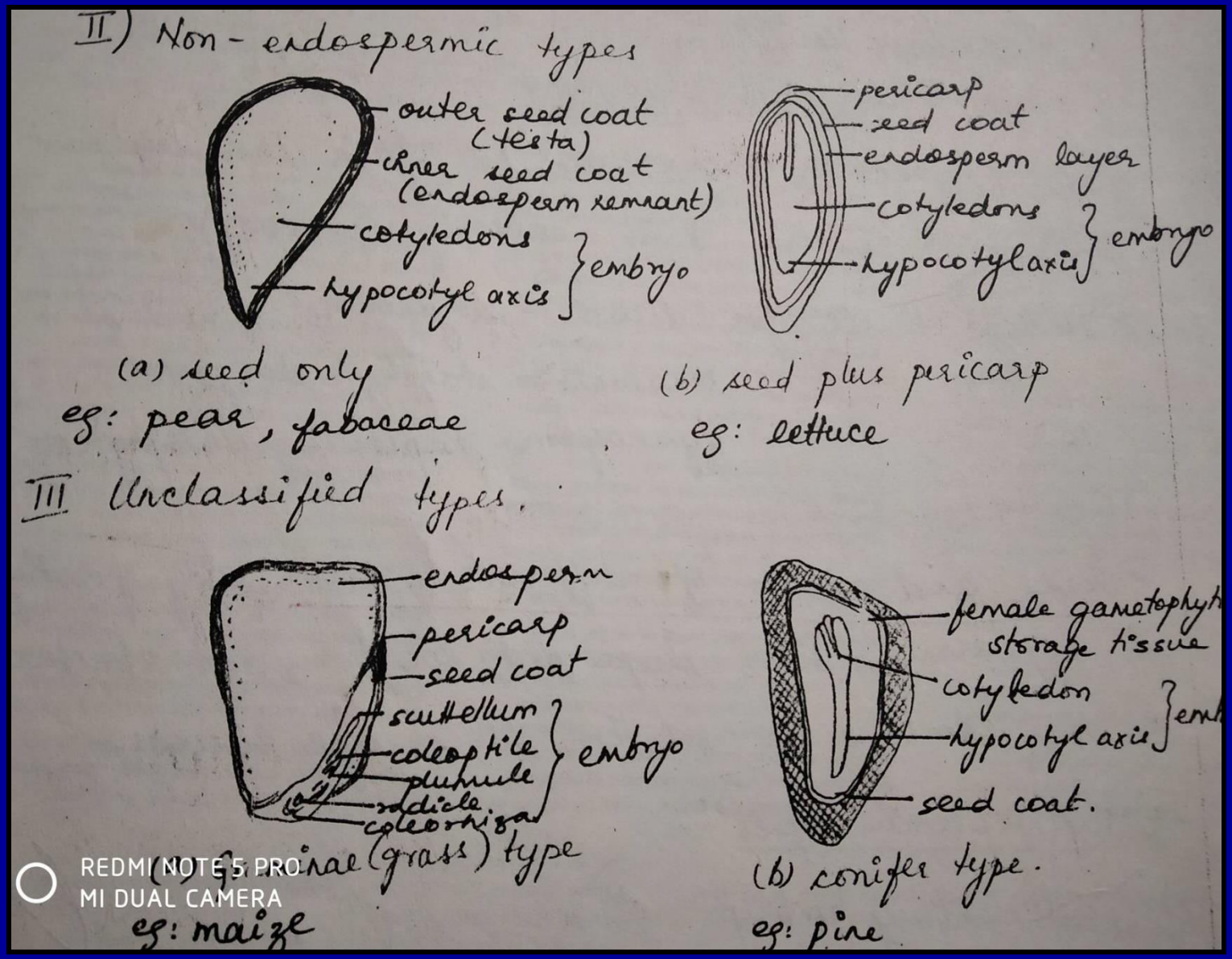


Fig:. Non endospermic and Unclassified type of seed

Unclassified seeds

These include seeds of monocots with their modified structure and location in seed.

Seed covering

- Consists of seed coat, remains of nucellus and endosperm, and some part of the fruits.
- Appearance of seed coat is characteristic of the plant family.
- Outer layer usually becomes dry, hard and thickened, brownish in colour.
- Inner seed coat layer are usually thin, transperant and membranous.
- Provide mechanical protection to embryo.
- In fruits such as achenes, caryopsis samaras and schizocarps, the pericarp and seed coat layers are contiguous.