

Double Fertilization
Embryogenesis
&
seed development

Surinder Kaur

DIET ROPAR

Cell No. 09988530775,

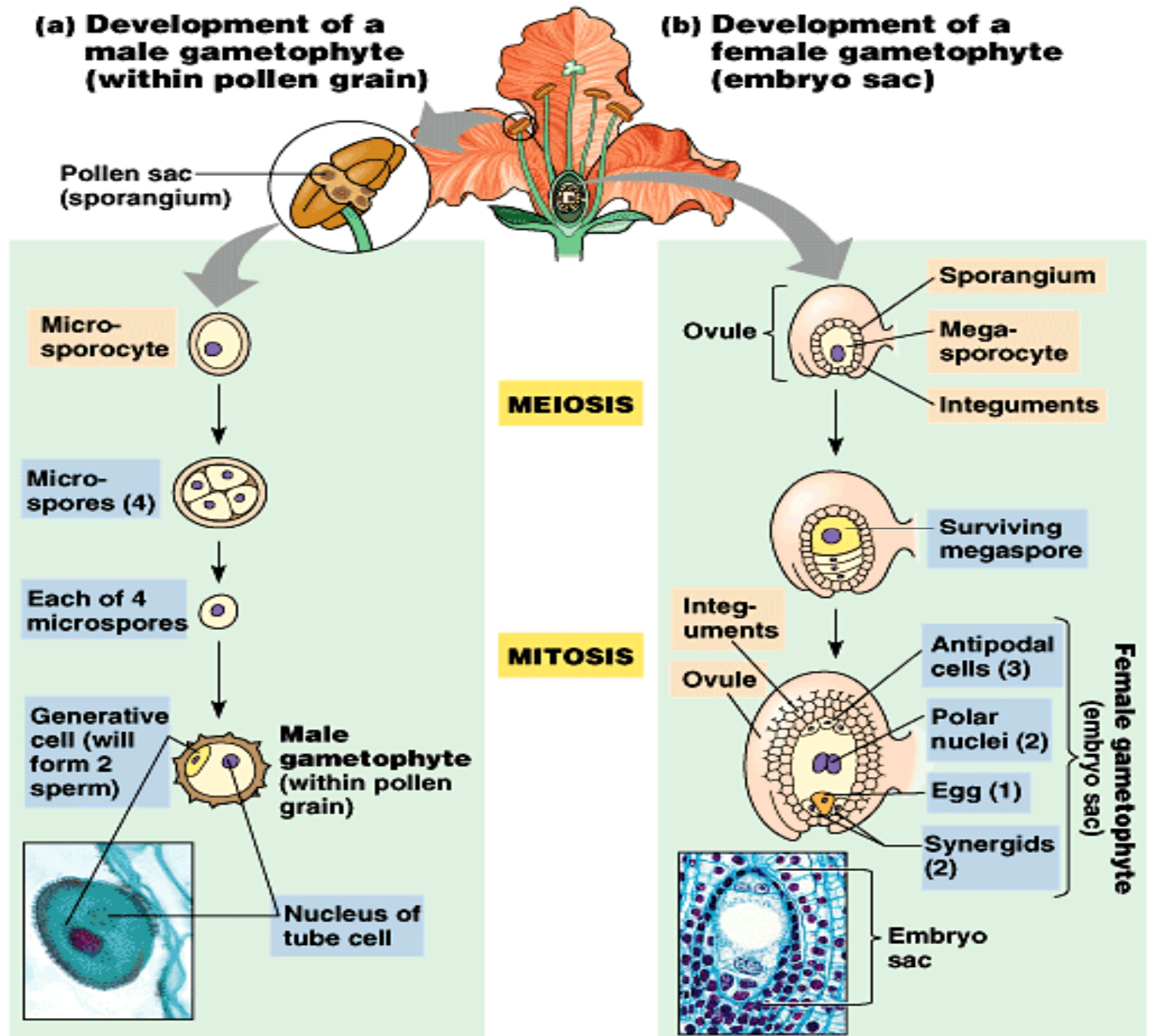
surinder-1998@yahoo.co.in

Punjab EDUSAT Society{PES}

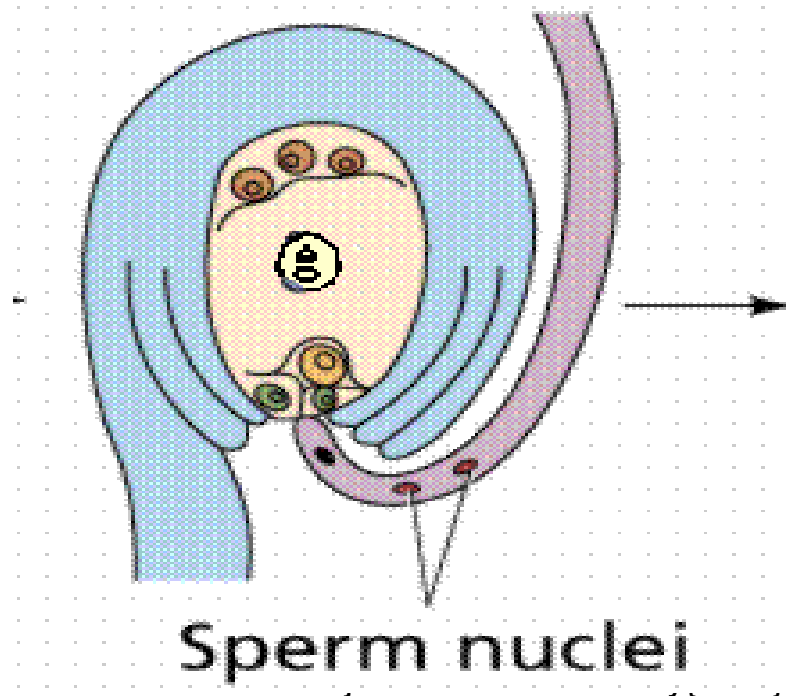
Male and female gametophytes develop within anthers and ovaries, respectively:
Pollination brings them together

- The male gametophyte begins its development within the sporangia (pollen sacs) of the anther.
- The female gametophyte begins to develop within the ovules of the ovary

The
development
of angiosperm
gametophytes
involves
meiosis
and mitosis.



- This megaspore divides by mitosis three times, resulting in one cell with eight haploid nuclei.
 - Membranes partition this mass into a multicellular female gametophyte - the egg sac.



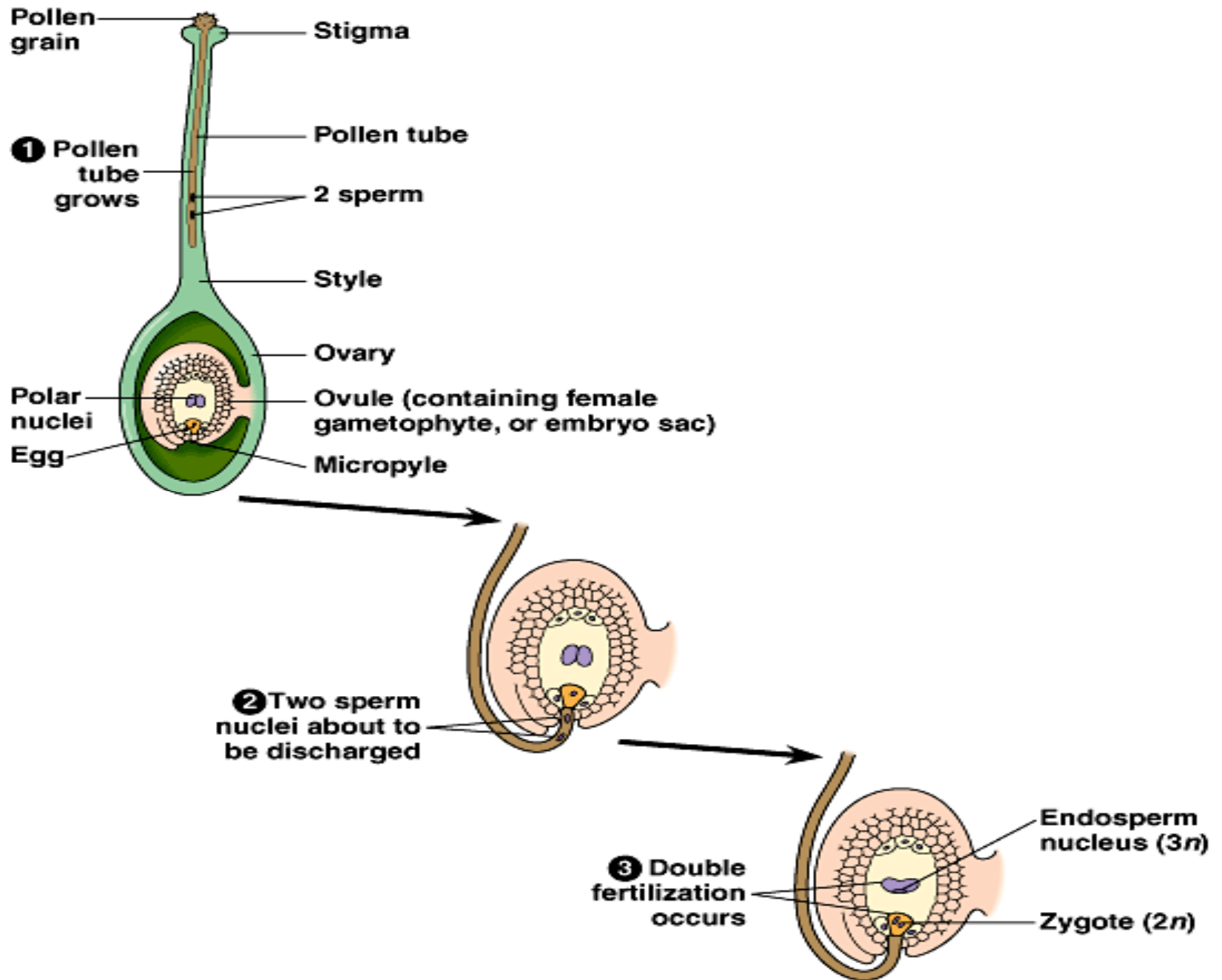
- At one end of the egg sac, two synergid cells flank the egg cell, or female gametophyte.
 - The synergids function in the attraction and guidance of the pollen tube.
- At the other end of the egg sac are three antipodal cells of unknown function.
- The other two nuclei, the polar nuclei, share the cytoplasm of the large central cell of the embryo sac.
- The ovule now consists of the embryo sac and the surrounding integuments (from the sporophyte).

Double fertilization gives rise to the zygote and endosperm

- The generative cells divide by mitosis to produce two male gametes.
- Directed by a chemical attractant, possibly calcium, the tip of the pollen tube enters the ovary, probes through the micropyle (a gap in the integuments of the ovule) and discharges two sperms within the embryo sac.

- Both sperm fuse with nuclei in the embryo sac.
 - One sperm fertilizes the egg to form the zygote.
 - The other sperm combines with the two polar nuclei to form a triploid nucleus in the central cell.
 - This large cell will give rise to the **endosperm**, a food-storing tissue of the seed.

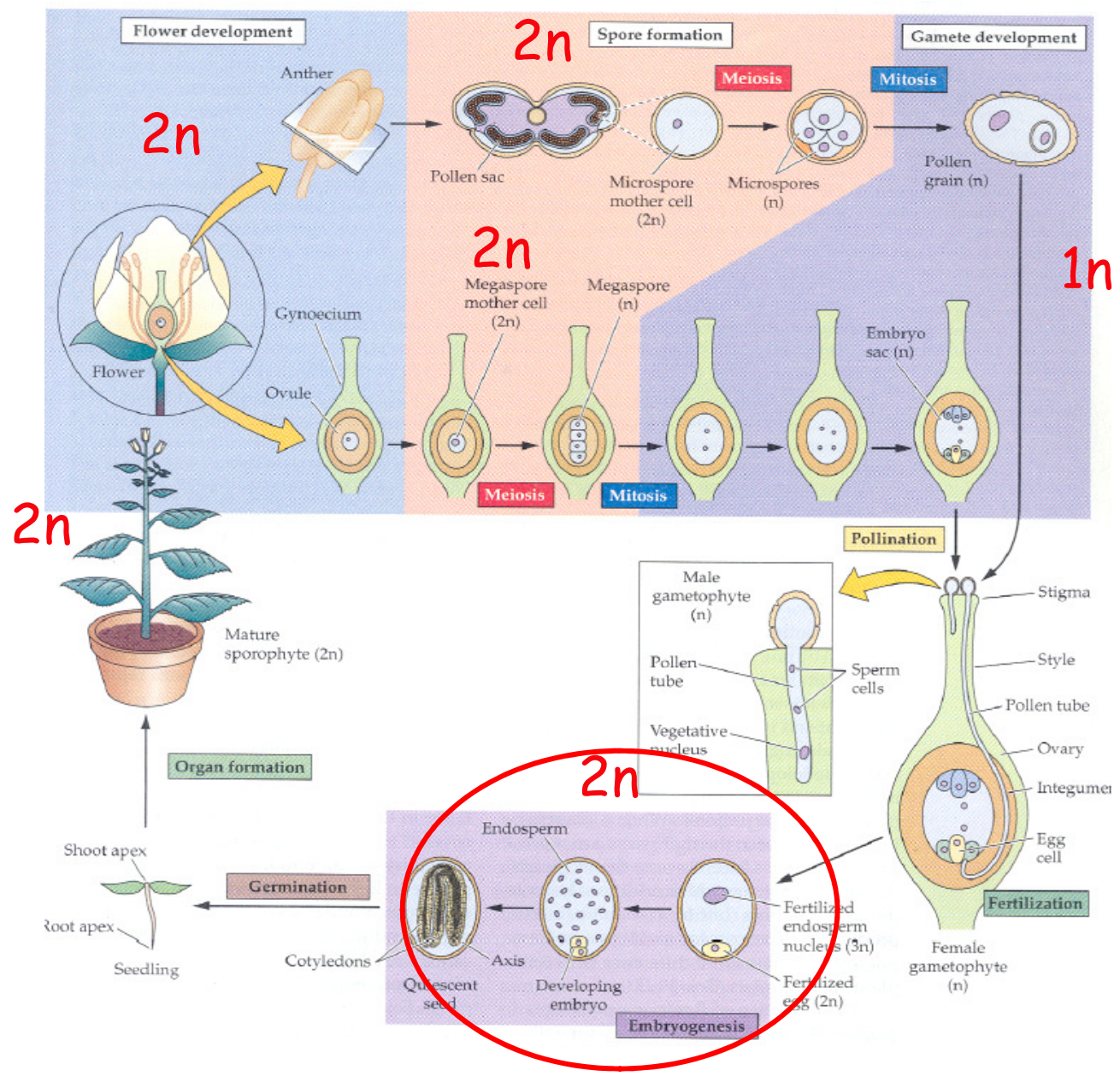
- The union of two sperm cells with different nuclei of the embryo sac is termed **double fertilization**.
 - Double fertilization is also present in a few gymnosperms, probably via independent evolution.
 - Double fertilization ensures that the endosperm will develop only in ovules where the egg has been fertilized.



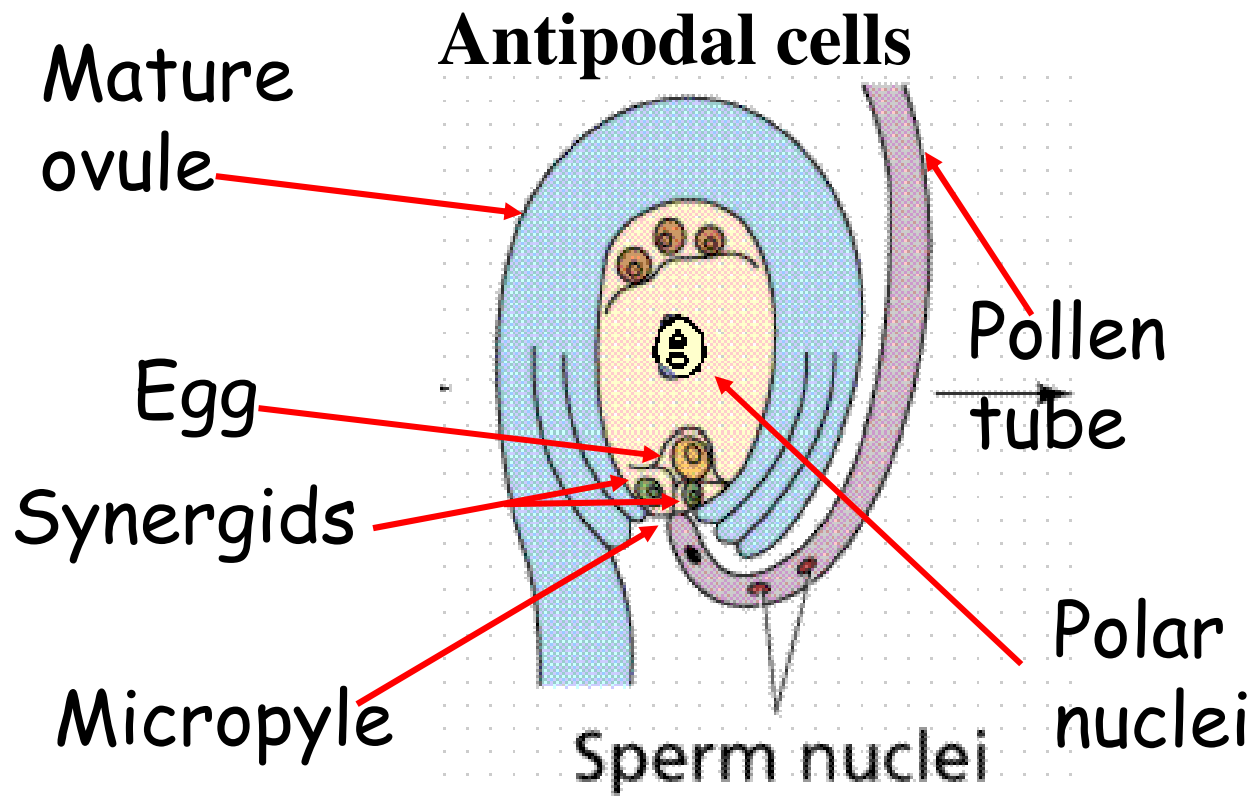
Post Fertilization Changes

1. Development of endosperm from 3N Nucleus
2. Development of embryo from 2N Nucleus
3. Development of Seed from Ovule
4. Development of Fruit from Ovary

Life cycle of a flowering seed plant



Endosperm development



- Begin with the fertilized polar nuclei
- Triploid

- Endosperm development usually precedes embryo development.
 - After double fertilization, the triploid nucleus of the ovule's central cell divides, forming a multinucleate “supercell” having a milky consistency.
 - It becomes multicellular when cytokinesis partitions the cytoplasm between nuclei and cell walls form and the endosperm becomes solid.
 - Coconut “milk” is an example of liquid endosperm and coconut “meat” is an example of solid endosperm.

Some facts about endosperm development

- Provide nutrients/signals for embryo development and seed germination
- Developmental stages are not well understood/defined
- Morphologically different in different species

Endosperm Information

Endosperm varies between plants

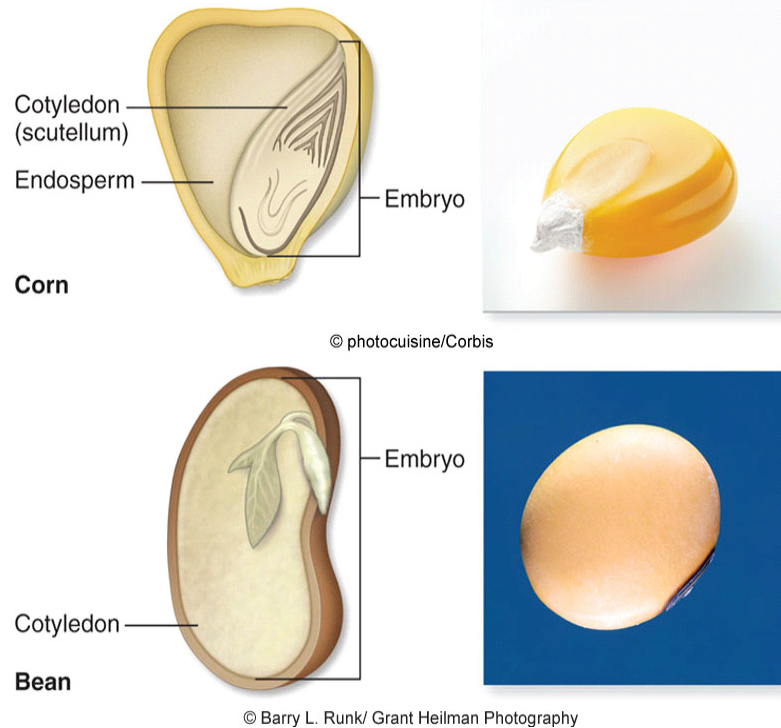
-In coconuts it is liquid

-In corn it is solid

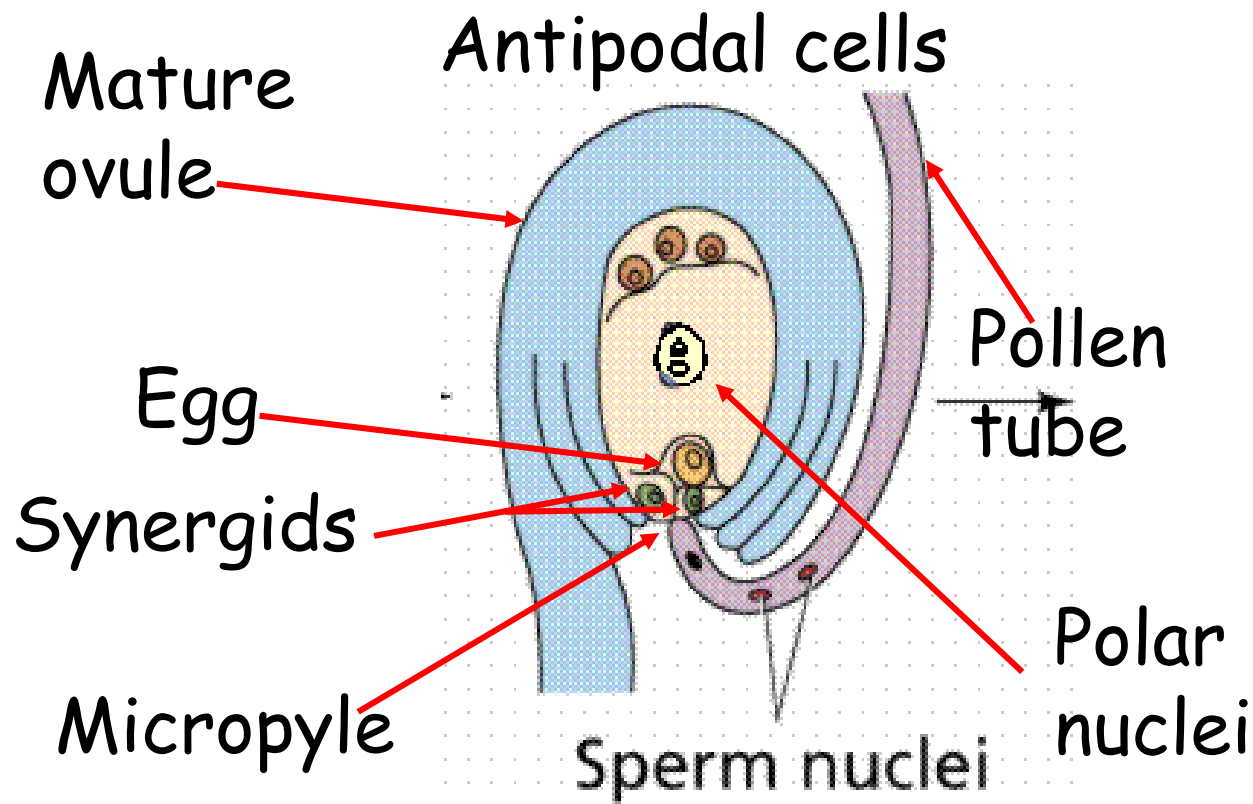
-In peas and beans
it is used up during
embryogenesis

-Nutrients are
stored in thick,
fleshy cotyledons

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



Embryo Development



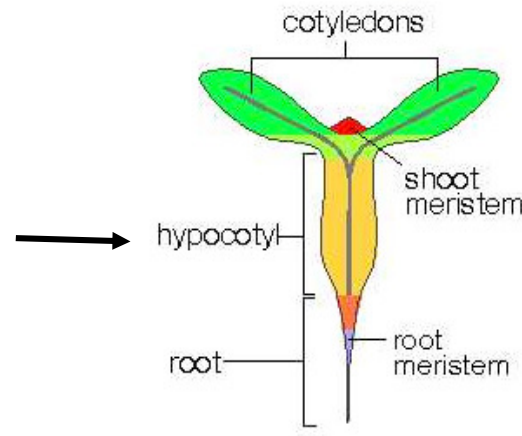
- Begin with the fertilized egg
- Diploid
- Establishment of patterns and meristem regions

Establishment of a body plan

Single fertilized egg



Mature embryo



Apical-basal axis

- cotyledons
- shoot meristem
- hypocotyl
- root& root mer.

radial axis



- epidermis
- cortex/ground tissue
- vasculature (phloem and xylem)

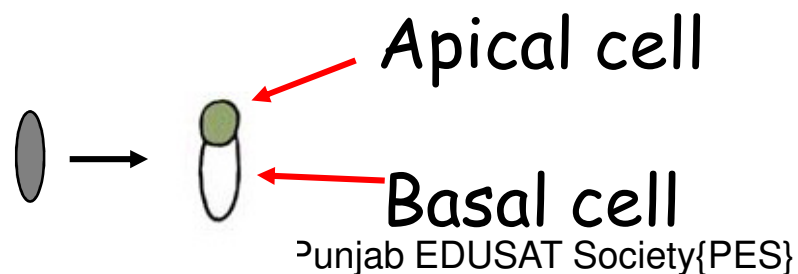
Steps for embryo development

1. Elongation of the fertilized egg

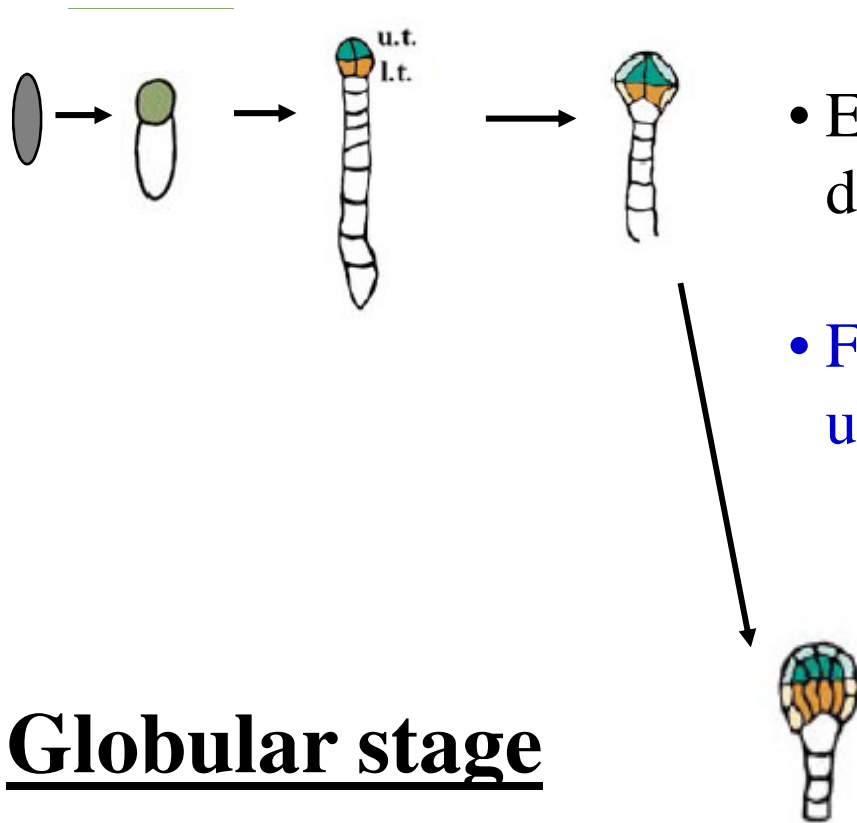
2. The first cell division is asymmetric.

The apical (top) cell receives most of the cytoplasm and is active in protein synthesis. The apical cell goes on to make the embryo proper

The basal cell and its descendants are highly vacuolated. They form the suspensor to connect to the maternal tissue.



Dermatogen stage



- Establish protodermal cells: anticlinal division
- Form hypophysis, suspensor cells undergo programmed cell death

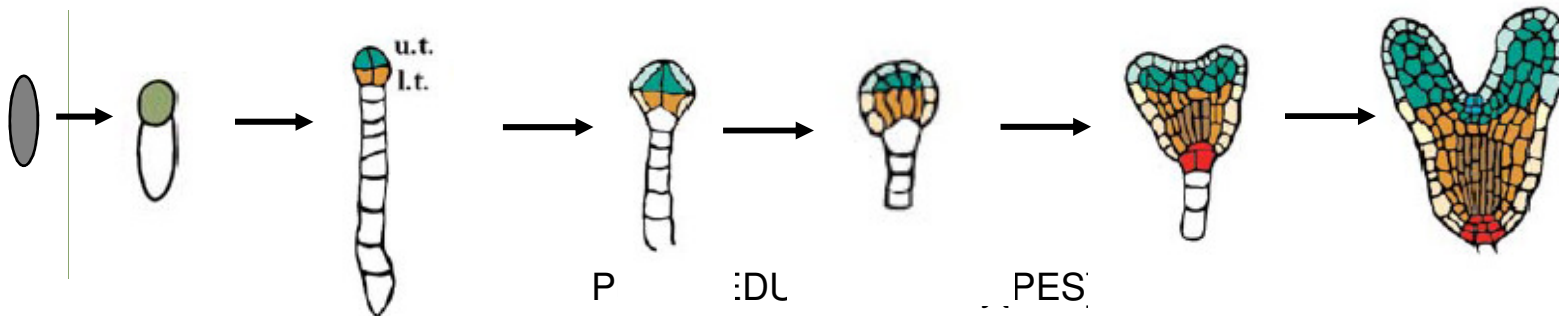
Globular stage

The inner cells divide anticlinally and periclinally, endowing the embryo an recognizable axis.

Heart stage

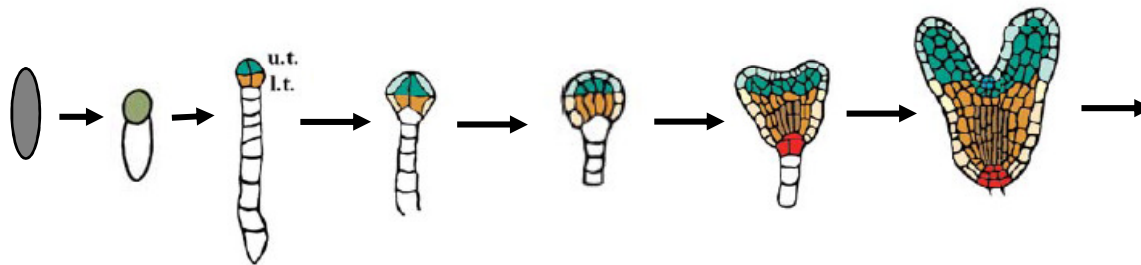


- Apical domain :
Cotyledon outgrowth
Establishing shoot apical meristem (SAM)
- Basal domain :
Establishing shoot axis
Establishing root apical meristem (RAM)
- Establishing basic tissue types: cortex, provascular tissue, and protoderm
- Suspensor cells undergo programmed cell death



Embryo development

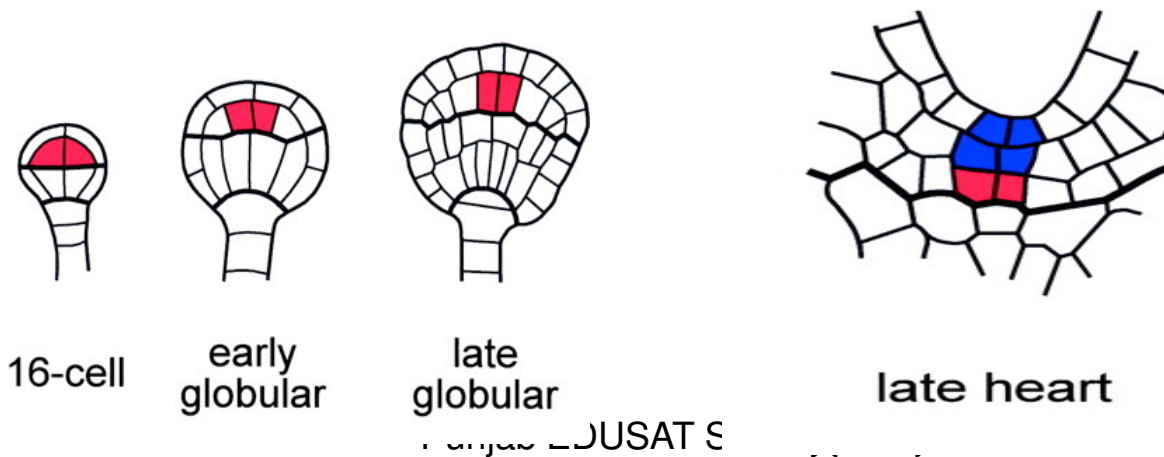
Embryonic origin of seedling structures: controlled by precise cell division, cell elongation and differentiation



- Pattern establishment: apical/basal and radial axes
- Establishment of meristem regions
 - shoot apical meristem (**SAM**)
 - root apical meristem (**RAM**)

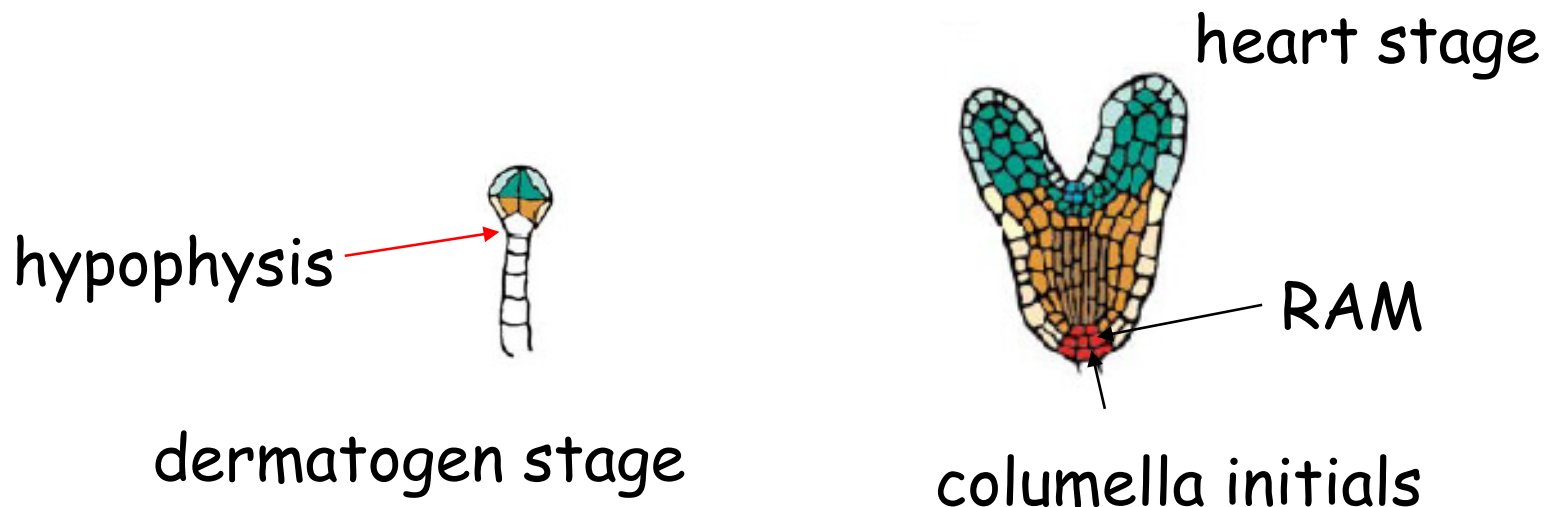
Shoot apical meristem (SAM)

- Give rise to the shoot system of a plant
- Initiate in the apical domain of the dermatogen stage (16-cell) and well established at the heart stage.



Root apical meristem (RAM)

- Give rise to the root system of a plant
- Initiated from the suspensor as **hypophysis** at the **dermatogen stage** and established at the **heart stage**. Hypophysis develops into root apical meristem and the columella initials.



The ovary develops into a fruit adapted for seed dispersal

- As the seeds are developing from ovules, the ovary of the flower is developing into a fruit, which protects the enclosed seeds and aids in their dispersal by wind or animals.

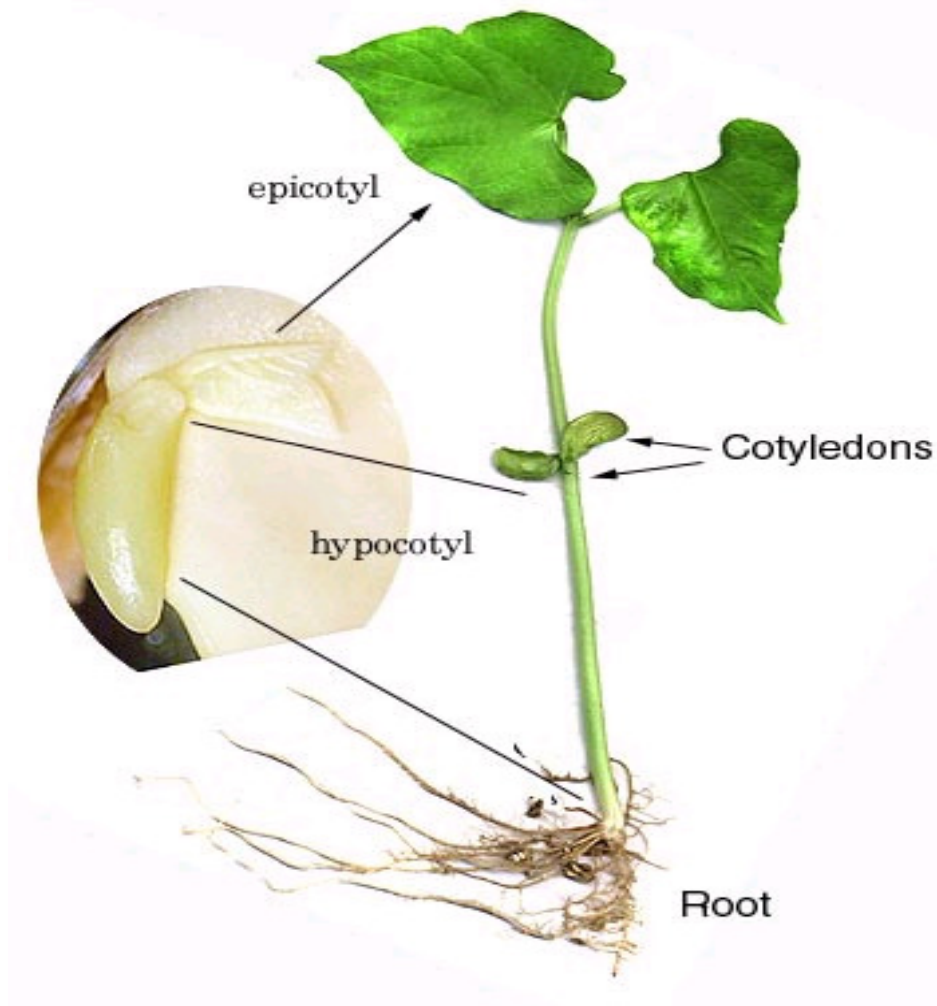
- The wall of the ovary becomes the **pericarp**, the thickened wall of the fruit, while other parts of the flower wither and are shed.
 - However, in some angiosperms, other floral parts contribute to what we call a fruit.
 - In apples, the fleshy part of the fruit is derived mainly from the swollen receptacle, while the core of the apple fruit develops from the ovary.



The ovule develops into a seed containing an embryo and a supply of nutrients

- After double fertilization, the ovule develops into a seed, and the ovary develops into a fruit enclosing the seed(s).
 - As the embryo develops, the seed stockpiles proteins, oils, and starch.
 - Initially, these nutrients are stored in the endosperm, but later in seed development in many species, the storage function is taken over by the swelling storage leaves (cotyledons) of the embryo itself.

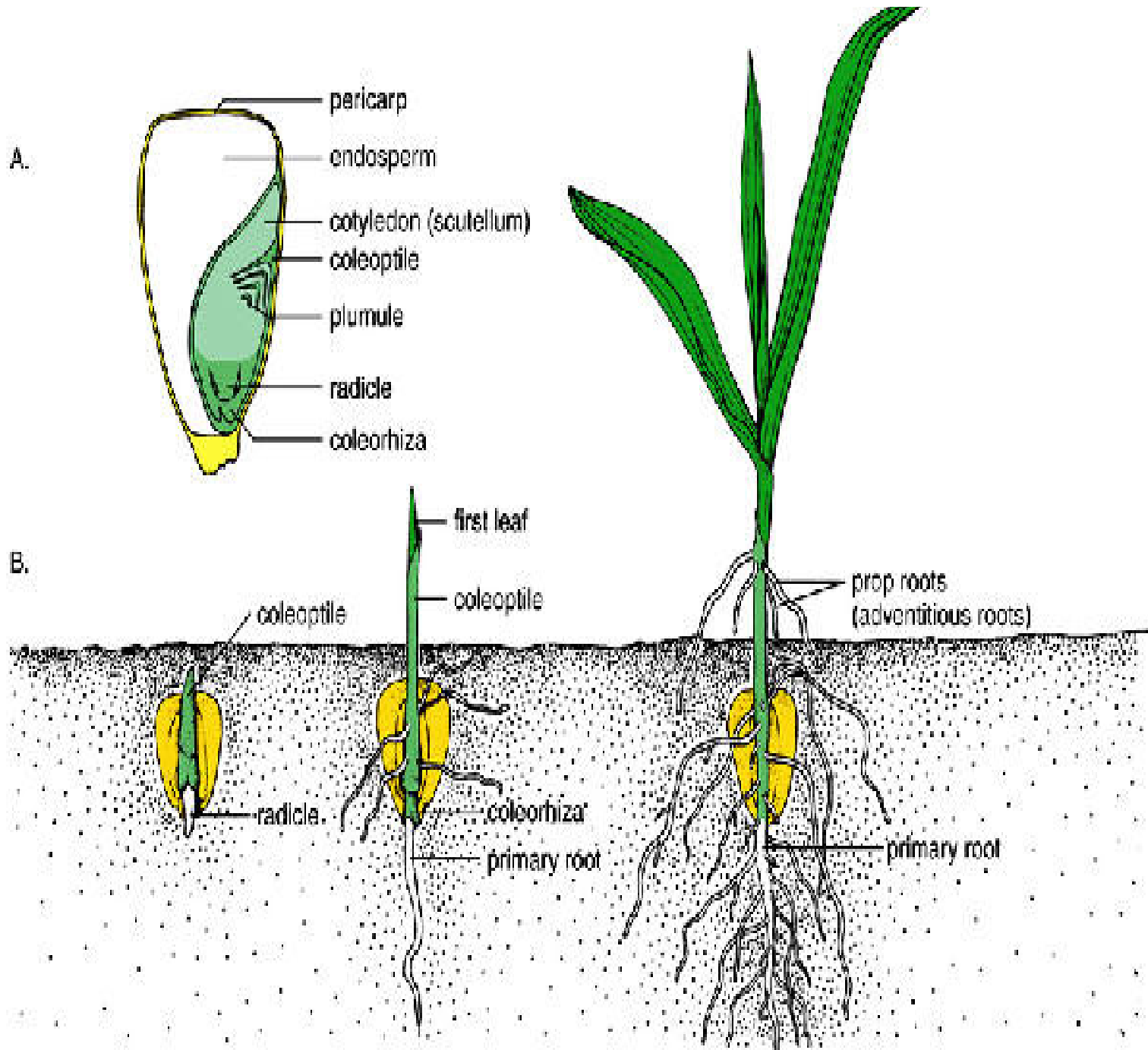
Parts of the Embryo



✿ Epicotyl - Grows into the leaves of the plant

✿ Hypocotyl - Becomes the stem

✿ Radicle - Becomes the root

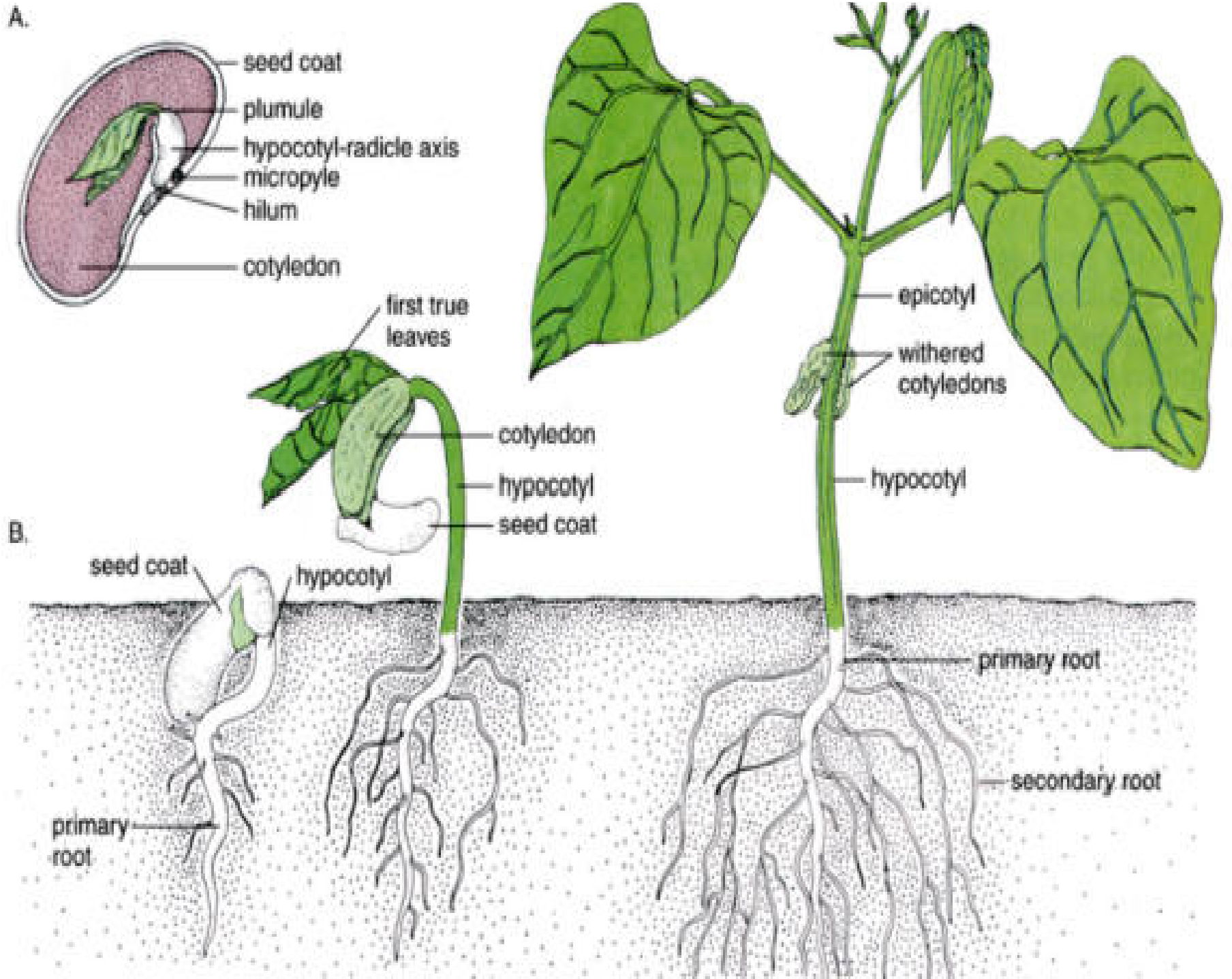


A.

- pericarp
- endosperm
- cotyledon (scutellum)
- coleoptile
- plumule
- radicle
- coleorhiza

B.

- first leaf
- coleoptile
- prop roots (adventitious roots)
- radicle
- coleoptile
- primary root
- coleorhiza
- primary root



thankx

Punjab EDUSAT Society{PES}