EMBRYO DEVELOPMENT

- The Embryo development or embryogeny is a pre-determined, genetically programmed and metabolically regulated development of the embryo from the zygote.

EMBRYO DEVELOPMENT….

- The early development of dicot and monocot embryos is fundamentally similar
- Later the development becomes very much different from each other
- Hence mature dicot and monocot embryos are distinctly different

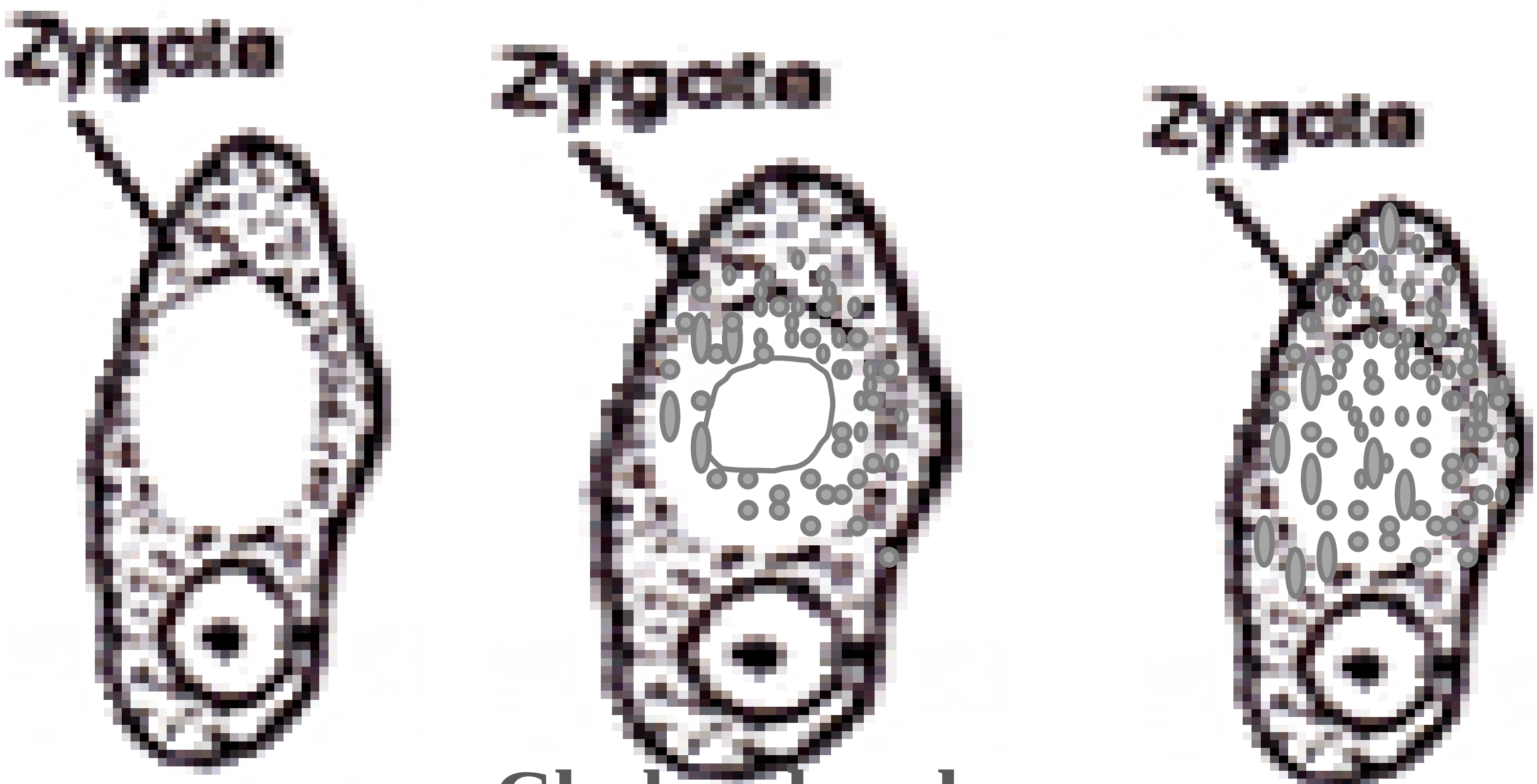
EMBRYO DEVELOPMENT….

Physiological changes in zygote

- The zygote enters into dormancy soon after syngamy, the duration of which varies according to the species
- During the dormancy period the large vacuole shrinks and becomes smaller and smaller
- Results in decrease size of the zygote

EMBRYO DEVELOPMENT….

Micropylar end



Chalazal end

A B C

EMBRYO DEVELOPMENT….

Physiological changes in zygote

- It causes the accumulation of cytoplasm at chalazal end
- Towards the end of dormancy period large number of active dictyosomes in cytoplasm results in cell wall formation
- Formation of many ribosomes and accelerated polysome formation leads to protein synthesis

EMBRYO DEVELOPMENT….

Physiological changes in zygote

- Towards the end of dormancy period the zygote ready to divide and it is highly polarised and isolated by the development of cell wall
- Plasmodesmatal connections to the neighbouring cells are blocked and the nucleus is surrounded by plastids & mitochondria

EMBRYO DEVELOPMENT….

Physiological changes in zygote

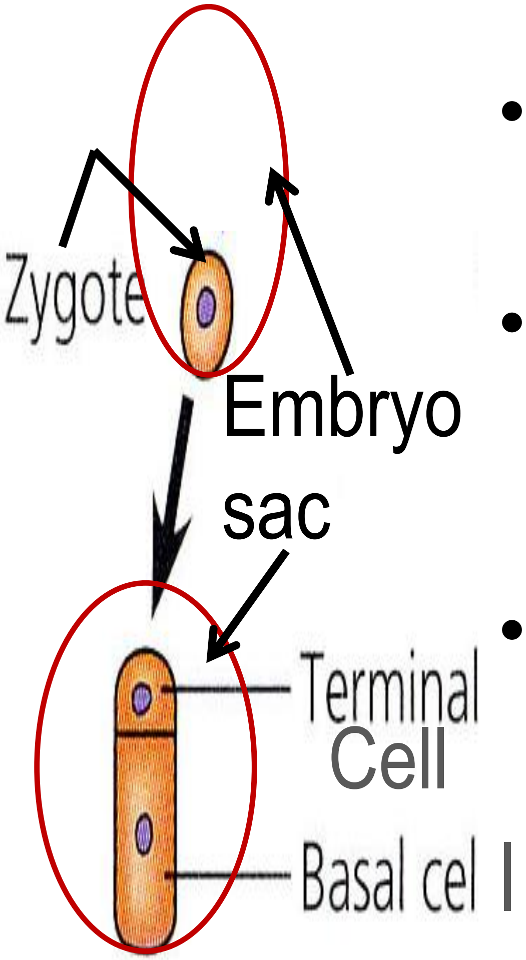
- The nucleus is at the chalazal region and the micropylar end is occupied by 1 or 2 vacuoles
- Very few cell organelles are at the micropylar region

EMBRYO DEVELOPMENT….

Micropylar end

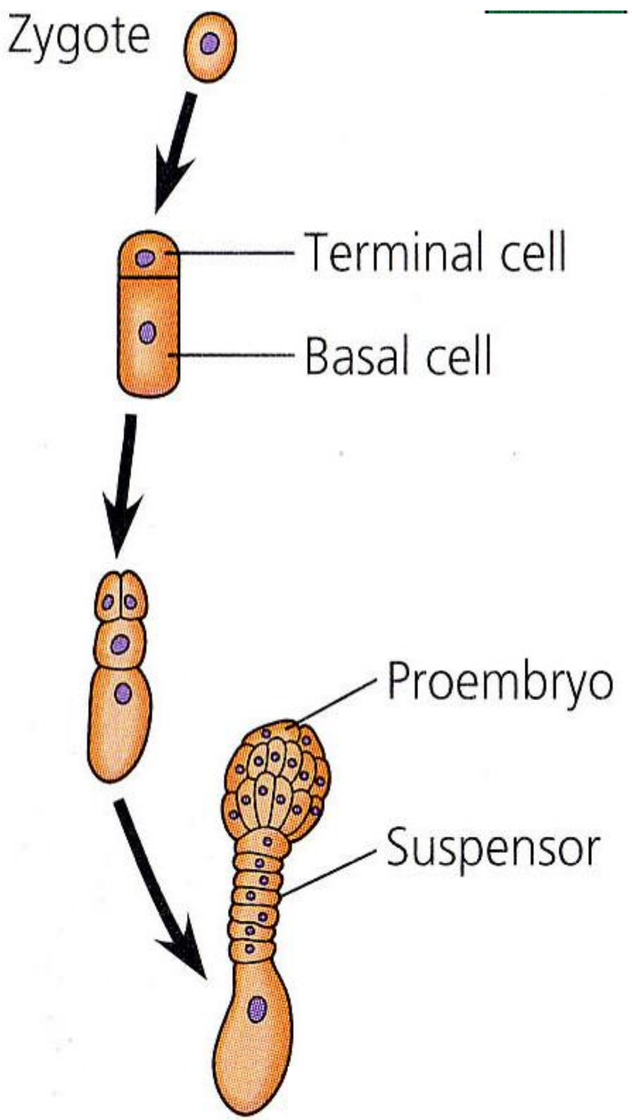
Chalazal end

EMBRYO DEVELOPMENT…



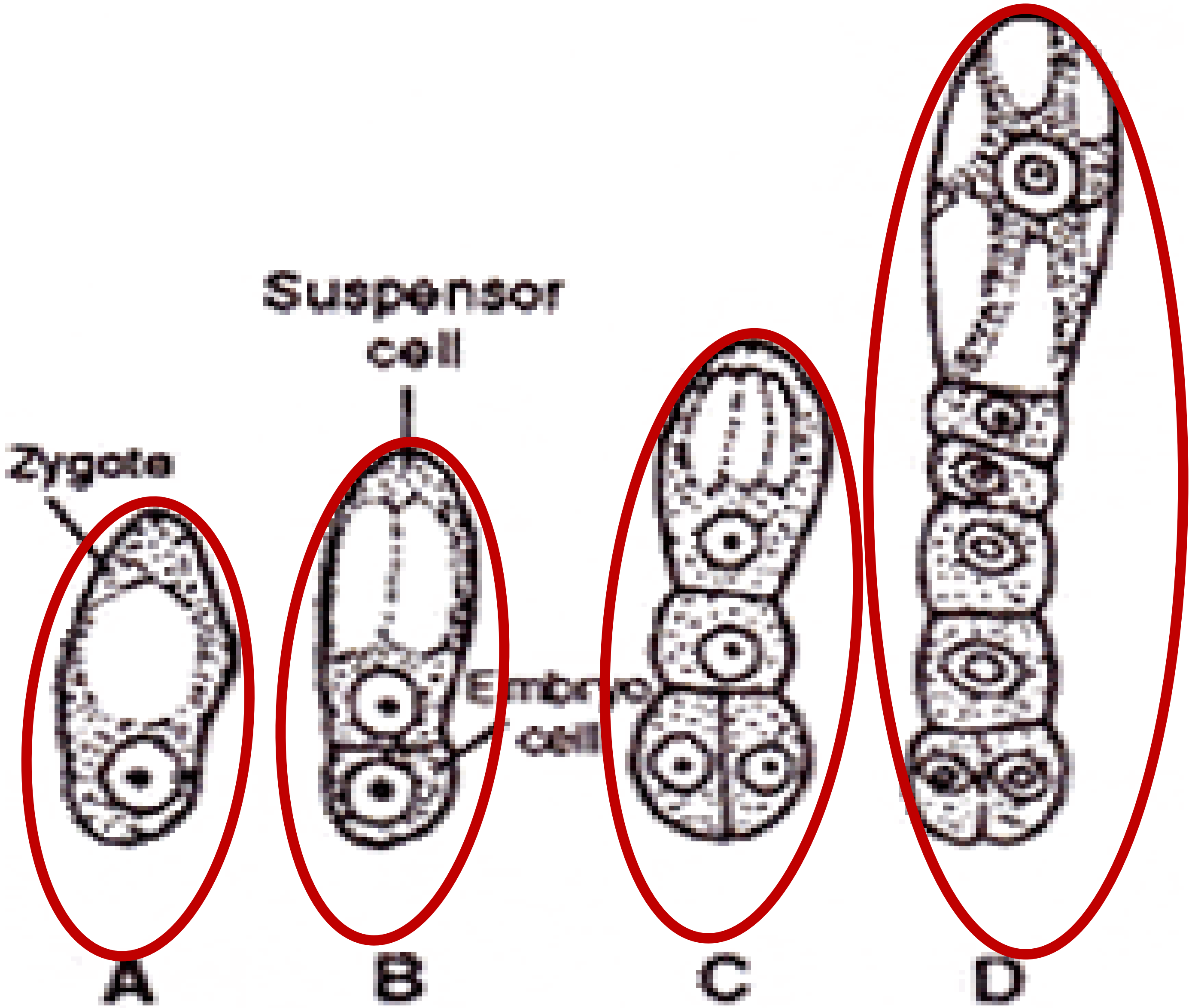
- Generally the diploid zygote divides to form a 2-celled pro-embryo
- From this 2-celled stage upto the differentiation of organs the embryo is called pro-embryo
- The first mitotic division of the zygote is transverse, splitting the fertilized egg into a large basal cell or suspensor cell close to micropyle and a small terminal cell or embryo cell projects into the embryo sac

EMBRYO DEVELOPMENT….

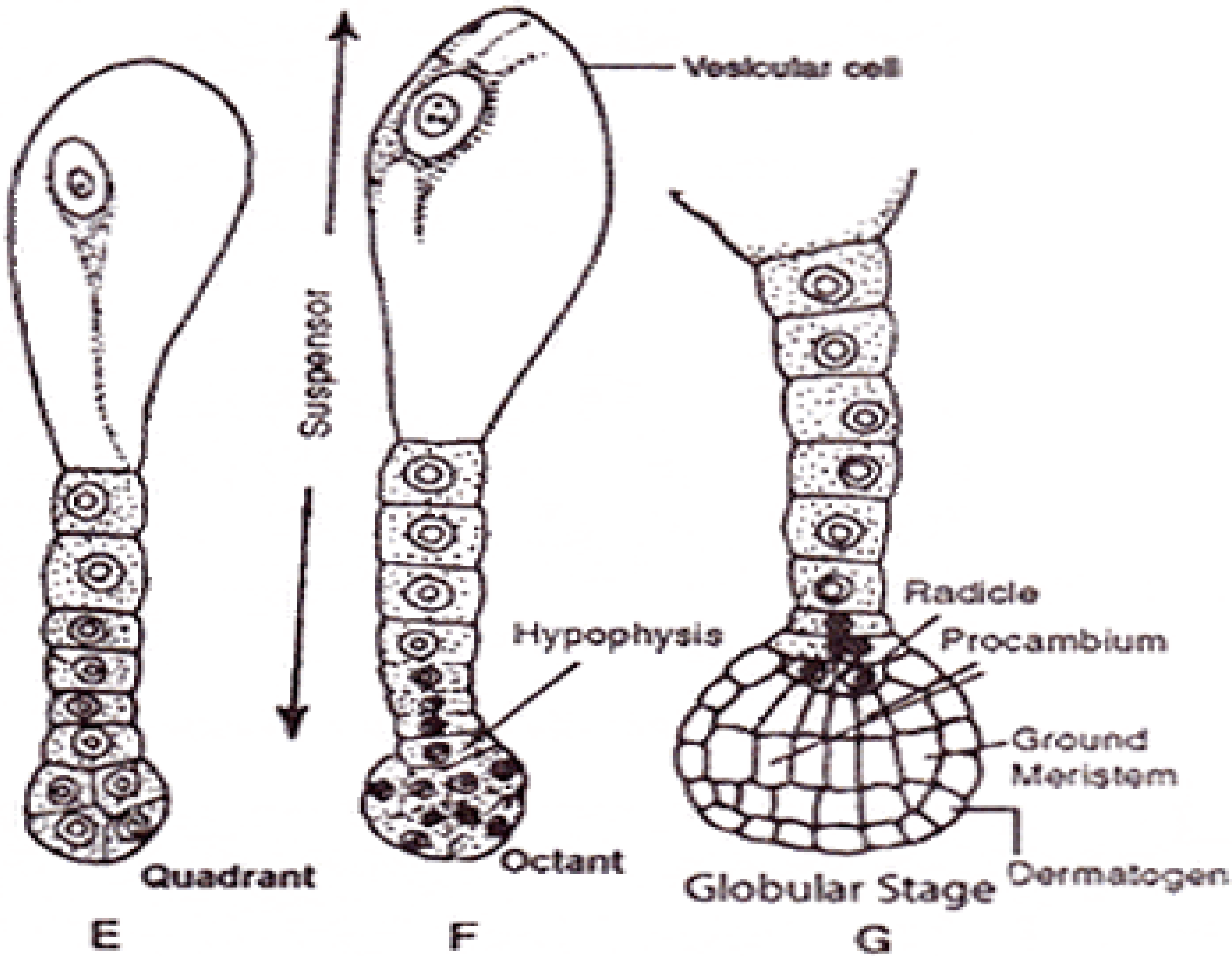


- The terminal cell eventually give rise to most of the embryo
- The basal cell continues to divide transversely, producing a thread of cells called the suspensor, which anchors the embryo to its parental tissue
- The suspensor also functions in the transfer of nutrients to the embryo from the parent plant (or endosperm)

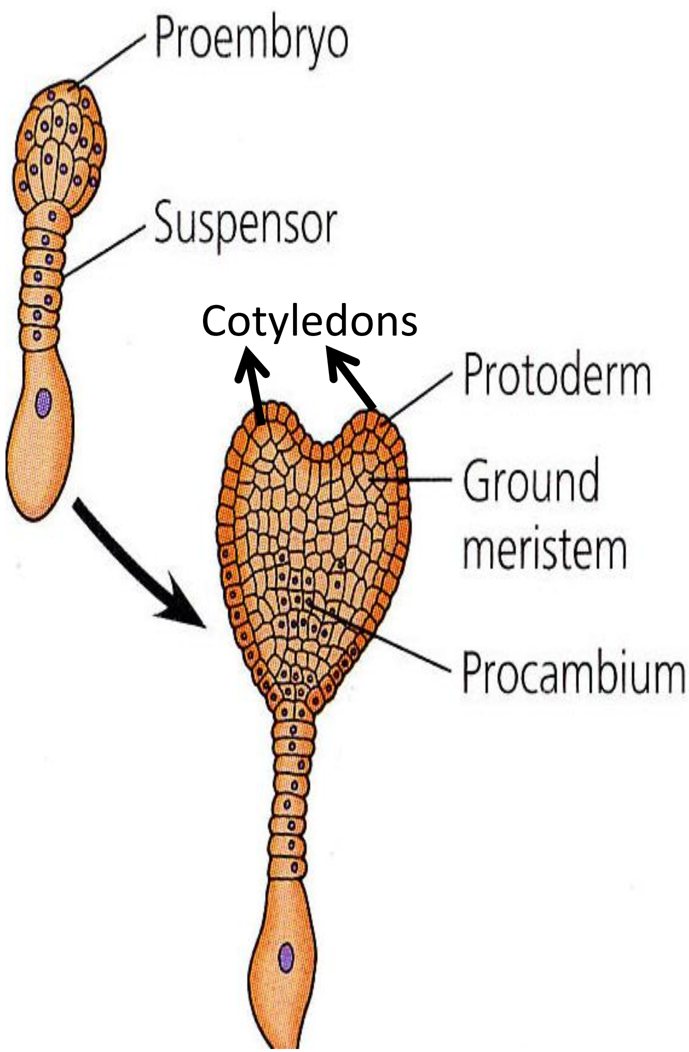
EMBRYO DEVELOPMENT….



EMBRYO DEVELOPMENT

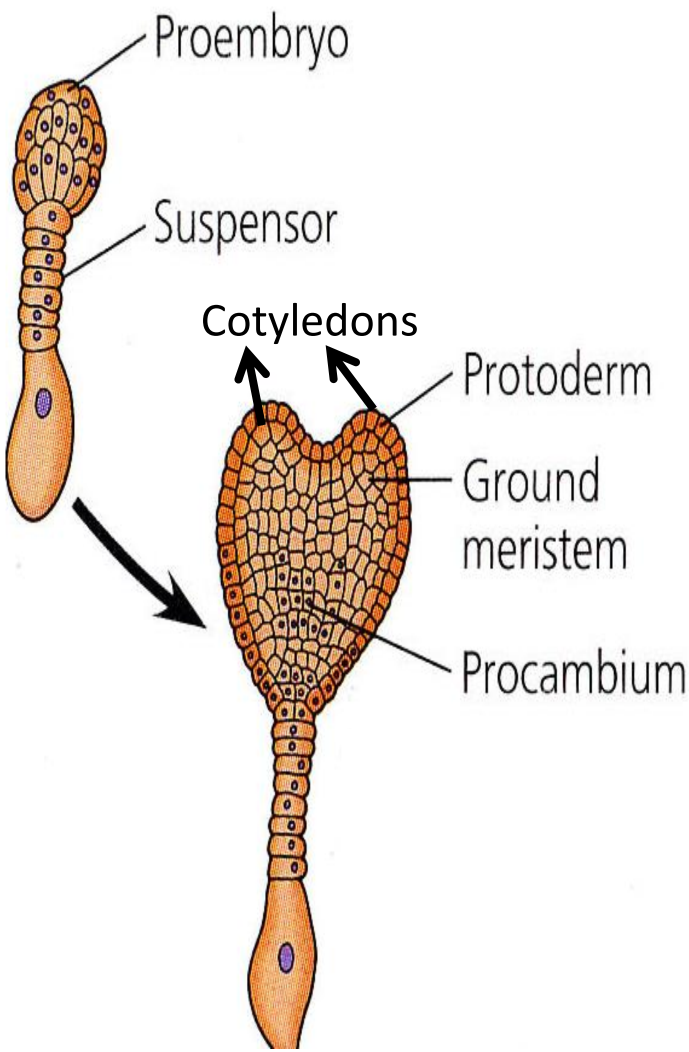


EMBRYO DEVELOPMENT….



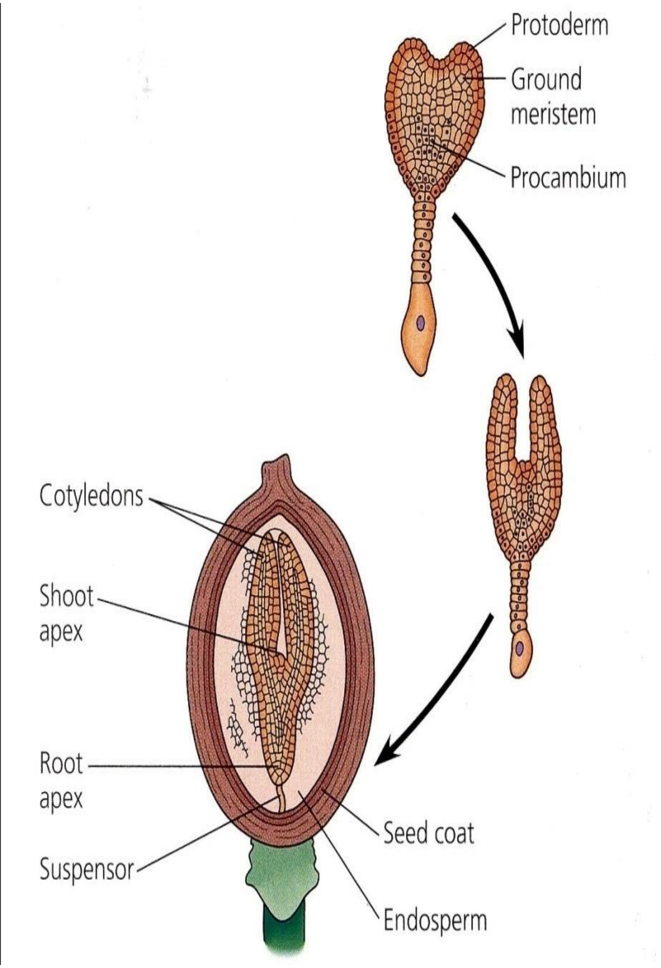
- It pushes the developing embryo into the endosperm
- so as to absorb nutrients from it
- The terminal cell divides several times and form a spherical pro-embryo attached to the suspensor
- The first cell of the suspensor towards the micropylar end becomes swollen and functions as a haustorium.

EMBRYO DEVELOPMENT….



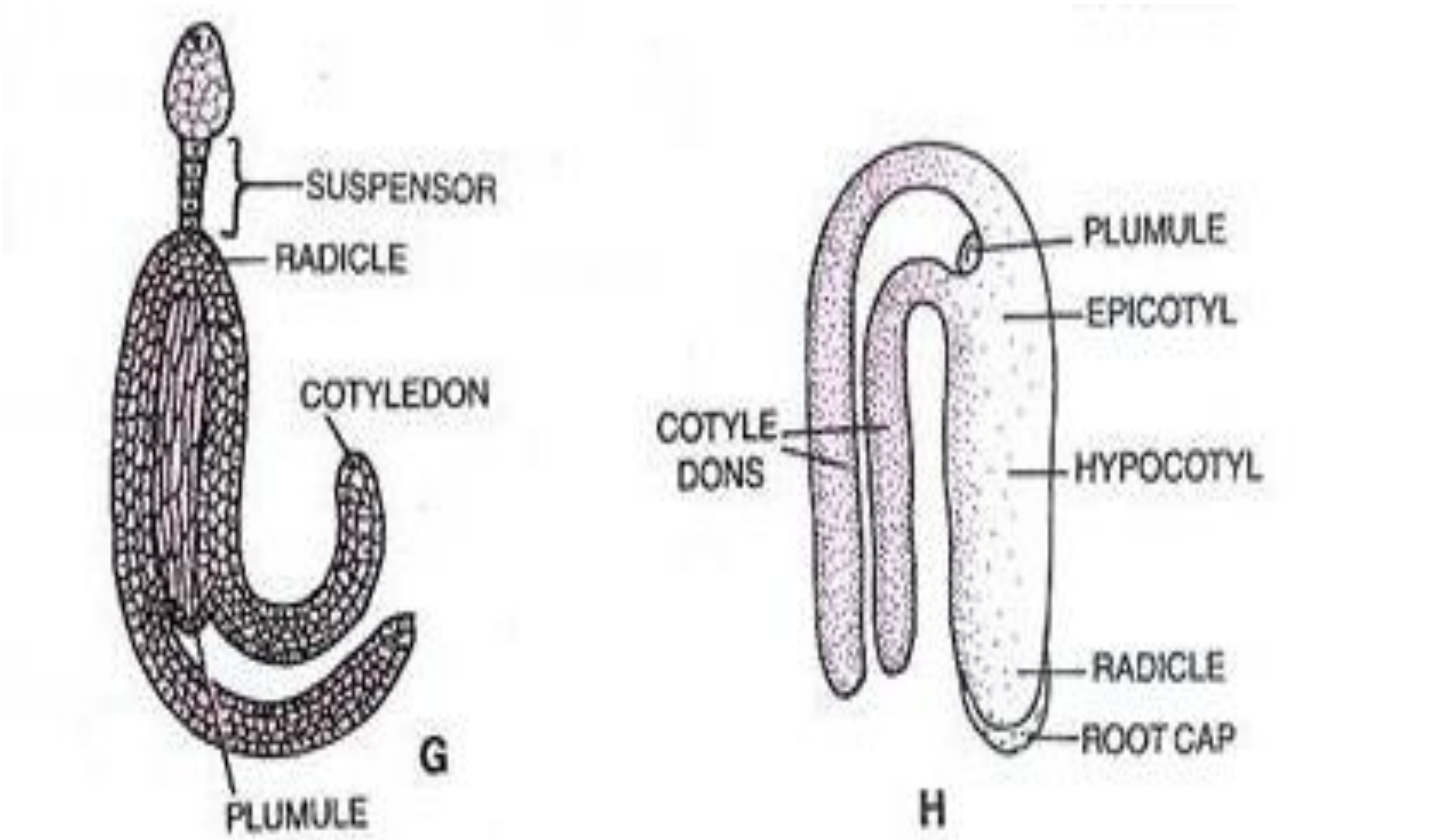
- The last cell of the suspensor at the end adjacent to the embryo is known as hypophysis.
- Hypophysis later gives rise to the radicle and root cap.
- The cotyledons begin to form as bumps on the pro-embryo give a heart shaped appearance to the embryo

EMBRYO DEVELOPMENT

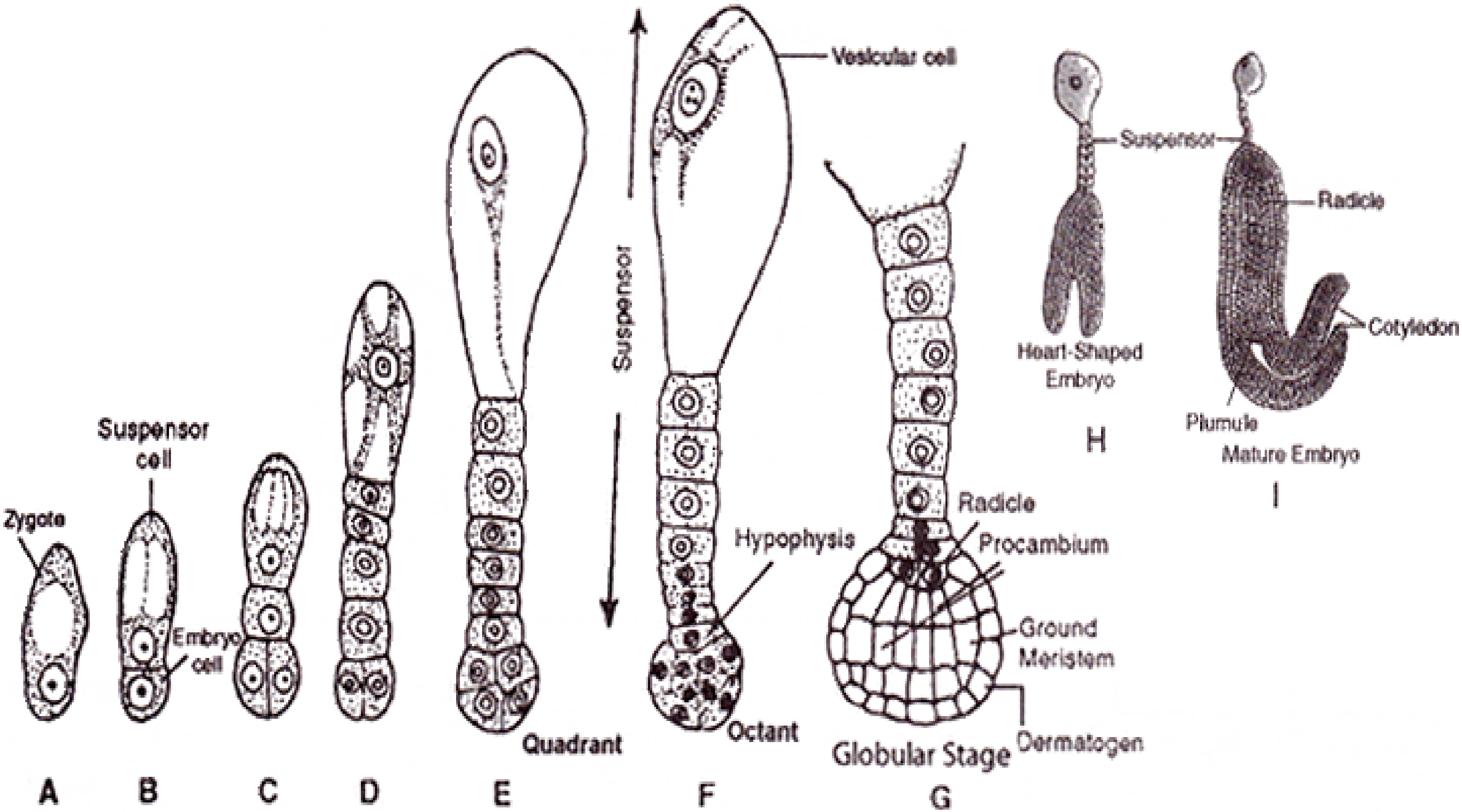


- Dicot embryos are heart-shaped or cordate at this stage due to the development of two cotyledons
- Monocots develop only one cotyledon, and hence not cordate

EMBRYO DEVELOPMENT



EMBRYO DEVELOPMENT



EMBRYO DEVELOPMENT

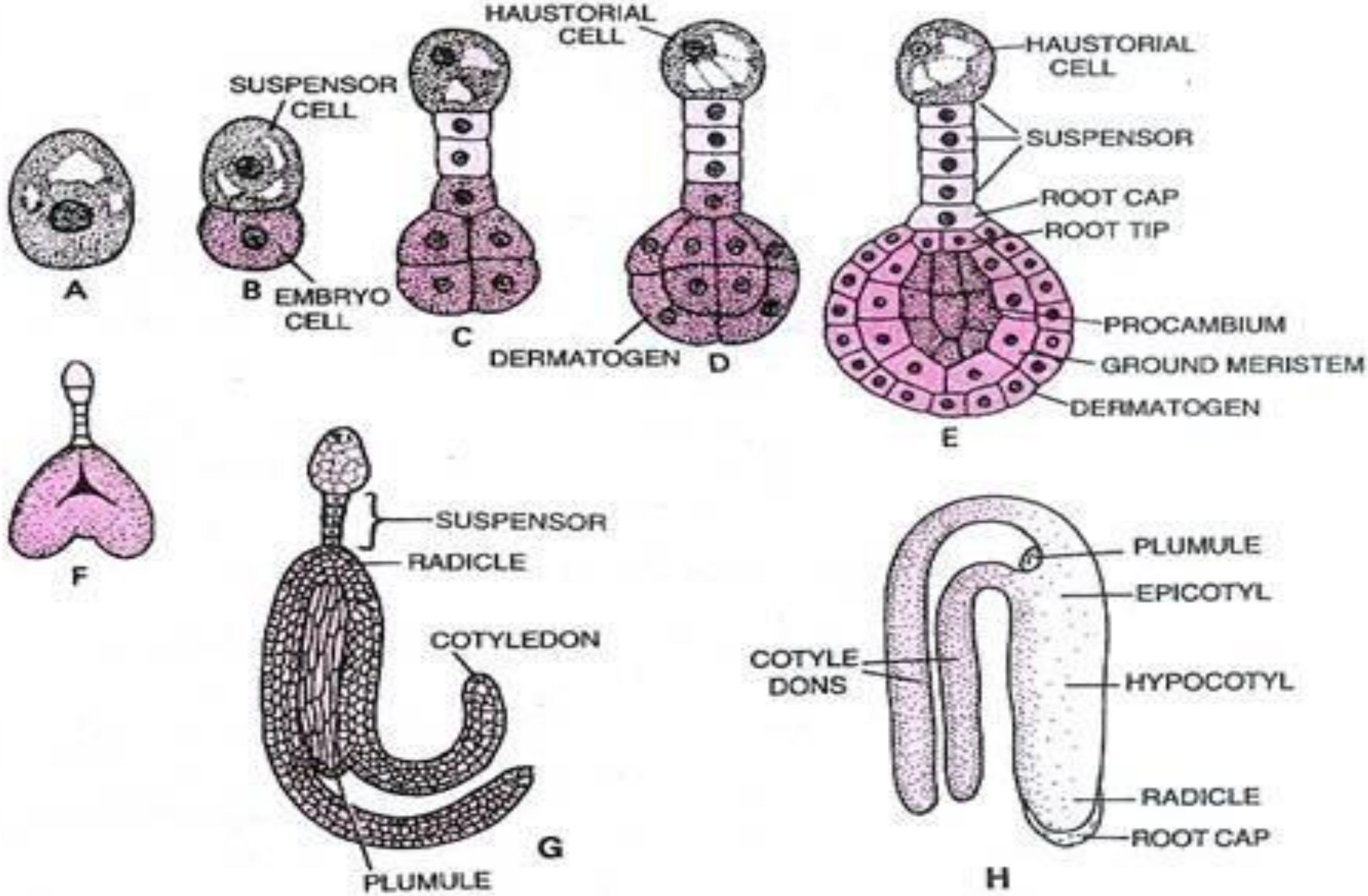
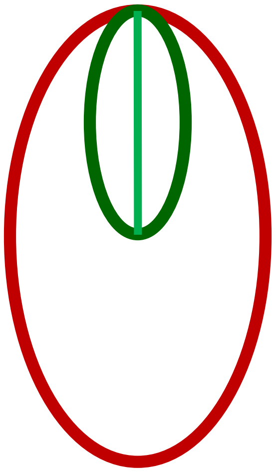


Fig. 2.30. Stages in the development of a dicot embryo. A, Zygote or oospore. B, Division of zygote into suspensor and embryo cells. C, Formation of suspensor and embryo octant. D, Periclinal divisions of embryo octants to form outer dermatogen. E, Globular embryo showing regions of radicle, procambium, ground meristem and dermatogen. F, Heart-shaped embryo. G, Mature dicotyledonous embryo. H, a typical dicot embryo.

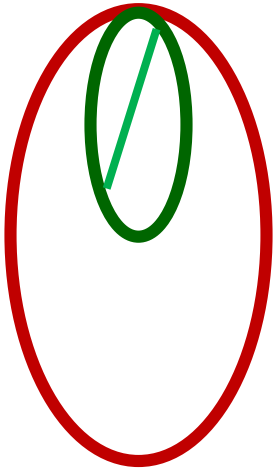
EMBRYO DEVELOPMENT….

Exemptions in Embryo development

- In some Loranthaceae members, the first division of zygote is longitudinal



- In some other families, the first division is oblique



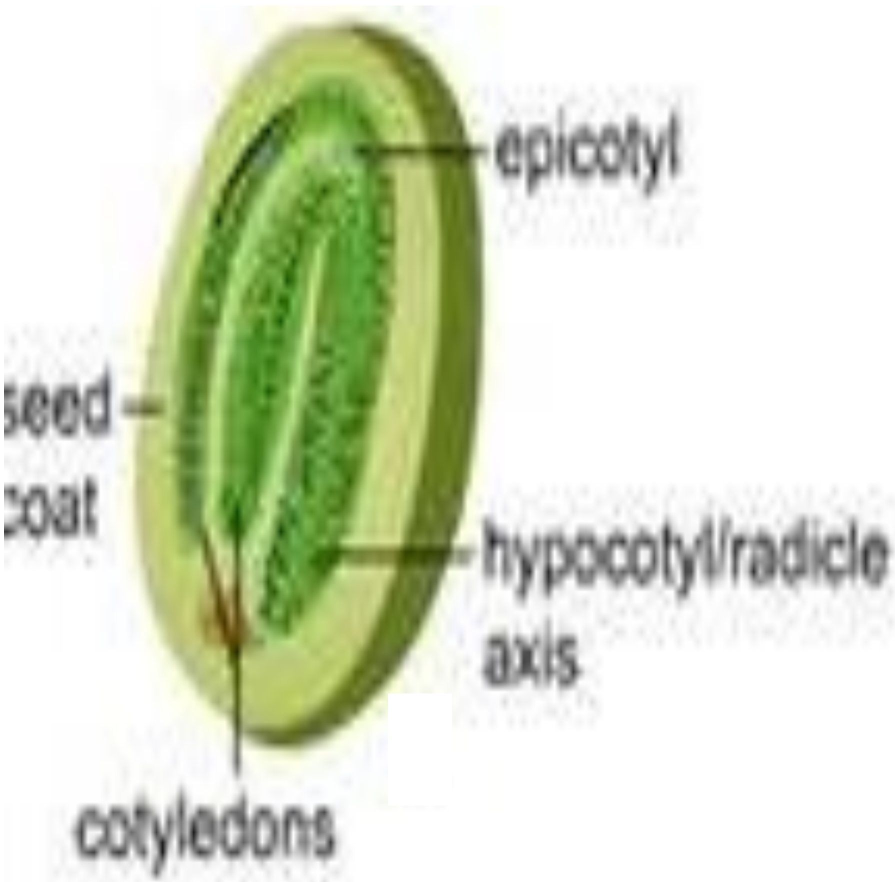
FULLY FORMED PLANT EMBRYO

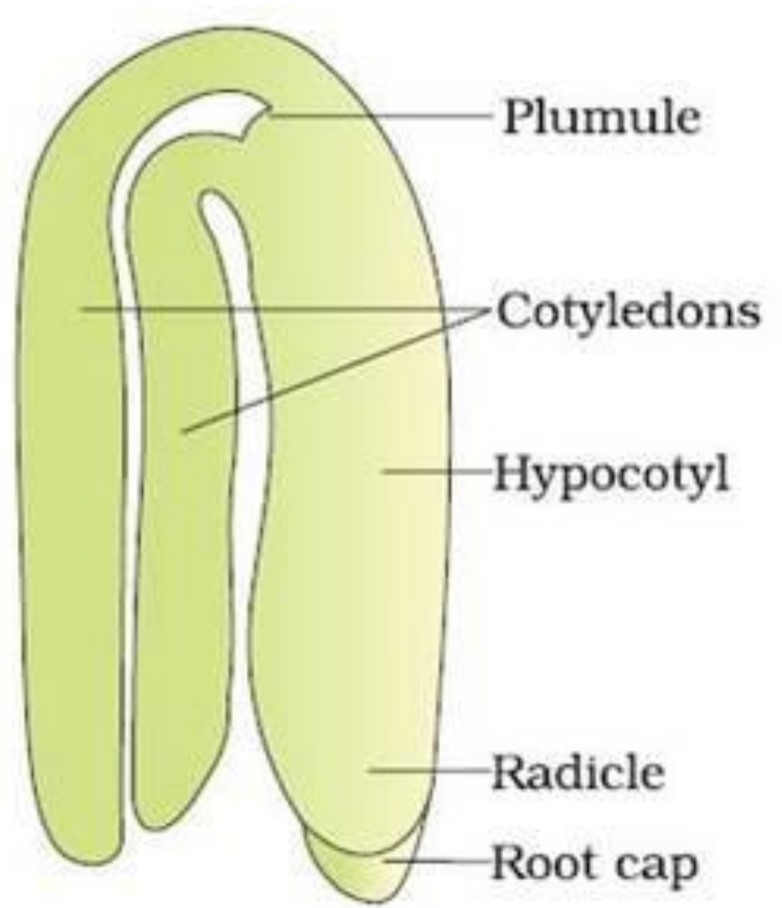
- The fully formed plant embryo shows following features:
- The root-shoot axis or Embryonal axis (meristems at opposite ends)
- One or two cotyledons or seed leaves are attached to it
- The single shield like cotyledons in monocot is called scutellum

FULLY FORMED PLANT EMBRYO

- The point of attachment of cotyledons to the embryonal axis is called cotyledonary node
- The portion of embryonal axis above the level of cotyledons is the epicotyl, which terminates with the plumule or stem tip.
- The cylindrical portion below the level of cotyledons is hypocotyl that terminates at its lower end in the radical or root tip.

FULLY FORMED PLANT EMBRYO





FULLY FORMED PLANT EMBRYO

- The plumule gives rise to the shoot system
- Radicle develops into root system
- The root tip is covered with a root cap.
- Rarely in plants such as Utricularia the mature embryo is spherical without rudiments of plumule, radicle and cotyledons

FULLY FORMED PLANT EMBRYO

- A radial pattern of protoderm (dermal), ground meristem (ground tissue) and procambium (vascular tissue) is differentiated in the plumule and radicle

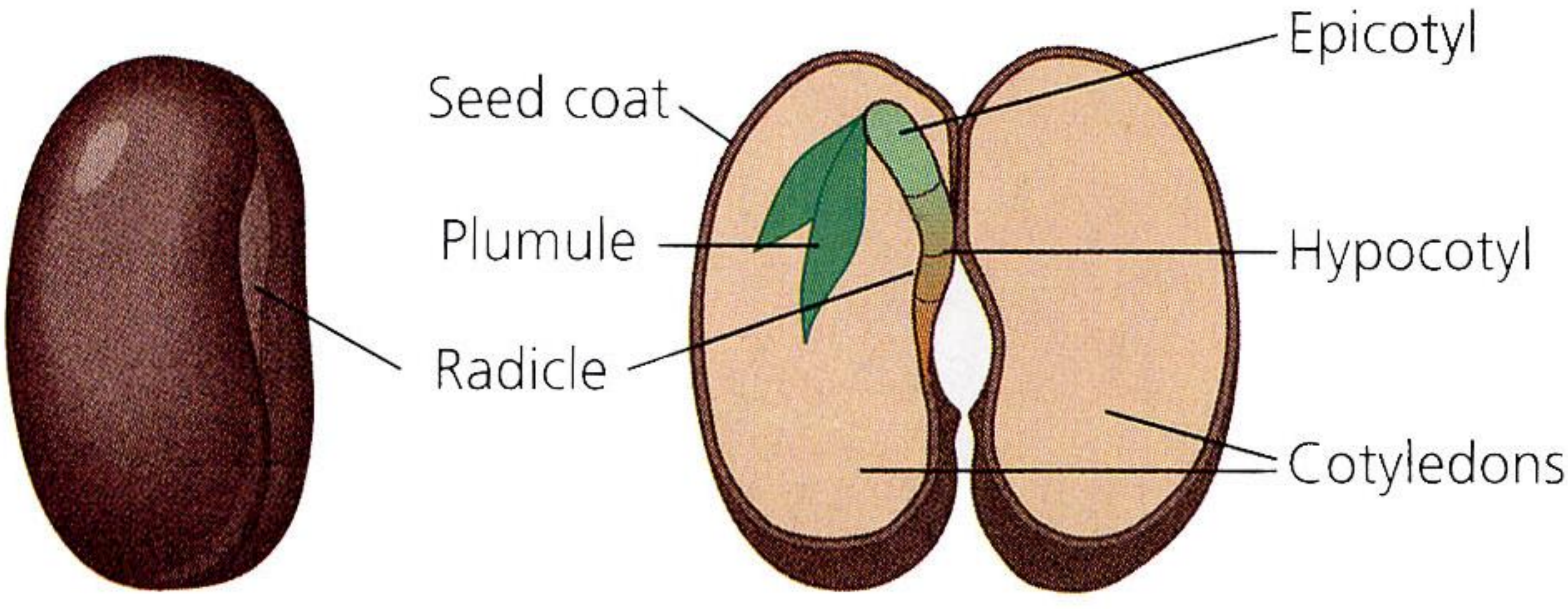
EMBRYO IN THE SEEDS

- The developing embryo remains embedded in the growing endosperm
- Both embryo and endosperm remain inside the nucellus
- The unused nucellus may remain in some mature seeds called perisperm

EMBRYO IN THE SEEDS

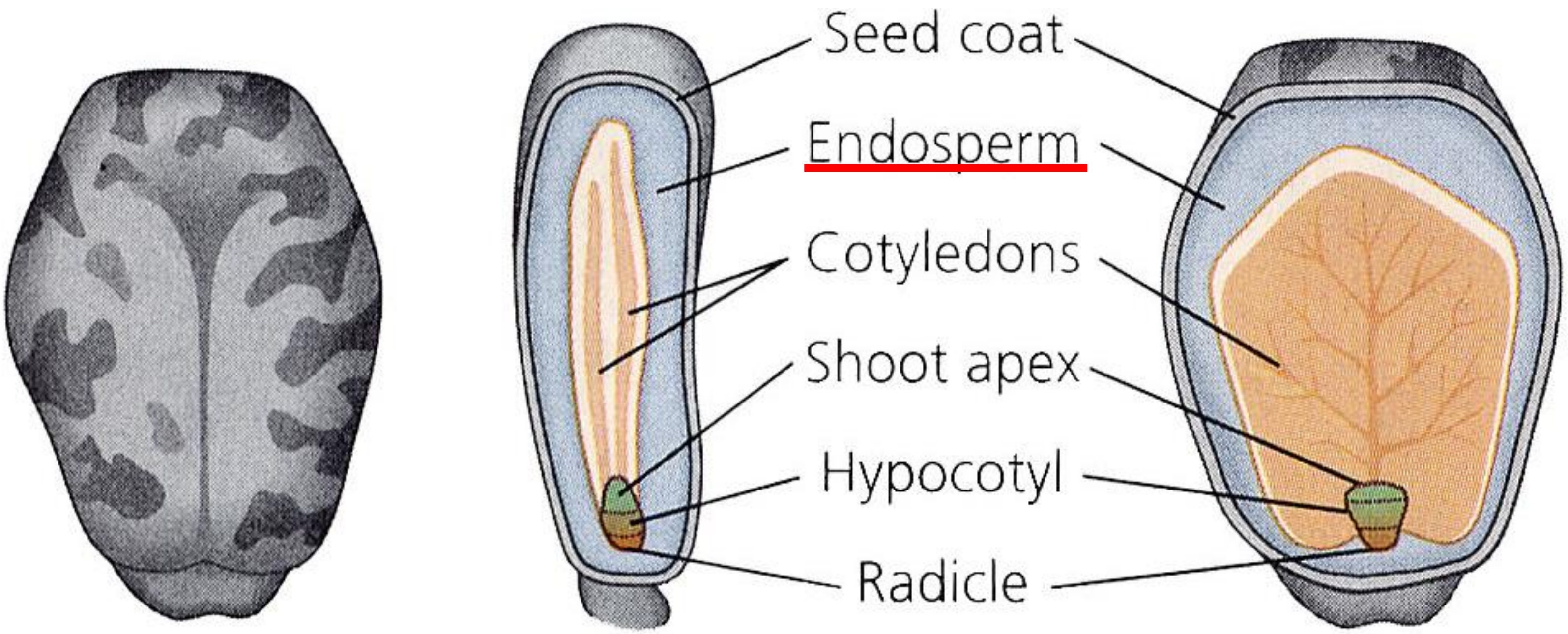
- Based on the presence or absence of endosperm in a fully formed seed there are two types of seeds
  - Non- endospermous or exalbuminous
    - Eg. Pea, groundnut, grams, mustard, etc.
  - Endospermous or Albuminous
    - Castor, Coconut, cereals, rubber, etc.

STRUCTURE OF A NON-ENDOSPERMOUS MATURE SEED WITH MATURE EMBRYO



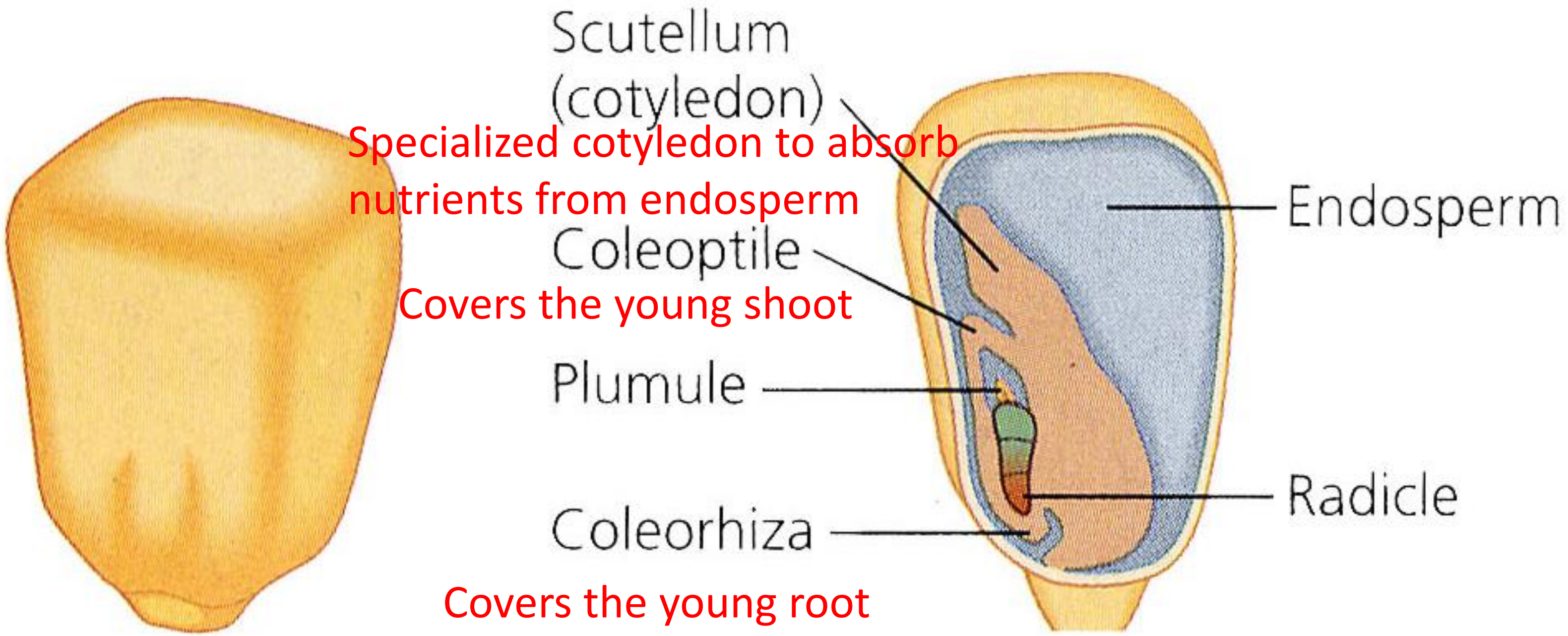
(a) Common bean. The fleshy cotyledons of the common garden bean, a dicot, store food that was absorbed from the endosperm when the seed developed.

STRUCTURE OF AN ENDOSPERMOUS MATURE SEED WITH MATURE EMBRYO



(b) Castor bean. The castor bean has membranous cotyledons that will absorb food from the endosperm when the seed germinates

STRUCTURE OF A MATURE MONOCOT SEED WITH SCUTELLUM



(c) Corn. Like other monocots, corn has only one cotyledon (the scutellum). The rudimentary shoot is sheathed in a structure called the coleoptile.

TYPES OF EMBRYO IN DICOT SEEDS

- 5 types of embryogeny are reported by P. Maheswary in 1950
- It is based on:
  - cellular configuration of embryo at the 4-celled stage
  - Role of each of these 4 cells in the organ development

TYPES OF EMBRYOGENY

(i) Crucifer or Onagrad type:

- Basal cell plays little or no role in the development of the embryo
- It is found in **Brassicaceae or cruciferae, Anonaceae, Scrophulariaceae, Ranunculaceae, Onagraceae**, etc.

(ii) Asterad type:

- Basal and terminal cells play an important role in the development of the embryo.
- The terminal cell of the two-celled pro-embryo divides by a transverse wall, Basal cell plays a little or no role in the development of the embryo
- It is found in **Asteraceae, Balsaminaceae,Vitaceae,etc.**

TYPES OF EMBRYOGENY

(III) Solanad type:

- Basal cell usually forms a suspensor of two or more cells
- Found in **solanaceae, compalunanaceae, Linaceae, etc.**

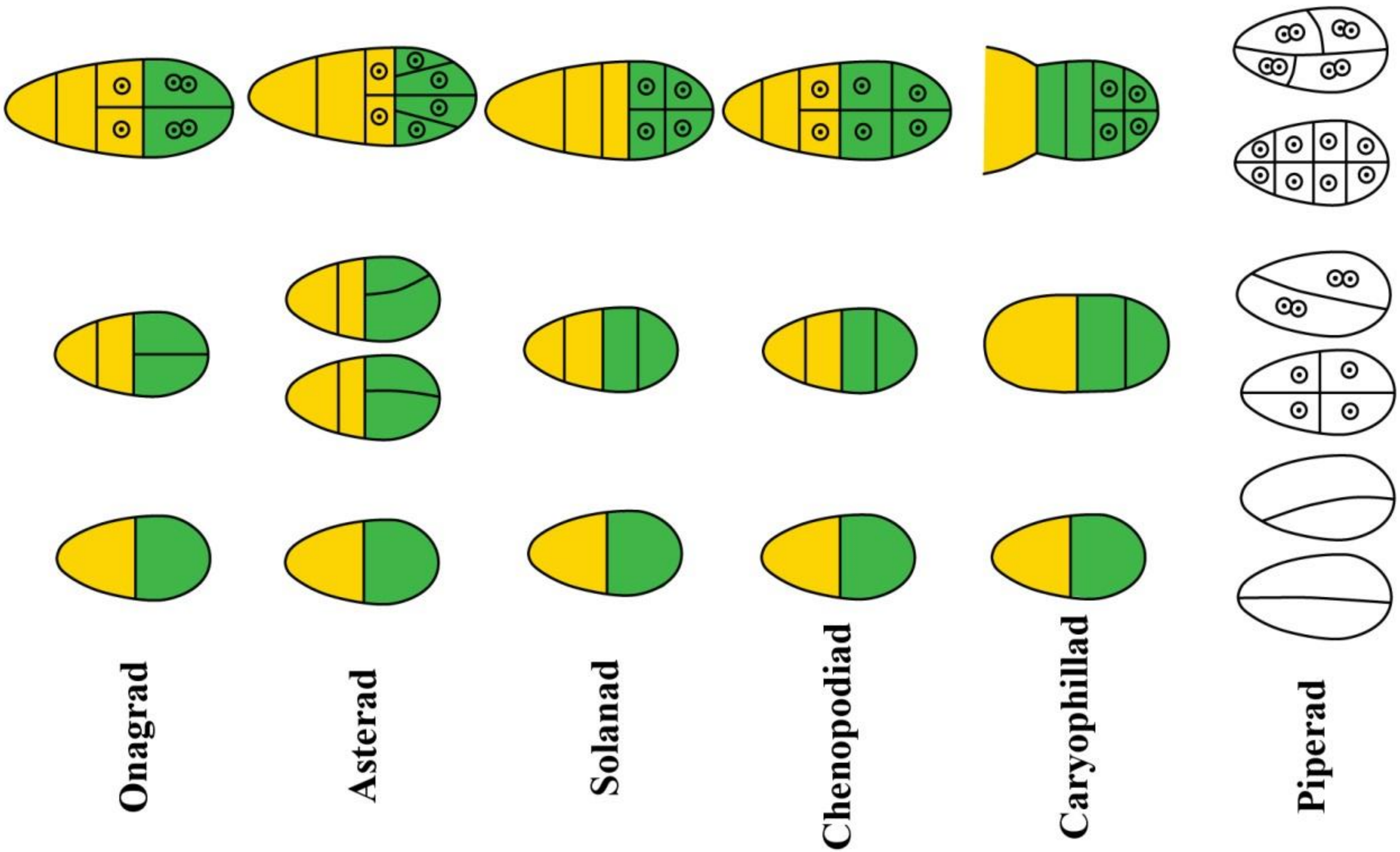
(IV) Caryophyllod type:

- Basal cell does divide further
- Found in **Crassulaeae, Caryophyllacae, Fumariacea,** etc.

(V) Chenopodiad type:

- Both basal and terminal cells take part in the development of the embryo
- Found in **Chenopodiacea, Boraginaceae, etc.**

TYPES OF EMBRYOGENY

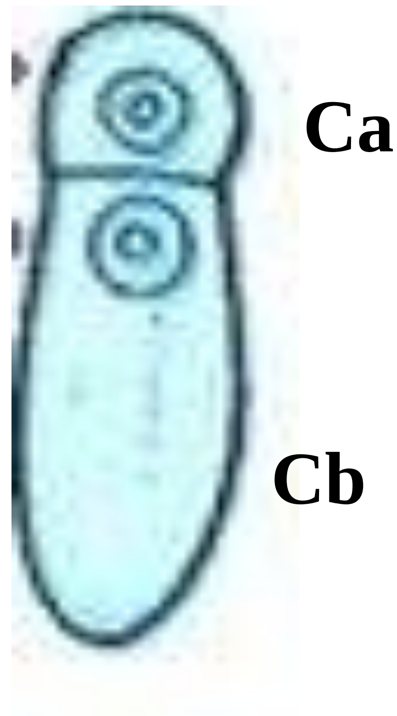


TYPICAL DICOT EMBRYO DEVELOPMENT- Capsella type

- The typical embryo development studied in *Capsella bursa pastoris* (shepherd's purse) of the Family Cruciferae by *Hanstein* and *Famintzin* in 1870
- It is the crucifer type of development
- The first division of the zygote is transverse leading to the formation of basal cell cb and a terminal cell ca

EMBRYO DEVELOPMENT IN *Capsella bursa pastoris*

A

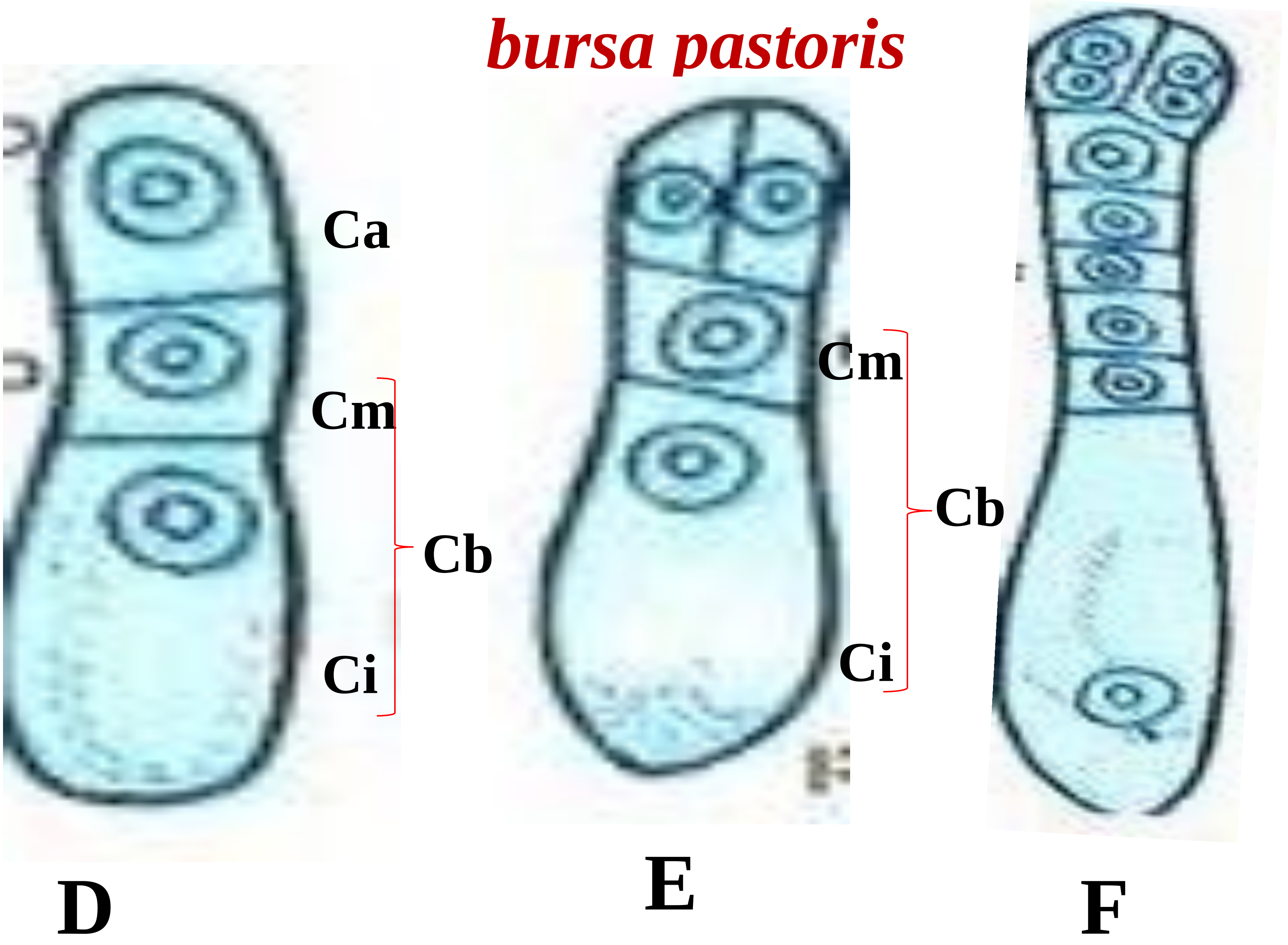


B

TYPICAL DICOT EMBRYO DEVELOPMENT

- Basal cell divides transversely to form 2 cells, cm and ci (D)
- The terminal cell ca divides longitudinally resulting in the formation of reverse-T shaped pro-embryo made up of 4 cells (E)
- Each of the two terminal cells now divides by vertical wall lying at right angles to the first to form quadrant stage (F)

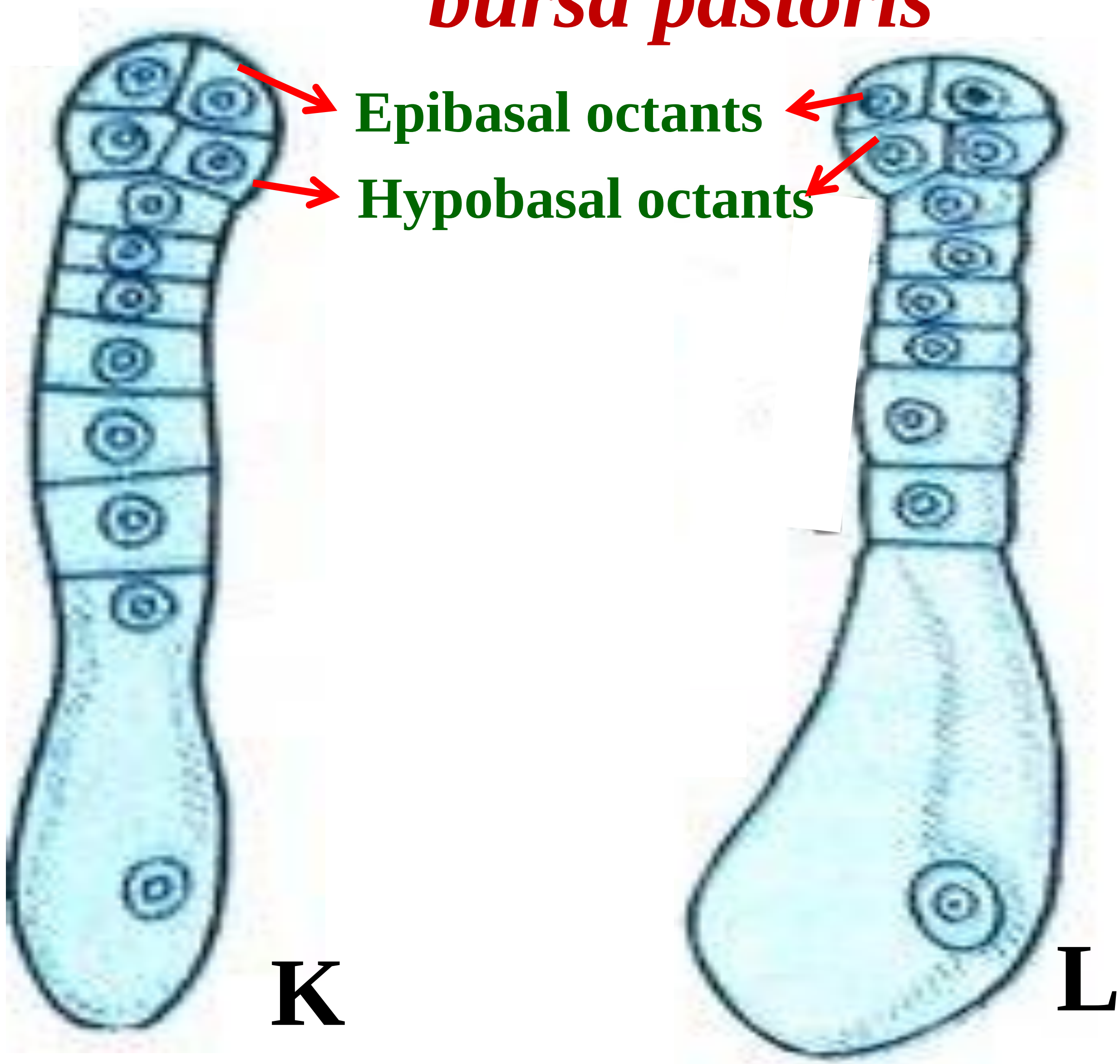
EMBRYO DEVELOPMENT IN *Capsella bursa pastoris*



TYPICAL DICOT EMBRYO DEVELOPMENT

- The two terminal cells divide further vertically at right angles to the first division to produce the quadrants
- The quadrant cells divide by transverse walls giving rise to octant stage **(K, L)**
- Of this octant lower four cells are called **hypobasal or posterior octants** and it form the stem tip and cotyledons and upper four cells named as **epibasal or anterior octants** form hypocotyl

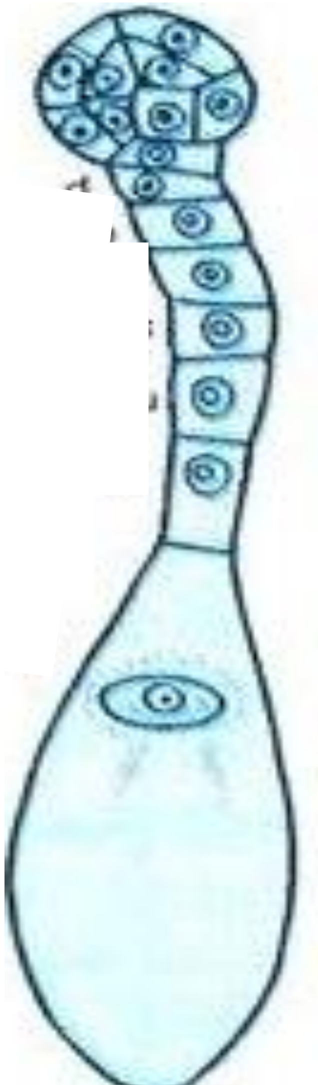
EMBRYO DEVELOPMENT IN *Capsella bursa pastoris*



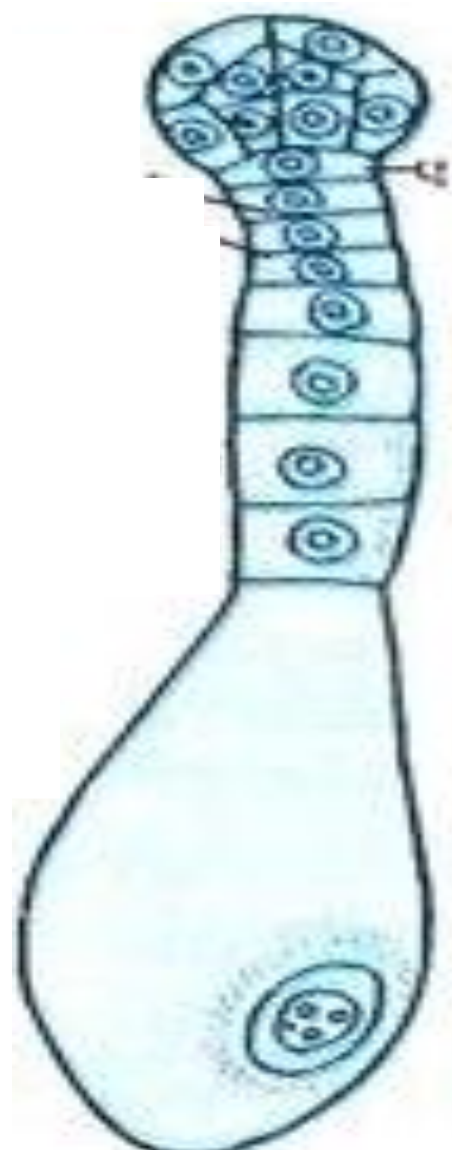
TYPICAL DICOT EMBRYO DEVELOPMENT

- All the eight cells of undergo periclinal division resulting in 16-celled stage differentiating an outer dermatogen and inner layer of cells (M, N).
- The cells of dermatogen divide anticlinaly to give rise to epidermis of embryo, while the inner cells by further divisions give rise to the periblem or ground meristem and plerome or procambium
- Periblem develops into cortex and plerome into stele

EMBRYO DEVELOPMENT IN *Capsella bursa pastoris*….

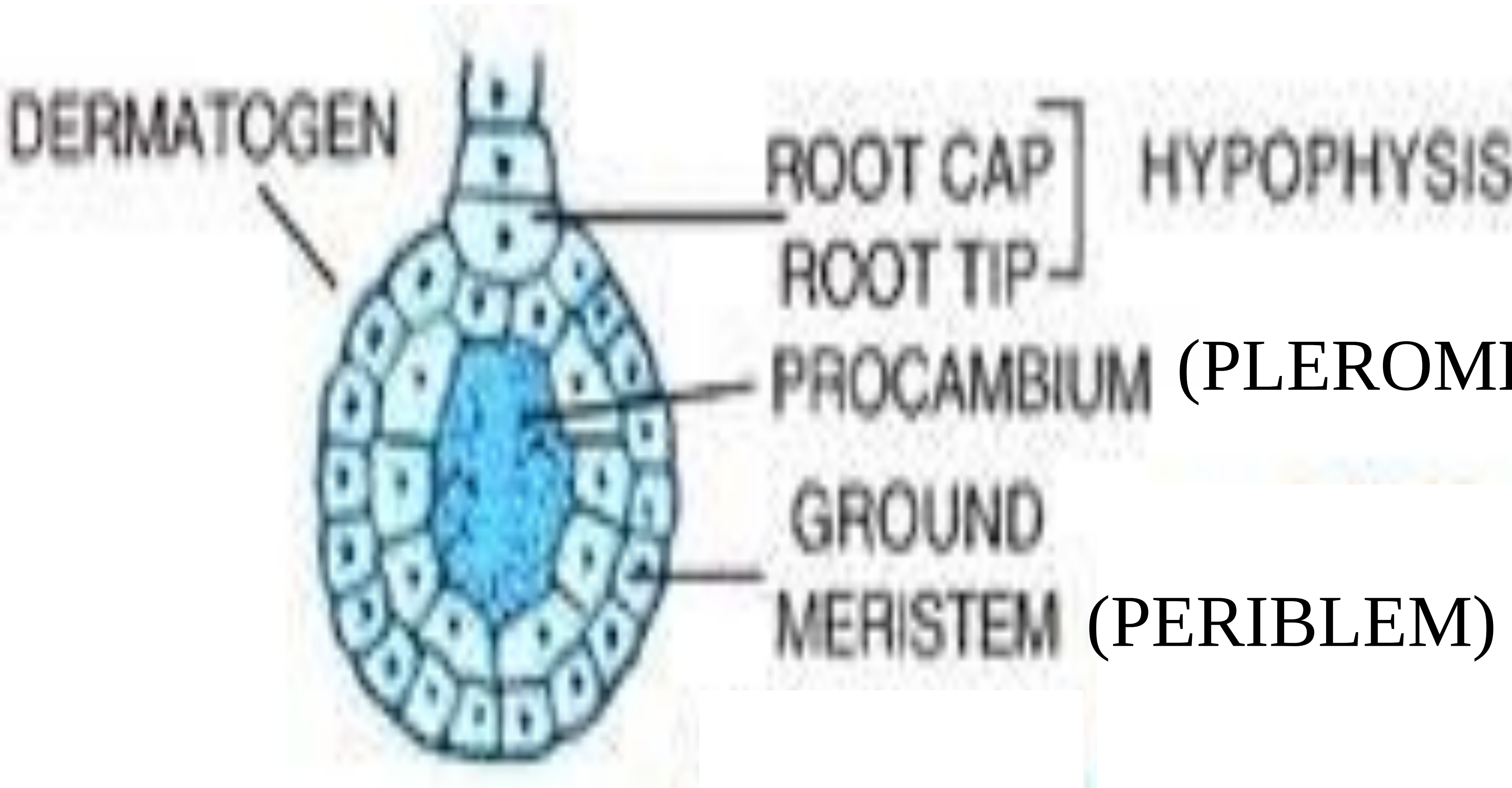


M



N

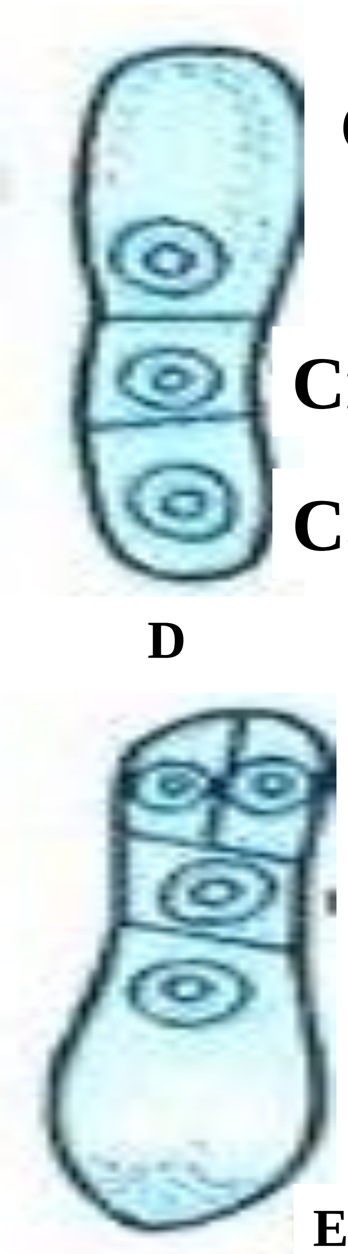
EMBRYO DEVELOPMENT IN *Capsella bursa pastoris*….

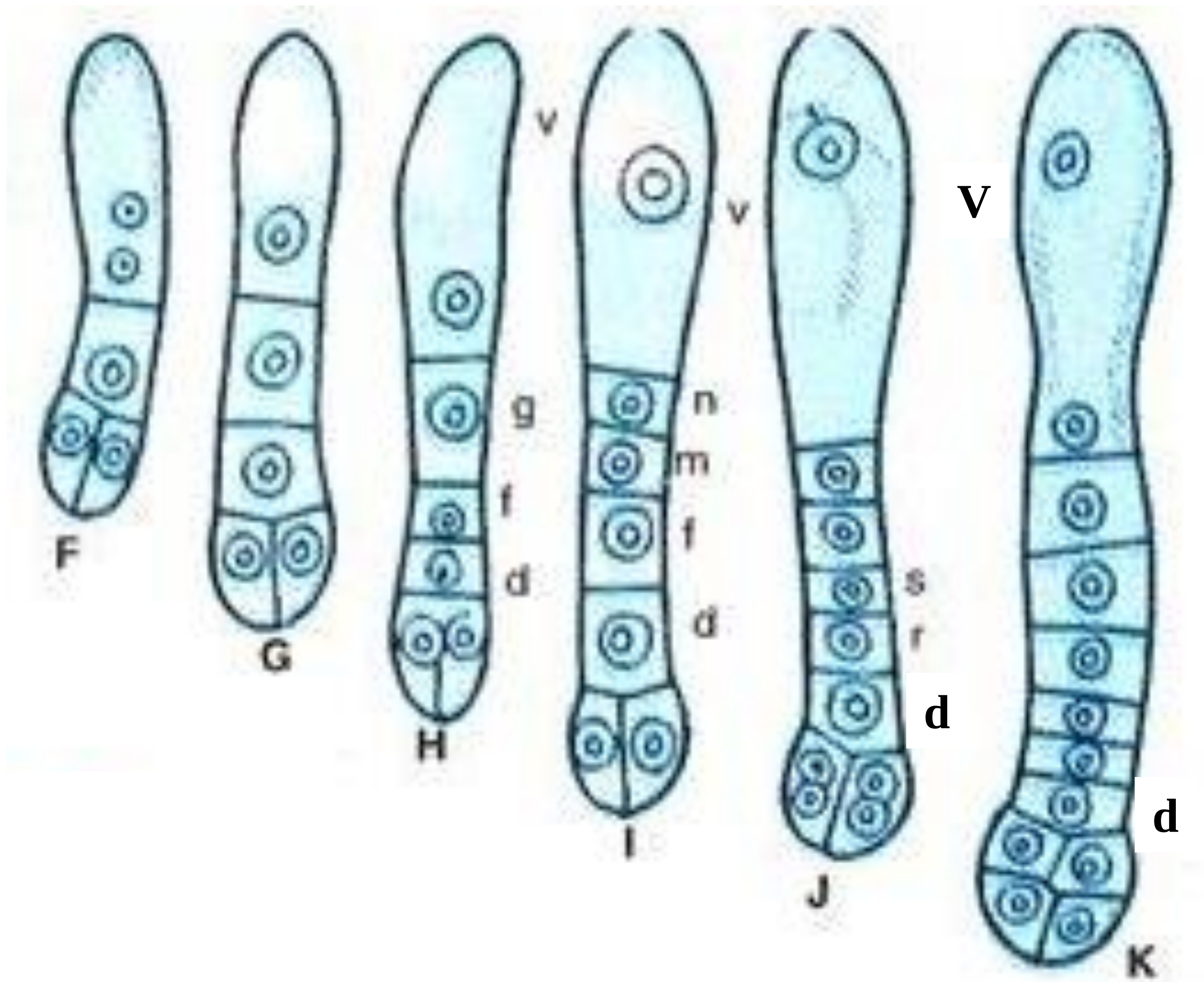


TYPICAL DICOT EMBRYO DEVELOPMENT

- By this time two basal cells ci and cm of four-celled proembryo (E) divide to form a row of 6-10 suspensor cells (F-K)
- Of which the uppermost cell (v) becomes swollen and vesicular to form haustorium.
- The lower most cell (d) functions as hypophysis

EMBRYO DEVELOPMENT IN *Capsella bursa pastoris*

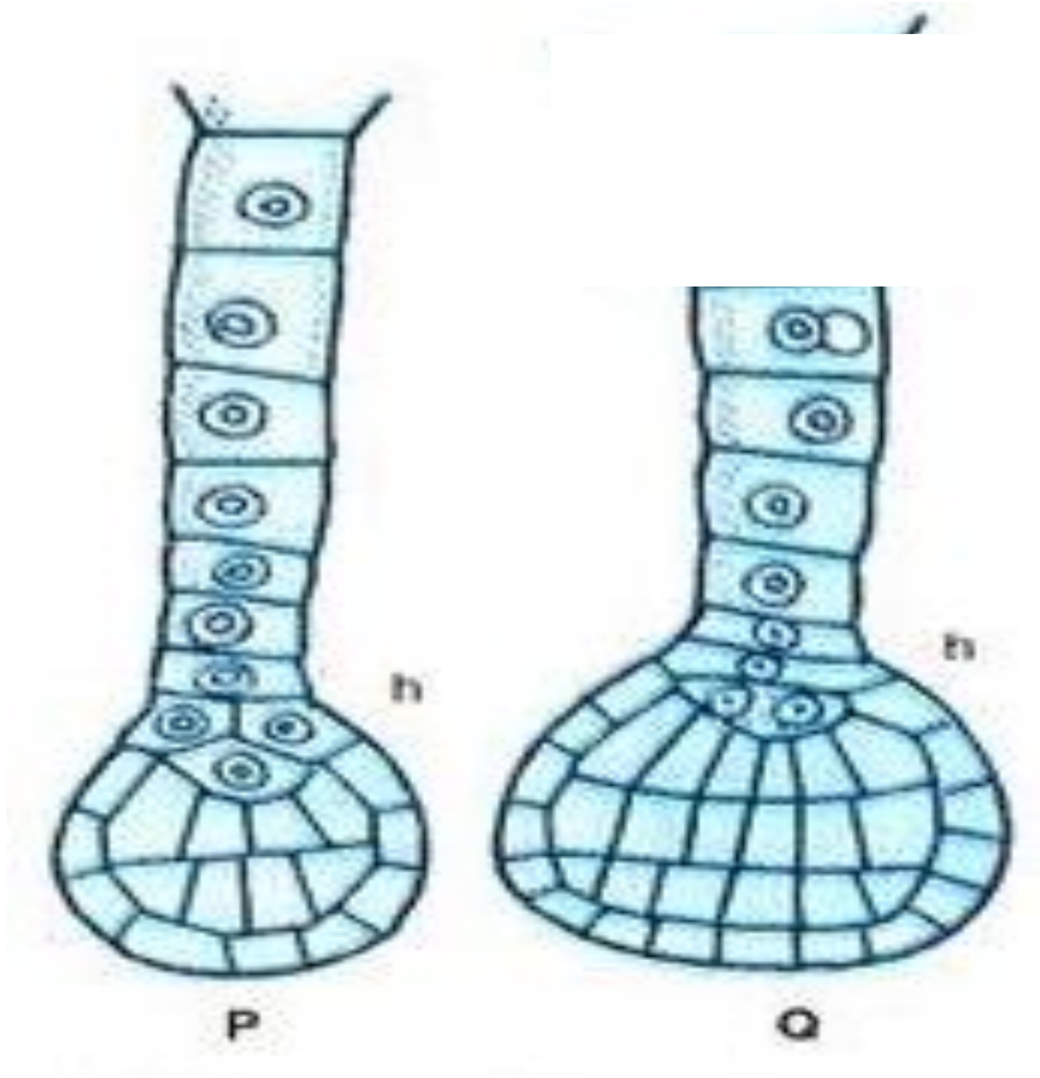




TYPICAL EMBRYO DEVELOPMENT

- The cell of hypophysis divided by two vertical divisions right angles to each other to give rise to eight cells
- Lower four of these form root cortex initials
- Upper four form root cap and root epidermis

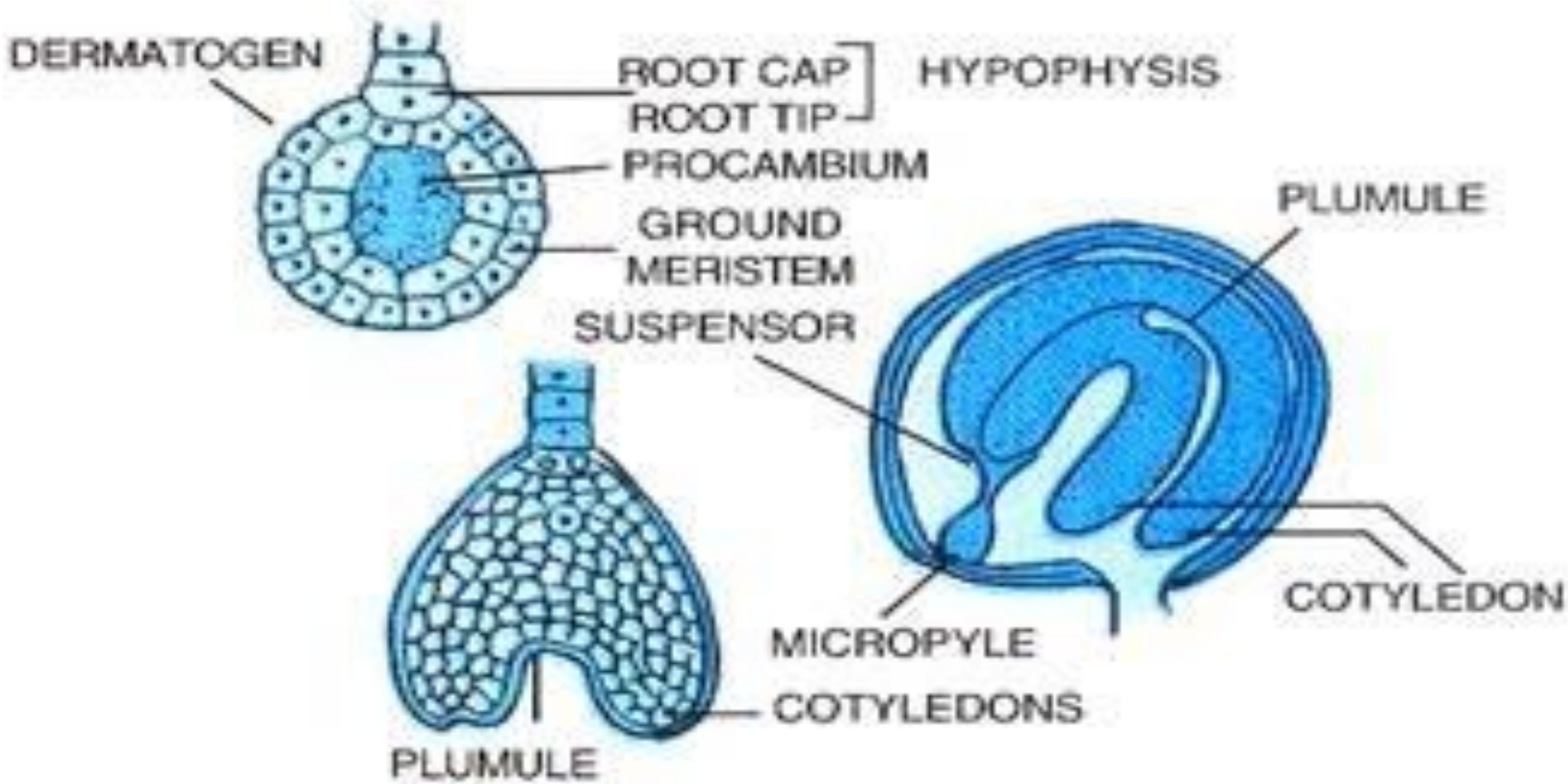
EMBRYO DEVELOPMENT IN *Capsella bursa pastoris*….



TYPICAL DICOT EMBRYO DEVELOPMENT

- A fully developed embryo of Dicotyledons has an embryonal axis differentiated into plumule, two cotyledons and radicle
- In the beginning embryo is globular
- With the continuous division & growth the embryo become heart shaped (chordate) which is made up of two primordial of cotyledons

EMBRYO DEVELOPMENT IN *Capsella bursa pastoris….*

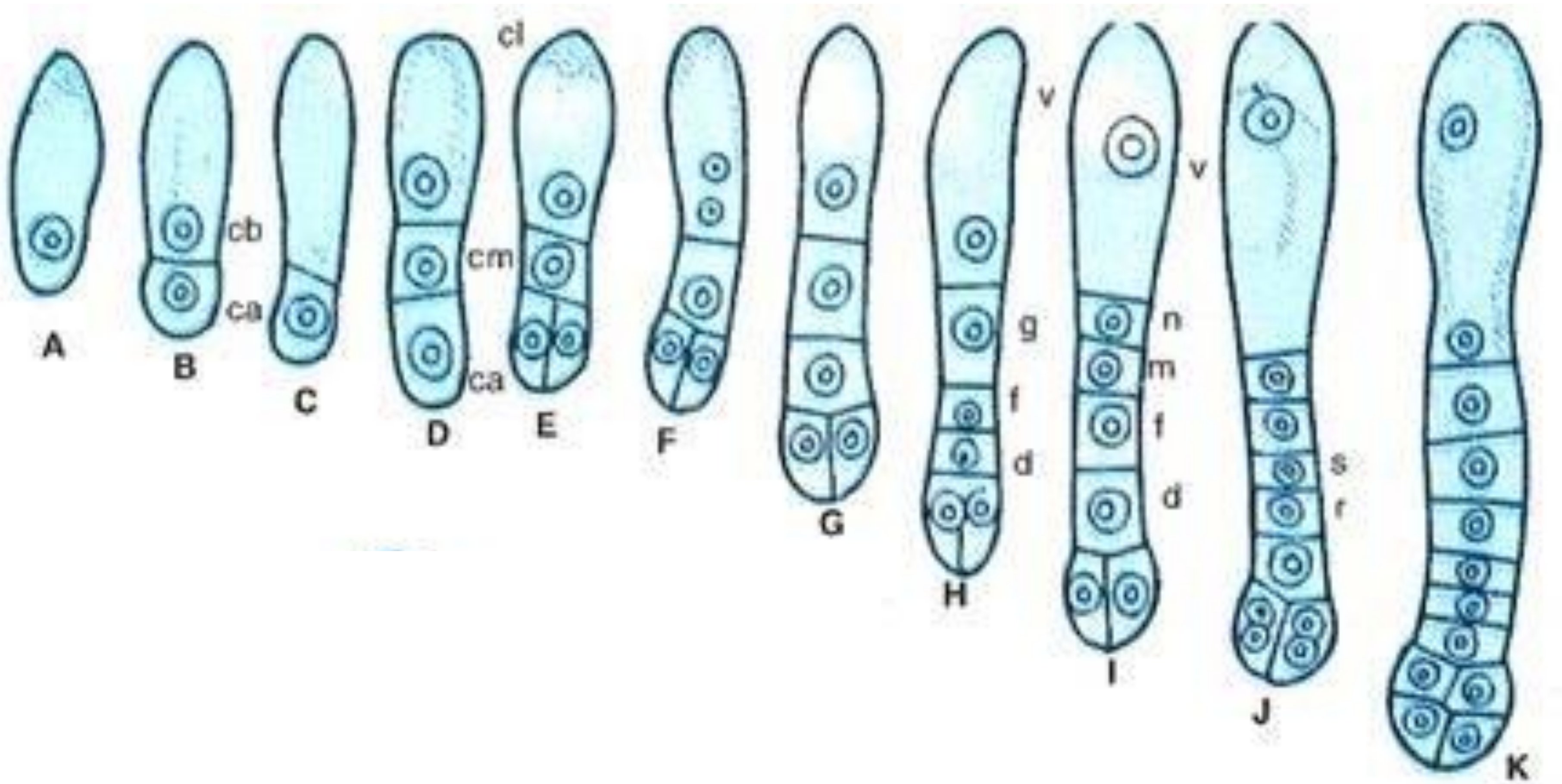


A. Globular embryo; B. Heart shaped (cordate) embryo; C. Horse shoe shaped embryo.

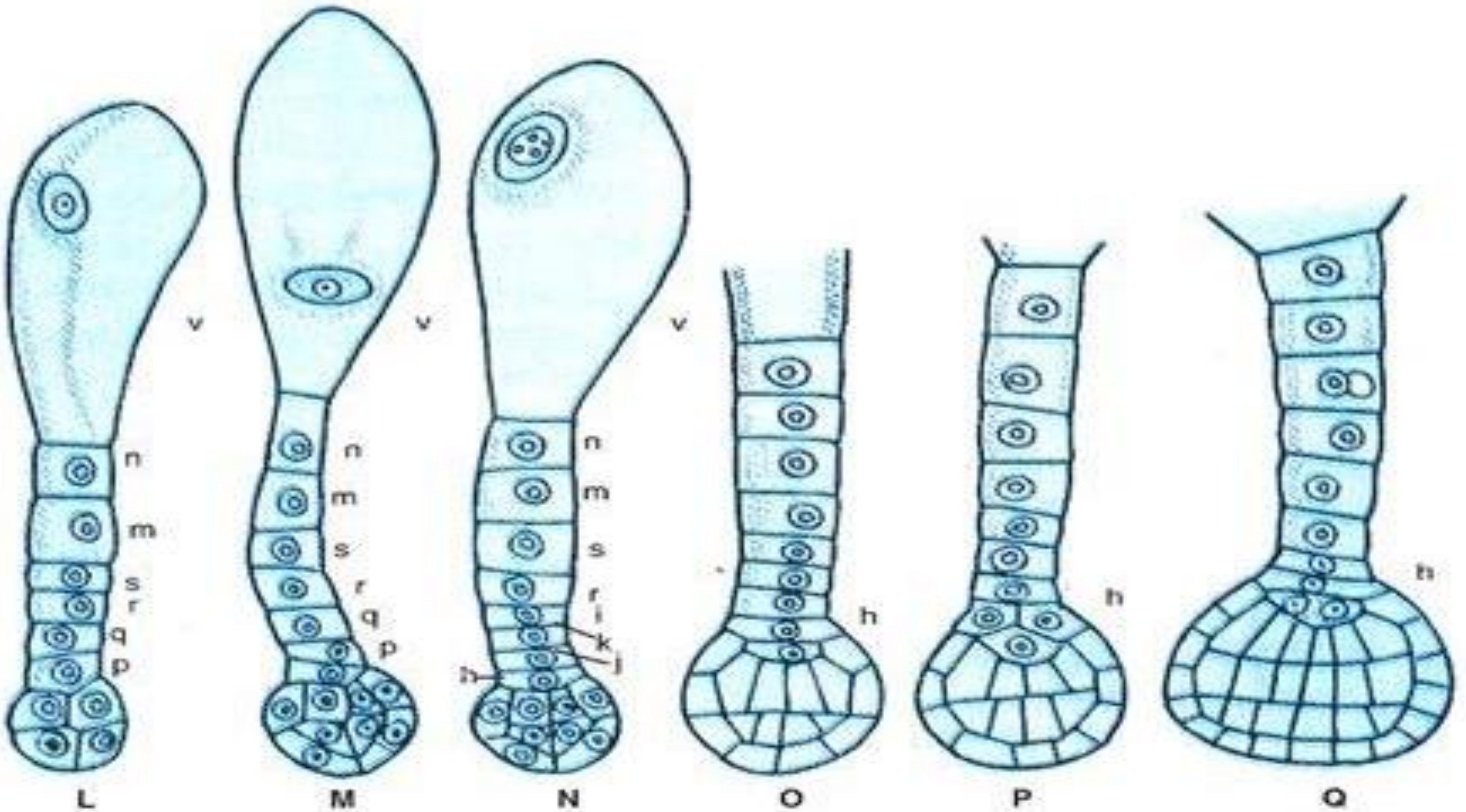
TYPICAL DICOT EMBRYO DEVELOPMENT

- The enlarging embryo consists of two cotyledons and embryonal axis
- The hypocotyl as well as cotyledons soon elongate in size.
- During further development, the ovule becomes curved like horse-shoe

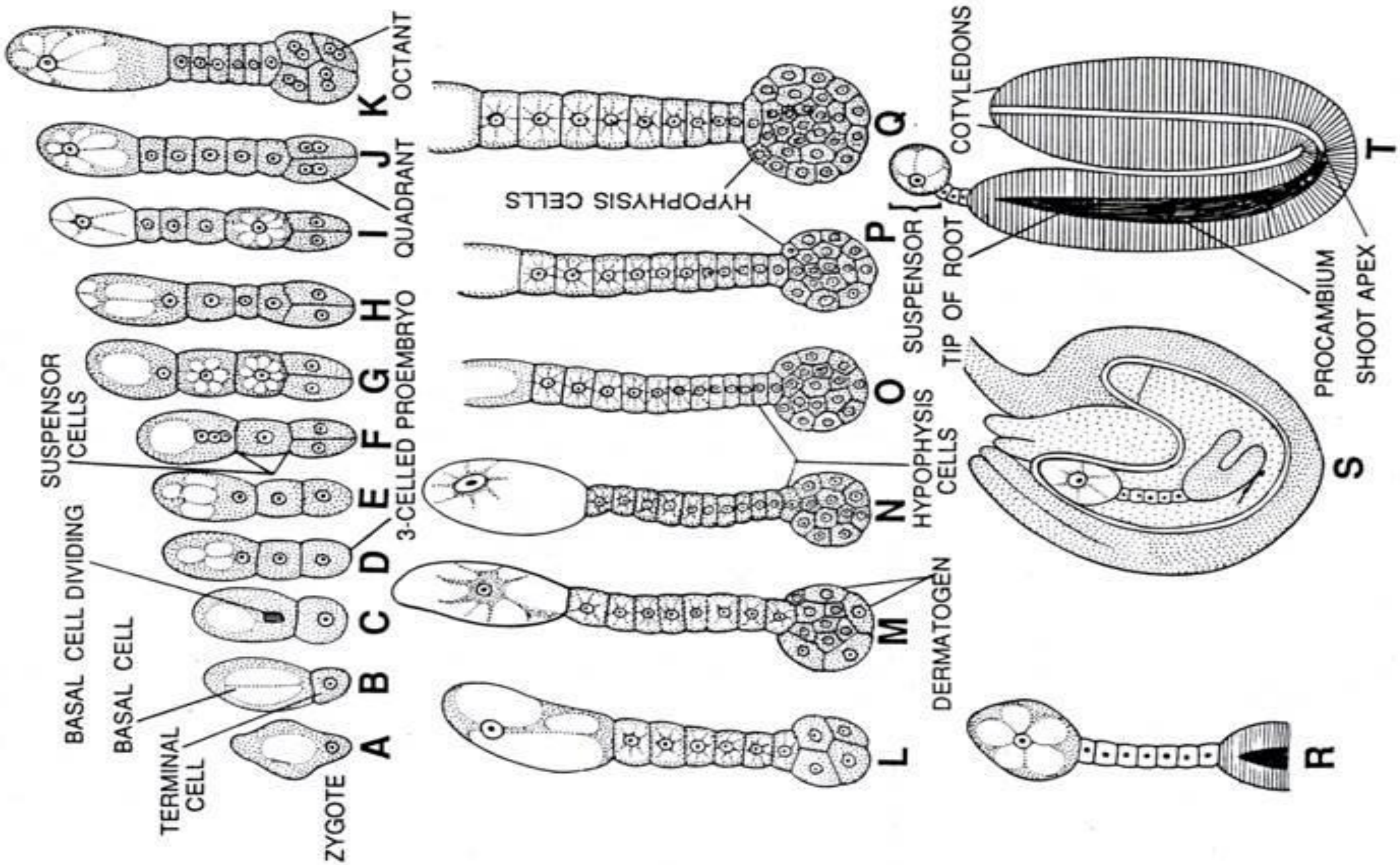
EMBRYO DEVELOPMENT IN *Capsella bursa pastoris*



EMBRYO DEVELOPMENT IN *Capsella bursa pastoris….*



EMBRYO DEVELOPMENT IN *Capsella bursa pastoris*….



MONOCOT EMBRYODEVELOPMENT

- In monocots a good deal of variation is found in the stages of development
- However, there is no essential difference between the monocotyledons and dicotyledons regarding the early cell divisions of proembryo.
- The embryogeny of monocot embryo has been traced out in the typical type Sagittaria sagittifolia of Allismaceae

MONOCOT EMBRYODEVELOPMENT

- Generally, 4 stages in the development of monocot embryo
  - ❖**Pro-embryo stage**
  - ❖**Globular stage**
  - ❖**Scutellar stage**
  - ❖**Coleoptile stage**

MONOCOT EMBRYODEVELOPMENT

- First of all zygote greatly enlarges in size
- The first division of the zygote is an asymmetrical transverse leading to the formation of a large basal cell and a small terminal cell
- Larger basal cell which lies towards micropylar end does not divide further

MONOCOT EMBRYODEVELOPMENT

- It is enlarged and transformed directly to form large suspensor or vesicular cell
- The terminal cell divides transversely and thus form a 3- called pro-embryo
- In the next stage, the lowermost cell of pro-embryo divides by two vertical divisions forming the quadrant stage

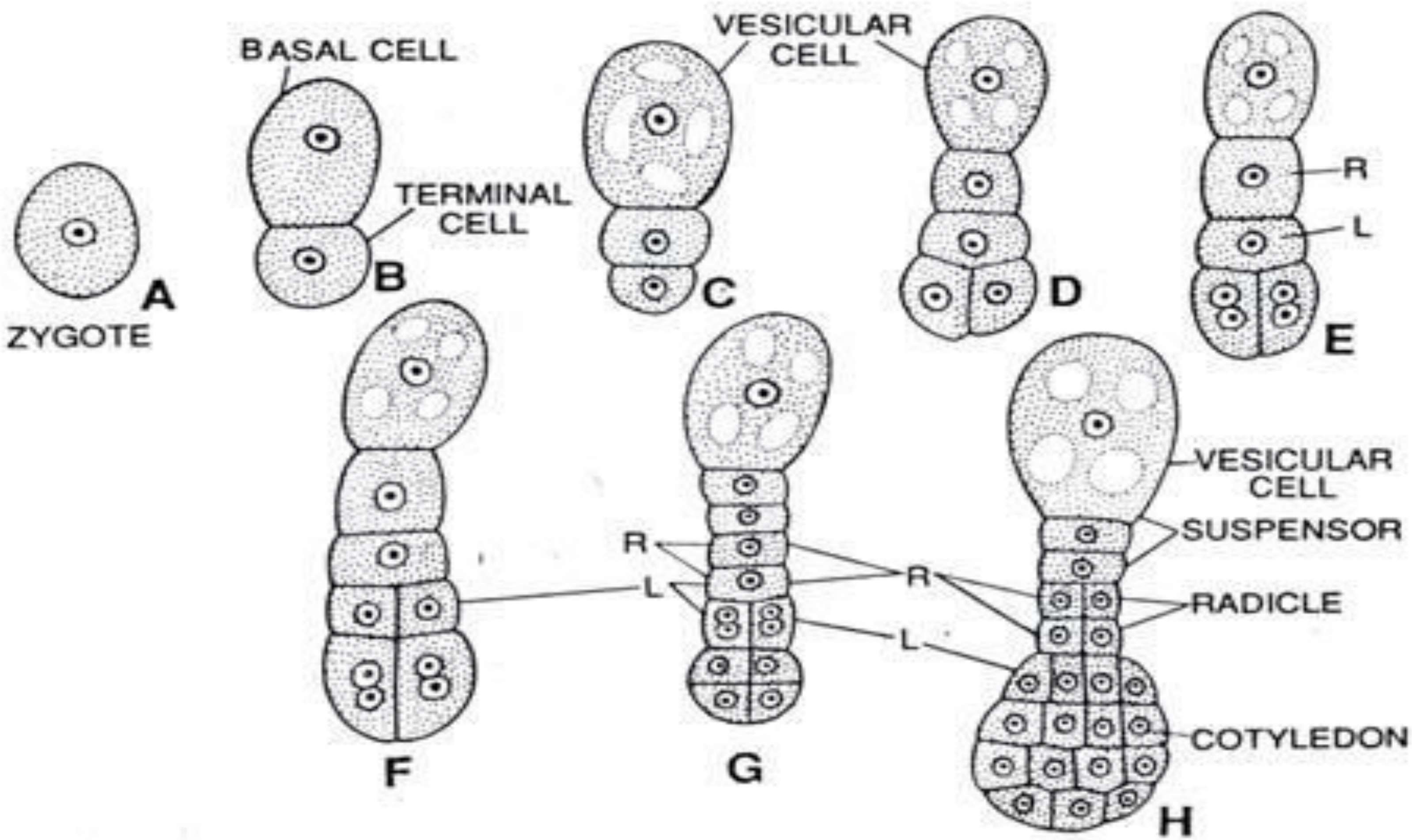
MONOCOT EMBRYODEVELOPMENT

- The quadrant now divide transversely forming the octants, the eight cells being arranged in two tiers of four cells each.
- The octants with the result of periclinal division, produce eight outer and eight inner cells
- The outer cells develops into dermatogen and inner give rise to periblem and plerome

MONOCOT EMBRYODEVELOPMENT

- The middle cell of the 3-celled pro-embryo divides transversely, forming an upper and a lower cell
- The upper cell undergoes repeated transverse and vertical divisions, differentiating into 3-6 suspensor cells, radicle, plumule and hypocotyl.

MONOCOT EMBRYODEVELOPMENT



Stages in the development of a typical monocot embryo in *Sagittaria*.

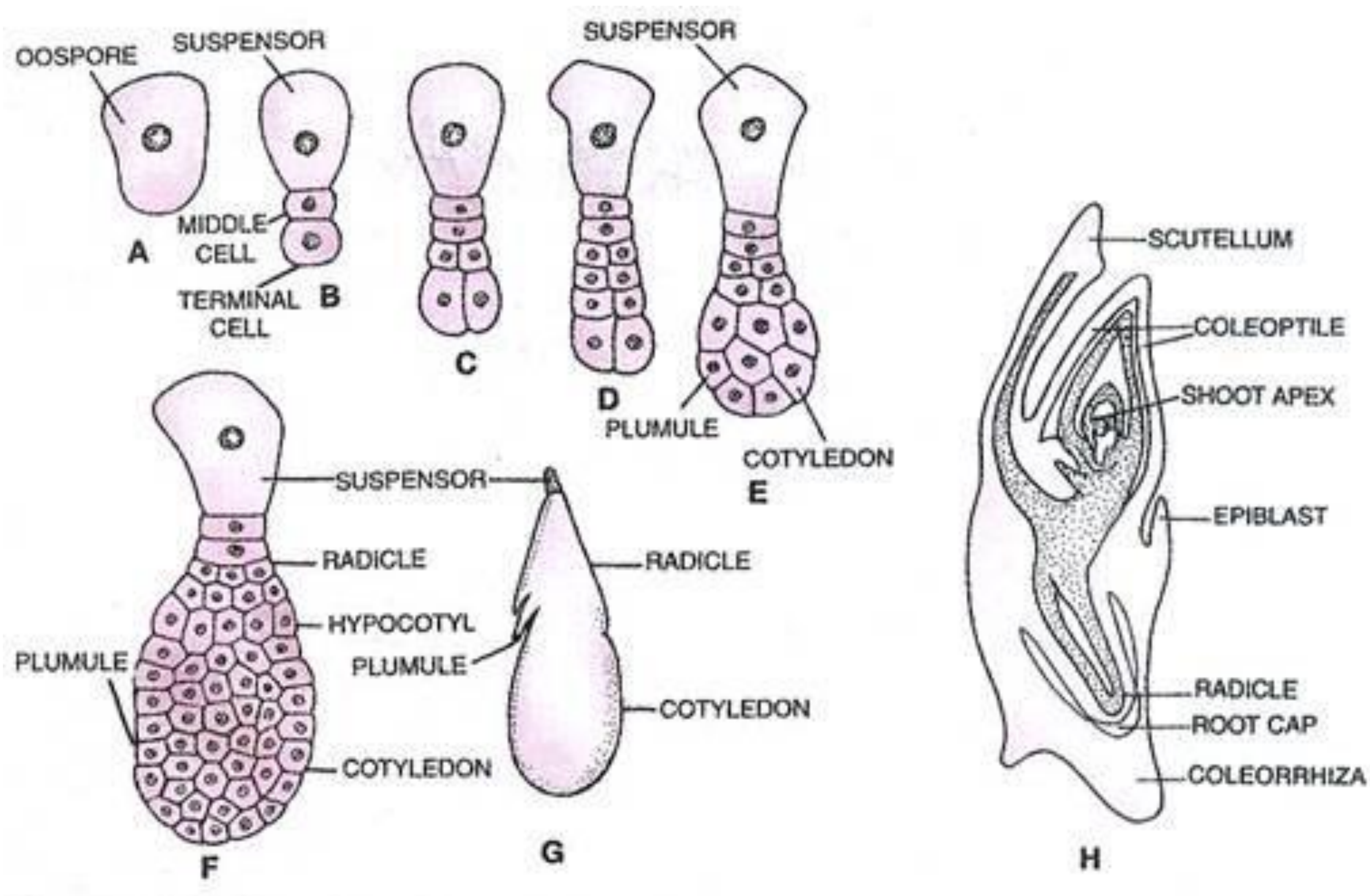
MONOCOT EMBRYODEVELOPMENT

- The eight cells of the octant stage, after differentiating into periblem, plerome and dermatogen, divide further and form a single cotyledon
- The cotyledon is terminal in position and plumule is situated laterally in a depression at the base of scutellum and embryo axis
- The structure of monocot mature embryo is more complex than dicot embryo

MONOCOT EMBRYO DEVELOPMENT

- In monocots like Colocasia, no suspensor is formed.
- In Agapanthus (family – Liliaceae); two cotyledons have been reported
- Conversely, in dicots like Ranunculus ficaria and some members of Apiaceae (Umbelliferae), have single cotyledon

MONOCOT EMBRYO DEVELOPMENT



DIFFERENCE BETWEEN MONOCOT AND DICOT EMBRYO

MONOCOT EMBRYO

- Only one cotyledon attached to the embryonal axis.
- Plumule is lateral.
- A single cotyledon occupies terminal position
- The envelope of plumule is called coleoptile
- Coleorrhiza is a protective sheath of radicle.
- A single cotyledon called scutellum is present.
- Relatively small suspensor

DICOT EMBRYO

- There are two cotyledons attached to an embryonal axis.
- Plumule occur distally (Wardlaw, 1955).
- Cotyledons occur laterally
- (Lakshmana, 1972)
- Coleoptile absent
- Coleorrhiza absent.
- Scutellum absent.
- Suspensor is larger

DIFFERENCE BETWEEN MONOCOT AND DICOT EMBRYO