Course- B.Sc. (Honours), Part -II

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Topic- Embryogenesis

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Plant embryogenesis

Plant embryogenesis is a process that occurs after the fertilization of an ovule to produce a fully developed plant embryo. This is a pertinent stage in the plant life cycle that is followed by dormancy and germination. The zygote produced after fertilization must undergo various cellular divisions and differentiations to become a mature embryo. An end stage embryo has five major components including the shoot apical meristem, hypocotyl, root meristem, root cap, and cotyledons. Unlike animal embryogenesis, plant embryogenesis results in an immature form of the plant, lacking most structures like leaves, stems, and reproductive structures.

Embryo:

After fertilization, the fertilized egg is called zygote or oospore which develops into an embryo. The oospore before it actually enters into the process undergoes a period of rest which may vary from few hours to few months. Generally the zygote (oospore) divides immediately after the first division of the primary endosperm nucleus.

Unlike gymnosperms where the early stages of the development show free nuclear divisions the first division of zygote is always followed by wall-formation resulting in a two-celled pro-embryo. Practically there are no fundamental differences in the early stages of the development of the embryos of monocots and dicots.

But in late stages, there is a marked difference between the embryos of dicotyledonous and monocotyledonous plants, hence their embryogenesis has been considered here separately.

Development of Embryo in Dicots:

According to Soueges, the mode of origin of the four-celled pro-embryo and the contribution made by each of these cells makes the base for the classification of the embryonal type. However, Schnarf (1929), Johansen (1945) and Maheshwari (1950) have recognized five main types of embryos in dicotyledons.

They are as follows:

I. The terminal cell of the two-celled pro-embryo divides by longitudinal wall.

(i) Crucifer type:

Basal cell plays little or no role in the development of the embryo.

(ii) Asterad type:

Basal and terminal cells play an important role in the development of the embryo.

II. The terminal cell of the two-celled proembryo divides by a transverse wall, Basal cell plays a little or no role in the development of the embryo.

III. Solanad type:

Basal cell usually forms a suspensor of two or more cells.

IV. Caryophyllod type:

Basal cell does divide further.

V. Chenopodiad type:

Both basal and terminal cells take part in the development of the embryo.

Here citing the example of Capsella bursa-pastoris (Shepherd's purse), the detailed study of Crucifer type of the development of the embryo has been given.

Development of dicot embryo in Capsella bursa-pastoris (Crucifer type):

For the first time Hanstein (1870) worked out the details of the development of embryo in Capsella bursa- pastoris, a member of Crucifeae.

The oospore divides transversely forming two cells, a terminal cell and basal cell. The cell towards the micropylar end of the embryo sac is the suspensor cell (i.e., basal cell) and the other one makes to the embryo .cell (i.e., terminal cell). The terminal cell by subsequent divisions gives rise to the embryo while the basal cell contributes the formation of suspensor.

The terminal cell divides by a vertical division forming a 4-celled 1-shaped embryo. In certain plants the basal cell also forms the hypocotyl (i.e., the root end of the embryo) in addition of suspensor. The terminal cells of the four-celled pro-embryo divide vertically at right angle to the first vertical wall forming four cells. Now each of the four cells divides transversely forming the octant stage (8-celled) of the embryo.

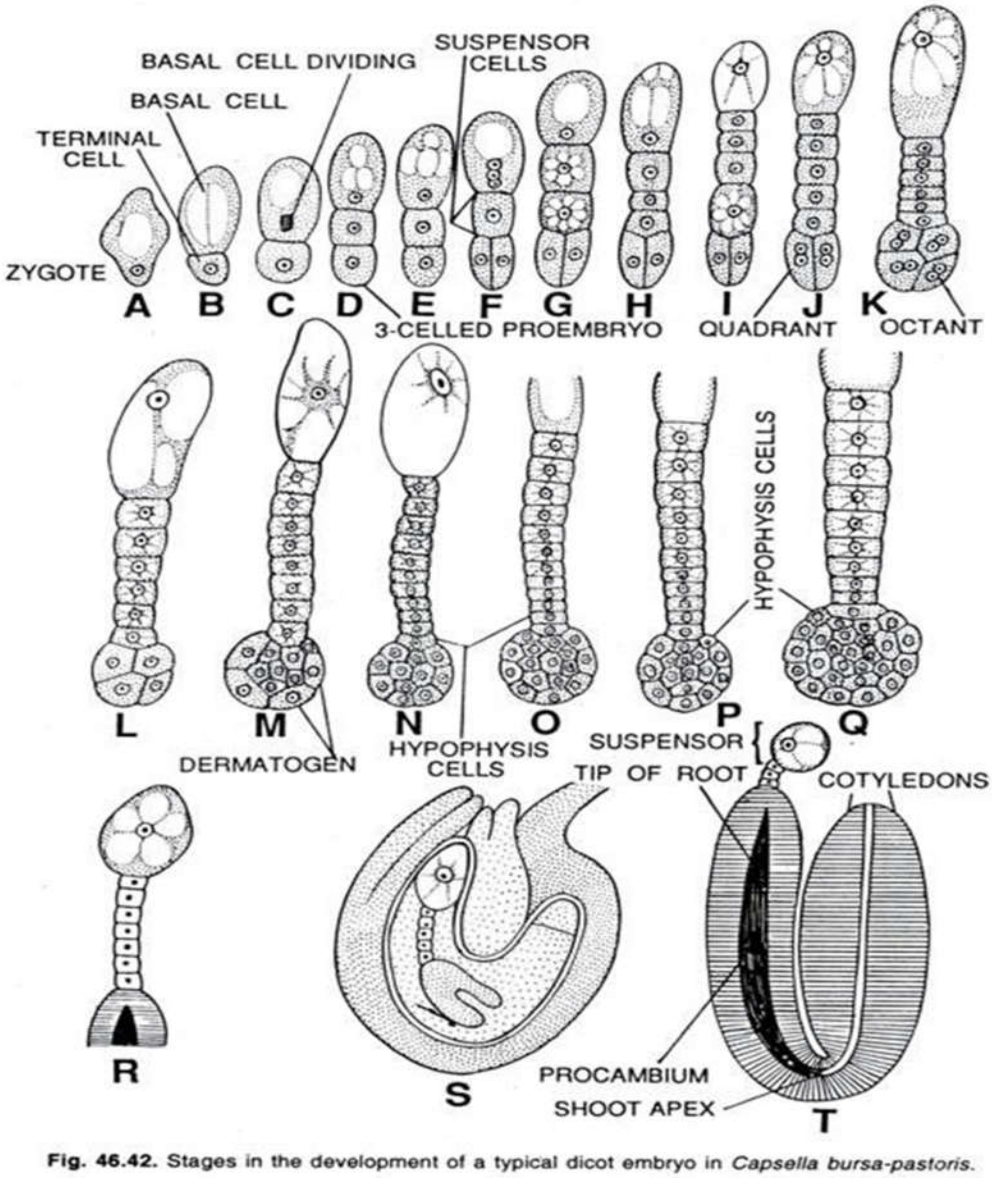

Fig. 46.42. Stages in the development of a typical dicot embryo in *Capsella bursa-pastoris.*

The four cells next to the suspensor are termed the hypo-basal or posterior octants while the remaining four cells make the epibasal or anterior octants. The epibasal octants give rise to plumule and the cotyledons, whereas the hybobasal octants give rise to the hypocotyl with the exception of its tip. Now all the eight cells of the octant divide periclinally forming outer and inner cells.

The outer cells divide further by anticlinal division forming a peripheral layer of epidermal cells, the dermatogen. The inner cells divide by longitudinal and transverse divisions forming periblem beneath the dermatogen and plerome in the central region. The cells of periblem give rise to the cortex while that of plerome form the stele.

At the time of the development of the octant stage of embryo the two basal cells divide transversely forming a 6-10 celled filament, the suspensor which attains its maximum development by the time embryo attains globular stage. The suspensor pushes the embryo cells down into the endosperm.

The distal cell of the suspensor is much larger than the other cells and acts as a haustorium. The lowermost cell of the suspensor is known as hypophysis. By further divisions, the hypophysis gives rise to the embryonic root and root cap.

With the continuous growth, the embryo becomes heart-shaped which is made up of two primordia of cotyledons. The mature embryo consists of a short axis and two cotyledons. Each cotyledon appears on either side of the hypocotyl. In most of dicotyledons, the general course of embryogenesis is followed as seen in Capsella bursa-pastoris.

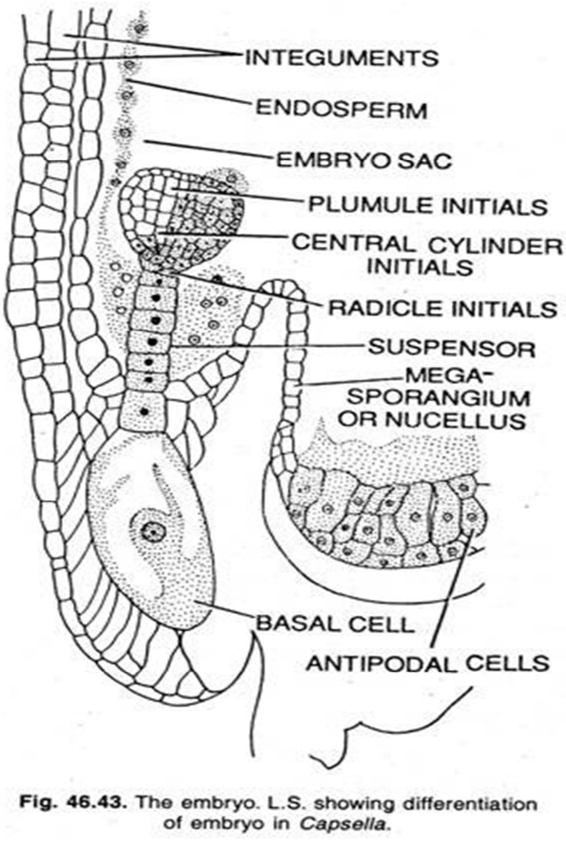

Fig. 46.43. The embryo. L.S. showing differentiation of embryo in *Capsella*.

Development of Embryo in Monocots:

There is no essential difference between the monocotyledons and the dicotyledons regarding the early cell divisions of the proembryo, but the mature embryos are quite different in two groups. Here the embryogeny of Sagittaria sagittifolia has been given as one of the examples.

The zygote divides transversely forming the terminal cell and the basal cell. The basal cell, which is the larger and lies towards the micropylar end, does not divide again but becomes transformed directly into a large vesicular cell. The terminal cell divides transversely forming the two cells. of these, the lower cell divides vertically forming a pair of juxtaposed cells, and the middle cell divides transversely into two cells.

In the next stage, the two cells once again divide vertically forming quadrants. The cell next to the quadrants also divides vertically and the cell next to the upper vesicular divides several times transversely. The quadrants now divide transversely forming the octants, the eight cells being arranged in two tiers of four cells each. With the result of periclinal division, the dermatogen is formed.

Later the periblem and plerome are also differentiated. All these regions, formed from the octants develop into a single terminal cotyledon afterwards. The lowermost cell L of the three-celled suspensor divides vertically to form the plumule or stem tip. The cells R form radicle. The upper 3-6 cells contribute to the formation of suspensor.

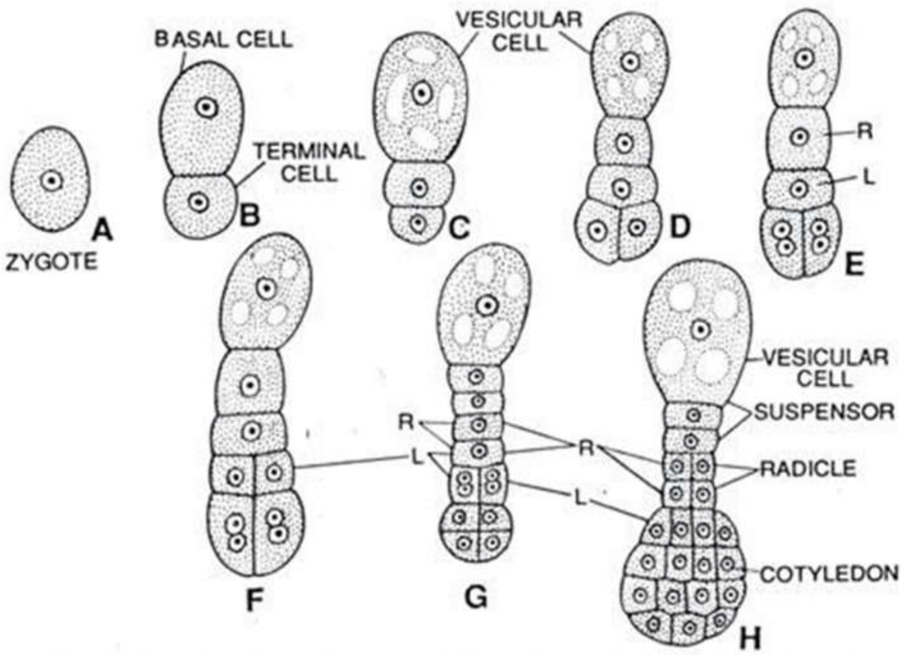

Fig. 46.44. Stages in the development of a typical monocot embryo in *Sagittaria*.