15 STUDIES ON MALE AND FEMALE GAMETOPHYTE OF ANGIOSPERMS

15.1 INTRODUCTION

Sexual reproduction in flowering plants requires the coordinated development of two reproductive organs of the flower, the anther and the pistil. In sexual reproduction basic processes are meiosis and fusion of gametes. By meiosis there is rearrangement of genes and then reduction of the number of chromosomes and subsequently fertilization restores original diploid chromosome number.

Both anther and pistil show characteristic structures and developmental phases which can be observed through microscopical techniques. The microscopical technique plays a dominant role in the study of sexual reproduction of angiospermic plants. It is very difficult to observe directly all the structure involved as they are very minute. Besides, the gametophytic tissues are deeply embedded in the surrounding tissues of the sporophyte. Thus, prepared slides of male gametophyte and female gametophyte can help you understand better the development of these structures as described in Unit 1, 2 and 3 of LSE-06. When you are observing the slides, you will see how the structures resemble. Draw these structures, exactly as you observe them in the given slide and not as you see them in the book.

Objectives

After going through these prepared slides of male and female gametophyte you will be able to:

- describe the structure of a male gametophyte—anther and a female gametophyte—ovule
- give structural details in the development of male gametophyte.
- describe the structural details of single pollen grain
- distinguish various types of ovules.
- identify the different stages of development of the embryo sac and describe a mature embryo sac.

15.2 MATERIALS REQUIRED

A For Studies on Male Gametophyte

T.S. young (developing) anther

T.S. anther showing tetrad

T.S. mature anther showing pollens.

B For Studies on female gametophyte

L.S. ovaries showing various types of ovules.

Early stage in ovule development.

Two celled stage of megaspore mother cell.

Linear tetrad of a megaspore.

Ovule with binucleate embryo sac.

Ovule with 4-nucleate embryo sac.

L.S. of ovule through mature embryo sac.

Globular stage of embryo.

Heart-shaped stage of embryo.

Horse-shoe shape stage of embryo.

Mature embryo showing two dicotyledons.

15.3 PROCEDURE

Observe all the given slides carefully, make neat labelled sketches of them and write comments. (Draw the figures as you observe them under microscope. (Do not copy from the book).

15.4 OBSERVATION

A Studies on Male Gametophyte

T.S. Young (developing) Anther

1. It is a multicellular—four cornered structure.
2. It has four microsporangia and an intervening connective tissue which is linked with the filament.
3. The central region of each microsporangium contains the sporogenous tissue — microspore mother cells. They eventually form the pollen grains.

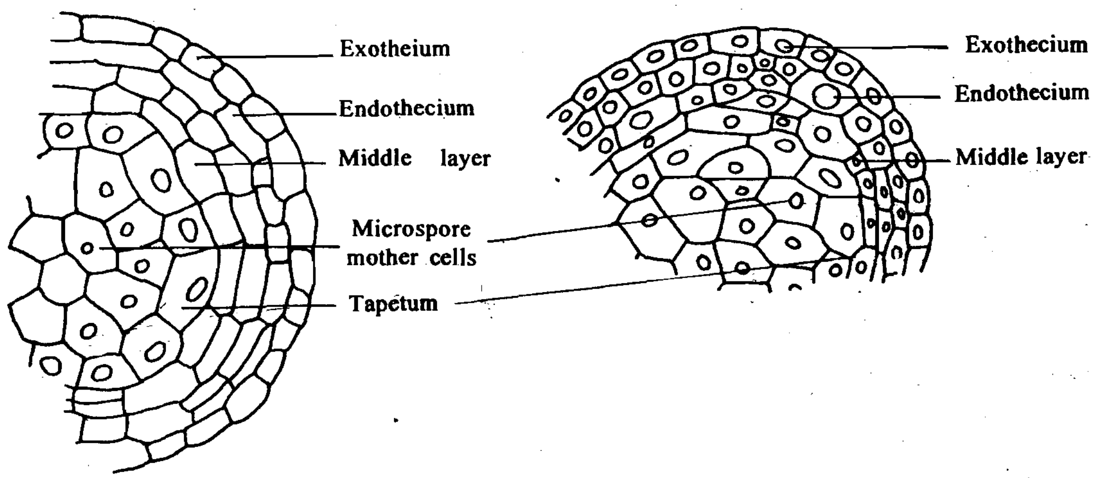


Fig. 15.1: T.S. of young developing anther.

4. All the microspore mother cells or pollen mother cells are interconnected by plasmodesmata.

T.S. of Anther Showing Tetrads

1. During microsporogenesis distinct changes occur in the anther wall.
2. The middle layer(s) usually get crushed gradually and ultimately degenerate.
3. The cells of the tapetum, in contrast enlarge and develop a complex ultrastructure, which indicates that they have become metabolically very active.
4. The cells of exothecium get stretched and endothecium develops fibrous thickening, the cells can also enlarge and become more vacuolate.
5. After microsporogenesis tetrads are formed.
6. The microspores start to differentiate whilst still associated in tetrads and encapsulated by callosic wall.

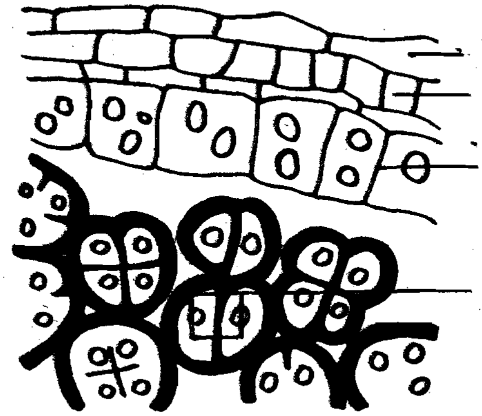


Fig. 15.2: T.S. anther showing tetrads.

T.S. of Mature Anther Showing Pollens

1. A typical anther is tetra sporangiate. It has a column of sterile tissue called the connective on either side of which is an anther lobe.
2. The mature anther wall comprises an exothecium and on inner side a layer of endothecium, 2 or 3 middle layers and a single layer tapetum.
3. Tapetum is the innermost layer of anther wall and attains its maximum development at the tetrad stage of microsporogenesis. Typically tapetum is composed of single layer of cells characterised by the presence of dense cytoplasm and prominent nuclei.
4. The sporogenous cells directly function as microspore mother cell or undergoes few mitoses to add up their number and then enter meiosis.
5. Each pollen mother cell by a meiotic division give rise to a group of four haploid microspores.

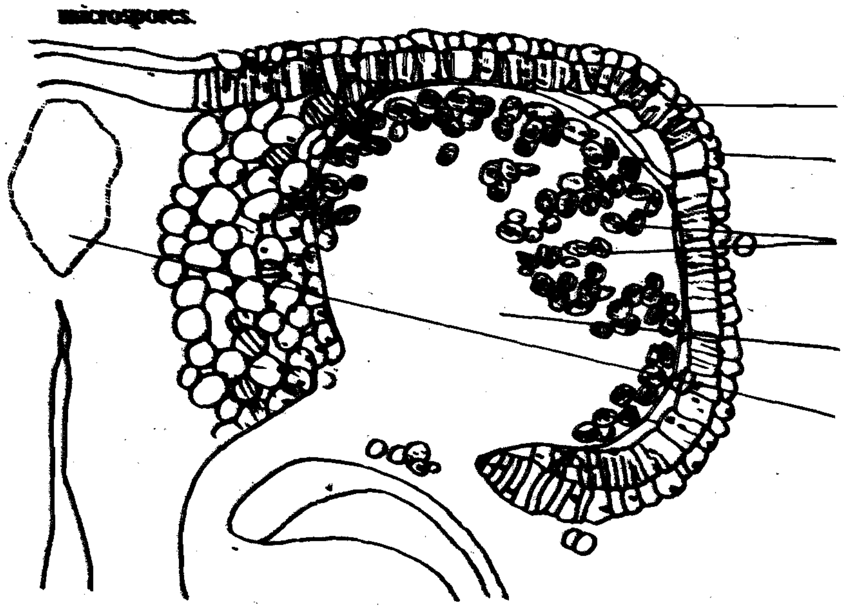


Fig. 15.3: T.S. mature anther showing dehiscence.

6. These aggregated four microspores are referred to as microspore tetrads.
7. Microspores, after release from the tetrads are known as pollen grains.
8. The pollen grain divides into two unequal cells. The bigger vegetative cell gives rise to pollen tube, and the small generative cell gives rise to two sperms by another mitosis.

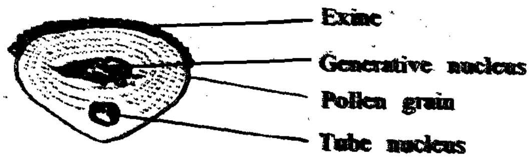


Fig. 15.4: Pollen grain.

9. Pollen grains have two layers, inner one is intine and the outer one is exine.

B. Studies on Female Gametophyte

L.S. of Ovaries Showing Various Types of Ovules

i) **Orthotropous:** When micropyle, chalaza and funicle lie in one straight line, eg., Polygonaceae, Urticaceae.

ii) **Anatropous:** When the funicle is sharply curved below the chalaza, so that the ovule is bent back along its stalk (or when the micropyle comes near to the placenta) eg. Sympetalae.

iii) **Amphitropous:** When longitudinal axis of the ovule is at right angle to the funicle/ or when the chalaza and micropyle are in a line at right angles to the funicle eg. Crossosomataceae.

iv) **Campylotropous:** When the ovule is bent upon itself and not upon the stalk so that the micropyle, chalaza and funicle and close together eg. Chenopodiaceae.

v) **Hemianatropous:** Here the body of the ovule is placed transversely or somewhat at right angle to funicle. Chalaza and microphyle are present in one straight line eg. Primulaceae.

vi) **Circinotropous:** Here the funicle is very long and the ovule rotates by 360° in such a way that it is completely circled around by the funicle and microphyle faces upward eg. Cactaceae.

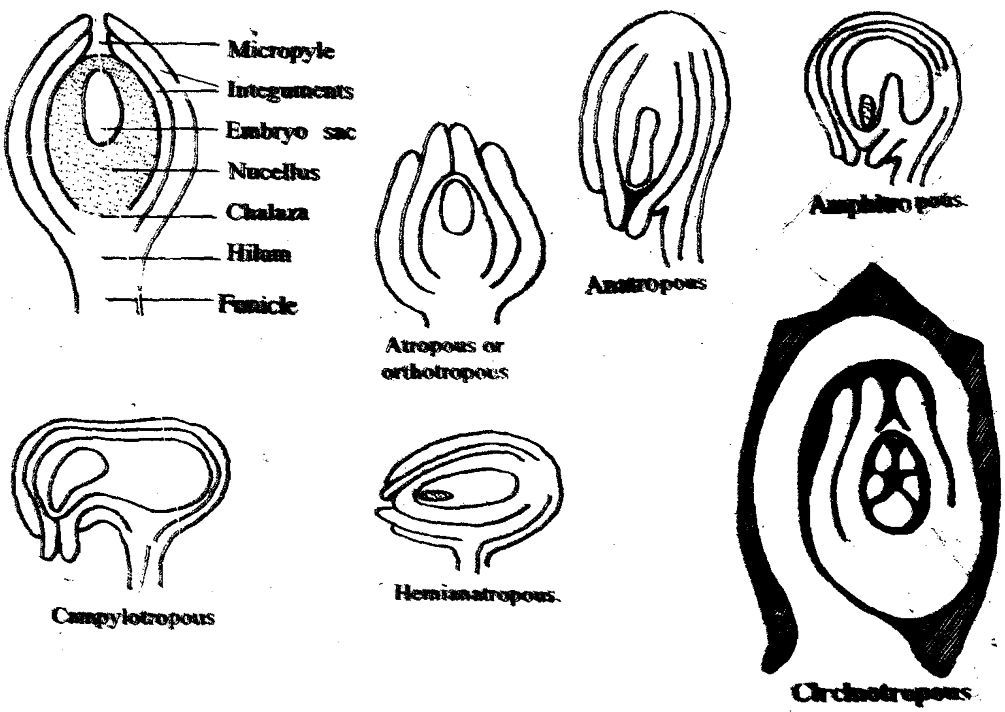


Fig. 15.5: Various types of ovules.

Early Stage in Ovule Development

1. In early stage of development, one cell of the nucellus develops into the megaspore mother cell.

2. The megaspore mother cell is conspicuous because of its much larger size, denser cytoplasmic content and more prominent nucleus.
3. Megaspore or Archesporial cell may directly behave as megaspore mother cell or it may cut off some parietal tissue.

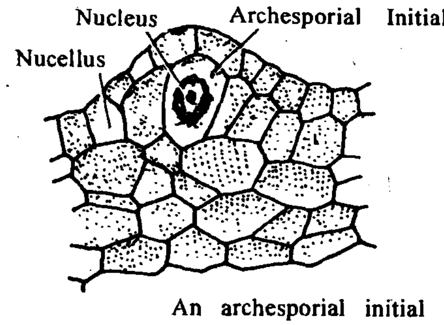


Fig. 15.6: An archesporial initial.

Two Celled Stage of Megaspore Mother Cell

1. Two cells are present one above the other.
2. These are formed after reduction division and thus each cell contains haploid set of chromosome.
3. From these two cells, tetrad is formed.

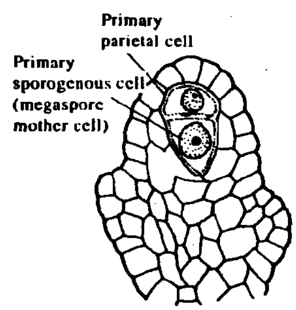


Fig. 15.7: Megaspore mother cell (2-celled stage).

Linear Tetrad of Megaspores

1. Four megaspore are arranged in linear fashion.
2. As a rule, one of the four resulting megaspores persists, while the other three degenerate.
3. The persisting, functional megaspore, which can be mono, bi-or tetranucleate develops into the embryo sac, the female gemetophyte.

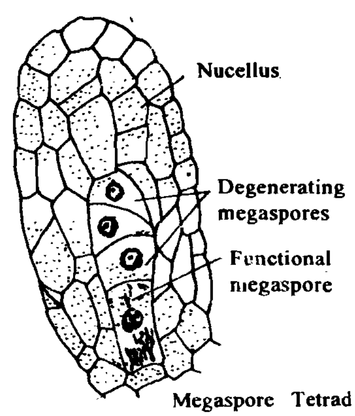
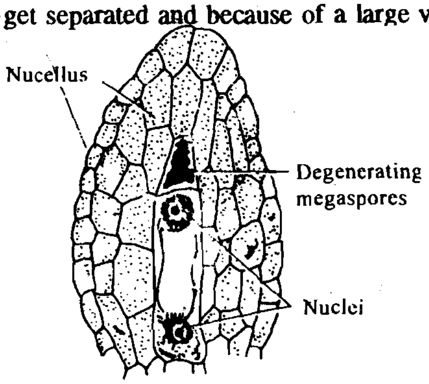


Fig. 15.8: Linear tetrad of megaspores.

Ovule with Bi-Nucleate Embryo Sac

1. Two nuclei are present in the embryo sac.
2. These two nuclei are formed by the division of the nucleus of the functional megaspore.

3. Next, the two nuclei get separated and because of a large vacoule migrate to the periphery.

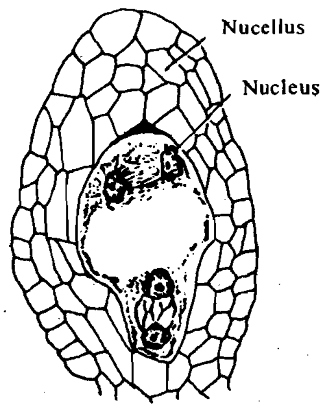


Binucleate embryo-sac

Fig. 15.9: Binucleate embryo sac.

Ovule with 4-Nucleate Embryo Sac

1. Embryo sac contains four nuclei.
2. Two nuclei are present near chalazal and other two near the micropylar end.
3. A large central vacuole is present.
4. At micropylar end traces of degenerated megaspores can be seen.



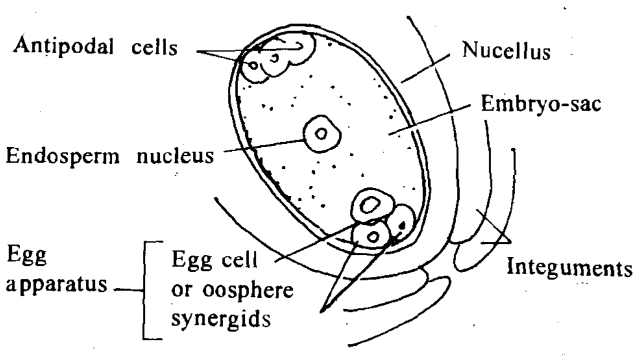
Four-nucleate embryo-sac.

Fig. 15.10: Four-nucleate embryo sac.

L.S. of Mature Embryo Sac

1. The mature embryo sac is enclosed usually in a thin layer of nucellus, which is enclosed in the integuments.
2. The integuments are absent only at the micropylar end where nucellus is exposed.
3. The embryo sac has 3 antipodal cell at the chalazal end.
4. The two nuclei known as polar nuclei come together and fuse just before fertilization and form secondary nucleus.
5. The three nuclei which move toward micropylar end form egg-apparatus with one egg cell and two synergids.

Embryo-sac



Globular Stage of Embryo

1. This is an early stage of embryo.
2. The globular parts is early embryo which is connected by suspensor.
3. The last cell of suspensor enlarges enormously and forms a bulbous base cell.
4. This enlarged basal cell performs the function of absorbing nutrients from the ovule and then conducting them to the terminal globular part which forms the bulk of the embryo.
5. The basal cell has a large vacuole and can also act as basal heustorial cell.

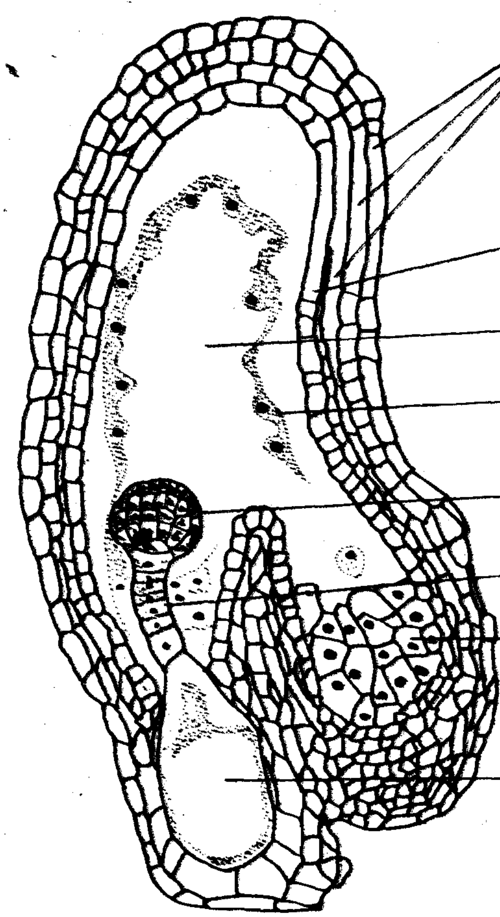


Fig. 15.12: Globular stage of embryo.

Heart Shape Stage of Embryo

1. The embryo has established three systems—the peripheral or dermal system, the middle or ground system the axial or vascular system.
2. The initiation of meristem or histogens takes place immediately.
3. The embryonic apex broadens out as two opposite elevations become visible.
4. The upward growth of primordia sharpens the outline and the embryo becomes heart-shaped.

Horse-shoe Shape Stage of Embryo

1. The mature embryo is a horse-shoe shaped structure which may remain lying embedded in the endosperm of which most of the part is utilized.
2. The cotyledons have grown longer than hypocotyl and lie adpressed to each other.
3. The hypocotyl is a short axis terminating in the root meristem.

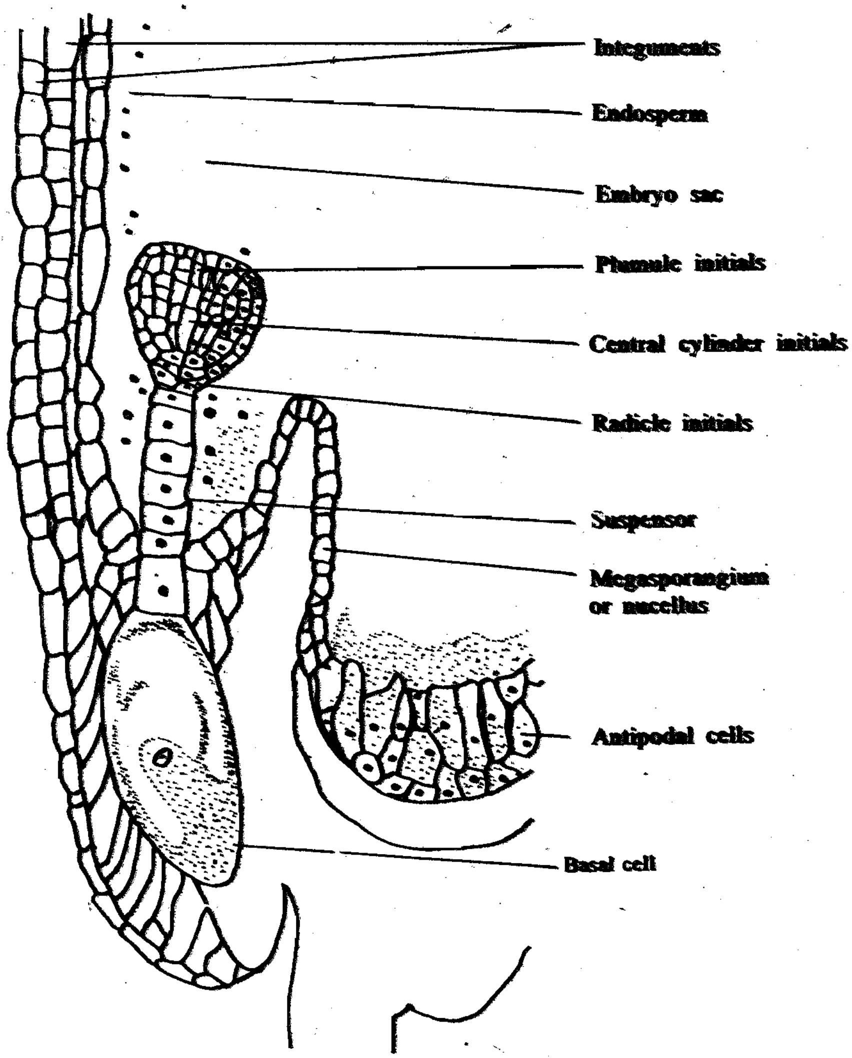


Fig. 15.13: Heart shape stage of embryo.

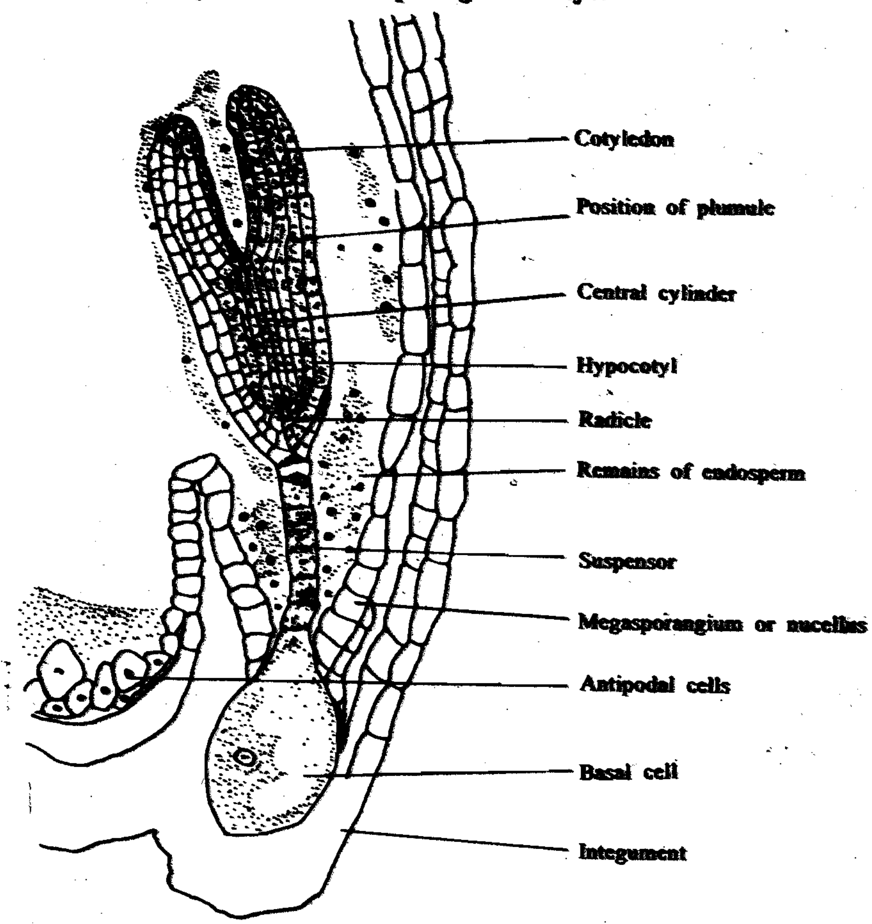


Fig. 15.14: Horse shoe shape stage of embryo.

Mature Embryo Showing Two Cotyledons.

1. This is fully mature embryo.
2. The cotyledons are fully developed, the plumule, central cylinder and root cap are also formed.
3. The cells of mature embryo acquire starch grains as reserve materials.
4. In this condition seed is shed and the embryo remain dormant until germination.

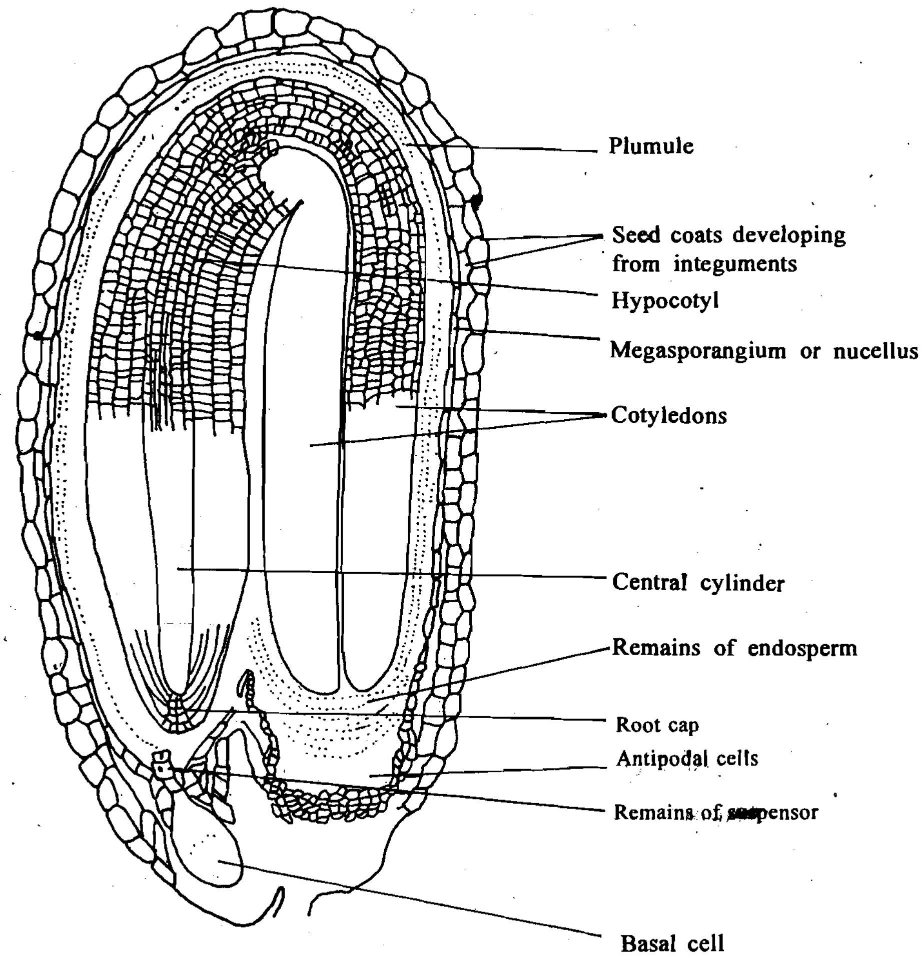


Fig. 15.15: Mature embryo showing two cotyledons.