ENDOSPERM

Q What it is ?

Ans → The endosperm is the chief nourishing almost formless mass of tissue representing the mai source of food for the developing embryo. Unl Gymnosperms, the endosperm in Angiosperms devel as a result of triple fusion ie the fusion of o haploid male gamete with two polar nuclei (or secondary nucleus). This in most of the cases it is a triploid (3n) exceptions - oenothera = 2n Paenia Fritillaria = 5n Pepromia = 5n tissue [and is formed after the act of double fertilization]

The endosperm may either be totally consumed in course of complete development of embryo so that the seeds are non-endosperm e.g.: albuminous (eg - Pea, Bean, Gram) or it may persists in mature seeds and called endosperm or albuminous seed (eg. maize, wheat, castor etc,

TYPES OF ENDOSPERM :-

On the basis of mode of development, it may be three types -

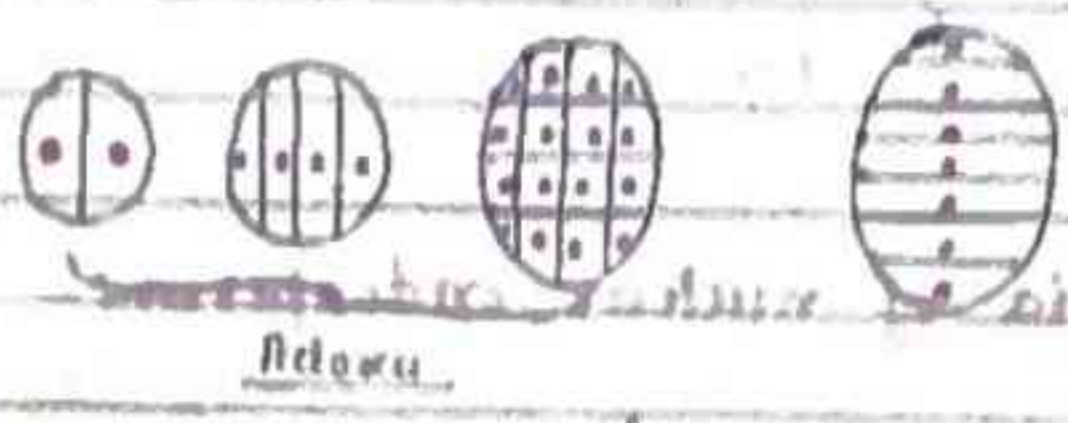
(1) Nuclear Endosperm :-

In this type, the first and subsequent divisions are free nuclear and is not accompained by wall formation. As divisions progress nuclei are pushed towards periphery in the embryo sac and centre is occupied by large vacuole.

After several free nuclear divisions, whose no. varies in different plants, endosperm ent cellular phase. In some plants cell wall formation never occurs eg - Lobelia, oxyspora but, however in Asclepias calotropis, wall formation occurs at very early stage

a wall so that the embryo sac becomes divided into several chambers from the very beginning.

The first wall may be vertical or in most of the cases it may be transverse. This type of endosperm development is largely confined to dicot families. In monocots this development is obtained in Araceae, Lamnaceae etc. 72 families out of 258 investigated exhibit cellular endosperm development (DAVIS - 1966).



1st, 2nd & 3rd = Transverse

e.g. Apocynaceae
Aristolochiaceae

Adoxa

1st & 2nd = vertical
3rd & 4th : transverse

Boraginaceae

In Adoxa the first and the second division of endosperm mother cell is vertical as to form four cylindrical cells. The third division is transversed to result into 8 cells arranged in two tiers. The 4th division is also transversed but further division become irregular.

Transverse orientation of the first wall is common in Apocynaceae, Aristolochiaceae, Boraginaceae etc.

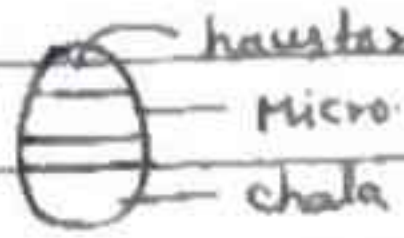
Haustoria development :— Many types :—

a) **Development of chalazal haustoria** → In Nymphaceae, Araceae [the primary chalazal cells of the endosperm mother cell undergoes no further subdivision & the function directly as a haustorium]. Example - Jadina rhombifolia (Bhatnagar & Sadhanwal, 1969) The haustorium branches profusely at the free end to give a

coralloid appearance

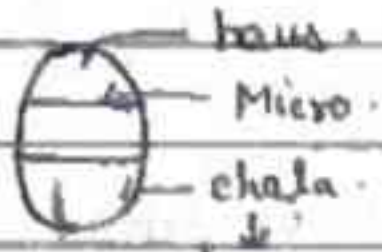
b) Development of Microbylar haustorium →

Example - Impatiens roylei [The microbylar chamber formed by the first division of the primary endosperm nucleus divides transversely into three cells. The uppermost cell forms] Giant haustorium with branching arms extending upto funiculus. Other example = Magnolia obovata.



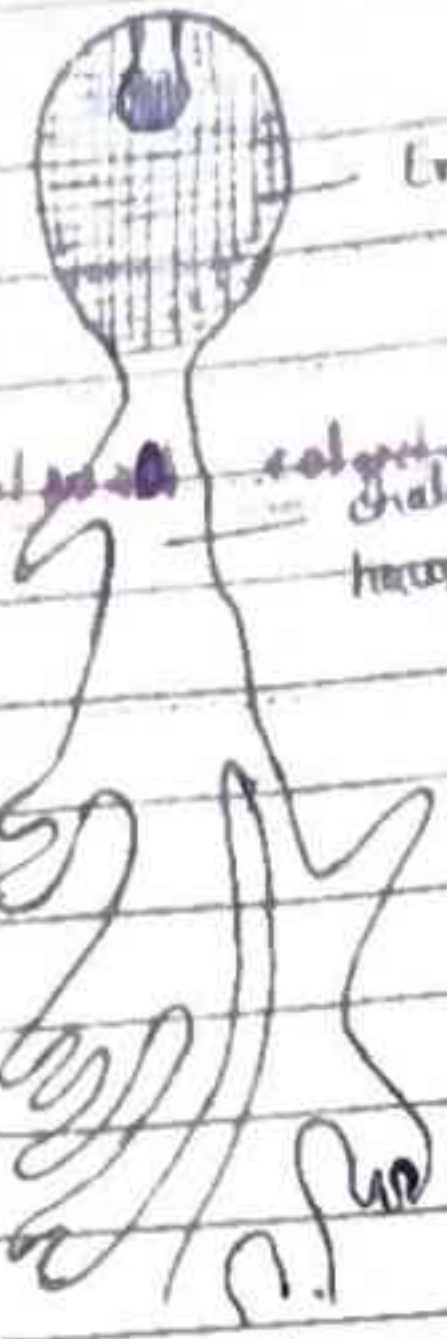
c) Development of both microbylar & chalazal haustorium :—

In Nemophila the chalazal chamber formed after the first division of endosperm nucleus. This gives rise to a small chalazal haustorium. The microbylar cell forms two daughter cells by a transverse division of which the upper becomes binucleate and form the microbylar haustorium. The central cells develop into the main endosperm tissue.



d) Development of secondary haustorium :—

In centranthera, the microbylar & chalazal haustoria are formed but none of them is very active. So, there is the development of sec. haustoria from the endosperm cell just beneath the microbylar haustorium. In case of Veronica, sec. haustorium arises from the chalazal region.



Nymphaceae, Araceae

Fig (a) chalazal haustorium in Iodina rhombifolia

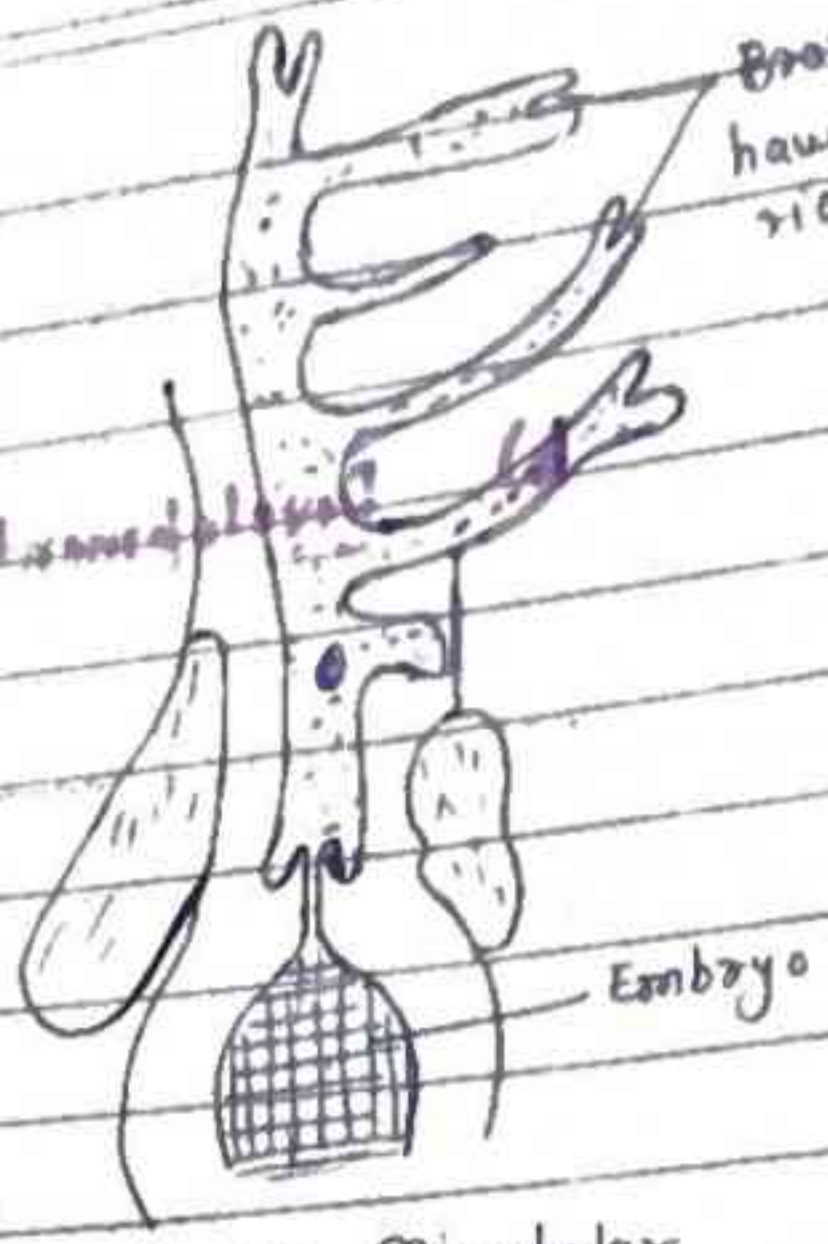


Fig (b) Micropylar

Fig (c) - Both types ie micropylar & chalazal haustoria in Nemophila aurita

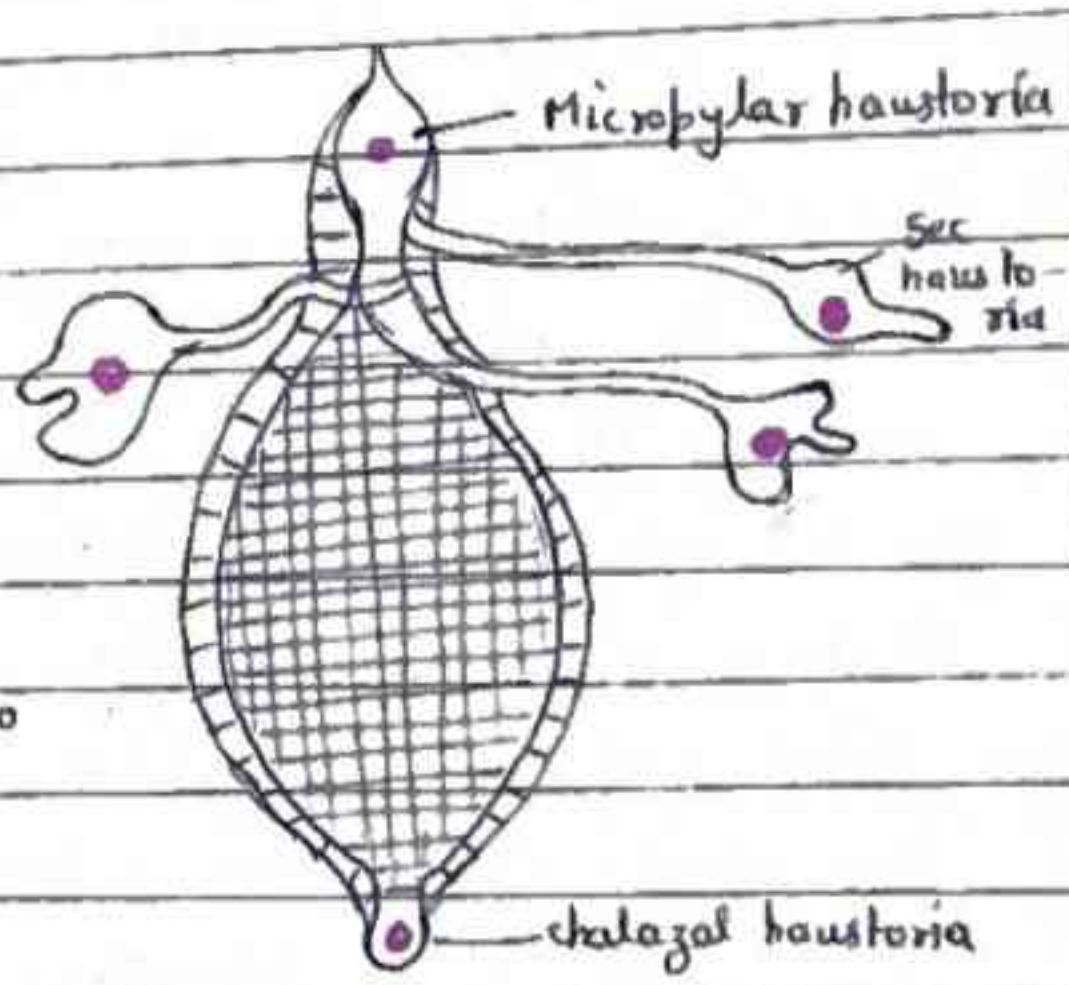


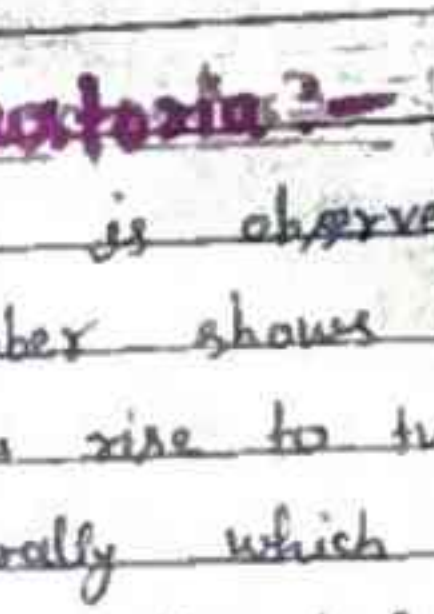
Fig (d) - Secondary haustorium in Centranthera

(3) **Helobial Type :-** This type of endosperm restricted largely to monocotyledon represents an intermediate type between the nuclear and cellular endosperm. It is known in 17 families of which 14 are monocotyledons.

In this type the first division of the primary endosperm nucleus results in the partition of the embryo sac into two chambers — a large micropylar and small chalazal chamber. Several free nuclear divisions take place in the micropylar chamber. The nucleus of the chalazal chamber either remains undivided or undergoes only a small number of divisions. So older ovule that chalazal chamber begins to degenerate and cell formation takes place in the micropylar chamber to result into a cellular mass of tissue.

At this stage, the chalazal chamber is almost crushed and shows only a few disorganised nuclei. Example - Eremurus, Scheuchzeria.

← **Haustoria** :— Development of distinct lateral haustoria is observed in Monochoria. The micropylar chamber shows active nuclear division and soon gives rise to two tubular outgrowths (haustoria) laterally which grow downward and invade the tissue of chalaza.



Endosperm of Monochoria

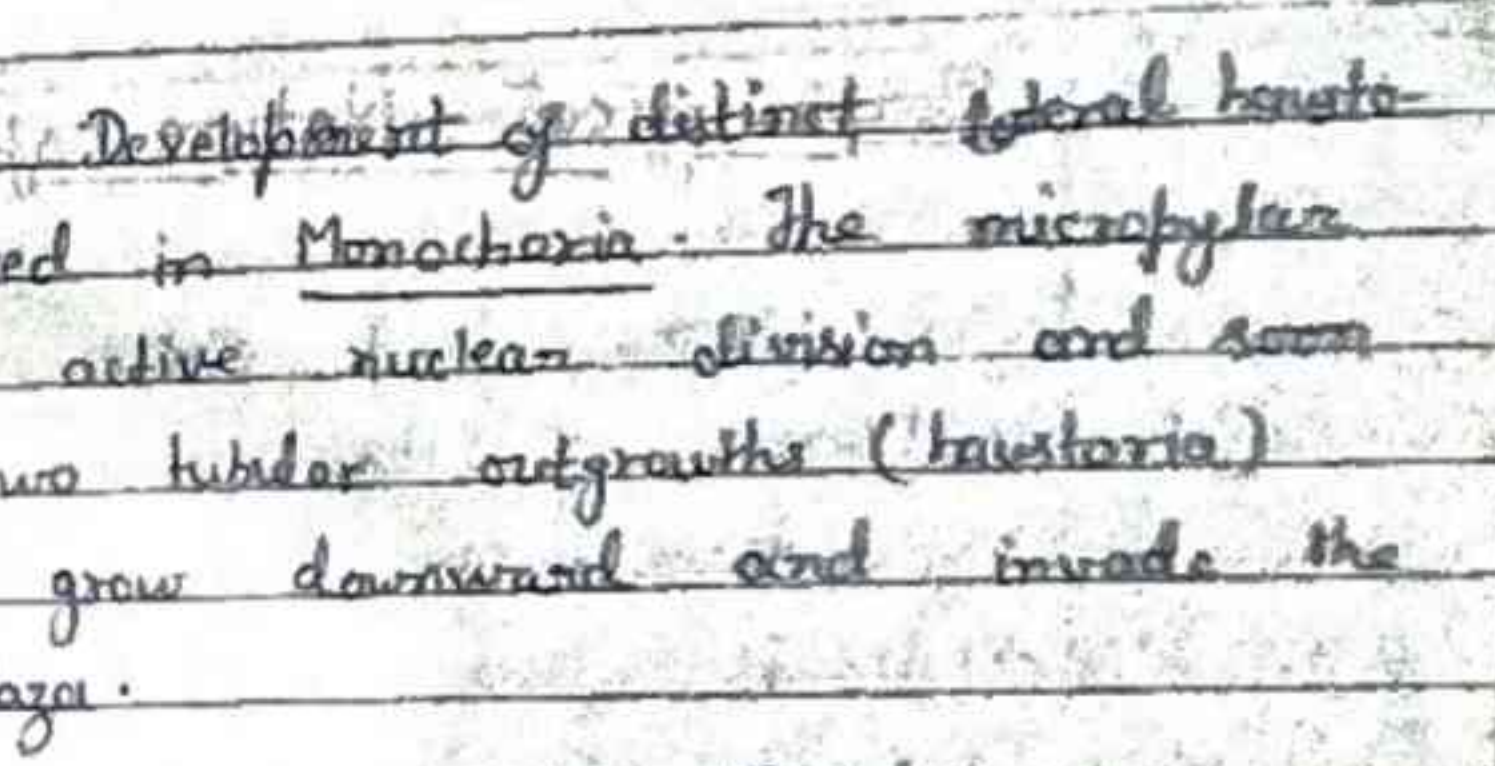
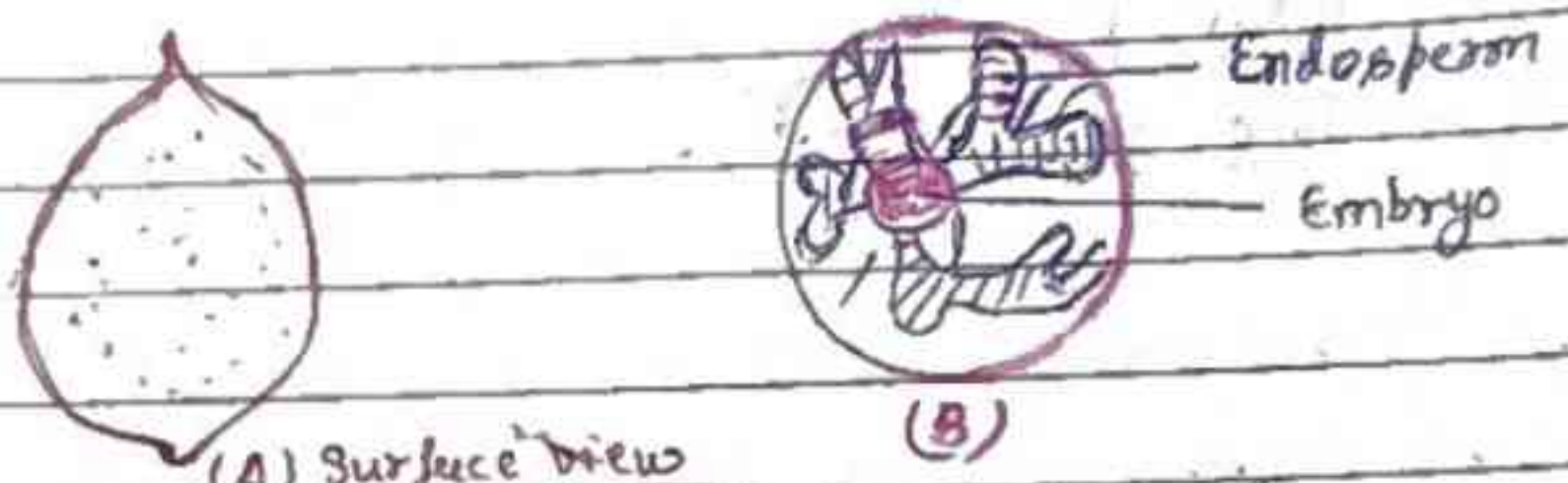


Fig - Endosperm forms

Ruminate endosperm :— Mature endosperm with any degree of irregularity and unevenness in its

surface contour is called ruminate endosperm. Irregularity is due to ingrowth of seed coat or due to unequal radial elongation of cells of any one layer. eg:- Annonaceae, Rubiaceae, Aristolochiaceae.

Ruminate endosperm is not the 4th type or endosperm and it may belong to any one of the 3 categories of endosperm development.



(A) Surface view (B)

Ruminate endosperm of Antigonon

Morphological Nature of Endosperm →

We know that the endosperm nucleus is the outcome of the fusion of three haploid nuclei, viz- two polar and one ♂ nucleus (= triple fusion) and is, therefore, triploid (3N) and so also the endosperm resulting from it. The nature of endosperm is very confusing and there are different views about it :—

(i) Strasburger (1900) regards it the female gametophyte or the vegetative tissue of the female gametophyte as its function is the storage of food material for the development of embryo and is formed after fertilization. From a triple fusion of nuclei by the process of free nuclear division like female gametophyte of Gymnosperm.

This view was also supported by Coult and Chamberlain (1912). But in Gymnosperm, the endosperm is the vegetative tissue of the female gametophyte and is formed before fertilization, each cell of which has haploid (N) number of chromosomes, while each cell of the endosperm in Angiosperms has triploid (3N) number of chromosomes.

This view that the endosperm in Angiosperms is a vegetative tissue of the female gametophyte is discarded because a gametophyte is always haploid.

(ii) SARGANT (1900) considered it to be a sporophytic tissue, the twin of an embryo, as it is the result of the fusion of secondary nucleus with the second ♂ gamete.

Applying the chromosome test also this view is discarded, because a sporophyte is always diploid (2n) whereas the endosperm is triploid (3N). Moreover, this view, also can not account for the development of the endosperm in Oenothera where endosperm nucleus is also diploid.

(iii) The more accepted view is that it can't be either gametophyte or a sporophyte in the strict sense of the terms due to its triploid nature. It might better be considered as an undifferentiated tissue containing the growth of the female gametophyte. Stimulation to develop by nuclear fusion should not be confused with the endosperm of Gymnosperm, which is a female gametophyte. It also develops after fertilization.

Function of Endosperm :—

The most important contribution of endosperm is to provide nourishment to the embryo during the early stages of development, as evidenced by the storage of nutritive material by this tissue as well as by the fact that embryo grows only when the endosperm develops properly. It is because of the fact that the young endosperm is rich in various growth hormones, such as Auxins, Cytokinins and Gibberellins.

Besides nutrition the endosperm also regulates the precise mode of embryo development.

Relationship among diff. types of Endosperms :—

We are still in dark regarding the phylogenetic sequence of evolution of various types of endosperm.

Shape of embryo :— Some workers reported that long and narrow embryo sacs generally have a cellular endosperm, while broad and short embryo sacs have nuclear endosperm.

Rate of growth of embryo :— A/c to V.S. Rao (1938) those plants in which growth and differentiation of embryo take place rapidly have a free nuclear endosperm and those in which the growth is slow or the mature seed contains only an undifferentiated embryo have a cellular endosperm.

Fragmenting cell plate during with nuclei of free nuclear :—

A/c to Swamy & Chamberlain (1963), the cellular type is more primitive than

nuclear type, since" ... even when the endosperm begins with free nuclear division, a rudimentary cell plate often appears, suggesting derivation from an endosperm in which nuclear division was followed by cell formation."

Schnarf (1926), Ame (1928), Gilsic (1928) supported this view.

Most other authors consider reverse derivation i.e. from nuclear to the cellular type, assuming cellular type to be more advanced.

However, this is still a debatable question, since both types occur side by side in the most primitive order (eg: Ranales) as well as the most advanced (eg: Campanulales.)