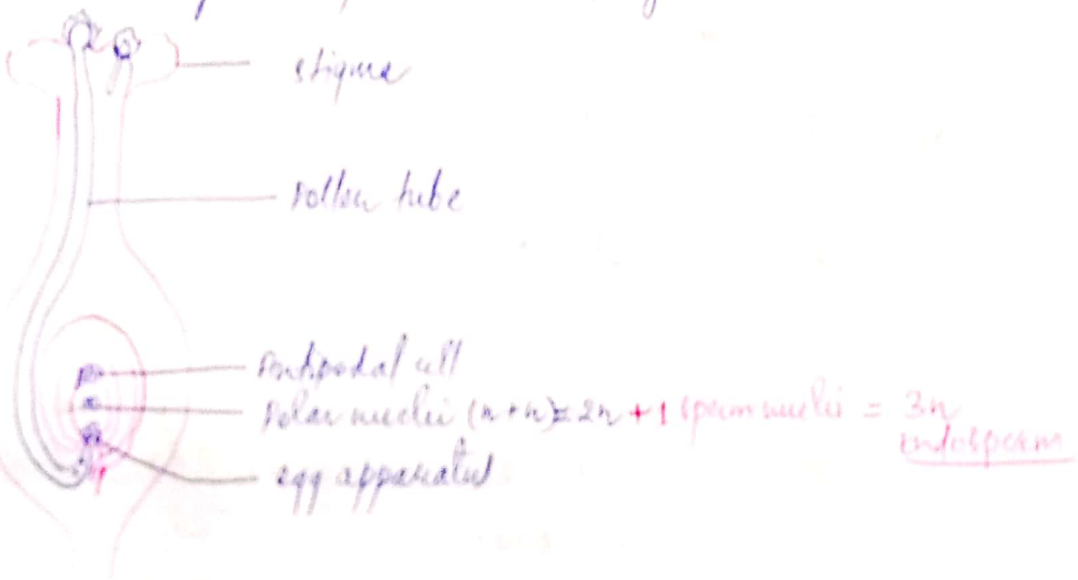
Endosperm

- The endosperm is an important tissue which function as the source of food material to the developing embryo.
- Endosperm is formed as a result of fertilization of the secondary nucleus by one of the 2 male gametes.



Eg - L.S of a flower showing growth of pollen tube towards embryo sac

- The cells of endosperm are triploid usually in angiosperm whereas it is haploid in Gymnosperm where it is formed before fertilization.
- In plants like bean, pea etc the entire endosperm is consumed for the nutrition of the developing embryo thus the mature seed are without endosperm and such seeds are known as non endospermic seed.
- On the other hand even the mature seed of cereal, coconut, castor the entire endosperm and such seed are called endospermic seed.

Types of Endosperm

On the basis of their development, the following 3 types of endosperm have been recognised.

(i) Nuclear
(ii) Cellular
(iii) Helobial

Most of the angiosperm show nuclear type of endosperm.

Nuclear endosperm

→ In this type of endosperm formation usually the first few div are simultaneous, but further the division becomes irregular
→ As the division are in progress the centre becomes occupie by a large vacuole and the nuclei becomes pushed to the periphery.
→ Most of the nuclei become aggregated at the micropylar and chalazal ends of the sac and only few nuclei become aggregated at the peripheral layers.
→ Sooner or later wall formation begins by the laying down of cell plates.
→ The wall formation occurs from the ~~bas~~ periphery o the sac towards the centre, or from the apex towar the base.
→ Eventually the entire embryosac becomes filled with or the ~~ent~~ entire endosperm may remain in the fr nuclear state excepting the one or 2 layers of cells formed on periphery.

Development of endosperm in coconut ~~[illegible]~~ is the classical example of nuclear endosperm.

→ In coconut the endosperm formation is quite interesting. Primary endosperm nucleus undergoes a no. of free nuclear divisions.

→ At about the time when the fruit is about 50mm long, clear water accumulate in the embryosac.
The nuclei formed by free nuclear divisions float in this water.

→ The watery or milky liquid endosperm, which fills the large embryo sac, contains numerous free nuclei. It is known as liquid syncytium.

→ By the time fruit becomes 100 mm long, cell walls are formed and each cell enclosed several nuclei.

→ Suspension at this time bears both free nuclei and nuclei enclosed in cell. They later on start settling at the periphery of the cavity.

→ Subsequently layers of cellular endosperm are deposited on the wall of the cavity and is known as coconut meat.

→ In mature coconuts the liquid endosperm turns milky and does not contain free nuclei or cells.

→ In Areca catechu the endosperm development follows the same procedures as in coconut, ~~[illegible]~~ but the embryosac cavity in Areca catechu is quite small and it becomes filled completely with endosperm which later on becomes quite hard.

endo

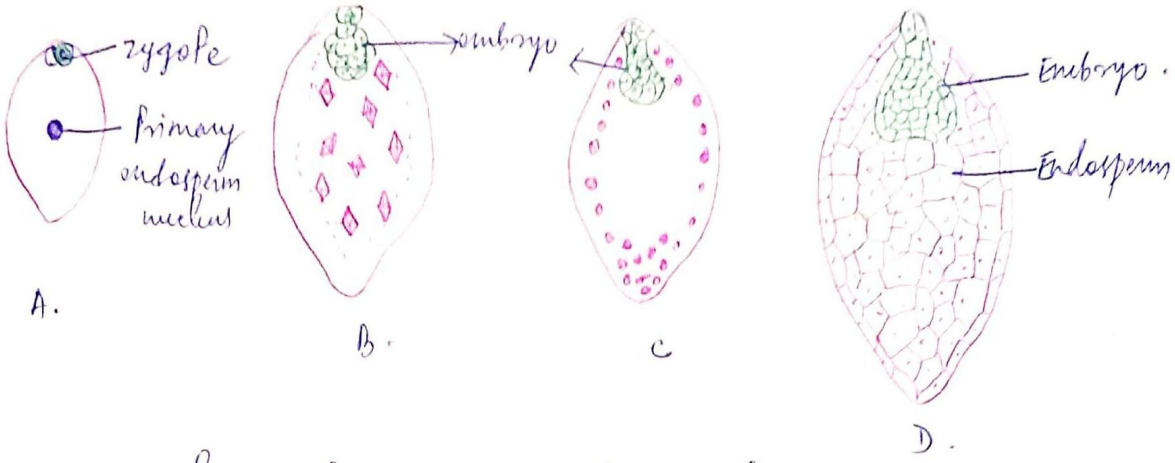


Fig - Nuclear endosperm in Acalypha indica

(A) → Embryo sac after fertilization, the primary endosperm nucleus and the zygote have not yet divided.

(B) → Embryo sac showing synchronous division of the endosperm nuclei

(C) → The endosperm nuclei move to the periphery ~~and chalazal~~

(D) → completely cellular endosperm.

In Phaseolus the cell formation may only be restricted to the micropylar part of the sac around the embryo.

In Oxyspora and Limnanthus wall formation never occurs.

In many cases endosperm has been seen to give out a haustorial structure.
The function of the haustoria is to invade the chalazal tissue and to bring about its dissolution.

eg. Grevillea robusta

Endosperm haustorium has been reported in several members of Cucurbitaceae, Leguminosae, and Proteaceae

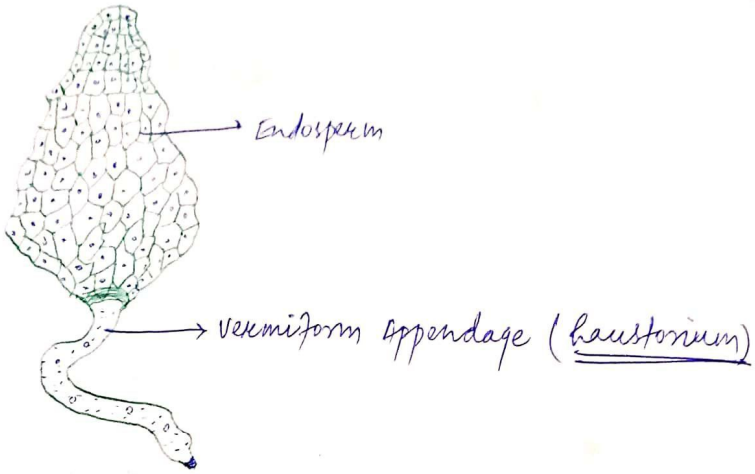


Fig - Endosperm in 'Grevillea robusta'.
Free nuclear vermiform appendage at the chalazal end of the cellular part of the endosperm.

Cellular endosperm

→ In this type, the division of the primary endosperm nucleus is immediately followed by wall formation. The division is usually transverse but also take place in other plane.

→ The cellular endosperm is characterised by the absence of free nuclear stage and all ~~the~~ nuclear divisions are followed ~~by~~ regularly by wall formation.

→ on the bases of the orientation of the wall after the ~~wall~~ first division this type of endosperm has been divided into several subtypes.

Vertical division of endosperm mother cell is of infrequent occurance.

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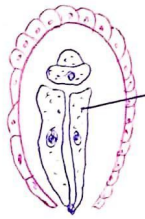

Fig - Stages
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→ Haustoria
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→ Nymphaea
→ Impatiens
→ Both micr
member

→ In Adoxa the first as well as the second division of the endosperm mother cells are vertical which result in the formation of 4 large identical cylindrical cells.

→ Next then divides by transverse division resulting in 8 cells arranged in two rows.

→ The 4th division is also transverse, but further divisions are irregular forming mass of endosperm cells.

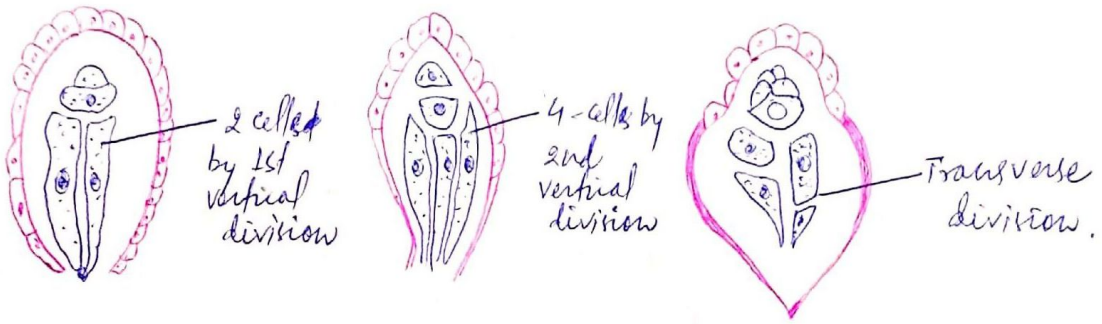


Fig - Stages of Development of Endosperm in Adoxa moschatellina.

In Senecio, there is no constancy in the orientation of the walls whereas in Annonaceae, Aristolochiaceae, Boraginaceae and few other families, the second and also the third divisions are transverse, resulting in a row of 4 or more cells.

→ In this type also the endosperm haustoria are differentiated and have been reported in several members of Gympetalae, few families belonging to the archichlamydeae and monocotyledons.

→ Haustoria are formed from the chalazal end or micropylar end or both the ends of the sac.

→ Nymphaeae and Araceae → haustoria formed from chalazal end

→ Impatiens → Haustoria develops from micropylar end.

→ Both micropylar and chalazal haustoria have been reported in members of → Acanthaceae, Scrophulariaceae, Boraginaceae

A prominent chalazal haustorium commonly occurs in Magnolia obovata.

The chalazal and micropylar chambers formed after the first division of the primary endosperm nucleus are of almost equal size.

→ The nuclear divisions in the micropylar chamber are accompanied by wall formation and thus a massive endosperm is formed.

→ But the nuclear division in the chalazal chamber are relatively ~~slow~~ slow and are not usually accompanied by wall formation.

→ In a mature endosperm the multinucleate chalazal chamber appears to be attached tail to the massive micropylar tissue. The chalazal tail acts as an effective haustorium and penetrates the chalazal nucellus.

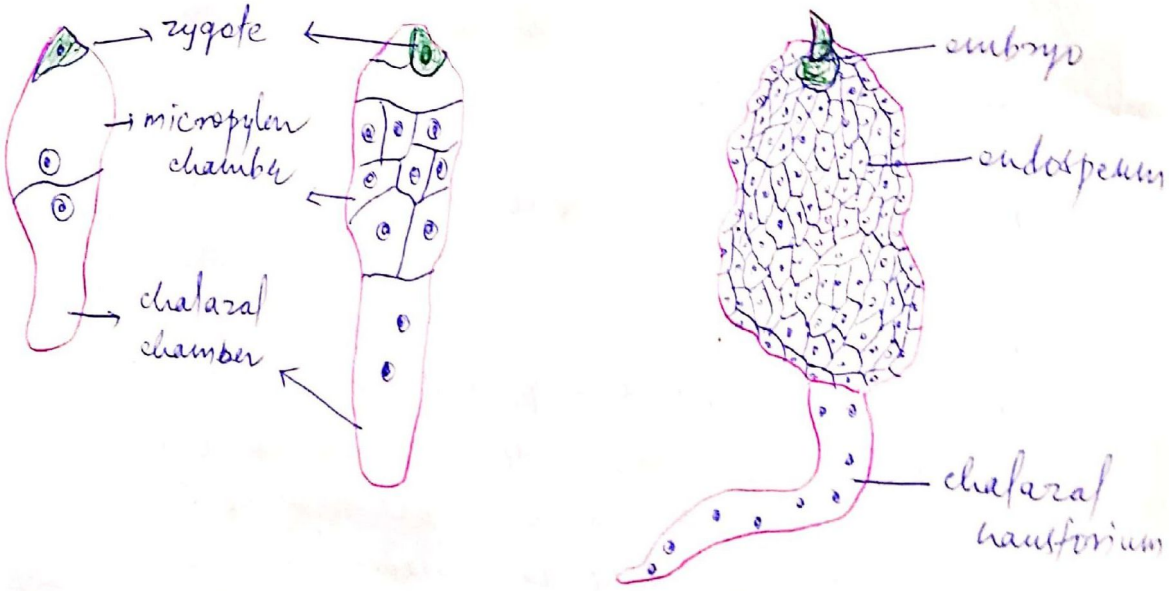
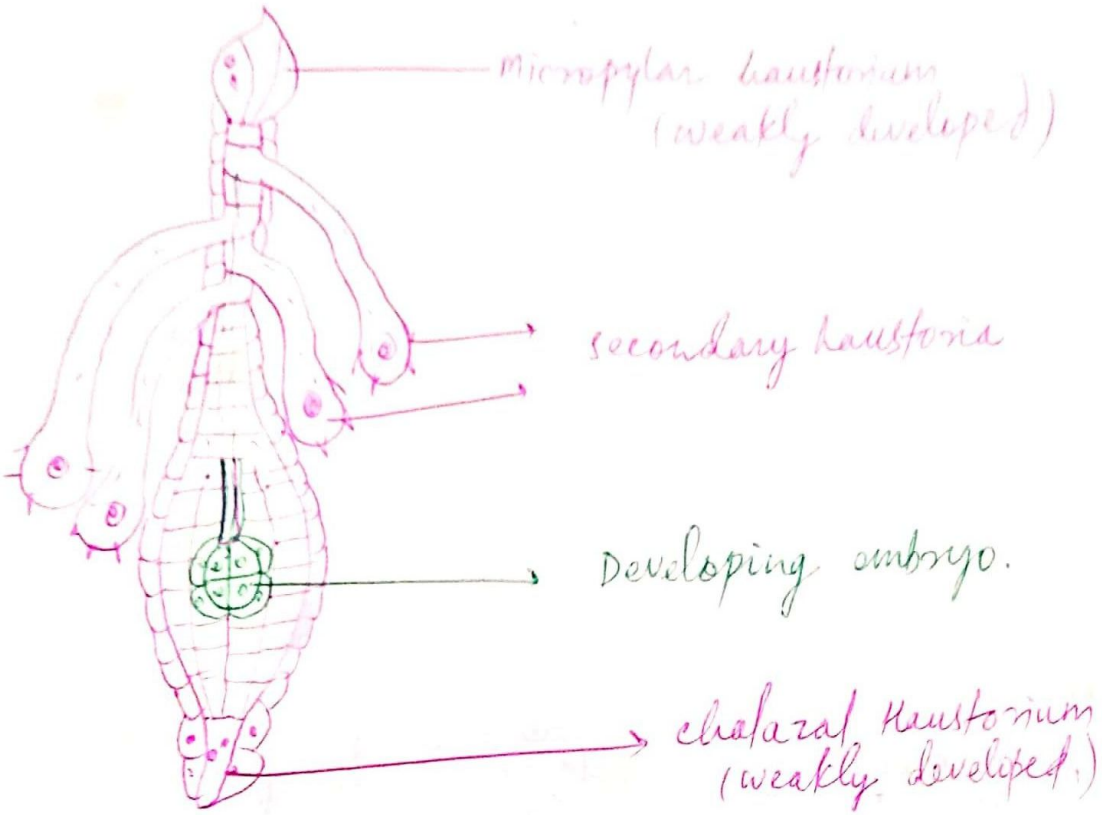


Fig – Endosperm dev. in Magnolia obovata and the mature endosperm showing chalazal haustorium

In Centrantheae both the micropylar and chalazal haustoria arise, but they are not so active and thus some secondary haustoria arise from the endosperm all just beneath the micropylar haustorium.



Eg → Haustoria in Santalum spp.

Helobial endosperm

This type of endosperm is intermediate b/w the nuclear and the cellular type.

→ This type of endosperm is restricted largely to the monocotyledons, and is frequently found in Helobiales

→ In this type the first division is followed by a transverse wall resulting in a micropylar and chalazal chamber. Further division are generally free nuclear and may be formed by the micropylar chamber only.

Eremurus may be cited as an example of a Helobial endosperm.

→ Free nuclear division occur in both, but more rapidly in the micropylar chamber.

→ when the chalazal chamber has 8 nuclei, the micropylar chamber has considerably a large 16 and when there are 30-32 nuclei in chalazal chamber the micropylar chamber has considerably a large no of nuclei.

→ In older ovule the chalazal chamber begins to degenerate. Finally when cell formation take place in the micropylar chamber, the chalazal chamber is almost crushed and shows only a few disorganized nuclei.

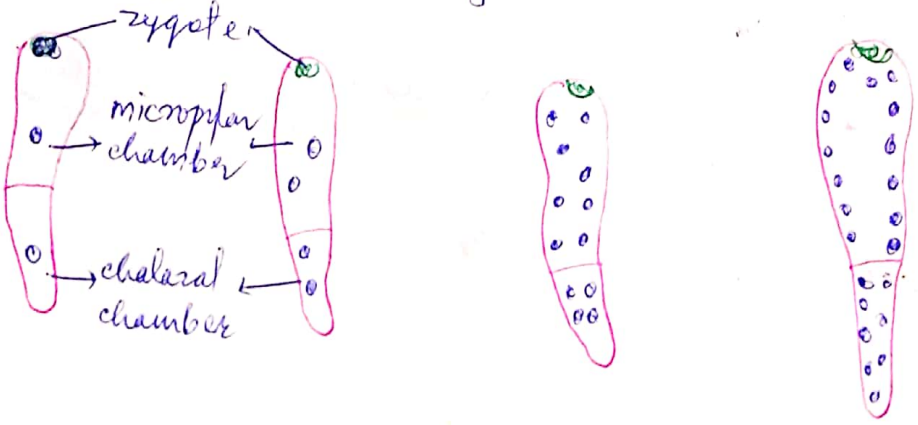


Fig → Development of Helobial type of endosperm in Eremurus

→ Endosperm haustoria develop in this type of endosperm al
→ In Monochoria the development of the lateral haustoria is a remarkable feature.

Early stages of development are typical of Helobial typ. the micropylar chamber shows active nuclear division than the chalazal and soon give rise to two tubular outgrowths (one in each side of the chalazal chamber) which grow downwards and invade