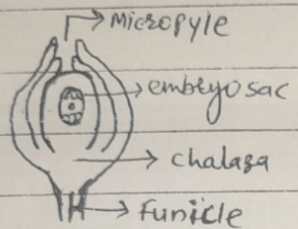
Unit - III

* Types of ovules :

There are six types of ovules in angiosperms. These are classified on the basis of the relative position of the micropyle, Chalaza & funicle.

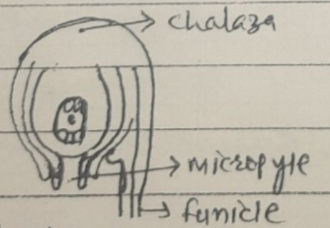
1. Orthotropous : (Straight)



* Orthotropous

In this type the ovule is erect or straight so that the funicle, chalaza & micropyle are situated on vertical axis in straight line with micropyle directed upwards. Hence it is also known as straight ovule. It is found in the members of family Polygonaceae, Piperaceae etc. e.g. Polygonum, piper etc.

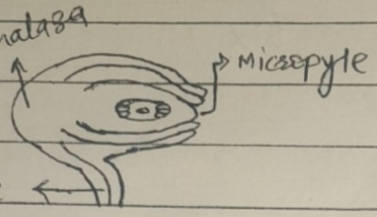
2. Anatropous : (Inverted)



* Anatropous

In this type due to unilateral growth of funicle, the whole body of the ovule is inverted through 180°. As a result the micropyle comes close to the base of the funicle. The nucellus remains straight i.e. micropyle & chalaza lie in one line & the funicle lies parallel to it. Hence it is also called as inverted ovule. It is the most common type of ovule found in angiosperms. e.g. castor, Solanum, sunflower (Helianthus) etc.

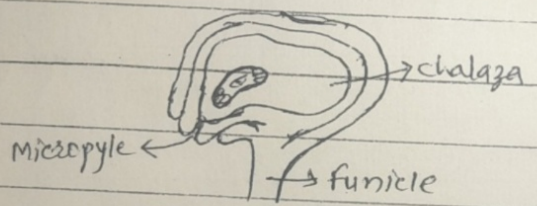
3]. Hemianatropous :



* Hemianatropous

In this type the body of the ovule is twisted through 90°, in such a way that it is placed transversely at right angles to the funicle. It is found in the members of the family Ranunculaceae & primulaceae. e.g. Ranunculus etc.

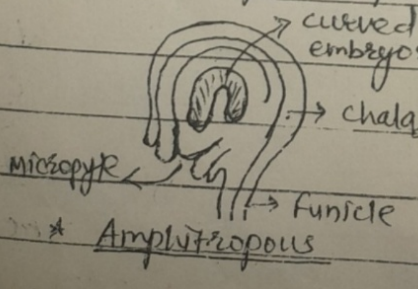
4]. Campylotropous :



* Campylotropous

This ovule is placed transversely on the funicle, But the body is bent in such a way that micropyle gets directed downwards & is not in straight line with chalaza. It is found in gram, bean, members of cruciferae like mustard, Chenopodiaceae, Capparidaceae etc.

5]. Amphitropous :

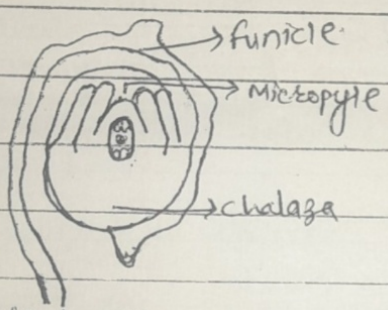


* Amphitropous

This type of ovule have a curved body like that of anatropous ovule. But here the embryo-sac within the ovule also curved & becomes

horse-shoe shaped. The micropyle is directed downwards & is not in straight line with chalaza. These ovules occurs in poppy, members of Alismaceae, Butomaceae etc.

6]. Circinotropous :



* Circinotropous

In this type the ovule is initially orthotropous but becomes anatropous due to unilateral growth of funicle. The growth is continues till the ovule once again becomes orthotropous. As a result the funicle is very long & completely surrounds the body of the ovule. This type of ovules occurs in plumbaginaceae (plumbago) & cactaceae (opuntia) etc.

* Structure of Anatropous Ovule (L.S.):

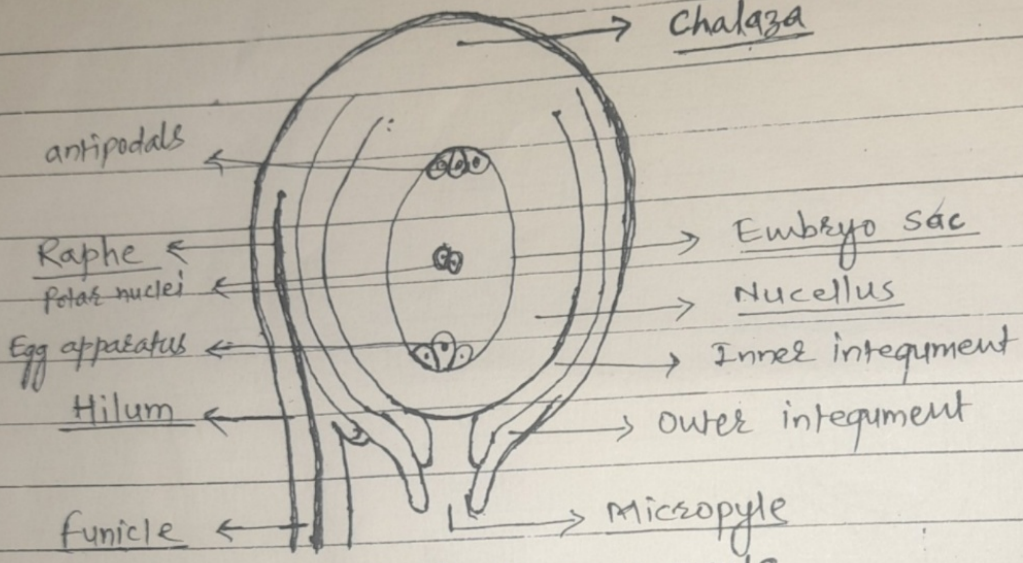


fig. L.S. of Anatropous ovule

The megasporangium together with an integuments is called ovule. The ovules are located inside the ovary, attached to a special tissue called placenta. Different types of ovules have been reported in angiosperms on the basis of relationship of funicle with the chalaza & micropyle. They are orthotropous, anatropous, amphitropous, campylotropous etc.

Anatropous ovule is the most common type of ovule found in angiosperms. These ovules are also called inverted ovules because the body of the ovule is so bent that micropyle is directed downwards & lies close to the funicle (hilum). The chalaza & the micropyle are present on the same axis but not the funicle.

A fully mature ovule consists of the stalk & the body.

A]. Stalk (Funicle) :

The stalk of ovule is called funicle. One end of the funicle is attached to placenta & the other end to the body of the ovule. The point of attachment of funicle with the body is called hilum. Hence the ovule is attached to the placenta by the funicle. In the anatropous ovule, the funicle sometimes extends up to the base of ovule & fuses with the main body forming a longitudinal ridge known as the raphe. The funicle supplies the food material to the body of ovule from placenta.

B]. Body of ovule :

It is main part of ovule remains attached to the funicle. It is formed by integuments & nucellus.

★ Integuments :

These are the coverings of ovule. The main body of the ovule is covered with one or two envelopes called integuments. In angiospermic ovule, outer integument & inner integuments are developed. Hence the ovule is bitegmic.

The body of the ovule shows two ends-

- the basal end called the chalazal end & the upper end is called the micropylar end. The basal part of the ovule where nucellus, integuments & funicle merge is called chalaza. The integuments completely surround the nucellus except at apex leaving a small opening called micropyle, through which the pollen tube enters. The integument protects the nucellus or megasporangium.

★ Nucellus :

The central mass of parenchymatous tissues of the ovule is called nucellus. The portion of ~~ovule~~ nucellus towards chalaza is called chalazal end & portion of nucellus towards micropyle is called micropylar end. The nucellus is a nutritive tissue which provides nutrition to the developing embryo after fertilization.

A large oval cell lying embedded in the nucellus towards the micropylar end is known as embryo sac or female gametophyte. Embryo sac contains egg apparatus, antipodals & secondary nucleus or polar nuclei. Embryo sac is the significant part of the mature ovule, which bears the embryo later on. The integuments are converted into seed coat & complete ovule is converted into seed.

Thus in angiosperm ovules are bitegmic & enclosed in the ovary. In the members of family, compositae & few of the families with gamopetalous corolla, the ovules are unitegmic.

Unit-III EMBRYOLOGY-II

Thus in angiosperm, ovules are bitegmic and enclosed in the ovary. In the members of family, compositae & few of the families with gamopetalous corolla; the ovules are unitegmic.

★ Unit-III EMBRYOLOGY-II

★ Development of female gametophyte: (Embryo sac)
(Megagametogenesis)

15m

The process of development of female gametophyte or embryo sac from megaspore is called megagametogenesis. The megaspore (n) is the first cell of the female gametophyte. The nucleus of the megaspore divides & develops into the female gametophyte or embryo sac.

Depending on the number of megaspores taking part in the development, the embryo sac of angiosperms is classified into three main categories. These are monosporic, bisporic & tetrasporic.

★ Monosporic embryo sac (Polygonum type):

The embryo sac which develops from only one, out of the four megaspores is called monosporic embryo sac. A monosporic (8-nucleate) embryo sac is known as polygonum type of embryo sac.

It is the most common type of embryo sac & is found in about 82% of the flowering plants. Hence it is generally called the normal type of embryo sac. It is called Polygonum type because it was first time described in Polygonum divaricatum by Strasburger (1879).

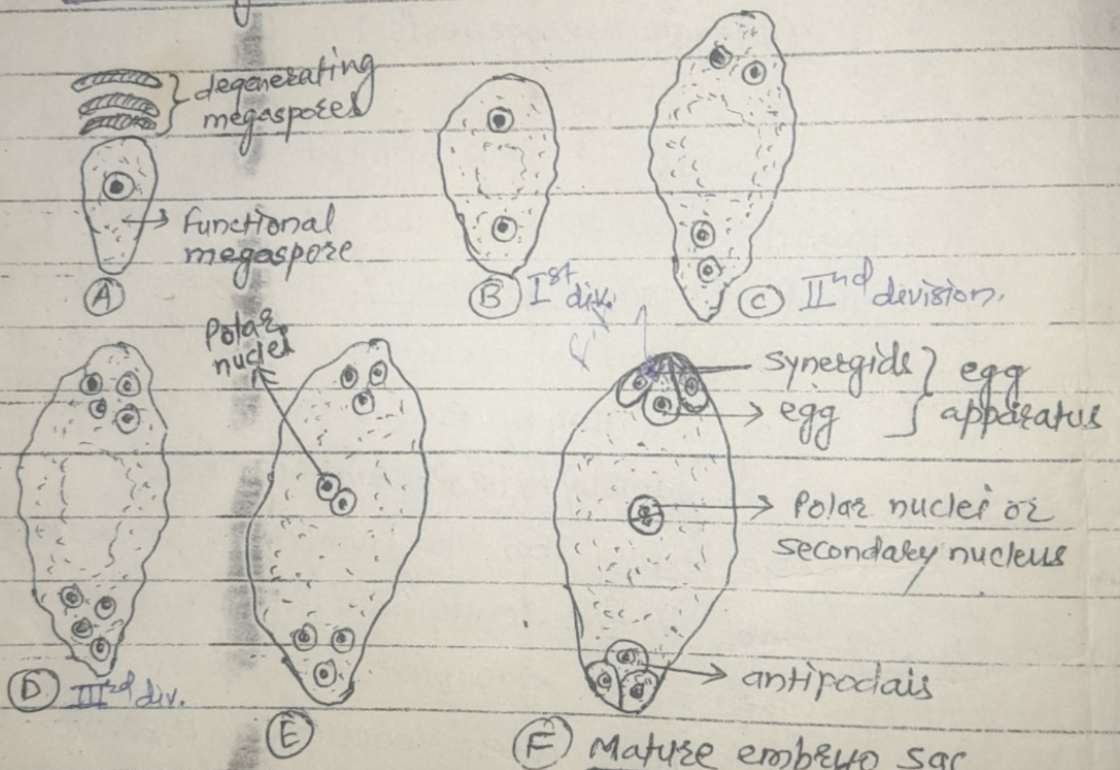


Fig. Developmental stages of Polygonum type of embryo sac (monosporic).

During the development of polygonum type of embryo sac, out of the linear tetrad, three megaspores towards the micropyle degenerate. The lowermost chalazal megaspore enlarges in size & remains functional.

The nucleus of this functional

megaspore undergoes three, free nucleat mitotic divisions to form 8-nucleate embryo sac.

In first mitotic division two nuclei are formed, of which one nucleus moves at the micropylar end & another nucleus moves at chalazal end. The large vacuole is formed in the developing embryo sac. Each nucleus divides by two successive mitotic divisions to produce four nuclei at each pole of the developing embryo sac.

From each pole one nucleus moves in the centre & remaining three nuclei present at micropylar end are converted into egg apparatus & three nuclei present at chalazal end are converted into antipodal cells. The central two nuclei of embryo sac called polar nuclei.

★ Structure: A fully developed monosporic, 8-nucleate & 7-celled polygonum type of embryo sac is large, oval in shape & shows following organisation. present in the ovules of flowering plants

a]. Egg apparatus:

It is a group of three cells situated at the micropylar end. The central large cell is called egg cell & two lateral cells called Synergids. Synergids show a filiform apparatus attached to their upper wall. It helps to attract & guide the pollen tube.

b]. Polar nuclei: From each pole one nucleus moves in the centre. These two central nuclei of the embryo sac

called polar nuclei. Generally both the polar nuclei fuse before fertilization & form a single diploid nucleus called secondary nucleus (2n).

c]. Antipodals :

The three cells situated at the chalazal end are called antipodal cells. These cells generally degenerate soon after fertilization.

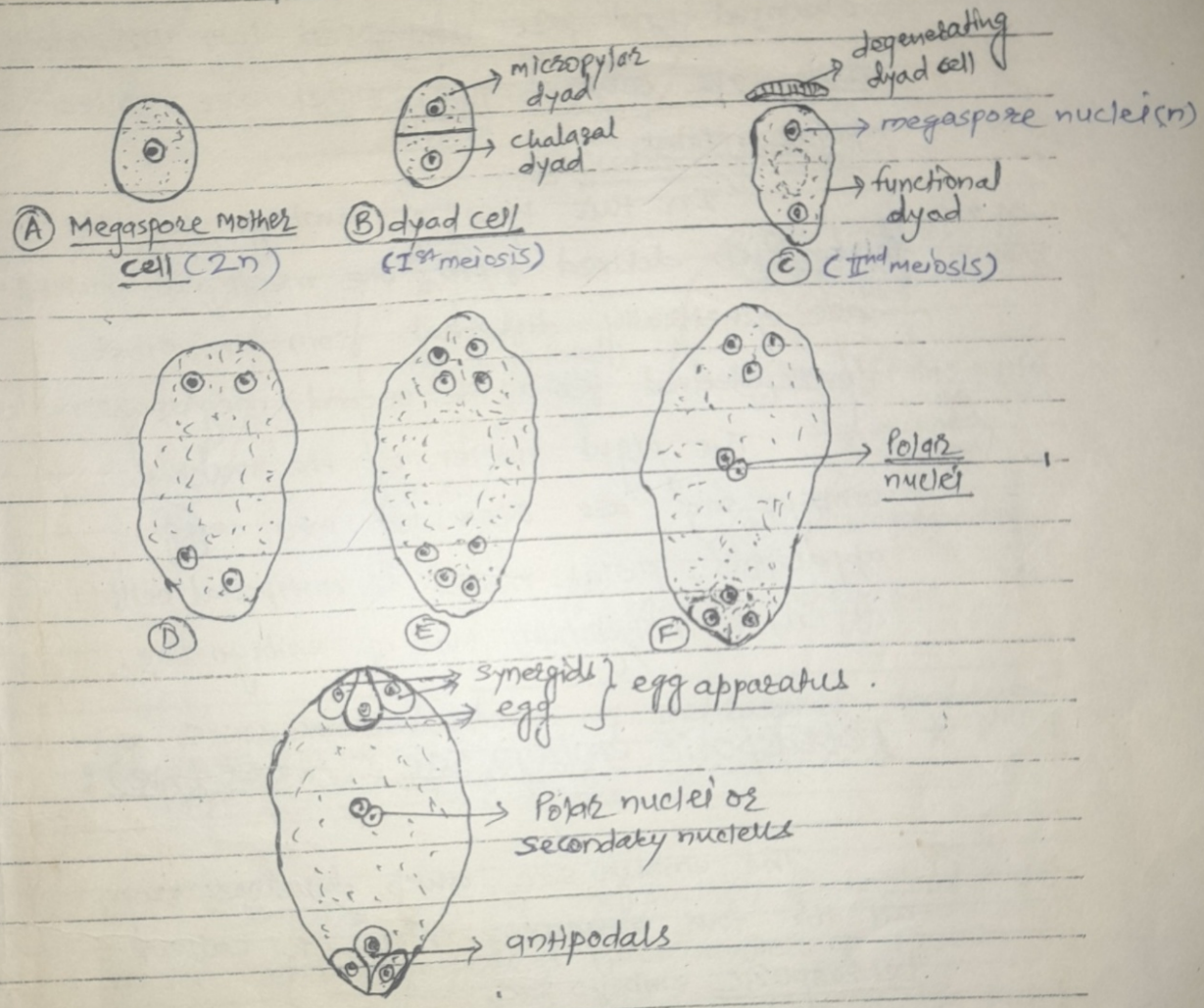
Thus in the development of embryo sac, only one functional megaspore is involved. Such type of embryo sac development is known as monosporic or Polygonum type. of embryo sac.

★ Bisporic embryo sac (Allium type) :

The embryo sac, which develops from one of the two dyads formed as a result of the first meiotic division (meiosis-I) of megaspore mother cell, is called bisporic embryo sac. One of the dyad towards micropyle degenerates. since there is no wall formation at the end of meiosis-II & both the megaspore nuclei produced in the functional dyad cell take part in the development of the embryo sac.

The bisporic embryo sac which develops from the chalazal dyad is

also called Allium type embryo sac, because it was reported in Allium species.



★ fig. Developmental stages of bisporic Allium type of embryo sac.

Each nucleus of the functional dyad undergoes two mitotic divisions & the mature ~~eight nuclei~~ embryo sac is 8-nucleate ~~are developed in the embryo sac~~, four nuclei are formed at each pole. From each pole one nucleus moves in the centre & remaining three nuclei present

at micropylar end are converted into egg apparatus & three nuclei present at the chalazal end are converted into antipodals. The central two nuclei are called polar nuclei.

In this type of embryo sac the 4 four nuclei derived from one megaspore nucleus are genetically different from the other four, derived from the second megaspore nucleus.

The eight nuclei of the mature embryo sac are organised into egg apparatus, polar nuclei & antipodal cells as in polygonum type of embryo sac.

* Tetrasporic embryo sac (Adoxa type):

The embryo sac which develops from all the four megaspore nuclei is called tetrasporic embryo sac.

Sometimes meiotic division of the megaspore mother cell is not followed by cytokinesis & hence all the four haploid nuclei lie in a single cell called coeno-megaspore. All these four nuclei of coeno-megaspore participate in the formation of embryo sac. Hence this type of embryo sac is called tetrasporic. It is genetically more heterogeneous than the bisporic type of embryo sac.

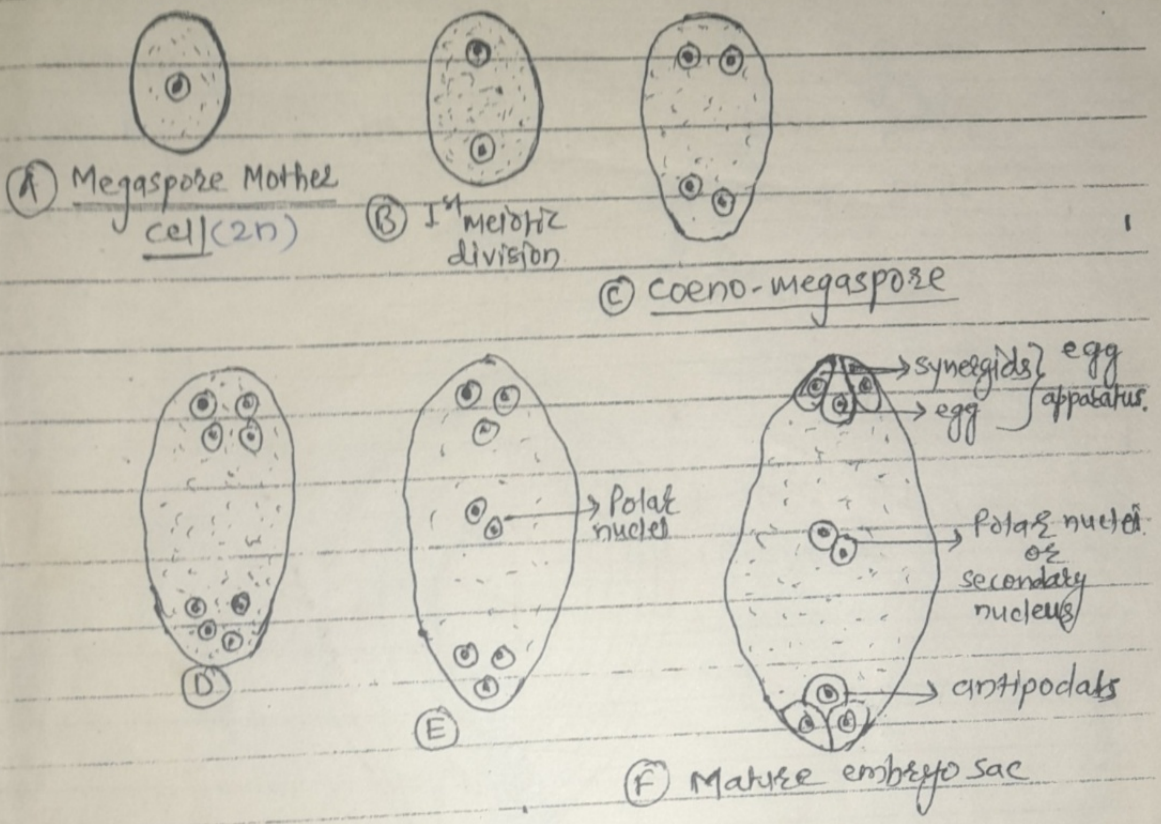


Fig. Developmental stages of tetrasporic embryo sac (Adoxa type).

On the basis of the position of haploid nuclei in the coeno-megaspore, the number of times these nuclei divide & the organisation of the nuclei, the tetrasporic embryo sacs are of various types e.g. Adoxa type, plumbago type, Drusa type etc.

Adoxa type of embryo sac is 8-nucleate & it was first described in Adoxa moschatellina by Jonsson (1879). In the development of the Adoxa type of embryo sac, the four haploid nuclei of the coeno-megaspore undergoes mitotic division to produce 8-nuclei, four at each pole.

The eight nuclei of the mature embryo sac are organised into egg apparatus, polar nuclei & antipodal cells as in polygonum type of embryo sac.

★ Double fertilization & its significance :

10m

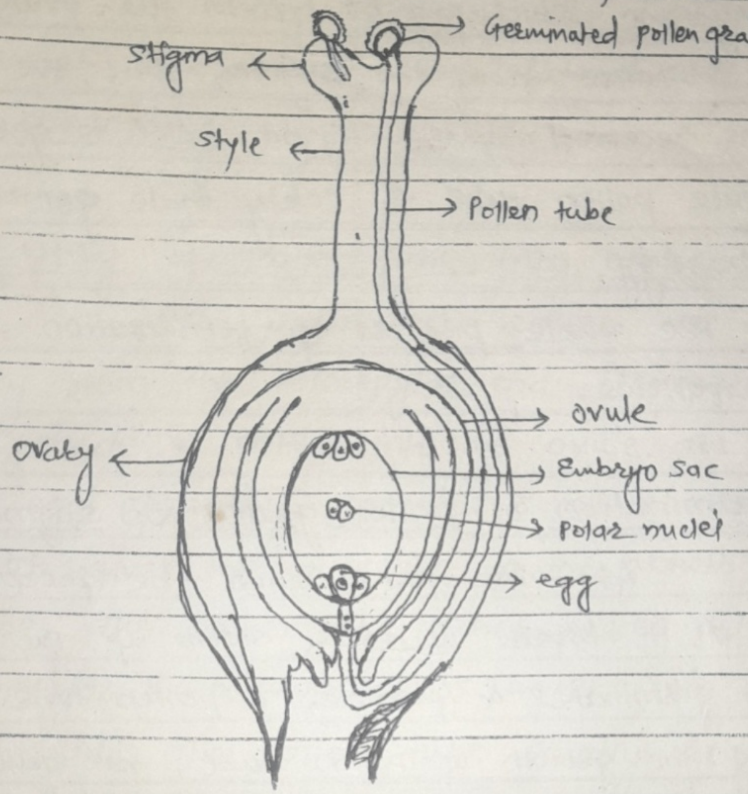


Fig. Process of fertilization

The fusion of male & female gametes is called fertilization. Angiosperms shows double fertilization. In which fusion of two male gametes takes places at two different places. One male gamete fuses with egg & the other male gamete fuses with the polar nuclei or secondary nucleus.

"This process of the fusion of one male gamete with egg & the other male gamete with polar nuclei is called double fertilization".

Fertilization results in the formation of a diploid zygote which is the first cell of a sporophyte.

Double fertilization was first observed by Nawaschin (1898) in Lilium species of angiosperms.

In angiosperms fertilization occurs in the embryo sac, which is located in the ovule, at a distance from the stigma. Thus, the pollen grains received by the stigma have to germinate, produce pollen tube & carry male gametes to the egg.

The whole process of fertilization is as follows.

I. Germination of pollen grains on stigma:

As pollen grains reach the receptive stigma, it absorbs water & swells up. The pollen grain germinates & produces a pollen tube. During the growth of pollen tube, the generative cell divides mitotically to produce two non-motile male gametes. The pollen tube contains a tube nucleus & two male gametes. Later on the tube nucleus degenerates. The pollen tube reaches the ovule by passing through the style.

II. Entry of pollen tube into the ovule:

The pollen tube enter into the ovule either through micropyle, through chalazal end or through integuments.

The entry of pollen tube through micropyle is called porogamy. It is most common in angiosperms.

The entry of pollen tube through chalaza

casuarina

is called chalazogamy e.g. casuarina.

The entry of pollen tube into the ovule through integuments from lateral side is known as mesogamy. e.g. cucurbita.

III. Entry of pollen tube into embryo sac:

The pollen tube enters the embryo sac only from the micropylar end irrespective of its mode of entry into the ovule. The synergids of egg apparatus secretes some chemical substances which gives the direction to the growth of pollen tube. The pollen tube either passes between a synergids & the egg cell or enters into one of the synergids. The pollen tube finally reaches the base of the egg cell where it ruptures to release the two male gametes into the embryo sac. The migration of two male gametes through the pollen tube is called siphonogamy.

IV. Syngamy and triple fusion: (Double fertilization)

Both the male gametes released in the embryo sac are used in the fertilization. Fusion of one of the male gamete with the egg is called syngamy or true fertilization. It results in the formation of a diploid zygote (2n).

The second male gamete fuses with the polar nuclei results in the formation of triploid primary endosperm nucleus (3n). As this process

involves the fusion of three haploid nuclei (two polar nuclei & one ~~male~~ male gamete), it is known as triple fusion.

This fusion of one male gamete with the egg & fusion of other male gamete with polar nuclei is called double fertilization. Thus double fertilization involves both syngamy & triple fusion. It is the important characteristic feature of angiosperms. It was first observed by Nawaschin (1898) in Lillium species of angiosperms.

* Significance of double fertilization:

1. Double fertilization is the unique feature of angiosperms.
2. It restores the diploid condition in the plants.
3. Triple fusion leads to the formation of triploid nutritive tissue called endosperm which is utilized by the developing embryo during seed development.
4. Double fertilization stimulates the development of embryo which leads to the formation of seeds & fruits.
5. The seeds produced as a result of double fertilization are more healthy, as a result the germination percentage of seeds increases.