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CONCEPT TUTORIALS

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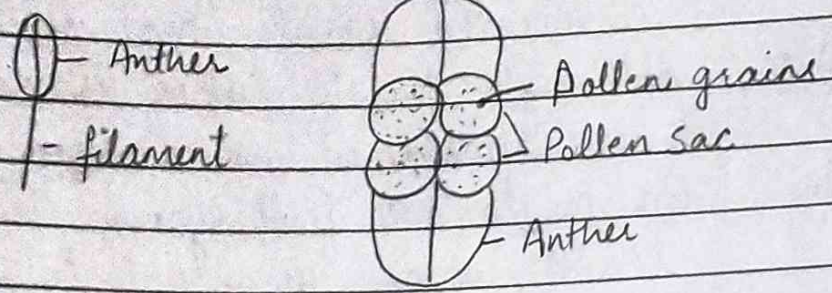
Ch-2 Sexual Reproduction in Flowering plants

Flower:- Flower is a modified condended shoot.
Flower has four parts:-
(1) Calyx (2) Corolla (3) Androceium (Male)
(4) Gynoceium (female)
Calyx and corolla are non essential parts of flower.
Androceium and Gynoceium are essential and reproductive part of flower.

Androceium:- It consists of stamen. Each stamen consists of a cylindrical, thread like filament and a broad terminal bilobed anther. ~~Ant~~
Each lobe of anther has two pollen sacs



Layers of anther:- The Outer layer is epidermis. Second layer is end endothecium, one to three middle layers, inner layer is tapetum.

Role of tapetum:- During microsporogensis, the cells of tapetum provide various hormones, enzymes, amino acids and nutritive materials.
The main functions of tapetum are:-
1. Transportation of nutrients
2. Secretion of enzymes and hormones
3. Production of Ubisch bodies, which helps in thickening of exine

4. Secretion of oily material (Pollenkit)
5. Secretion of special proteins.

Microsporogenesis:- During the development of the microsporangium, the cells of sporogenous tissue may divide in various planes and finally separate from each other to function as microspore mother cells. Some of the microsporocytes or mother cells degenerate and provide nourishment to other.

The surviving microsporocytes are connected with each other and each microsporocytes develops an internal layer of Callose. The microsporocytes then divides by meiosis and give rise haploid microspores by the process called Cytokinesis.

Pollinium:- All the microspores of an anther lobe remain united to form pollinium.

Dehiscence of Anther:- Mature pollen sacs, dries up and become powdery. The tapetum becomes absorbed. The anther dries up. All the pollen sacs of an anther forms a single chamber. All the layers of anther will break.

Microspore and pollen Grain:- Microspore or pollen grain are haploid, uninucleate, minute spores produced in large numbers as a result of meiosis in microspore mother cells inside the microsporangia.

Pollen Grain has two layers:-(a) exine (b) intine. The pollen grains consists of a yellow sticky material called Pollenkit. This helps in the pollen grains to attach with insects for pollination.

The branch of biology which deals with the study

of pollen grains called Palynology.

Development of male gametophyte :-

- It has two phases :-

1. Pre-pollination development
2. Post-pollination development

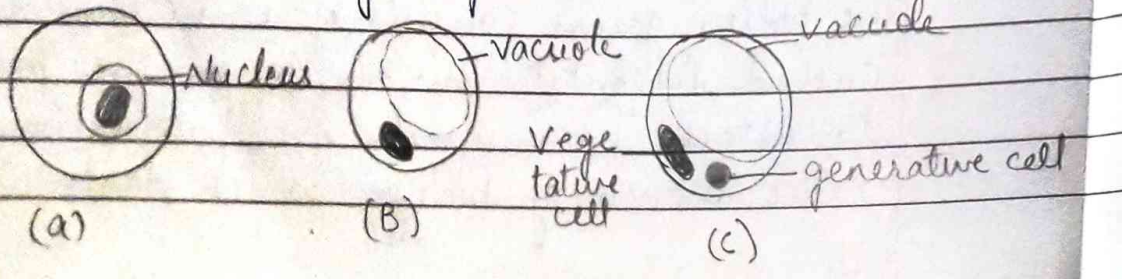
Pre-pollination development :-

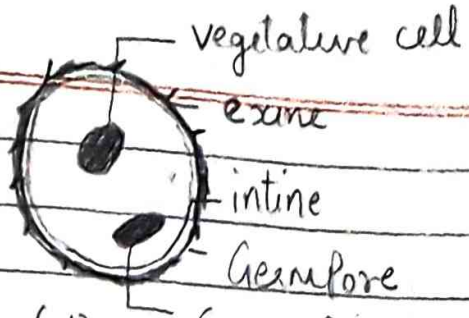
The wall of microspore continues to differentiate. Microspore nucleus then divides mitotically into two daughter nuclei. These are two unequal nuclei. The smaller one named generative cell and larger one vegetative cell (tube cell)

In majority of angiosperms, the pollen grains are shed from the anther at this bicelled stage. but in some cases, the generative cell further divided into two male gametes.

Post-Pollination development :- The pollen grains are transferred to the stigma by the process called pollination. On the stigma, the pollen grains absorbs water and swells within a few minutes. The vegetative cell enlarges and comes out through one the apertures in the form of pollen tube.

The vegetative tube nucleus and generative cell (2 male gametes) migrates into the pollen tube. The tube nucleus has no important function and may degenerate.





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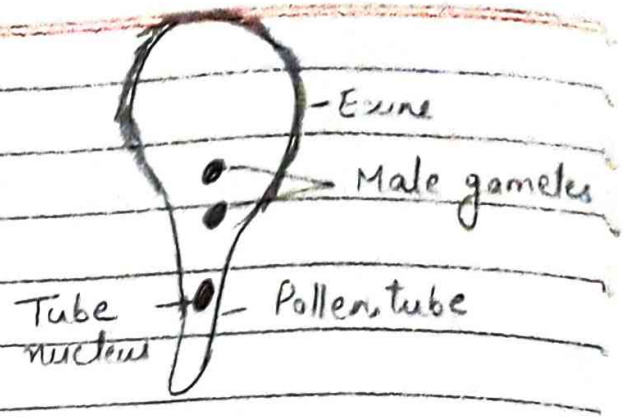
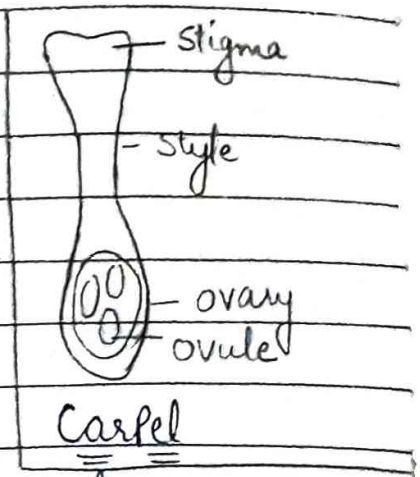


(E)

The Carpel :→ A carpel consists of ovary, style and Stigma



Carpel

Structure of Ovule :- Ovule develops into a seed after fertilization.

Parts of ovule - (1) Funiculus :- It is the stalk like structure which attaches the ovule to the placenta.

(2) Hilum :- It is the point of attachment of the body of the ovule with the funiculus.

(3) Raphe :- It is the longitudinal ridge formed by ovule lengthwise fusion of funiculus with the body of ovule in a anatropous ovule.

(4) Nucellus :- It is the mass of parenchymatous tissue surrounded by integuments. It provides nourishment to the developing embryo

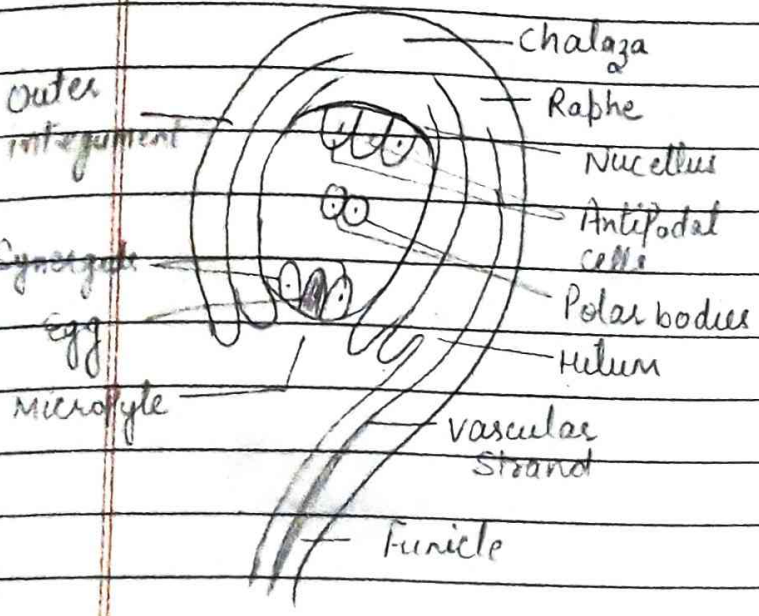
(5) Embryo sac :- It is the female gametophyte which contains the egg apparatus

(6) Integuments :- These are outer coverings of ovule provide protection to the developing embryo

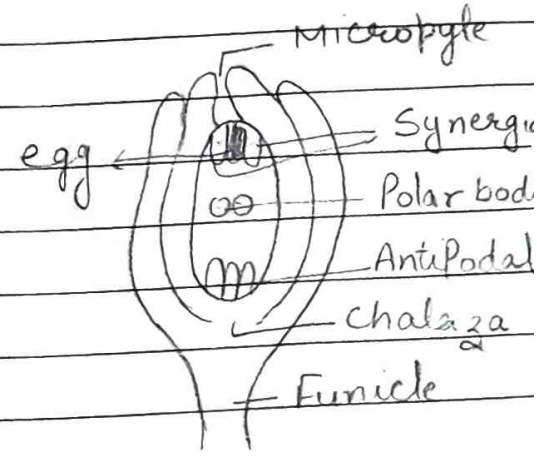
(7) Micropyle :- It is a narrow pore or passage formed the projection of the integuments through which the tube enters into ovule.

(8) Chalaza :- It is the place of origin of the integuments or the basal swollen part of the nucellus.

TYPES OF OVULES :- (1) Orthotropous ovule
(2) Anatropous ovule
(3) Hemitropous ovule
(4) Campylotropous ovule
(5) Amphitropous Ovule
(6) Circinotropous ovule



Orthotropous ovule

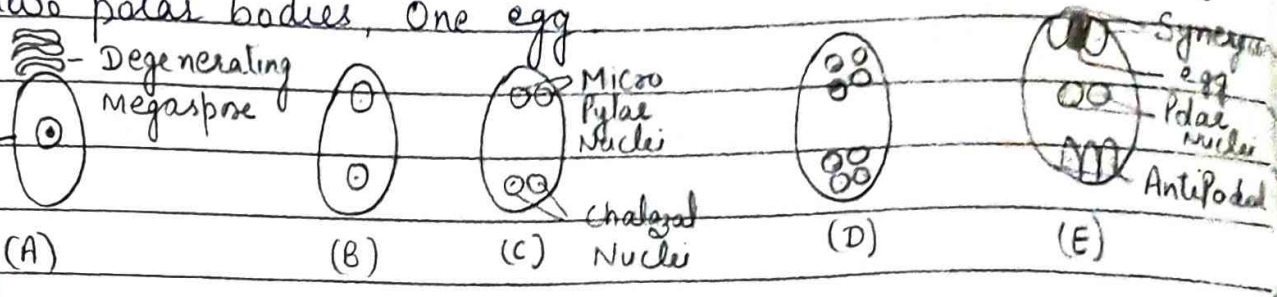


Anatropous ovule

Megasporogenesis and Development of Female Gametop
Formation of mega-spores from megaspore mother cell is called megasporogensis.

The diploid megaspore mother cell enlarges in size and divides by meiosis to form a tetrad of four haplo megaspores. The chromosome number remains half. The four megaspores lies in a linear tetrad structure. But only one megaspore situated towards Chalazal end remains functional. Other three cells

degenerate and finally disappear. The functional haploid megaspore enlarges in size and show mitotic divisions and give rise to eight-nucleate embryo sac. These eight cells produce three antipodal cells, two synergids, two polar bodies, One egg.



POLLINATION:- Transfer of pollen grains from the opened anthers of the stamen to the receptive stigma of the carpel is called pollination.

Types of pollination:-

(1) Self pollination
(2) Cross pollination

Self pollination:- Self pollination involves the transfer of pollen grains from the anthers of a flower to the stigma of the same flower or genetically similar flower.

Types of Self pollination:→(A) Autogamy:- It is a kind of pollenation in which the pollen from the anthers of a flower are transferred to the stigma of the same flower. It occurs by three methods:-

(a) Cleistogamy:- Some plants never open. These flowers are known as cleistogamous flowers. e.g oxalis, Vi These flowers are bisexual, colourless and do secrete nectar.

(b) Homogamy:- Anthers and stigma of the bisexual fl of some plants mature at the same time. This

is known as Homogamy.

(c) Bud Pollination :- Anthers and stigma of the bisexual flowers of some plants mature before the opening of the buds to ensure self-pollination.

[B] Geitonogamy :- It is a kind of pollination in which the pollen from the anthers of one flower are transferred to the stigma of another flower borne on the same plant.

Advantages of Self Pollination :-

1. Chances of pollination are more
2. Self-pollination maintains purity of the race and avoids mixing
3. It needs not to produce a large number of pollen grains
4. Flowers need not to possess devices such as large and showy petals etc.

Disadvantages of self pollination :-

1. offsprings continuously gets weaker after every generation
2. less chances of the production of new species and varieties.

CROSS POLLINATION :- It involves pollination transfer of pollen grains from the flower of one plant to the stigma of flower of another plant. It is also called Xenogamy.

Reasons of cross-Pollination :- (1) Herkogamy :- Flowers posses some mechanical barrier to avoid self pollination.

(2) Dichogamy :- Pollen and stigma mature at different times.

(3) Self incompatibility - when pollination fails to take place.

(4) Male Sterility - The pollen grains of some plants are not functional.

Agents of Cross Pollination :-

(1) Anemophily (wind Pollination) :- Mode of pollination is wind.

Characters :- (1) Flowers are small colourless, odourless and nectarless

(2) Calyx and corolla are either reduced or absent.

(3) When flowers are unisexual, male flowers are more abundant than female flowers.

(4) In bisexual flowers, the stamens are generally numerous.

(5) Pollen grains are small, light, dry, dusty and some times winged.

(6) The flowers are well exposed in the air.

(7) The Stigma are large, well-exposed, hairy, feathery

(2) Hydrophily (water-pollination) Mode of pollination is water.

Characters :- (1) Flowers are small, colourless, odour and nectarless.

(2) Calyx, corolla and other floral parts are unwe

(3) Pollen grains and stigma are generally unwet

(4) The stigma are long and sticky.

Example of water-pollination :- Vallisneria

It is a submerged fresh water plant. It is u

Mature male flowers are abscised from the spadi

float on the surface of water. The mature female flowers also float on the water surface, but remain attached to the female plants with the help of long stalks. The male flowers come close to female flowers where anthers burst to release the pollens. Pollination occurs on the surface of water.

[3] Entomophily [Insect Pollination]:- Mode of pollination are insects.

Characters:- (1) The flowers are usually large, brightly coloured and showy to attract insect pollination.
(2) Small flowers bloom in bunches to attract the insects.
(3) The outer surface of pollen grains may be rough, spiny or sticky.
(4) Pollen grains of certain flowers are edible. Many insects visit these flowers to eat their pollens or to carry them.
(5) Some flowers produce heavy fragrance to guide the moths.

Example of Entomophily:- Salvia

Salvia is two lipped or bilobed. The lower lip provides platform for the visiting insect and the upper lip is fertile. lower lip is sterile. When the insect visits on lower lip, the upper lip bends itself on the insect and shelter pollen grains on the insect. Pollen grains deposited upon the back of the bee. So, bee helps in pollination.

[4] Ornithophily:- [Bird Pollination] Mode of Pollination is birds.

Characters:- 1) The flowers are usually large in

size
(2) The flowers are brightly coloured
(3) The flowers produce abundant watery nectar.
(4) They are usually scentless.

[5] Chiropterophily [Bat Pollination] Mode of pollination is bats.

Characters :- 1) Flowers are large in size
2) Flowers have dull in colour and produce a strong scent.
3) Flowers have pollen kit.

Advantages of Cross Pollination :-
1. Cross pollination brings about genetic recombination and produce new varieties
2. It results in healthy and stronger offsprings
3. Variations caused due to cross pollination may result in production of disease resistant plants
4. It results in production of seeds in self-sterile plants.

Disadvantages :- 1. Cross pollination is not economical.
2. Cross pollination is uncertain because a factor of chance is always involved
3. It involves addition of some undesirable characters or loss of important characters.

POLLEN PISTIL INTERACTION :- When pollination takes place, the pollen grain secretes some enzymes like glycoproteins, lipids etc and the stigma also secretes enzymes like Carbohydrates, lipids, proteins

etc when there is interaction between the chemicals of pollen grains and chemicals of stigma, then there is formation of pollen tube takes place. This is known as pollen-pistil interaction.

Self Incompatibility :→

The Stigma of a particular plant receives a number of pollen grains, either from same type or from others. If the pollen grains belonging to right mating type germinate on stigma, develop pollen tube and bring about fertilization. The pollen grains belonging to other types will discarded (destroy).

If a pistil carrying functional female gametophyte gets pollinated with right mating types of pollen grain, but fails to set seeds due to inability of their gametes to fuse with each other, this phenomenon is called Sexual Incompatibility. (self incompatibility)

Emasculation and Bagging:- Removal of stamens or anthers or killing of pollen grains of a bisexual flowers without affecting the female reproductive system (organs) is called Emasculation.

The Emasculated flower is immediately enclosed in a bag to avoid pollination by any unwanted pollen. This process is known as bagging.

Fertilization:→ Fusion of male gamete with the female gamete to form a diploid zygote is known as Fertilization.

Siphonogamy :- In angiosperms, the male gametes are carried to the egg by a pollen tube. This process is called Siphonogamy.

Entry of Pollen tube into the ovule :-

After reaching the ovary, the pollen tube enters the ovule

Porogamy :- If the pollen tube enters through micropylar end.

Chalazogamy :- If the pollen tube enters through Chalaza.

Mesogamy :- If the pollen tube enters through integuments.

Most common ~~entry~~ of entry of pollen tube is through micropylar end.

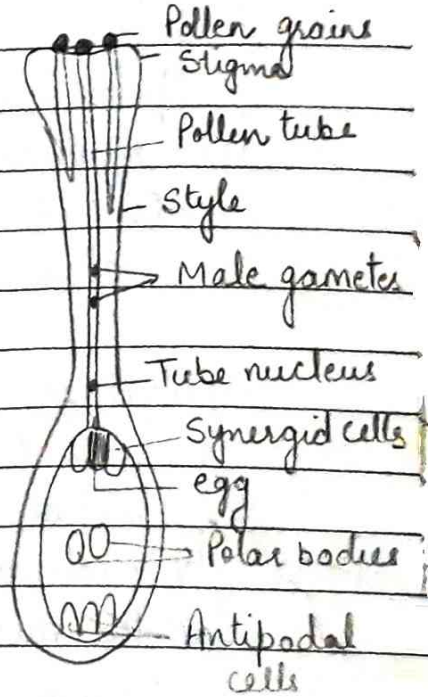
The tip of the pollen tube enters into one synergid. This synergid starts degenerating.

Pollen tube releases 2 male gametes into the embryo sac.

Double Fertilization Triple fusion :-

In angiosperms, One male gamete fuses with egg to form diploid zygote. This process is known as syngamy or generative fertilization. This diploid zygote finally develops into embryo.

Other male gamete fuses with two polar bodies and form Primary Endosperm Nucleus (PEN). This is called triple fusion or vegetative



Fertilization

fertilization.

The two acts of fertilizations constitute the process of double fertilization.

⇒ One male gamete + egg = Zygote (diploid)

⇒ One male gamete + 2 Polar bodies = PEN

Primary Endosperm Nucleus.

Post Fertilization Changes:→ Soon after fertilization, the flowers begins to lose its shine. The petals, stamens and style either fall or withes away.

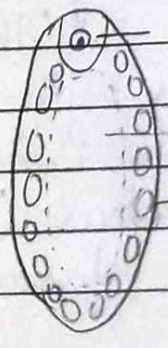
Four Majors Changes takes place after fertilization

1. Development of Endosperm from Primary Endosperm nucleus.
2. Development of Embryo from diploid Zygote.
3. Development of seed from ovule.
4. Development of Fruit from ovary

[A] Development of Endosperm :→ Endosperm is formed from triple fusion of one male gamete and two polar bodies. Endosperm is of three types :-

(a) Nucleas
(b) Cellular
(c) Helobial

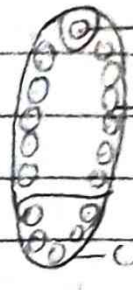
Nucleas Endosperm :→ In this type, the PEN divides by repeated mitotic free nucleas divisions without the formation of walls. A big central vacuole develops and pushing all the nuclei to the peripheral cytoplasm.



Cellular endosperm - In this type, PEN is divided longitudinally as well as transversly with cell wall.

Cellular Endosperm

Helobial Endosperm: This is the intermediate between Nuclear and cellular endosperm. Embryo sac is divided transvessally into two unequal parts. Larger side is in micropylar end and smaller is in Chalaza end. There is mitotic free nuclear division. A big central vacuole develops in the embryo sac The nuclei lies peripheral.



Helobial → Endosperm

[B] Development of Embryo :→ In ~~Dicto~~ Dicotyledons :-

(1) In dicots, the zygote enlarges in size and divides by a transverse division into two unequal cells. The larger basal cell is called suspensor cell lies towards micropylar end and smaller terminal cell called embryonal cell lies towards chalazal end.

(2) The basal suspensor cell divides by transverse division and the terminal embryonal cell divides by longitudinal division.

(3) Transverse division divides the cell into two cells and the longitudinal division forms seven to eight cell.

(4) Proembryo divides longitudinally forming four celled quadrant Stage.

(5) Each of the four cells of quadrant stage divides by transverse division to form eight celled octant Stage.

(6) Eight cells of octant stage divides into outer cell and inner cell. Eight celled octant now becomes sixteen celled.

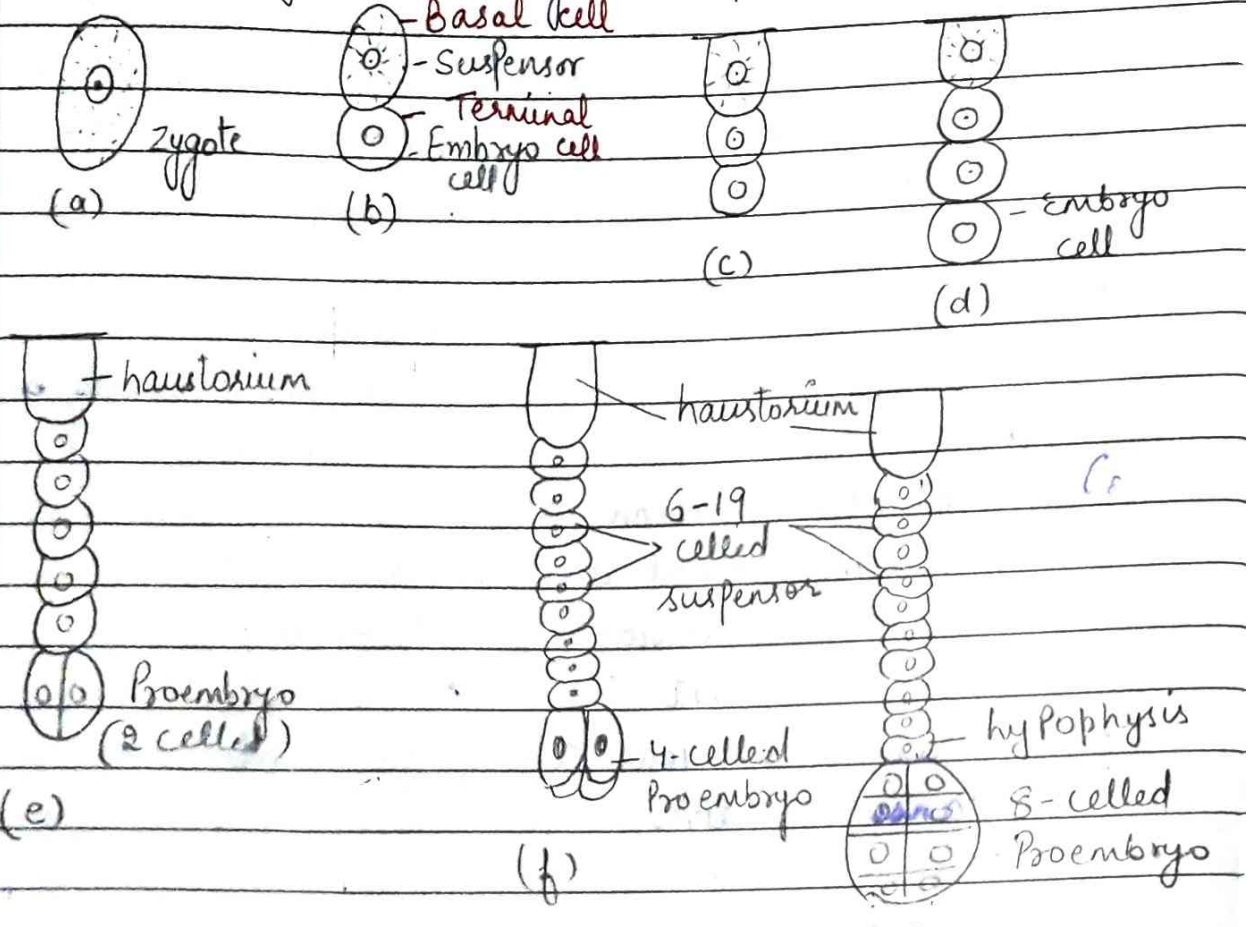
(7) Outer cell layer divides to form embryonic surface layer as epidermis and inner cells divides to form ground meristem and procambium of cotyledons, hypocotyl and plumule.

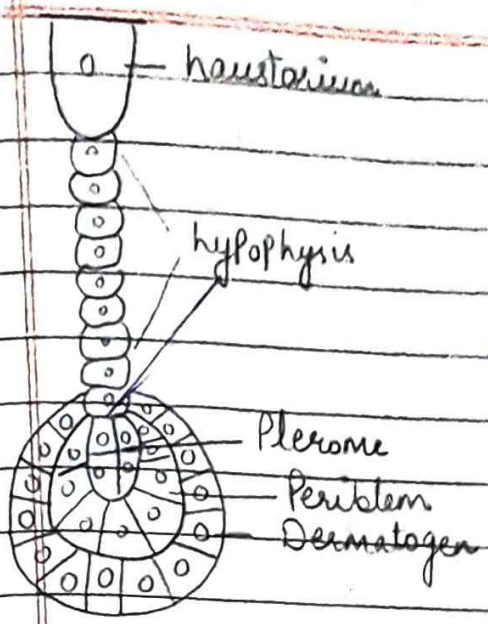
(8) The suspensor cell at terminal end is called hypophysis.

(9) The hypophysis divides by transverse and longitudinal divisions to form three tiers of cells. The inner tiers forms root ~~protoderm~~ and radicle. Middle tier ~~form~~ and outer tier forms root protoderm and root cap.

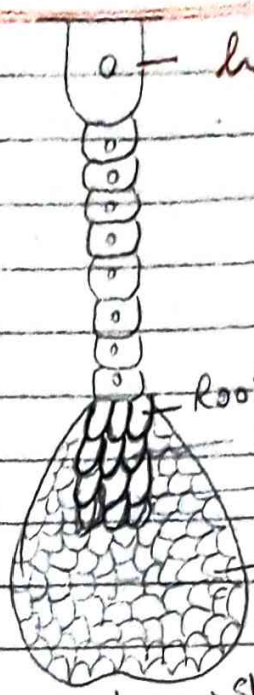
(10) At this stage embryo is known as proembryo. This is transformed into embryo with the development of radicle, plumule and cotyledons.

(11) Cotyledons grows rapidly and few cells forms plumule.



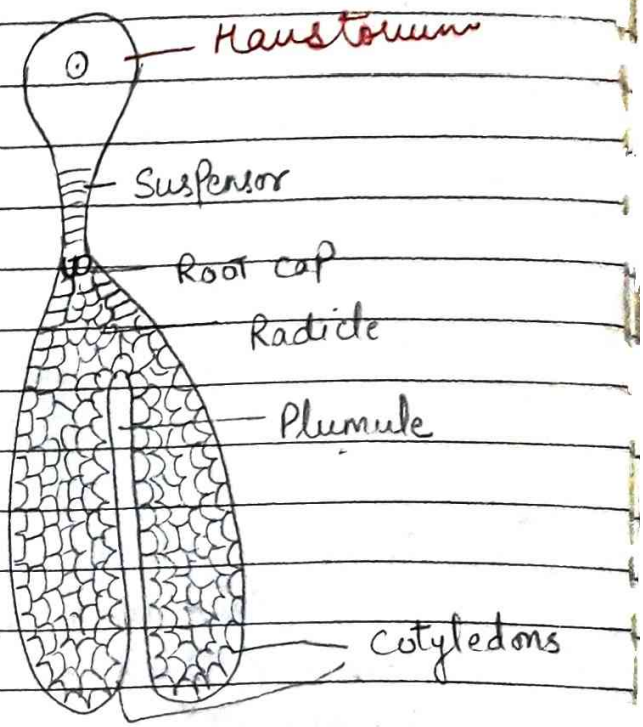


(h)
Globular embryo



Heart shaped Embryo

(I)



(J)

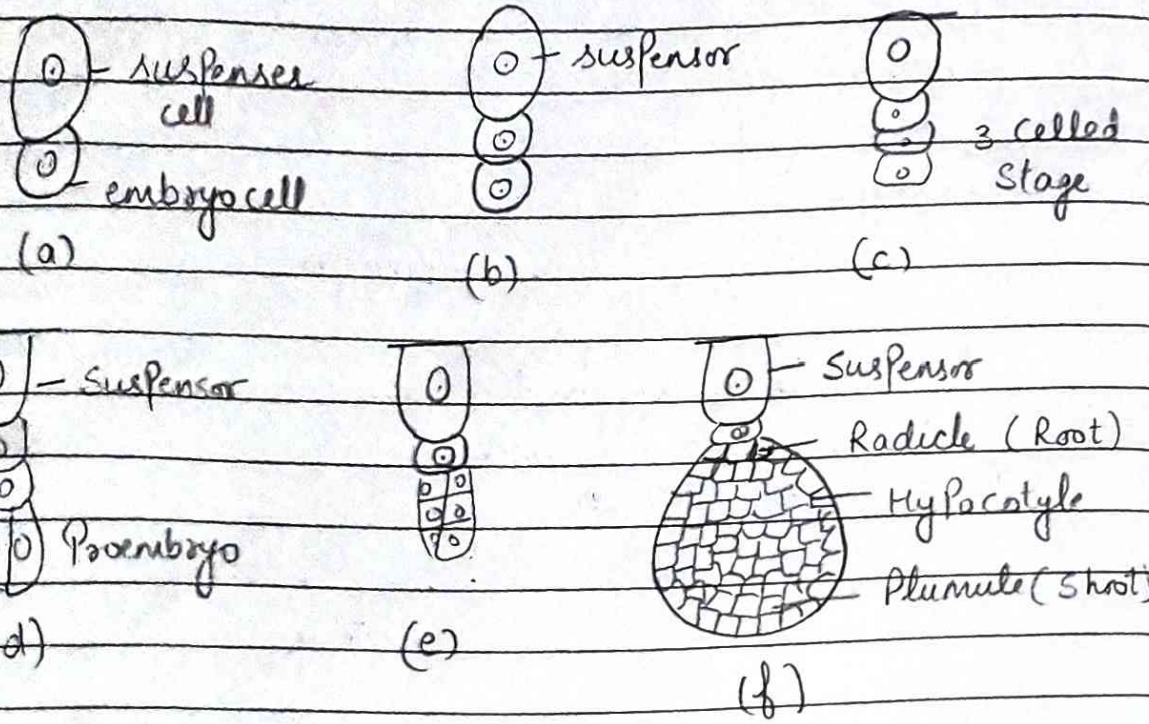
Monocot Embryo :- (1) Zygote divides by transversall
To form upper large cell and lower smaller ce
called as embryonal cell
(2) upper cell remains undivided
(3) Embryonal cell will divide transversally to for

3-celled Proembryo.

(4) The lowest most cell of proembryo which is towards chalazal end divides many times to form a single terminal Cotyledon.

(5) The middle cell divides many times, to form part of suspensor, plumule, radicle etc.

(6) Mature monocot embryo has single terminal Cotyledons, lateral plumule and a radicle.



[C] Development of seed from ovule :→

Seed is a fertilized ovule. It contains embryo, reserve food material and is very well protected by one or two seed coats. In angiosperms, seeds are present inside the fruit.

Seeds ~~are of two~~ which store food in endosperm or albuminous seeds e.g. wheat, Onion, Corn etc.

Seeds in which the endosperm is used up are called exalbuminous e.g Pea, bean, gram etc.

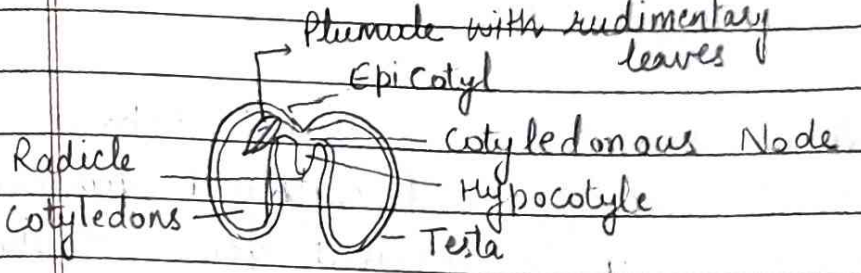
These are also called non-endospermic seeds.

Perisperm:- The nucellus (Central part of ovule) is generally used up during the development of embryo but in some cases, it remains outside the endosperm in the form of a thin layer, called perisperm.

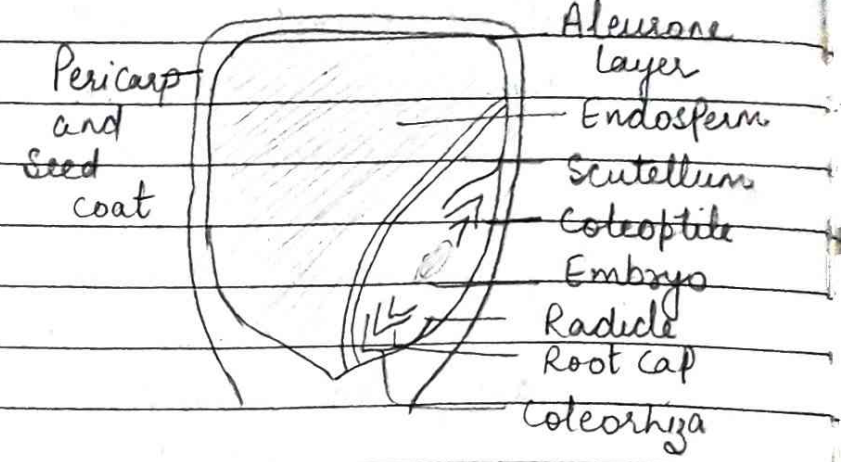
Testa and Tegmen:- The outer seed coat is testa and the inner integument, if persists forms the tegmen.

The micropyle remains in the form of a fine pore on the surface of seed.

Dormancy:- The condition of seed when it fails to germinate even though the environmental conditions is called dormancy.



Dicotyledonous Seed.



Monocot Seed

[D] **Development of fruit from ovary:-** Fruit is developed from ovary. The wall of the ovary is transformed into pericarp (fruit wall).

Types:- Two types of fruits are there:-

(1) **True fruit** :- The fruit derived from the ovary. no other part involves in the formation of fruit. These are called True fruits e.g Mango, Banana, Grapes, Tomato etc.

(2) **False Fruit** :- The fruit derived from ovary along with other accessory floral parts are called false fruits e.g Apple, fig etc.

Parthenocarpic fruits:- Some plants are able to produce fruits without fertilization. Such fruits are known as parthenocarpic fruits. They are seedless or contain non-viable seeds.
e.g - Citrus, Pineapple etc.

Apomoxis:- It is also called asexual reproduction. In this, seeds are formed without fusion of gametes. Embryo may be formed from diploid cell of nucellus.

Aposposy :- Formation of embryo from any other cell of embryo sac without fertilization.

Polyembryony :- The presence of more than one embryo in the seed is termed as polyembryony.

Imp. Differences

Microsporogenesis	Megasporogenesis
1. It is the meiotic formation of haploid microspores	1. It is the meiotic formation of haploid megaspores
2. Diploid microspose mother cell undergoes meiosis	2. Diploid megaspore mother cell undergoes meiosis.
3. Microspose tetrad is tetrahedral	3. Megaspore tetrad is linear
4. It is found in micro sporangium	4. It is found in mega-sporangium
5. All the spores of tetrad are functional	5. Only one spose is functional among the spores of tetrad.

Hypocotyl	Epicotyl
1. It is the postion of an embryonal axis that lie below cotyledon in an embryo	1. It is the portion of an embryonal axis that lie above the cotyledon
2. It terminates with radicle	2. It terminates with plumule.

Coleoptile	Coleorhiza
1. It is a conical protective sheath that encloses the plumule in the monocot seed.	1. It is undifferentiated sheath that encloses the radicle and root cap in a monocot seed
2. It comes out of soil and turns green	2. It remains inside the soi and is non green
3 It performs photosynthesis	3. It does not perform photosyn

Integument	Testa
1. It is an ~~inner~~ outermost covering of an ovule	1. It is the outermost covering of a seed
2. It is thin and living	2. It is thick and dead
3. It is a part of pre-fertilization tissue	3. It is the result of post fertilization changes in gynoecium.

Exine	Intine
1. It is hard, outermost layer covering the pollen	1. It is the inner layer of a pollen
2. Exine is made up of sporopollenin	2. Intine is made up of cellulose and pectin.

Radicle	Plumule
1. Radicle is an embryonic root	1. It is a site of emergence of the shoot
2. It is positively hydro-trophic	2. It is positively phototrophic
3. It is protected by protective sheath known as Coleorhiza	3. It is protected by a protective sheath called Coleoptile.

Perisperm	Pericarp
1. It is the persistent remains of ovule in the seed	1. It is the wall of fruit formed by ovarian wall
2. It is usually dry	2. It may be fleshy or dry

Perisperm	Endosperm
1. The residual and persistent nucellus is a perisperm.	1. After Triple fusion, the central cell of an embryo sac becomes primary endosperm cell and develops into an endosperm.
2. For example, black pepper and sugar beet	2. For example, castor and groundnut

Geitonogamy	Xenogamy
1. Types of cross pollination where the pollens of flower are transferred to stigma of another flower located on same plant.	1. Type of cross pollination where pollens of flower get transferred to the stigma of a flower present on another plant.
2. It does not induce genetic variation.	2. It induces genetic variation into the progeny.

Wind Pollinated flowers	Insect Pollinated flowers
1. These flowers have well exposed stamens in order to achieve complete dispersion of pollen grains. Flower possess large feathery stigma to trap the air borne pollens easily.	1. The flowers are clustered into an inflorescence. There is a need of pollinating agents such as insects like flies and beetles.
2. Pollen grains are light and non sticky that facilitates easy transport from one place to another.	2. Flowers are large and co ful, so as to attract insects and are rich i nectar.

Parthenogenesis	Parthenocarpy
1. When single gamete undergoes development to form a new organism without fertilisation, it is the process of parthenogenesis	1. Parthenocarpy it is the process of formation of fruit from unfertilized ovules. The fruit produced is seedless
2. e.g whiptail lizard	2. e.g banana

Albuminous seed	Non-albuminous seed
1. Residual endosperm retains a part of endosperm that is not completely consumed during the development of an embryo.	1. There is no residual endosperm as it is completely consumed during the process of embryo development.
2. e.g Groundnut and Pea	2. e.g wheat and Sunflower

Male Gametophyte	Female Gametophyte
(1) The male gametophyte of angiosperms is derived from the microspore which is produced inside the pollen chamber of anthers.	(1) The female gametophyte of angiosperms is derived from megaspore which is formed inside the nucellus of ovule.
(2) Generally the microspores are shed at maturity and transferred from anther to stigma	(2) The microspores are not shed from the ovules.
(3) The mature male gametophyte is 3-celled	(3) The mature female gametophyte is 7-celled.
(4) All the 3 cells are functional	(4) Out of 7, only egg and 2 polar nuclei are functional

Self Pollination	Cross Pollination
1. It is the transfer of pollen grains from the anther of a flowers to the stigma of either the same or genetically similar flowers	(1) Cross pollination is the transfer of pollen grains from the anther of a flowers to the stigma of genetically different flowers.
2. Self pollination can occur in Cleistogamous flowers	(2) Cross pollination can occur only when the flowers open
3. External pollinating agents are not required	(3) External pollinating agents are required
4. It results in the production of pure line offsprings	(4) It results in the production of zygotes with a higher degree of heterozygosity
5. These are not produce Variability among offsprings	(5) These produce plants having Variations
6. e.g - Rice, wheat, Pea, Potato, Brinjal etc	(6) e.g Maize, Turnip, Carrot, apple, Banana etc

Imp Questions

i) Q Name the phase all Organisms have to pass through before they can reproduce sexually?

Ans Formation of gametes through gametogensis

(2) Q A bilobed, dithecous anther has 100 microspore mother cells per microsporangium. How many male gametophytes, this anther can produce?

Ans They can produce 1600

(3) Q:- Further development of microsporangia give rise to the formation of:—

Ans Pollen sacs.

(4) Q The innermost wall layer of the microsporangium consting of dense cytoplasm with more than one nucleu

Ans Tapetum

(5) Q:- The mature pollen grain contains two types of cells. Which are they?

Ans Vegetative cell and Generative cell.

(6) Q:- Majority of angiosperm species shed the pollen grain at the stage of ____ ?

Ans:- Two celled stage

(7) Q:- Give an example of a plant that came to India as a contaminant and is a cause of pollen allergy.

Ans Carrot grass.

(8) Q:- Where is placenta situated?

Ans In the Ovarian Cavity

(9) Q:- Why do the pollen grains of Vallisneria have a mucilaginous covering?

Ans In Vallisneria, the male flowers are present on the surface of water. In order to protect pollen grain from getting wet mucilaginous covering is present over them.

(10) Q:- During double fertilization, the primary endosperm cell develops into ____ ?

Ans An endosperm

(11) Q:- The flowers of brinjal is refered to as Chasmogamous while that of beans is cleistogamous. How are they different from each other?

Ans Flowers of brinjal are similar to flowers of other species where anthers and stigma are exposed. Such flowers are called Chasmogamous. The flowers of bean, on the other hand, remain closed to ensure self pollination. Such flowers, which remain closed so that cross pollination does not occur, are called cleistogamous.

) Q:- What is seed dormancy? Give its two advantages.

Ans: Seed dormancy is the condition of seed when it fails to germinate even though the environmental conditions usually considered favourable for germination of seed are provided.

Advantages:- (1) Dissemination of seeds at desired time

(2) Adaptation of successful seed germination under fav. conditions.

(13) Q:- Banana is a parthenocarpic fruit where as oranges show polyembryony? How they differ from each other?

Ans: Banana fruits are seedless. Such fruits are called parthenocarpic i.e produce embryo without fertilization. The seeds of oranges have many embryo of different size and shape. The orange seeds develop many embryos due to polyembryony.

(14) Q:- If you squeeze a seed of orange you might observe many embryos of different sizes. How is it possible Explain.

Ans:- In orange seed, embryos originate by adventive embryony from diploid cells of nucellus or integuments and are thus in large number inside a seed.

(15) Q:- In angiosperms, zygote is diploid while primary endosperm cell is triploid Explain?

Ans:- An unusual form of reproduction is seen in flowering plants in which one sperm nucleus fuses with an egg to form a zygote. Simultaneous fusion of the second male gamete with the polar nuclei, resulting in a primary endosperm nucleus, which is often triploid.