8. Reproduction in Plants

8.1 : Modes of Reproduction (Asexual and Sexual)

Q.1. What is reproduction? State the two major modes of reproduction.

Ans: Reproduction is the ability ofliving beings (organisms) to give rise to young ones of their own kind. There are two major modes of reproduction. These are:

i) **Asexual reproduction or Apomixis** (apo = without; mixis = mixing)
Asexual reproduction is uniparental, i.e. only one parent is involved and offsprings are genetically identical to their parents. It is a rapid method of reproduction.

ii) **Sexual reproduction or Amphimixis** (amphi = both; mixis = mixing) It involves mixing or fusion of genetic material of male and female gametes. The offsprings produced are not identical to parents. They show genetic variation. It is a slow method of multiplication.

Q.2. Write a short note on asexual reproduction in lower organisms.

Ans: There are different methods of asexual reproduction in lower organisms. These are :

i) **Binary fission :** It is common in unicellular organisms. Parent cell divides to produce two equal cells that give rise to two new individuals. e.g. bacteria and *Amoeba.*

ii) **Budding :** In budding, the division is unequal and small cells called buds are produced that remain attached initially to the parent cell.
Eventually, the small cells (buds) get separated and mature into new individuals. e.g. Yeast

iii) **Spore formation:** Different types of motile and non-motile spores are produced by algae and fungi. Mostly algae produce motile spores called **zoospores.** e.g. Chlamydomonas, while fungi produce nonmotile spores called **conidia.** e.g. *Penicillium.*

iv) **Fragmentation :** Filamentous algae reproduce by fragmentation, i.e. filaments get broken into small fragments and each fragment develops into new individual.

<u>Asexual reproduction (Vegetative propagation) in Angiosperms</u>

Q.3. What-is vegetative propagation ?

Ans: Vegetative propagation is a kind of asexual reproduction which occurs with the help of vegetative organs like root, stem, leaf or bud. It is also called as vegetative reproduction.

a) <u>Natural Methods</u>

Q.4. Give brief account of natural vegetative propagation in Angiosperms.

Ans: Natural methods of vegetative propagation :

A. Root Tuber : e.g. Sweet Potato (*Ipomoea batatas*)

i) It is a modification of root for vegetative reproduction.

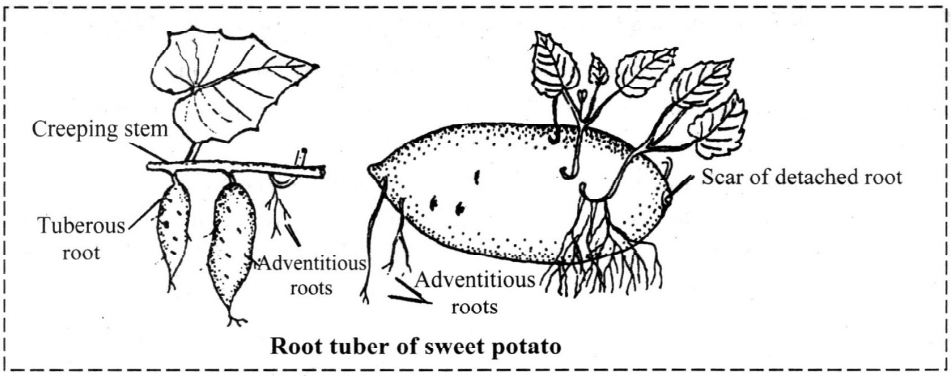
ii) These roots develop from the nodes of stem.

iii) They become tuberous and fleshy for storage of food.

iv) In addition to the storage of food, these roots also develop adventitious buds on their surface which sprout under favourable conditions to produce 'leafy shoots' and adventitious roots.

v) Under suitable environmental conditions, these leafy shoots separate and develop into new plants.

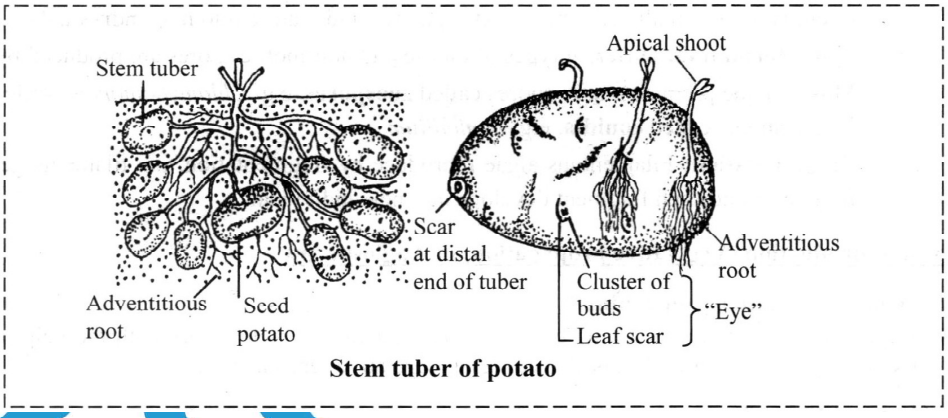
vi) The tuberous roots' are adventitious and when produced singly are called as simple tuberous roots. e.g. sweet potato and when produced in groups or clusters are called as fasciculated tuberous roots. e.g. *Asparagus and Dahlia.*



Root tuber of sweet potato

B. Stem tuber : *e.g. Solanum tuberosum*

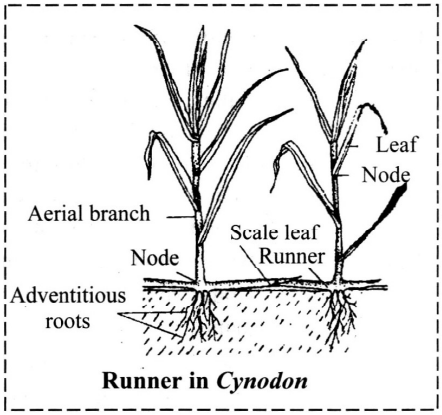
i) Stem tuber is a modified stem for vegetative reproduction.
ii) In case of potato, some lateral branches are produced from the underground part of stein which grow down in the soil.
iii) The tip of these branches store food and hence are swollen.
iv) These tubers show nodes, internodes, scale leaves and axillary buds.
v) A stem tuber has many notches on its surface called 'eye'.
vi) The eyes that are seen on the surface of the tuber represent nodes.
vii) Each 'eye' is actually a node and is made up of one or more axillary buds substended by a leaf scar.
viii) Under favourable conditions, axillary buds develop into new plants.



Stem tuber of potato

C. Vegetative propagation by runner: e.g. *Cynodon*

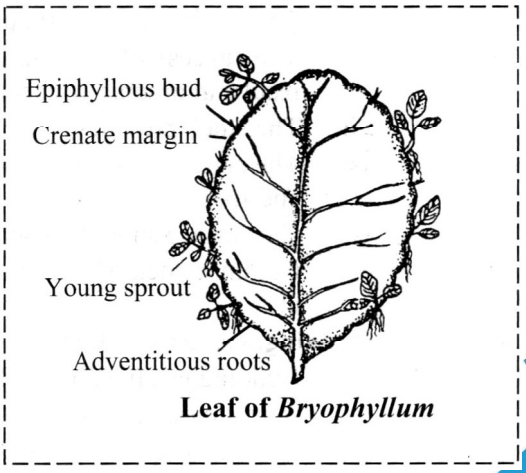
i) Runner is a slender, prostrate, sub-aerial branch with short or long internode and creeps horizontally on the soil.
ii) Runner develops from the axillary bud in the axil of the lowest leaf.
iii) After creeping some distance, away from the parent plant, it produces shoots from upper side and roots from lower side of the nodes.
iv) Many runners are produced by the parent plant which may get detached from the parent plant to develop into new plants.



Runner in *Cynodon*

D. Vegetative propagation by leaf : e.g. *Bryophyllum*

i) In some plants, leaves also take part in vegetative reproduction.
ii) In Bryophyllum, leaves are fleshy and notched along the margin.
iii) Adventitious buds called epiphyllous buds are developed on the leaves. These buds start sprouting on the leaf to form the plantlets.
iv) These plantlets fall off from parent plant to continue their growth in the soil.



Leaf of *Bryophyllum*

Q.5. Explain how commercial cultivation of sweet potato and potato crop is done?

Ans: Commercial cultivation of sweet potato:

1) Sweet potato is an example of tuberous roots.
ii) These roots have adventitious buds on their surface which sprout under favourable conditions to produce 'Leafy shoots' and adventitious roots from the base of shoot.
iii) These can be separated and planted for commercial cultivation.

Commercial cultivation of potato :

i) Potato is an example of stem tubers.
ii) Stem tuber has many notches on its surface and are called as 'eyes'.
iii) The tuber or its pieces, each at least with one 'eye' are grown separately for commercial cultivation.

b) Artificial Methods

Q.6. What are the artificial methods of vegetative propagation?

Ans: Artificial methods of vegetative propagation or Horticultural methods :

These are the methods used by man in which a portion of plant body is separated from the parent plant mechanically (by special technique) to propagate new plants.This method is used by horticulturists for quick production and also for combining good qualities of two different varieties.

A. Cutting :

It is defined as a process by which a plant is produced by cutting a vegetative portion from the parent plant and growing it in a suitable medium under favourable conditions. Some of the common cuttings are :

i) Root cutting: e.g. Apple, Tamarind, Lemon
ii) Stem cutting: e.g: Sugarcane, Rose, Grapes etc.
iii) Leaf cutting: e.g. *Peperomia, Bryophyllum, Sansevieria.*

B. Grafting :

Grafting is an art of joining parts of two plants in such a manner that they unite and continue their growth as one plant (composite plant).

i) This is the characteristic feature of dicotyledonous plants which have cambium for secondary growth.
ii) As mono cots do not have inter or intrafascicular cambium and do not show secondary growth, grafting is not possible in monocots.
iii) Part ofthe rooted plant on which grafting is done is called **stock** (root stock).
iv) While the part which is inserted on stock is called **scion** (graft).
v) The stock and scion should be mutually compatible.

vi) The success of grafting depends upon the match of cambium between stock and scion which results in organic connection between them.
vi) The stock provides root, while scion becomes shoot of the new plant.
viii) The stock usually has a strong root system, while scion has strong desired characters of flowers and fruits.
ix) Cut surface should be held together tightly by wrapping, nailing etc.
x) Common methods of grafting are Tongue (whip) grafting, Wedge grafting and Crown grafting, etc.

C. Budding: e.g. Rose, Mulberry, Rubber.

i) Budding is a type of grafting in which bud is a scion.
ii) In this method, instead of a branch, a single bud along with a piece of bark is used as a scion.
iii) In the stock, 'T' or T' shaped incision is made upto the bark.
iv) A single bud with little bark is then inserted in the slit of the stock.
v) Both are tied by polythene or by plantain fibre.
vi) Bud germinates after 3 weeks and a new plant is produced.

Q.7. What is the common method of propagation in *Bryophyllum* ?

Ans: The common method of propagation in *Bryophyllum* is leaf cuttings and leaf buds.

Q.8. Define grafting.

Ans: Grafting is an art of joining parts of two plants in such a manner that they unite and continue their growth as one plant (composite plant).

Q.9. Explain the terms scion and stock and mention advantages of grafting.

Ans:i) Part ofthe rooted plant on which grafting is done is called stock (root stock).
ii) While the part which is inserted on stock is called scion (graft).
iii) The stock and scion should be mutually compatible.

Advantages of grafting :

i) Grafting promotes the physical and physiological umon of two different plants for economic advantage.
ii) Grafting is a quicker method of reproduction.
iii) Flowers and fruits that are produced on scion are superior in quality.
iv) Grafting is easier and less expensive method of multiplication of plants.

Q.10.Why is grafting not possible in monocots ?

Ans: Monocots do not have inter or intrafascicular cambium and do not show secondary growth. Thus, grafting is not possible in monocots.

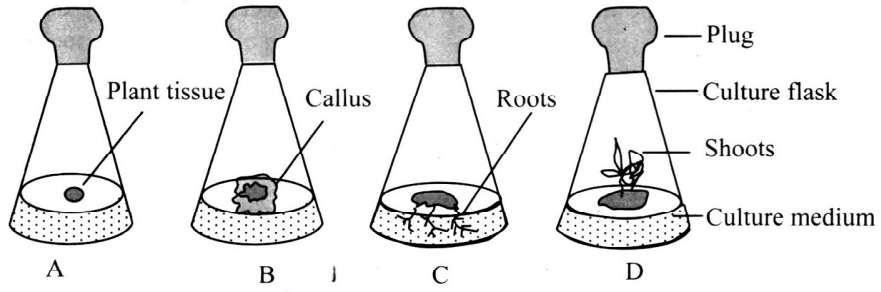
Q.11.Why is the base of stem dipped in auxin during stem cutting ?

Ans: During stem cutting, basal end of stem is dipped in auxin to promote the rapid growth of roots.

<u>Micropropagation</u>

Q.12. Explain the process of micropropagation.

Ans:i) Micropropagation is the practice of rapidly multiplying plant material to produce a large number of progeny plants, using modern plant tissue culture methods.
ii) It is a technique of raising new plants from small pieces of tissue (taken from shoot tips or other suitable part of the plant) on a culture medium under aseptic conditions.
iii) Small amount of tissue is taken from shoot tips or other suitable part of the parent plant and grown on a culture medium under aseptic conditions.
iv) Tissue develops into an undifferentiated mass of cells called as callus.
v) Callus can be maintained and multiplied indefinitely.
vi) When small portion or even single cells of callus tissues are transferred to another suitable medium containing growth hormones, they develop into small plantlets or micropropagules.
vii) The plantlets are then transplanted in pots or soil to develop into mature plants.
viii) These micropropagules are genetically identical, i.e. clones.



Growth and Morphogenesis in callus

Q.13.Enlist the advantages of vegetative propagation.

Ans: Advantages of vegetative propagation :

i) It is more rapid, easier and cheaper method of propagation of plants as compared to propagation by seeds.

ii) It is possible to obtain clones (a population of genetically similar individuals) as plants produced will have same characters as that of parent plants.

iii) It is the means of reproduction in those plants where sexual reproduction is absent or do not form viable seeds. e.g. Banana, Figs, Pineapple, Jasmine, etc.

iv) It helps to retain desirable characters in plants which may not be possible in plants raised from seeds.

v) Methods like grafting allows physical and the physiological joining of two different varieties. Desired character of the stock (eg. disease resistance, vigour, etc) can be transferred to the scion.

vi) It is easy to get rid of pathogens from any part of the plant by vegetative propagation.

vii) It helps in the production of clones of economically useful and rare plants.

Q.14. Distinguish between Asexual and Sexual reproduction.

Ans:

No.	Asexual reproduction	Sexual reproduction
i)	It does not involve formation and fusion of gametes.	It involves formation of male and female gametes and their fusion
ii)	Meiosis never takes place.	Meiosis takes place during gamete formation.
iii)	All the individuals in the progeny are identical.	Genetic variability occurs III the sexually reproducing organisms.
iv)	Reproduction through tubers, bulbs, rhizomes etc.	Reproduction through seed formation.
v)	It is a rapid method of multiplication	It is less rapid method of multiplication.

8.2 : Sexual Reproduction

8.2.1 Flower structure

Q.15.Define Flower.

Ans: Flower is defined as "a highly specialized reproductive shoot", concerned with sexual reproduction in higher plants.

OR

Flower is a condensed and modified shoot, specialized for sexual reproduction.

Q.16.Which are the essential whorls of a flower? Why ?

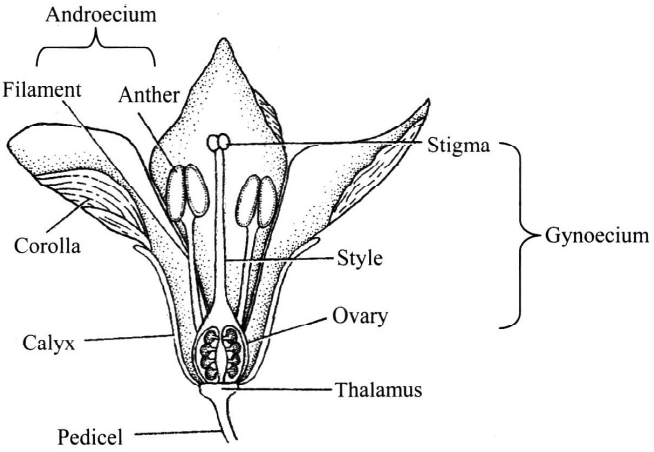
Ans: Androecium and Gynoecium are called essential whorls because they take part in sexual reproduction by forming male and female gametes respectively.

Q.17.Which are the non-essential whorls of a flower ? Why ?

Ans: Calyx and Corolla are called the non-essential whorls of a flower because they do not take part in sexual reproduction.

Q.18.With the help of a neat labelled diagram, describe the structure of a typical flower.

Ans:



Parts of a typical flower: L. S. of flower showing various parts

i) A typical flower consists of a stalk called pedicel, thalamus and four whorls - Calyx, Corolla, Androecium and Gynoecium.

ii) **Androecium and Gynoecium** are called essential whorls because they take part in sexual reproduction by forming male and female gametes respectively.

iii) **Calyx and Corolla** are called non-essential whorls of a flower because they do not take part in sexual reproduction.

iv) **Pedicel :** Stalk of the flower is called as pedicel.

v) **Thalamus :** It is also known as torus. It is a highly condensed shoot, shows presence of 4 nodes and 3 internodes, each node gives rise to a floral whorl.

vi) **Calyx :** It is the outermost whorl of the flower which is made up of green coloured sepals. Calyx protects the flower in bud condition. Also, being green, it performs the function of photosynthesis.

vii) **Corolla :** It is the largest, second whorl of the flower inner to calyx, made up of brightly coloured petals. Being brightly coloured, it attracts insects for pollination. Also, it protects inner whorls, viz. androecium and gynoecium.

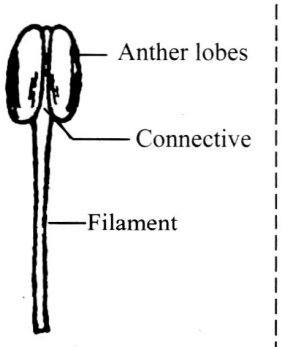
viii) **Androecium :** It is an essential, third whorl of the flower inner to corolla. It is the male reproductive part of a flower and made up of stamens. Each stamen is made up of three parts - filament, anther and connective. An anther contains four pollen sacs containing many pollen grains. Pollen grain develops into male gametophyte with two male gametes.

ix) **Gynoecium :** It is an essential and innermost whorl of a flower and made up of carpels. Each carpel is made up of a swollen portion at the base called as ovary, tube-like structure called style which possesses stigma at its tip. Ovary contains ovules which possesses the female gamete .

8.2.2 Structure of anther

Q.19. Describe the structure of stamen.

Ans:



Stamen

i) Androecium is the male reproductive floral whorl, having definite number of individual members called stamens.
ii) It consists of filament, anther and connective.
iii) Filament is basal, sterile, slender stalk. iv) Anther is upper sac-like fertile part.
v) Generally, anther consists of two lobes, sometimes anther consists of one lobe.
vi) Each anther lobe has two pollen sacs or pollen chambers.
vii) Joining the two anther lobes, is a strip of sterile tissue called connective.
viii) A large number of pollen grains are produced inside the anther lobes.
Function : It produces pollen grains. Pollen grain develops into male gametophyte with two male gametes.

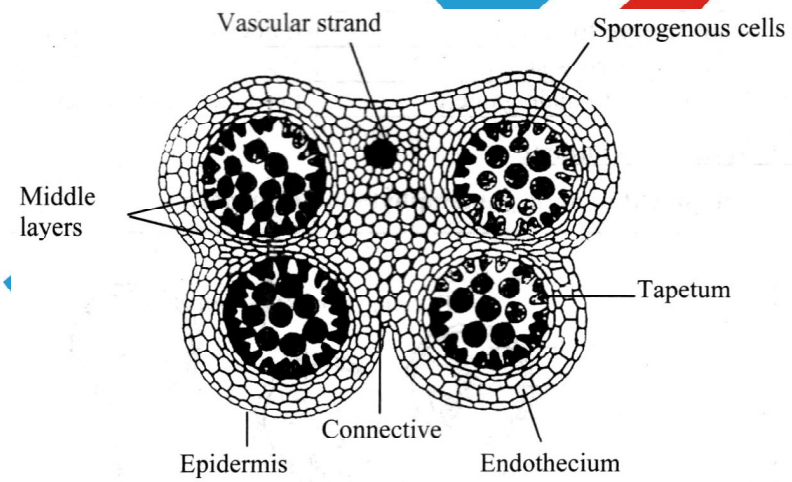
Q.20.What is microsporogenesis ? **[Oct 2013]**

Ans: The process of formation of microspores from microspore mother cell through meiotic cell division inside the microsporangia or pollen sacs is called microsporogenesis.

Q.21.With the help of a suitable diagram, describe T.S. of anther in brief. **[Mar 2013 Old Course]**

Ans: Internally, anther shows anther wall and pollen sacs.

a) Anther wall : The anther wall is divided into :
i) Epidermis: It is the outermost protective layer of anther which consists of flattened cells.
ii) Endothecium: It is present below the epidermis. Cells of endothecium show fibrous thickenings of callose. Fibrous thickenings and hygroscopic nature of cells help in the dehiscence of anther at maturity.
iii) Middle layers : They lie inner to endothecium. 1 to 3 layers of parenchyma cells are present surrounding the sporogenous tissue of microsporangium. Cells of these layers degenerate at maturity, i.e. after the formation of microspores.
iv) **Tapetum:** It is the innermost layer of anther wall, present around the pollen sac. It provides nutrition to the de eloping pollen grains. It also contributes in the formation of sporopollenin, a component of pollen exine.



T.S. of Anther

b) Microsporangium or Pollen sacs: Anther is a bilobed structure. Each lobe contains two sporangia or pollen sacs at four corners. Pollen sacs contain number of diploid sporogenous cells (microsporocytes) which divide mitotically to form microspore mother cells. Each diploid microspore mother cell (2n) undergoes meiotic division to form four haploid microspores (n) or pollen grains.

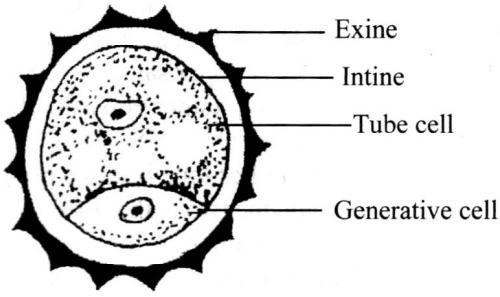
Q.22.What is the ploidy of microspore tetrad cells ?

Ans: Microspores are haploid. Microspore represents the first cell of male gametophyte.

Q.23.Draw a labelled diagram of pollen grain (sectional view) and explain its structure.

Ans: i) Pollen grain is best defined as a partially developed male gametophyte.

ii) A pollen grain is a spherical structure with two walls.
iii) The outer thick and rough wall is called **exine**, while I the inner thin and smooth wall is called **intine.** The exine shows one or more pores called germ pores.
iv) Exine is made up of complex substance called sporopollenin which protects the pollen grain from: physical and biological degradation. :
v) Initially, the pollen grain is unicellular and uninucleate. But at maturity, it divides by mitosis to form two I haploid cells.
vi) The larger cell is called **tube cell** which has a tube nucleus. The smaller one is called generative cell which has a generative nucleus.
vii) The generative nucleus eventually divides mitotically to form two non-motile male gametes.



Pollen grain (Sectional view)

Q.24.Explain the role of tapetum in the formation of pollen-grain wall.
Ans: Tapetum is glandular in nature and forms Ubisch body. Ubisch body transports sporopollenin (biologically most resistant compound) to the exine to resist physical, biological and chemical attacks.

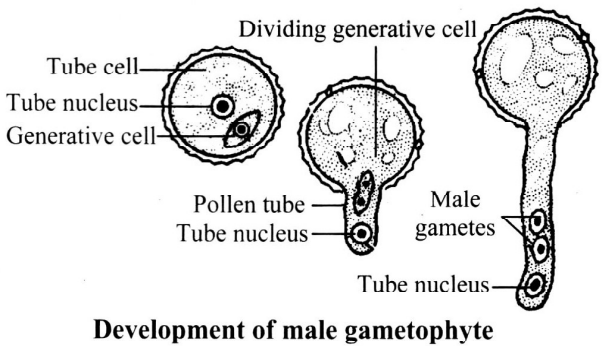
Q.25.What are germ pores? State their function.
Ans: Germ pores are the regions on the surface of pollen grain, where the exine is very thin or absent. During pollen germination, the intine grows out through one of the germ pores.

Q.26. Distinguish between vegetative and generative cell of pollen grain.
Ans:

No.	Vegetative cell	Generative Cell
i)	It is large in size than the generative cell.	It IS small, spindle-shaped and floats in the cytoplasm of vegetative cell.
ii)	It has abundant reserve food materials.	It does not have reserve food materials.
iii)	The nucleus is irregularly shaped.	The nucleus is small round/oval shaped.
iv)	Provides nourishment to male gamete.	Produces male gamete.

8.2.3 Development of Male Gametophyte

Q.27. Describe the development of male gametophyte in angiosperms.
Ans :



Development of male gametophyte

Development of male gametophyte :
The microspore or pollen grain is the first cell of the male gametophyte.
The development of male gametophyte is endosporic and monosporic.
It is completed in the following two stages at two different places:

A) Before pollination in the pollen sac :
i) The protoplast of pollen grain divides mitotically to form two unequal cells, viz. a small generative cell and a large vegetative or tube cell.
ii) The generative cell has a large nucleus, thin cytoplasm and lacks reserve food and vacuole.

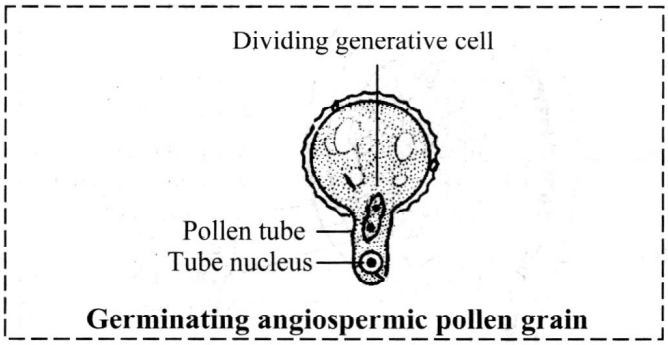
iii) The vegetative or tube cell has a large vacuole, thick cytoplasm, nucleus and reserve food.
iv) In most angiosperms, pollen grains are released at two-celled stage after dehiscence of anther.
v) In some angiosperms, the generative cell divides by mitosis to form two male gametes and therefore, three-celled pollen grains are released from anther.

B) After pollination on the stigma :

i) After pollination, the two-celled pollen grain gets deposited on the stigma and absorbs the sugary stigmatic secretion.
ii) Due to this, volume of cytoplasm increases, thus creating a pressure on the intine.
iii) The intine comes out in the form of a tube-like structure called pollen tube through the germ pore.
iv) The tube nucleus, cytoplasm and generative cell, all migrate into the pollen tube.
v) The pollen tube grows through the style towards the ovule due to some chemical stimulus inside the ovary.
vi) The generative cell of the pollen grain divides by mitosis and forms two haploid non-motile gametes.
vii) The pollen tube consisting of two male gametes and a degenerating tube nucleus represents the male gametophyte.

Q.28. Give a neat and labelled sketch ofthe germinating angiospermic pollen grain. [Oct 2014]

Ans:



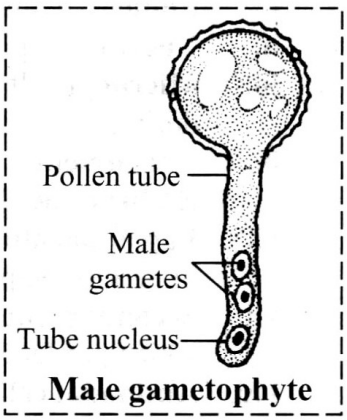
Germinating angiospermic pollen grain

Q.29. In angiosperms, which structure represents male gametophyte ?

Ans: In angiosperms, male gametophyte is represented by a pollen grain with pollen tube and two male gametes.

Q.30. Explain the structure of male gametophyte of angiosperms with .the help of a suitable diagram. [Mar 2013]

Ans:



Male gametophyte

i) Microspore or pollen grain is the initial cell of male gametophyte. Development of gametophyte is completed after pollination on stigma.
ii) When pollen grain is deposited on the stigma, it absorbs sugary stigmatic secretions. As a result, intine comes out to form the pollen tube.
iii) The generative cell of pollen grain divides by mitosis in pollen tube to form two haploid non-motile male gametes.
iv) This pollen tube with two male gametes, thin cytoplasm and a degenerating sterile vegetative nucleus

represents male gametophyte.

Q.31.Arrange the following terms in a correct developmental sequence: Pollen grain, sporogenous tissue, microspore tetrad, pollen mother cell, male gametes.

Ans: Sporogenous tissue, pollen mother cell, microspore tetrad, pollen grain, male gametes.

8.2.4 Structure of Anatropous Ovule

Q.32.Sketch, label and describe the various parts of an anatropous ovule and state their functions.

Ans: Ovule is the integumented megasporangium of seed bearing plants. Ovule has two parts :

i) Stalk or funicle ii) Body of ovule

i) Stalk or funicle : The ovule is attached to placenta by means of a stalk called funiculus or funicle. The point of attachment of funicle to the ovule is known as **hilum.** In anatropous ovule, major part of funicle remains attached to the body of the ovule fomiing a ridge called **raphe.**

ii) Body of ovule: Funicle bears swollen part at its tip called body of the ovule. It is made of the following parts :

Nucellus : It is the central major part of ovule made up of parenchymatous tissue (2n). It contains female gametophyte or embryo sac.

Chalaza : The basal part of nucellus is called chalaza. Integuments of ovule develop from chalaza.

Micropyle: The integuments leave a narrow opening at the terminal end of nucellus called micropyle.

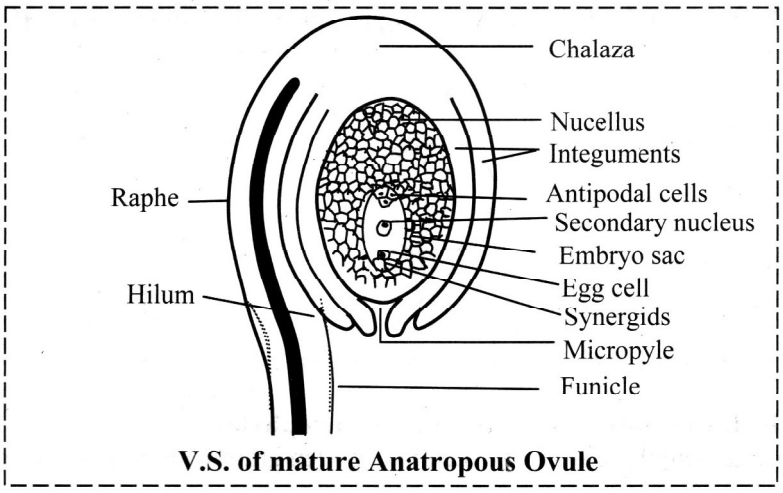
Integuments: The protective coverings of nucellus are called integuments.

Embryo sac: It is 8-nucleated and 7-celled structure. It consists of :

a) Egg apparatus : It is a group of 3 cells towards micropylar end. The central cell is the female gamete, i.e. egg flanked by two cells which are called synergids.

b) Secondary nucleus : It is a diploid structure formed by fusion of 2 polar nuclei.

c) Antipodal cells : It is group of three cells towards chalazal end.



V.S. of mature Anatropous Ovule

Functions of different parts of ovule :

i) Funicle : It attaches the ovule to the placenta and draws nourishment from placenta.

ii) Nucellus : It gives rise to embryo sac.

iii) Micropyle : It forms a passage for pollen tube before fertilization. It also serves as entry for water during seed germination.

iv) Integuments : It protects nucellus and embryo sac. It develops into seed coat.

v) Embryo sac : It gives rise to female gamete.

vi) Egg apparatus : After fertilization, egg gives rise to diploid zygote which later develops into embryo. Synergids help in fertilization after which they degenerate.

vii) Secondary nucleus : After fertilization, it is converted into a triploid primary endosperm nucleus which produces triploid endosperm.

viii) Antipodal cells: After fertilization, they degenerate.

Q.33. Write a short note on Egg apparatus.

Ans: The egg apparatus is a group of 3 cells towards the micropylar end. The central cell is the female gamete,

i.e. egg flanked by two cells which are called synergids. After fertilization, egg gives rise to diploid zygote which later develops into embryo. Synergids help in fertilization after which they degenerate. The filiform apparatus of synergids attracts pollen tube during fertilization.

8.2.5 Development of Female Gametophyte

Q.34. What is megasporogenesis?

Ans: The process of formation of haploid megaspores from diploid megaspore mother cells by meiotic division is called megasporogenesis.

Q.35. With a neat labelled diagram, explain development of female gametophyte.

Ans: i) In a young ovule, a single hypodermal cell differentiates to form **archesporial cells.**

ii) These cells are diploid and collectively called as **nucellus.**

iii) At maturity, one of the archesporial cells, act as **megaspore mother cell** and undergoes meiosis to form four haploid **megaspores,** arranged in a linear tetrad.

iv) The formation of megaspore is called **megasporogenesis.**

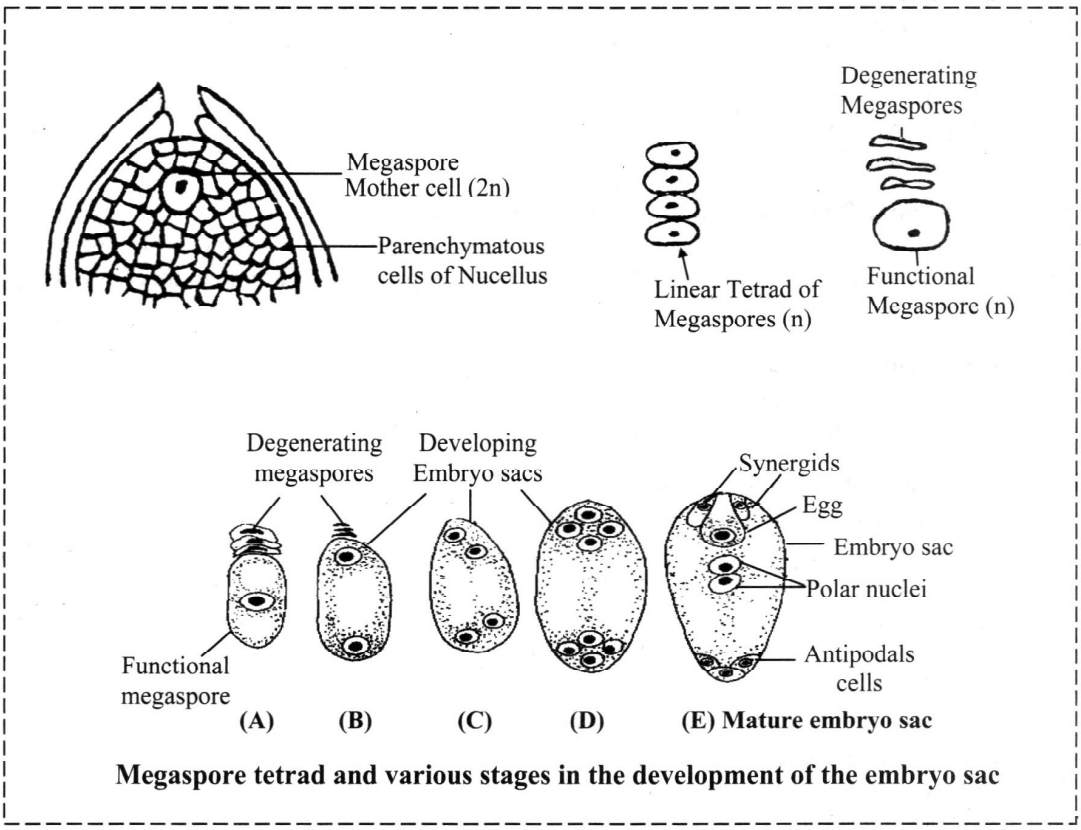
v) Out of the four haploid megaspore, upper 3 (towards micropylar end) degenerate and one at the base remains functional. It is the 1st(cell of female gametophyte.

vi) The functional megaspore enlarges and undergoes mitotic nuclear division to produce two nuclei.

vii) These nuclei, migrate to opposite poles of the megaspore.

viii) At each pole, nucleus divides twice to form 4 nuclei, 4 at each pole.

ix) The functional megaspore enlarges gradually and becomes 8 nucleated embryo sac.



Megaspore tetrad and various stages in the development of the embryo sac

x) The two nuclei, one from each pole (polar nuclei) migrate to the centre and fuse to form **diploid secondary nucleus.**

xi) The three nuclei at the chalaza end form **antipodal cells,** while the three at the micropylar end form **egg apparatus** of which one in the centre is the **egg** and the other two are **synergids.**

xii) The embryo sac is 7-celled and 8-nucleated called polygonum type.

xiii) The development of female gametophyte in angiosperms is completely **endosporic,** i.e. within the

megaspore and **monosporic** as female gametophyte develops from a single megaspore. (However, in some angiosperms, it may be bisporic or tetrasporic).

Q.36. What is funiculus ?

Ans: The ovule is attached to placenta by means of a stalk called funiculus or funicle. It attaches the ovule to the placenta and draws nourishment from placenta.

Q.37. Describe the structure of mature female gametophyte with labelled diagram.

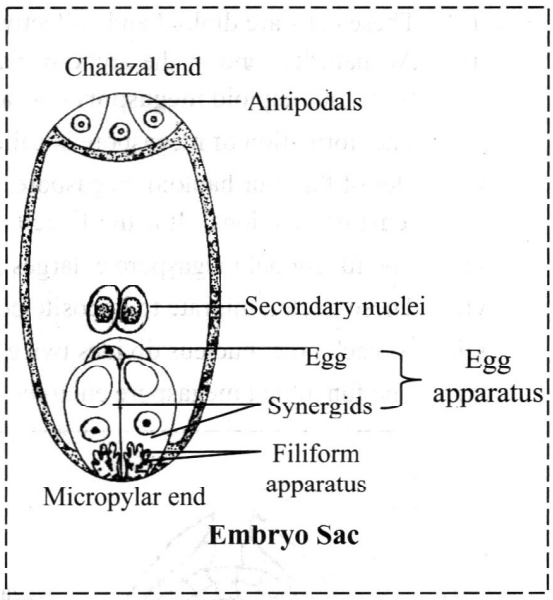
Ans: In angiosperms, female gametophyte is represented by an embryo sac.

It is 8-nucleated and 7-celled structure, consisting of :

i) **Egg apparatus :** It is a group of three cells towards : micropylar end. The central cell is the female gamete, i.e. egg which is flanked by two cells called 1 synergids. After fertilization, egg gives rise to diploid zygote which later develops into embryo. The synergids bear special cellular thickenings at the micropylar tip called filiform apparatus, which play an important role in guiding pollen tubes into the egg apparatus.

ii) **Secondary nucleus :** It is a diploid structure formed by fusion of 2 polar nuclei. After fertilization, it gets converted into a triploid primary endosperm nucleus which produces triploid endosperm.

iii) **Antipodal cells :** It is group of three cells towards chalazal end. After fertilization, they degenerate.



Embryo Sac

Q.38. What is micropyle? State its function in ovule as well as in seed.

Ans: Micropyle is the opening at the terminal end of nucellus where the integuments do not cover the nucellus completely. In ovule, micropyle acts as a passage for the entry of pollen tube into the ovule during fertilization. In seed, it allows entry of water during germination.

Q.39. What is filiform apparatus and give its role ?

Ans: The extensive wall invaginations in the synergids at the micropylar tip is called filiform apparatus. It plays an important role in attracting the pollen tube towards the egg-apparatus.

Q.40. Why development offemale gametophyte is called monosporic and endosporic ?

Ans: Monosporic development of female gametophyte: During megasporogenesis, megaspore mother cell undergoes meiosis to form four haploid megaspores, arranged in a linear tetrad.Out of the four haploid megaspores, upper 3 (towards micropylar end) degenerate and one at the base remains functional. This lowermost functional megaspore further forms embryo sac which is nothing but a female gametophyte. As female gametophyte develops from a single megaspore, it is called monosporic development.

Endosporic development of female gametophyte: As female gametophyte develops within the wall/ membrane of the megasporangium (ovule), it is caned endosporic development.

Q.41. Differentiate between Microsporogenesis and Megasporogenesis. Which type of cell division occurs during these events? Name the structures formed at the end ofthese two events.

Ans: i) Difference between Microsporogenesis and Megasporogenesis.

No.	Microsporogenesis	Megasporozenesis
a.	It is the formation of microspores from microspore mother cells due to meiosis.	It is the formation of megaspores from a megaspore mother cell due to meiosis.
b.	Many spore mother cells are involved.	One spore mother cell is involved.
c.	Microspore leads to the development of male	Megaspore leads to the formation of female
d.	Occurs in Pollen sacs (microsporangia) in anther lobes.	Occurs in nucellus of ovule.

ii) **Type of cell division during micro sporogenesis and megasporogenesis: meiosis.**

iii) **Structure formed :**

a) **Due to microsporogenesis :** microspores (pollen grains) are formed which lead to development of male gametophyte.

b) **Due to megasporogenesis:** megaspores are formed. Out of them, one megaspore leads to the development of female gametophyte (embryo sac).

Q.42. Distinguish between Male gametophyte and Female gametophyte.

Ans:

No.	Male gametophyte	Female gametophyte
i)	It develops from a microspore.	It develops from a functional megaspore.
ii)	Initial development takes place in anther and finally	Entire development takes place in the ovule.
	completed after pollination on stigma.	
iii)	Many male gametophytes are formed per	Only one female gametophyte is formed per
	microsporangium. megasporangium.	
iv)	It is only 3 celled.	It is 7 celled.
v)	It comes out of pollen grain by forming a pollen tube.	It remains surrounded by the membrane of the megaspore.
vi)	It does not remain permanently inside the pollen sac.	It remains permanently in the nucellus.
vii)	It degenerates after fertilization.	It develops into endosperm and zygote after fertilization.

8.3 : Pollination : Types and agencies

Q.43.Define pollination. Enlist agents for pollination.

Ans:Pollination: The transfer of pollen grains from anther to the stigma of flower is called pollination. The two main agencies for pollination are as follows :

Abiotic agencies: Physical factors like wind and water which help in transfer of pollen grains from anther to stigma are called abiotic agencies.

Biotic agencies: Living organisms such as insects, birds, bats, etc are called biotic agencies.

Q.44. What are the two main types of pollination ?

Ans: Pollination is of two types - Self-pollination and Cross-pollination.

i) Self-pollination IAutogamy (auto = self; Gamos = marriage) :
It is the transfer of pollen grains from anther to the stigma of same flower or a different flower produced on the same plant.

ii) **Cross Pollination /Aliogamy** (allos = different; Gamos = marriage) :
It is the transfer of pollen grains from anther of a flower to the stigma of another flower produced on a different plant having dissimilar genetic make up, with the help of external agents like wind, water, insects, etc.

Q.45. What is self pollination ? Explain its types.

Ans:Self Pollination :

Self pollination is the transfer of pollen grains from anther to the stigma of same or genetically similar flower produced on the same plant.

It is possible only when anther and stigma mature simultaneously.

Self pollination is of 2 types :

i) **Autogamy** (Auto: self, gamos : marriage):

It is self pollination which occurs between anther and stigma of the same flower. e.g. Pea.

ii) **Geitonogamy** (Geiton: neighbour, gamos = marriage):
It is the transfer of pollen grains from anthers of one flower to stigma of another flower produced on the same plant. e.g. Cucurbits. Geitonogamy resembles cross pollination in the requirement of pollen transfer or pollinating agency.

Q.46. Give the advantages and disadvantages of self pollination.

Ans: Advantages :

i) It is a sure method with least chances of failure.
ii) Plants produced are genetically pure.
iii) Least wastage of pollen grains, hence economic method.
iv) No expenditure of energy to develop adaptations for pollination.

Disadvantages :

i) It is not possible to introduce a desirable character in the offsprings.
ii) It is not possible to eliminate an undesirable character from the offsprings.
iii) Continuous self pollination, generation after generation results in a weak progeny.
iv) Self pollination produces comparatively less number of seeds which are also of poor quality.
v) Seeds are less viable.
vi) Evolution is not possible as variations are not produced.

Q.47.What is cross pollination ? Explain its types.

Ans:Cross Pollination :

It is the transfer of pollen grains from anther of a flower to the stigma of another flower produced on a different plant having dissimilar genetic make up, with the help of external agents like wind, water, insects, etc. There are two sub-types of cross pollination:

i) Xenogamy :
It is the transfer of pollen grains from anther of a flower to the stigma of another flower produced on a different plant belonging to the same species. e.g. Papaya

ii) Hybridization :
It is the transfer of pollen grains from anther of a flower to the stigma of another flower produced on a different plant belonging to a different variety, sub-species or species. e.g. Pollination between two species or varieties of cotton.

Q.48.Define the terms: Allogamy and xenogamy.

Ans:Allogamy:

It is also called as cross pollination. It is the transfer of pollen grains from anther of a flower to the stigma of another flower produced on a different plant having dissimilar genetic make up, with the help of external agents like wind, water, insects, etc.

Xenogamy :

It is the transfer of pollen grains from anther of a flower to the stigma of another flower produced on a different plant belonging to the same species. e.g. Papaya

Q.49.Give the advantages and disadvantages of cross pollination.

Ans: Advantages:

i) Offsprings produced are healthier and are well adapted to the environment.
ii) Seeds are produced in large numbers with higher viability and of better quality.
iii) Possibility of variations results in new desired varieties of plants, hence favours the process of evolution.
iv) The offsprings show better vigour (hybrid vigour) and vitality.

Disadvantages:

i) The plants have to depend upon various external agencies.
ii) There is expenditure of energy due to the adaptations such as bright colour, nectar, fragrance, etc. in attracting insects.
iii) There is considerable wastage of pollen grains.
iv) Since cross pollination result in the formation of new genotypes, it may also develop undesirable characters in the progeny. Some desirable characters may get eliminated.
v) Genetic purity is not maintained.

Q.50. Enlist the floral adaptations for the following:

i) Anemophily

Ans:Floral adaptations for anemophily :

a) Pollination carried out by wind is called as anemophily.
b) Flowers are small, numerous, inconspicuous and not showy.
c) Inflorescence or flowers may be pendent so that they may swing.
d) Stamens possess long filaments and anthers are versatile.
e) Pollen grains are smooth, dry and light in weight.
f) Flowers bear well exposed stamens so that they can be easily dispersed by wind currents.
g) Pollen grains are produced in large numbers to compensate their wastage.
h) To catch pollen grains, the stigmas become sticky, hairy, feathery or branched.
i) Flowers are devoid of scent, nectar, etc.
e.g. Grasses, Maize, Jowar, Sugarcane, etc.

ii) Hydrophily

Ans:Floral adaptations for hydrophily :

a) Pollination carried out by water is called hydrophily.
b) Flowers are small, inconspicuous and unisexual.
c) Floral parts and pollen grains are unwettable, i.e. coated with mucilage.
d) In plants with submerged female flowers, the pollen grains have specific gravity equal to or slightly greater than water.
e) In plants with floating female flowers, the pollen-grains have specific gravity less than that of water.
f) Stigma is long and sticky.
g) Scent, colour and nectar absent in flowers.
e.g. *Vallisneria, Ceratophyllum*

iii) Entomophily

Ans: Floral adaptations for entomophlly :

a) Pollination carried out by insects is called as entomophily (bees are most common agents).
b) Flowers are large and attractive. When small, they are clustered into an inflorescence (e.g. sunflower).
c) Flowers have attractive bright colors, with pleasant fragrance and nectar gland.
d) In some plants, additional modifications are made to attract insects. e.g. Corona in passion flower and petalloid bracts in Bougainvillea.
e) Pollen grains possess spiny or rough outer wall.
f) Stigma has rough and sticky surface.
g) To favour insect pollination, some plants develop special mechanism e.g. liver mechanism in *Salvia. e.g. Jasmine, Rose, Salvia, Bougainvillea.*

iv) Ornithophily

Ans: Floral adaptations for ornithophily :

a) Pollination carried out by birds is called ornithophily.
b) Flowers are large with thick and fleshy floral parts.
c) Corolla is tubular or funnel shaped.
d) Flowers are with bright colours for attracting the birds.
e) Flowers lack fragrance as birds have poor sense of smell.
f) Pollen grains are sticky.
g) Large amount of sugary nectar produced by the flower is used as drink by the birds.
e.g. Callistemon (bottle brush), *Bignonia, Butea and Bombax* (silk cotton).
h. The commonly pollinating birds are: crow, bulbul, sunbirds and humming birds.

v. Chiropterophily

Ans: Floral adaptations for Chiropterophily :

a) Pollination takes place with the help of bats.
b) Flowers are large, stout enough so that bats can hold on to the flowers.
c) Chiropterophilous plants are nocturnal, i.e. open their flowers during night time.
d) Flowers emit rotten fruits like fermenting fruity odour.
e) Flowers have large number of stamens to produce a considerably large quantity of pollen grains.
e.g. *Anthocephallus* (Kadamb), *Adansonia* (Baobab tree), *Bauhinia.*

Q.51.Distinguish between Self and Cross pollination.
Ans:

No.	Self pollination	Cross pollination
i)	It is the transfer of pollen grains from anther to of the stigma of either the same or different flower present on the same plant.	It is the transfer of pollen grains from anther one flower to the stigma of another flower on a different plant.
ii)	Only one plant is involved.	Two plants are involved.
iii)	Both anthers and stigma mature at the same time.	Anthers and stigma mature at different times.
iv)	External pollinating agents are not required.	External pollinating agents are required to carry pollen grains.
v)	It is economical for the plant.	It is highly wasteful method.
vi)	There is no wastage of pollen grains.	There is wastage of pollen grains.
vii)	There is no wastage of energy for attracting pollinators.	There is wastage of energy for attracting pollinators.
viii)	It produces pure lines.	It gives rise to offspring having variations among themselves.
ix)	Useful characters are maintained by self pollination.	Useful characters may be diluted or eliminated.
x)	Adaptability to changed environment is absent due to absence of variability.	Plants are better adapted to changed environment due to introduction of variation.
xi)	Self pollination can occur even in closed flower.	It occurs only when the flowers are open.
xii)	Yield of the plant falls with time. It does not help in producing new races, varieties	Yield of the plant does not fall below an average. It helps in producing new races, varieties and
xiii)	and species and thus does not help in evolution.	even species and thus helps in evolution.

Q.52. Distinguish between flowers pollinated by biotic agents and by abiotic agents.
Ans:

No.	Flowers pollinated by biotic agents	Flowers pollinated by abiotic azents
i)	Flowers are large.	Flowers are small.
ii)	Flowers are brightly coloured and showy to attract agents.	Flowers are not brightly coloured or showy.
iii)	Produce nectar and fragrance.	Neither produce nectar nor fragrance .
iv)	Flowers produce comparatively less quantity of pollen grains. grains.	Flowers produce large quantity of pollen

Q.53. Distinguish between Anemophilous and Entomophilous flowers.
Ans:

No.	Anemophilous flowers	Entomophilous flowers
i)	Wind pollinated flowers	Insect pollinated flowers.
ii)	Size of flowers is small.	Size of flowers is large or present in groups to show conspicuous appearance.
iii)	Not brightly coloured.	Brightly coloured.
iv)	Odourless.	Usually odour/fragrance present.
v)	Nectar is not produced.	Nectar or edible pollen usually present.
vi)	Number of pollen grains produced inlarge quantity.	Number of pollen grains are less.
vii)	Stigma is branched or hairy.	Stigma is usually unbranched and sticky.
viii)	Pollination is non-directional.	Pollination is directional and highly specific .
ix)	Pollen grains are light and smooth.	Pollen grains are heavier and sticky.

Q.54.How can insects help in pollinating the *Salvia flower* ?

Ans:i) In *Salvia*, flower is bisexual and protandrous, i.e. anthers mature earlier than stigma.
ii) The two stamens of flower have long bifurcated connective.
iii) Upper branch of connective bears fertile anther lobe, while lower has sterile anther lobe.
iv) When an insect enters the flower, it pushes the lower sterile lobes. As a result, the upper fertile anther lobe bends down.
v) The fertile anther lobe comes in contact with back side of insect body and pollen grains are dusted there.
vi) When the same insect visits another flower with matured gynoecium, the pollen grains are picked up by the receptive stigma.
vii) This mechanism is called lever-mechanism or turn-pipe mechanism.

Q.55. Define: Hypohydrophily and Epihydrophily.

Ans:Hypohydrophily :

Pollination that takes place with the help of water below the water surface inhydrophytes bearing submerged female flowers is called hypohydrophily. e.g. *Zostera* and *Ceratophyllum.*

Epihydrophily :

When pollination occurs on the surface of water, it is called epihydrophily. e.g. *Vallisneria*

Q.56. How does pollination take place in *Vallisneria* ?

Ans:i) In *Vallisneria*, epihydrophily type of pollination takes place.
ii) *Vallisneria* is a dioecious plant (male and female flowers are produced on different plants) and flowers are submerged.
iii) At the time of maturity, the male flowers are detached from the male inflorescence and begin to float on water surface.
iv) The female flowers have coiled, long pedicel which undergoes uncoiling at the time of maturity and reaches the water surface.
v) The male flowers surround the female flower and undergo anthesis due to which pollen grains are deposited on the stigma of female flower and cross pollination is achieved.

Outbreeding devices

Q.57. What are the outbreeding devices that encourage cross pollination ?

Ans: Outbreeding devices that encourage cross pollination are:

i) **Unisexuality :** Flowers are unisexual and are present on different plants, thus promoting cross pollination.

ii) **Dichogamy :** In this, flowers are bisexual, anthers and stigma mature at different times. Dichogamy is of two types :

a) **Protandry :** Anthers mature first, but the stigma of the same flower is not receptive at that time. e.g. Sunflower, cotton and *Salvia.*

b) **Protogyny :** Stigma of carpel matures earlier than anthers of the same flower. e.g.Ranunculus and Mirabilis jalapa.

iii) **Self-sterility or self-incompatibility :** Pollen grains of a flower are incapable of effecting fertilization by inhibiting their germination on stigma. e.g. Potato, Tobacco and *Petunia axillaris.*

Q.58.Write a short note on Dichogamy.

Ans: In many plants, self pollination is avoided as stamens and carpels do not mature simultaneously. Such a condition is called Dichogamy. In some plants, pollen grains are released much before stigma becomes receptive (protandry e.g. Sunflower) and in some plants, stigma becomes receptive first (protogyny e.g. *Michelia*). In such conditions, self pollination cannot take place, thus Dichogamy encourages cross pollination.
Pollen-pistil interaction

Pollen - pistil interaction

Q.59.Draw a diagram of L.S. of pistil showing growth of pollen tube and explain pollen-pistil interaction.

Ans: Pollen-pistil interaction :

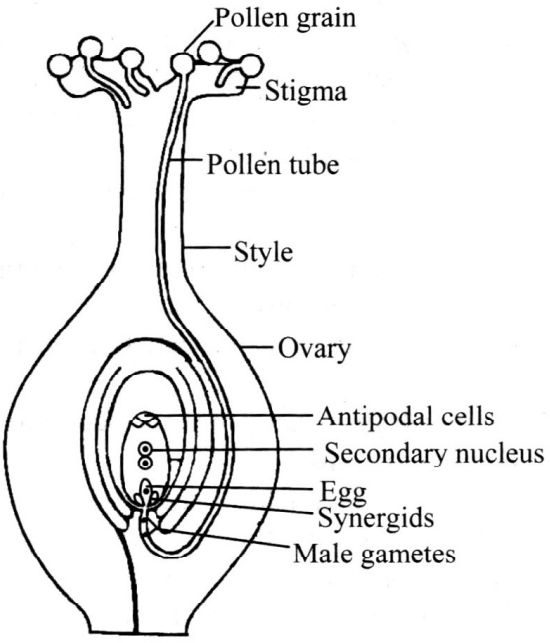
i) Following compatible pollination, the pollen grain germinates on the stigma and produces a pollen tube through one of the germ pores.
ii) The contents of the pollen grain move into the pollen tube.
iii) Pollen tube grows through the tissues of the stigma and style and reaches the ovary.
iv) Pollen tube, after reaching the ovary, enters the ovule through the micropyle and then enters one of

the synergids through the filiform apparatus.

v) Many recent studies have shown that filiform apparatus present at the micropylar part of the synergids guides the entry of pollen tube.

vi) All these events from pollen deposition on the stigma until the entry of pollen tube in the ovule are together referred to as pollen-pistil interaction.

vii) The ability of pistil to recognize the pollen is due to certain chemical components present in the pollen grain which interact with those of the pistil.



L.S. of pistil showing growth of Pollen tube

8.4 : Double Fertilization : Process and Significances

Q.60.What is 'double fertilization'? Describe it with the help of a neat and well labelled diagram. Give its importance. [Mar 2014]

Ans: Definition :

The fusion of one male gamete with egg and that of another male gamete with secondary nucleus is called as double fertilization. It is the characteristic feature of angiosperms. It was discovered by Nawaschin (1897) in *Lilium martagon* plant.

It consists of two processes:

a) Syngamy :

It is the fusion of first male gamete with egg. It results in the formation of diploid zygote which develops to form embryo. It is also called generative fertilization.

b. Triple Fusion :

It is the fusion of second male gamete with secondary nucleus. It results in the formation of triploid PEN (Primary Endosperm Nucleus) which develops to form endosperm. Since both male gametes participate in fertilization, it is called double fertilization.

Process of double fertilization is described as follows :

i) After pollination, the intine of the pollen grain forms pollen tube and passes through the germ pore.

ii) The growth of pollen tube is stimulated by the sugary substance produced on the stigma.

iii) The pollen tube with two male gametes and tube nucleus runs through the style and finally turns towards the micropylar end of the ovule in the cavity of the ovary.

iv) The length of the pollen tube depends on the length of style.

v) When the pollen tube enters through the micropylar end of the ovule for fertilization, it is called

porogamy (sometimes it may enter through integuments and called as **mesogamy** or sometimes through chalaza and called as **chalazogamy**).

vi) Filiform apparatus of synergids attract the pollen tube towards egg apparatus.

vii) As the pollen tube elongates, it carries with it two haploid, non-motile male gametes and hence, the fertilization is also called **siphonogamy** (siphon = tube).

viii) On piercing the nucellus, the pollen tube penetrates the embryo sac. Its tip penetrates the embryo sac and reaches the egg apparatus passing either between the egg and synergids or between one synergid and wall of embryo sac.

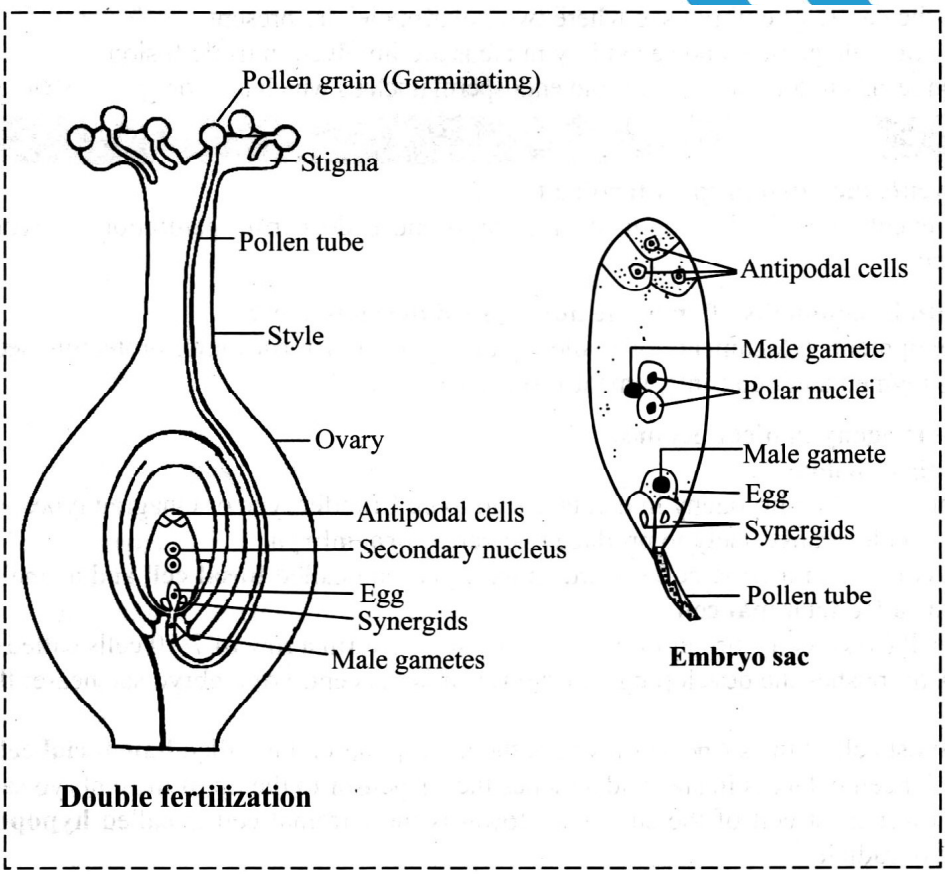
ix) Ultimately, the tip of the pollen tube bursts and two male gametes are released.

x) The tube nucleus degenerates before bursting of the pollen tube.

xi) One of these male gametes fuses with the egg cell or oosphere causing fertilization, as a result of which diploid oospore or zygote is formed. This is called **first fertilization or syngamy.**

xii) The other male gamete fuses with the secondary nucleus forming the triploid endosperm nucleus which later on gives rise to endosperm. This is called as **triple fusion or second fertilization.**

xiii) Thus, this process of fertilization which occurs twice in the same embryo sac at a time by two male gametes (syngamy and triple fusion) is called **double fertilization.**



Double fertilization

Significance of double fertilization :

i) Both male gametes are utilized.

ii) Syngamy results in the formation of zygote which gives rise to the embryo.

iii) Due to formation of zygote, diploid condition is restored.

iv) As male and female gametes fuse, there is recombination of maternal and paternal characters, which results in variation.

v) Double fertilization triggers embryonic development, which leads to the formation of seed and fruit.

vi) Seeds are viable with high percentage of germination.

vii) Endosperm is situated in the vicinity of the embryo and hence, food is readily available to the growing embryo.

Q.61.Define the terms: Siphonogamy and syngamy

Ans: Siphonogamy (siphon = tube) :

The process offertilization in which the pollen tube carries (with it two haploid non-motile male gametes to the female gamete (egg) is called siphonogamy.

Syngamy :

The fusion of one male gamete with the egg cell or oosphere causing fertilization, as a result of which diploid oospore or zygote formed is called syngamy or first fertilization.

Q.62. What is the difference between syngamy and triple fusion taking place during double fertilization?

Ans: In syngamy, one male gamete fuses with the female gamete/egg to form diploid zygote. In triple .fusion, another male gamete fuses with secondary nucleus to form triploid primary endosperm nucleus.

Q.63.What is the ploidy level of endosperm in Angiosperms ?

Ans: Endosperm formed during double fertilization is triploid.

Q.64.What is triple fusion? Where and how does it take place? Name the nuclei involved in triple fusion.

Ans: i) Fusion of second male gamete with secondary nucleus (formed due to fusion of two polar nuclei) is called triple fusion.
ii) It occurs in the centre of embryo sac where two polar nuclei are present.
iii) The nucleus of male gamete and secondary nucleus are involved in triple fusion.
iv) Triple fusion results in formation of triploid endosperm nucleus which later on gives rise to endosperm.

8.5 : Post fertilization Changes

Q.65.Which are the events included in 'post fertilization'?

Ans: Post fertilization events include development of embryo and endosperm, maturation of ovules into seeds and ovary into fruit.

Q.66.What happen with integuments of an ovule during seed development ?

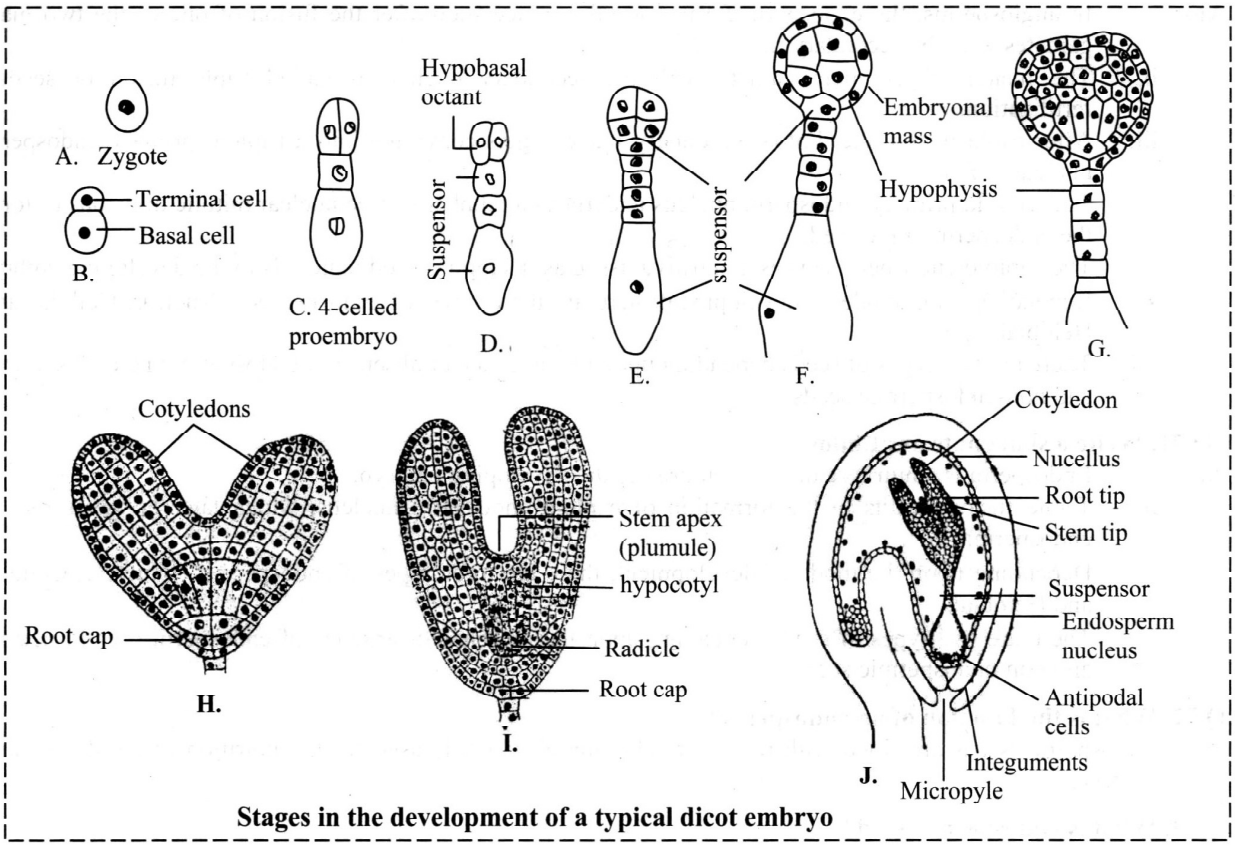
Ans: During seed development, integuments of ovule become hard and form tough protective seed coat. Inner integument forms tegmen and outer integument forms testa.

Q.67.Describe the embryogeny in dicotyledons.

Ans: Embryogeny in dicotyledons :

The most common type of embryogeny in dicots is said to be Crucifer type or Onagrad type.

i) The zygote divides transversely to produce two celled **proembryo.**
ii) Pro embryo consists of a large cell towards micropylar end called **basal cell** and a small cell towards chalazal end called **terminal cell.**
iii) Suspensor cell (basal cell) further divides transversely to form a row of 7-10 cells called **suspensor.**
iv) The suspensor, pushes the developing embryo towards the centre of embryo sac nearer the developing endosperm.
v) The upper most cell of the suspensor towards the micropylar end is called **haustorial cell.**
vi) The haustorial cell enlarges in size and attaches the suspensor to the tip of the embryo sac.
vii) While the lower most cell of the suspensor towards the terminal cell is called **hypophysis**. It give rises to part of radicle.
viii) The terminal cell divides by a vertical division at right angle to the first one to form 4-celled embryo (quadrant). Each of the four cells divide by transverse wall giving rise to 8 celled stage (octant) called embryonal mass.
ix) Four cells towards the suspensor form the hypocotyl and plerome of radicle. The four terminal cells form plumule and cotyledons.
xi) By further divisions, embryonal mass becomes globular and heart shaped (cordate).
xii) The two lobes later develop into two cotyledons, while a group of cells present in the groove of two lobes forms the plumule.
xiii) Embryo with 2 cotyledons is called dicot embryo. e.g. Mango, China



Stages in the development of a typical dicot embryo

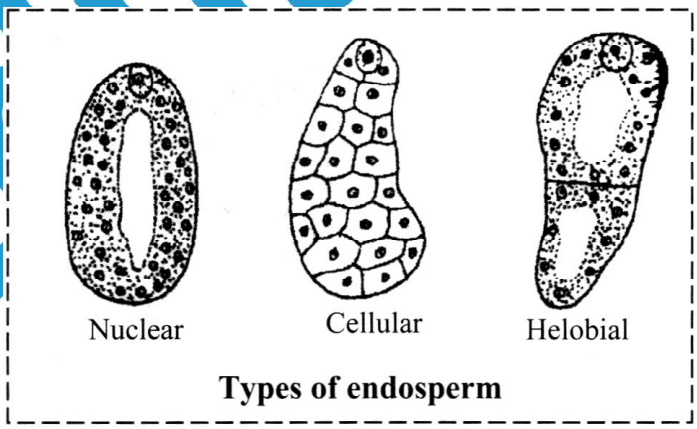
Q.68.What are the developmental stages of an angiospermic embryo ?

Ans: Pro embryo, globular embryo, heart shaped embryo and mature embryo are the developmental stages of an angiospermic embryo.

Q.69.Describe the three types of endosperm.

i) The endosperm are of three types :

Nuclear type :



Types of endosperm

In this type, the first division of PEN and few subsequent nuclear divisions are not accompanied by wall formation. The nuclei produced are free in the cytoplasm of embryo sac and they remain free indefinitely. Wall formation may take place later in coconut. Cell wall formation of endosperm is never found complete. e.g. Maize, Wheat, Rice, Sunflower.

ii) Cellular type :

In this case, after each nuclear division, cell wall formation takes place. So, the endosperm is of cellular form. e.g. Datura, Petunia, Balsam.

iii) Helobial type :

It is an intermediate type between nuclear and cellular type. First division is accompanied by division of cytoplasm but subsequent divisions are free nuclear. The chamber towards micropylar end is usually larger than the chamber towards chalazal end. e.g. Eremurus, Asphodelus, Vallisneria.

Q.70.Describe the development of endosperm in angiosperms.

Ans:i) In angiosperms, the endosperm formation takes place soon after the fusion of one of the two male gametes with the secondary nucleus.

ii) The fusion of the male gamete with the secondary nucleus is called triple fusion or second fertilization.

iii) After triple fusion, the diploid secondary nucleus gets converted into a triploid primary endosperm nucleus (PEN).

iv) The triploid primary endosperm nucleus undergoes a number of free nuclear mitotic divisions to form the endosperm of the seed.

v) The triploid endosperm acts as a nutritive tissue as it supplies food materials to the developing embryo.

vi) Depending upon mode of development there are three types of endosperms - Nuclear, Cellular and Helobial type.

vii) There are two types of seeds depending upon the presence or absence of endosperm, viz. endosperrnic and non-endospermic seeds.

Q.71. Write a short note on: Endosperm.

Ans:i) Endosperm is a nutritive tissue. It nourishes the developing embryo.

ii) Triple fusion results in the formation of triploid endosperm nucleus, which later on gives rise to endosperm.

iii) Depending upon the mode of development, there are three types of endosperms – Nuclear, Cellular and Helobial.

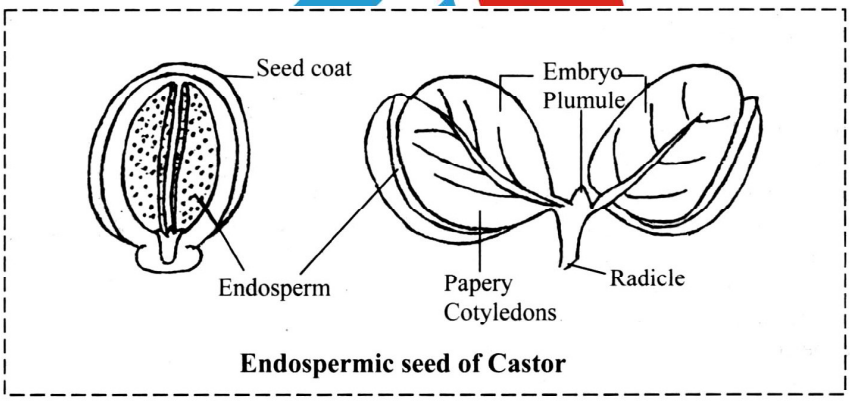
iv) There are two types of seeds depending upon the presence or absence of endosperm – endosperrnic and non-endospermic seeds.

Q.72.What is the function of an endosperm?

Ans: Endosperm tissues are filled with reserve food material which is used for the nutrition of the developing embryo.

Q.73.What is endospermic seed ?

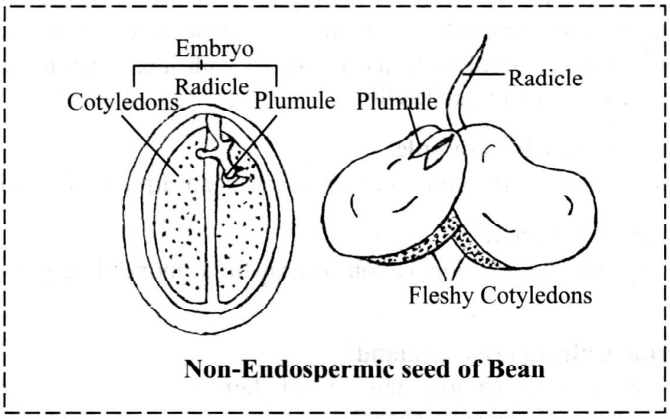
Ans: In some seeds, the endosperm is not absorbed by the embryo. Thus in the final seed, the endosperm is present and hence the cotyledons remain thin and papery. Such seeds are called endospermic or albuminous seeds. e.g. Maize, Castor.



Endospermic seed of Castor

Q.74. What is non-endospermic seed ?

Ans: Sometimes, the endosperm is absorbed by the developing embryo completely. Thus, in the seed, the endosperm is absent and the cotyledons become fleshy to store the reserve food. Such seeds are called nonendospennic or ex-albuminous seeds. e.g. Bean, Pea.



Non-Endospermic seed of Bean

Q.75.Classify the follwing into endospermic and non endospermic seeds: Sunflower, pea, bean, castor, maize, coconut, gram.

Ans: Endospennic seed: Castor, Sunflower, Coconut, maize on-endospermic seed: Pea, Bean, gram.

Q.76.Describe the post fertilization changes with reference to ovule and ovary.

Ans: After fertilization, a series of changes occur in the ovule and ovary to form seeds and fruits along with development of embryo and endosperm. These changes are known as post fertilization changes.

Post fertilization changes with reference to ovule :

i) A seed is a fertilized mature ovule that possesses an embryonic plant, stored food (sometimes absent) and a protective coat or coats.

ii) An ovule develops into seed after some changes. The two integuments develop into seed coats. The outer one is called testa and inner one is tegmen. Some post fertilization changes are:

a) Ovule (megasporangium) forms seed.
b) Ovary (carpel) forms fruit.
c) Egg cells forms embryo.
d) Nucellus forms perisperm.
e) Secondary nucleus forms endosperm.
f) Outer integument forms Testa (i.e. outer seed coat).
g) Inner integument forms Tegmen (i.e. inner seed coat).
h) Micropyle forms an opening in the seed (i.e. micropyle).

Post fertilization changes with reference to ovary :

A fruit is regarded as a mature or ripened ovary. Ovary wall develops to form an outer covering known as pericarp which consists of epicarp, mesocarp and endocarp.

Parthenocarpy

Q.77. What is parthenocarpy ?

Ans:i) Parthenocarpy (Parthenos=virgin; karpos=fruit) is the production and development of seedless fruits.

ii) In some plants, fruits are formed even in absence of pollination and fertilization. Such fruits are always seedless, succulent and more desirable than normal seed containing fruits.

iii) Parthenocarpy is of two types;

a) Natural parthenocarpy :
When seedless fruits are produced in the absence of pollination and fertilization, the phenomenon is called natural parthenocarpy. Eg. Banana.

b) Induced parthenocarpy :
When seedless fruits are produced by spraying the flowers with growth promoting hormones such as Indole Acetic Acid (IAA), Naphthalene Acetic Acid (NAA), Gibberellins, etc. Eg. Tomato produces seedless fruits, if treated with auxin, while grape vine forms seedless fruits on being treated with gibberellin.

Q.78.What is parthenocarpic fruit? Give example.

Ans: The fruit which develops without fertilization is called as parthenocarpic fruit. e.g. Banana.

Q.79.How can parthenocarpy be induced?

Ans: Parthenocarpy can be induced through application of growth hormones like gibberellins. Fruits produced through parthenocarpy are seedless.

Q.80.Why are parthenocarpic fruits in great demand ?

Ans: Parthenocarpic fruits are formed without the act of fertilization, hence these fruits are seedless. Parthenocarpic fruits like banana, grapes, pineapple are therefore in great demand, since they are preferred by consumers.

Q.81.If one can induce parthenocarpy through the application of growth substances, which fruits would you select to induce parthenocarpy and why ?

Ans: Parthenocarpic fruits are seedless. Because seedless fruits in plants like banana, grapes and guava are in great demand, the process is of practical value. Apomixis and Polyembryony

Q.82.What is apomixis and what is its importance ?

Ans: Apomixis (apo = without; mixis = mixing) :

i) It is an asexual mode of reproduction in which new individuals are formed without formation of gametes and their fusion.

ii) Thus, apomixis is a form of asexual reproduction that mimics sexual reproduction in higher plants.

iii) The organism that can reproduce by apomixis is callea as an apomict.

iv) It has been reported particularly in grasses and also in few flowering plants of family Asteraceae.

Importance:

i) Rapid development of new hybrid varieties is possible due to apomixis.

ii) Apomictic varieties do not change their genetic make-up and thus 'breed true'.

Q.83.Explain the process of polyembryony.

Ans: Polyembryony :

i) Polyembryony was first discovered by Leeuwenhoek (1719) in Citrus.

ii) It is the presence of more than one embryo in the seed. It occurs due to the presence of more than one egg cell in the embryo sac or more than one embryo sac in the ovule and possibly the fertilization of all the egg cells.

iii) In some cases, a number of embryos may develop simultaneously from different parts of the ovules, like synergids and antipodal cells, from tissues of nucellus and integuments.

iv) Onion, groundnut, mango, lemon and orange are some of the examples of polyembryony.It is very common in conifers (Gymnosperms).

Q.84.How does banana and orange fruit differ from each other with respect to seeds ?

Ans: Banana is a natural parthenocarpic fruit thus it is seedless, whereas seed of orange contains many embryos, thus showing polyembryony.

Significance of eeds and fruits

Q.85.What ha led to the conquest of land by angiosperms?

Ans: The distribution and dominance of angiosperms on the earth is due to seeds. Success of seeds as propagule is done due to following characteristics :

i) Dormancy: It is the temporary suspension of growth. One of the factors which control dormancy is the presence of certain growth inhibitors in the seeds which prevent germination. During this period, seeds are dispersed at different places (Zygote produced by Cryptogams, germinate immediately).

ii) Viability: It is the functional ability of seeds to germinate after considerable dormancy period. Germination can be delayed till the onset of favourable conditions.

iii) Reserve food: Fully developed embryo is nourished by food stored in either endosperm or cotyledons during germination of seed and a seedling is produced. .

iv) Protective coat: Testa, the outer, hard seed coat, gives protection against the mechanical shocks, fluctuations in temperature and dry conditions. Animals eat fruits and either throwaway seeds or if are consumed, they are not digested due to the hard seed coat and are removed through excreta.

v) Dispersal: Some seeds produce various structures like wings, pappus calyx (persistent and hairy), hooks or sticky substances, and seeds are actively or passively transported to distant places.

vi) Edible fruits: Many fruits are consumed by different organisms and seeds are thrown. Thus, development of fruits and seeds play significant role in the spread of the species.

Additional Theory Questions :

Q.1 What is amphimixis ? [Oct 2013] *Refer Q.l. (ii)*

Q.2. What is vegetative reproduction? Describe any 'three' natural methods of vegetative reproduction

with examples. [Oct 2014] *Refer Q.3 and 4.*

Q.3. Describe any four natural methods of vegetative propagation in angiosperms with suitable diagram. *Refer Q.4.*

Q4. Explain different methods of natural vegetative reproduction with example and labelled diagrams.[Mar 2013 Old Course] *Refer Q.4.*

Q.5. Explain natural vegetative propagation through leaves giving example. *Refer Q.4 d)*

Q.6. Define stock and scion. *Refer Q.9. (i and ii)*

Q.7. Give the significance of vegetative propagation. *Refer Q.13*

Q.8. Sketch and label the V.S. of typical flower. Refer Q.18.

Q.9. Describe the T.S. of anther. *Refer Q.21.*

Q.10.Sketch and label T.S. of anther. *Refer Q.21.*

Q.11.Sketch and label pollen grain. *Refer Q.23.*

Q.12. Sketch and label male gametophyte in angiosperms. *Refer Q.30.*

Q.13.Describe the structure ofa mature anatropous ovule. *Refer Q.32.*

Q.14. Sketch and label V. S. of anatropous ovule. [Oct 2013] *Refer Q.32.*

Q.15.Describe the development of female gametophyte in angiosperms. *Refer Q.35.*

Q.l6. Write a note on embryo sac. *Refer Q.37.*

Q.17.Sketch and label embryo sac. *Refer Q.37.*

Q.18. What is meant by monosporic development offemale gametophyte? *Refer Q.40.*

Q.19.Describe autogamy and allogamy. *Refer Q.44.*

Q.20. Give advantages of self pollination. [Oct 2013] *Refer Q.46.*

Q.21. Enlist the merits and demerits of self and cross pollination. *Refer Q.46 and 49.*

Q.22. Write short notes on:

i) **Anemophily** *Refer Q.50 (i)*

ii) **Hydrophily** *Refer Q.50 (ii)*

iii) **Entomophily** *Refer Q.50 (iii)*

iv) **Omithophily** *Refer Q.50 (iv)*

v) **Chiropterophily** *Refer Q.50 (v)*

Q.23. Give the scientific term used for insect pollinated plants and one example. *Refer Q.50 (iii).*

Q.24.Give two floral adaptations of bird pollinated plants. *Refer Q.50 (iv).*

Q.25.Define geitonogamy and xenogamy. Give advantages of self pollination and cross pollination. Explain how dichogamy favours cross pollination. [Mar 2013] *Refer Q.45 (ii), 47 (i), 46, 49 and 58.*

Q.26.Explain double fertilization and give its significance. *Refer Q.60.*

Q.27. Give the significance of double fertilization. *Refer Q.60.*

Q.28. What is syngamy? *Refer Q.61.*

Q.29.Define triple fusion. *Refer Q.64 (i).*

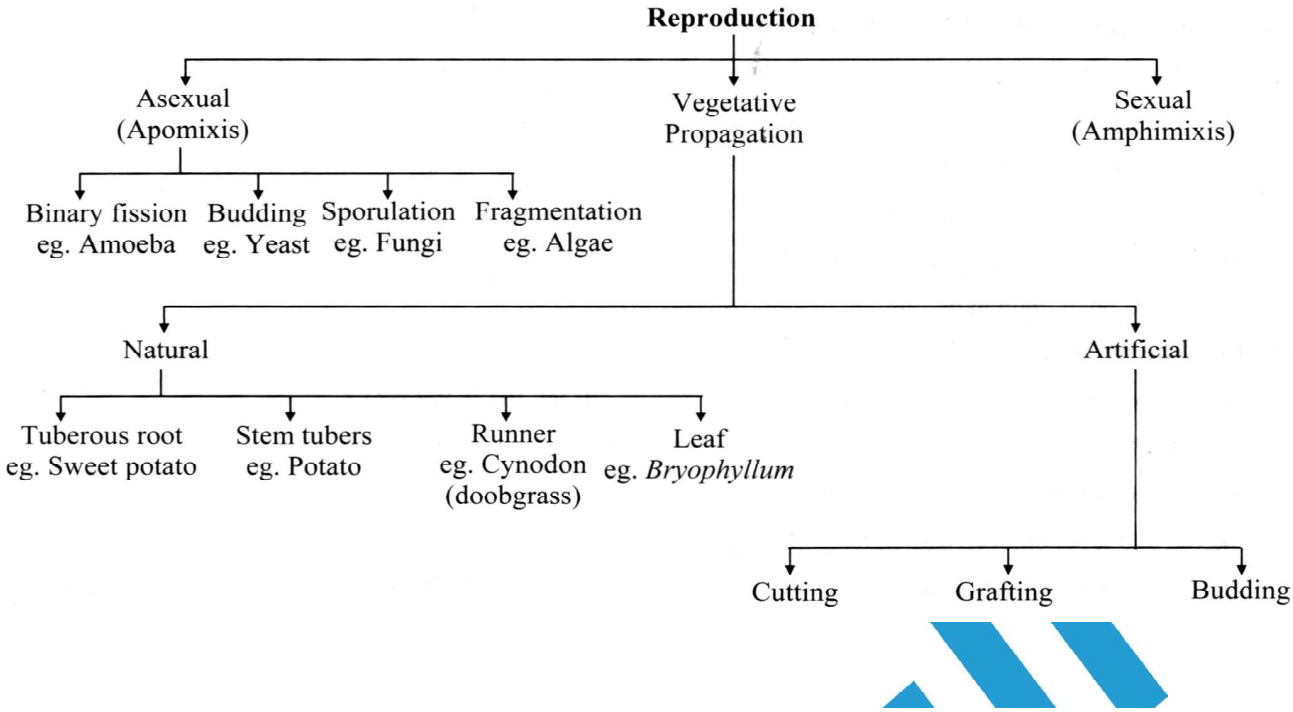
Q.30. Name the nuclei taking part in triple fusion. *Refer Q.64 (iii).*

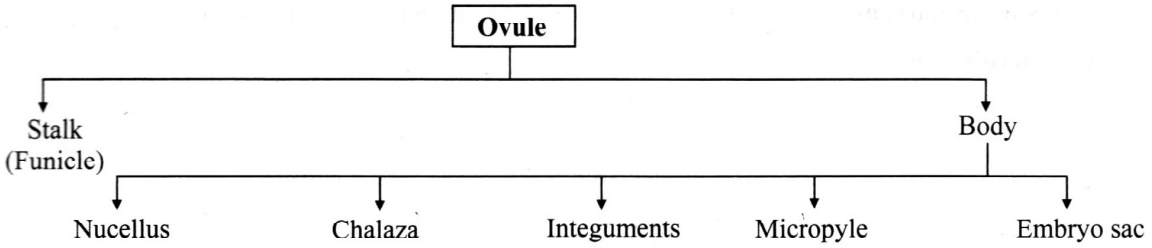
Q.31. Write short note on: Triple fusion. *Refer Q.64.*

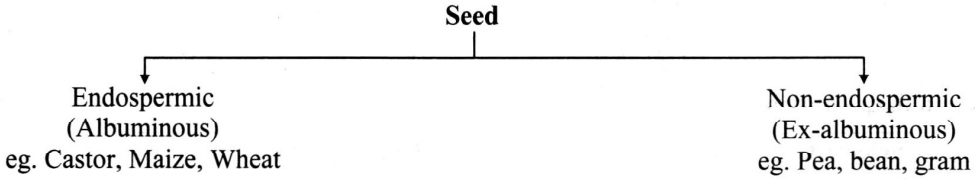
Q.32. Describe the development of embryo in angiosperms. *Refer Q.67.*

Q.33. What are endospermic and non endospermic seeds? Give one example of each. *Refer Q.73 and 74.*

Quick Review :







Sexual Reproduction

Flower: specialized reproductive shoot

Non- essential Whorls

Calyx (Made up of sepals)

* Sepals fused – Gamosepalous
* Sepals free – Polysepalous

Corolla (Made up of petals)

* Petals fused – Gamopetalous
* Petals free – Polypetalous

Essential Whorls

Androecium (Made up of stamens)

(Stamen = Filament + Anther + Connective)

* Stamens fused – Synandrous
* Stamens free – Polyandrous

Gynoecium (Made up of carpels)

(Carpel = Ovary + Style + Stigma)

* Apocarpous – free carpels
* Syncarpous – fused carpels

- **Pollination**

i)	Pollination	Transfer of pollen grains from anther to stigma		
ii)	Autogamy	Types of self-pollination		
iii)	Geitonogamy			
iv)	Entomophily	Pollination by Insects	Biotic agents	Types of Cross pollination
v)	Omithophily	Pollination by birds		
vi)	Chiropterophily	Pollination by Bats		
vii)	Malacophily	Pollination by Snails		
viii)	Ophiophily	Pollination by Snakes		
ix)	Anemophily	Pollination by Wind	Abiotic agents	
x)	Hydrophily	Pollination by water		

- **Fate of various parts of a flower at the time offruit formation (After fertilization)**

Before fertilization	After fertilization
Ovary	Fruit
Ovule	Seed
Outer integument	Testa
Inner integument	Tegmen
Funicle	Stalk of seed
Egg	Zygote/embryo
Secondary nucleus	PENlEndosperm
Svnergids	Degenerate
Antipodals	Degenerate
Hilum	Scar
Nucellus	Perisperm

- **Scientists and their contribution**

No.	Scientists	Contribution	Year
i)	Rudolph Camevarius	First to describe sexual reproduction in plants	1694
ii)	Ubisch	Discovered the role of tapetum in anthers of angiosperms	-
iii)	Hanstein	First to study early development of embryo	-
iv)	Panchanan Maheshwari	Great plant embryologist of India. Introduced embryology of Angiosperms	
v)	A.V. Leeuwenhoek	First discovered polyembryony in Citrus	1719

Multiple Choice Question

1. Sexual reproduction-is also called
a) apomixis b) cross pollination
c) amphimixis d) both (b) and (c)

2. Which of the following plant is not propagated by root tuber ?
a) Sweet potato b) *Dalbergia*
c) Guava d) Onion

3. Which of the following is not a stem modification ?
a) Stolon b) Rhizomes
c) Bulbils d) Tuber of sweet potato

4. In Bryophyllum, the vegetative takes place through
a) stem b) grafting
c) leaves d) root

5. Rose plant cannot be propagated by
a) stem cutting b) budding
c) grafting d) root cutting

6. In vegetative reproduction, when two different individuals participate then it is called, ___
a) Layering b) Grafting
c) Cutting d) Doubling

7. In grafting, the rooted plant is used as a
a) Scion b) Stock
c) Stem d) Root

8. The part which is being grafted is called
a) stock b) scion
c) graft d) both b) and c)

9. The success of grafting depends upon the union of
a) cambium b) meristem
c) phloem d) phellogen

10. The highly condensed and swollen tip of the pedicel in a flower is called
a) stalk b) thalamus
c) internode d) node

11. Gynoecium and Androecium are called
a) outer whorls
b) accessory whorls
c) reproductive whorls
d) non-essential whorls

12. Gynoecium consists of
a) Stamen b) carpel
c) pistil d) both (b) and (c)

13. When the flower has all the four whorls, it is called____. flower.
a) complete b) bisexual
c) both (a) and (b) d) unisexual

14. Male gametophyte is formed from
a) stamen b) pollen grain
c) epidermis d) endothecium

15. The pollen sacs receive from
a) endothecium b) tapetum
c) epidermis d) sporogenous tissue

16. The outer wall of pollen grain is
a) exme b) intine
c) germpore d) testa

17. In sunflower, self pollination is avoided by
a) protogyny b) unisexuality
c) self sterility d) protandry

18. Which cell gives rise to the two male gametes?
a) Germ pore b) Vegetative cell
c) Generative cell d) Tube cell

19. Stalk of the ovule is called
a) funicle b) hilum
c) raphae d) placenta

20. Ovule attaches to the stalk at a point called
a) funicle b) hilum
c) raphae d) placenta

21. The base of the ovule is called
a) chalaza b) raphae
c) micropyle d) placenta

22. In Angiosperms, the common type of ovule is
a) Anatropous b) Orthotropous
c) Hernianatropous d) Campylotropous

23. ____acts as an entry for pollen tube.
a) Nucellus b) Micropyle
c) Synergids d) Funicle

24. At the time of fertilization, the ovule is
a) 7 – celled b) 8 – celled
c) 6 – celled d) 9 – celled

25. An angiospermic plant has to produce 88 viable ovules. How many meiotic divisions will be needed to produce equal number of female gametophytes by this plant?
a) 88 b) 22
c) 44 d) 132

26. How many meiotic divisions are required for the formation of 100 seeds? **[Oct 2013]**
a) 25 b) 50
c) 100 d) 125

27. For formation of 50 seeds, how many minimum meiotic divisions are necessary ? **[Mar 2014]**
a) 25 b) 50
c) 75 d) 63

28. At the time of fertilization, the ovule is nucleated._____
a) 6 b) 7
c) 8 d) 9

29. When pollen grains are transferred from anther to stigma of another flower of the same mother plant, it is called
a) autogamy b) geitonogamy
c) xenogamy d) allogamy

30. The cross pollination within the same species is also called
a) hybridization b) xenogamy
c) allogamy d) autogamy

31. In anemophilous flowers, pollen grains are
a) dry b) moist
c) sticky d) few in number

32. Which of the following IS not an anemophilous flower ?
a) Grass b) Maize
c) Sorghum d) Ceratophyllum

33. In anemophilous flower, stigma is
a) pentafid b) feathery
c) smooth d) winged

34. In Vallisneria, pollination occurs
a) on the surface of water.
b) below the surface of water.
c) through wind.
d) deep in water.

35. Which of the following is not an entomophilous flower?
a) Salvia b) Hibiscus
c) Helianthus d) Hydrilla

36. In entomophily, insects visits flowers for
a) nectar b) colour
c) corolla d) calyx

37. Bird pollinated flowers are
a) without colour b) small
c) scentless d) without nectar

38. In bisexual flowers, maturation of gynoceium before androecium is known as___. **[Mar 2014]**

39. Pollination through bats is called
a) Chiropterophily b) Ornithophily
c) Entomophily d) Ophiophily

40. Secondary nucleus is also known as
a) Generative nucleus b) Tube nucleus
c) Definitive nucleus
d) Primary endosperm nucleus

41. In Angiosperms, free nuclear divisions compulsorily take place during
a) endosperm development
b) embryo development
c) female gametophyte development
d) male gametophyte development

42. During fertilization, male gametes are carried by pollen tube. This is called **[Oct 2013]**
a) Syngamy b) Mesogamy
c) Polygamy d) Siphonogamy

43. When the pollen tube pierces through integuments, it is called
a) porogamy b) siphonogamy
c) chalazogamy d) mesogamy

44. The fusion of egg cell with male gamete is called
a) siphonogamy b) syngamy
c) porogamy d) mesogamy

45. In a recently fertilized ovule, the haploid, diploid and triploid conditions are respectively seenm
a) endosperm, nucellus, egg
b) egg, nucellus, endosperm
c) antipodals, oospore, primary endosperm nucleus
d) polar nuclei, secondary nucleus, endosperm

46. Second male gamete fuses with
a) antipodals b) synergids
c) secondary nucleus d) degenerates

47. The uppermost cell of suspensor forms
a) haustorial cell b) quadrant
c) plumule d) hypocotyl

48. Albumin is also known as
a) pensperm b) synergids
c) plumule d) endosperm

49. The endosperm having no wall formation around nucleus is called endosperm.
a) nuclear b) cellular
c) helobial d) locular

50. The coconut water is
a) plerome b) endosperm
c) embryo d) chalaza

51. Fruit wall is also called as
a) pericarp b) epicarp
b) mesocarp d) endocarp

52. Growth promoting substance used to induce parthenocarpy is
a) agar b) gibberellin
c) kinetin d) ABA

53. Polyembryony occurs in
a) Maize b) Corchorus
c) Citrus d) Carthamus

54. Formation of seedless fruit is called as
a) Gymnocarpy b) Apocarpy
c) Angiocarpy d) Parthenocarpy

55. Wind pollinated flowers are
a) small, scented and colurless
b) small, non-scented and colourless
c) big, scented and coloured
d) big, non-scented and colourless

Answer Keys

1. c)	**2.** d)	**3.** d)	**4.** c)	**5.** d)	**6.** b)	**7.** b)	**8.** d)	**9.** a)	**10.** b)
11. c)	**12.** d)	**13.** c)	**14.** b)	**15.** b)	**16.** a)	**17.** d)	**18.** c)	**19.** a)	**20.** b)
21. a)	**22.** a)	**23.** b)	**24.** a)	**25.** a)	**26.** d)	**27.** d)	**28.** c)	**29.** b)	**30.** b)
31. a)	**32.** d)	**33.** b)	**34.** a)	**35.** d)	**36.** a)	**37.** c)	**38.** b)	**39.** a)	**40.** d)
41. c)	**42.** d)	**43.** d)	**44.** b)	**45.** c)	**46.** c)	**47.** a)	**48.** d)	**49.** a)	**50.** b)
51. a)	**52.** b)	**53.** c)	**54.** d)	**55.** b)					