XII

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SEXUAL REPRODUCTION IN FLOWERING PLANTS

SYLLABUS

Flower structure; Development of male and female gametophytes; Pollination-types, agencies and examples; Outbreeding devices; Pollen-Pistil interaction; Double fertilization; Post fertilization events-Development of endosperm and embryo, Development of seed and formation of fruit; Special modes-apomixis, parthenocarpy, polyembryony; Significance of seed and fruit formation.

KEY CONCEPTS

INTRODUCTION

* Angiosperm originated either in the beginning of Cretacious period or in ending of Jurassic period of Mesozoic era. It means they are originated between Cretacious and Jurassic period on the earth.
* Angiosperm dominated over the earth in Coenozoic era. So this era is known as "Golden Period of Angiosperms".
* First of all N.Grew realized the fact, Stamens are male sex organ of flower (Anatomy of plants)
* Sexuality in plant first of all reported by Jacob Camerarius.
* He reported Anthers are the male sex organ and Ovary with style and stigma are female sex organ, and for the formation of seed, interaction is essential in between both the sex organs.
* Significance of pollination and role of insects in pollination was recognized by Josheph Kolreuter.
* **C.F. Wolf** - Father of plant Embryology.
* **Prof. P. Maheshwari**- Father of Indian plant Embryology. He wrote a book - 'An Introduction to Embryology of Angiosperms'.
* Floriculture – Science of cultivation, breeding and marketing of flowers.
* Most of the important Angiospermic characters are found in Capsella so that for the study of Angiosperms, it is considered as a **"Typical Angiosperm".**
* It is an annual plant and grows as weed during the winter season in the field.
* The main plant of the Capsella is a **sporophyte** (diploid) and it is differentiated into root, stem and leaves.
* Capsella is a **heterosporous** plant it means two different types of spores are formed in the life cycle which are classified into two categories in which male spores are called **Microspores** and female spores are called **Megaspores**.
* The process of reproduction takes place in this plant through a special structure, called flower.
* **Calyx, Corolla, Androecium** and **Gynoecium** are present in the typical or complete flower.

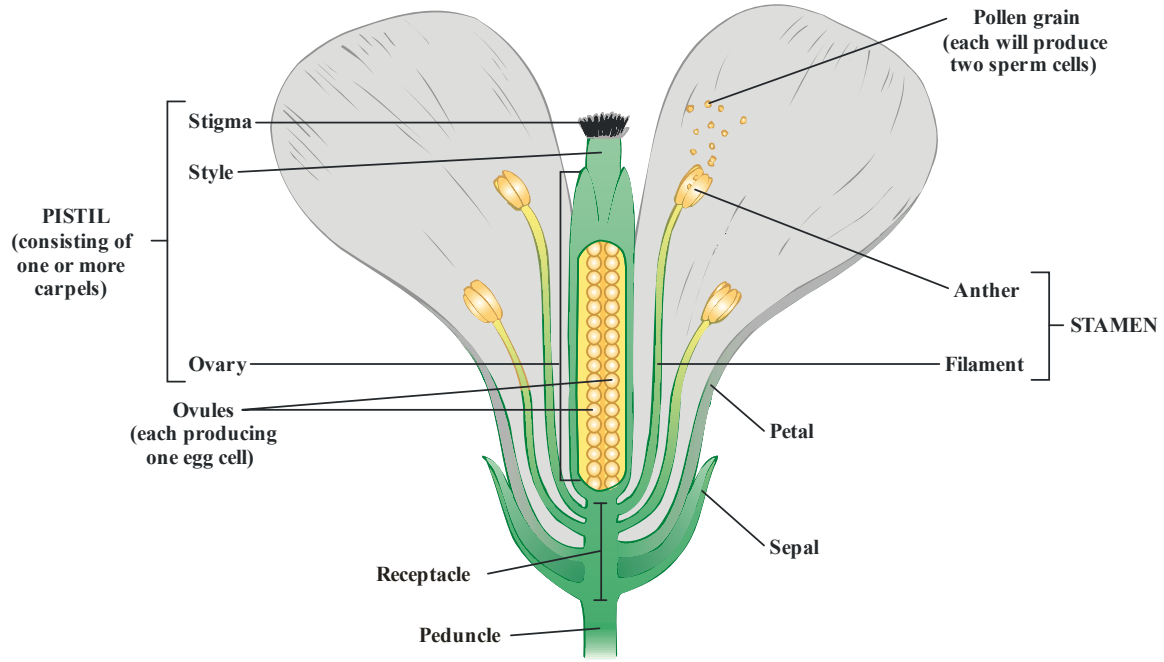


Figure : Cutaway view of an *Arabidopsis* flower. Each flower has four sepals (two are shown), four petals (two are shown), six stamens, and one long pistil. Four of the stamens are long, and two are short (two long and two short are shown). Pollen grains develop within sacs in the anthers. In Arabidopsis, the compound pistil consists of two carpels that each contain numerous ovules.

* The calyx (consists of sepals) and corolla (consists of petals) are termed accessary whorls of the flower. Because these structures do not participate in the process of reproduction, only helps.
* The androecium (consists of stamens-Male unit) and gynoecium (consists of carpels-Female unit) are known as essential whorls, because they are directly related with the reproduction.

FLOWER IS A MODIFIED SHOOT

* According by Goethe, flower is modified shoot.
* Flower has a stalk like - structure called pedicel.
* Free end of the pedicel is flattaned or dome shaped which is called **thalamus**. The thalamus is a type of modified stem, on which nodes and internodes are present.
* Nodes are present very close to each other and internodes are small highly reduced in the thalamus.
* The whorls present in the flower are the modifications of leaves and arranged in four circles on the thalamus.
* The four nodes are present on the thalamus, in which first modified leaves are attached on the first lower node are called **calyx.**
* The corolla born on the second node. **Androecium** is present on the third node and **gynoecium** on the fourth node in uppermost position.
* In some of the plants the length of internode increases which is present in between Calyx and Corolla is called **Anthophore** e.g. Silene plant, *Dianthus*.
* The length of internode between the corolla and androecium increases then it is called **androphore** e.g. *Passiflora*.
* If the internode between androecium and gynoecium increases then it is called **gynophore**. e.g. *Capparis*.
* If both androphore and gynophore are present in the same flower it is called **gynandrophore** or androgynophore. e.g. *Gynandropsis pentaphylla* and *Cleome gynandra*.
* **Sepals** are also modified vegetative leaves.

* In **Mussaenda** flower, one sepals of calyx modified into leaf like bright and attractive yellow coloured structure called "Advertising flag". It helps in pollination
* **Monocarpic plants :** The plants in which flowering and fruiting takes place only once in the whole life cycle are called monocarpic. e.g. Annual & Biennial plants.
* **Polycarpic plants :** The plants in which flowering and fruiting takes place many times in the entire life cycle are known as polycarpic. e.g. Perennial plant.

Exception : Bamboo, Centuary plant (*Agave americana*) are perennial plants but they are the example of monocarpic plants.

Bamboo species flower only once in their life time generally after 50-100 years, produce large number of fruits and die.

SEXUAL REPRODUCTION

* In Angiosperms male and female gametes are formed in male and female sex organs by the process of meiosis.
* Both the gametes fuse together to form a diploid zygote which gives rise embryo. It means the process in which embryo is formed by meiosis and fertilization is called **Amphimixis.**

Male reproductive organ - Androecium

* Male reproductive organ is called androecium and their unit is called **stamen**.
* Stamen is also known as microsporophyll.
* A typical stamen is differentiates into two parts - a long, thin structure is called **filament** which joins the stamen to the thalamus.
* The free end of the filament, a swollen spore bearing structure is called **anther**.
* Anther and filament are attached together with help of small region, called **connective**. Connective contains vascular tissues.
* The main parts of the stamen is the anther.
* Each anther generally **bilobed structure** i.e., anther has two anther lobes is called **dithecous**.

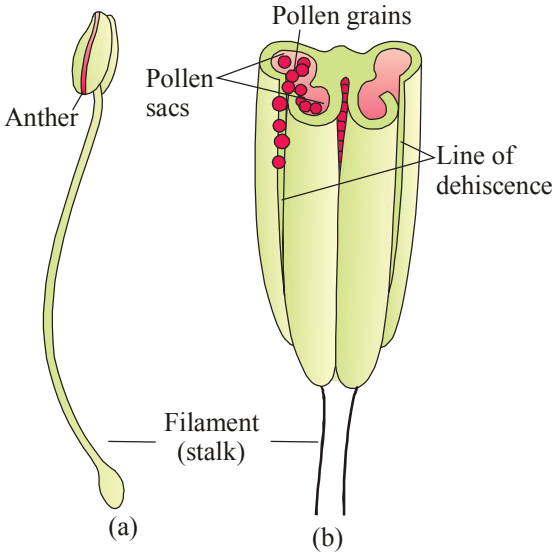


Figure : (a) A typical stamen; (b) Three–dimensional cut section of an anther

* A typical anther has four microsporangia which develops into pollen sacs it is **tetrasporangiate.**
* Pollen grains are formed inside the pollen sac through the meiotic division of pollen mother cells.
* In **Capsella**, which is member of the cruciferae or **Brassicaceae**, anther are dithecous and tetrasporangiate type.
* But in **Malvaceae**, the anther of stamen has only one anther lobe. This is called **monothecous** and it contains only two pollen sacs called Bisporangiate.

Structure of Anther

* In the transverse section of anther, it is seen almost tetragonal and microsporangium appears near circular in outline.

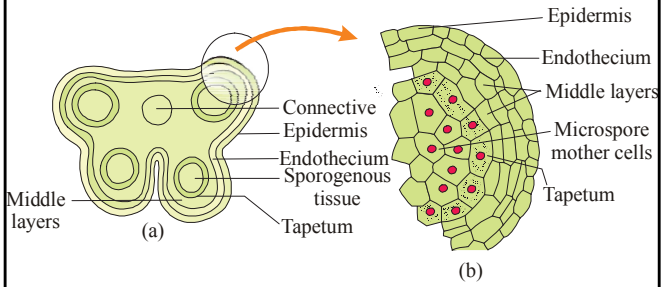


Figure : (a) Transverse section of a young anther; (b) Enlarged view of one microsporangium showing wall layers

The following structures are present in the anther

(i) Epidermis :

* It is the outermost layer of anther. It is single celled thick and continuous layer but not archesporia in origin.
* It forms the outermost protective layer.

(ii) Endothecium :

* This layer is present below the epidermis. It is single celled thick layer.
* During the maturation of anther, various changes takes place in different walls of cells of endothecium.
* The outer wall of these cells remains thin walled, but inner walls and radial walls become thick due to thickening of **α-cellulose fibers**.
* Callose bands are also present along the radial walls. At some places callose bands and fibrous thickening are absent. These places are called **stomium.**
* The dehiscence of anther takes place only from these places.
* Endothecium becomes hygroscopic nature due to presence of fibrous thickening. So it helps in **dehiscence** of anther.

(iii) Middle layer :

* Middle layer is consist of parenchymatous cells. This layer is one to three celled thick structure.
* Food is stored by **parenchymatous cells** in this layer. Middle layer is **ephemeral (short lived)** in nature and absent in a mature anther.

(iv) Tapetum :

* It is the inner most layer which acts as **nutritive layer**. This is single layered thick.
* The cells of the tapetum initially diploid but they become polyploid and multinucleate due to endomitosis and free nuclear division respectively.
* Tapetum absorbs food from the middle layer and provide nutrition to the microspore mother cells or developing microspores.
* The tapetum layer disappears in the mature anther.

Tapetum is of two types :

(a) Amoebid Tapetum/Invasive tapetum/ Periplasmodial tatetum:

* It is found in primitive angiosperm. Such type of tapetum absorb all foods from the middle layer.
* This type of tapetum provide nutrition to the microspores after degeneration. Example: *Typha, Alisma* & *Tradescantia.*

(b) Glandulor or Secretory Tapetum :

* It is advanced type of tapetum. It is not degenerates quickly.
* It absorbs nutrients from the middle layer and secreted into the cavity of the microsporangia (Pollen sacs).
* Usually it is found in most of Flowering plants (**Capsella**). Before degeneration of cells of tapetum, they form special granules called **Proubisch bodies** in cytoplasm. Here they are surrounded by **sporopollenin**.
* Now they are called **Ubisch bodies** or orbicules. At last tapetum degenerates and ubisch bodies released into pollen sacs.
* Ubisch bodies (sporopollenin) participates in the formation of outer covering (Exine) of Pollen grains.

Functions of tapetum

* Tapetum provides nutrition to the MMC or PMC/Developing pollens.
* Secretion of sporopollenin and pollenkitt materials.
* Secretion of enzyme and hormone.
* Formation of ubisch bodies.

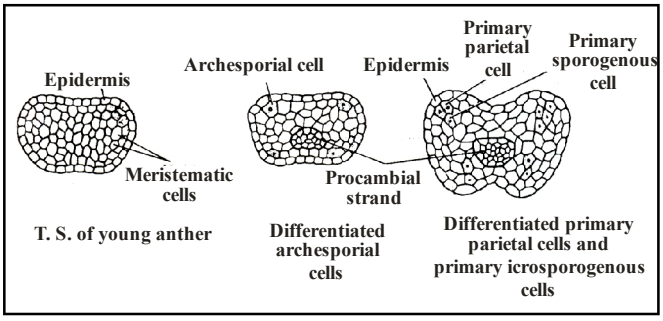
Pollen sacs

* Four Pollen sacs are present in the anther.
* Pollen sacs are also known as microsporangia.
* Inside the pollen sacs, microspores are formed by the meiotic division of microspore mother cells (pollen mother cells).

Development of Anther and Microsporogenesis

* The development of **anther** is **eusporangiate** type i.e. it is developed from more than one archesporial cells.

* The anther appears as outgrowth like structure in the initial stage which shows spherical or oval shaped structure.
* At this stage, it is a mass of meristematic cells which is surrounded by a single cells thick outer layer. This layer is known as **epidermis**.
* First of all vascular tissue are formed in middle region Simultaneously group of cells which are located just below the epidermis in vertical rows of hypodermal region at the four corners become large. These cells are called **archesporial cells.**
* These cells divide **periclinally** to form **primary parietal cells** and **primary sporogenous cells**.



* Primary parietal cells undergo further periclinal and anticlinal division to form a series of 3-5 layers making the walls of the anther.
* Out of them outer most layer of anther is formed just below the epidermis by primary parietal cells is called **endothecium or fibrous layer**.
* The endothecium is followed by 1-3 celled thick layer is termed **middle layer**.
* The innermost layer of the anther which surrounds pollen sacs is called **tapetum**. Later the tapetal cells play a significant role during the meiotic cell division in microsporogenous cells & in pollen development.
* The primary sporogenous cells divide twice or more than two by mitotic division to form sporogenous cells and later sporogenous differentiated into microspore mother cells during the formation of wall of **pollen sac.**
* Each microspore mother cell or cell of sporogenous tissue divide to form four haploid microspore or pollen grain by **meiotic division** or reduction division.

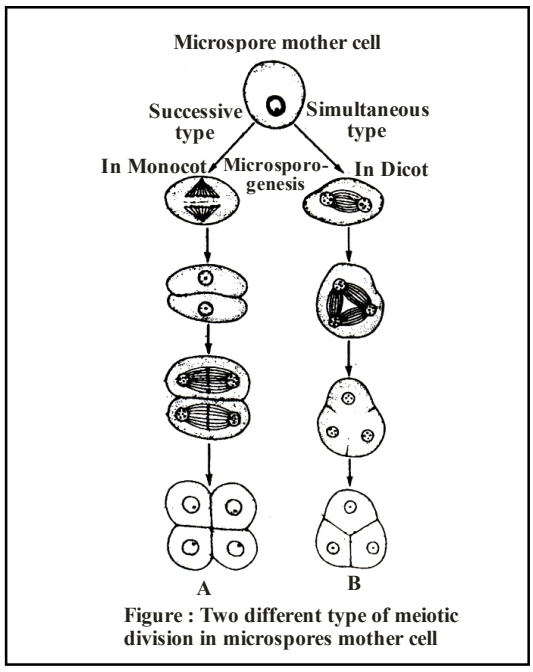


Figure : Two different type of meiotic division in microspores mother cell

* At the initial stage all four microspores are attached together with the help of callose layer. This group of microspores is called **tetrad**. After some time, this callose layer is dissolved by callase enzyme, which is secreted by tapetum.
* During this period spherical bodies are formed inside the tapetal cells before their disintegration. These spherical bodies are known as **Ubisch-bodies**. Ubisch body is made up of a complex substance called **sporopollenin**. It is the polymer of carotenoids.
* After the formation of ubisch body, the tapetum layer degenerates. Ubisch bodies participate in the formation of exine of the microspores inside the pollen sacs. Now thick walled microspores are called **pollen grains.**
* **Types of tetrads :** The arrangement of the microspores in tetrad condition as follows :

(i) **Tetrahedral tetrad :** Four haploid microspores arranged in tetrahedral form.
Example : Dicotyledons- (Capsella).

(ii) **Isobilateral tetrad :** This condition is found in monocotyledons. Microspores are arranged at the lateral side of each other.

(iii) **Decussate Tetrad type :** In this two microspores lies at the right angle of other microspores. Example :- Magnolia

(iv) **T-Shaped tetrad :** Two microspores lie longitudinally and two microspores lie at transversely in this type of tetrad.
Example : Aristolochia & Butomopsis.

(v) **Linear tetrad :** In this tetrad all four pollens arranged in linear order.
Example, Halophylla, Halophia.

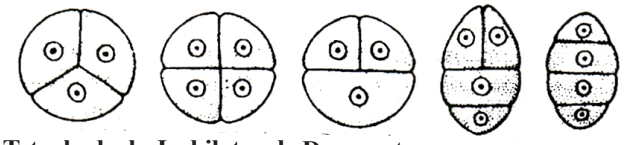


Figure : Different type tetrad of angiosperm

* All the above type of tetrads are found in Aristolochia elegans.
* Most common type of tetrads is Tetrahedral.

Facts about types of Pollen grains

* In Asclepiadaceae (**Calotropis**) and Orchidaceae family, all the pollen grains joined together to form "Pollinium".
Pollinium of Calotropis is called "Translator apparatus".

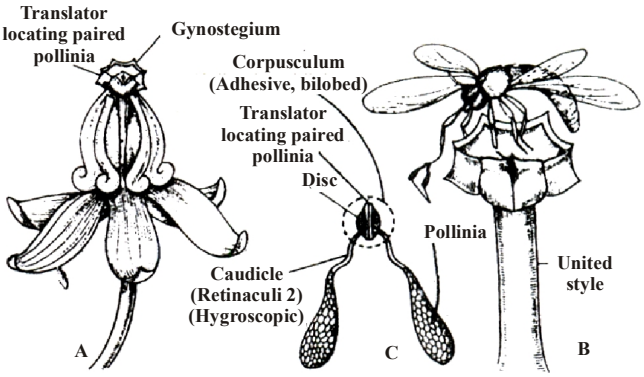


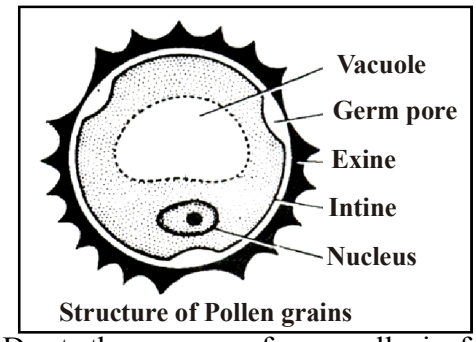
Figure : Translator apparatus

* More than four pollen grains are found in tetrad called "Polyspory" e.g. Cuscuta.
* Pollen grains of some plants present in air cause allergy are called "aero allergens" e.g. *Chenopodium, Parthenium, Sorghum*, and *Amaranthus*. ("Hay fever" is caused by pollens of Ambrosia.]
* Pollen grains of many plant species cause severe allergies and bronchial disorders in some people leading to chronic respiratory disorders like - asthma, bronchitis. For ex. Parthenium (carrot / congress grass) – in India cause pollen allergy and asthma.
* Pollen grains are rich in nutrients. It has become a fashion in recent years to use pollen tablets as food supplements in western countries. Large number of pollen products in form of tablets and syrups are available in market. Pollen consumption has been claimed to increase the performance of athletes and race horses.
* In Cyperaceae family only one pollen grain is formed from pollen mother cell. e.g., Cyperus.
* Largest pollen - *Mirabilis*.
* Smallest pollen - *Myosotis*.
* Longest pollen - *Zostera* (Filiform pollen or filamentous pollen grain). Pollen grain long, ribbon like, without exine.
* Eight nucleated embryo sac type of pollen is found in *Hyacinthus*. [This type of pollen grain discovered by Nemec. So it is called **Nemec phenomenon**)
* Viability of pollen grains depends on temperature and humidity. In some cereals like rice and wheat – pollen grains loss viability within 30 minutes of their release. In some members of Rosaceae, Leguminoseae and Solanaceae pollen grains are viable for months.
* Pollen grains can be stored like semen of humen being for years by cryopreservation in liquid nitrogen at –196ºC temperature. Such pollens can be used as **pollen banks** similar to seed banks in crop breeding programmes.

Structure of microspore or pollen grain

* Pollen grains are generally spherical, measuring about 25-50 micrometers in diameter.
* Pollen grain surrounded by two distinct wall layers. The outer wall layer is thick, rigid and ornamented, called **exine**.
* This layer is formed mainly by cutin and sporopollenin.
* **Sporopollenin** is highly resistant organic material.
* It is nonbiodegradable. It can withstand high temperatures, strong acids and alkali.

* No enzyme that degrades sporopollenin is so far known.



Structure of Pollen grains

* Due to the presence of sporopollenin, fossils of pollen grain are always found in good condition. The presence of fossils of pollen grains can forecast the presence of natural resources like petroleum, coals etc. in the earth.
* The inner wall of pollen grain is thin, soft and elastic in nature. It is called **intine**. It is made up at **pectin** and Cellulose or pecto-cellulose.
* At few places exine is absent or present in the form of thin layer. These thin places are called **germ pore**. The intine comes out through the any one germ pore during the germination of pollen grain in the form of **pollen tube.**
* The number of germpore, structure and ornamentation of exine is a significant feature of taxonomy.
* A detail study of pollen grains is called Palynology.
* Three germ pore (lens / slit type or circular) are present in pollen grain of dicots(Capsella). This type of pollen grain are called **tricolpate**. Only one germ pore is present in monocots and pollen grain is called **monocolpate**.

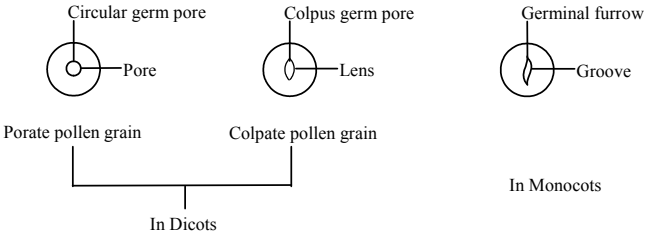


Figure : Type of Germpore

* The plants in which pollination takes place by insects, their pollen grains having oily layer around the pollen grain. It is called **pollen-kitt**. It is composed of lipids and carotenoids. e.g., capsella.

Function of pollen kitt :

(i) This oily layer protects the pollen grain from the harmful ultraviolet rays.

(ii) Its sticky surface helps to attach with the insects.

(iii) Its yellow colour attracts the insects. Pollen kit is present on the pollens of Capsella.

Dehiscence of Anther

* During the maturation of anther, various changes takes place in walls of anther.
* In the beginning, middle layer degenerates due to absorption of food by tapetum.
* In a mature anther only two layers epidermis and endothecium are present in the form of outer covering.
* The sterile tissues present between both the pollen sacs of each anther lobe degenerate. So both pollen sacs of the each anther lobe fuse together to form single pollen sac.
* Therefore, in the mature anther only two pollen sacs are present.

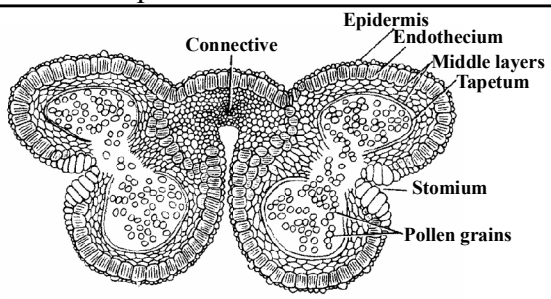


Figure : A mature dehisced anther.

* **Dehiscence** of anther takes place during the dry season. Due to the hygroscopic nature of endothecium, loss of water takes place from the cell of endothecium.
* Walls of endothecial cells try to contract due to the loss of water but inner and radial walls do not contract due to presence of fibrous thickening whereas outer thin walled cells of endothecium contract and become concave or incurved.
* Incurving of outer walls exert pulling force or tension over the entire surface of anther. Due to tension, thin walled stomal cells breaks off and dehiscence of anther takes place and pollen grains are present in pollen sacs released into the atmosphere.

* Dehiscence of anther in most of the angiosperms is longitudinal. Dehiscence of anther of Capsella is **longitudinal.**

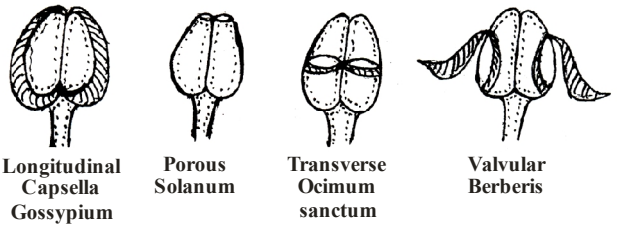


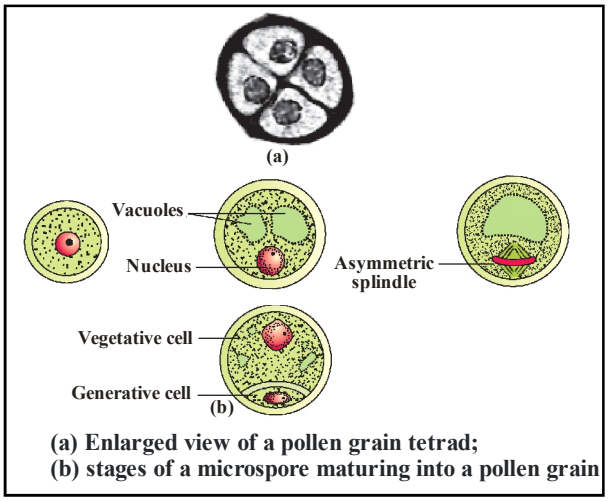
Figure : Mode of Dehiscence of anther

Micro-Gametogenesis or development of male gametophyte

* In flowering plants, pollen grain or microspore is considered as first cell of male gametophyte.
* Partial germination or development of pollen grain takes place before dehiscence of anther is called precocious development.
* Development of pollen also takes place at mother place [inside pollen sac of anther] is called **In-situ development.**

(i) Pre Pollination development :

* In the beginning of the process, only nucleus of pollen grain divided by unequal mitotic division, resulting two unequal size of nucleus are formed.
* Small nucleus present near the wall is called **generative nucleus** and large nucleus present inside the cytoplasm is called **Tube or Vegetative nucleus.**
* Both the nuclei are surrounded by cytoplasm and it becomes dense, then followed by unequal cytokinesis, resulting two cells of unequal size are formed.
* Larger cell in which large nucleus is present known as **Vegetative cell** (or tube cell) and smaller cell in which small nucleus is present, called **generative cell.**
* Now pollen grains come in **bicelled** stage. This stage of pollen grain is called partially developed male gemetophyte or **mature pollen grain**.
* In over 60% Angiosperms pollination of pollen grains take place in bicelled and binucleated stage and in remaining angiosperm pollination occurs at **3 celled stage** (In this generative cell divides and form two male gametes).
* The development of pollen which takes place inside the sporangium is also known as **endosporic development.**
* Now, generative cell changed into vermiform or spindle shaped structure with dense cytoplasm and detached from the wall and enters inside the vegetative cell.



(a) Enlarged view of a pollen grain tetrad;
(b) stages of a microspore maturing into a pollen grain

(ii) Post Pollination development :

* Further development of pollen grain takes place on the stigma of Carpel after pollination.
* Pollens absorb moisture and sugar content from the stigma. Due to this volume of cytoplasm increased. It exerts pressure on the both outer layers. Because of this pressure intine comes out through anyone germ pore in the form of tube like structure called **pollen tube.**
* First of all **vegetative** nucleus enter into the pollen tube and assumes terminal [tips] position. This spindle shaped generative now enter into the pollen tube.
* Inside the pollen tube, generative cell divides **mitotically** and to form a two non motile male gametes.
* Now male gametophyte comes in three celled structure in which one vegetative cell and two male gametes are present.
* This three celled stage represents the mature male gametophyte of Angiosperm [Capsella also]. Male gametophyte is highly reduced and completely depends on sporophyte.
* For the formation of mature pollen grain, one meiotic and one mitotic division is required. For the formation of mature male gametophyte, one meiotic and two mitotic divisions are required.

FEMALE REPRODUCTIVE ORGAN-GYNOCIUM

* Gynoecium is the female reproductive organ. The free unit of gynoecium is called **pistil** or **carpel.**
* Carpel is also known as **megasporophyll.**
* The carpel is differentiate into three distinct region (i) Stigma (ii) Style (iii) Ovary
* The free end of the carpel which receives pollen grains is called **stigma**.
* A long, narrow tubular structure is present in between the stigma and ovary called **style**.
* The basal swollen part of the carpel is called **ovary**.
* The ovules are also known as **integumentated megasporongia** which are borne on a cushion-like tissue called **placenta** in the ovarian cavity.
* One (wheat, paddy, mango) or more than one (Papaya, Watermelon, Orchids) ovules are present inside the ovary.

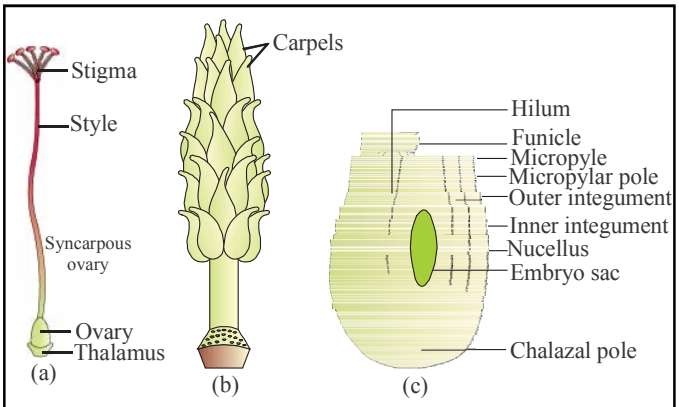
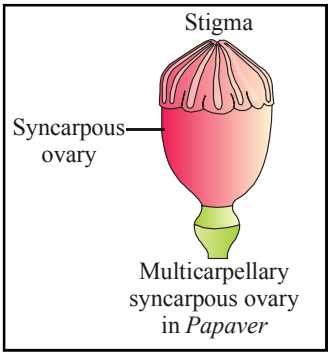


Figure : (a) A dissected flower of *Hibiscus* showing pistil ; (b) A multicarpellary, apocarpous gynoecium of *Michelia*; (c) typical anatropous ovule.

* **Apocarpous gynoecium (free carples) -** Rose, Lotus, *Michelia*.
* **Syncarpous gynoecium (fused carples) -** *Papaver*, *Hibiscus*.



Structure of ovule or Megasporanium

* Each ovule attached to the placenta by means of a thin stalk called **funicle** or funiculus/Funiculum.
* The point of attachment of the funicle with the ovule is called **hilum**.
* The main region of the ovule is composed by mass of parenchymatous cells called **nucellus**.
* Nucellus is the main part of ovule. The nucellus is covered by one or two coats called **integuments**.

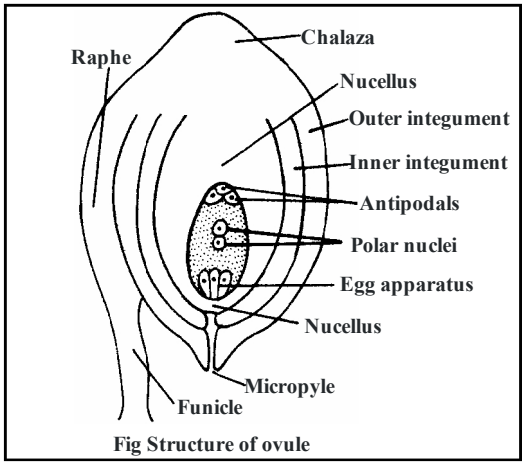


Fig Structure of ovule

* In ovule of most of the plant funicle is attached to the main body of ovule for some distance (at lateral side) to form a ridge like structure known as **Raphe**.
* Vascular tissues are present inside the funiculus which supply food material from the placenta to the body of ovule.
* Base of the ovule is called **Chalaza.** Integument is absent just opposite to the chalaza, so that a narrow passage (pore) is formed which is called **micropyle**.
* Micropyle in bitegmic ovule has two parts - outer region which is surrounded by outer integument is called **exostome**.
* The inner part of micropyle which is surrounded by inner integument called **endostome**.
* In most of the Angiosperm entire part of the nucellus is utilized by developing embryo sac but in some of the Angiosperm some part of the nuclellus remain inside the ovules that part of the nucellus present inside the seed in the form of a thin layer known as **perisperm**. Perisperm is commonly found in Piperaceae (*piper nigrum*) and Zingiberaceae Families (Turmeric, Ginger) and beet, castor.

* Some filaments are attached with funicle (some times placental) are known as **"Obturators".**
* The function of obturators is to guide the passage of pollen tube towards the micropyle inside the ovary.

Special Integuments :

(i) **Aril :** It is the type of third integuments which develops from funicle at the base of the ovule. e.g. *Myristica, Asphodelus* and *Litchi.*

(ii) **Caruncle or Strophiole :** It is formed due to the proliferation (out growth) of outer integuments over the micropyle. e.g. Ricinus communis (Castor). It is formed by sugary contents so helps in absorption of water during germination of seeds and dispersal of seeds by ants called myrmecochory.

Types of ovules

(a) **On the basis of integuments**

* A single integumented ovule is called **unitegmic ovule.** Example - members of Gamopetalae and Gymnosperm.
* Two integumented ovule is called **bitegmic ovule.** Example-In most of Angiosperm [Polypetalae-*Capsella* and Monocots].
* The ovule in which integuments are absent is called **Ategmic ovule** e.g. *Olax, Liriosma, Loranthus & Santalum.*

(b) **On the basis of nucleus :**

(i) **Tenuinucellate :** The nucellus is either less developed or present in the form of single layer. Example : Gamopetalae group.

(ii) **Crassinucellate :** The nucellus is massive type i.e., it is made up of many layers. Example : Polypetalae group and Monocots

(c) **On the basis of position of different parts :**

There are six different types of ovules are found in Angiosperms on the basis of relationship of the micropyle, chalaza, and hilum with body of the ovule and orientation on the funiculus:

(i) **Atropous or Orthotropous :**

* The body of ovule is upright in position.
* The micropyle, chalaza and hilum lie in one straight line, so that this ovule is called straight or upright ovule.
* Example:- Betel, *Piper, Polygonum* and in Gymnosperms.
* It is the most primitive and most simple type of ovule. Raphe is absent.

(ii) **Anatropous ovule :**

* In this type, the body of the ovule completely turned at 180° angle, due to unilateral growth of funiculus, so it is also called inverted ovule.
* The chalaza and micropyle lie in straight line. The hilum and micropyle lie side by side very close to each other.
* This type of ovule is found in 80% families of Angiosperms but not in Capsella.
* In this ovule micropyle facing downward condition.
* This is the most common type of ovule so that it is considered as a "typical ovule" of Angiosperms. eg. Members of Malvaceae, Cucurbitaceae, Solanaceae, Compositae family and Pea. It is also called resupinate ovule.

(iii) **Hemitropous or Hemi-anatropous ovule :**

* In this ovule, the body of the ovule bent on funcile at 90° angle, i.e., body of ovule present at right angle to the funiculus.
* This is intermediate type between ortho and anatropous ovules.
* This ovule is also called horizontal ovule because body of ovule present in horizontal position on the funiculus.
* Micropyle and chalaza are present in the same line but micropyle is situated away from hilum. Example- *Ranunculus, Primula*.

(iv) **Campylotropous ovule :**

* In this type of ovule, the body of ovule is curved and micropyle, chalaza are not present in straight line.
* Micropyle comes close to the hilum.
* Eg.: Leguminosae, Capparidaceae, Cruciferae family [Capsella]

(v) **Amphitropous ovule :**

* In this type of ovule, curvature is effective in the nucellus and due to this effect of nucellus, embryo sac becomes horse shoe shaped.

* Micropyle comes close to the hilum. It is also called as transverse ovule. e.g. *Mirabilis, Lemna* and Poppy (*Papaver*), *Alisma, Butomaceae* family.

(vi) Circinotropous ovule :

* In this type of ovule, body of ovule becomes inverted and again turned into straight position due to the growth of funiculus so that body of ovule present an funicle at 360°.
* The entire body of ovule is surrounded by funiculus. It is also known as **coiled ovule**.
* Micropyle is situated away from hilum.
  e.g. Cactaceae family-Opuntia.

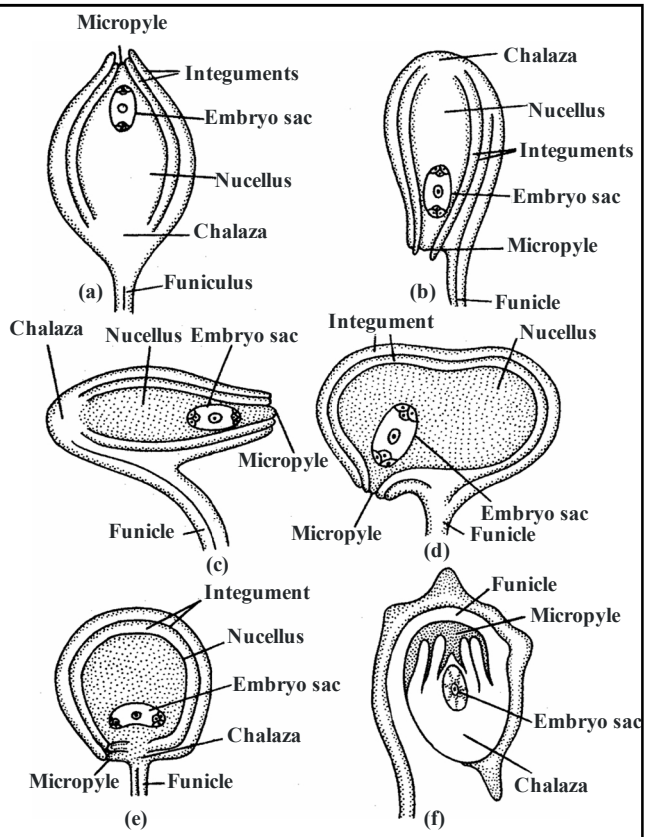


Fig Differ ent forms of the ovule in longitudinal section (a) Orthotropous, (b) Anatropous, (c) Hemianatropous, (d) Campylotropous, (e) Amphitropous, (f) Circinotropous

Megasporogenesis

* The process of formation of megaspores from the **Megaspore Mother Cell (MMC)** is called **megasporogenesis**.
* During the development of ovule, in the beginning of this process, **nucellus** develops form the **placenta** in the form of a small rounded out growth like structure.
* At this stage, all the cells of nucellus are undifferentiated, homogenous and meristematic and finally they become parenchymatous.
* This mass of cells surrounded by single celled thick layer of epidermis.
* Any one hypodermal cell of nucellus is differentiated and increase in size.
* It becomes different from rest of the cells due to presence of distinct nucleus. It is called **archesporial cell**.
* Archesporium divides mitotically to form an outer primary parietal cell and **Primary Sporogenous cell**.
* The primary sporogenous cell directly act as a **megaspore mother cell** (At micropylar region).
* It divides **meiotically** to form, four haploid **megaspores**.
* The four haploid megaspores generally arranged in linear tetrad.
* Generally the lower most or chalazal megaspore remains functional out of four megaspores and the other three which lie towards the micropyle degenerate.
* The functional megaspore produces female gametophyte. In most of Angiosperms [Capsella, Chalazal megaspore remains functional.]

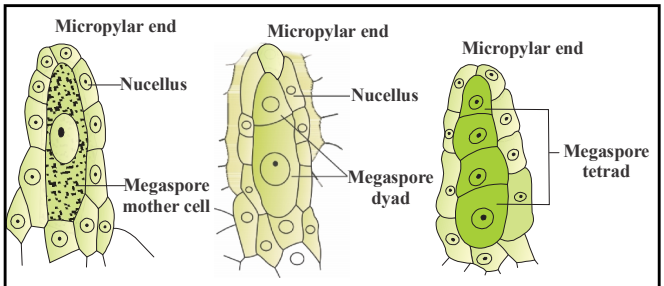


Figure : Parts of the ovule showing a large megaspore mother cell, a dyad and a tetrad of megaspores

Development of Embryosasc or Female gametophyte

Megagametogenesis :

* Megaspore is the first cell of the **female gametophyte**.
* This megaspore grows in size and obtains nutrition from the nucellus.
* The nucleus of megaspore divides mitotically to form a two nuclei.

* Each nucleus moves towards the opposite pole and reaches at their respective poles.
* Both the nuclei lie at poles divide twice mitotically. Resulting in four nuclei formed at each pole [Total 8-nuclei].
* Out of the four, one-one nucleus migrates from the both poles [one nucleus from chalazal side and one nucleus from micropylar side] towards the centre. They are known as **polar nuclei**.
* Both polar nuclei are present in the centre.

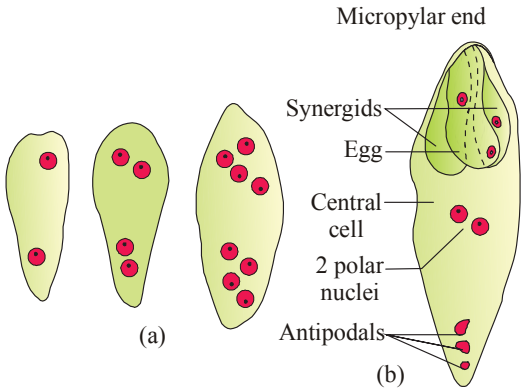


Figure : (a) 2, 4, and 8-nucleate stages of embryo sac and a mature embryo sac; (b) A diagrammatic representation of the mature embryo sac.

* Remaining three-three nuclei at each pole surrounded by cytoplasm to form cells as a result of cytokinesis.
* Three cells are formed towards the **micropyle** in which one cell is large and more distinct out of three cells. This is called **egg cell** and remaining two smaller cells are known as **synergids**.
* These three micropylar cells collectively known as **egg-apparatus**. [1 Egg cell + 2 Synergids]
* The three cells are formed toward the Chalaza are called **antipodal cells**. Both the polar nuclei present in the central cell.
* Just before the process of fertilization they unite or fuse together in the centre to form **secondary nucleus** (or definitive nucleus). It is diploid in nature [2n] and one in number.

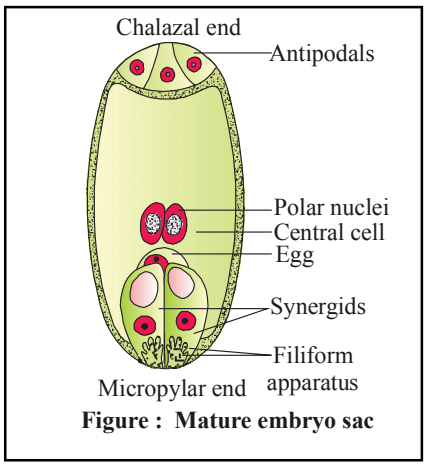


Figure : Mature embryo sac

* After 3 mitosis in megaspore seven celled and eight nucleated structure is formed.
* This eight nucleated and seven celled structure is called **female gametophyte** or **embryosac** of Angiosperms.
* This type of embryosac is known as **"polygonum type"** because it is discovered by Strasburger in Polygonum plant.
* Polygonum type embryosac is most common type in Angiosperms [Capsella].
* Polygonum type of embryosac develops from single megaspore so it is also known as monosporic embryosac.
* Fingers like structures are produced from the outer wall of the synergids are known as **filiform apparatus**.
* With the help of these structures, synergids absorb food from the nucellus and transfer to the embryosac.
* Filiform also secrete chemicals which attracts and guide the pollen tube.

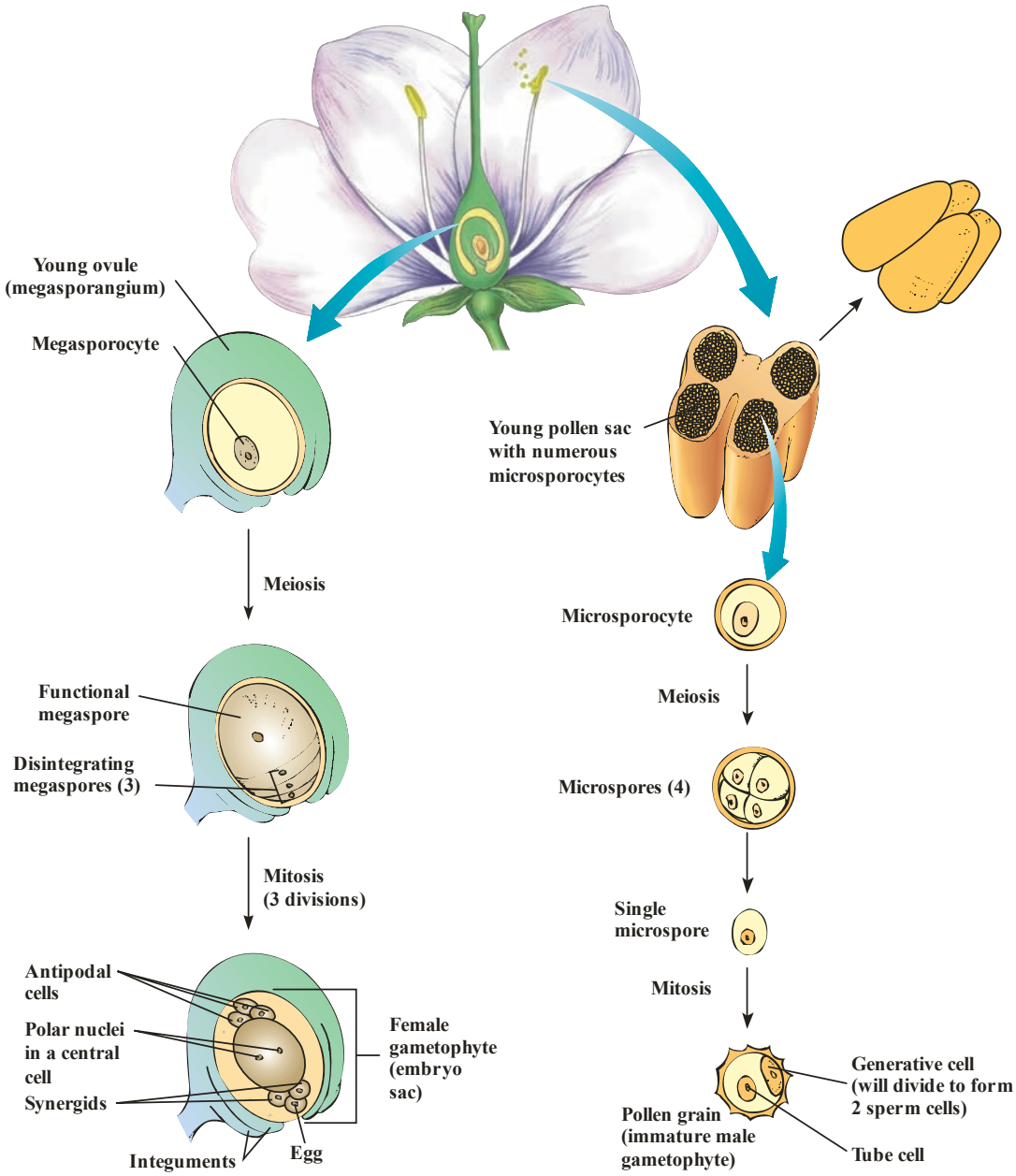


Figure : Female and male gametophytes (Left side) The female gametophyte, or embryo sa develops within the ovule. (Right side) The immature male gametophytes, or pollen grains, develop within pollen sacs in the anthers.

Type of Embryosacs

(i) Monosporic Embryosac : It is of two types

(a) Polygonum type : It is eight nucleated and seven celled embryosac (develops from chalazal megaspore).

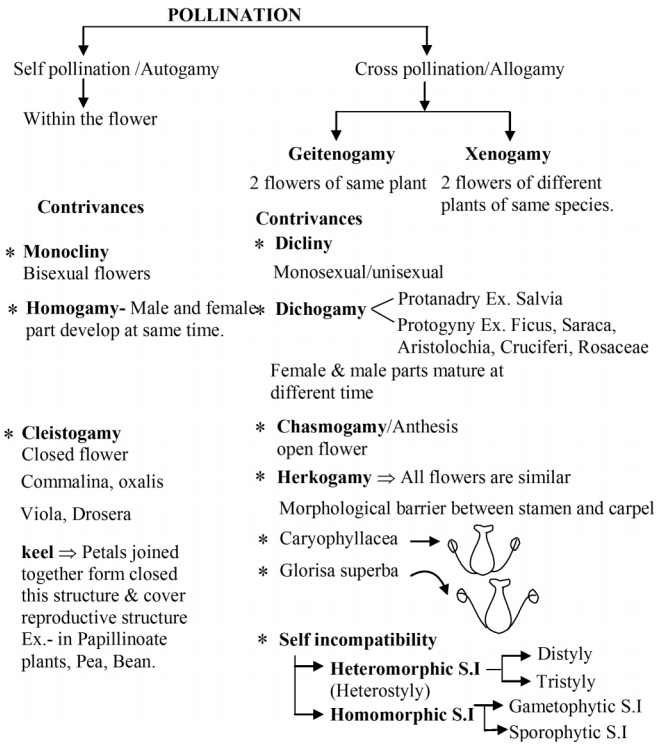
(b) Oenothera type : Exceptionally it is four nucleated in which only one nucleus in a central cell and three nucleus in egg apparatus. Antipodal cells are absent. Endosperm will be diploid (Embryosac develops from micropylar megaspore).

(ii) Bisporic Embryosac : 7 celled, 8 nucleated embryosac is formed by two nucleated megaspore.

(iii) Tetrasporic Embryosac : Seven celled and eight nucleated embryosac is formed by four nucleated megaspore. Beside this different other types of embryosacs are also formed.

POLLINATION

"Pollination is defined as the process of transfer of pollen grains from anther to the stigma of the same flower or of different flower of the same species."



1. Self Pollination or autogamy :

* If the pollen grain are transferred from an anther to the stigma of the same flower, or different flowers of the same plant is called self pollination or autogamy.

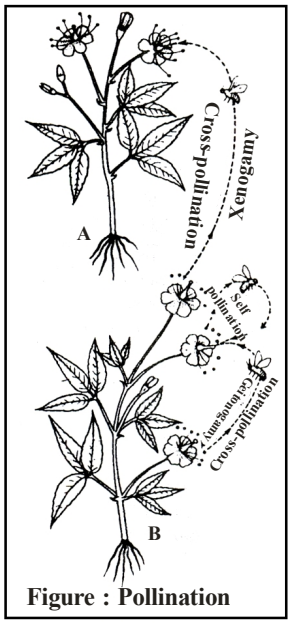


Figure : Pollination

2. Geitonogamy : When, pollination takes place in between the two flowers of the same plant then it is called geitonogamy. From the genetical point of view geitonogamy is self pollination because all flowers of the same plant are genetically identical. But functionally or ecologically, it is considered as cross pollination.

3. Xenogamy or Cross pollination or Allogamy: When the pollination takes place in between the two different flowers of two different plants of the same species then it is called xenogamy. This is real or true cross pollination. Genetically, as well as ecologically, it is cross pollination.

Note :

1. Monoecious plants

* If both male and female flowers are present on same plant but flowers are unisexual.
* Eg., Castor, Cucurbits, Coconut and Maize.
* It prevents autogamy but not geitonogamy.

2. Dioecious plants

* If male and female flowers are present on different plants and flowers are unisexual.
* Eg. Papaya, Date palm.
* It prevents both autogamy and geitonogamy.

Contrivances or adaptation for self pollination

(i) Monocliny : (Bisexuality) it means flowers are bisexual. e.g., Pea.

(ii) Homogamy : When both the sex organs of a flower mature at the same time it is called homogamy. So that chances for self pollination increased. E.g. Pea.

(iii) Cleistogamy :

* Some plants such as Viola (common pansy), Oxalis, and Commelina produce two types of flowers – **chasmogamous** flowers which are similar to flowers of other species with exposed anthers and stigma, and **cleistogamous** flowers which do not open at all.
* In such flowers, the anthers and stigma lie close to each other.
* When anthers dehisce in the flower buds, pollen grains come in contact with the stigma to effect pollination.

Thus, cleistogamous flowers are invariably autogamous as there is no chance of cross-pollen landing on the stigma.

* Cleistogamous flowers produce assured seed-set even in the absence of pollinators.

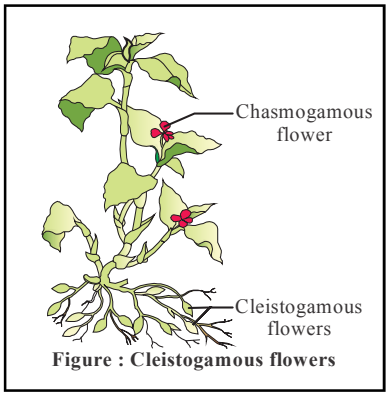


Figure : Cleistogamous flowers

* A special type of cleistogamy is found in flowers of legume plant. The sex organs are closed in a structure which is formed by joining of some petals. It is called **keel**. This keel never opens. So only self pollination takes place in these plants.

(iv) Bud pollination : Occurs in bud stage before the opening of flowers. Eg. Wheat, Rice.

Contrivances for cross pollination

(i) Dicliny : Unisexuality of the flower confirms cross-pollination. Self pollination never takes place in these flowers. It means allogamy becomes compulsory. Examples - *Date Palms, Carica (Papaya)*

(ii) Dichogamy : In many bisexual flowers of the plants, stamens and carpels of a flower do not mature at the same time. Dichogamy is of two types.

(a) Protandry : The anther of a flower mature earlier than carpels, is called protandry. In most of the plants of Angiosperms, cross pollinated only because of protandrus condition.
E.g. Salvia, Sunflower, Cotton, Capsella

(b) Protogyny : The carpels of the flower mature earlier than stamens. It occurs in few plants e.g. Ficus bengalensis (Banyan), Saraca indica (Ashok), Ficus religiosa (Peepal), Aristolochia, most of plants of Cruciferae and Rosaceae family.

(iii) Chasmogamy or Anthesis : Opening [blooming] of the floral bud in the form of a flower is called anthesis.

(iv) Herkogamy : In some plants, morphological barriers are formed in between the anther and stigma of the same flower, so self pollination can not occurs and pollen grains from the anther are unable to reach the stigma of the same flower. Only cross pollination is possible. e.g. Gloriosa, Calotropis.

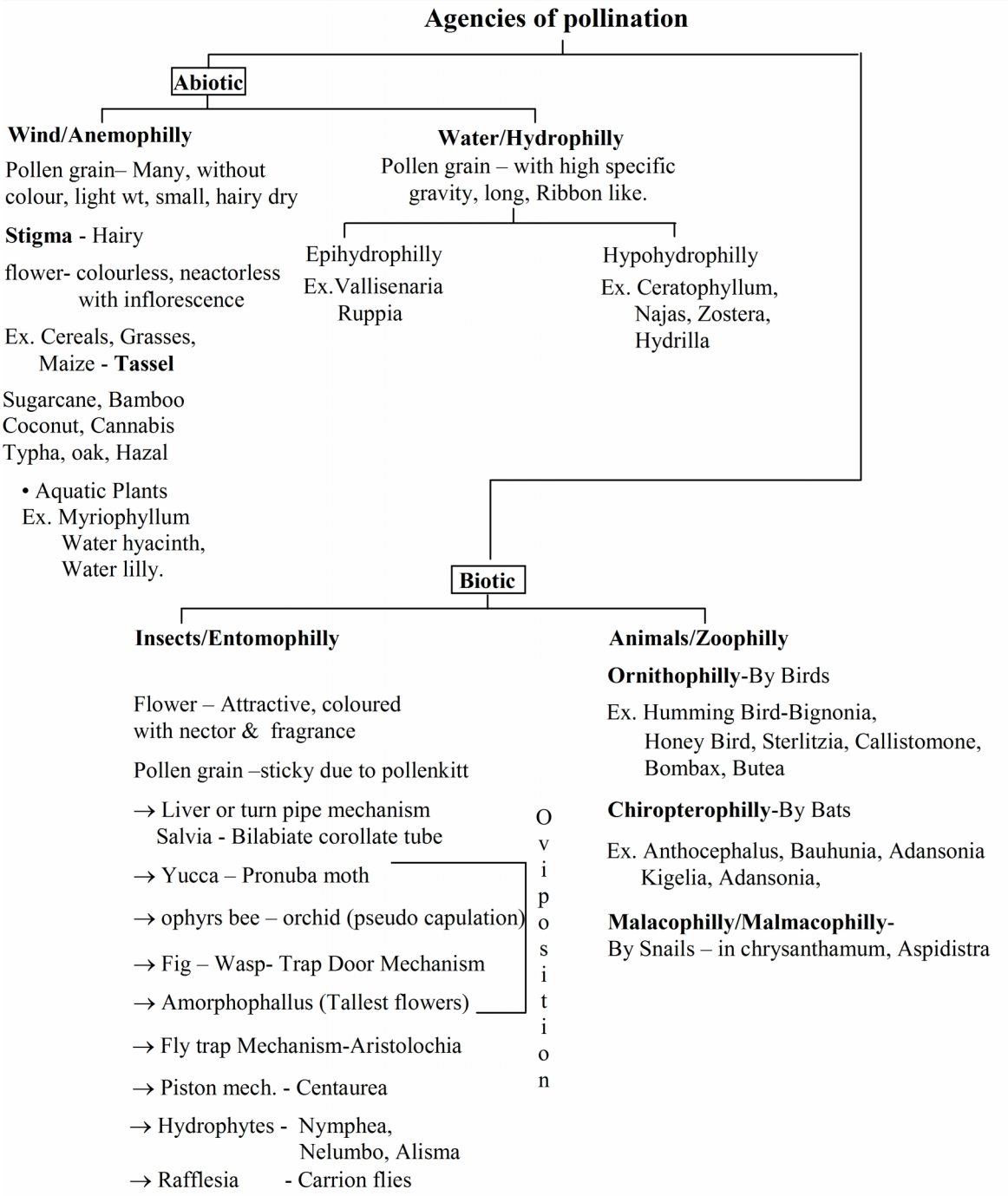
(v) Heterostyly : There is difference in between the length of the filaments of stamens and length of style in flowers of some plants. Some of the plants having long stamen and short style, and in some of the plants bears long style and short stamens. Due to this reason, self pollination can not possible in these plants e.g. Prim rose and *Linum, Primula*.

(vi) Self sterility or self incompatibility or intraspecific incompatibility :

* In this condition the pollen grains of the flower can not germinates on the stigma of the same flower. This condition is called self sterility.
* This is a parental (Genetical) characteristic feature which is controlled by genes.
* Such as in Petunia, *Malva, Thea, Passiflora,* Grapes (*Vitis*), Apple (*Pyrus malus*).
* Incompatibility involves many complex mechanisms associated with interactions of pollen and stigmatic tissues.
* If the incompatibility is due to the genotype of the sporophytic/stigmatic tissues, it is termed **sporophytic incompatibility** on the other hand, if it is due to the genotype of the pollen, it is termed **gametophytic incompatibility**. This may be due to prevention of pollen germination, retardation of growth, deorientation of pollen tube or even failure of nuclear fusion.
* It is controlled by genes with multiple alleles (s-allele). Enlarged pollen tube turns upwards and degenerates in style.

Agents of pollination

Plants use two abiotic (wind and water) and one biotic (animals) agents to achieve pollination.



1. Anemophily :

* When the pollen grains are transfer from one flower to the another flower through the wind then it is called anemophily and flower is known as anemophilous flowers. Such as Cereal plants: Maize etc. Anemophily is also found in all Gymnosperms.
* The anemophilous plants produce enormous amount of pollen grains.
* The pollen grains are very small, light weight and dry (Non-sticky) and their stigma is hairy or brushy and mucilagenous (Sticky). They often possess well exposed stamens.

* **Yellow clouds** are formed in the sky during the wind pollination in Pinus. These yellow clouds are formed due to the pollen grains called **"Sulphur Showers".**
* Anemophilous flowers are neither attractive nor with fragrance. They do not have nectar glands. Anemophilous flowers are generally unisexual.
* Wind pollination is common in grasses.
* Maximum loss of pollen grains only takes place in this pollination. It is completely non directional process.
* Wind pollinated flowers generally have a single ovule in each ovary.
* Eg.-Gymnosperms, Sugarcane, Bamboo, Coconut, Cannabis, Grasses, Date palms and Maize (corn).

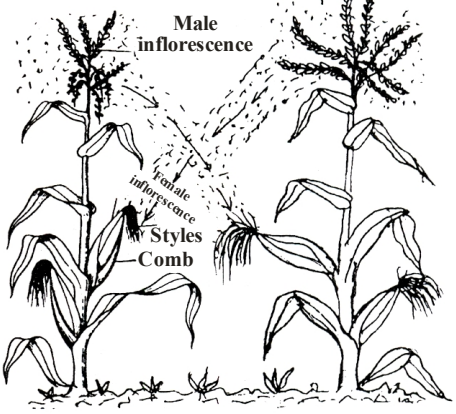


Figure : Air pollination in Maize plant

2. Hydrophily :

* Pollination brings by water is known as hydrophily.
* Pollination by water is quite rare In flowering plants and is limited to about 30 genera, mostly monocotyledons.

It is of two types.

(i) Epihydrophily :

* When the pollination takes place on the surface of water is called epihydrophily e.g. Vallisneria and Ruppia.
* ***Vallisneria*** is a dioecious plant and flowers are unisexual.
* In **Vallisneria**, the female flower reach the surface of water by the long stalk and the male flowers or pollen grains are released on to the surface of water.

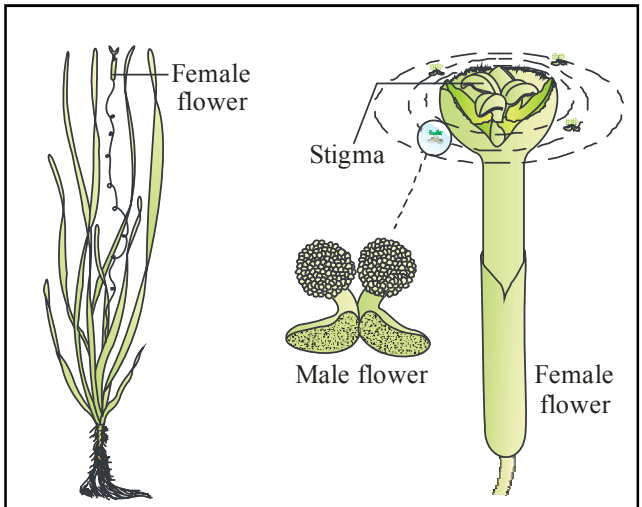


Figure : Pollination by water in Vallisneria

* They are carried passively by water currents; some of them eventually reach the female flowers and the stigma.
* Pedicel of female flowers are long and coiled. But at maturity due to uncoiling they also reach the water surface.
* All activities of **Vallisneria** take place inside the water except pollination.

(ii) Hypohydrophily :

* When the pollination takes place inside the water is called hypohydrophily. e.g. Ceratophyllum, Najas and Zostera (Seagrasses) and Hydrilla.
* Pollen grains in many such species are long, ribbon like and they are carried passively inside the water; some of them reach the stigma and achieve pollination.
* In most of the water-pollinated species, pollen grains are protected from wetting by a mucilaginous covering.

3. Zoophily :

* When the pollination brings by animals is called zoophily.
* Generally in zoophillous plants, flowers are very large, attractive and maximum number of nectar glands are present .

(i) Entomophily :

* The pollination takes place with the help of insects is known as entomophily.
* Most of insect pollination (80%) only by Honey bees. They are ornamental plants.

* Ornamental plants utilize their maximum energy in this pollination and develops different types of adaptation for attraction of insects. These flowers are attractive in colour.
* They posses special fragrance. Nectar glands are also present.
* Eg. lemon, Coriander, Onion, Lobia, Apple, Pear Sunflower (Asteraceae family) and Labiatae family. Cucumber, Cotton, Tobacco and *Brassica, Eucalyptus*.
* The pollen grains of insect pollinated flowers become sticky due to presence of pollen kitt.
* Some of the plants develop special adaptation for insect pollination.
* The lever mechanism or turn pipe mechanism is found in **Salvia** for pollination.
* The flowers of Salvia have bilabiatecorolla.

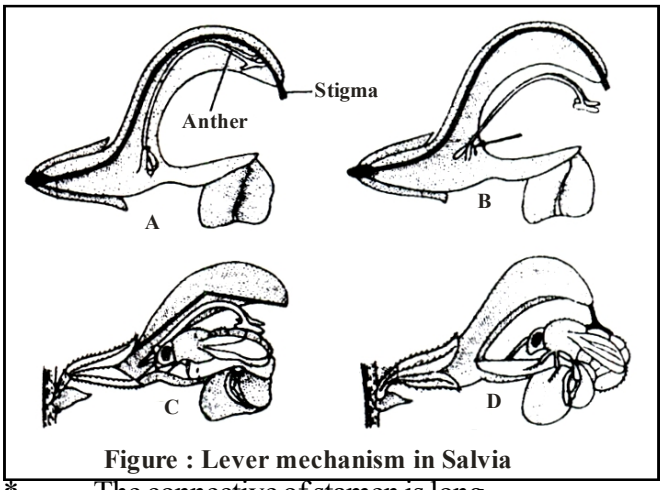
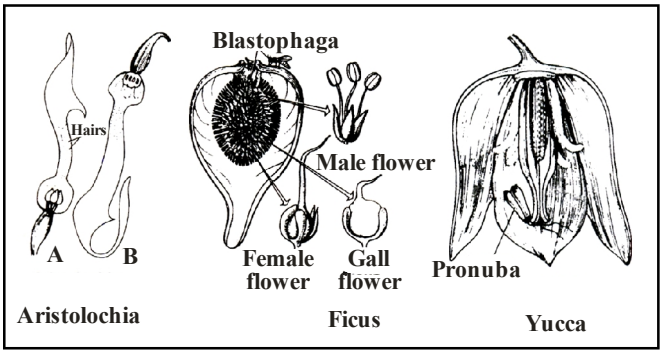


Figure : Lever mechanism in Salvia

* The connective of stamen is long.
* The anterior anther lobe is fertile while posteriorly lobe is sterile.
* When the insect lands on the lower lip and pushes the sterile lobe, the fertile lobe of anther brings down to touch the back of insect and thus depositing the pollen grains on the back of insect.
* Some of the flowers have attractive bracts i.e. bright and coloured e.g. Bougainvillea.
* **Yucca plant** develops symbiotic relation ship with an insect *Pronuba yuccasela moth (Tegeticula)*.
* The pollination in "Yucca takes place only by Pronuba female moth. This insect lays eggs in the ovary of flower. Life cycle of both depend on each other.
* In tallest flower of *Amorphophallus* (the flower itself is about 6 feet in height), process of pollination is same as Yucca means it provides space (safe place) for laying eggs.
* **Floral rewards :** To sustain animals visits, the flowers have to provide rewards to the animals. Nectar and pollen grains are usual floral rewards. In some species floral rewards are in providing safe places to lay eggs.
eg. *Yucca, Amorphophallus*
* **Pollen / Nectar robbers:** Many insects may consume pollen or the nectar without bringing about pollination, such floral visitors are referred to as pollen / nectar robbers.
* "**Trap door mechanism**" is found in species of *Ficus* (*Peepal, Fig* etc.) for pollination [By Blastophaga wasp (insect)] because Hypanthodium type of inflorescence is present. (Symbiosis), Protogyny in found in species of Ficus.



* In Aristolochia **"Fly trap mechanism"** is found for pollination. This flower is known as "**Pit fall flower**". Funnel shaped flower has viscous material. Smell like rotten leaves of tobacco. Insects are trapped like in prison.
* Orchid Ophrys (*Ophrys speculum*) flower pollinated by Wasp (*Colpa aurea*) by means or pseudo-copulation. The appearance and odour of the flower like female wasp [Mimicry].
* In Rafflesia (foul odour like rotten meat) the pollination is brought about by Carrion flies (Entomophily) and dispersal of seeds by Elephant (Zoochory).
* *Nymphaea* (water lily), water hyacinth, *Nelumbo* or *Nelumbium* (Lotus), *Alisma* are also entomophilous plants while they are hydrophytes.

(ii) When the process of pollination takes place by birds then it is known as ornithophily. e.g. Sun bird and humming bird in Bignonia plant and by Honey bird in Strelitzia plant, Callistemon (Bottle brush), Bombax [Silk cotton tree,] Butea monosperma.

(iii) **Chiropterophily :** If the pollination brings through the bats (*Pteropus*) is called chiropterophily. These flowers are big in size e.g. *Anthocephalus kadamba, Bauhinia & Kigelia plants, Adansonia.*

(iv) **Myrmecophily :** (Termite pollination) : This pollination brings about by Termites and Ants. *Prosopis* (kikar), Acacia, (Mimosoideae family) and some members of Rubiaceae family etc.

(v) **Malacophily or Malmacophily :** This pollination brings about by Snails e.g., *Lemna Aspidistra lurida* and *Chrysanthemum*.

NOTE

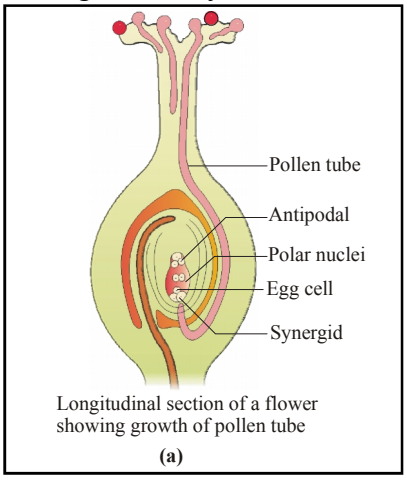
* Mango is pollinated by air or insect (mainly by insect).
* Rose is pollinated by insect (Red or orange species are pollinated by birds)
* Banana is pollinated by bats or birds (mainly by bats)
* In Some Plants pollination occurs by snake which is called "Ophiophily". eg. Santalum (Sandal)
* Night flowering plants are pollinated by Moths. They are highly scented.Their flower generally white coloured.
* Orchids are pollinated by Wasps/Snails.
* Favourable colour of Honey bees is yellow, but they are blind to red colour.
* The flowers pollinated by flies and beetles secrete foul odour to attract these animals.
* Among the animals, insects, particularly bees are the dominant biotic pollinating agents.
* Larger animals such as some primates (Lemurs), arboreal (tree-dwelling) rodents, or even reptiles (Gecko lizard and garden lizard) have also been reported as pollinators in some species.

Outbreeding Devices

* Continuous **autogamy** or **self-pollination** results in inbreeding depression.
* Flowering plants have developed many devices to avoid self pollination and to encourage cross-pollination. Such devices are called **Outbreeding devices.**
* Pollen released and stigma receptivity is not synchronized.
* Spatial separation of anthers and stigmas.
* Anther and stigma are placed at different positions.
* Self incompatibility.
* Production of unisexual flowers.
* eg: castor, maize (prevents autogamy);papaya (prevents autogamy & geitonogamy).

Pollen pistil interaction

* All the events - from pollen deposition on the stigma until pollen tubes enter the ovule - are together referred as **pollen-pistil interaction.**
* The pistil has the ability to recognize the pollen, whether it is or right type (Compatible) or of the wrong type (incompatible).
* If it is compatible, the pistil accepts the pollen.
* The ability of the pistil to recognize the pollen by continuous dialogue mediated by chemical like **Boron, Inositol and sucrose level.**
* The pollen grain germinates on the stigma to produce a pollen tube through one of the germ pores.
* The contents of the pollen grain move into the pollen tube. Pollen tube grows through the tissues of the stigma and style and reaches the ovary.



Longitudinal section of a flower showing growth of pollen tube

(a)

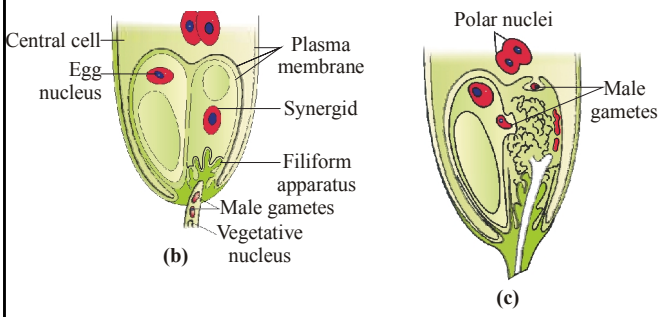


Figure : (a) L.S. of pistil showing path of pollen tube growth; (b) enlarged view of an egg apparatus showing entry of pollen tube into a synergid; (c) Discharge of male gametes into a synergid and the movements of the sperms, one into the egg and the other into the central cell.

* In some plants, pollen grains are shed at two-celled condition (a vegetative cell and a generative cell). In such plants, the generative cell divides and forms the two male gametes during the growth of pollen tube in the stigma.
* In plants which shed pollen in the three-celled condition, pollen tubes carry the two male gametes from the beginning.
* Pollen tube, after reaching the ovary, enters the ovule through the micropyle and then enters one of the synergids through the filiform apparatus.
* **Filiform** apparatus present at the micropylar part of the synergids guides the entry of pollen tube.
* All these events–from pollen deposition on the stigma until pollen tubes enter the ovule–are together referred to as pollen-pistil interaction.
* Pollen-pistil interaction is a dynamic process involving pollen recognition followed by promotion or inhibition of the pollen.

Artificial hybridization

Types of cross-pollination performed by man for crop improvement. Achieved by

(i) **Emasculation** i.e. removal of anthers from the flower bud of a bisexual flower before the anther dehisces using a pair of forceps.

(ii) **Bagging** i.e. covering the emasculated flowers with a bag of suitable size to protect them from contamination with unwanted pollen If flower is unisexual, emasculation is not needed.

Flower bud bagged & when the stigma becomes receptive, pollination is done using desired pollen & the flower is rebagged.

FERTILIZATION

* The fusion of male gamete with female gamete is called fertilization.
* This process is completed in the following steps:

1. Germination of pollen grain :

* After pollination, pollen grains germinate on the stigma. They absorb moisture and sugar contents from stigma and swellup.
* The intine of pollen grain grows out through the any one germinal pore of exine, in the form of tube like out growth is called pollen tube.
* One pollen tube develops in Capsella and most of Angiosperms is called **monosiphonous condition**, but more than one pollen tubes develops in Malvaceae and Cucurbitaceae family. It is called **polysiphonous condition.**
* Pollen tube produces enzymes which digest the tissue of the stigma and style.
* When the pollen tube comes down from the stigma into the style, first of vegetative nucleus enter, into the pollen tube then it is followed by generative cell.
* The tube nucleus always occupies in terminal position in pollen tube.
* The vegetative nucleus (tube nucleus) controls the growth of the pollen tube. Mean while, the generative cell divide mitotically to form two male gametes.
* Both of the male gametes are non motile.
* Boron element and calcium ions (mainly Boron) are essential for the growth of pollen tube and best temperature for growth of pollen tubs is 20-30°C. Pollen tube shows **apical growth** and chemotropic movement.
* Pollen tube was discovered by **G.B. Amici** in *Portulaca* plant.
* Longest pollen tube is found in ***Zea mays*** (Maize).
* The solid style, has a core of transmitting (transmission) tissue while in hollow style the styla canal is lined by glandular cells (glandular tissue).

2. Entry of pollen tube into the ovule :

* Finally, the pollen tube enters in the ovary at that time ovule becomes mature.
* Inside the ovary obturators guides the passage of pollen tube towards the micropyle.
* A mature ovule in which embryo sac also matured, has three paths for the entry of pollen tube:

(i) **Porogamy :** In this, pollen tube enters into the ovule through the micropyle. It is found in most of Angiosperms [Capsella].

(ii) **Chalazogamy :** In this method, the pollen tube enter into the ovule through the chalaza. This method is discovered in Casuarina by Treub [1891] e.g. Betula and Juglans (walnut).

(iii) **Mesogamy :** In this method, pollen tube enter into the ovule either through integuments- (Cucurbita) or through the funiculus - *Pistacia* and *Populus*.

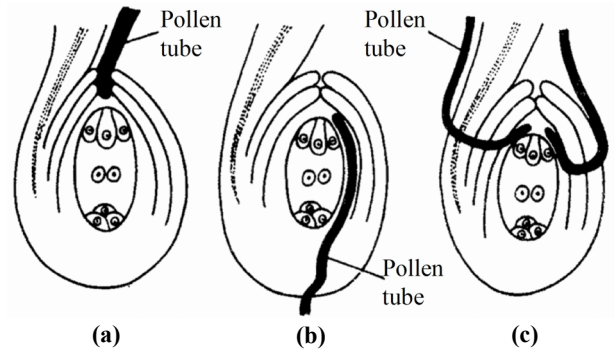


Fig Entry of pollen tube in to the ovule
(a) Porogamy, (b) Chalazogamy, (c) Mesogamy

3. Entry of pollen tube into Embryosac :

* Pollen tube can enter into the ovule through the any passage but inside embryosac, only enter through the **egg apparatus cell (i.e. synergid)**.
* After the entrance inside the ovule, it grows towards the egg apparatus because synergid cells secrete the chemical (hormones) which attracts the growth of pollen tube. It means pollen tube shows chemotropic movement in ovary.
* Any one synergid starts degenerating when the pollen tube comes near egg apparatus. The pollen tube enter into the embryosac through the degenerating synergid.
* When tip of the pollen tube enters into the embryosac vegetative nucleus degenerates. The tip of the pollen tube swells and burst (Endosmosis] after reaching inside the embryosac.
* The pollen tube released all contents including both male gametes inside the degenerating synergid of embryosac.
* Two dark granules appears in the region of degenerating synergid. These are known as **X-bodies.** They are two in no. and both X-bodies are the degenerating tube nucleus and degenerating synergid nucleus.

4. Fusion of gametes :

* Before or after the entrance of pollen tube into the embryosac (means before fertilization) both polar nuclei of the central cell fused together to form a **diploid nucleus.** It is known as **secondary nucleus** or definitive nucleus.
* Out of two one male gamete fertilized with egg cell and to form a **diploid zygote**. This fusion is known as **syngamy.** This is true fertilization process. (Discovered by Strasburger (1884) in Monotropa.)
* The second male gamete fused with **diploid secondary nucleus** This fusion is known as **triple fusion** resulting, a triploid (3n) structure is formed. It is called **primary endosperm nucleus (PEN).**
* Fertilization takes place twice at a time in Angiosperm is called **double fertilization.**
* Double fertilization was discovered by "Nawaschin" in *Lilium* and *Fritillaria* plants.
* Double fertilization and triple fusion is the **specific** or universal characteristic of Angiosperm.
* Five nuclei and three gametes participate in double fertilization.
* A zygote is formed by true fertilization (syngamy) develops into **embryo**. Triploid primary endosperm nucleus is formed in **PEC (primary endosperm cell)** by triple fusion.
* The central cell after triple fusion becomes the **primary endosperm cell (PEC)** and develops into the **endosperm** while the zygote develops into an **embryo**.

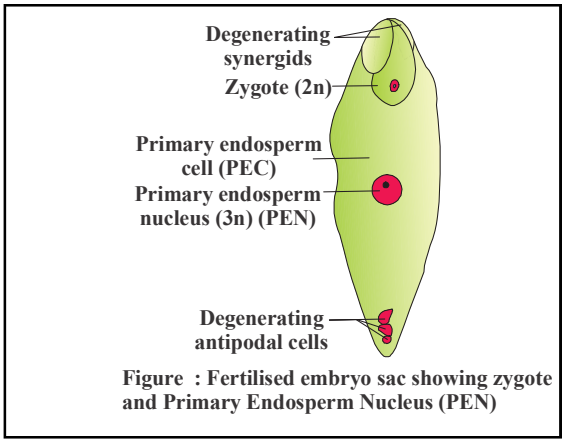


Figure : Fertilised embryo sac showing zygote and Primary Endosperm Nucleus (PEN)

* All the remaining cells of embryosac like **antipodal cells, synergids** degenerate excluding zygote and primary endosperm nucleus after the fertilization. At this time, zygote obtains food from degenerating synergids and antipodal cells.
* The **fertilization** in which non motile gametes are carried to female gamete through pollen tube is known as "Siphonogamy".

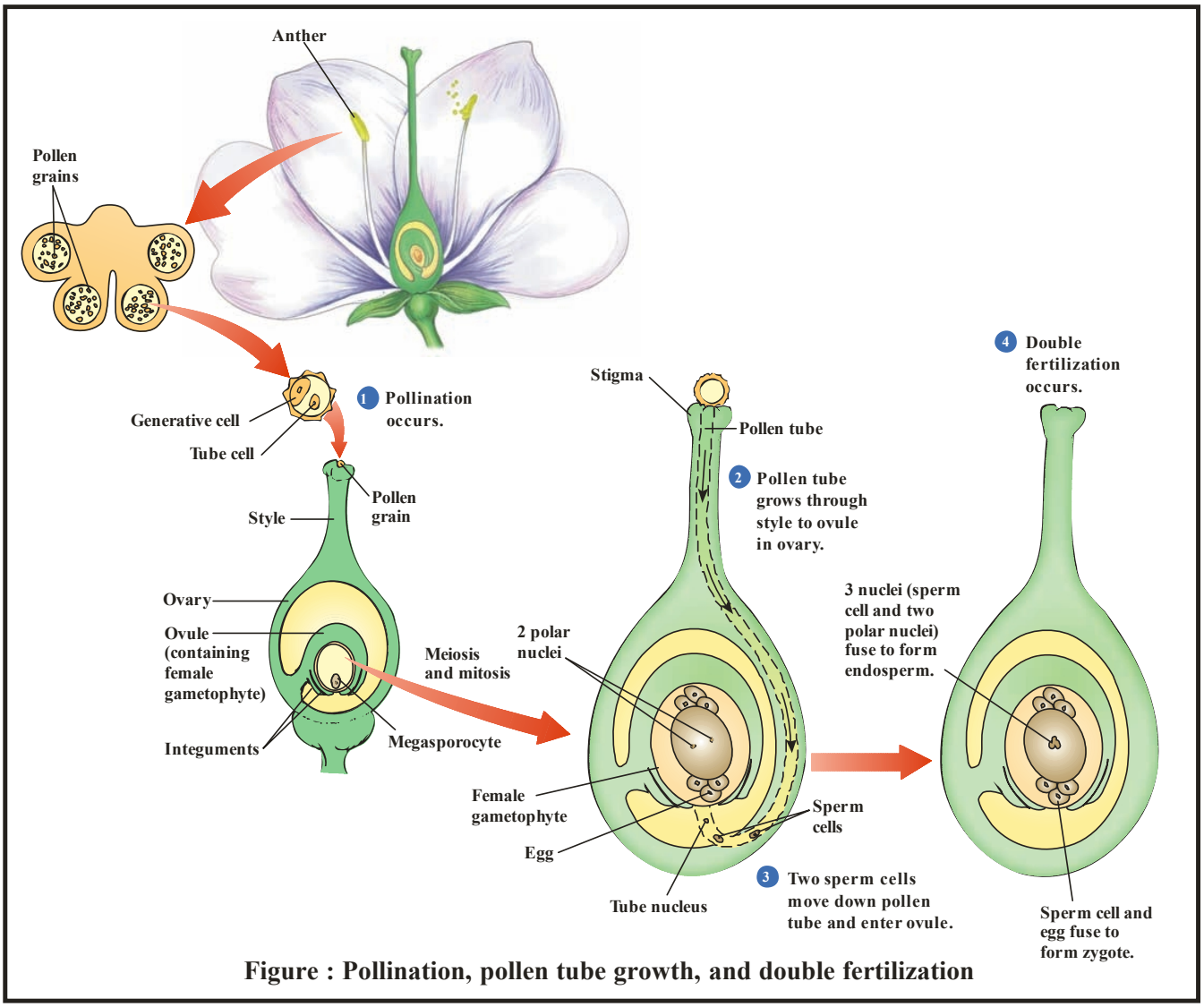


Figure : Pollination, pollen tube growth, and double fertilization

POST FERTILIZATION

Following double fertilisation, events of endosperm and embryo development, maturation of ovule(s) into seed(s) and ovary into fruit, are collectively termed post-fertilisation events.

1. Development of endosperm :

* Endosperm development precedes embryo development.
* The primary endosperm cell divides repeatedly and forms a triploid endosperm tissue which stores reserve food materials. It is utilized by the embryo during the early development then after at the time of seed germination.
* Food is present in endosperm.
* The endosperm is of three types on the basis of development.

(i) Nuclear Endosperm :

* This type of endosperm mostly found in **Dicotyledon** (Polypetalae). Nuclear endosperm is also present in Capsella.
* Such type of endosperm develops by free nuclear divisions thus a **multinucleated endosperm** is formed. Later on cytokinesis takes place, so that multicellular endosperm is formed at maturity.
* This type of endosperm is the most common in Angiosperms.

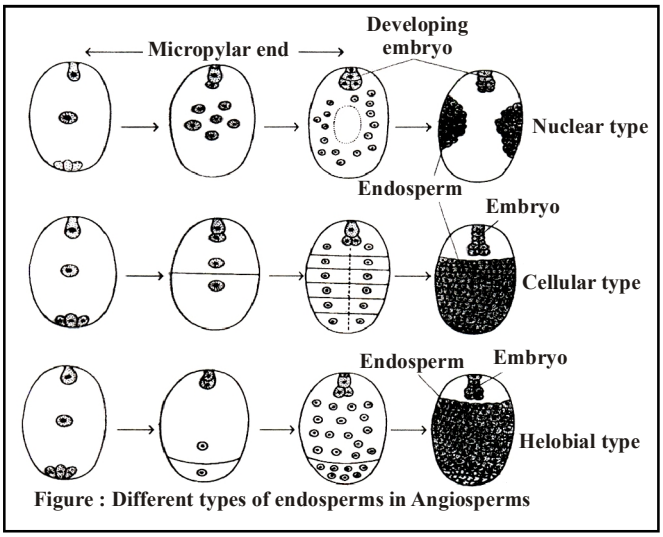


Figure : Different types of endosperms in Angiosperms

(ii) Cellular Endosperm :

* This type of endosperm is found in Gamopetalae group.
* During the development, each division of primary endosperm nucleus is followed by cytokinesis. So that endosperm is remains cellular from the beginning.

(iii) Helobial Endosperm :

* During the development of this type of endosperm first division of primary endosperm nucleus is followed by unequal cytokinesis so that two unequal sized cells are formed (Cell towards the micropyle is large).
* Now free nuclear divisions takes place in each cells, results it becomes multinucleated.
* Eventually cytokinesis takes place at a time so that it is changed into a cellular endosperm. This type of endosperm is found in order helobiales (**Monocots**). It is intermediate type of endosperm.

NOTE

* Endosperm is absent in some of Angiosperms e.g. In Orchidaceae, Podostemaceae and Trapaceae.
* Exceptionally, some of the plants have diploid endosperm instead of triploid such as in Oenothera.
* **Maize** and **Tomato** have **mosaic endosperm** in which patches of different colours are present.
* The endosperm in Betelnut or Arecanut (Arecaceae) and Annonaceae family is rough surfaced. It is known as **"ruminate endosperm".**
* The drinking portion (coconut water) is **nuclear endosperm** and edible portion is **cellular endosperm** in Coconut.

2. Development of embryo

(i) In Dicot : Development of embryo in Capsella was discovered by "Hanstein".

* Embryo develops at the micropylar end of the embryo sac where the zygote is situated. Most zygotes divide only after certain amount of endosperm is formed. This is an adaptation to provide assured nutrition to the developing embryo. Though the seeds differ greatly, the early stages of embryo development **(embryogeny)** are similar in both monocotyledons and dicotyledons.

* The first division of Oospore is transverse, results two cells are formed. The one cell lies towards micropyle is called **basal cell or suspensor cell**. The other cell is formed towards the Chalaza is called **apical cell** or terminal cell or **embryonal cell.**
* The basal cell and embryonal cell divide simultaneously.
* The embryonal cell divides by mitotic divisions to gives rise to the proembryo and subsequently to the globular, heart shaped and mature embryo.
* The suspensor cells divided by transverse divisions forming a 6-10 celled long filament like structure which is termed suspensor. The main function of suspensor is to push the developing embryo into food laden endosperm to provide nutrition.
* The **micropyler cell** of the suspensor swells up. This cell of suspensor is known as haustorial-cell.

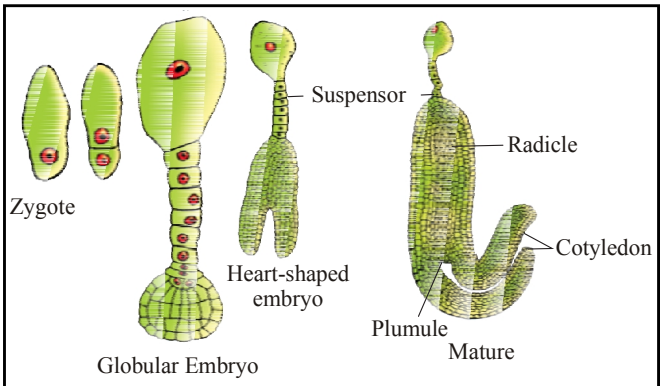


Figure : Stages in embryo development in a dicot

* In Capsella due to the curved position of body of ovule embryo becomes curved. This curved position of the embryo is called Torpedo (Mature embryo).
* An axis is present between plumule and radicle is called embryonal axis, it is also called Tigellum (main embryonal axis).
* Both the cotyledons are present at lateral position of embryonal axis and plumule is formed in terminal position in Dicotyledon embryo.
* This type of development of embryo is known as Crucifer type or **Onagrad type**. It is the most common type of development in **Dicots.**
* **Crucifer type** of development is also found in Capsella.

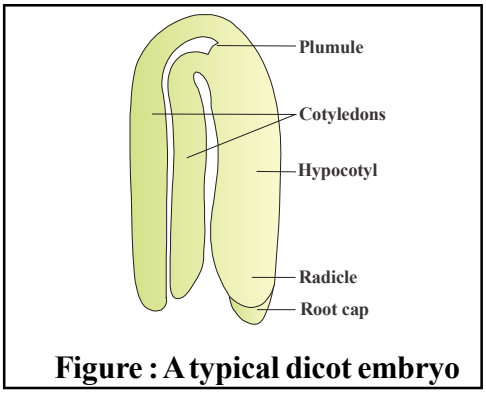


Figure : A typical dicot embryo

* A typical dicotyledonous embryo consists of an **embryonal axis** and two **cotyledons**.
* The portion of embryonal axis above the level of cotyledons is the **epicotyl**, which terminates with the **plumule** or stem tip.
* The cylindrical portion below the level of cotyledons is **hypocotyl** that terminates at its lower end in the **radicle** or **root tip**. The root tip is covered with a **root cap**.

(ii) In Monocotyledon :

* Embryos of monocotyledons possess only one cotyledon.
* In the grass family the cotyledon is called **scutellum** that is situated towards one side (lateral) of the embryonal axis.
* At its lower end, the embryonal axis has the radical and root cap enclosed in an undifferentiated sheath called **coleorrhiza**.
* The portion of the embryonal axis above the level of attachment of scutellum is the epicotyl.
* Epicotyl has a shoot apex and a few leaf primordia enclosed in a hollow foliar structure, the **coleoptile**.

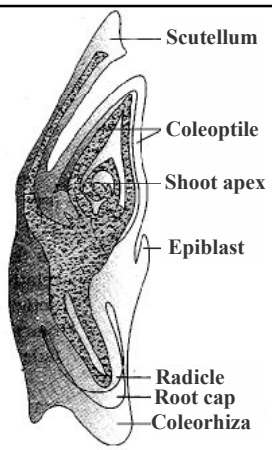
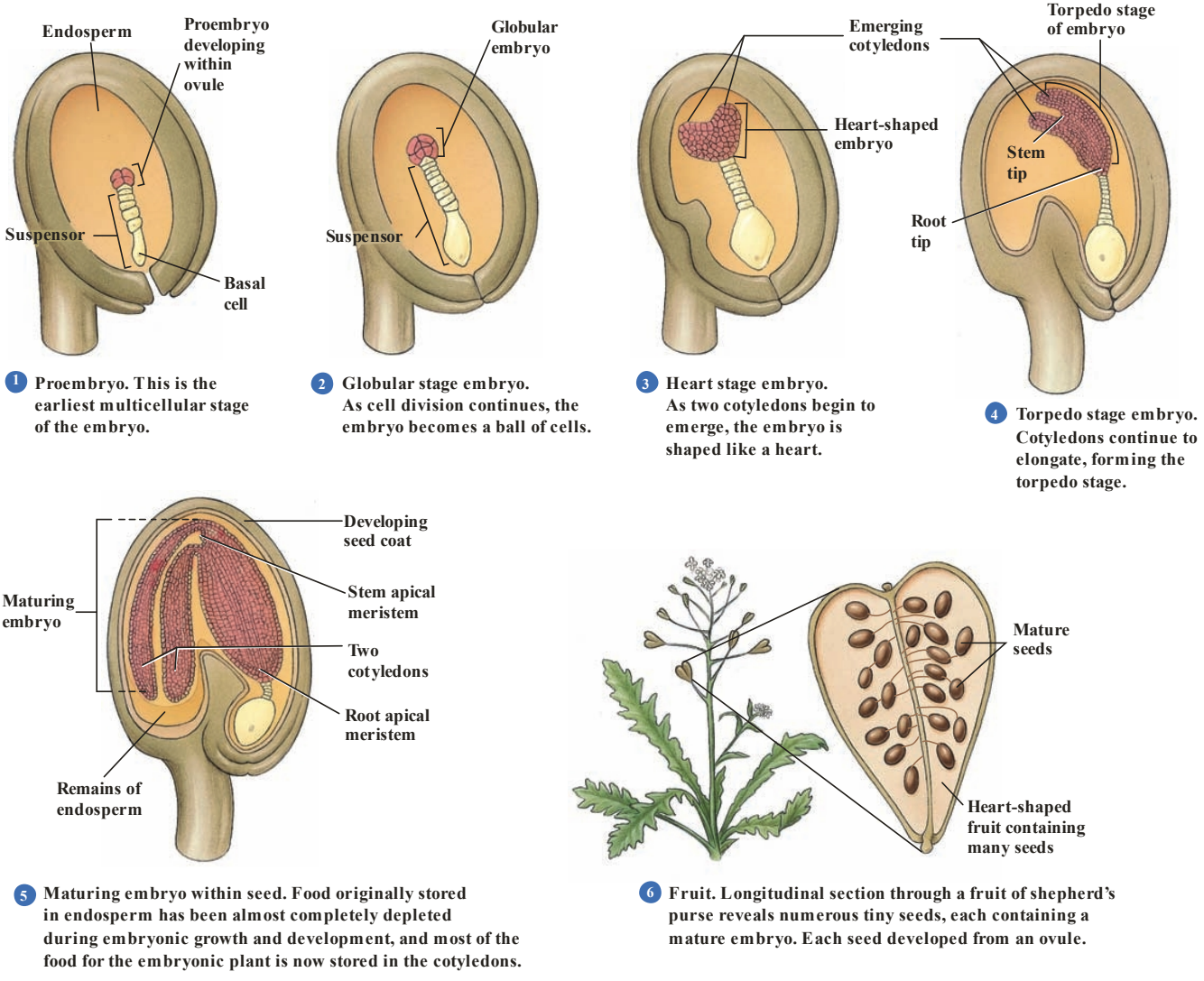


Figure : L.S. of an embryo of grass (Monocotyledons)



1 Proembryo. This is the earliest multicellular stage of the embryo.

2 Globular stage embryo. As cell division continues, the embryo becomes a ball of cells.

3 Heart stage embryo. As two cotyledons begin to emerge, the embryo is shaped like a heart.

4 Torpedo stage embryo. Cotyledons continue to elongate, forming the torpedo stage.

5 Maturing embryo within seed. Food originally stored in endosperm has been almost completely depleted during embryonic growth and development, and most of the food for the embryonic plant is now stored in the cotyledons.

6 Fruit. Longitudinal section through a fruit of shepherd's purse reveals numerous tiny seeds, each containing a mature embryo. Each seed developed from an ovule.

Figure : Embryonic development in shepherd's purse (*Capsella bursa-pastoris*)
The ovule is shown apart from the ovary in parts (1) through (5) .

Post fertilization change

(1) Ovary - Fruit
(2) Ovule - Seed
(3) Ovary wall - Pericarp or fruit wall
(4) Integument - Seed coat
(5) Outer integument - Testa (Outer seed coat)
(6) Inner integument - Tegmen (Inner seed coat)
(7) Nucellus - Degenerate(Sometimes present in the form of perisperm)
(8) Egg cell - Embryo
(9) Synergids & antipodals - Degenerate
(10) Hilum of ovule - Hilum of seed (scar on seed)
(11) Funiculus of ovule - Stalk of seed (may be left or broken)
(12) Micropyle of ovule - Micropyle of seed
(13) Chalaza of ovule - Chalaza of seed

Ploidy level in different parts of plant

Sporophyte (Zygote, Embryo, Radicle, Plumule, Cotyledon, Nucellus, Integument, Microspore mother cell, Megaspore mother cell, Ovary wall, Fruit wall, Carpel, Sepal, Petal, Stamen, Leaf, Root, Stem) = 2n

Gametophyte (Microspore/Pollen grain, Tube cell, Generative cell, Male gamete, Female gamete, Megaspore, Embryosac, Synergid, Antipodals, Egg cell) = n

ANGIOSPERM LIFE CYCLE

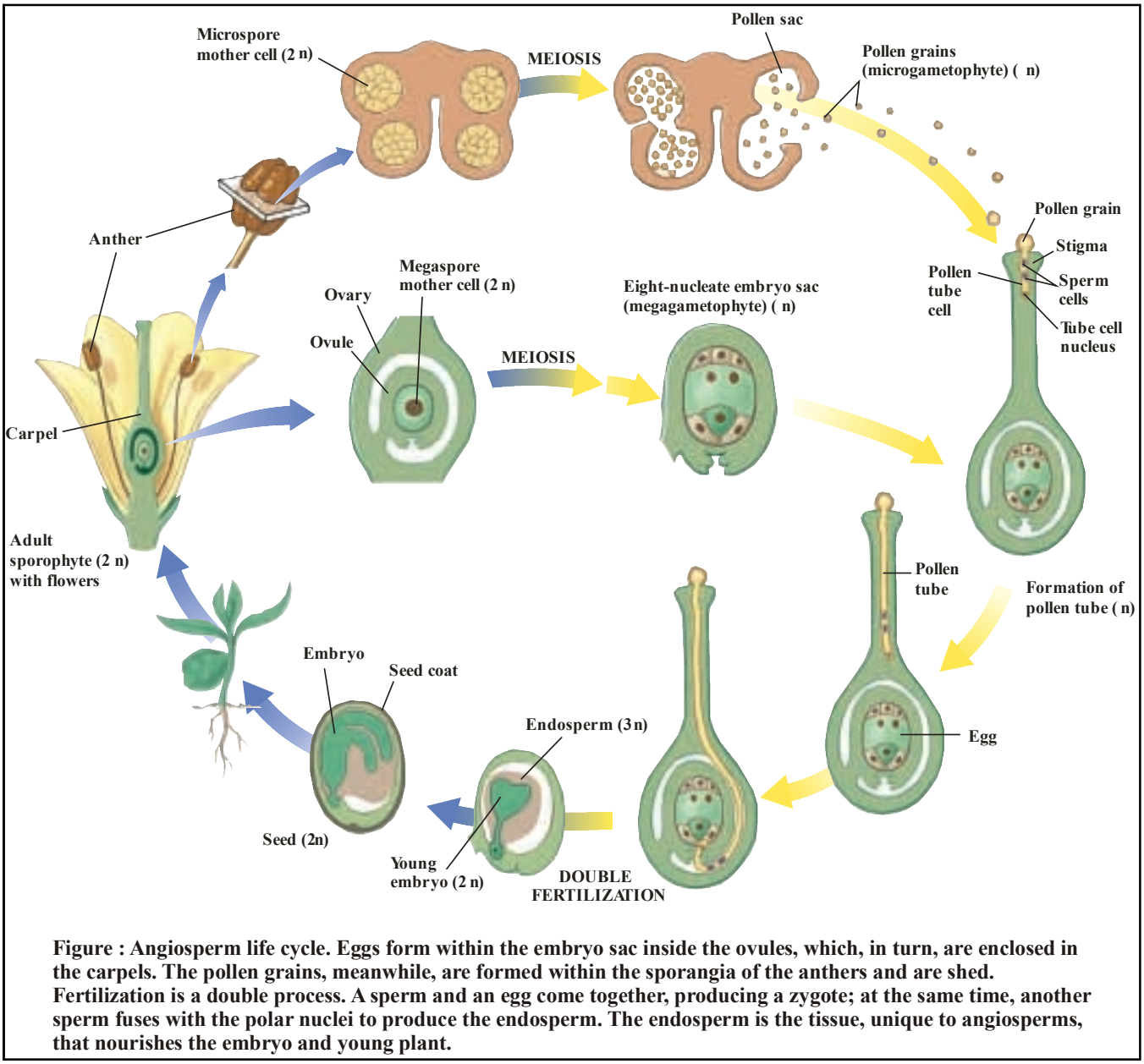


Figure : Angiosperm life cycle. Eggs form within the embryo sac inside the ovules, which, in turn, are enclosed in the carpels. The pollen grains, meanwhile, are formed within the sporangia of the anthers and are shed. Fertilization is a double process. A sperm and an egg come together, producing a zygote; at the same time, another sperm fuses with the polar nuclei to produce the endosperm. The endosperm is the tissue, unique to angiosperms, that nourishes the embryo and young plant.

ANGIOSPERMIC SEED

* Morphologically, ripened ovule is known as **seed**. In other words, seed is a mature, **integumented megasporangium (Ovule).**
* All the structures, which are present inside the seed coat are collectively termed as **Kernel**.
* Typical mature seed is having three main parts: (i) Seed coat, (ii) Embryo, (iii) Endosperm.

Endosperm

* It is the nutritive tissue which may be present or absent in the seeds.
* The angiospermic seed classified into two categories on the presence or absence of endosperm in seeds :

1. Non Endospermic or Ex-albuminous seed or Non-albuminous seeds:

* Such type of seeds do not have an endosperm at maturity, therefore are called non endospermic or Exalbuminous seeds.

* The endospermic tissues are absorbed during the development of embryo.
* The absorbed food materials from the endosperm is stored in cotyledons that why they become so large and fleshy e.g. Capsella and most of dicotyledons. But in Castor, seeds are endospermic.

2. Endospermic or Albuminous seed :

* This type of seeds, food is stored in endosperm.
* The endospermic tissue in these seeds are utilized during the germination of seed and their cotyledons are thin and membranous e.g. most of Monocot seeds e.g. Wheat, Rice, Coconut, Barley and Maize etc. But in Orchid, seeds are non-endospermic.

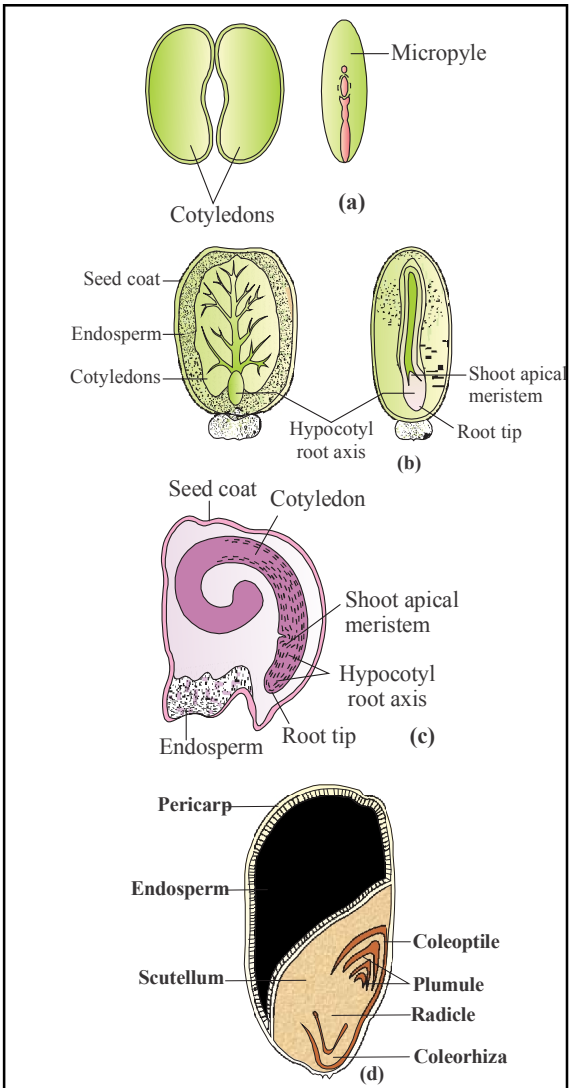


Figure : Structure of some seeds (a) Bean seeds, (b) Castor (Dicot), (c) Onion, (d) maize grain

NOTE

* Endospermic dicot seeds: e.g., Castor, Papaya, Cotton.
* Non-endospermic dicot seeds: e.g., Gram, Bean, Pea, cucumber, Tamarind, Groundnut or Peanut.
* Endospermic monocot seeds: e.g.. Maize, Rice, Wheat, Coconut and Barley.
* Non-endospermic monocot seeds: Orhid, Pothos (money plant), Vallisneria, Alisma, Amorphophallus.

FRUITS

* The transformation of ovules into seeds and ovary into fruit proceeds simultaneously. The ovary wall develops into the fruit wall, called **pericarp**.
* **True Fruit** develops only from the ovary, e.g. mango, tomato.
* **False Fruit** develops from parts of the flower other than the ovary e.g. apple, strawberry,cashew etc.
* Fruit developed without fertilization is called **Parthenocarpic** fruits.e.g Banana.
* Parthenocarpy can be induced through the application of growth hormones like Auxins.
* The first stimulus for fruit development comes from pollination while second stimulus is received from developing seeds and the third stimulus is provided by the availability of nutrients.

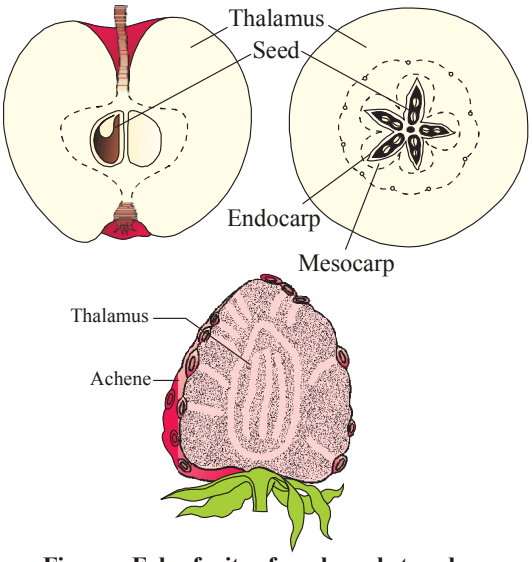
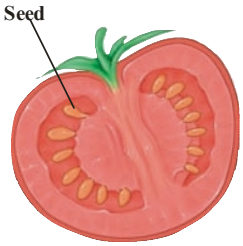


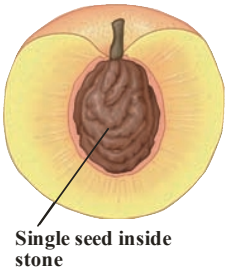
Figure : False fruits of apple and strawberry

Types of Fruits

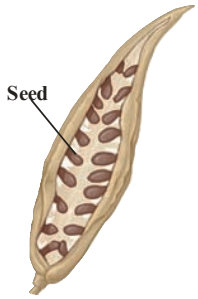
Fruits are botanically classified into four groups-simple, aggregate, multiple, and accessory-based on their structure and mechanism of seed dispersal.



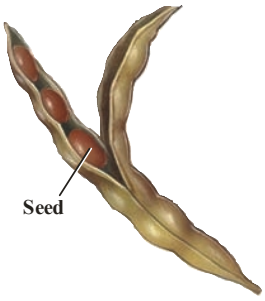
Berry (simple fruit)
A simple, fleshy fruit in which the fruit wall is soft throughout.
Tomato (Lycopersicon lycopersicum)



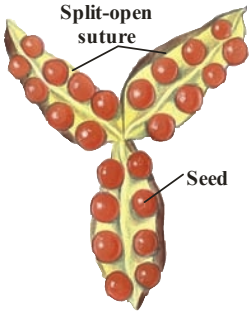
Drupe (simple fruit)
A simple, fleshy fruit in which the inner wall of the fruit is a hard stone.
Peach (Prunus persica)



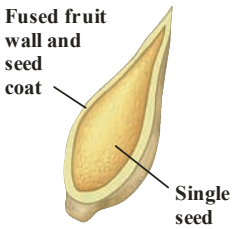
Follicle (simple fruit)
A simple, dry fruit that splits open along one suture to release its seeds; fruit is formed from ovary that consists of a single carpel.
Milkweed (Asclepias syriaca)



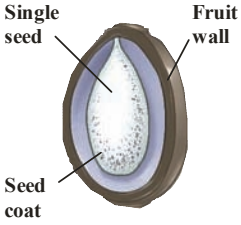
Legume (simple fruit)
A simple, dry fruit that splits open along two sutures to release its seeds; fruit is formed from ovary that consists of a single carpel.
Green bean (Phaseolus vulgaris)



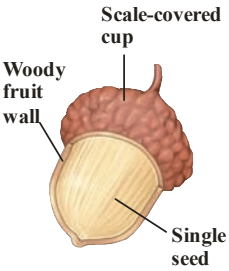
Capsule (simple fruit)
A simple, dry fruit that splits open along two or more sutures or pores to release its seeds; fruit is formed from ovary that consists of two or more carpels.
Iris (Iris)



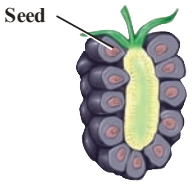
Caryopsis (simple fruit)
A simple, dry fruit in which the fruit wall is fused to the seed coat.
Wheat (Triticum)



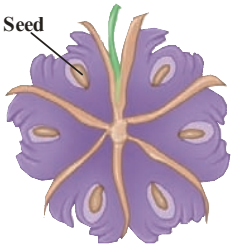
Achene (simple fruit)
A simple, dry fruit in which the fruit wall is separate from the seed coat.
Sunflower (Helianthus annuus)



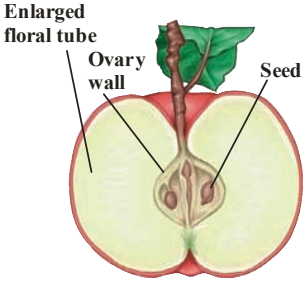
Nut (simple fruit)
A simple, dry fruit that has a stony wall, is usually large, and does not split open at maturity.
Oak (Quercus)



Aggregate fruit
A fruit that develops from a single flower with several to many pistils (i.e., carpels are not fused into a single pistil).
Blackberry (Rubus)



Multiple fruit
A fruit that develops from the ovaries of a group of flowers.
Mulberry (Morus)



Accessory fruit
A fruit composed primarily of nonovarian tissue (such as the receptacle or floral tube).
Apple (Malus sylvestris)

GERMINATION OF SEED

1. Epigeal germination:

* Due to hypocotyl growth or elongation, cotyledons are pushed out of soil.
* This type of germination occurs in Capsella, Castor, Tamarind, bean, etc.
* In some cases, these above ground cotyledons become green leaf like (cotyledonary leaves) and perform photosynthetic function till the seedling assumes independency.

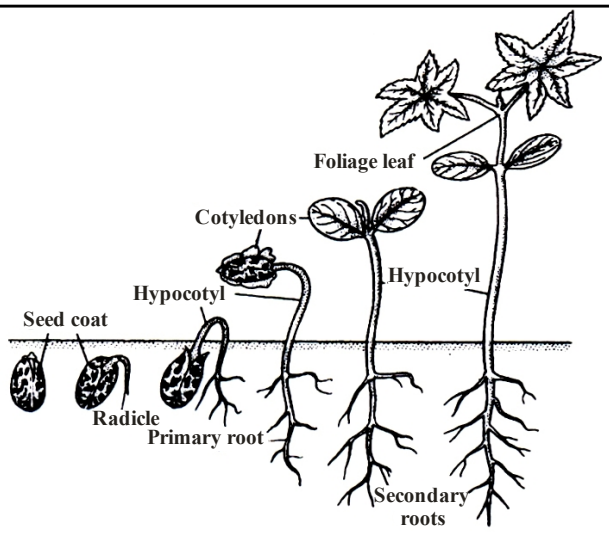


Figure : Epigeal germination of castor seed

2. Hypogeal germination:

* Due to growth in epicotyl plumule comes out of the ground and cotyledons remain underground.
* This type of germination occurs in most of the monocytyledons and few dicotyledons. e.g., Maize, Rice, Wheat. Coconut, Gram, Pea. Peanut and Mango, etc.

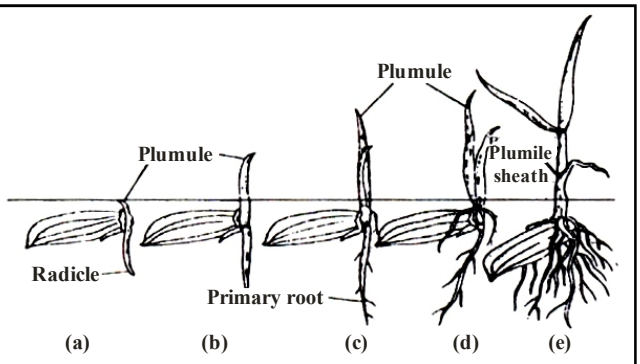


Figure : Hypogeal germination of rice seed

3. Vivipary :

* A special type of seed germination is characteristic of Mangrove vegetation, found in muddy, saline conditions, e.g.. *Rhizophora, Avicennia, Ceriops, Breguira, Sonneratia*. etc.
* Here there is no resting period of embryo and germination occurs inside the fruit, while it is attached to the parent plant, i.e., **"in-situ germination".**

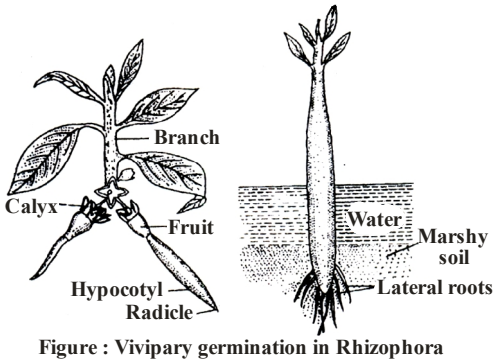


Figure : Vivipary germination in Rhizophora

Dormancy of seed

* The presence of dormancy in a seed is the most important characteristic feature. Because of this character, seeds remain viable for many years.
* The seeds are dispersed very far places through water, air or insects.
* Most of the seeds are unable to germinate just after dispersal.
* They germinate after sometime. The time between the maturation and germination of seed is known as "**Dormancy period".**
* The state of inhibited germination as a result of internal causes is usually called 'dormancy'.
* This seed dormancy is of considerable advantage to the plant which helps in adverse environmental conditions.
* The embryo remains inactive in this period and all the growth processes suspended temporarily.

Factor affecting seed germination

1. Moisture or water :

* The moisture or water is the most important factor for germination of seed. Generally, the cells of embryo contain about **10-15% water** in **dormancy period**.

* For **active life** processes, **water** must be present about **75-90%.**
* Water is absorbed through seed coat and micropyle.

2. Oxygen (O_2) :

* The process like cell division, cell elongation etc. of the embryo requires energy. This energy is released by the oxidation of organic substances.
* Oxygen is essential for oxidation process.

3. Temperature :

* The favourable range of temperature is **20-25°C** for germination of seed

4. Food or Nutrition:

* The embryo depends upon stored food materials in **cotyledons** or **endosperm** in the germination period upto the formation of primary root from the radicle and first leaf from the plumule.

5. Light :

* Most of the plants do not require light up to the formation of first leaf. But for some plants light is very essential for germination. They will not germinate in the dark. For example seed of **Orchids, Tobacco, Lettuce, Capsella**, Mistletoe etc. (+ve photoblastic seeds).
* After the development of newly leaves an shoot light becomes very essential factor.

Viability

* This is called existence of life in a seed.
* Seeds of a large number of species live for several years.
* Some seeds can remain alive for hundreds of years.
* There are several records of very old yet viable seeds.
* The oldest is that of a lupine, Lupinus arcticus excavated from Arctic Tundra. The seed germinated and flowered after an estimated record of 10,000 years of dormancy.
* A recent record of 2000 years old viable seed is of the date palm, *Phoenix dactylifera* discovered during the archeological excavation at King Herod's palace near the Dead Sea.
* The viabilityof seed can be tested out by T.T.C. (2, 3, 5, triphenyl tetrazolium chloride).
* The embryonal axis of living seed becomes pink in colour in the solution of T.T.C.

NOTE

* Highest amount of **fat** is found in endosperm of **Coconut.**
* **125 meiotic** divisions are essential for development of 100 grains of Wheat.
* Two generaticn and three type of genotypic cells are present in **Angiospermic seed.**
* Largest and heaviest seed (6 kg) is found in *Lodoicea maldivica*. Its fruit is 1 meter in length and of weight 18 kg.
* **Smallest or minute seeds** are found in **Orchids** which are lightest in plant kingdom and are called "Dust seeds" [wt. 20.33 µg].
* The seed of ***Cuscuta*** and ***Santalum*** lacks cotyledons.
* Dormancy is absent in **Mangrove** plants uke ***Rhizophora*.**
* Occurence of more than two male gametes into the ovule is called "***Polyspermy***". It may be due to entry of more than one pollen tube into embryosac.
* When two pollen tube enter into an ovule and release their contents. It is possible that the one male gamete of one pollen tube fertilizes the egg cell and one male gamete of another pollen tube participates in triple fusion (with secondary nucleus). It is called **heterofertilization.**
* Water is a regular mode of transport for male gametes among the lower plants like algae, bryophytes and pteridophytes. It is believed that bryophytes and pteridophytes are limited in their distribution because of the need of water for the transport of male gametes and fertilisation.

APOMIXIS

* It is a form of asexual reproduction that mimics sexual reproduction where seed are formed without fertilisation e.g. species of Astereceae and grasses.
* Diploid egg cell is formed without meiosis and develops into seed without fertilization.

* In Citrus and Mango the nucellar cells starts dividing, protrude into the embryo sac and develop into embryo.
* Hybrid plants are developed by apomixis to maintain the genetic identity.
* In flowering plants, there are two main types of **Apomixis**.
  (1) Agamospermy (2) Vegetative Propagation

Agamospermy

* In this type **embryo** is formed without fertilization and meiotic division.
* It means plants belonging in this category propagated through **seeds** but the embryo formation does **not involve meiosis** and **syngamy**.
* It occurs by following methods:

(a) **Diplospory :** In this method megaspore mother cell directly gives rise to an embryo sac without meiosis. This embryo sac is diploid and a diploid embryo is formed without fertilization from diploid **egg** of this embryo sac.
Ex. *Parthenium, Taraxacum.*

(b) **Apospory :** Formation of gametophyte directly from sporophyte without meiosis is known as **apospory**. In this **gametophyte** always remains **diploid.** Ex. *Heiracium*, *Ranunculus*, *Rubus*.

(c) **Adventive Embryony :** In this method, an embryo is formed from any **diploid cells (Nucellus or integuments)** of the ovule except embryosac. This **diploid cell** behave like a **zygote.** Ex. from Nucellus – Citrus, *Mangifera*, Opuntia, Onion from Integuments in *Spiranthus australis*.

Parthenogenesis

* Formation of embryo from unfertilized egg is called parthenogenesis.
* In this process haploid egg cell of female gametophyte is responsible to form a haploid embryo without fertilization.

Apogamy

In this process any haploid cell of female gametophyte except egg cell is responsible to form a haploid embryo without fertilization.

Note : If both gametophyte and sporophyte are diploid in Parthenogenesis and apogamy then it is called diploid Parthenogenesis and diploid apogamy respectively.

POLYEMBRYONY

* Occurrence of more than one embryo in a seed e.g.Orange. lemon, onion, mango, ground nut.
* More than one egg may be formed in the embryo sac.
* More than one embryo sac may be formed in an ovule.
* First of all, it is observed by **Leeuwenhoek** in **Citrus (Orange) seeds**.

Polyembryony is commonly found in **Gymnosperm** but it is also found in some of Angiospermic plants such as **Orange, Lemon** and **Nicotiana** etc.

Adventive embryony is also example of **polyembryony** in which additional number of embryos are formed from **nucellus** or **integuments.**

ANDROGENIC HAPLOID PLANTS

* This concept was given by **Haberlandt** and practically **proved by Steward**. It is based on totipotency.
* Anther of the **Datura** plant grown on culture medium by **Guha** and **Maheshwari**.
* As a result of this culture, haploid and diploid two different type of plants are formed. **Diploid** plants developed from the **wall of the anther** and **haploid** plants developed from the **pollen grains**.
* Such type of haploid plants which were obtained from the pollen grains by tissue culture are known as androgenic plants.

Significance of Apomixis over hybrid seeds

* Generally hybrid seeds are utilized in cultivation of most of crops and vegetables.
* The hybrid seeds have to be produced every year. If the seeds collected from hybrid are sown, the plants in the progeny will segregate and do not maintain hybrid characters.

* The production of hybrid seeds is costly so cost of hybrid seeds is too expensive for the farmers. So if these hybrid made into apomicts, there is no segregation of characters in the hybrid progeny.
* The farmers can keep on using the hybrid seeds to raise new crop year after year and no need to buy hybrid seeds every year.
* Because of the importance of apomixis in hybrid seed industry, active research is going on in many laboratories around the world to understand the genetics of apomixies and to transfer apomictic genes into hybrid varieties.

CONCEPT REVIEW

* Pollen forms within pollen sacs in the anther. Each **pollen grain** contains two cells. One generates two sperm cells, and the other produces a **pollen tube** through which the sperm cells reach the ovule.
* An egg and two **polar nuclei**, along with several other nuclei, are formed in the ovule. Both egg and polar nuclei participate directly in fertilization.
* **Pollination** is the transfer of pollen grains from anther to stigma. After pollination, **fertilization**, the fusion of gametes, occurs.
* Flowering plants have **double fertilization**. In the ovule, the egg fuses with one sperm cell, forming a zygote (fertilized egg) that eventually develops into a multicellular embryo in the **seed**. The two polar nuclei fuse with second sperm cell, forming a triploid nutritive tissue called **endosperm**.
* Male gamete (n) + Egg (n) → Zygote (2n)
* Male gamete (n) + Two fused polar nuclei (2n) → Primary endosperm nucleus (PEN)
* A typical microsporangium appears circular in outline. It is surrounded by 4 walls.
  Outermost layer = Epidermis
  Second layer = Endothecium
  Middle layer = 2 - 4 layers of cells
  Innermost layer = Tapetum
* The innermost layer tapetum is multinucleated, with dense cytoplasm; it nourishes the developing pollen grain.
* The centers of each microsporangium contain homogenous cells called sporogenous tissues.
* Sporogenous tissue (2n)→ MMC (2n) $\xrightarrow{\text{Meiosis}}$ Microspore (tetrad) $\xrightarrow[(n)]{\text{Mitosis}}$ 4 Microspores (n) → 4 Pollen grains (n)
* **Embryo development :**
  Zygote → Pro-embryo → Globular embryo → Heart shaped embryo → Mature embryo
* **Difference between Embryo and Endosperm**

S.N.	Embryo	Endosperm
1.	It is formed by fertilized egg (syngamy)	It is formed by fusion of secondary nucleus (triple fusion)
2.	It is always diploid structure.	It is generally triploid structure.
3.	It gives rise to new plant.	It provides nutrition to the developing embryo.
4.	Cotyledons, plumule and radicle are formed in embryo	Such type of structures are never formed.
5.	Embryo is present in seed.	It is only found in endospermic seeds otherwise it degenerates with the formation of seed.

* **Difference between Egg cell and secondary nucleus :**

S.N.	Egg cell	Secondary nucleus
1.	It is present near the micropyle, inside the embryo sac.	It is present the middle of the embryo sac.
2.	Generally egg is surrounded by two synergids.	It is not surrounded.
3.	Only single nucleus is present in it.	It is formed by fusion of two polar nuclei.
4.	It is haploid structure.	It is diploid structure.
5.	It is fertilized with one male gamete and to form a diploid zygote (Embryo).	It is fused with one male gamete and to form a triploid primary endosperm nucleus (Endosperm).

* Difference between Pollination and Fertilization

S.N.	Pollination	Fertilization
1.	Transfer of pollen grains from anther to stigma of the flower is called pollination.	Fusion of male gametes and egg cell in embryo sac situated inside the ovule is called fertilization.
2.	This process take place before fertilization.	This process take after pollination.
3.	For the completion of this process, insects, water, air like agencies are essential.	There is no any external medium is utilized in this process.
4.	Pollen tube is not formed.	Pollen tube is formed which transfer male gametes up to egg cell.
5.	This process take place on outer parts of flower, so that it is external mechanism.	This process take place inside the flower, so that it is internal mechanism.

* Difference between Monocotyledonous and Dicotyledonous seed

S.N.	Monocotyledonous Seeds	Dicotyledonous Seeds
1.	Only single cotyledon is present with embryo	Two cotyledon are present with embryo.
2.	Generally cotyledon is thin or papery	Cotyledons are thick.
3.	Generally seeds are endospermic	Generally seeds are non endospermic, some times may be endospermic.
4.	Cotyledon is also called scutellum	Not called by this name.
5.	In seed plumule is covered by coleoptile and radicle is covered by coleorrhiza.	Coleoptile and coleorhiza are not formed.
6.	Plumule is in lateral position and cotyledon are is in terminal position	Plumule is in terminal position and cotyledons are present in lateral position.
7.	Radicle degenerates after sometime and adventitious roots are formed at that place.	Radicle is responsible to form primary root.
8.	In some of the seeds, seed coats and cotyledon fused together e.g. Wheat etc.	Such types of seed are not found.

* Difference between Male and Female gametophyte

S.N.	Male gametophyte	Female gametophyte
1.	It is developed from microspore or pollen grain.	It is developed from megaspore.
2.	It does not remain embedded permanently in microsporangium.	It remains embedded permanently in megasporangium.
3.	Male gametes come out of pollen grain due to the formation of pollen tube.	Female gamete always remains inside, covered by membrane of megasporangium.
4.	There are two phases of growth-prepollination and post pollination.	Only single phase of growth.
5.	It is there called structure in mature stage.	It has seven cells in mature stage.
6.	It will distintegrate after fertilization	Two new structure are formed after fertilization, that is endosperm and oospore.

IMPORTANT POINTS

* **Allogamy :** Reaching of pollen grains to the stigma of different plant.
* **Apomixis :** Formation of new individuals through asexual reproduction without involving the formation and fusion of gametes.
* **Chasmogamous Flowers :** Flowers with exposed anthers ad stigma.
* **Cleistogamous Flowers :** Flowers which never open.
* **Coleorhiza :** A protective sheath of radicle in monocot seed.
* **Coleoptile :** A protective sheath of plunule in monocot speed.
* **Endothecium :** A fibrous layer is the anther next to epidermis.
* **Epicotyl :** The portion of embryonic axis between the plumule and cotyledon.
* **Geitonogany :** Self pollination between flowers of the same plant.

* **Hyocotyl :** The region of embryonic axis between the radicle and the point of attachment of the coty ledons.
* **Micropyle :** A small pore in the ovule through which the pollen tube enters.
* **Monocarpellary Condition :** Gynoecium represented by single carpel.
* **Nucellus :** Multicellular tissue in the centre of ovule where embryo sac is present.
* **Parthenocarpy :** Production of seedless fruits.
* **Polyembryony :** Presence of more than one embryo in a seed.
* **Scutellun :** Partially developed single cotyledon of monocot seed.
* **Syncarpous Condition :** Two or more carpels fused together to form a single compound ovary.
* **Tapetum :** Nutritive layer of cells around pollen sac.
* **MMC :** Microspore mother cell.
* **PEN :** Primary endospern nucleus.
* **PEC :** Primary endosperm cell.
* Nucellar embryo is apomictic diploid.
* Ovule is attached to the placenta by a stalk named funicle.
* Polygonium type of embryo sac/typical female gametophyte of angiosperms is 7-celled, 8-nucleate.
* Ovule is curved and the embryo sac is horse-shoe shaped. Micrpyle, chalaza and funicle occur near one another. The ovule is amphitropous.
* Ovule is straight with funiculus, embryo sac, chalaza and micropyle lying on one straight line. It is orthotropous.
* Ovule is inverted with body fused to funicle, micropyle lying close to hilum and facing the placenta. It is anatropous.
* Water is not required in the fertilization of Pisum.
* Secondary nucleus forms the endosperm.
* In angiosperms, triple fusion is required for formation of endosperm.
* Chromosome number in oosphere is 8. The number in angiospermic endosperm shall be 24.
* A plant pollinated by bats is *Kigellia*.
* Double fertilization results in formation of endosperm.
* Process of fusion between male and egg nuclei is syngamy.
* Embryo sac is part of female reproductive system.
* Embryo of sunflower has two cotyledons.
* Tapetum occurs in anther wall.
* Formation of an organism from a single, male gamete without fusion with egg is an example of parthenogenesis.
* Anemophily occurs in coconut.
* Radicle end of embryo is towards micropyle.
* Double fertilization results in producing of triploid nucleus.
* Arrangement of nuclei in normal dicot embryo sac is 3 + 2 + 3.
* Number of chromosomes in an angiosperms plant is 14. Number of chromosomes in synergid cells will be 7.
* In mature embryo sac, the central cell is binucleate.
* Monocot seed generally shows hypogeal germination.
* Type of ovule present in *Opuntia* is Circinotropous.
* Hilum represents junction between ovule and funicle.
* Coconut water and edible part of coconut represent endosperm.
* PEN develops into endosperm. It occurs after double fertilization.
* **Table : Floral Characteristics Associated with Various Animal Pollinators**

Animal Pollinator	Common Flower Color	Scent	Pollinator Reward	Time of Flowering
Bee	Yellow, blue, purple	Strong, floral	Nectar, pollen	Day
Butterfly	Red, pink	Weak, floral	Nectar	Day
Moth	White	Strong, sweet	Nectar	Dusk, night
Carrion fly	Reddish-brown,	Strong, rotten	No reward	Day, night
Beetle	purple	Strong, various scents	Nectar, pollen	Day, night
Bird	Green, white	No scent	Nectar	Day
Bat	Red, pink	Strong, musklike or sweet	Nectar, pollen	Night

QUESTION BANK

EXERCISE - 1 (LEVEL-1) [NCERT EXTRACT]

SECTION - 1 (VOCABULARY BUILDER)

Choose one correct response for each question.

For Q.1-Q.5

Match the column I with column II.

Q.1

	Column I		Column II
(a)	Alternation of generation	(i)	The diploid plant which produces diploid microspores and megaspores.
(b)	Sporophyte	(ii)	The haploid stage of the plant that bears the gametes.
(c)	Gametophyte	(iii)	Where the life cycle alternates between a diploid sporophyte and a haploid gametophyte.
(d)	Inflorescence	(iv)	Flowers that are borne in a group.

Codes

(A) (a) – (iii), (b) – (i), (c) – (ii), (d) – (iv)
(B) (a) – (i), (b) – (ii), (c) – (iii), (d) – (iv)
(C) (a) – (ii), (b) – (i), (c) – (iv), (d) – (iii)
(D) (a) – (iii), (b) – (iv), (c) – (i), (d) – (ii)

Q.2

	Column I		Column II
(a)	Complete flower	(i)	A flower that lacks one of the four whorls.
(b)	Incomplete flower	(ii)	Where a plant bears the male and female flowers or flower parts on the different plants.
(c)	Monoecious	(iii)	A flower that has all four whorls-calyx, corolla, stamens, and carpels.
(d)	Dioecious	(iv)	Where a plant bears both the male and female flowers or flower parts on the same plant.

Codes

(A) (a) – (iii), (b) – (i), (c) – (ii), (d) – (iv)
(B) (a) – (i), (b) – (ii), (c) – (iii), (d) – (iv)
(C) (a) – (iii), (b) – (i), (c) – (iv), (d) – (ii)
(D) (a) – (iii), (b) – (iv), (c) – (i), (d) – (ii)

Q.3

	Column I		Column II
(a)	Calyx	(i)	The second whorl of a flower that is made of brightly colored petals to attract pollinators.
(b)	Sepal	(ii)	The leafy parts of a flower-part of the outermost whorl.
(c)	Corolla	(iii)	The brightly colored parts of a flower that attract pollinators.
(d)	Petal	(iv)	The outermost whorl that is made of leafy sepals.

Codes

(A) (a) – (iv), (b) – (ii), (c) – (i), (d) – (iii)
(B) (a) – (i), (b) – (ii), (c) – (iii), (d) – (iv)
(C) (a) – (ii), (b) – (i), (c) – (iv), (d) – (iii)
(D) (a) – (iii), (b) – (iv), (c) – (i), (d) – (ii)

Q.4

	Column I		Column II
(a)	Stamen	(i)	The third whorl of a flower that forms the male gametophytes.
(b)	Filament	(ii)	The innermost whorl that forms the female gametophytes.
(c)	Anther	(iii)	The thin stem of the stamens that bear anther at the tip.
(d)	Carpel	(iv)	The sac located at the tip of a stamen and bears the pollen grains.

Codes

(A) (a) – (iv), (b) – (ii), (c) – (i), (d) – (iii)
(B) (a) – (i), (b) – (iii), (c) – (iv), (d) – (ii)
(C) (a) – (ii), (b) – (i), (c) – (iv), (d) – (iii)
(D) (a) – (iii), (b) – (iv), (c) – (i), (d) – (ii)

Q.5

	Column I	Column II
(a)	Ovary	(i) The tip of the carpel where the pollen lands during pollination
(b)	Stigma	(ii) The male gametophyte of a plant.
(c)	Ovule	(iii) The lower part of a carpel that bears ovules.
(d)	Pollen	(iv) The round structure/s formed inside an ovary where the female gamerophyte develops.

Codes

(A) (a) – (iv), (b) – (ii), (c) – (i), (d) – (iii)
(B) (a) – (i), (b) – (iii), (c) – (iv), (d) – (ii)
(C) (a) – (ii), (b) – (i), (c) – (iv), (d) – (iii)
(D) (a) – (iii), (b) – (i), (c) – (iv), (d) – (ii)

SECTION - 2 (BASIC CONCEPTS BUILDER)

For Q.6 to Q.30 :
Choose one word for the given statement from the list.

Corolla, Gametogenesis, 10-15%, slow down, dormancy, Exine, Intine, Embryogenesis, Anther, Sepal, 2, 3, 4, 8, 7, Hypocotyle, Polyembryony, nucellus, Xenogamy, Radicle, Corolla, Root cap, Radicle

Q.6 Meiotic cell division takes place during ____

Q.7 Individual part or segment of calyx is called ___.

Q.8 Mass of cells enclosed by integuments is called ___.

Q.9 Nuclei are found in female gametophyte is ___.

Q.10 Occurrence of more than one embryo is called ___.

Q.11 ____ cells are found in female gametophyte.

Q.12 The terminal structure of stamen is called ____

Q.13 Petals together form ____

Q.14 Pollens have two prominant walls which are ___ and ___.

Q.15 The cylindrial portion below the cotyledons is ___ that terminates to ____ and tip called ___.

Q.16 A seed matures if water content is reduced to ____. If the general metabolism ____. The embryo enter a state called _____.

Q.17 Transfer of pollen grains from the anther to stigma of another flower of different plant is called ___.

Q.18 In ovule protective covering (integuments) are generally ____ in number.

Q.19 Number of microsporangia in an angiospermic anther is ____

Q.20 A longitudinal groove runs lengthwise separating the theca. This groove is called line of dehiscence. **[True / False]**

Q.21 The process of formation of microspore from the microspore mother cell is called megasporo-genesis. **[True / False]**

Q.22 'Microspores arranged in a cluster of four cells called megaspore tetrad'. **[True / False]**

Q.23 Sporopollenin is made up of organic material. **[True / False]**

Q.24 Sporopollenin is absent at the germpore. **[True / False]**

Q.25 Microspore develops into ova. **[True / False]**

Q.26 Cells at the chalazal end are called synergid cells. **[True / False]**

Q.27 Cells in the micropylar region are called antipodal cell. **[True / False]**

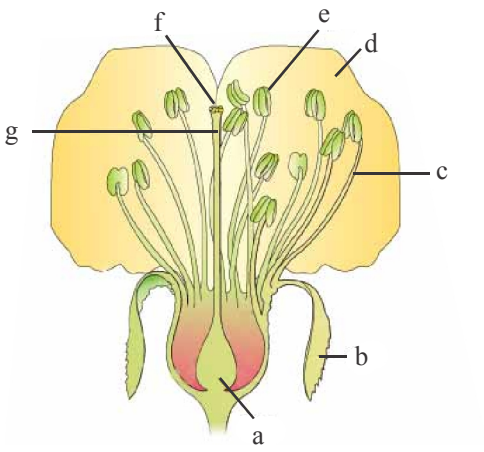
Q.28 Chances of pollination in air and water are increased by increasing number of pollens. **[True / False]**

Q.29 Wind pollinated flower have long well exposed stigma. **[True / False]**

Q.30 In coconut the cellular endosperm surrounds the nuclear endosperm. **[True / False]**

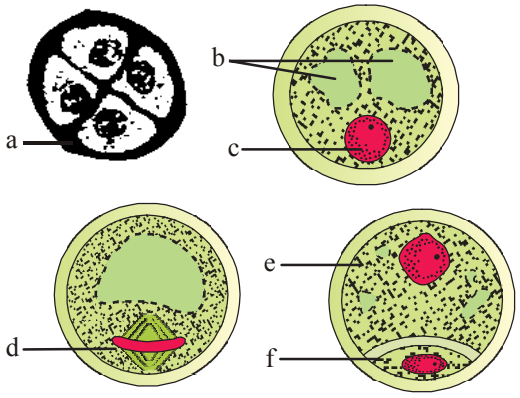
SECTION - 3 (ENHANCE DIAGRAM SKILLS)

Q.31 Identify A to G in following figure and answer accordingly.



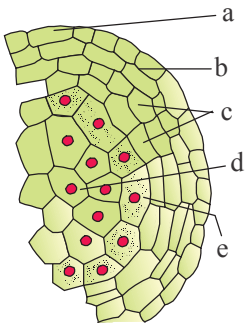
(A) a-Ovary, b-Filament, c-Sepal, d-Petal, e-Style, f-Stigma, g-Anther
(B) a-Sepal, b-Ovary, c-Petal, d-Filament, e-Anther, f-Stigma, g-Style
(C) a-Ovary, b-Sepal, c-Filament, d-Petal, e-Anther, f-Stigma, g-Style
(D) a-Petal, b-Anther, c-Stigma, d-Style, e-Filament, f-Sepal, g-Ovary

Q.32 Identify the structures marked A to F in the given diagram.



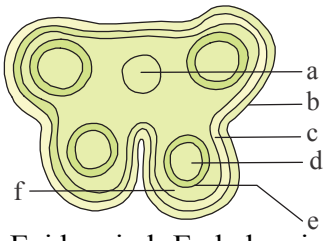
(A) a-Asymmetric nucleus, b-Nucleus, c-Generative cell, d-Vegetative cell, e-Pollen, f-Pollen tetrad
(B) a-Pollen tetrad, b-Pollen, c-Generative cell, d-Vegetative cell, e-Asymmetric spindle, f-Nuclues
(C) a-Pollen tetrad, b-Vacuole, c-Nucleus, d-Asymmetric spindle, e-Vegetative cell, f-Generative cell
(D) a-Vacuole, b-Nucleus, c-Pollen tetrad, d-Vegetative cell, e-Asymmetric spindle, f-Generative cell

Q.33 Identify (a) to (e) in the following diagram.



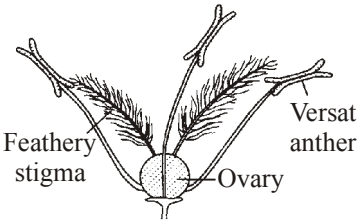
(A) a-Tapetum, b-Microspore mother cell, c-Middle layer, d-Endothecium, e-Epidermis
(B) a-Epidermis, b-Middle layer, c-Microspore mother cell, d-Tapetum, e-Endothecium
(C) a-Middle layer, b-Epidermis, c-Tapetum, d-Microspore mother cell, e-Endothecium
(D) a-Epidermis, b-Endothecium, c-Middle layer, d-Microspore mother cell, e-Tapetum

Q.34 Identify A to E in the following diagram.



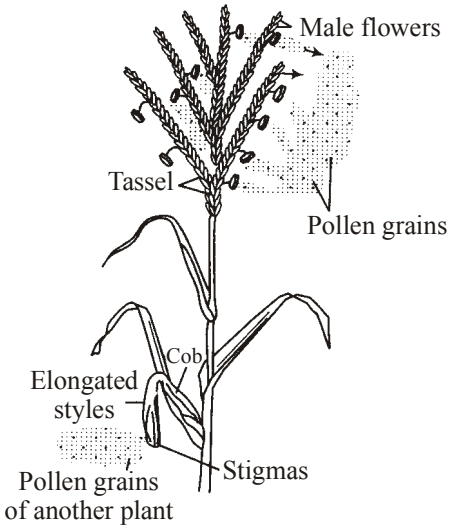
(A) a-Epidermis, b-Endodermis, c-Connective tissues, d-Sporogenous tissue, e-Middle layer f-Tapetum
(B) a-Endoderm is, b-Connective tissue, c-Epidermis, d-Tapetum, e-Sporogenous tissue, f-Middle layer
(C) a-Tapetum, b-Middle layer, c-Sporongenous tissue, d-Connective tissues, e-Endodermis, f-Epidermis
(D) a-Connective tissue, b-Epidermis, c-Endothecium, d-Sporogenous tissue, e-Tapetum, f-Middle layer

Q.35 The diagram depicts a flower with



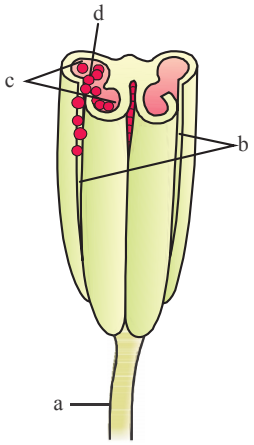
(A) Air pollination (B) Anemophily
(C) Water pollination (D) Hybridisation

Q.36 Diagram depicts.



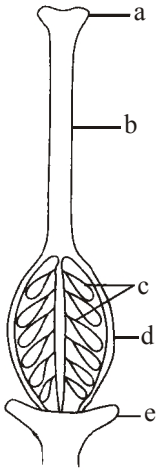
(A) Entomochily (B) Wind pollination
(C) Myrmecophily (D) Ornithophily

Q.37 Identify a to d in the following diagram.



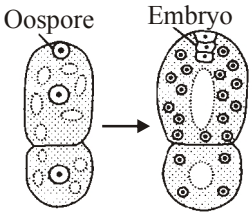
(A) a-Filament, b-Pollen sac, c-Pollen grain, d-Line of dehiscence
(B) a-Filament, b-Pollen sac, c-Line of dehiscence, d-Pollen grain
(C) a-Line of dehiscence, b-Filament, c-Pollen sac, d-Pollen grains
(D) a-Filament, b-Line of dehiscence, c-Pollen sac, d-Pollen grains

Q.38 Identify (a) to (e) in the following diagram.



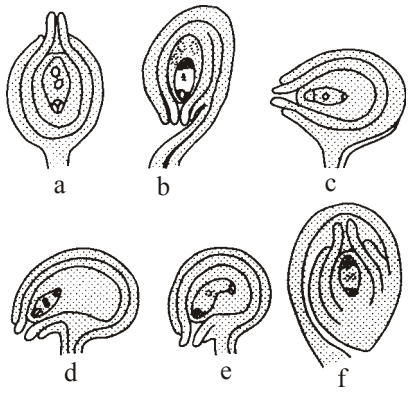
(A) a-Style, b-Stigma, c-Ovules, d-Thalamus, e-Ovary
(B) a-Ovary, b-Thalamus, c-Ovules, d-Style, e-Stigma
(C) a-Thalamus, b-Cycle, c-Stigma, d-Ovary, e-Ovules
(D) a-Stigma, b-Style, c-Ovules, d-Ovary, e-Thalamus

Q.39 Identify the type of endosperm in given diagram.



(A) Cellular (B) Nucleus
(C) Helobial (D) Persist

Q.40 Identify different ovules of diagrams (a) to (f)

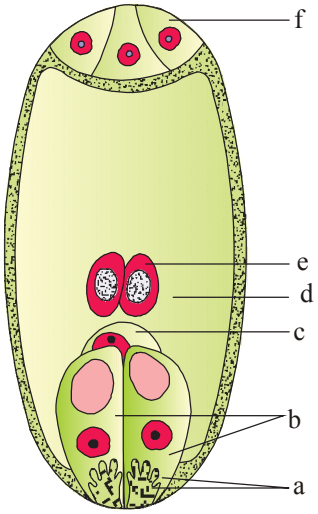


(A) a-Circinotropous, b-Amphitropous, c-Campylotropous, d-Hemitropous, e-Anatropous, f-Orthotropous
(B) a-Campylotropous, b-Anatropopous, c-Hemitropous, d-Amphitropous, e-Circinotropous, f-Orthotropous
(C) a-Orthotropous, b-Anatropous, c-Hemitropous, d-Campylotropous, e-Amphitropous, f-Circinotropous
(D) a-Campylotropous, b-Anatropous, c-Hemitropous, d-Amphitropous, e-Orthotropous, f-Circinotropous

Q.41 In the given diagram of pistil in which part fertilisation takes place.

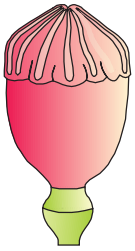
(A) d (B) c
(C) b (D) a

Q.42 Identify (a) to (f) in the diagram.



(A) a-Egg, b-Filiform apparatus, c-Synergid, d-Antipodal cell, e-Polar nuclei, f-Central cell
(B) a-Egg, b-Synergid, c-Filiform apparatus, d-Antipodal cell, e-Central cell, f-Polar nuclei
(C) a-Central cell, b-Egg, c-Synergid, d-Antipodal cell, e-Filiform apparatus, f-Polar nuclei
(D) a-Filiform apparatus, b-Synergid, c-Egg, d-Central cell, e-Polar nuclei, f-Antipodal cell

Q.43 Identify the type of ovary in diagram.

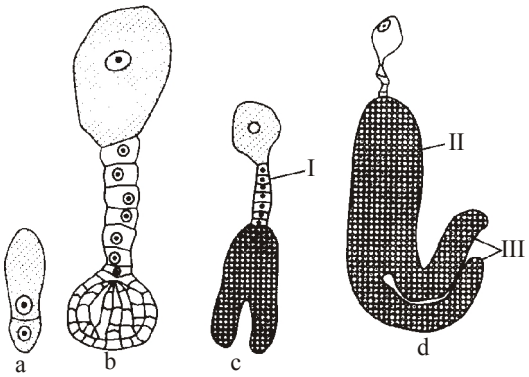


(A) Multicarpallery apocarpous
(B) Multicarpellary syncarpous
(C) Multrcarpellary pistillate
(D) Monocarpellary apocarpous

Q.44 Identify the type of ovary in diagram.

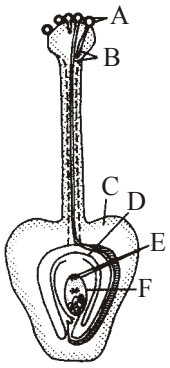
(A) Monocarpellary syncarpous
(B) Monocarpellary apocarpous
(C) Multicarpellary syncarpous
(D) Multicarpellary apocarpous

Q.45 Identify the different stages in embryogenesis in the given diagram a, b, c and d.



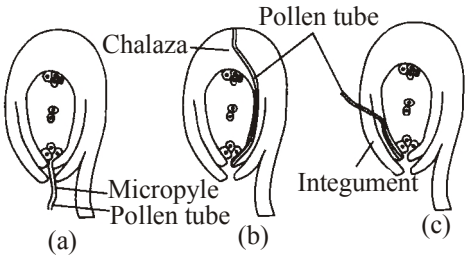
(A) a-Two celled stage, b-Heart-shaped, c-Globular, d-Mature embryo
(B) a-Two celled stage, b-Mature embryo, c-Heart-shaped, d-Globular type
(C) a-Two celled stage, b-Globular type, c-Heart-shaped, d-Mature embryo
(D) a-Mature embryo, b-Heart-shaped, c-Globular type, d-Two celled stage

Q.46 Identify (a) to (f) in the following diagram.



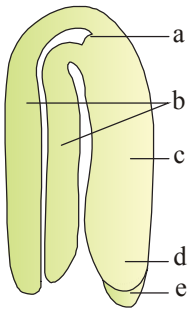
(A) a-Pollen tube, b-Ovary, c-Ovule, d-Antipodal cell, e-Pollen grain, f-Secondary nucleus, (polar nuclei)
(B) a-Polar nuclei (secondary nucleus), b-Antipodal cell, c-Ovule, d-Ovary, e-Pollen tube, f-Pollen grain
(C) a-Pollen grain, b-Pollen tube, c-Ovary, d-Ovule, e-Antipodal cell, f-Secondary Nucleus (polar nuclei)
(D) a-Antipodal cell, b-Ovule, c-Ovary, d-Secondary nucleus, e-Pollen grain, f-Pollen tube

Q.47 Identify the correct modes of entry of pollen tube in the diagrams given below.



(A) a-Mesogamy, b-Chalazogamy, c-Porogamy
(B) a-Chalazogamy, b-Porogamy, c-Mesogamy
(C) a-Porogamy, b-Chalazogamy, c-Monogamy
(D) a-Porogamy, b-Mesogamy, c-Chalazogamy

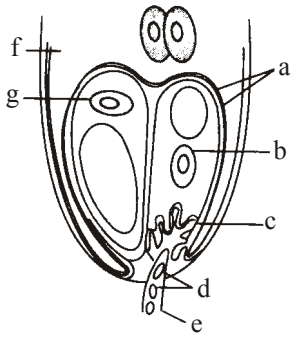
Q.48 Identify the (a) to (e) in following diagram.



(A) a-Cotyledons, b-Hypocotyle, c-Plumule, d-Root cap, e-Radicle
(B) a-Radicle, b-Root cap, c-Plumule, d-Hypocotyle, e-Cotyledons

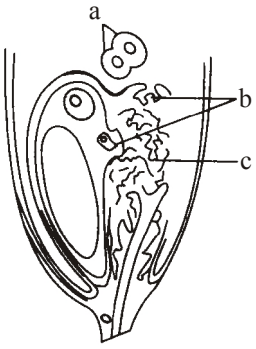
(C) a-Hypocotyle, b-Cotyledons, c-Plumule, d-Radicle, e-Root cap
(D) a-Plumule, b-Cotyledons, c-Hypocotyle, d-Radicle, e-Root cap

Q.49 Diagram showing entry of pollen tube to embryo sac. Identify (a) to (g) in the diagram.



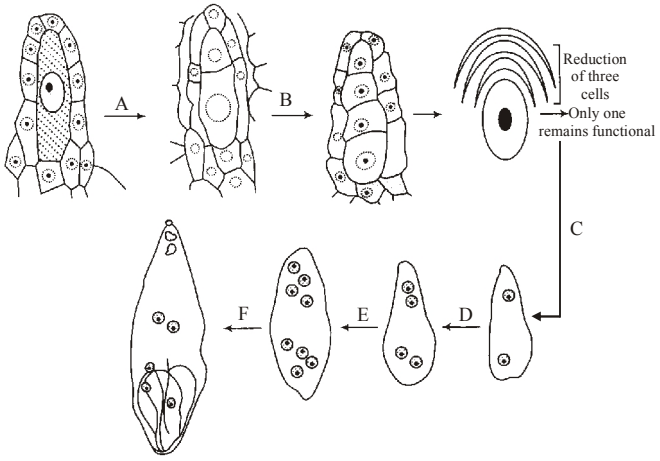
(A) a-Synergid, b-Filiform apparatus, c-Male gamete, d-Plasma membrane, e-Central, f-Egg nucleus, g-Vegetative nucleus
(B) a-Filiform apparatus, b-Central cell, c-Egg nucleus, d-Vegetative nucleus, e-Male gamete, f-Synergid, g-Plasma membrane
(C) a-Plasma membrane, b-Synergid, c-Filiform apparatus, d-Male gametes, e-Vegetative nucleus, f-Central cell, g-Egg nucleus
(D) a-Central cell, b-Egg nucleus, c-Vegetative nucleus, d-Male gametes, e-Synergid, f-Plasma membrane, g-Filiform apparatus

Q.50 Diagram showing discharge of gametes in the egg apparatus. Identity a, b and c.



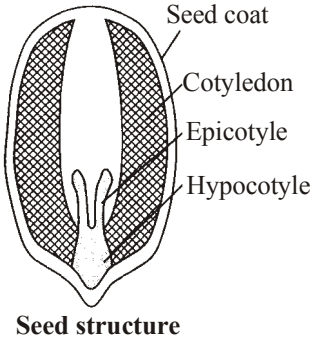
(A) a-Polar nuclei, b-Female gametes, c-Synergid cell
(B) a-Male gametes, b-Synergid cell, c-Polar nuclei
(C) a-Synergid cell, b-Male gametes, c-Polar nuclei
(D) a-Polar nuclei, b-Male gametes, c-Synergid cell

Q.51 Identify (a) to (f) in diagram given below



(A) a-Mitosis, b-Meiosis-I, c-Meiosis-II, d-Mitosis, e-Meiosis, f-Meiosis
(B) a-Meiosis-I, b- Meiosis-II, c-Mitosis, d-Mitosis, e-Mitosis, f-Embryosac
(C) a-Embryosac, b-Meiosis-I, c-Meiosis-II, d-Mitosis, e-Mitosis, f-Mitosis
(D) a-Mitosis, b-Mitosis, c-Mitosis, d-Meiosis, e-Meiosis, f-Meiosis

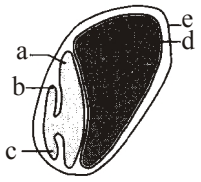
Q.52 Find out the type of seed and three embryonal parts out of the four labellings given below.



Seed structure

(A) Monocot (seed coat, cotyledon, epicotyle)
(B) Dicot (seed coat, epicotyle, hypocotyle)
(C) Monocot (seed coat, hypocotyle, cotylodon)
(D) Dicot (cotyledon, epicotyle, hypocotyle)

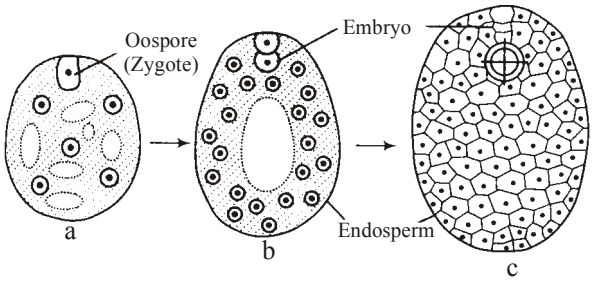
Q.53 Find out the type of seed and identify cotyledons epicotyle and endosperm.



Monocot seed structure

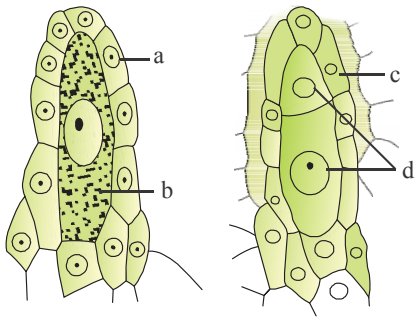
(A) monocots-a, b and c
(B) dicots-b, a and c
(C) monocots-a, b and d
(D) dicots-d, e and a

Q.54 Identify the type of endosperm in given diagram.



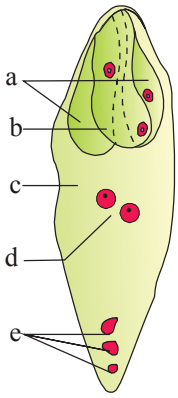
(A) Cellular
(B) Helobial
(C) Nuclear
(D) None of these

Q.55 Identify the labelling of given diagrams



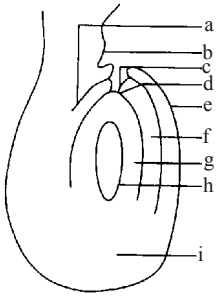
(A) a-MMC, b-Megaspore dyad, c-Nucellus, d-Nucleus
(B) a-Nucellus, b-Megaspore dyad, c-Nucellus, d-MMC
(C) a-Nucellus, b-MMC, c-Nucellus, d-Megaspore dyad
(D) a-MMC, b-Nucelles, c-Megaspore dyad, d-Nucleus

Q.56 Identify (a) to (e) in the diagram given below.



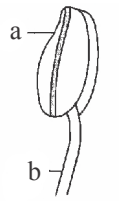
(A) a-Antipodal, b-2 polar nuclei, c-Central cell, d-Egg, e-Synergids
(B) a-Antipodal, b-Central cell, c-2 polar nuclei d-Egg, e-Synergids
(C) a-2 polar nuclei, b-Central cell, c-Antipodal cell, d-Egg, e-Synergids
(D) a-Synergids, b-Egg, c-Central cell, d-2 polar nuclei, e-Antipodal cell

Q.57 Identify (a) to (i) in the given diagram.



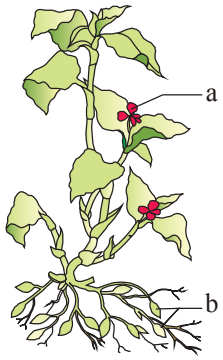
(A) a-Chalazal end, b-Embryo sac, c-Nucellus, d-Inner integuments, e-Outer integuments, f-Micropylar pole, g-Micropyle, h-Funicle, i-Hilum
(B) a-Inner integuments, b-Nucellus, c-Embryo sac, d-Chalazal end, e-Hilum, f-Funicle, g-Micropyle, h-Micropylor end, i-Outer integuments
(C) a-Hilum, b-Funicle, c-Micropyle, d-Micropylar pole, e-Outer integuments, f-Inner integuments, g-Nucellus, h-Embryo sac, i-Chalazal pole
(D) a-Micropylar end, b-Micropyle, c-Funicle, d-Hilum, e-Outer integuments, f-Inner integuments, g-Nucellus, h-Embryo sac, i-Chalazal end

Q.58 Identify a and b in diagram given below.



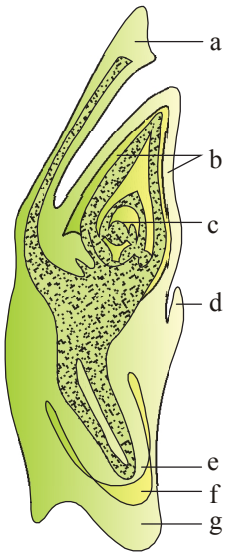
(A) a-Stamen; b-Pistil
(B) a-Anther; b-Filament
(C) a-Filament; b-Anther
(D) a-Pistil; b-Stamen

Q.59 Identify the type of flower a and b.



(A) a-Cleistogamous; b-Chasmogamous
(B) a-Homogamous; b-Heterogamous
(C) a-Chasmogamous; b-Cleistogamous
(D) a-Heterogamous; b-Homogamous

Q.60 In figure find out coleoptile, shoot apex and epiblast



(A) a, b and c (B) b, c and d
(C) d, f and g (D) e, f and g

Q.61 In previous figure find out scutellum, radicle
(A) a and e (B) e and f
(C) f and g (D) g and b

Q.62 In previous figure find out f and g.
(A) f-Radicle; g-Root cap
(B) f-Root cap; g-Coleorhiza
(C) f-Epiblema; g-Radicle
(D) f-Root cap; g-Epiblema

SECTION - 4 (ENHANCE PROBLEM SOLVING SKILLS)

Choose one correct response for each question.

PART - 1 : FLOWER

Q.63 Zygote is always –
(A) haploid (B) diploid
(C) triploid (D) tetraploid

Q.64 Select incorrectly matched pair
(A) Calyx – Epicalyx
(B) Corolla – Petal
(C) Androecium – Stamen
(D) Gynoecium – Carpel

Q.65 Flower is a –
(A) modified male plant only.
(B) modified female plant only.
(C) modified reproductive shoot.
(D) vegetative shoot system.

PART - 2 : PRE-FERTILISATION-STRUCTURE AND EVENTS

Q.66 Microsporangium produces
(A) male gametes (B) female gametes
(C) pollen (D) Both (A) and (C)

Q.67 Microsporangia develops in to
(A) pollens (B) microgametes
(C) megagametes (D) pollen sacs

Q.68 Pollen grains of different plants, differ in
(A) size and shape only
(B) colour and design only
(C) size, shape and design only
(D) size, shape, colour and design

Q.69 The inner most layer of microsporangium is
(A) tapetum (B) endothecium
(C) middle layer (D) epidermis

Q.70 Exine of pollen is made up of
(A) sporopollenin (B) sporogenous tissue
(C) spongiform tissue (D) inorganic material

Q.71 A typical angiosperm anther is
(A) bilobed (B) dithecous
(C) Both (A) and (B) (D) monothecous

Q.72 Which of the following perform microsporogenesis?
(A) Microspore mother cell
(B) Pollen mother cell
(C) Both (A) and (B)
(D) None of these

Q.73 Function of tapetum is to provide –
(A) protection (B) nutrition
(C) respiration (D) All of these

Q.74 The vegetative cell is
(A) Small, has large irregularly shaped nucleus.
(B) Large, has large irregularly shaped nucleus.
(C) Large with spindle shaped nucleus.
(D) Small, spindle shaped nucleus.

Q.75 Pollen grains have ability to tolerate extreme temperatures because of the presence of –
(A) sporopollenin (B) suberin
(C) cubin (D) callose

Q.76 60% of the angiosperms shed their pollens at the
(A) 2-celled stage (B) 3-celled stage
(C) 4-celled stage (D) 1-celled stage

Q.77 Pollen grains can cause
(A) bronchial afflications (B) asthma
(C) bronchitis (D) All of these

Q.78 Viability of pollen grains depends on
(A) temperature (B) humidity
(C) Both (A) and (B) (D) pressure

Q.79 The innermost wall layer of anther –
(A) Is nutritive in function
(B) Helps in dehiscence of anther
(C) Is haploid and protective in function
(D) Forms microspores

Q.80 The thin and continuous wall layer of pollen is
(A) Exine (B) Intine
(C) Germ pore (D) Endothecium

Q.81 The process of formation of microspores from a pollen mother cell is called
(A) Megasporogenesis
(B) Microsporogenesis
(C) Megagametogenesis
(D) Microgametogenesis

Q.82 *Parthenium* or carrot grass is imported with –
(A) wheat (B) grass
(C) rise (D) maize

Q.83 Microsporogenesis is
(A) formation of microspores
(B) formation of female gametes
(C) formation of tapetum
(D) All of the above

Q.84 The pollen grain represents
(A) Male gamete
(B) Male gametophyte
(C) Microsporophyll
(D) Microsporangium

Q.85 Intine is made up of –
(A) cellulose (B) pectin
(C) Both (A) and (B) (D) protein

PART - 3 : PISTIL, MEGASPORANGIUM AND EMBRYO SAC

Q.86 Micropyle exists in
(A) seed (B) ovule
(C) Both (A) and (B) (D) fruit only

Q.87 Micropyle is formed by
(A) absence of integuments
(B) absence of funicle
(C) absence of nucellus
(D) absence of embryo sac

Q.88 The nutritive tissue present in the ovule is called
(A) Nucellus (B) Funicle
(C) Embryo (D) Integuments

Q.89 The stalk which joins ovule and placenta is called
(A) funicle (B) hilum
(C) chalaza (D) micropyle

Q.90 Embryo sac is also called
(A) female gamete (B) synergids
(C) female gametophyte (D) egg of angiosperm

Q.91 Integumented megasporangium is
(A) Ovule (B) Pollen sac
(C) Pollen grain (D) Embryo sac

Q.92 Synergids are
(A) haploid (B) diploid
(C) triploid (D) tetraploid

Q.93 Megasporogenesis is
(A) formation of fruit
(B) formation of seeds
(C) formation of megaspores
(D) Both (B) and (C)

Q.94 The number of embryo sac in an ovule is generally
(A) One (B) Many
(C) Four (D) Three

Q.95 Two nuclei with one cell are found in –
(A) antipodal cell (B) chalazal cell
(C) central cell (D) synergid cell

Q.96 The largest cell of the mature embryo sac is
(A) Antipodal cells (B) Synergids
(C) Central cell (D) Egg cell

Q.97 Egg apparatus consists of –
(A) 2 synergids+2 eggs (B) 1 synergids + 1 eggs
(C) 2 synergids+1 egg (D) 2 synergids+4 eggs

Q.98 Filiform apparatus are
(A) special cellular thickning at antipodal cell.
(B) special cellular thickning at micropylar end.
(C) special cellular thickning at synergid cells.
(D) special cellular thickning at nuclear end.

Q.99 An ovule is a
(A) differentiated megasporangium
(B) dedifferentiated megasporangium
(C) integumented megasporangium
(D) redifferentiated megasporangium

Q.100 An orthotropous ovule is one in which micropyle and chalaza are –
(A) right angles of funicle
(B) parallel of funicle
(C) in straight line of funicle
(D) parallel along with ovule

Q.101 The number of nuclei in a mature embryo sac are
(A) Eight (B) Seven
(C) Six (D) Four

Q.102 Single megasporic development is called
(A) single sporic (B) unisporic
(C) monosporic (D) nulleiporic

Q.103 The embryo sac develops at _____ of ovule.
(A) Chalazal end (B) Micropylar end
(C) Central region (D) Funicle

PART - 4 : POLLINATION

Q.104 Pollination is –
(A) shedding of pollens
(B) maturing of anther
(C) transfer of pollen to stigma
(D) formation of pollen

Q.105 Water pollinated plant is
(A) *Vallisneria* (B) *Hydrilla*
(C) *Zostera* (D) All of these

Q.106 Emasculation
(A) Prevent self-pollination in female parent.
(B) Prevent cross pollination in female parent.
(C) Prevent self-pollination in male parent.
(D) Prevent cross pollination in male parent.

Q.107 Geitonogamy is
(A) Genetically autogamous
(B) Ecologically autogamous
(C) Genetically allogamous
(D) Functionally autogamous

Q.108 Self-incompatibility is a device for
I. ensuring cross-pollination
II. preventing self-fertilisation
III. ensuring self-fertilisation
IV. genetic control for self-fertilisation
Choose the correct statements from those given above
(A) I, II and III (B) I, II, III and IV
(C) I, III and IV (D) I, II and IV

Q.109 An interesting modification of flower shape for insect pollination occurs in some orchids in which a male insect mistakes the pattern on the orchid flower for the female species and tries to copulate with it, thereby pollinating the flower. This phenomenon is called
(A) Pseudo-pollination
(B) Pseudo-parthenocarpy
(C) Mimicry
(D) Pseudo-copulation

Q.110 Cleistogamous flowers are
(A) self-pollinated (B) insect pollinated
(C) bird pollinated (D) wind pollinated

Q.111 Autogamy stands for
(A) self-pollination in same flower
(B) self-pollination in different flower
(C) pollination in two flowers
(D) division in embryo

Q.112 Pollen pistil interaction is
(A) Chemically mediated process.
(B) Dynamic process.
(C) Genetically controlled process.
(D) More than one option is correct.

Q.113 Grass family (Poaceae) contains
(A) exposed stigma (B) versatile anther
(C) Both (A) and (B) (D) large pollens

Q.114 The type of pollination which brings genetically different types of pollen on the stigma is
(A) Autogamy (B) Xenogamy
(C) Geitonogamy (D) Cleistogamy

Q.115 Xenogamy or cross-pollination is performed by
I. abiotic agencies. II. biotic agencies.
III. insects only.
Select the correct option for the given question.
(A) I and III (B) II and III
(C) only III (D) I and II

Q.116 Wind pollinated flowers often have –
(A) single ovule in each ovary
(B) numerous flowers packed into inflorescence
(C) Both (A) and (B)
(D) None of the above

Q.117 Which of the following is not a characteristic feature of insect pollinated flowers?
(A) Fragrance
(B) Nectaries
(C) Foul odour
(D) Mucilaginous covering on pollen grains

Q.118 *Chasmogamous* as well as *Cleistogamous* both types of flowers are found in –
(A) *Commelina* (B) *Arachis hypogea*
(C) *Magnifera indica* (D) *Zea mays*

Q.119 Aquatic plant like water-hyacinth and water lily are pollinated by
(A) water (B) air
(C) insect (D) Both (B) and (C)

Q.120 Female flowers remain submerged in water and the pollen grains are released inside water in –
(A) *Vallisneria* (B) Sea grasses
(C) Water hyacinth (D) Water lily

Q.121 Example of autogamy/self-pollination is/are
(A) chasmogamous flowers
(B) cleistogamous flowers
(C) geitonogamy
(D) Both (A) and (B)

Q.122 Continued self-pollination results in
(A) inbreeding depression
(B) out breeding depression
(C) hybrid vigour
(D) better result in offsprings

Q.123 Feathery stigma and versatile anthers are characteristic of –
(A) Wind pollinated flowers.
(B) Insect pollinated flowers.
(C) Water pollinated flowers.
(D) Bat pollinated flowers.

Q.124 Device to discourage self-pollination or increase cross-pollination is
(A) pollen release and stigma receptivity are not synchronised.
(B) anther & stigma placed at different position
(C) same height of stamen and stigma
(D) Both (A) and (B)

Q.125 Self incompatibility is
(A) for encouraging selt-fertilisation pollination.
(B) genetic method for preventing self-pollination.
(C) Both (A) and (D)
(D) found in unisexual flower

Q.126 The most common insect pollinator is
(A) Bee (B) Ant
(C) Wasp (D) Butterflies

Q.127 Majority of plants use
(A) biotic agent for pollination
(B) non-biotic agent for pollination
(C) air for pollination
(D) animals for pollination

Q.128 Wind pollinated and water pollinated plants
(A) are colourful (B) are non-colourful
(C) are small in size (D) produce nector

Q.129 Insect pollinated flowers are
(A) nector producing (B) colourful
(C) fragnance producing (D) All of these

Q.130 Water pollination
(A) is rare in flowering plant
(B) is limited to 30 genera
(C) takes place mostly in monocotyledons
(D) All of the above

Q.131 Common floral reward provided by plants to pollinator are –
(A) Nectar and pollen
(B) Pollen and enzymes
(C) Hormones and nectar
(D) All of these

Q.132 Cleistogamous flowers are strictly autogamous because they remain –
(A) always open
(B) always close
(C) always fragrance
(D) are brighty coloured

Q.133 Characteristics of wind pollinated pollens is, they are –
(A) non-sticky
(B) light
(C) large number in production
(D) All of these

PART - 5: DOUBLE FERTILISATION

Q.134 Male gametes whether 2 celled or 3-celled are identical in genetic make up because –
(A) of mitosis (B) of meiosis
(C) of amitosis (D) binary fission

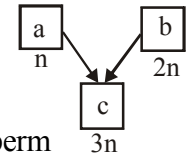
Q.135 How many number of nuclei are involved in fertilisation?
(A) 1 (B) 2
(C) 3 (D) 5

Q.136 The diploid and triploid product of double fertilization respectively are –
(A) Zygote and primary endosperm nucleus
(B) Endosperm and cotyledons
(C) Embryo and perisperm
(D) Zygote and scutellum

Q.137 Generally pollen tube enters through –
(A) micropylar region (B) antipodal region
(C) chalazal end (D) nuclear region

Q.138 The number of female nuclei involved in double fertilisation is
(A) 2 (B) 3
(C) 4 (D) 1

Q.139 Find out a, b and c in the given flow chart.



(A) a-Female gamete, b-Male gamete, c-Endosperm
(B) a-Endosperm, b-Female gamete, c-Male gamete
(C) a-Male gamete, b-Polar nuclei, c-Endosperm
(D) a-Female gamete, b-Endosperm, c-Male gamete

PART - 6 : POST-FERTILISATION-STRUCTURE AND EVENTS

Q.140 Out of the following choose the post-fertilisation events
(A) Endospermeogenesis (B) Embryogenesis
(C) Both (A) and (B) (D) Organogenesis

Q.141 Non-endosperrnic seeds are seen in
(A) groundnut (B) pea
(C) beans (D) Allof these

Q.142 Endospermic seeds are seen in –
(A) castor (B) coconut
(C) Both (A) and (B) (D) None of these

Q.143 Find out right statement(s)
I. Endosperm formation is the prior event than zyote formation.
II. Angiospermic endosperm is 3n.
III. Gymnospermic endosperm is n.
(A) Only I (B) II and III
(C) I and III (D) I, II and III

Q.144 Long, ribbon-like pollen grains are seen in some
(A) aquatic plants
(B) wind-pollinated grasses
(C) gymnosperms
(D) bird-pollinated flowers

Q.145 Find out right statement(s}.
I. Most common endosperm is of nuclear type.
II. Coconut water is male gametophyte.
III.Coconut has both nucellar and cellular type of endosperm.
(A) I, II and III (B) I and III
(C) II and III (D) I and II

PART - 7 : EMBRYO

Q.146 Scutellum is
(A) cotyledon in dicots
(B) cotyledon in gymnosperm
(C) rnonocot root
(D) cotyledon in grass family

Q.147 Polyembryony is reported in
I. Citrus II. Mango III. *Gossypivm*
(A) I and III (B) II and III
(C) I, II and III (D) I and II

Q.148 Coleorhiza is
(A) lower end of embryonal axis in monocot.
(B) lower end of embryonal axis in dicots.
(C) lower end of embryonal axis in patato family.
(D) upper end of embryonal axis in monocot.

Q.149 Epicotyle is the upper part of embryonal axis in
(A) monocots (B) dicots
(C) All plants (D) All of these

PART - 8 : SEED

Q.150 Perisperm is found in
(A) black pepper (B) apple
(C) beet (D) Both (A) and (C)

Q.151 Why seed dormancy takes place?
(A) Due to favourable conditions
(B) Due to unfavourable conditions
(C) Due to embryonic conditions
(D) Due to specific endosperm conditions

Q.152 False fruit is a fruit in which
(A) only ovary take part in fruit development.
(B) only embryo take part an fruit development.
(C) only chalazal cells take part an fruit development.
(D) ovary and other floral part included in fruit.

Q.153 True fruit is directly derived from
(A) stem (B) root
(C) ovary (D) None of the above

Q.154 Pericarp is dry in –
(A) Guava, mango, mustard
(B) Mango, groundnut, orange
(C) Groundnut, mustard
(D) Orange, guava, mango

Q.155 Parthenocarpic fruit
(A) develops from fertilisation
(B) developed from fertilised ovary
(C) develops from unfertilised ovary
(D) develops from ovules

Q.156 Which of the following is a parthenocarpic fruit?
(A) Banana (B) Apple
(C) Strawberry (D) Pomegranate

Q.157 Non-albuminous seed
(A) has no reserve food (B) called exalbuminous
(C) has thin cotyledons (D) All of these

Q.158 Function of aleurone layer is to
(A) prepare amylase (B) prepare protinase
(C) prepare peptidase (D) prepare food

Q.169 Ovary develops into
(A) fruit (B) seed
(C) fruit wall (D) embryo

Q.160 Albuminous seed
(A) has no endosperm
(B) has thick cotyledons
(C) have food storage in cotyledons
(D) Both (B) and (C)

PART - 9 : APOMIXIS AND POLYEMBRYONY

Q.161 Apomixis is seen in
(A) Asteraceae (B) grasses
(C) Both (A) and (B) (D) None of these

Q.162 Adventive polyembryony is common in –
(A) Wheat (B) Apple
(C) Mango (D) *Orobanche*

Q.163 Apomixis is the development of
(A) seeds with fertilisation
(B) seeds without fertilisation
(C) seed from vegetative cells
(D) seeds from reproductive cells

Q.164 Apomixis arises due to
(A) rapid reproduction in plants
(B) slow reproduction in plants
(C) Both (A) and (B)
(D) None of the above

Q.165 Polyembryony is a type of
(A) apomixis (B) fertilisation
(C) fusion (D) embryogenesis

Q.166 Vegetative / Asexual reproduction and apomixis are common in
(A) type of cell division
(B) clone nature of offsprings
(C) Both (A) and (B)
(D) only in dicot plant

Q.167 Apomixis is like
(A) sexual reproduction (B) fertilisation
(C) parthenogenesis (D) asexual reproduction

Q.168 Type of cell division takes place in apomixis is
(A) reductional (B) meiosis
(C) Both (A) and (B) (D) mitosis

Q.169 Ovules contain many embryo in
(A) citrus (B) orange
(C) mango (D) All of these

EXERCISE - 2 (LEVEL-2)

Choose one correct response for each question.

Q.1 Center of each microsporangium is occupied by
(A) sporogenous tissue
(B) spongious tissue
(C) central tissue
(D) microspore mother cell

Q.2 If male plant have genotypes = S_AS_B.
and female plant have genotypes = S_CS_B.
Then the result would be
(A) all of the pollen will germinate
(B) all pollen will die
(C) fertilisation doesn't occur
(D) half pollen die and half will germinates on stigma

Q.3 In chasmogamy pollination takes place in –
(A) open flower
(B) closed flower
(C) large flower
(D) geitonogamy flower

Q.4 Megaspore mother cell is found near the region of –
(A) micropyle (B) chalaza
(C) nucellus (D) integuments

Q.5 A typical angiosperm anther is ____ and ____.
(A) Bilobed, tetrasporangiate
(B) Bilobed, monosporangiate
(C) Bilobed, bisporangiate
(D) Tetralobed, monosporangiate

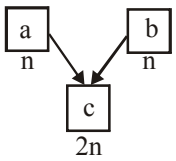
Q.6 Nuclear polyembryony is reported in
(A) Citrus (B) Gossypium
(C) Triticum (D) Brassica

Q.7 Double endosperm is found in –
(A) Wheat (B) Rice
(C) Pea (D) Coconut

Q.8 Exalbuminous seeds are of –
(A) Wheat, pea, groundnut
(B) Castor, pea, groundnut
(C) Pea, ground nut, beans
(D) Wheat, castor, rice

Q.9 Cleistogamous flower is found in –
(A) Tobacco (B) *Viola*
(C) *Mirabilis* (D) None of these

Q.10 Find out a, b and c in the flow chart given below.



(A) a-Female gamete, b-Male gamete, c-Embryo
(B) a-Male gamete, b-Female gamete, c-Embryo
(C) a-Female gamete, b-Male gamete, c-Embryo
(D) a-Male gamete, b-Embryo, c-Female gamete

Q.11 Pollen grains are generally _____ in outline measuring _____ micrometers in diameter.
(A) Spherical, 25-50 (B) Oblong, 25-50
(C) Oval, 10-25 (D) Spherical, 75-100

Q.12 The most resistant organic material known which makes up the outermost layer of pollen wall is
(A) Pectin (B) Cellulose
(C) Sporopollenin (D) Lignin

Q.13 "In Western countries a large number of _____ product (s) in the form of tablets and _____ are available in market. Pollen consumption has been claimed to increase the _____ of athelete".
(A) pistil, syrup, power
(B) stamen, food, sexual urge
(C) carpel, yoghurt, labido
(D) pollen, syrup, performance

Q.14 Testa of a seed is produced from
(A) ovary wall (B) hilum
(C) outer integument of ovule (D) funicle

Q.15 In embryo sac the number of → synergid → egg cell → central cell → antipodal cell follows the order
(A) 1-1-2-3 (B) 2-1-3-2
(C) 2-1-2-3 (D) 3-2-1-2

Q.16 Unisexual condition / dioecy prevents
(A) autogamy (B) geitonogamy
(C) self-fertilisation (D) All of these

Q.17 Pollens are considered as well preserved fossils due to the presence of
(A) exine (B) intine
(C) mexine (D) protein

Q.18 Most oldest viable seed is of
(A) lupine (B) *Ficus*
(C) date palm (D) phoenix

Q.19 ____ egg cell, ____ zygote, _____ endosperm. Find out the correct ploidy nature.
(A) 2n, 3n, 4n (B) 1n, 1n, 3n
(C) 1n, 2n, 3n (D) 1n, 2n, 4n

Q.20 An ovule, where embryo sac is horse shoe-shaped and funicle and micropyle are close to each other, is –
(A) amphitropous (B) circinotropous
(C) atropous (D) anatropous

Q.21 Which one of the following plants is monoecious?
(A) Papaya (B) *Marchantia*
(C) *Pinus* (D) *Cycas*

Q.22 Which one of the following plant has both essential whorls in flower?
(A) Zea (B) Coconut
(C) *Hibiscus* (D) Papaya

Q.23 The two-celled stage of mature pollen grain consists of –
(A) Vegetative cell, generative cell
(B) Vegetative cell, one male gamete
(C) Two male gametes
(D) Generative cell, one male gamete

Q.24 Dioecious condition prevents
(A) Autogamy (B) Geitonogamy
(C) Xenogamy (D) Both (A) & (B)

Q.25 In 40% angiosperms, the pollen grains are shed at –
(A) Four-celled stage (B) Three-celled stage
(C) Two-celled stage (D) Five-celled stage

Q.26 Hermaphrodite flower have
(A) male and female on same plant.
(B) male and female on same flower.
(C) male and female on different flower.
(D) None of these

Q.27 Chalazal pole is present
(A) opposite to micropyle
(B) at the origin of integuments
(C) opposite to nucellus
(D) near the embryo sac

Q.28 Thalamus contributes in the fruit formation in
(A) apple (B) strawberry
(C) cashewnut (D) All of these

Q.29 The cylindrical portion below the level of cotyledons on embryonal axis is –
(A) Epicotyl (B) Hypocotyl
(C) Radicle (D) Plumule

Q.30 The single cotyledon in monocots is –
(A) Scutellum which is lateral in position.
(B) Aleurone layer which is terminal in position.
(C) Scutellum which is centrally placed.
(D) Epiblast which is haploid & lateral in position.

Q.31 Which one of the following would not lead to formation of clones.
(A) double fertilisation
(B) apomixis
(C) vegetative reproduction
(D) tissue culture

Q.32 A typical dicotyledonous embryo consist of an ____ axis and ____ cotyledons.
The portion of embryonal axis above the level of cotyledons is ____ which terminates with the ____ or stem tip.
(A) plumule, epicotyle, cotyledons, embryonal axis
(B) embryonal axis, cotyledons, epicotyle, plumule
(C) embryonal axis, epicotyle, cotyledons, plumule
(D) embryonal axis, plumule, cotyledons, epicotyle

Q.33 In fruits the ovule integuments get transformed into
(A) seed (B) fruit wall
(C) seed coat (D) cotyledons

Q.34 Apomictic embryos in citrus arise from
(A) synergids
(B) maternal sporogenous tissue in ovule
(C) antipodal cell
(D) haploid egg

Q.35 In *Amorphophallus* and *Yucca*, the moth lay egg into the –
(A) locule of ovary (B) on stigma
(C) into the fruit wall (D) on style

Q.36 Aleurone layer is found in
(A) dicotyledons (B) monocotyledons
(C) Both (A) and (B) (D) None of these

Q.37 Among the terms listed below, those that of are not technically correct names for a floral whorl are:
i. Androecium ii. Carpel
iii. Corolla iv. Sepal
(A) i and iv (B) iii and iv
(C) ii and iv (D) i and ii

Q.38 Choose the correct statement –
(A) The nutritional layer of anther wall is tapetum
(B) End product of microsporogenesis in a PMC is microspore tetrad.
(C) Both (A) and (B)
(D) None of these

Q.39 Embryo sac is to ovule as ____ is to an anther.
(A) Stamen (B) Filament
(C) Pollen grain (D) Androecium

Q.40 Which of the following plant provides safe place insect for laying eggs?
(A) Sage plant (B) *Amorphophallus*
(C) *Ophrys* (D) Mango

Q.41 In a typical complete, bisexual and hypogynous flower the arrangement of floral whorls on the thalamus from the outermost to the innermost is:
(A) Calyx, corolla, androecium and gynoecium
(B) Calyx, corolla, gynoecium and androecium
(C) Gynoecium, androecium, corolla and calyx
(D) Androecium, gynoecium, corolla and calyx

Q.42 A dicotyledonous plant bears flowers but never produces fruits and seeds. The most probable cause for the above situation is:
(A) Plant is dioecious and bears only pistillate flowers.
(B) Plant is dioecious and bears both pistillate and staminate flowers.
(C) Plant is monoecious.
(D) Plant is dioecious and bears only staminate flowers.

Q.43 The sheath enclosing plumule and radicle respectively in monocot seed are –
(A) Coleoptile and coleorhiza
(B) Coleorhiza and coleoptile
(C) Scutellum and epiblast
(D) Aleurone layer and pericarp

Q.44 Perispermic seeds are
(A) Castor, sunflower (B) Black pepper, beet
(C) Maize, beet (D) Barley, maize

Q.45 The outermost & innermost wall layers of microsporangium in an anther are respectively:
(A) Endothecium and tapetum
(B) Epidermis and endodermis
(C) Epidermis and middle layer
(D) Epidermis and tapetum

Q.46 There are ____ meiotic division(s) and ____ mitotic divisions required to form two male gametes from a PMC.
(A) 2, 3 (B) 1, 2
(C) 2, 1 (D) 1, 1

Q.47 Pollen allergy is caused by pollens of
(A) Rose (B) *Clematis*
(C) *Parthenium* (D) Sunflower

Q.48 The pollen viability period of rice and pea respectively, is
(A) 30 minutes and several months.
(B) Several months and 30 minutes.

(C) Few days and few months.
(D) Few days in both the cases.

Q.49 Cryopreservation means storing of products in
(A) Liquid nitrogen (B) Liquid oxygen
(C) Liquid hydrogen (D) Liquid helium

Q.50 During microsporogenesis, meiosis occurs in:
(A) Endothecium
(B) Microspore mother cells
(C) Microspore tetrads
(D) Pollen grains.

Q.51 From among the sets of terms given below, identify those that are associated with the gynoecium.
(A) Stigma, ovule, embryo sac, placenta
(B) Thalamus, pistil, style, ovule
(C) Ovule, ovary, embryo sac, tapetum
(D) Ovule, stamen, ovary, embryo sac

Q.52 What does the filiform apparatus perform role during fertilization?
(A) It guides pollen tube from a synergid to egg
(B) It helps in the entry of pollen tube into a synergid.
(C) It prevents entry of more than one pollen tube into the embryosac
(D) It brings about opening of the pollen tube.

Q.53 What is the direction of micropyle in anatropous ovule?
(A) Upward (B) Downward
(C) Right (D) Left

Q.54 In angiosperm, all the four microspores of tetrad are covered by a layer which is formed by –
(A) Pectocellulose (B) Callose
(C) Cellulose (D) Sporopollenin

Q.55 Starting from the innermost part, the correct sequence of parts in an ovule are –
(A) egg, nucellus, embryo sac, integument
(B) egg, embryo sac, nucellus, integument
(C) embryo sac, nucellus, integument, egg
(D) egg, integument, embryo sac, nucellus.

Q.56 Number of correct statements –
(i) Shedding of pollen grains takes place at three-celled stage in 60% of angiosperms.
(ii) Pollen viability period for rice is 30 minutes.
(iii) Light and non-sticky pollen grains are characteristic of wind-pollinated flowers.
(iv) Dioecious condition in plants prevents xenogamy.
(A) 1 (B) 2
(C) 3 (D) 4

Q.57 Choose the option that are true for a typical female gametophyte of a flowering plant:
i. It is 8-nucleate and 7-celled at maturity.
ii. It is free-nuclear during the development.
iii. It is situated inside the integument but outside the nucellus.
iv. It has an egg apparatus situated at the chalazal end.
(A) i and iv (B) ii and iii
(C) i & ii (D) ii & iv

Q.58 Autogamy can occur in a chasmogamous flower if
(A) Pollen matures before maturity of ovule
(B) Ovules mature before maturity of pollen
(C) Both pollen and ovules mature simultaneously
(D) Both anther and stigma are of equal lengths.

Q.59 Choose the **incorrect** statements
(A) The ploidy level of female gametophyte is diploid in flowering plants.
(B) Integumented megasporangium is also called as ovary.
(C) The embryo sac lies at chalazal end of ovule.
(D) All are correct

Q.60 Choose the correct statement from the following:
(A) Cleistogamous flowers always exhibit autogamy.
(B) Chasmogamous flowers always exhibit geitonogamy.
(C) Cleistogamous flowers exhibit both autogamy and geitonogamy.
(D) Chasmogamous flowers never exhibit autogamy.

Q.61 Choose the **correct** statement
(i) The intine is made of pectin and cellulose.
(ii) An apocarpous gynoecium has several free carpels.
(iii) During the life cycle of flowering plants, male and female gametes are formed in Pollen grain and embryo sac respectively.
(A) i, ii are correct (B) ii, iii are correct
(C) i, iii are correct (D) i, ii, iii are correct

Q.62 A particular species of plant produces light, non-sticky pollen in large numbers and its stigmas are long and feathery. These modifications facilitate pollination by:
(A) Insects (B) Water
(C) Wind (D) Animals

Q.63 Choose the one that prevents both autogamy and geitonogamy.
(A) Monoecious plant bearing unisexual flowers.
(B) Dioecious plant bearing only male or female flowers.
(C) Monoecious plant with bisexual flowers.
(D) Dioecious plant with bisexual flowers.

Q.64 Choose the correct option.
I. Autogamy is obligatory in cleistogamous flowers.
II. The shedding of pollen grains occurs at three-celled stage in 40% of angiosperms.
III. Single cotyledon of monocots is lateral in position and called as scutellum.
IV. Wall of the fruit is called pericarp.
(A) I, II are correct but III, IV are incorrect.
(B) III, IV are correct but I, II are incorrect.
(C) I, III are correct but II, IV are incorrect.
(D) I, II, III and IV are correct.

Q.65 In a fertilised embryo sac, the haploid, diploid and triploid structures are:
(A) Synergid, zygote and primary endosperm nucleus.
(B) Synergid, antipodal and polar nuclei.
(C) Antipodal, synergid and primary endosperm nucleus.
(D) Synergid, polar nuclei and zygote.

Q.66 Choose the odd one w.r.t. gynoecium.
(A) Gynoecium represents the female reproductive part of flower.
(B) The gynoecium may be syncarpous or apocarpous.
(C) The number of ovules in papaya and mango is one.
(D) The ovules are attached to placenta.

Q.67 While planning for an artificial hybridization programme involving dioecious plants, which of the following steps would not be relevant:
(A) Bagging of female flower
(B) Dusting of pollen on stigma
(C) Emasculation
(D) Collection of pollen

Q.68 Choose the correct option.
I. Double fertilization involves syngamy and triple fusion.
II. The most common type of endosperm in angiosperms is nuclear.
III. Perispermic seeds have persistent nucellus.
IV. Ploidy level of the cells in microspore tetrad is diploid.
(A) I, II are correct but III, IV are incorrect.
(B) III, IV are correct but I, II are incorrect.
(C) I, II, III are correct but IV is incorrect.
(D) II, IV are correct but I, III are incorrect.

Q.69 In the embryos of a typical dicot & a grass, true homologous structures are:
(A) Coleorhiza and coleoptile
(B) Coleoptile and scutellum
(C) Cotyledons and scutellum
(D) Hypocotyl and radicle.

Q.70 The ploidy level of nucellus and female gametophyte respectively is –
(A) n, n (B) n, 2n
(C) 2n, n (D) 2n, 2n

Q.71 The number of mitotic generations required to form a mature embryo sac is –
(A) One (B) Two
(C) Three (D) Four

Q.72 The phenomenon observed in some plants wherein parts of the sexual apparatus is used for forming embryos without fertilisation is called:
(A) Parthenocarpy
(B) Apomixis
(C) Vegetative propagation
(D) Sexual reproduction.

Q.73 The structures which guide the pollen tube into synergid is
(A) Antipodals (B) Germ pore
(C) Aril (D) Filiform apparatus

Q.74 The phenomenon wherein, the ovary develops into a fruit without fertilisation is called:
(A) Parthenocarpy
(B) Apomixis
(C) Asexual reproduction
(D) Sexual reproduction

Q.75 Which of the following represents the cells in a pollen?
(A) one sperm cell, two pollen tube cells.
(B) two sperm cells, one synergid, one central cell.
(C) three antipodal cells and one sperm cell.
(D) one pollen tube cell and two sperm cells.

Q.76 Which specific part of the flower transforms into a seed?
(A) ovary (B) stamen
(C) ovule (D) embryo sac

Q.77 Which cell of the embryo sac fuses with the sperm cell to form endosperm?
(A) egg cell (B) synergids
(C) antipodal cells (D) central cell

Q.78 Endosperm cells are
(A) haploid (B) diploid
(C) triploid (D) None of these

Q.79 A strawberry is a
(A) simple fruit (B) aggregate fruit
(C) multiple fruit (D) none of these

Q.80 A pineapple is a –
(A) simple fruit (B) aggregate fruit
(C) multiple fruit (D) none of these

Q.81 A garden pea or a green bean is a –
(A) simple fruit (B) aggregate fruit
(C) multiple fruit (D) none of these

Q.82 A radicle forms –
(A) stems (B) leaves
(C) flowers (D) roots

Q.83 Which of the following processes refers to the transfer of pollen grain from the anther to the stigma?
(A) pollination (B) fertilization
(C) imbibition (D) differentiation

Q.84 Which of the following term refers to specialized cells becoming unspecialized?
(A) differentiation (B) dedifferentiation
(C) redifferentiation (D) none of these

Q.85 Anther of Arceuthobium plant is –
(A) Tetra sporangiate (B) Bisporangiate
(C) Monosporangiate (D) (A) and (B) both

Q.86 Which part of the reproductive structure produces both enzyme & hormones –
(A) Archesporium (B) middle layer
(C) Tapetum (D) Endo thecium

Q.87 Ubisch bodies are produced in –
(A) Embryosac (B) Endothecium
(C) Pollen grain (D) Tapetum

Q.88 The mature male gametophyte in angiosperm is represented
(A) Pollen grain (B) Germinating pollen grain
(C) Embryo sac (D) Anther

Q.89 Which structure of pollen grain protect it from ultra violet rays –
(A) Sporopollenin (B) Pollen kitt
(C) Ubisch body (D) A & B both

Q.90 What type of ovule found in Capsella –
(A) Anatropous (B) Orthotropous
(C) Circinotropous (D) None

EXERCISE - 3 (LEVEL-3)

Choose one correct response for each question.

Q.1 The end of juvenile phase in angiospermic plant is marked by –
(A) Formation of flower
(B) Formation of fruit without seed
(C) Abscission of all leaves in autumn
(D) Initiation of axillary bud

Q.2 Choose the correct option.
I. Typical anther of angiosperm is bilobed and dithecous.
II. Typical anther of angiosperm is tetrasporangiate.
III. The sequence of wall layers in microsporangium is epidermis, middle layers, endothecium and tapetum.
IV. Tapetum cells have dense cytoplasm and have only one nucleus.
(A) I, II are correct but III, IV are incorrect.
(B) III, IV are correct but I, II are incorrect.
(C) I, III are correct but II, IV are incorrect.
(D) II, IV are correct but I, III are incorrect.

Q.3 Mark the incorrect statement
(A) Outer three layers of anther wall are protect in function.
(B) Sporogenous tissue, occupies the centre each microsporangium.
(C) Cells of tapetum and endothecium show increase in DNA contents by endomitosis and polyteny.
(D) Ploidy level of microspore tetrad is haploid

Q.4 In artificial hybridisation the steps involved are
I. bagging II. emasculation
III. rebagging
Their right arrangement is
(A) I → II → III (B) II → I → III
(C) III → II → I (D) II → III → I

Q.5 Choose the correct option from the following
I. Dehydration and dormancy of mature seed are crucial for seed storage.
II. Seed of *Lupinus arcticus* is the oldest one which germinated after 2000 year.
III. Orchid seed is one of largest seed in plant Kingdom.
IV. Seeds of parasitic plants *Orobanche* and *Striga* are tiny seeds.
(A) I, II are correct but III, IV are incorrect.
(B) I, IV are correct but II, III are incorrect.
(C) III, IV are correct but I, II are incorrect.
(D) II, III are correct but I, IV are incorrect.

Q.6 Which of the following statement is applicable for all flowering plants?
(A) Monosiphonous pollen tube.
(B) Non-motile and morphologically dissimilar gametes.
(C) Presence of pollinium.
(D) Division of generative cell after pollination.

Q.7 Consider the given characters and choose incorrect w.r.t. ornithophily
a. Bright petals b. Many stamens
c. Nectarless flower d. Edible pollens
e. Night blooming flowers
(A) c and e (B) a and b
(C) b and c (D) c, d and e

Q.8 Select a correct match
(A) Geitonogamy – *Vallisneria*
(B) Heterostyly – *Primula*
(C) Apocarpous – *Hibiscus*
(D) Anemophily – *Adansonia*

Q.9 Which is incorrect statement?
I. Each cell of sporogenous tissue in anther is capable of giving rise to microspore tetrad.
II. The pollen grain represent male gametophyte.
III. Pollen grains are usually triangular and 10-15 µm in diameter.
IV. Sporopollenin is one of the most resistance organic material which can be destroyed only by strong acids and alkali.
(A) I, II are incorrect but III, IV are correct
(B) III, IV are incorrect but I, II are correct
(C) I, III are incorrect but II, IV are correct
(D) II, IV are correct but I, III are incorrect

Q.10 If the chromosome number in the root cell of Zea mays is 20, then what would be the chromosome number in the cell of radicle (a), hypocotyl (b), epiblast (c), aleurone layer (d) and scutellum (e) respectively?
(A) a = 20; b = 30; c = 20; d = 30; e = 20
(B) a = 20; b = 20; c = 20; d = 30; e = 20
(C) a = 20; b = 30; c = 30; d = 30; e = 20
(D) a = 30; b = 20; c = 20; d = 20; e = 30

Q.11 Which of the following is **incorrect** for angiosperm?
(A) Pollen grain – Haploid
(B) Megaspore – Diploid
(C) Synergid – Haploid
(D) Endosperm – Triploid

Q.12 Match the following columns.

	Column I	**Column II**
(a)	Calyx	(i) Stamen
(b)	Corolla	(ii) Petal
(c)	Androeeium	(iii) Sepal
(d)	Gynoecium	(iv) Carpel

Codes
(A) (a) – (iii), (b) – (ii), (c) – (i), (d) – (iv)
(B) (a) – (i), (b) – (ii), (c) – (iii), (d) – (iv)
(C) (a) – (ii), (b) – (i), (c) – (iv), (d) – (iii)
(D) (a) – (iii), (b) – (iv), (c) – (i), (d) – (ii)

Q.13 Study the following statements and choose the **correct** option
I. Tapetum nourishes the developing pollen grains.
II. Hilum represents junction between ovule and funicle.
III. In aquatic plants, water hyacinth and waterlily pollination is by water.
(A) I, II are correct but III, IV are incorrect.
(B) I, II, IV are correct but III incorrect.
(C) I, IV are correct but II, III are incorrect.
(D) II, IV are correct but I, III are incorrect.

Q.14 Choose the mismatch option for pollination.
(A) Wind – Corn cob
(B) Water – Water hyacinth
(C) Water – *Zostera*
(D) Insect – *Amorphophallus*

Q.15 Match the following columns.

	Column-I	**Column-II**
a.	Coleorrhiza	(i) Reduced cotyledon
b.	Polyspory	(ii) Covering of radicle
c.	Epiblast	(iii) Glandular structure
d.	Obturator	(iv) Cuscuta

Codes
(A) a-(ii), b-(iv), c-(iii), d-(i)
(B) a-(iv), b-(ii), c-(i), d-(iii)
(C) a-(ii), b-(iv), c-(i), d-(iii)
(D) a-(iii), b-(iv), c-(i), d-(ii)

Q.16 Which of the following statements is **wrong**?
(A) Pollen grains remain viable for several months because their outer covering is made sporopollenin.
(B) No enzyme can degrade sporopollenin.
(C) Pollen grains are well represented in fossil strata due to sporopollenin.
(D) Pollen wall has cavities containing proteins.

Q.17 The gynoecium consists of many free pistils in flowers of –
(A) Papaver (B) *Michelia*
(C) Aloe (D) Tomato

Q.18 Which statement is **incorrect**?
(A) Intine is the inner wall of pollen grain and exhibit fascinating array of patterns and designs.
(B) The mature pollen grains has two cells, the bigger is vegetative cell and the smaller is generative cell which floats in cytoplasm of vegetative cell
(C) Carrot grass pollens cause pollen allergy.
(D) Pollen grains of pea and rose maintain viability for months.

Q.19 Highly specialized sex organs of *Chara* are borne on the –
(A) Adaxial face of the long lateral branch on each intemode.
(B) Adaxial face of the short lateral branch on each node.
(C) Abaxial face of the short lateral branch on each internode.
(D) Abaxial face of the short lateral branch on each node.

Q.20 Select incorrect statement regarding microsporogenesis in an anther –
(A) Large number of microspore mother cells differentiate in one pollen sac.
(B) Each microsporogenesis involves one meiosis and two mitosis.
(C) Microspore tetrads may be tetrahedral or isobilateral.
(D) It consumes tapetum and middle layers.

Q.21 In castor, proliferation of the outer integumentary cells at micropylar region
(A) Lacks hygroscopic ability
(B) Attract ants and helps in myrmecophily
(C) Is called epiblast
(D) Stores sugary substances

Q.22 An angiospermic plant is having 24 chromosomes in its leaf cells. The number of chromosomes present in synergid, pollengrain, nucellus & endosperm will be respectively
(A) 12, 12, 12, 72 (B) 8, 8, 12, 36
(C) 12, 12, 24, 36 (D) 12, 12, 12, 36

Q.23 The pistil of China rose is –
(A) Multicarpellary, syncarpous
(B) Multicarpellary, apocarpous
(C) Monocarpellary
(D) Monocarpellary and uniovulate

Q.24 Match the entries in Column I with those of Column II and choose the correct answer:

Column I (Name of pollination)	**Column II (Type of pollination)**
a. Cleistogamy	m. Insect pollination
b. Geitonogamy	n. Bud pollination
c. Entomophily	o. Pollination between flowers in the same plant.
d. Xenogamy	p. Wind pollination
	q. Cross pollination

(A) a - n; b - o; c - m; d - q
(B) a - q; b - p; c - o; d - n
(C) a - o; b - m; c - q; d - n
(D) a - m; b - q; c - n; d - o

Q.25 In castor and maize plants –
(A) autogamy is prevented but not geitonogamy.
(B) both autogomy and geitonogamy are prevented.
(C) male and female flowers are borne by different plants.
(D) the anthers and stigma are placed at different positions to encourage cross pollination.

Note (Q.26-Q.31) :
(A) Statement- 1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement -1
(B) Statement -1 is True, Statement -2 is True ; Statement-2 is NOT a correct explanation for Statement - 1
(C) Statement - 1 is True, Statement- 2 is False
(D) Statement -1 is False, Statement -2 is False

Q.26 **Statement 1 :** The two cotyledons in seed are embryonic leaves.
Statement 2 : The embryo contains radicle and plumule.

Q.27 **Statement 1 :** Angiospermic flowers perform the function of sexual reproduction.
Statement 2 : The male and female reproductive structures are found in the flowers.

Q.28 **Statement 1 :** Chasmogamous flowers require pollinating agents.
Statement 2 : Cleistogamous flowers do not expose their sex organs.

Q.29 **Statement 1 :** Most common type of ovule is anatropous.
Statement 2 : Anatropous ovule is horse - shoe shaped.

Q.30 **Statement 1 :** The largest cell of the embryo sac is central cell.
Statement 2 : It consists of a fused nuclei.

Q.31 **Statement 1 :** The ovary forms fruit after fertilization.
Statement 2 : The ovary forms parthenocarpic fruits without fertilization.

EXERCISE - 4 (PREVIOUS YEARS AIPMT/NEET EXAM QUESTIONS)

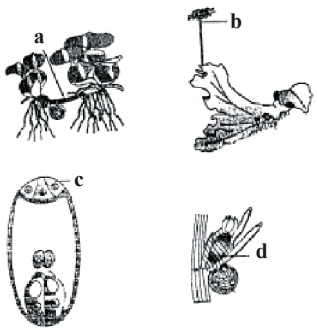
Choose one correct response for each question.

Q.1 Apomictic embryos in Citrus arise from **[AIPMT 2010]**
(A) Synergids
(B) Maternal sporophytic tissue in ovule
(C) Antipodal cells
(D) Diploid egg

Q.2 Transfer of pollen grains from the anther to the stigma of another flower of the same plant is called – **[AIPMT 2010]**
(A) Xenogamy (B) Geitonogamy
(C) Karyogamy (D) Autogamy

Q.3 Wind pollinated flowers are – **[AIPMT 2010]**
(A) Small, brightly coloured, producing large number of pollen grains.
(B) Small, producing large number of dry pollen grains.
(C) Large producing abundant nectar and pollen.
(D) Small, producing nectar and dry pollen.

Q.4 Examine the figures (a-d) given below and select the right option out of A-D, in which all the four structures a, b, c and d are identified correctly.
Structures :



Options :

	a	b	c	d
(A)	Sucker	Seta	Megaspore mother cell	Gemma cup
(B)	Rhizome	Sporangiophore	Polar cell	Globule
(C)	Runner	Archegoniophore	Synergid	Antheridium
(D)	Offset	Antheridiophore	Antipodals	Oogonium

Q.5 Filiform apparatus is a characteristic feature of **[AIPMT 2011]**
(A) Suspensor (B) Egg
(C) Synergid (D) Zygote

Q.6 Nucellar polyembryony is reported in species of **[AIPMT 2011]**
(A) Citrus (B) Gossypium
(C) Triticum (D) Brassica

Q.7 Which one of the following pollinations is autogamous ? **[AIPMT 2011]**
(A) Geitonogamy (B) Xenogamy
(C) Chasmogamy (D) Cleistogamy

Q.8 Wind pollination is common in **[AIPMT 2011]**
(A) Legumes (B) Lilies
(C) Grasses (D) Orchids

Q.9 In angiosperms, functional megaspore develops into **[AIPMT 2011]**
(A) Embryo sac (B) Ovule
(C) Endosperm (D) Pollen sac

Q.10 What is common between vegetative reproduction and apomixis ? **[AIPMT 2011]**
(A) Both are applicable to only dicot plants
(B) Both bypass the flowering phase
(C) Both occur round the year
(D) Both produce progeny identical to the parent

Q.11 An organic substance that can withstand environmental extremes and cannot be degraded by any enzyme is **[AIPMT 2012]**
(A) Cuticle (B) Sporopollenin
(C) Lignin (D) Cellulose

Q.12 Even in absence of pollinating agents seed-setting is assumed in **[AIPMT 2012]**
(A) *Commellina* (B) *Zostera*
(C) *Salvia* (D) Fig

Q.13 What is the function of germ pore ? **[AIPMT 2012]**
(A) Emergence of radicle
(B) Absorption of water for seed germination
(C) Initiation of pollen tube
(D) Release of male gametes

Q.14 Which one of the following statements is wrong **[AIPMT 2012]**
(A) When pollen is shed at two celled stage, double fertilization does not take place.
(B) Vegetative cell is larger than generative cell.
(C) Pollen grains in some plants remain viable for months.
(D) Intine is made up of cellulose and pectin.

Q.15 Plants with ovaries having only one or a few ovules, are generally pollinated by **[AIPMT 2012]**
(A) Bees (B) Butterflies
(C) Birds (D) Wind

Q.16 Advantage of cleistogamy is – **[NEET 2013]**
(A) Vivipary
(B) Higher genetic variability
(C) More vigorous offspring
(D) No dependence on pollinators

Q.17 Megasporangium is equivalent to **[NEET 2013]**
(A) Ovule (B) Embryo sac
(C) Fruit (D) Nucellus

Q.18 Which one of the following statements is correct? **[NEET 2013]**
(A) Tapetum nourishes the developing pollen.
(B) Hard outer layer of pollen is called intine.
(C) Sporogenous tissue is haploid.
(D) Endothecium produces the micorspores.

Q.19 Which one of the following statements is correct? **[AIPMT 2014]**
(A) The seed in grasses is not endospermic.
(B) Mango is a parthenocarpic fruit.
(C) A proteinaceous aleurone layer is present in maize grain.
(D) A sterile pistil is called a staminode.

Q.20 Geitonogamy involves – **[AIPMT 2014]**
(A) Fertilisation of a flower by the pollen from another flower of the same plant.
(B) Fertilization of a flower by the pollen from the same flower.
(C) Fertilization of a flower by the pollen from a flower of another plant in the same population.
(D) Fertilisation of a flower by the pollen from a flower of another plant belonging to a distant population.

Q.21 Male gametophyte with least number of cells is present in: **[AIPMT 2014]**
(A) *Pteris* (B) *Funaria*
(C) *Lilium* (D) *Pinus*

Q.22 Pollen tablets are available in the market for – **[AIPMT 2014]**
(A) In vitro fertilization
(B) Breeding programmes
(C) Supplementing food
(D) Ex situ conservation

Q.23 Function of filiform apparatus is to : **[AIPMT 2014]**
(A) Recognize the suitable pollen at stigma
(B) Stimulate division of generative cell
(C) Produce nectar
(D) Guide the entry of pollen tube

Q.24 Non-albuminous seed is produced in **[AIPMT 2014]**
(A) Maize (B) Castor
(C) Wheat (D) Pea

Q.25 Which of the following are the important floral rewards to the animal pollinators ? **[AIPMT 2015]**
(A) Nectar and pollen grains.
(B) Floral fragrance and calcium crystals.
(C) Protein pellicle and stigmatic exudates.
(D) Colour and large size of flower.

Q.26 Which one of the following may require pollinators, but is genetically similar to autogamy? **[AIPMT 2015]**
(A) Xenogamy (B) Apogamy
(C) Cleistogamy (D) Geitonogamy

Q.27 Which one of the following statements is not true **[AIPMT 2015]**
(A) Pollen grains of some plants cause severe allergies and bronchial afflictions in some people.
(B) The flowers pollinated by flies and bats secrete foul odour to attract them.
(C) Honey is made by bees by digesting pollen collected from flowers.
(D) Pollen grains are rich in nutrients, and they are used in the form of tablets and syrups.

Q.28 The hilum is a scar on the: **[AIPMT 2015]**
(A) Fruit, where it was attached to pedicel.
(B) Fruit, where style was present.
(C) Seed, where micropyle was present.
(D) Seed, where funicle was attached.

Q.29 Transmission tissue is characteristic feature of **[AIPMT 2015]**
(A) Solid style (B) Dry stigma
(C) Wet stigma (D) Hollow style

Q.30 Filiform apparatus is characteristic feature of: **[RE-AIPMT 2015]**
(A) Nucellar embryo (B) Aleurone cell
(C) Synergids (D) Generative cell

Q.31 In angiosperms, microsporogenesis and megasporogenesis **[RE-AIPMT 2015]**
(A) form gametes without further divisions
(B) Involve meiosis
(C) occur in ovule
(D) occur in anther

Q.32 Flowers are unisexual in: **[RE-AIPMT 2015]**
(A) Cucumber (B) China rose
(C) Onion (D) Pea

Q.33 Coconut water from a tender coconut is: **[RE-AIPMT 2015]**
(A) Free nuclear endosperm
(B) Innermost layers of the seed coat
(C) Degenerated nucellus
(D) Immature embryo

Q.34 Which one of the followng fruits is parthenocarpic? **[RE-AIPMT 2015]**
(A) Apple (B) Jackfruit
(C) Banana (D) Brinjal

Q.35 Male gametophyte in angiosperms produces: **[RE-AIPMT 2015]**
(A) Single sperm and a vegetative cell.
(B) Single sperm and two vegetative cells.
(C) Three sperms.
(D) Two sperms and a vegetative cell.

Q.36 The coconut water from tender coconut represents – **[NEET 2016 PHASE 1]**
(A) Endocarp
(B) Fleshy mesocarp
(C) Free nuclear proembryo
(D) Free nuclear endosperm

Q.37 Which of the following statements is not correct? **[NEET 2016 PHASE 1]**
(A) Pollen grains of many species can germinate on the stigma of a flower, but only one pollen tube of the same species grows into the style.
(B) Insects that consume pollen or nectar without bringing about pollination are called pollen/nectar robbers.
(C) Pollen germination and pollen tube growth are regulated by chemical components of pollen interacting with those of the pistil.
(D) Some reptiles have also been reported as pollinators in some plant species.

Q.38 Cotyledon of maize grain is called **[NEET 2016 PHASE 1]**
(A) Plumule (B) Coleorhiza
(C) Coleoptile (D) Scutellum

Q.39 Seed formation without fertilization in flowering plants involves the process of **[NEET 2016 PHASE 1]**
(A) Sporulation (B) Budding
(C) Somatic hybridization (D) Apomixis

Q.40 In majority of angiosperms – **[NEET 2016 PHASE 2]**
(A) Egg has a filiform apparatus
(B) There are numerous antipodal cells
(C) Reduction division occurs in the megaspore mother cells.
(D) A small central cell is present in the embryo sac.

Q.41 Pollination in water hyacinth and water lily is brought about by the agency of – **[NEET 2016 PHASE 2]**
(A) Water (B) Insects or wind
(C) Birds (D) Bats

Q.42 The ovule of an angiosperm is technically equivalent to – **[NEET 2016 PHASE 2]**
(A) Megasporangium
(B) Megasporophyll
(C) Megaspore mother cell
(D) Megaspore

Q.43 A dioecious flowering plant prevents both: **[NEET 2017]**
(A) Autogamy and xenogamy
(B) Autogamy and geitonogamy
(C) Geitonogamy and xenogamy
(D) Cleistogamy and xenogamy

Q.44 Functional megaspore in an angiosperm develops into: **[NEET 2017]**
(A) Ovule (B) Endosperm
(C) Embryo sac (D) Embryo

Q.45 Attractants and rewards are required for : **[NEET 2017]**
(A) Anemophily (B) Entomophily
(C) Hydrophily (D) Cleistogamy

Q.46 Flowers which have single ovule in the ovary and are packed into inflorescence are usually pollinated by – **[NEET 2017]**
(A) Water (B) Bee
(C) Wind (D) Bat

Q.47 Double fertilization is exhibited by **[NEET 2017]**
(A) Gymnosperms (B) Algae
(C) Fungi (D) Angiosperms

Q.48 Double fertilization is **[NEET 2018]**
(A) Fusion of two male gametes with one egg.
(B) Fusion of one male gamete with two polar nuclei.
(C) Fusion of two male gametes of a pollen tube with two different eggs.
(D) Syngamy and triple fusion

Q.49 Pollen grains can be stored for several years in liquid nitrogen having a temperature of **[NEET 2018]**
(A) –196°C (B) –80°C
(C) –120°C (D) –160°C

Q.50 Which of the following has proved helpful in preserving pollen as fossils? **[NEET 2018]**
(A) Oil content (B) Cellulosic intine
(C) Pollenkitt (D) Sporopollenin

Q.51 Which one of the following statements regarding post-fertilization development in flowering plants is incorrect? **[NEET 2019]**
(A) Ovary develops into fruit.
(B) Zygote develops into embryo.
(C) Central cell develops into endosperm.
(D) Ovules develop into embryo sac

Q.52 Persistent nucellus in the seed is known as **[NEET 2019]**
(A) Chalaza (B) Perisperm
(C) Hilum (D) Tegmen

Q.53 What is the fate of the male gametes discharged in the synergid? **[NEET 2019]**
(A) One fuses with egg other(s) degenerate (s) in the synergid.
(B) All fuse with the egg.
(C) One fuses with the egg, other(s) fuse(s) with synergid nucleus.
(D) One fuses with the egg and other fuses with central cell nuclei.

ANSWER KEY

EXERCISE-1 (SECTION-1&2)

(1) (A) **(2)** (C) **(3)** (A)
(4) (B) **(5)** (D)
(6) Gametogenesis **(7)** Sepal **(8)** Nucellus
(9) 8 **(10)** Polyembryony
(11) 7 **(12)** Anther **(13)** Corolla
(14) Exine, Intine
(15) Hypocotyle, radicle, root cap
(16) 10-15%, slow down, dormancy
(17) Xenogamy
(18) 2 **(19)** 4 **(20)** True
(21) False **(22)** False **(23)** True
(24) True **(25)** False **(26)** False
(27) False **(28)** True **(29)** True
(30) True

EXERCISE - 1 [SECTION-3 & 4]

Q	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
A	C	C	D	D	A	B	D	D	C	C	B	D	B	D	C	C	C	D	C	D
Q	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70
A	B	D	C	C	C	D	C	B	C	B	A	B	B	A	C	D	D	D	A	A
Q	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
A	C	C	B	B	A	A	D	C	A	B	B	A	A	B	C	C	A	A	A	C
Q	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110
A	A	A	C	A	C	C	C	C	C	C	A	C	B	C	D	A	A	D	D	A
Q	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130
A	A	D	C	B	D	C	D	A	D	B	D	A	A	D	B	A	A	B	D	D
Q	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
A	A	B	D	A	D	A	A	B	C	C	D	C	D	A	B	D	D	A	B	D
Q	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	
A	B	D	C	C	C	A	D	A	A	D	C	C	B	A	D	C	D	D	D	

EXERCISE - 2

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	A	D	A	A	A	A	D	C	B	B	A	C	D	C	C	D	A	A	C	A
Q	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
A	C	C	A	D	B	B	A	D	B	A	A	B	C	B	A	B	C	C	C	B
Q	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
A	A	D	A	B	D	B	C	A	A	B	A	B	B	B	B	B	C	C	D	A
Q	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
A	D	C	B	D	A	C	C	C	C	C	C	B	D	A	D	C	D	C	B	C
Q	81	82	83	84	85	86	87	88	89	90										
A	A	D	A	B	C	C	D	B	D	D										

EXERCISE - 3

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	A	A	C	B	B	B	A	B	B	B	B	A	B	B	C	A	B	A	B	B
Q	21	22	23	24	25	26	27	28	29	30	31									
A	D	C	A	A	A	B	A	B	C	B	B									

EXERCISE - 4																				
Q	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	B	B	B	D	C	A	D	C	A	D	B	A	C	A	D	D	A	A	C	A
Q	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
A	C	C	D	D	A	D	C	D	A	C	B	A	A	C	D	D	A	D	D	C
Q	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**							
A	B	A	B	C	B	C	D	D	A	D	D	B	D							

SOLUTIONS

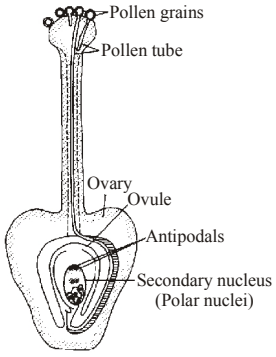
EXERCISE-1

(1) (A) **(2)** (C) **(3)** (A)
(4) (B) **(5)** (D)
(6) Gametogenesis **(7)** Sepal **(8)** Nucellus
(9) 8 **(10)** Polyembryony
(11) 7 **(12)** Anther **(13)** Corolla
(14) Exine, Intine
(15) Hypocotyle, radicle, root cap
(16) 10-15%, slow down, dormancy
(17) **Xenogamy** is also called cross-fertilisation. Transfer of pollen grains from anther to the stigma of a different plant of same species. This is the only pollination, which brings genetically different types of pollen grains to the stigma.
(18) **2.** Generally, there are two integuments (bitegmic), but sometimes one integuments also found (unitegmic) in the ovule. They protect the ovule from external injuries.
(19) **4.** Each theca contains two microsporangia so total four microsporangia present in angiospermic anther.
(20) **True.** Because for releasing the pollens there are grooves, which separates the two theca and form line of dehiscence.
(21) False **(22)** False **(23)** True
(24) **True.** So that at the time of germination the pollen tube can emerge out from germ pore.
(25) False
(26) **False.** In the embryo sac the cells, which are present at the chalazal end are called antipodal cells. At the micropylar end the synergid and egg cells are present.
(27) False.
(28) **True.** Plants, in which the water or air pollination is prevelant, produces large number of pollens because of wastage of pollen during pollination by abiotic means.
(29) **True.** In wind pollination the stigma is large and open for more chances of pollination as there is no biotic agency for pollination.
(30) True **(31)** (C) **(32)** (C)
(33) **(D).** Microsporangium is mainly surrounded by four layers/wall, i.e., Epidermis, endothecium, middle layer and tapetum.
(i) Epidermis endothecium and middle layer help in protection and dehiscence of anther from pollen.
(ii) Tapetum nourishes the developing pollen grain.
(34) (D)
(35) **(A).** Presence of feathery and exposed stigma are the characters of wind-pollinated plant.
(36) (B) **(37)** (D)
(38) **(D).** Stigma : Landing ground for pollen grains
Style : Passage for pollen tube
Ovary : Embryos sac/fruit
Ovules : Formation of seed
Thalamus : Receptacle for ovary.
(39) (C)
(40) **(C).** Orthotropous: It is also called atropous. It is erect no bending is there, e.g., *Polygonum*.
Anatropous " Completely inverted, e.g., *Helianthus*.
Hemitropous : The micropyle and chalaza line at 90° to funicle, e.g., *Ranunculus*.
Campylotropous more curvature than hemitropous, e.g., *Capparis*, musturd.
Amphitropous : Horse shoe like, e.g., *Capsella*.
Circinotropous : Ovule straight micropyle upward due to unilateral growth of funicle it become inverted, e.g., *Opuntia*.
(41) **(B).** Fertilisation is the process in which the fusion of male and female gametes takes place. This process takes place in the ovary.
(42) (D)
(43) **(B).** The gynoecium represents the female reproductive part of the flower. The gynoecium may consist of single pistil (monocarpellary) or may have more than one pistil (multicarpellary).
When there are more than one pistil fused together than the pistil is called multicarpellary syncarpous pistil when the pistils are not in fused condition than this type of ovary is called multicarpellary apocarpous pistil.

(44) (D)

(45) **(C).** Embryo develops at the micropylar end of the ovule or embryo sac, where the zygote is situated. Most zygote divide only after certain amount of endosperm is formed. The early stages of embryonic development is same in both monocotyledons and dicotyledons. The zygote give rise to the proembryo and subsequently into globular, heart-shaped and mature embryo.

(46) **(C).**



Germination of pollen grain on stigma

(47) **(C).** Modes of entry of pollen tube

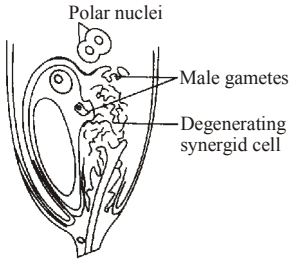
(i) **Porogamy :** Entry of pollen tube takes place through micropylar end, e.g., Lily.

(ii) **Chalazogamy :** Entry of pollen tube takes place through the chalazal end, e.g., *Casuarina, Juglans.*

(iii) **Mesogamy :** Entry of pollen tube takes place through the integuments, e.g., *Cucurbita, Populus.*

(48) (D) **(49)** (C)

(50) **(D).**



Discharge of male gametes into a synergid and the movements of the sperms, one into the egg the other into the central cell.

(51) (B)

(52) **(D).** Dicot, cotyledon, epicotyle and hypocotyle are the three main parts of embryo.

(53) **(C).** Monocot a-Cotyledon, b-Epicotyle, c-Radicle, d-Endosperm, e-Seed coat.

(54) (C) **(55)** (C) **(56)** (D)

(57) **(C). Megasporangium :** The ovule is a small structure attached to the placenta by means of stalk called funicle. The body of the ovule fuses with funicle in the region called hilum. Thus, hilum represents the junction between ovule and funicle. Each ovule has one or two protective envelope called integuments. These Integuments encircle the ovule except the tip, where a small opening called micropyle is organised. Opposite to the micropylar end is the chalaza representing basal part of the ovule.

(58) **(B).**

Stamen

Filament	**Anther**
Long cylindrical stalk of the stamen	Generally terminal bilobed structure of stamen is called anther

(59) **(C).** a-Chasmogamous-male and female part remain on the same flower but there are modification for ensuring self-fertilisation. b-Cleistogamous (closed flower).

(60) (B) **(61)** (A) **(62)** (B)

(63) **(B).** Fusion of male and female haploid gametes leads to the formation of a diploid zygote.

(64) (A)

(65) **(C).** Flower is a modified shoot meant for reproduction.

(66) **(D).** Pollens contain male gametes hence both the terms are used in angiosperms during sexual reproduction.

(67) **(D).** Microsporangia is like a sac in which pollen develops. Also called pollen sac at the time of maturity.

(68) **(D).** Pollens of different species are different in size, shape, colour and because different species are adopted differently according to their environment.

(69) **(A).** The inner most layer is tapetum. Tapetum nourishes the developing pollens.

(70) **(A).** Exine of pollen is made up of sporopollenin.

(71) **(C).** Bilobed or dithecous are the same terms used in angiospermic anther lobes.

(72) **(C).** Microspore mother cell and pollen mother cell are the same term and form male gametes (pollens) by the process called microsporogenesis.

(73) **(B).** **(74)** (B) **(75)** (A)

(76) **(A).** 60% of angiosperms shed their pollens at two celled stage and in rest 40% the pollens are shed at three celled stage which is formed by division in generative cell mitotically.

(77) **(D).** Pollen grains of many species cause severe allergies and bronchial afflications. In some people often leading to chronic respiratory disorders, i.e., asthma, bronchitis, etc. Remember that Parthenium or carrot grass that came to India as a contaiminant with imported wheat has become obiquitous in occurance and cause pollen allergy.

(78) **(C).** The period in which the pollen grains remain viable is highly variable. It depends on the temperature and humidity. In some cereals such as rice and wheat, the pollen grains loose viability with in 30 minutes of their release and in some members of Rosaceae, Leguminosae and Solanaceae, they maintain variability for months.

(79) (A) **(80)** (B) **(81)** (B)

(82) **(A).** *Parthenium* is also called congress or carrot grass, which came with wheat variety imported from Mexico. Now, it is a serious weed of wheat and produce large number of pollen grains which causes bronchial allergies.

(83) **(A).** **Microsporogenesis :**
During developmental phase of anther the cells of sporogenous tissue undergoes meiotic division to form microspore tetrad. The process of formation of microspore from pollen mother cell is called microsporogenesis. The microspores are formed and arranged in a group of four cells called microspore tetrad. Microspore develops into the pollen grain and represents the male gametophyte.

(84) (B) **(85)** (C)

(86) **(C).** Micropyle is found is both seed and ovule. In seed it is the pore through which water goes inside during germination. In ovule the absense of integument form micropyle.

(87) (A) **(88)** (A) **(89)** (A)

(90) **(C).** Embryo sac and female gametophyte are the sames terms used for female reproductive part in angiosperms.

(91) (A)

(92) **(A).** In embryo sac-synergids, egg cells, antipodal cells all are haploid because they are formed by mitotic division in haploid megaspore cell.

(93) **(C).** Megaspore is commonly called as ovum. These terms are generally used in case of plants and animals. The process of formation of ova or megaspore called oogenesis or megasporogenesis respectively.

(94) (A)

(95) **(C).** Two nuclei with one cell are found in central cell.

(96) (C)

(97) **(C).** 2 synergids and 1 egg cell.

(98) **(C).** Filiform apparatus are the special thickning of synergid cells for guiding the pollen tube and male gamete, so that the fusion takes place properly.

(99) **(C).** An ovule is an integumented megasporangium found in spermatophytes, which develops into seed after fertilisation. An angiospermic ovule is typically an ovoid and whitish structure. It occurs inside the ovary, where it is attached to a parenchymatous tissue called placenta either singly or in a cluster.

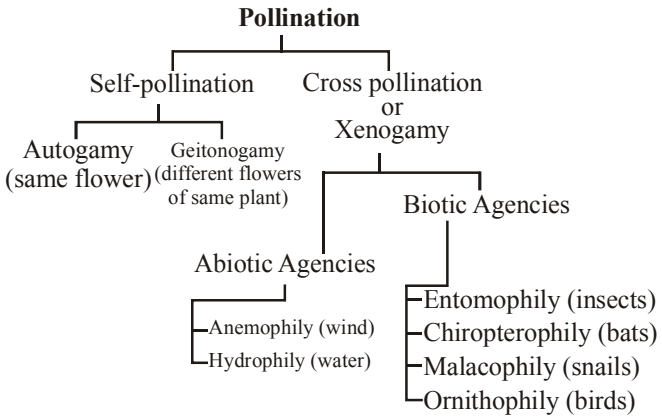
(100) **(C).** Orthotropous or atropous or straight is the most primitive and simplest type of ovule in the angiosperms. It is erect (i.e., micropyle at upper end) and here micropyle, chalaza, funicle are in the same straight line, e.g., in Polygonaceae and Piperaceae.

(101) (A)

(102) **(C).** Although the meaning of unisporic monosporic, single sporic cell is same but only monosporic term is used for single megaspore.

(103) (B)

(104) **(C).** **Pollination :** Transfer of pollen grains to the stigma is called pollination.



(105) **(D).** Some examples of water pollinated plants are *Vallisneria* and *Hydrilla*, which grow in fresh water and several marine sea-grasses such as *Zostera*. Not all aquatic plants use water for pollination. In a majority of aquatic plants such as water hyacinth and water lily the flower emerge above the level of water and are pollinated insects or wind as in most of the land plants.

(106) (A) **(107)** (A) **(108)** (D)

(109) (D)

(110) **(A).** As they are closed. So, no chance for bird, wind, water, insect pollination.

(111) **(A).** Self-pollination : When the process of pollination occurs in the same plant, it is called self-pollination. It is of two types –

(i) Autogamy : When pollination takes of place in the same flower of a plant. Here, no pollinating agent is required.

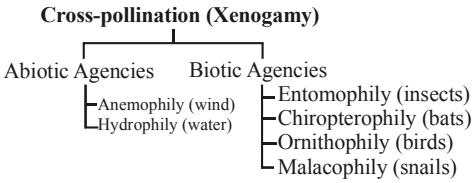
(ii) Geitonogamy : Transfer of pollen grains from anther to stigma of another flower of same plant. Although the geitonogamy is functionally cross-pollination involving a pollinating agent, genetically it is similar to autogamy since the pollen grains come from the same plant.

(112) (D)

(113) **(C).** Flowers of grass family (Poaceae) are generally pollinated by the wind. They have exposed stigma and versatile anther.

(114) (B)

(115) **(D).**



(116) **(C).** Wind pollinated flowers often have single ovule in each ovary and numerous flowers packed into an inflorescence. A familiar example is corn comb.

(117) (D) **(118)** (A)

(119) **(D).** Water hyacinth is aquatic plant but it is not pollinated by water. It is pollinated by insect and air or wind.

(120) (B)

(121) **(D).**

Autogamy (Auto-self: gamous—marriage)

Homogamy/Chasmogamy	Cleistogamy
The anthers and stigma of open flower is brought together by growth, bending or folding so that pollination takes place in same flower. e.g., Four 0' clock, *Catharanthus* (Vinea) etc.	(Kleisto-closed; gamy-marriage) In that the flower never opens to ensure the self pollination. e.g., *Commelina, Viola, Oxalis*, etc.

(122) **(A).** Continued self breeding means there is continuation of genetic material to the progeny from the parents. As they are the product of same genotype of same plant. This leads to less productivity called inbreeding depression.

(123) (A)

(124) **(D).** Flowering plants have developed many devices to discourage self-pollination. In some species, pollen, releases and stigma receptibility is non-syncronised, i.e., either the pollen is released before the stigma becomes receptive or stigma becomes receptive much before the release of pollen. In some other species the anther and stigma are placed at the different positions so that the pollen can not come in contact with the stigma of same flower. Both these devices prevent autogamy.

The third device to prevent inbreeding is self-incompatibility.

This is genetic mechanism and prevents self pollination (from same flower or other flower of same plant) from fertilising the ovules by inhibiting pollen germination or pollen tube growth in pistill.

(125) **(B).** Genetic method for preventing self-fertilisation.

(126) (A)

(127) **(A).** Majority of plants use biotic agents for pollination because that reduce the chances of wasting pollens.

(128) **(B).** Because wind pollinated and water pollinated plants do not need any biotic agency for pollination so no need for fragrance. Nector and colourfulness. Generally, wind pollinated plant are big in size due to producing more pollen and have exposed stigma for easily capturing pollens.

(129) **(D).** Majority of insect pollinated flower are large, colourful, fragrant and rich in nectar in order to attract the insects for pollination.

(130) **(D).** Water pollinated plants are very less and limited to 30 genera and mostly are cotyledons. It is rare in flowering plants.

(131) (A)

(132) **(B).** They remain close for ensuring self-pollination.

(133) **(D).** Wind pollens are non-sticky, light so that they can go far away and are produced in large numbers, because there is a lot of wastage of pollens.

(134) **(A).** Two or three celled stage of male gametes are formed by the mitotic cell division and in mitosis the genetic make up remains identical. That is why generative cell and vegetative cell in male gametes are identical in genetic make up.

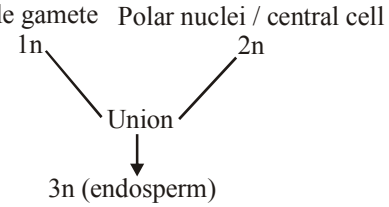
(135) **(D).** **Nuclei involved in fertilisation :** Two nuclei from polar cell, two nuclei from male gametes (generative and vegetative) and one nucleic from egg cell.

(136) (A)

(137) **(A).** Micropylar region the most common way for entry of pollen tube (porogamy).

(138) **(B).** Two polar nuclei one egg cell (total 3 nuclei).

(139) **(C).**



(140) **(C).** Though organogenesis is a part of post fertilisation events but it is included in the embryogensis. Endospermogenesis is the post-fertilisation event under which formation of endosperm takes place.

(141) (D) **(142)** (C)

(143) **(D).** All statement are correct. In gymnosperm the triple fusion is rare so their endosperm is haploid and in angiosperm endosperm is formed prior to zygote and triploid.

(144) **(A).** In most water pollinated plants, the pollen grains are long and ribbon-like and are protected from wetting by mucilagenous covering.

(145) **(B).** In coconut endosperm two type of division takes place, cellular and nuclear and it is the female gametophyte not male. In coconut endosperm cellular endosperm surrounds the nuclear endospores.

(146) **(D).** Embryos of monocotyledons possess only one cotyledon. In the grass family the cotyledon is called scutellum that is situated toward the one side (lateral) of the embryonal axis. At its lower end, the embryonal axis has the radical and root cap enclosed in an undifferentiated sheath called coleorhiza.

The portion of the embryonal axis above the level of attachment of scutellum is epicotyl. Epicotyl has a shoot apex and few leaf primordia enclosed in hollow structure the coleoptile.

(147) **(D).** Occurrence of more than one embryo in a seed is referred as polyembryony.

(148) **(A).** Lower end of embryonal axis in monocot.

(149) (B)

(150) **(D).** Sometime the nucellus does not completely consumed so it persist. It is found in many plant like black pepper and beet. This nucellus is called perisperm.

(151) **(B).** As the seed matures, its water content is reduced and seed becomes relatively dry (10-15% moisture by mass). The general metabolic activity of the embryo slows down. The embryo may enter a state of inactivity called dormancy. When favourable condition are available (adequate moisture, oxygen, suitable temperature) seeds germinate.

(152) **(D).** Ovary and other floral part makes fruit.

(153) **(C).** Fruit developed from unfertilised ovary.

(154) (C)

(155) **(C).** In most of the species fruits are results of fertilisation. There are few species in which fruits develop without fertilisation. Such fruit are called parthenocarpic fruits. Banana is one such example. Parthenocarpy can be induced through application of growth hormones and such fruit are seed less.

(156) (A)

(157) **(D).** Non-albuminous seeds are also called ex-albuminous. In them reserve food consumed by embryo so their cotyledons are very thin.

(158) **(A).** Aleurone layer prepare amylase (an enzyme), which acts on the starch and frees the glucose unit for developing embryo.

(159) **(A).** The transformation of part of flower.

Before Fertilisation		**After Fertilisation**
Calyx, corolla Androecium, style and stigma	–	Wither
Ovary	–	Fruit
Ovary wall	–	Pericarp
Ovule	–	Seed
Integuments	–	Seed coats
Outer integuments	–	Testa
Inner integuments	–	Tegman
Micropyle	–	Micropyle
Funicle	–	Stalk of seed
Nucellus (if persistant)	–	Perisperm
Egg cell	–	Zygote (oospore)
Synergid	–	Disintegrate

(160) **(D).** Albuminous seed retain a part of endosperm as it is not completely used up during embryonic development, e.g., Wheat, maize, barley, castor, sunflower. Their cotyledons are fleshy and thick as compared to the non-albuminous seed.

(161) **(C).** Although seeds, in general are the product of fertilisation, a few flower plants such as some species of Asteraceae and grasses, have evolved special mechanism to produced seed without fertilisation called apomixis.

(162) (C)

(163) **(B).** Seeds without fertilisation.

(164) **(A).** In apomixis there is no fertilisation so, the time consuming is less as compared to plants which reproduce by sexual method. Hence, it is the rapid mode of reproduction in plants.

(165) **(D).** Polyembryony is the formation of more than one embryo so it is the type of embryo-genesis.

(166) **(C).** In asexual and apomictic reproduction the mitotic cell divison takes place. Due to mitotic cell division in both these type of reproduction resultant progeny are identical to parents.

(167) **(D).** Asexual reproduction

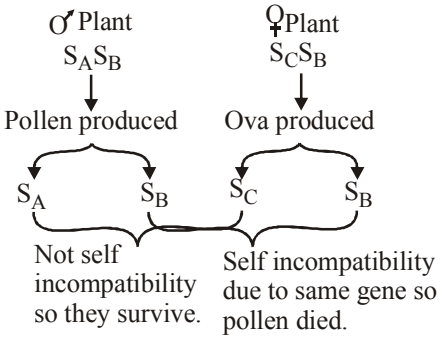
(168) **(D).** In apomixis the diploid egg is formed without the reductional division. This diploid egg may derived directly from the somatic cell (apospory), in some plants Megaspore Mother Cell (MMC) act as the diploid egg called diplospory.

(169) **(D).** In citrus, mango plants some of the nucellar cell surrounding the embryo sac starts dividing, protrude into embryo sac and develop into many embryos. In such species each ovule contains many embryos. Occurrence of more than one embryo is referred to as polyembryony.

EXERCISE-2

(1) **(A).** In center there is sporogenous tissue in the cells of which meiosis takes place which leads to formation of microspore tetrad.

(2) **(D).**



(3) **(A).** Chasmogamy is the type of autofertilisation (self-fertilisation) in which both male and female gametes present on same flower but pistil and stamen have special adaptation like bending length, etc., so that fertilisation takes place. They are open flower not closed like cleistogamous flowers.

(4) **(A).** Ovules generally differentiate a single Megaspore Mother Cell (MMC) in the micropylar region of the undifferentiated tissue (nucellus). It is a large cell containing dense cytoplasm and prominent nucleus. The MMC undergoes meiotic division.

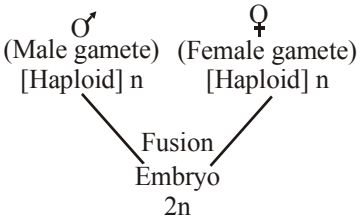
(5) (A)

(6) **(A).** Occurrence of more than one embryo in a seed is reffered as Polyembryony. In many citrus and mango varieties some of the nucellar cells surrounding the embryo sac start dividing, proturde into embryo sac and develop into the embryos. In such species, each ovule contains many embryos (nucellar polyembryony).

(7) (D) **(8)** (C)

(9) **(B).** Bisexual flowers which do not open at all are called cleistogamous. In such flowers, anthers and stigma lie close to each other. Viola (common pansy) has both cleistogamous and chasmogamous flowers. Chasmogamous flowers remain open with exposed anthers and stigma.

(10) **(B).**



(11) (A) **(12)** (C)

(13) **(D).** Pollen, syrup increase / improve performance because pollen contain highly nutritive material in the form of vegetative cell.

(14) **(C).** The outer seed coat (testa) of a seed is produced from outer integument of ovule. The inner integument forms tegmen (inner seed coat). Ovary wall forms pericarp (fruit wall). **(15) (C).**

(16) **(D).** Another device to prevent the self pollination is the production of unisexual flowers present on the same plant such as castor and maize (monoecious). It prevents autogamy but not geitonogamy.
In several species such as papaya, male and female flowers are present on different plants, that is each plant is either male or female (dioecy). This condition prevents both autogamy and geitonogamy.

(17) **(A).** Pollens are well preserved because the sporopollenin. It is hard and resistable to many organic and inorganic compounds.

(18) **(A).** Viability means ability to grow. This is a certain time period in which plant seed have ability to germinate. Lupine have the viability period about 10,000 years.

(19) **(C).** Egg cell-haploid, formed by meiosis.
Zygote-Diploid formed by union of male female gametes.
Endosperm-triploid, it is a union of male gamete (vegetative), which is haploid and central cell, which is diploid together make triploid structure.

(20) **(A).** In amphitropous type, curvature is observed both in the body of ovule and embryo sac. The embryo sac assumes horse shoe-shape, e. g., in Papaveraceae, Alismaceae and Butomalaceae, etc.

(21) (C) **(22)** (C) **(23)** (A)

(24) (D) **(25)** (B)

(26) **(B).** Hermaphrodite flower is also called monoecious or bisexual flower. Majority of plants have this type of flowers.

(27) **(A).** Chalazal pole is present just, opposite to the micropylar end and chalaza represents the basal part of the ovule.

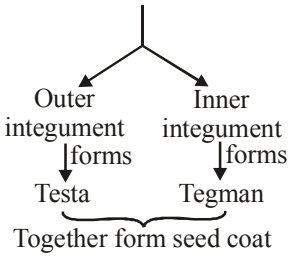
(28) **(D).** In most of the plants the fruit develops from the ovary (true fruits) and other floral part degenerate and fall off. However in a few species such as apple, strawberry, cashew, etc., the thalamus also contributes to fruit formation such fruits are called false fruit.

(29) (B) **(30)** (A)

(31) **(A).** Clone is an individual obtained from a single parent through apomixis or vegetative reproduction or tissue culture. The process of fusion of two male gametes in a single embryo sac is called double fertilisation. It is found in sexual reproduction of angiosperms only and discovered by Nawaschin (1989).

(32) (B)

(33) **(C).** Ovule integuments generally two in number



(34) **(B).** Synergids, antipodal cell, haploid egg don't take part in seed or apomictic seed formation because they are haploid and take part in sexual reproduction. Only maternal sporogenous tissue in ovule takes part in seed formation in apomictic embryogenesis.

(35) **(A).** In some species floral rewards are seen in providing safe places to lay eggs : an example is that of the tallest flower *Amorphophallus*. A similar relationship exist between a species of moth and the plant *Yucca* where both the species moth and plant cannot complete their life cycles without each other.

The moth deposits its eggs in the locule of the ovary and flower in turn gets pollinated by moth. The larvae of moth come out of the eggs as the seed starts developing.

(36) **(B).** Aleurone layer is the layer surrounds the endosperm. It is made up of protein. It is found only in monocotyledons.

(37) **(C).** The technically correct terms for the floral whorls are (from outermost to innermost) calyx, carol la, androecium and gynoecium. They are made up of sepals, petals, stamens and carpels, respectively.

(38) (C)

(39) **(C).** A typical carpel consist of ovary which can have many ovules. Each ovule has an embryo sac, which in turn has a single egg cell.

Similarly, in majority of angiosperms each stamen consists of a bilobed anther, which in turn has two pollen sacs in each lobe, consisting of pollen grains.

(40) (B) **(41)** (A)

(42) **(D).** Fruits can develop from a single ovary of a single flower (simple fruit) or from several free carpels of a single flower (aggregate) or from whole inflorescence (multiple). In total fruits develop from ovaries. This is why, a dioecious plant (unisexual) bearing only staminate (male) flowers will not produce fruits, whereas monoecious plants (bisexual) or dioecious plants bearing only pistillate (female) flowers or pistillate & staminate both can bear fruits (pollination).

(43) (A) **(44)** (B)

(45) **(D).** The wall layers of a microsporangium from outermost to innermost are: epidermis, endothecium, middle layers and tapetum. The first three layers generafly provides protection and help in dehiscencs of anther. Tapetum performs nutritive function for pollen grains.

(46) (B) **(47)** (C)

(48) (A) **(49)** (A)

(50) **(B).** Microsporogenesis is the formation of microspores in the form of tetrads, which later separate and are called pollen grains. Microspore mother cell (2n) undergoes meiosis for the formation of haploid pollen grains formed first in the form of spore tetrads.

(51) **(A).** Stigma is a part of pistil on which pollen grain lands. Each ovary may have many ovules, which have many ovules, which have embryo sacs in them. Placenta is a tissues/

ridge inside ovary to which ovules are attached. Thalamus is the terminal part of the axis of flower which bear all floral appendages. Tapetum is the innermost layer of microsporangium while stamen is component of androecium.

(52) (B) **(53)** (B) **(54)** (B)

(55) **(B).** Eggcell is inside the embryo sac in the ovule. The embryosacisfurther enclosed by the parenchymatous tissue, nucellus, which later provide nutrition to developing embryo.Nucellus is ultimately surrounded by integuments.

(56) **(B).** (i) False (ii) True (iii) True (iv) False

(57) **(C).** Female gametophyte is present inside of the nucellus. Egg apparatus is situated at the micropylar end. Nuclear endospermis the most common type of endosperm. Female gametophyteis 8-nucleate and 7-celled at maturity because of presence of secondary nucleus.

(58) **(C).** Autogamy is pollination within a flower, chasmogamous flowers are those in which anthers and stigma are exposed. For autogamy, in such a flower to take place, pollen and ovule should mature simultaneously and anther and stigma to lie close to each other.

(59) **(D).**

(i) The ploidy level of gametophyte is n.

(ii) Integumented megasporangium is called ovule.

(iii) The embryo sac or female gametophyte lies at micropylar end of ovule.

(60) **(A).** Autogamy: Pollination within the same flower

Geitonogamy:Pollination between different flowers of same plant.

Xenogamy: Pollination between different plants.

Pollination: Transfer of pollen grain from anther to stigma.

Cleistogamousflower (that do not open at all) always exhibit autogamy,where as chasmogamous flowers (with exposed anthersand stigma) can exhibit autogamy, geitonogamy or xenogamy.

(61) (D)

(62) **(C).** Light, non-sticky pollens produced in large numbers are generally traits of wind pollinated plants (anemophilous). Insect and animal pollinated plants have sticky pollens. Long and feathery stigma is also characteristic of anemophilous plants. Maize *Cannabis* and many grasses are some of the examples of this category.

(63) **(B).** Monoecious plant (bisexual) bearing either bisexual or unisexual flowers can exhibit both autogamy as well as geitonogamy. Dioecious (unisexual) plants bearing only male or female flowers will not show autogamy or geitonogamy and only xenogmay is possible.

(64) (D)

(65) **(A).** Double fertilization is the fusion of two male gametes brought by a pollen tube to two different cells of the same female gametophyte in order to produce two different structures. It is found only in angiosperms where it was first discovered by Nawaschin in 1898 in *Fritillaria* and *Lilium*. Out of the two male gametes one fuses with egg or oosphere to perform generative fertilization. Generative fertilization is also called syngamy or true fertilization. It give rise to a diploid zygote or oospore. The second male gamete fuses with two haploid polar nuclei or diploid secondary nucleus of the central cell to form a triploid primary endosperm nucleus (PEN). This is called as vegetative fertilization (or triple fusion).

In angiosperms, the female gametophyte (or embryo sac) is an oval multicellular haploid structure which is embedded in the nucellus towards micropylar half of the ovule.

The typical and the most common type of embryo sac, found in 80% flowering plants is called *Polygonum* type of embryo sac. It contains 8 nuclei but 7 cells - 3 micropylar, 3 chalazal and one central. It is formed by one meiosis and three mitosis. The three micropylar cells are collectively known as egg apparatus. One middle cell is larger and

is called egg or oosphere. The remaining two cells are called synergids, which bear filiform apparatus. The three chalazal cells of the embryo sac are called antipodal cells.

(66) (C)

(67) **(C).** Artificial hybridisation is human performed crossing of two different plants having complementary good traits in order to obtain an overall superior variety. Artificial hybridisation has been used by plant breeders for crop improvement programme. Two precautionary measures in artificial hybridisation are emasculation and bagging. Emasculation is removal of stamens from the floral buds of female parent so that chances of self pollination are eliminated. In case of dioecious (unisexual) plants, emasculation is not required.

(68) **(C).** Ploidy level of the cells in microspore tetrad is haploid (n).

(69) **(C).** During the development of dicot embryo, initially the dicot embryo is globular and undifferentiated. Early embryo with radial symmetry is called proembryo. It is transformed into embryo with the development of radicle, plumule and cotyledons. Two cotyledons differentiate from the sides with a faint plumule in the centre. At this time the embryo becomes heart-shaped. Part of embryo axis between the plumule and cotyledonary node is epicotyl (above the level of cotyledons) while the part between radicle and cotyledonary node is called hypocotyl (below the level of cotyledons). The single cotyledon of monocotyledonous seed (e.g. maize grain) is called scutellum. It occupies the major portion of the embryo regions of grain. **(70)** (C) **(71)** (C)

(72) **(B).** Apomixis is the term given to any phenomenon that leads to formation of embryo wherein parts of the sexual apparatus are used, but without fertilization. Fertilisation is also absent in vegetative propagation, but parts of sexual apparatus are not involved. An example of apomixis is Citrus.

(73) (D)

(74) **(A).** Fertilised ovary is technically called fruit. But if ovary develop into fruit, without fertilisation, it is called parthenocarpic fruit. Such fruits are generally seedless. Some common examples found in nature are: *Citrus*, banana, etc. parthenocarpy can be artifically induced too with the help of application of certain plant hormones, specially, auxin and gibberellines.

(75) **(D).** A pollen contains two sperm cells & one pollen tube cell.

(76) **(C).** Ovule becomes the seed.

(77) **(D).** The diploid central cell fuses with the sperm cell and eventually forms the endosperm.

(78) **(C).** Haploid sperm cell fuses with diploid central cell to form a triploid cell that forms the endosperm.

(79) **(B).** Strawberry is an aggregate fruit that is derived from many ovaries of the same flower.

(80) **(C).** A pineapple is derived from the ovaries of many flowers that stay together.

(81) **(A).** Garden peas and green beans are simple fruits because they are derived from one ovary of a single flower.

(82) **(D).** Radicle forms primary root of the seedling.

(83) **(A).** Pollination is the process of transfer of pollen grain from the anther to the stigma.

(84) **(B).** Dedifferentiation is when specialized cells become unspecialized.

(85) (C)

(86) **(C).** The tapetum is a specialised layer of nutritive cells found within the sporangium, particularly within the anther, of flowering plants, where it is located between the sporangenous tissue and the anther wall.

(87) **(D).** The tapetum secretes a peri-tapetal membrane with Ubisch bodies, first with clusters of globules, then exine-like spines on the top of clusters.

(88) **(B).** Microspores develop in the microsporangium and form mature pollen grains (male gametophytes), which are then used to fertilize female gametophytes.

(89) **(D).** Sporopollenin protects the living vegetative and generative cell in the pollen grain against

mechanical damage, chemical break-down and too rapid dessication and it provides a shield against the agressive ultraviolet radiation of the sun. On the surface of the outer wall and in cavities remnants of the tapetum can be found. Sometimes the grain is covered by a liquid, fatty substance, so-called "pollenkit". Intine, exine and cytoplasm can all three contain allergens that may cause hay fever.

(90) **(D).** **Orthotropous ovule:** It is atropous or straight, where the micropyle, chalaza and the funiculus, all are in the same line. Ex-Cycas, Family Polygonaceae and Piperaceae.

Anatropous ovule: It is of the most common occurrence more than 80% of angiosperm family). In this ovule, the funicle is long whole body of the ovule is inverted, through 180°. As a result the micropyle comes close to the funicle. Ex-Most common in dicots and monocots, Ex Asteraceae, Solanaceae.

Circinotropous ovule: It is of a very rare occurrence. Here the body of the ovuyle is bent through 360°, so that it takes a one complete turn. (Micropyle, chalaza and the nucellus are all in same plane). Ex-Opuntia.

EXERCISE-3

(1) (A) **(2)** (A) **(3)** (C)

(4) **(B).** **Artificial Hybridisation :** In such crossing experiments where it is important to make sure that only the desired pollen grains are used for pollination and stigma is protecting from contaimination (from unwanted pollen), this technique is used.

Steps in Artificial Hybridisation

(i) **Emasculation :** Removal of anthers from the flower bud before the anther dehiscence using forceps. This step referred to as emasculation.

(ii) **Bagging :** Emasculated flowers have to be covered with a bag of suitable size, generally made up of butter paper to prevent contamination of its stigma with unwanted pollen. This process is called bagging.

(iii) **Rebagging :** When the stigma of bagged flower attains receptivity, mature pollen grains collected from the anthers of the male parent are dusted on the stigma and the flowers are rebagged, and the fruits allowed to developed.

(5) (B) **(6)** (B) **(7)** (A) **(8)** (B)

(9) (B) **(10)** (B) **(11)** (B)

(12) **(A).** **Androecium :** Male reproductive part of the flower is called androecium. Its Individual part is called stamen. Stamen is further divided into anther and filament.

Gynoecium : It is the female reproductive part, also called pistil. The individual gynoecium is called carpel, which is further divided into (i) stigma, (ii) style and (iii) ovary.

(13) (B) **(14)** (B) **(15)** (C) **(16)** (A)

(17) (B) **(18)** (A) **(19)** (B) **(20)** (B)

(21) (D) **(22)** (C) **(23)** (A) **(24)** (A)

(25) **(A).** In maize and castor flowers are unisexual. Autogamy and geitonogamy are prevented in *Carica papaya*.

(26) **(B).** In angiosperms, cotyledons are embryonic leaves. Embryo also has radicle and plumule which gives rise to root and shoot respectively.

(27) **(A).** Angiospermic flowers possess male and female sex organs and perform the sexual reproduction.

(28) **(B).** The majority of angiosperms bear chasmogamous flowers, which means the flowers expose their mature anthers and stigma to the pollinating agents. There is another group of plants which set seeds without exposing their sex organs. Such flowers are called cleistogamous and the phenomenon cleistogamy.

(29) **(C).** The ovules where micropyle comes to lie close to the funiculus due to unilateral growth of the ovule are called anatropous. This is the most common type of ovule in angiosperms. Where the curvature of the ovule also affects the nucellus so that the later becomes horse shoe-shaped the ovule is called amphitropous.

(30) **(B).** The central cell is the largest cell of the embryo sac. It has a highly vacuolate cytoplasm which is rich in reserve food and Golgi bodies. In the middle the cell contains two polar nuclei which have large nucleoli. The polar nuclei fuse to form a single diploid secondary or fusion nucleus.

(31) **(B).** After fertilization the ovary begins to grow and gradually matures into the fruit. In some cultivated varieties of oranges, banana, grapes, apples, pineapples and some other fruits the ovary may grow into the fruit without fertilization. Such a fruit is seedless or with immature seeds and is known as the parthenocarpic fruits.

EXERCISE-4

(1) **(B).** Apomixis is abnormal kind of sexual reproduction in which egg or other cells associated with egg (synergids, antipodals, etc.) develop into embryo without fertilization and meiosis. Development of embryos directly from sporophytic tissues like nucellus and integuments is called adventive embryony which is also a type of apoximis. E.g., Citrus, mango.

(2) **(B).** Geitonogamy is the transfer of pollen grains from the anther to stigma of another flower on the same plant or genetically similar plant, e.g., in maize.

(3) **(B).** Pollination by wind is called anemophily and such plants in which pollination occurs by wind are called anemophilous plants. They are characterized by small flowers, pollens present in large number which are small, dry and light in weight (carried upto 1300 Km by wind), number of ovules are generally reduced in ovary (biological significance), have feathery or brushy stigma (to receive the pollen). Grasses and palms are generally anemophilous.

(4) **(D).** a - Offset of water hyacinth (*Eichhorinia*)
b-Antheridiophore of *Marchantia*
c-Antipodals of the mature embryo sac
d-Oogonium of *Chara*

(5) **(C).** In angiosperms, the female gametophyte is called embryo sac. It contains 8 nuclei but 7 cells - 3 micropylar, 3 chalazal and one central. The three micropylar cells are collectively known as egg apparatus. One middle cell is larger and is called egg or oosphere. The remaining two cells are called synergids or help cells. Each of them (synergids) bears a filiform apparatus in the micropylar region, a lateral hook, chalazal vacuole and a central nucleus.

(6) **(A).** In nucellar polyembryony, some of the nucellar cells surrounding the embryo sac start dividing. Then it protrudes into the embryo sac and develop into the embryos. In such species, each ovule contains many embryos. Occurrence of more than one embryo in a seed is referred as polyembryony. Nucellar polyembryony is found in many of the citrus and mango varieties.

(7) **(D).** Autogamy is a kind of pollination in which the pollen from the anthers of a flower are transferred to stigma of the same flower. Cleistogamy, homogamy, bud pollination are three methods of the autogamy. Cleistogamy occurs in those plants, which never open and ensure complete self-pollination. E.g. *Commelina bengalensis, Oxalis, Viola,* etc.

(8) **(C).** Anemophily is pollination of a flower in which the pollen is carried by the wind. Examples of anemophilous flowers are those of grasses and conifers.

(9) **(A).** Embryo sac is a cell that develops in the ovule of flowering plants. It is equivalent to the female gametophyte of lower plants, although it is very much reduced. Typically it contains eight nuclei formed by division of the megaspore mother cell. Megaspore mother cell divides by meiosis to give rise to four haploid megaspores. One of the megaspores develops into the embryo sac; the other abort.

(10) **(D).** Apomixis is a reproductive process in plants that superficially resembles normal sexual reproduction but in which there is no fusion of gametes. The embryos develop simply by division of a diploid cell the ovule.

So, the progenies produced are identical to the parent. In vegetative reproduction also progenies produced are identical to the parents.

(11) (B). Sporopollenin is a major component of the tough outer (exine) walls of spores and pollen grains. it is chemically very stable and is usually well preserved in soils and sediments. It can withstand environmental extremes and cannot be degraded by enzymes and strong chemical reagents.

(12) (A). Some plants such as *Viola* (common pansy), *Oxalis*, and *Commellina* produce two types of flowers chasmogamous flowers which are similar to flowers of other species with exposed anthers and stigma, and cleistogamous flowers which do not open at all. In such flowers, the anthers and stigma lie close to each other. When anthers dehisce in the flower buds, pollen grains come in contact with the stigma to effect pollination. thus, cleistogamous flowers are invariably autogamous as there is no chance of cross pollen landing on the stigma. Cleistogamous flowers produce assured seed-set even in the absence of pollinators.

(13) (C). In a pollen grain, exine is thin or absent at certain places. These areas may have thickened intine or deposition of callose. They are called germ pores (if rounded) or germinal furrows (if elongated). After pollination, the pollen grain on the stigma absorbs water and nutrients from the stigmatic secretion through its germ pores. the tube or vegetative cell enlarges and comes out of pollen grains through germ pore to form a pollen tube.

(14) (A). In 60% of flowering plants, the pollen grains are shed at two celled stage (tube cell + generative cell). Further, development of male gametophyte (pollen grain) occurs on stigma. Pollen grain gives rise to pollen tube which absorbs nourishment from the cells of style for its growth. Generative cell divides to give rise to two male gametes. Out of these, one fuses with the egg to form diploid zygote (generative fertilization or syngamy) whereas the second male gamete fuses with the two haploid polar nuclei or diploid secondary nucleus of the central cell to form primary endosperm nucleus (vegetative fertilization or triple fusion). these two acts of fertilization occur in the same embryo sac and are referred to as double fertilization.

(15) (D). Anemophily is an abiotic means of pollination by wind and, being non-directional, a wasteful process as the pollen would reach the stigma through wind is a hit or miss affair. During the transit of pollen through wind, a considerable amount of pollen is lost because it never reaches a proper stigma. To stand this loss, anemophilous plants have to produce enormous quantities of pollen. Anemophily is also associated with reduction in the number of ovules per ovary. Some models predict that plants benefit from numerous inexpensive flowers distributed throughout the inflorescence, each with a single ovule or a few ovules. In grasses there is just one ovule per ovary. This is to increase the probability of successful pollination of each ovule.

(16) (D). Cleistogamy is not dependable on pollinator because flowers never open.

(17) (A). Ovule is also called integumented Megasporangium.

(18) (A). Sporogenoustissue is always diploid, endothecium is second layer of antherwall and hard outer layer of poller is called exine but tapetum always nurishes the developing pollen.

(19) (C). Mango – seeded fruit
Sterile stamen – staminode
Seeds in grasses – endospermic

(20) (A). Geitonogamy is transfer of pollen grains from the anther to the stigma of another flower of the same plant.

(21) (C). Male gametophyte is highly reduced in angiosperm and is known as pollen grain. It is 2 or 3-celled.

(22) (C). Pollen grains are rich in nutrients and it has become a fashion in recent years to use pollen tablets as food supplements.

(23) **(D).** Filiform apparatus, present in synergids, play an important role in guiding the pollen tube into the synergid.

(24) **(D).** Seed of garden pea is ex-albuminous or non-endospermic.

(25) **(A).** Nectar and pollen grains are important floral rewards to the animal pollinators such as moths, butterflies, wasps, bees, birds, etc. They visit the flowers for nector, edible pollen grains and shelter and nursing (as in fig and Yucca). Besides, edible floral parts and young seeds are also usual rewards for pollinators. In turn, while visiting flowers, they come in contact and adhere pollen grains and bring about pollination, when they visit another flower.

(26) **(D).** Geitonogamy is genetically self pollination but it requires pollinatiors.

(27) **(C).** Honey is made by bees by nectar and pollens. Bees collect pollen and nectar in the spring when most flowers and plants are in bloom. They collect them in their stomach about an hour, the nector mixes with the proteins and enzymes produced by bees, which convert nectar into honey.

(28) **(D).** The hilum is a scar (mark) on the seed, produced by separation from its funicle or placenta. The point of attachment of the body of the ovule (later which forms seed) with the funicle is known as hilum.

(29) **(A).** Transmitting tissue is characteristic feature of solid style. In solid style, there is a central region of transmitting tissue, which consists of densely cytoplasmic cells with intercellular mucilage through which pollen tube grow.

(30) **(C).** Filiform apparatus is finger like projections in each synergid.

(31) **(B).** Each microspore mother cell of anther undergoes meiosis to form microspore tetrad while megspore moter cell of ovule under goes meiosis to form megaspore tetrad.

(32) **(A).** Flowers are unisexual in cucumber.
[Family - Cucurbitaceae]

(33) **(A).** Coconut water is free nuclear endosperm.

(34) **(C).** Formation of fruit without fertilisation is called parthenocarpy.
Banana is a parthenocarpic fruit therefore seedless.

(35) **(D).** Male gametophyte in angiosperm is 3-celled containing 2 male gametes (sperms) an vegetative cell.

(36) **(D).** Coconut milk represents free nuclear endosperm where the division of PEN is not followed by cytokinesis.

(37) **(A).** Pollen grains of different species are incompatible, so they fail to germinate.

(38) **(D).** Large, shield shaped cotyledon of grass family is called scutellum.

(39) **(D).** Apomixis is a special mechanism to produce seeds without fertilisation.

(40) **(C).** Megaspore Mother Cell (MMC) undergoes meiosis to form megaspore.

(41) **(B).** Water hyacinth and water lily are aquatic plants pollinated by insect or wind.

(42) **(A).** Integumented and stalked megasporangium is called ovule.

(43) **(B).** When unisexual male and female flowers are present on different plants the condition is called dioecious and it prevents both autogamy and geitonogamy.

(44) **(C).** Megaspore is the first cell of female gametophytic generation in angiosperm. It undergoes three successive generations of free nuclear mitosis to form 8-nucleated and 7-celled embryo sac.

(45) **(B).** Insect pollinated plants provide rewards as edible pollen grain and nectar as usual rewards. While some plants also provide safe place for deposition of eggs.

(46) **(C).** Wind pollination or anemophily is favoured by flowers having a single ovule in each ovary, and numerous flowers packed in an inflorescence. Wind pollination is a non-directional pollination.

(47) **(D).** Double fertilization is a characteristic feature exhibited by angiosperms. It involves syngamy and triple fusion.

(48) **(D).** Double fertilization is a unique phenomenon that occur in angiosperms only.
Syngamy + Triple fusion = Double fertilization

(49) **(A).** Pollen grains can be stored for several years in liquid nitrogen at –196°C (Cryopreservation)

(50) **(D).** Sporopollenin cannot be degraded by enzyme; strong acids and alkali, therefore it is helpful in preserving pollen as fossil.

Pollenkitt – Help in insect pollination.

Cellulosic Intine – Inner sporoderm layer of pollen grain known as intine made up cellulose & pectin.

Oil content – No role is pollen preservation.

(51) **(D).** Following are the post-fertilisation changes.

- Ovule → Seed
- Ovary → Fruit
- Zygote → Embryo
- Central cell → Endosperm

(52) **(B).** Persistent Nucellus is called Perisperm
e.g.: Black pepper, Beet

(53) **(D).** In flowering plants, out of the two male gametes discharged in synergids, one fuses with the egg and other fuses with the secondary or definitive nucleus present in central cell.

Egg (n) + 1st male gamete (n)→ Zygote (2n)
Secondary nucleus (2n) +2nd male gamete (n)
(central cellnuclei) → PEN (3n)