# Avinashilingam Institute for Home Science and Higher Education for Women

**(Deemed to be University under Category 'A' by MHRD, Estd. u/s 3 of UGC Act 1956)**
**Re-accredited with 'A+' Grade by NAAC. Recognised by UGC Under Section 12B**
**Coimbatore - 641 043, Tamil Nadu, India**

**Bachelor's Degree Examination – July 2020**
**IV Semester**

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| **Class : II UG** | | **Time** | **: 3 hours** |
| **Major : Zoology** | | **Max. Marks: 100** | |

**18BZOI06 DSE IV – Diversity of Angiosperms**

**Part A** **10x1=10**

**Choose the Correct Answer**

1. Egg apparatus consists of
   a.Egg b. Egg and pollen nuclei
   c. Egg and synergids d. Egg and antipodal cells
2. Which cell organelle is involved in apoptosis
   a. Lysosome b. Endoplasmic reticulum
   c. Golgi bodies d. Mitochondria
3. Which one of the following is not a constituent element of xylem
   a. Vessels b. Tracheid's
   c. Xylem fibres d. Companion cells
4. The vascular bundles are scattered in
   a. Dicot stem b. Monocot stem
   c. Dicot leaf d. Dicot root
5. Dark reaction refers to
   a. Calvin cycle b. Krebs cycle
   c. EMP pathway d. Z-scheme
6. An example for C4 plant is
   a. Rice b. Wheat
   c. Potato d. Sugarcane
7. Which of the following is NOT an adaptation of xerophytic plants?
   a. Presence of palisade like tissues in stem
   b. Presence of thick cuticle
   c. CAM cycle for photosynthesis
   d. Large leaf is present
8. Which of the following requires maximum energy
   a. Secondary consumer b. Decomposer
   c. Primary consumer d. Producers
9. Haploid set of chromosomes in garden pea is
   a.7 b.14
   c.12 d.23
10. Bagging is done to
    a. Avoid cross pollination
    b. Avoid self-pollination
    c. Achieve desired pollination
    d. Prevent contamination from foreign pollen

**Part B** **5 x 6 = 30**

**Answer ALL questions**

**Each answer should not exceed 400 words or two pages**

11. a. Explain the structure of mature anther.

(or)

11. b. With a neat sketch explain the structure of chloroplast.

12. a. Draw and explain the anatomy of monocot stem.

(or)

12. b. Describe the types of simple tissues.

13. a. Write note on glycolysis.

(or)

13. b. Explain the structure of stomata.

14. a. List out the ecological adaptation of hydrophytes.

(or)

14. b. Write short notes on basic concepts of ecosystem.

15. a. What is monohybrid cross? Explain.

(or)

15. b. Enumerate the importance of plant breeding.

**Part C** **5 x 12 = 60**

**Answer ALL questions**

**Each answer should not exceed 800 words or four pages**

16. a. Explain the structure and functions of Nucleus.

(or)

16. b. Mitochondria are powerhouse of the cell-Justify the statement.

17. a. Write an essay on endosperm and its type.

(or)

17. b. Give a detailed account on complex tissues.

18. a. Write in detailed about dark reaction.

(or)

18. b. Describe the process of photorespiration.

19. a. Write an essay on water pollution.

(or)

19. b. List out and explain the ecological adaptation of xerophytes.

20. a. Give a detailed account on hybridization techniques.

(or)

20. b. Explain the dihybrid cross with suitable example.

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**Scheme of Evaluation Set II**

**Paper Code and Title of the Paper: 18BZO106, Diversification of Angiosperms**

**Part A**

1. c. Egg and synergids
2. d. Mitochondria
3. d. Companion cells
4. b. Monocot stem
5. a. Calvin cycle
6. d. Sugarcane
7. d. Large leaf is present
8. d. Primary consumer
9. a.7
10. d. Prevent contamination from foreign pollen.

**Part B**

**11.a.**

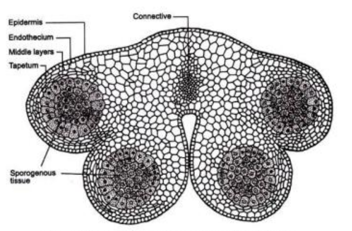



Fig. 1.1 : T.S. of the tetrasporangiate anther showing its various tissues

- Epidermis, endothecium, middle wall layers- and the tapetum constitute the anther wall.

**i. Epidermis**:

- The epidermis is a single layered protective sheath of the anther. It divides anticlinally and tries to keep space with the enlarging internal tissues of the anther. As a consequence they undergo considerable stretching in surface area. It provides the structural integrity to the anther, assists in gaseous diffusion, prevents moisture loss, and in the dehiscence of the anther lobes.

**ii. Endothecium**:

- The outer most layers of the descendants of the parietal cell located immediately below the epidermis are called the endothecium. It attains the maximum development before the dehiscence of the anther.
- The specialized nature of the endothecium together with the stomium helps in the dehiscence of the anther.

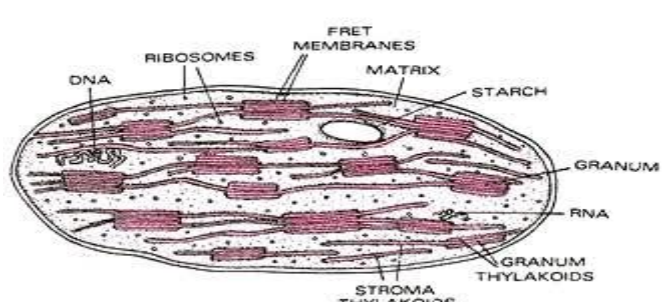
**iii. Middle Layer**:

- The cells of the middle layer are usually ephemeral and become flattened and crushed by early meiosis in the pollen mother cell However, the layers persist in Ranunculus and Lilium, and the layer adjacent to the endothecium may even develop fibrous thickenings.

**iv. Tapetum:**

- The tapetum is the innermost layer of the anther wall and is usually derived from the parietal layer.
- However, it may have a dimorphic origin in a few species, viz., in Alectrathomsoni the inner tapetum consists of larger cells that is derived from the cells of the connective, whereas, the outer tapetum of smaller cells is derived from the parietal layer.

**11.bstructure of chloroplast:**




Chloroplasts responsible for the photosynthesis of the plants, are the characteristic features of the cells of green plants. Around the chloroplast is present a double membrane envelope.Each membrane of chloroplasst is 35 to 50

Å thick.Many dark-coloured grana are present. These are interconnected by means of photosynthetic lamellae or thylakoids.A colourless matrix or stroma is present in the chloroplast.There are present some interconnecting interregnal projections called frets.Park and Biggins (1964) have observed some sphere like structures within the membrane component of the granular disc. These are called quantasomes.Quantasomes are structural and functional units of chloroplast. About 250 chlorophyll molecules are present in a quantasome.

**12.aAnatomy of monocot stem:**

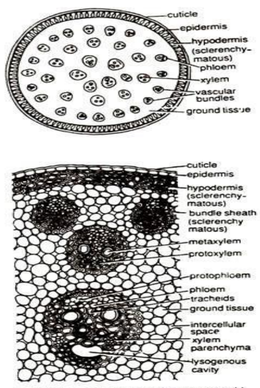



Fig. 108. *Zea mays*: Upper – T. S. stem (diagrammatic); Lower– T. S. stem (A part cellular).

**Epidermis**

1. It is the outermost layer of stem. 2. The outer wall of cells is covered by a thick cuticle. 3. The continuity of the layer is broken by few stomata. 4. Epidermal hairs are absent

**Hypodermis:**

5. It is two to three cells thick, sclerenchymatous and present just below the epidermis. 6. Cells are polygonal in shape.

**Ground tissue**:

7. It is not differentiated into cortex, endodermis, pericycle and pith. 8. The cells are parenchymatous and extend from below the sclerenchyma to the centre.9. The cells are small and compactly arranged below the hypodermis but they are large, round and loosely arranged in the centre.

**Vascular Bundles**:

10. Vascular bundles are many and scattered in the ground tissue with no definite arrangement.11. They are small and more in number towards the periphery than the centre of the section.12. Each vascular bundle is conjoint, collateral, closed and endarch.13. A well-developedsclerenchymatous sheath surrounds each vascular bundle which is more prominent at its upper and lower faces.14. Xylem and phloem constitute the vascular bundle.

**15. Phloem:**

(i) Consists of only sieve tubes and companion cells. (ii) Phloem fibres and phloem parenchyma arc absent.(iii) The outer parts of the phloem, which is broken and disorganized, is called protophloem.

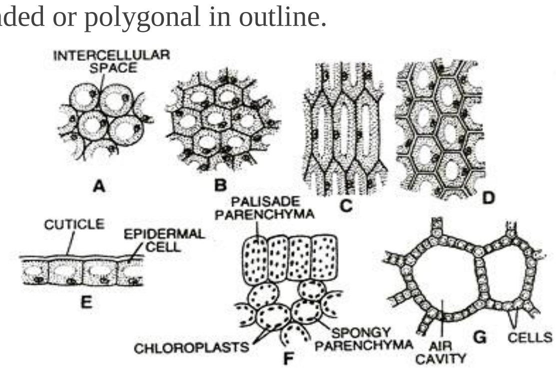
(iv) Inner phloem contains sieve tubes and companion cells, and called metaphloem

**16. Xylem**:

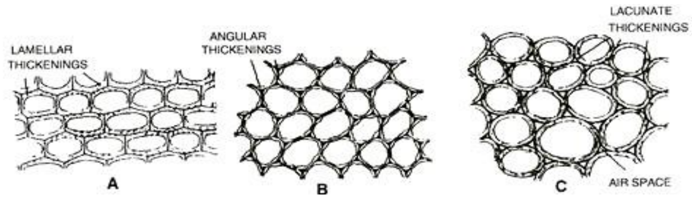
(i) Consists of vessels (protoxylem and metaxylem), tracheids and xylem parenchyma. (ii) Vessels are in the from of ‘Y’.(iii) Metaxylem is present at the divergent ends of ‘Y’ in the form of two big oval vessels.(iv) Protoxylem is present at the lower arm of ‘Y’, consisting of two small vessels.(v) Protoxylem is surrounded by tracheids and xylem parenchyma.

**12.b. Types of simple tissues**

- A simple permanent tissue is that tissue which is made up of similar permanent cells that carry out the same function or similar set of functions. Simple permanent tissues are of three types— parenchyma, collenchyma and sclerenchyma.
- Parenchyma is a simple permanent living tissue- which is made up of thin-walled similar isodiametric cells.It is the most abundant and common tissue - Typically the cells are isodiametric (all sides equal). They may be oval, rounded or polygonal in outline.

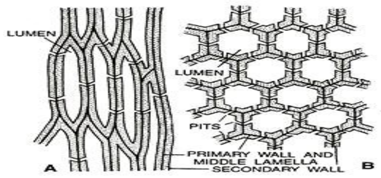



- Collenchyma is a simple permanent tissue of retractile non-lignified living cells which possess pectocellulose thickenings in specific areas of their walls. The cells appear conspicuous under the microscope due to their higher refractive index.The cells are often elongated- They are circular, oval or angular in transverse section- Internally each cell possesses a large central vacuole and a peripheral cytoplasm- Chloroplasts are often present- Wall possesses uneven longitudinal thickenings in specific areas.

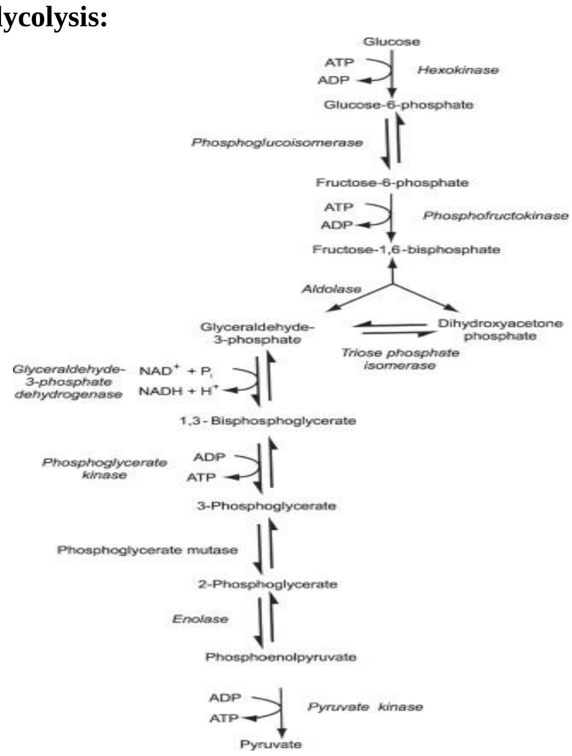



**(a) Sclerenchyma Fibres:**

- The sclerenchyma fibres are highly elongated (1-90 cm), narrow and spindle-shaped thick-walled cells with pointed or oblique end walls- The fibres generally occur in longitudinal bundles - where the pointed ends of adjacent fibres get interlocked to form a strengthening- tissue.




**13.a.Glycolysis:**




Glycolysis

- *Glycolysis* ('splitting of sugar') is the most common dissimilatory pathway; it occurs widely and is found in animal and plant cells as well as in microorganisms. The majority of microbes utilise the glycolytic pathway for the catabolism of carbohydrates such as glucose and fructose. This series of reactions occurs in the cytosol of microbes and can operate either aerobically or anaerobically. Fig. 1.5 shows the steps in the glycolytic pathway.
  Important features of glycolysis are discussed as follows:
- An enzyme called hexokinase uses the energy of ATP to add a phosphate group to glucose to form glucose-6-phosphate. Similarly, an enzyme, called phosphofructokinase, uses ATP to add a phosphate group to fructose-6-phosphate to form fructose-1,6-diphosphate. This 6-carbon compound is then split by an enzyme, called aldolase, into two 3-carbon moieties, dihydroxyacetone phosphate and glyceraldehyde-3-phosphate. These two compounds are interconvertible by the action of triose isomerase.
- The oxidation of glyceraldehyde-3-phosphate results in the removal of a pair of electrons by $NAD^+$ and the addition of a phosphate group to form 1,3-diphosphoglyceric acid. This high-energy compound can be used for ATP synthesis by substratelevel phosphorylation. Similarly, the removal of $H_2O$ from 2-phosphoglycerate results in the high-energy compound phosphoenolpyruvate, which also can be used to synthesise ATP by substrate-level phosphorylation.
- For each molecule of glucose metabolized, two molecules of ATP are used up and four molecules of ATP are formed. Therefore, for each molecule of glucose metabolized by glycolysis, there is a net yield of two ATP molecules.
- The overall equation for the glycolytic pathway is:
  Glucose + 2ADP + 2NAD+ + 2Pi→ 2pyruvate + 2NADH + $2H^+$ + 2ATP
- In the absence of oxygen, the electrons removed from glyceraldehyde-3-phosphate can be used to reduce pyruvic acid to lactic acid or ethanol or other products. In organisms having electron transport systems, the electrons can be used to generate a proton motive force. That is, NADH + $H^+$ can be used to produce energy via oxidative phosphorylation.

**13.b Structure of stomata**

- The stomata are minute pores which occur in the epidermis of the plants. Each stoma remains surrounded by two kidneys or bean shaped epidermal cells the guard cells. The stomata may occur on any part of a plant except the roots. The epidermal cells bordering the guard cells are called accessory cells or subsidiary cells.

- Generally the term stoma is applied to the stomatal opening and the guard cells. The guard cells are living and contain chloroplasts in them. They also contain a larger proportion of protoplasm than other epidermal cells. Usually in the leaves of dicotyledons the stomata remain scattered whereas in the leaves of monocotyldons they are arranged in parallel rows.

- The number of stomata may also range on the surface of a single leaf from a few thousand to hundreds of thousands per square centimetre. Stomata occur on both upper and lower surfaces of leaf, but especially they are confined to the lower surface. In floating leaves Stomata are confined only on the upper surface of the leaf.Under normal conditions the stomata remain closed in the absence of light or in night or remain open in the presence of light or in day time. Structurally the stomata may be of different types.

**14.a Ecological adaptations of hydrophytes**:

**A. Roots:**

1. Due to availability of plenty of water root system is secondary importance and least significant.2. Roots absent in Wolfia, Ceratophylum.3. Poorly developed roots are seen in Hydrilla.4. Submerged leaves compensate for roots in Salvania.5. Root caps are absent in Hydrophytes.6. Amphibious plants growing in mud will have distinct root caps.7. Root caps are replaced by root pockets in Pistia.8. If present roots are generally fibrous adventitious reduced in lenth unbranched or poorly branched.9. Balancing roots are present in Pistia, Eichornia.

**B. Stems:**

1. Stem is long slender and flexible in submerged plants Eg: Hydrilla, Potamogeton.2. Stem is slender or thick, short and spongy in free floating forms Eg; Eichornia.3. Stem is a rhizome in rooted plants with free floating leaves Eg: Nymphaea and Nelumbo.

**C. Leaves**:

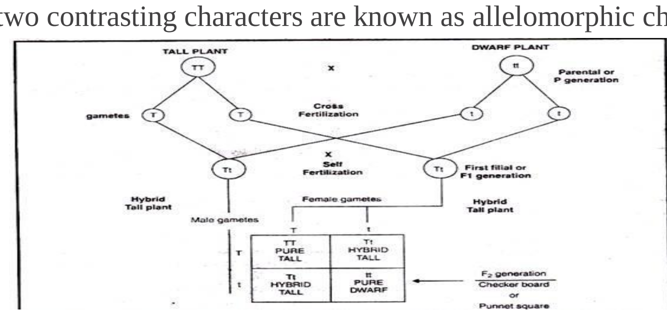
1. In submerged forms leaves are thin long and ribbon like (Eg: Vallisnaria) long and linear.(Potamogeton) finely dissected (eg; Ceratophylum).2. Floating leaves are large and flat with wax coating Eg: Nyphaea, Nelumbo and Victoria regia.3. Largest simple leaves in plant kingdom are present in Victoria regia.4. Petioles are long flexible and covered with mucilage.

**14.b.Basic concepts of ecosystem:**

- The concept of ecosystem was first put forth by A.G. Tansley (1935). Ecosystem is the major ecological unit- It has both structure and functions- The structure is related to species diversity. The more complex is the structure the greater is the diversity of the species in the ecosystem. The functions of ecosystem are related to the flow of energy - cycling of materials through structural components of the ecosystem. Woodbury (1954), ecosystem is a complex in which habitat, plants - animals are considered as one interesting unit, the materials and energy of one passing in and out of the others. E.P. Odum, the ecosystem is the basic functional unit of organisms and their environment interacting with each other and with their own components. An ecosystem may be conceived - studied in the habitats of various sizes, e.g., one square metre of grassland, a pool, a large lake, a large tract of forest, balanced aquarium, a certain area of river and ocean.All the ecosystems of the earth are connected to one another, e.g., river ecosystem is connected with the ecosystem of ocean, and a small ecosystem of dead logs is a part of large ecosystem of a forest. A complete self-sufficient ecosystem is rarely found in nature but situations approaching self-sufficiency may occur.

**15.a.Monohybrid cross explain**

- In a monohybrid cross the two parents differ through a single character. Mendel took a tall pea plant and crossed with a dwarf plant. He transferred the pollen grains of tall pea plants and placed them on the stigma of the dwarf pea plant and vice versa. To prevent self-pollination he earlier removed all stamens from the flowers of the dwarf plant. Mendel noticed that all the progenies of F) or first filial generation were tall plants. This gave him the clue to state the Law of dominance.According to this law, out of a pair of contrasting characters (tallness and dwarfness) one character (tallness) appeared in the F, generation and the other character (dwarfness) remained hidden or suppressed. The character which appeared in $F_t$ generation is called dominant and the other character remained hidden is called recessive character. These two contrasting characters are known as allelomorphic characters or allelomorphs or alleles.




- Mendel now allowed the plants to self pollinate and produce $F_2$ or second filial generation of plants. Among $F_2$ plants he observed tall as well as dwarf plants in the ratio 3:1. This ratio is monohybrid ratio. The recessive character (dwarfness) which was hidden in the $F_1$ generation appeared in $F_2$ generation.Among the $F_2$ tall plants 1/3rd were pure tall and the remaining 2/3rd were hybrid tall behaving like the plants of $F_2$ generation. The recessive dwarf plant bred true. Thus, the $F_2$ ratio are classified into two categories: Phenotypic ratio (3 tall: 1 dwarf) and Genotypie ratio (1 pure tall: 2 hybrid tall: 1 pure dwarf).In the parental generation both tall (TT) and dwarf (tt) plants have similar alleles of gene and hence called homozygous plants.The $F_1$ plants have different alleles of the same gene (Tt) and hence known as heterozygous plants. Mendel represented the dominant factor through the capital letter and recessive factor by means of small letter. Thus, pure tall plant will be TT and dwarf plant will be represented by tt.

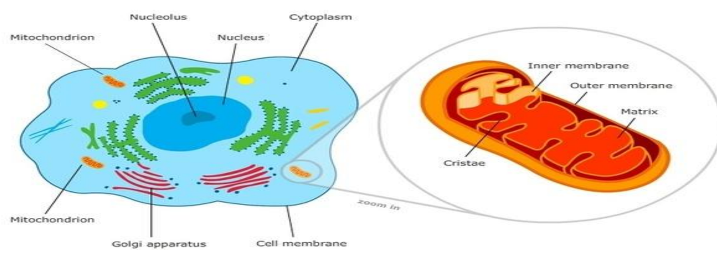
**15.bImportance of plant breeding**

- It enhances the production of food by reducing dosses due to diseases.Reduces the dependance on fungicides and bacteriocides.Fungi Diseases caused by fungi are brown rust of wheat, red rot of sugar cane, late blight of potato, etc.Bacteria Diseases caused by bacteria are black rot of crucifers, blight of rice, citrus canker, etc.Virus Diseases caused by virus are tobacco mosaic, turnip mosaic, etc.

**Part C**

**16.aMitochondria:**

- Mitochondria are tiny organelles inside cells that are involved in releasing energy from food.This process is known as cellular respiration. It is for this reason that mitochondria are often referred to as the powerhouses of the cell. Cells that need a lot of energy, like muscle cells, can contain thousands of mitochondria.




Cell featuring mitochondria

Mitochondria are tiny organelles inside cells that are involved in releasing energy from food. This process is known as cellular respiration.

Apart from cellular respiration, mitochondria also play a key role in the ageing process as well as in the onset of degenerative disease.

**The powerhouse function**

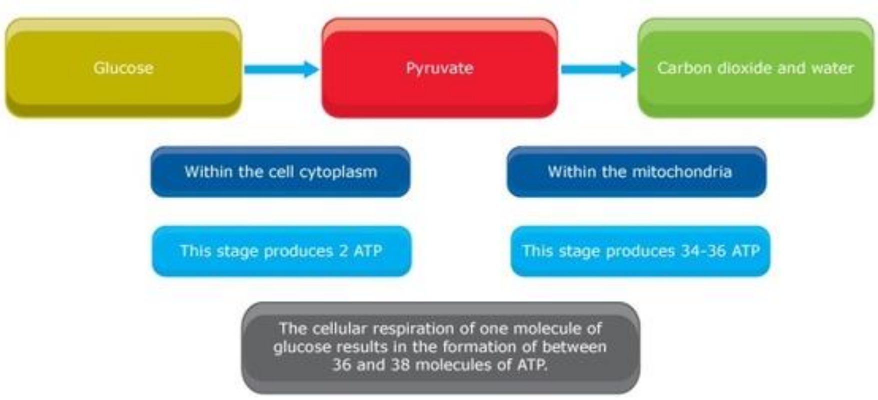
When the breakdown products from the digestion of food find their way into the cell, a series of chemical reactions occur in the cytoplasm.

This allows some of the energy locked up in these products to be released and incorporated into the universal energy supplier in cells known as ATP (adenosine triphosphate).

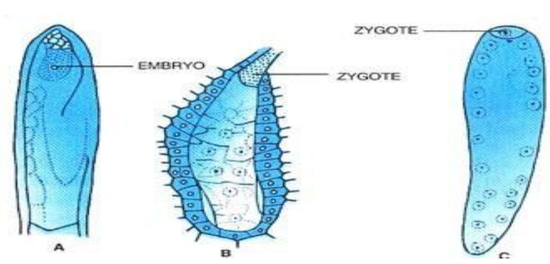
Remaining molecular fragments from this process then enter the mitochondria, and in a complex series of steps, they are finally converted into carbon dioxide and water.

The energy locked up in these fragments is incorporated into more ATP.

The ATP molecules produced in this way can then be used by the cell to supply the energy needed to function. ATP → ADP + P + energy to function.




**16.b. Endosperms and its types:**




***(i) Nuclear type:***

- In nuclear type of endosperm the first division of primary endosperm nucleus and few subsequent nuclear divisions are not accompanied by wall formation. The nuclei produced are free in the cytoplasm of the embryo sac and they may remain free indefinitely or wall formation takes place later. In the coconut, cell wall formation of endosperm is never found complete. In Areca and Phoenix the endosperm becomes very hard .

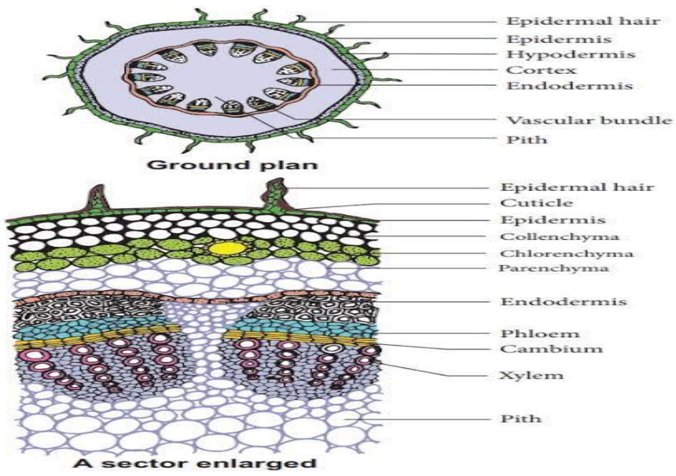
***(ii) Cellular type:***

- In this case, there is cytokinesis after each nuclear division of endosperm nucleus. The endosperm, thus, has a cellular form, from the very beginning because first and subsequent divisions are all accompanied by wall formation e.g. Petunia, Datura, Adoxa, etc.

***(iii) Helobial type:***

- It is an intermediate type between the nuclear and cellular types. The first division is accompanied by cytokinesis but the subsequent ones are free nuclear. The chamber towards micropylar end of embryo sac is usually much larger than the chamber towards chalazal end.

**17.a.Anatomy of dicot stem:**




The microscopic structure of T.S. of stem shows following distinct regions:

- Epidermis, Cortex (hypodermis, general cortex, endodermis), Pericycle, Medullary rays,Vascular bundles
- Pith

Microscopic structure of transverse section of sunflower flower

1**. Epidermis** is the outermost layer of (dicot) stem with multicellular epidermal stem hairs. The cells are living, barrel shaped and compactly arranged without intercellular spaces and chloroplasts. They may contain stomata for gaseous exchange. The epidermis is externally covered by thick cuticle. The epidermal multicellular stem hairs help in protection and heat loss.

2**. Cortex** is present below the epidermis in several layers. It can be differentiated into:

Hypodermis consists of 3-5 layers of collenchyma without spaces. It contains thickenings by the deposition of extra cellulose with pectin and gives mechanical support. Due to the presence of chloroplast, it also helps in photosynthesis.

General cortex encloses intercellular spaces with resin ducts, each surrounded by a layer of small thin walled spherical or oval cells. It is made from loosely arranged parenchymatous. The cortical cells may contains chloroplast and perform photosynthesis. Some oil ducts line with epithelial cells. It also helps in gaseous exchange and storage of food materials.

Endodermis is unilayered innermost cortex made from more or less barrel shaped compactly arranged parenchymatous tissues. It store starch and often called starch sheath. Casparian stripes are clearly visible in the endodermis region. It is the deposition of lignin and suberin. Several dicot stem may not bear distinct endodermis.

3. **Pericycle**, several cells in thickness, with sclerenchyma and intervening masses of parenchyma is heterogenous. They have thick wall sclerenchymatous tissue found on patches above the pholem or bast, hence also termed as hard bast or bundle cap. The hard bast helps in mechanical support and parenchyma helps in storage of food materials.

4. **Medullary rays** are parenchymatous, radially elongated or polygonal cells lie in between vascular bundles. It helps for the radial conduction of water and food materials. It is extension of pith, hence also called pith rays.

5. **Vascular bundles** are conjoint, collateral, open and arranged in a ring . Each bundle is composed of outer phloem and inner xylem on the same radius with a strip of cambium in between them.

Phloem lies outside of the vascular bundle and composed of sieve tubes, companion cells and phloem parenchyma and few bastfibers. Companion cells are associated with sieve tubes.

**17.b.Complex tissues:**

- The complex tissues are heterogeneous in nature, being com-posed of different types of cell elements. The latter remain contiguous and form a struc-tural part of the plant, adapted to carry on a specialised function.Xylem and phloem are the complex tissues which constitute the component parts of the vascular bundle. They are also called vascular tissues.

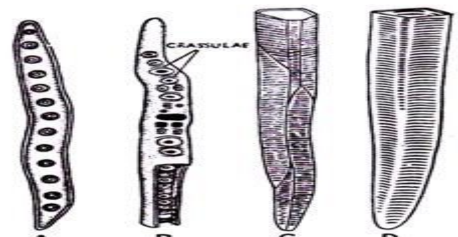
**Xylem**:

- Xylem is a complex tissue forming a part of the vascular bundle. It is primarily ins-trumental for conduction of water and solutes, and also for mechanical support. Primary xylem originates from the procambium of apical meristem, and secondary xylem from the vascular cambium. As a complex tissue it consists of different types of cells and elements, living and non-living.The tissues composing xylem are tracheids, tracheae or vessels, fibres, called xylem fibres or wood fibres, and parenchyma, referred to as xylem or wood parenchyma.

**Tracheids:**

- A tracheid is a very much elongate cell  occurring along the long axis of the organ. The cells are devoid of protoplast, and hence dead. A tracheid has a fairly large cavity or lumen without any contents and tapering blunt or chisel-like ends.The end walls usually do not uniformly taper in all planes. Tracheids are round or polyhedral in cross-section. They are really the most primitive and fundamental cell- types in xylem from phylogenetic point of view. The wood of ancient vascular plants was exclusively made of tracheids. This is the only type of element found in the fossils of seed-plants.The wall is hard, moderately thick and usually lignified. Secondary walls are depo-sited in different manners, so that the tra-cheids may be annular, spiral, reticulate, scalariform or pitted.

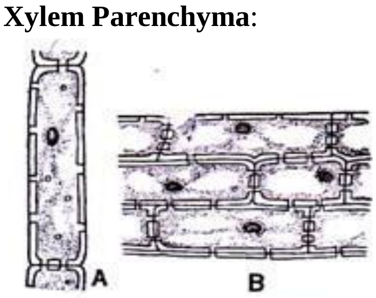
Tracheids




**Xylem Fibres:**

- Some fibres remain associated with other elements in the complex tissue, xylem, and they mainly give mechanical support. As previously stated, fibres are very much elongated, usually dead cells with lignified walls.Xylem fibres or wood fibres are mainly of two types: fibre-traeheids  andlibiriform fibres  which usually intergrade, so much so that it is difficult to draw a line of de-marcation between them.Fibre-tracheids, as already reported, are intermediate forms between typical fibres and tracheids; they possess bordered pits, though the borders are not well-developed. Libiriform fibres ate narrow ones with highly thickened secondary wall.

**Xylem Parenchyma**:




- Living parenchyma is a constituent of xylem of most plants. In primary xylem they remain associated with other elements and derive their origin from the same meristem. In secondary xylem parenchyma occurs in two forms: xylem parenchyma  is somewhat elongate cells and lie in vertical series attached end on end; ray parenchyma cells occur in radial transverse series in many woody plants.Parenchyma is abundant in the secondary xylem of most of the plants, excepting a few conifers like Pinus, Taxus and Araucaria. These are the only living cells in xylem.

**Phloem:**

- The other specialised complex tissue forming a part of the vascular bundle is phloem It is composed of sieve elements, companion cells, parenchyma and some fibres. Sclerotic cells may also be present.Phloem is chiefly instrumental for transloca-tion of organic solutes—the elaborated food materials in solution. The elements of phloem originate from the procambium of apical meristem or the vascular cambium.

**Sieve Elements**:

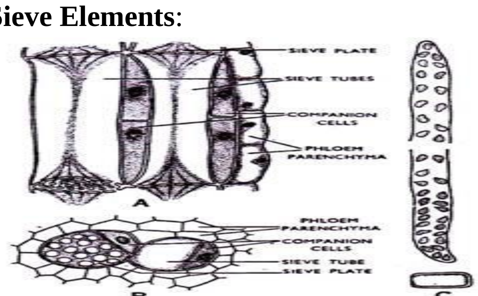



FIG. 542. Sieve elements. A. Sieve tubes in l.s. B. Same in t.s. C. Sieve cell in l.s. and t.s.

- The most important constituents of phloem are the sieve elements, the sieve tubes and sieve cells. From onto-genetic point of view a sieve tube resembles a vessel and a sieve cell a tracheid.Sieve tubes  are long tube-like bodies formed from a row of cells arranged in longitudinal series where the end-walls are perforated in a sieve-like manner. The perfo-rated end-walls are called the sieve plates, through which cytoplasmic connections are established between adjacent cells.

**Sieve tube**

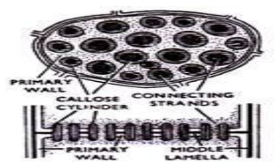



FIG. 543. Sieve tube. Structure of sieve area of an angiosperm in surface (upper) and sectional (lower) views (diagrammatic).

- A sieve plate - showing stages of development and maturation

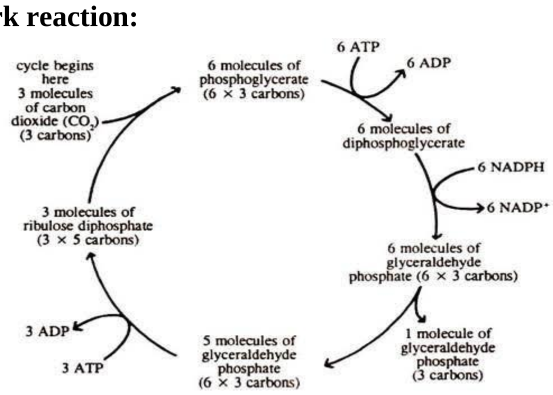
  Ontogeny of the Sieve Elements:
- In spite of close ontogenetic resemblance between tracheary elements of xylem and sieve elements of phloem, the latter unlike the former, are living. They originate from the mother cells (Fig 545) which are usually short cylindrical or elongate ones.The mother cell divides longitudinally into two daughter cells, one of which serves as the sieve element and the other one becomes the companion cell, of course in those cases where companion, cells occur. The sieve element undergoes gradual differentiation. It grows in length, cytoplasm gets more and more vacuolated, so that it may have a lining layer of cytoplasm round a large central vacuole.It has been stated that protoplasmic strands pass through the pores of the sieve areas and that the strands remain surrounded by callose. With the differentiation of the tube the amount of callose increases and finally forms something like a pad on the sieve plate.

  **Companion Cells:**
- Companion cells remain associated with the sieve tubes of angiosperms, both ontogenetically and physiologically.
- These are smaller elongate cells, having dense cytoplasm and prominent nuclei. Starch grains are never present.
- The companion cells are so firmly attached to the sieve tubes that they cannot be normally separated by maceration.
- In transverse section it appears as a small triangular, rectangular or polyhedral cell with dense protoplast .

  **Parenchyma**:
- Besides companion cells and albuminous cells, a good number of parenchyma cells remain associated with sieve elements. These are living cells with cellu-lose walls having primary pit fields. They are mainly concerned with storage of organic food matters. Tannins, crystals and other materials may also be present.

  **Fibres:**
- Sclerenchymatous fibres constitute a part of phloem in a large number of seed plants, though they are rare in pteridophytes and some spermatophytes.They occur both in primary and secondary phloem. These are typical elongated cells having inter-locked ends, lignified walls with simple pits. The fibres of primary phloem are essentially similar to those occurring in cortex and secondary phloem.

**18.a.dark reaction:**




In the second stage of photosynthesis, the energy generated by the light reactions is I used to reduce carbon. Carbon is available to photosynthetic cells in the form of carbon dioxide. In algae, such as those seen in Figure 5.11, the carbon dioxide is dissolved in the surrounding water. In plants, carbon dioxide reaches the photosynthetic cells through specialised openings in leaves and green stems, called stomata.The reduction of carbon takes place in the stroma in a cycle called the Calvin cycle (named after its discoverer, Melvin Calvin). The Calvin cycle is analogous to the Krebs cycle in that, in each turn of the cycle, the starting compound is again regenerated. The starting (and ending) compound is a five-carbon sugar with two phosphates attached, ribulosediphosphate (RuDP).The cycle begins when carbon dioxide enters the cycle and is bound to RuDP, which then splits to form two molecules of phosphoglycerate, or PGA. (Each PGA molecule contains three carbon atoms, hence the name, the three-carbon pathway.). The enzyme catalyzing these crucial reactions (RuDP carboxylase) is very abundant in chloroplasts, making up more than 15 percent of the total chloroplast protein. (It is said to be the most abundant protein in the world.) This enzyme is located on the surface of the thylakoid membranes.The complete cycle is diagrammed in Figure 5.12. As in the Krebs cycle, each step is regulated by a specific enzyme. At each full turn of the cycle, a molecule of carbon dioxide enters the cycle, is reduced, and a molecule of RuDP is regenerated.Six revolutions of the cycle, with the introduction of six atoms of carbon, are necessary to produce a six-carbon sugar, such as glucose.

**The overall equation is:**

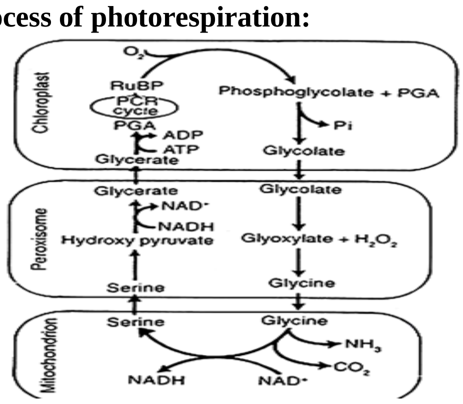
$6RuDP + 6CO_2 + 18ATP + 12NADPH + 12H^+ + 12H_2O \rightarrow 6RuDP + glucose + 18P_i + 18ADP + 12NADP^+$

The immediate product of the cycle itself is glyceraldehyde phosphate. This same sugar-phosphate is formed when the fructose diphosphate molecule is split at the fourth step in glycolysis

The Calvin cycle is not the only carbon fixation pathway used in the dark reactions. In some plants, the first product of $CO_2$ fixation to be detected is not the three carbon molecule phosphoglycerate, as it is in the Calvin cycle.

It is the four-carbon compound oxaloacetic acid. (Oxaloacetic acid is also an intermediate in the Krebs cycle.) Plants that utilise this pathway, also known as the Hatch-Slack pathway, are commonly called C4, or four-carbon plants, as distinct from the C3 plants that use only the Calvin cycle. The oxaloacetic acid is formed when carbon dioxide is bound to a compound known as phosphoenolpyruvate (PEP). This reaction is catalysed by the enzyme PEP carboxylase. The oxaloacetic acid is then reduced to malic acid or converted (with the addition of an amino group) to aspartic acid. These steps take place in mesophyll cells. The next step is a surprise: The malic acid (or aspartic acid, depending on the species) is transported to bundle-sheath cells where it is decarboxylated to yield CO2 and pyruvic acid. The CO2 then enters the Calvin cycle. One might well ask why C4 plants should have evolved such a seemingly clumsy and energetically expensive method of providing carbon dioxide to the Calvin cycle. This question can be answered only by considering the function of the leaf as a whole. Carbon dioxide is not continuously available to the photosynthesizing cells. It enters the leaf by way of the stomata, specialised pores that open and closes depending on, among other things, water stress. PEP carboxylase has a higher CO2 affinity than does RuDP carboxylase, so it keeps the CO2 concentration lower within the leaf (that is, it fixes carbon dioxide faster, at low levels). This maximises the gradient of carbon dioxide between the cells and the outside air. A higher gradient means the leaf will trap a larger fraction of the passing stream of carbon dioxide. If the stomata must be closed much of the time, as in a hot, dry climate, the plant with C4 metabolism will take up more carbon dioxide with each gasp (so to speak) than the plant that has only C3 metabolism. Hence, it is at a distinct advantage in drought-ridden areas.The list of plants known to utilise the four-carbon pathway has grown to over 100 genera, at least a dozen of which have both C3 and C4 species. This pathway undoubtedly has arisen many times independently in the course of evolution. Sugarcane, corn, and sorghum are among the best-known C4 plants.

**18.b.process of photorespiration:**




It is interesting to know that in the plants possessing Calvin cycle, the enzyme RuBP carboxylase can initiate the reversal of photosynthetic reactions. This process occurs when there is low $CO_2$, concentration but high $O_2$, concentration. At mid-day, when temperature and $CO_2$ content are high, the affinity of RuBP carboxylase increases for $O_2$ but decreases for $CO_2$. Thus, it converts RuBP to 3-carbon compound (PGA) and a 2-carbon compound (phosphoglycolate). The phosphoglycolate is converted rapidly to glycolate in the peroxisomes. Glycolate is further converted to glycine, serine, $CO_2$ and $NH_3$ without the generation of ATP or NADPH. Thus net result is oxidation of organic food synthesized during photosynthesis. This process is called photorespiration or glycolate pathway as it occurs at high rate in the presence of light. As already mentioned that photorespiration is a loss to the net productivity of green plants having Calvin cycle.

The green plants having Calvin cycle are $C_3$ plants. Overcoming photo-respiratory loss poses a challenge to plants growing in the tropics. Photorespiration occurs due to fact that the active site of enzyme Rubisco (ribulosebisphosphate carboxylase oxygenase) is same for both carboxylation and oxygenation.

(i) Chloroplast
(ii) Peroxisome, and
(iii) Mitochondria.

Under conditions of high light and limited CO2 supply, photorespiration plays an important role for protection of plants from photo-oxidative damage. This shows that if enough CO2 is not available to utilise light energy for carboxylation, and excess energy inflicts damage to plants.

However, photorespiration being oxygenation of RuBP, utilises part of light energy and saves the plant from photo-oxidative damage. The relative levels of O2 and CO2 are responsible for determination of the occurrence of photorespiration as both of these gases (O2 and CO2) compete for the same active site of enzyme Rubisco.

Increased O2 level increases photorespiration; while increased CO2 level decreases photorespiration, and increases C3 photosynthesis

**19.a.Water pollution:**

**Ground Water Pollution:**

More and more people throughout the world, including India, are now dependent on ground water for drinking, agricultural and industrial use.In the recent past, ground water was considered generally pure and safe for drinking.

However, recent studies have revealed that ground water sources are also facing major threats of pollution.

Ground water is being polluted by percolation of contaminated surface water through the layers of the earth. Release of raw sewage in unlined soak-pits and release of toxic effluents by the industries into surface water bodies, are the main causes of ground water pollution Indiscriminate and overuse of fertilizers, chemicals and pesticides have also caused ground water pollution through the seepage of irrigation water into ground water reserves.

The hazards of ground water pollution depend on several factors such as:

i. Concentration or toxicity of the pollutant

ii. The level of ground water if the level is higher chances of contamination are more

iii. Conditions of ground water recharge

Water is essential for all forms of life and none can survive on this earth without water. The surface of earth measures 50,000 billion hectare of which about 70% is covered by water and the rest is land. The total volume of water on the earth is 1011 million cubic kilometers of which about 97% i.e., 986 million cubic kilometers is contained in oceans and an additional 3 million cubic kilometers of salty water is buried underground and the remaining 2.5% (22 million cubic kms) account for the total fresh water, frozen water of glaciers and polar ice caps.Of the 113 river basins in India, 14 are major, 44 are medium and 55 are minor (major basins are larger than 20,000 square km., minor basins are smaller than 2000 sq km). Three major rivers, namely the Ganga, the Brahmaputra, and the Indus, are snow fed rivers originating from the Himalayas and the other major rivers originate either in the central plains or in peninsular India.

Chemically, water contains two parts hydrogen and one part oxygen. Water for human consumption should be clean, colourless, odorless, well aerated, cool, soft, palatable, free from dissolved toxic substances and suspended particles. But water is rarely found in pure state. Man has polluted the bodies of water to an alarming state. In recent years the pollution of water has become one of the most significant environmental problems in the world.There is a great concern for rapidly deteriorating quality of water. The causes of water pollution are many but urbanisation, industrialization and increasing pollution are more prominent among them. Water is said to be polluted when its quality or composition is changed either naturally or as a result of human activities and it becomes unsuitable for drinking and less suitable for domestic, agricultural, industrial, recreational and other uses.The dissolved or suspended substances which deteriorate the quality of water and make it unfit for human consumption are called water pollutants. In other words, water pollutants are those physical, chemical or biological factors which are harmful to aquatic life and to those who consume water. Water pollutants include several chemicals in dissolved or suspended state, some physical factors such as heat, radiations, and some bio-pollutants such as aquatic microorganisms, particularly pathogens (Table 13.2).

The main sources of marine pollution are:

1. Municipal wastes and sewage 2. Industrial effluents 3. Runoff agricultural wastes 4. Oil spills from tankers
5. Offshore drilling and mining 6. Submarine nuclear testing 7. Dumping of radioactive wastes The consequences of marine pollution are as follows:

i. The pollutants adversely affect the productive ocean regions, thus causing huge losses of fish populations and coral reefs. This results in economic losses amounting to billions of dollars per year.

ii. Eutrophication, due to the influx of organic pollutants, results in the formation of red tides. These are blooms (massive growth) of red algae, which inhibit the movement of ships and also kill marine fauna.

iii. Dumping of huge amounts of toxic wastes in a short duration of time, creates areas of oxygen-depleted zones in the coastal waters. In these zones, most of the aquatic lives die or migrate elsewhere.

iv. Discarded garbage, sewage, plastic refuse, etc. that are dumped in the oceans sometimes accumulate in the beaches. This spoils the aesthetic beauty of the region and results in loss of tourism.

Water Pollutants and their Effects:

Contamination of water with industrial wastes is most dangerous. The sewage of big cities is often drained into rivers. This sewage promotes the growth of phytoplankton's. The excessive growth depletes the oxygen of water. This reduction of oxygen and the presence of poisonous wastes affect the fish population. Besides these, rivers, lakes and ponds are also used directly by people for bathing or washing. This contaminates the water with the germs of various diseases- like cholera, dysentery and hepatitis.The effluents produce physical, chemical and biological changes in water. Some pollutants produce only temporary effects in water whereas others have long standing effects. There are several types of physical and chemical effects produced by pollutants.

**19.b.Ecological adaptations of xerophytes:**

1. Plants growing in habitats where water supply is absent or physiologically dry are called Xerophytes.
2. Xerophytes classified based on their (a) Morphology (b) Physiology (c) Life cycle pattern
3. Plants growing in dry or arid zones are called Ephimerals or Drough evaders or drought escapers. Eg; Tribulus

4. Ephemerals are Annuals and complete their life cycles in 6-8 weeks.
5. Xerophytic plants absorbing more water during rainy season and storeing them in different body parts are called Succulents or drought avoiding plants.
6. Succulents store water in the form of mucilage.
7. Leaf succulents: Bryophylum, Aloe, Agave.
8. Root succulents: Asparagus
9. Perennial plants which can withstand prolonged period of drought are called Non-succulents or true xerophytes Eg: Casurina, Nerium, Ziziphus, Calotropis etc.
10. Ecological adaptations of Xerophytes.
11. The all three major groups of xerophytes have some common adaptations to survive in very dry conditions.
a. Roots:
1. Root system is very well developed with extensive branching and often longer than shoot system.
2. Root hairs and root caps are very well developed.
b. Stems:
1. Mostly they are stunted, woody hard and covered with thick bark.
2. In some xerophytes stem becomes underground.
3. In some plants stem becomes fleshy, green, leaf-like phylloclades covered with spines, Eg: Opuntia.
4. Stems are usually covered by hairs and or waxy coatings.
c. Leaves:
1. Leaves are very much reduced small scale like and sometimes modified in to spines to reduce the rate of transpiration. Lamina may be long narrow needle-like or divided in to many leaflets as Eg: Acacia.
2. Foliage leaves become thick fleshy and succulent or tough and leathery in texture. Eg: Aloe.
3. Leaf surfaces are shiny glazed to reflect light and heat. Eg.Calotropis.

**20.a.Hybridization techniques:**
It involves the following steps
(i) Selection of parents.
(ii) Selfing of parents or artificial self-pollination.(iii) Emasculation.(iv) Baggingv) Tagging(vi) Crossing
(vii) Harvesting and storing the F, seeds(viii) Raising the F1 generation.
**(i) Selection of parents:**

- The selection of parents depends upon the aims and objectives of breeding. Parental plants must be selected from the local areas and are supposed to be the best suited to the existing conditions.

**(ii) Selfing of parents or artificial self-pollination:**
It is essential for inducing homozygosity for eliminating the undesirable characters and obtaining inbreeds.
**(iii) Emasculation**:
It is the third step in hybridization. Inbreeds are grown under normal conditions and are emasculated. Emasculation is the removal of stamens from female parent before they burst and shed their pollens. It can be defined as the removal of stamens or anthers or the killing of the pollen grains of a flower without affecting in any way the female reproductive organs. Emasculation is not required in unisexual plants but it is essential in bisexual or self-pollinated plants.
Various methods used for emasculation are:
(a) Hand Emasculation or Forceps or Scissor Method: This method is generally used in those plants which have large flowers. In this method the corolla of the selected flowers is opened and the anthers carefully removed with the help of fine-tip forceps.
Emasculation in Wheat
(b) Hot Water Treatment: Removal of stamens with the help of forceps is very difficult in minute flowers. In such small hermaphrodite flowers (e.g., Bajra, Jowar) emasculation is done by dipping the flowers in hot water for a certain duration (1-10 minutes) of time.
The time varies from species to species. This method Is based on the fact that gynoecia can withstand the hot temperature at which the anthers are killed. In this method an equipment is used which is placed on a simple heavy stand.It consists of a cylindrical metallic container of 60 cm length, with one hole of 5 cm to 16 cm diameter on one end to pass over a bajra or jowar head. After inserting the panicle inside the container a cork is fitted in the hole to close it.
Hot water equipment for emasculation
The panicle is inserted in the container prior to blooming for a particular duration of time. It has been observed that pollen grains of rice are killed by immersing the inflorescence for 5 to 10 minutes in the hot water maintained at 40-44°C in a thermos flask.
(c) Cold Water Treatment:
Like hot water cold water also kills pollen grains without damaging the gynoecium. In rice 0-6°C temperature is maintained to kill the pollen grains. This method is less effective than hot water treatment.
(d) Alcohol Treatment Method:

This method is not commonly used for emasculation because duration of treatment is an important factor since a very short duration is required failing which even the gynoecium may be damaged. Flowers or inflorescences are immersed in alcohol of a suitable concentration for a brief period. In alfa-alfa, a treatment of even 10 seconds with 57 % alcohol is sufficient to kill the pollen grains.

(e) Suction Method:

It is a mechanical method and is suitable for the crops having minute flowers. In this method the amount of pressure is applied in such a way that only anthers are sucked out and other parts of the flower like gynoecium remain intact. However, in this method 10-15% self pollination takes place. It is one of the major drawback of this method.

(f) Male Sterility or Self-incompatibility Method:

Emasculation option can be eliminated by the use of male-sterile plants, In some self-pollinated plants for example, Sorghum, Onion, Barley etc. anthers are sterile and do not produce any viable pollens! Similarly self-incompatibility may also be used to avoid emasculation.

(g) Chemical Gametocides:

Certain chemicals are capable of causing male sterility, when sprayed before flowering e.g., 2, 4-D, naphthalene acetic acid (NAA), maleic-hydrazide (MA), tribenzoic acid etc. FW450 in cotton may be used for bringing about emasculation.

**(iv) Bagging**:

It is the fourth step and completed with emasculation. The emasculated flower or inflorescence is immediately bagged to avoid pollination by any foreign pollen. The bags may be made of paper, butter paper, glassine or fine cloth. Butter paper or vegetable parchment bags are most commonly used. The bags are tied to the base of the inflorescence or to the stalk of the flower with the help of thread, wire or pins. The bagging is done with the emasculation in bisexual plants and before the stigma receptivity and dehiscence of the anthers in unisexual plants. Both male and female flowers are bagged separately to prevent contamination in male flowers and cross-pollination in female flowers.

**(v) Tagging:**

The emasculated flowers are tagged just after bagging. Generally circular tags of about 3 cm or rectangular tags of about 3 x 2 cm are used. The tags are attached to the base of flower or inflorescence with the help of thread.

The information on tag must be as brief as possible but complete bearing the following information:

(i) Number referring to the field record (ii) Date of emasculation (iii) Date of crossing (iv) Name of the female parent is written first followed by a cross sign (x) and then the male parent, e.g., C x D denotes that C is the female parent and D is the male parent.

**(vi) Crossing**:

It is the sixth step. It can be defined as the artificial cross-pollination between the genetically unlike plants. In this method mature, fertile and viable pollens from the male parent are placed on the receptive stigma of emasculated flowers to bring about fertilization. Pollen grains are collected in petridishs (e.g., Wheat, cotton etc.) or in paper bags {e.g., maize) and applied to the receptive stigmas with the help of a camel hair brush, piece of paper, tooth pick or forceps. In some crops (e.g., Jowar, Bajra) the inflorescences of both the parents are enclosed in the same bag.

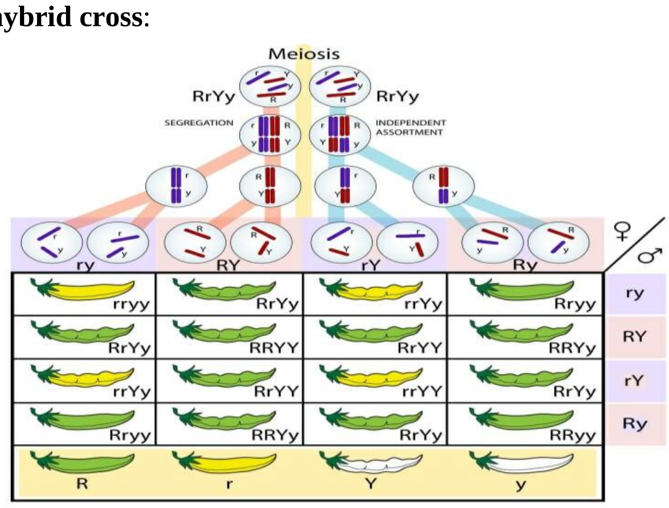
(vii) Harvesting and Storing the F1 Seeds:

Crossed heads or pods of desirable plants are harvested and after complete drying they are threshed. Seeds are stored properly with original tags.

**(viii) Raising the F1 generation**:

In the coming season, the stored seeds are sown separately to raise the F1 generation. The plants of F1 generation are progenies of cross seeds and therefore are hybrids.

**20.b.Dihybrid cross**:




A dihybrid cross is an experiment in genetics in which the phenotypes of two genes are followed through the mating of individuals carrying multiple alleles at those gene loci. Most sexually reproducing organisms carry two copies of each gene, allowing them to carry two different alleles. Historically, an organism with parts from two different true-breeding lines was referred to as a “hybrid”. Thus, the name “dihybrid cross” comes from the historical act of observing the future generations after two “pure lines” are crossed.

The classic model of a dihybrid cross is based in Mendelian genetics, so we will use Mendel’s peas for our example. See the image below. This image describes a dihybrid cross between two pea plants, looking at the traits of pod color and pod shape. The pods can be yellow or green, which is determined by the “R” gene. The “R” allele is dominant, and will cause the pod to be green in any plant where it is present. The “r” allele is recessive, and a genotype of “rr” will cause yellow pods. For pod shape, there are also two alleles present for the gene. The “Y” allele is dominant and causes wrinkled pods, whereas two “y” alleles cause a smooth shaped pod. The characters these alleles represent can be seen at the bottom of the chart, in the yellow box. At the top of the chart are the gametes produced by the mother. The mother and father are both dihybrids, “RrYy”. This means that after the process of *gametogenesis*, they will have produced the same gametes. The two cells at the top of the chart represent two diploid cells, as they enter meiosis. The two pathways shown highlight how eight different combinations can be created with these two cells. The left pathway shows how individual alleles are segregated into their own gametes after being replicated during *meiosis I*, then separated during *meiosis II*. The right side pathway shows the same thing, with the additional rearrangement of the parental genes. This is known as *independent assortment*, and also accounts for the variety created by sexual reproduction.

At the end of this process, four different classes of gametes are created. They are: “ry”, “RY”, “rY”, and “Ry”, as listed on the top and sides of the chart. The Punnett square is completed, showing the offspring that this cross would produce. If you count the different types of offspring, you will notice that there are only a few types. There is 1 smooth, yellow plant. There are 3 wrinkled, yellow plants. There are 3 green, smooth plants. Lastly, there are 9 wrinkled, green plants. This dihybrid cross shows the typical 9:3:3:1 *phenotypic ratio* expected when the traits both show complete dominance and are independent of each other.