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Contents

- Latest CBSE Syllabus 6 - 11
- Sample Question Paper-2022 Fully Solved (Issued by Board dated 16th Sep. 2022) 16 - 29
- Solved Paper-2022 (Delhi & Outside Delhi Sets) 30 - 40

(To download Solved paper for Term-I 2021-22 & Latest Topper's Answers 2020, scan the QR Code given on Page 40)

Unit I : Reproduction

1. Sexual Reproduction In Flowering Plants 1 - 40
2. Human Reproduction 41 - 78
3. Reproductive Health 79 - 94
   - Self Assessment Paper-1 95 - 96

Unit II : Genetics and Evolution

4. Principles of Inheritance and Variation 97 - 136
5. Molecular Basis of Inheritance 137 - 175
6. Evolution 176 - 192
   - Self Assessment Paper-2 193 - 195

Unit III : Biology and Human Welfare

7. Human Health and Diseases 196 - 224
8. Microbes in Human Welfare 225 - 247
   - Self Assessment Paper-3 248 - 249

Unit IV : Biotechnology and its Applications

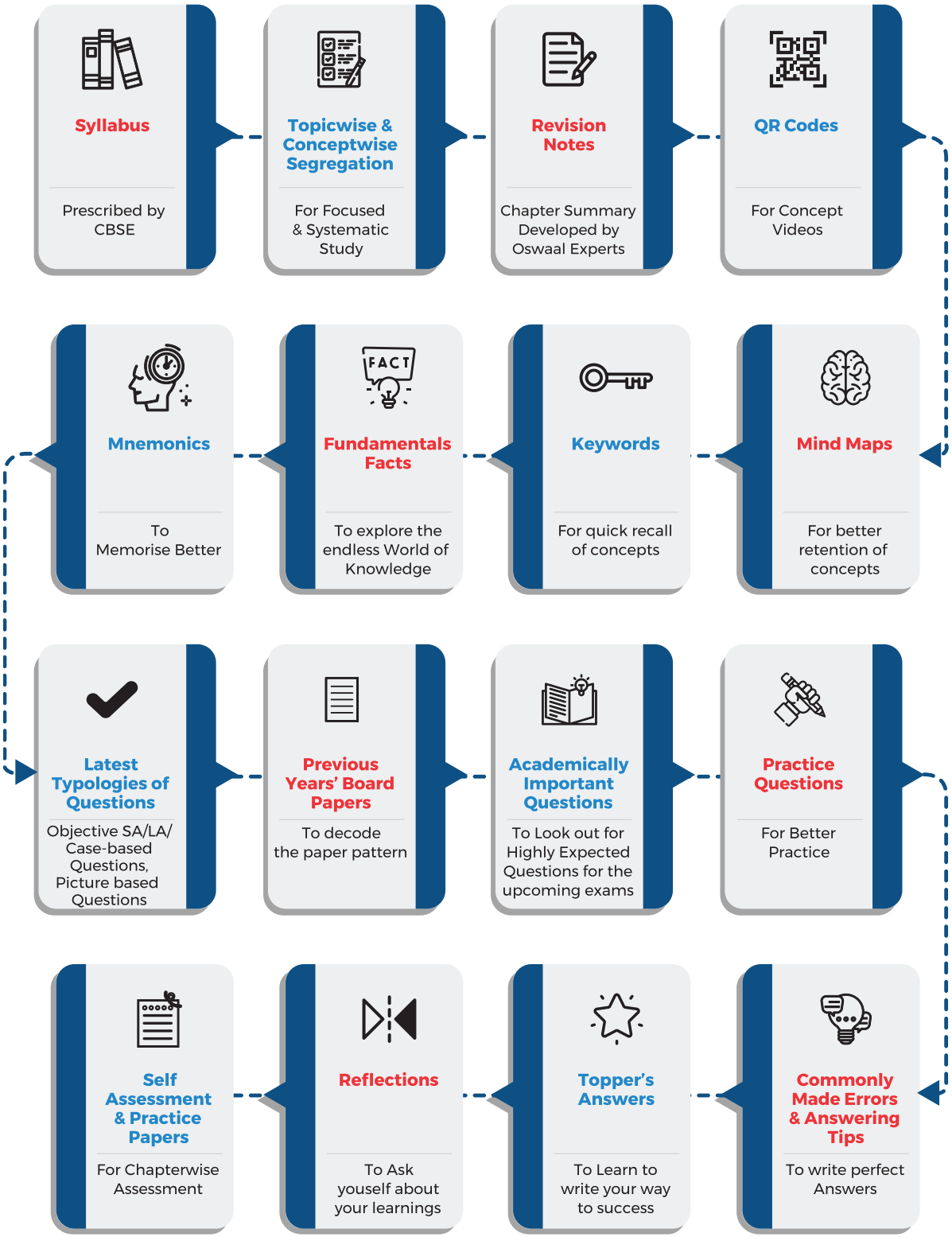
9. Biotechnology : Principles and Processes 250 - 280
10. Biotechnology and its Applications 281 - 298
    - Self Assessment Paper-4 299 - 300

Unit V : Ecology and Environment

11. Organisms and Populations 301 - 313
12. Ecosystem 314 - 331
13. Biodiversity and its Conservation 332 - 349
    - Self Assessment Paper-5 350 - 351
    - Practice Paper-1 352 - 356
    - Practice Paper-2 357 - 360

How to use this Book

Chapter Navigation Tools



What is on your wishlist for this Academic Year?

- Do better than the previous year
- Perfect every concept, every topic, and every question from the very beginning

You said it, we heard it!

Practice means to perform, repeatedly in the face of all obstacles, some act of vision, of faith, of desire. Practice is a means of inviting the perfection desired.

-Martha Graham

As we usher into a brand-new Academic Year 2023-24, Oswaal Books, with its all-new Question Banks, empowers you to perfect your learning, consistently!

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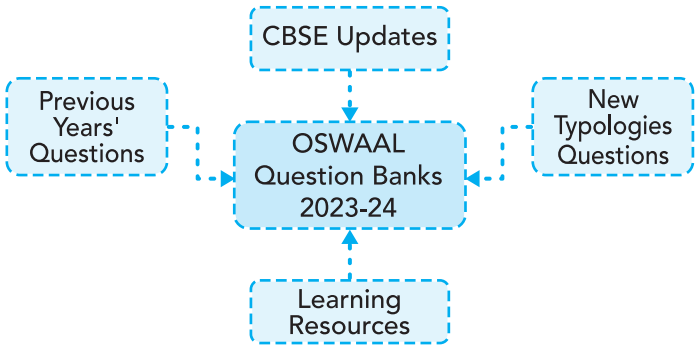

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This Question Bank would not have been made possible without the valuable contributions of the esteemed members of the Oswaal Editorial Board-Authors, Editors, Subject matter experts, Proofreaders & DTP operators who worked day and night to bring this incredible book to you. We are also highly grateful to our dear students for all their valuable and impeccable inputs in the making of this one-of-a-kind exam preparation tool.

All the best Students!! Be the perfectionist that you are!

Team Oswaal Books

Syllabus

Latest Syllabus

BIOLOGY (Code No. 044)

CLASS–XII (Theory)

Time : 03 Hours **Max. Marks : 70**

Unit No.	Title	Marks
VI	Reproduction	16
VII	Genetics and Evolution	20
VIII	Biology and Human Welfare	12
IX	Biotechnology and its Applications	12
X	Ecology and Environment	10
	Total	70

UNIT - VI : REPRODUCTION

Chapter-2 : Sexual Reproduction in Flowering Plants

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 dispersal and fruit formation.

Chapter-3 : Human Reproduction

Male and female reproductive systems; microscopic anatomy of testis and ovary; gametogenesis - spermatogenesis and oogenesis; menstrual cycle; fertilisation, embryo development upto blastocyst formation, implantation; pregnancy and placenta formation (elementary idea); parturition (elementary idea); lactation (elementary idea).

Chapter-4 : Reproductive Health

Need for reproductive health and prevention of Sexually Transmitted Diseases (STDs); birth control - need and methods, contraception and medical termination of pregnancy (MTP); amniocentesis; infertility and assisted reproductive technologies - IVF, ZIFT, GIFT (elementary idea for general awareness).

UNIT - VII : GENETICS AND EVOLUTION

Chapter-5 : Principles of Inheritance and Variation

Heredity and variation: Mendelian inheritance; deviations from Mendelism – incomplete dominance, co-dominance, multiple alleles and inheritance of blood groups, pleiotropy;

elementary idea of polygenic inheritance; chromosome theory of inheritance; chromosomes and genes; Sex determination - in humans, birds and honey bee; linkage and crossing over; sex linked inheritance - haemophilia, colour blindness; Mendelian disorders in humans - thalassemia; chromosomal disorders in humans; Down's syndrome, Turner's and Klinefelter's syndromes.

Chapter-6 : Molecular Basis of Inheritance

Search for genetic material and DNA as genetic material; Structure of DNA and RNA; DNA packaging; DNA replication; Central Dogma; transcription, genetic code, translation; gene expression and regulation - lac operon; Genome, Human and rice genome projects; DNA fingerprinting.

Chapter-7 : Evolution

Origin of life; biological evolution and evidences for biological evolution (paleontology, comparative anatomy, embryology and molecular evidences); Darwin's contribution, modern synthetic theory of

evolution; mechanism of evolution - variation (mutation and recombination) and natural selection with examples, types of natural selection; Gene flow and genetic drift; Hardy - Weinberg's principle; adaptive radiation; human evolution.

UNIT - VIII : BIOLOGY AND HUMAN WELFARE

Chapter-8 : Human Health and Diseases

Pathogens; parasites causing human diseases (malaria, dengue, chikungunya, filariasis, ascariasis, typhoid, pneumonia, common cold, amoebiasis, ring worm) and their control; Basic concepts of immunology - vaccines; cancer, HIV and AIDS; Adolescence - drug and alcohol abuse.

Chapter-10 : Microbes in Human Welfare

Microbes in food processing, industrial production, sewage treatment, energy generation and microbes as bio-control agents and bio-fertilizers. . Antibiotics; production and judicious use.

UNIT - IX : BIOTECHNOLOGY AND ITS APPLICATIONS

Chapter-11: Biotechnology–Principles and Processes

Genetic Engineering (Recombinant DNA Technology).

Chapter-12 : Biotechnology and its Application

Application of biotechnology in health and agriculture: Human insulin and vaccine production, stem cell technology, gene therapy; genetically modified organisms - Bt crops; transgenic animals; biosafety issues, biopiracy and patents.

UNIT - X : ECOLOGY AND ENVIRONMENT

Chapter-13 : Organisms and Populations

Population interactions - mutualism, competition, predation, parasitism; population attributes - growth, birth rate and death rate, age distribution. (Topics excluded: Organism and its Environment, Major Aboitic Factors, Responses to Abioitic Factors, Adaptations)

Chapter-14 : Ecosystem

Ecosystems: Patterns, components; productivity and decomposition; energy flow; pyramids of number, biomass, energy (Topics excluded: Ecological Succession and Nutrient Cycles)

Chapter-15 : Biodiversity and Conservation

Biodiversity - Concept, patterns, importance; loss of biodiversity; biodiversity conservation; hotspots, endangered organisms, extinction, Red Data Book, Sacred Groves, biosphere reserves, national parks, wildlife, sanctuaries and Ramsar sites.

Syllabus

PRACTICALS

Time allowed : 3 Hours **Max. Marks: 30**

Evaluation Scheme		Marks
One Major Experiment 5		5
One Minor Experiment 2 & 3		4
Slide Preparation 1 & 4		5
Spotting		7
Practical Record + Viva Voce	(Credit to the students' work over the academic session may be given)	4
Investigatory Project and its Project Record + Viva Voce		5
	Total	30

A. List of Experiments

1. Prepare a temporary mount to observe pollen germination.
2. Study the plant population density by quadrat method.
3. Study the plant population frequency by quadrat method.
4. Prepare a temporary mount of onion root tip to study mitosis.
5. Isolate DNA from available plant material such as spinach, green pea seeds, papaya, etc.

B. Study and observer the following (Spotting):

1. Flowers adapted to pollination by different agencies (wind, insects, birds).
2. Pollen germination on stigma through a permanent slide or scanning electron micrograph.
3. Identification of stages of gamete development, i.e., T.S. of testis and T.S. of ovary through permanent slides (from grasshopper/mice).
4. Meiosis in onion bud cell or grasshopper testis through permanent slides.
5. T.S. of blastula through permanent slides (Mammalian).
6. Mendelian inheritance using seeds of different colour/sizes of any plant.
7. Prepared pedigree charts of any one of the genetic traits such as rolling of tongue, blood groups, ear lobes, widow's peak and colour blindness.
8. Controlled pollination - emasculation, tagging and bagging.
9. Common disease causing organisms like *Ascaris, Entamoeba, Plasmodium,* any fungus causing ringworm through permanent slides, models or virtual images. Comment on symptoms of diseases that they cause.
10. Models specimen showing symbolic association in root modules of leguminous plants, Cuscuta on host, lichens.
11. Flash cards models showing examples of homologous and analogous organs.

Practical Examination for Visually Impaired Students of Class XI and XII Evaluation Scheme

Time: 02 Hours **Max. Marks: 30**

Topic	Marks
Identification/Familiarity with the apparatus	5

Written test (based on given/prescribed practicals)	10
Practical Record	5
Viva	10
Total	**30**

General Guidelines

- The practical examination will be of two hour duration. A separate list of ten experiments is included here.
- The written examination in practicals for these students will be conducted at the time of practical examination of all other students.
- The written test will be of 30 minutes duration.
- The question paper given to the students should be legibly typed. It should contain a total of 15 practical skill based very short answer type questions. A student would be required to answer any 10 questions.
- A writer may be allowed to such students as per CBSE examination rules.
- All questions included in the question paper should be related to the listed practicals.

  Every question should require about two minutes to be answered.
- These students are also required to maintain a practical file. A student is expected to record at least five of the listed experiments as per the specific instructions for each subject. These practicals should be duly checked and signed by the internal examiner.
- The format of writing any experiment in the practical file should include aim, apparatus required, simple theory, procedure, related practical skills, precautions etc.
- Questions may be generated jointly by the external/internal examiners and used for assessment.
- The viva questions may include questions based on basic theory / principle / concept, apparatus / materials / chemicals required, procedure, precautions, sources of error etc.

Class XII

A. Items for Identification/ familiarity with the apparatus for assessment in practicals (All experiments)

Beaker, flask, petriplates, soil from different sites - sandy, clayey, loamy, small potted plants, aluminium foil, paint brush, test tubes, starch solution, iodine, ice cubes, Bunsen burner/spirit lamp/water bath, large flowers, Maize inflorescence, model of developmental stages highlighting morula and blastula of frog, beads/seeds of different shapes/size/texture Ascaris, Cactus/Opuntia(model).

B. List of Practicals

1. Study of flowers adapted to pollination by different agencies (wind, insects).
2. Identification of T.S of morula or blastula of frog (Model).
3. Study of Mendelian inheritance pattern using beads/seeds of different sizes/texture.
4. Preparation of pedigree charts of genetic traits such as rolling of tongue, colour blindness.
5. Study of emasculation, tagging and bagging by trying out an exercise on controlled pollination.
6. Identify common disease causing organisms like Ascaris (model)and learn some commonsymptoms of the disease that they cause.

7. Comment upon the morphological adaptations of plants found in xerophytic conditions.

Note: The above practicals may be carried out in an experiential manner rather than recording observations.

Prescribed Books:

1. Biology, Class-XII, Published by NCERT
2. Other related books and manuals brought out by NCERT (consider multimedia also)
3. Biology Supplementary Material (Revised). Available on CBSE website.

Syllabus

QUESTION PAPER DESIGN (THEORY)

BIOLOGY (044)

Competencies	
Demonstrate Knowledge and Understanding	50%
Application of Knowledge / Concepts	30%
Analyse, Evaluate and Create	20%

Note:

- Typology of questions: VSA including MCQs, Assertion – Reasoning type questions; SA; LAI; LA-II; Source-based/ Case-based/ Passage-based/ Integrated assessment questions.
- An internal choice of approximately 33% would be provided.

Suggestive verbs for various competencies

- **Demonstrate, Knowledge and Understanding**

  State, name, list, identify, define, suggest, describe, outline, summarize, etc.
- **Application of Knowledge/Concepts**

  Calculate, illustrate, show, adapt, explain, distinguish, etc.
- **Analyze, Evaluate and Create**

  Interpret, analyse, compare, contrast, examine, evaluate, discuss, construct, etc.

❑❑❑

NEP Derived Learning Resources Prescribed by CBSE for Year 2023-24

Artificial Intelligence (AI)

Mode of Assessment

Elective Subject (Classes 8, 9 & 10)
+
Integrated with other subjects like: Mathematics, Science, Physics, Economics, Sociology, Languages from classes 9-12

Skills to be Developed

- Analysis & Critical Thinking
- Interaction and cooperation
- Innovativeness and initiative
- Vocational ethics
- Communication skills

Implications For Students

Students should opt for this curriculum to:
- Become future ready & become at par with their counterparts at a global level.
- Visualise jobs of the future and prepare for them.

Art Integration Learning (AIL)

Mode of Assessment

Art-Integrated Projects as Subject Enrichment Activity

Skills to be Developed

- Art-based enquiry
- Investigation & Exploration
- Critical Thinking
- Creativity

Implications For Students

- At least one Art-Integrated Project in each subject shall be taken up by all students of classes I to XII.
- In a minimum one project work of students from classes I – XII, it is mandatory to integrate any art form of the paired State/UT, as defined under Ek Bharat Shrestha Bharat Programme.

For Activities Scan the Code

Competency Based Assessment (CBA)

Mode of Assessment

Competency based Questions makes the students understand and apply what they learn in real life situations

Skills to be Developed

- Analysis
- Critical Thinking
- Conceptual Clarity

Implications For Students

40% of the Questions will be asked in the form of:
- MCQs, True/False, Matching Types & Cloze/Gap filling Questions
- Stand Alone Short & Long Answer Questions
- Linked Questions (Source & Case-based Questions)

Hear it from our Happy Readers!

Good Book!
According to me, it is a brilliant book for CBSE students. It prepares students really well for the upcoming 2022-23 exams. Thankfully, Maths is no more a worry. Must buy!

Priyanka

All concepts have been explained with examples which simplifies the understanding of the concepts and makes practice very easy. It is worth the money.

Siddharth Gupta

This question bank is the best. It helps me to improve my skills and knowledge. My teacher recommended this book and it helps me a lot to increase my grades.

Avishake Kar

Great Book
This is really a nice book. It helps my son a lot in studies. Many of his friends recommended Oswaal Question Bank to him, so we bought it. It is good and helpful.

Amrik Singh Gujral

Very good book for 12th class preparation. This book contains Previous Years' Questions which is very helpful in exams. It also includes VSAQs, SAQs and one mark questions for exam practice. One must read this book to achieve high percentile in exams.

Priya J.

Outstanding Book!
It is really an outstanding book.
With this question bank, we are able to get 90+ % in CBSE Board.
It is really helpful.

Om Lingyat

I would definitely recommend this book for 12th Boards. It is covering the latest and updated syllabus with great-quality of questions.

Aryan

Fantastic book!
Along with Previous Years Questions & Board Marking scheme answers this book also includes new typology of questions: MCQs, Assertion-Reason, VSA ,SA , LA & case-based questions. Fantastic to study!!

Sumit

UNIT – VI REPRODUCTION

CHAPTER 1

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 fertilisation; post fertilisation events – development of endosperm and embryo, development of seed and formation of fruit; special modes-apomixis, parthenocarpy, polyembryony; significance of seed dispersal and fruit formation.

In this chapter you will study

Flower structure; development of male and female gametophyte; pollination-types, agencies and examples; outbreeding devices; pollen-pistil interaction; double fertilisation; post fertilisation events. Significance of seed dispersal and fruit formation.

List of Topics

Topic-1: Sexual Reproduction in Flowering Plants **Page No. 1**

Topic-2: Pollination and fertilisation **Page No. 13**

Topic-3: Post fertilisation changes and special modes of reproduction **Page No. 24**

Topic-1 Sexual Reproduction in Flowering Plants

Concepts Covered • *Structure of a flower, male and female reproductive structures, development of male and female gametophytes.*

Revision Notes

Flower

- Flowers are the site of sexual reproduction in flowering plants.
- Parts of a typical angiospermic flower are: sepals, petals, stamens and pistils.
- The four whorls of the flower are attached on a central axis called thalamus.
- A flower can be bisexual (contains both male and female reproductive parts) or unisexual (only one of the reproductive parts is present).

Male Reproductive Structures

Androecium (Whorl of Stamens)

- Androecium consists of a whorl of stamens.
- The number and length of the stamens are variable in flowers of different species.
- A stamen has three parts namely, anther, filament and connective.

(a) Anther

- It is the terminal and bilobed part of stamens attached with filament. A bilobed anther is called dithecous.
- Each lobe has two pollen sacs or microsporangia. Therefore, the anther is tetrasporangiate.
- A longitudinal groove runs lengthwise separating the theca.

(b) Filament

- It is the long and slender stalk part of the stamen.
- Its proximal end is attached to the thalamus or petals of the flower.

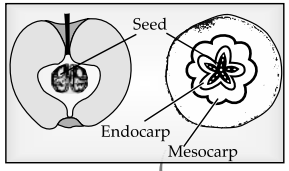
(c) Connective

- The structure which connects the anther lobes is known as connective.

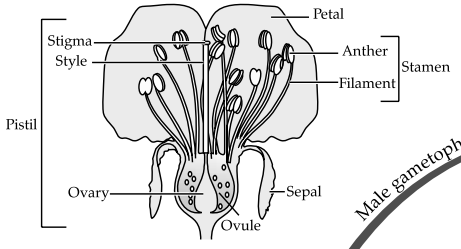
Transverse section of an anther

- The anther is tetragonal in a structure consisting of four microsporangia or pollen sacs located at

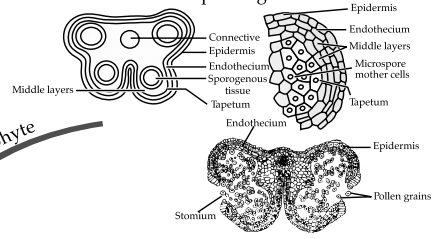
Sexual Reproduction in Flowering Plants



Seed dispersal help the species to colonise in other areas and many fruits have mechanisms for dispersal of seeds.



Stamen, Microsporangium and pollen grain



Male gametophyte

Female gametophyte

Pre-fertilisation events

Flower Structure

Significance of seed dispersal and fruit formation

Special modes

Apomixis

Polyembryony

Parthenocarpy

Production of seed without fertilisation

Occurrence of more than one embryo in a seed

Development of fruit without fertilisation

When parts other than ovary contribute to the fruit formation. e.g.: Apple

When fruit develops from ovary e.g.: Mango

False fruit

True fruit

Formation of fruit

Development of endosperm

It provides nutrition to growing embryo

Consumed completely in seed e.g..; pea, groundnut,

Persist in some seed e.g.; castor , coconut .

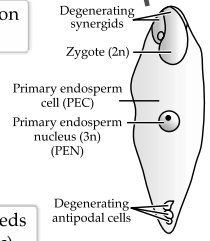
Development of embryo

Development of seed

Post- Fertilisation Events

Double fertilisation

Syngamy + Triple fusion =Double fertilisation.

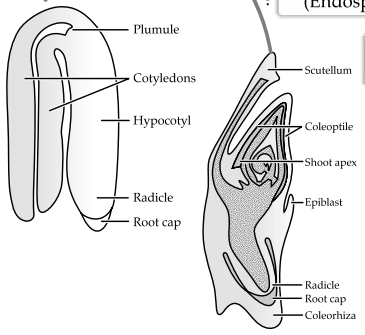


Dicot embryo

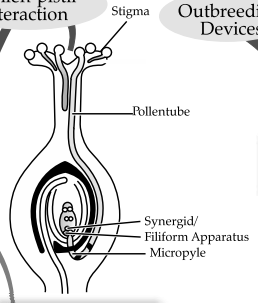
L.S. of Monocot embryo.

Albuminous seeds (Endospermic)

Non-albuminous seeds (Non-endospermic)



Pollen-pistil interaction



It is a dynamic process involving pollen recognition followed by pollen tube growth.

Artificial Hybridisation

It is one of the major approaches of crop improvement by using desired pollen grains for pollination.

Achieved by

Emasculation

Bagging

Pollination

Types

Autogamy: pollen transfer from the anther to the stigma of the same flower

Geitonogamy : pollen transfer from the anther to the stigma of another flower of the same plant.

Xenogamy : pollen transfer from anther to the stigma of a different plant.

Agencies

Abiotic

- Wind (Anemophily) e.g. grasses;
- Water (Hydrophily) e.g. *Vallisneria, Hydrilla.*

Biotic

- Insects (Entomophily) e.g. *Yucca*
- Birds (Ornithophily) e.g.Daylilies

Outbreeding Devices

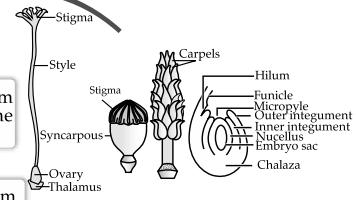
Devices for promoting cross pollination

Self–incompatibility

Arrangement of anther and stigma at different positions.

Production of unisexual flowers (Dicliny)

Pollen release and stigma receptivity not synchronised.



Pistil, megasporangium, embryo sac

Trace the Mind Map

‣ First Level ‣ Second Level ‣ Third Level

the corners, two in each lobe.
- The microsporangia develop to become pollen sacs.
- They extend longitudinally throughout the length of an anther.
- These are packed with pollen grains.

Structure of microsporangium or pollen sac
- It is circular and is generally surrounded by wall layers namely,
  (a) Epidermis **(b)** Endothecium
  (c) Middle layers **(d)** Tapetum
- The first two layers perform the function of protection and help in **dehiscence** of anther to release the pollens.
- The middle layers and the innermost layer, (tapetum) nourishes the developing pollen grains.
- The cells of the tapetum possess dense cytoplasm and more than one nuclei.
- When the anther is young, a group of compactly arranged **homogenous** cells called sporogenous tissues occupies the centre of each microsporangium.

Key Words

Homogenous: Common origin or environment.

Dehiscence: Splitting or bursting

Viability: Ability to survive.

Microsporogenesis

Scan to know more about this topic

Microsporogenesis

- When the anther develops, each cell of sporogenous tissue undergoes meiotic division to form microspore tetrads.
- Each cell of sporogenous tissue is a microspore mother cell (MMC) or pollen mother cell (PMC).
- The process of formation of microspores from a pollen mother cell (PMC) through meiosis is called microsporogenesis.

Dehiscence of anther
- The microspores get arranged in a group of four cells and each group is called microspore tetrad.
- As the anthers mature and dehydrate, the microspores dissociate from each other and develop into pollen grains.
- From each microsporangium, thousands of pollen grains are formed and released due to the **dehiscence** of anther.

Pollen grain (Male gametophyte)
- Pollen grain germinate and give rise to male gametophyte.
- These are spherical, measuring about 25-50 micrometers in diameter.
- Pollen grains are well preserved as fossils due to the presence of sporopollenin, a tough, resistant and stable material.
- A pollen grain has a two-layered wall namely, exine and intine.

(a) Exine
- Exine is the hard outer layer which is made up of sporopollenin.
- The sporopollenin is one of the most resistant organic materials.
- It can withstand high temperature and strong acids and alkali.
- It cannot be degraded by enzymes.
- The exine has apertures called germ pores where sporopollenin is absent.

(b) Intine
- It is the inner, thin and continuous layer that is made up of cellulose and pectin.
- A mature pollen grain contains two cells namely, vegetative cell and generative cell.

(i) Vegetative cell
- It is the bigger cell having abundant food reserve and a large irregularly shaped nucleus.

(ii) Generative cell
- It is the smaller cell that floats in the cytoplasm of the vegetative cell.
- It is spindle shaped with dense cytoplasm and a nucleus.
- The pollen grains are generally shed at the 2-celled stage in flowering plants.
- In other plants, the generative cell divides mitotically to give rise to the two male gametes before pollen grains are shed in a 3-celled stage.
- Once they are shed, pollen grains have to land on the stigma before they lose **viability**.
- The period of pollen grains remaining viable varies and depends on the prevailing temperature and humidity.
- The viability of pollen grains of some cereals such as rice, wheat, etc. is 30 minutes while some members of Leguminosae, Rosaceae & Solanaceae have viability for months.
- Pollen grains of some plants like *Parthenium* are allergic for some people leading to chronic respiratory disorders such as asthma, **bronchitis**, etc.
- Pollen grains are rich in nutrients.
- Pollen tablets are used as food supplements.
- Pollen consumption in the form of tablets and syrups increases the performance of athletes and race horses.
- It is possible to store pollen grains for years in liquid nitrogen (–196°C).
- The pollens stored in the pollen banks for **crop breeding** programmes.

Key Words

Bronchitis: Inflammation of the mucous membrane in the bronchial tubes.

Crop breeding: Deals with the production and selection of superior phenotypes for the development of improved and new varieties.

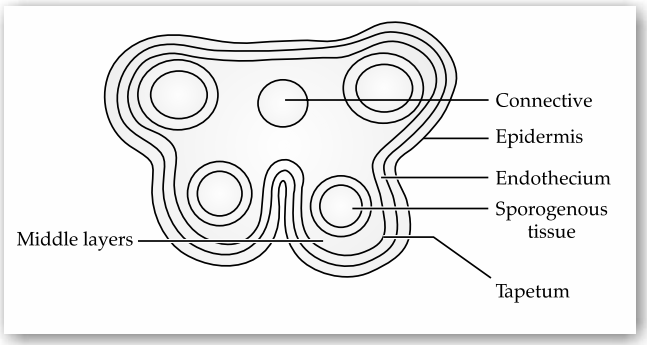


Fig 1.1: Transverse Section of a young anther

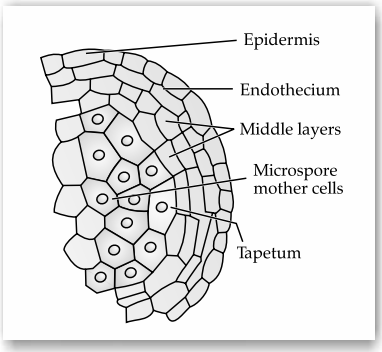


Fig 1.2: Enlarged view of an microsporangium

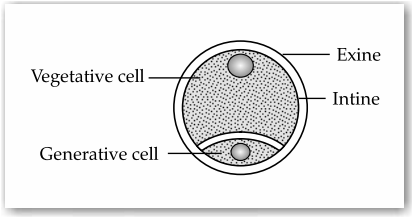


Fig 1.3: Structure of two-celled male gametophyte (pollen grain)

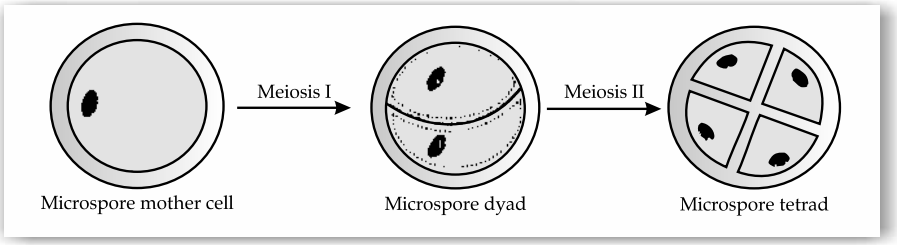


Fig 1.4: Microsporogenesis

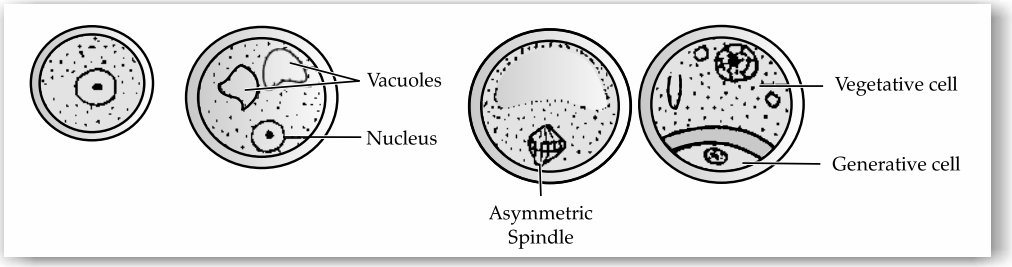


Fig 1.5: Stages of a microspore maturing into a pollen grain

Mnemonics

Concept: Male Reproductive Structures
Mnemonic: Ask **F**or **C**onnectivity
Interpretation: Anther, Filament, Connective

Concept: Structures of microsporangium or pollen sac
Mnemonic: Eating **T**omato
Interpretation: Endothecium, Tapetum

Concept: Female Reproductive Structures
Mnemonic: Small **S**oft **O**rnament
Interpretation: Stigma, Style, Ovary

Female Reproductive Structures

Gynoecium (Pistil)

- It represents the female reproductive part of the flower.
- If it consists of a single pistil or carpel then, it is known as monocarpellary or if it has more than one pistil or carpel then, it is called multicarpellary.
- When there is more than one carpel, they may be fused then the pistil is known as syncarpous or may be free then, it is known as apocarpous.
- Each carpel has three parts namely stigma, style and ovary.

(a) Stigma

It is a landing platform for pollen grains.

Key Words

Placenta: The surface of the carpel to which the ovules are attached.

Integuments: Outer hard protective layer in plants.

Degenerate: To loose structural or physical ability.

(b) Style

It is an elongated slender part beneath the stigma.

(c) Ovary

- It is the basal swollen part of the carpel.
- Inside the ovary is the ovarian cavity called the locule where the **placenta** is located.
- **Placenta** contains the ovules or megasporangia.
- The number of ovules in an ovary may be one as seen in wheat, paddy, mango, etc., or many as seen in papaya, watermelon, orchids, etc.

Megasporangium (Ovule)

Scan to know more about this topic

Megasporangium

- It is a small structure attached to the placenta by a stalk called the funicle.
- The junction where the body of the ovule and funicle fuse is called the hilum.
- Each ovule has one or two and some times three protective coverings called **integuments**.
- **Integuments** encircle the ovule except at the tip where a small opening called micropyle is organised.
- Opposite to the micropylar end is the chalaza which is the basal part of the ovule.
- Within the integuments, there is a mass of cells called nucellus which contains reserve food materials.
- Inside the nucellus there is an embryo sac, which is also called as the female gametophyte.
- An ovule has a single embryo sac usually formed from a single haploid megaspore.

Megasporogenesis

- The formation of haploid megaspores from the diploid megaspore mother cell (MMC) as a results of meiosis is called megasporogenesis.
- A single megaspore mother cell is differentiated in the micropylar region of the nucellus.
- The megaspore mother cell is a large cell containing dense cytoplasm and a prominent nucleus.
- The megaspore mother cell undergoes meiotic division resulting in the production of four haploid megaspores.

Female gametophyte (Embryo sac)

- In most of the flowering plants, only one megaspore is functional while the other three **degenerate**.
- The functional megaspore develops into the female gametophyte or embryo sac.
- This method of embryo sac formation from a single megaspore is termed as monosporic development.

Development of Female gametophyte

- The nucleus of the functional megaspore divides mitotically to form two nuclei which move towards the opposite poles, forming a two-nucleated embryo sac.
- Two more sequential mitotic nuclear divisions result in the formation of the four-nucleated and later the eight-nucleated stages of the embryo sac
- These divisions are strictly free nuclear, i.e., nuclear divisions are not followed immediately by cell wall formation.
- After eight-nucleate stage, the organisation of the typical female gametophyte or embryo sac takes place.
- Generally six of the eight nuclei are surrounded by cell walls and organised into cells.
- The remaining two nuclei called the polar nuclei are found below the egg apparatus in the large central cell.

Distribution of the cells within the embryo sac

- The three cells consisting of two synergids and one egg cell which are grouped at the micropylar end constitute the egg apparatus.
- The synergids have special cellular thickenings at the micropylar tip called filiform apparatus.
- The filiform apparatus helps to guide the pollen tubes into the synergid.
- Three cells at the chalazal end organise as the antipodals.
- Thus, a typical mature angiosperm embryo sac at maturity is eight-nucleate and seven-celled.

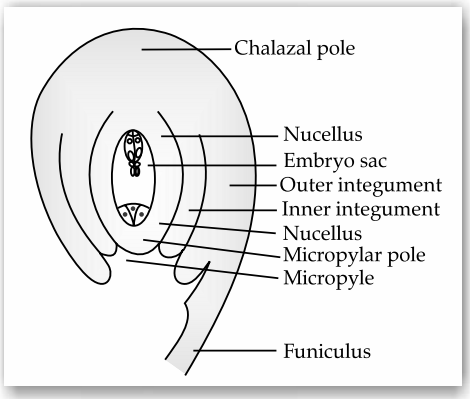


Fig 1.6: A diagrammatic view of a typical anatropous ovule

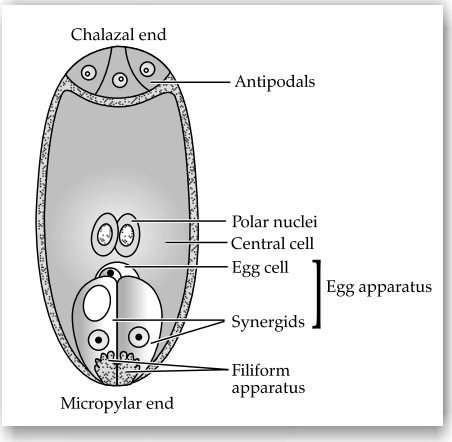


Fig 1.7: A diagrammatic view of the mature embryo

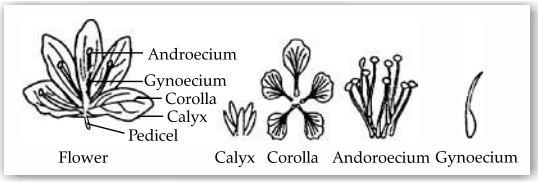
OBJECTIVE TYPE QUESTIONS (1 mark each)

A Multiple Choice Questions

Q. 1. 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) A

Ans. Option (C) is correct.



Explanation: All the four whorls of the plant with their relative position in flower can be indicated through following diagram. Sepals collectively form a whorl, called as calyx while technically the carpel is known as gynoecium. The floral whorls formed by petals and stamens are called as corolla and androecium, respectively.

Q. 2. Embryo sac is related to ovule as _____ is related to an anther.

(A) Stamen **(B)** Filament
(C) Pollen grain **(D)** Androecium K

Q. 3. 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 K

Ans. Option (A) is correct.

Explanation: In a typical complete, bisexual and hypogynous flower, the arrangement of floral whorls on the thalamus from the outermost to the inner most is as follows:

(i) Calyx: It is the outermost whorl of sepals.
(ii) Corolla: It is a whorl of petals inside the calyx.
(iii) Androecium: It is a whorl of stamens inside the corolla.
(iv) Gynoecium: It is a whorl of pistils (in the centre of the flower forming inner most whorls).

Q. 4. 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. E

Ans. Option (D) is correct.

Explanation: In dioecious plants, the unisexual male flower is staminate, that is, bearing stamens only, while the female is pistillate or bearing pistil only. For the production of fruits and seeds fertilisation must take place, which is possible only in the presence of both male and female flowers. When the plant is dioecious, it will give rise to the following situations:

(i) If the plant is dioecious and bears only pistillate flowers, fertilisation can take place with the help of pollinators.

(ii) If the plant is dioecious and bears only staminate flowers, fertilisation cannot take place, because female gamete is non-motile which can't reach the male gamete in order to fuse with it. When the plant is monoecious, that is, carrying both stamen and pistil together, it may lead to self-fertilisation and production of seed.

These questions are for practice and their solutions are available at the end of the chapter

Q. 5. The outermost and 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 **K**

Ans. Option (D) is correct.

Explanation: The outermost and innermost wall layers of microsporangium in an anther are respectively, epidermis and tapetum. A typical microsporangium is generally surrounded by four-wall layers, that is, the epidermis, (outermost protective layer), endothecium, (middle fibrous layers) and the tapetum (innermost nutritive layer).

Q. 6. During microsporogenesis, meiosis occurs in:

(A) Endothecium
(B) Microspore mother cells
(C) Microspore tetrads
(D) Pollen grains. **K**

Q. 7. 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 **A**

Ans. Option (A) is correct.

Explanation: Gynoecium indicates the female reproductive part of the flower which consists of pistil. Each pistil has three parts, that is, stigma, style and ovary. Inside the ovarian cavity, the placenta is located. Arising from the placenta there are the megasporangia, commonly called ovules.

The functional megaspore undergoing the meiotic division develops into the female gametophyte or embryo sac. Thalamus, tapetum and stamen are not a part of gynoecium. Thalamus is the part of flower which form the base on which all the floral whorls rest upon. Tapetum is the innermost nutritive layer or microsporangium and stamens are male reproductive part (androecium) of plant.

Q. 8. From the statements given below 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) and (ii) **(D)** (ii) and (iv) **U**

Ans. Option (C) is correct.

Explanation: Statement (i) and (ii) are correct regarding female gametophyte of flowering plant. The female gametophyte or embryo sac is located inside the nucellus, enclosed within the integuments. In a majority of flowering plants, one of the megaspore is functional while the other three degenerates. Three repeated mitotic divisions of the functional megaspore results in the formation of seven-celled or eight-nucleate embryo sac. Six of the eight nuclei are organised at the two poles. Three cells grouped at micropylar end forms egg apparatus and 3 at the chalazal end form antipodal cells. The large central cell at the centre has two polar nuclei. The meiotic divisions in the formation of embryo sac are strictly free nuclear, that is nuclear divisions are not followed immediately by cell-wall formation. Gametophyte is situated at micropylar end not at chalazal end.

Q. 9. 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. **K**

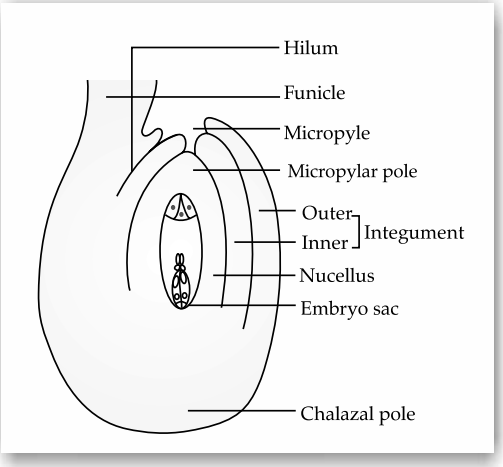
Q. 10. The structure of bilobed anther consists of:

(A) 2 thecae, 2 sporangia
(B) 4 thecae, 4 sporangia
(C) 4 thecae, 2 sporangia
(D) 2 thecae, 4 sporangia **K**

Ans. Option (D) is correct.

Explanation: Anther is a sac-like structure that produces pollen grains. It is bilobed and each lobe has two theca i.e., dithecous.

Q. 11. In the figure of anatropous ovule given below, choose the correct option for the characteristic distribution of cells within the typical embryo sac.



K

	Number of cells at chalazal end	Number of cells at micropylar end	Number of nuclei left in central cell
(A)	**3**	**2**	**3**
(B)	**3**	**3**	**2**
(C)	**2**	**3**	**3**
(D)	**2**	**2**	**4**

Ans. Option (B) is correct.

Explanation: At the micropylar end, out of the four nuclei, only three differentiate into two synergids and one egg cell. Together they are known as egg apparatus. The synergids have special cellular thickenings at the micropylar tip. These are

These questions are for practice and their solutions are available at the end of the chapter

together called the filiform apparatus. It helps to guide the pollen tubes into the synergid. Similarly, at the chalazal end, three out of the four nuclei differentiate as antipodal cells. The remaining two cells (of the micropylar end and the chalazal end) move towards the center and are known as polar nuclei, which are situated in a large central cell. Hence, at maturity, a typical mature angiosperm embryo sac (the female gametophyte) appears as a 7-celled structure, though it has 8-nucleate.

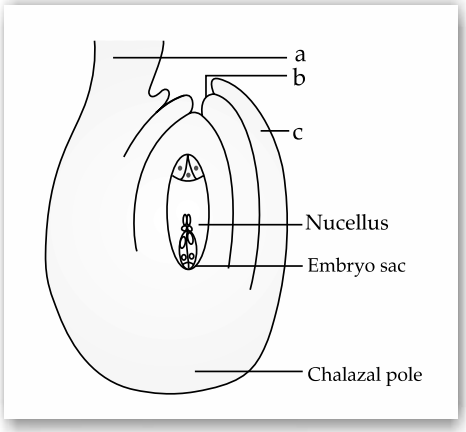
Q. 12. Megaspore, the first cell of female gametophytic generation develops into:

(A) Pollens **(B)** Embryo sac
(C) Ovule **(D)** Anthers AI K

Ans. Option (B) is correct.

Explanation: 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.

Q. 13. Observe the figure given below. What is the function of part labeled as (c)?

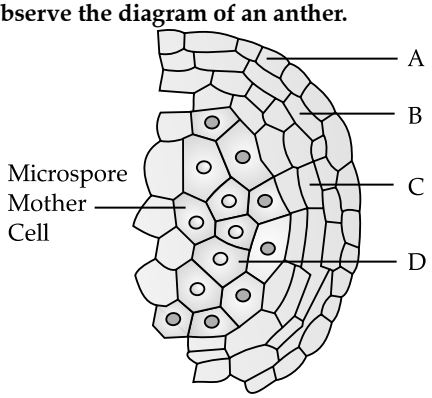


(A) Provides nutrition to the developing embryo.
(B) Protects the developing embryo.
(C) Point where the body of the ovule is attached to the funiculus.
(D) Marks the point where the pollen tube enters the ovule at the time of fertilisation. A

Ans. Option (B) is correct.

Explanation: The part labelled as (c) is integument. Integuments are outer layers surrounding the ovule that provide protection to the developing embryo.

Q. 14. Observe the diagram of an anther.



Which of these marked label nourishes the developing pollen grains?

(A) A **(B)** B
(C) C **(D)** D Ap

Ans. Option (D) is correct.

Explanation: The part labelled as D is tapetum. The tapetum is the innermost layer that nourishes the developing pollen grains.

Q. 15. Choose the correct statement.

(A) Mature embryo sac has numerous antipodal cells.
(B) The reduction division occurs in the megaspore mother cells.
(C) There is a small central cell in the embryo sac.
(D) The egg cell has a filiform apparatus. A

Ans. Option (B) is correct.

Explanation: Megaspore mother cell divide meiotically to form four haploid megaspores which undergoes mitosis so that a haploid female gamete is formed. Antipodal cells are three in number. A large central cell is present in the embryo sac. The synergids bear filiform apparatus.

B Assertion and Reason

Directions: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

(A) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(B) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(C) Assertion (A) is true but reason (R) is false.
(D) Assertion (A) is false but reason (R) is true.

Q. 1. Assertion (A): Tapetum is a part of anther wall that has 2-3 layers of cells.

Reason (R): Tapetum layers helps in development and growth of pollen grain. K

Ans. Option (A) is correct.

Explanation: In flowering plants, tapetum are the specialised cells that provide nutrition to the pollen grain within the anther.

Q. 2. Assertion (A): Pollen grains are best preserved as fossils.

Reason (R): The sporopollenin of exine is highly resistant to the action of strong acids and alkali and can withstand a high temperature. U

Q. 3. Assertion (A): Tapetum is formed during the process of the formation of microsporangium.

Reason (R): The play an important role in guiding the pollen tube into the synergid. AI U

Ans. Option (C) is correct.

Explanation: Tapetum plays an important role in nourishing pollen mother cells (PMCs) or microspores.

Q. 4. Assertion (A): Flowers are structure of sexual reproduction.

Reason (R): Different types of embryological process occurs inside the flower. U

Ans. Option (A) is correct.

Explanation: Flowers are morphological and embryological marvels and the sites of sexual reproduction.

Q. 5. Assertion (A): The megaspore mother cell divide meiotically to produce four megaspores.

Reason (R): Megaspore mother cells haploid while megaspores are diploid. K

Ans. Option (C) is correct.

Explanation: The megaspore mother cell is diploid. It undergoes meiosis (reduction division) to produce a group of four megaspores which are haploid.

Q. 6. Assertion (A): Embryo sac is 7 - celled, 8 nucleated structure.

Reason (R): All cells are haploid. K

Ans. Option (C) is correct.

Explanation: The female gametophyte, also called embryo sac is mostly a 7-celled structure. There is a large central cell with two polar nuclei which later fuse to form secondary nucleus. The micropylar end of central cell is occupied by the egg apparatus, comprising an egg cell and two synergids, and at its chalazal end three antipodal cells are present. Cell of the egg apparatus and the antipodal cells are uninucleate and haploid whereas the central cell is binucleate or diploid. Thus, embryo sac is 7 - celled, 8 nucleated structure.

Q. 7. Assertion (A): Megaspore mother cell undergoes meiotic division to form four haploid megaspores.

Reason (R): All four megaspores form female gametophyte. U

Ans. Option (B) is correct.

Explanation: The megaspore mother cells undergo meiosis and form a row of four haploid megaspores. Only one (the chalazal megaspore) remains functional, which enlarges and gives rise to female gametophyte or embryo sac.

SUBJECTIVE TYPE QUESTIONS

Very Short Answer Type Questions (1 mark each)

Q. 1. How many meiotic divisions are required to produce 76 seeds in a Guava fruit? AI E

Ans. 95. **[CBSE Marking Scheme, 2020] 1**

Detailed Answer:

In female, one meiotic division of megaspore mother cell leads to formation of one egg cell. So, 76 egg cells are formed from 76 meiotic divisions.

In male, one meiotic division of sperm mother cell leads to formation of four haploid cells, So 76 functional pollens will be formed by $\frac{76}{4} = 19$ meiotic divisions.

So, total meiotic division required to produce 76 seeds 76 + 19 = 95. **1**

Q. 2. What is the function of germ pore? U

Ans. Germ pores are present in the pollen grains through which the germ tube or pollen tube makes its exit on germination. **1**

Q. 3. What is the use of pollen tablets? K

Q. 4. How many microsporangia are present in a typical anther of angiosperm? U

Ans. Four microsporangia are present in a typical anther of angiosperm. **1**

Q. 5. How many pollen grains and ovules are likely to be formed in the anther and the ovary of an angiosperm bearing 25 microspore mother cells and 25 megaspore mother cells respectively?

E [CBSE Foreign, 2013, CBSE SQP, 2018]

Ans. Microspore mother cells 25 × 4=100 pollen grains and from megaspore mother cells 25 ovules respectively. ½ + ½

[CBSE Marking Scheme, 2018]

Short Answer Type Questions-I (2 marks each)

Q. 1. How many cells are present in the pollen grains at the time of their release from anther? Name the cells.

K [Outside Delhi Set-III, 2017]

Q. 2. "Pollen grains in wheat are shed at the 3-celled stage while in peas they are shed at the 2-celled stage." Explain. Where are germ pores present in a pollen grain? K [Outside Delhi Set-II, 2017]

Ans. At the time of shedding, wheat pollen consist of one vegetative and two male gametes (3 celled), while pea pollen consists of one vegetative and one generative cell (2 celled). ½ + ½

Germ pores are present on the exine (where sporopollenin is absent). **1**

[CBSE Marking Scheme, 2017]

Q. 3. A pollen grain in angiosperm at the time of dehiscence from an anther could be 2-celled or 3-celled. Explain. How are the cells placed within the pollen grain when shed at a 2-celled stage?

K [Outside Delhi Set-I 2017]

Ans. In 2-celled stage, the mature pollen grain contains a generative and vegetative cell, whereas, in the 3-celled stage, one vegetative cell and two male gametes are present. ½ + ½

The generative cell floats in the cytoplasm of the vegetative cell. **1**

[CBSE Marking Scheme, 2017]

Q. 4. In a flowering plant, a microspore mother cell produces four male gametophytes while a megaspore mother cell form only one female gametophyte. Explain. A [Delhi Set-II 2017]

These questions are for practice and their solutions are available at the end of the chapter

Ans. A microspore mother cell/PMC on meiosis forms 4 functional pollen grains/male gametophyte 1
A megaspore mother cell/MMC on meiosis also forms four megaspores but out of it only one is functional and the other three degenerate. **1**
[CBSE Marking Scheme, 2017]

Q. 5. Mention the ploidy of the different types of cells present in the female gametophyte of an angiosperm. Ap **[Delhi Set-III 2017]**

Ans. Synergids = n/haploid, egg = n/haploid, polar nuclei = n/haploid, antipodals = n/haploid = ½ × 4 // all types of cell of female gametophyte are haploid / n = 2 **[CBSE Marking Scheme, 2017] 2**

Detailed Answer:

The functional megaspore developed by the meiotic division of megaspore mother cell and so it is haploid. Hence, almost all the cells present in the female gametophyte i.e., three antipodals, two synergids and one egg are haploid. However, the two haploid nuclei of the central cell fuse to give rise to a single diploid nucleus. Therefore, the ploidy level of the central cell may become diploid.

Commonly Made Error

- Many students commit the mistake of writing the ploidy of polar nuclei incorrectly.

Answering Tips

- Students should understand the concept of Haploid (n) and Diploid (2n). While studying plant reproduction, at every step, understand the basic concepts of alternation of generation, viz., megasporogenesis, microsporogenesis, fertilisation, embryonic development and endosperm formation.
- Understand the location of haploid and diploid nuclei in the embryo sac.

Q. 6. Angiosperm bearing unisexual flowers are said to be either monoecious or dioecious. Explain with the help of one example each. U

Short Answer Type Questions-II (3 marks each)

Q. 1. When and where do tapetum and synergids develop in flowering plants? Mention their functions. K **[Outside Delhi Set-I 2019]**

Ans. Tapetum: Microsporogensis. Microsporangium (anther), nourishes the developing pollen grains.
Synergids: Megasporogensis, Megasporangium (ovule), synergids form apparatus to guide the pollen tube into it.
½ × 6 **[CBSE Marking Scheme, 2019]**

Detailed Answer:

Tapetum: Tapetum is formed during the process of formation of Microsporogensis.
Function: It nourishes the developing pollen grains.
Synergids: They are formed inside the ovule during the process of megasporogenesis.
Function: Synergids have special cellular thickenings at the micropylar tip called filiform apparatus, which play an important role in guiding the pollen tubes into it.

Q. 2. Where are the following structures present in a male gametophyte of an angiosperm? Mention the function of each one of them.
(a) Germ pore
(b) Sporopollenin
(c) Generative cell
AI A **[Outside Delhi Set-I 2019]**

Ans. (a) Germ pore: Pollen-grain exine, site from where pollen tube emerges.
(b) Sporopollenin: Exine of pollen-grains, protects the pollen grains from high temperature/ and strong acids & alkali/enzymes/adverse condition.
(c) Generative cells: Pollen grains, give rise to two male gametes. ½ × 6
[CBSE Marking Scheme, 2019]

Detailed Answer:

(a) Germ pore: It is present in the exine of the pollen grains.
Function: The content of pollen grain move into the pollen tube through the germ pore.
(b) Sporopollenin: It is present in exine of the pollens grains.
Function: Sporopollenin can withstand high temperature and strong acids and alkalies. it is the most resistant organic material known.
(c) Generative cells: It is present inside the pollen grains.
Function: It give rise to male gametes through mitosis.

Q. 3. Pollen banks are playing a very important role in promoting plant breeding programme the world over. How are pollens preserved in the pollen banks? Explain. How are such banks benefiting our farmer? Write any two ways.
U **[Delhi Set-I, 2019]**

Q. 4. (i) Do all pollen grains remain viable for the same length of time? Support your answer with two suitable examples.
(ii) How are pollen grains stored in pollen banks? State the purpose of storing pollen grains in banks. K **[Delhi Set-I, II, III 2017 Comptt]**

Ans. (i) No **1**
Examples:
(a) Cereals / rice / wheat - pollen grains / loose viability within thirty minutes of their release. ½
(b) In some members of Rosaceae / Leguminosae, it maintain viability for months. ½

These questions are for practice and their solutions are available at the end of the chapter

(ii) Using cryopreservation techniques / in liquid nitrogen (– 196º C) ½
Maintaining viability / preserving threatened species / preserving commercially important plants / to be used for crop breeding programmes ½
[CBSE Marking Scheme, 2017]

Q. 5. (i) Draw a labelled diagram of a section of an enlarged view of microsporangium of an angiosperm.
(ii) Name the cells and the event they undergo to produce pollen grains.
K [Outside Delhi, Set-II, Comptt. 2016]

Ans. (i) Refer to Topic/ Revision Notes/ Important Diagrams/ Fig 1.2 ½ × 4
(ii) Microspore mother cell/pollen mother cell, through meiosis. ½ + ½
[CBSE Marking Scheme, 2016]

Detailed Answer:

(ii) There are the microspore mother cells (MMC) or pollen mother cells (PMC) in the microsporangium that produce pollen grains. They are diploid (2*n*) cells and undergo meiosis to produce pollen grains. The process is called as microsporogenesis.

Q. 6. (i) Draw a labelled sketch of a mature 7-celled, 8-nucleate embryo sac.
(ii) Which one of the cells in an embryo-sac produce endosperm after double fertilisation?
A I K [Foreign Set-I, 2016]

OR

A mature embryo-sac in a flowering plant may possess 7-cells, but 8-nuclei. Explain with the help of a diagram only. A [Delhi Set-I 2017]

Ans. (i) Refer to Topic 1/ Revision Notes/ Important Diagrams/ Fig 1.7 **2½**
(ii) Central cell. ½
[CBSE Marking Scheme, 2016]

Detailed answer:

(ii) After double fertilisation, the Primary Endosperm Nucleus (PEN) is formed as a result of triple fusion (fusion of one male gamete (*n*) with a diploid secondary nucleus (2*n*) or with two haploid polar nuclei) produces endosperm.

Commonly Made Error

- Instead of embryo sac, students often draw the entire anatropous ovule. Some students label the diagram incorrectly.

Answering Tip

- Practice drawing a well-labelled diagram of embryo sac.

Q. 7. (a) Name the organic material exine of the pollen grain is made up of. How is this material advantageous to pollen grain?
(b) Still it is observed that it does not form a continuous layer around the pollen grain. Give reason.
(c) How are 'pollen banks' useful? A I U

Ans. (a) Sporopollenin ½
Most resistant to high temperature / strong acids / alkali / no enzymes can degrade it.
(any one) ½
(b) (Germs pores) to allow the pollen tube to emerge out/pollen germination. 1
(c) Helps in storing pollen grains for years/for crop breeding programmes. **1**
[CBSE Marking Scheme, 2016]

Detailed Answer:

(a) Exine is the hard outer, protective covering of the pollen grain. It is made of sporopollenin. Sporopollenin is one of the most resistant organic compounds, which can withstand high temperature, strong acids and alkalies. It cannot be degraded by any of the known enzymes. Hence, it acts as a shield and protects the pollen grain from getting damaged.

(b) Exine does not form a continuous layer around the pollen grain. It is absent in certain sections forming germ pores, where sporopollenin is absent. Germ pores, serves as an outlet for the formation of a pollen tube.

(c) Pollen grains can be stored for years in liquid nitrogen at – 196°C. After this treatment, they are stored in pollen banks. Such conserved pollen grains can be later used in plant breeding programs.

Commonly Made Error

- Students often get confused between the outer and inner layer name i.e. exine and intine.

Answering Tip

- Be specific while writing the answer and give the chemical nature of the two layers.

Long Answer Type Questions (5 marks each)

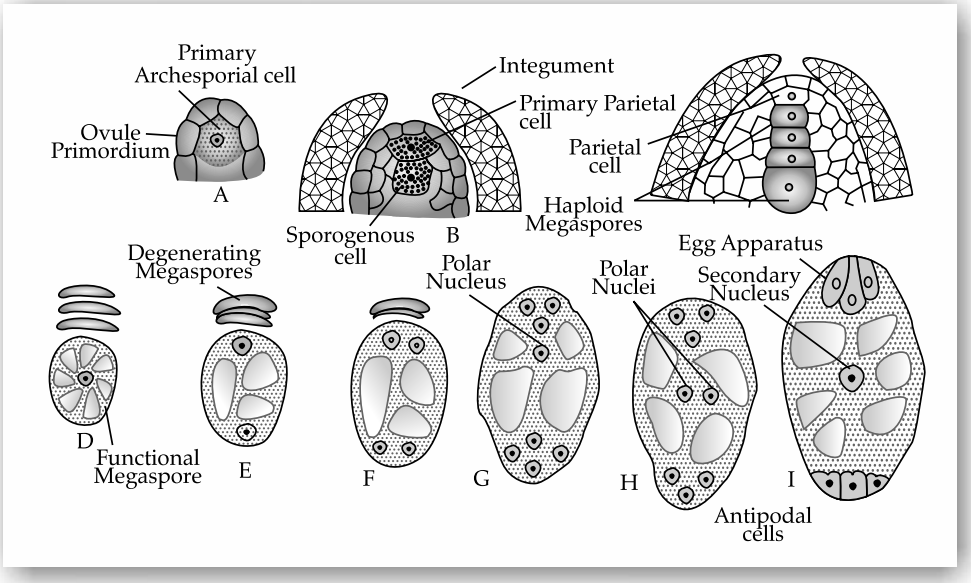
Q. 1. (a) Describe the process of megasporogenesis, in an angiosperm.
(b) Draw a diagram of a mature embryo sac of angiosperm, label its any six parts. A I U **[Delhi Set-I 2020]**

Ans. (a) Megasporogenesis is the process of formation of the four megaspores form the megaspore mother cell (MMC) in the region of nucellus through meiosis. It occurs inside the ovule.

Megaspore mother cell is large and contains a dense cytoplasm and prominent nucleus. The MMC undergoes meiotic division to produce four megaspores.

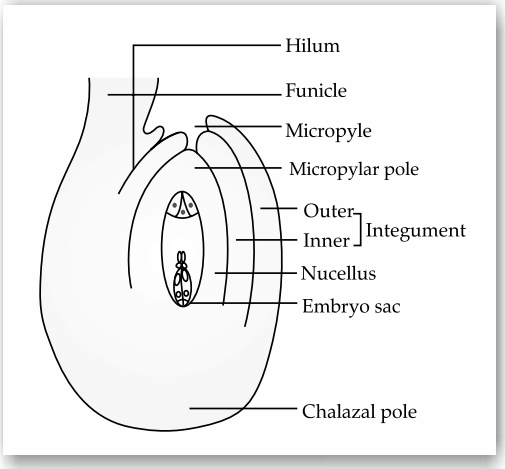
In a majority of flowering plants, only one megaspore is functional while the other three degenerate. The single functional megaspore develops into the female gametophyte.

This method of embryo sac formation from a single megaspore is termed monosporic development.



Development of embryo sac **5**

(b) Diagram of mature embryo sac of an angiosperm:



3+2

Commonly Made Error

- Some students draw micropylar and chalazal ends in opposite directions. Few of them get confused between polar nuclei and secondary nucleus.

Answering Tip

- Lay stress on drawing correct diagrams. Also, learn thoroughly the position of antipodal cells and egg apparatus regarding micropyle.

Q. 2. (a) Where does microsporogenesis occur in an angiosperm? Describe the process of microsporogenesis.

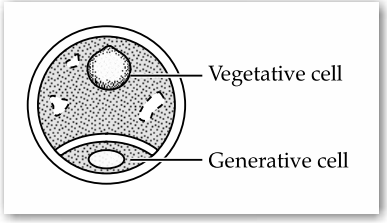
(b) Draw a labelled diagram of the two-celled male gametophyte of an angiosperm. How is the three-celled male gametophyte different from it?

K [Outside Delhi Set-II, 2020]

Ans. (a) The process of formation of microspores or pollen grains from microspore or pollen mother cell (MMC or PMC) by meiosis is called micro-sporogenesis. It takes place in pollen sacs or microsporangia of each anther lobe.

The cells of sporogenous tissue of microsporangium functions as potential MMC/ PMC in the anther. They undergo meiosis and as a result form four microspores or pollen grains arranged in tetrads. The pollen grains separate from the tetrads and give rise to two celled male gametophyte while still *in situ*. In the majority of angiosperms, the pollen is released from the anther at 2 celled stages while in some at 3-celled stage as the generative cell divides to form 2 male gametes.

(b) Structure of 2 celled gametophytes:



Difference between 2-celled gametophyte and 3-celled gametophyte: In over 60% of angiosperms, pollen grains are shed at the 2-celled stage. In others, the generative cell divides mitotically to give rise to the two male gametes before pollen grains are shed (3-celled stage). **2+1+2**

Q. 3. Where does the process of megasporogenesis start in an angiosperm? Describe the process upto the formation of embryo sac. U **[Delhi Set-II, 2019]**

Topic-2 Pollination and Fertilisation

Concepts Covered • *Modes of Pollination,* • *Pollen-Pistil Interaction, Artificial Hybridisation, Double Fertilisation*

Revision Notes

Modes of Pollination

- The process of transfer of pollen grains from the anther to the stigma of a pistil is known as pollination.
- There are few external agents which help the plants for pollination to take place.
- Pollination is of three types based on the source of pollens namely,
  (a) Autogamy
  (b) Geitonogamy
  (c) Xenogamy

Scan to know more about this topic

Pollination

Autogamy

- When the pollen grains are transferred from the anther to the stigma of the same flower, it is known as autogamy.
- In flowers with exposed anthers and stigma, a complete autogamy is rare and hence the anthers and stigma should lie close to each other to enable self-pollination. Along with this there should be **synchrony** in pollen release and **stigma receptivity**.
- Plants like *Viola* (common pansy), *Oxalis* and *Commelina* produce two types of flowers namely Chasmogamous flowers and Cleistogamous flowers.

(a) Chasmogamous flowers

- They are similar to flowers of other species with exposed anthers and stigma.

(b) Cleistogamous flowers

- They do not open at all.
- Anthers and stigma lie close to each other.
- They are autogamous as there is no chance of cross-pollination.
- When anthers dehisce in the flower buds, pollen grains come in contact with the stigma for pollination.
- Cleistogamous flowers produce assured seed set even in the absence of pollinators.

Geitonogamy

- When the pollen grains are transferred from the anther to the stigma of another flower of the same plant, it is known as geitonogamy.
- It involves pollination with the help of a pollinating agent. It is structurally cross-pollination but genetically self-pollination.
- It is genetically similar to autogamy because the pollen grains come from the same plant.

Xenogamy

- When the pollen grains are transferred from anther to the stigma of a different plant, it is known as xenogamy. It brings about genetically different types of pollen grains to the stigma.

Agents of pollination:

- **There are two types of agents of pollination namely:**
  (a) Biotic agents
  (b) Abiotic agents

Abiotic Agents

- There are two abiotic agents namely, wind and water which help pollination to takes place.

Pollination by Wind

- The pollination taking place by the wind is called anemophily.
- Wind and water pollinated flowers are not very colourful and do not produce nectar.
- Wind pollinated flowers often have a single ovule in each ovary.
- Numerous flowers remain packed into an inflorescence.
- Example – In corn cob, the tassels are the stigma and style wave in the wind to trap pollen grains. Wind pollination is commonly seen in grasses.

Key Words

Synchrony: Fluctuation of multiple populations of different places in the same way.

Stigma receptivity: Ability of stigma to support viable anther for germination.

Characteristics of Anemophilous flowers

- The flowers produce an enormous amount of pollen.
- The pollen grains are light and non-sticky so that they can be transported through wind currents.
- They often possess well-exposed stamens for easy dispersal of pollens into wind currents.
- They have large, feathery and sticky stigma to trap air-borne pollen grains.

Pollination by Water

- The pollination taking place by water is called hydrophily.
- It is limited to about 30 genera, mostly monocotyledons.
- In *Vallisneria*, the female flowers reach the surface of the water by the long stalk and the male flowers or pollen grains are released on to the surface of the water. These male flowers or pollen grains are carried by water currents and reach the female flowers.

- In sea grasses, the female flowers remain submerged in water and the long, ribbon-like pollen grains are carried inside the water and reach the stigma.
- The pollen grains of most of the water-pollinated species have a mucilaginous covering to protect from wetting.
- Not all aquatic plants use hydrophily. For example, in aquatic plants like water hyacinth, water lily, etc., the flowers emerge above the level of water for entomophily or anemophily i.e., for pollination to takes place by insects or wind.
- It is seen in *Vallisneria* & *Hydrilla* (freshwater), *Zostera* (marine sea-grasses), etc.

Biotic Agents

- Some flowering plants use animals as pollinating agents like Bees, butterflies, flies, beetles, wasps, ants, moths, birds (sunbirds and hummingbirds) bats, some primates (lemurs), arboreal (tree-dwelling) rodents, reptiles (gecko lizard & garden lizard) etc.
- When the pollination takes place by insects, it is known as entomophily.
- Often flowers of animal pollinated plants are specifically adapted for a particular species of animal.
- When the animal comes in contact with the anthers and the stigma, pollen grains may get stuck to the body of the animals, which results in pollination.
- **S**ome plants provide safe places as a floral reward to lay eggs as seen in *Amorphophallus***,** the tallest flower.
- There is a very close obligatory symbiotic relationship between the species of moth (*Pronuba***)** and the plant *Yucca*. They cannot complete their life cycles without each other. The moth deposits its eggs in the locule of the ovary and the flower gets pollinated by the moth. The larvae of the moth come out of the eggs as the seeds start developing.
- Many insects consume pollen or nectar without bringing about pollination. They are called pollen/nectar robbers.

Characteristics of Entomophilous Flowers

- Flowers are large, colourful, fragrant and rich in nectar.
- When the flowers are small, they form inflorescence to make them visible.
- The flowers pollinated by flies and beetles secrete foul odours to attract these animals.
- The pollen grains are generally sticky.

Key Words

Unisexual flowers: Flower which contain only one i.e., either male or female reproductive parts in it.

Monoecious: An individual possessing both male and female reproductive organs.

Outbreeding Devices (Devices for promoting Cross-Pollination)

- To avoid self-pollination, cross-pollination is encouraged in plants as follows:

(a) Avoiding Synchronisation

- In some species, pollen release and stigma receptivity are not synchronised.
- Either the pollen is released before the stigma becomes receptive or the stigma becomes receptive before the release of pollen i.e., the anther and stigma mature at different times. This phenomenon is called dichogamy. It prevents autogamy.

(b) Arrangement of Anther and Stigma at different Positions

- In some species, the arrangement of anther and stigma at different positions prevents autogamy.

(c) Self-incompatibility

- It is a genetic mechanism that prevents pollen of one flower to germinate on the stigma of the same flower on of the same plant due to the presence of similar sterile genes in pollen and stigma.

(d) Production of Unisexual Flowers (Dicliny)

- **Monoecious** plants such as castor and maize, where the male and the female flowers are present on the same plant prevents autogamy but not geitonogamy. On the other hand, dioecious plants like papaya, where the male and female flowers are present on different plants prevent both autogamy and geitonogamy.

Pollen-pistil Interaction

Scan to know more about this topic

Pollen-Pistil interaction

- It is a dynamic process involving pollen recognition followed by promotion or inhibition of the pollen.
- This interaction takes place through the chemical components produced by them.
- If the pollen is compatible, then the pistil accepts it and promotes post-pollination events.
- 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.
- The pollen tube grows through the tissues of the stigma and style and reaches the ovary.
- If the pollen is incompatible, then the pistil rejects the pollen by preventing pollen germination on the stigma or the pollen tube growth in the style.
- In some plants, the pollen grains are shed at the two-celled stage, the generative cell divides and forms the two male gametes during the growth of the pollen tube on the stigma.
- In plants that shed pollen in the three-celled stage, the pollen tubes carry two male gametes from the beginning.
- The pollen tube, after reaching the ovary, enters the ovule through the micropyle chalaza/integuments and then enters one of the synergids through the filiform apparatus.
- The filiform apparatus present at the micropylar part of the synergids guides the entry of the pollen tube.
- A plant breeder can manipulate pollen-pistil interaction, even in incompatible pollinations, to

get desired hybrids.

Artificial Hybridisation

- It is one of the major approaches of crop improvement programme by using desired pollen grains for pollination.
- This is achieved by emasculation and bagging techniques.
- Emasculation is the removal of anthers by using forceps from the **bisexual flower** bud of female parent before the anther dehiscence.

Key Words

Bisexual flower: Flower containing both male and female reproductive organs.

Synergids: In angiospermic flowers, one of the two small cells lying near the micropyle in the embryo sac.

- The emasculated flowers are then covered with a suitable bag made up of butter paper to prevent contamination of its stigma with unwanted pollen. This is called bagging.
- When the stigma attains receptivity, the mature pollen grains collected from anthers of the male parent are dusted on the stigma. Then the flowers are rebagged and allowed to develop the fruits.
- If the female parent produces unisexual flowers, there is no need for emasculation.
- The female flower buds are bagged before the flowers open.
- When the stigma becomes receptive, pollination is carried out using the desired pollen and the flower rebagged.

Double Fertilisation

Scan to know more about this topic

Double fertilisation

- The pollen tube after entering one of the **synergids** releases its contents including the two male gametes into the cytoplasm of the synergid.
- One of the male gametes moves towards the egg cell and fuses with its nucleus by the process of syngamy to form a diploid cell called the zygote.
- The other male gamete moves towards the two polar nuclei located in the central cell and fuses with them to produce a triploid primary endosperm nucleus (PEN).
- As this involves the fusion of three haploid nuclei, it is called triple fusion.
- Since two types of fusions viz. syngamy and triple fusion take place in an embryo sac, it is called double fertilisation.
- The central cell after triple fusion becomes the primary endosperm cell (PEC) and develops into the endosperm while the zygote develops into an embryo.
- It is an event unique to flowering plants.

OBJECTIVE TYPE QUESTIONS (1 mark each)

A Multiple Choice Questions

Q. 1. 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 U

Ans. Option (C) is correct.

Explanation: Autogamy is a method of self-pollination. It is a process in which the stigma of a flower receives pollens from the anther of same flower. For autogamy both the sex organs of a chasmogamous flower should mature at the same time. As chasmogamous flowers open at maturity, pollen release and stigma receptivity should be synchronised for the process of autogamy. In such flowers, the length of anther and stigma plays secondary role in autogamy, e.g., in case of protandry (in which pollens mature early) and protogyny (in which stigma matures early) leads to cross-pollination.

Q. 2. 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. E

Ans. Option (A) is correct.

Explanation: The pollination that occurs in opened flowers is called chasmogamy. It is of two types, that is, self-pollination (autogamy) and cross-pollination. Cross-pollination is of two types, that is, geitonogamy and xenogamy. So, we can say that chasmogamous flowers exhibit both autogamy (self-pollination) and allogamy (cross pollination). While, in cleistogamous flower the anthers and stigma lies close to each other within the closed flowers.

When anthers dehisce in the flower buds, pollen grains come in contact with the stigma for effective pollination. Thus, these flowers are invariably autogamous as there is no chance of cross-pollen landing on the stigma.

Q. 3. 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 U

Ans. Option (C) is correct.

Explanation: Plants use two abiotic (wind and water) and one biotic (animals) agent to achieve pollination. Majority of plants use biotic agents for pollination. Pollination by wind is more common amongst abiotic pollination. It requires the light and non-sticky pollen grains so that, they can be transported in wind currents. They often possess well-exposed stamens (so that the pollens are easily dispersed into wind currents) and large often feathery stigma to easily trap air-borne pollen grains. Wind pollination is common in grasses. Pollination by water is called hydrophily which is quite rare in flowering plants but occurs in aquatic plants. Zoophily is pollination through the agency of animals. Entomophily (pollination by insects) is the most common type of zoophily which occurs through the agency of animals.

Q. 4. From among the situations given below, 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 **A**

Ans. Option (B) is correct.

Explanation: Dioecious plants (bearing either male or female flowers) prevent both autogamy and geitonogamy. Autogamy is a method of self-pollination in which the transfer of pollen grains from anther to stigma of the same flower takes place. Geitonogamy is the transfer of pollen grains from anther to stigma of another flower of the same plant. It is ecologically cross-pollination which is supposed to be equivalent to self-pollination because all flowers on a plant are genetically identical.

Q. 5. While planning for an artificial hybridisation 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 **A**

Ans. Option (C) is correct.

Explanation: Artificial hybridisation is one of the major methods of crop improvement programme.

This cross will make sure that only the desired pollen grains are used for pollination and the stigma is protected from contamination (from unwanted pollen). This is achieved by emasculation and bagging techniques. If the female parent produces unisexual flowers, there is no need for emasculation (a process of removal of anther). The female flower buds are bagged before the flowers open. When the stigma becomes receptive, pollination is carried out using the desired pollen and the flower rebagged. This protects them from contamination by unwanted pollen grains. When the female parent bears bisexual flowers, removal of anthers from the flower bud before the anther dehisce is necessary.

Q. 6. In a flower, if the megaspore mother cell forms megaspores without undergoing meiosis and if one of the megaspores develops into an embryo sac, its nuclei would be:

(A) Haploid
(B) Diploid
(C) A few haploid and a few diploid
(D) With varying ploidy. **E**

Ans. Option (B) is correct.

Explanation: In some species, the diploid egg cell is formed without reduction division and develops into an embryo without fertilisation. It is a sexual reproduction which occurs in the absence of pollinators or in extreme environments. In some species like citrus plants, nucellar cells surrounding the embryo sac start dividing and develop into embryos. It occurs in the megaspore mother cell without undergoing meiosis and produces diploid embryo sac through mitotic divisions. It helps in the preservation of desirable characters for indefinite period. Thus, it can be concluded that apomictic species produce diploid cells. Haploid cells will be formed during sexual reproduction when cell will undergo meiosis.

Q. 7. Which one of the cell in an embryo-sac produce endosperm after double fertilisation? **A**

(A) Synergids cell **(B)** Antipodal cell
(C) Central Cell **(D)** Egg

Q. 8. 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. **K**

Ans. Option (A) is correct.

Explanation: In a fertilised embryo sac, the haploid, diploid and triploid structures are synergids, zygote and primary endosperm nucleus respectively.

Q. 9. In an embryo sac, the cells that degenerate after fertilisation are:

(A) Synergids and primary endosperm cell.
(B) Synergids and antipodals.
(C) Antipodals and primary endosperm cell.
(D) Egg and antipodals. **U**

Ans. Option (B) is correct.

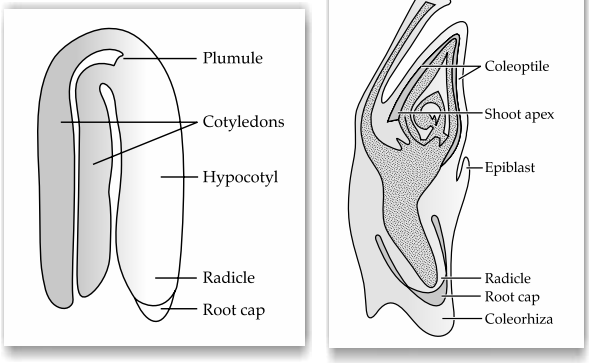
Explanation: In unfertilised embryo sac, the antipodals and synergids are distinctly present at chalazal end and micropylar end respectively while, in fertilised embryo sac, antipodals and synergids gradually degenerate after the formation of zygote.

Q. 10. In the embryos of a typical dicot and a grass, true homologous structures are:

(A) Coleorhiza and coleoptile
(B) Coleoptile and scutellum
(C) Cotyledons and scutellum
(D) Hypocotyl and radicle. K

Ans. Option (C) is correct.

Explanation: A typical dicotyledonous embryo consists of two cotyledons. While, embryos of monocotyledons possess only one cotyledon and it is called scutellum (in grass). Cotyledons of dicots, are simple structures generally thick and swollen due to storage of food reserves (as in legumes) and embryo of monocots consists of one large and shield shaped cotyledon known as scutellum situated towards one side (lateral) of the embryonal axis.



(A) **(B)**

Q. 11. 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. K

Q. 12. The phenomenon wherein, the ovary develops into a fruit without fertilisation is called:

(A) Parthenocarpy
(B) Apomixis
(C) Asexual reproduction
(D) Sexual reproduction K

Ans. Option (A) is correct.

Explanation: Parthenocarpy is the formation of seedless fruits without fertilisation. The fruits developed from unfertilised ovary are called parthenocarpic fruits.

Q. 13. Fragrant flowers with well developed nectaries are an adaptation for

(A) hydrophily **(B)** anemophily
(C) entomophily **(D)** None of these K

Ans. Option (C) is correct.

Explanation: Fragrant flowers with well-developed nectaries are an adaptation for entomophily. In entomophily, insects are the pollinating agents. These are the most common biotic agents of pollination.

Q. 14. The total number of nuclei involved in double fertilisation in angiosperm are

(A) two **(B)** three
(C) four **(D)** five K

Ans. Option (D) is correct.

Explanation: Double fertilisation is the process in angiosperms. It involves fusion of one male gamete (haploid) with egg (haploid) to form zygote (diploid) that gives rise to embryo accompanied with fusion of other male gamete (haploid) with two polar nuclei (secondary nucleus) to form primary endosperm nucleus (PEN) that gives rise to a nutritive tissue called endosperm.

Q. 15. Heterostyly as a contrivance for cross-pollination is found in

(A) *Pennisetum* **(B)** *Impatiens*
(C) *Primula vulgaris* **(D)** *Oenothera* K

Ans. Option (C) is correct.

Explanation: Heterostyly is the presence of 2–3 types of flower with different heights of styles and stamens. In dimorphic heterostyly, there are two types of flower, pin eyed (long style and short stamens) and thrum eyed (short style and long stamens), e.g., *Primula vulgaris* (primrose), jasmine.

B Assertion and Reason

Directions: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

(A) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(B) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(C) Assertion (A) is true but reason (R) is false.
(D) Assertion (A) is false but reason (R) is true.

Q. 1. Assertion (A): Cleistogamous flowers can produce seeds without pollination.

Reason (R): Cleistogamous flowers have no chance of cross pollination and they are invariably autogamous. U

Ans. Option (A) is correct.

Explanation: Cleistogamous flowers mean anther and stigma lie close to each other in the closed flower. They are bisexual which cannot open even at maturity and thus self-pollination occurs. As they are closed consider as invariable autogamous.

Q. 2. Assertion (A): Entomophilous flowers are large, colourful, fragrant and rich in nectar.

Reason (R): It helps in attracting the pollinating agent. U

Ans. Option (A) is correct.

Explanation: Entomophily is a type of pollination, which is carried out by insects. Fragrance and colour of the flower's attract insects.

Q. 3. Assertion (A): Perisperm is a haploid tissue.

Reason (R): Perisperm is the remains of nucellus which surround the embryo in certain seeds. K

These questions are for practice and their solutions are available at the end of the chapter

Ans. Option (D) is correct.

Explanation: Perisperm is a nutritive tissue of a seed derived from the nucellus and deposited externally to the embryo sac. It is diploid.

Q. 4. Assertion (A): Pea, bean, mustard are non-albuminous seeds.

Reason (R): These seeds retain a part of endosperm as it is not completely used up during embryo development. K

Q. 5. Assertion (A): Geitonogamous flowering plants are cross-pollinated plants.

Reason (R): In geitonogamous flowering plants, the pollen is transferred to the stigma of another flower of another plant. U

Ans. Option (C) is correct.

Explanation: In geitonogamous flower, the pollen is transferred to the stigma of another flower of the same plant.

Q. 6. Assertion (A): Fertilisation in flowers, produces fruits and seeds.

Reason (R): After fertilisation the ovary develops into fruits and ovule develops into seed. U

Q. 7. Assertion (A): Seed is the final product of sexual reproduction in angiosperms.

Reason (R): A seed typically bears seed coat, cotyledons and an embryonal axis. U

Ans. Option (B) is correct.

Explanation: After fertilisation, the ovary is developed into fruit and ovule develop into seed, and seeds are the final products of sexual reproduction. The seed bear protective seed coat, cotyledons and embryonal axis.

SUBJECTIVE TYPE QUESTIONS

Very Short Answer Type Questions (1 mark each)

Q. 1. Write one advantage and one disadvantage of cleistogamy to flowering plants.

AI U [CBSE, Comptt, Set 1,2,3, 2018]

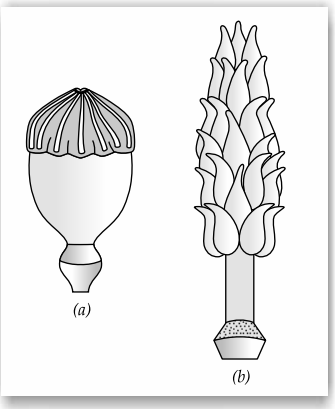
Ans. Advantage - Assured seed set / maintain pure lines ½

Disadvantage - No variation / only parental characters are preserved / it can lead to inbreeding depression ½

(Any one) [CBSE Marking Scheme, 2018]

Q. 2. Which one of the cell in an embryo-sac produce endosperm after double fertilisation? K

Q. 3. These pictures show the gynoecium of (i) *Papaver* and (ii) *Michellia* flowers. Write the difference in the structure of their ovaries.



U [Delhi Set-I, 2015] [Delhi, Comptt. 2015]

Ans. (i) Multicarpellary ovary showing fused syncarpous pistil.

(ii) Multicarpellary ovary showing free apocarpous pistil.

[CBSE Marking Scheme, 2015] ½ + ½

Q. 4. If the stamens are well exposed usually which mode of pollination the plant is expected to follow ? K

Q. 5. What is chiropterophily? K

Ans. The pollination of plants by bats is called chiropterophily. **1**

Q. 6. Write down characteristic features of flower's of insect pollinated plants? K

Ans. Flower's of insect-pollinated plants are colourful, fragrant and they secrete nectar. [Outside Delhi Set-II, 2020]

Short Answer Type Questions-I (2 marks each)

Q. 1. Name and explain the technique that can be used in developing improved crop varieties in plants bearing female flowers only.

U [Outside Delhi Set-II, 2020]

Ans. Artificial hybridisation is one of the major approaches of crop improvement programme to improve crop yield. In this method, desired pollen grains are used for pollination. This is achieved by emasculation and bagging techniques. If the females parent is unisexual, then there is no need for emasculation. In this case, the female flower buds are directly bagged before the flowers open. When the stigma becomes receptive, suitable pollens are dusted onto it so as to allow germination. **2**

Q. 2. When are the non-flowering plants said to be homothallic and monoecious, and heterothallic and dioecious? give an example of each.

K [Outside Delhi Set-II, 2020]

Ans. In plants

(a) Bisexual term is used for homothallic and monecious plants, whereby male and female reproductive structures are found in the same plant. e.g., Cucurbits and coconuts.

These questions are for practice and their solutions are available at the end of the chapter

(b) Unisexual term is used for heterothallic and dioecious plants whereby male and female reproductive structures are on a different plant. e.g. papaya and date palm. **1+1**

Q. 3. Explain the process of pollination in *Vallisneria*. 1
K [Delhi Set-III, 2019]

Q. 4. You are conducting artificial hybridisation on papaya and potato. Which one of them would require the step of emasculation and why? However, for both, you will use the process of bagging. Justify giving one reason.
U [Delhi Set-I, 2019]

Ans. Potato **1**

Flowers of potato have both male and female reproductive parts in the same flower / bisexual flowers / monoecious plant. ½

Bagging: To prevent unwanted pollens from coming on the stigma. ½

[CBSE Marking Scheme, 2019]

Detailed Answer:

Emasculation is the removal of anthers from the flower bud before the anther dehisces to avoid self-pollination in flowers.

Potato requires emasculation as it bears bisexual flowers.

Papaya bears unisexual flowers, so, there is no need of emasculation.

Bagging is the process of covering the flowers bearing stigmas with a bag of suitable size, generally made up of butter paper.

Both (papaya and potato flowers) will require a bagging process to prevent contamination of their stigmas with unwanted pollen.

Emasculation and bagging ensure that the female flower is completely protected from contamination.

Q. 5. Gynoecium of a flower may be apocarpous or syncarpous. Explain with the help of an example each. K [Outside Delhi Set-II, 2016]

Ans. Carpels are free (apocarpous), e.g.: *Michelia*.
½ × 2 = 1

Carpels are fused (syncarpous), e.g.: *Papaver*.
(Any other suitable correct example)
½ × 2 = 1

[CBSE Marking Scheme, 2016]

Detailed Answer:

Gynoecium represents the female reproductive part of the flower. If a gynoecium has multiple, distinct (free, unfused) carpels, it is apocarpous. The example includes strawberry, buttercup, etc. If a gynoecium has multiple carpels fused into a single structure, it is syncarpous. The example includes Tulip and most flowers. **1+1=2**

Commonly Made Error

- Students often get confused between the terms-syncarpous and apocarpous.

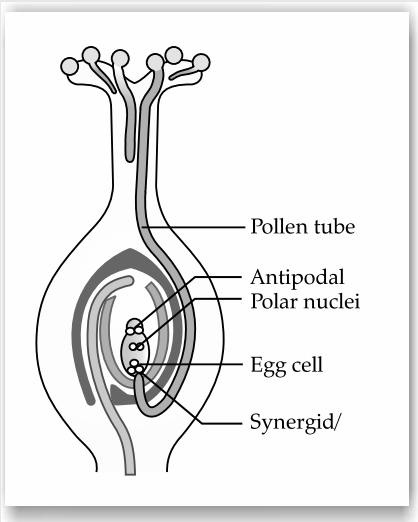
Answering Tip

- Carefully understand the terms with suitable example.

Short Answer Type Questions-II (3 marks each)

Q. 1. Draw a well-labelled diagram of L.S of a pistil of a flower showing the passage of growing of pollen tube up to its destination. K **[CBSE SQP 2020]**

Ans.



(Diagram =1 Mark) (Any four labellings ½ x 4=2)

[CBSE Marking Scheme, 2020]

Q. 2. Explain double fertilisation in an angiosperm.
U [Outside Delhi Set-II, 2020]

Ans. It is a characteristic feature of flowering plants. In this process, out of the two sperm nuclei, one sperm nucleus fuses with the egg nucleus to form an embryo (the process is called syngamy) and the other fuses with the secondary nucleus to form endosperm (the process is called triple fusion).

Because two kinds of fusion—syngamy and triple fusion—take place, the process is known as double fertilisation. **3**

Q. 3. Explain three different modes of pollination that can occur in a chasmogamous flower.
U [Delhi Set-I, 2020]

Q. 4. How does a bisexual flowering plant ensures cross pollination? Explain. U [Delhi Set-III, 2019]

Ans. -Pollen release and stigma receptivity are non synchronized, either the pollen is released before the stigma becomes receptive / stigma becomes receptive before the release of pollen. **½ × 2**

- Anther and stigma are placed at different positions, pollen cannot come in contact with the stigma of the same flower. **½ × 2**
- Self-incompatibility, prevents self pollen from fertilising the ovules. **½ × 2**

[CBSE Marking Scheme, 2019]

Detailed Answer:

Flowering plants have developed many devices to discourage self-pollination and to encourage

These questions are for practice and their solutions are available at the end of the chapter

cross-pollination. Such out-breeding devices are as follows:

(i) **Avoiding synchronisation:** In some species, pollen release and stigma receptivity are not synchronised. Either the pollen is released before the stigma becomes receptive or stigma becomes receptive before the release of pollen. It prevents autogamy.

(ii) **Arrangement of anther and stigma at different positions:** In some species, the arrangement of anther and stigma at different positions prevents autogamy.

(iii) **Self-incompatibility:** It is a genetic mechanism that prevents pollen of one flower from germinating on the stigma of the same flower.

Q. 5. (a) Differentiate between geitonogamy and xenogamy.

(b) Write the difference in the characteristics of the progeny produced as a result of the two processes. K [Delhi Set-II, 2019]

Ans. (a)

Geitonogamy	Xenogamy
• Transfer the pollen grains from anther to the stigma of another flower of the same plant.	• Transfer of pollen grains from the anther to stigma of a different plant of the same species.

1+1

(b) Characters of progeny in geitonogamy are same as parents/no variation/ introduces homozygosity (pure lines)/low rate of variation can cause inbreeding depression ½
Characters of progeny in Xenogamy are different from parents/ variation is observed/ genetically different from parent/ no inbreeding depression ½

[CBSE Marking Scheme, 2019]

Q. 6. (i) What are the benefits of choosing a dioecious plant species for plant breeding experiments?

(ii) How would you proceed to cross-pollinate a monoecious flower? K [Foreign, Set- I 2017]

Ans. (i) (Unisexual) self pollination avoided, emasculation not required ½ + ½

(ii) (a) Emasculation
(b) Bagging
(c) Pollination by spraying desired pollen
(d) Rebagging ½ × 4

[CBSE Marking Scheme, 2017]

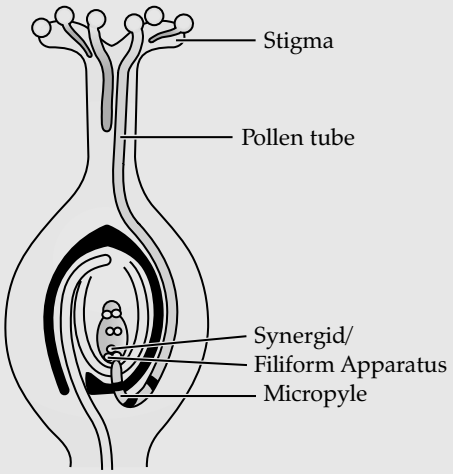
Q. 7. (a) Can a plant flowering in Mumbai be pollinated by pollen grains of the same species growing in New Delhi? Provide explanations to your answer. AE

(b) Draw the diagram of a pistil where pollination has successfully occurred. Label the parts involved in reaching the male gametes to its desired destination.

AI U [Outside Delhi Set-I, 2017]

Ans. (a) Yes, By artificial means (any relevant explanation). ½+½

(b) Diagram with following labelling
Stigma, Pollen tube, Synergids / Filiform Apparatus, Micropyle ½×4



[CBSE Marking Scheme, 2017]

Detailed Answer:

(a) It is possible by artificial hybridisation where the pollen grain of one flower is introduced artificially on the stigma of another flower. But there should not be self-incompatibility.

- For this, in one flower emasculation i.e. removal of anthers is done and then the flower is bagged.
- After some time, the bag is removed and then desired pollen grains are introduced on its stigma. **1+2**

Q. 8. Explain the process of pollination in *Vallisneria.* How is it different in water-lily, which is also an aquatic plant? U [Outside Delhi Set-II 2017]

Ans. In *Vallisneria,* pollination takes place through water, the female flower reach the surface of water by long stalk, male flowers / pollen grain released on to the surface of water, carried passively by water current reaching the female flowers / stigma. ½ × 4=2

In Water lily, pollination takes place through wind or insect, female flower emerges above the surface of water and gets pollinated.

[CBSE Marking Scheme, 2017] ½ × 2 =1

Topper Answer, 2017

OR

13. Vallisneria shows hydrophilic pollination ie, pollination is done with the help of water as ~~a~~ agent. Vallisneria is an aquatic plant, found in freshwater. It shows epihydrophily ie, pollination occurs at the surface of water. The female flowers reach the surface of water by their long stalks. Male flowers or pollen grains are also released on to the surface of water, which are carried passively by water currents. Some pollen grains reach the stigma of female flower and effects pollination (The pollen grains are covered with mucilagenous covering to avoid wetting.)

Water - lily, although being an aquatic plant, is pollinated by wind or some insects as in the case of terrestrial plants. This is because the flowers of water lily are present much above the surface of water / water level. Hence hydrophily do not occur.

Long Answer Type Questions (5 marks each)

Q. 1. (a) Explain the process of syngamy and triple fusion in angiosperms.

(b) Trace the development of the product of syngamy up to its mature stage in a dicot plant.

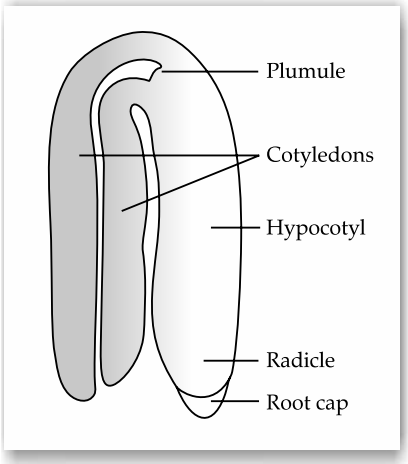
(c) Draw and label three important parts of a mature dicot embryo. K [Delhi Set-II, 2020]

Ans. (a) When the pollen grain falls on the stigma, they germinate and give rise to the pollen tube that passes through the style and enters into the ovule. After this, the pollen tube enters one of the synergids and releases two male gametes. Out of the two male gametes, one gametes fuses with the nucleus of the egg cell and forms the zygote. The process is known as syngamy. The other male gamete fuses with the two polar nuclei located in the central cell to form a triploid primary endosperm nucleus (PEN). Since, the process involves the fusion of three haploid nuclei, it is known as triple fusion.

(b) The product of syngamy is zygote. It develops into an embryo having two cotyledons. The steps are:

- Embryo develops at the micropylar end of the embryo sac where the zygote is situated.
- The zygote gives rise to the proembryo and subsequently to the globular, heart-shaped and mature embryo.
- A typical dicot embryo consists of an embryonal axis and two cotyledons.
- The portion of embryonal axis, which lies above the level of cotyledon, is the known as epicotyl. It terminates with the plumule (shoot tip).
- The cylindrical portion of the embryonal axis, which lies below the level of cotyledons, is hypocotyl. It terminates with the radicle (root tip). The root tip is covered with a root cap.

(c) Structure of a dicotyledonous embryo:



2+2+1

Q. 2. (a) Describe the process of double fertilisation in angiosperms. U [Delhi Set III, 2020]

(b) Trace the development of polyploid cell that is formed after double fertilisation in a non-albuminous seed and albuminous seed. A

Ans. (a) Double fertilisation is unique event to flowering plants. When the pollen grain falls on the stigma, they germinate and give rise to the pollen tube that passes through the style and enters into the ovule.

After this, the pollen tube enters one of the synergids and releases two male gametes.

Out of the two male gametes, one gametes fuses with the nucleus of the egg cell and forms the zygote. The process is known as syngamy.

The other male gamete fuses with the two polar nuclei located in the central cell to form a triploid primary endosperm nucleus (PEN). Since, the process involves the fusion of three haploid nuclei, it is known as triple fusion.

Since two kinds of fusions (syngamy and triple fusion) take place in an embryo sac it is known as double fertilisation.

(b) The triploid endosperm nucleus formed during double fertilisation leads to the formation of the triploid primary endosperm cell (PEC). This PEC undergoes repeated mitotic divisions to form a multicellular triploid endosperm. This serves as the nutritive tissue for the budding embryo within the seed.

In the case of albuminous seeds, the endosperm is retained and in many cases, a rudimentary cotyledon often termed as Scutellum is derived from it in case of monocots.

In case of non-albuminous seeds, this multicellular triploid endosperm is almost completely utilised or digested or absorbed to aid in the formation of fleshy cotyledon tissue as in case of most dicot seeds. **3+2**

Q. 3. (a) Explain the process of double fertilisation in angiosperms.

(b) Why does the development of endosperm proceeds that of embryo?

(c) List the parts of a typical dicot embryo.

AI K **[Delhi Set-II, 2019]**

Ans. (a) (i) One male gamete fuses with the egg cell in the embryo sac to form a zygote (2n), called syngamy ½ + ½

(ii) Other male gamete fuses with two polar nuclei to form PEN (primary endosperm nucleus) (3n), triple fusion ½ + ½

(iii) Both syngamy and triple fusion together called as double fertilization ½

(b) Endosperm contains the reserve food material which is used for the nutrition of developing embryo. **1**

(c) Radicle, Plumule, Cotyledons. ½ × 3

[CBSE Marking Scheme, 2019]

Q. 4. (a) Describe any two devices in a flowering plant which prevent both autogamy and geitonogamy.

(b) Explain the events upto double fertilisation after the pollen tube enters one of the synergids in an ovule of an angiosperm.

AI U **(Outside Delhi, 2018)**

Ans. (a) (i) Production of unisexual flower (in different plants) **1**

(ii) Self incompatibility. **1**

(b) (i) Pollen tube releases 2 male gametes in the cytoplasm of synergid.

(ii) One male gamete fuses with egg cell syngamy, resulting in diploid zygote.

(iii) Other male gamete fuses with polar nuclei / triple fusion, to form triploid PEN (Primary Endosperm Nucleus) / PEC (Primary Endosperm Cell). **1 × 3 [CBSE marking scheme, 2018]**

Topper Answer, 2017

OR

(a) → Self-incompatibility ~~+~~ this is a genetic mechanism present in plants in which the pollen grain either from the same flower or a different flower of the same plant is prevented from ~~fertilising the ovules~~ reaching the ovary by inhibiting pollen germination on the stigma or pollen tube growth in the style.

& → Production of unisexual flowers ~~&~~ in which male and female ~~&~~ flowers are present on different plants. This device is called dioecy.

Thus, both the devices prevent autogamy and geitonogamy.

b) After the pollen tube enters one of the synergids, two male gametes are released into the cytoplasm of the synergids. One of the male gamete moves towards the egg cell, fuses with the nucleus to form the diploid zygote. The other male gamete moves towards the large central cell, fuses with the two polar nuclei to form the ~~triploid~~ triploid primary endosperms nucleus.
The process in which the male gamete fuses with the egg cell is called syngamy and the process in which the haploid male gamete fuses with the two haploid polar nuclei is called triple fusion.
As there are two types of fusion - syngamy and triple fusion in the embryo sac, this is called double fertilisation - an event unique to angiosperms.

Q. 5. (i) Geitonogamy and xenogamy, both require pollinating agents, yet they are very different from each other. Explain how.

(ii) Describe the characteristics of flowers that are pollinated by wind.

A I Ap [Foreign Set-III 2017]

Ans. (i) Geitonogamy is the transfer of pollen grains from the anther to stigma / pollination of another flower of the same plant // self-pollination and genetically same pollen to the stigma. **1**

Xenogamy is transfer of pollen grain from the anther of one flower to the stigma of another flower of another plant of the same species / pollination of a flower of a different plant // cross pollination and genetically different type of pollens to the stigma. **1**

(ii) (a) Pollen grains are light, non-sticky.

(b) Well exposed stamens.

(c) Large and feathery stigma.

(d) Flowers often have a single ovule in each ovary / inflorescence. **(Any three)**

[CBSE Marking Scheme, 2017] 5

Q. 6. (a) When a seed of an orange is squeezed, many embryos, instead of one are observed. Explain how it is possible.

(b) Are these embryos genetically similar or different? Comment.

U [Outside Delhi Set-I, 2017]

Ans. (a) Polyembryony, nucellar cells surrounding embryo sac start dividing, protrude into the embryo sac and develop into many embryos. **1+1+1**

(b) These embryos are genetically similar, as produced from nucellus cells by mitotic division / formed without fertilisation (but different from the embryo formed by fertilisation). **1+1**

[CBSE Marking Scheme, 2017]

Detailed Answer:

(a) It is due to polyembryony.

Occurrence of more than one embryo in a seed is called polyembryony.

In orange, the nucellus cells, synergids or integument cells develop into several embryos of different sizes. e.g., Citrus.

Sometimes the formation of more than one egg in an embryo sac can lead to polyembryony.

(b) In such embryos, parental characters are maintained hence they are genetically similar. In this process, there is no segregation of characters in the offspring (progeny). **3+2**

Q. 7. (i) Explain the post-pollination events leading to seed production in angiosperms.

(ii) List the different types of pollination depending upon the source of pollen grain.

A I K [Delhi Set-I, 2016]

Ans. (i) Pollen pistil interaction, germination of pollen tube that carries two male gametes, double fertilisation/syngamy and triple fusion, development of endosperm, development of the embryo, maturation of ovule into a seed.

½ × 6 = 3

(ii) Autogamy / self pollination / Geitonogamy **1**

Xenogamy / cross pollination. **1**

[CBSE Marking Scheme, 2016]

Detailed Answer:

(i) Post-pollination changes leading to seed production are:

(a) Germination of pollen tube which will ultimately transfer two male gametes to the embryo sac.

(b) Double fertilisation: In this, one male gamete will fuse with the egg forming zygote (syngamy).
Male gamete (n) + Egg (n) → Zygote ($2n$)
Another male gamete will fuse with a central cell (2 polar nuclei) forming triploid Primary Endosperm Nucleus (PEN).
Male gamete (n) + Central cell ($2n$) → PEN (3 n) (Triple fusion)

(c) Zygote will develop into an embryo while PEN gives rise to endosperm.

(d) Integuments get hard and form the seed coat.

(e) Ovule is thus converted into a seed.

(f) Seeds are the fertilised ovules that are developed inside a fruit.

(ii) Depending on the source of pollen grains, pollination is of the following types:

(a) Autogamy: Where pollen of a flower reaches the stigma of the same flower.

(b) Geitonogamy: Pollen grain of one flower reaches the stigma of another flower of the same plant.

(c) Cross pollination or Xenogamy: When pollen grain of a flower from one plant pollinates the stigma of a flower on another plant. **3+2=5**

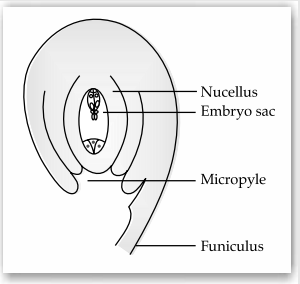
Q. 8. Explain the events upto fertilisation that occur in a flower after the pollen grain has landed on its compatible stigma. U [Foreign Set. I, 2016]

Q. 9. (a) As a senior biology student, you have been asked to demonstrate to the students of secondary level in your school, the procedure(s) that shall ensure cross-pollination in a hermaphrodite flower. List the different steps that you would suggest and provide reasons for each one of them. A

(b) Draw a diagram of a section of a megasporangium of an angiosperm and label funiculus, micropyle, embryo sac and nucleus. U

Ans. (a) Emasculation, removal of anthers from the flower bud before the anther dehisce to avoid self-pollination. ½ + ½
Bagging, to prevent contamination of its stigma with unwanted pollen grains. ½ + ½
Re- bagging, the stigma of the mature ovary is dusted with desired pollen grains and rebagged to allow the fruit to develop. ½ + ½

(b)



2

[CBSE Marking Scheme, 2016]

Detailed Answer:

(a) Cross-pollination of a hermaphrodite flower can be achieved by:

(i) Emasculation: It is the process of removal of anthers (using forceps) from the bisexual flower bud without affecting the female reproductive part, i.e., pistil.

(ii) Bagging: The emasculated flower is then covered with a suitable bag so as to prevent contamination of the stigma with unwanted pollen grains. When the stigma of the bagged flower becomes receptive, the pollen grains collected from the other flower are dusted onto the stigma and then the flower is re-bagged and allowed to develop the fruits.

Topic-3

Post-fertilisation Changes and Special Modes of Reproduction

Concepts Covered • *Embryo and its Development* • *Structure and types of Seed* • *Fruit and its types* • *Apomixis and Polyembryony*

Revision Notes

Embryo and its Development

Post-fertilisation Events

- The development of endosperm and embryo, the maturation of ovule(s) into seed(s) and ovary into fruit are post-fertilisation events.

Scan to know more about this topic

Post-fertilisation events

Endosperm Development

- The primary endosperm cell divides repeatedly by mitosis to form a triploid endosperm tissue.
- Endosperm cells are filled with reserve food materials that are used for the nutrition of the developing embryo.

These questions are for practice and their solutions are available at the end of the chapter

- During the endosperm development, the primary endosperm nucleus undergoes successive mitotic nuclear divisions to give rise to free nuclei. This stage is called free-nuclear endosperm.
- Then the endosperm becomes cellular due to the cell wall formation.
- For example, the tender coconut water is a free-nuclear endosperm that is made up of thousands of nuclei and the surrounding white kernel is the cellular endosperm.

Embryo Development

- The embryo develops at the micropylar end of the embryo sac where the zygote is situated.
- The zygotes divides only after the formation of a certain amount of endosperm to provide nutrition to the developing embryo.
- The development of embryo is similar in monocotyledons and dicotyledons up to the octant stage.
- The zygote gives rise to the pro-embryo and subsequently to the globular, heart-shaped and mature embryo.

Dicotyledonous Embryo

- It has a central embryonal axis and two lateral cotyledons.
- The portion of the embryonal axis above the level of cotyledons is the epicotyl, which terminates into the plumule (stem tip).
- The cylindrical portion below the level of cotyledon is hypocotyl that terminates into the radicle (root tip).
- The root tip is covered with a root cap.

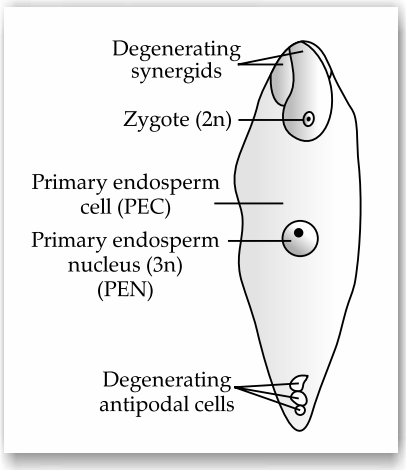


Fig 1.8: Fertilised embryo sac

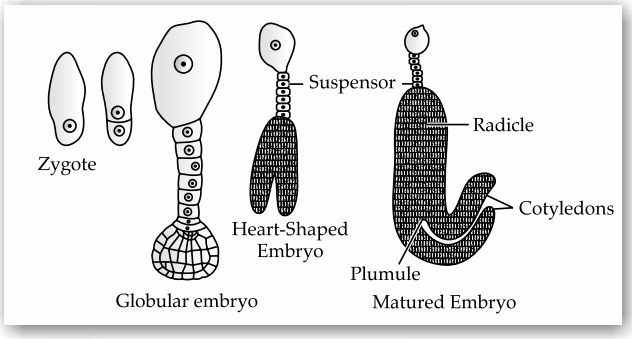


Fig. 1.9: Stages in embryo development in a dicot showing zygote and primary endosperm nucleus

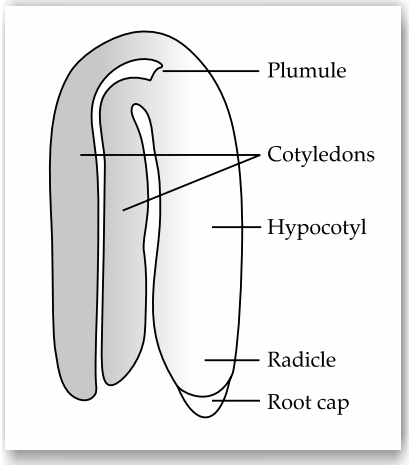


Fig 1.10: A typical dicot embryo

Monocotyledonous Embryo

- They possess only one cotyledon.
- In the grass family, the cotyledon is called the scutellum which is situated lateral to the embryonal axis.
- At its lower end, the embryonal axis has the radicle and root cap enclosed in an undifferentiated sheath called coleorhiza.
- The portion of the embryonal axis above the level of attachment of the scutellum is the epicotyl.
- It has a shoot apex and a few leaf primordia enclosed in a hollow foliar structure called coleoptile.

Seed

- Seed is the final product of sexual reproduction.
- It is the fertilised ovule formed inside fruits.
- It consists of the seed coat(s), cotyledon(s) and an embryonal axis.
- The cotyledons are simple, thick and swollen due to the storage of food as seen in most of the dicots.
- Mature seeds may be non-albuminous or albuminous.

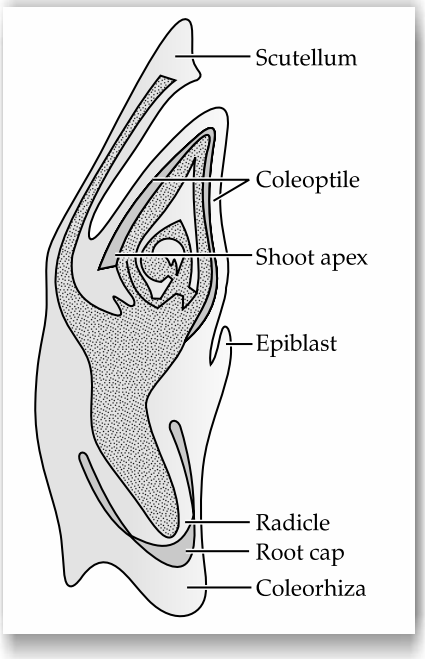


Fig 1.11: L.S of an embryo of grass

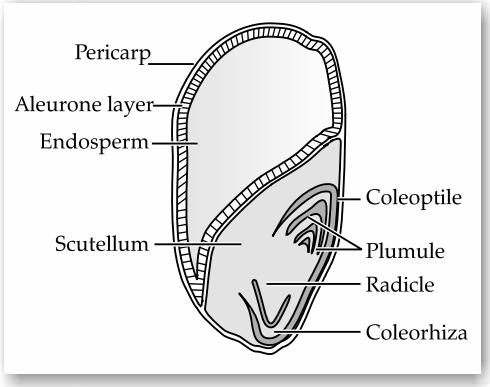


Fig 1.12: L.S (grain of maize)

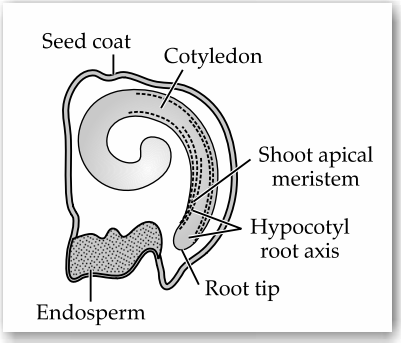


Fig 1.13: L.S. (monocot seed of onion)

- **Non-albuminous or Non-endospermic Seeds**
  - These seeds have no residual endosperm as it is completely consumed during embryo development.
    Examples - pea, groundnut, beans.

Key Word

Pericarp: Part of fruit formed from the wall of the ripened ovary.

- **Albuminous or Endospermic Seeds**
  - These seeds retain a part of the endosperm as it is not completely used up during embryo development.
    Examples: wheat, maize, barley, castor, coconut, sunflower.
  - In some seeds like black pepper, beet, etc., the remnants of nucellus also persistent. It is called the perisperm.
  - **I**nteguments of ovules harden as tough protective seed coats.
  - It has a small pore (micropyle) through which oxygen and water enter into the seed during germination.
  - As the seed matures, its water content gets reduced and the seeds become dry (10-15 % moisture by mass). The general metabolic activity of the embryo slows down.
  - The embryo may enter a state of inactivity (dormancy).
  - If favourable conditions are available such as adequate moisture, oxygen and suitable temperature, they germinate.
- **Fruit**
  - The ovary develops into a fruit after pollination and fertilisation.
  - The transformation of ovules into seeds and ovary into fruit proceeds simultaneously.
  - The wall of the ovary develops into a **pericarp**.
  - The fruits may be fleshy as seen in guava, orange, mango, etc., or may be dry as seen in groundnut, mustard, etc.,
  - Many fruits have mechanisms for the dispersal of seeds.
  - Fruits are of two types namely:
    - **(a) True fruits:** When the fruit develops only from the ovary and other floral parts degenerate and fall off, they are called true fruits. Examples- mango, maize, grape.
    - **(b) False fruits:** When parts of a flower other than the ovary also contribute to the fruit formation, they are called false fruits. Examples– apple, strawberry, cashew, etc.

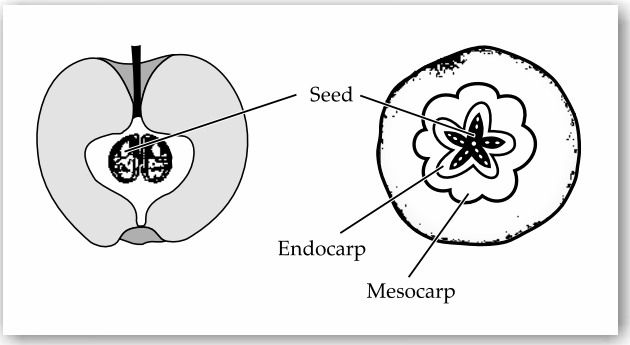


Fig 1.14: Sectional view of an apple

- In some species such as banana, the fruits develop without fertilisation, these fruits are called parthenocarpic fruits.
- Parthenocarpy can be induced through the application of **growth hormones**. Such fruits are seedless.

Advantages of Seeds

- The pollination and fertilisation processes are independent of water while the seed formation is more dependable.
- Seeds have better adaptive strategies for dispersal to new habitats and help the species to colonise in other areas.
- They have food reserves and so young seedlings are nourished until they are capable of photosynthesis.
- The hard seed coat protects the young embryo.
- Since seeds are the products of sexual reproduction, they generate new genetic combinations leading to variations.
- The dehydration and dormancy of mature seeds are crucial for the storage of seeds.
- It can be used as food throughout the year and also to raise a crop in the next season.

Viability of Seeds after Dispersal

- In a few species, the seeds lose viability within a few months or live for several years.
- Some seeds remain alive for hundreds of years.
- The oldest is lupine (*Lupinus arcticus*) excavated from Arctic Tundra. The seed germinated and flowered after an estimated record of 10,000 years of dormancy.
- 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.

Apomixis and Polyembryony

- Apomixis (apo = without; mixis = mixing together) means the production of seeds without fertilisation.
- It is seen in some species of Asteraceae and grasses.
- The apomixis is a form of asexual reproduction that mimics sexual reproduction.
- The occurrence of more than one embryos in a seed is called polyembryony.

Development of Apomictic Seeds

- In some species, the diploid egg cell is formed without reduction division and develops into the embryo without fertilisation.
- In species like Citrus and Mango varieties, some of the nucellar cells surrounding the embryo sac divide and protrude into the embryo sac and develop into the embryos. Hence, in these species, each ovule contains many embryos.

Key Word

Growth hormone: Hormones which stimulate cell division, flowering, enlargement, dormancy, abscission such as Auxins, Gibberellins, cytokinins, ethylene, ABA etc.

Importance of Apomixis in Hybrid Seed Industry

- Hybrid seeds have to be produced every year.
- If the seeds collected from hybrids are sown, the plants in the progeny will segregate and lose hybrid characters.
- The production of hybrid seeds is costly. Hence the cost of hybrid seeds is also expensive for the farmers.
- If the hybrids are made into apomict, there is no segregation of characters in the hybrid progeny. This helps farmers to use the hybrid seeds to raise new crop year after year without losing hybrid characteristics.

Mnemonics

1. Concept: Cells in Mature Embryo sac
Mnemonics: All **P**urpose **C**entral **E**ducation **S**enior **F**ederation
Interpretation: Antipodal, Polar nuclei, Central cell, Egg cell, Synergid, Filiform apparatus
2. Concept: L. S. of Grain of maize
Mnemonics: Personal **A**ssistant **E**ngineer and **S**enior **C**ommandant of **R**ailway **P**olice **C**rops.
Interpretation: Pericarp, Aleurone layer, Endosperm, Scutellum, Coleoptile, Radicle, Plumule, Coleorhiza

OBJECTIVE TYPE QUESTIONS (1 mark each)

Multiple Choice Questions

Q. 1. The coconut water from tender coconut represents:
(A) Endocarp
(B) Fleshy mesocarp
(C) Free nuclear endosperm
(D) Free nuclear pro-embryo U

Ans. Option (C) is correct.
Explanation: The coconut water from tender coconut represents free nuclear endosperm as it is made up of thousands of free nuclei.

Q. 2. The wheat grain has an embryo with one large shield-shaped cotyledon known as:

These questions are for practice and their solutions are available at the end of the chapter

(A) epiblast **(B)** coleorhiza
(C) scutellum **(D)** coleoptile

Ans. Option (C) is correct.

Explanation: The embryo of wheat have only-one cotyledon which is called scutellum. It is situated towards lateral side of embryonal axis.

Q. 3. Perisperm differs from endosperm in:

(A) being a haploid tissue
(B) having no reserve food
(C) being a diploid tissue
(D) its formation by fusion of secondary nucleus with several sperms

Ans. Option (C) is correct.

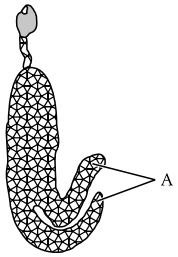
Explanation: Perisperm is the remains of nucellus surrounding the embryo before fertilisation. It is diploid.

SUBJECTIVE TYPE QUESTIONS

Very Short Answer Type Questions (1 mark each)

Q. 1. Identify 'A' in the figure showing a stage of embryo development in a dicot plant and mention its function.

K [Outside Delhi Set-I, Comptt. 2016]



Q. 2. Name the type of fruit apple is categorised under and why? Mention two other examples which belong to the same category as apple.

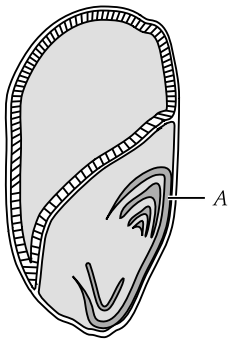
K **[Outside Delhi Set-III, Comptt. 2016]**

Ans. False fruit, thalamus contributes to fruit formation. Strawberry, Cashew (any other correct examples) ½ + ½

[CBSE Marking Scheme, 2016]

Q. 3. Given below is a section of a Maize grain. Identify 'A' and state its function.

K [Outside Delhi Set-II, III Comptt. 2016]



Ans. Coleoptile, protecting the shoot apex/plumule.

[CBSE Marking Scheme, 2016] ½ + ½

Short Answer Type Questions-I (2 marks each)

Q. 1. State two advantages of an apomictic seed to a farmer. U

Q. 2. It is said apomixis is a type of asexual reproduction. Justify. U **[Delhi Set-III, 2019]**

Ans. Apomixis is the formation of seeds or embryo without fusion of gametes / fertilisation/ Diploid egg cell is formed without reductional division and develops into the embryo without fertilisation / Some cells of the nucleus start dividing and develop into embryo. **(Any two) 1 + 1**

[CBSE Marking Scheme, 2019]

Q. 3. "For a common man both mango and strawberry are fruits, but not for a biology students". Justify.

E [Outside Delhi Set-II, 2019]

Ans. Mango is a true fruit as it develops from the ovary, strawberry is a false fruit as it is formed by the thalamus. **1 + 1**

[CBSE Marking Scheme, 2019]

Q. 4. Name a distinguishing structure seen in a mature black pepper seed and not in a pea seed. State how does it develop. E [Outside Delhi Set-III, 2019]

Ans. Perisperm is seen in a mature black pepper seed, the residual persistent nucleus is perisperm. **1+1**

[CBSE Marking Scheme, 2019]

Q. 5. (a) You are given castor and bean seeds. Which one of the two would you select to observe the endosperm?

(b) The development of endosperm precedes that of embryo in plants. Justify .

E [Outside Delhi Set-I, 2019]

Ans. (a) Castor **1**

(b) Endosperm stores reserve food materials / provides nutrition to the developing embryo **1**

[CBSE Marking Scheme, 2019]

Detailed Answer:

(a) Castor is to be selected for observing endosperm.
In beans, the endosperm is completely consumed by the developing embryo before the seed is formed while in castor, it is not utilised and thus persists in the seed.

These questions are for practice and their solutions are available at the end of the chapter

(b) Endosperm development precedes embryo development as the primary endosperm cell divides repeatedly and forms a triploid endosperm tissue. The cells of this tissue are filled with reserve food materials and are used for the nutrition of the developing embryo.

Q. 6. In case of polyembryony, an embryo A develops from the synergids and the embryo B develops from the nucellus. State the ploidy of embryo A and B. AI E

Ans. A- Haploid ; B- Diploid ½ + ½

[CBSE Marking Scheme, 2018]

Q. 7. Draw a sectional view of an apple and label the different parts of an ovary in it. Fruits develop from an ovary. Then why is apple referred to as a false fruit? K **[Foreign Set-III 2017]**

Ans. For diagram: Refer to Topic 3/ Revision Notes/ Fig 1.15

Thalamus also contributes to fruit formation

[CBSE Marking Scheme 2017] 1 + 1

Q. 8. Differentiate between pericarp and perisperm.

A **[Delhi Set-I, Comptt. 2017]**

Ans. Pericarp - wall of the fruit (which develops from the wall of ovary). **1**

Perisperm - persistent residual nucellus. 1

[CBSE Marking Scheme 2017]

Q. 9. For a layman, both apples and mangoes are 'fruits'. Do you agree? Give reasons in support of your answer. A **[Delhi Set-III Comptt. 2017]**

Ans. No. **1**

Apple - thalamus, (false fruit) ½

Mango - Ovary, (true fruit) ½

The parthenocarpic fruits never contain seeds.

[CBSE Marking Scheme, 2017]

Commonly Made Error

- Students often commit mistake in differentiating between true fruit, false fruit and parthenocarpic fruit.

Answering Tips

- Understand the concept of fruits carefully.
- Learn the differences between true fruits, false fruits and parthenocarpic fruits in tabular form for easy understanding and retention. Lay stress on examples of each.

Q. 10. Out of many papaya plants growing in your garden, only a few bear fruits. Give reason. K

Ans. Unisexual / Dioecious // male and female flowers are borne on separate plants, only plants bearing female flowers will bear fruits.

1 + 1 [CBSE Marking Scheme, 2016]

Q. 11. A single pea plant in your kitchen garden produces pods with viable seeds, but the individual papaya plant does not. Explain. Ap

Ans. Pea: Flowers of pea plants are bisexual, monoecious / self pollinated (to produce pods with viable seeds). ½ + ½

Papaya: Dioecious plant / unisexual plant bearing male and female flowers on separate plants, unable to produce viable seeds as there is no cross pollination / it could be a male plant which is unable to produce fruit and seeds. ½ + ½

[CBSE Marking Scheme, 2016]

Q. 12. A non-biology person is quite shocked to know that apple is a false fruit, mango is a true fruit and banana is a seedless fruit. As a biology student how would you satisfy this person?

A **[Delhi Set-I, 2015]**

Ans. The fruit is a ripened ovary where as seed develops from the ovule. Mango is a true fruit because it develops only from the ovary of the flower. Apple is a false fruit because here in this case along with the ovary thalamus of the flower also takes part in the formation of fruit. Banana is a seedless fruit as it develops without the stimulus of pollination and fertilisation. Such fruits are also called as parthenocarpic fruits. **2**

Short Answer Type Questions-II (3 marks each)

Q. 1. "Apomixis is a form of asexual reproduction that mimics sexual reproduction in plants". Explain with the help of a suitable example.

U **[CBSE SQP, 2020]**

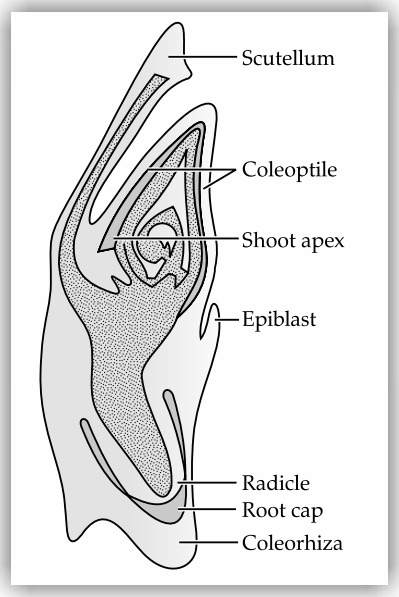
Ans. In some species, the diploid egg cell is formed without reduction division and develops into the embryo without fertilisation. **1**

In many *Citrus* and *Mango* varieties, some of the nucellar cells surrounding the embryo sac start dividing, protrudes into the embryo sac and develops into the embryos. In such species, each ovule contains many embryos. **2**

[CBSE Marking Scheme, 2020]

Q. 2. Draw L.S. of an embryo of grass and label its parts. AI U **[Outside Delhi Set-I, 2019]**

Ans.



(Any Three Correctly Labelled Parts) 1×3

Q. 3. If the meiocyte of a maize plant contains 20 chromosomes, write the number of chromosomes in the endosperm and embryo of the maize grain and give reasons in support of your answer.
E [CBSE, Comptt, Set 1,2,3, 2018]

Ans. Endosperm = 30 , Embryo = 20 ½ × 2
Diploid meiocyte (20 chromosomes) form haploid gametes (10 chromosomes).
Two haploid gametes fuse to form diploid (20) zygote which develops into a (diploid = 20) embryo / syngamy of two haploid gametes to form a diploid zygote. **1**
One haploid gamete (chromosome 10) fuses with two polar nuclei (chromosome 10 + 10) to form (triploid - 30) endosperm nuclei (which divides to form endosperm) / Triple fusion of three haploid nuclei (1 gamete + 2 polar nuclei) to form a triploid endosperm. **1**
[CBSE marking Scheme, 2018]

Commonly Made Error

- Students often get confused between the number of chromosomes in the endosperm and embryo.

Answering Tip

- Take sufficient practice of such questions.

Q. 4. Do you think apomixis can be compared with asexual reproduction? Support your answer, giving one reason. How is apomixis beneficial to farmers? Explain. A [CBSE, Comptt, Set 1,2,3, 2018]

Q. 5. Differentiate between parthenocarpy and parthenogenesis. Give one example of each. U

Q. 6.. Parthenocarpy and apomixis have been observed in some plants. Give an example of each. State a similarity and a difference observed between the two processes. U [Delhi Set-III 2017]

Ans.

Parthenocarpy.	Apomixis
Fruit is formed without fertilisation.	Seed is formed without fertilisation.
Seedless fruits are produced.	Fruits with seeds are produced.

(Any one difference) 1

e.g.,: Banana / grapes / any other correctly.

e.g.,: Species of Asteraceae / grasses /any other correctly. **1**

Similarity: In both processes development takes place without fertilisation. **1**

[CBSE Marking Scheme, 2017]

Q 7. (a) Trace the development of an endosperm after fertilisation with reference to coconut. Mention the importance of endosperm development.

(b) Write the importance of 'pollen bank'. A

Ans. (a) In coconut Primary Endosperm Nucleus (PEN-3n) undergoes successive nuclear divisions, give rise to free - nuclear endosperm known as coconut water, white kernel is the cellular endosperm, provides nourishment to the growing embryo. ½×4

(b) Storage / cryopreservation (storage in liquid nitrogen at – 196° C), to use in crop breeding programmes. ½+½

[CBSE Marking Scheme, 2017]

Detailed Answer:

(a) Endosperm development:
- The primary endosperm cell divides repeatedly to form a triploid endosperm tissue.
- Endosperm cells are filled with reserve food materials which are used as the nutrition by the developing embryo.
- During the endosperm development, the primary endosperm nucleus undergoes successive nuclear divisions to give rise to free nuclei. This stage is called free-nuclear endosperm.
- Then the endosperm becomes cellular due to the cell wall formation.
- *For example*, the tender coconut water is a free-nuclear endosperm that is made up of thousands of nuclei and the surrounding white kernel is the cellular endosperm.

(b) Pollen grains can be stored for years in liquid nitrogen at – 196°C. After this treatment, they are stored in pollen banks. Such conserved pollen grains can be later used in plant breeding programs. **2+1**

Q. 8. (i) How does a farmer use the dormancy of seeds to his advantage?

(ii) What advantages a seed provides to a plant?
U [Outside Delhi Set-II, 2016]

Ans. (i) For storage (dehydration) of seeds to be used as food, to raise the crop in the next season. ½ + ½

(ii) Seed formation is more dependable, better adaptive strategy for dispersal to new habitat, hard seeds protect young embryo, being a product of sexual reproduction they generate new genetic combinations / genetic variations / sufficient food reserve for the young seedling to be nourished.

[CBSE Marking Scheme, 2016] ½ × 4

Detailed Answer:

(i) Dormancy of mature seeds is crucial for storage of seeds. It can be used by farmers as food throughout the year and also to raise crop in the next season.

(ii) Advantages of seed to a plant:
(a) Seed formation is more dependable.
(b) Seeds have better adaptive strategies for dispersal to new habitats and help the species to colonise in other areas.
(c) Seeds have sufficient food reserves and hence can nourish the young seedlings until they are capable of photosynthesis.

These questions are for practice and their solutions are available at the end of the chapter

(d) The hard seed coat protects the young embryo.
(e) The seeds generate new genetic combinations leading to variations.
(f) Dehydration and dormancy of mature seeds are crucial for the storage of seeds which can be used as food throughout the year and also to raise a crop in the next season. **3**

Commonly Made Error

- Students forget to write the uses of seeds to plant clearly. They often repeat the points.

Answering Tip

- Students should write the advantages of seeds in points.

Q. 9. (i) How are parthenocarpic fruits produced by some plants and apomictic seeds by some others? Explain.
(ii) When do farmers prefer using apomictic seeds? A I U **[Outside Delhi Set-III, 2016]**

Ans. (i) In some species such as banana, the fruits develop without fertilisation, these fruits are called parthenocarpic fruits.
In some species, the diploid egg cell is formed without reduction division and develops into the embryo without fertilisation, the seeds produced are called apomictic seeds.
(ii) Hybrid varieties of food and vegetable crops are being extensively cultivated to increase their productivity.
- If these hybrids are made into apomicts, there is no segregation of characters in the hybrid progeny and the cost is reduced.
- The farmers can use the hybrid seeds to raise new crop year after year and are not required to buy hybrid seeds every year. **3**

Commonly Made Error

- Students often commit mistake in differentiating between true fruit, false fruit and parthenocarpic fruit.

Answering Tips

- Understand the concept of fruits carefully.
- Learn the differences between true fruits, false fruits and parthenocarpic fruits in tabular form for easy understanding and retention. Lay stress on examples of each.

Q. 10. Describe the development of endosperm after double fertilisation in an angiosperm. Why does endosperm development precedes that of zygote?
U **[Outside Delhi Set-I, 2015]**

Ans. (i) After triple fusion, the central cell develops into a primary endosperm cell which contain triploid primary endosperm nucleus.
(ii) The primary endosperm cell undergoes successive cell divisions to form triploid endosperm which has abundant food reserves.
(iii) The primary endosperm nucleus undergoes successive nuclear divisions to form many free nuclei. This type of endosperm development is called free nuclear endosperm, after which cell walls are laid and the endosperm becomes cellular endosperm. e.g., coconut water is nuclear endosperm (containing many free nuclei). While white kernel around is the cellular endosperm.
The endosperm development precedes that of zygote to ensure that endosperm containing abundant food reserves is formed earlier and can nourish the developing embryo. **3**

Q. 11. Double fertilisation is reported in plants of both, castor and groundnut. However, the mature seeds of groundnut are non-albuminous and castor are albuminous. Explain the post-fertilisation events that are responsible for it. U **[Delhi Set-I, 2015]**

Ans. Development of endosperm (preceding the embryo) takes place in both, developing embryo derives nutrition from endosperm
Endosperm is retained / persists / not fully consumed in castor, endosperm is consumed in groundnut. **1+1+1**
[CBSE Marking Scheme, 2015]

Detailed Answer:
Endosperm development precedes embryo development. The triploid primary endosperm nucleus (PEN) undergoes repeated mitotic divisions, without cytokinesis. At this stage of development, the endosperm is called free-nuclear endosperm. Cell wall formation takes place later on. As a result, the endosperm becomes partly or fully cellular. The cells of the endosperm store food materials, which are later used by the developing embryo.
In non-albuminous or non-endospermic seeds, the endosperm may be completely utilised by the developing embryo before the maturation of seeds e.g., pea, bean, groundnut, etc. In albuminuous or endospermic seeds, a portion of endosperm persists in the mature seeds. e.g., castor. **3**

Long Answer Type Questions (5 marks each)

Q. 1. (a) Explain any two ways by which apomictic seed can develop.
(b) List one advantage and one disadvantage of a apomictic crop.
(c) Why do farmers find production of hybrid seeds costly? U **[Delhi Set-I, 2019]**

Ans. (a) In some species, the diploid egg cell is formed without reduction division and develops into the embryo without fertilisation.
More often, as in many Citrus and Mango varieties, some of the nucellar cells surrounding the embryo sac start dividing, protrude into the embryo sac and develop into the embryos.
(b) Advantage: Apomixis is an effective means of rapid production of pure lines and provides an easy way of hybrid seed production.

Disadvantage: It reduces genetic diversity from parent to offspring plants due to a lack of variations in asexual reproduction.

(c) One of the problems of hybrids is that hybrid seeds have to be produced every year. If the seeds collected from hybrids are sown, the plants in the progeny will segregate and do not maintain hybrid characters. Production of hybrid seeds is costly and hence the cost of hybrid seeds become too expensive for the farmers. **5**

Q. 2. (a) Explain the process of double fertilisation in angiosperms.

(b) Why does the development of endosperm precedes that of embryo?

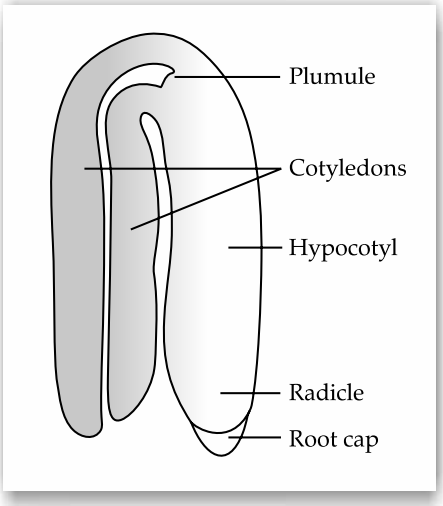
(c) List the parts of a typical dicot embryo.

U [Delhi Set-III, 2019]

Ans. (a) Process of double fertilisation: After entering one of the synergids, the pollen tube releases the two male gametes into the cytoplasm of the synergid. One of the male gametes moves towards the egg cell and fuses with its nucleus thus completing the syngamy. This results in the formation of a diploid cell, the zygote. The other male gamete moves towards the two polar nuclei located in the central cell and fuses with them to produce a triploid primary endosperm nucleus (PEN). As this involves the fusion of three haploid nuclei it is termed triple fusion. Since two types of fusions, syngamy and triple fusion take place in an embryo sac the phenomenon is termed double fertilisation.

(b) Endosperm development precedes embryo development as the primary endosperm cell divides repeatedly and forms a triploid endosperm tissue. The cells of this tissue are filled with reserve food materials and are used as the nutrition of the developing embryo.

(c) 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.



Structure of a dicotyledonous embryo **5**

Q. 3. (a) A capsicum flower has 240 ovules in its ovary. But, it produces a fruit with only 180 viable seeds.

Explain giving a reason that could be responsible for such a result.

(b) Describe the development of an endosperm in a viable seed. Why does endosperm development precede embryo development?

(c) Give an example of an angiosperm seed that has a perisperm. Name the part the perisperm develops from. E U [Delhi Set-I, 2017]

Ans. (a) Less number of pollen grains / male gametes were available / all pollen grains did not germinates / all pollen grains did not form pollen tubes / many pollen were not compatible / 60 ovules not fertilised / only 180 fertilised. **1**

(b) PEN undergoes successive nuclear divisions to give rise to free nuclei / free nuclear endosperm, cell wall formation occurs and the endosperm becomes cellular. **1+1**

Cells of endosperm are filled with reserve food materials that are used for nutrition of developing embryo. **1**

(c) Black pepper / beet. ½

Nucellus. ½

[CBSE Marking Scheme, 2017]

Detailed Answer:

(a) A seed is formed when an ovule is fuses with a pollen grain which carry male gamete; i.e., one pollen is require for one seed. In the above case it seems that not all the ovules fused with a pollen grains to form seeds and only 180 ovules were fertilised by pollen grains, so the reason could be:

(i) Less number of pollen grains may have landed on the stigma so less number of male gametes to fertilise all the 240 were unavailable

(ii) At the time of pollination pollen would have dry up. Dry up pollen could not be able to germinate on the stigma.

(iii) More temperature may have reduce the stickiness of stigma. So, stigma would have been pollinated with less effective pollen grains.

(iv) Some pollen grains may have failed to germinate due to shorter pollen tube.

(b) The endosperm development is a result of triple fusion. During triple fusion, one of the male gamete fuses with the two polar nuclei of the central cell and give rise to primary endosperm cell (PEC). The primary endosperm cell divides repeatedly and forms a triploid endosperm tissue. The most common type of endosperm development is free-nuclear, in which the PEN undergoes successive nuclear divisions to give rise to a number of free nuclei. The endosperm thus formed is called free nuclear endosperm. Subsequently cell formation occurs and the endosperm becomes cellular.

The endosperm thus developed is required to provide essential nutrients to the growing embryo.

Therefore endosperm development occurs before the embryo development.

(c) The perisperm is developed from the residual, persistent nucellus in some seeds. It is found in black pepper and beetroot. **5**

Q. 4. Read the following statement and answer the questions that follow:

"A guava fruit has 200 viable seeds".

(a) What are viable seeds?

(b) Write the total number of:

(i) Pollen grains

(ii) Gametes in producing 200 viable guava seeds.

(c) Prepare a flowchart to depict the post-pollination events leading to viable-seeds production in a flowering plant.

A [Delhi Set-I, 2017]

Ans. (a) Seeds that remain alive / gives rise to new plant / ability to germinate. **(Any one) 1**

(b) (i) 200. ½

(ii) 600 gametes / 400 male gametes / 200 female gametes. ½

(c) Pollen grain germinates on stigma, pollen tube carrying the male gametes reach the ovule, discharge male gametes near the egg, syngamy / fusion of male gamete with egg occurs to form zygote, triple fusion / fusion of male gamete with two polar nuclei to form PEN (Primary Endosperm Nucleus), ovule develops into seed. ½×6

[CBSE Marking Scheme, 2017]

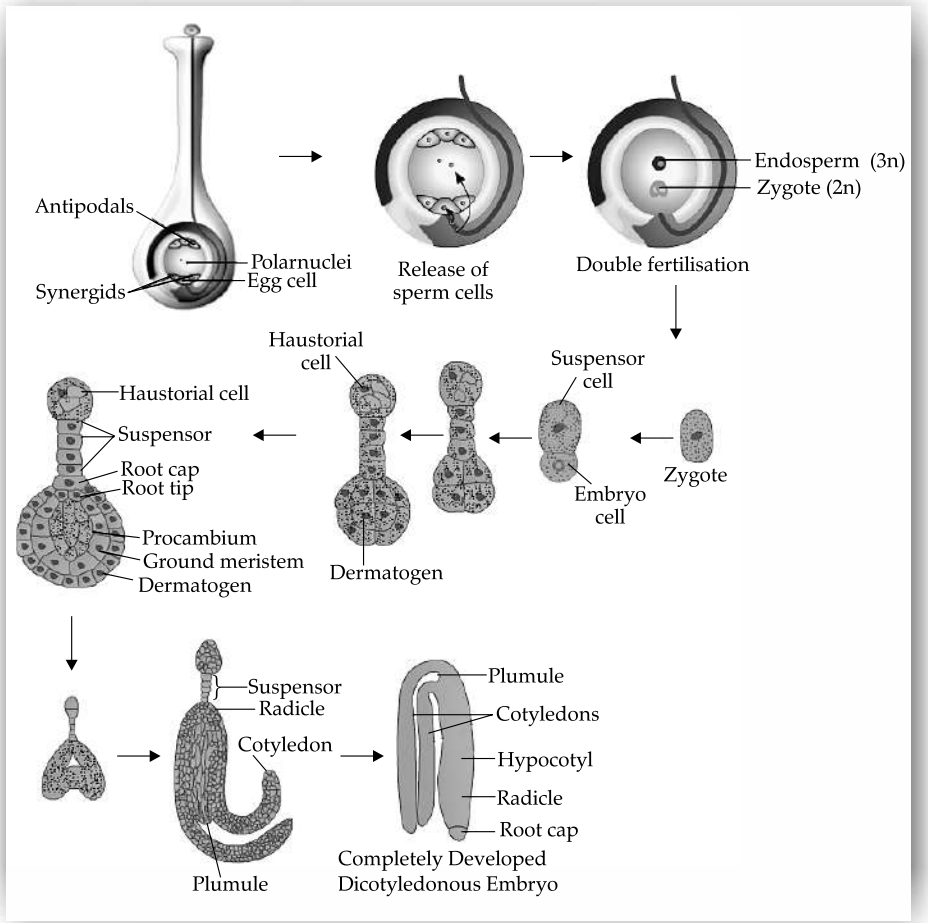
Detailed Answer:

(a) Those seeds that carry a living embryo and are capable of germinating into a seedling under appropriate conditions are termed as viable seeds.

(b) (i) Number of pollen grains required to form 200 seeds will be 200 only as each pollen grain carries two generative cells or male gametes and only one of the two are involved in zygote formation.

(ii) In total, 400 gamete cells are required for the production of 200 viable zygotes leading to the formation of 200 guava seeds.

(c) Flowchart depicting the post pollination events:



3

Q. 6. Read the statement and answer the questions that follow:

A flower of brinjal has 520 ovules in its ovary. However, it produces a fruits with only 480 viable seeds.

(a) What could have prevented the rest of the 40 ovules from mating into viable seeds? Explain giving a reasons.

(b) Describe the development of a dicot embryo in a viable seed.

(c) Why certain angiosperm seeds are albuminous while others are exalbuminous? Explain. **5**

A **[Delhi Set-II, 2017]**

Ans. (a) Less number of pollen grains / less number of male gametes were available / all pollen grains did not germinate / all pollen grains did not form pollen tubes / many pollen were not compatible / 40 ovules did not get fertilised / only 480 ovules were fertilised. **1**

(b) Zygote divides (mitotically) to give rise to pro embryo, globular, heart shaped, mature embryo (give marks if all stages shown correct diagrammatically). **½×4**

(c) Albuminous - Endosperm is not completely used up during embryo development / residual endosperm found in the seed. **1**

Ex-albuminous: Endosperm is completely consumed / no residual endosperm is left in the seed. **1**

[CBSE Marking Scheme, 2017]

Detailed Answer:

(a) A seed is formed when an ovule is fuses with a pollen grain that carries male gametes; i.e.,one pollen is require for one seed. In the above case it seems that not all the ovules fused with a pollen grains to form seeds and only 480 ovules were fertilised by pollen grains, so the reason could be:

(i) Less number of pollen grains may have landed on the stigma so less number of male gametes to fertilise all the 520 were unavailable

(ii) At the time of pollination, pollen would have dried up. Dried up pollen cannot germinate on the stigma.

(iii) More temperature may have reduce the stickiness of stigma. So, stigma would have been pollinated with less effective pollen grains.

(iv) Some pollen grains may have fail to germinate due to shorter pollen tube.

(b) Development of a dicot embryo:

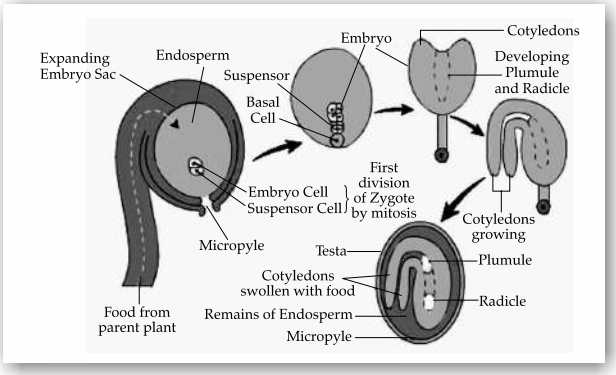
Zygote is the first cell of early embryo development in flowering plants including bean plant.

The zygote develops after the fusion of male sperm nuclei released from pollen grain with the egg present in the embryo sac. This fusion is called syngamy.

The embryo develops at the micropylar end of the embryo sac where the zygote is situated.

The zygote divides into a larger cell called suspensor cell towards the micropylar end and a smaller cell called embryonal cell towards antipodal cells.

The suspensor cell divides mitotically to form 6-10 celled structure called suspensor. The last suspensor cell is called hypophysis that forms radicle tip. The zygote divides mitotically and gives rise first to the pro-embryo, then to the globular and heart-shaped mature embryo. A typical dicot embryo consists of an embryonal axis and two cotyledons. The portion of the embryonal axis above the level of cotyledons is called epicotyl. It contains the plumule (shoot tip). The portion below the axis is called hypocotyl. It contains the radicle (root tip). The root tip is covered by the root cap.



(c) When zygote forms the embryo, the endosperm provides nourishment to the growing embryo. During this, the endosperm is utilised and eaten up. In the seeds like pea, gram etc. endosperm is completely eaten up by the growing embryo and the food for later development of the embryo is stored in cotyledons which become massive. Such seeds are ex-albuminous. While in seeds like castor and maize, the endosperm persists in the seed as food storage tissue and such seeds are albuminous. **5**

Commonly Made Error

- Students usually fail to label the diagram correctly.

Answering Tip

- Draw diagram with proper labelling. Incorrect labelling may deduct your marks.

Q 7. (a) Explain the post-pollination events leading to seed production in angiosperms.

(b) List the different types of pollination depending upon the source of pollen grain.

K **[Delhi Set-I, 2016]**

COMPETENCY BASED QUESTIONS (1 mark each)

Case based MCQs

I. Read the following passage and answer any of the four questions on the basis of the same:

Gynoecium, is the female reproductive part of the flower. It may consist of a single or more than one pistil. These pistil may be free or fuse. Each pistils has three parts, stigma, style and ovary. Ovary has an ovarian cavity, which has one or many chambers or locules. The placenta is located inside the ovarian cavity. Megasporangia or ovule arise from the placenta. K + Ap

Q. 1. In which of the following plants the number of ovules in an ovary is one?

(A) Mango **(B)** Orchids
(C) Water melon **(D)** Papaya

Ans. Option (A) is correct.

Explanation: Mango possess a single ovule in each ovary and orchids, watermelon, and papaya have multiple ovules present in each ovary.

Q. 2. A multicarpellary, syncarpous gynoecium is found in:

(A) *Papaver* **(B)** Brinjal
(C) Tomato **(D)** All

Ans. Option (D) is correct.

Explanation: *Papaver*, brinjal, and tomato all have multicarpellary, syncarpous gynoecium. In this condition carpels are more than one and fused.

Q. 3. 82% of ovules found in angiosperms are ..... .

(A) Anatropous **(B)** Amphitropous
(C) Orthotropous **(D)** Circinotropous

Ans. Option (A) is correct.

Explanation: Anatropous ovule is found in 82% angiosperm and it completely inverted ovule turned back 180 degrees on its stalk.

Q. 4. Which among the following cell is binucleate in an embryo sac?

(A) Antipodal cell **(B)** Central cell
(C) Synergid **(D)** Female gamete

Ans. Option (B) is correct.

Explanation: Central cell form binucleate endosperm mother cell upon fertilisation with one of the two sperm cells, forms triploid endosperm to nourish embryo development.

Q. 5. Flowers with both androecium and gynoecium are called:

(A) Bisexual flowers **(B)** Anther
(C) Unisexual flowers **(D)** Androgynous

Ans. Option (A) is correct.

Explanation: Androecium is the male part and gynoecium is the female part. The flowers, which have both of these are called bisexual flower.

II. Read the following passage and answer any of the four questions on the basis of the same:

A typical anther is bilobed. It is a tetragonal structure consisting of four microsporangia. These microsporangia form pollen sac which on maturity gets filled with a pollen grains. Pollen grains represent the male gametophytes, their cell wall is very hard. Pollen grains of many species cause severe allergies which cause various diseases in human beings. K + E

Q. 1. Which among the following is a major cause of pollen allergy in India?

(A) *Mirabilis* **(B)** *Myosotis*
(C) *Parthenium* **(D)** *Pistia*

Ans. Option (C) is correct.

Explanation: *Parthenium* is a invasive species in India, and its is also known as carrot grass or congress grass which is the major cause of allergy in India. The *parthenium* weed produces as much as 3,000 million pollen grains per square meter during the flowering season.

Q. 2. Select the odd one out with respect to wall layers of microsporangium in flowering plants.

(A) Integument **(B)** Tapetum
(C) Endothecium **(D)** Middle layers

Ans. Option (A) is correct.

Explanation: The integuments are the outer layer(s) of the ovule and develop into a seed coat as the ovule matures following fertilisation.

Q. 3. Study of pollen grains is called ..... .

(A) Bryology **(B)** Mycology
(C) Algology **(D)** Polynology

Ans. Option (D) is correct.

Explanation: Study of pollen grains is called polynology.

Q. 4. The prominent pollen grain aperture called germ pore is present in:

(A) Exine **(B)** Intine
(C) Vegetative cell **(D)** Generative cell

Ans. Option (A) is correct.

Explanation: The prominent pollen grain aperture called germ pore is present in exine. It is decay-resistant outer coating of a pollen grain or spore.

Q. 5. Assertion (A): The innermost layer of microsporangium is called tapetum.

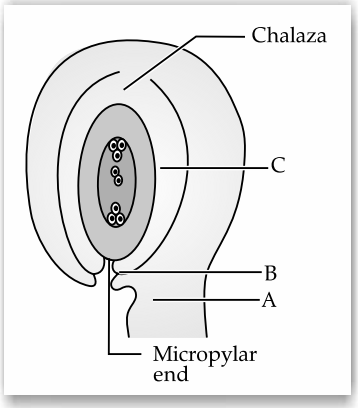
Reason (R): Tapetum nourishes the develop into pollen grains.

(A) Both assertion (A) and reason (R) are true and (R) is correct explanation of assertion (A).
(B) Both assertion (A) and reason (R) are true, but reason (R) is not the correct explanation of assertion (A).
(C) Assertion (A) is true, but reason (R) is false.
(D) Assertion (A) is false, but reason (R) is true.

Ans. Option (A) is correct.

Explanation: Cells of tapetum have dense cytoplasm and more than one nuclei, which help in nourishing the developing pollen grains.

III. Study the given diagram and answer any of the four questions given below:



U + R

Q. 1. This diagram represent which type of ovule:

(A) Atropous **(B)** Orthotropous
(C) Anatropous **(D)** Amphitropous

Ans. Option (C) is correct.

Explanation: Anatropous ovule is the completely inverted ovule turned back 180 degrees on its stalk. Ovule is a small body that contains the female germ cell of a plant; develops into a seed after fertilisation.

Q. 2. A is the stalk of the ovule and is called:

(A) Hilum **(B)** Pedicle
(C) Chalazal pole **(D)** Funicle

Ans. Option (D) is correct.

Explanation: Funicle is the stalk that attaches an ovule to the placenta in the ovary of a flowering plant. It contains a strand of conducting tissue leading from the placenta into the chalaza.

Q. 3. The junction of attachment of funicle with the body of ovule at B is:

(A) Funicle **(B)** Hilum
(C) Nucellus **(D)** Chalazal pole

Ans. Option (B) is correct.

Explanation: A scar on a seed (as a bean) marking the point of attachment of the ovule is called hilum. There is small pore, called micropyle, which represent the micropyle of ovule.

Q. 4. Tegmen develops from the part labelled C part in the figure is called:

(A) Inner integument
(B) Outer Integument
(C) Funicle
(D) Chalazal pole

Ans. Option (A) is correct.

Explanation: The seed has two layers: one is outer called the testa, which develops from the outer integument and another is inner layer called the tegmen, which develops from the inner integument of the ovule.

Q. 5. Assertion (A): Most common type of ovule is anatropous.

Reason (R): Anatropous ovule is horse-shoe shaped.

(A) Both assertion (A) and reason (R) are true and (R) is correct explanation of assertion (A).
(B) Both assertion (A) and reason (R) are true, but reason (R) is not the correct explanation of assertion (A).
(C) Assertion (A) is true, but reason (R) is false.
(D) Assertion (A) is false, but reason (R) is true.

Ans. Option (C) is correct.

Explanation: Funiculus lies at the micropylar end and due to the unilateral growth of the ovule it is called anatropous ovule. In angiosperms, the curvature of the ovule affects the nucellus and later it becomes horse shoe-shaped. Such ovule is called amphitropous.

Case based Subjective Questions

I. Read the given passage and answer the questions.

The pollen-pistil interaction begins with pollination, followed by pollen adhesion to the stigma. After it adheres, it imbibes water and gets hydrated which initiates pollen tube germination. There are different agents of pollination like wind, insects, birds and water. Anemophilous flowers are pollinated by the agency of wind. These flowers are small and inconspicuous.. The pollen grains are very light, non-sticky and sometimes winged. Entomophilic flowers are pollinated by insects. These flowers are often attractive to look at with bright petals and are fragrant to attract the insect visitors to them. They often have broad stigmas or anthers to allow the insect to perch on it. Many of the insect-pollinated flowers also secrete nectar which attracts bees, butterflies or other similar insects to the flowers. The pollen grain surface of such flowers produces mucilaginous secretion. Hydrophilic flowers are pollinated by water. It is commonly found in algae, bryophytes, pteridophytes and some angiosperms. The pollen grains may have a mucilaginous covering to protect it from getting wet. U + K

Q. 1. The pollen-pistil interaction is a dynamic process that involves pollen recognition. If the pollen is compatible, then the pistil accepts it and promotes post-pollination events. What happens if the pollen is incompatible to the stigma?

Ans. If the pollen is incompatible to the stigma, then the pistil rejects the pollen by preventing pollen germination on the stigma or the pollen tube growth in the style.

Q. 2. Mention the three types of pollination based on the sources of incoming pollen grains.

Ans. Pollination is of three types based on the source of pollens namely,

(i) Autogamy **(ii)** Geitonogamy
(iii) Xenogamy

Q. 3. Do all aquatic plants use hydrophily as the preferred mode of pollination? If yes, then justify with example and if no, give reason.

Ans. No, all aquatic plants does not adopt hydrophily. For example, in aquatic plants like water hyacinth, water lily, etc., the flowers emerge above the level of water for entomophily or anemophily i.e., for pollination to takes place by insects or wind.

Q. 4. Flowers generally have a sweet soothing smell. Why some flowers smell foul?

Ans. The flowers pollinated by flies and beetles secrete foul odours to attract these animals for pollination.

II. Read the given passage and answer the questions.

Hybrid seeds created by crossing two varieties have superior qualities including high yield, pest resistance and climate tolerance and have been used by farmers for decades. In a breakthrough for farmers across the world, especially those from developing countries, scientists have discovered a way to clone hybrid seeds of rice. Hybrid seeds created by crossing two varieties have superior qualities including high yield, pest resistance and climate tolerance and have been used by farmers for decades. However, a major challenge with such crops so far has been that unlike other crops, their seeds do not produce plants with same qualities. So, farmers have had no option but to buy expensive hybrid seeds every year. Asexual reproduction through seeds, called Apomixis, is known to occur naturally in more than 400 species of wild plants, but not in crops. The embryos can develop directly from a diploid egg or the nucellus in the ovule without fertilisation. This mechanism of seed production allows a plant to clone itself through a seed, without fertilisation and, thus prevents any loss of hybrid characters in plants. However, recreating these pathways in crop plants has been a challenge to science. U + K

Q. 1. Seed is the final product of sexual reproduction. Mature seeds can be differentiated into two types. What are they?

Ans. Mature seeds may be non-albuminous or albuminous.

Non-albuminous or Non-endospermic Seeds: These seeds have no residual endosperm as it is completely consumed during embryo development. Examples: pea, groundnut, beans.

Albuminous or Endospermic Seeds: These seeds retain a part of the endosperm as it is not completely used up during embryo development. Examples, wheat, maize, barley, castor, coconut, sunflower.

Q. 2. Some fruits have no seeds. What do we call such fruits and how they are formed?

Ans. In some species such as banana, the fruits develop without fertilisation, these fruits are called parthenocarpic fruits. Such fruits are seedless.

Q. 3. What are the advantages of production of hybrid seeds through apomixis?

Ans. Hybrid seeds have to be produced every year and its quite a costly process. Farmers cannot sow the seeds from hybrid plants to grow new crops as the plants in the progeny will segregate and lose hybrid characters. If the hybrids are made into apomict, there is no segregation of characters in the hybrid progeny. This helps farmers to use the hybrid seeds to raise new crop year after year without losing hybrid characteristics.

Q. 4. What is site for embryo development in a flower? Where does the developing embryo gets its nutrition?

Ans. The embryo develops at the micropylar end of the embryo sac where the zygote is situated. The developing embryo gets its nutrition from Endosperm.

Solutions for Practice Questions (Topic-1)

MCQ

Ans. 2. Option (C) is correct.

Explanation: The pollen grains represent the male gametophyte. As the anther matures and dehydrate, the microspores dissociate from each other and develop into pollen grains. So, embryo sac is to ovule as pollen grain is to an anther.

Ans. 6. Option (B) is correct.

Explanation: During microsporogenesis, meiosis occurs in microspore mother cells. As the anther develops, the microspore mother cells of the sporogenous tissue undergo meiotic divisions to form microspore tetrads. The microspore tetrad after dehydration is separated into pollen grains.

Ans. 9. Option (B) is correct.

Explanation: Starting from the innermost part, the correct sequence of parts in an ovule is egg, embryo sac, nucellus, and integument.

A&R MCQ

Ans. 2. Option (A) is correct.

Explanation: Pollen grains are well preserved as fossils because of the presence of sporopollenin which is the most resistant organic material known.

VSAQ

Ans. 3: Pollen tablets are used in the human diet as a food supplement because of their high nutritional value. **1**

SAQ-I

Ans. 1: Pollen grain may be released at the 2-celled stage. One vegetative and one generative cell. **1+1**

Ans. 6: Monoecious Angiosperms: Plants bear both male and female unisexual flowers on the same plant. ½

e.g., Cucurbits/coconut/maize.

(Any one) ½

Dioecious Angiosperms: Plant, which bear either male or female unisexual flowers on different plants.

e.g., Papaya/date palms. **1**

[CBSE Marking Scheme, 2016]

SAQ-II

Ans. 3: Cryopreservation / preserved in liquid nitrogen (– 196° C). **1**

Availability of pollen of different genetic strains (for wider use) / Cryopreservation increases viability of pollens (which can be used in crop breeding programmes) / Can be preserved / stored for longer duration / Conserve large number of species/ To prevent complete extinction of any species / Maintain biodiversity. **(Any two) 1 + 1**

[CBSE Marking Scheme, 2019]

Detailed Answer:

Pollen banks are used to store pollens for a long period in viable conditions. Pollens are preserved in a bank using cryopreservation i.e., they are stored in the viable condition under low temperature (–196° C) using liquid nitrogen. 1

Importance of pollen banks to our farmers are:

(i) They are used in crop breeding programmes.

(ii) They preserve agricultural biodiversity in the form of valuable genetic resources.

(iii) Desired species can be obtained at low cost effectively. **(Any two) 1+1**

LAQ

Ans. 3:- Nucleus / Ovules

A single MMC / megaspore mother cell differentiates in the micropylar region of the nucleus, MMC undergoes meiosis, to produce four (haploid) megaspores, one of the megaspore functional, the nucleus of functional megaspore undergoes free nuclear division, to form 2 nucleate - 4 nucleate - 8 nucleate embryo sac, cell wall formation occurs in six of 8 nuclei, two polar nuclei occur in the large central cell to form 8 nucleated and 7 celled embryo-sac. **½ × 8**

[CBSE Marking Scheme, 2019]

Solutions for Practice Questions (Topic-2)

MCQ

Ans. 7. Option (C) is correct.

Explanation: In female gametophyte, central cell is involved in the double fertilisation that help in the endosperm development while antipodal cells provides nourishment to the egg cell, and synergid cell help in pollen tube growth.

Ans. 11. Option (B) is correct.

Explanation: Apomixis is the term given to any phenomenon that leads to formation of embryo wherein parts of the sexual apparatus are used, but without fertilisation. An example of apomixis is citrus.

A&R MCQ

Ans. 4. Option (C) is correct.

Explanation: In non-albuminous seeds, seeds does not retain any endosperm as it is completely used up during embryo development.

Ans. 3. Option (B) is correct.

VSAQ

Ans. 2: Central cell. **1**

Detailed answer:

After double fertilisation, the primary endosperm nucleus (PEN) are formed as a result of triple fusion that is fusion of one male gamete (n) with diploid secondary nucleus (2n).

Ans. 4: Wind pollination. **1**

SAQ-I

Ans. 3: Long stalk of female flowers, pollen released on the surface of water, pollen grains are carried passively by water current, Pollens reach the stigma. **½×4**

[CBSE Marking Scheme, 2019]

Detailed answer:

Pollination in *Vallisneria* is achieved through the water. The female flower reaches the surface of the water by the long stalk and the male flowers or pollen grains are released on to the surface of the water. They are carried passively by water currents. Some of them eventually reach the female flowers and the stigma and achieve pollination.

Commonly Made Error

- Students commit the error of describing the process of pollination of water hyacinth, water lily or sea grasses instead of *Vallisneria*.

Answering Tip

- Discuss, with examples, the characteristics of different types of pollination and the reasons for their adaptation.

SAQ-II

Ans. 3: (i) Autogamy: It is the transfer of pollen grains from the anther to the stigma of the same flower. Complete autogamy is rare in flowers with exposed anthers and stigma. Autogamy in such flowers requires synchrony in pollen release and stigma receptivity. Also, the anthers and stigma should lie close to each other to enable self-pollination.

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

(iii) Xenogamy: It is the transfer of pollen grains from the anther to the stigma of a different plant. This brings genetically different types of pollen grains to the stigma. **1+1+1**

LAQ

Ans. 8: The pollen grain germinates on the stigma to produce a pollen tube through one of the germ pores, the content of the pollen grain moves into the pollen tube, a pollen tube grows through the tissues of the stigma and style and reaches the ovary, the generative cell divides and forms two male gametes during the growth of pollen tube (in the stigma), the pollen tube enters the ovule through the micropyle and then enters one of the synergids (through filiform apparatus), the pollen tube releases two male gametes (in the cytoplasm of synergids), one of the male gametes fuses with the egg cell to form a zygote (2n) (syngamy), the other male gamete fuses with two polar nuclei (in a central cell) to form primary endosperm nucleus (PEN-3n)/PEC.

[CBSE Marking Scheme, 2016] 5

Solutions for Practice Questions (Topic-3)

VSAQ

Ans. 2: Cotyledons–Store food (for growth of embryo of the seed)

[CBSE Marking Scheme, 2016] ½ + ½ = **1**

SAQ-I

Ans. 1: Advantages of apomictic seeds to a farmer are:

(i) Reduces the cost of hybrid breeding programmes.

(ii) Desired traits can be maintained without losing superiority of hybrids over parents. Farmers can replant these seeds year after year. **1+1**

Commonly Made Error

- Students often write vague answer.

Answering Tip

- Learn the concept of apomictic seeds with its advantages to farmers.

SAQ-II

Ans. 4: Yes, apomixis can be compared with asexual reproduction as like asexual reproduction, apomixis is the mechanism of seed production without involving the process of meiosis and syngamy.

Importance of apomixis to farmers: The method of producing hybrid seeds by cultivation is very expensive for farmers. Also, by sowing hybrid seeds, it is difficult to maintain hybrid characters as characters segregate during meiosis. Apomixis thus prevents the loss of specific characters into hybrid. If hybrids with desirable characteristics can be made into apomict, there is no segregation of characters in the hybrid progeny and farmer can continue using hybrid seeds year after year and without buying new seeds. Also, it is cost-effective method for producing seeds.

Ans. 5: Differences between parthenogenesis and parthenocarpy:

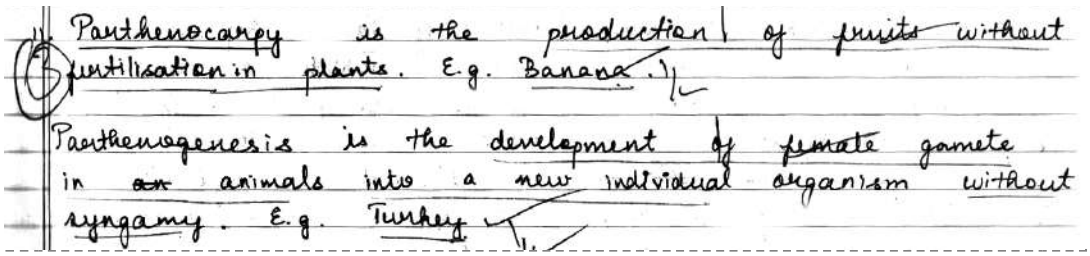
Parthenogenesis	Parthenocarpy
New organism develops without fertilisation. **1**	Formation of fruit without fertilisation. **1**
e.g., Drones /male honey bee / turkey / rotifers / some lizards / any other correct example. ½	e.g., banana / grapes / any other correct example. ½

1½ + 1½

[CBSE Marking Scheme, 2018]

Topper Answer, 2018

OR


Parthenocarpy is the production of fruits without fertilisation in plants. E.g. Banana. ½

Parthenogenesis is the development of female gamete in animals into a new individual organism without syngamy. E.g. Turkey ½

LAQ

Ans. 7: (a) Pollen pistil interaction, germination of pollen tube that carries two male gametes, double fertilisation / syngamy and triple fusion, development of endosperm, development of embryo, maturation of ovule into seed. **½ × 6 = 3**

(b) Autogamy / self pollination / Geitonogamy **1**

Xenogamy / cross pollination. **1**

[CBSE Marking Scheme, 2016]

Detailed Answer:

(a) After entering one of the synergids, the pollen tube releases the two male gametes into the cytoplasm of the synergid. One of the male gametes moves towards the egg cell and fuses with its nucleus thus completing the syngamy. This results in the formation of a diploid cell, the zygote. The other male gamete moves towards the two polar nuclei located in the central cell and fuses with them to produce a triploid primary endosperm nucleus (PEN). As this involves the fusion of three haploid nuclei it is termed triple fusion. Since two types of fusions, syngamy and triple fusion take place in embryo sac, the phenomenon is termed double fertilisation.

Endosperm development precedes embryo development. The triploid primary endosperm nucleus (PEN) undergoes repeated mitotic divisions, without cytokinesis. At this stage of development, the endosperm is called free-nuclear endosperm. The cells of the endosperm store food materials, which are later used by the developing embryo.

The endosperm may be completely utilised by the developing embryo before the maturation of seeds as in pea, bean, groundnut etc. in non-albuminous or non-endospermic seeds. In albuminous or endospermic seeds, a portion of endospermic may remain in the mature seeds. e.g., castor.

(b) There are three types of pollination namely: autogamy, geitonogamy and xenogamy.

(i) Autogamy: It is the process of transferring the pollen grains from the anther to the stigma of the same flower. It s a self pollination.

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

(iii) Xenogamy: It is the process of transferring the pollen grains from anther to the stigma of a different plant. It is a cross-pollination. **3+2**

REFLECTIONS

1. Can you recall the process of male gametophyte or pollen grain formation from the anthers?
2. Do you remember how to draw the structure of mature ovule with complete labelling?
3. Can you understand the ploidy of zygote formed after double fertilisation?
4. Were you able to remember the different types of pollination and its agents?

❐❐❐