

CBSE XII 2025

**Chapter and Topic-Wise
Solved Papers
2011-2024**

Biology

(All Sets : Delhi & All India)



Title : CBSE Class XII : Chapter and Topic-wise Solved Papers 2011 - 2024:
Biology (All Sets - Delhi & All India)

Language : English

Editor's Name : Amit Singh

Copyright © : 2024 CLIP

No part of this book may be reproduced in a retrieval system or transmitted, in any form or by any means, electronics, mechanical, photocopying, recording, scanning and or without the written permission of the Author/Publisher.

Typeset & Published by :

Career Launcher Infrastructure (P) Ltd.

A-45, Mohan Cooperative Industrial Area, Near Mohan Estate Metro Station, New Delhi - 110044

Marketed by :

G.K. Publications (P) Ltd.

Plot No. 63, Sector-27A, Near Sector - 28 Metro Station, Faridabad, Haryana-121003

ISBN : 978-93-56819-67-2

Printer's Details : Print in India, New Delhi.

For product information :

Visit www.gkpublications.com or email to gkp@gkpublications.com

CONTENTS

1.1-1.20	Sexual Reproduction in Flowering Plants
1.1	[Topic 1] Flowers and its Parts
1.2	Previous Years' Examination Questions Topic 1
1.3	Solutions
1.4	Multiple Choice Questions
1.5	Solutions
1.6	[Topic 2] Pollination
1.6	Previous Years' Examination Questions Topic 2
1.7	Solutions
1.9	Multiple Choice Questions
1.10	Solutions
1.11	[Topic 3] Post-fertilisation: Structure and Events
1.11	Previous Years' Examination Questions Topic 3
1.13	Solutions
1.19	Multiple Choice Questions
1.20	Solutions
2.21-2.40	Human Reproduction
2.21	[Topic 1] Reproductive Systems
2.22	Previous Years' Examination Questions Topic 1
2.24	Solutions
2.26	Multiple Choice Questions
2.26	Solutions
2.27	[Topic 2] Gametogenesis
2.28	Previous Years' Examination Questions Topic 2
2.31	Solutions
2.34	Multiple Choice Questions
2.34	Solutions
2.35	[Topic 3] Fertilization, Pregnancy and Embryonic Development
2.36	Previous Years' Examination Questions Topic 3
2.36	Solutions
2.39	Multiple Choice Questions
2.40	Solutions

3.41-3.48	Reproductive Health
3.41	[Topic 1] Reproductive Health-Problems and Strategies
3.42	Previous Years' Examination Questions Topic 1
3.44	Solutions
3.47	Multiple Choice Questions
3.48	Solutions
4.49-4.76	Principles of Inheritance and Variation
4.49	[Topic 1] Mendel's Laws of Inheritance
4.51	Previous Years' Examination Questions Topic 1
4.54	Solutions
4.63	Multiple Choice Questions
4.65	Solutions
4.66	[Topic 2] Sex-Determination and Genetic Disorders
4.68	Previous Years' Examination Questions Topic 2
4.70	Solutions
4.73	Multiple Choice Questions
4.75	Solutions
5.77-5.104	Molecular Basis of Inheritance
5.77	[Topic 1] The DNA & RNA World
5.81	Previous Years' Examination Questions Topic 1
5.85	Solutions
5.94	Multiple Choice Questions
5.96	Solutions
5.97	[Topic 2] Genetic Code, Human Genome Project & DNA Fingerprinting
5.99	Previous Years' Examination Questions Topic 2
5.100	Solutions
5.103	Multiple Choice Questions
5.104	Solutions
6.105-6.114	Evolution
6.105	[Topic 1] Origin of Life on Earth and Various Related Exidences
6.106	Previous Years' Examination Questions Topic 1
6.107	Solutions
6.110	Multiple Choice Questions
6.110	Solutions

6.111	[Topic 2] Biological Evolution, Its Mechanism and Evolution of Man
6.111	Previous Years' Examination Questions Topic 2
6.112	Solutions
6.113	Multiple Choice Questions
6.114	Solutions
7.115-7.132	Human Health and Diseases
7.115	[Topic 1] Health, Common Diseases in Human and Immunity
7.119	Previous Years' Examination Questions Topic 1
7.122	Solutions
7.127	Multiple Choice Questions
7.128	Solutions
7.129	[Topic 2] Adolescence and Drug/Alcohol Abuse
7.130	Previous Years' Examination Questions Topic 2
7.131	Solutions
7.131	Multiple Choice Questions
7.132	Solutions
8.133-8.142	Microbes in Human Welfare
8.133	[Topic 1] Microbes in Household Products, Industrial Products and in Sewage Treatment
8.134	Previous Years' Examination Questions Topic 1
8.135	Solutions
8.138	Multiple Choice Questions
8.138	Solutions
8.139	[Topic 2] Microbes in Production of Biogas, as Bio-control Agents and Bio-fertilizers
8.139	Previous Years' Examination Questions Topic 2
8.140	Solutions
8.141	Multiple Choice Questions
8.142	Solutions
9.143-9.156	Biotechnology: Principles and Processes
9.143	[Topic 1] Principles of Biotechnology and Tools of Recombination DNA Technology
9.145	Previous Years' Examination Questions Topic 1
9.146	Solutions

9.149	Multiple Choice Questions
9.149	Solutions
9.150	[Topic 2] Process of Recombinant DNA Technology
9.151	Previous Years' Examination Questions Topic 2
9.153	Solutions
9.155	Multiple Choice Questions
9.156	Solutions
10.157-10.168	Biotechnology and Its Applications
10.157	[Topic 1] Biotechnological Applications in Agriculture and Medicine
10.159	Previous Years' Examination Questions Topic 1
10.160	Solutions
10.165	Multiple Choice Questions
10.165	Solutions
10.166	[Topic 2] Transgenic Animals and Bioethical Issues
10.167	Previous Years' Examination Questions Topic 2
10.167	Solutions
10.167	Multiple Choice Questions
10.168	Solutions
11.169-11.180	Organisms and Populations
11.169	[Topic 1] Organisms and Their Environment
11.171	Previous Years' Examination Questions Topic 1
11.171	Solutions
11.173	Multiple Choice Questions
11.173	Solutions
11.174	[Topic 2] Population
11.175	Previous Years' Examination Questions Topic 2
11.176	Solutions
11.179	Multiple Choice Questions
11.180	Solutions
12.181-12.194	Ecosystem
12.181	[Topic 1] Ecosystem—Structure & Function, Productivity & Decomposition
12.182	Previous Years' Examination Questions Topic 1
12.182	Solutions
12.184	Multiple Choice Questions

12.184	Solutions
12.185	[Topic 2] Energy Flow & Ecological Succession
12.186	Previous Years' Examination Questions Topic 2
12.187	Solutions
12.190	Multiple Choice Questions
12.190	Solutions
12.191	[Topic 3] Nutrient Cycling & Ecosystem Services
12.192	Previous Years' Examination Questions Topic 3
12.192	Solutions
12.193	Multiple Choice Questions
12.194	Solutions
13.195-13.204	Biodiversity and Its Conservation
13.195	[Topic 1] Biodiversity
13.196	Previous Years' Examination Questions Topic 1
13.198	Solutions
13.200	Multiple Choice Questions
13.200	Solutions
13.201	[Topic 2] Conservation of Biodiversity
13.202	Previous Years' Examination Questions Topic 2
13.202	Solutions
13.204	Multiple Choice Questions
13.204	Solutions
1-19	Solved Paper 2024



PREFACE

Biology can be exhaustive. Your basic concepts of Biology need to be in place if you want to excel in the Board Examination. At Career Launcher, our goal is not only to help you maximize your scores in Class XII Biology Board Exam, but also to lay a strong foundation in the subject to help you get ahead in your college and professional career. Over the last decade, we all have seen how the question paper pattern of Class XII Biology paper has kept changing. Bearing in mind this unpredictable nature of Class XII board papers, we've come up with Chapter & Topic-wise Solved Papers for Biology for Class XII - to help you prepare better and face the Boards with confidence.

Exclusively designed for the students of CBSE Class XII by highly experienced teachers, the book provides solutions to all actual questions of Biology Board Exams conducted from 2011 to 2024. The solutions have been prepared exactly in coherence with the latest marking pattern; after a careful evaluation of previous year trends of the questions asked in Class XII Boards and actual solutions provided by CBSE.

The book follows a three-pronged approach to make your study more focused. The questions are arranged Chapter-wise so that you can begin your preparation with the areas that demand more attention. These are further segmented topic-wise and eventually the break-down is as per the marking pattern. This division will equip you with the ability to gauge which questions require more emphasis and answer accordingly.

We hope the book provides the right exposure to Class XII students so that you not only ace your Boards but mold a better future for yourself. And as always, Career Launcher's school team is behind you with its experienced gurus to help your career take wings.

Let's face the Boards with more confidence!

Wishing you all the best,

Team CL



Blueprint & Marks Distribution

Class 12th Biology 2024-25 Analysis Unit Wise

Time 3 hours

Max. Marks: 70

Units	Name of Units	No. of Periods	Marks Distribution
Unit VI	Reproduction	30	16
Unit VII	Genetics and Evolution	40	20
Unit VIII	Biology and Human Welfare	30	12
Unit IX	Biotechnology and Its Applications	30	12
Unit X	Ecology and Environment	30	10
	Total	160	70

UNIT VI. REPRODUCTION

30 Periods

Chapter-1: 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 and fruit formation.

Chapter-2: Human Reproduction

Male and female reproductive systems; Microscopic anatomy of testes and ovary; Gametogenesis - Spermatogenesis & Oogenesis; Menstrual cycle; Fertilisation embryo development upto blastocyst formation, implantation; Pregnancy and placenta formation (Elementary idea); Parturition (Elementary idea); Lactation (Elementary idea).

Chapter-3: Reproductive Health

Need for reproductive health and prevention of sexually transmitted diseases (STD); 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

40 Periods

Chapter-4: 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, honey bee; Linkage and crossing over; Sex linked inheritance - Haemophilia, Colour blindness; Mendelian disorder in humans - Thalassemia; Chromosomal disorders in humans; Down's syndrome, Turner's and Klinefelter's syndromes.

Chapter-5: 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 and human genome project; DNA fingerprinting.

Chapter-6: Evolution

Origin of life; Biological evolution and evidences for biological evolution (paleontological, comparative anatomy, embryology and molecular evidence); 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

30 Periods

Chapter-7: Human Health and Diseases

Pathogens; Parasites causing human diseases (Malaria, Filariasis, Ascariasis, Typhoid, Pneumonia, Common Cold, Amoebiasis, Ring Worm); Basic concepts of Immunology - Vaccines; Cancer, HIV and AIDs; Adolescence – Drug and Alcohol Abuse.

Chapter-8: Microbes in Human Welfare

In household food processing, Industrial Production, Sewage Treatment, Energy Generation and as Biocontrol Agents and Biofertilizers. Antibiotics; Production and Judicious use.

UNIT IX. BIOTECHNOLOGY AND ITS APPLICATIONS

30 Periods

Chapter-9: Biotechnology - Principles and Processes

Genetic Engineering (Recombinant DNA technology).

Chapter-10: Biotechnology and its Applications

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

30 Periods

Chapter-11: Organisms and Populations

Organisms and environment: Habitat and niche, Population and ecological adaptations; Population Interactions - Mutualism, Competition, Predation, Parasitism; Population Attributes - growth, birth rate and death rate, age distribution.

Chapter-12: Ecosystem

Patterns, Components; Productivity and Decomposition; Energy Flow; Pyramids of Number, Biomass, Energy; Nutrient Cycles (Carbon and Phosphorous); Ecological Succession; Ecological Services - Carbon Fixation, Pollination, Seed Dispersal, Oxygen Release (in brief).

Chapter-13: Biodiversity and its Conservation

Concept of Biodiversity; Patterns of Biodiversity; Importance of Biodiversity; Loss of Biodiversity; Biodiversity Conservation; Hotspots, Endangered Organisms, Extinction, Red Data Book, Biosphere Reserves, National Parks, Sanctuaries and Ramsar sites.

Sexual Reproduction in Flowering Plants

[Topic 1] Flowers and its parts

Summary

Structure of Flower

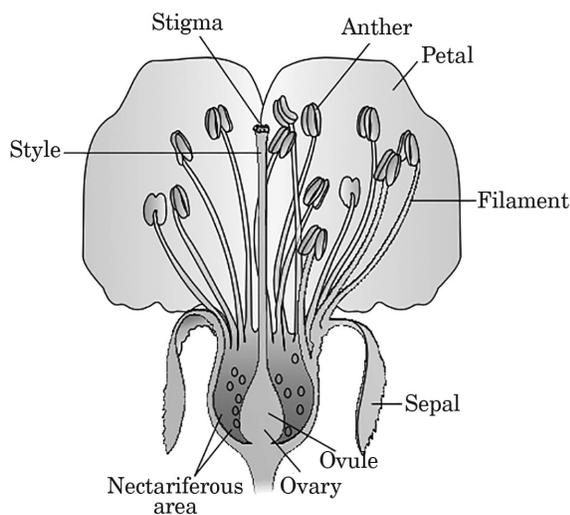


Fig.: Structure of Flower

Flower is the reproductive structure in plants. This is where male and female gametes fuse.

Structures and Events of pre-fertilization

The male reproductive system in a flower is called androecium that contains whorl of stamens and a female reproductive part known as gynoecium consisting pistil.

- **Stamen:** It is the organ of the flower that produces pollen.

It consists of three main parts namely: filament which is a lean and long stalk and has a bilobed extension known as an anther.

There are four microsporangia located at the four sided structure of anther, two in each lobe. The further development of microsporangia takes place and converts into pollen sacks. Microsporogenesis can be defined as the process in which microspores are formed from the mother cell. They are divided by the process of meiosis.

Pollen grain : The pollen grains represent the male gametophytes.

The presence of sporopollenin ensures the pollen grains are well preserved as fossils. Generative cell and the vegetative cell are the two cells present in a matured pollen grain.

- **Pistil :** The gynoecium represents the female reproductive part of the flower. Gynoecium consisting of single pistil is known as monocarpellary and of multiple pistils is known as multicarpellary.

Gynoecium consists of pistils and each pistil has three part, the stigma, style and the ovary. From the placenta, megasporangia arises which are also called as ovules. An ovary may have one ovule such as in paddy or mango or it may have several ovules such as in water melons.

The stigma lands on pollen grains. Beneath the stigma is a lean part known as style. The bottom bulged part is ovary.

Megasporangium (Ovule)

The female gametophyte is situated inside the nucleus. The megaspore is responsible for formation of a single embryo. The process in which megaspores are formed from the mother cell is coined as meiosis.

Female gametophyte

Monosporic development is the method of embryo sac formation from a single megaspore. In general an angiosperm embryo sac at maturity, though it is 8 nucleate is 7 celled.

PREVIOUS YEARS'

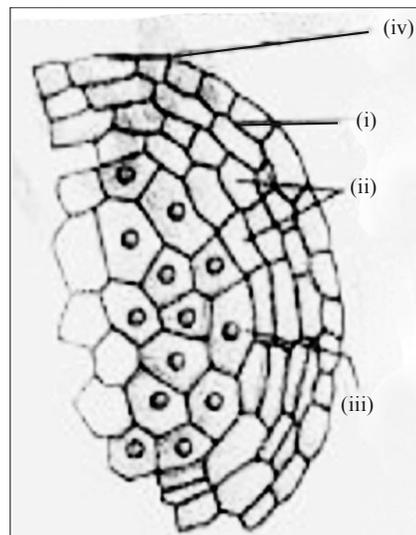
EXAMINATION QUESTIONS

TOPIC 1

▶ 1 Mark Questions

- An anther with malfunctioning tapetum often fails to produce viable female gametophytes. Give any one reason. [DELHI 2013]
- Name the part of the flower which the tassels of the corn-cob represent. [ALL INDIA 2014]
- Which one of the following part of the plant when put into the soil is likely to produce new offspring ?
 - Part of an internode
 - A stem cutting with a node
 - Part of a primary root
 - A flower [DELHI 2020]
- Enclosed within the integuments of a typical anatropous ovule is a diploid mass of cellular tissue known as:
 - Megaspore mother cell
 - Nucellus
 - Synergids
 - Embryo sac [TERM I 2022]
- The aquatic plant having long and ribbon like pollen grains is:
 - Vallisneria
 - Hydrilla
 - Eichhornia
 - Zostera [TERM I 2022]

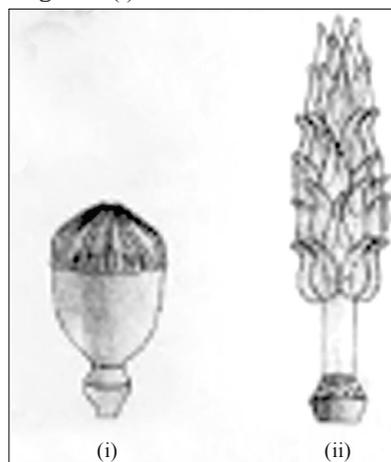
- In the transverse section of a young anther shown below, identify the correct sequence of wall layers from outside to inside:



	(i)	(ii)	(iii)	(iv)
(a)	Middle layers	Endothecium	Epidermis	Tapetum
(b)	Tapetum	Middle layers	Endothecium	Epidermis
(c)	Epidermis	Endothecium	Middle layers	Tapetum
(d)	Endothecium	Middle layers	Tapetum	Epidermis

[TERM I 2022]

- Which condition of gynoecium (pistil) is shown the figures (i) and (ii) ?



- (i) multicarpellary apocarpous, (ii) multicarpellary syncarpous
- (i) multicarpellary syncarpous, (ii) multicarpellary apocarpous
- (i) bicarpellary apocarpous, (ii) bicarpellary syncarpous
- (i) bicarpellary syncarpous, (ii) bicarpellary apocarpous

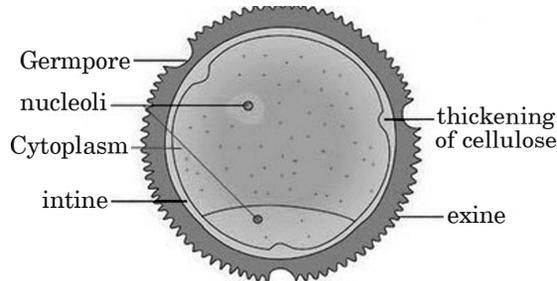
[TERM I 2022]

2 Marks Question

8. Why do moss plants produce very large number of male gametes? Provide one reason. What are these gametes called? [ALL INDIA 2015]

3 Marks Question

9. Draw a diagram of a male gametophyte of an angiosperm. Label any four parts. Why is sporopollenin considered the most resistant organic material? [DELHI 2011]



5 Marks Question

10. (a) Draw a L.S. of a pistil showing pollen tube entering the embryo-sac in an angiosperm and label any six parts other than stigma, style and ovary.
(b) Write the changes a fertilized ovule undergoes within the ovary in an angiosperm plant. [ALL INDIA 2013]



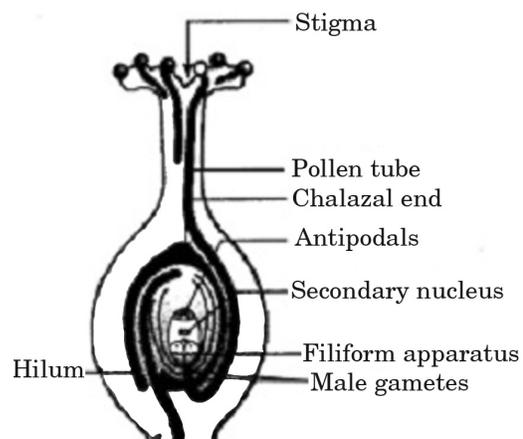
Solutions

- The main function of the tapetum include nourishment of viable male gametes. Hence, malfunctioning tapetum often fails to produce viable male gametophytes. [1]
- Style and stigma that are female reproductive parts of a flower which represents the tassels of the corn-cob. [1]
- A stem cutting with a node when put into soil is likely to produce a new offspring. So, the correct option is (b). [1]
- (b) Ovule has one or more protective envelope called an integument. Nucellus is a mass of cells enclosed within the integuments. An embryo sac is present inside the nucellus. [1]
- (c) To achieve pollination, plants use various pollinating agents such as wind, insects and water. Aquatic plants are pollinated by water. e.g Hydrilla, Zostera, etc. In water lilies, the flower emerges above the water level and is then pollinated by insects. In the case of Vallisneria, pollination occurs at the surface of the water and is termed as Epihydrophyly. In another group, as sea grasses like Zostera, the female flower

remains submerged in water and pollen grains are released. The pollen grains of such a group are long and have a ribbon-like structure. [1]

6. (d) The diagram in the question shows an enlarged view of a micro-sporangium wall layer or anther wall. It is covered by four layers, namely the epidermis, followed by the endothecium, the middle layer, and the last inner layer, which is the tapetum. The three outer layers help in the dehiscence of the anther to release the pollen and also perform the function of protection. The inner tapetal layer helps in nourishing the developing pollen grains. [1]
7. (b) In figure (i), the plant has multiple carpels which are fused together representing multicarpellary syncarpous condition. In case of figure (ii), the plant has separate carpels (not fused together), therefore, it is termed as multicarpellary apocarpous. [1]
8. Moss such as Sphagnum are bryophytes. For fertilization water is an essential requirement. Mosses produce flagellated male gametes which swim across the water to reach the female gamete. In this process, a majority of male gametes fail to reach the female gametes. Therefore, large number of male gametes are produced by mosses to ensure fertilization. The male gametes of mosses are antherozoids in antheridium. [1+1]
9. Sporopollenin that made outer layer of pollen which is exine considered as most resistant organic material because Sporopollenin is highly resistant to temperature, acid, alkali or enzymatic action. [3]

10. (a)



[2]

Fig.: L.S. of a pistil showing pollen tube entering the embryo-sac in an angiosperm

- (b) (i) Seed is formed from the fertilized ovule. A seed develop seed coat. This is the outermost covering of the seed and provides protection to the seed from adverse environmental conditions. The outer layer of seed coat is known as testa and inner layer of seed is called as tegma. Seed coat also contain germ pore that aid in the entry of oxygen and water that is required during seed germination.
- (ii) Embryo is formed from fertilised egg (*zygote*).
- (iii) Antipodal cells degenerate.
- (iv) Synergid cells degenerate.
- (v) Central triploid cell form the endosperm.
- (vi) Chalaza and micropyle remain but nucellus is gets consumed. [3]

MULTIPLE CHOICE QUESTIONS

- Water is absorbed by
 - Root hairs
 - Root caps
 - Root
 - Root apex
- Pneumatophores occur in plants of
 - Sandy soil
 - Saline marshy soil
 - Marshy soil
 - Water
- Roots developing from plant parts other than radicle are
 - Epiphyllous
 - Epicaulous
 - Adventitious
 - Fibrous
- Roots are feebly developed in
 - Hydrophytes
 - Mesophytes
 - Xerophytes
 - Halophytes
- Nodulated roots occurs in
 - Pea
 - Wheat
 - Mustard
 - Rice
- Root cap takes part in
 - Formation of new cells
 - Absorption of Water and Minerals
 - Protection of root meristem
 - Storage of food.
- Conical fleshy roots occur in
 - Sweet Potato
 - Dahlia
 - Asparagus
 - Carrot
- Napiform roots are recorded from
 - Radish
 - Carrot
 - Beet
 - Sweet Potato
- Fusiform roots are found in
 - Solanum tuberosum*
 - Calocasia*
 - Daucus carota*
 - Raphanus Sativus*
- Plants which flower only once in their life is
 - Polycarpic
 - monocarpic
 - Cleistocarpic
 - Pesicarpic
- Third whorl in flower is of
 - Petal
 - Sepal
 - Stamen
 - Pistil
- Flower is modified shoot because
 - in some flowers thalamus become elongated and shows distinct nodes and internodes
 - flowers aggregate to form inflorescence
 - epicalyx is present in some flowers
 - essential organs are present in some flowers.
- In monoecious plants
 - male and female parts are borne by the same plant but not by the same flower
 - male and female parts are borne by the same flower
 - male and female parts are borne by the different plant
 - none of the above.
- A flower is said to be complete when it has
 - Corolla
 - androecium and gynoecium
 - Calyx and corolla only
 - all the four whorls
- Protandry is the situation when
 - anthers and stigma mature at the same time
 - anthers mature later than the stigma of the flower
 - anthers mature earlier than the stigma of the same flowers.
 - anthers of the flower pollinate the stigma of the same flower.

16. In a bisexual flowers when the gynoecium matures earlier than the androecium it is called
 (a) Protogyny (b) Protandry
 (c) Autogamy (d) Heterogamy
17. In which of the following plants do the male and female flowers occur in the same individual.
 (a) pumpkin (b) gram
 (c) rose (d) hibiscus
18. In a flower, when the ovary is situated on the torus above all other floral whorls, the flower is said to be.
 (a) Perigynous (b) epigynous
 (c) inferior (d) hypogynous
19. A flowers is brightly colored, scented and secrete nectar. It is most probably.
 (a) pollinated by insects
 (b) sterile
 (c) pollinated by wind
 (d) an insectivorous plant
20. A bisexual flower which never open in its life span is called.
 (a) homogamous (b) heterogamous
 (c) polygamous (d) deistogamous.
5. The primary top root and its branches of leguminous plants, i.e, plants belonging to sub family papilionatal of family leguminosae (e.g. pea, gram, and groundnut etc) bear nodule like swellings, called root nodules. [1]
6. It is a cap like parenchymatous multicellular structure which protects the root-apex. As the root is continuously growing downwards into the soil, friction with soil particles wears out the root-cap while its outer cells are being constantly replaced by new growth from its base. [1]
7. The swollen root is broad at the base and tapers gradually towards the apex. [1]
8. The root is nearly globular or spherical in shape. The basal portion of root is much swollen which suddenly tapers towards the apex giving a top shaped appearance, e.g., Turnip and Beet. [1]
9. The storage root is like a spindle, narrow towards both base and apex. It occurs in Raphanus sativus. The basal part of it is made of tap root. [1]
10. Monocarpic plants are those that flower, set seeds and then die. The term was first used by Alphonse de candolle. [1]
11. The stamen is the third whorl of a flower, the male reproductive part. The stamen is made of a thin vertical thread-live structure called a filament topped with a circular or a oblong structure called an anther. The anther produces pollen, which is the male contribution to be reproduction process in plants. [1]
12. The thalamus is the short abbreviated axis bearing the four sets of floral leaves. It is the swollen end of the peduncle or pedicle with four nodes and very much compressed internodes. The floral leaves remain inserted on the nodes in whorls or spirally. The axis nature of the thalamus becomes quite evident in some flower in which thalamus is considerably long and the internodes are distinct. [1]
13. Monecious plants have both male and female flowers rather than perfect flowers. Corn (maize) is a good example of a monecius plant species. It has two types of flowers that develop of different parts of the plant. The male flower forms at the top of the plant and is called the tassle. [1]

Answer Keys

1. (a) 2. (c) 3. (c) 4. (a) 5. (a)
 6. (c) 7. (d) 8. (c) 9. (d) 10. (b)
 11. (c) 12. (a) 13. (a) 14. (d) 15. (c)
 16. (a) 17. (a) 18. (d) 19. (a) 20. (d)



Solutions

1. The root hairs enhance the exposed surface area of the root, for the absorption of water from the soil [1]
2. Some plants growing in salty marshes some branches of top root grow vertically upwards in to the air from horizontally secondary roots. There roots are called pneumatophores. [1]
3. In monocotyledonous plants the radicle dies immediately after germination of seeds and later these roots arise from any portion (stem, leaves etc.) of the plant [1]
4. Root system is very much reduced in some floating plants and in submerged plants the roots are absent. [1]

14. Flower is the reproductive part of the plant. It consists of female organ (whorl) made of carpels (Pistil/gynoecium), male organ (whorl) made of stamens (Androecium) and corolla made of petals, usually attractive part act as protective part also and outermost whorl-calyx, made of sepals, usually green but otherwise coloured in many cases. When flower has all these four whorls then flower is called as complete flower, missing any whorl make it incomplete. [1]
15. Protandry is a state in hermaphroditic systems that is characterized by the development of male organs or maturation of their products before the appearance of the corresponding female product thus inhibiting self-fertilization and that is encountered commonly in mints, legumer and composites and among diverse groups of invertebrate animals. [1]
17. Most plants sprout bisexual flower (which have both male and female parts), evolutionary biologists have recently discovered. Plants with male and bisexual flowers produce more seeds. Why this is true is new scientific mystery, but it probably has something to do with male flower hoarding less of a plant's energy (making more of it available to crack out seed) [1]
18. In hypogynous flowers, the perianth and stamens are attached to the receptacle below the gynecium; the ovary is superior to these organs, and the remaining floral organs. [1]
19. Insect pollinated flowers are brightly coloured and sweet smelling to attract insects to itself. This required the coevolution of insects and flowering plants in the development of pollination behaviour by the insects and pollination mechanisms by the flowers, benefiting both groups. [1]
20. Cleistogamy (kleisto-closed, gamous marriage) [1]

[Topic 2] Pollination

Summary

- Pollination is the transfer of pollen grains from anther to stigma of a pistil.
- Pollination can be conducted through abiotic agents like wind and water and biotic agent like animals.
- We can prevent self-pollination by various practices like, In some species pollen release and stigma receptivity cannot take place simultaneously. In some species anther and stigma are at different positions, third device is incompatible and another way to prevent self pollination and encourage cross pollination is production of unisexual flowers.

There are three types of pollination, on the basis of source of pollen:

- Autogamy: When the pollination is attained within the same flower and pollen grains transfer from the anther to the stigma of the same flower.
- Geitonogamy: When pollen grains transfer from the anther to the stigma of a different flower of same plant.
- Xenogamy: When the pollen grains transfer from anther to the stigma of another plant.

Pistel- Pollen Interaction

- Emasculation is the process carried out in bisexual flowers by removing their anthers using a pair of forceps before the anther bursts open.

- A bag of convenient size, usually made up of butter paper is used to cover the flowers that are emasculated to prevent contamination of that flowers stigma with unwanted pollen is called bagging.

Double-Fertilisation

- When two types of fusions happen inside the embryo sac the first being triple fusion and the other syngamy this event is called double fertilization. After triple fusion, the central cell becomes the primary endosperm cell and is developed into endosperm. The zygote is developed into an embryo.

PREVIOUS YEARS'

EXAMINATION QUESTIONS

TOPIC 2

▣ 1 Marks Questions

1. To overcome incompatible pollinations so as to get desired hybrids, a plant breeder must have the knowledge of _____.
 - (a) pollen-nucellar interaction
 - (b) pollen-egg cell interaction
 - (c) pollen-pistil interaction
 - (d) pollen-embryo sac interaction

[TERM I 2022]

2. Pollen grains retain viability for months in plants belonging to different families given below:

- (i) Solanaceae (ii) Leguminosae
(iii) Gramineae (iv) Rosaceae
(v) Liliaceae

The correct option is:

- (a) (i), (ii) and (v) (b) (i), (ii) and (iv)
(c) (ii), (iv) and (v) (d) (i), (iii) and (v)

[TERM I 2022]

3. Floral reward/s provided by insect pollinated flowers to sustain animal visit is/are:

- (a) nectar and fragrance
(b) nectar and pollen grains
(c) pollen grains and fragrance
(d) fragrance and bright colour

[TERM I 2022]

▶ 2 Marks Question

4. State one advantage and one disadvantage of cleistogamy. [DELHI 2012]

▶ 3 Marks Questions

5. Double fertilization 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 fertilization events that are responsible for it. [DELHI 2015]

6. (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?

[ALL INDIA 2016]

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.

- (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.

[ALL INDIA 2017]

8. Why are beehives kept in crop field during flowering period? Name any two crop fields where this is practiced. [ALL INDIA 2014]

9. How does a bisexual flowering plant ensures cross pollination ? Explain. [DELHI 2019]

10. Explain three different modes of pollination that can occur in a chasmogamous flower.

[DELHI 2020]

11. One of the major approaches of crop improvement programme is Artificial Hybridisation. Explain the steps involved in making sure that only the desired pollen grain pollinate the stigma of a bisexual flower by a plant breeder.

[DELHI 2023]

▶ 5 Marks Questions

12. (a) Why is Fertilization in an angiosperm referred to as double fertilization? Mention the ploidy of the cells involved.

- (b) Draw a neat labelled sketch of L.S. of an endospermous monocot seed. [DELHI 2012]

13. A flower of tomato plant following the process of sexual reproduction produces 240 viable seeds. Answer the following questions giving reasons:

- (a) What is the minimum number of pollen grains that must have been involved in the pollination of its pistil?

- (b) What would have been the minimum number of ovules present in the ovary?

- (c) How many megaspore mother cells were involved?

- (d) What is the minimum number of microspore mother cells involved in the above case?

- (e) How many male gametes were involved in this case? [DELHI 2015]



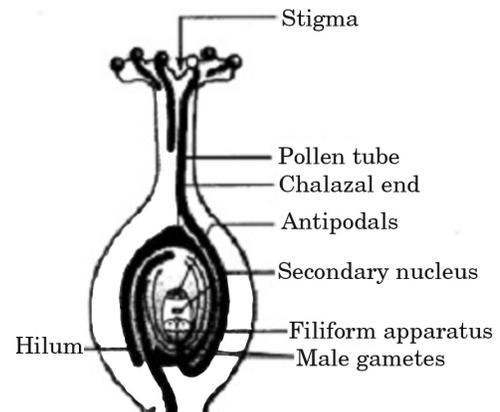
Solutions

1. (c) The process of transfer of pollen grains from the anther to the stigma of the same flower (self-pollination) or another flower of the same species (cross pollination) is known as pollination. This process does not guarantee the transfer of the right type of pollen onto the stigma. Sometimes, the wrong type of pollen (incompatible) also lands on the stigma. But the pistil has the ability to identify whether the pollen is compatible or incompatible. The pollen-pistil interaction is group of events that occur from the time of pollen deposition over the stigma till the time of pollen tube growth and its entry into the ovule. [1]

2. (b) The pollen grains have to land on the stigma after shedding before losing their viability. It is highly variable in different parts and depends upon the temperature or humidity to some extent. In Rosaceae, Leguminosae and Solanaceae, the pollen grains maintain viability for months whereas in some cereals the viability is lost within 30 minutes of release. [1]

- 3 (b) The insect-pollinating flowers are large, fragrant, colorful and rich in nectar. Animals like bees, butterflies, etc., are attracted to flowers by their colorful petals and fragrance. To sustain animal visits, flowers need to reward the animals. Nectar and pollen grains are the most common rewards [1]
4. Cleistogamy is the phenomenon of self-pollination and takes place in unopened flower. The advantage of cleistogamy is that it produces seed even in the absence of pollination. The disadvantage is that it produces flowers are exactly similar to the parent and hence have no variation. [2]
5. Double fertilisation occurs in both castor and groundnut but their mature seeds are different as far as endosperm is concerned. One of the male gamete fuses with polar nuclei to form primary endosperm nucleus. It divides mitotically without cytokinesis to initiate the formation of endosperm. As a result of repeated nuclear division, free nuclear endosperm is formed. Then, cell wall formation occurs around each nucleus to become cellular endosperm. In groundnut, endosperm may be completely utilised by the developing embryo before the maturation of seeds. Such seeds are called non-albuminous or non-endospermic seeds. But in castor seed, a portion of endosperm remains in the seed and is used up during seed germination. Such seeds are called albuminous or endospermic seed. [1+1+1]
6. (a) The exine is made of sporopollenin. It is one of the most resistant organic material. It can withstand high temperature, strong acids and alkalis. It cannot be degraded by any of the known enzymes. Hence, sporopollenin protects pollen grain from any kind of damage. [1]
- (b) Exine layer is not a continuous layer around pollen grain. Continuity of the layer is broken by a pore called germ pore through which pollen tube emerges. [1]
- (c) Pollen grains at a large can be stored for years in liquid nitrogen at (-196°C) . So, after this treatment they are stored in pollen banks. Such stored pollen grains can be used in plant breeding programs. [1]
7. (a) Yes, such type of pollination can be achieved by artificial means or artificial hybridisation. But there should not be any self-incompatibility. In such type of pollination pollen grain of one flower from one city is introduced artificially on the stigma of another flower of another city. [2]

- (b) Diagram of a pistil after pollination [1]



8. Beehives are kept in crop field during flowering period as they help in the pollination of the crop that increases the yield of that crop. Bees while collecting nectar from the flower help in the transfer of pollen. For example, apple and watermelon. [3]
9. A bisexual flowering plant ensures cross pollination by following ways:
- In some species, pollen release and stigma receptivity are not synchronized. Either pollen is released before the stigma becomes receptive or stigma becomes receptive before the release of pollen. [1]
 - The anther and stigma are placed at different positions so that pollen cannot come in contact with stigma of the same flower. [1]
 - Self incompatibility - It inhibits pollen germination/pollen tube growth in the pistil. [1]
10. The three different modes of pollination that can occur in a chasmogamous flower are :
1. **Autogamy** : In this type, pollination is achieved within the same flower. It requires synchrony is pollen release, stigma receptivity and close placing of anther and stigma, so that self-pollination can occur. [1]
 2. **Geitonogamy** : Transfer of pollen grains from the anther to the stigma of another flower of the same plant. [1]
 3. **Xenogamy** : Transfer of pollen grains from anther to the stigma of a different plant. [1]
11. Artificial hybridization 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.

(a) **Emasculation** : Emasculation is the process of removal of anthers (using forceps) from the bisexual flower bud without affecting the female reproductive part i.e. pistil. [1]

(b) **Bagging** : 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. [1]

When the stigma of the bagged flower attains receptivity, 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. (1)

12. (a) Fertilization in an angiosperm referred to as double fertilization because out of two sperm nuclei, one is fertilized with egg nucleus to form an embryo and the other one fuse with polar nuclei to form endosperm [2]

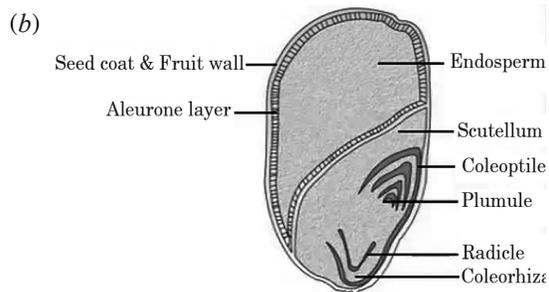


Fig: L.S. of Endospermous monocot seed. [3]

13. (a) The minimum number of pollen grains are involved in the pollination of its pistil are 240. One of the male gametes fuses with the egg cell to form the zygote that eventually give rise to seeds. Therefore, in order to form in 240 seeds, number of pollen grains are required is 240. [1]
- (b) The number of ovules involved in this process would be 240, as the number of viable seeds are 240. After fertilisation, the ovary becomes fruit and the ovules becomes seeds. Therefore, the number of ovules are corresponding to the number of seeds developed. [1]
- (c) During the process of gametogenesis, 240 megaspore mother cells are involved because out of four (tetrad) megaspores formed after meiosis, only one megaspore is functional and it develops further and the rest three megaspores get degenerated. [1]

(d) Minimum 60 microspore mother cells are involved in producing 240 pollen grains. Each microspore mother cell divides by meiosis to give rise to 4 microspores or pollen grains. Since 1 microspore mother cell would produce 4 microspores, therefore, to obtain 240 pollen grains 60 microspore mother cells are required. [1]

(e) The number of male gametes involved in seed formation would be 240 as one of the male gametes fuses with egg nuclei to form zygote, which will further give rise to the seed. [1]

MULTIPLE CHOICE QUESTIONS

- Which one of the following is an example of cleistogamy.
 - Sunflower
 - Vallisneria
 - Commelina
 - Calotropis
- When pollen grains of a flower pollinate the stigma of another flower of the same plant, it is called
 - Dichogamy
 - Herkogamy
 - Geitonogamy
 - Autogamy
- Which prevents self pollination
 - Self sterility
 - Herkogamy
 - Dichogamy
 - All of the above.
- Dichogamy which helps in cross pollination is a floral mechanism in which
 - Pollen sac and stigma are at different heights
 - Anther and stigma mature at different times
 - Structure of pollen sac and stigma functions as hurdles
 - Pollen grain is unable to germinate on the stigma of the same flower.
- Pollination by slug and snails is called
 - Ornithophilous
 - Malacophilous
 - Anemophilous
 - Chiropterophilous
- Pollination by water is seen in
 - Nelumbium
 - Vallisneria
 - Eichornia
 - Nymphaea
- A close relation between flower and pollinating agent is best exhibited by
 - Cocos
 - Salvia
 - Yucca
 - Avena

8. Wind pollination is common in
 - (a) orchids
 - (b) legumes
 - (c) lilies
 - (d) grasses
9. The pollination which occurs in one plant is
 - (a) Herkogamy
 - (b) Cleistogamy
 - (c) Dichogamy
 - (d) Dicliny
10. In which of the following pollination takes place by lever mechanism.
 - (a) Salvia
 - (b) Ficus
 - (c) Antirrhinum
 - (d) Ocimum.
11. Feathery stigma is present in
 - (a) Wheat
 - (b) Pea
 - (c) Caesalpinia
 - (d) Datura
12. In sausage tree (*Kigelia africana*) the pollination takes place by
 - (a) Birds
 - (b) Bats
 - (c) Winds
 - (d) Insects.
13. Anemophilous pollination is mainly observed in
 - (a) Gramineae
 - (b) Annonaceae
 - (c) Papilionaceae
 - (d) Euphorbiaceae
14. Flowers preventing self-pollination is called
 - (a) Dichogamy
 - (b) Protandry
 - (c) Herkogamy
 - (d) Protogyny
15. Both, autogamy and geitonogamy are prevented in
 - (a) Papaya
 - (b) Cucumber
 - (c) Castor
 - (d) Maize.
16. In which one of the following pollination is autogamous
 - (a) deistogamy
 - (b) Geitonogamy
 - (c) Xenogamy
 - (d) Cosmogony
17. The pollination of two flowers on different plants is known as.
 - (a) Xenogamy
 - (b) Geitonogamy
 - (c) Cleistogamy
 - (d) Dichogamy

Answer Keys

- | | | | | |
|---------|---------|---------|---------|---------|
| 1. (c) | 2. (c) | 3. (d) | 4. (b) | 5. (b) |
| 6. (b) | 7. (b) | 8. (d) | 9. (b) | 10. (a) |
| 11. (a) | 12. (b) | 13. (a) | 14. (c) | 15. (a) |
| 16. (a) | 17. (a) | | | |



Solutions

1. In Cleistogamy bisexual flowers never open therefore the pollengrains may only pollinate the stigma of the same flower e.g. commelina bengalensis (day flower) [1]
2. Geitonogamy is the transfer for pollen grains from anthers of one flower to another flower of either the same plant or genetically similar plant or between two clones. [1]
3. Self sterility, herkogamy and dichogamy are adaptation for cross pollination. [1]
4. Dichogamy is the maturation of anther and stigmas of a flower at different times, e.g. sunflower. [1]
5. Malacophily is cross pollination brought about by the agency of snails, slugs e.g. Arisaema (Cobra plant) [1]
6. Vallisneria is sub merged, dioecious, fresh water plant. Hence pollinated in water. [1]
7. In salvia (sage plant), a member of family labiatae pollination occurs by bees and there is a special mechanism called "Turn pipe mechanism" or Lever mechanism of pollination. [1]
8. Wind pollination is common in grasses and gymnosperms. [1]
9. Cleistogamy is the process of self pollination [1]
10. Salvia has turn pipe or lever mechanism for pollination by honey bee. [1]
11. Feathery stigma is characteristic of wind pollination. [1]
12. Chiropterophily is pollination by bats e.g. *Kigelia africana*. *Adansonia* etc. [1]
13. Anemophilous plants bear small and inconspicuous flowers. The pollen grains are small, light, smooth and dry. [1]
14. Herkogamy are mechanical devices that prevent self pollination and favour cross pollination even in homogamous flowers. [1]
15. Papaya is dioecious so that it prevents both Autogamy and Geitonogamy (method of self pollination). [1]
16. Self pollination is favoured by cleistogamy. [1]
17. Xenogamy is the cross pollination between two flowers of different plants. [1]

[Topic 3] Post-fertilisation: Structure and Events

Summary

Post-fertilisation events is a collective term given to transformation of ovary into fruits, ovules into seeds and the development of embryo and endosperm that starts after the double fertilisation process.

Endosperm

Before the development of the embryo, endosperms develop. The cells of the endosperm tissue contain banked food materials and are also used to provide nutrition to the developing embryo. It is either to be entirely eaten up by the developing embryo (e.g., pea, groundnut, beans) before the seed matures or it may exist in the mature seed. For example- coconut.

The Embryo

- At the micropylar end of embryo sac the embryo development begins, this is where zygote is situated. Embryogeny refers to the early stage of embryo development which is common in both dicotyledonous and monocotyledonous embryo.

Seed

- The mature may be of two types either non-albuminous or ex- albuminous. The non albuminous seeds have no residual endosperm as it is consumed during embryonic development where as in albuminous seeds a part of endosperm is retained as it is not completely used up during embryonic development.

Apomixis and Polyembryony

- Some species of Asteraceae and grasses and few other flowering plants have evolved a special mechanism to produce seeds without fertilization and this is called 'Apomixis'.
- The event of presence of more than one embryo in a seed is referred to as polyembryony.

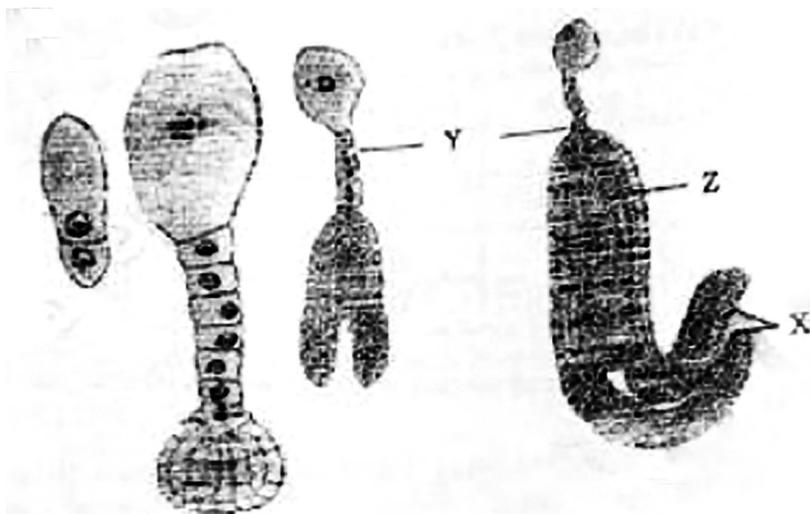
PREVIOUS YEARS'

EXAMINATION QUESTIONS

TOPIC 3

▣ 1 Mark Questions

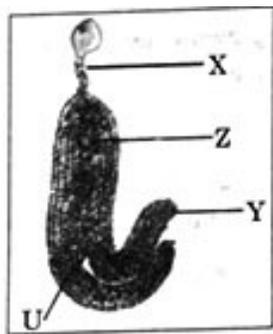
- Normally one embryo develops in one seed but when an orange seed is squeezed many embryos of different shapes and sizes are seen. Mention how it has happened. [DELHI 2011]
 - Why banana is considered a good example of parthenocarpy? [DELHI 2012]
 - In a typical dicotyledonous embryo, the portion of embryonal axis above the level of cotyledons is:
 - Plumule
 - Coleoptile
 - Epicotyle
 - Hypocotyle
 [TERM I 2022]
4. Choose the correct labellings for the parts X, Y and Z in the given figure of the stages in embryo development in a dicot:



- X is suspensor, Y is radicle and Z is cotyledon
- X is radicle, Y is cotyledon and Z is suspensor
- X is cotyledon, Y is suspensor and Z is radicle
- X is zygote, Y is radicle and Z is cotyledon

[TERM I 2022]

5. Select the option that shows the correctly identified 'U', 'X', 'Y' and 'Z' in a developing dicot embryo. (1)



- (a) X – Plumule ($2n$), Y – Suspensor (n), Z – Cotyledon ($2n$), U – Radicle ($2n$).
 (b) X – Plumule ($2n$), Y – Suspensor ($2n$), Z – Radicle ($2n$), U – Cotyledon ($2n$).
 (c) X – Suspensor ($2n$), Y – Cotyledon ($2n$), Z – Radicle ($2n$), U – Plumule ($2n$).
 (d) X – Cotyledon ($2n$), Y – Radicle (n), Z – Plumule (n), U – Suspense (n).

[DELHI 2023]

2 Marks Questions

6. Differentiate between albuminous and non-albuminous seeds, giving one example of each. [DELHI 2011]
 7. Geitonogamous flowering plants are genetically autogamous but functionally cross-pollinated. Justify. [DELHI 2013]
 8. In angiosperms, zygote is diploid while primary endosperm cell is triploid. Explain. [ALL INDIA 2013]
 9. A mature embryo-sac in a flowering plant may possess 7-cells, but 8-nuclei. Explain with the help of a diagram only. [DELHI 2017]
 10. 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? [ALL INDIA 2017]
 11. State two advantages of an apomictic seed to a farmer. [DELHI 2020]

3 Marks Questions

12. State what is apomixis? Comment on its significance. How can it be commercially used? [ALL INDIA 2015]
 13. Explain the function of each of the following:
 (a) Coleorhizae
 (b) Umbilical cord
 (c) Germ pores [DELHI 2012]

14. (a) Describe the endosperm development in coconut.
 (b) Why is tender coconut considered a healthy source of nutrition?
 (c) How are pea seeds different from castor seeds with respect to endosperm?

[ALL INDIA 2013]

15. Explain any three advantages the seeds offer to angiosperms. [DELHI 2014]
 16. Why angiosperm anthers are called dithecous? Describe the structure of its microsporangium. [ALL INDIA 2014]
 17. How does the megaspore mother cell develop into 7-celled, 8 nucleate embryo sac in an angiosperm? Draw a labelled diagram of a mature embryo sac. [ALL INDIA 2011]

5 Marks Questions

18. Give reason why:
 (i) Most zygote in angiosperms divide only after certain amount of endosperm is formed.
 (ii) Groundnut seed are ex-albuminous and castor seed are albuminous.
 (iii) Micropyle remains as a small pore in the seed coat of a seed.
 (iv) Integuments of an ovule harden and the water content is highly reduced, as the seed matures.
 (v) Apple and cashew are not called as true fruits. [ALL INDIA 2012]
 19. Draw a diagrammatic sectional view of a mature anatropous ovule and following parts in it:
 (i) that develops into seed coat.
 (ii) that develops into an embryo after fertilization.
 (iii) that develops into an endosperm in an albuminous seed
 (iv) through which the pollen tube gains its entry into the embryo sac.
 (v) that attach the ovule to the placenta
 Describe the characteristics feature of wind pollinated flowers. [DELHI 2013]
 20. (a) Coconut palm is monoecious, while date palm is dioecious. Why are they so called?
 (b) Draw a labelled diagram of sectional view of a mature embryo sac of an angiosperm. [DELHI 2014]
 21. (a) Explain the different ways apomictic seeds can develop, Give an example of each.
 (b) Mention one advantage of apomictic seeds to farmers.
 (c) Draw a labelled mature stage of a dicotyledonous embryo. [ALL INDIA 2014]

22. (a) Plan an experiment and prepare a flow chart of the steps that you would follow to ensure that the seeds are formed only from the desired sets of pollen grains. Name the type of experiment that you carried out.
(b) Write the importance of such experiments. [ALL INDIA 2015]
23. (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. [DELHI 2016]
24. (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.
(b) Draw a diagram of a section of a megasporangium of an angiosperm and label funiculus, micropyle, embryo sac and nucellus. [ALL INDIA 2016]
25. 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 flow-chart to depict the post-pollination events leading to viable-seed production in a flowering plant. [DELHI 2017]
26. (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. [ALL INDIA 2017]
27. (a) Describe any two devices in a flowering plant which prevent both autogamy and geitonogamy.
(b) Explain the events up to double fertilization after the pollen tube enters one of the synergids in an ovule of an angiosperm. [DELHI 2018]
28. (a) Explain the process of double fertilization in angiosperms.
(b) Why does the development of endosperm precede that of embryo?
(c) List the parts of a typical dicot embryo. [DELHI 2019]
29. (a) Describe the process of double fertilisation in angiosperms.
(b) Trace the development of polyploid cell that is formed after double fertilisation in a non-albuminous seed and albuminous seed. [DELHI 2020]
30. (i) Explain the monosporic development of embryo sac in the ovule of an angiosperm.
(ii) Draw a diagram of the mature embryo sac of an angiospermic ovule and label any four parts in it. [DELHI 2023]



Solutions

- Presence of more than one embryo is called as polyembryony, is the phenomenon responsible for embryos of different shapes and sizes are seen in oranges. This occur due to formation of two or more embryo from the nucellar cells surrounding the embryo. These cells divide and protrude into the embryo. Then they develop as seeds. [1]
- Banana is considered a good example of parthenocarpy because it produces seedless fruit in the absence of successful fertilization by application of hormones [1]
- (c) A dicotyledonous embryo comprises of an embryonal axis and two cotyledons. The part of embryonal axis above the cotyledon is epicotyl which emerges as plumule, whereas the cylindrical portion below the level of the cotyledon is hypocotyl which forms radicle. [1]
- (c)
 - A transverse wall divides the zygote or oospore into suspensor cell and an embryonal cell.
 - The suspensor cells is divided by transverse divisions to constitute 6-10 celled suspensor.
 - The upper cell of the suspensor filament towards the micropylar end is called haustorial cell, whereas the cell lying above the embryo cell is called hypophysis.
 - The haustorial cell enlarges in size and attaches the suspensor to embryo sac.
 - By second longitudinal division and then by transverse division, the embryonal cell form an octant or an eight celled embryo.
 - The lower four cells of the octant away from suspensor arises Plumule and 2 Cotyledons, the above four cells near the suspensor forms hypocotyl and stele of radicle. [1]
- (c) The part labelled in the given option are correct. [1]

6. Seed is formed as a result of sexual reproduction in angiospermic plants. Seed contain three important parts: seed coat, cotyledons and embryo axis. Mature seed can be classified into albuminous and non-albuminous seed on the basis of reserve food. [1]

(i) Albuminous seed: they store or retain their some part of endosperm during the period of embryo development. Example is sun-flower [½]

(ii) Non-albuminous seed: they consume entire endosperm during the period of embryo development. Example is pea. [½]

7. The pollination where pollen grain is transferred from one flower anther to stigma of another flower in the same plant is known as geitonogamy. As, in this type of plants, gametes are coming from the same parent it is known as autogamous but at the same time since, pollen grain is transferred from one flower anther to stigma of the another flower which require the pollinating agent is known as cross-pollination. [1+1]

8. Zygote is formed by the fusion of haploid male gamete and haploid female gamete by the process of syngamy. [1]

Male gamete (n) + Egg (n) → Zygote (2n)

Primary endosperm is formed by the fusion of secondary nucleus which is diploid and male gamete which is haploid. Hence, endosperm is triploid

Secondary nucleus (2n) + Male gamete (n) → Primary endosperm (3n) [1]

9. Diagram of mature embryo-sac in a flowering plant may possess 7-cells, but 8-nuclei. 7 cells are: 3 antipodal cells (3 nuclei), 1 central cell (2 nuclei), 1 egg cell (1 nucleus) and 2 synergids (2 nuclei). [1]

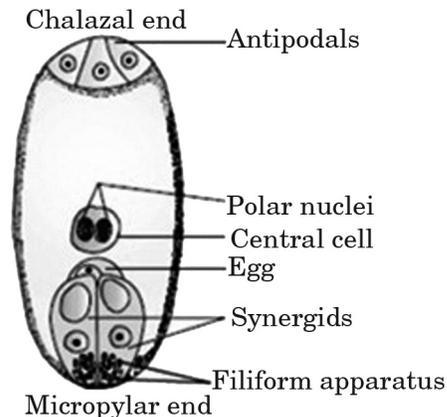


Fig.: Mature embryo-sac [1]

10. In most of the angiosperms, pollen grains released at 2-celled stage. Pollen grain contains a small generative and a large vegetative cell. At 3-celled stage pollen grains contains one vegetative cell and two male gametes. [1]

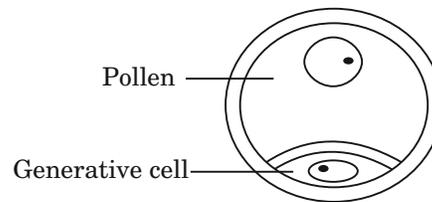


Fig.: Schematic diagram of a pollen grain with two cells [1]

11. The two advantages of apomictic seeds are as follows :

1. They reduce the cost of hybrid breeding programmes. [1]
2. The desirable traits can be maintained without losing the superiority of hybrids over parents. [1]

12. Apomixis is a process by which new individuals are formed without involving the process of meiosis and syngamy (fertilization) due to non-formation of gametes. Apomixis can be seen in certain plants like grasses, citrus plants, conifers like pine etc. Significance of Apomixis: Apomixis is an alternative process by which hybrid varieties can be raised from hybrid seeds. If the Hybrid seeds are sown they segregate their characteristics in progeny plants. Therefore, Hybrid seeds have to be produced every year as these cannot be collected from hybrid plants. By making hybrid seeds as apomicts, rapid multiplication of genetically uniform individuals can be achieved without risk of segregation by apomixis. [2]

Commercial applications of apomixis are:

- By apomixis, hybrid seeds can be produced, which will provide higher and better yield.
- It prevents the loss of specific characteristics in the hybrid plants.
- Apomixis is a cost-effective method of producing seeds. [1]

13. (a) Coleorhiza is a sheath like structure in the seed of plants that provide protective covering enclosing radicle and root cap. [1]

(b) The functions of umbilical cord are:

- (i) Deliver oxygen to the foetus
- (ii) Delivers nutrients to foetus
- (iii) Withdrawing of CO₂ & waste. [1]

- (c) Germ pores is the region through which the pollen tube enters the ovary. [1]

14. (a) Coconut endosperm formation is of nuclear type which involve the nuclear division of primary endosperm without the formation of cell wall. [1]
- (b) Tender coconut considered a healthy source of nutrition as its endosperm is rich in nutrients like proteins, minerals, vitamins. [1]
- (c) Pea is a non-albuminous seed as they consume entire endosperm during the period of embryo development where castor seed is an albuminous seed as it retains some part of endosperm during the period of embryo development. [1]
15. Three advantages that the seeds offer to angiosperms are:
- (a) Seeds provide protection of the embryo from adverse environmental conditions. [1]
- (b) Seed provide nourishment to the embryo. [1]
- (c) Dispersal of seed helps them to have better adaptive strategies. [1]
16. Angiosperm anthers are called dithecous because it is bilobed with each lobe having two theca. Structure of its microsporangium include four layers:
- (i) Epidermis: Provide protection
- (ii) Endothecium: Provide protection
- (iii) Middle layer: Provide protection [1]
- (d) Tapetum : Nourishes the pollen grain

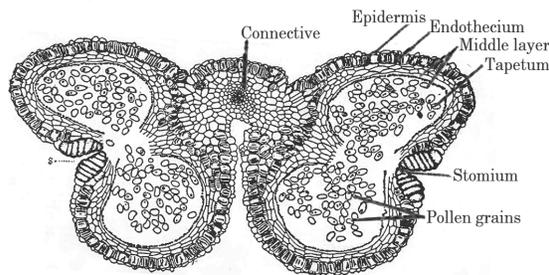


Fig.: Microsporangium

17. Mitosis in the megaspore mother cell leads to formation two nuclei which move to two opposite poles. After that, further mitotic divisions lead to the formation of 4 nuclei and 8 nuclei embryo sac in an angiosperm. This division is unique because nuclear division is not followed by cell wall formation. Out of the eight nuclei, six are covered by cell wall while remaining two nuclei

are placed above the egg apparatus in the central cell. Among the six cells, three cells are placed at micropylar end, in which two are called as synergids and one is egg cell. Remaining three cells are placed at chalazal end and are known as antipodals. In this way, megaspore mother cell develop into 7-celled, 8 nucleate embryo sac in an angiosperm. [2]

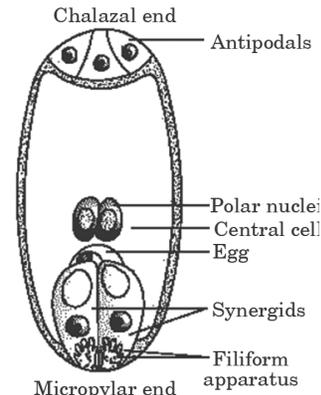


Fig.: Mature embryo sac [1]

18. (i) Most zygote in angiosperms divide only after certain amount of endosperm is formed to get nourishment from the endosperm for the developing embryo. [1]
- (ii) Groundnut is a non-albuminous seed as they consume entire endosperm during the period of embryo development whereas castor seed is an albuminous seed as it retain their some part of endosperm during the period of embryo development [1]
- (iii) Micropyle remains as a small pore in the seed coat of a seed because it provide the entry for water and oxygen which is required for the germination. [1]
- (iv) Integuments of an ovule protect the embryo from the harsh environmental conditions and help the seed to remain viable. [1]
- (v) Apple and cashew are not called as true fruits because their fruit is not formed from ovary but it develop from thalamus. [1]

19.

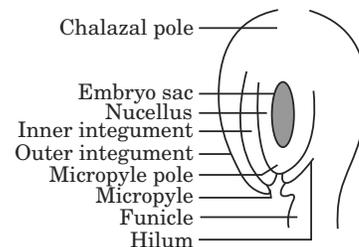


Fig.: Mature anatropous ovule [3]

Fig: sectional view of a mature anatropous ovule
The characteristics feature of wind pollinated flowers are

- (a) Large number of pollen grain production
(b) Pollen are smooth and light [2]

20. (a) Coconut palm is monoecious due to the presence of male and female flowers on the same plant. [2]

Date palm is dioecious due to the presence of either male flower or female flower exclusively on one plant. [1]

- (b) [2]

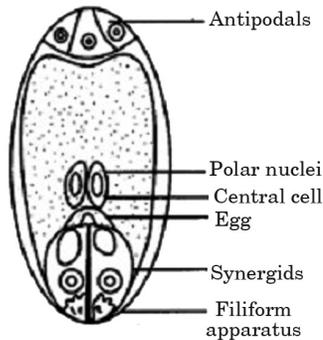


Fig.: sectional view of a mature embryo sac

21. (a) Different ways apomictic seeds can develop are:

- (i) Diploid embryo is formed without the process of fertilization. Example is banana. [1]
(ii) Some nucellar cells surrounding the embryo sac, enter into the embryo sac, divide in a continuous manner and lead to the formation of embryo. Example is mango. [1]

- (b) Farmers can use the hybrid seeds for the next season that reduce the seed cost. [1]

- (c) [2]

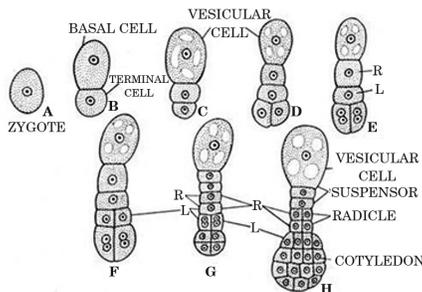


Fig.: Mature stage of a dicotyledonous embryo

22. (a) The name of the experiment or technique to obtain seeds from a desired set of pollen grains is 'Artificial Hybridization'. In this technique, only desired pollen grains are used to pollinate the stigma of a desired plant. The specific stigma is kept protected from the contact of unwanted pollen.

This Flow chart of the steps of the experiment:

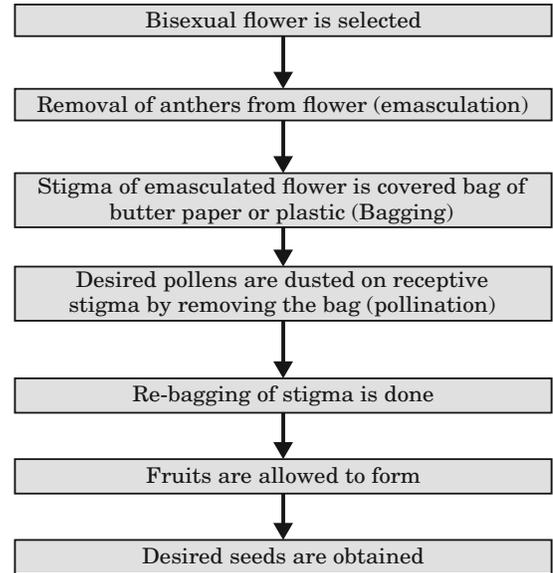


Fig.: Artificial hybridization [1½]

- (b) Importance of artificial hybridization are:

- (i) Creation of new genetic recombination with better qualities.
(ii) Incorporation of a large number of desirable characters into a single variety. [2]

23. (a) After the pollination, pollen grains are transferred to the stigma. As a result of pollen-pistil interaction, germination of pollen grains occur. Pollen tubes arise from pollen grains. Pollen tubes carrying two male gametes enters into the embryo sac for double fertilization. One male gamete fuses with the egg cell (syngamy), while the other fuses with two polar nuclei to form primary endosperm nucleus (PEN). The fertilised egg develops into zygote, which eventually develops into an embryo while the PEN develops to form endosperm. After double fertilisation, the ovule matures into a seed while the ovary matures into a fruit. [2]

- (b) Different types of pollination depending upon the source of pollen grain are: [1]

Autogamy: A type of pollination in which transfer of pollen grains from the anther to the stigma of the same flower. For examples as in Pansy, Oxalis.

Geitonogamy: Transfer of pollen grain from anther of one flower to the stigma of another flower of the same plant. [1]

Xenogamy: A pollination in which transfer of pollen grains from anther to the stigma of a different plant. In xenogamy, genetically different types of pollen grains are introduced to the stigma. [1]

24. Cross-pollination in a hermaphrodite or bisexual flower can be achieved by:

Emasculation: by removing anthers of one of the flowers. [1]

Bagging: The emasculated flower is covered by a bag to prevent contamination of its stigma by unwanted pollen grains. [1]

Rebagging: When the stigma of the bagged flower becomes receptive, the pollen grains collected from the other flower are dusted on the stigma and allow the fruit to develop after pollination and fertilisation by covering the stigma with a bag. [1]

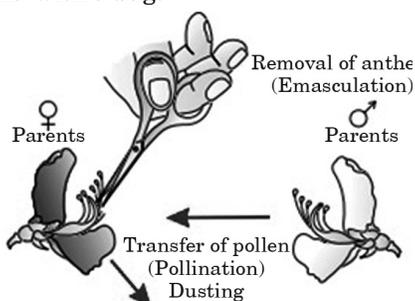


Fig.: A diagram of a section of a megasporangium of an angiospermic plant.

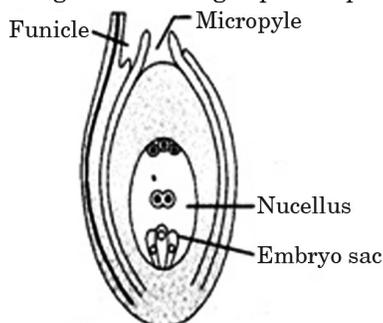


Fig.: Megasporangium [1]

25. (a) Seeds that remain alive and can give rise to new plant or have the capacity to germinate into a new plant are called viable seeds [1]
- (b) (i) Number of pollen grains required is 200. [1]
- (ii) Number of gametes required is 600 gametes (400 male gametes and 200 female gametes). [1]
- (c) A flow-chart showing the post-pollination events leading to viable-seed production in a flowering plant: [1]

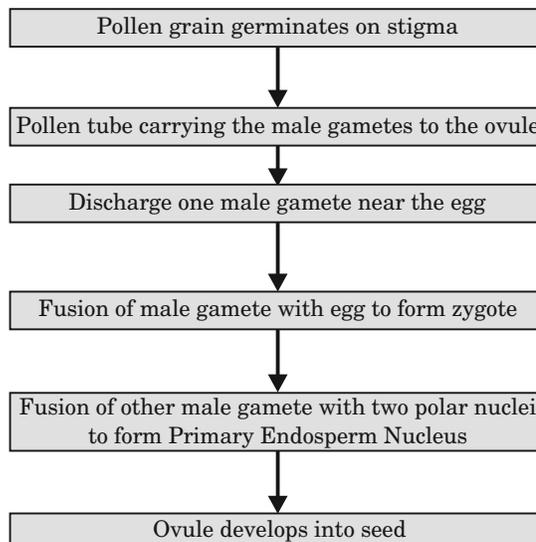


Fig.: Post pollination event in a flowering plant

26. (a) When a seed of an orange is squeezed, instead one, many embryos are observed in it. This happens due to the phenomenon called polyembryony. Polyembryony may arise due to the development of embryos from synergids or from antipodal cells. Some embryos can also be developed from sporophytic cells of ovule such as nucellus or integument. [3]
- (b) The embryos develop as a result of polyembryony are genetically similar. The embryos developing from gametophytic tissues such as synergids and antipodal cells are similar to each other, but not to their parents. Similarly the embryos that are formed from sporophytic tissues are usually similar to each other as well as their parents. [2]
27. (a) A type of pollination in which there is transfer of pollen grains from anther to the stigma of same flower is called autogamy and in geitonogamy there is transfer of pollen grains from anther to the stigma of another flower of same plant. Two devices that prevent both autogamy and geitonogamy are: [1]
- (i) Self-incompatibility is a genetic mechanism which prevents self-pollen from fertilising the ovules by inhibiting pollen germination or pollen tube growth in the pistil. [1/2]
- (ii) Dioecious plants: Male and female flowers are present on different plants, that is each plant is either male or female. [1/2]

(b) The events seen after the pollen tube enters one of the synergids in an ovule are as follows:

- (i) Pollen tube, after reaching the ovary, enters the ovule through the micropyle and thus enters one of the synergids through filiform apparatus.
- (ii) After entering into synergid, the pollen tube releases the two male gametes into the cytoplasm of the synergids.
- (iii) One of the male gametes move towards the egg cell and fuses (fertilization) with it results in formation of the zygote.
- (iv) The other male gamete move towards the two polar nuclei located in the central cell and fuses to form triploid primary endosperm nucleus (PEN). This involves fusion of three haploid nuclei & hence termed as triple fusion.
- (v) Two types of fusions, fertilization (syngamy) and triple fusion takes place in an embryo sac and hence the phenomenon is termed as double fertilisation.
- (vi) After fertilisation, PEN becomes the primary endosperm cell and develops into endosperm while zygote develops into an embryo. [2]

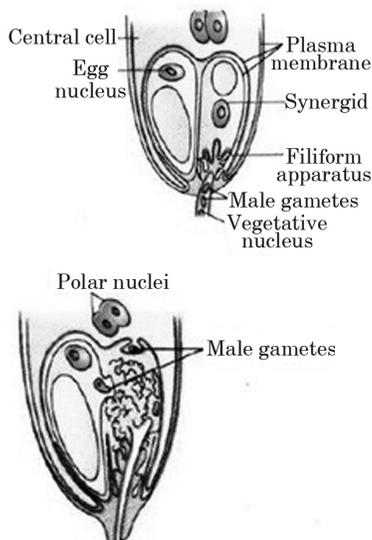


Fig.: Double fertilization [1]

28. (a) Double fertilization in angiosperms:

- After entering one of the synergids, pollen tube releases the two male gametes into cytoplasm of the synergid. [½]
- One of male gamete fuses with egg cell, thus completing the syngamy; hence resulting in formation of zygote. [½]

- The other male gamete move towards the polar nuclei located in central cell and fuses with them to produce a triploid PEN. [½]
- Since two types of fusions, syngamy and triple fusion take place - take place; it is termed as double fertilization. [½]

(b) Development of endosperm precedes that of embryo :

Because cells of endosperm tissue are filled with reserve food materials and are used for the nutrition of the developing embryo.

[1½]

(c) Parts of a typical dicot embryo:

- Plumule
- Cotyledons
- Hypocotyl
- Radicle
- Root cap

[1½]

29. (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 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). Since two types of fusions, syngamy and triple fusion take place in an embryo sac. The phenomenon is termed double fertilisation. [3]

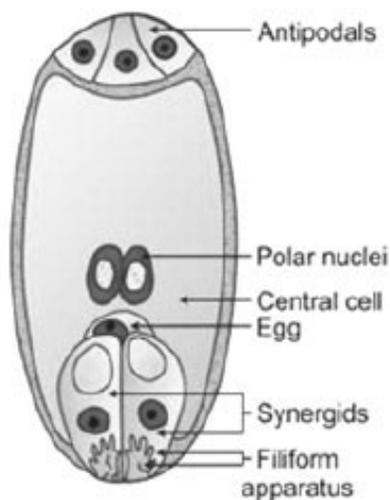
(b) Mature seeds may be non-albuminous or albuminous.

- Non-albuminous seeds have no residual endosperm as it is completely consumed during embryo development. [1]
- Albuminous seeds retain a part of endosperm as it is not completely used up during embryo development. [1]

30. (i) Formation of the embryo sac has been explained as follows:

- The female gametophyte develops from a single functional megaspore. This megaspore undergoes three successive mitotic divisions to form 8-nucleated embryo sac.
- The first mitotic division in the nucleus of the functional megaspore forms two nuclei. One nucleus move towards the micropylar end, while the other nucleus move towards the chalazal end. This results into 2-nucleate embryo sac.

- Two more sequential mitotic nuclear divisions at their respective ends i.e. at the micropylar and chalazal end of the embryo sac result in the formation of the 4-nucleate and later the 8-nucleate stages of the embryo sac.
 - These divisions are strictly free nuclear, i.e. nuclear divisions are not followed immediately by cell wall formation.
 - After the 8-nucleate stage, cell walls are laid down leading to the organization of the typical female gametophyte or embryo sac.
 - Six of the 8 nuclei get surrounded by the cell wall and remaining two nuclei called polar nuclei are situated below the egg apparatus in the large central cell. [3]
- (ii) A diagrammatic representation of the mature embryo sac is:



Mature Embryo Sac

(Any four labels) ($\frac{1}{2} \times 4 = 2$)

MULTIPLE CHOICE QUESTIONS

- Syngamy means
 - fusion of similar spores
 - fusion of dissimilar spores
 - fusion of cytoplasm
 - fusion of gametes
- When the pollen tube enters through the micropyle it is termed as.
 - Chalazogamy
 - Mesogamy
 - Porogamy
 - Name of the above
- Female gametophyte of a typical dicot at the time of fertilization is
 - 8 celled
 - 7 celled
 - 6 celled
 - 4 celled
- Double fertilization was discovered by
 - Karl Scharf
 - P. Maheshwari
 - S.G. Nawaschin
 - B.G.L. Swamy
- Fertilization of egg takes place inside
 - Anther
 - Stigma
 - Pollen tube
 - Embryo sac
- Which pollen tube enters by integuments, then the process is called.
 - Mesogamy
 - Porogamy
 - Chalozogamy
 - Pseudogamy
- Double fertilization is a characteristic of
 - Gymnosperms
 - Bryophytes
 - Angiosperms
 - Pteridophytes
- A pollen tube grows down the style because
 - It helps in fertilization
 - It takes nutrients from the style
 - Filiform apparatus of synergids attracts the pollen tube
 - of chemical attraction.
- Germination of pollen grain on the stigma is
 - Autogamy
 - In vivo germination
 - In vitro germination
 - None of there
- Number of nuclei taking part in double fertilization is.
 - 2
 - 3
 - 4
 - 5
- The phenomenon of syngamy (fertilization) in angiosperms was discovered by
 - Svedberg
 - Strasburger
 - Nawaschin
 - Coulter and chamberlin.
- The cells that divides to form two male nuclei in angiosperms is.
 - Vegetative cell
 - Generative cell
 - Tube cell
 - Antheridial cell
- Growth of pollen tube towards embryo sac is
 - Geotropism
 - Thigmotaxis
 - Chemotaxis
 - Phototaxis

14. In an angiospermic plant, endosperm is formed due to fertilization of secondary nucleus but it is absent in some of the seeds Viz. Pea, bean, Phaseolus (moong) etc.; It is due to lack of
 (a) Certain enzymes
 (b) Dicotyledonous hormone
 (c) Growth hormone
 (d) None of the above.
15. Through which route the pollen tube enters the ovule
 (a) Chalaza (b) Micropyle
 (c) Funiculus (d) All of these
16. Which of the following is without exception in angiosperms
 (a) Secondary growth
 (b) Presence of vessels
 (c) Double fertilization
 (d) Autotrophic nutrition
17. The formation of embryo without fusion of gametes is termed as
 (a) Apospory (b) Isogamy
 (c) Apogamy (d) Syngamy
18. Which of the following is not true for double fertilization
 (a) Discovered by Nawaschin
 (b) Male gamete and secondary nucleus fused to form endosperm nucleus
 (c) Endosperm nucleus is diploid
 (d) Endosperm provide nutrition to embryo.
19. Through which cell of the embryo sac, does the pollen tube enter the embryo sac.
 (a) Egg cell
 (b) Central cell
 (c) Persistent synergid
 (d) Degenerated synergid
20. After fertilization the outer integument forms.
 (a) Testa (b) Tegmen
 (c) Perisperm (d) Pericarp

Answer Keys

1. (d) 2. (c) 3. (b) 4. (c) 5. (d)
 6. (a) 7. (c) 8. (c) 9. (b) 10. (d)
 11. (b) 12. (b) 13. (c) 14. (d) 15. (d)
 16. (c) 17. (c) 18. (c) 19. (d) 20. (a)



Solutions

1. Syngamy is fusion of one of the two male gametes with egg to produce diploid zygote (oospore) [1]

2. Porogamy is the most common way in angiosperms e.g. Lily. [1]
3. In mature female gametophyte, 3 antipodal cells, 2 Synergids, 1 egg and 1 diploid secondary nucleus are present. [1]
4. Double fertilization was discovered by Nawaschin, (1898) in fritillaria and Liliium. [1]
5. Because egg is the part of embryo sac. [1]
6. In mesogamy pollen tube penetrates laterally through integuments (cucurbita) and funiculus (e.g. pistacia) [1]
7. Because in gymnosperms, bryophytes and pteridophytes single fertilization is found. [1]
8. Filiform apparatus of synergids secretes some chemical substance which is polysacchioride in nature which attract pollen tube. [1]
9. Germination of pollen grains completes on stigma i.e., in vivo. It means in natural conditions or within the cell. [1]
10. 5 i.e., 2 sperm nuclei, 2 pollen nuclei and one egg nucleus. [1]
11. In angiosperms, male gametes reach the female gamete with the help of pollen tube. (Strasburger, 1884) [1]
12. Generative cell divides into two male gametes, if it has not divided already. [1]
13. Growth of pollen tube towards the embryo sac is chemotaxis because this movement is induced by chemicals like auxin hormone and carbohydrate. [1]
14. Pea, bean and phaseolus seeds are non-endospermic because endosperm is fully consumed during their embryo development. It is an advance character of angiosperm. [1]
15. All three type can be route of the pollen tube enters in the ovule as chalazogamy mesogamy and porogamy. [1]
16. Double fertilization is found only in angiosperm. In which secondary nucleus form triploid cell and egg convert into diploid zygote. Triploid cell to form endosperm and diploid zygote to form embryo. [1]
17. The formation of sporophyte from gametophytic cell without fertilization is called apogamy. [1]
18. Endosperm is triploid (3n) [1]
19. Synergids are short lived (one of them degenerated long before fertilization and second after entry of pollen tube into embryo sac) [1]
20. After fertilization the outer integument forms testa, inner integument forms tegmen and ovary wall forms pericarp. [1]