

**SAMPLE CONTENT**



# BIOLOGY

**Vol.  
I**

**Based on Latest Paper Pattern and Textbook**

**Phenotypic variations:**

Phenotypic variations observed within populations may be caused due to genetic differences between individuals, or due to differences in environmental factors, or by interaction between genetics and the environmental factors.



**Std. XII Sci.**

**Dr. M.D. Gangakhedkar**  
M.Sc., Ph.D, DHE.

**Ms. Khushbu Bohara**  
M.Sc. (Botany)

**Dr. P. C. Thomas**  
M.Sc., M. Phil., Ph. D.

**Mr. Amit Patil**  
M.Sc. (Biochemistry)

**Ms. Krupa Devani**  
M.Sc. (Biotechnology)

**Target** Publications® Pvt. Ltd.

# PERFECT BIOLOGY (Vol. I)

## Std. XII Sci.

### Salient Features

- Written as per **Latest Board Paper Pattern**
- Subtopic-wise segregation for powerful concept building
- Complete coverage of Textual Exercise Questions and Intext Questions
- Marks provided to the Questions as per relevant weightage wherever deemed necessary
- Relevant Previous Years' Board Questions:  
**March 2009 to July 2023**
- Each chapter contains:
  - 'Quick Review' of the chapter for quick revision
  - 'Apply Your Knowledge' section for application of concepts
  - 'Exercise' to provide Theory questions and MCQs for practice
  - 'Competitive Corner' to give the glimpse of prominent competitive examinations
  - 'Topic Test' at the end of each chapter for self-assessment
- Includes Important Features for holistic learning:
  - *About the Chapter*                      - *Reading Between the Lines*                      - *NCERT Corner*
  - *Enrich Your Knowledge*                      - *Gyan Guru*                      - *Connections*
  - *Caution*
- Q.R. codes provide:
  - The Video/pdf links boosting conceptual retention
  - Solutions of Topic Tests
  - Model Question Paper along with Solution

Printed at: **Print to Print**, Mumbai

© Target Publications Pvt. Ltd.

No part of this book may be reproduced or transmitted in any form or by any means, C.D. ROM/Audio Video Cassettes or electronic, mechanical including photocopying; recording or by any information storage and retrieval system without permission in writing from the Publisher.

## PREFACE

**Perfect Biology Vol. I, Std. XII Sci.** is intended for every Maharashtra State Board aspirant of Std. XII, Science. The scope, sequence, and level of the book are consistent with the latest textbook released by the Maharashtra State board.

At this crucial juncture in their lives, when the students are grappling with the pressures of cracking a career-defining board examination, we wanted to create a book that not only develops the necessary knowledge, tools, and skills required to excel in the examination, but also enables students to appreciate the beauty of the subject and piques their curiosity.

We believe that students respond favourably to meaningful content, if it is presented in a way that is easy to read and understand, rather than being mired down with facts and information. Consequently, we have always placed the highest priority on writing clear and lucid explanations of fundamental concepts. Moreover, special care has been taken to ensure that the topics are presented in a logical order. The coherent Question/Answer approach helps students expand their horizon of understanding of the concepts.

The primary purpose of this book is to assist the students in preparing for the board examination. However, this is closely linked to other goals: to exemplify how important and how incredibly interesting Biology is, and to help the student become an expert thinker and problem solver.

Every chapter in this book begins with a brief introduction of the topic to capture students' imagination and stimulate their appetite for the topic. The scope of the book extends beyond the State Board examination as it also offers a plethora of Multiple Choice Questions (MCQs) in order to familiarize the students with the pattern of competitive examinations.

In addition, the Topic-Test has been carefully crafted to focus on concepts, thus providing the students with a quick opportunity for self-assessment and giving them an increased appreciation of chapter-preparedness. '**Model Question Paper**' along with solution based on updated Board Paper Pattern is provided which can be accessed through QR Code to help students assess their preparedness for final Board Examination.

We believe that the study of Biology helps in the understanding of many fascinating and important phenomena. In this vein, we have put an effort to relate Biology to real-world events in order to show students that Biology is a vibrant, constantly evolving science that has relevance in our modern world. We hope this book becomes a valuable tool for you and helps you to understand the concepts of Biology.

Our **Perfect Biology Vol. I, Std. XII Sci.** adheres to our vision and achieves several goals: **building concepts, recapitulation, self-study, self-assessment** and **student engagement**-all while encouraging students towards cognitive thinking.

The flow chart on the adjacent page will walk you through the key features of the book and elucidate how they have been carefully designed to maximize the student learning.

*We hope the book benefits the learner as we have envisioned.*

Publisher

**Edition:** Sixth

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.

Please write to us on: [mail@targetpublications.org](mailto:mail@targetpublications.org)

## KEY FEATURES

**'About the Chapter'** is a short introduction designed to stimulate students' appetite for the topic.

**About the chapter**

**Reading between the lines**

Reading between the lines provides elaboration or missing fragments of the concept which is essential for complete understanding of the concept.

NCERT Corner covers information from NCERT textbook relevant to topic.

**NCERT Corner**

**Connection**

Connections enable students to interlink concepts covered in different chapters.

Caution helps students to clarify the differences between two related words or concepts.

**Caution**

**Diagrams in Hand-drawn Format**

Diagrams in Hand-drawn format are easy to memorize, save time and efforts of the students.

QR code provides:

- i. Access to a video/PDF in order to boost understanding of a concept or activity
- ii. Solutions to the Topic Tests
- iii. Model Paper with Solution

**QR Codes**

**Enrich Your Knowledge**

Enrich Your Knowledge presents fascinating information about the concept covered.

Continued...

## KEY FEATURES

Gyan Guru illustrates real life applications or examples related to the concept discussed.

**GG-Gyan  
Guru**

**Apply  
Your  
Knowledge**

Apply Your Knowledge includes challenging questions.

Quick review includes tables/ flow charts to summarize the key points in a chapter.

**Quick  
Review**

**Competitive  
Corner**

Competitive Corner presents latest questions from prominent [NEET (UG), MHT-CET] competitive exams based entirely on the syllabus covered in the chapter.

Includes relevant Board questions from March 2009 to July 2023

**Board  
Questions**

Sample Content

## PAPER PATTERN

- There will be one single theory paper of 70 Marks and practical examination of 30 Marks in Biology.
- Duration of theory paper will be 3 hours.

**Section A:** (18 Marks)

This section will contain Multiple Choice Questions and Very Short Answer (VSA) type of questions.

There will be 10 MCQs and 8 VSA type of questions, each carrying **One** mark.

Students will have to attempt all the questions.

**Section B:** (16 Marks)

This section will contain 12 Short Answer (SA-I) type of questions, each carrying **Two** marks.

Students will have to attempt any 8 questions.

**Section C:** (24 Marks)

This section will contain 12 Short Answer (SA-II) type of questions, each carrying **Three** marks.

Students will have to attempt any 8 questions.

**Section D:** (12 Marks)

This section will contain 5 Long Answer (LA) type of questions, each carrying **Four** marks.

Students will have to attempt any 3 questions.

### Distribution of Marks According to the Type of Questions

Type of Questions		
MCQ	1 Mark each	10 Marks
VSA	1 Mark each	8 Marks
SA - I	2 Marks each	16 Marks
SA - II	3 Marks each	24 Marks
LA	4 Marks each	12 Marks

### Disclaimer


This reference book is transformative work based on latest Textbook of Std. XII Biology published by the Maharashtra State Bureau of Textbook Production and Curriculum Research, Pune. We the publishers are making this reference book which constitutes as fair use of textual contents which are transformed by adding and elaborating, with a view to simplify the same to enable the students to understand, memorize and reproduce the same in examinations.

This work is purely inspired upon the course work as prescribed by the Maharashtra State Bureau of Textbook Production and Curriculum Research, Pune. Every care has been taken in the publication of this reference book by the Authors while creating the contents. The Authors and the Publishers shall not be responsible for any loss or damages caused to any person on account of errors or omissions which might have crept in or disagreement of any third party on the point of view expressed in the reference book.

© reserved with the Publisher for all the contents created by our Authors.


No copyright is claimed in the textual contents which are presented as part of fair dealing with a view to provide best supplementary study material for the benefit of students.

# CONTENTS

Chapter No.	Chapter Name	Marks without option	Marks with option	Page No.
1	Reproduction in Lower and Higher Plants	6	8	1
2	Reproduction in Lower and Higher Animals	6	8	33
3	Inheritance and Variation	4	6	78
4	Molecular Basis of Inheritance	4	6	116
5	Origin and Evolution of Life	4	6	151
6	Plant Water Relation	5	7	185
7	Plant Growth and Mineral Nutrition	5	7	212
8	Respiration and Circulation	7	10	242
•	Scan the given Q.R. Code in <i>Quill – The Padhai App</i> to view the Model Question Paper with Solution.			

Chapters 9 to 15 are a part of Std. XII: Perfect Biology (Vol. II)

[Reference: Maharashtra State Board of Secondary and Higher Secondary Education, Pune - 04]

- Note:**
- \* mark represents Textual question.
  - # mark represents Intext question.
  -  symbol represents textual questions that need external reference for an answer.

Scan the adjacent QR Code to know more about our **“Model Question Papers with solutions”** book for Std. XII (Sci.) and Gear up yourself to score more in the XII Board Examination.

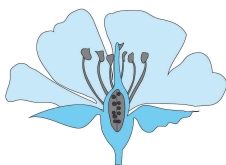


Scan the adjacent QR Code to know more about our **“Board Questions with Solutions”** book for Std. XII (Sci.) and Learn about the types of questions that are asked in the XII Board Examination.



# 1

## Reproduction in Lower and Higher Plants



### About the chapter...

In this chapter, students would be learning about the distinctions between gamete and gametophyte, male and female gametophyte, zygote and embryo. Students would also get clear idea about the development of the male and female gametophyte in angiosperms and the significance of double fertilization. Chapter also throws light on concept of vegetative propagation, parthenocarpy and polyembryony, etc. This chapter carries a weightage of 8 marks with options and 6 marks without options in the board examination.

### CONTENTS AND CONCEPTS

- 1.0 Introduction
- 1.1 Asexual Reproduction
- 1.2 Sexual Reproduction
- 1.3 Microsporogenesis
- 1.4 Structure of Anotropous Ovule
- 1.5 Megasporogenesis
- 1.6 Pollination
- 1.7 Outbreeding Devices (Contrivances)

- 1.8 Pollen-Pistil Interaction
- 1.9 Double Fertilization
- 1.10 Development of Endosperm
- 1.11 Development of Embryo
- 1.12 Seed and Fruit Development
- 1.13 Apomixis
- 1.14 Parthenocarpy
- 1.15 Polyembryony

### 1.0 Introduction

Q.1.

i. Can you recall? (Textbook page no. 01)

a. How do plants reproduce without seeds?

[1 Mark]

Ans: Plants reproduce without seeds by vegetative propagation.

b. How does vegetative propagation occur in nature?

[1 Mark]

Ans: Vegetative propagation occurs with the help of vegetative organs like root, stem, leaf or bud.

ii. Why reproduction is an essential process?

[1 Mark]

Ans: Reproduction is an essential process as it leads to continuation of species as well as to maintain the continuity of life.

### 1.1 Asexual Reproduction

Q.2.

i. What is reproduction?

ii. Name the two methods of reproduction.

[2 Marks]

Ans:

i. Reproduction is a process by which living organisms produce the offsprings of their own type.

ii. Two methods of reproduction: Asexual reproduction and Sexual reproduction.

Q.3. Define clones.

[1 Mark]

Ans: Morphologically and genetically identical individuals produced by asexual reproduction are called as clones.

Q.4. Write a short note on asexual reproduction in lower organisms.

[3/4 Marks]

Ans:

i. **Asexual reproduction:** It is a process of reproduction in which single parent is involved that results in production of morphologically and genetically identical progeny.

ii. Asexual reproduction in lower organisms occurs by following methods:

a. **Fragmentation:** Multicellular organisms **break into fragments** and each fragment can develop into new individuals. It occurs in *Spirogyra*.

b. **Budding:** It is a common method of reproduction in unicellular organisms like yeast and *Protosiphon* (Algae). Under favourable conditions one or more **outgrowths (buds) are formed on parent cell**. These buds on separation from the parent body develop into new individual.





- c. **Spore formation:** It occurs in *Chlamydomonas*. In this, flagellated, motile zoospores are formed which grow independently into new individuals.
- d. **Binary fission:** It occurs in *Amoeba*, *Paramecium*, *Chlorella*, *Diatoms* and *Chlamydomonas*
- e. **Conidia formation:** It occurs in *Penicillium*
- f. **Gemma formation:** It occurs in *Marchantia*

**READING BETWEEN THE LINES**



**Asexual Reproduction**

**Binary fission:** In this, parent cell divides to produce two equal cells that give rise to two new individuals. e.g. *Bacteria* and *Amoeba*.

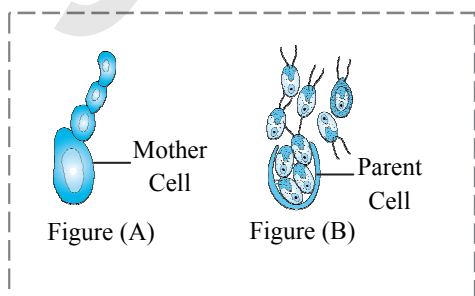
**Conidia formation:** Fungi produce non-motile spores called **conidia**. e.g. *Penicillium*.

**Gemmae formation:** Gemmae develops in cupshaped receptacles known as **gemma cups**.

**NCERT Corner**

- i. **Sporulation:** When the products of multiple fission become individually surrounded by the cyst walls before their release from the parent, the process is known as sporulation. The spores remain inactive in the cyst during unfavourable conditions. When condition becomes favourable, the cyst hatches and gradually grows into an adult. It occurs in *Amoeba*.
- ii. **Regeneration:** Regeneration is the process of renewal, restoration and growth. It is commonly observed in *Hydra*, planarian flatworm and echinoderms. A lizard can discard a part of tail when in danger, and the tail can regenerate later. In humans, liver can regenerate if partially damaged.

**Q.5. Identify the type of asexual reproduction given in the figures. [2 Marks]**



**Ans:** **Figure (A):** Budding in yeast  
**Figure (B):** Zoospores in *Chlamydomonas*

**Q.6 Activity (Textbook page no. 01)**

**Sprinkle a small spoonful of yeast over warm water and then add sugar. Cover it and wait for 10 minutes. Yeast becomes bubbly over the water proving that it is still active.**

**Ans:**

- i. In the given activity, yeast solution becomes bubbly after 10 minutes.
- ii. Due to favourable conditions yeast cells undergo asexual reproduction i.e. budding.
- iii. During this process, gas like carbon dioxide is formed in the mixture of yeast, sugar and water.
- iv. As the number of yeast cells divides, more gas is formed due to which mixture becomes bubbly proving that yeast is still active.

**Q.7. Can you recall? (Textbook page no. 01)**

**The capacity to reproduce by vegetative propagation:**

**Root - Sweet potato, Asparagus, Dahlia.**

**Leaf - Bryophyllum, Kalanchoe, Begonia, etc.**

**Stem - rhizome (turmeric), tubers (potato), bulbs (onion), etc.**

**How does vegetative propagation occur in nature? [1 Marks]**

**Ans:** Refer Q.1 (i-b)

**READING BETWEEN THE LINES**



**Vegetative propagation by root:** e.g. *Sweet Potato*

- i. It is a modification of root for vegetative reproduction.
- ii. The underground roots in some plants store plenty of reserve food. Due to this, they become swollen.
- iii. These roots develop adventitious buds on their surface which sprout under favourable conditions to produce leafy shoots and adventitious roots.
- iv. Under suitable environmental conditions, these leafy shoots separate and develop into new plants.

**Vegetative propagation by stem:**

- i. **Rhizome:** Small plantlets develop from rhizome of ginger.
- ii. **Tuber:** Small plantlets emerge from the eyes (buds) of potato tuber.
- iii. **Bulbs:** It is condensed disc like underground stem. The upper surface of disc bears whorl of fleshy leaves. e.g. *Onion*, *garlic*.



**Vegetative propagation by leaf:**

- i. In some plants like *Bryophyllum*, leaves take part in vegetative propagation.
- ii. Adventitious buds called epiphyllous buds are developed on the leaves. These buds start sprouting on the leaf to form the plantlets.
- iii. These plantlets fall off from parent plant to continue their growth in the wet soil.

**Q.8. Activity (Textbook page no. 15)**

Prepare chart for natural vegetative propagation exhibited by flowering plants indicating the vegetative part/s and the different examples.

Ans:

Organ	Part	Name of the plant
Tuber	Stem	Potato
Rhizome	Stem	Ginger
Napiform root	Root	Beet
Stolon	Stem	<i>Mentha</i>
Leaf buds	Leaf	<i>Bryophyllum</i>
Bulbil	Floral buds	<i>Agave</i>
Runner	Stem	Lawn Grass
Bulb	Stem	Onion

[Note: Students are expected to collect more information about the topic]

**Q.9.**

- i. What are the artificial methods of vegetative propagation? [3 Marks]
- ii. What is vegetative reproduction? Describe any 'three' natural methods of vegetative reproduction with examples. [2 Marks] [Oct 14][July 18]

Ans:

i. Artificial methods of vegetative propagation are as follows:

a. **Cutting:**

1. The small piece of any vegetative part of a plant having one or more buds is used for propagation.
2. Some of the common cuttings are:  
Stem cutting - e.g. Rose, *Bougainvillea*;  
leaf cutting - e.g. *Sansevieria*;  
root cutting e.g. Blackberry.

b. **Grafting:**

1. In this, parts of two plants are joined in such a way that they grow as one plant.

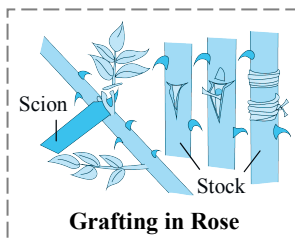
2. Part of the rooted plant on which grafting is done is called **stock** (root stock).

3. While the part which is inserted on stock is called **scion** (graft).

4. Budding is also called **bud grafting** in which single bud is a scion.

5. A single bud is then inserted in the slit of the stock.

6. Grafting is done in plants like Apple, Rose, Pear, etc.



c. **Tissue culture:** It is a method in which small amount of tissue is taken from shoot tips or other suitable part of the parent plant and grown *in-vitro* on an artificial medium under aseptic conditions to get many plantlets. Micropropagation method is also used now a days.

ii. Vegetative propagation is a method of reproduction in which plants reproduce asexually through their vegetative parts. Natural methods of vegetative reproduction are:

- a. Roots: Sweet potato;
- b. Leaf: *Bryophyllum*;
- c. Stem: Rhizome (*Turmeric*).



**Connections**

In chapter 11, you will study Tissue culture and Micropropagation in detail.

**ENRICH YOUR KNOWLEDGE**



**Grafting:**

- i. This is the characteristic feature of dicotyledonous plants which have cambium for secondary growth.
- ii. Grafting is not possible in monocots due to absence of inter or intrafascicular cambium and secondary growth.
- iii. The success of grafting depends upon the match of cambium between stock and scion which results in organic connection between them.
- iv. Common methods of grafting are Tongue (whip) grafting, Wedge grafting and Crown grafting, etc.



**Q.10. Do you know?** (Textbook page no. 02)

**Why does gardener choose to propagate plants asexually?** [2 Marks]

**Ans:** Gardner chooses to propagate plants asexually because of following advantages:

- i. It is more rapid, easier and cheaper method of propagation of plants as compared to propagation by seeds.
- ii. It is possible to obtain clones of economically useful and rare plants as only one parent is involved in reproduction.
- iii. It is the only means of reproduction in plants which are unable to reproduce sexually or in plants which do not form viable seeds. e.g. Banana, Figs, Pineapple, etc.
- iv. By the methods like grafting desired character of the stock (e.g. disease resistance, vigour, etc.) can be transferred to the scion, which will help to increase the yield.

### 1.2 Sexual Reproduction

#### NCERT Corner

- i. Before organisms can reproduce sexually, they have to reach a certain stage of growth and maturity, which is called the **juvenile phase** in animals. In plants, it is called **vegetative phase**. This phase has variable durations in different organisms.
- ii. The **reproductive phase** begins after the end of juvenile/vegetative phase. Flowering in higher plants marks the beginning of the reproductive phase. Few plants exhibit unusual flowering For e.g.
  - a. Bamboo species flower only once in their lifetime, generally after 50 – 100 years, produce numerous fruits and die.
  - b. *Strobilanthus kunthiana* (Neelakuranji) flowers once in 12 years.

**Q.11. Define flower and write its function.**

[2 Marks]

**Ans:**

- i. The flower is specialized reproductive structure of a plant in which sexual reproduction takes place.

OR

Flower is defined as “a highly specialized reproductive shoot”, concerned with sexual reproduction in higher plants.

OR

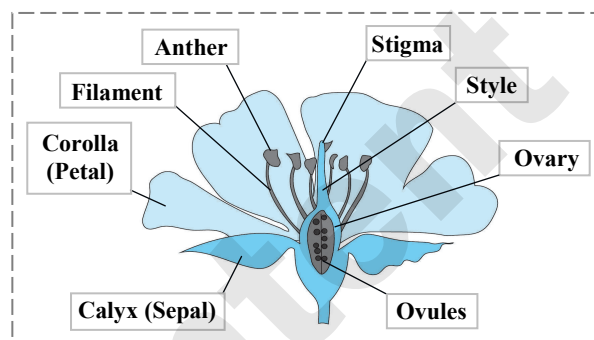
- ii. Flower is a condensed and modified shoot, specialized for sexual reproduction.
- ii. The function of flower is to produce haploid gametes and to ensure that fertilization will take place.

**Q.12. Activity** (Textbook page no. 02)

**Label the parts of flower in the given diagram.**

[2 Marks]

(Answers are directly given in bold)



**Q.13. Name the four whorls of a typical flower.**

[1 Mark]

**Ans:** A typical flower consists of Calyx, Corolla, Androecium and Gynoecium.

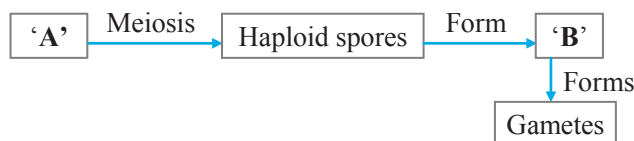
**Q.14. Write a short note on sexual reproduction.**

[3 Marks]

**Ans: Sexual reproduction:**

- i. **Definition:** It is a mode of reproduction which involves fusion of two compatible gametes or sex cells.
- ii. **Sequential events that occur in sexual reproduction** are grouped into three distinct stages viz. Pre-fertilization, Fertilization and the Post-fertilization.
- iii. Pre-fertilization stage involves: gamete formation (meiosis).
- iv. Fertilization is fusion of male and female gametes which results in formation of zygote and embryo (embryogenesis). Changes that happen after fertilization are grouped together into post-fertilization changes.
- v. **Benefits:** Sexual reproduction leads to generation of variations, which are useful for the survival and the evolution of species.

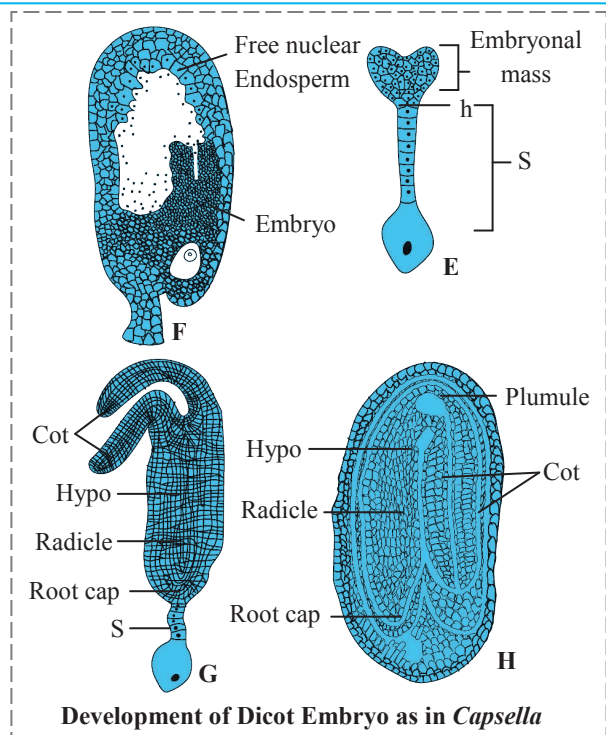
**Q.15. Complete the given flow chart.** [2 Marks]



**Ans:** A: Diploid Sporophyte      B: Gametophyte

Page no. **5** to 17 are purposely left blank.

To see complete chapter buy **Target Notes** or **Target E-Notes**



Development of Dicot Embryo as in *Capsella*

- A: Oospore.
- B: Two celled proembryo.
- B<sup>1</sup>: 4-celled I-shaped proembryo;
- C: Further development of embryo.
- D: L. S. of ovule
- E: Embryonal mass
- F: L. S. of ovule.
- G: Embryo;
- H: Mature seed;
- Cot: Cotyledons;
- Hypo: Hypocotyl;
- S: Suspensor,
- h: Hypophysis;
- Embryo: Developing embryo

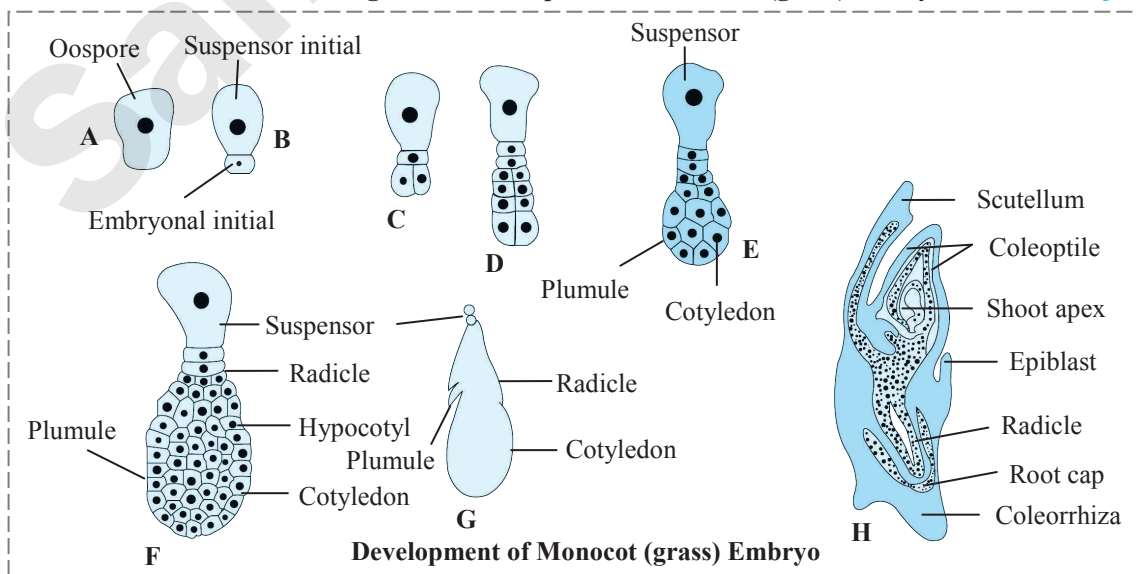
**Development of dicot embryo:**

- i. The zygote divides to form two-celled **proembryo**.
- ii. The larger cell towards the micropyle is called **basal** or **suspensor initial cell** and smaller cell towards chalaza is called **terminal** or **embryonal initial cell**.
- iii. The suspensor cell divides transversely in one plane to produce filamentous suspensor of 6-10 cells.
- iv. The first cell of the suspensor towards the micropylar end becomes swollen and functions as a **haustorium**.
- v. The lowermost cell of suspensor is known as **hypophysis**.
- vi. The suspensor helps in pushing the embryo in the endosperm.
- vii. The embryonal initial undergoes three successive mitotic divisions to form **octant**.
- viii. The planes of divisions are at right angles to each other.
- ix. The lower tier of four cells of octant give rise to **hypocotyl** and **radicle** whereas four cells of upper tier form the plumule and the one or two cotyledons.
- x. The hypophysis by further division gives rise to the part of **radicle** and **root cap**.
- xi. Subsequently, the cells in the upper tier of octant divide in several planes so as to become **heart shaped** which then forms two lateral cotyledons and a terminal plumule.
- xii. Further enlargement of hypocotyl and cotyledons result in a curvature of embryo and it appears **horse-shoe shaped**.

**Q.71. Draw the neat and labelled diagram of development of monocot (grass) embryo.**

**[3 Marks]**

Ans:



Development of Monocot (grass) Embryo



- vi. \_\_\_\_\_ is the transfer of pollen grains from anther of the flower to the stigma of the same or a different flower.
- vii. Once the pollen reaches the stigma, pollen tube traverses down the \_\_\_\_\_ to the ovary where fertilisation occurs.
- viii. The \_\_\_\_\_ is the base of the flower to which other floral parts are attached.
- ix. The \_\_\_\_\_ are coloured to attract the insects that carry the pollen. Some flowers also produce \_\_\_\_\_ or \_\_\_\_\_ that attracts insects.
- x. The whorl \_\_\_\_\_ is green that protects the flower until it opens.

Pollination
style
thalamus
petals, sweet odour, nectar
calyx

**\*Q.100. Match the columns. [2 Marks]**

	Column - I (Structure before seed formation)		Column - II (Structure after seed formation)
A.	Funiculus	I.	Hilum
B.	Scar of ovule	II.	Tegmen
C.	Zygote	III.	Testa
D.	Inner integument	IV.	Stalk of seed
		V.	Embryo

- a. A - V, B - I, C - II, D - IV
- b. A - III, B - IV, C - I, D - V
- c. A - IV, B - I, C - V, D - II
- d. A - IV, B - V, C - III, D - II

**Ans:** The correct answer is: c. A - IV, B - I, C - V, D - II

**PRACTICAL / PROJECT**

**\*Q.101. Natural vegetative propagation by leaves only in different vascular plants.**

**Ans:** Vegetative propagation by Leaf:

- i. In some plants like *Bryophyllum*, leaves take part in vegetative propagation.
- ii. Adventitious buds called epiphyllous buds are developed on the leaves. These buds start sprouting on the leaf to form the plantlets.
- iii. These plantlets fall off from parent plant to continue their growth in the wet soil.

[Note: Students are expected to collect more information about Natural vegetative propagation by leaves only in different vascular plants.]

**APPLY YOUR KNOWLEDGE**

**Q.102. How many meiotic divisions are required to form the following number of pollen grains and female gametophytes: 28, 52, 72, 100 [4 Marks]**

**Ans:**

Number of pollen grains and female gametophytes	Number of meiotic divisions required to form pollen grains	Number of meiotic divisions required to form female gametophytes
28	7	28
52	13	52
72	18	72
100	25	100

[Hint: Each diploid (2n) microspore mother cell (MMC) undergoes meiotic division to form four haploid microspores (n) or pollen grains.

1 (MMC)  $\xrightarrow{\text{Meiosis}}$  4 Megaspores  $\xrightarrow{3 \text{ degenerate}}$  1 Functional megaspore]

**Q.103. An angiospermic plant has 10 flowers. Each flower has 10 stamens in which anthers are tetrasporangiate. Each pollen chamber has 10 microspore mother cells. How many total pollen grains will that plant produce? [3 Marks]**

**Ans:** Two anther lobes contain 4 pollen sacs. Each pollen sac has 10 microspore mother cells. Each diploid microspore mother cell (2n) undergoes meiotic division to form four haploid pollen grains (n).  
 4 pollen sacs  $\rightarrow$  40 microspore mother cells  $\rightarrow$  160 pollen grains  
 160 pollen grains will be produced by one stamen.  
 10 stamens  $\rightarrow$  1600 pollen grains  
 Each flower has 10 stamens and there are 10 such flowers.  
 $\therefore 1600 \times 10 = 16000$  pollen grains.

**Q.104. If a tetraploid male flower fertilizes a diploid female flower find the ploidy of zygote and endosperm. [2/3 Marks]**



**Ans:** A tetraploid male flower will produce two diploid male gametes, i.e.  $2n$  and  $2n$ .  
 A diploid female flower will produce one haploid egg ( $n$ ), and diploid secondary nucleus ( $2n$ ).  
 Zygote  $\rightarrow (2n) + (n) = 3n$   
 Endosperm  $\rightarrow (2n) + (2n) = 4n$

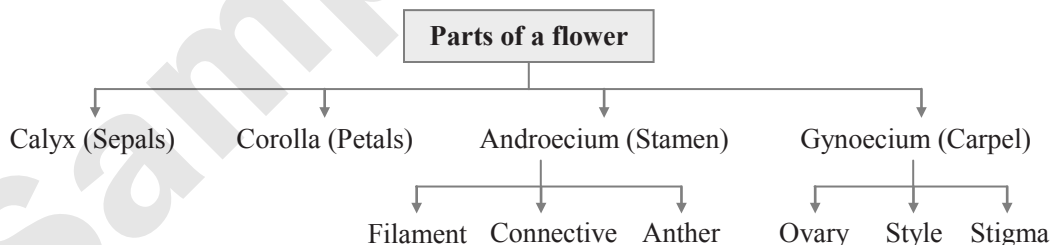
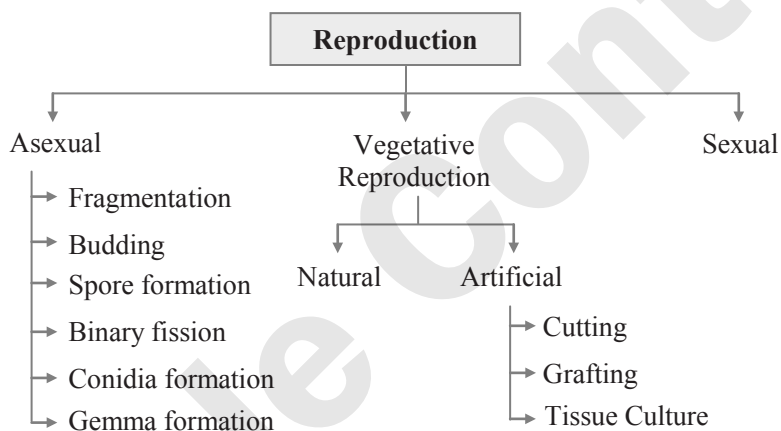
**Q.105. If there are 48 chromosomes in a diploid bisexual plant, how many chromosomes will be present in:** [4 Marks]

- |                |                |
|----------------|----------------|
| i. Root        | ii. Stem       |
| iii. Leaf      | iv. Ovary      |
| v. Pollen      | vi. Antipodals |
| vii. Endosperm |                |

**Ans:**

No.	Part	Ploidy	No. of chromosomes present
i.	Root	$2n$	48
ii.	Stem	$2n$	48
iii.	Leaf	$2n$	48
iv.	Ovary	$2n$	48
v.	Pollen	$n$	24
vi.	Antipodals	$n$	24
vii.	Endosperm	$3n$	72

### QUICK REVIEW



### Microsporogenesis

Microspore mother cells ( $2n$ )  $\xrightarrow[\text{meiotically}]{\text{divide}}$  Pollen grain ( $n$ )

### Development of male gamete

Pollen grain  $\xrightarrow[1^{\text{st}} \text{ mitotic division}]{}$  Vegetative Cell  
 Pollen grain  $\xrightarrow[1^{\text{st}} \text{ mitotic division}]{}$  Generative Cell  $\xrightarrow[2^{\text{nd}} \text{ mitotic division}]{}$  2 non-motile male gametes



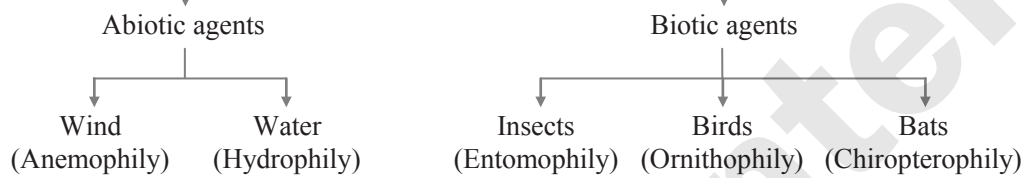
**Megasporogenesis**

Megaspore mother cell (2n)  $\xrightarrow[\text{meiotically}]{\text{divides}}$  4 Megaspores (n)

**Development of female gametophyte**

1 Functional Megaspore  $\xrightarrow[\text{mitotic divisions}]{\text{Undergoes three}}$  8 nucleated, 7 celled Embryo sac

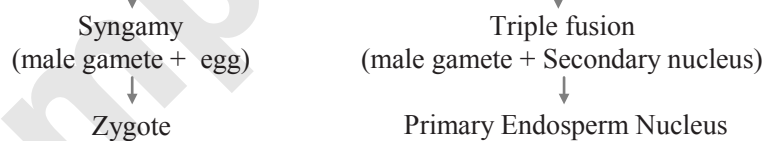
**Pollination**



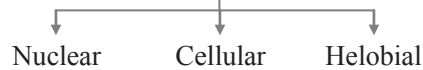
**Outbreeding Devices**



**Double fertilization**



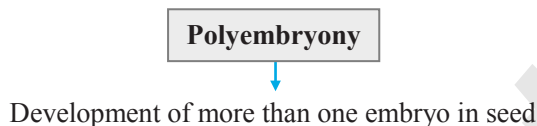
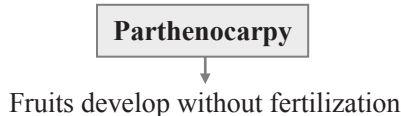
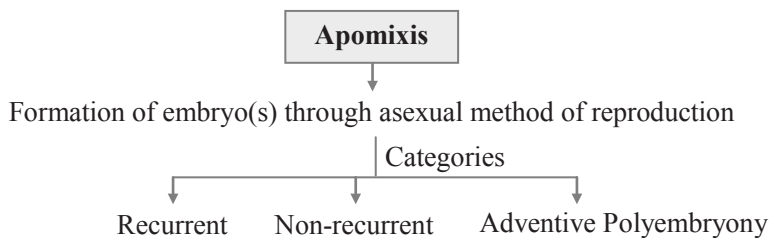
**Types of endosperm**



**Types of Seeds**







### EXERCISE

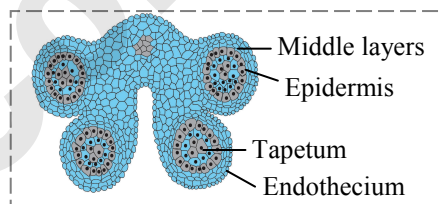
#### 1.1 Asexual Reproduction

- What are the two methods of reproduction? **[1 Mark]**  
**Ans:** Refer Q.2.(ii)
- Describe the methods of asexual reproduction in lower organisms. **[2/3 Marks]**  
**Ans:** Refer Q.4.(ii)
- Explain the advantages of asexual reproduction in horticulture. **[2 Marks]**  
**Ans:** Refer Q.10.
- How yeast reproduce asexually? **[2 Marks]**  
**Ans:** Refer Q.4.(ii-b) and Q.5 (A) Figure
- Define stock and scion. **[1 Mark] [July 18]**  
**Ans:** Refer Q.9. (i-b-2,3)
- What is artificial method of vegetative propagation? Describe:  
(i) Cutting, (ii) Budding. **[2 Marks] [Mar 20]**  
**Ans:** Refer Q.9. (i-a, b-4,5,6)

#### 1.2 Sexual Reproduction

- Sketch and label T.S. of anther. **[3 Marks] [Mar 15]**  
**OR**  
Sketch and label the T.S. of undehisced anther. **[3 Marks] [Oct 15]**  
**Ans:** Refer Q.18 (Diagram)

- Identify the incorrect labels in the given figure of T.S. of anther. **[2 Marks]**



- Ans:** Refer Q.18.
- What is tetrasporangiate anther? **[1 Mark]**  
**Ans:** Refer Q.17.(iv)
  - Write a short note on anther wall. **[2 Marks]**  
**Ans:** Refer Q.18.(ii)
  - What is the role of tapetum? **[1 Mark]**  
**Ans:** Refer Q.19.

#### 1.3 Microsporogenesis

- What is microsporogenesis? **[2 Marks]**  
**Ans:** Refer Q.20.
- Give a neat and labelled sketch of the germinating angiospermic pollen grain. **[2 Marks] [Oct 14]**  
**OR**  
Sketch and label structure of male gametophyte in angiosperm. **[2 Marks] [Mar 19]**  
**Ans:** Refer Q.25. (Diagram)
- What are germ pores? State their function. **[2 Marks]**  
**Ans:** Refer Q. 21. (iv-d, e)



15. Explain the structure of male gametophyte of angiosperms with the help of a suitable diagram.

[2 Marks] [Mar 13]

Ans: Refer Q.21, 25 (Diagram)

#### 1.4 Structure of Anatroous Ovule

16. Define the following terms: [2 Marks]

- i. Apocarpous flower
- ii. Syncarpous flower

Ans: i. Refer Q.27 (iii) ii. Refer Q.27 (iv)

17. Sketch and label V. S. of anatropous ovule.

[3 Marks] [Mar 17; Oct 13]

OR

Sketch and label the diagram of ovule most commonly seen in angiosperms.

[2 Marks] [July 22]

Ans: Refer Q.28 (Diagram)

18. What is micropyle? [1 Mark]

Ans: Refer Q.28 (vi)

#### 1.5 Megasporogenesis

19. Sketch and label stages in development of angiospermic female gametophyte from functional megaspore. [3 Marks] [July 16]

Ans: Refer Q.31. (Diagram)

20. Why development of female gametophyte is called monosporic and endosporic?

[2/3 Marks] [NCERT]

Ans: Refer Q.31. (xii, xiii)

#### 1.6 Pollination

21. Define pollination. Explain different types of self and cross pollination with suitable examples. [July 19]

Ans: Refer Q.35 (i), 36, 41, 42, 44, 45

22. i. What is pollination?
- ii. Differentiate between Anemophily and Entomophily with reference to :
  - a. pollinating agent
  - b. stigma
  - c. nectar
  - d. fragrance

[3 Mark] [July 23]

Ans: Refer Q.35 (i), Q.44 and Q.50

23. Describe any three adaptations in anemophilous flowers.

Mention any one example of the anemophilous flower.

[2 Marks] [Mar 23]

Ans: Refer Q.44

24. Describe any three adaptations in hydrophilous flowers.

Mention any one example of the hydrophilous flower.

[2 Marks] [Mar 23]

Ans: Refer Q.46

25. Write a short note on epiphydrophyly. [2 Marks]

Ans: Refer Q.47.(ii)

26. Give the floral adaptations of entomophily.

[1 Mark] [July 17]

OR

Enlist any 'two' floral adaptations in *Salvia*.

[2 Marks] [Mar 17]

Ans: Refer Q.50.

27. Kabban Park in Bengaluru is having dull flowers with strong fragrance, abundant nectar and edible pollen grains. Identify the type of pollination, the flowers are adapted for.

[1 Mark] [July 22]

Ans: Refer Q.54

#### 1.7 Outbreeding Devices (Contrivances)

28. Explain outbreeding devices in angiospermic plants. [2 Marks] [Mar 19]

Ans: Refer Q.55.

#### 1.8 Pollen-Pistil Interaction

29. Describe pollen pistil interaction. [4 Marks]

Ans: Refer Q.56.

#### 1.9 Double Fertilization

30. 'Formation of primary endosperm nucleus is called triple fusion'. Give reason.

[1 Mark] [Mar 15]

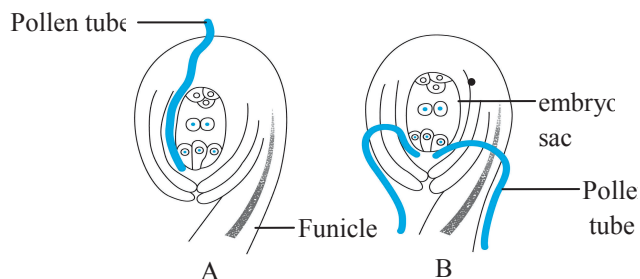
Ans: Refer Q.61 (x-b)

31. What is 'double fertilization'? Describe it with the help of a neat and well labelled diagram. Give its importance. [Mar 14]

Ans: Refer Q.61 and Q.64.

32.

i. Following are the diagrams of entry of pollen tube into ovule. Identify the type A and B.



ii. Give any four points of significance of double fertilization. [3 Marks] [Mar 23]

Ans: Refer Q.63 and Q.64.



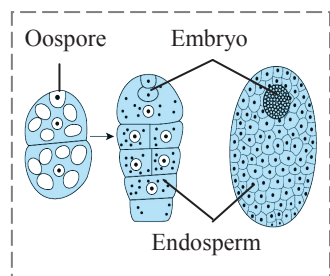
### 1.10 Development of Endosperm

33. Describe the formation of helobial endosperm.

[2 Marks] [July 16]

Ans: Refer Q.67 (iii)

34. Comment on the type of endosperm shown in the diagram below:



[1 Mark]

Ans: Refer Q.66 (ii)

### 1.11 Development of Embryo

35. What is embryogenesis? Explain it with the help of dicot embryo.

[4 Marks]

Ans: Refer Q.69, and Q.70

### 1.12 Seed and Fruit Development

36. Name the outer and inner seed coat. [1 Mark]

Ans: Refer Q.75 (i, ii)

37. Differentiate between albuminous and exalbuminous seeds.

[2 Marks] [July 22]

Ans: Refer Q.76

38. Define dormancy. [1 Mark]

Ans: Refer Q.84 (i)

### 1.13 Apomixis

39. What is apomixis and what is its importance?

[2/3 Marks] [NCERT]

Ans: Refer Q.86

### 1.14 Parthenocarpy

40. The process of fruit formation without fertilization is termed as \_\_\_\_\_.

[1 Mark] [July 22]

Ans: Refer Q.91(ii)

### 1.15 Polyembryony

41. Define polyembryony. State its different types.

[3 Marks] [July 22]

Ans: Refer Q.96

### MULTIPLE CHOICE QUESTIONS

[1 Mark Each]

- Chlamydomonas* reproduce asexually by
  - binary fission
  - spore formation
  - budding
  - gemmule formation
- In grafting, the part of stem containing more than one bud called \_\_\_\_\_ is joined onto a rooted plant.
  - stock
  - cutting
  - scion
  - clone
- Vegetative propagation takes place with the help of leaves in \_\_\_\_\_ plant. [Oct 15]
  - Kalanchoe*
  - Oxalis*
  - Cynodon*
  - Dahlia*
- A ditheous anther is
  - unisporangiate
  - trisporangiate
  - tetrasporangiate
  - bisporangiate
- How many meiotic divisions will be needed to produce 44 female gametophytes in angiosperms? [Oct 15]
  - 11
  - 22
  - 44
  - 66
- How many mitotic divisions take place during the formation of a female gametophyte from a functional megaspore? [Mar 23]
  - One
  - Two
  - Three
  - Four
- How many meiotic and mitotic divisions occur during the development of male gametophyte from the microspore mother cell? [Mar 22]
  - One meiotic and two mitotic
  - Two meiotic only
  - Two mitotic only
  - One mitotic and one meiotic
- If the number of chromosomes in an endosperm cell is 27, what will be the chromosome number in the definitive nucleus? [Mar 15]
  - 9
  - 18
  - 27
  - 36
- \*9. In ovule, meiosis occurs in
  - integument
  - nucellus
  - megaspore
  - megaspore mother cell



10. During double fertilization second male gamete fuses with \_\_\_\_\_. [Mar 19]  
(A) antipodal cell (B) egg cell  
(C) secondary nucleus (D) synergids
- \*11. Point out the odd one.  
(A) Nucellus (B) Embryo sac  
(C) Micropyle (D) Pollen grain
12. During fertilization, male gametes are carried by pollen tube. This is called [Oct 13]  
(A) Syngamy (B) Mesogamy  
(C) Polygamy (D) Siphonogamy
13. In bisexual flowers, maturation of gynoecium before androecium is known as \_\_\_\_\_. [Mar 14]  
(A) protandry (B) protogyny  
(C) gynandry (D) dicliny
14. Which of the following plant shows geitonogamy?  
(A) Pea  
(B) *Cucurbita maxima*  
(C) *Vallisneria*  
(D) *Zostera*
- \*15. Which of the following types require pollinator but result is genetically similar to autogamy?  
(A) Geitonogamy (B) Xenogamy  
(C) Apogamy (D) Cleistogamy
16. A versatile anther is an adaptation for \_\_\_\_\_ type of pollination. [July 18]  
(A) anemophilous (B) entomophilous  
(C) hydrophilous (D) ornithophilous
17. Which of the following aquatic plant is anemophilous?  
(A) *Potamogeton* (B) Lotus  
(C) Water hyacinth (D) Water lily
- \*18. Insect pollinated flowers usually possess  
(A) Sticky pollens with rough surface  
(B) Large quantities of pollens  
(C) Dry pollens with smooth surface  
(D) Light coloured pollens
19. Lever mechanism of pollination is observed in \_\_\_\_\_. [Mar 15]  
(A) *Salvia* (B) Jasmine  
(C) *Bougainvillea* (D) *Butea*
- \*20. The ploidy level is NOT the same in  
(A) Integuments and nucellus  
(B) Root tip and shoot tip  
(C) Secondary nucleus and endosperm  
(D) Antipodals and synergids
21. When pollen tube enters ovule through integuments it is called as  
(A) syngamy (B) porogamy  
(C) chalazogamy (D) misogamy
- \*22. In angiosperms, endosperm is formed by/ due to  
(A) free nuclear divisions of megaspore  
(B) polar nuclei  
(C) polar nuclei and male gamete  
(D) synergids and male gamete
23. Endosperm of angiosperm is \_\_\_\_\_. [July 16]  
(A) haploid (B) diploid  
(C) triploid (D) tetraploid
24. The type of endosperm in which division of triploid primary endosperm nucleus is immediately followed by wall formation is called \_\_\_\_\_ endosperm.  
(A) nuclear (B) cellular  
(C) helobial (D) mosaic
25. After fertilization, ovary wall develops into  
(A) pericarp (B) perisperm  
(C) testa (D) tegmen
- \*26. If diploid chromosome number in a flowering plant is 12, then which one of the following will have 6 chromosomes?  
(A) Endosperm (B) Leaf cells  
(C) Cotyledons (D) Synergids
27. How many meiotic divisions are required for the formation of 100 seeds? [Oct 13]  
(A) 25 (B) 50 (C) 100 (D) 125
28. Polyembryony is commonly observed in  
(A) mango (B) orange  
(C) lemon (D) all of these

ANSWERS TO MULTIPLE CHOICE QUESTIONS

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



**COMPETITIVE CORNER**

1. For the formation of 140 angiospermic seeds how many meiotic cell divisions are expected?

[MHT CET 2019]

(A) 175 (B) 280 (C) 560 (D) 240

**Hint:** For formation of 140 angiospermic seeds 140 male gametes and 140 female gametes are required.

For formation of 140 male gametes, the number of meiotic divisions required will be 35.

(1 Microspore mother cell  $\xrightarrow{\text{meiosis}}$  4 microspores)

For formation of 140 female gametes, the number of meiotic divisions required will be 140.

(1 Megaspore mother cell  $\xrightarrow{\text{meiosis}}$  4 megaspores  $\xrightarrow{3 \text{ degenerate}}$  1 functional megaspore)

Therefore, for the formation of 140 angiospermic seeds 175 meiotic cell divisions are expected.

2. In angiosperms, a male gametophyte is developed from a pollen mother cell by \_\_\_\_\_.

[MHT CET 2019]

(A) one meiotic and two mitotic divisions

(B) two mitotic divisions

(C) one mitotic and two meiotic divisions

(D) a single meiotic division

3. A typical angiosperm embryo sac at maturity is:

[NEET (UG) 2021]

(A) 8-nucleate and 8-celled

(B) 8-nucleate and 7-celled

(C) 7-nucleate and 8-celled

(D) 7-nucleate and 7-celled

4. Heterostyly is a contrivance for \_\_\_\_\_.

[MHT CET 2021]

(A) geitonogamy only

(B) autogamy only

(C) xenogamy only

(D) geitonogamy and xenogamy

5. How many of the following statements are true about the figure given below.

i. Germination of pollen grain.

ii. Motile male gametes.

iii. Two male gametes and one female gamete.

iv. Pollen grain without exine.

v. Tube nucleus at the tip of pollen tube.



[MHT CET 2022]

(A) i and v are true (B) ii and iv are true  
(C) i and ii are true (D) ii and iii are true

**Hint:** ii. Non-motile gametes

iii. Two male gametes and one tube nucleus

iv. Pollen tube with exine

6. After double fertilization in angiosperms, the products of syngamy and triple fusion are \_\_\_\_\_ and \_\_\_\_\_ respectively.

[MHT CET 2022]

(A) diploid embryo and triploid endosperm

(B) diploid embryo and diploid endosperm

(C) triploid embryo and haploid endosperm

(D) triploid embryo and diploid endosperm

**Hint:** Syngamy is the fusion of haploid female gamete (n) and haploid male gamete (n) to form diploid zygote (2n). In triple fusion, second haploid male gamete (n) fuses with diploid secondary nucleus (2n) producing PEN that develops into triploid endosperm (3n).

7. Match the type of pollination given in Column-I with its pollinating agent from Column-II.

[MHT CET 2022]

	Column-I		Column-II
i.	Ornithophily	a.	Bat
ii.	Entomophily	b.	Wind
iii.	Anemophily	c.	Bird
iv.	Chiropterphily	d.	Insect

(A) i – b, ii – c, iii – d, iv – a

(B) i – c, ii – a, iii – d, iv – b

(C) i – d, ii – c, iii – b, iv – a

(D) i – c, ii – d, iii – b, iv – a

8. Identify the INCORRECT statement related to Pollination: [NEET (UG) 2022]

(A) Flowers produce foul odours to attract flies and beetles to get pollinated

(B) Moths and butterflies are the most dominant pollinating agents among insects

(C) Pollination by water is quite rare in flowering plants

(D) Pollination by wind is more common amongst abiotic pollination.

**Hint:** Bees are the most dominating agents among insects.

9. In male reproductive whorl of a flower the archesporial cells are formed by \_\_\_\_\_.

[MHT CET 2023]

(A) epidermal cell of anther

(B) hypodermal cell of anther

(C) cells of connective

(D) cells of tapetum



10. If the chromosome number in cells of integuments is 10, then what will be the chromosome number in the synergids, definitive nucleus and antipodal cells in the embryo sac of an angiospermic ovule? [MHT CET 2023]  
 (A) 5, 5, 5 respectively  
 (B) 5, 10, 5 respectively  
**(C) 10, 5, 10 respectively**  
 (D) 5, 5, 10 respectively

**Hint:** In angiosperms, the synergids and antipodal cells both are haploid and integuments as well as definitive nucleus are diploid.

11. Identify the correct sequence of events of pollen pistil interaction given below. [MHT CET 2023]  
 (a) pollen tube grows through the stigma, style and reaches the ovule.  
 (b) Pollen grain lands on the stigma.  
 (c) Pollen germinates to form pollen tube.  
 (d) Pollen tube carrying 2 male gametes enter the ovule.  
 Choose the correct option.  
 (A)  $b \rightarrow c \rightarrow d \rightarrow a$  **(B)  $b \rightarrow c \rightarrow a \rightarrow d$**   
 (C)  $b \rightarrow a \rightarrow c \rightarrow d$  (D)  $b \rightarrow d \rightarrow a \rightarrow c$

12. In angiosperm, the haploid, diploid and triploid structures of a fertilized embryo sac sequentially are : [NEET (UG) 2023]

- (A) Antipodals, synergids, and primary endosperm nucleus  
**(B) Synergids, Zygote and Primary endosperm nucleus**  
 (C) Synergids, antipodals and Polar nuclei  
 (D) Synergids, Primary endosperm nucleus and zygote

**Hint:**

<b>Haploid</b>	Antipodals, synergids, polar nuclei
<b>Diploid</b>	Zygote
<b>Triploid</b>	Primary endosperm nucleus

13. In angiosperms the correct sequence of events in formation of female gametophyte in the ovule is  
 i. 3 successive free nuclear divisions in functional megaspores.  
 ii. Degeneration of 3 megaspores.  
 iii. Meiotic division in megaspore mother cell.  
 iv. Migration of 3 nuclei towards each pole.  
 v. Formation of wall resulting in seven celled embryo sac.  
 Choose the **correct** answer from the options given below: [NEET (UG) 2023 (Manipur)]  
 (A) ii, iii, i, iv, v **(B) iii, ii, i, iv, v**  
 (C) i, ii, iii, iv, v (D) iii, v, i, iv, ii

Time: 1 Hour 30 Min

TOPIC TEST

Total Marks: 25

### SECTION A

#### Q.1. Select and write the correct answer:

[04]

- i. \_\_\_\_\_ is the innermost nutritive layer of anther wall.  
 (A) Endothecium (B) Epidermis (C) Tapetum (D) Middle layer
- ii. A narrow opening at the apex of an ovule is called  
 (A) chalaza (B) micropyle (C) nucellus (D) hilum
- iii. Pollination by insect is called as  
 (A) chiropterophily (B) entomophily (C) anemophily (D) hydrophily
- iv. Which of the following is an ex-albuminous seed?  
 (A) castor (B) coconut (C) maize (D) pea

#### Q.2. Answer the following

[03]

- i. Define megasporogenesis.
- ii. Give any two examples of plants in which pollination occurs by water.
- iii. What is coleoptile and coleorhiza?

**SECTION B****[08]****Attempt any Four:**

- Q.3. Draw neat and labelled diagram of maize grain.
- Q.4. Write any four adaptations of hydrophilous flowers.
- Q.5. Write a short note on grafting.
- Q.6. i. What is cellular type endosperm?  
ii. Name any two plants which possess this type of endosperm.
- Q.7. Write significance of seed and fruit formation.
- Q.8. Development of female gametophyte in angiosperm is monosporic and endosporic. Give reason.

**SECTION C****[06]****Attempt any Two:**

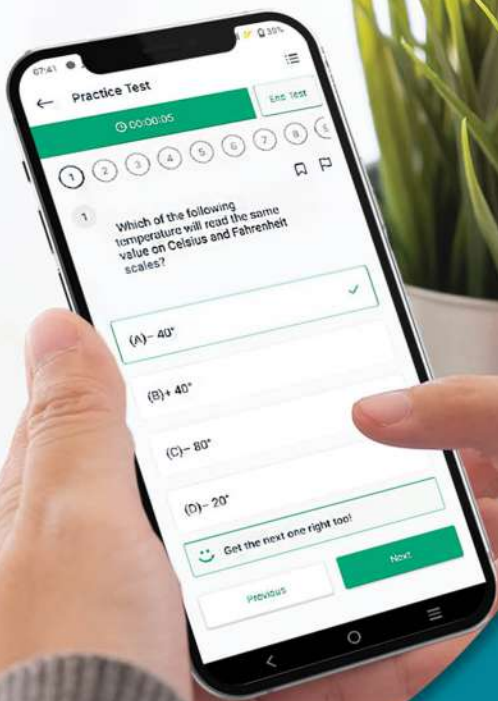
- Q.9. i. What are endospermic seeds?  
ii. Give two examples.
- Q.10. Explain the term parthenocarpy.
- Q.11. Draw neat and labelled diagram of T.S. of anther.

**SECTION D****[04]****Attempt any One:**

- Q.12. Explain the process of double fertilization.
- Q.13. Explain in detail structure of an anatropous ovule.

Scan the given Q. R. Code in *Quill - The Padhai App*  
to view the solutions of the Topic Test.





Give your XII<sup>th</sup> exam preparation the  
**TECHNOLOGY BOOST!**

Practice more than  
**4,500 MCQs**

Use Coupon Code  
**QUILLPADHAI2023**

Also available for X<sup>th</sup>, XI<sup>th</sup>, MHT-CET, NEET & JEE

- Practice chapter-wise & full syllabus MCQs in test format
- Get instant verification of your answer
- Detailed analysis of every test on completion
- Option to save questions for future reference



Scan QR Code  
to download  
the app

Visit our website to know more about our  
range of books for **X<sup>th</sup>, XI<sup>th</sup>, MHT-CET, NEET & JEE**

**Visit Our Website**

**Target Publications® Pvt. Ltd.**  
Transforming lives through learning.

**Address:**

B2, 9<sup>th</sup> Floor, Ashar, Road No. 16/Z,  
Wagle Industrial Estate, Thane (W)- 400604

**Tel:** 88799 39712 / 13 / 14 / 15

**Website:** www.targetpublications.org

**Email:** mail@targetpublications.org



Explore  
our range of  
**STD. XII Sci.**  
Books

