2026
EXAMINATION

CBSE
QUESTION & CONCEPT BANK

Chapter-wise & Topic-wise

CLASS 12

- Chapter-wise **CONCEPT MAPS**
- Important Questions with Detailed Explanations **NCERT & EXEMPLAR**
- Handpicked & High yield from Past 10 Years **PYQs**
- Revision Blue Print & Solved Questions **COMPETENCY FOCUSED**
- CBSE 2025 Past Year & SQP Solved Papers **LATEST CBSE PAPERS**
- As per Latest Pattern **MOCK TESTS**

BIOLOGY

Chapter-wise Weightage and Trend Analysis of
CBSE Past 6 Years' Papers

CHAPTERS	2020	2022	2023	2024	2025
Reproduction in Organisms (*Rationalised*)	1	-	-	-	-
Sexual Reproduction in Flowering Plants	7	7.7	12	11	11
Human Reproduction	7	8.4	11	8	9
Reproductive Health	5	2.8	4	2	3
Principles of Inheritance and Variation	6	11.2	10	10	9
Molecular Basis of Inheritance	8	11.9	11	10	10
Evolution	7	–	4	5	6
Human Health and Disease	5	4	8	9	9
Strategies for Enhancement in Food Production (*Rationalised*)	6	-	-	-	-
Microbes in Human Welfare	6	7	4	6	5
Biotechnology: Principles and Processes	6	6	9	9	2
Biotechnology and Its Applications	4	5	2	3	12
Organisms and Populations (*Some portion is Rationalised*)	6	2	2	8	6
Ecosystem (*Some portion is Rationalised*)	5	–	2	2	3
Biodiversity and Conservation	3	8	6	2	6
Environmental Issues (*Rationalised*)	5	-	-	-	-

**The marks allotment mentioned above is chapter-wise and includes internal choice questions as well. Therefore, the total might not match the Maximum Marks of the respective Previous Year Paper.*

***For the year 2021, the exam was not conducted*

Question Typology

YEAR	Objective Questions		Subjective Questions			Case-Based type
	MCQs	A/R	VSA	SA	LA	
2025	12	4	5	7	3	2
2024	12	4	5	7	3	2
2023	12	4	5	7	3	2
2022 (Term II)	-	-	6	6	-	1
2022 (Term I)	50	4	-	-	-	6
2020	5	-	7	12	3	-

Evolving Trends in CBSE Exam Patterns

2020

- MCQ questions are introduced from this year onwards, replacing VSA (1 mark) questions.
- More competency based questions added compared to last year.
- The number of sections in the paper increased to 5 sections (A, B, C, D and E).
- Reorganization of short-answer questions into three distinct types across Sections B, C, and D.
- Internal choices decreased by 27% from last year.
- Diagram-based questions are added.

2022

- Chapters were divided into two papers: Term I and Term II, with some chapters being excluded.

Term I

- All sections consisted only of objective questions and carried equal marks.
- 50/60 questions were needed to attempt.
- Introduction of Assertion/Reason-based questions and case-based MCQ questions.

Term II

- Total number of questions reduced.
- All sections consisted only of subjective questions.
- Introduction of case-based subjective questions.
- Internal choice has given in sections A, B and C.

2023

- Rationalised syllabus adopted from this year onwards.
- The total number of questions has increased.
- Internal choice has given in sections B, C, D and E.
- Competency based questions increased in number.
- The number of case-based subjective questions has increased.

2024

- No changes in exam pattern.

2025

- More than 50% of the marks were allocated to competency-based questions, while the rest of the exam pattern remained unchanged.

For the year 2021, the exam was not conducted.

HOW TO USE THIS BOOK

This book is structured to support your learning journey of preparing for your board exams through a variety of engaging and informative elements. Here's how to make the most of it:

CBSE Solved Paper of 2025 with detailed solutions: *Get yourself updated with the latest Board Question Papers. With provided explanations, learn the effective answering techniques to achieve higher scores.*

CBSE Solved Paper

CBSE SOLVED PAPER 2025

SECTION - A

*Questions no. **1** to **16** are Multiple Choice Type Questions, carrying **1** mark each. Choose the best option.* $16 \times 1 = 16$

1. What are minisatellites?

(*a*) 10-40 bp sized small sequences within the genes.

(*b*) Short coding repetitive sequences region on the eukaryotic genome.

(*c*) Short non-coding repetitive sequences forming a large portion of eukaryotic genome.

(*d*) Regions of coding strand of DNA.

Ans.(*c*) Mini satellites are short, non-coding repetitive DNA sequences (typically 10–100 bp long) that make up a significant part of the eukaryotic genome, often involved in genetic variability. *(1 M)*

2. Identify the ***incorrect*** statement regarding PCR.

(*a*) Two sets of primers are required during polymerisation.

(*b*) The process of replication is repeated multiple times to produce one billion copies.

(*c*) Thermostable DNA polymerase is used for extension of primers.

(*d*) Annealing is required to separate both the strands of template DNA.

Ans.(*d*) In polymerase chain reaction (PCR), annealing refers to the process where two sets of primers bind to the complementary strands of the DNA template. The separation of the template DNA strands is done by heat induced denaturation, not by annealing. *(1 M)*

"A large ground finch (Geospiza magnirostris) on the Galapagos Islands, one of Darwin's finches. It has a large beak adapted for cracking seeds found on the ground. This bird exemplifies natural selection, where variations in beak sizes and shapes adapt to different food sources, illustrating how species evolve over time to fit their ecological niches."

Preview

At the start of every chapter, you'll find a thoughtfully chosen image and a quote that captures the main idea and motivation of the topic. This approach aims to get your interest and give you a glimpse of the theme ahead.

Before diving into the details, we outline the syllabus and analyze the weightage given to each topic over the past five years. This helps you prioritize your study focus based on the significance of each section.

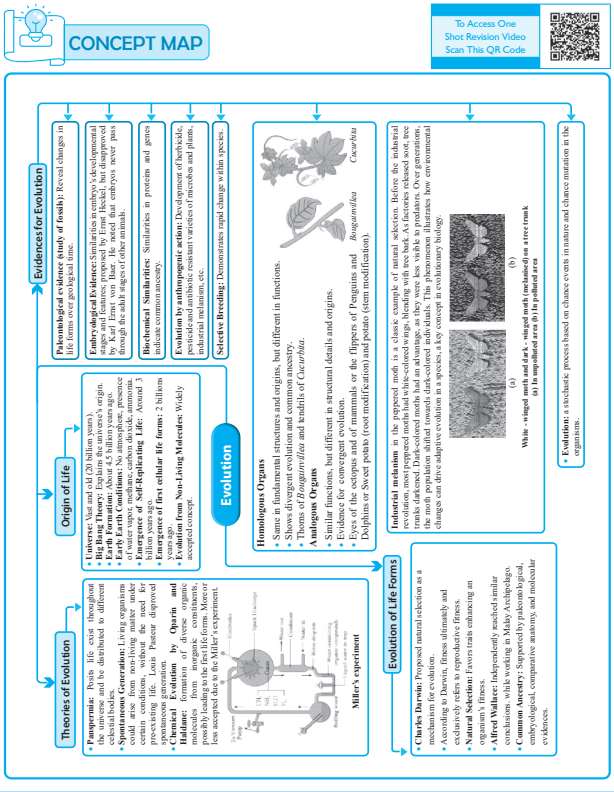
SYLLABUS & WEIGHTAGE

List of Concept Names	Years				
	2020	2022 (Term II)	2023	2024	2025
Origin of Life, Evolution of Life Forms - A Theory, Evidences for Evolution (Origin of life; Biological evolution and Evidences for biological evolution (palaeontology, comparative anatomy, embryology and molecular evidences)	1 Q (2 M) 1 Q (5 M)	–	–	2 Q (1 M Each)	–
Adaptive Radiation, Biological Evolution, Mechanism of Evolution (Adaptive radiation; Darwin's contribution and natural selection with examples; modern synthetic theory of evolution; mechanism of evolution: variation and mutation)	–	–	–	–	1 Q (3 M)
Hardy-Weinberg Principle, A Brief Account of Evolution & Origin and Evolution of Man (Hardy- Weinberg's principle: Gene flow and genetic drift, variation (mutation and recombination), types of natural selection; Human evolution)	–	–	1 Q (1 M) 1 Q (3 M)	1 Q (3 M)	1 Q (1 M) 1 Q (2 M)

For the year 2021, the exam was not conducted

CONCEPT MAP

To Access One Shot Revision Video Scan This QR Code



Concept Map

The concept map appears to be a comprehensive study aid that outlines key concepts in a structured format. Use it to understand the chapter's structure and as a quick reference to recall important highlights.

A QR Code to access One Shot Revision Video of the chapter.

1 ORIGIN OF LIFE, EVOLUTION OF LIFE FORMS - A THEORY, EVIDENCES FOR EVOLUTION

NCERT Definitions *(Commonly asked in 1 mark)*

- **Evolutionary biology:** The study of the history of life forms on Earth.
- **Big Bang theory:** A scientific theory explaining the early development of the Universe as a result of a massive explosion.
- **Panspermia:** It states that the spores of life exist all over the universe and can be propagated through space from one location to another.
- **Chemical evolution:** Assemblage of simple inorganic constituents and formation of diverse organic molecules, eventually leading to more complex molecular systems and first living cells.
- **Spontaneous generation:** An obsolete theory suggesting life arises spontaneously from non-living matter.
- **Biogenesis:** The concept that life originates from pre-existing life.
- **Darwinian fitness:** Capacity of an organism to survive and reproduce better than others occupying the same environment.
- **Natural selection:** A process where individuals possessing specific inherited traits have a higher survival and reproduction rate compared to other individuals due to those traits.
- **Epochs:** Subdivisions of geological time, smaller than periods and eras, representing significant changes in Earth's history.
- **Periods:** Larger subdivisions of geological time within eras, marked by distinct geological and biological events.
- **Eras:** Major divisions of geological time, encompassing several periods and marking significant changes in Earth's history.
- **Fossils:** They are remains of hard parts of life-forms found in rocks.
- **Artificial selection:** Selective breeding by humans to create new breeds or varieties of plants and animals.
- **Evolution:** It is a stochastic process based on chance events in nature and chance mutation in the organisms.

Important Facts

01 The light we see from stars today started its journey millions of years ago. ***~ Looking back in time***

02 The Universe is approximately 20 billion years old, with Earth forming about 4.5 billion years ago.

03 Life appeared 500 million years after the formation of earth, i.e., almost four billion years back

04 Early Earth's atmosphere was rich in methane, ammonia, water vapours, hydrogen, etc., but lacked free oxygen. ***~ Reducing atmosphere***

05 Spontaneous generation theory was disproved by Louis Pasteur.

06 S.L. Miller's experiment demonstrated the formation of amino acids by mimicking ancient Earth conditions. ***— Proof of Chemical Evolution***

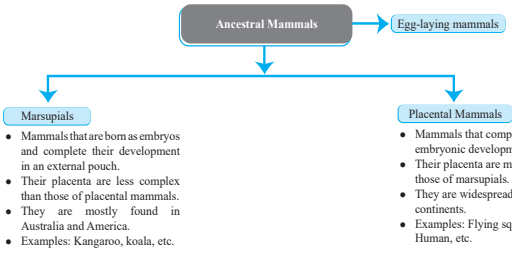
07 The ship on which Charles Darwin embarked on his five-year voyage, leading to his observations and formulation of the theory of evolution by natural selection. ***~ H.M.S. Beagle***

08 The geological history of earth closely correlates with the biological history of earth.

NCERT Definitions: *It simplifies complex topics into brief, easy-to-understand explanations.*

Important Facts: *Quick, bullet point facts that are crucial for exams.*

Classification



Marsupials

- Mammals that are born as embryos and complete their development in an external pouch.
- Their placenta are less complex than those of placental mammals.
- They are mostly found in Australia and America.
- Examples: Kangaroo, koala, etc.

Placental Mammals

- Mammals that complete their embryonic development in the uterus.
- Their placenta are more complex than those of marsupials.
- They are widespread, found on all continents.
- Examples: Flying squirrels, Wolf, Human, etc.

Difference Between

Lamarckism vs. Darwinism

Lamarckism	Darwinism
Proposed by Jean-Baptiste de Lamarck	Proposed by Charles Darwin
Based on the principles of use & disuse of organs and inheritance of acquired characteristics	Based on the two key concepts: Branching descent and natural selection
Organisms develop new traits during their lifetime to adapt to their environment	Variations exist in populations, and advantageous traits are selected over generations
Traits acquired during an organism's life are passed onto offspring	Only heritable traits that provide a survival advantage are passed onto offspring
Emphasizes the role of environment and behaviour directly influencing traits	Emphasizes the role of genetic variation and environmental pressures in shaping evolution
Largely discredited with the discovery of genetic inheritance	Widely accepted and forms the basis of modern evolutionary biology

Darwinian Variations vs. Hugo de Vries' Mutation

Darwinian Variations and Views on Evolution	Hugo de Vries' Mutation and Views on Evolution
Originated from Charles Darwin's observations on natural selection	Originated from Hugo de Vries' work on evening primrose
Suggests evolution occurs through small, gradual changes over time	Suggests evolution occurs through large, sudden changes in a population
Variations are small and directional	Mutations are random and directionless
Believed minor variations lead to gradual evolution	Believed mutations cause speciation (saltation)

Classification: *It organizes complex information into clear categories, making it easier for students to grasp differences, recognize patterns, and predict properties or behaviors in their learning.*

Difference Between: *Side-by-side comparisons to help distinguish similar concepts.*

Real Life Application Based Questions

1. **A scientist studying the adaptive radiation of Darwin's finches on the Galápagos Islands sets up an experiment where h provides different food sources (seeds, insects, nectar) on separate islands. How would he expect the finches' beak shape to change over several generations, and what does this illustrate about natural selection?**

Ans. Over several generations, finches on islands with seeds may develop stronger, thicker beaks to crack seeds, while those on island with insects might evolve thinner, pointed beaks for insect feeding, and those with nectar might develop long, slender beaks fc accessing flowers. This experiment illustrates adaptive radiation and natural selection, as finches adapt their beak shapes to explo available food resources, enhancing their survival and reproduction in varying environmental conditions.

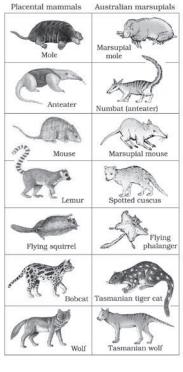
Myth Buster

- **Myth: Natural selection causes individuals to evolve.**
  Fact: Individuals do not evolve; populations evolve over time through changes in allele frequencies.
- **Myth: A favourable trait in one environment is always favourable.**
  Fact: Environmental factors vary, so a trait favourable in one environment may be useless or even detrimental in another.

Mnemonics

- **To remember examples of Australian marsupials:**
  "My Son Nearly Missed The Two Flights"
  - M → Marsupial mole
  - S → Spotted cuscus
  - N → Numbat
  - M → Marsupial mouse
  - T → Tasmanian tiger cat
  - T → Tasmanian wolf
  - F → Flying phalanger

- **To remember examples of Placental mammals:**
  Mammals And Marine Life Fascinate Biologists Worldwide
  - M → Mole
  - A → Anteater
  - M → Mouse
  - L → Lemur
  - F → Flying squirrel
  - B → Bobcat
  - W → Wolf



Real-Life Application Based Questions: *Exercises that connect theory with practical scenarios. It will enhance your understanding and relevance of concepts.*

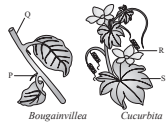
Myth Buster: *Clear up common misconceptions to ensure your understanding is accurate.*

Mnemonics: *Memory aids to help you retain and recall information.*

COMPETENCY BASED SOLVED EXAMPLES

Multiple Choice Questions (1 M)

1. **The hypothesis that "Life originated from pre-existing non-living organic molecules was proposed by** *(Re)* **(CBSE, 2020)**
   (*a*) Oparin and Haldane (*b*) Louis Pasteur
   (*c*) S.L. Miller (*d*) Hugo de Vries
2. **A group of students are trying to replicate the famous Miller-Urey experiment using a different set of molecules compared to those employed in the original study.**
   Their experiment will be deemed supportive and aligning with the Miller-Urey experiment solely on the condition that the molecular weight of - *(An)* **(CBSE CFPQ, 2023)**
   (*a*) reactants > products (*b*) reactants = products
   (*c*) reactants < products (*d*) reactants > products



Bougainvillea *Cucurbita*

(*a*) P and S (*b*) P and R
(*c*) Q and S (*d*) Q and R

8. ***Ginkgo biloba* is also known as a living fossil as it has changed very little over time. It is resistant to disease and pests, is tolerant of a wide range of environmental conditions and is the last-standing member of its botanical family.**
   The above is an example of which of the following phenomena? *(Ap)*
   (*a*) Speciation (*b*) Fossilization
   (*c*) Adaptive radiation (*d*) Survival of the fittest

Hints & Explanations

Multiple Choice Questions

1. (*a*) The hypothesis that life originated from pre-existing non-living organic molecules was proposed by Oparin and Haldane.
2. (*c*) The Miller-Urey experiment demonstrated that simple molecules (reactants) like water, methane, ammonia, and hydrogen could react to form more complex organic molecules (products) with higher molecular weights, such as amino acids. Therefore, the molecular weight of the products should be greater than that of the reactants to support the experiment's findings.

Mistakes 101 : What not to do!

Students might mistake the requirement of the experiment by focusing on the exact molecules used. Another common mistake is confusing the relationship between the molecular weights of reactants and products.

3. (*a*) Gaseous mixture used by Miller for synthesis of amino acids included methane, ammonia, hydrogen and water vapours.
4. (*b*) Louis Pasteur's experiments disproved the spontaneous generation theory, which suggested that life could arise spontaneously from non-living matter. His work supported the idea of biogenesis, where life comes from pre-existing
3. (*b*) The first life forms did appear around 500 million years after the formation of Earth. The Reason is also true, as the first life forms are believed to have originated from inorganic molecules through chemical evolution.
   The Reason discusses the process of the origin of life but does not provide a specific timeline to explain why life appeared 500 million years after Earth's formation.
4. (*a*) The change in the moth population over time, with a shift towards moths that matched the changing background colour of tree trunks due to industrialization, illustrates the process of natural selection where advantageous traits lead to increased survival and reproductive success in a changing environment.
5. (*c*) Lichens are indeed used as indicators of pollution because they are highly sensitive to pollutants, especially sulfur dioxide. The Reason (R) is incorrect as a polluted environment actually inhibits their growth rather than accelerating it by providing more nutrition.
6. (*a*) Both the assertion and the reason are true, and the reason correctly explains that beetles with traits that provide camouflage will survive better and reproduce more, leading to an increase in their population.
7. (*d*) The assertion is false because there are other mechanisms of evolution such as genetic drift and mutation. The reason is true as natural selection indeed involves survival and reproduction of individuals with favourable traits.
8. (*d*) The assertion is false because survival depends on various factors including environmental conditions and physical traits.

For each topic, solved examples are provided including tagging of Competencies, PYQs, CBSE SQPs, etc., that exemplify how to approach and solve questions. This section is designed to reinforce your learning and improve problem solving skills.

Solved Examples

MISCELLANEOUS EXERCISE

Multiple Choice Questions (1 M)

1. For the MN-blood group system, the frequencies of M and N alleles are 0.7 and 0.3, respectively. The expected frequency of MN-blood group bearing organisms is likely to be *(Ev)* **(NCERT Exemplar)**
   (*a*) 42% (*b*) 49%
   (*c*) 9% (*d*) 58%
6. Fossil X can be considered to have evolved earlier than fossil Y if: *(Un)*
   (*a*) Y has vestigial structures that are homologous to functional structures in fossil X
   (*b*) Y is structurally more complex than fossil X
   (*c*) Y is in better state of preservation than X
   (*d*) X is found in lower stratum of undisturbed sedimentary rock than Y
7. Which of the following mutations were discovered by Hugo deVries? *(Re)*

ANSWER KEYS

Multiple Choice Questions

1. (*a*) 2. (*d*) 3. (*b*) 4. (*a*) 5. (*b*) 6. (*a*) 7. (*b*) 8. (*c*) 9. (*c*) 10. (*d*)
11. (*c*) 12. (*b*) 13. (*c*) 14. (*c*)

Assertion and Reason

1. (*a*) 2. (*d*) 3. (*b*) 4. (*a*) 5. (*c*) 6. (*a*) 7. (*c*) 8. (*d*) 9. (*c*) 10. (*a*)

HINTS & EXPLANATIONS

Multiple Choice Questions

1. (*a*) The frequency of heterozygotes (MN) is calculated as 2pq, where p and q are the frequencies of alleles M and N, respectively.
   Given:
   Frequency of M allele (p) = 0.7
   Frequency of N allele (q) = 0.3
   Frequency of MN = $2pq = 2 \times 0.7 \times 0.3 = 0.42$ or 42%
2. (*d*) Finch 4's small and pointed beak suggests that it is adapted to feeding on insects, indicating it likely inhabits areas where insects are plentiful.
3. (*b*) Early Earth had a reducing atmosphere with no free oxygen, favouring anaerobic conditions. The first organisms were likely chemo-heterotrophs, obtaining energy from
10. (*d*) The brain capacity of *Australopithecines* was in range of 400cc-450cc.
11. (*c*) Divergent evolution describes the process where related species evolve different traits and adapt to various environmental conditions, while their fundamental structures remain similar.
12. (*b*) Industrial melanism in *Biston betularia* is an example of directional selection, where darker moths (one extreme of phenotypic range) had a survival advantage in polluted areas, leading to an increase in their population.
13. (*c*) Natural selection favours individuals with advantageous traits. Here, yellowish skin camouflages the treefrogs against yellow lichen, aiding survival and reproduction (survival of the fittest).

At the end of each chapter, you'll find additional exercises intended to test your grasp of the material. These are great for revision and to prepare for exams.

Answer Keys and Explanations including Topper's Explanations, Mistakes 101, Nailing the right answer and Key takeaways to know how to write the ideal answer.

MOCK TEST-1

Time allowed: 3 hours Maximum Marks: 70

General Instructions:

Read the following instructions carefully and strictly follow them:

(i) The question paper has ***five*** *sections and* ***33*** *questions. All questions are* ***compulsory****.*

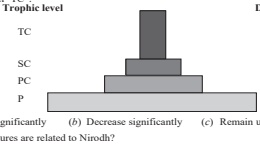
(ii) ***Section–A*** *has* ***16*** *questions of* ***1*** *mark each;* ***Section–B*** *has* ***5*** *questions of* ***2*** *marks each;* ***Section–C*** *has 7 questions of* ***3*** *marks each;* ***Section–D*** *has* ***2*** *case-based questions of* ***4*** *marks each; and* ***Section–E*** *has* ***3*** *questions of 5 marks each.*

(iii) There is no overall choice. However, internal choices have been provided in some questions. A student has to attempt only ***one*** *of the alternatives in such questions.*

SECTION - A

Questions no. ***1*** *to* ***16*** *are Multiple Choice* ***(MCQ)*** *type Questions, carrying* ***1*** *mark each.* ***16 × 1 = 16***

1. Which of the following statements are correct with respect to hormones secreted by placenta?
   (*i*) Placenta secretes relaxin during later stages of pregnancy.
   (*ii*) Placenta secretes a high amount of FSH during pregnancy.
   (*iii*) Placenta secretes relaxin during the initial stage of pregnancy.
   (*iv*) Placenta secretes hCG and hPL during pregnancy.
   (*a*) (*i*) and (*iv*) (*b*) (*i*), (*ii*) and (*iv*) (*c*) (*iii*) and (*iv*) (*d*) (*ii*), (*iii*) and (*iv*)
2. Kernel colour in corn is a trait determined by two alleles. The dominant allele (P) produces a purple colour and the recessive allele (p) produces a yellow colour. By crossing two plants, an ear of corn is produced. The kernels are purple and yellow coloured. The yellow kernels can be best described as
   (*a*) Homozygous dominant (*b*) Hybrid (*c*) Heterozygous (*d*) Homozygous recessive
3. Suppose an environmental disturbance leads to the elimination of organisms at level 'SC'. How would it primarily impact the biomass of level 'TC'?



   (*a*) Increase significantly (*b*) Decrease significantly (*c*) Remain unchanged (*d*) Fluctuate unpredictably
4. How many features are related to Nirodh?
   A. Prevention of STDs B. Physiological changes in cervical mucus C. Phagocytosis of sperms
   D. Male contraceptive device E. It is a surgical method
   (*a*) 2 (*b*) 3 (*c*) 4 (*d*) 5

Mock Test Papers: Test your preparedness with our Mock Test Papers designed to mirror the format and difficulty of real exams. Use the detailed explanations to identify areas of strength and opportunities for improvement.

Mock Test

CONTENTS

Questions have been categorized according to the Bloom's Taxonomy (as per CBSE Board). The following abbreviations have been used in the book:

(*Un*) - Understanding (*Re*) - Remembering (*Ap*) - Applying
(*An*) - Analysing (*Cr*) - Creating (*Ev*) - Evaluating

Upcoming CBSE SQPs/ APQs can be accessed through this QR

CBSE SOLVED PAPER 2025

Time allowed : 3 hours **Maximum Marks : 70**

GENERAL INSTRUCTIONS:

Read the following instructions carefully and follow them:

*(i) This question paper contains **33** questions. **All** questions are **compulsory**.*

*(ii) Question paper is divided into **five** sections – Sections **A, B, C, D** and **E**.*

*(iii) **Section A** – questions number **1** to **16** are multiple choice type questions. Each question carries **1** mark.*

*(iv) **Section B** – questions number **17** to **21** are very short answer type questions. Each question carries **2** marks.*

*(v) **Section C** – questions number **22** to **28** are short answer type questions. Each question carries **3** marks.*

*(vi) **Section D** – questions number **29** and **30** are case-based questions. Each question carries **4** marks. Each question has subparts with internal choice in one of the subparts.*

*(vii) **Section E** – questions number **31** to **33** are long answer type questions. Each question carries **5** marks.*

*(viii) There is no overall choice. However, an internal choice has been provided in Sections B, D and E of the question paper. A candidate has to write answer for only **one** of the alternatives in such questions.*

(ix) Kindly note that there is a separate question paper for visually impaired candidates.

(x) Wherever necessary, neat and properly labelled diagrams should be drawn.

SECTION - A

*Questions no. **1** to **16** are Multiple Choice Type Questions, carrying **1** mark each. Choose the best option.* *16 × 1 = 16*

1. What are minisatellites?

(*a*) 10-40 bp sized small sequences within the genes.

(*b*) Short coding repetitive sequences region on the eukaryotic genome.

(*c*) Short non-coding repetitive sequences forming a large portion of eukaryotic genome.

(*d*) Regions of coding strand of DNA.

Ans. (*c*) Mini satellites are short, non-coding repetitive DNA sequences (typically 10–100 bp long) that make up a significant part of the eukaryotic genome, often involved in genetic variability. *(1 M)*

2. Identify the ***incorrect*** statement regarding PCR.

(*a*) Two sets of primers are required during polymerisation.

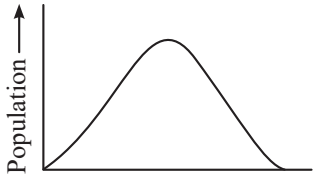
(*b*) The process of replication is repeated multiple times to produce one billion copies.

(*c*) Thermostable DNA polymerase is used for extension of primers.

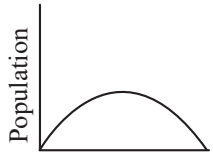
(*d*) Annealing is required to separate both the strands of template DNA.

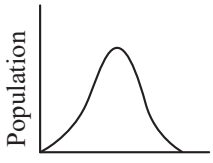
Ans. (*d*) In polymerase chain reaction (PCR), annealing refers to the process where two sets of primers bind to the complementary strands of the DNA template. The separation of the template DNA strands is done by heat induced denaturation, not by annealing. *(1 M)*

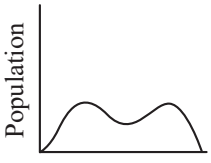
7. The given graph shows the range of variation among population members, for a trait determined by multiple genes. If this population is subjected to disruptive selection for several generations, which of the following distributions is most likely to result?



Choose the correct option:

(*a*) 

(*b*) 

(*c*) 

(*d*) 

Ans. (*c*) If a population is subjected to disruptive selection, extreme values for a trait are favored over intermediate ones, causing the population to split into two distinct groups over generations, resulting in the formation of two peaks in the trait distribution. *(1 M)*

8. Which one of the following immune system components does ***not*** correctly match with its respective role?

(*a*) Interferons – Secreted by virus-infected cells and protect non-infected cells from further viral infection.

(*b*) Macrophages – Mucus-secreting cells that trap microbes entering into the body.

(*c*) B-Lymphocytes – Produce antibodies in response to pathogens into blood to fight with them.

(*d*) IgA – Present in colostrum in early days of lactation to protect infants from diseases.

Ans. (*b*) Macrophages are immune cells that act as cellular barriers by engulfing and destroying pathogens through phagocytosis. They do not secrete mucus. *(1 M)*

9. Which one of the following is ***not*** the product of transgenic experiments?

(*a*) Pest-resistant crop variety

(*b*) High nutritional value in grains

(*c*) Drought-resistant crops

(*d*) Production of insulin by rDNA technique

Ans. (None) All the options listed (pest-resistant crop variety, high nutritional value in grains, drought-resistant crops, and the production of insulin by rDNA technique) are products of genetic modification or transgenic experiments. *(1 M)*

10. A biologist studied the population of rats in a granary. He found the average natality was 280, average mortality was 200, immigration was 40 and emigration was 50. The net increase in population is:

(*a*) 80 (*b*) 70 (*c*) 10 (*d*) 90

Ans. (*b*) To calculate the net increase in the population, we use the following formula:

Net increase = (Natality + Immigration) - (Mortality + Emigration)

Given, Natality = 280, Mortality = 200, Immigration = 40, Emigration = 50

Net increase = (280 + 40) - (200 + 50) = 320 – 250 = 70

Therefore, the net increase in population of rats is 70. *(1 M)*

11. India has only 2.4% of the world's land area but its share of the global species diversity is:

(*a*) 8·1% (*b*) 12·9% (*c*) 7·3% (*d*) 5·1%

Ans. (*a*) India, despite covering only 2.4% of the world's land area, accounts for 8.1% of global species diversity. This highlights the country's rich biodiversity, with a wide variety of flora and fauna present across its diverse ecosystems. *(1 M)*

12. Out of the following, select the correct match:

(*a*) Transgenic cow milk – Human beta-lactalbumin protein

(*b*) ELISA – Antigen antibody interaction

(*c*) Corn Borer – *cry II Ab* gene

(*d*) Cotton plant – *Meloidegyne incognitia*

Ans. (*b*) ELISA is based on the principle of antigen-antibody interaction.

- Transgenic cow milk- Rich in human alpha-lactalbumin
- *cryIAb* gene controls corn borer.
- Transgenic cotton plants are resistant to *Bacillus thuringiensis*. *(1 M)*

SEXUAL REPRODUCTION IN FLOWERING PLANTS

1

"In flowering plants, we see a prime example of insect pollination, such as a bee actively harvesting pollen from purple aster. The bee's body is designed for pollination, showcasing its hairy texture which traps pollen grains, facilitating the transfer of pollen between flowers, a critical process for plant reproduction."

SYLLABUS & WEIGHTAGE

List of Concept Names	Years				
	2020	2022 (Term I)	2023	2024	2025
Pre-Fertilisation: Structures and Events (Flower structure; development of male and female gametophytes; pollination - types, agencies and examples; out breeding devices; pollen-pistil interaction)	–	7 Q*	1 Q (5 M)	1 Q (3 M)	2 Q (1 M Each) 1 Q (4 M) 1 Q (5 M)
Double Fertilisation **Post-Fertilisation: Structures and Events** (Double fertilisation; post fertilisation events - development of endosperm and embryo, development of seed and formation of fruit; special modes- apomixis, parthenocarpy, polyembryony; Significance of seed dispersal and fruit formation)	1 Q (3 M)	4 Q*	1 Q (3 M)	3 Q (1 M Each) 1 Q (5 M)	–

For the year 2021, the exam was not conducted

** All questions were of MCQ type and carried equal marks.*

Sexual Reproduction in Flowering Plants

CONCEPT MAP

Pre-fertilisation: Structures and Events

Gametogenesis / Gamete Formation
Occurs in specialised structures: anthers (male) and ovules (female).

Gamete transfer through pollination
Transfer of pollen grains to stigma of a pistil for fertilisation.

Megasporogenesis and Monosporic Embryo sac Development

Megaspore mother cell (2n)
↓ Meiosis
Megaspore tetrad i.e., 4 Megaspores (n)
↓
A single chalazal megaspore is functional; rest degenerate
↓
Functional Megaspore (n)
↓ 1st nuclear division
Two nucleated stage
↓ 2nd nuclear division
Four nucleated stage
↓ 3rd nuclear division
Eight nucleated stage
↓ Cell walls are now laid down, forming 8 nucleated, 7-celled embryo sac

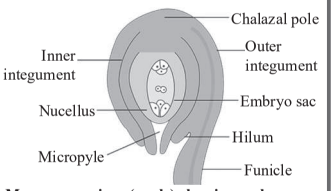
These divisions are strictly free nuclear and no cell walls are laid yet

Development of embryo sac from a single megaspore (monosporic development)

Chalazal end
Antipodals
Polar nuclei
Central cell
Egg
Synergids
Filiform apparatus
Micropylar end

Ovule

- Ovule usually has a single embryo sac formed from a megaspore.



Megasporangium (ovule) showing embryo sac

Biotic Agent

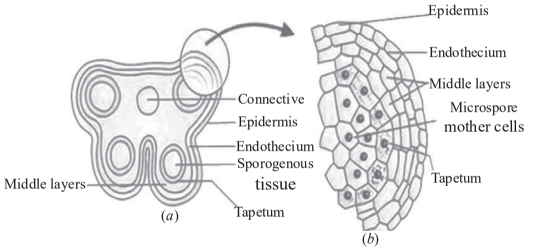
Insects (Bees, butterflies, flies, ants, wasps, etc.), birds (sunbirds humming birds), bats, some primates (lemurs), arboreal rodents, and reptiles (gecko lizard and garden lizard), etc.

Floral Adaptation

- **Nectar Production:** Flowers produce nectar to attract pollinators.
- **Color and Scent:** Bright colors and fragrances lure pollinators.
- **Mimicry:** Some flowers mimic female insects to facilitate pollination e.g., *Ophrys*
- **Offers Oviposition (egg-laying) site:** In some species floral rewards are in providing safe places to lay eggs; Some flowers, like the 6-feet *Amorphophallus* and *Yucca*.

Structure of Microsporangium

- Each microsporangium has four wall layers (**epidermis**, **endothecium** and **middle layers** protect the microsporangium and aid in anther dehiscence and the **tapetum** nourishes developing pollen grains) and a central sporogenous tissue that gives rise to pollen grains.

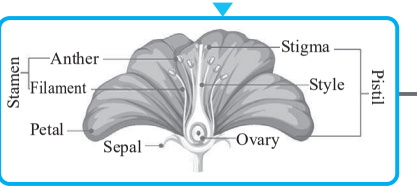


(a) T.S. of Young Anther **(b) Enlarged view of Microsporangium**

Microsporogenesis and Microgametogenesis:

Pollen mother cell (2n) —Meiosis→ Microspore tetrad i.e., 4 microspores (n)
↓ Anther matures and dehydrates
4 Pollen grains (n) or Male gametophyte
↓ Pollen mitosis I (Unequal division)
Vegetative cell (n) + Generative cell (n)
↓ Pollen mitosis II
Male gamete (n) + Male gamete (n)

Flower-A Fascinating Organ of Angiosperms



Female Reproductive Part (Pistil)

- Gynoecium in a flower represents the female reproductive part.
- It can be a single pistil (monocarpellary) or multiple pistils (multicarpellary).
- Pistils may be fused (syncarpous) or separate (apocarpous).

Male Reproductive Part (Stamen)

- Comprises a filament and a bilobed anther.
- Anther is dithecous, containing four microsporangia that become pollen sacs.

Pollinating agents

Abiotic Agents: Wind, Water

Wind pollinated flower

- Flowers are not colorful and do not produce nectar.
- Pollen grains are light and non-sticky.
- Have exposed stamens and large feathery stigmas to facilitate pollen dispersal and capture, e.g., grasses.

Water pollinated flower

- Flowers are not very colorful and do not produce nectar.
- Pollen grains are long, ribbon like released inside water and are carried passively; some of them reach the stigma and achieve pollination.
- E.g., *Vallisneria*, *Hydrilla* and *Zostera*.

Cross pollination

Xenogamy

- Cross-pollination between different flowers on different plants.

Self pollination

Geitonogamy

- Pollination between different flowers on the same plant.
- Geitonogamy is functionally cross-pollination but genetically self-pollination.

Autogamy

- Self-pollination within the same flower
- Ensures fertilisation but reduces genetic diversity.
- Requires perfect synchrony in pollen release and stigma receptivity.
- Some plants like *Viola* (Common Pansy), *Oxalis*, and *Commelina* produce chasmogamous (with exposed anthers and stigma, allowing cross-pollination) and cleistogamous (flowers do not open and ensure autogamy) flowers.

Pollen Grain (25-50 μm in diameter)

Component	Main Function	Location
Exine (made of sporopollenin)	Provides protection due to its resistance to extreme conditions and aids in the preservation of pollen grains as fossils.	Outer layer of the pollen grain wall.
Intine (made of cellulose and pectins)	Essential for the maturation of the pollen grain and pollen tube germination.	Inner layer of the pollen grain wall, beneath the exine.
Germ pores	Serve as sites for pollen tube emergence, facilitating the process of germination.	Specific regions on the exine where sporopollenin is absent.
Vegetative cell	Provides nutrients and energy for the growth of the pollen tube.	Larger cell within the pollen grain, contains a large nucleus and abundant food reserves.
Generative cell	Divides mitotically to produce two male gametes for fertilisation.	Smaller cell that floats in the cytoplasm of the vegetative cell, typically spindle-shaped.

- Some plants release **2-celled pollen** (one generative and one vegetative cell), while others disperse **3-celled pollen** (one vegetative and two male gametes).

Microsporogenesis pollen yield:

$P = N \times 4$

(∵ each microspore mother cell produces 4 microspores/pollens)
where,
P = Number of pollen grains
N = Number of microspore mother cell

Pollen Viability and Storage:

- Pollen viability varies, influenced by temperature and humidity.
- Rice, wheat pollen: lose viability within 30 minutes of their release.
- Pollen in some members of Rosaceae, Leguminoseae, Solanaceae: viable for months.
- Pollen can be stored for years in liquid nitrogen (-196°C), can be used as pollen banks in crop breeding programmes.

To Access One Shot Revision Video Scan This QR Code

Sexual Reproduction in Flowering Plants

Endosperm Development

- Occurs before embryo development due to its crucial role in nutrition of embryo.
- Primary endosperm cell (PEC) divides and forms a triploid endosperm tissue.
- Contains reserve food materials for the developing embryo.
- In the most common type of endosperm development:
  - Primary endosperm nucleus (PEN) undergoes multiple nuclear divisions.
  - Results in formation of many free nuclei.
  - This phase is known as free-nuclear endosperm.
  - Following free-nuclear stage, cell walls begin to form.
  - Endosperm shifts from a free-nuclear to a cellular structure.
  - The number of nuclei before this transition varies widely.
- Endosperm can be persistent (e.g., castor, coconut) or consumed by the embryo (e.g., pea, groundnut, beans).

Artificial Hybridisation: Steps For Controlled Pollination in Bisexual Flowers

Emasculation:

Remove anthers with forceps before pollen release.

Bagging:

- Cover emasculated flowers with butter paper bags to avoid unwanted pollen contamination.
- Once stigma is receptive, dust selected pollen.
- Rebag flowers for fruit development.

Note: If the female parent produces unisexual flowers, there is no need for emasculation.

Outbreeding Devices (To Avoid Inbreeding Depression)

- Encourage cross-pollination to overcome inbreeding depression.
- Flowering plants have developed many devices to discourage self pollination.

Hereditary Device:

- Self-incompatibility: Genetic mechanism blocking self-pollen fertilisation by hindering germination or pollen tube growth.

Physiological Device:

- Asynchronous pollen release and stigma receptivity.
- Spatial separation of anther and stigma i.e., the anther and stigma are placed at different positions so, that the pollen cannot come in contact with the stigma of the same flower.
- Production of unisexual flowers in monoecious (castor, maize) and dioecious (papaya) plants.

Post-fertilisation Events

Fruit

Ovary develops into a fruit, with the ovary wall becoming the **pericarp**.

- **True Fruit** — Fruit develops solely from the ovary of the flower, e.g., mango.
- **False Fruit** — Fruit develops from both the ovary and surrounding floral parts, like the thalamus, e.g., apple, strawberry, cashew, etc.
- **Parthenocarpic Fruits** — Fruit develops without fertilisation, occurs in species like banana, leading to seedless fruits.

Seed

- Final product of sexual reproduction, formed inside fruits.
- Ovules inside the ovary develop into seeds.
- Consist of seed coat(s), cotyledon(s), and embryonal axis.

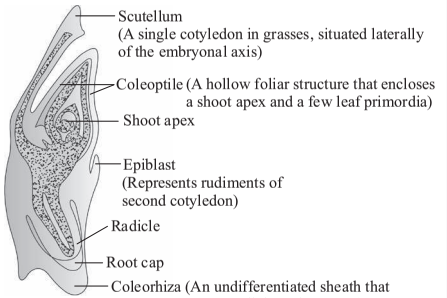
- **Seed dormancy:** As seeds mature, they reduce water content (10-15% moisture by mass), and embryo metabolic activity slows down and may enter a state of dormancy.
- **Non-albuminous Seed:** No residual endosperm as it is completely consumed during embryo development, e.g ., pea, groundnut, beans.
- **Albuminous Seed:** Retain a part of the endosperm as it is not completely used up during embryo development, e.g., wheat, maize, barley, castor coconut.
- **Cotyledons:** Thick and swollen, store food reserves.
- **Perisperm:** Some seeds like black pepper and beet, remnants of the nucellus persist as the perisperm.
- **Seed coat:** Integuments of ovules harden to form tough seed coats, and the micropyle allows oxygen and water entry during germination.

Embryo development

- Develops at the micropylar end of the embryo sac.
- Typically, zygotes divide only after some endosperm is formed.
- Early embryonic stages are similar in monocots and dicots.
- **Components of Embryonal Axis:** Epicotyl + Plumule + Hypocotyl + Radicle

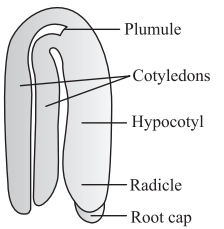
Monocot Embryo

- Monocotyledonous embryo have one cotyledon.



Dicot Embryo

- Dicotyledonous embryo has an embryonal axis with two cotyledons.



Double Fertilisation and Fate of Male Gametes

Involves two fertilisation events in the embryo sac, syngamy and triple fusion.

Syngamy

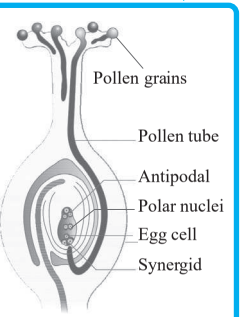
- Fusion of one male gamete with the egg cell forming a diploid zygote ($2n$).
- **Zygote** develops into the **embryo**.

Triple fusion

- Fusion of the other male gamete with two polar nuclei in central cell forming a triploid **primary endosperm nucleus (PEN) ($3n$)**.
- After triple fusion, the central cell becomes the **primary endosperm cell (PEC)**.
- **PEC** develops into the **endosperm**, a nutritive tissue.

Pollen-Pistil Interaction

- Chemical components of pollen and pistil determine compatibility.
- Compatible pollen triggers pollen tube formation on the stigma.
- Certain plants release **two-celled pollen** (vegetative and generative cell).
- The generative cell divides into two male gametes during pollen tube growth.
- **Three-celled pollen** already contains two male gametes.
- The pollen tube enters the ovule through the micropyle, then enters one of the synergids through the filiform apparatus.



L.S. of a flower showing growth of pollen tube

Polyembryony

In plants like *Citrus* & Mango, nucellar cell division yields multiple embryos in a single ovule, notably observable in squeezed orange seeds.

Apomixis

- Form of asexual reproduction in some flowering plants, mimicking sexual reproduction but occurring without fertilisation.
- Diploid egg cell in some species develops directly into embryo without reduction division and fertilisation.
- Mostly observed in Asteraceae and grasses.
- Valuable in agriculture, maintains hybrid traits efficiently.

1 PRE-FERTILISATION: STRUCTURES AND EVENTS

NCERT Definitions *(Commonly asked in 1 mark)*

- **Stamen:** The male reproductive part of a flower, consisting of a long and slender stalk called filament, and a bilobed anther that produces pollen.
- **Microsporangium:** A structure within the anther, located at the corners, where pollen grains are produced and which further matures to form pollen sacs.
- **Dithecous:** An anther with two thecae, or compartments, each containing two microsporangia.
- **Tapetum:** Innermost wall layer of microsporangium that nourishes pollen grains.
- **Sporogenous tissue:** A group of compactly arranged homogenous cells located in the centre of each microsporangium
- **Microspore tetrad**: Arrangement of microspores in a cluster of four cells.
- **Pollen grain:** The male gametophyte in angiosperms that carries male germ cells to the female reproductive structures.
- **Intine:** The inner wall of a pollen grain, characterised by a thin and continuous layer composed of cellulose and pectin.
- **Exine:** Hard outer layer of a pollen grain made up of sporopollenin.
- **Pistil:** The female reproductive part of a flower, consisting of stigma(serves as a landing platform for pollen grains), style (an elongated stalk-like structure that supports the stigma) and the ovary (basal bulged part that contains the ovules).
- **Megasporangium (Ovule):** Structure within the ovary of the flower where the female gametophytes are developed.
- **Funicle:** The stalk-like structure that attaches the ovule to the placenta.
- **Hilum:** The region where the body of the ovule fuses with the funicle.
- **Integuments:** Protective envelopes that surround the ovule.
- **Embryo sac:** The female gametophyte within the ovule, where fertilisation occurs.
- **Micropyle:** A small opening in the integuments of the ovule through which the pollen tube enters.
- **Nucellus:** Mass of cells having abundant food reserves, enclosed by integuments.
- **Chalaza:** Basal part of the ovule that lies opposite to the micropyle.
- **Anatropous:** The type of ovule where the body of ovule is inverted at 180° and micropyle lies near the funicle while chalazal end is present on the opposite side.
- **Locule:** Ovarian cavity where placenta is located.
- **Monosporic development:** Method of embryo sac formation from a single megaspore.
- **Stigma receptivity:** The ability of the pistil to accept or reject pollen grains based on chemical dialogue. This dialogue is mediated by chemical components of the pollen interacting with those of the pistil.
- **Inbreeding depression:** Refers to the reduced survival and fertility of offspring of related individuals.
- **Artificial hybridisation:** Method in crop improvement programmes where different species or genera are crossed to combine desirable traits and produce commercially 'superior' varieties.
- **Emasculation:** Removal of anthers from the bisexual flower bud before the anther dehisces using a pair of forceps.
- **Bagging:** It is the procedure where emasculated flowers are covered with a butter paper bag to prevent contamination from unwanted pollen.

Important Facts

01 The most resistant organic materials found in the outer layer of the pollen grain capable of withstanding high temperatures, strong acids, alkalis, and enzymes. ~ ***Sporopollenin***

02 The number and length of stamens vary across different species. ~ ***Stamens variability***

03 The wall layer of microsporangium possesses dense cytoplasm and generally have more than one nucleus.
~ ***Tapetum***

04 An ovule generally has a single embryo sac formed from a megaspore.

05 In over 60% of angiosperms, pollen grains are shed at a 2-celled stage while in others, the generative cell divides mitotically to form two male gametes before shedding, resulting in a 3-celled stage.

06 One meiotic event produces four pollen grains, and each pollen grain can produce two male gametes.

07 The formation of an '8-nucleate, 7-celled' embryo sac involves one meiotic and three mitotic divisions.

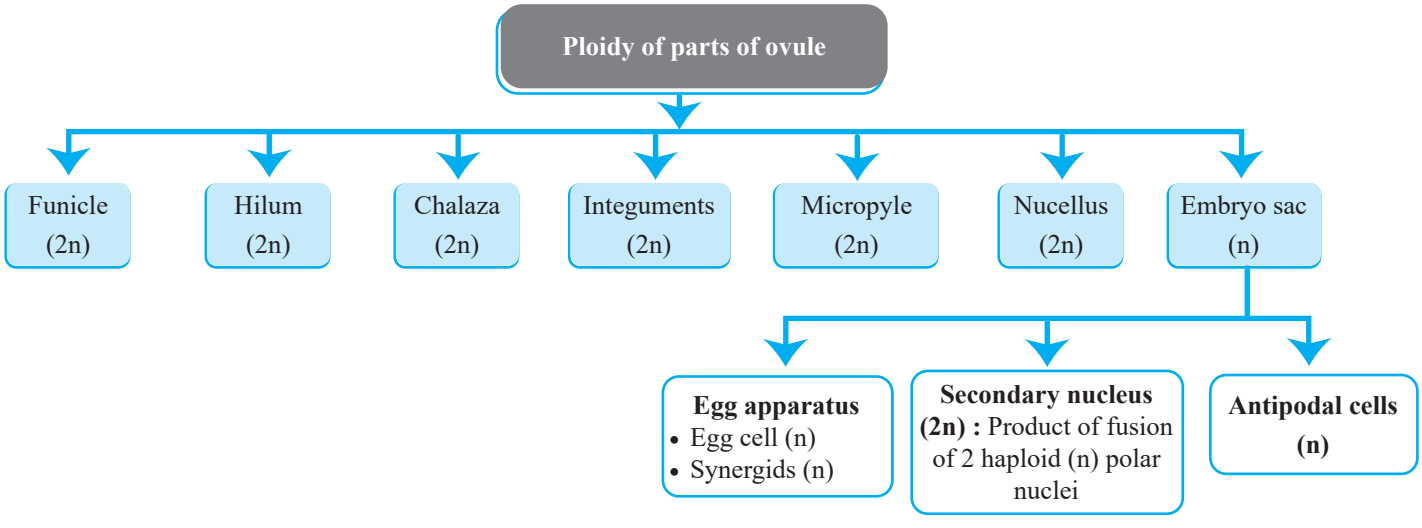
08 The cellular thickenings at the micropylar tip play an important role in guiding the pollen tubes into the synergid.
~ ***Filiform apparatus***

09 The plant that provides floral rewards as safe places for insects to lay eggs and has a flower about 6 feet in height.
~ ***Amorphophallus***

10 In *Vallisneria*, female flowers reach the surface of water *via* long stalk, while male flowers or pollen released on to the surface of water, carried by water currents to achieve pollination while in sea grasses (*Zostera*), submerged female flowers receive elongated, ribbon-like pollen grains directly in water.

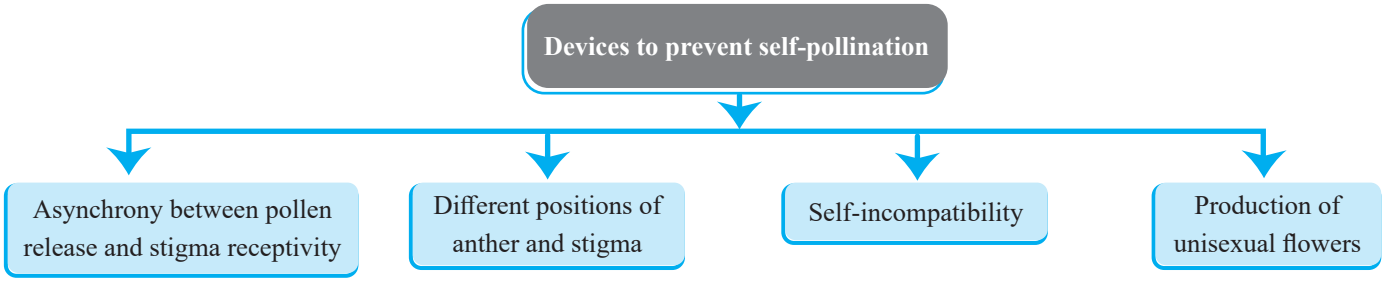
11 In some cereals such as rice and wheat, pollen grains lose viability within 30 minutes of their release, and in some members of Rosaceae, Leguminoseae and Solanaceae, they maintain viability for months.

Classification



Types of Pollination depending on the source of pollen				
Pollination type	**Pollen source**	**Genetic outcome in offsprings**	**Common in plants**	**Requirement of pollinating agents**
Autogamy	Same flower	Same genetic material (self-pollination)	*Viola, Oxalis, and Commelina*	May or may not be required
Geitonogamy	Different flower on the same plant	Same genetic material (cross-pollination)	Common in plants where flowers are closely spaced	Required
Xenogamy	Different flower on a different plant	Genetically diverse (cross-pollination)	Preferred in diverse ecosystems with varied plant species	Required

Types of pollination based on agents of pollination			
Aspect	**Wind pollination**	**Water pollination**	**Animal pollination**
Pollen characteristics	Light, non-sticky pollen	Ribbon-like, have mucilaginous covering Pollen may be released on surface of water or underwater.	Sticky or spiny pollen to adhere to animals
Flower characteristics	No scent or nectar; exposed stamens. Large, feathery stigmas to catch pollen. Often single ovule in each ovary.	Subtle features, non-showy	Bright colourful, scented, nectar-rich
Examples	Grasses, corn, etc	Freshwater (*Vallisneria*, *Hydrilla*), Marine (*Zostera*)	Orchids, roses, etc



Difference Between

Microsporogenesis vs. Megasporogenesis

Feature	Microsporogenesis	Megasporogenesis
Definition	Formation of microspores from pollen mother cells (PMC)	Formation of megaspores from megaspore mother cells (MMC)
Location	Anthers within the stamen	Ovules within the ovary
Product	Microspores that develop into male gametophyte (pollen grains)	Megaspores that develop into female gametophyte (embryo sac)
Number of functional gametes produced	Four functional microspores	Four megaspores: One (functional) and three (degenerate)

Cleistogamous vs. Chasmogamous flowers

Aspect	Cleistogamous Flowers	Chasmogamous Flowers
Definition	Flowers do not open at all	Flowers has exposed anthers and stigma
Pollination	Always autogamous, as they self-pollinate.	Can be autogamous, geitonogamous and xenogamous
Seed Set	Assured seed-set even without pollinators	Often dependent on pollinator availability or other factors

Vegetative cell vs. Generative cell

	Vegetative cell	Generative cell
Size	Large	Smaller and floats in the cytoplasm of the vegetative cell
Presence of reserve food material	Contains abundant food reserve	Does not have a food reserve
Shape of nucleus	Large, Irregular	Spindle shaped with dense cytoplasm

Monoecious vs. dioecious

Monoecious	Dioecious
Both male and female flowers are present on the same plant.	Male and female flowers are present on separate plants.
Prevents autogamy but not geitonogamy	Prevents both autogamy and geitonogamy
E.g., Castor, maize	E.g., Papaya

Real Life Application Based Questions

1. **Have you ever heard that some people have allergies to pollen grains? Are these allergies seasonal? What are the common symptoms?**

Ans. Yes, pollen grains from many species can cause severe seasonal allergies leading to chronic respiratory disorders such as asthma and bronchitis. Symptoms typically include sneezing, coughing, and breathing difficulties.

2. **How does pollen storage help conserve plant biodiversity?**

Ans. Storing pollen aids in protecting plant species, especially those at risk of extinction. It allows for future plant reproduction through artificial pollination, supporting efforts to maintain or increase plant diversity in nature and botanical gardens.

3. **Have you ever seen bees frequently visiting certain flowers in the garden, like roses or sunflowers? Why do you think bees are particularly attracted to these flowers, and how does this benefit both the bees and the flowers?**

Ans. Yes, bees are attracted to these flowers primarily for nectar, which serves as a food source. In return, bees aid in pollination by transferring pollen from one flower to another, thus playing a crucial role in the reproductive cycle of plants.

4. **Why might a flower evolve to have a specific shape, size, or color? Consider the orchid *Ophrys*, which mimics female bees to attract male bees. How does this specific adaptation benefit the orchid?**

Ans. The orchid *Ophrys* benefits from mimicking female bees as it ensures that male bees, attempting to mate with the flower, inadvertently pollinate it. This specificity in floral morphology ensures efficient and targeted pollination by exploiting the mating behaviors of bees.

5. **When we observe certain plants, such as *Yucca*, closely, we can see the eggs and larvae of some insects on them. What leads these specific insects to choose these plants for laying their eggs, and how does it benefit the insects?**

Ans. Insects like moths lay eggs on specific plants such as *Yucca* because these plants provide a secure habitat for their offspring. Both species, moths and the plant ,cannot complete their life cycles without each other. The moth deposits its eggs in the locule of the ovary and the flower, in turn, gets pollinated by the moth. The larvae of the moth come out of the eggs as the seeds start developing.

6. **Farmers often seek to increase crop yield through selective breeding. How can understanding the mechanism of pollen-pistil recognition help farmers ensure that only desired pollen successfully fertilises crops?**

Ans. Understanding pollen-pistil recognition allows farmers to selectively breed crops by ensuring compatibility between specific pollen and pistils. This targeted approach can increase crop yields, improve genetic traits, and enhance resistance to diseases by promoting successful cross-pollination with desired traits.

7. **In ecosystems where both monoecious and dioecious plants are present, how might the presence of unisexual flowers affect the plant community's structure and reproductive success?***

Ans. The presence of unisexual flowers in monoecious and dioecious plants can influence the plant community by reducing the likelihood of self-pollination and enhancing cross-pollination between different plants. This can lead to a more genetically diverse and resilient plant community, which is crucial for ecological stability and adaptation.

Myth Buster

- **Myth: All flowers are colorful and have a pleasant scent.**
  Fact: While many flowers are colorful and scented to attract pollinators, some are not. Some flowers, like those pollinated by wind or water, may be small, lack scent, and appear dull because they do not need to attract animal pollinators.
- **Myth: All pollination leads to fertilisation.**
  Fact: Not all pollination events result in fertilisation. For fertilisation to occur, the pollen that lands on the stigma must be compatible. Incompatible pollen, whether from a different species or from the same plant in cases of self-incompatibility, does not lead to successful fertilisation.

** Concepts beyond the board exam syllabus, offering deeper insight and critical thinking on NCERT topics.*

- **Myth: All brightly colored and scented flowers are pollinated by insects.**
  Fact: While insects are the most common pollinators, many other animals, such as birds, bats, primates (lemurs), arboreal (tree-dwelling) rodents, or even some reptiles (gecko and garden lizard), can also pollinate flowers.
- **Myth: Pollen's only role is to fertilise the ovule.**
  Fact: Besides fertilisation, pollen grains are rich in nutrients and are used as dietary supplements in the form of tablets and syrups, believed to enhance athletic and race horse performance.
- **Myth: Pollination by water is common among all aquatic plants.**
  Fact: Pollination by water is quite rare and limited to about 30 genera of mostly monocotyledons. Many aquatic plants, such as water lilies and water hyacinth, have flowers that emerge above water and are pollinated by insects or wind, not by water.
- **Myth: Cleistogamous flowers (flowers that do not open) are less evolved than open, pollinated flowers.**
  Fact: Cleistogamous flowers represent a highly evolved strategy to ensure seed production, especially under adverse conditions or when pollinators are scarce. These flowers self-pollinate internally, guaranteeing reproduction without the need for pollinator services, which can be an advantage in stable but resource-limited environments.

Mnemonics

- **Wall layers of microsporangium: "Every Elephant Might** meet **Tigers"**

Every	**E**lephant	**M**ight	meet	**T**igers
↓	↓	↓		↓
Epidermis	Endothecium	Middle layers		Tapetum

- **Examples of plants that produce two types of flowers – Chasmogamous and Cleistogamous: "Power, Control, Ownership"**

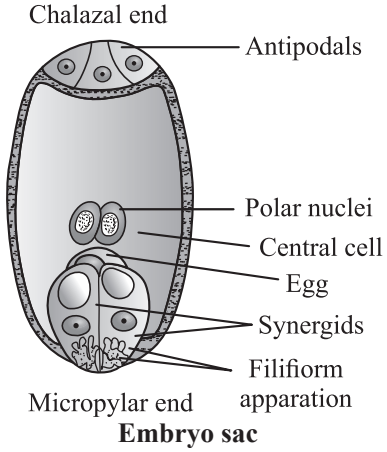
Power	**C**ontrol	**O**wnership
↓	↓	↓
Common pansy (*Viola*)	*Commelina*	*Oxalis*

- **To remember examples of monoecious and dioecious plants: "Make Connections Manifest Dreams Pursue"**

Make	**C**onnections	**M**anifest	**D**reams	**P**ursue
↓	↓	↓	↓	↓
Monoecious	Castor	Maize	Dioecious	Papaya

- **To remember arrangement of cells and nuclei in the embryo sac:**

"At **Chalazal's Base**,
Three Antipodals Race,
in the **Centre**,
Two Polar Nuclei Embrace,
near the **Micropyle**,
Synergids and an **Egg** Face,
Making the **Embryo sac**,
a Fascinating Place."



Embryo sac

- **Examples of a single ovule ovary: "Man Won iPad"**

Man	**W**on	i**P**ad
↓	↓	↓
Mango	Wheat	Paddy

- **Examples of a multiple ovule ovary: "Papa Waters Orchids"**

Papa	**W**aters	**O**rchids
↓	↓	↓
Papaya	Watermelon	Orchids

COMPETENCY BASED SOLVED EXAMPLES

Multiple Choice Questions

(1 M)

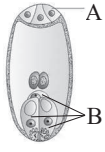
1. Pollen grains retain viability for months in plants belonging to different families given below: *(Re)* **(CBSE, 2022 Term-I)**

(i) Solanaceae (ii) Leguminoseae
(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)

2. Study the given diagram and choose the correct option against 'A' and 'B' *(Re)* **(CBSE APQ, 2023)**

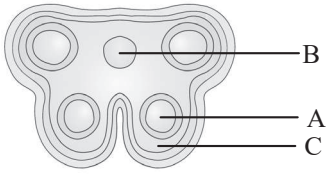


(*a*) A-Egg apparatus; B-Polar body
(*b*) A-Antipodals; B-Egg apparatus
(*c*) A-Synergids; B- Egg apparatus
(*d*) A-Central cell; B-Antipodals

3. The outermost and innermost wall layers of microsporangium in an anther are respectively: *(Re)* **(NCERT Exemplar)**

(*a*) Endothecium and tapetum
(*b*) Epidermis and endodermis
(*c*) Epidermis and middle layer
(*d*) Epidermis and tapetum

4. Which of the following structures contains PMC? *(Re)*



(*a*) Only A (*b*) Only B
(*c*) Both A and C (*d*) Only C

5. Starting from the innermost part, the correct sequence of parts in an ovule are, *(Un)* **(NCERT Exemplar)**

(*a*) egg, nucellus, embryo sac, integument
(*b*) egg, embryo sac, nucellus, integument
(*c*) embryo sac, nucellus, integument, egg
(*d*) egg, integument, embryo sac, nucellus

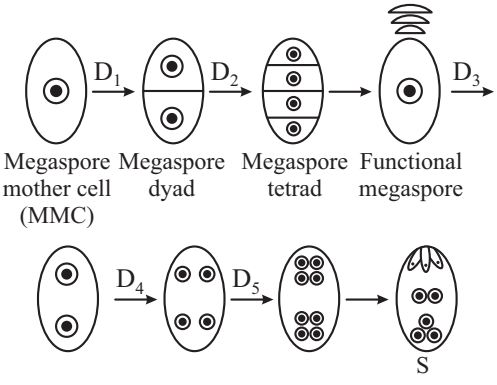
6. "Cells of the tapetum of a microsporangium are usually multinucleate".
Which of the following can be a reason for the tapetal cells to become multinucleate? *(An)* **(CBSE CFPQ, 2023)**

(*a*) They fuse with the polar cells of the megasporangium.
(*b*) They do not undergo karyokinesis.
(*c*) They do not undergo cytokinesis.
(*d*) They do not undergo mitosis.

7. Choose the correct statement from the following: *(Un)*

(*a*) Cleistogamous flowers always exhibit autogamy.
(*b*) Chasmogamous flowers always exhibit geitonogamy.
(*c*) Cleistogamous flowers exhibit both autogamy and geitonogamy.
(*d*) Chasmogamous flowers never exhibit autogamy.

8. The figure given below shows megasporogenesis and development of typical female gametophyte in angiosperms. In which of the following options all divisions (D_1 to D_5) and structure (S) are correctly identified? *(Un)*



(*a*) D_1 - Meiosis I
D_2 - Meiosis II
D_3 - Mitosis
D_4 - Mitosis
D_5 - Mitosis
S - Microgametophyte

(*b*) D_1 - Meiosis I
D_2 - Meiosis II
D_3 - Mitosis
D_4 - Mitosis
D_5 - Mitosis
S - Embryo

(*c*) D_1 - Meiosis I
D_2 - Meiosis II
D_3 - Mitosis
D_4 - Mitosis
D_5 - Mitosis
S - Embryo sac

(*d*) D_1 - Mitosis
D_2 - Meiosis
D_3 - Mitosis
D_4 - Mitosis
D_5 - Mitosis
S - Embryo sac

9. During the pollen grain formation, the generative cell divides to give rise to the two male gametes. What is the ploidy of the generative cell? *(Re)*

(*a*) n (*b*) 2n
(*c*) 3n (*d*) 4n

10. Choose the correct option according to P & Q. *(Un)*

(*a*) P- Multicarpellary, syncarpous pistil of *Papaver*.
(*b*) Q- Multicarpellary, syncarpous gynoecium of *Michelia*.
(*c*) P- Multicarpellary, apocarpous pistil of *Papaver*.
(*d*) Q- Multicarpellary, apocarpous androecium of *Michelia*.

11. **Consider three plants with the following modes of pollination:** **(*Un*) (CBSE CFPQ, 2024)**

Plant P: autogamy

Plant Q: xenogamy

Plant R: geitonogamy

Which of the above case/s is/are most likely to NOT show genetic variation in the offspring?

(*a*) only P (*b*) only Q
(*c*) only P and R (*d*) only Q and R

Assertion and Reason (1 M)

Direction: The following questions consist of two statements – Assertion (A) and Reason (R). Answer these questions by selecting the appropriate option given below:

(*a*) Both A and R are true, and R is the correct explanation of A.

(*b*) Both A and R are true, but R is not the correct explanation of A.

(*c*) A is true, but R is false.

(*d*) A is false, but R is true.

1. **Assertion (A):** Pollen tube germinates through the germ pores on the pollen grains.

   Reasoning (R): Pollen-pistil compatibility chemicals help to dissolve sporopollenin for the pollen tube to germinate. **(*Un*) (CBSE CFPQ, 2023)**

2. **Assertion (A):** The microsporangia are located at the corners of the anther.

   Reason (R): The length of the stamen depends on the number of microsporangia in the anther. **(*Un*)**

3. **Assertion (A):** Tapetum is the innermost layer of anther which is single layered.

   Reason (R): Tapetum is polyploid and multinucleated. **(*Un*)**

4. **Assertion (A):** Chalaza is found opposite the micropyle in an ovule.

   Reason (R): Integuments encircle the nucellus and shield it. **(*Un*)**

5. **Assertion (A):** The ploidy of the megaspore mother cell (MMC) is haploid (*n*).

   Reason (R): The MMC undergoes meiotic division during megasporogenesis. **(*Re*)**

6. **Assertion (A):** Pollen grains are well preserved as fossils.

   Reason (R): The exine of pollen grains is made up of sporopollenin, which can withstand high temperatures, strong acids and alkali. **(*Re*)**

7. **Assertion (A):** In maize, the presence of unisexual flowers on the same plant helps in preventing self-pollination.

   Reason (R): Maize plants are dioecious. **(*Un*)**

8. **Assertion (A):** The introduction of a mutation in the tapetum cells of anthers can affect pollen viability.

   Reason (R): The tapetum layer provides essential nutrients for the developing pollen grains. **(*Un*)**

9. **Assertion (A):** Corn cobs have a multiple ovule in each ovary and numerous flowers packed into an inflorescence.

   Reason (R): Corn plants tassels wave in the wind to trap pollen grains. **(*Re*)**

10. **Assertion (A):** The flower of *Amorphophallus* provides a safe place for insects to lay eggs, which assists in pollination.

    Reason (R): Providing a safe place for egg-laying by insects increases the chances of these insects visiting the flower, thereby enhancing pollination. **(*Un*)**

Subjective Questions

Very Short Answer Type Questions (2 M)

1. **You are conducting artificial hybridization on papaya and maize. Which one of them would require the step of emasculation and why? However for both you will use the process of bagging. Justify giving one reason.** **(*Un*) (CBSE, 2019)**

Ans. Maize requires emasculation because it is a monoecious plant having unisexual flowers; removal of stamens prevents self-pollination and ensures cross-pollination in hybridization whereas papaya is unisexual so there is no need for emasculation. *(1 M)*

However, for both papaya and maize, the process of bagging is needed to prevent cross-pollination from other plants. Bagging helps in ensuring controlled pollination, which is necessary for artificial hybridization. *(1 M)*

2. **The exine layer of pollen grains contains sporopollenin which is a highly resistant chemical. Sporopollenin allows pollen grains to be well-preserved as fossils.**

   (*a*) Can fossilised pollens fertilise an ovum of the same species in the present day? Justify.

   (*b*) How do scientists preserve pollen grains for later use? **(*Ap*) (CBSE CFPQ, 2023)**

Ans. (*a*) No

Reason: Fossilised pollen grains, despite being well-preserved due to the sporopollenin, are no longer viable for such a long time as those taken for fossilisation. *(1 M)*

(*b*) Scientists preserve pollen grains by storing them at low temperatures in liquid nitrogen at -196°C. *(½ M)*

Such stored pollen can be used as pollen banks,similar to seed banks, in crop breeding programmes. *(½ M)*

3. **"Continued self-pollination results in inbreeding depression".**

   (*a*) Mention ONE impact of inbreeding depression on the upcoming generations in farmland.

   (*b*) State ONE way in which cross-pollination helps in avoiding inbreeding depression.

   (*Ap*) (CBSE CFPQ, 2023)

Ans. (*a*) Inbreeding depression can result in loss of fertility and vigour in the existing population. *(1 M)*

(*b*) Cross pollination brings about variation of characters that help in increased vigour of the population. *(1 M)*

4. When and where do tapetum and synergid cells develop in flowering plants? Mention their functions. *(Un)* **(CBSE, 2019)**

OR

Where are the following structures present in a male gametophyte of an angiosperm? Mention the function of each one of them. *(Un)* **(CBSE, 2019)**

(*a*) Germ pore

(*b*) Sporopollenin

(*c*) Generative cell

Ans. Tapetum development:

- During microsporogenesis within the microsporangium. *(½ M)*
- Develops inside the anthers of a stamen, specifically within the microsporangia as one of the four wall layers surrounding the sporogenous tissue. *(½ M)*

Function of tapetum:

- Nourishes the developing pollen grains. *(½ M)*

Synergid cells development:

- During megasporogenesis within the megasporangium (ovule). *(½ M)*
- Located within the embryo sac of the ovule at the micropylar end, forming part of the egg apparatus. *(½ M)*

Function of synergid: Have a filiform apparatus that plays an important role in guiding the pollen tubes into the synergid. *(½ M)*

OR

(*a*) Germ pore

- Location: Present on the pollen grain exine. *(½ M)*
- Function: Serves as an aperture for the pollen tube to emerge during pollen germination. *(½ M)*

(*b*) Sporopollenin

- Location: Found in the outer wall (exine) of pollen grains. *(½ M)*
- Function: Provides protection against environmental stresses; it is one of the most resistant organic materials known. *(½ M)*

(*c*) Generative cell

- Location: Located inside the pollen grain, initially as part of the vegetative cell's cytoplasm. *(½ M)*
- Function: Divides to form two male gametes necessary for fertilisation. *(½ M)*

5. Explain three different modes of pollination that can occur in a chasmogamous flower. *(Un)* **(CBSE, 2020)**

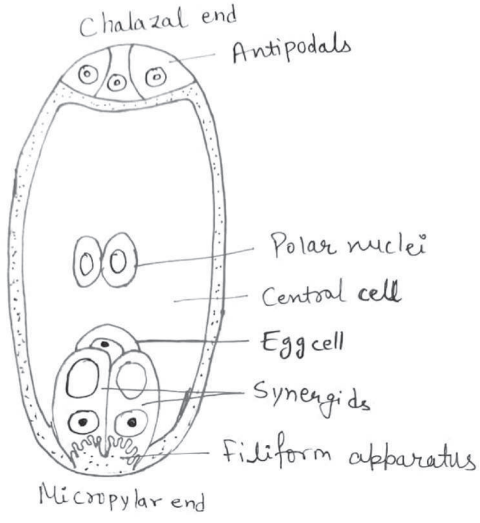
Ans. Modes of Pollination in chasmogamous flowers:

- Autogamy: Pollen is transferred to the stigma of the same flower, promoting self-pollination. *(1 M)*
- Geitonogamy: Pollen is transferred to a different flower but on the same plant, effectively acting as self-pollination genetically. *(1 M)*
- Xenogamy: Pollen is transferred to a flower on a different plant, ensuring cross pollination and genetic diversity. *(1 M)*

Long Answer Type Questions **(5 M)**

1. With a neat, labelled diagram, describe the parts of a mature angiosperm embryo sac. Mention the role of synergids. *(Cr, Re)* **(NCERT Exemplar)**

Ans.



(2½ M)

Parts of the embryo sac:

(i) Egg Apparatus: Located at the micropylar end, includes one egg cell and two synergids.

(ii) Central Cell: Contains two polar nuclei, positioned in the middle of the embryo sac.

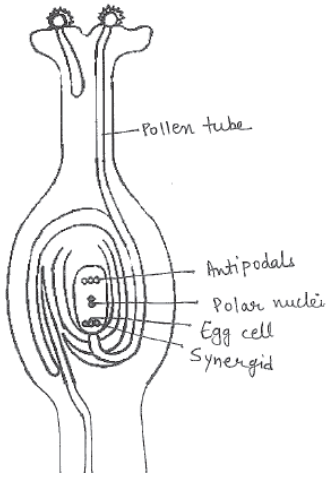
(iii) Antipodal Cells: Found at the chalazal end, typically comprising three cells. *(1½ M)*

Role of synergids:

The synergids have special cellular thickenings at the micropylar tip called filiform apparatus, which play an important role in guiding the pollen tubes into the synergid. *(1 M)*

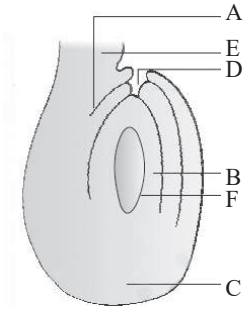
2. Draw the longitudinal section of the flower showing the growth of the pollen tube. *(Cr)*

Ans.



(5 M)

3. Analyse the different parts of an anatropous ovule given below. Answer the following questions it follows: *(An)*



(*a*) Identify and describe the parts labelled A to F.

(*b*) Explain the significance of B in the context of megaspore development.

Ans. (*a*) **A:** Hilum - It is the region where the body of the ovule fuses with a funicle. *(½ M)*

B: Nucellus - It is the tissue that surrounds the embryo sac and provides nourishment to the developing gametophyte. *(½ M)*

C: Chalaza - Basal part of the ovule lying opposite to the micropylar end. *(½ M)*

D: Micropyle - A small opening in the integuments of the ovule that allows for the entry of the pollen tube during the process of fertilisation. *(½ M)*

E: Funicle - The stalk that attaches an ovule to the placenta in the ovary. *(½ M)*

F: Embryo sac - The female gametophyte that contains the egg cell and is the site of fertilisation. *(½ M)*

(*b*) The nucellus, labelled as B plays a critical role in the development of the megaspore within the ovule as it provides nutritional support and protection to the developing megaspore. It is the tissue in the ovule where megaspore mother cell (MMC) undergoes meiosis to yield four megaspores, essential for female gametophyte formation. *(2 M)*

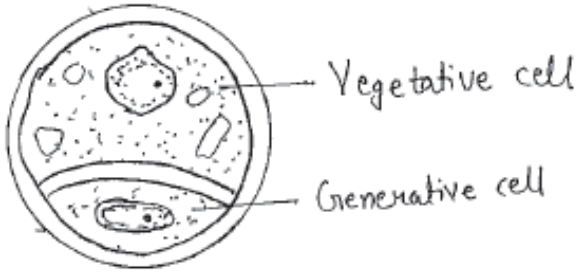
4. (*a*) Describe the process of megasporogenesis till the development of embryo sac, in an angiosperm.

(*b*) Draw the diagram of pollen grain showing the 2- celled stage. *(Un, Cr)*

Ans. (*a*) Megasporogenesis in an angiosperm involves the following steps:

- An ovule differentiates a single megaspore mother cell (MMC) in the micropylar region of the nucellus. *(½ M)*
- MMC undergoes meiotic division, resulting in four megaspores. *(½ M)*
- Of the four megaspores produced, one is functional while the other three degenerate. *(½ M)*
- The functional megaspore develops into the female gametophyte or embryo sac through monosporic development. *(½ M)*
- Mitotic divisions of the functional megaspore's nucleus form a 2-nucleate, then a 4-nucleate, and eventually an 8-nucleate embryo sac without forming cell walls immediately (free-nuclear divisions). *(½ M)*
- Finally, cell walls are formed, organizing the six out of the eight nuclei into cells, with the remaining two (polar nuclei) situated in the central cell below the egg apparatus. *(½ M)*

(*b*)



(2 M)

5. Some structures of anther and ovule are given below.

Pollen mother cell, microspore, generative cell, nucellus, synergids, antipodal cells. *(Re, Un)*

(*a*) Mention the ploidy of given structures.

(*b*) Explain the vegetative cell, its roles. What would happen if we destroy the vegetative cell by a laser?

(*c*) What percentage of angiosperms shed 2-celled pollen, and what occurs in others before release?

Ans. (*a*) Pollen mother cell - 2n

Microspore - n
Generative cell -n
Nucellus - 2n
Synergids - n
Antipodal cells - n *(½ × 6 = 3 M)*

(*b*) When the pollen grain is mature it contains two cells, the vegetative cell and generative cell. The vegetative cell is bigger and has abundant food reserves. If it is destroyed, formation of pollen tube and transport of male gametes towards embryo sac will be disrupted. *(1 M)*

(*c*) Approximately 60% of angiosperms release 2-celled pollen grains. In the remaining species, the generative cell undergoes mitosis, resulting in the 3-celled stage before pollen grains are shed, reflecting the diverse reproductive strategies for successful pollination. *(1 M)*

Key Takeaways

From this answer, students learn the ploidy levels of various reproductive structures in angiosperms.

Hints & Explanations

Multiple Choice Questions

1. (*b*) Pollen grains maintain viability for months in some members of the Leguminosae, Rosaceae and Solanaceae families.

2. (*b*) A-Antipodals; B-Egg apparatus

3. (*d*) From the outermost to the innermost, the layers of a microsporangium are as follows: epidermis, endothecium, middle layers and tapetum.

4. (*a*) Pollen mother cells, also known as microspore mother cells, are diploid cells derived from the sporogenous tissue (A) in the anther. They undergo meiotic divisions to form four haploid microspores, which then develop into pollen grains.

5. (*b*) Starting from the innermost part of the ovule, the correct sequence is the egg, which is located inside the embryo sac. The embryo sac is surrounded by the nucellus, and the outermost layers are the integuments.

Key Takeaways

After reading the answer, students learnt the precise anatomical structure of an ovule, starting from the innermost to outermost part.

6. (*c*) The tapetal cells become multinucleated due to the failure of cytokinesis, which is the division of the cell's cytoplasm.

7. (*a*) Chasmogamous flowers, with open blossoms, undergo either self-pollination (autogamy) or cross-pollination (geitonogamy or xenogamy). Cleistogamous flowers remain closed, promoting self-pollination due to proximity of anthers and stigma.

Mistakes 101: What not to do!

A common mistake is misinterpreting the terms "cleistogamous" and "chasmogamous." Students often confuse their breeding behaviors, leading to errors in selecting the correct option that describes their pollination characteristics accurately.

8. (*c*) The diagram illustrates megasporogenesis in angiosperms. Starting with a megaspore mother cell (MMC) which undergoes meiosis I and meiosis II, producing a megaspore dyad and then a tetrad. One megaspore develops into a functional megaspore through mitotic divisions, it develops into a female gametophyte or embryo sac.

Mistakes 101: What not to do!

Students might confuse the process of meiosis with mitosis, leading to incorrect identification of the divisions.

9. (*a*) The generative cell in the pollen grain is haploid, meaning it has a single set of chromosomes (n). This cell divides mitotically to form two haploid male gametes.

10. (*a*) *Papaver* (P) exhibits a multicarpellary, syncarpous pistil, where multiple carpels are fused together to form a single ovary. In contrast, *Michelia* (Q) features an apocarpous gynoecium, with separate, unfused carpels.

11. (*c*) Autogamy (self-pollination) and geitonogamy (pollination within the same plant) do not promote genetic variation, whereas xenogamy (cross-pollination) does.

Assertion and Reason

1. (*c*) Pollen-pistil compatibility chemicals play a role in the germination of the pollen tube, but they do not dissolve the sporopollenin in the pollen exine. Instead, the pollen tube growth is facilitated by the compatible interaction between the pollen and the pistil.

2. (*c*) Microsporangia are indeed situated at the corners of the anther in flowering plants. The length of the stamen, which holds the anther, is primarily determined by genetic factors and not by the number of microsporangia within the anther.

3. (*b*) Microsporangium generally is surrounded by four wall layers; the innermost layer is tapetum. It is single layered and it provides nourishment to the developing pollen grains. It is typically a multinucleated or polypoid.

4. (*b*) The chalaza is located opposite the micropyle in an ovule. It is a distinct region at the basal end of the ovule. Integuments encircle the nucellus except at the tip where a small opening is present called micropyle.

5. (*d*) The ploidy of the megaspore mother cell (MMC) is diploid (2n), and it undergoes meiotic divisions to produce 4 haploid megaspores.

6. (*a*) Pollen grains are effectively preserved as fossils due to their exine, the outer wall, which consists of sporopollenin—a highly durable organic substance. This material resists degradation from high temperatures, strong acids, and alkalis, and no known enzyme can break it down.

7. (*c*) Maize has unisexual flowers on the same plant (monoecious), which prevents self-pollination i.e., autogamy but not geitonogamy.

8. (*a*) Introduction of mutations in the gene of tapetum cells can affect pollen viability since the tapetum layer is crucial for providing nutrients necessary for pollen development, directly impacting pollen grain health and functionality.

9. (*d*) Corn cobs do not have multiple ovules in each ovary; they typically have a single ovule per ovary.

10. (*a*) *Amorphophallus* flowers and insects engage in a mutually beneficial relationship. The flower provides a safe place for insects to lay their eggs, while the insects assist in pollination by transferring pollen between flowers. This arrangement ensures the survival and reproduction of both species.

MOCK TEST-2

Time allowed: 3 hours | Maximum Marks: 70

General Instructions:

Read the following instructions carefully and strictly follow them:

*(i) The question paper has **five** sections and **33** questions. **All** questions are **compulsory**.*

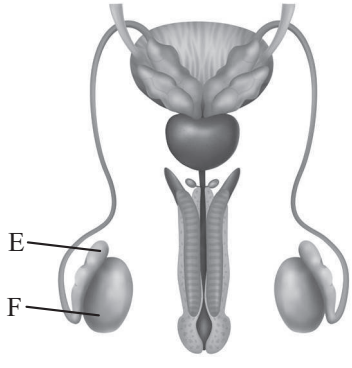
*(ii) **Section–A** has **16** questions of **1** mark each; **Section–B** has **5** questions of **2** marks each; **Section–C** has 7 questions of **3** marks each; **Section–D** has **2** case-based questions of **4** marks each; and **Section–E** has **3** questions of **5** marks each.*

*(iii) There is no overall choice. However, internal choices have been provided in some questions. A student has to attempt only **one** of the alternatives in such questions.*

SECTION - A

*Questions no. **1** to **16** are Multiple Choice **(MCQ)** type Questions, carrying **1** mark each.* ***16 × 1 = 16***

1. Which of the following correctly matches the structures labeled E and F with their functions?



(*a*) E - Epididymis: Site where sperms matures; F - Testes: Site where spermatogenesis occurs.

(*b*) E - Epididymis: Site for storage of sperm; F - Vas deferens: Transport sperms from testicles to urethra.

(*c*) E - Seminiferous tubules: Network of tubules responsible for temperature regulation; F - Rete testis: Site for initial sperm maturation.

(*d*) E - Rete testis: Network of tubules responsible for sperm storage; F - Seminiferous tubules: Main site of sperm production.

2. A gene showing codominance has

(*a*) One allele dominant on the other

(*b*) Alleles tightly linked on the same chromosome

(*c*) Alleles that are recessive to each other

(*d*) Both alleles independently expressed in the heterozygote

3. Select the correct statement about diseases and immunisation.

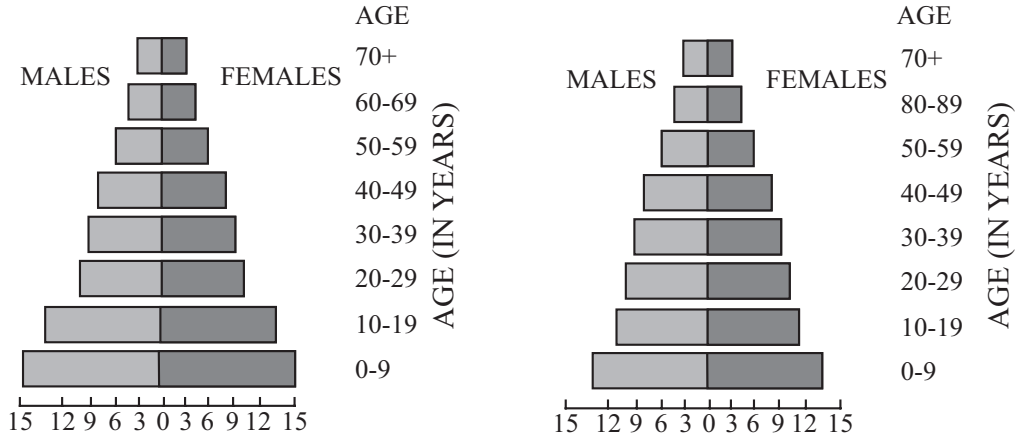
(*a*) If due to some reason B and T-lymphocytes are damaged, the body will not produce antibodies against pathogens.

(*b*) Injection of dead/inactivated pathogens causes passive immunity.

(*c*) Certain protozoans have been used in mass production of hepatitis-B vaccine

(*d*) Injection of snake antivenom against snakebites is an example of active immunisation.

4. Given two population pyramids A and B from two different periods of the same country:
Pyramid A: Displays a broad base, indicating a significant young population, and narrows as age increases. Pyramid B: Shows a more uniform distribution across most age groups.



Which of the following statements is true?

(*a*) Pyramid A represents a period where the country experienced a youth bulge, while Pyramid B suggests a period of more balanced age distribution due to lower birth rates.

(*b*) Pyramid B represents a recent phase where the country had a surge in birth rates, while Pyramid A shows an earlier period with more elderly people.

(*c*) Both pyramids represent periods with similar population dynamics, showing no significant change in birth and death rates.

(*d*) Pyramid A signifies an era with reduced fertility rates, while Pyramid B indicates an era with a rapidly aging population.

5. Which of the following water samples in the table given below, will have a higher concentration of organic matter?

Water Sample	Level of pollution	Value of BOD
(a)	High	High
(b)	Low	Low
(c)	Low	High
(d)	High	Low

6. The enzyme used in the polymerase chain reaction is a:

(*a*) DNA dependent RNA polymerase (*b*) RNA dependent DNA polymerase

(*c*) DNA dependent DNA polymerase (*d*) RNA dependent RNA polymerase

7. David Tilman's long-term ecosystem experiments using outdoor plots showed that

(*a*) Increased diversity contributed to lower productivity (*b*) Increased diversity contributed to higher productivity

(*c*) Increased diversity has no impact on productivity (*d*) Increased diversity has unpredictable impact on productivity

8. Which of the following are haploid, diploid and triploid structures in a fertilized embryo sac?

(*a*) Synergid, zygote and primary endosperm nucleus

(*b*) Synergid, polar nuclei and zygote

(*c*) Antipodal, synergid and primary endosperm nucleus

(*d*) Synergid, polar nuclei and zygote

9. Most foods derived from genetically modified crops contain

(*a*) The same number of genes as food produced from conventional crops

(*b*) The same number of genes as food produced from hybrid crops

(*c*) One or two additional genes

(*d*) Hundreds of additional genes

10. Which of the following statements is not correct?

(*a*) Pyramid of biomass in sea is generally upright (*b*) Pyramid of energy is always upright

(*c*) Pyramid of numbers in a grassland ecosystem is upright (*d*) Pyramid of biomass in sea is generally inverted

11. The immature male germ cell undergoes division to produce sperms by the process of spermatogenesis. Choose the correct one with reference to above.

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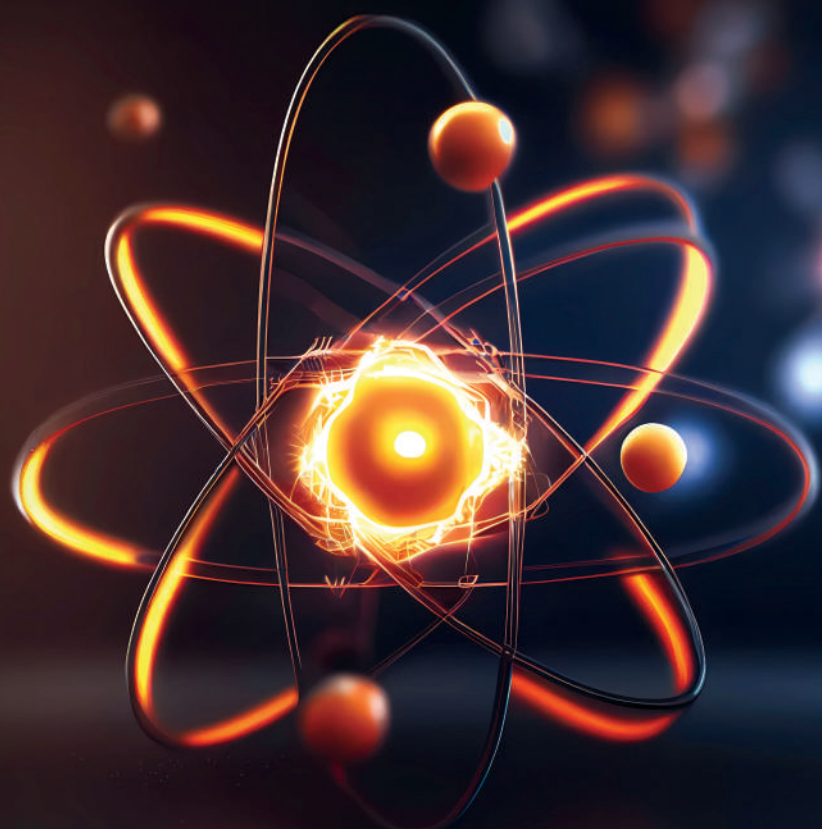

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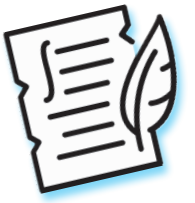

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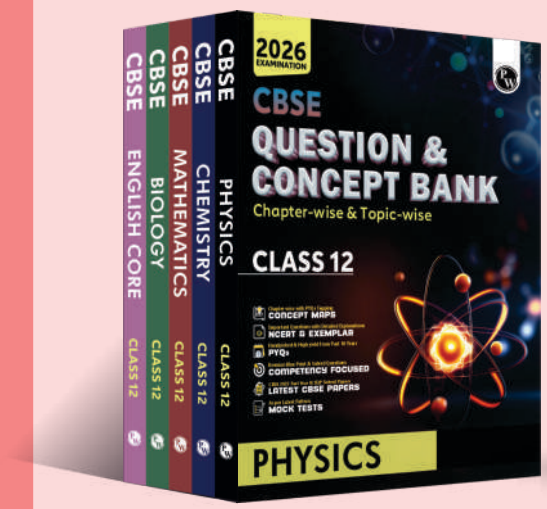

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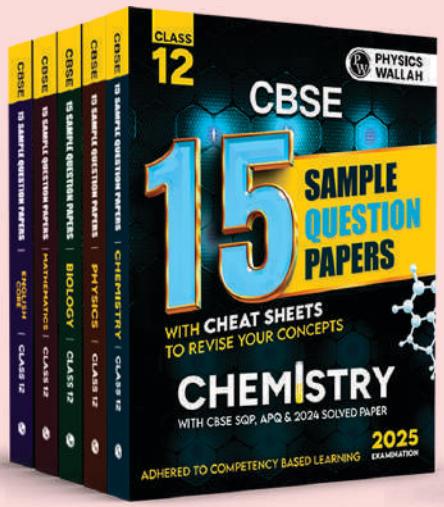

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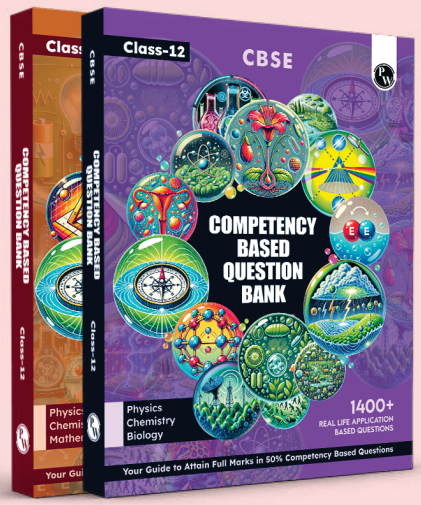

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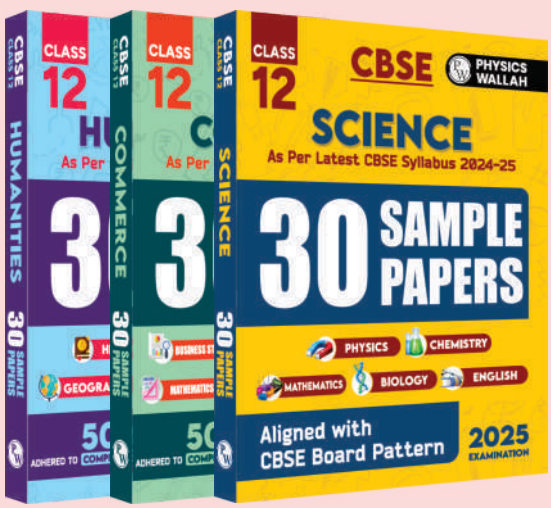

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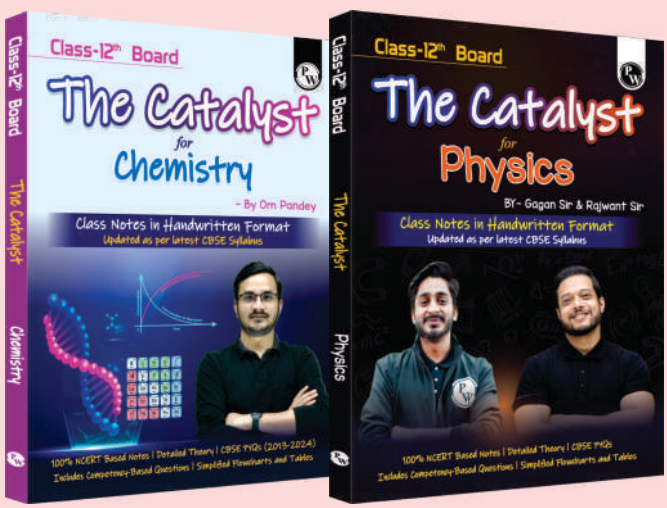

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