CUET PG 2024 Plant Biotechnology Question Paper with Solutions

Time Allowed : 1 Hour 45 Mins	**Maximum Marks :** 300	**Total Questions :** 75

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The examination duration is 105 minutes. Manage your time effectively to attempt all questions within this period.
2. The total marks for this examination are 300. Aim to maximize your score by strategically answering each question.
3. There are 75 mandatory questions to be attempted in the Plant Biotechnology paper. Ensure that all questions are answered.
4. Questions may appear in a shuffled order. Do not assume a fixed sequence and focus on each question as you proceed.
5. The marking of answers will be displayed as you answer. Use this feature to monitor your performance and adjust your strategy as needed.
6. You may mark questions for review and edit your answers later. Make sure to allocate time for reviewing marked questions before final submission.
7. Be aware of the detailed section and sub-section guidelines provided in the exam. Understanding these will aid in effectively navigating the exam.

1: Very often plants produce undifferentiated mass of cells at the site of wound which is known as

(A) Embryo
(B) Branch
(C) Callus
(D) Bud

Correct Answer: (A) Embryo

Solution:
An embryo represents the early developmental stage in both plants and animals, characterized by rapid cellular division, differentiation, and establishment of the foundational structures of the organism. In plants, the embryo develops within the seed, originating from the fertilized ovule after the fusion of male and female gametes. This process occurs during sexual reproduction and marks the beginning of a new generation in the plant's life cycle.
It is composed of several distinct parts, including the radicle (future root), hypocotyl (stem-like structure below the cotyledons), epicotyl (stem-like structure above the

cotyledons), and cotyledons (seed leaves). These structures are essential for the establishment of the seedling, as they enable the plant to germinate and grow by utilizing the stored nutrients within the seed. Beyond its role in reproduction, plant embryos can play a role in tissue regeneration and repair.

Quick Tip

Embryo represents the early stage of growth and regeneration in plants.

2: Root culture is used to produce

(A) Plantibodies
(B) Alkaloids
(C) Proteins
(D) Fruits

Correct Answer: (B) Alkaloids

Solution:
Root cultures specialize in producing secondary metabolites, like alkaloids. These compounds are commonly used in medicinal products due to their biochemical properties.For instance, alkaloids like morphine and codeine, derived from Papaver somniferum (opium poppy), are potent analgesics used to manage pain.
Root cultures, whether derived from whole plants or through techniques like hairy root induction via Agrobacterium rhizogenes, offer a stable and scalable system for producing these valuable compounds. These cultures can be optimized using biotechnological interventions, such as elicitors, nutrient modifications, or genetic engineering, to enhance the yield of specific alkaloids.

Quick Tip

Root cultures are natural factories for alkaloids, key in pharmaceutical uses.

3: Synthetic seeds are

(A) Somatic embryos encapsulated in matrix
(B) Callus encapsulated in matrix
(C) Root tip encapsulated in matrix
(D) Seeds encapsulated in matrix

Correct Answer: (A) Somatic embryos encapsulated in matrix

Solution:
Synthetic seeds are artificially created seed-like structures, encapsulating somatic embryos or other propagules in a protective gel matrix, typically sodium alginate. These seeds are enriched with nutrients, growth regulators, or antifungal agents to enhance viability and

germination. They offer advantages such as ease of handling, storage, and transportation, along with enabling mass propagation and preservation of valuable plant germplasm. Synthetic seeds are particularly useful for propagating elite genotypes, conserving endangered species, and supporting reforestation efforts. Despite challenges like low conversion rates and genetic stability, advancements in encapsulation and germination methods are improving their efficiency and applicability.

Quick Tip

Synthetic seeds = Somatic embryos + matrix. Used for easy propagation.

4: The procedures used to overcome darkening of explants include

(A) Adding antioxidants to culture medium
(B) Presoaking explants in antioxidants
(C) Adding ascorbic acid in the media
(D) Frequently transferring explants into fresh media

Correct Answer: (C) Adding ascorbic acid in the media

Solution:
Ascorbic acid, commonly known as vitamin C, is a potent antioxidant that plays a crucial role in plant tissue culture by mitigating oxidative stress. It scavenges reactive oxygen species (ROS) and free radicals, which can accumulate during the excision or handling of explants, preventing cellular damage. By reducing oxidative browning and phenolic accumulation, ascorbic acid maintains the viability and health of explants. Its addition to culture media enhances tissue regeneration, ensuring optimal growth and development. This property makes it an essential component in improving the success rates of in vitro plant propagation.

Quick Tip

Ascorbic acid acts as an antioxidant to prevent darkening of explants.

6: Cytokinins

(A) Are derivatives of adenines
(B) Are important for shoot induction
(C) Have property of cell elongation
(D) Usually promotes cell division if added together with auxin in culture

Choose the correct answer from the options given below:

(A) **(A), (B), and (C) only**
(B) **(A), (B), and (D) only**
(C) **(A), (C), and (D) only**
(D) **(B), (C), and (D) only**

Correct Answer: (B) (A), (B), and (D) only
Solution:
Cytokinins, derived from adenine, are key plant growth regulators that promote cell division and shoot formation, especially in the presence of auxins. They influence processes like chloroplast development, nutrient mobilization, and delay of senescence. Unlike auxins or gibberellins, cytokinins do not significantly contribute to cell elongation. Instead, their role is crucial in maintaining cellular proliferation and regulating shoot-to-root balance in tissue culture and plant development.

> Quick Tip
>
> Cytokinins = **Adenine derivatives** for **cell division and shoot induction**.

7: Match List-I with List-II

List-I	List-II
(A) Seed Culture	**(I)** Useful for obtaining genetic manipulation
(B) Anther Culture	**(II)** Generating plants of small seeds
(C) Endosperm Culture	**(III)** Development of seedless fruits
(D) Protoplast Culture	**(IV)** Haploid production

Choose the correct answer from the options given below:

(A) **(A) - (III), (B) - (IV), (C) - (I), (D) - (II)**
(B) **(A) - (I), (B) - (IV), (C) - (II), (D) - (III)**
(C) **(A) - (III), (B) - (IV), (C) - (II), (D) - (I)**
(D) **(A) - (I), (B) - (IV), (C) - (III), (D) - (II)**

Correct Answer: (A) (A) - (III), (B) - (IV), (C) - (I), (D) - (II)
Solution:
The correct match for plant tissue cultures is: - **(A)** Seed Culture: Development of seedless fruits (III).
- **(B)** Anther Culture: Haploid production (IV).
- **(C)** Endosperm Culture: Useful for obtaining genetic manipulation (I).
- **(D)** Protoplast Culture: Generating plants of small seeds (II).

> Quick Tip
>
> **Seed = Fruits**, **Anther = Haploid**, **Endosperm = Manipulation**, **Protoplast = Small seeds**.

8: Match List-I with List-II

List-I	List-II
(A) Cellulase	**(I)** Fungi
(B) Pectinase	**(II)** Bacteria
(C) Zymolyase	**(III)** Aspergillus spp.
(D) Macerase	**(IV)** Helix spp.

Choose the correct answer from the options given below:

(A) **(A) - (IV), (B) - (III), (C) - (II), (D) - (I)**
(B) **(A) - (I), (B) - (II), (C) - (III), (D) - (IV)**
(C) **(A) - (IV), (B) - (II), (C) - (III), (D) - (I)**
(D) **(A) - (I), (B) - (III), (C) - (IV), (D) - (II)**

Correct Answer: (D) (A) - (I), (B) - (III), (C) - (IV), (D) - (II)
Solution:
The correct match for enzymes and their sources is: - **(A)** Cellulase: Fungi (I).
- **(B)** Pectinase: Aspergillus spp. (III).
- **(C)** Zymolyase: Helix spp. (IV).
- **(D)** Macerase: Bacteria (II).

Quick Tip

Cellulase = Fungi, **Pectinase = Aspergillus spp.**, **Zymolyase = Helix spp.**, **Macerase = Bacteria**.

9: Match List-I with List-II

List-I (Crop)	List-II (Somaclonal variants obtained)
(A) Rice	**(I)** High carotene content
(B) Maize	**(II)** Grain color
(C) Carrot	**(III)** Glyphosate resistance
(D) Wheat	**(IV)** Glycine mutant

Choose the correct answer from the options given below:

(A) **(A)-(IV), (B)-(I), (C)-(III), (D)-(II)**
(B) **(A)-(III), (B)-(IV), (C)-(II), (D)-(I)**
(C) **(A)-(I), (B)-(II), (C)-(IV), (D)-(III)**
(D) **(A)-(I), (B)-(IV), (C)-(III), (D)-(II)**

Correct Answer: (B) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)

Solution:
The correct matches for the crops and their somaclonal variants are:

- **(A) Rice** – **(III)** Glyphosate resistance: Rice has been modified to develop resistance against herbicides.
- **(B) Maize** – **(IV)** Glycine mutant: Maize is genetically improved to include glycine-related mutations.
- **(C) Carrot** – **(II)** Grain color: Carrots are known for generating variants affecting visual traits like color.
- **(D) Wheat** – **(I)** High carotene content: Wheat is biofortified to enhance nutritional value like carotene levels.

Quick Tip

Match each crop with its most well-documented modification. For example: **Rice = Herbicide resistance**, **Maize = Amino acid modification**, **Carrot = Aesthetic traits**, **Wheat = Nutritional traits**.

10: Match List-I with List-II

List-I (Phases of plant cells in culture)	**List-II (Changes in growth pattern)**
(A) Lag phase **(B)** Exponential phase **(C)** Linear phase **(D)** Deceleration phase	**(I)** Rate of cell division and elongation decreases **(II)** Cells prepare to divide **(III)** Cell division slows but cell expansion increases **(IV)** Highest rate of cell division

Choose the correct answer from the options given below:

(A) **(A)-(III), (B)-(IV), (C)-(II), (D)-(I)**
(B) **(A)-(II), (B)-(IV), (C)-(I), (D)-(III)**
(C) **(A)-(III), (B)-(IV), (C)-(I), (D)-(II)**
(D) **(A)-(IV), (B)-(III), (C)-(II), (D)-(I)**

Correct Answer: (A) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)

Solution:
The correct matches for the phases of plant cells in culture are:

- **(A) Lag phase** – **(III)** Cells prepare to divide: This is the initial phase where cells adjust to the environment and prepare for division.
- **(B) Exponential phase** – **(IV)** Highest rate of cell division: Rapid growth and division occur in this phase.
- **(C) Linear phase** – **(II)** Cell division slows but cell expansion increases: Growth continues at a steady but slower pace.
- **(D) Deceleration phase** – **(I)** Rate of cell division and elongation decreases: Growth rate declines as nutrients become limiting.

Quick Tip

Each phase represents a distinct growth characteristic: **Lag = Preparation**, **Exponential = Rapid growth**, **Linear = Steady growth**, **Deceleration = Decline**.

11: Shoot tip culture is performed through the following steps:

(A) Shoot tip collection from the plant
(B) Axillary shoot proliferation

(C) Rooting of shoots
(D) Primary culture of tip

Choose the correct answer from the options given below:

(A) **(B), (D), (C), (A)**
(B) **(A), (C), (B), (D)**
(C) **(A), (D), (B), (C)**
(D) **(C), (B), (D), (A)**

Correct Answer: (C) (A), (D), (B), (C)

Solution:
Shoot tip culture follows these sequential steps:

- **(A)** Shoot tip collection from the plant: The initial step is collecting the shoot tip for culturing.
- **(D)** Primary culture of tip: The collected shoot tip is placed in a nutrient-rich medium for primary culture.
- **(B)** Axillary shoot proliferation: Shoots proliferate from the cultured tip.
- **(C)** Rooting of shoots: The proliferated shoots are transferred to rooting media to develop roots.

Quick Tip

The steps are logically ordered – **Collection** $\rightarrow$ **Primary culture** $\rightarrow$ **Proliferation** $\rightarrow$ **Rooting**.

12: Different steps for regeneration via organogenesis:

(A) Shoot formation
(B) Callus formation
(C) Initial explant
(D) Plantlet

Choose the correct answer from the options given below:

(A) **(A), (D), (C), (B)**
(B) **(D), (B), (A), (C)**
(C) **(B), (C), (A), (D)**
(D) **(C), (B), (A), (D)**

Correct Answer: (D) (C), (B), (A), (D)

Solution:
The correct sequence for regeneration via organogenesis is:

- **(C)** Initial explant: The starting material is taken from a plant.
- **(B)** Callus formation: Cells dedifferentiate and form an unorganized mass (callus).
- **(A)** Shoot formation: Shoots are induced from the callus.
- **(D)** Plantlet: Fully developed plantlets are obtained.

> Quick Tip
>
> The progression is **Explant → Callus → Shoot → Plantlet**.

13: Following steps are used in Bergmann cell plating technique:

(A) Passing cells through gauge
(B) Mixing cells with molten agar medium
(C) Plating cells in petridishes
(D) Cell suspension

Choose the correct answer from the options given below:

(A) **(D), (A), (B), and (C) only**
(B) **(A), (B), and (C) only**
(C) **(B), (D), and (A) only**
(D) **(C), (B), and (D) only**

Correct Answer: (A) (D), (A), (B), and (C) only

Solution:
The steps for Bergmann cell plating technique are as follows:

- **(D)** Cell suspension: Preparation of a suspension of cells.
- **(A)** Passing cells through gauge: Cells are passed through a fine gauge to ensure uniformity.
- **(B)** Mixing cells with molten agar medium: Uniform mixing of cells in a growth medium.
- **(C)** Plating cells in petridishes: The mixture is plated in petridishes for culture.

> Quick Tip
>
> Bergmann technique follows the order **Suspension → Filtration → Mixing → Plating**.

14: In vitro techniques to produce haploids are used to generate:

(A) **Heterozygous lines only**
(B) **Homozygous lines only**
(C) **Null lines only**
(D) **Mutant lines only**

Correct Answer: (B) Homozygous lines only

Solution:
Haploids are used to produce homozygous lines. This is because haploid plants contain a single set of chromosomes, and doubling them using techniques like colchicine results in completely homozygous lines, which are essential for plant breeding and genetics research.

> Quick Tip
>
> Haploids simplify the production of **homozygous lines** by chromosome doubling.

15: The chromosome number of a haploid plant can be doubled using:

(A) **Cytokinin only**
(B) **Auxin only**
(C) **Colchicine only**
(D) **Agar only**

Correct Answer: (C) Colchicine only

Solution:
Colchicine is used to double the chromosome number in haploid plants. It works by inhibiting spindle fiber formation during cell division, resulting in the duplication of chromosomes without cytokinesis, thereby producing a diploid plant from a haploid.

> Quick Tip
>
> Colchicine is widely used for chromosome doubling in plant breeding.

16: Different plant tissue culture methods used to produce haploids:

(A) **Embryo as well as root culture**
(B) **Microspore as well as shoot culture**
(C) **Anther as well as microspore culture**
(D) **Anther as well as meristem culture**

Correct Answer: (C) Anther as well as microspore culture

Solution:

Haploids are produced by culturing male gametophytic tissues, such as anthers or isolated microspores, under specific conditions that trigger embryogenesis or direct plantlet formation. These techniques bypass fertilization, resulting in plants with a single set of chromosomes. Haploids are invaluable in plant breeding, enabling rapid development of homozygous lines through chromosome doubling. This accelerates the creation of improved cultivars with desirable traits, making anther and microspore culture essential tools in modern agriculture.

Quick Tip

Haploid production methods primarily use **anther and microspore cultures**.

17: Development of haploid plants from male gametophytic tissue is known as:

(A) **Androgenesis**
(B) **Gynogenesis**
(C) **Organogenesis**
(D) **Morphogenesis**

Correct Answer: (A) Androgenesis

Solution:
Androgenesis involves the induction of haploid plant development directly from male gametophytic tissues, such as pollen grains or microspores, under in vitro conditions. This method bypasses the zygotic pathway, leading to haploid plants with a single set of chromosomes. By doubling their chromosomes, fully homozygous lines can be achieved in a single generation. Androgenesis is a crucial tool in plant breeding, expediting the development of uniform and improved crop varieties.

Quick Tip

Androgenesis = Male gametophytic tissue-derived haploid plants.

18: When anthers containing microspores at the middle to late uninucleate stage are cultured on solid media, they form:

(A) **Pollens**
(B) **Ovule**
(C) **Cybrids**
(D) **Callus**

Correct Answer: (D) Callus

Solution:
Culturing anthers with microspores on solid media often results in the formation of a callus, a mass of undifferentiated cells. This process involves dedifferentiation of microspores triggered

by stress or specific culture conditions. The callus can subsequently be induced to regenerate into haploid plants by manipulating growth regulators and environmental factors. This technique is widely used in plant breeding to develop homozygous lines quickly and efficiently.

Quick Tip

Anther culture → Callus formation → Haploid plant regeneration.

19: Microspores may give rise to the plants having:

(A) **One extra chromosome**
(B) **Half of the number of chromosomes**
(C) **Double of the number of chromosomes**
(D) **Triple of the number of chromosomes**

Correct Answer: (C) Double of the number of chromosomes

Solution:
Microspores naturally develop into haploid plants containing a single set of chromosomes, ideal for plant breeding. To achieve diploid plants, colchicine or other antimitotic agents are used to inhibit spindle formation during cell division, resulting in chromosome doubling. This process creates homozygous diploid plants in a single generation, bypassing the need for multiple breeding cycles. Such plants are essential for developing stable and improved crop varieties.

Quick Tip

Microspore → Haploid → Chromosome doubling → Diploid.

20: Problem of mixoploidy associated with anther culture was overcome by:

(A) **Microspore culture**
(B) **Ovule culture**
(C) **Root culture**
(D) **Shoot culture**

Correct Answer: (A) Microspore culture

Solution:
Mixoploidy, a condition where cells within a tissue have different ploidy levels, is a common issue in anther culture. Microspore culture helps to overcome this problem by isolating individual microspores and allowing them to develop into uniform haploid plants.

Quick Tip

Microspore culture is key to overcoming mixoploidy in anther culture.

21: Gynogenic embryogenesis can be developed by culturing-

(A) **Ovary and root**
(B) **Ovule and anther**
(C) **Microspore and ovary**
(D) **Ovary and ovule**

Correct Answer: (D) Ovary and ovule

Solution:
Gynogenic embryogenesis refers to the development of an embryo from female gametophytic tissues such as the ovary or ovule. This technique is widely used in breeding programs to produce haploids and analyze the maternal genome.

Quick Tip

Gynogenesis is based on ovary and ovule tissue cultures.

22: Chromosome elimination technique was established for the production of-

(A) **Polyploids**
(B) **Haploids**
(C) **Diploids**
(D) **Triploids**

Correct Answer: (B) Haploids

Solution:
Chromosome elimination techniques involve selectively removing chromosomes to produce haploid plants. This process is often used in hybridization and doubled haploid breeding programs to create homozygous lines rapidly.

Quick Tip

Chromosome elimination = Haploid production.

23: For the development of diploid plantlets, the order of tissue culture steps will be:

(A) **Development of haploid plantlet**

(B) **Collection of flowers**
(C) **Isolation and culture of anthers**
(D) **Colchicine treatment**

Correct Answer: (D), (A), (B), (C)

Solution:
The sequence of tissue culture steps for developing diploid plantlets is: 1. Colchicine treatment to double the chromosomes.
2. Development of haploid plantlets.
3. Collection of flowers to initiate anther culture.
4. Isolation and culture of anthers.

Quick Tip
Use **colchicine first** for chromosome doubling in haploid plantlets.

24: Different steps involved in the elimination of chromosomes in cereals through plant tissue culture:

(A) **Embryo culture**
(B) **Chromosome elimination**
(C) **Crossing**
(D) **Monoploid plant development**

Correct Answer: (C), (B), (D), (A)

Solution:
The process involves: 1. Crossing plants to create hybrids.
2. Chromosome elimination to create haploids.
3. Developing monoploid plants from haploids.
4. Embryo culture to regenerate plantlets.

Quick Tip
Cross → Eliminate → Monoploid → Culture.

25: Homozygous lines developed through the anther culture must be analyzed to check their ploidy status through-

(A) **The color of the flowers**
(B) **Counting of plastids in stomata**
(C) **Chromosome number**
(D) **Number of nucleoli**

Correct Answer: (C) Chromosome number

Solution:
Chromosome counting is the most reliable and precise method for determining the ploidy level of homozygous lines derived from anther culture. This technique involves directly counting the number of chromosomes in root tip cells, providing an accurate assessment of ploidy. In contrast, methods like plastid counting and nucleoli evaluation are indirect, offering less certainty in confirming ploidy status. Despite being less precise, these alternative methods can still provide useful preliminary insights into the ploidy of plant tissues.

Quick Tip

Chromosome number is the gold standard for ploidy analysis.

26: Match List I with List II

List I (In plant tissue culture)	List II (Related method/process/example)
(A) Ploidy level checking	**(III)** Plastid number in stomata
(B) Diploidization	**(IV)** Endomitosis
(C) Exclusive generation of male plants	**(II)** Haploid induction
(D) Gynogenic plants	**(I)** Morus indica

(A) **(A) - (II), (B) - (III), (C) - (IV), (D) - (I)**
(B) **(A) - (III), (B) - (IV), (C) - (II), (D) - (I)**
(C) **(A) - (IV), (B) - (III), (C) - (I), (D) - (II)**
(D) **(A) - (III), (B) - (I), (C) - (IV), (D) - (II)**

Correct Answer: (B) (A) - (III), (B) - (IV), (C) - (II), (D) - (I)

Solution:
- Ploidy levels are checked by counting plastids in stomata.
- Diploidization involves endomitosis for chromosome doubling.
- Haploid induction generates exclusive male plants.
- Gynogenic plants are linked to Morus indica as a model.

Quick Tip

Plastid (Ploidy), Endomitosis (Diploidization), Haploid (Male Plants), Morus indica (Gynogenesis).

27: Most commonly used chemical for protoplast fusion is:

(A) **PEG**
(B) **Mannitol**
(C) **FDA**
(D) **Ethylene**

Correct Answer: (A) PEG

Solution:
Polyethylene Glycol (PEG) is commonly used in protoplast fusion to enhance the process of membrane fusion by reducing electrostatic repulsion between the membranes of individual protoplasts. It works by facilitating the adhesion of the protoplast membranes, allowing them to merge and form hybrid cells. PEG is particularly useful in plant genetic engineering and somatic hybridization. This method enables the combination of genetic material from different plant species, creating novel genotypes with desirable traits.

> Quick Tip
>
> **PEG is the standard chemical for protoplast fusion.**

28: Protoplasts are:

(A) **Cells without peroxisome**
(B) **Cells without cell wall**
(C) **Cells without chloroplast**
(D) **Cells without chromoplast**

Correct Answer: (B) Cells without cell wall

Solution:
Protoplasts are isolated plant cells that have undergone enzymatic digestion to remove the cell wall, leaving the plasma membrane and internal organelles, such as the nucleus, mitochondria, and chloroplasts, intact. This process allows for direct manipulation of the cell's genetic material, facilitating experiments like gene transformation, somatic hybridization, and chromosome analysis. Protoplasts are crucial in plant biotechnology, enabling techniques like genome editing and regeneration of whole plants. Their versatility makes them an essential tool in plant research and breeding.

> Quick Tip
>
> **Protoplasts = Plant cells without cell wall.**

29: Plant cell protoplasts can be prepared by treating cells with:

(A) **Cellulase, hemicellulase, and pectinase**
(B) **Cellulase and pectinase only**
(C) **Pectinase only**
(D) **Cellulase and hemicellulase**

Correct Answer: (A) Cellulase, hemicellulase, and pectinase

Solution:

Protoplasts are isolated through enzymatic digestion of the plant cell wall using a combination of cellulase, hemicellulase, and pectinase. These enzymes specifically break down the major components of the cell wall: cellulose, hemicellulose, and pectin. The process results in the removal of the rigid cell wall, leaving behind the protoplast, which consists of the plasma membrane and internal organelles. This technique is essential for various applications in plant biotechnology, including genetic modification and somatic cell fusion.

> Quick Tip
>
> **A combination of enzymes is required for protoplast preparation.**

30: Fluorescein diacetate (FDA) stain is used for:

(A) **Mitochondrial apoptosis**
(B) **Chlorophyll content**
(C) **Nuclei staining**
(D) **Protoplast viability**

Correct Answer: (D) Protoplast viability

Solution:
FDA (fluorescein diacetate) stain is a fluorochrome used to assess the viability of protoplasts by detecting enzymatic activity and membrane integrity. When FDA enters viable cells, intracellular esterases cleave it into fluorescein, emitting green fluorescence under UV light. This fluorescence indicates that the cell's enzymes are active and the plasma membrane is intact, signifying cell viability. Non-viable cells, which lack membrane integrity, do not fluoresce, allowing for the identification of healthy protoplasts in culture.

> Quick Tip
>
> **FDA = Protoplast viability.**

31: Agar in plant tissue culture acts as

(A) **Solidifying agent**
(B) **Growth factor**
(C) **Diplodization enhancer**
(D) **Organogenesis enhancer**

Correct Answer: (A) Solidifying agent
Solution:
Agar is commonly used in plant tissue culture as a solidifying agent. It provides a stable surface for plant growth and nutrient uptake.

> Quick Tip
>
> **Agar = Solidifying agent in tissue culture**.

32: Following sequence is followed for the protoplast culture

(A) **Plant regeneration**
(B) **Treatment of cells with enzyme mixture**
(C) **Callus culture**
(D) **Leaf sterilization and removal of epidermis to expose mesophylls**

Correct Answer: (B) Treatment of cells with enzyme mixture
Solution:
Protoplast culture involves the isolation of protoplasts through enzymatic treatment of cells to remove cell walls, followed by culture under specific conditions.

Quick Tip

Sequence: **Treatment with enzymes → Protoplast culture**.

33: Different steps in the generation of somaclonal variation without in vitro selection

(A) **Explant selection**
(B) **Whole plant generation**
(C) **Callus formation**
(D) **Shoot generation**

Correct Answer: (B) Whole plant generation
Solution:
Somaclonal variation arises during callus formation and plant regeneration. It is a result of genetic or epigenetic changes occurring in vitro.

Quick Tip

Somaclonal variation = Variability during **plant generation**.

34: Following are the disadvantages of somaclonal variation

(A) **Novel variants may arise**
(B) **Variations are cultivar dependent**
(C) **Most of the variations are of no apparent use**
(D) **Variations are not always stable and heritable**

Correct Answer: (D) Variations are not always stable and heritable
Solution:
A key disadvantage of somaclonal variation is the instability and poor heritability of traits, which limits their practical application.

Quick Tip

Disadvantage: **Unstable and non-heritable traits**.

35: The somatic hybrids produced through protoplast fusion need authentication and purification due to low efficiency of fusion. This may be performed by the following complementations:

(A) **Alpha-complementation**
(B) **Chlorophyll deficiency complementation**
(C) **Auxotroph complementation**
(D) **Resistance marker complementation**

Correct Answer: (D) Resistance marker complementation
Solution:
Resistance markers are used to identify successful hybrid cells, ensuring authentication and selection in somatic hybridization.

Quick Tip

Use **resistance markers** for somatic hybrid screening.

36: Match List I with List II

List I (First species out of two used for intergeneric hybrid production through protoplast fusion)	**List II (Second species out of two used for intergeneric hybrid production through protoplast fusion)**
(A) *Solanum tuberosum*	**(I)** *Atropa belladonna*
(B) *Arabidopsis thaliana*	**(II)** *Echinochloa oryzicola*
(C) *Datura innoxia*	**(III)** *L. esculentum*
(D) *Oryza sativa*	**(IV)** *B. campestris*

(A) **(A) - (III), (B) - (IV), (C) - (I), (D) - (II)**
(B) **(A) - (IV), (B) - (III), (C) - (II), (D) - (I)**
(C) **(A) - (II), (B) - (IV), (C) - (III), (D) - (I)**
(D) **(A) - (III), (B) - (I), (C) - (IV), (D) - (II)**

Correct Answer: (A) (A) - (III), (B) - (IV), (C) - (I), (D) - (II)

Solution:
- *Solanum tuberosum* is paired with *L. esculentum.*
- *Arabidopsis thaliana* matches *B. compestris.*
- *Datura innoxia* links with *Atropa belladonna.*
- *Oryza sativa* is paired with *Echinochloa oryzicola.*

Quick Tip

Common intergeneric hybrids for tissue culture experiments for better retention.

37: Match List I with List II

List I (Somatic hybrids)	List II (Traits transferred via protoplast fusion)
(A) *Nicotiana tabacum*	**(I)** High nicotine content
(B) *Solanum spp.*	**(II)** Black rot resistance
(C) *Brassica spp.*	**(III)** Tobacco mosaic virus resistance
(D) *Nicotiana rustica*	**(IV)** Potato virus X resistance

(A) **(A) - (IV), (B) - (III), (C) - (II), (D) - (I)**
(B) **(A) - (II), (B) - (III), (C) - (I), (D) - (IV)**
(C) **(A) - (III), (B) - (IV), (C) - (I), (D) - (II)**
(D) **(A) - (I), (B) - (II), (C) - (III), (D) - (IV)**

Correct Answer: (C) (A) - (III), (B) - (IV), (C) - (I), (D) - (II)

Solution:
- *Nicotiana tabacum* contributes resistance to tobacco mosaic virus.
- *Solanum spp.* provides resistance to potato virus X.
- *Brassica spp.* exhibits black rot resistance.
- *Nicotiana rustica* transfers high nicotine content.

Quick Tip

The unique traits transferred through somatic hybrids for practical applications.

38: Match List I with List II

List I (Terms related to Plant tissue culture)	List II (Suitable explanation of the terms)
(A) Cybrids	**(I)** *In vitro* development of plants through tissue culture
(B) Somatic embryos	**(II)** Embryos produced from somatic cells
(C) Micropropagation	**(III)** Development of male plants from anther
(D) Androgenesis	**(IV)** Cytoplasmic sterile line is fused with another cell line mixing the cytoplasmic genome

(A) **(A) - (II), (B) - (III), (C) - (IV), (D) - (I)**
(B) **(A) - (IV), (B) - (I), (C) - (III), (D) - (II)**
(C) **(A) - (I), (B) - (II), (C) - (III), (D) - (IV)**
(D) **(A) - (III), (B) - (IV), (C) - (I), (D) - (II)**

Correct Answer: (B) (A) - (IV), (B) - (I), (C) - (III), (D) - (II)

Solution:
- Cybrids involve cytoplasmic genome mixing.
- Somatic embryos arise from somatic cells.
- Micropropagation is the *in vitro* development of plants.
- Androgenesis develops male plants from anther culture.

Quick Tip

Align key terminologies with their correct definitions for mastering tissue culture concepts.

39: Match List I with List II

List I (Plants)	List II (Somaclonal variants for herbicide resistance)
(A) *Nicotiana tabacum*	**(I)** Imidazolinone
(B) *Beta vulgaris*	**(II)** Chlorosulfuron
(C) *Glycine max*	**(III)** Glyphosate
(D) *Datura inoxia*	**(IV)** Imazethapyr

(A) **(A) - (III), (B) - (I), (C) - (IV), (D) - (II)**
(B) **(A) - (IV), (B) - (III), (C) - (II), (D) - (I)**
(C) **(A) - (III), (B) - (II), (C) - (IV), (D) - (I)**
(D) **(A) - (I), (B) - (IV), (C) - (III), (D) - (II)**

Correct Answer: (C) (A) - (III), (B) - (II), (C) - (IV), (D) - (I)

Solution:
- *Nicotiana tabacum* develops resistance to glyphosate.
- *Beta vulgaris* is resistant to chlorosulfuron.
- *Glycine max* shows resistance to imazethapyr.
- *Datura inoxia* is resistant to imidazolinone.

Quick Tip

Somaclonal variation helps in introducing herbicide resistance to improve crop survival.

40: Nitrobacter spp involved in nitrogen cycle converts

(A) **Nitrite to nitrate**
(B) **Nitrite to nitrogen**
(C) **Nitrate to nitrogen**
(D) **Nitrate to nitrogen dioxide**

Correct Answer: (A) Nitrite to nitrate

Solution:
- Nitrobacter spp. is a nitrifying bacterium responsible for oxidizing nitrite (NO_2^-) into nitrate (NO_3^-).
- This is a crucial step in the nitrogen cycle, enhancing soil fertility by making nitrogen available for plants.

Quick Tip

Nitrobacter converts nitrite to nitrate, while Nitrosomonas converts ammonia to nitrite.

41: Nitrification is a process of conversion of

(A) **Nitrates to ammonium**
(B) **Ammonium compounds to nitrites and nitrates**
(C) **Nitrogen to nitrites and nitrates**
(D) **Nitrites to ammonium**

Correct Answer: (B) Ammonium compounds to nitrites and nitrates

Solution:
- Nitrification is the biological oxidation of ammonium (NH_4^+) to nitrites (NO_2^-) and then to nitrates (NO_3^-) by nitrifying bacteria.
- This process is critical for converting ammonium into forms usable by plants.

Quick Tip

Nitrification converts ammonium (NH_4^+) to nitrites (NO_2^-) and nitrates (NO_3^-).

42: Free living bacteria having nitrogenase converts atmospheric nitrogen to

(A) **Ammonium**
(B) **Nitrates**
(C) **Nitrites**
(D) **Urea**

Correct Answer: (A) Ammonium

Solution:
- Free-living nitrogen-fixing bacteria (e.g., Azotobacter) possess nitrogenase, which reduces atmospheric nitrogen (N_2) to ammonium (NH_4^+).
- This process is known as biological nitrogen fixation and is vital for maintaining the nitrogen cycle.

Quick Tip

Nitrogenase reduces N_2 to NH_4^+ in free-living bacteria like Azotobacter.

43: *Nitrosomonas spp.* is useful for plants because it

(A) **Oxidises ammonia to ammonium salts**
(B) **Oxidises ammonia to nitrogen**
(C) **Oxidises ammonia to nitrites**
(D) **Reduces ammonia to nitrites**

Correct Answer: (C) Oxidises ammonia to nitrites

Solution:
- *Nitrosomonas spp.* is a nitrifying bacterium that oxidizes ammonia (NH_3) into nitrites (NO_2^-), an essential step in the nitrogen cycle.
- This helps in making nitrogen available to plants in usable forms.

Quick Tip

Nitrosomonas spp. **oxidizes ammonia to nitrites in the nitrification process.**

44: Leguminous plants have bacteria for

(A) **Nitrogen fixation**
(B) **Sulphate fixation**
(C) **Phosphate fixation**
(D) **Water conservation**

Correct Answer: (A) Nitrogen fixation

Solution:
- Leguminous plants form symbiotic relationships with nitrogen-fixing bacteria like *Rhizobium*.
- These bacteria convert atmospheric nitrogen (N_2) into ammonia (NH_3), which is further utilized by plants for growth.

Quick Tip

Legumes + *Rhizobium* = Nitrogen fixation for plant growth.

45: Denitrification is carried by

(A) ***Pseudomonas*** **and** ***Rhizobium***
(B) ***Pseudomonas*** **and** ***Thiobacillus***
(C) ***Pseudomonas*** **and** ***Nitrobacter***
(D) ***Nitrosomonas*** **and** ***Thiobacillus***

Correct Answer: (B) ***Pseudomonas*** **and** ***Thiobacillus***

Solution:

- Denitrification is the process of reducing nitrates (NO_3^-) back to nitrogen gas (N_2) or nitrous oxide (N_2O) by denitrifying bacteria like *Pseudomonas* and *Thiobacillus.*
- This process is crucial for completing the nitrogen cycle.

> Quick Tip
>
> **Denitrification = *Pseudomonas* and *Thiobacillus* reduce nitrates to nitrogen gas.**

46: Nodules for the purpose of nitrogen fixation in non-leguminous plants are induced by

(A) **Nitrosomonas**
(B) **Nitrobacter**
(C) **Rhizobium**
(D) **Frankia**

Correct Answer: (D) Frankia

Solution:
Frankia is an actinobacterium that induces nodulation in non-leguminous plants such as Alnus and Casuarina, facilitating nitrogen fixation. Unlike Rhizobium, which is specific to leguminous plants, Frankia forms nodules in these non-leguminous hosts.

> Quick Tip
>
> **Frankia nodulates non-leguminous plants; Rhizobium is for legumes.**

47: Biological nitrogen fixation is performed by

(A) **Azotobacter and Beijerinckia**
(B) **Nostoc and Anabaena**
(C) **Rhizobium, Rhodospirillum, and Frankia**
(D) **Nitrobacter and Pseudomonas**

Correct Answer: (A) Azotobacter and Beijerinckia

Solution:
Azotobacter and Beijerinckia are free-living nitrogen-fixing bacteria. They convert atmospheric nitrogen into ammonia, making it accessible for plant use. They play a critical role in nitrogen fixation in the soil, especially for non-leguminous crops.

> Quick Tip
>
> **Free-living nitrogen fixers include Azotobacter and Beijerinckia.**

48: Biological nitrogen fixation is performed by some

(A) **Symbiotic bacteria**
(B) **Free-living anaerobic bacteria**
(C) **Cyanobacteria**
(D) **Free-living aerobic bacteria**

(A) **(A), (B) and (D) only**
(B) **(A), (B) and (C) only**
(C) **(A), (B), (C) and (D)**
(D) **(B), (C) and (D) only**

Correct Answer: (C) (A), (B), (C) and (D)

Solution:
Biological nitrogen fixation is carried out by a variety of organisms, including: - **Symbiotic bacteria** like Rhizobium in legume root nodules. - **Free-living anaerobic bacteria** like Clostridium. - **Cyanobacteria** like Nostoc and Anabaena, which fix nitrogen in aquatic and terrestrial environments. - **Free-living aerobic bacteria** like Azotobacter in well-aerated soils.
These organisms utilize the enzyme nitrogenase to convert atmospheric nitrogen into ammonia, which can be assimilated by plants.

Quick Tip

All four categories: Symbiotic, Free-living Anaerobic, Cyanobacteria, and Free-living Aerobic.

49: Match List I with List II

List I (Host Plant)	**List II (N-fixing symbionts)**
(A) Sugarcane	**(I)** *Nostoc*
(B) Water fern	**(II)** *Azotobacter*
(C) *Casuarina*	**(III)** *Anabaena*
(D) *Gunnera*	**(IV)** *Frankia*

(A) **(A) - (II), (B) - (III), (C) - (IV), (D) - (I)**
(B) **(A) - (III), (B) - (IV), (C) - (II), (D) - (I)**
(C) **(A) - (IV), (B) - (III), (C) - (I), (D) - (II)**
(D) **(A) - (III), (B) - (II), (C) - (IV), (D) - (I)**

Correct Answer: (A) (A) - (II), (B) - (III), (C) - (IV), (D) - (I)

Solution:
- Sugarcane associates with *Azotobacter* for nitrogen fixation.
- Water fern forms symbiotic relationships with *Anabaena*.

- *Casuarina* associates with *Frankia*.
- *Gunnera* is associated with *Nostoc*.

Quick Tip
The symbiotic associations of host plants and nitrogen-fixing symbionts can improve agricultural practices.

50: Match List I with List II

List I (Plant)	List II (Free-living Plant Growth Promoting Bacteria)
(A) Soybean	**(I)** *Rhizobium leguminosarum*
(B) Alfalfa	**(II)** *Azorhizobium*
(C) Clover	**(III)** *Sinorhizobium meliloti*
(D) Sesbania	**(IV)** *Bradyrhizobium japonicum*

(A) **(A) - (II), (B) - (IV), (C) - (III), (D) - (I)**
(B) **(A) - (IV), (B) - (III), (C) - (I), (D) - (II)**
(C) **(A) - (III), (B) - (II), (C) - (IV), (D) - (I)**
(D) **(A) - (II), (B) - (I), (C) - (IV), (D) - (III)**

Correct Answer: (B) (A) - (IV), (B) - (III), (C) - (I), (D) - (II)

Solution:
- Soybean associates with *Bradyrhizobium japonicum*.
- Alfalfa is linked to *Sinorhizobium meliloti*.
- Clover forms symbiosis with *Rhizobium leguminosarum*.
- Sesbania is associated with *Azorhizobium*.

Quick Tip
The specific plant-bacteria associations to enhance understanding of nitrogen-fixing symbioses.

51: Nodulation process in plants occurs in different steps. Arrange the following in the correct sequence:

(A) **Plant cell differentiation**
(B) **Curling of the root hair**
(C) **Contact of Rhizobium with root hair**
(D) **Infection thread progression to cortex cells**

(A) **(D), (B), (C), (A)**
(B) **(A), (B), (C), (D)**
(C) **(B), (A), (D), (C)**
(D) **(C), (B), (D), (A)**

Correct Answer: (D) (C), (B), (D), (A)

Solution:
The nodulation process begins with: 1. Contact of *Rhizobium* with the root hair.
2. Curling of the root hair to facilitate bacterial entry.
3. Infection thread progression into the root cortex cells.
4. Finally, plant cell differentiation leads to nodule formation.

Quick Tip
The sequence: *Contact* $\rightarrow$ *Curling* $\rightarrow$ *Infection Thread* $\rightarrow$ *Differentiation.*

52: The systematic production of proteinase inhibitors in young tomato plants is triggered by a complex sequence of events. Arrange the following in the correct order:

(A) **Synthesis of systemin**
(B) **Synthesis of prosystemin on the wound site**
(C) **Activation of several genes including proteinase inhibitors**
(D) **Synthesis of jasmonic acid**

(A) **(A), (B), (C), (D)**
(B) **(B), (A), (C), (D)**
(C) **(B), (A), (D), (C)**
(D) **(C), (B), (D), (A)**

Correct Answer: (C) (B), (A), (D), (C)

Solution:
The correct sequence of events is as follows: 1. Synthesis of prosystemin at the wound site.
2. Synthesis of systemin.
3. Synthesis of jasmonic acid as a signal molecule.
4. Activation of several genes, including those encoding proteinase inhibitors.

Quick Tip
The sequence as *Prosystemin* $\rightarrow$ *Systemin* $\rightarrow$ *Jasmonic Acid* $\rightarrow$ *Gene Activation.*

53: The correct order of steps for developing a transgenic plant through plant tissue culture will be

(A) **Putative transgenic adult plant**
(B) **Regeneration on selection media**
(C) **Explant selection**
(D) **Addition of acetosyringone and Agrobacterium having transgene**

(A) **(C), (D), (B), (A)**
(B) **(A), (B), (C), (D)**
(C) **(B), (A), (D), (C)**
(D) **(C), (B), (D), (A)**

Correct Answer: (A) (C), (D), (B), (A)

Solution:
The correct sequence is as follows: 1. Explant selection as the initial step for plant tissue culture.
2. Addition of acetosyringone and Agrobacterium containing the transgene to infect the explant.
3. Regeneration on a selection media to ensure transgenic development.
4. Development of a putative transgenic adult plant as the final product.

Quick Tip
Use the sequence *Explant* → *Agrobacterium* → *Regeneration* → *Adult Plant.*

54: Which of the following molecule DOES NOT have an auxin-like activity?

(A) **1-Naphthalene Acetic Acid**
(B) **Benzyladenine**
(C) **2-methoxy-3,6-dichlorobenzoic acid**
(D) **2,4-Dichlorophenoxy Acetic Acid**

Correct Answer: (B) Benzyladenine

Solution:
- Auxins promote plant growth, primarily elongation of cells in stems. Examples include 1-Naphthalene Acetic Acid and 2,4-Dichlorophenoxy Acetic Acid.
- Benzyladenine is a cytokinin, not an auxin, as it promotes cell division rather than elongation.

Quick Tip
Cytokinins like Benzyladenine promote cell division, whereas auxins aid in elongation.

55: Which of the following tissue would be most suitable for raising virus-free plants?

(A) **Leaf mesophyll cells**
(B) **Immature embryos harvested from immature seeds**
(C) **Intercalary meristem**
(D) **Actively growing tissue from shoot tips**

Correct Answer: (D) Actively growing tissue from shoot tips

Solution:
- Shoot tips are actively dividing meristematic tissues, typically free from viral infections due to their high metabolic rate and lack of vascular connections to infected tissues.
- Immature embryos or leaf mesophyll cells are less reliable for virus elimination.

Quick Tip

Always choose shoot apical meristems for producing virus-free plants in tissue culture.

56: During the organogenesis from the callus, relatively high ratio of BAP to IAA, would be favoured for?

(A) **Maintaining the callus for a longer period of time**
(B) **Development of shoots from the callus**
(C) **Development of roots from the callus**
(D) **Rapid induction of roots**

Correct Answer: (B) Development of shoots from the callus

Solution:
A higher ratio of cytokinin (such as BAP) to auxin (IAA) promotes shoot development from callus tissue by stimulating cell division and bud formation. Conversely, a lower cytokinin to auxin ratio favors root induction, as auxins play a key role in root meristem development. This balance is crucial for controlling the direction of plant regeneration during tissue culture.

Quick Tip

Cytokinins like BAP encourage shoot formation, while auxins like IAA support root induction.

57: Which of the following is a carbohydrate, but CANNOT be used as carbon source for *in vitro* plant tissue culture?

(A) **Sucrose**
(B) **Maltose**
(C) ***Myo*-inositol**
(D) **Cellobiose**

Correct Answer: (C) *Myo*-inositol

Solution:
- While *myo*-inositol is a carbohydrate, it is not metabolized as a carbon source.
- Sucrose and maltose are commonly used as energy sources in plant tissue culture media.

Quick Tip

Myo-inositol is added as a vitamin, not a primary carbon source.

58: Match the following plant tissue culture media components in List I with their functions in List II.

List I	**List II**
(A) Gelrite	**(IV)** Media solidification agent
(B) 2,4-Dichlorophenoxyacetic acid	**(III)** Callus induction
(C) Polyvinylpyrrolidone	**(I)** Prevent oxidation of phenols
(D) Abscisic acid	**(II)** Stress hormone

(A) **(A) - (IV), (B) - (II), (C) - (I), (D) - (III)**
(B) **(A) - (III), (B) - (I), (C) - (II), (D) - (IV)**
(C) **(A) - (III), (B) - (IV), (C) - (II), (D) - (I)**
(D) **(A) - (IV), (B) - (III), (C) - (I), (D) - (II)**

Correct Answer: (D) (A) - (IV), (B) - (III), (C) - (I), (D) - (II)

Solution:
- Gelrite solidifies culture media.
- 2,4-D is an auxin used for callus induction.
- Polyvinylpyrrolidone prevents phenol oxidation in culture media.
- Abscisic acid acts as a stress hormone.

Quick Tip

Gelrite = Solidification, 2,4-D = Callus, PVP = Oxidation prevention, Abscisic acid = Stress.

59: In plant tissue culture, explants are dedifferentiated to form callus. Callus tissue can be regenerated into complete plantlets primarily by altering the concentration of:

(A) **Amino acids**
(B) **Vitamins and *myo*-inositol**
(C) **Sugars and vitamins**
(D) **Growth regulators**

Correct Answer: (D) Growth regulators

Solution:
Plantlet regeneration relies on a delicate balance between auxins and cytokinins, two key plant hormones. High auxin concentrations stimulate rooting by promoting cell division and elongation in the root meristem. On the other hand, higher levels of cytokinin encourage

shoot regeneration by stimulating cell differentiation and bud formation. The appropriate ratio of these hormones is crucial for optimal plant regeneration, ensuring both healthy root and shoot development during tissue culture processes.

> Quick Tip
>
> Balance of growth regulators like auxin and cytokinin is key for plant regeneration.

60: For *ex vitro* rooting, shoots are treated with .... and transplanted directly in the potting mix. Choose the correct option.

(A) **Benzylaminopurine**
(B) **Auxin**
(C) **Thidiazuron**
(D) **Abscisic acid**

Correct Answer: (B) Auxin

Solution:
Auxins such as Indole-3-butyric acid (IBA) or Naphthaleneacetic acid (NAA) are commonly used to promote root formation in plant shoots by stimulating cell division and elongation in the root meristem. These hormones are crucial in plant tissue culture for ensuring the successful development of roots on regenerated shoots. Rooting is essential for the establishment of plantlets in soil or potting mix, as it enables them to absorb water and nutrients. Successful rooting increases the survival rate of transplanted plants, ensuring healthy growth in their new environment.

> Quick Tip
>
> Auxin application is critical for successful rooting during *ex vitro* conditions.

61: Colchicine is used for the production of

(A) **Somaclones**
(B) **Hybrids**
(C) **Polyploids**
(D) **Gametoclones**

Correct Answer: (C) Polyploids

Solution:
- Colchicine is an alkaloid that disrupts spindle fiber formation during cell division, preventing chromosome segregation.
- This results in doubling of chromosome number, leading to the production of polyploid cells.

- Polyploids are commonly used in agriculture for creating larger and more robust plants.

Quick Tip
Colchicine is widely used in plant breeding to induce polyploidy and enhance genetic diversity.

62: Technique of anther culture was described for the first time by

(A) **Haberlandt**
(B) **Guha and Maheshwari**
(C) **Cocking and Bergmann**
(D) **Heinz and Takebe**

Correct Answer: (B) Guha and Maheshwari

Solution:
- Guha and Maheshwari developed the technique of anther culture in 1964.
- This method involves culturing anthers to produce haploid plants, which are valuable in genetic studies and plant breeding.
- It was a revolutionary step in plant tissue culture.

Quick Tip
Guha and Maheshwari for their pioneering work in haploid plant production through anther culture.

63: Which of the following tissue would be most suitable for the development of haploids from a male sterile plant?

(A) **Pollen grains**
(B) **Apical meristem**
(C) **Nucellus**
(D) **Ovule**

Correct Answer: (D) Ovule

Solution:
- Ovules are part of the female reproductive structure and can be used to develop haploids through gynogenesis.
- This process involves culturing unfertilized ovules or ovaries to generate haploid plants.
- It is a critical method for developing haploids from male sterile plants.

Quick Tip

Haploids from male sterile plants can be developed using unfertilized ovules through gynogenesis.

64: Which of the following statement is NOT TRUE for the haploid plants?

(A) **Double haploids produced from haploids are very useful for genome mapping.**
(B) **Haploid production is very useful to generate exclusively male plants.**
(C) **Haploid production is one of the quickest methods to achieve homozygosity.**
(D) **Haploids cannot be used for developing disease resistance varieties.**

Correct Answer: (D) Haploids cannot be used for developing disease resistance varieties.

Solution:
- Haploids are essential in breeding programs, especially for developing disease-resistant varieties.
- Double haploids, created by chromosome doubling, enable genome mapping and homozygosity.
- Statement (D) is incorrect as haploids are indeed used in creating disease-resistant plants.

Quick Tip

Haploids speed up plant breeding by reducing the time required to achieve homozygosity.

65: Following are the various stages of a diploid plant generation from anthers.

(A) **Homozygous diploid plants**
(B) **Explant preparation**
(C) **Differentiating callus**
(D) **Incubating anthers on culture media**
(E) **Colchicine treatment**
(F) **Haploid plantlets**

(A) **(A), (B), (D), (C), (E), (F)**
(B) **(B), (D), (C), (E), (F), (A)**
(C) **(B), (D), (E), (C), (F), (A)**
(D) **(E), (B), (D), (C), (F), (A)**

Correct Answer: (B) (B), (D), (C), (E), (F), (A)

Solution:
- Steps in diploid plant generation:
1. Explant preparation.

2. Incubating anthers on culture media.
3. Differentiation of callus.
4. Chromosome doubling using colchicine.
5. Haploid plantlets formed.
6. Formation of homozygous diploid plants.

Quick Tip

The sequence: Explant → Anther culture → Callus → Colchicine → Haploid → Diploid.

66: Frequency of albino production is high in?

(A) **Gynogenesis**
(B) **Androgenesis**
(C) **Somatic embryogenesis**
(D) **Micropropagation**

Correct Answer: (B) Androgenesis

Solution:
Albino plants are often produced during androgenesis due to disruptions in plastid segregation or mutations in the plastid genome. In androgenesis, the development of haploid plants from male gametophytic tissues can lead to irregular inheritance of plastids, resulting in non-functional chloroplasts. As a result, these plants lack chlorophyll and exhibit an albino phenotype. Such plants are typically non-viable unless treated to induce plastid or chromosomal restoration, highlighting the complexity of plastid inheritance in plant regeneration.

Quick Tip

Androgenesis can be a useful method for haploid production but requires optimized conditions to minimize albino offspring.

67: Choose the correct combination of statements from the given list

(A) **Haploid plants regenerated through the callus culture would always be exactly similar to the parent plant.**
(B) **Production of haploids is very useful for developing homozygous lines that can be used for breeding research.**
(C) **Time taken to produce homozygous lines through doubled haploids is same as for selfing/inbreeding.**
(D) **Haploids have been successfully coupled with the breeding programs in several crops.**

(A) **(B) and (D) only.**

(B) **(A) and (C) only.**
(C) **(B) and (C) only.**
(D) **(C) and (D) only.**

Correct Answer: (A) (B) and (D) only.

Solution:
- Haploid plants are critical for breeding as they expedite the development of homozygous lines.
- Haploids have been successfully integrated into breeding programs across various crops.

Quick Tip
Haploids shorten the breeding cycle, especially in crop improvement programs.

68: Match List I with List II

List I	**List II**
(A) Polyethylene glycol	**(III)** Somatic hybrids
(B) Homokaryons	**(II)** Cell wall degrading enzymes
(C) Doubled haploids	**(I)** Fusogen
(D) Macerozyme	**(IV)** Anther culture

(A) **(A) - (III), (B) - (IV), (C) - (II), (D) - (I)**
(B) **(A) - (IV), (B) - (I), (C) - (III), (D) - (II)**
(C) **(A) - (III), (B) - (I), (C) - (IV), (D) - (II)**
(D) **(A) - (I), (B) - (II), (C) - (III), (D) - (IV)**

Correct Answer: (D) (A) - (I), (B) - (II), (C) - (III), (D) - (IV)

Solution:
- Polyethylene glycol acts as a fusogen in somatic hybridization.
- Homokaryons require cell wall degrading enzymes for preparation.
- Doubled haploids are often used in anther culture for plant breeding.
- Macerozyme is used for somatic hybrid preparation.

Quick Tip
Matching components of tissue culture techniques simplifies understanding of their applications.

69: The first isolation of protoplasts by mechanical method was achieved by

(A) **Klercker**
(B) **Hanstein**

(C) **Cocking**
(D) **Melchers and Labib**

Correct Answer: (A) Klercker

Solution:
Klercker pioneered the mechanical isolation of protoplasts in the early 20th century, which was a significant breakthrough in plant biology. By developing methods to remove the cell wall, he enabled the study of plant cells at a deeper level, free from the rigid structure. This innovation laid the foundation for advancements in plant tissue culture, genetic engineering, and somatic hybridization. His work opened the door for manipulating plant cells, fostering new techniques in crop improvement and plant biotechnology.

Quick Tip
Protoplast isolation is crucial for genetic manipulation and somatic hybridization.

70: Water fern Azolla can be used as biofertilizer because

(A) **It has rhizobium in symbiotic association**
(B) **It has large quantity of humus**
(C) **It has symbiotic cyanobacteria**
(D) **It has mycorrhiza**

Correct Answer: (C) It has symbiotic cyanobacteria

Solution:
Azolla, a water fern, forms a symbiotic relationship with the cyanobacterium *Anabaena*, which is capable of fixing atmospheric nitrogen. The cyanobacteria convert nitrogen gas (N) into ammonia (NH), a bioavailable form of nitrogen that enriches the soil. This mutualistic association benefits both partners, as the fern provides a protected environment and nutrients for the cyanobacteria. Azolla is commonly used as a natural fertilizer in rice paddies and other agricultural systems, reducing the need for synthetic nitrogen fertilizers.

Quick Tip
Azolla is particularly effective in rice paddies, reducing the need for synthetic fertilizers.

71: How many ATPs are required to generate four molecules of NH_3 during symbiotic nitrogen fixation?

(A) **22**
(B) **16**
(C) **28**
(D) **32**

Correct Answer: (D) 32

Solution:
- For the fixation of nitrogen, 8 ATPs are consumed for each molecule of NH_3. Thus, for 4 molecules of NH_3, a total of $4 \times 8 = 32$ ATPs are required.

Quick Tip

ATP consumption for nitrogen fixation is proportional to the number of NH_3 molecules produced.

72: Which of the following element play a key role in the process of biological nitrogen fixation in legumes?

(A) **Zn**
(B) **Mn**
(C) **Zu**
(D) **Mo**

Correct Answer: (D) Mo

Solution:
Molybdenum (Mo) is an essential trace element that acts as a cofactor for the nitrogenase enzyme, which is crucial for nitrogen fixation in plants. It enables the enzyme to catalyze the conversion of atmospheric nitrogen (N) into ammonia (NH), a form usable by plants for growth. Without sufficient molybdenum, nitrogen fixation efficiency is reduced, leading to impaired plant development. Molybdenum also plays a role in other enzymatic processes, such as nitrate reduction, supporting overall plant nutrition.

Quick Tip

Mo is essential for nitrogenase activity in legumes.

73: Which of the following is a biological control method to control pests?

(A) **Companion planting**
(B) **Fumigation**
(C) **Pesticide applications**
(D) **Installing traps**

Correct Answer: (A) Companion planting

Solution:
Companion planting is an agricultural practice where specific plants are grown together to enhance each other's growth, repel pests, and reduce the need for chemical pesticides. Certain plant combinations work synergistically, with some plants emitting natural compounds that deter harmful insects or attract beneficial predators. For example, planting marigolds with tomatoes can help repel nematodes, while basil near tomatoes can deter aphids. This natural pest control method promotes biodiversity and sustainability in gardening and farming.

> Quick Tip
>
> Companion planting is an eco-friendly pest control method.

74: Which of the following organism can be used as a biocontrol agent in the treatment of plant diseases?

(A) **Chlorella**
(B) **Anabaena**
(C) **Lactobacillus**
(D) **Trichoderma**

Correct Answer: (D) Trichoderma

Solution:
Trichoderma species are widely recognized for their biocontrol properties, as they effectively suppress a broad range of plant pathogens. These fungi compete for nutrients and space, produce antimicrobial metabolites, and can induce plant resistance to disease. Trichoderma species also promote plant growth by enhancing nutrient uptake and stimulating root development. As biocontrol agents, they offer an eco-friendly alternative to chemical pesticides, improving sustainable agricultural practices.

> Quick Tip
>
> Trichoderma is effective against fungal pathogens.

75: Nitrogen fixation by *Rhizobium* in nodule requires-

(A) **Aerobic environment**
(B) **Anaerobic environment**
(C) **Facultative aerobic environment**
(D) **Facultative anaerobic environment**

Correct Answer: (B) Anaerobic environment

Solution:
The nitrogenase enzyme, responsible for converting atmospheric nitrogen (N) into ammonia (NH) during nitrogen fixation, operates optimally in an anaerobic environment. Oxygen inhibits its activity by binding to the enzyme, preventing the reduction of nitrogen. To protect nitrogenase from oxygen damage, nitrogen-fixing organisms, such as certain bacteria and plants, often create specialized microenvironments, like the root nodules in legumes. These adaptations ensure efficient nitrogen fixation, essential for plant growth and soil fertility.

Quick Tip

Anaerobic conditions are maintained in nodules by leghemoglobin.
