CUET PG 2024 Plant Biotechnology Shift 2

Time Allowed :1 Hours 45 minutes	**Maximum Marks :**300	**Total Questions :**75

General Instructions

Read the following instructions very carefully and strictly follow them:

1. This question paper comprises 75 questions. All questions are compulsory.
2. Each question carries 04 (four) marks.
3. For each correct response, the candidate will get 04 (four) marks.
4. For each incorrect response, 01 (one) mark will be deducted from the total score.
5. Un-answered/un-attempted response will be given no marks.
6. To answer a question, the candidate needs to choose one option as the correct option.
7. However, after the process of challenges of the Answer Key, in case there are multiple correct options or a change in the key, only those candidates who have attempted it correctly as per the revised Final Answer Key will be awarded marks.
8. In case a question is dropped due to some technical error, full marks shall be given to all the candidates irrespective of the fact who have attempted it or not.

Question 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 is an early stage of development in plants and animals. In plants, it develops from a fertilized ovule and plays a role in regeneration and repair at the wound site.

Quick Tip

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

Question 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.

Quick Tip

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

Question 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 made by encapsulating somatic embryos in a protective matrix, ensuring preservation and ease of handling for propagation purposes.

Quick Tip

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

Question 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 helps reduce oxidative damage by scavenging free radicals, preventing darkening of explants during tissue culture.

Quick Tip

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

Question 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 are derivatives of adenine and are known to promote shoot induction and cell division when combined with auxin. They do not directly aid in cell elongation, which is primarily attributed to auxins and gibberellins.

Quick Tip

Remember: Cytokinins = **Adenine derivatives** for **cell division and shoot induction**.

Question 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

Remember: **Seed = Fruits**, **Anther = Haploid**, **Endosperm = Manipulation**, **Protoplast = Small seeds**.

Question 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

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

Question 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

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

Question 10: Match List-I with List-II

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

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

Question 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

Remember: The steps are logically ordered – **Collection → Primary culture → Proliferation → Rooting**.

Question 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

Remember: The progression is **Explant** → **Callus** → **Shoot** → **Plantlet**.

Question 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

Remember: Bergmann technique follows the order **Suspension** → **Filtration** → **Mixing** → **Plating**.

Question 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

Remember: Haploids simplify the production of **homozygous lines** by chromosome doubling.

Question 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

Remember: Colchicine is widely used for chromosome doubling in plant breeding.

Question 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 using anther culture and microspore culture, as these techniques involve male gametophytic tissues that can be induced to develop into haploid plants. These methods are commonly used in plant breeding.

Quick Tip

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

Question 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 refers to the development of haploid plants from male gametophytic tissues such as pollen or microspores. It is a widely used technique in plant breeding to produce homozygous lines rapidly.

Quick Tip

Remember: **Androgenesis = Male gametophytic tissue-derived haploid plants.**

Question 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:
When anthers containing microspores are cultured on solid media, they often form a callus. This callus can be further induced to regenerate into haploid plants under appropriate conditions.

Quick Tip

Remember: **Anther culture → Callus formation → Haploid plant regeneration.**

Question 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 initially form haploid plants with a single set of chromosomes. When treated with colchicine or similar agents, chromosome doubling occurs, producing diploid plants with two sets of chromosomes.

Quick Tip

Remember: **Microspore → Haploid → Chromosome doubling → Diploid.**

Question 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

Remember: **Microspore culture is key to overcoming mixoploidy in anther culture.**

Question 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

Remember: **Gynogenesis is based on ovary and ovule tissue cultures.**

Question 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

Remember: **Chromosome elimination = Haploid production.**

Question 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

Remember: Use **colchicine first** for chromosome doubling in haploid plantlets.

Question 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

Remember: **Cross → Eliminate → Monoploid → Culture.**

Question 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 number is the most direct and accurate method to assess the ploidy status of homozygous lines developed via anther culture. Other methods like plastid counting and nucleoli evaluation are indirect.

Quick Tip

Remember: **Chromosome number is the gold standard for ploidy analysis.**

Question 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

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

Question 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 a widely used chemical in protoplast fusion to facilitate membrane adhesion and fusion by reducing repulsion between protoplast membranes.

Quick Tip

Remember: **PEG is the standard chemical for protoplast fusion.**

Question 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 plant cells from which the cell wall has been removed, leaving only the plasma membrane and cell organelles intact.

Quick Tip

Remember: **Protoplasts = Plant cells without cell wall.**

Question 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 by enzymatic digestion of the cell wall using cellulase, hemicellulase, and pectinase to break down cellulose, hemicellulose, and pectin components.

Quick Tip

Remember: **A combination of enzymes is required for protoplast preparation.**

Question 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 stain is a fluorochrome used to test the viability of protoplasts by indicating enzymatic activity and membrane integrity.

Quick Tip

Remember: **FDA = Protoplast viability.**

Question 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

Remember: **Agar = Solidifying agent in tissue culture**.

Question 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** $\rightarrow$ **Protoplast culture**.

Question 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

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

Question 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**.

Question 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

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

Question 36: Match List I with List II

List I (First species out of two used for inter-generic 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

Tip: Recall common intergeneric hybrids for tissue culture experiments for better retention.

Question 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

Tip: Understand the unique traits transferred through somatic hybrids for practical applications.

Question 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

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

Question 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

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

Question 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

Tip: Remember, Nitrobacter converts nitrite to nitrate, while Nitrosomonas converts ammonia to nitrite.

Question 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

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

Question 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

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

Question 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

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

Question 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

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

Question 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

Remember: **Denitrification = *Pseudomonas* and *Thiobacillus* reduce nitrates to nitrogen gas.**

Question 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

Remember: **Frankia nodulates non-leguminous plants; Rhizobium is for legumes.**

Question 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

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

Question 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

Quick Tip: **Remember all four categories: Symbiotic, Free-living Anaerobic, Cyanobacteria, and Free-living Aerobic.**

Question 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

Tip: Understanding the symbiotic associations of host plants and nitrogen-fixing symbionts can improve agricultural practices.

Question 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

Tip: Remember the specific plant-bacteria associations to enhance understanding of nitrogen-fixing symbioses.

Question 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

Tip: Remember the sequence: *Contact* $\rightarrow$ *Curling* $\rightarrow$ *Infection Thread* $\rightarrow$ *Differentiation*.

Question 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

Tip: Remember the sequence as *Prosystemin* $\rightarrow$ *Systemin* $\rightarrow$ *Jasmonic Acid* $\rightarrow$ *Gene Activation*.

Question 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

Tip: Use the sequence *Explant* $\rightarrow$ *Agrobacterium* $\rightarrow$ *Regeneration* $\rightarrow$ *Adult Plant*.

Question 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

Remember: Cytokinins like Benzyladenine promote cell division, whereas auxins aid in elongation.

Question 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

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

Question 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 (BAP) to auxin (IAA) promotes shoot development from the callus.
- Conversely, a lower ratio promotes root induction.

Quick Tip

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

Question 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

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

Question 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

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

Question 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 involves auxin and cytokinin balance.
- High auxin supports rooting, while higher cytokinin promotes shoot regeneration.

Quick Tip

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

Question 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 like IBA or NAA stimulate root formation in shoots.
- Rooting aids successful transplantation in the soil or potting mix.

Quick Tip

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

Question 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

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

Question 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

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

Question 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

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

Question 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

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

Question 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

Tip: Remember the sequence: Explant $\rightarrow$ Anther culture $\rightarrow$ Callus $\rightarrow$ Colchicine $\rightarrow$ Haploid $\rightarrow$ Diploid.

Question 66: Frequency of albino production is high in?

(A) **Gynogenesis**

(B) **Androgenesis**

(C) **Somatic embryogenesis**

(D) **Micropropagation**

Correct Answer: (B) Androgenesis

Solution:

Albino production is significantly higher during androgenesis due to improper plastid segregation or mutations in the plastid genome.

Quick Tip

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

Question 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

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

Question 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

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

Question 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, laying the groundwork for advances in tissue culture.

Quick Tip

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

Question 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 hosts symbiotic cyanobacteria (*Anabaena*), which fix atmospheric nitrogen, enriching the soil with bioavailable nitrogen.

Quick Tip

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

Question 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

Tip: Remember, ATP consumption for nitrogen fixation is proportional to the number of NH_3 molecules produced.

Question 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) acts as a cofactor for nitrogenase, the enzyme involved in nitrogen fixation.

Quick Tip

Tip: Mo is essential for nitrogenase activity in legumes.

Question 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 involves growing specific plants together to repel pests and control pest populations naturally.

Quick Tip

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

Question 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 used as biocontrol agents due to their ability to suppress plant pathogens.

Quick Tip

Tip: Trichoderma is effective against fungal pathogens.

Question 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:

- Nitrogenase enzyme requires an anaerobic environment to function effectively during nitrogen fixation.

Quick Tip

Tip: Anaerobic conditions are maintained in nodules by leghemoglobin.
