

# NEET UG 2023 E2 Botany Question Paper with Solutions

Time Allowed :3 Hours	Maximum Marks :720	Total Questions :200
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## General Instructions

Read the following instructions very carefully and strictly follow them:

1. The Answer Sheet is this Test Booklet. When you are directed to open the Test Booklet, take the Answer Sheet and fill in the particulars in ORIGINAL Copy carefully with blue/black ball pen only.
2. The test is of 3 hours 20 minutes duration and the Test Booklet contains 200 multiple-choice questions (four options with a single correct answer) from Physics, Chemistry, and Biology (Botany and Zoology). 50 questions in each subject are divided into two Sections (A and B) as per details given below:
3. (a) Section A shall consist of 35 (Thirty-five) questions in each subject (Question Nos. 1 to 35, 51 to 85, 101 to 135 and 151 to 185).
4. (b) Section B shall consist of 15 (Fifteen) questions in each subject (Question Nos. 36 to 50, 86 to 100, 136 to 150 and 186 to 200). In Section B, a candidate needs to attempt any 10 (Ten) questions out of 15 (Fifteen) in each subject.
5. Candidates are advised to read all 15 questions in each subject of Section B before they start attempting the question paper. In the event of a candidate attempting more than ten questions, the first ten questions answered by the candidate shall be evaluated.
6. Each question carries 4 marks. For each correct response, the candidate will get 4 marks. For each incorrect response, one mark will be deducted from the total scores. The maximum marks are 720.
7. Rough work is to be done in the space provided for this purpose in the Test Booklet only.
8. On completion of the test, the candidate must hand over the Answer Sheet (ORIGINAL and OFFICE Copy) to the Invigilator before leaving the Room/Hall. The candidates are allowed to take away this Test Booklet with them.
9. Use of Electronic/Manual Calculator is prohibited.

## Section - A

1. Given below are two statements :

**Statement I:** The forces generated by transpiration can lift a xylem-sized column of water over 130 meters height.

**Statement II:** Transpiration cools leaf surfaces sometimes 10 to 15 degrees, by evaporative cooling.

**In the light of the above statements, choose the most appropriate answer from the options given below :**

- (A) Both Statement I and Statement II are correct.
- (B) Both Statement I and Statement II are incorrect.
- (C) Statement I is correct but Statement II is incorrect.
- (D) Statement I is incorrect but Statement II is correct.

**Correct Answer:** (A) Both Statement I and Statement II are correct.

**Solution:**

**Step 1: Understanding the Question:**

The question asks us to evaluate two statements related to the process of transpiration in plants and determine their correctness.

**Step 3: Detailed Explanation:**

**Statement I:** This statement describes the transpiration pull theory (or cohesion-tension theory). The evaporation of water from leaves creates a negative pressure potential, or tension, in the xylem. This tension pulls the water column upwards from the roots. The cohesive forces between water molecules and adhesive forces between water and xylem walls allow this column to be maintained without breaking. This force is indeed powerful enough to lift water to the tops of the tallest trees, which can be over 100 meters (e.g., Giant Sequoias). Therefore, lifting water over 130 meters is plausible. This statement is correct.

**Statement II:** Transpiration is the process of water evaporating from plant surfaces, primarily the leaves. Evaporation is a cooling process because the water molecules with the highest kinetic energy (i.e., the hottest molecules) are the ones that escape as vapor, leaving the remaining water and the surface cooler. This evaporative cooling can lower the leaf temperature by 10 to 15 degrees Celsius compared to its surroundings, preventing heat damage from intense sunlight. This statement is also correct.

**Step 4: Final Answer:**

Since both Statement I and Statement II are factually correct statements about transpiration, the correct option is (A).

**Quick Tip**

Remember the three main roles of transpiration: (1) creating transpiration pull for water absorption and transport, (2) transporting minerals from the soil, and (3) cooling the leaf surface. Both statements here refer to key aspects of these roles.

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**2. In gene gun method used to introduce alien DNA into host cells, microparticles of \_\_\_\_\_ metal are used.**

- (A) Copper
- (B) Zinc
- (C) Tungsten or gold
- (D) Silver

**Correct Answer:** (C) Tungsten or gold

**Solution:**

**Step 1: Understanding the Question:**

The question asks about the type of metal microparticles used in the gene gun (or biolistic) method for genetic transformation.

**Step 3: Detailed Explanation:**

The gene gun method is a physical method of introducing DNA into cells. In this technique, the DNA of interest is coated onto microscopic particles. These particles are then accelerated to a high velocity and shot into the target cells or tissues.

The microparticles must be dense enough to penetrate the cell walls and membranes and chemically inert so they do not react with the DNA or harm the cell.

Gold (Au) and Tungsten (W) are heavy, dense, and biologically inert metals, making them ideal for this purpose. They are used as microscopic pellets or "bullets" to carry the foreign DNA into the host cells.

**Step 4: Final Answer:**

Therefore, the correct metals used are Tungsten or gold.

**Quick Tip**

Associate "gene gun" or "biolistics" with heavy, inert metals. Gold and tungsten are the standard choices because they provide the necessary momentum and are non-reactive.

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**3. Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R :**

**Assertion A:** The first stage of gametophyte in the life cycle of moss is protonema stage.

**Reason R:** Protonema develops directly from spores produced in capsule.

**In the light of the above statements, choose the most appropriate answer from the options given below :**

- (A) Both A and R are correct and R is the correct explanation of A.
- (B) Both A and R are correct but R is NOT the correct explanation of A.
- (C) A is correct but R is not correct.

(D) A is not correct but R is correct.

**Correct Answer:** (A) Both A and R are correct and R is the correct explanation of A.

**Solution:**

**Step 1: Understanding the Question:**

This question requires us to analyze the relationship between an Assertion and a Reason concerning the life cycle of mosses (a type of bryophyte).

**Step 3: Detailed Explanation:**

**Assertion A:** In the life cycle of a moss, the dominant phase is the gametophyte. This phase begins with the germination of a haploid spore. The spore does not directly develop into the leafy moss plant but first forms a filamentous, creeping, green, branched structure called the protonema. This is the juvenile or first stage of the gametophyte. Thus, Assertion A is correct.

**Reason R:** The protonema stage originates from the germination of a haploid spore. These spores are produced within the capsule of the sporophyte stage through meiosis. So, the protonema develops directly from a spore. Thus, Reason R is correct.

**Connecting A and R:** The reason R (that the protonema develops from a spore) correctly explains why the protonema (Assertion A) is the first stage of the gametophyte. The life cycle sequence is Spore  $\rightarrow$  Protonema  $\rightarrow$  Leafy gametophyte. Therefore, R is the correct explanation for A.

**Step 4: Final Answer:**

Both Assertion A and Reason R are correct, and Reason R correctly explains Assertion A.

#### Quick Tip

Remember the life cycle stages of mosses. Unlike higher plants, the gametophyte is the dominant phase and it has two distinct stages: the initial protonema and the subsequent leafy stage.

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**4. Unequivocal proof that DNA is the genetic material was first proposed by**

- (A) Frederick Griffith
- (B) Alfred Hershey and Martha Chase
- (C) Avery, Macleoid and McCarthy
- (D) Wilkins and Franklin

**Correct Answer:** (B) Alfred Hershey and Martha Chase

## Solution:

### Step 1: Understanding the Question:

The question asks to identify the scientists who provided the definitive or "unequivocal" proof that DNA, and not protein, is the genetic material.

### Step 3: Detailed Explanation:

- **Frederick Griffith (1928):** His experiment on *Streptococcus pneumoniae* demonstrated the "transforming principle," showing that genetic material could be transferred between bacteria, but he did not identify what this material was.
- **Avery, Macleod, and McCarty (1944):** They conducted biochemical experiments to identify Griffith's transforming principle. Their results strongly suggested that DNA was the genetic material, but many scientists were still skeptical, favoring protein.
- **Alfred Hershey and Martha Chase (1952):** Their "blender experiment" provided the conclusive evidence. They used bacteriophages (viruses that infect bacteria) and labeled the viral protein with radioactive sulfur ( $^{35}\text{S}$ ) and the viral DNA with radioactive phosphorus ( $^{32}\text{P}$ ). They found that only the  $^{32}\text{P}$  (DNA) entered the bacterial cells to direct the synthesis of new viruses. This was considered the unequivocal proof that DNA is the genetic material.
- **Wilkins and Franklin:** Their work involved X-ray diffraction of DNA, which was crucial for Watson and Crick to determine the double-helix structure of DNA, but it didn't prove its function as the genetic material.

### Step 4: Final Answer:

The experiment by Hershey and Chase provided the definitive proof, making option (B) the correct answer.

#### Quick Tip

To distinguish these experiments, remember the keywords: Griffith → Transformation. Avery, Macleod, McCarty → Biochemical identification. Hershey and Chase → Unequivocal proof using radioactive bacteriophages.

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5. The thickness of ozone in a column of air in the atmosphere is measured in terms of :

- (A) Dobson units
- (B) Decibels
- (C) Decameter
- (D) Kilobase

**Correct Answer:** (A) Dobson units

**Solution:**

**Step 1: Understanding the Question:**

The question asks for the standard unit of measurement for the thickness of the atmospheric ozone layer.

**Step 3: Detailed Explanation:**

- **Dobson Unit (DU):** This is the standard unit used to measure the total amount of ozone in a vertical column of air from the ground to the top of the atmosphere. One Dobson Unit is the number of ozone molecules required to create a layer of pure ozone 0.01 millimeters thick at a temperature of 0 degrees Celsius and a pressure of 1 atmosphere.
- **Decibels (dB):** This is a logarithmic unit used to measure the intensity of sound.
- **Decameter (dam):** This is a unit of length equal to 10 meters.
- **Kilobase (kb):** This is a unit of length in molecular biology, equal to 1000 base pairs of DNA or RNA.

**Step 4: Final Answer:**

The correct unit for measuring ozone thickness is the Dobson unit.

#### Quick Tip

Associate specific units with their measurements: Ozone layer → Dobson Units (DU), Sound → Decibels (dB), DNA/RNA length → base pairs (bp) or kilobases (kb).

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**6. In tissue culture experiments, leaf mesophyll cells are put in a culture medium to form callus. This phenomenon may be called as:**

- (A) Differentiation
- (B) Dedifferentiation
- (C) Development
- (D) Senescence

**Correct Answer:** (B) Dedifferentiation

**Solution:**

**Step 1: Understanding the Question:**

The question describes a process in plant tissue culture where specialized (differentiated) cells like leaf mesophyll are induced to form an unspecialized mass of cells (callus). We need to

identify the correct term for this process.

### Step 3: Detailed Explanation:

- **Differentiation:** The process by which cells become specialized in structure and function (e.g., a meristematic cell becoming a mesophyll cell).
- **Dedifferentiation:** The process by which mature, differentiated cells revert to a meristematic, undifferentiated state and regain the capacity for cell division. This is exactly what happens when leaf mesophyll cells form a callus.
- **Redifferentiation:** The process where dedifferentiated cells (like callus cells) differentiate again to form new specialized cells, tissues, or organs.
- **Development:** The overall sum of processes (growth and differentiation) in an organism's life history.
- **Senescence:** The process of aging in living organisms.

### Step 4: Final Answer:

The formation of callus from differentiated leaf mesophyll cells is a classic example of dedifferentiation.

#### Quick Tip

Remember the sequence in plant tissue culture: Differentiated explant  $\xrightarrow{\text{Dedifferentiation}}$  Undifferentiated callus  $\xrightarrow{\text{Redifferentiation}}$  Differentiated plantlet.

### 7. Large, colourful, fragrant flowers with nectar are seen in :

- (A) insect pollinated plants
- (B) bird pollinated plants
- (C) bat pollinated plants
- (D) wind pollinated plants

**Correct Answer:** (A) insect pollinated plants

**Solution:**

#### Step 1: Understanding the Question:

The question provides a set of floral characteristics (large, colourful, fragrant, with nectar) and asks which type of pollination they are adapted for.

#### Step 3: Detailed Explanation:

These characteristics are adaptations to attract biotic pollinators. Let's analyze them for each option:

- **Insect pollinated plants (Entomophily):** Insects are attracted by visual cues (large, colourful petals) and olfactory cues (fragrance). They are rewarded with food (nectar). The combination of all these features strongly points to insect pollination.
- **Bird pollinated plants (Ornithophily):** Flowers are typically large and brightly coloured (often red or orange), produce copious amounts of nectar, but are usually odourless because birds have a poor sense of smell.
- **Bat pollinated plants (Chiropterophily):** Flowers are often large, dull-coloured (whitish or greenish), open at night, and have a strong, musty or fermented odour. They also produce abundant nectar.
- **Wind pollinated plants (Anemophily):** Flowers are typically small, inconspicuous, and lack colour, fragrance, and nectar as they do not need to attract pollinators. They produce large quantities of light, non-sticky pollen.

**Step 4: Final Answer:**

The combination of large size, bright colours, fragrance, and nectar is a classic suite of adaptations for attracting insects.

**Quick Tip**

Match the floral adaptations to the senses of the pollinator. Insects: sight (colour) and smell (fragrance). Birds: sight (bright colours), but poor smell. Wind: no need for attractants.

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**8. Frequency of recombination between gene pairs on same chromosome as a measure of the distance between genes to map their position on chromosome, was used for the first time by**

- (A) Thomas Hunt Morgan
- (B) Sutton and Boveri
- (C) Alfred Sturtevant
- (D) Henking

**Correct Answer:** (C) Alfred Sturtevant

**Solution:**

**Step 1: Understanding the Question:**

The question asks to identify the scientist who first utilized the concept of recombination frequency to create genetic maps.

**Step 3: Detailed Explanation:**

- **Thomas Hunt Morgan:** He performed pioneering work with *Drosophila melanogaster* that established the concepts of linkage (genes on the same chromosome tend to be inherited together) and recombination (crossing over can break linkages). His work laid the foundation for gene mapping.
- **Sutton and Boveri:** They independently proposed the Chromosomal Theory of Inheritance, which states that genes are located on chromosomes.
- **Alfred Sturtevant:** He was an undergraduate student in T.H. Morgan's lab. In 1913, he had the insight that the frequency of recombination between two linked genes could be used as a measure of the physical distance separating them on a chromosome. He used this principle to construct the first-ever genetic map for the X chromosome of *Drosophila*.
- **Henking:** He was a German biologist who first discovered the X chromosome in insects in 1891, referring to it as the "X-body".

#### Step 4: Final Answer:

Although Morgan's lab did the foundational work, it was Alfred Sturtevant who first applied recombination frequencies to map genes.

#### Quick Tip

Remember the hierarchy: Morgan discovered linkage and recombination, but his student Sturtevant was the one who brilliantly used the recombination \*frequency\* data to create the first gene map.

### 9. Which of the following stages of meiosis involves division of centromere?

- (A) Metaphase I
- (B) Metaphase II
- (C) Anaphase II
- (D) Telophase

**Correct Answer:** (C) Anaphase II

**Solution:**

#### Step 1: Understanding the Question:

The question asks at which specific stage of meiosis the centromere, which holds sister chromatids together, splits.

#### Step 3: Detailed Explanation:

Let's review the key events of meiotic stages:

- **Meiosis I:** This is the reductional division. In **Anaphase I**, homologous chromosomes separate and move to opposite poles. The sister chromatids remain attached at their centromeres; the centromeres do **not** divide.

- **Meiosis II:** This is the equational division, very similar to mitosis.
  - **Metaphase II:** Individual chromosomes (each composed of two sister chromatids) align at the metaphase plate.
  - **Anaphase II:** The centromeres of each chromosome finally split, and the sister chromatids are pulled apart towards opposite poles. Now, each chromatid is considered an individual chromosome.
- **Telophase I & II:** The final stages where chromosomes decondense and nuclear envelopes reform.

**Step 4: Final Answer:**

The division of the centromere occurs during Anaphase II of meiosis.

**Quick Tip**

A key difference between Meiosis I and Meiosis II is the behavior of centromeres. Anaphase I separates homologous chromosomes (no centromere split). Anaphase II separates sister chromatids (centromere splits).

**10. What is the role of RNA polymerase III in the process of transcription in Eukaryotes?**

- (A) Transcription of rRNAs (28S, 18S and 5.8S)
- (B) Transcription of tRNA, 5S rRNA and snRNAs
- (C) Transcription of precursor of mRNA
- (D) Transcription of only snRNAs

**Correct Answer:** (B) Transcription of tRNA, 5S rRNA and snRNAs

**Solution:**

**Step 1: Understanding the Question:**

The question asks for the specific function of RNA polymerase III in eukaryotic cells. Eukaryotes have three distinct RNA polymerases, each with a specialized role.

**Step 3: Detailed Explanation:**

The division of labor among the three main eukaryotic RNA polymerases is as follows:

- **RNA Polymerase I:** Located in the nucleolus, it is responsible for transcribing the genes for most ribosomal RNAs (rRNAs), specifically the 28S, 18S, and 5.8S rRNA subunits.
- **RNA Polymerase II:** Located in the nucleoplasm, it transcribes the precursors of messenger RNA (mRNA), called heterogeneous nuclear RNA (hnRNA), as well as most small nuclear RNAs (snRNAs).

- **RNA Polymerase III:** Located in the nucleoplasm, it is responsible for transcribing the genes for transfer RNA (tRNA), the 5S rRNA subunit, and some other small RNAs, including some snRNAs (like U6 snRNA).

**Step 4: Final Answer:**

Based on this division, the role of RNA Polymerase III is the transcription of tRNA, 5S rRNA, and snRNAs.

**Quick Tip**

Use the mnemonic "R-M-T" for Polymerases 1-2-3. Pol I makes rRNA. Pol II makes mRNA. Pol III makes tRNA (and other small RNAs).

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**11. Among 'The Evil Quartet', which one is considered the most important cause driving extinction of species?**

- (A) Habitat loss and fragmentation
- (B) Over exploitation for economic gain
- (C) Alien species invasions
- (D) Co-extinctions

**Correct Answer:** (A) Habitat loss and fragmentation

**Solution:**

**Step 1: Understanding the Question:**

The question refers to 'The Evil Quartet', a term for the four major causes of biodiversity loss, and asks which one is the most significant driver of species extinctions.

**Step 3: Detailed Explanation:**

'The Evil Quartet' consists of:

1. **Habitat loss and fragmentation:** This involves the destruction of natural habitats (e.g., deforestation, urbanization) and the breaking up of large habitats into smaller, isolated patches. This directly reduces the living space and resources for species, isolates populations, and is widely regarded by ecologists as the single greatest threat to biodiversity worldwide.
2. **Over-exploitation:** This is the harvesting of species from the wild at rates faster than natural populations can recover (e.g., overfishing, overhunting).
3. **Alien species invasions:** The introduction of non-native species into an ecosystem, where they can outcompete, prey on, or introduce diseases to native species.
4. **Co-extinctions:** The extinction of one species leading to the extinction of another that depends on it (e.g., a specialist parasite when its host goes extinct).

While all four are serious threats, habitat loss and fragmentation affects the largest number of species and is considered the primary cause of current extinctions.

**Step 4: Final Answer:**

The most important cause driving species extinction among the Evil Quartet is Habitat loss and fragmentation.

**Quick Tip**

When asked for the most important cause of biodiversity loss, habitat loss is almost always the correct answer. It's the foundational problem that exacerbates other threats.

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**12. Given below are two statements :**

**Statement I: Endarch and exarch are the terms often used for describing the position of secondary xylem in the plant body.**

**Statement II: Exarch condition is the most common feature of the root system.**

**In the light of the above statements, choose the correct answer from the options given below :**

- (A) Both Statement I and Statement II are true.
- (B) Both Statement I and Statement II are false.
- (C) Statement I is correct but Statement II is false.
- (D) Statement I is incorrect but Statement II is true.

**Correct Answer:** (D) Statement I is incorrect but Statement II is true.

**Solution:**

**Step 1: Understanding the Question:**

The question asks to evaluate two statements regarding the arrangement of xylem (endarch and exarch conditions) in plants.

**Step 3: Detailed Explanation:**

**Statement I:** The terms 'endarch' and 'exarch' describe the pattern of development of the **primary xylem**, not the secondary xylem. They refer to the relative position of the first-formed primary xylem (protoxylem) and the later-formed primary xylem (metaxylem).

- **Endarch:** Protoxylem is located towards the center (pith), and metaxylem is towards the periphery. This is characteristic of stems.
- **Exarch:** Protoxylem is located towards the periphery, and metaxylem is towards the center. This is characteristic of roots.

Since these terms apply to primary xylem, Statement I is incorrect.

**Statement II:** As explained above, the exarch condition, where the protoxylem is on the outside, is the defining arrangement of vascular bundles in the roots of vascular plants. Therefore, Statement II is correct.

**Step 4: Final Answer:**

Since Statement I is incorrect and Statement II is true, the correct option is (D).

**Quick Tip**

Remember: "Ex-" in Exarch refers to "exterior," meaning protoxylem is towards the outside (as in roots). "En-" in Endarch refers to "interior," meaning protoxylem is towards the inside/pith (as in stems). These terms only apply to primary xylem.

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**13. Axile placentation is observed in**

- (A) Mustard, Cucumber and Primrose
- (B) China rose, Beans and Lupin
- (C) Tomato, Dianthus and Pea
- (D) China rose, Petunia and Lemon

**Correct Answer:** (D) China rose, Petunia and Lemon

**Solution:**

**Step 1: Understanding the Question:**

The question asks to identify the group of plants that all exhibit axile placentation from the given options. Placentation is the arrangement of ovules within the ovary.

**Step 3: Detailed Explanation:**

In **axile placentation**, the ovary is partitioned into two or more chambers (locules) by septa, and the placenta is located in the central axis where the septa meet. The ovules are attached to this central placenta.

Let's analyze the options:

- (A) Mustard and Cucumber have parietal placentation. Primrose has free-central placentation.
- (B) China rose has axile placentation. Beans and Lupin (family Fabaceae) have marginal placentation.
- (C) Tomato has axile placentation. Dianthus has free-central placentation. Pea (family Fabaceae) has marginal placentation.
- (D) **China rose, Petunia, and Lemon** all have syncarpous, multilocular ovaries with the ovules arranged on a central placenta. This is the definition of axile placentation. Tomato is another common example.

**Step 4: Final Answer:**

The group of plants in option (D) correctly shows examples of axile placentation.

**Quick Tip**

Memorize a few key examples for each placentation type:

- **Marginal:** Pea, Bean (Fabaceae)
- **Axile:** Tomato, China rose, Lemon (think of a sliced orange)
- **Parietal:** Mustard, Argemone, Cucumber
- **Free-central:** Dianthus, Primrose
- **Basal:** Sunflower, Marigold (Asteraceae)

**14. Expressed Sequence Tags (ESTs) refers to**

- (A) All genes that are expressed as RNA.
- (B) All genes that are expressed as proteins.
- (C) All genes whether expressed or unexpressed.
- (D) Certain important expressed genes.

**Correct Answer:** (A) All genes that are expressed as RNA.

**Solution:****Step 1: Understanding the Question:**

The question asks for the definition of Expressed Sequence Tags (ESTs) in the context of genomics.

**Step 3: Detailed Explanation:**

An EST is a short, single-pass sequence read from a randomly selected clone from a cDNA library.

Here's the breakdown of the process:

1. All the messenger RNA (mRNA) is extracted from a cell or tissue. This mRNA represents all the genes that are being actively transcribed, or "expressed as RNA."
2. Reverse transcriptase is used to make complementary DNA (cDNA) from the mRNA templates.
3. This cDNA is then sequenced. A short, single read from one of these cDNA molecules is an EST.

Therefore, ESTs represent fragments of genes that are being expressed as RNA at the time of sample collection. The goal of EST projects is to get a snapshot of all transcribed genes.

**Step 4: Final Answer:**

ESTs are derived from mRNA, so they represent all genes that are expressed as RNA.

**Quick Tip**

Focus on the name: "Expressed" Sequence Tags. In molecular biology, the primary step of gene expression is transcription into RNA. ESTs are tags or identifiers for these transcribed sequences.

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**15. What is the function of tassels in the corn cob?**

- (A) To attract insects
- (B) To trap pollen grains
- (C) To disperse pollen grains
- (D) To protect seeds

**Correct Answer:** (B) To trap pollen grains

**Solution:****Step 1: Understanding the Question:**

The question asks for the function of "tassels in the corn cob". It is crucial to recognize that the terminology in the question is likely imprecise. In corn (Maize), the **tassel** is the male inflorescence at the apex of the plant which produces and disperses pollen. The **silks** are the long, thread-like styles of the female flowers, which emerge from the top of the ear (the cob). The silks are the structures physically associated with the cob. The question likely uses the term "tassels" incorrectly to refer to the silks.

**Step 3: Detailed Explanation:**

Let's analyze the functions based on correct botanical terms:

- **Function of the Tassel (at plant apex):** To produce and disperse a large amount of light pollen into the wind. This corresponds to option (C).
- **Function of the Silks (on the cob):** To trap airborne pollen grains. Each silk is a stigma and style, and its feathery, sticky surface is adapted to catch pollen. This corresponds to option (B).

Given the question asks about the function of a structure "in the corn cob" and the provided correct answer is (B), it is clear that the question intended to ask about the silks. The function of the silks is to trap pollen grains for fertilization.

**Step 4: Final Answer:**

Assuming "tassels in the corn cob" refers to the silks, their function is to trap pollen grains.

### Quick Tip

Be aware of potentially confusing terminology in exam questions. For corn: Tassel = male flower at the top (disperses pollen). Silk = female style on the cob (traps pollen). Remember corn is wind-pollinated (anemophilous), so it doesn't need to attract insects.

**16. Spraying of which of the following phytohormone on juvenile conifers helps in hastening the maturity period, that leads to early seed production?**

- (A) Indole-3-butyric Acid
- (B) Gibberellic Acid
- (C) Zeatin
- (D) Abscisic Acid

**Correct Answer:** (B) Gibberellic Acid

**Solution:**

**Step 1: Understanding the Question:**

The question asks which plant hormone (phytohormone) is used commercially to make young conifer trees mature faster and produce seeds earlier than they would naturally.

**Step 3: Detailed Explanation:**

Let's review the main functions of the listed hormones:

- **Indole-3-butyric Acid (IBA):** This is an auxin, primarily used to promote root formation in cuttings.
- **Gibberellic Acid (GA):** Gibberellins have many roles, including promoting stem elongation, breaking seed dormancy, and inducing flowering. A key commercial application is spraying juvenile conifers with GA to overcome juvenility and induce early cone and seed production. This is valuable in breeding programs.
- **Zeatin:** This is a cytokinin, which primarily promotes cell division (cytokinesis) and is involved in delaying senescence.
- **Abscisic Acid (ABA):** This is a growth-inhibiting hormone, involved in inducing dormancy and responding to stress (like drought).

**Step 4: Final Answer:**

Gibberellic acid is the phytohormone used to hasten maturity in juvenile conifers.

### Quick Tip

Remember the key commercial roles of gibberellins: increasing fruit size (grapes), elongating stems (sugarcane), speeding up the malting process (brewing), and promoting early seed production (conifers).

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17. In the equation  $GPP - R = NPP$ , GPP is Gross Primary Productivity, NPP is Net Primary Productivity. R here is

- (A) Photosynthetically active radiation
- (B) Respiratory quotient
- (C) Respiratory loss
- (D) Reproductive allocation

**Correct Answer:** (C) Respiratory loss

**Solution:**

**Step 1: Understanding the Question:**

The question asks for the meaning of the term 'R' in the fundamental ecological equation relating Gross and Net Primary Productivity.

**Step 2: Key Formula or Approach:**

The equation is given:  $NPP = GPP - R$ .

**Step 3: Detailed Explanation:**

- **Gross Primary Productivity (GPP):** This is the total amount of chemical energy, in the form of organic matter, that producers (like plants) create in a given area through photosynthesis. It's the total energy captured from the sun.
- **Respiratory Loss (R):** Producers must use some of the energy they capture for their own life processes, such as cellular respiration, growth, and maintenance. This energy, which is lost as heat and is not converted into biomass, is termed respiratory loss.
- **Net Primary Productivity (NPP):** This is the energy that remains as biomass after the producers have met their own respiratory needs. It is the energy available to the next trophic level (consumers).

Therefore, the equation  $NPP = GPP - R$  means that the Net available energy (NPP) is the Gross energy captured (GPP) minus the energy used up for respiration (R).

**Step 4: Final Answer:**

R represents Respiratory loss.

#### Quick Tip

Think of productivity like a personal budget. GPP is your gross income. R (Respiration) is your essential expenses (rent, food). NPP is your net savings (the money available for other things).

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18. Family Fabaceae differs from Solanaceae and Liliaceae. With respect to the stamens, pick out the characteristics specific to family Fabaceae but not found in Solanaceae or Liliaceae.

- (A) Diadelphous and Ditheous anthers
- (B) Polyadelphous and epipetalous stamens
- (C) Monoadelphous and Monotheous anthers
- (D) Epiphyllous and Ditheous anthers

**Correct Answer:** (A) Diadelphous and Ditheous anthers

**Solution:**

**Step 1: Understanding the Question:**

The question asks for a characteristic feature of the stamens of the family Fabaceae that distinguishes it from the families Solanaceae and Liliaceae.

**Step 3: Detailed Explanation:**

Let's compare the stamen characteristics of the three families:

- **Fabaceae (Subfamily Papilionoideae, e.g., Pea):** Stamens are typically ten. Their key feature is that they are **diadelphous**, meaning the filaments are fused to form two bundles (commonly in a (9)+1 arrangement, where 9 are fused and one is free). The anthers are **ditheous** (having two lobes).
- **Solanaceae (e.g., Petunia):** Stamens are five and are **epipetalous** (fused to the petals). They are not diadelphous. The anthers are ditheous.
- **Liliaceae (e.g., Lily):** Stamens are six and are often **epiphyllous** or epitepalous (fused to the tepals). They are not diadelphous. The anthers are ditheous.

Comparing these, the **diadelphous** condition is a unique and defining characteristic of Fabaceae. While all three have ditheous anthers, the combination of diadelphous stamens and ditheous anthers is specific to Fabaceae in this context.

**Step 4: Final Answer:**

The specific characteristic of Fabaceae stamens is the diadelphous condition.

**Quick Tip**

Associate key floral features with plant families. For Fabaceae, the most distinctive features are the papilionaceous (butterfly-shaped) corolla, diadelphous stamens, and a monocarpellary ovary with marginal placentation.

**19. In angiosperm, the haploid, diploid and triploid structures of a fertilized embryo sac sequentially are :**

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

**Correct Answer:** (C) Synergids, Zygote and Primary endosperm nucleus

**Solution:**

**Step 1: Understanding the Question:**

The question asks to identify a sequence of structures from a fertilized embryo sac that corresponds to haploid ( $n$ ), diploid ( $2n$ ), and triploid ( $3n$ ) ploidy levels, in that specific order.

**Step 3: Detailed Explanation:**

Let's determine the ploidy of the key structures in an embryo sac after double fertilization:

- **Haploid ( $n$ ):** The synergids and antipodal cells are part of the original female gametophyte (embryo sac) and are haploid. They typically degenerate after fertilization, but they are present.
- **Diploid ( $2n$ ):** The zygote is formed by the fusion of one haploid male gamete ( $n$ ) with the haploid egg cell ( $n$ ). Thus, the zygote is diploid ( $2n$ ).
- **Triploid ( $3n$ ):** The Primary Endosperm Nucleus (PEN) is formed by the fusion of the second haploid male gamete ( $n$ ) with the diploid central cell (which contains two polar nuclei,  $n + n$ ). This is called triple fusion, and it results in a triploid ( $3n$ ) nucleus, which develops into the endosperm.

Now let's check the options for the required sequence (haploid, diploid, triploid):

- (A) Synergids ( $n$ ), PEN ( $3n$ ), Zygote ( $2n$ ). Order is  $n$ ,  $3n$ ,  $2n$ . Incorrect.
- (B) Antipodals ( $n$ ), Synergids ( $n$ ), PEN ( $3n$ ). No diploid structure listed. Incorrect.
- (C) **Synergids ( $n$ ), Zygote ( $2n$ ), Primary endosperm nucleus ( $3n$ )**. Order is  $n$ ,  $2n$ ,  $3n$ . Correct.
- (D) This option lists structures before fertilization is complete (Polar nuclei are not yet fused with the male gamete). Incorrect.

**Step 4: Final Answer:**

The correct sequence of haploid, diploid, and triploid structures is Synergids, Zygote, and Primary endosperm nucleus.

### Quick Tip

Remember the products of double fertilization in angiosperms:

1. Male gamete (n) + Egg (n) → Zygote (2n)
2. Male gamete (n) + Central Cell (n+n) → PEN (3n)

Other cells in the embryo sac (synergids, antipodals) remain haploid (n).

---

## 20. Which hormone promotes internode/petiole elongation in deep water rice?

- (A) GA<sub>3</sub>
- (B) Kinetin
- (C) Ethylene
- (D) 2, 4-D

**Correct Answer:** (C) Ethylene

**Solution:**

### Step 1: Understanding the Question:

The question asks to identify the plant hormone responsible for the rapid elongation of internodes or petioles in deep-water rice plants, which helps them keep their leaves above the water level during flooding.

### Step 3: Detailed Explanation:

- Deep-water rice varieties have a remarkable ability to grow rapidly when submerged in water. This response is primarily mediated by the hormone **ethylene**.
- When the plant is submerged, ethylene accumulates in the submerged parts because its diffusion into the air is blocked by water.
- This increased concentration of ethylene promotes rapid cell division and elongation in the internodes, causing the stem to grow quickly and raise the leaves above the water surface.
- While Gibberellic Acid (GA) is also involved in stem elongation, in this specific case of deep-water rice, ethylene is the primary trigger.
- Kinetin is a cytokinin involved in cell division. 2,4-D is a synthetic auxin, often used as a herbicide.

**Step 4: Final Answer:**

The hormone that promotes internode/petiole elongation in deep water rice is Ethylene.

**Quick Tip**

Remember the specific roles of ethylene. While it is commonly known as the 'ripening hormone', it also has crucial roles in stress responses, such as promoting elongation in submerged plants like deep-water rice.

---

**21. Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R :**

**Assertion A:** Late wood has fewer xylary elements with narrow vessels.

**Reason R:** Cambium is less active in winters.

**In the light of the above statements, choose the correct answer from the options given below :**

- (A) Both A and R are true and R is the correct explanation of A.
- (B) Both A and R are true but R is NOT the correct explanation of A.
- (C) A is true but R is false.
- (D) A is false but R is true.

**Correct Answer:** (A) Both A and R are true and R is the correct explanation of A.

**Solution:**

**Step 1: Understanding the Question:**

The question asks us to evaluate an Assertion about the structure of late wood and a Reason concerning the activity of cambium, and to determine the relationship between them.

**Step 3: Detailed Explanation:**

**Assertion A:** In temperate regions, trees form distinct annual rings. The wood formed during the later part of the growing season (autumn/winter) is called late wood or autumn wood. This wood is characterized by having fewer xylem elements (tracheids and vessels), which are smaller and have narrower lumens. The wood is denser and darker in color. So, Assertion A is true.

**Reason R:** The activity of the vascular cambium is regulated by physiological and environmental factors. During spring, the cambium is very active, producing a large number of wide xylem vessels. In winter, the conditions are less favorable for growth, so the activity of the cambium decreases significantly. So, Reason R is true.

**Connecting A and R:** The decreased activity of the cambium during winter (Reason R) is the direct cause for the production of fewer and narrower xylary elements that constitute the

late wood (Assertion A). Therefore, the Reason correctly explains the Assertion.

**Step 4: Final Answer:**

Both Assertion A and Reason R are true, and R is the correct explanation of A.

**Quick Tip**

Remember the contrast: Spring wood (early wood) = active cambium, wide vessels, light color. Autumn wood (late wood) = less active cambium, narrow vessels, dark color. The combination of these two forms an annual ring.

---

**22. Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R :**

**Assertion A:** ATP is used at two steps in glycolysis.

**Reason R:** First ATP is used in converting glucose into glucose-6-phosphate and second ATP is used in conversion of fructose-6-phosphate into fructose-1,6-diphosphate. In the light of the above statements, choose the correct answer from the options given below :

- (A) Both A and R are true and R is the correct explanation of A.
- (B) Both A and R are true but R is NOT the correct explanation of A.
- (C) A is true but R is false.
- (D) A is false but R is true.

**Correct Answer:** (A) Both A and R are true and R is the correct explanation of A.

**Solution:**

**Step 1: Understanding the Question:**

The question presents an Assertion about the number of ATP consumption steps in glycolysis and a Reason specifying those steps. We need to evaluate their correctness and relationship.

**Step 3: Detailed Explanation:**

**Assertion A:** Glycolysis is the metabolic pathway that converts glucose into pyruvate. The initial phase of glycolysis is known as the preparatory or investment phase, where energy (in the form of ATP) is consumed to activate the glucose molecule. In this phase, ATP is indeed consumed at two distinct steps. Thus, Assertion A is true.

**Reason R:** The two steps where ATP is consumed are:

1. **Step 1:** Glucose is phosphorylated to glucose-6-phosphate by the enzyme hexokinase. This step uses one molecule of ATP.
2. **Step 3:** Fructose-6-phosphate is phosphorylated to fructose-1,6-bisphosphate by the enzyme phosphofructokinase. This step uses a second molecule of ATP.

The Reason correctly identifies both of these ATP-consuming steps. Thus, Reason R is true.

**Connecting A and R:** Reason R provides the specific details of the two steps where ATP is used, thereby correctly and completely explaining Assertion A.

**Step 4: Final Answer:**

Both Assertion A and Reason R are true, and R is the correct explanation of A.

**Quick Tip**

Remember glycolysis as a 10-step process. Steps 1 and 3 are the "investment" steps (ATP used). Steps 7 and 10 are the "payoff" steps (ATP produced). Net gain is 2 ATP and 2 NADH per glucose.

---

**23. Identify the correct statements :**

**A. Detrivores perform fragmentation.**

**B. The humus is further degraded by some microbes during mineralization.**

**C. Water soluble inorganic nutrients go down into the soil and get precipitated by a process called leaching.**

**D. The detritus food chain begins with living organisms.**

**E. Earthworms break down detritus into smaller particles by a process called catabolism.**

**Choose the correct answer from the options given below :**

(A) A, B, C only

(B) B, C, D only

(C) C, D, E only

(D) D, E, A only

**Correct Answer:** (A) A, B, C only

**Solution:**

**Step 1: Understanding the Question:**

The question asks us to identify the correct statements about the process of decomposition from a given list.

**Step 3: Detailed Explanation:**

Let's analyze each statement:

- **A. Detrivores perform fragmentation.** This is **correct**. Detritivores, like earthworms, break down detritus (dead organic matter) into smaller particles. This process is called fragmentation.

- **B. The humus is further degraded by some microbes during mineralization.** This is **correct**. Humus is a dark amorphous substance that is highly resistant to microbial action and decomposes at an extremely slow rate. Eventually, it is degraded by microbes, and this process, which releases inorganic nutrients, is called mineralization.
- **C. Water soluble inorganic nutrients go down into the soil and get precipitated by a process called leaching.** This is **correct**. Leaching is the process by which water-soluble substances (like inorganic nutrients released during decomposition) are washed down through the soil profile and may precipitate as unavailable salts.
- **D. The detritus food chain begins with living organisms.** This is **incorrect**. The detritus food chain (DFC) begins with dead organic matter (detritus). The grazing food chain (GFC) begins with living organisms (producers).
- **E. Earthworms break down detritus into smaller particles by a process called catabolism.** This is **incorrect**. The physical breakdown of detritus by earthworms is called fragmentation, as stated in A. Catabolism refers to the enzymatic degradation of detritus into simpler inorganic substances by bacteria and fungi.

Therefore, the correct statements are A, B, and C.

**Step 4: Final Answer:**

The option that includes only statements A, B, and C is (A).

**Quick Tip**

Decomposition involves three main processes: 1. **Fragmentation:** Physical breakdown by detritivores (e.g., earthworm). 2. **Leaching:** Soluble nutrients wash down into the soil. 3. **Catabolism:** Chemical/enzymatic breakdown by microbes (bacteria, fungi). Humification and Mineralization are outcomes of these processes.

**24. The process of appearance of recombination nodules occurs at which sub stage of prophase I in meiosis?**

- (A) Zygotene
- (B) Pachytene
- (C) Diplotene
- (D) Diakinesis

**Correct Answer:** (B) Pachytene

**Solution:**

**Step 1: Understanding the Question:**

The question asks to identify the specific sub-stage of Prophase I where recombination nodules

are observed.

### Step 3: Detailed Explanation:

Prophase I of meiosis is a long and complex phase divided into five sub-stages:

1. **Leptotene:** Chromosomes start to condense.
2. **Zygotene:** Homologous chromosomes pair up (synapsis) to form bivalents. The synaptonemal complex begins to form.
3. **Pachytene:** This is the longest stage. Bivalents are clearly visible as tetrads. **Crossing over**, which is the exchange of genetic material between non-sister chromatids of homologous chromosomes, occurs during this stage. The sites where crossing over occurs are marked by the appearance of protein complexes called **recombination nodules**.
4. **Diplotene:** The synaptonemal complex dissolves, and homologous chromosomes start to separate, except at the sites of crossing over, which are now visible as X-shaped structures called chiasmata.
5. **Diakinesis:** Chromosomes are fully condensed, and terminalization of chiasmata occurs. The nuclear envelope breaks down.

### Step 4: Final Answer:

Recombination nodules, the sites of crossing over, appear during the Pachytene stage.

#### Quick Tip

Use a mnemonic to remember the order and key events of Prophase I: "Lazy Zebra Pounces On Dingoes Daily" **L**eptotene (Condensation) **Z**ygotene (Synapsis) **P**achytene (Crossing over/Recombination nodules) **D**iplotene (Chiasmata visible) **D**iakinesis (Terminalization)

---

**25. How many ATP and NADPH<sub>2</sub> are required for the synthesis of one molecule of Glucose during Calvin cycle?**

- (A) 12 ATP and 12 NADPH<sub>2</sub>
- (B) 18 ATP and 12 NADPH<sub>2</sub>
- (C) 12 ATP and 16 NADPH<sub>2</sub>
- (D) 18 ATP and 16 NADPH<sub>2</sub>

**Correct Answer:** (B) 18 ATP and 12 NADPH<sub>2</sub>

**Solution:**

### Step 1: Understanding the Question:

The question asks for the total number of ATP and NADPH molecules required to produce one

molecule of glucose (a 6-carbon sugar) via the Calvin cycle.

**Step 2: Key Formula or Approach:**

The Calvin cycle must "turn" multiple times to produce one molecule of glucose.

1. Determine the requirements for one turn of the cycle (fixing one CO<sub>2</sub>).
2. Determine how many turns are needed for one glucose molecule.
3. Calculate the total requirements.

**Step 3: Detailed Explanation:**

**Per one turn of the Calvin cycle (fixing 1 CO<sub>2</sub>):**

- **Reduction Phase:** 2 molecules of ATP and 2 molecules of NADPH are used to convert 3-PGA to G3P.
- **Regeneration Phase:** 1 molecule of ATP is used to regenerate RuBP from RuMP.
- **Total per turn:** 2 ATP + 1 ATP = 3 ATP, and 2 NADPH.

**For synthesis of one glucose molecule (C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>):**

- A glucose molecule has 6 carbon atoms.
- The Calvin cycle fixes one carbon atom per turn.
- Therefore, 6 turns of the cycle are required to produce the equivalent of one glucose molecule.

**Total Calculation:**

- Total ATP = (ATP per turn) × (Number of turns) = 3 ATP × 6 = **18 ATP**
- Total NADPH = (NADPH per turn) × (Number of turns) = 2 NADPH × 6 = **12 NADPH**

Note: NADPH<sub>2</sub> is an older notation for NADPH + H<sup>+</sup>, representing the reduced form.

**Step 4: Final Answer:**

To synthesize one molecule of glucose, 18 ATP and 12 NADPH are required.

**Quick Tip**

Remember the simple ratio for the Calvin cycle: For every 1 CO<sub>2</sub> fixed, you need 3 ATP and 2 NADPH. Since glucose has 6 carbons, multiply these numbers by 6.

---

**26. The phenomenon of pleiotropism refers to**

- (A) presence of several alleles of a single gene controlling a single crossover.
- (B) presence of two alleles, each of the two genes controlling a single trait.

- (C) a single gene affecting multiple phenotypic expression.  
(D) more than two genes affecting a single character.

**Correct Answer:** (C) a single gene affecting multiple phenotypic expression.

**Solution:**

**Step 1: Understanding the Question:**

The question asks for the definition of pleiotropy (or pleiotropism).

**Step 3: Detailed Explanation:**

Let's analyze the given definitions:

- **(A) presence of several alleles of a single gene...:** This describes multiple allelism (e.g., ABO blood groups), not pleiotropy.
- **(B) presence of two alleles, each of the two genes...:** This is a somewhat confusing statement and does not correctly define any standard genetic term.
- **(C) a single gene affecting multiple phenotypic expression.:** This is the correct definition of pleiotropy. A single gene influences two or more seemingly unrelated phenotypic traits. A classic example is the gene for phenylketonuria (PKU), which causes mental retardation, reduced hair, and skin pigmentation.
- **(D) more than two genes affecting a single character.:** This is the definition of polygenic inheritance (e.g., human skin color, height).

**Step 4: Final Answer:**

Pleiotropy is when one gene controls multiple traits.

**Quick Tip**

To avoid confusion: **Pleiotropy:** One gene → Many traits (e.g., PKU) **Polygenic Inheritance:** Many genes → One trait (e.g., skin color)

---

**27. Upon exposure to UV radiation, DNA stained with ethidium bromide will show**

- (A) Bright red colour  
(B) Bright blue colour  
(C) Bright yellow colour  
(D) Bright orange colour

**Correct Answer:** (D) Bright orange colour

**Solution:**

**Step 1: Understanding the Question:**

The question asks about the appearance of DNA when it is stained with ethidium bromide and then exposed to UV light. This is a standard procedure in molecular biology, particularly in agarose gel electrophoresis.

**Step 3: Detailed Explanation:**

- **Ethidium bromide (EtBr)** is a fluorescent dye that intercalates, or inserts itself, between the stacked base pairs of the DNA double helix.
- By itself, EtBr fluoresces only weakly. However, when it is intercalated into DNA, its fluorescence increases dramatically.
- This complex (DNA-EtBr) absorbs ultraviolet (UV) radiation (around 300 nm) and emits the absorbed energy as visible light in the orange part of the spectrum (around 590 nm).
- Therefore, when a gel containing DNA is soaked in EtBr and then placed on a UV transilluminator, the DNA bands become visible as bright orange bands.

**Step 4: Final Answer:**

DNA stained with ethidium bromide fluoresces bright orange under UV radiation.

**Quick Tip**

Associate "DNA," "gel electrophoresis," and "ethidium bromide" with "UV light" and "bright orange bands." This is a fundamental visualization technique in molecular biology.

---

**28. The reaction centre in PS II has an absorption maxima at**

- (A) 680 nm
- (B) 700 nm
- (C) 660 nm
- (D) 780 nm

**Correct Answer:** (A) 680 nm

**Solution:****Step 1: Understanding the Question:**

The question asks for the specific wavelength of light at which the reaction center of Photosystem II (PS II) shows maximum absorption.

**Step 3: Detailed Explanation:**

In photosynthesis, there are two photosystems, PS I and PS II. Each photosystem has a reaction center, which is a specific chlorophyll 'a' molecule that gets excited and initiates the light-dependent reactions.

- **Photosystem II (PS II):** Its reaction center is called P680 because it shows peak absorption of light at a wavelength of 680 nm.
- **Photosystem I (PS I):** Its reaction center is called P700 because it shows peak absorption of light at a wavelength of 700 nm.

Therefore, the absorption maxima for the reaction center in PS II is 680 nm.

**Step 4: Final Answer:**

The correct answer is 680 nm.

**Quick Tip**

A simple way to remember is that in the Z-scheme of electron transport, PS II comes before PS I. Similarly, the number 680 comes before 700. So, PS II corresponds to P680, and PS I corresponds to P700.

---

**29. During the purification process for recombinant DNA technology, addition of chilled ethanol precipitates out**

- (A) RNA
- (B) DNA
- (C) Histones
- (D) Polysaccharides

**Correct Answer:** (B) DNA

**Solution:**

**Step 1: Understanding the Question:**

The question asks which macromolecule is precipitated out from a solution by adding chilled ethanol during DNA purification.

**Step 3: Detailed Explanation:**

The process of isolating DNA involves several steps:

1. Lysis of the cells to release the cellular contents.
2. Removal of other macromolecules like RNA (using ribonuclease), proteins (using protease), etc.
3. After these treatments, the DNA remains in the aqueous solution.

4. DNA is insoluble in alcohols like ethanol or isopropanol. When chilled ethanol is added to the aqueous solution of DNA, the DNA precipitates out as fine, white threads.
5. This precipitated DNA can then be removed from the solution by a process called spooling.

This technique, known as ethanol precipitation, is a standard method to isolate and concentrate DNA.

**Step 4: Final Answer:**

The addition of chilled ethanol causes the DNA to precipitate.

**Quick Tip**

Remember the final step of DNA isolation: "chilled ethanol precipitation." The low temperature and the alcohol both reduce the solubility of DNA, causing it to come out of the solution.

---

**30. Which micronutrient is required for splitting of water molecule during photosynthesis?**

- (A) manganese
- (B) molybdenum
- (C) magnesium
- (D) copper

**Correct Answer:** (A) manganese

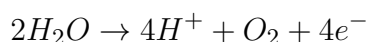
**Solution:**

**Step 1: Understanding the Question:**

The question asks to identify the micronutrient that acts as a cofactor in the photolysis (splitting) of water during the light-dependent reactions of photosynthesis.

**Step 3: Detailed Explanation:**

The splitting of water molecules occurs in the lumen of the thylakoids and is associated with Photosystem II (PS II). The reaction is:



This reaction is catalyzed by the Oxygen-Evolving Complex (OEC). The OEC requires the presence of certain inorganic ions to function correctly. The key mineral elements involved are:

- **Manganese (Mn):** It is the central component of the OEC and plays a crucial role in the oxidation of water.
- **Chloride (Cl<sup>-</sup>):** It is also required for the water-splitting reaction.

Other options:

- **Molybdenum (Mo):** Component of nitrogenase and nitrate reductase.
- **Magnesium (Mg):** Central atom in the chlorophyll molecule.
- **Copper (Cu):** Component of plastocyanin, an electron carrier.

**Step 4: Final Answer:**

Manganese (Mn) is the essential micronutrient for the splitting of water.

#### Quick Tip

Associate specific micronutrients with key processes. For photosynthesis, remember: Mg for chlorophyll structure and Mn for water splitting.

---

**31. Movement and accumulation of ions across a membrane against their concentration gradient can be explained by**

- (A) Osmosis
- (B) Facilitated Diffusion
- (C) Passive Transport
- (D) Active Transport

**Correct Answer:** (D) Active Transport

**Solution:**

**Step 1: Understanding the Question:**

The question asks for the term that describes the transport of ions across a membrane from a region of lower concentration to a region of higher concentration, which is "against their concentration gradient."

**Step 3: Detailed Explanation:**

Let's analyze the transport mechanisms:

- **Passive Transport:** Movement of substances across a membrane **down** the concentration gradient (from high to low concentration). It does not require energy. Simple diffusion and facilitated diffusion are types of passive transport.
- **Osmosis:** A special case of passive transport involving the movement of water across a semi-permeable membrane.
- **Facilitated Diffusion:** Passive transport that requires a membrane protein to facilitate the movement of substances down their concentration gradient.
- **Active Transport:** The movement of substances across a membrane **against** their concentration gradient (from low to high concentration). This "uphill" movement requires energy, typically provided by ATP, and involves specific carrier proteins or pumps.

The key phrase in the question is "against their concentration gradient," which is the defining characteristic of active transport.

**Step 4: Final Answer:**

The phenomenon described is Active Transport.

**Quick Tip**

Memorize these key phrases:

- **Down the gradient** = Passive (No energy)
- **Against the gradient** = Active (Requires energy)

---

**32. Among eukaryotes, replication of DNA takes place in**

- (A) M phase
- (B) S phase
- (C) G<sub>1</sub> phase
- (D) G<sub>2</sub> phase

**Correct Answer:** (B) S phase

**Solution:**

**Step 1: Understanding the Question:**

The question asks to identify the specific phase of the eukaryotic cell cycle during which DNA replication occurs.

**Step 3: Detailed Explanation:**

The eukaryotic cell cycle is divided into two main stages: Interphase and M phase (Mitotic phase).

- **Interphase** is the period of growth and preparation for cell division. It is further subdivided into:
  - **G<sub>1</sub> phase (Gap 1):** The cell grows and carries out its normal metabolic functions. It is the phase between mitosis and DNA replication.
  - **S phase (Synthesis phase):** This is the phase where DNA replication occurs. The amount of DNA in the cell doubles (from 2C to 4C), but the chromosome number remains the same.
  - **G<sub>2</sub> phase (Gap 2):** The cell continues to grow and prepares for mitosis. Proteins needed for cell division are synthesized.
- **M phase (Mitosis):** This is the phase where the cell actually divides, consisting of nuclear division (mitosis) and cytoplasmic division (cytokinesis).

Thus, DNA replication is the defining event of the S phase.

**Step 4: Final Answer:**

DNA replication takes place in the S phase of the cell cycle.

**Quick Tip**

Remember that 'S' in S phase stands for 'Synthesis', specifically the synthesis of new DNA. This is a crucial event that must occur before a cell can divide.

---

**33. Cellulose does not form blue colour with Iodine because**

- (A) It is a disaccharide.
- (B) It is a helical molecule.
- (C) It does not contain complex helices and hence cannot hold iodine molecules.
- (D) It breaks down when iodine reacts with it.

**Correct Answer:** (C) It does not contain complex helices and hence cannot hold iodine molecules.

**Solution:**

**Step 1: Understanding the Question:**

The question asks for the structural reason why cellulose does not give a positive iodine test (blue-black color), unlike starch.

**Step 3: Detailed Explanation:**

- The iodine test is used to detect the presence of starch. Starch is a polysaccharide made of two components: amylose and amylopectin.
- Amylose has a helical (coiled) structure. When iodine is added, iodine molecules ( $I_3^-$  and  $I_5^-$  ions) slip into the center of these helices. This interaction forms a charge-transfer complex that absorbs light, producing a characteristic blue-black color.
- Cellulose is also a polysaccharide made of glucose units. However, the glucose units in cellulose are linked by  $\beta$ -1,4 glycosidic bonds, which result in long, straight, unbranched chains.
- These linear chains lie parallel to each other and are held together by hydrogen bonds, forming strong microfibrils. Cellulose does not have a helical structure.
- Because cellulose lacks the complex helical coils, it cannot trap the iodine molecules. Therefore, no color change occurs when iodine is added to cellulose.

Analyzing the options:

- (A) is incorrect. Cellulose is a polysaccharide, not a disaccharide.
- (B) is incorrect. Cellulose is a linear, not a helical, molecule.
- (C) is correct. It accurately states that cellulose does not have the necessary helical structure to bind with iodine.
- (D) is incorrect. Cellulose does not break down upon reaction with iodine.

**Step 4: Final Answer:**

The correct reason is that cellulose does not have a helical structure to hold iodine molecules.

**Quick Tip**

Remember the structure-function relationship:

- **Starch (helical)** → Traps Iodine → Blue color
- **Cellulose (linear)** → Cannot trap Iodine → No color

**34. The historic Convention on Biological Diversity, 'The Earth Summit' was held in Rio de Janeiro in the year :**

- (A) 1985
- (B) 1992
- (C) 1986
- (D) 2002

**Correct Answer:** (B) 1992

**Solution:**

**Step 1: Understanding the Question:**

This is a knowledge-based question asking for the year of the Earth Summit held in Rio de Janeiro, where the Convention on Biological Diversity was opened for signature.

**Step 3: Detailed Explanation:**

- The United Nations Conference on Environment and Development (UNCED), popularly known as the **Earth Summit**, was held in Rio de Janeiro, Brazil.
- This landmark event took place from June 3 to June 14, **1992**.
- A key outcome of this summit was the adoption of the Convention on Biological Diversity (CBD), which had three main goals: the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising out of the utilization of genetic resources.

**Step 4: Final Answer:**

The Earth Summit was held in 1992.

**Quick Tip**

Memorize key dates for major environmental conferences. The Rio "Earth Summit" of 1992 is a foundational event in global environmental policy.

**35. Identify the pair of heterosporous pteridophytes among the following :**

- (A) *Lycopodium* and *Selaginella*
- (B) *Selaginella* and *Salvinia*
- (C) *Psilotum* and *Salvinia*
- (D) *Equisetum* and *Salvinia*

**Correct Answer:** (B) *Selaginella* and *Salvinia*

**Solution:****Step 1: Understanding the Question:**

The question requires identifying a pair of pteridophytes where both plants are heterosporous.

**Step 3: Detailed Explanation:**

Pteridophytes can be classified based on the type of spores they produce:

- **Homosporous Pteridophytes:** They produce only one type of spore, which develops into a bisexual gametophyte (having both antheridia and archegonia). The majority of pteridophytes fall into this category. Examples include *Lycopodium*, *Equisetum*, *Psilotum*, and most ferns like *Dryopteris*.
- **Heterosporous Pteridophytes:** They produce two distinct types of spores: smaller microspores (which develop into male gametophytes) and larger megaspores (which develop into female gametophytes). This condition is a precursor to the seed habit seen in gymnosperms and angiosperms. Key examples are *Selaginella*, *Salvinia*, *Azolla*, and *Marsilea*.

Let's examine the options:

- (A) *Lycopodium* is homosporous; *Selaginella* is heterosporous.
- (B) *Selaginella* is heterosporous; *Salvinia* is heterosporous. This is the correct pair.
- (C) *Psilotum* is homosporous; *Salvinia* is heterosporous.
- (D) *Equisetum* is homosporous; *Salvinia* is heterosporous.

#### Step 4: Final Answer:

Both *Selaginella* and *Salvinia* are heterosporous pteridophytes.

#### Quick Tip

To easily answer such questions, memorize the four main examples of heterosporous pteridophytes: *Selaginella*, *Salvinia*, *Azolla*, and *Marsilea*. Most other common pteridophytes are homosporous.

## Section - B

### 36. Match List I with List II :

#### List I

- A. M Phase
- B. G<sub>2</sub> Phase
- C. Quiescent stage
- D. G<sub>1</sub> Phase

#### List II

- I. Proteins are synthesized
- II. Inactive phase
- III. Interval between mitosis and initiation of DNA replication
- IV. Equational division

Choose the correct answer from the options given below :

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

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

**Solution:**

#### Step 1: Understanding the Question:

This is a matching question that requires associating different phases of the cell cycle (List I) with their correct descriptions or events (List II).

#### Step 3: Detailed Explanation:

Let's match each item from List I with its correct counterpart in List II.

- **A. M Phase:** This is the mitotic phase where cell division occurs. Mitosis is known as **equational division** because the number of chromosomes in the daughter cells is equal to that of the parent cell. So, **A matches with IV**.
- **B. G<sub>2</sub> Phase:** This is the second gap phase, which occurs after DNA synthesis (S phase) and before mitosis (M phase). During G<sub>2</sub>, the cell grows, and **proteins are synthesized** in preparation for division, such as the proteins that make up microtubules. So, **B matches with I**.

- **C. Quiescent stage ( $G_0$ ):** This is a non-dividing state that cells can enter from the  $G_1$  phase. While metabolically active, the cell does not proliferate. It is considered an **inactive phase** with respect to the cell cycle. So, **C matches with II.**
- **D.  $G_1$  Phase:** This is the first gap phase. It represents the **interval between the completion of mitosis and the initiation of DNA replication** (S phase). So, **D matches with III.**

The correct set of matches is A-IV, B-I, C-II, D-III. This corresponds to option (C).

#### Step 4: Final Answer:

The correct match is A-IV, B-I, C-II, D-III.

#### Quick Tip

Visualize the cell cycle as a clock:  $M \rightarrow G_1 \rightarrow S \rightarrow G_2 \rightarrow M$ .  $G_0$  is an exit ramp from  $G_1$ . Knowing the sequence and the key event of each phase makes matching questions straightforward.

#### 37. Match List I with List II:

##### List I

- A. Iron
- B. Zinc
- C. Boron
- D. Molybdenum

##### List II

- I. Synthesis of auxin
- II. Component of nitrate reductase
- III. Activator of catalase
- IV. Cell elongation and differentiation

Choose the correct answer from the options given below :

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

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

#### Solution:

#### Step 1: Understanding the Question:

The question requires matching micronutrients (List I) with their specific physiological roles in plants (List II).

#### Step 3: Detailed Explanation:

Let's analyze the function of each micronutrient:

- **A. Iron (Fe):** Iron is a crucial component of electron carriers like cytochromes and ferredoxin. It is also required for the activation of the enzyme **catalase** and is essential for the formation of chlorophyll. So, **A matches with III.**

- **B. Zinc (Zn):** Zinc activates several enzymes, especially carboxylases. It is also essential for the **synthesis of auxin** (a plant hormone). So, **B matches with I**.
- **C. Boron (B):** Boron is involved in many processes, including pollen germination, membrane function, and  $\text{Ca}^{2+}$  utilization. It also plays a key role in **cell elongation and cell differentiation**. So, **C matches with IV**.
- **D. Molybdenum (Mo):** Molybdenum is a **component of** several important enzymes involved in nitrogen metabolism, most notably **nitrate reductase** and nitrogenase. So, **D matches with II**.

The correct set of matches is A-III, B-I, C-IV, D-II. This corresponds to option (C).

#### Step 4: Final Answer:

The correct match is A-III, B-I, C-IV, D-II.

#### Quick Tip

To master mineral nutrition, focus on one unique and important function for each element:

- **Fe** → Catalase / Cytochromes
- **Zn** → Auxin synthesis
- **B** → Pollen germination / Cell elongation
- **Mo** → Nitrate reductase / Nitrogenase

#### 38. Match List I with List II :

##### List I

- A. Cohesion
- B. Adhesion
- C. Surface tension
- D. Guttation

##### List II

- I. More attraction in liquid phase
- II. Mutual attraction among water molecules
- III. Water loss in liquid phase
- IV. Attraction towards polar surfaces

Choose the correct answer from the options given below :

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

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

**Solution:**

#### Step 1: Understanding the Question:

This question requires matching terms related to the properties of water and water transport

in plants (List I) with their correct definitions or descriptions (List II).

**Step 3: Detailed Explanation:**

Let's match each term:

- **A. Cohesion:** This refers to the attraction between molecules of the same substance. In water, it is the **mutual attraction among water molecules** due to hydrogen bonding. So, **A matches with II.**
- **B. Adhesion:** This is the attraction between molecules of different substances. In plants, it describes the **attraction of water towards polar surfaces**, such as the lignocellulosic walls of the xylem vessels. So, **B matches with IV.**
- **C. Surface tension:** This is a property of liquids where molecules at the surface are more strongly attracted to each other (cohesion) than to the molecules in the air above. This results in **more attraction in the liquid phase** compared to the gaseous phase, creating a 'skin' on the surface. So, **C matches with I.**
- **D. Guttation:** This is a physiological process in plants involving the **water loss in liquid phase** (as droplets of xylem sap) from the tips of leaves through special pores called hydathodes. It occurs when root pressure is high and transpiration is low. So, **D matches with III.**

The correct set of matches is A-II, B-IV, C-I, D-III. This corresponds to option (A).

**Step 4: Final Answer:**

The correct match is A-II, B-IV, C-I, D-III.

**Quick Tip**

To differentiate the terms:

- **Cohesion:** Water sticking to water.
- **Adhesion:** Water sticking to other things (like xylem walls).
- **Surface Tension:** A result of cohesion at the water-air interface.
- **Guttation:** Water loss as a liquid (Guttation → Liquid). Transpiration is water loss as a gas.

---

**39. How many different proteins does the ribosome consist of?**

- (A) 80
- (B) 60
- (C) 40
- (D) 20

**Correct Answer:** (A) 80

**Solution:**

**Step 1: Understanding the Question:**

The question asks for the approximate number of different proteins that make up a ribosome.

**Step 2: Detailed Explanation:**

Ribosomes are complex cellular organelles responsible for protein synthesis. They are composed of ribosomal RNA (rRNA) and proteins.

The composition differs slightly between prokaryotes and eukaryotes.

- **Prokaryotic ribosomes** are 70S type, composed of a 30S subunit (with ~21 proteins) and a 50S subunit (with ~34 proteins), totaling about 55 proteins.
- **Eukaryotic ribosomes** are 80S type, composed of a 40S subunit (with ~33 proteins) and a 60S subunit (with ~49 proteins).

The total number of proteins in a eukaryotic ribosome is approximately  $33 + 49 = 82$  proteins. Among the given options, 80 is the closest value to the number of proteins in a eukaryotic ribosome. In the context of general biology questions, "ribosome" often refers to the eukaryotic type unless specified otherwise.

**Step 3: Final Answer:**

Based on the composition of a eukaryotic ribosome, the number of different proteins is approximately 80.

**Quick Tip**

Remember the ribosome types and their subunits: Prokaryotes have 70S (50S + 30S) ribosomes, while Eukaryotes have 80S (60S + 40S) ribosomes. The 'S' stands for Svedberg unit, a measure of sedimentation rate, which is why the subunits' S values don't add up directly to the total.

---

**40. Match List I with List II :**

**List I**

- A. Oxidative decarboxylation
- B. Glycolysis
- C. Oxidative phosphorylation
- D. Tricarboxylic acid cycle

**List II**

- I. Citrate synthase
- II. Pyruvate dehydrogenase
- III. Electron transport system
- IV. EMP pathway

**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-I, C-II, D-IV

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

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

**Solution:**

**Step 1: Understanding the Question:**

This is a matching question that requires connecting key metabolic processes (List I) with their associated enzymes or alternative names/components (List II).

**Step 2: Detailed Explanation:**

Let's analyze each item in List I and find its correct match in List II.

- **A. Oxidative decarboxylation:** This is the process that converts pyruvate (from glycolysis) into acetyl-CoA before it enters the Krebs cycle. This reaction is catalyzed by the **Pyruvate dehydrogenase** complex. So, **A matches II**.
- **B. Glycolysis:** This is the initial pathway for glucose breakdown. It is also known as the **EMP pathway**, named after its discoverers Embden, Meyerhof, and Parnas. So, **B matches IV**.
- **C. Oxidative phosphorylation:** This is the final stage of cellular respiration where ATP is synthesized. It relies on the movement of electrons through the **Electron transport system (ETS)** to create a proton gradient. So, **C matches III**.
- **D. Tricarboxylic acid (TCA) cycle:** Also known as the Krebs cycle or citric acid cycle. The very first step of this cycle is the condensation of acetyl-CoA with oxaloacetate to form citrate, a reaction catalyzed by the enzyme **Citrate synthase**. So, **D matches I**.

**Step 3: Final Answer:**

The correct matching is: A-II, B-IV, C-III, D-I. This corresponds to option (D).

**Quick Tip**

To master cellular respiration, create a flowchart. Start with glucose and map its journey through glycolysis, the link reaction (oxidative decarboxylation), the Krebs cycle, and finally the electron transport chain (oxidative phosphorylation). Label the key enzymes and products at each stage.

**41. Match List I with List II :**

**List I (Interaction)    List II (Species A and B)**

- |                 |                   |
|-----------------|-------------------|
| A. Mutualism    | I. $+(A), O(B)$   |
| B. Commensalism | II. $-(A), O(B)$  |
| C. Amensalism   | III. $+(A), -(B)$ |
| D. Parasitism   | IV. $+(A), +(B)$  |

**Choose the correct answer from the options given below :**

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

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

**Solution:**

**Step 1: Understanding the Question:**

The question requires matching different types of ecological interactions (List I) with their symbolic representation (List II), where '+' denotes benefit, '-' denotes harm, and 'O' denotes no effect.

**Step 2: Detailed Explanation:**

Let's define each interaction and determine its symbolic representation.

- **A. Mutualism:** An interaction where both species A and B benefit. This is represented as (+, +). So, **A matches IV.**
- **B. Commensalism:** An interaction where one species (A) benefits, and the other species (B) is neither harmed nor benefited (unaffected). This is represented as (+, O). So, **B matches I.**
- **C. Amensalism:** An interaction where one species (A) is harmed, and the other species (B) is unaffected. This is represented as (-, O). So, **C matches II.**
- **D. Parasitism:** An interaction where one species (the parasite, A) benefits at the expense of the other species (the host, B), which is harmed. This is represented as (+, -). So, **D matches III.**

**Step 3: Final Answer:**

The correct set of matches is A-IV, B-I, C-II, D-III. This corresponds to option (B).

### Quick Tip

Create a small table to memorize population interactions. Use three columns: Interaction Name, Species A Effect (+, -, O), and Species B Effect (+, -, O). This makes it easy to recall all combinations quickly during an exam.

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42. Main steps in the formation of Recombinant DNA are given below. Arrange these steps in a correct sequence.

- A. Insertion of recombinant DNA into the host cell.
- B. Cutting of DNA at specific location by restriction enzyme.
- C. Isolation of desired DNA fragment.
- D. Amplification of gene of interest using PCR.

Choose the correct answer from the options given below :

- (A) B, C, D, A
- (B) C, A, B, D
- (C) C, B, D, A
- (D) B, D, A, C

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

**Solution:**

**Step 1: Understanding the Question:**

The question asks to arrange the given steps of creating recombinant DNA in the correct chronological order.

**Step 2: Detailed Explanation:**

Let's analyze the logical flow of the recombinant DNA technology process.

1. **Step C: Isolation of desired DNA fragment.** The very first step is to obtain the genetic material containing the gene of interest. This involves isolating the total DNA from the source organism.
2. **Step B: Cutting of DNA at specific location by restriction enzyme.** Once the DNA is isolated, both the source DNA (containing the gene of interest) and the vector DNA (e.g., a plasmid) are cut with the same restriction enzyme to create complementary "sticky ends".
3. **Step D: Amplification of gene of interest using PCR.** Before ligating the gene into the vector, it is often amplified using the Polymerase Chain Reaction (PCR) to create millions of copies. This ensures a sufficient quantity of the gene is available for the subsequent steps. (After cutting, the fragments are separated by gel electrophoresis and the

desired fragment is eluted, which is then amplified).

4. (*Ligation*) The amplified gene of interest is then joined (ligated) with the cut vector DNA using DNA ligase. This forms the recombinant DNA molecule. This step is implicit between D and A.
5. **Step A: Insertion of recombinant DNA into the host cell.** Finally, the recombinant DNA is introduced into a suitable host organism (like *E. coli*) through a process called transformation. The host cell will then replicate the recombinant DNA and produce the desired protein.

### Step 3: Final Answer:

The correct sequence of the given steps is  $C \rightarrow B \rightarrow D \rightarrow A$ . This corresponds to option (C).

#### Quick Tip

Think of Recombinant DNA Technology as a recipe: 1. **Get ingredients** (Isolate DNA - C). 2. **Chop/prepare** ingredients (Cut with enzymes - B). 3. **Make more** of the key ingredient (Amplify with PCR - D). 4. **Mix and bake** (Insert into host - A). This analogy can help you remember the sequence of steps logically.

---

### 43. Given below are two statements :

**Statement I:** Gause's 'Competitive Exclusion Principle' states that two closely related species competing for the same resources cannot co-exist indefinitely and competitively inferior one will be eliminated eventually.

**Statement II:** In general, carnivores are more adversely affected by competition than herbivores.

**In the light of the above statements, choose the correct answer from the options given below :**

- (A) Both Statement I and Statement II are true.
- (B) Both Statement I and Statement II are false.
- (C) Statement I is correct but Statement II is false.
- (D) Statement I is incorrect but Statement II is true.

**Correct Answer:** (C) Statement I is correct but Statement II is false.

#### Solution:

#### Step 1: Understanding the Question:

The question presents two statements related to ecological competition and asks to evaluate

their correctness.

### Step 2: Detailed Explanation:

#### Analysis of Statement I:

This statement provides the definition of Gause's 'Competitive Exclusion Principle'. It correctly states that when two species compete for the exact same limited resources, one will be more efficient and will eventually outcompete and eliminate the other. This is the standard and correct definition of the principle. Therefore, **Statement I is correct.**

#### Analysis of Statement II:

This statement makes a generalization that carnivores are more adversely affected by competition than herbivores. This is not necessarily true and is a false generalization. Competition can be intense at any trophic level.

- Herbivores often compete for specific host plants, which can be a very limited resource, leading to intense competition.
- Carnivores might have broader diets or larger territories, which can sometimes mitigate direct competition.
- The intensity of competition depends on the degree of niche overlap and resource limitation, not just the trophic level. For example, the introduction of an invasive herbivore can have devastating competitive effects on native herbivores.

Thus, stating that one group is "more adversely affected" in general is incorrect. Therefore, **Statement II is false.**

### Step 3: Final Answer:

Statement I is correct, and Statement II is false. This corresponds to option (C).

#### Quick Tip

Remember Gause's principle with the classic experiment on two species of \*Paramecium\*. When grown separately, both thrived. When grown together, one species always outcompeted the other for the limited food resource. This principle holds true only if the resources are limited and the species share the exact same niche.

---

**44. Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R :**

**Assertion A:** A flower is defined as modified shoot wherein the shoot apical meristem changes to floral meristem.

**Reason R:** Internode of the shoot gets condensed to produce different floral appendages laterally at successive nodes instead of leaves.

**In the light of the above statements, choose the correct answer from the options**

given below :

- (A) Both A and R are true and R is the correct explanation of A.
- (B) Both A and R are true but R is NOT the correct explanation of A.
- (C) A is true but R is false.
- (D) A is false but R is true.

**Correct Answer:** (A) Both A and R are true and R is the correct explanation of A.

**Solution:**

**Step 1: Understanding the Question:**

This is an Assertion-Reason question. We need to determine if both statements are true and if the Reason correctly explains the Assertion.

**Step 2: Detailed Explanation:**

**Analysis of Assertion A:**

The assertion states that a flower is a modified shoot where the shoot apical meristem transforms into a floral meristem. This is the fundamental botanical definition of a flower. The apical meristem, which normally produces leaves and lengthens the stem, undergoes a change to produce the parts of a flower. Hence, **Assertion A is true.**

**Analysis of Reason R:**

The reason explains the morphological changes that occur during this modification. The axis of the shoot (stem) becomes condensed, meaning the internodes do not elongate. This brings the nodes very close together. From these successive nodes, modified leaves arise, which are the floral appendages (sepals, petals, stamens, and carpels). This is a precise description of how a shoot is modified into a flower. Hence, **Reason R is true.**

**Connecting A and R:**

The Reason (R) describes the exact process of modification mentioned in the Assertion (A). It explains \*how\* the shoot is modified by detailing the condensation of internodes and the development of floral appendages from nodes. Therefore, **R is the correct explanation of A.**

**Step 3: Final Answer:**

Both Assertion A and Reason R are true, and R is the correct explanation of A. This corresponds to option (A).

**Quick Tip**

Remember the evidence for a flower being a modified shoot: 1. The thalamus (receptacle) is a condensed stem with nodes and internodes. 2. Floral parts (sepals, petals, etc.) are homologous to leaves. 3. The position of a flower (axillary or terminal) is similar to that of a branch.

---

45. Which of the following statements are correct about Klinefelter's Syndrome?  
A. This disorder was first described by Langdon Down (1866).  
B. Such an individual has overall masculine development. However, the feminine development is also expressed.  
C. The affected individual is short statured.  
D. Physical, psychomotor and mental development is retarded.  
E. Such individuals are sterile.  
Choose the correct answer from the options given below :

- (A) A and B only
- (B) C and D only
- (C) B and E only
- (D) A and E only

**Correct Answer:** (C) B and E only

**Solution:**

**Step 1: Understanding the Question:**

The question asks to identify the correct statements describing Klinefelter's Syndrome from a given list. Klinefelter's Syndrome is a chromosomal disorder characterized by the karyotype 47, XXY.

**Step 2: Detailed Explanation:**

Let's evaluate each statement:

- **A. This disorder was first described by Langdon Down (1866).** This is **incorrect**. Langdon Down described Down's Syndrome (Trisomy 21). Klinefelter's Syndrome was described by Dr. Harry Klinefelter in 1942.
- **B. Such an individual has overall masculine development. However, the feminine development is also expressed.** This is **correct**. Individuals are phenotypically male but have an extra X chromosome, leading to features like underdeveloped testes, sparse body hair, and development of breasts (gynaecomastia).
- **C. The affected individual is short statured.** This is **incorrect**. Individuals with Klinefelter's Syndrome are often taller than average, with long limbs. Short stature is a characteristic of Turner's Syndrome (45, XO).
- **D. Physical, psychomotor and mental development is retarded.** This is **incorrect**. While some individuals may have learning disabilities or delayed speech development, severe mental retardation is not a typical feature. This description is more characteristic

of Down's Syndrome.

- **E. Such individuals are sterile.** This is **correct**. The presence of an extra X chromosome leads to abnormal development of the testes (testicular atrophy), resulting in very low or no sperm production, causing sterility.

**Step 3: Final Answer:**

The correct statements are B and E. Therefore, the correct option is (C).

**Quick Tip**

Create a comparison table for the three main chromosomal disorders: Down's Syndrome (Trisomy 21), Klinefelter's Syndrome (XXY), and Turner's Syndrome (XO). List key features like karyotype, sex, stature, fertility, and mental development for each to avoid confusion.

---

**46. Melonate inhibits the growth of pathogenic bacteria by inhibiting the activity of**

- (A) Succinic dehydrogenase
- (B) Amylase
- (C) Lipase
- (D) Dinitrogenase

**Correct Answer:** (A) Succinic dehydrogenase

**Solution:**

**Step 1: Understanding the Question:**

The question asks which enzyme's activity is inhibited by malonate (spelled as 'Melonate' in the question), leading to the inhibition of bacterial growth.

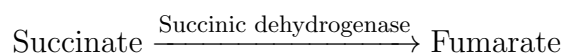
**Step 2: Key Formula or Approach:**

This question relates to the concept of enzyme inhibition, specifically competitive inhibition. A competitive inhibitor is a molecule that structurally resembles the substrate of an enzyme and competes with it for binding to the active site.

**Step 3: Detailed Explanation:**

Malonate is a classic example of a competitive inhibitor. Its chemical structure is very similar to that of succinate.

Succinate is the natural substrate for the enzyme **succinic dehydrogenase**, which catalyzes the oxidation of succinate to fumarate in the Krebs cycle (TCA cycle).



Because malonate has a similar structure to succinate, it can bind to the active site of the succinic dehydrogenase enzyme. However, the enzyme cannot act on malonate. By occupying the active site, malonate prevents the actual substrate (succinate) from binding, thereby inhibiting the enzyme's activity.

This inhibition disrupts the Krebs cycle, a central metabolic pathway for energy production. By blocking this crucial pathway, malonate inhibits cellular respiration and thus prevents the growth of pathogenic bacteria.

**Step 4: Final Answer:**

Malonate inhibits the enzyme succinic dehydrogenase. This corresponds to option (A).

**Quick Tip**

Remember the key pair for competitive inhibition: **Succinate** (substrate) and **Malonate** (inhibitor) for the enzyme **Succinic dehydrogenase**. The structural similarity is the reason for the inhibition. This is a frequently tested example in competitive exams.

---

**47. Which one of the following statements is NOT correct?**

- (A) The micro-organisms involved in biodegradation of organic matter in a sewage polluted water body consume a lot of oxygen causing the death of aquatic organisms.
- (B) Algal blooms caused by excess of organic matter in water improve water quality and promote fisheries.
- (C) Water hyacinth grows abundantly in eutrophic water bodies and leads to an imbalance in the ecosystem dynamics of the water body.
- (D) The amount of some toxic substances of industrial waste water increases in the organisms at successive trophic levels.

**Correct Answer:** (B) Algal blooms caused by excess of organic matter in water improve water quality and promote fisheries.

**Solution:**

**Step 1: Understanding the Question:**

The question asks to identify the incorrect statement among the four options related to water pollution and its ecological effects.

**Step 2: Detailed Explanation:**

Let's analyze each statement:

- **(A)** This statement is **correct**. When sewage with high organic matter is discharged into water, decomposer microorganisms multiply rapidly. Their respiration consumes a large amount of dissolved oxygen (DO) from the water. This sharp decrease in DO can lead to

the death of fish and other aquatic organisms. This is related to high Biochemical Oxygen Demand (BOD).

- **(B)** This statement is **incorrect**. Algal blooms are a result of nutrient enrichment (eutrophication), often from organic pollution. While algae produce oxygen during the day, their massive growth has severe negative consequences. They block sunlight to submerged plants, and when they die, decomposers consume vast amounts of oxygen, leading to hypoxia or anoxia (severe oxygen depletion). This kills fish and drastically **deteriorates** water quality. It certainly does not "promote fisheries."
- **(C)** This statement is **correct**. Water hyacinth (*Eichhornia crassipes*) is a notorious invasive aquatic weed that thrives in nutrient-rich (eutrophic) water bodies. Its rapid growth covers the water surface, disrupting the ecosystem by blocking light and leading to oxygen depletion when the plants die and decay.
- **(D)** This statement is **correct**. This describes the phenomenon of **biomagnification** (or bioaccumulation). Certain toxic substances like DDT and mercury are not metabolized or excreted and accumulate in an organism's tissues. As these organisms are consumed by others higher up the food chain, the concentration of the toxin increases at each successive trophic level.

### Step 3: Final Answer:

The statement that is not correct is (B).

#### Quick Tip

Associate algal blooms with the term 'eutrophication'. Remember that despite the initial 'bloom' of life, the ultimate consequence of eutrophication is oxygen depletion and a decline in water quality and biodiversity, often leading to fish kills.

---

### 48. Which of the following combinations is required for chemiosmosis?

- (A) membrane, proton pump, proton gradient, ATP synthase
- (B) membrane, proton pump, proton gradient, NADP synthase
- (C) proton pump, electron gradient, ATP synthase
- (D) proton pump, electron gradient, NADP synthase

**Correct Answer:** (A) membrane, proton pump, proton gradient, ATP synthase

**Solution:**

**Step 1: Understanding the Question:**

The question asks for the essential components required for the process of chemiosmosis, which is the mechanism for ATP synthesis in both cellular respiration and photosynthesis.

**Step 2: Detailed Explanation:**

According to Peter Mitchell's chemiosmotic hypothesis, the synthesis of ATP is coupled to the transport of electrons and the movement of protons. The process requires four key components:

1. **A membrane:** An intact inner mitochondrial membrane (for respiration) or a thylakoid membrane (for photosynthesis) is required. This membrane separates two compartments and is impermeable to protons ( $H^+$ ).
2. **A proton pump:** As electrons move through the electron transport chain embedded in the membrane, energy is released. This energy is used by protein complexes in the chain to actively pump protons from one side of the membrane to the other (e.g., from the mitochondrial matrix to the intermembrane space).
3. **A proton gradient:** The pumping of protons creates a concentration gradient and an electrical potential across the membrane. This electrochemical gradient of protons is also known as the proton motive force, which stores potential energy.
4. **ATP synthase:** This is a large enzyme complex embedded in the membrane. It has a channel that allows protons to flow back down their electrochemical gradient. The energy released by this flow of protons is used by ATP synthase to catalyze the synthesis of ATP from ADP and inorganic phosphate (Pi).

Option (A) lists all four of these essential components. Options (C) and (D) incorrectly mention an "electron gradient" instead of a "proton gradient". Options (B) and (D) mention "NADP synthase," which is not the correct term; the enzyme is ATP synthase. (NADP reductase is an enzyme in photosynthesis, but it reduces  $NADP^+$  to NADPH, it doesn't synthesize NADP).

**Step 3: Final Answer:**

The correct combination required for chemiosmosis is a membrane, a proton pump, a proton gradient, and ATP synthase. This corresponds to option (A).

### Quick Tip

Use the analogy of a hydroelectric dam to remember chemiosmosis:

- **Dam** = Membrane
- **Pump forcing water up** = Proton Pump
- **Water stored at high level** = Proton Gradient
- **Turbine generating electricity** = ATP Synthase

49. Identify the correct statements :

- A. Lenticels are the lens-shaped openings permitting the exchange of gases.
- B. Bark formed early in the season is called hard bark.
- C. Bark is a technical term that refers to all tissues exterior to vascular cambium.
- D. Bark refers to periderm and secondary phloem.
- E. Phellogen is single-layered in thickness.

Choose the correct answer from the options given below :

- (A) B, C and E only
- (B) A and D only
- (C) A, B and D only
- (D) B and C only

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

**Solution:**

**Step 1: Understanding the Question:**

The question asks to identify the correct statements about plant anatomy, specifically related to bark and associated structures.

**Step 2: Detailed Explanation:**

Let's evaluate each statement:

- **A. Lenticels are the lens-shaped openings permitting the exchange of gases.** This is **correct**. Lenticels are porous tissues consisting of cells with large intercellular spaces, found in the bark of woody stems and roots. They serve as a pathway for direct gas exchange between the internal tissues and the atmosphere.
- **B. Bark formed early in the season is called hard bark.** This is **incorrect**. Bark formed early in the season (spring) is called 'early' or 'soft' bark, while that formed late in the season (autumn) is called 'late' or 'hard' bark.

- **C. Bark is a technical term that refers to all tissues exterior to vascular cambium.** This statement is generally considered correct in a broad sense, but D is more specific and botanically precise. Bark is a non-technical term, but in botany, it encompasses all tissues outside the vascular cambium. However, some consider this definition less precise than D. Let's compare with D.
- **D. Bark refers to periderm and secondary phloem.** This is a more precise and commonly accepted definition of bark in botanical terms. The periderm (phellem, phellogen, phelloderm) is the outermost protective layer, and the secondary phloem is the inner bark. Together, they constitute what is commonly called bark. This is **correct**. Since both C and D are given, D is the better, more specific definition. In the context of MCQs where one must choose the 'most' correct statements, D is preferred over the more general C. The question asks for correct statements, and since the combination A and D exists, it implies C might be considered incorrect in this context.
- **E. Phellogen is single-layered in thickness.** This is **incorrect**. Phellogen, or cork cambium, is a meristematic tissue. Like the vascular cambium, it is typically composed of one or a few layers of cells, not strictly a single layer.

### Step 3: Final Answer:

Statements A and D are the most accurate and correct descriptions. Therefore, the correct option is (B).

#### Quick Tip

To remember the components of bark, think from the outside in: Bark = Periderm + Secondary Phloem. And remember that Periderm itself is composed of three layers: Phellem (cork), Phellogen (cork cambium), and Phelloderm (secondary cortex). All of these are outside the vascular cambium.

**50. Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R :**

**Assertion A:** In gymnosperms the pollen grains are released from the microsporangium and carried by air currents.

**Reason R:** Air currents carry the pollen grains to the mouth of the archegonia where the male gametes are discharged and pollen tube is not formed.

**In the light of the above statements, choose the correct answer from the options given below :**

- (A) Both A and R are true and R is the correct explanation of A.
- (B) Both A and R are true but R is NOT the correct explanation of A.
- (C) A is true but R is false.

(D) A is false but R is true.

**Correct Answer:** (C) A is true but R is false.

**Solution:**

**Step 1: Understanding the Question:**

This is an Assertion-Reason question about pollination and fertilization in gymnosperms. We must evaluate the truthfulness of both statements and the relationship between them.

**Step 2: Detailed Explanation:**

**Analysis of Assertion A:**

The assertion states that gymnosperm pollen is released from the microsporangium and carried by wind (air currents). This is the definition of anemophily (wind pollination), which is the characteristic mode of pollination in most gymnosperms (like *Pinus*, *Cycas*). Therefore, **Assertion A is true.**

**Analysis of Reason R:**

The reason describes the events after pollination. It correctly states that air currents carry the pollen grains to the ovule (which contains the archegonia). However, it incorrectly states that "the male gametes are discharged and pollen tube is not formed." This is the crucial error. In all gymnosperms (and angiosperms), the pollen grain germinates on the ovule to form a pollen tube. This pollen tube grows towards the archegonium and then discharges the non-motile male gametes near the egg cell to facilitate fertilization. The formation of a pollen tube (siphonogamy) is a key feature of seed plants. Therefore, the statement "pollen tube is not formed" makes the entire **Reason R false.**

**Step 3: Final Answer:**

Assertion A is a true statement, but Reason R is a false statement. This corresponds to option (C).

#### Quick Tip

Remember that the evolution of the pollen grain and the pollen tube were crucial adaptations for plants to colonize land. The pollen tube eliminates the need for water for fertilization, a requirement for bryophytes and pteridophytes. Both gymnosperms and angiosperms exhibit this feature (siphonogamy).