NEET UG 2023 G3 Botany Question Paper with Solutions

Time Allowed :3 Hour 20 Minutes	**Maximum Marks :**720	**Total Questions :**200

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

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

(A) Transcription of only snRNAs
(B) Transcription of rRNAs (28S, 18S and 5.8S)

(C) Transcription of tRNA, 5 srRNA and snRNA
(D) Transcription of precursor of mRNA

Correct Answer: (C) Transcription of tRNA, 5 srRNA and snRNA

Solution:

Step 1: Understanding the Question:
The question asks for the specific function of RNA polymerase III in the transcription process within eukaryotic cells.

Step 2: Detailed Explanation:
In eukaryotes, there are three main types of RNA polymerases, each responsible for transcribing different types of RNA:

- **RNA Polymerase I:** Located in the nucleolus, it transcribes most ribosomal RNAs (rRNAs), specifically the 28S, 18S, and 5.8S rRNA genes.

- **RNA Polymerase II:** Located in the nucleoplasm, it transcribes the precursor of messenger RNA (pre-mRNA), which is then processed to form mRNA. It also transcribes most small nuclear RNAs (snRNAs) and microRNAs (miRNAs).

- **RNA Polymerase III:** Located in the nucleoplasm, it transcribes transfer RNA (tRNA), 5S rRNA (a component of the ribosome), and some small nuclear RNAs (snRNAs), such as U6 snRNA.

Based on these functions, option (C) correctly identifies the products of RNA polymerase III transcription.
Option (A) is incorrect because Pol III transcribes more than just snRNAs.
Option (B) is incorrect as these rRNAs are transcribed by RNA Polymerase I.
Option (D) is incorrect as the precursor of mRNA is transcribed by RNA Polymerase II.

Step 3: Final Answer:
Therefore, the role of RNA polymerase III is the transcription of tRNA, 5S rRNA, and some snRNAs.

Quick Tip

Create a simple table to memorize the functions of the three eukaryotic RNA polymerases. For example: Pol I $\rightarrow$ rRNA (most), Pol II $\rightarrow$ mRNA, Pol III $\rightarrow$ tRNA and 5S rRNA. This makes it easy to recall during an exam.

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

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

Correct Answer: (A) Active Transport

Solution:

Step 1: Understanding the Question:
The question asks to identify the transport mechanism responsible for moving ions across a membrane from a region of lower concentration to a region of higher concentration, which is "against their concentration gradient."

Step 2: Detailed Explanation:
Let's analyze the given options:

- **Active Transport:** This process moves substances (like ions) across a cell membrane against their concentration gradient (from low to high concentration). This movement requires energy, typically in the form of ATP (adenosine triphosphate).

- **Osmosis:** This is the movement of water molecules across a selectively permeable membrane from a region of high water potential to a region of low water potential. It does not directly involve the transport of ions against their gradient.

- **Facilitated Diffusion:** This is a type of passive transport where substances move across membranes down their concentration gradient (from high to low concentration) with the help of membrane proteins (channels or carriers). It does not require energy.

- **Passive Transport:** This is the general term for the movement of substances across a membrane without the use of metabolic energy, following the concentration gradient. Simple diffusion and facilitated diffusion are types of passive transport.

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

Step 3: Final Answer:
The movement of ions against their concentration gradient is explained by active transport, which requires energy expenditure.

Quick Tip

Remember the key distinction: "Down the gradient" (high to low concentration) = Passive Transport (no energy). "Against the gradient" (low to high concentration) = Active Transport (requires energy).

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

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

Correct Answer: (A) Bright orange colour

Solution:

Step 1: Understanding the Question:
The question asks about the appearance of DNA stained with ethidium bromide when it is exposed to ultraviolet (UV) light.

Step 2: Detailed Explanation:
Ethidium bromide (EtBr) is a fluorescent dye commonly used in molecular biology laboratories to visualize DNA in agarose gel electrophoresis.

- EtBr works by intercalating, or inserting itself, between the base pairs of the DNA double helix.
- When the gel containing the EtBr-stained DNA is placed under a UV transilluminator, the EtBr molecules absorb the UV radiation.
- This absorption of energy excites the EtBr molecules, causing them to fluoresce.
- The light emitted during this fluorescence is in the orange part of the visible spectrum.

Therefore, the DNA bands on the gel appear as a bright orange colour. The other colours listed are incorrect for EtBr staining.

Step 3: Final Answer:
DNA stained with ethidium bromide fluoresces with a bright orange colour under UV radiation.

Quick Tip

This is a standard technique in molecular biology. Associate Ethidium Bromide (EtBr) + DNA + UV light with "bright orange bands". This is a frequently asked direct recall question.

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

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

Correct Answer: (B) 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 2: Detailed Explanation:
Let's examine the units provided:

- **Kilobase (kb):** A unit of length for DNA or RNA sequences, equal to 1000 base pairs. Not used for atmospheric measurements.
- **Dobson units (DU):** This is the standard unit used to measure the total amount of ozone in a vertical column of air in the atmosphere. One Dobson Unit is the number of molecules of ozone that would be 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):** A logarithmic unit used to measure the intensity of sound.
- **Decameter (dam):** A unit of length equal to 10 meters. While a unit of thickness, it is not the specialized unit used for the ozone layer.

The correct unit specifically for ozone layer thickness is the Dobson unit.

Step 3: Final Answer:
The thickness of the ozone layer is measured in Dobson Units.

Quick Tip

Associate "Ozone layer" with "Dobson Units". This is a key factual point in environmental science and ecology topics. Remember that the other units are from completely different fields of science.

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105. Among eukaryotes, replication of DNA takes place in

(A) G_2 phase
(B) M phase
(C) S phase
(D) G_1 phase

Correct Answer: (C) 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 2: Detailed Explanation:
The eukaryotic cell cycle is divided into two main stages: Interphase and the M phase (Mitotic phase). Interphase is further subdivided into three phases:

- **G_1 phase (Gap 1):** This is the first growth phase where the cell grows and carries out normal metabolic functions.
- **S phase (Synthesis phase):** This is the phase where the cell synthesizes a complete copy of the DNA in its nucleus. DNA replication occurs during this stage. The amount of DNA in the cell doubles.
- **G_2 phase (Gap 2):** The cell continues to grow and prepares for mitosis. It synthesizes proteins and organelles needed for cell division.
- **M phase (Mitotic phase):** This is the phase of actual cell division, which includes mitosis (nuclear division) and cytokinesis (cytoplasmic division).

Therefore, DNA replication is confined to the S phase of the cell cycle.

Step 3: Final Answer:
In eukaryotes, DNA replication takes place during the S phase of the cell cycle.

Quick Tip

Remember the mnemonic for the cell cycle: Go (G_1) -¿ Sally (S) -¿ Go (G_2) -¿ Make (M) -¿ Cookies (Cytokinesis). The 'S' for Sally stands for Synthesis, which is when DNA replication happens.

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

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

Correct Answer: (C) Gibberellic Acid

Solution:

Step 1: Understanding the Question:
The question asks to identify the plant hormone (phytohormone) that can be used to speed up the maturation process in young conifer trees, leading to earlier production of seeds.

Step 2: Detailed Explanation:
Let's review the primary functions of the given phytohormones:

- **Abscisic Acid (ABA):** Generally known as a stress hormone, it induces dormancy, stomatal closure, and abscission (shedding of leaves/fruits). It inhibits growth.

- **Indole-3-butyric Acid (IBA):** This is an auxin. Auxins are primarily involved in root initiation, apical dominance, and cell elongation. IBA is commonly used as a rooting hormone for cuttings.

- **Gibberellic Acid (GA):** Gibberellins have a wide range of effects, including promoting stem elongation (bolting), breaking seed dormancy, and inducing flowering and fruit development. A key commercial application is spraying juvenile conifers with GA to hasten maturity and promote early seed cone production for breeding programs.

- **Zeatin:** This is a type of cytokinin. Cytokinins promote cell division (cytokinesis), chloroplast development, and delay senescence (aging). They work in conjunction with auxins to control differentiation.

The specific function of hastening maturity in conifers to induce early seed production is a well-known effect of Gibberellic Acid.

Step 3: Final Answer:
Spraying juvenile conifers with Gibberellic Acid helps in hastening their maturity period, leading to early seed production.

Quick Tip

Associate Gibberellins (GA) with "bolting" (rapid stem elongation before flowering) and overcoming juvenility. This makes it easier to remember their role in promoting flowering and seed production.

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

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

Solution:

Step 1: Understanding the Question:
The question presents two statements about transpiration and asks to evaluate their correctness.

Step 2: Detailed Explanation:
Analysis of Statement I:
This statement refers to the transpiration pull, which is the main driver of water movement in the xylem according to the cohesion-tension theory. The combined forces of cohesion (water molecules sticking together), adhesion (water molecules sticking to xylem walls), and the tension created by evaporation from leaves (transpiration) can generate a very strong negative pressure potential. This force is sufficient to pull water up to the tops of the tallest trees, such as the coastal redwood (*Sequoia sempervirens*), which can exceed 100 meters. Therefore, lifting water over 130 meters is within the capability of this mechanism. Statement I is correct.

Analysis of Statement II:
Transpiration is the process of water evaporating from the leaf surface. 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 behind the cooler molecules. This process of evaporative cooling can significantly lower the temperature of the leaf surface, often by 10 to 15 degrees Celsius, protecting the leaves from overheating in direct sunlight. Statement II is correct.

Step 3: Final Answer:
Since both statements accurately describe phenomena related to transpiration, both Statement I and Statement II are correct.

Quick Tip

For questions with two statements, analyze each one independently first. Determine if it's true or false on its own before looking at the combined options. This prevents confusion.

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

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

Correct Answer: (C) 1992

Solution:

Step 1: Understanding the Question:
The question asks for the year in which the historic "Earth Summit," which led to the Convention on Biological Diversity, was held in Rio de Janeiro.

Step 2: Detailed Explanation:
The United Nations Conference on Environment and Development (UNCED), popularly known as the Earth Summit or the Rio Summit, was a major international conference held in Rio de Janeiro, Brazil.

- The summit took place from June 3 to June 14, **1992**.
- It was a landmark event that brought global attention to environmental issues and sustainable development.

- One of the key outcomes of the summit was the signing of the Convention on Biological Diversity (CBD), a multilateral treaty with objectives for conserving biological diversity, the sustainable use of its components, and the fair sharing of benefits from genetic resources.

The other years are incorrect. The World Summit on Sustainable Development was held in Johannesburg in 2002.

Step 3: Final Answer:
The Earth Summit was held in Rio de Janeiro in 1992.

Quick Tip

The 1992 Rio Earth Summit is a critical date in environmental history. Memorize this year along with its key outcomes, such as the Convention on Biological Diversity (CBD) and the Framework Convention on Climate Change (UNFCCC).

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

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

Correct Answer: (B) manganese

Solution:

Step 1: Understanding the Question:
The question asks to identify the micronutrient that is essential for the photolysis (splitting) of water during the light-dependent reactions of photosynthesis.

Step 2: Detailed Explanation:
The splitting of water molecules (H_2O) into protons (H^+), electrons (e^-), and oxygen (O_2) occurs in Photosystem II (PS II). This reaction is catalyzed by the Oxygen Evolving Complex (OEC).

$$2H_2O \rightarrow 4H^+ + 4e^- + O_2$$

The core of the OEC is a cluster of four **manganese** ions (Mn) and one calcium ion (Ca^{2+}), which are stabilized by proteins. The manganese ions cycle through different oxidation states to catalyze the water-splitting reaction. Therefore, manganese is the essential micronutrient for this process.

Let's look at the other options:

- **Copper (Cu):** A component of plastocyanin, an electron carrier protein in the electron transport chain between PS II and PS I.

- **Molybdenum (Mo):** A component of enzymes like nitrogenase (for nitrogen fixation) and nitrate reductase.

- **Magnesium (Mg):** A macronutrient, not a micronutrient. It is the central atom in the chlorophyll molecule, essential for capturing light energy, but not directly involved in splitting water.

Step 3: Final Answer:
Manganese (Mn) is the crucial micronutrient required for the splitting of water molecules during photosynthesis.

Quick Tip

Remember the key roles of micronutrients in photosynthesis: Mn for water splitting, Cu in plastocyanin, and Mg (a macronutrient) as the core of chlorophyll.

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

Correct Answer: (B) 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 and a reason related to the consumption of ATP during glycolysis. 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:
Glycolysis is a 10-step pathway that breaks down glucose. The initial part of the pathway is known as the preparatory or investment phase, where energy (in the form of ATP) is consumed to prepare the glucose molecule for cleavage. In this phase, ATP is indeed used at two specific steps. So, Assertion A is true.

Analysis of Reason R:
The reason specifies the two steps where ATP is used:

1. **Step 1:** Glucose is phosphorylated to glucose-6-phosphate. This reaction is catalyzed by the enzyme hexokinase and consumes one molecule of ATP.

$$\text{Glucose} + \text{ATP} \rightarrow \text{Glucose-6-phosphate} + \text{ADP}$$

2. **Step 3:** Fructose-6-phosphate is phosphorylated to fructose-1,6-bisphosphate. (Note: "diphosphate" is an older term, "bisphosphate" is preferred but both refer to the same molecule). This reaction is catalyzed by phosphofructokinase-1 (PFK-1) and consumes a second molecule of ATP.

$$\text{Fructose-6-phosphate} + \text{ATP} \rightarrow \text{Fructose-1,6-bisphosphate} + \text{ADP}$$

The reason correctly identifies the exact two steps of ATP consumption in glycolysis. So, Reason R is true.

Conclusion:
Since Assertion A states that ATP is used in two steps, and Reason R correctly lists these two steps, Reason R is the correct explanation for Assertion A.

Step 3: Final Answer:
Both Assertion A and Reason R are true, and R is the correct explanation of A.

Quick Tip

For Assertion-Reason questions, follow a systematic approach: 1. Check if Assertion (A) is true. 2. Check if Reason (R) is true. 3. If both are true, check if R correctly explains A by asking "Is A true because of R?".

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

(A) wind pollinated plants
(B) insect pollinated plants

(C) bird pollinated plants
(D) bat pollinated plants

Correct Answer: (B) insect pollinated plants

Solution:

Step 1: Understanding the Question:
The question describes a set of floral characteristics (large, colourful, fragrant, with nectar) and asks to identify the corresponding mode of pollination.

Step 2: Detailed Explanation:
Plants have evolved specific floral traits to attract different types of pollinators. This is known as pollination syndrome. Let's analyze the traits given:

- **Large and Colourful Flowers:** These are visual signals to attract pollinators from a distance. Insects, especially bees and butterflies, have good colour vision.

- **Fragrant Flowers:** Scent is a chemical attractant, especially for insects like moths (at night) and bees.

- **Nectar:** This is a sugary fluid that serves as a food reward for the pollinator.

These characteristics—visual appeal, scent, and a food reward—are classic adaptations for attracting insects. This is called **entomophily**.
Let's consider other options:

- **Wind pollinated (anemophilous) plants:** Flowers are typically small, inconspicuous, not colourful, lack nectar and scent, and produce large amounts of light, dusty pollen.

- **Bird pollinated (ornithophilous) plants:** Flowers are often large, brightly coloured (especially red or orange), have little to no scent (birds have a poor sense of smell), and produce copious amounts of dilute nectar.

- **Bat pollinated (chiropterophilous) plants:** Flowers are typically large, pale or white, open at night, and have a strong, musty or fruity odour.

The combination of being colourful AND fragrant is most characteristic of insect pollination.

Step 3: Final Answer:
The combination of large, colourful, fragrant flowers with nectar is a hallmark of insect pollinated plants.

Quick Tip

Think of floral characteristics as "advertisements" for pollinators. Bright colors and sweet smells attract insects, just like advertisements attract customers. Wind-pollinated plants don't need to advertise, so their flowers are plain and functional.

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

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

Solution:

Step 1: Understanding the Question:
This is an Assertion-Reason question about the life cycle of a moss. We need to evaluate both statements and their relationship.

Step 2: Detailed Explanation:
Analysis of Assertion A:
The life cycle of a moss (a bryophyte) shows a dominant gametophyte generation. When a haploid spore germinates, it first develops into a filamentous, branching, green structure called the protonema. This is the juvenile, or first stage, of the gametophyte. Later, buds arise from the protonema, which develop into the mature, leafy gametophyte (gametophore). Therefore, Assertion A is correct.

Analysis of Reason R:
The sporophyte generation in mosses ends with the capsule (sporangium), which produces haploid spores through meiosis. When these spores are released and land on a suitable substrate, they germinate and grow directly into the protonema. Therefore, the statement that the protonema develops directly from spores produced in the capsule is correct. Reason R is correct.

Conclusion:
Assertion A states that the protonema is the first stage of the gametophyte. Reason R explains how this protonema stage originates (from a spore). Thus, Reason R provides the correct explanation for Assertion A.

Step 3: Final Answer:
Both Assertion A and Reason R are correct, and R is the correct explanation of A.

Quick Tip

To master bryophyte life cycles, draw a simple diagram: Spore (n) → Germination → Protonema (n) → Leafy Gametophyte (n) → Gametes (n) → Fertilization → Zygote (2n) → Sporophyte (2n) → Meiosis in Capsule → Spores (n). This visual aid helps clarify the sequence of stages.

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113. Which of the following stages of meiosis involves division of centromere?

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

Correct Answer: (D) Anaphase II

Solution:

Step 1: Understanding the Question:
The question asks to identify the specific stage of meiosis where the centromeres, which hold sister chromatids together, divide.

Step 2: Detailed Explanation:
Meiosis consists of two successive nuclear divisions, Meiosis I and Meiosis II.

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

- **Meiosis II:** This is the equational division, and it is very similar to mitosis.
  - In **Metaphase II**, individual chromosomes (each consisting of two sister chromatids) align at the metaphase plate.
  - In **Anaphase II**, the centromeres finally divide (split). This allows the sister chromatids to separate and move to opposite poles. Once separated, each chromatid is now considered an individual chromosome.
- Telophase and Metaphase I do not involve centromere division.

Therefore, the division of the centromere occurs during Anaphase II.

Step 3: Final Answer:
The division of the centromere in meiosis occurs during Anaphase II.

Quick Tip

Remember this key difference: Anaphase I separates homologous chromosomes. Anaphase II separates sister chromatids. The separation of sister chromatids is only possible after the centromere divides.

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

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

Correct Answer: (D) 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 in angiosperms that are haploid (n), diploid (2n), and triploid (3n), respectively.

Step 2: Detailed Explanation:
In angiosperms, double fertilization occurs. The embryo sac (female gametophyte) contains several cells with different ploidy levels before and after fertilization.

- **Haploid (n) structures:** Before fertilization, the egg cell, synergids, and antipodal cells are all haploid. After fertilization, the synergids and antipodals degenerate, but they are still considered haploid structures of the embryo sac.

- **Diploid (2n) structure:** One male gamete (n) fuses with the egg cell (n) to form the **zygote**, which is diploid (2n). The zygote develops into the embryo.

- **Triploid (3n) structure:** The other male gamete (n) fuses with the central cell, which contains two polar nuclei (n + n). This fusion results in the **Primary Endosperm Nucleus (PEN)**, which is triploid (3n). The PEN develops into the endosperm, a nutritive tissue.

Now let's check the options for the sequence: haploid, diploid, triploid.

- (A) Synergids (n), antipodals (n), Polar nuclei (n+n, not a single structure after fertilization) - Incorrect sequence.
- (B) Synergids (n), Primary endosperm nucleus (3n), zygote (2n) - Incorrect order.
- (C) Antipodals (n), synergids (n), primary endosperm nucleus (3n) - Incorrect sequence.
- (D) Synergids (n), Zygote (2n), and Primary endosperm nucleus (3n) - Correct sequential order of ploidy (n, 2n, 3n).

Step 3: Final Answer:
The correct sequence of haploid, diploid, and triploid structures is Synergids (n), Zygote (2n), and Primary endosperm nucleus (3n).

Quick Tip

Memorize the products of double fertilization: 1. Sperm (n) + Egg (n) $\rightarrow$ Zygote (2n) 2. Sperm (n) + 2 Polar Nuclei (n+n) $\rightarrow$ Primary Endosperm Nucleus (3n) This will help you quickly identify the ploidy of key structures in a fertilized embryo sac.

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115. Expressed Sequence Tags (ESTs) refers to

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

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

Solution:

Step 1: Understanding the Question:
The question asks for the correct definition of Expressed Sequence Tags (ESTs).

Step 2: Detailed Explanation:
The term "Expressed Sequence Tag" itself gives a clue.

- **Expressed:** This refers to gene expression, which is the process of a gene's information being used to synthesize a functional gene product. The primary step of expression is transcription, where a gene's DNA sequence is copied into an RNA molecule (mRNA, tRNA, rRNA, etc.).

- **Sequence Tag:** This refers to a short subsequence of a DNA sequence.

ESTs are generated by sequencing short fragments of complementary DNA (cDNA). cDNA is synthesized from messenger RNA (mRNA) using the enzyme reverse transcriptase. Since mRNA is the product of gene transcription, cDNA represents the sequences of genes that are being expressed (transcribed into RNA) in a particular cell or tissue at a particular time. Therefore, ESTs are tags or markers for genes that are expressed as RNA. Option (B) is the most accurate description.

- Option (A) is too restrictive; ESTs represent all expressed genes found in the cDNA library, not just "certain important" ones.

- Option (C) is incorrect because not all transcribed RNAs are translated into proteins (e.g., rRNA, tRNA). ESTs are derived from all mRNA, regardless of whether it's translated.

- Option (D) is incorrect because ESTs only represent expressed genes, not unexpressed genes (which are not transcribed into mRNA).

Step 3: Final Answer:
Expressed Sequence Tags (ESTs) refer to all genes that are expressed as RNA.

Quick Tip

Break down the term: "Expressed" means transcribed into RNA. "Sequence Tag" means a piece of a sequence. So, ESTs are pieces of sequences from transcribed (expressed) genes. This helps in deducing the correct answer.

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

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

Solution:

Step 1: Understanding the Question:
The question presents two statements about the arrangement of xylem in plants (endarch and exarch) and asks for an evaluation of their correctness.

Step 2: Detailed Explanation:
Analysis of Statement I:
The terms "endarch" and "exarch" describe the pattern of development of **primary xylem**, not secondary xylem. These terms refer to the position of the first-formed primary xylem (protoxylem) relative to 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.

Secondary xylem is formed by the vascular cambium during secondary growth and does not follow this developmental pattern. Therefore, Statement I is incorrect.

Analysis of Statement II:
As explained above, the exarch arrangement of primary xylem (protoxylem on the outside, metaxylem on the inside) is the defining characteristic of the vascular bundles in the roots of vascular plants. Therefore, Statement II is true.

Step 3: Final Answer:
Based on the analysis, Statement I is incorrect, and Statement II is true.

Quick Tip

Use a mnemonic to remember the xylem arrangement: "Exarch in roots, Endarch in stems." The 'x' in exarch can remind you of the 'x' shape xylem often forms in a root cross-section. Also, remember these terms apply only to primary xylem.

---

117. What is the function of tassels in the corn cob?

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

Correct Answer: (C) To trap pollen grains

Solution:

Step 1: Understanding the Question:
The question asks for the function of "tassels in the corn cob". This phrasing is slightly ambiguous, as the tassel and the cob are separate parts of the corn plant. The tassel is the male inflorescence at the top, and the cob is the ear that bears the female flowers and kernels. The structures emerging from the cob are called silks. It is highly likely the question is referring to the function of these silks.

Step 2: Detailed Explanation:
Let's clarify the botanical terms for a corn plant (maize):

- **Tassel:** This is the male flower cluster located at the apex (top) of the plant. Its function is to produce and **disperse pollen grains** into the wind. So, option (D) is the function of the actual tassel.

- **Ear (Cob):** This is the female inflorescence located on a side shoot. It develops into the fruit (the "corn on the cob").

- **Silks:** These are the long, thread-like structures that emerge from the tip of the ear. Each silk is a style and stigma. The function of the silks is to **trap airborne pollen grains**. Each silk is connected to an ovule, and successful pollination of a silk leads to the fertilization of that ovule, which then develops into a corn kernel.

Given the options and the phrasing "in the corn cob", the question is almost certainly asking about the function of the silks, not the tassel at the top of the plant. The function of the silks is to trap pollen grains.

- (A) To protect seeds: The husk protects the seeds (kernels).
- (B) To attract insects: Corn is wind-pollinated, not insect-pollinated.
- (C) To trap pollen grains: This is the function of the silks on the cob.
- (D) To disperse pollen grains: This is the function of the tassel at the top of the plant.

Based on the likely intent of the question, option (C) is the correct answer.

Step 3: Final Answer:
Assuming "tassels in the corn cob" refers to the silks emerging from the cob, their function is to trap pollen grains.

Quick Tip

Be aware that exam questions sometimes use common or slightly inaccurate terminology. The Tassel (top) produces pollen, and the Silk (on the cob) receives it. Understanding the function of both parts helps you deduce the intended answer even with confusing wording.

---

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

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

Correct Answer: (C) Pachytene

Solution:

Step 1: Understanding the Question:
The question asks to identify the specific substage of Prophase I of meiosis where recombination nodules are observed.

Step 2: Detailed Explanation:
Prophase I is the longest phase of meiosis and is divided into five substages:

1. **Leptotene:** Chromosomes start to condense and become visible.
2. **Zygotene:** Homologous chromosomes pair up in a process called synapsis, forming bivalents. The synaptonemal complex begins to form.
3. **Pachytene:** Synapsis is complete. The paired chromosomes are called bivalents or tetrads. This is the stage where **crossing over** occurs between non-sister chromatids of homologous chromosomes. The sites where crossing over happens are marked by the appearance of protein complexes called **recombination nodules**. These nodules contain the enzymes necessary to cut and rejoin the DNA strands.
4. **Diplotene:** The synaptonemal complex dissolves, and the homologous chromosomes start to separate, but they remain attached at the sites of crossing over, which are now visible as chiasmata.
5. **Diakinesis:** Chromosomes become fully condensed, and the chiasmata terminalize (move towards the ends of the chromatids). The nuclear envelope breaks down.

Therefore, recombination nodules, which are the sites of crossing over, appear during the Pachytene stage.

Step 3: Final Answer:
The appearance of recombination nodules occurs during the Pachytene substage of prophase I.

Quick Tip

Remember the sequence of Prophase I: Leptotene, Zygotene, Pachytene, Diplotene, Diakinesis (LZPDD). A mnemonic like "Lazy Zebra Painted Purple During Day" can help. Associate Pachytene with "Packing together" and "Crossover".

---

119. The phenomenon of pleiotropism refers to

(A) more than two genes affecting a single character.
(B) presence of several alleles of a single gene controlling a single crossover.
(C) presence of two alleles, each of the two genes controlling a single trait.
(D) a single gene affecting multiple phenotypic expression.

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

Solution:

Step 1: Understanding the Question:
The question asks for the definition of pleiotropism (or pleiotropy).

Step 2: Detailed Explanation:
Let's analyze the definition and compare it with the options.
Pleiotropy is a condition in which a single gene influences two or more seemingly unrelated phenotypic traits. A mutation in a pleiotropic gene can have a range of effects on the organism. A classic example is phenylketonuria (PKU), an inherited disorder in humans. A single gene that codes for the enzyme phenylalanine hydroxylase is mutated. This single genetic defect leads to multiple phenotypic consequences, including mental retardation, reduced hair and skin pigmentation, and eczema.
Now let's examine the given options:

- (A) more than two genes affecting a single character: This describes **polygenic inheritance**, the opposite of pleiotropy.
- (B) presence of several alleles of a single gene controlling a single crossover: This describes **multiple alleles**, which relates to the variety of alleles for a single gene in a population, not the number of traits a single gene affects. Crossover is a separate meiotic process.
- (C) presence of two alleles, each of the two genes controlling a single trait: This is a confusing statement but does not describe pleiotropy.
- (D) a single gene affecting multiple phenotypic expression: This is the correct definition of pleiotropy.

Step 3: Final Answer:
The phenomenon of pleiotropism refers to a single gene affecting multiple phenotypic expressions.

Quick Tip

To avoid confusion, remember:

- **Pleiotropy:** One gene → Many traits (e.g., PKU, sickle-cell anemia).
- **Polygenic Inheritance:** Many genes → One trait (e.g., skin color, height).

They are inverse concepts.

---

120. 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) D, E, A only
(B) A, B, C only
(C) B, C, D only
(D) C, D, E only

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

Solution:

Step 1: Understanding the Question:
The question asks to identify the correct statements related to the process of decomposition from the given list.

Step 2: Detailed Explanation:
Let's analyze each statement:

- **A. Detrivores perform fragmentation.** Detrivores, such as earthworms, break down dead organic matter (detritus) into smaller particles. This process is known as fragmentation. This statement is **correct**.

- **B. The humus is further degraded by some microbes during mineralization.** Humus is a dark, amorphous substance that is highly resistant to microbial action and decomposes at an extremely slow rate. Microbes degrade humus to release inorganic nutrients, a process called mineralization. This statement is **correct**.

- **C. Water soluble inorganic nutrients go down into the soil and get precipitated by a process called leaching.** Leaching is the process where water-soluble inorganic nutrients percolate down into the soil horizon and can become unavailable as precipitated salts. This statement is **correct**.

- **D. The detritus food chain begins with living organisms.** The detritus food chain (DFC) begins with dead organic matter (detritus). The grazing food chain (GFC) begins with living organisms (producers). This statement is **incorrect**.

- **E. Earthworms break down detritus into smaller particles by a process called catabolism.** Earthworms perform fragmentation. Catabolism is the enzymatic breakdown of detritus into simpler inorganic substances by bacteria and fungi. This statement is **incorrect**.

Step 3: Final Answer:
Statements A, B, and C are correct. Therefore, the correct option includes only these three statements.

Quick Tip

Remember the three main steps of decomposition in order: Fragmentation (physical breakdown by detritivores), Leaching (washing away of soluble nutrients), and Catabolism (chemical breakdown by microbes). Mineralization and humification occur as part of catabolism.

---

121. Cellulose does not form blue colour with Iodine because

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

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

Solution:

Step 1: Understanding the Question:
The question asks for the reason why cellulose does not give a positive iodine test (blue colour), unlike starch.

Step 2: Detailed Explanation:
The iodine test for starch works because of the structure of amylose, a component of starch.

- **Starch (Amylose):** It consists of α-glucose units linked together, which causes the chain to form a coiled, helical structure. Iodine molecules (I_2) can fit inside this helix, forming a starch-iodine complex that absorbs light in such a way that it appears blue-black.

- **Cellulose:** It consists of β-glucose units. The linkages between these units result in a straight, linear chain. These chains are packed tightly together via hydrogen bonds to form microfibrils. Cellulose does not form complex helices.

Because cellulose lacks the helical structure necessary to trap iodine molecules, the characteristic blue colour is not produced.
Analyzing the options:
(A) is incorrect. Cellulose does not break down.
(B) is incorrect. Cellulose is a polysaccharide, not a disaccharide.
(C) is incorrect. It is not a helical molecule in the way starch is.
(D) correctly states that cellulose does not have the complex helices required to hold iodine molecules.

Step 3: Final Answer:
Cellulose does not produce a blue colour with iodine because its linear structure lacks the complex helices needed to trap iodine molecules.

Quick Tip

Associate the starch-iodine test with the helical structure of amylose. Remember that cellulose is a straight-chain polymer due to its β-1,4 glycosidic bonds, which makes it structurally different and unable to form the iodine complex.

---

122. In the equation
GPP – R = NPP
GPP is Gross Primary Productivity
NPP is Net Primary Productivity
R here is

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

(D) Respiratory loss

Correct Answer: (D) Respiratory loss

Solution:

Step 1: Understanding the Question:
The question asks to identify what the term 'R' represents in the ecological equation relating Gross Primary Productivity (GPP) and Net Primary Productivity (NPP).

Step 2: Detailed Explanation:
Let's define the terms in the equation:

- **Gross Primary Productivity (GPP):** This is the total rate at which solar energy is captured by producers (like plants) during photosynthesis to create organic matter. It represents the total amount of food produced.

- **Net Primary Productivity (NPP):** This is the rate at which producers create biomass that is actually available to the next trophic level (herbivores). It is the energy that remains after the producers have met their own metabolic needs.

- **R (Respiration):** Producers use a significant portion of the energy they capture (GPP) for their own life processes, such as cellular respiration, growth, and maintenance. This energy consumed by the producer is known as **respiratory loss**.

The equation GPP - R = NPP means that the Net Primary Productivity is what's left over from the Gross Primary Productivity after subtracting the energy lost to respiration.

Step 3: Final Answer:
In the given equation, R represents the energy lost by the producers through respiration, i.e., Respiratory loss.

Quick Tip

Think of GPP as the 'gross salary' of an ecosystem's producers. 'R' is the 'tax' or 'living expenses' (energy used for respiration). NPP is the 'net salary' or 'take-home pay'—the energy available to be saved (as biomass) or spent (by consumers).

---

123. How many ATP and $NADPH_2$ are required for the synthesis of one molecule of Glucose during Calvin cycle?

(A) 18 ATP and 16 $NADPH_2$
(B) 12 ATP and 12 $NADPH_2$
(C) 18 ATP and 12 $NADPH_2$
(D) 12 ATP and 16 $NADPH_2$

Correct Answer: (C) 18 ATP and 12 $NADPH_2$

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 via the Calvin cycle. (Note: $NADPH_2$ is often used to represent NADPH + H^+).

Step 2: Key Formula or Approach:
The synthesis of one molecule of glucose ($C_6H_{12}O_6$) requires 6 molecules of CO_2 to be fixed. This means the Calvin cycle must turn 6 times. We need to calculate the energy requirement for a single turn and then multiply it by 6.

Step 3: Detailed Explanation:
The Calvin cycle has three main stages: Carboxylation, Reduction, and Regeneration.

1. **Carboxylation:** CO_2 is fixed to RuBP. No energy is consumed here.

2. **Reduction:** The product of carboxylation (3-PGA) is reduced to triose phosphate. For each molecule of CO_2 fixed:
   - 2 molecules of ATP are used.
   - 2 molecules of NADPH are used.

3. **Regeneration:** The starting molecule, RuBP, is regenerated from triose phosphate. For each molecule of CO_2 fixed:
   - 1 molecule of ATP is used.

Total requirement per turn (for 1 CO_2):

$$\text{ATP} = 2(\text{from reduction}) + 1(\text{from regeneration}) = 3 \text{ ATP}$$
$$\text{NADPH} = 2(\text{from reduction}) = 2 \text{ NADPH}$$

Total requirement for 6 turns (for 1 glucose):

$$\text{Total ATP} = 3 \text{ ATP/turn} \times 6 \text{ turns} = 18 \text{ ATP}$$
$$\text{Total NADPH} = 2 \text{ NADPH/turn} \times 6 \text{ turns} = 12 \text{ NADPH}$$

Step 4: Final Answer:
Therefore, the synthesis of one molecule of glucose requires 18 ATP and 12 NADPH.

Quick Tip

Remember the "3-2-1" rule for the Calvin cycle per CO_2 fixed: 3 ATPs are used (2 in reduction, 1 in regeneration) and 2 NADPHs are used (both in reduction). Since glucose has 6 carbons, multiply these numbers by 6.

---

124. In gene gun method used to introduce alien DNA into host cells, microparticles of __ metal are used.

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

Correct Answer: (D) Tungsten or gold

Solution:

Step 1: Understanding the Question:
The question asks to identify the metal used for making microparticles in the gene gun (biolistics) method of genetic transformation.

Step 2: Detailed Explanation:
The gene gun, or biolistic particle delivery system, is a method for directly transferring genetic material into cells. The procedure involves:

1. Coating microscopic particles of a heavy metal with the DNA of interest.
2. Loading these DNA-coated particles onto a carrier sheet.
3. Propelling the particles at a very high velocity towards the target cells or tissues.

The particles must be dense enough to penetrate the cell walls and membranes without causing excessive damage. They must also be chemically inert so they don't react harmfully with the cell's contents.
The metals commonly used for this purpose are **gold (Au)** and **tungsten (W)** due to their high density and chemical inertness. Silver, copper, and zinc are not typically used as they can be toxic to cells.

Step 3: Final Answer:
Microparticles of tungsten or gold are used in the gene gun method.

Quick Tip

Associate "gene gun" or "biolistics" with the precious metals Gold or the heavy metal Tungsten. Think of them as tiny, dense "bullets" used to shoot DNA into cells.

---

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

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

Correct Answer: (B) Habitat loss and fragmentation

Solution:

Step 1: Understanding the Question:
The question asks to identify the most significant cause of species extinction from the four major causes known as 'The Evil Quartet'.

Step 2: Detailed Explanation:
'The Evil Quartet' is a term used to describe the four main causes of biodiversity loss:

1. **Habitat loss and fragmentation:** This involves the destruction or division of natural habitats due to activities like deforestation for agriculture, urbanization, and mining. When an organism's home is destroyed or broken into small, isolated patches, its populations decline, and it faces a higher risk of extinction. This is widely recognized by ecologists as the single greatest threat to biodiversity worldwide.

2. **Over-exploitation:** This refers to harvesting species from the wild at rates faster than natural populations can recover. Overfishing, overhunting, and excessive logging are examples.

3. **Alien species invasions:** When non-native species are introduced into an ecosystem, they can outcompete native species for resources, introduce diseases, or alter the habitat, leading to the decline and extinction of native organisms.

4. **Co-extinctions:** This occurs when the extinction of one species causes the extinction of another species that depended on it, such as a plant and its specific pollinator.

While all four are significant threats, **habitat loss and fragmentation** is considered the most important and primary driver of species extinction.

Step 3: Final Answer:
Among 'The Evil Quartet', habitat loss and fragmentation is the most important cause of species extinction.

Quick Tip

Remember that all other causes of extinction are often exacerbated by habitat loss. If an animal has nowhere to live, it cannot survive, making this the most fundamental threat.

---

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

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

Solution:

Step 1: Understanding the Question:
This Assertion-Reason question deals with the characteristics of late wood (autumn wood) and the activity of the cambium.

Step 2: Detailed Explanation:
Analysis of Assertion A:
In temperate regions, trees form annual rings due to seasonal variations in the activity of the vascular cambium.

- **Early wood (Spring wood):** Formed during spring when conditions are favorable. It has a larger number of xylary elements (vessels, tracheids), and the vessels have wider cavities.
- **Late wood (Autumn wood):** Formed during autumn or winter when conditions are less favorable. It has fewer xylary elements, and the vessels are narrow and thick-walled. This wood is denser.

So, the statement "Late wood has fewer xylary elements with narrow vessels" is **true**.

Analysis of Reason R:
The activity of the vascular cambium is regulated by physiological and environmental factors, including hormones and climate. In spring, the cambium is very active. In contrast, during the unfavorable conditions of winter, the cambium becomes less active or dormant. So, the statement "Cambium is less active in winters" is **true**.

Conclusion:
The reduced activity of the cambium during winter (Reason R) is the direct cause for the formation of late wood with its characteristic features of fewer and narrower vessels (Assertion A). Therefore, Reason R is the correct explanation for Assertion A.

Step 3: Final Answer:
Both Assertion A and Reason R are true, and R is the correct explanation of A.

Quick Tip

Remember the contrast: Spring = Active Cambium → Wide Vessels (Early Wood). Winter = Less Active Cambium → Narrow Vessels (Late Wood). The reason (cambium activity) directly explains the result (wood structure).

---

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

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

Correct Answer: (C) Alfred Hershey and Martha Chase

Solution:

Step 1: Understanding the Question:
The question asks to identify the scientists who provided the first "unequivocal" or definitive proof that DNA is the genetic material.

Step 2: Detailed Explanation:
Let's review the contributions of the scientists listed:

- **Frederick Griffith (1928):** Conducted the "transforming principle" experiment with *Streptococcus pneumoniae*. He showed that genetic material could be transferred from heat-killed pathogenic bacteria to living non-pathogenic bacteria, but he did not identify

what this material was.

- **Avery, Macleod, and McCarty (1944):** They expanded on Griffith's work and used biochemical methods (enzymes like proteases, RNases, DNases) to show that the transforming principle was DNA. While their evidence was very strong, some in the scientific community remained skeptical, believing protein was a more likely candidate for the complex genetic material.

- **Alfred Hershey and Martha Chase (1952):** They conducted experiments using bacteriophages (viruses that infect bacteria). They radioactively labeled the phage's protein coat with sulfur-35 (^{35}S) and its DNA with phosphorus-32 (^{32}P). They found that only the ^{32}P (DNA) entered the bacterial cells to direct the synthesis of new phages. This provided clear, direct, and widely accepted proof that DNA, not protein, is the genetic material. Their experiment is considered the unequivocal proof.

- **Wilkins and Franklin:** Their X-ray diffraction images of DNA were crucial for Watson and Crick to determine the double helix structure of DNA, but they did not prove its function as the genetic material.

Step 3: Final Answer:
The unequivocal proof that DNA is the genetic material was provided by the Hershey-Chase experiment.

Quick Tip

Memorize the timeline of discovery: 1. Griffith: "Something" is transferred (Transforming Principle). 2. Avery, Macleod, McCarty: "Something" is DNA (Biochemical proof). 3. Hershey & Chase: It is definitely the DNA that is transferred (Unequivocal proof using radioactive tracers).

---

128. 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) Henking
(B) Thomas Hunt Morgan
(C) Sutton and Boveri
(D) Alfred Sturtevant

Correct Answer: (D) Alfred Sturtevant

Solution:

Step 1: Understanding the Question:
The question asks who first used the frequency of genetic recombination to create a map of genes on a chromosome.

Step 2: Detailed Explanation:
Let's look at the contributions of the individuals mentioned:

- **Henking:** Discovered the X chromosome.
- **Thomas Hunt Morgan:** Working with *Drosophila melanogaster* (fruit flies), he established the chromosomal theory of inheritance, demonstrating that genes are located on chromosomes. He also discovered concepts like linkage and recombination.
- **Sutton and Boveri:** Independently proposed the Chromosomal Theory of Inheritance, which states that chromosomes are the carriers of genetic material.
- **Alfred Sturtevant:** He was an undergraduate student in T.H. Morgan's lab. In 1913, he had a crucial insight: he reasoned that the frequency of recombination between two linked genes is proportional to the physical distance between them on the chromosome. Based on this principle, he used recombination data from fruit fly crosses to construct the very first genetic map, showing the linear arrangement of genes on a chromosome.

While Morgan's work laid the foundation, it was his student, Sturtevant, who first applied the concept of recombination frequency to gene mapping.

Step 3: Final Answer:
Alfred Sturtevant was the first to use recombination frequency to map the position of genes on a chromosome.

Quick Tip

Remember the relationship: Morgan was the professor who discovered linkage and recombination. Sturtevant was his student who had the brilliant idea to use the recombination frequencies to make the first gene map.

---

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

(A) 780 nm
(B) 680 nm
(C) 700 nm

(D) 660 nm

Correct Answer: (B) 680 nm

Solution:

Step 1: Understanding the Question:
The question asks for the peak absorption wavelength of the reaction center chlorophyll of Photosystem II (PS II).

Step 2: Detailed Explanation:
In higher plants and algae, the light-dependent reactions of photosynthesis involve two photosystems: Photosystem I (PS I) and Photosystem II (PS II). Each photosystem has a light-harvesting complex (antenna molecules) and a reaction center.

- **Photosystem II (PS II):** The reaction center of PS II is a special chlorophyll a molecule designated as **P680**. This indicates that it has a peak absorption of light at a wavelength of **680 nm**. PS II is involved in the splitting of water and is the first photosystem in the Z-scheme of electron transport.

- **Photosystem I (PS I):** The reaction center of PS I is designated as **P700**, meaning its absorption maximum is at **700 nm**.

The other wavelengths listed (780 nm, 660 nm) are not the standard designations for the reaction centers of PS I or PS II.

Step 3: Final Answer:
The reaction centre in PS II has an absorption maximum at 680 nm.

Quick Tip

Remember the order in the Z-scheme: PS II comes first, then PS I. The numbers associated with them are P680 and P700, respectively. Associate the smaller number (680) with the first photosystem (PS II) and the larger number (700) with the second (PS I).

---

130. 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) Epiphyllous and Dithecous anthers
(B) Diadelphous and Dithecous anthers
(C) Polyadelphous and epipetalous stamens

(D) Monoadelphous and Monothecous anthers

Correct Answer: (B) Diadelphous and Dithecous anthers

Solution:

Step 1: Understanding the Question:
The question asks to identify the characteristics of stamens that are specific to the family Fabaceae when compared to Solanaceae and Liliaceae.

Step 2: Detailed Explanation:
Let's compare the stamen characteristics of the three families:

- **Family Fabaceae (Legume family):** The androecium typically consists of ten stamens. A key feature is that the filaments are often fused. The most common arrangement is **diadelphous**, where they are fused into two groups, usually nine in one bundle and one free ((9)+1). The anthers are **dithecous** (two-lobed).

- **Family Solanaceae (Potato family):** There are five stamens. They are **epipetalous**, meaning the filaments are attached to the petals. The anthers are dithecous.

- **Family Liliaceae (Lily family):** There are six stamens, arranged in two whorls of three (3+3). They are often **epiphyllous** or **epitepalous**, meaning the filaments are attached to the tepals (undifferentiated petals and sepals). The anthers are dithecous.

Now let's evaluate the options based on this comparison:
(A) Epiphyllous condition is characteristic of Liliaceae.
(B) **Diadelphous** condition is a hallmark of Fabaceae and is not found in Solanaceae or Liliaceae. Dithecous anthers are common to all three, but the combination is specific.
(C) Polyadelphous (filaments in many bundles) is found in families like Rutaceae (Citrus). Epipetalous condition is found in Solanaceae.
(D) Monoadelphous (filaments in one bundle) and monothecous anthers are characteristic of the family Malvaceae (China rose), not Fabaceae.

Step 3: Final Answer:
The diadelphous condition of stamens is the specific characteristic of family Fabaceae among the given options.

Quick Tip

To differentiate plant families, focus on unique floral characteristics. For Fabaceae, remember the "pea flower" structure: papilionaceous corolla and diadelphous stamens ((9)+1). For Solanaceae, remember epipetalous stamens. For Liliaceae, remember parts in threes and epiphyllous stamens.

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

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

Correct Answer: (C) Dedifferentiation

Solution:

Step 1: Understanding the Question:
The question describes the process where specialized leaf mesophyll cells are induced to form an undifferentiated mass of cells (callus) in tissue culture and asks for the correct term for this process.

Step 2: Detailed Explanation:
Let's define the relevant terms in plant development:

- **Differentiation:** The process by which cells derived from meristems mature and undergo structural changes to perform specific functions. For example, a meristematic cell differentiating into a mesophyll cell.

- **Dedifferentiation:** The process where already differentiated, mature cells lose their specialization and regain the ability to divide actively. In this case, the specialized, non-dividing mesophyll cells are stimulated by the culture medium to revert to a meristematic state and start dividing to form the undifferentiated callus. This is dedifferentiation.

- **Redifferentiation:** The process where the dedifferentiated cells of the callus once again differentiate to form specialized cells, tissues, and organs like roots and shoots.

- **Senescence:** The process of aging in plants.

The phenomenon described in the question, where specialized cells form an unspecialized callus, is a classic example of dedifferentiation.

Step 3: Final Answer:
The formation of callus from differentiated leaf mesophyll cells is called dedifferentiation.

Quick Tip

Remember the sequence in plant tissue culture: 1. **Explant** (differentiated cells) 2. → **Dedifferentiation** → **Callus** (undifferentiated cells) 3. → **Redifferentiation** → **Plantlet** (differentiated organs)

---

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

(A) 2, 4-D
(B) GA_3
(C) Kinetin
(D) Ethylene

Correct Answer: (D) 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 varieties when they are submerged.

Step 2: Detailed Explanation:
Deep water rice has a remarkable adaptation to survive flooding. When the plant is submerged, the reduced oxygen (hypoxia) triggers a significant increase in the synthesis of the gaseous hormone **ethylene**.

- **Ethylene** accumulates in the submerged parts of the plant because its diffusion out of the tissues is much slower in water than in air.
- This high concentration of ethylene triggers a signaling cascade that either reduces the level of abscisic acid (ABA, a growth inhibitor) or increases the sensitivity of the cells to gibberellins (GA).
- The ultimate result is a dramatic increase in cell division and elongation in the internodes, causing the stem to grow rapidly and keep the leaves above the water surface for photosynthesis and gas exchange.

While gibberellins (like GA_3) are the direct promoters of stem elongation, ethylene is the primary hormonal signal that initiates this specific response to submergence in deep water rice. Among the choices given, ethylene is the most appropriate answer for promoting this adaptive elongation.

- **2, 4-D** is a synthetic auxin.
- GA_3 is involved, but ethylene is the primary trigger.

- **Kinetin** is a cytokinin, primarily involved in cell division.

Step 3: Final Answer:
Ethylene is the hormone that promotes internode/petiole elongation in deep water rice as an adaptation to flooding.

Quick Tip

For questions about specific plant adaptations, remember the primary trigger. In deep water rice, the trigger for elongation is submergence, which leads to the accumulation of the gaseous hormone Ethylene.

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

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

Correct Answer: (C) DNA

Solution:

Step 1: Understanding the Question:
The question asks what biological macromolecule precipitates when chilled ethanol is added during a typical DNA purification protocol.

Step 2: Detailed Explanation:
The process of isolating DNA involves several steps:

1. **Lysis:** Breaking open the cells to release their contents, including DNA.
2. **Purification:** Removing other macromolecules like proteins, RNA, and lipids. This is often done using enzymes like proteases and RNases.
3. **Precipitation:** Separating the DNA from the remaining solution. DNA is a polar molecule and is soluble in aqueous solutions. However, it is insoluble in ethanol (or isopropanol).

When cold ethanol is added to the aqueous DNA solution, it disrupts the hydration shell around the DNA molecules. The presence of salt (like sodium acetate) in the buffer neutralizes the negative charge of the phosphate backbone of DNA. This combination causes the DNA molecules to aggregate and precipitate out of the solution. The precipitated DNA can then be seen as a

mass of fine white threads, which can be spooled out with a glass rod.

Step 3: Final Answer:
The addition of chilled ethanol causes the precipitation of DNA.

Quick Tip

Remember the final step of most DNA extraction kits: "Add ethanol to precipitate DNA." The cold temperature of the ethanol helps to increase the yield of the precipitate.

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134. Identify the pair of heterosporous pteridophytes among the following :

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

Correct Answer: (C) Selaginella and Salvinia

Solution:

Step 1: Understanding the Question:
The question asks to identify a pair where both members are heterosporous pteridophytes.

Step 2: Detailed Explanation:
Pteridophytes can be classified based on the types of spores they produce:

- **Homosporous:** These plants produce only one type of spore, which develops into a bisexual (monoecious) gametophyte bearing both antheridia and archegonia. The majority of pteridophytes are homosporous. Examples include *Psilotum*, *Lycopodium*, and *Equisetum*.

- **Heterosporous:** These plants produce two distinct types of spores: small microspores that develop into male gametophytes, and large megaspores that develop into female gametophytes. Heterospory is an important evolutionary step towards the seed habit. Key examples of heterosporous pteridophytes are *Selaginella*, *Salvinia*, *Azolla*, and *Marsilea*.

Let's analyze the given pairs:
(A) *Equisetum* (homosporous) and *Salvinia* (heterosporous).
(B) *Lycopodium* (homosporous) and *Selaginella* (heterosporous).
(C) ***Selaginella*** (heterosporous) and ***Salvinia*** (heterosporous). This pair consists of two heterosporous pteridophytes.
(D) *Psilotum* (homosporous) and *Salvinia* (heterosporous).

Step 3: Final Answer:
The pair of heterosporous pteridophytes is *Selaginella* and *Salvinia*.

Quick Tip

For competitive exams, it's essential to memorize the key examples of heterosporous pteridophytes: *Selaginella*, *Salvinia*, *Azolla*, and *Marsilea*. Most other common pteridophytes you encounter will be homosporous.

---

135. Axile placentation is observed in

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

Correct Answer: (A) 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.

Step 2: Detailed Explanation:
Axile placentation is a type of ovule arrangement where the ovary is divided into two or more chambers (locules) by septa. The ovules are attached to a central column or axis where the septa meet. This is found in multicarpellary, syncarpous (fused carpels) ovaries.
Let's analyze the placentation types in the plants listed in each option:

- **(A) China rose, Petunia and Lemon:**
  - **China rose** (*Hibiscus*): Has axile placentation.
  - **Petunia** (Family Solanaceae): Has axile placentation.
  - **Lemon** (*Citrus*): Has axile placentation.

  This option correctly lists three plants with axile placentation.

- **(B) Mustard, Cucumber and Primrose:**
  - **Mustard**: Has parietal placentation.
  - **Cucumber**: Has parietal placentation.
  - **Primrose**: Has free-central placentation.
- **(C) China rose, Beans and Lupin:**

- **China rose**: Has axile placentation.
- **Beans** and **Lupin** (Family Fabaceae): Have marginal placentation.

- **(D) Tomato, Dianthus and Pea:**
  - **Tomato**: Has axile placentation.
  - **Dianthus**: Has free-central placentation.
  - **Pea**: Has marginal placentation.

Step 3: Final Answer:
The group where all plants show axile placentation is China rose, Petunia, and Lemon.

Quick Tip

Associate placentation types with key examples:

- **Marginal:** Pea (Legumes)
- **Axile:** Tomato, Lemon, China rose
- **Parietal:** Mustard, Cucumber
- **Free-central:** *Dianthus*, *Primula* (Primrose)
- **Basal:** Sunflower, Marigold

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

Correct Answer: (B) 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 that requires evaluating the definition of a flower and the

developmental changes involved.

Step 2: Detailed Explanation:
Analysis of Assertion A:
The botanical definition of a flower is that it is a highly modified and condensed reproductive shoot. This modification involves the transformation of the shoot apical meristem, which normally produces vegetative structures (leaves and stems), into a floral meristem, which produces the parts of a flower. So, Assertion A is **true**.

Analysis of Reason R:
The modification from a vegetative shoot to a flower involves several key changes. The axis of the shoot (the future thalamus or receptacle) stops elongating, so the internodes become highly condensed and are not distinguishable. Instead of producing leaves at the nodes, the floral meristem produces modified leaves, which are the floral appendages: sepals, petals, stamens, and carpels, arranged in successive whorls. So, Reason R is also **true**.

Conclusion:
Reason R perfectly explains the "modification" mentioned in Assertion A. It details the process of how a shoot is modified—by condensing the internodes and producing floral appendages instead of regular leaves. Therefore, Reason R is the correct explanation for Assertion A.

Step 3: Final Answer:
Both Assertion A and Reason R are true, and R is the correct explanation of A.

Quick Tip

Think of a flower as a "telescoped" shoot. The stem is compressed into the thalamus, and the leaves are transformed into the colourful and reproductive parts of the flower. This helps visualize why a flower is considered a modified shoot.

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137. How many different proteins does the ribosome consist of?

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

Correct Answer: (B) 80

Solution:

Step 1: Understanding the Question:
The question asks for the total number of different proteins found in a ribosome. As the type of ribosome (prokaryotic vs. eukaryotic) is not specified, we should consider both and see which

one fits the options.

Step 2: Detailed Explanation:
Ribosomes are composed of ribosomal RNA (rRNA) and proteins. The number of proteins differs between prokaryotic and eukaryotic ribosomes.

- **Prokaryotic (70S) Ribosome:**
  - Small subunit (30S): Contains about 21 proteins.
  - Large subunit (50S): Contains about 31-34 proteins.
  - Total: Approximately 52-55 proteins.
- **Eukaryotic (80S) Ribosome:**
  - Small subunit (40S): Contains about 33 proteins.
  - Large subunit (60S): Contains about 49 proteins.
  - Total: Approximately 82 proteins.

Comparing these values to the given options:
(A) 20
(B) 80
(C) 60
(D) 40
The value **80** is the closest approximation for the number of proteins in a eukaryotic ribosome. In the context of general biology questions, "ribosome" often implicitly refers to the more complex eukaryotic type, and numbers are often rounded.

Step 3: Final Answer:
A ribosome (typically referring to a eukaryotic 80S ribosome) consists of approximately 80 different proteins.

Quick Tip

When a biology question is general and could apply to both prokaryotes and eukaryotes, check if the options align better with one than the other. The number 80 is a strong indicator that the question is referring to a eukaryotic ribosome.

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138. Melonate inhibits the growth of pathogenic bacteria by inhibiting the activity of

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

Correct Answer: (B) Succinic dehydrogenase

Solution:

Step 1: Understanding the Question:
The question asks which enzyme's activity is inhibited by malonate (spelled here as melonate), thereby inhibiting bacterial growth.

Step 2: Detailed Explanation:
Malonate is a classic example of a **competitive inhibitor**. This type of inhibition occurs when a molecule that is structurally similar to the enzyme's actual substrate binds to the active site, blocking the substrate from binding.

- The enzyme in question is **succinic dehydrogenase**, which is a key enzyme in the Krebs cycle (citric acid cycle).
- The normal substrate for this enzyme is **succinate**.
- The inhibitor, **malonate**, has a chemical structure very similar to succinate.

Because of this structural similarity, malonate can bind to the active site of succinic dehydrogenase. However, the enzyme cannot act on malonate, so the catalytic reaction is blocked. This inhibition of the Krebs cycle disrupts cellular respiration and ATP production, which in turn inhibits the growth of the bacteria.

Step 3: Final Answer:
Malonate inhibits the activity of succinic dehydrogenase.

Quick Tip

Remember the classic pair: Substrate = Succinate, Enzyme = Succinic Dehydrogenase, Competitive Inhibitor = Malonate. This is a frequently cited example of competitive inhibition in biochemistry.

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139. Match List I with List II :

List I	List II
A. Oxidative decarboxylation	I. Citrate synthase
B. Glycolysis	II. Pyruvate dehydrogenase
C. Oxidative phosphorylation	III. Electron transport system
D. Tricarboxylic acid cycle	IV. EMP pathway

Choose the correct answer from the options given below :

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

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

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

Solution:

Step 1: Understanding the Question:
The question requires matching metabolic processes or steps from List I with their associated enzymes, pathways, or systems from List II.

Step 2: Detailed Explanation:
Let's match each item from List I to its correct counterpart in List II.

- **A. Oxidative decarboxylation:** This is a reaction where a carboxyl group is removed as CO_2 and the molecule is oxidized. A prime example in cellular respiration is the link reaction, where pyruvate is converted to acetyl-CoA. This reaction is catalyzed by the **Pyruvate dehydrogenase** complex. So, **A matches with II**.

- **B. Glycolysis:** This is the pathway for the breakdown of glucose into pyruvate. It is also known by the names of the scientists who elucidated it: Embden, Meyerhof, and Parnas. Hence, it is called the **EMP pathway**. So, **B matches with IV**.

- **C. Oxidative phosphorylation:** This is the metabolic pathway in which cells use enzymes to oxidize nutrients, thereby releasing energy which is used to produce ATP. The process is driven by the flow of electrons through the **Electron transport system (ETS)** located in the inner mitochondrial membrane. So, **C matches with III**.

- **D. Tricarboxylic acid (TCA) cycle:** Also known as the Krebs cycle. The very first step of this cycle involves the combination of acetyl-CoA (a 2-carbon molecule) with oxaloacetate (a 4-carbon molecule) to form citrate (a 6-carbon molecule). This reaction is catalyzed by the enzyme **Citrate synthase**. So, **D matches with I**.

Step 3: Final Answer:
The correct matching is: A-II, B-IV, C-III, D-I. This corresponds to option (A).

Quick Tip

For matching questions on cellular respiration, create a mental flowchart: Glycolysis (EMP pathway) → Pyruvate → Oxidative Decarboxylation (Pyruvate Dehydrogenase) → Acetyl-CoA → TCA Cycle (starts with Citrate Synthase) → Electron Carriers → Oxidative Phosphorylation (Electron Transport System).

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

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

Solution:

Step 1: Understanding the Question:
The question asks to evaluate the correctness of two statements, one about Gause's Competitive Exclusion Principle and the other about the relative impact of competition on carnivores versus herbivores.

Step 2: Detailed Explanation:
Analysis of Statement I:
This statement provides the definition of Gause's 'Competitive Exclusion Principle'. The principle posits that when two species compete for the exact same limited resources in a stable environment, one species will always be more efficient and will eventually 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 broad generalization that carnivores are more adversely affected by competition than herbivores. This is not a universally accepted ecological rule. Competition can be extremely intense at any trophic level. For example, herbivores may compete intensely for a specific host plant, while carnivores might compete for territory or a wide range of prey. It is not possible to state definitively that one group is always "more adversely affected" than the other. The intensity of competition depends on factors like resource availability, niche overlap, and population density, not just the trophic level. Therefore, Statement II is considered false.

Step 3: Final Answer:
Based on the analysis, Statement I is a correct definition, while Statement II is an incorrect generalization.

Quick Tip

For statement-based questions in ecology, be wary of absolute generalizations. Ecological interactions are complex and context-dependent. A statement claiming something is "always" or "in general" true for a large, diverse group like "carnivores" should be scrutinized carefully.

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141. Which of the following combinations is required for chemiosmosis?

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

Correct Answer: (B) 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 to generate ATP.

Step 2: Detailed Explanation:
Chemiosmosis is the process that couples the energy stored in a proton gradient across a membrane to the synthesis of ATP. According to Peter Mitchell's chemiosmotic theory, the process requires the following key components:

1. **A membrane:** An intact membrane (like the inner mitochondrial membrane or the thylakoid membrane) is necessary to create a closed compartment and maintain a separation of charges and concentrations.

2. **A proton pump:** This is typically an electron transport chain that uses the energy from electrons to actively pump protons (H^+ ions) from one side of the membrane to the other, against their concentration gradient.

3. **A proton gradient:** The pumping of protons creates a high concentration of protons on one side of the membrane. This electrochemical gradient is also known as a proton motive force, which stores potential energy.

4. **ATP synthase:** This is a transmembrane enzyme complex. It has a channel that allows protons to flow back across the membrane down their electrochemical gradient. The kinetic energy from this proton flow is used by the enzyme to catalyze the phosphorylation

of ADP to ATP.

Option (B) correctly lists all four of these essential components. The other options are incorrect because they mention an "electron gradient" instead of a proton gradient or "NADP synthase" instead of ATP synthase.

Step 3: Final Answer:
The combination required for chemiosmosis is a membrane, a proton pump, a proton gradient, and ATP synthase.

Quick Tip

Think of chemiosmosis like a hydroelectric dam. The **membrane** is the dam wall. The **proton pump** is the pump that fills the reservoir. The **proton gradient** is the water stored at a high level. The **ATP synthase** is the turbine that generates electricity (ATP) as water flows through it.

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

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

Solution:

Step 1: Understanding the Question:
This is an Assertion-Reason question about the process of pollination in gymnosperms.

Step 2: Detailed Explanation:
Analysis of Assertion A:
Gymnosperms, such as conifers, are characterized by wind pollination (anemophily). Their pollen grains, produced in microsporangia (pollen sacs), are typically light and winged, adapted for dispersal by wind or air currents. This statement is factually correct. So, Assertion A is true.

Analysis of Reason R:
This statement describes what happens after the pollen is carried by air. While air currents do carry the pollen to the ovule, the rest of the statement contains inaccuracies. The pollen grain lands on the micropyle of the ovule, not directly at the mouth of the archegonium. The most significant error is the claim that a "pollen tube is not formed." In all modern gymnosperms, the pollen grain germinates to form a pollen tube. The pollen tube grows towards the archegonium and delivers the male gametes for fertilization. This process is called siphonogamy. Therefore, the statement that a pollen tube is not formed is false. So, Reason R is false.

Step 3: Final Answer:
Assertion A is a true statement, but Reason R is a false statement.

Quick Tip

A key feature of seed plants (gymnosperms and angiosperms) is the formation of a pollen tube (siphonogamy) to deliver non-motile or motile male gametes to the egg. The absence of a pollen tube is characteristic of more primitive plant groups.

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143. Which one of the following statements is NOT correct?

(A) The amount of some toxic substances of industrial waste water increases in the organisms at successive trophic levels.
(B) 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.
(C) Algal blooms caused by excess of organic matter in water improve water quality and promote fisheries.
(D) Water hyacinth grows abundantly in eutrophic water bodies and leads to an imbalance in the ecosystem dynamics of the water body.

Correct Answer: (C) 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 given options related to water pollution and its ecological effects.

Step 2: Detailed Explanation:

- **(A)** This statement describes biomagnification, where the concentration of persistent toxic substances (like DDT or mercury) increases at higher trophic levels in a food chain. This is a well-documented ecological phenomenon. So, this statement is correct.

- **(B)** This statement describes the effect of sewage pollution. The organic matter in sewage serves as food for decomposer microorganisms. Their population explodes, and they consume large amounts of dissolved oxygen (high Biological Oxygen Demand or BOD). This oxygen depletion leads to the death of fish and other aquatic organisms. So, this statement is correct.

- **(C)** This statement claims that algal blooms improve water quality. This is completely false. Algal blooms are caused by eutrophication (excess nutrient enrichment, not just organic matter). These blooms degrade water quality by imparting colour and odour. Furthermore, when the massive amount of algae dies, their decomposition consumes huge quantities of dissolved oxygen, leading to hypoxic or anoxic conditions and mass fish kills. This severely harms, rather than promotes, fisheries. So, this statement is NOT correct.

- **(D)** This statement describes the impact of water hyacinth (*Eichhornia crassipes*), an invasive species that thrives in nutrient-rich (eutrophic) waters. Its rapid growth covers the water surface, blocking light and depleting oxygen, which disrupts the aquatic ecosystem. So, this statement is correct.

Step 3: Final Answer:
The statement that is not correct is (C), as algal blooms drastically reduce water quality and are detrimental to fisheries.

Quick Tip

Remember that "eutrophication" and "algal bloom" are negative terms in ecology, associated with pollution and ecosystem damage. Any statement claiming they are beneficial is almost certainly incorrect.

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144. 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 E only
(B) A and B only
(C) C and D only
(D) B and E only

Correct Answer: (D) 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 with a karyotype of 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. 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**. The presence of a Y chromosome determines the male sex, so the individual is phenotypically male. However, the extra X chromosome leads to the expression of some female characteristics, such as gynecomastia (enlarged breasts).

- **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 characteristic of Turner's Syndrome (45, XO).

- **D. Physical, psychomotor and mental development is retarded.** This is an overgeneralization and largely **incorrect**. While some individuals may have learning disabilities or delayed speech development, severe intellectual disability is not a typical feature.

- **E. Such individuals are sterile.** This is **correct**. The presence of an extra X chromosome disrupts the development of the testes, leading to small, firm testes that do not produce sperm (azoospermia), resulting in infertility.

Step 3: Final Answer:
The correct statements are B and E. Therefore, the correct option is (D).

Quick Tip

To remember the key features of aneuploidies, create a small comparison table.

- **Klinefelter's (XXY):** Tall Male, Gynecomastia, Sterile.
- **Turner's (XO):** Short Female, Webbed neck, Sterile.
- **Down's (Trisomy 21):** Short stature, Characteristic facial features, Intellectual disability.

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145. 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 and C only
(B) B, C and E only
(C) A and D only
(D) A, B and D only

Correct Answer: (C) A and D only

Solution:

Step 1: Understanding the Question:
The question asks to identify the correct statements about anatomical features of woody stems, particularly bark and related structures.

Step 2: Detailed Explanation:
Let's analyze each statement:

- **A. Lenticels are the lens-shaped openings permitting the exchange of gases.** This is **correct**. Lenticels are porous tissues on the bark that allow for gas exchange between the internal living cells and the outside atmosphere.

- **B. Bark formed early in the season is called hard bark.** This is **incorrect**. Bark formed early in the season (spring) is called soft bark, while bark formed late in the season (autumn) is called hard bark.

- **C. Bark is a technical term that refers to all tissues exterior to vascular cambium.** This statement is **incorrect** because "bark" is generally considered a non-technical

term. The description of what it includes is correct, but calling it a "technical term" is botanically imprecise and can be a point of distinction in exam questions.

- **D. Bark refers to periderm and secondary phloem.** This is **correct**. Bark is composed of two main parts: the periderm (which includes phellogen, phellem, and phelloderm) and the secondary phloem (inner bark). This is a correct description of the components of bark.

- **E. Phellogen is single-layered in thickness.** This is **incorrect**. Phellogen, or cork cambium, is a meristematic tissue and is typically described as being a couple of layers thick, not strictly a single layer.

Step 3: Final Answer:
The correct statements are A and D. Therefore, the correct option is (C).

Quick Tip

In plant anatomy, precise terminology is key. Remember that "bark" is a common term for everything outside the vascular cambium, which structurally consists of the periderm and secondary phloem. Also, distinguish between early/soft bark and late/hard bark.

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146. Match List I with List II :

List I	List II
A. M Phase	I. Proteins are synthesized
B. G_3 Phase	II. Inactive phase
C. Quiescent stage	III. Interval between mitosis and initiation of DNA replication
D. G_1 Phase	IV. Equational division

Choose the correct answer from the options given below :

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

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

Solution:

Step 1: Understanding the Question:
The question requires matching the phases of the eukaryotic cell cycle (List I) with their corresponding descriptions or events (List II).

Step 2: Detailed Explanation:
Let's perform the matching:

- **A. M Phase:** This is the mitotic phase, where the cell undergoes division. 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_2 Phase:** This is the second gap phase, which occurs after DNA synthesis (S phase) and before mitosis (M phase). During this phase, the cell continues to grow and synthesizes proteins and organelles needed for mitosis, such as tubulin for the spindle fibers. So, **B matches with I (Proteins are synthesized)**.

- **C. Quiescent stage (G_0):** This is a non-dividing state that cells can enter from the G_1 phase. Cells in G_0 are metabolically active but have exited the cell cycle and are not preparing to divide. It can be considered an **inactive phase** with respect to cell division. So, **C matches with II**.

- **D. G_1 Phase:** This is the first gap phase. It represents the **interval between the completion of mitosis (M phase) and the initiation of DNA replication (S phase)**. So, **D matches with III**.

Step 3: Final Answer:
The correct matching is A-IV, B-I, C-II, D-III, which corresponds to option (D).

Quick Tip

Visualize the cell cycle as a clock: M $\rightarrow$ G_1 $\rightarrow$ S $\rightarrow$ G_2 $\rightarrow$ M. G_1 is the gap between M and S. G_2 is the gap between S and M. S is for Synthesis (DNA replication). M is for Mitosis (division). G_0 is an exit ramp from G_1.

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

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

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

Solution:

Step 1: Understanding the Question:
The question asks to match different types of ecological interactions with their symbolic representations, where '+' indicates benefit, '-' indicates harm, and '0' indicates no effect.

Step 2: Detailed Explanation:
Let's match each interaction with its description:

- **A. Mutualism:** An interaction where both species benefit from each other. The representation is (+, +). So, **A matches with IV**.
- **B. Commensalism:** An interaction where one species benefits, and the other is neither harmed nor benefited (unaffected). The representation is (+, 0). So, **B matches with I**.
- **C. Amensalism:** An interaction where one species is harmed, and the other is unaffected. The representation is (-, 0). So, **C matches with II**.
- **D. Parasitism:** An interaction where one species (the parasite) benefits at the expense of the other (the host), which is harmed. The representation is (+, -). This also applies to predation. So, **D matches with III**.

Step 3: Final Answer:
The correct set of matches is A-IV, B-I, C-II, D-III. This corresponds to option (C).

Quick Tip

Create a simple table in your notes for all population interactions (+,-,0 notation). This makes it very easy to recall during an exam. Remember that predation, parasitism, and herbivory all fall under the (+, -) category.

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148. Match List I with List II :

List I	List II
A. Cohesion	I. More attraction in liquid phase
B. Adhesion	II. Mutual attraction among water molecules
C. Surface tension	III. Water loss in liquid phase
D. Guttation	IV. Attraction towards polar surfaces

Choose the correct answer from the options given below :

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

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

Solution:

Step 1: Understanding the Question:
The question asks to match properties related to water transport in plants (List I) with their correct descriptions (List II).

Step 2: Detailed Explanation:
Let's match the terms:

- **A. Cohesion:** This is the intermolecular attraction between like-molecules. In the context of 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 unlike molecules. In xylem, it is the **attraction of water molecules towards polar surfaces** of the tracheary elements (xylem walls). So, **B matches with IV**.

- **C. Surface tension:** This is a property of liquids that allows them to resist an external force, due to the cohesive nature of their molecules. Water molecules are attracted to each other more strongly than to the air above, resulting in a higher attraction for each other in the liquid phase compared to the gaseous phase. So, **C matches with I**.

- **D. Guttation:** This is the loss of water in the form of liquid droplets from the hydathodes of leaves, which occurs when root pressure is high and transpiration is low. It is a form of **water loss in the liquid phase**. So, **D matches with III**.

Step 3: Final Answer:
The correct matching is A-II, B-IV, C-I, D-III, which corresponds to option (B).

Quick Tip

Remember the "C-A-T" of water transport: **C**ohesion (water-water), **A**dhesion (water-xylem), and **T**ension (pull from transpiration). Guttation is different from transpiration as it involves liquid water loss, not vapor.

149. 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, D, A, C
(B) B, C, D, A
(C) C, A, B, D
(D) C, B, D, A

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

Solution:

Step 1: Understanding the Question:
The question asks to arrange the given steps of creating recombinant DNA in the correct logical order.

Step 2: Detailed Explanation:
The process of recombinant DNA technology follows a specific sequence of steps to create a genetically modified organism. Let's analyze the given steps to find the correct order.

1. **B. Cutting of DNA at specific location by restriction enzyme.** The process begins with the source DNA (e.g., a genome) and the vector DNA (e.g., a plasmid). Both must be cut, usually with the same restriction enzyme, to generate compatible ends.

2. **C. Isolation of desired DNA fragment.** After cutting the source DNA, which contains many genes, the specific fragment of interest (the gene) must be separated and isolated from the other fragments. This is typically done using gel electrophoresis.

3. **D. Amplification of gene of interest using PCR.** Once the desired gene fragment is isolated, the Polymerase Chain Reaction (PCR) is often used to make millions of copies of it. This ensures that there is enough of the gene to ligate into the vector. (This is followed by ligation of the gene into the vector to create the recombinant DNA).

4. **A. Insertion of recombinant DNA into the host cell.** Finally, the newly created recombinant DNA (vector containing the gene of interest) is introduced into a suitable host cell (like a bacterium) through a process called transformation.

Therefore, the most logical sequence is B $\rightarrow$ C $\rightarrow$ D $\rightarrow$ A.

Step 3: Final Answer:
The correct sequence of steps for the formation of Recombinant DNA is B, C, D, A.

Quick Tip

Think of recombinant DNA technology like a "cut, copy, and paste" operation.

- **Cut (B):** Use restriction enzymes as molecular scissors.
- **Isolate (C):** Separate the piece you want.
- **Copy (D):** Use PCR to make more copies.
- **Paste & Insert (A):** Ligate the gene into a vector and insert it into a host.

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150. Match List I with List II :

List I	List II
A. Iron	I. Synthesis of auxin
B. Zinc	II. Component of nitrate reductase
C. Boron	III. Activator of catalase
D. Molybdenum	IV. Cell elongation and differentiation

Choose the correct answer from the options given below :

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

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

Solution:

Step 1: Understanding the Question:
The question requires matching essential mineral elements (micronutrients) with their specific physiological roles in plants.

Step 2: Detailed Explanation:
Let's match each nutrient from List I to its function in List II.

- **A. Iron (Fe):** Iron is a crucial component of proteins involved in electron transport, such as cytochromes and ferredoxin. It is also an essential **activator of the catalase** enzyme. So, **A matches with III**.

- **B. Zinc (Zn):** Zinc is an activator for many enzymes, especially carboxylases. Critically, it is required for the **synthesis of auxin** (IAA), as it is involved in the synthesis of the precursor, tryptophan. So, **B matches with I**.

- **C. Boron (B):** Boron has multiple roles, including pollen germination, membrane function, and carbohydrate translocation. It is also required for **cell elongation and cell differentiation**. So, **C matches with IV**.

- **D. Molybdenum (Mo):** Molybdenum is a structural **component of** several key enzymes involved in nitrogen metabolism, most notably nitrogenase and **nitrate reductase**. So, **D matches with II**.

Step 3: Final Answer:
The correct matching is A-III, B-I, C-IV, D-II. This corresponds to option (D).

Quick Tip

For mineral nutrition, focus on the most unique and frequently asked functions:

- Mo $\rightarrow$ Nitrate reductase
- Zn $\rightarrow$ Auxin synthesis
- Mg $\rightarrow$ Chlorophyll center
- Mn $\rightarrow$ Photolysis of water
- Fe $\rightarrow$ Activator of catalase

Memorizing these key pairs will help you solve many matching questions.
