

NEET UG 2023 E6 Botany Question Paper with Solutions

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

Read the following instructions very carefully and strictly follow them:

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

Section - A

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

- (A) Osmosis
(B) Facilitated Diffusion

- (C) Passive Transport
- (D) Active Transport

Correct Answer: (D) Active Transport

Solution:

Step 1: Understanding the Question:

The question asks for the biological process that allows ions to move across a cell membrane from a region of lower concentration to a region of higher concentration. This movement is described as being "against their concentration gradient."

Step 2: Detailed Explanation:

Let's define the transport mechanisms listed:

- **Passive Transport (including Osmosis and Facilitated Diffusion):** This is the movement of substances **down** a concentration gradient (from high to low concentration). It does not require the cell to expend metabolic energy (ATP). It's a spontaneous process, like an object rolling downhill.
- **Active Transport:** This is the movement of substances **against** a concentration gradient (from low to high concentration). This is an "uphill" process that requires specific membrane carrier proteins (pumps) and the expenditure of cellular energy, typically in the form of ATP.

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

Step 3: Final Answer:

The movement of ions against a concentration gradient is carried out by active transport. Therefore, option (D) is the correct answer.

Quick Tip

Remember the "hill" analogy for transport:

- Moving **downhill** (from high to low concentration) is **passive** and requires no energy.
- Moving **uphill** (from low to high concentration) is **active** and requires energy.

2. How many ATP and NADPH₂ are required for the synthesis of one molecule of Glucose during Calvin cycle?

- (A) 12 ATP and 12 NADPH₂
- (B) 18 ATP and 12 NADPH₂

- (C) 12 ATP and 16 NADPH₂
(D) 18 ATP and 16 NADPH₂

Correct Answer: (B) 18 ATP and 12 NADPH₂

Solution:

Step 1: Understanding the Question:

The question asks for the total energy input (in terms of ATP and NADPH) needed to produce one molecule of glucose via the Calvin cycle (C3 cycle).

Step 2: Detailed Explanation:

The synthesis of one molecule of glucose (a 6-carbon sugar) requires the fixation of 6 molecules of carbon dioxide. We can calculate the total requirement by first finding the requirement per CO₂ molecule fixed.

- **For one turn of the Calvin cycle (1 CO₂ fixed):**
 - **Reduction step:** 2 ATP and 2 NADPH are used.
 - **Regeneration step:** 1 ATP is used.
 - **Total per CO₂:** 3 ATP and 2 NADPH.
- **For the synthesis of one glucose molecule (6 CO₂ fixed):**
 - **Total ATP:** $6 \text{ CO}_2 \times 3 \text{ ATP/CO}_2 = 18 \text{ ATP}$.
 - **Total NADPH:** $6 \text{ CO}_2 \times 2 \text{ NADPH/CO}_2 = 12 \text{ NADPH}$.

(Note: NADPH₂ is an older notation for NADPH + H⁺ or simply NADPH).

Step 3: Final Answer:

To synthesize one molecule of glucose, 18 ATP and 12 NADPH are required. Therefore, option (B) is the correct answer.

Quick Tip

Remember the 3:2 ratio of ATP to NADPH for fixing one CO₂ in the C3 cycle. To make glucose (6 carbons), you need 6 CO₂. So, just multiply by 6: (6 × 3 ATP) and (6 × 2 NADPH).

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

- (A) Manganese
(B) Molybdenum
(C) Magnesium

(D) Copper

Correct Answer: (A) Manganese

Solution:

Step 1: Understanding the Question:

The question asks to identify the specific mineral micronutrient that is essential for the process of photolysis, which is the splitting of water molecules during the light-dependent reactions of photosynthesis.

Step 2: Detailed Explanation:

The splitting of water ($\text{H}_2\text{O} \rightarrow 2\text{H}^+ + 2\text{e}^- + [\text{O}]$) occurs within Photosystem II (PSII). This reaction is catalyzed by a part of PSII called the Oxygen-Evolving Complex (OEC).

- **Manganese (Mn):** The catalytic core of the OEC contains a cluster of four manganese ions. These ions are essential for the oxidation of water and the release of oxygen. Chloride (Cl^-) and Calcium (Ca^{2+}) ions are also involved.
- **Molybdenum (Mo):** Is a component of enzymes involved in nitrogen metabolism, like nitrate reductase.
- **Magnesium (Mg):** Is a macronutrient and the central atom of the chlorophyll molecule. It also acts as an enzyme activator for RuBisCO and PEPCase.
- **Copper (Cu):** Is a component of plastocyanin, an electron carrier protein in the electron transport chain.

The direct role in splitting water is fulfilled by manganese.

Step 3: Final Answer:

Manganese is the micronutrient required for the splitting of water during photosynthesis. Therefore, option (A) is correct.

Quick Tip

Associate key minerals with their primary roles in photosynthesis:

- **Mg** → Center of **Chlorophyll**.
- **Mn** → Manages water splitting.
- **Cu** → Part of Plastocyanin, a carrier.

4. Given below are two statements :

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

Statement II: Exarch condition is the most common feature of the root system.
In the light of the above statements, choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Question:

The question presents two statements about the arrangement of xylem in plants. We need to evaluate the correctness of each statement.

Step 2: Detailed Explanation:

Analysis of Statement I:

The terms 'endarch' and 'exarch' describe the pattern of development and final position of the **primary xylem**, specifically the relationship between the first-formed protoxylem and the later-formed metaxylem. These terms do not apply to secondary xylem, which is formed from the vascular cambium and develops radially. Therefore, Statement I is **incorrect**.

Analysis of Statement II:

Let's define the conditions:

- **Exarch:** Protoxylem is located towards the periphery (outside) and metaxylem is towards the center. The development is centripetal. This condition is the characteristic feature of **roots**.
- **Endarch:** Protoxylem is located towards the center (pith) and metaxylem is towards the periphery. The development is centrifugal. This condition is characteristic of **stems**.

Thus, the exarch condition is indeed the most common feature of the root system. Therefore, Statement II is **true**.

Step 3: Final Answer:

Statement I is incorrect, but Statement II is true. This corresponds to option (D).

Quick Tip

Use a simple mnemonic:

- **EX**arch has protoxylem on the **exterior** → characteristic of roots.
- **EN**darch has protoxylem on the **ent**erior (internal) → characteristic of stems.

Crucially, remember these terms apply only to **PRIMARY XYLEM**.

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

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

Reason R: Cambium is less active in winters.

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

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

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

Solution:

Step 1: Understanding the Question:

The question presents an assertion about the characteristics of late wood and a reason related to the seasonal activity of the cambium. We must evaluate both statements and their causal relationship.

Step 2: Detailed Explanation:

Analysis of Assertion A:

In regions with distinct seasons, the wood formed during the later part of the growing season (autumn) is called late wood. Due to less favorable conditions, the cambium produces fewer xylem elements (xylary elements). These elements, particularly the vessels, have narrower lumens and thicker walls, making the wood denser and darker in color. So, Assertion A is **true**.

Analysis of Reason R:

The vascular cambium is a layer of meristematic cells whose activity is highly dependent on environmental factors like temperature and photoperiod. In winter, these conditions are unfavorable, causing the cambium's activity to decrease significantly or become dormant. So, Reason R is **true**.

Relationship between A and R:

The reduced activity of the cambium during the unfavorable conditions of late autumn and winter (Reason R) is the direct physiological cause for the production of the dense late wood with fewer, 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 correctly explains A. Therefore, option (A) is the correct answer.

Quick Tip

Associate wood types with seasons and cambial activity:

- **Spring (Early wood):** High activity → Wide vessels, less dense.
- **Autumn (Late wood):** Low activity → Narrow vessels, more dense.

The combination of one ring of early wood and one ring of late wood constitutes an annual ring.

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

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

Correct Answer: (B) DNA

Solution:

Step 1: Understanding the Question:

The question asks which biological macromolecule is precipitated from an aqueous solution when chilled ethanol is added, a standard step in molecular biology protocols.

Step 2: Detailed Explanation:

The principle of DNA precipitation is based on changing its solubility.

- DNA is a polar molecule with a negatively charged phosphate backbone, making it soluble in polar solvents like water.
- Ethanol is much less polar than water.
- When salts (to neutralize the charge on the DNA backbone) and chilled ethanol are added to the aqueous DNA solution, the ethanol disrupts the hydration shell around the DNA molecules.
- This makes the DNA insoluble, causing it to aggregate and precipitate out of the solution. The precipitated DNA can then be seen as a mass of white threads.

Other cellular components like RNA fragments, proteins, and sugars generally remain in the supernatant.

Step 3: Final Answer:

The addition of chilled ethanol is the standard method for precipitating DNA. Therefore, option (B) is correct.

Quick Tip

This is a fundamental lab technique. Remember the simple recipe for isolating DNA: lyse cells, remove proteins and RNA with enzymes, then precipitate the DNA with **chilled ethanol**.

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

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

Correct Answer: (C) Tungsten or gold

Solution:

Step 1: Understanding the Question:

The question asks to identify the metals that are used to create the microprojectiles for the gene gun (biolistics) method of genetic transformation.

Step 2: Detailed Explanation:

The gene gun method, or biolistics, is a physical method for delivering DNA into cells, especially plant cells with tough cell walls.

1. The foreign DNA is coated onto the surface of microscopic particles.
2. These particles need to be very dense to have enough momentum to penetrate the cell.
3. They also need to be chemically inert, so they don't harm the cell.
4. The metals that best fit these criteria are **gold (Au)** and **tungsten (W)**. They are both very dense and have low chemical reactivity.
5. These DNA-coated "bullets" are then accelerated to high velocity and fired at the target cells.

Step 3: Final Answer:

The microparticles used in the gene gun method are made of tungsten or gold. Therefore, option (C) is the correct answer.

Quick Tip

Think of the gene gun as firing "golden bullets". This mnemonic helps to remember that dense and inert precious metals like **gold** and its heavy counterpart **tungsten** are used to carry the DNA cargo.

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

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

Correct Answer: (B) 1992

Solution:

Step 1: Understanding the Question:

This is a factual question asking for the year of the 'Earth Summit' in Rio de Janeiro, which led to the Convention on Biological Diversity.

Step 2: Detailed Explanation:

The United Nations Conference on Environment and Development (UNCED), widely known as the **Earth Summit**, was a major international conference held in Rio de Janeiro, Brazil. The summit took place in **June 1992**. It was a pivotal event for global environmental policy, resulting in key agreements like the Convention on Biological Diversity (CBD) and the UN Framework Convention on Climate Change (UNFCCC). The year 2002 corresponds to the World Summit on Sustainable Development in Johannesburg.

Step 3: Final Answer:

The Earth Summit in Rio de Janeiro was held in 1992. Therefore, option (B) is correct.

Quick Tip

Memorize key dates for major environmental treaties:

- **1987:** Montreal Protocol (on ozone depletion).
- **1992:** Rio Earth Summit (on biodiversity and climate change).
- **1997:** Kyoto Protocol (on greenhouse gas emissions).

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

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

(D) Synergids, antipodals and Polar nuclei

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

Solution:

Step 1: Understanding the Question:

The question asks to identify an option that lists structures from a fertilized angiosperm embryo sac in the correct sequence of ploidy: haploid (n), diploid (2n), and triploid (3n).

Step 2: Detailed Explanation:

Following double fertilization in an angiosperm:

- **Haploid (n) structures:** The synergids and antipodal cells are remnants of the original female gametophyte. They are haploid (n).
- **Diploid (2n) structure:** The **zygote** is formed from the fusion of one haploid (n) male gamete with the haploid (n) egg cell. Thus, the zygote is diploid (2n).
- **Triploid (3n) structure:** The **Primary Endosperm Nucleus (PEN)** is formed from the fusion of the second haploid (n) male gamete with the diploid (n+n) central cell. Thus, the PEN is triploid (3n).

Let's check the options for the sequence n, 2n, 3n:

- (A) Synergids (n), PEN (3n), Zygote (2n). Incorrect sequence.
- (B) Antipodals (n), Synergids (n), PEN (3n). Incorrect sequence.
- (C) **Synergids (n), Zygote (2n), PEN (3n)**. Correct sequence.
- (D) Polar nuclei are present before fertilization is complete. Incorrect.

Step 3: Final Answer:

The correct sequence of haploid, diploid, and triploid structures is Synergids, Zygote, and Primary endosperm nucleus. Therefore, option (C) is correct.

Quick Tip

For questions about double fertilization, quickly list the ploidy of the resulting structures:

- $\text{Zygote} = \text{Egg}(n) + \text{Sperm}(n) = 2n$
- $\text{PEN} = \text{Central Cell}(n+n) + \text{Sperm}(n) = 3n$
- $\text{Synergids/Antipodals} = n$ (remnants)

Then match the required sequence with the options.

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

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

Correct Answer: (D) Bright orange colour

Solution:

Step 1: Understanding the Question:

The question asks for the color observed when DNA stained with ethidium bromide is visualized using ultraviolet (UV) light. This is a standard technique in molecular biology.

Step 2: Detailed Explanation:

In agarose gel electrophoresis, DNA fragments are separated by size. To see these fragments, they must be stained.

- **Ethidium bromide (EtBr)** is a fluorescent dye that intercalates, or inserts itself, between the stacked base pairs of DNA.
- When the gel containing the DNA and EtBr is exposed to UV light, the EtBr molecules absorb the high-energy UV radiation.
- They then re-emit this energy as lower-energy visible light, a process called fluorescence.
- The characteristic color of this fluorescence for EtBr-stained DNA is a **bright orange**.

Step 3: Final Answer:

DNA stained with ethidium bromide fluoresces bright orange when exposed to UV radiation. Therefore, option (D) is correct.

Quick Tip

This is a core factual detail from biotechnology labs. Create a simple mental link: **DNA + EtBr + UV = Bright Orange**.

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

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

(D) Epiphyllous and Dithecoux anthers

Correct Answer: (A) Diadelphous and Dithecoux anthers

Solution:

Step 1: Understanding the Question:

The question asks to identify a characteristic feature of the stamens (androecium) that is unique to the family Fabaceae when compared with Solanaceae and Liliaceae.

Step 2: Detailed Explanation:

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

- **Fabaceae (specifically subfamily Papilionoideae, e.g., pea):** The androecium typically consists of 10 stamens. Their most distinctive feature is that the filaments are fused into two groups, a condition called **diadelphous**. The common pattern is (9)+1, where nine filaments are fused into a tube and one is free. The anthers are dithecoux (two-lobed).
- **Solanaceae (e.g., potato):** The androecium has 5 stamens which are **epipetalous** (attached to the petals). The anthers are dithecoux.
- **Liliaceae (e.g., lily):** The androecium has 6 stamens which are **epiphyllous** or epitepalous (attached to the tepals). The anthers are dithecoux.

From this comparison, the diadelphous condition is the unique feature of Fabaceae. Dithecoux anthers are common to all three, but the combination in option (A) makes it the correct choice.

Step 3: Final Answer:

The diadelphous arrangement of stamens is a specific characteristic of Fabaceae not found in Solanaceae or Liliaceae. Therefore, option (A) is the correct answer.

Quick Tip

For plant family classification, memorize the key features of the androecium:

- **Fabaceae:** Diadelphous ((9)+1) stamens
- **Solanaceae:** Epipetalous stamens
- **Liliaceae:** Epiphyllous/Epitepalous stamens
- **Malvaceae:** Monadelphous stamens, monothe coux anthers

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

- (A) GA₃
- (B) Kinetin

- (C) Ethylene
(D) 2, 4-D

Correct Answer: (C) Ethylene

Solution:

Step 1: Understanding the Question:

The question asks to identify the key plant hormone that triggers the rapid elongation of internodes or petioles in deep water rice as an adaptation to flooding.

Step 2: Detailed Explanation:

Deep water rice has a fascinating survival mechanism for floods.

- When the rice plant is submerged, the gaseous hormone **ethylene** gets trapped in the plant tissues and its concentration rises.
- This accumulation of ethylene acts as the primary signal that the plant is underwater.
- The ethylene then induces the synthesis and activity of **gibberellins** (like GA₃).
- The gibberellins are the direct effectors that cause rapid cell division and elongation in the internodes, leading to stem growth that keeps the leaves above the water surface for photosynthesis.

While gibberellin (GA₃) is the hormone that directly causes elongation, **ethylene** is the crucial initial trigger that promotes this response specifically in deep water rice. The question asks what "promotes" the elongation, and ethylene is the key promoter of this specific adaptive process.

Step 3: Final Answer:

Ethylene is the hormone that initiates the rapid internode elongation response in deep water rice. Therefore, option (C) is the correct answer.

Quick Tip

This is a classic example of hormonal synergy in response to an environmental cue. Remember the signaling pathway: **Submergence → Ethylene accumulation (signal) → Gibberellin action (effector) → Rapid growth**. Ethylene is the primary promoter.

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

- (A) Thomas Hunt Morgan
(B) Sutton and Boveri

- (C) Alfred Sturtevant
(D) Henking

Correct Answer: (C) Alfred Sturtevant

Solution:

Step 1: Understanding the Question:

The question asks to identify the scientist who first conceived and applied the principle that recombination frequency between linked genes could be used to determine their relative distance and order on a chromosome, thereby creating a genetic map.

Step 2: Detailed Explanation:

Let's review the contributions of the scientists mentioned:

- **Thomas Hunt Morgan:** Working with *Drosophila melanogaster*, he provided the experimental proof for the Chromosomal Theory of Inheritance. He discovered gene linkage (genes on the same chromosome are inherited together) and recombination (crossing over can separate linked genes).
- **Sutton and Boveri:** They independently formulated the Chromosomal Theory of Inheritance, which states that genes reside on chromosomes.
- **Alfred Sturtevant:** As an undergraduate student in Morgan's lab, Sturtevant had a pivotal insight. He hypothesized that the **frequency** of recombination between two genes is proportional to the physical distance separating them on the chromosome. In 1913, he used this principle to construct the very first genetic map, showing the linear arrangement of genes on the X chromosome of *Drosophila*.
- **Henking:** He was a cytologist who, in 1891, identified a peculiar nuclear structure in insect sperm cells, which he labeled the "X-body." This was later identified as the X chromosome.

While Morgan discovered recombination, it was his student, Sturtevant, who used the frequency of this event to map genes.

Step 3: Final Answer:

Alfred Sturtevant was the first person to use recombination frequency as a measure of distance to map gene positions. Therefore, option (C) is the correct answer.

Quick Tip

Remember the progression of discovery: 1. **Sutton & Boveri:** Proposed the theory. 2. **T.H. Morgan:** Provided experimental proof of linkage and recombination. 3. **Alfred Sturtevant:** Applied recombination frequencies to create the first genetic map.

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

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

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

Solution:

Step 1: Understanding the Question:

The question requires identifying a pair of plants from the given options where both members are pteridophytes that exhibit heterospory. Heterospory is the production of two distinct types of spores (microspores and megaspores).

Step 2: Detailed Explanation:

Most pteridophytes are homosporous, meaning they produce only one type of spore. However, some are heterosporous, which is an important evolutionary step towards the seed habit. Let's analyze the given options:

- **Homosporous Pteridophytes:** *Lycopodium*, *Equisetum*, *Psilotum*.
- **Heterosporous Pteridophytes:** *Selaginella*, *Salvinia*, *Marsilea*, *Azolla*.

Now let's check the pairs:

- (A) *Lycopodium* (homosporous) and *Selaginella* (heterosporous). This pair is mixed.
- (B) ***Selaginella* (heterosporous) and *Salvinia* (heterosporous)**. This pair consists of two heterosporous pteridophytes.
- (C) *Psilotum* (homosporous) and *Salvinia* (heterosporous). This pair is mixed.
- (D) *Equisetum* (homosporous) and *Salvinia* (heterosporous). This pair is mixed.

Step 3: Final Answer:

The correct pair where both plants are heterosporous pteridophytes is *Selaginella* and *Salvinia*. Therefore, option (B) is correct.

Quick Tip

For pteridophyte classification, it's crucial to memorize the few key examples of heterospory: *Selaginella* and the aquatic ferns *Salvinia*, *Azolla*, and *Marsilea*. If you remember these four, you can answer most questions on this topic.

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

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

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

Solution:

Step 1: Understanding the Question:

The question asks for the specific function of RNA polymerase III, which is one of the three main RNA polymerases in eukaryotic nuclei.

Step 2: Detailed Explanation:

In eukaryotes, there is a division of labor among the RNA polymerases:

- **RNA Polymerase I:** Located in the nucleolus, it is responsible for transcribing the genes for the large ribosomal RNAs (rRNAs), specifically the 28S, 18S, and 5.8S rRNA molecules.
- **RNA Polymerase II:** Located in the nucleoplasm, it transcribes all protein-coding genes to produce precursor messenger RNA (pre-mRNA or hnRNA). It also transcribes most small nuclear RNAs (snRNAs).
- **RNA Polymerase III:** Located in the nucleoplasm, it is responsible for transcribing the genes for smaller RNA molecules. These include **transfer RNA (tRNA)**, the **5S ribosomal RNA (5S rRNA)**, and some other small RNAs, including some **snRNAs** (like U6 snRNA).

Based on this:

- Option (A) describes the function of RNA Pol I.
- Option (B) correctly describes the main products of RNA Pol III.
- Option (C) describes the function of RNA Pol II.
- Option (D) is incomplete, as RNA Pol III transcribes more than just snRNAs.

Step 3: Final Answer:

The role of RNA polymerase III is the transcription of tRNA, 5S rRNA, and some snRNAs. Therefore, option (B) is the correct answer.

Quick Tip

Use the mnemonic **R-M-T** for polymerases **I-II-III**:

- Pol **I** → **rRNA**
- Pol **II** → **mRNA**
- Pol **III** → **tRNA** (and other small RNAs like 5S rRNA)

16. Expressed Sequence Tags (ESTs) refers to

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

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

Solution:

Step 1: Understanding the Question:

The question asks for the definition of "Expressed Sequence Tags" (ESTs), a term from the field of genomics and bioinformatics.

Step 2: Detailed Explanation:

Let's break down the term:

- **Expressed:** This refers to genes that are actively being transcribed. The first product of gene expression is an RNA molecule.
- **Sequence Tags:** These are short, single-pass DNA sequences obtained from a cDNA clone. They act as "tags" or identifiers for the full-length gene.

The process of generating ESTs involves isolating all the messenger RNA (mRNA) from a cell or tissue, converting it into complementary DNA (cDNA) using reverse transcriptase, and then sequencing short fragments of these cDNAs. Because ESTs are derived from mRNA, they represent portions of genes that are actively being transcribed. Therefore, they are a snapshot of **all genes that are expressed as RNA** in that particular sample. Option (B) is incorrect because not all RNA is translated into protein. Option (C) is incorrect because ESTs only represent expressed genes. Option (D) is incorrect because the technique captures all expressed genes, not just "certain important" ones.

Step 3: Final Answer:

ESTs are used to identify all genes that are being transcribed into RNA. Therefore, option (A) is the most accurate definition.

Quick Tip

Focus on the first word: **Expressed**. Gene expression starts with transcription into RNA. Therefore, ESTs are directly linked to the set of genes that are expressed as RNA (the transcriptome).

17. Cellulose does not form blue colour with iodine because

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

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

Solution:

Step 1: Understanding the Question:

The question asks for the molecular reason why cellulose does not produce the characteristic blue-black color with iodine, whereas starch does.

Step 2: Detailed Explanation:

The iodine test is specific for the structure of starch, particularly its amylose component.

- **Starch:** Starch is a polymer made of α -glucose units. The α -1,4 glycosidic linkages cause the amylose chain to form a **coiled, helical structure**. Iodine molecules (as I_3^- and I_5^- ions) can slip into the core of this helix, forming a charge-transfer complex that absorbs light and appears blue-black.
- **Cellulose:** Cellulose is a polymer made of β -glucose units. The β -1,4 glycosidic linkages result in a **straight, linear chain**. These chains align parallel to each other, forming strong, rigid fibers held together by hydrogen bonds.

Since cellulose is a linear molecule and does not form complex helices, there is no space for the iodine molecules to become trapped. Therefore, the color-producing complex cannot form. Evaluating the options:

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

Step 3: Final Answer:

Cellulose does not give a blue color with iodine because its linear structure lacks the helices required to trap iodine molecules. Option (C) is the correct explanation.

Quick Tip

Remember the simple structural difference and its consequence:

- **Starch** (α -glucose) $\rightarrow$ **Helical** $\rightarrow$ Traps Iodine $\rightarrow$ Blue Color.
- **Cellulose** (β -glucose) $\rightarrow$ **Linear** $\rightarrow$ Cannot Trap Iodine $\rightarrow$ No Color.

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

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

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

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

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

Solution:

Step 1: Understanding the Question:

The question presents an Assertion and a Reason about ATP consumption 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 divided into two phases: the preparatory (or energy investment) phase and the payoff phase. During the investment phase, energy is consumed to prepare the glucose molecule for cleavage. Specifically, two molecules of ATP are invested per molecule of glucose. So, Assertion A is **true**.

Analysis of Reason R:

Reason R identifies the two specific steps where ATP is used:

1. The first ATP is used in the first step of glycolysis, where hexokinase phosphorylates glucose to form glucose-6-phosphate.
2. The second ATP is used in the third step of glycolysis, where phosphofructokinase phosphorylates fructose-6-phosphate to form fructose-1,6-bisphosphate (often written as fructose-1,6-diphosphate in older texts).

This statement accurately describes the two ATP-consuming reactions in glycolysis. So, Reason R is **true**.

Relationship between A and R:

Reason R precisely details the two steps mentioned in Assertion A, thereby providing a direct and correct explanation for it.

Step 3: Final Answer:

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

Quick Tip

To remember the steps of glycolysis, focus on the key enzymes of the investment phase: **Hexokinase** (first ATP) and **Phosphofructokinase** (second ATP). These are the two energy-requiring steps.

19. The phenomenon of pleiotropism refers to

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

Correct Answer: (C) A single gene affecting multiple phenotypic expression

Solution:

Step 1: Understanding the Question:

The question asks for the correct definition of the genetic term "pleiotropy" (or pleiotropism).

Step 2: Detailed Explanation:

Let's analyze the given options in the context of genetics:

- **Pleiotropy:** This is a condition where **one single gene** controls or influences **multiple, often unrelated, phenotypic traits**. A classic human example is phenylketonuria (PKU), where a mutation in a single gene leads to a range of symptoms including mental retardation, eczema, and reduced pigmentation.
- Option (A) incorrectly links multiple alleles to crossover.
- Option (B) is a convoluted and incorrect description.
- Option (C) accurately defines pleiotropy.
- Option (D) defines the opposite concept, **polygenic inheritance**, where a single character (like human height) is influenced by multiple genes.

Step 3: Final Answer:

The correct definition of pleiotropy is a single gene affecting multiple phenotypic expressions. Therefore, option (C) is the correct answer.

Quick Tip

To avoid confusion between pleiotropy and polygenic inheritance, remember:

- **Pleiotropy:** One gene → **Plethora** (many) of traits.
- **Polygenic:** **Poly** (many) genes → One trait.

20. Identify the correct statements:

- A. Detritivores perform fragmentation.
- B. The humus is further degraded by some microbes during mineralization.
- C. Water soluble inorganic nutrients go down into the soil and get precipitated by a process called leaching.
- D. The detritus food chain begins with living organisms.
- E. Earthworms break down detritus into smaller particles by a process called catabolism.

Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Question:

The question asks to identify the correct statements from a list that describes the various processes involved in decomposition in an ecosystem.

Step 2: Detailed Explanation:

Let's evaluate each statement:

- **A. Correct.** Fragmentation is the physical breakdown of detritus into smaller pieces, which is performed by detritivores like earthworms and termites.
- **B. Correct.** Humus is a stable end-product of decomposition that degrades very slowly. The process by which microbes eventually break down humus to release inorganic nutrients is called mineralization.
- **C. Correct.** Leaching is the process by which water-soluble inorganic nutrients are washed down into lower soil horizons by percolating water, often making them unavailable to plants. The term "precipitated" can be part of this process as they can form unavailable salts.
- **D. Incorrect.** The detritus food chain (DFC) begins with dead organic matter (detritus), not living organisms. The grazing food chain (GFC) begins with living producers.

- **E. Incorrect.** The process by which earthworms break down detritus is called **fragmentation** (a physical process). **Catabolism** is the enzymatic, chemical degradation of detritus by microorganisms like bacteria and fungi.

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

Step 3: Final Answer:

The combination of correct statements is A, B, and C, which corresponds to option (A).

Quick Tip

To master decomposition, clearly distinguish the key steps: 1. **Fragmentation:** Physical breakdown (by earthworms). 2. **Leaching:** Soluble nutrients wash away. 3. **Catabolism:** Chemical breakdown (by microbes). 4. **Humification:** Formation of humus. 5. **Mineralization:** Release of minerals from humus.

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

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

Correct Answer: (A) Dobson units

Solution:

Step 1: Understanding the Question:

The question asks for the specific unit used to measure the total amount of ozone in a vertical column of the atmosphere (i.e., the thickness of the ozone layer).

Step 2: Detailed Explanation:

Let's analyze the units provided:

- **Dobson Units (DU):** This is the standard unit of measurement for total column ozone. One Dobson Unit is defined as a layer of pure ozone that would be 0.01 mm thick at standard temperature and pressure (0°C and 1 atm).
- **Decibels (dB):** A logarithmic unit used to measure sound intensity.
- **Decameter (dam):** A unit of length, equal to 10 meters.
- **Kilobase (kb):** A unit used in molecular biology to denote the length of a DNA or RNA molecule, equal to 1000 base pairs.

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

Step 3: Final Answer:

The thickness of the ozone layer is measured in Dobson units. Therefore, option (A) is correct.

Quick Tip

This is a straightforward factual question. It's important to associate specific scientific phenomena with their unique units of measurement. For atmospheric science, **Ozone Layer** ↔ **Dobson Units (DU)** is a key association to remember.

22. Given below are two statements :

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

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

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

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

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

Solution:

Step 1: Understanding the Question:

We need to evaluate the validity of two statements about the physiological consequences of transpiration in plants.

Step 2: Detailed Explanation:

Analysis of Statement I:

The cohesion-tension-transpiration pull theory is the most widely accepted explanation for the ascent of sap in tall trees. Transpiration from the leaves creates a strong negative pressure potential (tension). Due to the cohesive forces of water, this tension pulls the entire column of water up the xylem. The tensile strength of a water column in the narrow xylem vessels is extremely high, sufficient to support a column of water well over 100 meters. The tallest trees are over 115 meters, so the claim that the force can lift water over 130 meters is considered physically plausible and is a correct statement of the power of this mechanism. Statement I is **correct**.

Analysis of Statement II:

Transpiration is the evaporation of water from plant surfaces. Evaporation is a cooling process because it requires energy (the latent heat of vaporization), which is drawn from the leaf tissue. This evaporative cooling prevents leaves from overheating in direct sunlight. A temperature reduction of 10 to 15 degrees Celsius is a well-documented and accepted value for this cooling effect. Statement II is **correct**.

Step 3: Final Answer:

Both statements accurately describe two of the main functions of transpiration. Therefore, both Statement I and Statement II are correct. Option (A) is the correct choice.

Quick Tip

Remember the two primary benefits of transpiration: 1. **Transport:** It provides the "pull" to lift water from roots to the highest leaves. 2. **Thermoregulation:** It acts as a natural "air conditioner" for the leaves. Both statements are factual representations of these benefits.

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

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

Correct Answer: (B) To trap pollen grains

Solution:

Step 1: Understanding the Question:

The question asks about the function of "tassels in the corn cob". This phrasing is biologically imprecise, as tassels and cobs are separate structures. We must infer the likely intent of the question.

Step 2: Detailed Explanation:

In a corn plant (*Zea mays*):

- The **tassel** is the male inflorescence at the top of the plant. Its function is to produce and **disperse pollen** into the wind (anemophily).
- The **ear** or **cob** is the female inflorescence. It produces long, sticky, feathery threads called **silks** (which are the stigmas and styles). The function of these silks is to **trap the airborne pollen grains**.

The question is poorly phrased. It likely confuses "tassels" with the "silks" that are part of the cob. Given the options and the provided answer key, the question is almost certainly asking about the function of the silks.

- Function of Tassel: Disperse pollen (Option C).
- Function of Silk (on the cob): Trap pollen (Option B).

Since the provided answer is (B), we must conclude the question intended to ask about the silks on the cob.

Step 3: Final Answer:

Assuming the question is referring to the silks emerging from the corn cob, their function is to trap pollen grains. Therefore, option (B) is the intended correct answer.

Quick Tip

Be aware of potential ambiguities in exam questions. For corn, know the distinct roles:

- **Tassel (Male, Top):** Disperses pollen.
- **Silk (Female, from Cob):** Traps pollen.

If the question links "tassel" and "cob" in a confusing way, consider the function of the part directly associated with the cob in pollination, which is the silk.

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

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

Correct Answer: (A) 680 nm

Solution:

Step 1: Understanding the Question:

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

Step 2: Detailed Explanation:

In higher plants, the light-dependent reactions of photosynthesis are driven by two distinct photosystems, Photosystem I (PS I) and Photosystem II (PS II). Each photosystem has a core complex containing a special pair of chlorophyll 'a' molecules known as the reaction center, which traps the light energy.

- The reaction center of **Photosystem II (PS II)** is designated as **P680**, which signifies that its peak light absorption occurs at a wavelength of **680 nm**.
- The reaction center of **Photosystem I (PS I)** is designated as **P700**, signifying its peak absorption at **700 nm**.

The question specifically refers to PS II.

Step 3: Final Answer:

The reaction center in PS II has an absorption maximum at 680 nm. Therefore, option (A) is the correct answer.

Quick Tip

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

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

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

Correct Answer: (B) Dedifferentiation

Solution:

Step 1: Understanding the Question:

The question describes a process in plant tissue culture where mature, specialized cells (leaf mesophyll) are induced to revert to an undifferentiated, dividing state, forming a mass of cells called a callus. We need to identify the correct term for this phenomenon.

Step 2: Detailed Explanation:

Let's define the terms:

- **Differentiation:** The process by which cells become specialized in structure and function. Leaf mesophyll cells are already differentiated.
- **Dedifferentiation:** The process by which mature, differentiated cells lose their specialized characteristics and regain the capacity for cell division, becoming meristematic again. The formation of a callus from an explant (like leaf mesophyll) is the classic example of dedifferentiation.

- **Redifferentiation:** The process where dedifferentiated cells (like those in a callus) differentiate again to form new specialized cells, tissues, and organs, eventually forming a whole plantlet.
- **Development:** The sum of all changes an organism undergoes in its life cycle, involving both growth and differentiation.
- **Senescence:** The process of aging.

The process described in the question, where specialized cells become unspecialized and start dividing, is correctly termed dedifferentiation.

Step 3: Final Answer:

The phenomenon is called dedifferentiation. Therefore, option (B) is the correct answer.

Quick Tip

Remember the sequence of events in plant tissue culture via callus formation: **Differentiated** cells (explant) $\xrightarrow{\text{Dedifferentiation}}$ **Undifferentiated** callus $\xrightarrow{\text{Redifferentiation}}$ **Differentiated** plantlet. This "D-D-R" sequence is a key concept.

26. Given below are two statements: One labelled as Assertion A and the other 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 options given below:

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

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

Solution:

Step 1: Understanding the Question:

The question presents an assertion and a reason regarding the life cycle of a moss. We need to evaluate the correctness of both statements and determine if the reason properly explains the assertion.

Step 2: Detailed Explanation:

Analysis of Assertion A:

The life cycle of a moss features a dominant gametophytic generation, which occurs in two stages. When a haploid spore germinates, it first grows into a filamentous, creeping, green structure called the **protonema**. This is the juvenile, or first stage, of the gametophyte. From this protonema, buds arise that develop into the mature, leafy gametophyte. Thus, Assertion A is **true**.

Analysis of Reason R:

The diploid sporophyte in mosses consists of a foot, seta, and capsule. Inside the capsule, meiosis takes place to produce haploid spores. These spores, upon release and finding a suitable environment, germinate and develop directly into the protonema. Thus, Reason R is **true**.

Relationship between A and R:

Reason R explains the origin of the protonema (from a spore), which correctly establishes it as the very first stage of the gametophytic generation. This directly explains why the assertion is true.

Step 3: Final Answer:

Both Assertion A and Reason R are correct, and R is the correct explanation of A. Therefore, option (A) is the correct choice.

Quick Tip

Memorize the sequence of the moss life cycle: Spore (n) → Protonema (n) → Leafy Gametophyte (n) → Gametes (n) → Zygote (2n) → Sporophyte (2n) → Spores (n). This clarifies the role of the protonema as the initial gametophytic stage.

27. Among eukaryotes, replication of DNA takes place in :

- (A) M phase
- (B) S phase
- (C) G₁ phase
- (D) G₂ phase

Correct Answer: (B) S phase

Solution:

Step 1: Understanding the Question:

The question asks to identify the specific phase of the eukaryotic cell cycle during which the cell's DNA is duplicated.

Step 2: Detailed Explanation:

The eukaryotic cell cycle is divided into two main stages: Interphase and M phase. Interphase, the period of growth and preparation, is further divided into three sub-phases:

- **G₁ phase (Gap 1):** The cell grows and carries out its metabolic functions.
- **S phase (Synthesis phase):** This is the specific phase where DNA replication occurs. The amount of DNA in the cell doubles, so that at the end of S phase, each chromosome consists of two identical sister chromatids.
- **G₂ phase (Gap 2):** The cell continues to grow and prepares for mitosis.
- **M phase (Mitotic phase):** The cell undergoes nuclear division (mitosis) and cytoplasmic division (cytokinesis).

DNA replication is exclusively confined to the S phase.

Step 3: Final Answer:

DNA replication in eukaryotes takes place during the S phase. Therefore, option (B) is correct.

Quick Tip

The 'S' in **S phase** stands for **Synthesis**. This is the easiest way to remember that DNA **synthesis** (replication) occurs during this specific stage of the cell cycle.

28. Axile placentation is observed in

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

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

Solution:

Step 1: Understanding the Question:

The question requires identifying a group of plants from the options that all share the characteristic of axile placentation. Placentation refers to the arrangement of ovules within the ovary.

Step 2: Detailed Explanation:

Axile placentation is where the ovary is divided into multiple chambers (locules) by septa, and the ovules are attached to the central axis where the septa meet. Let's analyze the placentation types in each option:

- **(A) Mustard, Cucumber and Primrose:** Mustard and Cucumber have parietal placentation; Primrose has free-central placentation.
- **(B) China rose, Beans and Lupin:** China rose has axile placentation; Beans and Lupin (Fabaceae) have marginal placentation.

- **(C) Tomato, Dianthus and Pea:** Tomato has axile placentation; Dianthus has free-central placentation; Pea (Fabaceae) has marginal placentation.
- **(D) China rose, Petunia and Lemon:** China rose (Malvaceae), Petunia (Solanaceae), and Lemon (Rutaceae) are all classic examples of plants with axile placentation.

Step 3: Final Answer:

The group of plants where all members exhibit axile placentation is China rose, Petunia, and Lemon. Therefore, option (D) is the correct answer.

Quick Tip

The best way to handle placentation questions is to memorize one or two key examples for each type:

- **Marginal:** Pea
- **Axile:** Tomato, Lemon, China rose
- **Parietal:** Mustard, Argemone
- **Free-central:** Dianthus, Primrose
- **Basal:** Sunflower, Marigold

29. In the equation $GPP - R = NPP$

GPP is Gross Primary Productivity

NPP is Net Primary Productivity

R here is

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

Correct Answer: (C) Respiratory loss

Solution:

Step 1: Understanding the Question:

The question presents the fundamental equation of ecosystem productivity and asks for the identity of the term 'R'.

Step 2: Detailed Explanation:

Let's define the terms in the context of ecological energy flow:

- **Gross Primary Productivity (GPP):** This is the total rate at which producers (plants) capture and store chemical energy through photosynthesis. It's the total energy assimilated.
- To maintain their life processes (growth, repair, transport), producers must use a portion of this captured energy for their own cellular **respiration**. This energy is not stored as biomass and is lost to the ecosystem as heat.
- **Net Primary Productivity (NPP):** This is the energy that remains stored as biomass after the producers' respiratory needs have been met. It is the energy available to the next trophic level (consumers).

The relationship is straightforward: Net Productivity is what is left after subtracting the costs from the Gross amount.

$$\text{NPP} = \text{GPP} - \text{R}$$

Here, **R** represents the energy consumed during **Respiration**, so it stands for **Respiratory loss**.

Step 3: Final Answer:

In the productivity equation, R represents the energy lost through respiration. Therefore, option (C) is the correct answer.

Quick Tip

Think of it like a monthly budget:

- **GPP** is your Gross Salary (total income).
- **R** (Respiration) is your Expenses (rent, food, bills).
- **NPP** is your Net Savings (money available to use or invest).

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

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

Correct Answer: (C) Anaphase II

Solution:

Step 1: Understanding the Question:

The question asks to identify the specific stage of meiosis during which the centromeres, which

hold the sister chromatids together, divide.

Step 2: Detailed Explanation:

Meiosis consists of two successive divisions, Meiosis I and Meiosis II.

- **Meiosis I** is the reductional division. Its primary event is the separation of homologous chromosomes. Throughout Meiosis I, sister chromatids remain attached at their centromeres. During **Anaphase I**, homologous chromosomes move apart, but the centromeres do **not** divide.
- **Meiosis II** is the equational division, which is mechanistically similar to mitosis. Its primary event is the separation of sister chromatids. During **Anaphase II**, the centromere of each chromosome finally divides, allowing the sister chromatids to be pulled to opposite poles. Once separated, they are considered individual chromosomes.

Therefore, the division of the centromere is the defining event of Anaphase II.

Step 3: Final Answer:

The division of the centromere occurs during Anaphase II. Thus, option (C) is the correct answer.

Quick Tip

Remember this key distinction:

- **Anaphase I:** Separation of homologous chromosomes. (Centromeres **do not** divide).
- **Anaphase II:** Separation of sister chromatids. (Centromeres **do** divide).

Anaphase II is functionally equivalent to the anaphase of mitosis.

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

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

Correct Answer: (B) Gibberellic Acid

Solution:

Step 1: Understanding the Question:

The question asks which plant hormone is used to accelerate the transition from the juvenile vegetative stage to the mature reproductive stage in conifers, thereby promoting early seed

production.

Step 2: Detailed Explanation:

Let's review the functions of the listed phytohormones:

- **Indole-3-butyric Acid (IBA):** An auxin, primarily used commercially to promote root initiation in cuttings.
- **Gibberellic Acid (GA):** Gibberellins have a wide range of effects, including stem elongation, breaking dormancy, and promoting flowering. A key agricultural/horticultural application is spraying GAs on juvenile conifers to overcome their long juvenile period. This hastens the maturation process, leading to early cone development and seed production, which is very useful in breeding programs.
- **Zeatin:** A type of cytokinin, which promotes cell division (cytokinesis) and delays leaf senescence.
- **Abscisic Acid (ABA):** Generally an inhibitory hormone involved in promoting dormancy and responses to stress, like stomatal closure.

The specific function of hastening maturity in conifers is a well-known role of gibberellic acid.

Step 3: Final Answer:

Gibberellic acid is used to hasten the maturity period in juvenile conifers. Therefore, option (B) is correct.

Quick Tip

For exams, focus on the most distinct and commercially important applications of each hormone class:

- **Auxins:** Rooting hormone.
- **Gibberellins:** Stem elongation, fruit size (grapes), breaking dormancy, and **hastening maturity in conifers**.
- **Cytokinins:** Delaying aging.
- **Ethylene:** Fruit ripening.
- **ABA:** Stress hormone, dormancy.

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

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

Correct Answer: (B) Alfred Hershey and Martha Chase

Solution:

Step 1: Understanding the Question:

The question asks to identify the scientists who provided the definitive, conclusive, or "unequivocal" proof that DNA is the molecule of heredity.

Step 2: Detailed Explanation:

The search for the genetic material involved a series of landmark experiments:

1. **Frederick Griffith (1928):** His "transformation experiment" showed that some "principle" could be transferred from dead virulent bacteria to live non-virulent bacteria, making them virulent. He did not identify the principle.
2. **Avery, Macleoid, and McCarthy (1944):** They conducted biochemical experiments to identify Griffith's transforming principle. They showed that only the enzyme that destroyed DNA (DNase) could prevent transformation, providing strong evidence that DNA was the genetic material. However, many scientists remained skeptical.
3. **Alfred Hershey and Martha Chase (1952):** Their "blender experiment" provided the final, conclusive proof. They used bacteriophages (viruses that infect bacteria) and labeled their protein coats with radioactive sulfur (^{35}S) and their DNA with radioactive phosphorus (^{32}P). They showed that only the ^{32}P (DNA) entered the host bacterium to direct the production of new viruses. This was accepted as the unequivocal proof.
4. **Wilkins and Franklin:** They used X-ray diffraction to study DNA structure, which was crucial for Watson and Crick's model.

Step 3: Final Answer:

The Hershey and Chase experiment provided the unequivocal proof that DNA is the genetic material. Therefore, option (B) is the correct answer.

Quick Tip

Remember the progression of the "search for the genetic material":

- **Griffith:** Discovered transformation.
- **Avery et al.:** Identified the transforming principle as DNA.
- **Hershey Chase:** Provided the **unequivocal proof** using radioactive tracers.

The word "unequivocal" is the key that points specifically to Hershey and Chase.

33. Large, colourful, fragrant flowers with nectar are seen in

- (A) Insect pollinated plants
- (B) Bird pollinated plants

- (C) Bat pollinated plants
- (D) Wind pollinated plants

Correct Answer: (A) Insect pollinated plants

Solution:

Step 1: Understanding the Question:

The question describes a suite of floral traits (large size, colorful, fragrant, nectar-producing) and asks to identify the corresponding pollination syndrome (the method of pollination).

Step 2: Detailed Explanation:

Different pollination strategies are associated with specific floral characteristics that attract the pollinator:

- **Insect pollination (Entomophily):** To attract insects, flowers are typically **large** (conspicuous), **colourful** (often in blues, yellows, or UV patterns), **fragrant**, and offer a food reward like **nectar**. This combination of traits perfectly matches the question's description.
- **Bird pollination (Ornithophily):** Flowers are often large and brightly colored (especially red), with abundant nectar, but are usually odorless as birds have a poor sense of smell.
- **Bat pollination (Chiropterophily):** Flowers are typically large, pale/dull-colored, open at night, and emit a strong, musty scent.
- **Wind pollination (Anemophily):** Flowers are small, inconspicuous, and lack color, fragrance, and nectar as they do not need to attract animals.

Step 3: Final Answer:

The combination of large, colorful, fragrant flowers with nectar is a classic adaptation for attracting insects. Therefore, option (A) is correct.

Quick Tip

To answer questions about pollination syndromes, consider the senses of the pollinator.

- **Insects:** Good vision (color) + good smell (fragrance).
- **Birds:** Excellent vision (bright colors) + poor smell.
- **Bats:** Nocturnal, so color is irrelevant; rely on strong smells.
- **Wind:** No senses, so no attractants are needed.

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

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

Correct Answer: (B) Pachytene

Solution:

Step 1: Understanding the Question:

The question asks to identify the specific substage of meiotic prophase I where recombination nodules, the sites of crossing over, become visible.

Step 2: Detailed Explanation:

Prophase I is the longest stage of meiosis and is divided into five substages:

1. **Leptotene:** Chromosome condensation begins.
2. **Zygotene:** Synapsis (pairing of homologous chromosomes) occurs.
3. **Pachytene:** The paired homologous chromosomes (bivalents) are clearly visible. During this stage, crossing over (the exchange of genetic material between non-sister chromatids) takes place. The sites where this occurs are marked by the presence of protein complexes called **recombination nodules**.
4. **Diplotene:** The synaptonemal complex dissolves, and homologous chromosomes start to separate, remaining attached at the points of crossover (chiasmata).
5. **Diakinesis:** Chromosomes become fully condensed, and chiasmata terminalize.

The key event of crossing over, mediated by recombination nodules, is the hallmark of the pachytene stage.

Step 3: Final Answer:

The appearance of recombination nodules occurs during the pachytene stage. Therefore, option (B) is correct.

Quick Tip

Associate a key word with each stage of Prophase I:

- Zygotene → Zipping (Synapsis)
- Pachytene → Patching (Crossing over / Recombination nodules)
- Diplotene → Dissolving (Chiasmata visible)

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

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

Correct Answer: (A) Habitat loss and fragmentation

Solution:

Step 1: Understanding the Question:

The question asks to identify the most significant driver of species extinction from the four major causes, which are collectively termed 'The Evil Quartet'.

Step 2: Detailed Explanation:

'The Evil Quartet' refers to the four major anthropogenic causes of biodiversity loss:

1. **Habitat loss and fragmentation:** This includes the outright destruction of habitats (e.g., deforestation, urbanization) and the breaking up of large habitats into smaller, isolated patches.
2. **Over-exploitation:** Harvesting species from the wild faster than they can reproduce (e.g., overfishing, poaching).
3. **Alien species invasions:** The introduction of non-native species that can outcompete, prey upon, or introduce diseases to native species.
4. **Co-extinctions:** The extinction of a species due to the extinction of another species on which it depends (e.g., a specialist parasite and its host).

Among these, ecologists overwhelmingly agree that **habitat loss and fragmentation is the single most important cause of species extinction worldwide**. Without a place to live, feed, and reproduce, no species can survive. The destruction of highly biodiverse areas like tropical rainforests is the prime example of this threat.

Step 3: Final Answer:

Habitat loss and fragmentation is considered the most important cause of species extinction. Therefore, option (A) is correct.

Quick Tip

When thinking about threats to biodiversity, remember that habitat is the foundation. You can't have a species without a home. That's why habitat loss is consistently ranked as the number one threat.

36. Identify the correct statements:

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

Choose the correct answer from the options given below:

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

Correct Answer: (B) A and D only

Solution:

Step 1: Understanding the Question:

The question asks to identify the factually correct statements from a list of five, all related to the anatomy of plant stems, particularly the bark and associated structures.

Step 2: Detailed Explanation:

Let's evaluate each statement for its accuracy:

- **A. Lenticels are the lens-shaped openings permitting the exchange of gases.** This statement is **correct**. Lenticels are porous regions in the periderm of woody stems that allow gas exchange between the internal tissues and the atmosphere, bypassing the impermeable cork layer.
- **B. Bark formed early in the season is called hard bark.** This statement is **incorrect**. The bark formed early in the growing season (spring) is called 'soft bark', while the bark formed later in the season is called 'hard bark'.
- **C. Bark is a technical term that refers to all tissues exterior to vascular cambium.** This statement is **incorrect**. 'Bark' is a *non-technical* term. While it does refer to all tissues outside the vascular cambium, calling it a "technical term" is incorrect from a strict botanical standpoint.
- **D. Bark refers to periderm and secondary phloem.** This statement is **correct**. This is the anatomical definition of bark. It includes the secondary phloem (inner bark) and the periderm (outer bark).
- **E. Phellogen is single-layered in thickness.** This statement is **incorrect**. Phellogen, or cork cambium, is a lateral meristem. Meristematic tissues consist of actively dividing cells and are typically a few layers thick, not strictly a single layer.

Based on this analysis, only statements A and D are correct.

Step 3: Final Answer:

The correct statements are A and D. Therefore, option (B) is the correct choice.

Quick Tip

Remember the key definitions for plant secondary growth:

- **Bark** (non-technical term) = everything outside the vascular cambium.
- **Bark** (anatomical composition) = Secondary Phloem + Periderm.
- **Periderm** = Phellem (cork) + Phellogen (cork cambium) + Phelloderm.

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

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

Correct Answer: (A) Succinic dehydrogenase

Solution:

Step 1: Understanding the Question:

The question asks to identify the enzyme whose activity is inhibited by malonate, which in turn stops the growth of pathogenic bacteria. This question is about a specific mechanism of enzyme inhibition.

Step 2: Detailed Explanation:

The action of malonate is a classic example of competitive enzyme inhibition.

- The enzyme **succinic dehydrogenase** is a key enzyme in the Krebs cycle (TCA cycle), which is central to cellular respiration in aerobic bacteria.
- The normal substrate for this enzyme is **succinate**.
- **Malonate** is a molecule that is structurally very similar to succinate.
- Because of this structural similarity, malonate can bind to the active site of the succinic dehydrogenase enzyme. However, the enzyme cannot act on malonate to form a product.
- By occupying the active site, malonate competes with the actual substrate (succinate) and blocks the enzyme's function.
- This inhibition of a crucial step in the Krebs cycle halts aerobic respiration, preventing ATP production and thus inhibiting bacterial growth.

The other enzymes listed (Amylase, Lipase, Dinitrogenase) are involved in different metabolic pathways and are not the target of malonate.

Step 3: Final Answer:

Malonate inhibits the activity of succinic dehydrogenase. Therefore, option (A) is the correct answer.

Quick Tip

The trio of **Succinate** (substrate), **Succinic dehydrogenase** (enzyme), and **Malonate** (competitive inhibitor) is a textbook example used to illustrate the principle of competitive inhibition. Memorizing this specific interaction is highly beneficial for exams.

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

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

Solution:

Step 1: Understanding the Question:

The question requires matching terms related to the physical properties of water and plant water relations (List I) with their correct definitions or descriptions (List II).

Step 2: Detailed Explanation:

Let's define each term in List I and find its corresponding description in List II:

- **A. Cohesion:** This is the intermolecular attraction between like-molecules. In water, it is the **mutual attraction among water molecules**, primarily due to hydrogen bonds. This creates the continuous water column in the xylem. So, **A matches with II**.
- **B. Adhesion:** This is the intermolecular attraction between unlike molecules. In the context of plants, it's the **attraction of water molecules towards polar surfaces**, such as the hydrophilic walls of the xylem vessels. So, **B matches with IV**.

- **C. Surface tension:** This is a property of liquids that results from cohesion. At the surface, water molecules are attracted to each other more strongly than to the air above them, creating a 'skin'. This can be described as water molecules having **more attraction in the liquid phase** than in the gaseous phase at the interface. So, **C matches with I.**
- **D. Guttation:** This is the process of exudation of water droplets (xylem sap) from the tips or margins of leaves through specialized pores called hydathodes. It is a form of **water loss in the liquid phase**, which occurs under conditions of high root pressure and low transpiration. So, **D matches with III.**

Based on this, the correct pairing is A-II, B-IV, C-I, D-III.

Step 3: Final Answer:

The correct combination is A-II, B-IV, C-I, D-III, which corresponds to option (A).

Quick Tip

Use simple associations to remember these terms:

- **Cohesion:** Attraction between **co**-workers (similar molecules, water-water).
- **Adhesion:** Attraction to something **additional** (different molecules, water-xylem wall).
- **Guttation:** Water loss as a liquid.
- **Transpiration:** Water loss as a vapor.

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

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

Solution:

Step 1: Understanding the Question:

The question requires matching four essential micronutrients (List I) with their specific physi-

ological functions in plants (List II).

Step 2: Detailed Explanation:

Let's analyze the function of each mineral element:

- **A. Iron (Fe):** Iron is a crucial component of electron transport proteins like cytochromes and ferredoxin. It is also an essential **activator for the enzyme catalase**. So, **A matches with III**.
- **B. Zinc (Zn):** Zinc is an activator for various enzymes, including carboxylases. It is critically required for the **synthesis of auxin (IAA)**. So, **B matches with I**.
- **C. Boron (B):** Boron is required for calcium uptake, pollen germination, membrane function, and most notably, **cell elongation and cell differentiation**. So, **C matches with IV**.
- **D. Molybdenum (Mo):** Molybdenum is a structural **component of nitrate reductase**, a key enzyme in nitrogen assimilation. It is also a component of nitrogenase. So, **D matches with II**.

The correct set of matches is A-III, B-I, C-IV, D-II.

Step 3: Final Answer:

The correct combination is A-III, B-I, C-IV, D-II, which corresponds to option (C).

Quick Tip

For mineral nutrition questions, focus on the most unique and frequently tested function for each element:

- **Zinc** → Auxin Synthesis
- **Molybdenum** → Nitrate Reductase
- **Boron** → Pollen Germination & Cell Differentiation
- **Iron** → Catalase Cytochromes
- **Manganese** → Photolysis of Water

40. Which of the following statements are correct about Klinefelter's Syndrome?

- A. This disorder was first described by Langdon Down (1866).
- B. Such an individual has overall masculine development. However, the feminine development is also expressed.
- C. The affected individual is short statured.
- D. Physical, psychomotor and mental development is retarded.
- E. Such individuals are sterile.

Choose the correct answer from the options given below:

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

Correct Answer: (C) B and E only

Solution:

Step 1: Understanding the Question:

The question asks to identify the correct statements from a given list that accurately describe the characteristics of Klinefelter's Syndrome.

Step 2: Detailed Explanation:

Klinefelter's Syndrome is a genetic condition caused by the presence of an extra X chromosome in males, resulting in the karyotype 47, XXY. Let's evaluate each statement:

- **A. Incorrect.** This disorder was first described by Harry Klinefelter in 1942. Langdon Down described Down's Syndrome.
- **B. Correct.** The presence of a Y chromosome leads to overall masculine development (i.e., the individual is male). However, the extra X chromosome leads to the expression of some feminine characteristics, such as the development of breasts (gynecomastia) and sparse body hair.
- **C. Incorrect.** Affected individuals are often taller than average, with long limbs. Short stature is a characteristic of Turner's Syndrome (45, XO).
- **D. Incorrect.** While some individuals may have learning difficulties or delayed speech development, severe mental retardation is not a typical feature of Klinefelter's Syndrome.
- **E. Correct.** Individuals with Klinefelter's Syndrome have small, underdeveloped testes and are invariably sterile due to a failure in sperm production (azoospermia).

Thus, the correct statements are B and E.

Step 3: Final Answer:

The correct combination of statements is B and E, which is found in option (C).

Quick Tip

To distinguish common chromosomal aneuploidies, create a simple chart:

Syndrome	Karyotype	Key Features
Klinefelter's	47, XXY	Tall male, gynecomastia, sterile
Turner's	45, XO	Short female, webbed neck, sterile
Down's	Trisomy 21	Short stature, mental retardation, specific facial features

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

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

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

Solution:

Step 1: Understanding the Question:

The question asks for the essential components that are collectively required for the process of chemiosmosis, which is the mechanism for ATP synthesis in mitochondria and chloroplasts.

Step 2: Detailed Explanation:

The Chemiosmotic Hypothesis, proposed by Peter Mitchell, outlines four indispensable components for ATP synthesis:

1. **An intact Membrane:** A membrane that is impermeable to protons (like the inner mitochondrial membrane or the thylakoid membrane) is required to maintain a separation of charges.
2. **A Proton Pump:** An energy source is needed to pump protons (H^+ ions) across the membrane against their concentration gradient. This is accomplished by the protein complexes of the electron transport chain, which use the energy of moving electrons.
3. **A Proton Gradient:** The pumping action creates a high concentration of protons on one side of the membrane, establishing an electrochemical potential gradient, also known as the proton-motive force. This gradient represents stored energy.
4. **ATP Synthase:** A specialized enzyme complex embedded in the membrane that has a channel allowing protons to flow back down their gradient. The enzyme harnesses the energy from this proton flow to synthesize ATP from ADP and P_i .

Option (A) lists all these four components correctly. The other options are incorrect as they mention "NADP synthase" (it should be ATP synthase) or an "electron gradient" (it is a proton gradient that drives the process).

Step 3: Final Answer:

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

Quick Tip

Remember the four essential elements of chemiosmosis with the acronym **M-P-G-A**:

- **M**embrane
- **P**roton Pump
- **G**radient (of protons)
- **A**TP Synthase

All four must be present and functional.

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

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

Correct Answer: (A) 80

Solution:

Step 1: Understanding the Question:

The question asks for the approximate total number of distinct proteins that make up a ribosome. The question is general, but in a biology context without further specification, it often refers to the more complex eukaryotic ribosome.

Step 2: Detailed Explanation:

Ribosomes are composed of ribosomal RNA (rRNA) and many different ribosomal proteins.

- **Eukaryotic Ribosome (80S):** This ribosome is composed of a large 60S subunit and a small 40S subunit.
 - The 60S subunit contains ~49 proteins.
 - The 40S subunit contains ~33 proteins.
 - Total proteins = $\sim 49 + 33 = \sim 82$ proteins.
- **Prokaryotic Ribosome (70S):** This ribosome consists of a 50S and a 30S subunit, with a total of about 55 proteins.

Looking at the options, the value **80** is the best approximation for the total number of proteins in a eukaryotic ribosome. The other numbers (60 and 40) correspond to the Svedberg units of the eukaryotic subunits, not the protein count.

Step 3: Final Answer:

A eukaryotic ribosome consists of approximately 80 different proteins. Therefore, option (A) is

the correct answer.

Quick Tip

Do not confuse the Svedberg (S) value, which is a measure of sedimentation rate, with the number of components. The 80S eukaryotic ribosome is made of 60S and 40S subunits. Memorize the approximate protein counts: ~80 for eukaryotes, ~55 for prokaryotes. The option 80 strongly points to the eukaryotic ribosome.

43. 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 a 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 node instead of leaves.

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

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

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

Solution:

Step 1: Understanding the Question:

This question presents an assertion that defines a flower as a modified shoot and a reason that describes the modification process. We need to assess the truthfulness of both statements and their causal relationship.

Step 2: Detailed Explanation:

Analysis of Assertion A:

From a morphological perspective, a flower is indeed considered to be a highly modified and condensed reproductive shoot. During the transition to flowering, the vegetative shoot apical meristem transforms into a floral meristem, which gives rise to the flower parts. This is a fundamental concept in botany. Thus, Assertion A is **true**.

Analysis of Reason R:

This statement explains the details of the modification. In a typical vegetative shoot, nodes are separated by visible internodes. In a flower, the axis (thalamus) does not elongate, which means the **internodes are extremely condensed**. This brings the nodes very close together. From these closely spaced nodes, the floral appendages (sepals, petals, stamens, carpels), which

are considered homologous to leaves, arise in whorls. This accurately describes the process of shoot modification into a flower. Thus, Reason R is **true**.

Relationship between A and R:

Reason R provides the specific anatomical changes (condensation of internodes, production of floral parts instead of leaves) that explain *why* a flower is considered a modified shoot. 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. Therefore, option (A) is the correct choice.

Quick Tip

Remember the homologous parts between a shoot and a flower:

- **Stem axis** → **Thalamus/Receptacle**
- **Leaves** → **Floral Whorls** (sepals, petals, stamens, carpels)

The key difference is the extreme compression of the internodes in the flower.

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

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

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

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

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

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

Solution:

Step 1: Understanding the Question:

The question presents two statements regarding pollination in gymnosperms. Assertion A describes the dispersal of pollen, and Reason R describes the events of fertilization. We must evaluate the correctness of both statements.

Step 2: Detailed Explanation:

Analysis of Assertion A:

Gymnosperms are typically wind-pollinated (anemophilous). Their pollen grains are produced in microsporangia and are released to be carried by wind or air currents to the female ovules. This statement is a correct description of pollination in gymnosperms. Therefore, Assertion A is **true**.

Analysis of Reason R:

This statement contains several factual errors about fertilization in gymnosperms.

1. The pollen grain lands on the ovule, near the micropyle, not directly at the "mouth of the archegonia."
2. The most significant error is the claim that a "pollen tube is not formed." A key characteristic of all seed plants (gymnosperms and angiosperms) is the formation of a pollen tube (siphonogamy). The pollen grain germinates on the ovule, grows a pollen tube through the nucellus, and discharges the male gametes near the egg cell within the archegonium.

Because it incorrectly states that a pollen tube is absent, Reason R is **false**.

Step 3: Final Answer:

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

Quick Tip

A fundamental feature of all seed plants (gymnosperms included) is siphonogamy, the formation of a pollen tube to deliver sperm cells to the egg. Any statement that claims gymnosperms lack a pollen tube is incorrect.

45. Match List I with List II:

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

- | | |
|-----------------|-------------------|
| A. Mutualism | I. $+(A), 0(B)$ |
| B. Commensalism | II. $-(A), 0(B)$ |
| C. Amensalism | III. $+(A), -(B)$ |
| D. Parasitism | IV. $+(A), +(B)$ |

Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Question:

The question requires matching different types of population interactions with their symbolic representations, where '+' indicates a benefit, '-' indicates harm, and '0' indicates a neutral effect for the interacting species A and B.

Step 2: Detailed Explanation:

Let's define each type of interaction:

- **A. Mutualism:** An interaction in which both participating species benefit. This is represented as (+, +). So, **A matches with IV.**
- **B. Commensalism:** An interaction where one species benefits, and the other is neither harmed nor helped. This is represented as (+, 0). So, **B matches with I.**
- **C. Amensalism:** An interaction where one species is harmed, and the other is unaffected. This is represented as (-, 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. This is represented as (+, -). So, **D matches with III.**

The correct set of matches is A-IV, B-I, C-II, D-III.

Step 3: Final Answer:

The correct combination is A-IV, B-I, C-II, D-III, which is option (B).

Quick Tip

Memorize the six main types of population interactions using the (+, -, 0) notation:

- Mutualism (+, +)
- Competition (-, -)
- Predation (+, -)
- Parasitism (+, -)
- Commensalism (+, 0)
- Amensalism (-, 0)

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

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

Choose the correct answer from the options given below :

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

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

Solution:

Step 1: Understanding the Question:

The question asks to arrange the listed steps of recombinant DNA technology in the correct chronological order.

Step 2: Detailed Explanation:

Let's outline the logical sequence of events in a typical gene cloning experiment:

1. **B. Cutting of DNA at specific location by restriction enzyme:** The first step is to use restriction enzymes to cut the source DNA (containing the gene of interest) and the vector DNA (e.g., a plasmid). This creates compatible ends for joining.
2. **C. Isolation of desired DNA fragment:** After cutting the source DNA, it yields numerous fragments. The specific fragment containing the gene of interest must be separated and purified, usually by gel electrophoresis.
3. **D. Amplification of gene of interest using PCR:** Often, the isolated gene fragment is available in very small quantities. To obtain a large number of copies for ligation, the Polymerase Chain Reaction (PCR) is used to amplify the fragment.
4. **A. Insertion of recombinant DNA into the host cell:** The amplified gene fragment is ligated (joined) into the cut vector, creating a recombinant DNA molecule. This recombinant DNA is then introduced into a suitable host cell (like *E. coli*) through a process called transformation, where it can be replicated.

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

Step 3: Final Answer:

The correct sequence of the main steps is B, C, D, A, which corresponds to option (A).

Quick Tip

Think of the process as a recipe:

1. **Cut** the ingredients (DNA) with a knife (restriction enzyme). (B)
2. **Isolate** the specific ingredient you need (gene fragment). (C)
3. **Amplify** your ingredient if you don't have enough (PCR). (D)
4. **Insert** the ingredient into your dish (vector) and put it in the oven (host cell). (A)

47. Given below are two statements:

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

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

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

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

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

Solution:

Step 1: Understanding the Question:

The question presents two statements related to the ecological concept of competition. We need to assess the validity of each statement.

Step 2: Detailed Explanation:

Analysis of Statement I:

This statement provides a definition of Gause's 'Competitive Exclusion Principle'. It correctly states that if two species with identical niches (competing for the same limiting resources) are in the same habitat, one will eventually outcompete and eliminate the other. This is a fundamental principle of population ecology. Therefore, Statement I is **correct**.

Analysis of Statement II:

This statement makes a broad generalization about the relative impact of competition on different trophic levels. There is no established ecological rule that says carnivores are generally more affected by competition than herbivores. In many ecosystems, competition among herbivores for limited plant resources can be extremely intense. Carnivore populations are often limited by prey availability (a bottom-up control) rather than direct competition with other carnivores, although such competition does exist. The statement is an oversimplification and is not considered a general rule. Therefore, Statement II is **false**.

Step 3: Final Answer:

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

Quick Tip

Remember the core of Gause's principle: "Complete competitors cannot coexist." For statements like Statement II, be cautious of broad generalizations in ecology. The intensity of competition is highly dependent on the specific ecosystem, resource availability, and niche overlap, not just the trophic level.

48. Match List I with List II:

List I

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

List II

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

Choose the correct answer from the options given below :

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

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

Solution:

Step 1: Understanding the Question:

The question requires matching various processes of cellular respiration (List I) with their associated enzymes, systems, or alternative names (List II).

Step 2: Detailed Explanation:

Let's analyze and match each item:

- **A. Oxidative decarboxylation:** This specifically refers to the link reaction where pyruvate is converted into acetyl-CoA. This reaction is catalyzed by the large enzyme complex called **Pyruvate dehydrogenase**. So, **A matches with II**.
- **B. Glycolysis:** This is the initial pathway of glucose breakdown in the cytoplasm. It is also famously known as the **EMP pathway**, named after its discoverers (Embden, Meyerhof, and Parnas). So, **B matches with IV**.
- **C. Oxidative phosphorylation:** This is the final stage of aerobic respiration where a proton gradient, generated by the electron transport chain, is used to produce a large amount of ATP. The entire process is mediated by the **Electron transport system (ETS)**. So, **C matches with III**.
- **D. Tricarboxylic acid cycle (TCA cycle):** Also known as the Krebs cycle. The first committed step of this cycle is catalyzed by the enzyme **Citrate synthase**, which combines acetyl-CoA with oxaloacetate to form citrate. So, the TCA cycle is directly associated with this enzyme. **D matches with I**.

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

Step 3: Final Answer:

The correct combination is A-II, B-IV, C-III, D-I, which is given in option (D).

Quick Tip

For cellular respiration, create strong mental links between processes and key players:

- Glycolysis $\Leftrightarrow$ EMP pathway
- Link reaction $\Leftrightarrow$ Oxidative decarboxylation $\Leftrightarrow$ Pyruvate dehydrogenase
- Krebs cycle $\Leftrightarrow$ TCA cycle $\Leftrightarrow$ Citrate synthase (starts the cycle)
- ATP synthesis (final step) $\Leftrightarrow$ Oxidative phosphorylation $\Leftrightarrow$ Electron transport system

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

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

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

Solution:

Step 1: Understanding the Question:

The question asks to identify the incorrect statement among the four options, all of which describe consequences of water pollution.

Step 2: Detailed Explanation:

Let's evaluate each statement's validity:

- **(A) Correct.** When sewage, rich in organic matter, enters a water body, decomposer microorganisms multiply rapidly. Their aerobic respiration consumes a large amount of dissolved oxygen, leading to a sharp drop in oxygen levels (hypoxia), which can cause mass mortality of fish and other aquatic organisms.

- **(B) Incorrect.** Algal blooms are caused by nutrient enrichment (eutrophication), specifically by excess nitrates and phosphates, not just "organic matter". These blooms are highly detrimental. They block sunlight to submerged vegetation. When the algae die, their decomposition by bacteria consumes vast quantities of dissolved oxygen, leading to hypoxic "dead zones". Therefore, algal blooms severely *deteriorate* water quality and *destroy* fisheries. The statement claims the opposite.
- **(C) Correct.** Water hyacinth (*Eichhornia crassipes*) is a notorious invasive aquatic weed that thrives in nutrient-rich (eutrophic) waters. Its rapid growth covers the water surface, disrupting the entire aquatic ecosystem.
- **(D) Correct.** This describes the process of biomagnification. Certain persistent toxic substances (like heavy metals or pesticides) from industrial effluents accumulate in organisms, and their concentration increases up the food chain.

Statement (B) is factually incorrect as it presents the effects of algal blooms as beneficial when they are actually harmful.

Step 3: Final Answer:

The incorrect statement is (B).

Quick Tip

Remember that terms like "eutrophication" and "algal bloom" are always associated with negative environmental impacts, including oxygen depletion, loss of biodiversity, and harm to fisheries. Any statement suggesting they are beneficial is almost certainly false.

50. Match List I with List II :

List I

List II

- | | |
|-------------------------|---|
| A. M Phase | I. Proteins are synthesized |
| B. G ₂ 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-III, B-II, C-IV, D-I
 (B) A-IV, B-II, C-I, D-III
 (C) A-IV, B-I, C-II, D-III
 (D) A-II, B-IV, C-I, D-III

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

Solution:

Step 1: Understanding the Question:

This question requires matching different phases of the eukaryotic cell cycle (List I) with their correct descriptions or key events (List II).

Step 2: Detailed Explanation:

Let's analyze each phase and match it with its description:

- **A. M Phase:** This is the Mitosis phase, where the cell divides. Mitosis is known as **Equational division** because the number of chromosomes in the daughter cells is equal to that in the parent cell. So, **A matches with IV**.
- **B. G₂ Phase:** This is the second gap phase, occurring after DNA synthesis and before mitosis. During this phase, the cell prepares for division, and important **proteins are synthesized**, such as tubulin for the mitotic spindle. So, **B matches with I**.
- **C. Quiescent stage (G₀):** This is a non-dividing phase where cells exit the cell cycle. Although metabolically active, they are in an **inactive phase** concerning proliferation. So, **C matches with II**.
- **D. G₁ Phase:** This is the first gap phase. It is the **interval between the end of mitosis and the initiation of DNA replication** (S phase). The cell grows significantly during this period. So, **D matches with III**.

The correct set of matches is A-IV, B-I, C-II, D-III.

Step 3: Final Answer:

The correct combination is A-IV, B-I, C-II, D-III, which is option (C).

Quick Tip

Visualize the cell cycle as a clock: $G_1 \rightarrow S \rightarrow G_2 \rightarrow M$.

- **G₁:** Interval before S.
- **S:** Synthesis of DNA.
- **G₂:** Synthesis of proteins for M.
- **M:** Mitosis (Equational division).
- **G₀:** Exit from G₁ (Quiescent/Inactive).