

NEET UG 2023 E5 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. 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 number of ATP and NADPH molecules (referred to as NADPH₂, an older notation for NADPH + H⁺) needed to produce one molecule of glucose (C₆H₁₂O₆) through the Calvin cycle.

Step 2: Detailed Explanation:

The Calvin cycle is the process of carbon fixation. To synthesize one molecule of glucose, which has 6 carbon atoms, the cycle must fix 6 molecules of CO₂.

Let's look at the requirements for fixing one molecule of CO₂:

- **Reduction Phase:** 2 molecules of ATP and 2 molecules of NADPH are used to convert 3-PGA to G3P.
- **Regeneration Phase:** 1 molecule of ATP is used to regenerate RuBP from G3P.
- **Total per CO₂:** 2 ATP + 1 ATP = 3 ATP, and 2 NADPH.

To synthesize one molecule of glucose (C₆), the cycle needs to turn 6 times.

- **Total ATP required:** 6 CO₂ × 3 ATP/CO₂ = **18 ATP**.
- **Total NADPH required:** 6 CO₂ × 2 NADPH/CO₂ = **12 NADPH**.

Step 3: Final Answer:

The synthesis of one molecule of glucose via the Calvin cycle requires 18 ATP and 12 NADPH. Therefore, option (B) is the correct answer.

Quick Tip

Remember the 3:2 ratio of ATP to NADPH for fixing one CO₂ molecule in the C₃ cycle. For a 6-carbon glucose molecule, you need to fix 6 CO₂ molecules. Just multiply the requirements by 6: (6 × 3 ATP) = 18 ATP, and (6 × 2 NADPH) = 12 NADPH.

2. 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 set of floral characteristics (large, colorful, fragrant, nectar-producing) and asks to identify the type of pollination associated with these traits. This is a question about pollination syndromes.

Step 2: Detailed Explanation:

Let's analyze the characteristics required for each type of pollination:

- **Insect pollinated plants (Entomophily):** To attract insects, flowers are typically **large** and conspicuous, **colourful** (often in shades visible to insects like blue, yellow, and UV), produce a **fragrance**, and offer a reward, usually **nectar**. This matches the description perfectly.
- **Bird pollinated plants (Ornithophily):** Flowers are often brightly colored (especially red), large, and produce a lot of nectar, but they are usually odorless since birds have a poor sense of smell.
- **Bat pollinated plants (Chiropterophily):** Flowers are typically large, pale or dull-colored, open at night, and emit a strong, musty, or fruity scent. They produce abundant nectar.
- **Wind pollinated plants (Anemophily):** Flowers do not need to attract pollinators, so they are small, inconspicuous, and lack color, fragrance, and nectar. They produce large amounts of lightweight pollen.

The combination of all four traits—large, colorful, fragrant, and nectar-rich—is the classic suite of adaptations for insect pollination.

Step 3: Final Answer:

The described floral characteristics are adaptations for attracting insects for pollination. Therefore, option (A) is the correct answer.

Quick Tip

Think about the senses of the pollinator:

- **Insects:** Use sight (color) and smell (fragrance).
- **Birds:** Use sight (bright colors, especially red) but not smell.
- **Bats:** Are nocturnal, use smell (strong odors).
- **Wind:** Is non-living, so no attractants are needed.

3. The phenomenon of pleiotropism refers to

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

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

Solution:

Step 1: Understanding the Question:

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

Step 2: Detailed Explanation:

Let's break down the definitions:

- **Pleiotropy:** This occurs when **one gene** influences **two or more seemingly unrelated phenotypic traits**. A classic example is phenylketonuria (PKU), where a single gene defect causes multiple symptoms like mental retardation, reduced hair, and skin pigmentation.
- **Option (A)** is incorrect. Multiple alleles refer to a gene having more than two allelic forms in a population.
- **Option (B)** is a confusing and incorrect description of genetic interaction.
- **Option (C)** provides the accurate definition of pleiotropy.
- **Option (D)** describes **polygenic inheritance**, where a single trait (like height or skin color) is controlled by multiple genes. It is the opposite of pleiotropy.

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

Remember the difference:

- **Pleiotropy:** One Gene → Many Traits
- **Polygenic Inheritance:** Many Genes → One Trait

They represent opposite gene-to-trait relationships.

4. 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 conceptualized and utilized recombination frequencies to create a genetic map.

Step 2: Detailed Explanation:

Let's review the contributions of the scientists listed:

- **Thomas Hunt Morgan:** He established the chromosomal theory of linkage using *Drosophila*. He demonstrated that genes are located on chromosomes and that linked genes can be separated by recombination (crossing over).
- **Sutton and Boveri:** They independently proposed the Chromosomal Theory of Inheritance, which postulates that chromosomes are the carriers of genes.
- **Alfred Sturtevant:** He was a student in Morgan's lab. He realized that the **frequency** of crossing over between two genes is a measure of the physical distance between them on the chromosome. Using this insight, he constructed the first-ever genetic map in 1913, mapping the relative positions of genes on the *Drosophila* X chromosome.
- **Henking:** He was the first to correctly identify the X chromosome, calling it the "X-body".

While Morgan's work laid the foundation, it was Sturtevant who made the conceptual leap to use recombination data for gene mapping.

Step 3: Final Answer:

Alfred Sturtevant was the first to use recombination frequency to map genes on a chromosome. Therefore, option (C) is the correct answer.

Quick Tip

Remember the progression: Sutton & Boveri (Theory) → T.H. Morgan (Proof of linkage and recombination) → Alfred Sturtevant (Application of recombination frequency for mapping). Sturtevant was Morgan's student.

5. 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 two statements regarding the physiological effects of transpiration in plants.

Step 2: Detailed Explanation:

Analysis of Statement I:

This statement refers to the transpiration pull, which is the main driver of water transport in tall trees according to the cohesion-tension theory. The evaporation of water from leaves creates a negative pressure potential (tension) in the xylem. This tension, combined with the cohesive properties of water, pulls the entire water column up from the roots. This force is remarkably strong and is sufficient to lift water to the tops of the tallest trees, some of which exceed 100 meters. A figure of 130 meters is within the physically calculated capabilities of this mechanism. Therefore, Statement I is **correct**.

Analysis of Statement II:

This statement describes the thermoregulatory role of transpiration. Evaporation is an endothermic process, meaning it requires energy. When water evaporates from the leaf surface, it absorbs heat energy (latent heat of vaporization) from the leaf. This process, known as evaporative cooling, effectively lowers the leaf temperature, protecting it from heat damage under intense sunlight. A cooling effect of 10 to 15 degrees Celsius is a well-documented and accepted value. Therefore, Statement II is **correct**.

Step 3: Final Answer:

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

Quick Tip

Remember the dual roles of transpiration:

1. Water Transport: Acts as a powerful "sucking" force (transpiration pull) to move water up tall plants.
2. Thermoregulation: Acts as a "radiator" to cool leaves through evaporation. Both statements are direct consequences of these functions.

6. 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 micronutrient essential for the photolysis (light-driven splitting) of water during the light-dependent reactions of photosynthesis.

Step 2: Detailed Explanation:

The splitting of water ($2\text{H}_2\text{O} \rightarrow 4\text{H}^+ + 4\text{e}^- + \text{O}_2$) occurs at Photosystem II (PS II). This reaction is catalyzed by the Oxygen-Evolving Complex (OEC), which is part of PS II. The OEC contains a crucial metallic cofactor.

- **Manganese (Mn):** A cluster of four manganese ions is at the catalytic heart of the OEC. These ions cycle through different oxidation states to facilitate the removal of electrons from water molecules. Calcium and chloride ions are also required.
- **Molybdenum (Mo):** Important for nitrogen metabolism (component of nitrogenase and nitrate reductase).
- **Magnesium (Mg):** A macronutrient that is the central atom in the chlorophyll molecule and an activator for enzymes like RuBisCO.
- **Copper (Cu):** A component of plastocyanin, an electron carrier in the photosynthetic electron transport chain.

The direct role in water splitting is uniquely performed by manganese.

Step 3: Final Answer:

Manganese is the essential micronutrient for the splitting of water in photosynthesis. Therefore, option (A) is the correct answer.

Quick Tip

Associate key minerals with their primary photosynthetic roles:

- **Mg** → **M**iddle of chlorophyll.
- **Mn** → **M**angles water (water splitting).
- **Cu** → **C**opper in Plastocyanin.

7. 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 peak absorption.

Step 2: Detailed Explanation:

Photosynthesis in higher plants involves two photosystems, PS I and PS II, which work in series. Each photosystem has a reaction center composed of a special pair of chlorophyll 'a' molecules that trap light energy.

- The reaction center of **Photosystem II (PS II)** is designated **P680** because it has an absorption maximum at a wavelength of **680 nm**.
- The reaction center of **Photosystem I (PS I)** is designated **P700** because it has an absorption maximum at a wavelength of **700 nm**.

The question specifically asks about 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 mnemonic: In the Z-scheme of electron transport, PS II comes before PS I. Numerically, 680 comes before 700. So, PS II = P680 and PS I = P700.

8. 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 requires identifying the correct statements from a list describing the process of decomposition in an ecosystem.

Step 2: Detailed Explanation:

Let's evaluate each statement:

- **A. Detritivores perform fragmentation. Correct.** Detritivores like earthworms physically break down large pieces of dead organic matter (detritus) into smaller particles. This process is called fragmentation.
- **B. The humus is further degraded by some microbes during mineralization. Correct.** Humus is a stable, dark-colored amorphous substance that decomposes very slowly. The final breakdown of humus by microbes, which releases inorganic nutrients, is called mineralization.
- **C. Water soluble inorganic nutrients go down into the soil and get precipitated by a process called leaching. Correct.** Leaching is the process where water-soluble nutrients move down through the soil profile with percolating water. They may become unavailable to plants if they move below the root zone.
- **D. The detritus food chain begins with living organisms. Incorrect.** The detritus food chain begins with dead organic matter (detritus). The grazing food chain begins with living producers.
- **E. Earthworms break down detritus into smaller particles by a process called catabolism. Incorrect.** The physical breakdown by earthworms is called **fragmentation**. **Catabolism** refers to the chemical and enzymatic breakdown of complex organic matter into simpler inorganic substances by microbes like bacteria and fungi.

Thus, statements A, B, and C are correct.

Step 3: Final Answer:

The correct combination of statements is A, B, and C. Therefore, option (A) is the correct answer.

Quick Tip

Distinguish the key terms in decomposition:

- **Fragmentation** (Physical, by Detritivores)
- **Catabolism** (Chemical, by Microbes)
- **Leaching** (Movement of soluble nutrients with water)
- **Humification** (Formation of humus)
- **Mineralization** (Release of minerals from humus)

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

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

Correct Answer: (A) Dobson units

Solution:

Step 1: Understanding the Question:

The question asks for the standard unit used to measure the thickness or concentration of the atmospheric ozone layer.

Step 2: Detailed Explanation:

Let's analyze the given units:

- **Dobson Units (DU):** This is the specific unit of measure for total column ozone. One Dobson Unit represents the number of ozone molecules required to create a layer of pure ozone 0.01 millimeters thick at a temperature of 0 degrees Celsius and a pressure of 1 atmosphere.
- **Decibels (dB):** A unit used to measure the intensity of sound.
- **Decameter (dam):** A unit of length, equal to 10 meters.

- **Kilobase (kb):** A unit of length for nucleic acid molecules, equal to 1000 base pairs.

The correct unit for atmospheric ozone measurement is the Dobson unit.

Step 3: Final Answer:

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

Quick Tip

This is a key factual recall question. Associate "ozone layer thickness" directly with "Dobson Units (DU)". It's the standard unit in atmospheric science.

10. 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 where specialized, mature plant cells (leaf mesophyll) are induced to revert to an undifferentiated, dividing state to form a callus. We need to identify the correct term for this process.

Step 2: Detailed Explanation:

Let's define the relevant terms:

- **Differentiation:** The process by which cells become specialized in structure and function. Leaf mesophyll cells are already differentiated.
- **Dedifferentiation:** The process by which differentiated cells lose their specialization and regain the ability to divide. This is exactly what happens when explants (like mesophyll cells) form a callus, which is an unorganized mass of undifferentiated, totipotent cells.
- **Redifferentiation:** The process where the dedifferentiated callus cells are induced to differentiate again into specialized cells to form plantlets (shoots and roots).
- **Development:** The overall process of growth and differentiation of an organism.
- **Senescence:** The process of aging in an organism.

The formation of callus from differentiated cells is the classic example of dedifferentiation.

Step 3: Final Answer:

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

Quick Tip

Remember the sequence in plant tissue culture: **Differentiated** Explant $\xrightarrow{\text{Dedifferentiation}}$ Undifferentiated Callus $\xrightarrow{\text{Redifferentiation}}$ **Differentiated** Plantlet. This "DDR" sequence is a fundamental concept.

11. 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 concerning the use of ATP in the glycolysis pathway. We need to evaluate the truthfulness of both statements and whether the reason correctly explains the assertion.

Step 2: Detailed Explanation:

Analysis of Assertion A:

Glycolysis is the metabolic pathway that converts one molecule of glucose into two molecules of pyruvate. The pathway has an initial "investment phase" where energy is consumed. In this phase, two molecules of ATP are used per molecule of glucose. Therefore, Assertion A is **true**.

Analysis of Reason R:

The reason specifies the two ATP-consuming steps:

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

2. **Step 3 of Glycolysis:** Fructose-6-phosphate is phosphorylated to fructose-1,6-bisphosphate by the enzyme phosphofructokinase. This reaction consumes a second molecule of ATP. (Note: "diphosphate" is an older term for "bisphosphate" but refers to the same molecule in this context).

The reason correctly identifies both steps where ATP is invested. Therefore, Reason R is **true**.

Relationship between A and R:

Reason R provides the precise details of the two steps where ATP is consumed, which directly and accurately explains why Assertion A is true.

Step 3: Final Answer:

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

Quick Tip

To master glycolysis, visualize the 10-step pathway. Clearly mark the two ATP investment steps (catalyzed by hexokinase and phosphofructokinase) and the four ATP generation steps (two steps that occur twice). This visual map helps in quickly answering such questions.

12. 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 provides the standard equation for ecosystem productivity and asks to identify the term represented by 'R'.

Step 2: Detailed Explanation:

Let's define the terms:

- **Gross Primary Productivity (GPP):** This is the total rate at which producers (like plants) convert light energy into chemical energy through photosynthesis. It's the total amount of organic matter produced.

- **Net Primary Productivity (NPP):** This is the rate at which producers create new biomass. It represents the energy that is actually available to the next trophic level (herbivores).
- To survive and grow, producers must use some of the energy they capture for their own metabolic activities. This energy consumption occurs through cellular **respiration**. The energy used in respiration is lost from the ecosystem as heat and is not converted into biomass.

The relationship is that the net productivity is what's left over from the gross productivity after the organism's own metabolic costs are paid. Therefore, the equation is: $NPP = GPP - R$ Where 'R' stands for the energy lost through **Respiration**, or **Respiratory loss**.

Step 3: Final Answer:

In the given equation, R represents the energy lost by producers due to respiration. Therefore, option (C) is the correct answer.

Quick Tip

Use a financial analogy:

- **GPP** = Gross Income (Total money earned)
- **R** (Respiration) = Expenses (Money spent to live)
- **NPP** = Net Income/Savings (Money left over, available to others)

13. 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 single most significant cause of species extinction from the four major causes known as 'The Evil Quartet'.

Step 2: Detailed Explanation:

'The Evil Quartet' is a term coined by biologist Jared Diamond to describe the four main human-caused drivers of extinction:

1. **Habitat loss and fragmentation:** This involves the destruction of natural habitats (e.g., deforestation for agriculture or urbanization) and the breaking up of large habitats into small, isolated patches.
2. **Over-exploitation:** Harvesting species from the wild at unsustainable rates (e.g., over-fishing, overhunting).
3. **Alien species invasions:** The introduction of non-native species that outcompete, prey on, or infect native species.
4. **Co-extinctions:** The extinction of one species leading to the extinction of another that depends on it (e.g., a specific pollinator and its plant).

While all four are serious threats, ecologists overwhelmingly agree that **habitat loss and fragmentation** is the number one cause of biodiversity loss globally. If a species' home is destroyed, it has nowhere to live, feed, or reproduce. The destruction of highly biodiverse ecosystems like tropical rainforests and coral reefs is particularly devastating.

Step 3: Final Answer:

The most important cause driving the extinction of species is habitat loss and fragmentation. Therefore, option (A) is correct.

Quick Tip

Remember the acronym **HIPPO** for threats to biodiversity: **H**abitat Destruction, **I**nvasive Species, **P**ollution, **P**opulation (human), and **O**verharvesting. 'H' (Habitat Destruction) is always listed first as it is the most significant threat. 'The Evil Quartet' is a similar concept, with habitat loss being the primary driver.

14. 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 can be used to speed up the transition from the juvenile to the adult (reproductive) phase in conifers, allowing for earlier seed production.

Step 2: Detailed Explanation:

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

- **Indole-3-butyric Acid (IBA):** An auxin primarily used to promote root formation in cuttings.
- **Gibberellic Acid (GA):** Gibberellins have many roles, including stem elongation (bolting), breaking dormancy, and promoting flowering and fruiting. A key commercial application is spraying juvenile conifers with GAs to overcome the long juvenile phase. This hastens maturity and induces early cone (and thus seed) production, which is valuable for forestry and breeding programs.
- **Zeatin:** A cytokinin that promotes cell division and delays senescence.
- **Absciscic Acid (ABA):** A stress hormone that promotes dormancy and stomatal closure.

The specific function of hastening maturity in conifers is a well-known effect of gibberellins.

Step 3: Final Answer:

Gibberellic acid is sprayed on juvenile conifers to accelerate maturity and induce early seed production. Therefore, option (B) is the correct answer.

Quick Tip

Focus on the unique and commercially important applications of plant hormones:

- **Gibberellins:** Increase grape size, promote malting, sugarcane elongation, and hasten conifer maturity.
- **Auxins:** Rooting hormone, weed killer (2,4-D).
- **Ethylene:** Fruit ripening.

15. 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 scientist(s) who provided the final, definitive ("unequivocal") evidence that DNA is the carrier of genetic information.

Step 2: Detailed Explanation:

Let's review the key experiments:

1. **Frederick Griffith (1928):** Discovered the "transforming principle" in bacteria but did not identify its chemical nature.
2. **Avery, Macleoid, and McCarthy (1944):** Through biochemical experiments, they demonstrated that the transforming principle was DNA. This was strong evidence, but some in the scientific community remained skeptical, believing that protein contaminants might be responsible.
3. **Alfred Hershey and Martha Chase (1952):** They conducted the famous "blender experiment" using bacteriophages (viruses). They used radioactive isotopes to label the phage's protein coat (^{35}S) and its DNA (^{32}P) separately. They showed that only the radioactive DNA entered the host bacteria to direct the synthesis of new viruses. This elegant experiment provided the conclusive, unambiguous proof that DNA is the genetic material.
4. **Wilkins and Franklin:** Provided the X-ray diffraction data that was crucial for Watson and Crick to determine the double-helix structure of DNA.

The Hershey-Chase experiment is universally regarded as the unequivocal proof.

Step 3: Final Answer:

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

Quick Tip

Remember the progression of evidence:

- **Griffith:** Something transforms bacteria.
- **Avery, Macleoid, McCarthy:** That something is DNA (biochemical evidence).
- **Hershey & Chase:** It is definitely DNA (radioactive labeling proof).

The keyword "unequivocal" points directly to the Hershey-Chase experiment.

16. 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, one of the three main types of RNA polymerases in eukaryotic cells.

Step 2: Detailed Explanation:

Eukaryotes have a division of labor for transcription among their RNA polymerases:

- **RNA Polymerase I:** Located in the nucleolus, it transcribes the genes for the large ribosomal RNAs (28S, 18S, and 5.8S rRNAs).
- **RNA Polymerase II:** Located in the nucleoplasm, it transcribes all protein-coding genes into messenger RNA (mRNA) precursors (hnRNA), as well as most small nuclear RNAs (snRNAs).
- **RNA Polymerase III:** Located in the nucleoplasm, it transcribes the genes for smaller RNA molecules, including transfer RNAs (tRNAs), the 5S ribosomal RNA (a small component of the ribosome), and some small nuclear RNAs (snRNAs, like U6 snRNA).

Let's check the options:

- (A) describes the function of RNA Polymerase I.
- (B) correctly describes the function of RNA Polymerase III.
- (C) describes the function of RNA Polymerase II.
- (D) is incomplete; RNA Polymerase III transcribes more than just snRNAs.

Step 3: Final Answer:

RNA polymerase III is responsible for transcribing tRNA, 5S rRNA, and some snRNAs. Therefore, option (B) is the correct answer.

Quick Tip

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

- Pol **I** → **r**RNA
- Pol **II** → **m**RNA
- Pol **III** → **t**RNA (and other small RNAs like 5S rRNA)

17. 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 DNA synthesis or replication occurs.

Step 2: Detailed Explanation:

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

- **Interphase** is the period of growth and preparation for division, and it is subdivided into three phases:
 - **G₁ phase (Gap 1):** The cell grows and performs its normal functions.
 - **S phase (Synthesis phase):** This is the specific period during which the cell's entire genome is replicated. The amount of DNA in the cell doubles (from 2C to 4C).
 - **G₂ phase (Gap 2):** The cell continues to grow and prepares for mitosis.
- **M phase:** The phase where cell division (mitosis and cytokinesis) actually occurs.

DNA replication is strictly confined to the S phase.

Step 3: Final Answer:

In eukaryotes, DNA replication takes place in the S phase of the cell cycle. Therefore, option (B) is the correct answer.

Quick Tip

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

18. 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 stage of meiosis where the centromeres split, allowing sister chromatids to separate.

Step 2: Detailed Explanation:

Let's analyze the key events of meiosis:

- **Meiosis I (Reductional Division):** The key event here is the separation of homologous chromosomes.
 - In **Anaphase I**, homologous chromosomes move to opposite poles, but the sister chromatids remain attached at their centromeres. The centromeres do **not** divide.
- **Meiosis II (Equational Division):** This phase is very similar to mitosis. The key event is the separation of sister chromatids.
 - In **Anaphase II**, the proteins holding the sister chromatids together at the centromere are broken down. The centromere divides, and the sister chromatids (now considered individual chromosomes) are pulled to opposite poles.

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

Step 3: Final Answer:

The division of centromeres occurs during Anaphase II of meiosis. Therefore, option (C) is the correct answer.

Quick Tip

Remember this key difference:

- **Anaphase I:** Homologous chromosomes separate. Centromeres do NOT divide.
- **Anaphase II:** Sister chromatids separate. Centromeres DO divide.

Anaphase II is functionally identical to Anaphase of mitosis.

19. 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, where the Convention on Biological Diversity was adopted.

Step 2: Detailed Explanation:

The United Nations Conference on Environment and Development (UNCED), commonly known as the **Earth Summit** or Rio Summit, was a landmark international conference held in Rio de Janeiro, Brazil, in **June 1992**. This summit resulted in several major agreements on environmental protection and sustainable development, including:

- The Convention on Biological Diversity (CBD)
- The United Nations Framework Convention on Climate Change (UNFCCC)
- The Rio Declaration on Environment and Development

The other years listed are incorrect. For instance, 2002 was the year of the World Summit on Sustainable Development in Johannesburg.

Step 3: Final Answer:

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

Quick Tip

Memorize these key dates for environmental conventions:

- **1987:** Montreal Protocol (Ozone)
- **1992:** Rio Earth Summit (Biodiversity, Climate Change)
- **1997:** Kyoto Protocol (Greenhouse gas emissions)

20. 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 about the early gametophyte stage in the life cycle of a moss. We need to evaluate their correctness and relationship.

Step 2: Detailed Explanation:

Analysis of Assertion A:

The dominant phase in the life cycle of a moss is the haploid gametophyte. This stage has two distinct phases. The life cycle begins when a haploid spore germinates. It first develops into a filamentous, creeping, green, and branched structure called the **protonema**. This is the juvenile, or first stage, of the gametophyte. So, Assertion A is **true**.

Analysis of Reason R:

The diploid sporophyte of a moss consists of a foot, seta, and capsule. Within the capsule, meiosis occurs to produce haploid spores. Upon release, these spores germinate on a suitable substrate to form the protonema. Therefore, the protonema develops directly from a spore. So, 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 structure of the gametophyte generation. This directly explains why it is considered the first stage.

Step 3: Final Answer:

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

Quick Tip

Remember the moss life cycle sequence: Spore (n) $\xrightarrow{\text{Germination}}$ Protonema (n) $\rightarrow$ Leafy gametophyte (n) $\rightarrow$ Gametes (n) $\xrightarrow{\text{Fertilization}}$ Zygote (2n) $\rightarrow$ Sporophyte (2n) $\rightarrow$ Spore (n). This clarifies the position of the protonema as the initial gametophytic stage.

21. 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 used to make the microprojectiles in the gene gun (biolistics) method of genetic transformation.

Step 2: Detailed Explanation:

The gene gun, or biolistic particle delivery system, is a physical method for transforming cells, especially plant cells with tough cell walls. The principle is as follows:

1. The DNA of interest is coated onto microscopic particles.
2. These particles need to be dense enough to penetrate the cell wall and membrane, and chemically inert so they don't harm the cell.
3. High-density, inert metals are ideal for this purpose. The most commonly used metals are **gold (Au)** and **tungsten (W)**.
4. These DNA-coated microparticles are accelerated to high speed and "shot" into the target tissue.

Other metals like copper, zinc, or silver are generally not used due to potential toxicity or lack of sufficient density.

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

Associate the "gene gun" with firing "golden bullets". This mnemonic helps remember that dense, inert, and valuable metals like **gold** and **tungsten** are used to carry the genetic cargo.

22. Cellulose does not form blue colour with iodine because

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

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

Solution:

Step 1: Understanding the Question:

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

Step 2: Detailed Explanation:

The iodine test relies on the specific three-dimensional structure of the polysaccharide.

- **Starch Structure and Iodine Test:** Starch is a polymer of α -glucose. One of its components, amylose, forms a **helical structure**. Iodine molecules (specifically I_3^- and I_5^- ions) can fit inside this helical coil. This interaction forms a charge-transfer complex that absorbs light, appearing intense blue-black.
- **Cellulose Structure:** Cellulose is a polymer of β -glucose. The β -1,4 glycosidic bonds cause the glucose units to be flipped relative to each other, resulting in a **straight, linear chain**. These linear chains are packed tightly together via hydrogen bonds to form rigid microfibrils.
- **Conclusion:** Since cellulose does not form helices, there are no coils to trap the iodine molecules. Without the formation of the iodine-polysaccharide complex, no blue color is produced.

Statement (A) is incorrect as cellulose is a polysaccharide. Statement (B) is incorrect as it's a linear, not helical, molecule. Statement (D) is incorrect. Statement (C) accurately describes the structural reason.

Step 3: Final Answer:

Cellulose does not have a helical structure capable of trapping iodine molecules. Therefore, option (C) is the correct answer.

Quick Tip

Remember the structural basis of the iodine test:

- **Starch (α -glucose linkage):** Forms a **helix** $\rightarrow$ Traps iodine $\rightarrow$ **Blue color**.
- **Cellulose (β -glucose linkage):** Forms a **straight chain** $\rightarrow$ Cannot trap iodine $\rightarrow$ **No color change**.

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 for the function of tassels in relation to the corn cob. This question is slightly ambiguously worded. Let's clarify the structures of a corn plant.

Step 2: Detailed Explanation:

Corn (*Zea mays*) is a monoecious, wind-pollinated plant.

- The **tassel** is the male inflorescence located at the very top of the plant. Its function is to produce and **disperse pollen grains** into the wind. So, option (C) is the function of the tassel itself.
- The **ear** or **cob** is the female inflorescence, located in a leaf axil. Emerging from the top of the ear are the **silks**. Each silk is a long stigma and style. The function of the feathery and sticky silks is to **trap the airborne pollen grains**.

Reconciling the Question and Answer:

The question "function of tassels in the corn cob" is likely flawed. The tassel is at the top of the plant, while the cob is the female part lower down. However, the provided answer key is (B). This implies the question intended to ask about the function of the structures on the cob responsible for receiving pollen, which are the silks. The function of the silks is to trap pollen grains. Given this common confusion in question phrasing, we select the answer corresponding to the function of the silks.

Step 3: Final Answer:

Assuming the question is referring to the pollen-receiving structures of the corn cob (the silks), their function is to trap pollen grains. Therefore, based on the provided answer key, option (B) is the intended correct answer.

Quick Tip

For corn, remember the distinct roles:

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

Be prepared for exam questions that may confuse these two parts. Read carefully to understand the intent.

24. Axile placentation is observed in

- (A) Mustard, Cucumber and Primrose
(B) China rose, Beans and Lupin

- (C) Tomato, Dianthus and Pea
(D) China rose, Petunia and Lemon

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

Solution:

Step 1: Understanding the Question:

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

Step 2: Detailed Explanation:

Axile placentation is characterized by a multilocular (chambered) ovary where the ovules are attached to the central axis where the septa meet. Let's check the placentation types for the plants in each option:

- **(A) Mustard, Cucumber and Primrose:** Mustard and Cucumber have parietal placentation, while Primrose has free-central placentation.
- **(B) China rose, Beans and Lupin:** China rose has axile placentation, but Beans and Lupin (Fabaceae) have marginal placentation.
- **(C) Tomato, Dianthus and Pea:** Tomato has axile placentation, but Dianthus has free-central placentation, and Pea has marginal placentation.
- **(D) China rose, Petunia and Lemon:** China rose (Malvaceae), Petunia (Solanaceae), and Lemon (Rutaceae) all exhibit axile placentation.

Step 3: Final Answer:

The correct combination of plants, all of which have axile placentation, is China rose, Petunia, and Lemon. Therefore, option (D) is the correct answer.

Quick Tip

Memorizing a few key examples for each placentation type is the best strategy for these questions.

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

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

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

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

Solution:

Step 1: Understanding the Question:

The question asks to identify a set of structures from a fertilized embryo sac that are haploid (n), diploid ($2n$), and triploid ($3n$) respectively.

Step 2: Detailed Explanation:

Following double fertilization in angiosperms, the embryo sac contains structures with different ploidy levels:

- **Haploid (n):** The synergids and antipodal cells are part of the original female gametophyte. Even after fertilization, they persist for a while before degenerating. Thus, they are haploid.
- **Diploid ($2n$):** The **zygote** is formed by the fusion of a haploid male gamete (n) and the haploid egg cell (n). Its ploidy is $2n$.
- **Triploid ($3n$):** The **Primary Endosperm Nucleus (PEN)** is formed by the fusion of the second haploid male gamete (n) with the diploid central cell (containing two polar nuclei, $n+n$). Its ploidy is $3n$.

Now let's check the sequence (n , $2n$, $3n$) in the options:

- (A) Synergids (n), Primary endosperm nucleus ($3n$), zygote ($2n$). Sequence is n , $3n$, $2n$. Incorrect.
- (B) Antipodals (n), synergids (n), primary endosperm nucleus ($3n$). Sequence is n , n , $3n$. Incorrect.
- (C) **Synergids (n), Zygote ($2n$), Primary endosperm nucleus ($3n$).** The sequence is n , $2n$, $3n$. **Correct.**
- (D) This option lists polar nuclei, which fuse to form the central cell 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 on double fertilization, quickly jot down the ploidy levels of the key players after fertilization:

- $n \rightarrow$ Synergids, Antipodals
- $2n \rightarrow$ Zygote
- $3n \rightarrow$ PEN/Endosperm

Then, match this pattern to the options.

26. 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 used in genomics.

Step 2: Detailed Explanation:

The term itself provides the definition:

- **Expressed:** This refers to genes that are transcriptionally active, i.e., being made into RNA. In a cell, the collection of all RNA transcripts is called the transcriptome.
- **Sequence Tags:** These are short, single-pass sequences of DNA that act as "tags" or identifiers for a longer gene sequence.

The process of generating ESTs involves isolating mRNA from a tissue, converting it to more stable complementary DNA (cDNA) using reverse transcriptase, and then sequencing short fragments of these cDNAs. The result is a library of tags representing the genes that were expressed as RNA in that tissue at that time. Therefore, ESTs are used to identify **all genes that are expressed as RNA**.

Step 3: Final Answer:

ESTs are short subsequences of cDNAs, and thus represent genes that are transcribed into RNA. Option (A) is the most accurate description.

Quick Tip

Focus on the word "Expressed" in EST. Gene expression begins with transcription into RNA. Therefore, ESTs are direct evidence of gene expression at the RNA level.

27. 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) Monadelphous and Monotheous anthers
- (D) Epiphyllous and Ditheous anthers

Correct Answer: (A) Diadelphous and Ditheous anthers

Solution:

Step 1: Understanding the Question:

The question asks for a characteristic of stamens that is unique to the family Fabaceae when compared to Solanaceae and Liliaceae.

Step 2: Detailed Explanation:

Let's compare the androecium (stamen) characteristics of the three families:

- **Fabaceae (subfamily Papilionoideae, e.g., pea):** Typically has 10 stamens. The characteristic feature is that their filaments are fused into two bundles. This condition is called **diadelphous**, most commonly in a (9)+1 arrangement where nine are fused and one is free. The anthers are **ditheous** (two-lobed).
- **Solanaceae (e.g., potato, petunia):** Has 5 stamens that are **epipetalous** (fused to the petals). The anthers are ditheous.
- **Liliaceae (e.g., lily, onion):** Has 6 stamens that are **epiphyllous** or **epitepalous** (fused to the tepals). The anthers are ditheous.

Now, evaluating the options:

- (A) **Diadelphous and Ditheous anthers:** The diadelphous condition is the distinctive feature of Fabaceae and is absent in the other two families.
- (B) **Polyadelphous** (many bundles) is found in families like Rutaceae (citrus), and **epipetalous** is found in Solanaceae.
- (C) **Monadelphous** (one bundle) and **Monotheous** (one lobe) anthers are characteristic of Malvaceae (china rose).
- (D) **Epiphyllous** stamens are characteristic of Liliaceae.

Step 3: Final Answer:

The diadelphous condition of stamens is the specific characteristic of Fabaceae that distinguishes it from Solanaceae and Liliaceae. Therefore, option (A) is correct.

Quick Tip

For plant family identification, memorize the key androecium features:

- **Fabaceae** → Diadelphous (9)+1
- **Solanaceae** → Epipetalous
- **Liliaceae** → Epiphyllous/Epitpalous
- **Malvaceae** → Monadelphous tube, monothecous anthers

28. 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 Prophase I where recombination nodules are formed.

Step 2: Detailed Explanation:

Prophase I of meiosis is a complex phase divided into five substages:

1. **Leptotene:** Chromosomes start to condense.
2. **Zygotene:** Synapsis (pairing of homologous chromosomes) occurs, forming bivalents.
3. **Pachytene:** This is the stage where crossing over, or genetic recombination, between non-sister chromatids of homologous chromosomes takes place. The sites where this enzymatic process occurs are morphologically marked by the appearance of proteinaceous structures called **recombination nodules**.
4. **Diplotene:** Homologous chromosomes begin to separate, but remain attached at sites of crossing over, which are now visible as chiasmata.
5. **Diakinesis:** Chromosomes are fully condensed, and chiasmata terminalize.

The key event of crossing over and the appearance of recombination nodules are hallmarks of the pachytene stage.

Step 3: Final Answer:

Recombination nodules appear during the Pachytene stage of Prophase I. Therefore, option (B) is the correct answer.

Quick Tip

Associate a key event with each substage of Prophase I:

- Zygotene: **Z**ipping up (Synapsis)
- Pachytene: **P**atching/Crossing over (Recombination Nodules)
- Diplotene: **D**esynapsis (Chiasmata visible)

29. 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 for the plant hormone responsible for the rapid stem elongation in deep water rice plants when they are submerged.

Step 2: Detailed Explanation:

Deep water rice exhibits a remarkable adaptation to flooding.

- When the plant is submerged, the gaseous hormone **ethylene** is unable to diffuse away and accumulates in the plant tissues.
- This accumulation of ethylene acts as a signal. It promotes the synthesis and sensitivity to another hormone, **gibberellin** (like GA₃).
- The gibberellin then directly stimulates cell division and elongation in the internodes, causing the stem to grow very rapidly and keep the leaves above the rising water level.

While gibberellin is the direct agent of elongation, **ethylene** is the primary trigger for this specific adaptive response in deep water rice. The question asks which hormone **promotes**

the elongation, and ethylene is the key promoter in this context.

Step 3: Final Answer:

Ethylene is the primary hormone that triggers internode elongation in submerged deep water rice. Therefore, option (C) is the correct answer.

Quick Tip

This is a classic example of hormonal interaction in response to an environmental cue. Remember the sequence: **Submergence** → **Ethylene accumulation** → **Gibberellin action** → **Rapid elongation**. Ethylene is the crucial initial signal.

30. 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 appearance of DNA when it is stained with ethidium bromide and viewed under UV light, a standard procedure in molecular biology.

Step 2: Detailed Explanation:

1. Agarose gel electrophoresis is used to separate DNA fragments.
2. Since DNA is invisible to the naked eye, a fluorescent dye is used to visualize it.
3. **Ethidium bromide (EtBr)** is an intercalating agent that fits between the base pairs of the DNA double helix.
4. When the gel is placed on a **UV transilluminator**, the EtBr molecules that are bound to the DNA absorb the UV radiation.
5. They then emit this energy as visible light, a phenomenon called fluorescence. The color of this emitted light is a characteristic **bright orange**.

Step 3: Final Answer:

DNA stained with ethidium bromide fluoresces bright orange under UV radiation. Therefore, option (D) is the correct answer.

Quick Tip

This is a fundamental fact from molecular biology labs. Memorize the combination:
DNA + Ethidium Bromide + UV Light = Bright Orange.

31. 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:

We must evaluate two statements regarding the arrangement of xylem in plants.

Step 2: Detailed Explanation:

Analysis of Statement I:

The terms 'endarch' and 'exarch' refer to the pattern of development of **primary xylem**, not secondary xylem. They describe the position of the first-formed protoxylem relative to the later-formed metaxylem. Secondary xylem is formed by the vascular cambium and grows radially, so these terms do not apply. Therefore, Statement I is **incorrect**.

Analysis of Statement II:

- **Exarch** arrangement means the protoxylem is located towards the periphery and the metaxylem towards the center. This is the characteristic condition found in **roots**.
- **Endarch** arrangement means the protoxylem is located towards the center (pith) and the metaxylem towards the periphery. This is characteristic of **stems**.

Therefore, the statement that the exarch condition is the most common feature of the root system is **correct**.

Step 3: Final Answer:

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

Quick Tip

Use a simple mnemonic to remember the xylem arrangements:

- **EX**arch is for roots (protoxylem is **external**).
- **EN**darch is for stems (protoxylem is **en**ternal/internal).

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

32. 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 to identify the transport mechanism that moves substances from a lower concentration to a higher concentration, which is "against their concentration gradient".

Step 2: Detailed Explanation:

Let's define the transport types:

- **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 is like an object rolling downhill.
- **Active Transport:** This is the movement of substances **against** a concentration gradient (from low to high concentration). This "uphill" movement requires specific carrier proteins (pumps) and the expenditure of metabolic energy, typically from ATP hydrolysis.

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

Step 3: Final Answer:

The movement of ions against their concentration gradient is defined as active transport. Therefore, option (D) is the correct answer.

Quick Tip

Remember the "hill" analogy:

- Moving **down** the concentration hill → **Passive Transport** (no energy needed).
- Moving **up** the concentration hill → **Active Transport** (energy is required).

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

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

Correct Answer: (B) DNA

Solution:

Step 1: Understanding the Question:

The question asks which macromolecule is precipitated out of an aqueous solution by the addition of chilled ethanol, a standard step in DNA isolation.

Step 2: Detailed Explanation:

The principle behind DNA precipitation is based on solubility.

- DNA is a polar molecule due to its negatively charged phosphate backbone, which makes it highly soluble in water.
- Ethanol is a less polar solvent than water.
- When chilled ethanol is added to an aqueous solution containing DNA and salts (which neutralize the backbone's charge), the ethanol disrupts the hydration shell around the DNA molecules.
- This causes the DNA to become insoluble and aggregate, precipitating out of the solution as a visible white, thread-like mass.

Most other cellular components, like RNA (after being treated with RNase), proteins (after being treated with protease), and simple sugars, remain soluble in the ethanol-water mixture.

Step 3: Final Answer:

The addition of chilled ethanol is a standard method used to precipitate DNA from a solution. Therefore, option (B) is the correct answer.

Quick Tip

This is a fundamental laboratory technique. Remember the simple rule: To get DNA out of a solution, you add **chilled ethanol**. The DNA will come out as white threads.

34. 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 asks to identify a pair from the options where both plants are pteridophytes and exhibit heterospory (production of two different types of spores).

Step 2: Detailed Explanation:

Pteridophytes can be homosporous (producing one type of spore) or heterosporous (producing microspores and megaspores).

- **Homosporous examples:** Most pteridophytes are homosporous, including *Lycopodium*, *Equisetum*, *Psilotum*, and most ferns like *Dryopteris*.
- **Heterosporous examples:** A few pteridophytes are heterosporous, a condition that is a precursor to the seed habit. Key examples to remember are *Selaginella*, *Salvinia*, *Azolla*, and *Marsilea*.

Let's analyze the pairs:

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

Step 3: Final Answer:

Both *Selaginella* and *Salvinia* are heterosporous pteridophytes. Therefore, option (B) is the correct answer.

Quick Tip

For exams, it's essential to memorize the key examples of heterosporous pteridophytes: *Selaginella*, *Salvinia*, *Marsilea*, and *Azolla*. Knowing these four will help you solve most questions on this topic.

35. 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 two statements about wood formation. Assertion A describes the anatomy of late wood (autumn wood), and Reason R provides a physiological cause. We need to evaluate their truthfulness and the relationship between them.

Step 2: Detailed Explanation:

Analysis of Assertion A:

In temperate climates, the vascular cambium's activity varies with the seasons. The wood formed in the later part of the growing season (autumn) is called late wood or autumn wood. During this time, the conditions are less favorable for growth. As a result, the cambium produces fewer xylem elements (xylary elements), and the vessels or tracheids have narrower lumens and thicker walls. This makes late wood denser and darker. Therefore, Assertion A is **true**.

Analysis of Reason R:

The activity of the vascular cambium is regulated by physiological and environmental factors. During unfavorable conditions like winter, with low temperatures and short days, the cambium becomes less active or even dormant. Therefore, Reason R is **true**.

Relationship between A and R:

The decreased activity of the cambium during the unfavorable conditions of late autumn and winter (Reason R) is the direct cause for the formation of late wood with its characteristic features of fewer and narrower xylary elements (Assertion A). The reduced activity leads to

slower growth and the production of denser wood. Thus, R is the correct explanation for A.

Step 3: Final Answer:

Both Assertion A and Reason R are true, and Reason R correctly explains Assertion A. Therefore, option (A) is the correct choice.

Quick Tip

Associate the seasons with cambial activity and wood type:

- **Spring (Early wood):** Favorable conditions → High cambial activity → More, wider vessels → Lighter, less dense wood.
- **Autumn (Late wood):** Unfavorable conditions → Low cambial activity → Fewer, narrower vessels → Darker, denser wood.

Section - B

36. 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 different protein molecules that constitute a ribosome. Since it doesn't specify prokaryotic or eukaryotic, we should consider both and see which fits the options best. Generally, such questions in a broad biology context refer to the more complex eukaryotic ribosome.

Step 2: Detailed Explanation:

Ribosomes are ribonucleoprotein complexes, meaning they are made of ribosomal RNA (rRNA) and ribosomal proteins.

- **Eukaryotic Ribosome (80S):** It is composed of a large subunit (60S) and a small subunit (40S).
 - The 60S subunit contains approximately 49 proteins.
 - The 40S subunit contains approximately 33 proteins.

– The total number of proteins is approximately $49 + 33 = 82$.

- **Prokaryotic Ribosome (70S):** It is composed of a 50S and a 30S subunit. The total number of proteins is approximately 55.

Comparing these values to the given options:

- (A) 80 is the closest and most appropriate rounded number for the ~ 82 proteins found in a eukaryotic ribosome.
- (B) 60 and (C) 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 unit (S) with the number of components. The 80S eukaryotic ribosome is made of 60S and 40S subunits. The total number of proteins is a fact to remember: ~ 80 for eukaryotes and ~ 55 for prokaryotes. The number 80 in the option is a strong hint that the question refers to eukaryotes.

37. 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 key processes and cycles in cellular respiration (List I) with their associated enzymes, pathways, or systems (List II).

Step 2: Detailed Explanation:

Let's analyze each item in List I:

- **A. Oxidative decarboxylation:** This is the specific term for the link reaction that converts pyruvate into acetyl-CoA. This reaction is catalyzed by the **Pyruvate dehydrogenase** complex. So, **A matches with II**.
- **B. Glycolysis:** This is the initial stage of glucose breakdown. It is also known by the eponym **EMP pathway**, after its discoverers Embden, Meyerhof, and Parnas. So, **B matches with IV**.
- **C. Oxidative phosphorylation:** This is the final process of aerobic respiration where ATP is synthesized using the energy from electron transport. This process is carried out 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 step of this cycle involves the enzyme **Citrate synthase**, which combines acetyl-CoA and 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 matching corresponds to option (D).

Quick Tip

Create a mental map of cellular respiration with these key associations:

- Glycolysis = EMP pathway.
- Link Reaction = Oxidative Decarboxylation = Pyruvate Dehydrogenase.
- Krebs Cycle = TCA Cycle = Citrate Synthase (first step).
- ATP Synthesis = Oxidative Phosphorylation = Electron Transport System.

38. Match List I with List II:

List I

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

List II

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

Choose the correct answer from the options given below :

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

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

Solution:

Step 1: Understanding the Question:

The question asks to match properties of water and a related plant physiological process (List I) with their correct descriptions (List II).

Step 2: Detailed Explanation:

Let's define each term in List I:

- **A. Cohesion:** This refers to the attraction between molecules of the same substance. For water, it is the **mutual attraction among water molecules** due to hydrogen bonding. So, **A matches with II**.
- **B. Adhesion:** This is the attraction between molecules of different substances. In plants, it's the **attraction of water towards polar surfaces**, like the lignocellulosic walls of the xylem. So, **B matches with IV**.
- **C. Surface tension:** This is a property of liquids that arises from cohesion. At the water-air interface, water molecules are more strongly attracted to each other in the liquid phase than to the air. This can be described as **more attraction in the liquid phase**. So, **C matches with I**.
- **D. Guttation:** This is the exudation of xylem sap as droplets from the tips of leaves. It is a process of **water loss in the liquid phase**, driven by root pressure. So, **D matches with III**.

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

Step 3: Final Answer:

The correct matching is represented by option (A).

Quick Tip

Remember the differences:

- **Cohesion:** Water-to-water attraction.
- **Adhesion:** Water-to-wall attraction.
- **Surface Tension:** A result of cohesion at the surface.
- **Guttation:** Water loss as a liquid (vs. Transpiration, which is loss as vapor).

39. 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:

We need to evaluate the correctness of two statements concerning the ecological principle of competition.

Step 2: Detailed Explanation:

Analysis of Statement I:

This statement provides the definition of Gause's Competitive Exclusion Principle. It accurately states that if two species have identical niches (i.e., they compete for the same limiting resources), they cannot coexist in the same place. The species with even a slight competitive advantage will eventually drive the other to local extinction. This is a correct and standard definition of the principle. Therefore, Statement I is **correct**.

Analysis of Statement II:

This statement makes a broad generalization comparing the impact of competition on carnivores versus herbivores. There is no such universal rule in ecology. Competition can be intense at any trophic level. In fact, it is often argued that herbivores face very intense competition because plant resources can be heavily defended or low in nutritional quality, and herbivore populations can reach high densities. Carnivores are often limited more by the availability of prey (a "bottom-up" control) than by direct competition, although interspecific competition among carnivores (e.g., lions vs. hyenas) is also a significant factor. The generalization that carnivores are *more* adversely affected is not supported and is considered **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 Statement II, be wary of sweeping generalizations in ecology. The intensity of competition is context-dependent and not strictly determined by trophic level.

40. 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:

The question asks to match the different phases of the eukaryotic cell cycle (List I) with their corresponding descriptions or defining events (List II).

Step 2: Detailed Explanation:

Let's analyze each phase from List I:

- **A. M Phase:** This is the Mitosis phase, which involves the division of the nucleus (karyokinesis) and cytoplasm (cytokinesis). Mitosis is specifically called **Equational division** because the chromosome number in the daughter cells remains the same as in the parent cell. So, **A matches with IV.**
- **B. G₂ Phase:** The second gap phase, following DNA replication (S phase). During G₂, the cell prepares for mitosis. This preparation includes the synthesis of proteins required for cell division, such as tubulin for the mitotic spindle. So, **B matches with I.**
- **C. Quiescent stage (G₀):** This is a state where cells exit the cell cycle and stop dividing. They are metabolically active but are in a non-proliferative or **inactive phase** with respect to division. So, **C matches with II.**
- **D. G₁ Phase:** The first gap phase. It represents the **interval between the end of mitosis and the initiation of DNA replication** (S phase). It's a major period of cell growth. 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 corresponds to option (C).

Quick Tip

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

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

41. 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 regarding the ecological impacts of water pollution.

Step 2: Detailed Explanation:

Let's analyze each statement:

- **(A) Correct.** When sewage with high organic content enters a water body, decomposer microorganisms flourish. Their aerobic respiration consumes large amounts of dissolved oxygen (DO), increasing the Biochemical Oxygen Demand (BOD). This depletion of oxygen can lead to the death of fish and other aquatic life.
- **(B) Incorrect.** Algal blooms are caused by nutrient enrichment (eutrophication), typically from nitrates and phosphates, not directly by organic matter. These blooms are extremely harmful. They block sunlight, and when the massive amount of algae dies and decomposes, the process consumes nearly all the dissolved oxygen, creating hypoxic "dead zones." This *severely degrades* water quality and *kills* fish, thereby harming fisheries.

- **(C) Correct.** Water hyacinth (*Eichhornia*) is an invasive aquatic plant that thrives in nutrient-rich (eutrophic) waters. It grows rapidly, covering the water surface, which disrupts the aquatic ecosystem by blocking light and reducing dissolved oxygen.
- **(D) Correct.** This statement describes biomagnification. Non-biodegradable toxic substances, like heavy metals or certain pesticides from industrial wastewater, accumulate in organisms. Their concentration increases at each successive trophic level of the food chain.

Statement (B) is factually incorrect as algal blooms are detrimental to water quality and aquatic life.

Step 3: Final Answer:

The incorrect statement is (B).

Quick Tip

Associate "algal bloom" and "eutrophication" with negative consequences: oxygen depletion, fish kills, and poor water quality. Any statement claiming they are beneficial is almost certainly wrong.

42. 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:

We need to evaluate two statements about pollination in gymnosperms. Assertion A describes how pollen is dispersed, and Reason R describes the subsequent events.

Step 2: Detailed Explanation:

Analysis of Assertion A:

Gymnosperms are predominantly wind-pollinated (anemophilous). Pollen grains, which develop

inside the microsporangium, are released and carried by wind (air currents) to the female cones that bear the ovules. This statement is a correct description of pollination in gymnosperms. Thus, Assertion A is **true**.

Analysis of Reason R:

This statement describes the post-pollination events incorrectly.

- The pollen grain lands on the ovule, not directly on the archegonium.
- The most critical error is the claim that a "pollen tube is not formed". In gymnosperms (and angiosperms), the pollen grain germinates to form a **pollen tube**. This tube grows towards the archegonium, carrying the male gametes. The formation of a pollen tube (siphonogamy) is a characteristic feature of seed plants.

Because it incorrectly denies the formation of a pollen tube, Reason R is **false**.

Step 3: Final Answer:

Assertion A is true, but Reason R is false. Therefore, option (C) is the correct answer.

Quick Tip

Remember that all seed plants (gymnosperms and angiosperms) exhibit siphonogamy, which means they form a pollen tube to deliver male gametes. This is a key evolutionary advancement over more primitive plants. Any statement claiming gymnosperms lack a pollen tube is incorrect.

43. 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 set of essential components needed for the process of chemiosmosis, the primary mechanism for ATP synthesis in cells.

Step 2: Detailed Explanation:

The chemiosmotic theory, proposed by Peter Mitchell, outlines the process of ATP synthesis. It requires the following components working together:

1. **A Membrane:** An intact, impermeable membrane (the inner mitochondrial membrane or the thylakoid membrane) is necessary to separate two compartments and maintain a gradient.
2. **A Proton Pump:** Protein complexes within the membrane (part of the electron transport chain) act as pumps, using energy from electron flow to actively transport protons (H^+) across the membrane into a small volume space.
3. **A Proton Gradient:** The pumping of protons creates an electrochemical gradient, also known as the proton-motive force. This gradient of H^+ ions represents stored potential energy.
4. **ATP Synthase:** A transmembrane enzyme complex that provides a channel for protons to flow back down their gradient. It harnesses the kinetic energy of this proton flow to catalyze the synthesis of ATP from ADP and inorganic phosphate.

Option (A) correctly lists all four essential components. The other options are incorrect because they mention an "electron gradient" (it's a proton gradient) or "NADP synthase" (the enzyme is ATP synthase; NADP reductase is a different enzyme in photosynthesis).

Step 3: Final Answer:

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

Quick Tip

Think of chemiosmosis like a hydroelectric dam:

- **Membrane** = The Dam Wall
- **Proton Pump** = The pumps that move water up into the reservoir
- **Proton Gradient** = The high water level in the reservoir (stored energy)
- **ATP Synthase** = The Turbine that generates electricity (ATP) as water flows through it

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

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

Choose the correct answer from the options given below :

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

(D) B, D, A, C

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

Solution:

Step 1: Understanding the Question:

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

Step 2: Detailed Explanation:

Let's analyze the logical flow of a genetic engineering experiment:

1. **Step B: Cutting of DNA at specific location by restriction enzyme.** The process begins by using restriction enzymes to cut the source DNA (which contains the gene of interest) and the vector DNA (like a plasmid). This creates compatible "sticky ends".
2. **Step C: Isolation of desired DNA fragment.** After cutting the source DNA, it results in many fragments. The specific fragment containing the desired gene must be separated from the rest, usually via gel electrophoresis.
3. **Step D: Amplification of gene of interest using PCR.** Once the desired gene fragment is isolated, it's often necessary to make many copies of it to ensure a sufficient quantity for the next step. This is done using the Polymerase Chain Reaction (PCR).
4. **Step A: Insertion of recombinant DNA into the host cell.** The amplified gene of interest is then ligated (pasted) into the prepared vector DNA, creating the recombinant DNA molecule. This recombinant DNA is then introduced into a host organism (like bacteria) through a process called transformation.

The logical sequence is $B \rightarrow C \rightarrow D \rightarrow A$.

Step 3: Final Answer:

The correct sequence of steps for forming recombinant DNA is B, C, D, A. Therefore, option (A) is correct.

Quick Tip

Think of the process like writing a report using a source book: 1. **Cut (B):** Use scissors (restriction enzymes) to cut out a paragraph (gene) from the source book (source DNA). 2. **Isolate (C):** Pick up the specific paragraph you cut out. 3. **Amplify/Copy (D):** Make many photocopies (PCR) of that paragraph. 4. **Insert (A):** Paste the copied paragraph into your report (vector) and submit it (insert into host).

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

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

Reason R: Internode of the shoot gets condensed to produce different floral appendages laterally at successive 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:

The question presents an assertion defining a flower and a reason explaining the modification. We need to assess their validity and relationship.

Step 2: Detailed Explanation:

Analysis of Assertion A:

Morphologically, a flower is considered a highly modified, condensed, reproductive shoot. The transition from vegetative growth to reproductive growth involves the transformation of the shoot apical meristem into a floral meristem, which then produces the floral organs. This statement is a standard and correct definition. Thus, Assertion A is **true**.

Analysis of Reason R:

This statement explains *how* the shoot is modified. In a typical shoot, nodes are separated by elongated internodes. In a flower, the axis (thalamus or receptacle) does not elongate, meaning the **internodes are highly condensed**. This brings the nodes very close together. From these nodes, the floral appendages (sepals, petals, stamens, carpels), which are homologous to leaves, arise in whorls. This accurately describes the modification process. Thus, Reason R is **true**.

Relationship between A and R:

Reason R provides the specific details of the modification (condensation of internodes, production of floral parts instead of leaves) that justify the definition of a flower as a modified shoot (Assertion A). Therefore, R is the correct explanation for 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

Remember the homology:

- Shoot axis $\leftrightarrow$ Thalamus/Receptacle
- Leaves $\leftrightarrow$ Floral parts (sepals, petals, etc.)

The key transformation is the extreme compression of the internodes of the shoot axis.

46. Match List I with List II:

List I

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

List II

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

Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Question:

The question requires matching four essential mineral nutrients with their primary physiological roles in plants.

Step 2: Detailed Explanation:

Let's determine the function for each mineral:

- **A. Iron (Fe):** Iron is a crucial component of electron carriers like cytochromes and is essential for chlorophyll synthesis. It also acts as an **activator of the enzyme catalase**. So, **A matches with III**.
- **B. Zinc (Zn):** Zinc is an activator for many enzymes, especially carboxylases. It is also required for the **synthesis of auxin (IAA)**. So, **B matches with I**.
- **C. Boron (B):** Boron is involved in calcium uptake, pollen germination, and, importantly, **cell elongation and cell differentiation**. So, **C matches with IV**.
- **D. Molybdenum (Mo):** Molybdenum is a key structural **component of the enzyme nitrate reductase**, which is vital for 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 matching is found in option (C).

Quick Tip

To remember these roles, focus on the most unique function for each micronutrient:

- **Zinc** → **Z**ooms up growth (Auxin synthesis).
- **Molybdenum** → **M**ostly for Nitrogen (Nitrate reductase).
- **Boron** → **B**uilding cells (Cell elongation/differentiation) and **B**aby-making (pollen germination).
- **Iron** → **I**mportant for Respiration (cytochromes) and detoxification (catalase).

47. 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 which of the five statements about plant anatomy (specifically bark and related structures) are factually correct.

Step 2: Detailed Explanation:

Let's evaluate each statement:

- **A. Lenticels are the lens-shaped openings permitting the exchange of gases.**
This is **correct**. Lenticels are porous regions in the periderm of woody stems that allow for gas exchange between the internal tissues and the atmosphere.

- **B. Bark formed early in the season is called hard bark.** This is **incorrect**. Early bark (spring bark) is soft, while late bark (autumn bark) is hard.
- **C. Bark is a technical term that refers to all tissues exterior to vascular cambium.** This is **incorrect**. Bark is a *non-technical* or common term. The statement itself describes the correct location but mischaracterizes the term as "technical".
- **D. Bark refers to periderm and secondary phloem.** This is **correct**. Anatomically, the term "bark" includes all tissues outside the vascular cambium, which are primarily the secondary phloem and the periderm. The periderm itself consists of phellogen (cork cambium), phellem (cork), and phelloderm.
- **E. Phellogen is single-layered in thickness.** This is **incorrect**. Phellogen (cork cambium) is a meristematic tissue and is typically a few cell layers thick, not strictly single-layered.

The only correct statements are A and D.

Step 3: Final Answer:

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

Quick Tip

Remember the composition of bark: Bark = Secondary Phloem + Periderm. And the composition of Periderm: Periderm = Phellem (cork) + Phellogen (cork cambium) + Phelloderm. Also, remember that "bark" is a non-technical term.

48. 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 descriptive statements for Klinefelter's Syndrome.

Step 2: Detailed Explanation:

Klinefelter's Syndrome is a chromosomal disorder with the karyotype 47, XXY. Let's analyze the statements:

- **A. Incorrect.** Langdon Down described Down's Syndrome. Klinefelter's Syndrome was described by Harry Klinefelter.
- **B. Correct.** The presence of the Y chromosome results in overall masculine development (male phenotype). However, the extra X chromosome leads to the expression of some feminine characteristics, such as gynecomastia (breast development).
- **C. Incorrect.** Individuals are often taller than average, not short statured. Short stature is a feature of Turner's Syndrome (45, XO).
- **D. Incorrect.** While some learning disabilities may be present, severe mental retardation is not a typical characteristic of Klinefelter's Syndrome.
- **E. Correct.** Individuals have underdeveloped testes and are typically sterile due to failure of sperm production (azoospermia).

The correct statements are B and E.

Step 3: Final Answer:

The correct combination of statements is B and E. Therefore, option (C) is the correct answer.

Quick Tip

For chromosomal syndromes, create a simple comparison table:

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

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

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

Correct Answer: (A) Succinic dehydrogenase

Solution:

Step 1: Understanding the Question:

The question asks which enzyme is inhibited by malonate, a substance that stops bacterial growth. This points to a mechanism of enzyme inhibition.

Step 2: Detailed Explanation:

Malonate is a classic example of a **competitive inhibitor**.

- The enzyme **succinic dehydrogenase** is a key component of the Krebs cycle. Its normal substrate is **succinate**.
- Malonate is structurally very similar to succinate.
- Because of this structural similarity, malonate can bind to the active site of succinic dehydrogenase, blocking the real substrate, succinate, from binding.
- This inhibition of a key enzyme in the Krebs cycle stops aerobic respiration, thus depriving the bacterium of energy (ATP) and inhibiting its growth.

The other enzymes listed have different functions and substrates and are not inhibited by malonate.

Step 3: Final Answer:

Malonate competitively inhibits the enzyme succinic dehydrogenase. Therefore, option (A) is the correct answer.

Quick Tip

The relationship between **succinate** (substrate), **succinic dehydrogenase** (enzyme), and **malonate** (competitive inhibitor) is a textbook example of competitive inhibition. Memorizing this specific trio is very useful for exams.

50. 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 asks to match different types of ecological interactions with their symbolic representations, where '+' denotes a benefit, '-' denotes harm, and '0' denotes a neutral effect.

Step 2: Detailed Explanation:

Let's define each interaction:

- **A. Mutualism:** An interaction where both species benefit. This is represented by (+, +). So, **A matches with IV.**
- **B. Commensalism:** One species benefits, while the other is unaffected. This is represented by (+, 0). So, **B matches with I.**
- **C. Amensalism:** One species is harmed, while the other is unaffected. This is represented by (-, 0). So, **C matches with II.**
- **D. Parasitism:** One species (the parasite) benefits, while the other (the host) is harmed. This is represented by (+, -). 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 matching is given in option (B).

Quick Tip

Memorize the symbolic representation of all six major population interactions:

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