

NEET UG 2023 F1 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. Which hormone promotes internode/petiole elongation in deep water rice?

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

(D) GA₃

Correct Answer: (B) Ethylene

Solution:

Step 1: Understanding the Question:

The question asks to identify the plant hormone that triggers the rapid elongation of internodes or petioles in deep water rice plants, a specific adaptation to survive flooding.

Step 2: Detailed Explanation:

Deep water rice has a remarkable ability to grow quickly when submerged. This response is a classic example of hormonal interaction.

1. When the plant is submerged, the gaseous hormone **ethylene** is trapped within the plant tissues due to its slow diffusion in water, causing its concentration to rise.
2. This increased concentration of ethylene acts as the primary signal. It promotes the synthesis and sensitivity of the plant to another group of hormones, the **gibberellins** (like GA₃).
3. The gibberellins then directly stimulate cell division and elongation in the internodes, leading to rapid stem growth that keeps the leaves above the water surface for photosynthesis.

While gibberellins are the direct effectors of elongation, ethylene is the crucial initial trigger in this specific environmental context. The question asks what "promotes" the elongation, and ethylene is the key promoter of this entire adaptive response. Kinetin is a cytokinin involved in cell division, and 2,4-D is a synthetic auxin.

Step 3: Final Answer:

Ethylene is the hormone that promotes the rapid internode/petiole elongation in deep water rice. Therefore, option (B) is the correct answer.

Quick Tip

Remember the specific and sometimes unique roles of plant hormones. For the special case of 'deep water rice', while gibberellins are the general promoters of stem elongation, ethylene is the critical trigger that accumulates during submergence and initiates the rapid growth response.

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

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

(D) Osmosis

Correct Answer: (C) Active Transport

Solution:

Step 1: Understanding the Question:

The question asks to identify the transport mechanism that moves ions across a cell membrane from a region of lower concentration to a region of higher concentration. The key phrase is "against their concentration gradient."

Step 2: Detailed Explanation:

Let's define the given transport processes:

- **Passive Transport (includes Facilitated Diffusion):** This is the movement of substances across a membrane **down** the concentration gradient (from high to low concentration). It is a spontaneous process and does not require the cell to expend metabolic energy.
- **Osmosis:** A specific type of passive transport that describes the movement of water across a semipermeable membrane.
- **Active Transport:** This is the movement of substances **against** their concentration gradient (from low to high concentration). This "uphill" movement is non-spontaneous and requires the cell to expend energy, typically in the form of ATP. It is carried out by specific membrane proteins called pumps.

The movement of ions against a concentration gradient is the defining characteristic of active transport.

Step 3: Final Answer:

The process that explains the movement and accumulation of ions against a concentration gradient is Active Transport. Therefore, option (C) is the correct answer.

Quick Tip

Use the "hill" analogy for membrane transport:

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

The phrase "against the gradient" always signifies active transport.

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

- (A) Bird pollinated plants
- (B) Bat pollinated plants
- (C) Wind pollinated plants
- (D) Insect pollinated plants

Correct Answer: (D) Insect pollinated plants

Solution:

Step 1: Understanding the Question:

The question describes a suite of floral characteristics (large size, bright colors, fragrance, and the presence of nectar) and asks to identify the mode of pollination associated with these traits. This is a question about pollination syndromes.

Step 2: Detailed Explanation:

Let's analyze the characteristics typically associated with each pollination method:

- **Bird pollination (Ornithophily):** Flowers are often large and brightly colored (especially red), produce copious dilute nectar, but are usually odorless as birds have a poor sense of smell.
- **Bat pollination (Chiropterophily):** Flowers are typically large, pale or dull-colored, open at night, and emit a strong, musty, or fermented odor to attract nocturnal bats.
- **Wind pollination (Anemophily):** Flowers do not need to attract pollinators, so they are generally small, inconspicuous, and lack color, fragrance, and nectar. They produce large amounts of lightweight pollen.
- **Insect pollination (Entomophily):** To attract insects, flowers are typically **large** and conspicuous, **colourful** (often in shades of blue, yellow, and ultraviolet which insects see well), **fragrant** to provide a scent trail, and provide a food reward, which is usually **nectar**. This combination perfectly matches the description in the question.

Step 3: Final Answer:

The combination of large, colorful, fragrant flowers with nectar is characteristic of plants pollinated by insects. Therefore, option (D) is the correct answer.

Quick Tip

To solve pollination syndrome questions, think from the pollinator's perspective and what senses it uses:

- **Insects:** Good vision (color) and smell → colorful, fragrant flowers.
- **Birds:** Excellent vision (especially red), but poor smell → colorful, odorless flowers.
- **Bats:** Nocturnal, rely on strong smell → large, pale, smelly flowers.
- **Wind/Water:** Non-living agents → no need for attractants.

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

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

Correct Answer: (A) Dedifferentiation

Solution:

Step 1: Understanding the Question:

The question describes a process where specialized, mature plant cells (leaf mesophyll) are induced to revert to a state of active cell division to form an undifferentiated mass of cells called a callus. We need to identify the correct biological term for this process.

Step 2: Detailed Explanation:

Let's define the relevant biological terms:

- **Differentiation:** The process by which cells, tissues, and organs become specialized for a particular function. Leaf mesophyll cells are already differentiated.
- **Dedifferentiation:** The process by which differentiated cells that have lost the ability to divide are stimulated to revert to a meristematic state and regain the capacity for cell division. This is precisely what happens when an explant (a piece of differentiated tissue) is placed on a nutrient medium and forms a callus.
- **Redifferentiation:** The process where dedifferentiated cells (like those in a callus) are induced to differentiate again into new, specialized cells and tissues to form organs or a whole plantlet.
- **Development:** The overall sum of processes that an organism undergoes throughout its life.
- **Senescence:** The process of aging.

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

Step 3: Final Answer:

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

Quick Tip

Remember the sequence in plant regeneration via callus: **Differentiated** cell (explant) → **Dedifferentiation** → **Undifferentiated** callus → **Redifferentiation** → **Differentiated** plantlet. This "DDR" sequence is fundamental to plant tissue culture.

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

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

Correct Answer: (A) 1992

Solution:

Step 1: Understanding the Question:

This is a factual question that asks for the year of the 'Earth Summit' held 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), widely known as the **Earth Summit** or the Rio Summit, was a major international conference.

- It was held in Rio de Janeiro, Brazil, in **June 1992**.
- This summit was a landmark event for global environmental governance and resulted in several important agreements, including the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC).
- The year 2002 is associated with the World Summit on Sustainable Development held in Johannesburg.

Step 3: Final Answer:

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

Quick Tip

Memorize the key dates for important environmental conventions:

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

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

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

Correct Answer: (A) DNA

Solution:

Step 1: Understanding the Question:

The question asks to identify the macromolecule that is precipitated from an aqueous solution by the addition of chilled ethanol during the process of DNA purification.

Step 2: Detailed Explanation:

The process of isolating DNA from a cell lysate involves separating DNA from other macromolecules like proteins, RNA, lipids, and polysaccharides. The final step is often to concentrate the DNA.

- 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 compared to water. When it is added to the aqueous solution (in the presence of cations like Na^+ to neutralize the DNA's charge), it disrupts the hydration shell around the DNA molecules.
- This disruption greatly reduces the solubility of DNA, causing it to aggregate and precipitate out of the solution. Using chilled ethanol enhances this effect.
- The precipitated DNA appears as a mass of fine white threads that can be spooled out. Other smaller molecules and contaminants typically remain dissolved in the ethanol-water mixture.

Step 3: Final Answer:

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

Quick Tip

This is a fundamental laboratory technique in molecular biology. Remember the key step for DNA isolation: after lysing the cells and removing other contaminants, you **precipitate DNA with chilled ethanol**.

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

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

Correct Answer: (A) 18 ATP and 12 NADPH₂

Solution:

Step 1: Understanding the Question:

The question asks for the total energy requirement, in terms of ATP and NADPH molecules, for the synthesis of one molecule of glucose through the Calvin cycle (C3 pathway). (Note: NADPH₂ is an older notation for NADPH + H⁺).

Step 2: Detailed Explanation:

The Calvin cycle must fix 6 molecules of CO₂ to produce one 6-carbon molecule of glucose. We can determine the total requirement by looking at the cost per CO₂ fixed.

- For each turn of the cycle (fixing 1 molecule of CO₂):
 - The **reduction** of 2 molecules of 3-PGA to 2 molecules of G3P requires **2 ATP** and **2 NADPH**.
 - The **regeneration** of RuBP requires **1 ATP**.
 - Therefore, the total cost for fixing one CO₂ is **3 ATP** and **2 NADPH**.
- To synthesize one molecule of glucose, the cycle must turn 6 times:
 - Total ATP required = 6 turns × 3 ATP/turn = **18 ATP**.
 - Total NADPH required = 6 turns × 2 NADPH/turn = **12 NADPH**.

Step 3: Final Answer:

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

Quick Tip

Remember the 3:2 ratio of ATP to NADPH for fixing one CO₂ in the C3 cycle. For glucose (C₆), you need 6 CO₂. So, the total is (6 × 3) ATP and (6 × 2) NADPH, which is 18 ATP and 12 NADPH.

**8. In the equation $GPP - R = NPP$
GPP is Gross Primary Productivity**

NPP is Net Primary Productivity
R here is

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

Correct Answer: (B) Respiratory loss

Solution:

Step 1: Understanding the Question:

The question provides the standard equation relating Gross Primary Productivity (GPP) and Net Primary Productivity (NPP) and asks to identify the term represented by 'R'.

Step 2: Detailed Explanation:

Let's define the terms in ecology:

- **Gross Primary Productivity (GPP):** This is the total rate at which photosynthetic producers capture and store chemical energy as biomass. It represents the total amount of photosynthesis.
- To live, grow, and maintain their tissues, the producers must use some of this captured energy for their own metabolic processes, primarily cellular **respiration**. This portion of energy is consumed by the producer and is not stored as biomass available to the next trophic level.
- **Net Primary Productivity (NPP):** This is the rate of energy storage as biomass that is left over after the producer has met its own respiratory needs. It is the energy available to herbivores.

The relationship is that the net amount is what remains from the gross amount after costs are subtracted.

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

In this equation, 'R' stands for the energy lost through **Respiration**, or **Respiratory loss**.

Step 3: Final Answer:

In the productivity equation, R represents the energy consumed by producers for respiration. Therefore, it is Respiratory loss. Option (B) is correct.

Quick Tip

Think of productivity like personal finance. GPP is your gross income (total money earned). R (Respiration) is your essential living expenses. NPP is your net income or savings (the amount you actually accumulate and can be passed on).

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

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

Correct Answer: (B) Tungsten or gold

Solution:

Step 1: Understanding the Question:

The question asks to identify the type of metal used for the microparticles (or microprojectiles) in the gene gun (biolistics) method of genetic transformation.

Step 2: Detailed Explanation:

The gene gun method, also known as biolistics, is a physical method for delivering foreign genetic material into cells.

1. In this technique, the DNA of interest is coated onto the surface of microscopic particles.
2. These particles need to be dense enough to have sufficient momentum to penetrate the cell wall and membrane of the target cells (especially tough plant cells).
3. They must also be chemically inert to avoid causing a toxic reaction inside the cell.
4. The most commonly used metals for these microparticles are high-density, inert metals like **gold (Au)** and **tungsten (W)**.
5. These DNA-coated particles are then accelerated to a high velocity and shot into the target tissue.

Other metals like zinc, silver, or copper are generally not used as they can be toxic to the cells or are not sufficiently dense.

Step 3: Final Answer:

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

Quick Tip

Think of the gene gun firing "golden bullets". This mnemonic helps to remember that dense, precious, and inert metals like **gold** and **tungsten** are used in the biolistics method to carry DNA into cells.

10. The phenomenon of pleiotropism refers to

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

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

Solution:

Step 1: Understanding the Question:

The question asks for the correct definition of the genetic phenomenon known as pleiotropy (or pleiotropism).

Step 2: Detailed Explanation:

Let's analyze the genetic terms related to the options:

- **Pleiotropy:** This is a situation where a **single gene** influences **multiple, often unrelated, phenotypic traits**. A well-known example is the genetic disorder Phenylketonuria (PKU), where a defect in a single gene leads to a wide range of symptoms, including mental retardation, eczema, and reduced skin and hair pigmentation.
- **Option (A)** is a confusing and incorrect description of gene interaction.
- **Option (B)** provides the accurate definition of pleiotropy.
- **Option (C)** describes the opposite phenomenon, **polygenic inheritance**, where a single character (like human height or skin color) is controlled by the cumulative effect of multiple genes.
- **Option (D)** describes multiple alleles, which is the existence of more than two alleles for a gene in a population, and incorrectly links it to crossover.

Step 3: Final Answer:

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

Quick Tip

To avoid confusion between pleiotropy and polygenic inheritance, remember the prefixes:

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

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

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

Solution:

Step 1: Understanding the Question:

The question presents an Assertion about the structure of late wood and a Reason about the seasonal activity of the cambium. We need to evaluate their truthfulness and their causal link.

Step 2: Detailed Explanation:

Analysis of Assertion A:

In temperate regions, trees show seasonal growth. The wood formed in the later part of the growing season (autumn/late summer) is called late wood or autumn wood. Under less favorable conditions, the vascular cambium produces fewer xylary elements (xylem cells), and these elements, particularly vessels, have narrower cavities. This makes late wood darker and denser. Thus, Assertion A is **true**.

Analysis of Reason R:

The vascular cambium is a layer of actively dividing cells responsible for secondary growth. Its activity is highly dependent on environmental factors like temperature and light. During winter, these conditions are unfavorable, causing the cambium to become less active or dormant. Thus, Reason R is **true**.

Relationship between A and R:

The reduced activity of the cambium in the less favorable conditions of late autumn and winter (Reason R) is the direct cause for the production of dense late wood with fewer and narrower xylem vessels (Assertion A). Therefore, Reason R is the correct explanation for Assertion A.

Step 3: Final Answer:

Both statements are correct, and the reason correctly explains the assertion. Hence, option (D) is the correct answer.

Quick Tip

Associate seasons with wood types:

- **Spring/Early Wood:** Favorable conditions → High cambial activity → More, wider vessels → Lighter color, less dense.
- **Autumn/Late Wood:** Unfavorable conditions → Low cambial activity → Fewer, narrower vessels → Darker color, more dense.

One annual ring = 1 early wood ring + 1 late wood ring.

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

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

Correct Answer: (A) S phase

Solution:

Step 1: Understanding the Question:

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

Step 2: Detailed Explanation:

The eukaryotic cell cycle is divided into two major phases: Interphase and M phase (Mitotic phase). Interphase is the period of cell growth and preparation for division, and it is further subdivided into three stages:

- **G₁ phase (Gap 1):** The cell grows and performs its normal metabolic functions. It is the interval between mitosis and DNA replication.
- **S phase (Synthesis phase):** This is the specific period during which the entire DNA content of the cell is replicated. At the end of this phase, each chromosome consists of two identical sister chromatids.
- **G₂ phase (Gap 2):** The cell continues to grow and synthesizes proteins necessary for mitosis.
- **M phase (Mitotic phase):** The cell undergoes nuclear division (mitosis) and cytoplasmic division (cytokinesis).

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

Step 3: Final Answer:

In eukaryotes, the replication of DNA takes place during the S phase. Therefore, option (A) is the correct answer.

Quick Tip

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

13. 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) Polyadelphous and epipetalous stamens
- (B) Monoadelphous and Monothealous anthers
- (C) Epiphyllous and Dithealous anthers
- (D) Diadelphous and Dithealous anthers

Correct Answer: (D) Diadelphous and Dithealous anthers

Solution:

Step 1: Understanding the Question:

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

Step 2: Detailed Explanation:

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

- **Fabaceae (specifically, subfamily Papilionoideae like pea):** The androecium typically has ten stamens. The defining characteristic is that the filaments of nine stamens are fused into a tube, while the tenth stamen is free. This arrangement is called **diadelphous** ((9)+1). The anthers are **dithealous** (two-lobed).
- **Solanaceae (e.g., potato, petunia):** The androecium has five stamens which are **epipetalous** (fused to the petals). The anthers are dithealous.
- **Liliaceae (e.g., lily, onion):** The androecium has six stamens which are **epiphyllous** or **epitepalous** (fused to the tepals). The anthers are dithealous.

Now let's analyze the options:

- (A) Polyadelphous (many bundles) and epipetalous are not features of Fabaceae.
- (B) Monoadelphous (one bundle) and monothealous anthers are characteristic of Malvaceae (China rose).
- (C) Epiphyllous stamens are characteristic of Liliaceae.
- (D) The **diadelphous** condition is a hallmark of Fabaceae and is not found in Solanaceae or Liliaceae.

Step 3: Final Answer:

The diadelphous condition of stamens is the specific characteristic of Fabaceae that distinguishes it from the other two families. Therefore, option (D) is the correct answer.

Quick Tip

For plant family identification, memorizing the key androecium features is crucial:

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

14. Axile placentation is observed in

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

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

Solution:

Step 1: Understanding the Question:

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

Step 2: Detailed Explanation:

Axile placentation is a type where the ovary is partitioned into multiple chambers (locules) by septa, and the ovules are borne on the central axis where the septa meet. Let's examine the placentation type in each option:

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

Step 3: Final Answer:

The correct group where all plants show axile placentation is China rose, Petunia, and Lemon. Therefore, option (C) is the correct answer.

Quick Tip

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

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

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

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

Correct Answer: (A) Selaginella and Salvinia

Solution:

Step 1: Understanding the Question:

The question asks to identify a pair of plants where both are pteridophytes and exhibit heterosporous (production of two different kinds of spores: microspores and megaspores).

Step 2: Detailed Explanation:

Pteridophytes can be classified based on the types of spores they produce.

- **Homosporous pteridophytes** produce only one type of spore. Most pteridophytes fall into this category, including *Lycopodium*, *Equisetum*, and *Psilotum*.
- **Heterosporous pteridophytes** produce two types of spores. This is a more advanced feature and is seen as a precursor to the seed habit. The key examples to remember are *Selaginella*, *Salvinia*, *Azolla*, and *Marsilea*.

Now let's check the given pairs:

- **(A) Selaginella and Salvinia:** Both *Selaginella* and *Salvinia* are well-known examples of heterosporous pteridophytes.

- (B) **Psilotum and Salvinia:** *Psilotum* is homosporous.
- (C) **Equisetum and Salvinia:** *Equisetum* is homosporous.
- (D) **Lycopodium and Selaginella:** *Lycopodium* is homosporous.

Step 3: Final Answer:

The correct pair of heterosporous pteridophytes is *Selaginella* and *Salvinia*. Therefore, option (A) is the correct answer.

Quick Tip

For exams, memorizing the four key examples of heterosporous pteridophytes—*Selaginella*, *Salvinia*, *Azolla*, and *Marsilea*—is a highly effective strategy for answering questions on this topic.

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

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

Correct Answer: (D) Dobson units

Solution:

Step 1: Understanding the Question:

The question asks for the specific unit used to quantify the thickness of the ozone layer in the atmosphere.

Step 2: Detailed Explanation:

Let's analyze the given units:

- **Decibels (dB):** A logarithmic unit for measuring sound intensity level.
- **Decameter (dam):** A metric unit of length, equal to 10 meters.
- **Kilobase (kb):** A unit used in genetics and molecular biology to measure the length of a DNA or RNA molecule, equal to 1000 base pairs.
- **Dobson units (DU):** This is the standard unit for measuring the total amount of ozone in a vertical column of the atmosphere. One Dobson Unit is the number of ozone molecules required to create a layer of pure ozone 0.01 mm thick at standard temperature and pressure.

The correct unit for measuring atmospheric ozone concentration is the Dobson unit.

Step 3: Final Answer:

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

Quick Tip

This is a straightforward factual question. It is important to associate specific scientific phenomena with their unique units of measurement. For environmental science, the key association to remember is **Ozone Layer Thickness** $\leftrightarrow$ **Dobson Units (DU)**.

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

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

Correct Answer: (A) To trap pollen grains

Solution:

Step 1: Understanding the Question:

The question asks for the function of "tassels in the corn cob". This phrasing is biologically imprecise, as the tassel and the cob are separate parts of the corn plant. We need to infer the intended meaning of the question.

Step 2: Detailed Explanation:

In a corn plant (*Zea mays*), which is monoecious and wind-pollinated:

- The **tassel** is the male inflorescence located at the apex (top) of the plant. Its function is to produce and **disperse pollen grains** into the wind. So, option (B) describes the function of the tassel itself.
- The **ear** or **cob** is the female inflorescence, located in a leaf axil. The long, silky threads that emerge from the top of the cob are the **silks**, which are the stigmas and styles. The function of these feathery and sticky silks is to **trap the airborne pollen grains**. So, option (A) describes the function of the silks on the cob.

Interpreting the Question and Answer Key:

The question is poorly worded. It combines "tassels" (the male part) with the "corn cob" (the female part). However, the provided answer key is (1), which corresponds to "To trap pollen grains". This indicates that the question was intended to ask about the function of the silks, which are the structures on the cob responsible for receiving pollen. Therefore, we select the

answer that describes 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 (A) is the intended correct answer.

Quick Tip

Be aware of poorly phrased questions in exams. For corn, clearly distinguish the roles:

- **Tassel** (top of plant, male): **Disperses** pollen.
- **Silk** (on the cob, female): **Traps** pollen.

If a question mixes these terms, try to understand the most likely intent based on the options provided.

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

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

Solution:

Step 1: Understanding the Question:

The question provides an Assertion and a Reason about the life cycle of mosses. We need to evaluate the truth of each statement and whether the Reason correctly explains the Assertion.

Step 2: Detailed Explanation:

Analysis of Assertion A:

In the life cycle of a moss, the dominant generation is the haploid gametophyte. This generation begins with the germination of a haploid spore. The spore does not directly grow into the familiar leafy moss plant. Instead, it first develops into a filamentous, branched, green structure called the **protonema**. This is considered the juvenile, or first stage, of the gametophyte.

Thus, Assertion A is **true**.

Analysis of Reason R:

The diploid sporophyte of a moss bears a capsule. Inside this capsule, meiosis occurs, producing haploid spores. These spores are released and, upon landing on a suitable substrate, germinate to develop directly into the protonema. Thus, the statement that the protonema develops directly from spores produced in a capsule is **true**.

Relationship between A and R:

Reason R explains the origin of the protonema (from a spore), which is precisely why it is considered the "first stage" of the gametophyte. The spore marks the beginning of the gametophytic generation, and the protonema is the first structure that develops from it. Therefore, R is the correct explanation for A.

Step 3: Final Answer:

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

Quick Tip

To understand the moss life cycle, trace the path: Spore (n) $\xrightarrow{\text{Germination}}$ Protonema (1st stage of gametophyte) $\rightarrow$ Leafy gametophyte (2nd stage) $\rightarrow$ Gametes $\rightarrow$ Zygote (2n) $\rightarrow$ Sporophyte (2n) $\rightarrow$ Capsule with Spores (n). This sequence clearly shows the protonema as the initial stage.

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

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

Solution:

Step 1: Understanding the Question:

The question presents two statements about the functions and effects of transpiration in plants.

We need to evaluate the scientific accuracy of both statements.

Step 2: Detailed Explanation:

Analysis of Statement I:

This statement refers to the transpiration pull, which is the primary mechanism for the ascent of sap in tall trees, as explained by the cohesion-tension theory. The evaporation of water from leaves creates a strong negative pressure (tension) in the xylem. This tension, transmitted down the continuous water column held together by cohesion, is powerful enough to pull water up from the roots to the top of the tallest trees on Earth (some over 115 meters). The theoretical limit of this force is well over 130 meters, so this statement is factually **correct**.

Analysis of Statement II:

This statement describes the cooling effect of transpiration. Evaporation is a process that requires energy, known as the latent heat of vaporization. When water evaporates from the leaf surface, it absorbs a significant amount of heat energy from the leaf. This evaporative cooling helps to regulate the leaf's temperature, preventing it from overheating under intense sunlight. A cooling effect of 10 to 15 degrees Celsius is a well-documented and accepted phenomenon. Therefore, this statement is also **correct**.

Step 3: Final Answer:

Both statements accurately describe important roles of transpiration. Therefore, both Statement I and Statement II are correct. Option (D) is the right choice.

Quick Tip

Remember the two main functions of transpiration: 1. Transport: It's the "engine" that drives the ascent of sap. 2. Thermoregulation: It acts as the plant's "air conditioning system." Both statements are direct consequences of these two functions.

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

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

Correct Answer: (A) Gibberellic Acid

Solution:

Step 1: Understanding the Question:

The question asks which plant hormone can be applied to young conifer trees to accelerate their transition from the juvenile stage to the mature, reproductive stage, thereby inducing

early seed production.

Step 2: Detailed Explanation:

Let's analyze the functions of the listed hormones:

- **Gibberellic Acid (GA):** Gibberellins have diverse roles, including promoting stem elongation (bolting), breaking seed dormancy, and inducing flowering. One of their significant commercial applications is in forestry, where spraying GAs on juvenile conifers helps to overcome the long juvenile phase. This hastens the maturation process and leads to early cone and seed production, which is valuable for breeding programs.
- **Zeatin:** A type of cytokinin, primarily involved in promoting cell division and delaying senescence.
- **Abscisic Acid (ABA):** An inhibitory hormone that promotes dormancy and stress responses.
- **Indole-3-butyric Acid (IBA):** A type of auxin, mainly used to stimulate root formation in cuttings.

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

Step 3: Final Answer:

Spraying with Gibberellic Acid helps in hastening the maturity period of juvenile conifers. Therefore, option (A) is the correct answer.

Quick Tip

For plant hormones, focus on their key commercial and agricultural applications:

- **Auxins (IBA):** Rooting cuttings.
- **Gibberellins (GA):** Increasing fruit size (grapes), elongating sugarcane, and **hastening conifer maturity**.
- **Cytokinins (Zeatin):** Delaying aging in produce.
- **Ethylene:** Fruit ripening.
- **ABA:** Stress response.

21. 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) Sutton and Boveri
- (B) Alfred Sturtevant
- (C) Henking

(D) Thomas Hunt Morgan

Correct Answer: (B) Alfred Sturtevant

Solution:

Step 1: Understanding the Question:

The question asks to identify the scientist who first proposed and used the idea that the frequency of genetic recombination could be used as a measure of the physical distance between genes on a chromosome, allowing for the construction of genetic maps.

Step 2: Detailed Explanation:

Let's look at the contributions of the scientists listed:

- **Sutton and Boveri:** They independently proposed the Chromosomal Theory of Inheritance, which states that genes are located on chromosomes.
- **Alfred Sturtevant:** As an undergraduate student in T. H. Morgan's lab, Sturtevant had the crucial insight that the frequency of crossing over between linked genes is proportional to the distance between them. In 1913, he used this principle to create the first-ever genetic linkage map for the X-chromosome of the fruit fly, *Drosophila melanogaster*.
- **Henking:** He was a cytologist who first identified the X chromosome, which he termed the "X-body."
- **Thomas Hunt Morgan:** He was a Nobel laureate whose work with fruit flies provided the experimental evidence for the Chromosomal Theory of Inheritance, including the concepts of gene linkage and recombination. While his work was foundational, it was his student, Sturtevant, who developed the mapping technique.

Step 3: Final Answer:

The scientist who first used recombination frequency to map gene positions was Alfred Sturtevant. Therefore, option (B) is the correct answer.

Quick Tip

Remember the chain of command in discovery: Sutton Boveri had the theory, T.H. Morgan provided the experimental proof of linkage and recombination, and his student, Alfred Sturtevant, made the brilliant leap to use the data to create the first gene map.

22. Expressed Sequence Tags (ESTs) refers to

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

(D) All genes that are expressed as RNA.

Correct Answer: (D) 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 concept from genomics and the Human Genome Project.

Step 2: Detailed Explanation:

The name itself provides the definition:

- **Expressed:** This refers to genes that are actively being transcribed into RNA. The collection of all RNA transcripts in a cell is its transcriptome.
- **Sequence Tags:** These are short, single-pass sequences of DNA that act as identifiers or "tags" for a full-length gene.

The methodology for creating ESTs involves isolating all the messenger RNA (mRNA) from a specific tissue, using the enzyme reverse transcriptase to create a library of complementary DNA (cDNA), and then sequencing short portions (tags) of these cDNAs. Because they are derived from mRNA, ESTs represent a snapshot of **all genes that are expressed as RNA** in that tissue at that particular time. This was a major strategy used in the Human Genome Project to quickly identify protein-coding genes.

Step 3: Final Answer:

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

Quick Tip

Focus on the first word: **Expressed**. The very first step of gene expression is transcription into RNA. Therefore, ESTs are directly derived from mRNA and serve as tags for the entire set of expressed genes (the transcriptome).

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

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

Correct Answer: (C) Bright orange colour

Solution:

Step 1: Understanding the Question:

The question asks about the visual appearance of DNA that has been stained with ethidium bromide and is then exposed to ultraviolet (UV) light. This is a standard visualization technique in molecular biology.

Step 2: Detailed Explanation:

Agarose gel electrophoresis is a common method used to separate DNA fragments by size. Since DNA is colorless, it must be stained to be seen.

- **Ethidium bromide (EtBr)** is a fluorescent dye that acts as an intercalating agent. It inserts itself between the stacked base pairs of the DNA double helix.
- After electrophoresis, the gel is placed on a UV transilluminator.
- When exposed to UV radiation, the EtBr molecules that are bound to the DNA absorb the high-energy UV light.
- They then re-emit this energy at a longer wavelength in the visible spectrum, a process called fluorescence.
- The characteristic color of this fluorescence is a **bright orange**.

This allows the bands of separated DNA to be visualized and photographed.

Step 3: Final Answer:

DNA stained with ethidium bromide fluoresces bright orange when exposed to UV light. Therefore, option (C) is the correct answer.

Quick Tip

This is a fundamental fact from the molecular biology lab. Create a simple mental link: **DNA + Ethidium Bromide + UV Light = Bright Orange**. This combination is frequently tested.

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

(D) Both A and R are true and R is the correct explanation of A.

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

Solution:

Step 1: Understanding the Question:

The question presents an Assertion and a Reason about the consumption of ATP in the glycolytic pathway. We need to evaluate the truthfulness of both statements and determine if the Reason correctly explains the Assertion.

Step 2: Detailed Explanation:

Analysis of Assertion A:

Glycolysis is the metabolic pathway that breaks down glucose. It consists of an initial energy investment phase and a subsequent energy payoff phase. In the investment phase, ATP is consumed to activate the glucose molecule. Specifically, two molecules of ATP are used for every molecule of glucose that enters the pathway. Therefore, Assertion A is **true**.

Analysis of Reason R:

Reason R specifies the two steps where ATP is consumed:

1. The first ATP is used in the first step of glycolysis, where the enzyme hexokinase phosphorylates glucose to form glucose-6-phosphate.
2. The second ATP is used in the third step of glycolysis, where the enzyme phosphofructokinase phosphorylates fructose-6-phosphate to form fructose-1,6-bisphosphate (interchangeably called fructose-1,6-diphosphate).

This statement accurately describes the two ATP-investment steps of glycolysis. Therefore, Reason R is **true**.

Relationship between A and R:

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

Step 3: Final Answer:

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

Quick Tip

To remember the energy investment in glycolysis, focus on the two kinases in the first phase: **Hexokinase** and **Phosphofructokinase**. These are the enzymes that catalyze the two steps where ATP is consumed.

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

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

Correct Answer: (A) Alfred Hershey and Martha Chase

Solution:

Step 1: Understanding the Question:

The question asks to identify the scientists who provided the definitive and conclusive ("unequivocal") proof that DNA, not protein, is the molecule of heredity.

Step 2: Detailed Explanation:

The discovery of DNA as the genetic material was a culmination of several key experiments:

1. **Frederick Griffith (1928):** His experiment on bacterial transformation in *Streptococcus pneumoniae* showed that a "transforming principle" could pass genetic information, but he did not identify it.
2. **Avery, Macleoid, and McCarthy (1944):** They conducted biochemical experiments to identify Griffith's transforming principle. By treating heat-killed bacteria with enzymes that destroy different macromolecules, they showed that only destroying DNA prevented transformation. This provided strong evidence, but some scientists were still skeptical, suggesting potential protein contamination.
3. **Alfred Hershey and Martha Chase (1952):** Their famous "blender experiment" provided the final, conclusive proof. They used bacteriophages (viruses that infect bacteria) and labeled their protein coats with radioactive sulfur (^{35}S) and their DNA with radioactive phosphorus (^{32}P). They showed that only the ^{32}P (DNA) entered the bacteria to direct the synthesis of new viruses. This was accepted by the scientific community as the unequivocal proof.
4. **Wilkins and Franklin:** Their work involved using X-ray diffraction to study the structure of the DNA molecule, which was crucial for Watson and Crick to build their double helix model.

The Hershey-Chase experiment is specifically credited with providing the unequivocal proof.

Step 3: Final Answer:

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

Quick Tip

Remember the key contributions in the search for the genetic material:

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

The keyword "unequivocal" is the signal that the question refers to the Hershey-Chase experiment.

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

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

Solution:

Step 1: Understanding the Question:

The question asks to identify the combination of correct statements from a list describing the processes of decomposition in an ecosystem.

Step 2: Detailed Explanation:

Let's evaluate each statement:

- **A. Detritivores perform fragmentation.** This is **correct**. Fragmentation is the physical breakdown of detritus into smaller particles, a process carried out by detritivores like earthworms.
- **B. The humus is further degraded by some microbes during mineralization.** This is **correct**. Humus is a dark, amorphous, and stable form of organic matter. Its slow decomposition 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.** This is **correct**. Leaching is the process where water-

soluble nutrients are washed down through the soil profile by water, and they can become unavailable to plants.

- **D. The detritus food chain begins with living organisms.** This is **incorrect**. The detritus food chain (DFC) begins with dead organic matter (detritus). It is the grazing food chain (GFC) that begins with living producers.
- **E. Earthworms break down detritus into smaller particles by a process called catabolism.** This is **incorrect**. The action of earthworms is called **fragmentation**. **Catabolism** refers to the enzymatic, chemical breakdown of detritus into simpler inorganic substances by microorganisms (bacteria and fungi).

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

Step 3: Final Answer:

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

Quick Tip

To master decomposition, clearly distinguish between the key processes:

- **Fragmentation:** Physical breakdown (e.g., by earthworms).
- **Leaching:** Washing away of soluble nutrients.
- **Catabolism:** Chemical/Enzymatic breakdown (by microbes).
- **Humification:** Formation of humus.
- **Mineralization:** Release of minerals from humus.

27. The reaction centre PS II has an absorption maxima at

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

Correct Answer: (D) 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) exhibits its peak absorption.

Step 2: Detailed Explanation:

Photosynthesis in higher plants utilizes two photosystems, PS I and PS II, which work in sequence. Each photosystem contains a reaction center, which is a special pair of chlorophyll 'a' molecules that trap light energy. These reaction centers are named after the wavelength of their maximum light absorption.

- The reaction center of **Photosystem II (PS II)** is called **P680** because it absorbs light most strongly at a wavelength of **680 nm**.
- The reaction center of **Photosystem I (PS I)** is called **P700** because it absorbs light most strongly at a wavelength of **700 nm**.

The question specifically asks about PS II.

Step 3: Final Answer:

The reaction center of Photosystem II has an absorption maximum at 680 nm. Therefore, option (D) is the correct answer.

Quick Tip

A simple mnemonic to remember the reaction centers: In the Z-scheme of electron flow, PS II comes before PS I. Similarly, the number 680 comes before 700. So, PS II corresponds to P680, and PS I corresponds to P700.

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

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

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

Solution:

Step 1: Understanding the Question:

The question asks to identify a set of structures from a fertilized angiosperm embryo sac that are listed in the specific sequence of ploidy: haploid (n), diploid (2n), and triploid (3n).

Step 2: Detailed Explanation:

After double fertilization in an angiosperm, the embryo sac contains structures with different ploidy levels. Let's determine the ploidy of the relevant structures:

- **Haploid (n):** The synergids and antipodal cells are components of the original female gametophyte. They persist for some time after fertilization before degenerating, and their ploidy is haploid (n).

- **Diploid (2n):** The **Zygote** is formed by the fusion of one haploid (n) male gamete with the haploid (n) egg cell. Thus, its ploidy is diploid (2n).
- **Triploid (3n):** The **Primary Endosperm Nucleus (PEN)** is formed by the fusion of the second haploid (n) male gamete with the diploid (n+n) central cell (formed from the fusion of two polar nuclei). Thus, its ploidy is triploid (3n).

Now we must check the options for the sequence: haploid, diploid, triploid.

- (A) Antipodals (n), synergids (n), PEN (3n). This is n, n, 3n. Incorrect.
- (B) **Synergids (n), Zygote (2n), Primary endosperm nucleus (3n).** This is n, 2n, 3n. **Correct.**
- (C) Synergids (n), antipodals (n), Polar nuclei (n each, but they fuse to form 2n central cell before fertilization). This option lists unfertilized components. Incorrect.
- (D) Synergids (n), PEN (3n), zygote (2n). This is n, 3n, 2n. Incorrect sequence.

Step 3: Final Answer:

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

Quick Tip

For questions on double fertilization, quickly write down the ploidy of the main products:

- Zygote (2n) = Egg (n) + Sperm (n)
- PEN (3n) = Central Cell (2n) + Sperm (n)
- Synergids/Antipodals (n) are remnants of the gametophyte.

Then, match the required sequence (n, 2n, 3n) to the options.

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

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

Correct Answer: (D) Manganese

Solution:

Step 1: Understanding the Question:

The question asks to identify the specific micronutrient that plays a crucial role in the photolysis, or light-dependent splitting, of water molecules during photosynthesis.

Step 2: Detailed Explanation:

The splitting of water ($2\text{H}_2\text{O} \rightarrow 4\text{H}^+ + 4\text{e}^- + \text{O}_2$) is catalyzed by the Oxygen-Evolving Complex (OEC), which is an integral part of Photosystem II (PSII). The function of the OEC is critically dependent on certain inorganic cofactors.

- **Manganese (Mn):** A cluster of four manganese ions forms the catalytic core of the OEC. These ions cycle through various oxidation states to facilitate the extraction of electrons from water.
- **Molybdenum (Mo):** This is a component of enzymes involved in nitrogen metabolism, such as nitrate reductase and nitrogenase.
- **Magnesium (Mg):** This is a macronutrient that is the central atom in the chlorophyll molecule and an activator for enzymes like RuBisCO.
- **Copper (Cu):** This is a component of plastocyanin, an electron carrier protein that shuttles electrons between the cytochrome b6f complex and Photosystem I.

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

Step 3: Final Answer:

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

Quick Tip

Create simple mnemonics to associate minerals with their key roles in photosynthesis:

- **Mg** is in the **M**iddle of chlorophyll.
- **Mn** **M**anages the splitting of water.
- **Cu** is in plastocyanin, a **c**arrier.

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

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

Correct Answer: (B) Anaphase II

Solution:

Step 1: Understanding the Question:

The question asks to identify the specific stage of meiosis where the centromere, the structure holding sister chromatids together, splits.

Step 2: Detailed Explanation:

Meiosis is a two-part cell division process.

- **Meiosis I** is the reductional division, where homologous chromosomes are separated. Throughout Prophase I, Metaphase I, and Anaphase I, the sister chromatids of each chromosome remain joined at the centromere. In **Anaphase I**, homologous chromosomes move apart, but the centromeres do **not** divide.
- **Meiosis II** is the equational division, which is mechanistically similar to mitosis. The main event is the separation of sister chromatids. In **Anaphase II**, the centromere of each chromosome finally divides, allowing the sister chromatids (now considered individual chromosomes) to be pulled towards opposite poles of the cell.

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

Step 3: Final Answer:

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

Quick Tip

Remember this key distinction:

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

The events of Anaphase II are identical to those of Anaphase in mitosis.

31. Cellulose does not form blue colour with iodine because

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

Correct Answer: (B) 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 fails to give a positive iodine test (blue-black color), which is a characteristic reaction of starch.

Step 2: Detailed Explanation:

The iodine test is specific to the three-dimensional structure of certain polysaccharides.

- **Starch (specifically amylose):** Starch is a polymer of α -glucose units linked by α -1,4 glycosidic bonds. This type of linkage causes the amylose chain to form a **helical coil**. Iodine molecules (I_3^- and I_5^-) can fit perfectly inside this helix, forming a charge-transfer complex that absorbs light and appears deep blue-black.
- **Cellulose:** Cellulose is a polymer of β -glucose units linked by β -1,4 glycosidic bonds. This linkage results in a **straight, linear chain**. These linear chains are packed tightly together, forming rigid microfibrils.

Because cellulose does not form complex helices, there is no place for the iodine molecules to be trapped. Therefore, the characteristic color complex does not form. Let's evaluate the options:

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

Step 3: Final Answer:

Cellulose does not form a blue color with iodine because its linear structure lacks the helices needed to trap iodine molecules. Option (B) provides the correct reason.

Quick Tip

Remember the link between monomer linkage, polymer shape, and the iodine test:

- **Starch (α -glucose):** → **Helical shape** → Traps iodine → **Blue color**.
- **Cellulose (β -glucose):** → **Linear shape** → Cannot trap iodine → **No color change**.

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

- (A) Over exploitation for economic gain
- (B) Alien species invasions
- (C) Co-extinctions

(D) Habitat loss and fragmentation

Correct Answer: (D) 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 drivers of biodiversity loss, collectively known as 'The Evil Quartet'.

Step 2: Detailed Explanation:

'The Evil Quartet' is a term used to describe the four main anthropogenic causes of biodiversity loss:

1. **Habitat loss and fragmentation:** This is the destruction of natural habitats (e.g., deforestation, wetland draining, urbanization) and the division of large, continuous habitats into smaller, isolated fragments.
2. **Over-exploitation:** This is the harvesting of species from the wild at rates faster than natural populations can recover (e.g., overfishing, overhunting).
3. **Alien species invasions:** The introduction of non-native species into an ecosystem, where they can outcompete, prey on, or spread diseases to native species.
4. **Co-extinctions:** The loss of one species leading to the extinction of another species that is dependent on it (e.g., a host-specific parasite).

Among these four, ecologists and conservation biologists overwhelmingly agree that **habitat loss and fragmentation is the most important and primary driver of species extinction worldwide**. The simple reason is that if a species' home is destroyed, it loses the resources it needs to survive and reproduce. The destruction of biodiversity hotspots like tropical rainforests and coral reefs exemplifies this threat.

Step 3: Final Answer:

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

Quick Tip

A common acronym for the major threats to biodiversity is HIPPO:

- **H** - Habitat Destruction
- **I** - Invasive Species
- **P** - Pollution
- **P** - Population (Human)
- **O** - Overharvesting

Habitat destruction is consistently listed as the primary threat.

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

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

Correct Answer: (A) 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 nuclear RNA polymerases in eukaryotic cells.

Step 2: Detailed Explanation:

Eukaryotic cells have a clear division of labor among their RNA polymerases for transcribing different classes of genes:

- **RNA Polymerase I:** Located in the nucleolus, it is responsible for transcribing the genes for most of the ribosomal RNAs (rRNAs), specifically the precursor for the 28S, 18S, and 5.8S rRNA molecules.
- **RNA Polymerase II:** Located in the nucleoplasm, it transcribes all protein-coding genes to synthesize precursor messenger RNA (pre-mRNA or hnRNA). It also synthesizes most small nuclear RNAs (snRNAs).
- **RNA Polymerase III:** Located in the nucleoplasm, it is responsible for transcribing the genes for a variety of small, non-coding RNAs. Its major products are **transfer RNA (tRNA)**, the **5S ribosomal RNA (5S rRNA)**, and some **small nuclear RNAs (snRNAs)** like U6 snRNA.

Let's evaluate the options based on this information:

- (A) Correctly lists the main products of RNA Polymerase III.
- (B) Describes the function of RNA Polymerase II.
- (C) Is incomplete; RNA Pol III synthesizes more than just snRNAs, and RNA Pol II makes most snRNAs.
- (D) Describes the function of RNA Polymerase I.

Step 3: Final Answer:

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

Quick Tip

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

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

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

Correct Answer: (3) Statement I is incorrect but Statement II is true

Solution:

Step 1: Understanding the Question:

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

Step 2: Detailed Explanation:

Analysis of Statement I:

The terms 'endarch' and 'exarch' refer to the arrangement of primary xylem, not secondary xylem.

Specifically, they describe the position of the protoxylem (the first formed primary xylem) in relation to the metaxylem (the later formed primary xylem).

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

- **Exarch:** Protoxylem is located towards the periphery and metaxylem is towards the center. This condition is characteristic of roots.

Since the statement mentions secondary xylem, Statement I is incorrect.

Analysis of Statement II:

The exarch condition, where the xylem develops from the outside inwards (centripetal development), is the defining feature of the vascular bundles in the root system of plants.

Therefore, Statement II is correct.

Step 3: Final Answer:

Based on the analysis, Statement I is incorrect and Statement II is true. This corresponds to option (3).

Quick Tip

To remember the difference, use this mnemonic: **Exarch** is in roots (**R** is far in the alphabet), while **Endarch** is in stems (**S** is closer). The terms describe the position of the *protoxylem* relative to the *metaxylem* in the **primary** vascular tissue.

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

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

Correct Answer: (1) Pachytene

Solution:

Step 1: Understanding the Question:

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

Step 2: Detailed Explanation:

Prophase I of meiosis is a complex phase divided into five sub-stages: Leptotene, Zygotene, Pachytene, Diplotene, and Diakinesis.

- **Leptotene:** Chromosomes condense and become visible.

- **Zygotene:** Homologous chromosomes pair up in a process called synapsis, forming bivalents.

The synaptonemal complex begins to form.

- **Pachytene:** This is the longest stage. Bivalents are clearly visible as tetrads. Crossing over, the exchange of genetic material between non-sister chromatids of homologous chromosomes, occurs at specific sites. These sites are marked by the appearance of proteinaceous structures called **recombination nodules**. These nodules contain the enzymes required for recombination, such as endonuclease and ligase.

- **Diplotene:** The synaptonemal complex dissolves, and the homologous chromosomes start to separate, except at the sites of crossing over, which are now visible as X-shaped structures called chiasmata.

- **Diakinesis:** Chiasmata terminalize (move to the ends of the chromatids), and the nuclear envelope breaks down.

Step 3: Final Answer:

The appearance of recombination nodules, which are the sites of crossing over, is a characteristic event of the **Pachytene** stage. Therefore, option (1) is the correct answer.

Quick Tip

Remember the sequence of Prophase I stages with the mnemonic "Lazy Zebra Playing Double Dutch" (Leptotene, Zygotene, Pachytene, Diplotene, Diakinesis). Associate Pachytene with "Packing" of chromosomes and "Patching" (crossing over).

Section - B

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

Correct Answer: (2) A is true but R is false

Solution:

Step 1: Understanding the Question:

This is an Assertion-Reason question. We need to evaluate the truthfulness of both Assertion (A) and Reason (R) and determine if R is the correct explanation for A.

Step 2: Detailed Explanation:**Analysis of Assertion A:**

Gymnosperms, such as conifers and cycads, predominantly rely on wind for pollination (anemophily). Their pollen grains are light, dry, and often winged (like in *Pinus*) to be easily carried by air currents from the male cones (containing microsporangia) to the female cones (containing ovules). So, Assertion A is true.

Analysis of Reason R:

The first part of the reason, "Air currents carry the pollen grains to the mouth of the archegonia," is slightly inaccurate. The air currents carry the pollen to the micropyle of the ovule. The pollen grain then germinates on the nucellus. The statement then claims "pollen tube is not formed." This is incorrect. In most gymnosperms (like *Pinus*), the pollen grain germinates to form a pollen tube. This tube grows through the nucellus and delivers the male gametes to the egg cell within the archegonium. This process is called siphonogamy. Therefore, the statement that the pollen tube is not formed is false. So, Reason R is false.

Step 3: Final Answer:

Since Assertion A is true and Reason R is false, the correct option is (2).

Quick Tip

Remember that pollination in gymnosperms is direct (pollen lands on the ovule), but fertilization is indirect (via a pollen tube). The formation of a pollen tube (siphonogamy) is a key evolutionary advancement seen in both gymnosperms and angiosperms.

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

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

Correct Answer: (1) Algal blooms caused by excess of organic matter in water improve water quality and promote fisheries

Solution:

Step 1: Understanding the Question:

The question requires us to identify the incorrect statement among the four options related to water pollution and ecosystem dynamics.

Step 2: Detailed Explanation:

Analysis of Option (1):

Algal blooms are a result of eutrophication, which is the enrichment of water bodies with nutrients (like nitrates and phosphates from organic matter, sewage, and fertilizers). This excessive growth of algae covers the water surface, blocking sunlight for submerged plants. When these algae die, their decomposition by aerobic bacteria consumes a large amount of dissolved oxygen, leading to hypoxic or anoxic conditions. This oxygen depletion causes mass death of fish and other aquatic organisms. Therefore, algal blooms severely degrade water quality and are detrimental to fisheries. This statement is incorrect.

Analysis of Option (2):

Water hyacinth (*Eichhornia crassipes*) is a notorious invasive aquatic weed that thrives in nutrient-rich (eutrophic) water bodies. Its rapid growth covers the water surface, chokes out native plants, and depletes dissolved oxygen, leading to a significant imbalance in the aquatic ecosystem. This statement is correct.

Analysis of Option (3):

This statement describes biomagnification (or bioaccumulation). Certain toxic, non-biodegradable substances (like mercury, DDT) from industrial waste accumulate in organisms. As these organisms are consumed by others higher up the food chain, the concentration of the toxin increases at each successive trophic level. This statement is correct.

Analysis of Option (4):

When sewage (rich in organic matter) is discharged into a water body, decomposer microorganisms (like bacteria) start breaking it down. This process is aerobic and consumes a significant amount of dissolved oxygen from the water. The measure of this oxygen consumption is called Biochemical Oxygen Demand (BOD). High BOD leads to a sharp drop in dissolved oxygen levels, which can be fatal for fish and other aquatic life. This statement is correct.

Step 3: Final Answer:

The statement in option (1) is factually incorrect. Algal blooms are harmful, not beneficial.

Quick Tip

When you see the term "algal bloom," immediately associate it with negative consequences: eutrophication, oxygen depletion (hypoxia), fish kills, and reduced water quality. It's a classic sign of water pollution.

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

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

Correct Answer: (4) Membrane, proton pump, proton gradient, ATP synthase

Solution:

Step 1: Understanding the Question:

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

Step 2: Detailed Explanation:

Peter Mitchell's chemiosmotic hypothesis outlines the key requirements for ATP synthesis via this process. Let's break them down:

1. **A Membrane:** An intact, impermeable membrane (like the inner mitochondrial membrane or the thylakoid membrane) is necessary to separate two aqueous compartments and maintain a proton gradient.
2. **A Proton Pump:** A mechanism is needed to pump protons (H^+ ions) across the membrane from one compartment to the other. This pumping is powered by the energy released from the electron transport chain (ETC).
3. **A Proton Gradient:** The action of the proton pump creates a difference in proton concentration and electrical charge across the membrane. This electrochemical potential difference is called the proton motive force or proton gradient. It is a form of stored energy.
4. **ATP Synthase:** This is a transmembrane enzyme complex (also called F_0 - F_1 particle) that has a channel allowing protons to flow back down their concentration gradient. This flow of protons provides the energy for the enzyme to synthesize ATP from ADP and inorganic phosphate (P_i).

Analyzing the options:

- (A) Incorrect. NADP synthase is not the correct term; it is NADP reductase, and the final product of chemiosmosis itself is ATP, made by ATP synthase.
- (B) and (C) are incomplete as they miss the essential membrane and proton gradient. They also incorrectly list an 'electron gradient' instead of a proton gradient as the direct driver.
- (D) Correctly lists all four essential components: the membrane to hold the gradient, the pump to create it, the gradient itself, and the ATP synthase to utilize the gradient's energy.

Step 3: Final Answer:

The correct combination of components required for chemiosmosis is a membrane, a proton pump, a proton gradient, and ATP synthase. This matches option (4).

Quick Tip

Visualize chemiosmosis as a hydroelectric dam. The **membrane** is the dam wall. The **proton pump** is the machinery that pumps water up to create a reservoir (**proton gradient**). The **ATP synthase** is the turbine through which the water flows back down, generating electricity (ATP).

39. Match List I with List II:

List I

- A. M Phase
- B. G₂ Phase
- C. Quiescent stage
- D. G₁ Phase

List II

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

Choose the correct answer from the options given below:

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

Correct Answer: (2) A-IV, B-I, C-II, D-III

Solution:

Step 1: Understanding the Question:

The question requires matching the phases of the cell cycle (List I) with their corresponding events or descriptions (List II).

Step 2: Detailed Explanation:

Let's analyze each phase in List I and match it with the correct description from List II.

- **A. M Phase:** This is the mitotic phase, where the cell divides. Mitosis is known as **equational division** because the number of chromosomes in the daughter cells is equal to that in the parent cell. So, **A matches with IV**.
- **B. G₂ Phase:** This is the second gap or growth phase, occurring after DNA synthesis (S phase) and before mitosis (M phase). During this phase, the cell continues to grow and synthesizes proteins (like tubulin for spindle fibers) and RNA in preparation for division. So, **B matches with I**.
- **C. Quiescent stage (G₀):** This is a non-dividing stage where cells exit the cell cycle. While metabolically active, they do not proliferate. It can be considered an **inactive phase** with respect to the cell division cycle. So, **C matches with II**.
- **D. G₁ Phase:** This is the first gap phase, which is the **interval between the completion of mitosis and the initiation of DNA replication** (S phase). The cell is metabolically active and grows during this phase. So, **D matches with III**.

Step 3: Final Answer:

The correct matching is: $A \rightarrow IV$, $B \rightarrow I$, $C \rightarrow II$, $D \rightarrow III$. This combination corresponds to option (2).

Quick Tip

Draw the cell cycle diagram (a circle with $G_1 \rightarrow S \rightarrow G_2 \rightarrow M$, and G_0 as an exit from G_1). Label the main event for each phase: G_1 (growth), S (synthesis/replication), G_2 (prepare for division), M (division). This visual aid makes solving matching questions much faster.

40. Match List I with List II:

List I (Interaction)

- A. Mutualism
- B. Commensalism
- C. Amensalism
- D. Parasitism

List II (Species A and B)

- I. $+(A)$, $O(B)$
- II. $-(A)$, $O(B)$
- III. $+(A)$, $-(B)$
- IV. $+(A)$, $+(B)$

Choose the correct answer from the options given below:

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

Correct Answer: (1) A-IV, B-I, C-II, D-III

Solution:

Step 1: Understanding the Question:

The question asks to match different types of population interactions with their symbolic representation, where '+' indicates a benefit, '-' indicates harm, and '0' indicates no effect.

Step 2: Detailed Explanation:

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

- **A. Mutualism:** An interaction where both species benefit. For example, lichens (algae and fungi). The representation is $(+, +)$. So, **A matches with IV**.

- **B. Commensalism:** An interaction where one species benefits, and the other is neither harmed nor benefited (unaffected). For example, an orchid growing on a mango tree. The representation is $(+, 0)$. So, **B matches with I**.

- **C. Amensalism:** An interaction where one species is harmed, and the other is unaffected. For example, Penicillium secreting penicillin which inhibits bacterial growth. The representation is $(-, 0)$. So, **C matches with II**.

- **D. Parasitism:** An interaction where one species (the parasite) benefits at the expense of

the other species (the host), which is harmed. For example, tapeworms in humans. The representation is (+, -). So, **D matches with III.**

Step 3: Final Answer:

The correct set of matches is A-IV, B-I, C-II, D-III. This corresponds to option (1).

Quick Tip

Create a simple table for all six major population interactions (Mutualism, Competition, Predation, Parasitism, Commensalism, Amensalism) and their corresponding signs (+/+, -/-, +/-, +/0, -/0). This is a high-yield topic for matching questions.

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

Correct Answer: (2) Statement I is correct Statement II is false.

Solution:

Step 1: Understanding the Question:

We need to evaluate two statements related to ecological competition and determine if they are correct.

Step 2: Detailed Explanation:

Analysis of Statement I:

This statement provides the definition of Gause's 'Competitive Exclusion Principle'. The principle indeed states that when two species compete for the exact same limited resources in a stable environment, they cannot coexist. The species with even a slight advantage will eventually outcompete and eliminate the other. This is a fundamental concept in ecology. Thus, Statement I is correct.

Analysis of Statement II:

This statement makes a broad generalization that carnivores are more adversely affected by

competition than herbivores. Competition can be intense at any trophic level. While carnivores compete for prey, which can be mobile and scarce, herbivores can also face intense competition for specific host plants, grazing areas, or nutrients. For example, multiple insect species may compete fiercely on a single plant, or different ungulates may compete for the same patch of grass. There is no universal rule that competition is always more severe for carnivores. Therefore, this generalization is considered ecologically inaccurate or at least not universally true, making Statement II false.

Step 3: Final Answer:

Statement I is a correct definition, while Statement II is an unsupported generalization. Therefore, Statement I is correct and Statement II is false. This corresponds to option (2).

Quick Tip

Remember that Gause's Principle has important caveats: it applies when resources are limited and the environment is stable. In nature, species often avoid exclusion through mechanisms like 'resource partitioning' (using the same resource in different ways, places, or times) and 'niche differentiation'.

42. Match List I with List II:

List I

List II

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

Choose the correct answer from the options given below:

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

Correct Answer: (2) A-III, B-I, C-IV, D-II

Solution:

Step 1: Understanding the Question:

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

Step 2: Detailed Explanation:

Let's analyze the function of each micronutrient in List I.

- **A. Iron (Fe):** Iron is a crucial component of proteins involved in electron transport, such as cytochromes. It is also essential for chlorophyll synthesis and is a key activator for the enzyme

catalase. So, **A matches with III.**

- **B. Zinc (Zn):** Zinc is required for the activity of various enzymes, most notably carboxylases. It is also essential for the **synthesis of auxin** (indole-3-acetic acid), a major plant growth hormone. So, **B matches with I.**

- **C. Boron (B):** Boron is required for the uptake and utilization of Ca^{2+} , membrane functioning, pollen germination, **cell elongation, and cell differentiation.** So, **C matches with IV.**

- **D. Molybdenum (Mo):** Molybdenum is a **component of several enzymes**, including nitrogenase and **nitrate reductase**, both of which are critical for nitrogen metabolism in plants. So, **D matches with II.**

Step 3: Final Answer:

The correct matching is: $A \rightarrow \text{III}$, $B \rightarrow \text{I}$, $C \rightarrow \text{IV}$, $D \rightarrow \text{II}$. This combination is given in option (2).

Quick Tip

The functions of micronutrients, especially their roles as enzyme activators or components, are frequently asked. Create flashcards to memorize key pairings: $\text{Zn} \rightarrow \text{Auxin synthesis}$, $\text{Mo} \rightarrow \text{Nitrate reductase}$, $\text{Fe} \rightarrow \text{Catalase/Chlorophyll synthesis}$, $\text{Mn} \rightarrow \text{Photolysis of water}$.

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

Correct Answer: (2) B and E only

Solution:

Step 1: Understanding the Question:

The question asks us to identify the correct statements describing Klinefelter's Syndrome from a given list of five statements. Klinefelter's Syndrome is a chromosomal disorder caused by the

presence of an extra X chromosome in males (XXY).

Step 2: Detailed Explanation:

Let's evaluate each statement:

- **A. This disorder was first described by Langdon Down (1866).** This is **false**. John Langdon Down described Down's Syndrome (Trisomy 21). Klinefelter's Syndrome was first described by Dr. Harry Klinefelter in 1942.
- **B. Such an individual has overall masculine development. However, the feminine development is also expressed.** This is **true**. Individuals are phenotypically male but have some female characteristics due to the extra X chromosome. A common symptom is gynaecomastia (development of breasts).
- **C. The affected individual is short statured.** This is **false**. Individuals with Klinefelter's Syndrome are often taller than average, with disproportionately long legs and arms. Short stature is characteristic of Turner's Syndrome.
- **D. Physical, psychomotor and mental development is retarded.** This is **false**. This description is more characteristic of Down's Syndrome. While individuals with Klinefelter's may have learning disabilities or delayed speech and language development, severe mental retardation is not a typical feature.
- **E. Such individuals are sterile.** This is **true**. The presence of an extra X chromosome leads to abnormal testicular development (small testes) and failure to produce sperm (azoospermia), resulting in sterility.

Step 3: Final Answer:

From the analysis, only statements B and E are correct. Therefore, the correct option is (2).

Quick Tip

Create a comparison table for the three most common chromosomal disorders: Down's Syndrome (Trisomy 21), Turner's Syndrome (XO), and Klinefelter's Syndrome (XXY). Include columns for Karyotype, Sex, Key Physical Features, and Fertility. This will help you quickly differentiate them in exams.

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

Correct Answer: (1) A and D only

Solution:

Step 1: Understanding the Question:

The question asks us to identify the correct statements from a list concerning anatomical structures in plants, particularly related to secondary growth and bark formation.

Step 2: Detailed Explanation:

Let's evaluate each statement:

A. Lenticels are the lens-shaped openings permitting the exchange of gases.

This statement is **correct**. During secondary growth, the epidermis is replaced by the periderm, which is impermeable to water and gases. Lenticels are porous tissues with loosely arranged complementary cells that allow for gaseous exchange between the internal living cells and the outside atmosphere.

B. Bark formed early in the season is called hard bark.

This statement is **incorrect**. Bark formed early in the season (spring) is called 'early' or 'soft bark'. Bark formed towards the end of the season (autumn) is called 'late' or 'hard bark'.

C. Bark is a technical term that refers to all tissues exterior to vascular cambium.

This statement is **incorrect**. Bark is a *non-technical* term. The phrase "all tissues exterior to vascular cambium" is a correct description of what bark includes, but calling it a "technical term" makes the statement false.

D. Bark refers to periderm and secondary phloem.

This statement is **correct**. Anatomically, bark is composed of two main regions: the outer bark, which is the periderm, and the inner bark, which is the secondary phloem.

E. Phellogen is single-layered in thickness.

This statement is **incorrect**. Phellogen, or cork cambium, is a meristematic tissue. It is typically a couple of layers thick, not strictly single-layered.

Step 3: Final Answer:

Based on the analysis, only statements A and D are correct. Therefore, option (1) is the correct choice.

Quick Tip

Remember the distinction between the technical and non-technical use of the term "bark". While it generally means "everything outside the vascular cambium", its incorrect classification as a "technical term" can be a trick in questions. Also, remember the components: Bark = Inner Bark (Secondary Phloem) + Outer Bark (Periderm).

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

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

Correct Answer: (4) 80

Solution:

Step 1: Understanding the Question:

The question asks for the approximate number of different proteins that make up a ribosome. The question is general, but the options point towards a specific type of ribosome.

Step 2: Detailed Explanation:

Ribosomes are complex cellular machinery made of ribosomal RNA (rRNA) and proteins. There are two main types:

- **Prokaryotic ribosomes (70S):** These are composed of a 50S and a 30S subunit and contain about 50-55 different proteins in total.
- **Eukaryotic ribosomes (80S):** These are composed of a 60S and a 40S subunit. The 60S subunit contains about 49 proteins, and the 40S subunit contains about 33 proteins. The total number of different proteins is approximately $33 + 49 = 82$, which is commonly rounded to **80**.

Given the options (20, 40, 60, 80), the number 80 is the correct approximation for the number of proteins in a eukaryotic ribosome. It is the most fitting answer.

Step 3: Final Answer:

A eukaryotic ribosome consists of approximately 80 different types of proteins along with rRNA. Therefore, option (4) is the correct answer.

Quick Tip

Remember the Svedberg units for ribosomes: Prokaryotes have 70S (50S + 30S) ribosomes, while Eukaryotes have 80S (60S + 40S) ribosomes. The number of proteins is higher in eukaryotic ribosomes, around 80.

46. Malonate inhibits the growth of pathogenic bacteria by inhibiting the activity of

- (A) Amylase
- (B) Lipase

- (C) Dinitrogenase
(D) Succinic dehydrogenase

Correct Answer: (4) Succinic dehydrogenase

Solution:

Step 1: Understanding the Question:

The question asks to identify the enzyme whose activity is inhibited by malonate, thereby affecting the growth of pathogenic bacteria. This question is about enzyme inhibition.

Step 2: Detailed Explanation:

The inhibition described is a classic example of **competitive inhibition**. In this type of inhibition, the inhibitor molecule closely resembles the structure of the enzyme's natural substrate.

- The enzyme in question is **succinic dehydrogenase**.
- Its natural substrate is **succinate**.
- The inhibitor is **malonate**.

Malonate is a structural analogue of succinate. Because of this similarity, malonate can bind to the active site of the succinic dehydrogenase enzyme. When malonate occupies the active site, it prevents the actual substrate, succinate, from binding. This blocks the enzyme's function.

Succinic dehydrogenase is a key enzyme in the Krebs cycle (citric acid cycle), which is a central pathway for energy production in aerobic organisms, including many pathogenic bacteria. By inhibiting this enzyme, malonate disrupts the Krebs cycle, severely reducing the bacteria's ability to produce ATP, which in turn inhibits their growth and proliferation.

Step 3: Final Answer:

Malonate is a competitive inhibitor of the enzyme succinic dehydrogenase. Therefore, option (4) is the correct answer.

Quick Tip

Remember the classic example of competitive inhibition: **Malonate** inhibits **Succinic Dehydrogenase** because it mimics the substrate **Succinate**. This is a frequently tested concept in bioenergetics and enzymology.

47. Match List I with List II:

List I

List II

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

Choose the correct answer from the options given below:

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

Correct Answer: (4) A-II, B-IV, C-I, D-III

Solution:

Step 1: Understanding the Question:

This is a matching question where we need to pair the terms related to properties of water and plant transport (List I) with their correct descriptions (List II).

Step 2: Detailed Explanation:

- **A. Cohesion:** This is the property of water molecules being attracted to each other due to hydrogen bonds. This corresponds to **II. Mutual attraction among water molecules.**
- **B. Adhesion:** This is the attraction of water molecules to a different substance, specifically to polar surfaces like the lignocellulosic walls of xylem vessels. This corresponds to **IV. Attraction towards polar surfaces.**
- **C. Surface tension:** This property is a direct result of cohesion. Water molecules at the surface are more strongly attracted to each other (in the liquid phase) than to the molecules in the air (gas phase). This creates a tension on the surface. This corresponds to **I. More attraction in liquid phase.**
- **D. Guttation:** This is the process of exudation of water in the form of liquid droplets from the tips of leaves (through hydathodes), typically occurring when transpiration is low and root pressure is high. This corresponds to **III. Water loss in liquid phase.**

Step 3: Final Answer:

The correct matching is: A → II, B → IV, C → I, and D → III. This sequence matches option (4).

Quick Tip

Remember the 'co-' in cohesion means 'together' (water with water), and 'ad-' in adhesion means 'to' (water to something else, like xylem walls). Guttation is 'water getting out' as a liquid, unlike transpiration which is water vapor.

48. Match List I with List II:

List I

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

List II

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

Choose the correct answer from the options given below:

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

Correct Answer: (3) A-II, B-IV, C-III, D-I

Solution:

Step 1: Understanding the Question:

The question requires us to match key processes in cellular respiration (List I) with their associated enzymes, pathways, or systems (List II).

Step 2: Detailed Explanation:

- **A. Oxidative decarboxylation:** This refers to the link reaction where pyruvate is converted to acetyl-CoA. This reaction is catalyzed by the **Pyruvate dehydrogenase** complex. Thus, **A matches with II**.
- **B. Glycolysis:** This is the initial pathway for glucose breakdown. It is also known as the Embden-Meyerhof-Parnas pathway, or **EMP pathway**. Thus, **B matches with IV**.
- **C. Oxidative phosphorylation:** This is the final stage of aerobic respiration where the majority of ATP is synthesized. It involves the transfer of electrons through a series of carriers, known as the **Electron transport system (ETS)**. Thus, **C matches with III**.
- **D. Tricarboxylic acid cycle (TCA cycle):** Also known as the Krebs cycle. The first step of this cycle involves the condensation of acetyl-CoA with oxaloacetate to form citrate. This reaction is catalyzed by the enzyme **Citrate synthase**. Thus, **D matches with I**.

Step 3: Final Answer:

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

Quick Tip

Create a flowchart of cellular respiration: Glycolysis (EMP pathway) → Link Reaction (Pyruvate Dehydrogenase) → Krebs Cycle (starts with Citrate Synthase) → ETS (Oxidative Phosphorylation). This visual map helps connect the processes and key players.

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

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

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

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

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

Correct Answer: (4) Both A and R are true and R is the correct explanation of A

Solution:

Step 1: Understanding the Question:

We must evaluate an Assertion and a Reason about the morphological nature of a flower and determine their truthfulness and the relationship between them.

Step 2: Detailed Explanation:

Analysis of Assertion (A):

The assertion states that a flower is a modified shoot, where the shoot apical meristem transitions into a floral meristem. This is the accepted botanical definition of a flower. The meristem's activity changes from producing vegetative parts (leaves, stems) to producing reproductive parts (floral whorls). So, Assertion A is **true**.

Analysis of Reason (R):

The reason explains the modification process: the internodes of the shoot do not elongate and become condensed. This brings the nodes very close together. From these condensed nodes, the floral appendages (sepals, petals, stamens, carpels) arise in whorls instead of leaves. This accurately describes the morphological changes that occur when a shoot becomes a flower. So, Reason R is also **true**.

Relationship between A and R:

Reason R provides the specific details of *how* a shoot is modified to become a flower. It explains the condensation of internodes and the development of floral appendages at nodes. This directly explains the statement made in Assertion A. Therefore, 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. This corresponds to option (4).

Quick Tip

For Assertion-Reason questions, follow a two-step process. First, check if A and R are individually true or false. Second, if both are true, ask "Why is A true?" and see if R answers that question. Here, "Why is a flower a modified shoot?" is answered by "Because its internodes condense and nodes produce floral parts instead of leaves."

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

Correct Answer: (2) C, B, D, A

Correct Answer: (4) B, C, D, A

Solution:

Step 1: Understanding the Question:

The question asks to arrange the key steps involved in creating a recombinant organism in the correct chronological order.

Step 2: Detailed Explanation:

Let's analyze the logical flow of creating recombinant DNA and introducing it into a host.

Step 1: Get the source DNA and cut it. To get a specific gene, one must first start with the source DNA (e.g., a whole genome) and cut it into manageable fragments. This is done using restriction enzymes. So, the first logical step is **B. Cutting of DNA at specific location by restriction enzyme.**

Step 2: Isolate the gene of interest. After cutting the source DNA, it results in a mixture of many different DNA fragments. The specific fragment containing the gene of interest must be separated and identified, usually through techniques like gel electrophoresis. Thus, the next step is **C. Isolation of desired DNA fragment.**

Step 3: Make copies of the gene. Once the desired DNA fragment is isolated, it's often necessary to create many copies of it to ensure a sufficient quantity for the next steps. This is achieved through the Polymerase Chain Reaction (PCR). So, the next step is **D. Amplification of gene of interest using PCR.**

Step 4: Insert the gene into a host. After amplification, the gene copies are ligated into a suitable vector (like a plasmid) to create recombinant DNA molecules. These recombinant molecules are then introduced into a host cell (like a bacterium) in a process called transformation. Thus, the final step in this sequence is **A. Insertion of recombinant DNA into the host cell.**

Step 3: Final Answer:

The correct logical sequence of the given steps is $B \rightarrow C \rightarrow D \rightarrow A$. This corresponds to option (4).

Quick Tip

Remember the general workflow for genetic engineering: **Cut** (with restriction enzymes), **Copy** (amplify with PCR), and **Paste** (ligate into a vector and insert into a host). The isolation step logically falls after cutting and before amplification.