NEET UG 2023 F2 Botany Question Paper with Solutions

Time Allowed :3 Hours	**Maximum Marks :**720	**Total Questions :**200

General Instructions

Read the following instructions very carefully and strictly follow them:

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

Section - A

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

Step 2: Detailed Explanation:
The splitting of water molecules (H_2O) into hydrogen ions (H^+), electrons (e^-), and oxygen (O_2) is a crucial step in photosynthesis. This process occurs in Photosystem II (PS II) and is catalyzed by the Oxygen Evolving Complex (OEC).
The OEC is a metalloenzyme complex that contains a cluster of four manganese ions (Mn) and one calcium ion (Ca^{2+}).
Manganese plays a direct catalytic role in the water-splitting reaction by undergoing changes in its oxidation state.
Therefore, manganese is the essential micronutrient for this process.
- **Molybdenum** is a component of enzymes like nitrate reductase and nitrogenase.
- **Magnesium** is a central component of the chlorophyll molecule and is also an activator for many enzymes, but not directly for water splitting.
- **Copper** is involved in redox reactions and is a component of plastocyanin, an electron carrier in photosynthesis.

Step 3: Final Answer:
The correct micronutrient required for the splitting of water is Manganese.

Quick Tip

Remember the key roles of micronutrients in photosynthesis. A simple mnemonic for water splitting is "Mn splits water". For chlorophyll, remember "Mg is in the middle". This helps distinguish their primary functions quickly.

---

2. 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: (C) Statement I is incorrect but Statement II is true

Solution:

Step 1: Understanding the Statements:
The question evaluates two statements related to the arrangement of vascular tissues (xylem) in plants.
- **Statement I** deals with the terms 'endarch' and 'exarch' and their application to secondary xylem.
- **Statement II** deals with the 'exarch' condition in the root system.

Step 2: Detailed Explanation:
Analysis of Statement I:
The terms 'endarch' and 'exarch' describe the pattern of development of **primary xylem**, not secondary xylem.
- **Endarch:** Protoxylem (the first formed xylem) is located towards the center (pith), and metaxylem (later formed xylem) is towards the periphery. This is characteristic of stems.
- **Exarch:** Protoxylem is located towards the periphery, and metaxylem is towards the center. This is characteristic of roots.
Since these terms apply to primary xylem, Statement I, which links them to secondary xylem, is incorrect.

Analysis of Statement II:
The exarch condition, where xylem development proceeds from the outside inwards (centripetal), is the defining characteristic of the vascular arrangement in the roots of vascular plants. Therefore, Statement II is correct.

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

Quick Tip

Remember: **Ex**arch is for roots (**Ex**ternal protoxylem), and **En**darch is for stems (**En**d internal protoxylem). These terms are only for primary tissues, as secondary growth occurs differently via the vascular cambium.

---

3. 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 scientist(s) who provided the definitive, or "unequivocal," proof that DNA is the molecule of heredity.

Step 2: Detailed Explanation:
While earlier experiments suggested DNA's role, the Hershey-Chase experiment is considered the conclusive proof.
- **Frederick Griffith (1928):** His experiment on bacterial transformation in *Streptococcus pneumoniae* showed a "transforming principle" could change non-virulent bacteria into virulent ones, but didn't identify it as DNA.
- **Avery, Macleod, and McCarty (1944):** They furthered Griffith's work and demonstrated that DNA was the transforming principle. However, their findings were not universally accepted by the scientific community at the time.
- **Alfred Hershey and Martha Chase (1952):** They conducted experiments using bacteriophages (viruses that infect bacteria). They labeled the phage's DNA with radioactive phosphorus-32 (^{32}P) and its protein coat with radioactive sulfur-35 (^{35}S). They found that only the radioactive DNA entered the bacterial cells to direct the synthesis of new viruses. This provided clear, unequivocal evidence that DNA, not protein, is the genetic material.
- **Wilkins and Franklin:** Their work involved X-ray diffraction of DNA, which was crucial for Watson and Crick to determine the double helix structure of DNA, but it did not prove DNA was the genetic material.

Step 3: Final Answer:
The Hershey-Chase experiment provided the unequivocal proof, so Alfred Hershey and Martha Chase are the correct answer.

Quick Tip

Associate the experiments with their conclusions: - Griffith -> Transformation principle exists. - Avery, Macleod, McCarty -> Transformation principle is DNA. - Hershey & Chase -> Unequivocal proof: DNA is the genetic material (using phages).

---

4. 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 definition of pleiotropism.

Step 2: Detailed Explanation:
Pleiotropy is a genetic phenomenon where a single gene influences two or more seemingly unrelated phenotypic traits. The gene product (a protein or RNA) participates in multiple metabolic pathways or has effects in different cell types or tissues.
A classic example is phenylketonuria (PKU), an inherited disorder in humans. A defect in a single gene that codes for the enzyme phenylalanine hydroxylase results in multiple phenotypes, including mental retardation, reduced hair and skin pigmentation.
Let's analyze the other options:
- (A) This is an incorrect description of gene interaction.
- (C) This describes **polygenic inheritance**, where a single trait (like height or skin color) is controlled by multiple genes. It is the opposite of pleiotropy.
- (D) This is an incorrect and confusing statement. The presence of several alleles of a single gene is called **multiple allelism**.

Step 3: Final Answer:
The correct definition of pleiotropism is a single gene affecting multiple phenotypic expressions.

Quick Tip

To remember the difference:
- **Pleio**tropy: One gene -> **Plu**ral effects.
- **Poly**genic: **Poly** (many) genes -> One trait.

---

5. 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 color observed when DNA stained with ethidium bromide (EtBr) is exposed to ultraviolet (UV) radiation. This is a standard technique in molecular biology.

Step 2: Detailed Explanation:
Ethidium bromide is a fluorescent intercalating agent commonly used in gel electrophoresis to visualize nucleic acids (DNA or RNA).
The process is as follows:
1. DNA is separated by size on an agarose gel.
2. The gel is soaked in a solution containing ethidium bromide.
3. EtBr molecules insert themselves (intercalate) between the stacked base pairs of the DNA double helix.
4. When the gel is placed under a UV transilluminator, the EtBr molecules that are bound to the DNA absorb the UV light (at around 300-360 nm) and re-emit it as visible light.
5. This emitted light is in the orange-to-red part of the spectrum, appearing as a bright orange color.
Therefore, the DNA bands on the gel become visible as bright orange bands under UV light.

Step 3: Final Answer:
DNA stained with ethidium bromide fluoresces bright orange when exposed to UV radiation.

Quick Tip

Associate **Ethidium Bromide + DNA + UV light** with **Bright Orange**. This is a fundamental visualization technique in molecular biology labs, and the color is very specific.

---

6. 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 set of floral characteristics (large, colourful, fragrant, with nectar) and asks to identify the corresponding mode of pollination.

Step 2: Detailed Explanation:
These characteristics are adaptations to attract specific pollinators. Let's analyze them in the

context of different pollination agents (a biotic pollination syndrome):
- **Large and Colourful petals:** These act as visual cues to attract pollinators from a distance. Insects, especially bees, are attracted to bright colors (like blue, yellow).
- **Fragrance:** Scent is a chemical attractant, especially for nocturnal insects like moths, and also for bees and flies.
- **Nectar:** This is a sugary fluid that serves as a food reward for the pollinator.
These features—visual signals, scent, and a food reward—are classic adaptations for **entomophily**, or insect pollination.

Let's look at the other options:
- **Bird pollinated plants (Ornithophily):** Flowers are often large, brightly colored (especially red or orange), but typically lack a strong fragrance, as birds have a poor sense of smell. They produce copious amounts of nectar.
- **Bat pollinated plants (Chiropterophily):** Flowers are typically large, pale or white, open at night, and have a strong, musty, or fruity odor. They also produce a large amount of nectar.
- **Wind pollinated plants (Anemophily):** Flowers are usually small, inconspicuous, not colorful, lack nectar and fragrance. They produce large quantities of light, dry pollen.

Step 3: Final Answer:
The combination of large, colorful, fragrant flowers with nectar is characteristic of insect-pollinated plants.

Quick Tip

Create a table to remember pollination syndromes. Columns: Pollinator (Wind, Water, Insect, Bird, Bat). Rows: Flower Size, Color, Scent, Nectar, Pollen type. This organizes the information for easy comparison.

---

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

(A) S phase
(B) G_1 phase
(C) G_2 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 replication occurs.

Step 2: Detailed Explanation:
The eukaryotic cell cycle is divided into two main stages: Interphase and M phase (Mitotic phase).
Interphase is the period of growth and preparation for cell division and is further subdivided into three phases:
- **G_1 phase (Gap 1):** The cell grows in size and synthesizes proteins and mRNA. It is a period of metabolic activity. No DNA replication occurs.
- **S phase (Synthesis):** This is the phase where DNA replication occurs. The cell synthesizes a complete copy of the DNA in its nucleus. The amount of DNA per cell doubles (from 2C to 4C), but the chromosome number remains the same (e.g., 2n).
- **G_2 phase (Gap 2):** The cell continues to grow and produces proteins and organelles needed for mitosis. It checks the duplicated chromosomes for errors before proceeding to mitosis.
M phase (Mitosis): This is the phase of actual cell division, including nuclear division (mitosis) and cytoplasmic division (cytokinesis).

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

Quick Tip

Remember the cell cycle phases with the mnemonic **Go Sally Go, Make Children!** for **G_1**, **S** (Synthesis of DNA), **G_2**, **M** (Mitosis), **C** (Cytokinesis). The S phase is key for DNA duplication.

---

8. 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).

Step 2: Detailed Explanation:
ESTs are a tool used in genomics to identify gene transcripts. The process involves:
1. Isolating messenger RNA (mRNA) from a cell. mRNA represents the genes that are actively being transcribed (expressed).
2. Using the enzyme reverse transcriptase to create a complementary DNA (cDNA) copy of the mRNA.

3. Sequencing short fragments (tags) from either the 5' or 3' end of these cDNAs. These short sequenced fragments are the Expressed Sequence Tags (ESTs).
Since ESTs are derived from mRNA, they represent portions of genes that are transcribed into RNA. This includes genes that code for proteins as well as genes that code for non-coding RNAs (like rRNA, tRNA). Therefore, the most accurate description is that they represent all genes expressed as RNA.
- (A) is incorrect because not all transcribed genes are translated into proteins (e.g., non-coding RNAs).
- (B) is incorrect because ESTs only represent expressed genes, not unexpressed ones (like those in heterochromatin or not active in that specific cell type).
- (C) is too vague; EST projects aim to be comprehensive for a given tissue, not just "certain important" genes.

Step 3: Final Answer:
ESTs represent all genes that are expressed as RNA in a given cell or tissue at a particular time.

Quick Tip

Break down the term: **Expressed** means it comes from mRNA (an expressed gene). **Sequence Tag** means it's a short piece of sequence that "tags" or identifies that gene. This directly leads to the concept of identifying genes that are expressed as RNA.

---

9. 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 primary driver of species extinction from the four major causes known as 'The Evil Quartet'.

Step 2: Detailed Explanation:
'The Evil Quartet' is a term used to describe the four main causes of biodiversity loss:
1. **Habitat loss and fragmentation:** This involves the destruction of natural habitats (e.g., deforestation, urbanization, pollution) and the breaking up of large habitats into smaller, isolated patches. This directly reduces the area available for species to live, find food, and reproduce. It is universally recognized by conservation biologists as the single greatest threat

to biodiversity and the leading cause of species extinction. For example, the destruction of tropical rainforests affects millions of species.
2. **Overexploitation:** This refers to harvesting species from the wild at rates faster than natural populations can recover (e.g., overfishing, overhunting). It has been a significant cause of extinction for many large animals (e.g., Steller's sea cow, passenger pigeon).
3. **Alien species invasions:** When non-native species are introduced into an ecosystem, they can outcompete native species for resources, introduce diseases, or alter the habitat, leading to the decline and extinction of native species (e.g., Nile perch in Lake Victoria).
4. **Co-extinctions:** This occurs when the extinction of one species leads to the extinction of another species that depends on it, such as a host-specific parasite or a plant and its obligate pollinator.

While all four are significant threats, habitat loss and fragmentation affects the largest number of species across the globe.

Step 3: Final Answer:
Habitat loss and fragmentation is considered the most important cause driving the extinction of species.

Quick Tip

Remember the acronym **HIPPO** for threats to biodiversity: **H**abitat Destruction, **I**nvasive Species, **P**ollution, **P**opulation (human), and **O**verharvesting. Habitat destruction is always at the top of the list in terms of impact.

---

10. 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: Analyzing the Assertion (A):
Assertion A states that ATP is used at two steps in glycolysis. Glycolysis is the metabolic

pathway that converts glucose into pyruvate. The initial part of this pathway is the "preparatory" or "investment" phase, where the cell invests energy in the form of ATP. Indeed, two molecules of ATP are consumed in this phase. Therefore, Assertion A is true.

Step 2: Analyzing the Reason (R):
Reason R describes the specific steps where ATP is used.
- **Step 1 of Glycolysis:** Glucose is phosphorylated to glucose-6-phosphate by the enzyme hexokinase. This reaction consumes one molecule of ATP. Glucose+ATP $\rightarrow$ Glucose-6-phosphate+ ADP
- **Step 3 of Glycolysis:** Fructose-6-phosphate is phosphorylated to fructose-1,6-bisphosphate by the enzyme phosphofructokinase-1. This reaction consumes a second molecule of ATP. Fructose-6-phosphate + ATP $\rightarrow$ Fructose-1,6-bisphosphate + ADP
The Reason R accurately describes these two ATP-consuming steps. Therefore, Reason R is also true.

Step 3: Evaluating the Relationship between A and R:
Reason R correctly identifies the two specific enzymatic steps where ATP is consumed in glycolysis. This provides a direct and accurate explanation for why Assertion A (that ATP is used in two steps) is true.

Step 4: Final Answer:
Both Assertion A and Reason R are true, and R is the correct explanation of A.

Quick Tip

For glycolysis, remember the "investment phase" (first half) and the "payoff phase" (second half). The investment is **2 ATP**, used at steps 1 and 3. The payoff is **4 ATP** and **2 NADH**. The net gain is 2 ATP and 2 NADH. Knowing the specific steps where energy is used and produced is key.

---

11. 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 and Terminology:
The question asks for the function of "tassels in the corn cob". This phrasing can be confusing. In a corn plant (maize), the plant is monoecious (having separate male and female flowers on

the same plant).
- The **tassel** is the male inflorescence located at the top of the plant. Its function is to produce and **disperse** pollen.
- The **ear** or **cob** is the female inflorescence, located at a leaf axil. The long, silky threads emerging from the top of the cob are called **silks**. Each silk is a style and stigma.
The question seems to mistakenly refer to the silks as "tassels in the corn cob". Given the options, the question is clearly asking about the function of the **silks** of the cob.

Step 2: Detailed Explanation:
- The function of the male tassel is to disperse pollen grains into the wind (anemophily). So, option (B) describes the function of the actual tassel, but not the structure "in the corn cob".
- The function of the silks (styles and stigmas) on the cob is to provide a large surface area to **trap** the wind-borne pollen grains. Each silk is connected to a potential kernel (ovule). Successful pollination occurs when a pollen grain lands on a silk and grows a pollen tube down to the ovule.
Therefore, the function of the structures on the cob designed for pollination is to trap pollen grains.
- (C) Protecting seeds (kernels) is the function of the husk that encloses the cob.
- (D) Corn is wind-pollinated, not insect-pollinated, so attracting insects is not a primary function.

Step 3: Final Answer:
Based on interpreting the question's intent to be about the silks of the cob, their function is to trap pollen grains.

Quick Tip

Be careful with common names in biology. In corn, **Tassel (top)** = Male flower, releases pollen. **Silk (on cob)** = Female style/stigma, traps pollen. The question is poorly phrased, but a process of elimination based on the location ("in the corn cob") leads to the function of the silk.

---

12. 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:
The question asks for the year of the Earth Summit held in Rio de Janeiro, where the Convention on Biological Diversity (CBD) was established.

Step 2: Detailed Explanation:
The United Nations Conference on Environment and Development (UNCED), popularly known as the **Earth Summit**, was a major international conference held in Rio de Janeiro, Brazil, from June 3 to June 14, **1992**.
This summit was a landmark event for global environmental policy. One of its key outcomes was the opening for signature of the Convention on Biological Diversity (CBD), a multilateral treaty with three main goals:
1. The conservation of biological diversity.
2. The sustainable use of its components.
3. The fair and equitable sharing of benefits arising from genetic resources.
Other major outcomes of the 1992 Earth Summit include the Rio Declaration on Environment and Development, Agenda 21, and the Framework Convention on Climate Change (UNFCCC).
- The World Summit on Sustainable Development was held in Johannesburg in 2002.

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

Quick Tip

Associate key environmental summits with their year and location: - **1992 Rio Earth Summit**: CBD, UNFCCC. - **1997 Kyoto Protocol**: Greenhouse gas emission targets (linked to UNFCCC). - **2002 Johannesburg Summit**: World Summit on Sustainable Development. - **2015 Paris Agreement**: Global climate change agreement.

---

13. 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: Analyzing Each Statement:
The question asks to identify the correct statements about decomposition and the detritus food chain.
Statement A: Detritivores perform fragmentation.
Detritivores, like earthworms, are organisms that feed on dead organic matter (detritus). By chewing and breaking down detritus into smaller pieces, they perform the process of fragmentation. This increases the surface area for microbial action. This statement is **correct**.

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

Statement C: Water soluble inorganic nutrients go down into the soil and get precipitated by a process called leaching.
Leaching is the process where water-soluble substances, including inorganic nutrients released during decomposition, are washed down through the soil profile. They can move beyond the root zone and become unavailable to plants. The description is **correct**.

Statement D: The detritus food chain begins with living organisms.
The detritus food chain (DFC) begins with dead organic matter (detritus), such as dead leaves, animal remains, etc. The grazing food chain (GFC) begins with living organisms (producers). This statement is **incorrect**.

Statement E: Earthworms break down detritus into smaller particles by a process called catabolism.
The physical breakdown of detritus into smaller particles by earthworms is **fragmentation** (as stated in A). **Catabolism** refers to the enzymatic breakdown of complex organic molecules into simpler inorganic substances by bacteria and fungi. This statement is **incorrect**.

Step 2: Final Answer:
The correct statements are A, B, and C. Therefore, the correct option is (D).

Quick Tip

Remember the three main steps of decomposition in order: 1. **Fragmentation** (physical breakdown by detritivores). 2. **Leaching** (washing away of soluble nutrients). 3. **Catabolism** (enzymatic breakdown by microbes). Humification and Mineralization occur alongside these processes. Distinguishing between fragmentation (physical) and catabolism (biochemical/enzymatic) is crucial.

14. The reaction centre in 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 of Photosystem II (PS II) shows maximum absorption.

Step 2: Detailed Explanation:
In the light-dependent reactions of photosynthesis, there are two photosystems, PS I and PS II, which work in sequence. Each photosystem consists of a light-harvesting complex (antenna molecules) and a reaction center.
The reaction center is a specific chlorophyll 'a' molecule that gets excited and loses an electron, initiating the electron transport chain.
- The reaction center of **Photosystem II (PS II)** is a chlorophyll 'a' molecule that has its absorption peak at a wavelength of **680 nm**. It is therefore called **P680**.
- The reaction center of **Photosystem I (PS I)** is a chlorophyll 'a' molecule that has its absorption peak at a wavelength of **700 nm**. It is therefore called **P700**.
The other wavelengths listed (660 nm, 780 nm) are not the absorption maxima for the reaction centers of either PS I or PS II.

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

Quick Tip

A simple way to remember is that PS II comes before PS I in the electron flow (Z-scheme), but its number is lower. PS II (P680) operates at a shorter wavelength (higher energy) than PS I (P700). Remember: II before I, 680 before 700.

---

15. 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 that exhibit axile placentation. Placentation refers to the arrangement of ovules within the ovary.

Step 2: Key Concept - Axile Placentation:
In axile placentation, the ovary is syncarpous (composed of two or more fused carpels) and partitioned by septa into multiple chambers or locules. The placenta is located in the central axis where the septa meet, and the ovules are attached to this central axis within each locule.

Step 3: Analyzing the Options:
Let's examine the placentation type for the plants in each option:
- **(A) China rose, Beans and Lupin:** China rose has axile placentation. However, Beans and Lupin (members of the Fabaceae family) have **marginal** placentation.
- **(B) Tomato, Dianthus and Pea:** Tomato has axile placentation. Dianthus has **free-central** placentation. Pea has **marginal** placentation.
- **(C) China rose, Petunia and Lemon:** China rose (Hibiscus), Petunia, and Lemon all have multicarpellary, syncarpous ovaries with **axile** placentation. This option is correct.
- **(D) Mustard, Cucumber and Primrose:** Mustard has **parietal** placentation. Cucumber can have parietal placentation. Primrose has **free-central** placentation.

Step 4: Final Answer:
The group of plants that all exhibit axile placentation is China rose, Petunia, and Lemon.

Quick Tip

Associate common examples with placentation types: - **Marginal**: Pea, Bean (think of a pea pod). - **Axile**: Tomato, Lemon, China rose (think of slices of tomato or lemon). - **Parietal**: Mustard, Argemone, Cucumber. - **Free-central**: Dianthus, Primrose. - **Basal**: Sunflower, Marigold. Visualizing cross-sections of these fruits can be very helpful.

---

16. 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 in plant tissue culture where specialized, permanent cells (leaf mesophyll cells) are stimulated to divide and form an undifferentiated mass of cells called a callus. It asks for the term that describes this phenomenon.

Step 2: Defining the Terms:
Let's define the relevant terms in plant development and tissue culture:
- **Differentiation:** The process by which cells, tissues, and organs acquire specialized features and functions. For example, a meristematic cell differentiating into a mesophyll cell.
- **Dedifferentiation:** The process by which mature, differentiated, non-dividing permanent cells revert to a meristematic state and regain the power of cell division. This is exactly what happens when leaf mesophyll cells form a callus. They lose their specialized structure and function to become an undifferentiated, dividing mass.
- **Redifferentiation:** The process by which dedifferentiated cells (like callus cells) divide and then differentiate again to form new, specialized cells, tissues, and organs. For example, callus cells forming roots or shoots.
- **Development:** A broad term encompassing all changes an organism goes through from germination to senescence.
- **Senescence:** The process of aging in plants.

Step 3: Final Answer:
The conversion of differentiated leaf mesophyll cells into an undifferentiated, proliferating callus is termed dedifferentiation.

Quick Tip

Remember the sequence in plant tissue culture: 1. **Explant** (differentiated cells, e.g., leaf piece). 2. **Dedifferentiation** -> Forms **Callus** (undifferentiated cells). 3. **Redifferentiation** -> Callus forms **Plantlet** (differentiated organs like roots/shoots).

---

17. 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 what macromolecule is precipitated when chilled ethanol is added during a typical DNA purification procedure. This is a standard step in DNA extraction.

Step 2: Detailed Explanation:
The process of DNA extraction from cells involves several steps:
1. **Lysis:** Breaking open the cells (e.g., using detergents) and nucleus to release the contents, including DNA, RNA, proteins, and lipids.
2. **Purification:** Removing other macromolecules. Enzymes like proteases are used to digest proteins (like histones), and RNases are used to digest RNA.
3. **Precipitation:** After removing most contaminants, the DNA is precipitated from the aqueous solution. DNA is soluble in water but insoluble in ethanol (especially when salt is present). Adding chilled ethanol causes the DNA to come out of solution and aggregate, forming a visible white precipitate that can be spooled out with a glass rod. The low temperature reduces the solubility further.
While RNA can also be precipitated with ethanol, in a typical DNA purification protocol, RNA has usually been degraded by RNase prior to this step. Histones would have been digested by protease. Other molecules like polysaccharides and lipids are also separated during the purification steps. The final precipitation step is specifically aimed at isolating the purified DNA.

Step 3: Final Answer:
The addition of chilled ethanol causes the purified DNA to precipitate out of the solution.

Quick Tip

Remember the key principle of DNA precipitation: DNA is a polar molecule, soluble in polar water but insoluble in less polar ethanol. Adding salt (like sodium acetate) neutralizes the negative charge on the DNA backbone, allowing the DNA strands to clump together and precipitate when ethanol is added. Using chilled ethanol enhances this effect.

---

18. 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 reason why cellulose does not give a positive iodine test (blue-black color), unlike starch.

Step 2: Key Concept - Iodine Test for Polysaccharides:
The iodine test works based on the structure of the polysaccharide. Starch is composed of two components: amylose and amylopectin. Amylose is a linear polymer of glucose with α-1,4 glycosidic bonds, which coils into a helical structure. When iodine solution (I_2-KI) is added, the polyiodide ions (I_3^- and I_5^-) slip inside this amylose helix. The interaction between the trapped iodine and the starch coil changes the electronic energy levels, causing the complex to absorb light and appear blue-black.

Step 3: Analyzing the Structure of Cellulose:
- Cellulose is also a polymer of glucose, but the glucose units are linked by β-1,4 glycosidic bonds.
- This β-linkage results in a straight, linear chain. Multiple cellulose chains are packed tightly together via hydrogen bonds to form rigid microfibrils.
- Unlike amylose, cellulose does not form a helical secondary structure. It exists as extended linear chains.
- Because it lacks the helical coils, there is no space for the iodine molecules to be trapped. Without this complex formation, the characteristic blue-black color is not produced.

Step 4: Evaluating the Options:
- (A) It is a helical molecule: Incorrect. Cellulose is a linear, unbranched molecule.
- (B) It does not contain complex helices and hence cannot hold iodine molecules: Correct. This accurately describes the structural reason for the negative test.
- (C) It breaks down when iodine reacts with it: Incorrect. Iodine does not break down cellulose.
- (D) It is a disaccharide: Incorrect. Cellulose is a polysaccharide, composed of thousands of glucose units. Cellobiose is the repeating disaccharide unit.

Step 5: Final Answer:
Cellulose does not form a blue color with iodine because its linear structure lacks the complex helices necessary to trap iodine molecules.

Quick Tip

Structural differences are key:
- **Starch** (α-glucose) -> **Helical** -> Traps iodine -> **Blue-black color**.
- **Cellulose** (β-glucose) -> **Linear/Straight** -> Cannot trap iodine -> **No color change**.

---

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

(A) Gibberellic Acid
(B) Zeatin
(C) Abscisic 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 used to speed up the maturation process in young conifer trees to achieve early seed production.

Step 2: Detailed Explanation of Phytohormone Functions:
- **Gibberellic Acid (GA):** Gibberellins are a class of plant hormones that regulate various developmental processes, including stem elongation, germination, dormancy, flowering, and fruit development. A significant commercial application of gibberellins is to promote flowering and cone (and thus seed) production in conifers. Spraying juvenile conifers with GA can overcome juvenility and induce the formation of reproductive structures much earlier than they would naturally occur.
- **Zeatin:** This is a type of cytokinin. Cytokinins primarily promote cell division (cytokinesis), chloroplast development, and delay of senescence. They are not the primary hormones used to hasten maturity for seed production.
- **Abscisic Acid (ABA):** This hormone is generally considered a growth inhibitor. It plays roles in stress responses (like closing stomata during water stress) and inducing and maintaining dormancy in buds and seeds. It would not hasten maturity.
- **Indole-3-butyric Acid (IBA):** This is a type of auxin. Auxins are primarily involved in cell elongation, apical dominance, and root initiation. IBA is commonly used as a rooting hormone for cuttings. It does not hasten the reproductive maturity of whole plants.

Step 3: Final Answer:
Gibberellic acid is the phytohormone used to hasten the maturity period in juvenile conifers for early seed production.

Quick Tip

Associate key commercial applications with each hormone:
- **Auxins (IBA, NAA)**: Rooting cuttings, weed killers (2,4-D).
- **Gibberellins (GA)**: Increasing fruit size (grapes), breaking dormancy, malting, promoting early flowering in conifers.
- **Cytokinins**: Tissue culture (shoot formation), delaying senescence. - **Ethylene**: Fruit ripening.
- **ABA**: Stress hormone, promoting dormancy.

20. 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 pteridophytes that are heterosporous.

Step 2: Key Concept - Homospory vs. Heterospory:
- **Homosporous** plants produce only one type of spore, which develops into a bisexual gametophyte (possessing both antheridia and archegonia). The majority of pteridophytes are homosporous.
- **Heterosporous** plants produce two distinct types of spores: smaller **microspores** that develop into male gametophytes and larger **megaspores** that develop into female gametophytes. This condition is an important evolutionary step towards the seed habit seen in gymnosperms and angiosperms.

Step 3: Analyzing the Pteridophytes listed:
- **Selaginella:** A classic example of a heterosporous pteridophyte.
- **Salvinia:** An aquatic fern that is also heterosporous.
- **Psilotum:** A primitive pteridophyte that is homosporous.
- **Equisetum** (Horsetail): A common pteridophyte that is homosporous.
- **Lycopodium** (Club moss): It is homosporous (in contrast to Selaginella, the "little club moss").

Step 4: Evaluating the Options:
- (A) **Selaginella and Salvinia:** Both are heterosporous. This is the correct pair.
- (B) Psilotum (homosporous) and Salvinia (heterosporous).
- (C) Equisetum (homosporous) and Salvinia (heterosporous).
- (D) Lycopodium (homosporous) and Selaginella (heterosporous).

Step 5: Final Answer:
The correct pair of heterosporous pteridophytes is Selaginella and Salvinia.

Quick Tip

Memorize the key examples of heterosporous pteridophytes: **Selaginella, Salvinia, Marsilea,** and **Azolla**. Most other commonly studied pteridophytes like *Dryopteris* (fern), *Equisetum*, *Lycopodium*, and *Psilotum* are homosporous. The "S" in Selaginella and Salvinia can help you remember them as "Special" (heterosporous).

---

21. 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: (A) Pachytene

Solution:

Step 1: Understanding the Question:
The question asks to identify the sub-stage of meiotic Prophase I where recombination nodules are observed.

Step 2: Detailed Explanation of Prophase I Sub-stages:
Prophase I is the longest phase of meiosis and is divided into five sub-stages:
1. **Leptotene:** Chromosomes begin to condense and become visible.
2. **Zygotene:** Homologous chromosomes pair up in a process called synapsis, forming bivalents. The synaptonemal complex begins to form between them.
3. **Pachytene:** Synapsis is complete. The paired homologous chromosomes are called bivalents or tetrads (four chromatids). This is the stage where **crossing over** occurs. The sites of crossing over are marked by the appearance of proteinaceous structures called **recombination nodules** along the synaptonemal complex. These nodules contain the enzymes required to cut and rejoin the chromatids.
4. **Diplotene:** The synaptonemal complex dissolves, and the homologous chromosomes begin to separate, but they remain attached at the points of crossing over, which are now visible as X-shaped structures called chiasmata.
5. **Diakinesis:** Chromosomes become fully condensed. The chiasmata terminalize (move to the ends), and the nuclear envelope breaks down.

Step 3: Final Answer:
Recombination nodules, the sites where crossing over happens, appear during the pachytene sub-stage.

Quick Tip

Use the mnemonic "Lazy Zebra Pounces On Dingoes Daily" for the stages: **L**eptotene, **Z**ygotene, **P**achytene, **D**iplotene, **D**iakinesis. Associate the key event with each stage: Zygotene - Synapsis; Pachytene - Crossing over (P for Pounces/Pachytene and C for Crossing over); Diplotene - Chiasmata visible.

---

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

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

Correct Answer: (B) Ethylene

Solution:

Step 1: Understanding the Question:
The question asks to identify the plant hormone responsible for promoting rapid stem (internode) and leaf stalk (petiole) elongation in rice plants that are submerged in deep water. This is an adaptation to keep the leaves above the water surface for photosynthesis.

Step 2: Detailed Explanation of Hormone Roles:
- **Ethylene:** This gaseous hormone plays a crucial role in responses to environmental stress, including flooding and submergence. In deep water rice, submergence leads to the accumulation of ethylene in the plant tissues. This high concentration of ethylene stimulates rapid cell division and elongation in the internodes, causing the plant to grow taller quickly and keep its leaves above water. It also promotes petiole elongation in some aquatic plants to help leaves reach the surface.
- **Kinetin:** A type of cytokinin, primarily involved in promoting cell division, not elongation.
- **2, 4-D (2,4-Dichlorophenoxyacetic acid):** A synthetic auxin. While auxins promote cell elongation, 2,4-D is primarily used as a herbicide, especially against broad-leaf weeds. It is not the primary hormone for this specific submergence response.
- **GA_3 (Gibberellic Acid):** Gibberellins are well-known for promoting stem elongation (e.g., bolting in cabbage). While ethylene can increase the sensitivity of tissues to gibberellins, ethylene itself is the primary trigger for the rapid internode elongation response in deep water rice.

Step 3: Final Answer:
Ethylene is the hormone that directly promotes internode/petiole elongation in deep water rice as a response to submergence.

Quick Tip

Remember ethylene's diverse and sometimes seemingly contradictory roles. It is known for fruit ripening and senescence, but also for specific growth promotions like root hair formation and the submergence response in rice. Think of it as a stress and developmental regulator.

---

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

(A) 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 who first used the frequency of genetic recombination to determine the relative distance and positions of genes on a chromosome, a process known as gene mapping.

Step 2: Detailed Explanation of Contributions:
- **Thomas Hunt Morgan:** Working with *Drosophila melanogaster* (fruit flies), Morgan's group established the concepts of linkage (genes on the same chromosome tend to be inherited together) and recombination (crossing over can separate linked genes). He observed that the frequency of recombination varied between different pairs of linked genes.
- **Alfred Sturtevant:** He was an undergraduate student in T.H. Morgan's lab. In 1913, Sturtevant had the brilliant insight that the variation in recombination frequency could be used as a measure of the physical distance between genes on a chromosome. He proposed that if two genes were far apart, crossing over was more likely to occur between them, resulting in a higher recombination frequency. Conversely, if they were close together, recombination would be less frequent. He used this principle to construct the first-ever genetic map for the X chromosome of *Drosophila*.
- **Sutton and Boveri:** They independently proposed the Chromosomal Theory of Inheritance, which states that genes are located on chromosomes. Their work provided the theoretical foundation but did not involve gene mapping.
- **Henking:** He was a German biologist who first discovered the X chromosome in insects in 1891, referring to it as the "X-body".

Step 3: Final Answer:
Alfred Sturtevant was the first to use recombination frequencies to map the positions of genes

on a chromosome.

Quick Tip

Connect the scientists to their core ideas:
- **Morgan**: Linkage and Recombination.
- **Sturtevant** (Morgan's student): Used Morgan's recombination data to create the first **Gene Map**.
- **Sutton & Boveri**: Chromosomal Theory of Inheritance.
Think of Sturtevant as the one who turned the abstract idea of recombination frequency into a concrete map.

---

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

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

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

Solution:

Step 1: Understanding the Question:
The question asks for the total number of ATP and NADPH molecules required to produce one molecule of glucose ($C_6H_{12}O_6$) through the Calvin cycle.

Step 2: Key Formula or Approach:
The Calvin cycle fixes carbon dioxide (CO_2) into a 3-carbon sugar (G3P). To make one molecule of glucose (a 6-carbon sugar), two molecules of G3P are required. This means the cycle must fix 6 molecules of CO_2. We need to calculate the energy cost for 6 turns of the cycle.
For **one turn** of the Calvin cycle (fixing one CO_2): - **Reduction phase:** 2 ATP and 2 NADPH are used. - **Regeneration phase:** 1 ATP is used. - **Total per turn:** 3 ATP and 2 NADPH.

Step 3: Detailed Calculation:
To synthesize one molecule of glucose ($C_6H_{12}O_6$), we need to fix 6 carbon atoms. Since each turn of the Calvin cycle fixes one molecule of CO_2, the cycle must run **6 times**.
- Total ATP required = (ATP per turn) $\times$ (Number of turns)

$$\text{Total ATP} = 3\,\text{ATP/turn} \times 6\,\text{turns} = 18\,\text{ATP}$$

- Total NADPH required = (NADPH per turn) $\times$ (Number of turns)

$$\text{Total NADPH} = 2\,\text{NADPH/turn} \times 6\,\text{turns} = 12\,\text{NADPH}$$

(Note: $NADPH_2$ is an older notation for NADPH + H^+, often simplified to NADPH in modern texts. The stoichiometry remains the same).

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

Quick Tip

Remember the requirements for just **one turn** of the Calvin cycle (fixing 1 CO_2): **3 ATP and 2 NADPH**. To make glucose (C_6), you need 6 turns. Simply multiply the single-turn cost by 6. $6 \times (3\text{ ATP} + 2\text{ NADPH}) = 18\text{ ATP} + 12\text{ NADPH}$.

---

25. 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 the correct explanation of A

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

Solution:

Step 1: Analyzing the Assertion (A):
The life cycle of a moss (a bryophyte) has two distinct stages: the gametophyte (dominant) and the sporophyte. The gametophyte itself consists of two stages. The first stage, which develops upon spore germination, is a filamentous, green, branching structure called the **protonema**. From this protonema, the leafy, upright second stage develops. Therefore, the assertion that the protonema is the first stage of the gametophyte is **correct**.

Step 2: Analyzing the Reason (R):
The moss life cycle involves an alternation of generations. The diploid sporophyte, which consists of a foot, seta, and capsule, produces haploid spores by meiosis within the capsule. When these spores are released and land on a suitable substrate, they germinate and develop directly

into the protonema. Therefore, the reason that the protonema develops directly from spores produced in the capsule is also **correct**.

Step 3: Evaluating the Relationship between A and R:
Reason R explains the origin of the protonema stage. It states how this "first stage" mentioned in the Assertion comes into being—by direct development from a spore. This provides a direct and accurate explanation for the Assertion. The protonema is the first stage *because* it is what germinates from the spore.

Step 4: Final Answer:
Both Assertion A and Reason R are correct, and R is the correct explanation of A.

Quick Tip

Visualize the moss life cycle: **Spore (n)** -> (Germination) -> **Protonema (n)** [First gametophyte stage] -> **Leafy gametophyte (n)** [Second stage] -> (Gametogenesis) -> **Gametes (n)** -> (Fertilization) -> **Zygote (2n)** -> **Sporophyte (2n)** -> (Meiosis in capsule) -> **Spore (n)**. This flow clearly shows the protonema's position and origin.

---

26. 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 to identify the specific function of RNA polymerase III in the process of transcription in eukaryotic cells.

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

- **RNA polymerase I:** Transcribes ribosomal RNAs (rRNAs), specifically the 28S, 18S, and 5.8S rRNA genes.

- **RNA polymerase II:** Transcribes the precursor of messenger RNA (mRNA), which is called heterogeneous nuclear RNA (hnRNA), as well as most small nuclear RNAs (snRNAs) and microRNAs (miRNAs).

- **RNA polymerase III:** Transcribes transfer RNA (tRNA), 5S ribosomal RNA (5S rRNA), and some other small RNAs, including some small nuclear RNAs (snRNAs like U6 snRNA).

Based on this information:
- Option (A) correctly lists the products of RNA polymerase III: tRNA, 5S rRNA, and snRNA.
- Option (B) describes the function of RNA polymerase II.
- Option (C) is incomplete as RNA polymerase III transcribes more than just snRNAs.
- Option (D) describes the main function of RNA polymerase I.

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

Quick Tip

To remember the functions of eukaryotic RNA polymerases, use the mnemonic "R-M-T" for Polymerases I, II, and III, corresponding to rRNA, mRNA, and tRNA respectively. Remember that Pol III also handles 5S rRNA and some snRNAs.

---

27. 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 unit of measurement used to quantify the thickness of the ozone layer in the atmosphere.

Step 2: Detailed Explanation:
Let's analyze the given options:
- **Decibels (dB):** A unit used to measure the intensity of a sound or the power level of an electrical signal. It is not related to atmospheric thickness.

- **Decameter (dam):** A unit of length equal to 10 meters. While it is a unit of length, it is not the standard unit for measuring the ozone layer.
- **Kilobase (kb):** A unit of length for DNA or RNA molecules, equal to 1000 base pairs. It is used in genetics and molecular biology.
- **Dobson units (DU):** This is the standard unit of measure for the total amount of ozone in a column of air from the ground to the top of the atmosphere. One Dobson Unit is the number of molecules of ozone that would be required to create a layer of pure ozone 0.01 millimeters thick at a temperature of 0 degrees Celsius and a pressure of 1 atmosphere.

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

Quick Tip

Associate "Dobson" with "Ozone." This is a factual question common in environmental science topics. Remember that a normal ozone layer thickness is around 300 DU.

---

28. Given below are two statements :
Statement I: The forces generated transpiration can lift a xylem-sized column of water over 130 meters height.
Statement II: Transpiration cools leaf surfaces sometimes 10 to 15 degrees 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 related to the physiological process of transpiration in plants. We need to evaluate the correctness of each statement.

Step 2: Detailed Explanation:
Analysis of Statement I:
Transpiration pull, also known as the cohesion-tension theory, is the primary driving force for the ascent of sap in tall trees.
The strong cohesive forces between water molecules and adhesive forces between water and xylem walls create a continuous water column.

The tension (negative pressure) generated by the evaporation of water from leaf surfaces is strong enough to pull this water column to great heights.
Scientific evidence and calculations support that this force can lift water to heights well over 100 meters, which is sufficient for the tallest trees (e.g., Sequoia, which can exceed 115 meters). Therefore, lifting water over 130 meters is a plausible capability of the transpiration pull. Statement I is correct.

Analysis of Statement II:
Transpiration involves the evaporation of water from the leaf surface. Evaporation is a cooling process because it requires energy (latent heat of vaporization), which is drawn from the leaf itself.
This evaporative cooling helps to dissipate solar radiation and prevents the leaf from overheating, especially in direct sunlight.
The cooling effect can lower the leaf temperature by as much as 10 to 15 degrees Celsius compared to the surrounding air or a non-transpiring surface. Statement II is correct.

Step 3: Final Answer:
Since both statements accurately describe aspects of transpiration, the correct option is that both Statement I and Statement II are correct.

Quick Tip

Remember the two key benefits of transpiration: 1. Ascent of sap (transporting water and minerals) and 2. Thermoregulation (cooling the leaf surface). This question tests both these fundamental concepts.

---

29. 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 asks to identify the meaning of the term 'R' in the ecological equation relating Gross Primary Productivity (GPP) and Net Primary Productivity (NPP).

Step 2: Detailed Explanation:

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

- **Producers' Respiration (R):** Plants, like all living organisms, need energy to live. They respire, using some of the organic matter (glucose) they produced during photosynthesis to fuel their metabolic processes (growth, maintenance, etc.). This consumption of energy is referred to as 'Respiratory loss'.

- **Net Primary Productivity (NPP):** This is the rate at which producers create biomass after accounting for the energy they used for their own respiration. It is the energy that is available to the next trophic level (herbivores).

The relationship between them is:

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

Or, as given in the question:

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

Thus, 'R' represents the energy lost by the producers through respiration.

Let's check the other options:
- **Respiratory quotient (RQ):** It is the ratio of CO_2 produced to O_2 consumed during respiration. It's a measure of metabolic state, not an amount of energy loss.
- **Reproductive allocation:** This is the portion of energy used specifically for reproduction, which is a part of the total respiratory loss and biomass allocation, not 'R' itself.
- **Photosynthetically active radiation (PAR):** This is the range of light wavelengths that photosynthetic organisms are able to use in the process of photosynthesis. It is an input for GPP, not a loss.

Step 3: Final Answer:
In the given equation, R stands for Respiratory loss.

Quick Tip

Think of it like a salary. GPP is your gross salary (total earnings). 'R' (Respiration) is like your taxes and living expenses (energy you use to live). NPP is your net salary or savings (the energy available to be passed on).

30. 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 Monothecous anthers
(C) Epiphyllous and Dithecous anthers
(D) Diadelphous and Dithecous anthers

Correct Answer: (D) Diadelphous and Dithecous anthers

Solution:

Step 1: Understanding the Question:
The question asks for a characteristic of the stamens that is unique to the family Fabaceae when compared to Solanaceae and Liliaceae.

Step 2: Detailed Explanation:
Let's analyze the characteristics of stamens in each family:

- **Fabaceae (Pea family):** A key feature of this family (specifically the subfamily Papilionoideae) is the arrangement of its stamens. There are typically 10 stamens, which are **diadelphous**, meaning they are fused into two bundles. The common arrangement is (9)+1, where nine stamens are fused to form a tube and one is free. The anthers are **dithecous**, meaning they have two lobes.

- **Solanaceae (Potato family):** This family typically has 5 stamens that are **epipetalous**, meaning they are attached to the petals. The stamens are free (not fused into bundles). The anthers are dithecous.

- **Liliaceae (Lily family):** This family typically has 6 stamens, arranged in two whorls of three. The stamens can be free or fused, and they are often **epiphyllous** or **epitepalous**, meaning they are attached to the tepals (undifferentiated sepals and petals). The anthers are dithecous.

Now let's evaluate the options based on this comparison:
- (A) Polyadelphous (fused into many bundles) is not typical for Fabaceae (e.g., found in Citrus). Epipetalous is a feature of Solanaceae.
- (B) Monoadelphous (fused into one bundle) is found in some plants like China rose (Malvaceae), not typically Fabaceae. Monothecous anthers (one lobe) are also not a feature of Fabaceae.
- (C) Epiphyllous is a feature of Liliaceae. Dithecous anthers are common to all three, so it's not a distinguishing feature.
- (D) **Diadelphous** stamens are a classic and distinctive feature of the Fabaceae family. **Dithecous** anthers are also present. This combination is specific to Fabaceae and not found in

Solanaceae or Liliaceae.

Step 3: Final Answer:
The characteristic specific to the stamens of Fabaceae is the diadelphous condition along with dithecous anthers.

Quick Tip

Remember the floral formula for the Papilionoideae subfamily of Fabaceae: $K_{(}5)\ C_{1+2+(2)}\ A_{(9)+1}\ G_1$. The $A_{(9)+1}$ part directly indicates the diadelphous condition of the androecium (stamens). This is a very high-yield characteristic for identification.

---

31. 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 metals used to coat DNA for delivery into host cells via the gene gun (biolistics) method.

Step 2: Detailed Explanation:
The gene gun, or biolistic particle delivery system, is a method for transforming cells, particularly plant cells. The principle is to physically shoot DNA into the target cells.
To do this, the desired DNA (the "alien DNA" or transgene) is coated onto microscopic particles. These particles act as "bullets" or microprojectiles.
The requirements for these microparticles are:

- They must be dense enough to have the momentum to penetrate the cell wall and membrane.

- They must be chemically inert so they do not react harmfully with the DNA or the cell's interior.

High-density and chemically inert metals are ideal for this purpose. The most commonly used metals for these microparticles are **gold (Au)** and **tungsten (W)**.
Zinc, silver, and copper are not typically used because they can be reactive or toxic to the cells at the concentrations needed.

Step 3: Final Answer:
Therefore, microparticles of Tungsten or gold are used in the gene gun method.

Quick Tip

Associate the gene gun with precious and heavy metals like gold. Gold is extremely non-reactive (inert), making it perfect for biological applications. Tungsten is another heavy, dense metal used for the same purpose.

---

32. 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 describes a situation where ions are moved across a cell membrane from a region of lower concentration to a region of higher concentration. This is termed moving "against the concentration gradient." We need to identify the transport mechanism responsible for this.

Step 2: Detailed Explanation:
Let's analyze the types of membrane transport:

- **Passive Transport:** This is the movement of substances across a membrane **down** the concentration gradient (from high to low concentration). It does not require metabolic energy (ATP). Simple diffusion, facilitated diffusion, and osmosis are types of passive transport.

- **Facilitated Diffusion:** A type of passive transport where substances move down their concentration gradient with the help of membrane proteins (channels or carriers). No energy is expended.

- **Osmosis:** The specific movement of water across a selectively permeable membrane from a region of high water potential to a region of low water potential. It is a form of passive transport.

- **Active Transport:** This is the movement of substances **against** their concentration gradient (from low to high concentration). This process is like pumping something "uphill" and therefore requires energy, usually in the form of ATP. It is carried out by specific membrane proteins called pumps.

The question explicitly states that ions are moving "against their concentration gradient." This is the defining characteristic of active transport.

Step 3: Final Answer:
The movement of ions against a concentration gradient is explained by Active Transport.

Quick Tip

Remember the analogy of a hill. Moving "down a gradient" (high to low) is like rolling down a hill - it happens passively without energy. Moving "against a gradient" (low to high) is like pushing a boulder up a hill - it requires active effort and energy (ATP).

---

33. 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, which holds the two sister chromatids of a chromosome together, divides or splits.

Step 2: Detailed Explanation:
Let's review the key events of the meiotic stages:

- **Meiosis I (Reductional Division):**
  - **Metaphase I:** Homologous chromosome pairs (bivalents) align at the metaphase plate. The centromeres do not split.

- **Anaphase I:** Homologous chromosomes separate and move to opposite poles. Sister chromatids remain attached at their centromeres. The centromeres **do not divide**. This is a key difference from mitosis.

- **Meiosis II (Equational Division):** This phase is very similar to mitosis.
  - **Metaphase II:** Individual chromosomes (each still composed of two sister chromatids) align at the metaphase plate.
  - **Anaphase II:** The centromeres of each chromosome **divide**, and the sister chromatids separate. They are now considered individual chromosomes and move to opposite poles.
- **Telophase:** This is the final stage where chromosomes decondense and nuclear envelopes reform. It does not involve centromere division.

From this analysis, the division of the centromere occurs during Anaphase II of meiosis. This event is what separates the sister chromatids.

Step 3: Final Answer:
The stage of meiosis that involves the division of the centromere is Anaphase II.

Quick Tip

Remember: "Ana-" means "apart" or "up." In Anaphase of mitosis and Anaphase II of meiosis, the chromatids are pulled apart. In Anaphase I, the homologous chromosomes are pulled apart. The key event that allows chromatids to separate is the splitting of the centromere, which happens only in Anaphase of mitosis and Anaphase II of meiosis.

---

34. 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, in order, haploid (n), diploid (2n), and triploid (3n).

Step 2: Detailed Explanation:
Let's determine the ploidy level of the structures within a typical angiosperm embryo sac *after*

fertilization:

- **Haploid (n) structures:** The embryo sac itself develops from a haploid megaspore. Before fertilization, the egg cell, synergids, and antipodals are all haploid. After fertilization, the synergids and antipodals degenerate, but they are still considered haploid structures if present.
- **Diploid (2n) structures:** Fertilization involves the fusion of a haploid male gamete with the haploid egg cell. This process, called syngamy, results in the formation of a **diploid zygote (2n)**, which will develop into the embryo.
- **Triploid (3n) structures:** The second male gamete (also haploid, n) fuses with the diploid central cell (which contains two polar nuclei, n + n). This process, called triple fusion, results in the formation of the **Primary Endosperm Nucleus (PEN)**, which is **triploid (3n)**. The PEN develops into the endosperm, which provides nutrition to the embryo.

Now let's evaluate the options based on the required sequence (haploid, diploid, triploid):
- (A) Antipodals (n), synergids (n), PEN (3n). This is not n, 2n, 3n.
- (B) **Synergids (n)**, **Zygote (2n)**, and **Primary endosperm nucleus (3n)**. This sequence correctly matches the required ploidy levels: haploid, diploid, and triploid.
- (C) Synergids (n), antipodals (n), Polar nuclei (n+n, exist before fertilization). This is not n, 2n, 3n.
- (D) Synergids (n), Primary endosperm nucleus (3n), and zygote (2n). The order is incorrect.

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

Quick Tip

Double fertilization is a hallmark of angiosperms. Remember the two key events: 1. Syngamy: Male gamete (n) + Egg (n) $\rightarrow$ Zygote (2n) 2. Triple Fusion: Male gamete (n) + Central Cell (2 polar nuclei, n+n) $\rightarrow$ PEN (3n) This concept is frequently tested.

---

35. Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R :
Assertion A: Late wood has fewer xylary elements with narrow vessels.
Reason R: Cambium is less active in winters.
In the light of the above statements, choose the correct answer from the options given below :

(A) Both A and R are true 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:
This is an Assertion-Reason question. We need to evaluate the truthfulness of both the Assertion (A) and the Reason (R). If both are true, we must then determine if the Reason correctly explains the Assertion.

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

- **Early wood (or spring wood):** Formed during the spring season when conditions are favorable. It is characterized by having numerous xylary elements (tracheids and vessels) with wider lumens to transport more water for the new growth of leaves.
- **Late wood (or autumn wood):** Formed during late summer or autumn. It is characterized by having **fewer xylary elements**, and the vessels are **narrower** and thicker-walled. This wood is denser.

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

Analysis of Reason (R):
The activity of the vascular cambium is influenced by physiological and environmental factors, such as temperature and water availability.

- In spring, with favorable conditions (warm temperature, ample water), the cambium is highly active.
- In winter (or the dry season), conditions become unfavorable (cold, less water). This leads to a decrease in the cambium's activity. It produces fewer cells, and the cells that are produced are smaller and thicker-walled.

So, the statement "Cambium is less active in winters" is correct. **Reason R is true**.

Connecting A and R:
The reduced activity of the cambium during winter/autumn (Reason R) is the direct cause for the formation of late wood, which has the characteristics described in Assertion A (fewer and narrower xylary elements). The cambium's lower activity results in the production of fewer, smaller-diameter vessels. Therefore, **R is the correct explanation of A**.

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

Quick Tip

For Assertion-Reason questions, follow a three-step process: 1. Check if A is true. 2. Check if R is true. 3. If both are true, check if R explains A by asking "Why?" after reading statement A. "Why does late wood have fewer, narrow vessels?" The answer is "Because the cambium is less active in winter." This confirms the link.

Section - B

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

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

Correct Answer: (D) Succinic dehydrogenase

Solution:

Step 1: Understanding the Question:
The question asks to identify the enzyme whose activity is inhibited by malonate, which in turn stops the growth of pathogenic bacteria. This points to a specific type of enzyme inhibition.

Step 2: Detailed Explanation:
The molecule referred to as "Melonate" is more commonly known as **malonate**. Malonate is a classic example of a **competitive inhibitor**.
Competitive inhibitors have a molecular structure very similar to the enzyme's natural substrate. They bind to the active site of the enzyme, blocking the actual substrate from binding, and thus inhibiting the enzyme's activity.

Let's look at the enzyme **succinic dehydrogenase**.

- This enzyme is a key component of the Krebs cycle (Citric Acid Cycle) and the electron transport chain.
- Its natural substrate is **succinate**.
- The reaction it catalyzes is the oxidation of succinate to fumarate.

$$\text{Succinate} \xrightarrow{\text{Succinic dehydrogenase}} \text{Fumarate}$$

- **Malonate** has a structure that is very similar to succinate.
- Because of this structural similarity, malonate can bind to the active site of succinic dehydrogenase but cannot be oxidized. This competitively inhibits the enzyme.

By inhibiting succinic dehydrogenase, malonate blocks the Krebs cycle, which is a central metabolic pathway for energy production in aerobic bacteria. This lack of energy production prevents the bacteria from growing and reproducing.

The other enzymes listed are not inhibited by malonate: - Amylase digests starch. - Lipase digests fats. - Dinitrogenase is involved in nitrogen fixation.

Step 3: Final Answer:
Malonate inhibits the enzyme succinic dehydrogenase.

Quick Tip

Malonate as a competitive inhibitor for succinic dehydrogenase is a textbook example used to explain enzyme inhibition. Remember the structural similarity: - Succinate: $^{-}OOC - CH_2 - CH_2 - COO^{-}$ - Malonate: $^{-}OOC - CH_2 - COO^{-}$ The only difference is one CH_2 group, making them look very similar to the enzyme's active site.

---

37. 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: (B) 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 listed:

- **A. Iron (Fe):** Iron is an essential component of proteins involved in electron transport, such as cytochromes. It is also a crucial activator for the enzyme **catalase**, which breaks

down hydrogen peroxide. Therefore, **A matches with III**.

- **B. Zinc (Zn):** Zinc is an activator for various enzymes, most notably carboxylases. It is also required for the **synthesis of auxin** (specifically, the precursor tryptophan). Therefore, **B matches with I**.

- **C. Boron (B):** Boron is required for the uptake and utilization of Ca^{2+}, membrane functioning, pollen germination, and crucially, for **cell elongation and cell differentiation**. It also plays a role in carbohydrate translocation. Therefore, **C matches with IV**.

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

Step 3: Matching the pairs:
- A → III - B → I - C → IV - D → II
This combination corresponds to option (B).

Step 4: Final Answer:
The correct match is A-III, B-I, C-IV, D-II.

Quick Tip

Create flashcards for micronutrients and their key functions. Some high-yield associations to remember are: - Zinc → Auxin synthesis - Molybdenum → Nitrate reductase - Boron → Pollen germination / Cell elongation - Iron → Catalase / Cytochromes - Manganese → Photolysis of water

---

38. 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 in 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: (A) Algal blooms caused by excess of organic matter in water improve water quality and promote fisheries

Solution:

Step 1: Understanding the Question:
The question asks to identify the incorrect statement among the four options provided, all of which relate to water pollution and its ecological consequences.

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

- **(A) Algal blooms caused by excess of organic matter in water improve water quality and promote fisheries:** This statement is incorrect. Algal blooms are a result of eutrophication, which is the enrichment of water bodies with nutrients (like nitrates and phosphates), often from organic waste or fertilizers. These blooms degrade water quality by imparting color and odor, and upon their death and decomposition, they lead to severe oxygen depletion (hypoxia or anoxia). This lack of oxygen causes mass death of fish and other aquatic organisms. Therefore, algal blooms severely harm, not promote, fisheries.

- **(B) Water hyacinth grows abundantly in eutrophic water bodies and leads to an imbalance in the ecosystem dynamics of the water body:** This statement is correct. Water hyacinth (*Eichhornia crassipes*) is an invasive aquatic weed that thrives in nutrient-rich (eutrophic) water. Its rapid growth covers the water surface, blocking sunlight for submerged plants and leading to oxygen depletion, thus disrupting the entire aquatic ecosystem.

- **(C) The amount of some toxic substances of industrial waste water increases in the organisms at successive trophic levels:** This statement is correct. This phenomenon is known as biomagnification (or bioamplification). Toxic substances that are not biodegradable, such as mercury and DDT, accumulate in an organism's tissues. As these organisms are eaten by others up the food chain, the concentration of the toxin increases at each successive trophic level.

- **(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:** This statement is correct. When sewage (organic matter) is discharged into water, decomposer microorganisms (like bacteria and fungi) begin to break it down. This decomposition is an aerobic process that consumes large amounts of dissolved oxygen (DO) from the water. The increased demand for oxygen is measured as Biochemical Oxygen Demand (BOD). If the BOD is high, the DO level can drop so low that fish and other aquatic life suffocate and die.

Step 3: Final Answer:
The incorrect statement is (A). Algal blooms are detrimental to water quality and fisheries.

Quick Tip

Remember that "eutrophication" sounds positive ("eu" means "good" or "well") but has negative ecological consequences. It means "well-fed" water, but this over-nutrition leads to algal blooms, high BOD, oxygen depletion, and ultimately, the death of aquatic life.

---

39. Match List I with List II :

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

Choose the correct answer from the options given below :

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

Solution:

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

Step 2: Detailed Explanation:
Let's analyze each item in List I and find its correct match in List II.

- **A. Oxidative decarboxylation:** This is a key step that links glycolysis and the Krebs cycle. It involves the conversion of pyruvate to acetyl-CoA. This reaction is catalyzed by the enzyme complex **Pyruvate dehydrogenase**. Therefore, **A matches with II**.

- **B. Glycolysis:** This is the initial pathway for glucose breakdown. It is also known as the **Embden-Meyerhof-Parnas (EMP) pathway**. Therefore, **B matches with IV**.

- **C. Oxidative phosphorylation:** This is the process where ATP is formed using the energy released from the transfer of electrons down a series of protein carriers. This entire setup is known as the **Electron transport system (ETS)** or electron transport chain (ETC). Therefore, **C matches with III**.

- **D. Tricarboxylic acid cycle (TCA Cycle):** This cycle is also known as the Krebs cycle or Citric Acid Cycle. The very first step of this cycle is the condensation of acetyl-CoA with oxaloacetate to form citrate. This reaction is catalyzed by the enzyme **Citrate synthase**. Therefore, **D matches with I**.

Step 3: Matching the pairs:
- A → II - B → IV - C → III - D → I
This combination corresponds to option (C).

Step 4: Final Answer:
The correct match is A-II, B-IV, C-III, D-I.

Quick Tip

Create a flowchart for cellular respiration. Label each major stage (Glycolysis, Link Reaction, Krebs Cycle, ETS) and write down the key enzymes, alternative names (like EMP pathway for Glycolysis), and main products. This will help you quickly solve matching questions.

---

40. Which of the following statements are correct about Klinefelter's Syndrome?
A. This disorder was first described by Langdon Down (1866).
B. Such an individual has overall masculine development. However, the feminine developement 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: (B) B and E only

Solution:

Step 1: Understanding the Question:
The question asks to identify the correct statements describing Klinefelter's Syndrome from a given list of five statements.

Step 2: Detailed Explanation:
Klinefelter's Syndrome is a genetic disorder caused by the presence of an extra X chromosome

in males, resulting in the karyotype 47, XXY. Let's evaluate each statement:

- **A. This disorder was first described by Langdon Down (1866):** This is incorrect. Langdon Down described Down's Syndrome. Klinefelter's Syndrome was described by Harry Klinefelter in 1942.

- **B. Such an individual has overall masculine development. However, the feminine developement is also expressed:** This is correct. Individuals are phenotypically male, but the extra X chromosome leads to the development of some feminine characteristics, such as gynaecomastia (development of breast tissue).

- **C. The affected individual is short statured:** This is incorrect. Individuals with Klinefelter's Syndrome are often taller than average, with long limbs. Short stature is characteristic of Turner's Syndrome (45, XO).

- **D. Physical, psychomotor and mental development is retarded:** This is incorrect. While some learning disabilities may occur, severe mental retardation is not a typical feature. The term "retarded" is also outdated and imprecise. Down's Syndrome is more commonly associated with developmental delays.

- **E. Such individuals are sterile:** This is correct. The presence of the extra X chromosome interferes with the normal development of the testes, leading to hypogonadism and sterility due to azoospermia (absence of sperm).

Step 3: Final Answer:
Based on the analysis, statements B and E are the only correct descriptions of Klinefelter's Syndrome. Therefore, the correct option is (B).

Quick Tip

To avoid confusion between chromosomal disorders, create a comparison table for Klinefelter's Syndrome (XXY Male), Turner's Syndrome (XO Female), and Down's Syndrome (Trisomy 21). Key features to compare are karyotype, sex, physical stature, fertility, and associated developmental characteristics.

---

41. Match List I with List II:

List I (Interaction)	List II (Species A and B)
A. Mutualism	I. +(A), 0(B)
B. Commensalism	II. -(A), 0(B)
C. Amensalism	III. +(A), -(B)
D. Parasitism	IV. +(A), +(B)

Choose the correct answer from the options given below:

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

Solution:

Step 1: Understanding the Question:
The question requires matching different types of ecological interactions (List I) with their symbolic representation (List II), where '+' indicates a benefit, '-' indicates harm, and '0' indicates no effect for the participating species A and B.

Step 2: Detailed Explanation:
Let's define each interaction and determine its symbolic representation:

- **A. Mutualism:** An interaction where both species benefit from the relationship. For example, the relationship between flowering plants and their pollinators. The representation is **+(A), +(B)**. Therefore, **A matches with IV**.

- **B. Commensalism:** An interaction where one species benefits, and the other is neither harmed nor benefited. For example, an orchid growing on a tree trunk. The orchid benefits from a place to grow, and the tree is unaffected. The representation is **+(A), 0(B)**. Therefore, **B matches with I**.

- **C. Amensalism:** An interaction where one species is harmed, and the other is unaffected. For example, the penicillium mold produces penicillin, which inhibits the growth of bacteria, but the mold itself derives no benefit or harm from this. The representation is **-(A), 0(B)**. Therefore, **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, ticks feeding on a dog. The representation is **+(A), -(B)**. Therefore, **D matches with III**.

Step 3: Matching the pairs:
- A $\rightarrow$ IV - B $\rightarrow$ I - C $\rightarrow$ II - D $\rightarrow$ III
This combination corresponds to option (A).

Step 4: Final Answer:
The correct match is A-IV, B-I, C-II, D-III.

Quick Tip

Use a simple table to memorize population interactions. Create three columns: Interaction Type, Species A Effect (+, -, 0), and Species B Effect (+, -, 0). This visual aid makes it easy to recall the relationships for matching or direct-answer questions.

---

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

Solution:

Step 1: Understanding the Question:
The question requires matching terms related to the properties of water and its transport in plants (List I) with their correct definitions or descriptions (List II).

Step 2: Detailed Explanation:
Let's analyze each term in List I and find its correct match in List II.

- **A. Cohesion:** This is the property of water molecules to be attracted to each other, primarily due to hydrogen bonds. This is a **mutual attraction among water molecules**. Therefore, **A matches with II**.

- **B. Adhesion:** This is the attraction of water molecules to a different substance. In plants, it refers to the attraction of water to the polar surfaces of the xylem cell walls. This is an **Attraction towards polar surfaces**. Therefore, **B matches with IV**.

- **C. Surface tension:** This is a consequence of cohesion. Water molecules at the surface are more strongly attracted to the water molecules below and beside them (in the liquid phase) than to the air molecules above. This creates a tension on the surface. It can be described as **More attraction in liquid phase** than in the gaseous phase. Therefore, **C matches with I**.

- **D. Guttation:** This is the exudation of water droplets (xylem sap) from the tips or margins of some vascular plants, such as grasses. It is a process of **water loss in liquid phase**, which occurs when transpiration is low and soil moisture is high. Therefore, **D matches with III**.

Step 3: Matching the pairs:
- A $\rightarrow$ II - B $\rightarrow$ IV - C $\rightarrow$ I - D $\rightarrow$ III
This combination corresponds to option (D).

Step 4: Final Answer:
The correct match is A-II, B-IV, C-I, D-III.

Quick Tip

To remember the difference between cohesion and adhesion:

- **Cohesion**: think "co-worker" - attraction between similar things (water-water).
- **Adhesion**: think "adhesive tape" - attraction between different things (water-xylem wall).

Also, distinguish Guttation (liquid water loss) from Transpiration (water vapor loss).

---

43. Given below are two statements:
Statement I: Gause's 'Competitive Exclusion Principle' states that two closely related species competing for the same resources cannot co-exist indefinitely and competitively inferior one will be eliminated eventually.
Statement II: In general, carnivores are more adversely affected by competition than herbivores.
In the light of the above statements, choose the correct answer from the options given below:

(A) Both Statement I and Statement II are 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: (B) Statement I is correct Statement II is false.

Solution:

Step 1: Understanding the Question:
The question presents two statements related to ecological principles. We need to evaluate the correctness of each statement.

Step 2: Detailed Explanation:
Analysis of Statement I:
This statement provides the definition of Gause's 'Competitive Exclusion Principle'. The principle, based on G.F. Gause's experiments with Paramecium species, posits that when two species compete for the exact same limited resources, one species will be more efficient and will eventually outcompete and eliminate the other. The definition given in the statement is accurate. Thus, **Statement I is correct**.

Analysis of Statement II:
This statement makes a generalization that carnivores are more adversely affected by competition than herbivores. This is a complex ecological issue, and such a broad generalization is often considered incorrect.

- **Competition among herbivores:** Herbivores can face intense competition, especially for high-quality forage. Overgrazing can deplete resources for all herbivore species in an area, leading to population declines. Competition for resources can be just as fierce as among carnivores.
- **Competition among carnivores:** Carnivores often compete for territory and mobile prey, which can be intense. However, they are often regulated by prey availability (a bottom-up control) as much as by direct competition (a top-down control).

Because competition can be extremely severe in both groups depending on specific environmental conditions, resource availability, and species involved, the generalization that one group is "more adversely affected" than the other is not universally true. Therefore, **Statement II is false**.

Step 3: Final Answer:
Statement I is a correct definition, while Statement II is an incorrect generalization. Therefore, Statement I is correct but Statement II is false.

Quick Tip

For statements making broad generalizations in ecology (e.g., "always," "in general," "more than"), be critical. Ecological interactions are highly complex and context-dependent. A principle like Gause's has a specific definition, which is easier to verify as true or false.

---

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: (A) A and D only

Solution:

Step 1: Understanding the Question:
The question asks to identify which of the five given statements about plant anatomy are correct.

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

- **A. Lenticels are the lens-shaped openings permitting the exchange of gases.** This is the correct definition. Lenticels are pores in the periderm of woody stems that allow for gaseous exchange between the internal tissues and the atmosphere. **(Correct)**
- **B. Bark formed early in the season is called hard bark.** This is incorrect. Bark formed early in the season (spring) is called 'early' or 'soft' bark. Bark formed late in the season (autumn) is called 'late' or 'hard' bark. **(Incorrect)**
- **C. Bark is a technical term that refers to all tissues exterior to vascular cambium.** This is incorrect. The error lies in the phrase "technical term". Bark is a **non-technical** term. While it does refer to tissues outside the vascular cambium, its classification as a "technical term" makes the statement false. **(Incorrect)**
- **D. Bark refers to periderm and secondary phloem.** This is a correct description of the components of bark. Bark is composed of the periderm (which includes phellem, phellogen, and phelloderm) and all the secondary phloem tissue. **(Correct)**
- **E. Phellogen is single-layered in thickness.** This is incorrect. Phellogen, or cork cambium, is a lateral meristem. Meristems are typically composed of a few layers of actively dividing cells, not just a single layer. **(Incorrect)**

Step 3: Final Answer:
Based on the analysis, only statements A and D are correct.

Quick Tip

Pay close attention to every word in a statement. In statement C, the definition of bark's location is correct, but the classification of the term as "technical" is the intended error. For statement B, remember the parallel with wood: early wood/bark has larger/softer cells due to favorable growing conditions.

45. 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 current 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: (B) 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 the Assertion (A) and the Reason (R) and then determine if R correctly explains A.

Step 2: Detailed Explanation:
Analysis of Assertion (A):
The statement says that in gymnosperms, pollen grains are released from the microsporangium and carried by air currents. This describes wind pollination (anemophily), which is the characteristic mode of pollination for the vast majority of gymnosperms (e.g., pines, firs). So, **Assertion A is true**.

Analysis of Reason (R):
This statement describes the events after pollination. Let's break it down:

- "Air currents carry the pollen grains to the mouth of the archegonia..." - This is inaccurate. The pollen grains are carried to the micropyle of the ovule, not directly to the archegonium which is located inside the ovule.
- "...where the male gametes are discharged..." - This happens only after the pollen grain germinates.
- "...and pollen tube is not formed." - This is the most significant error. Gymnosperms (with few primitive exceptions) are siphonogamous, which means they **do form a pollen tube**. The pollen tube grows through the nucellus to deliver the male gametes to the egg cell within the archegonium. The formation of a pollen tube is a key feature.

Since the statement claims a pollen tube is not formed, the entire reason is fundamentally flawed. So, **Reason R is false**.

Step 3: Final Answer:
Since Assertion A is true and Reason R is false, the correct option is (B).

Quick Tip

Remember that both gymnosperms and angiosperms exhibit siphonogamy, meaning they form a pollen tube. The key difference in their reproduction lies in aspects like the presence of an ovary (absent in gymnosperms, hence "naked seeds") and the process of double fertilization (absent in gymnosperms).

---

46. 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: (D) B, C, D, A

Solution:

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

Step 2: Key Formula or Approach:
The general workflow for creating recombinant DNA and transforming a host is as follows: 1. Isolate the source DNA (containing the gene of interest) and the vector DNA. 2. Cut both DNAs with the same restriction enzyme. 3. Isolate the gene of interest from the rest of the source DNA fragments. 4. Amplify the gene of interest to get many copies (optional but standard). 5. Ligate the gene of interest into the vector to create recombinant DNA. 6. Introduce this recombinant DNA into a suitable host organism.

Step 3: Detailed Explanation:
Let's apply this workflow to the given steps:

- **Step 1: B. Cutting of DNA at specific location by restriction enzyme.** This is the initial step to generate the fragments from which the gene will be selected. This is

done on both the source and vector DNA.

- **Step 2: C. Isolation of desired DNA fragment.** After cutting, the mixture of DNA fragments is separated (usually by gel electrophoresis), and the specific fragment containing the gene of interest is isolated.

- **Step 3: D. Amplification of gene of interest using PCR.** Once the desired fragment is isolated, Polymerase Chain Reaction (PCR) is used to create millions of copies of it, ensuring there is enough material for the next steps.

- **Step 4: A. Insertion of recombinant DNA into the host cell.** After the gene is ligated into a vector (a step not listed but implied between D and A), the final recombinant DNA molecule is introduced into the host cell through transformation.

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

Step 4: Final Answer:
The correct sequence of steps is B, C, D, A.

Quick Tip

Remember the logic of genetic engineering: "Cut, Paste, Copy, Insert."

- **Cut**: Use restriction enzymes (Step B).
- **Isolate/Select**: Isolate the piece you want (Step C).
- **Copy**: Make many copies using PCR (Step D).
- (**Paste**: Ligate into a vector - not listed).
- **Insert**: Put the final product into a host cell (Step A).

---

47. Match List I with List II :

List I	List II
A. M Phase	I. Proteins are synthesized
B. G_2 Phase	II. Inactive phase
C. Quiescent stage	III. Interval between mitosis and initiation of DNA replication
D. G_1 Phase	IV. Equational division

Choose the correct answer from the options given below :

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

Solution:

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

Step 2: Detailed Explanation:
Let's analyze each phase from List I:

- **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. Therefore, **A matches with IV**.

- **B. G_2 Phase:** This is the second gap phase, occurring after DNA synthesis (S phase) and before mitosis (M phase). During this phase, the cell continues to grow and **proteins are synthesized**, particularly those needed for mitosis like tubulin. Therefore, **B matches with I**.

- **C. Quiescent stage (G_0):** This is a resting or non-dividing stage that cells enter from G_1. While metabolically active, they are in an **Inactive phase** with respect to cell proliferation. Therefore, **C matches with II**.

- **D. G_1 Phase:** This is the first gap phase. It represents the **Interval between mitosis and initiation of DNA replication** (S phase). The cell grows and prepares for DNA synthesis during this phase. Therefore, **D matches with III**.

Step 3: Matching the pairs:
- A $\rightarrow$ IV - B $\rightarrow$ I - C $\rightarrow$ II - D $\rightarrow$ III
This combination corresponds to option (B).

Step 4: Final Answer:
The correct match is A-IV, B-I, C-II, D-III.

Quick Tip

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

- **G_1**: Gap 1 (after division, before DNA replication).
- **S**: Synthesis (DNA replication).
- **G_2**: Gap 2 (after DNA replication, before division).
- **M**: Mitosis (division).
- **G_0**: An exit ramp from G_1 for non-dividing cells.

---

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

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

Correct Answer: (D) 80

Solution:

Step 1: Understanding the Question:
The question asks for the number of different proteins found in a ribosome. Ribosomes are complex structures composed of ribosomal RNA (rRNA) and proteins. Their composition differs between prokaryotes and eukaryotes.

Step 2: Detailed Explanation:
Let's examine the protein composition of both prokaryotic and eukaryotic ribosomes:

- **Prokaryotic Ribosome (70S):**
  - Small subunit (30S): Contains 16S rRNA and about 21 proteins.
  - Large subunit (50S): Contains 23S and 5S rRNA, and about 34 proteins.
  - Total proteins: Approximately 21 + 34 = 55 proteins. This is close to the value of 60 in option (A).
- **Eukaryotic Ribosome (80S):**
  - Small subunit (40S): Contains 18S rRNA and about 33 proteins.
  - Large subunit (60S): Contains 28S, 5.8S, and 5S rRNA, and about 49 proteins.
  - Total proteins: Approximately 33 + 49 = 82 proteins. This is very close to the value of **80** in option (D).

Given the options, 80 is the most accurate answer, representing the approximate number of proteins in a eukaryotic ribosome. In biology questions without specified context (prokaryotic vs. eukaryotic), the eukaryotic model is often the default, or the options guide you to the intended answer. Here, 80 is a much better fit for the eukaryotic ribosome than any other option.

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

Quick Tip

Remember the ribosome types: Prokaryotes have 70S (50S + 30S) ribosomes, and Eukaryotes have 80S (60S + 40S) ribosomes. The eukaryotic ribosome is larger and more complex, containing more proteins (around 80) and larger rRNA molecules.

---

49. 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: (D) 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.

Step 2: Detailed Explanation:
Chemiosmosis, as proposed by Peter Mitchell, is the mechanism by which ATP is produced during cellular respiration and photosynthesis. It relies on the generation of a proton gradient across a membrane, which then drives ATP synthesis. The key requirements are:

1. **A Membrane:** An intact, impermeable membrane (like the inner mitochondrial membrane or the thylakoid membrane) is necessary to separate two compartments and maintain a concentration gradient.

2. **A Proton Pump:** This is a mechanism to actively transport protons (H^+) across the membrane from one compartment to another, against their concentration gradient. This is typically achieved by the energy released from electron transport chains.

3. **A Proton Gradient:** The pumping of protons creates a higher concentration of H^+ on one side of the membrane than the other. This electrochemical gradient is also known as the proton-motive force and stores potential energy.

4. **ATP Synthase:** This is a transmembrane enzyme complex that provides a channel for protons to flow back down their gradient. The kinetic energy from this proton flow is used by the enzyme to catalyze the synthesis of ATP from ADP and inorganic phosphate (Pi).

Now let's evaluate the options:
- (A) is incorrect because it lists NADP synthase instead of ATP synthase. - (B) and (C) are incorrect because they mention an "electron gradient." It is an electron *flow* that powers the proton pump to create a *proton gradient*. - (D) correctly lists all four essential components: **Membrane, proton pump, proton gradient, ATP synthase**.

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

Quick Tip

Think of chemiosmosis like a hydroelectric dam:

- **Membrane** = The dam wall.
- **Proton Pump** = The pumps that move water up into the reservoir.
- **Proton Gradient** = The reservoir of water held behind the dam (potential energy).
- **ATP Synthase** = The turbine that generates electricity (ATP) as water flows through it.

---

50. Given below are two statements : One is labelled as Assertion A and the other is labelled as Reason R :
Assertion A: A flower is defined as modified shoot wherein the shoot apical meristem changes to floral meristem.
Reason R: Internode of the shoot gets condensed to produce different floral appendages laterally at successive node instead of leaves.
In the light of the above statements, choose the correct answer from the options given below :

(A) Both A and R are true 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:
This is an Assertion-Reason question about the morphological nature of a flower. We must assess the validity of both statements and the explanatory link between them.

Step 2: Detailed Explanation:
Analysis of Assertion (A):
The statement defines a flower as a modified shoot. This is the fundamental concept in floral morphology. The vegetative shoot apical meristem, which normally produces leaves and elongates the stem, undergoes a transformation to become a floral meristem. This floral meristem has determinate growth and produces floral organs instead of leaves. The assertion is a standard and correct definition. So, **Assertion A is true**.

Analysis of Reason (R):
The statement describes the specific modifications that occur when a shoot becomes a flower. The axis of the shoot (which becomes the thalamus or receptacle) stops elongating, causing the internodes to become highly compressed or "condensed". The appendages produced at these successive, close-packed nodes develop into floral parts (sepals, petals, stamens, carpels) instead of typical foliage leaves. This statement accurately describes the morphological changes. So, **Reason R is true**.

Connecting A and R:
The Assertion makes the claim that a flower is a modified shoot. The Reason explains exactly how the shoot is modified (internodes condense, appendages become floral parts). Therefore, the Reason provides the structural evidence and mechanism for the claim made in the Assertion. Reason R is the correct explanation of Assertion A.

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

Quick Tip

Remember the evidence for the "flower as a modified shoot" theory:

- Homology: Floral parts and leaves have similar developmental origins.
- Position: Flowers arise in positions where shoots normally would (axillary or terminal).
- Structure: The thalamus is a condensed stem with nodes and internodes, and the floral parts are arranged on it.

This concept is central to understanding plant morphology.