CUET PG 2025 Botany Question Paper with Solutions

Time Allowed :1 Hour 30 Mins	Maximum Marks :300	Total Questions :75

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The examination duration is 90 minutes. Manage your time effectively to attempt all questions within this period.
2. The total marks for this examination are 300. Aim to maximize your score by strategically answering each question.
3. There are 75 mandatory questions to be attempted in the Agro forestry paper. Ensure that all questions are answered.
4. Questions may appear in a shuffled order. Do not assume a fixed sequence and focus on each question as you proceed.
5. The marking of answers will be displayed as you answer. Use this feature to monitor your performance and adjust your strategy as needed.
6. You may mark questions for review and edit your answers later. Make sure to allocate time for reviewing marked questions before final submission.
7. Be aware of the detailed section and sub-section guidelines provided in the exam. Understanding these will aid in effectively navigating the exam.

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1. Transformation in bacteria was discovered by:

(A) F. Griffith
(B) Lederberg and Tatum
(C) Avery
(D) McCarty

Correct Answer: (A) F. Griffith

Solution:

Step 1: Understanding the Concept:
The question asks to identify the scientist who discovered the process of transformation in bacteria. Transformation is the genetic alteration of a cell resulting from the direct uptake and incorporation of exogenous genetic material from its surroundings through the cell membrane.

Step 2: Detailed Explanation:

- **F. Griffith (1928):** Conducted experiments with two strains of *Streptococcus pneumoniae*, a virulent (S) strain and a non-virulent (R) strain. He observed that when heat-killed S-strain bacteria were mixed with live R-strain bacteria and injected into mice, the mice died. He isolated live S-strain bacteria from the dead mice. He concluded that some "transforming principle" from the heat-killed S-strain had been taken up by the live R-strain, transforming them into the virulent S-strain. This was the discovery of bacterial transformation.

- **Lederberg and Tatum (1946):** Discovered bacterial conjugation, a process of genetic transfer between bacterial cells through direct contact or a bridge-like connection.

- **Avery, McCarty, and Macleod (1944):** Expanded on Griffith's work to identify the "transforming principle." Through a series of experiments using enzymes to destroy different types of molecules (proteins, RNA, DNA), they proved that DNA was the genetic material responsible for transformation.

Therefore, while Avery and McCarty identified the molecule responsible for transformation, it was F. Griffith who first discovered the phenomenon itself.

Step 3: Final Answer:
Based on the historical context of these discoveries, Frederick Griffith is credited with the discovery of bacterial transformation.

Quick Tip

For questions about scientific discoveries, remember the timeline. Griffith's discovery of the *phenomenon* of transformation (1928) came before Avery, McCarty, and Macleod's identification of DNA as the *transforming principle* (1944).

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2. In angiosperms, which process involves the fusion of male gamete with the egg cell?

(A) Double fertilization
(B) Syngamy
(C) Fragmentation
(D) Pollination

Correct Answer: (B) Syngamy

Solution:

Step 1: Understanding the Concept:
The question asks for the specific term for the fusion of a male gamete with the female gamete (egg cell) in flowering plants (angiosperms).

Step 2: Detailed Explanation:
Let's analyze the given options in the context of angiosperm reproduction:

- **Pollination:** This is the process of transferring pollen grains from the anther to the stigma of a flower. It is a prerequisite for fertilization but is not the fusion of gametes itself.

- **Syngamy:** This is the general biological term for the fusion of two gametes to form a diploid zygote. In the context of angiosperms, it specifically refers to the fusion of one of the two male gametes with the egg cell.

- **Double fertilization:** This is a complex process unique to angiosperms. It involves two fertilization events:

  1. The fusion of one male gamete with the egg cell (this is **syngamy**) to form the zygote.
  2. The fusion of the second male gamete with the two polar nuclei in the central cell to form the triploid primary endosperm nucleus (PEN).

  While syngamy is a part of double fertilization, the question asks for the specific process of male gamete and egg cell fusion, which is most accurately described as syngamy.

- **Fragmentation:** This is a form of asexual reproduction where an organism breaks into fragments, each of which can develop into a new individual. It is not related to sexual reproduction involving gametes.

Step 3: Final Answer:
The fusion of the male gamete with the egg cell is precisely termed syngamy. Double fertilization is the larger event that includes syngamy. Therefore, syngamy is the most specific and correct answer.

Quick Tip

Be precise with terminology. While syngamy is a component of double fertilization in angiosperms, the term 'syngamy' specifically refers to the fusion of the male gamete and the egg. 'Double fertilization' refers to the entire process involving both fusions (syngamy and triple fusion).

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3. Which of the following is used to stain endospores?

(A) Safranin
(B) Malachite green
(C) Crystal violet
(D) Brilliant green

Correct Answer: (B) Malachite green

Solution:

Step 1: Understanding the Concept:
The question asks to identify the primary stain used in the endospore staining procedure. Endospores are dormant, tough, and non-reproductive structures produced by some bacteria. Their tough outer coating makes them resistant to typical staining methods.

Step 2: Detailed Explanation:
The most common method for staining endospores is the **Schaeffer-Fulton method**. This differential staining technique involves the following steps and reagents:

1. **Primary Stain:** Malachite green is applied to the bacterial smear. Heat is used as a mordant to force the stain into the resistant endospores. Both the vegetative cells and the endospores appear green at this stage.

2. **Decolorizer:** Water is used to wash the smear. The water-soluble malachite green is easily rinsed out from the vegetative cells but not from the endospores.

3. **Counterstain:** Safranin is applied. It stains the now colorless vegetative cells pink or red. The endospores retain the green color of the primary stain.

Let's look at the other options:

- **Safranin:** Used as the counterstain in both Gram staining and endospore staining.

- **Crystal violet:** Used as the primary stain in Gram staining.

- **Brilliant green:** A different type of stain, often used as a selective agent in culture media.

Step 3: Final Answer:
Based on the standard Schaeffer-Fulton endospore staining protocol, malachite green is the specific primary stain used to color the endospores.

Quick Tip

Associate stains with specific procedures: Crystal Violet and Safranin are key to Gram staining. Malachite Green and Safranin are key to endospore staining. This helps in quick recall during exams.

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4. Match the LIST-I with LIST-II

LIST-I (Family/Characteristic, etc.)	**LIST-II (Species/Examples)**
A. Myrtaceae	I. Psidium
B. Hypanthodium inflorescence	II. Carnation
C. Caryophyllaceae	III. Fig
D. Asteraceae	IV. Inula

Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
This question requires matching plant families or characteristics (List-I) with their corresponding example species (List-II). This tests knowledge of plant taxonomy and morphology.

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

- **A. Myrtaceae:** This is the myrtle family. A common example from this family is guava, whose scientific name is *Psidium guajava*. Thus, **A matches with I (Psidium)**.

- **B. Hypanthodium inflorescence:** This is a special type of inflorescence where the receptacle forms a flask-shaped structure with a terminal opening. The flowers are borne on the inner wall of this cavity. This is a characteristic feature of the genus *Ficus*, which includes the fig tree. Thus, **B matches with III (Fig)**.

- **C. Caryophyllaceae:** This is the carnation or pink family. Carnation (*Dianthus caryophyllus*) is the quintessential example of this family. Thus, **C matches with II (Carnation)**.

- **D. Asteraceae:** This is the sunflower or composite family, one of the largest families of flowering plants. *Inula* is a genus within this family. Thus, **D matches with IV (Inula)**.

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

Quick Tip

For "Match the Following" questions, start with the pairs you are most confident about. In this case, knowing that guava (*Psidium*) is in Myrtaceae (A-I) and fig has a hypanthodium inflorescence (B-III) can quickly narrow down the options.

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5. Which of the following bacteria belong to the coliform group ?
A. *Escherichia coli*
B. *Streptococcus faecalis*
C. *Clostridium perfringens*
D. *Bacillus*
Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
The question asks to identify bacteria that belong to the "coliform group". This term can have a strict microbiological definition and a broader application in water quality testing, where it's often used interchangeably with "fecal indicator bacteria".

Step 2: Detailed Explanation:

- **Strict Definition of Coliforms:** Coliforms are defined as rod-shaped, Gram-negative, non-spore-forming, facultative anaerobic bacteria that ferment lactose with the production of acid and gas at 35-37°C.

- **A. *Escherichia coli*:** Fits this definition perfectly and is the primary indicator of fecal contamination.
- **B. *Streptococcus faecalis* (now *Enterococcus faecalis*):** Is Gram-positive and coccus-shaped. It is not a coliform by definition.
- **C. *Clostridium perfringens*:** Is Gram-positive and forms spores. It is not a coliform.
- **D. *Bacillus*:** Is a genus of Gram-positive, spore-forming rods. It is not a coliform.

- **Broader Context (Fecal Indicators):** In many contexts, particularly older literature or applied environmental microbiology, the "coliform group" is discussed alongside other important indicators of fecal pollution.
  - **A. *E. coli*:** The classic fecal coliform.
  - **B. *S. faecalis*:** Used as an indicator of fecal pollution (fecal streptococci).
  - **C. *C. perfringens*:** Its spores can indicate past or remote fecal contamination due to their longevity.

Step 3: Analyzing the Options and Final Answer:
By the strict definition, only *E. coli* (A) is a coliform. However, there is no option for "A only". All options that include A also include other bacteria. This strongly suggests that the question is using a broader definition that encompasses key fecal indicator bacteria rather than adhering to the strict taxonomic/biochemical definition of coliforms. In this broader sense, *E. coli*, *S. faecalis*, and *C. perfringens* are all commonly monitored as indicators of fecal pollution. *Bacillus* species are generally environmental (soil) bacteria and not considered fecal indicators. Therefore, the most plausible intended answer is the group of common fecal indicator organisms.
This makes option (B) A, B, and C only, the best choice among the given alternatives.

Quick Tip

In competitive exams, if the technically correct answer isn't an option, re-evaluate the question's potential context. Here, "coliform group" is likely used as a synonym for "fecal indicator group," which makes an otherwise incorrect option the best fit.

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6. To increase the amount of mugineic acid, rice plants were transformed (using *Agrobacterium*) with a fragment of barley genomic DNA containing two *naat* genes; *naat-A* and *naat-B*, encoding the subunits of the enzyme

(A) S-adenosylmethionine synthetase
(B) Nicotinamine aminotransferase
(C) Nicotinamine synthase
(D) Deoxymugineic acid synthase

Correct Answer: (B) Nicotinamine aminotransferase

Solution:

Step 1: Understanding the Concept:
The question describes a genetic engineering experiment to enhance the production of mugineic acid in rice. It specifically mentions the introduction of two genes abbreviated as *naat-A* and *naat-B* and asks for the name of the enzyme they encode.

Step 2: Key Formula or Approach:
The key to solving this question lies in understanding the nomenclature used in molecular biology and biochemistry. The gene name often directly corresponds to the enzyme it encodes. Here, the gene is named *naat*. We need to identify the enzyme name that corresponds to this abbreviation.

Step 3: Detailed Explanation:
Let's break down the biosynthesis pathway for mugineic acids (a type of phytosiderophore):

$$\text{Methionine} \rightarrow \text{S-adenosylmethionine (SAM)} \xrightarrow{\text{NAS}} \text{Nicotianamine (NA)} \xrightarrow{\text{NAAT}} \text{3"-deamino-3"-oxonicotian}$$

The enzymes involved are:

- **NAS:** Nicotianamine Synthase
- **NAAT:** Nicotianamine Aminotransferase
- **DMAS:** Deoxymugineic Acid Synthase

The question explicitly states that the introduced genes are *naat-A* and *naat-B*. The abbreviation *naat* directly stands for **N**icotian**a**mine **A**mino**t**ransferase. Therefore, these genes encode the subunits of the enzyme Nicotinamine aminotransferase.

Step 4: Final Answer:
The genes *naat-A* and *naat-B* encode the enzyme Nicotinamine aminotransferase.

Quick Tip

In molecular biology questions, gene names are often acronyms or abbreviations of the enzyme or protein they encode. Pay close attention to these abbreviations, as they provide a direct clue to the answer (e.g., *naat* for Nicotinamine Aminotransferase).

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7. Guttation occurs when:

(A) Transpiration rate is very high
(B) Transpiration rate is very low
(C) Cell sap is pure water
(D) Temperature is high

Correct Answer: (B) Transpiration rate is very low

Solution:

Step 1: Understanding the Concept:
Guttation is the exudation of liquid water (xylem sap) from the tips or margins of leaves, through special pores called hydathodes. The question asks for the environmental condition that leads to guttation.

Step 2: Detailed Explanation:
Guttation is a result of a specific interplay between root pressure and transpiration rate.

- **Root Pressure:** When soil moisture is high, water actively enters the root xylem due to osmotic potential. This builds up a positive hydrostatic pressure, known as root pressure, which pushes water up the xylem column from below.

- **Transpiration:** This is the process of water vapor loss from the plant, primarily through stomata in the leaves. Transpiration creates a negative pressure or tension (transpirational pull) that pulls water up the xylem.

Guttation occurs when:

1. **Root pressure is high:** This typically happens at night when the soil is moist and mineral ions are actively transported into the root xylem, causing water to follow by osmosis.

2. **Transpiration rate is very low:** This also typically occurs at night due to high humidity, low temperatures, and closed stomata. With transpiration being negligible, the transpirational pull is absent. The positive pressure from the roots continues to push water up the xylem. Since this water cannot escape as vapor, it is forced out in liquid form through the hydathodes.

Let's analyze the options based on this understanding:

- (A) Transpiration rate is very high: This would lead to rapid water loss as vapor, preventing any liquid exudation. This is incorrect.

- (B) Transpiration rate is very low: This condition, combined with positive root pressure, is precisely what causes guttation. This is correct.

- (C) Cell sap is pure water: Cell sap (and xylem sap) is a solution of water, minerals, and organic substances; it is never pure water. This is incorrect.

- (D) Temperature is high: High temperatures usually increase the rate of transpiration (unless humidity is 100%), which would inhibit guttation. This is incorrect.

Step 3: Final Answer:
The primary condition that allows root pressure to cause the exudation of liquid water is a very low rate of transpiration.

Quick Tip

Remember the key difference: Transpiration is the loss of water as *vapor* from stomata, driven by a pull from above. Guttation is the loss of water as *liquid* from hydathodes, driven by a push from below (root pressure). Guttation happens when the "pull" (transpiration) is weak or absent.

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8. A flower is hypogynous with axile placentation and swollen placenta. Which family does this flower belong to?

(A) Asteraceae
(B) Lamiaceae
(C) Solanaceae
(D) Malvaceae

Correct Answer: (C) Solanaceae

Solution:

Step 1: Understanding the Concept:
The question asks to identify a plant family based on a specific combination of floral characteristics. We need to analyze each characteristic and see which family fits the description.

Step 2: Detailed Explanation:
Let's break down the given floral characteristics:

- **Hypogynous flower:** This means the flower has a superior ovary. The petals, sepals, and stamens are attached at the base of the ovary.
- **Axile placentation:** The ovary is partitioned into two or more chambers (locules), and the ovules are attached to the central axis where the partitions meet.
- **Swollen placenta:** The placenta (the tissue to which the ovules are attached) is fleshy and enlarged.

Now let's examine the options:

- **(A) Asteraceae:** This family typically has an inferior ovary (epigynous flower) and basal placentation. This does not match.

- **(B) Lamiaceae:** This family has a superior ovary (hypogynous) and axile placentation. However, the placenta is not typically swollen, and the ovary is characteristically divided

into four locules by a false septum.

- **(C) Solanaceae:** This family is characterized by having a superior ovary (hypogynous), bicarpellary syncarpous gynoecium, and axile placentation with a prominent, swollen placenta on which numerous ovules are borne. The septum is often oblique. This is a perfect match for the description. A classic example is the tomato (*Solanum lycopersicum*).

- **(D) Malvaceae:** This family has a superior ovary (hypogynous) and axile placentation, but the placenta is not characteristically swollen as described for Solanaceae.

Step 3: Final Answer:
The combination of a hypogynous flower, axile placentation, and a swollen placenta is a distinct characteristic of the family Solanaceae.

Quick Tip

To master questions on plant families, create a comparative chart of key characteristics (ovary position, placentation, inflorescence, fruit type) for major families like Solanaceae, Fabaceae, Asteraceae, and Malvaceae. The swollen placenta is a very strong keyword for Solanaceae.

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9. Flooding stress is also known as:

(A) Chilling stress
(B) Reactive oxygen species
(C) Oxygen deficient stress
(D) Drought stress

Correct Answer: (C) Oxygen deficient stress

Solution:

Step 1: Understanding the Concept:
The question asks for another name for flooding stress in plants. Flooding stress refers to the adverse conditions experienced by a plant when its root zone is saturated with water for an extended period.

Step 2: Detailed Explanation:
When soil is flooded, the water displaces the air present in the soil pores. Plant roots require oxygen for cellular respiration to produce the ATP needed for nutrient uptake and other metabolic activities.

- The lack of air in waterlogged soil leads to a condition of low oxygen (hypoxia) or no oxygen (anoxia) for the roots.
- This directly translates to an "oxygen deficient stress" because the primary problem for the plant roots is the inability to respire aerobically.

Let's analyze the other options:

- **(A) Chilling stress:** Caused by exposure to low, non-freezing temperatures. This is unrelated to flooding.
- **(B) Reactive oxygen species (ROS):** ROS are harmful molecules produced as a byproduct of metabolism under various stress conditions, including oxygen deficiency. However, ROS are a *consequence* of the stress, not the stress itself.
- **(D) Drought stress:** This is caused by a lack of water, which is the complete opposite of flooding stress.

Step 3: Final Answer:
The primary physiological challenge imposed by flooding is the lack of oxygen for the root system. Therefore, it is correctly known as oxygen deficient stress.

Quick Tip

For questions on abiotic stress, focus on the primary causal factor. For flooding, it's water displacing air, leading to lack of O. For drought, it's lack of HO. For salinity, it's high salt concentration causing osmotic stress and ion toxicity.

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10. What is the role of NAD(P)H as a component of Nitrate reductase in Nitrogen fixation?

(A) As a prosthetic group
(B) As a cofactor
(C) As an electron donor
(D) As an electron accepter

Correct Answer: (C) As an electron donor

Solution:

Step 1: Understanding the Concept:
The question asks for the specific function of NAD(P)H in the enzymatic reaction catalyzed by Nitrate reductase. This enzyme is crucial for nitrogen assimilation (not fixation) in plants,

where nitrate is converted to a usable form.

Step 2: Detailed Explanation:
The enzyme Nitrate reductase catalyzes the reduction of nitrate (NO) to nitrite (NO). This is the first step in converting nitrate absorbed from the soil into ammonia for use in amino acid synthesis. The chemical reaction is a redox reaction:

$$NO_3^- + NAD(P)H + H^+ \xrightarrow{\text{Nitrate reductase}} NO_2^- + NAD(P)^+ + H_2O$$

In this reaction:

- **Nitrate (NO)** gains electrons, so it is reduced. It acts as the electron accepter.
- **NAD(P)H** loses electrons (and a proton) to become NAD(P), so it is oxidized. A substance that gets oxidized in a reaction provides electrons to another substance.

Therefore, the role of NAD(P)H is to provide the reducing power, i.e., to act as the **electron donor**.

Step 3: Analysis of Options:

- **(A) As a prosthetic group:** A prosthetic group is a non-protein component that is tightly and permanently bound to an enzyme. NAD(P)H is a coenzyme (or cosubstrate) that binds transiently to the enzyme. Thus, this is incorrect.

- **(B) As a cofactor:** While NAD(P)H is a type of cofactor (specifically, a coenzyme), this term is general. "Electron donor" describes its specific chemical role in this particular reaction, which is more precise.

- **(C) As an electron donor:** This accurately describes its function of providing electrons to reduce nitrate. This is the correct and most specific answer.

- **(D) As an electron accepter:** This is incorrect. Nitrate is the electron accepter.

Step 4: Final Answer:
The specific role of NAD(P)H in the nitrate reductase reaction is to donate electrons for the reduction of nitrate.

Quick Tip

Remember the mnemonic OIL RIG: Oxidation Is Loss (of electrons), Reduction Is Gain (of electrons). In the reaction, NAD(P)H becomes NAD(P), losing electrons (Oxidation), so it must be the electron donor.

11. White jute is obtained from:

(A) *Corchorus olitorius*
(B) *Corchorus capsularis*
(C) *Cocus nucifera*
(D) *Crotalaria juncea*

Correct Answer: (B) *Corchorus capsularis*

Solution:

Step 1: Understanding the Concept:
The question asks for the botanical source of "White jute," a commercially important plant fiber. This requires knowledge of economic botany.

Step 2: Detailed Explanation:
Jute is one of the most important natural fibers, obtained from the stem (bast fiber) of plants belonging to the genus *Corchorus*. There are two main cultivated species:

- ***Corchorus capsularis*:** This species is commonly known as **White Jute**. It is characterized by its round seed pods ('capsularis' refers to the capsule). The fiber is lighter in color.

- ***Corchorus olitorius*:** This species is known as **Tossa Jute** or Nalta Jute. It has long, cylindrical seed pods. Its fiber is generally stronger, softer, and more lustrous but can be more brownish.

Let's look at the other options:

- ***Cocus nucifera*:** This is the coconut palm. The fiber obtained from its husk is called coir, not jute.

- ***Crotalaria juncea*:** This plant is known as Sunn hemp, which is another important source of bast fiber, but it is not jute.

Step 3: Final Answer:
Based on the common names associated with the species, White jute is obtained from *Corchorus capsularis*.

Quick Tip

For economic botany questions, link the common name of the product (e.g., White Jute, Tossa Jute, Cotton, Coir) to its specific botanical source (*Corchorus capsularis*, *Corchorus olitorius*, *Gossypium* spp., *Cocus nucifera*).

12. The major phytochemicals present in leaves of *Camellia sinensis* are:
A. Epicatechin gallate
B. Caffeine
C. Theobromine
D. Epigallocatechin gallate
Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
The question asks to identify the major phytochemicals found in the leaves of *Camellia sinensis*, the plant used to make tea. This involves knowing the main chemical constituents of tea.

Step 2: Detailed Explanation:
The chemical composition of tea leaves is complex, but the major bioactive components fall into two main categories: polyphenols (specifically flavonoids) and alkaloids.

- **Polyphenols (Catechins):** These are the most abundant compounds. The major catechins in tea are Epigallocatechin gallate (EGCG), Epigallocatechin (EGC), Epicatechin gallate (ECG), and Epicatechin (EC). Both **(A) Epicatechin gallate** and **(D) Epigallocatechin gallate** are very significant components. EGCG is typically the most abundant.

- **Alkaloids (Methylxanthines):** The primary alkaloids are caffeine and theobromine. **(B) Caffeine** is a major component, responsible for tea's stimulating effects. **(C) Theobromine** is also present, but typically in much smaller quantities than caffeine.

Step 3: Analysis of Options:
All four listed compounds are present in tea leaves. However, the question asks for the "major" phytochemicals, and the options require us to select a subset of three.

- (A) Epicatechin gallate, (B) Caffeine, and (D) Epigallocatechin gallate are all present in high concentrations and are considered major components.
- (C) Theobromine, while present, is considered a minor alkaloid compared to caffeine in *Camellia sinensis*.
- Therefore, the best option that groups the most significant components is the one that includes A, B, and D, while excluding the least abundant one, C.

The combination of A, B, and D represents the key catechins and the primary alkaloid, making it the most accurate choice for "major phytochemicals".

Step 4: Final Answer:
The most appropriate answer is (C) A, B and D only, as it includes the most abundant catechins and the primary alkaloid, while excluding the minor alkaloid theobromine.

Quick Tip

When a question asks for "major" components and all listed options are technically present, look for the ones that are most abundant or most characteristic. In tea, EGCG and Caffeine are the stars. Theobromine is more associated with cacao (*Theobroma cacao*).

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13. Match the LIST-I with LIST-II

LIST-I **Plant Name**	**LIST-II** **Most common part as medicine**
A. *Withania somnifera*	I. Fruit
B. *Aloe barbedensis*	II. All parts of plants
C. *Aegle marmelos*	III. Root
D. *Datura metel*	IV. Leaves

Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
This question tests knowledge of medicinal plants, specifically which part of the plant is most commonly used for its therapeutic properties.

Step 2: Detailed Explanation:
Let's match each plant from List-I with its primary medicinal part from List-II.

- **A. *Withania somnifera* (Ashwagandha):** This is a well-known adaptogenic herb in Ayurveda. The part most valued for its medicinal properties is the **Root**. So, **A matches with III**.

- **B. *Aloe barbadensis* (Aloe vera):** The thick, fleshy **Leaves** of this plant contain the gel and latex that are widely used for skin conditions and as a laxative. So, **B matches with IV**.

- **C. *Aegle marmelos* (Bael):** The **Fruit** of the Bael tree, both ripe and unripe, is used extensively in traditional medicine, particularly for digestive ailments like diarrhea and dysentery. So, **C matches with I**.

- **D. *Datura metel*:** This plant contains potent tropane alkaloids and is toxic. In traditional medicine, various parts including the leaves, flowers, and seeds are used, often externally. Given the options, and after matching the other three with their specific parts, the most fitting description is **All parts of plants**, as the active principles are distributed throughout the plant. So, **D matches with II**.

Step 3: Final Answer:
By combining the correct matches, we get the following sequence:

- A $\rightarrow$ III
- B $\rightarrow$ IV
- C $\rightarrow$ I
- D $\rightarrow$ II

This corresponds to the option (D) A-III, B - IV, C - I, D - II.

Quick Tip

In matching questions, solve the pairs you are most certain about first. For example, knowing Ashwagandha (*Withania*) = Root and Aloe = Leaves immediately narrows down the possible answers, making it easier to deduce the remaining pairs.

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14. The botanical name of Fenugreek (methi):

(A) *Papaver somniferum*
(B) *Trigonella foenum-graecum*
(C) *Nigella sativa*
(D) *Elettaria cardamomum*

Correct Answer: (B) *Trigonella foenum-graecum*

Solution:

Step 1: Understanding the Concept:
The question requires the identification of the correct botanical (scientific) name for the common spice Fenugreek, also known as 'methi'.

Step 2: Detailed Explanation:
Let's analyze the given options, which are all botanical names of well-known plants:

- **(A) *Papaver somniferum*:** This is the scientific name for the Opium Poppy, a source of opium and poppy seeds.
- **(B) *Trigonella foenum-graecum*:** This is the correct and universally accepted botanical name for Fenugreek. It belongs to the family Fabaceae (the legume family).
- **(C) *Nigella sativa*:** This is the scientific name for Black Cumin or Kalonji, another common spice.
- **(D) *Elettaria cardamomum*:** This is the scientific name for Cardamom, also a very popular spice.

Step 3: Final Answer:
Based on botanical nomenclature, Fenugreek (methi) is identified as *Trigonella foenum-graecum*.

Quick Tip

It's highly beneficial to memorize the botanical names of common spices, cereals, pulses, and medicinal plants as they are frequently asked in competitive exams. Create flashcards for quick revision.

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15. Match the LIST-I with LIST-II

LIST-I **Class of Mutagens**	**LIST-II** **Examples**
A. Alkylating agent	I. Acridine Orange
B. Base analog	II. Nitrous acid
C. Intercalating agent	III. Mustard gas
D. Deamination agent	IV. 5-Bromouracil

Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
The question requires matching different classes of chemical mutagens with their correct examples. A mutagen is a physical or chemical agent that changes the genetic material, usually DNA, of an organism.

Step 2: Detailed Explanation:
Let's analyze and match each class of mutagen in List-I:

- **A. Alkylating agent:** These agents donate an alkyl group (e.g., -CH, -CHCH) to amino or keto groups in nucleotides. This alters base-pairing properties. **Mustard gas** is a classic example of an alkylating agent. Thus, **A matches with III**.

- **B. Base analog:** These are molecules that are structurally similar to the normal purine and pyrimidine bases in DNA. They can be incorporated into DNA during replication and cause mispairing. **5-Bromouracil** is an analog of thymine. Thus, **B matches with IV**.

- **C. Intercalating agent:** These are flat, planar molecules that can insert themselves (intercalate) between the stacked base pairs of DNA. This insertion distorts the double helix and can lead to frameshift mutations during DNA replication. **Acridine Orange** is a well-known intercalating agent. Thus, **C matches with I**.

- **D. Deamination agent:** These agents work by removing an amino group (-NH) from a nucleotide base. **Nitrous acid** (HNO) deaminates cytosine to uracil and adenine to hypoxanthine, causing incorrect base pairing. Thus, **D matches with II**.

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

Quick Tip

For mutagen questions, focus on the mechanism of action. 'Alkylating' adds alkyl groups, 'Base analog' mimics a base, 'Intercalating' inserts between bases, and 'Deamination' removes an amino group. Connecting the name to the mechanism helps in recalling examples.

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16. A specimen cited in the protologue is neither the holotype nor an isotype, nor one of the syntypes. This specimen is known as:

(A) Topotype
(B) Paratype
(C) Neotype
(D) Epitype

Correct Answer: (B) Paratype

Solution:

Step 1: Understanding the Concept:
The question asks for the correct term for a specific type of botanical specimen used in taxonomy, based on its definition according to the International Code of Nomenclature for algae, fungi, and plants (ICN). The key is understanding the definitions of different 'type' specimens. The question text in the source appears to be a combination of two separate definitions, but the first sentence clearly defines one of the options.

Step 2: Detailed Explanation:
Let's define the terms related to type specimens:

- **Holotype:** The single specimen or illustration designated by the author as the nomenclatural type.
- **Isotype:** Any duplicate specimen of the holotype.
- **Syntype:** Any one of two or more specimens cited by the author when no holotype was designated, or any one of two or more specimens simultaneously designated as types.
- **Paratype:** A specimen cited in the protologue (the original description) that is neither the holotype nor an isotype, nor one of the syntypes. This definition exactly matches the question.
- **Topotype:** A specimen collected from the same locality as the holotype. It's a geographical term, not a formal type designation under the ICN.
- **Neotype:** A specimen selected to serve as the type when all original material is lost or destroyed.
- **Epitype:** A specimen selected to serve as an interpretative type when the holotype or other original type material is demonstrably ambiguous.

Step 3: Final Answer:
The definition provided in the question—"A specimen cited in the protologue is neither the holotype nor an isotype, nor one of the syntypes"—is the precise definition of a **Paratype**.

Quick Tip

Remember the hierarchy and purpose of type specimens. The holotype is the primary reference. Isotypes are duplicates. Paratypes are other specimens listed in the original publication. Neotypes are replacements for lost material. Understanding this logic helps differentiate them.

17. Match the LIST-I with LIST-II

LIST-I **Gene Interaction**	**LIST-II** **Dihybrid ratio for a single character**
A. Duplicate dominant epistasis	I. 9:7
B. Duplicate recessive epistasis	II. 15:1
C. Recessive epistasis	III. 9:3:4
D. Dominant & Recessive Epistasis	IV. 13:3

Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
This question tests the knowledge of modified Mendelian dihybrid ratios that result from different types of gene interactions, specifically epistasis. Epistasis occurs when the effect of one gene is masked or modified by another gene at a different locus. The standard dihybrid ratio is 9:3:3:1, which gets modified in epistasis.

Step 2: Detailed Explanation:
Let's match each type of gene interaction with its characteristic phenotypic ratio:

- **A. Duplicate dominant epistasis:** The dominant allele at either of the two loci (A_B_, A_bb, or aaB_) produces the same dominant phenotype. Only the double recessive genotype (aabb) produces the recessive phenotype. The ratio becomes (9+3+3) : 1, which is **15:1**. Thus, **A matches with II**.

- **B. Duplicate recessive epistasis (Complementary genes):** The dominant alleles at both loci are required to produce the dominant phenotype (A_B_). All other genotypes (A_bb, aaB_, aabb) produce the recessive phenotype. The ratio becomes 9 : (3+3+1), which is **9:7**. Thus, **B matches with I**.

- **C. Recessive epistasis:** A recessive genotype at one locus (e.g., aa) masks the expression of alleles at another locus (B/b). The genotypes A_B_ and A_bb produce two different phenotypes, while aaB_ and aabb produce a third, single phenotype. The ratio becomes 9 : 3 : (3+1), which is **9:3:4**. Thus, **C matches with III**.

- **D. Dominant & Recessive Epistasis (or Dominant Inhibitory Epistasis):** The question uses a slightly ambiguous term, but the ratio 13:3 is characteristic of a specific interaction where a dominant allele at one locus (A) and the recessive genotype at that same locus (aa) combined with the recessive genotype at the second locus (bb) produce the same phenotype. Essentially, the dominant allele at the second locus (B) is required for the alternative phenotype, but only when the first locus is not dominant (aaB_). A more common name is Dominant Inhibitory Epistasis where a dominant allele at one locus suppresses the expression of the other locus. This leads to a (9+3+1) : 3 or **13:3** ratio. Thus, **D matches with IV**.

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

Quick Tip

To quickly derive these ratios, start with the standard 9:3:3:1. For "duplicate recessive," you need both dominant genes, so only the '9' group is different (9:7). For "duplicate dominant," you need only one dominant gene, so only the '1' group (double recessive) is different (15:1). For "recessive epistasis," the double recessive 'aa' group masks the 'B' gene, so group '3' (aaB_) and '1' (aabb) are combined (9:3:4).

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18. Match the LIST-I with LIST-II

LIST-I (Characteristic, feature)	**LIST-II (Family)**
A. Monoadelphous stamen	I. Malvaceae
B. Cremocarp	II. Lamiaceae
C. Gynobasic style	III. Apiaceae
D. Capitulum	IV. Asteraceae

Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
This question requires matching specific morphological features (related to androecium, fruit,

gynoecium, and inflorescence) with the plant families in which they are characteristic.

Step 2: Detailed Explanation:
Let's analyze each characteristic in List-I:

- **A. Monoadelphous stamen:** This condition, where all stamens are fused by their filaments into a single tube (staminal tube) surrounding the style, is a hallmark characteristic of the family **Malvaceae** (the Mallow family, which includes cotton and hibiscus). Thus, **A matches with I**.

- **B. Cremocarp:** This is a special type of dry schizocarpic fruit that splits into two one-seeded segments called mericarps. This fruit type is characteristic of the family **Apiaceae** (also known as Umbelliferae, the Carrot family). Thus, **B matches with III**.

- **C. Gynobasic style:** In this condition, the style arises from the base of a deeply four-lobed ovary. This is a defining feature of the family **Lamiaceae** (also known as Labiatae, the Mint family). Thus, **C matches with II**.

- **D. Capitulum:** Also known as a head, this is an inflorescence consisting of a dense cluster of small, sessile flowers arranged on a common receptacle. This is the characteristic inflorescence of the family **Asteraceae** (also known as Compositae, the Sunflower family). Thus, **D matches with IV**.

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

Quick Tip

Certain features are extremely strong indicators for specific families. For exams, memorize these key associations: Monoadelphous stamens → Malvaceae; Gynobasic style → Lamiaceae; Capitulum → Asteraceae; Cremocarp fruit → Apiaceae.

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19. In which of the following molecular markers, polymerase chain reaction (PCR) is required?
A. Restriction Fragment Length Polymorphism (RFLP)
B. Random Amplified Polymorphic DNAs (RAPD)
C. Amplified Fragment Length Polymorphism (AFLP)
D. Sequence-Tagged Sites (STSs)
Choose the correct answer from the options given below:

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

(D) B, C and D only

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

Solution:

Step 1: Understanding the Concept:
The question asks to identify which of the listed molecular marker techniques rely on the Polymerase Chain Reaction (PCR) as a core part of their methodology. PCR is a technique used to amplify specific segments of DNA.

Step 2: Detailed Explanation:
Let's examine each marker technique:

- **A. Restriction Fragment Length Polymorphism (RFLP):** This is a non-PCR based technique. It involves cutting genomic DNA with restriction enzymes, separating the resulting fragments by gel electrophoresis, and then using a labeled probe to detect specific fragments via Southern blotting. No amplification step is involved.

- **B. Random Amplified Polymorphic DNAs (RAPD):** The name itself says "Amplified". This technique uses short, arbitrary primers to amplify random segments of the genomic DNA using PCR. The presence or absence of amplified bands indicates polymorphism. PCR is essential.

- **C. Amplified Fragment Length Polymorphism (AFLP):** This technique also has "Amplified" in its name. It is a multi-step process that begins with restriction digestion of DNA, followed by ligation of specific adapters, and then selective PCR amplification of a subset of these fragments. PCR is essential.

- **D. Sequence-Tagged Sites (STSs):** An STS is a short, unique sequence in a genome. Its presence within a DNA sample is detected by designing specific primers for that sequence and performing a PCR assay. A successful amplification (producing a band of the expected size) confirms the presence of the STS. PCR is essential.

Step 3: Final Answer:
Based on the analysis, RAPD, AFLP, and STS are all PCR-based techniques, while RFLP is not. Therefore, the correct group is B, C, and D.

Quick Tip

A quick way to solve this is to look for the word "Amplified" in the name of the marker (like in RAPD and AFLP), which is a direct giveaway that PCR is involved. For others, remember that RFLP is the classic, non-PCR hybridization-based method.

20. The genera which belongs to the family Characeae are:
A. *Tolypella*
B. *Nitella*
C. *Nigella*
D. *Chara*
Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
The question asks to identify which of the given genera are members of the family Characeae. The Characeae are a family of green algae in the order Charales, commonly known as stoneworts.

Step 2: Detailed Explanation:
Let's analyze each genus listed:

- **A. *Tolypella*:** This is a well-established genus within the family Characeae. It is closely related to *Chara* and *Nitella*.

- **B. *Nitella*:** This is another prominent and widely distributed genus belonging to the family Characeae.

- **C. *Nigella*:** This is a genus of flowering plants (angiosperms) belonging to the family Ranunculaceae (the buttercup family). A famous species is *Nigella sativa* (black cumin). It is not an alga and does not belong to Characeae.

- **D. *Chara*:** This is the type genus for the family Characeae and the order Charales. It is one of the most common and well-studied stoneworts.

Step 3: Final Answer:
The genera *Tolypella*, *Nitella*, and *Chara* are all members of the family Characeae. The genus *Nigella* is a flowering plant. Therefore, the correct combination is A, B, and D.

Quick Tip

Be careful with similar-sounding names in biology. *Nitella* (an alga) and *Nigella* (a flowering plant) are easily confused. Recalling that *Nigella sativa* is a spice can help you immediately identify it as a flowering plant and exclude it from an algal family.

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21. The elements of the xylem are:
A. Tracheids
B. Vessels
C. Xylem parenchyma
D. Sclereids
Choose the correct answer from the options given below :

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

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

Solution:

Step 1: Understanding the Concept:
The question asks to identify the constituent elements of xylem tissue. Xylem is a complex permanent tissue in vascular plants responsible for conducting water and minerals from the roots to the rest of the plant and providing mechanical support.

Step 2: Detailed Explanation:
Xylem is composed of four main types of cells or elements:

1. **Tracheids (A):** These are elongated, tube-like cells with tapering ends and lignified walls. They are the primary water-conducting elements in gymnosperms and pteridophytes.
2. **Vessels (B):** These are long cylindrical structures made up of many cells called vessel members, arranged end to end. They are the main water-conducting tissue in angiosperms.
3. **Xylem Parenchyma (C):** These are living parenchymatous cells associated with xylem. They are responsible for the storage of food materials and the radial conduction of water.
4. **Xylem Fibres:** These are sclerenchymatous cells that provide mechanical strength to the plant body.

Now let's look at option D:

- **Sclereids (D):** Sclereids (or stone cells) are a type of sclerenchyma tissue. While xylem fibres are also sclerenchymatous, sclereids are not considered one of the four fundamental components of xylem tissue. Sclereids are typically found in other parts of the plant like the cortex, pith, fruit walls, and seed coats, providing hardness and support.

Therefore, the primary elements that constitute the xylem tissue are tracheids, vessels, and xylem parenchyma (along with xylem fibres). Sclereids are not a standard component.

Step 3: Final Answer:
The correct elements of xylem listed in the options are A (Tracheids), B (Vessels), and C (Xylem parenchyma). Thus, the correct choice is A, B and C only.

Quick Tip

Remember the four components of xylem as "TV-XF-XP": Tracheids, Vessels, Xylem Fibres, and Xylem Parenchyma. Note that both xylem fibres and sclereids are types of sclerenchyma, but only fibres are listed as a main component of xylem.

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22. The role of Bulliform cells in monocotyledonous leaves is :

(A) to prevent excessive transpiration by rolling of leaves
(B) to protect the mesophyll cells of the leaf
(C) in exchange of gases with the surrounding environment.
(D) in storage

Correct Answer: (A) to prevent excessive transpiration by rolling of leaves

Solution:

Step 1: Understanding the Concept:
The question asks for the primary function of bulliform cells, which are specialized cells found in the leaves of many monocots, particularly grasses.

Step 2: Detailed Explanation:
Bulliform cells are large, thin-walled, highly vacuolated, and bubble-shaped cells located in the adaxial (upper) epidermis of the leaf. Their function is directly related to the plant's water status.

- **Under turgid conditions (sufficient water):** The bulliform cells are full of water and swollen (turgid). This keeps the leaf blade flat and fully exposed to sunlight for photosynthesis.
- **Under flaccid conditions (water stress):** When the plant loses water due to excessive transpiration or lack of water absorption, the bulliform cells lose their turgor pressure and become flaccid. This causes the leaf to curl or roll inwards, with the adaxial surface on the inside.

The rolling of the leaf reduces the surface area exposed to the dry, outside air. This in turn reduces the rate of water loss (transpiration) and helps the plant conserve water during periods of drought. This is a hygroscopic movement.

Step 3: Final Answer:
The main role of bulliform cells is to facilitate the rolling and unrolling of the leaf to regulate water loss. Therefore, their function is to prevent excessive transpiration by causing the leaves to roll up.

Quick Tip

Associate "Bulliform cells" with "rolling leaves" in grasses. This is a mechanism to combat water stress. Think of it as the leaf folding up to protect itself from drying out.

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23. Match the LIST-I with LIST-II

LIST-I **Types of Sclereids**	**LIST-II** **Examples**
A. Astrosclereids	I. Leaves of Monocots
B. Macrosclereids	II. Olive leaves
C. Osteosclereids	III. Kidney bean seeds
D. Trichosclereids	IV. *Nymphea* leaves

Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
The question requires matching different morphological types of sclereids (stone cells) with plant parts where they are characteristically found. Sclereids are a type of sclerenchyma cell with highly thickened, lignified walls.

Step 2: Detailed Explanation:
Let's match each type of sclereid with its example:

- **A. Astrosclereids:** These are star-shaped sclereids with radiating arms. They are famously found in the leaves and petioles of aquatic plants like the water lily, ***Nymphea***. Thus, **A matches with IV**.

- **B. Macrosclereids:** These are elongated, rod-shaped or columnar cells. They are very common in the seed coats of leguminous plants, forming a hard protective layer. **Kidney**

bean seeds belong to the legume family. Thus, **B matches with III**.

- **D. Trichosclereids:** These are hair-like, often branched sclereids that can be very long. They are found in the leaves and stems of various plants, including the leaves of the **Olive** tree (*Olea europaea*). Thus, **D matches with II**.

- **C. Osteosclereids:** These are bone-shaped or spool-shaped sclereids, being enlarged at their ends. They are found in seed coats and leaves, including the sub-epidermal layers in the **leaves of some monocots**. Thus, by elimination and by known occurrences, **C matches with I**.

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

Quick Tip

To remember sclereid types, use their names as clues: Astro = star (like in Nymphea), Macro = large/columnar (like in seed coats), Osteo = bone (spool-shaped), Tricho = hair (like in olive leaves).

---

24. Which of the following statements are correct regarding protein synthesis in eukaryotes?
A. 3'-Cap of mRNA present.
B. Ribosomes of 80S type dissociate into 40S and 60S subunits.
C. Translation is not simultaneous with transcription.
D. Initiation codon of mRNA is recognised by anticodon of Met-tRNA.
Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
The question asks to identify the correct statements about protein synthesis (translation) specifically in eukaryotic cells. This requires knowledge of the key features that distinguish eukaryotic translation from prokaryotic translation.

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

- **A. 3'-Cap of mRNA present.** This statement is **incorrect**. Eukaryotic mRNA undergoes post-transcriptional modification which includes the addition of a 7-methylguanosine cap at the **5' end**, not the 3' end. The 3' end typically has a poly-A tail.

- **B. Ribosomes of 80S type dissociate into 40S and 60S subunits.** This statement is **correct**. Eukaryotic cells have 80S ribosomes, which are composed of a small 40S subunit and a large 60S subunit. (The Svedberg units are not additive).

- **C. Translation is not simultaneous with transcription.** This statement is **correct**. In eukaryotes, transcription occurs inside the nucleus, while translation occurs in the cytoplasm. Due to this spatial and temporal separation (and the need for mRNA processing), the two processes cannot be coupled, unlike in prokaryotes where they occur simultaneously in the cytoplasm.

- **D. Initiation codon of mRNA is recognised by anticodon of Met-tRNA.** This statement is **correct**. The start codon for translation in eukaryotes is AUG, which is recognized by the anticodon of a special initiator tRNA carrying the amino acid Methionine (Met).

Step 3: Final Answer:
Statements B, C, and D are correct, while statement A is incorrect. Therefore, the correct option is the one that includes only B, C, and D.

Quick Tip

Remember the key differences between prokaryotic and eukaryotic protein synthesis: **Eukaryotes:** 80S ribosomes (60S+40S), 5' cap 3' tail, monocistronic mRNA, transcription in nucleus, translation in cytoplasm (separate), initiator is Met-tRNA. **Prokaryotes:** 70S ribosomes (50S+30S), no cap/tail, polycistronic mRNA, transcription and translation are coupled, initiator is fMet-tRNA.

---

25. Paracytic type of stomata are distinctive feature of:

(A) Ranunculaceae
(B) Brassicaceae
(C) Rubiaceae
(D) Caryophyllaceae

Correct Answer: (C) Rubiaceae

Solution:

Step 1: Understanding the Concept:
The question asks to identify the plant family characterized by paracytic stomata. Stomatal types are classified based on the number and arrangement of subsidiary cells surrounding the two guard cells.

Step 2: Detailed Explanation:
Let's define the stomatal types associated with the given families:

- **Paracytic (or Rubiaceous) type:** The stomata are surrounded by two subsidiary cells whose long axes are parallel to the guard cells. As the alternative name "Rubiaceous" suggests, this type is a distinctive feature of the family **Rubiaceae**.
- **Anomocytic (or Ranunculaceous) type:** The stoma is surrounded by cells that are indistinguishable from the other epidermal cells. This is characteristic of the family **Ranunculaceae**.
- **Anisocytic (or Cruciferous) type:** The stoma is surrounded by three subsidiary cells, one of which is distinctly smaller than the other two. This is characteristic of the family **Brassicaceae** (Cruciferae).
- **Diacytic (or Caryophyllaceous) type:** The stoma is enclosed by two subsidiary cells whose common wall is at a right angle to the long axis of the guard cells. This is characteristic of the family **Caryophyllaceae**.

Step 3: Final Answer:
Based on the classification, paracytic stomata are a distinctive feature of the family Rubiaceae.

Quick Tip

The alternative names for stomatal types are often derived from the family they characterize. Remembering these associations can be a great shortcut: **Para**cytic = **Ru**biaceous **Anomo**cytic = **Ranun**culaceous **Aniso**cytic = **Cruci**ferous **Dia**cytic = **Caryo**phyllaceous

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26. *Selaginella* is also known as:

(A) Resurrection plant
(B) Peat moss
(C) Club moss
(D) Horsetail

Correct Answer: (A) Resurrection plant

Solution:

Step 1: Understanding the Concept:
The question asks for a common name for the genus *Selaginella*, which is a pteridophyte.

Step 2: Detailed Explanation:
Let's examine the common names given in the options:

- **(A) Resurrection plant:** This name is given to several plants that can survive extreme dehydration and appear to come back to life when rehydrated. Certain species of *Selaginella*, notably *Selaginella lepidophylla*, exhibit this remarkable property and are famously sold as "resurrection plants".
- **(B) Peat moss:** This is the common name for bryophytes of the genus *Sphagnum*.
- **(C) Club moss:** This is the common name primarily used for pteridophytes of the genus *Lycopodium*. *Selaginella* is sometimes referred to as "spike moss" or "lesser club moss" due to its resemblance, but "club moss" usually refers to *Lycopodium*.
- **(D) Horsetail:** This is the common name for pteridophytes of the genus *Equisetum*.

Step 3: Final Answer:
While *Selaginella* is related to club mosses, the term "resurrection plant" is a very specific and well-known common name for members of this genus due to their unique physiological adaptation. Therefore, it is the most appropriate answer among the choices.

Quick Tip

For pteridophyte classification, memorize the common names for the main genera: *Lycopodium* → Club moss *Selaginella* → Spike moss / Resurrection plant *Equisetum* → Horsetail *Pteris*, *Dryopteris*, etc. → Ferns

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27. Specialised cells are generally found in the plant leaves which contain outgrowths of epidermal cell wall, made of calcium carbonate or silicon dioxide in a cellulose matrix are called as:

(A) Raphides
(B) Cystolith
(C) Druses
(D) Lithocysts

Correct Answer: (D) Lithocysts

Solution:

Step 1: Understanding the Concept:
The question asks to identify the specialized cells in plant leaves that contain specific mineral

deposits. These deposits are described as outgrowths of the epidermal cell wall and are composed of calcium carbonate or silicon dioxide within a cellulose matrix. This phenomenon is a form of biomineralization in plants.

Step 3: Detailed Explanation:
Let's analyze the given options:
(A) Raphides: Raphides are needle-shaped crystals, typically made of calcium oxalate, found in the vacuoles of plant cells called idioblasts. [11, 12, 14] They are not outgrowths of the cell wall.

(B) Cystolith: A cystolith is the actual outgrowth or concretion of the epidermal cell wall, composed of calcium carbonate on a cellulose stalk. [1, 5, 7] While the description matches the structure, the question asks for the name of the **specialised cell** that **contains** this structure, not the structure itself.

(C) Druses: Druses are star-shaped or globular aggregates of calcium oxalate crystals, also found within plant cells (idioblasts), usually in the vacuole. [11, 15, 16] They are not outgrowths of the cell wall.

(D) Lithocysts: Lithocysts are the specialized, enlarged epidermal cells that contain cystoliths. [2, 8, 17] The question specifically asks for the name of the **specialised cells**, making this the correct answer. The cystolith is the structure *within* the lithocyst. [1, 10]

Therefore, the specialized cells containing these outgrowths are called Lithocysts.

Step 4: Final Answer:
The correct option is (D) because Lithocysts are the specialized epidermal cells that house the cystoliths, which are the calcium carbonate outgrowths of the cell wall. [2, 3, 8]

Quick Tip

To avoid confusion, remember the relationship: The **Cystolith** (the stone or mineral deposit) is found inside the **Lithocyst** (the stone-cell). The question asks for the cell, not the deposit within it.

---

28. Which of the following amino acid is basic in nature?

(A) Alanine
(B) Lysine
(C) Threonine
(D) Methionine

Correct Answer: (B) Lysine

Solution:

Step 1: Understanding the Concept:
Amino acids are classified based on the chemical properties of their side chain (R-group). Basic amino acids have side chains containing nitrogenous groups that can accept a proton (H) at physiological pH, thereby acting as bases and carrying a positive charge.

Step 2: Detailed Explanation:
Let's analyze the side chains of the given amino acids:

- **(A) Alanine:** Has a simple methyl group (-CH) as its side chain. It is nonpolar and neutral.
- **(B) Lysine:** Its side chain contains a terminal amino group (-NH) at the end of a four-carbon chain (- (CH)-NH). This amino group readily accepts a proton to become -NH, making lysine a basic amino acid.
- **(C) Threonine:** Has a hydroxyl group (-OH) in its side chain. It is polar but uncharged (neutral).
- **(D) Methionine:** Contains a sulfur atom (thioether) in its side chain. It is nonpolar and neutral.

Step 3: Final Answer:
Among the given options, only lysine has a side chain with an amino group that imparts basic properties to the molecule.

Quick Tip

Remember the three basic amino acids: Histidine, Arginine, and Lysine (mnemonic: HAL). Arginine is the most basic, due to its guanidinium group.

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29. The example of facultative CAM plant which carries on C metabolism under unstressed conditions is:

(A) *Mesembryanthemum crystallinum*
(B) *Opuntia*
(C) *Chrysanthemum*
(D) *Amaranthus edulis*

Correct Answer: (A) *Mesembryanthemum crystallinum*

Solution:

Step 1: Understanding the Concept:
The question asks to identify a facultative CAM plant. Crassulacean Acid Metabolism (CAM) is a photosynthetic adaptation to arid conditions. Obligate CAM plants use this pathway all the time. Facultative CAM plants, however, can switch between C photosynthesis and CAM photosynthesis in response to environmental cues like drought or salinity.

Step 2: Detailed Explanation:
Let's analyze the photosynthetic pathways of the given plants:

- **(A) *Mesembryanthemum crystallinum* (Common ice plant):** This is the classic textbook example of a facultative CAM plant. It performs C photosynthesis when water is abundant but switches to the CAM pathway under drought or salt stress.

- **(B) *Opuntia* (Prickly pear cactus):** This is an obligate CAM plant. It is a succulent that lives in arid environments and always uses the CAM pathway to conserve water.

- **(C) *Chrysanthemum*:** This is a typical C plant. It does not perform CAM photosynthesis.

- **(D) *Amaranthus edulis*:** This is a C plant, characterized by Kranz anatomy. It does not perform CAM photosynthesis.

Step 3: Final Answer:
Mesembryanthemum crystallinum is a known facultative CAM plant that uses C metabolism in unstressed conditions and switches to CAM under stress.

Quick Tip

Remember the key difference: "Obligate" means always, "Facultative" means having the option to switch. Cacti are obligate CAM plants. The ice plant (*Mesembryanthemum*) is the most common example of a facultative CAM plant.

---

30. Arrange the following substrates of the glycolysis pathway in a chronological order of their occurrence in the pathway, starting from Glucose.
A. Fructose-6-phosphate
B. Pyruvic acid
C. Glucose-6-phosphate
D. 2- Phosphoglycerate
Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
The question requires ordering a given set of intermediates as they appear in the glycolysis pathway, which is the metabolic pathway that converts glucose into pyruvate.

Step 2: Detailed Explanation:
Let's trace the path of glycolysis from glucose:

1. The first step is the phosphorylation of Glucose to form **Glucose-6-phosphate (C)**.

2. Glucose-6-phosphate is then isomerized to form **Fructose-6-phosphate (A)**.

3. Fructose-6-phosphate is further phosphorylated and then cleaved, and after several more steps in the payoff phase, the intermediate **2-Phosphoglycerate (D)** is formed.

4. 2-Phosphoglycerate is converted to phosphoenolpyruvate, which is then converted to the final product of glycolysis, **Pyruvic acid (B)**.

So, the chronological order of the given substrates is: C $\rightarrow$ A $\rightarrow$ D $\rightarrow$ B.

Step 3: Final Answer:
The correct sequence is Glucose-6-phosphate (C), followed by Fructose-6-phosphate (A), then 2-Phosphoglycerate (D), and finally Pyruvic acid (B). This corresponds to the option C, A, D, B.

Quick Tip

For pathway questions, identify the starting and ending points first. Here, Glucose-6-phosphate (C) is the first intermediate after glucose, and Pyruvic acid (B) is the final product. This immediately points to an answer that starts with C and ends with B, quickly narrowing down the choices.

---

31. Identify the plants from the following which do not exhibit Kranz anatomy:
A. *Aloe*
B. *Zea mays*

C. *Agave*
D. *Opuntia*
Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
Kranz anatomy is a specialized leaf structure found in C plants. It is characterized by having two distinct types of photosynthetic cells: the mesophyll cells and the bundle sheath cells arranged in a wreath-like ('Kranz') manner around the vascular bundles. The question asks to identify plants that *lack* this anatomy. C plants and CAM plants do not have Kranz anatomy.

Step 2: Detailed Explanation:
Let's determine the photosynthetic pathway of each plant:

- **A. *Aloe*:** A succulent plant that uses CAM (Crassulacean Acid Metabolism) photosynthesis to conserve water. It does **not** have Kranz anatomy.
- **B. *Zea mays* (Maize/Corn):** A classic example of a C plant. It **exhibits** Kranz anatomy.
- **C. *Agave*:** A succulent plant that uses CAM photosynthesis. It does **not** have Kranz anatomy.
- **D. *Opuntia* (Cactus):** A succulent plant that uses CAM photosynthesis. It does **not** have Kranz anatomy.

The plants that do not exhibit Kranz anatomy are *Aloe* (A), *Agave* (C), and *Opuntia* (D).

Step 3: Final Answer:
The correct combination of plants lacking Kranz anatomy is A, C, and D.

Quick Tip

Remember this simple rule: Kranz anatomy is the structural hallmark of C plants. CAM plants and C plants lack it. Identifying the plant's photosynthetic pathway is the key to answering such questions.

---

32. Match the LIST-I with LIST-II

LIST-I Minerals	LIST-II Deficiency Symptoms in plants
A. Calcium	I. Intervenous chlorosis associated with the development of small necrotic spots
B. Zinc	II. Accumulation of Urea in the leaves
C. Manganese	III. Necrosis of young meristematic regions such as root tips or young leaves
D. Nickel	IV. Display of rosette habit

Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
This question requires matching essential mineral elements with their specific deficiency symptoms in plants.

Step 2: Detailed Explanation:

- **A. Calcium (Ca):** Calcium is a structurally important component of the cell wall (as calcium pectate) and is relatively immobile within the plant. Therefore, deficiency symptoms appear first in young, growing tissues. A classic symptom is the **necrosis (death) of young meristematic regions like root tips and young leaves**. Thus, **A matches with III**.

- **B. Zinc (Zn):** Zinc is required for the synthesis of auxin, a plant hormone that promotes cell elongation. Zinc deficiency leads to reduced auxin levels, causing stunted growth with short internodes, resulting in a **rosette habit** (leaves are clustered in a circular form). Thus, **B matches with IV**.

- **C. Manganese (Mn):** Manganese is an activator for many enzymes and is essential for the water-splitting step in photosynthesis. Deficiency leads to **interveinal chlorosis (yellowing between veins) and the development of necrotic spots**. Thus, **C matches with I**.

- **D. Nickel (Ni):** Nickel is a component of the enzyme urease, which is vital for metabolizing urea into ammonia. In the absence of nickel, urea can accumulate to toxic levels, leading to **leaf tip necrosis**. Thus, **D matches with II**.

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

Quick Tip

Focus on unique symptoms: "Rosette habit" is a keyword for Zinc deficiency. "Necrosis of young tips" points to an immobile element like Calcium. "Urea accumulation" is specifically linked to Nickel's role in the urease enzyme.

---

33. What is the correct general scheme of the fungal succession on herbivore dung:
A. Basidiomycetes
B. Discomycetes
C. Phycomycetes
D. Pyrenomycetes
Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
The question asks for the typical sequence of fungal groups (succession) that colonize herbivore dung. This ecological succession is driven by the fungi's different enzymatic capabilities to break down organic compounds of varying complexity.

Step 2: Detailed Explanation:
The succession of coprophilous (dung-inhabiting) fungi generally follows this pattern:

1. **First Stage - Phycomycetes (C):** (Now often classified as Zygomycetes). These are the pioneers, like *Mucor* and *Pilobolus*. They grow very rapidly, utilizing the simple, soluble sugars and carbohydrates readily available in the dung. They usually appear within the first few days.
2. **Second Stage - Ascomycetes (B and D):** After the simple sugars are depleted, Ascomycetes appear. They have enzymes (cellulases) to break down more complex carbohydrates like cellulose. This group includes Discomycetes (cup fungi, like *Ascobolus*) and Pyrenomycetes (flask fungi, like *Sordaria*). They typically appear after the Phycomycetes. The order between Discomycetes (B) and Pyrenomycetes (D) can vary, but they represent the middle stage.

3. **Third Stage - Basidiomycetes (A):** These are the final colonizers, appearing after several weeks. Fungi like *Coprinus* (a mushroom) have powerful enzymes (ligninases) to decompose the most resistant components of the dung, such as lignin and complex cellulose.

The overall sequence is from simple sugar consumers to cellulose decomposers to lignin decomposers.

Step 3: Final Answer:
The correct chronological order is C (Phycomycetes) → B (Discomycetes) → D (Pyrenomycetes) → A (Basidiomycetes). This corresponds to option (D).

Quick Tip

Think of fungal succession on dung as a race for food. The fastest sprinters (**P**hycomycetes) eat the easy food (sugars) first. Then come the marathon runners (**A**scomycetes) that can digest tougher food (cellulose). Finally, the ultra-marathoners (**B**asidiomycetes) arrive to break down the hardest food (lignin).

---

34. Which of the following is a macrophyte?

(A) *Spirogyra*
(B) Diatoms
(C) *Azolla*
(D) *Eudorina*

Correct Answer: (C) *Azolla*

Solution:

Step 1: Understanding the Concept:
A macrophyte is an aquatic plant that is large enough to be visible to the naked eye. The term includes aquatic vascular plants (like ferns and flowering plants) and macroalgae. It excludes microscopic algae (phytoplankton).

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

- **(A) *Spirogyra*:** This is a filamentous green alga. While its filaments can form large, visible mats (making it a macroalga), it is a simple, non-vascular organism.
- **(B) Diatoms:** These are unicellular, microscopic algae. They are a major component of phytoplankton and are definitely not macrophytes.
- **(C) *Azolla*:** This is a genus of small, free-floating aquatic ferns. As a vascular plant (a pteridophyte), it is unequivocally classified as a macrophyte.

- **(D) *Eudorina*:** This is a motile, colonial green alga. The entire colony is microscopic and part of the phytoplankton. It is not a macrophyte.

Step 3: Final Answer:
Among the choices, *Azolla* is a vascular plant (an aquatic fern) and is the clearest and most definite example of a macrophyte.

Quick Tip

In biology, the term macrophyte most commonly refers to aquatic vascular plants. If you see an option that is a fern, moss, or flowering plant living in water, it's a very strong candidate for being a macrophyte compared to algae.

---

35. The common inter-cellular parasitic algae among the following is:

(A) *Cladophora*
(B) *Chlamydomonas chrenbergii*
(C) *Cephaleuros*
(D) *Protoderma*

Correct Answer: (C) *Cephaleuros*

Solution:

Step 1: Understanding the Concept:
The question asks to identify a genus of algae that is known to be parasitic and grows inter-cellularly (between the cells) within a host plant.

Step 2: Detailed Explanation:
Let's examine the lifestyles of the given algae:

- **(A) *Cladophora*:** A genus of filamentous green algae that is typically free-living in freshwater or marine environments. It is not parasitic.
- **(B) *Chlamydomonas chrenbergii*:** A species of unicellular, motile green alga. It is free-living, commonly found in soil and freshwater. It is not parasitic.
- **(C) *Cephaleuros*:** This is a well-known genus of parasitic green algae. Species like *Cephaleuros virescens* grow on the leaves of terrestrial plants (e.g., tea, coffee, mango) and cause a disease commonly called "red rust". The algal filaments grow in the subcuticular and inter-cellular spaces of the host leaf.
- **(D) *Protoderma*:** This is a genus of green algae that grows as a crust on various substrates like rocks or other plants (epilithic or epiphytic). It is not considered a parasite.

Step 3: Final Answer:
Cephaleuros is the common example of an inter-cellular parasitic alga among the given options.

Quick Tip

The association of *Cephaleuros* with the disease "red rust" on tea plants is a classic example of algal parasitism taught in botany. Remembering this specific example can help you quickly answer such questions.

---

36. The requirement of sunlight for the germination of seeds, is known as:

(A) Phototropism
(B) Photoblasty
(C) Photonasty
(D) Nyctinasty

Correct Answer: (B) Photoblasty

Solution:

Step 1: Understanding the Concept:
The question asks for the specific biological term that describes the effect of light on seed germination.

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

- **Phototropism:** This is the directional growth of a plant in response to a light stimulus. For example, a plant stem growing towards a light source. It relates to growth, not germination.

- **Photoblasty:** This term specifically refers to the response of seeds to the presence or absence of light for germination. Seeds that are stimulated to germinate by light are called positively photoblastic (e.g., lettuce), while those whose germination is inhibited by light are negatively photoblastic (e.g., onion). This perfectly matches the question's description.

- **Photonasty:** This is a non-directional movement of plant parts (like leaves or petals) in response to changes in light intensity. For example, the opening and closing of some flowers during the day and night.

- **Nyctinasty:** This is a nastic movement related to the diurnal cycle (day and night), often called "sleep movements." For example, the folding of leaves of a leguminous plant in the

evening.

Step 3: Final Answer:
The correct term for the requirement of sunlight for seed germination is photoblasty.

Quick Tip

Break down the words: 'Photo' relates to light. 'Tropism' is directional growth, 'nasty' is non-directional movement, and 'blasty' relates to germination or budding. This helps in differentiating between these similar-sounding terms.

---

37. Among the following ecosystems, which has the least Net Primary Production (NPP)?

(A) Savanna
(B) Estuaries
(C) Open ocean
(D) Agricultural land

Correct Answer: (C) Open ocean

Solution:

Step 1: Understanding the Concept:
Net Primary Production (NPP) is the rate at which photosynthetic producers create net useful chemical energy. It is the total primary production (GPP) minus the energy used by the producers for their own respiration. The question asks to identify the ecosystem with the lowest NPP per unit area.

Step 2: Detailed Explanation:
Let's compare the productivity of the given ecosystems:

- **Savanna:** These grasslands have moderate productivity, limited by seasonal rainfall.

- **Estuaries:** These are among the most productive ecosystems in the world. The constant influx of nutrients from rivers combined with ample sunlight creates ideal conditions for high NPP.

- **Open ocean:** The open ocean has a very low NPP per unit area. This is primarily because it is nutrient-limited (especially nitrogen and phosphorus) and light can only penetrate the shallow surface layer (photic zone). While its vast area means it contributes significantly to global NPP, its productivity rate per square meter is extremely low, comparable to a

desert.

- **Agricultural land:** The productivity of agricultural land can be very high due to subsidies of water, fertilizers, and pesticides. However, it is generally less productive than a healthy estuary or tropical rainforest.

Step 3: Final Answer:
When comparing NPP on a per-unit-area basis, the open ocean is the least productive due to severe nutrient limitation.

Quick Tip

Don't confuse total global NPP with NPP per unit area. The open ocean has a huge total NPP because it covers ˜70% of the Earth, but its productivity per square meter is extremely low. Estuaries and tropical rainforests have the highest NPP per unit area.

---

38. Which of the following is NOT the characteristic feature of xerophytic plants?

(A) Lacks Aerenchyma
(B) Chlorophyll mostly in stem and leaves
(C) Palisade generally on both sides of leaves
(D) Thin walled epidermal cells

Correct Answer: (D) Thin walled epidermal cells

Solution:

Step 1: Understanding the Concept:
The question asks to identify a feature that is NOT an adaptation found in xerophytes (plants adapted to survive in arid conditions). Xerophytic adaptations are primarily aimed at reducing water loss and storing water.

Step 2: Detailed Explanation:
Let's analyze the features listed:

- **(A) Lacks Aerenchyma:** Aerenchyma is a spongy tissue with large air spaces found in aquatic plants (hydrophytes) for buoyancy and gas exchange. Xerophytes, living in dry conditions, do not need this tissue. Its absence is characteristic of them.

- **(B) Chlorophyll mostly in stem and leaves:** In many xerophytes, leaves are reduced to spines to minimize water loss (e.g., cactus). In such cases, the stem becomes flattened, green (containing chlorophyll), and takes over the function of photosynthesis. This is a

common xerophytic adaptation.

- **(C) Palisade generally on both sides of leaves:** Leaves that are exposed to high light intensity from all angles (isobilateral leaves) often have palisade mesophyll on both the upper and lower sides to maximize photosynthesis. This is a common feature in xerophytes.

- **(D) Thin walled epidermal cells:** This is **not** a xerophytic feature. To prevent water loss through transpiration, xerophytes have very thick-walled epidermal cells, often covered by a thick waxy cuticle and multiple layers of epidermis. Thin walls would offer little resistance to water loss.

Step 3: Final Answer:
Thin-walled epidermal cells are characteristic of hydrophytes or mesophytes, not xerophytes. Therefore, this is the feature that is not characteristic of xerophytic plants.

Quick Tip

When thinking about xerophytes, always consider adaptations that would help a plant survive a drought. Thick cuticle, sunken stomata, reduced leaves, and deep roots are all features that reduce water loss or increase water uptake. Thin cell walls would do the opposite.

---

39. 'Aconite', a drug used for nasal problems and sore throat, is obtained from tuberous roots of:

(A) *Ocimum sanctum*
(B) *Aconitum ferox*
(C) *Withania somnifera*
(D) *Azadirachta indica*

Correct Answer: (B) *Aconitum ferox*

Solution:

Step 1: Understanding the Concept:
The question asks for the botanical source of the drug 'Aconite'. This requires knowledge of pharmacognosy or economic botany.

Step 2: Detailed Explanation:
Let's identify the plants listed:

- **(A) *Ocimum sanctum*:** This is Holy Basil or Tulsi, widely used in traditional medicine, but it is not the source of Aconite.

- **(B) *Aconitum ferox*:** This is a species of Monkshood, also known as Indian Aconite. The name of the drug, 'Aconite', is directly derived from the genus name, *Aconitum*. The tuberous roots of this plant are the source of the drug, which contains potent alkaloids like pseudaconitine. It is highly toxic but used in minute, processed quantities in traditional medicine systems.

- **(C) *Withania somnifera*:** This is Ashwagandha or Indian Ginseng. Its roots are used as an adaptogen and nervine tonic, but it is not the source of Aconite.

- **(D) *Azadirachta indica*:** This is the Neem tree. Various parts of the tree have medicinal properties (antiseptic, antifungal), but it is not the source of Aconite.

Step 3: Final Answer:
The drug Aconite is obtained from the tuberous roots of *Aconitum ferox*.

Quick Tip

In questions linking a common drug name to a botanical source, often the drug name is derived directly from the genus name of the plant. Here, 'Aconite' is from *Aconitum*. Other examples include 'Digitalin' from *Digitalis* and 'Quinine' from *Cinchona*.

---

40. If the number of chromosomes in the egg cell of a plant is 8, then what would be the number of chromosomes in its endosperm?

(A) 8
(B) 16
(C) 24
(D) 12

Correct Answer: (C) 24

Solution:

Step 1: Understanding the Concept:
This question deals with the ploidy levels of different cells in an angiosperm during its life cycle. The key is to know the process of double fertilization which forms the zygote and the endosperm.

Step 2: Key Formula or Approach:

- The egg cell in an angiosperm is haploid (n).
- The endosperm is formed by the fusion of one male gamete (n) with the central cell, which contains two polar nuclei (n + n).

- Therefore, the endosperm is triploid (3n).

Step 3: Detailed Explanation:

1. We are given that the number of chromosomes in the egg cell is 8. Since the egg cell is haploid, we have:

$$n = 8$$

2. The endosperm is triploid, meaning its chromosome number is 3n.

3. We can now calculate the number of chromosomes in the endosperm:

$$\text{Endosperm chromosomes} = 3n = 3 \times 8 = 24$$

Step 4: Final Answer:
The number of chromosomes in the endosperm would be 24.

Quick Tip

Remember the ploidy levels in a typical angiosperm: Egg cell (n), Zygote (2n), and Endosperm (3n). If you are given the chromosome number for any one of these, you can easily calculate the others.

---

41. Which of the following mutations is most likely to contribute to the development of cancer?

(A) Loss-of-function mutation in a tumor suppressor gene.
(B) Gain-of function in a DNA repair enzyme.
(C) Silent mutation in a proto-oncogene.
(D) Deletion of non-coding intronic regions in a tumor suppressor gene.

Correct Answer: (A) Loss-of-function mutation in a tumor suppressor gene.

Solution:

Step 1: Understanding the Concept:
Cancer is a disease of uncontrolled cell proliferation, often caused by mutations in genes that regulate the cell cycle. The two main types of genes involved are proto-oncogenes and tumor suppressor genes.

Step 2: Detailed Explanation:
Let's evaluate how each mutation would affect cancer risk:

- **(A) Loss-of-function mutation in a tumor suppressor gene:** Tumor suppressor genes (e.g., p53, Rb) act as the "brakes" of the cell cycle, stopping division if there is DNA damage. A loss-of-function mutation is like having faulty brakes. This allows cells with mutations to continue dividing, leading to cancer. This is a very common mechanism in cancer development.

- **(B) Gain-of function in a DNA repair enzyme:** DNA repair enzymes fix mutations. A "gain-of-function" would mean the enzyme works better or more efficiently. This would lead to fewer mutations being propagated, which would *decrease* the risk of cancer, not increase it.

- **(C) Silent mutation in a proto-oncogene:** Proto-oncogenes are the "accelerators" of the cell cycle. They need a "gain-of-function" mutation to become oncogenes and promote cancer. A silent mutation, by definition, does not change the amino acid sequence of the protein, so it would not alter the protein's function and would not contribute to cancer.

- **(D) Deletion of non-coding intronic regions in a tumor suppressor gene:** Introns are removed from the mRNA transcript before translation. Deleting an intron would likely have no effect on the final protein, unless the deletion affects critical splice sites or regulatory sequences. This is far less likely to cause a loss of function compared to a mutation directly within a coding region (exon).

Step 3: Final Answer:
The most likely mutation to contribute to cancer from the given options is a loss-of-function mutation in a tumor suppressor gene, as it removes a crucial control point for cell division.

Quick Tip

Remember the car analogy for cancer genetics:

- **Proto-oncogenes** are the accelerator. Cancer mutation is a **gain-of-function** (accelerator stuck down).
- **Tumor suppressor genes** are the brakes. Cancer mutation is a **loss-of-function** (brakes fail).

---

42. What is the correct sequence of Transmembrane multiprotein complexes of the electron transport chain during respiration?
A. Succinate dehydrogenase
B. NADH dehydrogenase
C. Cytochrome c oxidase
D. Cytochrome bc1 complex

Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
The question asks for the correct sequence of the major protein complexes of the mitochondrial electron transport chain (ETC). These complexes are typically numbered I through IV.

Step 2: Detailed Explanation:
Let's identify each complex listed:

- **B. NADH dehydrogenase** is **Complex I**. It accepts electrons from NADH.
- **A. Succinate dehydrogenase** is **Complex II**. It accepts electrons from succinate (via FADH). It is also part of the Krebs cycle.
- **D. Cytochrome bc1 complex** is **Complex III**. It accepts electrons from Coenzyme Q (which gets them from Complex I and II).
- **C. Cytochrome c oxidase** is **Complex IV**. It accepts electrons from cytochrome c (which gets them from Complex III) and transfers them to the final electron acceptor, oxygen.

The question asks for the sequence of the complexes themselves. They are conventionally ordered numerically from I to IV. Although Complex I and II operate in parallel, feeding electrons to Complex III, the standard listing of all four main complexes follows their numerical order.
The correct sequence based on the complex numbers is I $\rightarrow$ II $\rightarrow$ III $\rightarrow$ IV.
Translating this back to the given letters: I = B (NADH dehydrogenase) II = A (Succinate dehydrogenase) III = D (Cytochrome bc1 complex) IV = C (Cytochrome c oxidase) So the sequence is B, A, D, C.

Step 3: Final Answer:
The correct sequence of the complexes in their standard numerical order is B, A, D, C.

Quick Tip

Memorize the names and numbers of the ETC complexes:

- Complex I: NADH dehydrogenase
- Complex II: Succinate dehydrogenase
- Complex III: Cytochrome bc1
- Complex IV: Cytochrome c oxidase

The electron flow path is I $\rightarrow$ Q $\rightarrow$ III $\rightarrow$ Cyt c $\rightarrow$ IV and II $\rightarrow$ Q $\rightarrow$ III $\rightarrow$ Cyt c $\rightarrow$ IV.

---

43. Which nitrogen fixing symbiont is associated with sugarcane as a host plant?

(A) Frankia
(B) Acetobacter
(C) Anabaena
(D) Nostoc

Correct Answer: (B) Acetobacter

Solution:

Step 1: Understanding the Concept:
The question asks to identify a nitrogen-fixing bacterium that lives in a symbiotic relationship with sugarcane. This type of symbiosis, where the microbe lives inside the plant tissues without causing disease, is called an endophytic relationship.

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

- **Frankia:** This is a genus of nitrogen-fixing, filamentous bacteria (actinomycetes) that forms root nodules on actinorhizal plants, such as alder (*Alnus*) and casuarina. It is not associated with sugarcane.

- **Acetobacter:** A specific species, *Gluconacetobacter diazotrophicus* (formerly in the *Acetobacter* genus), is a well-known endophytic bacterium that lives within the tissues of sugarcane. It can fix significant amounts of atmospheric nitrogen, contributing to the plant's nitrogen needs.

- **Anabaena:** This is a genus of filamentous cyanobacteria. It is famous for its symbiotic relationship with the aquatic fern *Azolla*, where it fixes nitrogen within the fern's leaves. It is not associated with sugarcane.

- **Nostoc:** This is another genus of cyanobacteria that can be free-living or form symbiotic relationships with fungi (to form lichens), bryophytes, and some vascular plants like cycads (in their coralloid roots). It is not the primary symbiont of sugarcane.

Step 3: Final Answer:
Based on established symbiotic relationships, *Acetobacter* (specifically *Gluconacetobacter*) is the correct nitrogen-fixing symbiont associated with sugarcane.

Quick Tip

Remember key symbiotic pairs: *Rhizobium*-legumes, *Frankia*-actinorhizal plants, *Anabaena-Azolla*, and *Acetobacter*-sugarcane. These are classic examples frequently asked in exams.

---

44. Cytokinin treatment extends the life span of detached *Xanthium* leaves by delaying chlorophyll and protein degradation. This experiment is called:

(A) Richmond-Lang effect
(B) Nyctinastic effect
(C) Epinasty
(D) Depot effect

Correct Answer: (A) Richmond-Lang effect

Solution:

Step 1: Understanding the Concept:
The question asks for the specific name of the phenomenon where the plant hormone cytokinin delays senescence (aging) in detached leaves, specifically the breakdown of chlorophyll and protein.

Step 2: Detailed Explanation:
Let's define the given terms:

- **Richmond-Lang effect:** This is the specific term used to describe the delay of senescence in leaves by the application of cytokinins. This effect was demonstrated by scientists Richmond and Lang, who observed that cytokinins could keep detached leaves green for a longer period by inhibiting the degradation of chlorophyll and proteins. This perfectly matches the description in the question.

- **Nyctinastic effect:** This refers to the "sleep movements" of plants, where leaves or petals fold in response to the onset of darkness. It is unrelated to senescence.

- **Epinasty:** This is the downward bending of leaves or other plant parts, often caused by the hormone ethylene. It is a growth response, not directly related to delaying senescence.

- **Depot effect:** This is a more general term that refers to the ability of cytokinins to mobilize nutrients towards the area of application, creating a nutrient "sink" or "depot." While this nutrient mobilization is part of the mechanism behind delaying senescence, the specific phenomenon itself is named the Richmond-Lang effect.

Step 3: Final Answer:
The experiment and the observed phenomenon are famously known as the Richmond-Lang effect.

Quick Tip

Associate keywords with hormone effects. For cytokinins, the key association is "delay of senescence" or "anti-aging," which is scientifically termed the Richmond-Lang effect.

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45. Which among the following is responsible for imparting blue and purple colour in some type of berries?

(A) Carotenoids
(B) Anthocyanins
(C) Isoflavanoids
(D) Aurones

Correct Answer: (B) Anthocyanins

Solution:

Step 1: Understanding the Concept:
The question asks to identify the class of plant pigments responsible for the blue and purple colors often seen in fruits like berries.

Step 2: Detailed Explanation:
Let's review the colors associated with each pigment class:

- **Carotenoids:** These pigments are responsible for yellow, orange, and red colors. Examples include carotene in carrots and lycopene in tomatoes. They do not produce blue or purple hues.

- **Anthocyanins:** These are water-soluble flavonoid pigments that appear red, purple, blue, or black depending on the pH. They are the primary pigments responsible for the coloration

of many fruits and flowers, including blueberries, blackberries, grapes, and purple cabbage.

- **Isoflavanoids:** These are a class of flavonoids that are typically colorless or pale yellow. They are known more for their biological activities (e.g., as phytoestrogens) than as vibrant pigments.

- **Aurones:** These are a class of flavonoids that produce golden yellow colors in some flowers.

Step 3: Final Answer:
The blue and purple colors in berries are due to the presence of anthocyanins.

Quick Tip

Remember the main color groups for plant pigments:

- **Chlorophylls:** Green
- **Carotenoids:** Yellow, Orange, Red
- **Anthocyanins:** Red, Purple, Blue

This simple classification will help you answer most questions about plant coloration.

---

46. *Synchytrium* is _____ fungi.

(A) Holocarpic and polycentric
(B) Holocarpic and endobiotic
(C) Eucarpic and polycentric
(D) Eucarpic and monocentric

Correct Answer: (B) Holocarpic and endobiotic

Solution:

Step 1: Understanding the Concept:
The question asks for the description of the thallus (body) of the fungus *Synchytrium*, a genus of Chytridiomycota. The terms describe the fungus's life strategy and structure.

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

- **Holocarpic vs. Eucarpic:**
  - **Holocarpic:** The entire thallus is converted into a reproductive structure (e.g., a sporangium or gametangium). There are no separate vegetative parts.

  - **Eucarpic:** The thallus is differentiated into distinct vegetative (e.g., rhizoids, mycelium) and reproductive parts.

- **Monocentric vs. Polycentric:**
  - **Monocentric:** The thallus produces only a single center of growth and reproduction.
  - **Polycentric:** The thallus has multiple centers of growth and reproduction connected by a rhizomycelium.

- **Endobiotic:** The fungus lives entirely inside the host's cells or tissues.

Synchytrium (e.g., *S. endobioticum*, which causes potato wart disease) is a primitive fungus. Its life cycle involves a motile zoospore that infects a host cell. Inside the host cell, the entire thallus develops into a reproductive structure (a sporangium or a resting spore) without forming any separate vegetative structures. This makes it **holocarpic**. Because it lives entirely within the host cell, it is also **endobiotic**.

Step 3: Final Answer:
The thallus of *Synchytrium* is correctly described as holocarpic (the whole thallus becomes a reproductive structure) and endobiotic (it lives inside the host).

Quick Tip

For primitive fungi like Chytrids, remember the 'holo-' and 'eu-' prefixes. **Holo** means 'whole' or 'entire,' so Holocarpic means the whole thallus reproduces. **Eu** means 'true,' so Eucarpic means it has true separate parts for vegetation and reproduction. *Synchytrium* is a classic example of a holocarpic fungus.

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47. During sexual reproduction in *Rhizopus*, projections from two compatible hyphae are attracted towards each other. These hyphae are called -

(A) Chlamydospores
(B) Azygospores
(C) Progametangia
(D) Zygophores

Correct Answer: (D) Zygophores

Solution:

Step 1: Understanding the Concept:
The question asks for the name of the specialized hyphae (filaments) in *Rhizopus* (a Zygomycete fungus) that grow towards each other to initiate sexual reproduction.

Step 2: Detailed Explanation:
Let's examine the terms related to sexual reproduction in *Rhizopus*:

- **Zygophores:** These are the specialized, aerial, fertile hyphal branches that arise from compatible mating strains (+ and -). They are chemically attracted and grow towards each other. The name literally means "zygote bearer". This term correctly describes the hyphae mentioned in the question.

- **Progametangia:** When the tips of two zygophores meet, they swell. These swollen tips, before a separating septum is formed, are called progametangia. They are the structures *at the tip* of the hyphae, not the hyphae themselves.

- **Chlamydospores:** These are thick-walled, asexual resting spores formed by the rounding up of a hyphal segment. They are not involved in sexual reproduction.

- **Azygospores:** These are spores that develop parthenogenetically (without fertilization) from a gametangium, but they look like zygospores. They are a type of spore, not a hypha.

Step 3: Final Answer:
The question asks for the name of the hyphae themselves, which are attracted to each other. The correct term for these specialized hyphal projections is zygophores.

Quick Tip

Remember the sequence in *Rhizopus* sexual reproduction: Compatible hyphae produce **Zygophores** (the branches) → tips swell to form **Progametangia** → septa form **Gametangia** → gametangia fuse to form a **Zygospore**. The question asks about the initial branches.

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48. Arrange the stages in the life cycle of "*Puccinia graminis*" in correct order of their occurrence, starting from *Triticum aestivum*
A. Teliospores appear as black raised streaks along leaf sheaths and stems of infected plants.
B. Basidiospores are discharged by an explosive mechanism and disseminated by wind.
C. Uredinospores germinate on wheat and spread the disease rapidly, under favorable conditions.
D. Basidiospores germinate on the leaves of the alternate host.
Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
The question asks to arrange the stages of the life cycle of *Puccinia graminis* (the black stem rust fungus) in the correct order, beginning with the infection on its primary host, wheat (*Triticum aestivum*). This fungus has a complex life cycle involving two hosts (wheat and barberry) and five spore stages.

Step 2: Detailed Explanation:
Let's trace the life cycle starting on wheat:

1. **Stage on Wheat (Summer):** The disease first appears on wheat as reddish-brown pustules, which contain urediniospores. These spores are responsible for the repeating stage of the infection, spreading rapidly from one wheat plant to another during the growing season. This matches statement **C**.

2. **Stage on Wheat (Late Summer/Autumn):** As the wheat plant matures, the fungus switches to producing teliospores in the same pustules, which now turn black. These teliospores are the overwintering stage. This matches statement **A**.

3. **Stage after Overwintering (Spring):** In the spring, the diploid teliospores undergo meiosis and germinate to produce a basidium, which bears four haploid basidiospores. These basidiospores are then released. This matches statement **B**.

4. **Stage on Alternate Host (Barberry):** The basidiospores are unable to infect wheat. They are carried by the wind and must land on and infect the alternate host, the barberry plant (*Berberis* sp.). This matches statement **D**. (On the barberry, the fungus will produce pycniospores and then aeciospores, which will then infect wheat to start the cycle again).

Step 3: Final Answer:
The correct chronological sequence starting from the main disease stage on wheat is C (Urediniospores) → A (Teliospores) → B (Basidiospore discharge) → D (Basidiospore germination on alternate host). This corresponds to option (C).

Quick Tip

Remember the host association for *Puccinia* spores: Urediniospores and Teliospores are on the primary host (wheat). Basidiospores infect the alternate host (barberry). Aeciospores (from barberry) infect the primary host (wheat). The red rust (Uredinia) always precedes the black rust (Telia) on wheat.

49. Which one of the following is a correct example of Fruticose Lichen?

(A) *Rhizocarpon*
(B) *Parmelia*
(C) *Cladonia*
(D) *Graphis*

Correct Answer: (C) *Cladonia*

Solution:

Step 1: Understanding the Concept:
The question asks to identify a genus of lichen that exhibits a fruticose growth form. Lichens are classified into three main morphological types based on their thallus structure.

Step 2: Detailed Explanation:
Let's define the three main growth forms of lichens and classify the given genera:

- **Crustose:** A crust-like thallus that is tightly attached to the substrate and cannot be removed without damaging it. Examples: ***Rhizocarpon*** (map lichen) and ***Graphis*** (script lichen).
- **Foliose:** A leaf-like, flattened thallus with a distinct upper and lower surface, loosely attached to the substrate. Example: ***Parmelia*** (rock shield lichen).
- **Fruticose:** A shrub-like, hair-like, or finger-like thallus that is erect or pendulous (hanging). It is attached to the substrate only at its base. Example: ***Cladonia*** (which includes reindeer moss), *Usnea* (old man's beard), and *Evernia*.

Step 3: Final Answer:
Among the given options, *Cladonia* is the correct example of a fruticose lichen.

Quick Tip

Use visual mnemonics for lichen types:

- **Crust**ose = like a **crust** of paint.
- **Foli**ose = like **foli**age or leaves.
- **Frut**icose = like a tiny **fru**it-bearing shrub.

---

50. In *Sphagnum*, the sporogonium is elevated by a special gametophytic structure known as:

(A) Pseudopodium
(B) Perichaetium

(C) Antheridium
(D) Amphithecium

Correct Answer: (A) Pseudopodium

Solution:

Step 1: Understanding the Concept:
The question asks for the name of the structure that elevates the mature sporophyte (sporogonium) in the moss genus *Sphagnum*. This is a key feature that distinguishes *Sphagnum* from many other mosses.

Step 2: Detailed Explanation:
In the life cycle of a typical moss, the sporophyte develops from the zygote while attached to the gametophyte. The sporophyte consists of a foot, a stalk called the **seta**, and a capsule. The elongation of the seta (a sporophytic, diploid tissue) is what lifts the capsule up for better spore dispersal.
However, in *Sphagnum* (peat moss), the seta remains very short and does not elongate significantly. Instead, after fertilization, a stalk-like structure develops from the gametophyte tissue of the archegonial branch, just below the foot of the sporophyte. This gametophytic (haploid) stalk elongates and pushes the entire mature sporogonium upwards. This structure is called a **pseudopodium**, which means "false foot".
Let's look at the other options:

- **Perichaetium:** The collective name for the modified leaves surrounding the archegonia (female sex organs).
- **Antheridium:** The male sex organ in bryophytes.
- **Amphithecium:** A layer of cells in the developing embryo of a moss that gives rise to the capsule wall.

Step 3: Final Answer:
The special gametophytic structure that elevates the sporogonium in *Sphagnum* is the pseudopodium.

Quick Tip

Remember the key difference: In most mosses, the capsule is raised by the **seta** (part of the sporophyte, 2n). In *Sphagnum*, it's raised by the **pseudopodium** (part of the gametophyte, n). 'Pseudo' means false, so it's a 'false stalk' because it's not a true seta.

---

51. Censer mechanism for spore dispersal from the capsule occurs in _____.

(A) Pellia
(B) Funaria

(C) Pogonatum
(D) Polytrichum

Correct Answer: (B) Funaria

Solution:

Step 1: Understanding the Concept:
The question asks to identify a bryophyte that uses a "censer mechanism" for spore dispersal. This mechanism involves the capsule, elevated on a stalk (seta), being swayed by the wind, causing spores to be shaken out gradually, much like a censer used for incense or a salt shaker. This is characteristic of many mosses with a well-developed peristome.

Step 2: Detailed Explanation:

- **Pellia:** This is a thalloid liverwort. Its capsule dehisces by splitting into four valves, and spore dispersal is aided by hygroscopic movements of elaters mixed with the spores. It does not have a censer mechanism.

- **Funaria:** This is a common moss with a long, flexible seta and a complex capsule with a ring of tooth-like structures called the peristome. The hygroscopic movement of these teeth (opening in dry conditions, closing in wet) regulates spore release. When the wind shakes the capsule, spores are peppered out through the peristome, which is a classic example of the censer mechanism.

- **Pogonatum and Polytrichum:** These mosses also have a dispersal mechanism where spores are shaken out. However, their capsule opening is covered by a membrane called an epiphragm, and spores escape through pores between the epiphragm and the peristome. This is often called a "pepper-pot" mechanism, which is a type of censer mechanism. However, *Funaria* with its elaborate hygroscopic peristome is the most widely cited and classic example of the censer mechanism in textbooks.

Step 3: Final Answer:
Among the given options, *Funaria* is the best and most classic example of a moss exhibiting the censer mechanism for spore dispersal.

Quick Tip

Associate different spore dispersal aids with bryophyte groups. Elaters are characteristic of liverworts (like *Pellia*, *Marchantia*). A peristome is characteristic of mosses (like *Funaria*). The censer or salt-shaker mechanism is a feature of mosses with a long seta.

52. Circinate vernation in ferns refers to -

(A) Uncoiling of new leaves from the base towards the apex
(B) System of leaf gaps in the stem
(C) Arrangement of sori on the leaf surface
(D) Presence of adventitious roots on the rhizome

Correct Answer: (A) Uncoiling of new leaves from the base towards the apex

Solution:

Step 1: Understanding the Concept:
The question asks for the definition of "circinate vernation," a term used in botany, particularly in relation to ferns.

Step 2: Detailed Explanation:

- **Vernation** refers to the arrangement of leaves in a bud.
- **Circinate** comes from the Latin word for 'circle' or 'coil'.
- **Circinate vernation** is the specific manner of development of a young fern leaf (frond). The frond is tightly coiled in the bud, resembling a watch spring or the head of a violin (hence the common name "fiddlehead"). As the leaf grows and matures, it uncoils from the base upwards towards the apex. This is a highly characteristic feature of most ferns.

Let's analyze the options:

- **(A) Uncoiling of new leaves from the base towards the apex:** This is the precise and correct definition of circinate vernation.
- **(B) System of leaf gaps in the stem:** This describes the anatomy of the vascular cylinder (stele) in ferns, not leaf development.
- **(C) Arrangement of sori on the leaf surface:** This relates to the position of the reproductive structures (sori), not the way the leaf unfolds.
- **(D) Presence of adventitious roots on the rhizome:** This describes the root system of the fern.

Step 3: Final Answer:
Circinate vernation is the characteristic coiling and subsequent uncoiling of young fern fronds.

Quick Tip

Associate "circinate vernation" directly with the image of a "fiddlehead." This unique, coiled appearance of a young fern frond is the key visual for this term.

53. The characteristic of Cleistogamous flowers is :

(A) They are pollinated by wind.
(B) They never open and are self-pollinated
(C) They are exclusively pollinated by insects.
(D) They are always open and cross pollinated

Correct Answer: (B) They never open and are self-pollinated

Solution:

Step 1: Understanding the Concept:
The question asks for the defining characteristic of cleistogamous flowers. The term itself provides a clue: 'cleisto' means closed, and 'gamy' refers to marriage or fertilization.

Step 2: Detailed Explanation:

- **Cleistogamous flowers** are flowers that are modified to remain closed and bud-like throughout their life. They never blossom or expose their reproductive organs to the outside environment.
- Since the flower never opens, pollination by external agents like wind (anemophily) or insects (entomophily) is impossible.
- Pollination must occur within the closed flower. The anthers dehisce to release pollen directly onto the stigma of the same flower. This ensures **autogamy** or self-pollination.
- Cleistogamy is an adaptation that guarantees seed set even in the absence of pollinators. Plants like *Viola* (Pansy) and *Commelina* often produce both open, cross-pollinating (chasmogamous) flowers and closed, self-pollinating (cleistogamous) flowers.

Analyzing the options:

- (A) and (C) are incorrect as external pollinators cannot access the closed flower.
- (D) describes chasmogamous flowers, the opposite of cleistogamous ones.
- (B) correctly states that they never open and are consequently self-pollinated.

Step 3: Final Answer:
The defining characteristic of cleistogamous flowers is that they remain closed and undergo self-pollination.

Quick Tip

Remember the two contrasting terms: **Chasmogamous** (chasma = open) flowers are open and allow for cross-pollination. **Cleistogamous** (cleisto = closed) flowers are closed and ensure self-pollination.

54. What is the role of Gibberellic acid in plants?

(A) It promotes cell division and elongation in stem tissues.
(B) It increases the levels of anti-oxidants
(C) It decreases the levels of plant growth hormones.
(D) It inhibits the synthesis of plant secondary metabolites.

Correct Answer: (A) It promotes cell division and elongation in stem tissues.

Solution:

Step 1: Understanding the Concept:
The question asks for a primary role of Gibberellic Acid (GA), which is one of the five major classes of plant hormones.

Step 2: Detailed Explanation:
Gibberellins are a group of plant hormones with a wide range of functions, but their most prominent effects are related to growth and development.

- **Stem Elongation:** This is the most dramatic and well-known effect of GA. It stimulates internodal elongation in stems, causing plants (especially genetic dwarf varieties) to grow tall. This effect is achieved by stimulating both cell division in the apical meristem and the subsequent elongation of those cells.
- **Seed Germination:** GAs break seed dormancy and promote germination by stimulating the production of hydrolytic enzymes (like α-amylase) in the aleurone layer of cereal grains.
- **Flowering and Fruit Development:** GAs can induce flowering in some plants (bolting in long-day plants) and are involved in fruit set and growth.

Let's evaluate the given options:

- **(A) It promotes cell division and elongation in stem tissues:** This accurately describes the primary mechanism by which gibberellins cause stem elongation.
- **(B) It increases the levels of anti-oxidants:** While hormonal changes can affect a plant's stress response, this is not a primary, defining role of GA.
- **(C) It decreases the levels of plant growth hormones:** GA is itself a major plant growth hormone and often acts synergistically with others, like auxins. This statement is incorrect.
- **(D) It inhibits the synthesis of plant secondary metabolites:** This is incorrect. The biosynthesis of gibberellins is itself a complex metabolic pathway, and its effects on other secondary metabolites are varied, not simply inhibitory.

Step 3: Final Answer:
The most accurate and primary role of Gibberellic acid listed is the promotion of cell division and elongation in stem tissues.

Quick Tip

Associate each major plant hormone with its "headline" function:

- **Auxin:** Apical dominance, tropisms, cell elongation.
- **Gibberellin:** Stem elongation, seed germination.
- **Cytokinin:** Cell division (cytokinesis), anti-aging.
- **Abscisic Acid (ABA):** Dormancy, stress response (stomata closure).
- **Ethylene:** Fruit ripening, senescence.

---

55. Which of the following hormones is synthesized from methionine?

(A) Auxin
(B) Gibberellin
(C) Cytokinin
(D) Ethylene

Correct Answer: (D) Ethylene

Solution:

Step 1: Understanding the Concept:
The question asks to identify the plant hormone whose biosynthetic pathway starts with the amino acid methionine.

Step 2: Detailed Explanation:
Let's review the primary precursors for the major plant hormones:

- **Auxin** (specifically Indole-3-acetic acid, IAA) is primarily synthesized from the amino acid **tryptophan**.

- **Gibberellin** is a terpenoid, synthesized from **geranylgeranyl pyrophosphate (GGPP)** via the MEP or MVA pathway. It is not derived from an amino acid.

- **Cytokinin** is a derivative of the purine base **adenine**.

- **Ethylene** (CH) is a simple gaseous hormone. Its biosynthesis in plants starts with the amino acid **methionine**. Methionine is converted to S-adenosylmethionine (SAM), then to 1-aminocyclopropane-1-carboxylic acid (ACC) by ACC synthase, and finally to ethylene by ACC oxidase.

Step 3: Final Answer:
Based on the biosynthetic pathways, ethylene is the plant hormone synthesized from methionine.

Quick Tip

For exams, it's very useful to remember the amino acid precursors for hormones:

- **Tryptophan → Auxin**
- **Methionine → Ethylene**

These two are the most commonly asked pairings.

---

56. The early development of monocot and dicot embryo is similar up to which stage?

(A) Octant stage
(B) Diad stage
(C) Globular stage
(D) Quadrant stage

Correct Answer: (C) Globular stage

Solution:

Step 1: Understanding the Concept:
The question is about plant embryogenesis and asks to identify the developmental stage at which the embryos of monocots and dicots, which have different final structures, are still morphologically similar.

Step 2: Detailed Explanation:
The development of the embryo from the zygote follows a series of predictable stages:

1. The zygote divides to form a two-celled proembryo, or a **diad**.
2. Further divisions lead to a four-celled stage (**quadrant**) and then an eight-celled stage (**octant**).
3. Continued cell division results in a spherical mass of cells, which is known as the **globular stage**.

Up to the globular stage, the embryo is radially symmetrical and looks essentially the same in both monocots and dicots. The key differentiation begins *after* this stage.

- In **dicots**, two cotyledons (seed leaves) begin to form, giving the embryo a heart shape (**heart stage**), which then elongates into the **torpedo stage**.
- In **monocots**, a single cotyledon develops, and the embryo typically becomes more cylindrical or scutiform, without passing through a distinct heart stage.

Step 3: Final Answer:
Since the major morphological divergence (development of one vs. two cotyledons) occurs after the globular stage, the early development is considered similar up to and including the globular stage.

Quick Tip

Think of the globular stage as the last point of "common design" in embryo development. After this spherical stage, the plant commits to its blueprint: two growing points for cotyledons in dicots (leading to the heart shape) or one in monocots.

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57. Mesosome is a specialized and differentiated form of _____.

(A) Ribosomes
(B) Mitochondria
(C) Cell membrane
(D) Cell wall

Correct Answer: (C) Cell membrane

Solution:

Step 1: Understanding the Concept:
The question asks to identify the cellular structure from which a mesosome is formed in prokaryotic cells.

Step 2: Detailed Explanation:

- Mesosomes are convoluted infoldings of the plasma membrane (cell membrane) found in many bacteria. They appear as vesicles, tubules, or lamellae within the cytoplasm.
- Historically, they were thought to be involved in various functions like cell wall synthesis, DNA replication, cell division (septum formation), and respiration (as an analogue to mitochondrial cristae).
- However, strong evidence now suggests that mesosomes are largely artifacts created during the chemical fixation and dehydration process used to prepare bacterial cells for electron microscopy. They are not typically seen in cells prepared by cryofixation.
- Regardless of their status as artifacts, for the purpose of a biology question asking about their structural origin, they are defined as being formed from the **cell membrane**.

Let's examine the options:

- (A) Ribosomes: These are separate particles for protein synthesis.

- (B) Mitochondria: These are organelles found in eukaryotes, not prokaryotes.
- (C) Cell membrane: This is the correct origin. Mesosomes are infoldings of this structure.
- (D) Cell wall: This is the rigid layer outside the cell membrane.

Step 3: Final Answer:
A mesosome is a specialized and differentiated form (an infolding) of the prokaryotic cell membrane.

Quick Tip

Even though mesosomes are now widely considered artifacts, in the context of most exam questions, you should remember their textbook definition: an infolding of the prokaryotic plasma membrane.

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58. In which specific region of the chloroplast, does Calvin cycle occurs?

(A) Thylakoid membranes
(B) Stroma
(C) Grana
(D) Inner membrane

Correct Answer: (B) Stroma

Solution:

Step 1: Understanding the Concept:
The question asks to identify the location of the Calvin cycle within the chloroplast. Photosynthesis in eukaryotes is divided into two main stages: the light-dependent reactions and the light-independent reactions (Calvin cycle). Each stage occurs in a specific compartment of the chloroplast.

Step 2: Detailed Explanation:

- **Light-dependent reactions:** This stage involves capturing light energy and using it to produce ATP and NADPH. These reactions are carried out by pigment-protein complexes (photosystems) and electron transport chains that are embedded in the **thylakoid membranes**. The thylakoids are often stacked into structures called **grana**.
- **Calvin cycle (Light-independent reactions):** This stage uses the ATP and NADPH produced during the light reactions to fix atmospheric carbon dioxide (CO) and synthesize sugars. This process is catalyzed by a series of enzymes, such as RuBisCO, which are soluble and located in the aqueous, fluid-filled space surrounding the thylakoids. This space is called the **stroma**.

- The **inner membrane** of the chloroplast regulates the passage of metabolites into and out of the stroma but is not the site of the Calvin cycle itself.

Step 3: Final Answer:
The Calvin cycle, being a series of enzyme-catalyzed reactions that fix CO, takes place in the stroma of the chloroplast.

Quick Tip

Remember the division of labor in the chloroplast: Light reactions happen *on the membranes* (thylakoids) because they need the membrane-bound protein complexes. The Calvin cycle happens in the *fluid* (stroma) because it involves soluble enzymes. Light provides the energy (ATP/NADPH) from the thylakoids to the stroma, and the stroma uses it to make sugar.

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59. A eukaryotic cell is exposed to a chemical that inhibits the 5' capping of pre-mRNA. What is the most likely effect on translation?

(A) Translation will initiate but elongation will be impaired.
(B) Translation will fail to initiate due to improper ribosome binding.
(C) The polyadenylation will not occur.
(D) Splicing of introns will be unaffected.

Correct Answer: (B) Translation will fail to initiate due to improper ribosome binding.

Solution:

Step 1: Understanding the Concept:
The question asks about the consequence of inhibiting the 5' cap addition to eukaryotic pre-mRNA, specifically its effect on translation. The 5' cap is a modified guanine nucleotide added to the 5' end of the mRNA transcript.

Step 2: Detailed Explanation:
The 5' cap has several crucial functions in eukaryotes:

1. **Protection:** It protects the mRNA from degradation by 5' exonucleases.
2. **Nuclear Export:** It is essential for the transport of the mRNA from the nucleus to the cytoplasm.
3. **Translation Initiation:** It serves as the primary recognition site for the ribosome to bind to the mRNA. The cap is recognized by the cap-binding complex (eIF4F), which then recruits the small ribosomal subunit (40S) to the mRNA. This is a critical step for initiating translation.

Let's analyze the options based on these functions:

- **(A) Translation will initiate but elongation will be impaired:** This is incorrect. The cap is essential for initiation, not elongation. Without the cap, initiation itself is blocked.
- **(B) Translation will fail to initiate due to improper ribosome binding:** This is correct. Without the 5' cap, the ribosome cannot be recruited to the mRNA efficiently, and thus translation cannot begin.
- **(C) The polyadenylation will not occur:** Polyadenylation (addition of a poly-A tail) occurs at the 3' end and is a separate process from 5' capping, although they are often coupled. Inhibiting capping doesn't directly prevent polyadenylation.
- **(D) Splicing of introns will be unaffected:** This is not the most likely or direct effect on translation. While capping can influence the efficiency of splicing for some introns, its most direct and critical role is in translation initiation. The question asks for the effect on *translation*.

Step 3: Final Answer:
Inhibiting 5' capping will prevent the proper binding of the ribosome to the mRNA, thereby causing a failure in the initiation of translation.

Quick Tip

Think of the eukaryotic mRNA modifications as "passports" and "instructions." The 5' cap is the "address label" that tells the ribosome where to bind and start reading. Without this label, the ribosome is lost and cannot begin its job of translation.

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60. What effect does the hypermethylation of promoter regions typically have on gene expression?

(A) Activation of transcription.
(B) Silencing of transcription.
(C) No effect on transcription.
(D) Increased translational efficiency.

Correct Answer: (B) Silencing of transcription.

Solution:

Step 1: Understanding the Concept:
The question asks about the role of DNA methylation, a key epigenetic modification, in regulating gene expression. Specifically, it focuses on the effect of hypermethylation (an excess of methylation) in the promoter region of a gene.

Step 2: Detailed Explanation:

- **DNA methylation** is the addition of a methyl group (-CH) to the DNA molecule, typically at CpG sites (a cytosine nucleotide followed by a guanine nucleotide).
- The **promoter** is a region of DNA where transcription is initiated. It's the binding site for RNA polymerase and transcription factors.
- **Hypermethylation** of a gene's promoter region is a well-established mechanism for gene silencing. It works in two main ways:
    1. The methyl groups can physically block the binding of transcription factors and RNA polymerase to the promoter, thus preventing transcription from starting.
    2. Methylated DNA can be recognized and bound by specific proteins called methyl-CpG-binding domain proteins (MBDs). These proteins, in turn, recruit histone deacetylases (HDACs) and other chromatin-remodeling proteins. This leads to the compaction of chromatin into a condensed, inactive state (heterochromatin), making the gene inaccessible for transcription.
- Therefore, hypermethylation of the promoter is strongly associated with the repression or **silencing of transcription**.

Step 3: Final Answer:
The typical effect of hypermethylation of promoter regions is the silencing of transcription.

Quick Tip

Remember this simple epigenetic rule: **Methylation Mutes**. High levels of DNA methylation in a promoter region generally lead to gene silencing. Conversely, demethylation or hypomethylation is associated with gene activation.

---

61. Treating chromatin with a non specific nuclease yields a segment of about 168 bp which is bound to 9 histone molecules (H2A, H2B, H3, H4 and H1). This whole structure is known as:

(A) Histone Octamer
(B) Nucleosome
(C) Chromatosome
(D) Histosome

Correct Answer: (C) Chromatosome

Solution:

Step 1: Understanding the Concept:
This question asks for the specific name of a chromatin structural unit defined by its DNA length and the complement of histone proteins, including the linker histone H1.

Step 2: Detailed Explanation:
Let's define the different levels of chromatin structure:

- **Histone Octamer:** This is the protein core of the nucleosome. It consists of eight histone molecules: two copies each of the core histones H2A, H2B, H3, and H4. It does not include DNA or histone H1.
- **Nucleosome (or Core Particle):** This is the fundamental repeating unit of chromatin. It consists of the histone octamer with approximately **147 base pairs (bp)** of DNA wrapped around it. It does not include the linker histone H1. Mild digestion of chromatin with micrococcal nuclease (MNase) yields this structure.
- **Chromatosome:** This is the next level of organization. It consists of the nucleosome core particle *plus* the linker histone H1, which binds to the DNA where it enters and exits the octamer. The addition of H1 protects a longer stretch of DNA from nuclease digestion. The chromatosome comprises the histone octamer, the linker histone H1 (total of 9 histone molecules), and about **168 bp** of DNA. This description perfectly matches the question.
- **Histosome:** This term is not standard in the context of chromatin structure.

Step 3: Final Answer:
The structure containing 168 bp of DNA, the histone octamer, and the linker histone H1 is called a chromatosome.

Quick Tip

Remember the progression of chromatin structure:

- **Histone Octamer** (8 core histones) + **~147 bp DNA** = **Nucleosome**
- **Nucleosome** + **Histone H1** ($\rightarrow$ protection of ~168 bp DNA) = **Chromatosome**

The key difference between a nucleosome and a chromatosome is the presence of the H1 linker histone.

---

62. The correct karyotype description of Patau Syndrome is _____.

(A) 47, +21
(B) 47, +18
(C) 47, +13
(D) 45, XO

Correct Answer: (C) 47, +13

Solution:

Step 1: Understanding the Concept:
The question asks for the specific karyotype associated with Patau Syndrome. A karyotype

describes the number and appearance of chromosomes in a cell. Human genetic syndromes are often caused by aneuploidy, an abnormal number of chromosomes.

Step 2: Detailed Explanation:
Let's identify the syndromes associated with each karyotype:

- **(A) 47, +21:** This indicates a total of 47 chromosomes, with an extra copy of chromosome 21. This condition is known as Trisomy 21, or **Down Syndrome**.
- **(B) 47, +18:** This indicates a total of 47 chromosomes, with an extra copy of chromosome 18. This condition is known as Trisomy 18, or **Edwards Syndrome**.
- **(C) 47, +13:** This indicates a total of 47 chromosomes, with an extra copy of chromosome 13. This condition is known as Trisomy 13, or **Patau Syndrome**.
- **(D) 45, XO:** This indicates a total of 45 chromosomes, with only one sex chromosome (an X chromosome) and the other missing. This condition is known as Monosomy X, or **Turner Syndrome**.

Step 3: Final Answer:
Patau Syndrome is correctly described by the karyotype 47, +13 (Trisomy 13).

Quick Tip

For exams, memorize the three most common autosomal trisomies:

- **Trisomy 21**: Down Syndrome
- **Trisomy 18**: Edwards Syndrome
- **Trisomy 13**: Patau Syndrome

Notice that the severity of the syndrome generally increases as the chromosome number decreases (i.e., Trisomy 13 is more severe than Trisomy 21).

---

63. What is the primary function of Bt toxin in genetically modified crops like Bt Cotton?

(A) Enhancing nutrient content.
(B) Providing resistance to fungal infections.
(C) Acting as a natural insecticide.
(D) Increasing drought tolerance.

Correct Answer: (C) Acting as a natural insecticide.

Solution:

Step 1: Understanding the Concept:
The question asks for the main purpose of incorporating the Bt toxin gene into crops such as cotton. "Bt" stands for *Bacillus thuringiensis*, a soil bacterium.

Step 2: Detailed Explanation:

- The bacterium *Bacillus thuringiensis* naturally produces a class of proteins called Cry proteins, commonly known as Bt toxins.
- These proteins are harmless to humans, mammals, and most beneficial insects, but they are highly toxic to the larvae of certain insect pests, such as the cotton bollworm.
- The mechanism of action involves the insect larva ingesting the protein. In the alkaline environment of the insect's midgut, the inactive protoxin is cleaved into its active form. This active toxin then binds to specific receptors on the gut wall, creating pores that lead to cell lysis, gut paralysis, and ultimately, the death of the insect.
- Genetic engineering has allowed scientists to isolate the gene (Cry gene) that codes for this toxin from the bacterium and insert it into the genome of plants like cotton, corn, and brinjal.
- The resulting genetically modified (GM) crop, such as Bt Cotton, can produce its own Bt toxin. When a susceptible insect pest tries to feed on the plant, it ingests the toxin and is killed. Therefore, the primary function of the Bt toxin is to make the plant resistant to certain insect pests, effectively making it act as a natural insecticide.

Step 3: Final Answer:
The primary function of Bt toxin in GM crops is to act as a built-in, natural insecticide, protecting the plant from specific insect pests.

Quick Tip

Remember the name: **Bt** stands for ***B****acillus* ***t****huringiensis*. This bacterium produces a protein toxic to insects. So, Bt crops are insect-resistant. The 't' in Bt can remind you of 'toxin'.

---

64. A plasmid vector contains a multiple cloning site (MCS) within the lac-Z gene. If foreign DNA is inserted into the MCS, what happens when competent cells are transformed with this plasmid and allowed to grow on a nutrient medium plate with X-gal and IPTG?

(A) Transformed cells with recombinant plasmids will appear blue.
(B) Transformed cells with recombinant plasmids will appear white.
(C) All transformed cells will appear blue.
(D) Non-transformed cells will appear white.

Correct Answer: (B) Transformed cells with recombinant plasmids will appear white.

Solution:

Step 1: Understanding the Concept:
This question describes blue-white screening, a common technique used in molecular cloning to identify bacteria that have taken up a recombinant plasmid (a plasmid containing an inserted piece of foreign DNA). The technique relies on the principle of insertional inactivation.

Step 2: Detailed Explanation:
Let's break down the components:

- **lac-Z gene:** This gene codes for the enzyme β-galactosidase.
- **X-gal:** A colorless artificial substrate for β-galactosidase. When cleaved by the enzyme, it produces a blue-colored product.
- **IPTG:** An inducer of the lac operon, which ensures that the lac-Z gene is expressed.
- **Multiple Cloning Site (MCS):** A short region containing many unique restriction sites, placed intentionally inside the lac-Z gene.

Now let's consider the two possible outcomes for transformed cells (cells that have taken up a plasmid):

1. **Non-recombinant plasmid:** The plasmid has re-ligated without an insert. The lac-Z gene is intact. The bacteria will produce functional β-galactosidase. This enzyme will cleave X-gal, and the bacterial colony will turn **blue**.
2. **Recombinant plasmid:** A piece of foreign DNA has been successfully inserted into the MCS. This insertion disrupts the lac-Z gene (**insertional inactivation**). The bacteria cannot produce functional β-galactosidase. As a result, X-gal is not cleaved, and the bacterial colony remains its natural color, which is **white**.

Non-transformed cells (cells that did not take up any plasmid) will not grow at all if the plasmid also contains an antibiotic resistance gene and the medium contains that antibiotic (which is standard practice). If they were to grow, they would be white as they lack the lac-Z gene.

Step 3: Final Answer:
Transformed cells containing the recombinant plasmid have an inactivated lac-Z gene and therefore will appear white on the X-gal/IPTG medium.

Quick Tip

Remember the key idea of blue-white screening:

- **Blue** = Bad (for the experimenter). The plasmid is non-recombinant.
- **White** = Wanted. The plasmid is recombinant, containing your gene of interest.

The insert inactivates the "blue-making" gene.

65. Sequentially arrange the steps involved in cryopreservation of plant cells in order of their occurrence.
A. Raising sterile tissue culture
B. Determination of viability
C. Freezing, Storage
D. Addition of cryoprotectants.
Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
The question asks for the correct chronological order of the major steps involved in cryopreservation, which is the process of preserving biological material (like plant cells) by cooling it to very low temperatures, typically in liquid nitrogen (-196°C).

Step 2: Detailed Explanation:
Let's analyze the logical flow of the process:

1. **A. Raising sterile tissue culture:** First, you need the biological material to preserve. You start by growing a healthy, sterile, and actively dividing culture of the plant cells or tissues. This is the starting material.
2. **D. Addition of cryoprotectants:** Before freezing, you must treat the cells with cryoprotectants (e.g., DMSO, glycerol). These substances protect the cells from damage caused by ice crystal formation during the freezing process. This is a crucial pre-treatment step.
3. **C. Freezing, Storage:** After adding cryoprotectants, the cells are subjected to a controlled cooling protocol to freeze them, and then they are transferred to long-term storage in liquid nitrogen.
4. **B. Determination of viability:** After a period of storage, and especially when you need to use the material, the cells are thawed. It is then essential to test their viability (i.e., to check if they have survived the freezing and thawing process) using methods like staining (e.g., with TTC or fluorescein diacetate). This is the final quality-control step.

Step 3: Final Answer:
The correct sequence of steps is: Raise the culture (A), add protective chemicals (D), freeze and store it (C), and finally, check if it survived (B). This corresponds to the order A, D, C, B.

Quick Tip

Think of cryopreservation like preparing a valuable item for long-term storage. First, you get the item (A. raise culture). Then, you wrap it in protective material (D. add cryoprotectants). Next, you put it in the storage unit (C. freeze). Finally, when you take it out, you check if it's still in good condition (B. determine viability).

---

66. Which of the following is a characteristic feature of Bacterial Artificial Chromosome (BAC) vector?

(A) They can carry large DNA inserts.
(B) They use eukaryotic cells as hosts.
(C) They lack selectable markers.
(D) They do not replicate autonomously.

Correct Answer: (A) They can carry large DNA inserts.

Solution:

Step 1: Understanding the Concept:
The question asks for a key characteristic of a Bacterial Artificial Chromosome (BAC) vector. BACs are cloning vectors used in molecular biology.

Step 2: Detailed Explanation:
Let's analyze the features of BAC vectors:

- BACs are based on the F-plasmid (fertility plasmid) of *E. coli*.
- Their most important feature is their ability to accept and maintain very **large DNA inserts**, typically ranging from 150 to 350 kilobase pairs (kbp). This makes them invaluable for constructing genomic libraries and for sequencing entire genomes.
- They use **bacterial cells** (specifically *E. coli*) as hosts, as indicated by the name "Bacterial" Artificial Chromosome.
- They contain essential vector components, including an origin of replication (oriS from the F-plasmid) that allows them to **replicate autonomously** in the host cell. The F-plasmid origin maintains a very low copy number (1-2 copies per cell), which contributes to the stability of large inserts.
- They possess **selectable markers**, such as an antibiotic resistance gene (e.g., chloramphenicol resistance), to allow for the selection of host cells that have successfully taken up the vector.

Evaluating the options:

- **(A) They can carry large DNA inserts:** This is the primary and defining characteristic of BACs.

- **(B) They use eukaryotic cells as hosts:** This is incorrect. They use bacterial hosts. Yeast Artificial Chromosomes (YACs) use eukaryotic (yeast) hosts.
- **(C) They lack selectable markers:** This is incorrect. They must have selectable markers for cloning to be feasible.
- **(D) They do not replicate autonomously:** This is incorrect. They have an origin of replication and replicate along with the host cell's chromosome.

Step 3: Final Answer:
The most significant characteristic feature of a BAC vector is its capacity to carry large DNA inserts.

Quick Tip

Associate different cloning vectors with their insert size capacity.

- **Plasmids:** Small inserts (< 15 kbp)
- **Bacteriophages (e.g., Lambda):** Moderate inserts (~ 25 kbp)
- **Cosmids:** Larger inserts (~ 45 kbp)
- **BACs:** Very large inserts (150-350 kbp)
- **YACs:** Extremely large inserts (> 1 Mbp)

---

67. Which sequence of steps is correct in the development of a genetically modified (GM) crop?
A. Insertion of the gene into the vector.
B. Identification of a desired gene.
C. Selection and screening of transformed plants.
D. Transfer of the vector into a plant cell.
Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
The question asks for the logical and chronological sequence of steps required to create a genetically modified (GM) plant.

Step 2: Detailed Explanation:
Let's arrange the steps in a logical workflow:

1. **B. Identification of a desired gene:** The very first step is to identify a gene that confers a desirable trait (e.g., insect resistance, herbicide tolerance, improved nutrition). You must know what gene you want to transfer before you can do anything else.
2. **A. Insertion of the gene into the vector:** Once the desired gene is isolated, it needs to be inserted into a suitable carrier, or vector (usually a plasmid like the Ti plasmid from *Agrobacterium tumefaciens*). This creates a recombinant DNA molecule.
3. **D. Transfer of the vector into a plant cell:** The recombinant vector is then used to transfer the desired gene into the target plant cells. This can be done using methods like *Agrobacterium*-mediated transformation or a gene gun.
4. **C. Selection and screening of transformed plants:** The transformation process is not 100% efficient. Therefore, after transformation, it is crucial to select the cells that have successfully incorporated the new gene (often using selectable markers like antibiotic resistance) and then regenerate whole plants from these transformed cells. These plants must then be screened to confirm the presence and expression of the new gene and the desired trait.

Step 3: Final Answer:
The correct sequence of steps is: Identify the gene (B), put it in a vector (A), transfer the vector to the plant (D), and then select and screen the results (C). This corresponds to the order B, A, D, C.

Quick Tip

Think of the process like sending a letter. First, you decide what to write (**B**, identify gene). Then, you put the letter in an envelope (**A**, insert into vector). Next, you mail the envelope (**D**, transfer vector). Finally, you check if the recipient received and understood it (**C**, select and screen).

---

68. Which of the following order is not included in Stachyospermae?

(A) Cordaitales
(B) Ginkgoales
(C) Cycadales
(D) Coniferales

Correct Answer: (C) Cycadales

Solution:

Step 1: Understanding the Concept:
The question is based on an older classification system of gymnosperms. This system, proposed by botanists like Sahni, divided gymnosperms into two major groups based on the position of the ovules:

- **Stachyospermae:** Ovules are borne on a stem or axis ('stachys' = spike/axis, 'sperma' = seed). This group is characterized by having simple, often needle-like or fan-shaped leaves.
- **Phyllospermae:** Ovules are borne on leaves or leaf-like structures ('phyllon' = leaf, 'sperma' = seed). This group has large, frond-like leaves.

Step 2: Detailed Explanation:
Let's classify the given orders according to this system:

- **Cordaitales:** An extinct order of gymnosperms considered ancestral to conifers. They had ovules borne on axes, placing them in Stachyospermae.
- **Ginkgoales:** Includes the living *Ginkgo biloba*. The ovules are borne on stalks (axes), placing this order in Stachyospermae.
- **Coniferales:** The conifers (pines, firs, etc.). Their ovules are borne on scales that are considered modified shoots or axes, placing them in Stachyospermae.
- **Cycadales:** The cycads. Their ovules are borne on modified leaves called megasporophylls. This leaf-borne ovule characteristic places them in the group **Phyllospermae**, not Stachyospermae. Other members of Phyllospermae include Pteridospermales (seed ferns).

Step 3: Final Answer:
Cycadales is part of Phyllospermae, not Stachyospermae. Therefore, it is the correct answer.

Quick Tip

To remember this classification, break down the names:

- **Stachyospermae** = Stachys (Stem/Axis) + Sperma (Seed) → Seeds on stems. (Think of conifers, Ginkgo).
- **Phyllospermae** = Phyllo (Leaf) + Sperma (Seed) → Seeds on leaves. (Think of cycads and seed ferns).

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69. Match the LIST-I with LIST-II

LIST-I **Type of proteins**	**LIST-II** **Examples**
A. Structural proteins	I. Ion Channels
B. Transport Proteins	II. Insulin
C. Hormonal Proteins	III. Seed Proteins
D. Storage Proteins	IV. Collagen

Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
The question requires matching different functional classes of proteins with their specific examples.

Step 2: Detailed Explanation:
Let's analyze each protein type and find its corresponding example:

- **A. Structural proteins:** These proteins provide support, shape, and framework to cells, tissues, and organisms. **Collagen** is the most abundant protein in mammals, forming the main structural component of connective tissues like skin, tendons, and bones. Thus, **A matches with IV**.
- **B. Transport Proteins:** These proteins facilitate the movement of substances across cell membranes or throughout the body. **Ion Channels** are a classic example; they are transmembrane proteins that form pores allowing specific ions to pass through the cell membrane. Another example would be hemoglobin, which transports oxygen. Thus, **B matches with I**.
- **C. Hormonal Proteins:** These proteins act as chemical messengers to regulate physiological processes. **Insulin** is a well-known protein hormone that regulates blood glucose levels. Thus, **C matches with II**.
- **D. Storage Proteins:** These proteins serve as a reserve of amino acids and nutrients. **Seed Proteins**, such as albumin and globulin found in seeds of legumes and cereals, store amino acids for the developing embryo during germination. Ovalbumin in egg white is another example. Thus, **D matches with III**.

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

Quick Tip

When tackling matching questions, start with the pairs you are most confident about. Most students know that Insulin is a hormone (C-II) and Collagen is structural (A-IV). This combination (A-IV, C-II) is only found in option (C), allowing you to solve the question quickly.

70. Which of the following is incorrectly matched ?

(A) Amino acids - Proteins
(B) Fatty acids - Deoxynucleotides
(C) Glucose - Polysaccharides
(D) Nucleoside triphosphate - Nucleic acids

Correct Answer: (B) Fatty acids - Deoxynucleotides

Solution:

Step 1: Understanding the Concept:
The question asks to identify the pair where the monomer (building block) is incorrectly matched with its corresponding polymer or macromolecule.

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

- **(A) Amino acids - Proteins:** This is a correct match. Proteins are polymers made up of amino acid monomers linked by peptide bonds.
- **(B) Fatty acids - Deoxynucleotides:** This is an incorrect match.
  - **Fatty acids** are the building blocks of lipids (fats and oils), along with glycerol.
  - **Deoxynucleotides** are the monomers of DNA (a nucleic acid). A deoxynucleotide itself is composed of three parts: a deoxyribose sugar, a phosphate group, and a nitrogenous base.

  There is no direct monomer-polymer relationship between fatty acids and deoxynucleotides.
- **(C) Glucose - Polysaccharides:** This is a correct match. Polysaccharides (like starch, glycogen, and cellulose) are polymers made up of monosaccharide monomers, with glucose being the most common one.
- **(D) Nucleoside triphosphate - Nucleic acids:** This is a correct match. Nucleic acids (DNA and RNA) are polymers made of nucleotide monomers. Nucleoside triphosphates (like ATP, GTP, CTP, TTP) are the activated precursors used during the synthesis of nucleic acid polymers. Two phosphate groups are cleaved off during polymerization, and the remaining nucleotide is incorporated into the growing chain.

Step 3: Final Answer:
The pair "Fatty acids - Deoxynucleotides" is incorrectly matched as they belong to two different classes of macromolecules.

Quick Tip

Memorize the four main classes of biological macromolecules and their monomers:

- **Carbohydrates** (Polysaccharides) → **Monosaccharides** (e.g., glucose)
- **Proteins** → **Amino acids**
- **Nucleic Acids** (DNA/RNA) → **Nucleotides**
- **Lipids** → **Fatty acids** & **Glycerol**

---

71. The enzyme responsible for synthesizing RNA primers during DNA replication is -

(A) DNA polymerase
(B) Primase
(C) Topoisomerase
(D) Helicase

Correct Answer: (B) Primase

Solution:

Step 1: Understanding the Concept:
The question asks to identify the specific enzyme that creates the short RNA primers needed to initiate DNA synthesis during replication.

Step 2: Detailed Explanation:
Let's review the roles of the key enzymes in DNA replication:

- **Helicase:** This enzyme unwinds the DNA double helix at the replication fork, separating the two strands to make them available as templates.
- **Primase:** This is a type of RNA polymerase. Its specific job is to synthesize short RNA sequences, called primers (about 5-10 nucleotides long), that are complementary to the template DNA strand. DNA polymerase cannot start a new DNA strand from scratch; it can only add nucleotides to an existing 3'-OH group. The RNA primer provides this starting point.
- **DNA polymerase:** This is the main enzyme of replication. It adds deoxynucleotides to the 3' end of the RNA primer, synthesizing the new DNA strand. It also has roles in proofreading and replacing the RNA primers with DNA.
- **Topoisomerase (or DNA gyrase in bacteria):** This enzyme relieves the torsional strain and supercoiling that builds up ahead of the replication fork as the DNA unwinds.

Step 3: Final Answer:
The enzyme specifically responsible for synthesizing the RNA primers is Primase.

Quick Tip

Remember the key limitation of DNA polymerase: it's an extender, not a starter. It needs a "primer" to get started. The enzyme that makes this primer is appropriately named **Primase**.

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72. Which of the following best explains the fluidity of the plasma membrane ?

(A) The presence of phospholipids in a rigid bilayer.
(B) The movement of proteins and lipids within the bilayer.
(C) The fixed positions of membrane proteins.
(D) The attachment of cholesterol to membrane proteins.

Correct Answer: (B) The movement of proteins and lipids within the bilayer.

Solution:

Step 1: Understanding the Concept:
The question asks for the best explanation of the 'fluidity' of the plasma membrane, a key concept in the Fluid Mosaic Model of cell membranes.

Step 2: Detailed Explanation:
The Fluid Mosaic Model describes the plasma membrane as a dynamic, fluid structure, not a static one.

- The "fluid" part refers to the fact that the components of the membrane, primarily phospholipids and proteins, are not locked in place.
- **Phospholipids** can move laterally (side-to-side), rotate on their axes, and occasionally "flip-flop" from one layer of the bilayer to the other (though this is rare). This lipid movement is a major contributor to membrane fluidity.
- **Membrane proteins** are also generally free to move laterally within the lipid bilayer, floating like icebergs in a sea of lipids.
- This constant **movement of both proteins and lipids** is the essence of membrane fluidity. It allows the membrane to be flexible, self-sealing, and involved in processes like cell signaling and transport.

Let's evaluate the options:

- (A) describes the opposite of fluidity by calling the bilayer "rigid."
- (C) is incorrect because most membrane proteins are not fixed; their ability to move is part of the membrane's fluidity.
- (D) is incorrect. Cholesterol modulates fluidity by interacting with phospholipids, not by attaching to proteins.

- (B) accurately describes the dynamic nature of the membrane, where both lipids and proteins are in constant motion.

Step 3: Final Answer:
The fluidity of the plasma membrane is best explained by the continuous movement of its constituent proteins and lipids within the bilayer.

Quick Tip

Remember the name of the model: **Fluid Mosaic Model**. "Fluid" refers to the movement of lipids and proteins. "Mosaic" refers to the patchwork pattern of proteins embedded within the lipid bilayer.

---

73. Sequence the following events involved in a point mutation in DNA.
A. Alteration in the amino acid sequence of a protein.
B. Change in mRNA codon during transcription.
C. Substitution of a single nucleotide in the DNA sequence.
D. Possible disruption of protein function or structure.
Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
The question asks for the correct chronological order of events that occur as a consequence of a point mutation in the DNA, following the principles of the central dogma of molecular biology (DNA $\rightarrow$ RNA $\rightarrow$ Protein).

Step 2: Detailed Explanation:
Let's trace the flow of information from the initial mutation to its final effect:

1. **C. Substitution of a single nucleotide in the DNA sequence:** The process must start with the mutation itself. A point mutation is a change in a single nucleotide base in the DNA. This is the root cause.
2. **B. Change in mRNA codon during transcription:** During transcription, the mutated DNA sequence serves as a template to create an mRNA molecule. The change in the DNA base will result in a corresponding change in the mRNA codon.

3. **A. Alteration in the amino acid sequence of a protein:** During translation, the ribosome reads the mRNA codons. If the changed codon now specifies a different amino acid (a missense mutation), the resulting polypeptide chain will have an altered amino acid sequence.

4. **D. Possible disruption of protein function or structure:** The change in the amino acid sequence can alter the protein's three-dimensional structure, which in turn can disrupt or change its biological function. This is the final phenotypic consequence of the mutation.

Step 3: Final Answer:
The correct sequence of events is: DNA mutation (C) → mRNA codon change (B) → Amino acid sequence change (A) → Protein function disruption (D). This corresponds to the order C, B, A, D.

Quick Tip

Always follow the central dogma: DNA → RNA → Protein. The problem must start at the DNA level (mutation), then affect the RNA (transcription), then the protein sequence (translation), and finally the protein's function (phenotype).

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74. Identify the correct sequence of steps in a dihybrid cross to test Mendel's Law of Independent Assortment
A. Selection of two traits in the parent generation.
B. Crossing of pure - breeding parents.
C. Analysis of phenotypic ratios in the F generation.
D. Observations of gamete combinations in the F generation.
Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
The question asks for the correct experimental procedure for a Mendelian dihybrid cross, which is designed to study the inheritance of two different traits simultaneously and demonstrate the Law of Independent Assortment.

Step 2: Detailed Explanation:
Let's outline the logical steps of the experiment:

1. **A. Selection of two traits in the parent generation:** The experiment begins with the scientist choosing two distinct, contrasting traits to study (e.g., seed shape and seed color in peas).
2. **B. Crossing of pure - breeding parents:** The next step is to perform the parental (P generation) cross. This involves crossing two parents that are pure-breeding (homozygous) for the selected traits, one dominant for both and the other recessive for both (e.g., RRYY x rryy).
3. **D. Observations of gamete combinations in the F generation:** The offspring of the P cross are the F generation. They are all heterozygous for both traits (e.g., RrYy). Mendel then self-crossed these F individuals. The key to independent assortment is observing that the F generation produces four different types of gametes (RY, Ry, rY, ry) in equal proportions. Step D, "Observations of gamete combinations in the F generation," refers to this step of generating and understanding the gametes from the F that will create the F generation.
4. **C. Analysis of phenotypic ratios in the F generation:** The offspring of the F self-cross are the F generation. The final step is to count the offspring and analyze their phenotypic ratios. If the genes assort independently, this ratio will be approximately 9:3:3:1. This analysis is the ultimate test of the law.

Step 3: Final Answer:
The correct experimental sequence is: Select traits (A) → Cross pure parents (B) → Observe F and its gametes for the next cross (D) → Analyze F results (C). This corresponds to the order A, B, D, C.

Quick Tip

Remember the flow of any Mendelian experiment: **P** (Parents) → **F** (First Filial) → **F** (Second Filial). You must set up the parents first (A, B), then produce and analyze the F (D), and finally produce and analyze the F (C).

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75. Select the phases which are included in the 'Interphase'.
A. S phase
B. M phase
C. G phase
D. G phase
Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:
The question asks to identify the specific phases that constitute the 'Interphase' part of the eukaryotic cell cycle. The cell cycle is the series of events that take place in a cell leading to its division and duplication.

Step 2: Detailed Explanation:
The eukaryotic cell cycle is broadly divided into two main stages:

1. **Interphase:** This is the longest phase of the cell cycle. It is the period of cell growth and DNA replication in preparation for cell division. Interphase is further subdivided into three distinct phases:
    - **G phase (Gap 1):** (C) The cell grows in size and synthesizes mRNA and proteins required for DNA synthesis.
    - **S phase (Synthesis):** (A) The cell replicates its DNA. At the end of this phase, each chromosome consists of two sister chromatids.
    - **G phase (Gap 2):** (D) The cell continues to grow and produces proteins and organelles needed for mitosis.
2. **M phase (Mitotic phase):** (B) This is the phase of actual cell division. It consists of mitosis (nuclear division) and cytokinesis (cytoplasmic division).

Therefore, Interphase includes the G, S, and G phases. The M phase is the separate, subsequent stage of division.

Step 3: Final Answer:
The phases included in Interphase are S phase (A), G phase (C), and G phase (D). The correct option is A, C and D only.

Quick Tip

Think of the cell cycle as a life story. **Interphase** is the long period of "living, growing, and preparing" (G, S, G). **M phase** is the short, dramatic event of "reproduction" or division. M phase is never part of Interphase.
