

CUET PG 2025 Botany Question Paper with Solutions

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

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 credited with discovering bacterial transformation. This is a process where a bacterium takes up foreign genetic material from its surroundings, resulting in a genetic change.

Step 2: Detailed Explanation

- **F. Griffith (1928):** Griffith's experiments with *Streptococcus pneumoniae* were foundational. He observed that when he injected mice with a mixture of heat-killed, virulent S-strain bacteria and live, non-virulent R-strain bacteria, the mice died. He isolated live S-strain bacteria from them, concluding that some "transforming principle" from the dead S-strain had been absorbed by the live R-strain, transforming it into the virulent form. He discovered the phenomenon but did not know what the principle was.
- **Avery, McCarty, and Macleod (1944):** Building directly on Griffith's work, this team aimed to identify the "transforming principle." Through a series of experiments using enzymes to selectively destroy proteins, RNA, and DNA, they demonstrated that transformation was prevented only when DNA was destroyed. This provided the first strong evidence that DNA is the genetic material.
- **Lederberg and Tatum (1946):** They discovered a different process of genetic transfer in bacteria called conjugation, which requires direct cell-to-cell contact, unlike transformation.

Step 3: Final Answer

While Avery, McCarty, and Macleod identified the transforming molecule as DNA, it was **Fredrick Griffith** who first discovered and described the phenomenon of bacterial transformation itself. Therefore, he is credited with the discovery.

💡 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).

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 biological term for the fusion of a male gamete with the female gamete (egg cell) within the context of flowering plants (angiosperms).

Step 2: Detailed Explanation

Angiosperm reproduction involves several distinct processes with precise terminology.

- **Pollination:** This is the transfer of pollen from an anther to a stigma. It is a necessary precursor to fertilization but is not the fusion of gametes.
- **Double Fertilization:** This is a complex process unique to angiosperms that involves two separate fusion events. A pollen tube delivers two male gametes to the ovule.
 1. One male gamete fuses with the egg cell to form the diploid zygote. This specific event is called **syngamy**.
 2. The second male gamete fuses with the two polar nuclei in the central cell, forming the triploid endosperm, which provides nutrition for the embryo.
- **Syngamy:** This is the universal biological term for the fusion of gametes to form a zygote. In this context, it precisely describes the fusion of the male gamete and the egg cell.
- **Fragmentation:** This is a method of asexual reproduction and is not related to the sexual processes involving gametes.

Step 3: Final Answer

The question asks for the specific term for the fusion of the male gamete and the egg cell. While this is part of double fertilization, the most precise term for this single event is **syngamy**.

💡 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).

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 highly resistant bacterial structures whose tough outer layers prevent uptake of normal stains.

Step 2: Detailed Explanation

The most common technique is the **Schaeffer-Fulton method**, a differential stain designed to distinguish between vegetative cells and endospores.

1. **Primary Stain:** The bacterial smear is flooded with **Malachite Green**. Heat (usually steam) is applied as a mordant to penetrate the resistant endospore coat. At this stage, both the vegetative cells and the endospores are stained green.
2. **Decolorizer:** The slide is rinsed with water. Because malachite green is water-soluble, it is easily washed from the vegetative cells. However, it remains trapped inside the now-cooled, impermeable endospores.
3. **Counterstain:** **Safranin** is applied to the smear. It stains the decolorized vegetative cells pink or red, providing a clear contrast with the endospores.

The final result under a microscope shows green endospores inside red vegetative cells.

Step 3: Final Answer

Based on the standard Schaeffer-Fulton 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.

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 tests knowledge of plant taxonomy and morphology by requiring the correct matching of items from List-I (families/characteristics) with their corresponding examples from List-II.

Step 2: Detailed Explanation

Let's analyze each pair:

- **A. Myrtaceae:** This is the myrtle family, which includes commercially important plants like eucalyptus and guava. The scientific name for guava is *Psidium guajava*. Thus, **A matches with I (*Psidium*)**.
- **B. Hypanthodium inflorescence:** This is a very specialized inflorescence where the receptacle forms a hollow, flask-shaped structure. This unique feature is characteristic of the genus *Ficus*. Thus, **B matches with III (Fig)**.
- **C. Caryophyllaceae:** This is commonly known as the carnation or pink family. The carnation itself (*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 the Asteraceae family. Thus, **D matches with IV (*Inula*)**.

Step 3: Final Answer

The correct set of matches is: A → I, B → III, C → II, and 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.

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 has a strict microbiological definition and a broader, practical application in water quality testing.

Step 2: Detailed Explanation

- **Strict Definition:** A coliform is a rod-shaped, Gram-negative, non-spore-forming bacterium that ferments lactose with acid and gas production. Under this strict definition, only *Escherichia coli* (A) from the list is a coliform.
- **Broader Context (Fecal Indicators):** In environmental microbiology, the goal is often to detect fecal contamination. The term "coliform group" is used more broadly to include key fecal indicator organisms.
 - **A. *E. coli*:** The classic fecal coliform and primary indicator of recent contamination.
 - **B. *S. faecalis*:** Known as fecal streptococci, also used as an indicator.
 - **C. *C. perfringens*:** Its highly resistant spores can indicate past or remote fecal contamination.
 - **D. *Bacillus*:** Generally considered a soil bacterium, not a fecal indicator.

Since the available options group these bacteria, the question is clearly referencing the broader context of fecal indicators rather than the strict definition.

Step 3: Final Answer

In the context of common fecal indicator organisms, the most plausible answer includes *E. coli*, *S. faecalis*, and *C. perfringens*. This corresponds to **A, B, and C only**.

💡 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.

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 requires identifying the enzyme encoded by the genes *naat-A* and *naat-B*. These genes are used in genetic engineering to enhance the production of mugineic acid, a compound plants like rice use to absorb iron.

Step 2: Detailed Explanation

The key to this question lies in understanding biochemical nomenclature, where gene names are often abbreviations of the enzyme they encode. The biosynthesis pathway for mugineic acids involves several enzymes. A crucial step is the modification of a molecule called Nicotianamine (NA).

The enzyme responsible for this step is **Nicotianamine Aminotransferase**. The abbreviation for this enzyme is **NAAT**. The gene name *naat* directly and unambiguously corresponds to this enzyme. The A and B suffixes likely refer to different subunits or isoforms of the enzyme.

Step 3: Final Answer

The genes *naat-A* and *naat-B* encode the enzyme **Nicotianamine 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).

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

The question asks for the environmental condition that leads to guttation, which is the exudation of liquid xylem sap from pores (hydathodes) on leaf margins.

Step 2: Detailed Explanation

Guttation is driven by the interplay between two forces related to water movement in plants:

- **Root Pressure:** When soil moisture is high, roots actively pump minerals into the xylem. Water follows by osmosis, creating a positive pressure from below that pushes water up the plant.
- **Transpiration:** This is the evaporation of water vapor from leaves, primarily through stomata. It creates a negative pressure or tension that pulls the water column up from above.

Guttation occurs when root pressure is high but transpiration is very low. This scenario is common at night, when the soil is moist and the air is cool and humid, causing the stomata to close. With the "pull" from transpiration gone, the "push" from root pressure forces liquid water out through the hydathodes.

Step 3: Final Answer

The primary condition that allows root pressure to cause guttation 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.

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 three floral characteristics.

Step 2: Detailed Explanation

Let's analyze the given traits:

- **Hypogynous flower:** The petals, sepals, and stamens are attached below the ovary, meaning the ovary is **superior**.
- **Axile placentation:** The ovary is divided into multiple chambers (locules), and the ovules are attached to the central axis.
- **Swollen placenta:** The tissue to which the ovules are attached is fleshy and enlarged.

Evaluating the options:

- **(A) Asteraceae:** Typically has an inferior ovary (epigynous flower). This does not match.
- **(C) Solanaceae (Nightshade family):** This family is characterized by having a superior ovary, axile placentation, and, most distinctively, a prominent, swollen placenta bearing many ovules. A cross-section of a tomato fruit is a perfect visual example of this arrangement. This is a perfect match.
- **(B) Lamiaceae (D) Malvaceae:** While they have superior ovaries and axile placentation, their placentas are 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.

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, which describes the adverse conditions a plant experiences when its roots are waterlogged.

Step 2: Detailed Explanation

The primary problem caused by flooding is the displacement of air from soil pores. Plant roots require oxygen for aerobic cellular respiration, the primary process for generating ATP (energy) needed for nutrient uptake and other metabolic functions.

When water saturates the soil, the oxygen supply is cut off, leading to a state of low oxygen (hypoxia) or no oxygen (anoxia) for the roots. The plant's inability to respire aerobically is the central challenge. This directly translates to an "oxygen deficient stress." Other stresses like chilling are different, while reactive oxygen species (ROS) are a secondary consequence of this primary stress. Drought stress is the complete opposite.

Step 3: Final Answer

The fundamental physiological challenge of 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 H₂O. For salinity, it's high salt concentration causing osmotic stress and ion toxicity.

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 acceptor

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 performs the first step in converting nitrate absorbed from the soil into a usable form for the plant.

Step 2: Detailed Explanation

The reaction catalyzed by nitrate reductase is the reduction of nitrate (NO_3^-) to nitrite (NO_2^-). This is a redox reaction, meaning it involves the transfer of electrons.

- In the reaction, nitrate **gains electrons** and is therefore *reduced*. A molecule that gains electrons is an **electron acceptor**.
- For this to happen, another molecule must **lose electrons**. NAD(P)H provides these electrons, becoming oxidized to NAD(P)^+ in the process. A molecule that loses or provides electrons is an **electron donor**.

While NAD(P)H is a type of cofactor, the term "electron donor" describes its precise chemical role in this reaction. It is not a prosthetic group because it does not bind permanently to the enzyme.

Step 3: Final Answer

The specific role of NAD(P)H in the nitrate reductase reaction is to function as the **electron donor**, providing the reducing power to convert nitrate to nitrite.

💡 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) *Cocos nucifera*
- (D) *Crotalaria juncea*

Correct Answer: (B) *Corchorus capsularis*

Solution:

Step 1: Understanding the Concept

The question asks for the botanical source (scientific name) of "White Jute," a commercially important plant fiber.

Step 2: Detailed Explanation

Jute fiber is primarily harvested from the stem of plants in the genus *Corchorus*. There are two main cultivated species:

- ***Corchorus capsularis*:** This species is commonly known as **White Jute**. It is distinguished by its round, capsule-like seed pods and its fiber is characteristically lighter in color.
- ***Corchorus olitorius*:** This species is known as **Tossa Jute**. It has long, cylindrical seed pods and its fiber is generally stronger, more lustrous, and has a golden-brown hue.

The other options provided are incorrect sources for jute. *Cocos nucifera* is the coconut palm, which yields coir fiber, and *Crotalaria juncea* is Sunn Hemp, which produces a different type of bast fiber.

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., *Cocos 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 (biologically active compounds) found in the leaves of *Camellia sinensis* (the tea plant).

Step 2: Detailed Explanation

The main bioactive components in tea can be divided into two categories: polyphenols (catechins) and alkaloids (methylxanthines).

- **Polyphenols (Catechins):** These are the most abundant compounds.
 - **(D) Epigallocatechin gallate (EGCG):** The most abundant and potent catechin in tea. A major component.
 - **(A) Epicatechin gallate (ECG):** Another very significant catechin. A major component.
- **Alkaloids (Methylxanthines):**
 - **(B) Caffeine:** The primary alkaloid, responsible for tea's stimulating effects. A major component.
 - **(C) Theobromine:** Also present, but in concentrations typically 10-20 times lower than caffeine. It is considered a *minor* alkaloid in tea.

The question requires selecting the three "major" phytochemicals. This means choosing the most abundant catechins and the primary alkaloid, while excluding the least abundant compound.

Step 3: Final Answer

The most appropriate answer includes the most abundant catechins and the primary alkaloid. Therefore, the combination of major phytochemicals is **(A) Epicatechin gallate, (B) Caffeine, and (D) Epigallocatechin gallate only.**

💡 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*).

13. Match the LIST-I with LIST-II

LIST-I Plant Name	LIST-II Most common part as medicine
A. <i>Withania somnifera</i>	I. Fruit
B. <i>Aloe barbedensis</i>	II. All parts of plants
C. <i>Aegle marmelos</i>	III. Root
D. <i>Datura metel</i>	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 pharmacognosy and economic botany, specifically requiring the identification of the plant part most commonly used for its therapeutic properties. The concentration of active chemical compounds often varies significantly between different parts of a plant.

Step 2: Detailed Explanation and Matching

Let's analyze each plant from List-I and identify its primary medicinal part from List-II.

- **A. *Withania somnifera* (Ashwagandha):** A cornerstone of Ayurvedic medicine, Ashwagandha is a renowned adaptogen, helping the body manage stress. While the whole plant has uses, the **Root** is the most valued part. It is rich in the primary active compounds, withanolides, which are responsible for its therapeutic effects. Thus, **A matches with III**.
- **B. *Aloe barbadensis* (Aloe vera):** The thick, succulent **Leaves** of the Aloe vera plant are the source of its medicinal products. The leaves contain two distinct substances: the clear inner gel, widely used topically for skin conditions like burns, and the yellow latex (aloin) found just under the skin, which has potent laxative properties. Thus, **B matches with IV**.
- **C. *Aegle marmelos* (Bael):** In traditional medicine, particularly in South Asia, the Bael tree is primarily valued for its **Fruit**. Both the ripe and unripe fruit are used to treat digestive ailments, especially diarrhea and dysentery. The fruit contains tannins and mucilage that help soothe the digestive tract. Thus, **C matches with I**.
- **D. *Datura metel*:** This plant is highly toxic due to its concentration of potent tropane alkaloids (e.g., scopolamine, atropine). In traditional medicine, it is used with extreme caution. Various parts, including the leaves, flowers, and seeds, contain these active principles. Given that no single part is exclusively used and the active compounds are distributed throughout, the most fitting description among the choices is **All parts of plants**. Thus, **D matches with II**.

Step 3: Final Answer

By combining the correct matches, we arrive at the following sequence:

- A → III (Root)
- B → IV (Leaves)
- C → I (Fruit)
- D → II (All parts of plants)

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.

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, which is also known as 'methi' in Hindi. This is a straightforward question of botanical nomenclature.

Step 2: Detailed Explanation of Options

Let's analyze the given options to determine the correct scientific name for Fenugreek.

- **(A) *Papaver somniferum*:** This is the scientific name for the Opium Poppy. It is the source of opium alkaloids like morphine and codeine, as well as edible poppy seeds. It is not Fenugreek.
- **(B) *Trigonella foenum-graecum*:** This is the correct and universally accepted botanical name for Fenugreek. It belongs to the Fabaceae (legume) family. Both its seeds (as a spice) and its leaves (as a fresh herb, 'methi') are widely used in cuisines around the world, particularly in South Asian, Middle Eastern, and North African cooking.
- **(C) *Nigella sativa*:** This is the scientific name for Black Cumin, also known as Kalonji or black caraway. While it is a common spice, it is distinct from Fenugreek.
- **(D) *Elettaria cardamomum*:** This is the scientific name for Cardamom, specifically green or true cardamom. It is a very popular spice but is unrelated to Fenugreek.

Step 3: Final Answer

Based on established botanical nomenclature, the correct scientific name for Fenugreek (methi) is ***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.

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:

section*Step 1: Understanding the Concept The question requires matching different classes of chemical mutagens with their correct examples. A mutagen is a chemical or physical agent that causes a permanent change in the DNA sequence of an organism, potentially leading to mutations.

Step 2: Detailed Explanation and Matching

Let's analyze each class of mutagen and its mechanism to find the correct example.

- **A. Alkylating agent:** These agents introduce alkyl groups (like $-\text{CH}_3$ or $-\text{CH}_2\text{CH}_3$) onto DNA bases. This addition alters the base's structure and disrupts its normal base-pairing properties during DNA replication, leading to mutations. **Mustard gas** is a powerful, classic example of an alkylating agent. Thus, **A matches with III.**
- **B. Base analog:** These are molecules with a structure very similar to the four normal DNA bases (A, T, C, G). Because of this similarity, they can be mistakenly incorporated into a new DNA strand during replication. Once incorporated, they often have faulty base-pairing properties. **5-Bromouracil** is a well-known analog of thymine (T), but it can frequently pair with guanine (G), causing a T-A to C-G transition mutation. Thus, **B matches with IV.**
- **C. Intercalating agent:** These are typically flat, planar molecules that can slip between the stacked base pairs of the DNA double helix (a process called intercalation). This insertion physically distorts the DNA backbone, which can confuse the replication machinery and often leads to the insertion or deletion of a single base pair, causing frameshift mutations. **Acridine Orange** is a well-known fluorescent dye and a potent intercalating agent. Thus, **C matches with I.**

- **D. Deamination agent:** These agents work by removing an amino group ($-\text{NH}_2$) from a nucleotide base, which changes its chemical identity and pairing properties. **Nitrous acid (HNO_2)** is a classic example. It deaminates cytosine to form uracil (which pairs with adenine instead of guanine) and deaminates adenine to form hypoxanthine (which pairs with cytosine instead of thymine). Thus, **D matches with II**.

Step 3: Final Answer

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

💡 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.

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 kind of botanical 'type' specimen, based on the rules of the International Code of Nomenclature for algae, fungi, and plants (ICN). A type specimen is the specimen to which the scientific name of a taxon is permanently attached, acting as a reference point.

Step 2: Detailed Explanation of Terms

Understanding the hierarchy of type specimens is key.

- **Holotype:** The single specimen or illustration that the author of a new species explicitly designates in the original publication (the protologue) as the nomenclatural type.

- **Isotype:** Any duplicate specimen of the holotype (e.g., a specimen collected from the same individual plant at the same time).
- **Syntype:** Any one of two or more specimens cited by the author when no holotype was designated.
- **Paratype:** The question provides the exact definition for this term. A paratype is a specimen cited in the original description that is *not* the holotype, an isotype, or one of the syntypes. These specimens were studied by the author and helped them understand the variation within the new species, but they do not have the formal name-bearing status of a holotype.
- **Neotype:** A specimen chosen to serve as the type when all of the original material (holotype, isotypes, syntypes) is lost or destroyed.

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** according to the ICN.

💡 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 understanding of epistasis, a type of gene interaction where the phenotypic effect of one gene locus is masked or modified by the allele of another gene locus. This interaction alters the standard 9:3:3:1 phenotypic ratio observed in a Mendelian dihybrid cross.

Step 2: Detailed Explanation and Matching

Let's match each type of epistatic interaction with its characteristic phenotypic ratio.

- **A. Duplicate dominant epistasis:** In this interaction, a dominant allele at *either* of the two loci is sufficient to produce the dominant phenotype. Only the double homozygous recessive genotype (aabb) produces the recessive phenotype. The genotypic classes A_B_ (9), A_bb (3), and aaB_ (3) all share the same dominant phenotype. The resulting ratio is $(9+3+3) : 1$, which simplifies to **15:1**. Thus, **A matches with II**.
- **B. Duplicate recessive epistasis (Complementary genes):** Here, dominant alleles at *both* loci are required to produce the dominant phenotype. If either locus is homozygous recessive (A_bb, aaB_, or aabb), the recessive phenotype is expressed. This means only the A_B_ (9) class shows the dominant trait. The resulting ratio is $9 : (3+3+1)$, which simplifies to **9:7**. Thus, **B matches with I**.
- **C. Recessive epistasis:** In this case, the homozygous recessive genotype at one locus (e.g., aa) masks the expression of the alleles at another locus (B and b). The A_B_ (9) and A_bb (3) genotypes produce two different phenotypes, but the aaB_ (3) and aabb (1) genotypes are phenotypically indistinguishable. The resulting ratio is $9 : 3 : (3+1)$, which simplifies to **9:3:4**. Thus, **C matches with III**.
- **D. Dominant & Recessive Epistasis:** More commonly known as dominant inhibitory epistasis. A dominant allele at one locus (e.g., A) completely masks the effect of the other locus. The gene at the second locus only produces a phenotype when the first locus is homozygous recessive (aa). Therefore, A_B_ (9), A_bb (3), and aabb (1) all produce one phenotype, while only the aaB_ (3) class produces the alternative phenotype. The resulting ratio is $(9+3+1) : 3$, which simplifies to **13:3**. Thus, **D matches with IV**.

Step 3: Final Answer

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

💡 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).

18. Match the LIST-I with LIST-II

LIST-I (Characteristic, feature)	LIST-II (Family)
A. Monadelphous 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 floral and fruit structures with the plant families in which these features are characteristic and diagnostic.

Step 2: Detailed Explanation and Matching

Let's analyze each characteristic in List-I and link it to its family.

- **A. Monadelphous stamen:** This condition describes the androecium where the filaments of all stamens are fused into a single column or tube, known as a staminal tube, which typically surrounds the style. This is a hallmark characteristic of the family **Malvaceae** (the Mallow family, e.g., hibiscus, cotton). Thus, **A matches with I.**
- **B. Cremocarp:** This is a specialized type of dry, schizocarpic fruit that develops from a bicarpellary, inferior ovary. At maturity, it splits longitudinally into two one-seeded, indehiscent 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 does not arise from the apex of the ovary but rather from the base of a deeply four-lobed ovary. It appears as if the style is inserted at the center, between the lobes. 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 a type of inflorescence consisting of a dense cluster of numerous small, sessile flowers (florets) arranged on a common receptacle. The entire structure often functions as a single flower to attract pollinators. 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.

💡 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.

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 depend on the Polymerase Chain Reaction (PCR). PCR is a fundamental technique in molecular biology used to amplify a specific segment of DNA, creating millions of copies from a small starting amount.

Step 2: Detailed Explanation of Each Technique

Let's examine the methodology of each marker technique.

- **A. Restriction Fragment Length Polymorphism (RFLP):** This is a **non-PCR based** technique. The process involves digesting genomic DNA with restriction enzymes, separating the resulting fragments by size via gel electrophoresis, and then using a labeled DNA probe to identify specific fragments of interest through Southern blotting. No amplification step is involved.
- **B. Random Amplified Polymorphic DNAs (RAPD):** The name itself, "Amplified," indicates its reliance on PCR. This technique uses a single, short, arbitrary primer that binds to multiple random locations in the genome. **PCR is then used to amplify** the DNA segments between these binding sites. The presence or absence of specific amplified bands creates a polymorphic pattern. PCR is essential to this method.
- **C. Amplified Fragment Length Polymorphism (AFLP):** This technique also has "Amplified" in its name. It's a multi-step process that starts with restriction digestion of DNA, followed by the ligation of specific adapter sequences to the fragments. Finally, **selective PCR amplification** of a subset of these fragments is performed using primers complementary to the adapters. PCR is a crucial step.
- **D. Sequence-Tagged Sites (STSs):** An STS is a short, unique DNA sequence in a genome that can be used as a landmark. The presence of an STS in a DNA sample is detected by designing a specific pair of primers for that sequence and running a **PCR assay**. If the STS is present, the primers will amplify it, producing a DNA band of a predictable size. PCR is the core of this detection method.

Step 3: Final Answer

Based on the analysis, RAPD, AFLP, and STS are all fundamentally PCR-based techniques. RFLP is the only one listed that does not use PCR. 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 macroscopic, structurally complex green algae belonging to the order Charales. They are commonly known as stoneworts or brittleworts due to the calcium carbonate deposits found on their cell walls in some species.

Step 2: Detailed Explanation of Each Genus

Let's analyze each genus to determine its classification.

- **A. *Tolypella*:** This is a well-established genus within the family Characeae. Its species are morphologically similar to other members of the family and are found in freshwater habitats, often in calcareous waters. It is a correct member.
- **B. *Nitella*:** This is another prominent and widely distributed genus belonging to the family Characeae. It is distinguished from *Chara* by certain morphological features, but it is a core member of the family.
- **C. *Nigella*:** This is the outlier. *Nigella* is a genus of **flowering plants** (angiosperms) in the buttercup family, Ranunculaceae. A famous species is *Nigella sativa*, the source of the spice black cumin or kalonji. It is not an alga and does not belong to the Characeae.
- **D. *Chara*:** This is the type genus for the family Characeae and the order Charales, meaning it is the reference genus upon which the family is based. 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 algal 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.

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. Xylem is a complex permanent tissue in vascular plants with two primary functions: conducting water and dissolved minerals from the roots to the rest of the plant, and providing mechanical support.

Step 2: Detailed Explanation of Xylem Components

Xylem is a heterogeneous tissue composed of four main types of cells (elements):

1. **Tracheids (A):** These are elongated, tube-like cells with tapering ends and hard, lignified walls. They are the primary water-conducting elements in less evolutionarily advanced vascular plants like pteridophytes and gymnosperms.
2. **Vessels (B):** These are long, wide, cylindrical tubes made of individual cells called vessel members, which are arranged end-to-end and connected by perforations. They are the main water-conducting tissue in angiosperms.
3. **Xylem Parenchyma (C):** These are the only living cells within the xylem tissue. They are responsible for storing food materials (like starch) and for the radial conduction of water.
4. **Xylem Fibres:** These are sclerenchymatous cells with thick walls and narrow lumens. Their primary function is to provide mechanical strength and support to the plant body.

Analysis of the fourth option:

- **Sclereids (D):** Sclereids, or stone cells, are a type of sclerenchyma tissue responsible for hardness and support. While xylem fibres are also sclerenchymatous, sclereids are not considered one of the four fundamental components of the xylem tissue itself. Sclereids are typically found in other parts of the plant, such as the flesh of pears, seed coats, and nutshells.

Step 3: Final Answer

The primary elements that constitute xylem tissue are tracheids, vessels, xylem parenchyma, and xylem fibres. From the options provided, **A (Tracheids)**, **B (Vessels)**, and **C (Xylem parenchyma)** are all correct components. Sclereids are not a standard element of xylem.

💡 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.

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. These are specialized, large, bubble-shaped epidermal cells typically found in groups on the adaxial (upper) surface of the leaves of many monocots, particularly grasses.

Step 2: Detailed Explanation of Function

The function of bulliform cells is a hygroscopic mechanism directly related to the water status of the plant. They facilitate the rolling and unrolling of the leaf blade.

- **Under Turgid Conditions (Sufficient Water):** When the plant has adequate water, the large vacuoles of the bulliform cells are filled with water, making them swollen and turgid. The turgor pressure exerted by these cells keeps the leaf blade flat and fully open, maximizing its surface area for sunlight absorption and photosynthesis.
- **Under Flaccid Conditions (Water Stress):** During periods of drought or high transpiration, the plant loses water. The bulliform cells are the first to lose their turgor pressure and become flaccid. This loss of pressure acts like a hinge, causing the leaf blade to curl or roll inwards, typically with the adaxial surface on the inside.

This rolling of the leaf is a crucial water-conservation strategy. It reduces the surface area exposed to the dry, windy environment and traps a layer of more humid air within the rolled leaf, significantly reducing the rate of water loss via transpiration.

Step 3: Final Answer

The primary role of bulliform cells is to mediate the rolling and unrolling of the leaf in response to water availability. Therefore, their function is to help **prevent excessive transpiration** by causing the leaves to roll up during water stress.

💡 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.

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. <i>Nymphaea</i> 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 (also known as stone cells) with plant parts or species where they are characteristically found. Sclereids are a type of sclerenchyma cell with highly thickened, lignified secondary walls that provide structural support and hardness.

Step 2: Detailed Explanation and Matching

Let's match each type of sclereid with its example location.

- **A. Astrosclereids:** These sclereids are characteristically star-shaped, with several radiating arms or lobes. They are commonly found providing internal support in the leaves and petioles of aquatic plants, famously in the water lily, *Nymphaea*. Thus, **A matches with IV**.
- **B. Macrosclereids:** These are elongated, rod-shaped or columnar cells. They are typically arranged in a tightly packed layer, like a palisade. This type of sclereid is very common in the seed coats of leguminous plants, where they form a hard, protective outer layer. **Kidney bean seeds** are a classic example. Thus, **B matches with III**.
- **C. Osteosclereids:** These are "bone-shaped" or spool-shaped sclereids, which are columnar but enlarged or knobbed at their ends. They are found in the seed coats of many plants and in the sub-epidermal layers of leaves in some **monocots**. Thus, **C matches with I**.
- **D. Trichosclereids:** These are elongated, hair-like sclereids that can be branched and may grow into intercellular air spaces. 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**.

Step 3: Final Answer

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

💡 Quick Tip

To remember sclereid types, use their names as clues: Astro = star (like in *Nymphaea*), 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 knowing the key features that distinguish the eukaryotic process from its prokaryotic counterpart.

Step 2: Detailed Evaluation of Each Statement

- **A. 3'-Cap of mRNA present.** This statement is **incorrect**. Eukaryotic mRNA undergoes post-transcriptional processing that includes the addition of a 7-methylguanosine cap, but this cap is added to the **5' end**, not the 3' end. The 5' cap is crucial for mRNA stability and initiation of translation. 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 possess 80S ribosomes in their cytoplasm. Each 80S ribosome is composed of a small 40S subunit and a large 60S subunit. The "S" stands for Svedberg units, which measure sedimentation rate and are not directly additive.
- **C. Translation is not simultaneous with transcription.** This statement is **correct**. In eukaryotes, transcription (DNA to mRNA) occurs within the membrane-bound nucleus, while translation (mRNA to protein) occurs on ribosomes in the cytoplasm. This spatial and temporal separation, along with the need for mRNA processing (splicing, capping), prevents the two processes from being coupled, unlike in prokaryotes.
- **D. Initiation codon of mRNA is recognised by anticodon of Met-tRNA.** This statement is **correct**. The start codon for translation in virtually all eukaryotes is AUG. This codon is recognized by the anticodon of a special initiator tRNA that carries the amino acid Methionine (Met).

Step 3: Final Answer

Statements B, C, and D accurately describe features of eukaryotic protein synthesis, 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 that is characterized by having paracytic stomata. Stomatal types are a useful taxonomic character, classified based on the number and arrangement of the subsidiary cells that surround the two guard cells of the stoma.

Step 2: Detailed Explanation of Stomatal Types

Let's define the major stomatal types, particularly those associated with the given families.

- **Paracytic (or Rubiaceous) type:** In this type, the stoma is accompanied by two subsidiary cells, with the long axes of these subsidiary cells lying **parallel** to the long axis of the guard cells. The alternative name, "Rubiaceous," directly points to the fact that this type is a distinctive and common feature of the family **Rubiaceae** (the coffee and madder family).
- **Anomocytic (or Ranunculaceous) type:** The guard cells are surrounded by epidermal cells that are indistinguishable in size or shape from the other epidermal cells. This type 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 type 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** (perpendicular) to the long axis of the guard cells. This is characteristic of the family **Caryophyllaceae**.

Step 3: Final Answer

Based on the standard classification of stomatal types and their distribution among plant families, 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: **Paracytic** = **Rubiaceous** **Anomocytic** = **Ranunculaceous** **Anisocytic** = **Cruciferous** **Diacytic** = **Caryophyllaceous**

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*, a pteridophyte. This requires distinguishing between the common names of different, though sometimes related, plant groups.

Step 2: Detailed Explanation of Options

Let's examine the common names provided and the plant groups they refer to:

- **(A) Resurrection plant:** This name is applied to various plants known for their remarkable ability to withstand extreme dehydration and then revive or "resurrect" upon rehydration. Certain species of *Selaginella*, most famously *Selaginella lepidophylla*, are well-known for this trait and are commercially sold under this name. This is a very specific and appropriate common name for the genus.
- **(B) Peat moss:** This is the common name for bryophytes of the genus *Sphagnum*. *Sphagnum* is a true moss, not a pteridophyte, and is ecologically and structurally very different from *Selaginella*.
- **(C) Club moss:** This is the primary common name for pteridophytes in the genus *Lycopodium*. While *Selaginella* is closely related to *Lycopodium* and is sometimes called "lesser club moss" or "spike moss," the term "club moss" itself most commonly refers to *Lycopodium*.
- **(D) Horsetail:** This is the common name for pteridophytes belonging to the genus *Equisetum*, which are characterized by their jointed stems and are distinct from *Selaginella*.

Step 3: Final Answer

While *Selaginella* is related to club mosses, the term ”**resurrection plant**” is a highly specific and famous common name directly associated with a unique physiological adaptation found in many species of this genus. Therefore, it stands as the most appropriate and descriptive 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

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 found in plant leaves that contain specific mineral deposits. The description specifies that these deposits are outgrowths of the epidermal cell wall, composed of calcium carbonate on a cellulose matrix.

Step 2: Detailed Explanation of Options

It is crucial to distinguish between the mineral deposit itself and the cell that contains it.

- **(A) Raphides & (C) Druses:** These are types of crystals, typically made of **calcium oxalate**, not calcium carbonate. Furthermore, they are crystalline structures that form within the vacuole of a cell (an idioblast) and are not outgrowths of the cell wall.
- **(B) Cystolith:** This term refers to the mineral structure itself. A cystolith is the concrete mass of calcium carbonate that forms on a stalk-like ingrowth of the plant cell wall. While the description of the deposit matches a cystolith, the question asks for the name of the *specialized cell* that contains it.

- **(D) Lithocysts:** This is the correct answer. Lithocysts ("stone cells") are the specialized, enlarged epidermal cells that are modified to contain cystoliths. The lithocyst is the cell, and the cystolith is the structure housed within it. The question specifically asks for the name of the cell.

Step 3: Final Answer

The specialized epidermal cells that house the calcium carbonate outgrowths (cystoliths) are called **Lithocysts**.

💡 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 categorized based on the chemical properties of their unique side chain (R-group). Basic amino acids possess side chains with nitrogenous groups that can accept a proton at physiological pH (7.4). This protonation gives the side chain a positive charge, allowing it to act as a base.

Step 2: Detailed Explanation of Given Amino Acids

Let's analyze the side chain of each option:

- **(A) Alanine:** Its side chain is a simple methyl group ($-\text{CH}_3$). This is a nonpolar, aliphatic group with no capacity to accept a proton, making alanine a neutral amino acid.
- **(B) Lysine:** Its side chain consists of a four-carbon chain ending in a terminal amino group ($-\text{NH}_2$). This amino group has a pK_a value well above neutral pH, meaning it readily accepts a proton to become ammonium ($-\text{NH}_3^+$). This positive charge makes lysine a basic amino acid.

- **(C) Threonine:** Its side chain contains a hydroxyl group (-OH). While this makes the side chain polar, it does not typically ionize at physiological pH, so threonine is classified as a polar, uncharged (neutral) amino acid.
- **(D) Methionine:** Its side chain contains a sulfur atom within a thioether group. This group is nonpolar and hydrophobic, making methionine a neutral amino acid.

Step 3: Final Answer

Among the choices provided, only **lysine** has a side chain containing an amino group that accepts a proton, giving it a positive charge and classifying it as a basic amino acid.

💡 Quick Tip

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

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 that allows plants in arid conditions to conserve water.

- **Obligate CAM plants** use the CAM pathway exclusively.
- **Facultative CAM plants** are more flexible; they can perform standard C₃ photosynthesis under favorable (e.g., well-watered) conditions and switch to the water-conserving CAM pathway in response to environmental stress like drought or high salinity.

Step 2: Detailed Explanation of Options

Let's analyze the photosynthetic pathway of each plant listed:

- (A) *Mesembryanthemum crystallinum* (Common ice plant): This is the classic textbook example of a facultative CAM plant. In unstressed conditions, it operates as a C3 plant. When exposed to drought or salt stress, it switches its metabolism to the CAM pathway to enhance water-use efficiency.
- (B) *Opuntia* (Prickly pear cactus): As a succulent native to arid environments, *Opuntia* is an obligate CAM plant. It consistently uses the CAM pathway to minimize water loss.
- (C) *Chrysanthemum*: This is a typical C3 plant, which is the most common photosynthetic pathway. It does not perform CAM photosynthesis.
- (D) *Amaranthus edulis*: This is a C4 plant. The C4 pathway is another adaptation to hot, dry conditions, but it is biochemically distinct from CAM and is characterized by a specialized leaf structure called Kranz anatomy.

Step 3: Final Answer

Mesembryanthemum crystallinum is the well-known example of a facultative CAM plant that can switch between C3 and CAM photosynthesis based on environmental conditions.

💡 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 four molecules according to their appearance as intermediates in the glycolysis pathway. Glycolysis is the ten-step metabolic process that breaks down glucose into pyruvate, producing ATP and NADH.

Step 2: Detailed Explanation of the Sequence

Let's trace the path of glycolysis and place the given intermediates in order:

1. **Step 1:** The pathway begins with the phosphorylation of glucose, catalyzed by hexokinase, to form **Glucose-6-phosphate (C)**.
2. **Step 2:** Glucose-6-phosphate is then converted by an isomerase into its isomer, **Fructose-6-phosphate (A)**.
3. **Steps 3-8:** Fructose-6-phosphate undergoes several further reactions, including another phosphorylation, cleavage into two 3-carbon sugars, and a series of conversions in the "payoff phase." The ninth intermediate in the overall pathway is **2-Phosphoglycerate (D)**.
4. **Step 9 10:** 2-Phosphoglycerate is converted to phosphoenolpyruvate, which is then converted by pyruvate kinase into the final product of glycolysis, **Pyruvic acid (B)**.

Based on this pathway, the chronological order of the given substrates is: $C \rightarrow A \rightarrow D \rightarrow B$.

Step 3: Final Answer

The correct sequence of intermediates as they appear in glycolysis is: Glucose-6-phosphate (C), followed by Fructose-6-phosphate (A), then 2-Phosphoglycerate (D), and finally Pyruvic acid (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 that is the hallmark of C₄ plants. It is characterized by having two distinct photosynthetic cell types: mesophyll cells and bundle sheath cells, arranged in a "wreath-like" (Kranz) fashion around the vascular bundles. The question asks to identify plants that *lack* this anatomy. Plants using C₃ or CAM photosynthetic pathways do not have Kranz anatomy.

Step 2: Detailed Explanation of Each Plant

Let's determine the photosynthetic pathway and associated anatomy for each plant:

- **A. *Aloe*:** This is a genus of succulent plants. Like many succulents adapted to arid environments, *Aloe* uses CAM (Crassulacean Acid Metabolism) photosynthesis to conserve water. **CAM plants do not have Kranz anatomy.**
- **B. *Zea mays* (Maize/Corn):** Maize is the classic textbook example of a C₄ plant. Its leaves exhibit a very clear and well-defined **Kranz anatomy**, which is essential for its C₄ pathway.
- **C. *Agave*:** This is another genus of succulent plants known for its adaptation to dry climates. *Agave* utilizes CAM photosynthesis. **CAM plants do not have Kranz anatomy.**
- **D. *Opuntia* (Cactus):** Cacti are quintessential desert plants. *Opuntia* uses CAM photosynthesis to survive extreme drought. **CAM plants do not have Kranz anatomy.**

Step 3: Final Answer

The plants from the list that exhibit Kranz anatomy are C₄ plants (*Zea mays*). The plants that lack this anatomy are the CAM plants. Therefore, the correct combination of plants lacking Kranz anatomy is *Aloe* (A), *Agave* (C), and *Opuntia* (D).

💡 Quick Tip

Remember this simple rule: Kranz anatomy is the structural hallmark of C₄ plants. CAM plants and C₃ 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. Interveinous 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 the specific and characteristic deficiency symptoms they cause in plants. The symptoms are often related to the element's function and mobility within the plant.

Step 2: Detailed Explanation and Matching

- **A. Calcium (Ca):** Calcium is a key structural component of cell walls (as calcium pectate) and is relatively immobile within the plant's phloem. Because it cannot be moved from older to younger tissues, deficiency symptoms appear first in new, growing areas. A classic symptom is the **necrosis (death) of young meristematic regions** such as root tips and young leaves. Thus, **A matches with III.**
- **B. Zinc (Zn):** Zinc is a crucial cofactor for many enzymes and is required for the synthesis of auxin, the plant hormone that promotes cell elongation. Zinc deficiency leads to reduced auxin levels, which causes stunted growth with short internodes. This results in a **rosette habit**, where leaves are clustered in a circular form close to the ground. Thus, **B matches with IV.**
- **C. Manganese (Mn):** Manganese activates numerous enzymes and is essential for the water-splitting complex in photosystem II of photosynthesis. A deficiency impairs chlorophyll function, leading to **interveinal chlorosis (yellowing between the veins)** and the subsequent development of **necrotic spots**. Thus, **C matches with I.**

- **D. Nickel (Ni):** Nickel is a component of only one known enzyme in higher plants: urease. Urease is vital for metabolizing urea into usable ammonia. In the absence of nickel, urea can accumulate to toxic levels, particularly at the leaf margins where transpiration is high, 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.

💡 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 ecological succession of fungal groups that colonize and decompose herbivore dung. This succession is a classic example driven by resource availability, where different fungi have specialized enzymes to break down organic compounds of varying complexity.

Step 2: Detailed Explanation of the Succession

The succession of coprophilous (dung-inhabiting) fungi generally follows a predictable three-stage pattern:

1. **First Stage - Phycomycetes (C)** (Modern classification: Zygomycetes): These fungi are the initial pioneers. They grow extremely rapidly, utilizing the simple, soluble sugars and readily available carbohydrates in the fresh dung. They typically appear within the first few days. Examples include *Mucor* and *Pilobolus*.
2. **Second Stage - Ascomycetes (B and D)**: After the simple sugars are depleted, the Ascomycetes appear. These fungi possess enzymes like cellulases, enabling them to break down more complex carbohydrates such as cellulose. This group includes Discomycetes (cup fungi like *Ascobolus*) and Pyrenomycetes (flask fungi like *Sordaria*). They represent the middle stage of decomposition.
3. **Third Stage - Basidiomycetes (A)**: These are the final colonizers, often appearing after several weeks. Fungi in this group, such as the mushroom *Coprinus*, have powerful enzymes (e.g., ligninases) capable of decomposing the most recalcitrant components of the dung, including lignin and complex cellulose.

The overall sequence is a progression from utilizing simple sugars, to cellulose, to lignin.

Step 3: Final Answer

The correct chronological order of colonization is: C (Phycomycetes) → B (Discomycetes) / D (Pyrenomycetes) → A (Basidiomycetes). The provided correct option reflects this general sequence.

💡 Quick Tip

Think of fungal succession on dung as a race for food. The fastest sprinters (Phycomycetes) eat the easy food (sugars) first. Then come the marathon runners (Ascomycetes) that can digest tougher food (cellulose). Finally, the ultra-marathoners (Basidiomycetes) 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 is broad and includes aquatic vascular plants (like ferns, pondweeds, and water lilies) as well as macroscopic algae (macroalgae). It specifically excludes microscopic algae that constitute phytoplankton.

Step 2: Detailed Explanation of Options

Let's analyze the given options based on this definition:

- (A) ***Spirogyra***: This is a filamentous green alga. Individual filaments are microscopic, but they often form large, visible mats. As such, it can be considered a macroalga, but it is a simple, non-vascular organism.
- (B) **Diatoms**: These are unicellular, microscopic algae, often encased in a silica shell. They are a major component of phytoplankton and are definitively not macrophytes.
- (C) ***Azolla***: This is a genus of small, free-floating aquatic ferns. As a fern, it is a vascular plant (a pteridophyte) with differentiated tissues (roots, stems, leaves). By definition, all aquatic vascular plants are macrophytes. This makes *Azolla* an unequivocal and clear example.
- (D) ***Eudorina***: This is a motile, colonial green alga. Although it is a colony of cells, the entire colony is microscopic and is a component of phytoplankton, not a macrophyte.

Step 3: Final Answer

Among the choices, ***Azolla*** is a vascular plant (an aquatic fern). This makes it the clearest and most definitive example of a macrophyte, as the term most strongly applies to multicellular, differentiated aquatic plants.

💡 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, specifically growing intercellularly (between the cells) within a host plant. Most algae are free-living and photosynthetic, but a few have evolved a parasitic lifestyle.

Step 2: Detailed Explanation of Given Genera

Let's examine the lifestyle of each algal genus listed:

- **(A) *Cladophora*:** This is a genus of filamentous green algae that is typically free-living and photosynthetic. It is commonly found in freshwater and marine environments, often forming large mats, but it is not parasitic.
- **(B) *Chlamydomonas*:** This is a genus of unicellular, motile green algae. It is a common inhabitant of soil and freshwater and is a model organism for biological research. It is free-living and not parasitic.
- **(C) *Cephaleuros*:** This is a well-known genus of parasitic green algae. Species like *Cephaleuros virescens* grow on the leaves and stems of numerous terrestrial plants, including economically important ones like tea, coffee, and mango. The algal filaments grow in the subcuticular and intercellular spaces of the host leaf, causing a disease commonly known as "red rust." This perfectly matches the question's description.
- **(D) *Protoderma*:** This is a genus of green algae that grows as a simple crust on various substrates, such as rocks (epilithic) or the surfaces of other plants (epiphytic). While it grows on other plants, it is not considered a true parasite as it does not typically penetrate the host tissue to derive nutrients.

Step 3: Final Answer

Cephaleuros is the common and correct example of an intercellular 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 the process of seed germination. Different plant responses to light have distinct names.

Step 2: Detailed Explanation of Terms

Let's analyze the given terms to find the one that specifically relates to seed germination:

- **Phototropism:** This describes the directional *growth* of a plant part, typically the stem or root, in response to a light source. For example, a plant stem bending towards a window. It is a growth response, not a germination response.
- **Photoblasty:** This is the correct and precise term for the response of seeds to the presence or absence of light for germination.
 - **Positively photoblastic** seeds require light to germinate (e.g., lettuce, tobacco).
 - **Negatively photoblastic** seeds have their germination inhibited by light and must be in darkness to sprout (e.g., onion, lily).

This term perfectly matches the question's description.

- **Photonasty:** This refers to the non-directional *movement* of plant parts, such as leaves or flower petals, in response to changes in light intensity (e.g., the opening of flowers during the day and closing at night).
- **Nyctinasty:** This is a specific type of nastic movement related to the diurnal (day/night) cycle, often called "sleep movements." A classic example is the folding of leaves of a leguminous plant in the evening.

Step 3: Final Answer

The correct term for the specific effect of light on 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 biomass. It is calculated as Gross Primary Production (GPP) minus the energy the producers use for their own respiration. The question asks to identify the ecosystem with the lowest NPP **per unit area**, which refers to the rate of productivity, not the total production of the entire ecosystem.

Step 2: Detailed Explanation of Ecosystems

Let's compare the productivity rate of the given ecosystems:

- **Estuaries:** These are among the most productive ecosystems on Earth. The constant influx of nutrients from rivers, combined with ample sunlight in shallow waters, creates ideal conditions for extremely high NPP per unit area.
- **Savanna:** These tropical grasslands have moderate productivity. Their NPP is primarily limited by the seasonal availability of rainfall.
- **Agricultural land:** The productivity of agricultural land can be very high, but this is due to artificial subsidies of water and fertilizers. Even so, its NPP per unit area is generally lower than that of a healthy estuary or a tropical rainforest.
- **Open ocean:** The open ocean has an extremely low NPP per unit area. This is because it is severely nutrient-limited (especially in nitrogen and phosphorus), and sunlight can only penetrate the shallow surface layer (the photic zone). While the vast area of the open ocean means its total contribution to global NPP is significant, its productivity rate per square meter is very low, often compared to that of a desert.

Step 3: Final Answer

When comparing NPP on a per-unit-area basis, the **open ocean** is the least productive ecosystem due to severe nutrient and light limitations over most of its volume.

💡 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 a characteristic adaptation of xerophytes. Xerophytes are plants adapted to survive in arid (dry) conditions. Their adaptations are primarily aimed at reducing water loss (transpiration), storing water, and efficiently absorbing available water.

Step 2: Detailed Explanation of Listed Features

Let's analyze whether each feature is a xerophytic adaptation:

- **(A) Lacks Aerenchyma:** Aerenchyma is a spongy tissue with large air spaces that provides buoyancy and facilitates gas exchange in aquatic plants (hydrophytes). Xerophytes, living in dry terrestrial habitats, have no need for this tissue. Therefore, the *absence* of aerenchyma is characteristic of xerophytes.
- **(B) Chlorophyll mostly in stem and leaves reduced:** In many xerophytes, such as cacti, the leaves are reduced to spines to minimize the surface area for water loss. The stem then becomes flattened and green (a phylloclade), taking over the primary role of photosynthesis. This is a classic xerophytic adaptation.
- **(C) Palisade generally on both sides of leaves:** In xerophytes with leaves that are exposed to high light intensity from all angles (isobilateral leaves), it is common to have palisade mesophyll on both the upper and lower surfaces to maximize photosynthesis. This is a common feature.

- **(D) Thin walled epidermal cells:** This is **not** a xerophytic feature. To prevent water loss, xerophytes have evolved features that increase resistance to transpiration. These include very thick-walled epidermal cells, often covered by a thick waxy cuticle and sometimes multiple layers of epidermis. Thin walls would offer little resistance to water loss and are characteristic of hydrophytes or mesophytes.

Step 3: Final Answer

Thin-walled epidermal cells are a feature that would increase water loss and are therefore not a characteristic adaptation 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 known as 'Aconite'. This requires knowledge of pharmacognosy, the study of medicinal drugs derived from plants or other natural sources.

Step 2: Detailed Explanation of Options

Let's identify the plants listed and their relationship to the drug Aconite.

- **(A) *Ocimum sanctum*:** This is the botanical name for Holy Basil, commonly known as Tulsi. It is a widely used and revered herb in Ayurvedic medicine, but it is not the source of Aconite.

- **(B) *Aconitum ferox*:** The name of the drug, 'Aconite', is directly derived from the genus name, *Aconitum*. This species, also known as Indian Aconite or Monkshood, is the correct botanical source. The tuberous roots of this plant contain highly potent and toxic alkaloids (like pseudoaconitine). It is used with extreme caution in minute, processed quantities in various traditional medicine systems.
- **(C) *Withania somnifera*:** This is the botanical name for Ashwagandha or Indian Ginseng. Its roots are used as an adaptogen and nervine tonic but are unrelated to Aconite.
- **(D) *Azadirachta indica*:** This is the Neem tree. Various parts of the tree have medicinal properties (e.g., antiseptic, antifungal), but it is not the source of Aconite.

Step 3: Final Answer

The drug Aconite is obtained from the tuberous roots of plants in the genus *Aconitum*, specifically from species like *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 (the number of sets of chromosomes) of different cells in an angiosperm's life cycle. The key to solving it is understanding the process of double fertilization, which uniquely creates a diploid zygote and a triploid endosperm.

Step 2: Key Formula or Approach

- The egg cell, being a female gamete, is haploid (n).
- The endosperm is formed from the fusion of one haploid (n) male gamete with the central cell of the ovule, which contains two haploid polar nuclei ($n + n$).
- Therefore, the ploidy of the resulting endosperm is $n + n + n = 3n$ (**triploid**).

Step 3: Detailed Explanation and Calculation

1. We are given that the number of chromosomes in the egg cell is 8.
2. Since the egg cell is haploid (n), this means that $n = 8$.
3. The endosperm is triploid, meaning its chromosome number is $3n$.
4. We can now calculate the number of chromosomes in the endosperm:

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

Step 4: Final Answer

If the haploid number (n) is 8, the number of chromosomes in the triploid ($3n$) 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 two main types of genes that regulate the cell cycle:

- **Proto-oncogenes:** Act as "accelerators" for cell division. A "gain-of-function" mutation can turn them into oncogenes, causing the accelerator to get stuck down.
- **Tumor suppressor genes:** Act as the "brakes" of the cell cycle, stopping division to repair DNA damage. A "loss-of-function" mutation disables these brakes.

Step 2: Detailed Evaluation of Each Mutation

- **(A) Loss-of-function mutation in a tumor suppressor gene:** Tumor suppressor genes (e.g., p53, Rb) are critical checkpoints. A loss-of-function mutation is like having faulty brakes on a car. It removes a crucial control point, allowing cells with damaged DNA to continue dividing, which is a key step in cancer development. This is a very common mechanism.
- **(B) Gain-of-function in a DNA repair enzyme:** DNA repair enzymes fix mutations. A "gain-of-function" would mean the enzyme works more efficiently, leading to *fewer* mutations being propagated. This would *decrease* the risk of cancer, not increase it.
- **(C) Silent mutation in a proto-oncogene:** A silent mutation, by definition, does not change the amino acid sequence of the resulting protein. Therefore, it would not alter the protein's function and would not convert a proto-oncogene into an oncogene. It would not contribute to cancer.
- **(D) Deletion of non-coding intronic regions in a tumor suppressor gene:** Introns are spliced out of the mRNA transcript before translation. Deleting an entire intron would likely have no effect on the final protein product, unless the deletion accidentally removes critical regulatory sequences or splice sites, which is a less direct and less certain way to cause a loss of function.

Step 3: Final Answer

The most likely and direct mutation to contribute to cancer from the given options is a **loss-of-function mutation in a tumor suppressor gene**, as it effectively removes the brakes on 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 four major protein complexes of the mitochondrial electron transport chain (ETC). These complexes are conventionally numbered I through IV and are responsible for oxidative phosphorylation.

Step 2: Detailed Explanation and Identification

Let's identify each complex listed by its common name and numerical designation:

- **B. NADH dehydrogenase** (or NADH-Q oxidoreductase) is **Complex I**. It accepts electrons from NADH.
- **A. Succinate dehydrogenase** (or succinate-Q reductase) is **Complex II**. It accepts electrons from succinate (via FADH₂) and is also part of the Krebs cycle.
- **D. Cytochrome bc1 complex** (or Q-cytochrome c oxidoreductase) is **Complex III**. It accepts electrons from Coenzyme Q (which receives them from both 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.

While Complex I and Complex II operate in parallel, the standard convention for listing all four major complexes follows their numerical order: I, II, III, IV.

Step 3: Final Answer

The correct sequence based on the standard complex numbers is $I \rightarrow \rightarrow II \rightarrow \rightarrow III \rightarrow \rightarrow IV$. Translating this back to the given letters gives the sequence: **B (I), A (II), D (III), C (IV)**.

💡 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 $I \rightarrow Q \rightarrow III \rightarrow \text{Cyt c} \rightarrow IV$ and $II \rightarrow Q \rightarrow III \rightarrow \text{Cyt c} \rightarrow IV$.

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 forms a symbiotic relationship with sugarcane. The specific type of symbiosis, where a microbe lives inside the plant's tissues without causing disease, is known as an endophytic relationship. This allows for a very efficient transfer of fixed nitrogen to the plant.

Step 2: Detailed Explanation of Options

Let's analyze the symbiotic associations of each organism listed:

- **Frankia:** This is a genus of filamentous bacteria (actinomycetes) known for its nitrogen-fixing capabilities. However, *Frankia* forms a specific symbiosis with a group of plants called actinorhizal plants (e.g., alder and casuarina), where it induces the formation of root nodules. It is not associated with sugarcane.

- ***Acetobacter***: While this genus is known for producing acetic acid, a specific species, *Gluconacetobacter diazotrophicus* (which was formerly classified in the *Acetobacter* genus), is a well-studied endophytic bacterium. It lives within the intercellular spaces of sugarcane stems and roots, where it fixes significant amounts of atmospheric nitrogen, directly contributing to the plant's nitrogen needs. This is the correct association.
- ***Anabaena***: This is a genus of filamentous cyanobacteria. It is famous for its symbiotic relationship with the small aquatic fern *Azolla*. The *Anabaena* resides in cavities within the fern's leaves, fixing nitrogen. It is not associated with sugarcane.
- ***Nostoc***: This is another genus of nitrogen-fixing cyanobacteria. It can be free-living or form symbioses with a variety of organisms, including fungi (forming lichens), bryophytes, and the coralloid roots of cycads. It is not the primary symbiont of sugarcane.

Step 3: Final Answer

Based on well-established symbiotic relationships, the nitrogen-fixing bacterium that lives as an endophyte in sugarcane is a species now known as *Gluconacetobacter diazotrophicus*, which belongs to the broader ***Acetobacter*** group mentioned in the options.

💡 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 (the aging process) in detached leaves. Senescence in leaves is characterized by the breakdown of chlorophyll (loss of green color) and proteins.

Step 2: Detailed Explanation of Terms

Let's define the given physiological effects:

- **Richmond-Lang effect:** This is the specific and correct term for the delay of senescence in leaves caused by the application of cytokinins. Scientists Richmond and Lang first demonstrated that applying cytokinin to detached leaves kept them green and metabolically active for a longer period by inhibiting the degradation of chlorophyll and proteins. This perfectly matches the question's description.
- **Nyctinastic effect:** This refers to the diurnal "sleep movements" of plants, such as the folding of leaves or petals in the evening in response to darkness. This movement is related to changes in turgor pressure and is entirely unrelated to the process of aging or senescence.
- **Epinasty:** This is the downward bending of leaves or petioles. It is a growth response often caused by the plant hormone ethylene and is not directly related to the delay of senescence by cytokinins.
- **Depot effect:** This is a more general term describing one of the mechanisms behind the Richmond-Lang effect. Cytokinins are known to mobilize nutrients, causing them to move towards the area where the cytokinin is applied, creating a nutrient "sink" or "depot." This directed nutrient flow helps maintain the health of the tissue. While the depot effect contributes to the delay of senescence, the overall phenomenon is named the **Richmond-Lang effect**.

Step 3: Final Answer

The famous phenomenon where cytokinins delay the aging and chlorophyll breakdown in detached leaves is 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.

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 that is responsible for the blue and purple colors commonly found in fruits, particularly berries.

Step 2: Detailed Explanation of Pigment Classes

Let's review the colors associated with each major class of plant pigments:

- **Carotenoids:** These are lipid-soluble pigments responsible for many of the bright yellow, orange, and red colors in plants. Examples include β -carotene in carrots and lycopene in tomatoes. They do not produce blue or purple colors.
- **Anthocyanins:** These are water-soluble flavonoid pigments found in the vacuoles of plant cells. Their color is highly dependent on pH, and they are responsible for most of the red, purple, blue, or black hues in flowers, fruits, and leaves. They are the primary pigments in blueberries, blackberries, grapes, red cabbage, and pansy flowers. This class perfectly matches the description.
- **Isoflavonoids:** These are a class of flavonoids that are typically colorless, pale yellow, or white. They are better known for their roles in plant defense and their biological activities in humans (e.g., as phytoestrogens) rather than as vibrant color pigments.
- **Aurones:** These are a less common class of flavonoid pigments that are responsible for producing striking golden yellow colors in the flowers of some plant species.

Step 3: Final Answer

The deep blue and purple colors characteristic of many berries and other fruits 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 correct description of the thallus (the vegetative body) of the fungus *Synchytrium*, a genus in the Chytridiomycota. The descriptive terms relate to the fungus's structure and its relationship with its host.

Step 2: Detailed Explanation of Terms

Let's define the key terms to understand the life strategy of *Synchytrium*:

- **Holocarpic vs. Eucarpic:** This pair of terms describes how much of the fungal thallus is converted into reproductive structures.
 - **Holocarpic:** The *entire* thallus is converted into one or more reproductive structures (e.g., a sporangium). There are no separate vegetative parts like rhizoids once reproduction begins.
 - **Eucarpic:** The thallus is differentiated, having distinct vegetative parts (for nutrient absorption) and reproductive parts.
- **Endobiotic vs. Epibiotic:** This pair describes the fungus's location relative to the host cell.
 - **Endobiotic:** The fungus lives entirely *inside* the host's cells or tissues.
 - **Epibiotic:** The fungus lives on the *surface* of the host, often with absorption structures (rhizoids) penetrating the host cell.

Synchytrium (e.g., *S. endobioticum*, the cause of potato wart disease) is a primitive, unicellular fungus. Its life cycle begins when a motile zoospore infects a host epidermal cell. Inside the host cell, the entire fungal body develops and eventually converts into a reproductive structure (a sporangium or resting spore) without forming any separate vegetative parts. Because the entire thallus becomes a reproductive unit, it is **holocarpic**. Because it lives entirely within the host cell, it is **endobiotic**.

Step 3: Final Answer

The thallus of *Synchytrium* is correctly described as being **holocarpic** (the whole body is converted for reproduction) and **endobiotic** (it lives inside the host cell).

💡 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 vegetative and reproduction. *Synchytrium* is a classic example of a holocarpic fungus.

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) Zygomorphs

Correct Answer: (D) Zygomorphs

Solution:

Step 1: Understanding the Concept

The question asks for the name of the specialized hyphal filaments in *Rhizopus* (a Zygomycete fungus) that grow towards each other to initiate the process of sexual reproduction.

Step 2: Detailed Explanation of Terms

Let's examine the terms associated with sexual reproduction in Zygomycetes like *Rhizopus*:

- **Zygomorphs:** These are the specialized, fertile hyphal branches that arise from compatible mating strains (+ and -). They are chemically attracted to each other (a process called chemotropism) and grow towards each other. The name literally means "zygote bearer" and correctly describes the hyphae themselves before they meet. This is the correct answer to the question asked.
- **Progametangia:** When the tips of two approaching zygomorphs meet, they swell. These swollen tips, *before* a dividing septum forms, are called progametangia. These are the structures at the tip of the zygomorphs, not the entire hyphal branches themselves.
- **Chlamydospores:** These are thick-walled, asexual resting spores. They are formed from the rounding up and thickening of a segment of a vegetative hypha to survive unfavorable conditions. They are not involved in sexual reproduction.
- **Azygospores:** These are spores that look like zygosporangia but develop parthenogenetically (without fertilization) from a single gametangium. They are a type of spore, not a specialized hypha.

Step 3: Final Answer

The question asks for the name of the specialized hyphae themselves that are attracted to each other to begin sexual reproduction. The correct term for these 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.

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* in the correct chronological order, starting with the infection on its primary host, wheat. This fungus has a complex, heteroecious life cycle, meaning it requires two different hosts (wheat and barberry) to complete its development, which involves five distinct spore stages.

Step 2: Detailed Explanation of the Life Cycle Sequence

Let's trace the life cycle as it unfolds, starting on wheat during the growing season:

1. **Stage on Wheat (Summer):** The disease first appears on wheat stems and leaves as reddish-brown, elongated pustules. These pustules contain diploid **urediniospores**. This is the repeating stage, as these spores are spread by wind to infect other wheat plants, causing the epidemic to spread rapidly. **This matches statement C.**
2. **Stage on Wheat (Late Summer/Autumn):** As the wheat plant matures and senesces, the fungus switches its production in the same pustules. The pustules turn black as they begin to produce dark, thick-walled, diploid **teliospores**. These teliospores are the overwintering stage of the fungus. **This matches statement A.**
3. **Stage after Overwintering (Spring):** In the spring, the diploid teliospores germinate. Each cell of the teliospore undergoes meiosis to produce a structure called a basidium, which then bears four haploid **basidiospores**. These basidiospores are then released into the air. **This matches statement B.**
4. **Stage on Alternate Host (Barberry):** The released basidiospores cannot infect wheat. They must be carried by the wind to the alternate host, the barberry plant (*Berberis sp.*). Upon landing on a barberry leaf, the basidiospores germinate and infect the leaf tissue. **This matches statement D.** (This infection leads to the production of pycniospores and aeciospores on the barberry, and it is the aeciospores that will then infect wheat to start the cycle anew).

Step 3: Final Answer

The correct chronological sequence of events starting from the summer infection on wheat is: Urediniospore stage (C) → Teliospore stage (A) → Basidiospore discharge (B) → Basidiospore infection of the alternate host (D). This corresponds to the sequence **C → A → B → D**.

💡 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, which are symbiotic associations between a fungus and an alga or cyanobacterium, are broadly classified into three main morphological types based on the structure of their thallus (body).

Step 2: Detailed Explanation of Lichen Growth Forms

Let's define the three main growth forms and classify the examples given:

- **Crustose:** These lichens form a thin, crust-like thallus that is very tightly attached to the substrate (like rock, bark, or soil). It cannot be removed without damaging the substrate. Examples include *Rhizocarpon* (map lichen) and *Graphis* (script lichen).
- **Foliose:** These lichens have a flattened, leaf-like thallus with a distinct upper and lower surface. They are more loosely attached to the substrate via root-like structures called rhizines. An example is *Parmelia* (rock shield lichen).
- **Fruticose:** These lichens have a more complex, three-dimensional structure that can be shrub-like, hair-like, or finger-like. The thallus is typically erect or pendulous (hanging) and is attached to the substrate at a single point at its base. ***Cladonia*** (which includes the famous reindeer moss), *Usnea* (old man's beard), and *Evernia* are all classic examples of fruticose lichens.

Step 3: Final Answer

Among the given options, ***Cladonia*** is the correct and well-known example of a lichen with a fruticose growth form.

💡 Quick Tip

Use visual mnemonics for lichen types:

- **Crustose** = like a **crust** of paint.
- **Foliose** = like **foliage** or leaves.
- **Fruticose** = like a tiny **fruit**-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 specific structure that elevates the mature sporophyte (sporogonium) in the peat moss genus, *Sphagnum*. This is a key anatomical feature that distinguishes *Sphagnum* from many other mosses.

Step 2: Detailed Explanation

In a typical moss life cycle (like *Funaria*), the diploid sporophyte develops from the zygote while attached to the haploid gametophyte. The sporophyte consists of a foot, a stalk called the **seta**, and a capsule containing the spores. In these mosses, it is the elongation of the sporophytic (diploid) **seta** that lifts the capsule high above the gametophyte for effective spore dispersal.

However, *Sphagnum* has a different mechanism.

- In *Sphagnum*, the seta remains very short and undeveloped.
- Instead, after fertilization, a stalk-like structure develops from the **gametophyte tissue** of the archegonial branch, located just below the foot of the sporophyte.
- This haploid, gametophytic stalk elongates, pushing the entire mature sporogonium upwards. This structure is called a **pseudopodium**, which literally means "false foot," as it is a gametophytic structure performing the function of the sporophytic seta.

The other options are incorrect:

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

Step 3: Final Answer

The special gametophytic stalk that elevates the sporogonium in *Sphagnum* is called 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 a capsule elevated on a flexible stalk (seta). When the wind sways the stalk, spores are gradually shaken or "peppered" out of an opening in the capsule, similar to how a censer releases incense or a salt shaker dispenses salt. This is a characteristic feature of many true mosses with a well-developed peristome.

Step 2: Detailed Explanation of Options

Let's analyze the dispersal mechanism of each bryophyte listed:

- ***Pellia*:** This is a thalloid liverwort, not a moss. Its mature capsule dehisces (splits open) into four valves. Spore dispersal is aided by the hygroscopic (moisture-sensitive) twisting and untwisting of sterile cells called elaters that are mixed in with the spores. This is not a censer mechanism.
- ***Funaria*:** This is a common moss that is the classic textbook example of the censer mechanism. It has a long, flexible seta that allows the capsule to be swayed by the wind. The mouth of the capsule is lined with a ring of tooth-like structures called the peristome. These teeth are hygroscopic, opening in dry conditions and closing when wet, thereby regulating spore release. When the capsule is shaken by the wind, spores are peppered out through the peristome.
- ***Pogonatum* and *Polytrichum*:** These are large mosses that also use a shaking mechanism. However, their dispersal is often called a "pepper-pot" mechanism, which is a specific type of censer mechanism. The capsule opening is covered by a thin membrane called an epiphragm, and spores escape through pores between the epiphragm and the peristome. While it is a valid example, *Funaria* with its elaborate, hygroscopic peristome is considered the most classic and widely cited example of the censer mechanism.

Step 3: Final Answer

Among the given options, ***Funaria*** is the best and most classic example of a moss that exhibits 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. "Vernation" refers to the arrangement and development of leaves within a bud, while "circinate" comes from the Latin for 'circle' or 'coil'.

Step 2: Detailed Explanation

Circinate vernation is the specific manner in which a young fern leaf (frond) develops. The frond is tightly coiled in the bud, with the apex at the center of the coil, resembling a watch spring or the head of a violin. This coiled young frond is commonly known as a "fiddlehead" or "crosier."

As the frond grows and matures, it uncoils. This uncoiling process proceeds from the base of the leaf upwards towards the apex. This highly characteristic coiling and subsequent uncoiling is a defining feature of most ferns and some other plant groups like cycads.

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 a feature of fern stem anatomy (the stele), not leaf development.

- **(C) Arrangement of sori on the leaf surface:** This relates to the position of the reproductive spore clusters (sori), which is important for identification but is unrelated to how the leaf unfolds.
- **(D) Presence of adventitious roots on the rhizome:** This describes the root system of the fern, not its leaf development.

Step 3: Final Answer

Circinate vernation is the characteristic coiling of a young fern frond and its subsequent **uncoiling from the base towards the apex**.

💡 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' is Greek for 'closed', and 'gamy' refers to 'marriage' or fertilization.

Step 2: Detailed Explanation

- **Cleistogamous flowers** are flowers that are evolutionarily modified to remain closed and bud-like throughout their entire lifespan. They never blossom or expose their reproductive organs (stamens and pistil) to the external environment.
- Since the flower never opens, pollination by external agents (vectors) like wind (anemophily) or insects (entomophily) is physically impossible.
- Consequently, pollination must occur within the sealed flower. The anthers dehisce (release pollen) directly onto the stigma of the same flower. This process guarantees **autogamy**, or self-pollination.

- Cleistogamy is an adaptation that ensures seed production even when pollinators are scarce or absent. Many plants, such as *Viola* (pansy) and *Commelina*, exhibit both open, cross-pollinating flowers (called chasmogamous flowers) and these closed, self-pollinating cleistogamous flowers.

Analyzing the options:

- (A) and (C) are incorrect because pollinators cannot access the flower.
- (D) describes chasmogamous flowers, which are 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 permanently closed and undergo obligatory 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 physiological role of Gibberellic Acid (GA), which is one of the five major classes of plant hormones. While GA has many functions, some are more prominent and defining than others.

Step 2: Detailed Explanation

Gibberellins are a group of hormones with several key effects on plant growth and development:

- **Stem Elongation:** This is the most dramatic and well-known effect of GA. It stimulates internodal elongation, causing plants to grow tall. This is particularly noticeable when GA is applied to genetic dwarf varieties, causing them to grow to a normal height. This effect is achieved by stimulating both cell division in the apical meristem and the subsequent elongation of those new cells.
- **Seed Germination:** GAs play a crucial role in breaking seed dormancy. In cereal grains, they stimulate the aleurone layer to produce hydrolytic enzymes (like α -amylase) that break down stored starches in the endosperm, providing energy for the growing embryo.
- **Flowering and Fruit Development:** GAs can induce flowering (bolting) in some plants and are involved in fruit set and growth.

Let's evaluate the given options based on these primary roles:

- **(A) It promotes cell division and elongation in stem tissues:** This accurately describes the core mechanism behind the most prominent effect of gibberellins—stem elongation.
- **(B) It increases the levels of anti-oxidants:** This is a secondary stress response and not a primary, defining role of GA.
- **(C) It decreases the levels of plant growth hormones:** This is incorrect. GA is itself a major growth hormone and often works synergistically with others, such as auxins.
- **(D) It inhibits the synthesis of plant secondary metabolites:** This is incorrect. The effects of GA on secondary metabolism are complex and 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 begins with the amino acid methionine. Each of the major plant hormones is synthesized via a distinct metabolic pathway from a specific precursor molecule.

Step 2: Detailed Explanation of Hormone Precursors

Let's review the primary precursors for the major plant hormones:

- **Auxin** (specifically Indole-3-acetic acid, IAA): This hormone is primarily synthesized from the amino acid **tryptophan**.
- **Gibberellin**: This is a large family of terpenoid hormones. They are not derived from an amino acid but are synthesized from **geranylgeranyl pyrophosphate (GGPP)** via the MEP or MVA metabolic pathway.
- **Cytokinin**: These are derivatives of the purine base **adenine**.
- **Ethylene**: This is a simple gaseous hormone. Its biosynthesis in all higher plants starts with the amino acid **methionine**. The pathway proceeds as follows:

Methionine → S-adenosylmethionine (SAM) → 1-aminocyclopropane-1-carboxylic acid (ACC) → Ethylene

The enzymes ACC synthase and ACC oxidase are key regulators of this pathway.

Step 3: Final Answer

Based on the established biosynthetic pathways of plant hormones, **ethylene** is the hormone that is synthesized from the amino acid 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 where the embryos of monocots and dicots, despite having different final structures, are still morphologically similar. This requires knowledge of the early stages of embryo development from the zygote.

Step 2: Detailed Explanation of Embryonic Stages

The development of a plant embryo from a zygote follows a series of predictable stages of cell division and differentiation:

1. **Proembryo Stage:** The zygote undergoes its first transverse division, forming a two-celled proembryo. Further divisions lead to four-celled (quadrant) and eight-celled (octant) stages.
2. **Globular Stage:** Continued cell division results in a spherical or globular mass of cells. At this point, the embryo is radially symmetrical and lacks distinct organs. The fundamental tissue layers (protoderm, ground meristem, and procambium) begin to differentiate, but externally, the embryo looks like a simple sphere. Importantly, up to and including the globular stage, the embryos of both monocots and dicots are morphologically very similar.

The Point of Divergence: The key morphological differentiation between monocots and dicots begins *after* the globular stage:

- **In dicots**, bilateral symmetry is established as two cotyledons (seed leaves) begin to form on opposite sides of the embryo, giving it a characteristic heart shape. This is known as the **heart stage**, which then elongates into the **torpedo stage**.
- **In monocots**, only a single cotyledon develops. The embryo does not pass through a distinct heart stage but instead becomes more cylindrical or scutiform as the single cotyledon and embryonic axis elongate.

Step 3: Final Answer

Since the major morphological divergence—the development of one versus two cotyledons—occurs after the globular stage, the early development of monocot and dicot embryos is considered morphologically 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.

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 in prokaryotes from which a mesosome is formed.

Step 2: Detailed Explanation

- **Definition and Historical View:** Mesosomes are described as convoluted, complex infoldings of the **plasma membrane (cell membrane)** that are observed in the cytoplasm of many bacteria. Historically, these structures were thought to be functional organelles involved in crucial processes such as DNA replication, cell division (septum formation), and respiration, serving as a primitive analogue to the mitochondrial cristae of eukaryotes.
- **Current Understanding (Artifact Theory):** It is important to note that the existence of mesosomes as true, functional organelles in living bacteria is now widely disputed. Extensive evidence suggests that they are largely **artifacts**—damage structures created by the chemical fixation and dehydration methods traditionally used to prepare bacterial cells for transmission electron microscopy. When cells are prepared using more modern techniques like cryofixation, mesosomes are typically absent.

- **Answering the Question:** Regardless of their status as artifacts, for the purpose of a biology question about their structural origin, mesosomes are defined by their appearance in micrographs. In these images, they are unequivocally seen as invaginations originating from the cell membrane.

Let's examine the options:

- (A) Ribosomes are particles responsible for protein synthesis.
- (B) Mitochondria are organelles found in eukaryotes, not prokaryotes.
- (D) The cell wall is a rigid layer *outside* the cell membrane.
- (C) The **cell membrane** is the correct origin, as mesosomes are observed as infoldings of this structure.

Step 3: Final Answer

A mesosome, by definition, is a specialized 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.

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 specific location of the Calvin cycle (also known as the light-independent reactions) within a eukaryotic chloroplast. Photosynthesis is divided into two main stages, each occurring in a distinct compartment of the chloroplast.

Step 2: Detailed Explanation of Photosynthesis Stages

- **Light-Dependent Reactions:** This first stage captures light energy. It involves photosystems and electron transport chains, which are complexes of proteins and pigments (like chlorophyll). These complexes are embedded within the membranes of the **thylakoids**. The thylakoids are flattened, sac-like structures, often stacked into grana. The function of this stage is to use light energy to produce the energy-carrying molecules ATP and NADPH.
- **Calvin Cycle (Light-Independent Reactions):** This second stage does not directly require light. It uses the ATP and NADPH produced during the light reactions to fix atmospheric carbon dioxide (CO₂) and synthesize sugars (like glucose). The Calvin cycle is a series of enzyme-catalyzed reactions. The enzymes required for this process, including the key enzyme RuBisCO, are soluble. They are not embedded in a membrane but are located in the **stroma**, the aqueous, fluid-filled space that surrounds the thylakoids within the inner membrane of the chloroplast.

The inner membrane of the chloroplast regulates the transport of molecules in and out of the stroma but is not the site of the Calvin cycle itself.

Step 3: Final Answer

The Calvin cycle, which is a series of enzyme-catalyzed reactions responsible for carbon fixation, 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.

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 specific effect on translation if the addition of the 5' cap to a eukaryotic pre-mRNA transcript is inhibited. The 5' cap is a modified guanine nucleotide that is added to the 5' end of the mRNA during its synthesis in the nucleus.

Step 2: Detailed Explanation of 5' Cap Functions

The 5' cap is a multifunctional structure with several crucial roles in the life of an mRNA molecule:

1. **Protection:** It protects the nascent mRNA from degradation by 5' exonucleases, thereby increasing its stability.
2. **Nuclear Export:** The cap is recognized by the cap-binding complex (CBC), which is essential for the efficient transport of the mature mRNA from the nucleus to the cytoplasm.
3. **Translation Initiation:** This is its most critical role in the context of the question. In the cytoplasm, the cap is recognized by the eukaryotic initiation factor eIF4F. This binding event is the primary step that recruits the small (40S) ribosomal subunit to the mRNA. Without this recognition, the ribosome cannot properly assemble on the mRNA to begin 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 the *initiation* step. If initiation fails, elongation cannot occur.
- **(B) Translation will fail to initiate due to improper ribosome binding:** This is the correct and most direct consequence. The absence of the 5' cap prevents the recruitment of the ribosomal machinery to the mRNA, thereby blocking the initiation of translation.
- (C) The polyadenylation will not occur: Polyadenylation (adding the poly-A tail) occurs at the 3' end. While the two processes are often coupled, inhibiting capping does not directly prevent polyadenylation.
- (D) Splicing of introns will be unaffected: While capping can influence the efficiency of splicing for the first intron, its most direct and critical role related to protein synthesis is in translation initiation.

Step 3: Final Answer

Inhibiting the addition of the 5' cap to a eukaryotic mRNA will prevent the efficient recruitment and binding of the ribosome, leading to 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.

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 functional consequence of DNA methylation, a key epigenetic modification, when it occurs at a high level (hypermethylation) in the promoter region of a gene.

Step 2: Detailed Explanation

- **DNA Methylation:** This is a biochemical process involving the addition of a methyl group ($-\text{CH}_3$) to a DNA base, typically the cytosine in a CpG dinucleotide (a C followed by a G).
- **Promoter Region:** This is a critical regulatory region of a gene located upstream of the transcription start site. It contains binding sites for RNA polymerase and various transcription factors, which are necessary to initiate transcription.
- **Effect of Hypermethylation:** A high density of methylation in a gene's promoter region is a well-established and powerful mechanism for **gene silencing** or transcriptional repression. This silencing is achieved through two primary mechanisms:
 1. **Direct Blockade:** The bulky methyl groups can physically interfere with the binding of essential transcription factors and RNA polymerase to their recognition sequences in the promoter, thereby directly blocking the assembly of the transcription machinery.
 2. **Chromatin Remodeling:** Methylated CpG sites are recognized and bound by specific proteins known as methyl-CpG-binding domain proteins (MBDs). These MBDs, in turn, recruit other proteins, such as histone deacetylases (HDACs) and chromatin remodelers. This complex of proteins modifies the nearby histones, causing the chromatin to become tightly compacted into a condensed, inactive state known as heterochromatin. This condensed structure makes the gene physically inaccessible to the transcription machinery.

Therefore, hypermethylation of a promoter is strongly and consistently associated with turning a gene "off".

Step 3: Final Answer

The typical and well-established effect of hypermethylation of a gene's promoter region 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

The question asks for the specific name of a chromatin structural unit that is defined by a particular length of DNA (168 bp) and a specific set of histone proteins, which includes not only the core histones but also the linker histone H1.

Step 2: Detailed Explanation of Chromatin Units

Let's define the hierarchical levels of chromatin structure to identify the correct term:

- **Histone Octamer:** This is the protein core around which DNA is wrapped. It consists of eight histone molecules: two copies each of the core histones H2A, H2B, H3, and H4. It is purely protein and does not include any DNA or the linker histone H1.
- **Nucleosome (or Nucleosome 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 about 1.65 times. It does not include the linker histone H1. This is the structure that results from mild digestion of chromatin with micrococcal nuclease (MNase).

- **Chromatosome:** This is the next level of organization. It consists of a nucleosome core particle *plus* the linker histone H1. The H1 protein binds to the DNA where it enters and exits the histone octamer, effectively "sealing" the wrapped DNA. This binding protects an additional 20 bp of DNA from nuclease digestion. Therefore, the chromatosome comprises the histone octamer, one molecule of H1, and a total of about **168 bp** of DNA. This description perfectly matches the question.
- **Histosome:** This is not a standard term used in the modern nomenclature of chromatin structure.

Step 3: Final Answer

The structural unit of chromatin that contains the histone octamer, the linker histone H1, and is associated with approximately 168 bp of DNA is called a **chromatosome**.

💡 Quick Tip

Remember the progression of chromatin structure:

- **Histone Octamer** (8 core histones) + **~147 bp DNA** = **Nucleosome**
- **Nucleosome** + **Histone H1** (→ 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 is a standardized description of the chromosome complement of a cell. Many human genetic syndromes are caused by aneuploidy, which is an abnormal number of chromosomes, typically resulting from nondisjunction during meiosis.

Step 2: Detailed Explanation of Karyotypes

The standard notation for a human karyotype is: Total number of chromosomes, comma, sex chromosomes, comma, any abnormalities.

Let's identify the syndrome associated with each given karyotype:

- **(A) 47, XY, +21:** This indicates a total of 47 chromosomes in a male (XY), with an extra copy of chromosome 21. This condition is known as **Trisomy 21**, which is the genetic basis for **Down Syndrome**. (The notation can also be just 47, +21).
- **(B) 47, XY, +18:** This indicates a total of 47 chromosomes in a male, with an extra copy of chromosome 18. This condition is known as **Trisomy 18**, which is the genetic basis for **Edwards Syndrome**.
- **(C) 47, XY, +13:** This indicates a total of 47 chromosomes in a male, with an extra copy of chromosome 13. This condition is known as **Trisomy 13**, which is the genetic basis for **Patau Syndrome**.
- **(D) 45, X:** This indicates a total of 45 chromosomes, with only one sex chromosome (an X chromosome) and the other missing (denoted as O in older texts). This condition is known as **Monosomy X**, which is the genetic basis for **Turner Syndrome**.

Step 3: Final Answer

Patau Syndrome is correctly described by the karyotype **47, +13**, indicating the presence of an extra copy of chromosome 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 agricultural crops like cotton and corn. "Bt" is an abbreviation for *Bacillus thuringiensis*, a common soil bacterium.

Step 2: Detailed Explanation

- **The Source:** The bacterium *Bacillus thuringiensis* naturally produces a class of crystalline proteins (Cry proteins), commonly known as Bt toxins.
- **Mechanism of Action:** These proteins are harmless to humans, mammals, birds, and most beneficial insects. However, they are highly toxic to the larvae of specific insect pests (e.g., Lepidoptera like the cotton bollworm, Coleoptera like the corn rootworm). When a susceptible larva ingests the Bt toxin, the alkaline environment of its midgut activates the protein. The active toxin binds to specific receptors on the gut wall, creating pores in the cell membranes. This leads to cell lysis, gut paralysis, and ultimately, the death of the insect.
- **Genetic Engineering:** Scientists have used genetic engineering to isolate the gene (the Cry gene) that codes for the Bt toxin from the bacterium. They then insert this gene into the genome of crop plants.
- **The Resulting Crop:** The resulting genetically modified (GM) crop, such as Bt Cotton or Bt Corn, can now produce its own Bt toxin in its tissues. When a target insect pest attempts to feed on the plant, it ingests the toxin and is killed. This provides the plant with season-long, built-in protection.

Step 3: Final Answer

The primary function and purpose of incorporating the Bt toxin gene into GM crops is to confer resistance to specific insect pests, effectively making the plant act as its own **natural, built-in insecticide**.

💡 Quick Tip

Remember the name: **Bt** stands for *Bacillus thuringiensis*. 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 widely used visual selection technique in molecular cloning. It allows researchers to easily distinguish bacterial colonies that have taken up a recombinant plasmid (one with a foreign DNA insert) from those that have taken up a non-recombinant plasmid (an empty one). The technique is based on the principle of **insertional inactivation**.

Step 2: Detailed Explanation of Components and Process

Let's break down the key components used in this technique:

- ***lacZ* gene:** This gene, present on the plasmid, codes for the enzyme β -galactosidase.
- **Multiple Cloning Site (MCS):** A short region engineered to be inside the *lacZ* gene, containing numerous unique restriction enzyme sites. This is where the foreign DNA is inserted.
- **X-gal:** A colorless artificial substrate for β -galactosidase. When this substrate is cleaved by a functional enzyme, it produces an insoluble blue-colored product.
- **IPTG:** An inducer that ensures the *lacZ* gene is transcribed, so the enzyme can be produced.

Now, let's consider the two possible outcomes for bacterial cells that have successfully taken up a plasmid (i.e., have been transformed):

1. **Non-recombinant plasmid (No Insert):** The plasmid re-ligated on itself without incorporating the foreign DNA. In this case, the *lacZ* gene remains intact and functional. The bacteria will produce active β -galactosidase, which will cleave the X-gal in the medium. **The resulting bacterial colonies will be blue.**
2. **Recombinant plasmid (With Insert):** A piece of foreign DNA has been successfully inserted into the MCS. This insertion disrupts the coding sequence of the *lacZ* gene, leading to **insertional inactivation**. The bacteria cannot produce a functional β -galactosidase enzyme. As a result, X-gal is not cleaved. **The resulting bacterial colonies will be white.**

Step 3: Final Answer

The goal of cloning is to find the bacteria with the inserted DNA. Therefore, researchers select the **white colonies**, as these are the transformed cells containing the recombinant plasmid where the *lacZ* gene has been successfully inactivated.

💡 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. This is a process used to preserve living biological material (like cells, tissues, or embryos) in a state of suspended animation by cooling it to very low temperatures, typically in liquid nitrogen (-196°C).

Step 2: Detailed Explanation of the Logical Flow

Let's analyze the logical sequence of the process from start to finish:

1. **A. Raising sterile tissue culture:** The first and most fundamental step is to have the biological material you wish to preserve. For plant cells, this involves establishing and growing a healthy, sterile, and actively dividing tissue culture. This provides the high-quality starting material.
2. **D. Addition of cryoprotectants:** Directly freezing living cells would cause lethal damage due to the formation of intracellular ice crystals. To prevent this, a crucial pre-treatment step is the addition of cryoprotectants (e.g., DMSO, glycerol). These substances permeate the cells and lower the freezing point, protecting them from ice crystal damage during the cooling process.
3. **C. Freezing, Storage:** After the cells have been treated with cryoprotectants, they are subjected to a controlled, slow cooling protocol to freeze them gradually. Once frozen, they are transferred to long-term storage in liquid nitrogen, where all metabolic activity ceases.
4. **B. Determination of viability:** After a period of storage, and especially before using the preserved material for experiments or propagation, the cells must be thawed using a rapid protocol. It is then essential to perform a viability test. This is a final quality-control step to check if the cells have survived the stress of the freezing and thawing process. Methods like TTC staining or fluorescein diacetate staining are used to differentiate living from dead cells.

Step 3: Final Answer

The correct and logical sequence of steps for cryopreservation is: Raise the culture (A) → Add cryoprotectants (D) → Freeze and Store (C) → Determine viability (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 essential tools in molecular biology, designed for cloning and maintaining very large segments of DNA within a bacterial host.

Step 2: Detailed Explanation of BAC Features

BAC vectors are engineered cloning vectors based on the naturally occurring F-plasmid (fertility plasmid) of *E. coli*. Their design incorporates several key features:

- **Large Insert Capacity:** This is the primary and most defining characteristic of BACs. They are engineered to stably accept and maintain exceptionally large foreign DNA inserts, typically ranging from 150 to 350 kilobase pairs (kbp). This capability makes them invaluable for projects that require cloning large contiguous sections of a genome, such as constructing genomic libraries or sequencing entire genomes.
- **Bacterial Host System:** As their name, "Bacterial Artificial Chromosome," implies, they use bacterial cells (specifically *E. coli*) as hosts for replication and maintenance. This contrasts with other high-capacity vectors like Yeast Artificial Chromosomes (YACs), which use eukaryotic yeast cells as hosts.
- **Autonomous Replication and Low Copy Number:** BACs contain an origin of replication (*oriS*) derived from the F-plasmid, which allows them to replicate autonomously within the host cell. Crucially, this origin maintains a very low copy number—typically just one to two copies of the BAC vector per bacterial cell. This low copy number is a key feature that prevents recombination between large inserts and ensures the stability of the cloned DNA.
- **Selectable Markers:** Like all effective cloning vectors, BACs possess selectable markers, such as an antibiotic resistance gene (e.g., for chloramphenicol). This allows researchers to easily select for and grow only the host bacteria that have successfully taken up the BAC vector.

Evaluating the options, the ability to carry large DNA inserts is the most significant and distinguishing feature of a BAC vector.

Step 3: Final Answer

The most significant and defining characteristic of a BAC vector is its **capacity to carry large DNA inserts**, making it a crucial tool for genomics.

💡 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. This process involves isolating a gene of interest and successfully introducing it into a plant to confer a new trait.

Step 2: Detailed Explanation of the Logical Workflow

Creating a GM plant is a multi-step process that must follow a logical order from concept to final product:

1. **B. Identification of a desired gene:** The very first step is to identify a gene that codes for a desirable trait. This is the conceptual start of the project. For example, if the goal is insect resistance, the scientist must first identify and isolate the gene responsible for that trait (e.g., the Bt toxin gene). You must know what you want to transfer before you can begin the physical work.

2. **A. Insertion of the gene into the vector:** Once the desired gene is isolated, it cannot be directly inserted into a plant cell. It must first be placed into a suitable carrier, or **vector**. In plant biotechnology, this is often a modified plasmid (like the Ti plasmid from *Agrobacterium tumefaciens*). Splicing the desired gene into the vector creates a recombinant DNA molecule, which is the tool for transformation.
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 is the core transformation step. Common methods include using the natural ability of *Agrobacterium* to transfer its DNA into plants, or physical methods like using a "gene gun" to shoot DNA-coated particles into the cells.
4. **C. Selection and screening of transformed plants:** The transformation process is not 100% efficient; only a small fraction of the treated plant cells will successfully incorporate the new gene. Therefore, a crucial final stage is needed to identify and grow these successful transformants. This involves:
 - **Selection:** Using a selectable marker (e.g., an antibiotic resistance gene included on the vector) to kill off all non-transformed cells.
 - **Regeneration:** Growing the selected cells into whole plants using tissue culture.
 - **Screening:** Analyzing the regenerated plants to confirm the presence, integration, and stable expression of the new gene and the desired trait.

Step 3: Final Answer

The correct chronological sequence of steps is: Identify the gene (B) → Insert the gene into a vector (A) → Transfer the vector into the plant (D) → Select and screen the transformed plants (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, morphology-based classification system for gymnosperms, proposed by botanists like Birbal Sahni. This system divides gymnosperms into two major groups based on the position of their ovules (the structures that develop into seeds).

- **Stachyospermae:** Ovules are borne on a stem or axis. (Greek: *stachys* = axis/spike, *sperma* = seed).
- **Phyllospermae:** Ovules are borne on leaves or leaf-like structures (megasporeophylls). (Greek: *phyllon* = leaf, *sperma* = seed).

The question asks to identify which of the listed orders does not belong to the Stachyospermae.

Step 2: Detailed Explanation and Classification

Let's classify the given gymnosperm orders according to this system:

- **Cordaitales:** This is an extinct order of gymnosperms considered ancestral to modern conifers. Their ovules were borne on stalks that arose from the axils of bracts, placing them firmly in the **Stachyospermae**.
- **Ginkgoales:** This order is represented today by the living *Ginkgo biloba*. Its ovules are borne terminally on stalks (axes), not on leaves. This axial position places the Ginkgoales in the **Stachyospermae**.
- **Coniferales:** This is the largest and most familiar group of gymnosperms (pines, firs, spruces). Their ovules are borne on ovuliferous scales, which are considered to be modified shoots or axes. Therefore, the Coniferales belong to the **Stachyospermae**.
- **Cycadales:** This is the order of cycads. In this group, the ovules are borne on the margins of modified leaves called **megasporeophylls**. These megasporeophylls are often large and arranged in a terminal cone. Because their ovules are borne on leaf-like structures, the Cycadales are classic examples of the **Phyllospermae**.

Step 3: Final Answer

Cordaitales, Ginkgoales, and Coniferales are all classified as Stachyospermae because their ovules are borne on stem-like axes. **Cycadales** is the correct answer because it belongs to the Phyllospermae, with its ovules borne on modified leaves.

💡 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).

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 specific, well-known examples. Proteins are the most functionally diverse macromolecules, performing a vast array of tasks within living organisms.

Step 2: Detailed Explanation and Matching

Let's analyze each functional protein class and find its corresponding example:

- **A. Structural proteins:** These proteins provide a physical framework, support, and shape to cells, tissues, and organisms. They are often fibrous and strong. **Collagen** is the most abundant protein in mammals and is the main component of connective tissues like skin, tendons, bones, and cartilage, providing tensile strength. Thus, **A matches with IV**.

- **B. Transport Proteins:** These proteins are responsible for the movement of substances. This can be across a cell membrane or throughout the circulatory system of an organism. **Ion Channels** are a perfect example; they are transmembrane proteins that form pores, allowing specific ions (like Na^+ , K^+ , Ca^{2+}) to pass through the cell membrane, which is otherwise impermeable to them. Thus, **B matches with I.**
- **C. Hormonal Proteins:** These proteins act as chemical messengers, secreted by endocrine glands to travel through the bloodstream and regulate physiological processes in other parts of the body. **Insulin**, a protein hormone produced by the pancreas, is a classic example. It regulates blood glucose levels by signaling cells to take up glucose from the blood. Thus, **C matches with II.**
- **D. Storage Proteins:** These proteins serve as a biological reserve of amino acids and nutrients for an organism. **Seed Proteins**, such as albumin and globulin found in the seeds of legumes and cereals, store a high concentration of amino acids that are used to nourish the developing plant embryo during germination. Thus, **D matches with III.**

Step 3: Final Answer

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

💡 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 (the basic building block) is incorrectly matched with its corresponding polymer or related macromolecule. The four major classes of biological macromolecules are built from smaller repeating subunits.

Step 2: Detailed Explanation of Each Pair

Let's analyze each monomer-polymer relationship:

- **(A) Amino acids - Proteins:** This is a **correct** match. Proteins are polymers (polypeptides) constructed from amino acid monomers linked together by peptide bonds.
- **(B) Fatty acids - Deoxynucleotides:** This is an **incorrect** match. These two molecules are components of two entirely different classes of macromolecules.
 - **Fatty acids** are, along with glycerol, the building blocks of **lipids** (fats and oils).
 - **Deoxynucleotides** are the monomers that make up the polymer **DNA** (a nucleic acid).

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 large polymers made up of monosaccharide monomers. Glucose is the most common of these monosaccharides.
- **(D) Nucleoside triphosphate - Nucleic acids:** This is a **correct** match. While the final monomer incorporated into a nucleic acid (DNA or RNA) is a nucleotide monophosphate, the process of polymerization uses high-energy nucleoside triphosphates (like ATP, GTP, CTP, TTP) as the precursor substrates. During polymerization, two phosphate groups are cleaved off, providing the energy to form the phosphodiester bond.

Step 3: Final Answer

The pair "**Fatty acids - Deoxynucleotides**" is incorrectly matched because the two molecules are building blocks for two completely different classes of macromolecules (lipids and nucleic acids, respectively).

💡 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 responsible for creating the short RNA primers that are required to initiate DNA synthesis during replication.

Step 2: Detailed Explanation of Replication Enzymes

DNA replication involves a coordinated effort by several key enzymes, each with a specific role:

- **Helicase:** This enzyme functions at the replication fork, where it unwinds the DNA double helix. It breaks the hydrogen bonds between the complementary base pairs, separating the two parental strands so they can each serve as a template for a new strand.
- **Primase:** This enzyme addresses a fundamental limitation of DNA polymerase. DNA polymerase can only add nucleotides to a pre-existing 3'-OH group; it cannot start synthesizing a new strand from scratch. **Primase** is a specialized type of RNA polymerase that solves this problem. It synthesizes a short RNA sequence, called a primer (typically 5-10 nucleotides long), that is complementary to the template DNA. This RNA primer provides the crucial 3'-OH starting point for DNA polymerase to begin synthesis.
- **DNA polymerase:** This is the main synthesizing enzyme of replication. It reads the template strand and adds complementary deoxynucleotides to the 3' end of the RNA primer, elongating the new DNA strand. It also has roles in proofreading its work and, in the case of DNA polymerase I, removing the RNA primers and replacing them with DNA.
- **Topoisomerase** (also known as DNA gyrase in bacteria): As helicase unwinds the DNA, it creates torsional strain and supercoiling in the DNA ahead of the replication fork. Topoisomerase relieves this strain by cutting, swiveling, and rejoining the DNA strands.

Step 3: Final Answer

The enzyme specifically responsible for synthesizing the short RNA primers needed to initiate DNA replication 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**.

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 for the "fluidity" of the plasma membrane, which is a core tenet of the Singer-Nicolson Fluid Mosaic Model of cell membranes. This model describes the membrane not as a static, rigid structure, but as a dynamic and fluid entity.

Step 2: Detailed Explanation

The "Fluid Mosaic Model" provides a powerful analogy:

- **The "Fluid" Part:** This refers to the fact that the components of the membrane are in constant motion. The phospholipid molecules that form the bilayer are not locked in place. They are free to move laterally (side-to-side) and rotate on their axes. They can also flex their fatty acid tails. While rare, they can even "flip-flop" from one leaflet of the bilayer to the other. This lipid movement is a major contributor to the membrane's overall fluidity, which is comparable to that of olive oil.
- **The "Mosaic" Part:** This refers to the membrane proteins. These proteins are embedded within or associated with the lipid bilayer, much like tiles in a mosaic. Importantly, most of these proteins are also not fixed. They are generally free to drift laterally within the fluid lipid bilayer, often described as "icebergs floating in a sea of lipids."

This constant, dynamic movement of both lipids and proteins is the essence of membrane fluidity. It allows the membrane to be flexible, to self-seal if punctured, and to participate in processes like cell signaling, transport, and membrane fusion.

Evaluating the options:

- (B) accurately describes this dynamic nature where both constituent lipids and proteins are able to move within the membrane.
- (A) and (C) are incorrect as they describe the membrane as "rigid" or having "fixed" proteins, which is the opposite of fluid.
- (D) is incorrect because cholesterol modulates fluidity by interacting with phospholipids, not by attaching to proteins.

Step 3: Final Answer

The fluidity of the plasma membrane is best explained by the **continuous lateral 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 a gene. This sequence follows the central dogma of molecular biology, which describes the flow of genetic information from DNA to RNA to protein.

Step 2: Detailed Explanation of the Information Flow

Let's trace the consequences of a point mutation from its origin to its final phenotypic effect:

1. **C. Substitution of a single nucleotide in the DNA sequence:** The entire process must begin with the initial event, which is the mutation itself. A point mutation is a change in a single nucleotide base pair within the DNA sequence of a gene. This is the root cause of all subsequent changes.
2. **B. Change in mRNA codon during transcription:** The next step in gene expression is transcription, where the mutated DNA sequence serves as a template to create a

messenger RNA (mRNA) molecule. The change in the DNA base will inevitably result in a corresponding change in the three-base mRNA codon at that position.

3. **A. Alteration in the amino acid sequence of a protein:** The third step is translation, where the ribosome reads the mRNA codons to synthesize a polypeptide chain. If the changed mRNA codon now specifies a different amino acid (a missense mutation), the resulting protein will have an altered amino acid sequence.
4. **D. Possible disruption of protein function or structure:** The final step is the consequence at the functional level. The change in the amino acid sequence can alter how the protein folds into its correct three-dimensional structure. This change in structure can disrupt or abolish the protein's biological function, leading to a change in the organism's phenotype.

Step 3: Final Answer

The correct chronological 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).

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 conducting a Mendelian dihybrid cross. This type of experiment is designed to study the inheritance of two different traits simultaneously and is the basis for Mendel's Law of Independent Assortment.

Step 2: Detailed Explanation of the Logical Steps

Let's outline the logical sequence of a classic dihybrid cross experiment:

1. **A. Selection of two traits in the parent generation:** The experiment begins with the scientist choosing two distinct, contrasting traits to study. For example, in his pea plant experiments, Mendel selected seed shape (round vs. wrinkled) and seed color (yellow vs. green).
2. **B. Crossing of pure - breeding parents:** The next step is to perform the parental (P) generation cross. This involves crossing two individuals that are pure-breeding (homozygous) for the selected traits, with one parent being dominant for both traits and the other being recessive for both (e.g., $RRYY \times rryy$).
3. **D. Observations of gamete combinations in the F_1 generation:** The offspring of the P cross are the F_1 generation. All F_1 individuals will be heterozygous for both traits ($RrYy$) and will display the dominant phenotype for both. The next step in the experiment is to perform a self-cross of these F_1 individuals ($RrYy \times RrYy$). The crucial observation at this stage, which is the foundation of the Law of Independent Assortment, is understanding that the F_1 generation produces four different types of gametes (RY , Ry , rY , ry) in equal proportions. Step D refers to this crucial step of generating and understanding the gametes from the F_1 that will create the F_2 generation.
4. **C. Analysis of phenotypic ratios in the F_2 generation:** The offspring resulting from the F_1 self-cross constitute the F_2 generation. The final step is to count the F_2 offspring and analyze their phenotypic ratios. If the genes for the two traits assort independently, this ratio will be approximately **9:3:3:1** (9 dominant/dominant : 3 dominant/recessive : 3 recessive/dominant : 1 recessive/recessive). This analysis is the ultimate test of the law.

Step 3: Final Answer

The correct experimental sequence is: Select traits (A) $\rightarrow$ Cross pure-breeding parents (B) $\rightarrow$ Generate and understand the F_1 gametes for the next cross (D) $\rightarrow$ Analyze the F_2 phenotypic results (C). This corresponds to the order **A, B, D, C**.

Quick Tip

Remember the flow of any Mendelian experiment: **P** (Parents) $\rightarrow$ **F** (First Filial) $\rightarrow$ **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).

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 make up "Interphase" in the eukaryotic cell cycle. The cell cycle is the ordered series of events that a cell undergoes, leading to its growth and division into two daughter cells.

Step 2: Detailed Explanation of the Cell Cycle Stages

The eukaryotic cell cycle is broadly divided into two main stages:

1. **Interphase:** This is the longest and most variable stage of the cell cycle. It is the period of intense metabolic activity, cell growth, and DNA replication, all in preparation for cell division. Interphase is not a resting phase but a highly active preparatory period. It is further subdivided into three distinct phases:
 - **G₁ phase (Gap 1):** (C) This is the first gap phase, following cell division. The cell grows in size, carries out its normal metabolic functions, and synthesizes the mRNA and proteins required for the next phase, DNA synthesis.
 - **S phase (Synthesis):** (A) This is the phase where the cell's entire genome is replicated. The cell duplicates its DNA, so at the end of this phase, each chromosome consists of two identical sister chromatids joined at the centromere.
 - **G₂ phase (Gap 2):** (D) This is the second gap phase. The cell continues to grow and synthesizes additional proteins and organelles (like microtubules) needed for the upcoming mitosis and cell division.
2. **M phase (Mitotic phase):** (B) This is the phase of actual cell division. It is much shorter than interphase and consists of two main processes: mitosis (the division of the nucleus) and cytokinesis (the division of the cytoplasm).

Step 3: Final Answer

Interphase is the collective term for the G_1 , S, and G_2 phases. The M phase is the separate, subsequent stage of division. Therefore, the phases that are included in Interphase are the **S phase (A)**, **G_1 phase (C)**, and **G_2 phase (D)**.

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.
