UPCATET Agriculture Botany Sample Paper-3

Duration: 20 Minutes **Maximum Marks: 100**

Instructions

- This paper contains **25** Multiple Choice Questions.
- Each correct answer carries **+4** mark. Incorrect answer: **−1** marks. Only **one** correct option.
- Unattempted questions carry **0** marks.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.

Q1. Which of the following modifications is observed in the roots of *Pandanus* (Screw pine) to provide additional mechanical support to the leaning stem?

(A) Prop roots

(B) Stilt roots

(C) Pneumatophores

(D) Fusiform roots

Q2. In agricultural crops belonging to the family Poaceae, the inflorescence is typically characterized as a:

(A) Capitulum (Head)

(B) Corymb

(C) Spikelet or panicle of spikelets

(D) Umbel

Q3. During the light reaction of photosynthesis, photolysis of water occurs near which specific component of the thylakoid membrane?

(A) Photosystem I (PS I) on the stroma-facing side

(B) Cytochrome b_6f complex

(C) Photosystem II (PS II) on the lumen-facing side

(D) ATP synthase complex

Q4. During which specific sub-stage of Prophase I in meiosis does the crossing over and formation of recombinant nodules take place?

(A) Leptotene

(B) Zygotene

(C) Pachytene

(D) Diplotene

Q5. The characteristic yellow or orange colour of the corolla in *Solanum melongena* (Brinjal) or other Solanaceous flowers is primarily due to the presence of which pigments inside the cells?

(A) Anthocyanins in the central vacuole

(B) Carotenoids within the chromoplasts

(C) Chlorophyll *b* inside the chloroplasts

(D) Phycobilins in the cytoplasm

Q6. What is the characteristic floral diagnostic feature of the family Fabaceae regarding its androecium arrangement?

(A) Monadelphous condition with numerous stamens

(B) Diadelphous condition typically arranged as (9) + 1

(C) Syngenesious condition with 5 stamens

(D) Epipetalous and tetradynamous condition

Q7. In C_4 plants such as Maize (*Zea mays*) and Sugarcane (*Saccharum officinarum*), the primary fixation of carbon dioxide (CO_2) by PEP carboxylase takes place in which cells?

(A) Bundle sheath cells

(B) Mesophyll cells

(C) Epidermal guard cells

(D) Phloem parenchyma cells

Q8. The presence of bulliform (motor) cells on the adaxial epidermis of leaves is a characteristic anatomical adaptation of which group of crop plants?

(A) Xerophytic dicots belonging to Solanaceae

(B) Hydrophytic plants

(C) Monocotyledonous crops belonging to Poaceae

(D) Halophytic mangroves

Q9. When a pure-breeding tall pea plant with round seeds (TTRR) is crossed with a dwarf plant with wrinkled seeds (ttrr), the F_2 generation shows a phenotypic ratio of 9:3:3:1. This outcome directly validates which of Mendel's principles?

(A) Law of Dominance

(B) Law of Segregation

(C) Law of Independent Assortment

(D) Law of Incomplete Dominance

Q10. The botanical name of 'Chickpea' or 'Bengal Gram' is *Cicer arietinum*. To which sub-family or family of agricultural crops does it belong?

(A) Caesalpinioideae

(B) Fabaceae (Papilionoideae)

(C) Mimosoideae

(D) Solanaceae

Q11. Which type of stomatal opening and closing mechanism is highly triggered by the rapid efflux of potassium ions (K^+) from the guard cells into adjacent subsidiary cells?

(A) Stomatal opening under high light intensity

(B) Stomatal closure in response to water stress and ABA signaling

(C) Continuous opening during high humidity conditions

(D) Active hydathode exudation (guttation)

Q12. Anatomically, the presence of a distinct 'Casparian strip' made of suberin deposition is a definitive diagnostic feature of which tissue layer in a dicot root?

(A) Exodermis

(B) Pericycle

(C) Endodermis

(D) Hypodermis

Q13. In which of the following crop plants do we find a modified underground stem known as a 'tuber' which possesses axillary buds commonly referred to as 'eyes'?

(A) *Ipomoea batatas* (Sweet potato)

(B) *Solanum tuberosum* (Potato)

(C) *Colocasia esculenta* (Taro)

(D) *Allium cepa* (Onion)

Q14. The key regulatory enzyme of glycolysis that converts Fructose-6-Phosphate to Fructose-1,6-Bisphosphate, consuming one molecule of ATP, is:

(A) Hexokinase

(B) Phosphofructokinase (PFK)

(C) Pyruvate kinase

(D) Aldolase

Q15. The persistent, enlarged, and green calyx that remains attached to the mature harvested fruit is a distinct commercial and botanical trait of which family?

(A) Poaceae

(B) Brassicaceae

(C) Solanaceae

(D) Fabaceae

Q16. During a laboratory estimation of transpiration using a potometer, a student observes a sharp decline in the rate of water movement when a crop branch is coated with vaseline on its lower (abaxial) surface. This indicates that the leaf is:

(A) Epistomatic

(B) Hypostomatic

(C) Amphistomatic with equal distribution

(D) Astomatic

Q17. Which of the following statements correctly identifies the anatomical distinction between a typical dicot stem and a typical monocot stem vascular bundle?

(A) Dicot stems have scattered closed vascular bundles; monocot stems have ringed open vascular bundles.

(B) Dicot stems have open vascular bundles arranged in a ring; monocot stems have closed vascular bundles scattered in the ground tissue.

(C) Monocot stems possess a well-defined cambium ring for secondary growth.

(D) Dicot stems lack a distinct pith area in the center.

Q18. In the floral formula of the family Solanaceae, the symbol representing the gynoecium condition is typically written as $\underline{G}_{(2)}$. This indicates that the ovary is:

(A) Inferior and monocarpellary

(B) Superior and syncarpous bicarpellary

(C) Inferior and apocarpous bicarpellary

(D) Superior and polycarpous free

Q19. If a somatic cell of an agricultural crop species contains 24 chromosomes ($2n = 24$), how many chromosomes and how many chromatids will be present in a cell of this crop at the end of Anaphase of Mitosis?

(A) 24 chromosomes and 24 chromatids

(B) 48 chromosomes and 48 chromatids

(C) 24 chromosomes and 48 chromatids

(D) 12 chromosomes and 24 chromatids

Q20. The structural modification of an inflorescence where the main axis remains short, and all flowers appear to arise from a single central point with a whorl of bracts at the base is called:

(A) Umbel

(B) Spike

(C) Raceme

(D) Catkin

Q21. A distinct structure called 'palea' and 'lemma' which enclose the essential reproductive organs (stamens and carpel) can be identified in the flowers of which agricultural crop family?

(A) Solanaceae

(B) Malvaceae

(C) Poaceae

(D) Cucurbitaceae

Q22. Which of the following compounds acts as the final electron acceptor in the electron transport chain (ETC) during aerobic respiration inside plant mitochondria?

(A) NAD^+

(B) Cytochrome c

(C) Molecular oxygen (O_2)

(D) Ubiquinone

Q23. Vexillary aestivation (also called descending imbricate) combined with a posterior largest petal called the 'Standard' or 'Vexillum' is found in:

(A) *Triticum aestivum* (Wheat)

(B) *Pisum sativum* (Pea)

(C) *Nicotiana tabacum* (Tobacco)

(D) *Capsicum annuum* (Chilli)

Q24. The physiological phenomenon where water is lost in the form of liquid droplets through specialized structures called hydathodes along the leaf margins of certain grasses is known as:

(A) Transpiration

(B) Guttation

(C) Imbibition

(D) Evaporation

Q25. Which type of chromosomal structural mutation involves the reversal of a segment direction by 180° within the same chromosome without changing the overall number of genes?

(A) Translocation

(B) Deletion

(C) Inversion

(D) Duplication

Detailed Solutions

Q1.

Solution

Concept:

Plant roots frequently evolve structural specializations beyond nutrient uptake to offer essential anchorage and stability. In sprawling monocotyledonous species growing along unsteady coastlines or muddy riverbanks, heavy leaning weights jeopardize vegetative survival. Under such critical environmental strain, specialized mechanical root networks develop directly from lower aerial nodes to secure the vertical integrity of the plant.

Solution:

(a) *Pandanus* (commonly known as Screw pine) develops prominent adventitious roots emerging obliquely from the basal nodes of its leaning, branched woody stem.

(b) These specialized roots grow downward into the substratum to act as structural props, bearing the architectural designation of stilt roots.

(c) Prop roots are distinct structural counterparts that descend vertically from horizontal aerial branches, seen typically in massive dicots like *Ficus benghalensis*.

(d) Pneumatophores serve respiratory needs in waterlogged mangrove habitats by performing gas exchange via lenticels, rather than fulfilling mechanical demands.

(e) Fusiform roots describe fleshy, tapered primary storage systems designed for food accumulation, characteristic of biennial crops like *Raphanus sativus*.

Final Answer: Stilt roots.

Answer: (B)

Go Back to Question 1

Q2.

Solution

Concept:

Angiosperm classification requires deep identification of inflorescence structures, which map out how individual florets cluster on the central peduncle axis. Families like Poaceae exhibit advanced modifications designed to optimize wind-driven pollination. These reproductive arrays feature highly reduced floral structures enclosed within tough protective bracts, creating a compact unit adapted for agricultural resilience.

Solution:

(a) The universal diagnostic feature of Poaceae (the grass family) is a condensed, specialized inflorescence structure designated as a spikelet.

(b) Each individual spikelet possesses a central axis called a rachilla, bearing sterile glumes at the base and fertile bracts above.

(c) A capitulum or head features a flattened, compressed receptacle packed with sessile ray and disc florets, unique to Asteraceae.

(d) A corymb displays individual flowers with pedicels of varying lengths that align flatly at the top, typically seen in Brassicaceae.

(e) An umbel features flowers arising from a common point on the peduncle tip, forming an umbrella-like silhouette characteristic of Amaryllidaceae.

Final Answer: Spikelet or panicle of spikelets.

Answer: (C)

Go Back to Question 2

Q3.

Solution

Concept:

The primary light-dependent reactions of oxygenic photosynthesis rely on highly coordinated thylakoid protein networks. Splitting water molecules generates electrons needed to replenish active reaction centers, alongside vital hydrogen ions and molecular oxygen. This enzymatic breakdown is highly localized to maintain a steep trans-membrane proton gradient that drives subsequent cellular energy conservation.

Solution:

(a) Photolysis of water occurs via an oxygen-evolving complex directly linked with the core structure of Photosystem II (PS II).

(b) This enzymatic oxidation is fixed on the inner lumen-facing side of the thylakoid membrane to release protons inside.

(c) Accumulating these protons directly inside the interior thylakoid lumen builds the necessary electrochemical force for ATP synthesis.

(d) Photosystem I operates near the stroma-exposed thylakoid surface, focusing on reducing NADP+ into NADPH rather than water splitting.

(e) The Cytochrome b_6f complex functions as an intermediary electron carrier shuffling vectors between the two main photosystems.

Final Answer: Photosystem II (PS II) on the lumen-facing side.

Answer: (C)

Go Back to Question 3

Q4.

Solution

Concept:

Meiotic division introduces essential genetic diversity into agricultural crop species through strategic homologous recombination. Prophase I contains highly precise chromosomal changes divided into five consecutive, morphology-based sub-stages. Identifying the exact molecular events within these sub-stages clarifies how parental alleles rearrange to produce novel phenotypic variations.

Solution:

(a) Crossing over between non-sister chromatids occurs strictly during pachytene, the third distinct sub-stage of meiotic Prophase I.

(b) Large protein complexes termed recombination nodules become plainly visible along the synaptonemal complex to direct genetic exchange.

(c) Leptotene marks the initial entry where long chromatin threads undergo visible condensation within the nucleus.

(d) Zygotene initiates reciprocal pairing between homologous chromosomes to build a structural scaffold called the synaptonemal complex.

(e) Diplotene features dissolution of this complex, leaving X-shaped points of contact known as chiasmata exposed at crossover sites.

Final Answer: Pachytene.

Answer: (C)

Go Back to Question 4

Q5.

Solution

Concept:

Plant cells partition metabolic pigments into diverse intracellular compartments based on specific chemical polarities. Floral structures rely heavily on these colorful molecules to attract pollinators or provide adaptive protection against solar radiation. The structural location and chemical class of these compounds determine the visual colors seen across agricultural varieties.

Solution:

(a) The bright yellow, orange, or red hues in petals and fruits result from fat-soluble carotenoid pigments.

(b) These hydrophobic compounds are biosynthesized and safely stored inside specialized double-membrane organelles called chromoplasts.

(c) Anthocyanins represent highly water-soluble pigments that dissolve in vacuolar sap, producing red, purple, or deep blue shades.

(d) Chlorophyll *b* functions as an accessory light-harvesting pigment that imparts green coloration within functional chloroplasts.

(e) Phycobilins serve as specialized accessory pigments confined to cyanobacteria and red algae, absent in higher angiosperm families.

Final Answer: Carotenoids within the chromoplasts.

Answer: (B)

Go Back to Question 5

Q6.

Solution

Concept:

The structural configuration of the androecium represents a core diagnostic element in identifying key agricultural families. Cohesion patterns explain how stamens fuse together or split into clusters across a flower. The legume family demonstrates a unique fusion pattern that provides a precise morphological marker for taxonomic classification.

Solution:

(a) The family Fabaceae displays a characteristic diadelphous stamen arrangement consisting of ten total functioning male units.

(b) Nine stamens fuse by their filaments into a shared tube, while one solitary stamen remains completely free, denoted as (9) + 1.

(c) Monadelphous structures feature filaments united into a single continuous central tube around the style, a classic trait of Malvaceae.

(d) Syngenesious configurations occur when anthers fuse laterally into a cylinder while their filaments remain distinct, unique to Asteraceae.

(e) Epipetalous, tetradynamous stamens are arranged with four long and two short units attached to petals, found in Brassicaceae.

Final Answer: Diadelphous condition typically arranged as (9) + 1.

Answer: (B)

Go Back to Question 6

Q7.

Solution

Concept:

C_4 crops use a specialized spatial division mechanism to suppress energetic losses from photorespiration. This structural division splits enzymatic duties between two concentric photosynthetic cell layers. Managing how inorganic carbon moves between these adjacent tissues ensures high carbon assimilation efficiency under hot, arid agricultural conditions.

Solution:

(a) Primary carbon fixation in C_4 species occurs in the cytoplasm of outer chloronchymatous mesophyll cells.

(b) Phosphoenolpyruvate carboxylase (PEPC) fixes bicarbonate onto PEP to yield a four-carbon dicarboxylic acid, oxaloacetate.

(c) This four-carbon intermediate is converted to malate and transported directly into internal bundle sheath cells.

(d) Inside the bundle sheath layer, decarboxylation releases concentrated CO_2 to fuel the standard Calvin cycle via Rubisco.

(e) Epidermal guard cells regulate physical gas exchange and stomatal apertures rather than driving primary carbon fixation pathways.

Final Answer: Mesophyll cells.

Answer: (B)

Go Back to Question 7

Q8.

Solution

Concept:

Monocot leaves exhibit specialized cellular adaptations to handle severe environmental water deficits. Under drought stress, specific epidermal cell groups lose water faster than adjacent tissue. This sudden drop in turgor pressure causes physical changes in the blade shape, minimizing solar exposure and preserving precious moisture resources.

Solution:

(a) Bulliform or motor cells are large, bubble-shaped epidermal cells positioned on the upper (adaxial) surface of monocot leaves.

(b) These specialized structures are a defining anatomical characteristic of grass species belonging to the family Poaceae.

(c) When turgor drops during dry periods, these cells collapse, causing the leaf blade to roll inward to minimize transpiration.

(d) Dicot crops within Solanaceae lack these motor cells, relying instead on stomatal closure and wilting to mitigate water stress.

(e) Hydrophytic and halophytic leaves are adapted for wet or saline conditions and do not develop bulliform rolling mechanisms.

Final Answer: Monocotyledonous crops belonging to Poaceae.

Answer: (C)

Go Back to Question 8

Q9.

Solution

Concept:

Classical Mendelian genetics explores how discrete genetic alleles segregate and combine across successive generations. Analyzing multi-trait crosses reveals whether specific physical traits are tied together or inherited independently. The resulting mathematical distributions in the offspring reveal how alleles sort into gametes.

Solution:

(a) A dihybrid cross involving two independent traits yields a classic 9:3:3:1 phenotypic ratio in the F_2 offspring generation.

(b) This mathematical outcome demonstrates that the inheritance of one trait is completely independent of another, validating the Law of Independent Assortment.

(c) The Law of Dominance explains why heterozygous F_1 hybrids display only the dominant phenotype, masking the recessive allele.

(d) The Law of Segregation states that allele pairs separate during gamete formation so that each gamete carries only one allele.

(e) Incomplete Dominance occurs when alleles blend to create an intermediate phenotype, disrupting classic Mendelian ratios.

Final Answer: Law of Independent Assortment.

Answer: (C)

Go Back to Question 9

Q10.

Solution

Concept:

Taxonomic classification groups economic crops based on shared reproductive structures, floral formulas, and vegetative characteristics. Pulse crops play a vital role in sustainable agriculture due to their symbiotic nitrogen-fixing relationships with soil bacteria. Identifying their sub-family alignment clarifies the unique floral patterns that define these essential legumes.

Solution:

(a) Chickpea (*Cicer arietinum*) belongs to the large legume family Fabaceae, historically designated as Papilionoideae.

(b) This family is characterized by zygomorphic papilionaceous flowers, a diadelphous androecium, and non-endospermic protein-rich seeds.

(c) Caesalpinioideae represents a different sub-family distinguished by regular or slightly irregular flowers with ascending imbricate aestivation.

(d) Mimosoideae features small actinomorphic florets arranged in dense heads, defined by prominent, elongated stamens.

(e) Solanaceae comprises nightshade crops like potato and tomato, which feature actinomorphic symmetry and epipetalous stamens.

Final Answer: Fabaceae (Papilionoideae).

Answer: (B)

Go Back to Question 10

Q11.

Solution

Concept:

Stomatal movements are controlled by changes in the turgor pressure of guard cells, which are regulated by the active transport of ions. Plant hormones and environmental stress trigger specific biochemical signaling pathways that alter membrane permeability. Understanding the direction of ion movement during stress helps explain how agricultural crops conserve water.

Solution:

(a) When an agricultural crop experiences water deficit stress, the plant synthesizes high levels of the hormone abscisic acid (ABA).

(b) Abscisic acid binds to receptors on the guard cell plasma membrane, initiating a signaling cascade that opens anion channels.

(c) The resulting depolarization of the membrane triggers a rapid efflux of potassium ions (K^+) and chloride ions out of the guard cells into surrounding subsidiary cells.

(d) As the intracellular ion concentration drops, the osmotic potential of the guard cells rises, causing water to move out via osmosis.

(e) This loss of water decreases the turgor pressure within the guard cells, causing them to flaccidly collapse and close the stomatal pore.

Final Answer: Stomatal closure in response to water stress and ABA signaling.

Answer: (B)

Go Back to Question 11

Q12.

Solution

Concept:

The internal anatomy of angiosperm roots features concentric tissue layers that control the radial movement of water and dissolved minerals from the soil. As fluid moves through the outer root cortex, it encounters a specialized cellular barrier before entering the vascular cylinder. This boundary forces the solution to pass through living protoplasts to filter out harmful substances.

Solution:

(a) The endodermis represents the innermost layer of the root cortex, forming a tight ring of barrel-shaped cells around the stele.

(b) The radial and transverse walls of these endodermal cells contain a specialized band of suberin deposition known as the Casparian strip.

(c) Suberin is a highly hydrophobic, waxy substance that is completely impermeable to water and dissolved nutrient ions.

(d) This strip blocks the apoplastic pathway, forcing water to enter the symplastic pathway by passing through the selectively permeable plasma membrane.

(e) The exodermis and hypodermis serve as peripheral protective outer layers, while the pericycle sits inside the endodermis to give rise to lateral roots.

Final Answer: Endodermis.

Answer: (C)

Go Back to Question 12

Q13.

Solution

Concept:

Vegetative propagation structures in agricultural crops are modified stems, roots, or leaves designed for nutrient storage and survival during dormancy. Recognizing the anatomical features of these organs helps distinguish modified stems from modified roots. True stem structures always possess regular nodes, internodes, and bud variations.

Solution:

(a) *Solanum tuberosum* (Potato) produces specialized underground stem modifications known anatomically as tubers for starch storage.

(b) The surface of a potato tuber features small depressions called eyes, which are structurally nodes containing axillary buds.

(c) These axillary buds retain complete meristematic potential and can sprout into new vegetative shoots when environmental conditions improve.

(d) *Ipomoea batatas* (Sweet potato) looks similar but is an adventitious storage root modification that completely lacks nodes and eyes.

(e) *Colocasia esculenta* develops a thick vertical underground stem called a corm, while *Allium cepa* forms a reduced stem disc called a bulb.

Final Answer: *Solanum tuberosum* (Potato).

Answer: (B)

Go Back to Question 13

Q14.

Solution

Concept:

Glycolysis is the fundamental metabolic pathway in plant respiration that breaks down glucose in the cytoplasm to generate chemical energy. The pathway is regulated by specific irreversible enzymatic reactions that serve as checkpoints. Identifying these rate-limiting enzymes explains how plant cells manage carbohydrate breakdown based on current energy demands.

Solution:

(a) The conversion of Fructose-6-Phosphate into Fructose-1,6-Bisphosphate is catalyzed by the regulatory enzyme Phosphofructokinase.

(b) This phosphorylation reaction is highly exergonic and requires the consumption of one molecule of ATP to transfer a phosphate group.

(c) Phosphofructokinase functions as a key allosteric controller of glycolysis, sensitive to internal ratios of ATP and ADP.

(d) Hexokinase operates at the very beginning of the pathway to phosphorylate free glucose into Glucose-6-Phosphate.

(e) Pyruvate kinase acts at the final step of glycolysis to generate pyruvate, while aldolase splits six-carbon sugars into three-carbon fragments.

Final Answer: Phosphofructokinase (PFK).

Answer: (B)

Go Back to Question 14

Q15.

Solution

Concept:

The family Solanaceae includes many economically valuable crops like tomatoes, eggplants, peppers, and potatoes. Taxonomic identification relies on observing which floral organs persist through pollination and fruit development. In many angiosperms, the calyx falls off early, but certain families keep these structures intact to protect the growing fruit.

Solution:

(a) A defining botanical characteristic of the family Solanaceae is the presence of a persistent calyx.

(b) Instead of withering and dropping off after fertilization, the sepals remain attached to the base of the developing fruit.

(c) In crops like brinjal and chilli, this green calyx grows slightly and remains intact through harvesting, providing structural support.

(d) Members of Poaceae possess highly reduced sepals modified into tiny scales called lodicules that do not form a typical calyx.

(e) Fabaceae and Brassicaceae crops generally have deciduous calyces that fall away long before the fruit reaches structural maturity.

Final Answer: Solanaceae.

Answer: (C)

Go Back to Question 15

Q16.

Solution

Concept:

Transpiration rates depend on the distribution and density of stomatal pores across the leaf surfaces. Plant species adjust their stomatal patterns based on growth habits and light exposure to manage water loss. Measuring changes in water movement after blocking one side of a leaf reveals the primary pathway for gas exchange.

Solution:

(a) Applying an impermeable layer of vaseline to a leaf surface blocks the stomatal pores, preventing water vapor from escaping.

(b) The student observed a sharp drop in water movement when vaseline was applied exclusively to the lower (abaxial) surface.

(c) This strong response indicates that most of the functional stomata are located on the lower side of the leaf blade.

(d) Leaves with stomata located primarily or entirely on the lower surface are botanically classified as hypostomatic.

(e) Epistomatic leaves have stomata on the upper surface, while amphistomatic leaves show an even distribution across both sides.

Final Answer: Hypostomatic.

Answer: (B)

Go Back to Question 16

Q17.

Solution

Concept:

The anatomical arrangement of vascular tissues in angiosperm stems differs fundamentally between dicotyledonous and monocotyledonous crops. These differences determine the plant's capacity for secondary growth and thickness expansion. Examining the structure and position of xylem and phloem bundles provides a reliable method for identifying plant groups.

Solution:

(a) Typical dicotyledonous stems arrange their vascular bundles in a neat, orderly ring within the ground tissue.

(b) These dicot bundles are open, meaning they contain a layer of intra-fascicular cambium between the xylem and phloem.

(c) Monocot stems display numerous vascular bundles scattered throughout the ground tissue, showing higher density near the periphery.

(d) Monocot vascular bundles are closed, lacking any cambium tissue, which prevents them from undergoing true secondary growth.

(e) Monocot stems also lack a distinct central pith, as the scattered bundle arrangement blends the cortex and medulla together.

Final Answer: Dicot stems have open vascular bundles arranged in a ring; monocot stems have closed vascular bundles scattered in the ground tissue.

Answer: (B)

Go Back to Question 17

Q18.

Solution

Concept:

Floral formulas summarize the structural organization, symmetry, and component fusion of flower parts using specific symbols. The gynoecium notation details carpel number, fusion state, and position relative to the receptacle. Deciphering these symbols helps identify the reproductive anatomy characteristic of different agricultural plant families.

Solution:

(a) In a floral formula, the letter G represents the gynoecium, which comprises the female reproductive structures of the flower.

(b) A horizontal line placed directly underneath the letter ($\underline{G}$) specifies that the ovary is superior.

(c) The number 2 inside parentheses indicates the presence of two distinct carpels that are fused together, termed syncarpous.

(d) Solanaceae flowers characteristically feature a superior, bicarpellary, syncarpous ovary with an obliquely placed septum.

(e) An inferior ovary is indicated by a line placed above the letter, while un-enclosed numbers signify separate carpels.

Final Answer: Superior and syncarpous bicarpellary.

Answer: (B)

Go Back to Question 18

Q19.

Solution

Concept:

Mitotic cell division preserves the chromosome number of somatic cells while distributing replicated genetic material equally to daughter cells. Tracking changes in chromosome structure requires distinguishing between single chromatids and paired sister chromatids. The total count shifts temporarily during specific stages when spindle fibers separate these structures.

Solution:

(a) During the S phase of interphase, DNA replicates so that each chromosome consists of two identical sister chromatids joined at a centromere.

(b) At the start of mitosis, a crop cell with $2n = 24$ contains 24 chromosomes and 48 individual chromatids.

(c) During anaphase, the centromeres split, and spindle fibers pull the sister chromatids toward opposite poles of the cell.

(d) Once separated, each individual chromatid is considered an independent, single-chromatid chromosome.

(e) This separation temporarily doubles the chromosome count within the single cell boundary to 48 chromosomes and 48 chromatids.

Final Answer: 48 chromosomes and 48 chromatids.

Answer: (B)

Go Back to Question 19

Q20.

Solution

Concept:

Inflorescence architecture describes how flowers are grouped on a shared reproductive axis, or peduncle. Modifications to this axis create distinct structural patterns that optimize pollination efficiency. Identifying where flower stalks attach and how bracts are arranged helps classify these diverse floral displays.

Solution:

(a) An umbel is an inflorescence where the main peduncle remains short, terminates at a central point, and produces multiple flowers.

(b) All individual flower stalks, or pedicels, branch out from this single apex, creating an umbrella-like shape.

(c) A cluster of protective bracts called an involucre typically forms a whorl at the base of this common branching point.

(d) A spike features sessile flowers attached along an elongated, unbranched central axis, a pattern common in many grasses.

(e) A raceme has an elongated axis with pedicellate flowers, while a catkin is a drooping spike of unisexual flowers.

Final Answer: Umbel.

Answer: (A)

Go Back to Question 20

Q21.

Solution

Concept:

The structural organization of flowers in the grass family features highly specialized modifications to facilitate wind pollination. Standard perianth structures like sepals and petals are largely absent or reduced to microscopic scales. Instead, unique vegetative bracts develop around the essential reproductive organs, creating an enclosed micro-environment that protects the running stamens and feathery stigmas until anthesis.

Solution:

(a) In the family Poaceae, individual florets are protected by two specific scale-like green bracts known as the lemma and the palea.

(b) The lemma represents the lower, outer, and larger bract which frequently develops a long bristle-like extension termed an awn.

(c) The palea acts as the upper, inner, and slightly smaller bract that fits tightly against the lemma to enclose the reproductive organs.

(d) Together, these two structures form a protective chamber around the three dangling stamens, the superior ovary, and two feathery stigmas.

(e) This characteristic arrangement is absent in Solanaceae, Malvaceae, and Cucurbitaceae, which feature standard showy calyx and corolla whorls for insect attraction.

Final Answer: Poaceae.

Answer: (C)

Go Back to Question 21

Q22.

Solution

Concept:

Aerobic respiration relies on a series of membrane-bound protein complexes located within the inner mitochondrial membrane to harvest cellular energy. Electrons extracted from oxidized metabolic substrates pass through a sequence of carriers with progressively higher redox potentials. This sequential transport releases free energy used to pump protons, requiring a strong terminal chemical sink to clear the pathway.

Solution:

(a) The electron transport chain passes low-energy electrons down a multi-complex gradient until they reach the terminal protein complex, Cytochrome c oxidase.

(b) At this final destination, molecular oxygen (O_2) acts as the ultimate electron acceptor due to its exceptionally high electronegativity value.

(c) Each molecule of oxygen consumes four metabolic electrons along with four free protons from the matrix to form water.

(d) Without the constant presence of oxygen, electron transit halts entirely, which stops proton pumping and prevents oxidative ATP synthesis.

(e) Soluble coenzymes like NAD^+ serve as upstream electron collectors in the matrix, rather than acting as terminal electron sinks.

Final Answer: Molecular oxygen (O_2).

Answer: (C)

Go Back to Question 22

Q23.

Solution

Concept:

The arrangement of petals within a flower bud provides an important taxonomic marker for identifying specific angiosperm families. Leguminous crops display unique structural adaptations in their corolla configuration to facilitate specialized insect pollination mechanics. This specific overlapping arrangement uses specialized petal sizes that distinguish this family from other common agricultural crops.

Solution:

(a) Vexillary or descending imbricate aestivation is a unique diagnostic feature found in the papilionaceous corolla of the family Fabaceae.

(b) *Pisum sativum* (Pea) possesses five distinct petals arranged in a highly specialized, asymmetric overlapping pattern.

(c) The largest outermost posterior petal is called the standard or vexillum, which completely encloses the internal lateral petals in bud.

(d) Two intermediate lateral petals called wings or alae overlap the two smallest anterior petals, which fuse to form the keel.

(e) *Triticum aestivum* lacks typical petals, while *Nicotiana tabacum* and *Capsicum annuum* exhibit valvate corolla symmetry inside the family Solanaceae.

Final Answer: *Pisum sativum* (Pea).

Answer: (B)

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Q24.

Solution

Concept:

Plants release excess moisture through different physiological mechanisms depending on root pressure and atmospheric humidity levels. When soil moisture is abundant but transpiration is restricted by high atmospheric humidity, root pressure builds within the vascular system. This force drives liquid water through specialized terminal vein terminations rather than letting it evaporate.

Solution:

(a) Guttation is the physiological process where water escapes as liquid droplets from specialized un-regulated pores called hydathodes.

(b) These hydathodes are structurally located directly at the vein endings along the leaf margins of certain grass species.

(c) This process occurs primarily during the early morning when high soil moisture drives water up the roots faster than it can evaporate.

(d) Transpiration describes the active loss of water vapor through regulated stomatal pores, which requires solar heat energy.

(e) Imbibition is a passive physical absorption of fluid by dry hydrophilic colloids, which drives seed germination rather than water exudation.

Final Answer: Guttation.

Answer: (B)

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Q25.

Solution

Concept:

Chromosomal aberrations alter the structural arrangement of genes along a chromosome without necessarily modifying the total quantity of genetic material. These structural mutations occur when physical breaks happen within the DNA phosphodiester backbone during faulty meiotic recombination. The way the broken segment reattaches determines the genetic impacts on the plant.

Solution:

(a) An inversion occurs when a single chromosome undergoes two internal breaks, flips exactly 180°, and reinserts into its original position.

(b) This structural mutation alters the linear sequence of alleles along the chromosome while keeping the total gene count constant.

(c) Translocation involves the exchange of broken segments between completely non-homologous chromosomes, which changes linkage groups.

(d) Deletion removes an entire segment of DNA, while duplication multiplies existing gene copies, altering the total genetic material present.

(e) Inversions are classified as paracentric or pericentric depending on whether the centromere is included within the inverted region.

Final Answer: Inversion.

Answer: (C)

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Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	C	3	C	4	C	5	B
6	B	7	B	8	C	9	C	10	B
11	B	12	C	13	B	14	B	15	C
16	B	17	B	18	B	19	B	20	A
21	C	22	C	23	B	24	B	25	C