UPCATET Agriculture Botany Sample Paper-2

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. The modification of root observed in *Pandanus* (Screw pine) for providing additional mechanical support to the leaning stem is known as:

(A) Prop roots

(B) Stilt roots

(C) Pneumatophores

(D) Velamen roots

Q2. The characteristic fruit type of the family Poaceae (Gramineae), which includes major cereal crops like wheat and rice, is known as a:

(A) Caryopsis

(B) Pod or Legume

(C) Berry

(D) Siliqua

Q3. The primary carbon dioxide (CO_2) acceptor molecule in the mesophyll cells of C_4 plants like maize and sugarcane is:

(A) Ribulose-1,5-bisphosphate (RuBP)

(B) Phosphoenolpyruvate (PEP)

(C) Oxaloacetic acid (OAA)

(D) 3-phosphoglyceric acid (PGA)

Q4. The physical exchange of genetic material between non-sister chromatids of homologous chromosomes occurs during which specific stage of Prophase-I?

(A) Leptotene

(B) Zygotene

(C) Pachytene

(D) Diplotene

Q5. In an onion bulb, the edible part that stores reserved food material represents which of the following modified structures?

(A) Fleshy scale leaves

(B) Condensed underground stem

(C) Adventitious roots

(D) Terminal bud

Q6. Which of the following field crops belongs taxonomically to the family Solanaceae?

(A) Potato (*Solanum tuberosum*)

(B) Chickpea (*Cicer arietinum*)

(C) Mustard (*Brassica juncea*)

(D) Soybean (*Glycine max*)

Q7. The loss of pure water vapor through the stomata of plants is actively regulated by changes in the turgidity of:

(A) Subsidiary cells

(B) Guard cells

(C) Epidermal cells

(D) Mesophyll cells

Q8. When a heterozygous F_1 hybrid plant (Rr) is backcrossed directly to its homozygous recessive parent (rr), the expected phenotypic ratio is:

(A) 3 : 1

(B) 1 : 1

(C) 9 : 3 : 3 : 1

(D) 1 : 2 : 1

Q9. Which type of inflorescence is characteristically found in the family Umbelliferae (Apiaceae), where all pedicels arise from a single central point?

(A) Corymb

(B) Umbel

(C) Cyathium

(D) Verticillaster

Q10. Diadelphous stamens, where filaments are fused into two bundles (typically 9 + 1), constitute a key floral diagnostic feature of which family?

(A) Fabaceae (Papilionaceae)

(B) Malvaceae

(C) Solanaceae

(D) Brassicaceae

Q11. During aerobic respiration, the complete conversion of one molecule of Pyruvic acid into CO_2 and H_2O inside the mitochondrial matrix occurs via:

(A) Glycolysis

(B) Tricarboxylic Acid (Krebs) Cycle

(C) Pentose Phosphate Pathway

(D) Lactic acid fermentation

Q12. Which of the following double-membrane-bound cell organelles contains its own circular DNA molecule and 70S ribosomes?

(A) Chloroplast

(B) Golgi apparatus

(C) Lysosome

(D) Endoplasmic Reticulum

Q13. The specialized water-secreting structures located at the margins of leaves of certain herbaceous plants that facilitate guttation are called:

(A) Stomata

(B) Hydathodes

(C) Lenticels

(D) Pneumatothodes

Q14. The dynamic floral component in the family Poaceae that represents the highly reduced perianth and aids in opening the glumes is the:

(A) Palea

(B) Lemma

(C) Lodicules

(D) Rachilla

Q15. Which essential plant macronutrient acts as the central structural atom of the chlorophyll porphyrin ring mechanism?

(A) Iron (Fe)

(B) Magnesium (Mg)

(C) Manganese (Mn)

(D) Phosphorus (P)

Q16. Mendel's principle of independent assortment can be structurally explained by the orientation and separation of chromosomal pairs during:

(A) Metaphase I / Anaphase I of meiosis

(B) Prophase of mitosis

(C) Metaphase of mitosis

(D) Telophase II of meiosis

Q17. Casparian strips, which are impregnated with suberin and govern radial water movement, are characteristically located in which anatomical zone of the plant root?

(A) Epidermis

(B) Pericycle

(C) Endodermis

(D) Exodermis

Q18. The persistent, enlarged calyx that encloses the mature fruit in *Physalis peruviana* (Cape gooseberry) belongs to which botanical family?

(A) Solanaceae

(B) Fabaceae

(C) Asteraceae

(D) Cucurbitaceae

Q19. The physiological phenomenon where light-dependent oxygen (O_2) uptake leads to a release of CO_2 without producing ATP or NADPH in C_3 plants is:

(A) Dark respiration

(B) Photorespiration

(C) Photophosphorylation

(D) Fermentation

Q20. A leaf modification where the petiole becomes green, flattened, and leaf-like to perform photosynthesis while the lamina is highly reduced is termed a:

(A) Phyllode

(B) Phylloclade

(C) Cladode

(D) Runner

Q21. Cruciform corolla, tetradynamous stamens (2 short outer and 4 long inner), and a siliqua fruit are diagnostic traits of which family?

(A) Brassicaceae (Cruciferae)

(B) Malvaceae

(C) Poaceae

(D) Fabaceae

Q22. According to the Munch mass flow hypothesis, the translocational movement of organic solutes through the phloem sieve elements occurs along a:

(A) Water potential gradient

(B) Turgor pressure gradient

(C) Electrical potential gradient

(D) Proton concentration gradient

Q23. In a dorsiventral dicotyledonous leaf, the vascular bundles are typically described as:

(A) Conjoint, collateral, and open

(B) Conjoint, collateral, and closed

(C) Radial and exarch

(D) Conjoint, bicollateral, and open

Q24. Which of the following fiber-yielding agricultural crops belongs to the family Malvaceae and features a monadelphous staminal tube?

(A) Cotton (*Gossypium* spp.)

(B) Jute (*Corchorus* spp.)

(C) Sunn hemp (*Crotalaria juncea*)

(D) Flax (*Linum usitatissimum*)

Q25. The meristematic tissue responsible for the increase in thickness or girth of the dicotyledonous stem over time is classified as:

(A) Apical meristem

(B) Intercalary meristem

(C) Lateral meristem

(D) Primary meristem

Detailed Solutions

Q1.

Solution

Concept:

Root modifications are structural variations developed by plants to adapt to their surrounding environment and perform specialized functions. While the primary function of a root system is anchorage and nutrient absorption, certain plants modify their roots to offer supplemental mechanical stability, store nutrients, or facilitate specialized gas exchange processes depending on their habitat.

Solution:

(a) Stilt roots are adventitious roots that arise from the lower nodes of the main stem. They grow obliquely downward into the substrate to provide crucial mechanical support against wind or unstable soil conditions.

(b) This structural adaptation is highly characteristic of plants like *Pandanus* (Screw pine), sugarcane, and maize, where the unbranched, leaning stem requires extra anchorage.

(c) Prop roots differ significantly by developing from large, horizontal aerial branches and growing vertically downward into the soil, acting as massive pillars, which is classically seen in the banyan tree (*Ficus benghalensis*).

(d) Pneumatophores are specialized respiratory structures seen in mangrove species like *Rhizophora* that grow negatively geotropically to absorb atmospheric oxygen from oxygen-depleted marshy soils.

(e) Velamen roots possess a specialized spongy, multilayered epidermal tissue called velamen, which allows epiphytic orchids to efficiently absorb ambient moisture directly from the atmosphere.

Final Answer: The modification is Stilt roots.

Answer: (B)

Go Back to Question 1

Q2.

Solution

Concept:

Fruit classification in botany is deeply tied to floral taxonomy and represents a vital diagnostic marker for agricultural crop families. In monocotyledonous grain crops, the structure of the mature ovary and its integration with the surrounding seed coat determines the exact agricultural classification of the harvested economic product.

Solution:

(a) A caryopsis is a distinctive type of simple, dry, indehiscent fruit where the pericarp (the mature fruit wall) is completely fused with the thin testa (seed coat) to form a single unified layer.

(b) This specific fruit type is the defining diagnostic characteristic of the family Poaceae (Gramineae), which encompasses the world's most critical cereal crops including wheat, rice, maize, barley, and oats.

(c) A legume or pod is a simple dry dehiscent fruit that splits open along both the dorsal and ventral sutures, which serves as the classic diagnostic marker for the family Fabaceae.

(d) A berry is a simple, fleshy fruit containing one or more seeds embedded within a succulent endocarp, commonly found in many solanaceous crops like tomatoes, brinjals, and chili peppers.

(e) A siliqua is a dry, elongated, dehiscent fruit developing from a bicarpellary ovary that splits along two valves from the base upward, characteristic of the family Brassicaceae.

Final Answer: The fruit type is Caryopsis.

Answer: (A)

Go Back to Question 2

Q3.

Solution

Concept:

Plants have evolved distinct carbon fixation pathways to optimize photosynthetic efficiency under varying environmental selection pressures. The initial biochemical capture of atmospheric carbon dioxide involves different primary carboxylating enzymes and specialized cellular compartments depending on whether the plant utilizes a classic C_3 or a highly evolved C_4 dicarboxylic acid cycle.

Solution:

(a) In C_4 plants, such as maize, sugarcane, sorghum, and pearl millet, the photosynthetic process is spatially segregated between two distinct cell layers: mesophyll cells and bundle sheath cells.

(b) The primary fixation of carbon dioxide occurs inside the cytoplasm of the mesophyll cells, where carbon dioxide combines with a three-carbon compound called phosphoenolpyruvate (PEP).

(c) This highly efficient carboxylation reaction is catalyzed by the enzyme phosphoenolpyruvate carboxylase (PEPcase), which exhibits a remarkably high affinity for carbon dioxide and no affinity for oxygen.

(d) This initial fixation produces oxaloacetic acid (OAA), a four-carbon dicarboxylic acid, which is then converted into malate and transported into the bundle sheath cells for decarboxylation.

(e) Conversely, ribulose-1,5-bisphosphate (RuBP) acts as the primary carbon dioxide acceptor molecule exclusively within C_3 plants, generating 3-phosphoglyceric acid (PGA) as the first stable product via the enzyme RuBisCO.

Final Answer: The molecule is Phosphoenolpyruvate (PEP).

Answer: (B)

Go Back to Question 3

Q4.

Solution

Concept:

Meiotic cell division is a fundamental biological mechanism that reduces the chromosome number by half while introducing genetic diversity into gametes. Prophase I of meiosis is highly complex and divided into five sequential substages where chromosomes must precisely pair, exchange genetic material, and prepare for architectural segregation.

Solution:

(a) Crossing over represents the precise physical reciprocal exchange of genetic segments between non-sister chromatids of homologous chromosomal pairs, resulting in the formation of novel recombinant genetic configurations.

(b) This highly coordinated genetic recombination event occurs exclusively during the pachytene substage of Prophase I and is mediated by a multi-protein macro-complex known as the recombination nodule.

(c) During the preceding leptotene stage, chromatin fibers condense into visible thread-like structures, while the subsequent zygotene stage marks the onset of synapsis, where homologous chromosomes pair up via the synaptonemal complex.

(d) Following the pachytene recombination event, the diplotene stage begins, characterized by the dissolution of the synaptonemal complex and the initial visualization of X-shaped cross-connections termed chiasmata.

(e) This sequential progression ensures proper alignment, genetic reshuffling, and eventual stable structural orientation of chromosomes prior to their segregation during the subsequent meiotic divisions.

Final Answer: The stage is Pachytene.

Answer: (C)

Go Back to Question 4

Q5.

Solution

Concept:

Underground structural modifications of plants allow survival through adverse environmental periods and serve as vegetative propagation organs. Stems and leaves frequently undergo dramatic evolutionary changes to accumulate nutritional reserves, shifting their morphology so significantly that anatomical origin must be evaluated to classify the tissue.

Solution:

(a) The onion plant (*Allium cepa*) forms a specialized underground modification known as a tunicated bulb, which features a highly reduced, flattened, disc-like stem at its basal core.

(b) The bulk of this bulb consists of numerous closely overlapping, fleshy scale leaves that develop directly from the upper surface of the condensed disc stem to store concentrated carbohydrates.

(c) When an onion is consumed, these succulent, thick scale leaves constitute the primary edible portion of the agricultural crop, providing nutrient reserves for subsequent seasonal growth.

(d) Adventitious roots emerge directly from the lower surface of the reduced disc-shaped stem to provide structural anchorage and absorb moisture from the surrounding soil matrix.

(e) A terminal bud is situated at the absolute center of the compressed stem disc, surrounded and protected by the concentric layers of fleshy scale leaves.

Final Answer: The structure is Fleshy scale leaves.

Answer: (A)

Go Back to Question 5

Q6.

Solution

Concept:

Botanical classification of major agricultural field crops is crucial for developing proper agronomic practices, crop rotation schedules, and crop protection protocols. Economic crops are grouped into specific botanical families based on shared floral morphology, seedling development patterns, and structural reproductive characteristics.

Solution:

(a) The cultivated potato plant (*Solanum tuberosum*) produces specialized underground stem modifications called tubers and belongs to the economically vital family Solanaceae, often termed the nightshade family.

(b) The chickpea (*Cicer arietinum*), a critical cool-season pulse crop valued for its protein content, belongs to the nitrogen-fixing leguminous family Fabaceae.

(c) Indian mustard (*Brassica juncea*), an important oilseed crop widely cultivated throughout northern India, is a member of the family Brassicaceae, which is characterized by a cruciform corolla.

(d) Soybean (*Glycine max*), a dual-purpose oilseed and protein grain crop cultivated globally, is taxonomically classified within the subfamily Papilionoideae of the family Fabaceae.

(e) Recognizing these family relationships helps agricultural scientists predict crop vulnerabilities to specific viral, bacterial, and fungal pathogens that target related host species.

Final Answer: The crop is Potato (Solanum tuberosum).

Answer: (A)

Go Back to Question 6

Q7.

Solution

Concept:

Transpiration is a critical physiological process that drives the ascent of sap and regulates leaf temperature through evaporative cooling. Because the uncontrolled loss of water vapor can cause severe cellular dehydration, plants regulate stomatal aperture via physical changes in specialized epidermal cells.

Solution:

(a) Stomatal pores are flanked by a pair of highly specialized, kidney-shaped or dumbbell-shaped epidermal cells known explicitly as guard cells, which control the aperture size.

(b) The inner cell walls of these guard cells facing the stomatal pore are significantly thickened and inelastic, whereas the outer walls are remarkably thin, flexible, and extensible.

(c) When water moves into the guard cells from adjacent cells, their turgor pressure increases, causing the outer thin walls to bulge outward and pull the inner thick walls apart, opening the pore.

(d) When the guard cells lose water and their turgor pressure drops, they become flaccid, causing the inner thick walls to collapse back against each other and close the pore.

(e) Subsidiary cells are adjacent epidermal cells that lack these specialized differential wall thickenings but assist the guard cells by acting as dynamic storage reservoirs for water and ions.

Final Answer: The cells are Guard cells.

Answer: (B)

Go Back to Question 7

Q8.

Solution

Concept:

Genetic crosses are fundamental diagnostic tools used by breeders to decipher the genotype of an individual displaying a dominant phenotype. By evaluating the phenotypic ratios of offspring resulting from specific parental combinations, researchers can deduce whether an organism is homozygous or heterozygous for a trait.

Solution:

(a) A testcross is a specific genetic cross where an F_1 hybrid individual displaying a dominant phenotype is mated back to a known homozygous recessive parental organism.

(b) In a monohybrid cross involving a single locus, a heterozygous plant (Rr) produces two distinct types of gametes in equal frequencies: 50% carrying allele R and 50% carrying allele r.

(c) The homozygous recessive parent (rr) can produce only one uniform class of gametes, all containing the recessive allele r.

(d) Fertilization yields two distinct genotypes in equal proportions: 50% heterozygous (Rr) showing the dominant phenotype and 50% homozygous recessive (rr) showing the recessive phenotype.

(e) This uniform distribution results in a predictable $1 : 1$ phenotypic and genotypic ratio, which confirms the heterozygous nature of the parent, whereas a $3 : 1$ ratio occurs during F_2 selfing.

Final Answer: The ratio is $1 : 1$.

Answer: (B)

Go Back to Question 8

Q9.

Solution

Concept:

An inflorescence is the natural architectural arrangement of flowers on a specialized floral axis termed the peduncle. In systematic agricultural botany, inflorescence architecture serves as a primary, stable diagnostic criterion for identifying major plant families and understanding pollinator interactions.

Solution:

(a) An umbel is a distinctive type of racemose inflorescence where the main axis remains abbreviated, causing all individual flower pedicels to emerge from a single, common central point.

(b) This gives the entire inflorescence an umbrella-like appearance and serves as the definitive floral diagnostic feature of the family Umbelliferae (also known as Apiaceae).

(c) A corymb features a short main axis where lower flowers possess longer pedicels than upper flowers, bringing all blossoms to roughly the same horizontal level, as seen in candytuft.

(d) A cyathium is a highly specialized pseudanthium inflorescence mimicking a single flower, containing a solitary central female flower surrounded by multiple male flowers, characteristic of *Euphorbia*.

(e) A verticillaster is a complex condensed inflorescence featuring clusters of sessile flowers arranged in false whorls at the nodes, characteristic of the mint family Lamiaceae.

Final Answer: The inflorescence is Umbel.

Answer: (B)

Go Back to Question 9

Q10.

Solution

Concept:

Floral morphology focuses heavily on the structural cohesion and organization of reproductive whorls to establish phylogenetic groupings. The androecium exhibits distinct variations in how staminal filaments and anthers fuse, providing critical morphological evidence used to categorize important agricultural plant families.

Solution:

(a) Diadelphous stamens occur when individual filaments fuse together into two distinct bundles or groups, while the anthers remain entirely free from one another.

(b) This condition is highly characteristic of the subfamily Papilionoideae within the family Fabaceae (Leguminosae), where typically nine filaments fuse into a basal trough while the tenth remains free (9 + 1).

(c) Monadelphous stamens occur when all filaments fuse into a single continuous central cylinder surrounding the style, a defining characteristic of the family Malvaceae.

(d) Solanaceous plants typically possess five distinct, free stamens that are epipetalous, meaning their filaments are fused directly to the inner surface of the corolla tube.

(e) Brassicaceous plants feature a tetradynamous androecium consisting of six free stamens arranged in two whorls, with two short outer stamens and four long inner stamens.

Final Answer: The family is Fabaceae (Papilionaceae).

Answer: (A)

Go Back to Question 10

Q11.

Solution

Concept:

Aerobic respiration is the multi-stage metabolic pathway by which plant cells breakdown organic substrates completely into inorganic products to extract stored biochemical energy. After glycolysis converts glucose into pyruvate within the cytosol, further breakdown requires routing the substrate into the matrix of the mitochondrion to fully oxidize the remaining carbon fragments.

Solution:

(a) The Tricarboxylic Acid Cycle, universally recognized as the Krebs cycle or citric acid cycle, serves as the central metabolic pathway for the total oxidation of acetyl groups derived from pyruvic acid.

(b) Before entry, pyruvic acid undergoes oxidative decarboxylation via the pyruvate dehydrogenase complex to generate acetyl-coenzyme A, producing the first molecule of carbon dioxide.

(c) Acetyl-coenzyme A enters the cycle by condensing with oxaloacetate to form citric acid, which undergoes a cyclic sequence of enzymatic transformations within the mitochondrial matrix.

(d) During these sequential steps, two additional carbon dioxide molecules are stripped away, completing the total carbon conversion of the initial pyruvic acid substrate.

(e) The process harvests high-energy electrons, transferring them to specialized coenzymes to yield nicotinamide adenine dinucleotide phosphate and flavin adenine dinucleotide for subsequent oxidative phosphorylation.

Final Answer: The cycle is Tricarboxylic Acid (Krebs) Cycle.

Answer: (B)

Go Back to Question 11

Q12.

Solution

Concept:

Eukaryotic plant cells are highly compartmentalized structures containing specialized organelle systems that possess unique evolutionary origins. Certain double-membrane-bound structures behave as semi-autonomous entities within the cytoplasm because they retain ancestral genetic architecture reminiscent of prokaryotic organisms.

Solution:

(a) The chloroplast is a double-membrane-bound photosynthetic organelle that exhibits semi-autonomous behavior due to the presence of its own dedicated internal genetic machinery.

(b) This organelle houses a specialized circular deoxyribonucleic acid molecule that encodes key structural proteins and metabolic enzymes necessary for internal photosynthetic operations.

(c) It contains distinct 70S ribosomes, which closely resemble prokaryotic translation machinery rather than the larger 80S ribosomes found scattered throughout the surrounding eukaryotic cytosol.

(d) The Golgi apparatus, lysosomes, and endoplasmic reticulum are single-membrane systems that lack an independent genome and depend entirely on nuclear-encoded genes for protein synthesis.

(e) The presence of circular genomes and prokaryotic-like ribosomes provides robust structural evidence supporting the endosymbiotic theory of organelle evolution in plants.

Final Answer: The organelle is Chloroplast.

Answer: (A)

Go Back to Question 12

Q13.

Solution

Concept:

Water movement through agricultural crops is governed by dynamic environmental conditions and internal hydrostatic pressures. While transpiration accounts for the vast majority of water loss under dry, luminous conditions, specific anatomical adaptations manage liquid water discharge when environmental evaporation gradients are severely compromised.

Solution:

(a) Hydathodes are specialized, permanently open microscopic structures situated along the margins or tips of leaves that facilitate the exudation of liquid water during high humidity.

(b) This physiological process, termed guttation, occurs when elevated soil moisture and minimal transpiration combine to create intense positive root pressure within the xylem system.

(c) This immense internal hydrostatic pressure forces unevaporated xylem sap outward through the parenchymatous epithem tissue and out of the plant body via hydathodes.

(d) Stomata differ fundamentally by actively regulating the transpirational loss of pure water vapor through the dynamic turgor-mediated movements of specialized flanking guard cells.

(e) Lenticels are structural breaks found primarily within the corky periderm layer of woody stems and roots that function to facilitate direct gas exchange.

Final Answer: The structures are Hydathodes.

Answer: (B)

Go Back to Question 13

Q14.

Solution

Concept:

The structural configuration of the grass flower is highly specialized to accommodate wind-driven pollination mechanisms within open agricultural ecosystems. Traditional perianth components are heavily modified or reduced, giving rise to unique structural components that manage the physical access to reproductive organs.

Solution:

(a) Lodicules are minute, scale-like structures positioned at the base of the ovary within the floret of plants belonging to the family Poaceae.

(b) These specialized structures represent evolutionary remnants of the traditional perianth whorl, functioning dynamically by swelling during the precise window of floral anthesis.

(c) By absorbing moisture and expanding rapidly, the turgid lodicules exert direct mechanical pressure against the enclosing bracts, pushing them apart to expose reproductive structures.

(d) The lemma represents the lower, larger green bract that encloses the individual floret, often bearing a stiff hair-like extension termed an awn.

(e) The palea is the inner, upper bract that pairs with the lemma to form a protective housing around the delicate internal reproductive components.

Final Answer: The component is Lodicules.

Answer: (C)

Go Back to Question 14

Q15.

Solution

Concept:

Mineral nutrition in crops depends on the availability of essential elements that fulfill specific structural, catalytic, or electrochemical roles within plant tissues. Certain macronutrients serve as irreplaceable structural building blocks for primary photosynthetic pigments, directly impacting light harvesting and agricultural productivity.

Solution:

(a) Magnesium is an indispensable macronutrient that functions as the critical central coordinating atom within the complex porphyrin ring structure of all chlorophyll molecules.

(b) This specific coordination configuration stabilizes the surrounding tetrapyrrole rings, creating a molecular cloud optimized for capturing and transferring solar energy during photosynthesis.

(c) A deficiency in magnesium immediately disrupts the structural assembly of new chlorophyll pigments, resulting in severe interveinal chlorosis across mature leaf tissues.

(d) Iron functions as a crucial catalytic cofactor during the biochemical biosynthesis of chlorophyll molecules but does not enter the final structural pigment molecule.

(e) Manganese acts as a vital ionic activator for enzymes involved in the photolysis of water molecules within the oxygen-evolving complex of photosystem II.

Final Answer: The macronutrient is Magnesium (Mg).

Answer: (B)

Go Back to Question 15

Q16.

Solution

Concept:

The transmission of inherited traits relies on the precise behavior of chromosomes during eukaryotic cell division. The spatial alignment and subsequent physical movement of genetic structures during reductional division provide the physical foundation for the classic ratios discovered through empirical plant breeding.

Solution:

(a) Mendel's law of independent assortment dictates that alleles governing distinct phenotypic traits segregate entirely independently of one another during the formation of gametes.

(b) This classic genetic principle finds its physical explanation during the coordinated progression of metaphase I and anaphase I of meiotic division.

(c) During metaphase I, bivalent homologous chromosome pairs align completely randomly along the equatorial plate relative to all other bivalent chromosomal configurations.

(d) During the subsequent anaphase I stage, these independently positioned homologous pairs separate physically and migrate toward opposite poles of the dividing cell.

(e) This random orientation and subsequent physical segregation ensure that maternal and paternal genetic structures are shuffled unpredictably, creating diverse allelic combinations in gametes.

Final Answer: The stages are Metaphase I / Anaphase I of meiosis.

Answer: (A)

Go Back to Question 16

Q17.

Solution

Concept:

Internal root anatomy is highly optimized to regulate the radial uptake of water and dissolved mineral ions from the surrounding soil matrix. Before entering the central vascular cylinders, all absorbed materials must pass through a specialized cellular checkpoint that screens and controls fluid movement.

Solution:

(a) Casparian strips are continuous, ribbon-like bands of hydrophobic suberin and lignin deposited within the radial and transverse cell walls of the root endodermis.

(b) The endodermis constitutes a single layer of tightly packed, barrel-shaped cells that forms the absolute innermost boundary of the root cortex.

(c) Because suberin is entirely impermeable to water, the Casparian strips effectively block the passive movement of fluids through the non-living apoplastic pathway.

(d) This structural barrier forces water and dissolved ions to cross the semi-permeable plasma membrane into the living symplastic pathway for selective filtration.

(e) This precise anatomical organization prevents the uncontrolled backflow of minerals and maintains the positive hydrostatic pressures required for root pressure generation.

Final Answer: The anatomical zone is Endodermis.

Answer: (C)

Go Back to Question 17

Q18.

Solution

Concept:

Taxonomic differentiation of crop families utilizes specific floral variations that persist long after pollination concludes. In certain specialized horticultural and crop species, auxiliary structures like the calyx do not wither away but instead remain active to protect developing reproductive tissues.

Solution:

(a) The Cape gooseberry (*Physalis peruviana*) produces an edible berry surrounded by a large, papery, bladder-like structure formed from a highly modified, persistent calyx.

(b) This specialized diagnostic feature, where individual sepals remain intact, enlarge continuously, and fuse around the ripening fruit, is characteristic of the family Solanaceae.

(c) This structural covering protects the delicate, sugar-rich fruit from herbivore damage, mechanical impacts, and adverse ambient environmental pressures during field development.

(d) Species belonging to the family Fabaceae typically exhibit a traditional green calyx that remains small and unchanged beneath the developing leguminous pod.

(e) Asteraceae species feature a heavily modified calyx known as a pappus, which forms hair-like or feathery structures designed to facilitate wind-driven seed dispersal.

Final Answer: The family is Solanaceae.

Answer: (A)

Go Back to Question 18

Q19.

Solution

Concept:

Photosynthetic productivity in temperate field crops is often hindered by evolutionary limitations within specific carbon fixation pathways. When ambient conditions lead to an unfavorable balance of internal gases, the primary carboxylating enzyme exhibits a wasteful dual affinity that initiates an energetic breakdown loop.

Solution:

(a) Photorespiration is a light-driven metabolic pathway where oxygen is consumed and carbon dioxide is released without the generation of chemical ATP or NADPH.

(b) This process occurs in C_3 plants when the enzyme ribulose-1,5-bisphosphate carboxylase-oxygenase binds with oxygen instead of carbon dioxide under high temperatures.

(c) This oxygenase activity splits ribulose-1,5-bisphosphate into one molecule of 3-phosphoglycerate and one molecule of 2-phosphoglycolate, initiating a complex recycling pathway.

(d) The subsequent salvage pathway spans three distinct cellular compartments: the chloroplast, the peroxisome, and the internal matrix of the mitochondrion.

(e) Because photorespiration loses previously fixed carbon and consumes biochemical energy, it significantly limits the overall photosynthetic efficiency of C_3 crops compared to C_4 systems.

Final Answer: The phenomenon is Photorespiration.

Answer: (B)

Go Back to Question 19

Q20.

Solution

Concept:

Plants exhibit morphological plasticity, developing structural modifications to withstand extreme environmental challenges like severe moisture deficits. When standard foliar structures risk excessive transpirational water loss, alternate vegetative tissues adapt to perform essential gas exchange and energy capture.

Solution:

(a) A phyllode is a specialized foliar modification where the leaf petiole or rachis becomes flattened, green, and leaf-like to conduct active photosynthesis.

(b) This structural adaptation is classically observed in xerophytic plants like the Australian Acacia, where the true compound leaf blade drops off early to reduce transpirational surface area.

(c) A phylloclade represents a modified, green, fleshy stem structure possessing multiple nodes and internodes that assumes photosynthetic roles, as seen in *Opuntia*.

(d) A cladode is a specialized stem modification similar to a phylloclade but limited to a single internode in length, typically seen in plants like *Asparagus*.

(e) These distinct modifications allow plants to maintain necessary carbohydrate production while minimizing surface moisture loss in arid or water-limited agricultural zones.

Final Answer: The modification is Phyllode.

Answer: (A)

Go Back to Question 20

Q21.

Solution

Concept:

Taxonomic diagnostic traits provide a systematic methodology for identifying plant families of high agricultural significance. Characterizing floral architecture, specific arrangements of the androecium, and unique morphological structures of mature fruits allows researchers to accurately classify field crops into their respective families.

Solution:

(a) The family Brassicaceae, classically designated as Cruciferae, is defined by a distinct floral layout featuring four free petals arranged diagonally to resemble a cross, a pattern known as a cruciform corolla.

(b) The androecium exhibits a tetradynamous structural distribution consisting of six stamens segregated into two distinct whorls, where two short outer stamens surround four elongated inner stamens.

(c) Following successful pollination, the superior bicarpellary ovary develops into a specialized simple dry dehiscent fruit called a siliqua, which splits open along two structural valves from the base upward.

(d) Members of the family Malvaceae differ by showcasing a fused monadelphous staminal column, while the family Poaceae features wind-pollinated florets that mature into a dry caryopsis fruit.

(e) The family Fabaceae is characterized by a papilionaceous corolla layout and ten stamens arranged in a diadelphous configuration, producing a standard dehiscent pod or leguminous fruit structure.

Final Answer: The family is Brassicaceae (Cruciferae).

Answer: (A)

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Q22.

Solution

Concept:

Long-distance transport of organic photoassimilates from photosynthetic source organs to growing sink tissues is a vital physiological process determining crop yield. Translocation pathways require specialized vascular tissues and functional driving forces capable of moving concentrated organic solutes across continuous cellular networks.

Solution:

(a) The mass flow hypothesis, originally postulated by Ernst Munch, outlines the physiological mechanism driving the bulk movement of organic solutes through the living sieve tubes of phloem tissue.

(b) Active sucrose loading into sieve elements at the photosynthetic source tissue decreases local water potential, prompting water to move osmotically from adjacent xylem vessels into the phloem.

(c) This localized influx of water generates a substantial hydrostatic turgor pressure at the source end, expanding the flexible boundaries of the living sieve element network.

(d) At the destination sink tissue, sucrose is actively unloaded for metabolic consumption or storage, raising the local water potential and causing water to exit the phloem back into the xylem.

(e) This localized exit of water causes a sharp drop in turgor pressure at the sink end, creating a continuous turgor pressure gradient that drives bulk solute transport along the phloem.

Final Answer: The gradient is Turgor pressure gradient.

Answer: (B)

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Q23.

Solution

Concept:

Anatomical characterization of internal vascular systems allows researchers to differentiate between monocotyledonous and dicotyledonous architectural configurations. The structural layout, spatial grouping, and secondary growth potential of xylem and phloem elements provide diagnostic evidence regarding the evolutionary specialization of leaf tissues.

Solution:

(a) A dorsiventral leaf configuration is typical of dicotyledonous plants, featuring structurally distinct upper adaxial and lower abaxial surfaces designed to optimize light capture and manage transpirational cooling.

(b) The internal vascular bundles embedded within the mesophyll layer are described as conjoint because the xylem and phloem strands are arranged together along the same radial axis.

(c) These bundles are categorized as collateral since the phloem tissue is situated externally toward the abaxial surface while the xylem tissue faces internally toward the adaxial leaf surface.

(d) They are classified as closed because they lack a functional layer of intrafascicular cambium tissue between the xylem and phloem strands, preventing any localized secondary growth within the leaf blade.

(e) Radial and exarch arrangements are restricted to the primary root anatomy of plants, where alternating xylem and phloem strands develop with the oldest protoxylem elements facing outward.

Final Answer: The vascular bundles are Conjoint, collateral, and closed.

Answer: (B)

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Q24.

Solution

Concept:

The classification of industrial and fiber-yielding agricultural crops depends on diagnostic structural profiles that align with specific botanical families. Evaluating the morphology of reproductive whorls, particularly the cohesion patterns of the androecium, enables precise taxonomic placement of economically significant crop plants.

Solution:

(a) True cotton plants, belonging to the genus *Gossypium*, are high-value agricultural fiber crops taxonomically classified within the core Malvaceae family, commonly designated as the mallow family.

(b) A primary diagnostic marker for the family Malvaceae is a monadelphous androecium, where the filaments of numerous stamens fuse together to create a single continuous central staminal tube.

(c) This specialized structural tube completely surrounds the elongated style of the pistil, terminating just below the stigmatic lobes where free anthers branch outward to display pollen.

(d) Jute belongs to the family Malvaceae under modern APG classifications but features distinct free stamens, whereas sunn hemp is a member of the family Fabaceae exhibiting a diadelphous configuration.

(e) Flax represents an oilseed and fiber crop belonging to the family Linaceae, which possesses a different floral layout lacking the characteristic monadelphous staminal column seen in cotton.

Final Answer: The crop is Cotton (Gossypium spp.).

Answer: (A)

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Q25.

Solution

Concept:

Plant growth is directed by localized zones of actively dividing undifferentiated cells known as meristems. These specialized meristematic regions are systematically categorized based on their spatial orientation within the plant body and their specific roles in driving either vertical elongation or horizontal expansion.

Solution:

(a) Lateral meristems are specialized tissues arranged parallel to the longitudinal axis of stems and roots, primarily occurring in dicotyledonous plants that undergo secondary thickening.

(b) The vascular cambium and cork cambium constitute the primary lateral meristems responsible for initiating secondary growth by generating new secondary xylem, secondary phloem, and periderm layers.

(c) The coordinated division of these lateral meristematic layers drives an increase in the thickness, diameter, or overall girth of the dicotyledonous stem over successive growing seasons.

(d) Apical meristems are positioned at the absolute tips of roots and shoots, actively dividing to drive primary vertical elongation along the main growth axis.

(e) Intercalary meristems are derived from apical zones but become separated by mature tissues, situated at the bases of nodes or leaf blades to facilitate rapid internodal elongation.

Final Answer: The tissue is Lateral meristem.

Answer: (C)

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Answer Key

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