UPCATET Agriculture Botany Sample Paper-4

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 net gain of ATP molecules produced directly via substrate-level phosphorylation during the complete breakdown of one molecule of glucose in Glycolysis is:

(A) 36 ATP

(B) 2 ATP

(C) 4 ATP

(D) 38 ATP

Q2. When a heterozygous round-seeded pea plant (Rr) is crossed with a homozygous wrinkled-seeded pea plant (rr), what will be the expected phenotypic ratio of the offspring?

(A) 3 : 1

(B) 1 : 1

(C) 9 : 3 : 3 : 1

(D) 1 : 2 : 1

Q3. Which of the following enzymes acts as the primary carbon dioxide acceptor in C4 plants like maize and sugarcane?

(A) RuBisCO

(B) PEP carboxylase (PEPCase)

(C) Malate dehydrogenase

(D) Pyruvate kinase

Q4. The false septum called 'replum', which divides the ovary into two chambers, is found in the fruits of which family?

(A) Brassicaceae (Cruciferae)

(B) Solanaceae

(C) Poaceae

(D) Fabaceae

Q5. The characteristic inflorescence observed in the family Asteraceae (Compositae), which resembles a single large flower, is called:

(A) Hypanthodium

(B) Cyathium

(C) Capitulum (Head)

(D) Verticillaster

Q6. The primary function of the casparian strips present in the endodermal cells of plant roots is to:

(A) Facilitate rapid gaseous exchange

(B) Act as a water-impermeable barrier forcing apoplastic movement into symplast

(C) Store reserve starch granules for the root system

(D) Initiate lateral root development

Q7. The non-allelic gene interaction in which one gene masks or suppresses the phenotypic expression of another independent gene is termed as:

(A) Codominance

(B) Incomplete dominance

(C) Epistasis

(D) Pleiotropy

Q8. The modification of root in *Pandanus* (Screw pine) that provides mechanical support to the leaning stem is known as:

(A) Prop roots

(B) Stilt roots

(C) Pneumatophores

(D) Velamen roots

Q9. Which type of vascular bundle is characteristically found in the stems of dicotyledonous agricultural crops?

(A) Conjoint, collateral, closed

(B) Conjoint, collateral, open

(C) Radial and open

(D) Conjoint, bicollateral, closed

Q10. During the light reaction of photosynthesis, the primary electron donor that supplies electrons to photosystem II (PS II) is:

(A) NADP+

(B) CO2

(C) H2O

(D) Plastocyanin

Q11. The floral formula $\% \oint^{\nearrow} K_{(5)}\, C_{1+2+(2)}\, A_{(9)+1}\, \underline{G}_1$ correctly represents which important crop family?

(A) Malvaceae

(B) Solanaceae

(C) Fabaceae

(D) Cucurbitaceae

Q12. In which of the following plants does the stem modify into a flattened, green, photosynthetic structure known as a phylloclade?

(A) Euphorbia

(B) Opuntia

(C) Ruscus

(D) Asparagus

Q13. The persistent, enlarged calyx that encloses the mature berry fruit is a diagnostic vegetative feature of which agricultural crop family?

(A) Fabaceae

(B) Solanaceae

(C) Poaceae

(D) Brassicaceae

Q14. The specialized pore present on the margins of leaves of plants like grasses and *Colocasia* that participates in guttation is called:

(A) Stoma

(B) Hydathode

(C) Lenticel

(D) Pneumathode

Q15. The hormone primarily responsible for inducing stomatal closure under conditions of severe water scarcity or drought stress is:

(A) Abscisic Acid (ABA)

(B) Indole-3-acetic acid (IAA)

(C) Gibberellic Acid (GA3)

(D) Zeatin

Q16. Which of the following pairs of crops and their respective botanical families is INCORRECTLY matched?

(A) Potato — Solanaceae

(B) Pigeon pea — Fabaceae

(C) Maize — Poaceae

(D) Mustard — Malvaceae

Q17. The characteristic inflorescence found in crops of the family Poaceae, such as rice and wheat, consists of basic units called:

(A) Spikelets

(B) Umbel

(C) Corymb

(D) Spadix

Q18. In a dorsiventral (dicotyledonous) leaf, the mesophyll tissue is clearly differentiated into which two regions?

(A) Spongy parenchyma and aerenchyma

(B) Palisade parenchyma and spongy parenchyma

(C) Chlorenchyma and sclchyma

(D) Pith and cortex

Q19. Which of the following organelles is present in plant cells but completely absent in typical animal cells?

(A) Mitochondrion

(B) Golgi apparatus

(C) Plastids (chloroplasts, chromoplasts, leucoplasts) and a large central vacuole

(D) Ribosome

Q20. The phenomenon of water loss from the aerial parts of a living plant in the form of water vapour is called transpiration. Which type of transpiration accounts for more than 90% of total water loss?

(A) Cuticular transpiration

(B) Lenticular transpiration

(C) Stomatal transpiration

(D) Bark transpiration

Q21. In the flower of a pulse crop (Fabaceae), the large posterior petal that overlaps the lateral wings is called the:

(A) Keel (Carina)

(B) Vexillum (Standard)

(C) Alae (Wings)

(D) Corona

Q22. Kranz anatomy is a highly specialized structural modification observed in the leaves of which group of agricultural crops?

(A) C3 plants

(B) C4 plants

(C) CAM plants

(D) Sciophytes

Q23. Which of the following agricultural crops belongs to the family Poaceae (Gramineae) and possesses a characteristic caryopsis fruit?

(A) Cicer arietinum

(B) Triticum aestivum

(C) Brassica campestris

(D) Solanum melongena

Q24. The non-functional, dark-coloured central core of secondary xylem in old dicot trees, which is highly resistant to insect attacks due to deposition of tannins and resins, is known as:

(A) Sapwood (Alburnum)

(B) Heartwood (Duramen)

(C) Softwood

(D) Earlywood

Q25. During which specific sub-stage of Prophase I in Meiosis does the crucial genetic event of 'crossing over' take place between non-sister chromatids?

(A) Leptotene

(B) Zygotene

(C) Pachytene

(D) Diplotene

Detailed Solutions

Q1.

Solution

Concept:

In cellular respiration, energy extraction occurs via distinct metabolic pathways. While pathways like the Electron Transport Chain generate ATP indirectly through a proton gradient and oxidative phosphorylation, specific enzymatic reactions in Glycolysis and the Krebs cycle transfer a phosphate group directly from a reactive substrate molecule to ADP. This mechanical process is designated as substrate-level phosphorylation.

Solution:

(a) Glycolysis breaks down one molecule of glucose ($C_6H_{12}O_6$) into two molecules of pyruvate within the cytoplasm of the plant cell.

(b) During the energy-yielding phase of glycolysis, two specific reactions execute substrate-level phosphorylation. The first occurs when 1,3-bisphosphoglycerate is converted to 3-phosphoglycerate by the enzyme phosphoglycerate kinase.

(c) The second occurs when phosphoenolpyruvate (PEP) is converted to pyruvate by pyruvate kinase.

(d) Because each step happens twice per initial glucose molecule, a gross total of 4 ATP molecules are synthesized through this direct biochemical pathway.

(e) However, the preparatory phase of glycolysis consumes 2 ATP molecules to phosphorylate glucose and fructose-6-phosphate. Subtracting these 2 consumed ATP from the 4 produced yields a net gain of exactly 2 ATP molecules via substrate-level phosphorylation during glycolysis.

Final Answer: The net gain is 2 ATP molecules.

Answer: (B)

Go Back to Question 1

Q2.

Solution

Concept:

Monohybrid crosses form the cornerstone of Mendelian genetics, demonstrating how alleles segregate during gametogenesis. When analyzing traits in agricultural crops like *Pisum sativum*, cross-pollinating an organism displaying a dominant phenotype with one expressing the recessive phenotype reveals predictable inheritance patterns governed by the underlying genotypic configurations.

Solution:

(a) The problem describes a typical test cross between a heterozygous round-seeded individual and a homozygous recessive wrinkled-seeded individual.

(b) The heterozygous round-seeded parent possesses the genotype Rr. Due to the law of segregation, it produces two distinct types of gametes in equal proportions: 50

(c) The homozygous wrinkled-seeded parent possesses the genotype rr. It can only produce one type of gamete, which exclusively carries the recessive allele (r).

(d) Combining these gametes using a Punnett square yields two genetic outcomes for the progeny: 50

(e) Thus, the expected phenotypic ratio among the offspring is exactly half round and half wrinkled, simplifying to a clean $1:1$ ratio.

Final Answer: The expected phenotypic ratio of the offspring is $1:1$.

Answer: (B)

Go Back to Question 2

Q3.

Solution

Concept:

To combat the inefficiencies of photorespiration in hot, arid environments, certain agricultural crops have evolved the C_4 photosynthetic pathway. This pathway utilizes spatial separation to fix atmospheric carbon dioxide efficiently, minimizing the oxygenase activity of RuBisCO by using an alternative primary carboxylating enzyme in the mesophyll cells.

Solution:

(a) In C_4 plants such as maize, sugarcane, and sorghum, the initial fixation of atmospheric carbon dioxide takes place within the cytosol of the mesophyll cells rather than the chloroplast stroma.

(b) The atmospheric carbon dioxide is first hydrated into bicarbonate ions (HCO_3^-).

(c) The primary acceptor of this carbon unit is a three-carbon compound called phospho-enolpyruvate (PEP).

(d) The reaction is catalyzed by the highly efficient enzyme phosphoenolpyruvate carboxylase, commonly abbreviated as PEP carboxylase or PEPCase. This enzyme possesses a remarkably high affinity for carbon dioxide and completely lacks affinity for oxygen.

(e) PEPCase fixes the carbon to form the four-carbon organic acid oxaloacetate (OAA). This metabolic specialization ensures that C_4 crops maintain high photosynthetic efficiency even under conditions of high temperature and closed stomata.

Final Answer: The primary carbon dioxide acceptor enzyme in C_4 plants is PEP carboxylase (PEPCase).

Answer: (B)

Go Back to Question 3

Q4.

Solution

Concept:

Gynoecium anatomy and ovary chamber configuration serve as critical diagnostic tools in structural taxonomy. While many plant families retain simple unilocular or multilocular ovaries throughout development, specific evolutionary modifications cause certain plant families to develop internal structural barriers that alter the structural mechanics of fruit maturation.

Solution:

(a) The family Brassicaceae (historically known as Cruciferae) contains major oilseed crops such as mustard (*Brassica campestris*) and radish.

(b) The gynoecium of flowers within this family is characteristically bicarpellary and syncarpous with a superior ovary.

(c) In its early developmental stage, the ovary is strictly unilocular, meaning it features only a single continuous internal chamber with parietal placentation.

(d) As development progresses toward fruit formation, a false internal septum called the replum develops between the two parietal placentae.

(e) This replum bisects the single chamber, converting the mature ovary into a bilocular structure. When the resulting siliqua fruit undergoes dehiscent splitting, the valves break away from the base upward, leaving the seeds attached to this persistent, membranous false septum.

Final Answer: The false septum called 'replum' is found in the family Brassicaceae (Cruciferae).

Answer: (A)

Go Back to Question 4

Q5.

Solution

Concept:

Inflorescences are specialized structures that group multiple flowers together to optimize pollination efficiency. Certain plant families have developed highly condensed, compound inflorescences where numerous individual florets are arranged systematically on a common receptacle to structurally mimic the appearance and functional attraction of a single large solitary flower.

Solution:

(a) The family Asteraceae (commonly known as the sunflower or Compositae family) features a highly evolved form of racemose inflorescence known as a capitulum or head.

(b) In a capitulum, the main floral axis becomes flattened, broadened, and concave or convex to form a large, fleshy, common structure termed the receptacle.

(c) Large numbers of small, sessile flowers, called florets, are crowded together on this shared receptacle in a centripetal arrangement.

(d) The inflorescence is surrounded at its base by a protective green whorl of bracts known collectively as an involucre.

(e) The florets are often differentiated into outer, strap-shaped ray florets and central, tubular disc florets. This integrated cooperative structure effectively tricks insect pollinators into treating the entire inflorescence as one single flower unit.

Final Answer: The characteristic inflorescence is Capitulum (Head).

Answer: (C)

Go Back to Question 5

Q6.

Solution

Concept:

Roots must selectively regulate the horizontal transport of water and dissolved mineral ions from the surrounding soil matrix into the central vascular cylinder. To prevent unregulated passive flow through the extracellular spaces, root tissues deploy anatomical barriers that force fluid components to pass through living cell membranes.

Solution:

(a) Water absorbed by root hairs travels horizontally across the cortex via two main routes: the apoplastic pathway (through non-living cell walls and intercellular spaces) and the symplastic pathway (through interconnected living protoplasts).

(b) The innermost layer of the root cortex is the endodermis, which acts as a physiological selective checkpoint guarding the vascular cylinder.

(c) The radial and transverse walls of these endodermal cells are impregnated with a specialized, waxy, hydrophobic polymer called suberin.

(d) This suberized band forms a continuous, water-impermeable barrier known as the casparian strip.

(e) Because water moving apoplastically cannot penetrate suberin, the casparian strip abruptly blocks the apoplastic pathway. This forces water and solute ions to cross the selectively permeable plasma membrane into the symplast, allowing the plant to regulate which minerals enter the xylem.

Final Answer: The function is to act as a water-impermeable barrier forcing apoplastic movement into symplast.

Answer: (B)

Go Back to Question 6

Q7.

Solution

Concept:

While Mendelian inheritance describes alleles of a single gene controlling a trait independently, real-world phenotypes are frequently shaped by non-allelic gene interactions. In these scenarios, separate genes located at entirely different loci interact with one another, allowing one gene locus to systematically override or mask the expression of another.

Solution:

(a) Epistasis is a classical form of non-allelic or inter-genic interaction where the phenotypic expression of a gene at one locus alters, suppresses, or completely masks the expression of a gene at a separate, independent locus.

(b) The gene that exerts the masking or suppressing effect is referred to as the epistatic gene.

(c) Conversely, the gene whose phenotypic expression is overridden or hidden is designated as the hypostatic gene.

(d) Epistasis differs fundamentally from dominance because dominance involves masking between alternative allelic variants occupying the exact same gene locus.

(e) Common examples of epistasis include fruit colour determination in summer squash and coat colour inheritance in animals, where alleles at an upstream regulatory locus determine whether downstream pigment genes can express themselves, distorting traditional Mendelian dihybrid ratios.

Final Answer: The non-allelic gene interaction is Epistasis.

Answer: (C)

Go Back to Question 7

Q8.

Solution

Concept:

Plants frequently modify their vegetative organs to survive unique environmental challenges or to secure physical stability. When a heavy or sprawling crop stem develops in loose, unstable coastal or swampy soils, normal underground root systems cannot provide sufficient anchoring strength, necessitating the growth of adventitious structural supports.

Solution:

(a) *Pandanus* (commonly called Screw pine) grows in coastal habitats and brackish swamps where the substrate is highly unstable and shifting.

(b) The main stem of *Pandanus* grows obliquely or leans to one side, making it highly susceptible to lodging or collapse under its own weight.

(c) To counter this mechanical instability, the plant develops thick, robust, adventitious roots arising from the lower nodes of the main aerial stem.

(d) These roots grow obliquely downward at an angle and penetrate firmly into the soil, acting like rigid support cables or struts.

(e) These specialized anchoring structures are classified as stilt roots. They are structurally distinct from prop roots, which hang vertically downward from horizontal aerial branches like those seen in the banyan tree (*Ficus benghalensis*).

Final Answer: The modification of root is Stilt roots.

Answer: (B)

Go Back to Question 8

Q9.

Solution

Concept:

The structural configuration of vascular tissue is a fundamental anatomical diagnostic feature used to differentiate major plant divisions. The arrangement, presence, or absence of meristematic cells within these bundles dictates whether an agricultural crop can undergo secondary growth to expand its girth.

Solution:

(a) In the stems of angiosperms, xylem and phloem are grouped together into structural units called vascular bundles.

(b) When xylem and phloem lie on the exact same radius within a bundle, the arrangement is termed conjoint and collateral, with phloem positioned toward the exterior and xylem toward the interior.

(c) In dicotyledonous crops (such as mustard, sunflower, and pulses), a narrow strip of active, lateral meristematic tissue called intrafascicular cambium is present between the xylem and phloem.

(d) The presence of this cambial layer renders the vascular bundle anatomically 'open', meaning it retains the developmental capacity to form secondary tissues.

(e) Conversely, monocotyledonous stems lack this cambium layer entirely, making their vascular bundles 'closed' and incapable of true secondary thickening.

Final Answer: The vascular bundle type is Conjoint, collateral, open.

Answer: (B)

Go Back to Question 9

Q10.

Solution

Concept:

The light-dependent reactions of photosynthesis convert radiant solar energy into stable chemical energy (ATP and $NADPH$). This process relies on a continuous flux of electrons passing along an organized electron transport chain embedded within the thylakoid membrane, requiring a steady input source to replace excited electrons.

Solution:

(a) Photosynthesis begins when photons strike the antenna complex of Photosystem II (PS II), exciting the reaction center chlorophyll molecule (P_{680}).

(b) This excitation drives P_{680} to eject high-energy electrons into the primary electron acceptor chain, leaving the PS II reaction center in an oxidized, electron-deficient state (P^{+}_{680}).

(c) To continue functioning, this powerful oxidant must extract replacement electrons from an external chemical donor.

(d) This deficiency is satisfied by the oxygen-evolving complex (OEC) located on the luminal side of the thylakoid membrane, which drives the photolysis of water ($2H_2O \rightarrow O_2 + 4H^+ + 4e^-$).

(e) Water acts as the ultimate primary electron donor, providing the necessary electrons to neutralize P^{+}_{680}, while concurrently generating molecular oxygen as a metabolic byproduct and releasing protons into the lumen.

Final Answer: The primary electron donor is H_2O.

Answer: (C)

Go Back to Question 10

Q11.

Solution

Concept:

Floral formulas are standardized symbolic representations that outline the structural composition, symmetry, and organ arrangement of a plant flower. In agricultural taxonomy, these formulas serve as distinct diagnostic fingerprints to identify and categorize essential crop families, detailing characteristics such as numerical variations, fusions, and the structural position of the gynoecium relative to other floral whorls.

Solution:

(a) The given floral formula begins with the percentage symbol (%), which indicates zygomorphic symmetry, meaning the flower can be divided into equal halves along only one single vertical plane.

(b) The second symbol ($\oint^{\nearrow}$) represents a bisexual or hermaphrodite flower containing both active male stamens and female carpels.

(c) The term $K_{(5)}$ denotes a calyx composed of five sepals that are physically fused or gamosepalous, indicated by the surrounding parentheses.

(d) The corolla expression $K_{1+2+(2)}$ presents a classic papilionaceous arrangement consisting of one large posterior standard petal, two lateral wing petals, and two anterior keel petals fused together.

(e) The androecium configuration $A_{(9)+1}$ details a diadelphous arrangement where ten total stamens are split into two separate groups: nine fused together in a tube and one remaining completely free. Finally, $\underline{G}_1$ indicates a monocarpellary, superior ovary which forms the structural foundation of the pulse family Fabaceae.

Final Answer: The floral formula represents the family Fabaceae.

Answer: (C)

Go Back to Question 11

Q12.

Solution

Concept:

Plants inhabiting arid or xerophytic environments face extreme transpiration stress, driving complex evolutionary modifications of their vegetative organs. To curb excessive water loss while preserving metabolic activity, certain species modify their leaves into non-photosynthetic structures and transfer vital carbon-fixation duties to specialized, structurally adapted green stems.

Solution:

(a) A phylloclade is a specialized, green, flattened or cylindrical stem modification characterized by multiple nodes and internodes that functions as the primary photosynthetic organ.

(b) In xerophytic plants like *Opuntia* (commonly known as prickly pear), the true leaves are highly modified into sharp, pointed spines to drastically minimize surface area and prevent water transpiration.

(c) To compensate for this complete loss of traditional foliage, the main stem undergoes significant anatomical transformation, becoming fleshy, flattened, and rich in chlorophyll reserves.

(d) This modified stem synthesizes organic nutrients and stores substantial water volumes inside mucilaginous tissues to endure prolonged drought spells.

(e) While *Euphorbia* also exhibits photosynthetic stem adaptations, its structure is typically fleshy and cylindrical rather than flattened, making *Opuntia* the definitive classic textbook example of a flattened phylloclade structure.

Final Answer: The plant that modifies into a flattened phylloclade is Opuntia.

Answer: (B)

Go Back to Question 12

Q13.

Solution

Concept:

The structural destiny of the calyx varies greatly across different angiosperm families after successful fertilization occurs. While sepals typically wither and drop away during early fruit development, certain crop families retain these structures, allowing them to grow continuously alongside the ripening ovary to serve alternative protective functions.

Solution:

(a) In most flowering plants, the calyx is caducous or deciduous, meaning it sheds immediately after pollination takes place.

(b) However, the nightshade family, Solanaceae, is characterized by an accrescent or persistent calyx that remains physically attached to the base of the developing fruit.

(c) Important agricultural crops within this family, including eggplant (*Solanum melongena*), tomato, and chili, display this distinctive botanical feature clearly.

(d) As the ovary matures into a fleshy berry, the persistent sepals do not wither; instead, they grow larger, remaining as a green, protective cap at the stem end of the crop.

(e) In specific genera like *Physalis* (ground cherry), this calyx expands dramatically to form a bladder-like husk that completely encloses the mature berry, shielding it from physical pests and environmental elements.

Final Answer: The persistent, enlarged calyx is a feature of the family Solanaceae.

Answer: (B)

Go Back to Question 13

Q14.

Solution

Concept:

Plants regulate internal moisture and hydrostatic pressure through distinct physiological pathways. While transpiration releases pure water vapor through adjustable stomatal pores during dry conditions, high soil moisture combined with high humidity prompts certain plants to expel liquid water directly through specialized structural openings.

Solution:

(a) Guttation is the physiological process by which plants exude liquid water droplets from uninjured leaf margins, typically occurring during late night or early morning hours.

(b) This phenomenon takes place when soil moisture is highly abundant and atmospheric humidity is near saturation, a combination that restricts normal air transpiration while driving strong root pressure upward.

(c) The liquid water is expelled through specialized, permanently open microscopic pores located at the tips or margins of veins, which are anatomically distinct from stomata.

(d) These unique structures are called hydathodes, or water stomata, and they open directly into small intercellular cavities lined by a mass of loosely arranged parenchyma cells called epithem tissue.

(e) Crops such as grasses, *Colocasia*, and *Tomatoes* rely on these structural hydathodes to relieve localized hydrostatic pressure within their vascular systems when environmental transpiration pathways are blocked.

Final Answer: The specialized pore that participates in guttation is called a Hydathode.

Answer: (B)

Go Back to Question 14

Q15.

Solution

Concept:

Phytohormones act as chemical signaling molecules that coordinate vital physiological adaptations in response to diverse environmental stresses. When crops encounter harsh environmental stress, they rapidly trigger specific hormonal cascades to preserve water and maintain homeostatic cellular balance.

Solution:

(a) Abscisic acid (ABA) is a vital phytohormone synthesized primarily within plant chloroplasts and vascular tissues, universally recognized as the primary plant 'stress hormone'.

(b) When an agricultural crop experiences severe environmental conditions like drought, soil salinity, or extreme heat, internal ABA concentrations rise sharply.

(c) This systemic hormone spike functions as an urgent chemical signal that triggers a rapid efflux of potassium ions (K^+) and malate from guard cells into surrounding epidermal tissues.

(d) The loss of these solute ions reduces turgor pressure within the guard cells, causing them to flaccidly collapse and tightly close the stomatal pore.

(e) This immediate closure minimizes further transpiration water loss, preserving internal moisture and protecting the crop from fatal dehydration during extended periods of environmental water deficits.

Final Answer: The hormone responsible for inducing stomatal closure is Abscisic Acid (ABA).

Answer: (A)

Go Back to Question 15

Q16.

Solution

Concept:

Systematic classification requires linking economic agricultural crops accurately to their respective botanical families based on shared reproductive and vegetative structures. Identifying errors in family matching demands a thorough understanding of standard diagnostic traits across major plant groupings.

Solution:

(a) Potato (*Solanum tuberosum*) is a premier member of the family Solanaceae, characterized by its modified underground stem tubers and bicarpellary superior ovaries.

(b) Pigeon pea (*Cajanus cajan*) is a core pulse crop belonging to the family Fabaceae, featuring zygomorphic papilionaceous flowers and nitrogen-fixing root nodules.

(c) Maize (*Zea mays*) is an essential cereal crop categorized under the monocotyledonous family Poaceae, exhibiting parallel leaf venation and characteristic spikelet inflorescences.

(d) Mustard (*Brassica campestris*) is an oilseed crop characterized by tetradynamous stamens and cruciform corollas, placing it squarely within the family Brassicaceae.

(e) Matching mustard with the family Malvaceae is completely incorrect, as Malvaceae typically encompasses crops like cotton and okra, which display distinct monadelphous stamen columns and valvate sepals.

Final Answer: The incorrectly matched pair is Mustard — Malvaceae.

Answer: (D)

Go Back to Question 16

Q17.

Solution

Concept:

The architectural arrangement of flowering parts within cereal crops is highly specialized to facilitate wind-driven pollination. The family Poaceae has developed highly condensed, bracketed floral structures where standard large petals are replaced by compact scales and protective vegetative bracts.

Solution:

(a) Cereal crops like wheat, rice, and maize belong to the family Poaceae and exhibit a highly modified compound inflorescence known as a spike of spikelets.

(b) The fundamental structural unit of this inflorescence layout is the individual spikelet, which is arranged along a central axis termed the rachis.

(c) Each individual spikelet contains a short central axis known as a rachilla, which bears one or more tiny, inconspicuous florets.

(d) At the base of each spikelet sit two empty, protective green bracts called glumes: the lower first glume and the upper second glume.

(e) Each individual floret within the spikelet is enclosed by two specific scale-like bracts: an outer bract called the lemma and an inner bract called the palea, optimizing the reproductive layout for wind pollination.

Final Answer: The basic units of the inflorescence are Spikelets.

Answer: (A)

Go Back to Question 17

Q18.

Solution

Concept:

Leaf anatomy reflects adaptation to sunlight interception and gas management. Dicotyledonous crops typically develop horizontal, dorsiventral leaves where the upper and lower surfaces experience unequal solar exposure, necessitating a clear structural division of interior photosynthetic tissues.

Solution:

(a) The internal ground tissue of a leaf located between the upper and lower epidermal layers is called the mesophyll, which is rich in chloroplasts.

(b) In a typical dorsiventral leaf of dicotyledonous agricultural crops, this mesophyll tissue is clearly differentiated into two separate structural zones.

(c) The upper zone, lying directly beneath the upper epidermis, consists of elongated, vertically arranged column cells called palisade parenchyma.

(d) These palisade cells are tightly packed with minimal intercellular gaps and contain a high density of chloroplasts to maximize solar energy absorption.

(e) The lower zone consists of loosely arranged, irregularly shaped cells called spongy parenchyma, which feature large internal air cavities to facilitate rapid internal gaseous diffusion.

Final Answer: The mesophyll is differentiated into palisade parenchyma and spongy parenchyma.

Answer: (B)

Go Back to Question 18

Q19.

Solution

Concept:

Eukaryotic cells share a core set of metabolic organelles, yet plant and animal evolutionary lineages have developed distinct subcellular specializations. Plant cells retain unique structural components dedicated to solar energy conversion and hydrostatic turgor maintenance that animal cells lack entirely.

Solution:

(a) Plant and animal cells both possess basic eukaryotic features, including membrane-bound nuclei, energy-producing mitochondria, golgi networks, and protein-synthesizing ribosomes.

(b) However, plastids represent a distinct category of double-membrane organelles found exclusively in autotrophic organisms like plants and algae.

(c) These include green chloroplasts for photosynthesis, colorful chromoplasts for pigment storage, and colorless leucoplasts for starch synthesis.

(d) Additionally, mature plant cells are distinguished by a massive, membrane-bound central vacuole enclosed by a specialized semi-permeable membrane called the tonoplast.

(e) This central vacuole stores cellular sap, manages waste products, and generates the internal turgor pressure vital for structural rigidity, features entirely missing from typical animal cells.

Final Answer: The organelles are Plastids and a large central vacuole.

Answer: (C)

Go Back to Question 19

Q20.

Solution

Concept:

Transpiration acts as a crucial engine that drives the upward ascent of sap and regulates temperature across plant tissues. This water loss occurs through multiple distinct structural pathways over the surface of vegetative aerial organs, varying significantly in total volume contribution.

Solution:

(a) Transpiration is categorized into three primary types based on the specific structural exit points involved: stomatal, cuticular, and lenticular.

(b) Cuticular transpiration happens via direct evaporation through the waxy outer layer of the epidermis, typically contributing less than 10

(c) Lenticular transpiration occurs through tiny ruptures in the woody bark of older stems called lenticels, accounting for a fraction of a percent.

(d) Stomatal transpiration takes place through the specialized microscopic stomatal pores distributed primarily across leaf surfaces.

(e) Because these pores are actively regulated by guard cells to facilitate photosynthetic carbon dioxide absorption, they serve as the primary route for water vapor loss, consistently accounting for 90% to 97% of all water transpired by a living plant.

Final Answer: Stomatal transpiration accounts for more than 90% of total water loss.

Answer: (C)

Go Back to Question 20

Q21.

Solution

Concept:

The structural architecture of flowers within the pea and pulse family showcases unique adaptations to promote specific pollination mechanisms. In these zygomorphic floral systems, the individual components of the corolla are differentiated into specialized sizes and shapes that interlock to shield reproductive organs while welcoming target insect pollinators.

Solution:

(a) The family Fabaceae (formerly Papilionaceae) exhibits a unique, highly specialized arrangement of petals known as a papilionaceous corolla.

(b) This butterfly-shaped corolla configuration contains five distinct petals that display a systematic, overlapping aestivation pattern called vexillary or descendingly imbricate.

(c) The outermost, largest posterior petal stands erect at the back of the flower structure and is anatomically named the vexillum, or standard petal.

(d) Moving inward, this massive standard petal physically overlaps two smaller, horizontally paired lateral petals termed the alae, or wings.

(e) Finally, these wing petals overlap two small anterior petals that are fused along their margins to form a boat-shaped structural housing called the carina, or keel, which safely encloses the vital internal stamens and gynoecium.

Final Answer: The large posterior petal is called the Vexillum (Standard).

Answer: (B)

Go Back to Question 21

Q22.

Solution

Concept:

To mitigate the metabolic energy losses caused by photorespiration in intense, arid conditions, certain agricultural crops have engineered complex internal structural changes. This adaptive leaf design coordinates spatial segregation between primary carbon capture and the final Calvin cycle to optimize overall photosynthetic performance.

Solution:

(a) Kranz anatomy is a highly specialized internal leaf structure that serves as the definitive anatomical marker for plants operating the efficient C_4 photosynthetic pathway.

(b) The term Kranz translates to 'wreath' or 'halo' in German, referring directly to the concentric ring-like arrangement of cells surrounding the vascular bundles.

(c) In these adapted leaves, the vascular bundles are tightly encircled by a prominent ring of large, thick-walled bundle sheath cells containing specialized chloroplasts.

(d) This layer is then systematically surrounded by an outer concentric ring of highly active mesophyll cells.

(e) This unique spatial arrangement allows C_4 agricultural crops like maize, sorghum, and sugarcane to initial-fix carbon dioxide in the mesophyll before pumping it safely into the bundle sheath cells, effectively neutralizing photorespiratory pathways.

Final Answer: Kranz anatomy is a highly specialized structural modification observed in the leaves of C4 plants.

Answer: (B)

Go Back to Question 22

Q23.

Solution

Concept:

Identifying and categorizing valuable economic field crops requires a firm understanding of structural morphology and systematic taxonomy. Dissecting the specific structural configurations of fruits, leaves, and stems allows agronomists to reliably separate major cereal grains from leguminous pulses and oilseeds.

Solution:

(a) A caryopsis is a distinctive type of simple, dry, indehiscent fruit where the thin outer pericarp is completely and inseparably fused with the internal seed coat.

(b) This particular fruit structure serves as a fundamental taxonomic diagnostic feature for the grass and cereal family, Poaceae (Gramineae).

(c) Evaluating the options, *Triticum aestivum* represents the common agricultural crop wheat, which is a premier monocot grain belonging directly to the Poaceae family.

(d) Looking at the alternatives, *Cicer arietinum* (chickpea) produces legumes within the family Fabaceae, while *Brassica campestris* (mustard) yields siliqua fruits in the Brassicaceae family.

(e) Finally, *Solanum melongena* (eggplant) bears fleshy berries within the family Solanaceae, leaving wheat as the only valid match for both the family Poaceae and the caryopsis fruit structure.

Final Answer: The agricultural crop is Triticum aestivum.

Answer: (B)

Go Back to Question 23

Q24.

Solution

Concept:

As perennial dicotyledonous woody crops expand in diameter over successive growing seasons, their internal vascular cylinders undergo extensive physiological partitioning. The oldest secondary xylem elements located near the center of the stem transition from active fluid conduction into stable mechanical and defensive zones.

Solution:

(a) During continuous secondary growth in older dicot stems, the active cambium produces new layers of secondary xylem toward the interior.

(b) Over time, the oldest concentric layers of xylem located at the deep center of the trunk lose their water-conducting capacity as the vessels become blocked by cellular tylose growths.

(c) This central structural core undergoes extensive chemical infusion, getting heavily impregnated with secondary organic compounds like tannins, resins, oils, and gums.

(d) This dark, highly modified, non-functional central core of secondary xylem is anatomically designated as heartwood or duramen.

(e) The dense chemical loading renders heartwood highly durable and uniquely resistant to mechanical decay and insect woodborers, distinguishing it from the outer, lighter, fluid-conducting sapwood or alburnum.

Final Answer: The dark-coloured central core of secondary xylem is known as Heartwood (Duramen).

Answer: (B)

Go Back to Question 24

Q25.

Solution

Concept:

Meiotic cell division introduces essential genetic variations into sexually reproducing organisms, driving evolutionary adaptation in crop breeding programs. The extended first prophase consists of highly organized sub-stages dedicated to pairing up, exchanging segments, and separating homologous chromosomes.

Solution:

(a) Prophase I of Meiosis I is a highly complex, protracted stage structurally subdivided into five distinct chronological phases: leptotene, zygotene, pachytene, diplotene, and diakinesis.

(b) In the initial leptotene phase, chromosomes condense, and in the subsequent zygotene phase, homologous chromosomes pair up side-by-side through synapsis to form bivalents.

(c) Once synapsis is complete, the cell enters the highly critical pachytene stage, where the paired chromosomes condense further and appear clearly as tetrads.

(d) During this pachytene phase, non-sister chromatids of homologous chromosomes break and exchange corresponding genetic segments at specific points, a process catalyzed by the recombinase enzyme complex.

(e) This physical exchange mechanism is called crossing over, and it serves as the primary biological driver of genetic recombination and new allelic assortments in plant populations.

Final Answer: Crossing over takes place during the Pachytene stage.

Answer: (C)

Go Back to Question 25

Answer Key

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