

UPCATET Agriculture Botany Sample Paper-1

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 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

Q2. In which type of inflorescence does the main axis terminate in a flower, resulting in limited growth, with the flowers arranged in a basipetal succession?

- (A) Racemose
- (B) Cymose
- (C) Hypanthodium
- (D) Cyathium

Q3. During which specific stage of prophase I in meiosis does the process of crossing over (genetic recombination) occur between non-sister chromatids of homologous chromosomes?

- (A) Leptotene



- (B) Zygotene
- (C) Pachytene
- (D) Diplotene

Q4. The characteristic fruit of the family Poaceae (Gramineae), where the pericarp is completely fused with the seed coat, is known as a:

- (A) Caryopsis
- (B) Legume
- (C) Siliqua
- (D) Berry

Q5. Which of the following environmental factors serves as the primary limiting factor for photosynthesis in well-watered C3 crop plants on a clear, warm, sunny day?

- (A) Light intensity
- (B) Atmospheric CO_2 concentration
- (C) Soil moisture content
- (D) Oxygen concentration

Q6. The botanical name of 'Pigeon pea' (Arhar), a major pulse crop belonging to the family Fabaceae, is:

- (A) *Cicer arietinum*
- (B) *Cajanus cajan*
- (C) *Vigna mungo*
- (D) *Glycine max*

Q7. When a standard root system develops directly from the elongation of the radicle of an embryo rather than from any other vegetative part, it is classified as a:

- (A) Adventitious root system
- (B) Tap root system



- (C) Fibrous root system
- (D) Prop root system

Q8. Which of the following processes is a major disadvantage associated with C3 plants compared to C4 plants, leading to a significant loss of fixed carbon under high temperature and oxygen levels?

- (A) Photoperiodism
- (B) Photorespiration
- (C) Transpiration
- (D) Glycolysis

Q9. The modified, parallel-veined, protective sheet-like structure that covers and encircles the stem at the base of a leaf in members of the family Poaceae is called the:

- (A) Petiole
- (B) Pulvinus
- (C) Leaf sheath
- (D) Stipule

Q10. The primary anatomical distinction between a dicot stem and a monocot stem regarding their vascular bundles is that monocot stems possess:

- (A) Conjoint, collateral, and open vascular bundles arranged in a ring
- (B) Conjoint, collateral, and closed vascular bundles scattered throughout the ground tissue
- (C) Radial vascular bundles with exarch xylem
- (D) Bicollateral and open vascular bundles

Q11. If a plant heterozygous for a single trait (Tt) is self-pollinated, what is the expected genotypic ratio among the resulting F_2 offspring according to Mendel's Law of Segregation?



- (A) 3 : 1
- (B) 1 : 2 : 1
- (C) 9 : 3 : 3 : 1
- (D) 1 : 1

Q12. Which of the following modifications is an example of an underground stem designed for food storage and perennation, characterized by nodes, internodes, scale leaves, and axillary buds?

- (A) Sweet potato
- (B) Carrot
- (C) Rhizome of Ginger

Q13. The persistent, enlarged, and often inflated calyx that covers the fruit in crops like 'Physalis' (ground cherry) or ashwagandha is a distinct botanical feature of which family?

- (A) Fabaceae
- (B) Solanaceae
- (C) Poaceae
- (D) Brassicaceae

Q14. The loss of water in the form of liquid droplets from the margins or tips of uninjured leaves through specialized structures called hydathodes is known as:

- (A) Transpiration
- (B) Guttation
- (C) Evaporation
- (D) Exudation

Q15. In the floral formula of a crop plant, the symbol $\oplus$ represents which type of floral symmetry?

- (A) Actinomorphic (Radial symmetry)



- (B) Zygomorphic (Bilateral symmetry)
- (C) Asymmetric
- (D) Epigynous

Q16. Which structural component of the stomatal apparatus undergoes changes in turgor pressure to directly regulate the opening and closing of the stomatal pore?

- (A) Subsidiary cells
- (B) Epidermal cells
- (C) Guard cells
- (D) Mesophyll cells

Q17. The highly characteristic 'Vexillary' or 'Papilionaceous' aestivation of the corolla, consisting of a large standard petal, two lateral wings, and two fused keel petals, is found in:

- (A) *Solanum nigrum*
- (B) *Pisum sativum*
- (C) *Triticum aestivum*
- (D) *Brassica campestris*

Q18. During glycolysis, which is the common pathway for both aerobic and anaerobic respiration, a single molecule of glucose is broken down in the cytoplasm to produce:

- (A) One molecule of Acetyl-CoA
- (B) Two molecules of Pyruvic acid
- (C) Two molecules of Lactic acid
- (D) One molecule of Citric acid

Q19. The condition known as 'oblique ovary' placed on a swollen placenta with axile placentation is a hallmark diagnostic feature of the family:



- (A) Poaceae
- (B) Solanaceae
- (C) Fabaceae
- (D) Cucurbitaceae

Q20. Which type of cell division maintains a constant chromosome number ($2n \rightarrow 2n$) across daughter cells and is primarily responsible for vegetative growth and tissue repair in plants?

- (A) Mitosis
- (B) Meiosis I
- (C) Meiosis II
- (D) Amitosis

Q21. Stilt roots, which provide additional mechanical support to the plant, are commonly observed emerging from the lower nodes of the stem in which of the following crops?

- (A) Banyan tree
- (B) Maize (*Zea mays*)
- (C) Mustard
- (D) Mango

Q22. The primary carboxylating enzyme responsible for fixing carbon dioxide in the mesophyll cells of C₄ plants like sugarcane and maize is:

- (A) RuBisCO
- (B) PEP carboxylase (PEPCase)
- (C) Pyruvate dehydrogenase
- (D) Malate dehydrogenase

Q23. Vascular bundles in the family Fabaceae are typically described as:

- (A) Radial and open



- (B) Conjoint, collateral, and open
- (C) Conjoint, collateral, and closed
- (D) Concentric and amphivasal

Q24. Which portion of the leaf anatomy contains the highest concentration of chloroplasts per cell and serves as the principal site for photosynthesis in a typical dorsiventral dicot leaf?

- (A) Spongy parenchyma
- (B) Palisade parenchyma
- (C) Bundle sheath cells
- (D) Epidermis

Q25. The composite, highly specialized inflorescence found in figs, where a fleshy receptacle forms a hollow cavity with an apical ostiole housing male, female, and gall flowers internally, is called a:

- (A) Umbel
- (B) Capitulum
- (C) Hypanthodium
- (D) Verticillaster



Detailed Solutions**Q1.****Solution**

Concept: Plant cells and animal cells exhibit distinct structural differences adapted to their unique physiological roles. While both share basic eukaryotic features like a nucleus, mitochondria, and endoplasmic reticulum, plant cells possess specialized structures required for autotrophic nutrition, mechanical support, and osmotic regulation, which are absent in heterotrophic animal cells.

Solution:

- (a) Plastids are double-membrane-bound organelles unique to plants and algae. They include chloroplasts (responsible for photosynthesis), chromoplasts (synthesizing and storing pigments), and leucoplasts (storing starch, lipids, or proteins).
- (b) Plant cells also contain a large, permanent central vacuole that occupies up to 90
- (c) Mitochondria, Golgi apparatus, and ribosomes are universal eukaryotic organelles. Mitochondria handle cellular respiration, the Golgi apparatus processes proteins, and ribosomes synthesize proteins. These three structures are functional in both plant and animal cells.
- (d) Since animals do not perform photosynthesis and rely on skeletal systems or alternative osmoregulation mechanisms, they lack plastids and large central vacuoles entirely.
- (e) Therefore, the presence of plastids along with a massive central vacuole is an exclusive diagnostic feature of plant anatomy.

Final Answer: Plastids (chloroplasts, chromoplasts, leucoplasts) and a large central vacuole

Answer: (C)

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Q2.

Solution

Concept: Inflorescence refers to the arrangement of flowers on the floral axis (peduncle). Based on whether the main apex continues to grow or terminates in a flower, inflorescences are broadly categorized into two major types: racemose and cymose, each following a distinct opening and developmental sequence.

Solution:

- (a) In a cymose inflorescence, the growth of the main axis is definite because the terminal meristem transforms into a flower bud. This stops the vertical elongation of the primary peduncle.
- (b) Subsequent lateral branches develop below this terminal flower, and each of these secondary branches also terminates in a flower, strictly limiting their individual growth.
- (c) Because the oldest flower is situated at the absolute apex, the development of new flowers proceeds downward toward the base. This arrangement pattern is termed basipetal succession.
- (d) In contrast, racemose inflorescences show indefinite growth with an acropetal succession, where the youngest flowers appear at the apex.
- (e) Special inflorescences like hypanthodium (fig) and cyathium (Euphorbia) are highly modified structures that do not follow simple basipetal main-axis configurations.

Final Answer: Cymose

Answer: (B)

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Q3.

Solution

Concept: Meiosis I features an extended, complex prophase divided into five sequential substages: leptotene, zygotene, pachytene, diplotene, and diakinesis. This phase is evolutionary critical because it introduces genetic variation through the physical exchange of maternal and paternal genetic material between homologous chromosome pairs.

Solution:

- (a) During the initial stages, leptotene involves chromatin condensation, and zygotene initiates the pairing of homologous chromosomes (synapsis) to form bivalents or tetrads held by the synaptonemal complex.
- (b) The third stage, pachytene, is characterized by the clear visibility of the four chromatids in each bivalent. During this stage, non-sister chromatids of homologous pairs break and swap corresponding segments.
- (c) This precise process of physical genetic exchange is known as crossing over. It is mediated by an enzyme complex called the recombination nodule.
- (d) In the subsequent diplotene stage, the synaptonemal complex dissolves, and the homologous chromosomes begin to separate, remaining attached only at the X-shaped cross-over points called chiasmata.
- (e) Thus, pachytene is the specific step where genetic recombination actually occurs.

Final Answer: Pachytene

Answer: (C)

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Q4.

Solution

Concept: The family Poaceae (Gramineae), encompassing vital agricultural cereal crops like wheat, rice, and maize, possesses distinct reproductive structures. Fruit classification in botany relies heavily on the structural relationship between the ripening ovary wall (pericarp) and the internal seed coat.

Solution:

- (a) A caryopsis is a simple, dry, indehiscent, single-seeded fruit characteristic of grasses. Its defining anatomical feature is that the pericarp becomes thin and completely fused with the underlying seed coat during maturation.
- (b) This complete fusion means the grain functions biologically and agriculturally as a single unit, often casually referred to as a naked seed, though it is morphologically a complete fruit.
- (c) A legume or pod is the characteristic fruit of the family Fabaceae, which dehisces along two sutures and does not have a fused pericarp-seed coat.
- (d) A siliquea is a dry dehiscent fruit developing from a bicarpellar ovary with a false septum, typical of Brassicaceae, while a berry is a fleshy multi-seeded fruit seen in Solanaceae.

Final Answer: Caryopsis

Answer: (A)

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Q5.

Solution

Concept: Blackman's Law of Limiting Factors dictates that when a chemical process is governed by multiple independent variables, its absolute rate is restricted by the factor operating at its minimum sub-optimal value. Photosynthesis depends on light, temperature, water, and carbon dioxide concentration.

Solution:

- (a) On a clear, warm, sunny day, ambient light intensity is abundant, and the plant is well-watered, meaning soil moisture is not a constraint and stomata can remain fully open.
- (b) Under these ideal external conditions, the ambient atmospheric carbon dioxide concentration (roughly 0.04
- (c) The primary carboxylating enzyme in C3 plants, RuBisCO, has a relatively low affinity for CO_2 and can also bind oxygen, leading to wasteful photorespiration when CO_2 levels are low.
- (d) Increasing light or water further under these specific conditions will not raise the photosynthetic yield because the enzyme sites are limited by the availability of carbon dioxide substrates.
- (e) Therefore, carbon dioxide availability acts as the bottleneck limiting factor for C3 crop productivity in bright sunlight.

Final Answer: Atmospheric CO_2 concentration

Answer: (B)

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Q6.

Solution

Concept: Agricultural botany requires the precise binomial nomenclature of major economic crops. Pigeon pea, locally known as Arhar or Red Gram, is a drought-resistant legume crop widely cultivated in tropical and subtropical regions for its protein-rich seeds, belonging to the subfamily Papilionoideae under Fabaceae.

Solution:

- (a) The valid botanical name for Pigeon pea is *Cajanus cajan*. It is characterized by a trifoliate leaf arrangement, vexillary aestivation, and a typical pod fruit.
- (b) Looking at the alternate choices, *Cicer arietinum* is the scientific name for Chickpea (Gram), which is another major pulse crop but has distinct morphotaxonomic features.
- (c) *Vigna mungo* is the botanical name for Black gram (Urad dal), known for its distinct hairy pods and specific nutritional profile.
- (d) *Glycine max* represents Soybean, an oilseed legume featuring exceptionally high protein and oil contents.
- (e) Matching the common agricultural name 'Arhar' with its established scientific designation yields *Cajanus cajan* as the single accurate taxonomic classification.

Final Answer: *Cajanus cajan*

Answer: (B)

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Q7.

Solution

Concept: Root systems are categorized based on their embryonic origin and structural development. During seed germination, the embryo contains a radicle that is genetically programmed to pierce the seed coat and grow downward into the soil to establish the primary anchorage and nutrient absorption pathways.

Solution:

- (a) When the radicle itself directly elongates and continues to grow as the main central axis of the underground system, it forms a permanent tap root. This primary root gives off lateral secondary and tertiary branches.
- (b) Tap root systems are highly characteristic of dicotyledonous agricultural plants, allowing deep soil penetration to access water reserves.
- (c) Adventitious roots differ fundamentally because they develop from any vegetative part of the plant body other than the embryonic radicle, such as stems, nodes, or leaves.
- (d) Fibrous roots occur when the primary root formed by the radicle is short-lived and replaced by a dense cluster of thin roots arising from the stem base, typical of monocots.
- (e) Prop roots are a specialized category of adventitious roots that hang down from aerial branches to provide mechanical support.

Final Answer: Tap root system

Answer: (B)

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Q8.

Solution

Concept: Photorespiration (the C2 cycle) is a light-dependent process that counters productive carbon fixation. It is initiated by the bifunctional property of the enzyme RuBisCO (Ribulose-1,5-bisphosphate carboxylase-oxygenase), which can bind either carbon dioxide or oxygen depending on their relative concentrations and temperature.

Solution:

- (a) Under elevated temperatures and high oxygen concentrations, the solubility of CO_2 drops more rapidly than O_2 , altering the ratio at the enzyme's active site. RuBisCO switches to its oxygenase activity.
- (b) Instead of fixing a molecule of CO_2 , RuBisCO binds O_2 to RuBP, breaking it down into one molecule of 3-phosphoglycerate and one molecule of 2-phosphoglycolate.
- (c) This phosphoglycolate enters a metabolic pathway across chloroplasts, peroxisomes, and mitochondria to salvage part of the carbon, releasing a previously fixed CO_2 molecule without generating ATP or NADPH.
- (d) C4 plants avoid this loss using Kranz anatomy, concentrating CO_2 around RuBisCO in bundle sheath cells to suppress oxygenase activity entirely.
- (e) Therefore, photorespiration acts as a major energetic disadvantage for C3 crops under hot, bright agricultural environments.

Final Answer: Photorespiration

Answer: (B)

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Q9.

Solution

Concept: The morphology of monocot leaves, especially within the family Poaceae, features adaptations distinct from dicots. A typical grass leaf lacks a long, distinct petiole and instead develops specialized basal structures designed to shield the stem node and intercalary meristem.

Solution:

- (a) In members of Poaceae, the leaf base is modified into a flattened, elongated structure known as the leaf sheath. This structure rolls around and clasps the stem, extending along the internode.
- (b) This sheath protects the young growing axillary buds and reinforces the relatively delicate nodes of agricultural grasses against physical bending or lodging.
- (c) A petiole is the distinct, stalk-like structure that connects a standard dicot leaf blade to the stem, which is typically absent or highly modified in grasses.
- (d) A pulvinus is a swollen leaf base capable of turgor movements, common in Fabaceae (legumes) but not found in Poaceae.
- (e) Stipules are small lateral appendages found at the base of the petiole in many dicot families, serving a protective function before the leaf unfolds.

Final Answer: Leaf sheath

Answer: (C)

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Q10.**Solution**

Concept: Plant anatomy relies on the spatial distribution and cellular arrangement of vascular tissues (xylem and phloem). Dicotyledonous and monocotyledonous stems show distinct evolutionary tracks in how they organize these transport tissues through their ground tissue matrix.

Solution:

- (a) Monocot stems contain numerous vascular bundles distributed throughout the parenchymatous ground tissue. There is no clear distinction between the cortex and the pith.
- (b) Each individual bundle in a monocot stem is described as conjoint and collateral (xylem and phloem on the same radius) and closed, meaning it lacks a vascular cambium layer between the xylem and phloem.
- (c) The absence of cambium prevents monocot stems from undergoing normal secondary growth.
- (d) In contrast, dicot stems have vascular bundles arranged in a neat, single concentric ring. These bundles are open, meaning they contain cambium that allows for secondary thickening over time.
- (e) Radial bundles with exarch xylem are anatomical features found in roots rather than stems, ruling out that option for stem identification.

Final Answer: Conjoint, collateral, and closed vascular bundles scattered throughout the ground tissue

Answer: (B)

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Q11.

Solution

Concept: Mendelian genetics describes how traits are transmitted from parents to offspring through discrete hereditary units called alleles. Gregor Mendel's Law of Segregation states that during gamete formation, the two alleles governing a specific trait separate from one another, ensuring each gamete carries only one allele for that gene.

Solution:

- (a) When a parent plant is heterozygous for a single gene locus, its genotype is designated as Tt. This individual produces two types of gametes in equal proportions: 50
- (b) Self-pollination or selfing involves crossing this heterozygous plant with itself ($Tt \times Tt$). The combinations of male and female gametes can be tracked using a standard Punnett square matrix.
- (c) Fusion of a T gamete with another T gamete yields a homozygous dominant offspring with the genotype TT.
- (d) Fusion of a T gamete with a t gamete, or vice versa, produces heterozygous offspring with the genotype Tt. This specific combination occurs twice within the four possible grid segments.
- (e) Fusion of two t gametes generates a homozygous recessive offspring with the genotype tt.
- (f) Counting these genetic combinations reveals exactly one TT, two Tt, and one tt. This results in a clear genotypic ratio of 1:2:1 among the F₂ generation, whereas the physical appearance or phenotypic ratio remains 3:1.

Final Answer: 1 : 2 : 1

Answer: (B)

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Q12.

Solution

Concept: Underground modifications of plant organs serve essential functions in agricultural crops, primarily focusing on long-term nutrient storage and perennation to survive unfavorable seasonal conditions. Distinguishing between modified roots and modified stems requires looking for fundamental anatomical landmarks like nodes, internodes, and bud structures.

Solution:

- (a) A rhizome is a horizontally growing, thick underground stem modification. Despite growing sub-surface, its structural identity as a stem is confirmed by the presence of distinct nodes and internodes along its axis.
- (b) Scale leaves are present at these nodal junctions, protecting dormant axillary buds that are fully capable of producing new aerial shoots and roots during the spring.
- (c) Ginger (*Zingiber officinale*) relies on this exact rhizome framework to accumulate starch reserves and propagate vegetatively across successive farming cycles.
- (d) In contrast, a carrot is a modified tap root structure designed for food storage, which lacks true nodes, internodes, or scale leaves along its fleshy body.
- (e) A sweet potato is an adventitious root modification that stores nutrients but does not possess the structural segmentation or structural organization of a true cauline stem.
- (f) Therefore, the rhizome of ginger fits all classical botanical criteria for an underground storage stem.

Final Answer: Rhizome of Ginger

Answer: (C)

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Q13.

Solution

Concept: Plant taxonomy uses distinct floral traits to classify agricultural crops into families. The calyx, representing the outermost whorl of a flower composed of sepals, usually serves a protective role during the bud stage and falls off or shrivels after fertilization takes place.

Solution:

- (a) In certain plant families, the calyx does not wither away after pollination. Instead, it remains attached to the developing fruit and undergoes secondary growth, expanding into a protective covering.
- (b) This botanical feature is known as a persistent, accrescent calyx. In crops like *Physalis* (ground cherry) and *Withania somnifera* (ashwagandha), it becomes inflated like a paper lantern around the berry.
- (c) This condition is a key identification feature for the family Solanaceae, which also includes nightshade crops like potato, tomato, brinjal, and chili.
- (d) Members of the family Fabaceae usually display a deciduous or regular green calyx that does not envelope the mature pod fruit in this manner.
- (e) The family Poaceae has highly reduced floral structures where sepals are modified into microscopic scales called lodicules, ruling them out completely.
- (f) Brassicaceae typically possesses four deciduous sepals arranged in two whorls that fall away as the silique fruit develops.

Final Answer: Solanaceae

Answer: (B)

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Q14.

Solution

Concept: Plants lose water through different physiological and physical pathways depending on environmental conditions, atmospheric humidity, and internal root pressure. Distinguishing between gaseous water loss and liquid exudation is important for understanding water relations in agricultural crops.

Solution:

- (a) Guttation is the process where plants release liquid water droplets from the uninjured margins, teeth, or tips of their leaves. This typically occurs during the night or early morning when soil moisture is high and transpiration is low.
- (b) Under these conditions, active mineral absorption builds up positive root pressure inside the xylem vessels, pushing water upward through the plant body.
- (c) This excess water is forced out through specialized, non-solidifying pore structures called hydathodes, located at the ends of leaf veins.
- (d) Transpiration differs fundamentally because it involves the evaporation of water in the form of invisible water vapor, primarily through regulated stomatal pores.
- (e) Evaporation is a purely physical surface phenomenon that does not depend on specialized plant anatomical structures like hydathodes.
- (f) Exudation is a broader term that includes the oozing of sap, latex, or resins from wounded or cut plant tissues rather than natural pores.

Final Answer: Guttation

Answer: (B)

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Q15.

Solution

Concept: A floral formula uses standardized typographic symbols to convey the structural composition, symmetry, whorl arrangement, and numerical counts of a flower's organs, serving as a shorthand representation in systematic agricultural botany.

Solution:

- (a) Floral symmetry describes how floral organs are arranged around the central axis of a flower, determining whether the flower can be divided into matching halves.
- (b) The symbol $\oplus$ is used in floral formulas to represent actinomorphic symmetry, which is also known as radial symmetry.
- (c) An actinomorphic flower can be divided into two identical mirror images along any vertical plane that passes directly through the central longitudinal axis, as seen in mustard and datura.
- (d) Zygomorphic or bilateral symmetry is represented instead by a percentage sign (
- (e) Asymmetric flowers cannot be divided into equal halves along any plane and are designated by separate notations.
- (f) Epigynous refers to an inferior ovary position where the floral parts arise above the gynoecium, which is designated by a line drawn above the 'G' symbol.

Final Answer: Actinomorphic (Radial symmetry)

Answer: (A)

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Q16.

Solution

Concept: Gas exchange and water loss in plants are regulated by the stomatal apparatus found in the epidermal layer of leaves. This cellular complex responds dynamically to environmental cues by adjusting the physical aperture of the stomatal pore.

Solution:

- (a) The stomatal apparatus consists of a central pore surrounded by two specialized, kidney-shaped or dumbbell-shaped epidermal cells known as guard cells.
- (b) Guard cells have unevenly thickened cell walls. The inner wall facing the pore is thick and inelastic, while the outer wall is thin and highly elastic.
- (c) When water moves into the guard cells from surrounding tissue, their turgor pressure increases. This causes the elastic outer walls to bulge outward, pulling the inner thick walls apart and opening the pore.
- (d) When the guard cells lose water and turgor pressure drops, they become flaccid, allowing the inner walls to return to their original position and closing the pore.
- (e) Subsidiary cells provide mechanical and osmotic support next to the guard cells but do not change shape to form the pore itself.
- (f) General epidermal and mesophyll cells make up the bulk of the leaf tissue but lack the specialized structural framework required to directly regulate stomatal movement.

Final Answer: Guard cells

Answer: (C)

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Q17.

Solution

Concept: Aestivation describes how sepals or petals are arranged inside a flower bud before the flower opens. This structural arrangement is an important taxonomic tool used to identify and distinguish different plant families.

Solution:

- (a) Vexillary or papilionaceous aestivation is a unique arrangement pattern found in the corolla of leguminous plants. It consists of five distinct petals with a specific overlapping sequence.
- (b) The outermost, largest petal is called the standard or vexillum. It overlaps two smaller lateral petals known as wings or alae.
- (c) These two wing petals, in turn, overlap the two smallest anterior petals, which are fused together to form a boat-shaped structure called the keel or carina.
- (d) This specialized floral arrangement is a diagnostic feature of the subfamily Papilionoideae within the family Fabaceae.
- (e) *Pisum sativum* (garden pea) is a classic agricultural representative of Fabaceae and exhibits this exact vexillary pattern.
- (f) *Solanum nigrum* shows valvate aestivation, *Triticum aestivum* features reduced glumes without true petals, and *Brassica campestris* exhibits a cruciform corolla with imbricate aestivation.

Final Answer: *Pisum sativum*

Answer: (B)

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Q18.

Solution

Concept: Respiration is a metabolic process where organic substrates are broken down step-by-step to release usable chemical energy in the form of ATP. Glycolysis, also known as the Embden-Meyerhof-Parnas (EMP) pathway, is the initial stage of this breakdown and occurs in the cytoplasm of all living cells.

Solution:

- (a) Glycolysis consists of a sequence of ten enzyme-catalyzed reactions that do not require molecular oxygen, making it a common pathway for both aerobic and anaerobic respiration.
- (b) The starting material for this pathway is a single six-carbon sugar molecule, typically glucose ($C_6H_{12}O_6$).
- (c) Through a series of phosphorylation, isomerization, and cleavage steps, this six-carbon hexose ring is split into two separate three-carbon fragments.
- (d) The final steps of glycolysis oxidize these fragments, yielding two molecules of pyruvic acid ($CH_3COCOOH$) along with a net gain of two ATP and two NADH molecules.
- (e) Acetyl-CoA is produced later inside the mitochondria during the link reaction, which occurs only under aerobic conditions.
- (f) Lactic acid is a product of anaerobic fermentation in specialized animal tissues or microbes, while citric acid is an intermediate formed inside the mitochondrial matrix during the Krebs cycle.

Final Answer: Two molecules of Pyruvic acid

Answer: (B)

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Q19.**Solution**

Concept: Gynoecium anatomy provides reliable structural criteria for plant family identification. Characterizing how carpels fuse, how the ovary is positioned, and how ovules attach to the placenta helps distinguish closely related agricultural crops.

Solution:

- (a) The family Solanaceae features a characteristic gynoecium structure composed of a bicarpellar, syncarpous superior ovary.
- (b) Inside the ovary, the partition wall or septum develops at an oblique angle relative to the median plane of the flower, rather than running strictly anterior-posterior. This orientation creates an oblique ovary.
- (c) The central placenta is noticeably swollen and holds numerous ovules arranged in an axile placentation pattern.
- (d) This structural combination—an oblique ovary resting on a swollen placenta—is a diagnostic feature used to identify the Solanaceae family, helping to distinguish it from other dicot groups.
- (e) Poaceae features a monocarpellar ovary with basal placentation, Fabaceae has a monocarpellar ovary with marginal placentation, and Cucurbitaceae typically possesses a tricarpellar inferior ovary with parietal placentation.

Final Answer: Solanaceae

Answer: (B)

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Q20.

Solution

Concept: Cell division is the biological process by which parent cells replicate and distribute their genetic material to form new daughter cells. Plants utilize different types of cell division to support vegetative growth, tissue repair, and sexual reproduction throughout their life cycle.

Solution:

- (a) Mitosis is known as equational division because the genetic material is replicated precisely, ensuring that each daughter cell receives an identical set of chromosomes matching the parent cell ($2n \rightarrow 2n$ or $n \rightarrow n$).
- (b) This division maintains genetic stability across cell generations, making it ideal for forming vegetative structures like roots, stems, leaves, and meristems.
- (c) Meiosis, or reductional division, reduces the chromosome number by half ($2n \rightarrow n$) across two sequential stages (Meiosis I and II), a process reserved for producing haploid spores or gametes.
- (d) Amitosis is an irregular, direct nuclear division where the nucleus splits without chromosome condensation or spindle formation, a process seen mainly in lower organisms or specialized endosperm tissues rather than regular vegetative growth.
- (e) Therefore, mitosis is the primary mechanism responsible for structural elongation, tissue repair, and biomass accumulation in agricultural crops.

Final Answer: Mitosis

Answer: (A)

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Q21.

Solution

Concept: Root modifications in agricultural botany serve diverse physiological and structural roles. Beyond the primary absorption of water and minerals, certain adventitious root systems undergo distinct morphological adaptations to offer extra structural reinforcement to tall, slender crop plants against mechanical stresses.

Solution:

- (a) Stilt roots are specialized adventitious roots that develop from the basal nodes of the main stem. These roots grow obliquely downward at an angle and penetrate firmly into the soil to act as anchors.
- (b) This modification provides extra mechanical balance to plants with tall, slender stems that are prone to tipping over due to wind or heavy foliage weight.
- (c) Maize (*Zea mays*) and sugarcane are typical agricultural crops that exhibit this root architecture to support their rapid upward vegetative growth.
- (d) Prop roots differ because they arise from large horizontal aerial branches and drop vertically straight down, a classic characteristic seen in the banyan tree.
- (e) Mustard develops a traditional tap root system with minor lateral branching without specialized mechanical aerial modifications.
- (f) Mango is a large arborescent dicot that relies entirely on a deep, expansive underground tap root system for its structural anchorage.

Final Answer: Maize (*Zea mays*)

Answer: (B)

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Q22.

Solution

Concept: The C₄ photosynthetic pathway is an evolutionary adaptation designed to minimize photorespiration in tropical regions. This mechanism separates the initial capture of carbon dioxide and its subsequent reduction into two distinct cellular layers: mesophyll cells and bundle sheath cells.

Solution:

- (a) In the mesophyll cells of C₄ plants like sugarcane and maize, atmospheric carbon dioxide is converted into bicarbonate ions (HCO_3^-) inside the cytoplasm.
- (b) The primary enzyme that catalyzes the initial fixation step is Phosphoenolpyruvate carboxylase, commonly abbreviated as PEP carboxylase or PEPCase.
- (c) PEPCase fixes the carbon substrate onto a three-carbon acceptor molecule called phosphoenolpyruvate (PEP) to form the four-carbon organic acid oxaloacetate (OAA).
- (d) PEPCase possesses a high affinity for inorganic carbon and does not bind molecular oxygen, preventing any competitive interactions with oxygen.
- (e) RuBisCO is also present in C₄ plants but is located inside the bundle sheath cells, where it handles the final fixation step within the Calvin cycle.
- (f) Pyruvate dehydrogenase and malate dehydrogenase handle intermediate organic acid transformations rather than primary atmospheric carbon dioxide capture.

Final Answer: PEP carboxylase (PEPCase)

Answer: (B)

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Q23.

Solution

Concept: The internal anatomy of organs in the family Fabaceae follows typical dicotyledonous structural rules. Analyzing the orientation, arrangement, and presence of generative tissue within the vascular bundles helps identify and distinguish these pulse crops.

Solution:

- (a) The vascular bundles in the stems of Fabaceae members are organized in a single concentric ring around a central pith area, which is typical for dicot stems.
- (b) Each individual bundle is described as conjoint and collateral, meaning the primary xylem and primary phloem sit together along the same radial line.
- (c) A strip of lateral meristematic tissue, known as the vascular cambium, is situated between the xylem and phloem layers within each bundle.
- (d) The presence of this active cambium strip makes the bundle open, giving the plant the capacity for secondary thickening and wood formation.
- (e) Closed vascular bundles lack this cambium layer and are scattered throughout the ground tissue, a layout characteristic of monocot stems.
- (f) Radial arrangements are found exclusively in root systems, while concentric configurations are restricted to specialized anomalous dicots and ferns.

Final Answer: Conjoint, collateral, and open

Answer: (B)

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Q24.

Solution

Concept: Dorsiventral (bifacial) leaves are typical of dicotyledonous crop plants. The internal ground tissue, known as the mesophyll, is differentiated into two distinct layers that specialize in either gas exchange or light absorption.

Solution:

- (a) Palisade parenchyma is located directly beneath the upper epidermis. It consists of elongated, column-like cells arranged vertically and packed closely together.
- (b) These cells contain a high concentration of chloroplasts per cell, which align along the walls to maximize light absorption.
- (c) This layout makes the palisade layer the principal site for light harvesting and carbon fixation within the leaf anatomy.
- (d) Spongy parenchyma sits below the palisade layer and contains loosely arranged, irregular cells with large intercellular air spaces designed to assist gas exchange.
- (e) Bundle sheath cells form a protective layer around the vascular veins but do not contain high densities of photosynthetic machinery in C3 dicots.
- (f) The epidermal layers are covered by a waxy cuticle and protect the internal tissues, typically lacking chloroplasts except within their specialized guard cells.

Final Answer: Palisade parenchyma

Answer: (B)

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Q25.

Solution

Concept: Specialized inflorescences develop highly modified branch systems to assist pollination. These composite structures group small, simplified flowers within a shared, protective modified axis to improve reproductive success.

Solution:

- (a) A hypanthodium is a specialized inflorescence characteristic of the genus *Ficus*, which includes figs, banyan, and peepal trees.
- (b) In this layout, the main peduncle fleshy axis grows and fuses into a hollow, cup-like spherical receptacle with a small opening at the top called an ostiole.
- (c) The internal cavity houses three types of flowers: male flowers near the ostiole, fertile female flowers at the base, and sterile female gall flowers in between.
- (d) This structure relies on a mutualistic relationship with specialized fig wasps, which enter through the ostiole to lay eggs and pollinate the flowers.
- (e) A umbel features flowers with stalks of equal length arising from a single point, which is typical for the family Apiaceae.
- (f) A capitulum consists of a flattened receptacle bearing numerous sessile florets, as seen in sunflowers, while a verticillaster features condensed axillary cymes typical of Labiatae.

Final Answer: Hypanthodium

Answer: (C)

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Answer Key

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

