SRMJEEE Biology Sample Paper – 3

Duration: 47 Minutes **Maximum Marks: 40**

Instructions

- This paper contains **40** Multiple Choice Questions (Single Correct Answer), modelled on the Biology section of **SRMJEEE** (SRM Joint Engineering Entrance Examination).
- Each correct answer carries **+1 mark**. There is **no negative marking**; an unattempted or wrong answer scores 0.
- Only **one** option is correct. Choose carefully.
- The actual SRMJEEE is a **computer-based test** conducted in remote-proctored online mode, with all sections sharing a common time window and no per-section limit.
- Personal calculators, mobile phones, log tables and other electronic gadgets are strictly prohibited.

Q1. The kingdom that includes single-celled *eukaryotic* organisms such as *Amoeba*, *Euglena* and the diatoms is:

(A) Monera

(B) Protista

(C) Fungi

(D) Animalia

Q2. Which group of plants is regarded as the first to develop a true vascular system, possessing both xylem and phloem for conduction?

(A) Pteridophytes

(B) Bryophytes

(C) Algae

(D) Fungi

Q3. The earthworm belongs to a phylum characterised by *metameric segmentation* of the body and a *closed* circulatory system. This phylum is:

(A) Arthropoda

(B) Mollusca

(C) Annelida

(D) Nematoda

Q4. In the taxonomic hierarchy, the basic (lowest) unit of biological classification — a group of organisms that can interbreed and produce fertile offspring — is the:

(A) genus

(B) family

(C) order

(D) species

Q5. The fleshy, swollen carrot (or radish) that stores food underground is an example of a modified:

(A) storage taproot

(B) stem tuber

(C) rhizome

(D) corm

Q6. A plant with trimerous flowers, parallel-veined leaves and the floral formula typical of monocots — represented by onion and *Aloe* — belongs to the family:

(A) Solanaceae

(B) Liliaceae

(C) Fabaceae

(D) Brassicaceae

Q7. In the frog, gaseous exchange is carried out through three routes — the moist skin, the lining of the buccal cavity and the lungs. This combined mode of breathing is best described as:

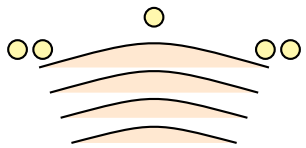
(A) only pulmonary (lungs)

(B) only cutaneous (skin)

(C) only buccal

(D) cutaneous, buccal and pulmonary together

Q8. The organelle shown below is a stack of flattened, curved membranous sacs (cisternae) with vesicles budding from its margins; it packages, modifies and secretes cell products. It is the:



Golgi apparatus — stacked cisternae with secretory vesicles

(A) mitochondrion

(B) lysosome

(C) Golgi apparatus

(D) ribosome

Q9. The rigid cell wall that surrounds and supports a typical plant cell is composed chiefly of the polysaccharide:

(A) cellulose

(B) chitin

(C) peptidoglycan

(D) glycogen

Q10. Malonate inhibits succinate dehydrogenase because it resembles the substrate succinate and binds at the active site. This type of enzyme inhibition, which can be overcome by raising the substrate concentration, is called:

(A) non-competitive inhibition

(B) competitive inhibition

(C) allosteric inhibition

(D) feedback (end-product) inhibition

Q11. The stage of mitosis in which the chromatin condenses into visible chromosomes, the nuclear envelope begins to break down, and assembly of the spindle apparatus starts, is:

(A) metaphase

(B) anaphase

(C) prophase

(D) telophase

Q12. The intimate, point-by-point pairing of homologous chromosomes to form bivalents (tetrads) during meiosis is called synapsis. It occurs in the substage of prophase I known as:

(A) leptotene

(B) pachytene

(C) diplotene

(D) zygotene

Q13. For a plant cell the water potential is given by $\Psi = \Psi_s + \Psi_p$. Water always moves from a region of:

(A) higher (less negative) water potential to lower (more negative) water potential

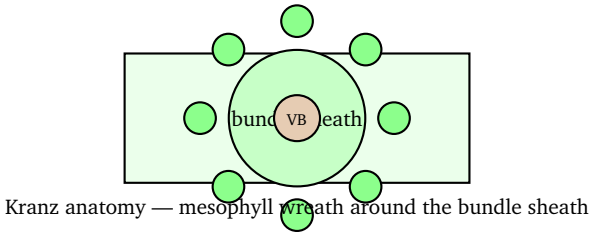
(B) lower water potential to higher water potential

(C) higher solute potential to lower solute potential only

(D) higher pressure potential to lower pressure potential only

Q14. In the leaf shown, the bundle-sheath cells form a wreath (Kranz) around the vascular bundle. In such C_4 plants the primary CO_2 acceptor in the

mesophyll is phosphoenolpyruvate (PEP), and the enzyme that fixes CO_2 there is:



Kranz anatomy — mesophyll wreath around the bundle sheath

(A) RuBisCO

(B) PEP carboxylase

(C) pyruvate kinase

(D) nitrogenase

Q15. In a eukaryotic cell, the reactions of the Krebs (tricarboxylic acid) cycle take place in the:

(A) cytoplasm

(B) inner mitochondrial membrane

(C) mitochondrial matrix

(D) nucleus

Q16. Which plant growth regulator promotes cell division (cytokinesis) and notably *delays* the senescence of leaves — the effect demonstrated by Richmond and Lang?

(A) auxin

(B) gibberellin

(C) abscisic acid

(D) cytokinin

Q17. Bile, secreted by the liver, aids digestion of fats by breaking large fat globules into tiny droplets (emulsification). With respect to digestive enzymes, bile:

(A) contains no digestive enzyme of its own

(B) is rich in the enzyme lipase

(C) contains the protein-digesting enzyme pepsin

(D) contains salivary amylase

Q18. The volume of air that still remains in the lungs even after the most forceful expiration — and which therefore cannot be exhaled — is the:

(A) tidal volume

(B) residual volume

(C) inspiratory reserve volume

(D) expiratory reserve volume

Q19. A person whose red blood cells carry the Rh antigen (the D antigen) on their surface is said to be:

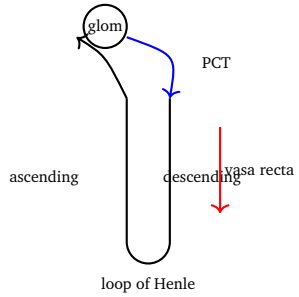
(A) of blood group O

(B) a universal donor

(C) Rh-negative

(D) Rh-positive

Q20. In the nephron shown, the hairpin loop of Henle together with the vasa recta sets up a gradient of increasing osmolarity towards the medulla, allowing the production of concentrated (hyperosmotic) urine. This arrangement is called the:



counter-current arrangement

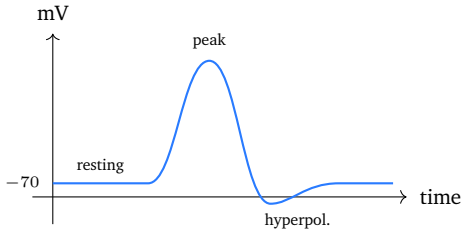
(A) ultrafiltration mechanism

(B) active-transport pump

(C) counter-current mechanism

(D) osmotic-shock mechanism

Q21. The trace below shows the membrane potential of a neuron. The negative resting potential ($\approx -70\,\text{mV}$) is maintained by the Na^+/K^+ pump, while the sharp rise (depolarisation) of the action potential is due mainly to the sudden influx of:



(A) sodium ions (Na^+)

(B) chloride ions (Cl^-)

(C) calcium ions (Ca^{2+}) only

(D) potassium ions (K^+)

Q22. During sudden stress or danger the body shows a rapid "fight-or-flight" response — raised heart rate, dilated pupils and increased blood glucose. The hormone chiefly responsible, secreted by the adrenal medulla, is:

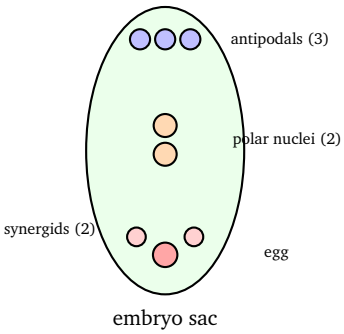
(A) insulin

(B) adrenaline (epinephrine)

(C) thyroxine

(D) aldosterone

Q23. The mature embryo sac (female gametophyte) of a typical angiosperm shown below is:



This embryo sac is:

(A) 3-celled and 3-nucleate

(B) 8-celled and 8-nucleate

(C) 4-celled and 8-nucleate

(D) 7-celled and 8-nucleate

Q24. In double fertilisation, the fusion of one male gamete with the two polar nuclei of the central cell is termed triple fusion. It gives rise to the:

(A) diploid ($2n$) zygote

(B) haploid (n) egg cell

(C) triploid ($3n$) primary endosperm nucleus

(D) diploid ($2n$) synergid

Q25. The process by which the female gamete (ovum) is formed from the oogonia within the ovary is called:

(A) oogenesis

(B) spermatogenesis

(C) gametogenesis in the testis

(D) fertilisation

Q26. The copper-T is an intra-uterine device used for contraception. The released copper ions act mainly by:

(A) permanently blocking the fallopian tubes by surgery

(B) suppressing sperm motility and viability, preventing fertilisation and implantation

(C) supplying oestrogen and progesterone like the pill

(D) acting as a physical barrier over the cervix only

Q27. The Punnett square shows a test cross in which a tall plant of unknown genotype is crossed with a dwarf (tt) plant. If the offspring appear in a tall : dwarf ratio of $1:1$ (as below), the unknown parent must be:

	t	t
Tt	Tt	tt

test cross $Tt \times tt$

(A) homozygous dominant (TT)

(B) homozygous recessive (tt)

(C) a tetraploid

(D) heterozygous (Tt)

Q28. In a person of blood group AB, both the A and the B antigens are fully expressed on the red blood cells, with neither allele masking the other. This is a classic example of:

(A) complete dominance

(B) incomplete dominance

(C) codominance

(D) epistasis

Q29. A male individual with 47 chromosomes and the sex-chromosome constitution XXY, showing under-developed testes and some feminine features, has the disorder known as:

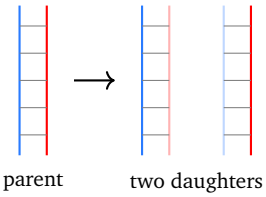
(A) Turner's syndrome

(B) Klinefelter's syndrome

(C) Down's syndrome

(D) Edward's syndrome

Q30. In the DNA molecule shown, replication separates the two strands and each old (parental) strand serves as a template for a new strand, so every daughter molecule has one old and one new strand. This mode of replication, confirmed by Meselson and Stahl, is called:



(A) semiconservative replication

(B) conservative replication

(C) dispersive replication

(D) bidirectional translation

Q31. Which set of properties correctly describes the genetic code?

(A) singlet, specific and overlapping

(B) doublet, ambiguous and species-specific

(C) triplet, degenerate, non-overlapping and nearly universal

(D) triplet, overlapping and non-degenerate

Q32. The theory that organs strengthen with use and weaken with disuse, and that such acquired characters are passed on to the offspring (e.g. the long neck of the giraffe), was proposed by:

(A) Charles Darwin

(B) Hugo de Vries

(C) Gregor Mendel

(D) Jean-Baptiste Lamarck

Q33. Filariasis (elephantiasis), caused by the nematode *Wuchereria bancrofti*, is transmitted to humans by the bite of the:

(A) *Aedes* mosquito

(B) *Culex* mosquito

(C) female *Anopheles* mosquito

(D) sandfly

Q34. When a person is given a vaccine and their own body produces antibodies in response, the immunity developed is:

(A) active immunity

(B) passive immunity

(C) innate (non-specific) immunity only

(D) passive immunity acquired through the placenta

Q35. The first antibiotic to be discovered, by Alexander Fleming, was penicillin, which is obtained from the mould:

(A) *Streptomyces griseus*

(B) *Lactobacillus*

(C) *Penicillium notatum*

(D) *Saccharomyces cerevisiae*

Q36. In recombinant DNA technology, the enzyme that joins two DNA fragments together by forming phosphodiester bonds — often called the "molecular glue" — is:

(A) restriction endonuclease

(B) DNA polymerase

(C) helicase

(D) DNA ligase

Q37. Nematode-resistant tobacco plants have been developed by introducing genes that silence specific parasite mRNAs through the formation of complementary double-stranded RNA. This cellular defence process is:

(A) transduction

(B) RNA interference (RNAi)

(C) transcription

(D) reverse transcription

Q38. The three repeated steps of one cycle of the polymerase chain reaction (PCR), carried out using a heat-stable Taq DNA polymerase, are in correct order:

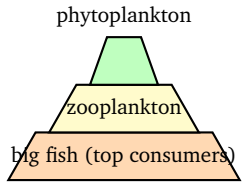
(A) denaturation, annealing, extension

(B) annealing, denaturation, extension

(C) extension, annealing, denaturation

(D) denaturation, extension, annealing

Q39. In a pond (aquatic) ecosystem, the small phytoplankton at the base have a much smaller standing biomass than the larger consumers they support. The pyramid of biomass shown for this ecosystem is therefore:



pyramid of biomass (pond)

(A) always upright

(B) linear (rectangular)

(C) inverted

(D) spindle-shaped

Q40. Regions that are exceptionally rich in species and have a very high level of endemism, but are also under serious threat of habitat loss, are designated for priority conservation as:

(A) sacred groves

(B) botanical gardens

(C) cryopreservation banks

(D) biodiversity hotspots

Detailed Solutions

Q1.

Solution

Concept — Kingdom Protista: In Whittaker's five-kingdom scheme, Protista is the kingdom that holds all single-celled *eukaryotic* organisms. These cells possess a true membrane-bound nucleus and membrane-bound organelles, which sets them apart from the prokaryotic Monera.

Key fact: *Amoeba* (a protozoan), *Euglena* (a flagellate that is both autotrophic and heterotrophic) and the diatoms (golden-brown photosynthetic algae with silica walls) are all unicellular eukaryotes and are therefore grouped under Protista. The kingdom forms a bridge linking simple prokaryotes with the more complex plants, animals and fungi.

Why other options are wrong:

- (A) Monera contains only *prokaryotes* (bacteria, cyanobacteria); they lack a true nucleus.
- (C) Fungi are eukaryotic but are largely multicellular with a chitinous wall and absorptive nutrition.
- (D) Animalia are multicellular eukaryotes with holozoic nutrition.

Final Answer: Unicellular eukaryotes belong to Protista $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q1

Q2.

Solution

Concept — Vascular tissue in plants: Vascular tissue (xylem for water conduction and phloem for food conduction) allows plants to grow tall on land and transport materials efficiently. The first plant group to evolve this true vascular system is a key milestone in plant evolution.

Key fact: *Pteridophytes* (ferns, *Selaginella*, horsetails) are the first true vascular plants (tracheophytes); they possess well-developed xylem and phloem. They are also called the "snakes of the plant kingdom" (cryptogams with vascular tissue) and have a dominant sporophyte.

Why other options are wrong:

- (B) Bryophytes (mosses, liverworts) are non-vascular "amphibians of the

plant kingdom"; they lack xylem and phloem.
- (C) Algae are simple thalloid plants without vascular tissue.
- (D) Fungi are not plants and have no conducting tissue.

Final Answer: First true vascular plants = pteridophytes $\Rightarrow$ $\boxed{A}$

Answer: (A) Go Back to Q2

Q3.

Solution

Concept — Phylum Annelida: Annelids are the first animals to show true *metameric segmentation*, where the body is divided into a series of similar ring-like segments (metameres) both externally and internally. They also possess a true coelom and a closed circulatory system.

Key fact: The earthworm (*Pheretima*) is a typical annelid. Its blood flows entirely within blood vessels (a *closed* circulatory system), and its body is built of many identical segments. Excretion is by segmentally arranged nephridia.

Why other options are wrong:

- (A) Arthropoda (cockroach, prawn) have an *open* circulatory system and a jointed chitinous exoskeleton.
- (B) Mollusca (snail, *Pila*) are mostly unsegmented with a muscular foot and usually open circulation.
- (D) Nematoda (roundworms) are unsegmented pseudocoelomates.

Final Answer: Earthworm belongs to Annelida $\Rightarrow$ $\boxed{C}$

Answer: (C) Go Back to Q3

Q4.

Solution

Concept — Taxonomic hierarchy: Living organisms are classified through a ranked series of categories — kingdom, phylum/division, class, order, family, genus and species — arranged from the broadest to the narrowest. Each successively lower category contains fewer organisms that share more characters.

Key fact: The *species* is the lowest and basic unit of classification. A species is a natural group of individuals that closely resemble one another and can interbreed freely to produce fertile offspring (e.g. *Homo sapiens*, *Mangifera indica*).

Why other options are wrong:

- (A) A genus is a group of related species and lies just above the species.
- (B) A family is a group of related genera; (C) an order is a group of related families.
- These are all higher categories, not the basic unit.

Final Answer: Basic unit of classification = species $\Rightarrow$ D

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Modifications of the taproot: The primary root and its branches sometimes become swollen with stored food. Because these structures develop from the radicle (root system), they are classed as root modifications, not stem modifications, and they bear no nodes, internodes or buds.

Key fact: The carrot and the radish are *storage (conical/fusiform) taproots* — the main taproot itself swells with reserve food. Being roots, they lack "eyes"/buds, distinguishing them from stem storage organs such as the potato.

Why other options are wrong:

- (B) A stem tuber (potato) is a swollen underground stem that bears axillary buds (eyes).
- (C) A rhizome (ginger) is a horizontal underground stem; (D) a corm (*Colocasia*) is a vertical condensed stem — all are *stem*, not root, modifications.

Final Answer: Carrot/radish = storage taproot $\Rightarrow$ A

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — Family Liliaceae: Liliaceae is a major *monocot* family. Its members typically show trimerous flowers (floral parts in multiples of three), a perianth of six tepals, six stamens, a superior tricarpellary ovary, and parallel venation in the leaves.

Key fact: Onion (*Allium cepa*), garlic, *Aloe*, tulip and *Asparagus* are common Lili-

aceae. Many store food in bulbs or rhizomes, and *Aloe* is valued medicinally. The trimerous, actinomorphic flowers are the diagnostic clue.

Why other options are wrong:

- (A) Solanaceae (potato, brinjal) are dicots with pentamerous flowers and a bicarpellary ovary.
- (C) Fabaceae have papilionaceous flowers; (D) Brassicaceae (mustard) have cruciform flowers and tetradynamous stamens — all dicot features.

Final Answer: Onion and *Aloe* belong to Liliaceae $\Rightarrow$ B

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Respiration in the frog: The frog is an amphibian and breathes by more than one route depending on whether it is in water, on land, or hibernating. Its moist, highly vascular skin makes a major contribution to gas exchange.

Key fact: The frog respires through three surfaces — the *skin* (cutaneous respiration, important in water and during hibernation), the *buccal cavity* lining (buccopharyngeal respiration), and the *lungs* (pulmonary respiration, on land when active). All three together meet its oxygen needs.

Why other options are wrong:

- (A) Lungs alone are insufficient, especially under water where the skin takes over.
- (B) Skin alone cannot support the active frog on land.
- (C) Buccal respiration is only a minor accessory route, never the sole one.

Final Answer: Frog uses skin, buccal cavity and lungs together $\Rightarrow$ D

Answer: (D) Go Back to Q7

Q8.

Solution

Concept — The Golgi apparatus: First described by Camillo Golgi, this organelle is a stack of flattened, curved membranous sacs called *cisternae*, with associated vesicles. It has a distinct polarity — a convex *cis* (forming) face and a concave *trans* (maturing) face.

Key fact: The Golgi apparatus is the cell's packaging and secretion centre. It receives proteins and lipids from the endoplasmic reticulum, chemically modifies them (e.g. glycosylation), sorts them, and packages them into vesicles for secretion or delivery. The stacked cisternae with budding vesicles in the figure are its signature.

Why other options are wrong:

- (A) The mitochondrion is a double-membraned organelle with inner cristae, not flat cisternae.
- (B) A lysosome is a single membrane-bound sac of digestive enzymes (not a stack).
- (D) A ribosome is a tiny non-membranous particle that synthesises protein.

Final Answer: Stacked cisternae for packaging = Golgi apparatus $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q8

Q9.

Solution

Concept — The plant cell wall: Unlike animal cells, plant cells are enclosed by a rigid, non-living cell wall outside the plasma membrane. This wall provides shape, mechanical strength and protection, and resists the osmotic entry of water (preventing bursting).

Key fact: The plant cell wall is made chiefly of *cellulose*, a long unbranched polymer of β-1,4-linked glucose units. The cellulose microfibrils are embedded in a matrix of hemicellulose and pectin; lignin is added later in woody tissues for extra rigidity.

Why other options are wrong:

- (B) Chitin forms the cell wall of fungi and the exoskeleton of arthropods.
- (C) Peptidoglycan (murein) makes up the bacterial cell wall.
- (D) Glycogen is the animal storage polysaccharide, not a wall material.

Final Answer: Plant cell wall is made of cellulose $\Rightarrow$ A

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Enzyme inhibition: Inhibitors reduce enzyme activity. A *competitive* inhibitor closely resembles the substrate in shape and competes with it for the same active site, whereas a non-competitive inhibitor binds elsewhere.

Key fact: Malonate resembles succinate and binds reversibly at the active site of succinate dehydrogenase, blocking the substrate. Because it competes for the same site, increasing the *substrate* concentration outcompetes the inhibitor and restores activity — the hallmark of *competitive inhibition*.

Why other options are wrong:

- (A) Non-competitive inhibitors bind at a separate site and are *not* relieved by more substrate.
- (C) Allosteric inhibition acts at a regulatory site, changing enzyme shape.
- (D) Feedback inhibition is the end product of a pathway switching off an earlier enzyme.

Final Answer: Substrate-mimicking, substrate-relieved inhibition = competitive $\Rightarrow$ B

Answer: (B) Go Back to Q10

Q11.

Solution

Concept — Phases of mitosis: Mitosis proceeds through prophase, metaphase, anaphase and telophase. Each phase is identified by the characteristic behaviour of the chromosomes and the spindle.

Key fact: In *prophase*, the diffuse chromatin condenses and coils into compact, visible chromosomes (each made of two sister chromatids), the nucleolus and nuclear envelope start to disappear, and the spindle apparatus begins to assemble between the separating centrosomes. It is the longest and the first stage of mitosis.

Why other options are wrong:

- (A) In metaphase the already-condensed chromosomes line up at the equa-

torial plate.
- (B) In anaphase sister chromatids separate and move to the poles.
- (D) In telophase the chromosomes decondense and nuclei reform.

Final Answer: Condensation and spindle assembly begin in prophase $\Rightarrow$ C

Answer: (C) Go Back to Q11

Q12.

Solution

Concept — Prophase I of meiosis: The long prophase I is divided into five sub-stages — leptotene, zygotene, pachytene, diplotene and diakinesis. The pairing and recombination of homologous chromosomes occur in a defined order across these sub-stages.

Key fact: *Synapsis* — the precise, point-by-point pairing of homologous chromosomes to form a bivalent (also called a tetrad, as it has four chromatids) — takes place during *zygotene*. The structure that holds the pair together is the synaptonemal complex.

Why other options are wrong:

- (A) In leptotene the chromosomes merely begin to condense; pairing has not yet started.
- (B) Pachytene is when crossing over (recombination) occurs, *after* synapsis.
- (C) In diplotene the paired homologues begin to separate, revealing chiasmata.

Final Answer: Synapsis (bivalent formation) occurs in zygotene $\Rightarrow$ D

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — Water potential (Ψ): The water potential of a cell measures the free energy of its water and determines the direction of water movement. It is the sum of the solute (osmotic) potential and the pressure potential: $\Psi = \Psi_s + \Psi_p$. Pure water at standard conditions has $\Psi = 0$.

Key fact: Water always moves *down* a water-potential gradient — that is, from a region of *higher (less negative) water potential to a region of lower (more negative)*

water potential — until equilibrium is reached. Adding solute lowers Ψ_s (makes it more negative), while turgor pressure raises Ψ_p.

Why other options are wrong:

- (B) Movement from lower to higher potential is the reverse of the natural (passive) direction.
- (C),(D) Direction is governed by the *total* water potential Ψ, not by Ψ_s or Ψ_p alone.

Final Answer: Water moves from higher to lower water potential $\Rightarrow$ A

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — The C_4 pathway and Kranz anatomy: C_4 plants (maize, sugarcane, sorghum) have a special leaf anatomy called *Kranz* (German for "wreath") anatomy, in which large, chloroplast-rich bundle-sheath cells form a ring around the vascular bundle, surrounded by mesophyll cells.

Key fact: In the mesophyll, CO_2 is first fixed onto the 3-carbon acceptor phosphoenolpyruvate (PEP) by the enzyme *PEP carboxylase* (PEPcase) to form the 4-carbon oxaloacetate. PEPcase has a high affinity for CO_2 and, unlike RuBisCO, does not bind oxygen, so C_4 plants avoid photorespiration.

Why other options are wrong:

- (A) RuBisCO fixes CO_2 later, in the bundle-sheath cells (the Calvin cycle), not the first step in mesophyll.
- (C) Pyruvate kinase is a glycolytic enzyme; (D) nitrogenase fixes nitrogen, not CO_2.

Final Answer: Primary CO_2 fixation in C_4 mesophyll is by PEP carboxylase $\Rightarrow$ B

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Stages of cellular respiration: Aerobic respiration occurs in stages located in different cell compartments — glycolysis in the cytoplasm, and the link reaction, Krebs cycle and electron transport in the mitochondrion.

Key fact: The *Krebs (TCA / citric acid) cycle* takes place in the *mitochondrial matrix*, the fluid-filled space enclosed by the inner membrane. Here acetyl-CoA combines with oxaloacetate, and through a cycle of reactions CO_2, NADH, $FADH_2$ and GTP are produced. The matrix contains all the enzymes required for the cycle.

Why other options are wrong:

- (A) The cytoplasm is the site of glycolysis, not the Krebs cycle.
- (B) The inner membrane (with cristae) houses the electron transport chain and ATP synthase, not the cycle.
- (D) The nucleus is concerned with the genetic material, not respiration.

Final Answer: Krebs cycle occurs in the mitochondrial matrix $\Rightarrow$ C

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Plant growth regulators: The five major classes (auxins, gibberellins, cytokinins, ethylene, abscisic acid) each have characteristic actions. Cytokinins were discovered as factors that stimulate cytokinesis (cell division).

Key fact: *Cytokinins* (e.g. kinetin, zeatin) promote cell division and, importantly, *delay the senescence (ageing) of leaves* by mobilising nutrients towards the treated area — the classic Richmond–Lang effect, in which detached leaves treated with cytokinin stay green far longer.

Why other options are wrong:

- (A) Auxin controls apical dominance and induces rooting, not delay of senescence.
- (B) Gibberellins promote stem elongation and bolting.
- (C) Abscisic acid is a growth *inhibitor* that promotes dormancy and *accelerates* senescence/abscission.

Final Answer: Cell division and delayed senescence = cytokinin $\Rightarrow$ D

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Role of bile in digestion: Bile is a greenish-yellow fluid made by the liver and stored in the gall bladder. It is released into the duodenum, where it acts on dietary fats. Its action is physical (and chemical via pH) rather than enzymatic.

Key fact: Bile *contains no digestive enzyme*. Its bile salts *emulsify* fats — they break large fat globules into countless tiny droplets, greatly increasing the surface area on which the enzyme pancreatic lipase can then act. Bile also neutralises the acidic chyme arriving from the stomach.

Why other options are wrong:

- (B) Lipase is supplied by the pancreas (and stomach), not by bile.
- (C) Pepsin is a gastric enzyme that digests proteins.
- (D) Salivary amylase comes from the saliva and acts on starch in the mouth.

Final Answer: Bile emulsifies fats and has no enzyme $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q17

Q18.

Solution

Concept — Respiratory volumes: The lungs are never fully emptied. Beyond the air that can be inhaled or exhaled with effort, a fixed amount stays behind to keep the alveoli partly inflated and ready for gas exchange.

Key fact: The *residual volume* (RV, about 1100–1200 mL) is the air that remains in the lungs even after the most forceful (maximal) expiration. Because it cannot be breathed out, it prevents the alveoli from collapsing and allows continuous gas exchange between breaths.

Why other options are wrong:

- (A) Tidal volume is the air moved in normal quiet breathing ($\sim$500 mL).
- (C) Inspiratory reserve volume is the *extra* air that can be forcibly inhaled.
- (D) Expiratory reserve volume is the extra air that can be forcibly *exhaled* — it can be breathed out, unlike RV.

Final Answer: Air left after maximal expiration = residual volume $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q18

Q19.

Solution

Concept — The Rh blood-group system: In addition to the ABO system, human red cells may or may not carry the Rhesus (Rh) antigen, chiefly the D antigen, first noted in the rhesus monkey. This determines a person's Rh status.

Key fact: A person whose red cells *carry* the Rh (D) antigen is *Rh-positive*; one whose cells lack it is Rh-negative. About 80% of people are Rh-positive. Rh incompatibility matters in transfusion and in pregnancy (an Rh^- mother carrying an Rh^+ foetus may make anti-Rh antibodies, causing erythroblastosis fetalis).

Why other options are wrong:

- (A) The ABO group (here "O") is a separate system and is not decided by the Rh antigen.
- (B) The "universal donor" is O-negative; carrying the Rh antigen does not make one a universal donor.
- (C) Rh-negative means the antigen is *absent* — the opposite of what is described.

Final Answer: Red cells bearing the Rh antigen = Rh-positive $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q19

Q20.

Solution

Concept — Concentrating the urine: Mammals can make urine more concentrated than their blood plasma. This depends on a steep osmotic gradient in the kidney medulla, built and maintained by the hairpin loop of Henle working alongside the vasa recta.

Key fact: The *counter-current mechanism* arises because filtrate in the descending and ascending limbs of the loop of Henle flows in opposite directions, and blood in the vasa recta flows counter to the filtrate. The differing permeabilities and active NaCl transport multiply a small gradient into a large one ($\sim$300 to $\sim$1200 mOsm), so the collecting duct (under ADH) can reabsorb water and concentrate the urine.

Why other options are wrong:

- (A) Ultrafiltration is the initial filtration at the glomerulus, not the concen-

trating step.

- (B) Active transport is one component, but the loop's design is specifically a counter-current arrangement.
- (D) "Osmotic-shock mechanism" is not a recognised renal term.

Final Answer: The loop of Henle uses the counter-current mechanism $\Rightarrow$ C

Answer: (C) Go Back to Q20

Q21.

Solution

Concept — Resting and action potentials: A resting neuron is polarised, with the inside about -70 mV relative to the outside. This is maintained by the Na^+/K^+ pump (3 Na^+ out, 2 K^+ in) and by the membrane being more permeable to K^+. A stimulus can trigger an action potential.

Key fact: When a stimulus reaches threshold, voltage-gated *sodium* channels open and Na^+ rushes *into* the axon down its electrochemical gradient. This sudden influx of Na^+ reverses the polarity (depolarisation), producing the rising spike of the action potential ($\approx +30$ mV). Repolarisation then follows as K^+ flows out.

Why other options are wrong:

- (B) Cl^- influx would hyperpolarise (make more negative), not depolarise.
- (C) Ca^{2+} matters at synapses (neurotransmitter release), not for the axonal depolarisation spike.
- (D) K^+ efflux causes *repolarisation*, the falling phase, not the rising spike.

Final Answer: Depolarisation is due to Na^+ influx $\Rightarrow$ A

Answer: (A) Go Back to Q21

Q22.

Solution

Concept — The adrenal gland: Each adrenal gland has an outer cortex and an inner medulla. The medulla secretes the catecholamines adrenaline (epinephrine) and noradrenaline, which prepare the body for sudden activity.

Key fact: *Adrenaline (epinephrine)* is the "emergency" or "fight-or-flight" hormone. Released during stress, fear or anger, it raises the heart rate and blood pressure, dilates the pupils and bronchioles, and increases blood glucose (by glycogenolysis)

— rapidly mobilising the body to face the situation.

Why other options are wrong:

- (A) Insulin (pancreas) *lowers* blood glucose — the opposite of a stress response.
- (C) Thyroxine (thyroid) controls long-term basal metabolic rate, not the rapid emergency response.
- (D) Aldosterone (adrenal cortex) regulates Na^+/water balance.

Final Answer: Fight-or-flight hormone = adrenaline $\Rightarrow$ B

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — The female gametophyte: The mature embryo sac develops from the functional megaspore by three free-nuclear mitotic divisions, giving eight nuclei, which then organise into a definite cellular arrangement.

Key fact: The typical (Polygonum-type) embryo sac is *7-celled and 8-nucleate*. The eight nuclei are organised as: an egg apparatus of three cells (one egg + two synergids) at the micropylar end, three antipodal cells at the chalazal end, and one large central cell containing *two* polar nuclei. Because the central cell holds two of the eight nuclei, there are 7 cells but 8 nuclei.

Why other options are wrong:

- (A) 3-celled/3-nucleate describes the mature *male* gametophyte (pollen), not the embryo sac.
- (B) "8-celled" is wrong because the two polar nuclei lie in a single (central) cell.
- (C) The count is 8 nuclei but 7 cells, not 4 cells.

Final Answer: Mature embryo sac = 7-celled, 8-nucleate $\Rightarrow$ D

Answer: (D) Go Back to Q23

Q24.

Solution

Concept — Double fertilisation: Unique to angiosperms, two male gametes from one pollen tube take part in two fusions inside the embryo sac — syngamy and triple fusion — hence the name double fertilisation.

Key fact: In *triple fusion*, one male gamete (n) fuses with the two polar nuclei ($n + n$) of the central cell, so three nuclei combine to form the *triploid ($3n$) primary endosperm nucleus (PEN)*. The PEN divides repeatedly to form the nutritive endosperm that feeds the developing embryo.

Why other options are wrong:

- (A) The diploid zygote forms from *syngamy* (male gamete + egg), the other fusion.
- (B) The egg is the haploid female gamete before fertilisation.
- (D) A synergid is a cell of the egg apparatus, not a product of triple fusion.

Final Answer: Triple fusion gives the $3n$ primary endosperm nucleus $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q24

Q25.

Solution

Concept — Gametogenesis: The formation of gametes is called gametogenesis. In the female it is termed oogenesis and in the male spermatogenesis; both involve meiosis but differ in detail and product.

Key fact: *Oogenesis* is the process of formation of the mature female gamete (ovum) in the ovary. It begins before birth with oogonia, which form primary oocytes; these arrest in meiosis I until puberty, when one resumes each cycle to give a secondary oocyte and, on fertilisation, the ovum — producing one functional egg and polar bodies.

Why other options are wrong:

- (B),(C) Spermatogenesis (in the testis) forms sperm, not the ovum.
- (D) Fertilisation is the fusion of the egg and the sperm, which happens *after* the gametes are formed.

Final Answer: Formation of the ovum in the ovary = oogenesis $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q25

Q26.

Solution

Concept — Intra-uterine devices (IUDs): IUDs are small devices placed inside the uterus by a doctor. They may be non-medicated, copper-releasing (Cu-T, Cu-7, Multiload-375) or hormone-releasing (LNG-20). The copper-releasing type is widely used and reversible.

Key fact: The *copper-T* releases Cu^{2+} ions that *suppress the motility and the fertilising capacity (viability) of sperm*. They also make the uterine environment hostile to sperm and unsuitable for implantation. Thus the copper-T prevents both fertilisation and implantation, without surgery and without hormones.

Why other options are wrong:

- (A) Surgically blocking the tubes is tubectomy (sterilisation), not an IUD.
- (C) Supplying oestrogen/progesterone is the action of oral pills (and hormonal IUDs), not the copper-T.
- (D) A cervical cap/diaphragm is a barrier method; the copper-T acts chemically inside the uterus.

Final Answer: Copper-T acts by impairing sperm motility/viability $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q26

Q27.

Solution

Concept — The test cross: A test cross is used to find the unknown genotype of an individual showing the dominant phenotype, by crossing it with a homozygous recessive partner. The ratio of the offspring reveals whether the dominant parent is homozygous or heterozygous.

Step 1 — Read the cross: The dominant (tall) parent is crossed with tt (dwarf). A $1:1$ tall : dwarf ratio means half the offspring are tall and half are dwarf.

Step 2 — Deduce the genotype: A dwarf offspring (tt) must receive a t from *each* parent. Since the recessive parent gives t, the dominant parent must also be able to give a t — so it carries one T and one t. The Punnett square ($Tt \times tt$) yields Tt (tall) and tt (dwarf) in a $1:1$ ratio, matching the figure.

Why other options are wrong:

- (A) A homozygous $TT \times tt$ cross gives *all* tall offspring (Tt), a $1:0$ ratio, not $1:1$.

- (B) A tt parent would itself be dwarf, not the tall parent being tested.
- (C) Tetraploidy is irrelevant to this monohybrid Mendelian cross.

Final Answer: A $1:1$ test-cross ratio means the parent is heterozygous (Tt) $\Rightarrow$ D

Answer: (D) Go Back to Q27

Q28.

Solution

Concept — Codominance: In codominance, two different alleles of a gene are both expressed fully and independently in the heterozygote, so the phenotype shows the effect of *both* alleles together rather than a blend.

Key fact: In blood group AB the genotype is $I^A I^B$. The I^A allele makes the A antigen and the I^B allele makes the B antigen, and in the AB individual *both* antigens appear on the red cells. Neither allele dominates the other — a textbook case of *codominance*.

Why other options are wrong:

- (A) In complete dominance one allele completely masks the other in the heterozygote.
- (B) In incomplete dominance the heterozygote shows an *intermediate* (blended) phenotype, e.g. pink flowers — not both characters at once.
- (D) Epistasis is one gene masking the expression of a different gene.

Final Answer: AB blood group = codominance $\Rightarrow$ C

Answer: (C) Go Back to Q28

Q29.

Solution

Concept — Sex-chromosome aneuploidy: Non-disjunction of the sex chromosomes during gamete formation can give an individual an abnormal number of X or Y chromosomes, producing characteristic syndromes.

Key fact: *Klinefelter's syndrome* results from an extra X chromosome in a male, giving the karyotype *47, XXY* (total 47 chromosomes). Such individuals are phenotypically male but have under-developed testes, are usually sterile, and show some feminine development such as gynaecomastia (the development of breast

tissue).

Why other options are wrong:

- (A) Turner's syndrome is 45, X (a single X) and occurs in females.
- (C) Down's syndrome is trisomy of autosome 21, not a sex-chromosome disorder.
- (D) Edward's syndrome is trisomy 18, an autosomal condition.

Final Answer: 47, XXY male = Klinefelter's syndrome $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q29

Q30.

Solution

Concept — Mechanism of DNA replication: When DNA copies itself, the two parental strands unwind and each acts as a template. Three models were once possible — conservative, semiconservative and dispersive — differing in how old and new strands are distributed.

Key fact: DNA replication is *semiconservative*: each daughter molecule contains one intact *old* (parental) strand and one newly synthesised strand. Meselson and Stahl proved this in 1958 using $^{15}\text{N}/^{14}\text{N}$ density labelling in *E. coli* and caesium chloride density-gradient centrifugation, observing an intermediate-density band after one generation.

Why other options are wrong:

- (B) Conservative replication would keep the parental duplex intact and make a wholly new duplex — ruled out by the experiment.
- (C) Dispersive replication would scatter old and new segments along both strands — also ruled out.
- (D) Translation is protein synthesis, not DNA copying.

Final Answer: One old + one new strand = semiconservative replication $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q30

Q31.

Solution

Concept — Properties of the genetic code: The genetic code is the set of rules by which the sequence of bases in mRNA is read as codons to specify amino acids during translation. It has several well-defined, universal features.

Key fact: The code is *triplet* (three bases code one amino acid, giving 64 codons), *degenerate* (most amino acids are specified by more than one codon), *non-overlapping* (each base is read only once, codons read in a continuous frame without commas) and *nearly universal* (the same codons mean the same amino acids in almost all organisms, with minor exceptions in mitochondria). It is also unambiguous — one codon codes for only one amino acid.

Why other options are wrong:

- (A) The code is triplet, not singlet, and it is non-overlapping.
- (B) It is unambiguous, not ambiguous, and essentially universal, not species-specific.
- (D) The code *is* degenerate and non-overlapping, so "overlapping, non-degenerate" is incorrect.

Final Answer: Triplet, degenerate, non-overlapping, nearly universal $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q31

Q32.

Solution

Concept — Theories of evolution: Several thinkers proposed mechanisms for how species change over time. Lamarck's idea, predating Darwin, centred on the effect of use and disuse and the inheritance of characters acquired during an organism's lifetime.

Key fact: *Jean-Baptiste Lamarck* proposed *Lamarckism* — the inheritance of acquired characters. He argued that organs used frequently become better developed while unused organs degenerate, and that such modifications are passed on to the offspring. His classic example is the giraffe stretching its neck to reach high foliage, the longer neck then being inherited.

Why other options are wrong:

- (A) Darwin proposed natural selection (survival of the fittest), not the inheritance of acquired characters.

- (B) Hugo de Vries proposed the mutation theory (evolution by sudden saltations).
- (C) Mendel established the laws of inheritance, not a theory of evolution.

Final Answer: Inheritance of acquired characters = Lamarck $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q32

Q33.

Solution

Concept — Filariasis (elephantiasis): This is a chronic disease caused by filarial nematode worms that lodge in the lymphatic vessels, blocking lymph drainage. The blockage leads to gross swelling of body parts such as the legs and the scrotum.

Key fact: Filariasis is caused by *Wuchereria bancrofti* (and *W. malayi*) and is transmitted from person to person by the bite of the *Culex* mosquito, which carries the infective larvae (microfilariae). The adult worms blocking the lymphatics produce the characteristic elephantiasis.

Why other options are wrong:

- (A) *Aedes* transmits dengue, chikungunya and yellow fever.
- (C) Female *Anopheles* transmits malaria.
- (D) The sandfly transmits kala-azar (leishmaniasis), not filariasis.

Final Answer: Filariasis is spread by the *Culex* mosquito $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q33

Q34.

Solution

Concept — Active vs passive immunity: Acquired immunity may be *active* (the body makes its own antibodies after exposure to an antigen) or *passive* (ready-made antibodies are received from outside). The two differ in onset, duration and the presence of memory.

Key fact: When a vaccine (a weakened or inactivated antigen) is given, the immune system itself responds by producing antibodies and memory cells. This is *active immunity* — slow to develop but long-lasting, and capable of a rapid secondary response on re-exposure.

Why other options are wrong:

- (B) Passive immunity is when pre-formed antibodies are injected (e.g. anti-tetanus serum); the body does not make them.
- (C) Innate immunity is the inborn, non-specific defence and does not involve a vaccine-induced antibody response.
- (D) Maternal antibodies crossing the placenta give *passive* immunity, not the active response described.

Final Answer: Body making its own antibodies after a vaccine = active immunity $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q34

Q35.

Solution

Concept — Antibiotics from microbes: Antibiotics are chemicals produced by some microorganisms that kill or inhibit other microbes. Their discovery transformed medicine, beginning with penicillin.

Key fact: *Penicillin*, the first antibiotic, was discovered by Alexander Fleming in 1928 from the blue-green mould *Penicillium notatum* (now *P. chrysogenum*), when he noticed it inhibited the growth of *Staphylococcus*. It was later purified and developed into a drug by Chain and Florey.

Why other options are wrong:

- (A) *Streptomyces griseus* yields streptomycin, a different and later antibiotic.
- (B) *Lactobacillus* is used to make curd, not penicillin.
- (D) *Saccharomyces cerevisiae* (yeast) is used for baking and brewing.

Final Answer: Penicillin comes from *Penicillium notatum* $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q35

Q36.

Solution

Concept — Joining DNA fragments: In making recombinant DNA, a gene is cut out and inserted into a vector. After the pieces are brought together, their ends must be sealed permanently — a job done by a specific joining enzyme.

Key fact: *DNA ligase* is the "molecular glue". It catalyses the formation of phosphodiester bonds, sealing the nicks between the sugar-phosphate backbones of two DNA fragments (for example, joining a foreign gene to a plasmid vector with matching sticky ends). This produces a stable recombinant DNA molecule.

Why other options are wrong:

- (A) Restriction endonucleases are the "molecular scissors" that *cut* DNA, the opposite role.
- (B) DNA polymerase synthesises new DNA strands from a template; it does not join separate fragments end-to-end.
- (C) Helicase unwinds the double helix during replication.

Final Answer: The joining enzyme is DNA ligase $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q36

Q37.

Solution

Concept — RNA interference (RNAi): RNAi is a natural cellular defence in which specific mRNA molecules are silenced (prevented from being translated) by complementary RNA. It is triggered by double-stranded RNA and is used to protect crops against parasites.

Key fact: To make nematode-resistant plants (e.g. tobacco against *Meloidogyne incognita*), genes are introduced using *Agrobacterium* so that the plant produces both sense and anti-sense RNA. These form a *double-stranded RNA* that initiates *RNA interference*, silencing a vital mRNA of the parasite; the nematode cannot survive in the transgenic host, which therefore becomes resistant.

Why other options are wrong:

- (A) Transduction is the transfer of bacterial genes by a bacteriophage.
- (C) Transcription is the synthesis of mRNA from DNA, not a silencing process.
- (D) Reverse transcription makes DNA from an RNA template (in retro-

viruses).

Final Answer: mRNA silencing by dsRNA = RNA interference $\Rightarrow$ B

Answer: (B) Go Back to Q37

Q38.

Solution

Concept — The polymerase chain reaction (PCR): PCR amplifies a specific DNA segment into millions of copies in vitro through repeated cycles of three temperature-controlled steps, using a heat-stable *Taq* DNA polymerase isolated from *Thermus aquaticus*.

Key fact: One PCR cycle, in correct order, is: (1) *denaturation* — heating to ∼94–95 °C separates the two DNA strands; (2) *annealing* — cooling to ∼50–60 °C lets the primers bind to their complementary sequences; (3) *extension (elongation)* — at ∼72 °C *Taq* polymerase synthesises the new strands. Repeating the cycle doubles the DNA each time.

Why other options are wrong:

- (B) Primers cannot anneal until the strands are first separated, so denaturation must come first.
- (C) Extension cannot precede denaturation and annealing — there is nothing to extend yet.
- (D) Extension must follow annealing (primers must bind before they can be extended).

Final Answer: Correct order = denaturation, annealing, extension $\Rightarrow$ A

Answer: (A) Go Back to Q38

Q39.

Solution

Concept — The pyramid of biomass: A pyramid of biomass shows the total dry weight (standing crop) of living matter present at each trophic level at a given time. Unlike the pyramid of energy, it can sometimes be inverted depending on the ecosystem.

Key fact: In a *pond (aquatic) ecosystem*, the producers are tiny, fast-reproducing phytoplankton with a very small standing biomass at any moment, yet they sup-

port a larger biomass of zooplankton and fish. This makes the *pyramid of biomass inverted* (narrow base, broad top). The producers turn over so rapidly that a small instantaneous biomass still feeds the larger consumers above.

Why other options are wrong:

- (A) "Always upright" is true only of the pyramid of *energy*; the biomass pyramid can invert.
- (B) A pyramid is not rectangular; biomass changes between levels.
- (D) "Spindle-shaped" describes a pyramid of *numbers* in a forest, not the pond biomass pyramid.

Final Answer: Pond pyramid of biomass is inverted $\Rightarrow$ C

Answer: (C) Go Back to Q39

Q40.

Solution

Concept — Biodiversity hotspots: Conservation resources are limited, so areas with the greatest biological richness and the greatest threat are given top priority. Norman Myers introduced the idea of biodiversity hotspots to focus such efforts.

Key fact: A *biodiversity hotspot* is a region with exceptionally high species richness, a high degree of *endemism* (species found nowhere else), and serious threat of habitat destruction. Their significance is that protecting these relatively small areas safeguards a disproportionately large share of global biodiversity. India has hotspots such as the Western Ghats–Sri Lanka, the Himalaya, the Indo-Burma region and Sundaland.

Why other options are wrong:

- (A) Sacred groves are small forest patches protected on religious grounds — a form of in-situ conservation, not the hotspot concept.
- (B) Botanical gardens are ex-situ collections of plants.
- (C) Cryopreservation banks store gametes/seeds ex situ at very low temperatures.

Final Answer: Species-rich, highly endemic, threatened regions = biodiversity hotspots $\Rightarrow$ D

Answer: (D) Go Back to Q40

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	A	3	C	4	D	5	A
6	B	7	D	8	C	9	A	10	B
11	C	12	D	13	A	14	B	15	C
16	D	17	A	18	B	19	D	20	C
21	A	22	B	23	D	24	C	25	A
26	B	27	D	28	C	29	B	30	A
31	C	32	D	33	B	34	A	35	C
36	D	37	B	38	A	39	C	40	D