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PREVIOUS YEAR PAPER · 2025

OLYMPIAD · STAGE I

NSEB

National Standard Examination in Biology

2025

Question paper, answer key and Zigyan solutions

60	216	120 min	21
Questions	Maximum marks	Time	Paper code

Question paper and official answer key: Indian Association of Physics Teachers (IAPT), NSEB 2025, paper code 21.
Solutions and notes: Zigyan. This booklet is not an IAPT publication.

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PART A-1 · ONE CORRECT OPTION

Q. 1 – 48 · +3 for a correct answer, –1 for a wrong one

1. Physiological mechanisms of C_3 and C_4 plants highlight fundamental differences in how they cope with stressors like water loss, high temperatures and photorespiration. C_3 plants rely on the Calvin cycle for carbon fixation while C_4 plants have a mechanism to concentrate CO_2 around Rubisco. The reason for C_3 plants to experience higher levels of photorespiration under environmental stress could be because

(A) C_3 plants have RUBISCO which has greater affinity for oxygen as compared to carbon dioxide.

(B) C_3 plants are unable to survive in high-temperature environments.

(C) C_3 plants cannot concentrate CO_2 effectively around Rubisco, increasing oxygen interference.

(D) C_3 plants cannot utilize ETS effectively during photosynthesis whereby there is excess production of oxygen free radicals.

Solution · Q1 **Answer: (C)**

C_3 plants have no mechanism to concentrate CO_2 around RuBisCO.

In heat and water stress the stomata close, the O_2 : CO_2 ratio near RuBisCO rises, and O_2 competes for its active site. This gives photorespiration.

RuBisCO itself has a much greater affinity for CO_2 than for O_2.

IAPT answer: (C) | **Zigyan answer:** (C)

2. Which of the following statements best describes the role of the origin of replication (*ori*) in a recombinant plasmid used for bacterial transformation?

(A) The *ori* is responsible for the antibiotic resistance of the plasmid.

(B) The *ori* ensures the plasmid is integrated into the bacterial chromosome.

(C) The *ori* allows the plasmid to replicate independently within the bacterial cell.

(D) The *ori* is involved in the transcription of the inserted gene.

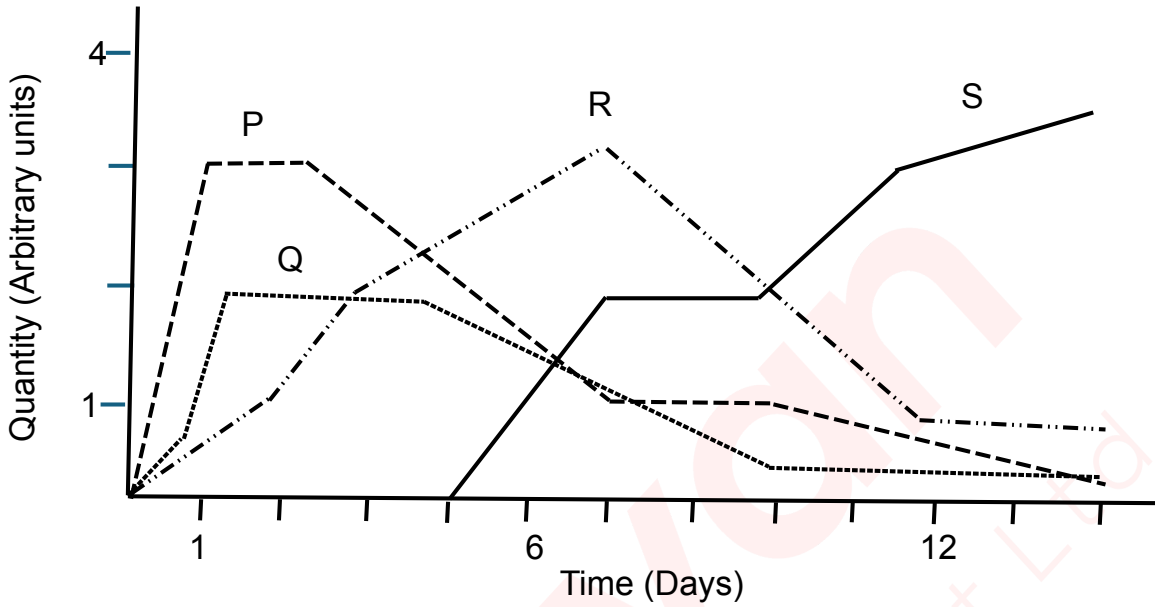
Solution · Q2 **Answer: (C)**

ori is the sequence where DNA replication starts.

So the plasmid, along with the inserted DNA, replicates in the bacterial cell independently of the chromosome.

IAPT answer: (C) | **Zigyan answer:** (C)

3. During wound healing, different cell populations occupy the wound site as time proceeds. The four types of cells/structures (P -S) that appear at wound healing site are depicted in the graph. They respectively indicate



(A) Monocytes, Fibroblasts, Neutrophils, Collagen

(B) Monocytes, Neutrophils, Collagen, Fibroblasts

(C) Neutrophils, Monocytes, Fibroblasts, Collagen

(D) Fibroblasts, Neutrophils, Monocytes, Collagen

Solution · Q3 **Answer: (C)**

P (early, highest peak): neutrophils, the first cells to arrive.

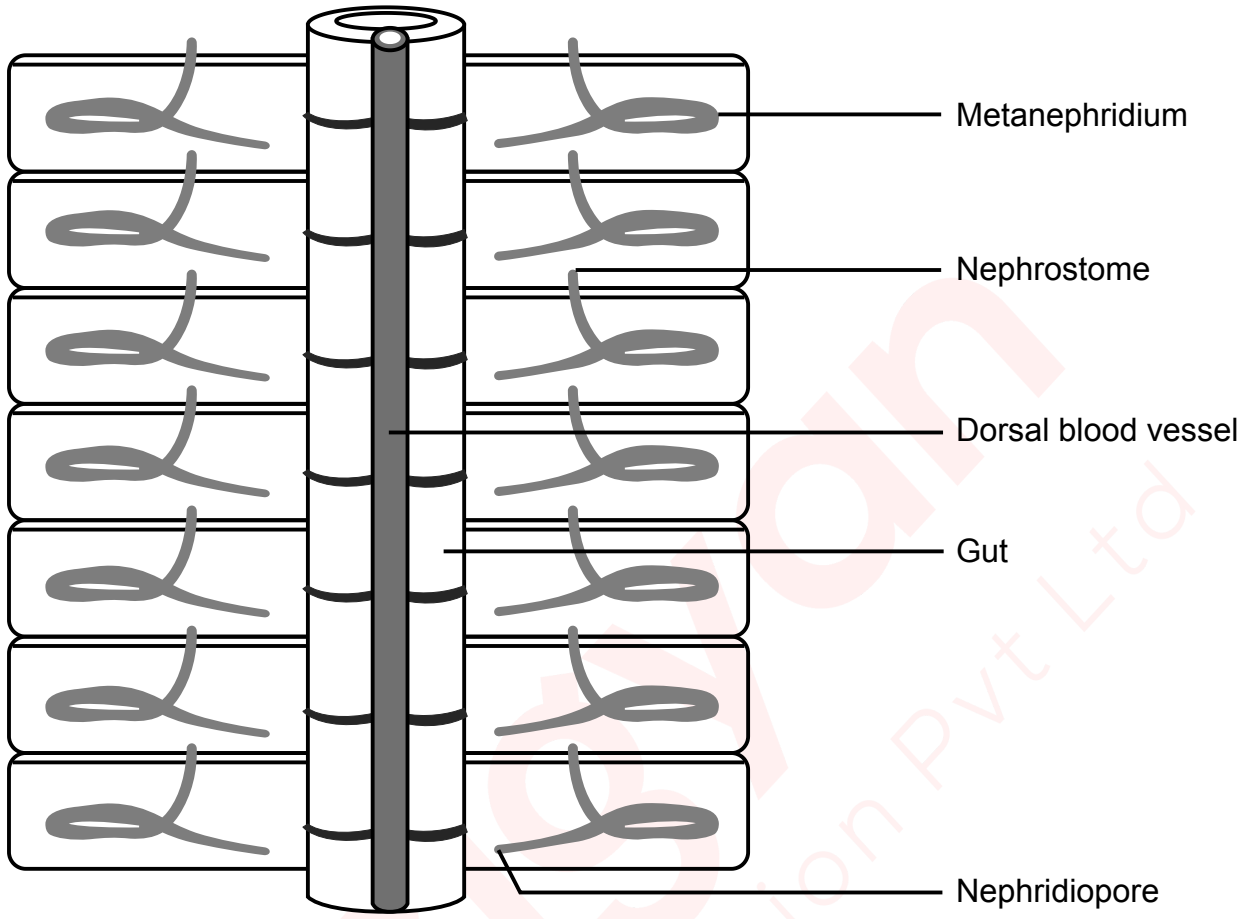
Q (stays high longer than P): monocytes, which become macrophages.

R (peaks near day 7): fibroblasts.

S (appears late and keeps rising): collagen laid down by fibroblasts.

IAPT answer: (C) | **Zigyan answer:** (C)

4. Dorsal view of 7 segments of earthworm is shown in the figure. The correct pathway of excretion in this animal is



(A) Metanephridium → Nephrostome → Gut → Nephridiopore

(B) Nephridiopore → Metanephridium → Gut → Exterior

(C) Coelom → Nephrostome → Nephridiopore → Exterior

(D) Dorsal blood vessel → Gut → Nephrostome → Nephridiopore → Exterior

Solution · Q4 **Answer: (C)**

The ciliated funnel (nephrostome) takes in coelomic fluid.

The fluid passes along the nephridial tubule and leaves through the nephridiopore.

∴ Coelom → Nephrostome → Nephridiopore → Exterior

IAPT answer: (C) | **Zigyan answer:** (C)

5. For plants to survive in environments with high salinity, salt tolerance is a crucial adaptation. Salt tolerance involves various physiological and biochemical adaptations that help plants to manage the stress caused by excess salt. Understanding these mechanisms is essential for developing salt-tolerant crops and improving agricultural productivity in saline soils. Which of the following statements best describes a key mechanism of salt tolerance in plants?

(A) Plants increase the uptake of sodium ions to enhance growth under high salinity.

(B) Plants produce osmoprotectants to stabilize proteins and membranes under salt stress.

(C) Plants reduce the production of potassium ions to avoid toxicity in saline environments.

(D) Plants enhance photosynthesis to counter the effects of salt stress by increased ETS activity.

Solution · Q5 **Answer: (B)**

Under salt stress plants accumulate osmoprotectants (compatible solutes) such as proline and glycine betaine.

These help to maintain water balance and to stabilise proteins and membranes.

IAPT answer: (B) | **Zigyan answer:** (B)

6. Kidneys are essential organs in vertebrates that play a vital role in maintaining homeostasis by excreting metabolic waste and reabsorbing necessary substances. Which of the following mechanisms is primarily responsible for the counter current multiplication process in the Loop of Henle?

(A) Secretion of urea in the collecting duct

(B) Passive diffusion of water in the descending limb

(C) Filtration of blood in the glomerulus

(D) Active transport of sodium ions in the ascending limb

Solution · Q6 **Answer: (D)**

The ascending limb is impermeable to water and moves salt out into the medullary interstitium, actively in its thick segment.

Counter current flow multiplies this into a large medullary osmotic gradient.

IAPT answer: (D) | **Zigyan answer:** (D)

7. Muscle function in obese runners can be significantly different from that in non-obese runners due to various factors. These factors can affect the overall performance. Which of the following statements best describes the muscle functions namely muscle strength (ability to exert force) and muscle endurance (ability to sustain the force) in obese runners compared to non-obese runners?

(A) Obese runners have higher muscle endurance but lower muscle strength compared to non-obese runners.

(B) Obese runners have lower muscle endurance and lower muscle strength compared to non-obese runners.

(C) Obese runners have higher muscle strength but lower muscle endurance compared to non-obese runners.

(D) Obese runners have similar muscle strength and endurance compared to non-obese runners.

Solution · Q7 **As per Zigyan: (C)**

Muscle strength, as defined here, is the force the muscle can exert.

In obese persons the extra body mass is a constant load on the antigravity leg muscles, so they exert a greater absolute force.

Their endurance is lower, as the muscles tire sooner when the effort is sustained or repeated.

Why Zigyan differs from IAPT: strength is lower in obese persons when it is divided by body mass, but the force actually exerted, which is the strength defined in the question, is greater.

Reference: Tomlinson and others, Biogerontology (2016), review on obesity and skeletal muscle strength: obese persons have greater absolute maximum strength than non-obese persons, but appear weaker when strength is normalised to body mass.

Reference: PLoS One (2015), study of obese and lean young women, citing earlier work in men: quadriceps fatigue during maximal voluntary contractions was significantly greater in obese men.

IAPT answer: (B) | **Zigyan answer:** (C)

8. Heart of fish is two-chambered with one atrium and one ventricle. The fish's respiratory system involves gills for oxygen exchange. Which of the following statement best describes the flow of blood through the heart of a fish?

(A) Blood flows from the ventricle to the atrium, then to the gills.

(B) Blood flows from the atrium to the ventricle, then to the gills.

(C) Blood flows from the gills to the atrium, then to the ventricle.

(D) Blood flows from the gills to the ventricle, then to the atrium.

Solution · Q8 **Answer: (B)**

Fish have single circulation.

Deoxygenated blood from the body enters the atrium (through the sinus venosus), goes to the ventricle and is pumped to the gills.

From the gills, oxygenated blood goes to the body without returning to the heart.

IAPT answer: (B) | **Zigyan answer:** (B)

9. Which of the following mechanisms is primarily responsible for the osmotic regulation in catadromous fishes like eels, when they migrate from freshwater and transition into seawater?

(A) Increased production of dilute urine.

(B) Active uptake of salts through the gills.

(C) Drinking of seawater and active excretion of salts.

(D) Decreased permeability of the skin.

Solution · Q9 **Answer: (C)**

In sea water the eel loses water by osmosis.

It drinks sea water to replace the water, and chloride cells in the gills actively secrete the excess salt.

IAPT answer: (C) | **Zigyan answer:** (C)

10. Which of the following statements best describes the role of restriction enzymes in the process of DNA amplification using primers?

(A) Restriction enzymes are used to synthesize primers that bind to specific DNA sequences.

(B) Restriction enzymes cut the DNA at specific sites, allowing primers to bind and initiate replication.

(C) Restriction enzymes are responsible for the elongation of primers during DNA synthesis.

(D) Restriction enzymes modify the primers to enhance their binding affinity to the target DNA.

Solution · Q10 **As per Zigyan: (B)**

A restriction endonuclease recognises a specific palindromic sequence and cuts both DNA strands. Of the four options, (B) states this action.

In PCR the primers are chemically synthesised. They anneal after the template strands are separated by heat, and DNA polymerase extends them.

Reference: NCERT Biology Class XII, Chapter 9 'Biotechnology : Principles and Processes', section 9.2.1: a restriction endonuclease binds its specific recognition sequence and cuts both strands of the DNA.

Reference: Same chapter, section 9.3.3: PCR uses chemically synthesised primers and DNA polymerase, which extends them; each cycle has denaturation, primer annealing and extension.

IAPT answer: (B) | **Zigyan answer:** (B)

11. In chemosynthetic bacteria, the electron transport system is crucial for energy production. Which of the following statements accurately describes the mechanism by which the electron transport system contributes to ATP synthesis?

(A) The electron transport system directly phosphorylates ADP to ATP without the involvement of a proton gradient.

(B) The electron transport system generates a proton gradient across the bacterial membrane, which drives ATP synthesis through chemiosmosis.

(C) The electron transport system uses chemical energy from organic molecules to excite electrons, which are then transferred to oxygen to produce ATP.

(D) The electron transport system incorporates carbon dioxide into organic molecules, which are then used to generate ATP.

Solution · Q11 **Answer: (B)**

Oxidation of inorganic substances such as NH_3 or NO_2^- supplies electrons to the electron transport system.

Electron flow builds a proton gradient across the cell membrane.

Protons returning through ATP synthase drive ATP formation (chemiosmosis).

IAPT answer: (B) | **Zigyan answer:** (B)

12. In a small population of beetles, the frequency of a particular allele (A) is 0.6, and the frequency of the alternative allele (a) is 0.4. Due to genetic drift, what is the most likely outcome for the allele frequencies after several generations?

(A) The frequency of allele A will increase to 1.0, and allele a will be lost.
(B) The frequency of allele a will increase to 1.0, and allele A will be lost.
(C) The frequencies of alleles A and a will change and lead to loss of one allele that is less fit.
(D) The frequencies of alleles A and a will fluctuate randomly and may lead to loss of either allele.

Solution · Q12 **Answer: (D)**

Genetic drift is a chance change in allele frequencies and is strong in small populations.

It does not depend on fitness, so the frequencies of A and a fluctuate randomly and either allele may be lost.

IAPT answer: (D) | **Zigyan answer:** (D)

13. The antibodies secreted by B-cells upon stimulation are classified according to the amino acid sequence of the

(A) light chain
(B) heavy chain
(C) both light and heavy chain
(D) hinge region

Solution · Q13 **Answer: (B)**

The class (isotype) of an antibody is fixed by the constant region of its heavy chain.

IgG, IgA, IgM, IgD and IgE carry the heavy chains γ, α, μ, δ and ε respectively.

IAPT answer: (B) | **Zigyan answer:** (B)

14. The r and K selections are two contrasting strategies in the reproductive ecology of organisms. The r-selected species are characterized by high reproductive rates while K-selected species have lower reproductive rates. Which of the following characteristics is most likely to be observed in a K-selected species?

(A) Long life span and early maturity
(B) Short lifespan and rapid population growth
(C) High parental investment and low offspring mortality
(D) Opportunistic reproduction and high dispersal ability

Solution · Q14 **Answer: (C)**

K-selected species live near the carrying capacity.

They mature late, have few offspring and invest heavily in their care, so offspring mortality is low.

IAPT answer: (C) | **Zigyan answer:** (C)

15. The efficiency and regulation of gene expression in an operon are significantly influenced by the promoter's strength and its interaction with regulatory proteins. Which of the following statements is the correct description of the role of the promoter in the regulation of the *trp* operon in *Escherichia coli*?

(A) The promoter of the *trp* operon is always active, leading to continuous transcription of the operon genes regardless of tryptophan levels.

(B) The promoter of the *trp* operon is only active in the presence of tryptophan, leading to the transcription of the operon genes.

(C) The promoter of the *trp* operon is repressed by the *trp* repressor protein in the presence of tryptophan, preventing transcription of the operon genes.

(D) The promoter of the *trp* operon is activated by the *trp* repressor protein in the absence of tryptophan, leading to the transcription of the operon genes.

Solution · Q15 **Answer: (C)**

The *trp* operon is repressible.

Tryptophan, the co-repressor, binds and activates the *trp* repressor.

This complex binds the operator, which overlaps the promoter. RNA polymerase is blocked, so transcription stops.

IAPT answer: (C) | **Zigyan answer:** (C)

16. In a routine medical check-up, it was found that Ms. Prishali's maternal grandmother is a carrier of the recessive allele for haemophilia. Her maternal grandfather does not have haemophilia. Prishali is not haemophilic and is married. Her husband does not have haemophilia. If Prishali gets two children: a son and a daughter, which of the following statements is correct?

(A) The son has a 0.5 probability of having haemophilia, while the daughter has a 0.5 probability of being a carrier.

(B) The son has a 0.125 probability of being haemophilic, while the daughter has a 0.125 probability of being a carrier.

(C) The son has a 0.25 probability of having haemophilia, while the daughter has a 0.25 probability of being a carrier.

(D) The son has a 0.75 probability of being haemophilic, while the daughter has a 0.25 probability of having haemophilia.

Solution · Q16 **As per Zigyan: (B)**

Haemophilia is X-linked recessive. Prishali's father is taken as non-haemophilic.

Maternal grandparents:

$X^HX^h \times X^HY$

So the chance that Prishali's mother is a carrier is one half.

Chance that Prishali is a carrier:

$$\Rightarrow 1/2 \times 1/2 = 1/4$$

Her husband is X^HY. For a haemophilic son:

$$\Rightarrow 1/4 \times 1/2 = 1/8 = 0.125$$

For a carrier daughter:

$$\Rightarrow 1/4 \times 1/2 = 1/8 = 0.125$$

Reference: NCERT Biology Class XII, Chapter 4 'Principles of Inheritance and Variation', section 4.8.2: haemophilia is a sex-linked recessive disease; a heterozygous carrier mother may pass it to her sons.

IAPT answer: (B) | **Zigyan answer:** (B)

17. Origin of life on primordial earth began with the earliest replicators like

(A) short RNA-like molecules
(B) long RNA-like molecules
(C) short DNA-like molecules
(D) long DNA-like molecules

Solution · Q17 **Answer: (A)**

In the RNA world, RNA both stored information and catalysed reactions.

Early copying had no proofreading and was error-prone, so only short RNA-like chains could be copied faithfully.

IAPT answer: (A) | **Zigyan answer:** (A)

18. In a population of eusocial insects, how would kin selection influence the allocation of resources among offspring, considering the varying degrees of relatedness within the colony?

(A) Kin selection leads to equal resource allocation among all offspring, regardless of relatedness.
(B) Kin selection causes workers to allocate more resources to offspring that are less related to them to increase genetic diversity.
(C) Kin selection results in preferential resource allocation to offspring with the highest genetic relatedness to the queen.
(D) Kin selection promotes random resource allocation to avoid favouritism and maintain colony harmony.

Solution · Q18 **As per Zigyan: (C)**

By Hamilton's rule, a helping trait is favoured when the benefit, weighted by relatedness, exceeds the cost.

$$rB > C$$

Here r is the relatedness between the worker giving care and the individual receiving it.

So care is biased towards closer kin. Only (C) gives preference on the basis of higher genetic relatedness.

Equal, random or less-related allocation does not follow from this rule.

Reference: A. F. G. Bourke, 'The validity and value of inclusive fitness theory', Proceedings of the Royal Society B, 2011, Box 1: in Hamilton's rule, r is the genetic relatedness between the actor and the recipient of a social behaviour.

IAPT answer: (C) | **Zigyan answer:** (C)

19. The length of Loop of Henle (LH) in nephron plays a crucial role in regulation of water in mammals. While considering beaver, otter, camel and hippopotamus, which of the following would be a correct depiction of the trend in the length of LH?

(A) Camel > Otter > Hippopotamus > Beaver
(B) Otter > Hippopotamus > Camel
(C) Camel > Hippopotamus > Beaver
(D) Beaver > Camel > Hippopotamus > Otter

Solution · Q19 **As per Zigyan: (C)**

Loops of Henle that are long for the size of the kidney help to form concentrated urine and save water.

The desert-living camel has very long loops, while the freshwater beaver has mainly short loops.

The hippopotamus comes between the two.

∴ Camel > Hippopotamus > Beaver

Reference: The Open University, OpenLearn, 'Animals at the extremes: the desert environment', section 3.2: urine concentration reaches about 2800 mOsmol per litre in the camel but only about 520 in the beaver.

Check: (B) and (D) do not keep the camel at the top, so both are ruled out.

IAPT answer: (C) | **Zigyan answer:** (C)

20. In animals, many embryonic cells are capable of crawling over a substrate using

(A) extracellular matrix
(B) integrins
(C) pseudopodia
(D) lamellipodia

Solution · Q20 **Answer: (D)**

A crawling cell pushes out flat, sheet-like, actin-rich lamellipodia at its leading edge.

Integrins only anchor the cell to the extracellular matrix, which serves as the substrate.

IAPT answer: (D) | **Zigyan answer:** (D)

21. The CORRECT assumption on Hardy-Weinberg equilibrium is

(A) small population size, random mating, no selection, no migration, no mutation
(B) large population size, random mating, no selection, no migration, no mutation
(C) large population size, random mating, heterozygotes survive the best, no migration, no mutation
(D) large population size, random mating, no selection, migrants enter from other populations, no mutation

Solution · Q21 **Answer: (B)**

Hardy-Weinberg equilibrium assumes a large population with random mating and no selection, migration or mutation.

IAPT answer: (B) | **Zigyan answer:** (B)

22. Based on the data on trophic niches and two reproductive strategies namely K- , r- strategies, a very primitive table (also called as periodic table of niche) can be constructed. In the context of the following table identify the correct option that places appropriate organisms in their proper niches.

		Trophic niche	
Strategy	**Primary producer**	**Herbivore**	**carnivore**
r	P	Q	R
Intermediate			
K	S	T	V

(A) P = Annual plants, R = Eagle, T = Antelope

(B) S = Shrubs, Q = caterpillars, V = Mantid

(C) S = Perennial Plants, Q = bees, V = falcons

(D) Q = Parrots, R = Dragonflies, S = Perennial plants

Solution · Q22 **Answer: (C)**

r-strategists are short-lived with many offspring; K-strategists are long-lived with few offspring.

(A) Eagle is a K-strategist, so it cannot be R.

(B) Mantid is an r-strategist, so it cannot be V.

(D) Parrots are K-strategists, so they cannot be Q.

(C) Perennial plants fit S, bees fit Q and falcons fit V.

IAPT answer: (C) | **Zigyan answer:** (C)

23. In molecular phylogenetics of vertebrates, which of the following gene markers would be **least preferred** for resolving deep divergences (hundreds of millions of years ago) due to its high substitution rate and risk of saturation?

(A) 12S ribosomal RNA mitochondrial gene

(B) Cytochrome b mitochondrial protein-coding gene

(C) RAG1 nuclear protein-coding gene

(D) 18S ribosomal RNA nuclear gene

Solution · Q23 **Answer: (B)**

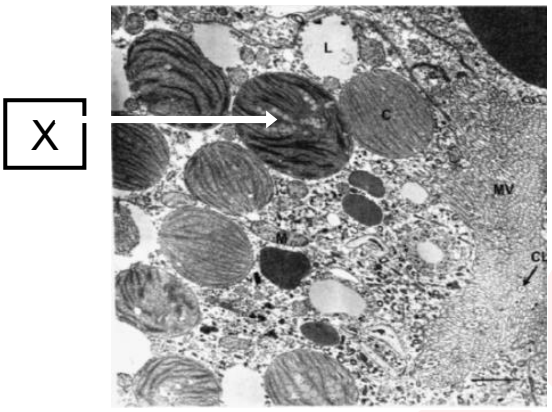
The mitochondrial protein-coding gene cytochrome b changes fast, especially at third codon positions.

Repeated substitutions at the same sites cause saturation and erase ancient phylogenetic signal.

rRNA genes and nuclear RAG1 are more conserved for such deep splits.

IAPT answer: (B) | **Zigyan answer:** (B)

24. *Elysia clarki*, a sea slug, after feeding is known to utilize photosynthesis for a period of time, essentially becoming a "solar-powered" organism. An electron micrograph of a section of the diverticulum (a digestive organ) of this organism is shown.



The structure labelled as X is:

(A) Mitochondrion (B) Chloroplast (C) Peroxisome (D) Food vacuole

Solution · Q24 **Answer: (B)**

X is a large oval body packed with parallel stacks of thylakoid membranes, so it is a chloroplast.

The slug takes it from the algae it eats and keeps it in the cells of its diverticulum (kleptoplasty).

IAPT answer: (B) | **Zigyan answer:** (B)

25. The 16S rRNA gene is commonly used for bacterial identification and phylogenetic studies. In a 16S rRNA gene sequencing analysis, it was observed that a particular operational taxonomic unit (OTU) is present in high abundance in the sample. When this OTU is compared to a reference database, however, it is found that it matches multiple different bacterial species with high similarity scores. What is the most likely explanation for this observation?

(A) The OTU represents a novel bacterial species that is not present in the reference database.

(B) The OTU is a result of sequencing errors and does not represent a real bacterial species.

(C) The OTU represents a highly conserved region of the 16S rRNA gene that is shared by multiple bacterial species.

(D) The OTU is a chimera formed during the PCR amplification process.

Solution · Q25 **Answer: (C)**

A highly conserved stretch of the 16S rRNA gene is nearly the same in many bacteria.

So an OTU covering it matches several species equally well and cannot be assigned to any single one.

IAPT answer: (C) | **Zigyan answer:** (C)

26. During 'Fight or flight response, both epinephrine and norepinephrine are secreted that lead to several physiological responses. Which of the following is **NOT** a 'Fight or flight' response?

(A) Vasoconstriction in the skin
(B) Dilatation of bronchioles
(C) Increased peristalsis
(D) Vasodilatation in skeletal muscles.

Solution · Q26 **Answer: (C)**

Sympathetic discharge with adrenaline and noradrenaline constricts skin vessels and dilates bronchioles and skeletal muscle vessels.

It slows gut movement, so increased peristalsis is not a 'fight or flight' response.

IAPT answer: (C) | **Zigyan answer:** (C)

27. In an experiment studying neuronal transmission, researchers observed that the application of a specific neurotransmitter resulted in a prolonged depolarization of the postsynaptic neuron. Which of the following mechanisms is most likely responsible for this observation?

(A) Activation of voltage-gated sodium channels leading to an influx of sodium ions.
(B) Inhibition of potassium channels preventing the efflux of potassium ions.
(C) Activation of ligand-gated ion channels allowing the influx of calcium ions.
(D) Inhibition of chloride channels preventing the influx of chloride ions.

Solution · Q27 **As per Zigyan: (B)**

Efflux of K^+ brings the membrane back towards its resting potential.

If a neurotransmitter inhibits K^+ channels, usually through G proteins and second messengers, this efflux is reduced and the depolarization lasts long.

Voltage-gated Na^+ channels stay active only very briefly.

Reference: NCERT Biology Class XI, Chapter 18 'Neural Control and Coordination', section 18.3.1: the rise in Na^+ permeability is extremely short-lived, and K^+ moving out then restores the resting potential.

Reference: Neuroscience Online (University of Texas Medical School at Houston), Chapter 6, section 6.8 'Metabotropic Synaptic Responses': a transmitter acting through G proteins can close normally open K^+ channels, which depolarizes the cell as a slow synaptic potential.

IAPT answer: (A) or (B) | **Zigyan answer:** (B)

28. In a population of butterflies, the allele for blue wings (B) is dominant over the allele for white wings (b). If the frequency of the blue-winged phenotype in the population is 84%, what is the frequency of the heterozygous genotype (Bb) assuming the population is in Hardy-Weinberg equilibrium?

(A) 0.16 (B) 0.32 (C) 0.48 (D) 0.64

Solution · Q28 **Answer: (C)**

Frequency of white-winged (bb) butterflies:

$$q^2 = 1 - 0.84 = 0.16$$

$$\Rightarrow q = 0.4$$

$$\Rightarrow p = 1 - 0.4 = 0.6$$

Frequency of heterozygotes:

$$2pq = 2 \times 0.6 \times 0.4 = 0.48$$

IAPT answer: (C) | **Zigyan answer:** (C)

29. Which of the following movements of water is prevented by the casparian strip in plants?

(A) Symplastic water movement from endodermal cell to xylem cell.
(B) Apoplastic water movement from cortical cell to xylem cell.
(C) Symplastic water movement from cortical cell to xylem cell.
(D) Apoplastic water movement from pericyle cell to xylem cell.

Solution · Q29 **Answer: (B)**

The suberized Casparian strip in the walls of endodermal cells is impermeable to water.

It stops the apoplastic flow from the cortex towards the xylem, so water must enter the symplast at the endodermis.

IAPT answer: (B) | **Zigyan answer:** (B)

30. Which of the following statements best describes the key advantage of using cDNA over genomic DNA in gene expression studies?

(A) cDNA contains introns, which are useful for studying gene regulation.
(B) cDNA is more stable than genomic DNA, making it easier to work with in the lab.
(C) cDNA represents only the expressed genes, providing a snapshot of gene activity.
(D) cDNA can be directly sequenced without the need for amplification.

Solution · Q30 **Answer: (C)**

cDNA is made from mRNA by reverse transcription.

So it lacks introns and represents only the genes expressed in that tissue at that time.

IAPT answer: (C) | **Zigyan answer:** (C)

31. How do deep diving marine mammals, such as whales and seals, avoid nitrogen bends (decompression sickness) during their prolonged and deep dives?

(A) They have a higher concentration of red blood cells that store more oxygen, reducing the need to breathe frequently.
(B) They collapse their lungs at depth, preventing nitrogen from dissolving into their blood.
(C) They have a unique enzyme that breaks down nitrogen bubbles in their bloodstream.
(D) They exhale completely before diving, eliminating nitrogen from their lungs.

Solution · Q31 **Answer: (B)**

At depth, high pressure collapses the alveoli and pushes the remaining air into airways where gas exchange does not occur.

So very little nitrogen enters the blood, and bubbles do not form during ascent.

IAPT answer: (B) | **Zigyan answer:** (B)

32. Torpor is a state of decreased physiological activity in animals, characterized by a reduced body temperature and metabolic rate. During torpor, which of the following mechanisms involving brown fat is most critical for preventing hypothermia in small mammals?

(A) Brown fat generates heat through shivering, which increases metabolic rate and body temperature during torpor.

(B) Brown fat stores energy in the form of triglycerides, which are oxidized to provide heat during torpor.

(C) Brown fat uncouples oxidative phosphorylation in mitochondria, leading to heat production without ATP synthesis.

(D) Brown fat generates heat through non-shivering thermogenesis, which helps maintain body temperature without increasing metabolic rate during torpor.

Solution · Q32 **Answer: (C)**

In brown fat mitochondria, uncoupling protein UCP1 lets protons return to the matrix without passing through ATP synthase.

The energy is released as heat instead of being used to make ATP.

This non-shivering thermogenesis raises the metabolic rate, so (D) is wrong.

IAPT answer: (C) | **Zigyan answer:** (C)

33. Which combination of relative concentrations of hormones is responsible for apical dominance seen in plants?

(A) Auxins and gibberellins

(B) Auxins and cytokinins

(C) Cytokinins and gibberelins

(D) Auxins and abscisic acid

Solution · Q33 **As per Zigyan: (B)**

Auxin from the shoot apex keeps the lateral buds suppressed.

Cytokinins act against this and promote the growth of lateral buds.

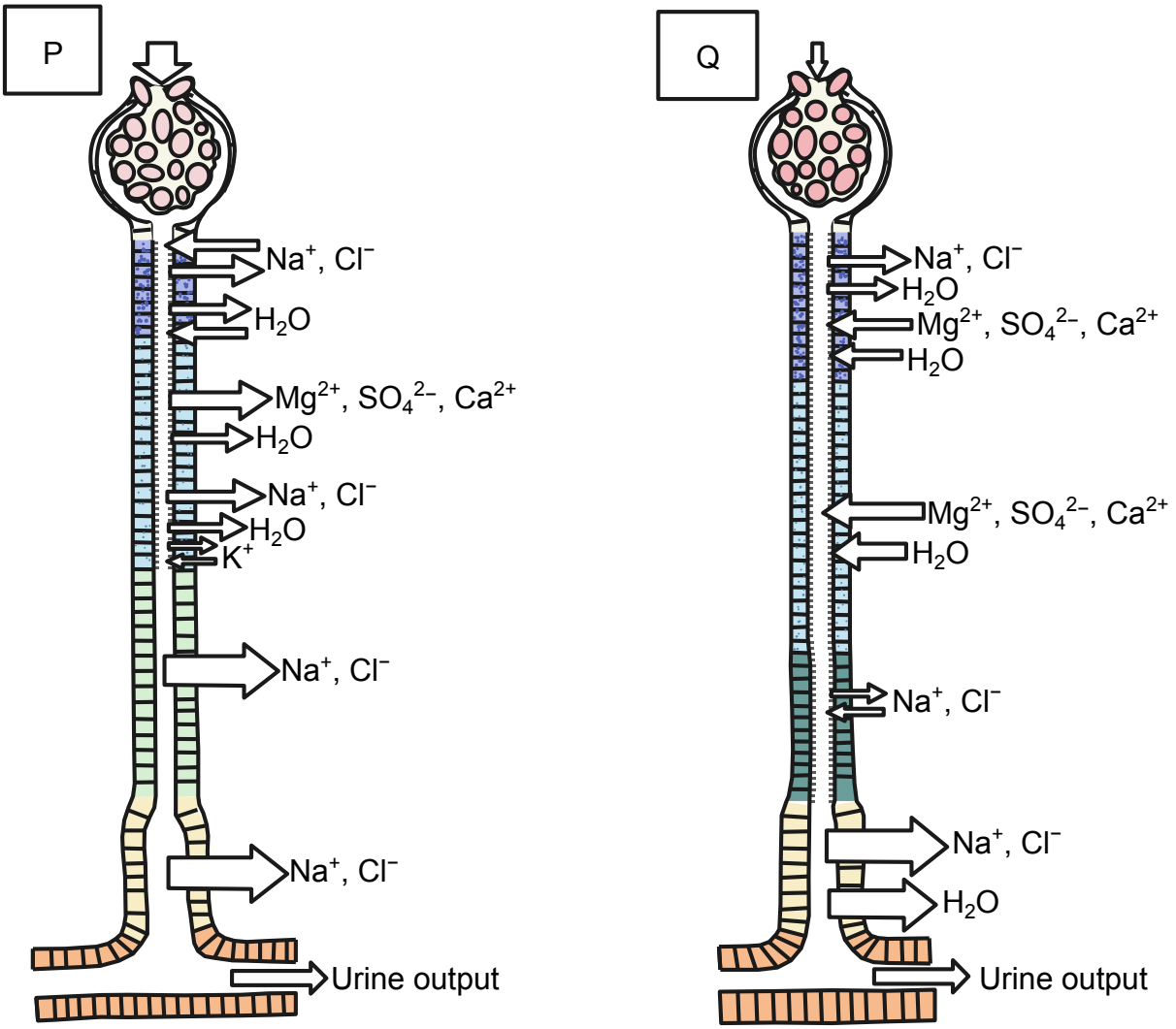
∴ apical dominance is decided by the relative levels of auxins and cytokinins.

Why Zigyan differs from IAPT: the hormone known to overcome auxin-induced apical dominance is cytokinin, so the deciding pair is auxins and cytokinins, not auxins and gibberellins.

Reference: NCERT Biology Class XI, Chapter 13 'Plant Growth and Development', sections 13.4.3.1 and 13.4.3.3: apical dominance, in which the apical bud inhibits lateral buds, is described under auxins, and cytokinins help overcome it. The section on gibberellins gives them no such role.

IAPT answer: (A) | **Zigyan answer:** (B)

34. Structures of nephrons along with permeabilities of different sections of renal tubule from two teleost fishes (P and Q) are depicted. Which of the following statements is correct?



(A) Fish P is likely to excrete concentrated urine as compared to Q.

(B) Fish Q is likely adapted to sea water habitat.

(C) In fish P, most of the ions are reabsorbed along the entire segment of renal tubule followed by water absorption by osmosis.

(D) Plasma osmolarity of fish P is likely to be higher than fish Q.

Solution · Q34 **Answer: (B)**

P has a large inflow into the glomerulus, and its later segments take back Na^+ and $C\ell^-$ without water.

∴ P passes dilute urine and is a freshwater fish.

Q has a small inflow and secretes Mg^{2+}, SO_4^{2-} and Ca^{2+} into the tubule, while its last segment takes back water.

∴ Q is adapted to sea water.

The plasma osmolarity of a freshwater teleost is lower than that of a marine teleost.

IAPT answer: (B) | **Zigyan answer:** (B)

35. In vertebrate systematics, which of the following correctly reflects a *monophyletic group* while excluding paraphyletic or polyphyletic groupings?

(A) Reptilia, excluding birds, because they are ectothermic and share similar skin morphology.

(B) "Fishes" including jawless, cartilaginous, and bony fishes, due to their shared aquatic habitat and gills.

(C) Tetrapoda, including amphibians, reptiles, birds and mammals, based on shared limb morphology.

(D) "Warm-blooded animals" including birds and mammals, based on convergent endothermy.

Solution · Q35 **Answer: (C)**

A monophyletic group contains a common ancestor and all of its descendants.

Tetrapoda is such a clade.

Reptilia without birds and 'fishes' are paraphyletic, while 'warm-blooded animals' is polyphyletic.

IAPT answer: (C) | **Zigyan answer:** (C)

36. Researchers conducted a study comparing two distinct successional systems:

Site 1: Occurring on a sterile, newly exposed volcanic ash substrate.

Site 2: Taking place in an abandoned agricultural field with pre-existing soils.

Over time, both sites showed an increase in soil nutrient levels, but the underlying processes differed between the two.

Which of the following statement is true about these succession processes?

(A) Site 1 is an example of primary succession.

(B) Succession at site 1 is likely to be a faster process due to rapid nutrient input from invasive species than site 2.

(C) Soil nutrient enhancement will be more pronounced at site 1 due to availability of inorganic nutrients in the form of ash.

(D) Both the sites will have a completely novel flora and fauna as a result of succession.

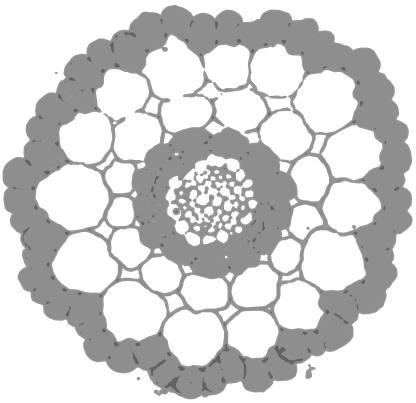
Solution · Q36 **Answer: (A)**

Site 1 is sterile, newly exposed ash with no soil or earlier community, so succession there is primary.

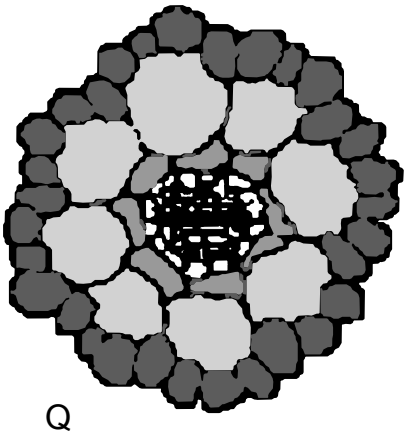
Site 2 already has soil, so it undergoes secondary succession, which is usually faster.

IAPT answer: (A) | **Zigyan answer:** (A)

37. Cross sections of the roots of two plants P and Q are shown below;



P



Q

P and Q most likely represent:

(A) Floating hydrophyte and a halophyte
(B) Halophyte and a hydrophyte
(C) Submerged hydrophyte and halophyte
(D) Halophyte and a mesophyte.

Solution · Q37 **Answer: (D)**

P has two layers of cortex and a two-layered endodermis, as in the root of salt cress, a halophyte.

The extra barrier helps to check the entry of salt into the stele.

Q has one cortical layer of eight large cells, a single endodermis and a diarch xylem plate.

This is the root plan of *Arabidopsis*, a mesophyte.

The eight large bodies in Q are cortical cells, not air chambers.

IAPT answer: (D) | **Zigyan answer:** (D)

38. During prolonged fasting, the liver ramps up gluconeogenesis to maintain blood glucose levels. However, gluconeogenic flux draws off oxaloacetate from the TCA cycle, risking the depletion of key intermediates required for both energy production and biosynthesis. Which of the following reactions most directly and efficiently replenishes the TCA cycle during fasting, thereby supporting both ATP generation and gluconeogenesis?

(A) Conversion of pyruvate to acetyl-CoA via the pyruvate dehydrogenase complex, providing acetyl-CoA to combine with residual oxaloacetate.
(B) Deamination of glutamate to form α-ketoglutarate via glutamate dehydrogenase, channelling amino acid carbon into the TCA cycle.
(C) Carboxylation of pyruvate to oxaloacetate catalyzed by pyruvate carboxylase, directly restoring the oxaloacetate pool.
(D) Transamination of alanine to pyruvate via alanine aminotransferase, indirectly supplying substrate for subsequent TCA cycle replenishment.

Solution · Q38 **Answer: (C)**

Pyruvate carboxylase makes oxaloacetate directly from pyruvate in liver mitochondria.

Pyruvate + HCO_3^- + ATP → Oxaloacetate + ADP + P_i

It is the chief refilling (anaplerotic) reaction, serving both the TCA cycle and gluconeogenesis.

Acetyl-CoA from fatty acid oxidation, plentiful in fasting, activates the enzyme.

IAPT answer: (C) | **Zigyan answer:** (C)

39. Which of the following cells show least telomerase activity?

(A) Sperm cells
(B) Embryonic stem cells
(C) Carcinoma cells
(D) Mature adipose cell

Solution · Q39 **As per Zigyan: (D)**

Telomerase is active in germ-line cells, embryonic stem cells and most cancer cells.

It is not active in adult somatic cells.

A mature adipose cell is a terminally differentiated somatic cell that no longer divides.

Reference: OpenStax Biology 2e, section 14.5 'DNA Replication in Eukaryotes': germ cells and adult stem cells usually have working telomerase, but the somatic cells of an adult do not.

IAPT answer: (D) | **Zigyan answer:** (D)

40. A researcher is attempting to amplify a specific gene fragment using PCR. The designed primer pair has a high GC content (~60%) and, upon analysis, exhibits regions of self-complementarity near the 3′ termini. When the PCR is run under standard cycling conditions, gel electrophoresis reveals only a faint band corresponding to the expected amplicon, but a dominant, sharp band appears at a size roughly twice the length of the individual primers. Which of the following best explains this observation?

(A) The 3′ self-complementarity in the forward primer alone leads to intra-molecular hairpin formation that completely sequesters the primer, resulting in inefficient target binding.
(B) The complementary 3′ ends of the forward and reverse primers facilitate dimerization, producing a primer-dimer that is preferentially amplified over the target sequence.
(C) The high GC content increases the melting temperature so dramatically that only non-specific, off-target binding occurs at the lower annealing temperature, yielding spurious short products.
(D) The primers undergo self-extension during the elongation phase due to internal priming on partially complementary regions within themselves, creating a consistent artifact of double-primer length.

Solution · Q40 **Answer: (B)**

The complementary 3′ ends let the forward and reverse primers pair with each other.

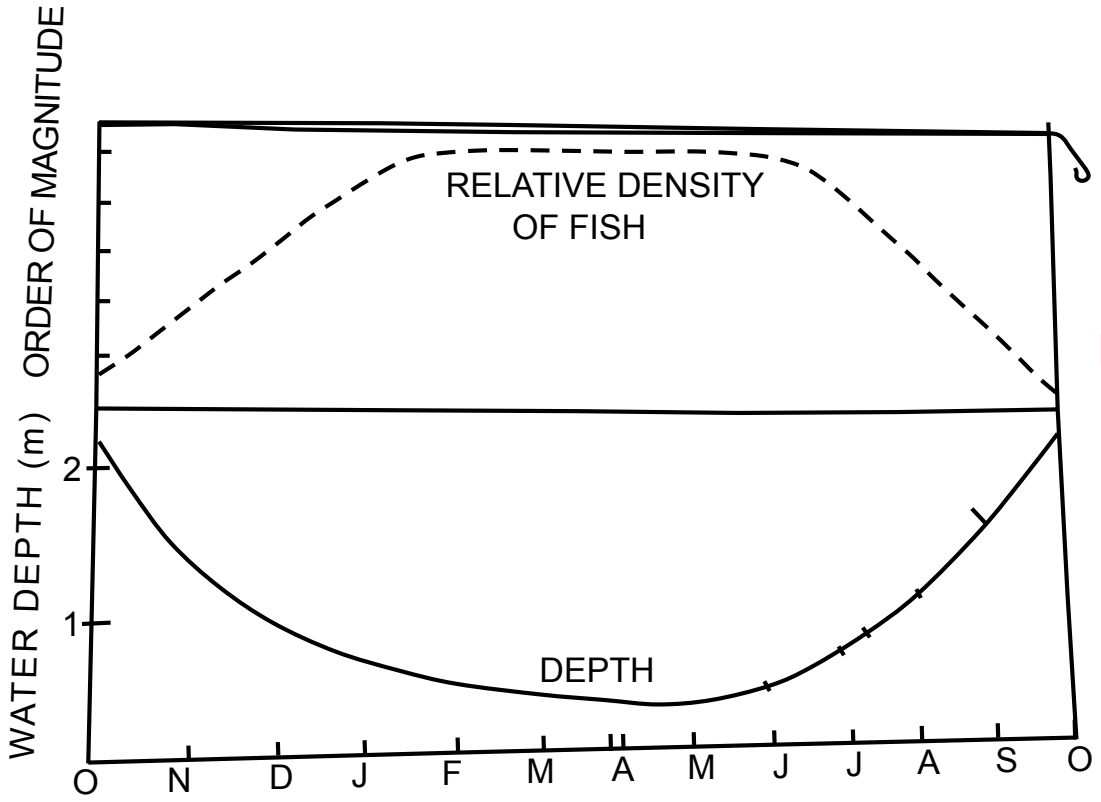
The DNA polymerase extends both 3′ ends, giving a short primer-dimer.

Its length is a little less than the two primers added together, about twice one primer.

This short product is amplified very efficiently and uses up primers and dNTPs, so the target band stays faint.

IAPT answer: (B) | **Zigyan answer:** (B)

41. In a tropical lake, the depth as well as expanse of the water goes on reducing as the summer progresses. This causes the ecological density of fish to increase, dropping again in monsoon as water fills in. A bird species feeds on these fish. The bird needs to incubate its eggs for one month and then feed the nestlings for another four months. The accompanying figure depicts changes in depth and fish density from October to October. What should be the ideal duration in which the bird needs to lay eggs?



(A) November- December
(B) January- February
(C) March- April
(D) May- June

Solution · Q41 **As per Zigyan: (B)**

In the graph, fish density is at its maximum from about February to the start of June, when the water is shallow.

Nestling feeding lasts four months, needs this rich food supply and begins one month after laying.

Eggs laid in January–February hatch in February–March.

Feeding then continues to about May–June, along the high-density part of the curve.

Why Zigyan differs from IAPT: after November–December laying, feeding starts in December–January while fish density is still rising; January–February laying places the feeding months on the maximum-density plateau.

Check: working backwards, feeding from February to May needs hatching in February and, with one month of incubation, egg laying in January.

IAPT answer: (A) | **Zigyan answer:** (B)

42. In the dense jungles of India, a male deer (stag) with massive, branching antlers engages in fierce battles with rivals to gain access to a harem of females. While these antlers provide a competitive edge during fights, they also slow the stag down, making it an easier target for predators. Interestingly, females still prefer males with the largest antlers.

In this context, which of the following scenarios BEST supports the Handicap Principle?

(A) **The Antlers as Honest Signals**: The size of the antlers demonstrates the stag's ability to survive despite the handicap, signalling superior strength and genetic quality to potential mates.

(B) **The Antlers as Weaponry:** The stag's antlers are primarily used to defeat rivals, ensuring reproductive success by physically eliminating competition.

(C) **Runaway Sexual Selection:** Female preference for larger antlers evolves independently of their utility, causing the trait to become exaggerated over generations.

(D) **The Antlers as Camouflage**: The antlers resemble branches, providing the stag with protection from predators and simultaneously increasing its attractiveness.

Solution · Q42 **Answer: (A)**

By the handicap principle, only a male of high quality can carry a costly trait and still survive.

So large antlers, which slow the stag, honestly signal strength and good genes to females.

IAPT answer: (A) | **Zigyan answer:** (A)

43. A researcher grows an *E. coli* culture in a batch medium that contains both glucose and lactose. The growth curve clearly exhibits an initial exponential phase on glucose, followed by a pronounced lag, and then a second exponential phase once lactose metabolism has initiated. Which of the following best explains the molecular mechanism underlying the lag period observed between the two exponential phases?

(A) The accumulation of acidic byproducts from rapid glucose metabolism induces transient cellular repair pathways, temporarily halting cell division until these byproducts are neutralized.

(B) Catabolite repression mediated by the cAMP-CRP complex suppresses the transcription of lactose-metabolizing enzymes while glucose is abundant, delaying the induction of the lac operon until glucose levels decline.

(C) An osmotic shock is incurred due to the simultaneous uptake of high concentrations of both sugars, necessitating a transient adjustment of the cell's internal solute balance before normal division resumes.

(D) The metabolic shift from aerobic to strictly anaerobic energy production during glucose consumption forces a reconfiguration of the electron transport chain, leading to a delay in the resumption of exponential growth on lactose.

Solution · Q43 **Answer: (B)**

This is diauxic growth due to catabolite repression.

While glucose is present, cAMP stays low, little cAMP-CRP forms and the *lac* operon is poorly transcribed; lactose entry is also blocked (inducer exclusion).

When glucose runs out, cAMP rises and cAMP-CRP, with the repressor removed by allolactose, allows strong transcription.

The lag is the time needed to make the lactose-using proteins.

IAPT answer: (B) | **Zigyan answer:** (B)

44. Elite sprinters often need to perform repeated maximal sprints with only brief recovery periods. One key factor in maintaining high power across bouts is the rapid replenishment of intramuscular phosphocreatine (PCr) during recovery. Which of the following muscular adaptations most directly enhances the rate of PCr resynthesis between sprint efforts?

(A) Upregulation of creatine kinase activity, thereby accelerating the immediate equilibrium between ADP and PCr.

(B) Increased mitochondrial density coupled with enhanced oxidative enzyme capacity, facilitating rapid ATP generation via oxidative phosphorylation.

(C) Elevated glycolytic enzyme activity, which boosts anaerobic ATP production during recovery intervals.

(D) Improved sarcoplasmic reticulum Ca^{2+}-ATPase function, leading to faster calcium clearance and increased overall energy turnover.

Solution · Q44 **Answer: (B)**

During recovery, PCr is rebuilt with ATP supplied mainly by oxidative phosphorylation.

Creatine + ATP → PCr + ADP

More mitochondria and oxidative enzymes supply this ATP faster, so PCr returns faster between sprints.

IAPT answer: (B) | **Zigyan answer:** (B)

45. In an isolated lung preparation subjected to sudden hypoxia, the pulmonary arteries exhibit an immediate vasoconstrictor response that is rapidly reversed when normoxic conditions are restored. Processes involved in the pathway to vasoconstriction are listed below.

I. Closure of oxygen sensitive K^+ channels

II. Opening of voltage dependent Ca^{++} channels

III. Reduction in mitochondrial Reactive Oxygen Species (ROS) production

IV. Increase in intracellular Ca^{++}

V. Membrane depolarization

The correct order of these processes is:

(A) I → III → V → IV → II

(B) V → IV → II → I → III

(C) II → IV → I → V → III

(D) III → I → V → II → IV

Solution · Q45 **Answer: (D)**

Hypoxia lowers mitochondrial ROS production (III).

The O_2-sensitive K^+ channels then close (I).

Less K^+ leaves the cell, so the membrane depolarizes (V).

Voltage-dependent Ca^{2+} channels open (II).

Intracellular Ca^{2+} rises (IV) and the smooth muscle contracts.

∴ III → I → V → II → IV

IAPT answer: (D) | **Zigyan answer:** (D)

46. Angiotensin-Converting Enzyme (ACE) converts Angiotensin I to II which acts as vasoconstrictor. Another endocrine hormone, namely vasopressin, also known as anti-Diuretic Hormone(ADH) increases water reabsorption from kidneys. Patients treated with ACE inhibitors are known to show reduced vasopressin levels over time. Which of the following is correct statement about these two molecules?

(A) Both are useful as anti-hypertensive drugs.

(B) Administering Vasopressin along with ACE inhibitors will increase the efficacy of the later.

(C) The effectiveness of ACE inhibitors will reduce over time due to reduced vasopressin levels in the blood.

(D) Vasopressin can be used as a drug in case of accidental overdose of ACE inhibitors.

Solution · Q46 **Answer: (D)**

ACE inhibitors lower blood pressure, whereas vasopressin constricts vessels and retains water, so it raises blood pressure.

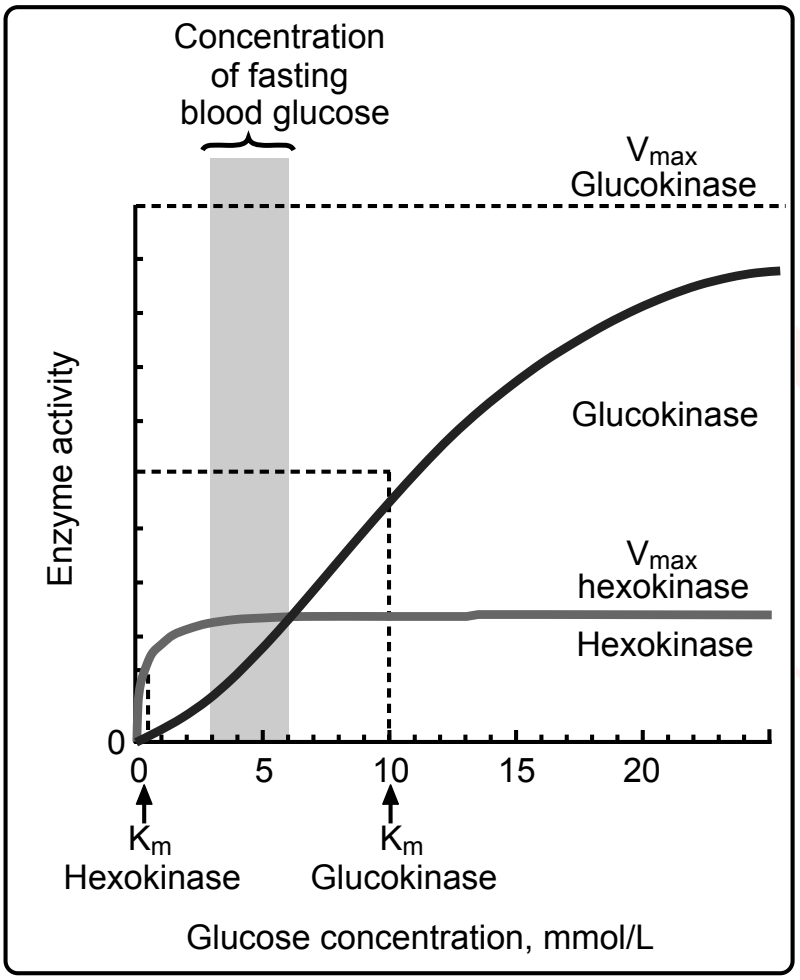
Hence it is not antihypertensive and would oppose an ACE inhibitor if given with it.

A fall in vasopressin cannot reduce the pressure-lowering effect of the inhibitor.

An overdose of an ACE inhibitor can cause severe hypotension, which vasopressin can help to correct.

IAPT answer: (D) | **Zigyan answer:** (D)

47. The kinetic parameters of two enzymes, namely hexokinase and glucokinase, that both use glucose as a substrate are depicted in the graph.



Which of the following are the correct interpretations?

I. Glucokinase is primarily active in the liver to remove excess glucose from the bloodstream after a meal.

II. Hexokinase is primarily active in the pancreas, where it is activated by high glucose concentrations to initiate insulin secretion.

III. Hexokinase will primarily function in tissues for glycolysis especially after fasting conditions.

IV. Glucokinase is primarily active in brain allowing it to respond to changes in blood glucose levels.

(A) I and III only (B) I and IV only (C) II and IV only (D) II and III only

Solution · Q47 **Answer: (A)**

Hexokinase has a very low K_m and low V_{max}; glucokinase has a high K_m (10 mmol/L) and high V_{max}.

I: liver glucokinase speeds up at the high glucose levels after a meal and takes up the excess. True.

III: hexokinase is nearly saturated even at fasting glucose levels, so glycolysis in tissues continues. True.

II, IV: the glucose sensor of pancreatic β-cells is glucokinase, while the brain depends mainly on hexokinase. False.

IAPT answer: (A) | **Zigyan answer:** (A)

48. During moderate exercise, cardiac output increases to meet the body's oxygen demands. Which of the following best explains how heart rate (HR) and stroke volume (SV) interact to maintain or increase cardiac output, especially when heart rate becomes excessively high?

(A) As heart rate increases, stroke volume always increases due to enhanced venous return, resulting in a proportional rise in cardiac output.

(B) At very high heart rates, stroke volume may decrease because diastolic filling time is reduced, which can limit cardiac output despite the high rate.

(C) Heart rate and stroke volume are independent of each other, so cardiac output increases linearly with heart rate alone.

(D) A high heart rate overcompensates for low stroke volume, ensuring increased cardiac output to meet body's oxygen demands.

Solution · Q48 **Answer: (B)**

Cardiac output depends on both heart rate and stroke volume.

$$CO = HR \times SV$$

At a very high heart rate, diastole is shortened and the ventricles fill less.

So stroke volume may fall, and this limits the cardiac output.

IAPT answer: (B) | **Zigyan answer:** (B)

PART A-2 · ONE OR MORE CORRECT OPTIONS

Q. 49 – 60 · 6 marks only if all correct options are marked · no negative marking

49. In a pond dug recently and filled with rain water, the water was assessed for various parameters, periodically during the development of the ecosystem. The likely observation(s) is/are

(A) day time net production exceeds night time respiration in initial stages.

(B) the gross production/ standing biomass (P/B) ratio would remain steady.

(C) entropy in the system, initially being low, would go on increasing.

(D) food chains would become progressively more complex.

Solution · Q49 **Answer: (A), (D)**

A new rain-water pond goes through autotrophic succession.

(A) At first, production exceeds respiration, so biomass builds up; true.

(B) As standing biomass accumulates, the P/B ratio falls; false.

(C) As organisation increases, entropy goes from high to low; false.

(D) Simple linear food chains develop into complex food webs; true.

IAPT answer: (A), (D) | **Zigyan answer:** (A), (D)

50. Though the lakes and the streams are fresh water environments, the communities inhabiting them show a drastic difference in behavior. Which of the following statement(s) seem(s) to explain it appropriately?

(A) Oxygen tension is comparatively more uniform in streams.

(B) Current is a major controlling and limiting factor in streams.

(C) Stream metabolism is generally slower and less variable than the Lake metabolism.

(D) Land-water interchange is relatively extensive in streams.

Solution · Q50 **Answer: (A), (B), (D)**

(A) Flowing, turbulent water keeps oxygen nearly uniform in streams; true.

(B) Current decides which organisms can live in a stream; true.

(C) Streams receive much organic matter from land and face floods, so their metabolism is the more variable one; false.

(D) Streams have a long land margin for their volume of water, so this exchange is extensive; true.

IAPT answer: (A), (B), (D) | **Zigyan answer:** (A), (B), (D)

51. Immunisation is a critical process in protecting individuals from infectious diseases. It involves the administration of vaccines, which stimulate the immune system to produce antibodies. When a vaccine is introduced into the body, it mimics an infection, prompting the immune system to respond. Which of the following statements best describe(s) the mechanism of antibody production and action in immunisation?

(A) Vaccines directly introduce antibodies into the bloodstream to provide immediate immunity against the pathogen.

(B) Vaccines stimulate the production of B cells, which then produce antibodies specific to the pathogenic antigen.

(C) Antibodies produced during immunisation can be effective against the toxins released during pathogenic infections.

(D) Vaccines stimulate production of lymphocytes, which are responsible for producing antibodies after vaccination.

Solution · Q51 **Answer: (B), (C), (D)**

(A) Giving ready-made antibodies is passive immunisation; a vaccine supplies antigen; false.

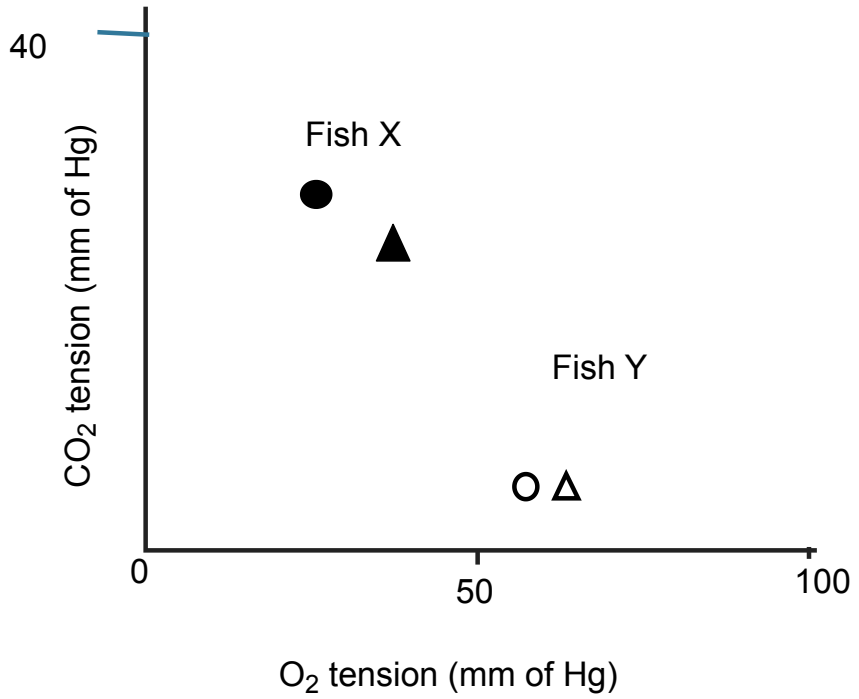
(B) Vaccine antigen activates B cells, which form plasma cells secreting specific antibodies; true.

(C) Such antibodies can neutralise toxins, as after tetanus toxoid; true.

(D) B lymphocytes, helped by T lymphocytes, are responsible for antibody formation; true.

IAPT answer: (B), (C), (D) | **Zigyan answer:** (B), (C), (D)

52. Measurement of oxygen and carbon dioxide content of two species of lungfish (X and Y) was monitored. The graph was plotted to show oxygen saturation and CO_2 levels in blood going to and coming from the lungs of the two fishes under varying oxygen tensions. Circles (o) indicate blood going to lungs and triangles (Δ) indicate blood coming out from lungs.



Mark the correct interpretation(s):

(A) Low CO_2 tension in fish Y reflects dominance of water-breathing over air-breathing.

(B) Gills of fish X are more efficient in oxygenation compared to its lungs.

(C) Higher saturation of oxygen in fish Y as compared to X is due to additional contribution from the lungs.

(D) Fish X will survive out of water for longer duration than fish Y.

Solution · Q52 **Answer: (A), (D)**

In Y, blood going to the lungs already has high O_2 and very low CO_2 tension; the lungs add little oxygen. The gills dominate.

In X, the lungs clearly raise O_2 tension and lower CO_2 tension, which stays high. This is mainly air breathing.

(A) CO_2 passes easily into water through the gills; true.

(B) In X, blood stays poorly oxygenated until it passes through the lungs; false.

(C) The higher level in Y is present before the lungs; false.

(D) X, relying on its lungs, lasts longer out of water; true.

IAPT answer: (A), (D) | **Zigyan answer:** (A), (D)

53. When Rh-negative mother carries Rh-positive baby, there's a risk of Rh incompatibility for the subsequent offspring. However, in about 20% of all the potential cases, the formation of antibodies is prevented, and risk of Rh sensitisation is reduced by protective mechanisms arising from interaction with other blood group genes.

In which of the following situations this mechanism will be observed?

(A) Rh negative mother with blood group O and Rh positive Baby with blood group A.

(B) Rh negative mother with blood group A and Rh positive Baby with blood group B.

(C) Rh negative mother with blood group B and Rh positive Baby with blood group O.

(D) Rh negative mother with blood group AB and Rh positive Baby with blood group A.

Solution · Q53 **Answer: (A), (B)**

Protection needs ABO incompatibility between mother and baby.

The mother's anti-A or anti-B antibodies destroy the baby's red cells entering her blood before she is sensitised to the Rh antigen.

(A) Mother O has anti-A, which acts on baby A; protected.

(B) Mother A has anti-B, which acts on baby B; protected.

(C) Baby O has no A or B antigen; not protected.

(D) Mother AB has neither antibody; not protected.

IAPT answer: (A), (B) | **Zigyan answer:** (A), (B)

54. Batesian and Müllerian mimicry are the two forms of mimicry where one species evolves to resemble the other. Batesian mimicry involves a harmless species mimicking a dangerous one, while Müllerian mimicry involves two or more dangerous species mimicking each other. Which of the following is/are correct statement(s) about these?

(A) Both types of the mimicry are the examples of coevolution.

(B) In Batesian mimicry, mimic will offer benefit to model and vice versa.

(C) Both the types are example of mutualistic relationships.

(D) Mullerian mimicry primarily benefits the prey by reducing predation pressure

Solution · Q54 **Answer: (A), (D)**

(A) Müllerian species converge on one signal. A Batesian mimic tracks its model, which is under pressure to differ. Both are coevolution; true.

(B) Only the mimic gains; the model loses when predators sample harmless copies; false.

(C) Batesian mimicry is therefore not mutualism; false.

(D) Predators learn one common warning pattern, so each prey species loses fewer individuals; true.

IAPT answer: (A), (D) | **Zigyan answer:** (A), (D)

55. Introduction of captive bred individuals into the wild is one of the conservation measures used for some species like the Bearded vulture (*Gypaetus barbatus*) which were wiped out from the European Apls. The problem with this conservation effort is not the size of the wild population; rather, it is the size of the captive population. Conservation biologists use effective population size (N_e) as a measure of the "genetic status" of a population which will sustain enough genetic variability in the captive birds to keep either the captive or the wild population thriving over the long term.

Which of the following measures would reduce the chance of the population losing its genetic variation due to genetic drift?

(A) Boosting the size of captive population of bearded vulture from its current level.

(B) Reduce the number of introduced birds per release to one per breeding season.

(C) Introduce male birds and female birds, alternately, after a “No-release” period in between.

(D) Recruiting additional founders into the captive population.

Solution · Q55 **Answer: (A), (D)**

Genetic drift removes variation faster when N_e is small.

(A) A larger captive population raises N_e; true.

(B) Releasing one bird a season does not raise N_e and gives the wild population very few founders; false.

(C) Releasing the sexes alternately, with gaps, adds neither breeders nor alleles; false.

(D) Additional founders bring new alleles and raise N_e; true.

IAPT answer: (A), (D) | **Zigyan answer:** (A), (D)

56. C_3 and C_4 plants represent two different pathways of carbon fixation during photosynthesis. C_4 plants, possess specialized leaf anatomy and biochemical pathways that allow them to thrive in intense sunlight, making them more resilient to climate stress. Which of the following statements best describe(s) the primary difference between C_3 and C_4 plants?

(A) C_3 plants use the Calvin cycle for carbon fixation, whereas C_4 plants use a different pathway to minimize photorespiration.

(B) C_3 plants have specialized leaf anatomy to reduce water loss, while C_4 plants do not.

(C) C_4 plants have a higher water-use efficiency compared to C_3 plants.

(D) C_4 plants can perform photosynthesis at lower carbon dioxide concentrations than C_3 plants.

Solution · Q56 **Answer: (A), (C), (D)**

(A) C_3 plants fix CO_2 directly in the Calvin cycle. C_4 plants first use the Hatch–Slack pathway, then the Calvin cycle in bundle sheath cells, limiting photorespiration; true.

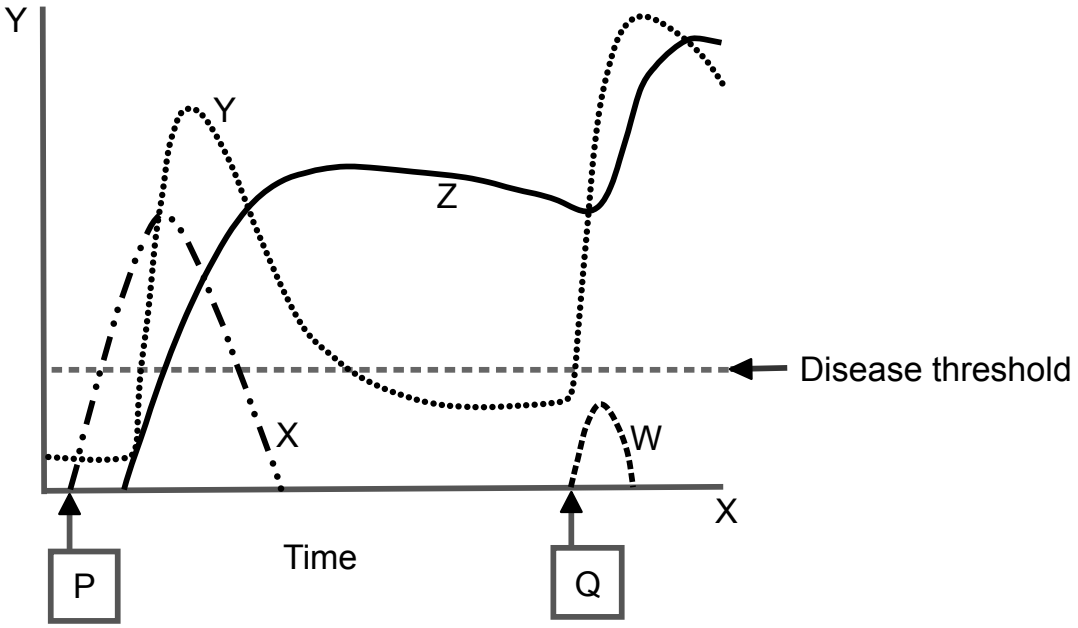
(B) The special Kranz anatomy belongs to C_4 plants; false.

(C) C_4 plants lose less water for each CO_2 fixed; true.

(D) They concentrate CO_2 around RuBisCO, so they work well at lower CO_2 levels; true.

IAPT answer: (A), (C), (D) | **Zigyan answer:** (A), (C), (D)

57. Adaptive immune responses following infection or vaccination are graphically shown below. X axis indicates time while Y-axis indicates titres (values) of respective parameters (W, X, Y and Z).



Mark the correct option(s):

(A) Y and Z most likely indicate T-cell and antibody response respectively.

(B) P and Q indicate vaccination and active infection respectively.

(C) Z indicates killer T cell response as a result of active infection.

(D) X and W indicate first and second infectious particle load of the same infective agent.

Solution · Q57 **Answer: (A), (D)**

X and W are the infectious loads after the exposures at P and Q.

(A) Y expands early and then contracts sharply, as T cells do; Z rises later and persists, as antibody does; true.

(B) After P the load crosses the disease threshold, so P is an infection causing disease, not vaccination; false.

(C) Z stays high long after the load has gone, so it is not the killer T cell curve; false.

(D) After Q, the quicker and stronger memory response keeps W small and below the threshold: same agent; true.

IAPT answer: (A), (D) | **Zigyan answer:** (A), (D)

58. An animal is repeatedly exposed to a conditional neutral stimulus without any consequential unconditioned stimulus (US). If the same animal is later exposed to the conditional stimulus (CS) paired with an unconditional stimulus, there is slower rate of subsequent associative learning. This is latent inhibition. Which of the following factor(s) account for the manifestation of latent inhibition?

(A) Repeated non-reinforced exposure to the CS leads to habituation, reducing the animal's attention to the stimulus and thus lowering its associability when later paired with a US.

(B) Pre-exposure of the CS elicits a robust dopaminergic surge that oversaturates reward pathways, in turn diminishing synaptic plasticity required for new associative learning.

(C) Repeated CS presentations without the US result in diminished prediction error (difference between predicted and actual outcome) signals, thereby reducing the learning drive when the CS is eventually paired with the US.

(D) The continual exposure to the CS transforms it into a conditioned inhibitor that signals the non-occurrence of the US, actively blocking subsequent excitatory conditioning.

Solution · Q58 **Answer: (A), (C)**

(A) Exposure without reinforcement lowers attention to the CS, so its associability falls; true.

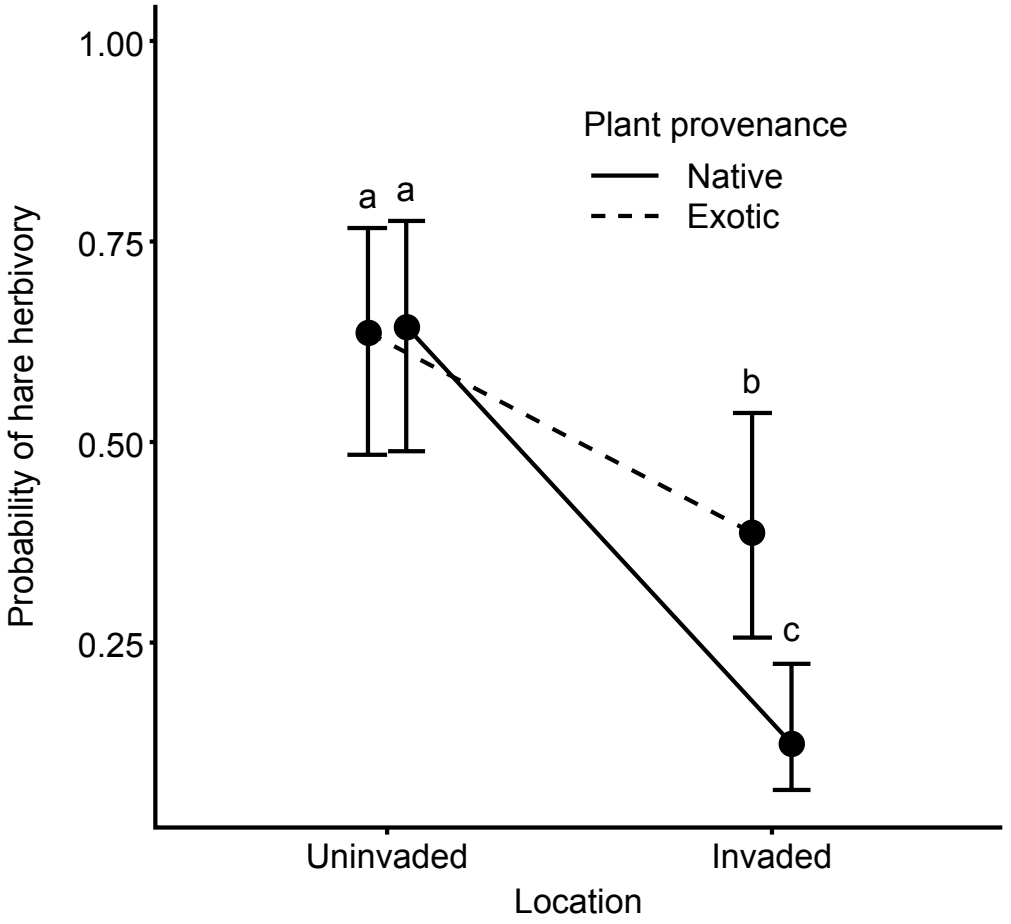
(B) A neutral, unrewarded stimulus produces no such strong dopamine surge; false.

(C) The CS comes to predict no US correctly. With little prediction error, attention and learning rate for this CS drop; true.

(D) A pre-exposed CS does not become a conditioned inhibitor; it is only slow to gain strength; false.

IAPT answer: (A), (C) | **Zigyan answer:** (A), (C)

59. The graph given below depicts the probability of European hare (*Lepus europaeus*) browsing [estimated marginal mean ± 95% Confidence Interval (CI)] on native and exotic plants in communities invaded and uninvaded by Scotch broom (*Cytisus scoparius*). Different lowercase letters indicate significant differences among means ($p < 0.05$).



In the context of the graph, which of the following statement(s) is/are correct?

(A) Broom invasion can have negative impact on native species since it could cause cumulative damage by facilitating both herbivores; generalists and specialists.

(B) Invasion of broom can lead to increase in survival and growth of other plant species, indirectly by release from hare browsing.

(C) The lower hare browsing in the invaded community is behaviourally mediated, since the denser broom may limit hares' ability to visually locate plants.

(D) Broom invasion has facilitative effects on native plants through apparent competition mediated by both mammalian and insect herbivores.

Solution · Q59 **As per Zigyan: (B), (C)**

In invaded communities, hare browsing falls on exotic plants and even more on native plants.

(A) The graph shows no added damage and nothing on specialist herbivores; false.

(B) Release from hare browsing can improve the survival and growth of these plants; true.

(C) Dense broom can screen plants from hares, a behavioural cause that fits the lower browsing; true.

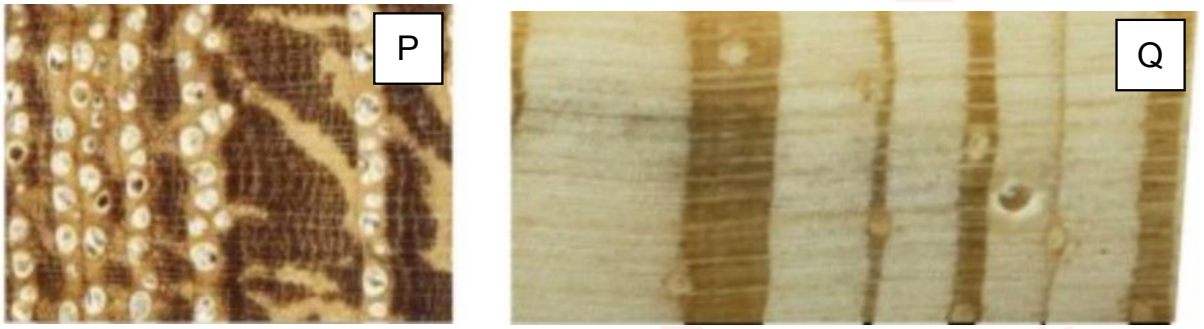
(D) Apparent competition cannot produce the facilitation claimed; false.

Why Zigyan differs from IAPT: apparent competition is a harmful indirect effect between species sharing an enemy, so broom cannot help native plants through it. The graph also records only hare browsing, with nothing about insects.

Reference: R. D. Holt and M. B. Bonsall, 'Apparent Competition', Annual Review of Ecology, Evolution, and Systematics, volume 48 (2017), abstract: the term commonly denotes negative indirect interactions between victim species that arise because they share a natural enemy.

IAPT answer: (B), (C), (D) | **Zigyan answer:** (B), (C)

60. Sections of Tree rings of Oak tree (P) and a pine tree (Q) are shown in the figure.



Which of the following is/are correct?

(A) The two trees are of the same age.

(B) It is likely that the oak tree faced a very severe winter in its second year of growth.

(C) Larger vessels seen in Oak tree represent summer wood.

(D) The tree rings patterns indicate that the two trees probably existed in the same environment.

Solution · Q60 **As per Zigyan: (B)**

Photo P is read from the pith side on the left towards the bark side on the right.

(A) Neither piece runs from pith to bark, so equal age does not follow; false.

(B) The second ring from the left is very narrow, with hardly any dense late wood. Growth was badly checked, as after a very severe winter; true.

(C) In oak, the large vessels form in spring; false.

(D) The two pieces show no matching, dated ring sequence that places both trees in one environment; false.

Why Zigyan differs from IAPT: oak forms its large vessels in spring, at the start of each ring. Wood formed later has smaller vessels, so the large ones are not summer wood.

Reference: OpenStax Biology 2e, section 30.2 'Stems': spring (early) wood has secondary xylem cells with a large internal diameter, and the number of vessel elements falls later in the season.

IAPT answer: (B), (C) | **Zigyan answer:** (B)

ANSWER KEY

NSEB 2025 · PAPER CODE 21

60
QUESTIONS · 216 MARKS

IAPT final answer key for paper code 21. ★ marks an answer given as per Zigyan.

1	(C)	2	(C)	3	(C)	4	(C)	5	(B)
6	(D)	7	(C)★	8	(B)	9	(C)	10	(B)★
11	(B)	12	(D)	13	(B)	14	(C)	15	(C)
16	(B)★	17	(A)	18	(C)★	19	(C)★	20	(D)
21	(B)	22	(C)	23	(B)	24	(B)	25	(C)
26	(C)	27	(B)★	28	(C)	29	(B)	30	(C)
31	(B)	32	(C)	33	(B)★	34	(B)	35	(C)
36	(A)	37	(D)	38	(C)	39	(D)★	40	(B)
41	(B)★	42	(A)	43	(B)	44	(B)	45	(D)
46	(D)	47	(A)	48	(B)	49	(A), (D)	50	(A), (B), (D)
51	(B), (C), (D)	52	(A), (D)	53	(A), (B)	54	(A), (D)	55	(A), (D)
56	(A), (C), (D)	57	(A), (D)	58	(A), (C)	59	(B), (C)★	60	(B)★

★ Answers as per Zigyan

- **Q7** — As per Zigyan: (C); IAPT key (B).
- **Q10** — As per Zigyan: (B); IAPT key (B).
- **Q16** — As per Zigyan: (B); IAPT key (B).
- **Q18** — As per Zigyan: (C); IAPT key (C).
- **Q19** — As per Zigyan: (C); IAPT key (C).
- **Q27** — As per Zigyan: (B); IAPT key (A) or (B).
- **Q33** — As per Zigyan: (B); IAPT key (A).
- **Q39** — As per Zigyan: (D); IAPT key (D).
- **Q41** — As per Zigyan: (B); IAPT key (A).
- **Q59** — As per Zigyan: (B), (C); IAPT key (B), (C), (D).
- **Q60** — As per Zigyan: (B); IAPT key (B), (C).

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OLYMPIADS · 2026

Olympiad results



TOP ACHIEVEMENT · CHEMISTRY

Qualified the Chemistry Olympiad twice, and selected for the HBCSE camp.

Saksham Bishnoi reached the national stage of the Chemistry Olympiad in two consecutive years and was selected for the Orientation-cum-Selection Camp at HBCSE, Mumbai. 4 Years Classroom - the same student who took AIR 168 in JEE Advanced 2026.

Qualified twice | HBCSE selection camp | Only student from Faridabad

Above MAS means above the **Minimum Admissible Score**: clearing it puts a student in the national band for their subject. It is a real threshold, not a participation marker.

CHEMISTRY · ABOVE MAS



Sulokya Bibhuty
Class XII
3 Years Classroom
Above MAS



Anay Gupta
Class XI
3 Years Classroom
Above MAS



Akshat Khator
Class XI
3 Years Classroom
Above MAS



Harshit Goyal
Class XII
4 Years Classroom
Above MAS



Hardik Sharma
Class XI
3 Years Classroom
Above MAS



Aarush Kumar
Class XII
1 Year Classroom
Above MAS

PHYSICS · ASTRONOMY · MATHEMATICS

PHYSICS



Sulokya Bibhuty
Class XII
3 Years Classroom
Above MAS

PHYSICS



Saksham Bishnoi
Class XII
4 Years Classroom
Above MAS

ASTRONOMY



Sulokya Bibhuty
Class XI
3 Years Classroom
Above MAS

MATHEMATICS · IOQM



Priyanshi
Class XI
4 Years Classroom
IOQM Qualifier

OLYMPIADS WE PREPARE STUDENTS FOR

NSEP	NSEC	NSEB	NSEA	IOQM	NSEJS
Physics	Chemistry	Biology	Astronomy	Mathematics	Class X and below

The olympiad pathway starts in Class 8.

NSEJS is open to Class 10 and below - the habit of staying with one hard problem is the one JEE Advanced rewards.

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RESULTS · 2021 – 2026

Our toppers, year by year

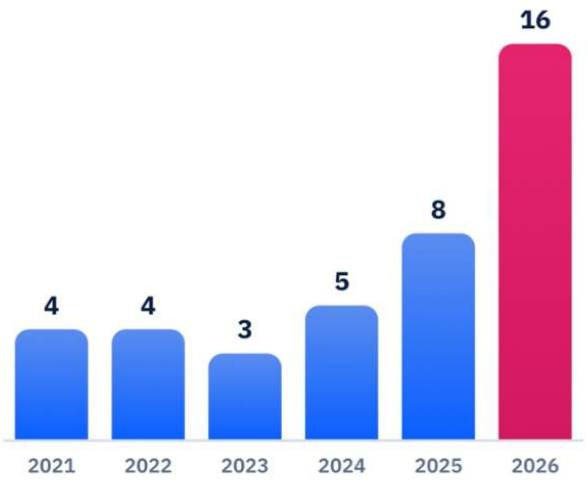
40
JEE Advanced selections in 6 years

AIR 168
best rank — Saksham Bishnoi, 2026

16 of 35
students selected, JEE Advanced 2026

14 of 35
above 98 percentile, JEE Main 2026

JEE ADVANCED SELECTIONS PER YEAR



BEST RANK EACH YEAR

YEAR	JEE ADVANCED	JEE MAIN
2026	**Saksham Bishnoi** AIR 168 · 4 Years Classroom	**Saksham Bishnoi** AIR 811 · 99.95 %ile
2025	**Chakshu** AIR 4,233 · 2 Years Classroom	**Chakshu** AIR 8,538 · 99.44 %ile
2024	**Harshit** AIR 777 · 2 Years Classroom	**Harshit** AIR 1,473 · 99.91 %ile
2023	**Aditya Jain** AIR 2,373 · 2 Years Classroom	**Aditya Jain** AIR 2,503 · 99.79 %ile
2022	**Rachit Sharma** AIR 698 · 1 Year Classroom	**Rachit Sharma** AIR 1,016 · 99.90 %ile
2021	**Sparsh Mittal** AIR 2,237 · 1 Year Classroom	**Sparsh Mittal** AIR 1,562

JEE ADVANCED 2026 — THIRTEEN NAMED SELECTIONS



Saksham Bishnoi
AIR 168
4 Years Classroom



Sulokya Bibhuty
AIR 1,315
3 Years Classroom



Aarush
AIR 2,699
1 Year Classroom



Manishka
AIR 2,869
4 Years Classroom



Oojit Kumar
AIR 5,765
4 Years Classroom



Harshit Goyal
AIR 6,407
4 Years Classroom



Pranab Sharma
AIR 6,750
3 Years Classroom



Aditya Dhar
AIR 15,183
3 Years Classroom



Arpit Anshuman
AIR 19,308
4 Years Classroom



Lokesh
AIR 22,857
3 Years Classroom



Arjun
AIR 24,674
3 Years Classroom



Sanyam Gulyani
AIR 25,123
1 Year Classroom



Saket
AIR 27,628
3 Years Classroom

Sixteen students of the 2026 batch were selected in JEE Advanced; the thirteen above are named with their All India Rank.

JEE MAIN 2026 — TOP SIX, WITH PERCENTILE



Saksham Bishnoi
AIR 811
99.95 %ile
4 Years Classroom



Sulokya Bibhuty
AIR 1,095
99.94 %ile
3 Years Classroom



Harshit Goyal
AIR 2,662
99.83 %ile
4 Years Classroom



Manishka
AIR 4,817
99.70 %ile
4 Years Classroom



Oojit Kumar
AIR 5,040
99.69 %ile
4 Years Classroom



Aarush
AIR 5,276
99.67 %ile
1 Year Classroom

14 of the 35 students in the 2026 batch scored above the 98th percentile in JEE Main.

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