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PREVIOUS YEAR PAPER · 2023

OLYMPIAD · STAGE I

NSEB

National Standard Examination in Biology

2023

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 2023, 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. A turtle draws its head back into its shell when its shell is touched. After being touched repeatedly, however, the turtle no longer withdraws its head. This behaviour is an example of :

(A) Conditioning
(B) Habituation
(C) Associative learning
(D) Kinesis

Solution · Q1 **Answer: (B)**

The response to a harmless stimulus fades when the stimulus is repeated again and again.

This is habituation, a simple form of learning.

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

2. During mating season, the belly of three-spined stickleback fish becomes red. The male sticklebacks show typical aggressive behaviour when they see a red-bellied male stickleback, or any red-coloured object in the vicinity. Identify another example of this type of behaviour from the following:

(A) Sparrow chicks exposing their gape for begging food from parents
(B) Person regaining balance on losing his/her foothold
(C) A dog sitting down on being pulled by the leash
(D) An earthworm burrowing deeper in the soil in daytime

Solution · Q2 **Answer: (A)**

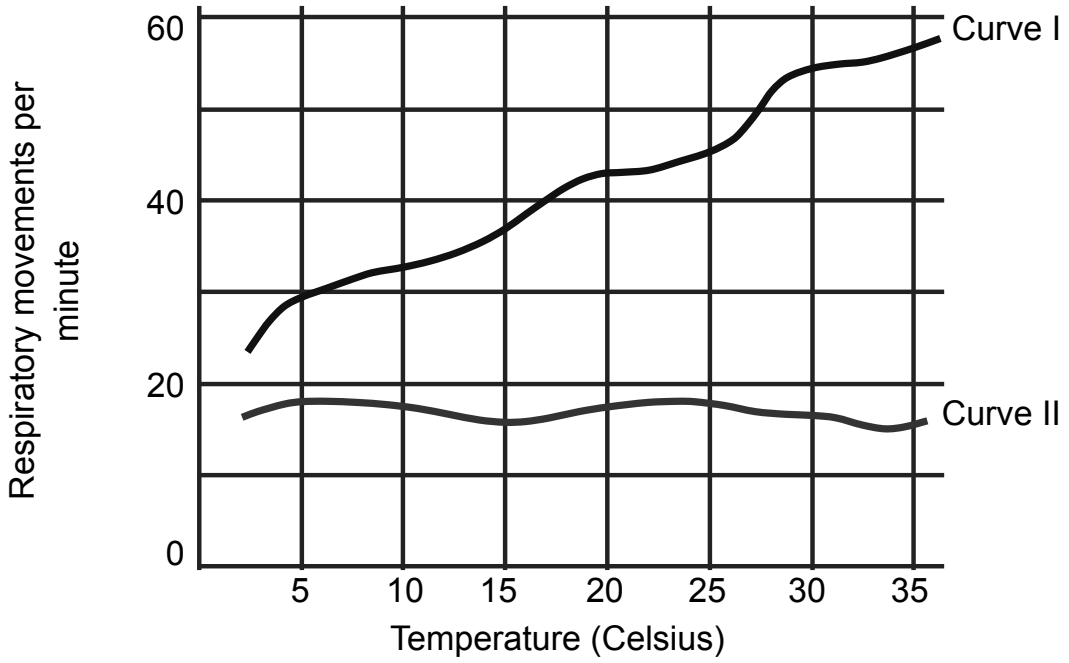
The red colour is a simple sign stimulus that releases a fixed action pattern, the male's aggression.

Gaping by sparrow chicks to beg food is also a fixed action pattern released by a simple stimulus, such as a parent arriving at the nest.

Regaining balance is a reflex, the dog's sitting is a trained response, and the earthworm's burrowing by day is movement away from light.

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

3. Studies have shown that the rate of respiration of an organism varies with fluctuations in temperature. Identify the correct pairing of the curves I and II with the animals from the given options, respectively;



Curve I Curve II

(A) Mackerel Fish Kangaroo
(B) Grizzly Bear Salmon fish
(C) Penguin Emu
(D) Sea cow Komodo dragon

Solution · Q3 **Answer: (A)**

Curve I rises with temperature, so it belongs to an ectotherm. Its metabolism and breathing rate increase as the surroundings warm.

Curve II stays nearly constant, as expected for an endotherm that keeps a steady body temperature.

Only mackerel (ectotherm) with kangaroo (endotherm) fits this order.

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

4. Molecular machines present in the eukaryotic cell perform several functions to ensure the optimum functionality of the cell and they are found in specific locations in the cell. A student had preparations of 3 such molecules – Chaperonin; Spliceosome and calcium dependent kinases. The cellular locations wherein these molecules would most predominantly be present respectively are:

(A) Nucleus; Cytoplasm; Nucleus
(B) Cytoplasm; Mitochondria; Cytoplasm
(C) Nucleus; Cytoplasm; Cytoplasm
(D) Cytoplasm; Nucleus; Cytoplasm

Solution · Q4 **Answer: (D)**

Chaperonins fold proteins, mostly in the cytoplasm.

Spliceosomes remove introns from pre-mRNA in the nucleus.

Calcium dependent kinases respond to Ca^{2+} signals mainly in the cytoplasm.

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

5. A zoologist was studying the nervous system of some organisms. She observed that specimen M showed presence of a nerve net, N showed presence of ventral nerve cord with segmented ganglia and O showed a nerve ring with radial nerves. Based on the observations, M , N and O most likely could respectively be:

(A) Mouse; lizard and squid
(B) Planaria; squid and hydra
(C) Hydra; leech and sea star
(D) Sea star; earthworm and squid

Solution · Q5 **Answer: (C)**

M has a nerve net: a cnidarian such as Hydra.

N has a ventral nerve cord with segmental ganglia: an annelid such as the leech.

O has a nerve ring with radial nerves: an echinoderm such as the sea star.

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

6. Descriptions of the alimentary canals of four animals P, Q, R and S are given below;

P: Short intestine and colon; small cecum.

Q: Simple stomach; large cecum.

R: Short intestine; cecum absent

S: Four-chambered stomach with large rumen; long small and large intestine.

Animals P, Q, R and S respectively could be:

(A) Carnivore; insectivore; non-ruminant herbivore; ruminant herbivore
(B) Carnivore; non-ruminant herbivore; insectivore; ruminant herbivore
(C) Non-ruminant herbivore; carnivore; insectivore; ruminant herbivore
(D) Insectivore; nonruminant herbivore; ruminant herbivore; carnivore

Solution · Q6 **Answer: (B)**

P, with a short gut and small cecum, is a carnivore, since meat is easy to digest.

Q, with a simple stomach and a large cecum for microbial fermentation, is a non-ruminant herbivore.

R, with a short intestine and no cecum, is an insectivore.

S, with a four-chambered stomach and large rumen, is a ruminant herbivore.

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

7. The plasma membrane of the root hair cells selectively allows absorbed minerals to pass through plasmodesmata into the endodermal cells which, then enter the xylem vessels. The indiscriminate absorption of minerals through apoplastic route, on the other hand, may admit undesirable minerals. This is prevented by ;

(A) Glycerolipids in membranes of pericycle cells

(B) Suberin in the wall of endodermal cells

(C) Lignin in the wall of xylem cells

(D) Sulfolipids in the membranes of xylem parenchyma cells

Solution · Q7 **Answer: (B)**

Walls of endodermal cells carry the Casparian strip, a band containing suberin that water and dissolved minerals cannot cross.

It blocks the apoplastic route. Minerals must cross a plasma membrane, which selects them before they reach the xylem.

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

8. 100 bacterial cells are inoculated in a growth medium. Each cell takes 30 minutes to duplicate. Select the number of cells present in the broth after 20 hours of incubation, assuming no cell death.

(A) 10^{14} (B) 10^{12} (C) 10^{112} (D) 100^{40}

Solution · Q8 **Answer: (A)**

Two divisions occur every hour, so the number of generations is

$$n = 20 \times 2 = 40$$

Number of cells:

$$N = N_0 \times 2^n$$

$$\Rightarrow N = 100 \times 2^{40}$$

$$2^{40} \approx 1.1 \times 10^{12}$$

$$\therefore N \approx 1.1 \times 10^{14}$$

The nearest option is 10^{14}.

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

9. It is observed that glucose absorption is slow if the energy drink contains only glucose as compared to drinks that contain glucose along with small amount of salt. Which of the following correctly explains this?

(A) Glucose absorption is carried out by a membrane protein which is symporter by nature.

(B) Glucose absorption is carried out by a membrane protein which is antiporter by nature.

(C) Na^+ and $C\ell^-$ ions interact with glucose molecules and break the hydration shell around them, making it easier for transport across membrane.

(D) Na^+ increases membrane potential thereby increasing the rate of transport.

Solution · Q9 **Answer: (A)**

Intestinal cells take in glucose together with Na^+ through a symporter, the sodium-glucose cotransporter.

Na^+ moving down its gradient carries glucose into the cell, so a little salt speeds up glucose absorption.

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

10. Digestion of ingested food can occur in two ways. Intracellular - by taking the food material inside the cell and then breaking it using digestive enzymes (e.g. Amoeba). Extracellular - by secreting digestive enzymes, breaking the molecules and transporting them inside the cell (e.g. Fungus).

What type of digestion is carried out in humans?

(A) Intracellular

(B) Extracellular

(C) Mainly intracellular but partially extracellular

(D) Mainly extracellular but partially intracellular.

Solution · Q10 **As per Zigyan: (D)**

Most food is digested outside cells by digestive enzymes, in the cavity of the alimentary canal and on the surface of its lining.

A part of protein digestion is completed inside cells. Dipeptides and tripeptides enter the absorptive cells of the intestine and are split there into amino acids.

So human digestion is mainly extracellular but partially intracellular.

Why Zigyan differs from IAPT: the question defines intracellular digestion as taking food material into a cell and breaking it there with enzymes. Absorbed small peptides are digested exactly this way, so digestion in humans is not only extracellular.

Reference: OpenStax Anatomy and Physiology 2e, section 23.7 'Chemical Digestion and Absorption: A Closer Look': dipeptides and tripeptides are actively carried into the absorptive cells of the intestine and are broken down to amino acids inside them.

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

11. Amytal is an inhibitor of Complex I involved in Electron Transport Chain (ETC). A cell free system was used to study the effect of amytal on electron transport chain. What effect do you expect on the Electron Transport Chain (ETC) system?

(A) Flow of electron will completely stop.
(B) There will be fewer electrons that will keep the ETC active.
(C) Electron flow through ETC will remain normal.
(D) Electrons will start flowing in reverse direction.

Solution · Q11 **Answer: (B)**

Amytal blocks electron flow through Complex I, so electrons from NADH cannot pass this way.

Electrons from $FADH_2$ still enter through Complex II and move on to ubiquinone and then to Complexes III and IV.

So the chain stays active, but with fewer electrons.

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

12. Smooth endoplasmic reticulum is **NOT** prevalent in which of the following?

(A) Ovary (B) Testis (C) Adipose tissue (D) Pancreas

Solution · Q12 **Answer: (D)**

Smooth ER is the site of lipid and steroid synthesis.

It is well developed in the steroid hormone secreting cells of ovary and testis, and it takes part in fat synthesis in adipose tissue.

Pancreatic acinar cells mainly make protein enzymes, so they are rich in rough ER instead.

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

13. A protein contains 90 amino acids. During its synthesis how many times t-RNA gets attached to the A-site of ribosome?

(A) 30 (B) 90 (C) 89 (D) 270

Solution · Q13 **Answer: (C)**

The first (initiator) aminoacyl-tRNA binds directly at the P-site.

Each of the remaining amino acids is brought in by a tRNA at the A-site.

Number of A-site attachments:

$$90 - 1 = 89$$

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

14. In the skeletal muscle cells, the calcium pump in the sarcoplasmic reticulum functions to :

(A) Maintain Ca^{2+} ions balance in the cytosol.

(B) Release Ca^{2+} ions in the cytosol and bringing about contraction of muscles.

(C) Collect Ca^{2+} ions back into sarcoplasmic reticulum and induce contraction of muscles.

(D) Induction of apoptosis in muscle cells.

Solution · Q14 **As per Zigyan: (A)**

The calcium pump of the sarcoplasmic reticulum uses ATP to move Ca^{2+} from the cytosol (sarcoplasm) back into the sarcoplasmic reticulum.

It thus restores and maintains the low Ca^{2+} level of the cytosol; this removal of Ca^{2+} relaxes the muscle.

Why Zigyan differs from IAPT: option (C) says that collecting Ca^{2+} back induces contraction, but pumping Ca^{2+} back masks the actin filaments again and the muscle relaxes.

Reference: NCERT Biology Class XI, Chapter 17 'Locomotion and Movement', section 17.2.2: contraction goes on until Ca^{2+} ions are pumped back into the sarcoplasmic cisternae; the actin filaments are then masked and the muscle relaxes.

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

15. A scientist wants to synthesize recombinant DNA. Identify the correct pair of enzymes that he will use to (i) Cut the vector DNA and (ii) Seal the DNA after inserting the fragment of interest, respectively;

(A) Exonuclease and ligase

(B) Helicase and Nuclease

(C) Helicase and ligase

(D) Endonuclease and ligase

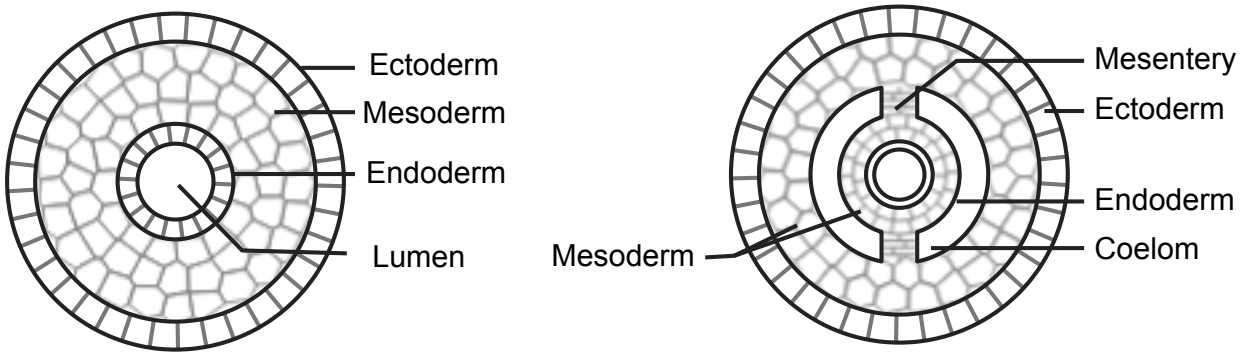
Solution · Q15 **Answer: (D)**

The vector DNA is cut at a specific site by a restriction endonuclease.

After the fragment is inserted, DNA ligase seals the cut ends.

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

16. The adjoining diagrams show the cross section of body of an invertebrate, through the middle region of the body.



(i) (ii)

Which of the following animals respectively, exhibit these body forms?

(A) (i) earthworm, (ii) cockroach
(B) (i) planaria (ii) Tapeworm
(C) (i) cockroach (ii) Ascaris
(D) (i) Planaria (ii) cockroach

Solution · Q16 **Answer: (D)**

(i) has no body cavity: mesoderm fills the whole space between ectoderm and endoderm. It is acoelomate, as in Planaria.

(ii) has a true coelom lined by mesoderm on both sides, with mesenteries. It is coelomate, as in cockroach.

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

17. Presence of two human traits X and Y were compared in the chimpanzee and hyena, a social carnivore. The results obtained are shown below.

Trait	Chimpanzee	Hyena
X	High	Moderate
Y	Rudimentary	No

Traits X and Y are most likely and respectively the:

(A) tool making and bipedal locomotion
(B) degree of intelligence and tool making
(C) bipedal locomotion and cooperation in hunting
(D) cooperation in hunting and degree of intelligence

Solution · Q17 **Answer: (B)**

Intelligence is high in the chimpanzee and moderate in the hyena, so it is X.

Tool making is seen in a simple form in the chimpanzee and is absent in the hyena, so it is Y.

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

18. A 65-year-old male admitted to the hospital showed symptoms like severe inflammatory response, kidney dysfunction, low levels of Na^+ and high levels of K^+ in the body. Which part of his endocrine system most probably must be impaired or dysfunctional?

(A) Hypothalamus
(B) Adrenal cortex
(C) Adrenal medulla
(D) Parathyroid gland

Solution · Q18 **Answer: (B)**

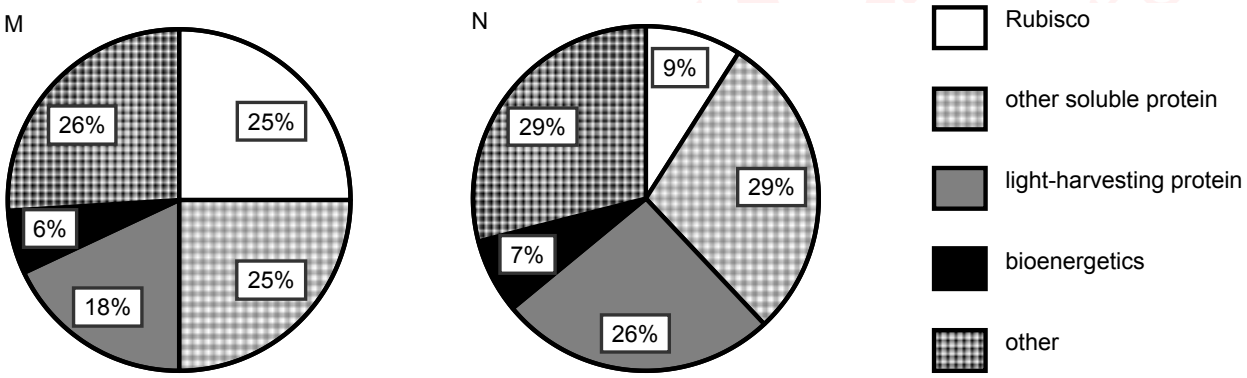
Low Na^+ with high K^+ shows lack of aldosterone, which makes the kidney retain Na^+ and excrete K^+.

Severe inflammation shows lack of cortisol, which has anti-inflammatory action.

Both hormones are secreted by the adrenal cortex.

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

19. Percent nitrogen in different components within the leaf of two plant species M and N is shown in the following diagrams.



M and N most likely respectively indicate:

(A) C3 and C4 plants
(B) Sun and Shade growing plants
(C) C3 and CAM plants
(D) Plants with low and high water availability

Solution · Q19 **Answer: (A)**

Rubisco holds 25% of the leaf nitrogen in M but only 9% in N.

C4 plants concentrate CO_2 around Rubisco in bundle sheath cells, so they need much less of this enzyme.

The extra enzymes of the C4 pathway, such as PEP carboxylase, fall among the other soluble proteins (29% in N, 25% in M).

∴ M is a C3 plant and N is a C4 plant.

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

20. Humans are able to smell L and D forms of the aromatic compound, carvone, distinctively because;

(A) They bind to the same olfactory receptor but differently.

(B) The same olfactory receptor differentially forms unique complex with each isomer and triggers different nerve impulses.

(C) Olfactory receptors are chiral and are distinct for each isomer.

(D) The enantiomer flips to attach with the same receptor at a different site.

Solution · Q20 **Answer: (C)**

Olfactory receptors are proteins and are therefore chiral.

So the two enantiomers of carvone are recognised by different receptors.

The brain receives different signals and perceives two different smells.

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

21. An Ecological research centre had studied a population of grasshoppers that live in a grassland and feed on grasses. A subpopulation of the same grasshoppers was observed to have access to a nearby forest where some individuals of the population fed on toxic herbs. After several decades when the same grasshopper population was studied again, it was observed that the grasshoppers that used to feed on toxic herbs in the forest were breeding true within themselves, isolated from the original grassland population. The Ecologists could identify the process as speciation. This is an example of which type of speciation?

(A) Peripatric (B) Allopatric (C) Sympatric (D) Parapatric

Solution · Q21 **Answer: (D)**

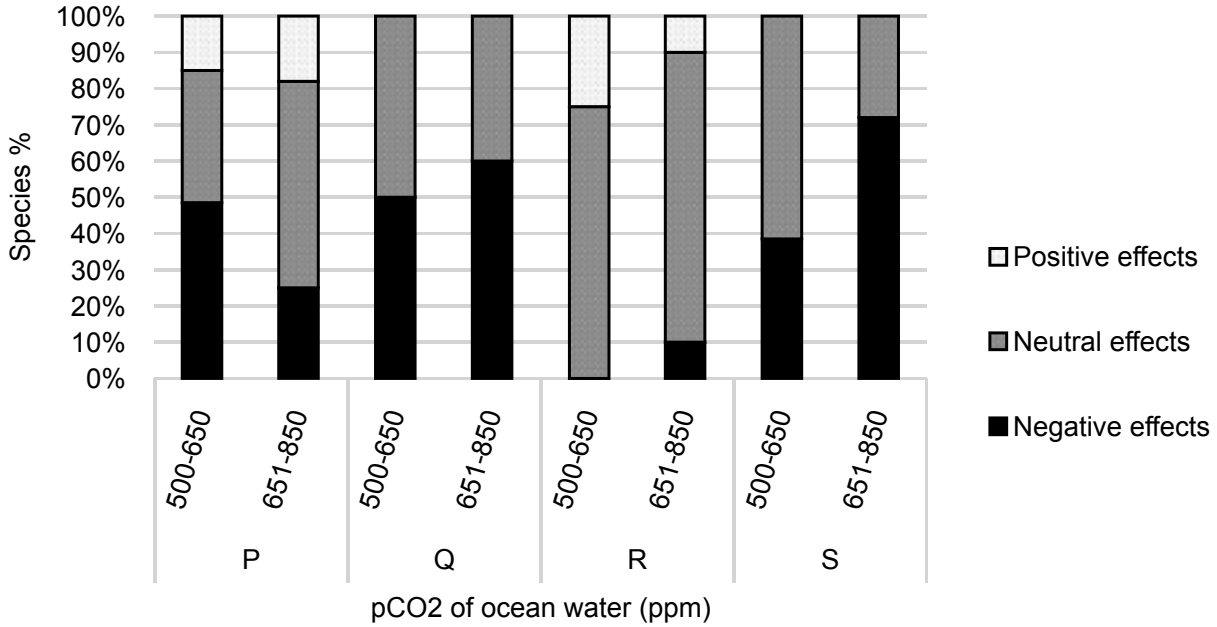
The forest lies next to the grassland and no physical barrier separates the two groups.

In this adjacent habitat, with a different selection pressure (toxic herbs), the subpopulation became reproductively isolated.

Speciation between neighbouring populations without a geographical barrier is parapatric.

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

22. Effect of sea water acidification is shown in the following graph for four aquatic animals namely crustaceans, echinoderms, fishes and molluscs.



The species belonging to R is most likely:

(A) Crustacean (B) Fish (C) Echinoderm (D) Mollusc

Solution · Q22 **Answer: (A)**

R is the least harmed group: no species is affected negatively at 500–650 ppm and only about 10% at 651–850 ppm, while some show positive effects.

Published comparisons show that molluscs and echinoderms are more sensitive to acidification than crustaceans; fish larvae can be very sensitive too.

∴ R represents crustaceans.

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

23. Different sites in the human body are listed with their partial pressure values of O_2 (pO_2) and CO_2 (pCO_2) in the following table. Identify the body sites represented by X, Y and Z.

Human Body Site	pO_2	pCO_2
X	160	0.3
Y	104	40
Z	< 40	> 45

(A) X – Exhaled air, Y – Alveolar capillaries, Z – Pulmonary vein
(B) X – Inhaled air, Y – Pulmonary vein, Z – Tissues
(C) X – Inhaled air, Y – Systemic arteries, Z – Pulmonary arteries
(D) X – Inhaled air, Y – Alveolar space, Z – Pulmonary arteries

Solution · Q23 **As per Zigyan: (B)**

X: these are the values of inhaled (atmospheric) air.

Z: cells use O_2 and produce CO_2, so O_2 diffuses from blood into tissues and CO_2 from tissues into blood.

Hence a pO_2 below 40 mm Hg with a pCO_2 above 45 mm Hg describes tissues.

Pulmonary arteries carry deoxygenated blood with values of 40 and 45 mm Hg, not below 40 and above 45.

Y: blood leaving the alveolar capillaries has come to equilibrium with alveolar air (104 and 40 mm Hg), so it represents the pulmonary vein.

Reference: NCERT Biology Class XI, Chapter 14 'Breathing and Exchange of Gases', section 14.3, Table 14.1 and its text: deoxygenated blood has pO_2 40 and pCO_2 45 mm Hg; the O_2 gradient runs from blood to tissues and the CO_2 gradient from tissues to blood.

Reference: OpenStax Anatomy and Physiology 2e, section 22.4 'Gas Exchange': pO_2 is about 104 mm Hg in alveolar air and about 100 mm Hg in the oxygenated blood of the pulmonary veins.

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

24. Recombination frequency between some genes is B – D > A – C > A – B. What could be the sequence of these genes on a chromosome?

(A) D-B-C-A (B) B-A-C-D (C) D-A-B-C (D) C-A-B-D

Solution · Q24 **As per Zigyan: (B)**

Recombination frequency increases with the distance between two genes, so the distances must follow:

$$BD > AC > AB$$

For the order B–A–C–D, take the gaps BA, AC and CD as 1, 3 and 1 units.

$$BD = 5,\ AC = 3,\ AB = 1$$

This satisfies the condition, so B–A–C–D can be the sequence.

Reference: NCERT Biology Class XII, Chapter 4 'Principles of Inheritance and Variation', section 4.3.3 'Linkage and Recombination': Sturtevant used the recombination frequency between genes on the same chromosome as a measure of the distance between them and mapped their positions.

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

25. During complete oxidation of substrate X to CO_2 and H_2O, a total of 110 H^+ ions were transported out across the inner mitochondrial membrane. If 4 H^+ ions are sent back to generate one ATP, calculate the number of ATPs generated and NADH oxidized (Assume that $FADH_2$ is NOT involved).

(A) 11 NADH and 28 ATPs
(B) 10 NADH and 32 ATPs
(C) 11 NADH and 38 ATPs
(D) 10 NADH and 28 ATPs

Solution · Q25 **As per Zigyan: (A)**

For each NADH oxidised, complexes I, III and IV pump out:

$$4 + 4 + 2 = 10\ H^+$$

NADH oxidised:

$$110 \div 10 = 11$$

ATP formed:

$$110 \div 4 = 27.5$$

Option (A) pairs 11 NADH with this ATP yield rounded up to 28.

Check: Working backwards, 11 NADH pump out 110 protons, and 27.5 ATP at 4 protons each use the same 110 protons.

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

26. Cells P, Q and R are mutants for enzymes x, y and z respectively. These enzymes are involved in the biosynthesis of the same amino acid. When P, Q and R were co-cultured in a plate lacking the amino acid, strains P and Q grew while R did not. When P and Q were co-cultured, Q grew while P did not. Find the sequence of the enzymes involved in the biosynthesis pathway of the amino acid.

(A) z, y, x (B) x, y, z (C) y, z, x (D) y, x, z

Solution · Q26 **Answer: (D)**

A mutant can grow when a partner blocked at a later step releases the intermediate that it cannot make.

With P, Q and R together, only R fails to grow, so neither partner can feed it. Enzyme z acts last.

With P and Q together, Q grows but P does not, so P feeds Q. Enzyme y acts before enzyme x.

∴ the order of the enzymes is:

$y \rightarrow x \rightarrow z$

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

27. Fresh leaves from two different plant species M and N were separately treated with sucrose solution to observe the stomatal status. This treatment was done (i) in the presence of light and (ii) in the absence of light. Following observations were recorded.

	Leaf M		Leaf N	
	Before sucrose treatment	**After sucrose treatment**	**Before sucrose treatment**	**After sucrose treatment**
In presence of light	Stomata open	Stomata closed	Stomata closed	Stomata closed
In the absence of light	Stomata closed	Stomata closed	Stomata open	Stomata closed

If osmosis is assumed to be absent, which of the following statements is TRUE?

(A) M & N are both dicots
(B) M is a C-4 plant
(C) M is a C-3 plant; N is a CAM plant
(D) M is a CAM plant; N is a C-4 plant

Solution · Q27 **Answer: (C)**

Leaf N has its stomata closed in light and open in the dark. This is the CAM pattern.

Leaf M has its stomata open in light and closed in the dark, the usual daytime pattern of a C-3 plant.

The only option that makes N a CAM plant is (C).

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

28. Which of the following statements about Ubiquinone is **WRONG**?

(A) It is an iron containing protein like cytochrome.
(B) It is a small hydrophobic molecule.
(C) It is a co-enzyme.
(D) It is not a protein.

Solution · Q28 **Answer: (A)**

Ubiquinone (coenzyme Q) is a small, lipid-soluble quinone that carries electrons in the inner mitochondrial membrane.

It is not a protein and contains no iron, unlike a cytochrome. So statement (A) is wrong.

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

29. Which of the following statements is correct about the G_0 phase of the cell cycle?

(A) The G_0 phase arrests the cell division and does not allow it to continue cell division ever again.

(B) Once cells come out of the G_0 phase, they directly start DNA synthesis.

(C) The G_0 phase is a preparatory phase.

(D) Cells enter the G_1 phase post the G_0 phase

Solution · Q29 **Answer: (D)**

G_0 is the quiescent stage. Its cells stay metabolically active but do not divide unless called on to do so.

On getting the signal to divide, they return to G_1 and only then move on to S phase.

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

30. In corn plants, a dominant allele 'I' inhibits kernel colour expression, while the recessive allele 'i' in homozygous condition permits colour expression. At a different locus, the dominant allele 'P' controls purple kernel colour while homozygous recessive genotype 'pp' creats red kernels. If plants heterozygous at both loci are crossed what will be the phenotypic ratio of purple:red: colourless ?

(A) 3:1:12 (B) 12:4:0 (C) 9:4:3 (D) 3:4:9

Solution · Q30 **Answer: (A)**

Cross:

IiPp × IiPp

Colourless, with at least one I allele:

$$3/4 = 12/16$$

Purple, with genotype iiP_:

$$1/4 \times 3/4 = 3/16$$

Red, with genotype iipp:

$$1/4 \times 1/4 = 1/16$$

$\therefore$ purple : red : colourless is 3 : 1 : 12.

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

31. A man with haemophilia (a recessive sex linked condition) has a daughter of normal phenotype. She marries a man who is not haemophilic. If the married couple has four sons, what is the possibility that all four will be haemophilic?

(A) 1/4 (B) 1/32 (C) 1/16 (D) 1/8

Solution · Q31 **Answer: (C)**

The daughter gets her father's only X chromosome, which carries the haemophilia allele. Being normal, she is a carrier.

Each son gets one of her two X chromosomes.

Chance that one son is haemophilic:

1/2

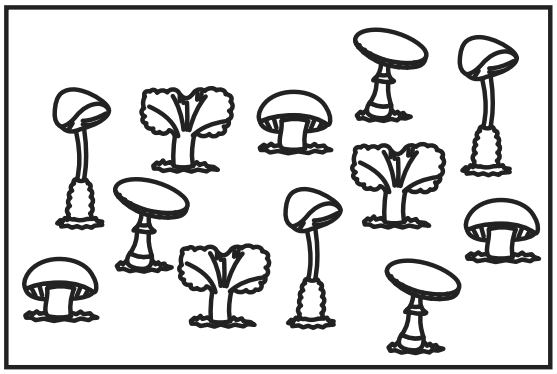
For all four sons:

$$(1/2)^4 = 1/16$$

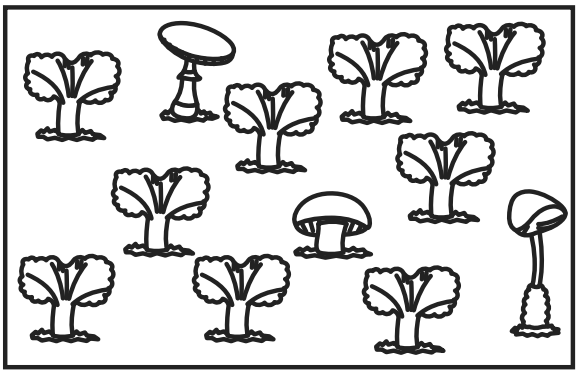
IAPT answer: (C) | **Zigyan answer:** (C)

32. The distribution of some mushroom communities in two habitats I and II are shown in the given figures.

Habitat I



Habitat II



Which of the following statements regarding these habitats is correct?

(A) Habitat I has greater species richness than II.

(B) Habitat II has a more even distribution of species than I.

(C) Habitat II has greater species evenness than I.

(D) Habitat I is more diverse than II.

Solution · Q32 **Answer: (D)**

Each habitat has 4 kinds of mushroom and 12 mushrooms in all, so species richness is the same.

The counts of the four kinds are 3, 3, 3 and 3 in habitat I, but 9, 1, 1 and 1 in habitat II.

Habitat I has far greater species evenness, so it is more diverse than habitat II.

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

33. A cell suspension has a concentration of 10^{12} cells/mL. An analyst diluted the suspension to a concentration of 10^6 cells/mL. How much reduction in concentration did the analyst achieve?

(A) 50% (B) 6 log (C) 5 log (D) 2 log

Solution · Q33 **Answer: (B)**

Fold reduction:

$$10^{12} \div 10^6 = 10^6$$

Log reduction:

$$\log_{10} 10^6 = 6$$

$\therefore$ the reduction is 6 log.

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

34. Note the following processes:

i. Mutation

ii. Recombination

iii. Post-translational modifications

iv. Crossing over during meiosis

v. Alternative splicing of RNA transcripts.

According to the findings of Human Genome Project, there are about 25000 genes; but there is evidence for greater number of different polypeptides. Which of the above-mentioned processes might explain the discrepancy between the number of genes and the number of polypeptides?

(A) i and ii (B) iii and v (C) i, ii and iv (D) All of the above

Solution · Q34 **Answer: (B)**

Alternative splicing (v) joins the exons of a transcript in different combinations, so one gene can give several polypeptides.

Post-translational modifications (iii), such as cutting a precursor chain, give still more kinds of products from the same gene.

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

35. Cells of the lower layers of human skin divide and replace dead cells. Why it is not correct to say that they are similar to plant meristem? Choose the correct reason from the following options.

(A) They are devoid of any cell wall.

(B) They are not isodiametric in shape.

(C) They can replace original cells only and not any other cell types.

(D) They divide by astral mitosis and show the presence of centriole.

Solution · Q35 **Answer: (C)**

A plant meristem has undifferentiated cells that can give rise to many different cell types and tissues.

The dividing cells in the lower layers of skin only replace the original cells of the skin. They do not form other cell types.

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

36. Thymus gland is always the preferred gland for DNA extraction because:

(A) Being a soft gland, extraction can be easily done.

(B) Being a vestigial organ in adults, it can be easily used for extraction.

(C) The majority of cells in the gland are lymphocytes which have the greatest ratio of nucleus to cytoplasm.

(D) The number of dividing cells in the gland at any given point of time is always high.

Solution · Q36 **Answer: (C)**

Most cells of the thymus are lymphocytes. Each has a large nucleus with very little cytoplasm around it.

This high nucleus to cytoplasm ratio gives a high yield of DNA from a given mass of tissue.

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

37. The TCA cycle is an amphibolic pathway. Anaplerotic reactions are such metabolic pathways that replenish TCA cycle intermediates when they leak away from the cycle. The leakage of Oxaloacetate from the TCA cycle forms which of the following?

(A) Porphyrins (B) Pyrimidines (C) Acetyl CoA (D) Mannose

Solution · Q37 **Answer: (B)**

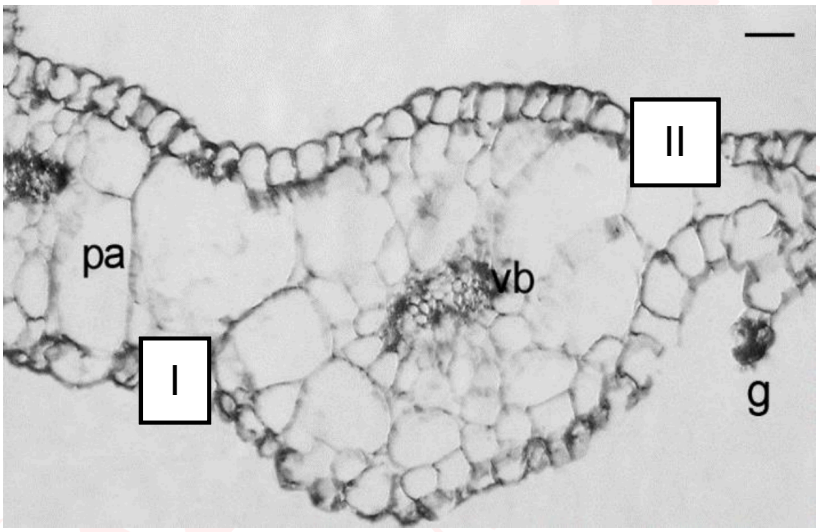
Oxaloacetate drawn from the cycle is converted to aspartate.

Aspartate is the precursor for the synthesis of pyrimidines.

Porphyrins are drawn from the cycle at succinyl CoA.

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

38. Observe the picture given below. It is a cross section of a leaf of an herbaceous perineal plant and the bar is equivalent to 35µm. 'pa' represents parenchyma, 'vb' represents vascular bundles, and 'g' represents glandular hair.



Which of the following respectively represent I and II marked in the picture?

(Choose the most appropriate one):

(A) Adaxial epidermis and abaxial ectoderm (B) Endodermis and Epidermis

(C) Abaxial epidermis and adaxial epidermis (D) Lower ectoderm and Upper ectoderm

Solution · Q38 **Answer: (C)**

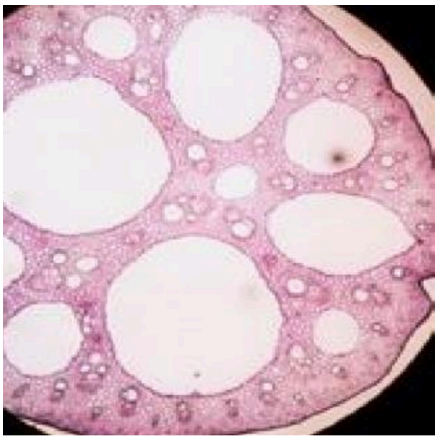
In a leaf, the midrib with its vascular bundle bulges out on the lower side.

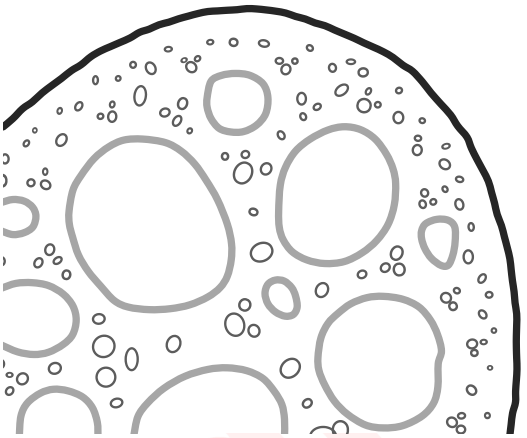
So I is the abaxial (lower) epidermis and II is the adaxial (upper) epidermis.

The outer layer of a leaf is epidermis; ectoderm is an animal germ layer.

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

39. A cross section of a petiole as seen under the light microscope and its schematic diagram is given below. From the anatomical characteristics seen, identify the correct statement from the following;





(A) The presence of empty spaces in parenchyma indicates a dying petiole.

(B) The thick epidermis indicates the plant to be found in highly saline areas.

(C) The dense vascular bundles to the periphery indicate the plant to be from an arid zone.

(D) Air filled spaces indicate the plant can survive in low oxygen areas.

Solution · Q39 **Answer: (D)**

The large air-filled cavities in the ground tissue of the petiole form aerenchyma.

Aerenchyma holds and conducts air, so the plant can survive in water or waterlogged places that are low in oxygen.

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

40. It is observed that plant 'M' requires 3000 ATPs and 1200 $NADPH_2$ for synthesis of starch; while the plant 'N' requires 1800 ATPs and 1200 $NADPH_2$ to synthesise same amount of starch. Plant 'M' and 'N' respectively could be:

(A) Sorghum and sugarcane

(B) Rice and Tomato

(C) Maize and Wheat

(D) A tropical plant and a succulent xerophyte.

Solution · Q40 **Answer: (C)**

Plant M, ATP : $NADPH_2$

$$3000 : 1200 = 30 : 12$$

Plant N, ATP : $NADPH_2$

$$1800 : 1200 = 18 : 12$$

For one glucose, the C_3 pathway uses 18 ATP and the C_4 pathway uses 30 ATP, each with 12 $NADPH_2$.

$\therefore$ M is a C_4 plant (maize) and N is a C_3 plant (wheat).

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

41. In one of the bacterium of *Acetobacter* family, it was found that the enzyme, succinate CoA-synthetase was absent. The bacteria are, however, useful in the production of vinegar since they use an alternate enzyme. In this context, which of the following statements is correct?

(A) These bacteria appear to have adapted to utilize the abundant citrate in its environment.
(B) These bacteria appear to have adapted to utilize the abundant lactate in its environment.
(C) These bacteria appear to have adapted to utilize the abundant acetate in its environment.
(D) These bacteria appear to have adapted to utilize the abundant nitrate in its environment.

Solution · Q41 **Answer: (C)**

Succinyl-CoA synthetase normally converts succinyl CoA to succinate.

These bacteria use succinyl-CoA : acetate CoA-transferase instead:

Succinyl CoA + Acetate → Succinate + Acetyl CoA

The cycle thus turns acetate into acetyl CoA, an adaptation to an acetate-rich environment.

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

42. Lagomorphs like rabbit are caecal fermenters and they produce faecal pellets from caecum. In this context, identify from the following, the most appropriate statement that explains this adaptation;

(A) The fibre digestion takes place in the caecum using microbes that are live in the caecum.
(B) They produce soft faeces containing nutrients from the cecum, in the night, which they eat again.
(C) They cannot chew the cud like bovines but they retain food in caecum for a long time to digest the fibre.
(D) They produce faeces only in the daytime and allow food to remain within the gut overnight to allow digestion of fibres.

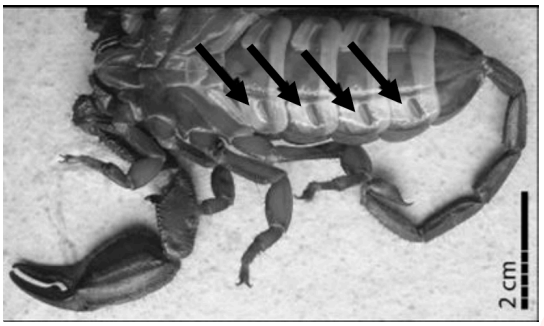
Solution · Q42 **Answer: (B)**

In rabbits, microbial fermentation occurs in the caecum, beyond the small intestine where most nutrients are absorbed.

They pass soft caecal pellets (night faeces), rich in microbial protein and vitamins, and eat them again to absorb these nutrients (caecotrophy).

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

43. The image shows a unique characteristic seen in a group of arthropods. The arrows point to which of the following?



(A) Segmental Gills
(B) Segmental Spiracles
(C) Book lungs
(D) Segmental tracheae

Solution · Q43 **Answer: (C)**

The animal is a scorpion, an arachnid. The arrows lie on four segments on its underside.

They mark the four pairs of book lungs, which open here through slit-like pores. Book lungs are a characteristic feature of arachnids such as scorpions and spiders.

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

44. An individual taking a leisurely walk in the forest trips over a rattlesnake leading to instant changes in the physiology. A few possible changes are listed below:

(i) Epinephrine binds to receptors in liver and on fat cells.

(ii) The nervous system stimulates endocrine cells in the adrenal gland.

(iii) Binding of epinephrine leads to decreased beating of heart.

(iv) Glycogen formation increases.

(v) Blood vessels in the digestive tract constrict.

(vi) Pumping of blood increases.

The changes that would occur in the given situation are:

(A) (i), (ii), (iv) and (vi)
(B) (ii), (iv) and (vi)
(C) (i), (ii), (v) and (vi)
(D) (i), (iii) and (iv)

Solution · Q44 **Answer: (C)**

In sudden danger, sympathetic nerves stimulate the adrenal medulla to release epinephrine, so (ii) occurs.

Epinephrine acts on liver and fat cells to release glucose and fatty acids, so (i) occurs.

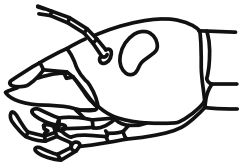
Gut blood vessels constrict and the heart pumps more blood, so (v) and (vi) occur.

(iii) is wrong because the heart beats faster. (iv) is wrong because glycogen is broken down.

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

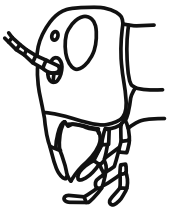
45. Three types of mouth parts in insects which are categorised based on the position of head with respect to the long axis of the body and the direction of the mouth parts. These are depicted below, marked as 1, 2 and 3. Match the three insects; X – Grasshopper; Y – Earwig; Z – Cicada with the correct type of the mouth parts.

1.



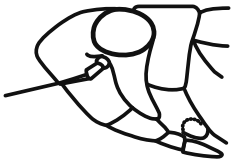
prognathous

2.



hypognathous

3.



opisthognathous

(A) X = 1, Y = 2, Z = 3
(B) X = 2, Y = 3, Z = 1
(C) X = 2, Y = 1, Z = 3
(D) X = 1, Y = 3, Z = 2

Solution · Q45 **Answer: (C)**

Grasshopper: mouthparts point downward (hypognathous).

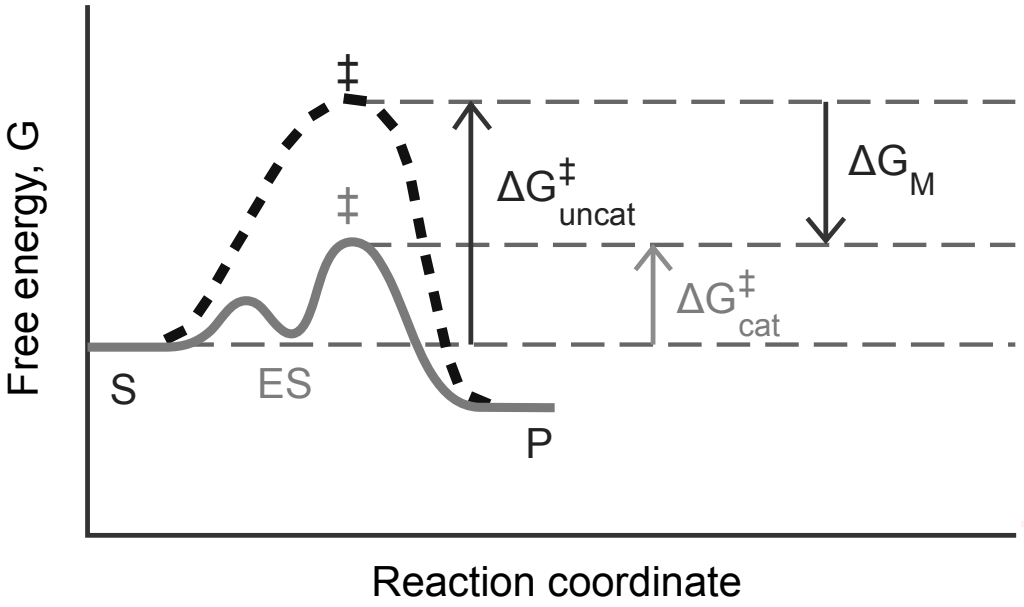
Earwig: mouthparts point forward (prognathous).

Cicada: the sucking beak points backward (opisthognathous).

$\therefore$ X = 2, Y = 1, Z = 3

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

46. Following is the reaction coordinate diagram for an enzyme (E) catalysed reaction using substrate (S) forming product (P) through the Enzyme-substrate Complex (ES). In this context which of the following statements is correct?



(A) Enzyme lowers the activation energy essential for the substrate to move to transition state

(B) Enzyme catalyzed reaction is a two-step reaction

(C) Enzyme provides energy to the substrate

(D) Enzyme helps the substrate to overcome the transition state faster to move to product state

Solution · Q46 **Answer: (A)**

The peak of the catalysed path is much lower than that of the uncatalysed path:

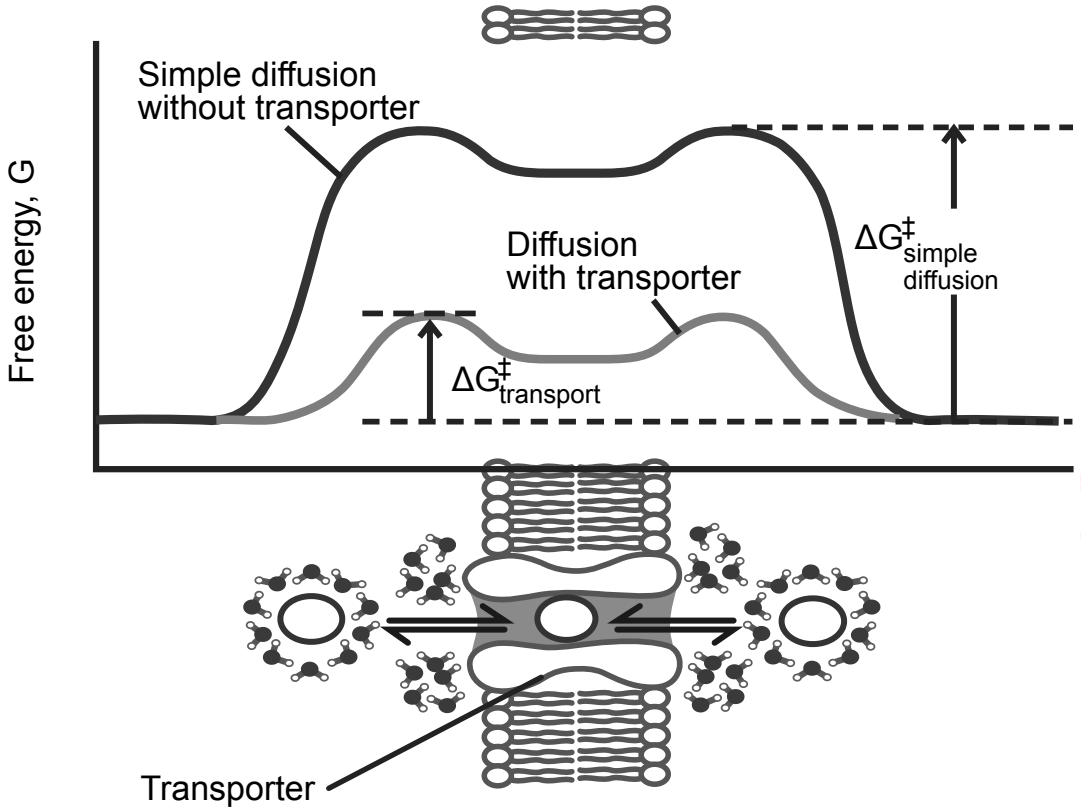
$$\Delta G^{\ddagger}_{cat} < \Delta G^{\ddagger}_{uncat}$$

So the enzyme lowers the activation energy needed by S to reach the transition state. It supplies no energy.

Enzyme action also involves an enzyme–product complex (EP), so it cannot simply be called a two-step reaction.

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

47. Following is the diagram representing transport of hydrophilic molecules across the membrane, mediated through transporter protein. What can you conclude from the given diagram?



(A) Transporter protein irreversibly converts the substrate to a transportable form.

(B) Transporter protein increases the free energy (G) for transmembrane diffusion of the solute.

(C) Transporter protein provides a hydrophobic passageway for the movement of molecules.

(D) Transporter protein removes the hydration shell and prepares the molecule to move across the membrane.

Solution · Q47 **Answer: (D)**

To cross the lipid bilayer unaided, the solute must lose its water shell, which needs very high activation energy.

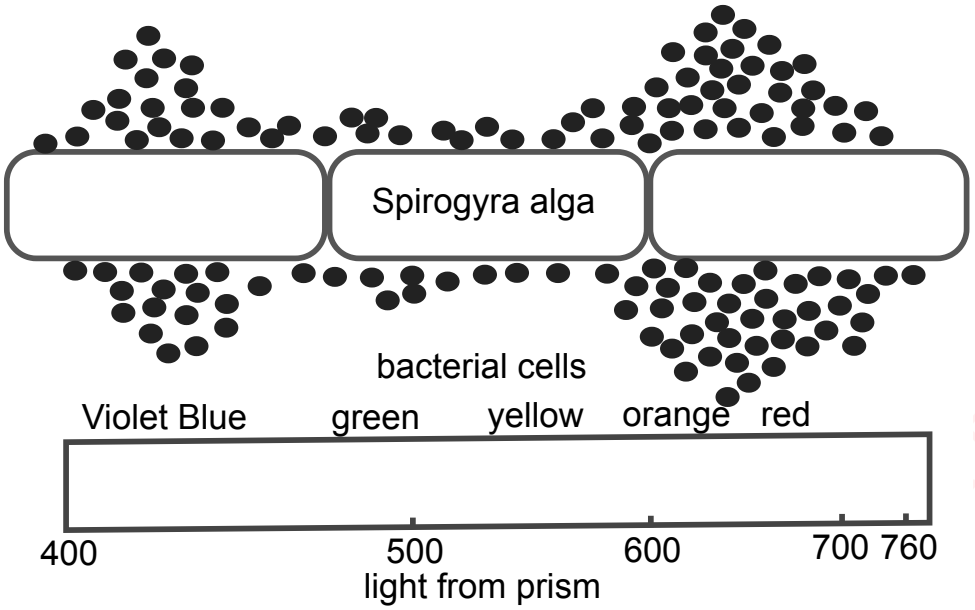
The transporter forms weak bonds with the solute in place of the water and provides a hydrophilic path, without chemically changing it.

∴ the energy barrier is much lower:

$$\Delta G^{\ddagger}_{transport} < \Delta G^{\ddagger}_{simple\ diffusion}$$

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

48. In an experiment, different cultures of a *Spirogyra sps* were exposed to a single spectrum of light from different spectral regions in the visible light using specific filters. Aerobic bacterial cells were also added to these cultures. The abundance of bacterial cells (black dots '•'), in each of the different cultures, against the visible spectrum (wavelengths in nm) is shown in the following diagrammatic presentation:



Select the correct conclusion from the statements given below:

(A) Green light leads to increased oxygen production.

(B) Green light is absorbed maximum by *Spirogyra sps*.

(C) Red light results in maximum oxygen production.

(D) Bacterial cells absorb red light.

Solution · Q48 **Answer: (C)**

Aerobic bacteria gather where the alga releases oxygen (Engelmann's experiment).

The largest crowd is in the orange-red part of the spectrum, and a smaller one is in violet-blue.

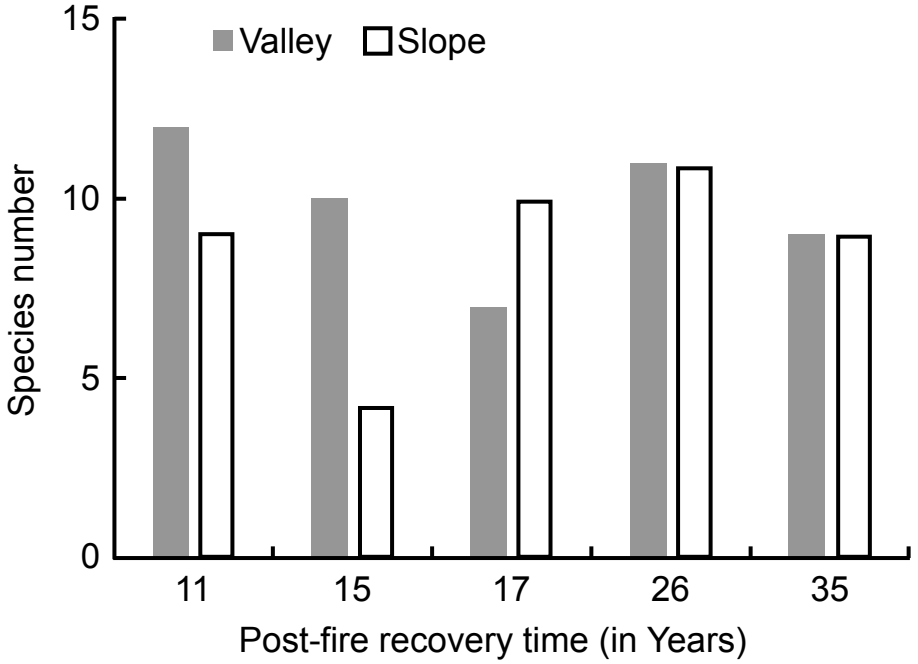
∴ red light results in maximum oxygen production.

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

PART A-2 · ONE OR MORE CORRECT OPTIONS

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

49. Secondary succession is seen in forests that are affected by fires. The following graphic presentation compares post-fire recovery of vegetation in slopes and valleys against the recovery time in years.



Which of the following is/are correct?

(A) The recovery along the slopes is faster during the middle stage of succession after fire as compared to valley.

(B) The recovery along the slopes is slower during the middle stages of succession after fire as compared to valley.

(C) The succession sets in faster along the valley than the slope after fire.

(D) The succession sets in slower along the valley than the slope after fire.

Solution · Q49 **Answer: (A), (C)**

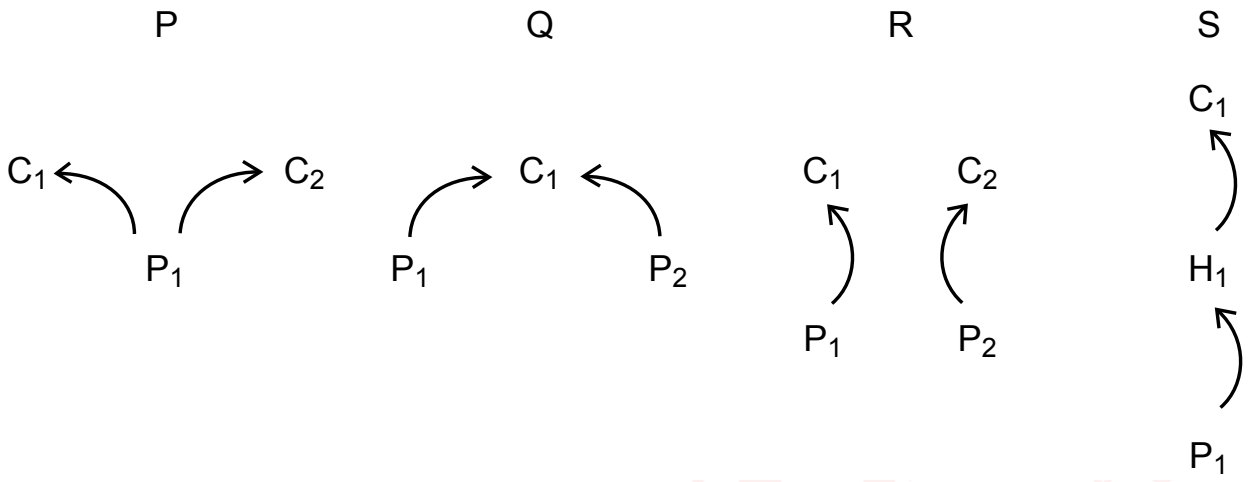
(A) From 15 to 17 years, species on the slope rise from about 4 to 10, while those in the valley fall from 10 to 7. ∴ true, and (B) is false.

(C) At 11 years, the valley already has 12 species against 9 on the slope. ∴ true, and (D) is false.

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

50. Ecosystems consist of populations of different species which constantly interact with each other. A few such interactions (P, Q, R and S) are depicted below.

P_1 and P_2 = Producer or Prey, H_1 = Herbivore and C_1 and C_2 = Carnivore.



Which of the following is/are correct description/s of these interactions?

(A) Indirect mutualism between C_1 and P_1 in S.

(B) Apparent competition between P_1 and P_2 in Q.

(C) Commensalism between C_1 and C_2 in P.

(D) Indirect mutualism between C_1 and C_2 in R.

Solution · Q50 **Answer: (A), (B)**

(A) In S, C_1 eats the herbivore that feeds on P_1, and P_1 supports the food of C_1. ∴ true.

(B) In Q, two prey share one predator. More of one prey raises C_1, which harms the other prey. ∴ true.

(C) In P, C_1 and C_2 compete for the same food, P_1. ∴ false.

(D) In R, the two food chains have no link. ∴ false.

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

51. Which of the following is true about protein translocation?

(A) Ribosomes can recognize the signal sequence in the protein and dock them on endoplasmic reticulum (ER).

(B) Protein translocation into the endoplasmic reticulum (ER) takes place simultaneously along with translation.

(C) A fully folded protein can enter the endoplasmic reticulum (ER) from the cytosol.

(D) Protein synthesis may involve free ribosomes, which are eventually docked to the endoplasmic reticulum (ER).

Solution · Q51 **Answer: (B), (D)**

(A) The signal sequence is recognised by the signal recognition particle (SRP), not by the ribosome. ∴ false.

(B) In SRP-guided transport, the growing chain enters the ER while it is being translated. ∴ true.

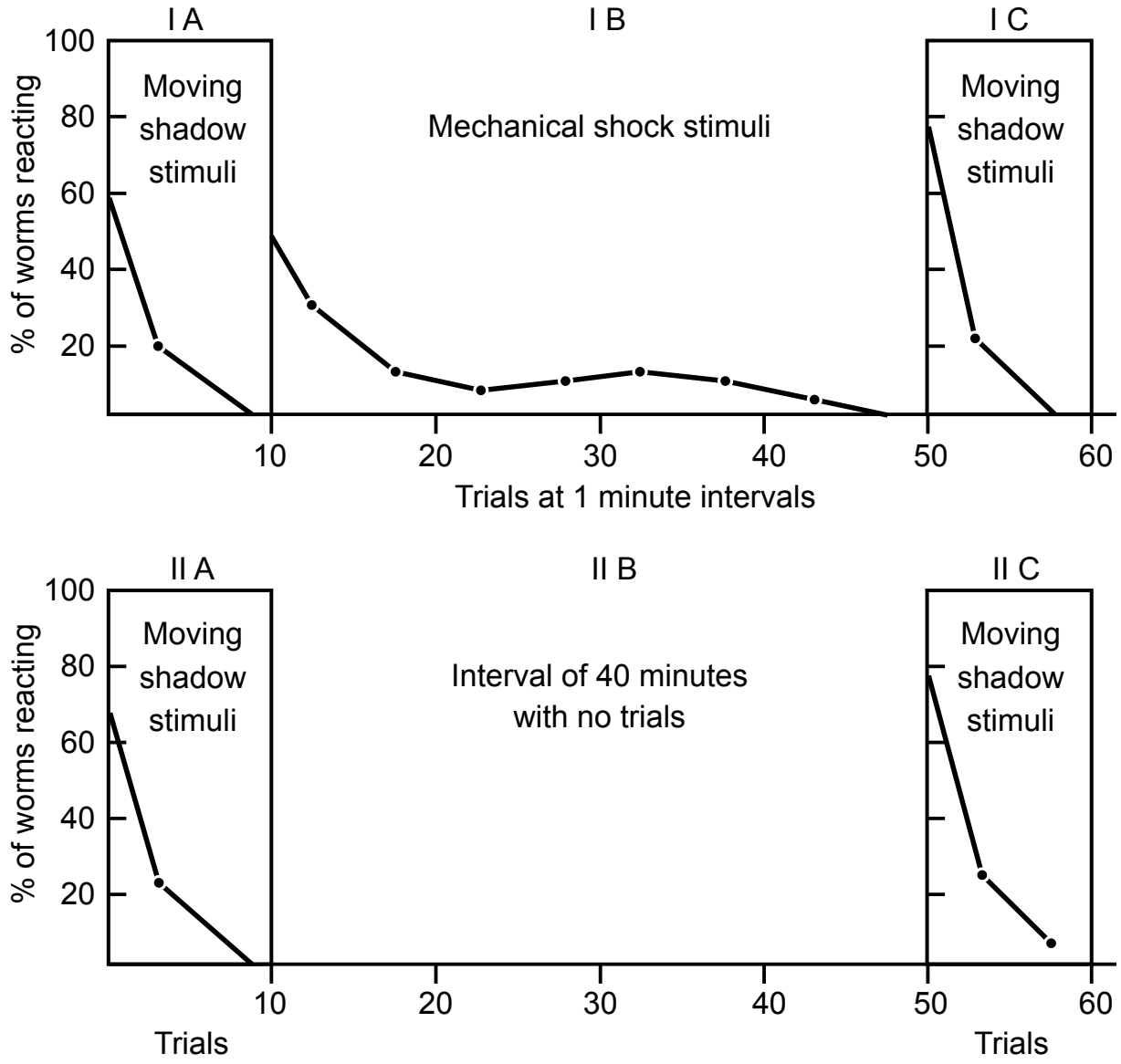
(C) The chain crosses the ER membrane unfolded and folds inside the lumen. ∴ false.

(D) Synthesis begins on free ribosomes; those making ER-targeted proteins are then docked on the ER. ∴ true.

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

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52. Nereis is a worm that burrows in the floor of brackish estuaries. Its head and anterior segments protrude from the burrow to feed on the surface around the burrow. During feeding a variety of stimuli induce the worm to jerk back into its burrow. For an experimental study, a behavioural scientist could easily get the worms to live in glass tubes in shallow basins of water. He recorded the retracting response of the worms when two types of stimuli – a moving shadow and mechanical shock by jarring of the basin were given to the worms at 1 min intervals. The results obtained for the experimental set ups (I and II) are shown where response to both stimuli are studied in set up I while that to only one stimulus is studied in set up II.



Which of the following statements is/are true with reference to the results obtained?

(A) Response in IA represents habituation while that in IIC represents sensitization.

(B) Habituation is always faster for a moving shadow stimulus than that for a mechanical shock stimulus.

(C) Sensory adaptation is always a permanent adaptation.

(D) Habituation to moving shadow stimulus is independent of the response to mechanical stimulus.

Solution · Q52 **Answer: (B), (D)**

(A) The response in IIC also falls with repeated trials, which is habituation. ∴ false.

(B) Each moving shadow response almost vanishes within about 10 trials, but the mechanical shock response needs nearly 40 trials. ∴ true.

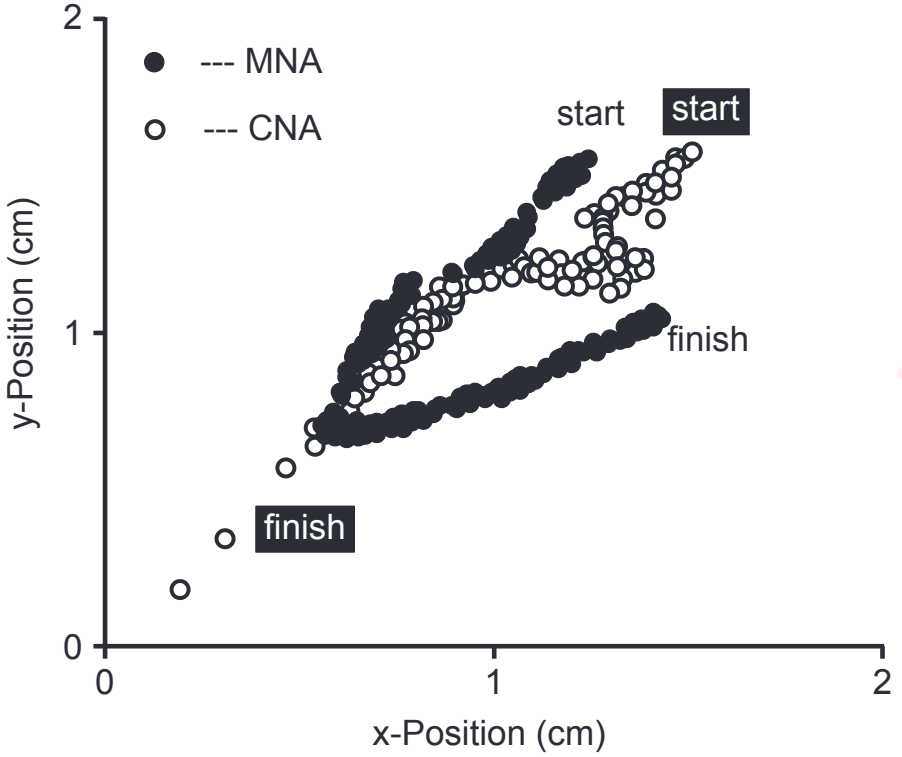
(C) Sensory adaptation is reversible. ∴ false.

(D) After the shock trials, the shadow response in IC recovers to the same high starting level as in IIC after plain rest. ∴ true.

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

53. The mechanosensory lateral-line system in fishes consists of thousands of neuromast sensory cells distributed across the body of the animal. In nature, the larvae of Zebra fish (*Danio rerio*) are generally predated by fish which use suction pressure to catch them. For an experiment 2 groups of larvae were prepared. One groups was 'caudal neuromasts ablated' (CNA) while the other one was 'middle neuromasts ablated' (MNA). These larvae were exposed to mild suction pressure created in water. As they tried to avoid the suction current, the positions of the two groups of larvae were recorded from the start to finish of the experiment. These recordings were plotted as shown in the figure below.

[*Note*: The suction source is located at the origin of the coordinate system]



Which of the following are the correct interpretations?

(A) The larvae with caudal neuromasts ablated are more efficient in avoiding the suction as compared to the larvae with middle neuroblasts ablated.

(B) The larvae with middle neuromasts ablated are more efficient in avoiding the suction as compared to the larvae with caudal neuroblasts ablated.

(C) It may be deduced that both the location and number of neuromasts play a role in detecting a continuous suction source.

(D) It may be deduced that only the location of neuromasts play a role in detecting a continuous suction source.

Solution · Q53 **As per Zigyan: (B), (C)**

In (A) and (B), "neuroblasts" stands for the ablated neuromasts.

MNA larvae turn back and finish far from the origin, but CNA larvae end close to the suction source.

∴ MNA larvae avoid suction better: (B) is true and (A) is false.

(C) Removing selected posterior lateral line neuromasts shows that both their position and their number affect detection of a steady suction source. ∴ true.

(D) Number matters along with position. ∴ false.

Reference: Olszewski, Haehnel, Taguchi and Liao (2012), PLoS ONE 7(5): e36661: this study removed chosen neuromasts along the body and concluded that the position and the number of flow sensors both play a part in detecting a continuous suction source; the escape burst depended critically on the tail neuromasts.

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

54. Proline is normally absent in membrane proteins. The possible reason(s) for this can be :

(A) It is a hydrophobic amino acid.

(B) It is unable to attain the required protein conformation.

(C) It causes kinks in α-helices.

(D) It forms peptide bond as an amide and its nitrogen is not bound to any hydrogen.

Solution · Q54 **As per Zigyan: (B), (C), (D)**

Proline does occur in many membrane-spanning helices, but it disturbs a regular helix.

(A) A hydrophobic side chain suits the lipid bilayer, so it cannot cause absence. ∴ false.

(B) Its ring joins the side chain to the backbone nitrogen, so it does not fit easily into a regular α-helix. ∴ true.

(C) It therefore favours a kink in the helix. ∴ true.

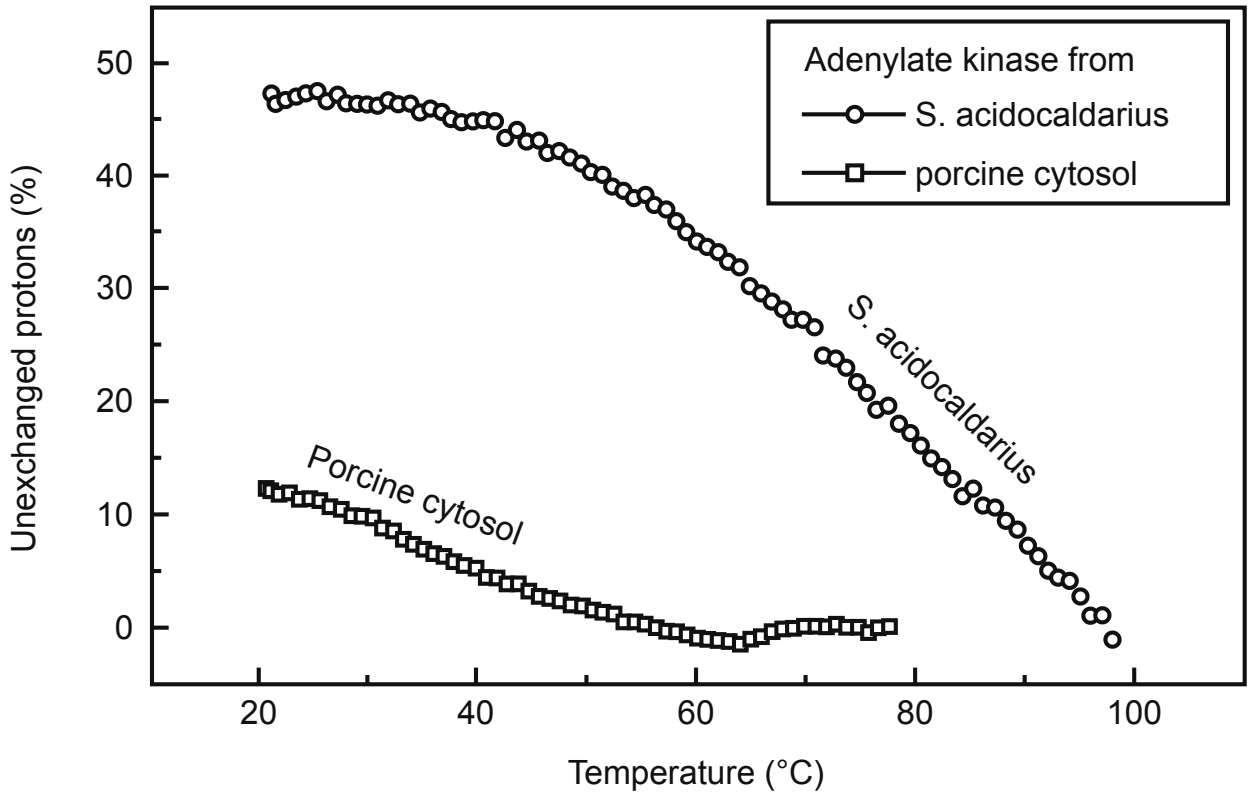
(D) In a peptide bond, its nitrogen has no H and cannot donate the helix hydrogen bond. ∴ true.

Reference: Wilman, Shi and Deane (2014), Proteins 82(9): 1960: proline lacks an amide proton and its ring fits poorly in an α-helix; it is very important for kinks, and about half of the membrane helices studied contained it.

Reference: Li, Goto, Williams and Deber (1996), Proceedings of the National Academy of Sciences USA 93(13): 6676: proline occurs frequently in the likely transmembrane helices of integral membrane proteins.

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

55. Enzymes from Hyperthermophiles, which grow optimally at temperatures between 80°C and 110°C show unique structure-function properties of high thermostability and optimal activity at temperatures above 70°C. The figure below illustrates the Hydrogen-deuterium exchange recorded in *Sulfolobus acidocaldarius* and porcine muscle cytosol adenylate kinases observed during a temperature gradient experiment.



Which of the following statements are correct in this context?

(A) At 20°C a much smaller fraction of the amide protons in *S. acidocaldarius* adenylate kinase are exchanged than in the porcine cytosolic enzyme indicating that more amide protons are involved in stable hydrogen bonds in the thermophilic enzyme.

(B) Lesser rigidity explains why hyperthermophilic enzymes are often inactive at low temperatures (i.e., around 20 to 37°C).

(C) Hyperthermophilic enzymes are less rigid than their mesophilic homologues at mesophilic temperatures and that rigidity is a prerequisite for high protein thermostability.

(D) Temperatures of greater than 90°C are needed before *S. acidocaldarius* adenylate kinase can show an exchange level as compared to the catalytically active mesophilic enzyme.

Solution · Q55 **Answer: (A), (D)**

(A) Near 20°C, unexchanged protons are about 47% in *S. acidocaldarius* and 12% in the porcine enzyme. So far fewer are exchanged in the thermophile: more are held in stable hydrogen bonds. ∴ true.

(B) These enzymes are often inactive at low temperature because they are too rigid. ∴ false.

(C) At mesophilic temperatures they are more rigid than mesophilic enzymes, not less. ∴ false.

(D) Near 37°C, the porcine enzyme keeps only about 6% unexchanged. The thermophile enzyme falls to this level only above 90°C. ∴ true.

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

56. Which of the following are TRUE about the peroxisomes found in yeast?

(A) They are not very active when yeast is cultured in the presence of glucose.

(B) They can multiply only by fission.

(C) They are very active when yeast is cultured in the presence of methanol.

(D) They grow in size by incorporating proteins and lipids synthesized in the endoplasmic reticulum.

Solution · Q56 **As per Zigyan: (A), (C), (D)**

(A) Yeast grown on glucose has few, small peroxisomes with little activity. ∴ true.

(B) Besides growth and fission, peroxisomes can also form *de novo* from the ER. ∴ false.

(C) In methanol-using yeasts, methanol makes peroxisomes proliferate; enzymes that oxidise it lie inside them. ∴ true.

(D) A growing peroxisome receives membrane lipids and some membrane proteins from the ER. ∴ true.

Reference: Farré, Mahalingam, Proietto and Subramani (2019), EMBO Reports 20(1): e46864: the ER supplies lipids for growth of the peroxisomal membrane and is a source of its membrane proteins; the yeasts *Pichia pastoris* and *Hansenula polymorpha* proliferate peroxisomes on methanol.

Reference: Motley and Hettema (2007), Journal of Cell Biology 178(3): 399: yeast peroxisomes multiply by growth and division, can also arise *de novo* from the ER, and existing ones can receive essential membrane components by the ER route.

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

57. The C4 plants have relatively more efficient photosynthetic machinery. This may be attributed to ;

(A) PEP carboxylase that has a higher affinity for CO_2 and no affinity for O_2.

(B) The entire dark reaction being carried inside a single cell type.

(C) CO_2 being concentrated in bundle sheath cells at the expense of ATP.

(D) Fixing of CO_2 even under low CO_2 concentration.

Solution · Q57 **Answer: (A), (C), (D)**

(A) PEP carboxylase traps carbon dioxide (as bicarbonate) efficiently and has no oxygenase activity. ∴ true.

(B) In C4 plants, the dark reactions are shared by mesophyll and bundle sheath cells. ∴ false.

(C) The C4 shuttle spends extra ATP to raise CO_2 around RuBisCO in bundle sheath cells, which keeps photorespiration very low. ∴ true.

(D) PEP carboxylase therefore fixes CO_2 even when its level is low. ∴ true.

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

58. 2,6-Dichlorophenolindophenolate (DCPIP), an electron acceptor, turns colourless from blue colour when it is added to a suspension containing mitochondria. What does this indicate?

(A) DCPIP is getting oxidized.

(B) DCPIP is getting reduced.

(C) ETC carried out by mitochondria is leaky.

(D) DCPIP acts as a respiratory substrate.

Solution · Q58 **As per Zigyan: (B), (C)**

Oxidised DCPIP is blue and reduced DCPIP is colourless.

Loss of colour shows that the dye gains electrons. ∴ (B) is true and (A) is false.

(C) The dye picks up electrons from respiratory complex II and from the quinol it forms, before they reach O_2. So electrons leak from the chain to the dye. ∴ true.

(D) DCPIP accepts electrons; it does not supply them as a fuel. ∴ false.

Reference: Jones and Hirst (2013), Analytical Biochemistry 442(1): 19: DCPIP is reduced directly by respiratory-chain complex II and also by the quinol that complex II produces.

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

59. In Batesian kind of mimicry a harmless animal (mimic) mimics a distasteful or poisonous animal (model) while in Mullerian type of mimicry, two related or unrelated distasteful or poisonous animals develop similar appearance. Which of the following statements about these types of mimicry are true?

(A) Mullerian mimicry benefits both prey and predator.

(B) Batesian mimicry is a type of mutualistic relationship.

(C) Batesian mimicry is an example of divergent evolution while Mullerian mimicry is an example of convergent evolution.

(D) It is essential to have a common predator for Mullerian mimicry to evolve.

Solution · Q59 **Answer: (A), (D)**

(A) In Mullerian mimicry, a shared warning pattern cuts the losses of both prey species, and the predator learns to avoid harmful prey with fewer bad trials. ∴ true.

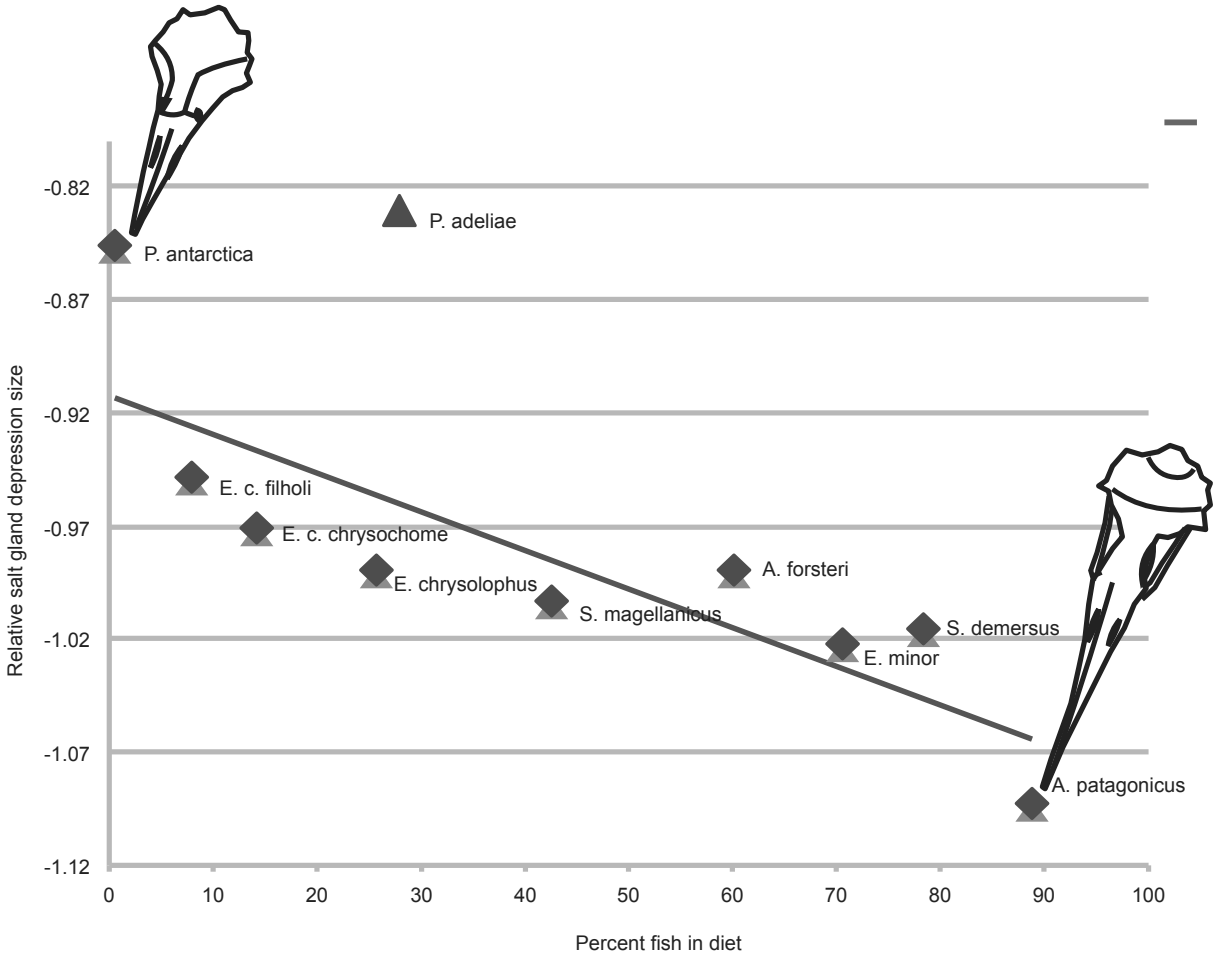
(B) In Batesian mimicry only the mimic gains, and the model is harmed. ∴ false.

(C) In both types the species come to look alike, which is convergence. ∴ false.

(D) The shared signal helps only when the same predator meets both species and learns it. ∴ true.

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

60. Salt glands in Penguins are located at the top of the skull in a depression above the eye. The figure below depicts the relationship between relative salt gland depression size and percent fish in the diet of 10 penguin species. Relative salt gland depression size was calculated as the log10 of depression surface area divided by cranial size index. Percentage of fish in diet was calculated using weighted mean percentage of fish consumed by a penguin species.



Which of the following statements are correct?

(A) Larger salt gland depressions correlating with a diet high, in hyposmotic fish and smaller salt gland depressions correlating with a diet high in isosmotic marine invertebrates.

(B) Larger salt gland depressions correlating with a diet high in isosmotic marine invertebrates, and smaller salt gland depressions correlating with a diet high in hypoosmotic fish.

(C) Adélie penguin (*P. adeliae*) an outlier probably because they recently shifted from a mostly-krill to a mostly-fish diet.

(D) Adélie penguin (*P. adeliae*) is an outlier probably because they recently shifted from a mostly-fish to a mostly-krill diet.

Solution · Q60 **Answer: (B), (D)**

The trend line falls: more fish in the diet goes with a smaller depression.

Marine invertebrates are isosmotic with sea water, so they bring in more salt than hypo-osmotic fish.

∴ (B) is true and (A) is false.

Isotopes in Adélie penguin eggshells show a change from a mainly fish diet to a mainly krill diet within about the last 200 years.

∴ (D) is true and (C) is false.

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

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ANSWER KEY

NSEB 2023 · PAPER CODE 21

60
QUESTIONS · 216 MARKS

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

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

★ Answers as per Zigyan

- **Q10** — As per Zigyan: (D); IAPT key (B).
- **Q14** — As per Zigyan: (A); IAPT key (C).
- **Q23** — As per Zigyan: (B); IAPT key (B).
- **Q24** — As per Zigyan: (B); IAPT key (B) or (C).
- **Q25** — As per Zigyan: (A); IAPT key (A).
- **Q53** — As per Zigyan: (B), (C); IAPT key (B), (C).
- **Q54** — As per Zigyan: (B), (C), (D); IAPT key (B), (C), (D).
- **Q56** — As per Zigyan: (A), (C), (D); IAPT key (A), (C), (D).
- **Q58** — As per Zigyan: (B), (C); 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

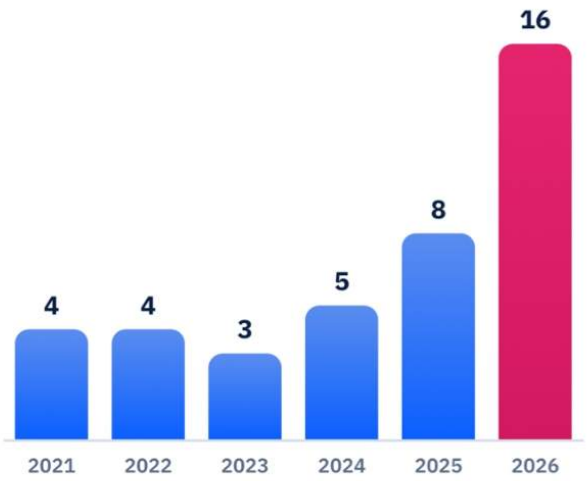
40
JEE Advanced selections in 6 years

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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