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PREVIOUS YEAR PAPER · 2022

OLYMPIAD · STAGE I

NSEB

National Standard Examination in Biology

2022

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 2022, paper code 21.
Solutions and notes: Zigyan. This booklet is not an IAPT publication.

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Sulokya Bibhuty

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Saksham Bishnoi qualified the Chemistry Olympiad twice and was selected for the Orientation-cum-Selection Camp at HBCSE, Mumbai.

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PART A-1 · ONE CORRECT OPTION

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

1. Compare adults of the animals listed below and find out which animal has both higher annual energy expenditure and higher energy expenditure per unit body weight per day?

(A) Python (B) Frog (C) Man (D) Penguin

Solution · Q1 **As per Zigyan: (D)**

Python and frog are ectotherms, so their energy use is low.

Man and penguin are endotherms and spend much more energy.

The penguin is far smaller than man, so it loses heat faster for each kg of its body.

Energy use per kg per day: penguin > man

The penguin thus joins a high yearly energy budget with this very high daily use per kg.

Man's larger yearly total comes from his much larger body mass.

Reference: OpenStax Biology 2e, section 33.1 'Animal Form and Function': endotherms need large amounts of energy to hold a constant body temperature, and a smaller endotherm has a higher basal metabolic rate per unit body weight than a larger one.

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

2. The correct sequence of arrangement in the decreasing order of size for Hemoglobin, *E.coli* ribosome and Tobacco mosaic virus (T.M.V.) is;

(A) *E.coli* ribosome > T.M.V. > hemoglobin (B) Hemoglobin > T.M.V. > *E.coli* ribosome

(C) T.M.V. > hemoglobin > *E.coli* ribosome (D) Hemoglobin > *E.coli* ribosome > T.M.V.

Solution · Q2 **As per Zigyan: no option is correct**

Approximate sizes:

T.M.V.: a rod about 300 nm long

E.coli 70S ribosome: about 15 nm × 20 nm

Hemoglobin molecule: about 5 to 6 nm across

∴ T.M.V. > *E.coli* ribosome > hemoglobin

No option shows this order.

Reference: NCERT Biology Class XI, Chapter 8 'Cell: The Unit of Life', section 8.4.2: the 70S ribosomes of prokaryotes measure about 15 nm by 20 nm.

Reference: RCSB PDB-101, Molecule of the Month 'Tobacco Mosaic Virus': purified particles of the virus are uniformly 300 nm long.

Reference: PubMed Central article 'A retrospective on statistical mechanical models for hemoglobin allostery': Pauling estimated the diameter of the haemoglobin molecule as 5.8 nm.

IAPT answer: question dropped by IAPT | **Zigyan answer:** none of the options is correct

3. Which of the following animals is triploblastic, acoelomate and with ciliated body surface?

(A) Obelia (B) Taenia (C) Planaria (D) Fasciola

Solution · Q3 **Answer: (C)**

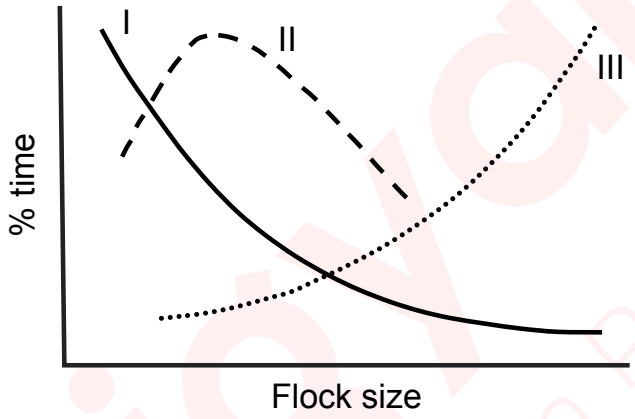
Obelia is a diploblastic cnidarian.

Adult Taenia and Fasciola have a tegument without cilia.

Planaria, a free-living flatworm, is triploblastic and acoelomate, with a ciliated epidermis.

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

4. Several factors can influence optimal flock size in birds. The following graph indicates % time spent in three major lifestyle habits by birds of different flock size.



The three habits I, II and III respectively are:

(A) feeding, scanning, fighting (B) fighting, feeding, scanning

(C) scanning, feeding, fighting (D) feeding fighting, scanning

Solution · Q4 **Answer: (C)**

A bigger flock shares the watch, so each bird scans less. I is scanning.

Feeding time rises as scanning falls, then drops as fights take up more time. II is feeding.

More competition means more fighting in larger flocks. III is fighting.

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

5. Predatory insects with two pairs of functional wings with an incomplete metamorphosis are:

(A) Dragonflies (B) Wasps (C) Caddisflies (D) Moths

Solution · Q5 **Answer: (A)**

Dragonflies (order Odonata) are predators with two pairs of working wings.

Their metamorphosis is incomplete:

egg → nymph → adult

Wasps, caddisflies and moths pass through a pupa.

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

6. Which of the following tools is used to determine the 3D structure of protein ?

(A) X- rays
(B) Mass spectrometry
(C) Liquid chromatography
(D) 2D gel electrophoresis

Solution · Q6 **Answer: (A)**

In X-ray crystallography, the diffraction pattern of a protein crystal is used to find the positions of its atoms in three dimensions.

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

7. Among the following amino acids, arginine could have an ionic interaction with:

(A) Lysine (B) Glutamic acid (C) Valine (D) Methionine

Solution · Q7 **Answer: (B)**

At physiological pH, the basic side chain of arginine is positively charged.

The acidic side chain of glutamic acid is negatively charged.

∴ these opposite charges form an ionic bond (salt bridge).

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

8. Embryos of reptiles, birds and mammals have extraembryonic membranes. They perform essential functions for the developing embryo.

Match the predominant function with each type of membrane.

	Membrane		Function
i.	Yolk sac	P.	Storing metabolic waste
ii.	Chorion	Q.	Source of food
iii.	Allantois	R.	Gas exchange
iv.	Amnion	S.	Fluid enclosing and protecting embryo

(A) i – Q, ii – S, iii – P, iv – S
(B) i – S, ii – P, iii – Q, iv – R
(C) i – Q, ii – R, iii – P, iv – S
(D) i – S, ii – Q, iii – R, iv – P

Solution · Q8 **Answer: (C)**

Yolk sac: source of food (Q)

Chorion: gas exchange (R)

Allantois: stores nitrogenous waste (P)

Amnion: holds the fluid that protects the embryo (S)

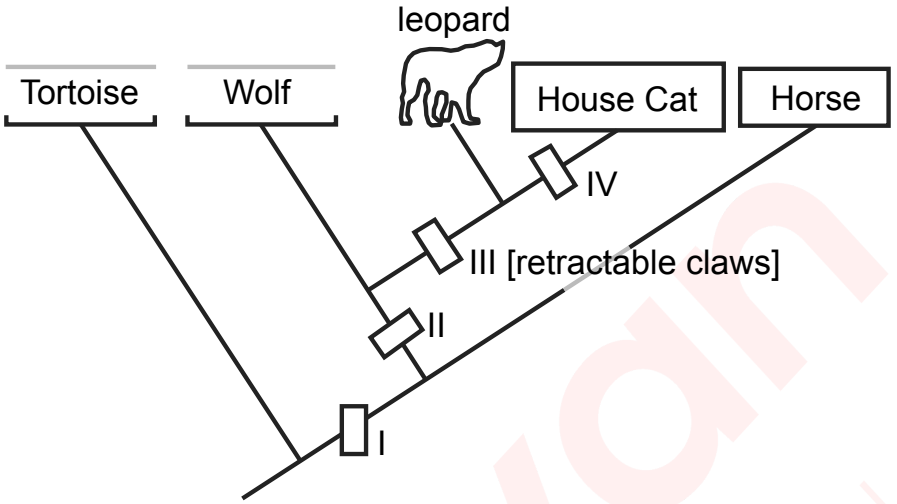
∴ i – Q, ii – R, iii – P, iv – S

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

9. Consider the following five animals:

horse, house cat, leopard, tortoise and wolf.

If they have to be correctly classified cladistically using the following scheme, what will be the characters at I, II, and IV respectively?



(A) I: carnivory II: hair IV: purring
(B) I: hair II: purring IV: carnivory
(C) I: purring II: hair IV: carnivory
(D) I: hair II: carnivory IV: purring

Solution · Q9 **Answer: (D)**

I is shared by all the mammals but not by the tortoise: hair.

II is shared by wolf, leopard and house cat but not by horse: carnivory.

IV occurs only in the house cat: purring (a leopard roars).

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

10. Birds show an adaptive cross-connection between blood vessels that increases the flexibility of their neck. The anastomosis between blood vessels of left and right side, allowing blood to flow freely even when the head twists and one of the vessels is pinched, is:

(A) Carotid anastomosis
(B) Cranial anastomosis
(C) Jugular anastomosis
(D) Branchial anastomosis

Solution · Q10 **Answer: (C)**

In birds, the jugular anastomosis is a cross vein joining the right and left jugular veins just below the head.

If a twist of the neck presses one jugular, blood from the head returns through the other.

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

11. An animal who is known to be a marsupial shows the following body features:

- Almost hairless big ears
- Forelimbs with sharp claws
- Grey coat color
- Long sticky snout

What can be deduced about the animal's habits/habitat?

i. The animal is likely to be diurnal.

ii. The animal is likely to dig deep burrows.

iii. The habitat is likely to be sandy deserts.

iv. The animal is likely to be insectivorous.

(A) i and ii only
(B) ii, iii and iv only
(C) ii and iii only
(D) all the four

Solution · Q11 **As per Zigyan: (C)**

The features fit the greater bilby, a burrowing marsupial of dry country.

It is active at night, so i is false.

Strong forelimbs with sharp claws serve to dig deep burrows, so ii is true.

Large, almost bare ears give off heat, which suits hot sandy deserts, so iii is true.

The bilby is an omnivore. Besides insects it eats seeds, bulbs, fruit and fungi, so it is not insectivorous and iv is false.

∴ only ii and iii are correct.

Reference: Queensland Government web page 'Greater bilby': it has a long pointed nose, large ears, pale blue-grey fur and strong long-clawed forelimbs, is an excellent burrower, and is a nocturnal omnivore eating insects and larvae, seeds, spiders, bulbs, fruit, fungi and small animals.

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

12. MHC-I is expressed by almost all normal cells but not abnormal and infected cells. Cells of which of the following lymphoid lineages recognize tumor cells and virus-infected abnormal cells by the absence of MHC-I ?

(A) Th Cells. (B) Tc Cells. (C) NK Cell. (D) B Cell

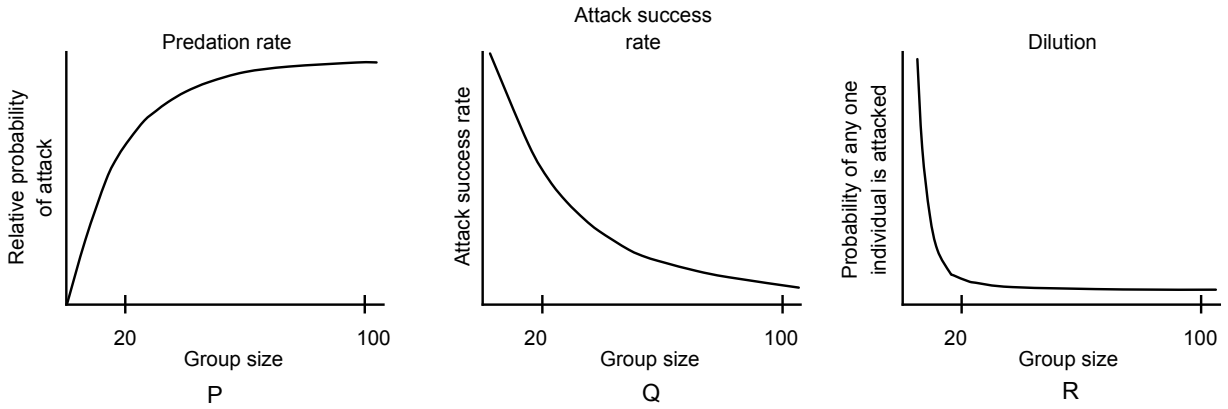
Solution · Q12 **Answer: (C)**

NK cells carry inhibitory receptors that bind MHC-I on healthy cells.

A tumor or virus-infected cell that lacks MHC-I gives no such stop signal, so the NK cell kills it ('missing self').

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

13. Empirical data suggests that optimal group size of animals is determined by costs and benefits associated with it. When predation risk and success rate were studied in prey-predator relationships, following graphs were obtained. Four possible factors that influence the group sizes of prey populations are given below.



I. Conspicuousness of group

II. Shared vigilance

III. Confusion effect

IV. Every individual with equal chance of being attacked

Match these against the correct graphs marked P, Q, and R:

(A) P: I; Q: II, III; R: IV
(B) P: IV; Q: II; R: III, IV
(C) P: IV; Q: II, III; R: I
(D) P: I; Q: II, III; R: IV

Solution · Q13 **As per Zigyan: (A)**

P: a larger group is more conspicuous, so predators attack it more often (I).

Q: shared vigilance warns the prey early and the confusion effect makes one target hard to pick, so attack success falls (II, III).

R: if every member is equally likely to be attacked, the risk to any one falls as the group grows (IV).

Options (A) and (D) are printed identical.

Check: For R, one attack shared equally among all members gives each a risk of one divided by group size, which matches the steep fall and then levelling of that curve.

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

14. In a protein structure, α-helix hairpin, β-hairpin and β-α-β unit are the examples of:

(A) Secondary structure
(B) Super secondary structure
(C) Tertiary structure
(D) Quaternary structure

Solution · Q14 **Answer: (B)**

The α-helix hairpin, β-hairpin and β-α-β unit are small combinations of neighbouring secondary structure elements (motifs).

Such motifs form the super secondary structure.

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

15. The immunoglobin (X) is present on mast cells and basophils. When bound to an antigen, it triggers the release of (Y) that causes (Z). Here X,Y and Z respectively refers to:

(A) IgA, Histamine and inflammation
(B) IgM, Interleukin and allergy.
(C) IgE, Histamine and allergy.
(D) IgD, Histamine and Interleukin.

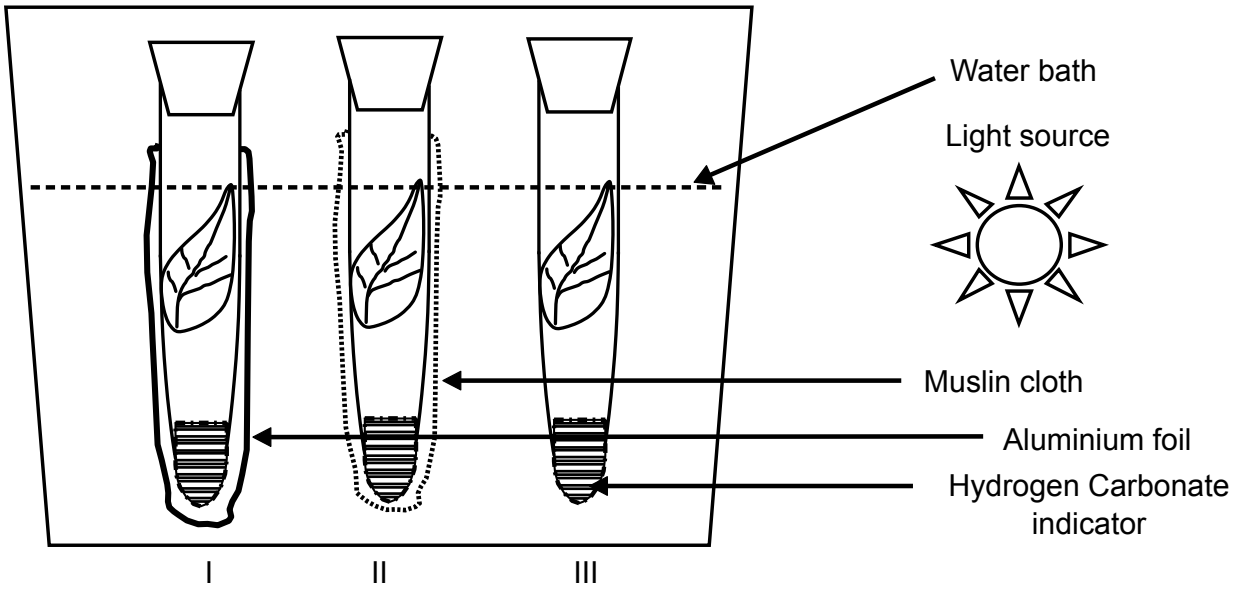
Solution · Q15 **Answer: (C)**

IgE sits on receptors of mast cells and basophils.

When an antigen binds to this IgE, the cells release histamine, which causes allergy.

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

16. Carefully observe the experimental setup given below. Hydrogen carbonate indicator is a cherry red coloured pH indicator which turns yellow in acidic conditions and purple in alkaline conditions. At the start of the experiment, equal quantities of this indicator (cherry red in colour) were added to each tube. A healthy green leaf of the same size was enclosed in each tube. The tubes were then kept for 15 min in a water bath to avoid heating due to the light source.



After incubation for a certain period of time, what would be the colour of the indicator in tubes I, II and III respectively?

(A) Cherry red, Cherry red, Yellow
(B) Yellow, Cherry red, Purple
(C) Purple, Yellow, Cherry red
(D) Yellow, Purple, Cherry red

Solution · Q16 **Answer: (B)**

I (aluminium foil, dark): only respiration occurs, CO_2 builds up and the indicator turns yellow.

II (muslin cloth, dim light): photosynthesis about balances respiration, so it stays cherry red.

III (uncovered, bright light): photosynthesis exceeds respiration, CO_2 falls and it turns purple.

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

17. Cyanogen bromide (CNBr) is a very selective agent that splits peptide bonds on the carbonyl side of every methionine residue in a protein. The number of polypeptides that will result from cutting of given protein by CNBr is:

NH_3^+ ~~~~~ Met . Met ~~~~~~ Met ~~~ Met ~~~~~ COO^-

(A) 3 (B) 4 (C) 5 (D) 6

Solution · Q17 **Answer: (B)**

CNBr cuts just after each of the four Met residues.

A chain follows the last Met, so four cuts give five pieces.

The second Met is joined directly to the first, so it is set free alone. A single amino acid residue is not a polypeptide.

∴ Four polypeptides are formed.

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

18. A hypothetical population had alleles "A" and "a" with frequencies 0.9 and 0.1respectively. The genotypic frequencies of "AA", "Aa" and "aa" were 0.81, 0.18 and 0.01 respectively. Suppose a negative selection pressure acts against the dominant phenotype resulting in the reduction of the frequency of A in the present generation from 0.9 to 0.8, then the genotypic frequencies of the zygotes formed would be respectively

(A) 0.81; 0.18 and 0.01 (B) 0.64; 0.32 and 0.04

(C) 0.8; 0.1 and 0.1 (D) 0.54; 0.44 and 0.02

Solution · Q18 **Answer: (B)**

Allele frequencies after selection:

$p = 0.8, q = 0.2$

Zygotes formed by random union of gametes:

$AA: p^2 = 0.64$

$Aa: 2pq = 0.32$

$aa: q^2 = 0.04$

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

19. While studying the effect of two plant growth regulators; IAA and Cytokinin, five different sets of culture tubes with varying concentrations of the hormones were prepared as given in the following table. Explants of parenchyma tissue derived from the stem of tobacco plant were transferred on culture medium of all sets. After a particular period of time, the **set V** showed undifferentiated large mass of tissue.

Sets	Conc. of IAA (mg dm^{-3})	Conc. of Cytokinin (mg dm^{-3})
I	-	0.2
II	2.0	-
III	2.0	0.02
IV	0.02	1.0
V	2.0	0.2

What would be the expected result of culturing in set I to IV respectively?

(A) Shoot formation, Root formation, No growth, Cell enlargement

(B) No growth, Cell enlargement, Root formation, Shoot formation

(C) Cell enlargement, No growth, Shoot formation, Root formation

(D) Root formation, Shoot formation , Cell enlargement, No growth

Solution · Q19 **Answer: (B)**

I (cytokinin only): no growth, as the explant also needs auxin.

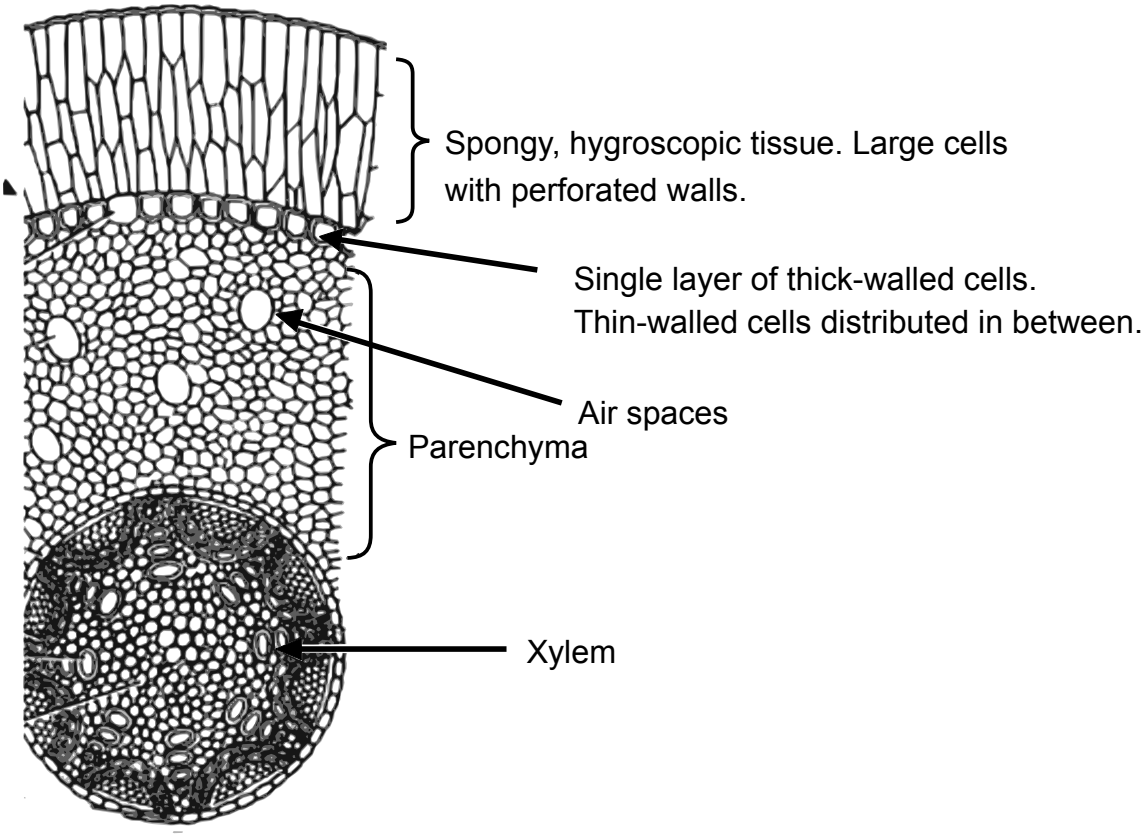
II (auxin only): cells enlarge, with hardly any division.

III (high auxin to cytokinin ratio): roots form.

IV (high cytokinin to auxin ratio): shoots form.

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

20. Veena found a preserved root specimen in her college laboratory. The specimen jar label was half torn so she could not read the full name of the sample. She took a cross section and observed it under the microscope. She was not aware of the exact tissue types so she drew the diagram and labeled it as per her understanding. Looking at the features she mentioned, it could most likely be:



(A) Stilt root of maize plant
(B) Hanging root of an orchid
(C) Pneumatophore of halophyte
(D) Root of a Pteridophyte

Solution · Q20 **Answer: (B)**

The spongy, hygroscopic outer tissue of large cells with perforated walls is velamen.

The layer below it, with thick-walled cells and thin-walled passage cells, is the exodermis.

Velamen is typical of the hanging (aerial) roots of epiphytic orchids.

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

21. During denaturation, globular protein becomes :

(A) Insoluble and inactive
(B) Inactive but soluble
(C) Unfolded and more soluble
(D) Soluble

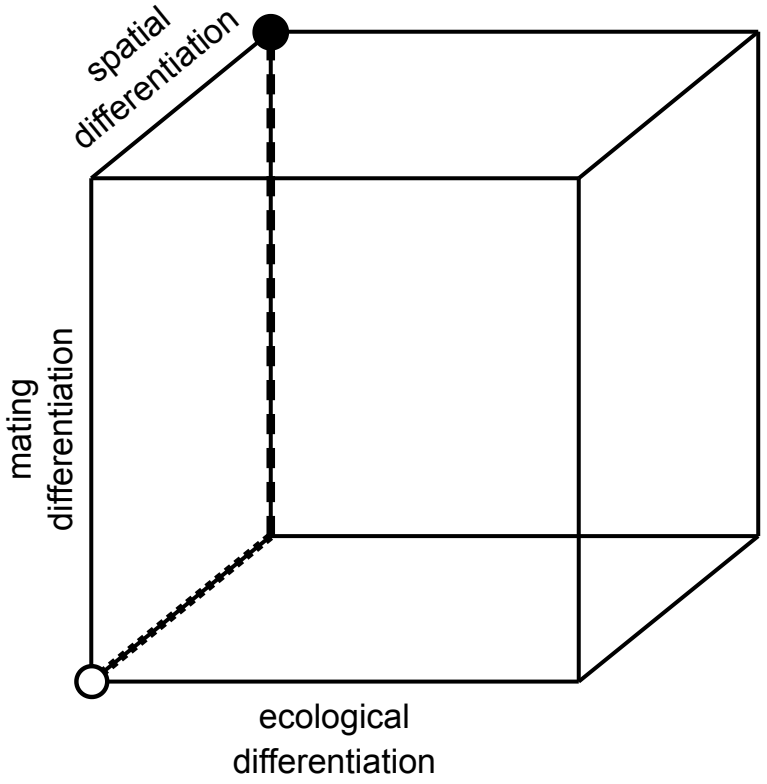
Solution · Q21 **Answer: (A)**

On denaturation the globular protein unfolds and its exposed hydrophobic groups make the chains aggregate, as in coagulation of egg white.

So it becomes insoluble and loses its biological activity.

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

22. The process of speciation is depicted in the adjoining figure with three factors that influence speciation. Identify the type of speciation that would explain the evolution of new species (marked with dark circle) from the original species (marked with white circle).



(A) Sympatric speciation
(B) Reproductive isolation
(C) Allopatric speciation
(D) Parapatric speciation

Solution · Q22 **Answer: (C)**

From the white circle, the path first runs the full length of the spatial axis, which means complete geographical separation.

It then rises along the mating axis, with no ecological differentiation.

Reproductive isolation arising after complete spatial separation is allopatric speciation; in parapatric speciation the separation is only partial.

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

23. Erythrocyte sedimentation rate (ESR) is a common hematology test performed using blood containing anticoagulant. It measures the rate at which the red blood cells (RBCs), in a sample of whole blood, fall to the bottom inside a specific tube, under gravity. This sedimentation is due to rouleau formation where RBCs form a stack because of their discoid shape. Which of the following statements about ESR is correct ?

(A) Inflammatory conditions cause increase in "Acute Phase Proteins" in plasma, that cause the RBCs to repel from each other to form stacks.

(B) Increase in positively charged plasma proteins, increases neutralization of the negative charges on the surface of the RBCs, which allows the formation of the rouleaux.

(C) Bacterial endotoxins in plasma inhibit platelet aggregation causing RBC to clump.

(D) Anticoagulants in the blood increase the negative ions in plasma which increases charges on RBC membranes causing them to stack and form the rouleaux.

Solution · Q23 **Answer: (B)**

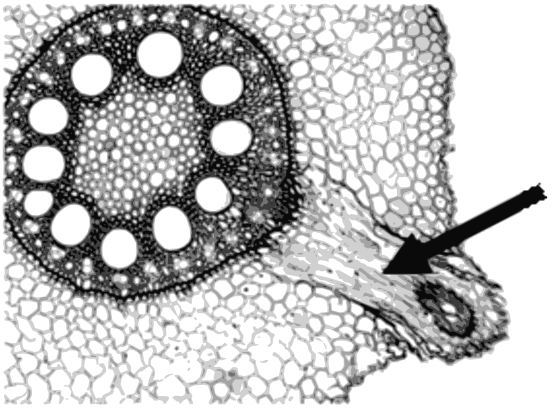
The negative charge on RBC surfaces normally keeps the cells apart.

In inflammation, positively charged plasma proteins increase and neutralise this charge.

So rouleaux form, settle faster and raise the ESR.

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

24. The adjoining figure is a transverse section of root of a monocot plant showing the stele. Identify the part pointed by arrow.



(A) Adventitious root

(B) Lateral root

(C) Tap root

(D) Adventitious bud

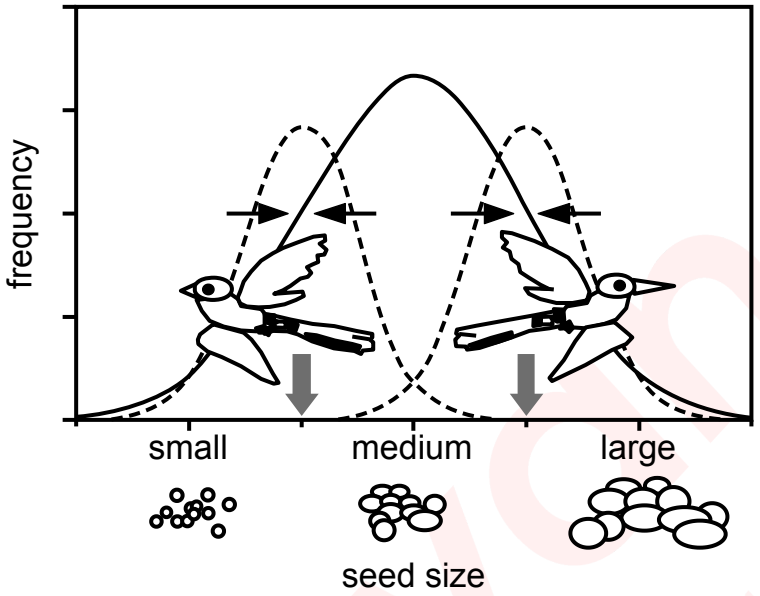
Solution · Q24 **Answer: (B)**

The arrow marks a branch that starts at the edge of the stele and grows out through the cortex.

A branch arising in this way from the pericycle of a root is a lateral root.

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

25. Evolutionary branching in a bird population is depicted in the figure below. Based on their phenotype (Bill size), the individuals compete for resources (seeds of different sizes). An individual can utilize only a limited fraction (indicated by the dashed curve) of the total available resources (solid curve).



Which of the following statements most appropriately describes the current status of the bird population, as shown in the figure?

(A) The mean bill size in the population does not match the most abundant resource, and therefore selection pushes the bill size to an intermediate value.

(B) The resources in the middle of the distribution curve are unutilized providing a new ecological niche to evolve in future.

(C) Since resources in the tails of the distribution curve are left unexploited, selection establishes individuals with either small or large beak sizes.

(D) Selection pressure splits the population into two ecological specialists that evolve an optimal compromise of foraging on the most abundant seeds and avoid competition.

Solution · Q25 **Answer: (D)**

The two dashed curves are two groups of birds, with smaller and larger bills, each using only part of the seed range.

The inward arrows show that selection now holds each group around its own peak.

Each peak lies between the abundant medium seeds and one end of the range, giving good food supply with little competition.

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

26. A student in a biochemistry lab found three solutions in unlabelled beakers on his working table. He marked the beakers as P, Q and R and found that the H^+ concentration (moles per litre) of the three solutions was 10^{-4}, 10^{-7} and 10^{-10} respectively. The solutions P, Q, and R respectively could be:

(A) Baking soda; sea water and beer
(B) Stomach acid; household ammonia and detergent
(C) Tomato juice; human blood and milk of magnesia
(D) Beer; human urine and vinegar

Solution · Q26 **Answer: (C)**

$$pH = -\log[H^+]$$

For P, Q and R respectively,

$$pH = 4, 7 \text{ and } 10$$

Tomato juice is acidic (pH about 4), human blood is near neutral (pH about 7.4) and milk of magnesia is basic (pH about 10).

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

27. Most ants, bees and wasps exhibit haplodiploidy wherein males are haploid and develop from unfertilized eggs while females are diploid and develop from fertilized eggs. Which of the following would be true if the genetic relatedness between two daughters from the same mother in humans and ants are compared?

The genetic relatedness will be:

(A) less by a factor of 0.5 in ants.
(B) same in both cases.
(C) greater by a factor of 0.25 in ants.
(D) greater by a factor of 0.5 in ants.

Solution · Q27 **As per Zigyan: (D)**

Both daughters are taken to have the same father.

An ant father is haploid, so both sisters get identical paternal genes. A maternal gene is shared with probability 0.5.

For ant sisters,

$$r = (0.5 \times 1) + (0.5 \times 0.5)$$

$$\Rightarrow r = 0.75$$

For human sisters,

$$r = (0.5 \times 0.5) + (0.5 \times 0.5)$$

$$\Rightarrow r = 0.50$$

Increase in ants as a fraction of the human value:

$$(0.75 - 0.50)/0.50 = 0.5$$

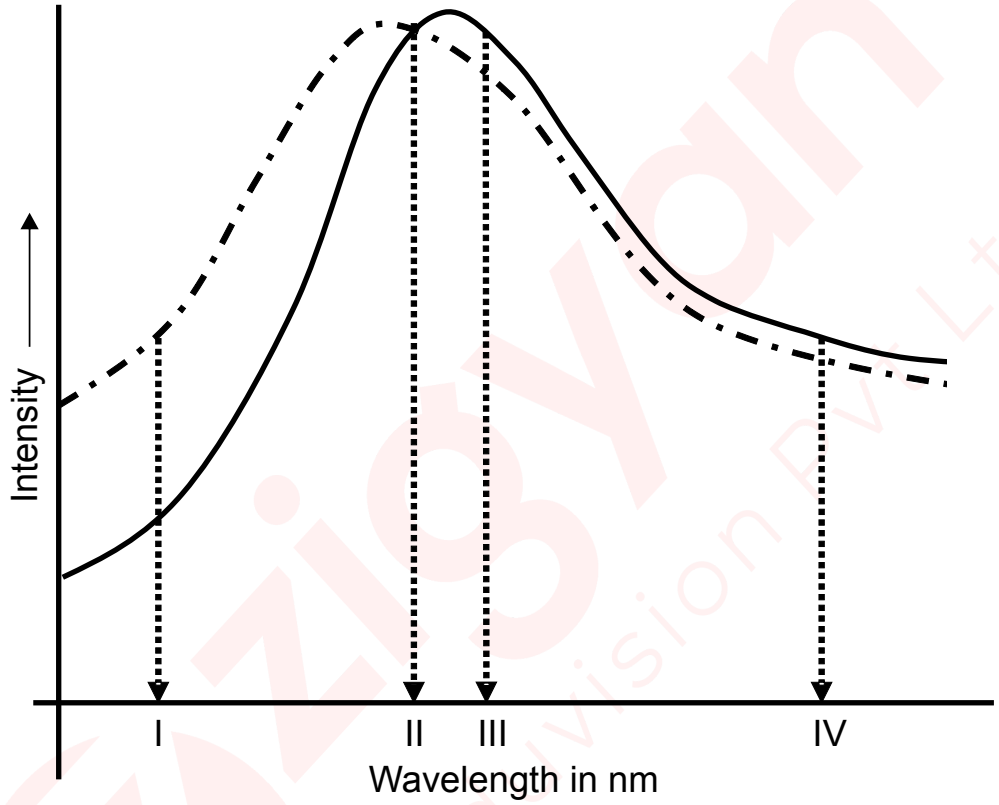
Why Zigyan differs from IAPT: 0.25 is only the subtracted gap between 0.75 and 0.50. A factor compares by multiplying: 0.50 raised by 0.5 of itself gives 0.75.

Reference: NCERT Biology Class XII, Chapter 4 'Principles of Inheritance and Variation', section 4.6.2: in the haplodiploid honey bee, females are diploid, while males are haploid and produce sperms by mitosis.

Check: Pick one gene of an ant daughter. If paternal (half the time), her sister surely has it; if maternal, she has it half the time. This totals three-quarters, against one-half for human sisters.

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

28. Urea is used to produce conformational changes in protein and these changes can be studied using fluorescence emission spectroscopy. In the adjoining figure changes in fluorescence emission is shown for different excitation wavelengths for a protein both in the absence (dotted line) and in the presence (solid line) of urea Which of the excitation wavelengths marked as I, II, III and IV will be the best one to study the conformational changes ?



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

Solution · Q28 **Answer: (A)**

The best excitation wavelength is the one at which urea changes the emission intensity the most.

The gap between the two curves is largest at I. It is zero at II and small at III and IV.

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

29. In a classic experiment, scientists selected fruit flies with many bristles (stiff, hairlike structures) on their abdomen. At the start of the experiment, the average number of bristles was 9.5. In each of the successive generations, scientists picked out 20% of the population with the greatest number of bristles and allowed them to reproduce. After 86 generations of such selection, the average number of bristles had quadrupled, to nearly 40.

This is an example of:

(A) Disruptive selection
(B) Natural selection
(C) Stabilizing selection
(D) Directional selection.

Solution · Q29 **Answer: (D)**

In every generation only one extreme, the flies with the most bristles, was bred. So the average kept shifting one way, from 9.5 to nearly 40.

This is directional selection. The scientists did the choosing, so it is not natural selection.

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

30. Warm blooded animals have mechanisms evolved for insulating their bodies. Choose the option that correctly depicts the increasing order of relative insulation that these body parts/components provide.

(A) Fat; Muscle; dry fur
(B) Muscle; fat; dry fur
(C) Muscle; dry fur; fat
(D) Dry fur; muscle; fat

Solution · Q30 **Answer: (B)**

Muscle conducts heat most readily, so it insulates least. Fat conducts less. Dry fur traps still air, a very poor conductor, so it insulates most.

Increasing insulation: muscle < fat < dry fur.

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

31. Which of the following is NOT TRUE about DNA polymerase-I ?

(A) It helps in the removal of primer and subsequent gap filling.
(B) It has both 5' to 3' and 3' to 5' exonuclease activity.
(C) It has low processivity and polymerization rate.
(D) It has only 5' to 3' exonuclease activity

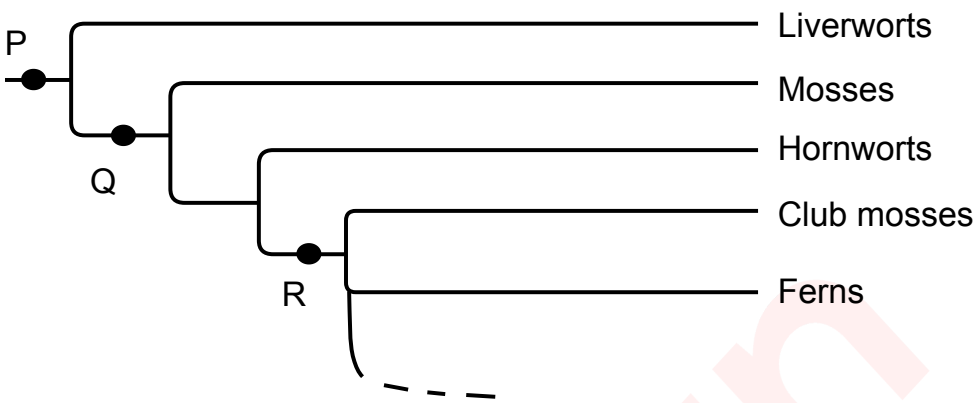
Solution · Q31 **Answer: (D)**

DNA polymerase I has polymerase activity and two exonuclease activities: 3' to 5' (proofreading) and 5' to 3' (primer removal).

So "only 5' to 3' exonuclease activity" is not true. Compared with DNA polymerase III, its processivity is low and its rate is slow.

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

32. The key characteristics that emerged during plant evolution are shown. P, Q and R respectively indicate:



(A) P: Persistent green sporophyte, Q: Protected embryos, R: Stomata

(B) P: Stomata, Q: Microphylls, R: Tracheids

(C) P: Microphylls, Q: Persistent green sporophyte, R: Stomata

(D) P: Protected embryos, Q: Stomata, R: Tracheids

Solution · Q32 **Answer: (D)**

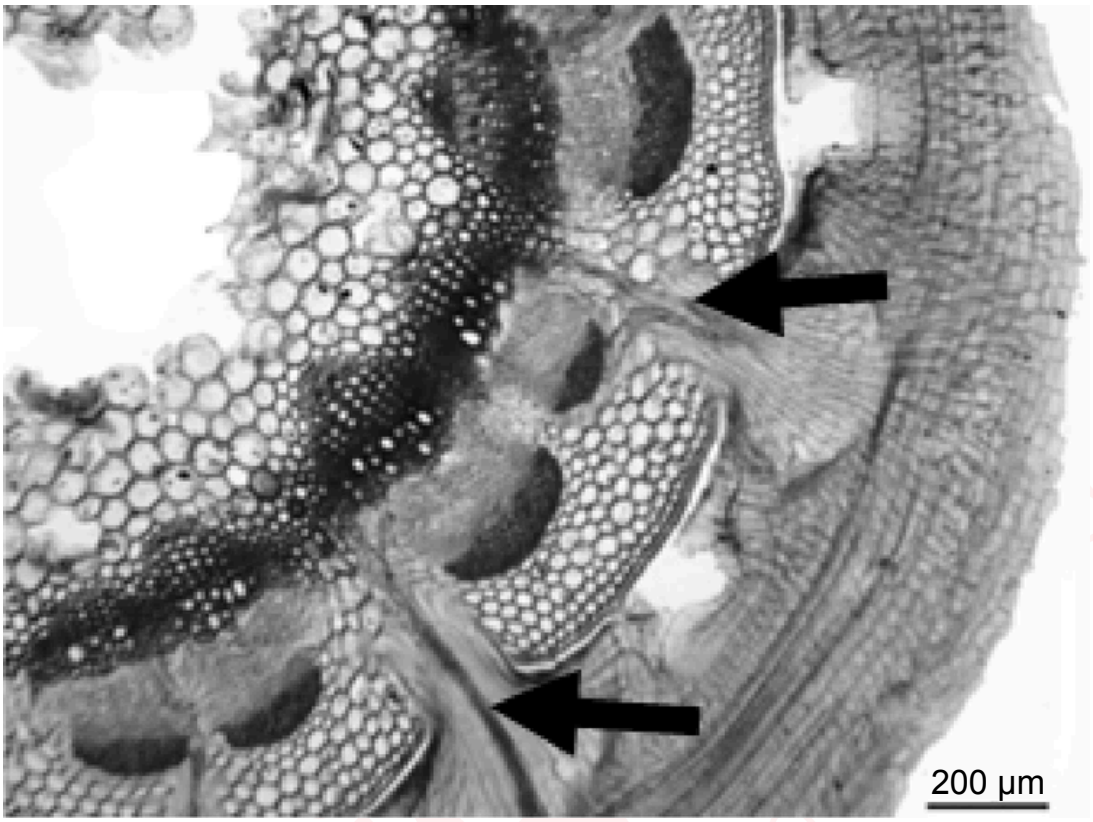
P comes before every branch, so it is common to all land plants: protected embryos.

Q arose after liverworts branched off: stomata, found in mosses and hornworts but not in liverworts.

R is shared by club mosses and ferns, which are vascular plants: tracheids.

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

33. The given figure is transverse section of a stem of *Trifolium repens* (White Clover), a flowering plant, with *Cuscuta epithymum* growing on its stem. Identify the part pointed by arrows.



(A) Cork cambium
(B) Haustorium of parasite
(C) Secondary phloem
(D) Vascular cambium

Solution · Q33 **Answer: (B)**

Cuscuta is a stem parasite. Its haustoria pierce the host stem from outside and reach the vascular bundles. The arrows mark these strands, running from the outer tissue into the vascular region of the host.

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

34. Na^+-K^+ATPase is essential for maintaining various cellular functions and its inhibition could result in diverse pathologic states. Ca^{2+} transport in cardiac muscles is also linked to Na^+-K^+ ATPase. Cardiac glycosides such as digoxin directly inhibit the Na^+-K^+ATPase. With respect to cardiac muscles, which of the following statements are correct events after digoxin inhibition of Na^+-K^+ATPase?

(A) Build-up of excessive K^+ extracellularly, and depletion of intracellular Na^+.
(B) Build-up of Ca^{2+} intracellularly leading to increased cardiac contractility.
(C) Inhibition Na^+-K^+ATPase stimulates the vagus nerve, causing an increase in heart rate.
(D) Changes in Na^+ ion concentration increases conduction of atrioventricular node causing stimulation of the sinoatrial node.

Solution · Q34 **Answer: (B)**

Digoxin blocks the Na^+-K^+ pump, so Na^+ rises inside the muscle cell.

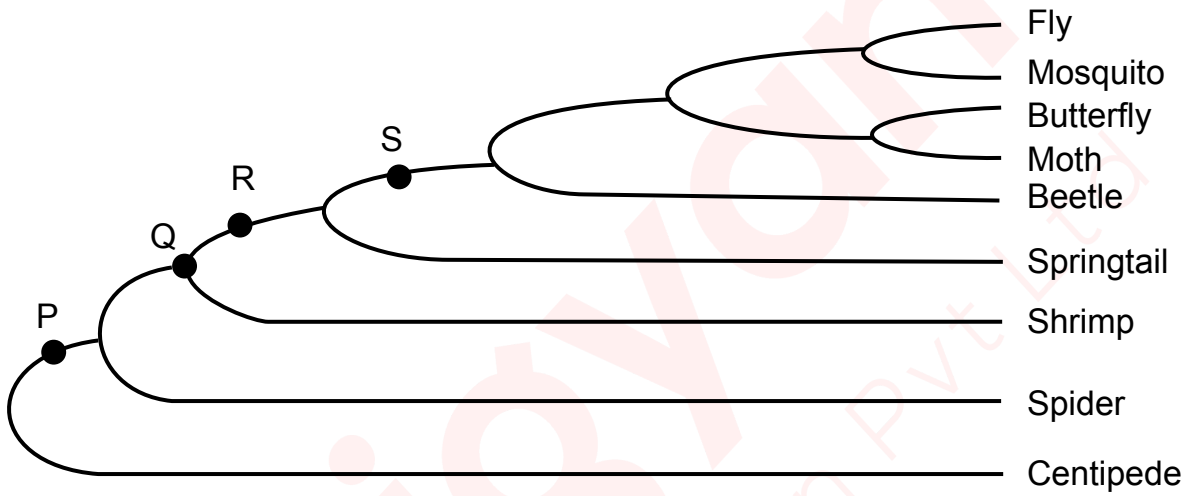
The weaker Na^+ gradient slows the Na^+/Ca^{2+} exchanger, so less Ca^{2+} leaves the cell.

Ca^{2+} builds up inside and contraction becomes stronger.

(A) fails as intracellular Na^+ rises. For (C) and (D): digoxin raises vagal tone, which slows the heart rate and AV nodal conduction.

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

35. In insects, it has been found that change in the Ubx gene resulted in modifying a protein that blocks the development of legs in the abdominal region. Among the positions indicated as P, Q, R, and S in the cladogram, where the Ubx gene seems to have mutated?



(A) P (B) Q (C) R (D) S

Solution · Q35 **Answer: (D)**

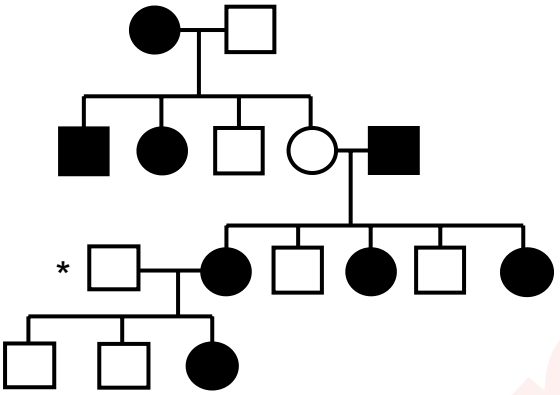
Shrimps have abdominal appendages. Springtails are six-legged but not true insects, and they also keep appendages on the abdomen.

Fly, mosquito, butterfly, moth and beetle are true insects, whose adults have no abdominal legs.

So the leg-blocking change in Ubx arose after the springtail line branched off and before these insects diverged, at S.

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

36. What type of gene is involved in the inheritance pattern depicted in the adjoining human pedigree?



* Note: the person from outside the family does not carry a defective allele.

(A) X linked recessive
(B) Y linked recessive
(C) X linked dominant
(D) Autosomal recessive

Solution · Q36 **Answer: (C)**

The affected man of generation II and his normal wife have only affected daughters and only normal sons. This fits an X-linked dominant gene.

Not autosomal recessive: the outsider has no defective allele, yet he and his wife have an affected daughter.

Not X-linked recessive, as his affected wife has normal sons. Not Y-linked, as females are affected.

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

37. The concentration of four components of air during respiration is provided in the table;

Gas (Pressure in Hg mm)	Air in inhalation	Air in exhalation	Air in Alveolus	Arterial blood	Venous Blood
1	158.25	116	100	95	37
2	5.0	47	47	47	47
3	596	568	573	573	573
4	0.3	28	40	40	46

Match the gases 1, 2, 3, and 4 with their names.

(A) 1 – Carbon dioxide, 2 – Water vapour, 3 – Nitrogen, 4 – Oxygen.
(B) 1 – Oxygen, 2 – Carbon dioxide, 3 – Nitrogen, 4 – Water vapour.
(C) 1 – Oxygen, 2 – Water vapour, 3 – Nitrogen, 4 – Carbon dioxide.
(D) 1 – Nitrogen, 2 – Water vapour, 3 – Oxygen, 4 – Carbon dioxide.

Solution · Q37 **Answer: (C)**

Gas 2 stays at 47 mm Hg in exhaled air, alveolar air and blood. It is water vapour, saturated at body temperature.

Gas 1 falls steadily from inhaled air to venous blood, so it is oxygen.

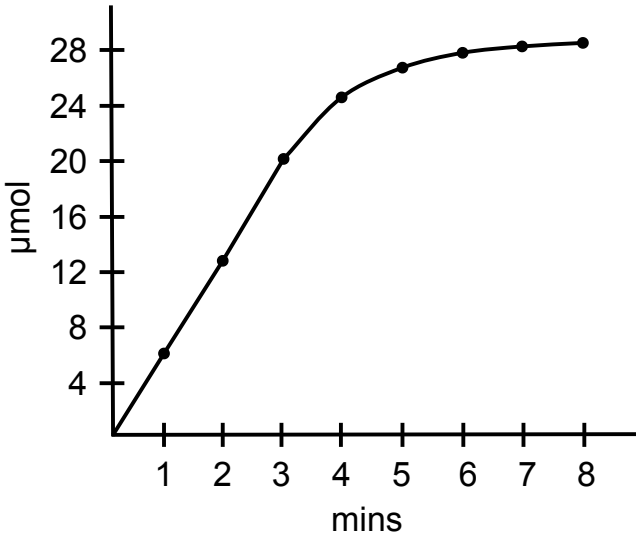
Gas 4 is very low in inhaled air and highest in venous blood, so it is carbon dioxide.

Gas 3 has the largest pressure and is unchanged between alveoli and blood, so it is nitrogen.

∴ 1 – oxygen, 2 – water vapour, 3 – nitrogen, 4 – carbon dioxide

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

38. A student was following an enzyme catalyzed reaction. As the reaction progressed, she obtained the following graph showing the conversion of the substrate into the product.



Which of the following is the correct method to calculate product formed per minute?

(A) $[(\mu moles)_{3\ min} - (\mu moles)_{1min}]/2$

(B) $[(\mu moles)_{8min} - (\mu moles)_{7min}]$

(C) $[(\mu moles)_{8min} - (\mu moles)_{1min}]/7$

(D) $[(\mu moles)_{5min} - (\mu moles)_{0min}]/5$

Solution · Q38 **Answer: (A)**

The rate is taken from the straight part of the curve, which lasts up to about 3 min.

Later the curve flattens, so intervals reaching 5, 7 or 8 min give lower values.

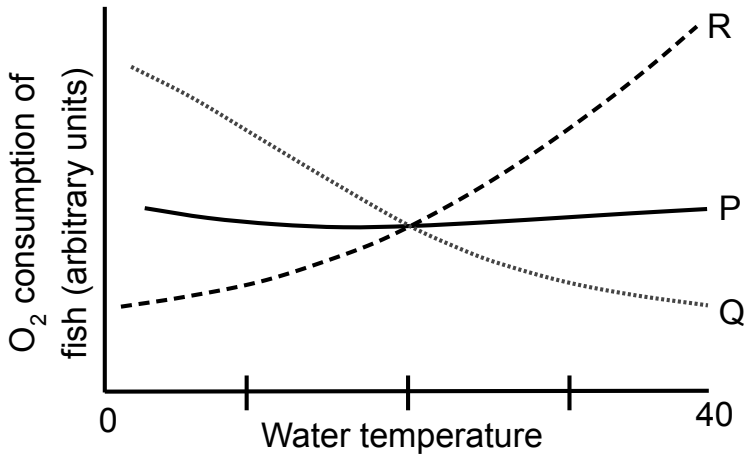
From 1 min to 3 min:

$$(20 - 6)/2 = 7\ \mu mol\ min^{-1}$$

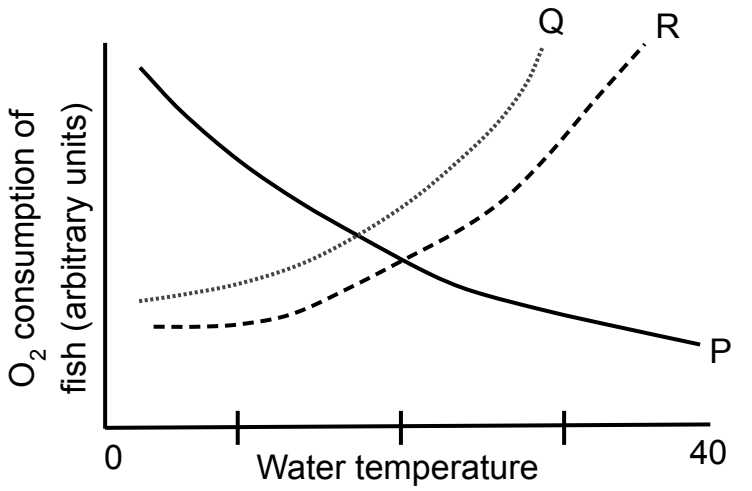
IAPT answer: (A) | **Zigyan answer:** (A)

39. Which of the following figures (marked A, B, C, and D) appropriately depict the relationship of (P) oxygen content of water, (Q) oxygen consumption of resting fish and (R) oxygen consumption of active fish with respect to water temperature?

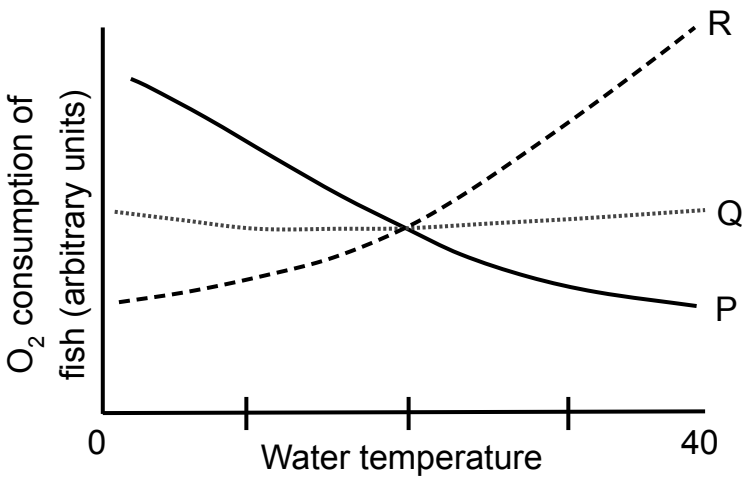
(A)



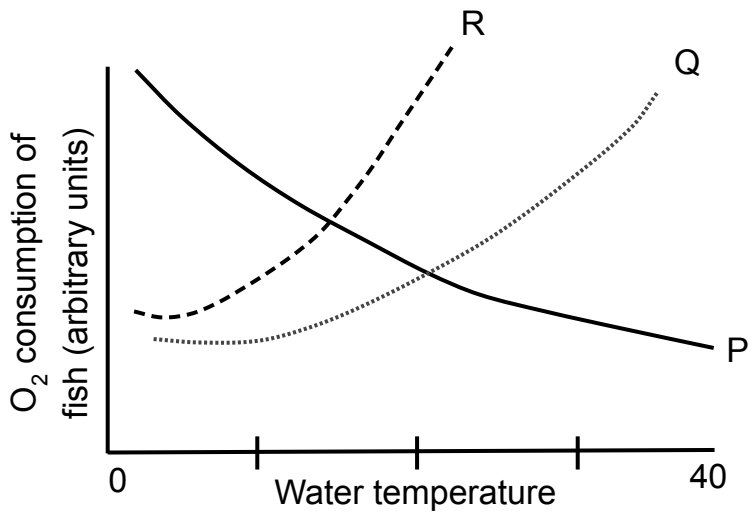
(B)



(C)



(D)



Solution · Q39 **Answer: (D)**

Warmer water holds less dissolved oxygen, so P must fall.

A fish is a cold-blooded animal. Its metabolic rate and O_2 use rise as the water warms.

An active fish uses more O_2 than a resting one, so R must lie above Q.

Only graph (D) shows all three. In (B), the resting curve wrongly lies above the active curve.

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

40. Colonisation of drier terrestrial habitats became possible in birds and mammals due to development of the renal system to manage osmotic concentration of urine. Which of the following adaptation is the most crucial for this development ?

(A) Insertion of aquaporins into the luminal plasma membrane.

(B) Differentiation of the kidney into the cortex and medulla

(C) Appearance of Henle's loops.

(D) Increase in renal circulation.

Solution · Q40 **As per Zigyan: (C)**

To save water, urine must become more concentrated than blood plasma.

The counter current in Henle's loops, supported by the vasa recta, builds a rising osmotic gradient in the medulla.

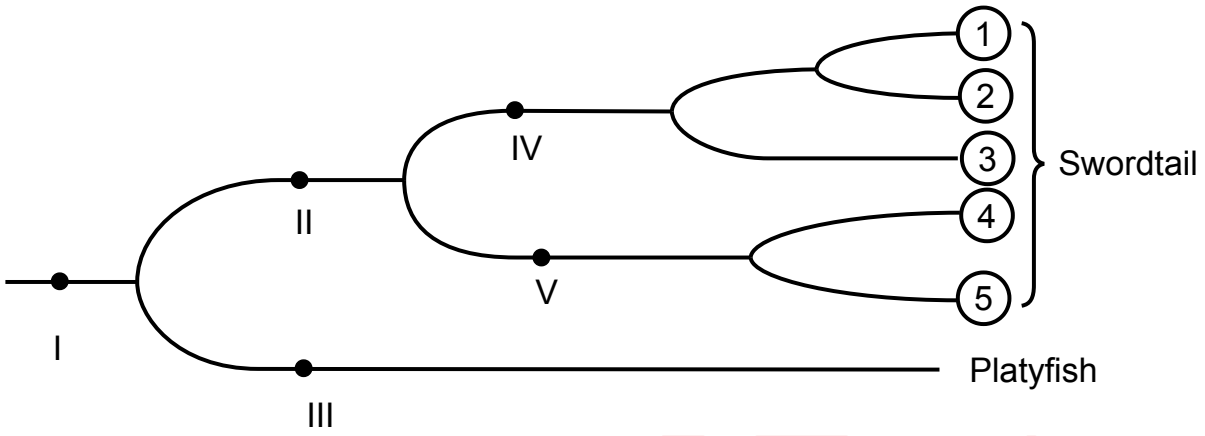
Water then leaves the collecting ducts along this gradient. Aquaporins help only because the gradient is present.

Why Zigyan differs from IAPT: cortex and medulla describe the layout of the kidney, while the Henle's loops are what create the medullary gradient that concentrates urine.

Reference: NCERT Biology Class XI, Chapter 16 'Excretory Products and their Elimination', section 16.4: in mammals, Henle's loop and the vasa recta are important for concentrating urine, as their counter currents keep osmolarity increasing towards the inner medulla.

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

41. Swordtail fishes belong to genus Xiphophorus. Males of these fishes have a long, colorful tail extension called Sword Males with short swords are less likely to be chosen by the female. In order to find whether female behavior of choosing longer sword evolved before or after the evolution of long sword, scientists used the closest relative of this fish, the platyfish, which lacks sword When they attached artificial long tail to male platyfish, females preferred the fish with long tails. Indicate in the diagram showing evolutionary relationship where these traits most likely have evolved.



(A) Female sensory bias : I Sword: II
(B) Female choice : I Sword: IV, V
(C) Female choice : II, III Sword: IV, V
(D) Female choice : IV, V Sword: IV, V

Solution · Q41 **Answer: (A)**

Female platyfish also prefer long tails, although their own males have no sword.

⇒ This sensory bias was already present in the common ancestor of platyfish and swordtails, at I.

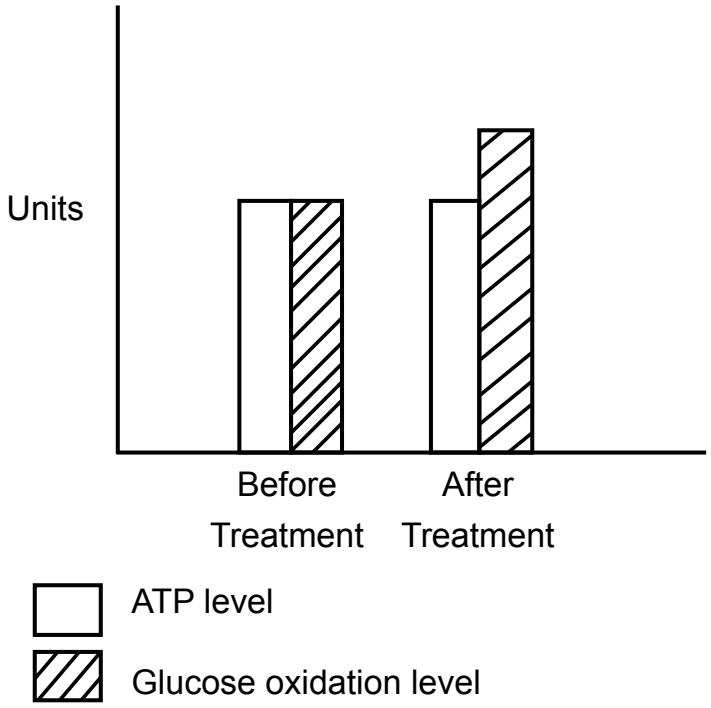
The sword is a feature of the swordtail group (1 to 5) and is absent in platyfish.

⇒ It arose once on their common branch, after the split, at II.

∴ Female sensory bias: I; sword: II

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

42. After making several unsuccessful attempts to qualify in the final wrestling team, a person went to take the advice of a physical trainer. After he explained the case to him, the trainer advised him to take a blood test and then start a regime of drug. He also advised blood test post regime. The results of both tests are given.



The most likely use of the drug is:

(A) to increase strength of skeletal mass.

(B) to reduce anaerobic respiration by the tissues.

(C) to reduce body weight by increasing body respiration.

(D) to get trained for endurance exercise to maintain low levels of ATP over long period

Solution · Q42 **Answer: (C)**

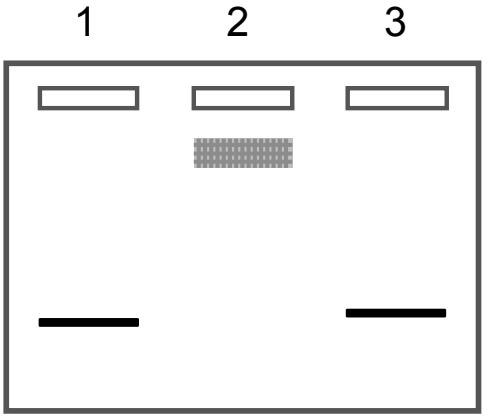
After treatment, glucose oxidation increases but the ATP level stays the same.

So the extra energy is released as heat. The drug acts as an uncoupler of oxidative phosphorylation.

The body uses up more stored fuel, so body weight falls.

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

43. Electrophoresis was carried out to test the efficacy of an anticancer drug. In lane 1- circular DNA sample alone, in lane 2 - DNA mixed with topoisomerase, and in lane 3 - DNA+ topoisomerase mixed with the anticancer drug were loaded in the wells of an agarose gel and electrophoresed The result was as follows.



What can be the possible mechanism of action of the drug?

(A) The drug is likely to act by protecting the cells from damage.

(B) The drug is likely to affect topoisomerase I and helping DNA repair mechanism.

(C) The lane I and III represent intact supercoiled DNA thus indicating no effect of the drug.

(D) The drug is likely to be effective by inhibiting topoisomerase I enzyme that helps in DNA repair at multiple check points.

Solution · Q43 **Answer: (D)**

Lane 1: intact circular DNA is supercoiled and compact, so it runs farthest.

Lane 2: topoisomerase relaxes the supercoils. Relaxed DNA moves slowly and stays higher in the gel.

Lane 3: with the drug, DNA again runs almost like lane 1, so it was not relaxed.

⇒ The drug works by inhibiting topoisomerase I. So it clearly has an effect.

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

44. The blood in the capillaries has both a greater hydrostatic and greater osmotic pressure than the surrounding tissue fluid The difference in hydrostatic pressure tends to force water and dissolved materials out of the capillaries into the tissue fluid while the difference in the osmotic pressure has the opposite effect, causing the capillaries to take up water and the dissolved materials from the tissue fluid. If the osmotic pressure differential at the arteriole and the venule ends are 25mm Hg each; then what would be the expected hydrostatic pressure differentials at the arteriole and venule ends respectively to result in 11mm Hg net outward pressure and 10 mmHg net inward pressure respectively?

(A) 36 and 35 (B) 16 and 15 (C) 16 and 35 (D) 36 and 15

Solution · Q44 **Answer: (D)**

Net pressure is the difference between the hydrostatic differential (outward) and the osmotic differential (inward).

At the arteriole end, with net outward pressure:

$$P_1 - 25 = 11$$

$$\Rightarrow P_1 = 36 \text{ mm Hg}$$

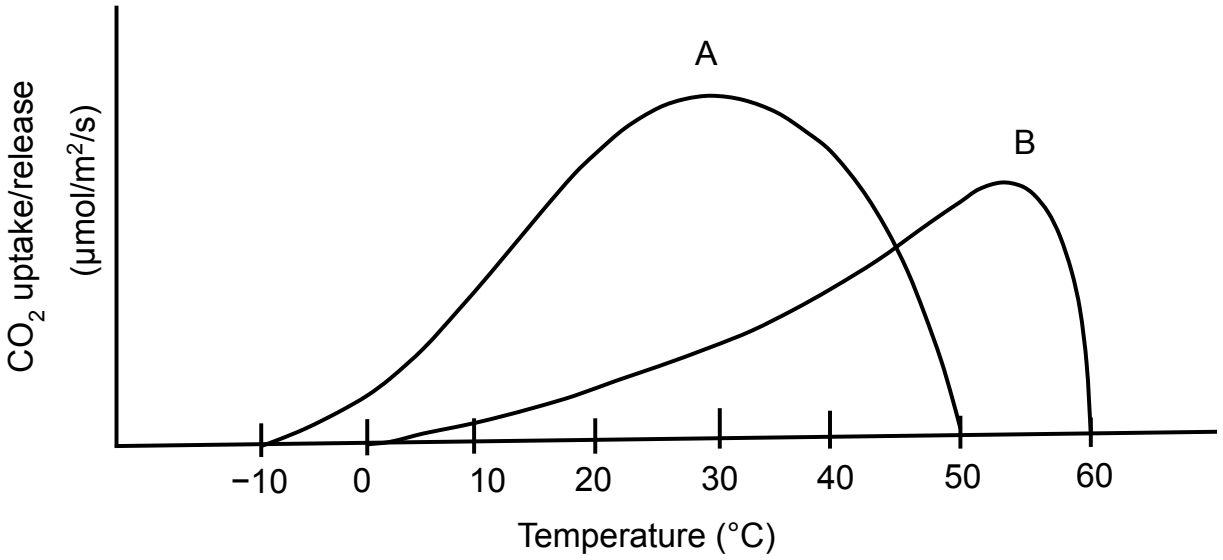
At the venule end, with net inward pressure:

$$25 - P_2 = 10$$

$$\Rightarrow P_2 = 15 \text{ mm Hg}$$

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

45. The response of the rates of photosynthesis (curve A) and respiration (curve B) to temperature is depicted in the graph.



The optimal temperature for net photosynthesis is:

(A) Between 10°C–20°C
(B) Between 20°C–30°C
(C) 32°C
(D) Between 40°C–50°C

Solution · Q45 **As per Zigyan: (B)**

Net photosynthesis is photosynthesis minus respiration. On the graph it is the vertical gap between curve A and curve B.

The gap widens while A rises faster than B, and narrows after that.

It is largest at about 25°C. It is already smaller at 32°C and much smaller between 40°C and 50°C.

∴ The optimum lies between 20°C and 30°C.

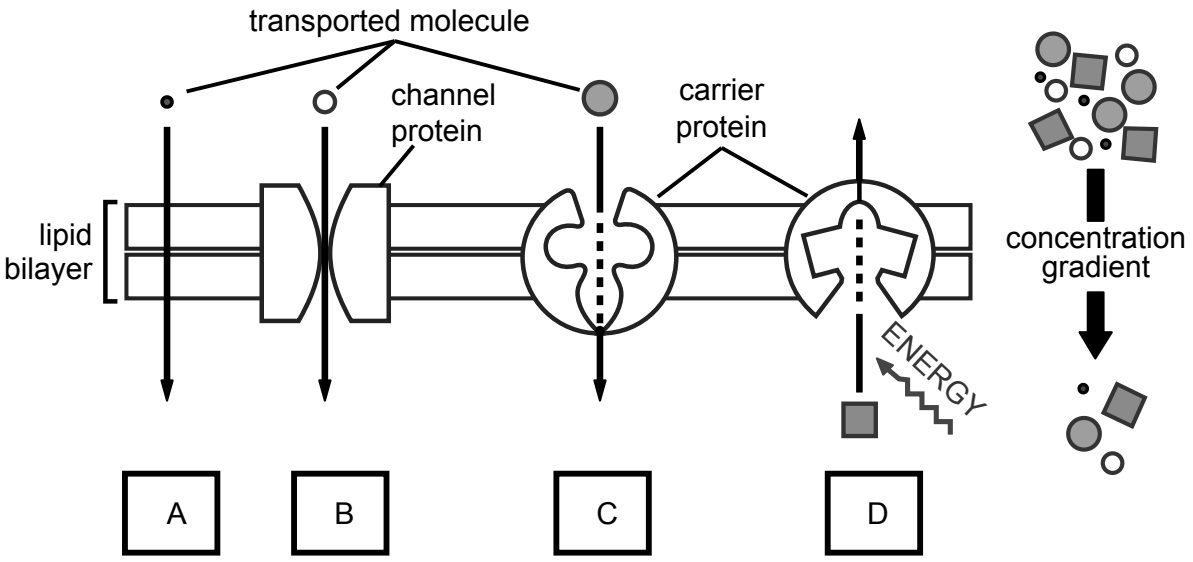
Why Zigyan differs from IAPT: the gap is still widening throughout 10°C to 20°C and is larger near 25°C, so the maximum lies above 20°C.

Reference: NCERT Biology Class XII, Chapter 12 'Ecosystem', section 12.2 'Productivity': net primary productivity is what remains of gross primary productivity after the respiration loss is taken away.

Check: Taking the peak height of curve A as 100, the gap measured on the graph is about 38 at 10°C, 71 at 20°C, 77 at 25°C, 72 at 30°C and 39 at 40°C.

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

46. In the figure given below identify the type of transport across membrane (marked A, B, C, and D) that needs maximum energy.



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

Solution · Q46 **Answer: (D)**

A is simple diffusion, B is diffusion through a channel and C is carrier-mediated (facilitated) diffusion.

These three move molecules down the concentration gradient and need no energy.

D moves the molecule against the gradient using energy, which is active transport.

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

47. Hydronephrosis is a condition in which kidneys become swollen due to incomplete emptying of the urinary tract. Given below are the values of water content and some major electrolytes in four different tissue samples. One of them is normal kidney. Identify the other three and match the right alphabet with the respective number.

Values per Kg fat free tissue	Water (gm)	K (mM)	Na (mM)	Cℓ (mM)
Normal Kidney	802.2	58.3	82.6	67.7
1.	765	82.1	32.4	21.5
2.	922	3.72	142.0	109.0
3.	830.1	56.4	77.3	53.0

i. Hydronephrotic Kidney

ii. Muscle

iii. Serum

(A) 1. – ii, 2. – iii, 3. – i.
(B) 1. – i, 2. – ii, 3. – iii.
(C) 1. – iii, 2. – ii, 3. – i.
(D) 1. – iii, 2. – i, 3. – ii.

Solution · Q47 **Answer: (A)**

Sample 1 has high K^+ with low Na^+ and $C\ell^-$. This is a cell-rich tissue: muscle (ii).

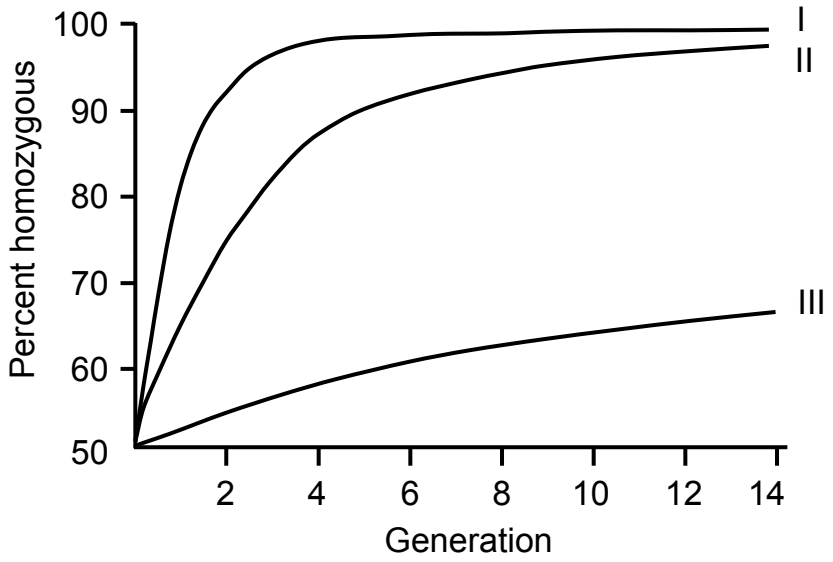
Sample 2 has the most water, high Na^+ and $C\ell^-$ and very little K^+. This is an extracellular fluid: serum (iii).

Sample 3 is close to normal kidney but holds more water, as in a swollen kidney: hydronephrotic kidney (i).

∴ 1 – ii, 2 – iii, 3 – i

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

48. Curves I, II and III in the graph represent the impact of inbreeding on the percentage of homozygotes in the successive generations.



The types of breeding represented by the curves I, II and III respectively are:

(A) Brother –sister mating; mating of first cousins; self-fertilization

(B) Mating of first cousins; brother-sister mating; self-fertilization

(C) Self-fertilization; brother-sister mating; mating of first cousins

(D) Self-fertilization; mating of first cousins; brother-sister mating

Solution · Q48 **Answer: (C)**

The closer the relationship between mates, the faster homozygosity rises.

Self-fertilization halves the heterozygotes in every generation, so it is the fastest: curve I.

Brother and sister share about half of their genes, so the rise is slower: curve II.

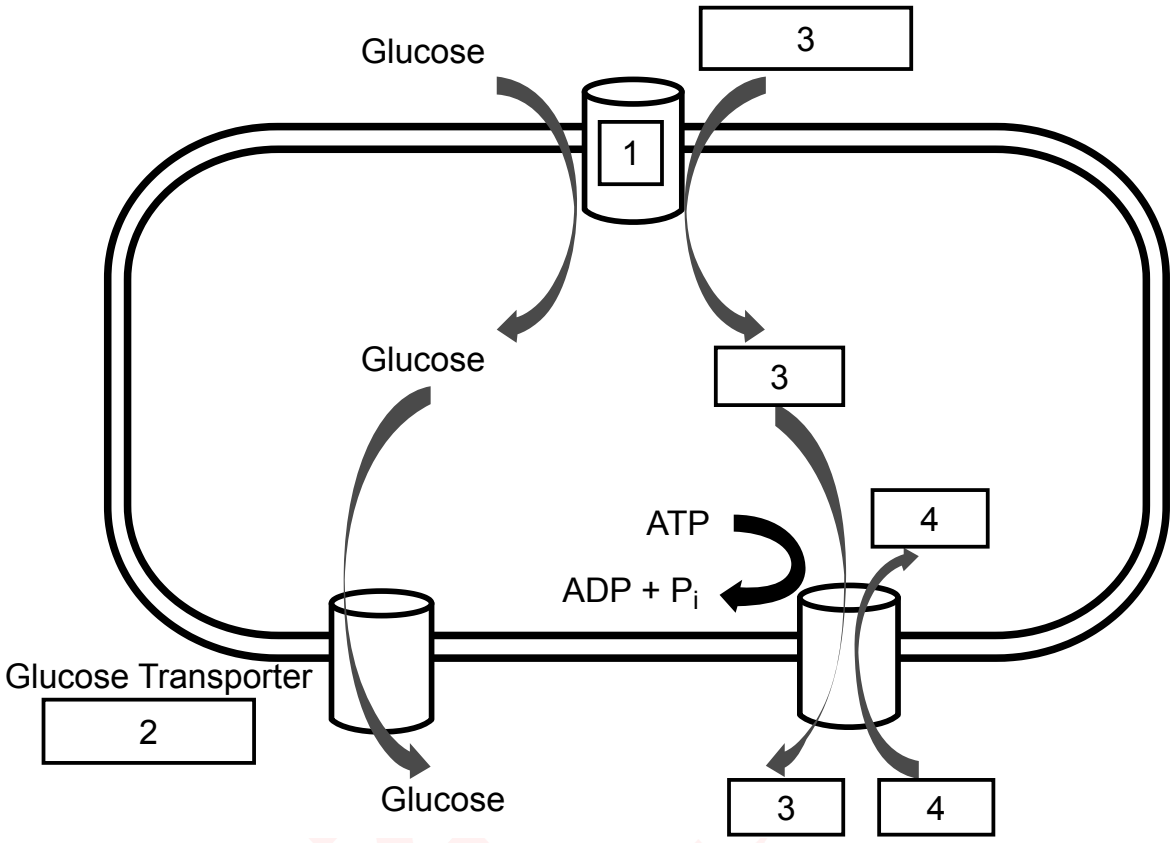
First cousins share only about one eighth, so the rise is the slowest: curve III.

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. The figure below depicts glucose transport into intestinal cells. Study the figure carefully and identify the correct statements.



(A) 1 is a Uniport Transporter while 2 is a Symport Transporter

(B) 1 is a Symport Transporter while 2 is a Uniport Transporter

(C) 3 is Na+ ions While 4 is K+ ions.

(D) 3 is K+ ions and 4 is Na+ ions.

Solution · Q49 **Answer: (B), (C)**

1 carries glucose and substance 3 into the cell together, so it is a symporter.

2 carries only glucose out, so it is a uniporter.

The ATP-driven pump sends 3 out and brings 4 in, as the Na^+-K^+ pump does.

$\therefore$ 3 is Na^+ and 4 is K^+.

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

50. Since the characters fundamental to land plants first appeared in bryophytes, the key to understand transition of plants from aquatic to terrestrial habitats can be found in bryophytes. Which of the following Statements are in consonance with this hypothesis?

(A) Stomata are seen originally as a sporangial specialization, but in some bryophytes it is also expressed in the sporophyte vegetative body.

(B) In most of the bryophytes, rhizoid formation is restricted to the gametophyte.

(C) The cell walls of bryophytes contain lignin-related polyphenolic compounds as protection against UV irradiation and attack by micro-organisms.

(D) The mature gametophyte is a thallus or a leafy shoot in liverworts, a leafy shoot in mosses and a thallus in hornworts.

Solution · Q50 **As per Zigyan: (B), (C), (D)**

(A) Bryophytes bear stomata only on the sporangium, not on a vegetative part of the sporophyte. ∴ false.

(B) Rhizoids belong to the gametophyte; the attached sporophyte (foot, seta, capsule) does not form them. ∴ true.

(C) Lignin-related polyphenols in the walls help against UV rays and microbes, both important on land. ∴ true.

(D) Liverworts are thalloid or leafy, mosses have a leafy shoot and hornworts a thallus. ∴ true.

Why Zigyan differs from IAPT: (A) puts bryophyte stomata on the vegetative sporophyte too, which is wrong, while (B) and (D) are correct bryophyte characters.

Reference: Renzaglia, Browning and Merced, Frontiers in Plant Science, Volume 11 (2020), 'With Over 60 Independent Losses, Stomata Are Expendable in Mosses', Introduction and Discussion: bryophytes carry stomata only on sporangia.

Reference: NCERT Biology Class XI, Chapter 3 'Plant Kingdom', sections 3.2, 3.2.1 and 3.2.2: the main bryophyte body is the gametophyte, attached by rhizoids; liverworts are thalloid or leafy, and mosses have a leafy stage.

Reference: OpenStax Biology 2e, section 25.3 'Bryophytes': hornwort gametophytes grow as flat thalli on the soil.

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

51. Renal portal system in reptiles drains the posterior part of the body into the kidney. In this context, with respect to reptilian body, which of the following statements are correct?

(A) Drug molecule injected in muscles of the front legs and the same drug molecule injected in muscles of hind legs can show different concentrations in circulating blood.

(B) Pharmacokinetics of a drug molecule will be same when administered in the vein of front legs or the tail vein.

(C) All drug molecules injected through the tail vein will show first site of metabolism in the liver.

(D) Drugs which are nephrotoxic should be injected in the front legs to reduce toxicity.

Solution · Q51 **Answer: (A), (D)**

Blood from the hind limbs and tail can pass through the kidneys before it reaches the general circulation.

(A) A hind-leg dose may be partly removed by the kidneys first, so blood levels can differ. ∴ true.

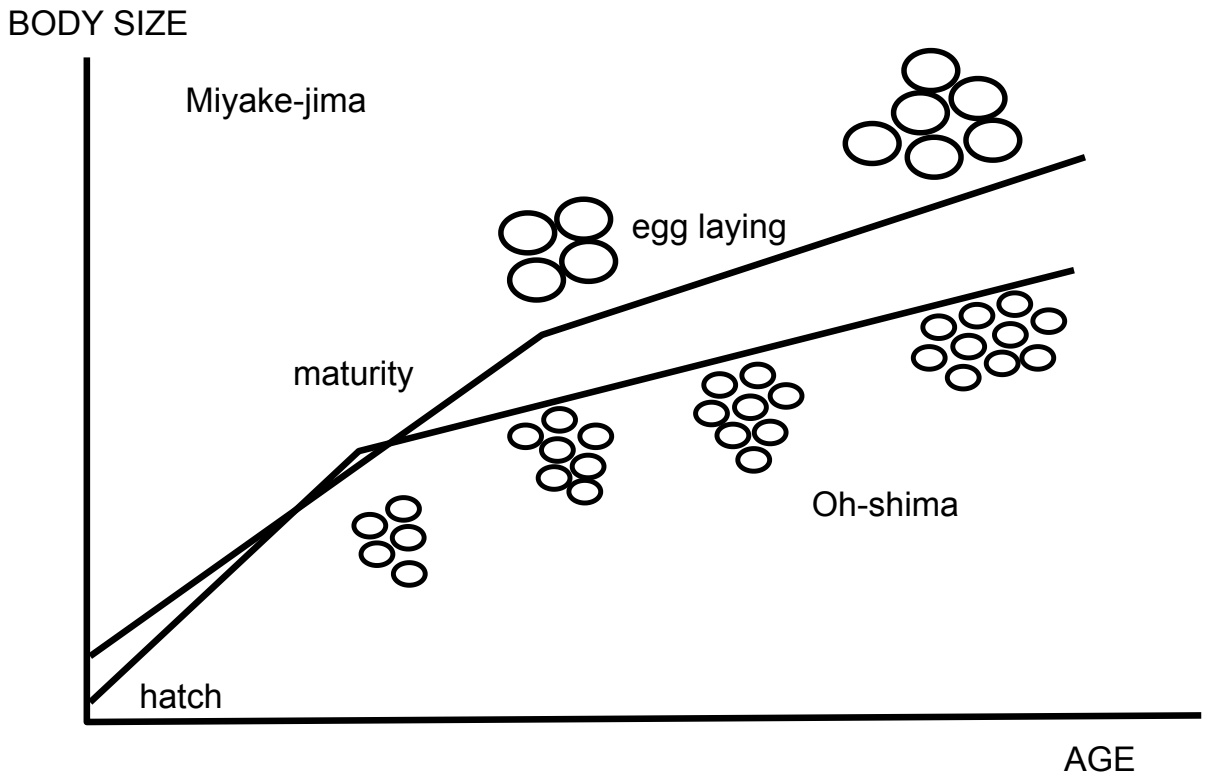
(B) The front-leg and tail routes drain differently, so the pharmacokinetics need not match. ∴ false.

(C) Tail blood can go to the kidneys first, so the liver is not always the first site. ∴ false.

(D) A front-leg dose avoids this direct first pass through the kidneys. ∴ true.

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

52. *Eumeces okadae* is an endemic skink of the Izu Islands in Japan. Growth and reproduction of female *Eumeces okadae* living on two islands is shown in the adjoining figure. The island of Oh-shima has richest predator fauna including weasels, snakes, and birds while Miyake-jima has only avian predators.



Choose the correct statement from the following;

(A) Divergence in the life history traits is influenced mainly by the age of maturity of the breeding individual.

(B) Populations in the island of Miyake-jima show a life history with late maturity with low fecundity.

(C) Heavy predation leads to a life history with late maturity and high fecundity.

(D) The divergence in life history traits is influenced by the age specificity and intensity of predation regime.

Solution · Q52 **Answer: (B), (D)**

From the figure, Miyake-jima females mature later, at a larger size, and lay fewer, larger eggs.

Oh-shima females, facing more kinds of predators, mature earlier and lay many small eggs.

Which ages predators attack, and how heavily, decides the best age of maturity and egg output.

∴ (B) and (D) are true.

(A) Age at maturity is one of the traits that diverged, not the main cause.

(C) Heavy predation goes with early maturity here.

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

53. Evolution of marine fishes shows that fish species have abandoned glomeruli to produce urine by tubular mechanisms. Aglomerular kidney lacks not only glomeruli but also the distal tubules. If aglomerular marine toadfish (*Opsanus tau*) is shifted to 10% sea water, it can survive upto several months. Which of the following event(s) could be taking place in the fish during acclimatisation to dilute sea water?

(A) Urine flow rate decreases.

(B) Kidney starts excreting solutes.

(C) The plasma osmotic pressure will increase.

(D) Significant branchial and intestinal solute uptake mechanisms set in.

Solution · Q53 **Answer: (B), (D)**

In 10% sea water, water tends to enter the fish and salts tend to leak out.

With no glomeruli or distal tubules, the kidney cannot make very dilute urine. It must put out solutes, such as Na^+, to remove water. ∴ (B) true.

The lost salt has to be regained through the gills and intestine. ∴ (D) true.

(A) The extra water must be removed, so urine flow does not fall. It rises.

(C) Plasma osmotic pressure falls.

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

54. Even in passive diffusion, energy is required for the solute to cross a bilayer membrane. This energy is related to the energy of hydration for the solute. Listed below are some solutes, in the context of which, choose the correct statement(s) from the following;

Solute
Glycol ($HO–CH_2–CH_2–OH$)
Glycerol ($HO–CH_2–CH(OH)–CH_2–OH$)
Erythritol ($HO–CH_2–CH(OH)–CH(OH)–CH_2–OH$)

(A) Glycol will diffuse fastest through a bilayer membrane amongst the three solutes listed

(B) Erythritol will diffuse fastest through a bilayer membrane amongst the three solutes listed

(C) The solute must first lose its waters of hydration, diffuse across the bilayer membrane, and then regain its waters on the opposite side.

(D) As the number of waters of hydration increases the activation energy for diffusion decreases.

Solution · Q54 **Answer: (A), (C)**

Each added –OH group forms more hydrogen bonds with water, which must be broken before the solute enters the lipid layer.

Activation energy: glycol < glycerol < erythritol

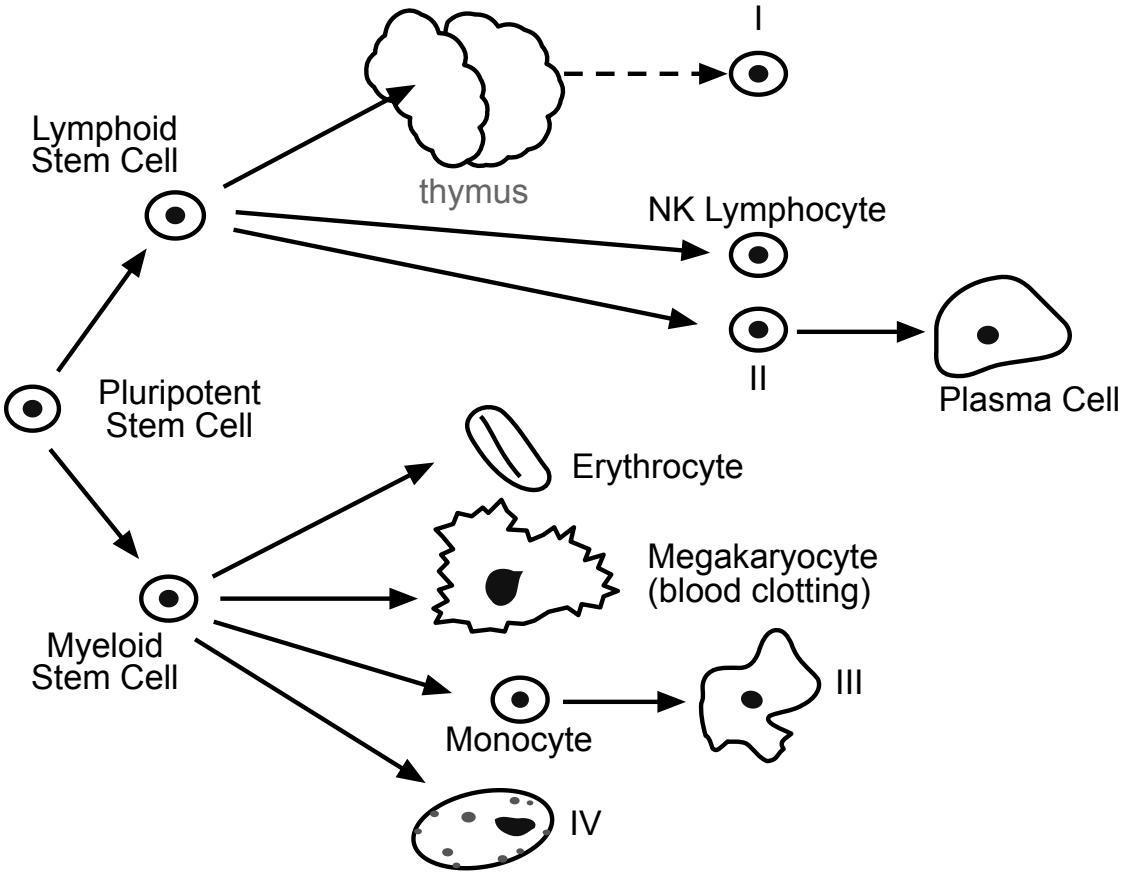
∴ Glycol diffuses fastest: (A) true, (B) false.

(C) The solute sheds its water, crosses the bilayer and is hydrated again on the other side. ∴ true.

(D) More hydration water raises the activation energy. ∴ false.

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

55. The lineage of cells of immune system are shown below in the figure. Identify the cells marked I, II, III and IV from the statements given.



(A) I is a T Lymphocyte while II is a B Lymphocyte.

(B) I is a B Lymphocyte while II is a T Lymphocyte.

(C) III is a granulocyte while IV is a macrophage.

(D) III is a macrophage while IV is a granulocyte.

Solution · Q55 **Answer: (A), (D)**

I matures in the thymus, so it is a T lymphocyte.

II gives rise to the plasma cell, so it is a B lymphocyte. ∴ (A) true.

III develops from a monocyte, so it is a macrophage.

IV arises from the myeloid stem cell and is drawn with granules, so it is a granulocyte. ∴ (D) true.

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

56. C4 photosynthesis is a complex physiological adaptation that confers greater productivity than the ancestral C3 photosynthetic type in environments where photorespiration is high. Identify correct statements related to the C4 physiology.

(A) In C4 plants there is a temporal separation of CO_2 fixation and synthesis of glucose.

(B) Leaf has functionally closely connected, discrete compartments, with a relatively large compartment to host the Calvin cycle.

(C) For adapting to arid areas, C4 plants have co-opted same areas of the leaf, for photosynthesis and for water storage cells.

(D) In most C4 plants, the feat of concentrating CO_2 is achieved by confining Rubisco to bundle-sheath cells.

Solution · Q56 **Answer: (B), (D)**

(A) C4 plants separate the two carboxylations in space; separation in time is seen in CAM plants. ∴ false.

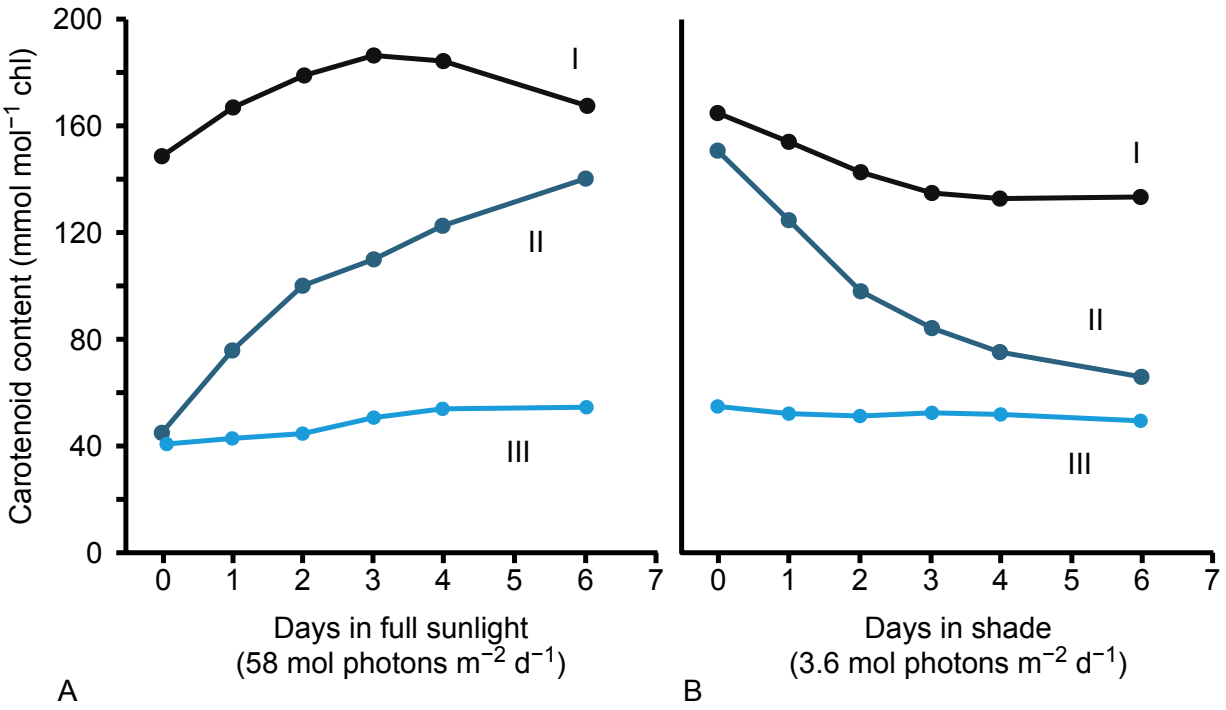
(B) Mesophyll and bundle-sheath cells work as linked compartments, and the large bundle-sheath cells run the Calvin cycle. ∴ true.

(C) In succulent C4 leaves, water-storage tissue is separate from the Kranz tissue that carries out C4 photosynthesis. ∴ false.

(D) Rubisco is confined to bundle-sheath cells, where CO_2 is concentrated. ∴ true.

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

57. A study of the changes in the content of carotenoid pigments of young leaves of cotton in strong and weak light was being carried out. Figure A shows the effects of transferring plants from shade into full sunlight while figure B shows the effects of transfer from sunlight into dark.



Based on the observations, which of the following statements are true ?

(A) II could be violaxanthin, which protects thylakoid membrane lipids from photo-oxidation.

(B) I could be xanthophylls, which contribute to increasing the light-harvesting capacity of the photosystems.

(C) I could be a photoprotector pigment like lutein.

(D) III could be a pigment, which is essential for light-gathering in low light intensities.

Solution · Q57 **As per Zigyan: (A), (C)**

Graph B shows a shift into shade (weak light), as its axis label states.

II rises about three times in strong light and falls sharply in shade. It fits the violaxanthin-cycle pigments, which protect thylakoid lipids. ∴ (A) true.

I is the most abundant, is higher in strong light and drops in shade. It can be a photoprotector such as lutein. ∴ (C) true.

A pigment meant to gather more light should increase in shade. I falls and III stays almost constant. ∴ (B) and (D) are not supported.

Reference: NCERT Biology Class XI, Chapter 11 'Photosynthesis in Higher Plants', section 11.4: accessory pigments, including xanthophylls and carotenoids, pass light energy to chlorophyll a and also protect it from photo-oxidation.

Check: the axis under graph B reads days in shade with 3.6 mol photons per square metre per day, so the plotted values are for weak light.

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

58. Animal species use various channels to communicate with each other. The selection of a communication channel depends on the ecology of the species and what kind of message the animal wishes to convey to its receivers. A few features of four such modes of communication (numbered 1 to 4) are tabulated below.

	Information available		**Cost to sender**	
Modes	**Fadeout time**	**Locatability of sender**	**Broadcast expense**	**Risk of being caught**
1	Fast	Fairly easy	High	Medium
2	Fast	Easy	Low	Low
3	Slow	Difficult	Low	Low
4	Fast	Easy	Low-Moderate	High

Choose the appropriate statements:

(A) 1 is Tactile signals while 2 is Auditory signal

(B) 1 is Auditory signals while 2 is Tactile signal

(C) 3 is Chemical signal and 4 is Visual signals.

(D) 3 is visual signals and 4 Chemical signals.

Solution · Q58 **Answer: (B), (C)**

Mode 1 fades fast, is fairly easy to locate and is costly to broadcast: auditory.

Mode 2 fades fast and costs and risks little: tactile.

Mode 3 lingers and its sender is hard to locate: chemical.

Mode 4 fades fast, reveals the sender easily and carries a high risk of being caught: visual.

∴ (B) and (C) are true.

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

59. Km values of enzymes provide information about their applications. In this context identify the correct statements from the following;

(A) A high Km value indicates the need for high substrate concentrations in order to achieve maximum reaction velocity.

(B) A low Km value indicates the need for high substrate concentrations in order to achieve maximum reaction velocity.

(C) If two enzymes, with similar Vmax in different metabolic pathways compete for the same substrate, then pathway involving enzyme that has the lower Km value is likely to be the 'preferred pathway'.

(D) If two enzymes, with similar Vmax in different metabolic pathways compete for the same substrate, then pathway that has enzyme with the higher Km value is likely to be the 'preferred pathway'.

Solution · Q59 **Answer: (A), (C)**

By the Michaelis–Menten equation,

$$v = \frac{V_{max}[S]}{K_m + [S]}$$

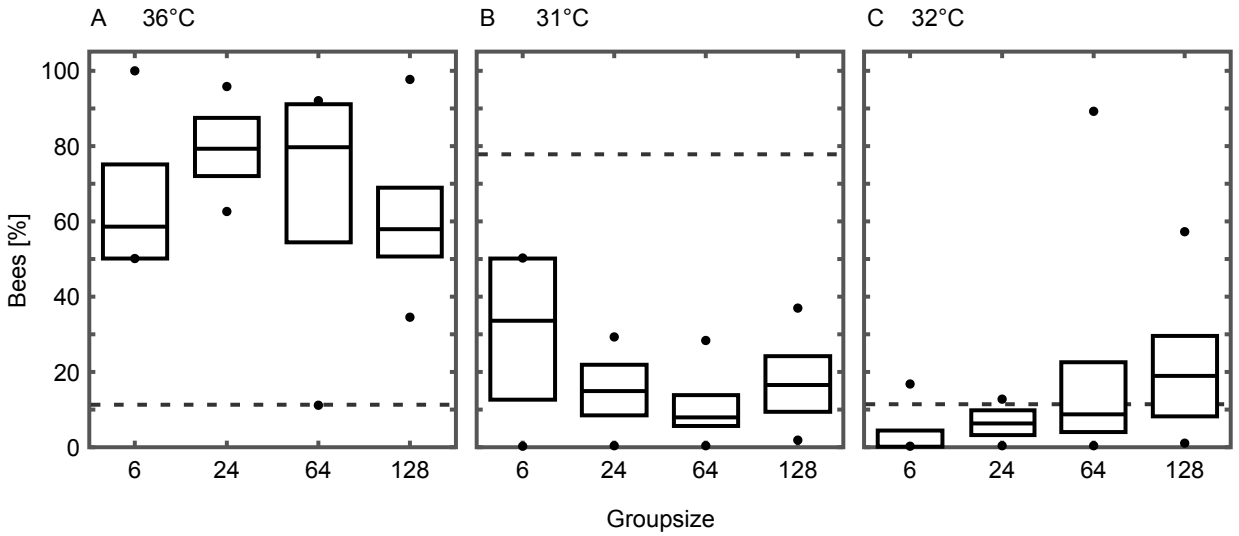
A higher K_m needs a higher substrate concentration to come close to V_{max}. ∴ (A) true, (B) false.

With similar V_{max}, the lower-K_m enzyme works faster when substrate is limited, so its pathway takes more of it.

∴ (C) true, (D) false.

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

60. Honey bee (*Apis mellifera*) is able to produce heat endothermically and is one of the main reasons for the wide distribution of this species as it allows the whole colony to survive cold winters. Young bees, however, are ectothermic and tend to position themselves, within the hive, in areas with the appropriate environmental conditions. In an experimental arena, different group sizes of young bees were introduced separately, where they were exposed to three different temperature zones. The bees were allowed to freely position themselves within these temperature zones and their positions were recorded after 30 minutes. The results are depicted below:



Which of the following statements are correct ?

(A) The median percentage of bees at 31°C and 32°C temperature areas decreased with increasing group size.

(B) Irrespective of the group size, 36°C is most likely to be the optimum temperature for the bees.

(C) There is no significant difference in the preference for cooler temperature areas (31°C and 32°C), in all group sizes of bees.

(D) In larger groups a percentage of bees may switch to cooler temperature areas (31°C and 32°C) due to crowding effects.

Solution · Q60 **Answer: (B), (D)**

At every group size the 36°C area has the highest median share, roughly 58% to 80%. ∴ (B) true.

(A) The 32°C median rises with group size, and the 31°C median rises again at 128. ∴ false.

(C) With 6 bees, the medians are about 33% at 31°C and nearly zero at 32°C. ∴ false.

(D) From 64 to 128 bees, the median falls at 36°C and rises at both cooler areas, as crowding would cause. ∴ true.

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

ANSWER KEY

NSEB 2022 · PAPER CODE 21

60
QUESTIONS · 216 MARKS

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

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

★ Answers as per Zigyan

- **Q1** — As per Zigyan: (D); IAPT key (D).
- **Q2** — As per Zigyan: no option is correct; dropped by IAPT.
- **Q11** — As per Zigyan: (C); IAPT key (C).
- **Q13** — As per Zigyan: (A); IAPT key (A) or (D).
- **Q27** — As per Zigyan: (D); IAPT key (C).
- **Q40** — As per Zigyan: (C); IAPT key (B).
- **Q45** — As per Zigyan: (B); IAPT key (A).
- **Q50** — As per Zigyan: (B), (C), (D); IAPT key (A), (C).
- **Q57** — As per Zigyan: (A), (C); IAPT key (A), (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

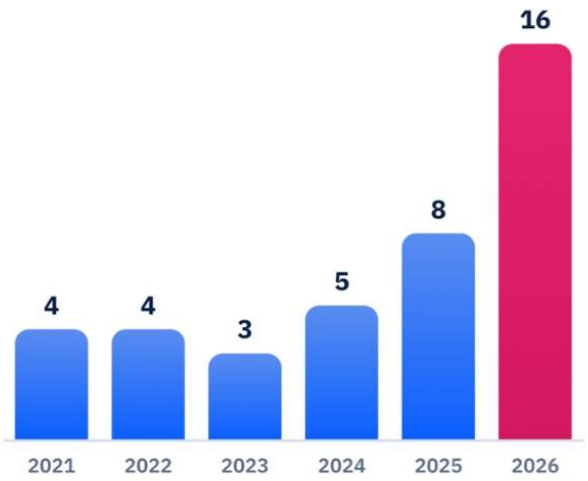
40
JEE Advanced selections in 6 years

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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