

**ASSOCIATION OF TEACHERS IN BIOLOGICAL SCIENCES**  
**National Standard Examination in Biology – 2023**  
**Date of Examination: November 26, 2023**

**Time: 2:30 PM to 4:30 PM**

**Question Paper Code: 24**

Student's									
Roll No:									

**Write the Question Paper code (mentioned above) on YOUR OMR Answer Sheet (in the space provided), otherwise your Answer Sheet will NOT be evaluated. Note that the same Question Paper Code appears on each page of the Question Paper.**

**Instructions to Candidates:**

1. Use of mobile phone, smart watch, and iPad during examination is STRICTLY PROHIBITED.
2. In addition to this Question Paper, you are given OMR Answer Sheet along with candidate's copy.
3. On the OMR sheet, make all the entries carefully in the space provided **ONLY** in **BLOCK CAPITALS** as well as by properly darkening the appropriate bubbles.  
**Incomplete/ incorrect/ carelessly filled information may disqualify your candidature.**
4. On the OMR Answer Sheet, use only **BLUE or BLACK BALL POINT PEN** for making entries and filling the bubbles.
5. Your **Ten-digit roll number and date of birth** entered on the OMR Answer Sheet shall remain your login credentials means login id and password respectively for accessing your performance / result in National Standard Examination in Biology - 2023.
6. Question Paper has two parts. In part A1 (Q. No.1 to 48) each question has four alternatives, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as shown.

**Q.No.12**       a             c       d

In part A2 (Q. No. 49 to 60) each question has four alternatives out of which any number of alternative (s) (1, 2, 3, or 4) may be correct. You have to choose **all** correct alternative(s) and fill the appropriate bubble(s), as shown

**Q.No.52**       a             c     

7. For **Part A1**, each correct answer carries 3 marks whereas 1 mark will be deducted for each wrong answer. In **Part A2**, you get 6 marks if all the correct alternatives are marked and no incorrect. No negative marks in this part.
8. Rough work may be done in the space provided. There are **18** printed pages in this paper
9. Use of **Non-programmable scientific** calculator is allowed.
10. No candidate should leave the examination hall before the completion of the examination.
11. After submitting Answer Paper, take away the Question Paper & Candidate's copy of OMR sheet for your future reference.

**Please DO NOT make any mark other than filling the appropriate bubbles properly in the space provided on the OMR Answer Sheet.**

**OMR Answer Sheets are evaluated using machine, hence CHANGE OF ENTRY IS NOT ALLOWED. Scratching or overwriting may result in a wrong score.**

**DO NOT WRITE ON THE BACK SIDE OF THE OMR ANSWER SHEET.**

**Instructions to Candidates (Continued) :**

*You may read the following instructions after submitting the Answer Sheet.*

12. **Comments/Inquiries/Grievances regarding this Question Paper, if any, can be shared on the Inquiry/Grievance column on [www.iapt.org.in](http://www.iapt.org.in) on the specified format till Dec 3, 2023.**
13. **The Answers/Solutions to this Question Paper will be available on the website: [www.iapt.org.in](http://www.iapt.org.in) by Dec 2, 2023.** The score card may be downloaded after Dec 24, 2023.
14. **CERTIFICATES and AWARDS:**  
Following certificates are awarded by IAPT/ATBS to students, successful in the National Standard Examination in Biology – 2023
  - (i) “CENTRE TOP 10 %” To be downloaded from [iapt.org.in](http://iapt.org.in) after 30.01.23
  - (ii) “STATE TOP 1 %” Will be dispatched to the examinee (iii) “NATIONAL TOP 1 %” Will be dispatched to the examinee
  - (iv) “GOLD MEDAL & MERIT CERTIFICATE” to all students who attend OCSC – 2024 at HBCSE MumbaiCertificate for centre toppers shall be uploaded on [iapt.org.in](http://iapt.org.in)
15. List of students (with centre number and roll number only) having score above **Minimum Admissible Score (MAS)** will be displayed on the website: [www.iapt.org.in](http://www.iapt.org.in) by **Dec 25, 2023**. See **the MAS clause** on the student’s brochure on the web.
16. List of students eligible to appear for Indian National Biology Olympiad (INBO – 2024) shall be displayed on [www.iapt.org.in](http://www.iapt.org.in) by Dec 30, 2023.

**ASSOCIATION OF TEACHERS IN BIOLOGICAL SCIENCES  
NATIONAL STANDARD EXAMINATION IN BIOLOGY (NSEB - 2023)**

**Time: 120 minute**

**Max. Marks: 216**

*Attempt All Sixty Questions*

**A – 1**

**ONLY ONE OUT OF FOUR OPTIONS IS CORRECT. BUBBLE THE CORRECT OPTION.**

1. 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:

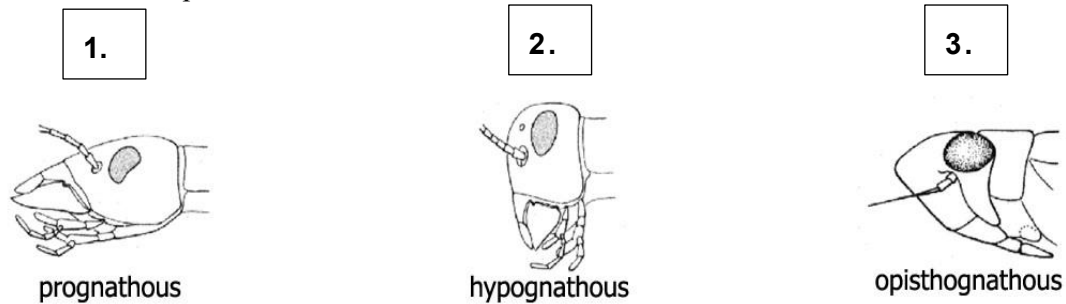
- (a) Carnivore; insectivore; non-ruminant herbivore; ruminant herbivore  
**(b) Carnivore; non-ruminant herbivore; insectivore; ruminant herbivore**  
(c) Non-ruminant herbivore; carnivore; insectivore; ruminant herbivore  
(d) Insectivore; nonruminant herbivore; ruminant herbivore; carnivore
2. The 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
3. 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)  $\text{Na}^+$  and  $\text{Cl}^-$  ions interact with glucose molecules and break the hydration shell around them, making it easier for transport across membrane.  
(d)  $\text{Na}^+$  increases membrane potential thereby increasing the rate of transport.
4. 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.

5. 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.

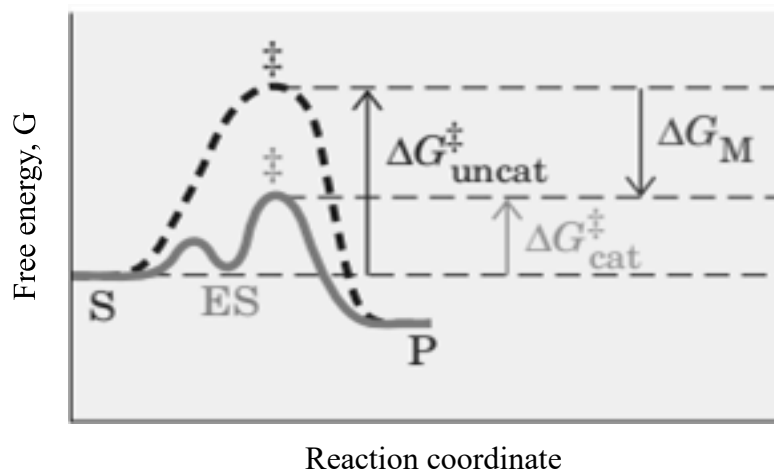
6. Three types of mouth parts in insects which are categorised based on the position of head with respect to the long axis of the body and the direction of the mouth parts. These are depicted below, marked as 1, 2 and 3. Match the three insects; X – Grasshopper; Y – Earwig; Z – Cicada with the correct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



- (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

Expl: Cicada is a bug with its labium folded backwards, while Earwig is an omnivore with forward facing mouthparts.

7. 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?

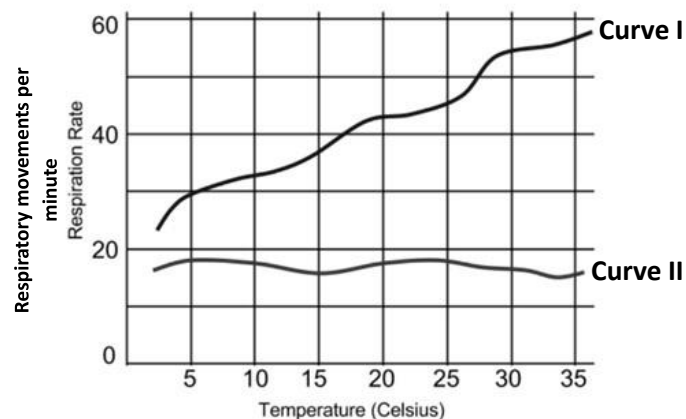


- (a) Enzyme lowers the activation energy essential for the substrate to move to transition state
- (b) Enzyme catalyzed reaction is a two-step reaction
- (c) Enzyme provides energy to the substrate
- (d) Enzyme helps the substrate to overcome the transition state faster to move to product state

8. 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
9. 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

Expl: Here the response of parents is triggered by the red coloured gape and the yellow sides of the beak. This behaviour is similar to that of the Stickleback.

10. 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**

- (a) **Mackerel Fish**
- (b) Grizzly Bear
- (c) Penguin
- (d) Sea cow

**Curve II**

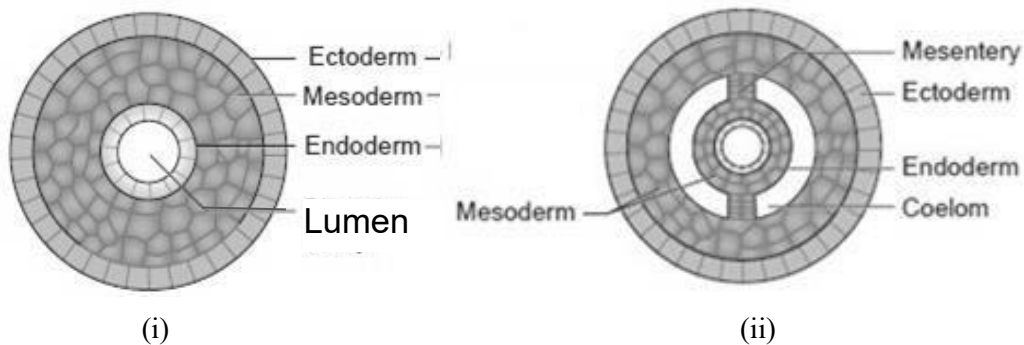
- (a) **Kangaroo**
- (b) Salmon fish
- (c) Emu
- (d) Komodo dragon

11. 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**

12. 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
13. Smooth endoplasmic reticulum is **NOT** prevalent in which of the following?  
(a) Ovary (b) Testis (c) Adipose tissue (d) **Pancreas**
14. 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
15. In the skeletal muscle cells, the calcium pump in the sarcoplasmic reticulum functions to : (a) Maintain  $\text{Ca}^{2+}$  ions balance in the cytosol.  
(b) Release  $\text{Ca}^{2+}$  ions in the cytosol and bringing about contraction of muscles.  
(c) **Collect  $\text{Ca}^{2+}$  ions back into sarcoplasmic reticulum and induce contraction of muscles.**  
(d) Induction of apoptosis in muscle cells.

Expl:  $\text{Ca}^{2+}$  binds with the protein participating in muscle contraction to induce muscle contraction and is then reabsorbed into the sarcoplasmic reticulum via  $\text{Ca}^{2+}$  ATPase. In addition, muscle relaxation is possible when  $\text{Ca}^{2+}$  is reabsorbed by the sarcoplasmic reticulum and during this process  $\text{Ca}^{2+}$ -ATPase (the  $\text{Ca}^{2+}$  pump) plays a key role. This process of  $\text{Ca}^{2+}$  uptake by the sarcoplasmic reticulum via  $\text{Ca}^{2+}$ -ATPase reduces intramuscular  $\text{Ca}^{2+}$  concentrations and results in muscle relaxation.

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



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

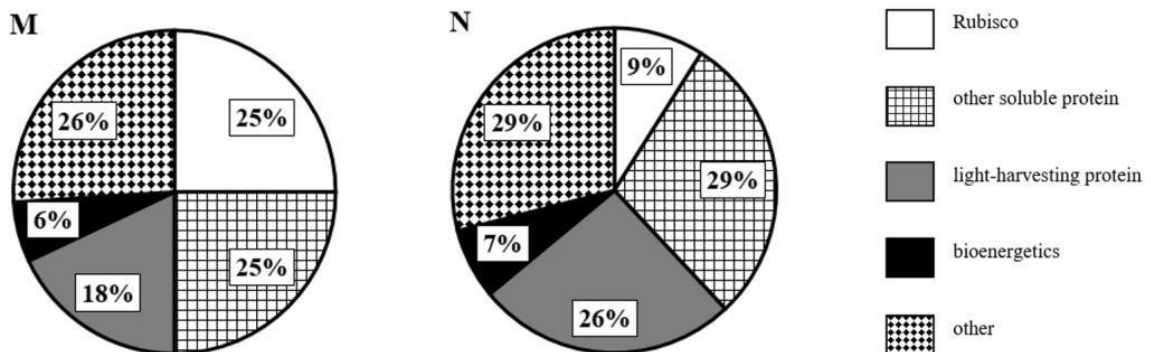
(d) (i) Planaria (ii) cockroach

18. 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
19. A 65-year-old male admitted to the hospital showed symptoms like severe inflammatory response, kidney dysfunction, low levels of  $\text{Na}^+$  and high levels of  $\text{K}^+$  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
20. 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
- Expl: In high  $\text{CO}_2$  environment when Rubisco functions near  $\text{CO}_2$  saturation, C4 species need one-third to one-quarter as much Rubisco as C3 species. Therefore, Rubisco content of C4 plants is much lower as compared to C3 species of similar life form.
21. 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.

22. 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.

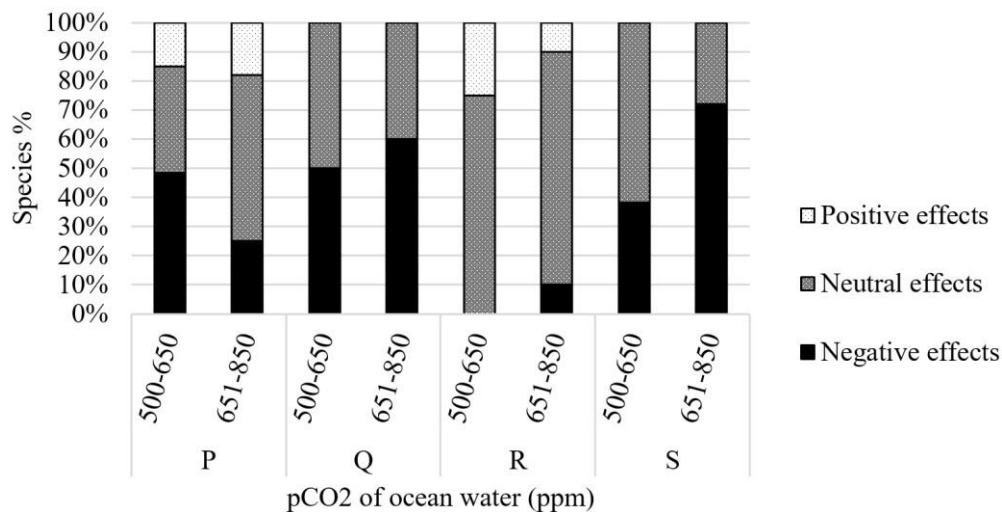
This is an example of which type of speciation?

- (a) Peripatric (b) Allopatric (c) Sympatric (d) **Parapatric**

Expl: In this example, the main population is still continuously distributed but the two population have different niches. The new species formation is by genetic isolation.

23. 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)  $100^{40}$

24. 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

Expl: Calcium deposition is maximally effected with acidification and crustaceans are known to develop thicker exoskeletons in acidified conditions.

25. Different sites in the human body are listed with their partial pressure values of O<sub>2</sub> (pO<sub>2</sub>) and CO<sub>2</sub> (pCO<sub>2</sub>) in the following table. Identify the body sites represented by X, Y and Z.

Human Body Site	pO <sub>2</sub>	pCO <sub>2</sub>
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

Expln: The Partial of oxygen in oxygenated pulmonary vein is very high.

26. 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

Expln: Recombination frequency between A-B is the least and B-D is maximum. So both “b” and “c” options are correct.

27. During complete oxidation of substrate X to  $\text{CO}_2$  and  $\text{H}_2\text{O}$ , a total of 110  $\text{H}^+$  ions were transported out across the inner mitochondrial membrane. If 4  $\text{H}^+$  ions are sent back to generate one ATP, calculate the number of ATPs generated and NADH oxidized (Assume that  $\text{FADH}_2$  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

28. 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)  $y, x, z$

29. 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

30. 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.

31. 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
32. 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' creates 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
33. 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
34. The distribution of some mushroom communities in two habitats I and II are shown in the given figures.



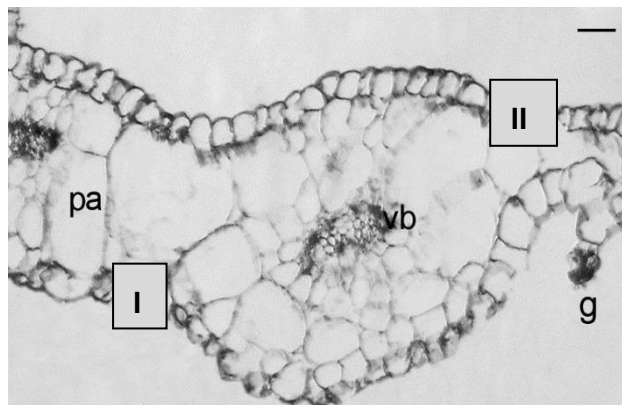
Which of the following statements regarding these habitats is correct?

- (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.
35. 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

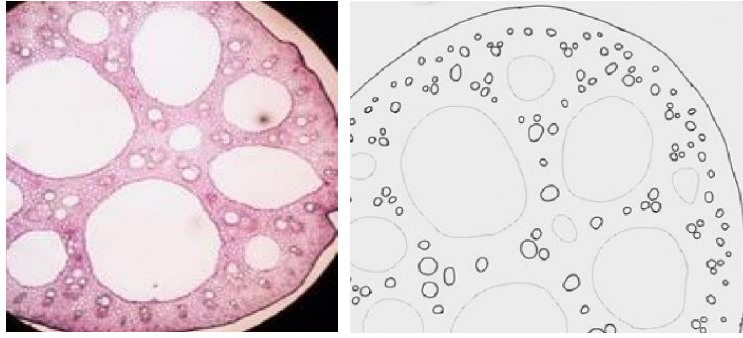
36. Cells of the lower layers of human skin divide and replace dead cells. Why it is not correct to say that they are similar to plant meristem? Choose the correct reason from the following options.
- (a) They are devoid of any cell wall.  
 (b) They are not isodiametric in shape.  
 (c) **They can replace original cells only and not any other cell types.**  
 (d) They divide by astral mitosis and show the presence of centriole.
37. 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.
38. 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
39. 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
40. 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.

41. It is observed that plant 'M' requires 3000 ATPs and 1200 NADPH<sub>2</sub> for synthesis of starch; while the plant 'N' requires 1800 ATPs and 1200 NADPH<sub>2</sub> 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.

42. 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.

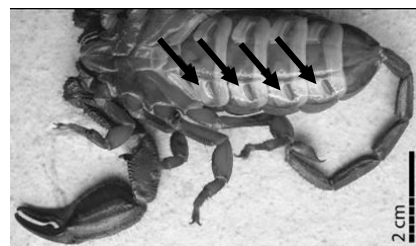
Expln: Acetic acid is converted to acetyl-CoA by acetyl-CoA synthetase to put acetate into the TCA cycle. Membrane-bound enzymes, alcohol dehydrogenase (ADH) and acetaldehyde dehydrogenase (ALDH) oxidize ethanol to acetic acid during respiration.

43. 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.

44. 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



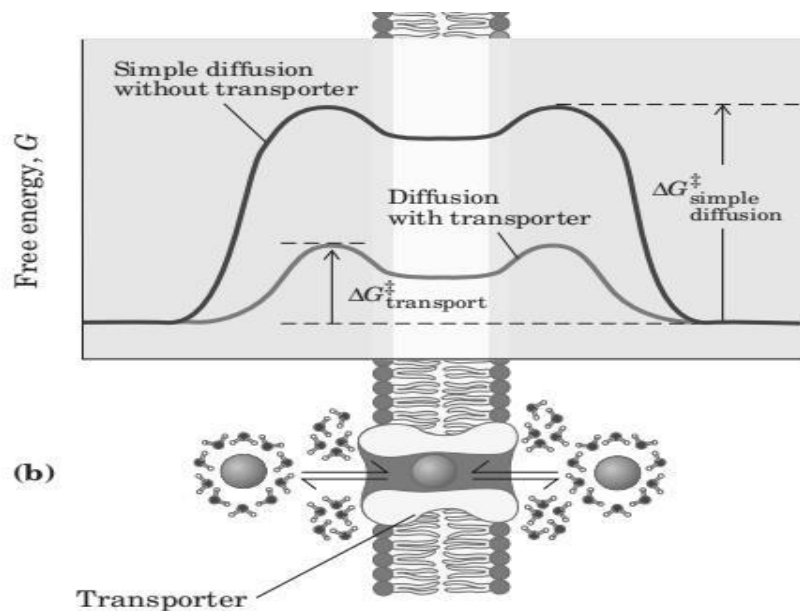
45. An individual taking a leisurely walk in the forest trips over a rattlesnake leading to instant changes in the physiology. A few possible changes are listed below:
- Epinephrine binds to receptors in liver and on fat cells.
  - The nervous system stimulates endocrine cells in the adrenal gland.
  - Binding of epinephrine leads to decreased beating of heart.
  - Glycogen formation increases.
  - Blood vessels in the digestive tract constrict.
  - Pumping of blood increases.

The changes that would occur in the given situation are:

- (i), (ii), (iv) and (vi)
  - (ii), (iv) and (vi)
  - (i), (ii), (v) and (vi)
  - (i), (iii) and (iv)
46. 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?
- 50%
  - 6 log
  - 5 log
  - 2 log

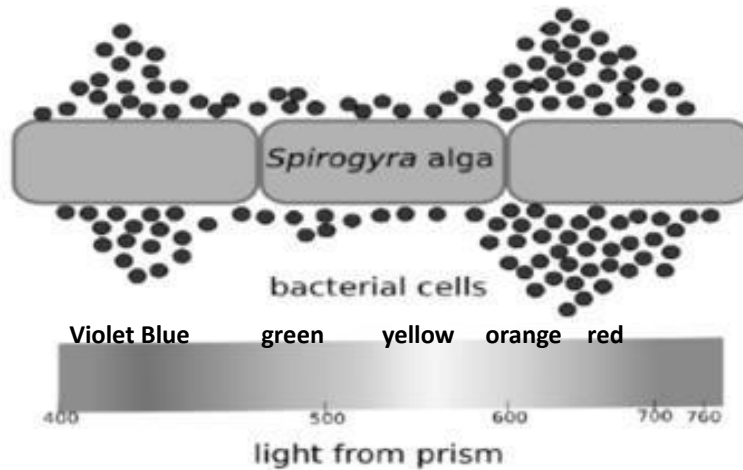
Expln: One log is 1:10 dilution.

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?



- Transporter protein irreversibly converts the substrate to a transportable form.
  - Transporter protein increases the free energy ( $G$ ) for transmembrane diffusion of the solute
  - Transporter protein provides a hydrophobic passageway for the movement of molecules.
  - Transporter protein removes the hydration shell and prepares the molecule to move across the membrane.
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:

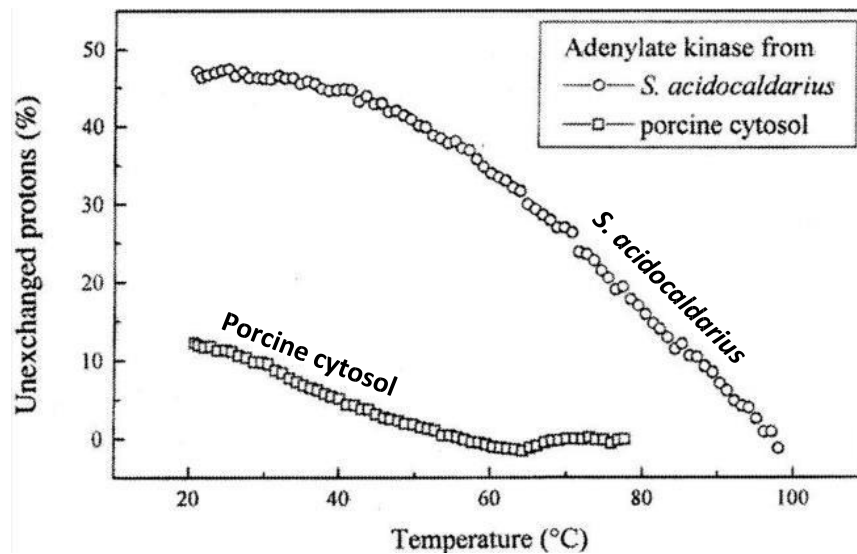
- (a) Green light leads to increased oxygen production.
- (b) Green light is absorbed maximum by *Spirogyra sps.*
- (c) Red light results in maximum oxygen production.
- (d) Bacterial cells absorb red light.

A – 2

ANY NUMBER OF OPTIONS (4, 3, 2 or 1) MAY BE CORRECT

MARKS WILL BE AWARDED ONLY IF ALL THE CORRECT OPTIONS ARE BUBBLED AND NO INCORRECT.

49. 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.

50. 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.

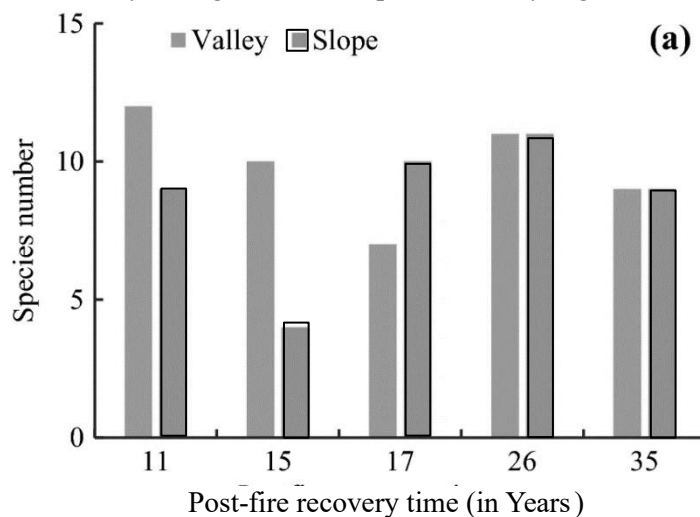
Expln: Peroxisomes can appear de-novo from ER.

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

- (a) PEP carboxylase that has a higher affinity for CO<sub>2</sub> and no affinity for O<sub>2</sub>.
- (b) The entire dark reaction being carried inside a single cell type.
- (c) CO<sub>2</sub> being concentrated in bundle sheath cells at the expense of ATP.
- (d) Fixing of CO<sub>2</sub> even under low CO<sub>2</sub> concentration.

Expln: In addition to property of PEP and higher efficiency of CO<sub>2</sub> fixation, in C4 plants the mesophyll does the initial CO<sub>2</sub> fixation using PEP carboxylase using C3 organic acid and CO<sub>2</sub> as substrates to make a C4 acid. This C4 acid is transported into the Bundle sheath cells to release CO<sub>2</sub> for final fixation via the Calvin Cycle.

52. 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?

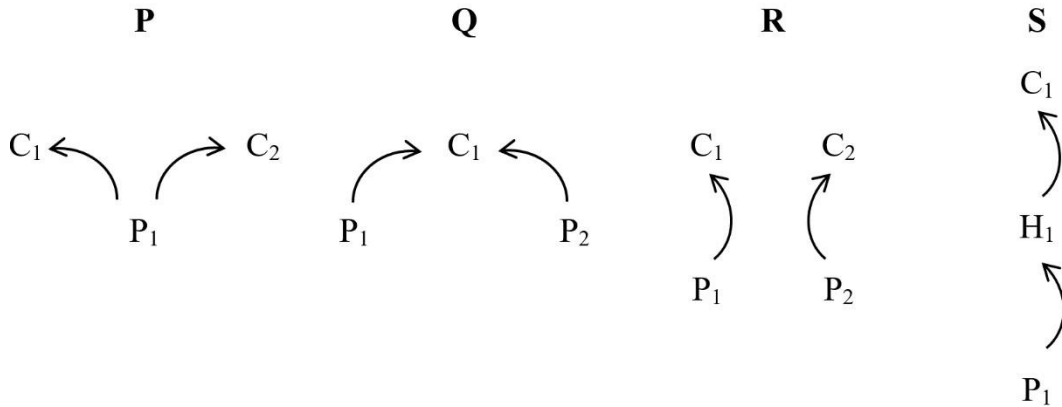
- (a) The recovery along the slopes is faster during the middle stage of succession after fire as compared to valley.
- (b) The recovery along the slopes is slower during the middle stages of succession after fire as compared to valley.
- (c) The succession sets in faster along the valley than the slope after fire.



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

53. 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.

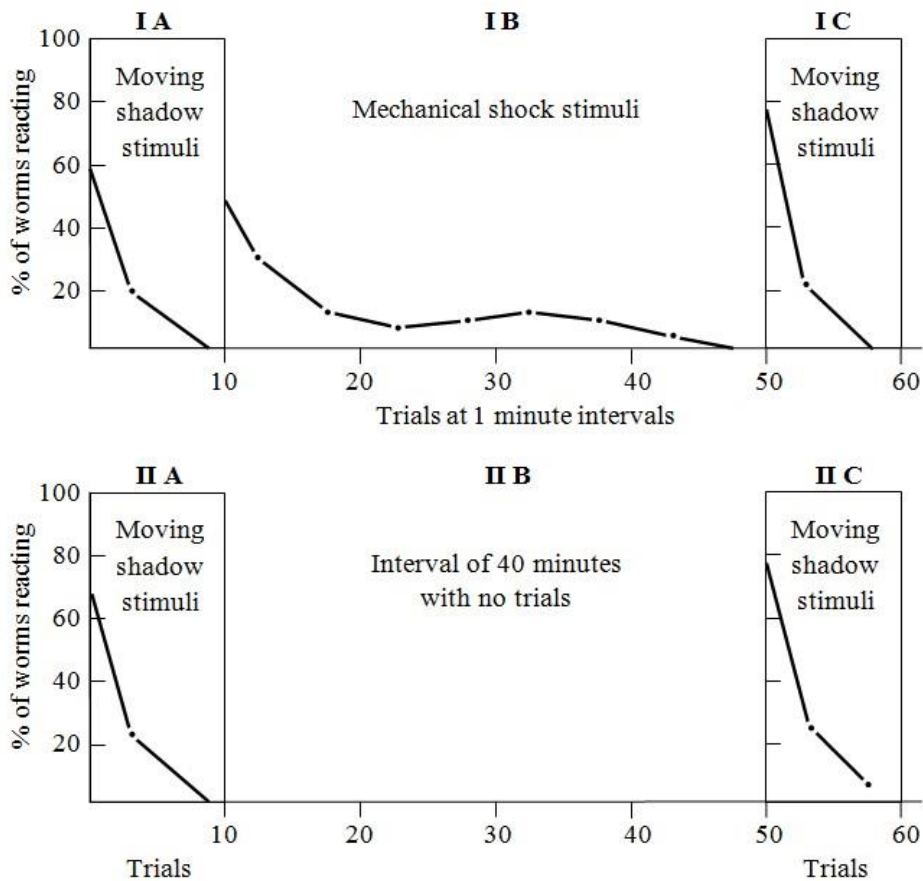
Expln: In S,  $P_1$  is indirectly benefited by predation on herbivore and in Q,  $P_1$  and  $P_2$  are in apparent competition for  $C_1$ .

54. 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).

Expln: Signal Amino acid signals are specifically targeted to ER or Mitochondria.

55. 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.



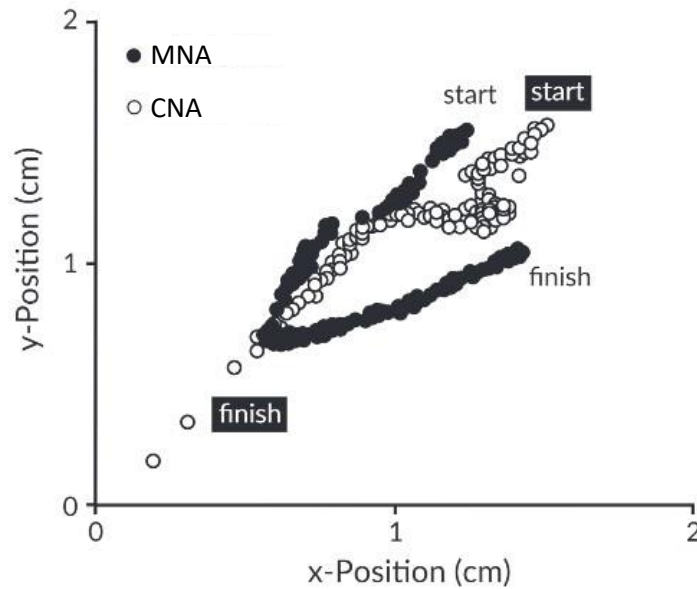
Which of the following statements is/are true with reference to the results obtained?

- (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.

Expln: The trial results II B shoes that the response to two stimuli are independent.

56. 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 neuroblasts 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.

Expln: MNA larvae avoid suction force as indicated by the black dot traces showing the turning away of the larvae. As is known from other sensory organs, increased number of neurons improves the sensory response. Therefore both the location and number can be deduced.

57. 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  $\alpha$ -helices.
- (d) It forms peptide bond as an amide and its nitrogen is not bound to any hydrogen.

Expln: Though proline is hydrophobic, its absence in membrane protein is due to factors mentioned in b, c and 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.

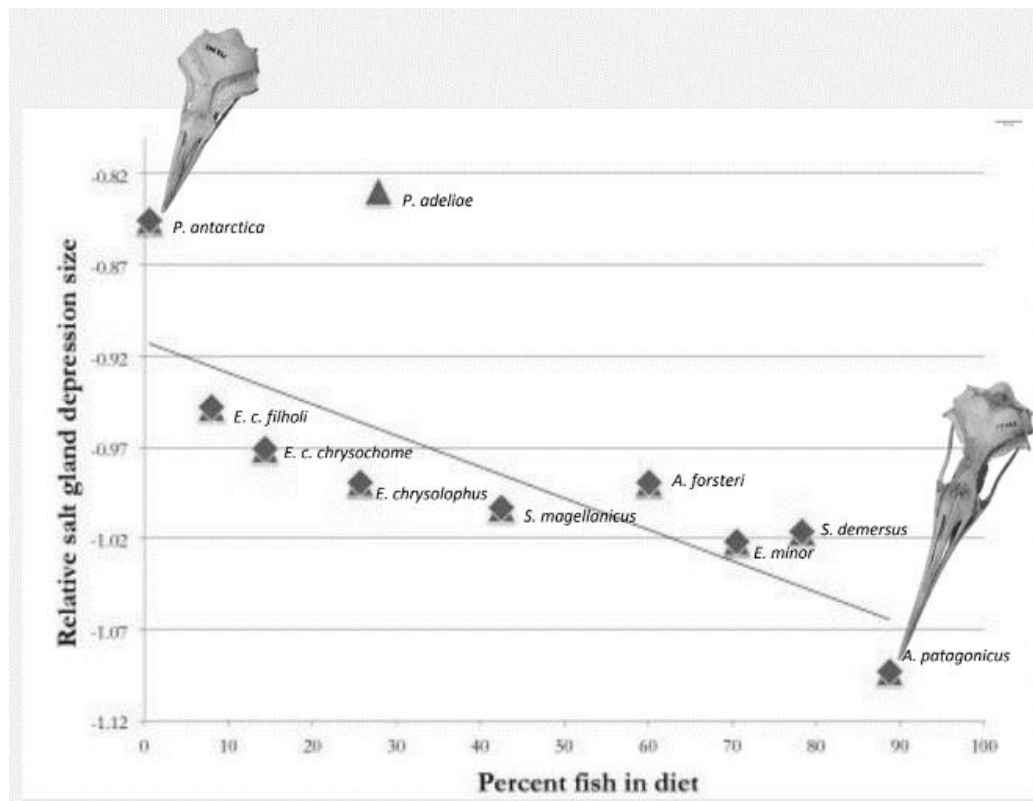
59. In Batesian kind of mimicry a harmless animal (mimic) mimics a distasteful or poisonous animal (model) while in Mullerian type of mimicry, two related or unrelated distasteful or poisonous animals

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.

Expln: Mullerian mimicry in addition to providing obvious benefit to the prey, benefits the predator by reducing the cost of associate leanings (only one encounter is sufficient for avoidance).

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 log<sub>10</sub> 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) 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 hyposmotic 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.

Expln: The option b is clearly reflected in the graph with higher fish intake in penguins with smaller salt gland depressions. Adélie penguin is an obvious outlier as shown by the graph and Krill is an abundant crustacean food source to shift as an alternate food resource during evolution.

## **Rough Work**