

Date: 26/11/2023



Question Paper Code

24

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Answers & Solutions

Time : 120 Minutes

for

Max. Marks : 216

National Standard Examination in Biology (NSEB) 2023

INSTRUCTIONS TO CANDIDATES

- (1) There are 60 questions in this paper.
- (2) 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. 22 a b 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 b c d

- (3) 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. No negative marks in this part.

A - 1 (Attempt All Sixty Questions)**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; non-ruminant herbivore; ruminant herbivore; carnivore

Answer (b)

Sol. The correct answer is option (b) as

- Carnivores possess short intestine and colon as well as small caecum.
- Simple stomach and large caecum is present in non-ruminant herbivores.
- Short intestine and absence of caecum is the feature of insectivores.
- Four-chambered stomach with large rumen, long small and large intestine is the feature of ruminant herbivores.

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

Answer (b)

Sol. Most of the water flow in roots occur via the apoplast-since the cortical cells are loosely packed and hence offer no resistance to water movement. However, the inner boundary of the cortex, the endodermis is impervious to water because of a band of suberised matrix called the casparian strips.

Therefore, the suberin in the wall of the endodermal cells of the root selectively allow absorbed mineral to pass through plasmodesmata, then enter the xylem vessels.

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

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

Answer (a)

Sol. The correct answer is option (a) because glucose absorption takes place *via* simple diffusion, facilitated diffusion and by secondary active transport along with Na^+ ions with the help of a symporter protein.

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

Answer (b)

Sol. The correct answer is option (b) as extracellular digestion takes place in animals *i.e.*, from platyhelminths to chordates while intracellular digestion takes place in protozoans as well as in poriferans.

Both intracellular and extracellular digestion takes place in coelenterates and ctenophores.

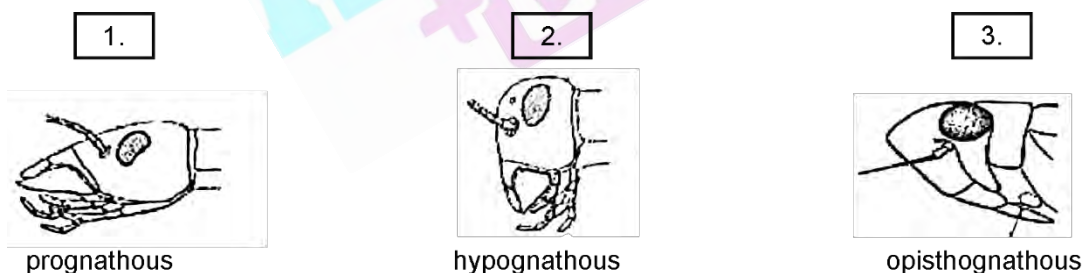
5. Amytal is an inhibitor of Complex I involved in Electron Transport Chain (ETC). A cell free system was used to study the effect of amytal on electron transport chain. What effect do you expect on the Electron Transport Chain (ETC) system?
- (a) Flow of electron will completely stop.
(b) There will 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.

Answer (b)

Sol. Amytal is a barbiturate. It inhibits the transport of electron through the NADH-CoQ reductase complex. Amytal will block the NADH oxidation but not FADH₂ oxidation. ETC consist of four complexes, out of which only complex I is inhibited, therefore, there will be less flow of electrons through the ETC.

There will be no complete stoppage of flow of electrons as FADH₂ oxidation is active in the ETC. Hence, flow of electrons will not remain in normal condition as the amytal inhibits the complex I.

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.



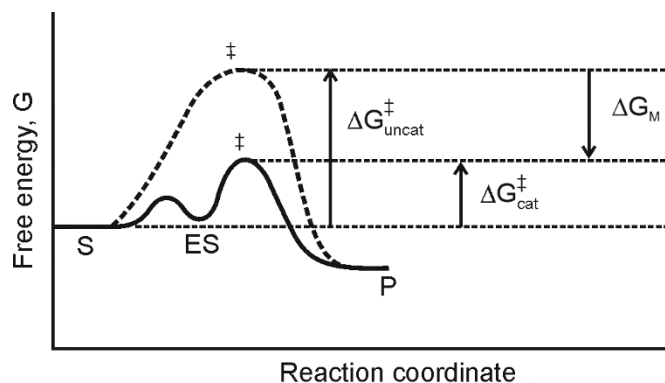
- (a) X = 1, Y = 2, Z = 3 (b) X = 2, Y = 3, Z = 1
(c) X = 2, Y = 1, Z = 3 (d) X = 1, Y = 3, Z = 2

Answer (c)

Sol. The correct answer is option (c) as grasshoppers possess hypognathous mouth part in which mouthparts are pointing downward.

- Earwigs possess prognathous mouth part in which mouthparts are pointing forward.
- Cicada possess opisthognathous mouthpart in which mouthparts are pointing backward.

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?



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

Answer (a)

Sol. The correct answer is option (a) as enzymes lowers activation energy and do not change the difference in energy levels between reactants and products.

- Option (b) is incorrect as enzyme catalysed reaction is a four-step reaction.
- Option (c) is incorrect as enzyme does not provide energy to substrate.
- Option (d) is incorrect as enzyme help the substrate to overcome the transition state faster to form enzyme substrate complex which further forms products and enzyme becomes free for the next substrate.

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

- Conditioning
- Habituation
- Associative learning
- Kinesis

Answer (b)

Sol. The correct answer is option (b) as habituation is a simple form of learning in which an animal stops responding to a stimulus, or cue, after a period of repeated exposure.

- Option (a) is incorrect as the case explained in the question is not associated with conditioning.
- Option (c) is incorrect as the case explained in the question is a form of non-associative learning *i.e.*, the stimulus is not linked with any punishment or reward.
- Option (d) is incorrect as kinesis only deals with the activity of an organism in response to a stimulus.

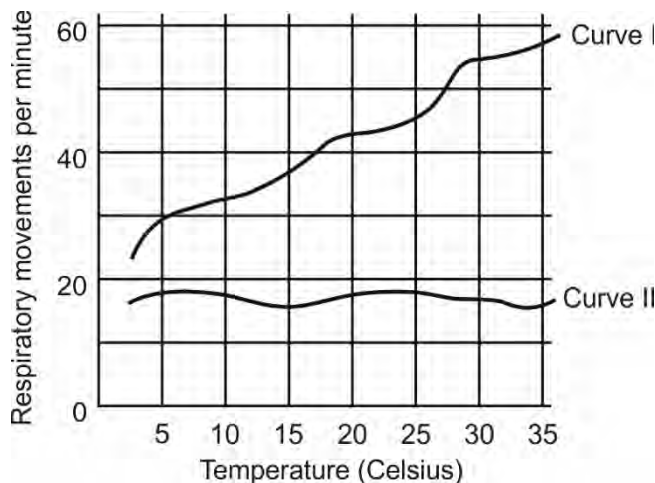
9. During mating season, the belly of three-spined stickleback fish becomes red. The male sticklebacks show typical aggressive behaviour when they see a red-bellied male stickleback, or any red-coloured object in the vicinity. Identify another example of this type of behaviour from the following:

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

Answer (d)

Sol. The correct answer is option (d) as the case explained in the question *i.e.*, behaviour of male sticklebacks depicts fixed action pattern which is basically an action that any species is programmed to do. They aren't really taught to do it. An earthworm burrowing deeper in the soil in daytime also illustrates fixed action pattern.

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

- Kangaroo
- Salmon fish
- Emu
- Komodo dragon

Answer (a)

Sol. The correct answer is option (a), because curve I and curve II respectively represent cold-blooded animals and warm-blooded animals. Cold-blooded animals can change their breathing rate according to change in temperature to fulfill the need of oxygen for their metabolism. Increase in temperature can lead to increased breathing rate as oxygen content decreases. Warm-blooded animals maintain constant body temperature, thus, breathing rate is maintained.

Option (b), (c) and (d) are incorrect as the organisms represented by curve I (Grizzly Bear, Penguin, Sea cow), are warm-blooded animals.

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

Answer (d)

Sol. • The Chaperonin family of barrel shaped particle promotes efficient protein folding. It allow nascent and denatured polypeptide to fold or refold while sequestered in a cylindrical cavity protected from the complex environment of the cytoplasm.

- The spliceosome is a ribonucleoprotein complex involved in RNA-splicing that is, the removal of non coding introns from precursor mRNA. It helps in mediating post transcription modification in nucleus.
- Calcium dependent kinases are key factors of plant signalling that convey calcium signal into physiological response to phosphorylating various substrates.

Therefore, chaperonin, spliceosome and calcium dependent kinases are predominantly found in cytoplasm, nucleus and cytoplasm respectively to ensure optimum functionality of the cell.

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

Answer (c)

Sol. Option (c) is the answer because,

- Presence of nerve net is a characteristic feature of cnidarians and ctenophores. *Hydra* is a freshwater cnidarian. Therefore, 'M' is cnidarian. *i.e.*, *Hydra*.
- Presence of ventral nerve cord with segmented ganglia is characteristic of annelids such as, leech. So, 'N' is leech.
- Nerve ring is seen in annelids, arthropods, molluscs and echinoderms. Sea star belongs to the phylum Echinodermata.

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

- (a) Ovary (b) Testis
(c) Adipose tissue (d) Pancreas

Answer (d)

Sol. Smooth endoplasmic reticulum is involved in several process excluding protein production.

Those cells involved in producing steroid hormones, such as Leydig cells in the testis and follicular cells in the ovary, have an extensive system of SER.

Adipose tissue serve as a fat reservoir.

Pancreas produces enzyme that help to digest food. Enzymes are made up of proteins so the rough endoplasmic reticulum would be abundant in pancreas.

In Pancreas smooth endoplasmic reticulum is not prevalent.

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

Answer (c)

Sol. During the process of protein synthesis, the initiator tRNA molecules carrying the amino acid methionine binds, to the AUG start codon of the mRNA transcript at the ribosome's P site where it will become the first amino acid incorporated into the growing polypeptide chain.

A new aminoacyl tRNA complex reaches the A site and form codon-anticodon bonding.

As the first tRNA gets attached only to P site, therefore, for the synthesis of 90 amino acid, 89 times tRNA gets attached to the A site of ribosome.

15. In the skeletal muscle cells, the calcium pump in the sarcoplasmic reticulum functions to :
- Maintain Ca^{2+} ions balance in the cytosol.
 - Release Ca^{2+} ions in the cytosol and bringing about contraction of muscles.
 - Collect Ca^{2+} ions back into sarcoplasmic reticulum and induce contraction of muscles.
 - Induction of apoptosis in muscle cells.

Answer (a)

Sol. Option (a) is the answer because,

When motor neuron input stops, the filaments slide back to their starting position as the muscle relaxes. Relaxation begins as proteins in the SR-pump uses energy from ATP hydrolysis to move Ca^{2+} back into the SR from the cytosol.

Option (b) and (c) are incorrect because, SERCA pump causes relaxation of muscle fibres by pumping Ca^{2+} back into the SR from the cytosol.

Option (d) is not the answer because, programmed death of cells is called apoptosis.

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;
- Exonuclease and ligase
 - Helicase and nuclease
 - Helicase and ligase
 - Endonuclease and ligase

Answer (d)

Sol. Option (d) is the answer because,

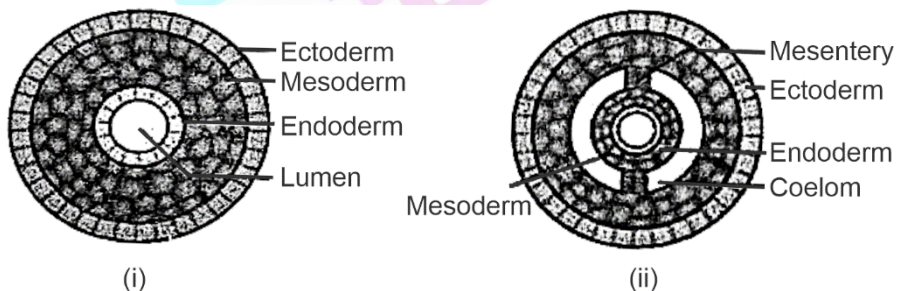
Restriction endonucleases recognise the specific sequence in a DNA and bind to it. They cut each of the two strands of the double helix at specific points in their sugar-phosphate backbones.

The DNA ligases are called molecular glue. They act on the cut DNA molecules and join their ends.

Option (a) is not the answer because, exonucleases remove nucleotides from the ends of the DNA.

Option (b) and (c) are not the answers because, DNA helicase separate two strands of DNA for replication.

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?

- (i) Earthworm, (ii) Cockroach
- (i) Planaria, (ii) Tapeworm
- (i) Cockroach (ii) Ascaris
- (i) Planaria, (ii) Cockroach

Answer (d)

Sol. • Option (d) is the answer because, given figure (i) represents cross section of body of acoelomates and figure (ii) represents cross section of the body of coelomates.

In option (d) – (i) *Planaria* belongs to Platyhelminthes which are acoelomates and (ii) cockroach belongs to Arthropoda which are coelomates.

- In option (a) – (i) Earthworm belongs to Annelida which are coelomates but figure (i) represents acoelomates. Therefore, Option (a) is not the answer.
- In option (b) – (ii) Tapeworm belongs to Platyhelminthes which are acoelomates but figure (ii) represents coelomate condition. Therefore, option (b) is not the answer.
- In option (c) – (i) Cockroach is a coelomate and (ii) *Ascaris* is a pseudocoelomate which are not matched with given figures (i) and (ii) respectively.

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

Answer (b)

Sol. Option (b) is the answer because, degree of intelligence is comparatively higher in chimpanzees than hyena.

Chimpanzee is our closest living relative on the evolutionary tree of life.

Option (a) is not the answer because, bipedal locomotion is not rudimentary in chimpanzees. They habitually walk both bipedally and quadrupedally.

Option (c) is not the answer because, cooperation in hunting is not rudimentary in chimpanzee. Chimpanzee hunting is cooperative, likely facilitated by behavioural and neuroendocrine mechanisms of coordination and reward.

Option (d) is not the answer because, hyenas have comparable intelligence levels to some primates.

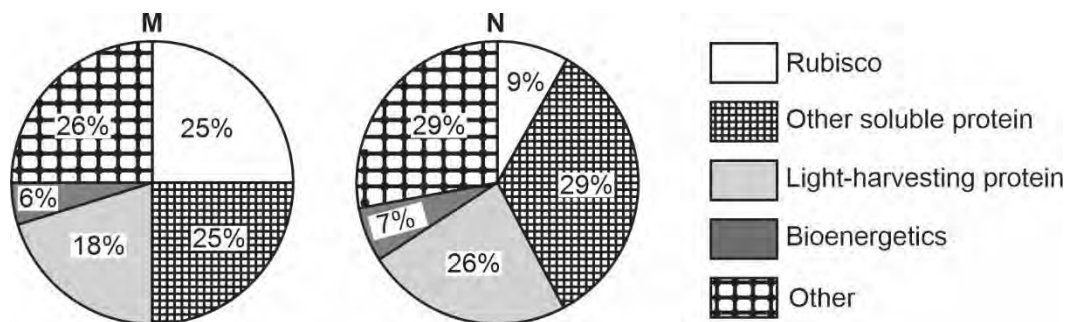
19. A 65-year-old male admitted to the hospital showed symptoms like severe inflammatory response, kidney dysfunction, low levels of Na^+ and high levels of K^+ in the body. Which part of his endocrine system most probably must be impaired or dysfunctional?

- (a) Hypothalamus
- (b) Adrenal cortex
- (c) Adrenal medulla
- (d) Parathyroid gland

Answer (b)

Sol. The correct answer is option (b) because adrenal cortex secretes many hormones, called as corticoids. Cortisol and aldosterone are corticoids which are involved in maintaining the kidney functions. Cortisol produces anti-inflammatory reactions and suppresses the immune response. Aldosterone acts mainly at the renal tubules and stimulates the reabsorption of Na^+ and water and excretion of K^+ and phosphate ions. So when adrenal cortex is impaired or dysfunctional then there will be severe inflammatory response, kidney dysfunction, low levels of Na^+ and high levels of K^+ in the body.

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

Answer (a)

Sol. In the given plant species, M represent the C₃ plant species and N represents the C₄ plants.

In C₃ species, the proportion of nitrogen allocated to RuBisCO, a major leaf protein; increases with an increase in leaf protein levels, and the amount of this enzyme correlates strongly with photosynthesis rate which largely responds to the produced biomass.

C₄ plants invest more nitrogen into light harvesting protein and have a higher light energy conversion and electron transport rate whereas they invest less to RuBisCO, compared with C₃ plants.

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

Answer (c)

Sol. The correct answer is option (c) because olfactory receptors are chiral and distinct for each isomer and several olfactory receptors in our nose are chiral and will register certain enantiomers more strongly than others.

Each receptor is specific for a particular odour.

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.

The is an example of which type of speciation?

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

Answer (a)

Sol. The correct answer is option (a) because when a small group of individual break off from the larger group and form a new species, this is called peripatric speciation.

The main difference between allopatric speciation and peripatric speciation is that in peripatric speciation, one group is much smaller than the other.

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}

Answer (a)

Sol. Number of bacterial cells inoculated in growth medium = 100

Time taken by a cell to duplicate = 30 min

Incubation time = 20 hours = 1200 min

Duplication of a cell = 2^n

here, n = number of generation

Number of generation required to duplicate cell in 20 hrs = $\frac{1200}{30} = 40$

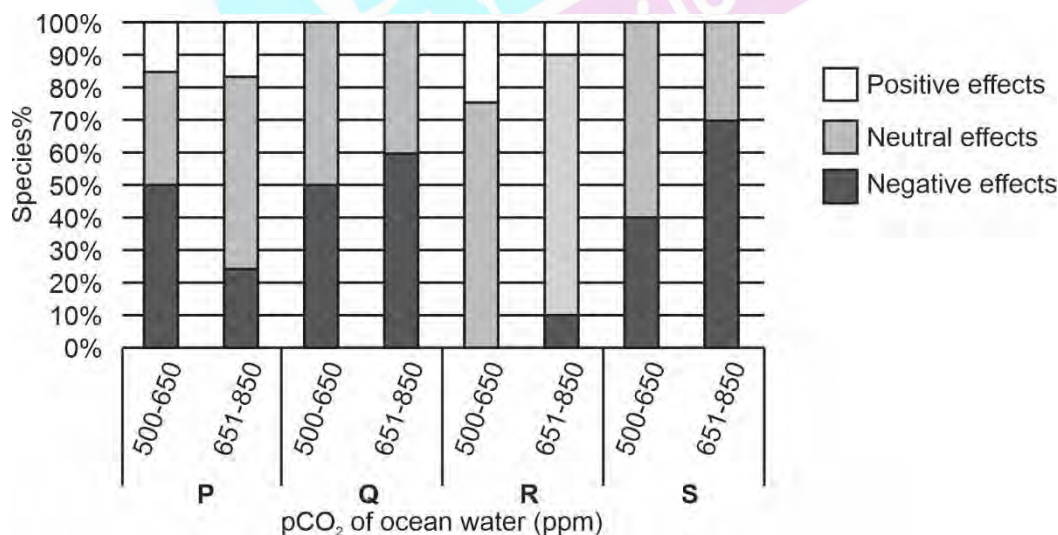
$\therefore n = 40$

Therefore, number of cells present in the broth after the 20 hours of incubation = 100×2^{40}

here, $2^{40} = 10^{12}$

Therefore $100 \times 10^{12} = 10^{14}$

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

Answer (b)

Sol. The correct answer will be option (b) as 'S' and 'Q' show negative effect then they might be mollusc and echinoderms as they are going to face trouble in building their shells and ossicles respectively due to acidification.

'P' will be crustacean as studies have found that they grow even stronger shells under high acidity.

'R' shows reduction in positive effect so they can be fish as they don't have shells but still they feel effects of acidification. They are also sensitive to pH and has to put its body into overdrive to bring its chemistry back to normal.

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

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

- (a) X – Exhaled air, Y – Alveolar capillaries, Z – Pulmonary vein
 (b) X – Inhaled air, Y – Pulmonary vein, Z – Tissues
 (c) X – Inhaled air, Y – Systemic arteries, Z – Pulmonary arteries
 (d) X – Inhaled air, Y – Alveolar space, Z – Pulmonary arteries

Answer (d)

Sol. The correct answer is option (d) because the value of

pO_2 in alveoli → 104 mm Hg

pO_2 in deoxygenated blood (pulmonary arteries) → 40 mm Hg

pO_2 in oxygenated blood (pulmonary vein) → 95 mm Hg

pCO_2 in deoxygenated blood (tissue) → 45 mm Hg

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

Answer (b*)

Sol. Recombination frequency between gene = $B-D > A-C > A-B$.


According to the given data

Maximum distance is between = B-D

Minimum distance is between = A-B


Therefore, the possible sequence of genes on a chromosome would be

B A C D



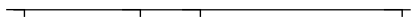
Here, option (c) and (d) can also be possible.

D A B C



or

C A B D



27. During complete oxidation of substrate X to CO_2 and H_2O , a total of 110 H^+ ions were transported out across the inner mitochondrial membrane. If 4 H^+ ions are sent back to generate one ATP, calculate the number of ATPs generated and NADH oxidized (Assume that FADH_2 is NOT involved)
- (a) 11 NADH and 28 ATPs
(b) 10 NADH and 32 ATPs
(c) 11 NADH and 38 ATPs
(d) 10 NADH and 28 ATPs

Answer (a)

Sol. Here, total 110 H^+ ions were transported across inner mitochondrial membrane.

For 1 ATP, 4 H^+ are sent back.

We know that 1 NADH results in 10 H^+ being transported out across the inner mitochondrial membrane.

Therefore, NADH required are = $\frac{110 \text{ H}^+}{10} = 11 \text{ NADH}$

For 4 H^+ ions = 1 ATP

110 H^+ ions = $27.5 \approx 28 \text{ ATPs}$

Therefore, for substrate X, 28 ATPs are generated and 11 NADH gets oxidised.

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

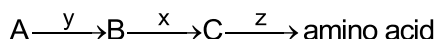
Answer (d)

Sol. $\text{A} \rightarrow \text{B} \rightarrow \text{C} \rightarrow \text{Amino acid}$

When P, Q and R are co-cultured R is unable to survive as enzyme z is catalysing the last step of converting substrate c to amino acid. So, even getting the substrate from rest of the mutants its unable to synthesize amino acid.

When P and Q are co-cultured P is unable to survive as the mutant cannot catalyse the second substrate B into C thus in the absence of unavailability of conversion of B into C its unable to survive.

Thus, the correct order of sequence will be



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

Answer (c)

Sol. In the given question, M is a C_3 plant as C_3 plants have the tendency to close the stomata in the absence of light. N is a C_4 plant as C_4 plants have the tendency to open their stomata in the absence of light.

Thus, the most appropriate option is (c)

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.

Answer (a)

Sol. Ubiquinone is a lipid consisting of a quinone level group and a polyphenol tail which varies in length depending on the organism. Ubiquinone is a component of a membrane bound electron transport chain and serve as a redox mediator in aerobic respiration via reversible redox cycling between ubiquinol, the reduced form of Co-enzyme Q and ubiquinone. These are hydrophobic in nature.

Ubiquinol possesses significant antioxidant properties and play an important role in the protection of lipids in the cell.

Hence, option (a) is wrong for ubiquinone.

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.

Answer (d)

Sol. (d) is the correct option.

Cells enter the G_1 phase post the G_0 phase.

Cells in G_0 phase are metabolically active but no longer proliferates unless called on to do so depending on the requirement of organisms.

Cells that temporarily enter G_0 phase where the cell undergoes continues growth but do not replicates its DNA until they are ready for S-phase. In which DNA synthesis or replication takes place.

Option (b) is incorrect because:

After exiting G_0 phase cells re-enter the G_1 phase, it does not directly starts DNA synthesis.

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

Answer (a)

Sol. ii → Permits colour

I → inhibits colour expression

P → purple colour

pp → red colour; hence

♀ × ♂
IiPp IiPp

| ♀ \ ♂ | IP | Ip | iP | ip |
|-------|--------------------|--------------------|--------------------|--------------------|
| IP | IIPP Colourless | IIPp Colourless | IiPP Colourless | IiPp Colourless |
| Ip | IIPp Colourless | Ippp Colourless | IiPp Colourless | Iipp Colourless |
| iP | IiPp Colourless | IiPp Colourless | iiPp Purple | iiPp Purple |
| ip | IiPp Colourless | Iipp Colourless | iiPp Purple | Iipp Red |

Phenotype ratio: Purple : Red : Colourless
3 : 1 : 12

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

Answer (c)

Sol. Man's genotype is X^hY → Haemophilic

Daughter's genotype is X^hX → Carrier

Daughter's husband is XY → Normal

| ♂ \ ♀ | X^h | X |
|-------|--------|----|
| X | X^hX | XX |
| Y | X^hY | XY |

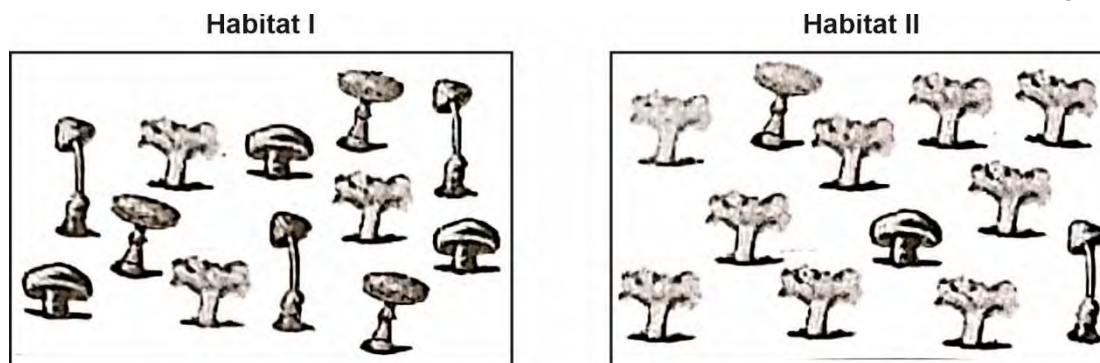
The probability that a son will be haemophilic is

$1/2$ or 50%

The probability that all four sons will be haemophilic is

$1/2 \times 1/2 \times 1/2 \times 1/2 = 1/16$

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?

- Habitat I has greater species richness than II.
- Habitat II has a more even distribution of species than I.
- Habitat II has greater species evenness than I.
- Habitat I is more diverse than II.

Answer (d)

- Sol.**
- Species richness is the number of species in a community.
 - Species evenness is a description of the distribution of abundance across the species in a community. Species evenness is highest when all species in a sample have the same abundance.
 - Species diversity is the product of species richness and species evenness.

In habitat I species diversity is more than II as here species richness is equal to habitat II but the species evenness is more than II.

35. Note the following processes:

- Mutation
- Recombination
- Post-translational modifications
- Crossing over during meiosis
- 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?

- (i) and (ii)
- (iii) and (v)
- (i), (ii) and (iv)
- All of the above

Answer (b)

- Sol.** In post-translational modification folding of primary amino acid change into fully functional protein and thus alternate folding can produce different forms of protein from the same gene.

Alternative RNA splicing is a splicing process during gene expression, that allows single gene to code for multiple proteins.

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.

Answer (c)

Sol. Correct answer is option **c**, because plant meristem is totipotent, so it can give rise to any type of cells. But the cells of lower layers of human skin can replace only original cells.

Option **a**, **b** and **d** are incorrect because animal cells lack cell wall which has no role in division and plant cells in spite of absence of centriole perform mitosis and only on the basis of cell division, we cannot differentiate a dividing animal cells with the meristem in plants.

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.

Answer (c)

Sol. The correct answer is option **c**, because the majority of the cells in the thymus are lymphocytes which have the greatest ratio of nucleus to cytoplasm. There are many white blood cells with large nuclei in this gland, thus, thymus is preferred gland for DNA extraction.

Option **a** is incorrect as all endocrine glands are soft.

Option **b** is incorrect because for extraction of DNA usually vestigial thymus is not used.

Option **d** is incorrect as the number of dividing cells in thymus is not high at any point of time because thymus undergoes regression at later stage.

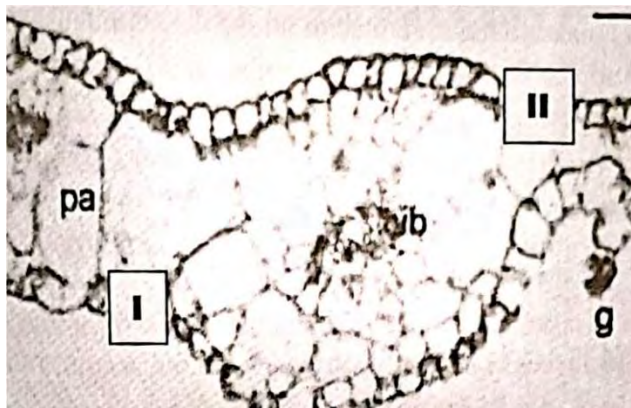
38. The TCA cycle is an amphibolic pathway. Anaplerotic reactions are such metabolic pathways that replenish TCA cycle intermediates when they leak away from the cycle. The leakage of Oxaloacetate from the TCA cycle forms which of the following?
- (a) Porphyrins
 - (b) Pyrimidines
 - (c) Acetyl CoA
 - (d) Mannose

Answer (b)

Sol. Amphibolic pathway produces a number of intermediates. These intermediates of the pathway are precursors of various compounds.

Oxaloacetic acid acts as the raw material for synthesis of alkaloids and pyrimidines.

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 $35\mu\text{m}$. '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

Answer (c)

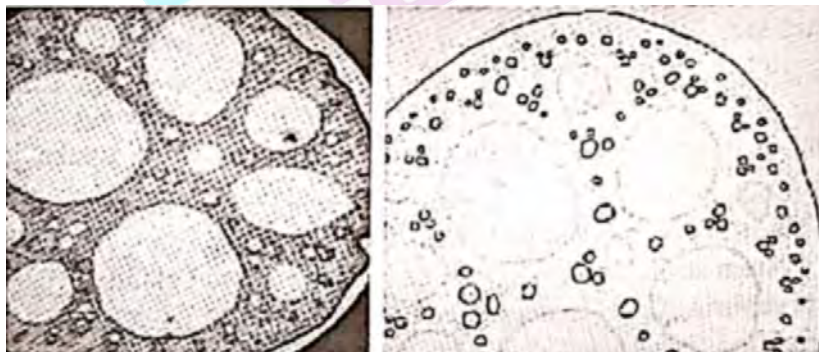
Sol. According to the given diagram and description

The given figure is of leaf. Hence there will be no endodermis.

I represents abaxial epidermis which represent lower surface of leaf.

II represents adaxial epidermis, which represent upper surface of leaf.

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.

Answer (d)

Sol. The given diagram indicates the presence of large empty spaces between parenchymatous cells which facilitate the movement of gases in and out of tissues and move oxygen from the stem to the root in plants exposed to flooding condition which is essential for plant survival since it reduces hypoxic stress.

Such adaptation is seen mainly in hypoxia condition.

41. It is observed that plant 'M' requires 3000 ATPs and 1200 NADPH₂ for synthesis of starch; while the plant 'N' requires 1800 ATPs and 1200 NADPH₂ 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

Answer (c)

Sol. Plant M is C₄ plant which require 30 ATP and 12 NADPH for synthesis of 1 molecules of glucose.

Plant N is C₃ plant which require 18 ATP and 12 NADPH for synthesis of 1 molecule of glucose.

So, M = C₄ plant = *Sorghum*

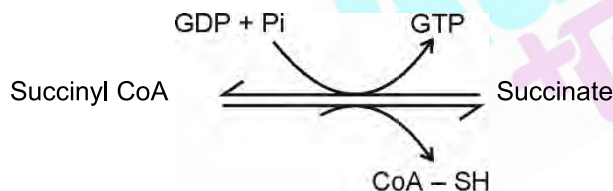
N = C₃ plant = *Wheat*.

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

Answer (c)

Sol. Succinate CoA synthetase converts :



Certain microbe have another variant of Kerbs cycle where Succinyl-CoA is converted to succinate by acetate: succinate CoA transferase instead of Succinyl CoA Synthetase (SCS). These microbes show enhanced tolerance to high levels of acetate produced by them during fermentation.

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

Answer (b)

Sol. The correct answer is option (b), because in rabbits, volatile fatty acids which are the energy component of fibre digestion, can be absorbed directly through the caecal epithelium. However, other nutrients such as amino acids, vitamins and minerals, are excreted in a special soft faecal pellet known as 'night faeces' which they eat again directly from the anus. It is an efficient way to capture and utilise the nutrients produced by the fermentation of feeds in the caecum.

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 |

Answer (c)

Sol. The correct answer is option (c), because the organism given in the figure is scorpion which is an arachnid of phylum Arthropoda. Presence of book lungs for respiration is unique feature of arachnids.

Option (a), (b) and (d) are not correct because segmental gills are present in crustaceans, segmental spiracles and segmental trachea are found in insects of phylum Arthropoda.

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:

- (i) Epinephrine binds to receptors in liver and on fat cells.
- (ii) The nervous system stimulates endocrine cells in the adrenal gland.
- (iii) Binding of epinephrine leads to decreased beating of heart.
- (iv) Glycogen formation increases.
- (v) Blood vessels in the digestive tract constrict.
- (vi) Pumping of blood increases.

The changes that would occur in the given situation are:

- | | |
|------------------------------|-------------------------|
| (a) (i), (ii), (iv) and (vi) | (b) (ii), (iv) and (vi) |
| (c) (i), (ii), (v) and (vi) | (d) (i), (iii) and (iv) |

Answer (c)

Sol. The correct answer is option (c), because the changes mentioned in (i), (ii), (v) and (vi) are possible in the given situation. During emergency, sympathetic-adrenal system works. Adrenal medulla secretes epinephrine which binds with receptors on liver and on fat cells to stimulate glycogenolysis and gluconeogenesis respectively leading to increase in glucose levels in blood. Epinephrine increases the heart beat, strength of heart contraction, leading to increased pumping of blood. Adrenaline causes vasoconstriction in the digestive tract to increase return of blood to heart.

Option (a), (b) and (d) are incorrect because statements (iii) and (iv) are wrong.

Epinephrine increases rate of heart beat and breakdown of glycogen.

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?
- (a) 50% (b) 6 log
(c) 5 log (d) 2 log

Answer (d)

Sol. A cell suspension has a concentration

→ 10^{12} cells/mL

After dilution the suspension concentration = 10^6 cells/mL

Reduction = $10^{12} - 10^6$

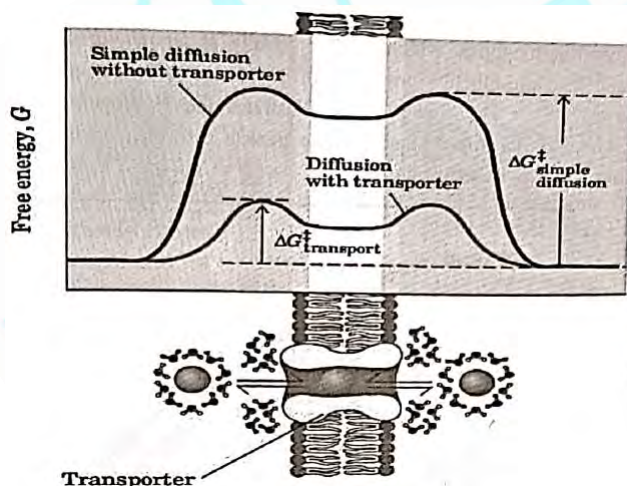
or $x = 10^{12} - 10^6$

or $\log x = \log 10^{\frac{12}{6}}$

= $\log 10^2$

= 2 log 10

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



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

Answer (d)

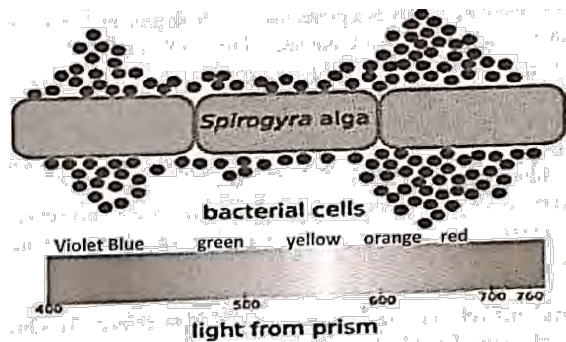
Sol. Option a is incorrect as transporter protein does not alter the molecular structure of transporting molecule. Even if slight modifications are required they will be reversible in nature.

Option (b) is incorrect as per the diagram with the aid of transporter molecule ΔG value is lowered.

Option (c) is incorrect as hydrophilic molecule cannot pass through a hydrophobic passageway.

Option (d) is correct as hydration shell is present on the molecule as it is exposed to external aqueous medium. For its transport the hydration shell is not required as the polarity of transporter is similar to the transporting molecule. The hydration shell will be formed again when the molecule comes in the internal aqueous environment of cell.

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

Answer (c)

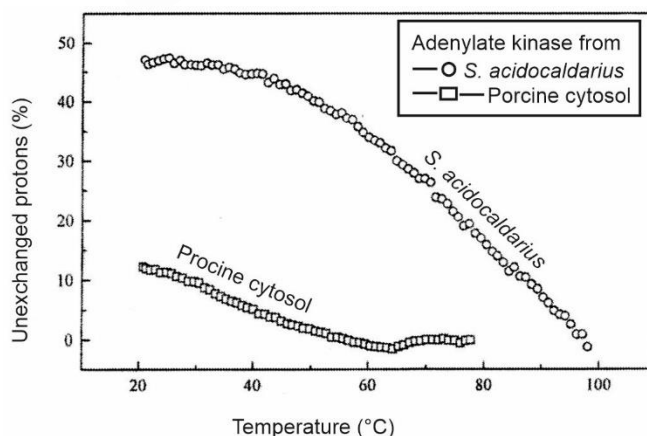
Sol. According to the given experiment.

Spirogyra sps. being a photosynthetic alga will utilise visible spectrum of light for photosynthesis and it has been seen that the maximum accumulation of aerobic bacteria in red region due to maximum release of O_2 during photosynthesis. This indicates that *Spirogyra* absorbs maximum wavelength of 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.

Answer (a, d)

Sol. Option (a) is correct as at 20°C a much smaller fraction of the amide protons in *Sulfolobus acidocaldarius* adenylate kinase (53%) are exchanged than in the porcine cytosolic enzyme (83%), indicating that considerable more amide protons are involved in stable hydrogen bonds in the thermophilic enzyme.

Option (b) is incorrect as excessive rigidity explains why hyperthermophilic enzymes are often inactive at low temperatures (i.e., around 20 to 37°C). Hyperthermophilic enzymes are more rigid than their mesophilic homologues at mesophilic temperature and their rigidity is a prerequisite for high protein thermostability. Thus, we could also infer that option (c) is incorrect.

Temperatures of 80 to 90°C and beyond are needed before *S. acidocaldarius* adenylate kinase can show an exchange level comparable to that of 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.

Answer (a, c, d)

Sol. Peroxisomes are diverse organelles, and even in the various cell type of single organism, they may contain different sets of enzymes. They can also adapt remarkably to changing conditions for example, yeast cells grown on sugar have small peroxisomes. But when some yeasts are grown on methanol, they develop large peroxisomes that oxidise methanol. When yeasts are grown on fatty acids, they develop large peroxisomes that break down fatty acids to acetyl CoA by β -oxidation. Thus, option a and c are correct.

Option (b) is incorrect as predominantly peroxisomes multiply by fission but it could also arise *de novo*. Thus, we can infer fission is not the only process.

Option (d) is correct as ER to peroxisome pathway functions to supply existing peroxisomes with essential membrane constituents, i.e., lipids and proteins.

51. The C_4 plants have relatively more efficient photosynthetic machinery. This may be attributed to;

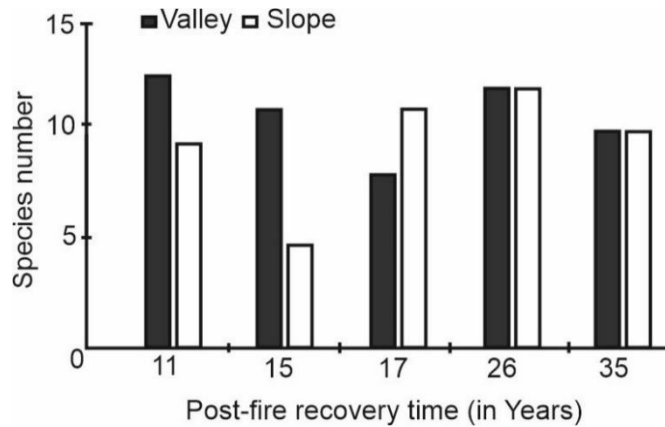
- (a) PEP carboxylase that has a higher affinity for CO_2 and no affinity for O_2 .
- (b) The entire dark reaction being carried inside a single cell type.
- (c) CO_2 being concentrated in bundle sheath cells at the expense of ATP.
- (d) Fixing of CO_2 even under low CO_2 concentration.

Answer (a, c, d)

Sol. Option (a) is correct as PEP carboxylase does not use oxygen as a substrate and it ensures only atmospheric CO_2 fixation.

Option (c) is correct as at the expense of two extra ATP, CO_2 is being concentrated in bundle sheath cells, thus enhancing the carboxylase activity of RuBisCO by increasing the CO_2 concentration at the enzyme site. Concentrating CO_2 in bundle sheath cells allows the CO_2 fixation even at low CO_2 concentration.

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.

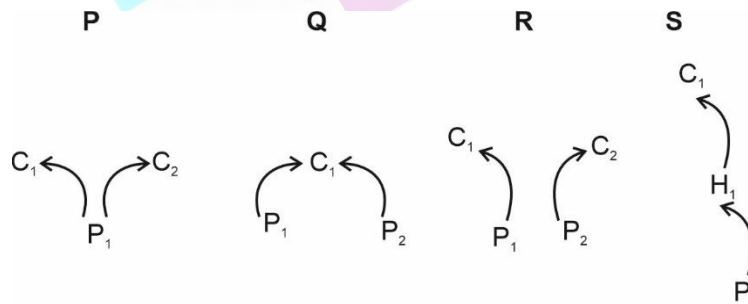
Answer (a, c)

Sol. As per the bar graph, in the initial stage (11 years mark), vegetation rapidly established on the scar of the burn in valleys. Thus, option (c) is correct and (d) is incorrect.

However, with increasing time, species richness gradually increased on slopes. In the middle and later stages of vegetation recovery, species richness and diversity of valleys and slopes were similar, or marginally higher on slopes (17 years mark).

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.

P₁ and P₂ = Producers or Prey, H₁ = Herbivore and C₁ and C₂ = Carnivore.



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

- (a) Indirect mutualism between C₁ and P₁ in S.
- (b) Apparent competition between P₁ and P₂ in Q.
- (c) Commensalism between C₁ and C₂ in P.
- (d) Indirect mutualism between C₁ and C₂ in R.

Answer (a, b, d)

Sol. Q → shows apparent competition

Here two prey species (P_1 , P_2) may compete because if either increases a shared predator (C_1) also increases, which operates detriment to other prey population.

S → Shows indirect food chain mutualism

Here, P_1 and C_1 are indirect mutualist as they share a herbivore H_1 .

R → Shows indirect mutualism

Here, C_1 and C_2 do not interact directly and consume different prey. P_1 , P_2 interact indirectly because their prey compete, if C_1 increases its prey P_1 decreases.

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)

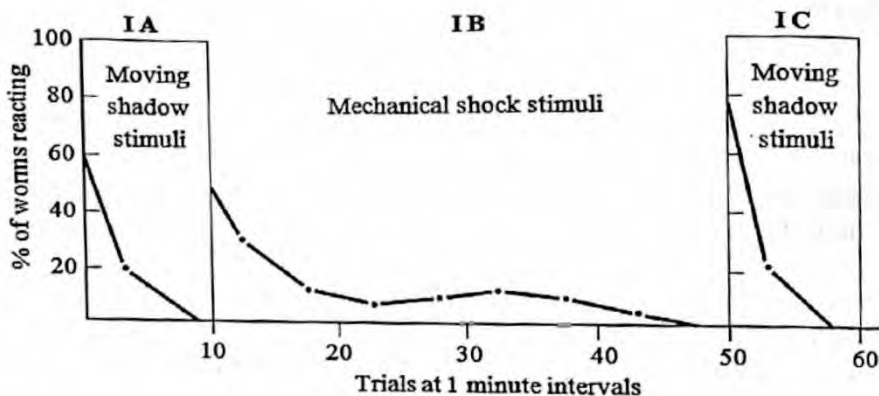
Answer (b, d)

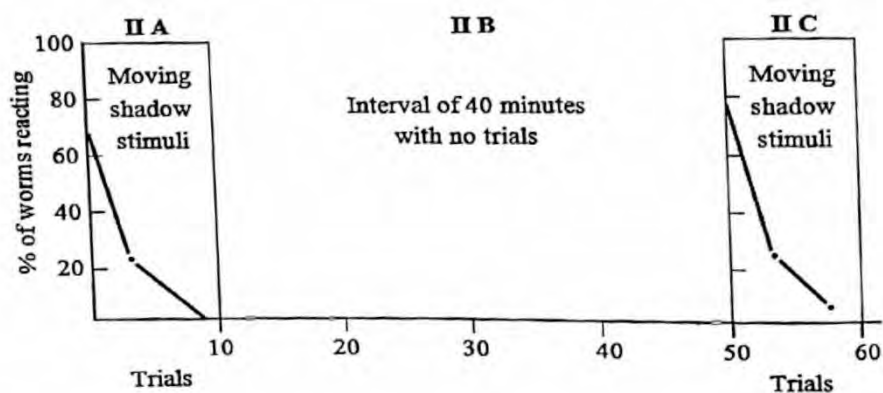
Sol. As a signal sequence emerges from the ribosome, it is recognised and bound by signal recognition particle (SRP). The ribosome nascent chain SRP complex is then targeted, via an interaction with the SRP receptor to a Sec 61p – containing translocation channel. Thus, option (a) is incorrect as ribosome does not recognise the signal sequence rather it emerges from it. Option (d) is correct because eventually the protein synthesized in free ribosomes eventually docked to the ER for proper folding.

Option (c) is incorrect as folding of proteins occurs inside the ER so fully folded functional proteins comes out of the ER, not entering it.

Option (b) is correct as translocation of proteins into mitochondria, chloroplasts, and peroxisomes occurs post translationally, after the protein has been made and released into the cytosol, whereas translocation across the ER membrane usually occurs during translation (co-translationally).

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?

- Response in IA represents habituation while that in IIC represents sensitization.
- Habituation is always faster for a moving shadow stimulus than that for a mechanical shock stimulus.
- Sensory adaptation is always a permanent adaptation.
- Habituation to moving shadow stimulus is independent of the response to mechanical stimulus.

Answer (b, d)

Sol. Option (b) and (d) are correct because,

Habituation is a decrease in a response to a frequently repeated stimulus, whereas sensitization is the increased reaction to a stimulus after repeated exposure.

In option (a) Response in IA represents habituation while that in IIC also represents habituation as there is a decrease in response (% of worms reacting) to a repeated exposure.

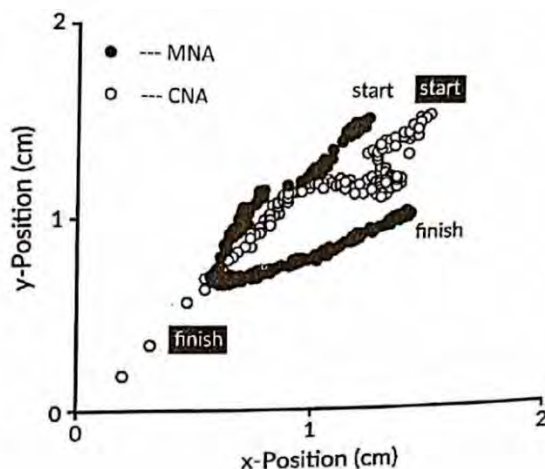
In option (c), Sensory adaptation is not always a permanent adaptation as when the stimulus is removed, sensory adaptation will be back to its original state.

From results obtained in experimental set up (I and II), Habituation is always faster for a moving shadow stimulus than that for a mechanical shock stimulus as response by worms is faster and decrement in response is also fast in moving shadow as compared to mechanical shock stimuli.

Habituation of moving shadow stimulus is independent of the response to mechanical stimulus as in both I and II. IC and IIC show same behavioural pattern. Therefore option (b) & (d) are correct.

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 group was 'caudal neuromasts ablated' (CNA) while the other one was 'middle neuromasts ablated' (MNA). These larvae were exposed to mild suction pressure created in water. As they tried to avoid the suction current, the positions of the two groups of larvae were recorded from the start to finish of the experiment. These recordings were plotted as shown in the figure below.

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



Which of the following are the correct interpretations?

- (a) The larvae with caudal neuromasts ablated are more efficient in avoiding the suction as compared to the larvae with middle neuroblasts ablated.
- (b) The larvae with middle neuromasts ablated are more efficient in avoiding the suction as compared to the larvae with caudal neuroblasts ablated.
- (c) It may be deduced that both the location and number of neuromasts play a role in detecting a continuous suction source.
- (d) It may be deduced that only the location of neuromasts play a role in detecting a continuous suction source.

Answer (b, d)

Sol. Option (b) and (d) are correct because,

The larvae with middle neuromasts ablated are more efficient in avoiding the suction as compared to the larvae with caudal neuromasts ablated. As one can see in the figure, MNA is far from origin of the coordinate system whereas CNA is near to it. Also, it may be deduced that the location of neuromasts play a role in directing a continuous suction source, as middle and caudal neuromasts are ablated whereas no numbers of neuromasts are as such mentioned in whole of the response.

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

Answer (b, c, d)

Sol. The correct answer is option (b), (c) and (d) as when proline is in a peptide bond, it does not have a hydrogen on the α -amino group, so it cannot donate a hydrogen to stabilise an α -helix or a β -sheet.

When proline is found in an α -helix, the helix will have a slight bend due to the lack of the hydrogen bond. Option (a) is incorrect as there are other hydrophobic amino acids also beside proline.

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.

Answer (b, c)

Sol. 2, 6-Dichlorophenol-indophenol has a strong-purple-violet-colour when oxidised but is colourless in the reduced form. Thus option a is incorrect but b is correct.

DCPIP acts as an electron acceptor or inhibitor of mitochondrial ETC thus option d is incorrect.

DCPIP can only gain electrons *in vitro* because it does not easily enter a living system. Thus, it can be inferred that DCPIP cannot enter into an intact mitochondria. It will only get colourless if it receives the electron, available only when ETC carried out by mitochondria is leaky.

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?
- Mullerian mimicry benefits both prey and predator.
 - Batesian mimicry is a type of mutualistic relationship.
 - Batesian mimicry is an example of divergent evolution while Mullerian mimicry is an example of convergent evolution.
 - It is essential to have a common predator for Mullerian mimicry to evolve.

Answer (a, d)

Sol. Option (a) and (d) are correct because,

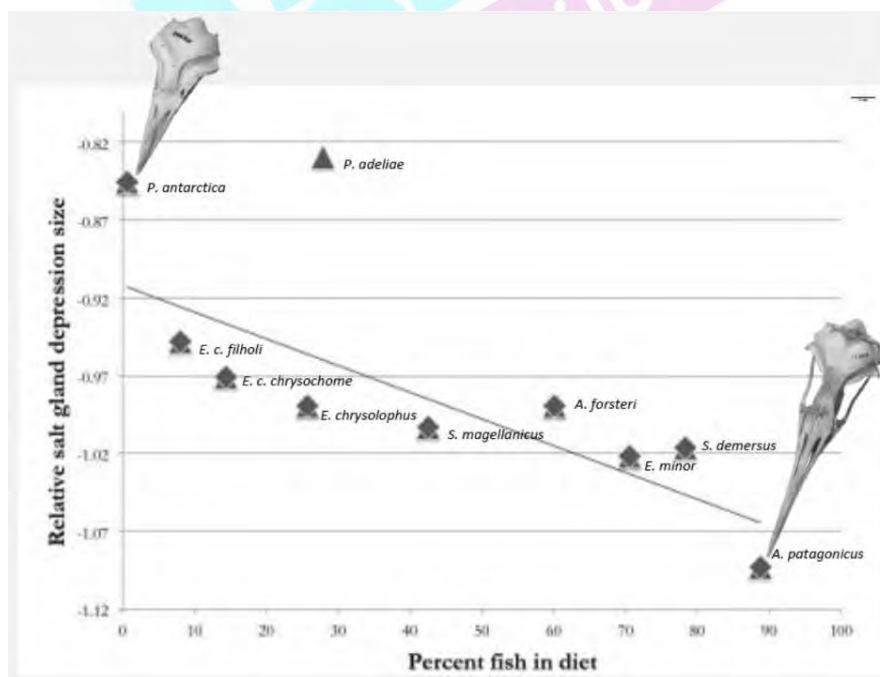
In mullerian mimicry two or more unpalatable species resemble each other. Presumably, the more unpalatable prey they are, the faster predators learn to avoid prey with that particular appearance. Therefore, it benefits both prey and predator.

Also, it is essential to have a common predator for mullerian mimicry to evolve because then only it is beneficial for two unrelated or related animals develop similar appearance.

Option (b) is incorrect because, as opposed to the mutualistic relationship between mullerian mimicry, batesian mimicry is considered to be parasitic (beneficial to the mimic).

Option (c) is incorrect because whether it is Batesian or Mullerian, mimicry is one of the most obvious examples of convergent evolution.

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_{10} of depression surface area divided by cranial size index. Percentage of fish in diet was calculated using weighted mean percentage of fish consumed by a penguin species.



Which of the following statements are correct?

- (a) Larger salt gland depressions correlating with a diet high, in hyposmotic fish and smaller salt gland depressions correlating with a diet high in isosmotic marine invertebrates.
- (b) Larger salt gland depressions correlating with a diet high in isosmotic marine invertebrates, and smaller salt gland depressions correlating with a diet high in hypoosmotic fish.
- (c) Adelie penguin (*P. adeliae*) an outlier probably because they recently shifted from a mostly-krill to a mostly-fish diet.
- (d) Adelie penguin (*P. adeliae*) is an outlier probably because they recently shifted from a mostly-fish to a mostly-krill diet.

Answer (b, d)

Sol. The correct answers are option (b) and option (d) because a salt glands in penguins are the adaptation that can allow marine organisms to ingest seawater and prey that is as salty as seawater. The larger the salt gland, the higher the inferred salt intake. Penguins eat teleost fish, which are hyposmotic with seawater and marine invertebrates which are isosmotic with seawater. According to this analysis there is a good correlation between salt gland and depression size (relative to body size) and diet, with larger salt gland depressions correlating with a diet high in isosmotic marine invertebrates and a smaller salt gland depressions correlating with a diet high in hyposmotic fish. Adélie penguin is an outlier probably because they recently shifted from a mostly-fish to a mostly-krill diet. Potential within species relationship will be explored.

□ □ □

