INDIAN ASSOCIATION OF PHYSICS TEACHERS
NATIONAL STANDARD EXAMINATION IN BIOLOGY
(NSEB - 2022)

Time: 120 minute **Max. Marks: 216**

Attempt All Sixty Questions

A - 1

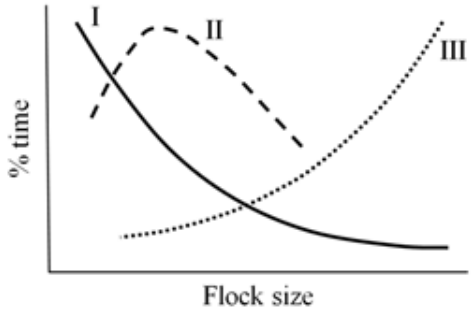
ONLY ONE OUT OF FOUR OPTIONS IS CORRECT. BUBBLE THE CORRECT OPTION.

1. Compare adults of the animals listed below and find out which animal has both higher annual energy expenditure and higher energy expenditure per unit body weight per day?
   (a) Python (b) Frog (c) Man (d) Penguin

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

3. Which of the following animals is triploblastic, acoelomate and with ciliated body surface?
   (a) Obelia (b) Taenia (c) Planaria (d) Fasciola

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



   The three habits I, II and III respectively are:
   (a) feeding, scanning, fighting (b) fighting, feeding, scanning
   (c) scanning, feeding, fighting (d) feeding fighting, scanning

5. Predatory insects with two pairs of functional wings with an incomplete metamorphosis are:
   (a) Dragonflies (b) Wasps (c) Caddisflies (d) Moths

6. Which of the following tools is used to determine the 3D structure of protein ?
   (a) X-rays (b) Mass spectrometry
   (c) Liquid chromatography (d) 2D gel electrophoresis

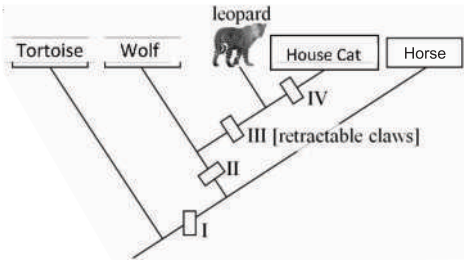
7. Among the following amino acids, arginine could have an ionic interaction with:
(a) Lysine (b) Glutamic acid (c) Valine (d) Methionine

8. Embryos of reptiles, birds and mammals have extraembryonic membranes. They perform essential functions for the developing embryo.
Match the predominant function with each type of membrane.

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

(a) i – Q, ii – S, iii – P, iv – S
(b) i – S, ii – P, iii – Q, iv – R
(c) i – Q, ii – R, iii – P, iv – S
(d) i – S, ii – Q, iii – R, iv – P

9. Consider the following five animals:
horse, house cat, leopard, tortoise and wolf.



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

(a) I: carnivory II: hair IV: purring
(b) I: hair II: purring IV: carnivory
(c) I: purring II: hair IV: carnivory
(d) I: hair II: carnivory IV: purring

10. Birds show an adaptive cross-connection between blood vessels that increases the flexibility of their neck. The anastomosis between blood vessels of left and right side, allowing blood to flow freely even when the head twists and one of the vessels is pinched, is:
(a) Carotid anastomosis (b) Cranial anastomosis
(c) Jugular anastomosis (d) Branchial anastomosis

11. An animal who is known to be a marsupial shows the following body features:
- Almost hairless big ears
- Forelimbs with sharp claws
- Grey coat color
- Long sticky snout

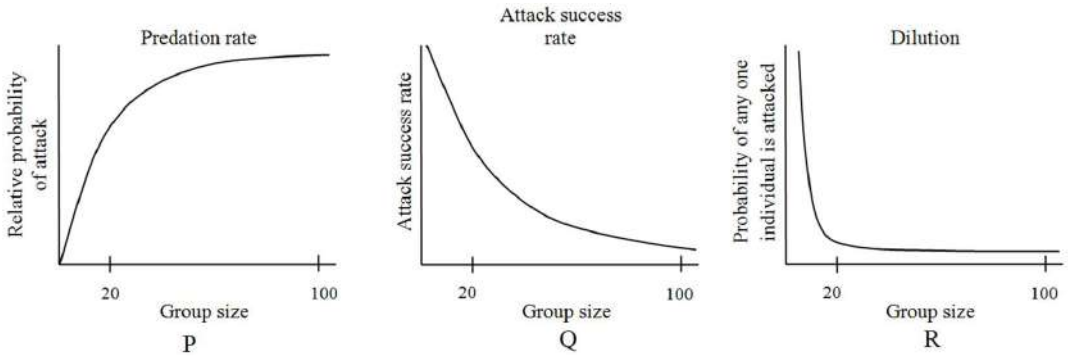
What can be deduced about the animal's habits/habitat?

i. The animal is likely to be diurnal.
ii. The animal is likely to dig deep burrows.
iii. The habitat is likely to be sandy deserts.
iv. The animal is likely to be insectivorous.

(a) i and ii only (b) ii, iii and iv only (c) ii and iii only (d) all the four

12. MHC-I is expressed by almost all normal cells but not abnormal and infected cells. Cells of which of the following lymphoid lineages recognize tumor cells and virus-infected abnormal cells by the absence of MHC-I ?
(a) Th Cells. (b) Tc Cells. (c) NK Cell. (d) B Cell

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



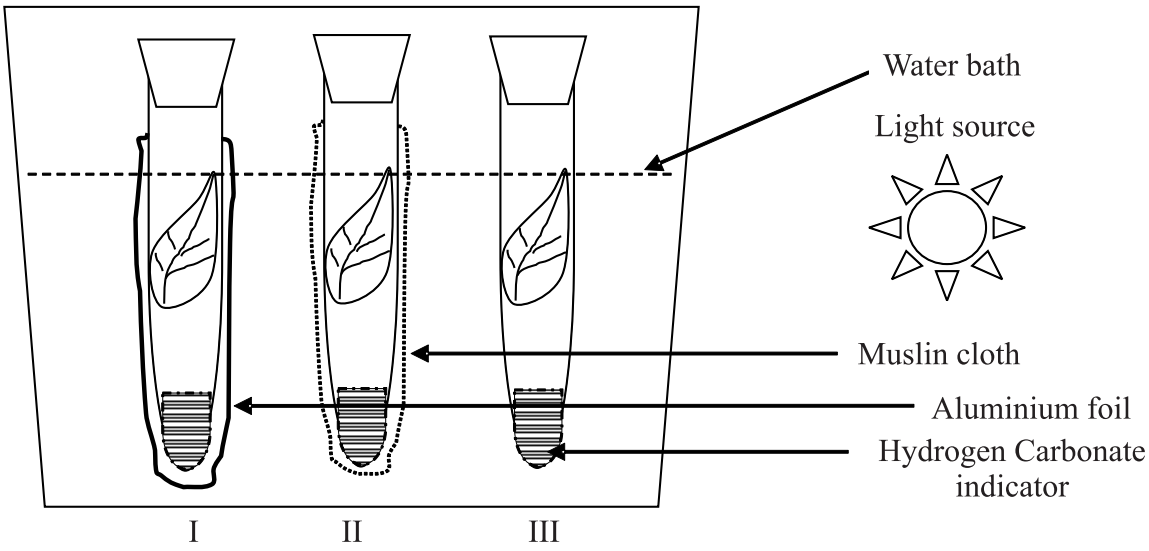
I. Conspicuousness of group II. Shared vigilance
III. Confusion effect IV. Every individual with equal chance of being attacked
Match these against the correct graphs marked P, Q, and R:

	P	Q	R
(a)	I	II, III	IV
(b)	IV	II	III, IV
(c)	IV	II, III	I
(d)	I	II, III	IV

14. In a protein structure, α-helix hairpin, β-hairpin and β-α-β unit are the examples of:
(a) Secondary structure (b) Super secondary structure
(c) Tertiary structure (d) Quaternary structure

15. The immunoglobin (X) is present on mast cells and basophils. When bound to an antigen, it triggers the release of (Y) that causes (Z). Here X, Y and Z respectively refers to:
(a) IgA, Histamine and inflammation (b) IgM, Interleukin and allergy.
(c) IgE, Histamine and allergy. (d) IgD, Histamine and Interleukin.

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



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

(a) Cherry red, Cherry red, Yellow
(b) Yellow, Cherry red, Purple
(c) Purple, Yellow, Cherry red
(d) Yellow, Purple, Cherry red

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

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

(a) 3
(b) 4
(c) 5
(d) 6

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

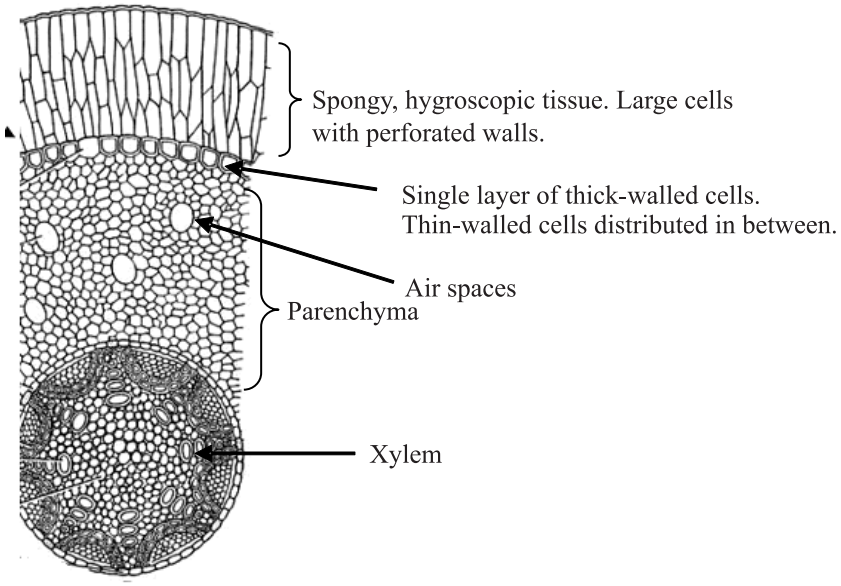
(a) 0.81; 0.18 and 0.01
(b) 0.64; 0.32 and 0.04
(c) 0.8; 0.1 and 0.1
(d) 0.54; 0.44 and 0.02

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

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

What would be the expected result of culturing in set I to IV respectively?
(a) Shoot formation, Root formation, No growth, Cell enlargement
(b) No growth, Cell enlargement, Root formation, Shoot formation
(c) Cell enlargement, No growth, Shoot formation, Root formation
(d) Root formation, Shoot formation , Cell enlargement, No growth

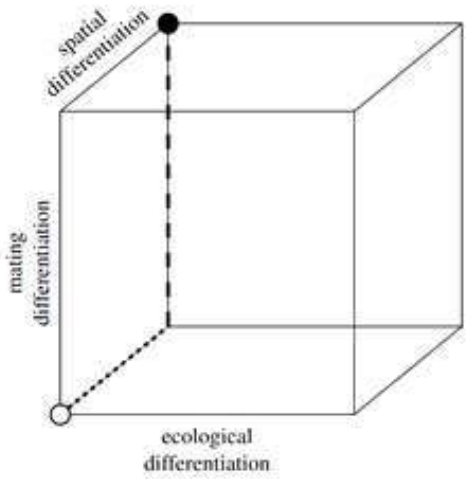
20. Veena found a preserved root specimen in her college laboratory. The specimen jar label was half torn so she could not read the full name of the sample. She took a cross section and observed it under the microscope. She was not aware of the exact tissue types so she drew the diagram and labeled it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



(a) Stilt root of maize plant
(b) Pneumatophore of halophyte
(b) Hanging root of an orchid
(d) Root of a Pteridophyte

21. During denaturation, globular protein becomes :
(a) Insoluble and inactive
(b) Inactive but soluble
(c) Unfolded and more soluble
(d) Soluble

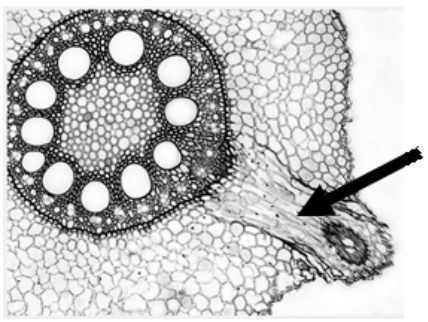
22. The process of speciation is depicted in the adjoining figure with three factors that influence speciation. Identify the type of speciation that would explain the evolution of new species (marked with dark circle) from the original species (marked with white circle).



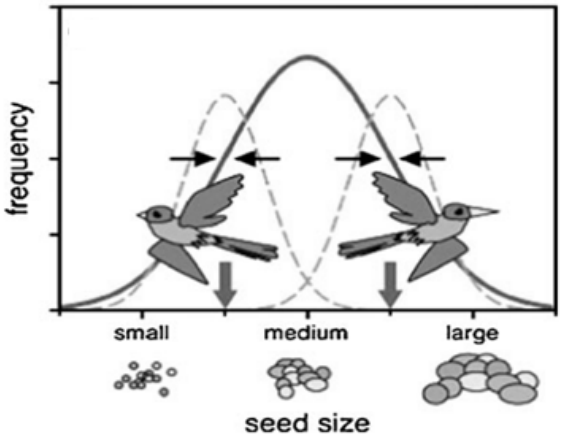
(a) Sympatric speciation
(b) Reproductive isolation
(c) Allopatric speciation
(d) Parapatric speciation

23. Erythrocyte sedimentation rate (ESR) is a common hematology test performed using blood containing anticoagulant. It measures the rate at which the red blood cells (RBCs), in a sample of whole blood, fall to the bottom inside a specific tube, under gravity. This sedimentation is due to rouleau formation where RBCs form a stack because of their discoid shape. Which of the following statements about ESR is correct ?
(a) Inflammatory conditions cause increase in "Acute Phase Proteins" in plasma, that cause the RBCs to repel from each other to form stacks.
(b) Increase in positively charged plasma proteins, increases neutralization of the negative charges on the surface of the RBCs, which allows the formation of the rouleaux.
(c) Bacterial endotoxins in plasma inhibit platelet aggregation causing RBC to clump.
(d) Anticoagulants in the blood increase the negative ions in plasma which increases charges on RBC membranes causing them to stack and form the rouleaux.

24. The adjoining figure is a transverse section of root of a monocot plant showing the stele. Identify the part pointed by arrow.
(a) Adventitious root
(b) Lateral root
(c) Tap root
(d) Adventitious bud



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



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

(a) The mean bill size in the population does not match the most abundant resource, and therefore selection pushes the bill size to an intermediate value.
(b) The resources in the middle of the distribution curve are unutilized providing a new ecological niche to evolve in future.
(c) Since resources in the tails of the distribution curve are left unexploited, selection establishes individuals with either small or large beak sizes.
(d) Selection pressure splits the population into two ecological specialists that evolve an optimal compromise of foraging on the most abundant seeds and avoid competition.

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

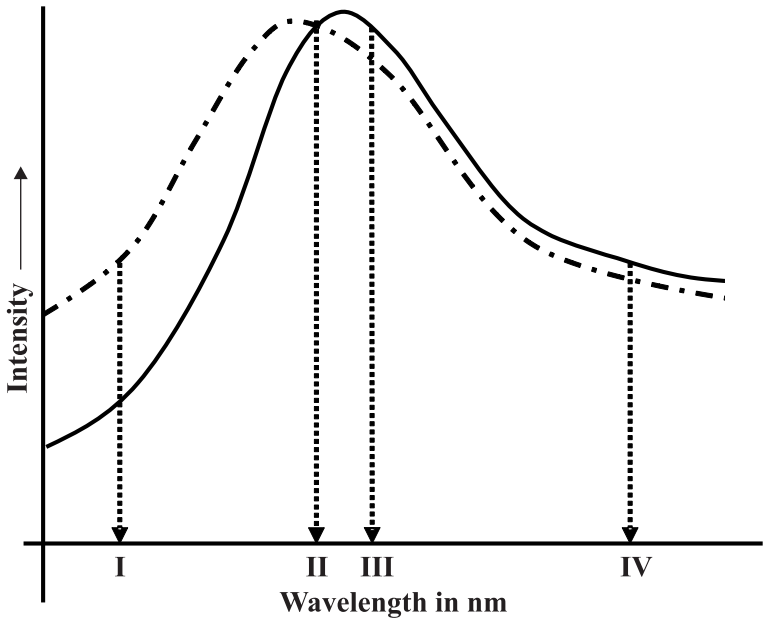
(a) Baking soda; sea water and beer
(b) Stomach acid; household ammonia and detergent
(c) Tomato juice; human blood and milk of magnesia
(d) Beer; human urine and vinegar

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

The genetic relatedness will be:

(a) less by a factor of 0.5 in ants.
(b) same in both cases.
(c) greater by a factor of 0.25 in ants.
(d) greater by a factor of 0.5 in ants.

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



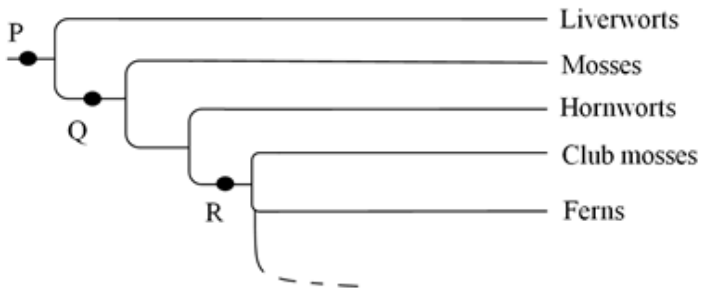
(a) I (b) II (c) III (d) IV

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

30. Warm blooded animals have mechanisms evolved for insulating their bodies. Choose the option that correctly depicts the increasing order of relative insulation that these body parts/components provide.
(a) Fat; Muscle; dry fur (b) Muscle; fat; dry fur
(c) Muscle; dry fur; fat (d) Dry fur; muscle; fat

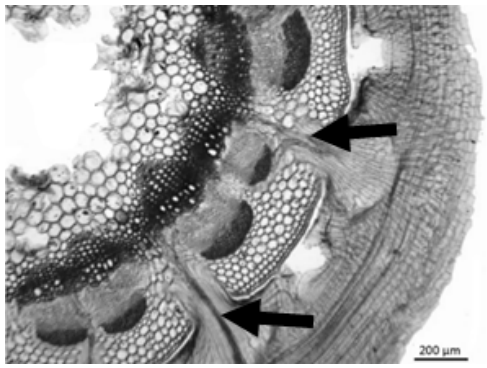
31. Which of the following is NOT TRUE about DNA polymerase-I ?
(a) It helps in the removal of primer and subsequent gap filling.
(b) It has both 5' to 3' and 3' to 5' exonuclease activity.
(c) It has low processivity and polymerization rate.
(d) It has only 5' to 3' exonuclease activity

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



(a) P: Persistent green sporophyte, Q: Protected embryos, R: Stomata
(b) P: Stomata, Q: Microphylls, R: Tracheids
(c) P: Microphylls, Q: Persistent green sporophyte, R: Stomata
(d) P: Protected embryos, Q: Stomata, R: Tracheids

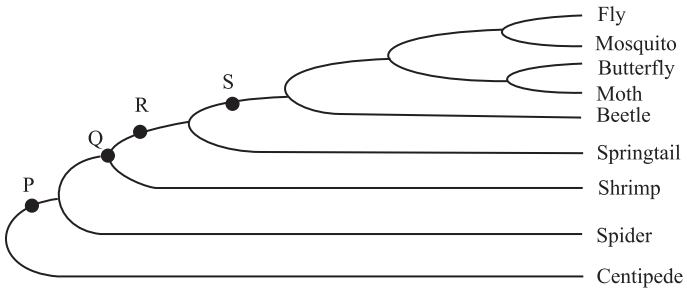
33. The given figure is transverse section of a stem of *Trifolium repens* (White Clover), a flowering plant, with *Cuscuta epithymum* growing on its stem. Identify the part pointed by arrows.



(a) Cork cambium
(b) Haustorium of parasite
(c) Secondary phloem
(d) Vascular cambium

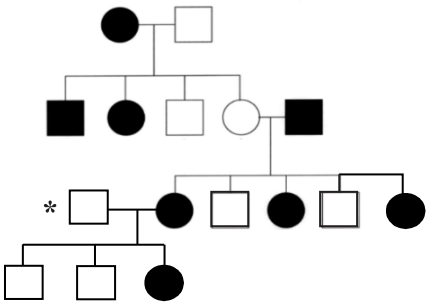
34. Na^+-K^+ATPase is essential for maintaining various cellular functions and its inhibition could result in diverse pathologic states. Ca^{2+} transport in cardiac muscles is also linked to Na^+-K^+ ATPase. Cardiac glycosides such as digoxin directly inhibit the Na^+-K^+ATPase. With respect to cardiac muscles, which of the following statements are correct events after digoxin inhibition of Na^+-K^+ATPase?
(a) Build-up of excessive K^+ extracellularly, and depletion of intracellular Na^+.
(b) Build-up of Ca^{2+} intracellularly leading to increased cardiac contractility.
(c) Inhibition Na^+-K^+ATPase stimulates the vagus nerve, causing an increase in heart rate.
(d) Changes in Na^+ ion concentration increases conduction of atrioventricular node causing stimulation of the sinoatrial node.

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



(a) P (b) Q (c) R (d) S

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



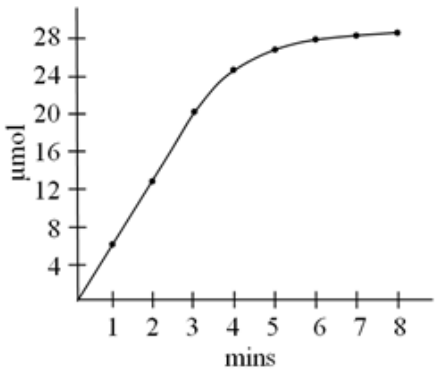
* Note: the person from outside the family does not carry a defective allele.
(a) X linked recessive (b) Y linked recessive
(c) X linked dominant (d) Autosomal recessive

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

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

Match the gases 1, 2, 3, and 4 with their names.
(a) 1 – Carbon dioxide, 2 – Water vapour, 3 – Nitrogen, 4 – Oxygen.
(b) 1 – Oxygen, 2 – Carbon dioxide, 3 – Nitrogen, 4 – Water vapour.
(c) 1 – Oxygen, 2 – Water vapour, 3 – Nitrogen, 4 – Carbon dioxide.
(d) 1 – Nitrogen, 2 – Water vapour, 3 – Oxygen, 4 – Carbon dioxide.

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

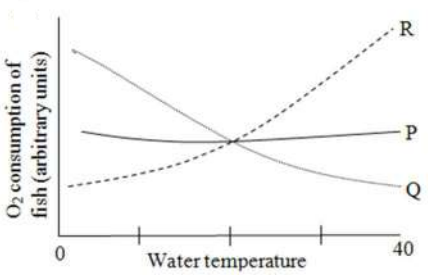


Which of the following is the correct method to calculate product formed per minute?

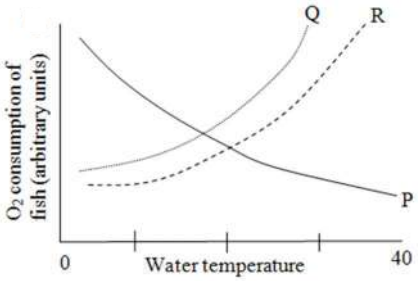
(a) $[(\mu moles)_{3\ min}-(\mu moles)_{1min}]/2$
(b) $[(\mu moles)_{8min}-(\mu moles)_{7min}]$
(c) $[(\mu moles)_{8min}-(\mu moles)_{1min}]/7$
(d) $[(\mu moles)_{5min}-(\mu moles)_{0min}]/5$

39. Which of the following figures (marked a, b, c, and d) appropriately depict the relationship of (P) oxygen content of water, (Q) oxygen consumption of resting fish and (R) oxygen consumption of active fish with respect to water temperature?

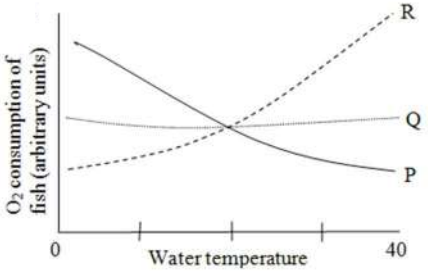
(a)



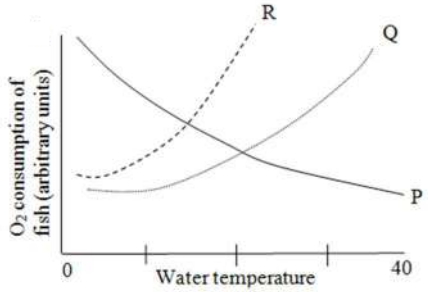
(b)



(c)



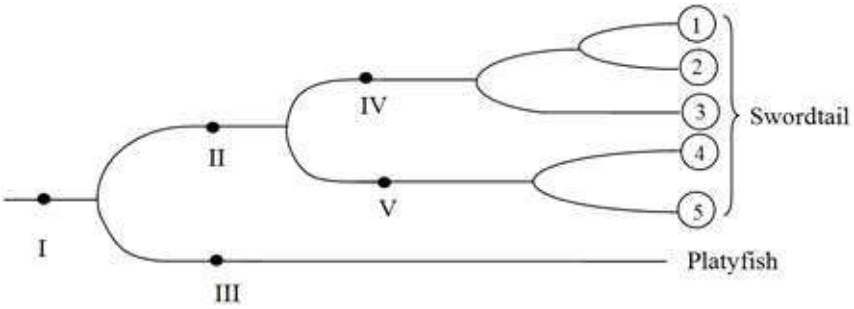
(d)



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

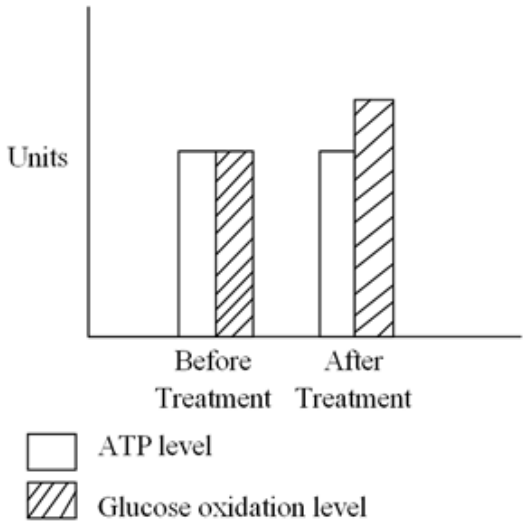
(a) Insertion of aquaporins into the luminal plasma membrane.
(b) Differentiation of the kidney into the cortex and medulla
(c) Appearance of Henle's loops.
(d) Increase in renal circulation.

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



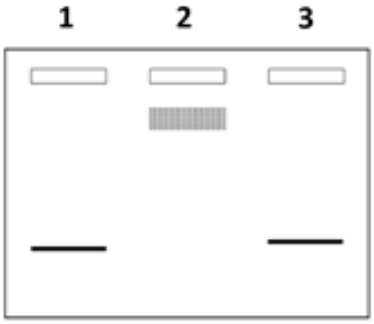
(a) Female sensory bias : I Sword: II
(b) Female choice : I Sword: IV, V
(c) Female choice : II, III Sword: IV, V
(d) Female choice : IV, V Sword: IV, V

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



The most likely use of the drug is:
(a) to increase strength of skeletal mass.
(b) to reduce anaerobic respiration by the tissues.
(c) to reduce body weight by increasing body respiration.
(d) to get trained for endurance exercise to maintain low levels of ATP over long period

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



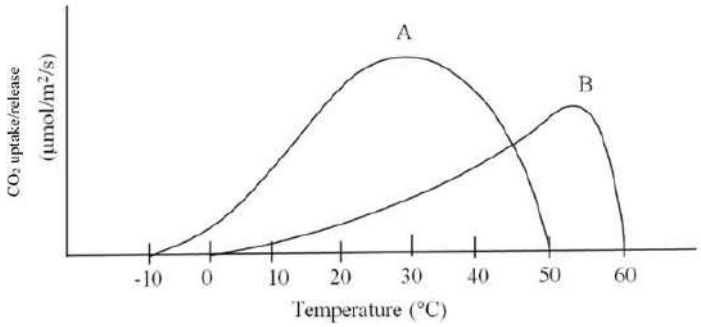
What can be the possible mechanism of action of the drug?

(a) The drug is likely to act by protecting the cells from damage.
(b) The drug is likely to affect topoisomerase I and helping DNA repair mechanism.
(c) The lane I and III represent intact supercoiled DNA thus indicating no effect of the drug.
(d) The drug is likely to be effective by inhibiting topoisomerase I enzyme that helps in DNA repair at multiple check points.

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

(a) 36 and 35 (b) 16 and 15 (c) 16 and 35 (d) 36 and 15

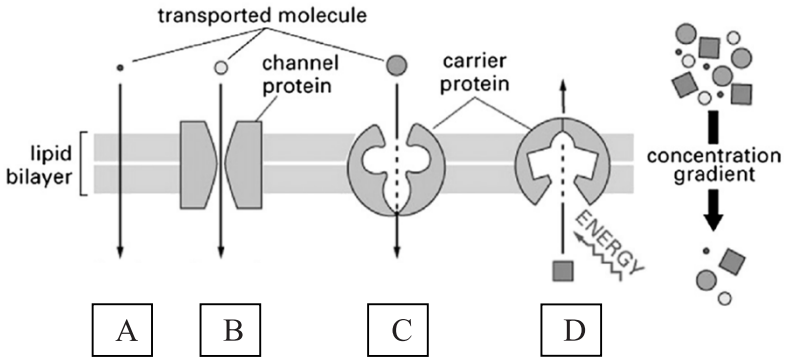
45. The response of the rates of photosynthesis (curve A) and respiration (curve B) to temperature is depicted in the graph.



The optimal temperature for net photosynthesis is:

(a) Between 10°C – 20°C (b) Between 20°C – 30°C
(c) 32°C (d) Between 40°C – 50°C

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



(a) A (b) B (c) C (d) D

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

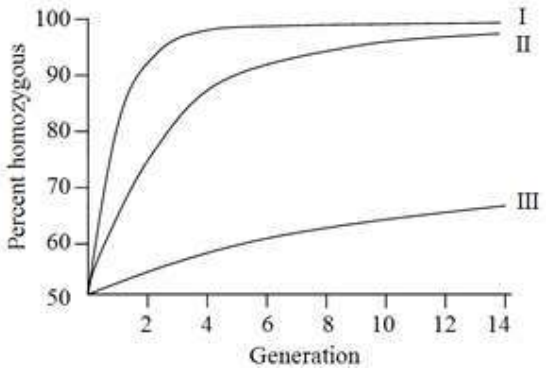
Values per Kg fat free tissue	Water (gm)	K (mM)	Na (mM)	Cl (mM)
Normal Kidney	802.2	58.3	82.6	67.7
1.	765	82.1	32.4	21.5
2.	922	3.72	142.0	109.0
3.	830.1	56.4	77.3	53.0

i. Hydronephrotic Kidney ii. Muscle iii. Serum

(a) 1.–ii, 2.–iii, 3.–i. (b) 1.–i, 2.–ii, 3.–iii.
(c) 1.–iii, 2.–ii, 3.–i. (d) 1.–iii, 2.–i, 3.–ii.

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

The types of breeding represented by the curves I, II and III respectively are:
(a) Brother –sister mating; mating of first cousins; self-fertilization
(b) Mating of first cousins; brother-sister mating; self-fertilization
(c) Self-fertilization; brother-sister mating; mating of first cousins
(d) Self-fertilization; mating of first cousins; brother-sister mating

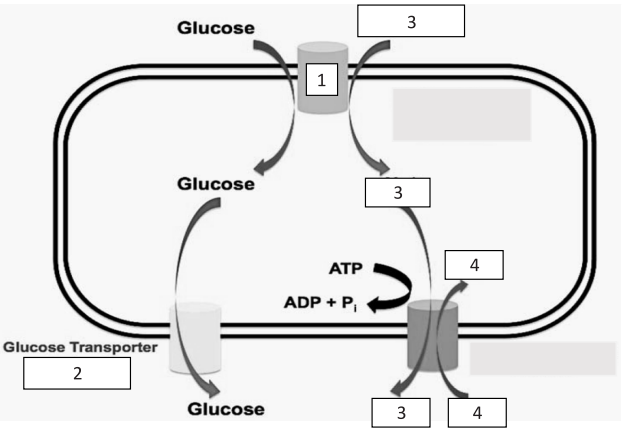


A – 2

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

MARKS WILL BE AWARDED ONLY IF ALL THE CORRECT OPTIONS ARE BUBBLED

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

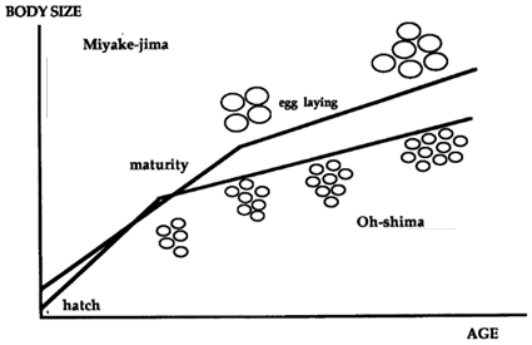


(a) 1 is a Uniport Transporter while 2 is a Symport Transporter
(b) 1 is a Symport Transporter while 2 is a Uniport Transporter
(c) 3 is Na+ ions While 4 is K+ ions.
(d) 3 is K+ ions and 4 is Na+ ions.

50. Since the characters fundamental to land plants first appeared in bryophytes, the key to understand transition of plants from aquatic to terrestrial habitats can be found in bryophytes. Which of the following Statements are in consonance with this hypothesis?
(a) Stomata are seen originally as a sporangial specialization, but in some bryophytes it is also expressed in the sporophyte vegetative body.
(b) In most of the bryophytes, rhizoid formation is restricted to the gametophyte.
(c) The cell walls of bryophytes contain lignin-related polyphenolic compounds as protection against UV irradiation and attack by micro-organisms.
(d) The mature gametophyte is a thallus or a leafy shoot in liverworts, a leafy shoot in mosses and a thallus in hornworts.

51. Renal portal system in reptiles drains the posterior part of the body into the kidney. In this context, with respect to reptilian body, which of the following statements are correct?
(a) Drug molecule injected in muscles of the front legs and the same drug molecule injected in muscles of hind legs can show different concentrations in circulating blood.
(b) Pharmacokinetics of a drug molecule will be same when administered in the vein of front legs or the tail vein.
(c) All drug molecules injected through the tail vein will show first site of metabolism in the liver.
(d) Drugs which are nephrotoxic should be injected in the front legs to reduce toxicity.

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



Choose the correct statement from the following;

(a) Divergence in the life history traits is influenced mainly by the age of maturity of the breeding individual.
(b) Populations in the island of Miyake-jima show a life history with late maturity with low fecundity.
(c) Heavy predation leads to a life history with late maturity and high fecundity.
(d) The divergence in life history traits is influenced by the age specificity and intensity of predation regime.

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

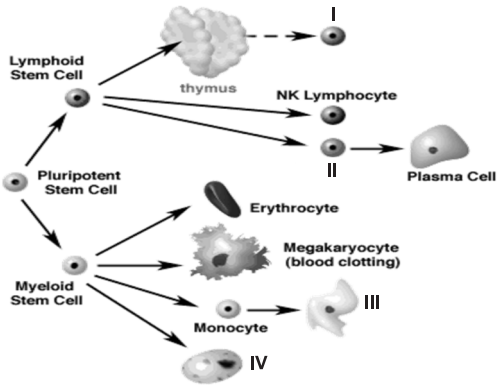
(a) Urine flow rate decreases.
(b) Kidney starts excreting solutes.
(c) The plasma osmotic pressure will increase.
(d) Significant branchial and intestinal solute uptake mechanisms set in.

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

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

(a) Glycol will diffuse fastest through a bilayer membrane amongst the three solutes listed
(b) Erythritol will diffuse fastest through a bilayer membrane amongst the three solutes listed
(c) The solute must first lose its waters of hydration, diffuse across the bilayer membrane, and then regain its waters on the opposite side.
(d) As the number of waters of hydration increases the activation energy for diffusion decreases.

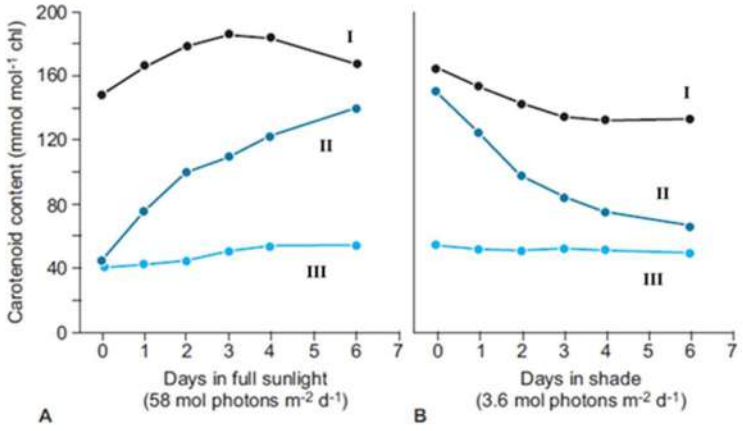
55. The lineage of cells of immune system are shown below in the figure. Identify the cells marked I, II, III and IV from the statements given.



(a) I is a T Lymphocyte while II is a B Lymphocyte.
(b) I is a B Lymphocyte while II is a T Lymphocyte.
(c) III is a granulocyte while IV is a macrophage.
(d) III is a macrophage while IV is a granulocyte.

56. C4 photosynthesis is a complex physiological adaptation that confers greater productivity than the ancestral C3 photosynthetic type in environments where photorespiration is high. Identify correct statements related to the C4 physiology.
(a) In C4 plants there is a temporal separation of CO_2 fixation and synthesis of glucose.
(b) Leaf has functionally closely connected, discrete compartments, with a relatively large compartment to host the Calvin cycle.
(c) For adapting to arid areas, C4 plants have co-opted same areas of the leaf, for photosynthesis and for water storage cells.
(d) In most C4 plants, the feat of concentrating CO_2 is achieved by confining Rubisco to bundle-sheath cells.

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



Based on the observations, which of the following statements are true ?
(a) II could be violaxanthin, which protects thylakoid membrane lipids from photo-oxidation.
(b) I could be xanthophylls, which contribute to increasing the light-harvesting capacity of the photosystems.
(c) I could be a photoprotector pigment like lutein.
(d) III could be a pigment, which is essential for light-gathering in low light intensities.

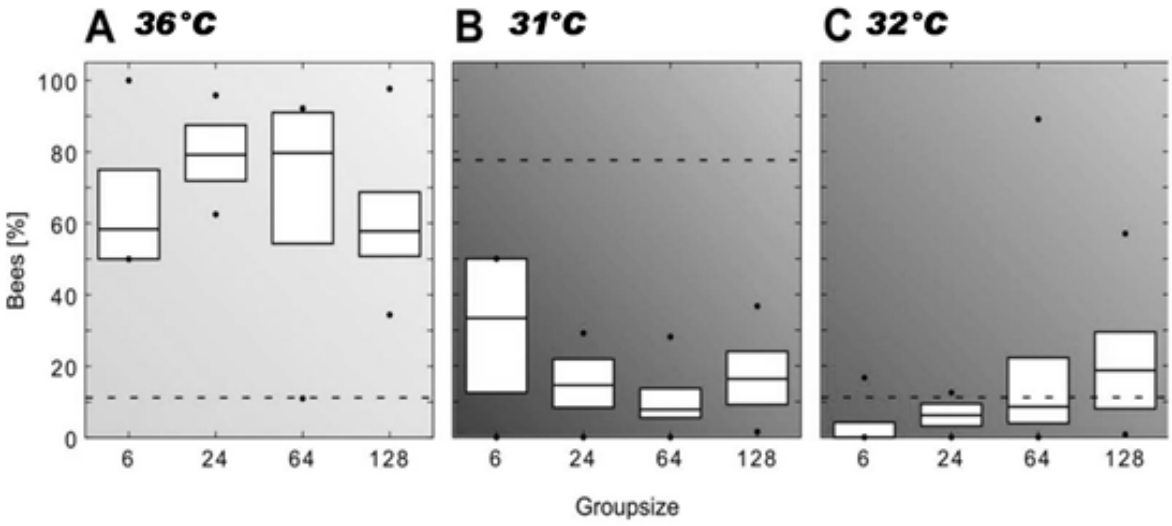
58. Animal species use various channels to communicate with each other. The selection of a communication channel depends on the ecology of the species and what kind of message the animal wishes to convey to its receivers. A few features of four such modes of communication (numbered 1 to 4) are tabulated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

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

Choose the appropriate statements:
(a) 1 is Tactile signals while 2 is Auditory signal
(b) 1 is Auditory signals while 2 is Tactile signal
(c) 3 is Chemical signal and 4 is Visual signals.
(d) 3 is visual signals and 4 Chemical signals.

59. *Km* values of enzymes provide information about their applications. In this context identify the correct statements from the following;
(a) A high *Km* value indicates the need for high substrate concentrations in order to achieve maximum reaction velocity.
(b) A low *Km* value indicates the need for high substrate concentrations in order to achieve maximum reaction velocity.
(c) If two enzymes, with similar Vmax in different metabolic pathways compete for the same substrate, then pathway involving enzyme that has the lower *Km* value is likely to be the 'preferred pathway'.
(d) If two enzymes, with similar Vmax in different metabolic pathways compete for the same substrate, then pathway that has enzyme with the higher *Km* value is likely to be the 'preferred pathway'.

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



Which of the following statements are correct ?

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

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

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

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

Rough Work

ASSOCIATION OF TEACHERS IN BIOLOGICAL SCIENCES

NATIONAL STANDARD EXAMINATION IN BIOLOGY

(NSEB - 2023)

Time: 120 minute **Max. Marks: 216**

Attempt All Sixty Questions

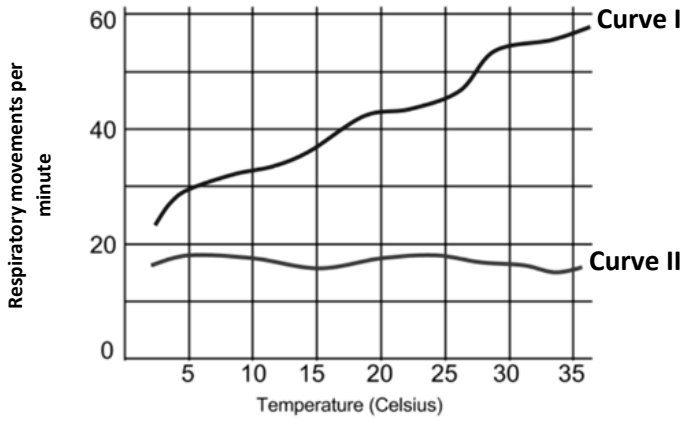
A – 1

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

1. 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

2. During mating season, the belly of three-spined stickleback fish becomes red. The male sticklebacks show typical aggressive behaviour when they see a red-bellied male stickleback, or any red-coloured object in the vicinity. Identify another example of this type of behaviour from the following:
   (a) Sparrow chicks exposing their gape for begging food from parents
   (b) Person regaining balance on losing his/her foothold
   (c) A dog sitting down on being pulled by the leash
   (d) An earthworm burrowing deeper in the soil in daytime

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



Curve I	**Curve II**
(a) Mackerel Fish	Kangaroo
(b) Grizzly Bear	Salmon fish
(c) Penguin	Emu
(d) Sea cow	Komodo dragon

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

5. A zoologist was studying the nervous system of some organisms. She observed that specimen M showed presence of a nerve net, N showed presence of ventral nerve cord with segmented ganglia and O showed a nerve ring with radial nerves. Based on the observations, M , N and O most likely could respectively be:
   (a) Mouse; lizard and squid
   (b) Planaria; squid and hydra
   (c) Hydra; leech and sea star
   (d) Sea star; earthworm and squid

6. Descriptions of the alimentary canals of four animals P, Q, R and S are given below;
   P: Short intestine and colon; small cecum.
   Q: Simple stomach; large cecum.
   R: Short intestine; cecum absent
   S: Four-chambered stomach with large rumen; long small and large intestine.

   Animals P, Q, R and S respectively could be:
   (a) Carnivore; insectivore; non-ruminant herbivore; ruminant herbivore
   (b) Carnivore; non-ruminant herbivore; insectivore; ruminant herbivore
   (c) Non-ruminant herbivore; carnivore; insectivore; ruminant herbivore
   (d) Insectivore; nonruminant herbivore; ruminant herbivore; carnivore

7. The plasma membrane of the root hair cells selectively allows absorbed minerals to pass through plasmodesmata into the endodermal cells which, then enter the xylem vessels. The indiscriminate absorption of minerals through apoplastic route, on the other hand, may admit undesirable minerals. This is prevented by ;
   (a) Glycerolipids in membranes of pericycle cells
   (b) Suberin in the wall of endodermal cells
   (c) Lignin in the wall of xylem cells
   (d) Sulfolipids in the membranes of xylem parenchyma cells

8. 100 bacterial cells are inoculated in a growth medium. Each cell takes 30 minutes to duplicate. Select the number of cells present in the broth after 20 hours of incubation, assuming no cell death.
   (a) 10^{14} (b) 10^{12} (c) 10^{112} (d) 100^{40}

9. It is observed that glucose absorption is slow if the energy drink contains only glucose as compared to drinks that contain glucose along with small amount of salt. Which of the following correctly explains this?
   (a) Glucose absorption is carried out by a membrane protein which is symporter by nature.
   (b) Glucose absorption is carried out by a membrane protein which is antiporter by nature.
   (c) Na^+ and 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.

10. Digestion of ingested food can occur in two ways. Intracellular - by taking the food material inside the cell and then breaking it using digestive enzymes (e.g. Amoeba). Extracellular - by secreting digestive enzymes, breaking the molecules and transporting them inside the cell (e.g. Fungus).
    What type of digestion is carried out in humans?
    (a) Intracellular
    (b) Extracellular
    (c) Mainly intracellular but partially extracellular
    (d) Mainly extracellular but partially intracellular.

11. Amytal is an inhibitor of Complex I involved in Electron Transport Chain (ETC). A cell free system was used to study the effect of amytal on electron transport chain. What effect do you expect on the Electron Transport Chain (ETC) system?
    (a) Flow of electron will completely stop.
    (b) There will be fewer electrons that will keep the ETC active.
    (c) Electron flow through ETC will remain normal.
    (d) Electrons will start flowing in reverse direction.

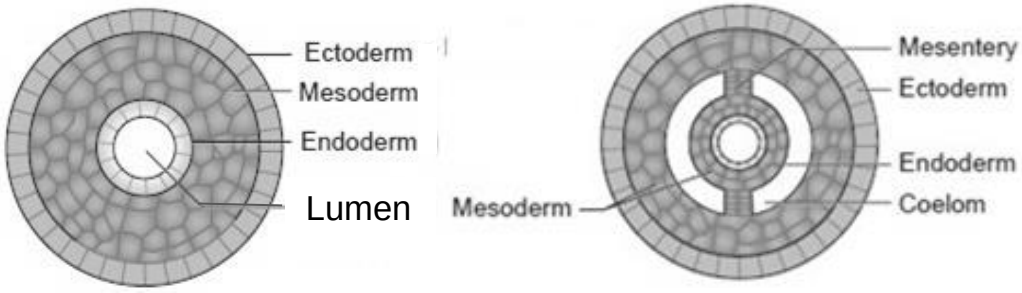
12. Smooth endoplasmic reticulum is **NOT** prevalent in which of the following?
    (a) Ovary (b) Testis (c) Adipose tissue (d) Pancreas

13. A protein contains 90 amino acids. During its synthesis how many times t-RNA gets attached to the A-site of ribosome?
    (a) 30 (b) 90 (c) 89 (d) 270

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

15. A scientist wants to synthesize recombinant DNA. Identify the correct pair of enzymes that he will use to (i) Cut the vector DNA and (ii) Seal the DNA after inserting the fragment of interest, respectively;
    (a) Exonuclease and ligase (b) Helicase and Nuclease
    (c) Helicase and ligase (d) Endonuclease and ligase

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



(i) (ii)

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

(a) (i) earthworm, (ii) cockroach (b) (i) planaria (ii) Tapeworm
(c) (i) cockroach (ii) Ascaris (d) (i) Planaria (ii) cockroach

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

Trait	Chimpanzee	Hyena
X	High	Moderate
Y	Rudimentary	No

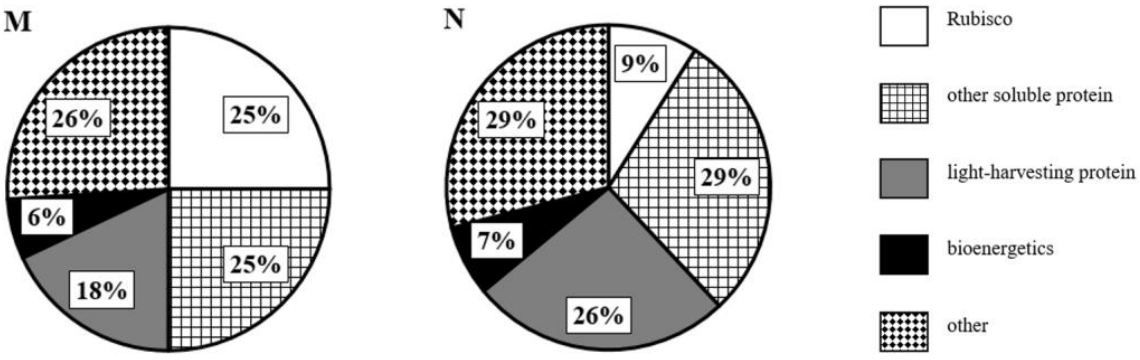
Traits X and Y are most likely and respectively the:

(a) tool making and bipedal locomotion
(b) degree of intelligence and tool making
(c) bipedal locomotion and cooperation in hunting
(d) cooperation in hunting and degree of intelligence

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

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

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



M and N most likely respectively indicate:

(a) C3 and C4 plants
(b) Sun and Shade growing plants
(c) C3 and CAM plants
(d) Plants with low and high water availability

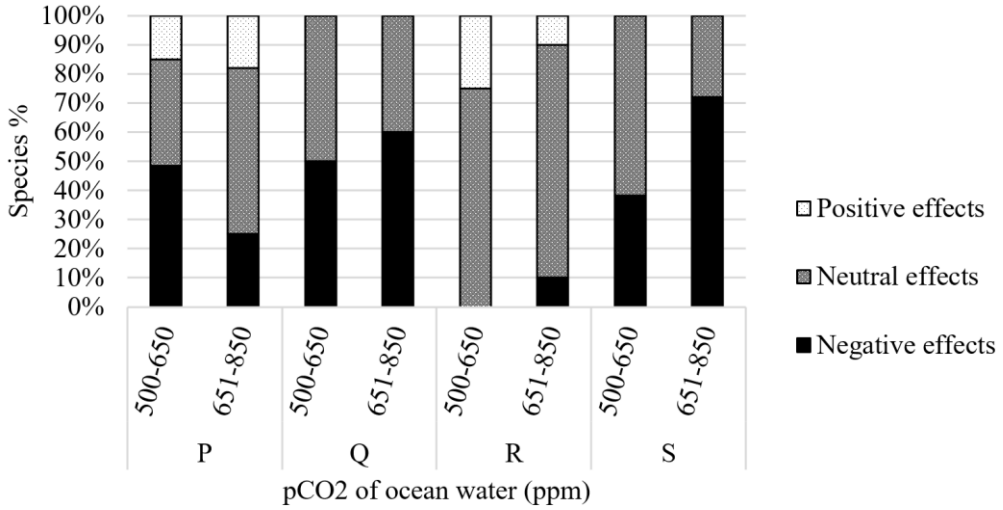
20. Humans are able to smell L and D forms of the aromatic compound, carvone, distinctively because;

(a) They bind to the same olfactory receptor but differently.
(b) The same olfactory receptor differentially forms unique complex with each isomer and triggers different nerve impulses.
(c) Olfactory receptors are chiral and are distinct for each isomer.
(d) The enantiomer flips to attach with the same receptor at a different site.

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

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

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



The species belonging to R is most likely:

(a) Crustacean (b) Fish (c) Echinoderm (d) Mollusc

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

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

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

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

(a) D-B-C-A (b) B-A-C-D (c) D-A-B-C (d) C-A-B-D

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

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

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

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

    If osmosis is assumed to be absent, which of the following statements is TRUE?
    (a) M & N are both dicots
    (b) M is a C-4 plant
    (c) M is a C-3 plant; N is a CAM plant
    (d) M is a CAM plant; N is a C-4 plant

28. Which of the following statements about Ubiquinone is **WRONG**?
    (a) It is an iron containing protein like cytochrome.
    (b) It is a small hydrophobic molecule.
    (c) It is a co-enzyme.
    (d) It is not a protein.

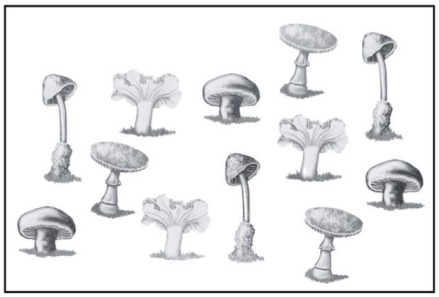
29. Which of the following statements is correct about the G_0 phase of the cell cycle?
    (a) The G_0 phase arrests the cell division and does not allow it to continue cell division ever again.
    (b) Once cells come out of the G_0 phase, they directly start DNA synthesis.
    (c) The G_0 phase is a preparatory phase.
    (d) Cells enter the G_1 phase post the G_0 phase

30. In corn plants, a dominant allele 'I' inhibits kernel colour expression, while the recessive allele 'i' in homozygous condition permits colour expression. At a different locus, the dominant allele 'P' controls purple kernel colour while homozygous recessive genotype 'pp' creats red kernels. If plants heterozygous at both loci are crossed what will be the phenotypic ratio of purple:red: colourless ?
    (a) 3:1:12 (b) 12:4:0 (c) 9:4:3 (d) 3:4:9

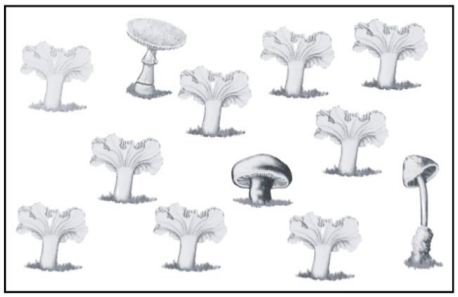
31. A man with haemophilia (a recessive sex linked condition) has a daughter of normal phenotype. She marries a man who is not haemophilic. If the married couple has four sons, what is the possibility that all four will be haemophilic?
    (a) 1/4 (b) 1/32 (c) 1/16 (d) 1/8

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

Habitat I



Habitat II



Which of the following statements regarding these habitats is correct?

(a) Habitat I has greater species richness than II.
(b) Habitat II has a more even distribution of species than I.
(c) Habitat II has greater species evenness than I.
(d) Habitat I is more diverse than II.

33. A cell suspension has a concentration of 10^{12} cells/mL. An analyst diluted the suspension to a concentration of 10^{6} cells/mL. How much reduction in concentration did the analyst achieve?
    (a) 50% (b) 6 log (c) 5 log (d) 2 log

34. Note the following processes:
    i. Mutation
    ii. Recombination
    iii. Post-translational modifications
    iv. Crossing over during meiosis
    v. Alternative splicing of RNA transcripts.

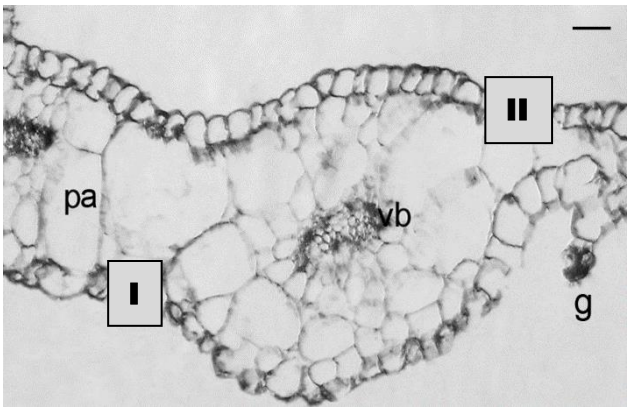
    According to the findings of Human Genome Project, there are about 25000 genes; but there is evidence for greater number of different polypeptides. Which of the above-mentioned processes might explain the discrepancy between the number of genes and the number of polypeptides?
    (a) i and ii (b) iii and v (c) i, ii and iv (d) All of the above

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

36. Thymus gland is always the preferred gland for DNA extraction because:
    (a) Being a soft gland, extraction can be easily done.
    (b) Being a vestigial organ in adults, it can be easily used for extraction.
    (c) The majority of cells in the gland are lymphocytes which have the greatest ratio of nucleus to cytoplasm.
    (d) The number of dividing cells in the gland at any given point of time is always high.

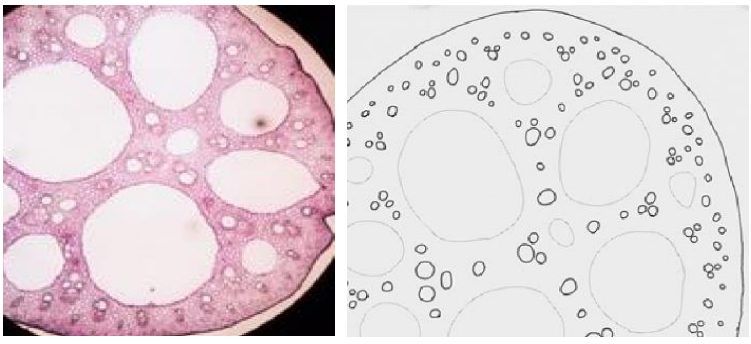
37. The TCA cycle is an amphibolic pathway. Anaplerotic reactions are such metabolic pathways that replenish TCA cycle intermediates when they leak away from the cycle. The leakage of Oxaloacetate from the TCA cycle forms which of the following?
    (a) Porphyrins (b) Pyrimidines (c) Acetyl CoA (d) Mannose

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



Which of the following respectively represent I and II marked in the picture?
(Choose the most appropriate one):
    (a) Adaxial epidermis and abaxial ectoderm
    (b) Endodermis and Epidermis
    (c) Abaxial epidermis and adaxial epidermis
    (d) Lower ectoderm and Upper ectoderm

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



    (a) The presence of empty spaces in parenchyma indicates a dying petiole.
    (b) The thick epidermis indicates the plant to be found in highly saline areas.
    (c) The dense vascular bundles to the periphery indicate the plant to be from an arid zone.
    (d) Air filled spaces indicate the plant can survive in low oxygen areas.

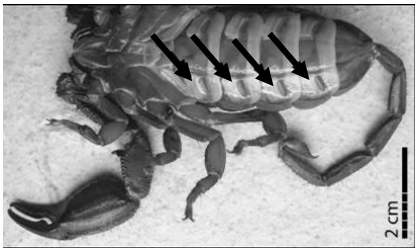
40. It is observed that plant 'M' requires 3000 ATPs and 1200 $NADPH_2$ for synthesis of starch; while the plant 'N' requires 1800 ATPs and 1200 $NADPH_2$ to synthesise same amount of starch. Plant 'M' and 'N' respectively could be:
    (a) Sorghum and sugarcane
    (b) Rice and Tomato
    (c) Maize and Wheat
    (d) A tropical plant and a succulent xerophyte.

41. In one of the bacterium of *Acetobacter* family, it was found that the enzyme, succinate CoA-synthetase was absent. The bacteria are, however, useful in the production of vinegar since they use an alternate enzyme. In this context, which of the following statements is correct?
    (a) These bacteria appear to have adapted to utilize the abundant citrate in its environment.
    (b) These bacteria appear to have adapted to utilize the abundant lactate in its environment.
    (c) These bacteria appear to have adapted to utilize the abundant acetate in its environment.
    (d) These bacteria appear to have adapted to utilize the abundant nitrate in its environment.

42. Lagomorphs like rabbit are caecal fermenters and they produce faecal pellets from caecum. In this context, identify from the following, the most appropriate statement that explains this adaptation;
    (a) The fibre digestion takes place in the caecum using microbes that are live in the caecum.
    (b) They produce soft faeces containing nutrients from the cecum, in the night, which they eat again.
    (c) They cannot chew the cud like bovines but they retain food in caecum for a long time to digest the fibre.
    (d) They produce faeces only in the daytime and allow food to remain within the gut overnight to allow digestion of fibres.

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

    (a) Segmental Gills
    (b) Segmental Spiracles
    (c) Book lungs
    (d) Segmental tracheae

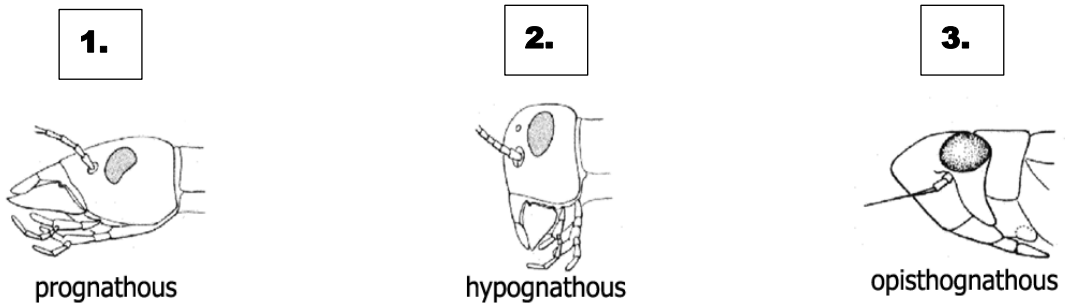


44. An individual taking a leisurely walk in the forest trips over a rattlesnake leading to instant changes in the physiology. A few possible changes are listed below:
    (i) Epinephrine binds to receptors in liver and on fat cells.
    (ii) The nervous system stimulates endocrine cells in the adrenal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

    The changes that would occur in the given situation are:

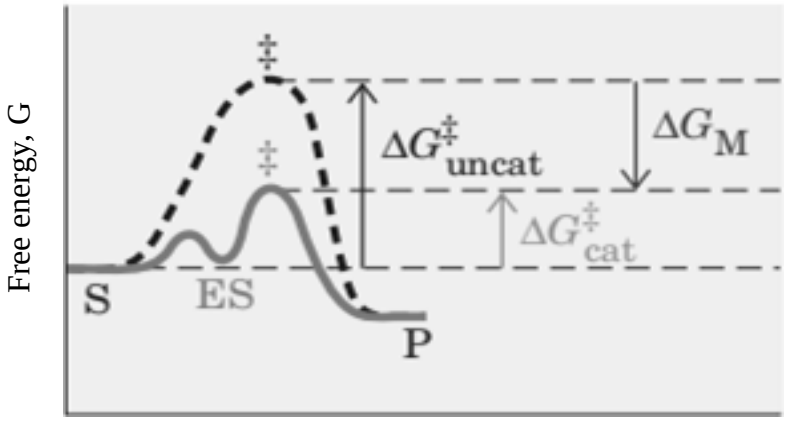
    (a) (i), (ii), (iv) and (vi)
    (b) (ii), (iv) and (vi)
    (c) (i), (ii), (v) and (vi)
    (d) (i), (iii) and (iv)

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



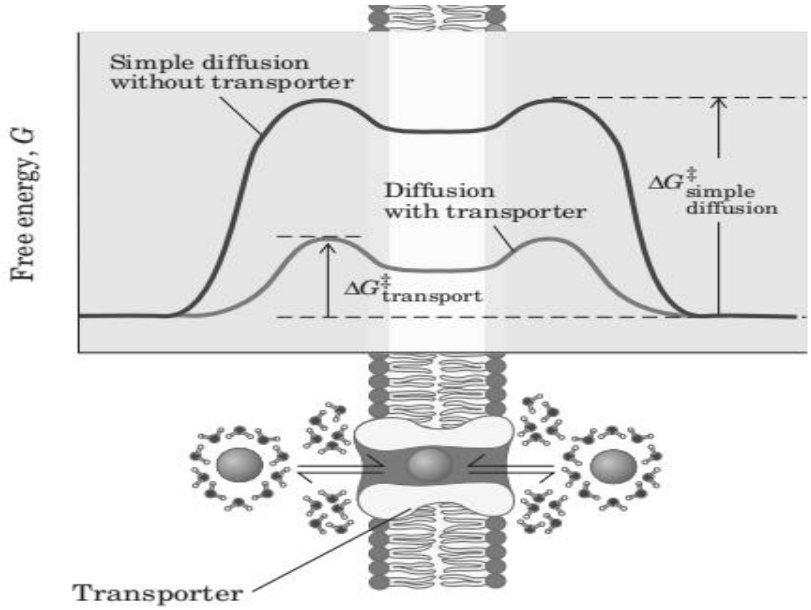
(a) X = 1, Y = 2, Z = 3
(b) X = 2, Y = 3, Z = 1
(c) X = 2, Y = 1, Z = 3
(d) X = 1, Y = 3, Z = 2

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



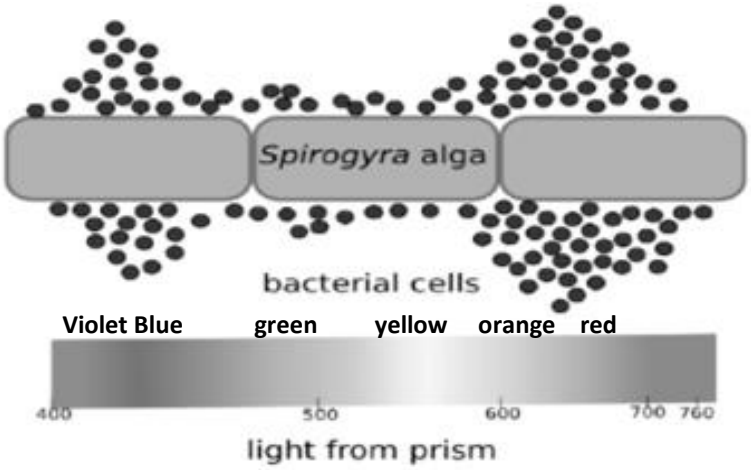
(a) Enzyme lowers the activation energy essential for the substrate to move to transition state
(b) Enzyme catalyzed reaction is a two-step reaction
(c) Enzyme provides energy to the substrate
(d) Enzyme helps the substrate to overcome the transition state faster to move to product state

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



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

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:



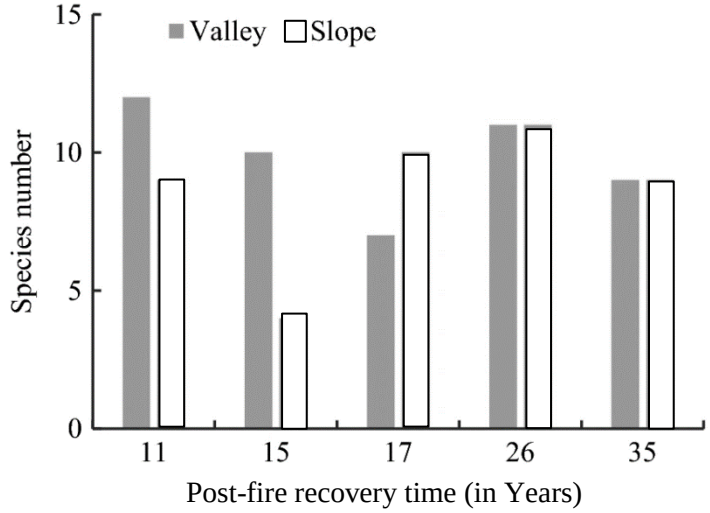
Select the correct conclusion from the statements given below:
(a) Green light leads to increased oxygen production.
(b) Green light is absorbed maximum by *Spirogyra sps*.
(c) Red light results in maximum oxygen production.
(d) Bacterial cells absorb red light.

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. 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?

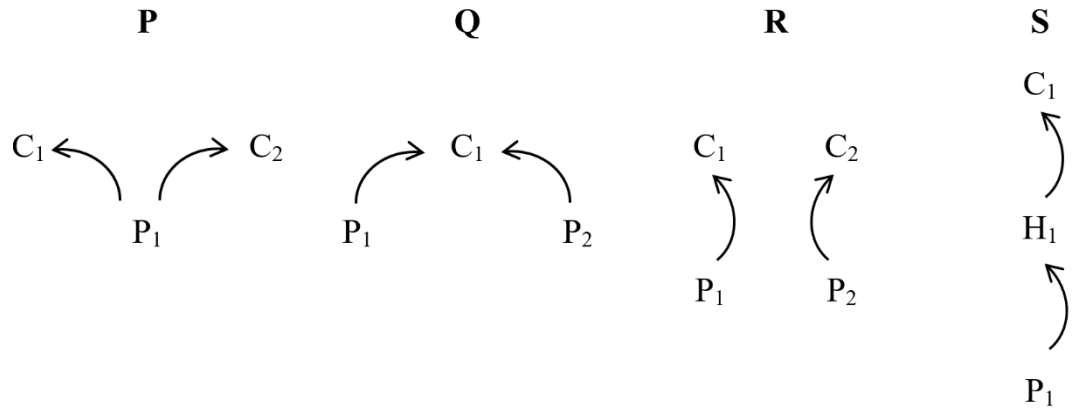
(a) The recovery along the slopes is faster during the middle stage of succession after fire as compared to valley.

(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.

50. Ecosystems consist of populations of different species which constantly interact with each other. A few such interactions (P, Q, R and S) are depicted below.
P_1 and P_2 = Producer **or** Prey, H_1 = Herbivore and C_1 and C_2 = Carnivore.



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

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

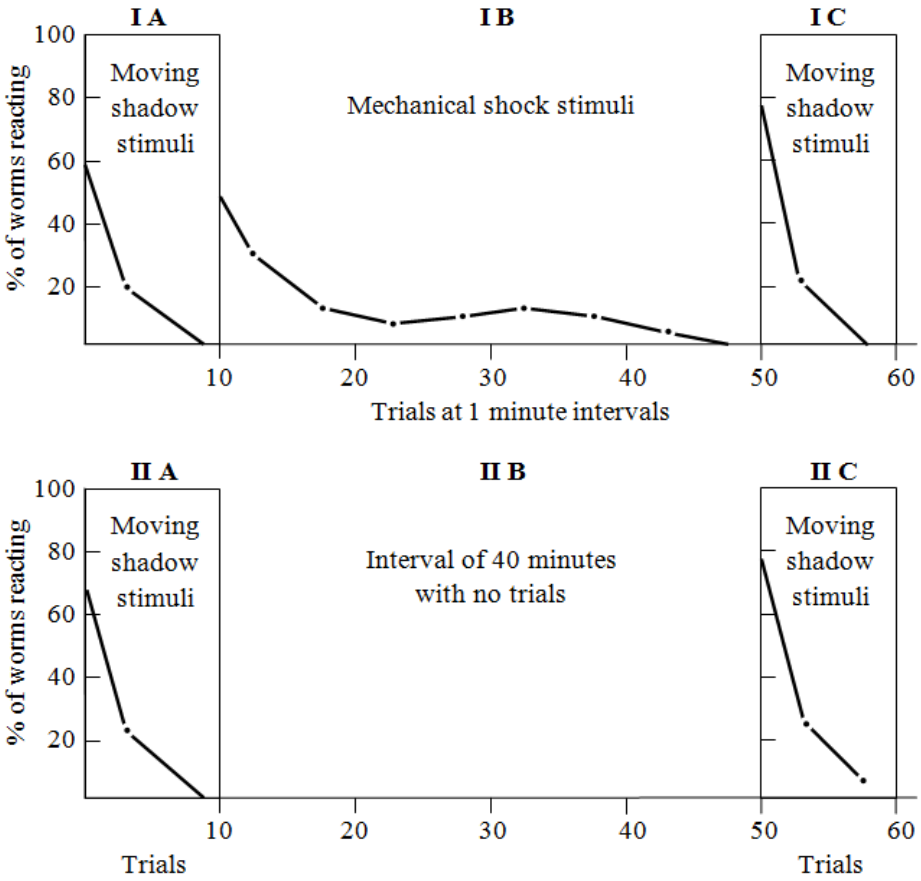
(b) Apparent competition between P_1 and P_2 in Q.

(c) Commensalism between C_1 and C_2 in P.

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

51. Which of the following is true about protein translocation?
    (a) Ribosomes can recognize the signal sequence in the protein and dock them on endoplasmic reticulum (ER).
    (b) Protein translocation into the endoplasmic reticulum (ER) takes place simultaneously along with translation.
    (c) A fully folded protein can enter the endoplasmic reticulum (ER) from the cytosol.
    (d) Protein synthesis may involve free ribosomes, which are eventually docked to the endoplasmic reticulum (ER).

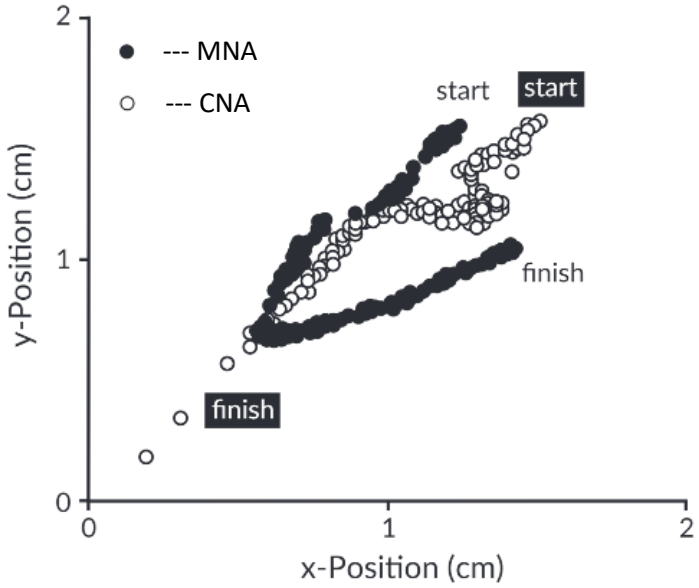
52. Nereis is a worm that burrows in the floor of brackish estuaries. Its head and anterior segments protrude from the burrow to feed on the surface around the burrow. During feeding a variety of stimuli induce the worm to jerk back into its burrow. For an experimental study, a behavioural scientist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



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

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

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

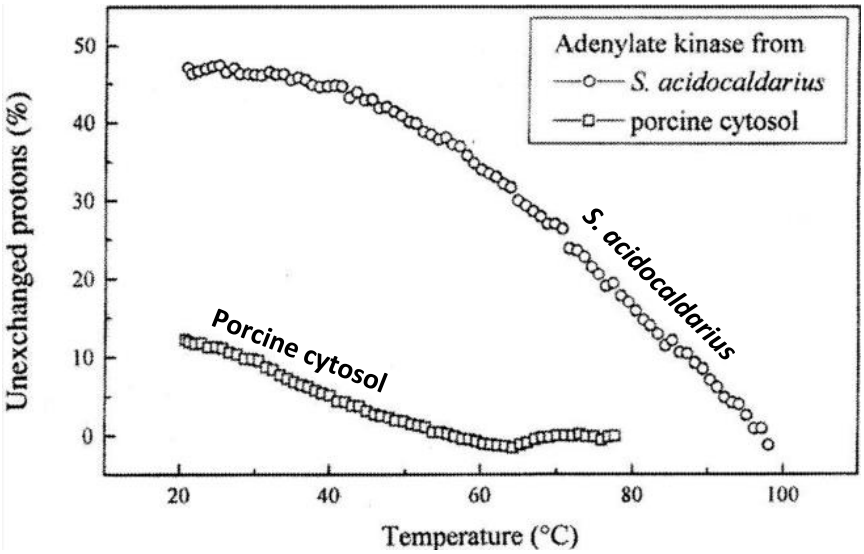


Which of the following are the correct interpretations?

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

54. Proline is normally absent in membrane proteins. The possible reason(s) for this can be :
(a) It is a hydrophobic amino acid.
(b) It is unable to attain the required protein conformation.
(c) It causes kinks in α-helices.
(d) It forms peptide bond as an amide and its nitrogen is not bound to any hydrogen.

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



Which of the following statements are correct in this context?

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

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

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

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

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

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

(b) They can multiply only by fission.

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

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

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

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

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

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

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

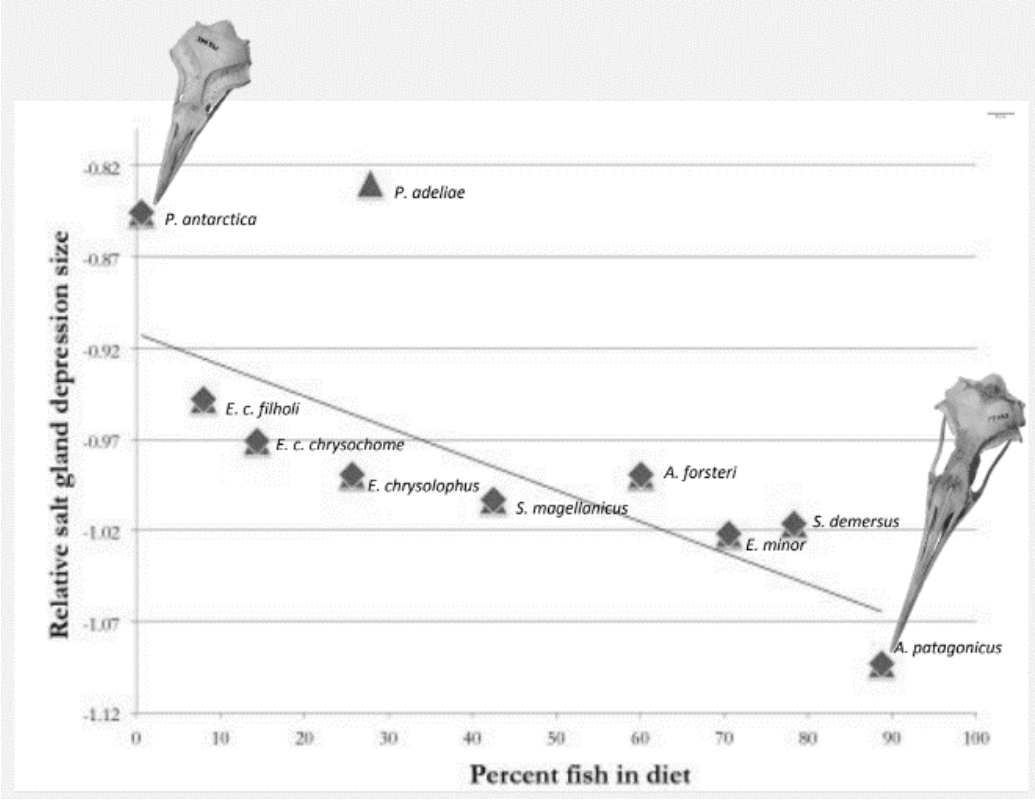
58. 2,6-Dichlorophenolindophenolate (DCPIP), an electron acceptor, turns colourless from blue colour when it is added to a suspension containing mitochondria. What does this indicate?

(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.

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



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

ASSOCIATION OF TEACHERS IN BIOLOGICAL SCIENCES

NATIONAL STANDARD EXAMINATION IN BIOLOGY

(NSEB - 2024)

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. A realized niche is the space occupied by a species under real-world conditions. Identify the factors that influence the establishment of realised niche of a species.

   (i) interspecific competition. (ii) predation.

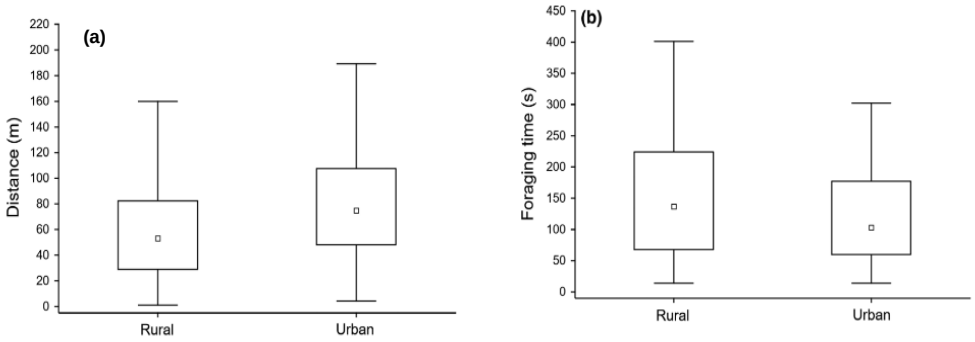
   (iii) availability of resources. (iv) intraspecific competition.

   Choose the correct option:

   (a) (i) and (iii) only (b) (ii), (iii), and (iv) only

   (c) (i), (iii) and (iv) only (d) (i), (ii), and (iii) only

2. A study conducted to analyse the foraging strategies of house sparrow compared observations on sparrow populations in rural and urban surroundings. The image below depicts the findings.



   The Marginal Value Theorem says that animals must forage by using most economic and efficient strategy that will balance energy gain and consumption. Which of the following interpretations of the study results, support the theorem?

   (a) The foraging distances in urban environs are shorter while those of rural environs are longer.
   (b) The sparrows spent more time in foraging in urban environs due to more "artificial habitats" in urban environs.
   (c) The sparrows spent less time foraging in urban areas where resources are at larger distances.
   (d) Rural environs with "more natural" habitats offer lesser resources at shorter distances.

3. Which of the following **cannot** be considered an advantage of the efficient photosynthetic pathway for the fixation of atmospheric carbon dioxide in C_4 plants?

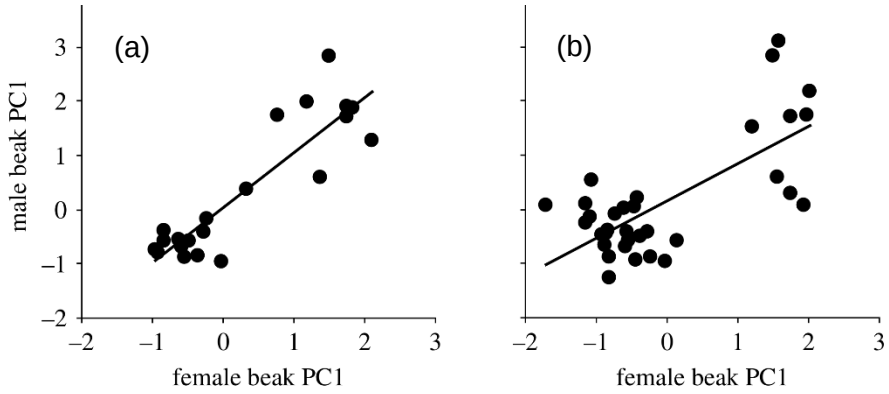
   (a) It facilitates adaptation to arid conditions.
   (b) It facilitates adaptation to high temperatures.
   (c) It facilitates lower energy cost per CO_2 fixed.
   (d) It facilitates survival in marginal environments.

4. Like the bony skeletons in vertebrates, haemolymph hydraulics enables some invertebrates in locomotion. Which of the following animals uses haemolymph hydraulics for locomotion?

   (a) Grasshopper (b) Spider (c) Crab (d) Octopus

5. Which of the following has a turnover time equal to lifetime of humans?
   (a) Lens of the eye (b) Sperm cells (c) Muscle cells of ribs (d) Hepatocytes

6. The population of Medium Ground Finch (*Geospiza fortis*) on Santa Cruz Island of Galapagos, features mainly large and small beak size morphs, with relatively few intermediates. The Figures (a) and (b) below depict the pairing patterns in two different breeding seasons. Male and female 'beak PC1' values are Principal Component - 1, indices derived based on beak length, depth and width.



Which of the following interpretation is correct?

(a) This type of breeding indicates a reproductive isolation purely of allopatric origin.
(b) There is disruptive selection in sympatry against birds with intermediate beak sizes.
(c) The pairing pattern indicates a selection pressure for intermediate beak sizes.
(d) The trend in the pairing patterns seen in two seasons indicates an efficient reproductive isolation between the morphs.

7. If one starts with 10,000 (10^4) bacterial cells in a culture that has a generation time of 2 hours, what would be the magnitude (ten-fold) of increase in cell number at 4 hours, 24 hours and 48 hours respectively?
   (a) Less than 1, 4, and 7 (b) 1, 3, and 7
   (c) Less than 1, 5, and 9 (d) 4, 16 and 49

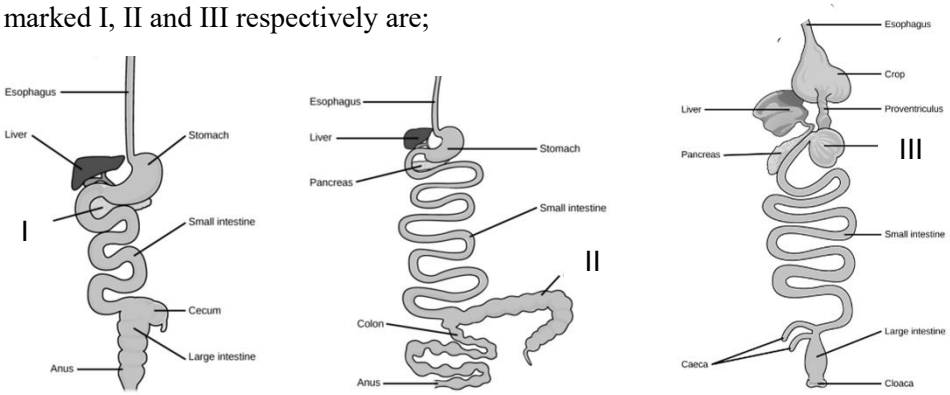
8. If atmospheric PO_2 is 130 mm of Hg and alveolar PO_2 of a person is 85 mm of Hg, which of the following is most likely correct?
   (a) The person is suffering from lung dysfunction.
   (b) The person is respiring at high altitude.
   (c) The partial pressure of oxygen in pulmonary arteries for the person must be between 60-130 mmHg.
   (d) The partial pressure of oxygen in pulmonary veins for the person must be between 40-60 mmHg.

9. Consider the following pathway involving glycolysis that further leads to citric acid (TCA) cycle. (PFK = Phosphofructokinase).

$$\mathbf{Glucose} \rightarrow \mathbf{F-6-PO_4} \underset{PFK}{\Longrightarrow} \mathbf{F1,6,bisPO_4} \rightarrow\rightarrow\rightarrow \mathbf{Pyruvate} \rightarrow \mathbf{Acetyl\ CoA} \rightarrow \mathbf{TCS\ Cycle}$$

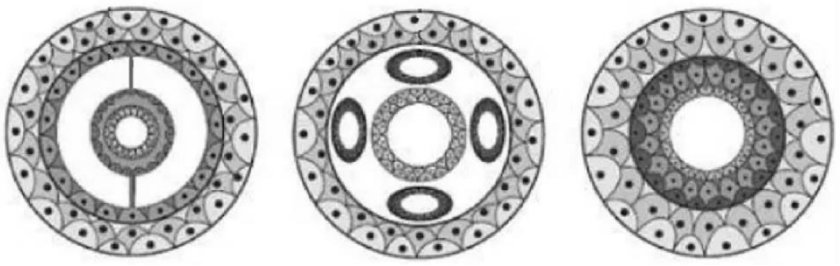
Which of the following molecules are likely to act as activators and inhibitors respectively of the enzyme PFK?
   (a) Citrate and ATP (b) AMP and ADP (c) ATP and citrate (d) AMP and citrate

10. The Gastrointestinal tracts with some associated organs are shown in the diagrams below. The names of the organs marked I, II and III respectively are;



(a) Duodenum, gall bladder and cardiac stomach
(b) Gall bladder, Intestinal diverticulum and pyloric stomach
(c) Pancreas, caecum and gizzard
(d) Pancreas, Intestinal diverticulum and stomach

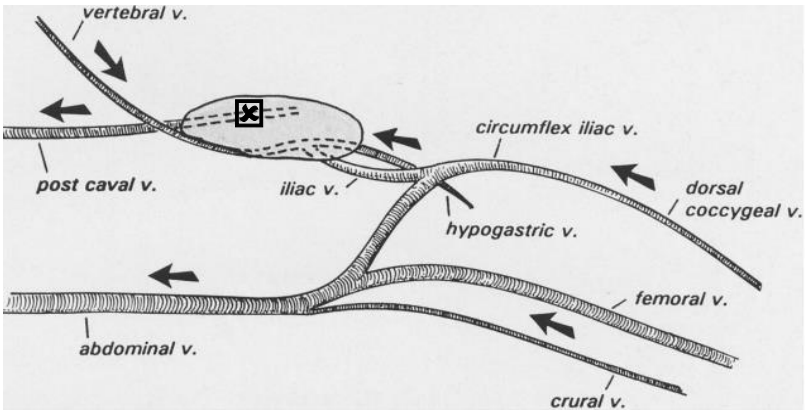
11. Coelom is the fluid filled space between the body wall and the digestive system. Its absence or presence significantly influences classification of animals. The schematic diagrams (i), (ii), and (iii) below depict three different variations in the coelomic condition. Select the correct sequence of animal group to respectively match the coelomic types (i), (ii) and (iii).



(i) **(ii)** **(iii)**

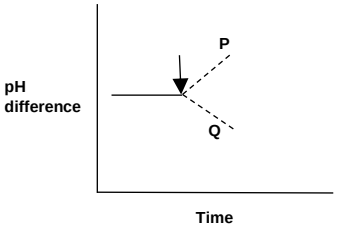
(a) Annelids, Roundworms and Flatworms
(b) Roundworms, Flatworms and Annelids
(c) Flatworms, Roundworms and Annelids
(d) Annelids, Flatworms and Roundworms

12. One of the portal systems evolved in lower vertebrates is to help drain the muscular hind legs. The image below depicts that portal system in the red-eared terrapin (*Trachemys scripta elegans*), a fresh water turtle and the most commonly kept pet reptile. The organ marked "☒" is _____.



(a) Lymph node (b) Kidney (c) Testis (d) Liver

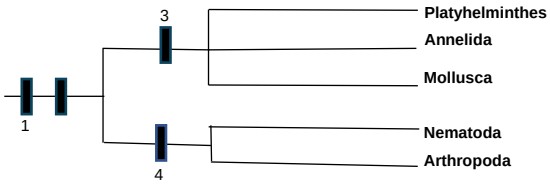
13. pH difference across inner mitochondrial membrane over time in an actively respiring cell is shown in the graph. The likely effects of addition of P and Q to the cell at the time indicated by arrow are also shown. Which of the following statements is correct?



(a) P is likely to be ATP synthase inhibitor.
(b) Q is likely to be cytochrome inhibitor.
(c) P is likely to be metabolic activator.
(d) Q is likely to be activator of anaerobic respiration.

14. Siamese cats show a mutated enzyme tyrosinase (required for the synthesis of melanin) that is active only below a temperature of 33^0C. Based on this information, which of the following is likely to be correct?
(a) Newly born Siamese kittens are likely to be creamy or white in colour.
(b) As the young grow to adulthood, mainly their belly portions are likely to turn dark.
(c) Newly born Siamese kittens are likely to show darker nose, paws, and ears than the rest of the body as compared to adults.
(d) The body of the Siamese cat is likely to be darker in summer as compared to winter season.

15. Phylogenetic classification of five animal phyla is shown below.



Which of the following options correctly identifies the characteristics associated with labels 1 to 4?
(a) 1 is Bilateral symmetry and 3 is Protostomy (b) 3 is Diploblasty and 4 is Triploblasty
(c) 1 is Bilateral symmetry and 2 is Deuterostomy (d) 2 is Protostomy and 3 is Spiral cleavage

16. Among several excretory products of animals, P, Q and R are tabulated along with their properties.

Properties	P	Q	R
Toxicity	+++	++	+
Energy cost	+	++	+++
Water loss during excretion	+++	++	+

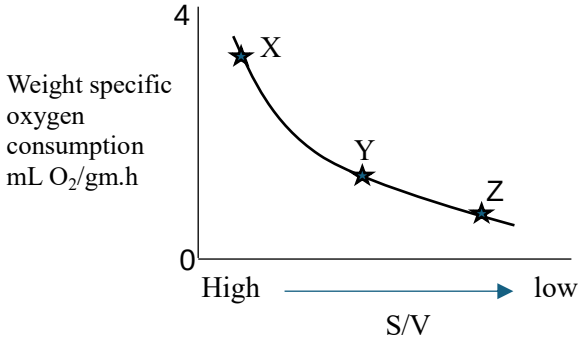
Waste product P most likely is:

(a) Urea (b) Carbon dioxide (c) Uric acid (d) Ammonia

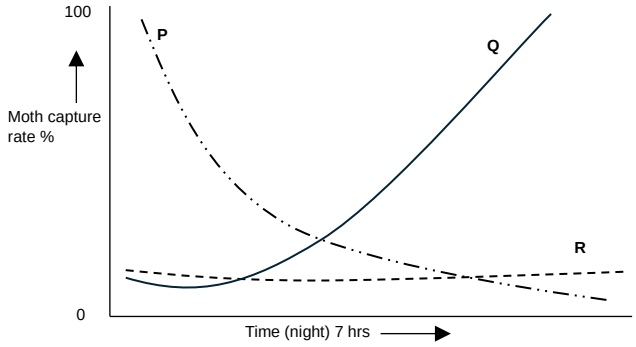
17. Weight specific oxygen consumption and body surface area to volume (S/V) ratio of three animals (X, Y and Z) is depicted in the graph.

X, Y and Z respectively indicate:

(a) Elephant, human, dog
(b) Shrew, sheep, cat
(c) Mouse, sheep, elephant
(d) Horse, dog, cat



18. In the event of a bat attack, tiger moths show three different types of responses. Some tiger moths show warning colouration indicating their toxic chemical defense while some moths produce clicking sounds to jam bat's sonar. Some moths show acoustic startling responses to deter the attacking bats. Scientists experimented with a bat colony that was not exposed to these moths. When they studied the moth capture rate against each of these moth responses, the following data was obtained.



Which of the following can be deduced from these results?

(a) P indicates response to jamming behaviour.
(b) Q indicates response to acoustic startle behaviour.
(c) R indicates bat's response to warning colouration for chemical toxicity.
(d) R indicates control behavior of bats in absence of all the three types of moth behaviour.

19. Zebra finches are monogamous birds mainly found in Australia and Indonesia. These birds (both male and female) lack any crest feather (ornamentation) on their head. To study the mate choice behaviour of zebra finches, the following experimental groups of modified individuals were made.

Group	Modification	Mate preference of female offspring
I	Both male and female ornamented and mated.	Ornamented male
II	Only males ornamented and mated with females.	Ornamented male
III	Only females ornamented and mated with males.	Both preferred equally
IV	Neither sex was ornamented and mated.	Both preferred equally

The results indicate that:

(a) Ornamentation of crest on either parent influences mate choice.
(b) Mate choice behavior is genetically determined and cannot be changed.
(c) Mate choice is influenced by imprinting.
(d) Mate choice behavior is dictated by presence or absence of ornamentation of female parent.

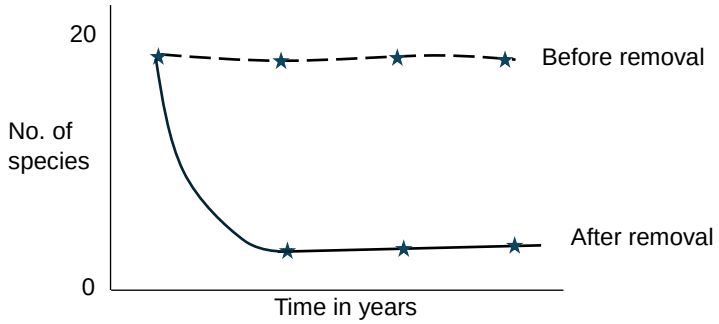
20. How many times does megaspore mother cell nucleus divide till the formation of female gametophyte in angiosperms?

(a) 5 (b) 11 (c) 4 (d) 8

21. Consider a germ cell having 3 pairs of homologous chromosomes. After meiotic division, how many possible combinations of chromosomes will be found in egg cells?

(a) 8 (b) 16 (c) 6 (d) 9

22. On a rocky intertidal habitat, a sea star (*Pisaster ochraceus)* and mussel (*Mytilus californianus)* are commonly found along with several other smaller sized species of various animals and algae. When all sea stars were removed from the habitat, the results obtained are depicted in the following graph.



What can be deduced from this data plotted in the graph?

(a) Sea star was a likely predator of mussels that overgrew in the habitat in the absence of Sea star.
(b) Mussels are the keystone species of the habitat.
(c) In absence of sea star, severe competition between the remaining species led to their extinction.
(d) Sea star is the dominant competitor for space to all other species thriving in the intertidal zone.

23. Primary spermatocytes undergo meiotic division to give rise to sperm cells. Nondisjunction of sex chromosomes during this division can lead to male gamete formation with abnormal number of chromosomes. If such a sperm cell fuses with a normal egg cell, which one of the following genotypes will not be found in the offsprings?

(a) XXY (b) XXX (c) XYY (d) YO

24. Australian Bush fly lays its eggs in the fresh dung of herbivores. As the dung hardens, no more eggs can be laid. When the eggs hatch, larvae feed on the dung until they pupate in the nearby soil. In an experiment, fixed volume of cow dung cakes (2 dm^3) was populated with different number of eggs ranging from 1400 – 4250. Figure 1 shows percentage of eggs emerged as adults from each dung cake. Each dot represents a 2 dm^3 dung cake. Figure 2 represents percentage survival for any original egg number which will give exactly 915 adults. What conclusion can be drawn?

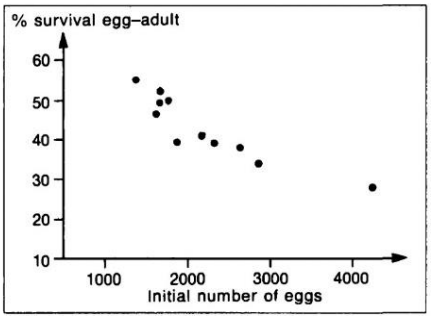


Figure 1

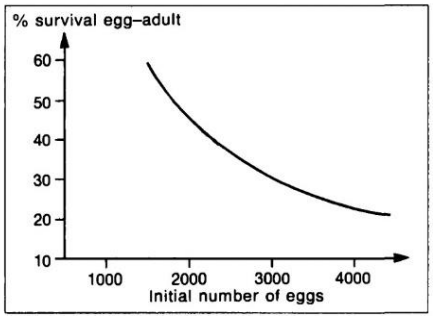


Figure 2

(a) The number of adults emerging from the dung cake of any size is always fixed.
(b) Dung cake populated with lesser number of eggs would have given higher number of adults emergence.
(c) Number of adults emerging is fixed if dung cake size is nearly constant.
(d) All the eggs laid by bush fly are not viable if the number is above 1400.

25. The amount of dead organic matter accumulated on the forest floor at any given point of time differs as one goes from equator to higher altitude. The table given below represents 4 forest types with the amount of dead organic matter measured per hectare.

Forest type	Mass of dead organic matter (tons/ha)
M	10
N	2
O	85
P	30-45

Which one represents a tropical rain forest?

(a) M (b) N (c) O (d) P

26. IUCN has listed several criteria in order to protect the area under the biological diversity hotspots. Some of these criteria are 1) the area must support 0.5 percent of the global total plant species (≈ 3,00,000) and 2) the region must have lost more than 70 percent of its original habitat. Based on this IUCN has already protected 25 hot spots all over the world.
A researcher comes up with four areas (i, ii, iii and iv) that support several endemic plants and face substantial loss of their natural habitat over a period. Which of these area/s can be protected under the global biodiversity hotspots?

Name of area	Number of endemic plant species in the area	Total area of Habitat (in sq km)	Loss of habitat (sq. km)
i	1250	15000	7500
ii	1512	80000	64000
iii	1525	90000	62000
iv	1275	36000	6000

(a) i and ii only (b) iii and iv only (c) ii only (d) iii only

27. 'Reproductive isolating mechanisms play an important role in speciation. One such interesting example is of two closely related species of cicadas of the genus *Magicicada*. Both *Magicicada tredecim* and *Magicicada septendecim* spend almost 99% of their lifetime underground in immature nymph state. They feed on xylem fluids from the roots. Individuals of both the populations are developmentally synchronized and in both the species, emergence occurs in large numbers. The mature nymph of *Magicicada tredecim* emerges out after 13 years and moults into adult form whereas *Magicicada septendecim* emerges out after 17 years. Therefore, even though being closely related and belonging to the same habitat, interspecific mating is avoided. This type of reproductive isolation is

(a) Spatial isolation (b) Temporal isolation
(c) Mechanical isolation (d) Behavioural isolation

28. Under normal circumstances, lipid bilayer of cell membrane allows certain molecules to readily pass through it. Which one is the correct order of molecules with respect to increasing permeability across the membrane?

(a) Vit. A < Ca^{2+} < Glycerol < Glucose (b) Ca^{2+} < Glucose < Glycerol < Vit. A
(c) Glucose < Glycerol < Vit. A < Ca^{2+} (d) Glycerol < Vit. A < Ca^{2+} < Glucose

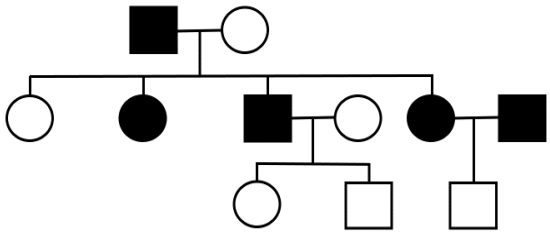
29. An experiment was carried out with a purified extract of a functional protein ribonuclease (R). The following steps were followed:
    (i) Extract and purify R from tissue.
    (ii) Add urea (disrupts the H_2 and ionic bonds) and mercaptoethanol (disrupts disulphide bridges).
    (iii) Slowly remove the chemical agents used in the previous step and then check for enzyme activity.
    (iv) Functional protein detected.

    The type of structure/s of R affected at step (ii) is/are:

    (a) 1º and 2º structures (b) 2º and 3º structures (c) 3º structure only (d) 1º structure only

30. A few statements regarding C_3, C_4 and CAM plants are given. Mark the correct statement.
    (a) In C_4 plants, the C_4 and C_3 pathways are separated temporally.
    (b) CAM plants utilize the C_4 pathway during the day and the C_3 pathway at night.
    (c) The C_3 pathway takes place in the bundle sheath cells of the C_4 plants.
    (d) Both C_4 and CAM plants keep their stomata open at night.

31. A pedigree for a rare congenital cataract condition is given below.

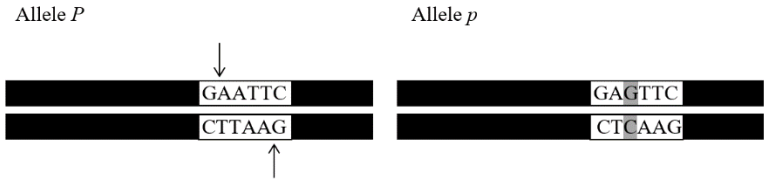


    The most likely mode of transmission of the trait is:

    (a) X-linked dominant (b) X-linked recessive
    (c) Autosomal dominant (d) Autosomal recessive

32. Restriction fragment length polymorphisms (RFLPs) are differences in DNA sequences due to mutations in restriction sites. These can serve as genetic markers. The RFLP gel patterns for members of a family can be obtained by restriction digestion of the sample containing the alleles for a particular trait and then carrying out electrophoresis, probing and blotting.

    Consider the following alleles – *P* (dominant allele) and *p* (recessive allele) responsible for an autosomal recessive trait. Note: Arrows indicate restriction sites.



    The number of bands that the RFLP profiles of an unaffected, affected and carrier individual for this trait would respectively show is:

    (a) 2, 1 and 2 (b) 2, 1 and 3 (c) 1, 2 and 3 (d) 1, 1 and 2

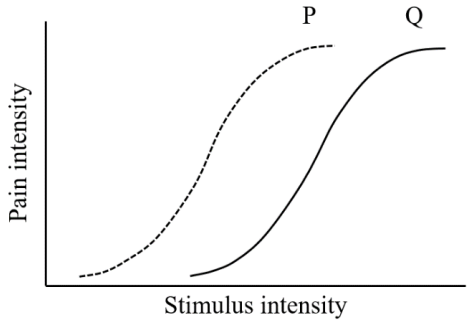
33. The presence or absence of certain structures in three types of cells is tabulated below.

	Plant	Animal	Bacteria
M	Present	Present	Present
N	Present	Present	Absent
O	Present	Absent	Present

Structures M, N and O could respectively be:

(a) Nucleus, Golgi apparatus and cell membrane
(b) Cell wall, endoplasmic reticulum and chloroplast
(c) Centrioles, ribosomes and cell wall
(d) Ribosomes, endoplasmic reticulum and cell wall

34. The sensation of pain and its intensity begins with the peripheral receptors (nociceptors) that are activated by thermal, mechanical, and chemical stimuli. Nociceptors are found in the skin, muscle and viscera. Hyperalgesia refers to an abnormally increased sensitivity to pain, which may be caused by damage to nociceptors or peripheral nerves and can cause hypersensitivity to stimulus. The following graph represents pain intensity as measured against stimulus intensity in two individuals represented by curves P and Q.



Mark the correct statement from the following statements.

(a) Curve P shows early habituation to pain as compared to Q.
(b) Curve Q could be the response in a normal healthy person while curve P could be a victim of platypus venom which is known to cause increased sensitivity to pain.
(c) Curve Q shows increased sensitization to stimulus of the same intensity as compared to that in curve P.
(d) It has been observed that long-term opioid usage for treatment of chronic pain leads to hyperalgesia. This can be observed in curve Q.

35. The type of parental care for a particular species of fish, bird and mammal is given below;

Species of	**Parental care**	**Mating Type**
Fish	Male only	X
Bird	Both male and female	Y
Mammal	Female only	Z

Mating systems X, Y and Z respectively, in these species would most likely be:

(a) Polygyny; promiscuous and polyandry
(b) Monogamy; Polygyny and monogamy
(c) Polyandry; monogamy and polygyny
(d) Polyandry; monogamy and polyandry

36. Pulse-chase analysis is a commonly used technique to study proteins in the cell. Cultured cells expressing the protein of interest are allowed to take up radioactively labelled amino acids for a brief interval (pulse) during which all the newly synthesized proteins incorporate the label. In an experiment 3H-leucine was added to a cell culture to label secretory proteins in the cell and radioactivity at different locations in the cell was recorded at 5, 10 and 45 minutes after addition. Which organelles respectively will show maximum radioactivity at these time points respectively?
    (a) Golgi apparatus; endoplasmic reticulum and secretory granules
    (b) Secretory granules; endoplasmic reticulum and Golgi apparatus
    (c) Endoplasmic reticulum; secretory granules and Golgi apparatus
    (d) Endoplasmic reticulum; Golgi apparatus and secretory granules

37. Treatment with which type of the following enzymes will be the most effective in digesting the basic framework of the myelin sheath around the axons?
    (a) Glycosidase (b) Protease (c) Nuclease (d) Lipase

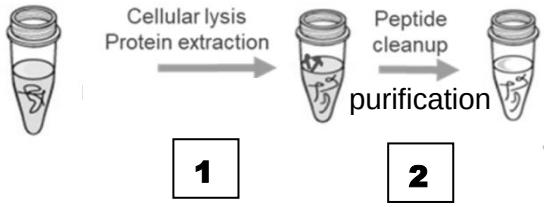
38. Modern vascular plants have evolved organs like the roots, stems and leaves to support terrestrial life. In evolutionary history, structural modifications are products of natural selection, that enable specialized adaptations. Pair the following plants with the plant organs that support an adaptation:

I.	*Solanum tuberosum*
II.	*Beta vulgaris*
III.	*Allium cepa*

i. Root
ii. Shoot

    (a) I –ii, II – i, III – ii (b) I – i, II – ii, III – ii (c) I – ii, II – ii, III – i (d) I – i, II – i, III – ii

39. The following image shows a sequence of processes involved in the classical solid – liquid extraction of peptides from a cell culture.

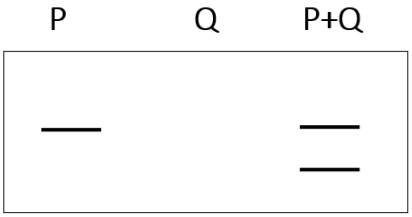


    Which of the following enzymes is generally used in this process during the step marked 1?
    (a) Lipase (b) Trypsin (c) Pepsin (d) Papain

40. Which among the following statements about chloroplast is **false**?
    (a) Proteins found in chloroplast are either encoded by the chloroplast DNA or the nuclear DNA.
    (b) Chloroplast genes exhibit Mendelian pattern of inheritance.
    (c) Photosystems I and II are spatially separated in the thylakoid membrane of the chloroplast.
    (d) Chemiosmotic mechanism converts the energy stored in chemical and electric potential to ATP similar to mitochondria.

41. Which of the following is true for a competitive inhibitor of an enzyme?
    (a) The inhibitor increases the stability of enzyme-substrate complex formed.
    (b) Maximum reaction velocity cannot be reached even at very high concentration of substrate.
    (c) Very high concentration of substrate can relieve inhibition completely.
    (d) The inhibitor only binds to the enzyme-substrate complex.

42. P and Q are the two nuclear proteins that are required for activating transcription of gene Y. Individually neither of the two is sufficient to activate the transcription of the gene Y. The upstream DNA sequence of gene Y was used to study the DNA binding properties of purified P and Q proteins separately as well as in combination. The bound fractions were eluted and confirmed by Western blotting (shown below) using antibodies against P and Q.



From the above which of the following statements are true?

(i) Only P can bind to upstream DNA of gene Y
(ii) P and Q both can bind to upstream DNA of gene Y
(iii) Q activates transcription once it is recruited to upstream DNA of gene Y by P
(iv) P is likely to activate the transcription of gene Y

(a) (i) and (iv) (b) (ii) and (iv) (c) (i) and (iii) (d) (ii) and (iii)

43. Following table depicts the carbon transport and decarboxylation in C_4 plant species. Fill in the blanks with the correct options for P, Q and R.

C_4 acid transported to bundle sheath cells	C_3 acid transported to mesophyll cells	Decarboxylase
Malate	------P-------	NADP + malic enzyme
------Q-------	Alanine	NAD + malic enzyme
Aspartate	------R-------	PEP carboxykinase

(a) P: Pyruvate Q: Aspartate R: Pyruvate
(b) P: Pyruvate Q: Malate R: Alanine
(c) P: Aspartate Q: Pyruvate R: Malate
(d) P: Aspartate Q: Aspartate R: Phosphoenol pyruvate

44. When two species of Monkey Flower plant (X and Y) were studied, following data was obtained:

Species	Nectar volume (µl)	Seeds per flower	Weight of horizontal shoots (stolons) that develop into roots
X: *Mimulus eastwoodiae*	4.94	25	0.49
Y: *Mimulus cardinalis*	50	280	0.07

Which of the following statements about plant X and / or Y is correct?

(a) Plant X allocates more resources towards shoot growth as compared to plant Y.
(b) Plant X allocates its resources to asexual reproduction more than plant Y.
(c) Species X is likely to be native in habitat with abundant water availability.
(d) Root to shoot growth ratio of both plants show inverse relationship.

45. Few characteristics of a particular animal behaviour are listed below:
    - Performed without learning
    - Are stereotypic
    - Cannot be modified by learning

    Which type of behaviour from the following do these indicate?

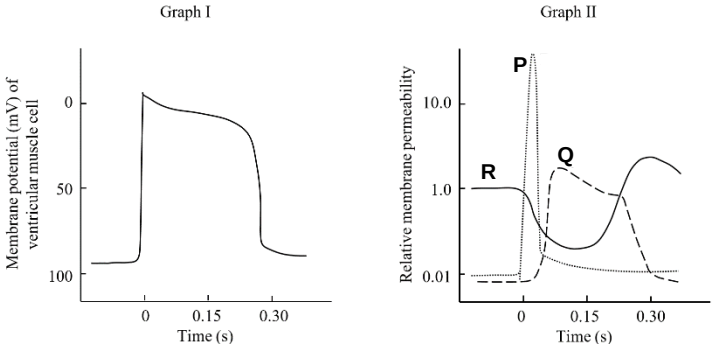
    (a) Operant conditioning (b) Habituation
    (c) Classical Conditioning (d) Fixed action pattern

46. Read the following observations made in the experiments done to investigate whether DNA or protein is the genetic material:
    i. ^{35}S labelled T_2 phages were adsorbed onto bacterial host cells. Upon thorough mixing bacterial cells and phage ghosts were separated. The radioactivity was recorded only in phage-ghosts and not in bacterial host cells.
    ii. ^{32}P labelled T_2 phages were adsorbed onto bacterial host. Upon thorough mixing bacterial cells and phage ghosts were separated. The bacterial host cells exhibited radioactivity.
    iii. Purified DNA of ϕ174 bacteriophage can successfully infect bacterial protoplasts and produce parental phage progeny.

    Which of the observations confirm that DNA and not protein propagates genetic information?

    (a) Only (i) (b) Only (i) and (ii) (c) Only (ii) and (iii) (d) (i), (ii), and (iii)

47. The changes in membrane potential of ventricular muscle cell are depicted in graph I. These changes result from the activity of the various ion channels involved in nerve conduction as represented in a corresponding graph II.



    P, Q and R in graph II respectively correspond to:

    (a) K^+ channels; Na^+ channels and Ca^{2+} channels
    (b) K^+ channels; Ca^{2+} channels and Na^+ channels
    (c) Na^+ channels; K^+ channels and Ca^{2+} channels
    (d) Na^+ channels; Ca^+ channels and K^+ channels

48. An enzyme "M" has a low Km value relative to the physiological concentration of its substrate. Another enzyme "N" has a high Km value relative to the physiological concentration of its substrate. In the normal physiological condition, and substrate concentrations within the physiological range, which of the following statement is correct?
    (a) The activity of "M" will vary as the concentration of substrate varies, and the rate of formation of product will depend on the availability of substrate.
    (b) Enzyme "M" will act at a more or less constant rate, regardless of variations in the concentration of substrate.
    (c) Enzyme "M" will not be normally saturated with the substrate.
    (d) Enzyme "N" will act at a more or less constant rate, regardless of variations in the concentration of substrate.

A – 2

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

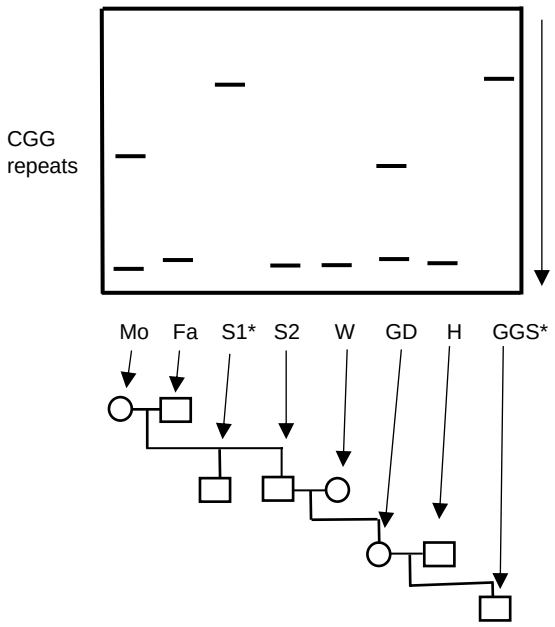
MARKS WILL BE AWARDED ONLY IF ALL THE CORRECT OPTIONS ARE BUBBLED AND NO INCORRECT.

49. In Bioinformatics, transcriptome is identified as the complete set of mRNA transcripts produced by the genome at any one time. Which of the following statements are correct?
    (a) Transcriptomes are made up of the complementary regions of both intron and exon portions of the transcribed DNA
    (b) Transcriptomes reflect the genes that are being actively expressed at any given time in the cell.
    (c) Transcriptome shows the conserved regulatory sequences of genes in active physiological state of a secretory cell.
    (d) Transcriptome varies considerably in different cells due to different patterns of gene expression.

50. Octopuses and Horseshoe crabs have blue blood because the protein transporting oxygen in their blood, hemocyanin, contains copper, instead of iron, making their blood appear blue rather than red. It is also seen in invertebrates living in habitats with very low temperature. Select the correct statement from the following.
    (a) Hemocyanin binds more oxygen molecules than haemoglobin and is found freely floating in blood.
    (b) Hemocyanin binds less oxygen molecules than haemoglobin and is found in the haemocytes.
    (c) Hemocyanin is more thermostable than haemoglobin and is bigger in size than haemoglobin
    (d) Hemocyanin is less thermostable than haemoglobin and is smaller in size than haemoglobin

51. Fragile X Syndrome (FXS) is a X-linked genetic disorder in which CGG base triplet number is abnormal as compared to normal healthy individual. The carriers have intermediate copy number of CGG repeats. The presence of CGG region is responsible for inactivation of protein required in brain and neural development.

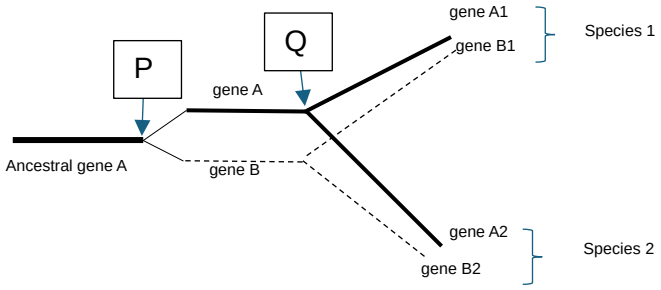
    Gel pattern of CGG repeats along with the family pedigree is shown below. * indicates persons affected with FXS.



    Which of the following statements are correct?

    (a) CGG repeat number is found highest in diseased person.
    (b) CGG repeat number remains stable when passed through sperm.
    (c) The FXS trait is X-linked recessive.
    (d) Individual S2 is a carrier for the disease and will transmit the disease to next generation.

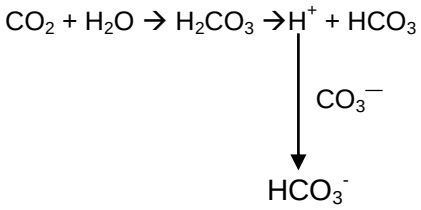
52. An organism's evolutionary history is documented in its genome. Evolution of ancestral gene A is shown in the figure below. Genes A1 and A2 are called orthologues while genes A1 and B1 are called paralogues.



Which of the following statements are true?

(a) P and Q respectively indicate speciation and duplication events.
(b) Hemoglobin and myoglobin are examples of paralogous genes.
(c) Paralogous genes are likely to provide chance to evolve novel functions in an organism.
(d) Polypoidy observed in plants is an example of event P.

53. Study the following reaction:



The reaction indicates:

(a) Alveolar hyperventilation
(b) Oceanic acidification
(c) Calcium depletion of coral reefs.
(d) Increased photosynthesis of oceanic algae.

54. A scientist found a brown cat with ears having an unusual curl. In order to find if this trait is dominant or recessive, she mated the cat with a random cat of the same species with uncurled ears. The mating resulted in all offsprings with non-curled ears. Which of the following can be deduced from this?

(a) The assumption for curled ear trait to be dominant is justified by the results.
(b) The assumption that the curled ear trait is recessive would have got justified only if the offspring showed 1:1 ratio of both phenotypes.
(c) The assumption for curled ear trait to be recessive is justified by the results.
(d) The results confirm that the randomly chosen cat is true breeding.

55. Considering Meiosis II as an independent event, which one of the following phenomena makes Meiosis II different from Mitotic division?

i. Sister chromatids are held together by protein complex called cohesins in metaphase-II only.
ii. Daughter cells may have sister chromatids with different genetic composition.
iii. In meiosis II, chromosome number of daughter cells remains unchanged.
iv. DNA replication does not take place before prophase II.

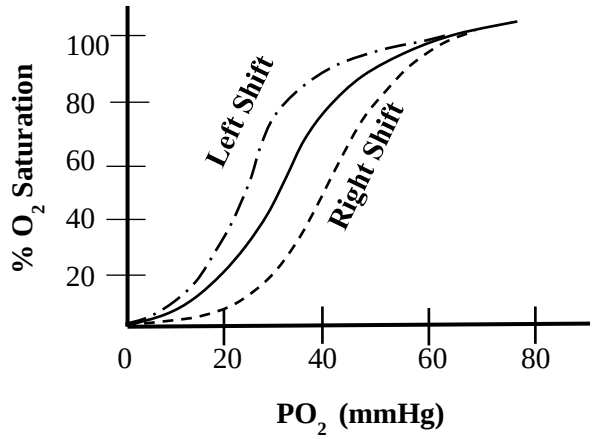
(a) Only ii
(b) Only i
(c) ii and iv
(d) i and iii

56. A few processes that occur in a cell are listed below.
    (i) Cholesterol uptake
    (ii) Chemiosmotic generation of ATP
    (iii) Movement of oxygen into cells
    (iv) Movement of glucose into cells
    (v) Secretion of mucous

    Which of the following statements regarding these processes are true?

    (a) (i) and (ii) are active processes while (iii), (iv) and (v) are passive processes.
    (b) (i) occurs by carrier-mediated endocytosis while (v) occurs by exocytosis.
    (c) (iii) and (v) occur by direct passage through the membrane.
    (d) A membrane protein is involved in the processes (ii) and (iv).

57. Approximately 97% of the total oxygen is transported as haemoglobin-bound O_2. Our body tries to maintain PO_2 in the blood and therefore oxygen delivery to tissues differs based on different physiological situations. The picture shows a O_2-dissociation curve (solid line). The curve shifts to right or left at different physiological conditions.



    Based on the graph, indicate which of the following statements are true.

    (a) At high altitude O_2 dissociation curve will exhibit a left shift.
    (b) In Methemoglobinemia, where methaemoglobin (Fe^{3+} in heme) is higher than normal, a right shift of the normal curve is observed.
    (c) During exercise, elevated level of CO_2 in the muscles needs to be removed. In this case, the normal graph will shift to the right.
    (d) In foetus, higher O_2 affinity of haemoglobin will cause a left shift of the curve.

58. Cortisol is a glucocorticoid hormone secreted in the blood whenever there is any kind of stress or 'fight or flight' situation. Which of the following is/are correct about this hormone?
    (a) It is likely to follow circadian rhythm.
    (b) It is likely to stimulate body carbohydrate and fat metabolism.
    (c) It is likely to reduce the blood pressure.
    (d) It is likely to induce immune system to mount greater response.

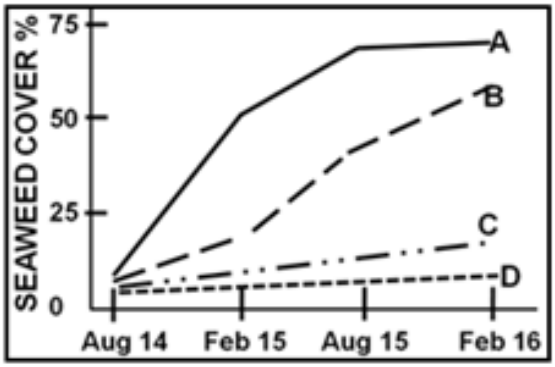
59. Lettuce seeds are known to germinate if exposed to a brief period of light. Plant physiologists carried out experiments to study the effects of repeated alternating flashes of red light (R) for 01 minute and far-red light (FR) for 4 minutes on the germination of lettuce seeds. The results of four experiments (1 – 4) are tabulated below.

Experiment	Treatment	Observations
1	R	Most germinate
2	R – FR	Few germinate
3	R – FR – R – FR – R – FR - R	Most germinate
4	R – FR – R – FR – R – FR – R – FR	Few germinate

Based on the results obtained, mark the correct statement(s) from the following:

(a) Red light and far-red light reverse each other's effects.
(b) Dormancy in experiment 4 could be overcome if the sequence had 4 periods of red light preceding the last far-red period.
(c) The ratio of 1:4 minutes of R:FR is required to ensure germination.
(d) The final exposure determines the germination response.

60. An experiment was carried out to understand animal interactions and community structure in an inter-tidal habitat. Four experimental plots were created: (A) Both Sea urchin and Limpets are removed, (B) Only Sea urchins are removed, (C) Only Limpets are removed and
(D) None is removed (Control). The % seaweed cover recorded over the experimental period lasting several months is depicted below;



Which of the following observations are correct?

(a) Seaweed growth was equally regulated by grazing of limpets and sea urchin.
(b) Limpets had least impact on the seaweed growth.
(c) Sea urchins have higher grazing potential as compared to limpets.
(d) In this community, sea urchins are regulators of the seaweed growth.