



**Solution (d)** The number of amino acids encoded is decided by  $R^n$

where,  $R$  = Number of various types of N-base

$n$  = The coding ratio

$2^2 = 4$  amino acid encodes

$2^3 = 8$  amino acid encodes

$2^4 = 16$  amino acid encodes

$2^5 = 32$  amino acid encodes

But total amino acids are 20 and minimum 5 coding assuming for 20 amino acids.

**3.** The order of permeability for the following molecules across the plasma membrane will be

(a) Cholesterol < Glycerol < Water

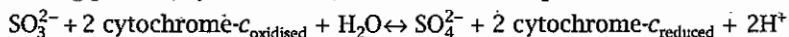
(b) Glycerol < Water < Cholesterol

(c) Water < Cholesterol < Glycerol

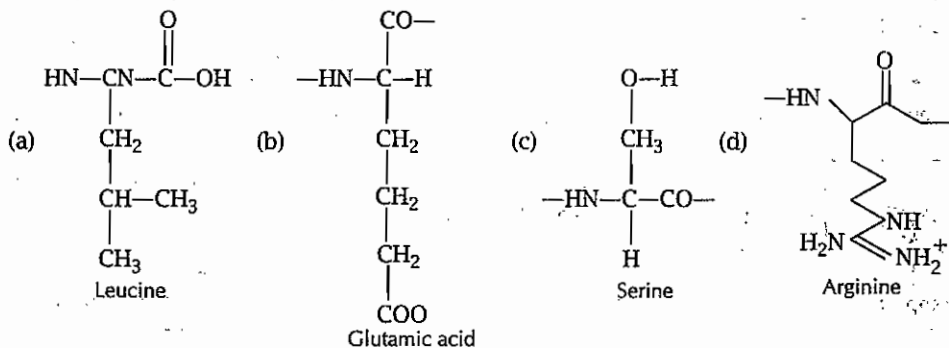
(d) Cholesterol < Water < Glycerol

**Solution (b)** Water moves from region of higher concentration to lower concentration by a semipermeable membrane through aquaporins or channels. Sterols are structural lipid present in the plasma membranes of most eukaryotic cells. Cholesterol is the major sterol present in the plasma membrane of animal cells. Two type of phospholipid present in bilayer glycerophospholipids in which hydrophobic regions are composed of two fatty acids joined to glycerol and sphingophospholipids in which a single fatty acids is joined to sphingosine.

**4.** Mammalian sulphide oxidase is the last enzyme in the pathway for degradation of sulphur containing amino acids. Sulphide oxidase catalyses the oxidation of sulphide to sulphate, using the haeme containing protein, cytochrome-c, as an electron acceptor.

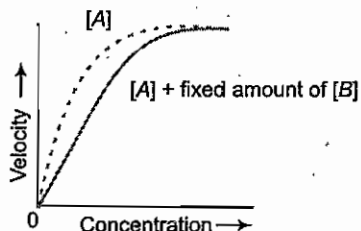


Amino acid that is most likely to be present at the substrate binding site of this enzyme is

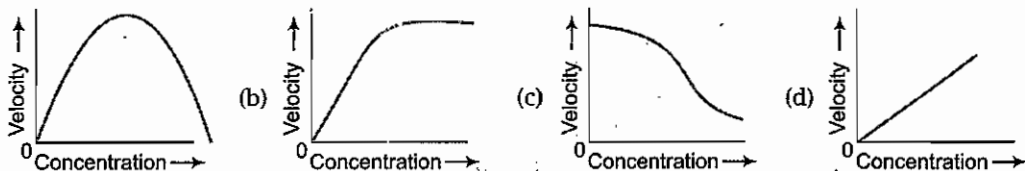


**Solution (d)** Sulphide oxidase catalyses the oxidation of sulphite to sulphate the terminal reaction in oxidative degradation of sulphur containing amino acids cysteine and methionine. The substrate binding site of sulphite oxidase consists of two arginine residues.

Consider a chemical reaction in which substrate  $A$  is enzymatically converted to product. The rate of change of substrate to product with increasing concentration of substrate is shown by broken line. The rate of reaction with increasing concentration of substrate  $A$  with a fixed amount of substance  $B$  is shown by unbroken line



If the same reaction is carried out with fixed quantity of substrate A and increasing concentration of B, the expected result will be



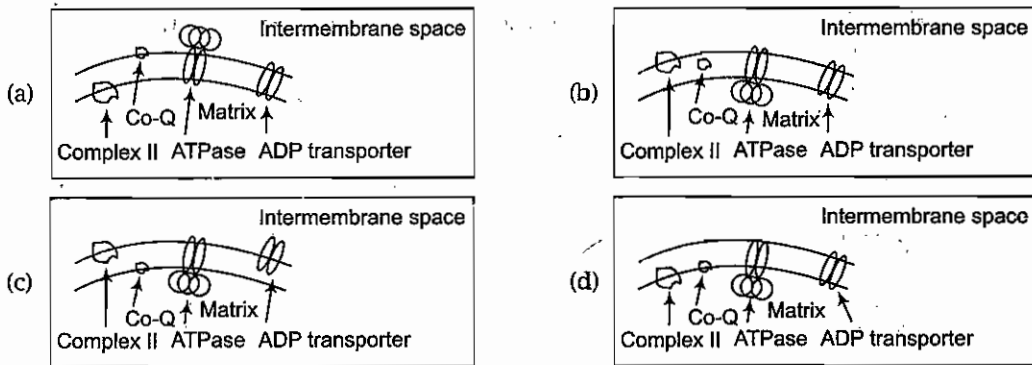
**Solution (c)** From the graph it is clear that substrate B has a negative effect on substrate A reaction if (A) substrate concentration is constant and concentration of substrate B increasing then the rate of reaction will down according to the decreasing the substrate A into product.

6. Which of the following will be true for a resting muscle cell as compared to a moderately active muscle cell?

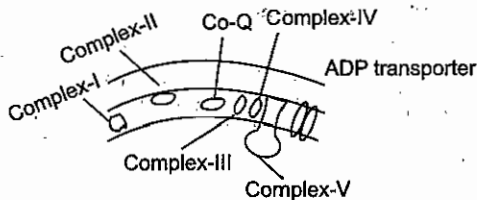
- I. Low ATP as compared to ADP
  - II. Low NADH as compared to  $NAD^+$
  - III. Low  $FADH_2$  as compared to FAD
  - IV. Slow rate of TCA cycle
- (a) III and IV      (b) II and III      (c) I and IV      (d) Only IV

**Solution (d)** Muscles contraction is an active process in which ATP are used. These ATP are generated in cellular respiration specially in TCA cycle, in resting muscles TCA cycle will be slow and ATP will be high as compared to ADP.

7. In the electron transport chain in mitochondria, several protein complexes transverse the mitochondrial inner membrane. Mark the figure that shows correct topology of these complexes.



**Solution (d)** The correct sequence of ETS in inner membrane of mitochondria is . . .

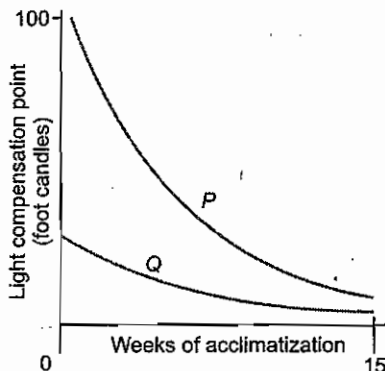


- (i) Complex I      NADH reductase donates two protons and two electrons to FMN
- (ii) Complex II      Succinate Q reductase
- (iii) Complex III       $QH_2$  cytochrome-c reductase complex
- (iv) Complex IV      cytochrome-c oxidase complex
- (v) Complex V      ATPase complex

8. When two plant *P* and *Q* were grown in a heavily shaded greenhouse, they showed the following changes in light compensation points.

Mark the correct interpretation.

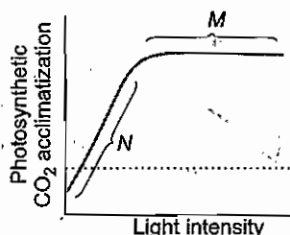
- The graph *P* indicates acclimatization of sun plants to low light intensities
- The graph *Q* indicates that the plant is a shade plant and cannot function at light intensities below a critical level
- The graph indicates that the plant *P* is a shade plant and acclimatizes much faster to low light conditions as compared to *Q*
- The graph indicates that plant *Q* is a sun plant and cannot acclimatize to low light intensities



**Solution (a)** The point in light intensity, where there is no apparent exchange of gases between the environment and photosynthetic organ is called light compensation point. Graph indicate that *P* plant is Sun plant and acclimatize to low light intensities as compared to *Q* plant (shade plants).

9. A typical light response curve of photosynthesis own. The limiting factor/s for photosynthesis at *M* and *N* is/are

- temperature and  $\text{CO}_2$  respectively
- $\text{CO}_2$  and light respectively
- only  $\text{CO}_2$
- light and  $\text{CO}_2$  respectively



**Solution (b)** According to law of limiting factors (proposed by Blackman) when a process is conditioned by a number of separate factors, the rate of process is limited by the pace of slowest factors (factor present in minimum amount). The rate of photosynthesis increased initially but soon it become constant. In the given graph on *M* Point the  $\text{CO}_2$  concentration increase then rate of photosynthesis increase and on *N* position the rate of reactions will increase with the increase of intensity of light.

10. Read the following description of a plant cell type.

"These are elongated tapering cells with cross walls, secondary thickenings with pits and are dead at maturity."

Which of the following is the correct statement about the function of cells described?

- They are the main food conducting cells of flowering plants
- They are the main water conducting cells of flowering plants
- They serve to protect the plants and retard water loss
- They conduct water in all vascular plants

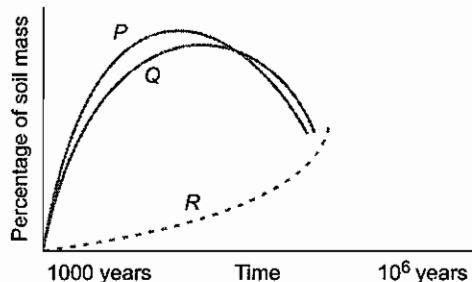
**Solution (d)** In given question, the structure is tracheids. Tracheids are elongated dead cells having lignified walls and wide lumen which take part in conduction of water. Their walls are tapering. These found in all vascular plants.

Girdling is a procedure sometimes followed in plants in which bark of the plant is removed in a circular pattern from any point. Which of the following can result from this?

- Improvement in fruit yield and quality
- Improvement in activity of meristem below girdle region
- Wilting of plant above the girdle region
- Death of roots due to unavailability of sap

**Solution (a)** In girdling experiment, the bark removed from the stem and thus transport of food does not takes place from girdled bark (contain phloem) so, the fruit size and quality may increase. Due to unavailability of food the roots die after sometime.

12. Soil formation is a slow and continuous process. Following graph indicates soil composition over time. In this graph P, Q and R must be



- (a) P: Biomass Q: Clay R: Humus  
 P: Humus Q: Biomass R: Clay  
 P: Clay Q: Humus R: Biomass  
 (u) P: Biomass Q: Humus R: Clay

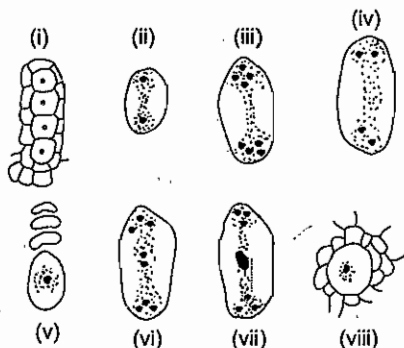
**Solution (d)** Actual soil formation or development is called pedogenesis and is mainly by microorganism. Continuous increase of biomass in soil increase the amount of humus and the clay become soil which have more water retaining capacity.

13. In an experiment, the aleurone layer of oat seeds is destroyed chemically. It is observed that such seeds fail to germinate. Which of the following treatments will be useful to trigger the germination?

- (a) Soaking the seeds in water containing glucose for long time  
 (b) Soaking the seeds in low concentration of abscisic acid  
 (c) Treating the seeds with amylase enzyme  
 (d) Treating the seeds with gibberellins

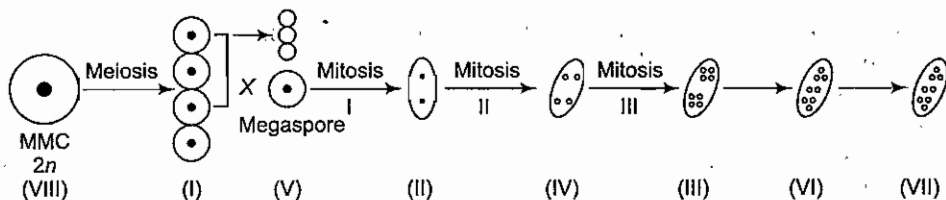
**Solution (c)** Gibberellin enhances seed germination by enhancing  $\alpha$ -amylase synthesis in aleurone layer. The amylase enzyme present in aleurone layer helps to seed germination.

14. Arrange the embryo sac development stages of angiosperms in correct order:



- (a) V → I → IV → II → III → VII → VI → VIII  
 (b) VIII → V → II → IV → III → VII → VI → I  
 (c) I → II → IV → V → VIII → III → VII → VI  
 (d) VIII → I → V → II → IV → III → VI → VII

**Solution (d)** In the hypodermal region of nucellus towards the micropylar end develops a primary archesporial cell which divides into outer primary cell wall and inner sporogenous cell (megaspore mother cell) which divides by meiosis to form a row of four haploid megaspores and the chalazal are remain functional which form nucleate embryo sac.



15. The circulatory system shown below represents

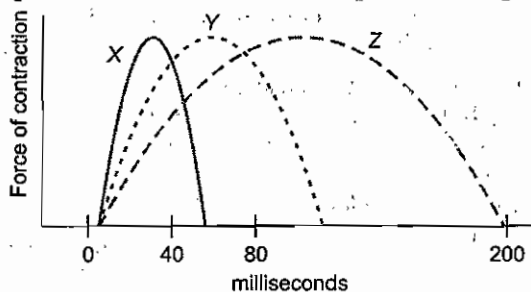


- (a) a bird                      (b) an amphibian                      (c) a mammal                      (d) a fish

**Solution (b)** The amphibians circulatory system is closed type and heart has three-chambered (two auricle and one ventricle). The circulatory system comprises blood vascular system and lymphatic system. Both system are interconnected.

16. Consider three different types of mammalian skeletal muscles

- I. Ocular muscle.
  - II. Soleus muscle (involved in continuous support of body against gravity).
  - III. Gastrocnemius muscle (involved in velocity of limb movements).
- Muscle contraction properties of these muscles are depicted in the graph.



The muscles represented by X, Y and Z are

- (a) X: (I) Y: (II) Z: (III)    (b) X: (II) Y: (I) Z: (III)    (c) X: (III) Y: (II) Z: (I)    (d) X: (I) Y: (III) Z: (II)

**Solution (d)** Muscle contraction is said to be isometric when the muscle does not shorten during contraction and isotonic, when it does shorten but the tension remains constant throughout the contraction. Ocular muscle has duration of isometric contraction of  $1/40$  s, gastrocnemius of about  $1/15$  s and soleus of about 113 s.

17. In reptiles such as lizards and turtles, the solute concentration of urine is never greater than that of plasma. This is due to the absence of

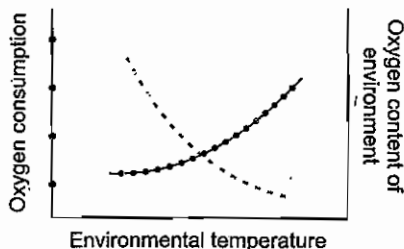
- (a) glomerulus                      (b) Bowman's capsule                      (c) loop of Henle                      (d) collecting duct

**Solution (c)** The descending limb of loop of Henle reabsorbs water, while ascending limb reabsorbed Na, K, Ca, Mg and Cl, i.e., The solute concentration in urine is controlled by the loop of Henle according to concentration of plasma.

18. Rate of metabolism of an animal is depicted in the graph.

Which animal is most likely

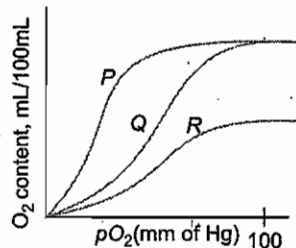
- (a) a fish  
(b) a terrestrial reptile  
(c) a dolphin  
(d) a mouse



**Solution (c)** Any given volume of air contains more  $O_2$  than the same volume of water under similar conditions. With increasing metabolic activities the consumption of  $O_2$  increases but  $O_2$  content decreasing in environment because fish use the dissolve  $O_2$  from water. The metabolic activities increase with temperature.

**11** Hemoglobin molecule binds to oxygen and transports it across various uses in animals. It shows a characteristic binding pattern at various partial pressures of oxygen. The three graphs P, Q and R in the figure represent binding patterns in

- |   |                                    |
|---|------------------------------------|
| (a) P: Individual adapted to sea level      | Q: Anaemic individual              |
| R: Individual adapted to high altitudes     |                                    |
| (b) P: Maternal haemoglobin                 | Q: Foetal haemoglobin              |
| R: Anaemic individual                       |                                    |
| (c) P: Individual adapted to high altitudes | Q: Individual adapted to sea level |
| R: Anaemic individual                       |                                    |
| (d) P: Anaemic individual                   | Q: Maternal haemoglobin            |
| R: Fetal haemoglobin                        |                                    |

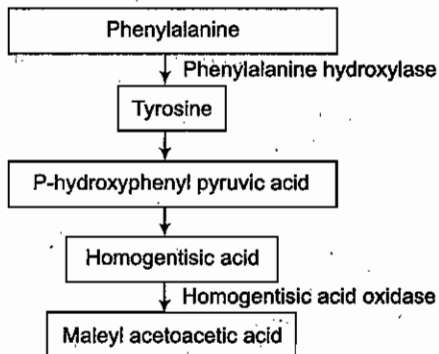


**Solution (c)** The amount of  $O_2$  that can bind with haemoglobin is determined by oxygen tension. The haemoglobin transport the  $O_2$  up to a saturation level. According to given graph, in high concentration of  $O_2$  haemoglobin saturated and adapted in P (to high altitude), Q (to sea level) and R (anaemic individual).

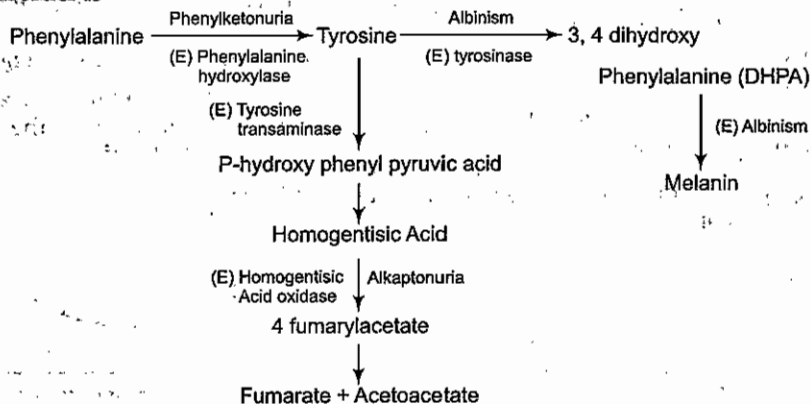
**20.** Phenylketonuria (PKU) results due to absence of phenylalanine hydroxylase and Alkaptonuria (AKU) results due to the absence of homogentisic acid oxidase. The following pathway shows, where these enzymes function.

If a person is homozygous for recessive alleles of both PKU and AKU, he will show symptoms of

- (a) only PKU
- (b) only AKU
- (c) PKU and AKU simultaneously
- (d) PKU initially and later AKU



**Solution (a)** The absence of phenylalanine hydroxylase due to recessive allele leads to no tyrosine synthesis and thus, alkaptonuria does not occur. A complete flow chart for PKU and AKU disorder is



21. You have cloned a human insulin cDNA and inserted it into *E. coli*. However, the insulin gene was not expressed. Which of the following could be the cause of your finding?
- The cDNA was inserted in opposite direction
  - The cDNA had an altered Shine-Dalgarno sequence
  - An intron was present in coding region
  - The cDNA encoded the protein which was not processed post translationally in *E. coli*
- (a) I, II and III      (b) I, II and IV      (c) I, III and IV      (d) I and III

**Solution (a)** cDNA (complementary DNA) is the product of reverse transcription from mRNA. Eukaryotic cDNA has altered Shine Dalgarno sequence than prokaryotic one, but it must same for recognition. These should be possibility of RNA processing as this mRNA has introns and exons sequences. After transcription and translation protein must be processed that its alpha and beta chain associated and C peptide chain removed.

22. Male child brought up in an orphanage was claimed by an old couple : This old couple had lost their daughter and son-in-law in an accident, when they were on a tour with the child, who was one year old. Another young couple also claimed that the child belonged to them, however, the wife got divorced after the child went missing and married another person.

Which test will be most appropriate to solve the parentage problem?

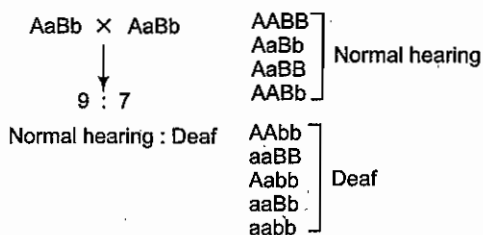
- Blood group matching of the child, the old couple and wife among the young couple
  - Matching of genomic DNA fingerprints of all the members with that of the child
  - Mitochondria DNA fingerprint matching of the old and young women with that of the child
  - Matching of the Y-chromosome of the old man with the child
- Solution (c)** In any organism some of the gene exclusively carried by the cytoplasm of female gamete like mitochondrial gene in son. This is also known as plasmogene inheritance. Since the old man is not father of the child then matching of Y-chromosome does not solve the problem.

23. In rabbits, two genes A and B are present on two different chromosomes. Products of both wild type A and B genes are essential for normal hearing. Homozygous recessive mutants either for A, B or both results in deafness.

If a double heterozygous male (AaBb) is crossed with a double heterozygous female, the ratio of phenotypically normal and deaf rabbits will be

- (a) 15 : 1      (b) 7 : 9      (c) 9 : 7      (d) 13 : 3

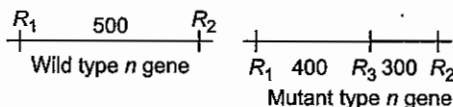
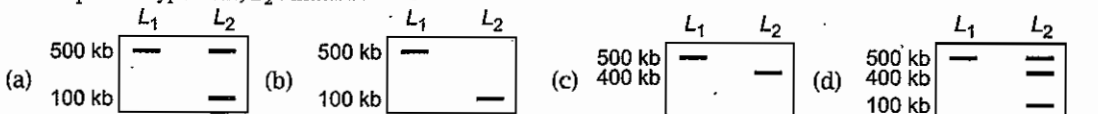
**Solution (c)** This cross shows complementary gene interaction. In such type of interaction two separate pairs of genes interact to produce the phenotype in such a way that neither of the dominant genes is expressive unless the other one is present.



24. The figure shows the restriction enzyme cutting sites (R-R<sub>3</sub>) in a wild type (*n*) and mutant (*n*<sup>-</sup>) gene.

a radioactively labelled probe (that hybridizes at a quence close to R<sub>1</sub>) is used for detecting the presence of NA fragments after gel electrophoresis and southern blotting, which of the following bond patterns will you expect?

**Note** L<sub>1</sub> : wild type DNA, L<sub>2</sub> : mutant DNA



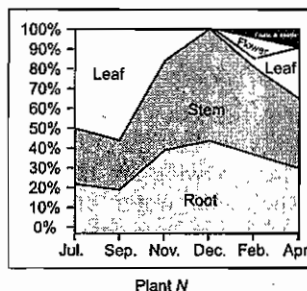
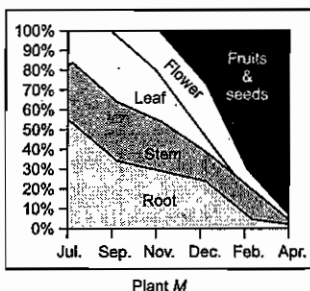


**Solution (c)** Since, the radioactively labelled probe hybridize at a sequence close to  $R_1$  the wild type with 500 kb and mutant type with 400 kb are detected after gel electrophoresis and Southern blotting.

- The evolutionary force that is believed to be the driving force behind sympatric evolution is
- (a) directional selection
  - (b) stabilizing selection
  - (c) disruptive selection
  - (d) balancing selection

**Solution (c)** In a heterogeneous environment a population exists within a diverse collection of microhabitats. Some organisms prefer to occupy one particular type of microhabitat called disruptive selection. In sympatric speciation the reproductive isolation can be a result of a number of factors, including competition for resources, disruptive selection and sexual selection.

**26.** The biomass of two different plant species *M* and *N* were analyzed and the respective fractions of the different plant parts were calculated. They have been represented below



Which of the following statements would be true for the above data?

- I. Plant *M* is an annual plant
- II. Plant *N* is a perennial plant
- III. Plant *N* is a deciduous plant
- IV. Plant *M* is an evergreen plant

- (a) I, II and III
- (b) I and II
- (c) I and III
- (d) All of these

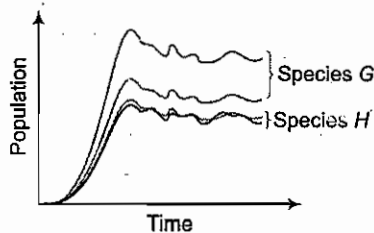
**Solution (a)** Given graph represent the phenology (seasonal changes in a vegetation). Plant *M* is annual complete its life cycle in one season, while plant *N* is perennial and deciduous.

**27.** The following curves show the growth of two different species of bacteria *G* and *H*. They were cultured in petri plates of two different sizes (7 cm diameter and 10 cm diameter) with 20 mL of a similar nutrient media. (The lighter colour indicates the population in the smaller petri plate).

Which of the following would be true for the above experiment?

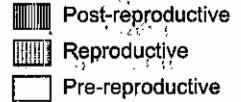
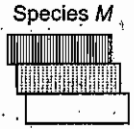
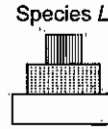
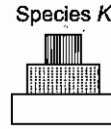
- I. Species *G* has reached its carrying capacity.
- II. Species *H* has reached its carrying capacity.
- III. Species *G* is limited in its population by space.
- IV. Species *H* is limited in its population by space.

- (a) I, II and III
- (b) I and II
- (c) III and IV
- (d) I, II, III and IV



**Solution (a)** The carrying capacity is the number of individuals within a population that can be supported within a particular environment. It can also be defined as the level beyond which major increase can occur. Species *H* is not limited by space because it is cultured in 10 cm diameter petri plate.

ity comprises of three species. The pyramids below show the distribution of pre-reproductive, reproductive and post-reproductive individuals. If the numerical representation of all the three species in the community is similar, which of the following statements would be true?

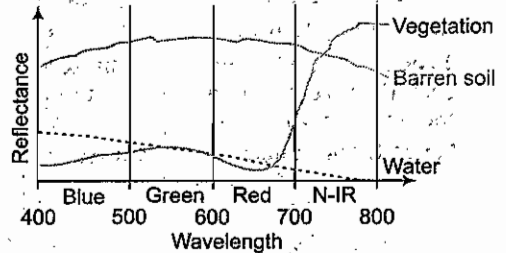


- I. Species K is a growing population.
- II. Species L is a growing population.
- III. Species M is a decreasing population.
- IV. The community is increasing in population.

- (a) I and II                      (b) II and III                      (c) I, II and III                      (d) All of these

**Solution (d)** Age pyramid is the model representing geometrically the proportions of different age groups in the population of any organism. Given age pyramid shows that species K and species L are growing population because pre-reproductive number are more than the reproductive and post reproductive phase. Species M age pyramid is urn-shaped (inverted) it shows decline population, i.e., this community have growing population.

29. Satellite-based sensors identify different objects based on their reflectance properties. Sensors are designed in a manner that they can identify the feature of interest. The following are the typical reflectance curves of vegetation, water and barren soil. The combination of which two spectra bands will best discriminate vegetation?



- (a) Red and N-IR                      (b) Green and Red  
(c) Blue and Green                      (d) Blue and Red

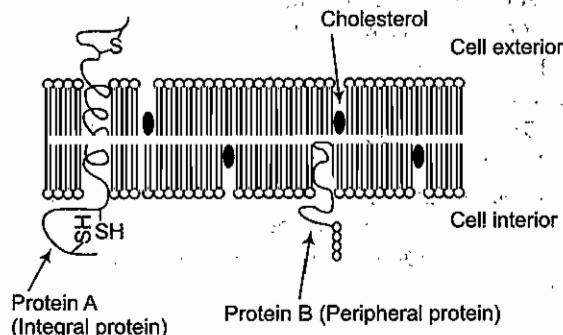
**Solution (a)** The graphic representation of curve showing the various wavelength of light reflected by a substance is called reflection curve. In the given curve red and N-IR spectra bands best discriminated vegetation, while green and red the barren soil.

30. Which of the following behaviours has a 'learning' component in it?

- (a) Instinct                      (b) Homeostasis                      (c) Reflex action                      (d) Imprinting

**Solution (d)** Learning is the modification of behaviour as a result of experience and can affect even innate behaviours. It has a specific innate component in the phenomenon of imprinting. Imprinting is characterized by irreversibility of learning and a limited critical period during which some type of imprinting may occur.

31. A student made a pictorial representation of a eukaryotic cell membrane and labelled the components as follows.



Mark against each statements as true or false with respect to error/s or correction/s required in the representation.

- (a) Protein A should be labelled as trans-membrane protein only and not as integral protein. ....  
 (b) The polarity of the protein A should be reversed because the cytosolic phase always shows reducing environment.....  
 Position of cholesterol molecule should be close to polar region as it contains a polar group .....  
 Protein B should be labelled as integral membrane protein and not as peripheral glycoprotein .....

- Solution** (a) False (trans-membrane protein is a type of integral protein).  
 (b) False (the cytosolic phase always show carbonyl group of protein).  
 (c) True  
 (d) True (peripheral protein covalently linked to lipid surface).

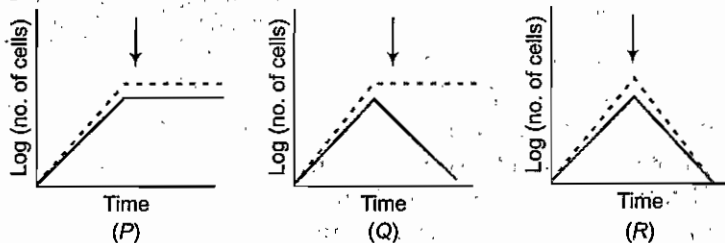
32. Following are three different antibacterial agents that have different mechanisms of action.

**Type I** It kills bacteria by inhibiting DNA-dependent RNA polymerase in bacterial cells, thus preventing transcription to RNA and subsequent translation to proteins (e.g., Rifampicin).

**Type II** It is a glycoside hydrolase and functions by attacking peptidoglycans of bacterial cell wall thus leading to lysis of the cell (e.g., Lysozyme).

**Type III** It inhibits growth of bacteria by affecting folic acid synthesis (e.g., Sulphonamide) When bacteria were grown in three culture media to which one of these antibacterial agents was added at the point shown by an arrow, growth patterns (P, Q and R) were obtained.

Match them against the correct type of antibacterial agent added and fill in the blanks.



- Solution** Rifampicin inhibits replication and transcription of DNA thus new cells are not formed and protein not synthesized Q type.  
 Sulphonamide inhibits growth of bacteria by affecting folic acid synthesis P type.  
 Lysozyme attacking bacterial cell wall (peptidoglycan)-leading to cell lysis R-type.

33. Consider a gene 25.5 kb in length. The regulatory region is 500 bp long. The number of exons and introns in a gene are 9 and 8 respectively with the mean size of each being 145 bp and 2960 bp respectively.

- A. What per cent of this gene is occupied by exons?  
 B. What will be the length of a polypeptide chain synthesized by this gene?

- Solution** A.  $25.5 \text{ kb} = 25500 \text{ bp}$   
 Total size of exon =  $9 \times 145 = 1305 \text{ bp}$   
 Percentage =  $\frac{1305 \times 100}{25500} = 5.118\%$
- B. Three base pair coded one nucleic acid total size of introns =  $8 \times 2960 = 23680$   
 Functional gene =  $25500 - 23680 = 1820 \text{ bp}$   
 3 bp code for termination codon, i.e., number of bp for protein synthesis =  $1820 - 3 = 1817$   
 Length of polypeptide =  $\frac{1817}{3} = 439$

34. Restriction endonucleases are enzymes that recognize short nucleotide sequences (restriction sites) in a DNA molecule and cleave the molecule at that site. The recognition site of the enzyme *TaqI* is TCGA.

What would be the maximum number of recognition sites that this enzyme would have on a DNA molecule that is 5 kb long? Assume that the DNA molecule has a random sequence with equal amount of each base.

**Solution** Restriction endonucleases cleave the DNA only within or near those sites which have specific base sequences called recognition sequences. The frequency of recognition site can be estimated by making two assumptions (i) The frequency of A, T, G and C are equal (ii) Bases are present random order. Therefore, a recognition sequence of 4 bases is expected to occur on an average. Once every  $4^4 = 256$  bp along a DNA molecule

Size of DNA = 5 kb = 5000 bp

**Note** Only a completely correct row will be given one point.

$$\text{Number of recognition sites} = \frac{5000}{256} = 19.53$$

35. Various methods can be used to isolate the chloroplasts from a plant material. Based on the types of chemicals used, their concentrations as well as treatment conditions, final results may vary. Study methods I to IV used to isolate chloroplasts from a plant leaf and match the resultant structure and function of chloroplast against each method. Choose from the options given below and fill in the table.

**Note** Only a completely correct row will be given one point.

Method	Chloroplast Morphology	CO <sub>2</sub> Fixation	Electron Transport	NADP Reduction
I. Isolation in hypertonic sugar solution.	—	—	—	—
II. Isolation in hypotonic sugar solution and immediate transfer to isotonic media.	—	—	—	—
III. Prolonged treatment in hypotonic sugar solution and later with high salt concentration.	—	—	—	—
IV. Plant extract subjected to sonication and detergent treatment.	—	—	—	—

Options for chloroplast morphology

- (i) Sub-chloroplast particles. (ii) Chloroplasts with broken envelope.  
(iii) Free lamellar chloroplasts. (iv) Intact chloroplasts.

Options for CO<sub>2</sub> fixation/electron transport/NADP reduction :

- (i) Unimpaired. (ii) Partially impaired.  
(iii) Absent. (iv) Addition of ferredoxin required.

**Solution** A. Chloroplast morphology

- I. Isolation in hypertonic solution—Intact chloroplast.  
II. Isolation in hypertonic sugar solution and immediate transfer to isotonic solution—Chloroplast with broken envelope.  
III. Prolonged treatment in hypotonic sugar solution and later with high salt concentration—free lamellar chloroplast.  
IV. Plant extract subject sonication and detergent treatment sub-chloroplast particles.

B. CO<sub>2</sub> fixation/Electron transport/ NADP reduction

- I. Unimpaired/Unimpaired/Unimpaired.  
II. Partially Impaired/Partially impaired/Partially impaired  
III. Absent/Partially impaired/Addition of ferredoxin required  
IV. Absent/Absent/Absent.

36. Heat produced by the oxidation of a foodstuff can be measured in two ways :

**Method I** By using Bomb's calorimeter, where the food is artificially oxidized and the heat produced is measured.

**Method II** By placing the animal in an insulated chamber, feeding a known quantity of food and measuring the heat production.

Among the three types of foods tested namely carbohydrates, proteins and lipids, the values obtained by both the methods matched only for two biomolecules. The biomolecule for which the values did not match is likely to be

- (a) lipid                                      (b) carbohydrate                                      (c) protein

Choose from the options and put a tick mark (✓) in the appropriate box.

(a)	(b)	(c)

B. Mark the statement/s that correctly interpret or reason the above result.

**Note** This part of the question will be assessed only if the answer to part A is correct.

- (a) The value obtained in method I was higher than in method II.  
 (b) The value obtained in method II was higher than in method I.  
 (c) Lipids contain a large excess of hydrogen as compared to carbon which will not get oxidized at physiological conditions.  
 (d) Molecules of carbohydrate contain oxygen atoms which will reduce the need for external oxygen.  
 (e) Nitrogen present in the proteins is not oxidized physiologically.  
 (f) Lipids contain long chain fatty acids. These molecules being non-polar in nature will not react with polar molecules such as oxygen.

Choose from the option/s and put tick mark (✓) in the appropriate boxes.

(i)	(ii)	(iii)	(iv)	(v)	(vi)

**Solution** A. Protein oxidizes as respiratory substance only when carbohydrate and lipids are not available. It is a structural component.

B. The value obtained in method I is as higher because in method II some energy is utilized by animal nitrogen present in the protein is not oxidized physiologically.

37. A typical summer flowering plant shows 15 hours as critical period. Which of the following treatment cycles respectively will make it flower in winter but not in summer?

- (a) Winter : 10h day - 14 h night  
 Summer : 16h day - 8 h night  
 (b) Winter : 10h day - 6 h night - 2 h artificial light - 6 h artificial darkness  
 Summer : 15 h day - 9 h night  
 (c) Winter : 10 h day - 8 h night - 6 h artificial light  
 Summer : 10 h day - 8 h night - 6 h artificial darkness  
 (d) Winter : 10 h day - 6 h artificial darkness - 8 h night  
 Summer : 10 h day - 6 h night - 3 h artificial darkness - 5 h artificial light

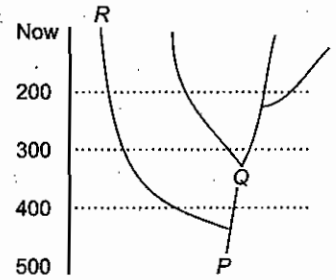
Choose from the options and put a tick mark (?) in the appropriate box.

(a)	(b)	(c)	(d)

**Solution** (c) The plants in summer require long time of photoperiod so 6 h artificial darkness inhibit the flowering.

38. Evolutionary tree of land plants is shown in the diagram. The correct description of P, Q and R is

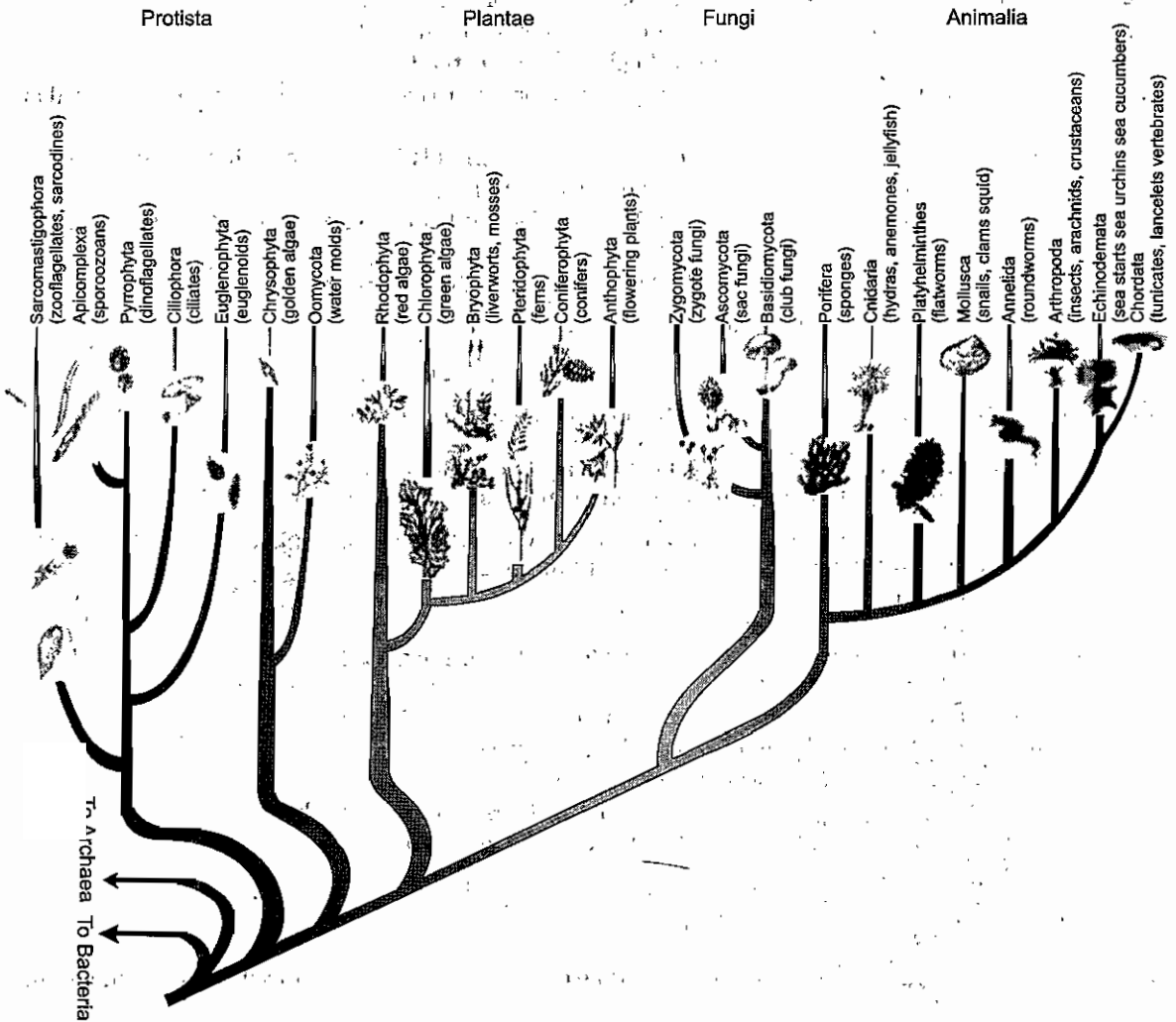
- |                                |                            |
|--------------------------------|----------------------------|
| (a) P : Protist ancestor       | Q : Primitive tracheophyte |
| R : Spermatophytes             |                            |
| (b) P : Green algal ancestor   | Q : Primitive tracheophyte |
| R : Bryophytes                 |                            |
| (c) P : Protist ancestor       | Q : Green algae            |
| R : Primitive vascular plant   |                            |
| (d) P : Primitive tracheophyte | Q : Origin of seeds        |
| R : Bryophytes                 |                            |



Choose from the options and put a tick mark (✓) in the appropriate box.

(a)	(b)	(c)	(d)

**Solution (b)**



39. Following are few peculiar structures found among plants. Indicate the tissue responsible for the distinguishing feature in each. Choose from the options below and write the number indicating the tissue type against each structure.

Gritty texture of fruit such as pear : \_\_\_

(b) Linen fibre : \_\_\_

Potato tuber : \_\_\_

(d) Walnut shell : \_\_\_

- lenchyma
- Sclerenchyma
- Parenchyma
- Phloem

**Solution** (a) Gritty texture of fruit such as pear—Sclerenchyma  
 (b) Linen fibre — Sclerenchyma  
 (c) Potato tuber — Parenchyma  
 (d) Walnut shell — Sclerenchyma

40. The pressure flow model explains phloem translocation as a flow of solution driven by an osmotically generated pressure gradient between source and sink. The values for water ( $\psi_w$ ), solute ( $\psi_s$ ) and pressure ( $\psi_p$ ) potentials in four different regions of a plant are given in the table. Determine the correct cell types that would have these values.

Regions in a Plant	Potentials
I.	$\psi_w = -0.4$ MPa $\psi_p = 0.3$ MPa $\psi_s = -0.7$ MPa
II.	$\psi_w = -1.1$ MPa $\psi_p = 0.6$ MPa $\psi_s = -1.7$ MPa
III.	$\psi_w = -0.8$ MPa $\psi_p = -0.7$ MPa $\psi_s = -0.1$ MPa
IV.	$\psi_w = -0.6$ MPa $\psi_p = -0.5$ MPa $\psi_s = -0.1$ MPa

**Options**

(a) Xylem vessel in leaf

(b) Phloem sieve element in leaf

(c) Phloem sieve element in root

(d) Xylem vessel element in root

Choose from the options and fill in the blanks :

I. ....

II. ....

III. ....

IV. ....

**Solution** Water potential is the difference between chemical potential of water at any point in a system and that of pure of water under standard conditions.

$$\psi_w = \psi_g + \psi_s + \psi_p$$

$\psi_w$  = Water potential

$\psi_g$  = Gravity potential

$\psi_s$  = Solute potential

$\psi_p$  = Pressure potential

water potential values in different

(a) Tissue are xylem vessels in leaf = - 0.8 MPa

(b) Phloem sieve element in leaf = - 1.1 MPa

(c) Phloem sieve element in root = - 0.4 MPa

(d) Xylem vessel element in root = - 0.6 mPa

41. The  $C_3$ ,  $C_4$  and CAM pathways are the major  $CO_2$  fixing pathways present in plants. The following are a few statements relating to one or more of the pathways. Assign all the possible pathways to each statement.

- (a)  $C_3$  pathway                      (b)  $C_4$  pathway                      (c) CAM pathway

**Note** Only an entirely correct answer in each blank will get 0.5 point.

Statements

- I. The Calvin cycle operates in the chloroplast .....
- II. The primary carboxylation is catalysed by RUBISCO .....
- III. The atmospheric  $CO_2$  is first fixed during the day .....
- IV. The whole process of  $CO_2$  uptake and its fixation takes place in a single cell .....

**Solution**

- I. The Calvin cycle operate in the chloroplast of  $C_3$ ,  $C_4$  and CAM plants.
- II. The primary carboxylation is catalyzed by RUBISCO in  $C_3$  plants and PEP carboxylase in  $C_4$  plants.
- III. The atmospheric  $CO_2$  is first fixed during the day in  $C_3$  and  $C_4$  plants, while during night in CAM plants.
- IV. The whole process of  $CO_2$  uptake and its fixation takes place in single cell in  $C_3$  and CAM plants while two cells in  $C_4$  plants.

42. A few life forms and the concentration of the environment relative to body fluids are listed in column I and column II of the table respectively.

Column I (Organism)	Column II (Environmental Concentration Relative to Body Fluids)
A. Freshwater fishes	1. Isoosmotic
B. Salt water fishes	2. Hyperosmotic
C. Sharks	3. Hypoosmotic
D. Amphibians	
E. Marine mammals	

Assign the correct environment (from column II) to the animals A-E.

**Solution**

Column I	Column II
✓ Freshwater fishes	Hypoosmotic (less than surrounding)
✓ Salt water fishes	Hyperosmotic (higher than surrounding)
Sharks	Isoosmotic (equal)
Amphibians	Hypoosmotic
✓ Marine mammals	Hyperosmotic

→ (remember)

43. Consider a 70 kg man whose initial plasma osmolarity is 280 mosm/L. Assume extracellular fluid (ECF) to be 20% of the body weight and intracellular fluid (ICF) volume to be 40% of the body weight.

A. Fill in the table

Initial condition	Volume (L)	Concentration (mosm/L)	Total (mosm)
ECF		280	
ICF		280	
Total body fluid		280	



- B. This man is injected with 2 lt of 1.5% NaCl solution (infused into ECF compartment). Assuming that no solute or water is lost from the body and there is no movement of NaCl into or out of the cells, what will be the concentration of solutes in ECF (mosm/lt) immediately after infusion?

Molecular weight NaCl : 58.5.

What will be the net qualitative effect of this infusion after osmotic equilibrium? Indicate as true (T) or false (F).

Net Qualitative Effect	True/False
(a) Extracellular volume will increase	
(b) Intracellular volume will decrease	
(c) Extracellular osmolarity will decrease	
(d) Intracellular osmolarity will decrease	
(e) There will be an increase in total body fluids	
(f) There will be an equal osmolarity between ECF and ICF	

Solution A.

Initial Condition	Volume (L)	Concentration mosm/L	Total mosm
ECF	14	280	3920
ICF	28	280	7840
Total body fluid	42	280	11760

B. 309.1 mosm/L

C.

Net Qualitative Effect	True/False
(a) Extracellular volume will increase	T
(b) Intracellular volume will decrease	T
(c) Extracellular osmolarity will decrease	F
(d) Intracellular osmolarity will decrease	F
(e) There will be an increase in total body fluids	T
(f) There will be an equal osmolarity between ECF and ICF	T

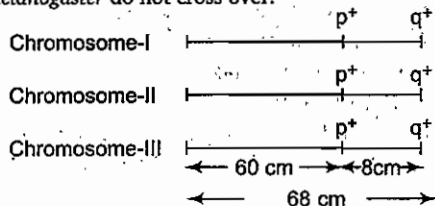
44. Two genes 'p' and 'q' are present on third chromosome of fruitfly, *Drosophila melanogaster*. The corresponding wild type alleles are represented as  $p^+$  and  $q^+$ . They were located at 60 and 68 cM positions respectively. A female fly ( $pp/q^+q^+$ ) was crossed with a male fly ( $p^+p^+/qq$ ). All offspring were phenotypically wild type.

A. What are the different kinds of gametes you expect from the  $F_1$  female and male? What will be the proportions of gametes?

B. If you cross one  $F_1$  female with a double recessive ( $pqpq$ ) male, what proportions of offspring will you expect?

Note Genes in male *Drosophila melanogaster* do not cross over.

Solution A.

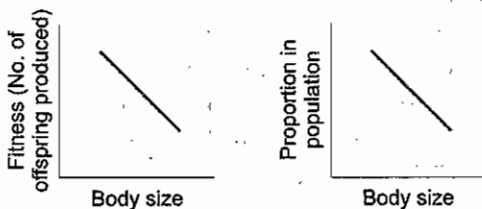


Distance between  $p$  and  $q$  is 8 cm which represent 8% of recombination. Each individual produces two types of gametes the parental and recombinants therefore, the proportion of gametes in  $F_1$  male is 46%  $pq^+$ , 46%  $p^+q$ , 4%  $pq$ , 4%  $p^+q^+$ .

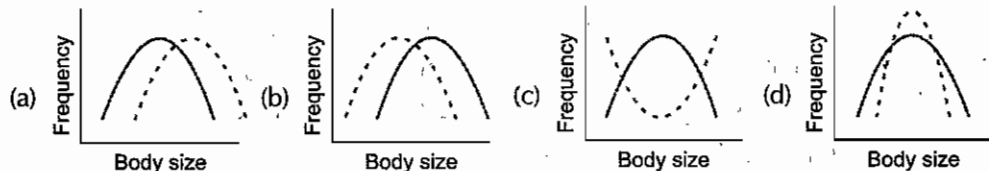
The crossing over is infrequently in wild type male *Drosophila*. So, the gamete proportion will be 50%  $pq^+$  and 50%  $p^+q$ .

B. The  $F_1$  offsprings are heterozygous type and an crossing with double recessive produce four types of offsprings in 46%  $pq^+$ , 46%  $p^+q$ , 4%  $pq$  and 4%  $p^+q^+$ .

45. Study the characteristics of population represented in the graphs below.



A. Mark the correct graph that represents the type of selection that this population is likely to undergo



Choose from the options and put a tick mark (✓) in the appropriate box.

(a)	(b)	(c)	(d)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

B. Choose the type of selection that this population is likely to undergo and put a tick mark (?) in the appropriate box.

- (a) Directional selection  
 (b) Stabilizing selection  
 (c) Disruptive selection  
 (d) Balancing selection

(a)	(b)	(c)	(d)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Solution** A. b-As body size increase than fitness or number of offspring produced and proportion in population it indicates that the population is shorting down and in future it will also decline.

B. This population show directional selection, i.e., dectning regularly.

46. A rat 'A' is familiarized with a three dimensional maze with some doors opening and closing at efinite intervals. Such a rat quickly reaches up to a specific chamber, where food is deposited as ompared to a rat 'B' which is not familiar with the maze. This is observed even if A and B are caged gether. Mark the following statements as true (T) or false (F).

- (i) Rats have an ability of cognitive learning .....  
 (ii) 'A' has a procedural knowledge of the maze .....  
 (iii) 'B' cannot perceive the direction of food .....  
 (iv) Temporal understanding is needed to succeed in crossing trap doors .....

**Solution** (i) True (ii) True (iii) False (iv) True

47. There are basic differences in the physiology and life histories such as mode of fertilization, bearing and rearing the young, etc., in different groups of animals. These can account for the differences in parental care as well as mating systems in these groups.

each of the following life history characteristics, assign the most probable mating system and parental care type. Choose from the options given below and fill in the table with the appropriate habits and numbers:

No.	Characteristics	Parental Care Type	Mating System
1.	Large investment required for incubating and feeding the young for prolonged time		
2.	Lactating females, internal fertilization		
3.	External fertilization, females exhibit territorial behaviour		

Options for parental care type

(a) Male parental care

(b) Female parental care

(c) Biparental care

(d) No parental care

Options for mating system

I. Monogamy

II. Polyandry

III. Polygyny

IV. Promiscuity

#### Solution

No.	Characteristics	Parental Care Type	Mating System
1.	Large investment required for incubating and feeding the young for prolonged time	Biparental care	Monogamy
2.	Lactating females, internal fertilization	Female parental care	Polygyny
3.	External fertilization, females exhibit territorial behaviour	Male parental care	Polyandry

48. In a study on the mycorrhizal community found in the rhizosphere (area around root system) of *Abies pindrow* (a conifer), the following information was found.

- Glomus aureus* was found to form an association with the plant irrespective of the presence of other species.
- Glomus viridis* formed an association with the plant only in the presence of another species of *glomus*.
- Glomus lobatus* formed an association with *Abies* only when no other species of *Glomus* was present.
- Diaspora spectabilis* formed an association with the plant in the presence of *Glomus viridis* only.

What would be the minimal composition of the mycorrhizal community. If *D. spectabilis* is detected? Indicate your answers by putting + or - against each species in the table.

Species	+/-
<i>G. aureus</i>	
<i>G. viridis</i>	
<i>D. spectabilis</i>	
<i>G. lobatus</i>	

#### Solution

Species	+/-
<i>G. aureus</i>	+
<i>G. viridis</i>	+
<i>D. spectabilis</i>	+
<i>G. lobatus</i>	-

Since, *Glomus lobatus* formed association, only when other species of *Glomus* was absent therefore, it have minimum composition in mycorrhizal community.

49. A two month study on a population of 500 rats showed that the emigration of individuals from the population was 1.5 times the rate of immigration. At the same time the birth rate was found to be two times the rate of death. If the number of emigrants during the period of study was 75 and the birth rate was 10%, what would be the number of rat individuals in the population at the end of the study?

**Solution** Number of emigrants = 75 = 1.5 IM

$$IM = \frac{75}{1.5} = 50$$

$$\text{Birth} = 500 \times \frac{10\%}{100} = 50$$

$$\text{Death} = \frac{50}{2} = 25$$

$$\begin{aligned} \text{No. of individuals at last} &= 500 + 50 + 50 - 75 - 25 \\ &= 500 \end{aligned}$$

50. A quadrat survey in a forest block revealed the following information. The size of each quadrat was 50 m × 50 m.

Species	No. of Individuals			
	Q1	Q2	Q3	Q4
<i>Tectona grandis</i>	7	8	5	6
<i>Dillenia pentagyna</i>	1	1	—	—
<i>Cordia sebastiana</i>	3	—	3	3
<i>Terminalia arjuna</i>	6	6	6	6
<i>Oroxylum indicum</i>	—	—	—	3
<i>Fimbrania colorata</i>	—	—	—	12
<i>Disopyros melanoxyton</i>	16	8	8	2
<i>Lagerstroemia parviflora</i>	43	31	35	—
<i>Dalbergia sissoo</i>	31	—	—	—

State whether the following statements are true (T) or false (F).

- Dalbergia sissoo* would have the highest abundance .....
- The density of *Tectona grandis* would be 2600 trees per km. sq. ....
- Dillenia pentagyna* would have the least abundance .....
- Frequency of *Dillenia pentayna* is lower than that of *Oroxylum indicum* .....

**Solution** Abundance =  $\frac{\text{Total no. of individuals of the species}}{\text{Total no. of quadrat having species}}$

$$\text{Density} = \frac{\text{Total no. of individuals of species}}{\text{Total no. of quadrat studied}}$$

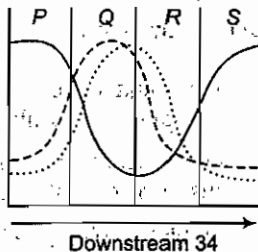
$$\text{Frequency} = \frac{\text{Total no. of quadrates having species}}{\text{Total no. of quadrat studied}} \times 100$$

$\frac{26}{25}$

Species	No. of Individuals				Frequency	Density	Abundance
	Q1	Q2	Q3	Q4			
<i>Tectona grandis</i>	7	8	5	6	100	6.5	6.5
<i>D. pentagyna</i>	1	1	—	—	50	0.5	1.0
<i>C. sebastiana</i>	3	—	3	3	75	2.25	3.0
<i>Terminalia arjuna</i>	6	6	6	6	100	6.0	6.0
<i>Oroxylum indicum</i>	—	—	—	3	25	0.75	3.0
<i>Fimbrania colorata</i>	—	—	—	12	25	3.00	12.0
<i>Disopyros melanoxyton</i>	16	8	8	2	100	8.5	8.5
<i>Lagerstroemia parviflora</i>	43	31	35	—	75	27.25	36.33
<i>Dalbergia sissoo</i>	31	—	—	—	25	7.75	31.0

- Highest abundance is of *Lagerstroemia parviflora*.
- Density of *Tectona grandis* would be 2600 trees/km<sup>2</sup>.
- Dillenia pentagyna* has least abundance.
- Frequency of *Dillenia pentagyna* is higher than that of *Oroxylum indicum*.

51. The levels of organic waste in the path of a river are shown by line (.....) in the figure.



- A. The lines (.....) and (.....) most likely represent
- phosphorus and nitrogen levels
  - nitrogen and oxygen levels
  - dissolved oxygen and carbon dioxide levels
  - decomposer microbes and oxygen levels

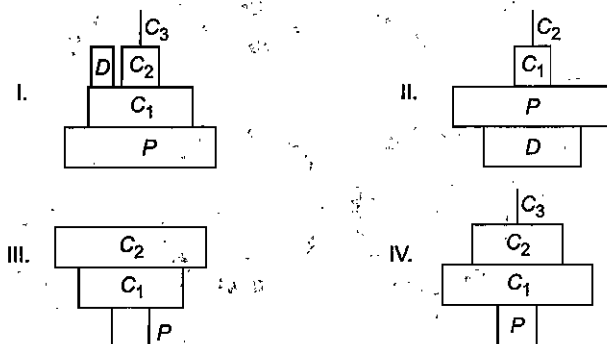
Choose from the options and put a tick mark (✓) in the appropriate box

(a)	(b)	(c)	(d)

B. Zone of recovery would be : P/Q/R/S

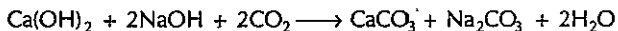
C. The Zone in which active swimmers will not be found would be : P/Q/R/S

- Solution**
- The number of decomposer microbes increase with depth of water body while oxygen level declines.
  - The zone of recovery is the prior position after lowest value. Therefore, *R* represent the zone of recovery.
  - The active swimmer are actually not found in deepest zones, i.e., zone *Q* and *R*.
52. Ecological pyramids depict the inter-relationships between the various trophic levels. Four pyramids are shown below. Match them against the correct description.



- Pyramid of biomass in a tree ecosystem .....
- Number of pyramid in grassland ecosystem .....
- Pyramid of biomass in a pond .....

- Solution**
- II. Pyramid of biomass in a tree ecosystem is upright, i.e., biomass decreasing with increasing trophic level.
  - I. Pyramid of number in grassland ecosystem is upright, i.e., the number decreases with increasing trophic level.
  - III. Pyramid of biomass in a pond or aquatic ecosystem is inverted. The biomass of phytoplanktons may be smaller than that of zooplanktons.
53. Soda lime is a mixture of sodium hydroxide and calcium hydroxide and can be used to measure the rate of  $\text{CO}_2$  production by soil microorganisms. It reacts with  $\text{CO}_2$  as follows



Assume the following

- Weight of dry soda lime just before the experiment : 'A' gm.
- 'A' gm soda lime incubated with soil in airtight container for 4 days and weighed : B gm.
- 'A' gm soda lime incubated without soil in airtight container for 4 days and weighed : C gm.
- Sample II dried and weighed : B<sub>d</sub>.
- Sample III dried and weighed : C<sub>d</sub>.

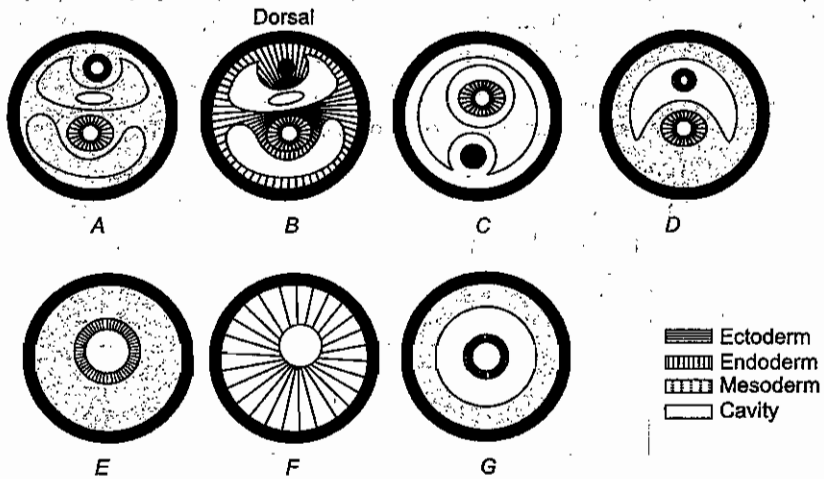
(Assume that soil moisture has no effect on the results)

Answer the following questions

- Amount of  $\text{CO}_2$  present in air inside the container :
- Amount of  $\text{CO}_2$  produced by soil organisms

- Solution**
- The amount of  $\text{CO}_2$  present in air inside the container =  $C - A$ .
  - Amount of  $\text{CO}_2$  produced by soil organisms =  $B - C$ .

54. Analyse the following schematic figures depicting basic architecture of body plan for multicellular animals and answer questions A-G.



A. A 'true' coelom is represented in

- (a) A and B only (b) A only  
 (c) B and C only (d) A, C and D only  
 (e) B, C and G only

Choose from the options and put a tick mark (✓) in the appropriate box.

(a)	(b)	(c)	(d)

B. The most likely evolutionary sequence of body plans acquired by multicellular animals is represented by :

- (a) E → F → G → C → A (b) E → G → D → C → A  
 (c) F → E → G → D → C → B → A (d) F → E → G → C → A

Choose from the options and put a tick mark (?) in the appropriate box.

(a)	(b)	(c)	(d)

C. Choose the correct body plan from A to G and fill in the table

	Column I (Name of the animal)	Column II (Body Plan)
(i)	Silverfish	
(ii)	Planaria	
(iii)	Jelly fish	
(iv)	Lizard	
(v)	Ascaris	

**Solution**

- A. A true coelom is lined by peritoneum (mesothelium in invertebrates), outer parietal and inner visceral. It is present in *A*, *C* and *D* figure.
- B. On the basis of presence, absence and nature of coelom animals are of three types, i.e., acoelomate, pseudocoelomate and eucoelomate having the evolutionary sequence as the evolutionary sequence of body plans in the figure is this  $F \rightarrow E \rightarrow G \rightarrow C \rightarrow A$
- C.

S.No.	Column I (Name of the animal)	Column II (Body Plan)	Column III (Phylum)
(i)	Silverfish	C	Arthropoda
(ii)	Planaria	E	Platyhelminthes
(iii)	Jelly fish	F	Coelenterata
(iv)	Lizard	A	Reptilia (Class)
(v)	<i>Ascaris</i>	G	Aschelminthes