

PART 'A'

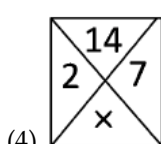
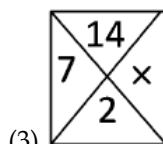
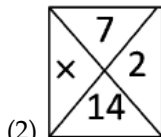
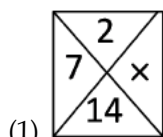
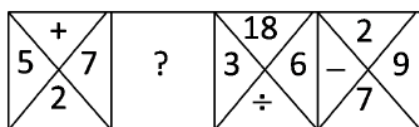
1. The random errors associated with the measurement of P and Q are 10% and 2%, respectively. What is the percentage random error in P/Q ?

(1) 12.0 (2) 9.8
(3) 8.0 (4) 10.2

2. In how many distinguishable ways can the letters of the word CHANCE be arranged?

(1) 120 (2) 720
(3) 360 (4) 240

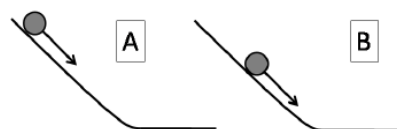
3. Find out the missing pattern.



4. Seeds when soaked in water gain about 20% by weight and 10% by volume. By what factor does the density increase?

(1) 1.20 (2) 1.10
(3) 1.11 (4) 1.09

5. Retarding frictional force f , on a moving ball, is proportional to its velocity, V . Two identical balls roll down identical slopes (A & B) from different heights. Compare the retarding forces and the velocities of the balls at the bases of the slopes.

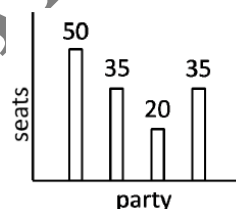


(1) $f_A > f_B$; $V_A > V_B$ (2) $f_A > f_B$; $V_B > V_A$
(3) $f_B > f_A$; $V_B > V_A$ (4) $f_B > f_A$; $V_A > V_B$

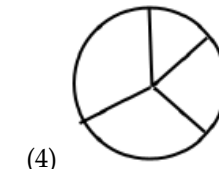
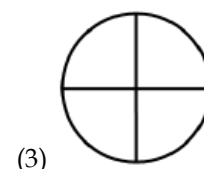
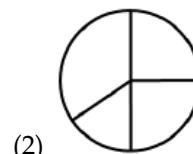
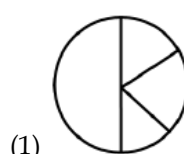
6. Two cockroaches of the same species have the same thickness but different lengths and widths. Their ability to survive in oxygen deficient environments will be compromised

(1) their thickness increases, and the rest of the size remains the same.
(2) their thickness remains unchanged, but their length increases.
(3) their thickness remains unchanged, but their width decreases.
(4) their thickness decreases, but the rest of the size remains unchanged.

7. The bar chart shows number of seats won by four political parties in a state legislative assembly.



Which of the following pie-charts correctly depicts this information?

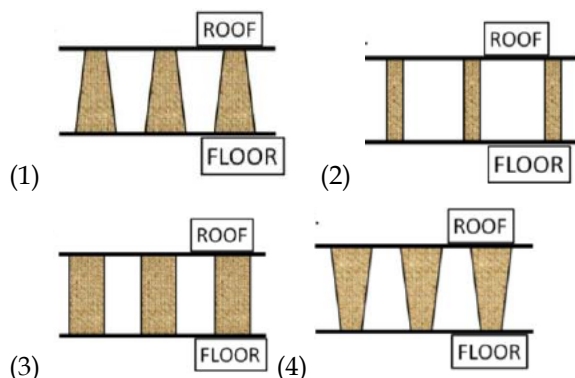


8. Intravenous (IV) fluid has to be administered to a child of 12 kg with dehydration, at a dose of 20 mg of fluid per kg of body weight, in 1 hour. What should be the drip rate (in drops/min) of IV fluid? (1mg = 20 drops)

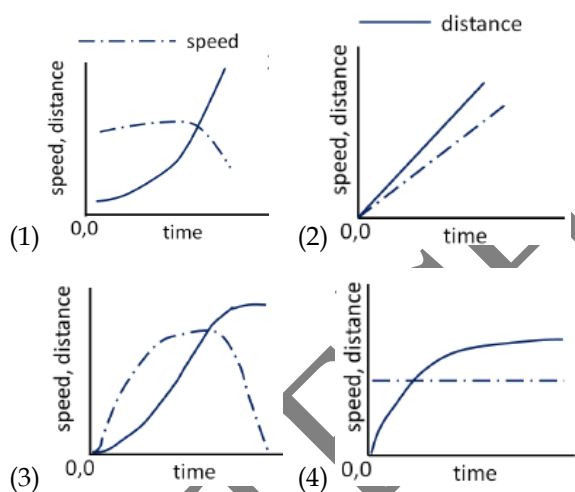
(1) 7 (2) 80
(3) 120 (4) 4

9. A hall with a high roof is supported by an array of identical columns such that, to a person lying

on the floor and looking at the ceiling, the columns appear parallel to each other. Which of the following designs conforms to this?



10. Which of the following graphs correctly shows the speed and the corresponding distance covered by an object moving along a straight line?



11. A normal TV screen has a width to height ratio of 4:3, while a high definition TV screen has a ratio of 16:9. What is the approximate ratio of their diagonals, if the heights of the two types of screens are the same?

- (1) 5:9 (2) 5:18
(3) 5:15 (4) 5:6

12. Comparing numerical values, which of the following is different from the rest?

- (1) The ratio of the circumference of a circle to its diameter.

- (2) The sum of the three angles of a plane triangle expressed in radians.

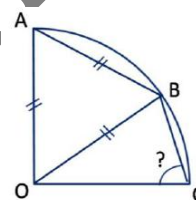
- (3) $22/7$.

- (4) The net volume of a hemisphere of unit radius, and a cone of unit radius and unit height.

13. A river is 4.1 km wide. A bridge built across it has $1/7$ of its length on one bank and $1/8$ of its length on the other bank. What is the total length of the bridge?

- (1) 5.1 km (2) 4.9 km
(3) 5.6 km (4) 5.4 km

14. OA, OB, and OC are radii of the quarter circle shown in the figure. AB is also equal to the radius.



What is angle OCB?

- (1) 60° (2) 75°
(3) 55° (4) 65°

15. Two iron spheres of radii 12 cm and 1 cm are melted and fused. Two new spheres are made without any loss of iron. Their possible radii could be

- (1) 9 and 4 cm (2) 9 and 10 cm
(3) 8 and 5 cm (4) 2 and 11 cm

16. A man buys alcohol at Rs. 75/cL, adds water, and sells it at Rs.75/cL making a profit of 50%. What is the ratio of alcohol to water?

- (1) 2:1 (2) 1:2
(3) 3:2 (4) 2:3

17. The sum of digits of a two-digit number is 9. If the fraction formed by taking 9 less than the number as numerator and 9 more than the

number as denominator is $\frac{3}{4}$, what is the number?

- (1) 36 (2) 63
(3) 45 (4) 54

18. The distance between X and Y is 1000 km. A person flies from X at 8 AM local time and reaches Y at 10 AM local time. He flies back after a halt of 4 hours at Y and reaches X at 4 PM local time on the same day. What is his average speed for the duration he is in the air?

- (1) 500 km/hour
(2) 250 km/hour
(3) 750 km/hour
(4) cannot be calculated with the given information

19. If a person travels $x\%$ faster than normal, he reaches y minutes earlier than normal. What is his normal time of travel?

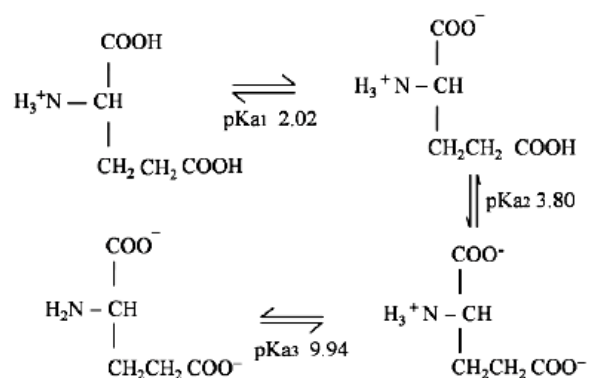
- (1) $\left(\frac{100}{x} + 1\right) y$ minutes (2) $\left(\frac{x}{100} + 1\right) y$ minutes
(3) $\left(\frac{y}{100} + 1\right) x$ minutes (4) $\left(\frac{100}{y} + 1\right) x$ minutes

20. A and B walk up an escalator one step at a time, while the escalator itself moves up at a constant speed. A walks twice as fast as B. A reaches the top in 40 steps and B in 30 steps. How many steps of the escalator can be seen when it is not moving?

- (1) 30 (2) 40
(3) 50 (4) 60

PART 'B'

21. Choose the most appropriate pH at which the net charge is zero for the molecule from the data shown below:



- (1) 2.02 (2) 2.91
(3) 5.98 (4) 6.87

22. Choose the correct statement about peptides in the Ramachandran plot.

- (1) Peptides that are unstructured will have all the backbone dihedral angles in the disallowed regions.
(2) It is not possible to conclude whether a peptide adopts entirely helix or entirely beta sheet conformation.
(3) The occurrence of beta turn conformation in a peptide can be deduced.
(4) The sequence of a peptide can be deduced.

23. Equilibrium constant (K'_{eq}) of a reaction is a ratio of product of substrate concentrations. The relation between (K'_{eq}) and free energy change in reaction ($\Delta G'$) is as follows $\Delta G' = -RT \ln K'_{eq}$. Reaction A and Reaction B have K'_{eq} values of 10 and 100, respectively. Which of the following statements is correct with respect to $\Delta G'$?

- (1) $\Delta G'$ of A = $\Delta G'$ of B
(2) $\Delta G'$ of A > $\Delta G'$ of B
(3) $\Delta G'$ of B > $\Delta G'$ of A
(4) $\Delta G'$ of A \equiv $\Delta G'$ of B

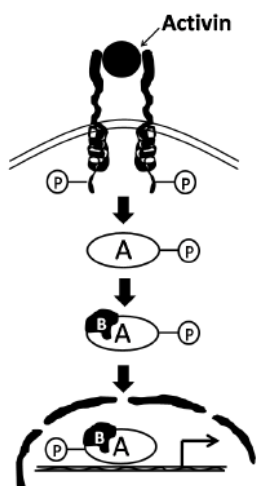
24. Excess oxygen consumed after a vigorous exercise is

- (1) to pump out lactic acid from muscle.

- (2) to increase the concentration of lactic acid in muscle.
- (3) to reduce dissolved carbon dioxide in blood.
- (4) to make ATP for gluconeogenesis.
25. Which one of the following describes the primary function of flippases?
- (1) Help in increasing lipid-protein interaction in the outer leaflet of the bilayer
- (2) Move certain phospholipids from one leaflet of the membrane to another
- (3) Localize more negatively charged membrane proteins in the lipid bilayer
- (4) Cause uncoupling of v-SNARES and t-SNARES after fusion of incoming vesicle with target membrane
26. Mitotic cyclin-CDK activity peaks in M phase. This is because
- (1) Mitotic cyclin is synthesised only in M phase.
- (2) Threshold level of mitotic cyclin accumulates only in late G2.
- (3) Cyclin subunit is activated by phosphorylation only in M phase.
- (4) The kinase subunit is activated by dephosphorylation only in M phase.
27. The gel to liquid crystalline phase transition temperature in phosphatidyl choline (PC) lipids composed of dioleoyl (DO), dipalmitoyl (DP), disteoyl (DS) and palmitoyl oleoyl (PO) fatty acids in increasing order will be
- (1) DOPC > DPPC > POPC > DSPC
- (2) DSPC > DPPC > POPC > DOPC
- (3) DPPC > DSPC > DOPC > POPC
- (4) POPC > DPPC > DOPC > DSPC
28. Which of the following is **NOT** an example of transmembrane transport between different subcellular compartments?
- (1) Transport from cytoplasm into the lumen of the endoplasmic reticulum
- (2) Transport from endoplasmic reticulum to the Golgi complex
- (3) Transport from stroma into thylakoid space
- (4) Transport from mitochondrial intermembrane space into the mitochondrial matrix
29. Which of the following are **NOT** transcribed by RNA polymerase II?
- (1) miRNA and some snRNA
- (2) miRNA and snoRNA
- (3) mRNA and snoRNA
- (4) tRNA and 5S rRNA
30. RNA editing, a post-transcriptional process, is achieved with the help of guide RNA (g- RNA). Which one of the following statements about the process is **NOT** true?
- (1) g-RNA dependent RNA editing happens in the kinetoplast DNA
- (2) g-RNA is involved in chemical modification of t-RNA
- (3) This process involves insertion or deletion of uridines
- (4) Sequences edited once may be re-edited using a second g-RNA
31. Telomerase, a RNA-protein complex which completes the replication of telomeres during DNA synthesis, is a specialised
- (1) RNA dependent DNA polymerase
- (2) DNA dependent DNA polymerase
- (3) DNA dependent RNA polymerase
- (4) RNA dependent RNA polymerase
32. Consider a short double-stranded linear DNA molecule of 10 complete turns with 10.5 bp/turn. The ends of the DNA molecule are sealed together to make a relaxed circle. This relaxed circle will have a linking number of

- (1) 105 (2) 20.5
(3) 10.0 (4) 10.5

33.



In the above signalling cascade, which one of the following molecules is denoted by 'B'?

- (1) STAT 5 (2) SMAD 6
(3) GSK3 β (4) SMAD 4

34. The secondary antibodies routinely used for the detection of primary antibodies in western blotting experiment are

- (1) anti-allotypic (2) anti-idiotypic
(3) anti-isotypic (4) anti-paratypic

35. Which of the following events will **NOT** usually lead to transformation of a normal cell into a cancer cell?

- (1) Gain of function of oncogenes
(2) Loss of function of tumor suppressors
(3) Gain of function of genes involved in nucleotide excision repair
(4) Loss of function of pro-apoptosis related genes

36. Which one of the following is a food borne toxin?

- (1) Tetanus toxin (2) Botulinum toxin
(3) Cholera toxin (4) Diphtheria toxin

37. Which one of the following statements is **WRONG**?

(1) The megasporocyte develops within the megasporangium of the ovule

(2) Megasporocyte undergoes meiosis to produce four haploid megaspores

(3) All the four megaspores undergo several mitotic divisions to form female gametophyte in most angiosperms

(4) Female gametophyte is haploid

38. Certain proteins or mRNAs that are regionally localized within the unfertilized egg and regulate development are called

- (1) gene regulators.
(2) morphometric determinants.
(3) cytoplasmic determinants.
(4) mosaic forming factors.

39. Cell to cell communication is important in development of an organism. The ability of cells to respond to a specific inductive signal is called

- (1) Regional specificity of induction
(2) Competence
(3) Juxtacrine signaling
(4) Instructive interaction

40. Apical ectodermal ridge induction is essential for tetrapod limb development. Which one of the following is **NOT** essential for the formation of a functional limb?

- (1) Tbx genes and Wnt
(2) Androsterone
(3) Apoptotic genes
(4) Fibroblast growth factor

41. Which one of the following best describes the symplast pathway of water flow from the epidermis to endodermis in a plant root?

(1) Water moves through cell walls and extracellular spaces without crossing any membrane

- (2) Water travels across the root cortex via the plasmodesmata
(3) Water crosses the plasma membrane of each cell in its path twice, once on entering and once on exiting
(4) Transport across the tonoplast
42. The herbicide, dichlorophenyldimethylurea, is an inhibitor of
(1) shikimate pathway for biosynthesis of aromatic amino acids.
(2) electron transport from P680 to P700.
(3) branched chain amino acid pathway.
(4) electron transport from P700 to ferredoxin.
43. Which one of the following compounds is **NOT** a part of alkaloid class of secondary metabolites?
(1) Lignin (2) Indole
(3) Tropane (4) Pyrrolidine
44. Which one of the following plant derived signalling molecules induces hyphal branching of arbuscular mycorrhizal fungi, a phenomenon that is observed at the initial stages of colonization by these fungi?
(1) Salicylic acid (2) Absciscic acid
(3) Strigolactones (4) Systemin
45. Serum has essentially the same composition as plasma **EXCEPT** that it lacks
(1) Albumin
(2) Stuart-Prower factor
(3) Antihemophilic factor
(4) Hageman factor
46. Which one of the following does **NOT** occur due to stimulation of baroreceptors?
(1) Bradycardia (2) Hypotension
(3) Venodilation (4) Vasoconstriction
47. Vasopressin secretion does **NOT** increase with
(1) exercise
(2) an increase in extracellular fluid volume
(3) standing
(4) vomiting
48. Which type of cells located in gastric glands is responsible for the release of histamine?
(1) Mucous neck cells
(2) Enterochromaffin-like cells
(3) Chief cells
(4) Parietal cells
49. If non-disjunction occurs in meiosis I, which of the following scenario is most likely to occur?
(1) Two gametes will be $n+1$ and two will be $n-1$
(2) One gamete will be $n+1$, two will be ' n ' and one will be $n-1$
(3) Two gametes will be normal and two will be $n-1$
(4) Two gametes will be normal and two will be $n+1$
50. Which of the following mutagens is most likely to result in a single amino acid change in a gene product?
(1) Acridine orange
(2) X-rays
(3) Ethylmethane sulphonate (EMS)
(4) Ethidium bromide
51. Maternal inheritance of coiling of shell in snail (*Limnaea peregra*) is well established. The dextral coiling depends on dominant allele D and sinistral coiling depends upon recessive allele d . A female F_1 progeny of dextral (Dd) type is crossed with a male sinistral snail. What will be the ratio of heterozygous: homozygous individuals in its F_2 progeny?
(1) 3:1 (2) 1:1
(3) 1:3 (4) 1:2:1

52. Which of the following is true for cells harbouring F' plasmid?
- (1) Their F plasmid is non-functional.
 - (2) They exhibit increased rates of transfer of all chromosomal genes.
 - (3) They are merodiploids.
 - (4) They fail to survive as the chromosomal origin of replication is inactivated.
53. An alga having chlorophyll a, floridean starch as storage product and lacking flagellate cells belongs to the class
- (1) Phaeophyceae. (2) Chlorophyceae.
 - (3) Rhodophyceae. (4) Xanthophyceae.
54. Which of the following is **NOT** true for monocots?
- (1) Sieve tube members with companion cells
 - (2) Vasculature atactostelic
 - (3) Tricolpate pollen
 - (4) Vascular cambium absent
55. Individuals occupying a particular habitat and adapted to it phenotypically but not genotypically are known as
- (1) Ecophenes. (2) Ecotypes.
 - (3) Ecospecies. (4) Coenospecies.
56. Which one of the following statements supports the concept of trade-off in the evolution of life history traits?
- (1) Level of parental care and clutch size are positively correlated
 - (2) Animals maturing early tend to live longer
 - (3) An increase in seed size is usually associated with a decrease in seed number
 - (4) Allocation of higher energy for reproduction leads to higher population growth
57. A plot of dN/dt as a function of population density yields a
- (1) rectangular hyperbola.
 - (2) negative exponential curve.
 - (3) positive rectilinear curve.
 - (4) bell-shaped curve.
58. For a species having logistic growth, if $K = 20,000$ and $r = 0.15$, the maximum sustainable yield will be
- (1) 450 (2) 1500
 - (3) 3000 (4) 6000
59. Which of the following is a correct ranking of ecosystems based on the root: shoot ratio of plants?
- (1) Tropical wet forest > Tropical dry forest > Temperate grassland > Tropical grassland
 - (2) Temperate grassland > Tropical grassland > Tropical wet forest > Tropical dry forest
 - (3) Tropical dry forest > Tropical wet forest > Tropical grassland > Temperate grassland
 - (4) Temperate grassland > Tropical grassland > Tropical dry forest > Tropical wet forest
60. Which of the following periods is known as "Age of Fishes"?
- (1) Devonian (2) Jurassic
 - (3) Cambrian (4) Carboniferous
61. Which of the following is **NOT** an assumption of the Hardy-Weinberg model?
- (1) Population mates at random with respect to the locus in question
 - (2) Selection is not acting on the locus in question
 - (3) One allele is dominant and the other is recessive at this locus
 - (4) The population is effectively infinite in size
62. Which of the following geological periods is characterized by the first appearance of mammals?

- (1) Tertiary (2) Cretaceous
(3) Permian (4) Triassic
63. In which of the following mating systems there is likely to be **NO** conflict of interest over reproductive success between the sexes?
(1) Polyandry (2) Monogamy
(3) Promiscuity (4) Polygamy
64. Which one of the following analytical techniques does **NOT** involve an optical measurement?
(1) ELISA
(2) Microarray
(3) Flow cytometry
(4) Differential Scanning Calorimetry
65. Which genes have been introduced in Bollgard II cotton to get resistance against cotton bollworm, tobacco budworm and pink bollworm?
(1) *cry1Ab + cry1Ac*
(2) *cry1Ac + cry2Ab*
(3) *cry1Ab + cry2Ab*
(4) *cry9C + cry2Ab*
66. Different leads are used to record ECG of humans. Which one of the following is **NOT** unipolar leads?
(1) Augmented limb leads
(2) V_1 and V_2 leads
(3) Standard limb leads
(4) VR and VL leads
67. The presence and distribution of specific mRNAs within a cell can be detected by
(1) Northern blot analysis
(2) RNase protection assay
(3) *in situ* hybridization
(4) real-time PCR
68. The tetanus vaccine given to humans in the case of a deep cut is a
(1) DNA vaccine
(2) recombinant vector vaccine
(3) subunit vaccine
(4) toxoid vaccine
69. The electrospray ionization spectrum of a mixture of two peptides show peaks with m/z values 301, 401, 501, and 601. The molecular weights of the peptides are
(1) 1200 and 1250 (2) 1200 and 1500
(3) 1350 and 1500 (4) 1250 and 1350
70. An optical measurement of a protein is taken both before and after digestion of the protein by a protease. In which of the following spectroscopic measurements the signal change, i.e., before *vs* after protease treatment, could be the maximum?
(1) Absorbance at 280 nm
(2) Circular dichroism
(3) Absorbance at 340 nm
(4) Fluorescence value
- PART 'C'**
71. From the following statements,
A. Hydrogen, Deuterium and Tritium differ in the number of protons
B. Hydrogen, Deuterium and Tritium differ in the number of neutrons
C. Both Deuterium and Tritium are radioactive and decay to Hydrogen and Deuterium, respectively
D. Tritium is radioactive and decays to Helium
E. Carbon-14 decays to Nitrogen-14
F. Carbon-14 decays to Carbon-13
pick the combination with **ALL** correct statements.
(1) A, B and F (2) B, D and E
(3) A, C and D (4) C, E and F
72. From the following statements,

- A. For a reaction to occur spontaneously the free energy change must be negative
- B. The interaction between two nitrogen molecules in the gaseous state is predominantly electrostatic
- C. By knowing bond energies, it is possible to deduce whether the bond is covalent bond or hydrogen bond
- D. Hydrophobic interactions are not important in a folded globular protein
- pick the combination with **ALL WRONG** statements.

- (1) A and B (2) B and C
(3) C and D (4) B and D

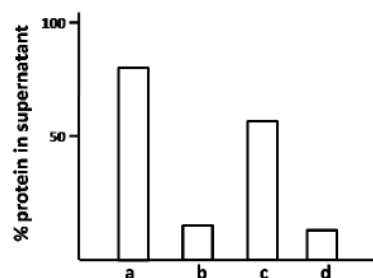
73. The following are four statements on peptide/protein conformation:

- A. Glycine has the largest area of conformationally allowed space in the Ramachandran plot ϕ and ψ
- B. A 20-residue peptide that is acetylated at the N-terminus and amidated at the C-terminus has $\phi = -60^\circ (\pm 5)$ $\Psi = -30^\circ (\pm 5)$ for all the residues. It can be concluded that conformation of the peptide is helix-turn-strand
- C. The allowed values of ϕ , Ψ for amino acids in a protein are not valid for short peptides
- D. A peptide Acetyl-A1-A2-A3-A4-CONH₂ (A1-A4 are amino acids) adopts a well defined β -turn. The dihedral angles of A2 and A3 determine the type of β -turn

Choose the combination of correct statements.

- (1) A and B (2) B and C
(3) A and D (4) C and D

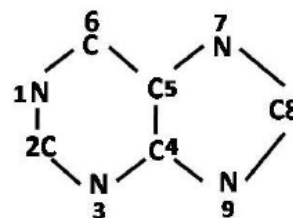
74. A researcher investigated a set of conditions for a protein with an isoelectric point of 6.5 and also binds to calcium. This protein was subjected to four independent treatments: (i) pH 6.4, (ii) 10% glycerol, (iii) 10 mM CaCl₂, (iv) 40% ammonium sulphate. This was followed by centrifugation and estimation of the protein in the supernatant. The results are depicted in the graph below:



Which of the following treatments best represents the results shown in the graph?

- (1) a = ammonium sulphate, b = glycerol, c = pH 6.4, d = CaCl₂
(2) a = CaCl₂, b = glycerol, c = ammonium sulphate, d = pH 6.4
(3) a = pH 6.4, b = CaCl₂, c = ammonium sulphate, d = glycerol
(4) a = CaCl₂, b = pH 6.4, c = glycerol, d = ammonium sulphate

75. In the biosynthesis of purine:

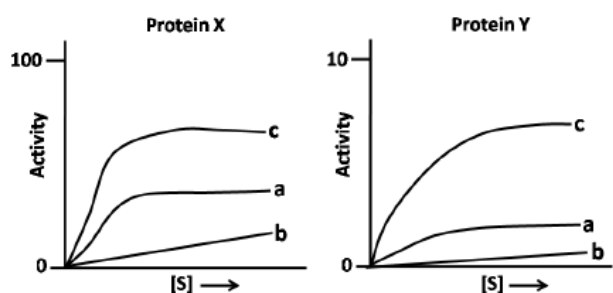


- (1) All N atoms, C4 and C5 are from aspartic acid
(2) N1 is from Aspartic acid; N3 and N9 are from Glutamine side-chain; N7, C4 and C5 are from Glycine

(3) N1 is from Aspartic acid; N3 from Glutamine side-chain; N9 from N attached to C α of Glutamine; N7, C4 and C5 are from Glycine

(4) N1 is from Glutamine; N3 from Glutamine side-chain; N9 from N attached to C α of Glutamine; N7, C4 and C5 are from Glycine

76. A researcher was investigating the substrate specificity of two different enzymes, X and Y, on the same substrate. Both the enzymes were subjected to treatment with either heat or an inhibitor which inhibits the enzyme activity. Following are the results obtained where a=inhibitor treatment, b=heat treatment and c=control.



Which of the following statements is correct?

- (1) Only protein X is specific for the substrate, S
- (2) Only protein Y is specific for the substrate, S
- (3) Both X and Y are specific for the substrate, S
- (4) Both X and Y are non-specific for the substrate, S

77. In an experiment, red blood cells were subjected to lysis and any unbroken cells were removed by centrifugation at 600g. The supernatant was taken and centrifuged at 100,000g. The pellet was extracted with 5M NaCl and again centrifuged at 100,000g. Which of the following proteins would be present in the supernatant?

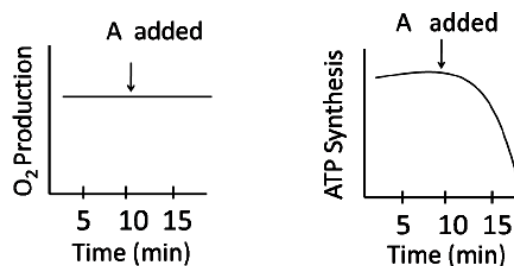
- (1) Band 3
- (2) Glycophorin
- (3) G protein-coupled receptor
- (4) Spectrin

78. In order to study the intracellular trafficking of protein 'A', it was tagged with GFP (A-GFP). Fluorescence microscopy showed that A-GFP co-localizes with LAMP1. In the presence of bafilomycin A, an inhibitor of H⁺-ATPase, AGFP does not co-localize with LAMP1. Instead, it co-localizes with LC3 puncta.

Which one of the following statements is TRUE?

- (1) A-GFP targets to the ER in the absence of bafilomycin A.
- (2) Autophagy is required for trafficking of A-GFP to lysosomes.
- (3) Bafilomycin A facilitates targeting of A-GFP to the ER.
- (4) Bafilomycin A facilitates targeting of A-GFP to the mitochondria.

79. 'A' is an inhibitor of chloroplast function. The production of O₂ and the synthesis of ATP are measured in illuminated chloroplasts before and after addition of 'A' as shown below



Which statement is correct?

- (1) 'A' inhibits the reduction of NADP⁺
- (2) 'A' inhibits the proton gradient and the reduction of NADP⁺
- (3) 'A' inhibits the proton gradient but not the reduction of NADP⁺
- (4) 'A' inhibits neither the proton gradient nor the reduction of NADP⁺

80. During cell cycle progression from G1 to S, cyclin D-CDK4 phosphorylates Rb and reduces its affinity for E2F. E2F dissociates from Rb and activates S-phase gene expression. Over

expression of protein 'A' arrests G1 phase progression.

Which of the following statements is TRUE?

1. 'A' inhibits Rb-E2F interaction
2. 'A' inhibits CDK4 activity
3. 'A' phosphorylates E2F
4. 'A' degrades Rb

81. Cells in S-phase of the cell cycle were fused to cells in the following stages of cell cycle: (a) G1 phase, (b) G2 phase, (c) M phase. These cells were then grown in medium containing tritiated thymidine. Maximal amount of freshly labelled DNA is likely to be obtained in Sphase cells fused with

- (1) G1 phase cells
- (2) G2 phase cells
- (3) M phase cells
- (4) Both G1 and G2 phase cells

82. Addition of the antibiotic cephalixin to growing *E. coli* cells lead to filamentation of the cells, followed by lysis. Cephalixin is an inhibitor of

- (1) protein synthesis
- (2) DNA synthesis
- (3) peptidoglycan synthesis
- (4) RNA polymerase

83. Fluorescently tagged protein was used to study protein secretion in yeast. Fluorescence was observed in:

- (a) the Golgi
- (b) the secretory vesicles
- (c) the rough ER.

Which of the following describes best the sequence in which these events occur?

- (1) (a) → (b) → (c) (2) (b) → (c) → (a)
- (3) (c) → (a) → (b) (4) (c) → (b) → (a)

84. In order to ensure that only fully processed mature mRNAs are allowed to be exported to

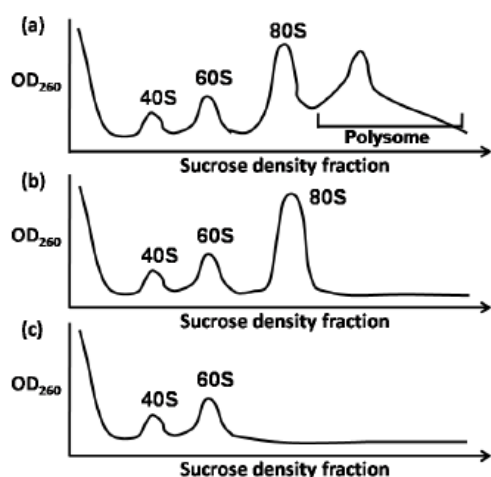
cytosol, pre-mRNAs associated with snRNPs are retained in the nucleus. To demonstrate this, an experiment was performed where a gene coding a pre-mRNA with a single intron was mutated either at the 5' or 3' splice sites or both the splice sites. Given below are a few possible outcomes:

- A. Pre-mRNA having mutation at both the splice sites will be retained in the nucleus because of the presence of bound snRNPs.
- B. Pre-mRNA having mutation at both the splice sites will be exported to cytosol because of the absence of bound snRNPs.
- C. Pre-mRNA mutated at either 3' or 5' splice sites will be retained in the nucleus because of the presence of bound snRNPs.
- D. Pre-mRNA mutated at either 3' or 5' splice sites will be exported to cytosol because of the absence of bound snRNPs.

Choose the correct combination of the possible outcomes:

- (1) B and C (2) A and D
- (3) B and D (4) A and C

85. Polysome profiling of cells treated with three hypothetical translation inhibitors is shown in the plots below. These three inhibitors are
- (i) CHP – leaky inhibitor of translation
 - (ii) LTM – arrests ribosome at the initiation codon
 - (iii) PTM – inhibits ribosome scanning



Match the polysome profile to the inhibitor

1. (i)-a;(ii)-b;(iii)-c
2. (i)-b;(ii)-c;(iii)-a
3. (i)-c;(ii)-b;(iii)-a
4. (i)-a;(ii)-c;(iii)-b

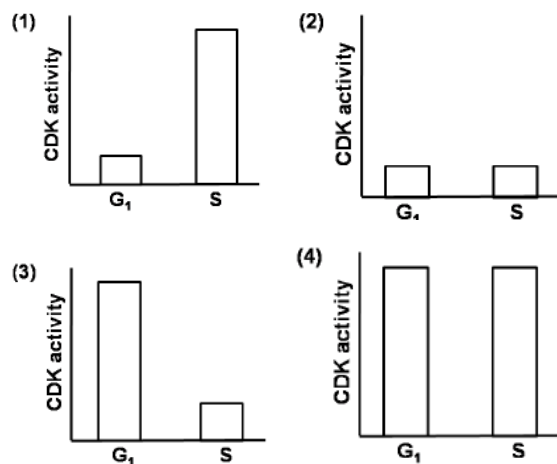
86. In mammals, CG rich sequences are usually methylated at C, which is a way for marking genes for silencing. Although the promoters of housekeeping genes are often associated with CpG islands yet they are expressed in mammals. Which one of the following best explains it?

- (1) Methylation of cytosine does not prevent the binding of RNA Pol II with the promoter, so housekeeping genes are expressed
- (2) During housekeeping gene expression, the enzyme methyltransferase is temporarily silenced by miRNA, thus shutting down global methylation
- (3) Unlike within the coding region of a gene, CG rich sequences present in the promoters of active genes are usually not methylated
- (4) As soon as the cytosine is methylated in the promoter region, the enzymes of DNA repair pathways remove the methyl group, thereby ensuring gene expression

87. Telomerase, a protein-RNA complex, has a special reverse transcriptase activity that completes replication of telomeres during DNA synthesis. Although it has many properties similar to DNA polymerase, some of them are also different. Which one of the following properties of telomerase is different from that of DNA polymerase?

- (1) Telomerase requires a template to direct the addition of nucleotides
- (2) Telomerase can only extend a 3' -OH end of DNA
- (3) Telomerase does not carry out lagging strand synthesis
- (4) Telomerase acts in a processive manner

88. In eukaryotes, a specific cyclin dependent kinase (CDK) activity is required for the activation of loaded helicases to initiate replication. On the contrary, this CDK activity inhibits the loading of helicases onto the origin of replication. Considering the fact that during each cycle, there is only one opportunity for helicases to be loaded onto origins and only one opportunity for these loaded helicases to be activated, which one of the following graphs best depicts this CDK activity in G₁ and S phases of the cell cycle?



89. In Trypanosomes, a 35 base leader sequence is joined with several different transcripts making functional mRNAs. The leader sequence is joined with the other RNAs by

- (1) a specific RNA ligase
- (2) the process of trans-splicing
- (3) a nucleophilic attack caused by a free guanine nucleotide
- (4) a nucleophilic attack caused by a 2' OH of an internal A present in the leader sequence

90. Following are the list of some of the pathogens (column A) and the unique mechanisms they employ for evading immune response (column B).

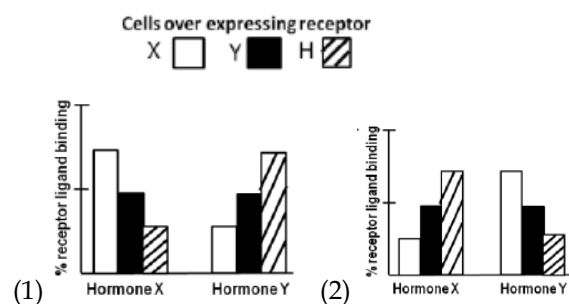
	A		B
a.	<i>Trypanosoma brucei</i>	(i)	Capable of employing unusual genetic processes by which they generate extensive variations in their variant surface glycoproteins (VSG)
b.	<i>Plasmodium falciparum</i>	(ii)	Capable of continually undergoing maturational changes in transformation to different forms which allow the organism to change its surface molecules

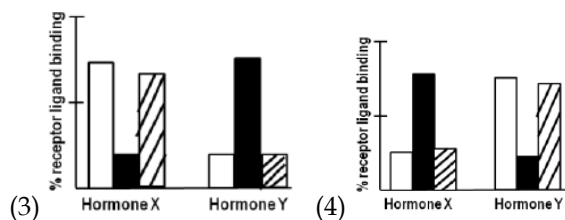
c.	<i>Haemophilus influenzae</i>	(iii)	Capable of evading immune response by frequent antigenic changes in its hemagglutinin and neuraminidase glycoproteins
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Which of the following is the correct match between the organisms and their respective mechanism to evade immune response?

- (1) a - (i), b - (ii), c - (iii)
- (2) a - (ii), b - (iii), c - (i)
- (3) a - (iii), b - (i), c - (ii)
- (4) a - (i), b - (iii), c - (ii)

91. Two steroid hormone receptors X and Y both contain a ligand binding domain and a DNA binding domain. Using recombinant DNA technology, a modified hybrid receptor H is prepared such that it contains the ligand binding domain of X and DNA binding domain of Y. Three sets of cells over-expressing receptors X, Y and H were then treated separately either with hormone X or with hormone Y. Assuming that there is no cross-reactivity, which one of the following graphs best represent the receptor-ligand binding in each case?





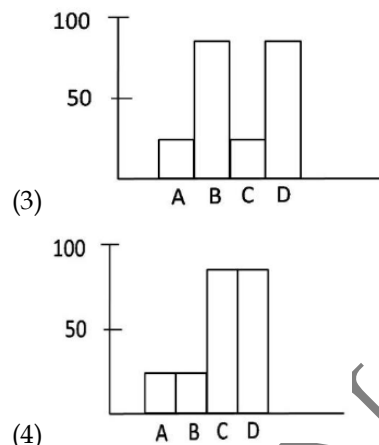
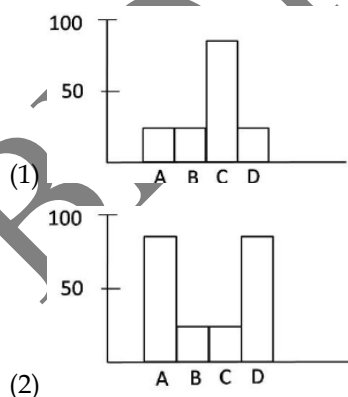
92. A protein X is kept in an inactive state in cytosol as complexed with protein Y. Under certain stress stimuli, Y gets phosphorylated resulting in its proteasomal degradation. X becomes free, translocates to nucleus and results in the transcription of a gene which causes cell death by apoptosis. Stress stimuli were given to following four different cases.

Case A: Protein Y has a mutation such that phosphorylation leading to proteasomal degradation does not occur.

Case B: Cells are transfected with a gene which encodes for a protein L that inhibits the translocation of protein Y to the nucleus.

Case C: Cells are transfected only with empty vector used to transfect the gene for protein L.

Case D: Cells are treated with Z-VAD-FMK, a broad spectrum caspase inhibitor. Which one of the following graphs best describes the apoptotic state of the cells in the above cases? Y-axis represents % apoptotic cells.



93. In animals, four separate families of cell-cell adhesion proteins are listed in Column A and their functional characteristics are given in Column B.

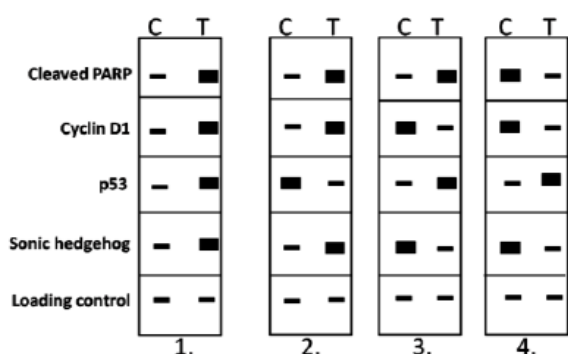
	A		B
a.	Integrin	(i)	Lectins that mediate a variety of transient, cell cell adhesion interactions in the blood stream
b.	Cadherin	(ii)	Contains extracellular Ig like domains and are mainly involved in the fine tuning of cell-cell adhesive interactions during development and regeneration.
c.	Ig-super-family	(iii)	Mediates Ca^{2+} -dependent strong homophilic cell-cell adhesion.
d.	Selectin	(iv)	Transmembrane cell adhesion proteins that act as extracellular

			matrix receptors
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Which one of the following is the correct combination?

- (1) a - (i), b - (ii), c - (iii), d - (iv)
- (2) a - (ii), b - (iii), c - (iv), d - (i)
- (3) a - (iii), b - (iv), c - (i), d - (ii)
- (4) a - (iv), b - (iii), c - (ii), d - (i)

94. A student treated cancer cells with an anticancer drug and performed western blot analysis. Which one of the following blots is the best representation of untreated control (C) and treated (T) samples?



95. Which one of the following statements regarding B cell receptor (BCR) and T cell receptor (TCR) is NOT true?
- (1) TCR is membrane bound and does not appear as soluble form as does the BCR
 - (2) Unlike BCR, most of the TCR are not specific for antigen alone but for antigen combined with MHC
 - (3) In order to activate signal transduction, BCR associates itself with Ig- α /Ig- β whereas TCR associates with CD3
 - (4) The antigen binding interactions of BCR is much weaker than TCR
96. In case of amphibians, the dorsal lip cells and their derivatives are called as "Spemann -

Mangold organizer". Following statements related to the "organizer" were made:

- A. It induces the host's ventral tissues to change their fates to form a neural tube and dorsal mesodermal tissues.
- B. It cannot organize the host and donor tissues into a secondary embryo.
- C. It does not have the ability to self-differentiate into dorsal mesoderm.
- D. It has the ability to initiate the movements of gastrulation.
- E. Both β -catenin and Chordin are produced by the organizer.

Which of the above statements are correct?

- (1) A and D
- (2) D and E
- (3) A and E
- (4) B and C

97. Driesch performed the famous "pressure plate" experiment involving intricate recombination with an 8-celled sea urchin embryo. This procedure reshuffled the nuclei that normally would have been in the region destined to form endoderm into the presumptive ectoderm region. If segregation of nuclear determinants had occurred, the resulting embryo should have been disordered. However, Driesch obtained normal larvae from these embryos. The possible interpretations regarding the 8-celled sea urchin embryo are:

- A. The prospective potency of an isolated blastomere is greater than its actual prospective fate.
- B. The prospective potency and the prospective fate of the blastomere were identical.
- C. Sea-urchin embryo is a "harmoniously equipotential system" because all of its potentially independent parts

interacted together to form a single embryo.

- D. Regulative development occurs where location of the cell in the embryo determines its fate.

Which of the above interpretation(s) is/are true?

- (1) Only A (2) Only D
(3) Only A and B (4) A, C and D

98. Consider the following events which occur during fertilization of sea urchin eggs.

- A. Resact/Speract are peptides released from the egg jelly and help in sperm attraction.
B. Bindin, an acrosomal protein, interacts in a species-specific manner, with eggs.
C. A "respiratory burst" occurs during cross-linking of the fertilization envelope, where a calcium-dependent increase in oxygen levels is observed.
D. IP₃, which is formed at the site of sperm entry, sequesters calcium leading to cortical granule exocytosis.

Which of the above statement(s) is **NOT** true?

- (1) Only C (2) A and C
(3) Only D (4) B and D

99. Following statements were given regarding the decisions taken during the development of mammalian embryos:

- A. The pluripotency of the inner cell mass (ICM) is maintained by a core of three transcription factors, Oct 4, Sox 2 and Nanog.
B. Prior to blastocyst formation each blastomere expresses both Cdx 2 and the Oct 4 transcription factors and

appears to be capable of becoming either ICM or trophoblast.

- C. Both ICM and trophoblast cells synthesize transcription factor Cdx (2)
D. Oct 4 activates Cdx 2 expression enabling some cells to become trophoblast and other cells to become ICM.

Which of the above statements are true?

- (1) A and B (2) A and C
(3) B and D (4) B and C

100. Apoptosis during early development is essential for proper formation of different structures. In *C. elegans*, apoptosis is accentuated by *ced-3* and *ced-4* genes, which in turn are negatively regulated by *ced-9* and eventually *EGL-1*. When compared to mammals, functionally similar homologues have been identified. Accordingly, which one of the following statements is **NOT** correct?

- (1) CED-4 resembles Apaf-1
(2) CED-9 resembles Bcl-XL
(3) CED-3 resembles caspase-3
(4) CED-4 resembles caspase-9

101. Individual and overlapping expression of homoeotic genes in adjacent whorls of a flower determine the pattern of floral organ development. In an *Arabidopsis* mutant, floral organs are distributed as follows:

Whorl 1 (outer most) – carpel

Whorl 2 – stamens

Whorl 3 – stamens

Whorl 4 (inner most) – carpel

Loss of function mutation in which one of the following genes would have caused the above pattern of floral organ development?

- (1) *APETALA 2* (2) *APETALA 3*
(3) *PISTILLATA* (4) *AGAMOUS*

102. In photosynthetic electron transport, electrons travel through carriers organized in the "Zscheme". The following are indicated as directions of electron flow:

- A. $P680 \rightarrow PQ_A \rightarrow PQ_B \rightarrow Cytb_6 \rightarrow Pheo \rightarrow PC \rightarrow P700$
B. $P700 \rightarrow A_0 \rightarrow A_1 \rightarrow FeS_X \rightarrow FeS_A \rightarrow FeS_B \rightarrow Fd$
C. $P680 \rightarrow Pheo \rightarrow PQ_A \rightarrow PQ_B \rightarrow Cytb_6 \rightarrow PC \rightarrow P700$
D. $P700 \rightarrow A_1 \rightarrow A_0 \rightarrow FeS_B \rightarrow FeS_A \rightarrow FeS_X \rightarrow Fd$

Which one of the following combinations is correct?

- (1) A and B (2) B and C
(3) C and D (4) A and D

103. Phytochrome-mediated control of photomorphogenesis is linked to many other gene functions. The following statements are made on the mechanism of phytochrome action:

- A. Phytochrome function requires COP1, an E3 ubiquitin ligase that brings about protein degradation
B. COP1 is slowly exported from the nucleus to the cytoplasm in the presence of light
C. HY5 is targeted by COP1 for degradation in the presence of light
D. HY5 is a transcription factor involved in photomorphogenic response

Which one of the following combinations is correct?

- (1) A, B and C (2) B, C and D
(3) A, B and D (4) A, C and D

104. The C_4 carbon cycle is a CO_2 concentrating mechanism evolved to reduce photorespiration. The following are stated as important features of the C_4 pathway:

- A. The leaves of C_4 plants have Kranz anatomy that distinguishes mesophyll and bundle sheath cells.
B. In the peripheral mesophyll cells, atmospheric CO_2 is fixed by phosphoenol pyruvate carboxylase yielding a four-carbon acid.
C. In the inner layer of mesophyll, NAD-malic enzyme decarboxylates four-carbon acid and releases CO_2
D. CO_2 is again re-fixed though Calvin cycle in the bundle sheath cells.

Which one of the following combinations is correct?

- (1) B, C and D (2) A, B and C
(3) A, B and D (4) A, C and D

105. Read the following statements related to plant pathogen interaction

- A. Systemic acquired resistance is observed following infection by compatible pathogen
B. Induced systemic resistance is activated following infection by compatible pathogen
C. A bacterial infection can induce effector triggered immunity (ETI) leading to hypersensitive response locally
D. NPR1 monomers that are released in cytosol due to salicylic acid accumulation is rapidly translocated to nucleus Which combination of above statements is correct?

- (1) A, B and C (2) A, C and D
(3) A, B and D (4) B, C and D

106. Given below are statements describing various features of solute transport and photoassimilate translocation in plants.

- A. Apoplastic phloem loading of sucrose happens between cells with no plasmodesmatal connections
B. Growing vegetative sinks (e.g., young leaves and roots) usually undergo symplastic phloem unloading
C. Movement of water between the phloem and xylem occurs only at the source and sink regions
D. Symplastic loading of sugars into the phloem occurs in the absence of plasmodesmatal connections

Select the option that gives a combination of correct statements:

- (1) Only A and C (2) Only B and C
(3) Only B and D (4) Only A and B

107. Given below are names of phytohormones in column I and their associated features/effects/functions in column II.

	I		II
A	Auxin	(i)	Delayed leaf senescence
B	Gibberellins	(ii)	Epinnastic bending of leaves
C	Cytokinin	(iii)	Polar transport
D	Ethylene	(iv)	Removal of seed dormancy

Select the correct set of combinations from the options given below:

- (1) A - (iii), B - (ii), C - (iv), D - (i)
(2) A - (iv), B - (iii), C - (i), D - (ii)

- (3) A - (iii), B - (iv), C - (i), D - (ii)
(4) A - (i), B - (iv), C - (iii), D - (ii)

108. If in a blood transfusion, type A donor blood is given to a recipient having type B blood, the red blood cells (RBCs) of donor blood would agglutinate but the recipient's RBCs would be least affected. These observations can be explained in the following statements:

- A. Agglutinins in recipient's plasma caused agglutination by binding with type A agglutinogens
B. The agglutinins of donor blood was diluted in recipient's plasma resulting in low agglutination
C. Low titre of anti-A agglutinins is the cause of low agglutination of recipient's RBCs
D. High agglutination of donor RBCs is the outcome of high titre of anti-B agglutinins

Which of the above statement(s) is/are INCORRECT?

- (1) Only A (2) A and B
(3) Only B (4) C and D

109. The arterial pressure usually rises and falls 4 to 6 mm Hg in a wave like manner causing "respiratory waves". The probable mechanism of these waves has been proposed in the following statements:

- A. The more negative intrathoracic pressure during inspiration reduces the quantity of blood returning to the left side of the heart causing decreased cardiac output.
B. The changes of intrathoracic pressure during respiration can excite vascular

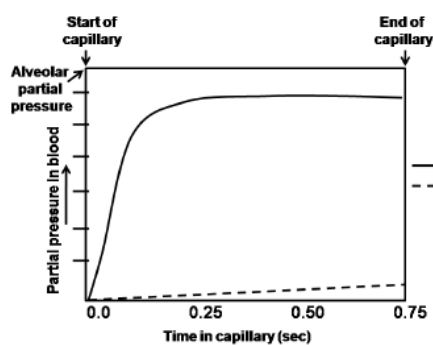
and atrial stretch receptors which affect heart and blood vessels.

- C. The activity of medullary respiratory centres can influence the vasomotor centre.
- D. The "respiratory waves" are outcome of the oscillation of the central nervous system ischemic pressure control mechanism.

Which of the above statement(s) is/are **NOT** appropriate?

- (1) Only A (2) A and B
(3) B and C (4) Only D

110. The uptake of nitrous oxide (N_2O) and carbon monoxide (CO) in the blood of lung alveolar capillary relative to their partial pressure and the transit time of red blood cell in capillary is shown in the figure below:



The reasons for difference in the pattern of alveolar gas exchange of N_2O and CO have been proposed in the following statements:

- A. N_2O does not chemically combine with proteins in blood but equilibrate rapidly between alveolar gas and blood
- B. CO has high solubility in blood
- C. CO has high solubility in the alveolar capillary membrane
- D. The dispersion of N_2O between alveolar gas and blood is considered as diffusion limited.

Which of the above statement(s) is/are **INCORRECT**?

- (1) Only A (2) A and B
(3) Only C (4) C and D

111. External pressure given on a mixed nerve causes loss of touch sensation while pain sensation remains relatively intact. On the other hand application of local anaesthetics on the same nerve, induces loss of pain sensation keeping touch sensation least affected. These observations can be explained by the following statements:

- A. External pressure causes loss of conduction of impulses in small diameter sensory nerve fibres
- B. Local anaesthetics depress the conduction of impulses in large diameter sensory nerve fibres
- C. Touch-induced impulses are carried by fibre type A
- D. Fibre type C is responsible for pain sensation

Which of the above statement(s) is/are **INCORRECT**?

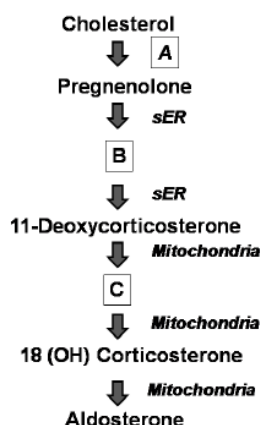
- (1) A and B (2) C and D
(3) Only C (4) Only D

112. The probable effects of lesion of left optic tract on the vision of a human subject are given below. Identify the correct statement.

- (1) Blindness in the left eye but the visual field of right remains intact.
- (2) Blindness in the right half of the visual fields of both the eyes.
- (3) Blindness in the left half of the visual field of left eye and blindness in the right half of the visual field of right eye.

(4) Blindness in the left half of the visual field of both the eyes.

113. The following diagram represents steroidogenic pathway in the Zona Glomerulosa of the adrenal cortex:



What do A, B and C represent, respectively?

- (1) sER, Progesterone, 11(OH) cortisol
 - (2) Mitochondria, Progesterone, Corticosterone
 - (3) Mitochondria, 3 α -pregnenolone, 11(OH) cortisol
 - (4) sER, Progesterone, Corticosterone
114. Inversions are considered as cross-over suppressors because
- (1) Homozygous inversions are lethal and thus they do not appear in next generation
 - (2) Inversion heterozygotes, i.e., one copy having normal chromosome and its homologue having inversion, does not allow crossing over to occur as they cannot pair at all
 - (3) Due to inversion present, four chromosomes take part in the pairing and crossing over events and make the structure difficult for separation and gamete formation
 - (4) The pairing and crossing overs do occur in inversion heterozygotes but the gametes having cross over products are lethal
115. A pair of alleles govern seed size in a crop plant. 'B' allele responsible for bold seed is

dominant over 'b' allele controlling small seed. An experiment was carried out to test if an identified dominant DNA marker (5kb band) is linked to alleles controlling seed size. A plant heterozygous for the marker and the alleles was crossed to a small seeded plant lacking the 5kb band. 100 progeny obtained from the cross were analysed for the presence and absence of the DNA marker. The results are tabulated below:

Phenotype	Plant with bold seed		Plant with small seed	
	Present	Absent	Present	Absent
No. of progeny showing presence or absence of DNA marker	22	23	27	28

Based on the above observations which one of the following conclusions is correct?

- (1) The DNA marker assorts independently of the phenotype
 - (2) The 5kb band is linked to the allele 'B'
 - (3) The 5kb band is linked to the allele 'b'
 - (4) The DNA marker assorts independently with bold seed out is linked to the small seed trait
116. Three *met*⁻ *E. coli* mutant strains were isolated. To study the nature of mutation these mutant strains were treated with mutagens EMS or proflavins and scored for revertants. The results obtained are summarized below:

Mutant strain	Mutagen treatment	
	EMS	Proflavin
A	-	+
B	+	-
C	-	-

(+ stands for revertants of the original mutants and - stands for no revertants obtained)

Based on the above and the typical mutagenic effects of EMS and proflavin, what was the nature of the original mutation in each strain?

(1) A-Transversion

B- Insertion or deletion of a single base

C- Deletion of multiple bases

(2) A-Transition

B- Transversion

C- Insertion or deletion of a single base

(3) A-Insertion or deletion of a single base

B- Transition

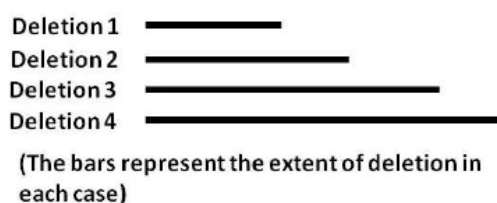
C- Deletion of multiple bases

(4) A- Transition

B- Insertion or deletion of multiple bases

C- Transversion

117. The following scheme represents deletions (1- 4) in the *rII* locus of phage T4 from a common reference point:



Four point mutations (a to d) are tested against four deletions for their ability (+) or inability (-) to give wild type (*rII*⁺) recombinants. The results are summarized below:

	a	b	c	d
1	+	+	+	+
2	+	+	+	-
3	+	-	+	-
4	-	-	+	-

Based on the above the predicted order of the point mutations is

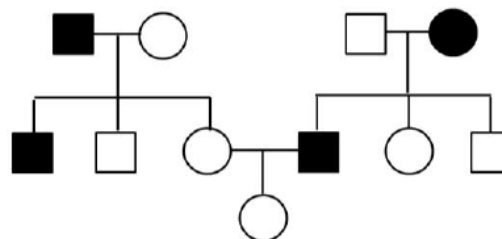
(1) b-d-a-c

(2) d-b-a-c

(3) d-b-c-a

(4) c-d-a-b

118. The following pedigree shows the inheritance pattern of a trait.



From the following select the possible mode of inheritance and the probability that the daughter in generation III will show the trait.

(1) X-linked recessive, probability is 1/2

(2) X-linked recessive, probability is 1/4

(3) Autosomal recessive, probability is 1/2

(4) Autosomal recessive, probability is 1/3

119. Interrupted mating experiments were performed using three different *Hfr* strains (1 - 3). The three strains have different combinations of selectable markers. The time of entry for markers for each strain is shown in the table below:

Strain	Time of entry				
<i>Hfr</i> #1	<i>met</i> (5')	<i>thr</i> (17')	<i>str</i> ^r (25')	<i>phe</i> (30')	<i>pro</i> (45')
<i>Hfr</i> #2	<i>str</i> ^r (15')	<i>pur</i> (28')	<i>pro</i> (35')	<i>his</i> (45')	<i>met</i> (55')
<i>Hfr</i> #3	<i>pro</i> (2')	<i>his</i> (12')	<i>met</i> (22')	<i>str</i> ^r (42')	<i>phe</i> (47')

(1) *met* - *thr* - *str*^r - *phe* - *pro* - *pur*^r - *his*

(b) *pur*^r - *pro* - *his* - *met* - *thr* - *str*^r - *phe*

(3) *str*^r - *pur*^r - *his* - *met* - *phe* - *pro* - *str*^r

(d) *his* - *met* - *phe* - *thr* - *pro* - *str*^r - *pur*^r

120. Peripatus is an interesting living animal having unjointed legs, nephridia, haemocoel, trachea, dorsal tubular heart, claws, jaws, continuous muscle layers in body wall. This is considered as a connecting link between
- (1) Nematoda and Annelida: continuous muscle layers in body wall, unjointed legs and nephridia being nematode characters while

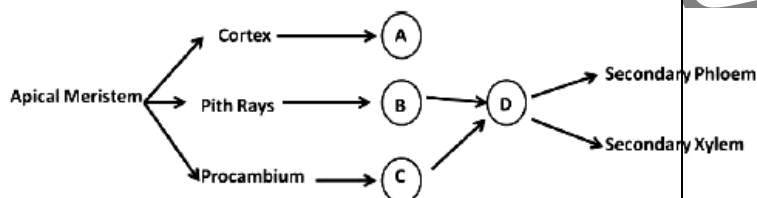
haemocoel, trachea and dorsal tubular heart being annelid characters

(2) Annelida and Arthropoda: unjointed legs and nephridia being annelid characters while claws, jaws, haemocoel, trachea and dorsal tubular heart being arthropod characters

(3) Arthropoda and Mollusca: unjointed legs and nephridia being mollusca characters while claws, jaws, trachea and dorsal tubular heart being arthropod characters

(4) Nematoda and Arthropoda: continuous muscle layers, unjointed legs and nephridia being nematode characters while claws, jaws, trachea and dorsal tubular heart being arthropod characters.

121. The following schematic diagram represents secondary growth in the angiosperms.



Based on the above scheme, which of the following options represents the correct identity of cambia labelled as A, B, C and D.

- (1) A - Inter-fascicular, B - Fascicular, C - Vascular, D - Cork
- (2) A - Fascicular, B - Inter-fascicular, C - Vascular, D - Cork
- (3) A - Cork, B - Inter-fascicular, C - Fascicular, D - Vascular
- (4) A - Cork, B - Fascicular, C - Inter-fascicular, D - Vascular

122. The table below lists the major fungal groups and their characteristics:

Fungal Groups	Characteristics
---------------	-----------------

A	Ascomycota	(i)	Hyphae aseptate, aseptate, coenocytic; asexual reproduction by sporangioophores
B.	Chytrids	(ii)	Hyphae aseptate, coenocytic; asexual reproduction by zoospores
C.	Glomeromycetes	(iii)	Hyphae aseptate, coenocytic; no sexual spores
D.	Zygomycetes	(iv)	Hyphae septate or unicellular; asexual reproduction by conidia

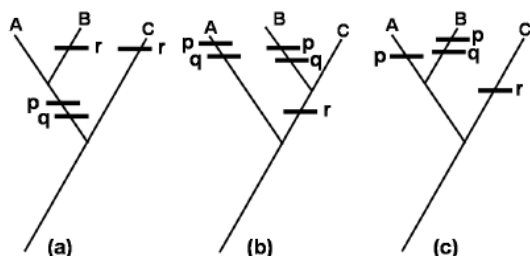
Which one of the following options represents the appropriate match between the fungal group and their characteristics?

- (1) A - (ii), B - (iii), C - (i), D - (iv)
- (2) A - (iv), B - (ii), C - (iii), D - (i)
- (3) A - (i), B - (iv), C - (iii), D - (ii)
- (4) A - (ii), B - (iv), C - (iii), D - (i)

123. As a biologist, you want to classify three taxa, A, B and C. You have the information on three traits, p, q and r. The trait that is ancestral is counted '0' and the trait that is derived is counted as '1'. The distribution of traits found in three taxa is given below

	A	B	C
p	1	1	0
q	1	1	0
r	0	1	1

Based on the above table, the following cladograms were drawn:



Based on trait distribution and the principle of parsimony, select the correct option.

- (1) Both 'a' and 'b' cladograms are possible
- (2) Only 'b' cladogram is possible
- (3) Only 'c' cladogram is possible
- (4) Only 'a' cladogram is possible

124. Given below are some pathogens and diseases of humans, animals and plants.

A	Bordetella pertussis	(i)	Lyme disease of humans
B	Tillketia indica	(ii)	Grain rot in rice
C	Borrelia burgdorferi	(iii)	Karnal bunt of wheat
D	Anaplasma marginale	(iv)	Whooping cough in humans
E	Burkholderia glumae	(v)	Hemolytic anemia in cattle

Which one of the following is the correct match between the pathogen and disease caused?

- (1) A - (iv), B - (iii), C - (i), D - (v), E - (ii)
- (2) A - (iv), B - (v), C - (i), D - (ii), E - (iii)
- (3) A - (iii), B - (iv), C - (v), D - (i), E - (ii)
- (4) A - (ii), B - (v), C - (i), D - (iii), E - (iv)

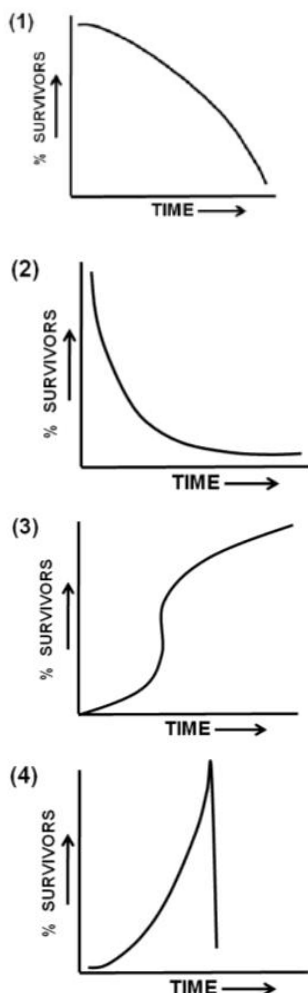
125. Given below are statements pertaining to organisms belonging to three domains of life. Identify the **INCORRECT** statement.

- (1) Unlike Bacteria and Eukarya, some Archaeal membrane lipids contain long chain hydrocarbons connected to glycerol molecules by ether linkage.
- (2) Peptidoglycans are absent in the cell wall of Archaea
- (3) Proteobacteria include many species of bacteriochlorophyll-containing, sulphur using photoautotrophs.
- (4) Mycoplasma, a group of low GC content, gram positive bacteria that lack cell wall, belong to the same family as the gram positive Mycobacteriaceae

126. You observed that two species of barnacles, species 1 and species 2, occupy upper and lower strata of intertidal rocks, respectively. Only when species 2 was removed by you from the lower strata, species 1 could occupy both the upper and lower strata. From the choices given below, what would be your inference from these observations?

- (1) Upper strata of the intertidal rock is the realized niche of species 1
- (2) Upper strata of the intertidal rock is the fundamental niche of species 1
- (3) Species 1 and species 2 exhibit mutualism
- (4) Species 1 can compete out species 2

127. In a natural system, a species producing large numbers of offsprings, with little or no parental care, generally exhibits which one of the following kind of survivorship curves?



128. Match the correct local names of temperate grasslands with their geographical range.

Geographical range		Local name of the grassland	
(i)	Asia	A	Pampas
(ii)	North America	B	Prairies
(iii)	South America	C	Steppes
(iv)	South Africa	D	Veldt

- (1) (i) – C, (ii) – B, (iii) – D, (iv) – A
 (2) (i) – C, (ii) – B, (iii) – A, (iv) – D
 (3) (i) – D, (ii) – B, (iii) – A, (iv) – C
 (4) (i) – B, (ii) – C, (iii) – A, (iv) – D

129. Following is a hypothetical life table for a species.

Age class (x)	Number alive (n_x)	Number dying (d_x)	Age specific survivorship (l_x)	Age specific fertility (m_x)
0 – 5	100	50		0.0
5 – 10	50		0.5	0.5
10 – 15		10		0.5
15 – 20	20	10	0.2	1.0
20 – 25		10		1.0

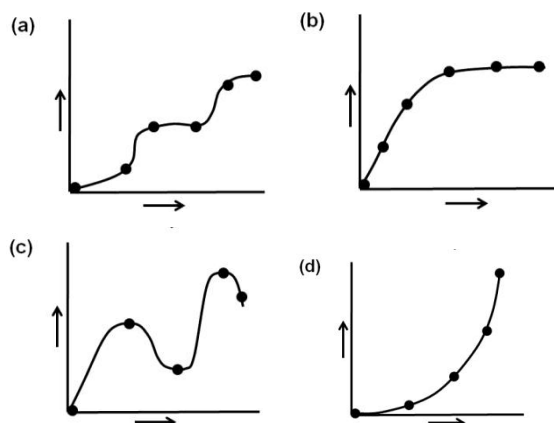
Which one of the following is the correct net reproductive rate (R_0)?

- (1) 0.0 (2) 0.3
 (3) 0.7 (4) 1.5

130. Which one of the following statements is true for the trends of Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD) in a water stream receiving pollutants from a point source?

- (1) In septic zone, both DO and BOD levels remain stationary
 (2) In recovery zone, both DO and BOD levels increase rapidly
 (3) In decomposition zone, DO level drops rapidly, whereas BOD level remains more or less stable
 (4) In septic zone, DO level decreases and BOD level increases whereas in recovery zone DO increases and BOD decreases

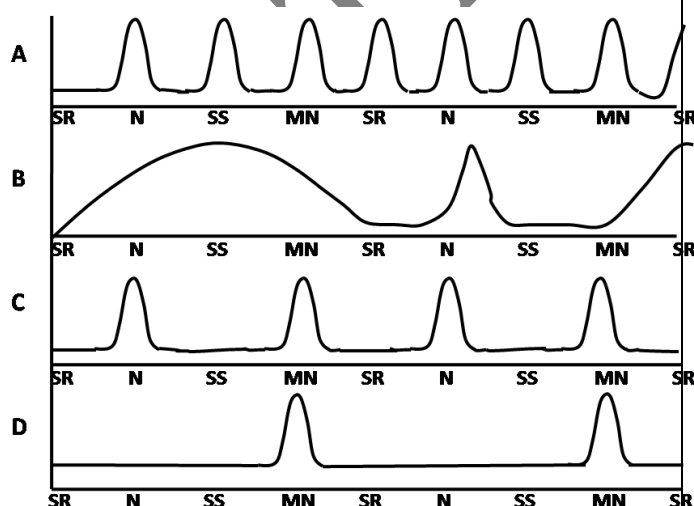
131. Following are the graphical representations of various hypotheses proposed for explaining the possible relationships between species richness (X-axis) and community services (Y-axis).



Which of the following options is the correct match between the graphical representations and the hypotheses?

- (1) (a) Redundancy, (b) Keystone, (c) Rivet, (d) Idiosyncratic
 (2) (a) Idiosyncratic, (b) Rivet, (c) Keystone, (d) Redundancy
 (3) (a) Rivet, (b) Redundancy, (c) Idiosyncratic, (d) Keystone
 (4) (a) Rivet, (b) Keystone, (c) Redundancy, (d) Idiosyncratic

132. Following are the plots representing biological rhythms at different time points depicted as: SR = Sunrise; N = Noon; SS = Sunset; MN = Midnight



Which of the plot(s) represent the ultradian biological rhythm(s)?

133.

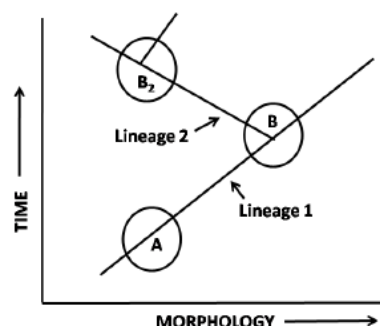
- (1) Plot B (2) Plots A and C
 (3) Plots C and D (4) Plot D

A population of non-poisonous butterflies have the same colour pattern as some highly poisonous butterflies. Assume that the population of non-poisonous butterflies is higher than the population of poisonous butterflies. Given this, what will be the impact of this mimicry on the fitness of the population of the poisonous butterflies in the presence of the predator?

- (1) It will lower the fitness, that is, fitness of the mimic is negatively frequency-dependent
 (2) It will increase the fitness, that is, fitness of the mimic is positively frequency-dependent
 (3) It will not affect the fitness, that is, fitness of the mimic is frequency independent
 (4) It will increase the fitness, that is, fitness of the mimic is negatively frequency-dependent

134.

Given below is a graphical representation of changes in morphological features over a period of geological time scale, where population A accumulates heritable morphological changes and give rise to a distinct species B. Population B splits into a distinct species B₂



Which of the above lineages represent the pattern of speciation by cladogenesis?

- (1) Lineage 1
 (2) Both the lineages 1 and 2

(3) Lineage 2

(4) Neither of the lineages 1 and 2

135. Red hair is a recessive trait in humans. In a randomly mating population in Hardy-Weinberg equilibrium, approximately 9% of individuals are red-haired. What is the frequency of heterozygotes?

(1) 81% (2) 49%

(3) 42% (4) 18%

136. The frequency of M-N blood types in a population of 6129 individuals is as follows:

Blood type	Genotype	Number of individuals
M	$L^M L^M$	1787
MN	$L^M L^N$	3039
N	$L^N L^N$	1303

The frequency of L^N allele in this population is

(1) 0.4605 (2) 0.2121

(3) 0.5395 (4) 0.2911

137. *Mayfair* genes (hypothetical) consist of a super family of transcription factors. They are found in 4 clusters in mammals; in 2 clusters in insects; and in a single cluster in an ancestor to insects. These data are consistent with all of the following explanations EXCEPT:

(1) Two successive genome duplication events occurred between ancestral organism and vertebrates

(2) The first duplication may have taken place before divergence of vertebrates

(3) Exon shuffling exclusively produced such cluster

(4) Whole genome duplications could lead to such observations

138. Fluorescence recovery after photobleaching (FRAP) is a method to estimate the diffusion of molecules in a membrane. Fluorescently labelled molecules such as

i. a receptor tagged with green fluorescent protein (GFP)

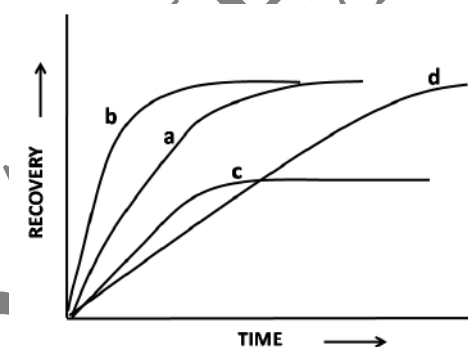
ii. a receptor labelled with GFP which interacts with cytoskeleton

iii. a labelled lipid

iv. a labelled protein that binds to the membrane surface are photobleached and the recovery profiles

(a-d) were obtained to estimate their diffusion coefficients.

The following data were obtained:



Which one of the combinations is correct?

(1) a = i; b = ii (2) b = iii; a = iv

(3) c = iii; d = iv (4) d = ii; b = i

139. *Agrobacterium* Ti plasmid vectors are used to generate transgenic plants. The following are examples of *vir* gene-encoded proteins that are important for the transfer of T-DNA into plants:

A. Vir E, a single-stranded DNA binding protein

B. Vir D2 that generates T-strands

C. Vir A that senses plant phenolic compounds

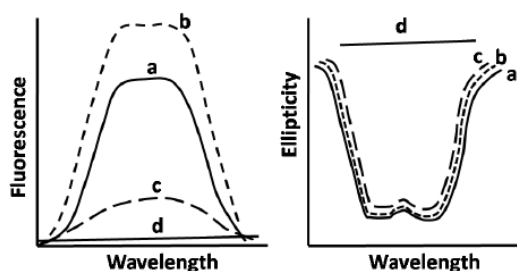
D. Vir F which directs T-complex proteins for destruction in proteasomes

Which one of the following combinations of proteins functions inside the plant cells?

(1) Only A and C (2) A, B and C

(3) Only B and C (4) A, B and D

140. A researcher is investigating structural changes in a protein by following tryptophan fluorescence and by circular dichroism (CD). Fluorescence and CD spectra of a pure protein were obtained in the absence of any treatment (a), in the presence of 0.5 M Urea (b), upon adding acrylamide, a quencher of tryptophan (c) and upon heating (d). The data are shown below:



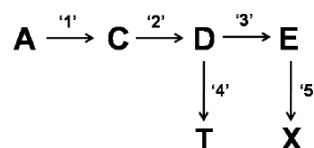
Which one of the following statements is correct?

- (1) CD is more sensitive to structural changes than fluorescence
 - (2) Fluorescence is more sensitive to structural changes than CD
 - (3) Both methods are equally responsive to structural changes
 - (4) Acrylamide alters the secondary structure of the protein
141. Polynucleotide kinase (PNK) is frequently used for radiolabeling DNA or RNA by phosphorylating 5'-end of non-phosphorylated polynucleotide chains. Which of the following statement about PNK is **NOT** true?
- (1) PNK catalyzes the transfer of α -phosphate from ATP to 5'-end of polynucleotide chains (DNA or RNA).
 - (2) PNK has 3'-phosphatase activity
 - (3) PNK is inhibited by small amount of ammonium ions
 - (4) PNK is a T4 bacteriophage-encoded enzyme

142. A gene encoding for protein X was cloned in an expression vector under the T7 RNA polymerase promoter and *lac* operator. Cells were induced by the addition of 1 mM IPTG at 37 °C for 6 h. Cells were lysed and fractionated into insoluble bodies and cell-free supernatant by centrifugation. Protein X is present in the insoluble bodies. Which one of the following strategies would you use to express protein X in the soluble fraction (cell-free supernatant)?

- (1) Increase the duration of induction with 1mM IPTG
- (2) Grow cells at lower temperature after induction with 1 mM IPTG
- (3) Increase the concentration of IPTG
- (4) Grow cells at higher temperature after induction with 1 mM IPTG

143. Engineering of metabolic pathways in plants can be achieved by introduction and over expression of appropriate candidate gene(s) using transgenic technology. The figure given below represents a biochemical pathway in plants where a precursor molecule 'A' is converted into products 'T' and 'X' through a series of enzymatic reactions. Enzymes 1-5 are involved in this pathway. Scientists attempted to increase the level of 'X' by introducing an additional copy of the gene for enzyme '5' under transcriptional control of a strong constitutive promoter. However, the developed transgenic plants did not display a proportionate increase in the level of 'X'.



The following statements were proposed for explaining the above results:

A. Enzyme '4' has greater affinity for D than enzyme '3'

B. Feedback inhibition of enzyme '5' by compound X

C. Substrate limitation for enzyme '5'

Which of the above statements could represent probable reasons for **NOT** obtaining a proportionate increase in the amount of X in the transgenic plants?

- (1) Only C (2) Only A and B
(3) Only A (4) A, B and C

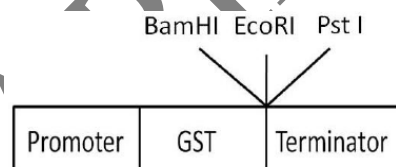
144. A single copy homozygous transgenic plant containing the transgene 'A' for fungal resistance was subsequently re-transformed with another gene 'B' for conferring resistance to salt-stress. The selection marker genes used for both the transformation experiments were different. Transgenic plants obtained following the re-transformation experiment were screened for salt-stress resistance and single copy events were identified by Southern hybridization. These single copy events were self-pollinated. In the event of the two T-DNAs (containing the A and B transgenes) getting integrated in unlinked locations in all the transgenic plants, the phenotypic ratios among the T1 progeny would be:

- (1) 3 (Fungal resistant + Salt-stress resistant): 1 (Fungal resistant)
(2) 1 (Fungal resistant): 2 (Fungal resistant + Salt-stress resistant): 1 (Salt-stress resistant)

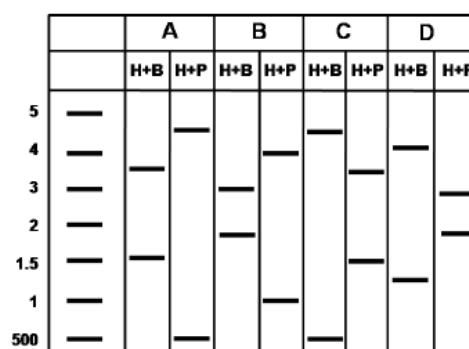
(3) 3 (Salt-stress resistant): 1 (Fungal resistant)

(4) 1 (Fungal resistant): 1 (Salt-stress resistant): 1 (Fungal resistant + Salt stress resistant)

145. You are inserting a gene of 2kb length into a vector of 3kb to make a GST fusion protein. The gene is being inserted at the EcoRI site and the insert has a HindIII site 500bp downstream of the first codon. You are screening for the clone with the correct orientation by restriction digestion of the plasmid using HindIII plus BamHI (H+B) and HindIII plus PstI (H+P). The map of the relevant region of the vector is shown below:



Given below is the pattern following restriction digestion of plasmid isolated from four independent clones (A, B, C or D).



Which of the plasmids shown above represents the clone in the correct orientation?

- (1) A (2) B
(3) C (4) D