

Part A (Attempt any 15 ONLY)

1. In a bacterial cell, a protein is synthesized at random location in the cytoplasm. The protein has to reach one pole of the cell for its appropriate function. The protein reaches the pole by

- (1) Chemical attraction
- (2) Random movement
- (3) Enzymatic reaction
- (4) Attraction between opposite charges

2. A precious stone breaks into four pieces having weights in the proportion 1:2:3:4. The value of such a stone is proportional to the square of its weight. What is the percent loss in the value incurred due to breaking?

- (1) 0
- (2) 30
- (3) 70
- (4) 90

3. Two runners starting together run on a circular path taking 6 and 8 minutes, respectively, to complete one round. How many minutes later do they meet again for the first time on the start line, assuming constant speeds?

- (1) 8
- (2) 24
- (3) 32
- (4) 60

4. The distribution of grades secured by students in a class is given in the table below.

Grade	Fraction of the Population
A	0.1
B	0.4
C	0.3
D	0.2

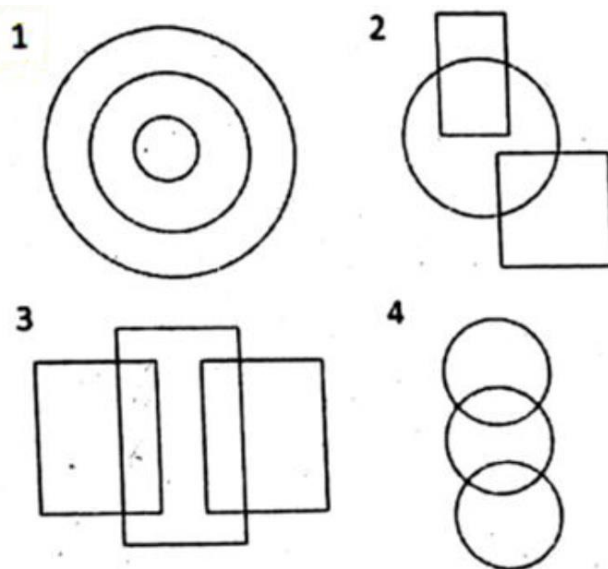
What is the least possible population of the class?

- (1) 2
- (2) 4
- (3) 8
- (4) 10

5. The nine numbers $X_1, X_2, X_3, \dots, X_9$, are in ascending order. Their average m is strictly greater than all the first eight numbers. Which of the following is true?

- (1) Average $(X_1, X_2, \dots, X_9, m) > m$ and Average $(X_2, X_3, \dots, X_9) > m$
- (2) Average $(X_1, X_2, \dots, X_9, m) < m$ and Average $(X_2, X_3, \dots, X_9) < m$
- (3) Average $(X_1, X_2, \dots, X_9, m) = m$ and Average $(X_2, X_3, \dots, X_9) > m$
- (4) Average $(X_1, X_2, \dots, X_9, m) < m$ and Average $(X_2, X_3, \dots, X_9) = m$

6. Which among the following diagrams represent women, mother, human beings?



- (1) Fig 1
- (2) Fig 2
- (3) Fig 3
- (4) Fig 4

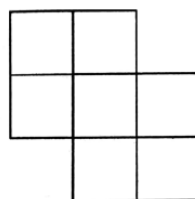
7. A boy and a girl make the following statements of which at most one is correct:

The one in a white shirt says; "I am a girl" (statement-I)

The one in a blue shirt says: "I am a boy" (statement-II)
Which of the following is the correct inference?

- (1) Statement-I is the correct but statement-II is incorrect
- (2) Statement-II is correct but Statement-I is incorrect
- (3) Both statement I and II are incorrect
- (4) The correctness of Statement I and II cannot be ascertained

8. How many quadrilaterals does the following figure



have?

- (1) 17
- (2) 18
- (3) 19
- (4) 20

9. 12 balls, 3 each of the colour red, green, blue and yellow are put in a box and mixed. If 3 balls are picked at random, without replacement, the probability that all 3 balls are of the same color is

- (1) 1/4
- (2) 1/12
- (3) 1/36
- (4) 1/55

10. Some aliens observe the roosters call before sunrise every day. Having no other information about roosters and sunrises, which of the following inferences would NOT be valid?

- (1) Rooster-call and sunrise may be independent cyclic events with the same periodicity
- (2) Both may be triggered by a common cause
- (3) Rooster-call may be causing the sunrise

(4) Sunrise cannot be the cause of rooster call as the roostercall precedes sunrise

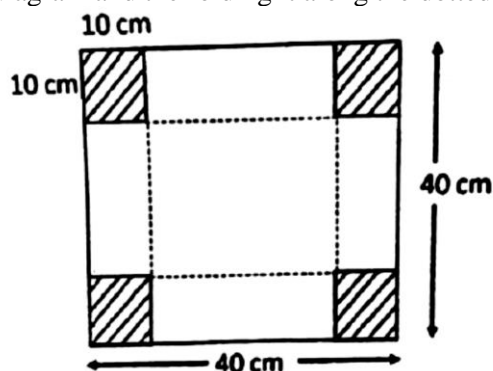
11. Twenty-one litres of water in a tank is to be divided into three equal parts using only 5, 8 and 12 litre capacity cans. The minimum number of transfers needed to achieve this is

- (1) 3 (2) 4
(3) 5 (4) 7

12. Of four agents Alpha, Beta, Gamma and Delta, three have to be sent together on a mission. If Alpha and Beta cannot go together and Gamma and Delta cannot go together, then which of the following holds?

- (1) Any three agents can be sent
(2) Alpha, Delta and any one out of Beta and Gamma can be sent
(3) Beta and Gamma and any one out of Alpha and Delta can be sent
(4) The mission is impossible

13. An open rectangular box is made by excluding the four identical corners of a piece excluding the four identical corners of a piece of paper as shown in the diagram and the folding it along the dotted lines



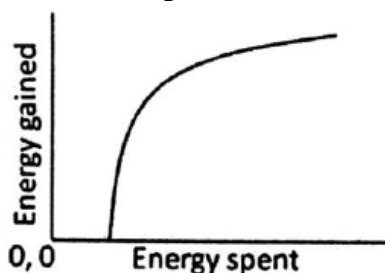
The capacity of the box in cm^3 is

- (1) 8000 (2) 1000
(3) 4000 (4) 6000

14. Which of the following is the largest?

- (1) 2^{50} (2) 3^{40}
(3) 4^{30} (4) 5^{20}

15. A monkey climbs a tree to eat fruits. The amount of energy gained after eating fruits and the energy spent in climbing on the different branches have a relationship shown in the figure



The ratio of energy gained to energy spent will be maximum

(1) at a point where the slope of the curve is at the maximum

(2) at a point where the slope of the curve is unity

(3) at a point on the curve where the tangent passes through the origin

(4) at the highest point on the curve

16. The length of a cylinder is measured 10 times yielding 10 distinct values. For this set of values, consider the following statements.

A. Five of these values will lie above the mean and is below it

B. Five of these values will lie above the median and five below it

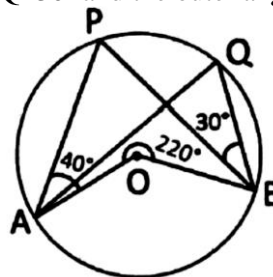
C. At least one value will lie above the mean

D. At least one value will lie at the median

Which of the following are necessarily correct?

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

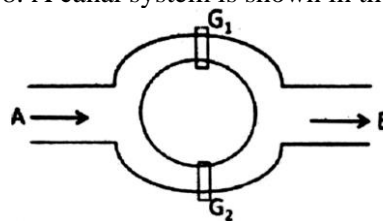
17. In a given circle, O is the centre, $\angle PAO = 40^\circ$, $\angle PBQ = 30^\circ$ and the outer angle $\angle LOB = 220^\circ$



Then $\angle LAQB$ is

- (1) 70° (2) 80°
(3) 60° (4) 110°

18. A canal system is shown in the figure



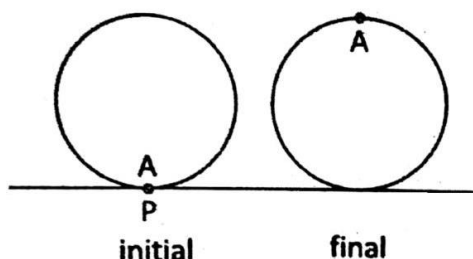
Water flows from A and B through two channels. Gates G_1 and G_2 are operated independently to regulate the flow. Probability of G_1 to be open is 20%. The probability that water will flow from A to B is

- (1) 10% (2) 20%
(3) 28% (4) 30%

19. A long ream of paper of thickness t is rolled tightly. As the roll becomes larger, the length of the paper wrapped in one turn exceeds the length in the previous turn by

- (1) t (2) $2t$
(3) πt (4) $2\pi t$

20. Point A on a wheel of radius r touches the horizontal plane at point P. It rolls without slipping, till point A is



at the highest position in the first turn. What is the final distance AP?

- (1) $2r$ (2) $r\sqrt{1 + \pi^2}$
 (3) $r\sqrt{4 + \pi^2}$ (4) $2r\sqrt{1 + \pi^2}$

PART B (Attempt any 35 ONLY)

21. Which one of the statements on protein conformation, detailed below is INCORRECT?

- (1) L- amino acids can occur in Type I' β - turns where φ, ψ are positive
 (2) A peptide rich in proline is unlikely to adopt α -helical structure
 (3) Proline residues have high propensity to occur in β -turns
 (4) The dihedral angles φ, ψ of amino acids in unfolded proteins are exclusively positive

22. Choose the INCORRECT statement from the following statements made for an enzyme- catalyzed reaction

- (1) The kinetic properties of allosteric enzyme do not diverge from Michaelis-Menten behaviour.
 (2) In feedback inhibition, the product of a pathway inhibits an enzyme of the pathway
 (3) An antibody that binds tightly to the analog of the transition state intermediate of the reaction $S \rightarrow P$, would promote formation of P when the analog is added to the reaction.
 (4) An enzyme with $K_{cat} = 1.4 \times 10^4 \text{ s}^{-1}$ and $K_m = 9 \times 10^{-5} \text{ M}$ has activity close to the diffusion controlled limit.

23. On sequence analysis of a double stranded DNA, the results showed the content of cytosine, C was 20%. What is the amount of A and T put together?

- (1) 20% (2) 30%
 (3) 50% (4) 60%

24. The first step in glycogen breakdown releases glucose units as

- (1) glucose 6- phosphate
 (2) glucose 1- phosphate
 (3) glucose
 (4) glucose and glucose 6- phosphate

25. The Na^+/K^+ ATPase pumps found on the plasma membrane of most animal cells. A mutation in the intrinsic phosphorylation site of the pump is most likely to affect

- (1) the outward movement of Na^+ only.
 (2) inward movement of K^+ only
 (3) both the inward and outward movement of K^+ and Na^+ .
 (4) has no effect on pump activity but affects its stability

26. The site of the division plane during cytokinesis of animal cells is determined

- (1) by position of nucleus
 (2) by the central spindle
 (3) by the pre-prophase band
 (4) randomly

27. To prepare individual tissue cells from a primary culture, the cell-cell and cell-matrix interaction must be broken. To achieve this would NOT use:

- (1) EDTA
 (2) Trypsin
 (3) Collagenase
 (4) Separase

28. Which one of the following statements is NOT true about nucleosomal organization of core particle?

- (1) The physical structure of DNA is altered in the middle of the core particle.
 (2) In the core particle, DNA is organized as flat super helix with 1.65 turns around the histone octamer.
 (3) While forming 30nm fibers, generally 6 nucleosomal per turn organize into a two start helix.
 (4) The N-terminal histone tails in a core particle are strictly ordered and exit from the nucleosomes between turns of the DNA.

29. During replication, RNaseH removes all of the RNA primer except the ribonucleotide directly linked to the DNA end. This is because

- (1) it can degrade RNA and DNA end. From their 5' end.
 (2) it can only cleave bonds between two ribonucleotides.
 (3) it can degrade RNA and DNA from their 3' end.
 (4) activity of RNaseH is inhibited by the presence of duplex containing both strands as DNA.

30. In a human cell line, a large fraction of double-strand DNA breaks are repaired by non-homologous end joining (NHEJ). An inhibitor of FLAP endonuclease will affect

- (1) recruitment of DNA-dependent kinase
 (2) gap trimming
 (3) DNA unwinding
 (4) pairing of micro-homology regions.

31. Sugar puckering in double stranded nucleic acids is exclusively

- (1) C-2' endo in double stranded DNA
 (2) C-3' endo in double stranded DNA
 (3) C-2' endo in double stranded RNA

(4) C-3' endo in hybrid duplex with one strand as DNA and other as RNA

32. Eukaryotic mRNA are modified to possess a 5' cap structure. Which one of the following is an INCORRECT statement about the function of the 5' cap structure?

- (1) It protects the mRNA from 5'→3' exo-ribonuclease attack.
- (2) It facilitates splicing of the nascent transcripts
- (3) It protects the transcripts from degradation by RNase III family enzymes.
- (4) It facilitates attachments to 40S subunit of ribosome.

33. Which one of the following does NOT belong to human antimicrobial proteins and peptides at epithelial surface forming part of innate immunity?

- (1) Lactoferrin
- (2) Defensin
- (3) Calprotectin
- (4) Vimentin

34. Which one of the following best describes death-upon-detachment?

- (1) Necroptosis
- (2) Anoikis
- (3) Extravasation
- (4) Metastasis

35. Fruit bats are known to harbor and spread several viruses that can infect other animals and humans. Which one of the following viruses NOT reported to spread by fruit bats?

- (1) Ebola
- (2) Nipah
- (3) SARS
- (4) HIV

36. In a type I hypersensitivity- mediated asthmatic response, which one of the following is thought to contribute significantly to the prolonged bronchospasm and build-up of mucous seen in asthmatics?

- (1) Thromboxane
- (2) Leukotriene
- (3) TGFβ
- (4) Chondroitin

37. In certain plants, the mechanism where timing of anther dehiscence and stigma receptivity do not coincide to avoid self-pollination is called

- (1) dichogamy
- (2) herkogamy
- (3) monoecy
- (4) Dioecy

38. In *Xenopus* embryos, β-catenin plays an important role in the Dorsal/Ventral axis development. What would you expect if the endogenous glycogen synthase kinase 3 (GSK3) is knocked out by a dominant negative form of GSK3 in the ventral cells of the early embryos?

- (1) Blocking of GSK3 on the ventral side has no effect. A normal embryo will form.
- (2) The resulting embryo will only have ventral sides
- (3) A second axis will form
- (4) The dorsal fate is suppressed.

39. Homeobox transcription factor (Hox proteins), play important roles in specifying whether a particular mesenchymal cell will become stylopod, zeugopod or autopod. Based on the expression patterns of these

genes, a model was proposed wherein these HOX genes specify the identity of a limb region. What would be the observed phenotype for human homozygous for a *HOXD13* mutation?

- (1) No zeugopod formation
- (2) Abnormalities of the hands and feet wherein the digits fuse
- (3) Deformities in stylopods
- (4) No femur of patella formation.

40. Which one of the following describes the function of silicon in plants?

- (1) Constituent of amino acids
- (2) Contributes to cell wall rigidity and elasticity
- (3) Constituent of the photosynthesis reaction centre
- (4) Maintenance of cell turgor and electroneutrality

41. Most of the plant disease resistance (R) gene products contain:

- (1) G-Box domains
- (2) Transcription repression domains
- (3) Leucine-rich repeats
- (4) Enzymatic activities

42. Out of several gibberellins identified in plants, which one

of the following is NOT bioactive

- (1) GA₁
- (2) GA₃
- (3) GA₄
- (4) GA₅

43. Nitrogenase, a complex metal containing enzyme is involved in conversion of N₂ to NH₃ Which one of the following metal is NOT involved in the activity of nitrogenase?

- (1) Molybdenum (Mo)
- (2) Iron (Fe)
- (3) Vanadium (V)
- (4) Cobalt (Co)

44. Which one of the following agents cause relaxation of mesengial cells?

- (1) Histamine
- (2) Thromboxane A₂
- (3) Norepinephrine
- (4) Dopamine

45. A patient comes to the hospital complaining of vomiting and diarrhea. The doctor suggested that the patient take glucose and electrolyte solution orally. Which one of following membrane proteins is likely to be involved in rehydrating the patient?

- (1) Cystic fibrosis transmembrane regulator (CFTR)
- (2) Sodium glucose transporter protein 1 (SGLT1)
- (3) Insulin receptor protein (IRP)
- (4) Sucrase –isomaltase protein (SIP)

46. Which one is required for vitamin B12 absorption in small intestine?

- (1) Cobalophilin
- (2) Hephaestin
- (3) Hepsidin
- (4) Na⁺-co-transporter

47. Which one is the correct sequence of events that takes place during phototransduction when light falls onto the retina?

- (1) Closure of Na^+ channels \rightarrow activation of transducing decreased release of glutamate \rightarrow decrease in intracellular cGMP \rightarrow structural changes in rhodopsin
- (2) Decreased release of glutamate \rightarrow structural changes in rhodopsin \square activation of transducin \square decrease in intracellular cGMP Closure of Na^+ channels
- (3) Structural changes in rhodopsin activation of transducin \rightarrow decrease in intracellular cGMP \rightarrow Closure of Na^+ channels \rightarrow Decreased release of glutamate \rightarrow
- (4) Decrease in intracellular cGMP \rightarrow activation of transducin \rightarrow decreased release of glutamate \rightarrow structural changes in rhodopsin \rightarrow Closure of Na^+ channels

48. A Lod score of 3 represents a Recombination Frequency (RF) that is

- (1) 3 times as likely as the hypothesis of no linkage
- (2) 30 times as likely as the hypothesis of no linkage
- (3) 100 times as likely as the hypothesis of no linkage
- (4) 1000 times as likely as the hypothesis of no linkage

49. Assuming that the A, B, C and D genes are not linked. The probability of a progeny being AaBBccDd from a cross between AABbccDd and aaBBccDD parents will be

- (1) 4/32
- (2) 3/16
- (3) 1/4
- (4) 3/32

50. The newborn baby of a mother having blood group AB, Rh⁺ and father having blood group O, Rh⁻, got mixed with other babies in the hospital. The baby with which of the following blood groups is expected to be of the said couple?

- (1) O, Rh⁺
- (2) O, Rh⁻
- (3) AB, Rh⁻
- (4) B, Rh⁺

51. Which one of the following DNA markers can be used to distinguish between a homozygote and heterozygote?

- (1) RAPD
- (2) AFLP
- (3) RFLP
- (4) ISSR

52. Which one of the following is a fungal disease of plants?

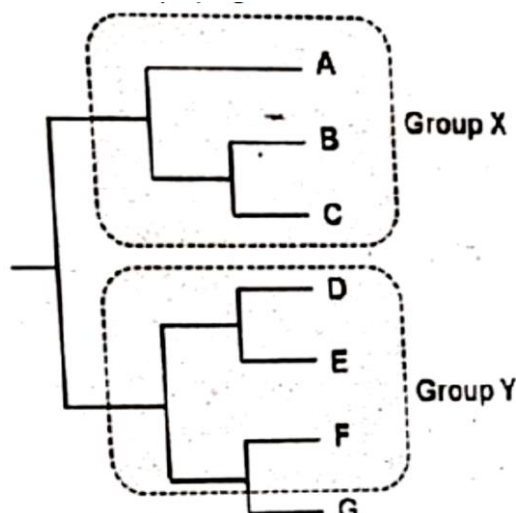
- (1) Cucumber mosaic
- (2) Fire Blight of pear
- (3) Crown gall
- (4) Apple scab

53. Which one of the following influenza A virus subtypes caused severe avian flu and was responsible for disease outbreak in the year 1997 in Hong Kong?

- (1) H1N1
- (2) H7N7
- (3) H3N2
- (4) H5N1

54. Depicted below is a phylogenetic tree of selected taxa:

(1) Group X is monophyletic and group Y is polyphyletic



(2) Group X is paraphyletic and group Y is monophyletic

- (3) Both group X and Y are monophyletic
- (4) Group X is monophyletic and Group Y is paraphyletic

55. Which of the following describes the identification features of non-poisonous snakes?

- (1) Cylindrical tail and small belly scales
- (2) Cylindrical tail, broad transverse belly scales and 4th infralabial scale is the largest
- (3) Flat tail, broad transverse scales and 3rd supralabial scale touches eye and nose
- (4) Cylindrical tail, broad transverse belly scales and a loreal pit between eye and nostril

56. A road is constructed, through a wet tropical forest, following which the population of a species of forest butterfly declines. Which of the following is NOT a possible explanation for the road causing a decline in the forest butterfly population?

- (1) Road facilitates immigration of gap-loving species which compete with the forest species.
- (2) Road facilitates increased movement of the forest butterfly within the forest, which reduces genetic diversity.
- (3) Road internally fragments the habitat and negatively affects important micro-habitat conditions for the forest butterfly.
- (4) Road facilitates invasion by non – native plants that displace native host and nectar plants of the forest butterfly.

57. Which one of the following statements regarding normal distribution is NOT correct?

- (1) It is symmetric around the mean
- (2) It is symmetric around the median
- (3) It is symmetric around the variance.
- (4) It is symmetric around the mode.

58. Tropical regions may have more species diversity because of the following possible reasons, EXCEPT

(1) tropical regions have had more limit to diversify under relatively stable climatic conditions than temperate regions.

(2) tropical regions have high spatial heterogeneity

(3) greater biological competition in the tropics leads to narrower niches

(4) lower predation intensity in the tropics allows survival of more prey species

59. Which one of the following statement is correct?

(1) Ecto-mycorrhizal associations predominantly reduce phosphorous limitation, and endo-mycorrhizal associations reduce both nitrogen and phosphorous limitations.

(2) Endo-mycorrhizal associations predominantly reduce phosphorus limitation, and ecto-mycorrhizal associations reduce both nitrogen and phosphorous limitations.

(3) Ecto and endo-mycorrhizal associations do not reduce nitrogen and phosphorous limitation.

(4) Ecto and endo-mycorrhizal associations are able to reduce only phosphorous limitation.

60. Which one of the following statement is correct for the process of speciation?

(1) Allopatric speciation occurs between adjacent populations.

(2) Parapatric speciation may occur between geographically separated populations.

(3) Sympatric speciation occurs within one continuously distributed population.

(4) Sympatric speciation occurs when continuously distributed populations are fragmented.

61. Which one of the following does NOT contribute to micro-evolutionary change?

(1) Mutation (2) Random mating

(3) Genetic drift (4) Natural selection

62. According to Hamilton's rule, altruistic behaviour can evolve when $rb > c$, where b is the extra benefit gained by the recipient as a result of the altruistic act, c is the cost to the actor arising from performing the altruistic act and r is the relatedness between the:

(1) individual performing the altruistic act and the offspring of the recipient

(2) individual performing the altruistic act and the recipient

(3) recipient and the offspring of the individual performing the altruistic act

(4) individual performing the altruistic act and the member of its population.

63. Analyses of nucleotide sequences of ribosomal RNA (rRNA) are particularly useful for evolutionary studies of living organisms because of the following reasons EXCEPT

(1) rRNA is evolutionary ancient

(2) no free – living organisms lacks rRNA

(3) rRNA, since critical for translation, can undergo lateral transfer amongst distant species.

(4) rRNA has evolved slowly over geological time.

64. Which one of the following is the most appropriate definition of 'Gene Pyramiding' in plants?

(1) Introducing different genes for resistance to a specific pest in different genotypes.

(2) Introducing a single gene for resistance to a particular pest in different genotypes.

(3) Introducing different genes for resistance to a single pest in a single genotype.

(4) Introducing a single gene for resistance to multiple pests in different genotypes.

65. To test the impact of cAMP on protein kinase A conformation in cells, an investigator made FRET biosensor by fusing two fluorescent protein at the N and C terminus of protein Kinase A. In the absence of cAMP in the cellular milieu, no FRET signal was detected. However, upon c-AMP addition, a strong emission at 530 nm was observed. What could be the best configuration of fluorophores that were used by the investigator?

(1) Green fluorescent protein (GFP) and Red fluorescent protein (RFP).

(2) CYAN fluorescent protein (CFP) and Yellow fluorescent protein (YFP)

(3) Yellow fluorescent protein (YFP) and Red fluorescent protein (RFP)

(4) Red fluorescent protein (RFP) and CYAN fluorescent protein (CFP)

66. In bioremediation by microorganisms detailed below, choose INCORRECT option?

(1) The organic contaminants provide a source of carbon

(2) The bacteria do not get energy by degrading contaminants.

(3) Bacteria can produce oxydized and reduced species that can cause metals to precipitate.

(4) Bacteria act on contaminants by aerobic and anaerobic respiration.

67. A multimeric protein when run on SDS gel showed 2 bands at 20 kDa and 40kDa. However, when the protein was run on a native gel, it showed a single band at 120 k Da. The native form of the protein would be

(1) homotrimer (2) heterotetramer

(3) heterodimer (4) heterotrimer

68. A solution contains NADH and NAD^+ , BOTH AT 0.1 mM concentration. If NADH has a molar extinction co efficient of 6220 and that of NAD^+ is negligible, the optical density measured in a cuvette of 5mm path length will be

(1) 0.62 (2) 0.062

(3) 0.31 (4) 0.031

69. Orientation of a cloned DNA fragment (gene) in a plasmid vector can be checked by

- (1) PCR using two genes – specific primers
- (2) Restriction digestion with an enzyme that has a single restriction site within the cloned gene and none in the vector
- (3) PCR using a combination of one gene specific primer and one vector – specific primer.
- (4) Restriction digestion with an enzyme that has two restriction sites within the vector sequence and none in the cloned gene.

70. The emission maximum of tryptophan fluorescence in a protein is ~ 335 nm. This suggests that tryptophan

- (1) is in a hydrophobic environment.
- (2) occurs in a helical segment
- (3) has proximal cysteine residues
- (4) is oxydized.

PART C (Attempt any 25 ONLY)

71. Equal volumes of pH 4.0 and pH 10.0 solutions are mixed. What will be the approximate pH of the final solution?

- (1) 7.0
- (2) 5.0
- (3) 6.0
- (4) 4.0

72. The inborn error of amino acid metabolism, alkaptonuria. is due to the lack of one of the following enzymes:

- (1) Fumaryl acetoacetate hydrolase
- (2) α -keto acid decarboxylase
- (3) Hornogentisate oxidase
- (4) p-hydroxyphertylpyruvate dehydroxylase

73. The structure of a protein with 100 residues was determined by X-ray analysis at atomic resolution and NMR spectroscopy. The following observations are possible.

- A. The dihedral angles determined from the X-ray structure and NMR will be identical.
- B. The dihedral angles determined from the X-ray structure will be more accurate.
- C. β -turns can be determined only by NMR.
- D. β -sheets can be more accurately determined from the X-ray structure.

Indicate the combination with ALL correct answers

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

74. The different arms in the tRNA structure are shown in Column A. The specific signatures associated with the different arms are shown in Column B.

	COLUMN A		COLUMN B
A.	Acceptor arm	(i)	Dihydrouridine
B.	Anticodon Arm	(ii)	8 bp stem and CCA Sequence
C.	T ψ C arm	(iii)	5 bp stem
D.	D - arm	(iv)	Pseudo-uridine

Choose the correct matches from the following:

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

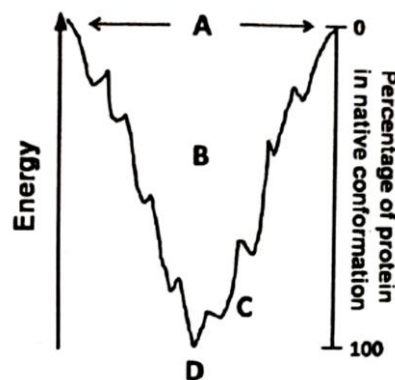
75. Some coenzymes that serve as transient carriers of specific chemical groups are shown below

	Coenzymes		Chemical Group transfer
A	Coenzyme A	(i)	Electrons
B	Flavin adenine Dinucleotide	(ii)	Acyl groups
C	Pyridoxal phosphate	(iii)	Hydride ions
D	Nicotinamide adenine dinucleotide	(iv)	Amino groups

Choose the combination with all correct matches

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

76. Thermodynamics of protein folding is depicted as a free energy funnel below.



Given below are regions in the diagram (Column X) and their representation (Column Y)

X	Y
A	(i) Native structure
B	(ii) Structure with highest entropy
C	(iii) Molten Globule
D	(iv) Discrete folding intermediates

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

77. Table below shows the list of organelles (column A) AND the signals (Column B) that target proteins to the organelle.

	A		B
a	Lysosome	(i)	Stretch of amino acid sequence rich in Lys and Arg residues
b	Mitochondria	(ii)	C-terminal tripeptide
c	Nucleus	(iii)	N-terminal amphipathic helix rich in Lys and Arg
d	Peroxisome	(iv)	Mannose-6-Phosphate

Choose the option that shows all correct matches

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

78. Following statements are made about chromatin remodelling in human cells:

- A. Local chromatin conformation may play more important role than the local DNA sequence of the promoter.
- B. Histones in nucleosome can undergo many different covalent modifications, which in turn, alter the chromatin architecture locally.
- C. Chromatin remodelling is a developmentally regulated passive process which does not require ATP.
- D. Several histone variants exist, which replace the standard histones in specific types of chromatin.

Select the option that has the combination of all correct answers.

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

79. In an experiment, the student has infected mammalian host cell with cytoplasmic RNA virus.

The virus growth was monitored by measuring the intracellular viral RNA at different time intervals. It was observed that viral RNA titre progressively went down with time, particularly 12 hours post infection. Following are few possibilities which can explain this observation.

- A. The virus infection triggered upregulation of miRNAs that might have down-regulated the host factor critical for viral RNA replication.
- B. The virus might encode miRNAs that regulate (inhibits) its own replication.
- C. One of the viral proteins inhibits replication of the viral RNA to restrict rapid proliferation.
- D. Viral RNA goes to nucleus with time and thus not detectable in the cytoplasm 12 hour post infection.

Which one of the following options has all correct statements?

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

80. Irrespective of the chromosomal configuration, a single X chromosome remains active in all diploid human somatic cell lines. Which one of the following mechanisms best accounts for the above phenomenon.

- (1) A maternally inherited X-chromosome is developmentally programmed to remain active by avoiding DNA methylation.
- (2) Chromosome specific expression and binding of rox1 to one of the X-chromosomes protects it from Xist mediated silencing.
- (3) The T-six gene produces just enough of the Xist antisense RNA to block one Xic locus.
- (4) A cell produces just enough of the blocking factor to block one Xic locus.

81. In eukaryotic cells, replication initiation from a replication origin occurs only once per cell cycle and Sphase CDKs play a vital role in the regulation of DNA replication. In budding yeast a protein complex known as the origin recognition complex (ORC) is associated with DNA replication origin during G1; however origins fire only once at the beginning of S-phase. DNA replication does not start in G1 because:

- A. MCM helicases are inactive in G1.
- B. Spindle checkpoint is active in G1.
- C. DNA polymerase is not recruited in G1.
- D. ORC and initiation factors Cdc6 and Cdt1 do not recruits MCM helicases to the site of replication initiation in G1.

Which of the above statements are correct.

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

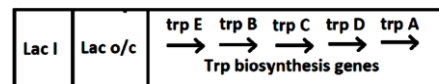
82. Measurements of the rate of actin treadmilling *in vivo* show that it can be several times higher than can be achieved with pure actin *in vitro*. The tread milling *in vitro* can be enhanced by providing

- A. Profilin that binds G-actin on the site opposite the nucleotide binding cleft.
- B. co-filin binds specifically to the ADP containing F-actin and destabilizes the actin filament.
- C. buffer with ATP and low levels of cations.
- D. buffer with ADP and low levels of cations.

Which of the above statements are correct.

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

83. In a strain of *E. coli*, a fusion between the *lac* and *trp* operon took place and the new locus structure is shown below. The strain lacks the wild-type *trp* operon.



Given below are some of the potential scenarios:

- A. Tryptophan will be synthesized in a medium containing lactose and tryptophan.
- B. Tryptophan synthesis will be repressed in a medium containing glucose.
- C. Tryptophan synthesis will take place only in the absence of sufficient tryptophan in the medium.

Choose the option that correctly describes the behaviours of the fusion operon.

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

84. Following statements have been made about removal of supercoiling produced by DNA unwinding at the replication fork:

- A. Accumulation of supercoils is the result of DNA helicase activity during unwinding of DNA
- B. Problem of DNA supercoiling is valid only for circular chromosomes of bacteria and not for the linear chromosomes

C. Supercoiling of DNA is removed by topoisomerases by breaking either one or both strands of DNA on the unreplicated DNA in front of replication fork.

D. Both topoisomerase I and topoisomerase can remove positive super-coiling during replication

Which one of the following options has all correct statements?

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

85. Phosphorylation of the α -subunit of eIF2 at Ser 51 position in *Saccharomyces cerevisiae* leads to sequestration of eIF2B, guanosine exchange factor. This phenomenon is

- (1) known to activate translation of the capped mRNAs in the cytosol
(2) known to activate translation of many key mRNAs possessing short ORFs (uORFs) in the mRNA sequence that proceed the main ORF
(3) an essential requirement for translation of IRES containing mRNAs.
(4) an essential requirement for the transport of mature mRNAs out of the nucleus

86. *E. coli* mutants isolated from a genetic screen showed following classes of mutations

- A. Point mutations in *lacI*
B. Deletions immediately downstream of the transcription start site of the *lacZYA* mRNA
C. Duplications of part or whole of *lacY*
D. Duplications of part or whole of *Lac A*

Choose the option which is likely to result in constitutive expression of the *lac* operon?

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

87. For *Escherichia coli* chromosomal DNA replication, which one of the following statements is true?

- (1) DNA polymerase I is the main polymerase required for DNA replication
(2) DNA polymerase I though identified originally by Kornberg as the one responsible for replication, is not important for the DNA replication process
(3) Requirement of DNA polymerase I is in the context of removal of RNA primer needed for DNA synthesis, and then fill in the same with DNA equivalent
(4) DNA polymerase I is the primary enzyme for error prone DNA synthesis in response to SOS.

88. Following observations were made about variations among genomes of eukaryotic organisms:

- A. Single nucleotide polymorphisms are the numerically most abundant type of genetic variants
B. Both. interspersed and tandem repeated sequences can show polymorphic variation
C. Mitotic recombination between mispaired repeats causes change in copy number and generates Minisatellites diversity in population

D. Smaller variable segments in the genome can be identified by paired end mapping technique

Select the option with all correct statements

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

89. There are number of specific T cell surface molecules involved in various functions of adaptive immune response. Column X represents a list of T cell surface molecules and Column Y with the possible functional characteristics:

Column X	Column Y
A. T cell Receptor	(i) binds to CD40 on B cells and APCs and triggers activation of APCs and activation/ differentiation of B cells.
B. CD 28	(ii) binds to MHC class I molecules and restricts T cytotoxic cells to recognizing only peptide presented on MHC class I
C. CD8	(iii) binds to B7-1,2 or CD80/86 on B cells and APCs, which triggers T cell activation.
D. CD154	(iv) consists of two polypeptide chains α and β and some consist of polypeptide chains γ and δ .

Which of the following option has all correct matches?

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

90. In an experiment it was observed that a protein was upregulated in cancer tissues (compared to control tissues) that showed correlation with disease progression. Following are a few possibilities, which can explain the above observation.

- A. A mutation could be located in the 3'UTR of the corresponding mRNA at a miRNA binding site.
B. A mutation changes the conformation of the protein, resulting in its better stability.
C. A mutation in the corresponding mRNA promotes ribosome read-through of the termination codon resulting in increased synthesis of the protein.
D. A mutation in the corresponding mRNA increased the stability of the RNA due to change in secondary structure.

Which one of the following combinations represents the most likely explanations?

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

91. The extracellular matrix contains a number of non-collagen proteins that typically have multiple domains, each with specific binding sites for other matrix molecules and cell surface receptors. These proteins therefore contribute to both organizing the matrix and helping cells attach to it. The most well characterized matrix protein of this kind is fibronectin. Which one of the following characteristics is NOT TRUE for fibronectin?

- (1) It is a large glycoprotein found in all vertebrates and important for many cell-matrix interactions.
- (2) It is composed of three polypeptides that are disulfide bonded into a crosslink structure.
- (3) In human genome, there is only one fibronectin gene containing about 50 exons, but the transcripts can be spliced in different ways to produce many different fibronectin isoforms.
- (4) Fibronectin binds to integrin through an RGD motif. Even very short peptide containing RGD sequence can inhibit attachment of cells to fibronectin matrix.

92. Following are the list of some cellular receptors (Column X) and with possible functional characteristics (Column Y):

Column x	Column y
A. Asialoglyco Protein receptor	(i) Intracellular high affinity receptor which upon binding with ligand acts as transcription factor and binds to DNA
B. Transferrin receptor	(ii) Extracellular receptor which upon binding with ligand is subjected to endocytosis. Receptor-ligand complex accumulates in acidic endosomes/CURL (compartment of uncoupling of receptor and ligand), delivers the cargo, receptor-ligand complex recycles back to cell surface and the ligand disassociates.
C. Steroid receptor	(iii) Extracellular receptor which upon binding with ligand is subjected to endocytosis. Receptor-ligand complex accumulates in acidic endosomes/CURL, ligand gets dissociated, transfers to lysosomes and the receptor recycles back to cell surface.

Which one of the following is the correct match?

- (1) A – (i); B – (ii); C – (iii)
 (2) A – (ii); B – (iii); C – (i)
 (3) A – (iii); B – (ii); C – (i)
 (4) A – (i); B – (iii); C – (ii)

93. In a laboratory experiment it was observed that both 'Virus A' and 'Virus B' could infect a mammalian host cell, when infected individually. Interestingly, if the cell were first infected with Virus A (with large MOI), Virus B failed to infect the same cell. If the Virus B (with large MOI) is added first followed by Virus A, both the virus can infect the cells. However, infection with 'Virus A' was found to be in lesser extent. Considering X and Y are the receptors/co-receptors which may be involved for the virus entry, following are few possibilities that can explain the observation.

- A. 'Virus A' uses 'X' as receptor and Y as coreceptor.
 B. 'Virus B' uses exclusively 'Y' as receptor for entry:
 C. Both 'Virus A' and 'Virus B' need X as receptor.

Choose the option with all correct statements.

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

94. While testing the effect of several potent anti-cancer compounds on cycling human oral cancer cells, a student observed that a major percentage of cells showed dose-deep cell death after 12 hours of drug treatment. However the remaining cells repopulated the culture dish once the compounds were removed and the cells were cultured in complete medium. The student made the following assumptions:

- A. Not all cells were equally affected by the compounds as they were not synchronized before treatment.
 B. The compound selectively killed cells which were in Go phase.
 C. The cancer stem cells were impervious to the effects of the compounds and therefore repopulated the culture.
 D. The cancer cells differentiated into a mesenchymal phenotype and grew in fresh culture medium containing inhibitors of epithelial-to-mesenchymal transition (EMT).

Which one of the following combination of assumptions would best justify the results?

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

95. When 8-cell embryo of tunicates is separated into 4 blastomere pairs and allowed to grow independently in culture medium, then each blastomere pair can form most the cell types; however, cells for nervous system are not developed. The following statements are formed from the above observations:

- A. Nervous system development demonstrated autonomous specification.
 B. The other tissue types are formed due to conditional specification.
 C. All the tissue types, except nervous tissues that developed demonstrated autonomous specification.
 D. Nervous system development demonstrated conditional specification.

The correct combination of statements that explains the above result is:

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

96. During wing development in chick, if Apical Ectodermal Ridge (AER) is removed, the limb development ceases, on the other hand placing leg mesenchyme directly beneath the wing AER, distal hindlimb structures develop at the end of the wing, and if replaced by non-limb mesenchyme sheath

- AER, the AER regresses. This may demonstrate that:
 A. the limb mesenchyme cells induce and sustain AER.
 B. the mesenchyme cells specify the type: wing or limb.
 C. the AER is responsible for specifying the type: wing or limb.
 D. the AER is responsible for sustained outgrowth and development of the limb
 E. the AER does not specify the type: wing or limb.

Which combination of above statements is demonstrated by the experiment?

- (1) A, B, C and D only
 (2) A, B, D and E only

- (3) C, D and E only
 (4) A and E only

97. The following statements regarding the generation of dorsal/ventral axis in *Drosophila* was made:

- A. Gurken protein moves along with the oocyte nucleus and signals follicle cells to adopt the ventral fate.
 B. Maternal deficiencies of either the gurken or torpedo gene cause ventralization of the embryo.
 C. Gurken is active only in the oocytes, Torpedo is active only in the somatic follicle cells.
 D. The Pipe protein is made in the dorsal follicle cells.
 E. The highest concentration of Dorsal is in the dorsal cell nuclei, which becomes the mesoderm.

Which one of the following combination of the above statements is true?

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

98. A specialized area of teratogenesis involves the misregulation of the endocrine system. Which one of the following statements regarding endocrine disruptors is true?

- (1) They can act as antagonist and inhibit the binding of a hormone to its receptors or block the synthesis of a hormone.
 (2) They do not affect the synthesis, elimination or transportation of a hormone in the body.
 (3) They do not mimic the effect of natural hormones.
 (4) Low dose exposure to endocrine disruptors is not sufficient to produce significant disabilities later in life.

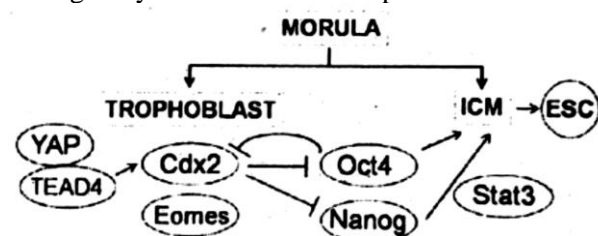
99. Given below are statements related to different aspects of plant growth and development.

- A. Leaf longevity is increased in ethylene insensitive mutants *eir1-1* and *ein2* of *Arabidopsis*.
 B. Programmed cell death (PCD) is responsible for the formation of prickles, thorns and spines in plants.
 C. Senescence and PCD occur only in the development of vegetative tissues and does not occur in reproductive tissues
 D. Redifferentiation of organelles is an integral component during initial stages of senescence in plants.

Which one of the following represents the combination of all correct statements?

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

100. The following demonstrates proposed functions of different genes which determine the decision to become either trophoblast or inner cell mass (ICM) blastomere during early mammalian development:



Based on the above figure, which one of the following assumptions is correct?

- (1) The interplay between *Cdx2* and *Oct4* can influence the formation of ICM
 (2) The ICM would form even if expression of *Oct4* was inhibited.
 (3) *YAP* and *TEAD4* are upstream components of *Cdx2* and can be inhibited by *Nanog*.
 (4) The expression of *Stat3* is optional for maintaining pluripotency of the ICM.

101. Jasmonate is known to inhibit root growth while auxin facilitates root growth. Upon infection with pathogenic bacteria that produce coronatine, we may expect the following in plants:

- A. Upregulation of *COI-1* gene and inhibition of root growth.
 B. Upregulation of *AuxI-1* gene and inhibition of root growth.
 C. Inhibition of *AuxI-1* gene and promotion of root growth.
 D. Inhibition of *COI-1* gene and promotion of root growth.

Which one of the following is correct?

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

102. Following are certain statements with regard to plant respiration:

- A. Metabolism of glucose into pyruvate through glycolysis generates NADH and not NADPH.
 B. Metabolism of glucose through oxidative pentose phosphate cycle does not produce NADPH.
 C. Cyanide forms a complex with haem iron of cytochrome oxidase leading to prevention of change in valency, which in turn stops electron transport in the respiratory chain.
 D. Alternative oxidase is insensitive to cyanide and has higher K_m than that of cytochrome oxidase.

Which one of the following combinations is correct?

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

103. Blue light receptor *cry1* binds to *COP1* and *SPA1* complex by interacting with C-terminal region of *cry1* (*CCT*) in a light dependent manner and regulates photomorphogenesis via transcription factor *HY5*.

Read the following statements:

- A. *cry1* binds to *COP1* and *SPA1* complex leading to degradation of *HY5*.
 B. *cry1* binds to *CON* and *SPA1* complex and prevents degradation of *HY5*.
 C. *CCT* is overexpressed and the plants are kept in dark.
 D. *CCT* is overexpressed and the plants are kept in light.

Which of the following combination of above statements will result in photo-morphogenesis?

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

104. After absorbing light, chlorophyll molecules in green plants exist in singlet and triplet states.

Following are certain statement on singlet and triplet states of chlorophyll molecules:

- A. Singlet state is short lived compared to triplet state.
- B: Singlet state is long lived compared to triplet state.
- C. Singlet state contains electrons with anti-parallel spins while triplet state has electrons with parallel spins.
- D. Singlet state contains electrons with parallel spins while triplet state has electrons with anti-parallel spins.

Which one of the following combinations is correct

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

105. Only members of the plant kingdom and many bacteria have capability of biological nitrogen reduction. In this regard following statements are given:

- A. Nitrogen is normally taken by the plant in their fully oxidized form but needs to be reduced before incorporation in organic molecules.
- B. Conversion of oxidized nitrogen into reduced nitrogen needs energy in the form of NAD(P).
- C. The metal associated with the enzyme nitrate reductase is Magnesium.
- D. Nitrate reduction takes place in the cytoplasm, whereas nitrite reduction takes place in chloroplast.

Which one of the following combinations of the above statements is correct?

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

106. During interaction with host, phytopathogens are known to deliver effector is directly into the host cells. The following statements were made regarding the role of these effector proteins.

- A. May promote pathogen virulence.
- B. May elicit avirulence response.
- C. May suppress defense response.
- D. May promote plant growth.

Which one of the following combinations of the above statements is correct?

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

107. The CO₂ dissociation curves of oxygenated and deoxygenated blood are given along with dissolved CO₂: below

Following are the statements deduced from the curves above and or based on the knowledge about CO₂ transport, which may or may not be correct:

- A. The deoxygenated haemoglobin has greater affinity for CO, than oxygenated haemoglobin.
- B. The deoxygenated haemoglobin does not bind with free H⁺ ions released during the formation of HCO₃⁻ from CO₂.
- C. The haemoglobin saturation with O₂ has no effect on CO₂ dissociation curve.
- D. O₂ and CO₂ bind to haemoglobin at different sites.

Which one of the following options represents a combination of all correct statements?

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

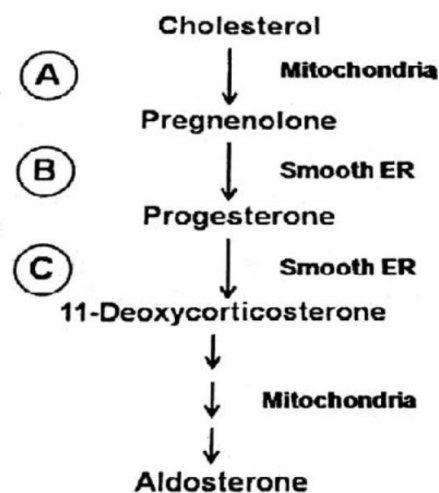
108. Given below are the different intervals/ durations of electrocardiogram of a human subject (column X) and the events in heart during the process (column Y).

COLUMN X		COLUMN Y	
A	PR interval	(i)	Ventricular action potential
B	QRS Duration	(ii)	Atrio ventricular conduction
C	QT interval	(iii)	Ventricular depolarization
D	ST Interval	(iv)	Plateau portion of the ventricular action potential

Which one of the following options is a correct match of entries in columns A and B?

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

109. The pathway of synthesis of aldosterone in zona glomerulosa along with the intracellular locations is shown below:



Which one of due following options represents correct matches for A, B and C?

- (1) A – (i); B – (ii); C – (iii) (2) A – (iii); B – (i); C – (ii)
- (3) A – (ii); B – (iii); C – (i) (4) A – (ii); B – (i); C – (iii)

110. Given below is a figure of pro-opio melanocortin (POMC) polypeptide and its cleavage products (marked as A, B, C, D) which have different hormonal activities. The names of the cleaved products obtained from POMC are shown in the table below the diagram. Which one of due following options represents A, B, Cad D correctly?

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

(4) A – (iii); B – (ii); C – (iv); D – (i)

111. During prolonged illumination, rhodopsin is desensitized which leads to the termination of visual response. The associated proteins (Column A) and their effects (Column B) are given below:

COLUMN – I		COLUMN – II	
a	Phosphorylated Opsin	i	Phosphorylates Opsin
b	Rhodopsin kinase	ii	Binds to phosphorylated Opsin
c	Arrestin	iii	Decreases activation of transducing
d	Phosphatase	iv	Reverses the termination process.

Which one of the matched combinations is correct.

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

112. Estrus cycle in rats is controlled by pituitary and gonadal hormones. While treating a set of rat with vitamin D, a student accidentally injected the rat with an inhibitor of 17 α hydroxypregnenolone and checked vaginal smear for 10 consecutive days. Which one of the following observation is correct?

- (1) The Smears showed well formed nucleated epithelial cell through the period.
 (2) The smears initially showed normal estrus stage but eventually entered a prolonged diestrus stage.
 (3) The smear showed leukocytes and few epithelial cells.
 (4) The cells showed metestrus for 3 days and then returned to the proestrus stage.

113. Centromere positions can be mapped in linear tetrads in some fungi. A cross was made between two strains a b and a⁺ b⁺ and 100 linear tetrads were analyzed. The genes a and b are located on two arms of the chromosome. The tetrad were divided into 5 classes as shown below

Class	1	2	3	4	5
	a b	a b	a b	a b	a b ⁺
	a ⁺ b	a b ⁺	a b	a ⁺ b ⁺	a ⁺ b
	a b ⁺	a ⁺ b	a ⁺ b ⁺	a b	a ⁺ b
	a ⁺ b ⁺	a ⁺ b ⁺	a ⁺ b ⁺	a ⁺ b ⁺	a b ⁺
Linear Tetrads	15	29	52	2	2

Based on the above observation the following conclusion were drawn:

- (A) Class 1 is a result of a cross over between 'a' and the centromere.
 (B) Class 2 is result of double crossover involving 3 strands between 'a' and the centromere.

(C) Class 5 is a result of a double crossover between 'a' centromere and 'b' - centromere.

(D) Class 4 is a result of a double cross over involving all the 4 strands.

Which one of the following options represents all correct statements?

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

114. Two Yellow mice with straight hair were crossed and the following progeny was obtained:

- 1/2 Yellow, straight hair
 1/6 Yellow, fuzzy hair
 1/4 gray, straight hair
 1/12 gray, fuzzy hair

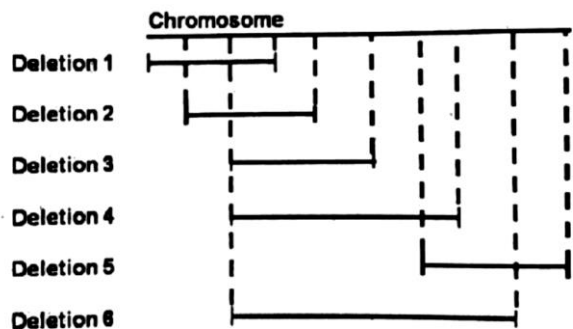
In order to provide genetic explanation for the results and assign genotypes to the parents and progeny of this cross the following statements were given:

- (A) The 6:2:3:1 ratio obtained here indicates recessive epistasis.
 (B) This cross concerns two independent characteristics – body colour and type of hair.
 (C) The deviation of dihybrid ratio from 9:3:3:1 to 6:2:3:1 may be due to one of the genes being a recessive lethal
 (D) The lethal allele is associated with straight hair
 The most appropriate combination of statements to provide genetic explanation for the result is:
 (1) B and C (2) A Only
 (3) B, C and D (4) A, C and D

115. A Family was examined for a given trait which is represented in the pedigree shown below. Further, the degree of expression of the trait is highly variable among members of the family; some are only slightly affected while others developed severe symptoms at an early stage The following statements are made to explain the pattern of inheritance shown in the pedigree.

- (A) X-linked dominant mutation
 (B) X-linked recessive mutation
 (C) Mitochondrial inheritance
 (D) Variable expression can be due to heteroplasmy
 The best possible explanation for this inheritance is
 (1) A and D (2) C and D
 (3) B only (4) A only

116. The location of six deletion (Shows as solid line underneath the chromosomes) has been mapped to the *Drosophila* chromosome as shown in the diagram given below:



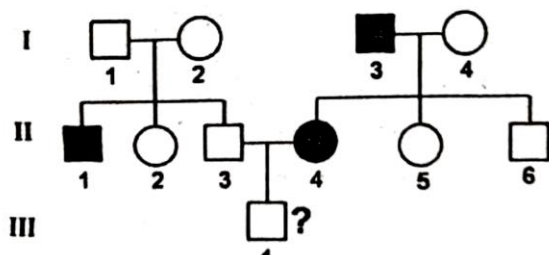
The recessive mutations a, b, c, d, e, f and g are known to be located in the region of deletions, but order of mutations on the chromosome is not known. When flies homozygous for the recessive mutations are crossed with flies homozygous for the deletion, the following result were obtained where the letter 'm' represents a mutant phenotype and '+' represents the wild type.

Mutations							
Deletion	a	b	C	d	e	f	g
1	+	M	M	M	+	+	+
2	+	+	M	M	+	+	+
3	+	+	+	M	M	+	+
4	M	+	+	M	M	+	+
5	M	+	+	+	+	M	M
6	M	+	+	M	M	M	+

The relative order of the seven mutant genes on chromosome is:

- (1) b c e a f g d (2) b c d f g e a
 (3) b c d e a f g (4) c d e a g f b

117. In the following pedigree, individuals with shaded circle or shaded square show presence of a recessive autosomal trait.



The calculated risk of occurrence of this trait for III-1 is

- (1) 1/2 (2) 1/4
 (3) 1/8 (4) 1/3

118. During the course of vertebrate evolution, the jaw bones got modified into three ear ossicles in mammals. Which one of the following is a correct match of ear ossicle and its ancestral jaw bone?

- (1) Stapes–Articular; Incus-Hymoandibular; Malleus-Quadrate
 (2) Stapes-Quadrate; Incus-Articular; Malleus-Hymoandibular
 (3) Stapes–Quadrate; Incus-Hymoandibular; Malleus-Articular
 (4) Stapes-Hymoandibular; Incus- Quadrate; Malleus-Articular

119. Given below are names of the animals in column X and the accessory respiratory organs teleost fishes (Column Y).

Column X		Column Y	
A	Anabas	i	Labyrinthine organ
B	Clarias	ii	Air sacs
C	Amphipnous	iii	Supra branchial cavity
D	Channa	iv	Arborescent organ

The correct match of the animals with the accessory respiratory organs they have are:

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

120. The terms expressing some of the developmental events or specific body structures are given in column X and the names of animals that are associated with them in column Y:

Column X		Column Y	
A	Torsion	i	Star Fish
B	Metagenesis	ii	Obelia
C	Apolysis	iii	Taenia
D	Pedicellaria	iv	Apple snail

The correct match of the terms in column X with the name of animals in column Y is:

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

121. The table lists characteristic anatomical features and names of plants.

Anatomical features		Plants	
i	Prostele, xylem core surrounded by phloem.	A	Lycopodium
ii	Siphonostele, center pith present or modulated protostele	B	Marsilea rhizome
iii	Eustele, conjoint vasculature on edges of the path.	C	Selaginella species
iv		D	Equisetum

Choose the option that correctly matches plant with their characteristic features.

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

122. The table given below provides a list of female gametophyte features and plant genera

Female Gametophyte		Plant genera	
(i)	Monosporic, 8 nucleate	A	Allium
(ii)	Monosporic, 4 nucleate	B	Oenothera
(iii)	Bisporic, 8 nucleate	C	Peperotnia
(iv)	Tetrasporic, 16 nucleate	D	Polygonum

Which one of the following options correctly matches the plant genera to female gametophyte features:

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

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

123. Following are some generalizations related to wood anatomy of higher plants:

- A. The axial system of conifer woods consist mainly or entirely of tracheids.
- B. The rays of conifers typically contain only parenchyma cells.
- C. The rays of angiosperms typically contain both sclerenchyma cells and tracheids.
- D. Angiosperm wood may be either diffuses porous or ring-porous.

Which one of the following options represents all correct statements?

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

124. A field ecologist gathers following data (abundance values) in order to study diversity of species in four plant communities.

Species	Community			
	C1	C2	C3	C4
SP1	90	0	0	40
SP2	60	0	0	65
SP3	15	25	25	40
SP4	0	180	0	0
SP5	25	0	215	45
SP6	65	0	20	55

Based on the above observations, the ecologist draws following conclusions:

- A. Plant communities C1 and C4 show strong similarity with each other
- B. Plant communities C1 and C4 as well as communities C2 and C3 show strong similarity with each other
- C. Plant community C1 is most diverse
- D. Plant community C4 is most diverse

Which of the following statements is correct regarding above conclusions?

- (1) All the conclusions are correct
- (2) Only conclusions A and D are correct
- (3) Only conclusions A and C are correct
- (4) Only conclusions B and D are correct

125. The table given below lists types of plant communities and types of growth forms.

Plant communities		Growth forms	
(i)	Dry grassland	A	Chamaephytes
(ii)	Semi desert	B	Cryptophytes
(iii)	Tropical forests	C	Hemicryptophytes
(iv)	Tuundra	D	Phanerophytes

Which of the following is the best match for the plant communities with most dominant growth form generally present in that community?

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

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

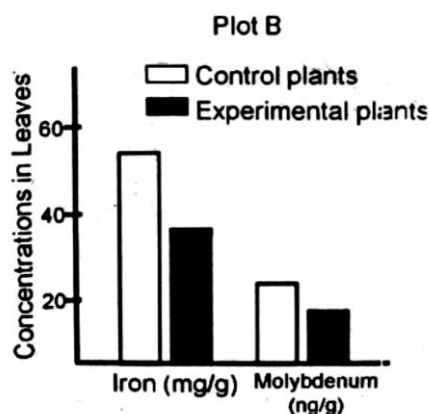
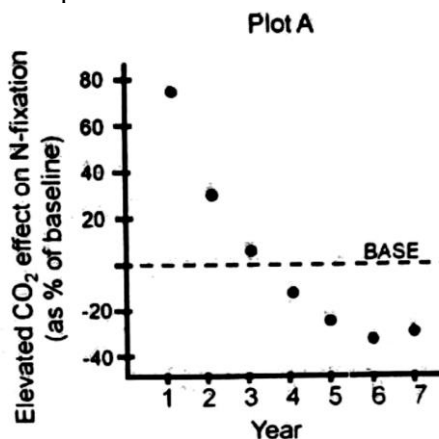
(4) i - C; ii - A; iii - D; iv - C

126. Following are some of the generalizations regarding energy flow in an ecosystem:

- A. Assimilation efficiency of carnivores is higher than herbivores.
- B. Consumption efficiency of aquatic herbivores is higher than terrestrial herbivores.
- C. Vertebrates have higher production efficiencies than invertebrates.
- D. Trophic level transfer efficiency is higher in terrestrial food chains than in marine. Based on the above, select the correct option.

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

127. In an experiment to show that biogeochemical cycles interact, nitrogen fixing vines (*Galactia* sp.) were grown in plots under normal levels of CO₂ (Control) and under artificially elevated atmospheric CO₂ (Experimental). Effect of elevated CO₂ levels on nitrogen fixation was measured over a period of 7 years (Plot A) and the concentrations of iron and molybdenum in the leaves of these plants were quantified at the end of the study (Plot B). Which one of the following inferences CANNOT be made from the above experiment?



- (1) Decreasing rate of N-fixation correlates with decreased levels of leaf iron and molybdenum, two micronutrients essential for N-fixation
- (2) An initial exposure to elevated CO₂ increased N-fixation by these plants

(3) There is a continuous decrease in N-fixation due to elevated CO₂ treatment.

(4) Plants exposed to continuous elevated levels of CO₂ had lower levels of iron and molybdenum in their leaves.

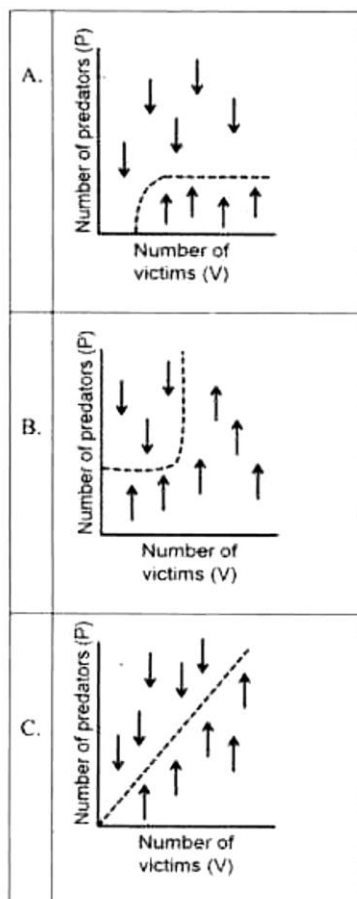
128. Match the following invasive plants to the likely habitats in which they are expected to occur:

Invasive plant	Habitat (s) that they invade
A Eichornia Crassipes	(i) Arid and semi-arid Habitats
B Lantana camara	(ii) Dry and moist tropical Forests
C Posopis juliflora	(iii) Wetlands

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

129. Incorporating additional ecological factors into the Lotka-Volterra predator-prey model can change the predator isocline. Given below are three statespace graphs (A-C) representing modification of predator isocline due to the ecological factors listed below (i-iii).

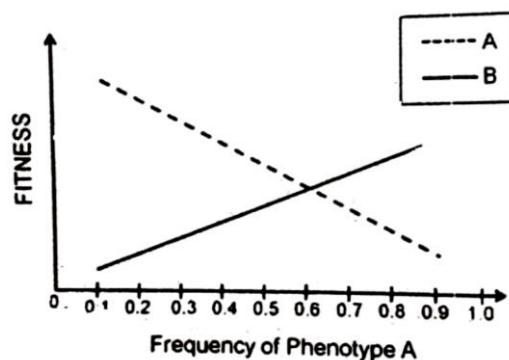
- (i) Victim abundance acting as predator carrying capacity
 (ii) Availability of alternate prey (victim) population
 (iii) Predator carrying capacity determined



Which one of the following options represents all correct matches of the state space graphs with their ecological factor?

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

130. Birds in a population show two foraging phenotypes: A and B. Birds of phenotype A search, attack and capture prey while birds of phenotype B steal prey from birds of phenotype A. A and B are maintained in the population through negative frequency-dependent selection. The graph below shows the fitness of A (broken line) and B (solid line) at different relative frequencies of A (frequency of B = 1 - frequency of A).

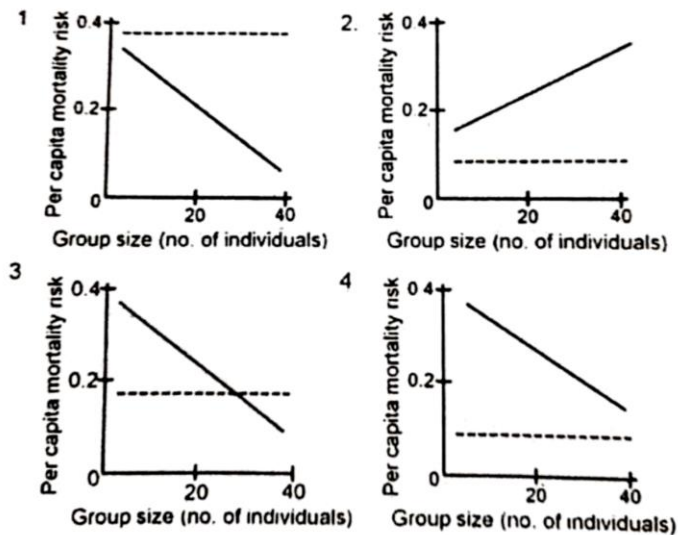


Which of the following statements does the graph support?

- (1) A outcompetes B; at equilibrium, A goes to fixation.
 (2) B outcompetes A; at equilibrium, B goes to fixation.
 (3) A and B are both maintained in the population; the equilibrium frequencies are A = 0.6, B = 0.4.
 (4) A and B are both maintained in the population; the equilibrium frequencies are A = 0.9, B = 0.1.

131. Antelopes are proposed to form groups to reduce the risk of predation. A researcher measured the predation of individuals in groups of different sizes. She found that per capita mortality risk decreased with increasing group size for males (solid line) but remained unchanged for female (dashed line). Furthermore, males in all groups experienced greater per capita mortality risk than females.

Identify the graph below that best depicts the above findings:



- (1) Fig 1 (2) Fig 2
 (3) Fig 3 (4) Fig 4

132. The prominent mammal species found in four different protected areas are listed below:

- Area A: Tiger, Wild dog, Leopard, Elephant
 Area B: Common langur, Barking deer, Wild dog, Elephant
 Area C: Tiger, Indian rhinoceros, Pygmy hog, Wild pig
 Area D: Blackbuck, Indian gazelle, Hyena, Indian wolf
 The area with the greatest phylogenetic diversity is

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

133. The Hardy-Weinberg principle states that allele frequencies in a population will remain constant over generations if certain assumptions are met.

- A. Random mating
 B. Mate choice
 C. Small population size
 D. Large population size
 E. Lack of mutations
 F. Directional selection

Which of the above factors will cause changes in allele frequencies over generations?

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

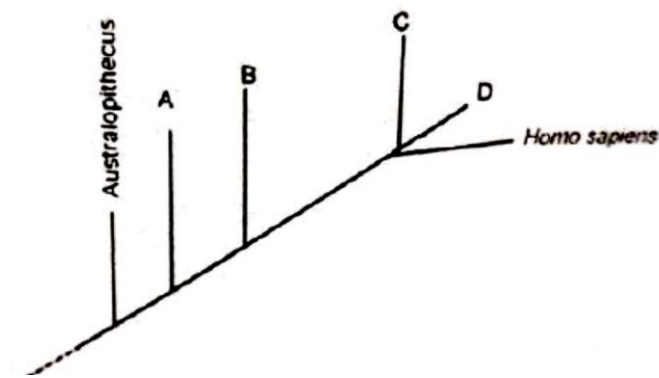
134. Given below are few traits and related functions:

TRAIT		FUNCTION	
(i)	Aposematism	A	Acquiring food
(ii)	Basking	B	Avoiding predation
(iii)	Cooperative Hunting	C	Territory defence
(iv)	Song	D	Thermoregulation

Match the above given traits to their most likely functions.

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

135. Following is a diagrammatic representation of human evolutionary tree.



In the above diagram A, B, C and D respectively represent:

- (1) Denisovan, *Homo habilis*, *Homo erectus*, *Homo neanderthalensis*
 (2) *Homo habilis*, *Homo erectus*, *Homo neanderthalensis*, Denisovan
 (3) *Homo erectus*, *Homo habilis*, *Homo neanderthalensis*, Denisovan
 (4) *Homo erectus*, Denisovan, *Homo neanderthalensis*, *Homo habilis*

136. Based upon phenotypic observation, it was concluded that an unknown gene responsible for an agronomically important trait is present in a particular plant. In order to identify the gene, a researcher proposes to use the following strategies:

- A. PCR amplification of the gene.
 B. Map based cloning of the gene.
 C. Subtractive DNA hybridization
 D. Genome sequencing
 E. Develop molecular markers linked to the trait

Which one of the following options is most suitable for identifying unknown gene?

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

137. A Transgenic plant contains two unlinked copies of the T-DNA of which one is functional and the other is silenced. Segregation of the transgenic to non transgenic phenotype would occur in a

- (i) Ratio in progeny obtained by backcrossing and in a
 (ii) ratio in F1 progeny obtained by self pollination.
 Fill in the blanks with the correct combination of (i) and (ii) from the options given below:

- (1) (i)— 3:1 and (ii)— 15 : 1
 (2) (i)— 1:1 and (ii) -- 3 : 1
 (3) (i)—3:1 and (ii) — 3 : 1
 (4) (i) —1:1 and (ii) -15 : 1

138. Column X lists two diseases and column Y lists name of proteins which are commonly used for routine clinical diagnosis of these diseases

Column – X		Column - Y	
A	Myocardial infarction	i	Amylase
B	Pancreatitis	ii	Creatine kinase
		iii	Lipase
		iv	Troponin

Find out correct combination.

- (1) A-ii; B-i; A-iv; B-iii (2) A-iii; B-iv; A-ii; B-i
 (3) A-i; B-ii; A-iii; B-iv (4) A-iv; B-iii ; A-i; B-ii

139. Given below are the steps to assess the population size of grasshoppers in a given area:

A. 'n' individuals are collected randomly from the study area in a defined period of time.

B. The captured individuals are counted, marked and released at the site of collection.

Next day, individuals are captured from the same site for same length of time. Number of marked (n_M) and unmarked (n_U)

C. This capture-release and recapture is continued till one gets 100% marked individuals

D. The size of the population (N) is estimated as follows:

$$\frac{N}{n} = \frac{n_m + n_u}{n_m}$$

E. The size of population (N) is estimated as follows:

$$\frac{N}{n} = \frac{n_u}{n_m}$$

The most appropriate combination of steps for estimating population size using mark recapture method is:

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

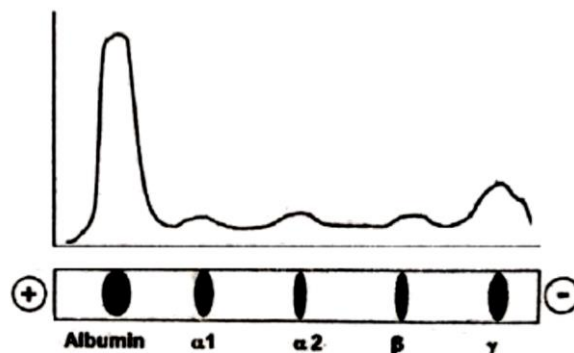
140. A neurophysiologist was interested in using the patch-clamp technique. Following statements are related to this technique:

- A. Intracellular movement of ion channels.
 B. Post-translational modification of the ion channel protein
 C. Ligand that controls the opening or closing of ion channels.
 D. Change in current flow in a single ion channel.

Which one of the following combinations will be achievable using the patch-clamp technique?

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

141. The blood plasma proteins (albumin and globulins) from a healthy person were separated by electrophoresis as shown above. The diagnosis of acute inflammation can be done based on one of the following observations.



- (1) Increase in both $\alpha 1$ and $\alpha 2$; decrease in Albumin
 (2) Increase in albumin; decrease in $\alpha 1$, $\alpha 2$ and β .
 (3) Increase in albumin and decrease in γ globulin
 (4) Only decrease in albumin.

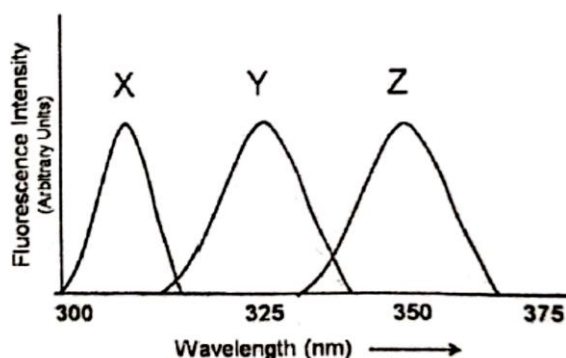
142. Following statements were given regarding factors influencing variation in expression levels of transgene in transgenic plants:

- A. Difference in restriction enzyme sites within the TDNA.
 B. Difference in copy number of the transgene.
 C. Variations in site of integration of the T-DNA within the plant genome.
 D. Presence of multiple promoters within the T-DNA region.

Which one of the following options represents a combinations of statements that would NOT lead to variations in transgene expression levels in transgenic plants generated using the same T-DNA/ binary vector?

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

143.



The above figure shows the fluorescence emission spectra of three different proteins; Protein (X), Protein (Y), and Protein (Z) excited at 280 nm. Which one of the following statements gives the correct interpretation?

- (1) Proteins (Y) and (Z) have tryptophan while protein (X) has only phenylalanine.
 (2) Protein (X) has only tyrosine and protein(Y) has tryptophan on the surface while protein (Z) has tryptophan buried inside.
 (3) Protein (X) has tryptophan buried inside while proteins (Y) and (Z) have tryptophan on the surface.

(4) Protein (X) has only tyrosine and protein (Y) has tryptophan buried and protein (Z) has tryptophan on the surface.

144. Specimens for light microscopy are commonly fixed with a solution containing chemicals that crosslink/denature cellular constituents. Commonly used fixatives such as formaldehyde and methanol could act in various ways as described below:

A. Formaldehyde crosslinks amino groups on adjacent molecules and stabilizes protein-protein and protein-nucleic acid interactions.

B. Methanol acts as a denaturing fixative and acts by reducing the solubility of protein molecules by disrupting hydrophobic interactions.

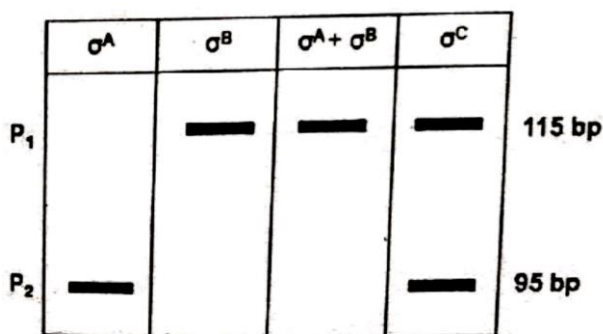
C. Formaldehyde crosslinks lipid tails in biological membranes.

D. Methanol acts on nucleic acids. Cross links nucleic acids with proteins and thus stabilizes protein-nucleic acid interactions.

Which one of the following combinations represents all correct statements?

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

145. Run off transcription assays were performed to establish the specificity of three novel sigma factors for their promoters. Result of the experiments are shown below:



Following inferences were made from these results:

- A. σ^A initiates transcription from P2 and σ^B from P1
 B. σ^C can initiate transcription from both promoters.
 C. σ^B Prevents initiation of transcription from P2
 D. σ^A Initiates transcription from P1

Choose the option that correctly interprets that results?

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

FINAL ANSWER KEYS OF JOINT CSIR-UGC TEST FOR JUNIOR RESEARCH FELLOWSHIP (JRF) AND ELIGIBILITY FOR LECTURESHIP (NET) HELD ON 16-06-2019.

SUBJECT: LIFE SCIENCES – SET-A (BILINGUAL & ENGLISH)

Question No.	Key	Question No.	Key	Question No.	Key
1	2	51	3	101	2
2	3	52	4	102	4
3	2	53	4	103	4
4	4	54	4	104	3
5	3	55	1	105	4
6	1	56	2	106	3
7	3	57	3	107	4
8	3	58	4	108	2
9	4	59	2	109	3
10	4	60	3	110	1
11	4	61	2	111	3
12	4	62	2	112	2
13	3	63	3	113	*
14	2	64	3	114	1
15	3	65	2	115	2
16	1	66	2	116	3
17	1	67	2	117	4
18	3	68	3	118	4
19	4	69	3	119	3
20	3	70	1	120	2
21	4	71	4	121	1
22	1	72	3	122	2
23	4	73	2	123	2
24	2	74	4	124	2
25	3	75	2	125	4
26	2	76	1	126	2
27	4	77	3	127	3
28	4	78	3	128	3
29	2	79	1	129	3
30	2	80	4	130	3
31	4	81	2	131	4
32	3	82	4	132	2
33	4	83	1	133	4
34	2	84	3	134	3
35	4	85	2	135	2
36	2	86	1	136	2
37	1	87	3	137	2
38	3	88	4	138	1
39	2	89	4	139	1
40	2	90	4	140	3
41	3	91	2	141	1
42	4	92	3	142	4
43	4	93	2	143	4
44	4	94	2	144	4
45	2	95	3	145	1
46	1	96	2		
47	3	97	3		
48	4	98	1		
49	3	99	3		
50	4	100	1		

*Benefit of marks to those who have attempted the question