

E

SUBJECT CODE BOOKLET CODE

2014(I)  
LIFE SCIENCES  
TEST BOOKLET

3

A

Time : 3:00 Hours

Maximum Marks: 200

INSTRUCTIONS

1. You have opted for English as medium of Question Paper. This Test Booklet contains one hundred and forty five (20 Part 'A'+50 Part 'B' +75 Part 'C') Multiple Choice Questions (MCQs). You are required to answer a maximum of 15, 35 and 25 questions from part 'A' 'B' and 'C' respectively. If more than required number of questions are answered, only first 15, 35 and 25 questions in Parts 'A' 'B' and 'C' respectively, will be taken up for evaluation.
2. Answer sheet has been provided separately. Before you start filling up your particulars, please ensure that the booklet contains requisite number of pages and that these are not torn or mutilated. If it is so, you may request the Invigilator to change the booklet of the same code. Likewise, check the answer sheet also. Sheets for rough work have been appended to the test booklet.
3. Write your Roll No., Name and Serial Number of this Test Booklet on the Answer sheet in the space provided. Also put your signatures in the space earmarked.
4. **You must darken the appropriate circles with a black ball pen related to Roll Number, Subject Code, Booklet Code and Centre Code on the OMR answer sheet. It is the sole responsibility of the candidate to meticulously follow the instructions given on the Answer Sheet, failing which, the computer shall not be able to decipher the correct details which may ultimately result in loss, including rejection of the OMR answer sheet.**
5. Each question in Part 'A' and 'B' carries 2 marks and Part 'C' questions carry 4 marks each respectively. There will be negative marking @ 25% for each wrong answer.
6. Below each question in Part 'A', 'B' and 'C' four alternatives or responses are given. Only one of these alternatives is the "correct" option to the question. You have to find, for each question, the correct or the best answer.
7. Candidates found copying or resorting to any unfair means are liable to be disqualified from this and future examinations.
8. Candidate should not write anything anywhere except on answer sheet or sheets for rough work.
9. Use of calculator is not permitted.
10. **After the test is over, at the perforation point, tear the OMR answer sheet, hand over the original OMR answer sheet to the invigilator and retain the carbonless copy for your record.**
11. Candidates who sit for the entire duration of the exam will only be permitted to carry their Test booklet.

3.  $\left(\frac{\pi}{2} + \frac{\pi}{2\sqrt{2}}\right) R$

4.  $\left(\frac{\pi}{4} + \frac{\pi}{\sqrt{2}}\right) R$

I have verified all the information filled in by the candidate.

.....  
*[Signature]*

**PART 'A'**

1.



On a semi-circle of diameter 10m drawn on a horizontal ground are standing 4 boys A, B, C and D with distances  $AB = BC = CD$ . The length of line-segment joining A and B is

- ✓ 1. 5 m
- 2. 6 m
- 3. 7 m
- 4.  $\frac{5\pi}{3}$  m

2. The following table shows the price of diamond crystals of a particular quality.

Wt. of a diamond crystal (in carat)	Price per carat (in lakh Rs.)
1	4
2	8
3	12
4	16

What will be the price (in lakh Rs.) of a 2.5 carat diamond crystal?

- ✓ 1. 10
- 2. 20
- 3. 25
- 4. 50

3. A man on the equator moves along  $0^\circ$  longitude up to  $45^\circ$  N. He then turns east and moves up to  $90^\circ$  E, and returns to the equator along  $90^\circ$  E. The distance covered in multiples of Earth's radius  $R$  is

- 1.  $\left(\frac{3}{4}\pi\right)R$
- 2.  $\left(\frac{\pi}{2} + \frac{\pi}{4\sqrt{2}}\right)R$
- 3.  $\left(\frac{\pi}{2} + \frac{\pi}{2\sqrt{2}}\right)R$
- 4.  $\left(\frac{\pi}{4} + \frac{\pi}{\sqrt{2}}\right)R$

4. What is the next number in the following sequence?

2, 3, 5, 6, 3, 4, 7, 12, 4, 5, 9, ...

- 1. 10
- 2. 20
- 3. 13
- 4. 6

5. To go from the engine to the last coach of his train of length 200 m, a man jumped from his train to another train moving on a parallel track in the opposite direction, waited till the last coach of his original train appeared and then jumped back. In how much time did he reach the last coach if the speed of each train was 60 km/hr?

- 1. 5 s
- 2. 6 s
- 3. 10 s
- 4. 12 s

6. How many digits are there in

$2^{17} \times 3^2 \times 5^{14} \times 7$  ?

- 1. 14
- 2. 15
- 3. 16
- 4. 17

7. The following sum is

$1 + 1 - 2 + 3 - 4 + 5 - 6 \dots - 20 = ?$

- 1. 10
- 2. -10
- 3. -11
- 4. -9

8. You are given 100 verbs using which you have to form sentences containing at least one verb, without repeating the verbs, under the condition that the number of verbs (from this set of 100) in any two sentences should not be equal. The maximum number of sentences you can form is

- 1. 10
- 2. 13
- 3. 14
- 4. 100

$1 + 1 - 2 + 3 - 4 + 5 - 6$

9. After giving 20% discount on the marked price to a customer, the seller's profit was 20%. Which of the following is true?

1. Sale price =  $\frac{\text{Marked price} + \text{Cost price}}{2}$ ,
2. Sale price <  $\frac{\text{Marked price} + \text{Cost price}}{2}$ ,
3.  $\frac{2}{3}(\text{Marked price} + \text{Cost price}) >$   
Sale price >  $\frac{\text{Marked price} + \text{Cost price}}{2}$ ,
4. Sale price >  $\frac{2}{3}(\text{Marked price} + \text{Cost price})$ .

10. November 9, 1994 was a Wednesday. Then which of the following is true?

1. November 9, 1965 is a Wednesday and November 9, 1970 is a Wednesday.
2. November 9, 1965 is not a Wednesday and November 9, 1970 is a Wednesday.
3. November 9, 1965 is a Wednesday and November 9, 1970 is not a Wednesday.
4. November 9, 1965 is not a Wednesday and November 9, 1970 is not a Wednesday.

11. A  $4 \times 4$  magic square is given below.

1	15	14	4
12	6	7	9
8	10	11	5
13	3	2	16

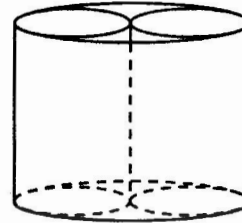
How many  $2 \times 2$  squares are there in it whose elements add up to 34?

1. 6
2. 9
3. 4
4. 5

12. Three years ago, the difference in the ages of two brothers was 2 years. The sum of their present ages will double in 10 years. What is the present age of the elder brother?

1. 6
2. 11
3. 7
4. 9

13.



Two identical cylinders of the same height as a bigger hollow cylinder were put vertically into the latter to fit exactly into it. The volume of the bigger cylinder is  $V$ . The volume of each of the smaller cylinders is

1.  $V/8$
2.  $V/4$
3.  $V/2$
4.  $V$

14. You get 20% returns on your investment annually, but also pay a 20% tax on the gain. At the end of 5 years, the net gain made by you (as percentage of the capital) is approximately

1. 0
2. 16
3. 80
4. 100

15. A cubic cavity of edge  $20 \mu\text{m}$  is filled with a fluid with a cubic solid of edge  $2 \mu\text{m}$ . What percent of the cavity volume is occupied by the fluid?

1. 10.0
2. 20.0
3. 90.0
4. 99.9

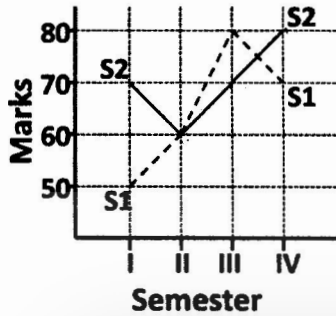
16. What is the length of the longest rod that can be put in a hemispherical bowl of radius 10 cm such that no end of the rod is outside the bowl? (Assume that the rod has negligible thickness.)

1.  $10\sqrt{2}$  cm
2.  $10\sqrt{3}$  cm
3.  $10\sqrt{4}$  cm
4.  $10\sqrt{5}$  cm

$x$   $7-5$   
 $8$   $6$   $4 = 10$   $16$



17. Marks obtained by two students S1 and S2 in a four semester course are plotted in the following graph



Which of the following statements is true?

- S2 got higher marks than S1 in all four semesters.
- Over four semesters, S1 improved by a higher percentage compared to S2.
- Total marks of S1 and S2 are equal.
- S1 and S2 did not get the same marks in any semester.

18. Find the missing number in the sequence

61, 52, 63, 94, \_\_, 18, 001, 121.

- 46
- 70
- 66
- 44

19. If a 4 digit year (e.g. 1927) is chosen randomly, what is the probability that it is NOT a leap year?

- $\frac{3}{4}$
- $\frac{1}{4}$
- $< \frac{1}{4}$
- $> \frac{3}{4}$

20. Coordinates of a point in x, y, z space is (1, 2, 3). What would be the coordinates of its reflection in a mirror along the x, z plane?

- (-1, -2, -3)
- (1, -2, -3)
- (1, -2, 3)
- (-1, 2, 3)

FOR ROUGH WORK

S1                      S2  
 50                      70  
 60                      60  
 80                      70  
 70                      80

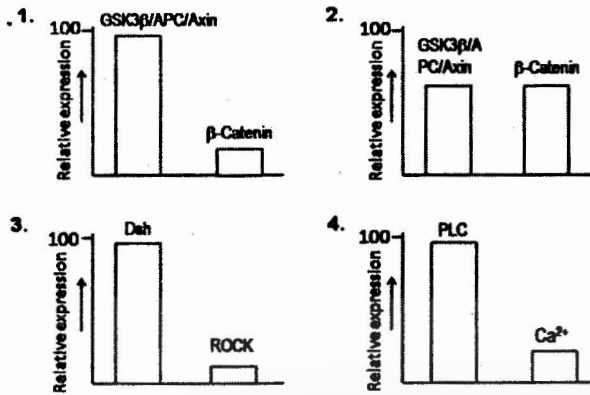


## PART 'B'

21. Which one of the following is unfavorable for protein folding?
- Hydrophobic interaction ✓
  - van der Waals interaction
  - Conformational entropy
  - Hydrogen bonding ✓
22. The maximum number of hydrogen bonds that can form between  $H_2N - NH_2$  (hydrazine) and water is
- |      |      |
|------|------|
| 1. 2 | 2. 1 |
| 3. 3 | 4. 4 |
23. The peptide unit ( $C^\alpha - C'O - NH - C^\alpha$ ) is planer due to
- restriction around  $C^\alpha - C'$  bond
  - restriction around  $C' - N$  bond
  - restriction around  $N - C^\alpha$  bond
  - hydrogen bonding between carbonyl oxygen and imino hydrogen of the peptide backbone.
24. Which one of the following is the most appropriate statement regarding folded proteins?
- ✓ Charged amino acid side chains are always buried.
  - Charged amino acid side chains are seldom buried.
  - Non-polar amino acid side chains are seldom buried.
  - Tyrosine residues are always buried.
25. Molecules primarily responsible for the formation of lipid raft are
- phosphatidyl serine and phosphatidyl choline.
  - phosphatidyl inositol and cholesterol.
  - glycosylphosphatidyl inositol and cholesterol.
  - sphingolipids and cholesterol.
26. Membrane-bound and free ribosomes, are structurally identical, but differ only at a given time in terms of association with
- acetylated proteins
  - glycosylated proteins
  - phospholipids
  - ✓ nascent proteins
27. Histone acetylase and chromatin remodeling complexes are recruited to specific regions of chromatin by
- gene activator proteins.
  - specific promoter sequence.
  - phosphorylation of histone acetylase.
  - dephosphorylation of chromatin remodeling complexes.
28. The dye used in Gram staining is
- Rhodamine
  - Methylene blue.
  - Giemsa
  - ✓ Crystal violet
29. Each origin of replication is activated only once. This is achieved because
- pre-replicative complex can only form in G1 and replication can only be initiated when pre-replication complex is disassembled at the beginning of S-phase.
  - replication can only be initiated when pre-replication complex is intact.
  - replication can only be initiated when unphosphorylated Rb is present.
  - pre-replicative complex can only form in S-phase.
30. The homologous genetic recombination is a DNA repair process referred to as recombination repair. Which one of the following statements is **INCORRECT** for recombination repair?
- DNA polymerase III stalls at the site of the damage. ✓
  - ✓ DNA polymerase III leaves a gap in the daughter strand.
  - The gap is filled by recombination between complementary parent strand homologous to daughter strand and the gapped daughter strand.
  - ✓ Homologous recombination process is catalyzed by topoisomerase II.

31. During protein synthesis in prokaryotes, the peptidyl transferase activity required for peptide bond formation is due to
1. ribosomal protein L26.
  2. 16S ribosomal RNA.
  3. 23S ribosomal RNA.
  4. aminoacyl tRNA.
32. After activation of a promoter by the DNA binding activity of a transcription factor, a co-activator is recruited at the region targeted for transcription which in turn creates a binding site for a chromatin remodeling complex. Which one of the following activities of the co-activator is responsible for the recruitment of chromatin remodeling complex?
1. Histone deacetylase activity.
  2. Histone methyl transferase activity.
  3. Histone acetyl transferase activity.
  4. DNA methyl transferase activity.
33. Prior to transcription, chromatin changes from an inactive state to an active state by various factors in a stepwise manner. Which one of the following is involved in the initial step during activation of a chromatin loop?
1. HMG 14.
  2. Single stranded DNA-binding protein.
  3. DNA polymerase III.
  4. Topoisomerase I.
34. A pathogen like *Mycobacterium*, which colonizes inside the cells of the host, is likely to be least affected by which one of the following host immune defense mechanisms?
1. Cell-mediated immune response
  2. CD4<sup>+</sup> T lymphocytes
  3. Cytokines
  4. Humoral immune response
35. Ethylene signaling pathway is important for fruit ripening. Which one of the following responses is routinely used to identify ethylene signaling pathway components?
1. Cotyledon expansion response
  2. Lateral root formation response
  3. Triple response
  4. Flowering time response
36. Which one of the following is a type of intercellular junction in animal cells?
1. Middle lamella
  2. Plasmodesmata
  3. Desmosomes
  4. Glycocalyx
37. Which one of the following is NOT related to immediate hypersensitivity reactions?
1. Mast cell degranulation results in histamine-mediated allergic reactions.
  2. Reaginic antibodies trigger allergic reactions.
  3. Granulomatous reaction is a key to contain infection.
  4. Anaphylactic reaction is triggered primarily by IgE
38. Which one of the following developmental processes in animals is more dependent on cellular movements?
1. pattern formation
  2. morphogenesis
  3. cell differentiation
  4. growth
39. Engrailed expression in *Drosophila melanogaster* defines
1. anterior margin of the segment.
  2. anterior compartment of each segment.
  3. posterior margin of each parasegment.
  4. posterior compartment of each segment.
40. During which one of the following stages of *Arabidopsis* embryogenesis, cell elongation throughout the embryonic axis and further development of the cotyledons occur?
1. Globular stage.
  2. Torpedo stage.
  3. Heart stage.
  4. Mature stage.
41. Which one of the following graphs represents the relative expression of proteins of Wnt-activated signaling cascades involved during development of an embryo?





42. Virus induced gene silencing (VIGS) is a process that takes advantage of the RNAi-mediated antiviral defence mechanism. Which one of the following ultimately guides siRNA to degrade the target transcript (mRNA)?
1. dsRNA
  2. ssRNA
  3. RNA Induced Silencing (RIS) Complex
  4. dsRNA binding protein
43. During the operation of C<sub>2</sub> oxidative photosynthetic cycle, which of the following metabolites is transported from chloroplast to peroxisome?
1. Glycerate
  2. Serine
  3. Glycine
  4. Glycolate
44. *Arabidopsis thaliana* seeds were planted on Murashige Skoog (MS) plates with or without a hormone added to the medium. Seeds were found to germinate late in the hormone containing MS plates as compared to MS plates without hormone. Identify the hormone.
1. Jasmonic acid
  2. Cytokinin
  3. Auxin
  4. Abscisic acid
45. Which one of the following molecular marker types uses combination of both restriction enzyme and PCR techniques?

1. SSR
2. AFLP
3. SNP
4. RAPD

46. One hemoglobin molecule containing four heme groups can bind with four O<sub>2</sub>. The reactions of Hb and O<sub>2</sub> are shown below. Which one of the following reactions is fastest?

1.  $Hb_4 + O_2 \rightleftharpoons Hb_4O_2$
2.  $Hb_4O_2 + O_2 \rightleftharpoons Hb_4O_4$
3.  $Hb_4O_4 + O_2 \rightleftharpoons Hb_4O_6$
4.  $Hb_4O_6 + O_2 \rightleftharpoons Hb_4O_8$

47. Which one of the following is required to anchor the synaptic vesicles to the cytoskeletal proteins in the pre-synaptic nerve terminals?

1. Syntaxin
2. Synaptobrevin
3. Synaptotagmin
4. Synapsin

48. Vasopressin acts on blood vessels leading to their constriction. Which one of the following signaling cascades will apply to the effect of vasopressin?

1. V<sub>1</sub>R → Phosphatidylinositol hydrolysis → Ca<sup>2+</sup> increase
2. V<sub>1</sub>R → Adenylate cyclase → cAMP
3. V<sub>2</sub>R → Phosphatidylinositol hydrolysis → Ca<sup>2+</sup> increase
4. V<sub>2</sub>R → Adenylate cyclase → cAMP

49. In an experiment involving mapping of 3 genes (*a*, *b* and *c*) in *Drosophila*, a three point test cross is carried out. The parental cross was *AAbbCC* × *aaBBcc*. The genotypes of the double crossovers are: *Aabbcc* and *aaBbCc*. Based on this, determine the order of the genes.

1. *acb*
2. *cab*
3. *abc*
4. *bac*

A C B  
a c B

50. In the following example, 3 independently assorting genes are known to govern coat color in mice. The genotype of few of the coat colors is given below:

- Agouti : *A - B - C -*  
 Black : *aa B - C -*  
 Albino : *- - - - cc*

A C B    a c B

What will be the expected frequency of albinos in the F<sub>2</sub> progeny from crosses of

A b C  
a B C

A B C



aA Bb Cc  
AA bb cc

pure black with albino of the genotype *AAbbcc*?

- 1. 1/4                      2. 1/16
- 3. 1/64                    4. 9/64

51. The distance between bacterial genes as determined from interrupted mating experiments are measured in units of

- ✓ 1. cM                      2. minutes
- 3. bp                        4. micrometers

52. A black Labrador homozygous for the dominant alleles (*BBEE*) is crossed with a yellow Labrador homozygous for the recessive alleles (*bbee*). On intercrossing the  $F_1$ , the  $F_2$  progeny was obtained in the following ratio:

9 black : 3 brown : 4 yellow

This is an example of

- 1. recessive epistasis where allele *e* is epistatic to *B* and *b*.
- 2. dominant epistasis where allele *E* is epistatic to *B* and *b*.
- 3. recessive epistasis where allele *e* is epistatic to *E*.
- ✓ 4. complementary epistasis where allele *b* is epistatic.

53. The organs 'radula' and 'clitellum' are found in

- 1. Coelenterata and Echinodermata, respectively.
- 2. Echinodermata and Coelenterata, respectively.
- ✓ 3. Annelida and Mollusca, respectively.
- 4. Mollusca and Annelida, respectively.

54. Which of the following is a correct hierarchial sequence for classifying a living organism?

- 1. Domain-Kingdom-Phylum-Class-Order-Family-Genus-Species.
- 2. Kingdom-Domain-Phylum-Class-Order-Family-Genus-Species.
- ✓ 3. Domain-Kingdom-Phylum-Order-Class-Family-Genus-Species.
- 4. Kingdom-Domain-Phylum-Order-Class-Family-Genus-Species.

55. *Branchiostoma* is a

- 1. deuterostome and schizocoelomate.
- 2. protostome and schizocoelomate.

- 3. deuterostome and enterocoelomate.
- 4. protostome and enterocoelomate.

56. The population size of a bird increased from 600 to 645 in one year. If the per capita birth rate of this population is 0.125, what is its per capita death rate?

- 1. 0.25                      2. 0.15
- 3. 0.05                      4. 0.02

57. The present global warming trend is expected to result in an increased incidence of malaria in temperate countries. The supposed underlying mechanism is that

- ✓ 1. higher temperatures make temperate country people more vulnerable to diseases.
- 2. malarial parasite grows better at higher temperatures.
- 3. the vector mosquito species requires warmer temperatures for reproduction.
- 4. anti-malaria drugs are less effective in temperate countries.

58. The most important reproductive strategies of big trees in a forest are

- 1. earlier age at first reproduction and production of a large number of small seeds.
- 2. earlier age at first reproduction and production of a small number of large seeds.
- ✓ 3. later age at first reproduction and production of a large number of small seeds.
- 4. later age at first reproduction and production of a small number of large seeds.

59. In rats, after the delivery of the offspring, mother shows the following behaviors. Which one of the following behaviors is NOT maternal?

- 1. Licking the pups
- 2. Huddling above the pups to access the ventrum
- 3. Lordosis of mother rat
- 4. Bringing back to the nest pups that wander away from it

60. In very small populations, genetic variation is often lost through genetic drift. If the population size of a mammal on an isolated island is 50, what percentage of its genetic variation is lost every generation?

- 1. 0.01
- 2. 0.5
- 3. 0.1
- 4. 0.05

61. The long feather train of a peacock is quoted as an example supporting

- 1. Hamilton's rule.
- 2. Zahavi's handicap principle.
- 3. The Red Queen hypothesis.
- ✓ 4. Haldane's rule.

62. An ant moving straight, upon encountering an obstacle, may turn either right or left and continue moving. To test the hypothesis that the direction chosen by the ant is random, the most appropriate statistical test is

- 1. Student's t-test.
- 2.  $\chi^2$ -test of independence.
- 3.  $\chi^2$ -test of goodness of fit.
- ✓ 4. correlation test.

63. Among the following antigens specific to a pathogen, which one is most likely to be ineligible as a vaccine with long lasting host protective effect?

- ✓ 1. A cell surface protein.
- 2. An enzyme involved in pathogen metabolism.
- 3. A signaling intermediate, which is a kinase.
- 4. A long chain fatty acid.

64. Which one of the following techniques is generally used to produce transgenic animals?

- ✓ 1. Processed mRNA containing only exons are introduced into blastocyst stage embryo.
- 2. Entire foreign nucleus is introduced in enucleated unfertilized egg.
- 3. Desired DNA is microinjected into fertilized eggs followed by implantation of embryo in a foster mother.
- 4. cDNA of desired gene is introduced into animal embryos and implanted in a foster mother.

65. Electron microscopes have much higher resolution than any type of light microscope because

- ✓ 1. of their higher magnification.
- 2. the lenses used are of much higher quality.
- 3. of very short wave length of electrons.
- 4. the images are viewed on screen rather than directly using an eye-piece or ocular lens.

66. Which one of the following statements is NOT correct for propagation and maintenance of mammalian cells *in vitro*?

- 1. Transformed cell lines do need external supply of serum to grow.
- 2. The cells that are obtained directly from the organism is a primary culture.
- ✓ 3. Trypsin is added to cell culture media to maintain cell's health.
- 4. HEPES buffer is generally used to maintain pH of the culture media.

67. A bioinformatics tool used to find the sequence similarity in the subunits of hemoglobin is

- 1. FASTA
- ✓ 2. BLAST
- 3. HUMMER
- 4. PSI:PLOT

68. The electro spray ionization spectrum of a highly purified protein shows multiple closely spaced peaks. This most likely arises due to

- 1. degradation of the protein during recording of the spectrum.
- ✓ 2. the presence of multiple conformations.
- 3. multiple charged species of the protein.
- 4. extensive aggregation of the protein.

69. The average energy absorbed by 10 gm of tissue from  $^{32}\text{P}$  radiation is  $14.9 \text{ Jkg}^{-1}$ . The average dose in rads is

- 1. 1490
- 2. 1.49
- 3. 14900
- 4. 149

70. In isoelectric focussing experiments, proteins are separated on the basis of their

- 1. relative content of only positively charged residues.
- 2. relative content of only charged residues.
- ✓ 3. relative content of positively and negatively charged residues.
- 4. mass to charge ratios.



## PART 'C'

71. 10 mM acetate buffer (pH 4.00) is diluted one million times with distilled water (pH 7.00). pH of this diluted buffer is:
- |         |         |
|---------|---------|
| 1. 4.00 | 2. 7.04 |
| 3. 8.00 | 4. 6.96 |

[Help:  $\log_{10} 10^x = x$ ;  $\log_{10} 1.10 = 0.04$ ;  $\log_{10} 1.01 = 0.004$ ]

72. Consider the structureless oligopeptide, R-G-P-S-T-K-M-P-E-Y-G-S-T-D-Q-S-N-W-H-F-R. The number of bonds that will be cleaved by trypsin and chymotrypsin treatments separately, are:

- |         |         |
|---------|---------|
| 1. 1, 2 | 2. 2, 2 |
| 3. 2, 3 | 4. 1, 3 |
- Handwritten notes: R, G, P, S, T, K, M, P, E, Y, G, S, T, D, Q, S, N, W, H, F, R. Cleavage sites: R, G, P, S, T, K, M, P, E, Y, G, S, T, D, Q, S, N, W, H, F, R.*

73. The internal energy of a gas increases by 1J when it is compressed by a force of 1 Newton through 2 metres. The heat change of the system is:

- |        |         |
|--------|---------|
| 1. 1 J | 2. -1 J |
| 3. 2 J | 4. -2 J |

74.  $\Delta G^\circ$  for the base pairing of oligonucleotides (n=5) at 300 K is  $-18 \text{ kJ mol}^{-1}$ . What would be the approximate value of the equilibrium constant K?

- |         |       |
|---------|-------|
| 1. 100  | 2. 10 |
| 3. 1000 | 4. 1  |

75. The reaction of glutamate and ammonia to glutamine and water has a value of  $+14 \text{ kJ mol}^{-1}$  for  $\Delta G^\circ$ . This is coupled with the ATP reaction ( $\text{ATP} + \text{H}_2\text{O} \rightleftharpoons \text{ADP} + \text{phosphate}$ ). The  $\Delta G^\circ$  for this reaction is  $-30 \text{ kJ mol}^{-1}$ . The  $\Delta G^\circ$  ( $\text{kJ mol}^{-1}$ ) for the coupled reaction

Glutamate +  $\text{NH}_3$  + ATP  $\rightleftharpoons$  Glutamine + ADP + Phosphate under equilibrium condition is

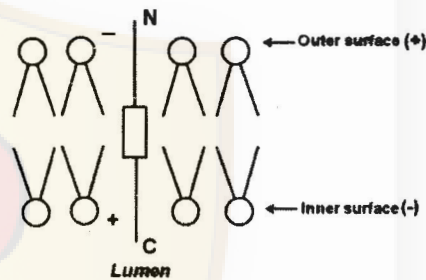
- |        |        |
|--------|--------|
| 1. 16  | 2. -44 |
| 3. -16 | 4. 44  |

76. A protein is composed of leucine, isoleucine, alanine, glycine, proline, one lysine, one arginine and two cysteines connected by a disulfide bond. Conformational analysis

indicates that the protein has elements of helix and beta structure. The protein is most likely

1. a non-specific protease.
2. not an enzyme.
3. a lipase.
4. a flippase.

77. You are studying a protein that inserts itself into a model membrane (liposomes) during a reconstitution process. The protein has an N-terminal, 18-amino acid hydrophilic segment that is located on the outside of the membrane, a 19-amino acid hydrophobic transmembrane segment flanked by negatively and positively charged amino acids, and a C-terminal domain that resides inside the lumen (as depicted below in the form of a cartoon).



For proper reconstitution of the protein, which of the following strategies will be appropriate?

1. Increase the number of negatively charged amino acids in the N-terminal
2. Increase the number of positively charged amino acids in the C-terminal
3. Removal of positively charged amino acids from the C-terminal
4. Increase the length of hydrophobic segment

78.  $^{125}\text{I}$ -labelled diaminofluorene (DAF) is a well known photoactivable hydrophobic probe of plasma membrane integral protein. To determine the approximate length and number of hydrophobic domain in any integral membrane protein, a controlled experiment (following standard protocol) is carried out. In order to ascertain the aforesaid aspects indicate the correct combination of experimental protocols from the following choices:

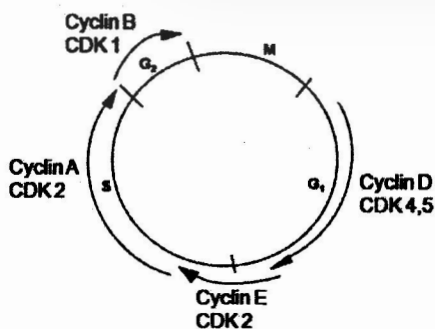


1. Intact membrane was allowed to interact with DAF and unincorporated DAF measured.
2. Intact membrane was allowed to interact with DAF, lysed and total protein precipitated with TCA and amount of radioactivity incorporated in the total proteins in the TCA precipitated fraction measured.
3. Intact membrane was allowed to interact with DAF, then membrane was solubilized with detergent, digested with proteases (limited proteolysis) run on SDS-PAGE followed by autoradiography.
4. Intact membrane was allowed to interact with DAF followed by complete proteolysis, SDS-PAGE and finally autoradiography.

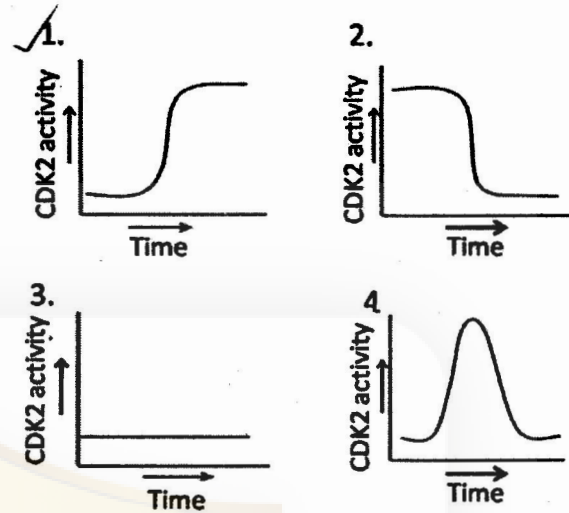
79. The tetrapeptide "KDEL" is well known as a retrieval signal of several newly synthesized proteins. This process is mediated through specific receptor - KDEL interaction. Any single amino acid change in this tetrapeptide is not allowed in terms of its binding with its receptors and its subsequent retention in specific organelle whereas, secretory proteins are devoid of such tetrapeptide. From this observation indicate the localization of the receptor of this tetrapeptide:

1. Plasma membrane
2. Golgi
3. Endoplasmic reticulum
4. Mitochondria

80. Cyclins are the regulatory subunits and cyclin-dependent kinases (CDKs) are the catalytic subunits. Following diagram represents the involvement of cyclins and CDKs in various stages of cell cycle:



If we knock down cyclin D in a cell by shRNA, which one of the following graphs correctly represents the level of CDK2 activity?



81. Chromosome organization becomes clearer from a series of biochemical, electron microscopic and X-ray crystallographic studies. When interphase chromatin is isolated in low salt buffer and observed under EM, 11 nm bead on string organization is seen. Interphase chromatin directly observed under EM shows 30 nm fibre. When histones are depleted from metaphase chromosome and visualized under EM, it shows a huge number of very large loops associated with scaffold.

Following interpretations can be made from these:

- A. 11 nm fibre is formed when nucleosomes are brought closer by scaffold.
- B. 30 nm interphase chromatin is formed by zig-zag organization of nucleosomes of 11 nm fibre.
- C. 30 nm fibre makes a solenoid packing to form the metaphase chromosome.
- D. 30 nm fibre gets organized into loops due to SARs getting associated with scaffold proteins and coming closer.

The correct combination of interpretations is:

1. A and D
2. A and C
3. A and B
4. B and D

82. To test whether bacteria with enhanced toluene degradative abilities could be created for cold environment, a TOL (toluene-degrading) plasmid from a mesophilic bacterial strain was transferred by conjugation into a facultative psychrophile. The psychrophile was able to degrade salicylate (SAL) but not toluene. The recombinant strain carried the introduced TOL plasmid and its own SAL plasmid. The results are as follows:

Temp (°C)	Optimum growth in presence of					
	SAL X			Y Toluene		
	A	B	C	A	B	C
37°C	-	-	-	+	-	-
25°C	-	-	-	+	-	-
10°C	-	+	+	-	-	+
0°C	-	+	+	-	-	+

Identify A, B, C, X and Y:

1. A. mesophile B. psychrophile C. transformant X. Toluene Y. Salicylate
2. A. mesophile B. psychrophile C. transformant X. Salicylate Y. Toluene
3. A. psychrophile B. transformant C. mesophile X. Salicylate Y. Toluene
4. A. transformant B. psychrophile C. mesophile X. Toluene Y. Salicylate

83. Aminoacyl-tRNA synthetases are very specific for aminoacylation of tRNAs with the correct cognate amino acids. However, there is a possibility of a mismatch between the tRNA and its cognate amino acid. This error is corrected by the inherent proof-reading activity of the aminoacyl-tRNA synthetase. In case of two very similar amino acids, namely valine and isoleucine, isoleucyl-tRNA synthetase employs the following possible approaches for an error-free aminoacylation.

- A. It removes an incorrect amino acid by hydrolyzing the aminoacyl-AMP linkage following the first reaction step.

- B. It is activated for proof-reading activity, leading to breakage of the bond between the wrong amino acid and tRNA.
- C. It has an intrinsic ability to recognize the structural difference between amino acids leading to abortive elimination of the non-cognate amino acid.
- D. It gets sequestered in the second step with the wrong amino acid, and that freezes the aminoacylation process.

Which of the following combinations is correct?

1. A and B
2. A and D
3. B and D
4. C and D

84. Attenuation is a mechanism involved in the regulation of tryptophan operon in *E. coli*. When tryptophan levels are high in the cell, region 2 of the trpL is blocked from pairing with region 3. This allows the pairing of region 3 and 4 leading to the formation a rho-independent terminator. What would be the structure of the trpL region in *E. coli* cells where protein synthesis has been inhibited?

1. Region 2 pairs with region 3 allowing transcription of the structural genes.
2. Region 1 and 2 will pair, allowing 3 and 4 to pair leading to attenuation.
3. There is no pairing in the trpL region and transcription of structural gene occurs.
4. Region 2 and 3 will pair leading to attenuation.

85. MicroRNAs (miRNAs) have recently been shown to play a significant role in the fine tuning of gene expression. Some miRNAs induce gene silencing by binding to mRNAs and inducing inhibition of translation. On the other hand, there are miRNAs that bind to mRNAs and activate their degradation. The following characteristics can be applicable to the miRNAs that inhibit mRNA translation:

- A. miRNA is partially complementary to a region of target mRNA in the 3' UTR.
- B. miRNA always base pairs with mRNA around a AU-rich sequence.

meso. → Ability to degrade  
 ↓  
 TOL → into psychrophili. → cold

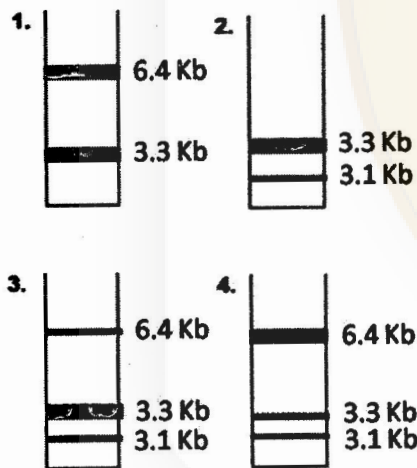


- C. miRNA base pairs with mRNA through 6-7 nucleotides at its 5' end referred to as "seed sequence" as well as few additional bases elsewhere.
- D. miRNA is always partially complementary to the 5' UTR of the target mRNA.

Choose the correct option from the following:

1. A and B
2. A and C
3. C and D
4. A and D

86. A 6.4 Kb plasmid DNA has two restriction endonuclease sites, HindIII and EcoRI. Complete double digestion of the plasmid with both the enzymes yields two fragments of 3.1 and 3.3 Kb. In order to study DNA repair process, a G:T mismatch was introduced in one strand of HindIII site and the damaged plasmid was incubated in a reconstituted repair system containing all the factors and enzymes required for repair. If the efficiency of the repair system is 50%, which one of the following band patterns on agarose gel will be obtained after treating the repaired plasmid with both HindIII and EcoRI?



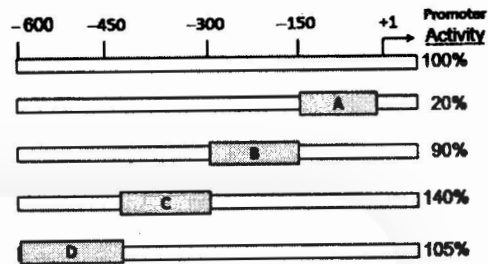
87. The following statements are made on DNA replication:
- A. Replication fork is a branch point in a replication 'eye' or 'bubble'.
  - B. A replication bubble contains two replication forks.
  - C. DNA replication is continuous according to the interpretation made by Okazaki.

- D. Multiple priming events are required for both leading and lagging strands to initiate DNA synthesis.

Which one of the following is the correct combination?

1. A and B
2. B and C
3. C and D
4. A and C

88.



In order to identify the regulatory regions of a novel promoter sequence shown above, four 150 bp deletion constructs were made in a luciferase reporter system as indicated above in boxes A to D. After transfection, the observed level of promoter activity (%) as analyzed by luciferase assay of all the constructs is indicated in the right of the figure. Identify the best correct combination of regions in the options given below that indicate the presence of a positive and a negative regulatory element, respectively.

1. B and D
  2. A and C
  3. A and D
  4. A and B
89. Following sets of *Plasmodium falciparum* sporozoites
- (i) normal sporozoites
  - (ii) sporozoites with mutation in the C-terminal of circumsporozoite (CS) antigen
  - (iii) sporozoites with mutation in the N-terminal region of circumsporozoite (CS) antigen

are injected into 2 groups of mice, one normal (Group A) and one (Group B) where localized knock down of heparan sulfate receptor for CS antigen in liver cells) is achieved by injecting specific shRNA expressing lentiviral particles in the liver

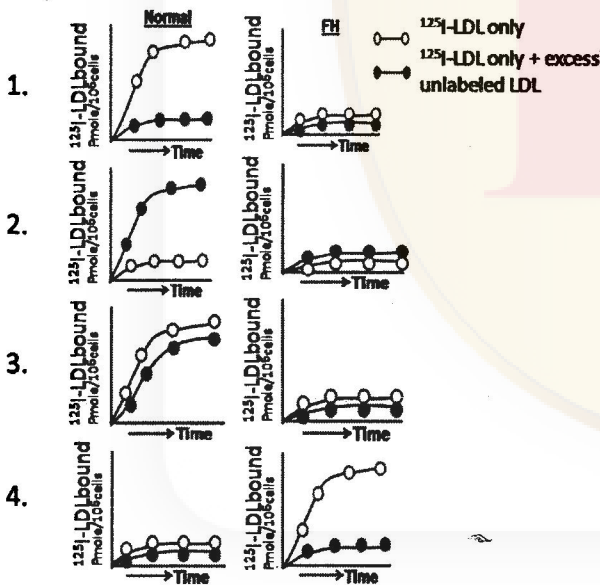


prior to infection. 15 days post infection, parasitemia is measured by counting infected RBC through Giemsa staining.

Which of the following groups will show maximum level of parasitemia?

1. Group B with set (i)
2. Group A with set (ii)
3. Group A with set (iii)
4. Group B with set (ii)

90. Patients suffering from familial hypercholesterolemia (FH) are mostly homozygous for the defective gene and have profoundly elevated levels of serum cholesterol. The reason may be that the gene for highly specific receptor for LDL is either defective or missing in these patients. In an experiment, cells were taken from both normal individual and homozygote (FH) subjects, incubated in buffer with <sup>125</sup>I-labeled LDL in presence or absence of excess unlabeled LDL for various time periods and then <sup>125</sup>I-labeled LDL bound to cells was measured. Which of the following is the best fit graph for the above experiment?



91. Collagen is the most prevalent extracellular matrix protein. Which of the following is NOT true for collagen?

1. Collagen is composed of triple helix consisting of two  $\alpha$  polypeptide chain and one  $\beta$  polypeptide chain wound around one another in a rope-like structure.
2. Glycine accounts for almost one third of the amino acids within collagen molecule.
3. Ascorbate is essential for collagen formation required for hydroxylation of proline.
4. Individual collagen polypeptide chains are synthesized on membrane-bound ribosomes with N-terminal signal sequences for directing them to ER lumen.

92. The following statements have been proposed for a cancer cell.

- A. Binding of p53 with MDM2, a ubiquitin E3 ligase, is a precondition for cancer progression.
- B. Phosphorylation of a tyrosine residue in the C-terminus of human c-Src is essential for cell invasion and motility.
- C. Loss of function of both alleles of a tumor suppressor gene prevents metastasis.
- D. Dimerization of c-myc-Max leads to enhanced cell proliferation.

Which of the combinations of the above statements is correct?

1. A and B
2. C and D
3. A and D
4. B and C

93. CD4<sup>+</sup> T cells are co-cultured with macrophages in the presence of immobilized anti-CD3 antibody under four different conditions:

- (A) Interleukin (IL)-4 plus anti-IFN $\gamma$  antibody,
- (B) IL-12 and anti-IL-4 antibody,
- (C) transforming growth factor (TGF)- $\beta$ ,
- (D) TGF- $\beta$  and IL-6

for three rounds to induce T-helper cell differentiation identifiable by the cytokines they express predominantly.

Which one of the following is the most likely combination of predominant cytokine expression in these cultures?

1. (A) IL-4, (B) IFN- $\gamma$ , (C) IL-10, (D) IL-17
2. (A) IFN- $\gamma$ , (B) IL-4, (C) IL-17, (D) IL-10
3. (A) IL-17, (B) IL-4, (C) IFN- $\gamma$ , (D) IL-10
4. (A) IL-17, (B) IL-10, (C) IL-4, (D) IFN- $\gamma$

94. Four groups of one-day old female BALB/c neonates had received the following treatments:

- A. Epidermal cells from C57BL/6 male plus anti- $\beta_2$  microglobulin antibody.
- B. Epidermal cells from C57BL/6 male plus antibodies to  $\beta_2$  microglobulin, CD40 ligand, CD80 and CD86.
- C. Epidermal cells from C57BL/6 female plus anti-CD80 antibody.
- D. Epidermal cells from C57BL/6 female mice.

When these BALB/c neonates grew six weeks old, they received skin transplant from C57BL/6 male mice. Transplantation rejection time varied between these four groups. Starting from the fastest to the slowest rejection, which one of the following is the most likely order?

1.  $D \geq C > A > B$
2.  $A > B > C \geq D$
3.  $B > A > D \geq C$
4.  $D > B \geq C > A$

95. At the 2-celled stage of *Caenorabditis elegans* development the blastomeres were experimentally separated and allowed to proceed in development. One of the blastomere (P1) developed generating all types of cells it would normally make while the other blastomere (AB) made only a fraction of the cell types it would normally make. The following conclusion could be drawn:

- A. The determination of both P1 and AB was autonomous.
- B. The determination of both P1 and AB was conditional.
- C. The determination of P1 was autonomous and AB was conditional.

D. Both asymmetric division and cell-cell interactions specify cell fate in early development.

Which of the above combinations is correct?

1. A and C
2. B and D
3. A and D
4. C and D

96. The proximal distal growth and differentiation of the tetrapod limb bud are made possible by a series of interactions between the apical ectodermal ridge (AER) and limb bud mesenchyme directly beneath it. Some of the interactions performed in chick demonstrated the following results:

- A. When the AER was removed at any time of development, further development of distal limb skeletal elements ceased.
- B. When leg mesenchyme was placed directly beneath the wing AER, distal hindlimb structures developed at the end of the wing.
- C. When limb mesenchyme was replaced by a non-limb mesenchyme beneath the AER, the limb still developed.
- D. When an extra AER was grafted onto an existing limb bud, the development of the limb ceased.

Which of the above combinations is correct?

1. A and B
2. A and C
3. B and D
4. B and C

97. Torpedo is a trans-membrane receptor on follicle cells that binds with Gurken protein located in the presumptive dorsal surface of the oocytes and inhibits a cascade leading to nuclear localization of the Dorsal protein. In an experiment, *Drosophila* germ line chimeras were made by interchanging pole cells (germ line precursors) between wild type embryos and embryos from mother homozygous for a mutation of *torpedo* gene. These transplants produced:

- i) wild type females whose egg came from mutant mother, and
- ii) *torpedo* deficient females whose egg came from wild type mother.



The possible outcome of this experiment can be:

- A. Torpedo deficient eggs developed in wild type ovary produced normal embryos.
- B. Wild type eggs developed in Torpedo deficient ovary produced ventralized embryos.
- C. Torpedo deficient eggs developed in wild type ovary produced ventralized embryos.
- D. Dorsal protein enters in the nuclei of dorsal side of embryos which came from wild type eggs developed in Torpedo deficient ovary.
- E. Dorsal protein remains cytoplasmic in the dorsal side of the embryos which came from wild type eggs developed in Torpedo deficient ovary.

Which of the above combinations is correct?

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

98. During lens formation in the *Xenopus*, the following statements have been proposed:

- A. Lens induction can be achieved in the absence of optic vesicle after priming of head ectoderm by the anterior neural plate.
- B. The optic vesicle can induce the presumptive trunk ectoderm to form the lens.
- C. Only the head ectoderm can respond to direct signals from the optic vesicle to form the lens.
- D. The anterior neural plate primes the head ectoderm via BMP4 and Fgf8 prior to signals from the optic vesicle.

Which of the above combinations is correct?

- 1. C and D                         2. B and D
- 3. A and D                         4. A and C

99. Mutation in a gene *x* in *Arabidopsis thaliana* results in more number of lateral root formation.

Which one of the following is the correct statement?

- 1. The gene product acts as a positive regulator of lateral root formation.
- 2. The gene product acts as a negative regulator of lateral root formation.

- 3. The gene product is not likely to be involved in lateral root formation.
- 4. The gene product promotes replication for lateral root development.

100. Nitrogen fixation is basically a process of converting nitrogen gas into ammonia (NH<sub>3</sub>). One of the key enzymes in the process is "nitrogenase". The production and activity of nitrogenase is very highly regulated as highlighted below:

- A. Nitrogen fixation through nitrogenase is an energetically expensive process.
- B. Nitrogenase encoding gene is under a constitutive promoter.
- C. Nitrogenase is highly sensitive to oxygen.
- D. Endogenous availability of the cofactor of nitrogenase enzyme is very low.

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

- 1. A and B
- 2. A and C
- 3. B and C
- 4. B and D

101. The amount of each enzyme present in the chloroplast stroma is regulated by mechanisms that control the concerted expression of nuclear and chloroplast genomes. Following are certain statements regarding the regulation of chloroplast enzymes:

- A. Nucleus-encoded enzymes are translated on 70S ribosomes in the cytosol and subsequently transported into the plastid.
- B. Plastid encoded enzymes are translocated in the stroma on prokaryote-like 70S ribosomes.
- C. Light modulates the expression of stromal enzymes encoded by the nuclear genome via specific photoreceptors.
- D. The eight small subunits of rubisco is encoded in plastid.

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

- 1. A and B                         2. A and C
- 3. B and C                         4. C and D



102. Aquaporins are a class of proteins that are relatively abundant in plant membranes. Following are certain statements regarding the properties of aquaporins:

- A. Aquaporins form water channels in membrane.
- B. Some aquaporins also transport uncharged molecules such as NH<sub>3</sub>.
- C. The activity of aquaporins is not regulated by phosphorylation.
- D. The activity of aquaporin is regulated by calcium concentration and reactive oxygen species.

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

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

103. In terpene biosynthesis pathways, three acetyl-CoA are joined together stepwise to form mevalonic acid. Which one of the following three steps is required by mevalonic acid to form isopentenyl diphosphate or isopentenyl pyrophosphate (IPP)?

- ✓ 1. Pyrophosphorylation, decarboxylation, and dehydration.
- 2. Alkylation, pyrophosphorylation and decarboxylation.
- 3. Methylation, dehydration and alkylation.
- 4. Phosphorylation, carboxylation and methylation.

104. Following statements are related to oxidative phosphorylation.

- A. Redox reactions of electron transport chain coupled with ATP synthesis are collectively called oxidative phosphorylation.
- B. Three major processes: glycolysis, oxidative pentose phosphate pathway and citric acid cycle are related to oxidative phosphorylation.
- C. Electron transport proteins are bound to outer of the two mitochondrial membranes.

D. In the electron transport chain electrons are transferred to oxygen from NADH.

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

- 1. A and D
- 2. B and C
- 3. C and D
- 4. A and C

105. Satellite RNAs (sat-RNAs) are species of RNA associated with specific strains of some plant RNA viruses, although it is not necessary for their replication.

Few statements are given below on sat-RNA

- A. Presence of sat-RNA leads to reduction in severity of disease symptoms.
- B. Presence of sat-RNA leads to increase in severity of disease symptoms.
- C. sat-RNA is constitutively expressed like coat proteins and is independent of virus infection.
- D. sat-RNA is not constitutively expressed like coat proteins but is expressed only after virus infection.

Which one of the following combinations of above statements regarding sat-RNA is correct?

- 1. A and B
- 2. B and C
- 3. C and D
- 4. A and D

106. The following statements are related to excretion in invertebrates:

- A. Flame cells are found in molluscs and jelly fish.
- B. Nephridia and Malpighian tubules convert ammonia to urea for water conservation.
- C. Green glands are found in flatworms and help in the excreta elimination.
- D. Excretory canals in nematodes carry waste materials to excretory pores in the body wall.

Choose the correct answer

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

107. Respiration can be inhibited voluntarily for some time. The point at which respiration cannot be voluntarily inhibited is known as breaking point. Following explanations are offered for the breaking point:

- A. J-receptors stimulate respiratory centers
- B. Hering-Breuer reflex operates
- C. The rise of arterial  $p\text{CO}_2$  stimulates the respiratory centre
- D. The fall of arterial  $p\text{O}_2$  stimulates the respiratory centre

Which of the above combination is correct?

- 1. A and B
- 2. B and C
- 3. C and D
- 4. A and D

108. A mechanical pressure was exerted on a specific location of a peripheral nerve of a mammal. The touch or pain receptors were stimulated from the skin surface innervated by the same nerve. The action potential generated by touch receptor stimulation was blocked beyond the point of mechanical pressure. But the action potential generated by pain receptor stimulation passes through the point of mechanical pressure.

Following explanations were offered for these observations:

- A. The large diameter 'A' fibres were affected by mechanical pressure
- B. The small diameter 'C' fibres were not affected by mechanical pressure
- C. The intermediate diameter 'B' fibres were affected by mechanical pressure
- D. The large diameter 'A' fibres were not affected by mechanical pressure

Which of the above combinations is correct?

- 1. A and B
- 2. B and C
- 3. C and D
- 4. A and D

109. When a skeletal muscle with an intact nerve supply is stretched, the muscle contracts and the tone increases. The following explanations are offered for this observation:

- A. Golgi tendon organ was stimulated by the stretching of muscle
- B.  $\gamma$ -motor neurons were excited by the stimulated afferent nerve fibres from the stretched muscle
- C. Muscle spindle was stimulated by stretching of muscle

D.  $\alpha$ -motor neurons were excited by the stimulated afferent nerve fibres from the stretched muscle

Which of the combination is correct?

- 1. A and B
- 2. B and C
- 3. C and D
- 4. A and D

110. Upon prolonged illumination, activated rhodopsin does not activate transducin, hence the vision is impaired. This could be because of the following explanations:

- A. Most of the activated rhodopsin gets phosphorylated and is unable to activate transducin.
- B. Most of the activated rhodopsin gets dephosphorylated and is unable to activate transducin.
- C. Arrestin further interacts with phosphorylated rhodopsin.
- D. Arrestin further interacts with dephosphorylated rhodopsin.

Which of the above combinations is correct?

- 1. A and C
- 2. B and D
- 3. A and D
- 4. B and C

111. An elderly person suffering from calcium deficiency was advised to take calcium rich food and to supplement the diet with vitamin D. The absorption of calcium in the intestine was increased with the supplementation of vitamin D. Following explanations were offered for this increased calcium absorption by vitamin D:

- A. The synthesis of calbindin- $\text{D}_{9\text{K}}$  and calbindin- $\text{D}_{28\text{K}}$  in enterocytes was stimulated.
- B. The number of  $\text{Ca}^{2+}$ -ATPase molecules in enterocytes was increased.
- C. The synthesis of divalent metal transporters 1 (DMT1) in the enterocytes was stimulated.
- D. The number of hephaestin in the enterocytes was increased.

Which of the above combinations is correct?

- 1. A and B
- 2. B and C
- 3. C and D
- 4. A and D

112. A series of cell lines was created by fusing mouse and human somatic cells. In mouse-human somatic cell hybrids, human chromosomes tend to get lost before becoming a stable cell line. Some hybrid cell lines may



carry human chromosome deletions. Each cell line was examined for the presence of chromosomes and for the production of an enzyme. The following results were obtained:

Cell line	Gene product	Chromosomal segments									
		1p	1q	2p	2q	3p	3q	4p	4q	5p	5q
A	+	+	+	-	-	+	+	-	-	+	+
B	+	-	-	+	+	-	-	+	+	+	+
C	-	+	+	-	-	+	+	-	+	-	+
D	+	-	-	+	+	+	+	-	-	+	-
E	-	+	+	+	+	-	+	-	-	-	-

Which segment of the chromosome has the gene encoding for the enzyme?

- 1p
- 5p
- 5q
- 4p

113. The following table summarizes the result of a cross between two strains of *Neurospora* having the alleles *D* and *d*, respectively. The table shows the different patterns of octad arrangement and the number of ascus observed of each type.

Octads						
D	d	D	d	D	d	
D	d	D	d	D	d	
D	d	d	D	d	D	
D	d	d	D	d	D	
d	D	D	d	d	D	
d	D	D	d	d	D	
d	D	d	D	D	d	
d	D	d	D	D	d	
Number of ascus observed	115	125	14	16	17	13

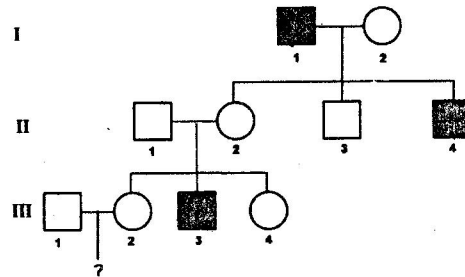
Total = 300

Based on the above, fill in the blanks from the options given below,

“The first two columns are from meiosis with no crossover between locus *D* and [A]. The patterns for these two columns represent [B] segregation pattern. The distance between the locus *D* and the centromere is [C] map units”.

- |    | A          | B               | C  |
|----|------------|-----------------|----|
| 1. | d allele   | first division  | 10 |
| 2. | centromere | first division  | 10 |
| 3. | d allele   | second division | 20 |
| 4. | centromere | second division | 10 |

114. The inheritance pattern of a common trait which shows complete penetrance is shown below:



Based on the above pedigree, fill in the blanks from the options given below:

“The trait is [A]. The probability that a child from the marriage of individual III-1 and III-2 will show the trait is [B], considering that the individual III-1 is a carrier of the trait.”

- |    | A         | B   |
|----|-----------|-----|
| 1. | Y-linked  | 0   |
| 2. | Y-linked  | 1/2 |
| 3. | Autosomal | 1/8 |
| 4. | Autosomal | 1/6 |

115. A hypothetical gene encodes a protein with the following amino acid sequence:

Phe- Pro- Thr- Ala- Val- Arg- Ser

A mutation of single nucleotide alters the amino acid sequence to

Phe- Leu- Leu- Leu- Leu- Val

A second single nucleotide mutation occurs in same gene restoring back the amino acid sequence to the original.

The following statements were made regarding the nature and location of the first mutation and that of the intragenic suppressor mutation:

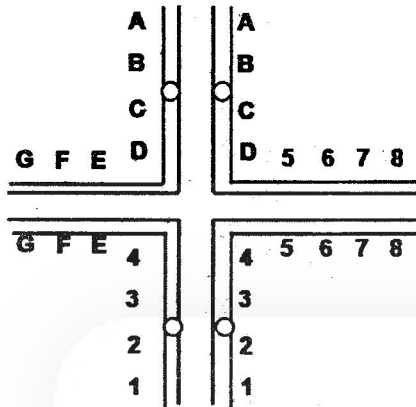
- The first mutation is a deletion in the second codon
- The first mutation is an insertion in the second codon
- The intragenic suppressor mutation is an insertion in the second codon
- The intragenic suppressor mutation is a deletion in the third codon

Which combination of the above statements is correct?

- A and C
- A and D
- B and C
- B and D



116. The following statements were made regarding chromosome pairing (shown in the figure below) and subsequent segregation during meiosis I in the reciprocal translocation heterozygote:



- Three ways of segregation in Anaphase I would be: adjacent 1 (vertically in the above figure), adjacent 2 (horizontally) and alternate.
- Gametes resulting from adjacent 1 and adjacent 2 segregation will be non-viable because of deletions and duplications of several genes.
- All gametes resulting from alternate segregation will be viable as they will carry both normal chromosomes or both chromosomes having translocations in the two poles, respectively.
- A dicentric and an acentric chromosome will be generated following alternate segregation.

Which of the following combination of statements will most appropriately explain the consequence?

- A, B and D
- A, B and C
- Only A and B
- Only A and C

117. Three Indian animals – cormorant, lion-tailed macaque and gerbil are to be matched with the ecosystem they inhabit – Wetland (A), Desert (B), Deciduous forest (C), or Rain forest (D). Which of the following is the correct match of each animal with its habitat?

- Cormorant – D; Lion-tailed macaque – C; Gerbil - B
- Cormorant – A; Lion-tailed macaque – C; Gerbil - D
- Cormorant – A; Lion-tailed macaque – D; Gerbil - B
- Cormorant – B; Lion-tailed macaque – C; Gerbil - D

118. The list below includes names of animal phyla and classes.

- Echinodermata
- Cephalopoda
- Annelida
- Mollusca
- Hirudinea
- Asteroidea
- Arthropoda
- Crustacea.

For a leech and lobster, the correct classification of phylum and class, respectively, is

- ~~Leech: Phylum – D, Class – B;~~  
Lobster: Phylum – A, Class - H
- ~~Leech: Phylum – C, Class – B;~~  
Lobster: Phylum – D, Class - C
- Leech: Phylum – C, Class – E;  
Lobster: Phylum – G, Class - H
- ~~Leech: Phylum – A, Class – G;~~  
Lobster: Phylum – C, Class - F

119. Some key characteristics of the four classes of phylum Mollusca are listed below:

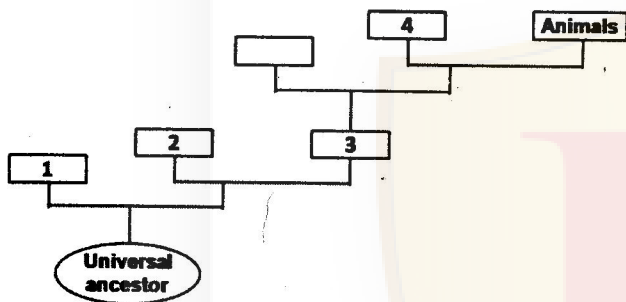
- They have two lateral (left and right) shells (valves) hinged together dorsally; they do not have distinct head or radula; they disperse from place to place largely as larvae.
- They generally creep on their foot; the heads of most of this group have a pair of tentacles with eyes at the end; during embryological development, they undergo torsion.
- They have oval bodies with overlapping calcareous plates; underneath the plates, the body is not segmented; they creep along using a broad, flat foot surrounded by a groove or mantle cavity in which the gills are arranged.

D. They have highly developed nervous system; most members of this class have closed circulatory systems.

The correct match of the above characteristics with the classes of Mollusca is

1. A - Polyplacophora B - Bivalvia  
C - Gastropoda D - Cephalopoda
2. A - Cephalopoda B - Polyplacophora  
C - Bivalvia D - Gastropoda
- ✓ 3. A - Bivalvia B - Gastropoda  
C - Polyplacophora D - Cephalopoda
4. A - Gastropoda B - Bivalvia  
C - Cephalopoda D - Polyplacophora

120. The diagram below depicts a simplified Tree of Life with three domains and one of the domains including Whittaker's three major kingdoms.



Which of the following is the correct naming of the numbered boxes?

1. ~~1 - Bacteria 2 - Archaea 3 - Eukarya 4 - Fungi~~
- ✓ 2. 1 - Archaea 2 - Bacteria 3 - Eukarya 4 - Plants ✓
3. 1 - Eukarya 2 - Bacteria 3 - Archaea 4 - Plants ✓
4. ~~1 - Archaea 2 - Bacteria 3 - Eukarya 4 - Fungi~~

121. Given below are some of the methods used to assess evolutionary phylogenetic relationships among plant taxa.

- A. 16S rRNA sequence
- B. Mitochondrial microsatellite
- C. Biochemical characterization
- D. Morphology

Which two of the above methods can best reveal the evolutionary phylogenetic relationships?

- ✓ 1. A and B
2. B and C
3. C and D
4. A and D

122. Sleeping sickness is a disease caused by a protozoan parasite and the following statements pertain to that disease:

50.50

- ✓ A. The vector for this disease is tsetse fly.
- B. The vector for this disease is *Trypanosoma brucei*.
- C. The parasite's body is covered by a dense coat of variable surface glycoprotein (VSG).
- D. There are several thousands of VSG genes, only one of them expressing at a time, which helps the parasite in evading host's immune response.
- E. Several thousand copies of VSG genes express concurrently, paralyzing the host immune system.

Which of the following is the correct combination of the statements given above?

1. ~~B, C and D~~
- ✓ 2. A, C and D
3. A, C and E
4. ~~B, C and E~~

123. There are three species of frogs - A, B and C.

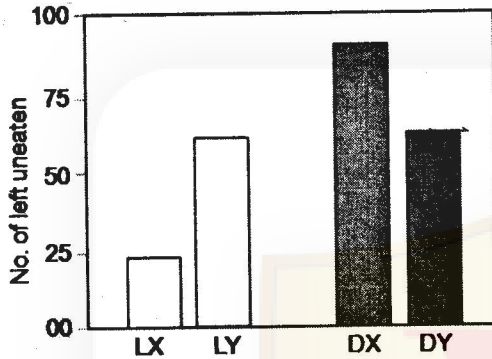
50.50

Species A does not provide parental care for its eggs and larvae. Species B is subjected to predation by a predator that selectively feeds only on small-sized larvae. Species C faces progressively decreasing opportunities for breeding with increasing age. Assuming that resources available for reproduction are similar for A, B and C, which of the following strategies would have been favored?

- ✓ 1. A should produce large number of small-sized offspring; B should produce a small number of large-sized offspring; C should breed earlier in life.
2. Species A and B should produce a small number of large-sized offspring and C should breed earlier in life.
3. Both species A and B should produce a large number of small-sized offspring and C should breed later in life but increase its clutch size.
4. ~~Species A should produce a small number of large-sized offspring; B should produce a large number of small-sized offspring and C should breed earlier in life with a small clutch size.~~



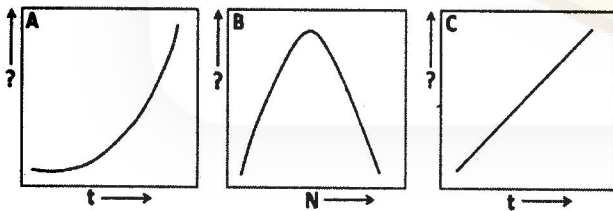
124. Fish species X and Y feed on mayfly nymphs in their stream habitat. In a laboratory experiment, the predation intensity of X and Y on their prey was tested under dark (D) and light (L) conditions. Thus, the experimental protocol included four aquaria - LX, LY, DX and DY. In each aquarium containing 100 mayfly nymphs, one fish was introduced and allowed to feed for 30 minutes. Then the fish was removed and the number of mayfly nymphs left uneaten in each aquarium was counted. The results are shown graphically below



The most significant conclusion from the results is:

- 1. X is a visual predator, but has less predation impact on the prey than Y.
- 2. X is a visual predator and has greater predation impact on the prey than Y.
- 3. Y is a visual predator and has greater predation impact on the prey than X.
- 4. Y is a visual predator but has less predation impact on the prey than X.

125. The three graphs (A, B, C) show population growth (N) patterns in relation to N or time (t).



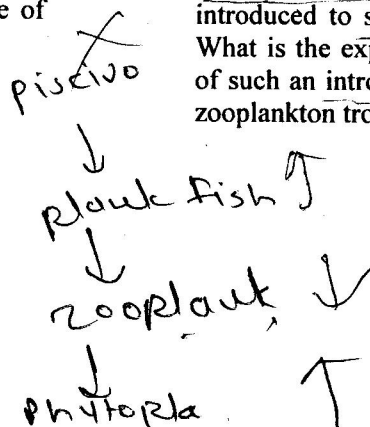
Which of the following is correct with reference to the Y-axis label and the type of population growth?

- 1. A: Y-axis: N, exponential growth  
B: Y-axis:  $dN/dt$ , logistic growth  
C: Y-axis:  $\ln(N)$ , exponential growth
- 2. A: Y-axis:  $dN/dt$ , exponential growth  
B: Y-axis:  $\ln(N)$ , logistic growth  
C: Y-axis: N, exponential growth
- 3. A: Y-axis:  $\ln(N)$ , exponential growth  
B: Y-axis:  $dN/dt$ , logistic growth  
C: Y-axis: N, exponential growth
- 4. A: Y-axis:  $dN/dt$ , exponential growth  
B: Y-axis:  $\ln(N)$ , logistic growth  
C: Y-axis: N, exponential growth

126. Which of the following set of observations is true with reference to a comparison of aquatic (A) and terrestrial (T) ecosystems?

- 1. Number of trophic levels is more in A than in T.  
Productivity/Biomass ratio is higher in T than in A.  
Herbivore assimilation efficiency is higher in A than in T.
- 2. Number of trophic levels is more in T than in A.  
Productivity/Biomass ratio is greater in A than in T.  
Herbivore assimilation efficiency is higher in T than in A.
- 3. Number of trophic levels is more in T than in A.  
Productivity/Biomass ratio is higher in T than in A.  
Herbivore assimilation efficiency is higher in T than in A.
- 4. Number of trophic levels is more in A than in T.  
Productivity/Biomass ratio is greater in A than in T.  
Herbivore assimilation efficiency is higher in A than in T.

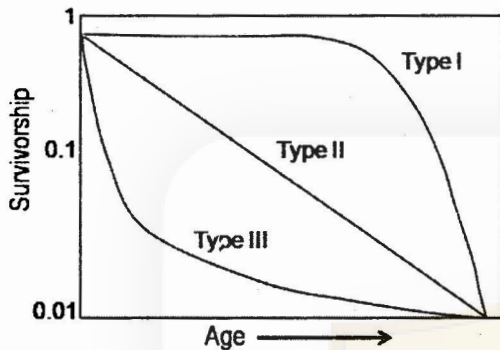
127. A small lake has three trophic levels – phytoplankton (autotrophs), Zooplankton (herbivore) and planktivorous fish (primary carnivore). Into this lake, a population of piscivorous fish (secondary carnivore) was introduced to study the 'top-down' effects". What is the expected long-term consequence of such an introduction to phytoplankton and zooplankton trophic levels?





- Zooplankton biomass will increase and phytoplankton biomass will decrease.
- Zooplankton biomass will decrease and phytoplankton biomass will increase.
- The biomasses of both zooplankton and phytoplankton will increase.
- The biomasses of both zooplankton and phytoplankton will decrease.

128. Following is the diagram of three idealized survivorship curves of animals.



Find the correct match between the group of animals and the respective survivorship curves.

- Marine pelagic fish and large mammals - III and I, respectively.
- Marine pelagic fish and large mammals - I and II, respectively.
- Some birds and large mammals - I and III, respectively.
- Marine pelagic fish and some birds - I and III, respectively.

129. Following are the characteristics of species that make them more or less prone to extinction:

- |                              |                             |
|------------------------------|-----------------------------|
| Rare - a                     | Common - b                  |
| Good dispersal rate - c      | Poor dispersal rate - d     |
| Low specialization - e       | High specialization - f     |
| High variability - g         | Low variability - h         |
| Low trophic status - i       | High trophic status - j     |
| Long life span - k           | Short life span - l         |
| High reproductive output - m | Low reproductive output - n |

Which of the following is the correct combination of characteristics that makes the species more prone to extinction?

- adfgjn
- acfhikm
- bdegiln
- befhikm

130. Assume that in terms of 'genetic fitness' the 'benefit' of performing an altruistic act to a relative is 500 units and the 'cost' involved is 150 units. Following Hamilton's Rule, the act should be performed if the relative is a
- only brother.
  - nephew or niece.
  - brother or step-sister.
  - only step-sister.

131. The following situations might lead to the evolution of monogyny in birds:

- Male has to assist the female in rearing the offspring.
- Male guards the female against other males trying to mate with her.
- One male may not produce enough sperm required to fertilize all the eggs produced by the female.

Which of the above is/are correct?

- Only A
- Only B
- A and B
- A and C

132. The body weight of adult female of a strain of *Drosophila* is  $1.8 \pm 0.45$  mg (mean  $\pm$  standard deviation). In a laboratory experiment, each of the 3 groups (A, B, C) of this strain was subjected to a different type of selection pressure having influence on the female body weight. After many generations of experimental selection pressure, the body weight changed as follows:

- Group A: Body weight distribution - Normal,  $1.8 \pm 0.08$  mg  
 Group B: Body weight distribution - Bimodal at 1.4 and 2.2 mg  
 Group C: Body weight distribution - Normal,  $2.2 \pm 0.08$  mg

Which of the following correctly gives the types of selection that have occurred in the three groups?

- Group A: Directional; Group B: Stabilizing; Group C: Disruptive
- Group A: Disruptive; Group B: Directional; Group C: Stabilizing
- Group A: Stabilizing; Group B: Disruptive; Group C: Directional
- Group A: Directional; Group B: Disruptive; Group C: Stabilizing

**133.** A few events in the history of life on earth are given below

- A. Radiation of mammals and birds; Flourishing of insects and angiosperms
- B. Primitive plants and fungi colonize land; Diversification of echinoderms.
- C. Seed plants appear; Fishes and Trilobites abundant; earliest amphibians and insects.
- D. Earliest birds and Angiosperms appear; Gymnosperms dominant
- E. Invasion of land by primitive land plants and Arthropods
- F. Mass marine extinctions; Reptiles radiate; Amphibians decline.

Which of the following is a correct match of the above events with the geological period during which they had occurred?

- 1. A: Ordovician; B: Tertiary;  
C: Permian; D: Silurian;  
E: Devonian; F: Jurassic
- 2. A: Permian; B: Devonian;  
C: Silurian; D: Ordovician;  
E: Tertiary; F: Jurassic
- ✓ 3. A: Tertiary; B: Ordovician;  
C: Devonian; D: Jurassic;  
E: Silurian; F: Permian
- 4. A: Permian; B: Devonian;  
C: Jurassic; D: Tertiary;  
E: Silurian; F: Ordovician;

**134.** Four different species concepts are given below:

- A. Species separate based on their use of different ecological niches and their presence in different habitats and environments.
- B. Differences in physical characteristics or molecular characteristics are used to distinguish species.
- C. Species are distinct if they are reproductively isolated.
- D. Phylogenetic trees and analyses of ancestry serve to differentiate species.

Which of the following gives the correct names of the above concepts?

- 1. A: Biological; B: Phylogenetic;  
C: Evolutionary; D: Ecological
- ✓ 2. A: Ecological; B: Phylogenetic;  
C: Biological; D: Evolutionary
- 3. ~~A: Evolutionary; B: Ecological;~~  
C: Biological; D: Phylogenetic
- 4. ~~A: Phylogenetic; B: Evolutionary;~~  
C: Ecological; D: Biological

**135.** Following are certain statements regarding the use of *Agrobacterium* in plant transformation.

- ✓ A. *A. tumefaciens* causes crown gall disease and *A. rhizogenes* causes hairy root disease.
- B. Region A in *Ti* plasmid is responsible for replication.
- C. Region D in *Ti* plasmid is responsible for virulence.
- D. Oncogenic (*onc*) region in T-DNA is responsible for unusual amino acid synthesis.

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

- 1. A and B
- 2. C and D
- 3. A and C
- 4. B and D

**136.** Marker-assisted selection (MAS) defined as selection based on molecular markers should have some important criterion for plant breeding activities. Some statements about these criteria are mentioned below:

- A. Marker should co-segregate with the desired trait of interest.
- B. Marker should not co-segregate with the desired trait of interest.
- C. Marker should be un-linked with the desired trait of interest.
- D. Marker is used for indirect selection of a genetic determinant or determinants of a trait of interest.

Which one of above combinations is correct?

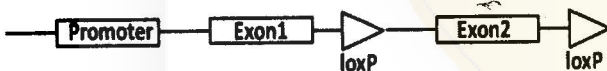
- 1. A and B
- 2. B and C
- 3. C and D
- 4. A and D



137. In order to develop a vaccine against a regulatory T cell-promoting but Th1 suppressing viral infection, four groups (A-D) of mice were primed with either killed virus (A) or a virus-derived immune dominant peptide (B), or the same peptide but with two substitutions (C) or were left unprimed (D). Upon infection challenge, the order of increasing severity of infection was observed to be B>A>D>C. To explain the contrasting effects of these two peptides (B) and (C), their MHC-binding affinities were assessed but no difference was found. Which of the following possibilities most likely to explain their contrasting effects?

1. The wild-type peptide (B) elicits T cell expansion but the mutant peptide (C) fails.
2. The wild-type peptide induces T cell deletion but the mutant peptide does not;
3. The wild-type peptide-MHC complex binds T cell receptor with significantly higher affinity than the mutant peptide-MHC complex.
4. The wild-type peptide induces deletion of T-Reg cells but increases IFN  $\gamma$  production by T cells, whereas the mutant peptide fails to induce these effects.

138. In a transgenic mice line, lox P sites are introduced in the target gene A in the following manner



This transgenic mice line was mated with another transgenic mice line where Cre recombinase is expressed only in B cells. What will be the expression profile of gene A in Cre/lox recombinant mice?

1. Gene will not be expressed in B cells, as orientation of exon 1 will be inverted by Cre.
2. Gene will not be expressed in B cells, as exon 2 will be deleted by Cre.
3. Gene will only be expressed in B cells of the recombinant mice where Cre removes the two lox P sites.

4. Gene will not be expressed in B cells as orientation of exon 2 will be inverted.

139. Cultured animal cells were transfected with expression vector encoding either  $\beta$ -galactosidase ( $\beta$ -gal) alone or expressing a fusion protein of  $\beta$ -gal and glucocorticoid receptor (GR). After transfection, cells were kept in presence or absence of Dexamethasone. Immunofluorescence with a labeled antibody specific for  $\beta$ -gal was used to detect the expressed protein in cytoplasm or nucleus of transfected cells. Possible results of the experiments are:

- A. Expression of  $\beta$ -gal alone in the cytoplasm in both absence or presence of Dexamethasone.
- B. Expression of  $\beta$ -gal-GR in the cytoplasm in the absence of Dexamethasone.
- C. Expression of  $\beta$ -gal alone in the nucleus both in the presence or absence of Dexamethasone.
- D. Expression of  $\beta$ -gal-GR in the nucleus in presence of Dexamethasone.
- E. Expression of  $\beta$ -gal alone in both cytoplasm and nucleus in presence or absence of Dexamethasone.
- F. Expression of  $\beta$ -gal-GR in both cytoplasm and nucleus in presence of Dexamethasone.

Choose the correct combination of results from the following options.

1. B, C and D
2. A, B and D
3. B, D and E
4. A, B and F

140. A small fraction of clear cellular lysate was run on an isoelectric focusing gel (IEF) to purify a particular protein, which showed a number of sharp bands corresponding to different pI values. The protein of interest has a pI of 5.2. Therefore, the band corresponding to pI 5.2 was cut, eluted with appropriate buffer and subjected to SDS-PAGE, which showed 3 distinct bands. Which one of the following inferences CANNOT be drawn from the above observations?



- Several different proteins having same pI may be present at the single band on IEF gel.
- SDS-PAGE showed 3 distinct bands which may represent molecular mass of different proteins.
- The protein of interest may be composed of 3 subunits.
- As the IEF gel showed a distinct band corresponding to pI 5.2, which is the pI of the protein of interest, the protein is composed of a single subunit.

141. In a plaque-forming cell assay, antigen specific B-cell numbers are assessed. In this assay, antigen coated sheep red blood cells (SRBCs) are lysed by the hapten-specific B cells by complement-mediated cytotoxicity. In an assay that tried to enumerate the TNP-specific B-cells elicited in TNP-KLH-primed mice, no plaques were formed despite the presence of antigen-specific antibody producing B cells. Which of the following is **NOT** the reason for the absence of plaques?

- The source of complement has anti-TNP antibody.
- The SRBC were stored for too long.
- The B cells were contaminated with LPS or lectins.
- The complement had anti-KLH antibody.

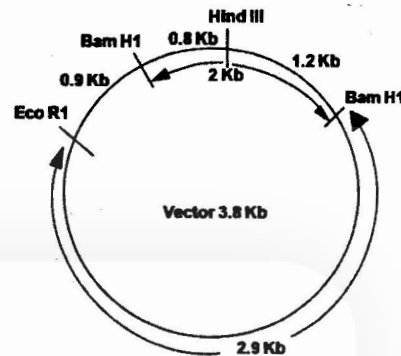
142. Cytochrome-c has only one tryptophan residue (W) which is buried. The protein in cacodylate buffer (pH 6.0) is excited at 280 nm, and its emission spectrum measured in the range of 300-450 nm. The same measurement was repeated on the protein in the buffer containing 6M guanidine hydrochloride. It was observed that there is an increase in the intensity of the emission spectrum of the guanidine hydrochloride treated cytochrome-c. The most probable reason for this increase is:

- W is near a hydrophobic patch present in the unfolded protein.
- W is near the heme in the native protein
- W is near carboxylate amino acid side chains in the native protein.
- W is in a polar pocket in the native protein.

143. The hydrogen atoms in the  $\delta$  (delta) methylene group of lysine will give the following splitting pattern in the  $^1\text{H}$ NMR spectra of lysine.

- Triplet of triplets
- Quintet
- Doublet of triplets
- Triplet of a doublet

144.



The above diagram represents a 2 Kb insert successfully introduced in between two BamHI sites of a 3.8 Kb vector in desired orientation. The HindIII site on the insert and EcoRI site on the vector is also indicated. If the insert was introduced in the **opposite orientation**, which one of the following statements is **INCORRECT**?

- Digestion with EcoRI will linearize the 5.8 Kb plasmid.
- Digestion with BamHI will yield one 3.8 and one 2.0 Kb fragment.
- Double digestion with EcoRI and HindIII will produce 1.7 Kb and 4.1 Kb fragments.
- Double digestion with EcoRI and HindIII will produce 2.1 Kb and 3.7 Kb fragments.

145. Combination of molecular markers with their classification based on either dominant or co-dominant types are shown below:

- SSR and RFLP: co-dominant.
- SSR and RAPD: co-dominant.
- RAPD and RFLP: dominant.
- AFLP and RAPD: dominant.

Which one of the following is the correct combination?

- A and B
- B and C
- C and D
- A and D

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