

**ENTRANCE EXAMINATIONS – 2018**  
**(Ph.D. Admissions - January 2019 Session)**

**Ph.D. Biochemistry**

|                 |  |
|-----------------|--|
| Hall Ticket No. |  |
|-----------------|--|

Time : 2 hours

Max. Marks : 80

Please read the following instructions carefully before answering:

1. Enter Hall Ticket number in the space provided above and also on OMR sheet.
2. Paper contains two sections: Part A and Part B together with 70 questions for 80 marks. **Part A contains 30 questions on research methodology. Questions 1 to 20 carries one mark each and questions 21 to 30 carries two marks each. Part B contains 40 questions on biology. Question number 31 to 70 carries one mark each.**
3. **There is no negative marking in any of the parts.**
4. Answers have to be marked on the OMR sheet as per the instructions provided.
5. Apart from OMR sheet, the question paper contains 15 (Fifteen) pages including the instructions.
6. **Please return the OMR answer sheet at the end of examination.**
7. No additional sheet will be provided.
8. Rough work can be carried out in the question paper itself in the space provided at the end of the booklet.
9. Non programmable calculators are allowed.

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**PART A**

*[Total 40 marks. Questions 1-20 carries 1 mark each and question 21 to 30 carries 2 marks each. There is no negative marking.]*

1. Find the missing of the series: 70, 71, 76, \_\_, 81, 86, 90, 91, ...
  - A. 70
  - B. 71
  - C. 80
  - D. 96
2. Three of the words will be in the same classification, the remaining one will not be. Your answer will be the one word that does NOT belong in the same classification as the others. Which word does NOT belong with the others?
  - A. Book
  - B. Index
  - C. Glossary
  - D. Chapter

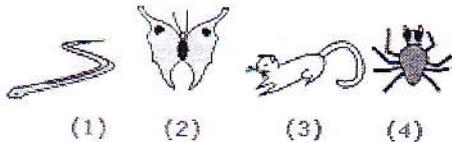
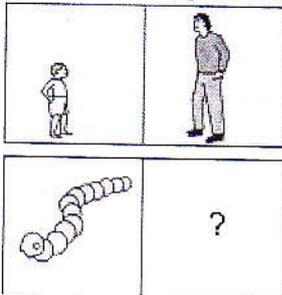
3. Sponge is to porous as rubber is to

- A. Massive
- B. Solid
- C. Elastic
- D. Inflexible

4. Light year is a measurement of

- A. speed of aeroplane
- B. speed of light
- C. Stellar distances
- D. speed of rockets

5. Choose the picture that would go in the empty box so that the two bottom pictures are related in the same way as the top two are related.



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

6. Find the statement that must be true according to the given information.

Krishnan's travel never bothered him because there were always seats available on the train and he was able to spend his 40 minutes comfortably reading the newspaper or catching up on paperwork. Ever since the train schedule changed, the train has been extremely crowded, and by the time the doors open at his station, there isn't a seat to be found.

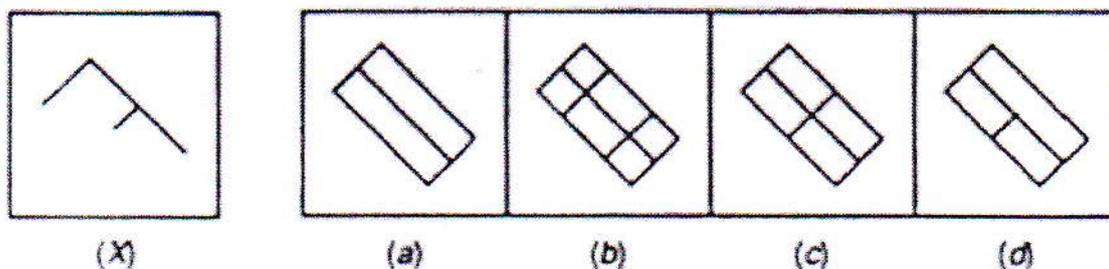
- A. Krishnan would be better off taking the bus to work
- B. Krishnan's travel is less comfortable since the train schedule changed
- C. Many travelers will complain about the new train schedule
- D. Krishnan will likely look for a new job closer to home

7. In a class of 90 students, where girls are twice that of boys, Shridar ranked fourteenth from the top. If there are 10 girls ahead of Shridar, how many boys are after him in rank?

- A. 23
- B. 26
- C. 25
- D. 22

8. If P is coded as +, Q is coded as -, R is coded as  $\times$  and S is coded as  $\div$  then evaluate  $7 P 7 Q 2 R 27 S 3 R 4?$
- A. -58  
B. -56  
C. -48  
D. -38
9. Srikanta walked 25 m towards west, took a left turn and walked 15 m. He again took a left turn and walked 29 m. He then took a left and walked 18 m, what is the shortest distance to his starting point?
- A. 5 m  
B. 4 m  
C. 3 m  
D. 7 m
10. A family consists of six people L, M, N, P, Q and R. R is the son of L but L is not the mother of R. P and L are married couples. N is the brother of L. M is the daughter of P. Q is the brother of P. In what relation M is related to R?
- A. Father  
B. Mother  
C. Sister  
D. Uncle
11. A book worth Rs. 1200 is given two successive discounts of 10% and 10% respectively. What is the percentage of discount which is equivalent to give as single discount?
- A. 20  
B. 19.5  
C. 21  
D. 19
12. If  $\log 27 = 1.431$ , then the value of  $\log 9$  is
- A. 0.754  
B. 0.854  
C. 0.954  
D. 0.654
13. Arrange the words given below in a meaningful sequence.  
1. Presentation. 2. Recommendation. 3. Arrival. 4. Discussion. 5. Introduction.
- A. 5, 3, 4, 1, 2  
B. 3, 5, 4, 2, 1  
C. 3, 5, 1, 4, 2  
D. 5, 3, 1, 2, 4
14. Fill the blank in the middle of the series:  $B_2CD$ , \_\_\_\_\_,  $BCD_4$ ,  $B_5CD$ ,  $BC_6D$
- A.  $B_2C_2D$   
B.  $BC_3D$   
C.  $B_2C_3D$   
D.  $BCD_7$

15. Which of the four options below fits in the embedded option in figure (X)?

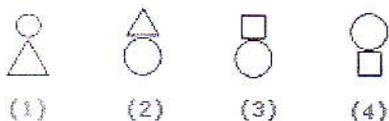


- A. (a)
- B. (b)
- C. (c)
- D. (d)

16. If South-East becomes North, North-East becomes West and so on. What will West become?

- A. North-East
- B. North-West
- C. South-East
- D. South-West

17. Look carefully at the sequence of symbols and select the correct pattern



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

18. If in a certain language, GRASP is coded as BMVNK, Which word would be coded as CRANE?

- A. FUDQH
- B. HWFSJ
- C. GVERI
- D. XMVIZ

19. If each side of a square is increased by 25%, find the percentage change in its area?

- A. 65.25
- B. 56.25
- C. 65
- D. 56

20. Fresh fruit contains 68% water and dry fruit contains 20% water. How much dry fruit can be obtained from 100 kg of fresh fruits?

- A. 20
- B. 30
- C. 40
- D. 50

21. To determine the binding and activation domain of a transcription factor TF that activates the transcription of gene X, various truncations were created and binding of transcription factor was determined through EMSA while report activity assay was performed to determine the region required for activation. Given below are the results of two experiments, on basis of these results, state which of the statement is correct.

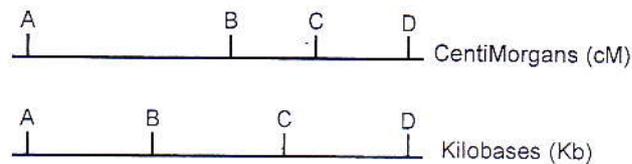
| Truncation                       | Binding to UAS <sub>x</sub> | β galactosidase activity |
|----------------------------------|-----------------------------|--------------------------|
| 1 NH <sub>2</sub> ————— 881 COOH | +                           | +++                      |
| 50 ————— 881                     | -                           | -                        |
| ————— 848                        | +                           | +++                      |
| ————— 792                        | +                           | ++                       |
| ————— 692                        | +                           | -                        |
| 74                               | +                           | -                        |
| 74 ————— 684 ————— 881           | +                           | +++                      |
| 74 ————— 738 ————— 881           | +                           | +++                      |
| 74 ————— 768 ————— 881           | +                           | ++                       |

- A. N- terminal region is essential for binding while C-terminal is required for activation
- B. C- terminal region is essential for binding while N-terminal is required for activation
- C. Only N- terminal is sufficient for both binding and activation
- D. Only C- terminal is sufficient for both binding and activation

22. A mutant of *E. coli* with a heat-sensitive DNA ligase (25°C permissive, 37°C nonpermissive) has been used to show that DNA synthesis is discontinuous. Examination of DNA replication in the presence of - [<sup>3</sup>H]- thymidine in the mutant would demonstrate which of the following?

- A. The accumulation of short segments of unlabeled DNA at 25°C and at 37°C
- B. The accumulation of short segments of unlabeled DNA at 25°C but not at 37°C
- C. The accumulation of short segments of radioactive DNA at 37°C but not at 25°C
- D. The accumulation of short segments of radioactive DNA at 25°C but not at 37°C

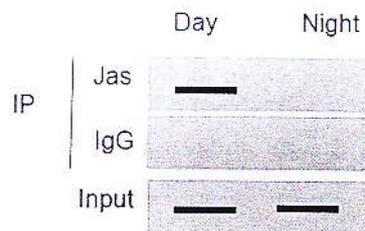
23. The uppermost panel of the accompanying figure shows the locations of four genes on the genetic map of an organism; the lower panel shows the locations of the same four genes on a physical map derived from the nucleotide sequence of the DNA of that organism.



The maps are not identical because

- There is no relationship between the position of genes in a genetic map and their positions on the DNA
- Recombination frequencies per kb of DNA are not uniform throughout a chromosome
- The further apart two genes are, the more likely they are to recombine
- Some genes contain introns

24. In a particular nocturnal plant species, it is observed that the flower produce fragrance for pollination during night and not at day time. The production of the fragrance is known to be under the control of gene *FA* and a transcription factor *JAS*. To get the molecular insight of this temporal production of the fragrance and role of transcription factor in this phenomenon, Chromatin Immunoprecipitation (ChIP) was performed with flower sample collected during day and night time, using anti *Jas* antibody and anti IgG antibody which served as control. Given below is the gel picture of PCR done using primer specific to *FA* promoter from IP DNA of the above mentioned antibodies. On basis of it, state which of statement given below is correct.



- JAS* is likely to act as an activator for fragrance production and is recruited at *FA* promoter during day
- JAS* is likely to act as an activator for fragrance production and is recruited at *FA* promoter during night
- JAS* is likely to act as repressor for fragrance production and is recruited at *FA* promoter during day
- JAS* is likely to act as repressor for fragrance production and is recruited at *FA* promoter during night

25. In cancer cells, a phenomenon known as Warburg effect is observed where cell avoid respiration and switch to aerobic fermentation. A research group was interested to elucidate whether similar effect occurs in yeast. For this, they subjected yeast cell to genotoxic stress and monitored the expression of *ADH* (marker for respiration) and *HXT* (marker for fermentation) through real time PCR.

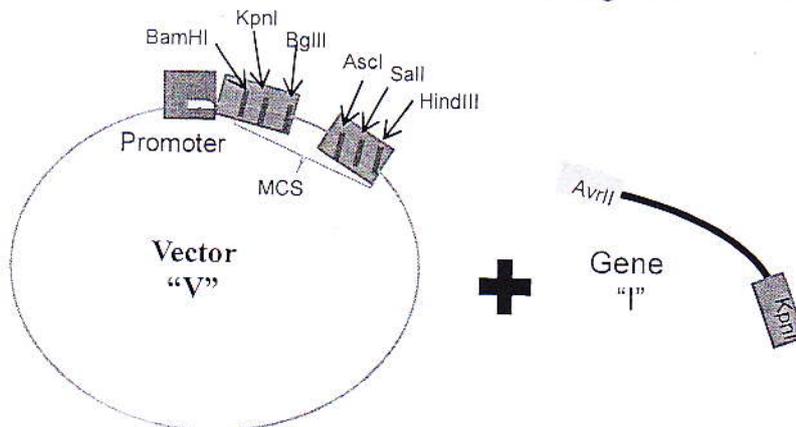
Given below is the Ct value obtained through real time PCR for the above mentioned genes in control and experimental condition.

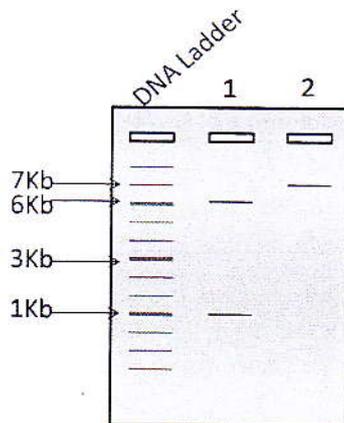
|                   | Control | Under genotoxic Stress |
|-------------------|---------|------------------------|
| <i>ADH</i>        | 16      | 21                     |
| <i>HXT</i>        | 21      | 18                     |
| Housekeeping gene | 18      | 20                     |

On basis of the above value predict which of the following statement is correct?

- Upon genotoxic stress, there is 6 fold down-regulation and 10 fold up-regulation in expression of *ADH* and *HXT* respectively, which in turn leads to shift from respiration to fermentation
- Upon genotoxic stress, there is 6 fold up-regulation and 10 fold down-regulation in expression of *ADH* and *HXT* respectively, which in turn leads to shift from respiration to fermentation
- Upon genotoxic stress, there is 8 fold up-regulation and 32 fold down-regulation in expression of *ADH* and *HXT* respectively, which in turn leads to shift from respiration to fermentation
- Upon genotoxic stress, there is 8 fold down-regulation and 32 fold up-regulation in expression of *ADH* and *HXT* respectively, which in turn leads to shift from respiration to fermentation

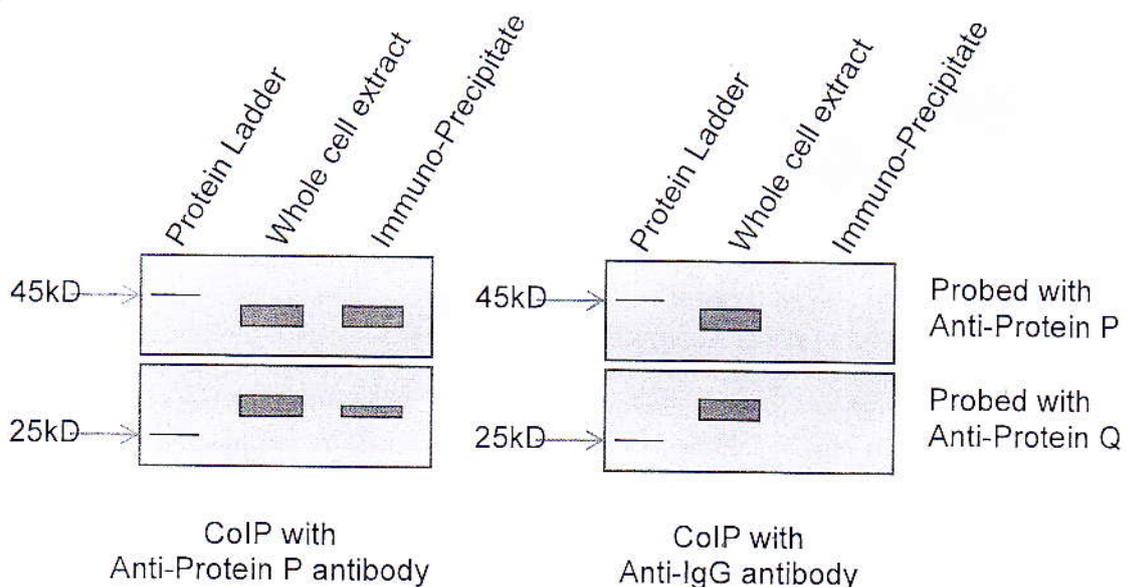
26. Anish need to perform directional cloning of gene "I" (1kb) into vector "V" (6kb) for expression of the gene. As shown in the figure gene "I" has *AvrII* restriction site upstream of start codon and *KpnI* restriction site downstream of stop codon. Multiple cloning site (MCS) of vector "V" contain poly-T tail in between restriction sites as mentioned in the figure. Poly-A tailed gene "I" was ligated with the vector. After ligation he got colonies harbouring two different types of plasmids. When plasmids were digested with *KpnI* restriction enzyme, he observed two type of band pattern on agarose gel. In one of the case upon *KpnI* digestion, he could see two bands in the gel and in other there was single band as shown in the figure. Base on the information provided which of the following statement is correct.





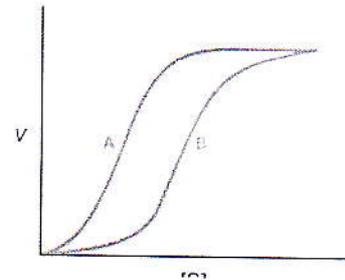
- A. Plasmids which gave two bands of sizes 6kb and 1 kb upon KpnI digestion are in correct orientation
- B. Plasmids which gave single band of size 7kb upon KpnI digestion are in correct orientation
- C. Both of them are in correct orientation
- D. None of them are in correct orientation

27. In a metabolic pathway two proteins P and Q are known to catalyze same reaction. They are also known to co-localize into mitochondria upon cellular stress. A research group hypothesized that protein P and Q interact with each other and function as a complex. To test their hypothesis they performed Co-Immuno precipitation. In order to understand protein interaction *in vivo*, they used whole cell extract (WCE). They added specific monoclonal antibody against protein P to the cellular lysate (WCE) and performed pull down using protein-A agarose bead. Immune precipitate was then eluted and ran on SDS-PAGE followed by western bolting. The blots were probed with anti-protein P and Q antibody and following bands were observed as shown in the figure. Experimental control was also performed. (Molecular weight of protein P is ~42kD and protein Q is ~27kD). Analyze the blots and choose correct statement inferring the result of experiment.



- A. Hypothesis is not correct as protein P and Q does not interact with each other  
 B. Hypothesis is correct as protein Q gets immune precipitated along with protein P  
 C. Co-IP is not a right experimental choice to show protein- protein interaction  
 D. None of the above

28. The dependence of the reaction velocity on the substrate concentration for an allosteric enzyme is shown in the Figure as curve A. A shift to curve B could be caused by the



- A. Addition of an irreversible inhibitor  
 B. Addition of allosteric activator  
 C. Addition of allosteric inhibitor  
 D. Dissociation of the enzyme into subunit

29. The frequency of two alleles for eye colour is 0.19 (b) and 0.81(B). Assuming that the population is in Hardy-Weinberg equilibrium, what is the frequency of heterozygous in the population?

- A. 31%  
 B. 25%  
 C. 50%  
 D. 19%

30. Given below are columns indicating immunization scenarios and the kind of antibody generated depending upon antigenic determinants of the injected antibodies. Find the most appropriate match.

| Immunization scenarios  | Kind of antibody generated depending antigenic determinants of the injected antibodies |
|---|--|
| (i) Anti-DNP antibodies produced in a BALB/c mouse are injected into a C57BL/6 mouse.           | (a) Idiotypic  |
| (ii) Anti-BGG monoclonal antibodies from a BALB/c mouse are injected into another BALB/c mouse. | (b) Isotypic   |
| (iii) Anti-BGG antibodies produced in a BALB/c mouse are injected into a rabbit.                | (c) Allotypic  |

- A. (i) - (b); (ii) - (a); (iii) - (c)  
 B. (i) - (a); (ii) - (b); (iii) - (c)  
 C. (i) - (c); (ii) - (b); (iii) - (a)  
 D. (i) - (c); (ii) - (a); (iii) - (b)

## PART B

[Questions 31-70 carries 1 mark each. Total 40 marks. There is no negative marking.]

31. Immunological cross-reaction may be due to
- Nonspecific antibodies
  - Genetic similarities between species
  - Similar epitopes on antigens
  - Chemical reactions with antigens
32. For the following *E. coli* diploids, indicate whether the strain is inducible or constitutive, or negative for  $\beta$ -galactosidase and permease, respectively?
- Genotype:  $i^- o^+ z^- y^+ / i^- o^c z^+ y^+$
- Negative for  $\beta$ -galactosidase and constitutive for permease
  - Negative for  $\beta$ -galactosidase and inducible for permease
  - Constitutive for both
  - Inducible for both
33. The most common mechanism for a protein recognition of a specific DNA sequence is through
- Insertion of beta sheet in the major groove of DNA
  - Insertion of alpha helix in the major groove of DNA
  - Insertion of beta sheet in the minor groove of DNA
  - Insertion of alpha-helix in the minor groove of DNA
34. The steps of glycolysis between Glyceraldehyde 3- phosphate and 3-phosphoglycerate involve all of the following, except
- ATP synthesis
  - The utilization of  $P_i$
  - Oxidation of NADH to  $NAD^+$
  - Catalysis by phosphoglycerate kinase
35. Which cytochrome has a protoporphyrin IX heme that is not covalently bound to protein?
- Cytochrome a
  - Cytochrome  $a_3$
  - Cytochrome b
  - Cytochrome c
36. How is protein synthesis terminated?
- A release factor recognizes the termination codon and enters the A site
  - A tRNA for the termination codon enter A site
  - A tRNA for the termination codon enter P site
  - The ribosome stalls at the termination codon and catalyzes the release of the protein from the tRNA

37. Which of the following is NOT a function of molecular chaperones in protein folding?
- A. Molecular chaperones assist proteins in finding their correct structure
  - B. Molecular chaperone specify the tertiary structure of a protein
  - C. Molecular chaperone can stabilize partially folded proteins and prevent them from aggregating with other proteins
  - D. Molecular chaperones can shield and protect exposed hydrophobic region of proteins
38. A receptor that binds immunoglobulin (antibody) to a cell surface is called a (n)
- A. Fc receptor
  - B. Complement receptor
  - C. Integrin
  - D. CD molecule
39. Activated macrophages can kill intracellular organisms by producing.
- A. Nitric oxide
  - B. Antibodies
  - C. Interleukins
  - D. Interferons
40. An individual's HLA haplotype is
- A. A chromosome segment
  - B. One allele at each MHC class I locus
  - C. One allele at each MHC class II locus
  - D. The individual's complete set of MHC alleles
41. The major forces linking antigen to antibody are
- A. Hydrogen bonds
  - B. Ionic bonds
  - C. Covalent links
  - D. Hydrophobic bonds
42. The hinge region of an immunoglobulin is flexible because it contains a large amount of which amino acids?
- A. Serine
  - B. Cysteine
  - C. Threonine
  - D. Proline
43. Which of the following molecule have both ionic and covalent bonding present in it?
- A.  $\text{NH}_2\text{CH}_2\text{COOH}$
  - B.  $\text{CH}_3\text{COONa}$
  - C.  $\text{CHCl}_3$
  - D.  $\text{H}_2\text{SO}_4$
44. Which of the following reaction would produce *meso* 2,3-dibromobutane?
- A. Electrophilic addition of HBr to (*E*)-1-bromobut-2-ene
  - B. Electrophilic addition of  $\text{Br}_2$  to (*E*)-2-butene
  - C. Electrophilic addition of  $\text{Br}_2$  to (*Z*)-2-butene
  - D. Nucleophilic addition of  $\text{Br}_2$  to (*Z*)-1-bromobut-2-ene

45. What would be the concentration of a glycine ( $\text{NH}_2\text{CH}_2\text{COOH}$ ) solution that was prepared by adding 560 mg of it into 250 mL water? (Atomic wt of C=12, H=1, N=14, and O=16 amu)
- A. 14.9 mM
  - B. 29.9 mM
  - C. 44.8 mM
  - D. 59.7 mM
46. Which of the following compound can react with  $\text{PCl}_5$  to give  $\text{POCl}_3$ ?
- A.  $\text{O}_2$
  - B.  $\text{CO}_2$
  - C.  $\text{H}_2\text{O}$
  - D. None of the above
47. Gametes that contain chromosomes with different combinations of genetic markers located in the same chromosomes are produced by
- A. Linkage
  - B. Independent assortment
  - C. Crossing over
  - D. Interference
48. Valine transport mutants arise spontaneously in a culture of *E.coli* at a frequency of  $10^{-2}$  per cell. Ampicillin resistant mutants arise spontaneously at a frequency of about  $10^{-3}$  per cell. If these two are independent events, what is the frequency of obtaining *E.coli* bearing both mutations?
- A.  $10^{-2}$
  - B.  $10^{-3}$
  - C.  $10^{-5}$
  - D.  $10^{-1}$
49. Which one of the following is true for bacterial transduction?
- A. Bacteriophages always kill the host cell
  - B. Faulty excision of phage from bacteria leads to incorporation of bacterial DNA into viral genome
  - C. Transcription of the viral DNA is essential for transduction
  - D. Retrotransposons mediate transfer of phage DNA to host and non-host bacteria
50. Which one of the following mutagens is most likely to produce a frame-shift mutation?
- A. Methyl methane sulfonic acid
  - B. Ethyl methane sulfonic acid
  - C. Acridine orange
  - D. UV radiation
51. Which of the following organelles is unlikely to contain ribosomes?
- A. Mitochondria
  - B. Chloroplast
  - C. Smooth endoplasmic reticulum
  - D. Rough endoplasmic reticulum

52. An enzyme has a  $V_{\max}$  of 150 micromoles product formed per minute by 1 mg of enzyme. The  $K_M$  for the major substrate of the enzyme is 1.5 mM. What is the initial reaction rate ( $v_0$ ) when the  $[S]$  is 0.5 mM, 3.0 and 15 mM?
- A. 37.5, 100, 136.4
  - B. 36.5, 100, 125
  - C. 35, 100, 125
  - D. 35.5, 100, 127.5
53. The following statement and reasoning are related to thyroid stimulating hormone (TRH)
- Statement (S):* Elephants rarely get cancer.  
*Reason (R):* Elephants have 20 copies of p53 gene.
- A. Both S and R are correct and R is not a correct explanation to S
  - B. Both S and R are correct and R is the correct explanation to S
  - C. S is correct but R is wrong
  - D. S is wrong but R is correct
54. A motor protein that walks on microtubules towards the minus end is
- A. Kinesin
  - B. Dynein
  - C. Actin
  - D. Microtubule associated protein
55. All of these amino acids can be glycosylated EXCEPT for
- A. Lysine
  - B. Serine
  - C. Arginine
  - D. Asparagine
56. The proteins that form channels between two neighboring cells and connect the cytoplasm of the two cells are
- A. Keratins
  - B. Claudins
  - C. Cadherins
  - D. Connexins
57. Which of the following electron transport chain complex does not contain any mitochondrial DNA encoded proteins?
- A. Complex I
  - B. Complex II
  - C. Complex III
  - D. Complex IV
58. Enzyme- substrate interactions predominately
- A. Ionic
  - B. Hydrophobic
  - C. H-bonds
  - D. All the above

59. The mitochondrial supercomplexes are usually formed with
- Complex III & IV
  - Complex II & IV
  - Complex II & III
  - Complex I & II
60. Human chorionic gonadotropin hormone peaks during first trimester of pregnancy for the following reasons
- To induce estrogen synthesis
  - Diagnose the pregnancy
  - Maintain the pregnancy by controlling progesterone levels
  - Enhance the oxygen supply to the fetus
61. All of these are structure prediction methods except
- Threading
  - Homology modeling
  - Ab-initio prediction
  - Maximum parsimony
62. Given are two columns, Set I and Set II. Find the correct match from the options given below.
- | Set I                  |  | Set II             |  |
|------------------------|--|--------------------|--|
| a) Secondary messenger |  | i) PKA             |  |
| b) Primary effector    |  | ii) G protein      |  |
| c) Transducer          |  | iii) Epinephrine   |  |
| d) Secondary effector  |  | iv) Adenyl cyclase |  |
|                        |  | v) cAMP            |  |
- a)-v      b)-i      c)-ii      d)-iv
  - a)-iv      b)-v      c)-i      d)-ii
  - a)-v      b)-iv      c)-ii      d)-i
  - a)-ii      b)-iv      c)-iii      d)-i
63. Full form of PSI BLAST is
- Position specific iterative basic local alignment search tool
  - Position specific iterative blasted local alignment search tool
  - Point specific iterative basic local alignment search tool
  - Point specific iterative blasted local alignment search tool
64. E-values in BLAST sequence alignment tool most closely denote
- Significance of sequence alignment
  - Sensitivity of sequence alignment
  - Scoring of sequence alignment
  - None of the above
65. Multiple sequence alignments are most commonly used to
- Perform sequence database search
  - Find matching sequences
  - Find conserved regions or domains in a protein family
  - Align sequences

66. In a gene regulatory network, nodes and edges refer to
- A. Circles and lines, respectively
  - B. Genes/gene products and their interactions, respectively
  - C. Coding genes and non-coding genes, respectively
  - D. Genes and proteins, respectively
67. p-values in differential expression analyses are
- A. Probability values to reject or accept null hypothesis
  - B. Probability values
  - C. q-values
  - D. None of the above
68. Why is the peptide bond planar?
- A. Bulky side chain prevent the free rotation around the bond
  - B. It exhibits partial double bond character, preventing rotation
  - C. Hydrogen bonding between NH and C=O groups limits the movement
  - D. None of the above
69. A weak acid, HA having pH 4.7, dissociates exactly half of its original concentration, what will be the pKa of the weak acid?
- A. 5.7
  - B. 4.9
  - C. 2.35
  - D. 4.7
70. If the absorption of electromagnetic radiation by matter results in the emission of radiation of same or longer wavelengths for a short time, the phenomenon is termed as
- A. Luminescence
  - B. Fluorescence
  - C. Phosphorescence
  - D. Spontaneous emission

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ROUGH WORK