

ENTRANCE EXAMINATIONS – 2019
(Ph.D. Admissions - January 2020 Session)

Ph.D. Biochemistry

Hall Ticket No.	
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Time: 2 h

Code No – V-67 (PhD – Biochemistry)

Max Marks: 70

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 60 questions for 70 marks. **Part A contains 25 questions on research methodology. Questions 1 to 15 carries one mark each and questions 16 to 25 carries two marks each. Part B contains 35 questions on subject. Question number 26 to 60 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 13 (Thirteen) 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.

PART A

[Total 35 marks. Questions 1-15 carries 1 mark each and question 16 to 25 carries 2 marks each. There is no negative marking.]

1. Jobin and Jadu standing in the opposite sides of a tower of 100 m are watching Jobin's brother sitting on the top of the tower. For Jobin the tower's top makes an angle of elevation of 30° and for Jadu 45° . How far Jadu and Jobin are standing apart?
A. 300 m
B. 200 m
C. 173 m
D. 273 m
2. In the microbiology paper, Taniya has scored 7 marks more than Ganiya. Taniya's mark was 52% of the sum of their marks. What marks they scored?
A. 45, 52
B. 80, 87
C. 84, 91
D. 48, 55

3. Three years ago the average age of a person, his wife and son was 27. Five years ago, the average age of his wife and son was 20. The present age of his son is one fourth of his age. What is the present age of his wife?

- A. 40 years
- B. 35 years
- C. 50 years
- D. 45 years

4. What would be the value of the given fraction?

$$\frac{241 \times 241 + 259 \times 259 - 241 \times 259}{241 \times 241 \times 241 + 259 \times 259 \times 259}$$

- A. $\frac{18}{500}$
- B. $\frac{1}{500}$
- C. $\frac{2041}{2059}$
- D. $\frac{2401}{2509}$

5. Assuming that the number 7*2 is divisible by 6, what would be the digit * in the number 7*2?

- A. 7
- B. 5
- C. 2
- D. 0

6. What would be the value of sum of 51+52+53+.....+99+100=?

- A. 3775
- B. 3575
- C. 3755
- D. 3735

7. What would be the lowest common multiple of 24, 36 and 40

- A. 480
- B. 360
- C. 240
- D. 120

8. Fill the missing in the series

DEF, DEF₂, DE₂F₂, _____, D₂E₂F₃

- A. D₃EF₃
- B. DEF₃
- C. D₂E₂F₂
- D. D₂E₃F

9. Select the correct answer which is closely resembles the water-image of the given combination.

NUCLEAR

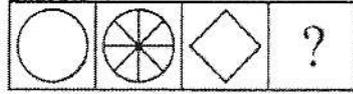
- (1) RAEΓCUII
- (3) IUCLRAV

- (2) IUCLRAV
- (4) IUCLRAV

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

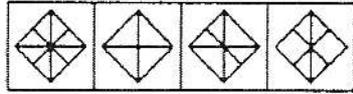
10. Which one of the answer figure would be the correct match with the question mark (?)?

Problem Figures:



(A) (B) (C) (D)

Answer Figures:

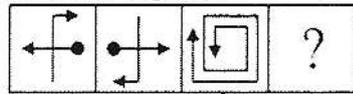


(1) (2) (3) (4)

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

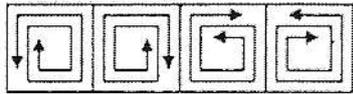
11. Identify the answer figure of the right side that would be the correct match with the question mark (?)?

Problem Figures:



(A) (B) (C) (D)

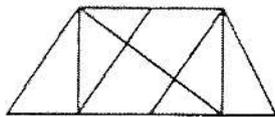
Answer Figures:



(1) (2) (3) (4)

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

12. Find out the number of triangles in the figure given below

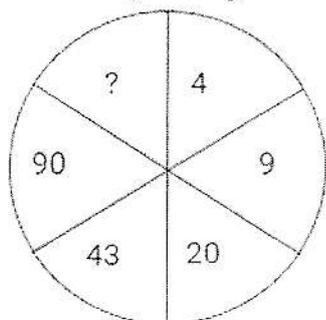


- A. 10
- B. 12
- C. 14
- D. 16

13. Six sides of a dice are numbered using the numbers 1 to 6, in such a way that 1 is adjacent to 2, 3 and 5. Predict which of the following statements is necessarily true about the numbers of different sides of the dice?

- A. 1 is adjacent to 4
- B. 2 is adjacent to 5
- C. 1 is adjacent to 6
- D. 4 is adjacent to 4

14. In the given figure below, find out the missing number.



- A. 145
- B. 185
- C. 127
- D. 239

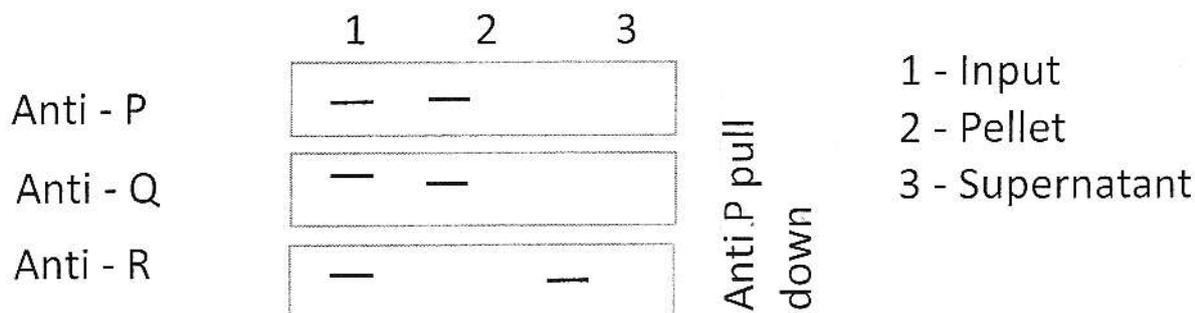
15. In a box there are 50 paise, two rupees and five rupees coins present in the ratio of 4:2:1. If the total amount of money present in the box is Rs 154, then how many 50 paise coins are there in the box?

- A. 56
- B. 28
- C. 44
- D. 77

16. An enzyme following Michaelis–Menten kinetics had a K_m of 6mM and V_{max} 25 μ mol/min for a reaction without inhibitor. When an inhibitor was used, it was observed that K_m was 6 mM and V_{max} was 20 μ mol/min. Given that concentration of inhibitor used is 10mM, what will be the K_i for this inhibitor?

- A. 10 mM
- B. 20 mM
- C. 40 mM
- D. 60 mM

17. In an organism it was observed that knock out of either of three gene P, Q and R lead complete inhibition of its DNA repair machinery. To get the molecular insights of the mechanism whether these proteins interact and function as a complex yeast two hybrid and Co-immunoprecipitation were performed. Yeast two hybrid analysis confirmed the interaction of P and Q, Q and R and also P and R. Given below is the blot picture, the readout of Co-



immunoprecipitation

Based on the above results the following statements were made:

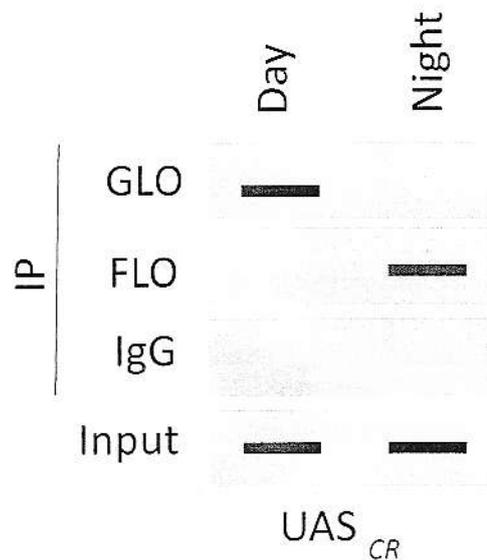
- 1) All three proteins P, Q and R do not form a complex.
- 2) Protein P, Q are in same sub-cellular compartment but R is not.
- 3) Protein P and Q interact strongly while there could be transient interaction of P and R.
- 4) Protein P and R interact strongly while there could be transient interaction of P and Q.

State which of the following combination of statements is correct

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

18. In a particular plant species, it is observed that the plant has crimson coloured flowers during the day time while white coloured flowers during night. The colour of the flower depends upon the production of pigment *crim*, known to be under the control of gene *CR* and transcription factors *GLO* and *FLO*. It is also observed that the pigment *crim* and the protein *Cr* are short-lived. To get the molecular insight of this temporal production of the pigment and the role of transcription factor in this phenomenon, Chromatin Immunoprecipitation (ChIP) was performed with flower sample collected during day and night time, using anti *GLO*, anti *FLO* antibody and IgG antibody which served as control.

Given below is the gel picture of PCR done using primer specific to *CR* promoter from IP DNA of above mentioned antibodies. On basis of it, state which of statement given below is correct.



- A. *FLO* likely act as activator for pigment production and is recruited at *CR* promoter during day.
- B. *GLO* likely act as activator for pigment production and is recruited at *CR* promoter during night.

C. FLO likely act as repressor for pigment production and is recruited at *CR* promoter during day.

D. GLO likely act as activator for pigment production and is recruited at *CR* promoter during day.

19. Given below are two columns, column A detailing the immunization scenarios, column B indicating whether anti-immunoglobulin antibodies would be formed to isotypic, allotypic, or idiotypic determinants.

Column A	Column B
i. Anti-DNP antibodies produced in a BALB/c mouse are injected into a C57BL/6 mouse	a. isotypic
ii. Anti-DNP antibodies produced in a BALB/c mouse are injected into a goat	b. allotypic
iii. Anti-BGG antibodies produced in a BALB/c mouse are injected into a rabbit	c. idiotypic
iv. Anti-BGG monoclonal antibodies from a BALB/c mouse are injected into another BALB/c mouse	

Select the option that represents the correct match of column A to column B.

- A. i-a; ii-b; iii-c; iv-c
 B. i-b; ii-a, iii-a; iv-c
 C. i-c; ii-b; iii-b; iv-b
 D. i-c; ii-c; iii-a; iv-b

20. A weak acid, HA, has a total concentration of 0.20M and is ionized (dissociated) to 2%;

The pH and K_a for this acidic solution are

- A. 2.00 and 7.16×10^{-5} M
 B. 2.39 and 8.16×10^{-5} M
 C. 3.10 and 8.01×10^{-5} M
 D. 3.39 and 6.80×10^{-4} M

21. You wish to determine the concentration of haemoglobin in a blood sample by spectrophotometry. You first create a standard curve of the absorbance at 412 nm of several solutions of known haemoglobin concentrations. The data for the standard curve is shown below. What is the concentration (in $\mu\text{g/mL}$) of haemoglobin in your sample if the absorbance obtained at 412 nm was 0.303? (Using line regression equation, $y = mx + 0.0246$)

Absorbance (412nm)	Concentration of standard solution ($\mu\text{g/ml}$)
0.069	1
0.113	2
0.201	4
0.377	8
<u>0.730</u>	<u>16</u>

- A. 6.31 $\mu\text{g/ml}$
 B. 6.00 $\mu\text{g/ml}$
 C. 6.80 $\mu\text{g/ml}$

D. 5.90 $\mu\text{g/ml}$

22. Which one of the following statements is **FALSE**?

- A. In *Drosophila*, sex chromosome dosage compensation is achieved by increased transcription of the male X chromosome
- B. In humans, individuals with XO chromosome will develop into phenotypically female
- C. In *Drosophila*, XXY carrying flies will develop as males
- D. In human cell lines with XXY chromosomes, there will be one barr body formed.

23. In hamsters, brown coat colour (BW) is dominant over beige coat colour (bw). When hamsters with brown coat colour were mated with ones with beige coat colour, in the F1 generation they produced 9 brown and 8 beige coloured offsprings. Then the brown coat coloured hamster was mated with its brown coat coloured parent. The parent genotype and the progeny phenotype are likely to be

- A. BwBW and bwbw and 1:1
- B. Bwbw and bwbw and 3:1
- C. Bwbw and Bwbw and 1:1
- D. BwBW and bwbw and 3:1

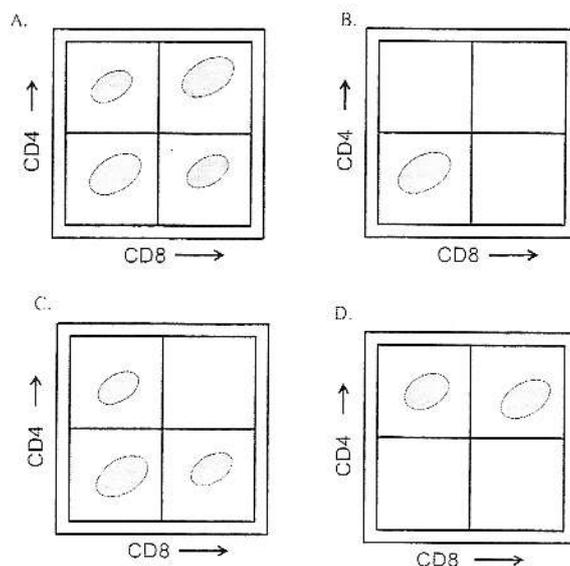
24. Given below are columns with proteases belonging to different classes and their mechanism of action.

Proteases	Mechanism of action
i. Renin	a. cysteine residue, activated by a histidine residue, plays the role of the nucleophile that attacks the peptide bond
ii. Papain	b. peptide bond is attacked by a serine residue that acts as a powerful nucleophile
iii. Chymotrypsin	c. a pair of aspartic acid residues that act together to allow a water molecule to attack the peptide bond.
iv. Thermolysin	d. a metal activated water molecule is involved in peptide bond cleavage

Select the option that represents the correct match of the proteases to their mechanism of action.

- A. i-c; ii-a; iii-b; d-iv
- B. i-a; ii-b; iii-c; d-iv
- C. i-d; ii-c; iii-b; d-a
- D. i-b; ii-a; iii-c; d-iv

25. Which of the following FACS plots represents anti-CD4 and anti-CD8 stained lymph-node cells from normal mice? Select the most appropriate answer.



PART B

[Total 35 marks. Questions 26-60 carries 1 mark each. There is no negative marking.]

26. Exonuclease III cuts
 - A. 3' end of Single stranded DNA
 - B. 3' end of Double stranded DNA
 - C. RNA from its 5' end
 - D. Intron sequences in eukaryotic tRNA
27. What would be the average DNA size that can be cloned in a cosmid vector?
 - A. 4000 bp
 - B. 20000 bp
 - C. 40000 bp
 - D. 75000 bp
28. What enzyme *LEU2* gene codes for?
 - A. β -isopropylmalate dehydrogenase
 - B. α -aminoadipate reductase
 - C. N-(5'-phosphoribosyl)-anthranilate isomerase
 - D. Imidazole glycerophosphate dehydrogenase
29. Lambda phage Q gene is important
 - A. Early in infection to promote lysogeny
 - B. To promote the expression of N-protein, an anti-terminator
 - C. To promote proteolytic cleavage of CI repressor
 - D. In the synthesis of head and tail proteins and to promote lytic infection
30. Sigma 54 protein in *E. coli* binds to core RNA polymerase to direct the synthesis of RNAs involved in
 - A. Nitrogen starvation

- B. Heat shock proteins
 - C. Flagellar synthesis
 - D. Cytochrome biogenesis and cell wall metabolism
31. The phenomena in which some cells evoke a specific developmental response in other cells is called
- A. Embryonic influence
 - B. Embryonic induction
 - C. Embryonic stimulation
 - D. Embryonic dominance
32. Many cells in the body divide only rarely, if at all; neurons, red blood cells, and keratinocytes are extreme examples. In which portion of the cell cycle would such cells be considered to be?
- A. G1
 - B. G2
 - C. G0
 - D. M
33. Kinesin motors move on
- A. Actin filaments
 - B. Microtubules
 - C. Neurofilaments
 - D. Myosin filaments
34. Superfamily of membrane transporter that actively transports variety of small molecules like sugars, peptides, amino acids is
- A. Antiporter
 - B. P-type pump
 - C. ABC transporter
 - D. Uniporter
35. Which of the following is NOT used to find distant relatives that do not match PROSITE patterns?
- A. BLASTp
 - B. PSI-BLAST
 - C. PHI-BLAST
 - D. None of the above
36. Which of the following is a database and a tool, respectively:
- A. NCBI and EBI
 - B. NCBI and PROSITE
 - C. EBI and T-COFFEE
 - D. EBI and GEO
37. Which of the following does not happen during glycolysis?
- A. Per glucose molecule converted to pyruvate four ATP are formed
 - B. Formation of glucose in cytosol is called substrate level phosphorylation
 - C. Kinase enzyme is involved in formation of ATP
 - D. One GTP is also formed

38. Find the reason behind compartmentalization of enzymes in mitochondria and cytosol during urea cycle
- A. To prevent reductive amination of α -ketoglutarate in the mitochondria
 - B. No specific reason
 - C. Urea is formed in the mitochondria only
 - D. Metabolites cannot pass through the mitochondrial membrane
39. Which of the following enzyme does NOT contain bound pyridoxal phosphate
- A. Threonine synthase
 - B. Pyruvate dehydrogenase
 - C. Alanine transaminase
 - D. Tryptophan synthase
40. Which of the following is not associated with biological nitrogen fixation
- A. Occurs in cyanobacteria
 - B. Requires ATP
 - C. NADH, Ferridoxin, and Nitrogenase enzyme complex
 - D. NADPH and Nitrogenase enzyme complex
41. Enzyme multiplicity is a mode of regulation of amino acid biosynthesis. Which of the following is correct example
- A. Shikimic acid synthase
 - B. Chorismic acid mutase and Aldolase
 - C. Lactate dehydrogenase
 - D. Chroismic acid mutase
42. What is the difference in Proton motive force generated across mitochondrial inner membrane and thylakoid membrane of chloroplast?
- A. In mitochondria, electric gradient contribution is more than proton gradient in generation of proton motive force while in chloroplast proton gradient contributes more proton motive force than electric gradient.
 - B. In mitochondria, proton gradient contributes more towards generation of proton motive force than electric gradient while in chloroplast electric gradient contributes more proton motive force than proton gradient.
 - C. In mitochondria, both proton and electric gradient equally contributes to the generation of proton motive force while in chloroplast electric gradient contributes more proton motive force than proton gradient.
 - D. In mitochondria, electric gradient contributes more proton motive force than proton gradient, while in chloroplast both proton and electric gradient equally contributes to the generation of proton motive force.
43. Cardiolipin is enriched in
- A. Vacuolar membrane
 - B. Mitochondrial membrane
 - C. Plasma membrane
 - D. Endoplasmic reticulum
44. Introns are present in the following mitochondrial DNA
- A. Human
 - B. Mouse

- C. Yeast
- D. Rat

45. What is the applied centrifugal field at a point equivalent to 5 cm from the centre of rotation and an angular velocity of 3000 rad s^{-1} ?

- A. $4.5 \times 10^{-7} \text{ cm s}^{-2}$
- B. $5.4 \times 10^{-7} \text{ cm s}^{-2}$
- C. $3.4 \times 10^{-7} \text{ cm s}^{-2}$
- D. $6.5 \times 10^{-7} \text{ cm s}^{-2}$

46. Among the listed amino acids, which one is not an intrinsic fluorophore of protein/ peptide?

- A. Valine
- B. Tyrosine
- C. Tryptophan
- D. Phenylalanine

47. Compound Z absorbs light of wavelength 410 nm. A $1.0 \times 10^{-3} \text{ mol dm}^{-3}$ solution of a compound Z gives an absorbance reading of 0.15 when placed in a solution cell of path length 1 cm. What is the value of the molar extinction (absorption) coefficient of Z?

- A. $1.5 \times 10^{-4} \text{ mol dm}^{-3} \text{ cm}^{-1}$
- B. $15 \text{ dm}^3 \text{ mol}^{-1} \text{ cm}^{-1}$
- C. $150 \text{ dm}^3 \text{ mol}^{-1} \text{ cm}^{-1}$
- D. $1500 \text{ dm}^3 \text{ mol}^{-1} \text{ cm}^{-1}$

48. NMR spectroscopy is based on

- A. Nuclear fission reaction
- B. Changes in the charge of nucleus
- C. Magnetic moment of the nucleus
- D. Electrical moment of the nucleus

49. A tetrapeptide has four pKa values and a pI of 3.5. How many amino acids in the peptide have an ionizable R-group?

- A. One
- B. Two
- C. Three
- D. Four

50. A peptide has the sequence Lys-Arg-Gln-Asp-Cys (lysine-arginine-glutamine-aspartate-cysteine). Which describes the peptide bonds in this peptide?

- A. All the peptide bonds are covalent amide bonds with tetrahedral geometry.
- B. All the peptide bonds have free rotation around the carbon-nitrogen bond.
- C. All the peptide bonds can be deprotonated when titrated with NaOH.
- D. All the peptide bonds have partial double-bond character and trans configuration.

51. Which of the following information is responsible to specify the three-dimensional shape of a protein?

- A. The protein's peptide bond
- B. The protein's amino acid sequence
- C. The protein's interaction with other polypeptides
- D. The protein's interaction with molecular chaperons

52. Which of the following is the basis of first dimension of separation for two-dimensional electrophoresis?

- A. Molecular weight
- B. Solubility
- C. Isoelectric point
- D. Folding

53. Which of the following is an example of tertiary structure in a protein?

- A. A multimeric protein
- B. A α -helix
- C. A β -pleated sheet
- D. A β -turn

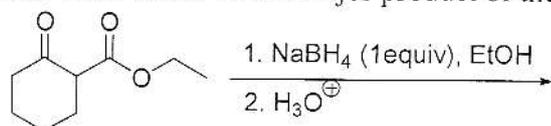
54. The compound 1,1,1-trichlorobutane is treated with aqueous potassium hydroxide. What major product it would form?

- A. 1-Butanol
- B. 2-Butanol
- C. Butanoic acid
- D. Butyne

55. Which one of the following organic acid is present in rancid butter?

- A. Acetic acid
- B. Formic acid
- C. Lactic acid
- D. Butyric acid

56. What would be the major product of the following reaction?



- A.
- B.
- C.
- D.

57. In a Michaelis-Menton plot of enzyme activity (reaction rate vs substrate concentration), the reason that the curve reaches a plateau, and does not increase any further upon adding more substrate is that
- A. All substrate has been converted to product
 - B. The active site is saturated with substrate
 - C. The substrate is inducing inhibition on the enzyme
 - D. There is a competitive inhibitor present
58. Enzymes can decrease the activation energy by bringing reacting species close together in an appropriate orientation. The reacting species in an enzymatic reaction
- A. Behaves like an intramolecular reaction rather than inter-molecular
 - B. Increases their entropy and causing the formation of an early transition state
 - C. Decreases their entropy and causing the increase in the activation energy
 - D. Behaves like inter-molecular rather than intra-molecular
59. Which of the following is correct in the case of positive cooperativity of allosteric enzymes?
- A. The fraction of T states exceeds that of the R state and the binding of ligand increases the amount of R state, thus increases the ease of ligand binding
 - B. The fraction of T states lower that of the R state and the binding of ligand increases the amount of R state, thus increases the ease of ligand binding
 - C. The fraction of R state exceeds that of the T state and the binding of ligand increases the amount of R state, thus increases the ease of ligand binding
 - D. The fraction of R state lower that of the T state and the binding of ligand increases the amount of T state, thus increases the ease of ligand binding
60. Most of the metabolic enzymes operate *in vivo*
- A. Below saturation
 - B. Below K_m
 - C. Below K_{cat}
 - D. Below saturation and below K_m

ROUGH WORK