

J-58

Hall Ticket No

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PhD. Entrance Examination, February 2015,

Time: 2 hrs

Code No – J-58 (PhD – Biochemistry)

Max Marks: 75

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 75 marks. Part A contains 45 questions, each question carries one mark. Part B contains 15 questions, each question carries two marks.
3. In Part A, there is negative marking. 0.33 marks will be deducted for each wrong answer. In Part B, there is negative marking. 0.66 marks will be deducted for each wrong answer.
4. Answers have to be marked on the OMR sheet as per the instructions provided.
5. Apart from OMR sheet, the question paper contains 14 (Fourteen) 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

*[Each question has only one right answer. Mark the right answer. Each question carries one mark. There is negative marking. 0.33 marks will be deducted for each wrong answer]*

1. If genetic code consisted of four bases per codon, rather than three, the maximum number of unique amino acids that could be encoded would be
  - A) 64
  - B) 128
  - C) 256
  - D) 512
2. You are conducting an experiment and found that the mean of 13 observations is 14. If the mean of the first 7 observations is 12 and that of the last 7 observations is 16, then the 7<sup>th</sup> observation is

- A) 12
- B) 14
- C) 16
- D) 18

3. There is degeneracy in the genetic code, where a particular amino-acid could be encoded by one or more codons. For example, the amino acid Leu is encoded by six codons, whereas Met is encoded by only 1 codon. In a pool of tri-peptides synthesized from a random pool of 9 nucleotide long RNA templates, what is the probability of finding Leu-Leu-Met?

- A)  $6^2/64^3$
- B)  $6^3/64^3$
- C)  $1/64^3$
- D)  $1/20^3$

4. In a synthesis of tri-nucleotides, A and C are mixed in 1:4 ratio in the presence of polynucleotide phosphorylase. What would be the percentage of CCA synthesis in this reaction?

- A) 0.8%
- B) 12.8 %
- C) 20%
- D) 60%

5. The E-value in a BLASTn search is:

- A) A measure of sequence homology
- B) A measure to assess statistical significance of a homology search hit.
- C) Used to establish sequence alignment score
- D) None of the above.

6. Protein structure prediction method for homologous proteins with 62% sequence identity is:

- A) Threading
- B) Homology modelling
- C) Ab-initio prediction
- D) None of the above

7. Which of the following best predicts the direction of a chemical reaction?

- A)  $\Delta S$  (entropy change)
- B)  $\Delta H$  (enthalpy change)

- C)  $\Delta E$  (internal energy change)  
D)  $\Delta G$  (Gibbs free energy change)

8. The ion product for liquid water,  $K_w$ , varies with temperature (T) as indicated by the change in  $pK_w$  shown in the accompanying table. The definition of neutrality is  $[H^+] = [OH^-]$ .

T ( $^{\circ}C$ )	$pK_w$
0	14.94
25	14.00
50	13.28
75	12.71

Which of the following is the pH of water at neutrality at  $50^{\circ}C$ ?

- A) 6.35  
B) 6.64  
C) 7.0  
D) 7.4

9. The nucleoside adenosine exists in a protonated form with a  $pK_a$  of 3.8. The percentage of the protonated form at pH 4.8 is closest to

- A) 1  
B) 9  
C) 50  
D) 91

10. The reversible reaction in which dihydroxyacetone phosphate and glyceraldehydes 3-phosphate combine to form fructose 1, 6 biphosphate is best characterized as

- A) An aldol condensation  
B) A Grignard reaction  
C) A free radical reaction  
D) A Hydrolytic reaction

11. Which of the following represents the most reduced form of carbon?

- A)  $R-CH_3$   
B)  $R-COOH$   
C)  $R-CHO$   
D)  $R-CH_2OH$

12. For single crossover, the frequency of recombinant gametes is half the frequency of crossing-over because

- A) a test cross between homozygote and heterozygote produces  $\frac{1}{2}$  heterozygous and  $\frac{1}{2}$  homozygote progeny.
- B) the frequency of recombination is always 50%.
- C) each crossover takes place between only two of the four chromatids of a homozygous pair.
- D) crossovers occur in about 50% of meioses.

13. While analyzing the result of a three-point testcross, a student determines that the interference is -0.23. What does the negative interference value indicate?

- A) Fewer double crossovers took place than expected on the basis of single-crossover frequencies.
- B) More double crossovers took place than expected on the basis of single-crossover frequencies.
- C) Fewer single crossovers took place than expected.
- D) A crossover in one region interferes with additional crossovers in the same region.

14. Conjugation between an  $F^+$  and an  $F^-$  cell usually results in

- A) two  $F^+$  cells.
- B) two  $F^-$  cells.
- C) an  $F^+$  and an  $F^-$  cell.
- D) an Hfr cell and an  $F^+$  cell.

15. In a typical cAMP mediated secondary messenger signaling transduction, which of the following order of events occur in a temporal fashion to amplify the signal.

a. Cellular response, b. cAMP production, c. Protein phosphorylation, d. adenylate cyclase activity

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

16. Which of the following hormone is responsible for sex determination in humans?

- A) Anti-müllerian hormone
- B) Estrogen
- C) Progesterone
- D) cortisol

17. Which of the following statements is NOT true for insulin action in the body?

- A) Insulin signaling opposes gluconeogenesis
- B) Gluconeogenesis is positively regulated by insulin
- C) Insulin signaling enhances glycolysis
- D) Fatty acid breakdown is inhibited by insulin action

18. If succinate is the substrate, how many H<sup>+</sup> ions would have translocated across the inner membrane of mitochondria via the q cycle redox loop mechanism?

- A) 2
- B) 3
- C) 4
- D) 6

19. When radioactive <sup>3</sup>H-NADH is added to a cell extract containing mitochondria, radioactivity quickly appears in the mitochondrial matrix. However, when <sup>14</sup>C-NADH is added to the same cell extract, no radioactivity is found in the mitochondrial matrix. This is because

- A) <sup>14</sup>C-NADH can not pass through the mitochondrial membranes whereas <sup>3</sup>H-NADH can pass through the membranes.
- B) <sup>14</sup>C-NADH has very short half life when compared to <sup>3</sup>H-NADH.
- C) The radioactive <sup>3</sup>H can transport through the membranes via shuttle system whereas <sup>14</sup>C cannot pass through the membrane.
- D) <sup>14</sup>C-NADH is rapidly utilized in the cytosol.

20. During pyrimidine biosynthesis, which of the following amino acid contributes most atoms to the pyrimidine ring?

- A) Aspartic acid
- B) Glutamic acid
- C) Glutamine
- D) Glycine

21. The number of high energy bonds required for synthesis one urea molecule are

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

22. Which of the following enzyme complexes perform similar functions?

- A) Pyruvate dehydrogenase and  $\alpha$ -ketoglutarate dehydrogenase

- B) Phosphofructokinase and fructose 1,6 bisphosphatase
- C) Malate dehydrogenate and lactate dehydrogenase
- D) Pyruvate carboxylase and pyruvate decarboxylase

23. Highly stable coiled coil protein structures result from

- A) handed supercoiled beta sheets
- B) Rigid beta sheets in left hand direction
- C) Right hand supercoiled alpha helices
- E) Left handed supercoiled alpha helices

24. The most common mechanism for a protein recognition of a specific DNA sequence is through

- A) Insertion of beta sheet in the major groove of DNA
- B) Insertion of alpha helix in the major groove of DNA
- C) Insertion of beta sheet in the minor groove of DNA
- D) Insertion of alpha-helix in the minor groove of DNA

25. The disease causing form of Prion ( $\text{PrP}^{\text{Sc}}$ , prion related protein scrapie) protein has a conformation different from  $\text{PrP}^{\text{c}}$  (prion-related protein cellular).  $\text{PrP}^{\text{Sc}}$  has

- A) Globular alpha helical region at the C terminus and a disordered N-terminus
- B) Flat beta sheet-like structure at the C-terminus and disordered N-terminus
- C) Flat beta sheet at C-terminus and alpha helical region at the N-terminus
- D) Flat beta sheet like structure at the N-terminus and alpha helical region at the C-terminus

26. Poly hydroxy proline at pH 7.0 will be a (clue: Stability of alpha helix is determined not only by interpeptide H-bonds but also by the nature of its amino acid side chains).

- A) Alpha helix
- B) Ordered structure
- C) No ordered structure
- D) Beta -sheet

27. In a peptide conformation, the angles of phi and psi designate the extent of rotation about the ---- and ----- bonds respectively

- A)  $\text{N}-\text{C}^{\alpha}$  and  $\text{C}-\text{C}$
- B)  $\text{C}-\text{C}^{\alpha}$  and  $\text{N}-\text{C}^{\alpha}$
- C)  $\text{C}^{\alpha}-\text{C}$  and  $\text{N}-\text{C}^{\alpha}$
- D)  $\text{N}-\text{C}^{\alpha}$  and  $\text{C}^{\alpha}-\text{C}$

28. What could be the possible explanation for the transfer of oxygen from adult hemoglobin to fetal hemoglobin

- A) Fetal hemoglobin has a higher oxygen affinity as it binds efficiently bisphosphoglycerate than adult hemoglobin
- B) Fetal hemoglobin has a higher oxygen affinity as it cannot bind bisphosphoglycerate as efficiently as adult hemoglobin
- C) Adult hemoglobin has a higher oxygen affinity than fetal hemoglobin.
- D) None of the above statements are correct

29. A coenzyme involved in amino acid metabolism

- A) Vitamin B12
- B) Vitamin B2
- C) Vitamin B6
- D) Pantothenic acid

30. Assuming an enzyme behaves according to the Michaelis-Menten equation, what percentage of  $V_{max}$  would be observed at  $10K_M$ ?

- A) 0.9%
- B) 90.9%
- C) 10.1%
- D) 9.1%

31. Which of the following statements is correct with regard to the formation of pre-replication complex and its activation by Cdk (Cyclin dependent kinase)?

- A) High Cdk activity allows Pre-replication complex (pre-RC) formation but does not allow its activation
- B) High Cdk activity allows prereplication complex and activation
- C) High Cdk activity allows formation of prereplication complex but activation of prereplication complex requires low Cdk activity
- D) Low Cdk activity allows pre-replication complex and high Cdk activity activates it.

32. Lambda phage goes into lytic stage when

- A) Increased in CI repressor
- B) Decline in Cro protein
- C) Decreased CI and increased Cro
- D) Increased CI and decline in Cro

33. Human apolipoprotein mRNA encodes 4563 aminoacid protein in liver where as in intestine it produces protein with 2153 aminoacids. The reason for tissue specific expression is

- A) One of the exons is skipped in while processing the mRNA in the intestine
- B) One of the long introns in the 3'end of mRNA is retained due to a splicing defect in liver mRNA
- C) RNA splicing defect lead to an extended exon 1 that contains partly an intron with stop codon in intestine mRNA

D) RNA editing by deamination resulted in a stop codon in the intestine mRNA.

34. Which amino acid is modified in prenylation?

- A) Arginine
- B) Cysteine
- C) Glycine
- D) Tyrosine

35. Exonuclease III attacks preferentially

- A) the 3' end of a linear DNA with 5' protruding ends.
- B) the 5' end of a linear DNA with 3' protruding ends
- C) the 3' blunt end than 5' side
- D) 3' single stranded DNA.

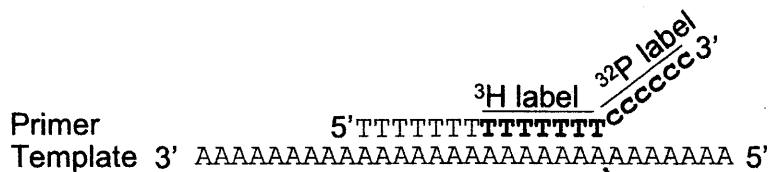
36. The movement of a transposon in yeast occurs by a

- A) Replication mechanism
- B) Cut and paste mechanism
- C) RNA-mediated mechanism
- D) Homologous recombination

37. Best option to obtain the full length mammalian secretory protein

- A) Immunoprecipitation and analysis by protein gel electrophoresis
- B) In vivo labeling using [<sup>35</sup>S] methionine, analysis by protein gel electrophoresis and autoradiography
- C) Cloning the gene with an affinity matrix tag , expression and purification of protein , and analysis by gel electrophoresis
- D) In vitro transcription and translation of the gene in wheat germ cell free lysates

38. A poly A template DNA as shown below is incubated with poly dT primer . The 3' end of the primer was labeled with <sup>3</sup>[H] (bold) and <sup>32</sup>[P] dexoycytidylate. The template- primer complex was then incubated with purified DNA polymerase 1 in the presence and absence of dTTP. What happens to the radioactive labels after 3-4 minutes in the presence of dTTP



- A) <sup>32</sup>[P] and <sup>3</sup>[H] label decrease
- B) No change in <sup>32</sup>[P] and <sup>3</sup>[H] labels



- C)  $^{32}\text{P}$  decreases but not  $^3\text{H}$  label
- D)  $^3\text{H}$  label increases and  $^{32}\text{P}$  label declines

39. A receptor that has an intrinsic kinase activity

- A) G-protein coupled receptors
- B) Acetylcholine receptors
- C) T-cell receptors
- D) Insulin receptor

40. Aldose reductase catalyzes the conversion of glucose to \_\_\_\_\_, thus implicate in the cataract formation.

- A) Galactitol
- B) Sorbitol
- C) Fructose
- D) Mannitol

41. Incidence of Beriberi, a neurological disorder is due to deficiency of which of the following?

- A) Cyanocobalamin
- B) Pyridoxal pyrophosphate
- C) Riboflavin
- D) Thiamine pyrophosphate

42. Cyclo-oxygenase catalyzes the formation of Prostaglandins from which of the following precursor?

- A) Cholesterol
- B) Palmitic acid
- C) Glycerol
- D) Arachidonic acid

43. Which of the complement systems mentioned below triggers histamine release from mast cells?

- A) C3b and C5b
- B) C5b and C6
- C) C3a and C5a
- D) C6, C7 and C8

44. A cytokine that interacts as chemoattractant for immune system cells and phagocytes to site of inflammation?

- A) Interleukin-12
- B) Interleukin-8

- C) Interleukin-2
- D) Interferon gamma

45. MHC –I specific cytotoxic T cells express a group of transmembrane proteins that interact with the T cell receptor is

- A) CD3 complex
- B) CD4 Complex
- C) CD8 Complex
- D) P56 Lck kinase

### PART B

*[Each question has only one right answer. Mark the right answer. Each question carries two marks. There is negative marking. 0.66 marks will be deducted for each wrong answer]*

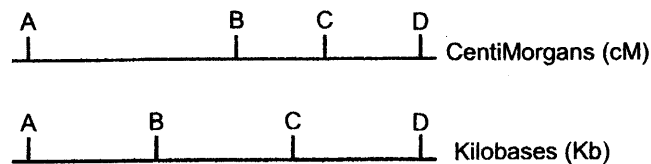
46. Consider the average in vivo turnover rates for proteins, DNA and mRNA. Which of the following orders best describes the turnover rate from fastest (shortest average lifetime) to slowest (longest average lifetime)?

- A) mRNA > DNA > proteins
- B) mRNA > proteins > DNA
- C) Proteins > mRNA > DNA
- D) proteins > DNA > mRNA

47. The DNA from the bacteriophage  $\phi$ X174 has a base composition of 25% A, 33% T, 24% G and 18% C. Which of the following best explains this observation?

- A) In viral genomes, the base pairing does not follow the standard Watson-Crick rules and allows G-A and C-T base pairs.
- B) Viral genomes are linear and tolerate base-pair mismatches.
- C) Nucleic acids from viruses are tightly complexed with nucleic acid binding proteins and so cannot base pair with one another
- D) The genome of bacteriophage  $\phi$ X174 is single-stranded.

48. 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

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

49. When the nucleus of a frog red blood cell which does not replicate DNA, is transplanted into an enucleated frog egg, the egg goes through several cell divisions. Which of the following is the best interpretation for this phenomenon?

- A) Isolated red-blood-cell nuclei synthesize DNA
- B) The nucleus plays no role in cell division
- C) An enucleated frog egg can divide
- D) The cytoplasm controls nuclear DNA synthesis.

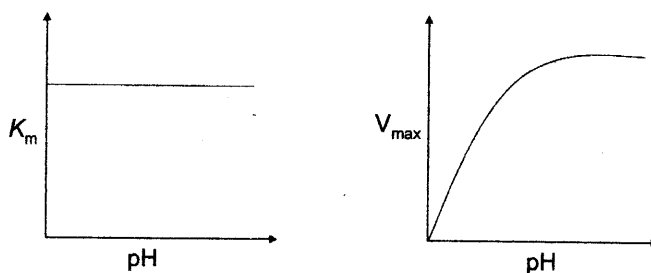
50. A mutant of *E. coli* with a heat-sensitive DNA ligase ( $25^{\circ}\text{C}$  permissive,  $37^{\circ}\text{C}$  nonpermissive) has been used to show that DNA synthesis is discontinuous. Examination of DNA replication in the presence of  $[\text{}^3\text{H}]$ -thymidine in the mutant would demonstrate which of the following?

- A) The accumulation of short segments of unlabeled DNA at  $25^{\circ}\text{C}$  and at  $37^{\circ}\text{C}$
- B) The accumulation of short segments of unlabeled DNA at  $25^{\circ}\text{C}$  but not at  $37^{\circ}\text{C}$
- C) The accumulation of short segments of radioactive DNA at  $37^{\circ}\text{C}$  but not at  $25^{\circ}\text{C}$
- D) The accumulation of short segments of radioactive DNA at  $25^{\circ}\text{C}$  but not at  $37^{\circ}\text{C}$

51. Thyroxine labeled with  $^{131}\text{I}$  is administered to a patient for the purpose of imaging the thyroid gland. The radioactive half life of the isotope is 8 days. The biological half life (the time required for half of the compound to be eliminated from the body) is 2 days. The time at which  $3/4^{\text{th}}$  of the original radioactivity will no longer be detectable in the body is closest to

- A) 2 days
- B) 3.3 days
- C) 4.8 days
- D) 16 days

52. The pH dependencies of  $K_m$  and  $V_{max}$  for an enzyme are shown below.



These data are most consistent with the requirement for

- A) A general base in catalysis
- B) A general acid in catalysis
- C) A dissociable cofactor in catalysis
- D) A basic residue in substrate binding

53. Which of the following mRNA molecules would form the most stable stem-loop structure?

- A) 5'.....GGCUU.....UUCGG.....3'
- B) 5'.....GGCUU.....AAGCC.....3'
- C) 5'.....GGCUU.....GGCUU.....3'
- D) 5'.....GGCUU.....CCGAA.....3'

54. How many grams of  $MgCl_2$  are required to prepare one litre of a 10-millimolar  $MgCl_2$  solution? (Atomic weight of Mg = 24.3g; atomic weight of Cl = 35.5g)

- A) 0.59g
- B) 0.95g
- C) 59g
- D) 95g

55. Genes a, b and c are widely spaced in the bacterial genome. Transducing phage from an  $a^+ b^+ c^+$  bacterium were used to infect a culture of  $a^- b^- c^-$  cells, and  $b^+$  transductants were selected. Which of the following best describes the predicted genotypes of these transductants?

- A) Mostly  $a^- b^+ c^-$
- B) Mostly  $a^- b^+ c^+$
- C) Mostly  $a^+ b^+ c^+$
- D) Mostly  $a^+ b^+ c^-$

56. The difference between the molecular weight of sucrose and that of the sum of the molecular weights of its components (glucose and fructose) is

- A) 0
- B) 1
- C) 16
- D) 18

57. If glucose labeled with  $^{14}\text{C}$  in position 1 is added to a bacterial culture under anaerobic conditions, which carbon atom of lactic acid would be labeled?

- A) The methyl carbon
- B) The carboxyl carbon
- C) The chiral carbon
- D) All three carbons

58. Consider the Meselson-Stahl experiment in which *E. coli* is grown for a long time in  $^{15}\text{N}$  medium and then transferred to  $^{14}\text{N}$  medium. Assuming that the bacterial DNA is fragmented into at least 100 pieces during isolation, what fraction of the total DNA is found at the density of  $^{15}\text{N}^{14}\text{N}$  at  $\frac{1}{2}$  generation after transfer of the *E. coli* to  $^{14}\text{N}$  medium?

- A) 0%
- B) 33%
- C) 50%
- D) 66%

59. For the following *E. coli* diploids, indicate whether the strain is inducible or constitutive, or negative for  $\beta$ -galactosidase and permease, respectively?

Genotype:  $i^- o^+ z^- y^+ / i^- o^c z^+ y^+$

- A) Negative for  $\beta$ -galactosidase and constitutive for permease
- B) Negative for  $\beta$ -galactosidase and inducible for permease
- C) Constitutive for both
- D) Inducible for both

60. The complementation data shown in the accompanying table are observed. The numbers refer to particular mutations. The symbols + and - indicate that the two mutations do and do not complement respectively. Which mutations are on the same gene?

	<i>Mutants</i>						
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>
<i>1</i>	-	+	+	+	+	+	-
<i>2</i>		-	+	-	+	+	+
<i>3</i>			-	+	+	-	+
<i>4</i>				-	+	+	+
<i>5</i>					-	+	+
<i>6</i>						-	+
<i>7</i>							-

- A) 1 and 4  
B) 2 and 5  
C) 3 and 6  
D) 4 and 5