

MID-SEMESTER/END-SEMESTER EXAMINATION

SEMESTER (Autumn/Spring)

Roll Number								Section		Name	
Subject Number	B	S	2	0	0	0	1	Subject Name	Science of Living Systems		
Department/Centre/School	School of Bioscience						Additional Sheets				

Important Instructions and Guidelines for Students

1. You must occupy your seat as per the Examination Schedule/Sitting Plan.
2. Do not keep mobile phones or any similar electronic gadgets with you even in the switched off mode.
3. Loose papers, class notes, books or any such materials must not be in your possession; even if they are irrelevant to the subject you are taking examination.
4. Data book, codes, graph papers, relevant standard tables/charts or any other materials are allowed only when instructed by the paper-setter.
5. Use of instrument box, pencil box and non-programmable calculator is allowed during the examination. However, the exchange of these items or any other papers (including question papers) is not permitted.
6. Write on both sides of the answer-script and do not tear off any page. **Use last page(s) of the answer-script for rough work.** Report to the invigilator if the answer-script has torn or distorted page(s).
7. It is your responsibility to ensure that you have signed the Attendance Sheet. Keep your Admit Card/Identity Card on the desk for checking by the invigilator.
8. You may leave the Examination Hall for wash room or for drinking water for a very short period. Record your absence from the Examination Hall in the register provided. Smoking and the consumption of any kind of beverages are strictly prohibited inside the Examination Hall.
9. Do not leave the Examination Hall without submitting your answer-script to the invigilator. **In any case, you are not allowed to take away the answer-script with you.** After the completion of the examination, do not leave your seat until the invigilators collect all the answer-scripts.
10. During the examination, either inside or outside the Examination Hall, gathering information from any kind of sources or exchanging information with others or any such attempt will be treated as '**unfair means**'. Don't adopt unfair means and also don't indulge in unseemly behavior.

Violation of any of the above instructions may lead to severe punishment.

Signature of the Student

To be Filled by the Examiner

Question Number	Part - I	Part - II	Total
Marks Obtained			
Marks Obtained (in words)		Signature of the Examiner	Signature of the Scrutiner

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

- §1. Mid-Spring semester of "Science of Living Systems (BS20001)" consists of UNIT-1. Students have to answer all questions in the corresponding question paper-cum answer script in 2 hrs time.
- §2. No query will be entertained regarding the questions during the examination.
- §3. No separate answer script is permissible. Space for rough work is provided.
- §4. Tick ALL the correct answers for the multiple choice questions.
- §5. For descriptive or quantitative questions, write the answer in the space provided below the question.
- §6. There is no negative marking.

MARKS OBTAINED

PART – I	PART – II	TOTAL
Signature	Signature	Signature

Indian Institute of Technology Kharagpur
Mid-Spring semester examination 2016
Subject: Science of living system (BS20001)

NAME

Roll #

Part – I (Total 18 marks) Choose (tick) ALL correct answers. Each question carries 0.5 mark.

1. If one DNA sample has 40% GC contents, what will be the percentage of Adenine base in that DNA sample? _____
2. During DNA replication, which of the following enzyme unwinds DNA strands?
(A) DNA polymerase (B) Helicase (C) Ligase (D) Primase
3. Which enzyme removes RNA primers during DNA replication
(A) Primase (B) Ribonuclease
(C) DNA polymerase III (D) DNA polymerase I
4. Which of the following enzyme is routinely used for polymerase chain reaction
(A) DNA polymerase I (B) Primase
(C) Taq polymerase (D) DNA polymerase I and Primase
5. Which one of the following is in correct order:
(A) Transcription, Translation, mRNA Splicing, Protein folding
(B) Transcription, mRNA Splicing, Translation, Protein folding
(C) Transcription, Translation, poly-adenylation Protein folding
(D) Transcription, Translation, 5' capping of mRNA, Protein folding
6. Function of RNA polymerase's sigma factor is the recognition of
(A) translational stop sequence (B) transcriptional start sequence
(C) translational start sequence (D) translational start sequence
7. Which of the following is NOT TRUE for codon?
(A) Contains three nucleotides (B) Contains multiple stop codons
(C) Contains multiple start codons (D) Complementary to tRNA anti-codon
8. Which one of the following is TRUE
(A) DNA is more stable than RNA (B) DNA is only right handed helix
(C) DNA is less stable than RNA (D) Both DNA and RNA can be synthesized from each other
9. The linkage between sugar and base is called
(A) Phosphodiester (B) Glycosidic(C) Hydrogen bond (D) Vander-Wall

10. In E. coli. Lac operon gene regulation, lactose induces gene expression
(A) through the binding of Lac repressor to promoter
(B) through the binding of Lac repressor to operator
(C) through the release of bound Lac repressor from the operator
(D) through the release of bound Lac repressor from the promoter

11. Arrange the following in the increasing order of protein structure hierarchy:

a: α -helix

b: amino acid sequence

d: quaternary structure

c: folded structure

(A) a, d, c, b

(B) b, a, c, d

(C) b, c, a, d

(D) a, c, d, b

12. When both C-alpha atoms are on the same side of a peptide bond, it is called a _____ isomer.

13. Which terminus (N or C) of an α -helix is most likely to interact with a DNA backbone? _____

14. Which of the following CAN NOT be close (adjacent) in primary structure

(A) two α -helices
(C) anti-parallel β -strands

(B) parallel β -strands
(D) an α -helix and a β -strand

15. Which of the following can fold independently in to a stable three-dimensional structure

(A) β -strands
(C) motifs

(B) α -helices
(D) domains

16. Which of the following amino acid residues have two covalent linkages with the backbone and side chain atoms.

(A) Glycine (B) Alanine (C) Proline (D) Phenyl alanine

17. In a helical wheel each residue can be plotted every _____ degree around a spiral path.

18. An enzyme that breaks a bond by adding water is called _____.

19. In a Lock and Key model of enzyme action, the part of the enzyme that recognizes the substrate is known as

(A) Enzyme-substrate complex
(B) Product-substrate complex
(C) Active site
(D) Co-enzyme

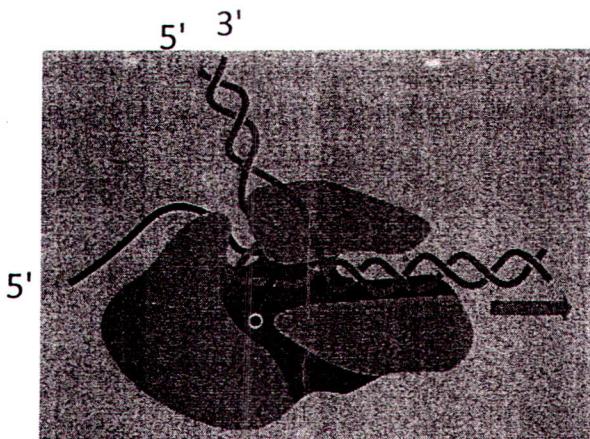
20. Which of the following is TRUE for a tRNA

- (A) Its gene is transcribed by RNA polymerase II.
- (B) It is normally composed of about 20 monomers.
- (C) During translation it interacts with mRNA.
- (D) Brings amino acid into the translating ribosome.

21. DNA and RNA polymerase differ in

- (A) the nucleotide substrates they incorporate.
- (B) their requirement for a primer.
- (C) the type of chemical reaction they catalyze.
- (D) their processivity

22. Which enzyme is depicted in the following schematic drawing?



- (A) DNA polymerase
- (B) RNA polymerase
- (C) Primase
- (D) Helicase

23. During DNA replication in the cell, Primase makes short primers that are then extended by the DNA polymerases. These primers ...

- (A) are made up of ribonucleotides.
- (B) are made more frequently in the leading strand than the lagging strand.
- (C) are joined to the neighboring DNA by DNA ligase.
- (D) provide a 3'-OH group for the DNA polymerases to extend.

24. Which of the following is TRUE

- (A) Protein folding takes place inside the nucleus.
- (B) Naturally occurring proteins are made of L amino acids.
- (C) Both the ribosomal subunits are necessary for protein synthesis.
- (D) Proteins always start with methionine amino acid.

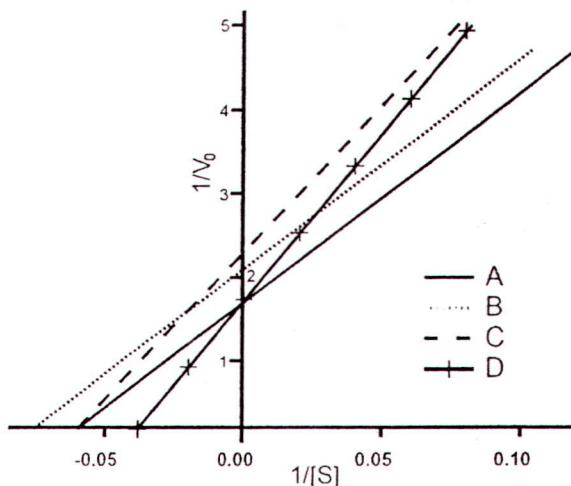
25. How many turns will be there in a 18 amino acid long helix? _____

26. A 100 amino acid long protein will be encoded by a mRNA containing _____ number of codons.

27. Which of the amino acids has maximum possible combinations of phi (ϕ) and psi (ψ) angles in its Ramachandran plot?
(A) Glycine (B) Lysine (C) Alanine (D) Tyrosine

28. On which of the following molecules would you find an anticodon?
(A) rRNA (B) mRNA (C) tRNA (D) small nuclear RNA

29. The curve which shows competitive inhibitor, the line 'A' belongs to uninhibited enzyme kinetics (symbols has their usual meaning) [Choose correct answer]
(a) B (b) C (c) D (d) None



30. Pepsin, a digestive enzyme which is secreted in stomach, and acts best at pH _____
(A) 10 (B) 7 (C) 6 (D) 2

31. Once a primary structure is formed, which of the following is not required to get the tertiary structure?
(A) H-bond (B) Salt bridges (C) vander Walls interactions (D) Peptide bond

32. The diameter of B-form of DNA is (P) and the distance between two adjacent bases in any of the DNA strands is (R). What are the correct values of 'P' and 'R'?
(A) P=2.0 nm, R= 0.34 nm (B) P=20 nm, R= 3.4 nm
(C) P=2.0 mm, R= 0.34 mm (D) P=2.0 nm, R= 3.4 nm

33. Melting of DNA at high temperature means
(A) Cleavage of DNA into nucleotides (B) Separation of base from the sugar
(C) Separation of phosphate from the sugar (D) Separation of two strands of DNA

34. Which one of the followings sequence of events occurred during DNA amplification by PCR

- (A) Extension / synthesis, Annealing, Denaturation
- (B) Denaturation, Annealing, Extension/ synthesis
- (C) Annealing, Extension/synthesis, Denaturation
- (D) Renaturation, Annealing, Extension/synthesis

35. In prokaryotes transcription and translation is

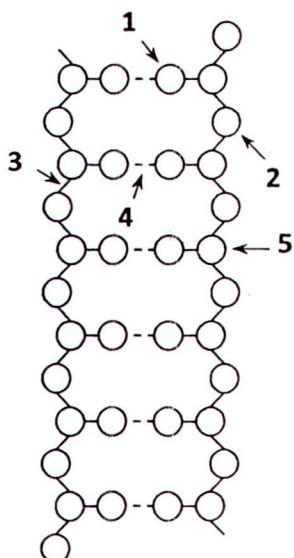
- (A) A coupled process that occurs in same compartment
- (B) A coupled process that occurs in different compartments
- (C) Not a coupled process that occurs same compartment
- (D) Not a coupled process that occurs in different compartments

36. *E. coli* bacterial DNA is

- (A) Double stranded, right handed, linear
- (B) Single stranded, right handed, circular
- (C) Double stranded, right handed, circular
- (D) Single stranded, left handed, linear

Part – II (Total 12 marks) Answer briefly.

1. Indicate which numbered feature (1 to 5) in the schematic drawing below of the DNA double helix corresponds to each of the following. For your answer match the numbers (1 to 5) with the letters (a to e)
- (1 Mark)



- (a) Hydrogen-bonding
- (b) Covalent linkage
- (c) Phosphate group
- (d) Nitrogen-containing base
- (e) Deoxyribose sugar

2. In a double-stranded DNA molecule, one of the chains has the sequence CCCATTCTA when read from the 5' to the 3' end. Indicate true (T) and false (F) statements below regarding this chain. (1 mark)
- (A) The other chain is heavier, i.e. it has a greater mass.
 - (B) There are no C base in the other chain.
 - (C) The 5'-terminal base of the other chain is G.
 - (D) The other chain is pyrimidine-rich.
3. How many DNA molecules are present in the nucleus of one normal human somatic cell and in the nucleoid of one *E. coli* bacteria? (1 mark)
4. As part of an ambitious student research project you create a short synthetic protein consisting of 30 amino acids. However, instead of linking the amino acids in the intended order of Trp – Gly – – Val – Ile, you accidentally synthesize protein in the reverse order, Ile – Val – – Gly – Trp. One of your classmates says the two protein must be identical, and bets you Rs 500 that the protein are structurally and functionally equivalent. What do you think? Explain briefly. (1 mark)
5. Draw the structure of a dipeptide. You can show the sidechains as R1 and R2. Also show all the atoms involved in the peptide plane. (1 mark)

6. Given $\Delta G_{\text{cat}} = 25 \text{ kJ/mol}$, $\Delta G_{\text{uncat}} = 65 \text{ kJ/mol}$, $R = 8.413 \text{ JK}^{-1}\text{mol}^{-1}$ and room temperature condition, calculate the rate enhancement by this enzyme. (1 mark)

7. Write down the Michaelis-Menten equation. (2 marks)
Using this equation determine the reaction rate when the substrate concentration [S] is equal to
i) saturation condition i.e. $[S] = \infty$
ii) K_m
iii) $K_m/2$

8. Estimate the V_{max} and K_m values by inspecting the following data (1 mark)

[S] (M)	$V_0 (\mu\text{M}/\text{min})$
2.5×10^{-6}	28
4.0×10^{-6}	40
1×10^{-5}	70
2×10^{-5}	95
4×10^{-5}	112
1×10^{-4}	128
2×10^{-3}	139
1×10^{-2}	140
2×10^{-2}	140

9. Mention two structural differences between a DNA helix and a protein helix. (1 mark)
10. Imagine that 1 L of a solution containing each of the 20 naturally occurring amino acids at 50 mM concentration each (total concentration of 1 M) is allowed to polymerize in a perfectly stepwise fashion such that at each step, a random amino acid can be incorporated into a growing polypeptide. The steps are repeated, until eventually the solution is only composed of 40-mers (and virtually all of the monomers have been used). What fraction of all 40-mers can possibly be present in this solution? Round your number to four decimal places.
Avogadro's number is 6×10^{23} . (1 mark)
11. What transcript (RNA) will be produced from the coding DNA sequence (5'-ATGCGTAGGTAGCT-3') of a double stranded DNA molecule? (0.5 mark)
12. Name the enzyme which helps to attach the appropriate amino acid to its tRNA. (0.5 mark)

SPACE FOR ROUGH WORK