M. Sc. (Biotechnology) Examination, 2023

(1st Year, 1st Semester)

Microbial Genetics and Fundamentals of Molecular Biology

Paper – CORE/TH/133

Time : Two hours Full Marks : 40

(Use a separate Answer script for each Group)

Group – A (Marks: 24)

Part – I

Answer any **two** questions.

1. a) What is melting temperature (T_m)? Is the melting temperature of a piece of DNA with defined sequence always "invariant"? Or it may alter under certain specific conditions? 2

   b) During the interaction between a DNA major groove binding protein such as *lac* repressor tetramer and DNA through the major groove, which chemical groups from the interacting DNA base pairs and from the amino acid residues from the repressor protein take part in this interaction? 2

2. Match the following column-I terms with correct options of column-II with their definition.

Column - I	Column - II
P. *trans* acting factors	(i) Luria Delbruck Fluctuation Test
Q. Spontaneous mutation	(ii) Bacteriophage infection
R. *cis-trans* concept	(iii) *lac* repressor
S. MOI	(iv) Seymour Benzer's Complementation Analysis with T4 rII locus

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3. a) Which moiety of the RNAse P plays a vital functional role? Present an experimental evidence that it is the RNAase P RNA and not the protein moiety that plays an actual functional role in cleaving the pre-tRNA substrate. 2

   b) How does twisting into a helix contribute to the stability of the overall structure of DNA, and its function? 2

4. a) What is stacking interaction? Which chemical force is instrumental behind the stacking interaction? 2

   b) What is a pseudoknot? Cite an example of the biological significance of a pseudoknot. 2

Part – II

Answer any **two** questions.

5. a) Consider a bacterial promoter with –35 and –10 elements. Which assay will be the most appropriate method to show that RNA polymerase binds at regions centered on the –35 and –10 positions upstream of the start site of transcription? 2

intrastrand cross links, chemically modified DNA and thymidine dimers. Both mechanisms occur in prokaryotes and humans in dark. Explain the process of Nucleotide excision repair with proper illustration.

Write the function of the enzymes: Helicase, Gyrase, Primase and DNA. Explain how it is done by DNA polymerase. 4+2+2=8

diameter in a typical interphase nucleus? Which enzymes are responsible for histone methylation and acetylation? What are the functional outcomes for histone modifications? Explain H3K36me3. Define CpG Island.

1+1+1+2+1+1+1=8

2. What is the composition of Ndc80 complex? Briefly state the function of Mist12 and Ndc80 complex in structuring Kinetochore assembly? Classify kinetochore according to their orientations or microtubule attachments on chromatids. Which orientation of kinetochore can be seen in meiosis I? What is the role of Aurora B protein in structuring Kinetochore assembly? 1+3+2+1+1=8

Group – C

Answer any **one** question. 1×8=8

1. The mechanism of restoring the ends of a DNA molecule in a chromosome relies on an enzyme called TELOMERASE : Explain the process. What do you mean by Direct DNA repair system? Explain briefly about repair mechanism of damage done by methylation of the O6 position of guanine in DNA. 4+1+3=8

2. There are two types of Excision repair (a) base excison repair system which involves removal of damaged nucleotides or chemically modified bases from DNA. (b) nucleotide excision repair system which can repair

b) Why dissociation of sigma factors is vital for transition of the RNA polymerase holoenzyme from initiation to elongation phase of prokaryotic transcription? Describe briefly the events involved in the dissociation of sigma factor from the RNA polymerase holoenzyme complex. 2

6. a) Consider the Rho-independent terminator sequence

5′-CCCAG**CCC**CGCCUAAUGAGC**GGG**CUUUUUUU3′

Why does a point mutation at any one of the boldfaced nucleotides would disrupt termination of transcription? How would you test your conclusion? 2

b) When a bacterial cell is present in an environment where both lactose and glucose are present, the glucose will be metabolized first and the lactose will only be used when the stores of glucose have been depleted. How does the bacterial cell recognize the fact that glucose is present and turn off the transcription even when lactose is present? 2

7. a) Write the name of a prokaryotic protein which acts as a negative as well as positive regulator of gene expression. How this protein regulates the expression of the relevant genes in prokaryote? 2

b) What phenotype you would anticipate in the following *E. coli* strain in terms of β-galactosidase

production (i) in absence of lactose and (ii) in its presence: $i^+o^+Z^+Y^-A^+$ and $i^+o^cZ^+Y^+A^+$? 2

8. a) How the mechanism of attenuation contributes to the regulation of *trpEDCBA* genes in *E.coli*? How attenuation is overridden in absence of tryptophan in the medium? 3

   b) What is riboswitch? Provide three examples where you come across the involvement riboswitches in the regulation of gene expression? 1

Part – III

Answer any **two** questions.

9. a) Explain why you cannot predict the exact RNA sequence if you are given a protein sequence? 1

   b) Describe what are the A, P, and E sites of the ribsome. Which t-RNA intermediates occupy each of these sites after peptidyl-transfer, but before translocation is completed by EF-G? 3

10. a) Which tRNA synthetase would you expect to have an editing pocket to hydrolyze an aminoacyl-tRNA mischarged with glycine? Explain your choice. 2

    b) You are given the following DNA sequence located in the middle of a gene

    5′-ACCGTTTCGGCTAGG-3′

    from *E. coli*. This strand represents the coding

strand. How many possible polypeptides that this sequence can encode. 2

11. a) Mention the different mechanisms used to ensure translation accuracy, beginning with the charging of the tRNA and continuing up to the transfer of the amino acid to the growing polypeptide chain. 3

    b) An ORF is 636 nucleotide long, including the initiator and termination codons. Calculate the number of amino acids in the protein translated from this mRNA with justification. 1

12. a) Present the peptidyl transfer reaction during protein synthesis. Which moiety in the ribosome catalyzes this reaction? What is the chemical nature of such moiety? 2

    b) What is wobble hypothesis? Mention the major reason, which is responsible for the exceptions in base pairing dictated by Wobble rule. 2

Group – B

Answer any **one** question. 1×8=8

1. Which are the major chromatin remodeler families in eukaryotes during ATP-dependent chromatin remodeling? Which remodelers are involved in DNA double-strand break (DSB) repair and nucleotide-excision repair (NER)? What is the chromatin fiber