*Name* : .....

*Roll No.* : .....

*Invigilator's Signature* : .....

**CS/MBT, PHMB, PHMC/SEM-1/MBT, PHMB, PHMC-103/2009-10**

# 2009

# MOLECULAR BIOLOGY

*Time Allotted* : 3 Hours *Full Marks* : 70

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words as far as practicable.*

Question No. 1 is compulsory and any *six* from the rest.

## GROUP – A

1. Answer any *ten* questions : 10 × 1 = 10

A) i) Which of the following statements is/are true ?

a) A chromosome contains many genes.

b) DNA replication copies both DNA strands of entire chromosomes.

c) Transcription only copies one strand of particular parts of chromosomes.

d) All of these.

e) None of these.

ii) Which one of the following mutations is likely to have the greatest effect on the function of a protein ?

a) A missense mutation of the last amino acid of the protein

b) A nonsense mutation of the 10th amino acid ( assuming the protein is more than 100 amino acids long )

c) A single base-pair change in an intron

d) A single base-pair change after the stop codon

e) None of these.

iii) The fact that a specific protein leaves a "footprint" on a DNA molecule is indicative of

a) lack of interaction between the specific protein and DNA

b) protection from DNAse by the specific protein

c) binding of the specific protein to all types of DNA

d) binding of the specific protein to a specific sequence of DNA.

B) Answer the question in *one* sentence each :

iv) Name the tautomeric forms of DNA bases.

C) State whether the following statement is *True* or *False* :

v) Melting point or Tm is the temperature at which the entire DNA is denatured.

D) Answer the questions in *one* sentence each :

vi) Name the most abundant protein associated with eukaryotic DNA.

vii) Exons from different RNA molecules can be fused by which splicing mechanism ?

E) Fill in the blanks :

viii) Adenylylation refers to transfer of ..... while adenylation refers to transfer of ..... .

F) Answer the questions in *one* sentence each :

ix) Name an antitermination factor in lambda phage.

x) Name a general transcription factor having helicase activity.

xi) What does the acronym ChIP stands for

xii) Name the activity encoded by the Lac/gene.

## GROUP – B

Answer any *six* of the following. 6 × 10 = 60

2. a) More complex organisms ( eukaryotes ) have decreased gene density in comparison to prokaryotes. Justify with suitable examples. 2

b) What is *C*-value ? *C*-value for a particular genome is always not equal to the number of nucleotides within the genes. Explain. 2

c) You are given a temperature-sensitive *E. coli* strain that lacks ligase activity at higher temperature ( 40°C ) but retains it at lower temperature ( 25°C ). If these strains were placed at 40°C what would be the outcome in terms of their DNA replication and survivability ? 2

d) Explain very briefly how eukaryotic replication is tightly regulated to ensure a single round of replication during each cell cycle. 2

e) Linear chromosomes require specialized proteins to ensure the completion of replication. Explain how such proteins direct the process. 2

3. a) What are the major strategies for replicating circular DNA ? With the help of diagrams explain any one such strategy. 3

b) Why do origins of replication tend to be A-T rich ? What is the function of DnaA proteins with respect to bacterial OriC ? 1 + 2

c) You are studying a protein that you suspect has DNA helicase activity. Describe how you would assay the protein for the activity and show sample positive results. 2

d) What are the different types of modifications of the histone *N*-terminal tails that take place to alter DNA accessibility ? 2

4. a) Glucose levels in bacterial cells are regulated by the activity of CAP and repressors. Explain. 5

b) If a gene is fused to the araBAD promoter, explain how the expression of the gene can be easily controlled by addition of arabinose. 5

OR

Give an example of a negative regulation of gene expression in a bacterial operon. 5

5. a) What are the features of Rho independent termination of transcription ? 2

b) Define between promoter and enhancer elements. 2

c) What effect would a mutation in an intron section of a gene have on the expression of the gene ? Explain. 1

d) How does the inducer galactose enter a cell under conditions when the lac operon is repressed ? 3

e) What feature of the Ga14 protein of *S. cerevisiae* has been exploited for using it as a tool to study protein-protein interactions ? 2

6. a) If you wished to design an inducible system similar to the *trp* operon in *S. cerevisiae*, would you be successful ? Explain your answer with reasons. 2

b) How do post-transcriptional modifications of eukaryotic mRNAs help in stabilizing the transcript ? 3

c) Does the protein CIII promote lytic or lysogenic growth ? Explain its mechanism of action. 1 + 2

d) Explain very briefly why the dimeric/tetrameric structure of the repressor crucial in maintaining lysogeny in lambda phage. 2

7. a) Explain why brief digestion of eukaryotic chromatin with micrococcal nuclease gives a DNA ladder of 200 bp, but longer digestion gives 146 bp fragments. 2

b) Why is it essential for linear eukaryotic DNA molecules to have multiple origins of replication contrary to *E. coli* that has a single origin of replication ? 1

c) List some of the important cellular functions associated with repetitive DNA. 1

d) Differentiate between spontaneous and induced mutation. 2

e) Write down the molecular mechanism of mutation by UV radiation. How can this mutation be repaired by excision ? 4

8. a) Explain with the help of Cot curves how DNA renaturation is related to DNA complexity for a typical mouse satellite DNA, unique fraction of calf DNA and *E. coli* DNA. 3

b) What is Ames test ? 1

c) How does DNA polymerase take part in mutation repair ? 1

d) Distinguish between transition and transversion mutation. 2

e) Define a lesion. Give examples of spontaneous and induced mutations ( two each ). 3

9. a) Outline the process of aminoacyl-*t*RNA formation. 4

b) What modifications of eukaryotic *m*RNAs facilitate translation ? 2

c) Why are more than 30 *t*RNAs necessary to translate *m*RNAs when there amino acids incorporated into proteins ? 1

d) Define and briefly outline the major function of (i) ribosomes and (ii) *P* sites on ribosome. $2 \times 1\frac{1}{2}$

10. a) Explain the phenomenon of SOS response in *E. coli* and the role of key players in the process. 3

b) Explain the mechanism by which the two-enzyme system recognizes certain mutagens and detoxifies them before they affect the DNA. 2

c) Explain the means of repair of DNA lesions in presence of light. 2

d) Describe briefly the signaling mechanism of IL-2-mediated gene expression. 3

11. Write short notes on any *four* of the following : $4 \times 2\frac{1}{2}$

a) *mi*RNAs

b) RISC

c) Intergenic suppression

d) TFIID

e) Okazaki fragments

f) Nucleosomes.