MOLECULAR BIOLOGY
(BIOT 2203)

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

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) If a 1000 kb fragment of DNA has 10 evenly spaced and symmetric replication origins and DNA polymerase moves at 1 kb per minute, how many minutes will it take to produce two daughter molecules ignoring the potential problem at the end of the linear piece of DNA? Assume that the 10 origins are evenly spaced from each other, none starting from the ends of the chromosome.
(a) 20 (b) 30 (c) 50 (d) 100.

(ii) In *E.coli*, the proteins, Mut S, Mut L and Mut H are involved in
(a) nucleotide excision repair (b) base excision repair
(c) mismatch repair (d) 5'-3' endonuclease activity.

(iii) In eukaryotic replication, helicase loading occurs at all origins during
(a) G0 phase (b) G1 phase
(c) S phase (d) G2 phase.

(iv) The 5’ end of the mature form of the eukaryotic mRNAs contains
(a) a triphosphate group
(b) monophosphate group
(c) a triphosphate group in reverse orientation
(d) no phosphate group.

(v) The presence of transposons in a genome can have an impact on gene expression by
(a) inducing gene silencing
(b) disrupting a gene by inserting into a coding region
(c) creating the potential for aberrant chromosomal rearrangements
(d) all of the above.

(vi) PAP is a unique enzyme because
(a) it can polymerise rGMPs
(b) it can polymerise rATPs
(c) it can polymerise rATPs without any template
(d) it can polymerise any rNTPs.

(vii) What would be the result, if an organism’s telomerase were mutated and nonfunctional?
(a) No DNA replication would take place
(b) The DNA polymerase enzyme would stall at the telomere
(c) Chromosomes would shorten with each new generation
(d) RNA primers could not be removed.

(viii) For their efficient translation, eukaryotic mRNAs possess the following sequence
(a) Shine-Dalgarno sequence (b) Kozak sequence
(c) anti Shine-Dalgarno sequence (d) any of them.

(ix) 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 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?
(a) The lac promoter binds glucose and shuts down the lac operon
(b) Glucose is a repressor molecule
(c) Catabolite-activating protein-cAMP complex is required for transcription, and its level is low when glucose is present
(d) The CAP binding site is activated.

(x) A few years ago, geneticists cloned the human gene responsible for the disease alkaptonuria. More than 90 years ago, Garrod's original studies of the disease alkaptonuria
(a) indicated that some diseases are caused by infectious agents
(b) provided very strong evidence for the one gene:one polypeptide hypothesis
(c) linked genetic defects to errors in metabolism
(d) none of the above.

Group – B

2. (a) Write only the reactions with diagram of the following enzymes of *E.coli*
(i) 5’-3’ polymerase by DNA polymerase-III
(ii) DNA ligase
(iii) Helicase
(iv) Topoisomerase-I.

(b) Write the name of experiment to prove that DNA replication in eukaryote occurs by semiconservative mode. Write the design, results and interpretation of the experiment with labelled diagram.

(c) The human chromosome contains 3.2×10^9 bp.
(i) How many Okazaki fragments will be required to complete the replication of human genome?
(ii) Calculate the number of origins required to replicate the human chromosome at 37^0C, if two replication forks proceeded from the origin?

(4 × 1) + (1 + 4) + (1 + 2) = 12

3. (a) Describe the mechanism of recombination by Holiday junction model.

(b) Describe the SOS repair system in *E.coi* with labelled diagram.

(c) Write the names of different types of mode of replication occurs in different organisms and organelles. Describe the type which occurs in DNA with labelled diagram.

(d) A circular molecule of DNA contains 1 million base pairs.
(i) If the rate of DNA synthesis at a replication fork is 100,000 nucleotides per minute, how much time will theta replication require to completely replicate the molecule, assuming that theta replication is bidirectional?
(ii) How long will replication of this circular chromosome take by rolling-circle replication? Ignore replication of the displaced strand in rolling-circle replication.

4 + 3 + 3 + 2 = 12

Group – C

4. Following is a DNA segment:

+1
5′ GTATGTACCTATAATGACGTTACCC**G**ACATAGCTACGATGACGATA 3′
3′ CATACATGGATATTACTGCAATGGGCTGT ATCGATGCTACTGC TAT 5′

(i) What is the significance of this sequence?
(ii) Is it a prokaryotic or eukaryotic DNA? Explain.
(iii) How the two strands are designated and explain their meaning.
(iv) Write down if you can find any consensus sequence here.

(4 + 4 + 2 + 2) = 12

5. (a) "Eukaryotic genes are split in nature" — explain. Describe an experiment to prove the presence of introns.

(b) How splicing of pre-mRNA occurs by self-splicing of intron.

(c) Mention the mechanism of transcription inhibition by the following: Rifampicin, α-amanitin.

4 + 4 + (2 + 2) = 12

Group – D

6. (a) Discuss the mechanism of synthesis of amino-acyl-tRNA.

(b) What are the points of attachments of tRNA to the ribosome?

(c) State how the movement of tRNA leads to the synthesis of peptides.

4 + 3 + 5 = 12

7. (a) (i) Write the detailed molecular mechanism for prokaryotic translation initiation.
(ii) Mention the role of different translational factors in it.
(iii) Where it differs from eukaryote?

(b) What are the common post–translational modifications occurs in eukaryotic proteins?

(4 + 3 + 2) + 3 = 12

Group – E

8. (a) Write the name of a prokaryotic protein which acts as negative as well as positive regulator of gene expression. How that protein regulates the gene expression in prokaryote.

(b) How antisense RNA control gene expression?

(c) What is an insulator? How does it affect the transcription of distant genes?

(d) The largest known polypeptide chain made by any cell is a protein called titin (made by mammalian muscle cells), and it has a molecular weight of 3,000,000 Daltons. (ii) Calculate time required for muscle cell to translate an mRNA coding for titin? (ii) Calculate the time required to synthesize a titin mRNA from the corresponding gene of titin? (Assume standard rate of translation and standard rate of transcription for eukaryotic cells).

(1 + 3) + 2 + (1 + 2) + 3 = 12

9. Write short notes on the following: **(4 × 3) = 12**
(i) Antitermination by N protein in lambda phage
(ii) Gene regulation in eukaryote by non-protein hormone
(iii) Gene silencing by micro RNA.