

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) Function of eukaryotic RNA pol IV is
(a) Synthesis of tRNA in eukaryote (b) Synthesis of mRNA
(c) Synthesis of siRNA in animals (d) Synthesis of siRNA in plants.
- (ii) Topoisomerase II favors transcriptional chain elongation because
(a) It is a DNA gyrase (b) It favors DNA supercoiling
(c) It favors DNA unwinding (d) It has exonuclease activity.
- (iii) 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.
- (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) a monophosphate group in reverse orientation.
- (v) Which of the following is not required for transcription in vivo?
(a) Nucleic acid (b) A primer
(c) CTP (d) A polymerase.
- (vi) During DNA replication, significant proportion of newly synthesized DNA in the lagging strand exists as small Okazaki fragments. The sizes of these units in bacteria are approximately
(a) 100 base pairs (b) 100 nucleotides
(c) 1000 base pairs (d) 1000 nucleotides.
- (vii) For the *E. Coli* genotype, I⁺P⁺O^cZ⁺Y⁺A⁺, the expression of β-galactosidase will be
(a) constitutive (b) inducible
(c) lethal (d) absent.

- (viii) If a completely radioactive double stranded DNA molecule undergoes two rounds of replication in a nonradioactive medium, what will be the radioactivity status of the four resulting molecules?
- (a) Half the number of molecules contains no radioactivity
 - (b) All four molecules contains radioactivity
 - (c) Three out of four molecules contain radioactivity
 - (d) Radioactivity is lost from all four molecules.
- (ix) 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.
- (x) In humans, the enzyme having reverse transcriptase activity is
- (a) Ribonuclease P
 - (b) Ribonuclease D
 - (c) Recombinase
 - (d) Telomerase.

Group- B

2. (a) Discuss the experiment (design, results conclusion and interpretation) with labelled diagram which showed that DNA synthesis during replication is semidiscontinuous. [(CO1)(Understand/LOCQ)]
- (b) Describe Nucleotide excision repair system in *E.coli*, with labelled diagram. [(CO1)(Remember/IOCQ)]
- (c) Write about the structure and function of primase and helicase in *E.coli* DNA replication. [(CO1)(Understand/IOCQ)]
- (d) A new bacterial species chromosome contains 6.6×10^6 bp. In the replication of the bacterial chromosome, about how many Okazaki fragments would be formed? What factors guarantee that the numerous Okazaki fragments are assembled in the correct order in the new DNA? [(CO1)(Analyse/HOCQ)]
- 4 + 3 + (1.5 + 1.5) + 2 = 12**
3. (a) Draw a molecule of DNA undergoing eukaryotic linear replication. On your drawing, identify (i) origin, (ii) polarity (5' and 3' ends) of all template strands and newly synthesized strands, (iii) leading and lagging strands, (iv) Okazaki fragments, (v) location of primers and (vi) position of Helicase, Topoisomerase and RepA. [(CO1)(Remember/LOCQ)]
- (b) Describe the mechanism of DNA damage by UV radiation and describe the mechanism of repair of that damaged DNA by light dependent repair system. [(CO2)(Remember, Explain/IOCQ)]
- (c) Describe the recombination mechanism of bacterial chromosome with λ DNA, with labelled diagram. [(CO2)(Remember/IOCQ)]
- 4 + 4 + 4 = 12**

Group - C

4. Following is a DNA segment:
 $5'GCTCAATCT-(50 \text{ bases})-TATAA-(25 \text{ bases})-ACCTTCCAGTG-3'$

3' CGAGTTAGA----- ATATT-----TGGAAGGTCAC-5'

- (i) What nucleotide sequence would be present in RNA transcript of this gene? Explain. [(CO3)(Explain/IOCQ)]
- (ii) Write the name of the RNA transcript Why it is called so? [(CO3)(Analyze/HOCQ)]
- (iii) Is it a prokaryotic or eukaryotic DNA? Explain. [(CO3)(Understand/IOCQ)]
- (iv) Name the two DNA strands and explain their meaning. [(CO3)(Analyze/LOCQ)]
- (v) If the non template strand as shown was part of a gene in *Bacillus subtilis*, would the same transcript be produced?
- (vi) Explain your view. [(CO3)(Analyze/HOCQ)]
- (6 × 2) = 12**
5. (a) What are the features of eukaryotic core promoter elements? [(CO3) (Remember/LOCQ)]
- (b) Mention the name and functions of the following factors: CPSF, CstF, PAP, PAB2. [(CO3) (Understand/IOCQ)]
- (c) What is the role of TFII F? Describe its structure and catalytic activities. [(CO4) (Explain/HOCQ)]
- 4 + 4 + 4 = 12**

Group - D

6. (a) Differentiate between the ribosome binding sites in Prokaryote and Eukaryote. [(CO5)(Understand/LOCQ)]
- (b) Write a short note on tRNA secondary structure and mention its role in translation. [(CO5) (Remember/IOCQ)]
- (c) 'Genetic code is universal' - explain. [(CO5)(Analyze/HOCQ)]
- 4 + 4 + 4 = 12**
7. (a) What marks the start and end point of ORF? [(CO5)(Remember/LOCQ)]
- (b) How degeneracy of codons is explained? [(CO5)(Understand/HOCQ)]
- (c) What is the enzymatic activity of amino acyl tRNA synthetase? [(CO4)(Analyze/IOCQ)]
- 4 + 4 + 4 = 12**

Group - E

8. (a) Explain the role of HRE in eukaryotic gene regulation by steroid hormone. [(CO6) (Understand/LOCQ)]
- (b) Explain how does antisense RNA control gene expression in eukaryote? [(CO6) (Understand/LOCQ)]
- (c) (i) Explain the experimental techniques used to find out the DNA binding sequence of a repressor molecule with a labelled diagram. [(CO6) (Explain /IOCQ)]
- (ii) The dissociation constant for a particular repressor-operator complex is very low, about 10^{-13} M. An *E. Coli* cell (volume 2×10^{-12} ml) contains 10

copies of the repressor. Calculate the cellular concentration of the repressor protein. How does this value compare with the dissociation constant of the repressor operator complex? What is the significance of this result?

[(C06) (analyse/HOCQ)]

3 + 3 + (4 + 2) = 12

9. (a) Which experimental techniques will be used to find out the operator DNA binding protein molecule in a prokaryotic organism? Describe the technique with a labelled diagram. [(C06)(Remember, Explain/LOCQ)]
- (b) Write the names of different DNA-binding domain (DBD) structural motif present in the proteins that are involved in the regulation of eukaryotic gene expression. Describe each of them. [(C06)(Remember/IOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	33.33	39.58	27.09

Course Outcome (CO):

After completion of this course, the students will be able to:

- C01.** Identify and analyze the different components and mechanism of replication.
- C02.** Describe different types of DNA damage and repair systems and recombination process.
- C03.** Comment on various components and detailed process of transcription.
- C04.** Comment on various components and mechanism of translation.
- C05.** Understood the rational of genetic code.
- C06.** Comprehend on models of gene regulation and apply the knowledge of gene regulation as genetic switch.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question