

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) The presence of transposons in a genome can have an impact on gene expression
(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.
- (ii) The *E. Coli* RNA polymerase is inhibited by the antibiotic Rifampicin, as
(a) It intercalates between the successive base pairs of DNA
(b) It bind to the β' subunit
(c) It blocks the growing RNA chain
(d) It blocks the σ subunit.
- (iii) Among the following base-pairing,
(i) A—U (ii) G—U (iii) I—U (iv) I—C.
The unusual pairing that can be present in the Wobble position are
(a) Only (i) (b) (i) & (ii)
(c) (ii), (iii), (iv) (d) All of (a), (b) & (c).
- (iv) Making a protein from a gene in eukaryotic cells involves:
(a) first, transport of mRNA, then its processing, then transcription, then translation
(b) first, transcription of the RNA, then its transport, then processing, then translation
(c) first, translation of the RNA, then its transport, then its processing, then transcription
(d) first, transcription of RNA, then its processing, then its transport, then translation.
- (v) The amino acyl tRNA synthatase can attach amino acid at:
(a) 2' --OH of the acceptor arm
(b) 3' --OH of the acceptor arm
(c) 5' --P of the acceptor arm
(d) Either 2' or 3' --OH of the acceptor arm.

- (vi) PAP can add nucleotides *in vivo* without any
(a) Primer (b) rNTPs
(c) Template (d) A polymerase.
- (vii) An altered form of a replicative DNA polymerase lacks 3' → 5' exonuclease activity.
This alteration would most likely result in which of the following?
(a) A decrease in processivity,
(b) An increased mutation rate
(c) An inability to replicate DNA
(d) An inability to remove RNA primers.
- (viii) Which one of the following is not important for regulation of the tryptophan operon by attenuation?
(a) Presence of two adjacent codons for tryptophan in the leader peptide sequence
(b) Coupled transcription-translation
(c) Concentration of tRNA charged with tryptophan
(d) The operator sequence of tryptophan operon.
- (ix) Histone code implies which of the following?
(a) Combination of different histone proteins to form a nucleosome
(b) Modification of histones
(c) Different histone proteins present in different eukaryotic organisms
(d) Different order of histone proteins in a given nucleosome.
- (x) Meselson and Stahl allowed bacteria raised in ¹⁵N medium to replicate in ¹⁴N medium. At the end of two rounds of DNA replication, they observed ____ band (s) in their centrifugation tubes which was/were composed of ____.
(a) 2; double strands of ¹⁴N DNA at the top and strands of ¹⁵N DNA base-paired to strands of ¹⁴N DNA in the middle.
(b) 2; double strands of ¹⁴N DNA at the top and double strands of ¹⁵N DNA at the bottom
(c) 1; double strands of DNA, each strand made up of a mixture of ¹⁴N and ¹⁵N DNA
(d) 1; single strands of ¹⁵N DNA base-paired to single strands of ¹⁴N DNA.

Group- B

2. (a) Define different types of recombination with labelled diagram. [[CO2](Remember/LOCQ)]
(b) Explain the mechanism and steps of *recBCD* pathway of homologous recombination in *E.coli*. [[CO2](Explain/IOCQ)]
(c) Explain the mechanism nucleotide excision repair system in *E.coli* with a labeled diagram. [[CO2](Explain/IOCQ)]
3 + 5 + 4 = 12
3. (a) Write the name of the experiment which showed that in prokaryote, DNA replication is bidirectional and describe design, results and interpretation of the experiment with labelled diagram. [[CO1](Explain/LOCQ)]
(b) Write the names of different proteins and enzymes with their functions, which take part in *E.coli* DNA replication. [[CO1](Remember/IOCQ)]

- (c) In an eukaryotic cell, if a 1500 kb fragment of DNA has 15 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 15 origins are evenly spaced from each other, none starting from the ends of the chromosome.

[[CO1](Analyse/HOCQ)]

$$(1 + 4) + 5 + 2 = 12$$

Group - C

4. (a) Refer to the following sequence of *E. coli*:
5'GCCGCCAGUUCCGCUGGCGGCAUUUUUU.....3'
- (i) Is it a DNA or RNA segment? Explain. [[CO3](Explain/LOCQ)]
- (ii) What molecular event can be observed here? [[CO3](Analyse/HOCQ)]
- (iii) Discuss in detail its molecular mechanism. [[CO3](Understand/IOCQ)]
- (b) Discuss the Rho-dependent termination in prokaryotes. [[CO3](Remember/HOCQ)]
- $$(2 + 2 + 4) + 4 = 12$$
5. (a) If the non-template strand of a gene in *E.coli* had the following sequence:
5' TTGACA—(18 bases)—TATAAT—(8 bases)—GCCTTCCAGTG 3'; then,
What nucleotide sequence would be present in the RNA transcript of this gene?
Explain. Why this DNA strand is called so? [[CO3](Analyse/IOCQ)]
- (b) If this non-template strand shown above were part of a gene in *Drosophila* rather than in *E.coli*, would the same transcript be produced? If not, then explain why. [[CO3](Understand/HOCQ)]
- $$(2 + 2 + 3) + (1 + 4) = 12$$

Group - D

6. (a) "Eukaryotic genes are split in nature"- Explain. Describe an experiment to prove it. [[CO3](Understand/IOCQ)]
- (b) Describe the molecular mechanism of intron splicing. [[CO3](Remember/LOCQ)]
- (c) What is the importance of SD-sequence in mRNA? [[CO4](Analyse/IOCQ)]
- $$4 + 4 + 4 = 12$$
7. (a) Describe the structure of prokaryotic and eukaryotic ribosomes. [[CO5](Understand/LOCQ)]
- (b) Mention the detailed function of 50S subunit in translation. What are the points of attachment for tRNA? How peptide bond is formed here? [[CO4](Describe/HOCQ)]
- $$3 + (3 + 3 + 3) = 12$$

Group - E

8. (a) Compare the growth pattern of wild type *E.coli* in the normal medium with the presence of following as only carbon source, with labelled diagram:
(i) only glucose, (ii) only lactose, (iii) both glucose and lactose.

What will be the conclusion from above three growth patterns of *E.coli*?

[[CO5](Remember, Explain/LOCQ)]

- (b) Draw a labelled diagram of the structure of *lac* operon. In the *lac* operon, describe the probable effect on gene expression due to the presence of the following:
- (i) Mutations in the *lac* operator
 - (ii) Mutations in the *lacI* gene
 - (iii) Mutations in the promoter.
- [[CO6](Explain/IOCQ)]
- (c) Write the assay principle and reaction for β -galactosidase.
- [[CO6](Remember /IOCQ)]
- (d) A messenger RNA 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.
- [[CO6](Analyse/HOCQ)]
- (3 + 1) + (1 + 3) + 3 + 1 = 12**
9. (a) What is epigenetics? Write the names of different processes for epigenetic gene regulation.
- [[CO6](Remember/LOCQ)]
- (b) Explain the mechanism of transcriptional gene silencing by methylation of DNA with labelled Diagram.
- [[CO6](Explain/IOCQ)]
- (c) Write the names of two types of small RNA which regulates gene expression explain molecular mechanism of gene regulation by anyone small RNA that you have mentioned
- [[CO6](Explain/IOCQ)]
- (d) Molecular weight of a prokaryotic double stranded DNA molecule is 2.9×10^9 Daltons. If a polypeptide chain contains 1,500 amino acid residues, calculate the number of such polypeptide chains that can be synthesised from the above DNA.
- [[CO6](Alalysis/HOCQ)]
- (1 + 2) + 3 + (1 + 3) + 2 = 12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	25	48.96	26.04

Course Outcome (CO):

After the completion of the course students will be able to

CO1. Identify and analyze the different components and mechanism of replication.

CO2. Describe different types of DNA damage and repair systems and recombination process.

CO3. Comment on various components and detailed process of transcription.

CO4. Comment on various components and mechanism of translation.

CO5. Understood the rational of genetic code.

CO6. 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.