

MOLECULAR BIOLOGY
(BTC2203)

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 4 (four) from Group B to E, taking one from each group.*

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

Group – A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) 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.
- (ii) A bacterial strain has a circular genome of 4.6×10^6 bp. It takes 40 minutes for the cell to completely replicate its genome from a single origin with two replication forks moving bidirectionally. What is the average rate of synthesis (bp/second) per single replication fork?
 - (a) 958 bp/second
 - (b) 1917 bp/second
 - (c) 2875 bp/second
 - (d) 3833 bp/second
- (iii) The 3' end of a mature eukaryotic mRNA contains
 - (a) A triphosphate group
 - (b) A poly A tail
 - (c) A 3' -OH group
 - (d) An oligo dT tail
- (iv) Topo II favours transcription because
 - (a) It favours DNA binding
 - (b) It favours DNA supercoiling
 - (c) It favours DNA unwinding
 - (d) It is an exonuclease
- (v) The eukaryotic protein that binds TATA-box is
 - (a) RNA polymerase I
 - (b) RNA polymerase II
 - (c) TF II H
 - (d) TBP
- (vi) Wobble position is the
 - (a) 3rd nucleotide of a codon
 - (b) 1st nucleotide of anticodon
 - (c) 1st nucleotide of codon
 - (d) 3rd nucleotide of anticodon
- (vii) 5' UTR contains:
 - (a) Shine-Dalgarno sequence only
 - (b) Anti Shine-Dalgarno sequence only
 - (c) Start codon
 - (d) Shine-Dalgarno sequence or Kozak sequence

- (viii) The small subunit of ribosome binds
 (a) mRNA (b) amino acyl tRNA
 (c) IF I (d) All of these
- (ix) Bacterial antibiotics can interfere with all of the following, except:
 (a) Protein Synthesis (b) Peptidoglycan Synthesis
 (c) Reverse Transcription (d) DNA Synthesis.
- (x) One of the reasons why non-substrate inducers (e.g. IPTG) are preferred over substrate inducers (e.g. lactose) for induction of an inducible operon is because:
 (a) They interact with the activation sequences and induce enhancers
 (b) They directly interact with the promoter sequences
 (c) They directly interact with the repressor
 (d) They directly interact with operator region.

Fill in the blanks with the correct word

- (xi) The enzyme responsible for relaxing supercoiled DNA to allow for the initiation of replication in *E.coli* is called _____.
- (xii) DNA ligase seals the nicks between DNA fragments by catalysing the formation of a _____ between the 3' hydroxyl and 5' phosphate ends of the DNA
- (xiii) Primase synthesizes the _____ primer at the site of replication to start the replication process. *in vivo*.
- (xiv) Operator is a segment of _____ and acts as a site of repressor attachment.
- (xv) One unusual base present in tRNA is _____.

Group - B

2. (a) Describe the structure of DNA pol-III in prokaryotic cell, mentioning the subunit names and their functions. [[CO1](Analyse/IOCQ)]
- (b) Explain with a proper diagram how the same DNA polymerase-III enzyme carries out the synthesis of DNA on both strands of DNA in *E. coli*.? [[CO1](Remember/LOCQ)]
- (c) What is replicon? Explain the steps and mechanism of initiation of DNA replication in *E. coli* with a labelled diagram. [[CO1](Apply/IOCQ)]
- 4 + 4 + 4 = 12**
3. (a) Discuss the experiment (design, results conclusion and interpretation) with labelled diagram which showed that DNA synthesis during replication is semidiscontinuous. [[CO3](Analyse/IOCQ)]
- (b) Explain the steps and mechanism of Nucleotide excision repair system in *E.coli*, with labelled diagram? [[CO2](Explain/IOCQ)]
- (c) Write about the structure and function of primase and helicase in *E.coli* DNA replication. [[CO2](Apply/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?

[[CO2](Apply/IOCQ)]

$$4 + 3 + (1.5 + 1.5) + 2 = 12$$

Group - C

4. (a) A segment of DNA in *E. coli* has the following sequence of nucleotide pairs:

+1

5'-TATAATGACGTTACCCGACATAGC-3'

3'-ATATTACTGCAATGGGCTGTATCG-5'

When this segment is transcribed by RNA polymerase, what will be the sequence of the mRNA? Analyse your answer.

[[CO3](Understand/HOCQ)]

- (b) Refer to the above DNA sequence to answer the following:

(i) What is the consensus sequence present?

(ii) What is the significance of +1?

(iii) Identify the sense strand.

(iv) What is the role of non-template strand?

[[CO3](Apply/IOCQ)]

$$4 + (4 \times 2) = 12$$

5. (a) Describe in detail the function of the followings in the assembly of TIC in eukaryote: TBP, TAF, TF II B, TF II F and TF II H.

[[CO3] (Remember/LOCQ)]

- (b) How transition from the initiation to elongation phase takes place in eukaryotic transcription?

[[CO3] (Understand/IOCQ)]

- (c) Mention the functions of the following enzymes in polyadenylation:

CPSF, Cst F, PAP and PAB 2

[[CO3] (Explain/HOCQ)]

$$5 + 3 + 4 = 12$$

Group - D

6. (a) What is ORF? What marks the start and end points of an ORF?

[[CO4](Understand/LOCQ)]

- (b) "Eukaryotic genes are split in nature"- Explain. Describe an experiment to prove it.

[[CO4](Understand/IOCQ)]

- (c) Discuss the molecular mechanism of polyadenylation.

[[CO4](Remember/LOCQ)]

$$4 + 4 + 4 = 12$$

7. (a) Compare and contrast between different intron splicing mechanism.

[[CO4](Understand/IOCQ)]

- (b) State how only 4 bases code for 20 amino acids?

[[CO4](Explain/LOCQ)]

- (c) What hypothesis is put forward to explain codon-anticodon base pairing?

[[CO5](Analyse/HOCQ)]

$$5 + 3 + 4 = 12$$

Group - E

8. (a) What are different types of motifs present in DNA binding protein? Describe their structural features.

[[CO6](Analyse/IOCQ)]

- (b) By which experimental techniques we can find out that *E.coli* cell contains DNA binding protein? Explain one of that technique with a labelled diagram.
[[CO6](Remember/IOCQ)]
- (c) Calculate the smallest number of molecules of ATP will be required to synthesize a protein with 100 amino acid by ribosome of *E.coli*.
[[CO6](Apply/HOCQ)]
4 + (1 + 4) + 3 = 12
9. (a) Explain the mechanism of gene regulation in eukaryote by a water soluble hormone, with a labelled diagram.
[[CO6](Analyse/IOCQ)]
- (b) Explain the mechanism of antitermination in phage lambda, with a labelled diagram.
[[CO6](Remember/LOCQ)]
- (c) Draw a diagram showing all the regulatory and structural elements of a eukaryotic gene.
[[CO6](Apply/IOCQ)]
- (d) (i) If 80% of the *E.coli* chromosome codes for specific proteins of average MW 70,000, how many protein can be made?
- (ii) Molecular weight of a prokaryotic double stranded DNA molecule is 6×10^6 . If a polypeptide chain contains 2,000 amino acid residues, calculate the number of such polypeptide chains that can be synthesised from the above DNA.
[[CO6](Apply/HOCQ)]
3 + 3 + 3 + (2 × 1.5) = 12
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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	23.9	57.3	18.8