B.TECH/ BT/4TH SEM/ BIOT 2203/2018

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) 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 nucleotides (b) 100 base pairs
(c) 1000 nucleotides (d) 1000 base pairs.

(ii) Meselson and Stahl allowed bacteria raised in ^{15}N medium to replicate in ^{14}N medium. At the end of two rounds of DNA replication, they observed _____ band (s) in their centrifugation tubes which was/were composed of _____.
(a) 1; single strands of ^{15}N DNA base-paired to single strands of ^{14}N DNA
(b) 1; double strands of DNA, each strand made up of a mixture of ^{14}N and ^{15}N DNA
(c) 2; double strands of ^{14}N DNA at the top and double strands of ^{15}N DNA at the bottom
(d) 2; double strands of ^{14}N DNA at the top and strands of ^{15}N DNA based-paired to strands of ^{14}N DNA in the middle.

(iii) For the E. coli genotype $I^+P^+O^cZ^+Y^+A^+$, the expression of β-alactosidase will be
(a) inducible (b) constitutive (c) absent (d) lethal.

(iv) Function of eukaryotic RNA pol III is
(a) synthesis of tRNA
(b) synthesis of mRNA
(c) synthesis of tRNA and 5S rRNA
(d) synthesis of rRNA except 5S rRNA.

(v) Translation in animal cells takes place
(a) in the cytoplasm only
(b) in the nucleus only
(c) in the cytoplasm and the mitochondrial matrix
(d) in the nucleolus only.

(vi) Which one of the following modification is common to both proteins and DNA?
(a) SUMOylation (b) Nitrosylation
(c) Methylation (d) Ubiquitination.

(vii) Match the antibiotics in Group-I with the targets of Group –II

Group-I	Group-II
P. Nalidixic acid	1. RNA polymerase-II
Q. α-amanitin	2. Bind at A site of ribosome
R. Puromycin	3. DNA gyrase
S. Rifampicin	4. RNA polymerase.

(a) P-1, Q-4, R-3, S-2 (b) P-3, Q-1, R-4, S-2
(c) P-3, Q-1, R-2, S-4 (d) P-1, Q-3, R-2, S-4.

(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) In humans, the enzyme having reverse transcriptase activity is
(a) Ribonuclease P (b) Ribonuclease D
(c) Recombinase (d) Telomerase.

(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
(a) they directly interact with the promoter sequences
(b) they directly interact with the repressor
(c) they directly interact with operator region
(d) they interact with the activation sequences and induce enhancers

Group – B

2. (a) Describe the experiment (design, results and interpretation) with labelled diagram which showed that DNA synthesis during replication is semidiscontinous.

(b) Describe Nucleotide excision repair system in E.coli, with labelled diagram.

(c) 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?

(d) Write about the structure and function of primase and helicase in *E.coli* DNA replication.

4 + 3 +(2 + 1) + 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.

(b) Describe the recombination mechanism of bacterial chromosome with λ DNA with labelled diagram.

(c) Describe the mechanism of DNA damage that occurs by UV radiation and describe the mechanism of repair of that DNA damage by light dependent repair system.

(d) A bacterium synthesizes DNA at each replication fork at a rate of 1000 nucleotides per second. If this bacterium completely replicates its circular chromosome by theta replication in 30 minutes, how many base pairs of DNA will its chromosome contain?

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

Group – C

4. Following is a DNA segment:

+1

5′ CATACATGGTATAATGACGTTACCCGACATAGCTACGATGACGATA 3′

3′ GTATGTACCATATT ACTGCAATGGGCTGT ATCGATGCTACTGC TAT 5′

(a) Write down the sequence of sense RNA strand produced from this.

(b) Why it is called the "sense" strand?

(c) Is it a prokaryotic or eukaryotic DNA? Explain.

(d) Name the two DNA strands and explain their meaning.

(e) If this DNA segment ends with following sequence:
5′ GCCGCCAGUUCCGCUGGCGGCAUUUUUUUUU 3′,
Then, what will be the termination mechanism? Explain.

(f) Name the symmetry found here.

2 × 6 =12

5.(a) Describe the process of assembly of eukaryotic transcription initiation complex.

(b) What is the significance of CTD of the largest subunit of RNA pol II in the transition of the enzyme from the initiation to elongation phase?

(c) Mention the functions of the following enzymes in capping enzyme complex: RNA terminal phophatase, Guanylyl transferase

5 +3 + 4= 12

Group – D

6.(a) What is ORF? Where it is present? Where it starts and ends? How ribosome starts translation from the start codon?

(b) What are isoaccepting tRNAs? What is meant by Glu-$tRNA^{Glu}$ and Glu-$tRNA^{Gln}$ and where are they found? Can they be inter converted?

(c) How chloramphenicol inhibits prokaryotic translation?

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

7. (a) Compare : Shine-Dalgarno sequence and Kozak sequence.

(b) Write a short note on the cloverleaf structure of tRNA.

(c) Why genetic code is called universal?

5+5+2= 12

Group – E

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

(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

(c) Write the assay principle and reaction for of β-galctosidase.

(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.

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

9. (a) What is HRE? Describe the role of HRE in eukaryotic gene regulation.

(b) What is antisense RNA? How does it control gene expression?

(i) Describe the experimental techniques used to find out the DNA binding sequence of a repressor molecule with a labelled diagram.

(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?

(1+2)+3+(4+2)= 12