7. (a) What is genetic code? Briefly mention its characteristics.

(b) What is the significance of the position of start codon in an ORF?

(c) State and explain Wobble hypothesis.

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

Group – E

8. (a) Define the following in the context of gene regulation with example:
(i) Silencer (ii) enhancer (iii) insulator (iv) appo-repressor

(b) Explain with labeled diagram the mode of operation of lac operon
(i) in absence of lactose   and   (ii) in presence of lactose

$$(1 \times 4) + (4 \times 2) = 12$$

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

(b) What determines whether phage lambda will enter the lytic or lysogenic state when it infects E.coli?

(c) 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?

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

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) Discontinuous replication in lagging strand is a result of which property of DNA?
(a) Complementary bases   (b) Charged phosphate group
(c) Antiparallel nucleotide strands   (d) Five-carbon sugar.

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

(iii) Which mechanism requires the ability to distinguish between newly synthesized and template strands of DNA?
(a) Nucleotide selection   (b) DNA proofreading
(c) Mismatch repair   (d) All of the above.

(iv) Function of eukaryotic RNA pol III is to synthesize
(a) all rRNA except 5S   (b) all mRNAs
(c) tRNA and small RNAs   (d) any RNA.

(v) Which type of replication requires a break in the nucleotide strand to get started?
(a) Theta replication   (b) Rolling-circle replication
(c) Linear eukaryotic replication   (d) All of the above.

(vi) Ribozyme is
(a) ribosomal RNA   (b) catalytic RNA
(c) type of lysozyme   (d) RNA polymer.

(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) All of the following are examples of housekeeping genes except ___
    (a) beta galactosidase   (b) ribosomal protein
    (c) RNA polymerase   (d) RNA primers could not be removed.

(ix) Which is NOT a DNA-binding domain?
    (a Leucine zipper   (b) Helix-turn-
    (c) Zinc finger   (d) Intron-exon-intron.

(x) Which is not a mechanism of epigenetic change?
    (a DNA methylation   (b) Alteration of a DNA base sequence in a promoter
    (c) Histone actylation   (d) Nucleosome repositioning.

Group – B

2. (a) Write the reaction mechanism with labeled diagram of the following enzymes of *E.coli*:
    (i) DNA polymerase-I   (ii) DNA ligase   (iii) Topoisomerase type-I

   (b) Describe Meselson & Stahl experiment, with labeled diagram.

   (c) The *E. coli* chromosome contains 4.64×10^6 bp. (i) How many turns of the double helix must be unwound during replication of the *E. coli* chromosome? (ii) From the above data, how long would it take to replicate the *E. coli* chromosome at 37 ^{0}C, if two replication forks proceeded from the origin? Assume replication occurs at a rate of 1,000 bp/s. Under some conditions E. coli cells can divide every 20 min. How might this be possible?

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

3. (a) In what types of cells end problem of DNA replication is absent? Describe with labeled diagram, the mechanism by which the end problem is solved in those types of cells?

   (b) Describe the SOS repair system in E.coli 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 mitochondrial 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.

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

Group – C

4. (a) What is central dogma of life? How it has been modified?

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

    3′ATATTACTGCAATGGGCTGT ATCGATGCTACTGC TATTCGCT GTATC 5′

    5′ TATAATGACGTTACCCGACATAGCTACGATGACGATAAGCGACATAG 3′

         +1

   When this segment of DNA is transcribed by RNA polymerase, what will be the sequence of nucleotides in the RNA transcript? What is the +1 site? Show the conserved sequence and mention its significance in prokaryotic transcription initiation.

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

5. (a) Describe the process of 5′ capping in eukaryotic mRNAs.

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

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

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

Group – D

6. (a) What is Shine-Dalgarno sequence? What is the role of this in eubacterial translation?

   (b) Describe the process of 3′ polyadenylation for eukaryotic mRNAs. What is the function of poly A+ tail?

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