GROUP—B

Answer *any* **one** question : 8×1=8

15. *(a)* Jack Szostak and colleagues proposed the double strand break model of DNA recombination in 1983. Write briefly about the main features of this model step by step.

(b) What are the properties of RecBCD enzyme?

(c) Write briefly about the action of RuvC Resolvase enzyme.

(d) Write the model of action of Ethyl methane sulfonate. 3+2+2+1=8

(OR)

16. *(a)* The existence of unstable form in tautomers may lead to error of base incorporation during DNA replication. Explain in brief what happens in the process.

(b) Discuss how deamination and depurination leads to mutation in DNA.

(c) "Kelner (1949) observed that the UV damage to DNA of *E. coli* could be reversed if UV irradiated cells are exposed to visible light in the blue range." Explain the mechanism of this repair system.

(d) Write briefly the role of MutS, MutL and MutH in mismatch repair of DNA in *E. coli*. 2+2+2+2=8

★★★

M. Sc. BIOTECHNOLOGY EXAMINATION, 2025

(1st Year, 1st Semester)

PAPER : SC/BT/PG/133T

(Microbial Genetics and Fundamentals of Molecular Biology)

Time : 2 *Hours* *Full Marks* : 40

GROUP—A (Marks 32)

PART—I (Answer any *one* question)

1. *(a)* Does the strength of a hydrogen bond depends on the relative geometrical positions of a given pair of hydrogen bond donor and acceptor? Provide an example where this particular feature of hydrogen bond affects the stability of DNA double helix. 2

(b) What do you mean by the compounds with high-energy bonds? Mention, how these compounds play key role in driving the energetically unfavourable biosynthetic reactions to the forward direction. 2

(c) Which moiety of the RNase P plays a vital functional role? Present an experimental evidence that it is the RNase P RNA and not the protein moiety that plays an actual functional role in cleaving the pre-tRNA substrate. 2

[CO1, CO4]

2. *(a)* What is a RNA pseudoknot? Cite an example of the biological significance of a pseudoknot. 2

(b) You treat a protein with the denaturant urea. For each interaction or bond below, state if that specific interaction or bond is disrupted by the urea treatment.

(i) Ionic bonds

(ii) Hydrogen bonds

(iii) Disulfide bonds

(iv) Peptide bonds 2

(c) Using a necessary diagram, describe what is base triple. In what type of biomolecules this type of interaction is frequently seen? 2

[CO1, CO4]

3. *(a)* Provide with necessary justification how it was ascertained that the peptidyl transferase activity in the ribosome is a ribozyme. 2

(b) What is stacking interaction? Which chemical force is instrumental behind the stacking interaction? 2

(c) What is writhe? Mention different kinds of writhes that are found in the biological system with specific examples. 2

[CO1, CO4]

13. In an interrupted mating experiment, five *Hfr* strains were tested for the sequence in which they transmitted ten gene markers F, G, O, P, Q, R, S, W, X, Y to an F^- recipient cell. The orders of transmission were :

Hfr H : Q S R P O F
Hfr BD1 : Y G F O P R
Hfr C : R S Q W X Y
Hfr N : O P R S Q W
Hfr 51 : Q W X Y G F

What is the gene sequence in the original strain from which these *Hfr* strains were derived? For each *Hfr* strain, state which donor gene marker should be selected in the recipients after conjugation to obtain the highest proportion of recombinants that will be *Hfr*? 6

[CO3, CO4]

14. *(a)* Distinguish between a missense and non-sense mutation. Which one among these two you think is more detrimental? 2

(b) Explain why in an *Hfr* X F^- cross the recipient F^- cell is not frequently transformed in *Hfr* strain. 2

(c) What do you mean by 'Chromosomal Aberration'? Mention a deadly disease that is associated with chromosomal aberration and list the type of specific aberration. 2

[CO3, CO4]

(OR)

11. *(a)* Mention the different mechanisms used to ensure translation accuracy, beginning with the charging of the tRNA and continuing up to the transfer of the amino acid to the growing polypeptide chain. 4

(b) An ORF is composed of 636 nucleotide long, including the initiator and termination codons. Calculate the number of amino acids in the protein translated from this mRNA. 1

[CO2, CO4]

PART—III (Answer any *one* question)

12. Match the following column–I terms with correct options of column–II with their definition.

Column–I	Column–II
P. *trans* acting factors	*(i)* Luria Delbruck Fluctuation Test
Q. Spontaneous mutation	*(ii)* Bacteriophage infection
R. *cis-trans* concept	*(iii)* *lac* repressor
S. MOI	*(iv)* Seymour Benzer's Complementation Analysis with T4 rII locus
T. Generalized Transduction	*(v)* Bacteriophage P22

6

PART—II (Answer all questions)

4. *(a)* A loss-of-function mutation happens in *dam* gene (encoding the Dam methylase) in *E. coli*. Predict the phenotype you would observe with respect to initiation of replication in this mutant. Briefly explain your answer. 2

(b) What is Okazaki fragment? Why these fragments are generated during DNA replication? Using necessary diagrams and flowchart briefly describe the experiment (long description is not necessary), which Okazaki designed to detect the existence of these smaller fragments. Why was it important to use a short exposure to the radioactive pulse rather than a longer one in this experiment? 3

(OR)

5. *(a)* In Meselson and Stahl's experiment, in which *E. coli* cells were grown in $^{15}NH_4Cl$ containing medium for many generations followed by transferring the cells to medium containing $^{14}NH_4Cl$ as the principal source of nitrogen. Aliquots were withdrawn at 20 minutes and 38 minutes after the shift to $^{14}NH_4Cl$ medium followed by the extraction of the genomic DNA and subjected to the centrifugation in a sedimentation equilibrium gradient with 6M CsCl. Assuming the DNA replication is semi-conservative, show what kinds of band-patterns of sedimenting DNA is expected to occur in the gradient at these two time points. Assume that the generation time of *E. coli* is approximately 20 minutes under the given growth condition. 2

(b) You have a collection of temperature sensitive mutant in *E. coli* cells and you believe that a fraction of this collection is defective in DNA replication. Design an experiment to identify which mutants in your collection indeed are defective in replication at 37 °C. 3

[CO2, CO4]

6. *(a)* Consider a bacterial promoter with –35 and –10 elements. Which assay will be the most appropriate method to show that RNA polymerase binds at regions centered on the –35 and –10 positions upstream of the start site of transcription? 2

(b) Describe briefly the events involved in the dissociation of sigma factor from the RNA polymerase holoenzyme complex. 3

(OR)

7. *(a)* Consider the Rho-independent terminator sequence.

5′-CCCAG**CCC**GCCUAAUGAGC**GGG**CUUUUUUUU-3′

Why does a point mutation at any one of the boldfaced nucelotides would disrupt termination of transcription? How would you test your conclusion? 2

(b) When a bacterial cell is present in an environment where both lactose and glucose are present, the glucose will be metabolized first and the lactose will only be used when the stores of glucose have been completely depleted. How does the bacterial cell recognize the fact that glucose is present and turn off the transcription even when lactose is present? 3

[CO2]

8. *(a)* Write the name of a prokaryotic protein, which acts as negative as well as positive regulator of gene expression. How does this protein regulate the expression of the relevant genes in prokaryotes? 3

(b) What phenotype you would anticipate in the following *E. coli* strains in terms of β-galctosidase production in absence of lactose and in its presence : *(i)* $i^+o^+Z^+Y^-A^+$ and *(ii)* $i^+o^cZ^+Y^+A^+$? 2

(OR)

9. *(a)* How does the mechanism of attenuation contribute to the regulation of *trpEDCBA* genes in *E. coli*? How is attenuation overridden in absence of tryptophan in the medium? 4

(b) What is riboswitch? Provide two examples where you come across the involvement riboswitches in the regulation of gene expression. 1

[CO2, CO4]

10. *(a)* Explain why you cannot predict the exact RNA sequence if you are given a protein sequence. 1

(b) Describe what are the A, P and E sites of the ribosome. Which t-RNA intermediates occupy each of these sites after peptidyl-transfer, but before translocation is completed by EF-G? 2

(c) What is the Shine-Dalgarno sequence? What binds to the sequence during translation? 2