

SC/BT/PG/133T/2024

MASTER OF SCIENCE EXAMINATION, 2024

(1st Year, 1st Semester)

BIOTECHNOLOGY

PAPER : SC/BT/PG/133T

(Microbial Genetics and Fundamentals of
Molecular Biology)

Time : 2 Hours

Full Marks : 40

Answer from both the Groups as directed.

GROUP—A

*Answer Question No. 1 and any **six** from
Question No. 2 to Question No. 11.*

1. Answer any **eight** questions : 1×8=8
- (a) Why weak chemical interactions play more critical functional roles in biological system than covalent bond?
 - (b) What is the difference between polar and non-polar molecules? Does Van der waals' interaction take place between the polar molecules?
 - (c) **Assertion (A) :** The base pairs at the two termini of a piece of linear DNA frequently unwinds and rewinds a phenomenon called breathing.
Reason (R) : Strength of base stacking is very minimal at the end of a linear piece of DNA.

BIOTECH-435

[Turn Over]

(2)

Choose the *correct* option.

- (i) Both (A) and (R) are true and (R) is the correct explanation of (A)
 - (ii) Both (A) and (R) are true and (R) is not the correct explanation of (A)
 - (iii) (A) is true but (R) is false
 - (iv) (A) is false but (R) is true
- (d) Eukaryotic core promoter contains TATA box at around-30 position (Choose the correct option)
- (i) in almost all genes of mRNAs
 - (ii) in almost all genes of rRNAs
 - (iii) in half of the genes of mRNAs
 - (iv) in half of the genes of rRNAs
- (e) An altered form of a replicative DNA polymerase lacks 3' → 5' exonuclease activity.
This alteration would most likely result in which of the following? (Choose the correct option)
- (i) A decrease in processivity
 - (ii) An increased mutation rate
 - (iii) An inability to replicate DNA
 - (iv) An inability to remove RNA primers
- (f) If you have a polypeptide of size 11 kilo Daltons, what would be the mass of the Open Reading Frame that codes for the polypeptide in Daltons?

(7)

GROUP—B

Answer *any one* question :

8×1=8

12. (a) Are there any mutagens which mimic the structure of DMT bases. If yes, give an example and discuss its mechanism of action.
- (b) Name the enzymes involved in DNA mismatch repair and nucleotide excision repair mechanisms.
- (c) Explain briefly the process of DNA recombination by the RecBCD enzyme. 3+2+3=8
13. (a) Acridine dyes have been shown to cause deletion or insertion of a single base pair. Explain in brief the mechanism of action.
- (b) How are recombination intermediate with two Holliday Junctions arising due to DSBR resolved?
- (c) “A Chi site is a short stretch of DNA in the genome of a bacterium near which homologous recombination is more likely to occur” — Explain.
- (d) Alkylating agents are reactive compounds that can transfer methyl or ethyl groups to a DNA base. Discuss briefly about this important type of damage and how they can be repaired. 2+2+2+2=8

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(6)

(b) What is F' *E. coli* strain? How is F' strain derived from Hfr strain? 3+1

9. (a) A Hfr strain (genotype Hfr His⁺Trp⁺arg⁺) was crossed with recipient F⁻ strain (Genotype F⁻ His⁻Trp⁻arg⁻). The mating mixture was plated on a minimal plates containing histidine and arginine but no tryptophan. Which one is the selected markers and which ones are unselected markers?

(b) Explain why in HFR X F⁻ cross, the F⁻ strain is not frequently converted into an Hfr strain? 2+2

10. Provide an experimental evidence to prove that in bacteria, genetic mutations arise in the absence of selection, rather than being a response to selection. Use a diagrammatic outline of your experiment without much description. 4

11. Match the following **Column-I** terms with **correct** options of **Column-II** with their definition : 4

Column-I	Column-II
P. trans-acting factors	(i) Luria Delbruck Fluctuation Test
Q. Spontaneous mutation	(ii) Bacteriophage infection
R. Plaque	(iii) DnaB
S. MOI	(iv) Quantification of Phage titre

(3)

(g) For their efficient translation, *E. coli* mRNAs possess a Shine-Dalgarno sequence for its recognition by an anti-Shine-Dalgarno sequence (ASD) present in one component of ribosome is (Choose the correct option)

- (i) 5S rRNA
- (ii) 23S rRNA
- (iii) 16S rRNA
- (iv) None of the above

(h) Which of the following is/are **not** essential for Hfr X F⁻ cross in *E. Coli*? (Choose the correct option)

- (i) Autonomous existence of F⁺ plasmid
- (ii) Integration of the F⁺ factor in the *E. coli* genome
- (iii) Presence of sex pili
- (iv) All of the above

(i) What is a plaque? How is it useful to the geneticists?

(j) How bacteriophages with single stranded DNA as their genome carry out their replication?

2. (a) Very briefly explain why DNA replication is semi-discontinuous in all organisms? Which experimental evidence supports that DNA replication is semi-discontinuous? Describe the experiment diagrammatically using flowchart (No description is necessary).

(4)

- (b) Is it possible to employ the sucrose-gradient centrifugation technique to separate the two DNA molecules, which are labeled with N¹⁴ and N¹⁵ respectively? Explain with justification. 3+1
3. (a) Explain with suitable diagram how do bacteria ensure that their DNA is neither over-replicated nor under replicated?
(b) What is the role of beta-clamp in DNA replication? 3+1
4. (a) Why is dissociation of sigma factor is vital for transition of the RNA polymerase holoenzyme from initiation to elongation phase of prokaryotic transcription? Describe briefly the events involved in the dissociation of sigma factor from the RNA polymerase holoenzyme complex.
(b) What is 'rut' site? How is this site involved in prokaryotic transcription? 3+1
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 is this DNA strand called so?
(b) Consider the Rho-independent terminator sequence
5'-CCCAGCCCGCCUAAUGAGCGGGCUUUUUUUU-3'
Why does a point mutation at any one of the boldfaced nucleotides would disrupt termination of transcription?
How would you test your conclusion? 2+2

(5)

6. (a) Show using a diagram the events involved in prokaryotic translation initiation. What is the role of IF1?
(b) What is the role of start codon in an ORF? 3+1
7. (a) Mention any three characteristics of genetic code.
(b) Explain why if you are given a protein sequence, you cannot predict the exact RNA sequence that was used by the cell to generate that sequence? 2+2
8. (a) 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 the Hfr strain 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?