

2021

BIOCHEMISTRY — HONOURS

Paper : CC-11

(Gene, Gene Expression and Regulation)

Full Marks : 50

The figures in the margin indicate full marks.

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

1. Answer **any five** questions : 2×5
- (a) What features distinguishes eukaryotic genome from prokaryotic genome?
 - (b) Define replication fork with labelled diagram.
 - (c) What is the source of energy used in formation of a peptide bond?
 - (d) Name two inhibitors of protein synthesis.
 - (e) Define mutagens with example.
 - (f) What do you mean by linking number of DNA?
 - (g) Differentiate between leading strand and lagging strand during replication.
 - (h) What are the consequences of a transposon insertion in
 - (i) the middle of the β galactosidase gene of the lac operon
 - (ii) the promoter region of the lac operon.
 - (i) What are riboswitches? How do they function?
 - (j) Differentiate between intragenic and intergenic suppression.
2. Answer **any two** questions :
- (a) What type of interaction occurs between t-RNA and m-RNA during protein synthesis? How do the roles of ATP and GTP differ in translation? Describe the importance of heterochromatin and euchromatin in DNA replication and gene expression. 1+2+2
 - (b) What are the main differences between prokaryotic DNA polymerase I, Polymerase II and Polymerase III? How many different kinds of t-RNA molecules are required for translation? What is the importance of 3'-OH group of a t-RNA? 3+1+1
 - (c) (i) Why do you think genetic information is stored in DNA and not in RNA?
(ii) Write down the functions of t-RNA. What are telomeres? 2+(2+1)

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- (d) (i) How does rolling circle DNA replication mechanism differ from the mechanism of chromosomal DNA replication. Explain with schematic diagram.
- (ii) List the most important differences between base excision repair and nucleotide excision repair.

3+2

Unit - IAnswer **any one** question.

3. (a) How would you prove that DNA synthesis occurs in 5' → 3' direction?
- (b) What do you mean by horizontal transfer of genes? What is Ames test? What is its importance?
- (c) A culture of *E. coli* growing in a medium containing $^{15}\text{NH}_4\text{Cl}$ is switched to a medium containing $^{14}\text{NH}_4\text{Cl}$ for 3 generations. (an 8 fold increase in population). What is the molar ratio of hybrid DNA (^{15}N – ^{14}N) to light DNA (^{14}N – ^{14}N) at this point? Explain your answer.
- 2+(1+3+1)+3
4. (a) The *E. coli* chromosome contains 4,000,000 bps. How many turns of the double helix must be unwound during replication of the *E. coli* chromosome? What is mismatch repair?
- (b) Explain post replication recombination repair with schematic diagram. What are the roles of topoisomerases during replication?
- (c) Which amino acid residue is in abundance in histones? Which histone is not part of nucleosome?
- (1+2)+(3+2)+(1+1)

Unit - IIAnswer **any one** question.

5. (a) Explain ρ-dependent termination of transcription with schematic diagram.
- (b) Determine the minimum energy cost in terms of ATP equivalents expended, required for the biosynthesis of the β globin chain of hemoglobin (146 residues) starting from a pool including all necessary amino acids, ATP and GTP. Assume that, no losses are incurred as a result of proof reading.
- (c) Distinguish between charged and uncharged tRNA? Briefly describe the steps of charging tRNA.
- 3+3+(1½+2½)
6. What is called charged tRNA? How eukaryotic initiator-tRNA molecules differ from the prokaryotic initiator molecule? Define consensus sequence with example. What is the basic composition of large subunit of a prokaryotic ribosome? "Coupled transcription and translation occurs in prokaryotes." – Explain. Why stop codon is important?
- 1+2+2+1+3+1

Unit - IIIAnswer **any one** question.

7. What are regulatory proteins? Define an effector and inducer with example. Explain how lactose molecules first enter an uninduced $i^+ p^+ o^+ z^+ y^+$ cell to induce β-galactosidase synthesis. What is a negatively controlled inducible operon? What is constitutive gene?
- 2+3+2+2+1

8. (a) *E. coli* cells are growing in a medium containing lactose, but no glucose. Indicate whether each of the following changes or conditions would increase, decrease or not change the expression of the lac operon. Explain with a suitable diagram.
- (i) Addition of a high glucose concentration.
 - (ii) A mutation that prevents dissociation of the lac repressor from the operator.
 - (iii) A mutation that completely inactivates β galactosidase.
 - (iv) A mutation that completely inactivates galactoside permease.
 - (v) A mutation that prevents binding of C R P to its binding site near the lac promoter.
- (b) How do you differentiate between monohybrid and dihybrid cross?
- (c) In a cross between a 'black' and 'white' guinea pig, all members of the F_1 generation are black. The F_2 generation is made up of $\frac{3}{4}$ th black and $\frac{1}{4}$ th white guinea pigs.
- (i) With a suitable diagram show the genotypes and phenotypes involved in this cross (both parents and offsprings).
 - (ii) Predict the genotype and phenotype of the offsprings arising from a mating between two F_2 white guinea pigs. (1×5)+1+(2+2)
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