



**ST JOSEPH’S UNIVERSITY, BENGALURU -27**

**B.Sc. Biotechnology- IV SEMESTER**

**SEMESTER EXAMINATION: APRIL 2024**

**(Examination conducted in May 2024)**

**BT422: MOLECULAR BIOLOGY**

**(For current batch students only)**

**Time: 2 Hours Max Marks: 60**

**This paper contains TWO printed pages and THREE parts**

**PART A**

**Answer any TEN of the following 2m x 10 = 20 marks**

1. What are Chargaff's rules? How do they contribute to our understanding of the structure and function of DNA?
2. How does the presence of two divalent metal ions (Mg2+ or Zn2+) in the palm domain of DNA polymerase contribute to DNA replication?
3. What are the key characteristics of DNA helicases? How do they contribute to the process of DNA replication?
4. DNA polymerase mistakenly inserts a C against a T during replication. Assuming that proofreading and mismatch repair do not correct the mismatch, name the type of the resulting mutation after the next round of replication?
5. Explain how oxidative damage to DNA can lead to the formation of 8-oxo-7,8-dihydroguanine (8-oxoG) lesions.
6. Explain the regulation of translesion polymerases in *E. coli* under normal circumstances and in response to DNA damage.
7. What is mRNA capping? What is the importance of this process?
8. Briefly explain the difference between the *upstream* and *downstream* regions of the DNA in the context of coding sequences.
9. What is the importance of the 16S rRNA with respect to initiation of translation?
10. Explain the events that take place in the A, P, and E sites of the ribosome.
11. Explain what happens to the Lac operon genes when glucose is present but lactose is absent in the growth medium.
12. Invertase enzyme is highly glycosylated, which increases the stability of this protein. Do you agree with the idea that this is an example of *transcriptional regulation*? Why or why not?

**PART B**

**Answer any FOUR of the following: 5m x 4 = 20 marks**

1. What are the differences in DNA packaging between euchromatin and heterochromatin? How do these differences impact gene expression?
2. Explain the sequential stages of DNA replication according to the trombone model in *E. coli* using a labeled diagram.
3. What are the features of eukaryotic replicator and initiator? Describe the binding of the initiator to the replicator sequence.
4. Using a flowchart, represent the molecular events associated with polyadenylation of mRNA. What is the importance of polyadenylation?
5. Briefly explain the process of termination of translation.
6. A student is growing *E. coli* cells in two flasks labeled ‘1’ and ‘2’. The nutrient media in both flasks is identical, except for the concentration of the amino acid tryptophan. The media in Flask 1 contains very low levels of tryptophan, while that in Flask 2 has high tryptophan levels. Using simple diagrams, explain how the tryptophan operon would respond in the cells of the two flasks.

**PART C**

**Answer any TWO of the following: 10m x 2 =20 marks**

1. (a) What is the end replication problem encountered during DNA replication? What is the strategy employed by the enzyme telomerase to overcome this challenge?

(b) Differentiate between base excision repair (BER) and nucleotide excision repair (NER). Provide details on their steps, enzymes involved, and differences in their recognition and repair processes.

1. (a) Explain the Hershey-Chase experiment. How did this experiment contribute to our understanding of DNA as the genetic material?

(b) Explain how the process of alternative splicing can result in the formation of diverse polypeptides from the same ORF corresponding to a genomic DNA segment.

1. (a) CRISPR-Cas9-mediated mutagenesis is used to induce mutations. This technique results in the insertion/deletion (indels) of a few nucleotide bases in the genomic DNA. Based on your understanding of frameshift mutations, explain why these indels result in loss of protein function.

(b) Given below are the images of wild type/normal (left) and mutant (right) *Drosophila* heads. The mutant fly has lost the function of a gene called *Antennapedia* (*Antp*), resulting in reduced eyes and abnormal legs arising from the head. Assuming that Antp is a negative regulator of certain genes, what may be the possible cause/s of the shown phenotypes?

