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

Registration Number:

Date & Session:

**M.Sc. BIOTECHNOLOGY – II SEMESTER**

**SEMESTER EXAMINATION: APRIL 2024**

**(Examination conducted in May/June 2024)**

**BT 8222 – MOLECULAR BIOLOGY**

**(For current batch students only)**

**Time: 2 hours Max Marks: 50**

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

**PART A**

**Answer any SEVEN of the following           2m x 7 = 14 marks**

1. The oxygen-binding proteins hemoglobin and myoglobin differ in that hemoglobin functions as a tetramer in red blood cells, whereas myoglobin functions as a monomer in muscle cells. The globular structure of hemoglobin and each hemoglobin monomer involves eight α-helical segments. Is it the primary, secondary, tertiary, or quaternary structure that differs most between these two proteins? Explain.
2. What is an ORF? Briefly describe the ORF/s of the SARS-COV2 viral genome.
3. Intergenic sequences make up 40% of the human genome. Where do these intergenic sequences come from and what are some of their functions?
4. Mention any two ways in which DNA replication can introduce double-strand breaks (DSBs) in a DNA template.
5. A key step in the initiation of replication in bacteria is to load the DnaB helicase onto the DNA at the replication origin. What proteins function at the replication origin during initiation prior to the loading of DnaB?
6. In *E. coli*, DNA polymerase I possesses 5’-exonuclease and 3’-exonuclease activities, whereas DNA polymerase III possesses only 3’-exonuclease activity. Why is there a difference in exonuclease activities associated with these two DNA polymerases?
7. Consider the Rho-independent terminator sequence given below:

5’-CCCAGC**CCG**CCUAAUGAGC**GGG**CUUUUUUUU-3’. Why would a missense mutation at any one of the nucleotides highlighted in bold disrupt the termination of transcription?

1. Write a brief note on the Shine-Dalgarno sequence.
2. What do you mean by constitutive control of transcription initiation? Give an example.

**PART B**

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

1. Describe the role of a DNA helicase at a replication fork. During PCR, you do not have to add DNA helicase to the reaction. Explain why not.
2. Compare and contrast the cut-and-paste mechanism of transposition with the replicative mechanism of transposition.
3. Describe the product of a splicing reaction in which the spliceosome recognizes a “pseudo” 3’-splice site within the intron instead of the actual 3’ splice site. The “pseudo” site is slightly upstream of the actual 3’ splice site. Illustrate this and describe how this could alter the translated protein product?
4. Describe the process polyadenylation.
5. *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 lacoperon. Draw a diagram depicting what is happening in each situation.

(a) Addition of a high concentration of glucose

(b) A mutation that prevents Lac repressor binding to the operator

(c) A mutation that completely inactivates β-galactosidase

(d) A mutation that completely inactivates permease

(e) A mutation that prevents binding of CRP to its binding site near the Lac promoter

1. Using a general diagram, explain RNA interference.

**PART C**

**Answer any TWO of the following:               8m x 2 = 16 marks**

1. Tissieres and Hopkins studied the relationship between DNA and protein synthesis. In one experiment, they measured the incorporation of amino acids into proteins in the presence of the enzyme deoxyribonuclease (DNase). They incubated a crude *E. coli* extract with varying concentrations of DNase for 10 min before adding the necessary components for the protein synthesis reaction including 14C-labeled alanine. The amount of radioactivity incorporated is represented as cpm (counts per minute) in the data summarized below:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **DNAse (µg/ml)** | 0 | 1 | 5 | 10 | 20 | 50 |
| **Cpm** | 813 | 334 | 372 | 364 | 386 | 426 |
| **% inhibition** |  | 59 | 54 | 55 | 53 | 48 |

a) What effect does the addition of DNase have on protein synthesis?

b) From what you know about the central dogma, explain why the addition of DNase

causes the effect on amino acid incorporation observed.

1. Using a correctly labelled diagram, describe the structure of a prokaryotic promoter. Also explain how transcription initiation takes place in prokaryotes.
2. Describe how, in bacteria, CRISPRs are a record of infections survived and resistance gained.