STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI –600 086
(For candidates admitted from the academic year 2023 – 2024 & thereafter)

M. Sc. DEGREE EXAMINATION, APRIL 2026
BIOINFORMATICS
SECOND SEMESTER

COURSE : CORE
PAPER : MOLECULAR BIOLOGY
SUBJECT CODE : 23BI/PC/MB24
TIME : 3 HOURS MAX. MARKS: 100

Q. No.	SECTION A All questions to be answered (10 x 1=10 marks)	CO	KL
1	In the study of DNA polymorphism, which structural conformation is characterized by a left-handed helical twist, a "zigzag" phosphate backbone, and is often associated with regions of active transcription or high salt concentrations? a) A-DNA b) B-DNA c) Z-DNA d) H-DNA	CO1	K1
2	During the eukaryotic cell cycle, the "M-phase checkpoint" (Spindle Checkpoint) specifically prevents the transition from metaphase to anaphase until which condition is met? a) All DNA replication is completed and error-free. b) All chromosomes are properly attached to spindle microtubules via kinetochores. c) The cell has reached a sufficient size and nutrient threshold. d) Cyclin D levels have peaked to activate CDK4.	CO1	K1
3	Unlike the nuclear genome, the DNA found within mitochondria and chloroplasts typically exhibits which of the following organizational characteristics? a) Linear structure with associated histone proteins. b) Circular structure, largely devoid of histones, following uniparental inheritance. c) Highly repetitive sequences with multiple centromeres. d) Presence of a 5' cap and a 3' poly-A tail on all genomic DNA strands.	CO1	K1
4	Which of the following infectious agents is composed entirely of protein with no detectable nucleic acids (DNA or RNA), and is responsible for causing transmissible spongiform encephalopathies? a) Viroids b) Bacteriophages c) Prions d) Retroviruses	CO1	K1
5	During DNA replication in eukaryotes, which specialized enzyme is responsible for extending the 3' ends of linear chromosomes to prevent the loss of genetic information during successive rounds of division? a) DNA Polymerase III b) Telomerase c) DNA Ligase d) Helicase	CO1	K1
6	In eukaryotic RNA processing, the process of Splicing involves the removal of non-coding sequences and the joining of coding sequences. What are these specific sequences called? a) Removal of Exons; joining of Introns b) Removal of Promoters; joining of Operators c) Removal of Introns; joining of Exons d) Removal of Poly-A tails; joining of 5' Caps	CO2	K2

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7	The "Wobble Hypothesis," proposed by Francis Crick, explains why there are fewer tRNA molecules than there are codons for amino acids. Which position of the codon-anticodon pairing allows for this non-standard base pairing? a) The first (5') position of the codon. b) The second position of the codon. c) The third (3') position of the codon. d) Any position within the anticodon loop.	CO2	K2
8	Which post-translational modification involves the covalent attachment of a small, 76-amino acid protein to a target protein, typically marking it for degradation by the 26S proteasome? a) Phosphorylation b) Ubiquitination c) Glycosylation d) Acetylation	CO2	K2
9	G-protein-coupled receptors (GPCRs) represent one of the largest families of cell surface receptors. Upon binding a signaling molecule, what is the immediate biochemical event that activates the associated heterotrimeric G-protein? a) Phosphorylation of the G-protein by a receptor tyrosine kinase. b) Displacement of GDP by GTP on the G\alpha subunit. c) Proteolytic cleavage of the G\beta\gamma complex. d) Internalization of the receptor-ligand complex into an endosome.	CO2	K2
10	Tumor suppressor genes and proto-oncogenes play opposing roles in cell cycle regulation. Which of the following statements correctly describes a characteristic of Tumor Suppressor Genes in the context of oncogenesis? a) They require a "gain-of-function" mutation in only one allele to promote cancer. b) They typically encode proteins that stimulate rapid cell division and inhibit apoptosis. c) They generally follow a "two-hit" model, where both alleles must be inactivated to lose their protective function. d) Their over-expression is a hallmark of most metastatic carcinomas.	CO2	K2
Q. No.	**SECTION B** **Answers in about 50 words (10 x 2= 20 marks)**	**CO**	**KL**
11	Differentiate between B-DNA and Z-DNA.	CO3	K3
12	Define Transposons.	CO3	K3
13	Briefly explain the evidence that supports the theory that mitochondria and chloroplasts originated as independent prokaryotic cells.	CO3	K3
14	What is the fundamental structural difference between a viroid and a prion, and how does each cause disease?	CO3	K3
15	Explain the role of the 3' to 5' exonuclease activity in DNA polymerase.	CO3	K3
16	Define the role of the Sigma (σ) factor in prokaryotic transcription.	CO4	K4
17	Describe the structural feature of a tRNA molecule that allows it to bridge the gap between a specific mRNA codon and its corresponding amino acid.	CO4	K4
18	Briefly explain the significance of "wobble" base pairing in the third position of a codon. How does this affect the number of tRNA species required by a cell?	CO4	K4
19	Distinguish between a G-protein coupled receptor (GPCR) and an intracellular hormone receptor**.**	CO4	K4

20	Explain why a "loss-of-function" mutation in the tumor suppressor genes is a critical step in oncogenesis.	CO4	K4
Q. No.	**SECTION C** **Answer in about 600 words (4 x 10= 40 marks)**	**CO**	**KL**
21	a) Contrast the functional roles of coding sequences (exons) with repetitive sequences. **OR** b) Compare and contrast the genome organization of a DNA virus versus an RNA virus.	CO4	K4
22	a) Compare and contrast Nucleotide Excision Repair (NER) and Base Excision Repair (BER). **OR** b) How do repressors and activators physically influence the binding of RNA polymerase to the promoter in prokaryotes?	CO4	K4
23	a) Compare the structural composition and assembly of prokaryotic (70S) and eukaryotic (80S) ribosomes. **OR** b) Explain the mechanism of RNA interference (RNAi). Distinguish between the roles of miRNA and siRNA in regulating gene expression at the translational level.	CO5	K5
24	a) Explain the process of signal amplification. How can a single signaling molecule binding to a cell surface receptor result in the activation of thousands of downstream effector proteins? **OR** b) Describe the regulated process of Apoptosis. Why is the evasion of this programmed cell death considered a "hallmark of cancer," and how do cancer cells typically bypass these death signals?	CO5	K5
Q. No.	**SECTION D** **Answer any TWO questions in about 1200 words (2x 15=30 marks)**	**CO**	**KL**
25	Discuss the structural organization and genetic mechanisms of Bacteria**.**	CO5	K6
26	Describe the integrated process of eukaryotic gene expression, starting from chromatin accessibility to the export of mRNA.	CO5	K6
27	Trace the journey of a protein from the initiation of translation to its final functional form.	CO5	K6
28	Discuss the genetic and therapeutic complexities of cancer.	CO5	K6

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