Indian Association for the Cultivation of Science
(Deemed to be University under *de novo* Category)
Integrated Bachelor's-Master's Program
Mid-Semester (Sem-I) Examination-Autumn 2022

Subject: *Molecules of life and cells*   **Subject Code(s): BIS 1101**
Full Marks: 25   **Time Allotted: 2 h**

Use separate pages for Part A and Part B
(Keep all subparts of a question together)

Part A: Answer all questions (25 marks)

1.   (i)   What are the chemical substances that compose the plasma membrane?   1

     (ii)   What is the difference between chromatin and chromosome?   1

     (iii) What are stress-fibers?   1

     (iv)   How does a lamellipodium structurally differ from a fillopodium?   1

     (v)   Choose the correct options: Cell cytoskeleton is involved in the following processes   1

            (a) Contractile ring formed during cytokinesis, (b) Anchoring the extracellular matrix,

            (c) Post-translational modification of proteins, (d) Post-transcriptional modification of mRNA

     (vi)   True or false: The role of ATP hydrolysis in actin polymerization is like the role of GTP   1
            hydrolysis in tubulin polymerization: both serve to weaken the bonds in the polymer and thereby
            promote depolymerization.

2.   (i)   Describe the cell migration of a fibroblast cell on a two-dimensional substrate with appropriate   2
            diagram.

     (ii)   Draw the characteristic length versus time plot of a dynamic microtubule and mark various   2
            features describing the dynamics.

     (iii) Write-down an expression for the average length of a microtubule and discuss how a suitable   2
            cellular condition can induce a short microtubule (less than the size of the cell) grow very long
            (much larger than the size of the cell).

     (iv)   Find the time taken for the plus end of a microtubule to grow $15\ \mu m$ from the centrosome of a   2
            hypothetical cell to its boundary (consider a simple polymerization process and MTs with 13
            protofilaments). How long does it take the filament to shrink to zero length if it undergoes rapid
            depolymerization upon reaching the boundary? Assume $[M] = 10\ \mu M$ and take rate constants
            from Table below (a tubulin dimer is about $8\ nm$ long).

monomer in solution	k_{on}^+ (plus end)	k_{off}^+	k_{on}^- (minus end)	k_{off}^-	$[M]_c^+$	$[M]_c^-$
actin						
ATP-actin	11.6±1.2	1.4±0.8	1.3±0.2	0.8±0.3	0.12±0.07	0.6±0.17
ADP-actin	3.8	7.2	0.16	0.27	1.9	1.7
microtubules						
growing (GTP)	8.9±0.3	44±14	4.3±0.3	23±9	4.9±1.6	5.3±2.1
rapid disassembly	0	733±23	0	915±72	not applicable	

Part B: Answer all questions (25 marks)

3. **1 mark for correct answer**   4

a) What is the base sequence of the DNA strand that would be complementary to the following single-stranded DNA molecule 5' GGATCTGATCCAGTCA 3'

b) Transcription occurs along a _____ template forming an mRNA in the _____ direction
A) 5' to 3'; 5' to 3'   B) 5' to 3'; 3' to 5'   C) 3' to 5'; 5' to 3'   D) 3' to 5'; 3' to 5'

c) Which mode of information transfer usually does not occur?
A) DNA to DNA   B) DNA to RNA   C) DNA to protein   D) all occur in a working cell

d) For double-stranded DNA, consider the following base ratios:

1. A/G
2. C/T
3. C/G
4. (A+C)/(G+T)
5. (A+G)/(C+T)
6. (A+T)/(G+C)

Which of those ratios always equals 1?
A).1 and 2   B). 4 and 6   C).3, 4, and 5 D).1, 4, and 5 E).3 and 6

4. Discuss the effects of point mutations on a DNA strand.   3

5. Describe the process by which nucleic acid sequence is translated into amono acid sequence   2

6. Indicate importance of different position in ribose (figure below) with regard to nucleic acid structure and synthesis   2

Ribose