Indian Association for the Cultivation of Science

(Deemed to be University under the *de novo* category)

Integrated Bachelor's-Master's Program

Mid-Semester Examination-2019(Semester-I)

Subject: Molecules of Life and Cells ***Subject Code(s): BIS 1101***

Full marks: 100 ***Time allotted: 2 h***

PART - A

Answer all questions

1. (a) Where in the cell can ribosomes be found? What is the main biological function of ribosomes? [1+2]

   (b) Of which substance are microtubules made? What are the dynamic instability phases of a microtubule? [1+2]

   (c) Describe the structure and function of centrosome. [2+1]

   (d) Name a few focal adhesion (FA) proteins. Draw a schematic diagram of FA. [1+2]

   (e) What are the steps of cell motility? [3]

   (f) Describe how actin polymerization drives protrusion of plasma membrane. [3]

2. The average time it takes particles to diffuse a distance of x cm is $t = x^2/2D$ where t is the time in seconds and D is the diffusion coefficient, which is a constant that depends on the size and shape of the particle.

   (a) How long would it take for a small molecule, a protein molecule, and a membrane-enclosed vesicle to diffuse across a cell 10 μm in diameter? A typical D for a small molecule is 5×10^{-6} cm^2 sec^{-1}, for a protein molecule 5×10^{-7} cm^2 sec^{-1} and for a membrane vesicle 5×10^{-8} cm^2 sec^{-1}.

   (b) Why do you suppose a cell relies on the strategy of polymerizing and depolymerizing cytoskeletal filaments, rather than on diffusion of filaments themselves, to accomplish its cytoskeletal rearrangements?

   [6+4]

3. (a) In a monomeric solution of tubulins, assume that only the microtubule plus end is dynamic. Given k_{on}= 10 (μM.s)$^{-1}$, k_{off} = 40 s^{-1}, estimate the change in length of a microtubule in unit time. Tubulin dimers are about 8 nm long. [M] = 15 nM

   (b) Describe the structure and function of a mitochondria. (2+1)

   (c) To characterize the geometry of mitochondria, assume that an "average" mitochondrion is a spherocylinder capsule with length 1 μm and diameter 0.8 μm. Estimate the volume of such structure and the area of the outer membrane.

   ↳ length of cylinder.

   [5+3+4]

4. (a) Find the maximum pressure exerted on the boundary of a eukaryotic cell of radius 3μm by a collection of 50 microtubules growing in random directions from the cell's center (quote your answer in atmospheres). Treat the growth mechanism to be a thermal ratchet and assume that the free tubulin dimer concentration in the cell is 100 μM. Critical concentration for GTP tubulin at the plus end of the microtubule is 5 μM and size of a tubulin dimer is about 8 nm.

   (b) Is the maximum force on each microtubule large enough to cause it to buckle (Flexural rigidity of microtubule $\kappa = 1.2 \times 10^{-23}$ $J.m$ is the product of Young's modulus E and moment of intertia of the cross-section I)?

   [6+4]

Part B (50 Marks total)

5. State true of false with explanation (1+2 mark each)

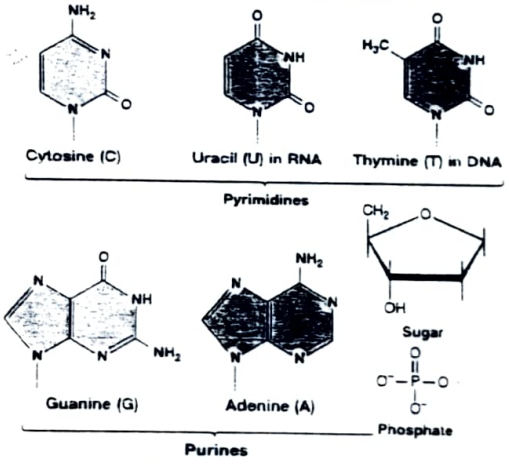
(a) Lipid bilayer is permeable to hydrophobic molecules T
(b) Lipid rafts contain soluble proteins F
(c) Bothe the layers of the plasma membrane of the cells are composed of identical lipids F
(d) Organelle specific proteins are always synthesized in specific Organelle. F
(e) No cell can synthesize ER de novo T

6. (2 marks each)

(a) Describe why do we call 'life' an autocatalytic process?
(b) What is the difference between vesicle and a micelle? Describe reverse micelles.
(c) Describe phase segregation in lipid bilayer.
(d) What is a gene?
(e) Describe the process of replication in brief.

7. (5 mark each)

(a) Use the chemical structure of phosphate, sugar and nitrogen base given below to draw the chemical structure of DNA structure, Name unusual structures of DNA other than double helix.



Nitrogenous bases

(b) Describe the process of transcription.
(c) What is lipid raft? Describe the mechanism by which they form.
(d) What is transition temperature, describe the difference between liquid ordered, disordered and gel phase of lipid bilayer.
(e) Describe the effect of Cholesterol, saturation and chain length on transition temperature.