

**Indraprastha Institute of Information Technology Delhi (IIITD)**  
**Department of Computational Biotechnology**  
**BIO211 – Cell Biology and Biochemistry**

**Mid-Semester Exam (October 31, 2021)**

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**Time duration:** 1 hour (10:00-11:00 AM)

**Total marks:** 50

**Instructions:**

1. You are required to submit a single PDF file with all the properly labelled answers.
2. Add your roll number to the file name.
3. You will have 5 mins extra after 11:00 AM to compile and return your answer sheets.

**Question 1.** Differentiate between **any two** of the following: [1.5 marks X 2]

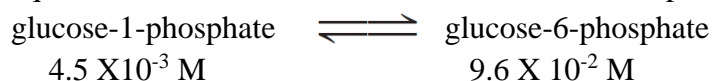
- (i) RNA and DNA nucleotides
- (ii) Endocytosis and Exocytosis
- (iii) Anabolism and Catabolism

**Question 2.** Neurons are one of the largest cells found in human body. Some of these neurons are as long as 2  $\mu\text{m}$  extending from spinal cord to the muscles of the toes. Trafficking of small vesicles usually takes place along the microtubules of the cytoskeleton, from the cell body of the neuron to its axonal tip. Assuming the average velocity of a vesicle is 1  $\mu\text{m/s}$ , calculate the time taken by a vesicle to move from the neuronal cell body in the spinal cord to the axonal tip in the toes? [2 marks]

**Question 3.** Firewood is chemically unstable compared with its oxidation products-  $\text{CO}_2$  and  $\text{H}_2\text{O}$ .

- (i) Comment on the standard free-energy change for this reaction,  
 $\text{Firewood} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$ . [2 marks]
- (ii) Why does not firewood stacked beside the fireplace undergo spontaneous combustion to make more stable products,  $\text{CO}_2 + \text{H}_2\text{O}$ . [2 marks]
- (iii) What can provide the activation energy for this reaction to proceed? [2 marks]
- (iv) Imagine there existed an enzyme for catalyzing the rapid oxidation of firewood at room temperature. Explain the role of enzyme in this case in terms of thermodynamics. [2 marks]

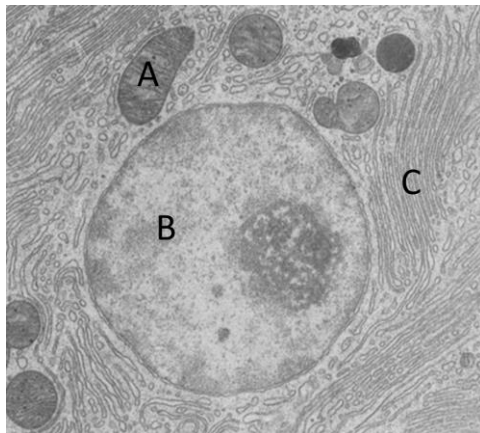
**Question 4.** If a 0.1 M solution of glucose 1-phosphate is incubated with a catalytic amount of phosphoglucomutase, the glucose 1-phosphate is transformed to glucose 6-phosphate. At equilibrium, the concentrations of the reaction components are



- (i) Calculate  $K'_{\text{eq}}$  and  $\Delta G'^{\circ}$  for this reaction at 25°C. [5 marks]

- (ii) For a thermodynamically favorable reaction, comment on the change in free energy, enthalpy and entropy of the system. [2 marks]

**Question 5.** Identify **any 2** of the cellular organelles marked in the following image and explain their structure and function. [4 marks]



**Question 6.** Answer **any one** of the following questions: [4 marks]

Conversion of Glucose 1-phosphate to fructose 6-phosphate occurs in a two steps reaction:

Glucose 1-phosphate  $\rightarrow$  glucose 6-phosphate ( $\Delta G'^{\circ} = -7.3$  kJ/mol)

Glucose 6-phosphate  $\rightarrow$  fructose 6-phosphate ( $\Delta G'^{\circ} = 1.7$  kJ/mol)

Calculate the equilibrium constant,  $K_{eq}$ , for the sum of the two reactions (Glucose 1-phosphate  $\rightarrow$  fructose 6-phosphate) at 25°C.

OR

The process of complete oxidation of 1 mole of glucose to  $\text{CO}_2$  and  $\text{H}_2\text{O}$  yields 686 kcal of free energy. How many ATP molecules could maximally be generated from one molecule of glucose, if the useful chemical energy available in the high energy phosphate bond of 1 mole of ATP is 12 kcal? (Hint: Avogadro's number =  $6.023 \times 10^{23}$ )

**Question 7.** What do you understand by the “polarity” of a polypeptide chain and that of a DNA molecule? [3 marks]

**Question 8.** A number of regulatory proteins present in *E. coli* can be found as one or two molecules per cell. If we assume that an *E. coli* contains just one molecule of a particular protein,

- (i) What is the molar concentration of this protein in the cell? [2.5 marks]  
(ii) If the molecular weight of this protein is 40 kDa, what is its concentration expressed as mg/ml? [2.5 marks]

(Hint: Vol. of *E. coli* = 1fL; Avogadro's number =  $6.023 \times 10^{23}$ )

**Question 9.** Write the chemical formula for a condensation reaction of two amino acids to form a peptide bond. [2 marks]

**Question 10.** Answer **any 10** of the following: [10 marks]

- (i) A polysaccharide used by animal as energy reservoir.
- (ii) One unsaturated fatty acid.
- (iii) A steroid that makes up the male sex hormone.
- (iv) Ordered display of full set of chromosomes of an organism.
- (v) Linker histone that pulls adjacent nucleosomes together into a regular repeating array.
- (vi) Enzyme that locks a sliding clamp around a newly formed DNA double helix.
- (vii) A eukaryotic transcriptional promoter.
- (viii) Enzyme responsible for recognition and attachment of the correct amino acid to appropriate tRNA.
- (ix) RNA molecule with catalytic activity.
- (x) Enzyme responsible for mRNA degradation.
- (xi) Initiator tRNA in prokaryotes.
- (xii) Enzymes that degrade proteins.

**Question 11.** Why replication of DNA is called semi-conservative in nature? [2 marks]

OR

What is meant by the discontinuous replication of DNA template?