Birla Institute of Technology and Science, Pilani – Pilani Campus
Semester-I, 2023-24
Comprehensive Examination
CHE F421: Biochemical Engineering

Date: 08/12/2023 **M.M:** 100

Duration: 3 Hr. **Weightage:** 50%

CLOSED BOOK (70 Marks)

Q.1. **Answer the following questions (2 marks each):** **10**

a) Amongst gram positive and gram-negative cells, which one is better suited to excretion of proteins? Justify your answer. Give an example of each category of cell.
b) What are prosthetic groups and conjugated proteins?
c) What are chelating agents? Give examples.
d) Discuss the role of t-RNA in protein synthesis.
e) What is the cause of difference in structure among primary, secondary, tertiary and quaternary structure of protein?

Q.2. Derive an expression to show the effect of pH on enzyme kinetics for ionizing enzyme. **10**

Q.3. Discuss the process of DNA replication with the help of neat schematic. Explain the steps in bullet points. **10**

Q.4. Answer the following: **10**

a) Enlist the compounds formed in Glycolysis cycle.
b) Major control sites in Glycolysis.
c) What happens to the end-product of Glycolysis, i.e. Pyruvate under the aerobic conditions, and anaerobic conditions?

Q.5. The specific growth rate for inhibited growth in a chemostat is given by the following equation: **10**

$$\mu_g = \frac{\mu_m S}{K_s + S + IK_s/K_I}$$

where,

S_0 = 10 g/l Ks = 1 g/l I = 0.05 g/l Yx/s= 0.1 g-cells/g-subs
X_0 = 0 K_I = 0.01 g/l μ_m = 0.5 h^{-1} k_d = 0

a. Determine *X* and *S* as a function of D when *I* = 0.

b. With inhibitor added to a chemostat, determine the effluent substrate concentration and *X* as a function of *D*.
c. Determine the cell productivity, *DX*, as a function of dilution rate.

Q.6. Derive an expression to determine the biomass concentrate at the exit of N^{th} reactor as a function of exit concentration from I^{st} reactor considering N-CSTFs in series. **10**

Q.7. a) Write a note on sterilization of liquids. **10**
b) Enlist various filter integrity test. Discuss anyone of them in detail.

OPEN BOOK (30 Marks)

Q.8 In a two-stage chemostat system, the volumes of the first and second reactors are V_1 = 500 l and V_2 = 300 l, respectively. The first reactor is used for biomass production and the second is for a secondary metabolite formation. The feed flow rate to the first reactor is F = 100 l/h, and the glucose concentration in the feed is S = 5.0 g/l. Use the following constants for the cells. **14**

$\mu_m = 0.3\ h^{-1}$, $K_S = 0.1$ g/l, $Y_{X/S} = 0.4$ g dw cells/g glucose

a. Determine cell and glucose concentrations in the effluent of the first stage.
b. Assume that growth is negligible in the second stage and the specific rate of product formation is $q_P = 0.02$ g P/g cell h, and $Y_{P/S} = 0.6$ g P/g S. Determine the product and substrate concentrations in the effluent of the second reactor.

Q.9. The enzyme, urease, is immobilized in Ca-alginate beads 2 mm in diameter. When the urea concentration in the bulk liquid is 0.5 m*M* the rate of urea hydrolysis is *v* = 10 mmoles-l-h. Diffusivity of urea in Ca-alginate beads is De = 1.5×10^{-5} cm^2/sec, and the Michaelis constant for the enzyme is K'm = 0.2 m*M*. By neglecting the liquid film resistance on the beads (i.e., [So] = [Ss]) determine the following: **16**

a. Maximum rate of hydrolysis *Vm*, Thiele modulus (ϕ), and effectiveness factor (η).
b. What would be the *Vm*, ϕ, and η values for a particle size of Dp = 4 m.

Hint: Assume $\eta = 3/\phi$ for large values of ϕ ($\phi > 2$).

*****The End*****