

National Exams Dec 2016

04-Chem-B4, Biochemical Engineering

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is a CLOSED BOOK EXAM. One of two calculators is permitted any Casio or Sharp approved models.
3. FIVE (5) questions constitute a complete exam paper. ANSWER ALL FIVE QUESTIONS.
4. Each question is of equal value.
5. Most questions require an answer in short essay format. Clarity and organization of the answer are important.

Question 1 (20 marks)

An enzyme reaction follows Michaelis-Menten Kinetics with a K_m of $4.7 \times 10^{-5} \text{M}$ and v_{\max} of 22 micromoles per L per min. What is the rate of reaction if the substrate concentration is $2 \times 10^{-4} \text{M}$ and $5 \times 10^{-4} \text{M}$ of (a) a competitive inhibitor; (b) a non-competitive inhibitor and (c) an un-competitive inhibitor. Assume K_i in all three cases to be $3 \times 10^{-4} \text{M}$. What is the rate of reaction in the absence of any inhibition?

Question 2 (20 marks)

A biotechnology company has obtained lab scale and pilot scale data for a process using cylindrical tank bioreactors. The lab scale bioreactor is 50 L in volume and the larger bioreactor has a volume of 10,000 L. Assume geometric similarity with tank height 3 times the tank diameter and the tank diameter is 3 times the impeller diameter for each bioreactor. Assume an impeller speed of 300 RPM in the smaller bioreactor. What is the impeller speed in the larger bioreactor assuming (a) equal impeller Reynolds number; (b) equal power per unit volume; (c) equal liquid pumping rate per unit volume (d) equal impeller tip speed.

Question 3 (20 marks)

Sketch, with appropriate descriptive labels, the process schematics for two different approaches for high temperature, short time (HTST) sterilization. Briefly compare advantages and disadvantages of each.

Question 4 (20 marks)

Discuss in detail the Air On and Air Off method and how it can be applied to determine parameters such as specific respiration rate of cells and the volumetric oxygen mass transfer coefficient?

Question 5 (20 marks)

- (i) Briefly describe (a) DNA structure; (b) structure of and types of RNA.
- (ii) Summarize the process of protein synthesis in your own words