Birla Institute of Technology and Science,
Pilani – Pilani Campus Semester-II, 2021-22

Mid-semester Examination (Regular)
CHE F421: Biochemical Engineering

Date: 10/03/2022 **Duration:** 1.5 Hr. **Max. Marks:** 70

CLOSED BOOK

1. What are the environmental factors which effect the microbial diversity. Classify these microbes based on these environmental factors.

(5 marks)

2. Draw the schematic of typical gram negative bacteria. Explain various components in detail.

(5 marks)

3. Explain electron transport chain with the help of a schematic. (5 marks)

4. At the end of glycolysis, each molecule of glucose has yielded 2 molecules of (a)_____, 2 molecules of (b)_____, and a net number of (c)_____ molecules of ATP. In the absence of oxygen, fermentation leads to the production of (d)_____. Glycolysis plus the citric acid cycle can convert the carbons of glucose to (e)_____ , storing the energy as ATP, _____ and (f)_____.

(6 marks)

5. Write a short note on the following:

a) Eucaryotes and Procaryotes

b) Algae, Fungi and Protozoa

c) Zwetterion

d) Isoelectric point

(7 marks)

6. E. coli grows from 0.10 kg-dry cell m^{-3} to 0.50 kg-dry cell m^{-3} in 1 h.

a) Assuming the exponential growth during this period, evaluate the specific growth rate.

b) Evaluate the doubling time during the exponential growth phase.

c) How much time would be required to grow from 0.10 kg-dry cell m^{-3} to 1.0 kg-dry cell m^{-3} ? You may assume the exponential growth during this period.

(10 marks)

7. Suppose that the following sequence describes an enzyme-substrate reaction with product inhibition:

$$E + S \underset{k_2}{\overset{k_1}{\rightleftharpoons}} ES$$

$$E + P \underset{k_4}{\overset{k_3}{\rightleftharpoons}} EP$$

$$ES + P \underset{k_6}{\overset{k_5}{\rightleftharpoons}} ESP$$

$$EP + S \underset{k_8}{\overset{k_7}{\rightleftharpoons}} EPS$$

$$ES \xrightarrow{k_9} E + P$$

Derive the rate equation by making the Michaelis-Menten assumption.

(12 marks)

8. A chemist measured the initial rate of an enzyme-catalyzed reaction in the absence and presence of inhibitor A and, in a separate procedure, inhibitor B. In each case, the inhibitor's concentration was 8.0 mM (8.0×10^{-3} M). The following data were obtained:

[S] (M)	v_0 ($M.s^{-1}$) No inhibitor	v_0 ($M.s^{-1}$) Inhibitor A	v_0 ($M.s^{-1}$) Inhibitor B
5.0×10^{-4}	1.25×10^{-6}	5.80×10^{-7}	3.80×10^{-7}
1.0×10^{-3}	2.00×10^{-6}	1.04×10^{-6}	6.30×10^{-7}
2.5×10^{-3}	3.13×10^{-6}	2.00×10^{-6}	1.00×10^{-6}
5.0×10^{-3}	3.85×10^{-6}	2.78×10^{-6}	1.25×10^{-6}
1.0×10^{-2}	4.55×10^{-6}	3.57×10^{-6}	1.43×10^{-6}

a) Determine the values of K_M and V_{max} of the enzyme.

b) Determine the type of inhibition imposed by inhibitors A and B, and calculate the value of K_I in each case.

(20 marks)

Supplementary Information for Exam

Rate expressions for:

Competitive inhibitors:

$$v = \frac{V_m[\mathrm{S}]}{K'_m\left[1+\frac{[\mathrm{I}]}{K_I}\right]+[\mathrm{S}]}$$

Non-Competitive Inhibitors:

$$v = \frac{V_m}{\left(1+\frac{[\mathrm{I}]}{K_1}\right)\left(1+\frac{K'_m}{[\mathrm{S}]}\right)}$$

Uncompetitive Inhibitors:

$$v = \frac{\frac{V_m}{\left(1+\frac{[\mathrm{I}]}{K_1}\right)}[\mathrm{S}]}{\frac{K'_m}{\left(1+\frac{[\mathrm{I}]}{K_1}\right)}+[\mathrm{S}]}$$