Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH(CHE)/SEM-8/CHE-802/2013

2013

BIOTECHNOLOGY AND BIOCHEMICAL ENGINEERING

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

i) The rate versus substrate concentration plot using Michaelis-Menten equation gives a

a) section of a rectangular hyperbola

b) section of a parabola

c) straight line

d) none of these.

ii) Damkohler number is defined by the ratio of

a) Maximum rate of reaction / Maximum rate of diffusion

b) Maximum rate of diffusion / Maximum rate of reaction

c) Maximum rate of production / Maximum rate of diffusion

d) none of these.

iii) The net effect of competition inhibition

a) is an increase in the maximum velocity

b) is a decrease in the maximum velocity

c) is an increase in the apparent Michaelis-Menten constant

d) is a decrease in the apparent Michaelis-Menten constant.

iv) The Hanse-Woolf plot gives slope equal to

a) V_m b) $1/V_m$

c) $-K_m$ d) K_m/V_m.

v) The Michaelis-Menten theory is based on the assumption that is used in

a) homogeneous catalysis

b) heterogeneous catalysis

c) both homogeneous and heterogeneous catalysis

d) none of these.

vi) Monod model is a kind of

a) structured & segregated model

b) unstructured & segregated model

c) structured & nonsegregated model

d) unstructured & nonsegregated model.

vii) The reaction involved in glycolysis includes

a) carbonization b) oxidation

c) phosphorylation d) dehydration.

viii) Gel chromatography is based on

a) solubility b) density

c) size d) surface activity.

ix) The best combination of reactors to achieve the substrate concentration at the maximum cell growth rate is

a) MFR followed by PFR b) PFR followed by MFR

c) two MFRs in series d) two PFRs in series.

x) Hormones are examples of which type of proteins ?

a) Structural b) Catalytic

c) Transport d) None of these.

xi) The terms 'stationary phase' and 'mobile phase' refer to

a) Filtration b) Chromatography

c) Membrane separation d) Centrifugation.

xii) In order to avoid wash-out of cells from a chemostat, $k\tau_m$ should be

a) equal to unity b) greater than unity

c) less than unity d) none of these

where k = maximum specific cell growth rate and τ_m = residence time.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following $3 \times 5 = 15$

2. Describe the zwitterionic structure of amino acids. Define iso-electric point and state its utility. 2 + 3

3. Explain how the rate of an enzymatic reaction depends on pH and temperature.

4. Define macronutrients and micronutrients with examples. Explain catabolic and anabolic processes. 3 + 2

5. Derive the rate equation of a substrate uninhibited enzymatic reaction using Michealis-Menten theory.

6. Define turn-over number of an enzyme. How is it related to K_{cat} of an enzyme ? 3 + 2

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Discuss the drawback of Michaelis-Menten theory. How it has been rectified in Briggs-Halden theory ? Deduce the rate equation of an uninhibited enzymatic reaction using Briggs-Halden theory. 2 + 2 + 4

b) Substrate *A* decomposes in the presence of enzyme *E*. To study the action of this enzyme, *A* and *E* are introduced into a batch reactor and the concentration of *A* is measured at various times (The initial concentration of enzyme (C_{E0})= 10gm/m^3). The data are given below :

Time (t), hr.	0	1	4	5
Concentration of A (C_A), mol/m^3	1200	840	100	30

Find the intrinsic kinetic parameters of Michaelis - Menten equation. 7

8. a) Describe the TCA cycle of glucose metabolism with detailed diagram. 10

b) What are fats ? Give the reaction for formation of fats from fatty acid and glycerol. 5

9. a) What are the main features of an allosteric enzyme ? Compare graphically the behaviour of allosteric enzymes with the enzymes following Michaelis-Menten equation. 3 + 3

b) Define specific activity of an enzyme. What is the unit of specific activity ? 2 + 2

c) To measure the amount of glucoamylase in a crude enzyme preparation, 1 ml of the crude enzyme preparation containing 8 mg protein is added to 9 ml of a 4·4% starch solution. One unit of activity of glucoamylase is defined as the amount of enzyme which produces 1 μ mol of glucose per minute in a 4% solution of Lintner starch at pH 4·5 and at 60°C. Initial rate of experiments shows that the reaction produces 0·6 μ mol of glucose/ml.min. What is the specific activity of the crude enzyme ? 5

10. a) Derive the performance equation of Chemostat in terms of substrate concentration and residence time used for carrying out a microbial fermentation reaction following substrate uninhibited Monod equation. 7

b) A specific bacterium lives and grows on lactose. In order to study the kinetic of this reaction, the following experimental data (in consistent units) were obtained from a batch reactor :

Time (t)	0	0·54	0·90	1·23	1·58	1·95	2·33	2·70
Concentration of substrate (C_A)	147	125	104	70	38	18	3	1
Concentration of cell (C_C)	15·5	23	30	38·8	48·5	58·3	61·3	62·5

Find the intrinsic kinetic parameters of Monod's equation. 8

11. a) The following data were obtained in a constant pressure filtration unit for Yeast suspension :

T min	4	20	48	76	120
V filtrate(l)	115	365	680	850	1130

Characteristics of the filter are as follows :

A = 2·28 m^2, C = 1920 kg/m^3, μ = $2 \cdot 9 \times 10^{-3}$ kg/ms, α = 4 m/kg.

i) Determine the pressure drop across the filter

ii) Determine the filter medium resistance r_m

iii) Determine the size of the filter for same pressure drop to process 4000 L cell suspension in 20 min. 9

b) Write short notes on any *two* of the following : 2 × 3 = 6

i) Reverse osmosis

ii) Concentration polarization

iii) Regulatory enzyme.

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