M.TECH/BT/2ND SEM/BIOT 5241/2022

BIOPROCESS TECHNOLOGY
(BIOT 5241)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Both K_m and V_{max} are affected by the inhibition factor in this type of enzyme inhibition
(a) competitive (b) non-competitive
(c) uncompetitive (d) all of the above.

(ii) The dissolved oxygen concentration in the medium below which the microbial system becomes oxygen limited is called
(a) saturation level (b) critical level
(c) optimum level (d) none of the above.

(iii) Leudeking Piret equation is applied to
(a) growth associated product (b) mixed growth associated product
(c) non-growth associated product (d) all the above.

(iv) Immobilization by surface immobilization results in
(a) washing out of enzymes
(b) minimum diffusion barrier between enzyme and substrate
(c) strong linkage between enzyme, substrate and matrix
(d) both (a) and (b).

(v) In a turbidostat
(a) cell concentration in the culture is maintained constant by monitoring optical density of the culture
(b) feed flow rate is controlled
(c) environment is dynamic
(d) all the above.

(vi) The relationship between the del factor, temperature and time is given as
(a) $\Delta = A.t.\ e^{-E/RT}$ (b) $\Delta = 1/(A.t.\ e^{-E/RT})$
(c) $\Delta = A.t.\ e^{E/RT}$ (d) $\Delta = A.t.T.$

(vii) The moist heat is more effective than the dry heat because the intrinsic heat resistance of vegetative cells is greatly
(a) increased in a dry state (b) decreased in a dry state
(c) increased in a wet state (d) decreased in a wet state.

(viii) The reduction of number of cells from 10^{10} to one will result into the del factor (Δ) of
(a) 1 (b) 10 (c) 23 (d) 10^3.

(ix) In sterilization process, spore of which of the following organism is considered as control?
(a) Bacillus subtilis (b) Clostridium botulinum
(c) Bacillus stearothermophilus (d) Aspergillus niger.

(x) Name the sterilization agent that is most frequently used in hospitals and clinical laboratories for the heat-labile liquid substances or antibiotics
(a) Dry heat (b) Radiation
(c) Filtration (d) Formaldehyde.

Group- B

2. The following data were obtained from enzymatic oxidation of phenol by phenol oxidase at different phenol concentrations.

S, mg/L	10	20	30	50	60	80	90	110	130	140	150
v, mg/(L.h)	5	7.5	10	12.5	13.7	15	15	12.5	9.5	7.5	5.7

i. What type of inhibition is this?
ii. Determine the constants V_m, K_m and K_{Si}.
iii. Determine the oxidation rate at [S]= 70mg/L. [(CO1)(Analyze/IOCQ)]

12

3. (a) Derive Michaelis-Menten Equation by quasi-steady state approach. [(CO1)(Understand/LOCQ)]

(b) Define enzyme immobilization. What are the advantages of immobilization technique? [(CO1)(Remember/LOCQ)]

6 + 6 = 12

Group - C

4. (a) Determine the amount of $(NH_4)SO_4$ to be supplied in a fermentation medium where the final cell concentration is 30g/L in a 10^3L culture volume. Assume that the cells are 12% nitrogen by weight and $(NH_4)SO_4$ is the only nitrogen source. [(CO3)(Analyze/IOCQ)]

(b) Derive the equation for optimum dilution rate(D_{opt}) for cell productivity(DX). [(CO4)(Understand/LOCQ)]

6 + 6 = 12

5. *E. Coli* have a maximum respiration rate, q_{O2max}, of about 240mg O_2/gX.h. It is desired to achieve a cell mass of 20g dry weight/L. The k_la is 120h^{-1} in a 1000L reactor (800L working volume). A gas stream enriched in oxygen is used which gives a value of C*= 28mg/L. If oxygen becomes limiting, growth and respiration slow, and oxygen consumption follows Monod model, that is

$$q_{O2} = \frac{q_{O2max} C_L}{\frac{0.2mg}{L} + C_L}$$

where C_L is the dissolved oxygen concentration in the fermenter. What is the value of C_L when the cell mass is 20g/L? [(CO4)(Analyze/IOCQ)]

12

Group - D

6. A 15 m^3 chemostat is operated at a dilution rate of 0.1 h^{-1}. A continuous direct steam injection steriliser with a flash cooling is utilised for medium sterilisation. The temperature of the holding section for the medium sterilisation is maintained at 130°C. The contaminant concentration in the raw medium is 10^5 per ml. An acceptable contamination risk is one organism in every three months. The activation energy for thermal death and Arrhenius constant are estimated to be 288.5 KJ/ gmol and 7.5 × 10^{39} h^{-1}, respectively. The inner diameter of the pipe of the steriliser is 12 cm. Determine the length of the holding section assuming perfect plug flow.

[(CO5)(Evaluate/HOCQ)]

12

7. (a) State four criteria for formulation of fermentation media.

[(CO5)(Remember/LOCQ)]

(b) Differentiate between Defined media and Technical media for microbial growth? [(CO5)(Understand/LOCQ)]

(c) Describe the methods used for sterilization of media in industrial scale.

[(CO5)(Remember/LOCQ)]

4 + 4 + 4 = 12

Group - E

8. A distillery unit produces 100 m^3 of absolute alcohol in a chemostat from cane molasses (containing 45% w/w sugar) containing *S. Cerevisiae*. The characteristics of the yeast are as follows: μ_{max} = 0.05 hr^{-1}, Ks = 2 g/L, Yx/s = 0.05, Yp/s = 0.5, So = 200 gm/lit. Find the volume of the reactor and amount of cane molasses required per day.

[(CO6)(Evaluate/HOCQ)]

12

9. (a) List the factors those affect alcohol fermentation process.

[(CO5)(Remember/LOCQ)]

(b) Name the theories behind industrial alcohol production process and describe the pathway followed by any of the theory. [(CO6)(Critique/HOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	37.5	31.25	31.25

Course Outcome (CO):

After completion of the course the students will be able to
1. Describe the mechanism of all types of enzyme substrate reactions,
2. Calculate various kinetic parameters associated therewith,
3. Comprehend various factors affecting the growth of cells and formation of products,
4. Solve mathematical problems related to various bioprocesses
5. Design mathematically model upstream and fermentation processes, and
6. Apply the concepts in real time industrial scenarios in biotechnology.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question