

BIOPROCESS & PROCESS INSTRUMENTATION
(BIOT 3133)

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 4 (four) from Group B to E, taking one from each group.*

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

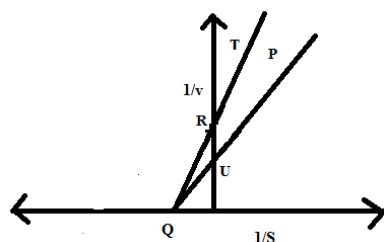
Group - A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) U tube manometer is used to measure the pressure of
(a) liquid (b) gas (c) liquid and gas (d) solid.
- (ii) Identify Q, R, U, P and T respectively from the graph below.



- (a) $-1/K_m, -1/V_{m,app}, 1/V_{max}, [I]=0, [I]>0$ (b) $-1/K_{m,app}, -1/K_m, 1/V_{max}, [I]=0, [I]>0$
(c) $-1/K_{m,app}, -1/K_m, 1/V_{max}, [I]>0, [I]=0$ (d) $1/V_{max}, 1/V_{max,app}, -1/K_m, [I]=0, [I]>0$
- (iii) Higher value of Michaelis constant signifies
(a) increased substrate affinity of the enzyme
(b) reduced substrate affinity of the enzyme
(c) decreased enzyme reaction rate
(d) none of the above.
- (iv) Lower value of Michaelis constant signifies
(a) increased substrate affinity of the enzyme
(b) reduced substrate affinity of the enzyme
(c) decreased enzyme reaction rate
(d) none of the above.
- (v) The overall stoichiometry for an aerobic cell growth is
 $3C_6H_{12}O_6 + 2.5NH_3 + O_2 \longrightarrow 1.5C_aH_bO_cN_d + 3CO_2 + 5H_2O$
What is the elemental composition formula of the biomass?
(a) $C_9H_{18.2}O_5N_{1.667}$ (b) $C_9H_{22.33}O_6N_{1.667}$
(c) $C_{10}H_{18.2}O_5N_{1.667}$ (d) $C_{10}H_{22.33}O_6N_{1.667}$.

- (vi) Which of the following time is not included in continuous sterilization?
 (a) Heating time (b) Cooling time
 (c) Holding time (d) All of these.
- (vii) The destruction of microorganisms by moist heat is described by _____.
 (a) Zero-order reaction (b) First-order reaction
 (c) Third-order reaction (d) Second-order reaction
- (viii) Which of the following is the method of filter sterilization?
 (a) Osmosis (b) Diffusion
 (c) Double Diffusion (d) Sitting Drop.
- (ix) The temperature of steam at around 540°C can be measured by
 (a) Thermometer (b) Radiation pyrometer
 (c) Thermopile (d) Thermocouple.
- (x) T type thermocouple is made of
 (a) iron-constantan (b) copper -constantan
 (c) platinum-rhodium (d) chromel-alumel.

Fill in the blanks with the correct word

- (xi) Enzymes may hold the substrates at certain positions and angles to improve the reaction rate, it is called_____.
- (xii) When binding of one substrate to the enzyme facilitates binding of other substrate molecules, the phenomenon is known as _____.
- (xiii) The phenomenon in which substrates are used in a sequential manner is known as _____.
- (xiv) _____ is a temperature measuring device based on Seebeck effect.
- (xv) Rate of a reaction is a function of _____.

Group - B

2. An inhibitor I is added to the enzymatic reaction at a level of 1.0 g/l. The following data were obtained for $K_m = 9.2$ g/l. Identify the type of inhibition and find K_I .

v, g/(L.min)	0.909	0.658	0.493	0.4	0.333	0.289	0.227
S, g/L	20	10	6.67	5	4	3.33	2.5

[[CO2](Examine/10CQ)]

(8 + 4) = 12

2. (a) Derive a batch kinetic mathematical model for enzyme substrate reaction.
[[CO1](Remember/LOCQ)]
- (b) Compare different types of enzyme inhibition graphically while explaining the differences explicitly.
[[CO2](Apply/10CQ)]

4 + 8 = 12

Group - C

4. (a) Mathematically prove that as time approaches to infinity, the number of viable organism approaches to zero in a liquid media during heat sterilisation. *[(CO4)(Analyse/IOCQ)]*
 (b) Compare between the batch sterilization and continuous sterilization with respect to their relative advantages and disadvantages. *[(CO4)(Remember/LOCQ)]*
6 + 6 = 12
5. It is desired to pasteurise 240 litre/min milk in a continuous pasteuriser by heating to 71°C for a sufficient time to achieve a 12 power reduction in the number of organism. An existing pasteuriser comprising of well insulated pipe 55 mm ID and 30 m long fed from a plate heat exchanger is available for the duty. Will it provide sufficient holding time? K_d for the organism is 1.84 sec^{-1} . *[(CO3)(Analyse/HOCQ)]*
12

Group - D

6. Establish a relationship between apparent yield coefficient and dilution rate in a chemostat. *[(CO4)(Remember/LOCQ)]*
12
7. A simple, batch fermentation of an aerobic bacterium growing on methanol gave the results shown in the table. Calculate: (i) maximum growth rate (μ_{\max}), (ii) Yield on substrate ($Y_{x/s}$), (iii) mass doubling time and (iv) specific growth rate at $t=10\text{h}$.

Time, h	0	2	4	8	10	12	14	16	18
X, g/L	0.2	0.211	0.305	0.98	1.77	3.2	5.6	6.15	6.2
S, g/L	9.23	9.21	9.07	8.03	6.8	4.6	0.92	0.077	0

[(CO4)(Evaluate/HOCQ)]
(4 + 2 + 3 + 3) = 12

Group - E

8. (a) How does the inclined tube manometer work? *[(CO5)(Analyse/IOCQ)]*
 (b) Illustrate on the working principle of pH meter. *[(CO6)(Remember/LOCQ)]*
6 + 6 = 12
9. (a) Write short note on Bourdon tube. *[(CO5)(Analyse/HOCQ)]*
 (b) Explain the principle of radiation pyrometer. *[(CO6)(Remember/LOCQ)]*
6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	35.4	33.3	31.3

Course Outcome (CO):

After the completion of the course students will be able to:

1. Understand the mechanism of enzyme action on a substrate explicitly.
2. Apply the above concepts to solve problems in the enzyme technology field.
3. Comprehend and solve any problem regarding sterilization of the medium used in fermentation.
4. Compare between a batch process and a continuous process regarding microbial growth.
5. Classify a microbial product and determine its productivity.
6. Appreciate the operation of different process instruments used for measuring various operating parameters of a bioprocess.

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