Name:

Enrolment No:

UPES

End Semester Examination, May 2025

Course : Bioprocess Engineering **Semester : IV**

Program : B.Tech - Biotechnology **Duration : 3 Hours**

Course Code: HSFT2012 **Max. Marks: 100**

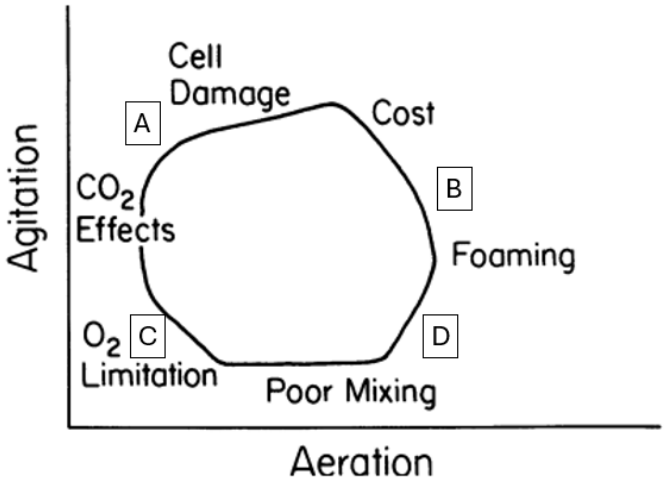
Instructions: All questions are compulsory.

Please read the questions carefully. The paper contains four sections.

S. No.	Section A Short answer questions/ MCQ/T&F (20Qx1.5M= 30 Marks)	Marks	COs
Q 1	True or false: "*S. cerevisiae* is procaryotic organism."	1.5	CO1
Q 2	List any one prokaryotic organism.	1.5	CO1
Q 3	Write the formula for bacterial doubling time	1.5	CO1
Q 4	Which of the following methods would be used to measure the concentration of bacterial contamination in processed peanut butter? a. turbidity measurement b. total plate count c. dry weight measurement d. direct counting of bacteria on a calibrated slide under the microscope	1.5	CO1
Q 5	Which of the following is the best definition of generation time in a bacterium? a. the length of time it takes to reach the log phase b. the length of time it takes for a population of cells to double c. the time it takes to reach stationary phase d. the length of time of the exponential phase	1.5	CO1
Q 6	Mechanical agitation is required only in _____ a. Packed bed b. Airlift reactor c. Stirred tank d. Bubble column	1.5	CO1
Q 7	Name one bioprocess used in our households.	1.5	CO1
Q 8	In which of the following bioreactors, the particles are not immersed in liquid? a. Air-lift reactor b. Stirred vessel c. Packed-bed d. Trickle-bed	1.5	CO1
Q 9	True or false: " T-flasks can be used for adherent and non-adherent cultures."	1.5	CO1

Q 10	What is the generation time if 100 bacterial cells have been growing logarithmically for 5 hours and produced 1.7×10^6 cells? a. 0.351 generations/hour b. 0.353 generations/hour c. 0.355 generation/hour d. 0.356 generation/hour	1.5	CO1
Q 11	Which of the following is not a scale-up process? a. Laboratory to pilot-scale b. Pilot-scale to industrial-scale c. Industrial to pilot-scale d. Laboratory to industrial-scale	1.5	CO1
Q 12	Which method can be used for protein estimation?	1.5	CO1
Q 13	List the use of a hemocytometer.	1.5	CO1
Q 14	List any one parameter that affects microbial growth.	1.5	CO1
Q 15	What is the primary difference between prokaryotic and eukaryotic cells? a. Presence of nuclear membrane b. Presence of mitochondria c. Presence of cell wall d. Mode of reproduction	1.5	CO2
Q 16	Which type of bioreactor operates without any input of fresh medium once started? a. Fed-batch b. Continuous c. Batch d. Perfusion	1.5	CO2
Q 17	Which term describes the time a substrate spends in a reactor? a. Residence time b. Growth rate c. Reaction velocity d. Half-life	1.5	CO2
Q 18	Which reactor model assumes no axial mixing? a. CSTR b. PFR c. Fed-batch d. Bubble column	1.5	CO2
Q 19	Which factor affects microbial metabolism the most? a. Temperature b. Oxygen c. Nutrient availability d. All of the above	1.5	CO2
Q 20	What is the main challenge in large-scale fermentation? a. Nutrient distribution b. Oxygen transfer	1.5	CO2

	c. Shear stress d. All of the above		
Section B (4Qx5M=20 Marks)			
Q 21	Describe the cellular processes occurring at each phase of the bacterial growth cycle.	5	CO2
Q 22	Describe the scale-up of a bioreactor. **(2 marks)** Recognize two conditions that are kept constant for scale-up and explain why. **(1.5*2= 3 marks)**	5	CO2
Q 23	a. Describe the parameter "degree of reduction." **(1 mark)** b. Write the empirical formula and calculate the degree of reduction of the following molecules **(2 marks each)** i. Methane ii. Citric acid	5	CO3
Q 24	Differentiate between the following **(2.5 marks each)** a. Macronutrients and micronutrients b. Defined and complex medium	5	CO3
Section C (2Qx15M=30 Marks)			
Q 25	a. Define bioreactor. **(3 marks)** b. Draw a bioreactor and label its parts. **(6 marks)** c. Outline the function of each of the parts mentioned in part b. **(6 marks)**	15	CO4
Q 26	A cubical bioreactor is utilized for the synthesis of fluorophore using a bacterial strain at a laboratory scale. The side of the bioreactor is 8 cm. The company decides to scale up by four times. a. Assess all possible ways of scaling up? **(3 marks)** b. Calculate the side length, surface area, and volume of the new bioreactor in all possibilities of scaling up (mentioned in part a) and summarize the values in a table. **(4*3 = 12 marks)**	15	CO5
Section D (2Qx10M=20 Marks)			
Q 27	Assume that experimental measurements for a certain organism have shown that cells can convert two-thirds (wt/wt) of the substrate carbon (alkane or glucose) to biomass. Solve for the stoichiometric coefficients **(a,b,c,d,e)** for the following biological reactions **(2 marks each)** Equation: $C_{16}H_{34}$ + **a** O_2 + **b** NH_3 → **c**($C_{4.4}H_{7.3}N_{0.86}O_{1.2}$) + **d** H_2O + **e** CO_2	10	CO3
Q28	The following curve shows the effects of agitation vs aeration in a bioreactor. The graph shows four bioreactors at points **(A, B, C, D)**.	10	CO4



Based on your understanding of bioreactors, for each labelled point on the graph, categorize the type of organism and type of bioreactor you will use and the advantages and disadvantages of the process for each bioreactor in a table format as shown below. **(2.5 marks each)**

Bioreactor	Type of organism used for bioprocess	Type of Bioreactor	Advantage	Disadvantage
A				
B				
C				
D				