Register Number: ……..

B.TECH DEGREE EXAMINATIONS: APRIL/MAY 2014

(Regulation 2009)

Fifth Semester

BIOTECHNOLOGY

BTY114**:** Bioprocess Principles

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Baffles are incorporated in the agitated vessel
   a) To prevent vortex and improve aeration efficiency
   b) To improve vortex and improve aeration efficiency
   c) To prevent vortex and reduce aeration efficiency
   d) To improve vortex and minimize the air flowrate
2. The first industrial microbial metabolite is
   a) Alcohol
   b) Acetic acid
   c) Acetone
   d) Lactic acid
3. An example of solidifying agents used in medium formulation is
   a) Sucrose
   b) Nicotinic acid
   c) Edamin
   d) Agar
4. The dummy factors required for Plackett-Burman design with 14 factors is
   a) 1
   b) 2
   c) 3
   d) 4
5. Sterilization was carried out with overall del factor of 38.7. Del factors of heating and cooling are 7.9 and 8.5 respectively. The specific death rate of a specific organism is 3.15 min^{-1} at 121°C. The holding time is
   a) 5.07 min
   b) 7.07 min
   c) 9.07 min
   d) 11.07 min
6. High activation energy in sterilization means
   a) Spore destruction
   b) Nutrient destruction
   c) Spore and nutrient destruction
   d) Neither spore nor nutrient destruction
7. μ_m and K_s in Monod equation can be calculated by plotting
   a) 1/S Vs 1/μ
   b) S Vs μ
   c) 1/S Vs μ
   d) S Vs 1/μ

8. Cell growth rate is directly proportional to $time^3$ in
   a) Yeast
   b) Bacteria
   c) Actinomycetes
   d) Filamentous organisms
9. The degree of reduction for methane and glucose are
   a) 0.8 & 4
   b) 8 & 4
   c) 0.8 & 0.4
   d) 8 & 0.4
10. In ethanol fermentation from glucose, the yield coefficient $Y_{P/S}$ on a mass basis is
    a) 0.511
    b) 0.491
    c) 0.531
    d) 0.471

PART B (10 x 2 = 20 Marks)

11. Differentiate online and offline fermenters.
12. List the different probes used for measuring pH in fermenters.
13. Define osmolality in cell culture?
14. In an industrial scale, crude complex media are preferred than simple defined media - Validate this statement.
15. Why chemical methods are not preferred for sterilization of growth media?
16. Mention the various methods of batch sterilization.
17. Write short notes on Leudeking - Piret kinetics.
18. Give four examples for growth inhibitors.
19. What is endogenous respiration?
20. What is the degree of reduction of carbon in CO_2 and nitrogen in ammonia?

PART C (5 x 14 = 70 Marks)

21. a) i) Describe briefly the concept of a fermenter, design. (7)
    ii) What factors do you consider as essential for a successful design and operation of a fermenter? (7)

(OR)

    b) Explain the requirements and classification of fermentation processes.

22. a) Discuss the nutritional and environmental requirements for microbial growth.

(OR)

    b) Explain the media optimization by Plackett-Burman method with suitable

example for 12 experimental run.

23. a) A medium containing vitamin is to be sterilized. Assume that the number of spores initially present is 10^5/L. The values of Arrhenius constant and activation energy of spores and vitamin are follows: $A_s = 10^{36}$ min^{-1}, E_s = 65 kcal/mol, $A_v = 10^4$ min^{-1}, E_v = 10 kcal/mol. The initial concentration of vitamin is 30 mg/L. Ignore the effects of heating and cooling times. Assume zeroth order kinetics for vitamin depletion and first order kinetics for spore destruction. Assume that 75% is used as working volume. Compare the amount of active vitamin in the sterilized medium when both sterilized at 121°C when we require in both cases that the probability of an unsuccessful fermentation be 10^{-3} for fermenters of:

i) 10 l (7)

ii) 10 kl (7)

(OR)

b) You are to sterilize 500 L of culture media containing a microbial count of $3x10^7$ cells/mL for use in a bioprocess. A possibility of contamination of 0.001 is acceptable. Ignoring any heating and cooling cycles, how long would the media need to be maintained at 125°C to achieve the required sterilisation? Activation energy E = 68.7 kcal/mol and Arrhenius constant A = 9.50 x 10^{37} min^{-1}

24. a) A simple batch fermentation of an aerobic bacterium gave the following results:

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	

i) Calculate the growth rate every two hours. (5)

ii) State when the growth rate is maximum. (4)

iii) Calculate the maximum specific growth rate. (5)

(OR)

b) Ethanol is produced in a fermentation process from molasses, according to the following description of the process: Molasses is pumped from a sugar company to a load cell (weighing apparatus) which measures its flow batchwise, and then

collected in a vessel. It is then pumped continuously to a series of four fermenters with equal flow rates to each fermenter via a mixer where it is mixed with water before entering the fermenters. The outflow of the first fermenter is transferred to the second one, and so on up to the last fermenter. The molasses contains 50% sugars and should be diluted by 50% before entering the fermenters. The total retention time in the fermenters is 24 hours. The yeast is bought and prepared in a vessel and then added to the first fermenter. The yeast in the outflow of the last fermenter is separated by a settling tank and is recycled to the first fermenter. The capacity of this plant is 30 tons ethanol/day. The ethanol is produced by a yield of 0.45 grams ethanol/gram sugars. Draw flowsheet of this process and elaborate in detail how you developed the flowsheet.

25. a) *Aspergillus niger* is used for the production of citric acid through glucose fermentation. The pH is maintained around 2. The biomass composition is $CH_{1.5}O_{0.3}N_{0.2}$. The nitrogen source is ammonium nitrate and no CO_2 formed. Citric acid production is 0.6 g/g glucose.

i) Write the stoichiometric equation (4)

ii) Calculate the degree of reduction for biomass and citric acid. (4)

iii) Calculate the possible stoichiometric coefficients. (6)

(OR)

b) Consider the aerobic growth of *S. cerevisiae* on glucose, described by $CH_2O + aO_2 + bNH_3 \rightarrow cCH_{1.8}N_{0.2}O_{0.5} + dH_2O + eCO_2$. Prove that $Y'_{X/S} = [1\text{-}0.25\ \gamma_s RQ]/[1\text{-}(1.05)RQ]$ where γ_s is degree of reduction of substrate and RQ is respiratory quotient.

****