KUMARAGURU college of technology
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Register Number: ……..

B.TECH DEGREE EXAMINATIONS: MAY 2015

(Regulation 2009)

Sixth semester

BIOTECHNOLOGY

BTY118: Bioprocess Engineering

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

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. k_La can be measured by sulphite oxidation method. The DO concentration measured by probe in sodium sulphite solution will be.
   a) Zero b) Maximum
   c) Constant d) Minimum
2. The major problems associated with turbidity measurements in bioreactors are.
   a) Fouling from gas bubbles b) Interference from gas bubbles
   c) Both a & c d) Accumulation of cells in turbidity sensors
3. In RTD measurement techniques, multiple peaks are obtained for PFR due to.
   a) Short circuiting b) Ineffective utilization of reactor volume
   c) Internal recirculation d) By-passing
4. The solubility of oxygen _____ with increase in temperature.
   a) Decrease b) No change
   c) Increase d) Maximum
5. The following items consist of two statements, one labeled as the "Assertion (A)" and the other as "Reason (R)". You are to examine those two statements carefully and select the answers to these items using the codes given below:
   Assertion (A): During fermentation, cells suffer inhibitory effects from exposure to very high oxygen partial pressure
   Reason(R) : Pure oxygen increases k_La value
   Codes:
   a) Both A and R are individually true and R is the correct explanation of A b) Both A and R are individually true but R is not the correct explanation of A
   c) A is true but R is false d) A is false but R is true

6. Measurement of the amount of heat evolved or absorbed in a chemical reaction change, change of the state or formation of a solution is called as.
   a) Flow injection analysis
   b) Flow cytometry
   c) Bomb calorimetery
   d) Microbial calorimetry
7. Plasmid stability is not influenced by_____.
   a) Segregational loss
   b) growth rate ratio
   c) Vector insert ratio
   d) Structural stability
8. If the height: diameter ratio remains constant, then surface: volume ratio _____ during scale-up process.
   a) Increases
   b) Increases and then decreases
   c) Decreases
   d) Decreased and increased
9. The commonly used insect species for recombinant virus culture is _____
   a) *Acaylpha indica*
   b) *Spodoptera frugiperda*
   c) *Lepidoptera sp.*
   d) *d)Taenia solium*
10. Fluxes through the assembly of the single cell model are modeled in a _____
   a) 1-dimensional distribution
   b) 3-dimensional distribution
   c) 2-dimensional distribution
   d) Single cell model

PART B (10 x 2 = 20 Marks)

11. Why the plug flow considered as an ideal pattern?
12. List two disadvantages associated with direct steam sterilizer.
13. How do you convert the partial pressure of DO measured using probe into its concentration?
14. The tracer studies were carried out with a pulse input in tubular bioreactor. Calculate the values of mean and variance ($\sum C_i$=20.9, $\sum t_iC_i$=22.7 , $\sum t_i^2C_i$= 37320.4).
15. How do you determine the cell number density in fermentation broth?
16. List the important factors influencing sample injection in FIA.
17. Assuming a random distribution at division of plasmid. Calculate the probability of forming plasmid-free cells if all the cells have 60 plasmids at division.
18. How the plasmid structural instability influence the genetic instability of the plasmid?
19. What are the disadvantages of unstructured model?
20. What do you mean by transient culture metabolism?

PART C (5 x 14 = 70 Marks)

21. a) Medium at a flow rate of 4000 lph is to be sterilized by heat exchange with steam in a continuous sterilizer. The liquid contains bacterial spores at a

concentration of $5x10^{12}$ m^{-3}; the activation energy and Arrhenius constant for thermal destruction of these contaminants are 283 $kJ.mol^{-1}$ and 5.7×10^{39} h^{-1}, respectively. A contamination risk of one organism surviving every 30 days operation is considered acceptable. The sterilizer pipe has an inner diameter of 30 cm; the length of the holding section is 12 m. The density of the medium is 1000 $kg.m^{-3}$ and the viscosity is 3.6 $kg.m^{-1}.h^{-1}$. What sterilizing temperature is required?

(OR)

b) Describe how the ills of a flow bioreactor can be diagnosed using tracer studies. Substantiate your answer with neat diagram.

22. a) Derive an expression for scale-up of a bioreactor using the following criteria:

(i) Constant power per unit volume. (5)

(ii) Constant KLa. (5)

(iii) Constant impeller tip speed. (4)

(OR)

b) A strain of *Azotobacter vinelandii* is cultured in a 15 m^3 stirred fermenter for alginate production. Under current operating conditions, k_La is 0.17 s^{-1}. Oxygen solubility in the broth is approximately 0.008 $kg.m^{-3}$.

(i) The specific rate of oxygen uptake is 12.5 $mmol.g^{-1}.h^{-1}$. What is the maximum possible cell concentration? (7)

(ii) The bacteria suffer growth inhibition after copper sulphate is accidently added to the fermentation broth. This causes a reduction in oxygen uptake rate to 3 $mmol.g^{-1}.h^{-1}$. What maximum cell concentration can now be supported by the fermenter? (7)

23. a) With a neat diagram, explain the working principle, application of flow injection analysis. Substantiate your answer with biotechnological application.

(OR)

b) How do you calculate the heat evolved during fermentation?

24. a) Consider industrial scale batch fermentation. A 10,000 L fermenter with 5×10^{10} cells/ml is the desired scaleup operation. Inoculum of the large tank is brought through a series of seed tanks and flasks, beginning with a single pure colony growing on a agar slant. Assume that a colony (10^6 plasmid containing cells is picked and placed in a test tube with 1 mL of medium. Calculate how many generations will be required to achieve the cell density in the 10,000l fermenter. What fraction of the total population will be plasmid-free cells if $\mu_{+}=1.0h^{-1}$, $\mu_{-}=1.2h^{-1}$ and P=0.0005.

(OR)

b) Derive an expression for plasmid instability model for batch fermentation.

25. a) Explain the importance of structured models in analysis of various bioprocesses.

(OR)

b) With a neat diagram, describe the following

(a) Single cell model. (7)

(b) Compartment models. (7)

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