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J 3090

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2009.

Fifth Semester

Biotechnology

BT 1303 — BIOPROCESS PRINCIPLES

(Regulation 2004)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the limitations of using biosensors for in *situ* monitoring of fermentation processes?

2. Give a neat labeled sketch of a turbidostat.

3. "In industrial scale, crude complex media are preferred instead of simple defined media" — validate this statement?

4. What is the role of serum in animal cell culture media?

5. What is meant by Decimal Reduction Time in context of sterilization?

6. Chemical methods (eg: formaldehyde) are not preferred for sterilization of growth media — why?

7. Aerobic degradation of benzoic acid by a mixed culture of microorganisms can be represented by the following reaction.

$$C_6H_5COOH + a\,O_2 + b\,NH_3 \rightarrow c\,C_5H_7NO_2 + d\,H_2O + e\,CO_2$$

Determine a, b, c, d and e if $RQ = 0.7$.

8. What is meant by maintenance energy and how it influences growth rate?

9. What is meant by an unstructured segregated model?

10. What are the key concepts of Ludeking-Piret model?

PART B — ($5 \times 16 = 80$ marks)

11. (a) (i) What are the general requirements for designing an industrial scale aerobic fermentation? Explain in detail with a suitable example. (12)

(ii) Write a brief note on how the selling price of a fermentation product is decided. (4)

Or

(b) List the various sensors used to determine the physical and chemical parameters in a fermenter. Explain the Dissolved Oxygen probe and pH probe in detail with neat labeled sketches. (16)

12. (a) Explain the nutrient requirements and environmental requirements for microbial growth and product formation. (16)

Or

(b) Explain the Plackett-Burman method and Simplex method used to optimize the media. (16)

13. (a) It is decided to steam sterilize 1000 Liter of fermentation medium containing 3 g/L of a growth limiting substrate thiamine. The medium can be assumed to contain 10^4 spores/ml and it is desired to achieve a safety level of 10^{-3}, this corresponds to the probability of an unsuccessful sterilization being 0.001. Calculate the concentration of thiamine remaining after the sterilization. Assume First order kinetics for destruction of cells and nutrient and given Kd (spores) = 5 min^{-1} and Kd (thiamine) = 0.01 min^{-1}. What alternatives can you suggest to minimize nutrient degradation? (16)

Or

(b) (i) An autoclave malfunctions, and the temperature reaches only 119.5°C. The sterilization time at this maximum temperature was 20 min. The jar contains 10 Liter of complex medium that has 10^5 spores/l. At 121°C $k_d = 1.0$ min^{-1} and $E_{od} = 90$ kcal/g-mole for the spores. What is the probability that the medium was sterile? (8)

(ii) Give a neat labeled layout of a High Temperature Short Time sterilizer? Explain its principle and advantages over the batch sterilization process? (8)

14. (a) (i) Combustion data for cells aerobically grown in glucose ($C_6H_{12}O_6$) is given

$$CH_{1.82}N_{0.14}O_{0.5} + 1.2O_2 \rightarrow x\,CO_2 + y\,N_2 + z\,H_2O$$

5% of ash is also formed. Given that μ = 1.25 hr^{-1} $Y_{X/S}$ = 0.6 g/g. Assume that K= 26 kcal/(electron equivalent). Calculate the total amount of heat produced (in kilocalories) in 100 L fermentation broth containing 10 g/L of cells. (8)

(ii) Briefly explain about product function stoichiometry? (8)

Or

(b) (i) Explain how growth stoichiometry and Yield coefficients influence the medium formulation? (8)

(ii) Explain about Respiratory Coefficient (RQ) and Degree of Reductance in detail, including the methods to determine them? (8)

15. (a) (i) A chemostat system (500 L, is to be used for biomass production. Glucose (10 g/L) at a flow rate of 100 L/hr is fed into the reactor. Given that μ_m = 1.5 hr^{-1}, Ks =0.4 g/L and $Y_{X/S}$ = 0.4. Calculate the cell and glucose concentration in the effluent of the reactor (8)

(ii) Explain any ONE unstructured Kinetic Model for growth (8)

Or

(b) (i) Cephasporin—X is produced by *Cephalosporiun*, sp in a fed-batch culture with intermittent addition of glucose solution. The initial culture volume at quasi-steady state is V_0= 400 L, and glucose containing solution is added at a flow rate of F = 50 L/hr. Glucose concentration in the feed solution and initial cell concentration are S_0= 200 g/L and X_0 = 20 g/L respectively. The kinetic and yield coefficients of the organism are μ_{max} = 0.2 hr^{-1}, K_s = 0.5 g/L, $Y_{X/S}$ = 0.32 gg^{-1}, qp = 0.05 hr^{-1}. Calculate concentration of glucose, cells and product at after 10 hours? (8)

(ii) Explain the unique assumptions to be made in growth and product kinetic models for filamentous organisms? (8)