KATHMANDU UNIVERSITY
End Semester Examination
May/June, 2022

Marks scored:

Level : B.Tech.
Year : II

Course : BIOT 210
Semester : II

Exam Roll No :

Time: 30 mins.

F.M. : 20

Registration No:

Date :

SECTION "A"
[20Q. × 0.5 = 10 marks]

Mark [×] in the most appropriate box.

1. All the following processes are unsteady process except
   [ ] Batch process [ ] Fed batch process
   [ ] Continuous process [ ] Semi batch process

2. Which of the following heat transfer equipment is easy to scale up in bioprocess system?
   [ ] External jacket [ ] Internal coils
   [ ] External coils [ ] External heat exchanger

3. The heat transfer mechanism/s that is least affected in bioprocessing is/are
   [ ] Convective transfer [ ] Conductive transfer
   [ ] Radiation [ ] Both convective and conductive transfer

4. The unit of overall heat transfer coefficient (U) is
   [ ] $W\ m^{-1}\ K^{-1}$ [ ] $m^{-2}\ K^{-1}$ [ ] $W\ m^{-2}\ K^{-1}$ [ ] $W\ m^{-3}\ K^{-1}$

5. The inlet and outlet temperatures of a colling coil of a fermenter are 15 °C and 30 °C respectively. If the fermenter is operated at 37 °C, what is the log mean temperature difference?
   [ ] 10 °C [ ] 13 °C [ ] 15 °C [ ] 17 °C

6. Which of the following dimensionless quantity is not important in a stirred tank reactor?
   [ ] Nusselt number [ ] Grashof number
   [ ] Prandtl number [ ] Reynolds number

7. The Control of the temperature during large scale fermentation is mostly done within
   [ ] 0.5 ^{0}C [ ] 1 ^{0}C [ ] 2 ^{0}C [ ] 5 ^{0}C

8. In two film theory of mass transfer, the boundary layer concentrations are at
   [ ] Steady state [ ] Equilibrium state
   [ ] Unsteady state [ ] Dynamic state

9. If the solubility of a substance in a fermentation broth is increased, it's volumetric mass transfer (N_A)
   [ ] Decreases [ ] Increases
   [ ] Remains constant [ ] Independent of solubility

10. The driving force for heat transfer in a plate heat exchanger is
[ ] Arithmetic temperature difference
[ ] Logarithmic temperature difference
[ ] Mean Squared temperature difference
[ ] Temperature difference only

11. The relationship between specific growth rate(μ) and dilution rate(D) in fed batch at quasi steady state is
[ ] $\mu=D$ [ ] $\mu=2D$ [ ] $\mu=D^2$ [ ] $\mu=D^{1/2}$

12. The most reliable procedure for measuring Kla is
[ ] Dynamic method [ ] Oxygen balance method
[ ] Sulphite oxidation method [ ] Unsteady state method

13. Most of the resistance to heat transfer to or from the fluid is contained in the
[ ] Liquid film [ ] Wall Barrier [ ] Fouling layer [ ] Bulk of the liquid

14. If dissolved oxygen concentration is above the critical oxygen concentration, Specific oxygen uptake rate is
[ ] Constant [ ] Minimum
[ ] Dependent of C_{AL} [ ] All of the above

15. Retention time is defined as
[ ] F/V [ ] V/F [ ] F/T [ ] T/F

16. In the equation $Q = UA\Delta T$; ΔT is
[ ] Geometric mean temperature difference.
[ ] Arithmetic mean temperature difference.
[ ] Logarithmic mean temperature difference
[ ] The difference of average bulk temperatures of hot and cold fluids.

17. A higher Ks value of Monod's equation means
[ ] Greater affinities to substrate
[ ] Lower affinities to substrate
[ ] Unaffected with the substrate bonding
[ ] Lower dissociation constant value

18. In sterilization process, spore of which of the following organism is used as positive control?
[ ] *Bacillus subtilis* [ ] *Clostridium botulinum*
[ ] *Bacillus stearothermophilus* [ ] *Aspergillus niger*

19. Feature of fed batch culture is
[ ] Not effective for catabolite repression
[ ] Controlled oxygen demand
[ ] Uniform temperature
[ ] Easy scale up

20. Wash out in steady state fermentation occurs when
[ ] Dilution rate is less than maximum specific growth rate.
[ ] Dilution rate is higher than the maximum specific growth rate.
[ ] Cell concentration reaches the maximum.
[ ] Specific growth rate is maximum

SECTION "B"

[10Q. × 1 = 10 marks]

Fill in the blanks.

21. The unit of mass transfer coefficient is _____.

22. The amount of steam needed for continuous sterilization is _____% of that used in batch processes

23. The condition at high dilution rate whereby x reduces to zero is known as _____.

24. In single-phase systems, the rate of mass transfer due to molecular diffusion is given by _____ law of diffusion.

25. True yield is defined as _____.

26. The relationship for volumetric rate of substrate uptake (r_s)in terms of biomass(x) and specific rate of substrate uptake(q_s) is _____.

27. The thickness of the thermal boundary layer in most heat transfer situations is _____ than the hydrodynamic boundary layer.

28. Enzyme conversion is not varied out for _____ process.

29. The mathematical expression for Nusslet number is _____.

30. _____ culture is used extensively in production of bakers' yeast to overcome catabolite repression.

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SECTION "C"
(Long answer questions)
[4Q. × 7 = 28 marks]

Attempt *ANY FOUR* questions.

1. Derive the expression for steady state substrate concentration in terms of dilution rate for enzymatic conversion in a continuous operation.

2. Explain the types of bioreactor configurations for heat transfer.

3. Explain the simple dynamic method for measurement of Kla.

4. Whole gutted fish are dried to make a protein paste. In a batch drier, the rate at which water is removed from the fish is roughly proportional to the moisture content. If a batch of gutted fish loses half its initial moisture content in the first 25 min, how long will the drier take to remove 95% of the water?

OR

The reaction equation for aerobic production of acetic acid from ethanol is:
$C_2H_5OH + O_2 \rightarrow CH_3CO_2H + H_2O$
Acetobacter aceti bacteria are added to vigorously aerated medium containing 10 g l^{-1} ethanol. After some time, the ethanol concentration is 2 g l^{-1} and 7.5 g l^{-1} of acetic acid is produced. How does the observed yield of acetic acid from ethanol compare with the theoretical yield?

5. A copper pipe of diameter 3 cm and wall thickness 4 mm is used in an antibiotic factory to convey hot water a distance of 50 m at a flow rate of 20 Ls^{-1}. The inlet temperature of the water is 90 °C. Due to heat losses to the atmosphere, the outlet water temperature is 84 °C. The ambient temperature is 25 °C. The inside of the pipe is covered with a layer of fouling with a fouling factor of 7500 W m^{-2} $°C^{-1}$. What proportion of the total resistance to heat transfer is provided by the fouling layer?

OR

A genetically engineered strain of yeast is cultured in a bioreactor at 30 °C for production of heterologous protein. The oxygen requirement is 80 mmol l^{-1} h^{-1}; the critical oxygen concentration is 0.004 mM. The solubility of oxygen in the fermentation broth is estimated to be 10 % lower than in water due to solute effects. What is the minimum mass transfer coefficient necessary to sustain this culture with dissolved oxygen levels above critical if the reactor is sparged with air at approximately 1 atm pressure?

SECTION "D"

[27 marks]

Attempt *ALL* questions.

6. A liquid stream is cooled from 70 °C to 30 ^{0}C in a double-pipe heat exchanger. Fluid flowing counter currently with this stream is heated from 20 ^{0}C to 45 ^{0}C. Calculate the log-mean temperature difference. [4]

7. When Streptococcus lactis bacteria are cultured in milk, the concentration of cells doubles every 55 min. If this rate of growth is maintained for 10 h, what is the final concentration of cells relative to the inoculum level? [4]

8. Draw a labeled typical temperature-time profile for batch sterilization of fermentation medium. [4]

9. Explain the unsteady state process with reference to bioprocess technology. [4]

10. What are the different roles of mass transfer in bioprocess technology? [4]

11. Define fed batch culture with examples. [4]

12. Write short note on (*ANY ONE*): [3]
    a. Heat exchangers
    b. Liquid solid mass transfer

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Explain with graphs and figures where ever required.

SECTION "B"
[5Q. × 3 = 15 marks]

Attempt *ANY FIVE* questions.

1. Explain about different neurotransmitters and receptors involve in ANS.
2. How does the body adapt when exposed to cold.
3. Draw a well labeled diagram of a human eye.
4. Explain how fever is induced in the body. Why does a person sweats at the time when fever subsides?
5. Write briefly about the buffer systems involved in generating new bicarbonate ions when Hydrogen ions are in excess to Bicarbonate ions?
6. How does the kidneys autoregulate renal blood flow and GFR?
7. What are the various events that occur following fertilization of the ovum till it gets implanted in the uterus?

SECTION "C"
[5Q. × 5 = 25 marks]

Answer *ANY FIVE* questions.

8. Elaborate on synthesis of thyroid hormone.
9. Describe in detail about the effects of sympathetic & parasympathetic outflow in various parts of the body system.
10. Elaborate on corticospinal tract with well labeled diagram.
11. How does the vibration of tympanic membrane converted to action potential?
12. Elaborate the mechanism of action of insulin. Give an account on functions of insulin.
13. Explain in detail about the Acute Renal Failure.
14. Describe in detail the various phases of ovarian cycle.

SECTION "D"

[2Q. × 7.5 = 15 marks]

Answer *ANY TWO* questions.

15. Differentiate between rods and cones? Explain the neural pathway that carries the image formed in retina to higher center with well labeled diagram. What are the conditions that can occur due to damage in this pathway? [1.5 + 4.5 + 1.5]

16. Explain the countercurrent multiplier system in detail. Also explain in detail the role of urea and vasa recta in preserving hyperosmolarity of renal medullary interstitium.

17. a. Elaborate on dorsal column medial leminiscal system. [3.5]
    b. Write a short note on gigantism and acromegaly. [4]