Duration: 120 min
Total Marks: 20

Part A (10 Marks)
Answer ALL questions and each question carries EQUAL marks

1. Rochelle salt in di-nitro salicylic (DNS) acid method acts as a _____.

2. The immobilization of enzyme in calcium alginate beads is mediated by _____ technique

3. Enumerate FOUR advantages of immobilizing enzymes for industrial applications.

4. *Escherichia coli* is capable of growing at a rate such that the culture doubles in biomass every 20 minutes. If 100 ml of nutrient medium is inoculated with about 1 µg of organisms and subsequently incubated for 24 h, what quantity of organisms might you expect to be produced?

5. An absorbance value of 1 unit (at 600 nm) corresponds to _____ g/l of biomass concentration based on a thumb's rule.

6. A certain yeast cell is said to have a doubling time of 90 minutes. What is its specific growth rate in hr^{-1}?

7. A 1 ml inoculum of same yeast cells (as mentioned in question **6**) at an OD of 5 (600 nm) is used to inoculate 1 L of fresh media. How long will it take for the new culture to reach an OD of 1?

8. A typical example for structured growth model is _____

9. Define the significance of the parameter 'Ks' in Monod's model.

10. In Monod's model, specific growth rate profile principally varies with change in substrate concentration in a _____ fashion.

Part B (10 Marks)
Answer ALL questions and each question carries EQUAL marks

11. A reaction mixture consisting of crude Cellulase enzyme with a K_m of 2.5mM acts on 0.35 M CMC substrate with no product formation. After 60 seconds, the reaction mixture was subjected for product quantification and 45µM (µM) of glucose was observed. Find the V_{max} and concentration of product formation after 135 seconds.

12. The absorbance of a DNS solution containing 0.500 mg/mL (mg) glucose was reported as 0.3500 at 440nm.

   a) Calculate the specific absorptivity, including units, on the assumption that a 1.00 cm cuvette was used.

   b) What will be the absorbance if the solution is diluted to twice its original volume.

13. A 20-1 stirred fermenter containing a *Bacillus thuringiensis* culture at 30°C is used for production of microbial insecticide, k_La is determined using the dynamic method. Air flow is shut off for a few minutes and the dissolved-oxygen level drops; the air supply is then re-connected. The following results are obtained.

↗ saturation (%)

Time (sec)	Dissolved oxygen tension
5	50
15	66

When steady state is established, the dissolved-oxygen tension is 78 % air saturation.

(a) Estimate k_La.

(b) An error is made determining the steady-state oxygen level which, instead of 78%, is taken as 70%. What is the percentage error in k_La resulting from this error in steady state oxygen level?

14. A simple batch fermentation of an aerobic bacterial strain grown on glucose limited mineral salt medium was performed in a lab scale bioreactor. The experimental results are tabulated as shown below:

weight (gm/L)   concentration (gm/L)

Time (h)	Cell Dry	Glucose
0	0.2	9.23
2	0.211	9.21
4	0.305	9.07
8	0.98	8.03
10	1.77	6.8
12	3.2	4.6
14	5.6	0.92
16	6.15	0.077
18	6.2	0

$\mu = \mu_{max} \dfrac{S}{K_s + S}$

(a) Calculate the maximum specific growth rate
(b) Calculate the saturation constant
(c) Calculate the cell mass doubling time

15. An experiment was performed on an exponential phase microbial culture, where the oxygen supply was disconnected and the dissolved oxygen (DO) concentration was allowed to fall to 43.5% saturation. At this point, aeration was resumed and the increase in DO concentration was monitored with respect to time. From the following data of the reoxygenation stage, calculate the quasi-steady state DO concentration and the gas-liquid mass transfer coefficient (k_La) for the reactor.

Time (s)	% DO Saturation
10	43.5
20	53.5
30	60
40	67.5
50	70.5
60	72
70	73
100	73.5
130	73.5