BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE PILANI, PILANI CAMPUS
I Semester 2022 – 2023 : Mid Semester Examination
CHE F 421: Biochemical Engineering: 01.11.2022 : Total duration-1.5 h (2:00 - 3:30 PM)

Closed Book **Max. Marks: 60**

Instructions: Make necessary assumption, wherever needed with proper justification.
Blanks + 9 Questions.

Blanks [7]

1. Intracellular composition of cells varies depending on the _____ and age of the cells and _____ *of the nutrient media.*
2. In _____fermentations**,** a large fraction of substrate carbon is converted to products and a smaller fraction is converted to cell mass (less than 30%)
3. DNA and RNA are polymers of _____.
4. Despite all their complexity, an understanding of biological systems can be simplified by analyzing the system at several different levels: molecular level, _____level, _____level and production level.
5. Microbes that grow at both aerobic and anaerobic conditions are referred as _____.

_____

1. Pfizer completed in less than six months the first plant for commercial production of penicillin by submerged fermentation process. How was the penicillin discovered and lead to first scaled up process envisaging the concept of bioprocess engineering ? **[5 M]**

2. You are asked to develop a medium for production of an antibiotic. The antibiotic is to be made in large amounts (1,00,000 L fermenters or so) and is relatively inexpensive. The host cell is a soil isolate of a bacterial species and the nutritional requirements for rapid growth are uncertain. Will you try to develop a defined or complex medium ? Why ? **[3 M]**

3. Starting from the simple reaction scheme of enzyme – substrate complex formation and a dissociation step of the ES complex. **Derive the Michaelis Menten Equation based on the Quasi steady state assumption.**

$$E + S \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} ES \xrightarrow{k_2} E + P \qquad (3.1)$$

The rate of product formation is :

$$v = \frac{d[P]}{dt} = k_2[ES] \qquad (3.2$$

where v is the rate of product formation or substrate consumption in moles/l-s. **[5 M]**

4. The following data were obtained for an enzyme-catalyzed reaction. The initial rate data for the enzyme-catalyzed reaction are as follows: **[3+5=8 M]**

a) Determine V_{max} and K_m by inspection.
b) Plot the data using the Eadie–Hofstee method and Line Weaver plot and determine these constants graphically. Explain the discrepancy in the two determinations.

[S] mol/l	v μmol/min
5.0×10^{-4}	125
2.0×10^{-4}	125
6.0×10^{-5}	121
4.0×10^{-5}	111
3.0×10^{-5}	96.5
2.0×10^{-5}	62.5
1.6×10^{-5}	42.7
1.0×10^{-5}	13.9
8.0×10^{-6}	7.50

5. Decarboxylation of glyoxalate (S) by mitochondria is inhibited by malonate (I). Using the following data obtained in batch experiments, determine the following: **[8 M]**

a. What type of inhibition is this?

b. Determine the constants Vm, Km, and KI.

Glyox,S (m*M*)	Rate of CO_2 evolution, v (mmoles/l-h)		
	I = 0	I = 1.26 mM	I = 1.95 mM
0.25	1.02	0.73	0.56
0.33	1.39	0.87	0.75
0.40	1.67	1.09	0.85
0.50	1.89	1.30	1.00
0.60	2.08	1.41	1.28
0.75	2.44	1.82	1.39
1.00	2.50	2.17	1.82

6. When enzymes are immobilized on internal pore surfaces of a porous matrix, substrate diffuses through the tortuous pathway among pores and reacts with enzyme immobilized on pore surfaces. Show the schematic representation and explain with the concept of Thiele Modulus. **[5 M]**

7. Explain the particular schematic for transfer of energy from energy generation to cell synthesis or maintenance. **[5 M]**

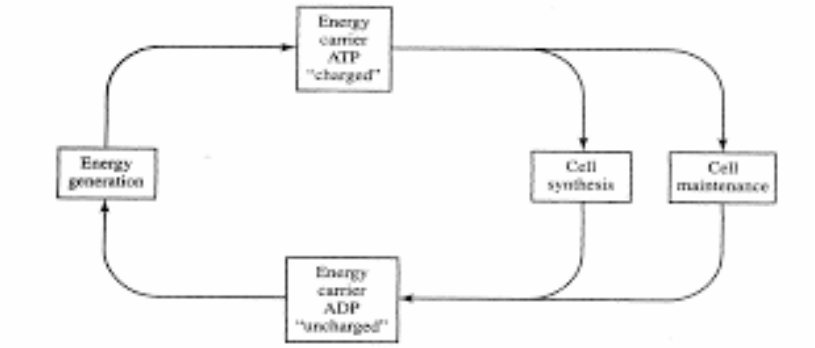

Figure 1.13 Transfer of energy from energy generation to cell synthesis or maintenance via an energy carrier, represented by ATP.

8. Metabolism is the sum total of all the chemical processes of the cell. The transfer of energy between catabolism and anabolism is termed as energy coupling reaction.

a) What are microbial cells referred as that obtain energy from oxidation of inorganic chemical and organic chemicals ? **[2]**

b) Explain the three major deductions of Hans A Kerbs cycle of organic catabolism ? **[3]**

c) Figure 1.15 illustrate graphically the relative free energy available from oxidation/ reduction coupled reaction by microorganisms. Explain the three major deduction from the Figure.**[3]**

d) Explain a typical fermentation reaction which utilizes both the electron donor and electron acceptor from the organic compounds and estimate the delta G . **[2]**

9. In reality, microorganisms are able to generate ATP by oxidative phosphorylation. What is the mechanism by which NADH free energy is transferred to ATP so that huge variation in energy potential is accommodated? **[4]**