| Reg. No. | | | | | | | | | | |
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# Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

## I SEMESTER M.TECH (INDUSTRIAL BIOTECHNOLOGY)

## END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: BIOPROCESS ENGINEERING [BIO 501]

**REVISED CREDIT SYSTEM**

Time: 3 Hours MAX. MARKS: 50

**Instructions to Candidates:**

- Answer **ANY FIVE FULL** the questions.
- Missing data may be suitable assumed.

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| **1A.** | The isolated *actinomycetes* strain have to be preserved to use in future, which method is best suitable for preservation of *actinomycetes*? | **3M** |
| **1B.** | What are the differences in cell envelop structure between gram-negative and gram-positive bacteria? These differences become important if you wish to genetically engineer bacteria to excrete proteins into the extracellular fluid. | **3M** |
| **1C.** | You are asked to develop a medium for production of an antibiotic. The antibiotic is to be made in large amounts (100000 l fermentation) and is relatively inexpensive. The host cell is a soil isolate of a fungal species, and the nutritional requirements for rapid growth are uncertain. Will you try to develop a defined or complex medium? Why? | **4M** |
| **2A.** | A total seven (n) variables (A, B, C, D, E, F and G) with four dummy variables (H, J, K and L) were selected. The glucose oxidase activity of the 12 trials are listed, perform the ANOVA and identify the significant parameters. | **10M** |

| Trial no | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $D_1$ | $D_2$ | $D_3$ | $D_4$ | ACTIVITY (U/mL) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **H** | L | L | L | L | H | H | L | H | H | L | 2.823 |
| 2 | L | L | L | L | L | L | L | L | L | L | L | 0.289 |
| 3 | H | H | H | L | H | H | L | H | L | L | L | 0.57 |
| 4 | L | H | L | L | L | H | H | H | L | H | H | 0.95 |
| 5 | L | L | L | H | H | H | L | H | H | L | H | 0.459 |
| 6 | L | H | H | L | H | L | L | L | H | H | H | 0.07 |
| 7 | L | H | H | H | L | H | H | L | H | L | L | 0.508 |
| 8 | H | H | L | H | H | L | H | L | L | L | H | 1.013 |
| 9 | L | L | H | H | H | L | H | H | L | H | L | 0.715 |
| 10 | H | H | L | H | L | L | L | H | H | H | L | 0.285 |
| 11 | H | L | H | H | L | H | L | L | L | H | H | 0.814 |
| 12 | H | L | H | L | L | L | H | H | H | L | H | 1.31 |

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<table>
<tr><td>3A.</td><td>The hydrolysis of urea by urease is only partially understood reaction and shows inhibition. The data for the hydrolysis of the reaction are,
<table>
<tr><td>Substrate concentration</td><td colspan="2">0.2 (M)</td><td colspan="2">0.02 (M)</td></tr>
<tr><td></td><td>1/v (l.min/mole)</td><td>I (M)</td><td>1/v (l.min/mole)</td><td>I (M)</td></tr>
<tr><td></td><td>0.22</td><td>0</td><td>0.68</td><td>0</td></tr>
<tr><td></td><td>0.33</td><td>0.0012</td><td>1.02</td><td>0.0012</td></tr>
<tr><td></td><td>0.51</td><td>0.0027</td><td>1.50</td><td>0.0022</td></tr>
<tr><td></td><td>0.76</td><td>0.0044</td><td>1.83</td><td>0.0032</td></tr>
<tr><td></td><td>0.88</td><td>0.0061</td><td>2.04</td><td>0.0037</td></tr>
<tr><td></td><td>1.10</td><td>0.0080</td><td>2.72</td><td>0.0044</td></tr>
<tr><td></td><td>1.15</td><td>0.0093</td><td>3.46</td><td>0.0059</td></tr>
</table>
a. Determine the Vmax, Km for this reaction.<br>b. What type of inhibition reaction is this?<br>c. Find out $K_I$</td><td>6M</td></tr>
<tr><td>3B.</td><td>Explain the different method of immobilization? How an immobilized enzyme can improve the stability and reusability of enzyme. Write on the supporting materials used for this process.</td><td>4M</td></tr>
<tr><td>4A.</td><td>It is required to provide a 40 $m^3$ fermenter with air at a rate of 20 $m^3$ $min^{-1}$ for a fermentation lasting 100 hours. From an investigation of the filter material to be used, the optimum linear air velocity was shown to be 0.3 m/s, at which the value of K was 3.07 $cm^{-1}$. Determine the dimensions of the filter, if the air in the fermentation plant contained 400 micro-organisms $m^{-3}$.</td><td>4M</td></tr>
<tr><td>4B.</td><td>Sketch the continuous sterilization performance chart and enlist its significance with respect to temperature, time and nutrient quality.</td><td>3M</td></tr>
<tr><td>4C.</td><td>How do you calculate the total magnification you are looking at a specimen with? Give an example to support your statement.</td><td>3M</td></tr>
<tr><td>5A.</td><td>A microorganism is cultured in a 10 L batch bioreactor, which initially contained 100 g/L growth substrate (considered to be a "high" concentration) and 0.2 g/L biomass. You are told by a colleague that the doubling time for this culture (in exponential phase) is very reproducible, with $t_d$ = 1.25 hours. After 6 total hours in culture, you measure the cell density and substrate concentration: $t$ = 6 h: $x$ = 1.24 g/L; $S$ = 73 g/L.<br>Estimate:<br>a. The maximum specific growth rate, $\mu_{max}$ ($h^{-1}$).<br>b. The yield coefficient, $Y_{X/S}$ (g biomass/g substrate).<br>c. The cell density at stationary phase (g/L).<br>d. The total culture time required to reach stationary phase (h).</td><td>5M</td></tr>
<tr><td>5B.</td><td>Develop a growth model for filamentous organisms in terms of biomass and list the assumptions made.</td><td>5M</td></tr>
<tr><td>6A.</td><td>The equation for aerobic production of Acetic Acid from ethanol is:</td><td>3M</td></tr>
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| | $C_2H_5OH + O_2 \longrightarrow CH_3CO_2H + H_2O$. *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 $l^{-1}$ acetic acid is produced. How does the overall yield of acetic acid from ethanol compare with the theoretical yield? | |
| **6B.** | The growth of baker's yeast on glucose may be simply described by the following equation:<br>$C_6H_{12}O_6 + 3O_2 + 0.48NH_3 \longrightarrow 0.48C_6H_{10}NO_3 + 4.32H_2O + 3.12CO_2$.<br>In a batch reactor of volume $10^5$l, the final desired yeast concentration is 50 gdw/l. using the above reaction stoichiometry:<br>(a) Determine the concentration and total amount of glucose and $(NH_4)_2SO_4$ in the nutrient medium.<br>(b) Determine the $Y_{X/S}$ and $Y_{X/O2}$. | **5M** |
| **6C.** | Determine the degree of reduction for $C_6H_6COOH$ and $C_5H_7NO_2$. | **2M** |