

### Problem 2.1

A batch reactor containing 0.3% (w/v) glucose and a simple medium is inoculated with a culture grown in a medium of the same composition. Optical density (OD) at 420 nm as a function of time evolves as shown in the Table (column 1).

The same strain, this time cultivated in complex medium, is inoculated in another batch reactor containing a mixture of glucose 0.15% (w/v) and lactose 0.15% (w/v). The evolution of optical density, at 420 nm, as a function of time is represented in the Table (column 2). If there is a linear relationship between optical density and cell concentration where 0.175 (OD) corresponds to 0.1 mg cells per ml, calculate:

- The maximum specific growth rate,  $\mu_{\max}$ ;
- The adaptation time,  $t_{\text{lag}}$ ;
- The growth yield coefficient,  $Y_{x/s}$ , assuming complete substrate exhaustion in each case.
- Explain the shape of the curves in each case.

Data:

Time(h)	OD (1)	OD (2)		Time (h)	OD (1)	OD (2)
0	0.06	0.06		4.5	0.44*	0.43
0.5	0.08	0.06		5.0	0.52*	0.48
1.0	0.11	0.06		5.5	0.52*	0.50
1.5	0.14	0.07		6.0		0.52
2.0	0.20	0.11		6.5		0.30*
2.5	0.26	0.13		7.0		0.42*
3.0	0.37	0.18		7.5		0.50*
3.5	0.49	0.26		8.0		0.50*
4.0	0.35*	0.32		* dilution 1:2		

### Problem 2.2

A certain microorganism was cultured in a batch reactor for 20 h. Samples were taken every 2 hours to measure cell and substrate concentration. Assess the degree of substrate limitation over time and calculate the maximum specific growth rate as well as the Monod constant..

T(h)	X (g/L)	S (g/L)
0	0.10	10.00
2	0.14	9.56
4	0.20	8.94
6	0.29	8.05
8	0.43	6.81
10	0.59	5.10
12	0.83	2.90
14	1.02	0.69
16	1.10	0.02
18	1.09	0.00
20	1.10	0.00

### Problem 2.3

*Escherichia coli* grows in a batch reactor using glucose as a substrate. The following table shows cell concentrations as a function of substrate concentration.

- Represent  $\mu$  as a function of time.
- Calculate  $\mu_{\max}$ .
- Calculate the apparent growth yield coefficient and the real growth yield coefficient.

Time (h)	Cell concentration (kg m <sup>-3</sup> )	Substrate concentration (kg m <sup>-3</sup> )
0.0	0.20	25.0
0.33	0.21	24.8
0.5	0.22	24.8
0.75	0.32	24.6
1.0	0.47	24.3
1.5	1.00	23.3
2.0	2.10	20.7
2.5	4.42	15.7
2.8	6.9	10.2
3.0	9.4	5.2
3.1	10.9	1.65
3.2	11.6	0.2
3.5	11.7	0.0
3.7	11.6	0.0