| Time (h) | $X$ (g/l) | $S$ (g/l) |
|---|---|---|
| 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 |

**6.2.** The growth of a microbial population is a function of pH and is given by the following equation:

$$\mu_g = \frac{1}{X}\frac{dX}{dt} = \frac{\mu_m S}{K_s\left(1+\frac{H^+}{k_1}\right)+S}$$

**a.** With a given set of experimental data ($X$ and $S$ versus $t$), describe how you would determine the constants $\mu_m$, $K_s$, and $k_1$.

**b.** How would the double-reciprocal plot $1/\mu_g$ versus $1/S$ change with pH (or $H^+$) concentration?

**6.3.** The following data were obtained for the effect of temperature on the fermentative production of lactic acid by a strain of *Lactobacillus delbrueckii*. From these data, calculate the value of the activation energy for this process. Is the value of the activation energy typical of this sort of biological conversion? (See Chapter 3.)

| Temperature (°C) | Rate constant (mol/l-h) |
|---|---|
| 40.4 | 0.0140 |
| 36.8 | 0.0112 |
| 33.1 | 0.0074 |
| 30.0 | 0.0051 |
| 25.1 | 0.0036 |

[Courtesy of A. E. Humphrey from "Collected Coursework Problems in Biochemical Engineering," compiled by H. W. Blanch for 1977 Am. Soc. Eng. Educ. Summer School.]

**6.4.** It is desired to model the growth of an *individual* bacterium. The cell transports $S_1$ into the cell enzymatically, and the permease is subject to product inhibition. $S_1$ is converted into precursors, $P$, that are converted finally into the macromolecular portion of the cell, $M$. The catalyst of all reactions is $M$.

**(1)** $S_1^* \xrightarrow[M]{} S_1$ (per unit surface area)
where $S^*$ = outside concentration of $S$

**(2)** $S_1 \xrightarrow[M]{} P$