6.6. *Pseudomonas sp.* has a mass doubling time of 2.4 h when grown on acetate. The saturation constant using this substrate is 1.3 g/l (which is unusually high), and cell yield on acetate is 0.46 g cell/g acetate. If we operate a chemostat on a feed stream containing 38 g/l acetate, find the following:

a. Cell concentration when the dilution rate is one-half of the maximum

b. Substrate concentration when the dilution rate is 0.8 D_{max}

c. Maximum dilution rate

d. Cell productivity at 0.8 D_{max}

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

6.7. The following data were obtained in a chemostat for the growth of *E. aerogenes* on a glycerol-limited growth medium.

D, h^{-1} dilution rate	$1/D$	S, mg/ml, glycerol	$1/S$	X, mg/ml cell conc.	ΔS	$\Delta S/X$	$\Delta S/X \cdot D$
0.05	20	0.012	83.3	3.2	9.988	3.12	0.156
0.10	10	0.028	35.7	3.7	9.972	2.7	0.270
0.20	5.0	0.05	20	4.0	9.95	2.49	0.498
0.40	2.5	0.10	10	4.4	9.90	2.25	0.90
0.60	1.67	0.15	6.67	4.75	9.85	2.075	1.245
0.70	1.43	0.176	5.68	4.9	9.824	2.005	1.405
0.80	1.25	0.80	1.25	4.5	9.20	2.045	1.635
0.84	1.19	9.00	0.11	0.5	—	—	—

Note: $S_0 = 10$ mg/ml.

For this system, estimate the values of:

a. K_s, mg glycerol/ml

b. μ_m, h^{-1}

c. $Y_{X/S}$, mg cells/mg glycerol

d. m_s, mg glycerol/mg cell-h

[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.]

6.8. The kinetics of microbial growth, substrate consumption, and mixed-growth-associated product formation for a chemostat culture are given by the following equations:

$$\frac{dX}{dt} = \frac{\mu_m S}{K_s + S} X$$

$$\frac{dS}{dt} = \frac{\mu_m S}{(K_s + S) Y_{X/S}} X$$

$$\frac{dP}{dt} = \alpha \frac{dX}{dt} + \beta X = (\alpha \mu_g + \beta) X$$

The kinetic parameter values are $\mu_m = 0.7$ h^{-1}, $K_s = 20$ mg/l, $Y_{X/S} = 0.5$ g dw/g substrate, $Y_{P/X} = 0.15$ gP/g·dw, $\alpha = 0.1$, $\beta = 0.02$ h^{-1}, and $S_0 = 1$ g/l.