

Problem Set 9

Due: 5/16/2006

1. Please code up the equations given in class on 5/8/06 for the continuous well-stirred cell bioreactor, solving for C, S, and DP for a range of D values from 0 to 1.5 hour⁻¹. Plot these quantities at each D value and find the optimal D value. You can put constraints in your code to get appropriate solutions for $D < \mu_{\max}$ and $D > \mu_{\max}$.

Starting values for the relevant constants are listed below, but please feel free to change them to get an idea of how the system responds differently with different values of these parameters.

$$\mu_{\max} = 1.0; \text{ \%hour}^{-1}$$

$$K_m = 0.2; \text{ \%g/L}$$

$$S_{in} = 10; \text{ \%g/L}$$

$$Y_s = 0.5;$$

$$Y_g = 0.5;$$

2. Consider a cell bioreactor run in batch mode, in two sequential stages. In the first stage, the cells proliferate exponentially with a constant specific growth rate constant, μ_{\max} , the nutrient is consumed in growth-associated manner proportionately to this specific cell growth rate, and no product is generated. This first stage ends when the nutrient concentration drops from its initial value to a value at which cell proliferation can no longer be supported; call this value s_c . In the second stage, the cell density remains constant at whatever value it reached in the first stage, nutrient is consumed at a rate first-order in both nutrient concentration and cell density, and product is generated at a rate proportional to the nutrient consumption rate. The batch is stopped when the nutrient concentration drops to a value at which product generation can no longer be supported; call this value s_f .

Develop an expression for the product concentration attained in the batch.

3. Please read the paper by Sarkar *et al.* (Molecular Pharmacology 63: 147 [2003]), describing a computational model for the pharmacokinetics and pharmacodynamics of modified GCSF as an improved therapeutic cytokine.