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PROBLEMS

16.1. A batch fermenter receives 1 l of medium with 5 g/l of glucose, which is the growth-rate-limiting nutrient for a mixed population of two bacteria (a strain of *E. coli* and *Azotobacter vinelandii*). *A. vinelandii* is five times larger than *E. coli.* The replication rates for the two organisms are:

$$\mu_{EC} = \frac{1.0 \ \ h^{-1} \, s}{0.01 \ \ g/l + s} - 0.05 \ \ h^{-1}$$

and

$$\mu_{AV} = \frac{1.5 \ \ h^{-1} \, s}{0.02 \ \ g/l + s} - 0.10 \ \ h^{-1}$$

The yield coefficients are:

$$Y_{EC} = 0.5 \ g \, dw/g \, glucose$$

$$Y_{AV} = 0.35 \ g \, dw/g \, glucose$$

The inoculum for the fermenter is 0.03 g dw/l of *E. coli* (1×10^8 cells/ml) and 0.15 g dw/l of *A. vinelandii* (1×10^8 cells/ml).

What will be the ratio of *A. vinelandii* to *E. coli* at the time when all of the glucose is consumed?

16.2. Consider Example 16.1, where we demonstrated that two bacteria competing for a single nutrient in a chemostat (well-mixed) could not coexist. Consider the situation where *B* can adhere to a surface but *A* cannot. Redo the balance equations, where *a* is the surface area available per unit reactor volume and the rate of attachment is first order in X_B with a rate constant k_{aB}. The sites available for attachment will be $(X_{BM}^{At} - X_B^{At})aV$. The attached cells can detach with a first-order dependence on the attached cell concentration (X_B^{At}) with a rate constant of k_{dB}. Attached cells grow with the same kinetics as suspended cells.

  a. Without mathematical proofs, do you think coexistence may be possible? Why or why not?

  b. Consider the specific case below and solve the appropriate balance equations for $D = 0.4 \ h^{-1}$: