

Math 637, Spring 2005, Assignment 1

Due Monday February 14 in Class

NOTE: Late assignments will not be accepted and, although problems may be discussed with others, all actual work must be done individually.

1. Write down the system of ordinary differential equations describing an enzyme with one allosteric inhibitory binding site and one active catalytic binding site, as discussed in class and shown in Figure 1.1 of Keener and Sneyd. Using a quasi-steady approximation, derive an expression for the reaction velocity V_{qs} . Discuss the differences between this result and that obtained using the equilibrium approximation, V_{eq} , including V_{max} and dependence on s , i , K_s and K_i . Choose a reasonable set of parameters and make comparison plots of V_{qs} and V_{eq} as functions of s and i .
2. Problem 4 (parts a and b only) on P.31 of K&S. Assume the initial concentrations of the two enzymes are the same ($e_{10} = e_{20} = e_0$), and interpret each reaction as a basic enzyme reaction ($E+S \leftrightarrow C \rightarrow E+P$).
3. Consider the model of facilitated oxygen diffusion in muscle respiration given in Section 2.3.1 of K&S. Compare the steady-state solution given for constant oxygen consumption g to one for a radially varying consumption of the form $\tilde{g}(r) = 3rg/2a$, where a is the radius of the muscle fiber cylinder. Include plots of critical oxygen concentration versus oxygen consumption rate, and free oxygen concentration versus radius. (Dimensional or dimensionless variables can be used.)