Math and Medicine: Homework Assignment 6
Due on October 6

1. Consider the model for T cells without HIV

$$\frac{dT}{dt} = \sigma - \delta_0 T$$

with $\sigma = 10^4$ cells/ml/day and $\delta_0 = 0.01$/day.

   a. Find the solution starting from an arbitrary initial condition.

   b. Choose one of the patients in Table 1 of the Perelson paper. How long would it take their T cell count to recover to 90% of normal after therapy?

2. Although antiviral therapy is very effective, patients are not completely cleared of virus, but most remain below the detection limit of about 50 virions/ml. Suppose a patient has 50 virions/ml.

   a. How many virions are being produced per day (assume the same clearance rate as in the paper)?

   b. What is the chance per day that a virion mutates to be resistant to one of the three drugs? Suppose that there are 5 different mutations that can give resistance.

   c. What is the chance per day that a virion mutates to be resistant to all three of the drugs?

3. Write equations for the dynamics of virus and infected cell numbers after initiation of treatment in the following cases.

   a. The antiviral medication that reduces virus production by infected cells to a fraction ϵ (such as 0.01) of production without treatment.

   b. A combination of medications that reduce virus infectivity (as in the paper, but where a small fraction of virions are infectious) and virus production (as in the previous problem).

   c. Extra Credit: Analyze one of these models.