Homework set #2
BENG 100
Spring 2008
Due: January 31, 2008

From Chapter 5

1. A spherical cell with the diameter of 10 μm has a protein concentration of 20 mg/ml. Determine the number of protein molecules within the cell if the molecular weight of an average protein is 50,000 Daltons(g/mol). Recall that Avogadro's number is N_A = 6.0221367 x 10^{23} molecules/mol.

2. The sphere, cylinder and rectangular parallelepiped are common shapes that could be used to model different living cells. Assume that you have 3 cells, a sphere, a cylinder, and a rectangular parallelepiped. Each cell has the same volume (1 μm^3), and the radius of the sphere and the cylinder are equal to the width of the two sides of the rectangular cell.
   a. What are the surface / volume ratios for these shapes?
   b. Which shape is better? Why?
   c. Why might a given weight of small cells be more metabolically active than the same weight of large cells? (Assume the density is constant)
   d. Does the answer in (c) change if you compared an equal number of cells (rather than an equal weight).

3. For a specific type of cell after 3 hours, the concentration of cells per ml of solution is about 400/mL. After 10 hours the concentration has gone up to 2000/mL. Estimate the initial concentration of cells.

4. Equal numbers of fibroblasts and endothelial cells are present initially in a culture.
   a. If endothelial cells double every 40 hours and fibroblasts double every 20 hours, draw a graph showing the percentage of cells in the culture that are fibroblasts as a function of time.
   b. What is the time required for the culture to contain 90% fibroblasts? Write an equation that describes this situation and, when solved for time, will provide the correct answer.

5. A bacterial culture is initially composed of 100 cells. After 1 hour the number of bacteria is 1.5 times the initial population.
   a. If the rate of growth is proportional to the number of bacteria present determine the time necessary for the number of bacteria to triple.
   b. What is the time required for a culture with $1x10^6$ of the same bacteria to triple? Explain your results.
   c. Under what conditions would the answers obtained in part b) be invalid?