CB&B752/MCDB452/MB&B752/MCDB752/CPSC752
Homework 3

The third homework is due on **Dec. 12th at 5:00pm**. All students should complete all problems except "Programming" part (This is a bonus). The complete assignment should be emailed to cbb752@gersteinlab.org

**1. Pesticides on apples**

During their growth season apples are frequently sprayed with pesticides to prevent damage by insects. By eating apples you accumulate these pesticides in your body. An important factor determining the concentration of pesticides is their half life in the human body. An appropriate mathematical model is:

$dP/dt = \sigma - \delta P$

where $\sigma$ is the daily intake of pesticides, i.e., $\sigma = \alpha A$ where A is the number of apples that you eat per day and $\alpha$ is the amount of pesticides per apple, and $\delta$ is the rate at which the pesticides decay in human tissues.

a. Sketch the amount of pesticides in your body, P(t), as a function of your age, assuming you eat the same number of apples throughout life.
b. How much pesticide do you ultimately accumulate after eating apples for decades?
c. Suppose you have been eating apples for decades and stop because you are concerned about the unhealthy effects of the pesticides. How long does it take to reduce your pesticide level by 50%?
d. Suppose you start eating two apples per day instead of just one. How will that change the model, and what is the new steady state? How long will it now take to reduce pesticide levels by 50% if you stop eating apples?
e. What is the decay rate ($\delta$) if the half-life is 50 days?

**2. Density dependent death**

Consider a replicating population where most of the death is due to competition with other individuals, i.e., let $f(N) = cN$ in a model where $dN/dt = bN - f(N)N$.

a. Sketch the *per capita* death rate as a function of N.
b. Sketch the *per capita* net growth rate as a function of N
c. Compute the steady states.
d. Are the steady-states stable?

[BONUS : PROGRAMMING]: Assuming N(0) = 1, simulate this model on the computer and find the parameter values that provide the best (i.e., least-squares) fit with the following experimental observations:

| Time (hours) | N |
|---|---|
| 0 | 1 |
| 3 | 1.22 |
| 6 | 1.27 |
| 12 | 2.09 |
| 24 | 2.45 |
| 36 | 2.22 |

Plot the predicted and observed values of N over 36 hours for these optimal parameters.