Additional Problems for Chapter 3

1. Many bacteria can double their numbers in 20 minutes. Assume a single such bacteria occupies an area of 2μm in diameter. If a petri plate is 10 cm in diameter, (a) how many of these bacteria can it hold, and (b) how long does it take under exponential growth to fill it?

2. Bacterial species A is innoculated on one side of a petri plate while species B on the other side. Species A's doubling time is 20 minutes and B's is 30 minutes. When is the plate covered with bacteria and what is the ratio of specis A to B?

3. Is the US population in exponential growth at the present time? How can you decide? One way to decide is from a figure such as Figure 3.5.4 which plots log(population) versus time: this should be a straight line. Maybe the figure represents a broken line, only the growth rate parameter r has changed. Using different pairs of points in the figure, compute r for that pair, plot the resulting population curve and compare with the empirical data. Be sure to select a pair in the lower part of the figure, a pair from the upper part, and a pair with one point in the lower part and the other in the upper part.

4. Plot a delay differential equation solution to the US population. Use the population 10 years before the present to predict the population 10 years ahead.

5. On of the first population growth models was by Fibonacci of Pisa who, in his book, "Liber Abaci," in 1202 introduced the sequence now known by his name,

$$1, 1, 2, 3, 5, 8, 13, 21, \ldots.$$

In this sequence, the next number is the sum of the last two starting with 1 and 1. The sequence was proported to model the growth of a rabbit population. Does this sequence exhibit exponential growth? Try to fit an exponential model to Fibonnacci's sequence. What is the growth rate parameter? the doubling time?