1. **(1 pt) mathbioLibrary/setABiocLabs/Lab121_H2_log_grow.pg**

Because of the accuracy of WebWork, you should use 5 or 6 significant figures on all problems.

This problem studies the behavior of the discrete logistic growth model as the growth parameter varies. For certain parameter values, it is possible for this discrete model to exhibit chaotic behavior. The discrete logistic growth model satisfies

$$P_{n+1} = f(P_n) = P_n + rP_n\left(1 - \frac{P_n}{M}\right).$$

This problem explores some of the complications that can arise as the parameter r varies.

a. Let $M = 4200$. The first step in studying this model is to find all equilibria (where the population stays the same). Determine the equilibria, P_e, by solving

$$P_e = f(P_e).$$

The equilibria are (with $P_{1e} < P_{2e}$)
$P_{1e} =$ _____ and $P_{2e} =$ _____

b. Let $r = 0.83$ with $P_0 = 100$. Simulate the discrete logistic growth model for $n = 50$ generations. Give the values from your simulations at $n = 2$, 5, 10, 20, 35, and 50.
$P_2 =$ _____, $P_5 =$ _____, $P_{10} =$ _____,
$P_{20} =$ _____, $P_{35} =$ _____, $P_{50} =$ _____,

c. Now let $r = 1.47$ with $P_0 = 100$. Simulate the discrete logistic growth model for $n = 50$ generations. Give the values from your simulations at $n = 2$, 5, 10, 20, 35, and 50.
$P_2 =$ _____, $P_5 =$ _____, $P_{10} =$ _____,
$P_{20} =$ _____, $P_{35} =$ _____, $P_{50} =$ _____,

d. Next let $r = 2.3$ with $P_0 = 100$. Simulate the discrete logistic growth model for $n = 50$ generations. Give the values from your simulations at $n = 2$, 5, 10, 20, 35, and 50.
$P_2 =$ _____, $P_5 =$ _____, $P_{10} =$ _____,
$P_{20} =$ _____, $P_{35} =$ _____, $P_{50} =$ _____,

e. Next let $r = 2.47$ with $P_0 = 100$. Simulate the discrete logistic growth model for $n = 50$ generations. Give the values from your simulations at $n = 2$, 5, 10, 20, 35, and 50.
$P_2 =$ _____, $P_5 =$ _____, $P_{10} =$ _____,
$P_{20} =$ _____, $P_{35} =$ _____, $P_{50} =$ _____,

f. Next let $r = 2.57$ with $P_0 = 100$. Simulate the discrete logistic growth model for $n = 50$ generations. Give the values from your simulations at $n = 2$, 5, 10, 20, 35, and 50.
$P_2 =$ _____, $P_5 =$ _____, $P_{10} =$ _____,
$P_{20} =$ _____, $P_{35} =$ _____, $P_{50} =$ _____,

g. Place the letter of the behavior of the logistic growth model next to each r value listed below:

___1. Model behavior $r = 2.47$ ___2. Model behavior $r = 1.47$ ___3. Model behavior $r = 2.57$ ___4. Model behavior $r = 2.3$ ___5. Model behavior $r = 0.83$	A. Periodic, Period 4 B. Stable, Oscillatory C. Periodic, Period 2 D. Stable, Monotonic E. Chaos F. None of the Above

h. Find a parameter value, r, that gives an oscillation with period 3. It has been shown that if the discrete logistic growth model gives a period 3 solution, then this discrete dynamical system has gone through chaos.

Period 3 oscillation when $r =$ _____,

i. In your Lab Report, create a graph showing the simulations for $r = 0.83$ and 1.47, then write a brief description of what you observe in these solutions. Create another graph showing the simulations for $r = 2.3$ and 2.47, then write another brief description of what you observe in these solutions. Finally, create a graph showing the simulation for $r = 2.57$ and your period 3 simulation, then write a brief description of what you observe in these simulations.