Bacteria Cultures

Lab Preparation

Fully appreciating the nature of growth and decay can help us understand much of what we see in the world around us. Many phenomena, such as the spread of the AIDS virus, radioactive decay, and the payments you can make on a car, can be modeled by functions that describe how things grow or decline over time. To prepare you for investigating such phenomena, you should work on a problem that you may have seen before:

If you place a penny on the first square of a checkerboard, two pennies on the second square, four on the third square, eight on the fourth square, and so on, how many pennies are on the very last square? A checkerboard is eight by eight squares.

Fill in the following table, in which the second column gives the number of pennies on the square whose number is in the first column.

Number of Square	Number of Pennies
1	
2	
3	
4	
5	
6	

Enter these values in a data matrix and plot the points. What patterns do you find in the data? Write an equation that gives the number of pennies as a function of the number of the square. Graph this equation and compare it to the table values. If your equation is correct, they should be the same. What is a reasonable domain and range for this function? What is the dollar value of the pennies on the 64^{th} square?

Lab: Bacteria Growth

A biologist is studying several different bacteria cultures. Equations, tables and graphs will be useful to her in understanding and making predictions about the growth of the bacteria. Your task is to create those equations, tables and graphs for each of the scenarios described below.

1. The first bacteria culture contains 1,500 bacteria initially and doubles every half-hour.

(a) Create a data table that shows the size of the population every half-hour for the first eight-hours. What patterns can you find in the data table?

(b) Create a graph of the relationship between time and the size of the culture. From your graph or your table, estimate the number of bacteria present in the culture after 45 minutes. Explain carefully how you got your estimate.

(c) Write an equation that represents the size of the bacteria culture as a function of time. Enter that equation in the data table window and compare it to your table values. Graph the equation and compare it to the graph of your table values.

(d) Using the equation, estimate the number of bacteria present in the culture after 45 minutes. How does this compare with your earlier estimate? Explain.

(e) Predict the number of bacteria in the culture after 24 hours. Justify your answer.

2. The biologist has a second culture to examine. She knows that the population of the culture doubles every 15 minutes. After 1 hour and 15 minutes, her assistant found that 80,000 bacteria were present.

(a) What was the size of the initial population?

(b) Predict the size of the culture at t=3 hours. What was the size of the population at 40 minutes? Explain and justify your answers.

(c) Create a graph of the population as a function of time. Find an equation that can be used to predict the size of the population at any time t.

(d) Examine the rate at which the bacteria culture is growing. How fast is the culture growing after 1 hour? After 1.5 hours? After 2 hours? Use a time interval of $h = 0.01$ hours to estimate these rates. Interpret these rates in terms of the context of the problem situation. How do these three rates compare?

3. The third bacteria culture started with 5,000 bacteria. The assistant found that after 3 hours the estimated population was 80,000.

(a) How long did it take for the population to double for the first time? How long after that will it take for the population to double the second time? How long after that will it take for the population to double the third time?

(b) Find an equation that can be used to predict the size of the population at any time t. Estimate the population after 3.5 hours.

(c) How does the doubling time found in (a) relate to your equation in (b)?

4. Find a general formula (or rule) that can be used to predict the bacteria population for any culture. You should define what each variable in your general formula stands for. You should illustrate how your general formula applies to each of the three scenarios in this investigation!

Lab Report

Your lab report should include your analysis of each of the three scenarios described above. You should include the necessary tables, graphs and equations that you found and an explanation of how you found them. Include a discussion of the rate at which the bacteria population is increasing. Discuss how you can find the doubling time for any bacteria culture. Discuss your general formula and how it can be used with the given information about any bacteria culture.