

Name: _____

The Power of Doubling Lab

If you were offered a choice between one million dollars and a penny on the first day of the month, two pennies on the second day, four pennies on the third, and so forth for 30 days, which would you choose? If you calculate this, you will find that the second choice would give you somewhat more than one million dollars. Each day you are doubling a larger number, and although the number of pennies increases slowly at first, it soon reaches over one million dollars. That is the power of doubling, or exponential growth.

Growth is defined as exponential when the increase of a quantity is proportional to the size of the quantity. The quantity may be numbers, as in the numbers of individuals in a population, or some other measure, such as amount of energy consumed. Exponential growth is very slow in the early stages, but quickly accelerates. A frequent measure of exponential growth is doubling time, that is, the amount of time required for the quantity to double. The shorter the doubling time, the faster the rate of growth.

The human population, like all populations of organisms, grows exponentially when unchecked. Although it took 130 years, from 1800 to 1930 for the world population to double, it doubled again by 1975, a mere 45 years. At this rate the world population of 5.5 billion in 1993 would be expected to reach 11 billion by 2035. Different areas of the world, however, have vastly different doubling times. While the doubling time for developed areas in 1993 was 162 years that for the less developed areas was 35 years.

In this activity, you will demonstrate exponential growth and determine the doubling time and growth rate of a simulated population.

MATERIALS:

2 pennies
200 dried beans (or dry macaroni)
2 small cups
Graph paper
1 larger paper cup
Marking pen

PROCEDURE:

- 1) Label one small paper cup, "Parents", and the other one "Offspring". Label the large cup, "Bean Pot". Place 10 beans in the "Parents" cup and the rest in the "Bean Pot". Each bean represents an individual in a population.
- 2) Toss the two pennies. If both pennies show heads, toss again. If both pennies show tails, one member of the population has died and you should remove a bean from the "Parents" cup and put it into the "Bean Pot". If one head and one tail show, a member of the population has had a child. To simulate the birth, take one bean from the "Parents" cup and one from the "Bean Pot" and place them in the cup marked "Offspring".
- 3) Continue tossing until there are no longer any beans in the "Parents" cup. Count the number of beans in the "Offspring" cup and record the number in record your data in Data Table A. The "Offspring" now become the parents, so move all of the beans from the "Offspring" cup into the "Parents" cup.
- 4) Repeat steps #2 and #3 until you have completed 10 generations.
- 5) Make a graph of your data, with generation number on the horizontal axis and population size on the vertical axis.

DATA TABLE A:

Generation #	Population Size
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

A large grid of graph paper with 20 columns and 20 rows. The grid is composed of small squares, with a slightly larger square at the top left corner, likely serving as a header or title area. The grid is empty and intended for data recording or graphing.

CONCLUSION QUESTIONS:

1. On average, how should the birth rate of this population compare with the death rate? How do you know this?
2. From your graph, determine the doubling times for the population at the beginning, the middle, and the end of the graph. Are they all the same? Explain why.
3. Assume that a generation is equal to 20 years. Use the doubling time from your graph to calculate the growth rate of the population, using the formula below:
Annual growth rate (%) = 70 / doubling time (yrs.)
4. In this simulation the parents had no choice about whether or not they were having a baby. What effect would choice have on the doubling time?
5. Write a short paragraph explaining the implications of this activity for the human population.
6. What environmental impacts does an exponentially growing human population have?