CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
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Project Number
J1213

Project Title
Cycling Antibiotics to Control Antimicrobial Resistance: A Mathematical Model

Abstract

Objectives/Goals
The purpose of my project is to determine if cycling various antibiotics can reduce antimicrobial resistance using a model I created on Excel.

Methods/Materials
Computer with Microsoft Excel
Parameters of bacterial growth rates
I created a mathematical model on Excel that represents the spread of antimicrobial resistance throughout a population of bacteria, and the effect when different antibiotics are cycled. Starting with binary fission (growth) for bacteria, I created the model by assembling equations made up of variables that explained what was happening (death from natural causes and antibiotics, rate bacteria become resistant and nonresistant, slowed growth rates of resistant bacteria) to show that cycling antibiotics reduces antimicrobial resistance. I also tested different values for each of the variables to see how sensitive the results were to each variable.

Results
The results showed that, with the values I chose, cycling antibiotics is a partial solution to antimicrobial resistance. The Stage 1 results were sensitive to a and s, and n could not be changed a lot because it has to be greater than a and less than 1; the results were not sensitive to r. Changing the value of n again did not change the percentages of resistant, AB1-resistant, and AB1AB2-resistant bacteria because, it increased the numbers of all the bacteria but did not change the proportion of how many bacteria were resistant and non-resistant. In Stage 2, changes in a and s caused dramatic changes, changes in n and r did not cause as much change, and even drastic changes in m produced less than .01% change because m was a small number.

Conclusions/Discussion
My hypothesis that cycling antibiotics is a partial solution to antimicrobial resistance appears, according to my model, to be correct. However, because I used a model to test my hypothesis, the results cannot show exactly what would happen if cycling was used in the real world. I did not use exact data or parameters in my model, partly because this is often not available, since this is such a new subject, and also because the parameters vary among bacteria and antibiotics. In the future, I would also like to include stochasticity to make my model more realistic. It is likely that cycling antibiotics will work for some, but not all combinations of bacteria and antibiotics, depending on the exact growth rates and reaction to the specific antibiotics.

Summary Statement
I built a mathematical model to show that cycling antibiotics reduces the spread of antibiotic resistance.

Help Received
Father helped me understand journals, taught me how to create graphs, edited my report; Mother found literature for me; helped me understand journals, proofread formulas; Jacob Pollock taught me about Excel and that I could create my own model; Teachers edited parts of my report and provided me with