**Lab: Antibiotic Resistance**

**Guiding Question:** Why is antibiotic resistance an issue? [Click here for a short bit of background knowledge.](https://docs.google.com/presentation/d/1C5qZQU_KonSfzbnLo_jNv7wNXZMI4c5T/edit?usp=sharing&ouid=115431687242584388426&rtpof=true&sd=true)

**Purpose:** To investigate the effect of antibiotic resistance on a population of pathogenic bacteria.

**Overview**: Bacterial illnesses, such as strep throat and tuberculosis, are treatable with the help of antibiotics. However, antibiotic resistance is a major issue due to the evolution of resistant bacteria. Nearly every population of pathogenic bacteria has a mutation present that makes some of the bacteria resistant to disease. In this lab activity, you will simulate the process of using antibiotics to treat a bacterial disease. You will collect data for 10 days (rounds) of taking a prescribed antibiotic treatment that you will then use to graph, analyze, and write a conclusion from.

# Pre-Lab Questions:

*Scan the QR code to the right to watch the introductory video. Use the information from the video and your prior knowledge to answer the following questions.*

1. Bacteria are everywhere, but not all cause disease. List 2-3 examples of good things bacteria do for us.
2. How do antibiotics kill or neutralize bacteria?
3. Where do the antibiotic resistant bacteria come from in the first place if bacteria make identical offspring via asexual reproduction?
4. What makes it possible for “super bacteria” to proliferate and thrive?
5. List at least 3 ways we can prevent and combat antibiotic resistance.
6. Natural selection is the mechanism by which evolution occurs. List the four principles of natural selection below. Next to each principle, briefly explain how antibiotic resistant bacteria could evolve via natural selection in a population.

# Hypothesis:

*Make a prediction about the relationship between taking an antibiotic consistently and its effect on a population of genetically varied bacteria.*

# Materials:

* 3 different colors of beads (representing high resistance bacteria, medium resistance bacteria, and low resistance bacteria)
* Bowl
* Dice

# Procedures:

1. Record in your data table which color beads represent low resistance, medium resistance, and high resistance bacteria.
2. Close your eyes and count out 20 random beads from the class bowl of bacteria and place in your petri dish. These represent the 20 bacteria in your body that you acquired from your environment. Return to your workspace and record the initial color distribution in the first line of the data table.
3. Role the die. If you role a 1, 2, 3, or 4, you remembered to take your antibiotic prescription. If you role a 5 or 6, you forgot and skip a day. Record “Take” or “Forgot” in the first column for Round 1.
	1. If you take your prescription for the round, remove 5 beads to represent 5 bacteria being killed by the medication. **You must start by removing the low resistance bacteria first as these would be the first to die.** If you run out of low resistance bacteria, you can then remove/kill the medium resistance bacteria. The high resistance bacteria will be killed last, and only after you’ve run out of the other two.
	2. If you forgot to take your prescription for the round, no beads are removed and you move on to step 4.
4. Bacteria reproduce rapidly, and this must be accounted for. After completing step 3, add 1 bead for each color of bacteria that is still remaining in the population (since there are only 3 colors, no more than 3 beads should ever be added each round.) Now, record the number of remaining bacteria of each color in the data table.
	1. Note: If a color no longer remains in the population, it can no longer reproduce and is not put back into the petri dish.
5. Repeat steps 3 and 4 for a total of 10 rounds, representing 10 days of the antibiotic prescription, or until all bacteria are killed.

# Results:

**Bacteria Distribution Table**:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Round** | **Take prescription or forgot?** | **# of low resistance bacteria remaining****Color =** | **# of medium resistance bacteria remaining****Color =** | **# of high resistance bacteria remaining****Color =** | **Total # of bacteria remaining in your body** |
|  |  |  |  |
| **Initial** | N/A |  |  |  |  | 20 |
| **End of Round 1** |  |  |  |  |  |
| **End of Round 2** |  |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **End of Round 3** |  |  |  |  |  |
| **End of Round 4** |  |  |  |  |  |
| **End of Round 5** |  |  |  |  |  |
| **End of Round 6** |  |  |  |  |  |
| **End of Round 7** |  |  |  |  |  |
| **End of Round 8** |  |  |  |  |  |
| **End of Round 9** |  |  |  |  |  |
| **End of Round 10** |  |  |  |  |  |

**Graph**:

*Below make an appropriate graph showing the change in the bacteria population over time. You will need to make sure to include a title, labeled X and Y-axis with units (if applicable), and a color-coded key. Think carefully about which type of graph would best be used for this data before getting started. You may delete this template and add your digital graph if you want.*


# Analysis:

*Write your analysis in the space below. The following topics need to be addressed:*

1. *Experimental set-up. Do NOT re-write the procedures, but do explain:*
	1. *What did the beads represent?*
	2. *What did the different colors of beads represent?*
	3. *What did rolling the die represent?*
	4. *What did the process of removing the beads represent?*
	5. *What did the process of adding colored beads left in the dish represent?*
2. *Refer to your data and explain what it shows you. Look for patterns as well. Include:*
	1. *Any bacteria that showed a generally increasing trend, and why this most likely happened.*
	2. *Any bacteria that showed a generally decreasing trend, and why this most likely happened.*
	3. *How many rounds it took to rid the body of all the bacteria, if applicable.*
3. *Error analysis. Write out at least three ways the data may not be completely accurate. Include a specific solution to prevent this problem in the future for each error.*

# Conclusion:

*The following topics need to be addressed:*

1. *Does the data support your hypothesis or not?*
2. *Provide a possible explanation, based on what we’ve learned, for why we got the results that we did.*
3. *Real world application.*
	1. *How does this simulation accurately represent antibiotic resistance in bacteria?*
	2. *What are the shortcomings of this simulation and its representation of antibiotic resistance? What could be modified to make it a more accurate representation in the future?*
	3. *Based on what you learned in this lab activity, why is it critical that patients follow the directions on their prescriptions?*
	4. *Research one example of an antibiotic-resistant disease in history and briefly describe the significance of this.*