LT: I can follow a multistep procedure to model how bacteria evolve resistance. 4.3.1

Purpose: In this simulation, you will model the effects of antibiotics on the population of disease-causing bacteria during an infection. You will imagine that you are sick with a bacterial infection. To treat the infection, the doctor has prescribed an 8-day course of antibiotics.

Background: Have you ever taken antibiotics or had to give them to an animal? Did you follow the directions completely? All antibiotics need to be administered as directed, which often means continuing the doses after the symptoms have already gone away. Why is this necessary?

Millions of harmless bacteria naturally live on and inside of animals, including humans. When harmful bacteria appear on the scene, an organism's immune system can usually keep a small population of them under control. If, however, these harmful bacteria reproduce too quickly, there are consequences - and this is called an infection.

Antibiotics are drugs that kill bacteria and help organisms fight off bacterial infections (but not viral infections such as the common cold.) A small number of bacteria in any population may not be affected by the antibiotic as quickly as the majority of the population. These bacteria, which are considered more "antibiotic resistant," continue to reproduce and grow even after most have been killed by antibiotic.

Completing the full course of antibiotics as prescribed helps make sure that these resistant bacteria do not survive and therefore won't be able to cause an infection or be transmitted to other individuals.

Materials:

✓ 20 blue disks	✓ 15 yellow disks
✓ 15 red disks	✓ 1 number cube

Procedure:

1. Each disk represents thousands of bacteria. Begin with 20 disks:

Color Disk	Type of Bacteria	Initial Number of Disks
Blue	Least harmful bacteria	13
Yellow	Resistant bacteria	6
Red	Extremely resistant	1

*Set the extra disks aside for now.

2. It is time for a dose of antibiotic. Toss a number cube and follow the directions in the Number Cube Key below:

Number Cube Key		
If you toss:	**What happened:**	**What you need to do:**
1, 3, 5, 6	The antibiotic was administered as prescribed so bacteria are being killed.	Remove 5 disks: remove all of the blue disks first, then the yellow, then the red.
2, 4	You missed a dose of antibiotics.	Do nothing.

3. Before recording your data on Table 1, consider that bacteria are reproducing all the time! If one more bacteria of a particular type (color) are still alive inside the organism, add 1 disk of that color to your population.

4. Record the number of disks of each type of bacteria that are now living inside the organism in Table 1: "Population of Harmful Bacteria Living in an Organism." Also, place a check (✓) next to each day that you take the antibiotic.

5. Repeat Steps 2-4 until you have completed Table 1.

6. Use your data in Table 1 to graph the population of each type of bacteria and for the total number of bacteria on the "Bacteria Graph" provided. Use different colored lines, or lines with different patterns, to represent each type of bacteria, and fill in the key accordingly.

Name:_____ **Date:** _____ **Class:** _____ **#:** _____

Pre-Lab Questions

1. What does the term "antibiotic resistant" refer to?
2. Why is it important to complete the full course of prescribed antibiotics?
3. What might the effects be of taking an antibiotic for a viral infection such as the common cold?

Table 1: _____

Days	Least Resistant Bacteria (Blue)	Resistant Bacteria (Yellow)	Extremely Resistant Bacteria (Red)	Total
Initial	**13**	**6**	**1**	**20**
1				
2				
3				
4				
5				
6				
7				
8				

How many doses of antibiotics did you miss? _____

Conclusion and Analysis Questions:
*******EXPLAIN ALL ANSWERS USING EVIDENCE FROM THE TEXT AND DATA.**

1. Did the antibiotic help to completely kill all of the harmful bacteria living inside the organism's body? Explain.

2. Why is it important to complete the full course of antibiotics as prescribed?

3. What were the strengths and limitations to this model of antibiotic treatment?

4. Imagine if the antibiotic was no longer administered once the symptoms went away. (For example, consider the point in the simulation when there were only two or three harmful bacteria left.) What do you predict might happen to an antibiotic's ability to kill the harmful bacteria if the infection returns? Explain your reasoning.

5. Imagine that after beginning the antibiotic treatment, you find out that the infection is viral and not caused by bacteria. Explain what would have happened to the body's **virus** and **bacteria** populations after each dose of antibiotic?

	3	2	1
Pre-Lab Understanding	The scientist demonstrates strong understanding and credibility. All pre-lab questions are answered correctly with detail and explanation.	The scientist demonstrates partial understanding and credibility. Most pre-lab questions are answered correctly with detail and explanation.	The scientist demonstrates limited understanding and credibility. Few pre-lab questions are answered correctly with detail and explanation.
Data Tables	Tables include a title, units and numbers rounded to the nearest tenth. Data is calculated and recorded thoroughly and accurately. There are no major errors.	Most data is calculated and recorded thoroughly and accurately. There are few major errors.	Little data is calculated and recorded thoroughly and accurately. There are many major errors.
Graph	The graph clearly shows the relationship between both variables. The graph accurately includes all of the following: -a title -axes labels (with units of measure) -units following constant scale -bars/lines represent correct values -a key (or labels) identify all lines/bars	The graph shows the relationship between both variables. The graph accurately includes most of the following: -a title -axes labels (with units of measure) -units following constant scale -bars/lines represent correct values -a key (or labels) identify all lines/bars	The graph partially shows the relationship between both variables. The graph accurately includes few of the following: -a title -axes labels (with units of measure) -units following constant scale -bars/lines represent correct values -a key (or labels) identify all lines/bars
Conclusion and Analysis	Conclusion and analysis are thorough and use specific evidence from data. There are many thorough, thoughtful, and relevant reflections that communicate purpose, strengths, limitations and inferential possibilities.	Conclusion and analysis are general and use some data evidence. There are several thorough, thoughtful, and relevant reflections that communicate purpose, strengths, limitations and inferential possibilities.	Conclusion and analysis are general and use little data as evidence. There are few thorough, thoughtful, and relevant reflections that communicate purpose, strengths, limitations and inferential possibilities.

Participation					
I often contributed good ideas that were relevant to the topic and task. I came to meetings prepared. I did my share of the work.	4	3	2	1	I seldom contributed good ideas. Sometimes I was talking off-task. I did not come to meetings prepared. I did not do my share of the work.
Working with Others					
I often compromised and cooperated. I did take initiative when needed and/or listened and respected the ideas of others.	4	3	2	1	I seldom compromised and cooperated. I did not take initiative when needed and/or did not listen and respect the ideas of others.
Product					
My part of the task is complete and accurate. My work was submitted on time.	4	3	2	1	I did not complete my part of the task. The information I presented was inaccurate and/or not done correctly. It was not completed on time.
Understanding Content					
I can speak about the topic and group work knowledgeably. I can sum-up the lesson.	4	3	2	1	I do not understand what I did in my group. I did not ask or answer questions. I cannot sum-up the lesson.