Modelling the Microbiome

Length: 30 minutes
Materials needed: For each group of three students: one clear plastic bag, coloured dry pasta (per group: 25 pieces of green pasta, 30 pieces of yellow pasta, 45 pieces of red pasta), student instruction sheet and worksheet. Note: you can use any material other than dry pasta that you have available. Dry beans or math manipulatives would also work.

- Watch the video to help understand the term microbiome.

"The Hidden World of Microbiomes" (3:12 mins)

https://www.youtube.com/watch?v=MjhDRG-mQ7w

- Instructions for teacher to provide to students: *"You will work in groups of three to model what happens to the microbiome (bacterial composition within the body) with antibiotic use. You will use coloured dry pasta in a clear bag. Each piece of pasta represents a bacterium. The different colours of pasta are representing different types of bacteria. There are many more than three types of bacteria in your body, but we will use three for today's exercise."*

- Hand out **Worksheet #5** and tally sheet to each group of three students. **Let the students know they can use calculators for this exercise**. Have students get dry pasta and plastic bag for their group.

- After students have completed the exercise, review together as a group.

- There are comprehension questions for deeper understanding on page 18 (**Worksheet #6**) and an answer key on page 19. This can be done as a group activity or as homework.

Worksheet # 5 Name: ____________________

Modelling Antibiotic Resistance

1

Assign roles to group members.

Recorder: Timer: Counter:

2

Get one clear zippered bag, and put the following amount of dry pasta into the bag:

- **12** pieces of green pasta (good bacteria)
- **2** pieces of yellow pasta (bad bacteria)
- **1** piece of red pasta (antibiotic resistant bacteria)

This bag of "bacteria" is a simplified sample of what is inside a 9-year-old girl, Marisa. Look at your tally sheet. **Check that the numbers of bacteria (pasta) you have in your bag matches what is written on the tally sheet.**

3

Marisa became sick with pneumonia, a bacterial infection.

- Add **15** more pieces of yellow pasta (bad bacteria).
- Fill out the "**Infection**" row on the tally sheet with what is in your bag now.
- Marisa's doctor prescribed an antibiotic. Marisa takes "**Antibiotic A**". This antibiotic can kill all bacteria except the red, antibiotic resistant, bacteria.

4

Mimic the actions of the antibiotic:

Timer: Time 20 seconds.
Counter: One by one, pick out green and yellow bacteria for 20 seconds **(no dumping the bag, take out one at a time).**
Recorder: Write down the new totals of what is in the bag in the "Antibiotic A" row on the chart.

Worksheet # 5

Marisa starts feeling better . The bacteria remaining in her body now replicate (make more copies of themselves).

5

Counter: for each bacteria remaining, put in **3 times** more pieces of the same colour *(tip: multiply the total number of each colour by 3 and add this number of each colour to the bag).*

Recorder: write new number of bacteria types on the chart in the "**Recolonization**" row.

Marisa gets a cold and her mother says to take some old antibiotics they have left over from her father last year. Marisa takes "**Antibiotic B**". It kills the good and bad bacteria that are susceptible (can be killed). Marisa doesn't feel better as she had a viral infection (remember: antibiotics don't kill viruses)!

6

Timer: time 30 seconds.

Counter: pick out green and yellow pasta **one at a time** for 30 seconds.

Recorder: tally up the bacteria in the bag and record this in the "**Antibiotic B**" row.

Remember from the video that bacteria can transfer genes (genetic information) to each other. This means that the antibiotic resistance could transfer to other bacteria, making them resistant also!

7

Timer: Time 5 seconds.

Counter: Pick out green and yellow pasta **one at a time** for 5 seconds. Count the number of pieces that were taken out – put this number of RED pieces back in the bag, as there was gene transfer.

Recorder: write the new totals in the "**Gene Transfer**" row.

Tally Sheet: Modelling Antibiotic Resistance

	Green Pasta (Good Bacteria)	Yellow Pasta (Bad Bacteria)	Red Pasta (Antibiotic Resistant Bacteria)	Total number of all Bacteria (green+yellow+red)	Proportion of Antibiotic Resistant Bacteria $\frac{\text{\# Red}}{\text{Total \#}}$	Percent of Antibiotic Resistant Bacteria X 100
Start (Baseline)	12	2	1	12+2+1 = 15	$\frac{1}{15} = 0.067$	0.067 X 100 = 6.7 6.7 % of the bacteria are antibiotic resistant.
Infection					$\frac{\square}{\square} = \square$	$\square$ X 100 = $\square$ $\square$ % of the bacteria are antibiotic resistant.
Antibiotic A					$\frac{\square}{\square} = \square$	$\square$ X 100 = $\square$ $\square$ % of the bacteria are antibiotic resistant.
Recolonization					$\frac{\square}{\square} = \square$	$\square$ X 100 = $\square$ $\square$ % of the bacteria are antibiotic resistant.
Antibiotic B					$\frac{\square}{\square} = \square$	$\square$ X 100 = $\square$ $\square$ % of the bacteria are antibiotic resistant.
Gene Transfer					$\frac{\square}{\square} = \square$	$\square$ X 100 = $\square$ $\square$ % of the bacteria are antibiotic resistant.

Worksheet # 6 Name: ______________________________

Comprehension Questions: Modelling Resistance

1. Did the percentage of antibiotic resistant bacteria become higher or lower over time?

2. What did you notice about how the number of good bacteria changed over time?

3. Did it help Marisa to take her father's old antibiotic (antibiotic B) when she had a viral infection? How did it effect bacteria in her body?

4. Luckily, the antibiotic resistant bacteria in the body weren't causing an infection. What would happen if the antibiotic resistant bacteria caused an infection?

5. How can we help preserve antibiotics for future generations?

Answer Key # 6 Name: ___________________________________

Comprehension Questions: Modelling Resistance

1. Did the percentage of antibiotic resistant bacteria become higher or lower over time?

The percentage of antibiotic resistant bacteria increased over time.

2. What did you notice about how the number of good bacteria changed over time?

The microbiome had fewer good bacteria and more harmful bacteria.

3. Did it help Marisa to take her father's old antibiotic (antibiotic B) when she had a viral infection? How did it effect the bacteria in her body?

No, the antibiotic did not help Marisa as antibiotics don't kill viruses. It could also be dangerous to take medication that is not prescribed to you, you should only take antibiotics that are prescribed to you.

The antibiotic then killed her good bacteria.

4. Luckily, the antibiotic resistant bacteria in the body weren't causing an infection. What would happen if the antibiotic resistant bacteria caused an infection?

If Marisa had an infection with antibiotic resistant bacteria, the infection would be much more difficult to treat. Sometimes antibiotic resistant infections are impossible to treat.

5. How can we help preserve antibiotics for future generations?

Stay up to date with vaccines (if you don't get sick you don't need an antibiotic).
Wash your hands frequently.
Don't take antibiotics for colds and flus (see a doctor if you are unsure).
Stay home when you are sick (to not spread infections).
Understand that viruses and bacteria are different.
Don't take antibiotics for a viral infection.
Only take antibiotics that are prescribed to you, and follow the written directions.
Don't take antibiotics without a prescription.
Dispose of any unused antibiotics (at a pharmacy) and don't share with anyone.