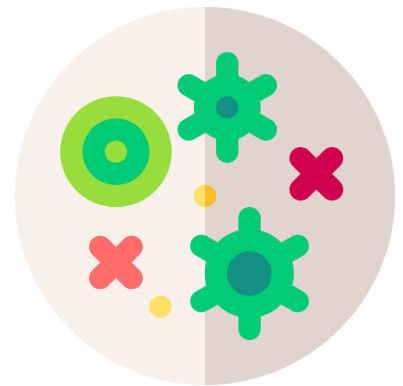

Antibiotic Resistance

A Closer Look at Bacteria and the Microbiome

Lesson Plan for Grade 8 Students



Overview

This lesson plan is for teachers, public health nurses, or health care students to use in a secondary school classroom. The lesson includes interactive discussions with the students and activities. There are optional activities for enhanced learning. The lesson plan is designed to be 45-60 minutes but can be adapted to fit your needs.

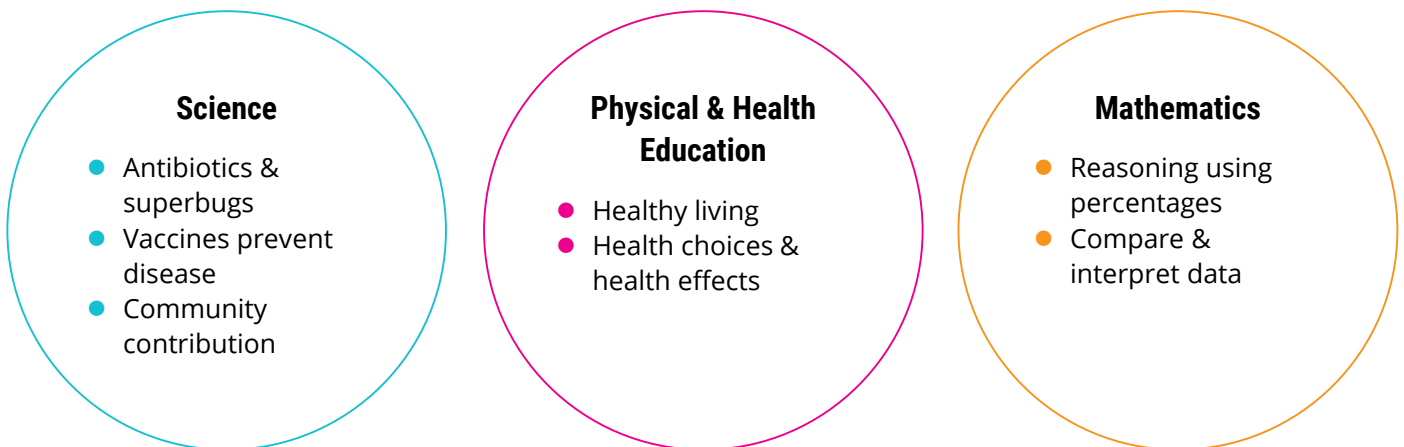
Please report your teaching back to us as the number of students taught in BC is reported to the Ministry of Health.

Please report teaching by visiting: antibioticwise.ca/report-teaching

Learning Outcomes

- Following this lesson, students will be able to:
 - Describe the microbiome and differences between bacteria and viruses.
 - Identify that antibiotics only work against bacterial infections, not viral infections.
 - Discuss how antibiotic resistance develops, and how to use antibiotics wisely.
 - Indicate ways to prevent the spread of infections, including proper handwashing and vaccinations.

How the lesson aligns with the BC Curriculum



Acknowledgements

The Antibiotic Wise program would like to thank Komal Adeel for her contributions to the creation of this lesson plan and associated materials.

For more lesson plans and teaching resources, visit antibioticwise.ca/teaching

Activity 1: Bacteria, Viruses, and the Microbiome

Length: 15 minutes

Materials: Worksheet #1 printed for each student, computer and projector for PowerPoint slides and optional video.

PowerPoint Slides: If using the prepared slide deck, this section will go through slides 1-10

This section starts with an introduction to the microbiome. Ask students if they know what the microbiome is. The microbiome is all of the living organisms, such as bacteria, viruses, and fungi, that are found in and on our body.

Emphasize that bacteria can be helpful or harmful to humans. Helpful (or good) bacteria are called **commensals**. They can help in digestion of foods, and can compete with bad bacteria and prevent infections. Harmful (or bad) bacteria are called **pathogens**.

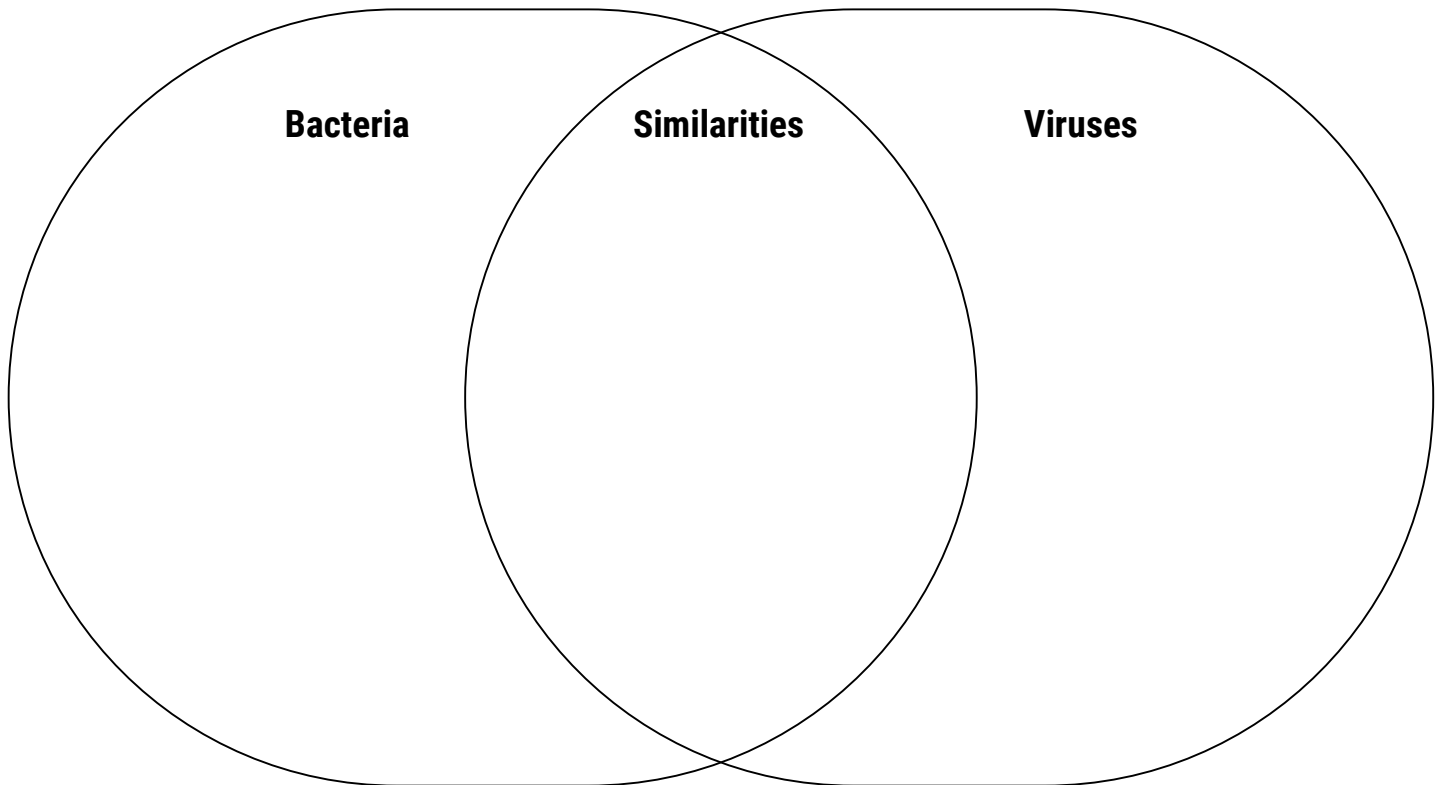
- Ask students to list similarities and differences between bacteria and viruses. (**Worksheet #1**). If they don't know any differences, provide examples from the answer key (**page 5**).
- Ask students if they can think of any illnesses caused by bacteria? Illnesses caused by viruses? (**Worksheet #1**). Students can guess, or look it up on the internet if time permits. Write answers on the board.
- Ask students what antibiotics are? Ask if they or anyone in their family ever taken antibiotics? Review that antibiotics are a class of medications that are specifically designed to kill bacteria. They do not work against viruses.
- As an example, ask students if they have ever heard of an antibiotic, for example penicillin. Antibiotics like penicillin are designed to attack the cell wall of bacteria. Based on our discussion on the difference between viruses and bacteria, would penicillin work against viruses? (No, because viruses do not have cell walls).
- Return to the list of illnesses caused by bacteria vs. viruses. Antibiotics can only be used for the illnesses that are caused by bacteria. They should not be used for illnesses caused by viruses.

Optional Video "Good Germs vs. Bad Germs" (2:54 mins)



youtu.be/qDluMg9lqn8

Bacteria and Viruses

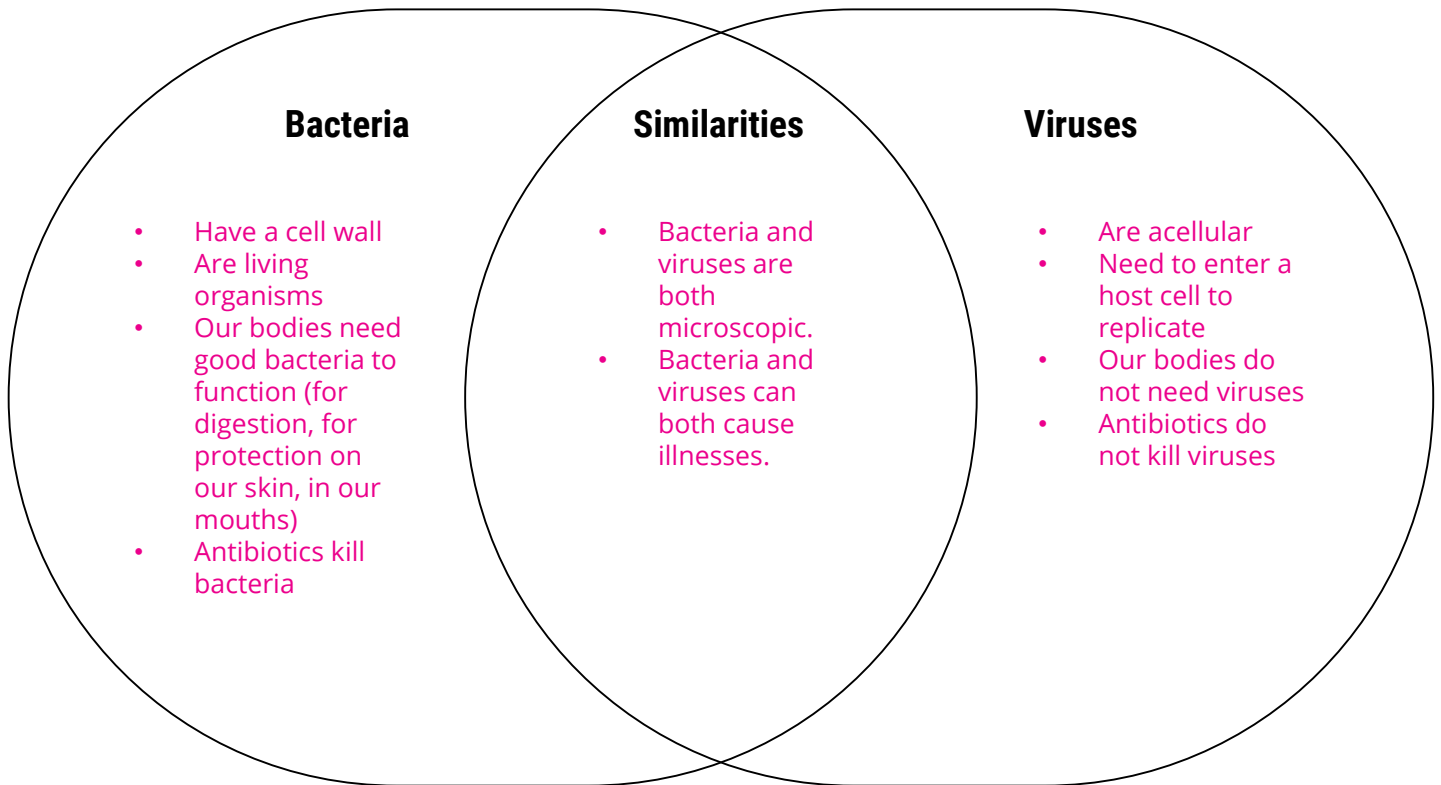


Illnesses caused by viruses	Illnesses caused by bacteria
<p>Word Bank</p> <div style="display: flex; justify-content: space-between;"> <ul style="list-style-type: none"> Common cold Strep throat Salmonella Influenza (Flu) <ul style="list-style-type: none"> COVID-19 Tuberculosis Urinary tract infections (UTIs) Chicken pox <ul style="list-style-type: none"> Pertussis Meningitis HPV Most sore throats </div>	

1. Antibiotics can work for illnesses caused by bacteria. True False

2. Antibiotics can work for illnesses caused by viruses. True False

Bacteria and Viruses



Illnesses caused by viruses	Illnesses caused by bacteria			
<ul style="list-style-type: none"> • Common cold • Influenza (Flu) • Chicken pox • HPV • Most sore throats • COVID-19 	<ul style="list-style-type: none"> • Strep throat • Tuberculosis • Urinary tract infections (UTIs) • Salmonella • Pertussis • Meningitis 			
<p>Word Bank</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 33%; vertical-align: top;"> <ul style="list-style-type: none"> • Common cold • Strep throat • Salmonella • Influenza (Flu) </td> <td style="width: 33%; vertical-align: top;"> <ul style="list-style-type: none"> • COVID-19 • Tuberculosis • Urinary tract infections (UTIs) • Chicken pox </td> <td style="width: 33%; vertical-align: top;"> <ul style="list-style-type: none"> • Pertussis • Meningitis • HPV • Most sore throats </td> </tr> </table>		<ul style="list-style-type: none"> • Common cold • Strep throat • Salmonella • Influenza (Flu) 	<ul style="list-style-type: none"> • COVID-19 • Tuberculosis • Urinary tract infections (UTIs) • Chicken pox 	<ul style="list-style-type: none"> • Pertussis • Meningitis • HPV • Most sore throats
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1. Antibiotics can work for illnesses caused by bacteria.

True

False

2. Antibiotics can work for illnesses caused by viruses.

True

False

Activity 2: Antibiotic Resistance

Length: 20 minutes

Materials: Worksheet #2 printed for each student, computer and projector for Powerpoint slides and optional video.

PowerPoint Slides: If using the prepared slide deck, this section will go through slides 11-27

- Why is it important to use antibiotics correctly? Improper use of antibiotics can lead to **antibiotic resistant bacteria (i.e. superbugs)**. Ask students if they know what this means.
- Review how antibiotic resistance develops: Bacteria are always randomly mutating. Sometimes, they will randomly develop a mutation that makes them resistant to antibiotics. Normally, the helpful (or good) bacteria in our body take up space and prevent the few resistant bacteria from taking over. When we overuse antibiotics, we kill the helpful (or good) bacteria. The resistant bacteria survive and have lots of space to multiply and grow. This is **natural selection**.
- Discuss how antibiotics are needed for modern medicine – surgery, childbirth, transplants, burn therapy, cancer treatments (and most modern medicine) relies on antibiotics to treat or prevent infections. Before antibiotics existed, people could die even from infected cuts and scrapes.
- When antibiotics are used too much or incorrectly (for example if they were used for treating viral infections), bacteria causing you to be sick may no longer respond to the drug and you may continue to be sick. *“To preserve antibiotics for the future, it’s our job to limit our use of antibiotics, to make sure we are using them for the right reason, so that they work when we really need them.”*

- Have students get in small groups to work on **Worksheet #2** (page 7).
- Review **Worksheet #2** with the class using Answer Key #2 on **page 8**. Emphasize that although every time we use antibiotics there is a risk of bacteria developing resistance, we want to combat this by using antibiotics **correctly and for the right reason**, not avoiding them entirely, because antibiotics can be helpful and even life-saving in many situations.
- Ask students how we can prevent antibiotic resistance. Use the following prompt: *“If you were at the doctors’ office, what questions could you ask to make sure you’re using antibiotics correctly?”* (Do I have a bacterial infection or a viral infection? Do I need antibiotics? How long do I need to take these antibiotics for?)

Optional Video “Antibiotic Resistance and the Rise of Superbugs” (7:23 mins)



youtu.be/fyRyZ1zKtyA (watch until 6:45)

Terry's Antibiotic Dilemma

Terry is feeling sick. He found some antibiotics in his medicine cabinet. What could happen if:

	Terry took the antibiotics and his illness was caused by a virus	Terry took the antibiotics and his illness was caused by a bacteria	Terry went to the doctor and was prescribed antibiotics
Would Terry feel better?			
What would happen to the good bacteria in his body?			
Is there a chance of resistance developing?			
Should Terry take the antibiotics?			

Terry's Antibiotic Dilemma

Terry is feeling sick. He found some antibiotics in his medicine cabinet. What could happen if:

	Terry took the antibiotics and his illness was caused by a virus	Terry took the antibiotics and his illness was caused by a bacteria	Terry went to the doctor and was prescribed antibiotics
Would Terry feel better?	No, because the antibiotics will not kill the virus	Most likely not. The antibiotics may or may not work against the specific bacteria he is infected with, and they could be expired.	Yes
What would happen to the good bacteria in his body?	Some of the good bacteria in his body would die.	Some of the good bacteria in his body would die.	Some of the good bacteria in his body would die.
<div style="border: 1px solid black; padding: 10px; margin: 10px auto; width: fit-content;"> <p><i>This is why a common side effect of antibiotics is an upset stomach (remember, good bacteria help with digestion). However, if he takes antibiotics correctly and only as long as prescribed by his doctor, his good bacteria will have a chance to bounce back.</i></p> </div>			
Is there a chance of resistance developing?	Yes – when good bacteria die, resistant bacteria can take over	Yes	Yes
Should Terry take the antibiotics?	No – they will not help with his illness and may cause resistance to develop.	No – they may not be the correct antibiotics for his illness. Some bacterial infections don't even need antibiotics because they get better on their own. Don't use old antibiotics!	Yes – even though there is a small chance of resistance, we want to use antibiotics when we need them so that illnesses don't spread or get worse.

Activity 3: Illness Prevention

Length: 20 minutes

Materials: Worksheet #3 printed for each student, computer and projector for Powerpoint slides and optional video.

PowerPoint Slides: If using the prepared slide deck, this section will go through slides 28 to the end of the slide deck

- Another important way we can prevent antibiotic resistance is by preventing the spread of infections – if we don't get sick, we don't need antibiotics in the first place!
- One way to prevent infections is to practice good hand hygiene. This includes handwashing, hand drying, and choosing the right product to clean your hands.
- Drying your hands is a very important step of hand hygiene, as wet hands actually transmit germs better than dry hands, and drying your hands removes 42% more germs than washing alone. Some hot air dryers actually promote the growth of bacteria, as bacteria like warm places, so it's best to use clean towels or paper towels when possible.
- Both soap and water and alcohol-based sanitizers can be used to clean your hands. Soap and water is good because it gets rid of bad bacteria and viruses, but good bacteria are not as easily removed. However, if you do not have access to water or a way to dry your hands, alcohol-based sanitizers are a good option. Alcohol-based sanitizers kill good bacteria as well as bad bacteria. Alcohol-based sanitizers are also not effective if your hands are greasy or visibly dirty – you must use soap and water.
- Alcohol based sanitizers and plain soap do not cause bacteria to develop antibiotic resistance. However, some sanitizers and soaps have ingredients that are antibacterial agents, such as triclosan or quaternary ammonium compounds (quats). These can promote resistance, and can remove good bacteria. Products labelled "antibacterial" usually have these agents. These products should be avoided as they are not needed to achieve good hand hygiene.

- Have students get in small groups to work on **Worksheet #3** (page 10) titled: "How can we prevent infections?" If students have a difficult time thinking of ideas, prompt them with hints such as – what are ways to stay healthy, or to prevent others from getting sick when we are sick?

- **Optional activity:**

Bring any of the following: hand soaps, alcohol-based sanitizers, antibacterial sanitizers, and/or toothpaste. Pass them around to student groups. Ask students if they can find any "ingredients to avoid" in the label, such as triclosan or quats, or signs that the product is appropriate to use (ex. "triclosan free" label, alcohol-based ingredients like ethanol). Alternatively, ask students to try this at home and check the products they use.

Brainstorm: How can we prevent infections?

1. Which hand hygiene methods are appropriate to use?

Soap and water	Yes	No
Alcohol-based sanitizers	Yes	No
Soaps and sanitizers with triclosan	Yes	No
Soaps and sanitizers with quats	Yes	No

2. What vaccines are routinely given in Grade 9 in BC? You can use the internet for research.

Brainstorm: How can we prevent infections?

Wash your hands frequently

- Use soap and water or alcohol-based sanitizers, NOT antibacterial agents
- Always remember to dry your hands, preferably with a clean paper towel

If you are sick, protect others from getting sick

- Stay home when you are sick

Stay up to date with vaccines (if you don't get sick you don't need an antibiotic)

Use antibiotics correctly

- Don't take antibiotics for colds and flus (see Doctor if you are unsure)
- Only take antibiotics prescribed to you, following the doctor's instructions.
- Dispose of any unused antibiotics (at a pharmacy)
- Don't share antibiotics with anyone.

1. Which hand hygiene methods are appropriate to use?

Soap and water

Yes

No

Alcohol-based sanitizers

Yes

No

Soaps and sanitizers with triclosan

Yes

No

Soaps and sanitizers with quats

Yes

No

2. What vaccines are routinely given in Grade 9 in BC? You can use the internet for research.

The routine grade 9 vaccine in BC are:

- Meningococcal quadrivalent conjugate vaccine
- Tdap vaccine (Tetanus, diphtheria, pertussis)

Some students may be offered other vaccines too if they haven't received them before

Summary

- Bacteria and viruses are different. They both can cause illness but only bacterial illnesses can be treated with antibiotics.
- Use antibiotics wisely. Bacteria can become resistant to antibiotics, so ask your doctor how to appropriately use antibiotics when they are prescribed to you.
- By preventing illness, we can minimize antibiotic use and stop the spread of superbugs. Handwashing with plain soap is the best way to stop the spread of infection. Receiving your routine immunization and staying home when you are sick also helps to stop the spread of infections.

Additional Activities for Enhanced Learning

- Watch the video on understanding the term microbiome.

“The Hidden World of Microbiomes” (3:12 mins)



youtu.be/MjhDRG-mQ7w

- Activity - Research a current news article on antibiotic resistance and how it has affected a person's life (**Worksheet #4**) (page 13).
- Activity – Modeling the Microbiome – Use math manipulatives to model changes in the microbiome after taking antibiotics. See instructions and **Worksheet #5** (pages 14-19).
- Activity – Create a visual representation of antibiotic resistance – newspaper article, cartoon, poster, or PowerPoint presentation. See **Worksheet #6** (page 20).

Antibiotic Resistance

Review: Antibiotics are medicines that can quickly help to heal some types of infections caused by bacteria. When antibiotics are used too much or not used the right way, they may not work anymore. This is called “antibiotic resistance”. Antibiotic resistance is when the bacteria that are causing you to be sick, no longer respond to the antibiotic and you continue to be sick. Antibiotic resistance is a defense mechanism of bacteria that allows them to survive and multiply, even when an antibiotic is present.

Assignment

Research a current news article about antibiotic resistance and answer the following questions. If possible, bring the article to class to share. You can look for an article from on-line newspapers such as The Globe and Mail or The National Post, or at a credible website such as: <https://antimicrobialresistancefighters.org/>

1. What type of infection is the article about?

2. In this article, how is antibiotic resistance impacting someone's life?

Instructions for Activity – 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)



youtu.be/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.

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	# Red / Total #	Percent of Antibiotic Resistant Bacteria X 100
Start (Baseline)	12	2	1	12+2+1 = 15	$\frac{1}{15} = 0.067$	$\frac{1}{15}$	0.067 X 100 = 6.7 6.7% of the bacteria are antibiotic resistant.
Infection					$\frac{\text{Red}}{\text{Total}} =$	$\frac{\text{Red}}{\text{Total}}$	X 100 = % of the bacteria are antibiotic resistant.
Antibiotic A					$\frac{\text{Red}}{\text{Total}} =$	$\frac{\text{Red}}{\text{Total}}$	X 100 = % of the bacteria are antibiotic resistant.
Recolonization					$\frac{\text{Red}}{\text{Total}} =$	$\frac{\text{Red}}{\text{Total}}$	X 100 = % of the bacteria are antibiotic resistant.
Antibiotic B					$\frac{\text{Red}}{\text{Total}} =$	$\frac{\text{Red}}{\text{Total}}$	X 100 = % of the bacteria are antibiotic resistant.
Gene Transfer					$\frac{\text{Red}}{\text{Total}} =$	$\frac{\text{Red}}{\text{Total}}$	X 100 = % of the bacteria are antibiotic resistant.

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 amount 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 the amount of 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?

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 amount 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 amount of 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.

Project on Antibiotic Resistance

Create a visual presentation about antibiotic resistance to share with the class.

1. Choose a format – newspaper article, cartoon, or poster.
2. Choose an aspect of antibiotic resistance as a focus. Some possible ideas:
 - A fictional news story on how antibiotic resistance affected someone’s life,
 - A poster about antibiotic resistance in Canada, or another country,
 - A fictional news article or cartoon imagining a world without antibiotics,
 - A fictional news article from the late 1940s when antibiotics first became widely used,
 - A cartoon to teach antibiotic stewardship (using antibiotics wisely),
 - An interview with a doctor/pharmacist/nurse about how antibiotic resistance can make it harder to treat patients.
3. Search for newspaper or cartoon templates on-line. Get a poster board or for an e-poster, use a PowerPoint poster template.
4. Determine the main message you want to convey. This will be your headline for your newspaper article, or the main subject for your poster/cartoon.
5. Write two to three main points to cover in your article/poster/cartoon.
6. Add colour, pictures, or quotes to make it more interesting.
7. Have fun and be creative!

Optional: send pictures of completed projects to info@antibioticwise.ca for us to see what you’ve done.