TOPIC
1.6

What medicines help protect us from microbes that make us sick?

Key Concepts

- Traditional First Peoples medicines and treatments come from resources in nature.
- Vaccines can help us prevent infections.
- Antibiotics can treat bacterial infections.

Curricular Competencies

- Demonstrate a sustained intellectual curiosity about a scientific topic or problem of personal interest.
- Make observations aimed at identifying your own questions about the natural world.
- Demonstrate an awareness of assumptions and identify information given and bias in your own work and secondary sources.
- Consider social, ethical, and environmental implications of the findings from their own and others' investigations.

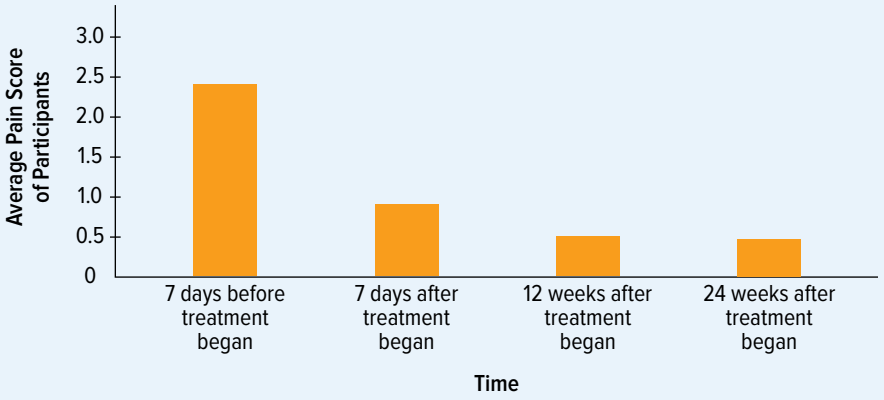
There is a new weapon in the fight against dangerous bacteria that resist antibiotics. And that weapon is found here in British Columbia, in a place called Kisameet Bay. Researchers from the University of British Columbia have found that Kisameet clay is able to kill pathogens that have become resistant to modern medicines. This comes as no surprise to the Heilsuk First Nation. They have been using the clay for hundreds of years to treat ulcers, arthritis, burns, and skin disorders. Researchers are investigating the clay to try to understand how and why it is so effective.

Starting Points

Choose one, some, or all of the following to start your exploration of this topic.

1. **Identifying Preconceptions** Which of the following statements do you think are true, and which are false? Why do you think so in each case?
   - Antibiotics are an effective treatment for the common cold.
   - Medicines prescribed by a doctor or developed by reputable pharmaceutical companies are the only reliable way to treat disease.
   - Vaccines do not have a proven track record in the treatment and prevention of disease.

2. **Analyzing** In people with osteoarthritis, the cartilage at the ends of bones wears down over time. Researchers designed a study of the use of ginger to relieve pain caused by this condition. People in the study ranked their pain 7 days before treatment started. Lower numbers represent less pain. Treatment involved a patch of 1 g of ginger mixed with water that was applied to the lower back for 30 min each day. How do you interpret the results shown in the graph?



Key Terms

Two key terms are highlighted in bold type in this Topic:

- vaccine
- antibiotics

Flip through the pages of this Topic to find these terms. Add them to your class Word Wall along with their meaning. Add other terms that you think are important and want to remember.

CONCEPT 1

Traditional First Peoples medicines and treatments come from resources in nature.

Activity

Ask an Elder or Medicine Person about Medicinal Plants

Which native plants are used as medicines in the place where you live? If possible, invite an Elder or medicine person from a local First Nation to speak to your class about the use of medicinal plants. Your teacher will help you follow the right protocol for when you invite and prepare for a First Nation visitor.

Whether it is using valerian root to help with sleep problems or boiled willow bark to treat an injury, First Peoples in British Columbia have a strong tradition of using resources from nature for medicinal purposes. For generations, First Peoples have relied on plants, animals, and even clay deposits to treat various illnesses and conditions. **Figure 1.23** shows some examples of medicinal plants used by First Peoples of British Columbia.

Figure 1.23 First Peoples have a long history of using plants for medicinal purposes.

Indian hellebore (*Veratrum viride*) can be found in open forests in much of the province. The plant is used by the Nuxalk Nation, for example, to treat skin and scalp conditions. When the plant is burned, the smoke is used as a decongestant.

Devil's club (*Opolopanax horridus*) grows along the coast, as well as in the interior, of British Columbia. Many First Peoples use this plant to treat breathing and digestive disorders, as well as arthritis and diabetes.

Pacific yew (*Taxus brevifolia*) is a small tree found along the coast of British Columbia. Many First Peoples make tea from the needles and bark to treat pain and internal injuries. The tree also has a cancer-fighting chemical in its bark.

Before you leave this page . . .

1. Demonstrate an understanding of how nature can be used to heal.
2. Why might it be important to identify and preserve plants used for medicinal purposes?

AT ISSUE

What factors put medicinal plants at risk?

What's the Issue?

Since time immemorial, First Peoples here and other Indigenous peoples around the world have used plants for healing purposes. Over time, people have discovered ways to prepare and use plants to treat stomachaches, aching joints, sore eyes, fevers, nosebleeds, and coughs and colds. Today, medicinal plants are important on both a global level and local level. More than five billion people rely on plants as their primary source of medicine. For some people, harvesting and selling medicinal plants is their only source of income.

However, some medicinal plants are at risk of being lost. Some may be destroyed as the land on which they grow is claimed for other uses, such as commercial farming or housing. Another reason is that as the medicinal properties of certain plants are studied and commercial interest in them increases, some medicinal plants are in danger of being overharvested. It is estimated that about 15 000 different types of medicinal plants are at risk for extinction due to overharvesting.

Dig Deeper

Collaborate with your classmates to explore one or more of these questions—or generate your own questions of interest to explore.

1. Do you believe that medicinal plants and other traditional medicines can or should be patented? What kinds of protections do you think there should be—not only for the plants, but also for the people who use and depend on them?
2. Suppose there is a proposal to cut down a large tract of forest so the land can be used to grow agricultural crops. The forest is a source of medicinal plants that are important to people in the region. You are going to a town hall meeting where this issue will be discussed and voted on. Prepare a list of questions to help you decide how you might vote.
3. What medicinal plants grow in your area? How are they used? Are any of the plants at risk? What factors are putting them at risk, and what can be done to change the situation?

CONCEPT 2

Vaccines can help us prevent infections.

Activity

What Do You Know About Vaccines?

Many babies get vaccines to protect them against diseases such as tetanus, whooping cough, measles, hepatitis B, and chicken pox. What do you know about vaccines? What questions do you have about vaccines? Discuss your ideas with your classmates.

vaccine a substance that causes a response in the body that protects it against a specific disease

A **vaccine** is a substance that is given to a person or animal to protect against a specific disease. Vaccines may be injected or taken orally. They are usually given to babies and children according to a schedule based on age.

Vaccines cause an immune response from the body, which results in the immune system "remembering" the exposure to the pathogen. If a person is exposed to that same pathogen after being vaccinated, the immune system recognizes it and immediately begins to defend the body against it. A vaccinated person does not get sick from exposure to the pathogen and is said to have immunity against the disease. Table 1.5 describes several types of vaccines.

Table 1.5 Types of Vaccines

Type of Vaccine	How It Works	Example
Live, attenuated vaccine	The vaccine contains living microbes that have been weakened in a laboratory so that they cannot cause disease. The immune system responds as if the body has been infected, providing strong, often lifelong, immunity against the disease after only one or two doses.	Used against microbes that cause measles, mumps, chickenpox, and yellow fever are made this way.
Inactivated vaccines	The vaccine contains microbes that have been killed with heat, chemicals, or radiation. This vaccine results in a weaker response from the immune system. To keep immunity, a person has to get booster shots periodically.	Used against hepatitis A, rabies, and whooping cough.
Subunit vaccines	Only specific pieces of microbes are used to make the vaccine. These pieces are separated from the microbe or made in a laboratory. Immunity is provided after several doses.	Vaccines include those for hepatitis B and a flu vaccine called Hib.
Toxoid vaccines	The vaccine is made using toxins that some types of bacteria produce. The toxins are inactivated in a laboratory so they no longer cause disease. Booster shots are usually needed to keep immunity strong.	Vaccines include those for diphtheria and tetanus.

Vaccines and Public Health

Many health agencies in Canada and around the world make strong arguments in favour of people getting vaccines. There are several reasons. For example, vaccines help protect each person who receives them against deadly diseases and diseases that can cause permanent damage, such as blindness, muscle paralysis, heart damage, and infertility. Vaccines can also help stop the spread of disease. The more people who receive vaccines against an infectious disease, the less the disease can spread from person to person.

Vaccines can also help stop an outbreak from turning into an epidemic or pandemic. For example, throughout history, smallpox has been a devastating disease. However, after a worldwide vaccination effort in the 20th century, the disease was declared eradicated in 1980. The last known natural case of smallpox occurred in Somalia in 1977. Many organizations are working to eradicate other diseases, including polio and measles. **Table 1.6** shows examples of vaccines that have been effective at preventing diseases.

Connect to Investigation 1-G on page 78

Connect to Investigation 1-H on page 79

Table 1.6 Effectiveness of Certain Vaccines

Disease	Number of Reported Cases, 1980	Number of Reported Cases, 2014	Percent Decrease in Cases
Diphtheria	97 774	7321	92.5
Measles	4 211 431	267 582	93.6
Polio	57 795	371	99.4
Tetanus	114 248	11 392	90.0
Whooping cough	1 982 384	220 504	88.9

Before you leave this page . . .

1. In your own words, explain what a vaccine is.
2. Make a graphic organizer of your choice to explain how vaccines help protect people against disease.

CONCEPT 3

Antibiotics can treat bacterial infections.

Activity

What Do You Know About Antibiotics?

Have you ever taken an antibiotic? Can you explain how it helped you? If not, how could you find the answer to this question? What other questions do you have about antibiotics?

antibiotic a substance that fights infections by interfering with the life processes of bacteria

Antibiotics are substances that fight infections by interfering with the life processes of bacteria. Either they kill bacteria or they prevent them from growing or reproducing. Each antibiotic is effective against specific types of bacteria. They are not useful against infections caused by viruses or other microbes.

Penicillin—The First Antibiotic Available on a Global Scale

Connect to Investigation 1-F on pages 76–77

As it sometimes happens in science, the discovery of penicillin was an accident. In 1928, a British scientist named Alexander Fleming returned to his laboratory from holiday to find several Petri dishes with *Staphylococcus* bacteria growing on them. One dish also had a large patch of mould growing on it. What caught Fleming's eye was that no bacteria were growing around the mould. The Petri dish Fleming found is shown in **Figure 1.24**. The mould had properties that stopped the bacteria from growing near it.

The scientific name of this mould is *Penicillium notatum*. Penicillin is the antibiotic that was derived from this mould. It was used to treat soldiers for bacterial infections during World War II. By 1950, it was widely available to the public, and the development of other antibiotics soon followed. You may have heard some of their names, such as erythromycin, amoxicillin, and tetracycline.

Figure 1.24 The area near the mould does not have bacteria growing around it. **What questions would you have asked if you had seen this Petri dish? Describe a controlled experiment that you would have carried out to answer these questions.**

The Development of Antibiotic-Resistant Bacteria

Millions of people have benefited from the use of antibiotics since their discovery. However, a serious problem has arisen from their overuse. Many types of bacteria have become resistant to antibiotics. Some diseases, such as tuberculosis, pneumonia, and meningitis, are now more difficult to treat as a result of antibiotic-resistant bacteria. **Figure 1.25** explains how a population of bacteria can become resistant to bacteria.

As time passes, the resistant bacteria will reproduce and become more common. As a result, the antibiotic is no longer effective against those bacteria. When this happens, a different antibiotic must be used to fight the infection. In recent years the term "superbugs" has been used to describe bacteria that are resistant to several types of antibiotics. One of the more common superbugs is methicillin-resistant *Staphylococcus aureus* (MRSA). Scientists are continuing to research new ways to treat infections caused by antibiotic-resistant bacteria.

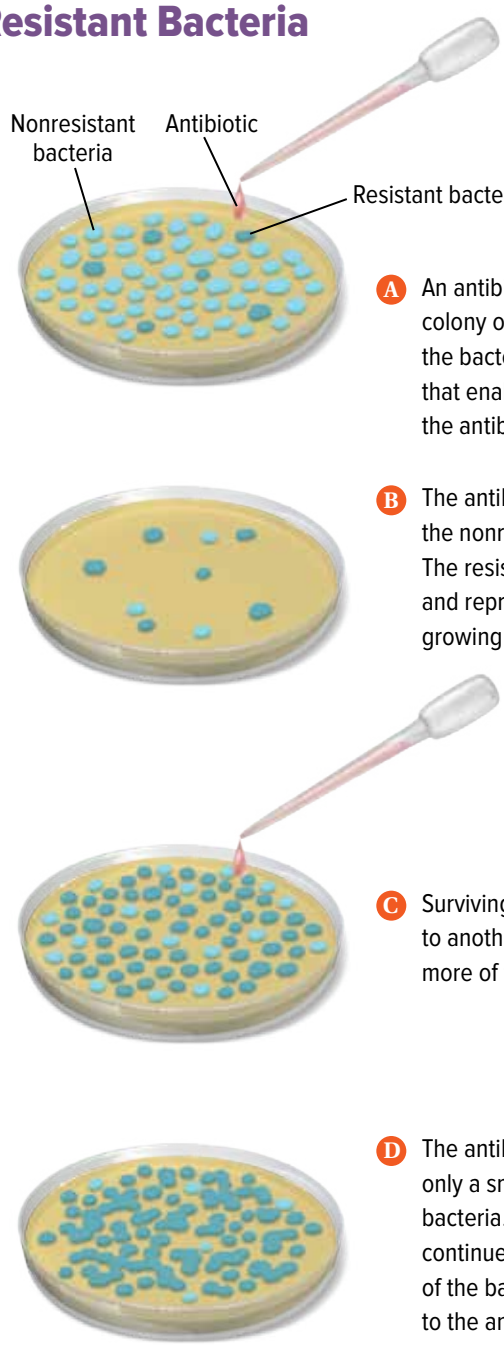


Figure 1.25 A population of bacteria can develop resistance to bacteria after being exposed to them over time.

Before you leave this page . . .

1. What are antibiotics? How are they used?
2. Suppose you had to describe to a grade 3 class how antibiotic-resistant bacteria develop. Create a brief presentation in the format of your choice to meet this goal.
3. Why do you think the medical community is concerned about antibiotic-resistant bacteria?

TAKE Action

Make a Difference

Implement a Handwashing Campaign

How often do you touch your face during the day? If you're like most people, you touch your nose, mouth, eyes, or ears many times, probably without even being aware of it. How clean are your hands throughout the day? Where have they been before you touch your face? What do you touch afterwards?

You cannot avoid coming in contact with microbes. They are everywhere in the world around you, indoors as well as outdoors. However, it is the pathogens that can cause disease that are a concern because they are so easily picked up, dropped off, and moved from object to object and from place to place.

Where do they come from and how do they get there? Consider each time you

- touch a doorknob
- tap a touchscreen
- shake someone's hand
- handle raw food
- use toilet paper
- cough
- sneeze

What other examples can you think of? Do you regularly wash your hands before or after you do any of these things?

Handwashing Helps

Washing hands with soap kills and removes pathogens and is a proven way to reduce their spread. Communities where people have been shown the importance of handwashing have seen a 31% decrease in the number of people who get sick with diarrhea. They've seen up to a 20% decrease in the number of people who get sick from colds and other respiratory infections.

According to the Canadian Centre for Occupational Health and Safety (CCOHS), handwashing with soap is the most effective way to reduce the spread of infections. It also helps reduce the development of antibiotic-resistant bacteria. When fewer people get sick, fewer antibiotics are prescribed. This, in turn, decreases the chances of bacteria developing resistance to antibiotics.

There's a Proper Way

Washing your hands may seem like a simple thing to do, but there actually is a "right" way to do it. And scientists estimate that only about 5% of people wash their hands properly. Proper hand washing begins with removing jewellery from hands and arms and then following the steps shown in the poster.

One thing the poster doesn't say is to avoid using antibacterial soap. It can kill the healthy bacteria that live on your skin. And it can contribute to the development of antibiotic-resistant bacteria.

An easy way to time 20 seconds is to remember that it is about the amount of time it takes to sing or hum the "Happy Birthday" song twice.

Questioning and Planning for Your Own Handwashing Campaign

Your task is to run a handwashing campaign in a setting of your choice. Research more information about successful campaigns. Some questions you could consider include, but are not limited to, the following.

- Where will you run your campaign—at home? at school? somewhere else in your community?
- Who will be your target audience?
- What information do you need to investigate and learn about?
- What catchy title can you create?
- Many successful campaigns have slogans, posters, videos, and information on websites. How will you get your message across?
- How can you evaluate the success of your campaign?

Analyze and Evaluate

1. How successful was your campaign? How well did your evaluation plans help you determine its success?
2. What have you learned that could help you improve the campaign?

Apply and Innovate

3. Take your campaign to the next level. For example, if you conducted it at home, consider running it at your school. If you ran it at school, consider a different school or somewhere else in your community. What changes do you need to make for a larger place and audience?

TAKE a Stand

Make a Difference

What can be done to prevent superbug outbreaks?

You volunteer at a long-term care home for seniors in your community. In your orientation package, a brochure discusses a superbug called MRSA. MRSA stands for methicillin-resistant *Staphylococcus aureus*. (Methicillin is a very powerful antibiotic.) Many people carry MRSA but do not get sick from it. However, when MRSA is transferred to people with weak immune systems, it can cause a deadly infection. As a result, MRSA is most dangerous in hospitals and care homes where people live close together. These places follow procedures to prevent infections and keep them from spreading.

The procedures include mandatory handwashing, extensive disinfecting, and screening new residents for MRSA. But not all long-term care homes follow them. Sometimes the home is underfunded and understaffed. You wonder how you could increase awareness of this issue. You decide to do some research.

Some things you learn include the following:

- 1 in 4 people in long-term care homes carry the bacteria that cause MRSA. If they go to a hospital, they bring the bacteria with them.
- Preventing infections takes time and money. Many long-term care homes do not have enough money or staff.
- All long-term care homes in the province must be open for inspection by health authorities. However, even a home with a High Risk rating is inspected just twice a year. A long-term care home with a Low Risk rating is only inspected every 18 months.

Analyze

1. What are the pros and cons of following the prevention procedures?
2. Should governments provide more funding for long-term care homes? Where could the money come from?
3. How might the long time between inspections affect infection prevention?

Communicate

4. Do you think this health problem and the factors that contribute to it can be improved? If not, what obstacles to improvement are there? If so, what do you think can, or must, be done? In either case, what additional information would you want or need to help you reach an informed opinion on the matter?

Check Your Understanding of **Topic 1.6**

QP Questioning and Predicting PC Planning and Conducting PA Processing and Analyzing E Evaluating
AI Applying and Innovating C Communicating

Understanding Key Ideas

1. Use a Venn Diagram to compare and contrast antibiotics and vaccinations. PA C
2. Describe the role an accident played in the development of the first antibiotic. PA C
3. Name a viral disease that people can be vaccinated against.
4. Explain why vaccination has helped to drastically reduce the number of reported cases of diseases such as measles in Canada. PA C
5. The active ingredient in aspirin is salicylic acid. It was first isolated from the bark of the willow tree. Today salicylic acid is made in laboratories by drug companies. Describe at least one benefit and one drawback of making salicylic acid this way. PA E AI

6. You are creating a health file about vaccines for HealthLink BC. PA AI E C
   a) What information do you think is most important to include in the file? Explain your reasoning.
   b) Create a graphic organizer to include in the file. It should clearly explain the four different types of vaccines that you learned about in this topic.
7. Develop a script that could be used for a 20-second PSA (public service announcement) about superbugs. PA AI E C

Connecting Ideas

8. It is recommended that pregnant women, infants, and people with weak immune systems should not be vaccinated for certain diseases. Explain how it is still possible for vaccines to protect these people from the diseases. (Hint: Think carefully about how the words "vaccinated" and "vaccines" are used in this question.) PA AI E
9. Many microbes and viruses that cause disease can be on our hands. In the last few years, use of alcohol-based hand sanitizers has become common. Why should you limit the use of hand sanitizers to your hands and not use them on the rest of your body? E AI C

Making New Connections

10. Methicillin-resistant *Staphylococcus aureus* (MRSA) is a common superbug. It has caused illness in many places throughout Canada, including British Columbia. QP PC AI
    a) Imagine that you are a scientist who has developed a new antibiotic for MRSA. Describe how you could plan an investigation to test how effective the antibiotic is.
    b) Imagine that you are a doctor working with patients who have MRSA. The antibiotic that was developed in part a) turns out to be effective. List three questions you would have about the antibiotic before you would believe that it is safe to use it for your patients.

INVESTIGATION
1-F

STRUCTURED INQUIRY

Antibacterial Agents (Dry Lab)

Skills and Strategies

- Processing and Analyzing
- Evaluating
- Communicating

Safety

CAUTION: This procedure has been modified so that you can measure, record, and analyze results without working with live bacteria.

What You Need

- ruler

You will learn and analyze a technique used to test how effective antibacterial agents are in limiting bacterial growth. An antibacterial agent is a substance that kills bacteria or inhibits (stops or slows) their ability to reproduce. Soap, mouthwash, and antibiotics are examples.

Question

How effective are different antibacterial agents?

Procedure

1. Read the boxed information about testing antibacterial agents.
2. Read the tests described in Part 1 and Part 2.
3. Perform the procedural steps in Part 2 and answer the questions that follow.
4. Answer the questions that follow both parts.

Testing the Effectiveness of Antibacterial Agents

Scientists use these steps to test the effectiveness of different antibacterial agents.

A The entire surface of a plate of nutrient medium is swabbed with the organism to be tested.

B A sterile paper disc is dipped into the antibacterial agent, or antibiotic is applied to the disc.

C The disc with the antibacterial agent is placed in the centre of the agar plate.

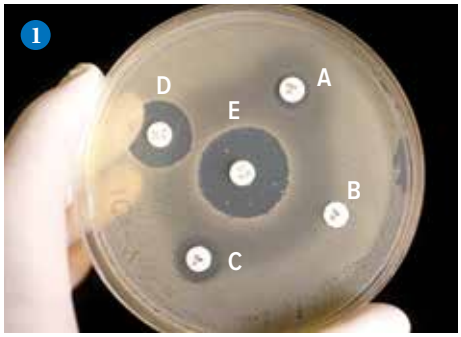
D After 18 h of incubation, the zones of inhibition at 37°C (diameters of the clear areas around the discs) are measured in millimetres.

Determining Effectiveness

If an antibacterial agent is effective at killing bacteria, then there will be a circular area around the paper disc that does not have any bacteria. This area is called a zone of inhibition. It is related to the effectiveness of the agent. The larger the zone, the more effective an agent is. Zones of inhibition can be compared by sight (qualitative), or they can be measured with a ruler (quantitative).

Part 1: Testing Antibiotics

Four antibiotics were tested to determine how well they inhibit the growth of bacteria. The photo shows five discs on a bacteria-covered plate. Four of the discs had an antibiotic applied to them. A fifth disc had water applied to it as a control.



Part 2: Testing Antiseptics

Antiseptics, such as mouthwash and ointments, have antibacterial properties that are gentle enough to be used on skin. Five antiseptics were tested for how well they inhibit the growth of bacteria. The photo shows five discs on a bacteria-covered plate. The antiseptics used were

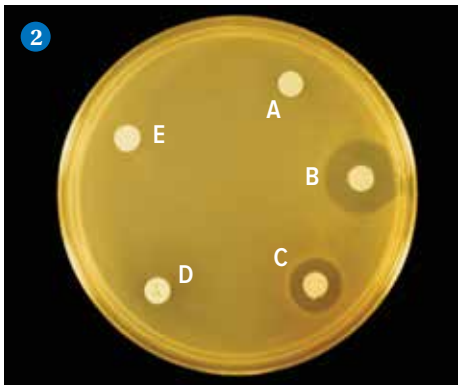
(A) Brand L mouthwash

(B) an antibacterial solution used in hospitals to prepare patients for surgery

(C) the main ingredient in an over-the-counter antibacterial cream

(D) iodine

(E) Brand S mouthwash



1. Use a ruler to measure the zone of inhibition for each disc. To do this, measure the diameter of the circle surrounding each disc.
2. Organize your results in a table.

Analyze and Interpret

1. Sketch the plate for Part 1.
2. Which disc do you think had the most effective antibiotic? Explain your choice.
3. Which disc do you think was the control? Explain your choice.
4. Sketch the plate for Part 2. Include a legend that shows the treatment each label (A to E) represents.
5. **a)** Which antiseptics were most effective? Which were least effective? How do you know?

   b) Are these results what you would have expected to see? Explain why or why not.

Conclude and Communicate

6. In Part 1, you assessed results by sight. In Part 2, you took measurements. Which method of observation—qualitative or quantitative—do you think was better for assessing the results of the tests? Why?

Apply and Innovate

7. For safety, this Investigation was done as a "dry lab." Results were provided, and you analyzed them. How could an investigation like this with actual organisms be done safely? In other words, what organism could you grow (and test) safely with as little danger as possible of people getting sick? Discuss your ideas in class. Do not carry them out without your teacher's input and guidance.

Measles Vaccination

Measles is a viral infection that causes high fever and a cough. A vaccine for measles has been available since the early 1960s. The World Health Organization (WHO) tracks data on the incidence of measles as well as the percentage of people around the world who get the measles vaccine each year. Do you think there is a link?

Skills and Strategies

- Processing and Analyzing
- Evaluating
- Communicating

What You Need

- graph paper
- coloured pencils
- metric ruler

Measles Incidence and Vaccinations

Year	Incidence of Measles (*indicates estimation)	Percent Vaccinated
1980	4 211 431	13
1983	3 843 120*	36
1986	2 375 248*	60
1989	1 984 329*	73
1992	1 499 898*	80
1995	760 634*	80
1998	694 466	80
2001	846 765	72
2004	509 734	85
2007	280 771	90

Question

What is the relationship between vaccination and the incidence of measles?

Procedure

1. Construct a graph to plot the data. Place *Year* on the *x*-axis. Place *Incidence of Measles* on the left *y*-axis and *Percent Vaccinated* on the right *y*-axis.
2. Decide how you will represent each part of the data on your graph. For example, you could choose to represent the *Incidence of Measles* data using bars and the *Percent Vaccinated* data using a line.
3. Use coloured pencils to plot the points on your graph.

Analyze and Interpret

1. Describe the connection between the incidence of measles and the percentage of people receiving a vaccine each year.
2. Explain why you think this connection exists.

Conclude and Communicate

3. In British Columbia, it is recommended that infants and young children receive a measles vaccine. In several other provinces, measles vaccines are required for school entrance. However, exemptions are possible for medical or religious reasons, or reasons of conscience. Write a short paragraph expressing your opinion about exemptions. Consider how exemptions might affect public health.

INVESTIGATION
1-H

OPEN INQUIRY

Approaches to Health and Wellness

Skills and Strategies

- Questioning and Predicting
- Planning and Conducting
- Processing and Analyzing
- Evaluating
- Applying and Innovating
- Communicating

What You Need

- access to print, digital, and human resources
- supporting materials provided by your teacher to help you organize and plan your thinking and research

People in different fields of inquiry and understanding draw on a variety of ways of approaching health and wellness. For example:

- Scientists testing Kisameet clay have found that it can kill the seven pathogens that are most resistant to antibiotics
- Medical engineers design nanoparticles that can deliver medicine to specific parts of the body; other researchers are working on new vaccines against various diseases.
- Elders, medicine people, and others who are wise in other ways of knowing, teach about attitudes, practices, and remedies that have supported health and wellness for thousands of years.

What assumptions and understandings do these and other approaches to health and wellness share? Where do they disagree? How much, or little, do they have in common? There are many questions one could investigate about health and wellness.

Question

What question about treating and preventing illness or maintaining health and wellness do you want to investigate?

Procedure

1. Reflect on ideas you have about health and wellness.
2. Write questions you have about the ideas you listed.
3. Choose one question, and develop a plan to find answers.

Analyze, Evaluate, and Communicate

1. Should western, biomedical ways of knowing be balanced with First Peoples and other ways of knowing? Why or why not?
2. What can be lost when First Peoples and other ways of knowing are excluded in matters related to health and wellness?