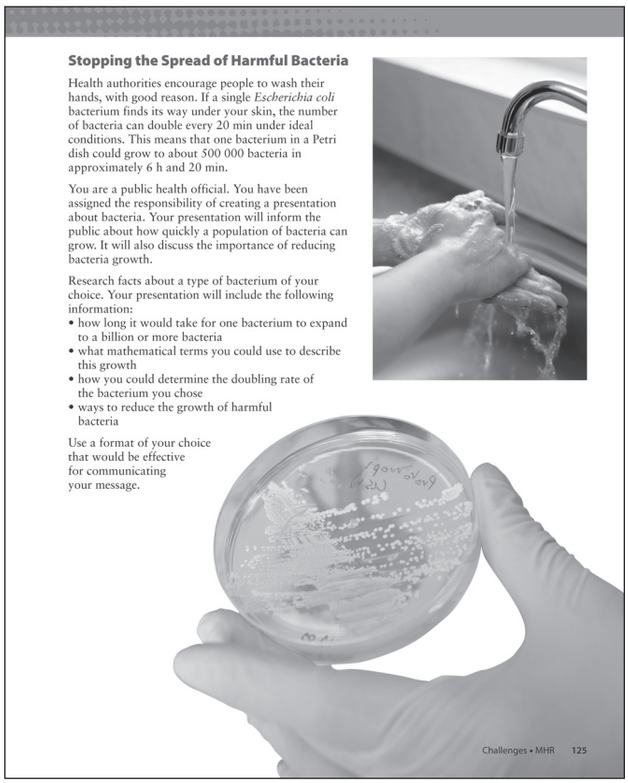


Stopping the Spread of Harmful Bacteria

Health authorities encourage people to wash their hands, with good reason. If a single *Escherichia coli* bacterium finds its way under your skin, the number of bacteria can double every 20 min under ideal conditions. This means that one bacterium in a Petri dish could grow to about 500 000 bacteria in approximately 6 h and 20 min.

You are a public health official. You have been assigned the responsibility of creating a presentation about bacteria. Your presentation will inform the public about how quickly a population of bacteria can grow. It will also discuss the importance of reducing bacteria growth.

Research facts about a type of bacterium of your choice. Your presentation will include the following information:
- how long it would take for one bacterium to expand to a billion or more bacteria
- what mathematical terms you could use to describe this growth
- how you could determine the doubling rate of the bacterium you chose
- ways to reduce the growth of harmful bacteria

Use a format of your choice that would be effective for communicating your message.

Challenges • MHR 125

Planning Notes: Stopping the Spread of Harmful Bacteria

You may wish to use the following steps to introduce and complete this Challenge:

1. Invite students to share their knowledge of bacteria. For example, if *E. coli* bacteria are ingested, they can cause gastrointestinal infection (food poisoning) and urinary tract infection. Other bacteria, such as those used in making cheese and yogurt, as well as many that help in digestion, are beneficial to humans.
2. Read through the paragraph regarding bacterial growth with students. Then, discuss and list methods of finding the time for one bacterium to grow to 500 000 bacteria.
3. With the class, discuss and list presentation options. Depending on the materials available, you may wish to have students choose from the following:
   - poster
   - report
   - PowerPoint presentation
   - graphic organizer
   - other

***MathLinks 9*, page 125**

Suggested Timing
40–50 minutes

Materials
- calculator
- poster paper
- coloured pencils and markers
- other materials for creating a poster
- word-processing software (optional)
- presentation software, such as PowerPoint (optional)

Blackline Masters
Master 1 Project Rubric

Mathematical Processes
- ☑ Communication (C)
- ☑ Connections (CN)
- ☑ Mental Mathematics and Estimation (ME)
- ☑ Problem Solving (PS)
- ☑ Reasoning (R)
- ☑ Technology (T)
- ☑ Visualization (V)

Specific Outcomes
N1 Demonstrate an understanding of powers with integral bases (excluding base 0) and whole number exponents by:
- representing repeated multiplication using powers
- using patterns to show that a power with an exponent of zero is equal to one
- solving problems involving powers.

N2 Demonstrate an understanding of operations on powers with integral bases (excluding base 0) and whole number exponents.
N4 Explain and apply the order of operations, including exponents, with and without technology.

4. Emphasize that their job is to educate the public on how quickly bacteria can grow and on ways to reduce the growth of harmful bacteria.
5. Clarify that the task is to
   - determine how many times a single bacterium needs to double to produce a billion or more bacteria
   - determine the time it will take to produce a billion or more bacteria
   - use correct mathematical terms to explain the growth
   - determine the doubling rate of the bacterium
   - list methods to reduce the growth of harmful bacteria
   - decide on a presentation form and implement it

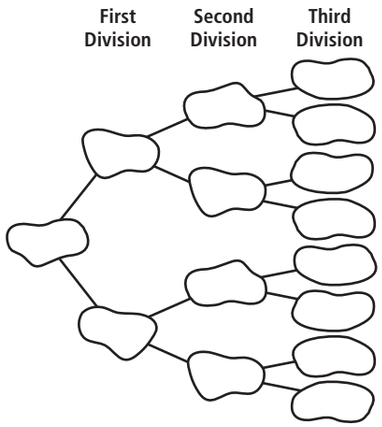
6. Review the **Master 1 Project Rubric** with students so that they will know what is expected.

Meeting Student Needs

- Some students may find it beneficial to visualize the growth rate by using a table to organize the increase in numbers of cells over time.

Time (min)	0	1	2	3	4	5
Number of Cells	1	2	4	8	16	32

- A diagram such as the one below may help some students conceptualize the term *doubling rate.* From the diagram, it is evident that after the third division, one cell becomes eight cells. Ask students how they could write the numbers 1, 2, 4, 8, etc. as powers of 2.



Time (min)	0	20	40	60
Number of Cells	1	2	4	8

Gifted and Enrichment

- Have students research the growth rate of a particular bacterium of their choice and work with that bacterium for their presentation.

Answers

Stopping the Spread of Harmful Bacteria

Example: It has been shown in a Petri dish that the *Escherichia coli* bacteria can double every 20 min. The original one bacterium would need to double 30 times in order to produce approximately one billion bacteria.
$2^{30} = 1\,073\,741\,824$
This would take $30 \times 20 = 600$ min, or 10 h.
This doubling rate is an exponential growth.

Ways to reduce growth:
- Wash your hands.
- Clean surfaces and utensils used for food preparation.
- Properly store perishable foods.
- Cover your mouth when coughing or sneezing.
- Disinfect open wounds.
- Do not share food or drink.
- Wash your hands before and after touching your eyes or nose cavity.

This Challenge can be used for either Assessment *for* Learning or Assessment *of* Learning.

Assessment	Supporting Learning
Assessment *for* Learning	
Stopping the Spread of Harmful Bacteria Discuss the Challenge with students. Have students complete the activity in pairs.	• Encourage students to use graphic organizers to help them organize their thoughts as they work on the project.
Assessment *of* Learning	
Stopping the Spread of Harmful Bacteria Introduce the Challenge to students. Have students complete the activity individually or in pairs.	• **Master 1 Project Rubric** provides a holistic descriptor that will assist you in assessing student work on this Challenge. Page 175 provides notes on how to use this rubric for the Challenge. • To view student exemplars, go to www.mathlinks9.ca, access the Teacher Centre on the Online Learning Centre, go to Assessment, and then follow the links.

The chart below shows the **Master 1 Project Rubric** for tasks such as this Challenge, Stopping the Spread of Harmful Bacteria, and provides notes that specify how to identify the level of specific answers for this project.

Score/Level	Holistic Descriptor	Specific Question Notes
5 **(Standard of Excellence)**	❑ Applies/develops **thorough** strategies and mathematical processes making **significant** comparisons/connections that demonstrate a **comprehensive** understanding of how to develop a complete solution ❑ Procedures are **efficient and effective** and may contain a **minor mathematical error** that does not affect understanding ❑ Uses **significant** mathematical language to explain their understanding and provides **in-depth** support for their conclusion	• provides a complete and correct solution
4 **(Above Acceptable)**	❑ Applies/develops **thorough** strategies and mathematical processes for making **reasonable** comparisons/connections that demonstrate a **clear** understanding ❑ Procedures are **reasonable** and may contain a **minor mathematical error** that may hinder the understanding in one part of a complete solution ❑ Uses **appropriate** mathematical language to explain their understanding and provides **clear** support for their conclusion	Demonstrates one of the following: • provides a complete response to all parts of the problem, with a weak justification • provides a complete and correct response to all parts of the problem; however, bullet 4 has fewer than three suggestions • provides complete and correct response with a presentation that does not represent their information
3 **(Meets Acceptable)**	❑ Applies/develops **relevant** strategies and mathematical processes making **some** comparisons/connections that demonstrate a **basic** understanding ❑ Procedures are **basic** and may contain a **major error or omission** ❑ Uses **common** language to explain their understanding and provides **minimal** support for their conclusion	Demonstrates one of the following: • correctly completes any 3 bullets and provides a reasonable presentation design • partially completes all bullets but there may be some calculation errors or omissions
2 **(Below Acceptable)**	❑ Applies/develops **some relevant** mathematical processes making **minimal** comparisons/connections that lead to a **partial solution** ❑ Procedures are **basic** and may contain **several major mathematical errors** ❑ Communication is **weak**	Demonstrates one of the following: • correctly completes bullets 1 and 2 • correctly completes bullets 1 and 3 • correctly completes bullets 1 and 3, and identifies only one example in bullet 4
1 **(Beginning)**	❑ Applies/develops an **initial start** that may be **partially correct** or could have led to a correct solution ❑ Communication is **weak or absent**	Demonstrates one of the following: • provides a correct initial start to a part of the problem • provides some correct suggestions for bullet 4 • provides a reasonable presentation design

For student exemplars, go to www.mathlinks9.ca and follow the links.