

2.8 Case Study Harmful Bacteria

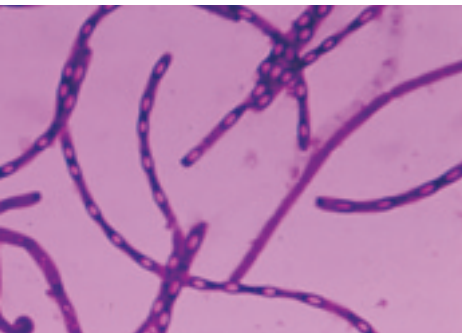


Figure 1

Bacillus anthracis results in the deadly disease anthrax, which affects cattle, sheep, and people. More recently, it has gained the public's attention as a terrorist biological agent after the September 11, 2001, tragedy.

toxin a poison produced in the body of a living organism. It is not harmful to the organism itself but only to other organisms.



Figure 2

The people of Walkerton, Ontario, suffered from serious contamination of their drinking water by a deadly strain of *E. coli* bacteria.

Bacteria are probably best known for causing disease. *Bacillus anthracis* was the first bacterium proven to cause a disease (**Figure 1**). The 1976 Legionnaire's disease outbreak in Philadelphia took scientists many months to identify and was caused by a bacterium named *Legionella pneumophila*. Some of the best-known bacterial plagues over the years have been diphtheria, typhoid fever, and bubonic plague (Black Death). Tuberculosis still affects many people in Canada each year, particularly in northern communities. It has also become a problem among the homeless in Toronto, Montreal, and Vancouver, as well as among people living with AIDS.

The Walkerton Tragedy

On May 12, 2000, heavy rains washed fecal bacteria from cattle manure into well water near the town of Walkerton, Ontario (**Figure 2**). Within 10 days, hundreds of residents had symptoms of *E. coli* poisoning: vomiting, cramps, bloody diarrhea, and fever. By May 22, the first death directly linked to *E. coli* was reported. Health-unit tests revealed that the drinking water was contaminated with the deadly strain *E. coli* O157:H7.

There are hundreds of strains of *E. coli* bacteria; the combination of numbers and letters in the name of the bacterium refers to the specific markers found on the bacterium's surface. Whereas most live harmlessly in the intestines of healthy animals, *E. coli* O157:H7 produces a dangerous poison or **toxin**. If the toxin is present in small amounts, the immune system of a healthy adult can fight the illness in 5 to 10 days without special treatment or antibiotics. The toxin may have a more dramatic effect, however, in young children and the elderly. It may destroy red blood cells and cause kidney failure, seizures, or strokes. About 2% to 7% of *E. coli* O157:H7 infections lead to these complications.

The major source of *E. coli* O157:H7 infections is undercooked ground beef, since fecal matter can contaminate beef as the meat is processed. *E. coli* O157:H7 is found in the intestines of cattle; when the cattle are killed, the bacteria can become mixed into beef when it is ground. Other sources of *E. coli* include processed meats, sprouts and leafy green produce, unpasteurized milk and juice, and contact with cattle. Drinking inadequately chlorinated water or swimming in contaminated lakes or pools may also expose people to this deadly strain. The organism is easily transmitted from person to person. Day-care or long-term-care centres, cattle barns, and petting zoos are prime areas of concern.

The Walkerton tragedy has prompted new government legislation on the testing and treatment of municipal drinking water. Proper chlorination of water would have prevented the death of seven people and the illness of more than 2300 in Walkerton. In addition to chlorination, ultraviolet light can be used for drinking-water purification: large-scale implementation of this technology will come with more research. New biological sensors and imaging techniques are also being developed to identify *E. coli* in minutes rather than days. It is hoped that these new technologies will prevent another tragedy like Walkerton.

Bacteria cause illness in a variety of ways. In the Walkerton example, toxins overloaded people's immune systems, reducing their ability to remove poisons from the body. In some cases, the sheer number of bacteria places such a tremendous burden on the host's tissues that normal function breaks down. In other cases, bacteria actually destroy cells and tissues. **Table 1** provides some examples of other diseases and/or destruction caused by bacteria.

Table 1 Examples of Harmful Effects of Bacteria

Type of bacteria	Disease/destruction produced
<i>Clostridium</i>	botulism, tetanus, gangrene
<i>Streptococcus</i>	strep throat, scarlet fever, pneumonia
<i>Staphylococcus</i>	boils; food spoilage; food poisoning; skin, blood, and eye infections; pneumonia
<i>Lactobacillus</i>	souring of milk
<i>Pseudomonas</i>	gasoline spoilage, food spoilage, blood infections, eye infections
<i>Bacillus</i>	destruction of silkworms, tuberculosis, anthrax
coliform bacteria	pollution of water sources, soft rot in plants, gastroenteritis, dysentery
<i>Spirillum</i>	syphilis

DID YOU KNOW?

Bacteria and Ulcers

Most stomach ulcers are caused not by spicy foods, acid, or stress, but by *Helicobacter pylori*. This bacterium is capable of living in the stomach because it secretes an enzyme that neutralizes stomach acids. *H. pylori* then weakens the protective lining of the stomach and intestine, allowing acids to irritate both areas. This causes stomach pain associated with ulcers. Antibiotics, such as amoxicillin and tetracycline can be used to treat ulcers caused by *H. pylori*.

Case Study 2.8 Questions

Understanding Concepts

- Describe the symptoms of *E. coli* O157:H7 poisoning.
- List the sources of *E. coli* O157:H7 contamination.
- Create a graphic organizer for **Table 1**. Draw the three basic bacterial shapes in the centre of a piece of paper. Working out from the middle, name each pathogen and the diseases it produces. (Additional information: clostridium, coliform, and pseudomonads are rod-shaped bacteria.)

Applying Inquiry Skills

- Pathogenic cases of *E. coli* have been tracked in Canada since 1985 (**Figure 3**). Analyze the trends and hypothesize about the causes.

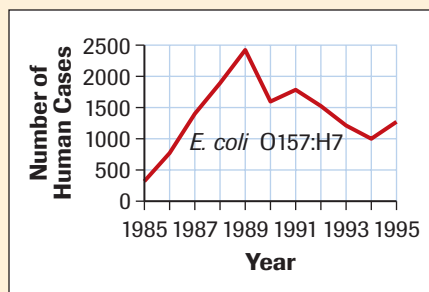


Figure 3
Incidence of *E. coli* O157:H7 in Canada per 100 000 population

Making Connections

- Explain how *E. coli* contamination can be prevented by the government, and by the population.

- Could you be a wastewater treatment technician? Describe this career: duties, education, job opportunities, personal strengths and skills required.



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- Prepare a fact sheet on any one of the diseases mentioned in this section. Conduct research to answer the following questions:
 - Description of disease
 - Diagnosis: What parts of the body are affected?
 - Organism causing disease: Give the genus and species name, and describe its characteristics.
 - Symptoms: List the common initial signs of the disease and the new symptoms that develop as the disease progresses.
 - Type of transmission: How is the disease passed from person to person?
 - Treatment: Consider all aspects, including those not based on Western medical tradition. Consider their effectiveness, cost, and why they may work.
 - Prognosis: What is the cure rate? Can the disease return to the same person?



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- If you obtain water from your own well, how can you get it tested, and what tests are performed?



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