

2026 CANADA GAIRDNER AWARD WINNERS

Explore the science behind today's biggest
breakthroughs



ABOUT GAIRDNER

The mission of the Gairdner Foundation is to celebrate, inform and inspire scientific excellence around the globe.

Established in 1957, the Gairdner Foundation is dedicated to fulfilling James A. Gairdner's vision to recognize major research contributions to the treatment of disease and alleviation of human suffering. Through the prestigious annual Canada Gairdner Awards, the Foundation celebrates the world's most creative and accomplished researchers whose work is improving the health and wellbeing of people around the world. **The Canada Gairdner Awards are recognized internationally as being among the most prestigious in the world, based on our reputation for rigorous review and early recognition of breakthroughs in science.**

The Gairdner Foundation brings people together to openly discuss science in order to better engage the public, understand the problems we face, and work together to find solutions. Through Gairdner Connects, our national outreach program, we bring science to communities across Canada to inspire future innovators and spark public dialogue about the role of research in addressing the world's most pressing health challenges.

BY THE NUMBERS

5 CANADA GAIRDNER
International Awards
For excellence in biomedical research

2 PETER GILGAN CANADA GAIRDNER
Momentum Awards
For mid-career investigators with exceptional research

1 JOHN DIRKS CANADA GAIRDNER
Global Health Award
For outstanding achievements in global health research

443 AWARDS to scientists from over **40** countries

103
Gairdner awardees have gone on to win the **Nobel Prize**



20 CANADIAN UNIVERSITIES | ENGAGING **6000+** students and researchers annually through outreach programs that give Canadians access to world-renowned scientists



ABOUT THE COLLECTION

This article is part of a larger collection introducing the discoveries of the 2026 Canada Gairdner Award winners, among the world's leading biomedical and global health researchers. From the inner workings of our cells to new approaches to preventing disease and improving treatment, these stories explore research shaping the future of human health.

To explore the other stories in this series, [check out the full collection here](#). By viewing the full collection, you'll discover the science behind this year's award-winning research and explore big questions such as:

- How can viruses help us fight antibiotic-resistant bacteria?
- How can technology help regulate blood pressure after spinal cord injury?
- How can we stop misfolded proteins from causing disease?
- How can scientists identify, measure and study thousands of proteins?
- How can scientists use 3D images to see inside cells?
- How can oral vaccines help prevent cholera?

ABOUT THE CREATORS

Each article was written by Gairdner student intern **Leanne Cherry**, an undergraduate student at McGill University studying Cognitive Science and Communication Studies, and developed in collaboration with the Award winners themselves. Passionate about science communication, Leanne is interested in making research accessible and combating science and health misinformation.

The articles were also reviewed by the students from the **Canadian Association of Girls in Science (CAGIS)**, whose thoughtful feedback helped make these stories clear, accurate and engaging for young readers.

Illustrations were created by **Heather Ng-Cornish**, an illustrator and communicator based in Ontario. Heather brings her science communication experience to her illustrations, creating clear, colourful and accessible visuals that help bring scientific ideas to life. To see more of her work, visit www.heatherngcornish.com

The Gairdner Foundation is committed to sharing the excitement of discovery with people of all ages. We hope this collection sparks your curiosity, encourages you to ask big questions, and inspires you to imagine the discoveries still waiting to be made.



LEANNE
CHERRY



HEATHER
NG-CORNISH



BACTERIA VS BACTERIA- ATTACKING VIRUSES: THE FIGHT AGAINST ANTIBIOTIC RESISTANCE

DR. KAREN MAXWELL

**PETER GILGAN CANADA GAIRDNER MOMENTUM AWARD
WINNER**

Professor, Department of Biochemistry, Temerty Faculty of Medicine,
University of Toronto, Canada

SUMMARY

Karen Maxwell has uncovered crucial details about how bacteria defend themselves against viruses, and how these viruses attack back. Maxwell's research marks a significant step in the field of phage therapy, which would allow us to target antibiotic-resistant bacteria with the help of bacteria-killing viruses, known as phages.

STUDENT REVIEWERS:



ADRIENNE
Grade 11



DEEPA
Grade 11



RANEEM
Grade 12



VIENNA
Grade 12

Antibiotics are a major lifesaver (literally) when it comes to treating bacterial infections. Before antibiotics, getting a mere paper cut could be a death sentence. However, despite how useful antibiotics have been to us, we have run into a new problem: antibiotic resistance. Because we have relied so heavily on antibiotics, we have given bacteria too many chances to adapt, making them much more difficult to combat. Antibiotic resistance poses a major threat to global health—but what if we could team up with bacteria's worst enemy to manage our antibiotic resistance problem?

Bacteriophages, or simply phages, are a kind of virus that only target and kill bacteria (**Figure 1**). Dr. Karen Maxwell, a researcher and professor in biochemistry at the University of Toronto, has uncovered crucial details about phage-bacteria conflict, exploring how bacteria defend themselves against phages, how phages overcome these defenses, and how both of them keep evolving to try to outsmart one another. Maxwell's work can help us figure out how best to use their interactions to our advantage.



FIGURE 1

A bacteriophage, also known as a phage, is a kind of virus that only targets and kills bacteria. Bacteriophages are the most abundant **biological entity** in existence, and are bacteria's deadliest natural predator.

BIOLOGICAL ENTITY

An individual being which is connected to living things, or is itself a living being. While viruses share many qualities with living beings, they are not technically considered to be alive—an idea which will be expanded upon in sections to come.

USING PHAGES TO FIGHT BACTERIAL INFECTIONS

Phage therapy is based on the idea that we can use these bacteria-killing viruses to target bacterial infections in humans and other animals. Phage therapy also has huge potential to help us fight antibiotic resistance.

One of the key advantages with using phages is that many infect only a limited range of **bacterial strains**. When we use phages against a bacterial infection, we can specifically target the bacteria that are most resistant to current antibiotics. In doing so, we can reduce the number of bacteria types who are exposed to a given treatment, which gives them fewer chances to adapt and develop resistance. Phages' pickiness is also useful because it allows us to target only the harmful bacteria and leave the rest of our microbiome—the beneficial bacteria and other organisms that live in our bodies—intact. General antibiotics aren't picky in this way, meaning they may allow more species of bacteria to develop resistance, and could also harm our microbiome in the process.

At the same time, we must remember that antibiotics are one of the most important advances in modern medicine. While general antibiotics can harm the good and healthy bacteria of our bodies, the fact that they are not picky also means that they can attack a wider range of harmful bacteria. Antibiotics have been necessary to reduce the death rate of bacterial infections, and also to make other medical procedures like cancer treatment, surgery, and even childbirth much safer. If you have ever had strep-throat, pneumonia, or a staph infection, there is a good chance you have taken antibiotics yourself. But, given the scale of the antibiotic resistance problem, it is important that we look into possible medical alternatives. By uncovering the many mysteries of phage-bacteria dynamics, researchers like Maxwell can help us bring phage therapy “to life”.

BACTERIAL STRAIN

A subgroup of a bacterial species. For example, some strains of the bacteria E. Coli can give you food poisoning and make you sick, whereas many others live safely and naturally in your body.

HOW PHAGES USE BACTERIA TO REPLICATE

A key difference between bacteria and viruses more broadly is that, while bacteria can reproduce on their own, viruses can only create more copies of themselves by taking over another organism's cell, which is then called its host cell. The fact that viruses require another cell's machinery to replicate is one of the reasons that phages are not technically considered to be living things. When a phage wants to reproduce, it attaches onto a bacterium and injects its genetic material (**DNA or RNA**) into its host. The genetic material can then use the bacterium to produce more phages.

In **lytic replication**, the phage's genetic material immediately takes the bacterium hostage, forcing the cell to redirect its resources toward producing new phages (**Figure 2**). Eventually, the bacterium becomes so full of phages that it bursts and dies, which distributes the phages to other bacteria and allows the cycle to start over again.

In **lysogenic replication**, on the other hand, the phage becomes a kind of microscopic sleeper agent, quietly inserting its genetic material into the bacterium's **genome** and waiting for a particular trigger before starting a new lytic replication cycle (**Figure 3**). These sleeper agents are called prophages, and because they are part of the bacterium's genes, they can be passed on to future generations of bacteria when the bacterial cell divides.

DNA VS. RNA

Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) are two ways organisms and other biological agents store instructions that tell cells how to make proteins. These instructions help determine how we develop and function: they make us who we are. A virus can have either DNA or RNA, but never both at the same time.

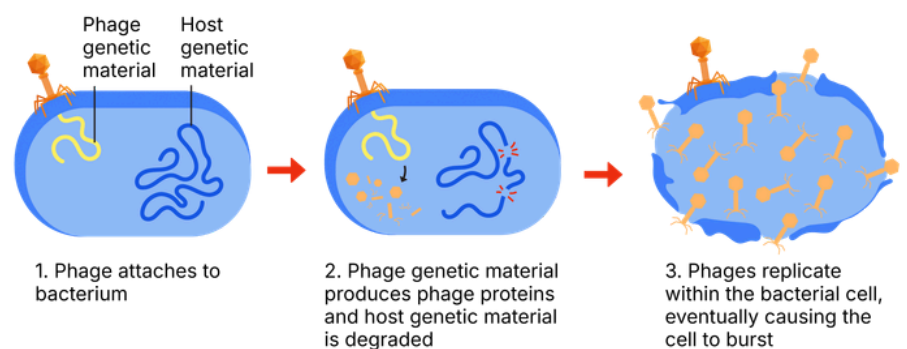
GENOME

The complete set of an organism's genetic material.

FIGURE 2

In lytic replication, the phage genetic material produces phage proteins inside the cell. The production of replicates leads to eruption of the cell.

Lytic replication



Lysogenic replication

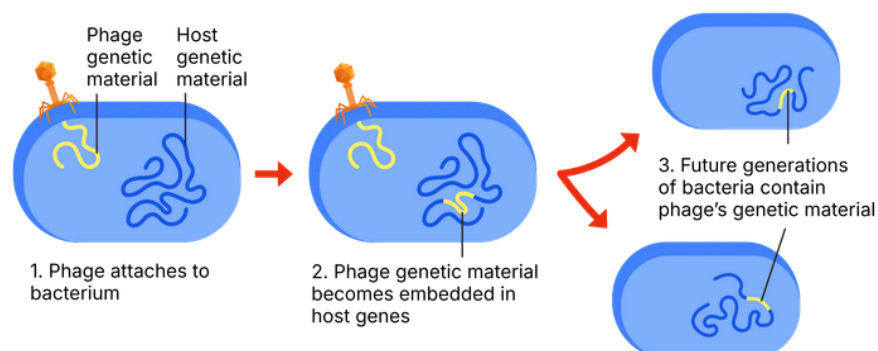


FIGURE 3

In lysogenic replication, the genetic material of the phage integrates into the bacterium's genetic material. Each new generation of the bacteria now contains phage genetic material.

PHAGE-BACTERIA COMBAT

Bacteria can use chemical weapons

Given that phages have been around for billions of years, it is not surprising that bacteria have evolved a number of different anti-phage defense mechanisms. For example, some bacteria will change the outer surface of their cells to prevent phages from injecting viral genetic material, almost as though they are putting on a suit of armour. Other bacteria have learned to sacrifice themselves once they realize they've been infected, in order to prevent the phages from reproducing and attacking other bacteria. Despite this diversity, many of these defence mechanisms were thought to rely on large **protein complexes**, which bacteria make by combining proteins and other cell parts.

However, Maxwell and her team demonstrated that in addition to using and producing protein complexes, bacteria can make a smaller chemical compound, called a **metabolite**, to protect themselves against phages. The team specifically looked at soil bacteria called *Streptomyces*, and found that they produce metabolites which prevent phages from reproducing properly. The metabolites interfere with phage DNA at an early stage in the phage's reproductive life cycle—a stage which is common to nearly all phage species. This finding suggests that bacterial metabolite production could protect against a wide variety of phages. We had known before that bacteria of many kinds produce these **metabolites**, but until Maxwell's work, we didn't understand why. We now know that it is a defense mechanism against phages, opening up a whole new line of questioning about bacteria's chemical defense.

Phages can prevent bacteria from talking to each other

Beyond the chemicals they use to prevent phage replication, bacteria also use chemical signals to communicate and coordinate their behaviour in a process known as **quorum sensing**. This form of communication relies on molecules released by the bacteria called **autoinducers**. Autoinducers accumulate as more bacteria are present, and the abundance of these molecules enables bacteria to detect when they are surrounded by many neighbours (**Figure 4**). With quorum sensing, bacteria detect a high concentration of autoinducers, and this tells them that it is time to unite and fight back against phages. One of the strategies that quorum sensing allows bacteria to do, for example, is to collectively change their cell surfaces. In a sense, the bacteria put up a collective shield, making it harder for phages to attack the group and inject their genetic material.

PROTEIN COMPLEX

Different chains of amino acids (the building blocks of protein) or other components of a cell linking with one another and forming a larger structure which can perform tasks.

METABOLITE

A small molecule produced during or as a result of some metabolic process, such as digestion or a chemical reaction within the body.

QUORUM SENSING

A form of chemical communication between bacteria with which they can coordinate their behaviour as a group.

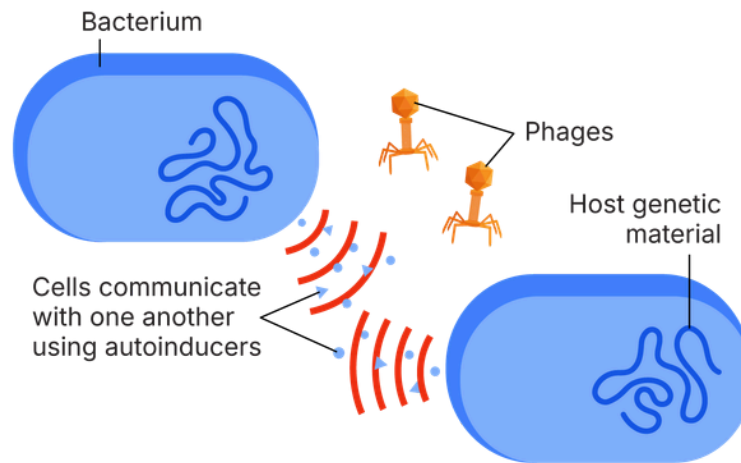
AUTOINDUCER

Chemical released by bacteria specifically for the purpose of coordinating behaviour in a group of bacteria.

Quorum sensing

FIGURE 4

Bacterial cells release molecules called autoinducers, which alert other cells that phages are present.



Unfortunately for bacteria, some phages have found ways to use quorum sensing to their advantage. Maxwell discovered a phage protein that can interfere with communication in its target bacterium, *P. aeruginosa*. This protein targets a part of bacteria that regulates many quorum-sensing behaviours. As a result, bacteria have a much harder time communicating and coordinating their defences against phages as a group. Maxwell's discovery may allow scientists and doctors to develop new ways to interfere with bacterial communication during infections. The idea here is that, if we can prevent bacteria from communicating, we may have an easier time fighting bacterial infections.

Maxwell demonstrated that phages not only target quorum-sensing to prevent bacterial coordination, but actually use bacterial quorum-sensing signals to support their own coordination. Phages use the chemical signals to send newly-produced phages only to bacteria that haven't yet been infected, making their attacks more efficient and widespread while reducing the number of phages that get wasted. This method was termed the “**anti-Kronos effect**” to signify how the technique helps preserve phage offspring—unlike Kronos, the ancient Greek god after which the method has named, who was known for eating his own children.

Maxwell's research also showed that phages can change the surface of their host cell to help them transmit their genetic material more easily, a property which had only been observed in other kinds of viruses. In understanding the phage-bacteria conflict better through these discoveries, we may also be able to improve the delivery of phage-based treatments.

Bacteria can use viral genetic information to their advantage

Though prophages can eventually become active and begin a lytic replication cycle—thus killing the host—Maxwell discovered that prophages can, in some cases, protect their host bacteria from contracting a different viral infection. She and her team first called attention to this phenomenon in 2016, and in 2024, they further refined the idea, demonstrating that a protein produced from prophage DNA could block the replication of a different phage, effectively turning a former viral invader into part of the bacterium's immune system. This finding highlights that the relationship between bacteria and phages is far more complicated than a simple battle between predator and prey.

MAXWELL'S RESEARCH: IMPORTANT FOR THEORY AND PRACTICE

As we mentioned, phages are pretty picky about which bacteria they attack. Even bacteria that belong to the same species can differ from one another, and it can be difficult to know exactly which strain is causing an infection. Phage therapy requires that we match the phage to the bacterial strain, and if we don't know which strain we're fighting against, it could be difficult to target the infection properly.

Luckily, people like Maxwell will continue to uncover the mysteries of phage-bacteria combat, which will not only help us improve our phage-based medications, but will help us fight antibiotic resistance more broadly. In her lab, Maxwell leads the next generation of scientists forward, paving the way for future researchers and demonstrating that her impact will be felt for many years to come.

Article written by Leanne Cherry

Illustrated by Heather Ng-Cornish

This article has been reviewed by Dr. Karen Maxwell and colleagues for accuracy and accessibility.

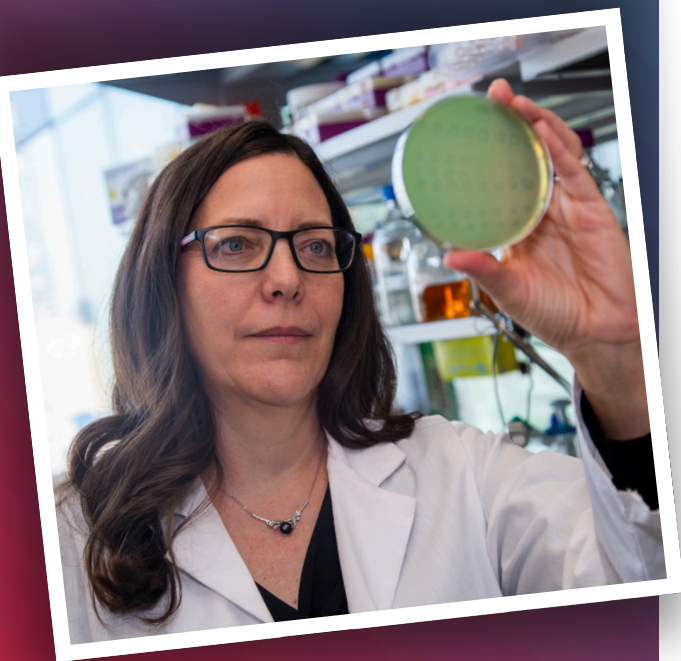


“

A lot of what we do as scientists is challenge each other. We poke holes in each other's arguments, and that's what science is all about. So, I think students need to have confidence in themselves and confidence in their ideas, but also be resilient enough that when people point out problems with your science, you're strong enough to withstand it.

”

- Karen Maxwell



MEET THE SCIENTIST: Dr. Karen Maxwell

Karen Maxwell is a professor in the Department of Biochemistry at the University of Toronto and holds a Tier 1 Canada Research Chair in Bacteriophage Biology and Therapeutics. She earned her Ph.D. in Molecular Genetics at the University of Toronto and completed postdoctoral research at the Ontario Centre for Structural Genomics. Her laboratory studies interactions between bacteria and the viruses that infect them, known as bacteriophages or phages. By investigating how phages infect bacteria and how bacteria defend themselves, her research is helping scientists better understand these complex relationships and explore how phages could be used to combat antibiotic-resistant bacterial infections.



YOUTH ACCESSIBILITY REVIEW

This article was reviewed by students through the Canadian Association for Girls in Science (CAGIS)—Canada’s largest and longest-running STEM (science, technology, trades, engineering, and math) club for girls and gender-diverse youth aged 7-17. This award-winning club, founded in 1992, supports interest in STEM with virtual programming and local clubs that visit labs, workshops, and field sites to meet mentors and do fun, hands-on activities. Their thoughtful feedback on clarity, accessibility, and reader engagement helped shape the final version of this article and ensure it is engaging and accessible for youth readers.



Adrienne Ma • Grade 11

“I hope to pursue a career in optometry to combine my love for helping others and my fascination for the human eye.”



Raneem Salah • Grade 12

“I’m excited to study human biology and find ways to impact society using that knowledge!”



Deepa Kalia • Grade 11

“I hope to combine my love of technology with my passion for business and explore how technology can be used to create innovative solutions and opportunities.”



Vienna Cipparrone • Grade 12

“I am intending on studying neuroscience and psychology, and I want to explore how psychological disorders affect brain structure and function.”

GAIRDNER CONNECTS

Gairdner Connects brings award-winning scientists to communities across Canada to engage, inspire, and spark dialogue. In doing so, it fosters meaningful connections between Gairdner Award winners and the next generation of researchers. **Through interactive events, classroom visits, community discussions, and digital resources, we inspire future innovators and spark dialogue about the role of science in addressing global health challenges.**

This article, developed in partnership with the **Canadian Association for Girls in Science (CAGIS)**, is part of the Gairdner Foundation's student outreach program to bring science to communities across Canada.

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