

20 Viruses and Prokaryotes



Cellular Basis of Life

Q: Are all microbes that make us sick made of living cells?

WHAT I KNOW

WHAT I LEARNED

20.1 What is a virus?

SAMPLE ANSWER: A virus is a tiny particle that can make people sick.

SAMPLE ANSWER: A virus is a nonliving particle made of proteins, nucleic acids, and sometimes lipids. Viruses can reproduce only by infecting a host's living cells.

20.2 What are prokaryotes and why are they important?

SAMPLE ANSWER: Prokaryotes are often referred to as bacteria, and some of them cause diseases.

SAMPLE ANSWER: Prokaryotes are unicellular organisms that lack a nucleus. Prokaryotes are essential in maintaining every aspect of the ecological balance of the living world. In addition, some species have specific uses in human industry.



20.3 How can we prevent bacterial and viral diseases from spreading?

SAMPLE ANSWER: Good hygiene helps prevent the spread of bacterial and viral diseases.

SAMPLE ANSWER: Many bacterial and viral diseases can be prevented by stimulating the body's immune system with vaccines, fighting infections with antibiotics, and maintaining clean and healthy habits.

20.1 Viruses

Lesson Objectives

-  Explain how viruses reproduce.
-  Explain how viruses cause infection.

Lesson Summary

The Discovery of Viruses In 1935, the American biochemist Wendell Stanley isolated a virus for the first time.

- ▶ A **virus** is a particle made of nucleic acid, protein, and, in some cases, lipids.
- ▶ A typical virus is composed of a core of DNA or RNA surrounded by a protein coat called a **capsid**.
- ▶ Viruses that infect bacteria are called **bacteriophages**. They enter living cells and, once inside, use the machinery of the infected cell to produce more viruses.

Viral Infections Viruses have two methods of infection once inside a host cell.

- ▶ In a **lytic infection**, a virus enters a cell, makes copies of itself, and causes the cell to burst, releasing new virus particles that can attack other cells. In the case of bacteriophage *T4*, viral DNA directs the synthesis of new viruses using materials in the cell.
- ▶ In a **lysogenic infection**, a virus integrates part of its DNA called a **prophage** into the DNA of the host cell. The viral genetic information replicates along with the host cell's DNA. Eventually, the prophage will remove itself from the host cell DNA and make new virus particles.

In a **retrovirus**, the genetic information is copied backward—from RNA to DNA instead of from DNA to RNA. The virus that causes the disease AIDS is a retrovirus.

Viruses must infect a living cell in order to reproduce. Although viruses are parasites, they are not made of cells and are not considered living things.

The Discovery of Viruses

1. What is a bacteriophage?
a virus that attacks bacteria

2. What are viruses?
They are particles of nucleic acid, protein, and in some cases lipids that can reproduce only by infecting living cells.

3. What is a capsid?
a virus's protein coat

4. How does a typical virus get inside a cell?
The capsid proteins "trick" the cell by binding to receptors on its surface.

5. What occurs when viruses get inside cells?
Once inside, the viral genes are expressed. This may lead to the cell's destruction.

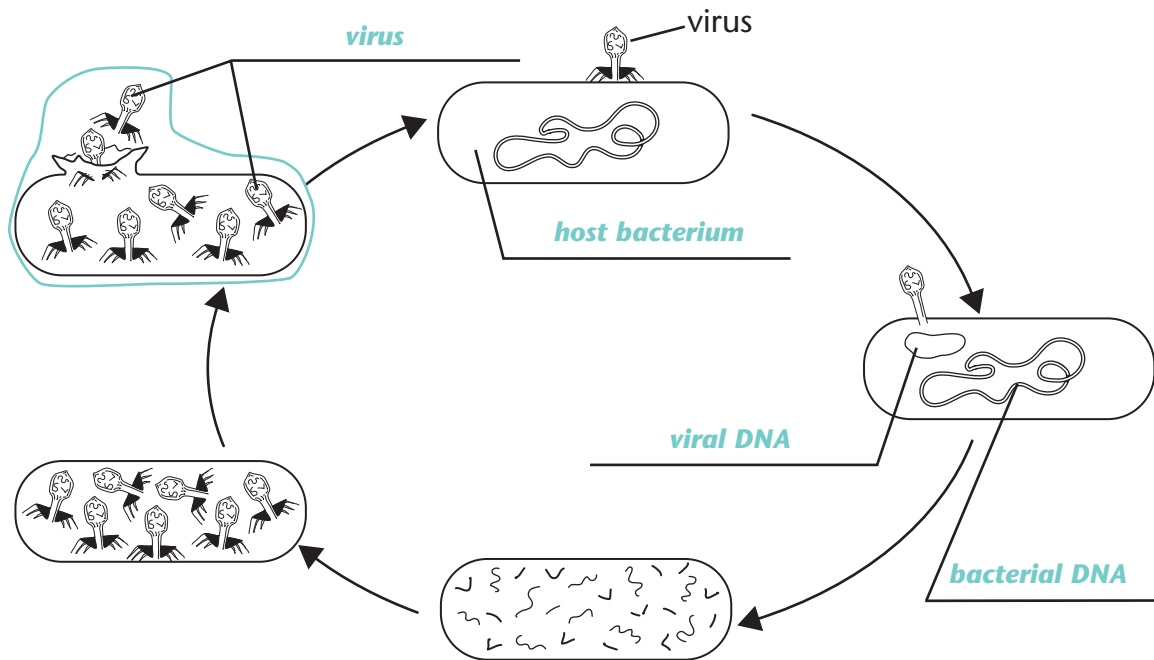
Viral Infections

6. **VISUAL ANALOGY** In the visual analogy, why is the outlaw locking up the sheriff, instead of the other way around?

The outlaw is locking up the sheriff because, like a virus, the outlaw has come in and taken over. The sheriff is basically hostage to the outlaw—as is a cell's DNA once a virus has entered a cell.



7. **THINK VISUALLY** The diagram below shows the lytic cycle of a viral infection. Label the bacterial DNA, host bacterium, viral DNA, and virus. Then, circle the step that shows lysis of the host cell.



8. In a lysogenic infection, how can one virus infect many cells?

The viral DNA is inserted into the host cell's DNA. It remains there and is copied each time the cell multiplies.

9. How is the common cold like the HIV virus?

They are both RNA viruses.




Apply the Big idea

10. What would happen to a virus that never came in contact with a living cell? Explain your answer.

The virus would never reproduce. Viruses do not have the structures necessary to metabolize, grow, repair damages, or reproduce without a host.

20.2 Prokaryotes

Lesson Objectives

-  Explain how the two groups of prokaryotes differ.
-  Describe how prokaryotes vary in structure and function.
-  Explain the role of bacteria in the living world.

Lesson Summary

Classifying Prokaryotes The smallest and most common microorganisms are **prokaryotes**, which are unicellular organisms that lack a nucleus. Prokaryotes are classified either in domain Bacteria or domain Archaea.

- ▶ They can be surrounded by a cell wall, which contains peptidoglycan. Inside the cell wall is a cell membrane surrounding the cytoplasm.
- ▶ Archaea look similar to bacteria, but are genetically closer to eukaryotes. Archaea lack peptidoglycan and have different membrane lipids than bacteria.

Structure and Function Prokaryotes are identified by characteristics such as shape, the chemical nature of their cell walls, the way they move, and the way they obtain energy.

- ▶ **Bacilli** are rod-shaped. **Cocci** are spherical. **Spirilla** are spiral or corkscrew-shaped.
- ▶ Most prokaryotes are heterotrophs. Others are autotrophs. Autotrophs may be photoautotroph, or chemoautotrophs.
- ▶ Prokaryotes that require a constant supply of oxygen to live are called obligate aerobes. Those that cannot survive in oxygen are called obligate anaerobes. Organisms that can survive without oxygen when necessary are called facultative anaerobes.

Prokaryotes reproduce asexually by **binary fission**, which results in two identical “daughter” cells. Many prokaryotes can form **endospores** when conditions are unfavorable in order to protect their DNA. They can also exchange genetic information by **conjugation**.

The Importance of Prokaryotes Prokaryotes are vital to maintaining the ecological balance of the living world.

- ▶ Some are decomposers that break down dead matter.
- ▶ Others are producers that carry out photosynthesis.
- ▶ Some soil bacteria convert natural nitrogen gas into a form plants can use through a process called nitrogen fixation.
- ▶ Humans use bacteria in industry, food production, and other ways.

Classifying Prokaryotes

For Questions 1–5, complete each statement by writing the correct word or words.

1. Unicellular organisms that lack a nucleus are called prokaryotes.
2. The two different domains of prokaryotes are Bacteria and Archaea.
3. A cell wall made of peptidoglycan protects some bacteria from damage.

11. What occurs in the process of binary fission?

It is a type of asexual reproduction in which a prokaryote grows to nearly double its size, replicates its DNA, and divides in half, producing two identical "daughter" cells.

12. What occurs during conjugation?

A hollow bridge forms between two bacterial cells, and genes move from one cell to the other.

The Importance of Prokaryotes

13. How do decomposers help the ecosystem recycle nutrients when a tree dies?

They feed on and digest the dead tissue, breaking it down into its raw materials, which are released back into the environment.

14. What would happen to plants and animals if decomposers did not recycle nutrients?

Plants would drain the soil of minerals and die, and animals that depend on plants for food would starve.

15. Why do all organisms need nitrogen?

They need nitrogen to make proteins and other molecules.

16. Why is the process of nitrogen fixation important?

Nitrogen fixation by bacteria converts nitrogen into a form that can be used by plants or that can be attached to amino acids that all organisms use.

17. What kind of relationship do many plants have with nitrogen-fixing bacteria?

They have a symbiotic relationship.

18. Describe three different ways that humans use bacteria.

Humans use bacteria to produce foods, such as yogurt; to synthesize drugs and chemicals; and to clean up waste.

Apply the Big idea

19. Suppose you were studying an infectious unicellular organism with a cell wall under a microscope. How could you confirm that the organism was a prokaryote? How could scientists determine whether it should be classified in domain Bacteria or domain Archaea?

If the organism were a prokaryote, it would not have a nucleus. Its DNA would be in its cytoplasm. If the organism were a member of the domain Bacteria, its cell wall would have peptidoglycan.