Lesson 3

Reading Guide

Key Concepts

ESSENTIAL QUESTIONS

- What are viruses?
- How do viruses affect human health?

Vocabulary

virus p. 247

antibody p. 251

vaccine p. 252

Multilingual eGlossary

What are viruses?

Inquiry **Painted Flowers?**

The streaking patterns on the petals of these tulips are not painted on but are caused by a virus. Tulips with these patterns are prized for their beautiful appearance. How do you think a virus could cause this flower's pattern? Do you think all viruses are harmful?

Launch Lab

10 minutes

How quickly do viruses replicate?

One characteristic that viruses share is the ability to produce many new viruses from just one virus. In this lab you can use grains of rice to model virus replication. Each grain of rice represents one virus.

Generation	First	Second	Third
Number of "viruses"			

1. Read and complete a lab safety form.
2. Copy the table above into your Science Journal.
3. Estimate the number of **grains of rice** in the **fishbowl** and record this number for the first generation.
4. One student will add the contents of his or her **cup** to the fishbowl. Estimate how many viruses are now in the fishbowl and record your estimate for the second generation.
5. The rest of the class will add the contents of their cups to the fishbowl. Estimate the number of viruses and record that number of viruses for the third generation.

Think About This

1. Recall that bacteria double every generation. How does the number of viruses produced in each generation compare with the number of bacteria produced in each generation?
2. **Key Concept** How could the rate at which viruses are produced affect human health?

Characteristics of Viruses

Do chicken pox, mumps, measles, and polio sound familiar? You might have received shots to protect you from these diseases. You might have also received a shot to protect you from influenza, commonly known as the flu. What do these diseases have in common? They are caused by different viruses. *A* **virus** *is a strand of DNA or RNA surrounded by a layer of protein that can infect and replicate in a host cell.* If you have had a cold, you have been infected by a virus.

A virus does not have a cell wall, a nucleus, or any other organelles present in cells. The smallest viruses are between 20 and 100 times smaller than most bacteria. Recall that about 100 bacteria would fit across the head of a pin. Viruses can have different shapes, such as the crystal, cylinder, sphere, and bacteriophage (bak TIHR ee uh fayj) shapes shown in Figure 12.

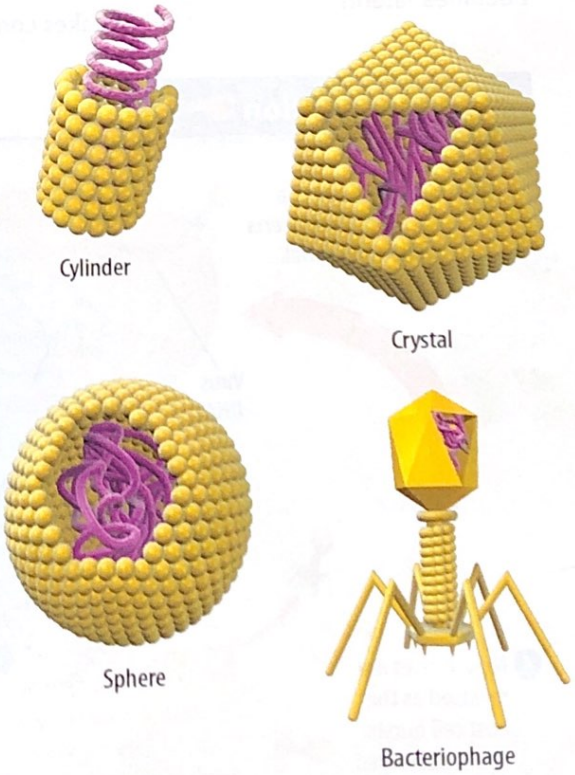


Figure 12 Viruses have a variety of shapes.

FOLDABLES

Make a folded book from a sheet of paper. Label it as shown. Use it to organize your notes on the replication sequence of a virus.

Dead or Alive?

Do you think that viruses are living things? Scientists do not consider viruses to be alive because they do not have all the characteristics of a living organism. Recall that living things are organized, respond to stimuli, use energy, grow, and reproduce. Viruses cannot do any of these things. A virus can make copies of itself in a process called replication, but it must rely on a living organism to do so.

Key Concept Check Are viruses alive? Explain why or why not.

Viruses and Organisms

Viruses must use organisms to carry on the processes that we usually associate with a living cell. Viruses have no organelles so they are not able to take in nutrients or use energy. They also cannot replicate without using the cellular parts of an organism. Viruses must be inside a cell to replicate. The living cell that a virus infects is called a host cell.

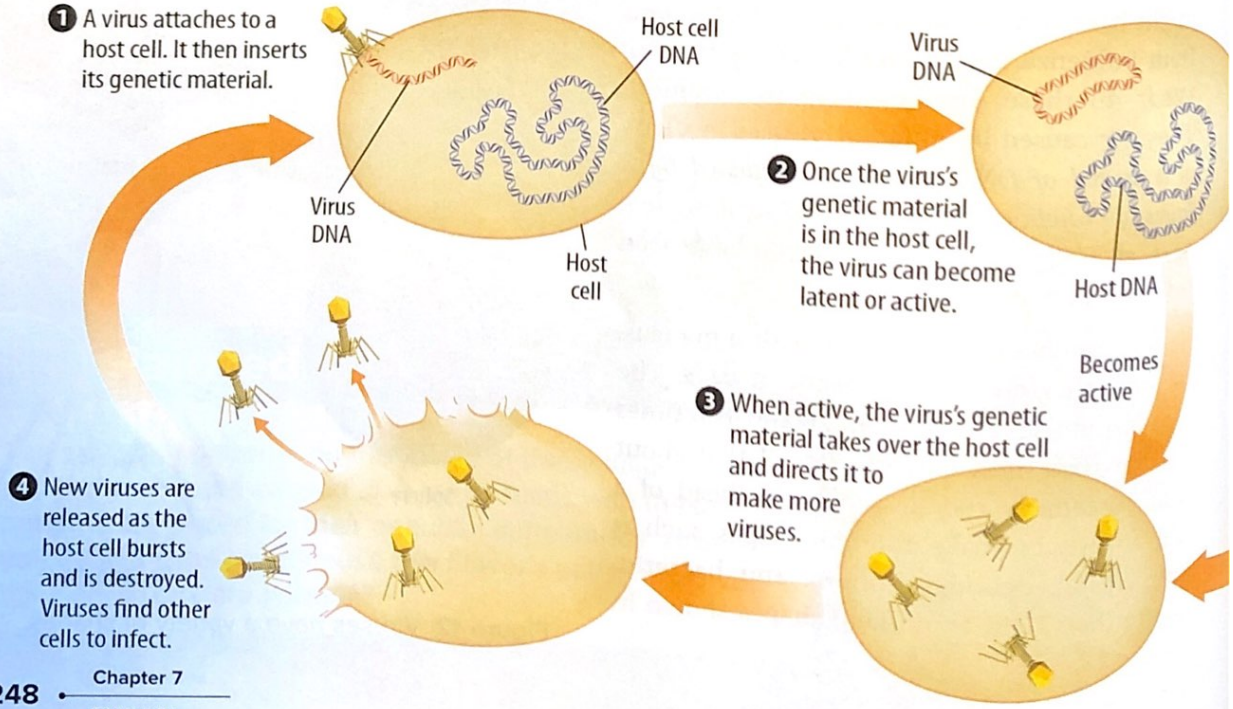
When a virus enters a cell, as shown in **Figure 13,** it can either be active or latent. Latent viruses go through an inactive stage. Their genetic material becomes part of the host cell's genetic material. For a period of time, the virus does not take over the cell to produce more viruses. In some cases, viruses have been known to be inactive for years and years. However, once it becomes active, a virus takes control of the host cell and replicates.

Figure 13 A virus infects a cell by inserting its DNA or RNA into the host cell. It then directs the host cell to make new viruses.

Visual Check What occurs when a virus becomes latent?

Viral Replication

Animation



Replication

As you read earlier, a virus can make copies of itself in a process called replication, shown in **Figure 13.** A virus cannot infect every cell. A virus can only attach to a host cell with specific molecules on its cell wall or cell membrane. These molecules enable the virus to attach to the host cell. This is similar to the way that only certain electrical plugs can fit into an outlet on a wall. After a virus attaches to the host cell, its DNA or RNA enters the host cell. Once inside, the virus either starts to replicate or becomes latent, also shown in **Figure 13.** After a virus becomes active and replicates in a host cell, it destroys the host cell. Copies of the virus are then released into the host organism, where they can infect other cells.

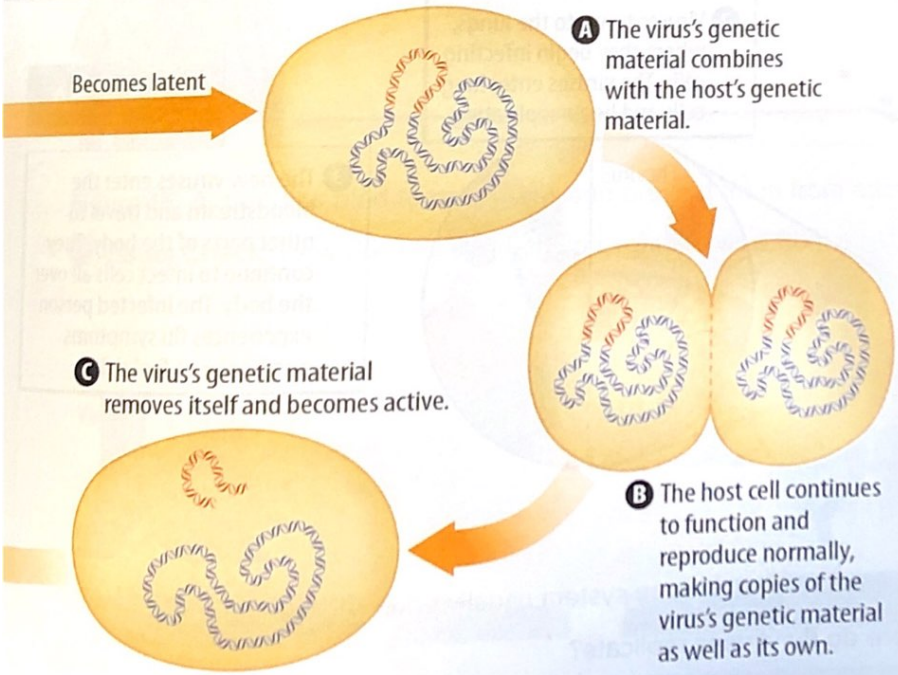
Mutations

As viruses replicate, their DNA or RNA frequently mutates, or changes. These **mutations** enable viruses to adjust to changes in their host cells. For example, the molecules on the outside of host cells change over time to prevent viruses from attaching to the cell. As viruses mutate, they are able to produce new ways to attach to host cells. These changes happen so rapidly that it can be difficult to cure or prevent viral diseases before they mutate again.

Reading Check How does mutation enable viruses to continue causing disease?

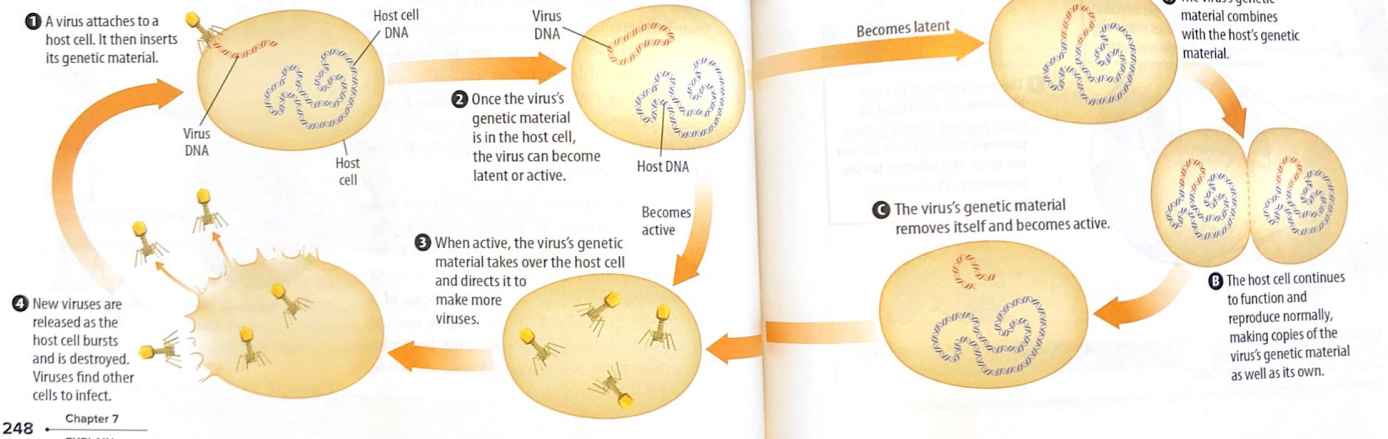
REVIEW VOCABULARY

mutation
a change in genetic material



Viral Replication

Animation



Viral Diseases

You might know that viruses cause many human diseases, such as chicken pox, influenza, some forms of pneumonia, and the common cold. But viruses also infect animals, causing diseases such as rabies and parvo. They can infect plants as well–in some cases causing millions of dollars of damage to crops. The tulips shown at the beginning of this lesson were infected with a virus that caused a streaked appearance on the petals. Most viruses attack and destroy specific cells. This destruction of cells causes the symptoms of the disease.

Some viruses cause symptoms soon after infection. Influenza viruses that cause the flu infect the cells lining your respiratory system, as shown in **Figure 14.** The viruses begin to replicate immediately. Flu symptoms, such as a runny nose and a scratchy throat, usually appear within 2-3 days.

Other viruses might not cause symptoms right away. These viruses are sometimes called latent viruses. Latent viruses continue replicating without damaging the host cell. HIV (human immunodeficiency virus) is one example of a latent virus that might not cause immediate symptoms.

HIV infects white blood cells, which are part of the immune system. Initially, infected cells can function normally, so an HIV-infected person might not appear sick. However, the virus can become active and destroy cells in the body's immune system, making it hard to fight other infections. It can often take a long time for symptoms to appear after infection. People infected with latent viruses might not know for many years that they have been infected.

Reading Check Why is HIV considered a latent virus?

The Flu

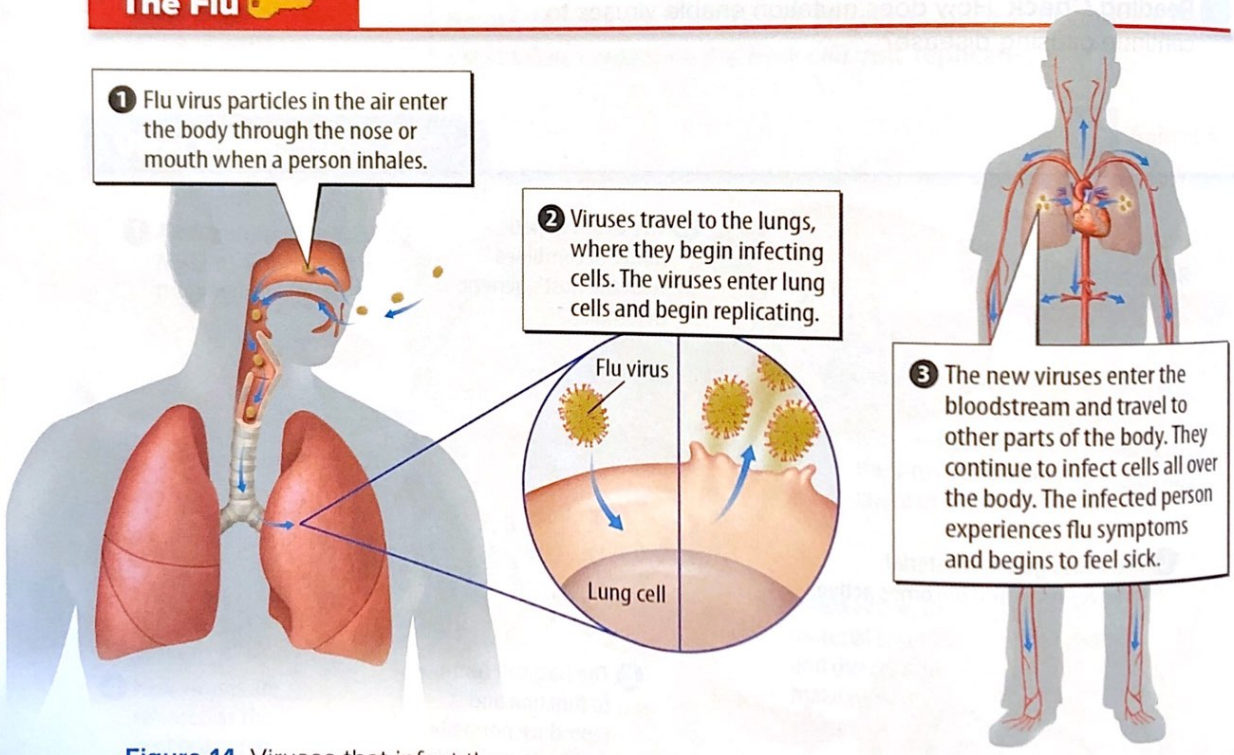


Figure 14 Viruses that infect the respiratory system usually enter through the nose or mouth.

Visual Check Where do flu viruses replicate?

Treating and Preventing Viral Diseases

Since viruses are constantly changing, viral diseases can be difficult to treat. Antibiotics work only against bacteria, not viruses. Antiviral medicines can be used to treat certain viral diseases or prevent infection. These medicines prevent the virus from entering a cell or stop the virus from replicating. Antiviral medicines are specific to each virus. Like bacteria, viruses can rapidly change and become resistant to medicines.

Health officials use many methods to prevent the spread of viral diseases. One of the best ways to prevent a viral infection is to limit contact with an infected human or animal. The most important way to prevent infections is to practice good hygiene, such as washing your hands.

Immunity

Has anyone you know ever had chicken pox? Did they get it more than once? Most people who became infected with chicken pox develop an immunity to the disease. This is an example of acquired **immunity**. When a virus infects a person, his or her body begins to make special proteins called antibodies. An **antibody** *is a protein that can attach to a pathogen and make it useless.* Antibodies bind to viruses and other pathogens and prevent them from attaching to a host cell, as shown in **Figure 15.** The antibodies also target viruses and signal the body to destroy them. These antibodies can multiply quickly if the same pathogen enters the body again, making it easier for the body to fight infection. Another type of immunity, called natural immunity, develops when a mother passes antibodies on to her unborn baby.

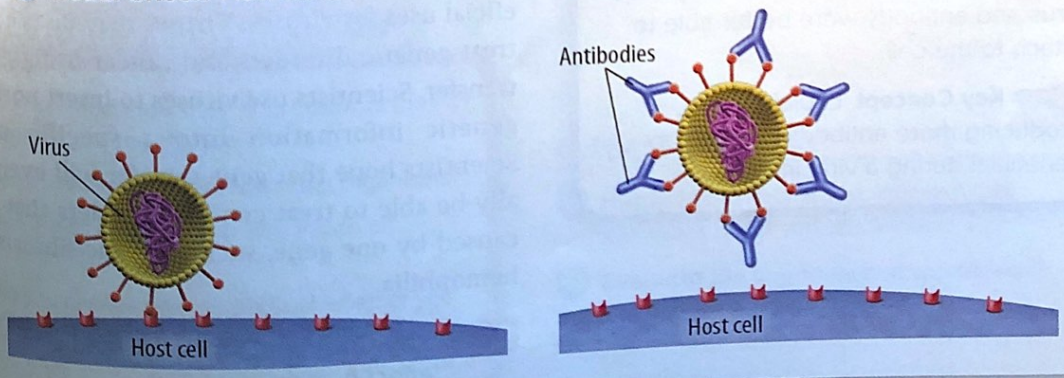
WORD ORIGIN

immunity
from Latin *immunis,* means "exempt, free"

Antibodies

Figure 15 Antibodies bind to pathogens and prevent them from attaching to cells.

Visual Check How does the antibody prevent the virus from attaching to the host cell?



MiniLab 20 minutes

How do antibodies work?

When a virus infects a cell it binds to part of that cell called a receptor. The virus and the receptor fit together like puzzle pieces.

1. Read and complete a lab safety form.
2. Cut out two **virus shapes** and two **cell shapes.**
3. Using one virus shape and one cell shape, note how the virus fits against the receptor on the cell. **Tape** the virus and the cell together.
4. Cut out one **antibody shape.** Note how the virus shapes and the antibody shapes attach and tape them together.
5. Try to attach the virus shapes and the antibody shapes you just joined to the cell receptor.

Analyze and Conclude

1. **Observe** whether the virus or the joined virus and antibody were better able to attach to the cell.
2. **Key Concept** Explain how producing more antibodies would be beneficial during a viral infection.

Vaccines

One way to prevent viral diseases is through vaccination. *A* **vaccine** *is a mixture containing material from one or more deactivated pathogens, such as viruses.* When an organism is given a vaccine for a viral disease, the vaccine triggers the production of antibodies. This is similar to what would happen if the organism became infected with the virus normally. However, because the vaccine contains deactivated pathogens, the organism suffers only mild symptoms or none at all. After being vaccinated against a particular pathogen, the organism will not get as sick if exposed to the pathogen again.

Vaccines can prevent diseases in animals as well as humans. For example, pet owners and farmers get annual rabies vaccinations for their animals. This protects the animals from the disease. Humans are then protected from rabies.

Research with Viruses

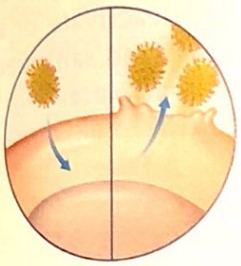
Scientists are researching new ways to treat and prevent viral diseases in humans, animals, and plants. Scientists are also studying the link between viruses and cancer. Viruses can cause changes in a host's DNA or RNA, resulting in the formation of tumors or abnormal growth. Because viruses can change very quickly, scientists must always be working on new ways to treat and prevent viral diseases.

You might think that all viruses are harmful. However, scientists have also found beneficial uses for viruses. Viruses may be used to treat genetic disorders and cancer using gene transfer. Scientists use viruses to insert normal genetic information into a specific cell. Scientists hope that gene transfer will eventually be able to treat genetic disorders that are caused by one gene, such as cystic fibrosis or hemophilia.

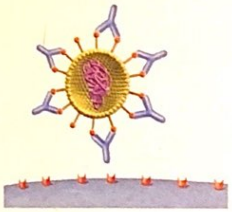
Key Concept Check How do viruses affect human health?

Visual Summary

A virus is a strand of DNA or RNA surrounded by a layer of protein.



Viruses cause human diseases such as chicken pox and influenza.



A person's body produces proteins called antibodies that prevent an infection by viruses.

FOLDABLES®

Use your lesson Foldable to review the lesson. Save your Foldable for the project at the end of the chapter.

What do you think NOW?

You first read the statements below at the beginning of the chapter.

5. Viruses are the smallest living organisms.

6. Viruses can replicate only inside an organism.

Did you change your mind about whether you agree or disagree with the statements? Rewrite any false statements to make them true.

Use Vocabulary

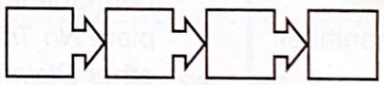
1. **List** the different shapes a virus can have.
2. **Describe** in your own words how a vaccine works.
3. **Use the term** *antibodies* in a sentence.

Understand Key Concepts

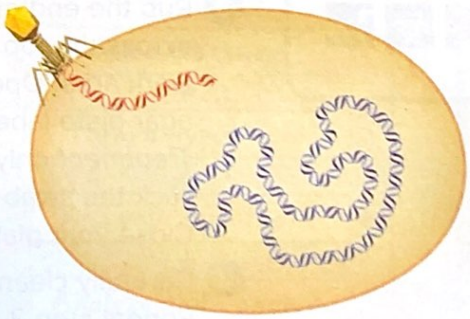
4. **Describe** the structure of a virus.
5. Which is made by the body to fight viruses?
   - **A.** antibody
   - **B.** bacteria
   - **C.** bacteriophage
   - **D.** proteins
6. **Classify** a virus as a living or nonliving thing. Explain your answer.
7. **Compare** a vaccine and an antibody.

Interpret Graphics

8. **Draw** a graphic organizer like the one below including the steps that occur when a virus infects a cell.



9. **Describe** what happens during this step of viral replication.



Critical Thinking

10. **Predict** the effect of preventing future mutations of the influenza virus.
11. **Evaluate** the importance of vaccines in keeping people healthy.