

## Chapter 19: Viruses

**19.1** *Describe a virus.*

**19.2** *Explain how viruses replicate and evolve.*

**19.3** *Use examples to illustrate the effects of animal and plant viruses, as well as prions, on their hosts.*

Besides the impact of viruses on human health, early experimental work with viruses provided important evidence that the genetic material was DNA. Viruses were also important in working out the molecular mechanisms of DNA replication, transcription, and translation and in the development of techniques for manipulating and transferring genes. As you learn about viruses in this chapter, you will build on the foundation necessary for an understanding of the molecular techniques of biotechnology. The role of viruses in horizontal gene transfer is significant in increasing genetic variation in many species.

**Study Tip:** The opening chapter figure gives a simplified view of viral reproduction. Read through it slowly and you will have the big picture to which you can add details throughout the chapter.

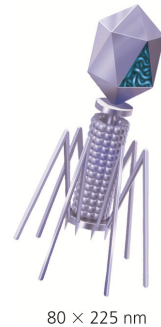
**Concept 19.1** *A virus consists of a nucleic acid surrounded by a protein coat*

**LO 19.1:** *Describe a virus.*

1. What was some early evidence of the existence of viruses? Why were they difficult to study?
2. What are the four forms of viral genomes?
3. What is a *capsid*? What different shapes may capsids have?
4. As you can see, all viruses consist of a nucleic acid enclosed in a protein coat. Some viruses also have a membranous envelope. What are the components of a *viral envelope*? Which component is derived from the host cell, and which is of viral origin?

Viral Envelope Component	Derived from Host or Virus?

5. What is the role of an *envelope* in animal viruses?
6. For the virus shown in the figure on the right, label the *protein capsid*, *tail fibers*, *head*, *tail sheath*, and *genome*.
  - a. What type of virus is this?
  - b. What does its name mean?
  - c. What is its host?
  - d. Is the genome of this virus DNA or RNA?



**Concept 19.2** *Viruses replicate only in host cells*

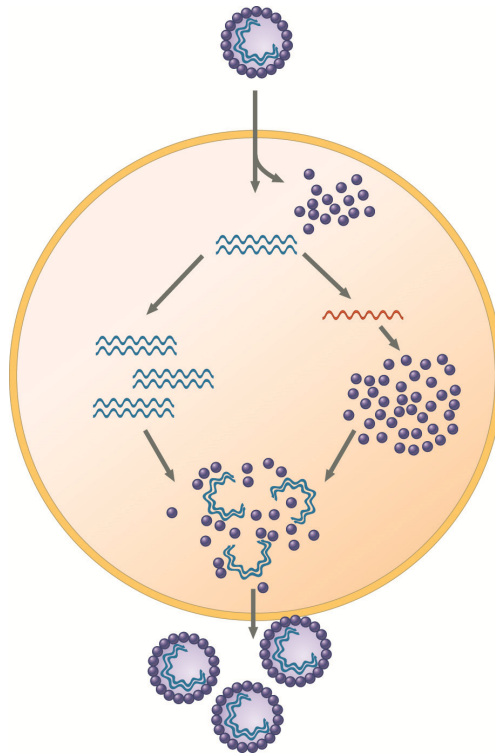
**LO 19.2:** *Explain how viruses replicate and evolve.*

7. What property of a virus determines its attachment to a host cell membrane?
8. Viruses are *obligate intracellular parasites*. What does this mean?
9. What is meant by *host range*? Distinguish between a virus with a broad host range and one with an extremely limited host range and give an example of each.
10. Compare the *host range* for the rabies virus to that of the human cold virus.
11. What components of the host cell does a virus use to reproduce itself?
12. How does a DNA virus reproduce its genome?
13. How do most RNA viruses replicate their genomes?

**Study Tip**

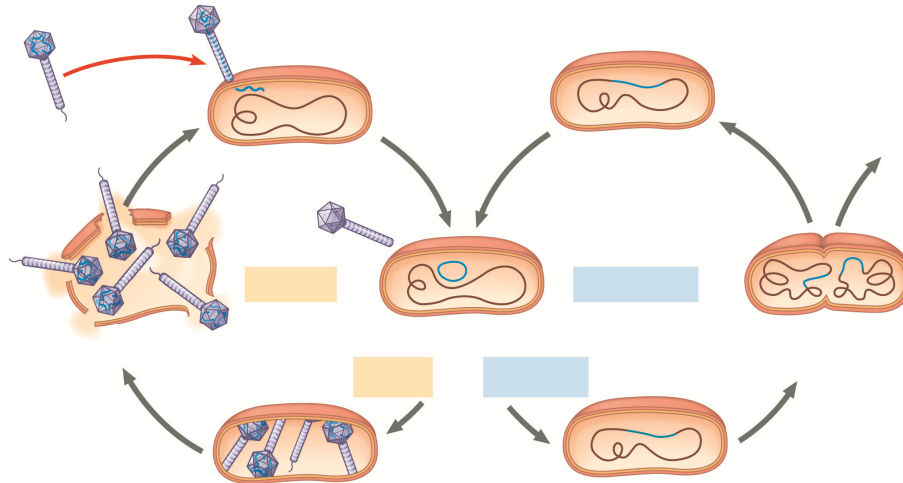
It is important to realize that many viruses have an RNA genome and therefore a high rate of mutation. Earlier you learned about the mechanisms of DNA repair that minimize mutation rates, but RNA replication lacks these repair enzymes.

14. On this figure of a simplified viral reproductive cycle, label the arrows to show these processes: *transcription*, *translation*, *infection*, *replication*, and *self-assembly*. Annotate your labels to explain the process of viral reproduction.



15. What are *bacteriophages*? Distinguish between *virulent* and *temperate* phages.
16. What portion of a phage enters the host cell? How does it do this?
17. What is a *prophage*?

18. Because cells that have incorporated phage DNA into their genome may continue to divide and propagate the viral genome, this might be considered somewhat like the Trojan horse. What might trigger the switchover from *lysogenic* to *lytic* mode?
19. Label these elements of the following figure: *lysogenic phage*, *lysogenic cycle*, *lytic cycle*, *prophage*, *phage DNA*, *bacterial chromosome*, and *self-assembly*.

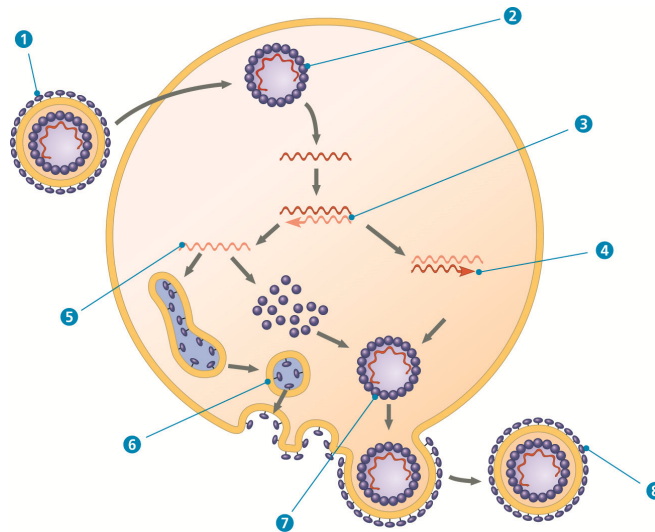


20. Describe the *lytic* and *lysogenic* modes of bacteriophage reproduction.
  - a. lytic cycle
  - b. lysogenic cycle

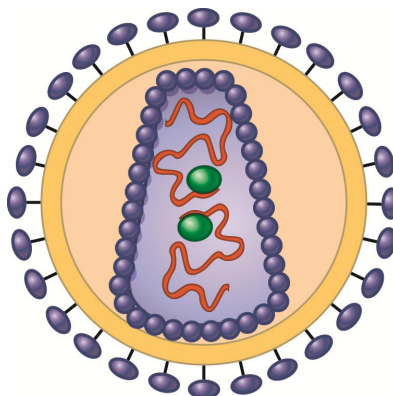
### Bacterial Defenses Against Phages

21. What are *restriction enzymes*? How do they help prevent viral infections of bacteria?
22. Why don't restriction enzymes destroy the DNA of the bacterial cells that produce them?
23. What are three ways bacteria may win the battle against the phages?
24. The CRISPR-Cas system was discovered when puzzling palindromic DNA repeats were found in the genomes of bacteria. These were found to be remnants from earlier phage infections, and it was learned that bacteria have nucleases (called Cas proteins) for cutting this phage DNA if it is encountered again. What happens when a phage infects a bacterial cell with the CRISPR-Cas system?

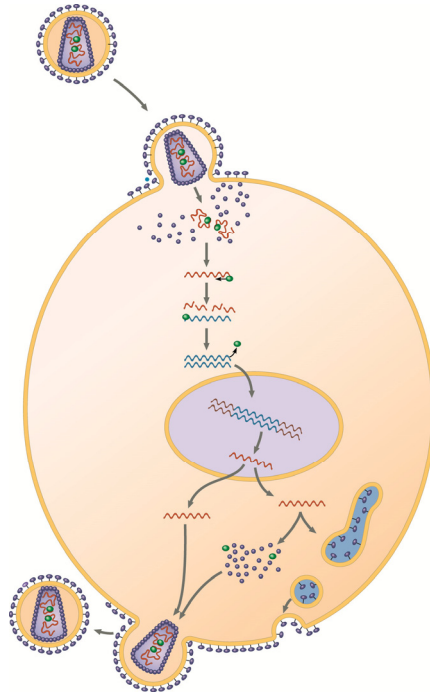
25. Study Figure 19.7 in your text. How does the bacterial cell identify the phage DNA when it is encountered? What happens to the phage DNA?
26. What are two viral elements that nearly all animal viruses have?
27. The infection of an animal cell by an RNA virus with an envelope is shown in this figure. In this viral infection the RNA genome serves as a template for mRNA synthesis. This is the pattern of infection for COVID-19, Ebola, influenza, measles, mumps, and rabies. Label this figure, and summarize the eight steps of infection as indicated by the label lines.



28. What is a *retrovirus*? How do retroviruses, such as HIV, replicate their genome?
29. Here is a sketch of HIV. Label these parts: *viral envelope*, *reverse transcriptase*, *RNA*, and *capsid*.



30. Figure 19.9 in your text shows the infection of a cell by HIV. Draw the label lines and explain what occurs at each of the 12 steps of the infectious process.



31. Compare and contrast a *prophage* and a *provirus*. Which one are *you* likely to carry?

### Evolution of Viruses

32. Describe the two possible sources of viral genomes. You will see each of these important *mobile genetic elements* again.

Possible Source	Description of the Mobile Genetic Element
Plasmids	
Transposons	

**Concept 19.3** *Viruses and prions are formidable pathogens in animals and plants*

**LO 19.3:** *Use examples to illustrate the effects of animal and plant viruses, as well as prions, on their hosts.*

**Study Tip**

Virtually every student in the United States and throughout most other countries in the world was affected by the closure of schools, social distancing, isolation, loss of life and economic upheaval that resulted from the emergence of COVID-19. Concept 19.3 will help you to understand the biology behind this emergent viral disease. The Scientific Skills Exercise describes how mutations in viruses allow scientists to track transmission of the disease. Although the exercise deals with the H1N1 influenza pandemic, these techniques were also used to track COVID-19

33. What are three ways that viruses make us ill? Why do we recover completely from a cold but not from polio?
34. What tools are in the medical arsenal against human viral diseases?
35. In late December 2019, COVID-19 arose in China and spread worldwide to become a pandemic. This and other *emerging viruses* such as HIV, Ebola, SARS, Chikungunya, and Zika seem to burst upon the human scene. Explain the three processes that contribute to the sudden emergence of viral diseases.
  - a.
  - b.
  - c.
36. The 2009 flu *pandemic* was caused by *H1N1*. The 2019-2020 COVID-19 pandemic was caused by a novel coronavirus, SARS-CoV. What is a pandemic? What does the name of the *H1N1* signify?

37. Explain what is meant by *vertical transmission* and *horizontal transmission* of plant viruses.
38. How do viruses spread throughout plant bodies?
39. Mad cow disease and chronic wasting disease (seen in deer and elk) are both caused by *prions*. Twenty years ago, an outbreak of mad cow disease in Europe led to widespread testing and a shift of consumer meat preferences, at the time, away from beef or consumption of imported beef. What are prions? How are they transmitted? What do they do?
40. Name four diseases caused by prions and two possible neurodegenerative diseases that may involve prions.
41. What are two alarming characteristics of prions?

*Test Your Understanding*, p. 414

Now you should be ready to test your knowledge. Place your answers here:

1. \_\_\_\_\_ 2. \_\_\_\_\_ 3. \_\_\_\_\_ 4. \_\_\_\_\_ 5. \_\_\_\_\_