

Name Key Period \_\_\_\_\_

## Chapter 19: Viruses

### Overview

Experimental work with viruses has provided important evidence that genes are made of nucleic acids. Viruses were also important in working out the molecular mechanisms of DNA replication, transcription, and translation. Viruses have been important in the development of techniques of 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.

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

1. What was some early evidence of the existence of viruses? Why were they difficult to study?  
*Tobacco mosaic disease cause not being microbial*  
*Size - 20 nm in diameter*
2. What was Wendell Stanley's contribution to our knowledge of viruses?  
*Crystallized the virus visible*
3. What are the four forms of viral genomes?  
*ds DNA*  
*ss DNA*  
*ds RNA*  
*ss RNA*
4. What is a capsid? What are capsomeres? What different shapes may capsids have?  
*capsid: protein shell enclosing the viral genome*  
*capsomere: single protein subunit of a capsid*  
*helical, icosahedral, helical, icosahedral head + tail*
5. As you 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 Component	Derived From
<i>proteins</i>	<i>host cell</i>
<i>phospholipids</i>	<i>host cell</i>

6. What is the role of an *envelope* in animal viruses?

protection - help virus avoid the host immune system; help identify & bind to host membrane

7. For the virus shown below, label the *protein capsid*, *tail fibers*, *head*, *tail sheath*, and *genome*.

- a. What type of virus is this?

bacteriophage

- b. What does its name mean?

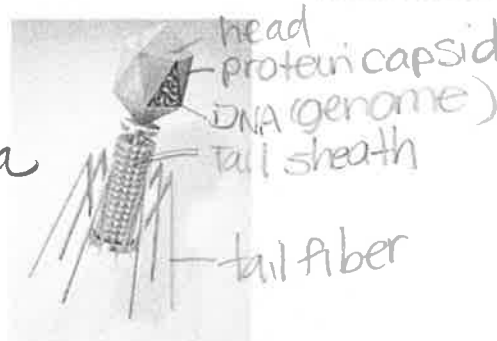
viruses that infect bacteria

- c. What is its host?

bacteria

- d. Is the genome of this virus DNA, or RNA?

DNA



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

8. What property of a virus determines its attachment to a host cell membrane?

lock + key fit between viral surface proteins + specific receptor molecules

9. Viruses are *obligate intracellular parasites*. What does this mean?

A parasite that doesn't only rely on host for nutrition, but also for reproduction

10. 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.

limited # of host species that a virus can infect

Broad: west nile virus, equine encephalitis virus  
(infect = mosquitoes, birds, horses + humans)

Narrow: Measles virus - humans

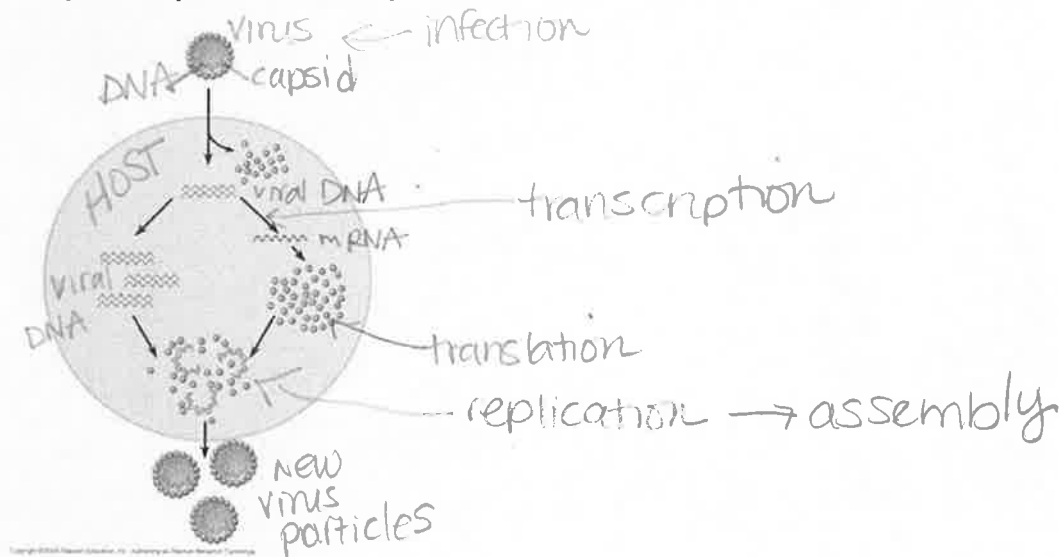
11. Compare the *host range* for the rabies virus to that of the human cold virus.

rabies virus: many species - human, mammals  
human cold virus - infects cells lining the upper respiratory tract

12. What components of the host cell does a virus use to reproduce itself?

use the DNA or RNA polymerases of the cell to replicate their genomes

13. How does a DNA virus reproduce its genome?  
Gets the DNA polymerase of the host cell to synthesize new genomes
14. How do most RNA viruses replicate their genome?  
use virally encoded RNA polymerases to replicate their genomes
15. On this figure of a simplified viral reproductive cycle, label arrows to show these processes: *transcription, translation, infection, replication, and self-assembly*. Annotate your labels to explain the process of viral reproduction.



16. What are *bacteriophages*? Distinguish between *virulent* and *temperate* phages.  
viruses that infect bacteria  
virulent - virus that replicates only by the lytic cycle  
temperate - virus that replicates by lytic or lysogenic cycle
17. What portion of a phage enters the host cell? How does it do this?  
only the genetic material  
bacteriophage binds to receptor, injects DNA into the cell
18. What are *restriction enzymes*? What is their role in bacteria?  
cellular enzymes that cut up the phage DNA  
restricts the ability of the phage to infect the bacterium

19. Why don't restriction enzymes destroy the DNA of the bacterial cells that produce them?

Because the bacterial cells own DNA is methylated in a way that prevents attack by its own restriction

20. What are three ways bacteria may win the battle against the phages?

enzymes  
(1) natural selection favors bacterial mutants w receptors that are no longer recognized by a particular type of phage  
(2) viral DNA often identified by foreign + cut up by restriction enzymes  
(3) most phages don't lyse their hosts

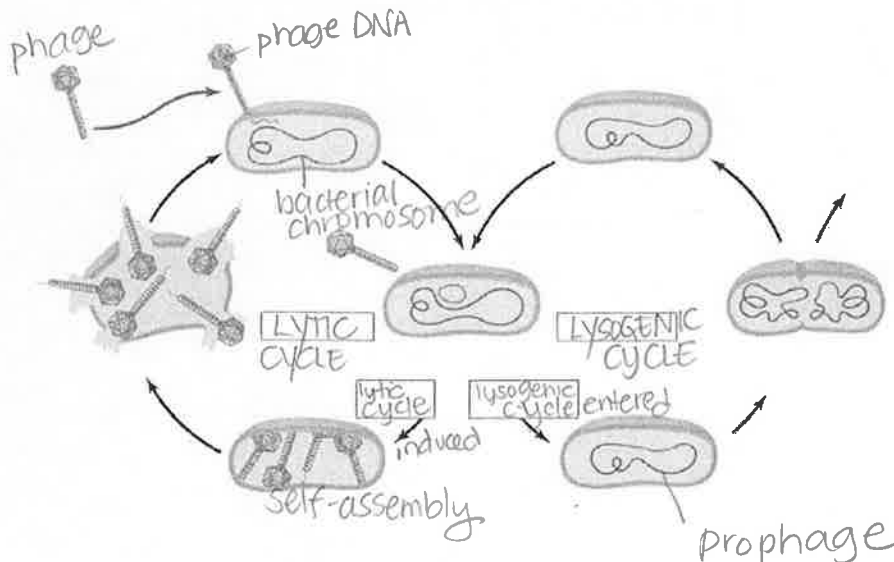
21. What is a prophage?

Viral DNA has been integrated into the bacterial chromosome

22. Since 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?

Environmental signal - certain chemical or high-energy radiation

23. Label the following elements of the figure below: *lysogenic phage*, *lysogenic cycle*, *lytic cycle*, *prophage*, *phage DNA*, *bacterial chromosome*, and *self assembly*.



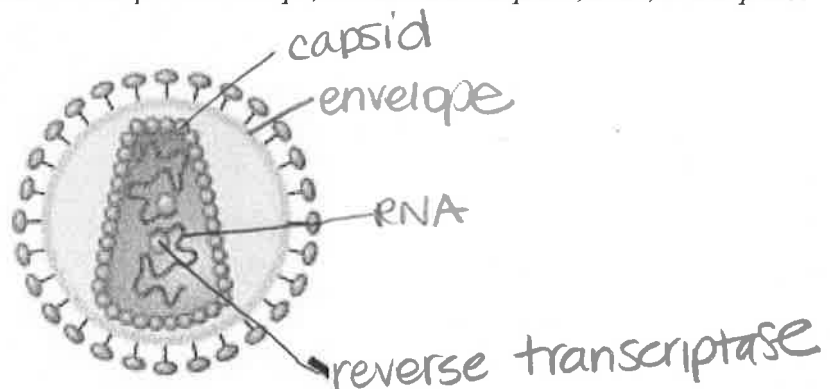
24. Describe the *lytic* and *lysogenic* modes of bacteriophage reproduction.  
lytic - a phage replication cycle that ends in death of the host cell  
lysogenic - a cycle which allows replication of the phage genome without destroying the host
25. There are some general differences between bacteriophages and animal viruses. What are two elements that nearly all animal viruses have?

animal viruses - envelope  
RNA genome

26. What is a *retrovirus*? How do retroviruses, such as HIV, replicate their genome?

contain reverse transcriptase  
transcribes RNA template into DNA

27. Here is a sketch of HIV. Label these parts: *envelope*, *reverse transcriptase*, *RNA*, and *capsid*.



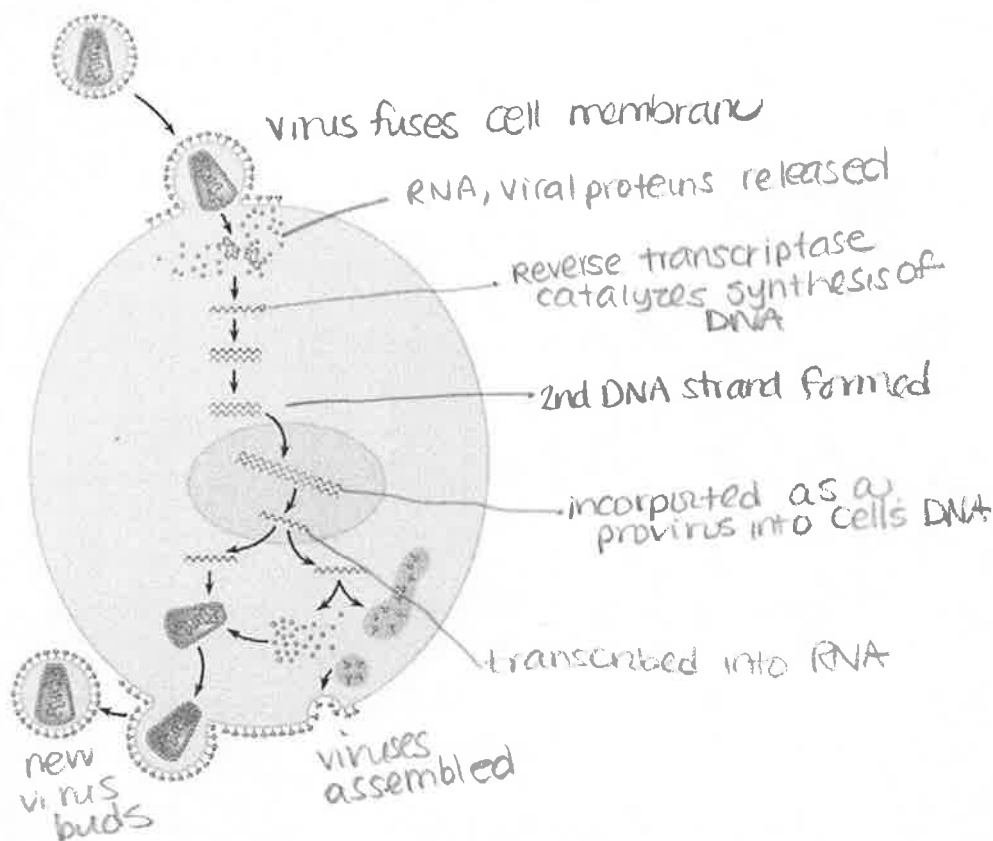
28. Compare and contrast a *prophage* and a *provirus*. Which one are you likely to carry?

leaves the host cell at the start of the lytic cycle

never leaves host's genome: permanent cell resident

provirus

29. This sketch shows the infection of a cell by HIV. Extend label lines to give a complete explanation of the process. Refer to your text Figure 19.8 for details.



30. The final section in this concept is titled "Evolution of Viruses." From this part, describe the two possible sources of viral genomes. You will see each of these important *mobile genetic elements* again.

	Description of the Mobile Genetic Element
<b>Plasmids</b>	small circular bacterial DNA - can exist apart from cell's genome, replicate independently + transfer to another location
<b>Transposons</b>	DNA segments that can move from one location to another within a cell's genome

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

31. What are three ways that viruses make us ill? Why do we recover completely from a cold but not from polio?
1. kill cells by causing the release of hydrolytic enzymes
  2. cause infected cells to produce toxins that lead to disease symptoms
  3. some have toxic molecular components - envelope proteins
32. What tools are in the medical arsenal against human viral diseases?
- antiviral drugs that resemble nucleosides and interfere with viral nucleic acid synthesis
33. Emerging viruses such as HIV, Ebola, and SARS seem to burst upon the human scene. What are three processes that contribute to this sudden emergence?
1. mutation of existing viruses
  2. dissemination of a viral disease from a small isolated human population.
  3. spread of existing viruses from other animals
34. The current flu pandemic is H1N1. What does this name mean?
- H1N1 - Hemagglutinin  
Neuraminidase
35. Distinguish between horizontal transmission and vertical transmission in plants.
1. horizontal - plant is infected from an external source
  2. vertical - plant inherits virus from a parent
36. How do viruses spread throughout plant bodies?
- plasmodesmata - cytoplasmic connections that penetrate plant cell walls
37. What is a viroid? What important lesson do they teach? Name one viroid disease.
- circular RNA molecules - single molecule can be an infectious agent that spreads a disease  
cadang-cadang - coconut palm disease

38. Prions strike fear into carnivores everywhere. What are they? How are they transmitted? What do they do?

- infectious proteins
- transmitted by food
- prion is a misfolded protein - converts normal proteins to misfolded → aggregate

39. Name four diseases caused by prions.

1. scrapie (sheep)
2. mad cow disease
3. Creutzfeldt - Jakob
4. Kuru

40. What are two alarming characteristics of prions?

1. Lengthy incubation period
2. No effective treatment

41. Two Nobel Prizes have been awarded for the study of prions. One went to Carlton Gadjusek, who worked with the Fore people of Papua New Guinea in the 1960s to determine the cause of a kuru epidemic. Who got the second Nobel Prize in this area, and when?

Stanley Prusiner - 1997

*Testing Your Knowledge: Self-Quiz Answers*

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

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