CHAPTER 18
MICROBIAL MODELS: THE GENETICS OF VIRUSES AND BACTERIA

OUTLINE
I. The Genetics of Viruses
   A. Researchers discovered viruses by studying a plant disease: science as a process
   B. A virus is a genome enclosed in a protective coat.
   C. Viruses can reproduce only within a host cell: an overview
   D. Phages reproduce using lytic or lysogenic cycles
   E. Animal viruses are diverse in their modes of infection and of replication
   F. Plant viruses are serious agricultural pests
   G. Viroids and prions are infectious agents even simpler than viruses
   H. Viruses may have evolved from other mobile genetic elements

II. The Genetics of Bacteria
   A. The short generation span of bacteria facilitates their evolutionary adaptation to changing environments
   B. Genetic recombination produces new bacterial strains
   C. The control of gene expression enables individual bacteria to adjust their metabolism to environmental change

SUMMARY
Researchers discovered viruses by studying a plant disease.
A virus is a genome enclosed in a protective coat.
Viruses can reproduce only within a host cell.
Phages reproduce using lytic or lysogenic cycles.
Animal viruses are diverse in their modes of infection and replication.
Plant viruses are serious agricultural pests.
Viroids and prions are infectious agents even simpler than viruses
Viruses may have evolved from other mobile genetic elements.
The short generation span of bacteria facilitates their evolutionary adaptation to changing environments
Genetic recombination produces new bacterial strains.
The control of gene expression enables just their metabolism to environmental change.

OBJECTIVES
After reading this chapter and attending lecture, the student should be able to:

1. Recount the history leading up to the discovery of viruses and discuss the contributions of A. Mayer, D. Ivanowsky, Martinus Beijerinck, and Wendell Stanley.

2. List and describe structural components of viruses.

3. Explain why viruses are obligate parasites.

4. Describe three patterns of viral genome replication.

5. Explain the role of reverse transcriptase in retroviruses.

6. Describe how viruses recognize host cells.

7. Distinguish between lytic and lysogenic reproductive cycles using phage T4 and phage λ as examples.

8. Outline the procedure for measuring phage concentration in a liquid medium.
9. Describe several defenses bacteria have against phage infection.

10. Using viruses with envelopes and RNA viruses as examples, describe variations in replication cycles of animal viruses.

11. Explain how viruses may cause disease symptoms, and describe some medical weapons used to fight viral infections.

12. List some viruses that have been implicated in human cancers, and explain how tumor viruses transform cells.

13. Distinguish between horizontal and vertical routes of viral transmission in plants.

14. List some characteristics that viruses share with living organisms, and explain why viruses do not fit our usual definition of life.

15. Provide evidence that viruses probably evolved from fragments of cellular nucleic acid.


17. Describe the process of binary fission in bacteria, and explain why replication of the bacterial chromosome is considered to be semiconservative.

18. List and describe the three natural processes of genetic recombination in bacteria.

19. Distinguish between general transduction and specialized transduction.

20. Explain how the F plasmid controls conjugation in bacteria.


22. For donor and recipient bacterial cells, predict the consequences of conjugation between the following: 1) F+ and F− cell, 2) Hfr and F− cell.

23. Define transposon, and describe two essential types of nucleotide sequences found in transposon DNA.

24. Distinguish between an insertion sequence and a complex transposon.

25. Describe the role of transposase and DNA polymerase in the process of transposition.

26. Explain how transposons can generate genetic diversity.

27. Briefly describe two main strategies cells use to control metabolism.

28. Explain why grouping genes into an operon can be advantageous.

29. Using the trp operon as an example, explain the concept of an operon and the function of the operator, repressor, and corepressor.

30. Distinguish between structural and regulatory genes.

31. Describe how the lac operon functions and explain the role of the inducer allolactose.
32. Explain how repressible and inducible enzymes differ and how these differences reflect differences in the pathways they control.

33. Distinguish between positive and negative control, and give examples of each from the lac operon.

34. Explain how CAP is affected by glucose concentration.

35. Describe how E. coli uses the negative and positive controls of the lac operon to economize on RNA and protein synthesis.