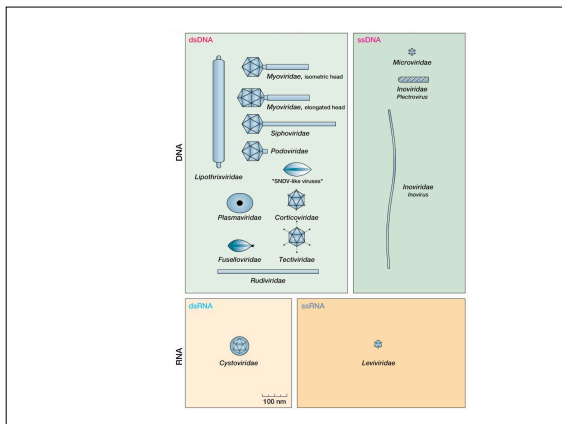


Chapter 17

The Viruses: Bacteriophages

Classification of Bacteriophages

- based on two major criteria
 - phage morphology
 - nucleic acid properties

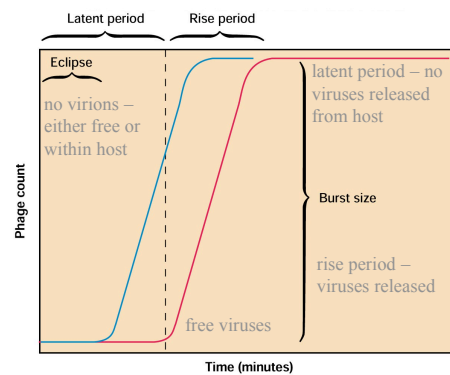


Reproduction of Double-Stranded DNA Phages: The Lytic Cycle

- lytic cycle
 - phage life cycle that culminates with host cell bursting, releasing virions
- virulent phages
 - phages that lyse their host during the reproductive cycle

The One-Step Growth Experiment

- mix bacterial host and phage
 -
- brief incubation (attachment occurs)
 -
- dilute greatly (released viruses can't infect new cells)
 -
- over time, collect sample and enumerate viruses



Focus on T4 replication

- complex process
- highly regulated
 - some genes expressed early
 - some genes expressed late
- early genes and late genes clustered separately

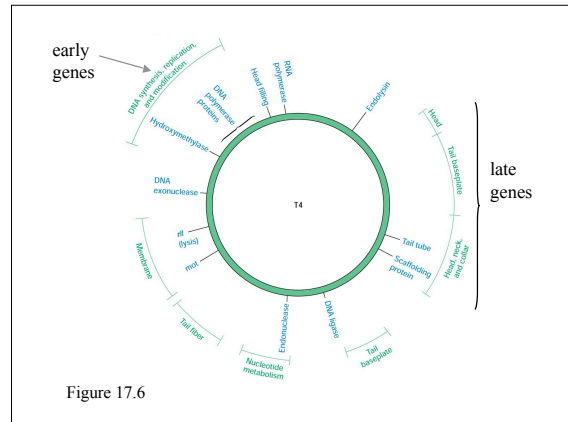


Figure 17.6

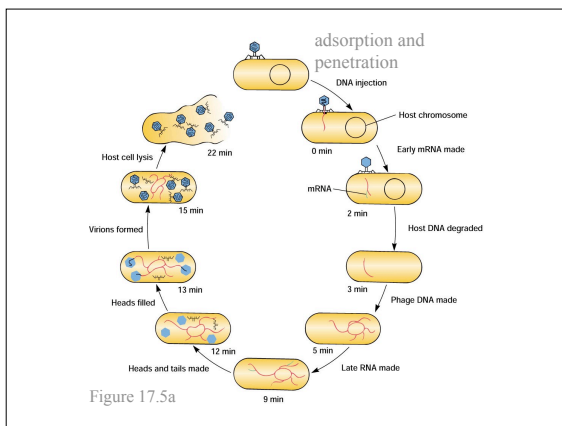
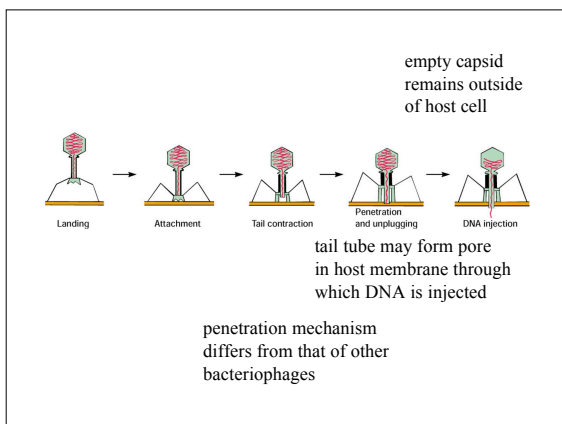


Figure 17.5a

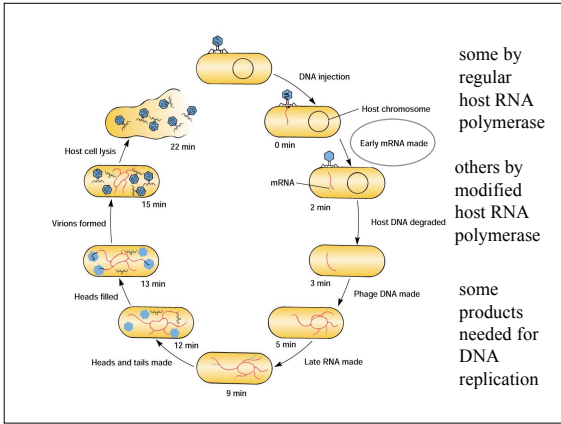
Adsorption to the Host Cell and Penetration

- receptor sites
 - specific surface structures on host to which viruses attach
 - specific for each virus
 - can be proteins, lipopolysaccharides, teichoic acids, etc.



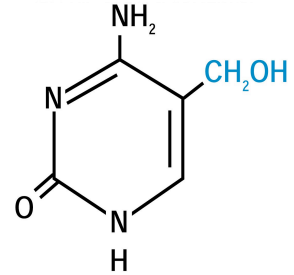
Synthesis of Phage Nucleic Acids and Proteins

- sequential process
 - early mRNA synthesis
 - synthesis of proteins that enable T4 to take over host cell
 - phage DNA replication
 - late mRNA synthesis
 - encode capsid proteins and other proteins needed for phage assembly



Synthesis of T4 DNA

- contains hydroxymethylcytosine (HMC) instead of cytosine
 - synthesized by two phage encoded enzymes
- then HMC glucosylated

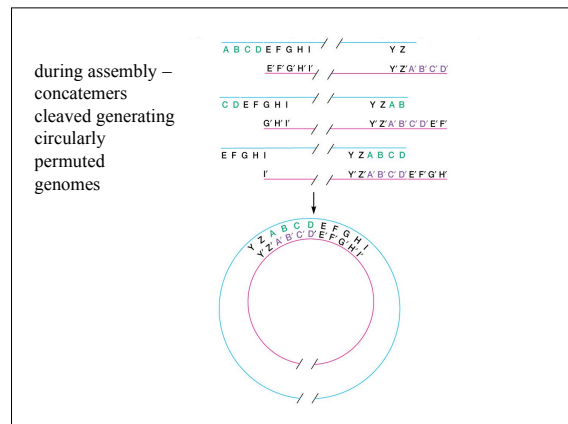
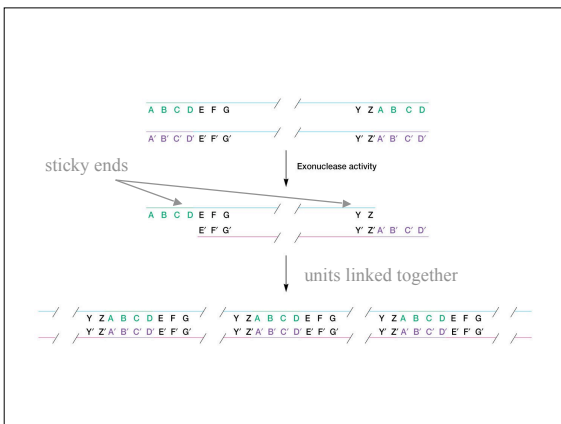


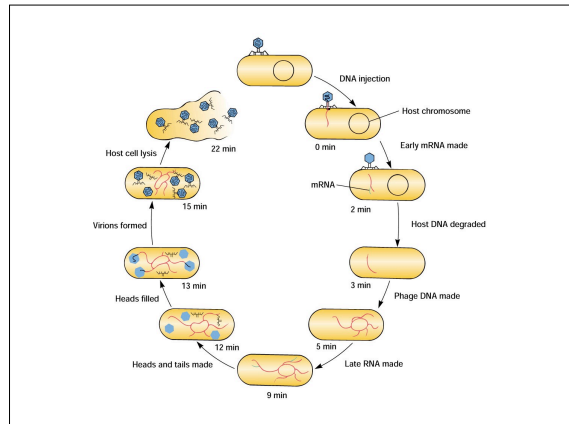
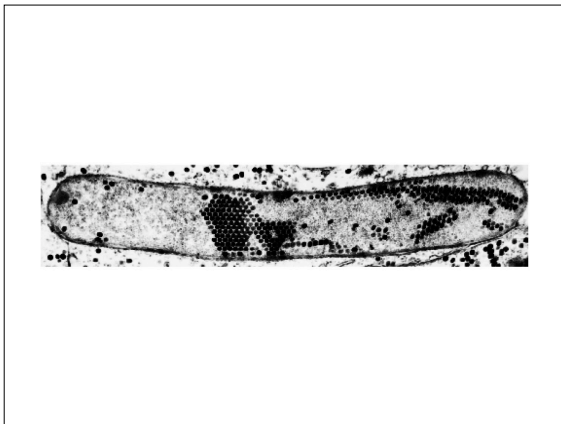
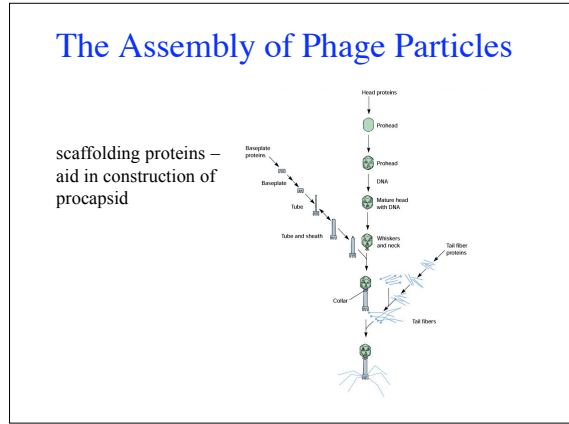
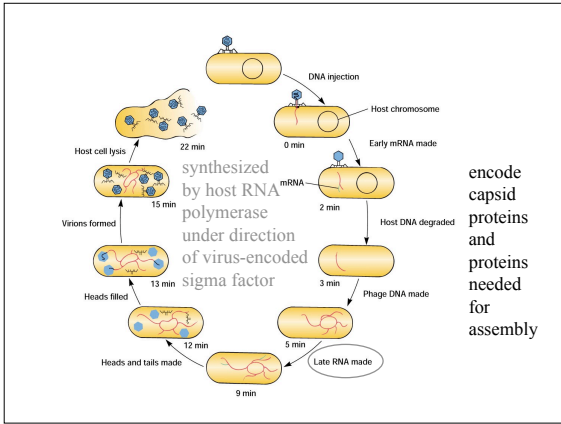
HMC glucosylation

- protects phage DNA from host restriction endonucleases
 - enzymes that cleave DNA at specific sequences
- restriction
 - use of restriction endonucleases as a defense mechanism against viral infection

Post synthesis events

- T4 DNA is terminally redundant
 - base sequence repeated at both ends
 - allows for formation of concatamers
 - long strands of DNA consisting of several units linked together





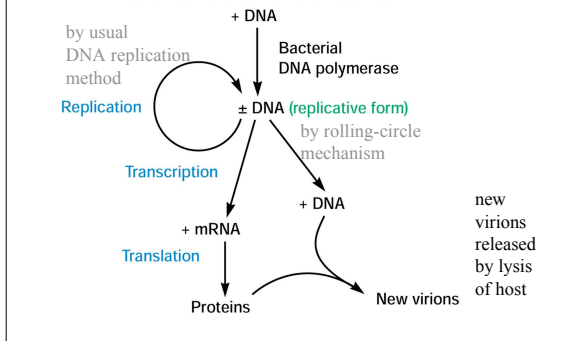
Release of Phage Particles

- lysis of host brought about by several T4 proteins
 - e.g., endolysin
 - attacks peptidoglycan
 - e.g., holin
 - produces lesion in cell membrane

Reproduction of Single-Stranded DNA Phages

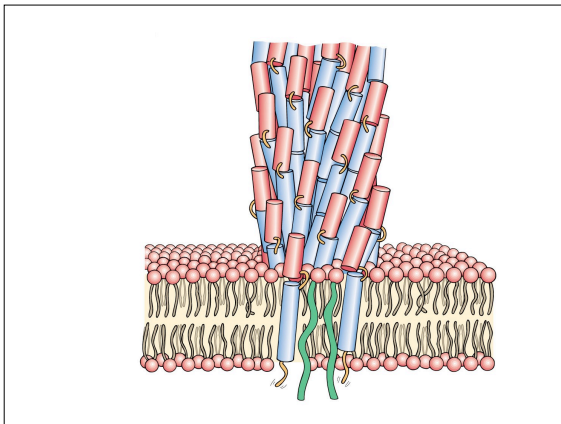
- focus on two phages
 - ϕ X174
 - filamentous phages

ϕX174



Filamentous phages

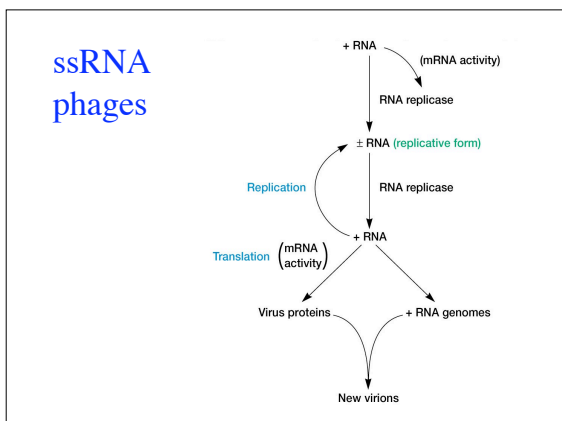
- similar to ϕX174
 - DNA enters host
 - replicative form (RF) synthesized
 - RF serves as template for mRNA synthesis
 - virus-encoded protein aids in formation of phage genome by rolling-circle method
 - BUT – phage particles assembled as they are secreted through host membrane without lysing host



Reproduction of RNA Phages

- most are plus strand RNA viruses
- only one (ϕ6) is double-stranded RNA virus
 - also unusual because is envelope phage

ssRNA phages



ϕ6 reproduction

- icosahedral virus with segmented genome
 - capsid contains an RNA polymerase
 - three distinct double-stranded RNA (dsRNA) segments
 - each encodes an mRNA
- mechanism of synthesis of dsRNA genome is not known

Temperate Bacteriophages and Lysogeny

- lysogeny
 - nonlytic relationship between a phage and its host
 - usually involves integration of phage genome into host DNA
 - prophage – integrated phage genome
 - lysogens (lysogenic bacteria)
 - infected bacterial host
 - temperate phages
 - phages able to establish lysogeny

Induction

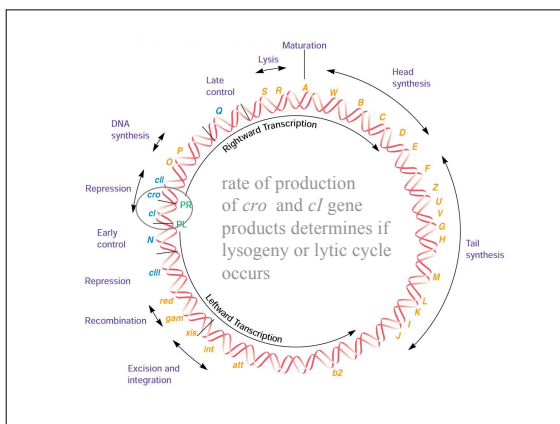
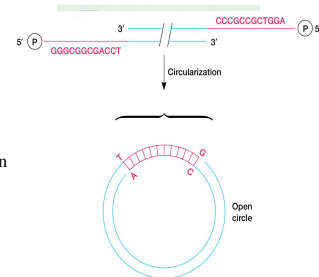
- process by which phage reproduction is initiated
- results in switch to lytic cycle

Lysogenic conversion

- change in host phenotype induced by lysogeny
 - e.g., modification of *Salmonella* lipopolysaccharide structure
 - e.g., production of diphtheria toxin by *Corynebacterium diphtheriae*

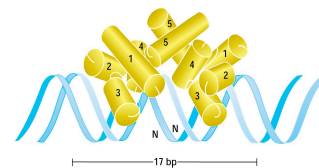
Focus on Lambda

- double-stranded DNA phage
- linear genome with cohesive ends
 - circularizes upon entry into host



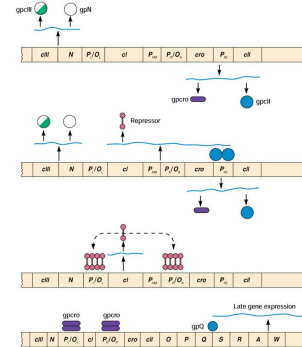
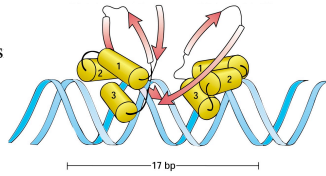
Lambda repressor

- product of *cI* gene
- blocks transcription of lytic cycle genes, including *cro* gene



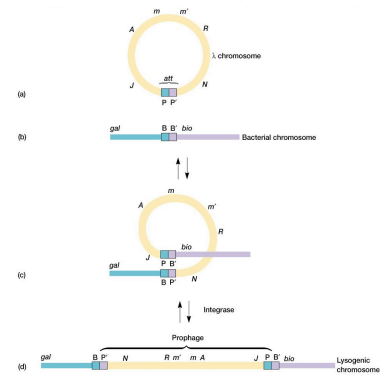
Cro protein

- involved in regulating lytic cycle genes
- blocks synthesis of lambda repressor



If lambda repressor wins...

- lambda genome inserted into *E. coli* genome
 - integrase
 - catalyzes integration



Induction

- triggered by drop in levels of lambda repressor
 - caused by exposure to UV light and chemicals that cause DNA damage
- excisionase
 - binds integrase
 - enables integrase to reverse integration process