

Chapter 13

Viruses, Viroids, and Prions

Biology 1009
Microbiology
Johnson-Summer 2003

Viruses

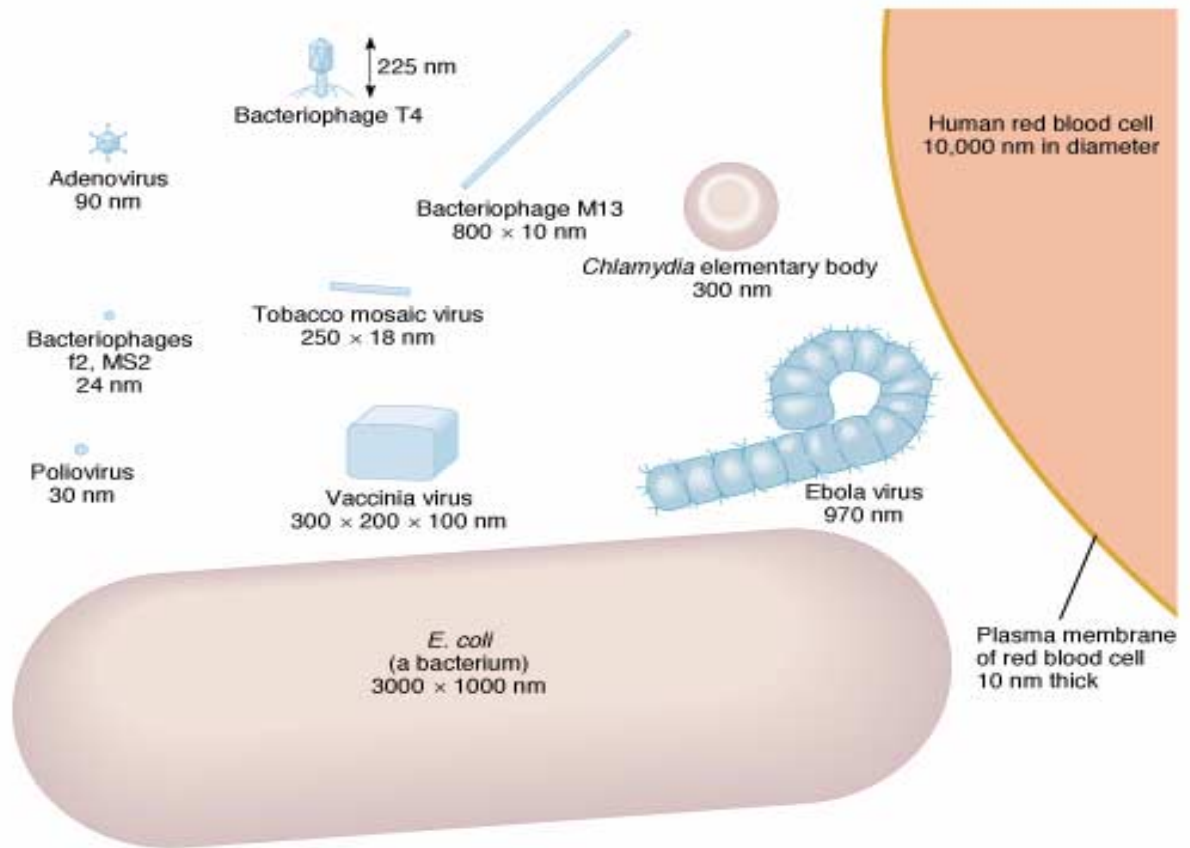
- Virology-study of viruses
- Characteristics:
 - acellular
 - obligate intracellular parasites
 - no ribosomes or means of protein synthesis
 - no ATP generating system
 - NOT ALIVE!

Typical Viruses

- Two parts:
 - 1) Nucleic acid
 - either DNA or RNA (never both) 2)
 - 2) Capsid (protein coat)
 - Some capsids surrounded by envelopes

Viral Size

*20-14000 nm
*Need electron microscope to view



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Host Range

- Variety of host cells that a virus can infect
- Specific viruses often have narrow host range
- Some viruses only infect:
 - plants
 - invertebrates
 - protozoans
 - fungi
 - bacteria

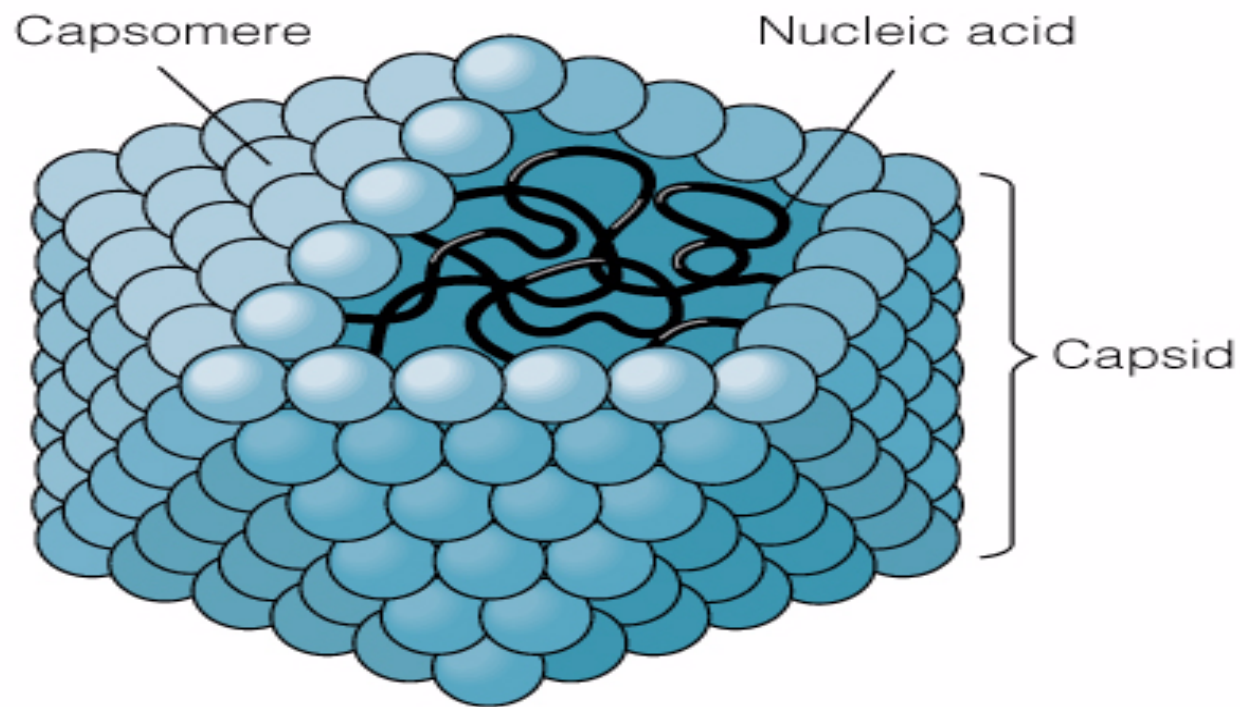
Host/Virus Interaction

- Host range is determined by the viruses ability to interact with host cell
- Binding sites on viral capsid or envelope combine with receptor sites on host cell membrane

Viral Structure

- Nucleic acid-DNA or RNA
- Capsid (coat protein)
 - Function:
 - Subunits:
 - Some have envelopes
 - made of lipids, proteins, and carbs
 - contain spikes-binding sites that help attach viruses to host/aid in viral ID

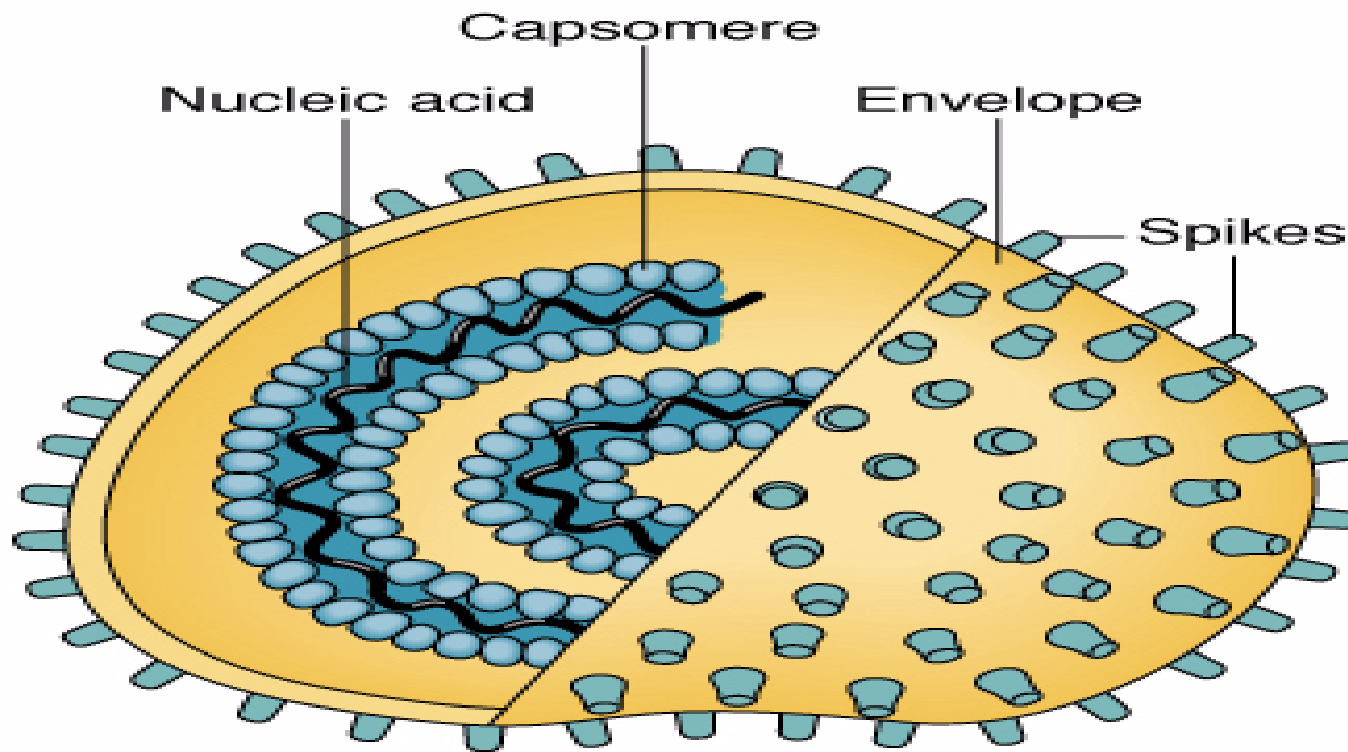
Viral Morphology



(a) A polyhedral virus

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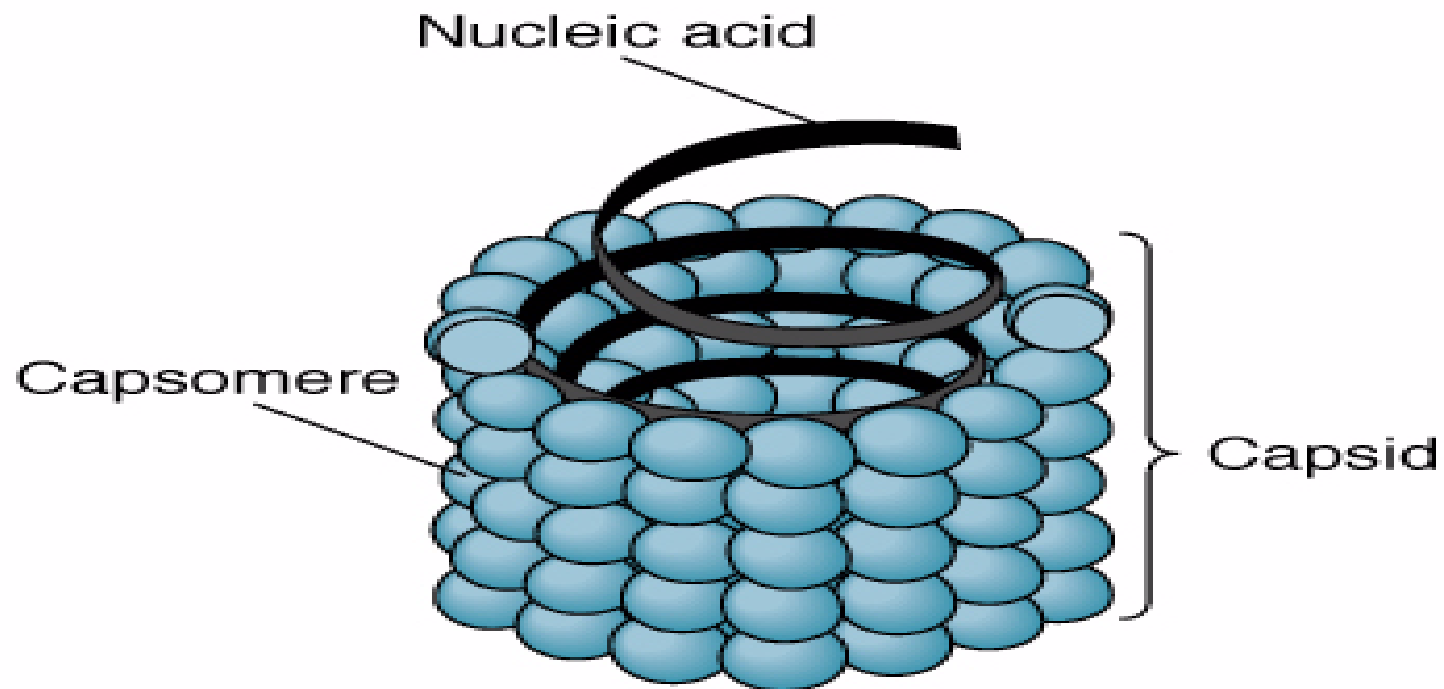
Viral Morphology



(a) An enveloped helical virus

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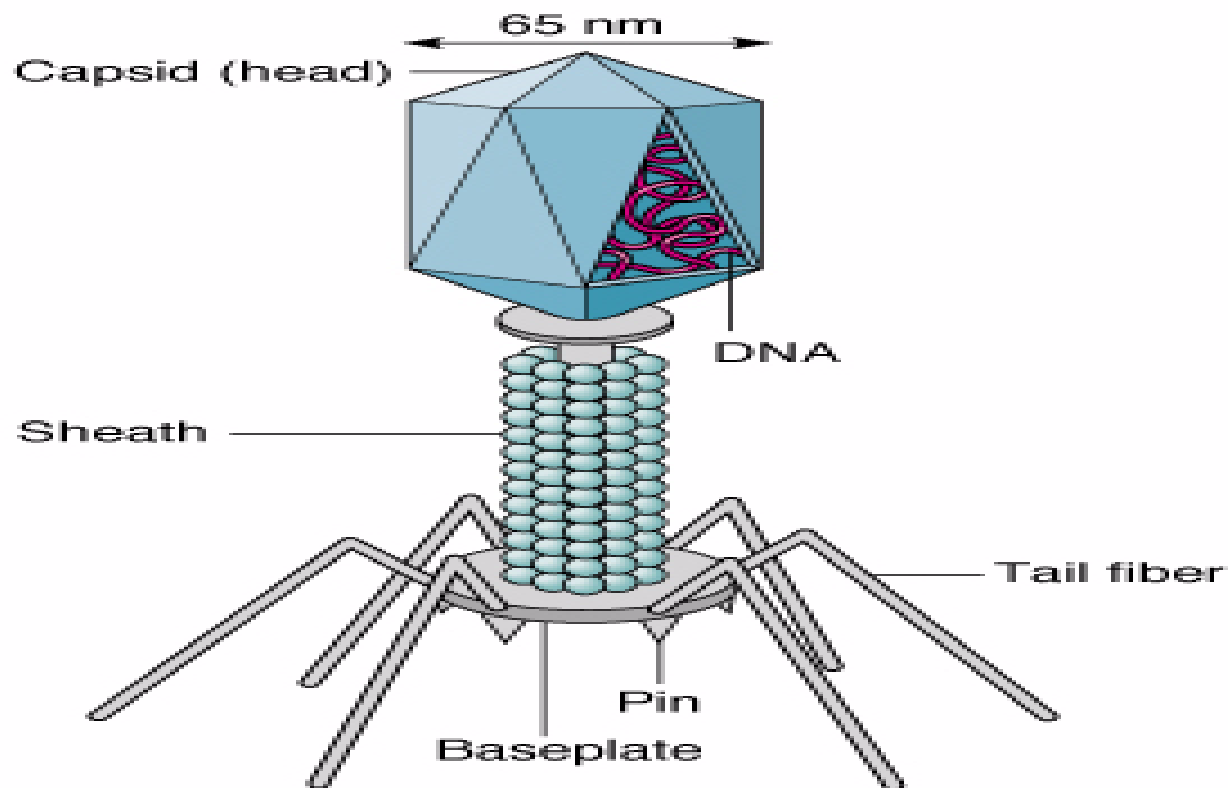
Viral Morphology



(a) A helical virus

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Viral Morphology



(a) A T-even bacteriophage

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Viral Classification

- Based on one of the following:
 - nucleic acid
 - morphology
 - strategy of replication

Isolation and Cultivation of Viruses

- Viruses must be grown in living cultures
- Bacteriophages:
 - easiest viruses to grow in the lab

Growing Bacteriophages

- Prepare a spread plate (lawn) of bacteria
- Add bacteriophages
- As virus replicates, bacteria in area destroyed, leaving a clear zone known as _____.

Growing Animal Viruses

- Three methods:
 - Living animals
 - Chicken embryos
 - Cell culture
 - Primary cell lines
 - Diploid cell lines
 - Continuous cell lines

Viroids

- Viroids:
 - infectious pieces of naked RNA
 - cause plant diseases
 - 300-400 nucleotides long
 - closed, folded 3 D shape

Prions

- Infectious proteins
- 1st discovered in the 1980's
- Diseases:
 - Mad cow
 - Creutzfeldt-Jakob
 - Chronic wasting
 - holes form in brain tissue

Viral Replication

- One virion may enter host and produce 1000's of viruses
- Viruses lack necessary enzymes for ATP/protein synthesis
- Utilizes host metabolic machinery

Replication of Bacteriophages

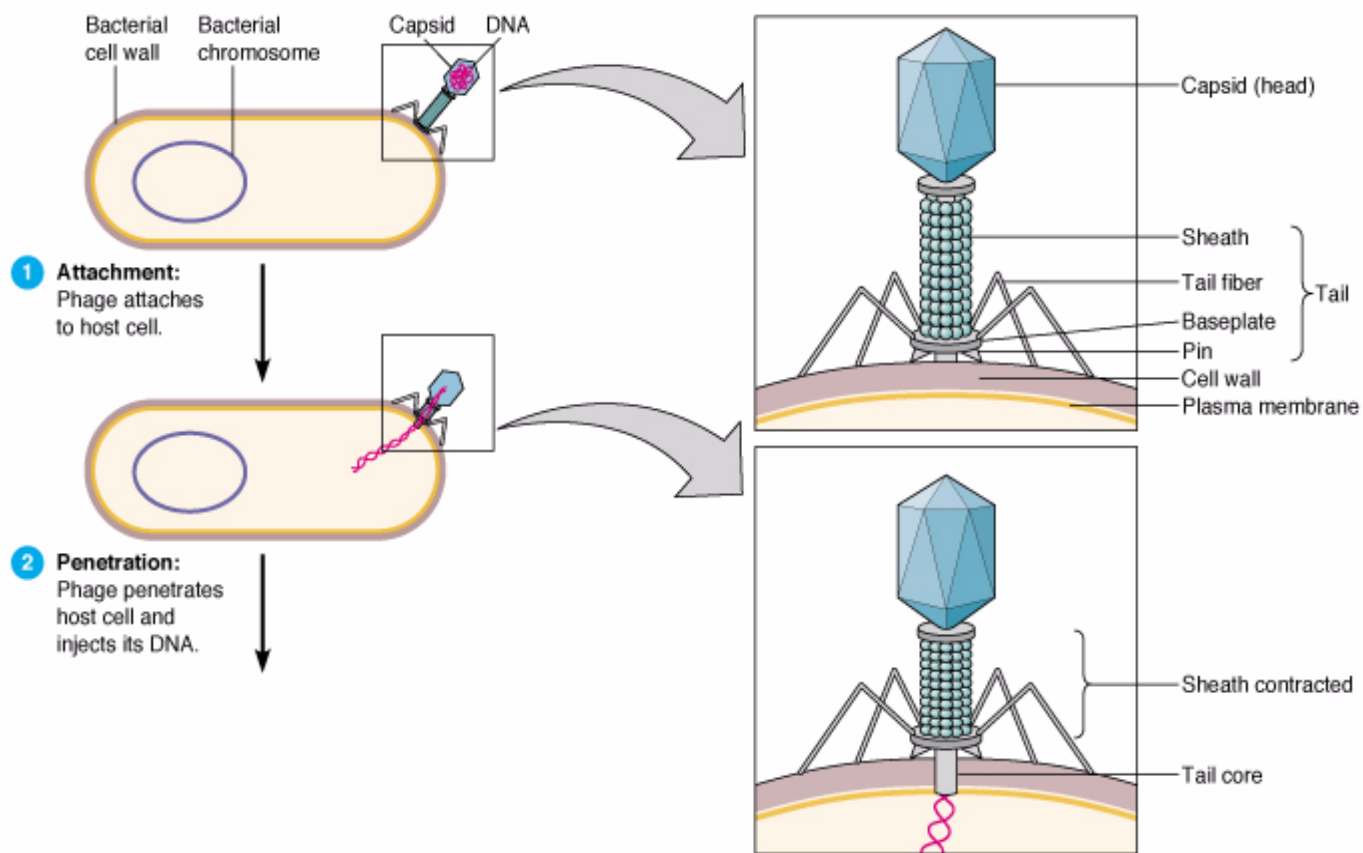
- Two mechanisms:
 - Lytic cycle
 - Lysogenic cycle

Lytic Cycle

Five steps:

- 1) Attachment: binding sites must match receptor sites on host bacterial cell
- 2) Penetration: viral DNA is injected into bacterial cell
- 3) Biosynthesis: virus uses host cells enzymes and machinery
 - *genome replication
 - *transcription
 - *translation

Bacteriophage Replication Lytic Cycle



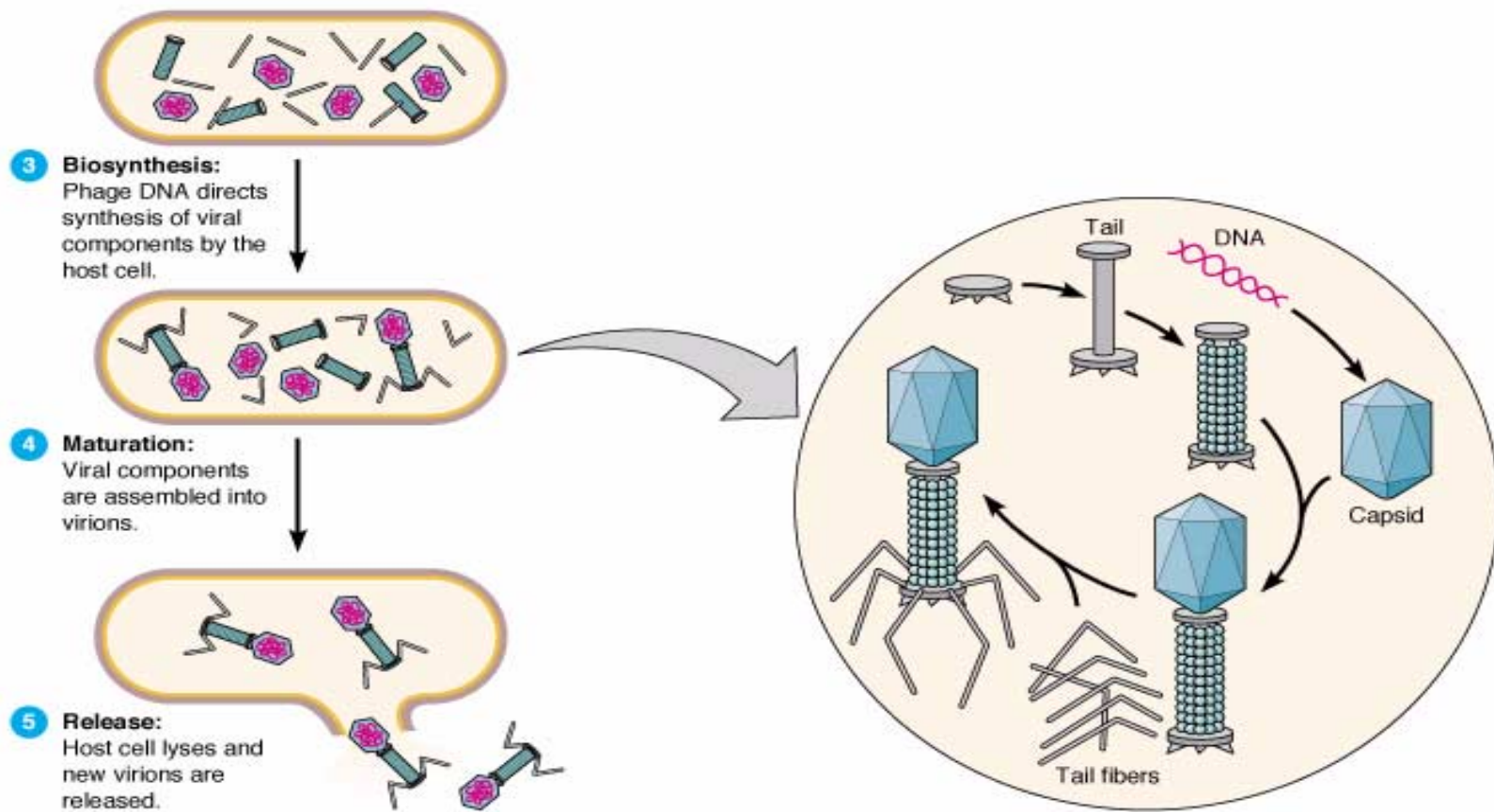
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Lytic Cycle (continued)

4) Maturation: viral particles are assembled

5) Release: lysis occurs

Bacteriophage Replication Lytic Cycle



Lysogenic Cycle

- 1) Attachment
- 2) Penetration
- 3) Integration: viral genome integrated into host cell genome
 - *virus is latent
 - *prophage

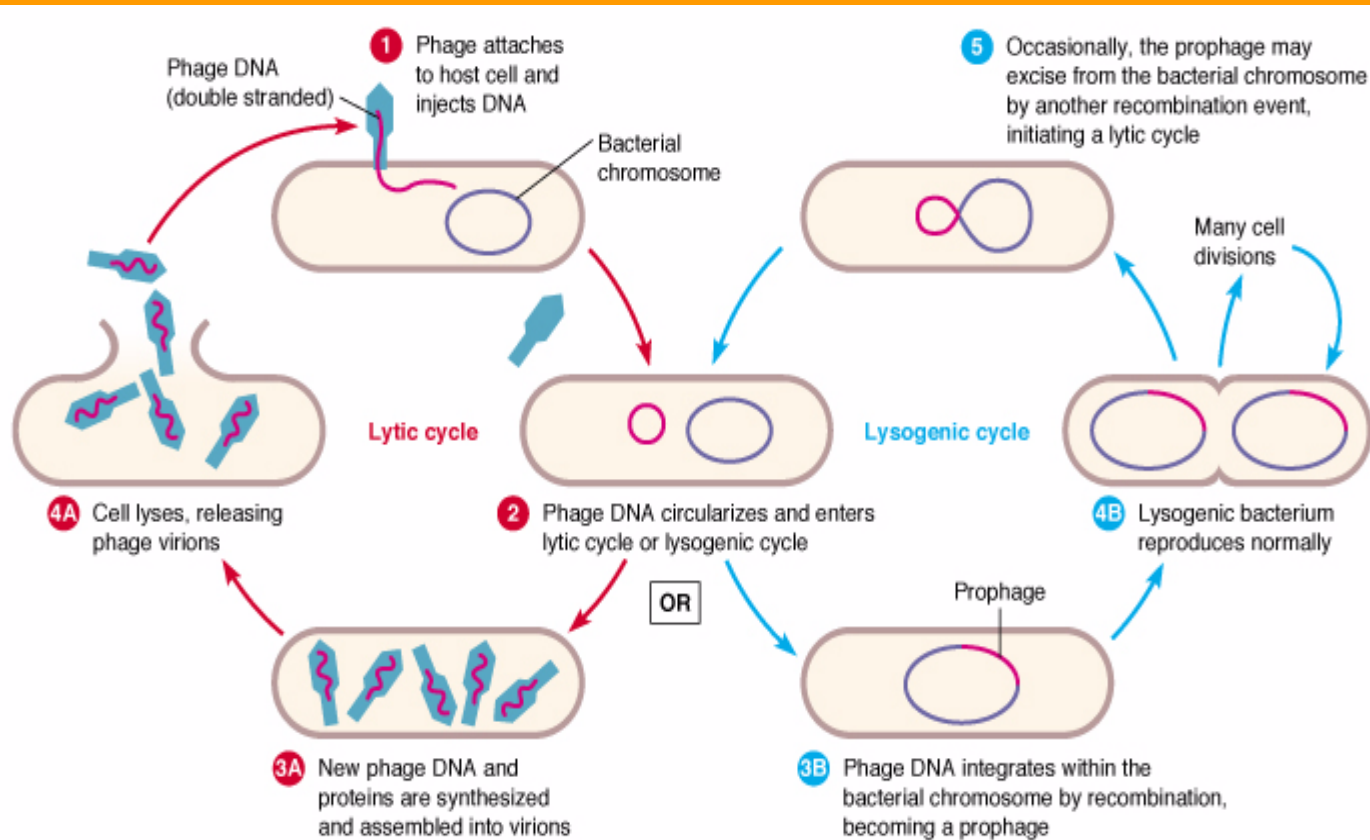
Lysogenic Cycle (continued)

- 4) Biosynthesis: viral genome activated
 - *genome replication
 - *transcription
 - *translation
- 5) Assembly
- 6) Release: lysis

Lysogenic Convergence

- Results when a bacterial cell infected by a virus that has entered the lysogenic cycle
 - Examples:
 - *Corynebacterium diphtheria*
 - *Clostridium botulinum*
 - *Streptococcus pyogenes* (may cause scarlet fever if lysogenic convergence occurs)

Lytic vs Lysogenic Cycle



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Animal Virus Replication

- 1) Attachment: binding sites must match receptor sites on host cell
- 2) Penetration: endocytosis occurs and entire virus enters cell
- 3) Uncoating: separation of the viral genome from the capsid

Animal Virus Replication (continued)

4) Biosynthesis

- *genome replication

- *transcription

- *translation

5) Maturation: virus particles assembled

6) Release: lysis

Enveloped Virus Replication

- 1) Attachment
- 2) Penetration
- 3) Uncoating
- 4) Biosynthesis
- 5) Maturation: assembly
- 6) Release: budding

Retro Viruses

- Unique
- 1975
 - RNA-----> DNA---->mRNA---->protein
 - utilizes reverse transcriptase
- Normal virus
 - DNA---->mRNA----->protein
 - Central Dogma of Molecular Genetics

Retro Viruses

- Include many cancer causing viruses
- HIV
 - Human Immunodeficiency Virus
 - causes AIDS
 - Acquired Immunodeficiency Syndrome

HIV

- Leads to AIDS
 - results in immune system failure
 - death usually results from opportunistic infection (pneumonia)
 - HIV-discovered in 1984

HIV Structure

- Retro virus
- RNA nucleic acid (two strands)
- envelope (gp 120 binding sites)
- reverse transcriptase

HIV Infection (cellular level)

1) Attachment:

*HIV gp 120 binding sites must match CD4 receptor sites

CD4 receptor sites

a) macrophages

b) CNS cells

c) T4 helper cells (CD4 cells)

HIV Infection (continued)

- 2) Penetration: viral membrane fuses with host cell membrane
- 3) Uncoating: capsid removed and viral genome exposed
- 4) Integration: viral genome enters host
Two possibilities:
 - a) nothing-virus remains latent
 - b) HIV genome expressed or "turned on"

HIV infection (continued)

- If HIV genome turned on--->
 - death usually results within 2 yrs
- What causes HIV genome to be turned on?
 - stress
 - alcohol/drug abuse
 - nutrition
 - exercise

Now that HIV genome is turned on....

5) Biosynthesis:

- *genome replication

- *transcription

- *translation

6) Maturation: viral particles put together

7) Release: by budding

Methods of HIV Transmission

- HIV transmitted by exposure to infected body fluids
 - Four body fluids
 - _____
 - _____
 - _____
 - _____

Ways in which infected fluids can be transferred from one person to another?

- High risk sexual contact
- Contaminated needles
- Blood to blood contact
- Mother to child

The Immune System and HIV

- Cellular Response
 - cells phagocytize microorganisms
- Humoral Response
 - antibodies destroy or inactivate microorganisms

Clinical Stages of HIV Infection

1) Acute Infection

- * Initial infection of HIV (exposure to infected body fluids)

- * Viremia:

- * May last for a couple of weeks

- * Normal CD4 count _____

Clinical Stages of HIV (continued)

2) Asymptomatic Disease

- *CD4 count now less than_____
- *Virus latent inside CD4 cells
- *Average latency=
- *No signs/symptoms of illness
- *HIV positive-antibodies detected in blood

Clinical Stages of HIV (continued)

3) Symptomatic Disease

- *CD4 cell count_____

- *viral genome turned on

- *symptoms appear: chronic fatigue, fever, diarrhea, weight loss

- *Susceptible to infections: bacterial pneumonia, meningitis, TB, yeast infections

HIV Stages of Infection(continued)

4) Advanced Disease (AIDS)

CD4 cell count _____

*Severe opportunistic infections

-*Pneumocystic carini* pneumonia

-Kaposi's sarcoma (cancer)

-Cryptosporidiosis (GI tract)

-Toxoplasmosis (brain)

-other bacterial, fungal, viral infections

Testing for HIV

- ELISA-enzyme linked immunosorbant assay
 - tests for HIV antibodies
 - after two positives, test for viral antigens completed
- Western blot
 - tests for HIV viral antigens

HIV Treatment

- NO CURE
- AZT (azidothymidine)
 - inhibits reverse transcriptase
- AIDS cocktail
 - AZT, 3TC, and a protease inhibitor

HIV Vaccine

- NONE AVAILABLE
- HIV mutates too quickly
- reverse transcriptase forms at least 1 mutation each time it is used
- 1 million variants during asymptomatic stage
- 100 million variants during AIDS