Viruses

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Ch. 9 Brock

General properties of viruses

- Replicate independently of the chromosome of cells, but dependent on cells
- Infect animals (and people), plants, and bacteria (**bacteriophage**)
- Extracellular forms (**virions**) are metabolically inert
- Contain either DNA or RNA
- Range in size from about 28 nm to about 200 nm in diameter
- Important tools for microbial geneticists and genetic engineers

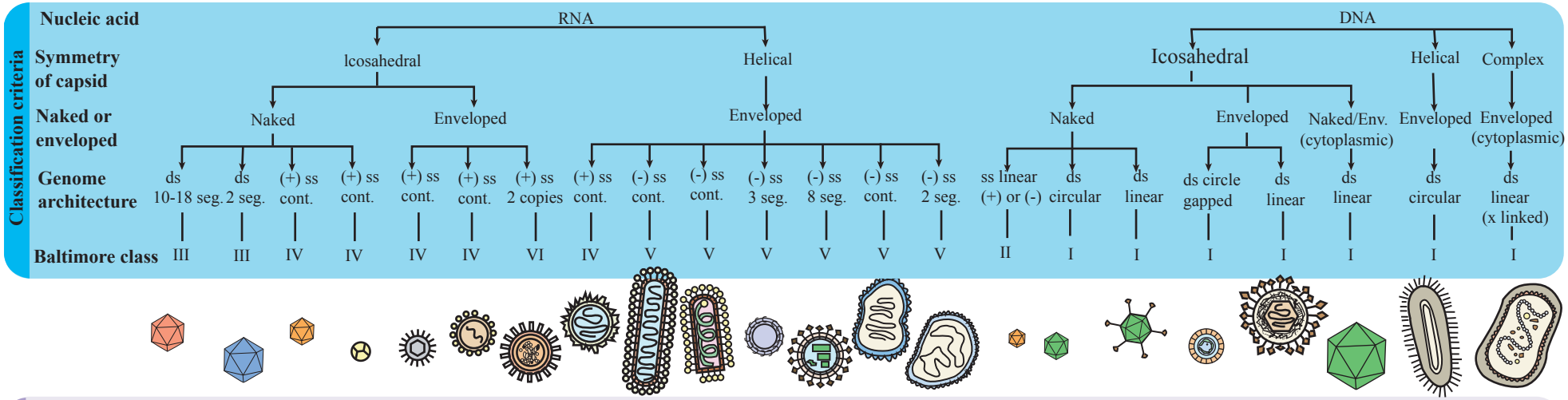

Figure by MIT OCW.

Viral structure

- Nucleic acid is within the protein coat (**capsid**)
- Subunits comprising the capsid are **capsomeres**
- Viral capsids are capable of self-assembly
- Rod-shaped viruses have **helical symmetry** and spherical viruses have **icosahedral symmetry**

Additional viral structures

- Some animal viruses are **enveloped**
  - Membrane is derived from host cell
  - Protein is viral-encoded
- Some bacterophage are **complex**
  - Icosahedral heads
  - Helical tails
  - Complex tail structure

Viral growth

- Number of infectious units in a viral suspension is called the **titer**
- Can enumerate plaque-forming units (**PFU**) on lawns of host cells
- **Plating efficiency** is the ratio of PFU/total virions

Images of cell plating removed due to copyright restrictions.
See Figure 9-6 in Madigan, Michael, and John Martinko. *Brock Biology of Microorganisms*. 11th ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2006. ISBN: 0131443291.

Animal virus methods

- Animal cells can be primary or continuous culture cell lines
- Plaque assays as well as cytopathic effect (CPE) can be observed

Images removed due to copyright restrictions.

Matrosovich et al. Virology Journal 3:63, 2006

Athmanathan et al. BMC Clinical Pathology 2:1, 2002

Viral replication

- During **eclipse** there are no intact virions
- **Maturation** begins with packaging of nucleic acid
- **Latent period** begins at entry and ends with release
- Lysis results in **one-step growth**
- **Burst size** = yield

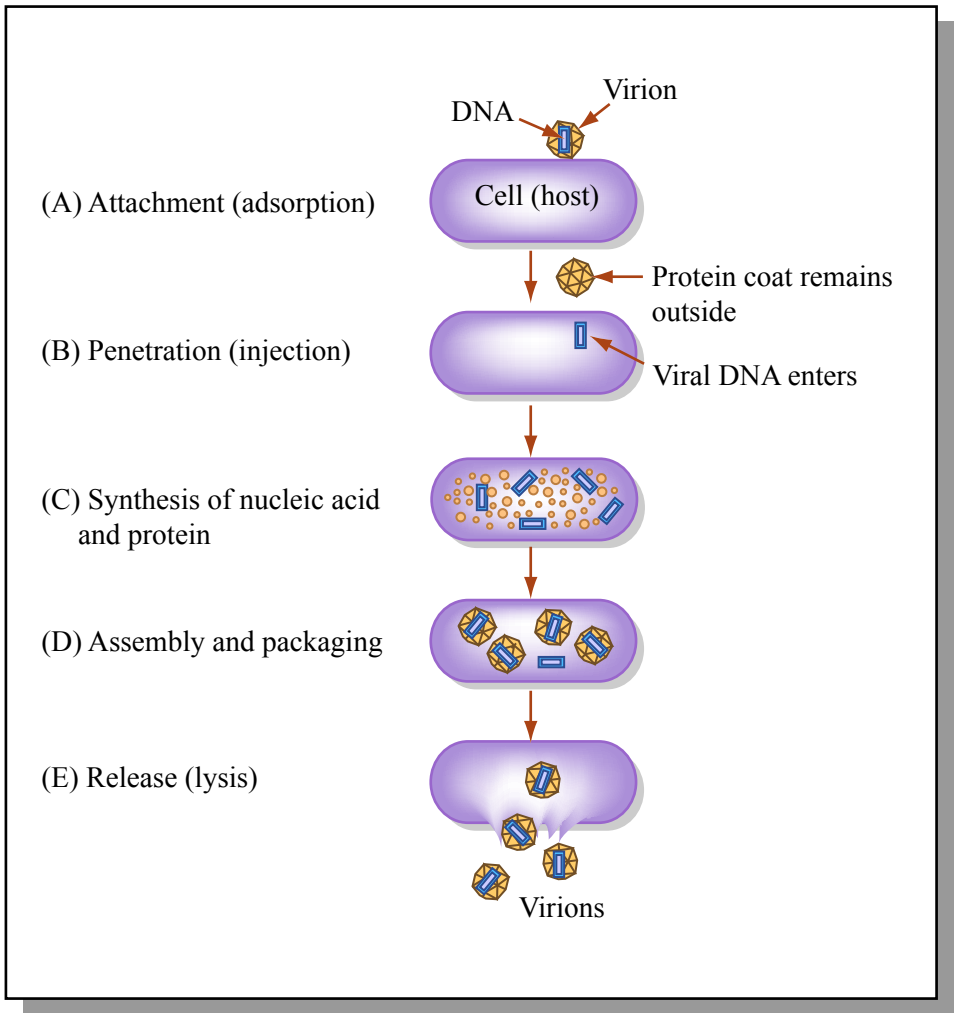

Figure by MIT OCW.

Attachment and penetration

- Virion binds specific **receptors** on the host cell surface
- Penetration leads to viral **uncoating**
- Restriction endonucleases can cleave bacterophage DNA

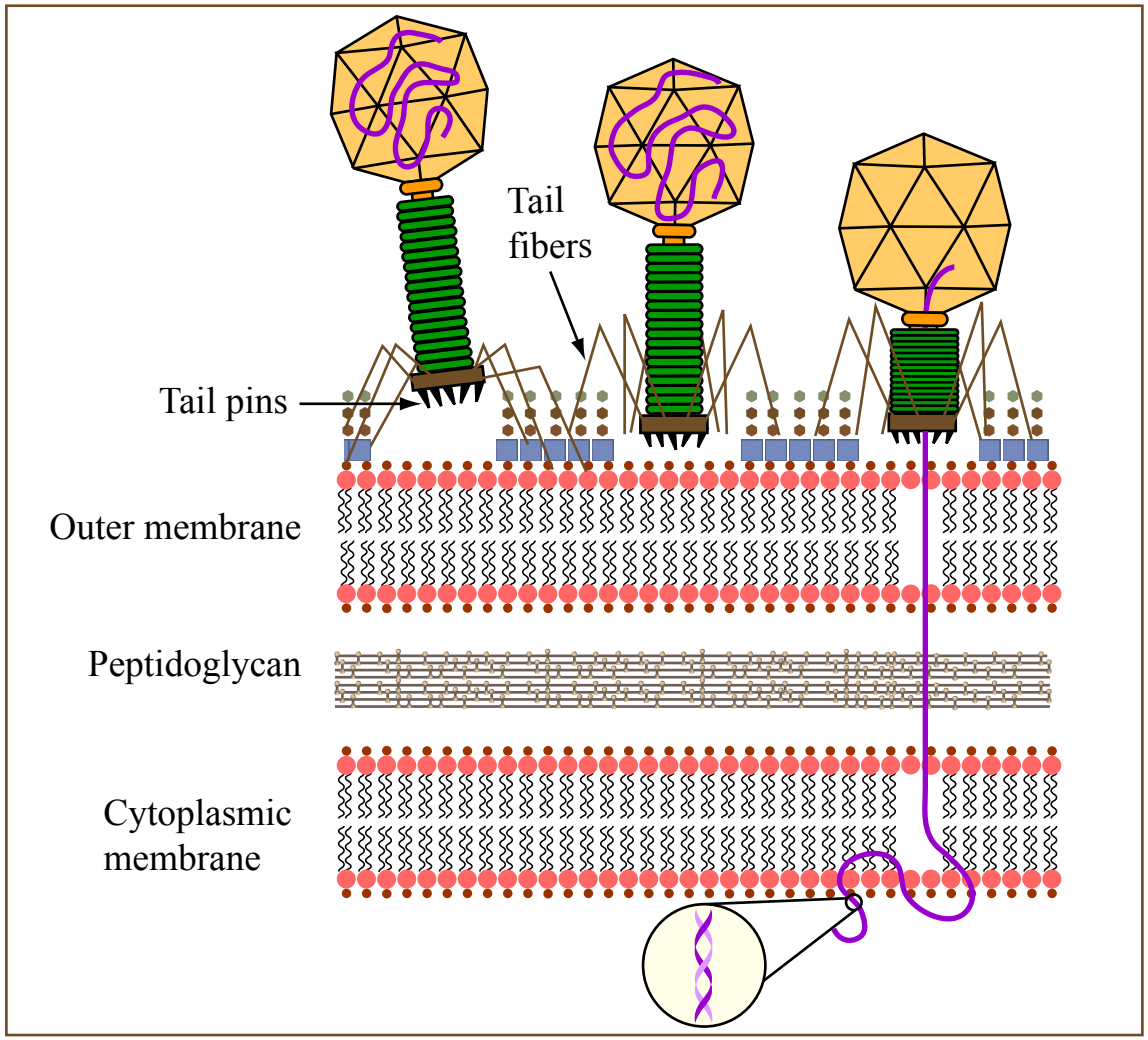

Figure by MIT OCW.

Viral replication: nucleic acids & protein

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See Figure 9-11 in Madigan, Michael, and John Martinko. *Brock Biology of Microorganisms*. 11th ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2006. ISBN: 0131443291

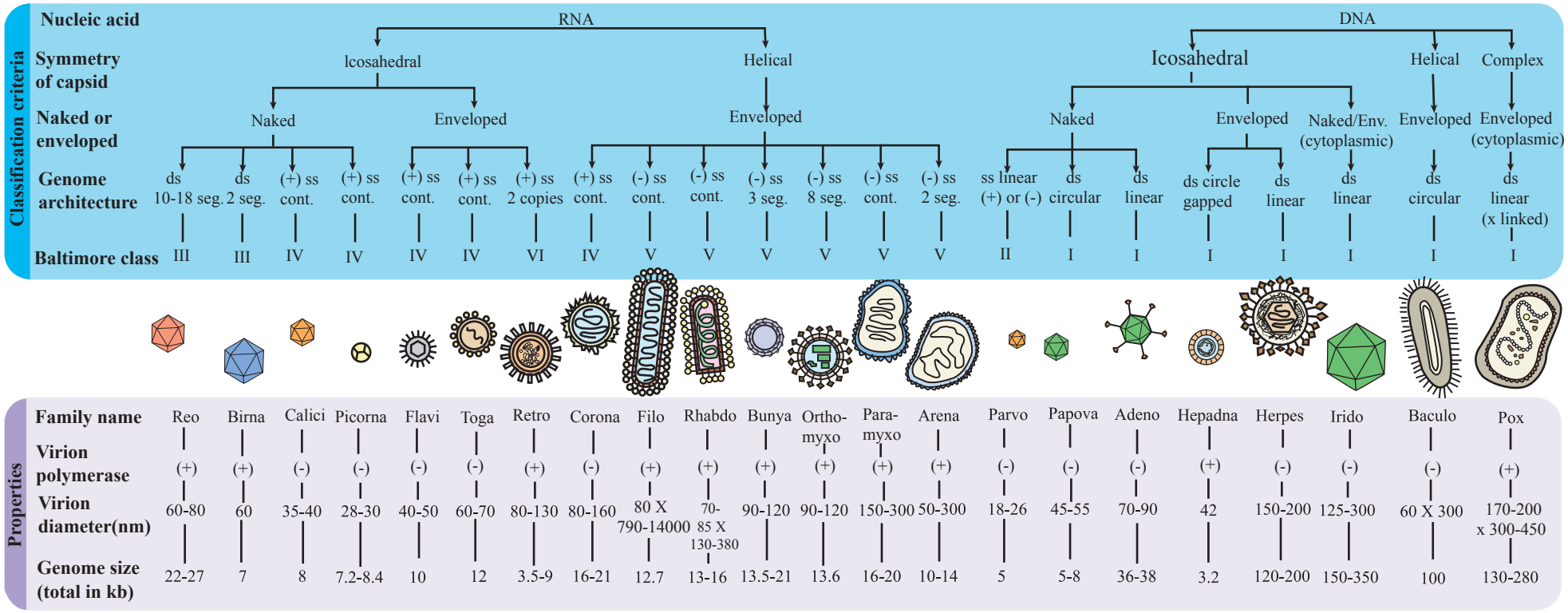

Figure by MIT OCW.

Virulent bacteriophage

- T-even phage are closely related
  - T4 is best studied
- ds linear DNA
  - 169 kb (> 250 proteins)
  - Circularly permutated
- 5-hydroxy-methylcytosine
  - Glucosylated base is resistant to restriction enzymes

T4 infection

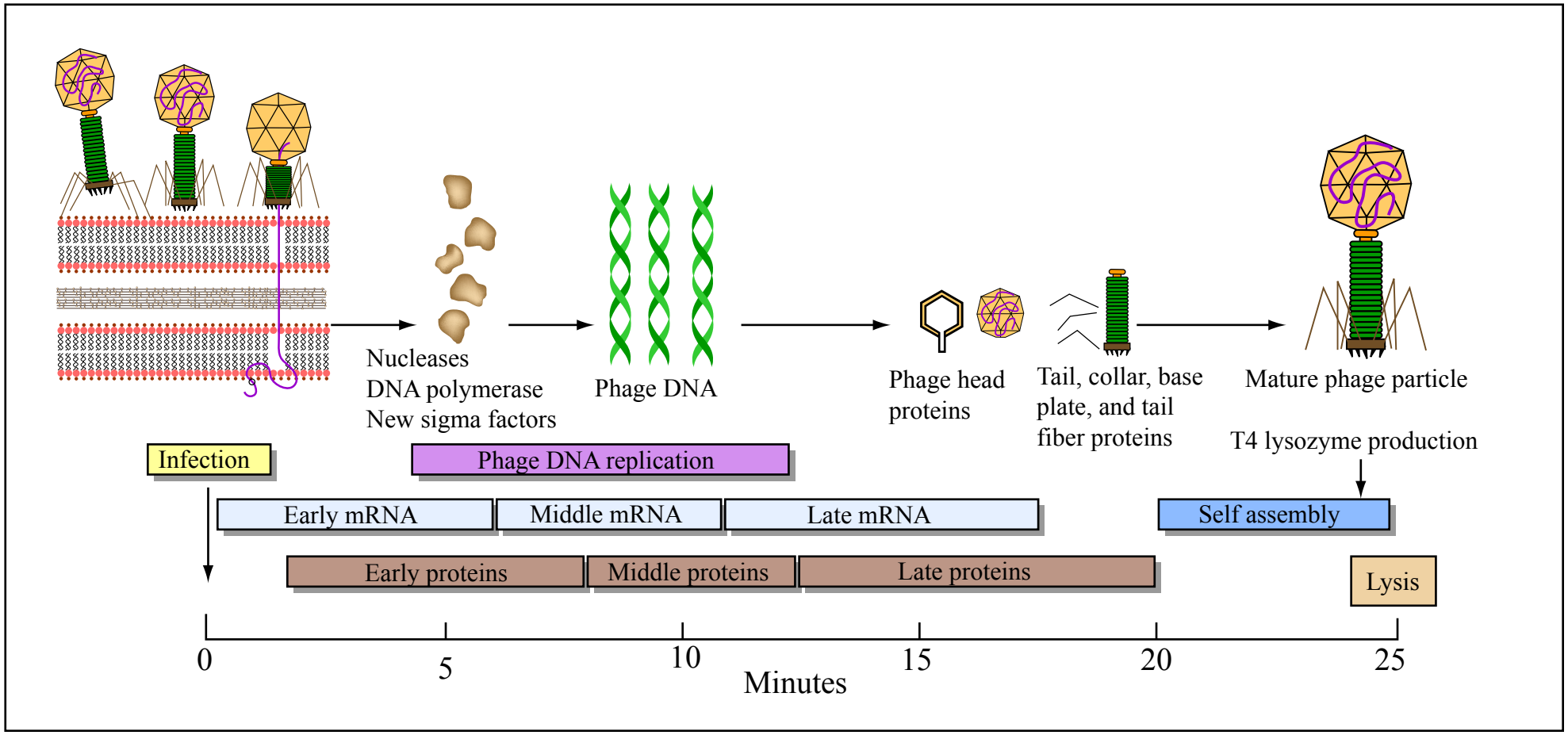

Figure by MIT OCW.

Temperate bacteriophage

- Can complete lytic cycle or become a prophage (lysogeny)
  - Most viral genes not expressed
  - Genome replicated synchronously with host genome
- Lysogens can become activated and undergo lytic replication

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Phage lambda

1. DNA circularlizes
2. Expression of N and Cro
3. Antitermination L1 and L2 (some Q)
4. Q antitermination R2
5. Cro acts as a repressor on O_L and O_R
6. Blocks expression of cI and cII (lysis)
7. Rolling circle replication

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See Figure 9-18b in Madigan, Michael, and John Martinko. *Brock Biology of Microorganisms*. 11th ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2006. ISBN: 0131443291.

Lysogeny

- To prevent late gene expression, cI (lambda repressor) must be expressed
- P_E is activated by cII
- Stabilized by cIII
- cI also represses at O_L and O_R, but in opposite order of Cro (lysogeny)
- P_M is activated once OR is fully bound by cI

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See Figure 9-19 in Madigan, Michael, and John Martinko. *Brock Biology of Microorganisms.* 11th ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2006. ISBN: 0131443291.

Animal viruses

- Can result in lytic infection, persistent infection, or latent infection
- Some viruses can transform the host cell

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See Figure 9-24 in Madigan, Michael, and John Martinko. *Brock Biology of Microorganisms*. 11th ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2006. ISBN: 0131443291.

Virus-like agents

- **Viroids** are small, circular ss RNA molecules
- Encode no proteins
- **Prions** are infectious proteins
- Contains no nucleic acid
- Cause transmissible spongiform encephalopathies (TSEs)