VIRUSES, VIROIDS and PRIONS

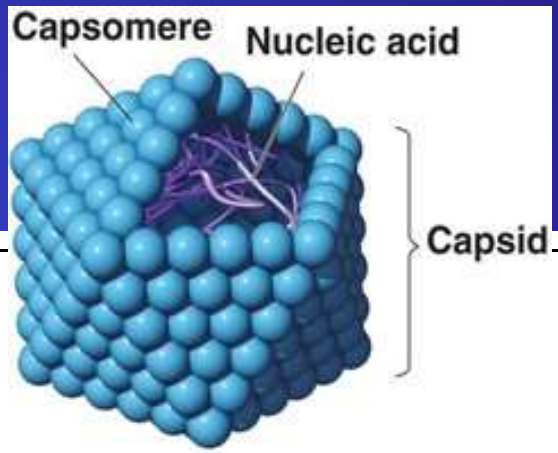
VIRUS

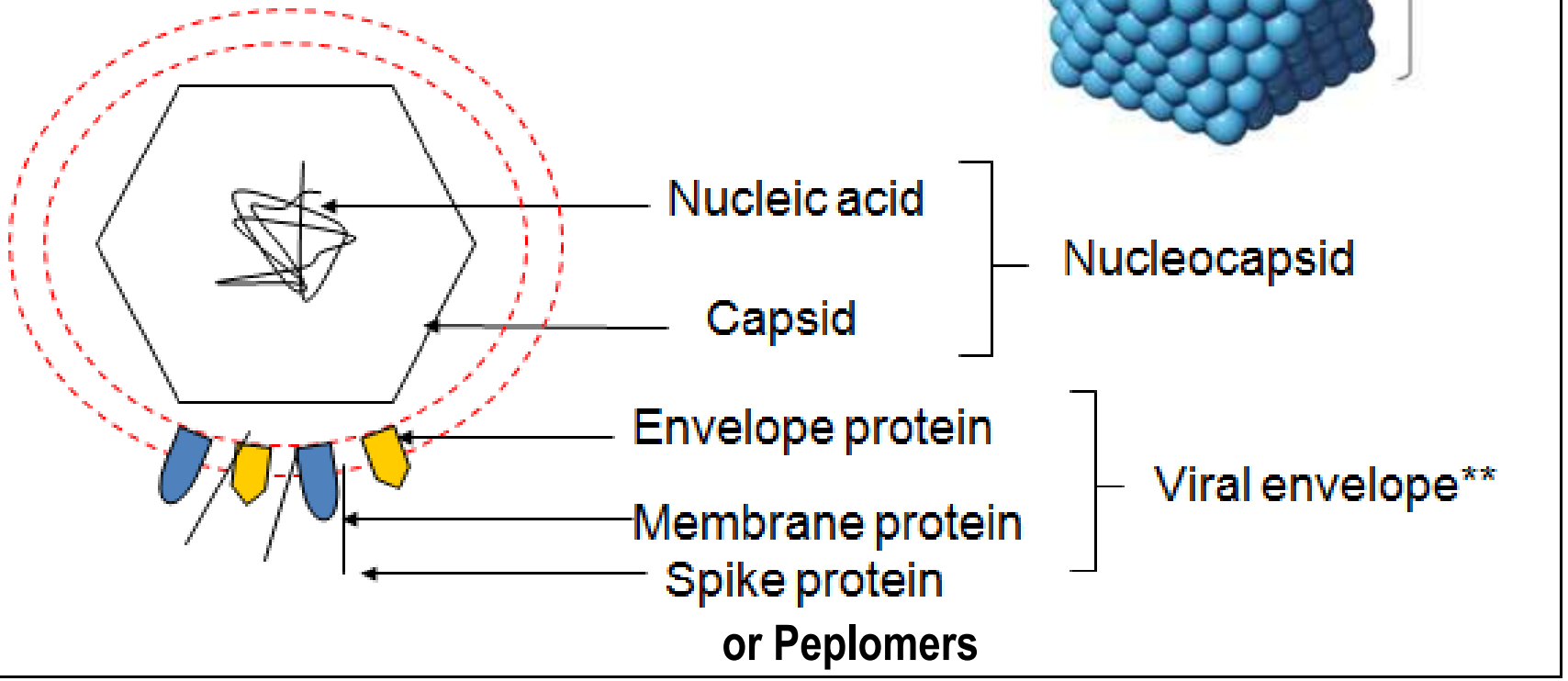
- Generally are quite small, 20-300 nm.
- Obligate intracellular parasite.
- Viruses can infect all types of life forms, from animals and plants to bacteria and archaea.
- Viral Genome: DNA or RNA
  : ss or ds

VIRAL COMPONENTS

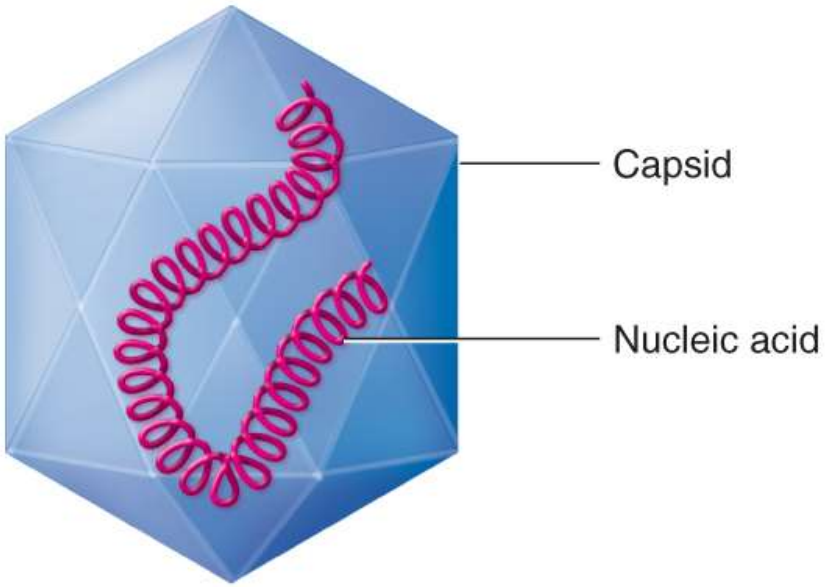
- Contain only those parts needed to invade and control a host cell
  - External coating
    - **Capsid -** a protein coat which forms from individual molecules called **capsomeres.**
    - Envelope- in 13 of the 20 families of animal viruses
    - If no envelope, called **naked virus**
  - Core
    - DNA
    - RNA
  - The capsid and the nucleic acid together are called the **nucleocapsid**
- Fully formed virus that is able to establish an infection in a host cell- **virion**

VIRAL COMPONENTS

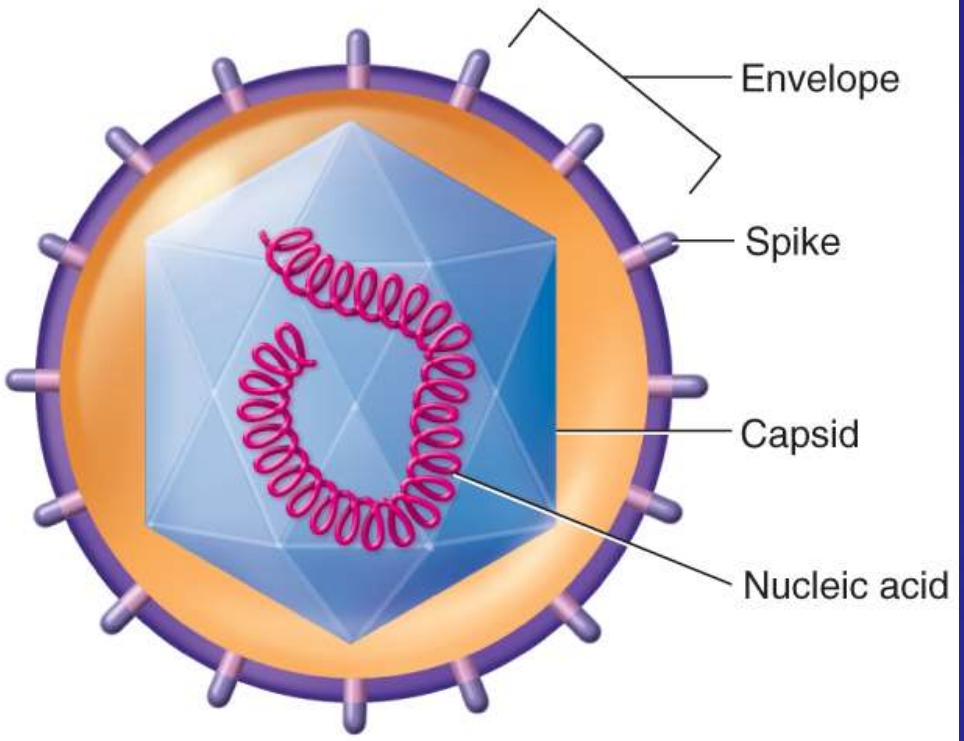




VIRAL COMPONENTS



(a) **Naked Nucleocapsid Virus**

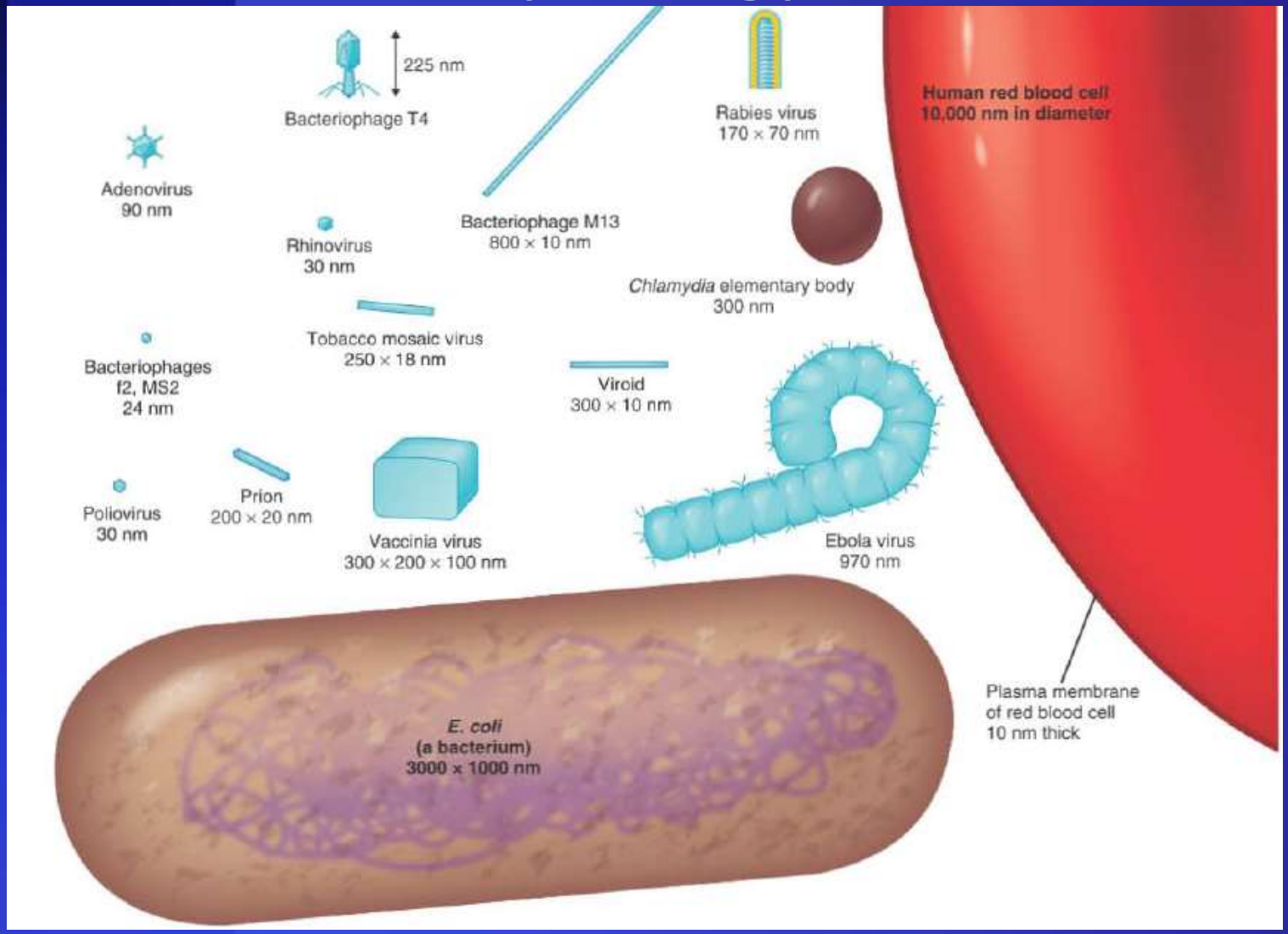


(b) **Enveloped Virus**

Ex. Polio virus

Ex. Herpes simplex

Viral Classification according to morphology

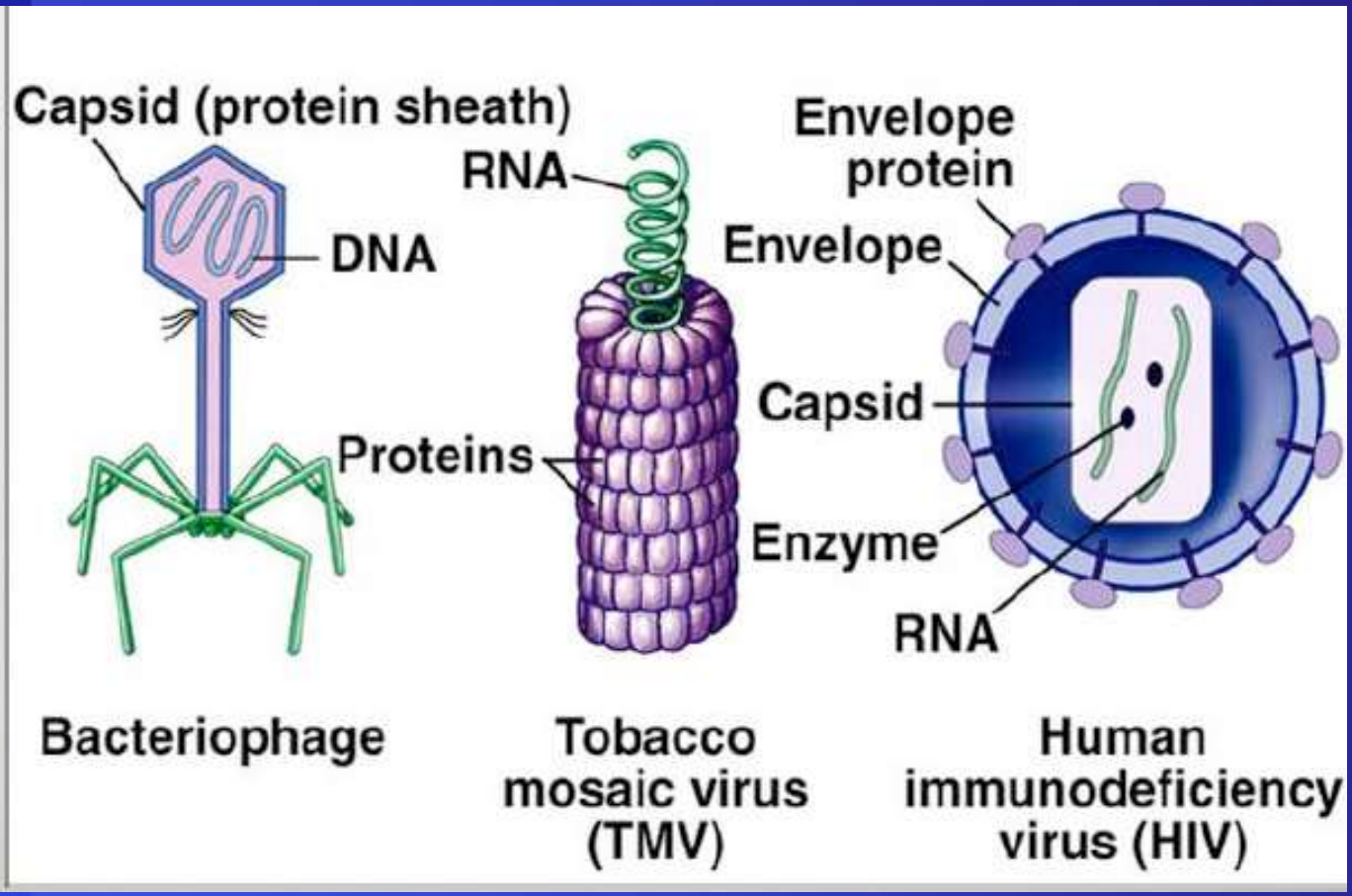


Viral Classification according to symmetry

COMPLEX

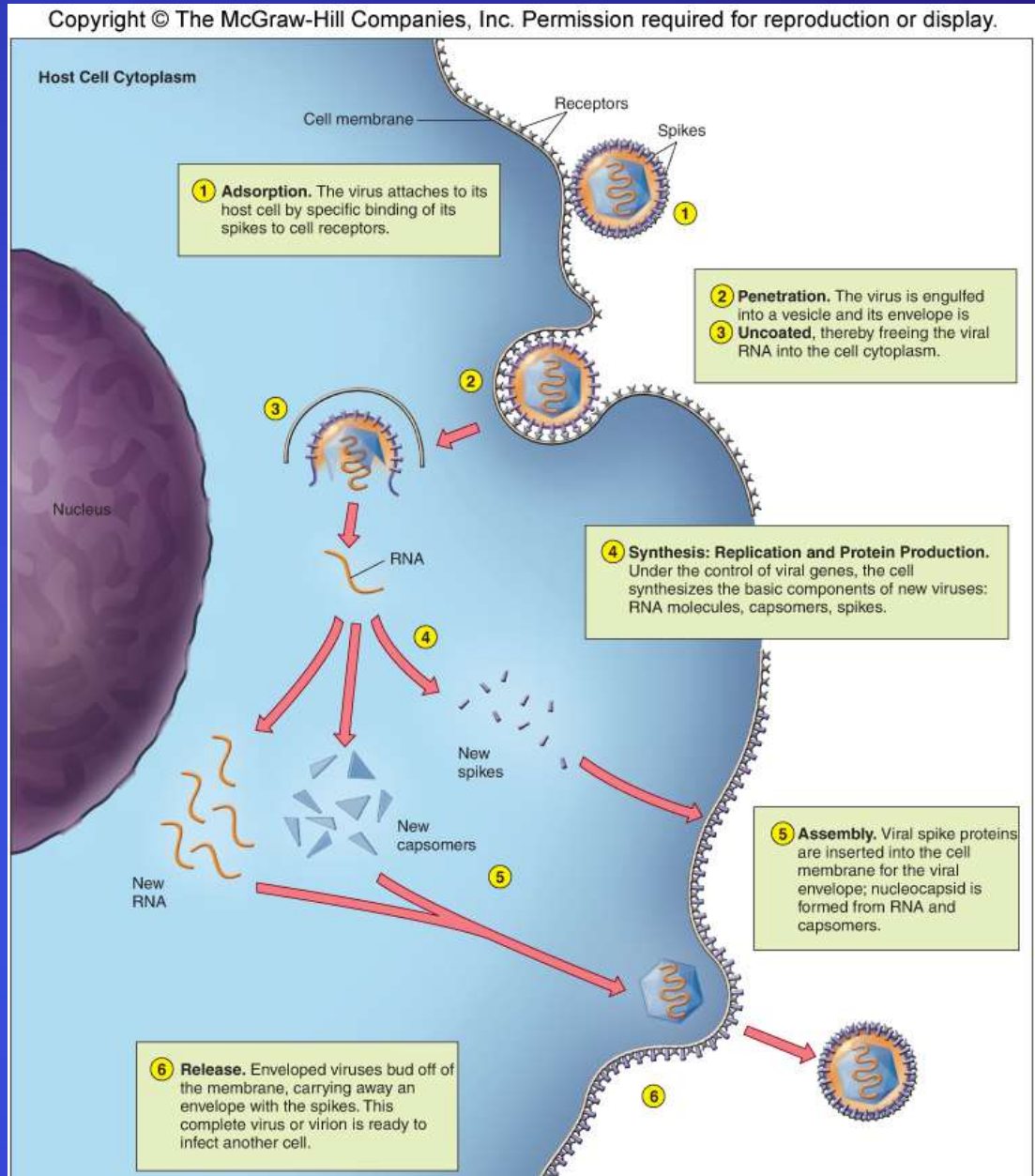
HELICAL

ICOSAHEDRAL



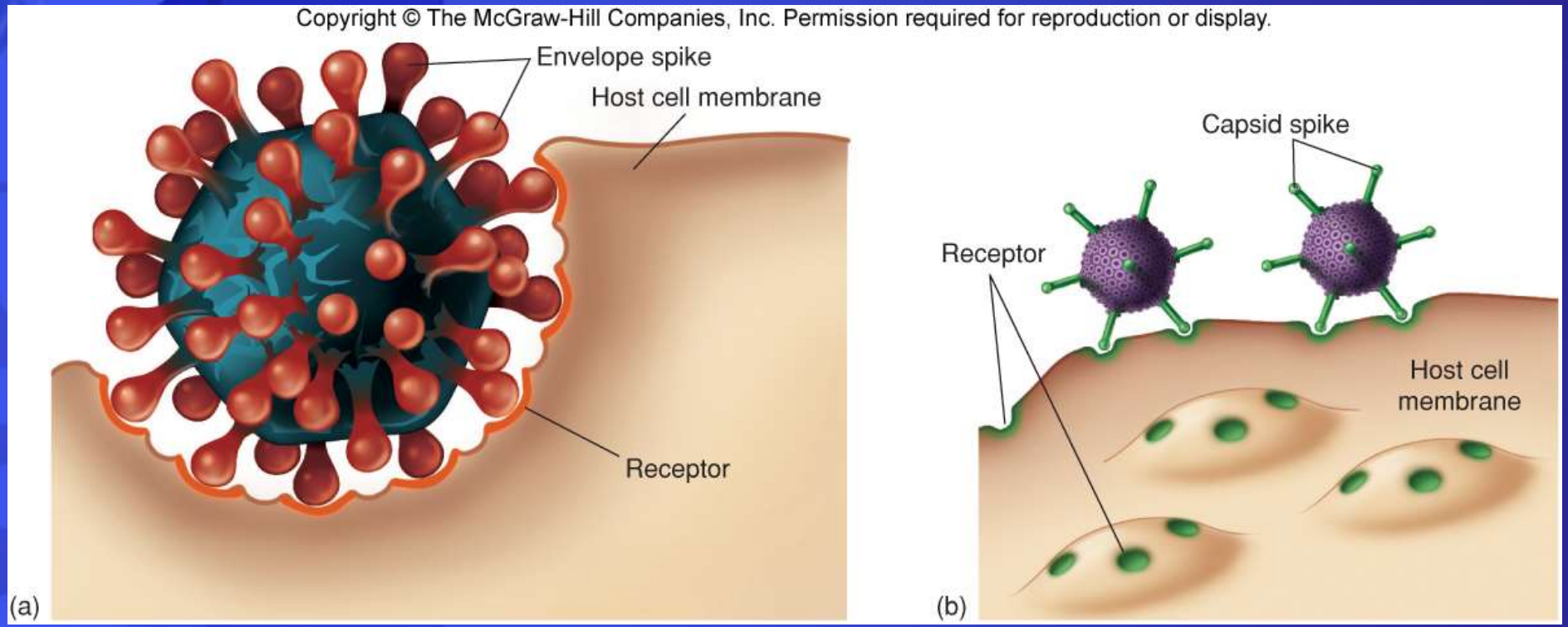
Modes of Viral Replication

- Adsorption
- Penetration
- Uncoating
- Synthesis
- Assembly
- Release



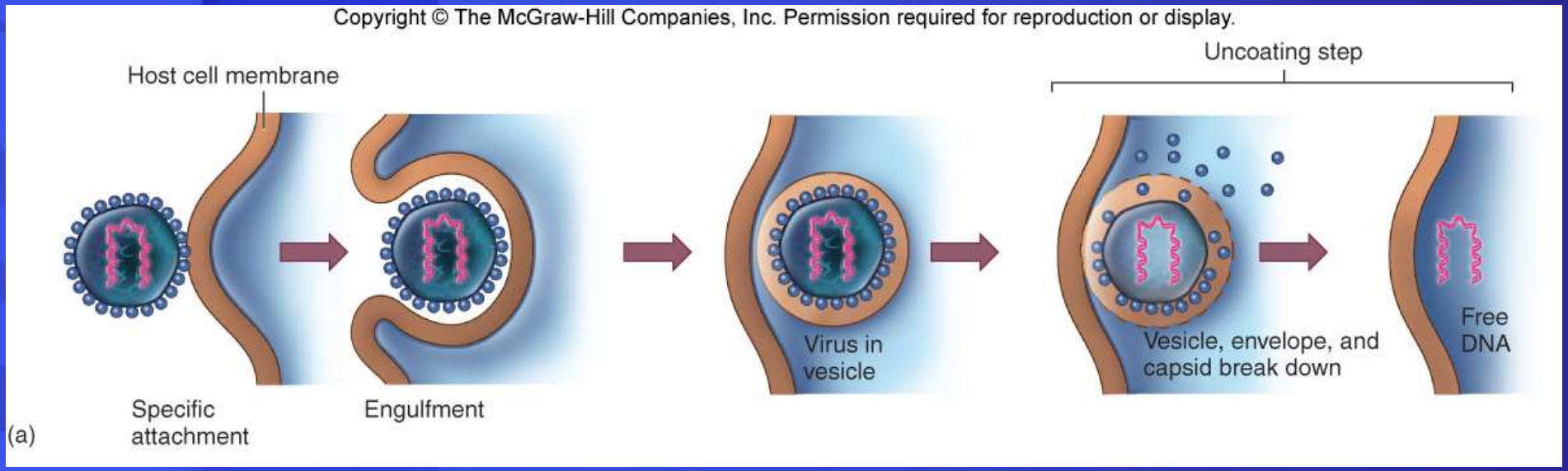
Adsorption

- Virus encounters susceptible host cells
- Adsorbs specifically to receptor sites on the cell membrane



Penetration & Uncoating

- Flexible cell membrane of the host is penetrated by the whole
- Endocytosis
- Uncoating immediately follows: Enzymes in the vacuole dissolve the envelope and capsid

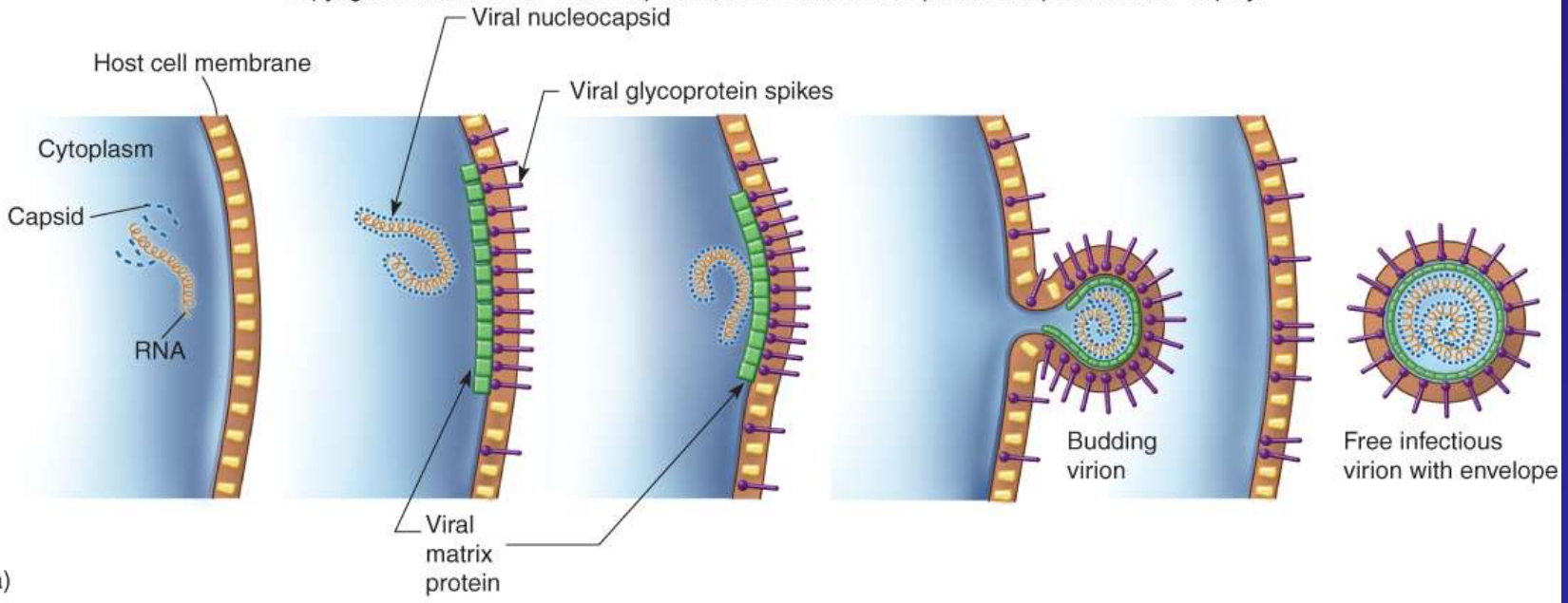


Synthesis

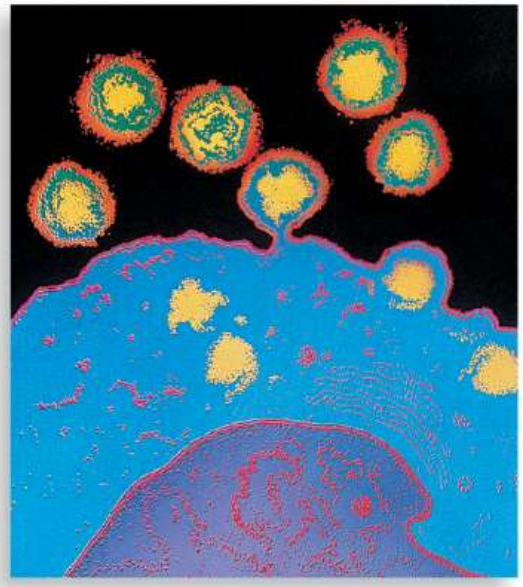
- Free viral nucleic acid exerts control over the host's synthetic and metabolic machinery
- DNA viruses- enter host cell's nucleus where they are replicated
  - DNA enters the nucleus and is transcribed into RNA
  - The RNA becomes a message for synthesizing viral proteins (translation)
  - New DNA is synthesized using host nucleotides

Assembly & Release

- Assembly of enveloped viruses needs interaction with plasma membrane which has been modified
- Final stage of infection
- Enveloped viruses released gradually by budding or exocytpsis.
- Naked viruses accumulate in cytoplasm and released during lysis



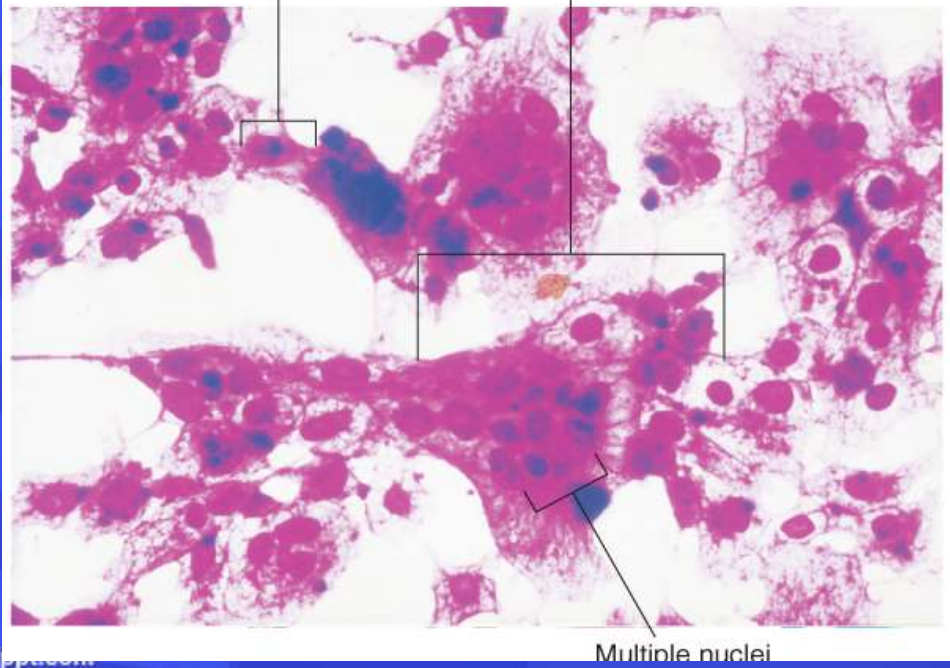
(a)



(b)

Damage to the Host Cell

- **Cytopathic effects**- virus-induced damage to the cell that alters its microscopic appearance
- **Inclusion bodies-** compacted masses of viruses or damaged cell organelles



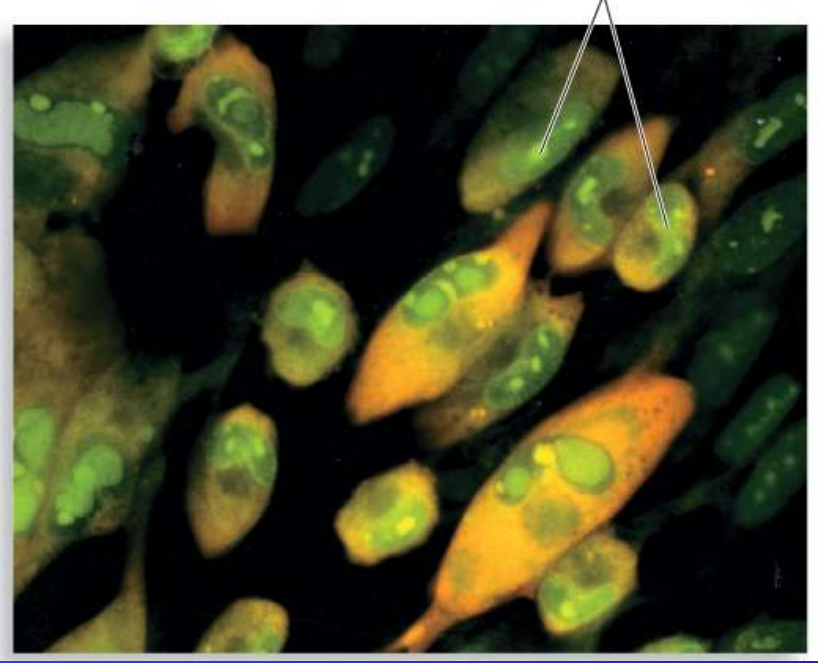
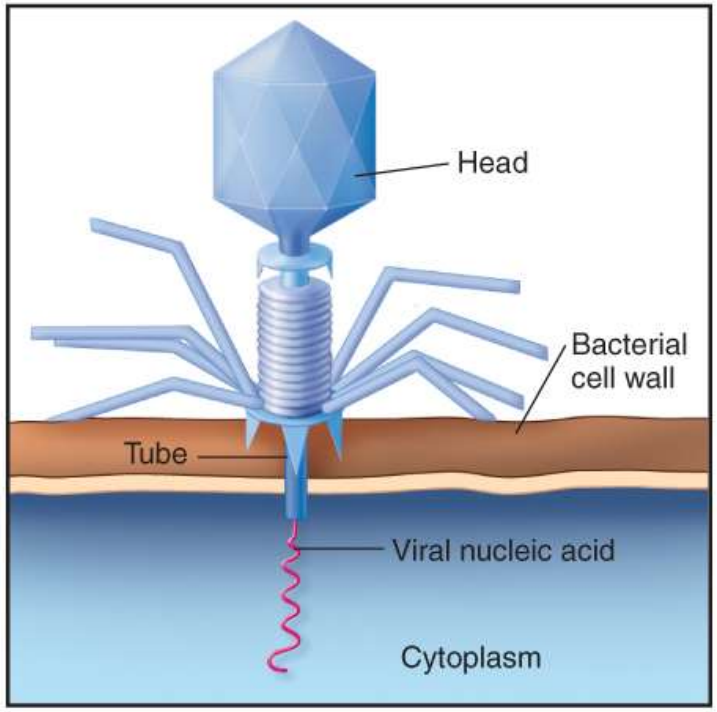


TABLE 6.6 Cytopathic Changes in Selected Virus-Infected Animal Cells

Virus	Response in Animal Cell
Smallpox virus	Cells round up; inclusions appear in cytoplasm
Herpes simplex	Cells fuse to form multinucleated syncytia; nuclear inclusions (see figure 6.16)
Adenovirus	Clumping of cells; nuclear inclusions
Poliovirus	Cell lysis; no inclusions
Reovirus	Cell enlargement; vacuoles and inclusions in cytoplasm
Influenza virus	Cells round up; no inclusions
Rabies virus	No change in cell shape; cytoplasmic inclusions (Negri bodies)
Measles virus	Syncytia form (multinucleate)

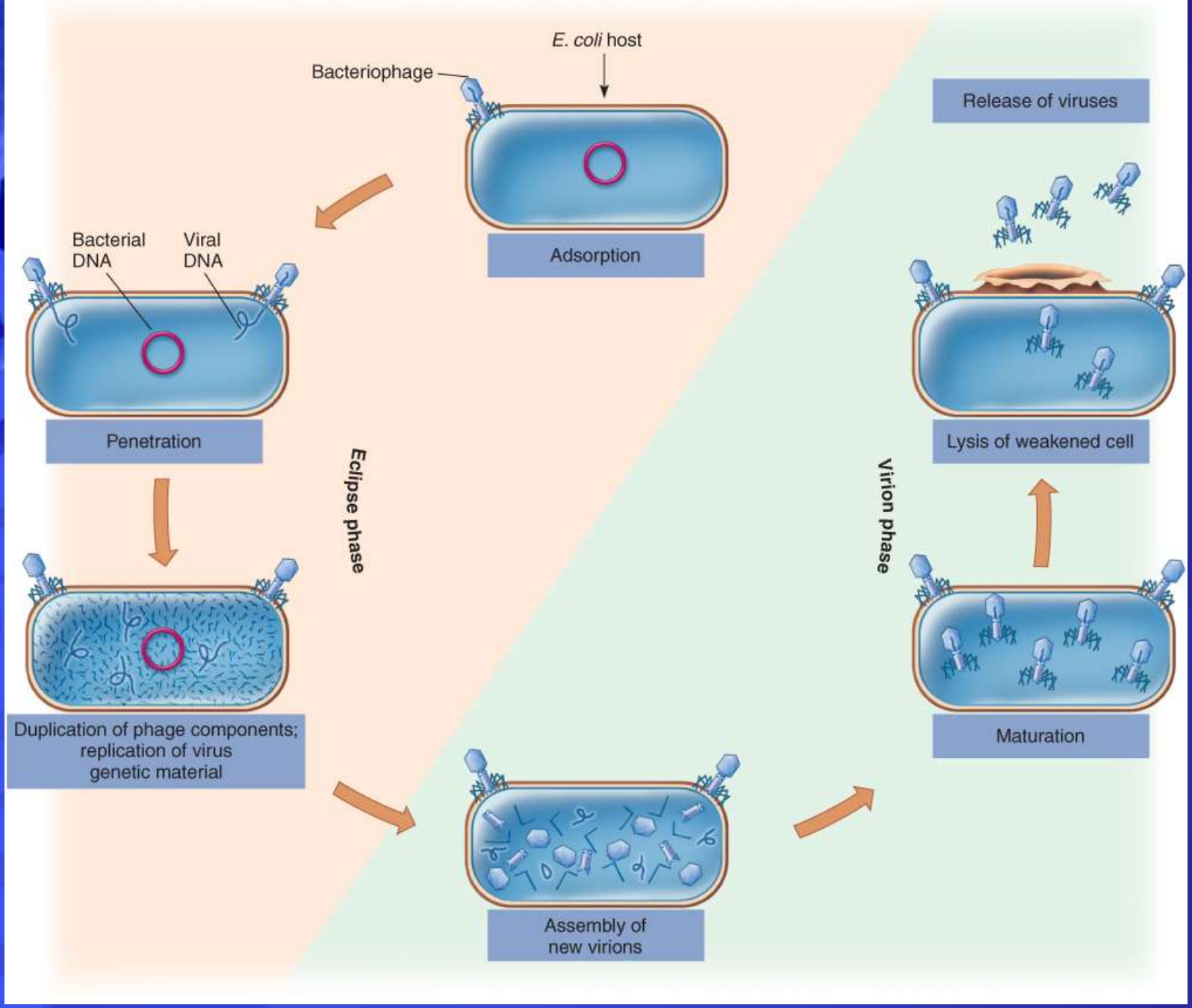
Viruses that Infect Bacteria

- Bacteriophage

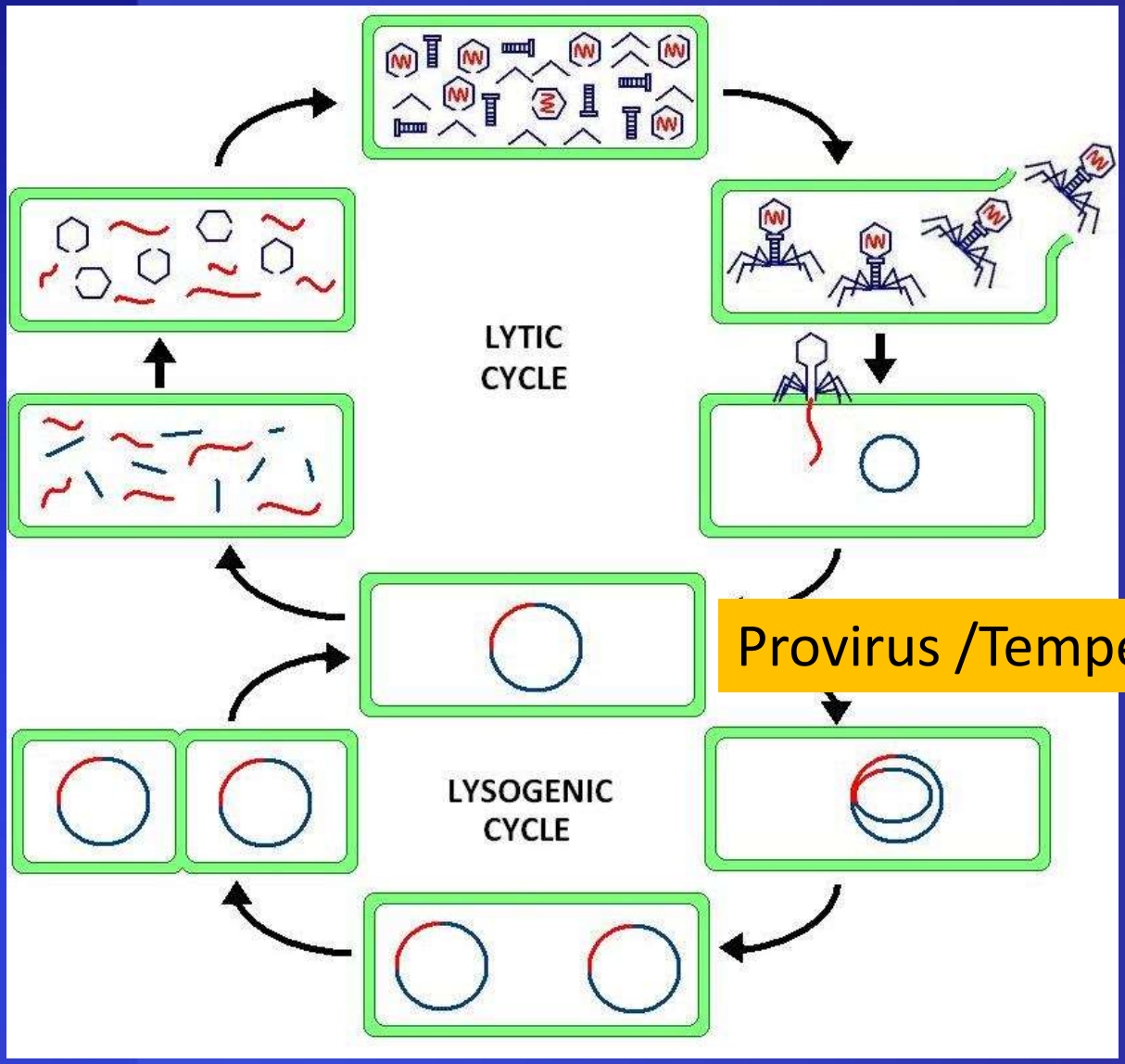


(a)

(b)



Cycles of Viral Reproduction



Provirus /Temperate virus

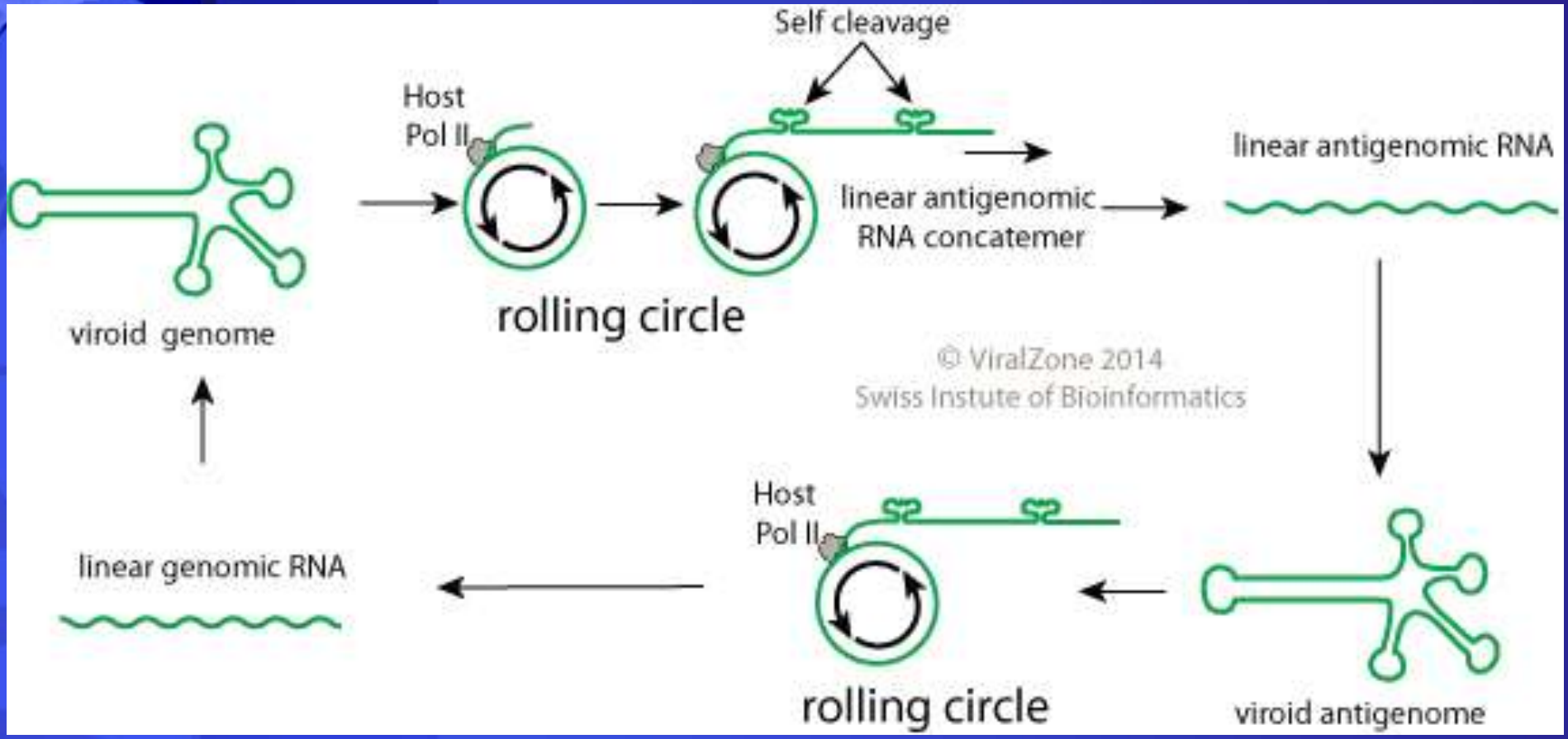
TABLE 6.7 Comparison of Bacteriophage and Animal Virus Multiplication

	Bacteriophage	Animal Virus
Adsorption	Precise attachment of special tail fibers to cell wall	Attachment of capsid or envelope to cell surface receptors
Penetration	Injection of nucleic acid through cell wall; no uncoating of nucleic acid	Whole virus is engulfed and uncoated, or virus surface fuses with cell membrane, nucleic acid is released
Synthesis and Assembly	Occurs in cytoplasm Cessation of host synthesis Viral DNA or RNA is replicated and begins to function Viral components synthesized	Occurs in cytoplasm and nucleus Cessation of host synthesis Viral DNA or RNA is replicated and begins to function Viral components synthesized
Viral Persistence	Lysogeny	Latency, chronic infection, cancer
Release from Host Cell	Cell lyses when viral enzymes weaken it	Some cells lyse; enveloped viruses bud off host cell membrane
Cell Destruction	Immediate	Immediate or delayed

VIROIDS

- Mostly plant pathogens
- Consists solely of small single- stranded circular RNA molecule having 250-370 nucleotides long.
- The RNA of a viriod doesn't encode any gene products; so they can't replicate themselves.
- They adopt the host RNA Polymerase II which synthesizes a negative RNA strand. Then it serves as a template for the synthesis of the other viriod RNAs.
- No protein coat.

Mode of Replication



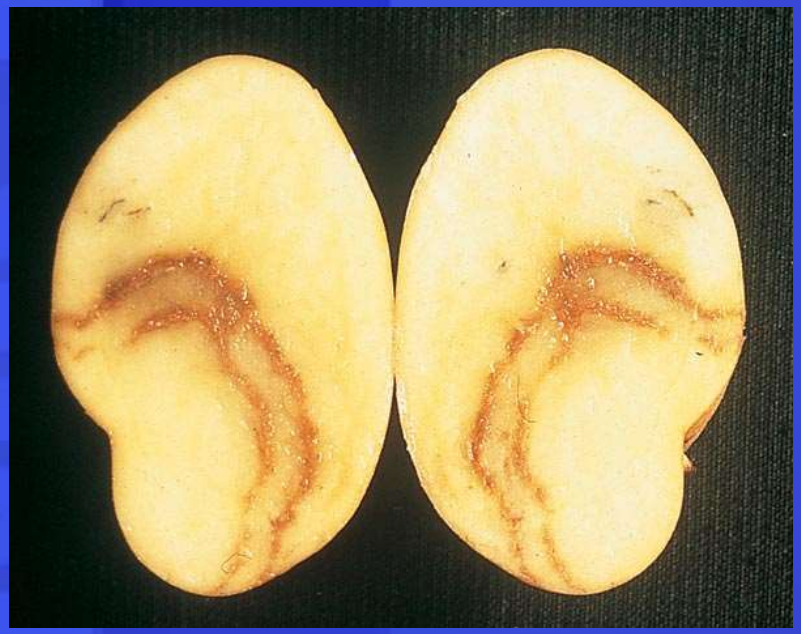
Transmission

- Viroid infections are transmitted by cross contamination following mechanical damage to plants as a result of horticultural or agricultural practices.

- Some are transmitted by aphids and they can also be transferred from plant to plant by leaf contact.

DISEASES CAUSED BY VIRIODS

- Viriods causes over 20 different plant diseases of which the most studied are
  - POTATO SPINDLE-TUBER DISEASE
  - CHRYSANTHEMUM STUNT DISEASE



Hepatitis D

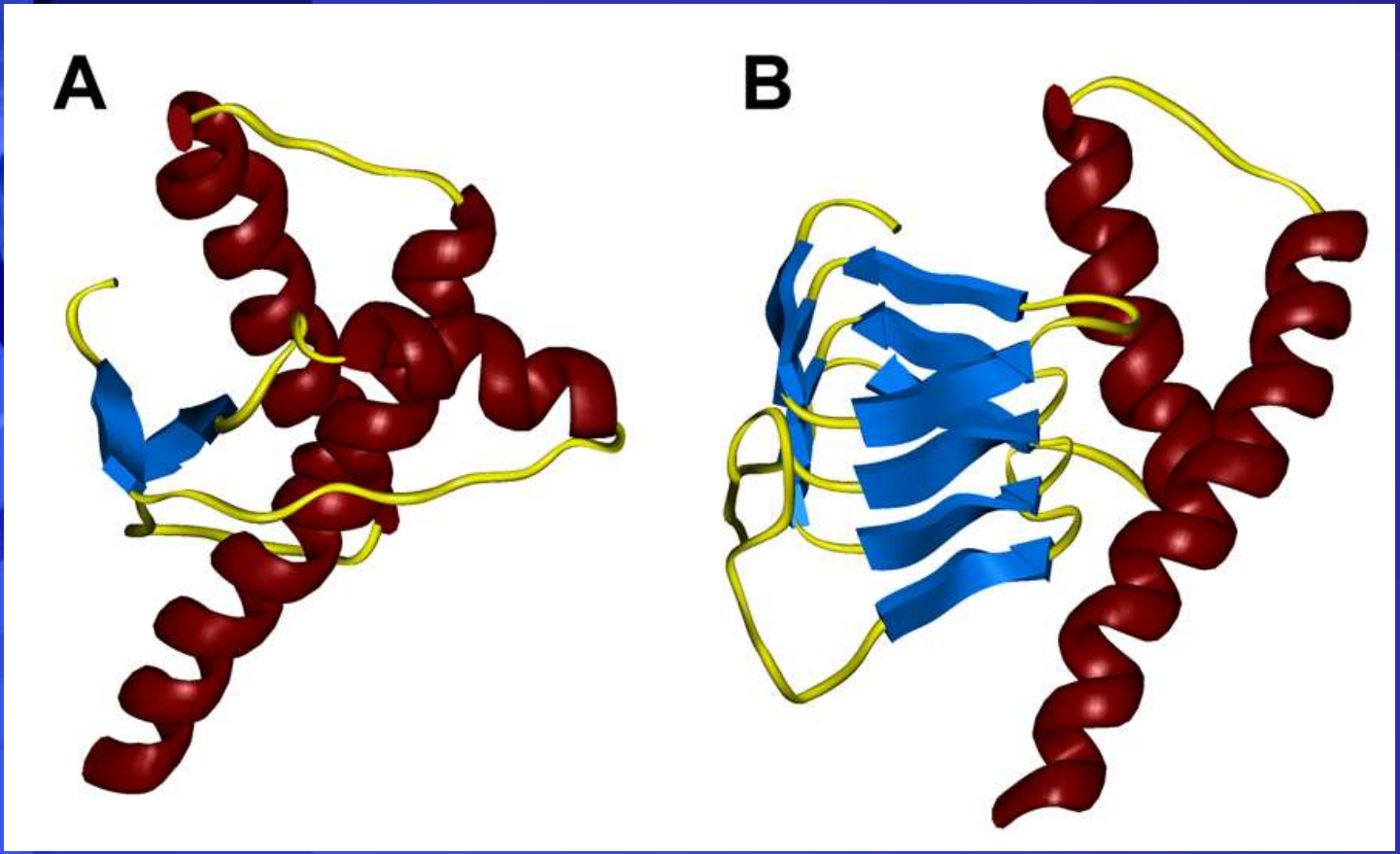
- Caused by Hepatitis delta virus(HDV).
- HDV is enclosed in a Hepatitis B virus capsid
- The HDV genome exists as an enveloped negative sense, single- stranded, closed circular RNA.
- HDV is the smallest viriod known to infect animals.

Hepatitis D

- Liver failure and rapid progression to liver cirrhosis.
- In combination to HBV, HDV has the highest mortality rate of all hepatitis infections.
- Enters the bloodstream and can be transmitted via blood or serum.

PRIONS

- Prions are infectious agents composed primarily of sialoglycoprotein.
- This protein is called prion protein (PrP)
- They contain no nucleic acid.
- They cause a variety of neurodegenerative diseases in humans and animals.



Normal prion protein

PrP^{c}

Abnormal prion protein

PrP^{Sc}

PATHOGENICITY

- The most studied prion is scrapie prion that causes the scrapie disease in sheeps and goats.
- Studies show that the causative agent, PrP^{Sc}, enters the brain of an animal converting the normal PrP^{c} to PrP^{Sc} which continue this conversion chain by changing its folding patterns.

MODE OF TRANSMISSION

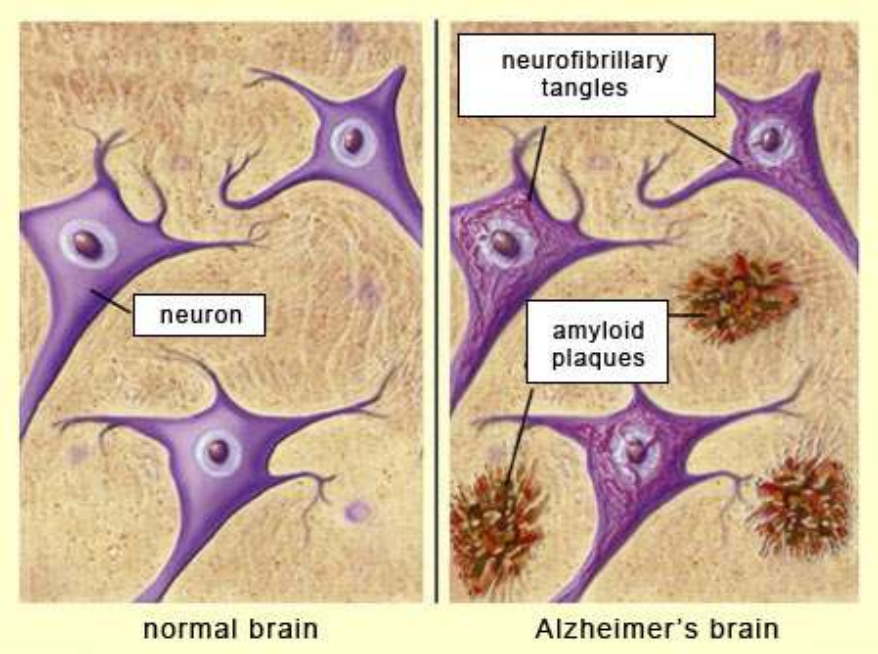
- It has been recognized that prion diseases can arise in three different ways:

1. Acquired
2. Familial
3. Sporadic

Current research suggests that the primary method of infection in animals is through ingestion.

DISEASES CAUSED BY PRIONS

- In cattles
  - Bovine Spongiform Encephalopathy or Mad Cow Disease
- In Humans
  - Alzheimer's disease
  - Down's syndrome
  - Fatal familial insomnia
  - Kuru Leprosy


neuron
neurofibrillary tangles
amyloid plaques
normal brain
Alzheimer's brain


World Down Syndrome Day
3.21.12
Anna.Theurer

	Virus	Viroids	Prions
Genome	DNA or RNA	RNA	None
Strand	Ds or ss	ss	ss
Coat	Capsid and Envelope	For HDV only	None
Target	Animal, plant, bacteria, archea	Plants	Animals
Host Cell / Organ	All type of cells	Plant cells	Nervous sysem

References

Baron, S. 2004. Structure and Classifications of Viruses. Medical Microbiology. 4th edition

Houghton Mifflin Harcort. 2014. Viral Structure and Replication. Microbiology.

Tortora, G., et.al. 2010. Microbiology: An Introduction. McGraw-Hill Companies