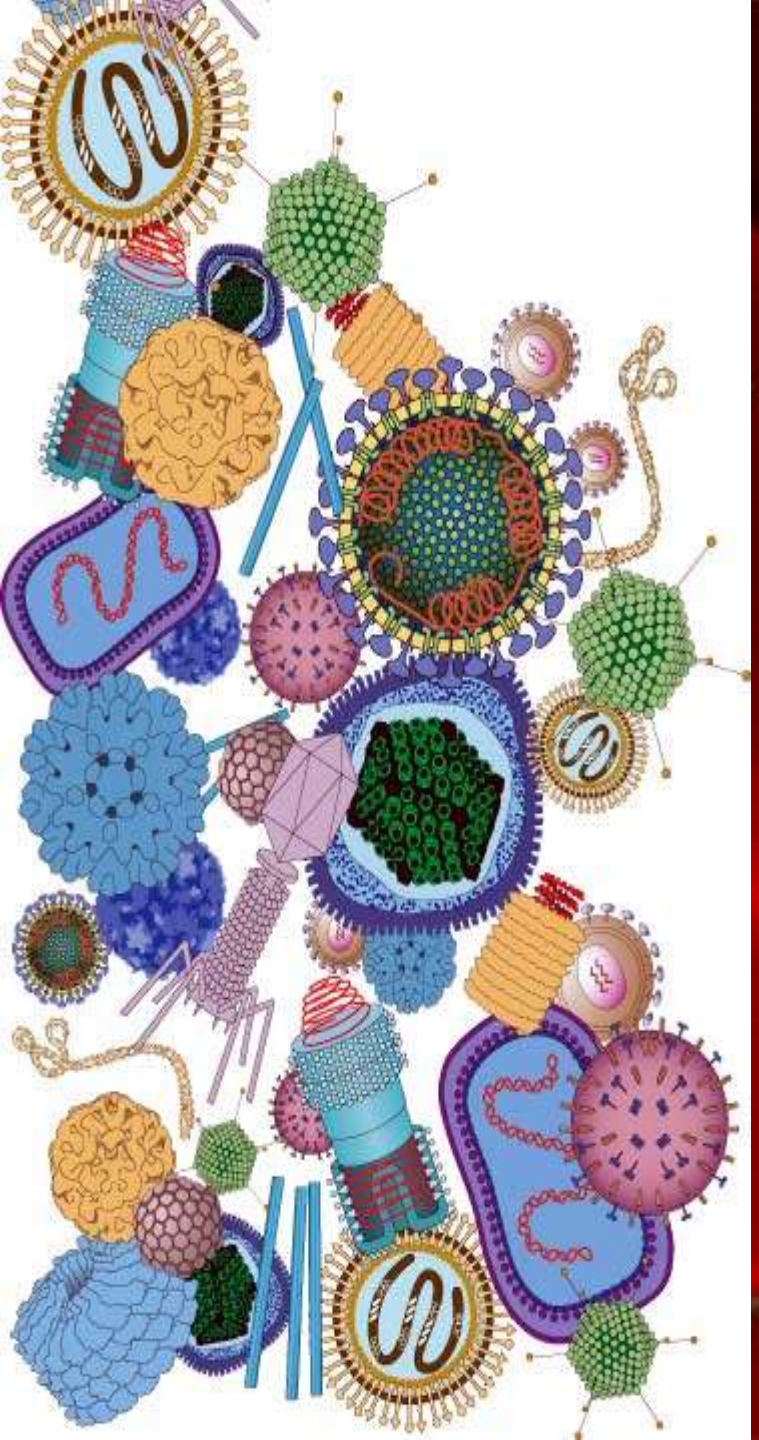
VIRUSES ,VIRIODS AND PRIONS

General Virology

- Conception
- Viruses
- Virion
- Size and Shape
- Structure
- Replication
- Viral Variation
- Classification



Viruses

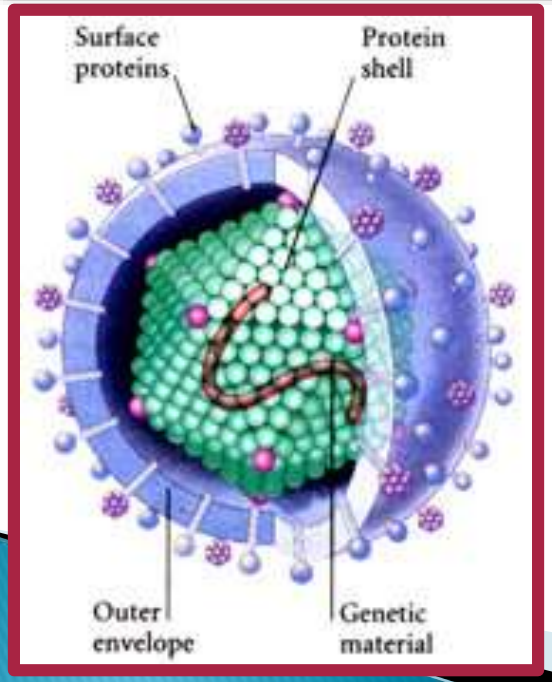
Doesn’t belong to any kingdom
-It’s not a plant or an animal.
-It’s not a fungi, protist, or bacteria.

WHAT IS A VIRUS?

A virus is an infectious agent made up of nucleic acid (DNA or RNA) wrapped in a protein coat called a capsid.

Viruses have no nucleus, no organelles, no cytoplasm or cell membrane—Non-cellular

This is why it does NOT belong to any kingdom.



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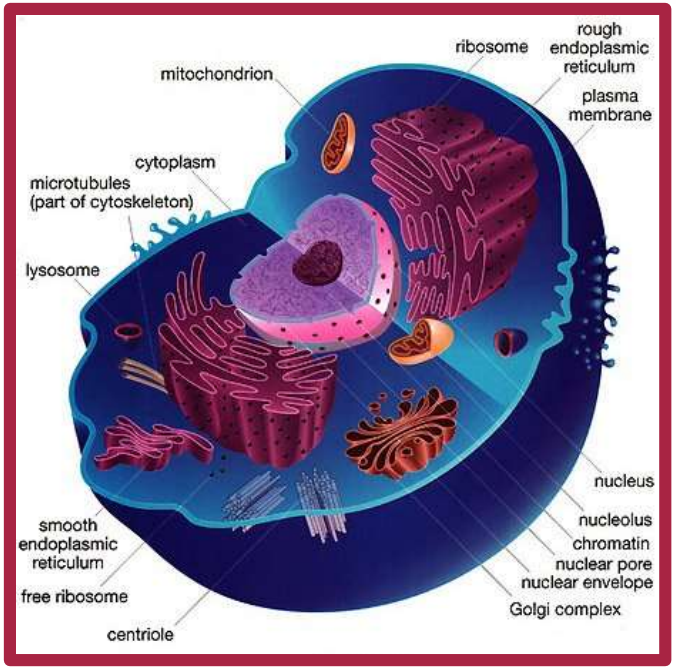


Viruses Structure

- Virus particle are also called virion
- Comprised of two parts:
- 1. Nucleic Acid
- 2. Protein coat (capsid)
- Nucleocapsid- capsid with nucleic acid inside
- Each capsid made of identical protein subunits called capsomeres.

Consequences of Viral Properties (Characterstics)

- Viruses are not living
- Viruses are obligate parasites
- Viruses must be able to use host cell processes to produce their components (viral messenger RNA, protein, and identical copies of the genome)
- Viral components must self-assemble

Challenges the way we define life

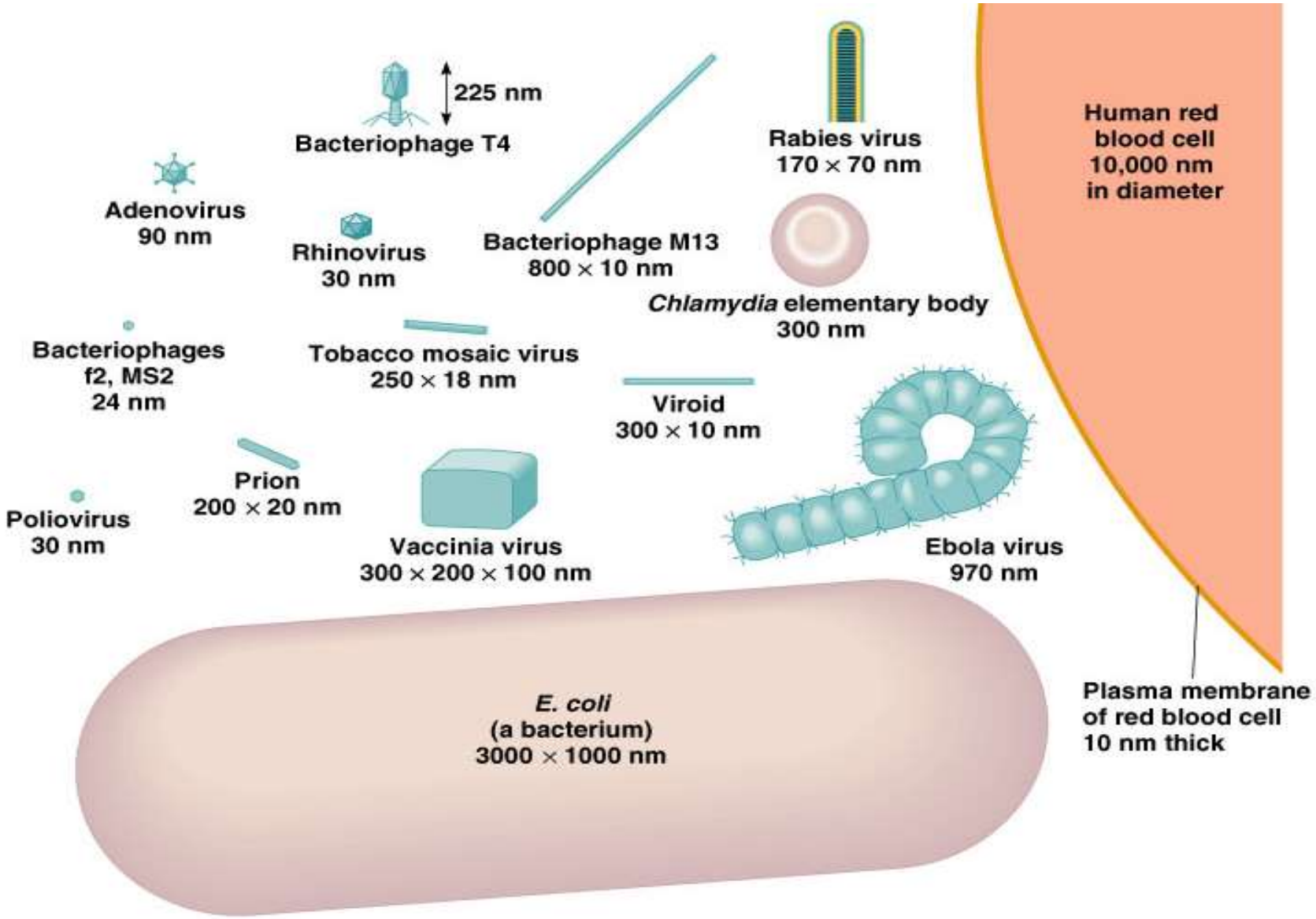
- viruses do not respire,
- nor do they display irritability应急性;
- they do not move
- they do not grow
- they do most certainly reproduce, and may adapt to new hosts.


How many characteristics of life do viruses possess?
ONE
*Genetic Material
Are viruses living?
NO

Methods of Analysis

- Electron microscopy : The resolution is 5nm (1nm = 10^{-9} m)
- X-ray crystallography

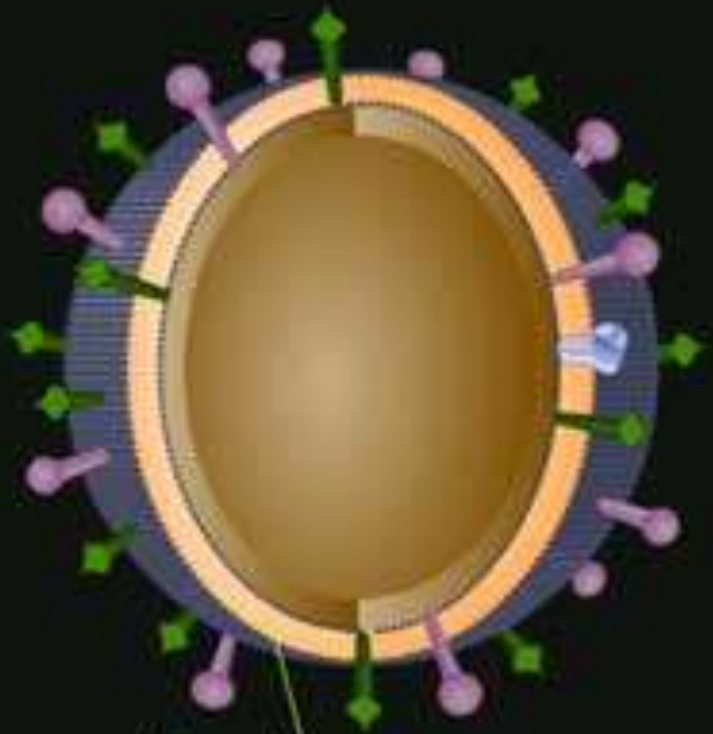
Size of Viruses



What is a virus made up of?

Thus the major components of virions are:

a) Nucleic acid b) Protein coat-capsid c) Lipid envelope



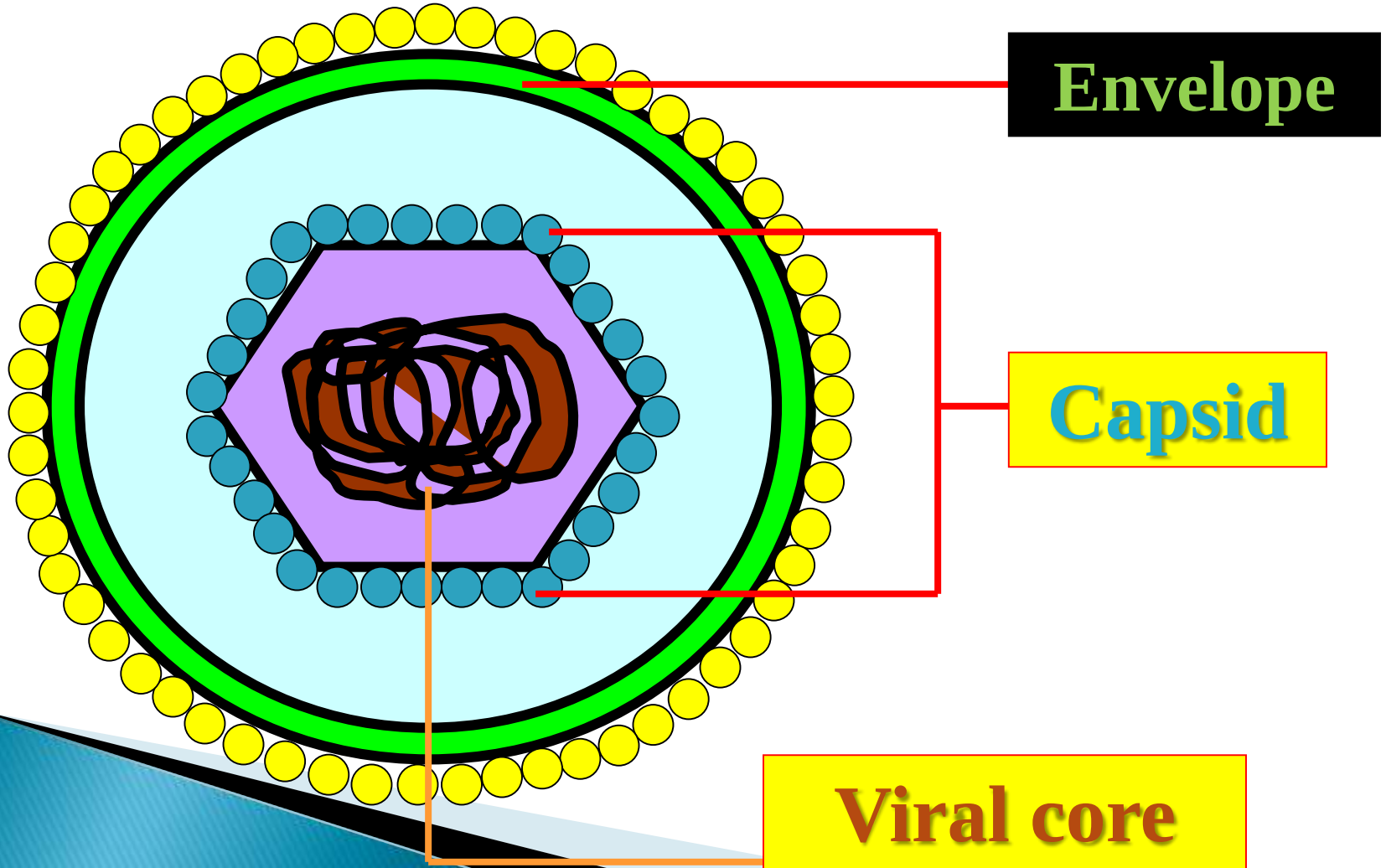
Envelope
(Phospholipid bilayer.)

Capsid

Nucleic acid
(Genome)

Viruses

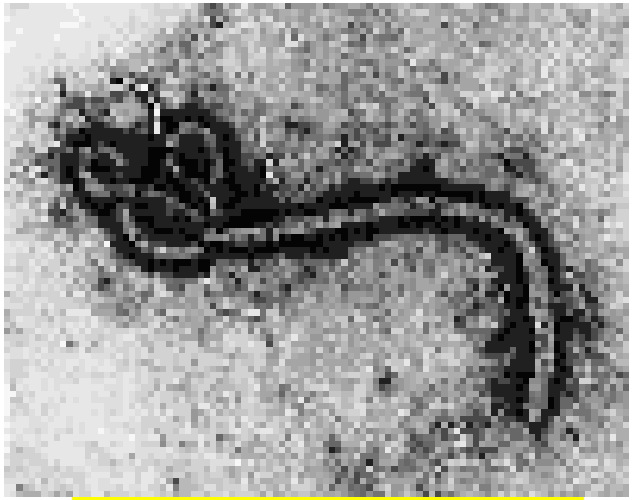
Virion (virus unit)



Virus Structure (Shape)

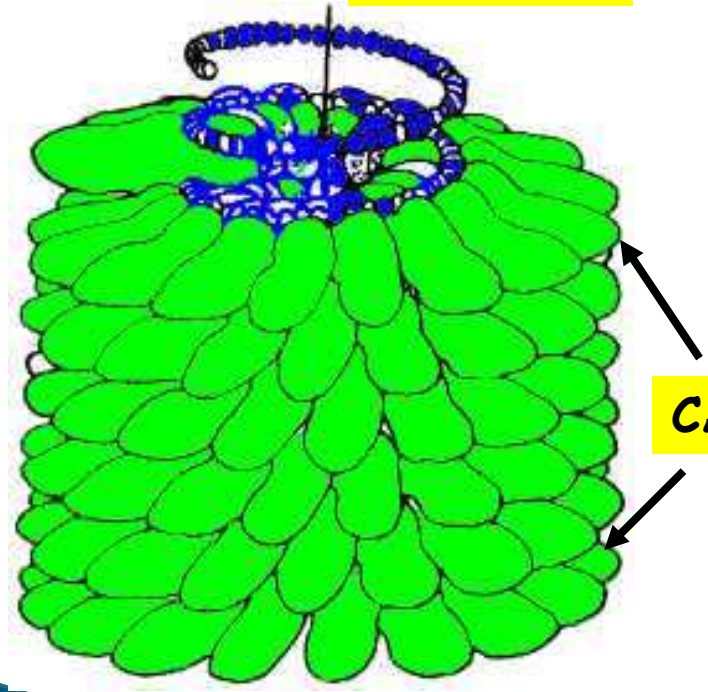
- 1- Helical
  - Ebola Virus
- 2- Icozahedral
  - Influenza Virus
- 3- Complex
  - Bacteriophage (Coliphage)

Helical symmetry



EBOLA VIRUS

Nucleic Acid



CAPSOMERES

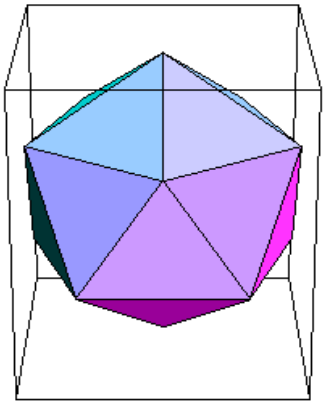
Capsid

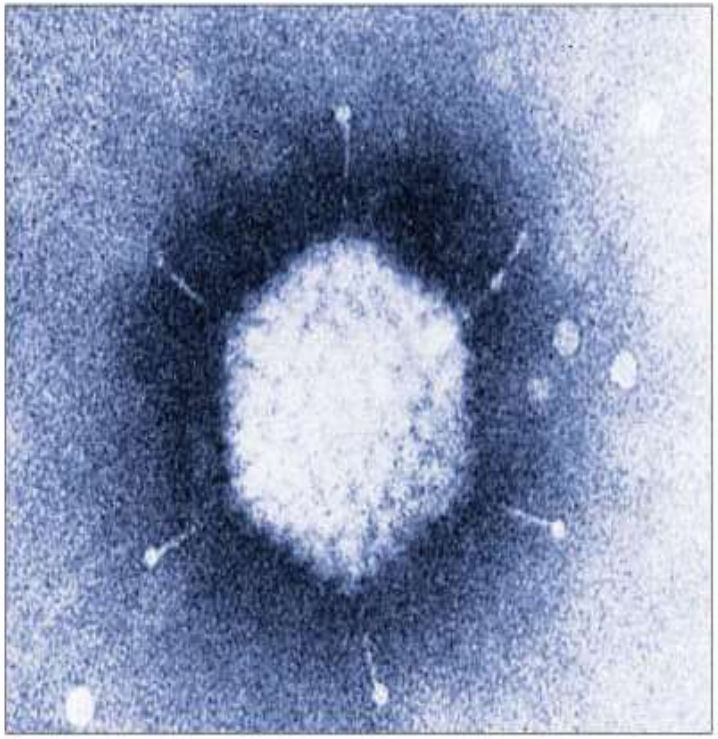
Helical

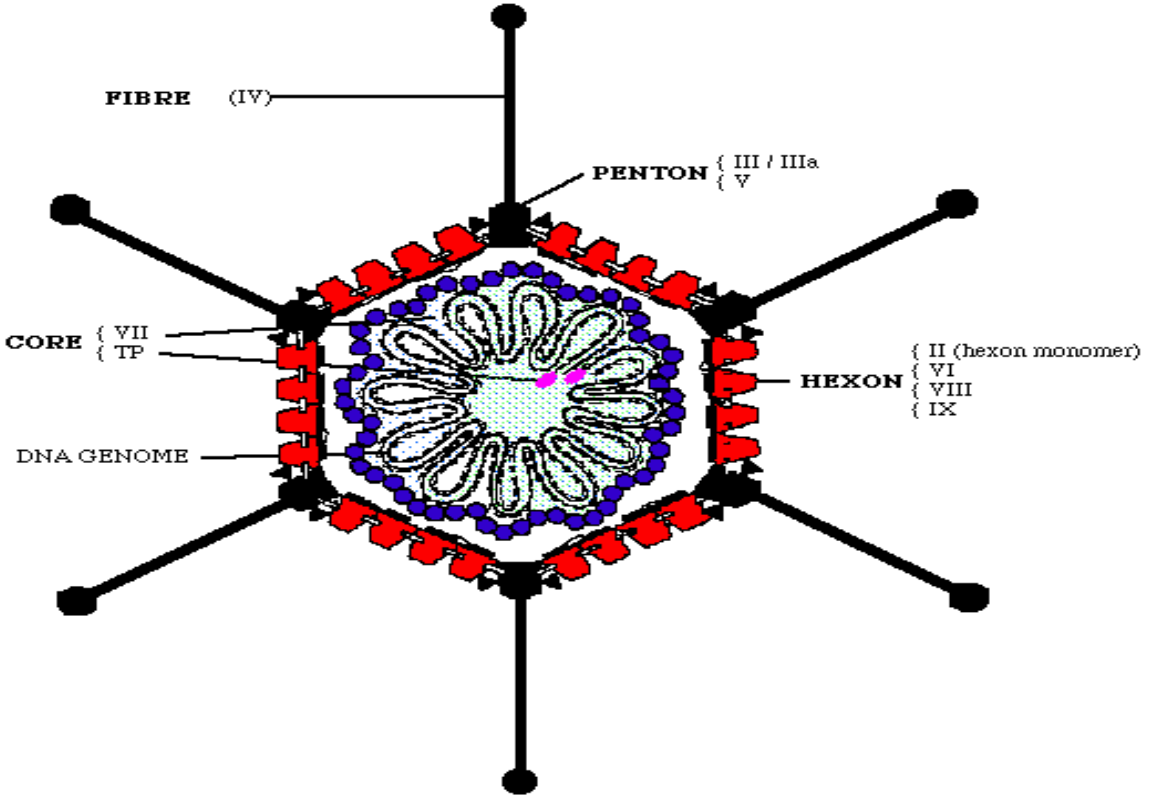
- **Examples:**

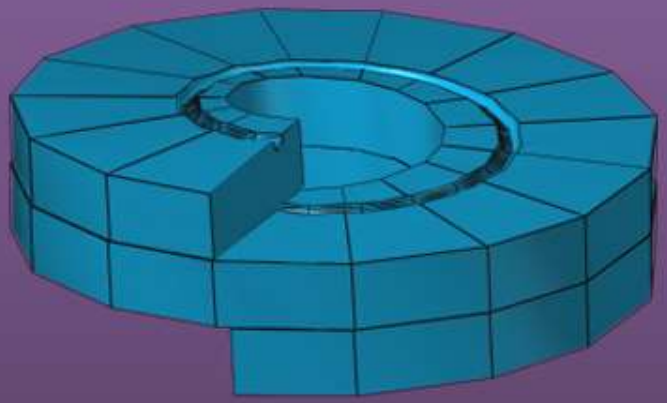
  California Encephalitis Virus
  Coronavirus
  Hantavirus
  Influenza Virus (Flu Virus)
  Measles Virus (Rubeola)
  Mumps Virus
  Parainfluenza Virus
  Rabies Virus
  Respiratory Syncytial Virus(RSV)

Cubic or icosahedral symmetry









HELICAL ICOSAHEDRAL

Nucleic acids (Core)

The genomes (sets of genes) maybe

1. Double stranded DNA (d.s. DNA).
2. Single stranded DNA (S.S. DNA).
3. Double stranded RNA (D.S. RNA).
4. Single stranded RNA (S.S. RNA).

They are called either a DNA or RNA virus depending on the type of nucleotide in the make-up.

They may be linear or circular

The smallest have only 4 genes and largest have several hundred.

DNA VIRUSES (Family) –suffex (–viridae)

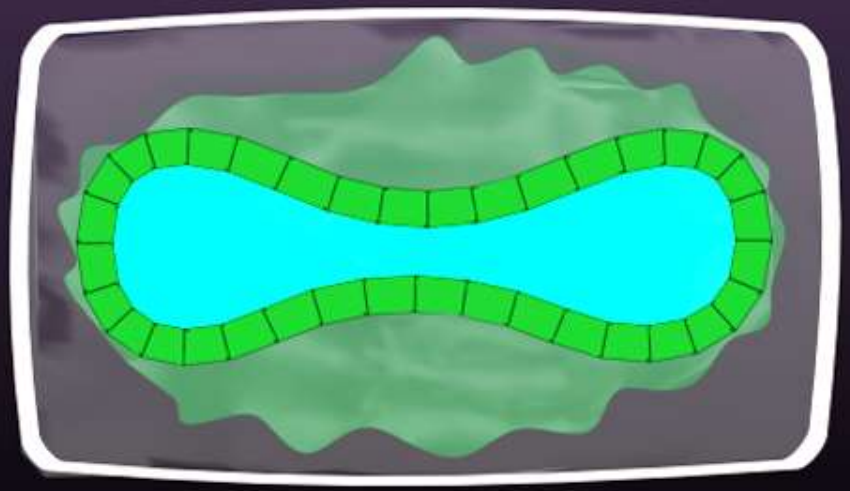
PARVOVIRIDAE

POLYOMAVIRIDAE

ADENOVIRIDAE

HERPESVIRIDAE

HEPADNAVIRIDAE



POXVIRIDAE

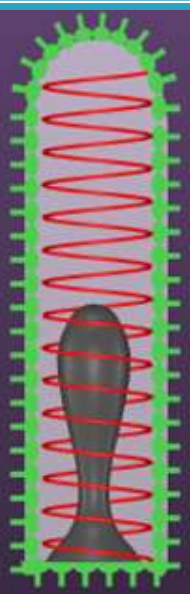
RNA VIRUSES (Family) –suffex (–viridae)

TOGAVIRIDAE
FLAVIVIRIDAE

PICORNAVIRIDAE

REOVIRIDAE

BUNYAVIRIDAE



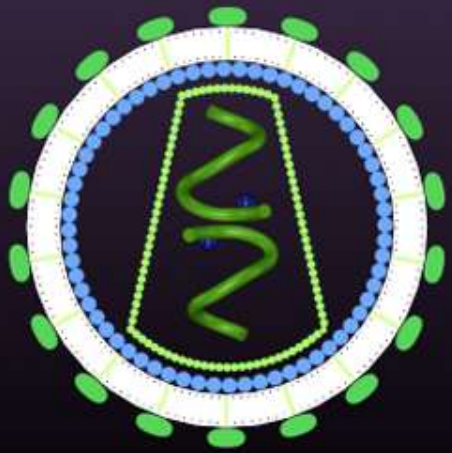
RHABDOVIRIDAE

ARENAVIRIDAE

CORONAVIRIDAE

PARAMYXOVIRIDAE

ORTHOMYXOVIRIDAE



RETROVIRIDAE

VIRUS GENOMES

DNA

Single Stranded

Double Stranded

Circular

RNA

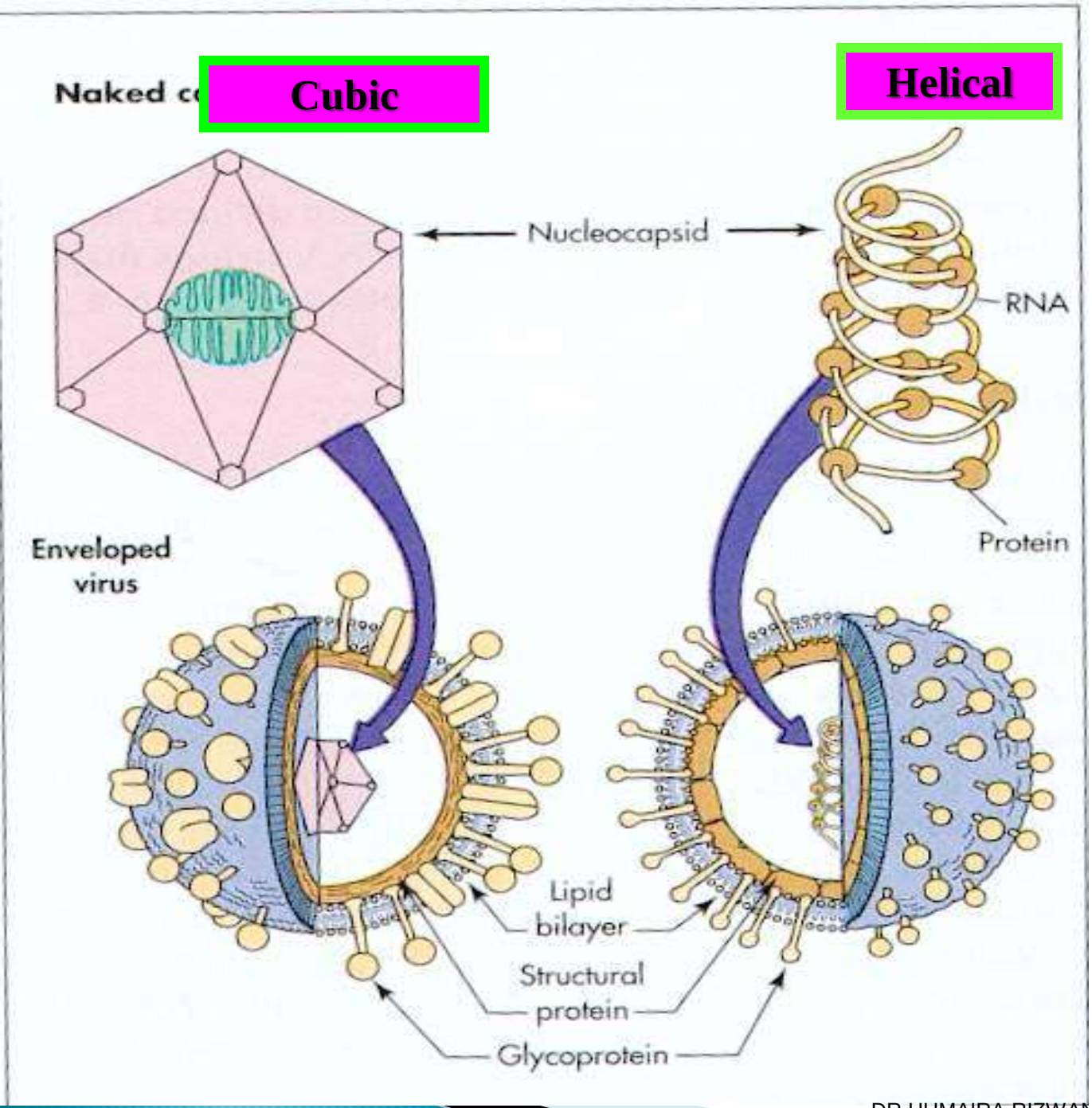
\+ or -

Segmented

Double Stranded Segmented

Two basic types of virions

- Naked: consist only of nucleic acid and capsid
- Enveloped virus: consists of nucleic acid, capsid, and envelope.

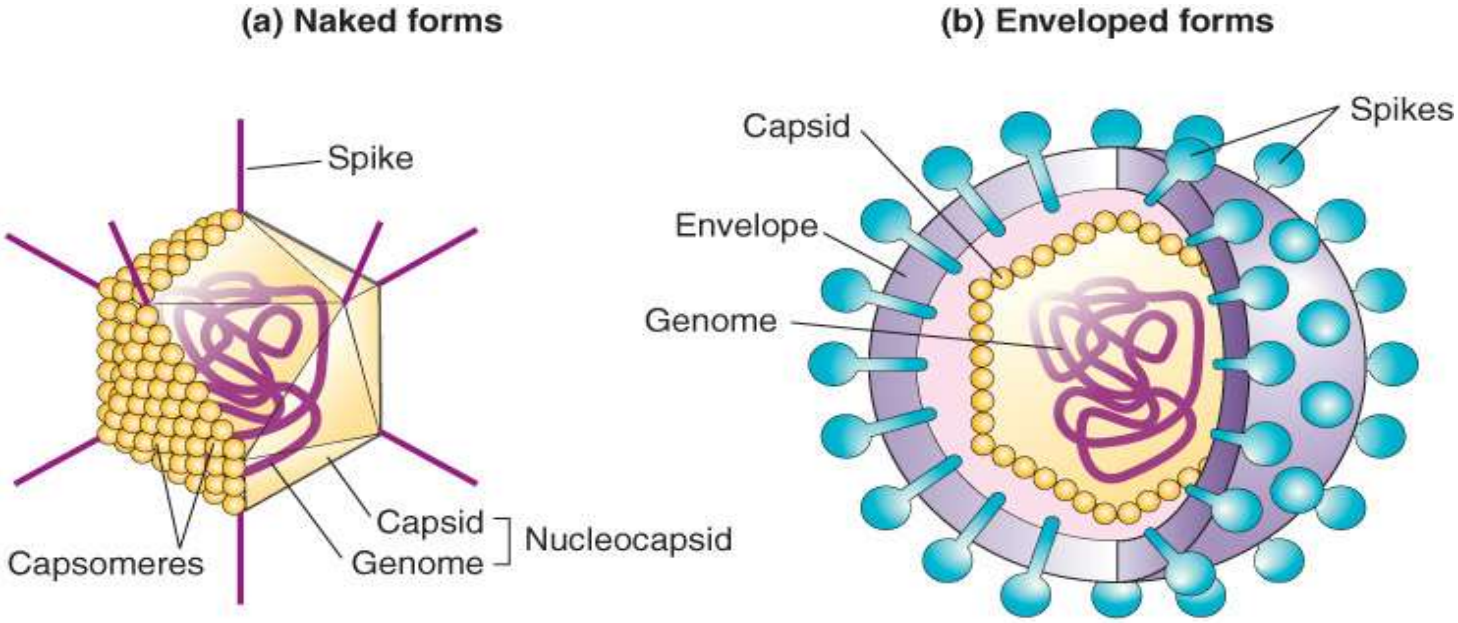


Naked Virus

Enveloped Virus

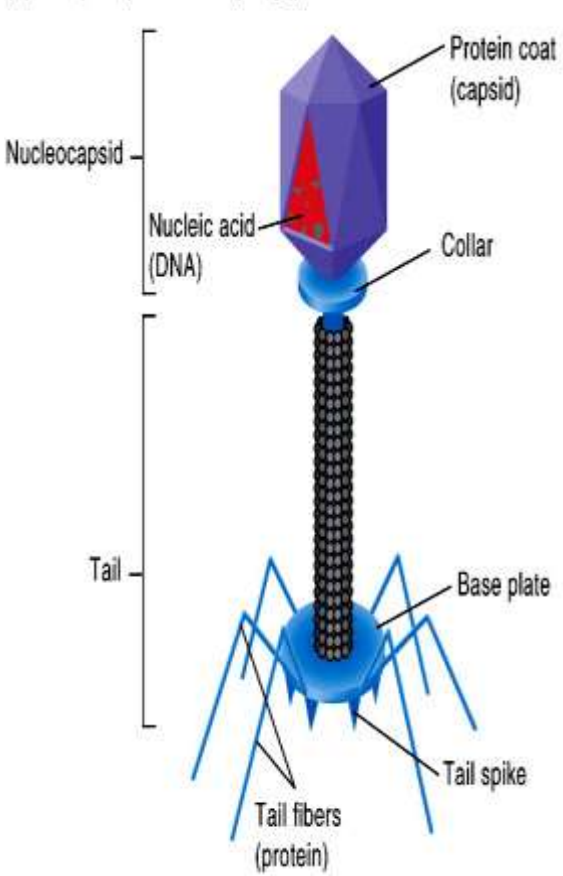
Naked Virus

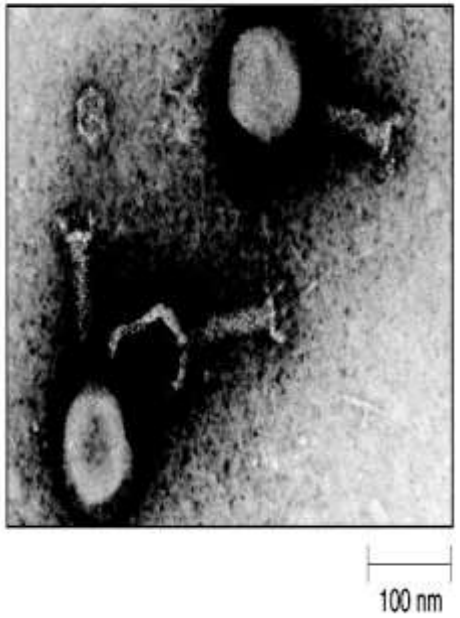
Enveloped Virus

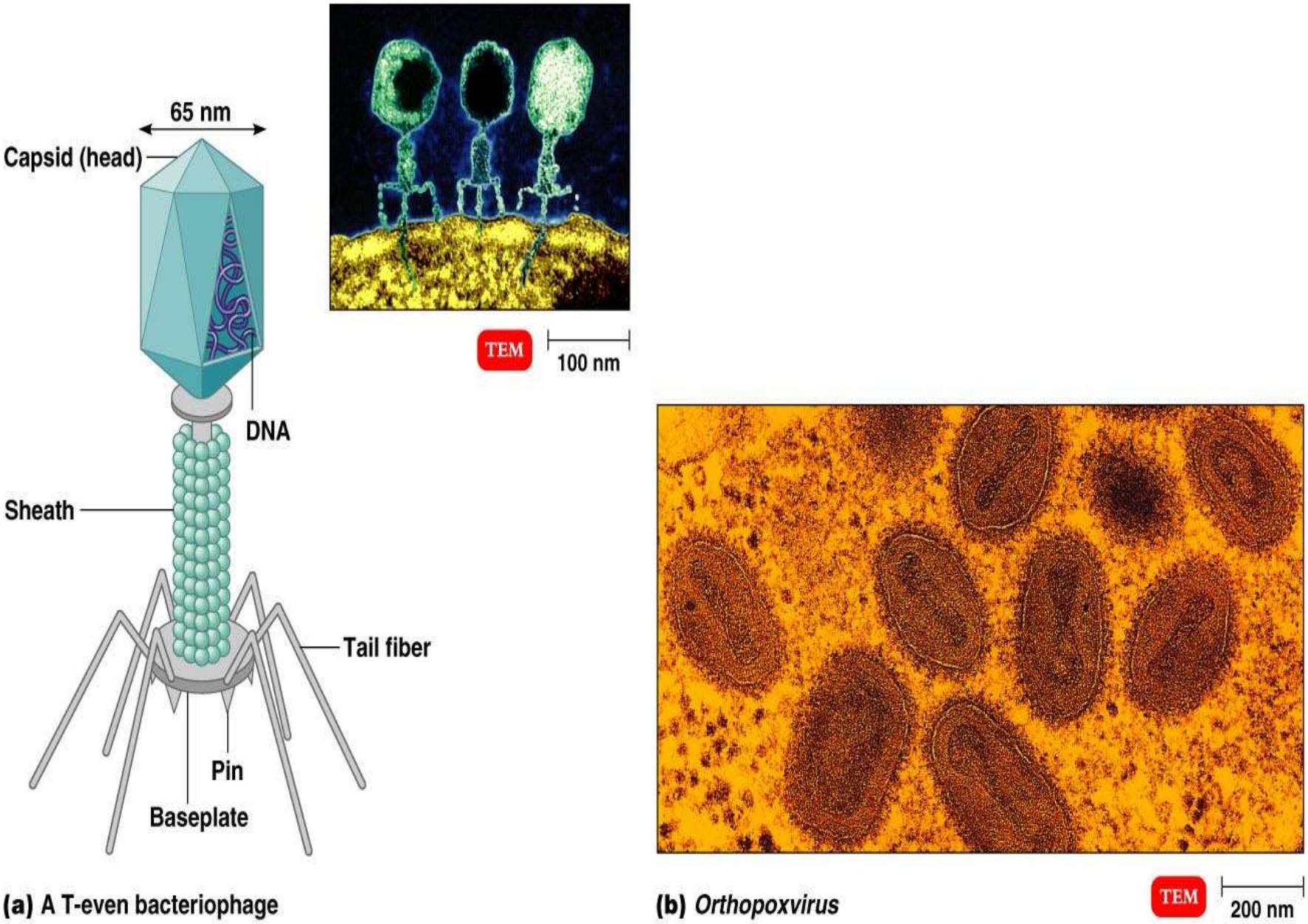


Bacteriophage

Virus that infects bacterial cells.







(a) A T-even bacteriophage

(b) *Orthopoxvirus*

Virus attachment to host cells

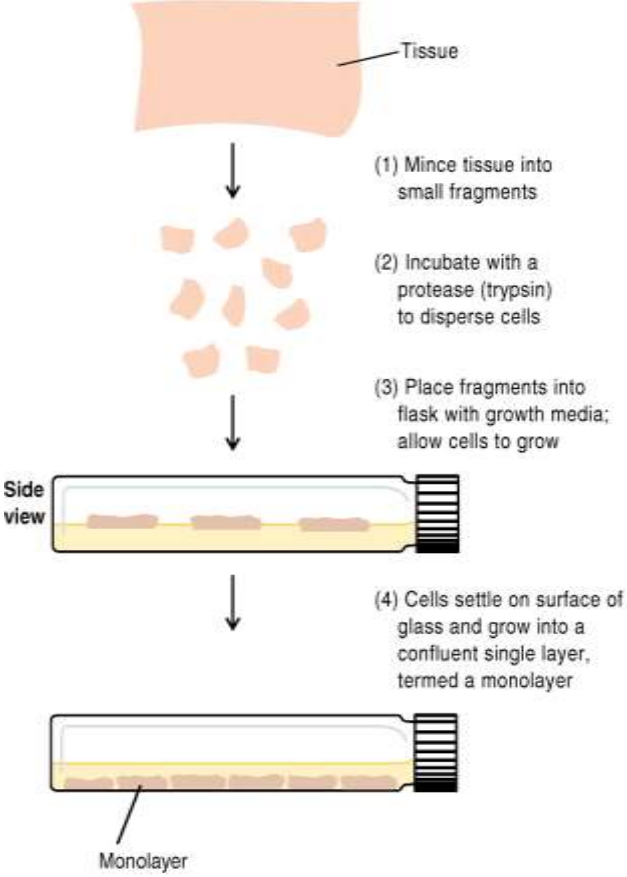
- All viruses must be able to attach to specific receptors on host cells
- **Attachment spikes** project from the capsid or envelope
- In viruses with tails– **tail fibers** attach the virus to the host cell

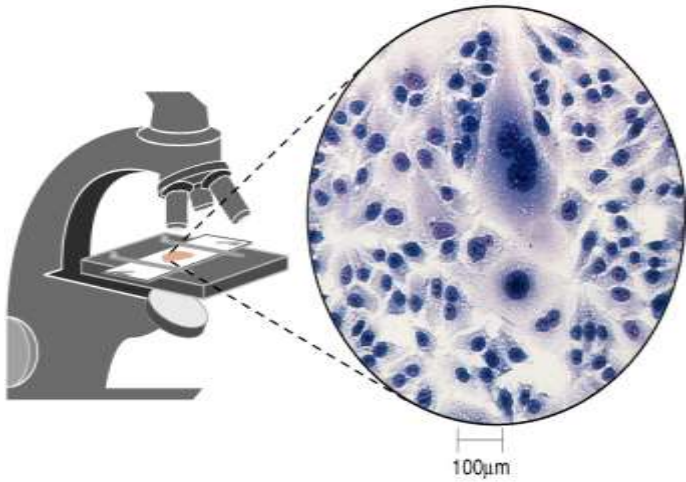
Methods of Study

Much more expensive and difficult to study animal viruses than bacteriophages

Cultivation in host cells

- Living animal
- Embryonated chicken eggs
- Cell or tissue culture *(= in vitro)*





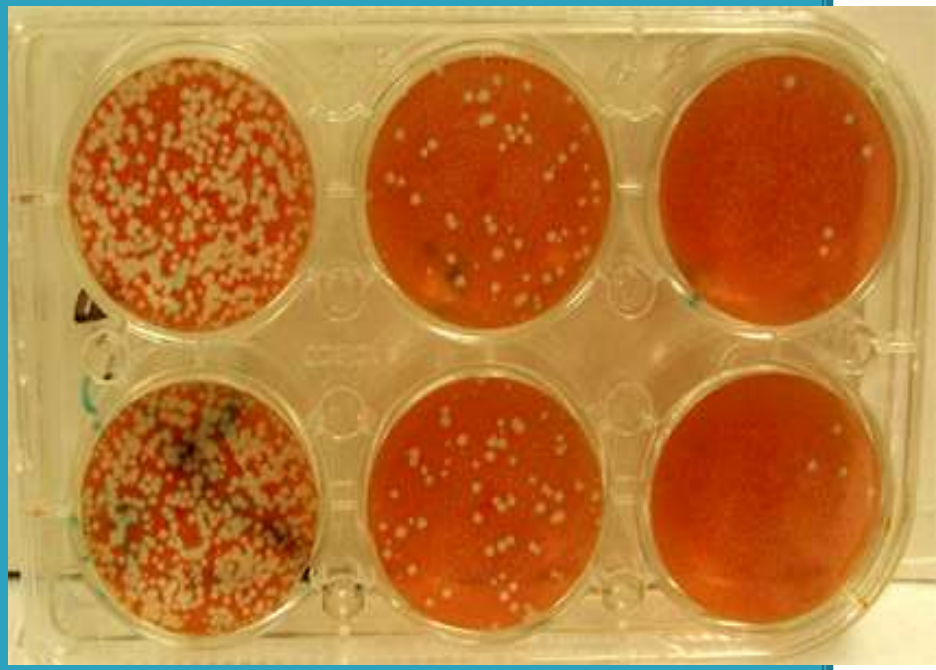
Methods of Study cont: Quantitation

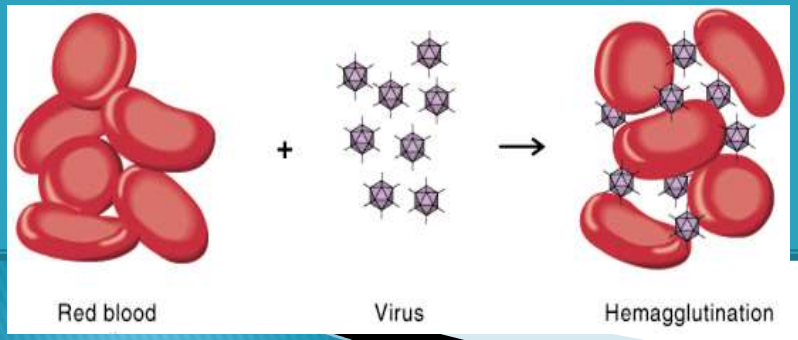
- **Plaque assay** (useful for infective and lytic viruses)

  Virion counting with EM

- Quantal assay
  (ID_{50} or LD_{50})

- Hemagglutination
  (e.g.influenza virus)





Multiplication of Bacteriophages

Two possible outcomes following viral infection of a bacterial cell

A. **Lytic Infection**: viruses multiply inside the cells they invade.

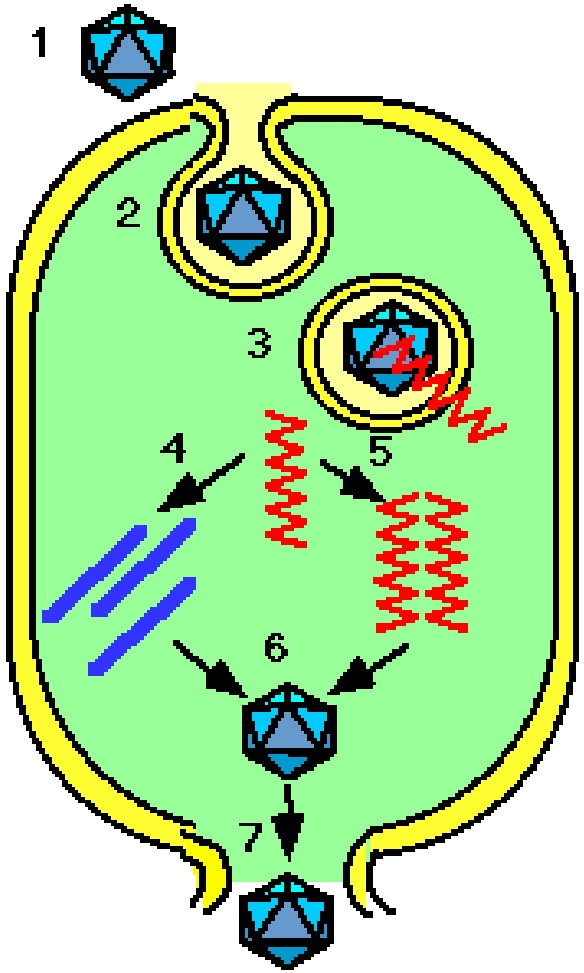
B. **Lysogenic Infection**: integrate viral DNA into host cell chromosome; the virus DNA replicates as the bacterial chromosome replicates.

A- Replication of lytic phages

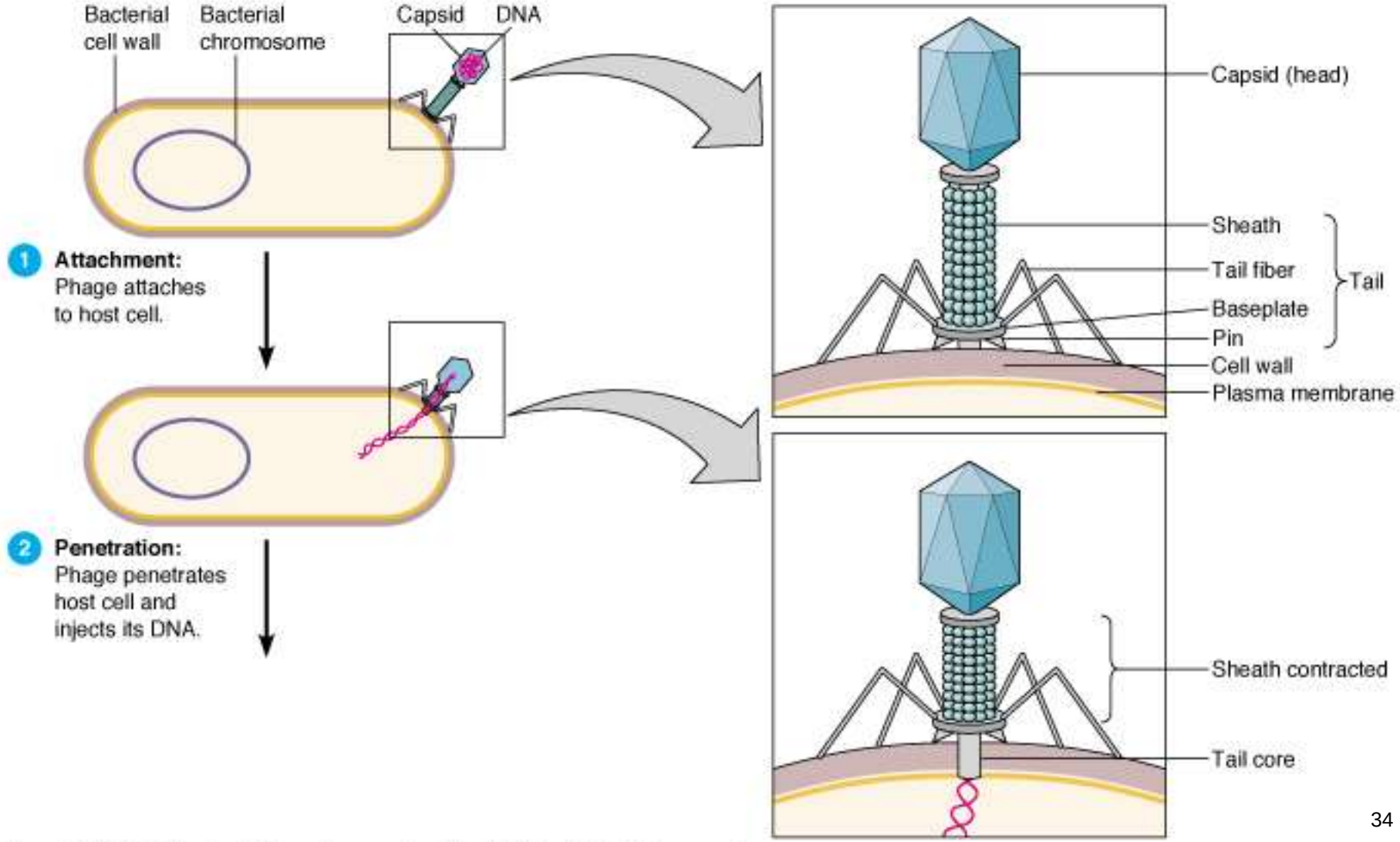
1. Phage nucleic acid enters the bacterium and capsid remains outside
2. Nucleic acid replicated along with phage proteins
3. Many virions are formed
4. Phages exit by bursting the cell
5. Phages that go through this life cycle are called **virulent**
6. **Virulent:** has the ability to overcome host defenses and cause disease

Typical infectious cycle

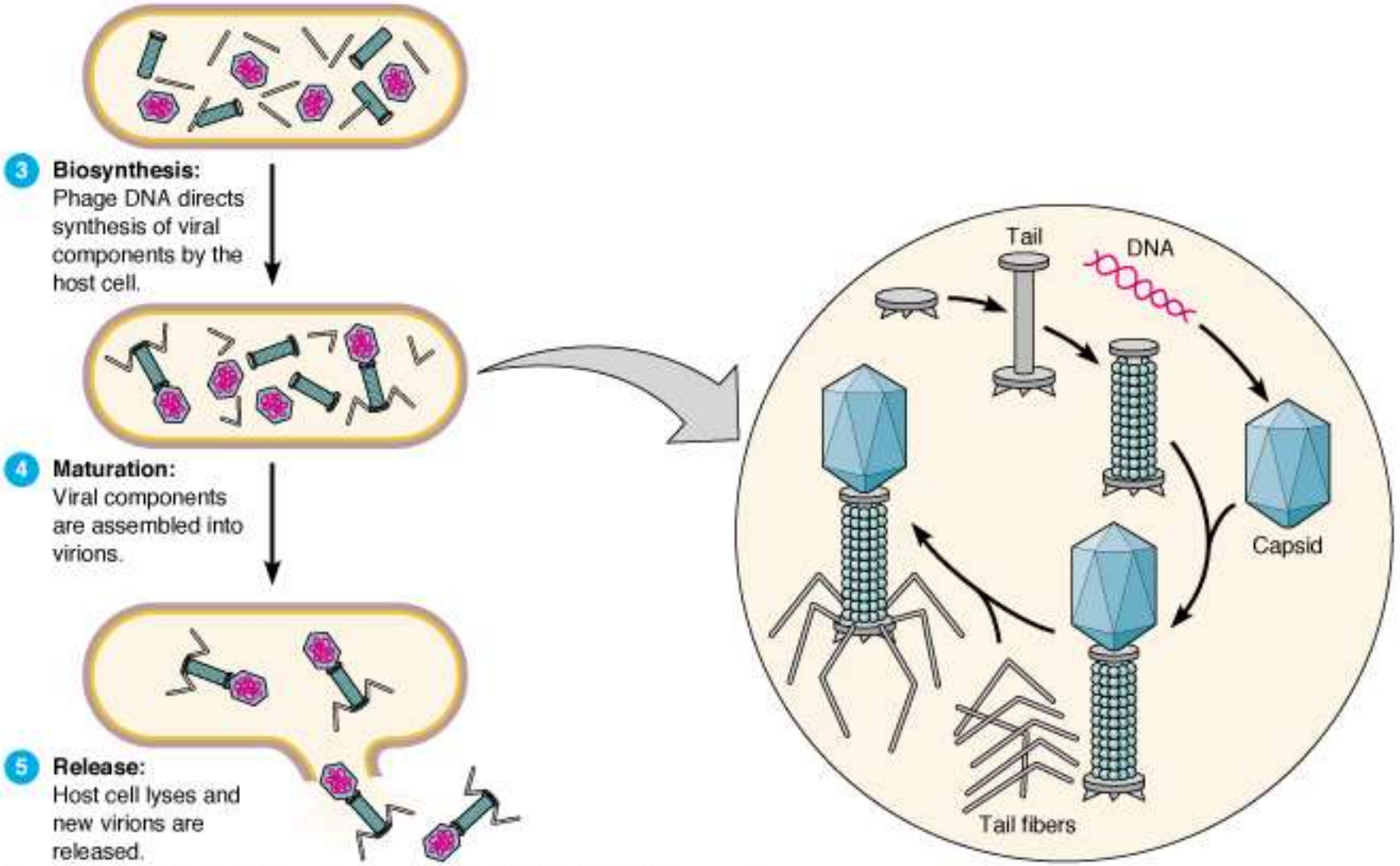
1. Attachment
2. Penetration
3. Uncoating
4. Transcription and/or translation
5. Replication
6. Assembly
7. Release



Attachment & Penetration

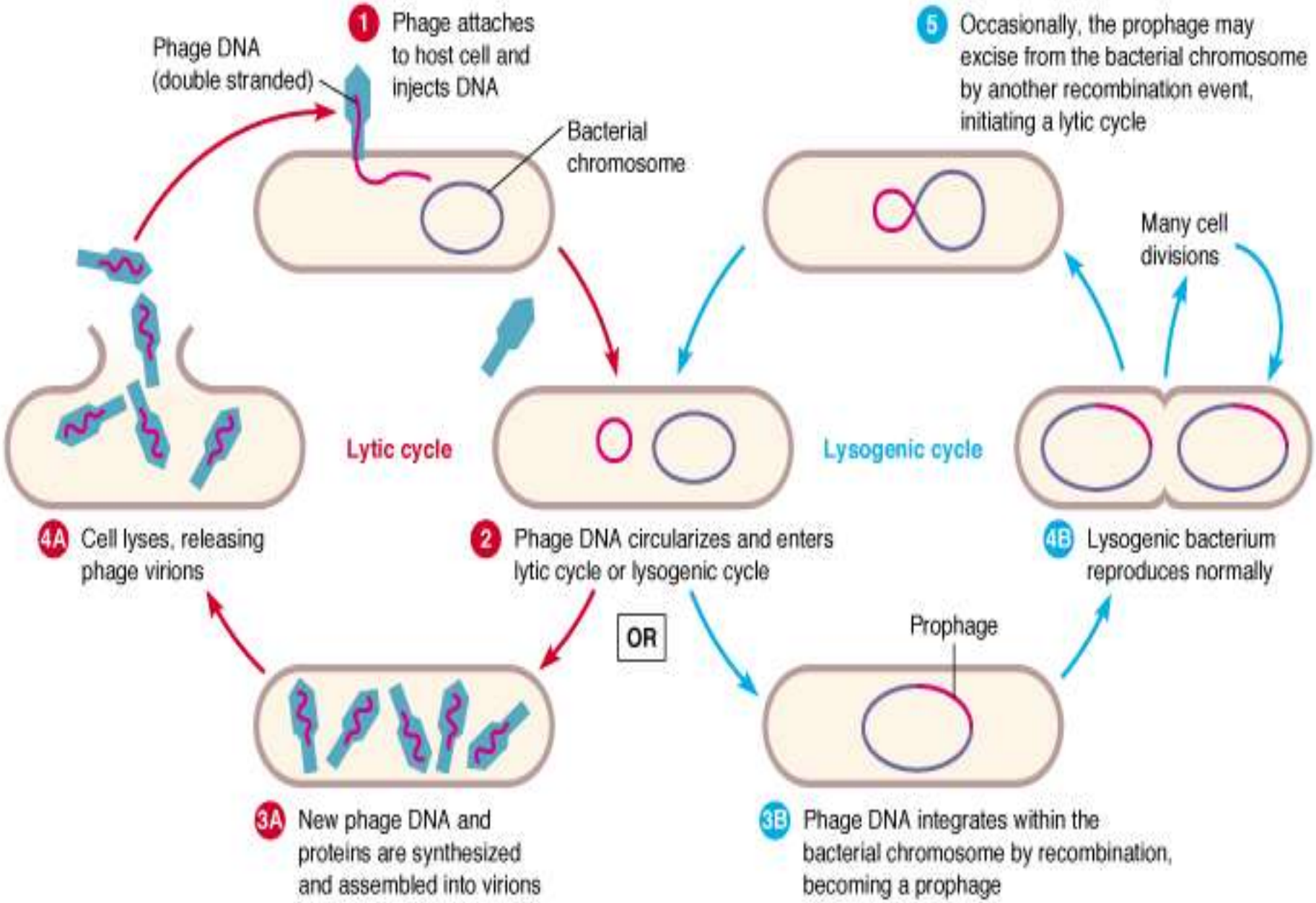


Uncoating, transcription/translation & Replication



B- Lysogenic Infection

- The viral DNA is incorporated into the host genome
- Each time the host chromosomes replicated and split into new cells, so is the viral DNA
- Phage may excise itself from the chromosome and later and revert to lytic growth



Host range of phages

- Host range: number of different bacteria that a particular phage can infect
- Two factors determine the host range of a phage:

1. Phage must be able to attach to receptors on host cell surface
2. The restriction modification system of the host cell

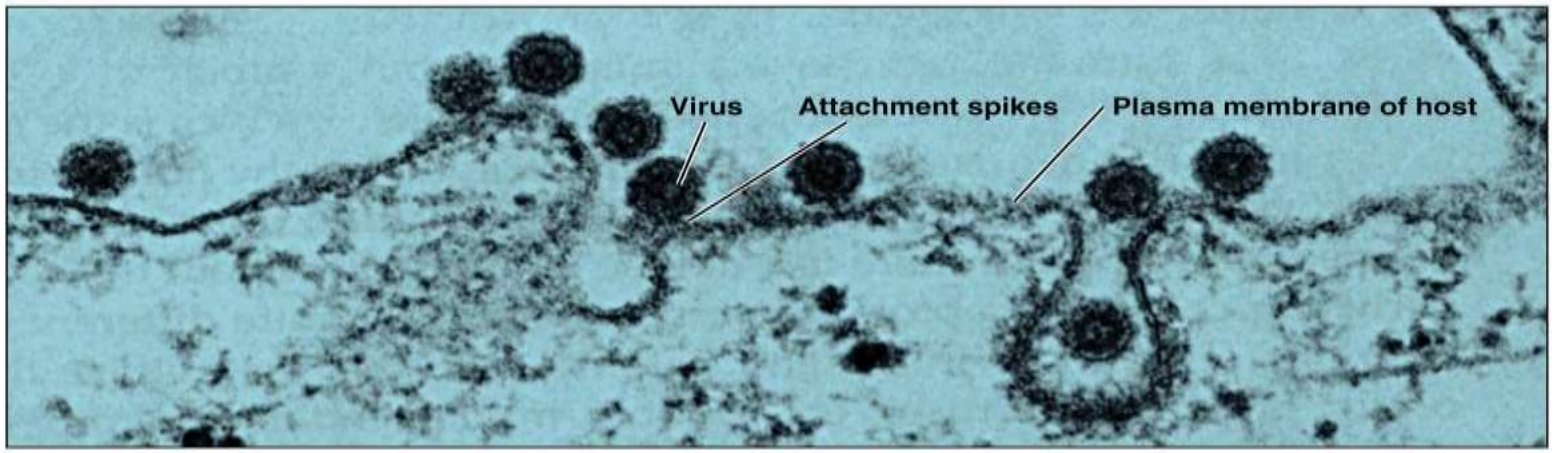
Receptors on bacterial surface

- Receptors vary in chemical structure and location
- Receptors are usually on cell wall, although a few phages attach to pili or flagella
- Receptor sites can be modified, thereby creating a resistant cell
- Some temperate phages can alter the cell surface, an example of **lysogenic conversion**
  - As a result receptor no longer available
  - Thus, prophage protects it's host and, in turn, is able to keep replicating inside of it

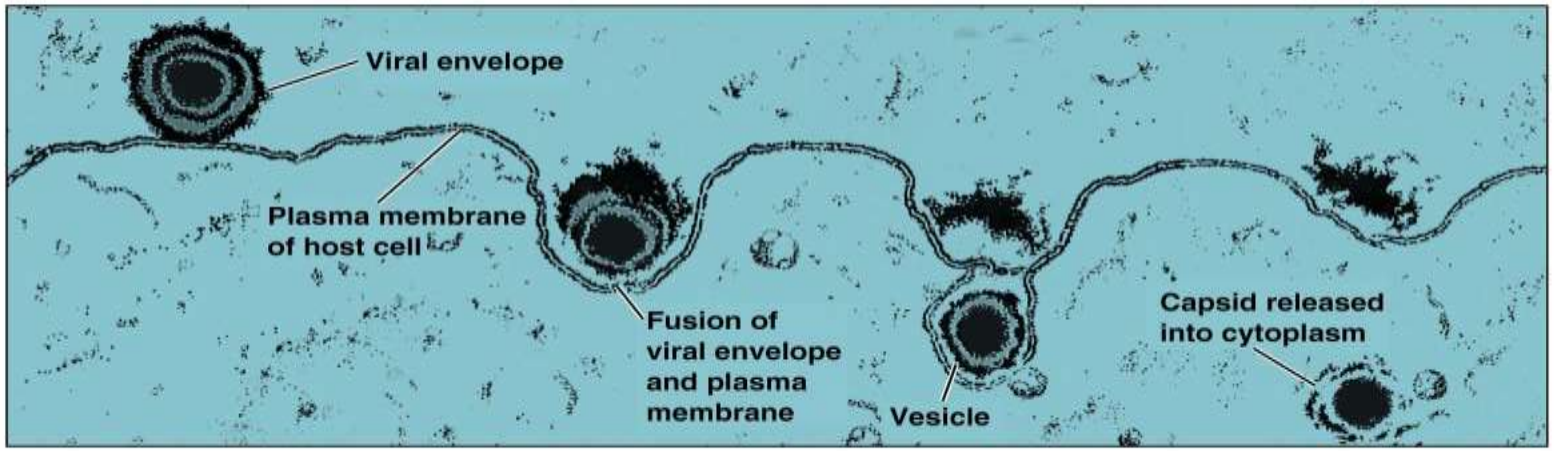
Restriction Modification System

- In some bacteria to protect themselves from viral infection
- Bacterial cell makes restriction enzyme and methylating enzyme
- **Methylating enzyme** adds methyl group to bacterial DNA
- Bacteria now knows this is it's own DNA
- Uses **restriction enzyme** to cut any DNA that is not methylated
- Cuts viral DNA– inactivating it

Electron micrograph of Entry of Animal Viruses into their Host Cells



(a) Entry of togavirus



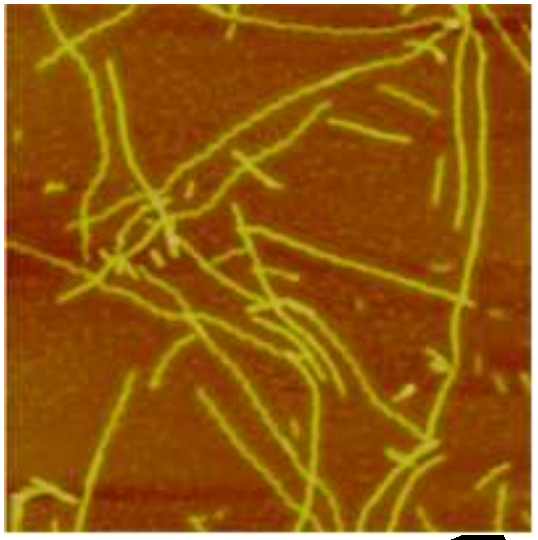
(b) Entry of herpesvirus

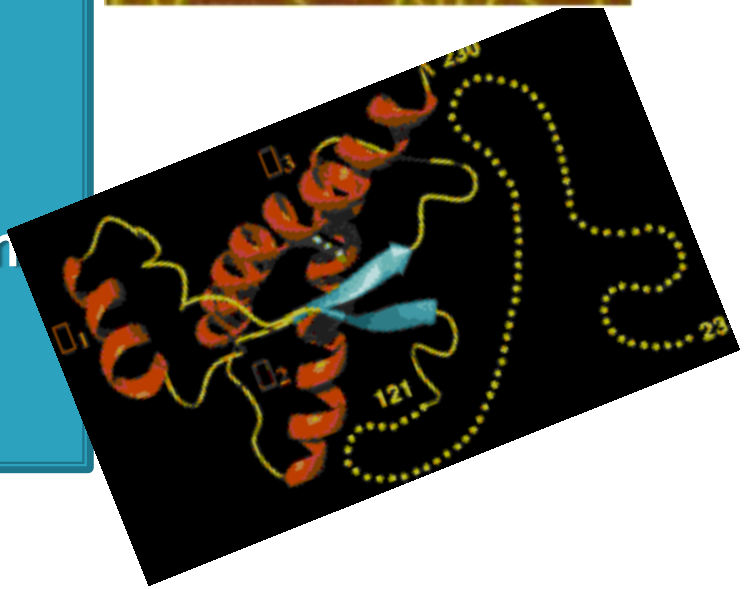
Viroids

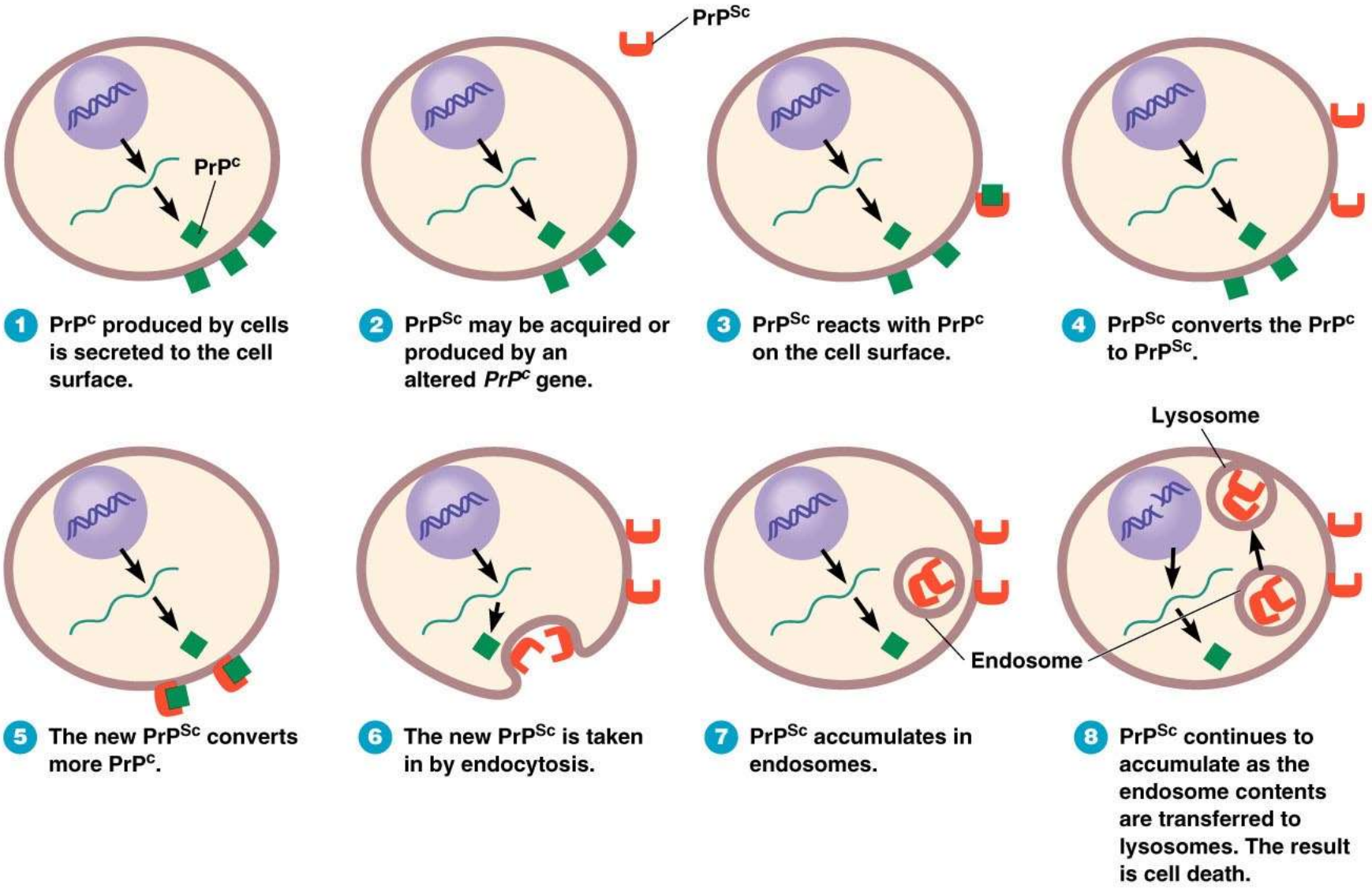
- Small, circular RNA molecules without a protein coat
- Infect plants
- Potato famine in Ireland
- Resemble introns cut out of eukaryotic

Prions

- Proteinaceous infectious agents
- Contain only protein, no nucleic acid
- Linked to number of fatal diseases in humans and animals
- Obligate intracellular parasite
- How does it replicate if no nucleic acid?
  - Prion protein converts host protein to prion protein







Prions

- Cannot be killed by UV light or nucleases, can be killed by proteases and heat
- Usually cannot be transmitted across species