



# 1- Introduction to Virology: Viral Morphology and Classification

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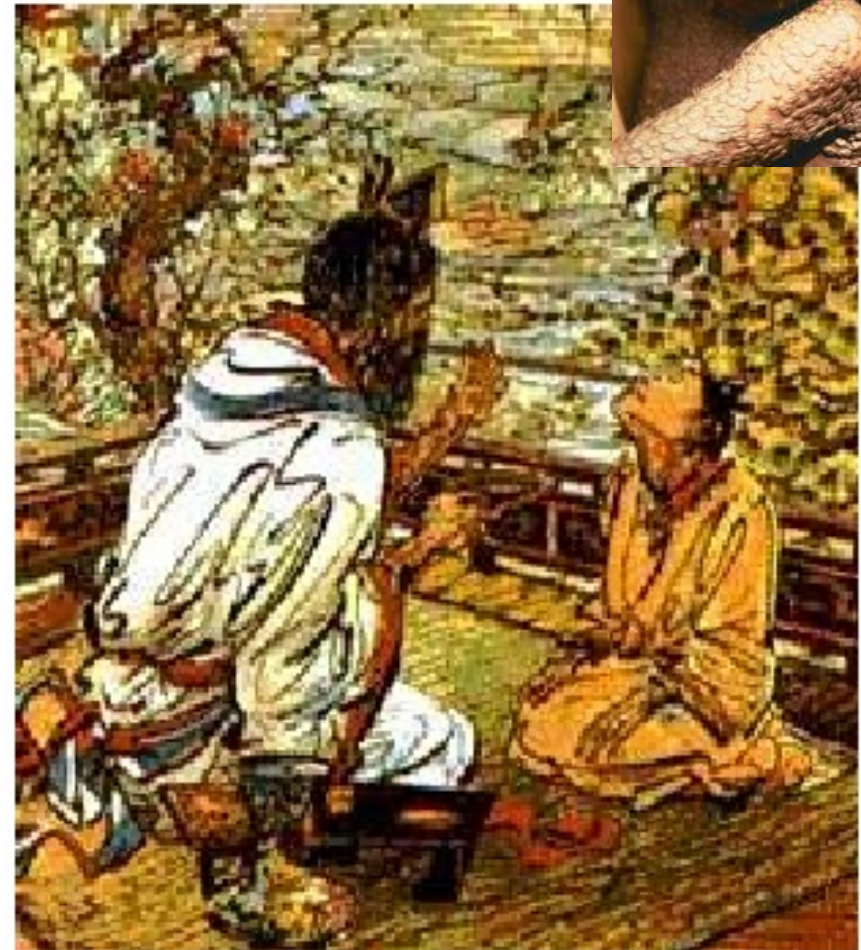
# Objectives

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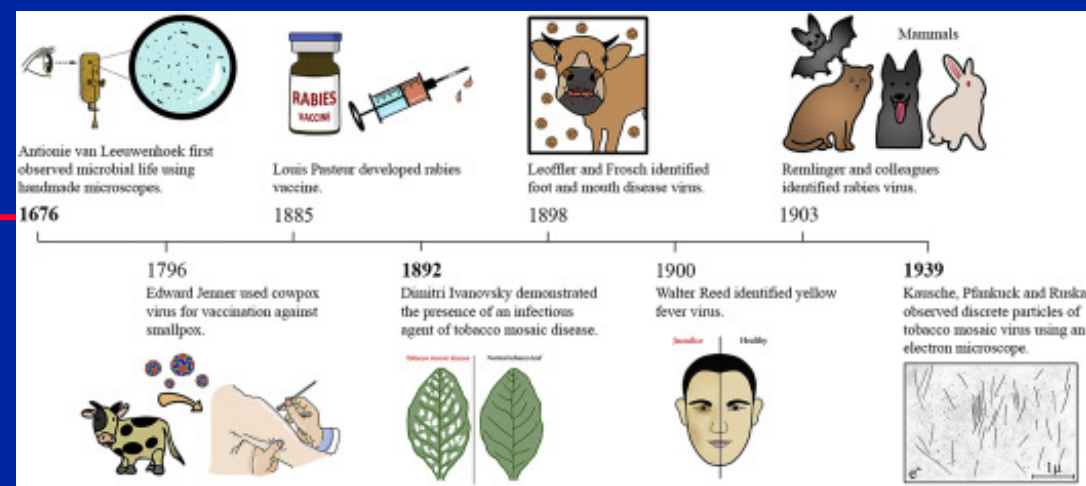
1. Introduction to virology history and definitions
2. To understand the medical importance of virology
3. To understand the characteristics/properties of viruses
4. To examine the structure and composition of viruses
5. To understand the classification of viruses

# History Virology

- Smallpox was endemic in China by 1000BC. In response, the practice of **variolation** was developed. Recognizing that survivors of smallpox outbreaks were protected from subsequent infection, variolation involved inhalation of the dried crusts from smallpox lesions like snuff, or in later modifications, inoculation of the pus from a lesion into a scratch on the forearm of a child.



# History



- Viruses were too small to be seen with the first microscopes. The cause of viral infections has been unknown for years. Important discoveries:
  - Louis Pasteur** first proposed the term **virus**
  - Ivanovski and Beijerinck** showed that a disease in tobacco was caused by a virus
  - Loeffler and Frosch** discovered an animal virus that causes foot –and–mouth disease in cattle
  - Walter Reed** discovered the yellow fever virus
- Many years of experimentation showed what we know today and by the 1950s virology had grown

# Virus Properties

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- A virus is defined as a nucleoprotein complex that infects cells and uses their metabolic processes to replicate
- Smallest known infective agents ranging from 20-450 nm
- Metabolically inert - no metabolic activity outside host cell; must enter host cell to replicate
- Contain only one type of nucleic acid, either DNA or RNA but never both
- Lack enzymes for most metabolic processes and lack machinery for protein synthesis
- The nucleic acid is encased in a protein shell, which may be surrounded by a lipid-containing membrane
- The entire infectious unit is termed a “virion”



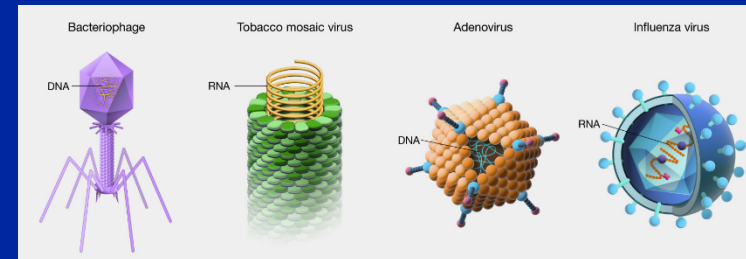
# Importance

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- Major cause of human illnesses
- Quick transmission
- New strains: SARS, Corona, birds flue, etc
- Epidemics/pandemics: Ebola Virus, COVID-19
- Availability of treatment



# Diversity

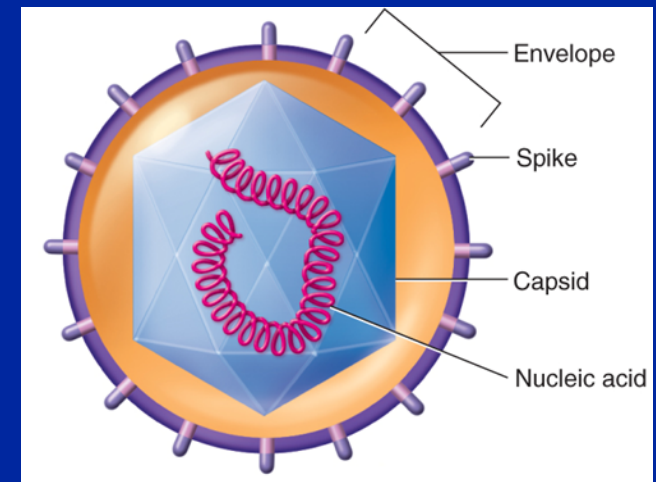
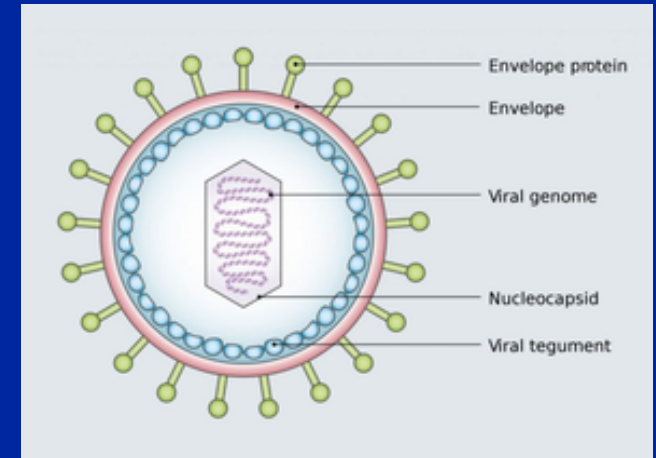


- Viruses vary greatly in structure, genome organization and expression, and strategies of replication and transmission.
- The virus infection may have little or no effect on the host cell or may result in cell damage or death.
- The host range for a given virus may be broad or extremely limited.
- Viruses infect unicellular organisms, such as mycoplasmas, bacteria, algae, and all higher plants, animals, and vertebrates.

# Definitions

- Virion: The complete virus particle
  1. **Nucleic acid**: Either DNA or RNA
  2. **Capsid**: The protein coat that encloses the viral genome
  3. **Envelope**: A lipid-containing membrane that surrounds some viruses
  4. **Glycoprotein spikes**: Projections from the envelope

**Nucleocapsid = Nucleic acid + capsid**  
(The protein-nucleic acid complex)





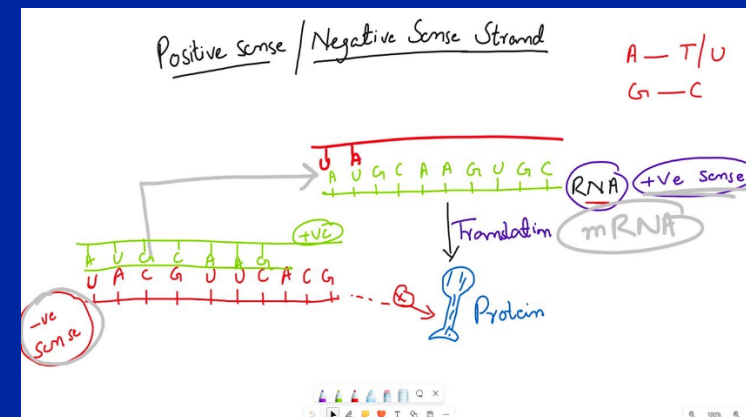
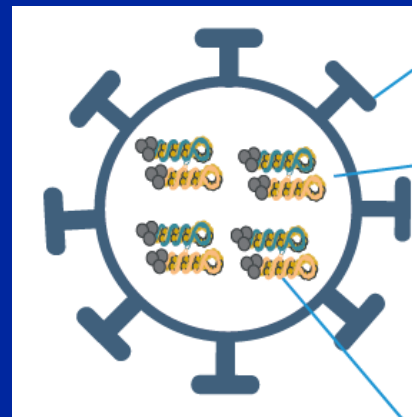
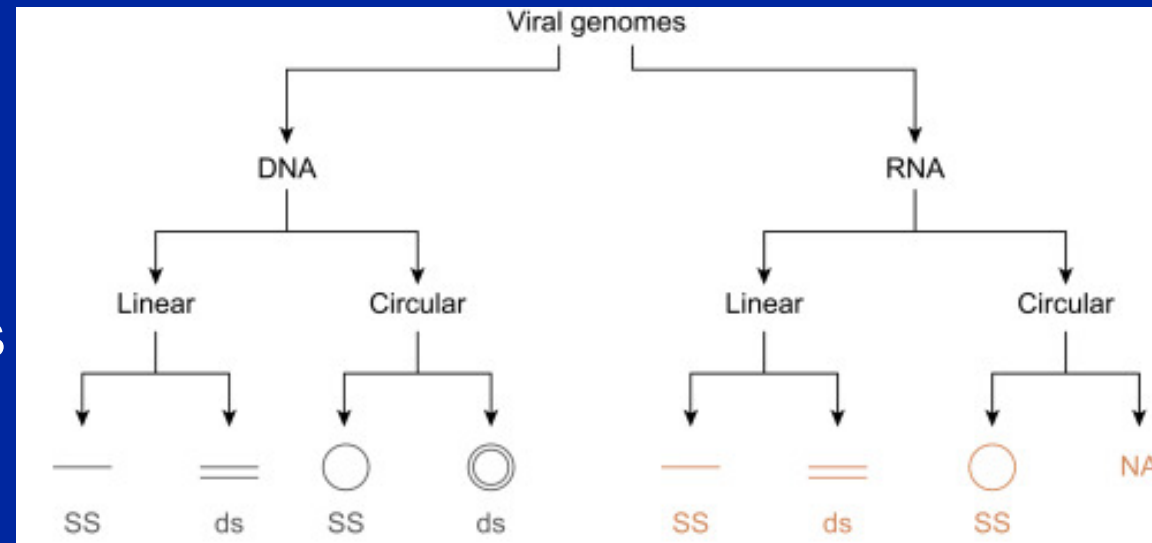
# Definitions

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- **Capsomeres:** Morphologic units are seen in the electron microscope on the surface of icosahedral viruses.
- **Peplomers:** Virus-encoded glycoproteins that are projected from the envelope
- **Defective virus:** A virus particle that is functionally deficient in some aspect of replication
- **Structural units:** The basic protein building blocks of the coat. They are usually a collection of more than one non-identical protein subunit “protomer”.

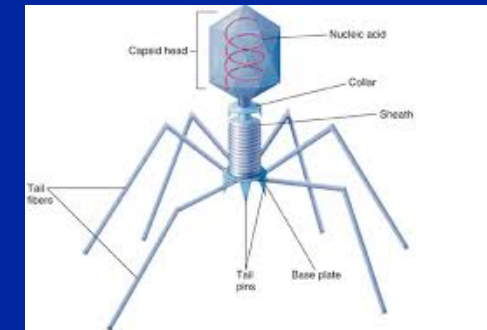
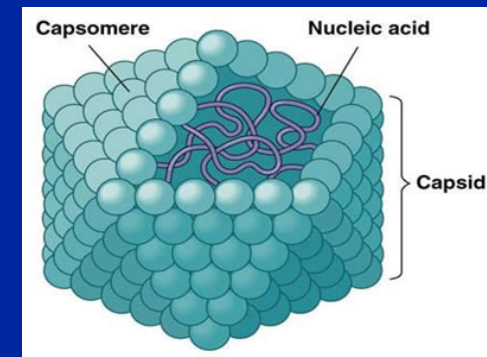
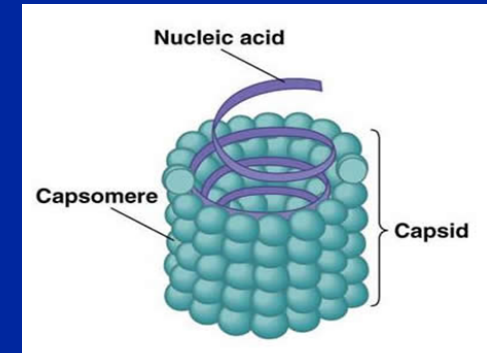
# 1. Genome – Nucleic Acid

- Genome- the total of the genetic information carried by an organism
- They only have the genes necessary to invade host cells and redirect their activity
  - DNA or RNA
  - single - or double - stranded
  - linear or circular
  - Segmented or intact
  - RNA positive or negative sense



# 2. Capsid

- Constructed from identical subunits called capsomers
- Made up of protein molecules
- Three different types
  1. helical - tubular
  2. icosahedral - isometric or cubic
  3. complex - does not conform to either of above



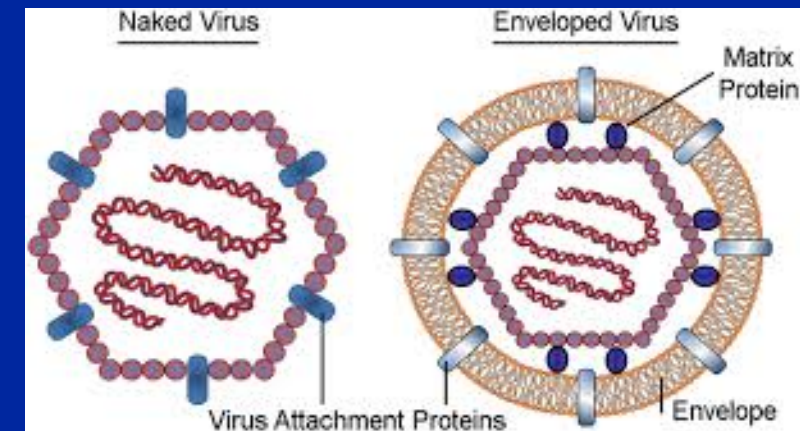
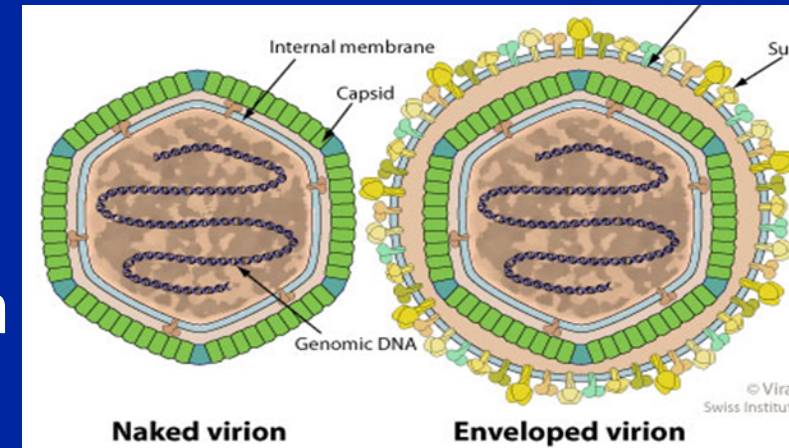
# 3. Envelope

Found in some viruses; lipoprotein envelope containing viral and host cell compounds

Enveloped viruses take a bit of the host cell membrane in the form of an envelope

Some proteins form a binding layer between the envelope and the capsid

Glycoproteins remain exposed as spikes (peplomers)- essential for attachment



# Functions of the Viral Capsid/Envelope

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- Protects nucleic acids
- Help introduce the viral DNA or RNA into a suitable host cell
- Stimulate the immune system to produce antibodies that can protect the host cells against future infections



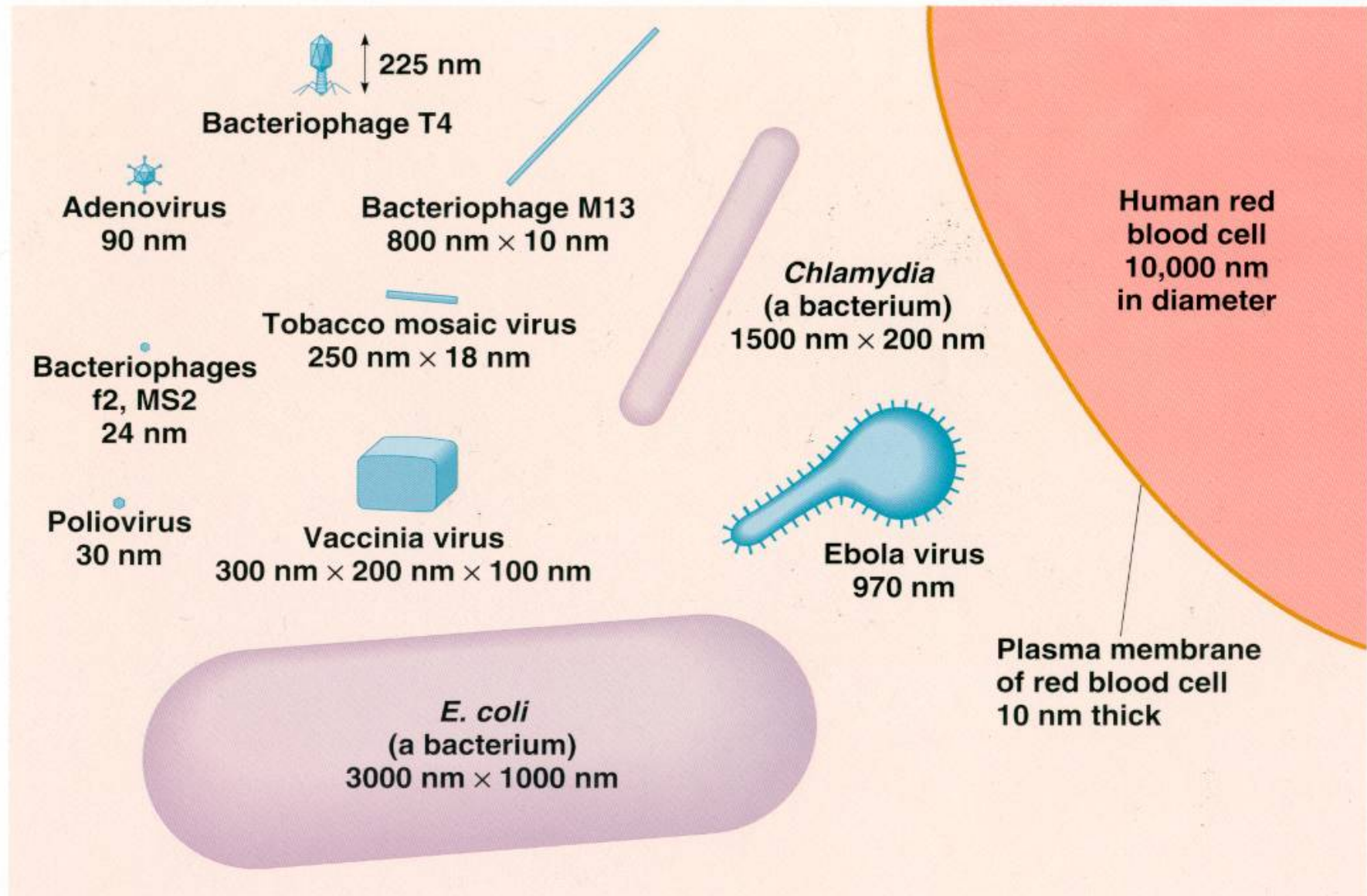
# Characteristics of Infectious Microorganisms

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Property	Bacteria	Viruses	Fungi	Protozoa
Size (nm)	100 -10,000	30 - 300	4,000 - 40,000	4,000 - 40,000
Nuclear structure	Prokaryotes	----	Eukaryotes	Eukaryotes
Obligate intracellular	No	Yes	No	No
Nucleic acids	DNA/RNA Haploid	DNA or RNA	DNA/RNA	DNA/RNA
Culture on Artificial media	Yes	No	Yes	Yes

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# Relative Sizes of Microorganisms



# Virus Naming

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- Viruses with similar structural, genomic & replication properties are grouped into families (suffix: viridae) e.g. Herpesviridae
- Families subdivided into genera (suffix: virus) e.g. Herpes simplex virus, Cytomegalovirus, Varicella zoster virus
- Subtypes based on nucleotide sequence and antigenic reactivities e.g. Herpes simplex virus type 1, Herpes simplex virus type 2

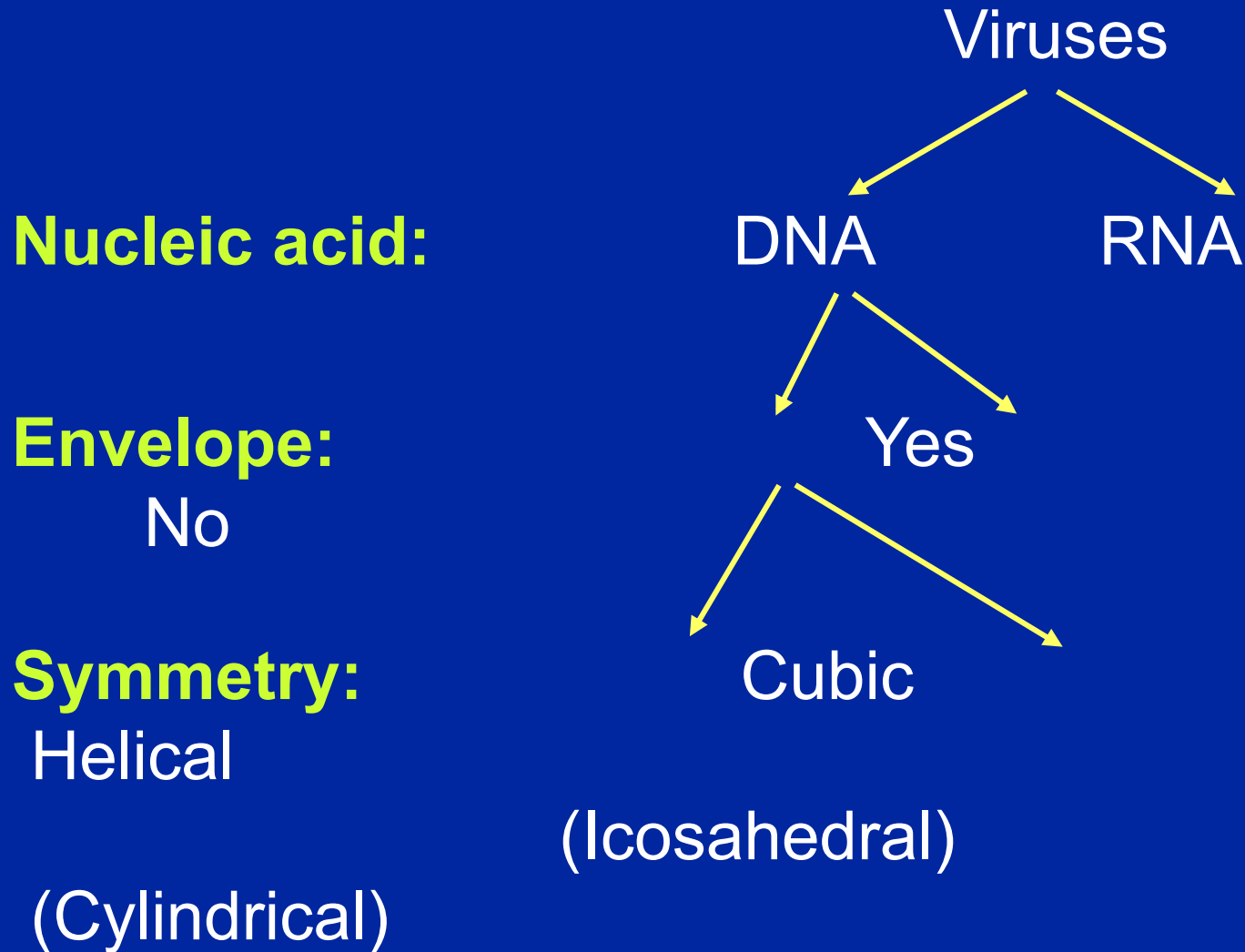
# Virus Classification

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- Historically based on:
  - Host preference: Plant, insect, animal, human
  - Target organ: respiratory, hepatic, enteric, etc.
  - Vector: arboviruses
- Overlapping, inconsistent
- Currently based on molecular biology of genome and biophysical structure

# Virus Classification

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# Virus Classification (Common)

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## DNA

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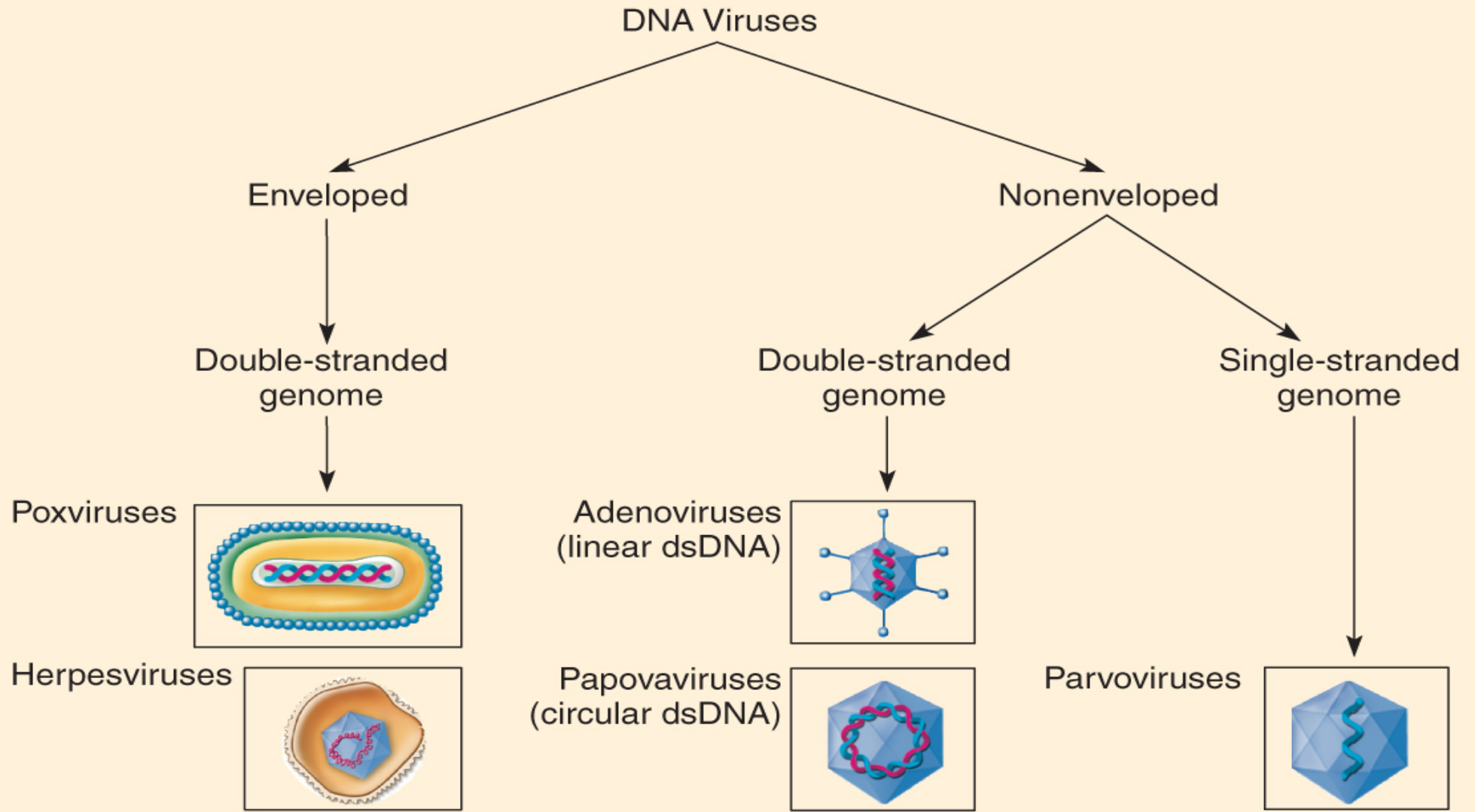
Hepatitis B  
Human Papilloma Virus  
Parvovirus B19  
Adenovirus  
Herpesviridae  
Polyomaviruses

## RNA

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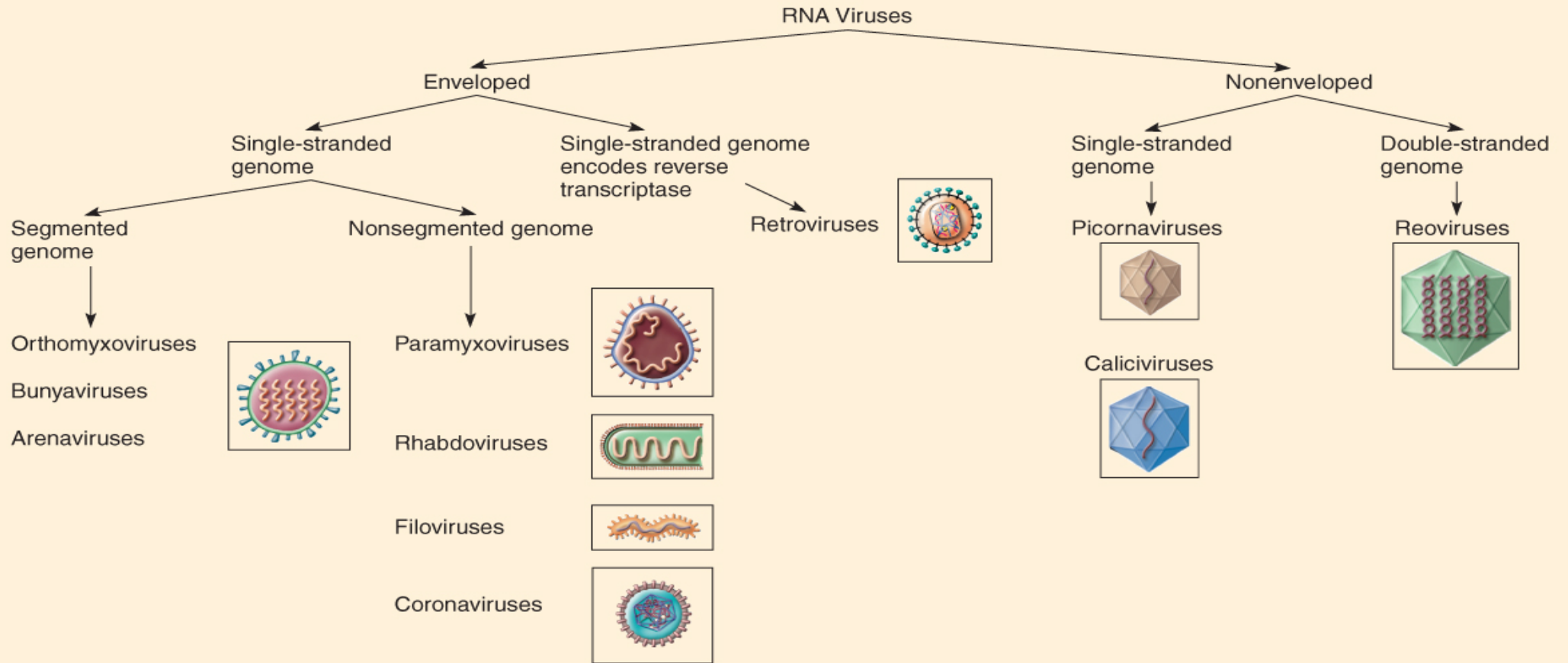
Influenza  
RSV  
Parainfluenza  
Hepatitis A, C, D, E  
Enteroviruses  
Encephalitis viruses  
Measles, Mumps, Rubella  
Norwalk, Rotavirus  
Virtually all others

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**TABLE 6.2****Medically Relevant DNA Virus Groups**

Source: Adapted from: *Poxviridae* from Buller et al., National Institute of Allergy & Infectious Disease, Department of Health & Human Services.

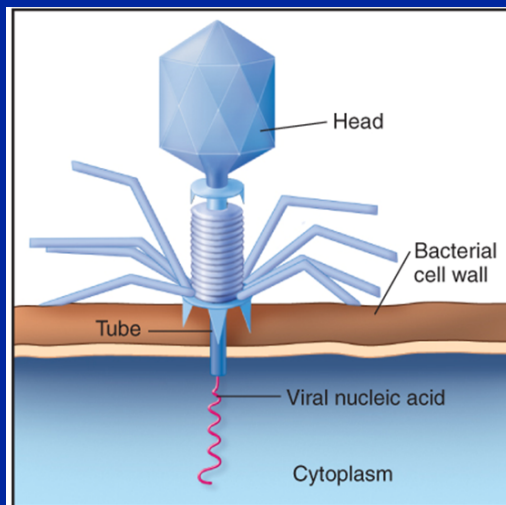
**TABLE 6.3** Medically Relevant RNA Viruses



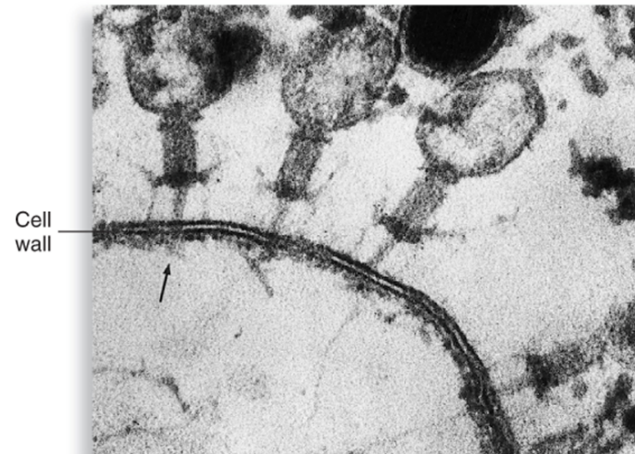
# Viruses that Infect Bacteria

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- Bacteriophage
- Most contain dsDNA
- Often make the bacteria they infect more pathogenic for humans

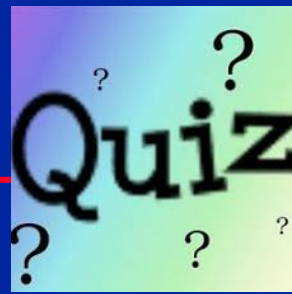


(a)



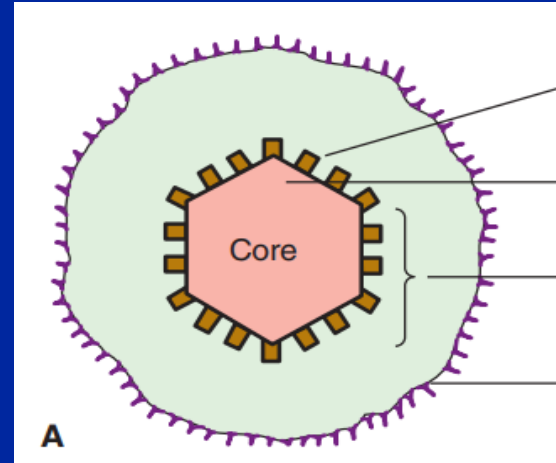
(b)

# Quiz?



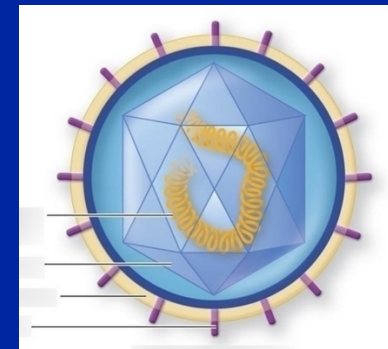
Q1. Identify the following structure/units in the attached diagram:

- 1.....
- 2.....
- 3.....
- 4.....



- 1
- 2
- 3
- 4

Q2. Describe the following viral structure:



Q3. Why does bacteriophage make bacterial infection more pathogenic to humans?

