Viruses

• Simple acellular infectious agents
• Consisting of one or more molecules of nucleic acids enclosed in a protein coat=capsid
• Protein coat or capsid could be icosahedral, helical, or complex in structure
• Varied in their genomic composition: dsDNA, ssDNA, dsRNA, or ssRNA
• May be covered by host derived membrane= envelope
Viruses (continued)

• Unable to reproduce independently=
  – Obligate intracellular parasites
  – Rely on host protein synthesis, enzymes

• Extremely small

• Have specific host range defined by host receptor
  – Species
  – Tissue

• Classified by several factors:
  
  Host
  Capsid symmetry
  Envelope
  Nucleic acid composition
  Disease caused by eukaryotic viruses
Size and Morphology

- **Shape**
  - Helical
  - Icosahedral
  - Complex

- **Outer surface**
  - Naked
  - Enveloped

![Diagram of virus structures](image)

Fig. 16.10
Influenza virus

- Hemagglutinin spike
- Neuraminidase spike
- Matrix protein
- Lipid bilayer
- Polymerase
- Ribonucleoprotein

50 nm
Bacteriophages

- Viruses that infect bacteria
- Extremely small
- Predominantly DNA for nucleic acid
- Model system
T4 phage life cycle

0 min: DNA injection

2 min: Early mRNA made

22 min: Host cell lysis

15 min: Virions formed

13 min: Heads filled

12 min: Heads and tails made

9 min: Late RNA made

3 min: Host DNA degraded

5 min: Phage DNA made
T4 phage assembly
Virus propagation and study

• Plaque assay
  – Bacteria
  – Cell culture

• Cytopathic effects
  – Cell culture
  – Whole organism

Fig. 16.4
Animal viruses

Fig. 18.3
Specificity for host receptor

**Table 18.1** Examples of Host Cell Surface Proteins That Serve as Virus Receptors

<table>
<thead>
<tr>
<th>Virus</th>
<th>Cell Surface Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adenovirus</td>
<td>Coxsackie adenovirus receptor (CAR) protein</td>
</tr>
<tr>
<td>Epstein-Barr virus</td>
<td>Receptor for the C3d complement protein on human B lymphocytes</td>
</tr>
<tr>
<td>Hepatitis A virus</td>
<td>Alpha 2-macroglubulin</td>
</tr>
<tr>
<td>Herpes simplex virus, type 1</td>
<td>Fibroblast growth factor receptor; a member of the tumor necrosis factor/nerve growth factor receptor family</td>
</tr>
<tr>
<td>Human immunodeficiency virus</td>
<td>CD4 protein on T-helper cells, macrophages, and monocytes; CXCR-4 or the CCR5 receptor</td>
</tr>
<tr>
<td>Influenza A virus</td>
<td>Sialic acid–containing glycoprotein</td>
</tr>
<tr>
<td>Measles virus</td>
<td>CD46 complement regulator protein</td>
</tr>
<tr>
<td>Poliovirus</td>
<td>Immunoglobulin superfamily</td>
</tr>
<tr>
<td>Rabies virus</td>
<td>Acetylcholine receptor on neurons</td>
</tr>
<tr>
<td>Rhinovirus</td>
<td>Intercellular adhesion molecules (ICAMs) on the surface of respiratory epithelial cells</td>
</tr>
<tr>
<td>Reovirus, type 3</td>
<td>β-adrenergic receptor</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>Acetylated sialic acid on glycoprotein</td>
</tr>
<tr>
<td>Vaccinia virus</td>
<td>Epidermal growth factor receptor</td>
</tr>
</tbody>
</table>
Direct penetration

Direct penetration by naked viruses

Capsid

Nucleic acid

Receptor

Fig. 18.4
Penetration by membrane fusion

Fig.18.4
Penetration by endocytosis

Entry of enveloped virus by endocytosis

Coated Pit → Coated vesicle → Endosome

Fig. 18.4
Herpes simplex 1 life cycle

- Linear, dsDNA virus
- Encodes 50-100 genes
- Uses host polymerase for RNA synthesis
- Viral DNA replication enzymes
Positive (+) sense RNA

- Poliovirus
- Rhinovirus
- Hepatitis A
- Dengue virus
- Rubella virus (German measles)

Positive single-stranded RNA viruses (picornaviruses)

\[+\text{RNA} \rightarrow \text{Proteins (after processing by host and virus-coded proteinases)} \rightarrow \pm\text{RNA} \rightarrow +\text{RNA (virion)}\]

Fig. 18.6
Negative (-) sense RNA viruses

- Influenza
- Rabies
- Ebola and Marburg
- Sin Nombre (Hantavirus)

**Negative single-stranded RNA viruses** (paramyxoviruses—mumps and measles; orthomyxoviruses—influenza)

Fig. 18.6
Retroviruses

- HIV
- HTLV
Viral budding

- Plasma membrane
- Neuraminidase
- Ribonucleoprotein
- Hemagglutinin
- Matrix protein