Introduction to Viruses

Classification, morphology and structure, Replication and Pathogenicity
Outlines

• Classification of Viruses
• morphology and structure
• Naked viruses( Non Enveloped )
• Replication
• Pathogenicity
• Transmission of Viruses
• Virus Tissue Tropism
Outlines ... cont.

• Acute Viral Infection
• Viruses and Human Tumours
• Bacteriophage
• Sub-viral agents
• Isolation of virus
• Diagnosis
• Treatment and Prevention of Virus Infections
Definition of a Virus

- Sub microscopic entity consisting of a single nucleic acid surrounded by a protein coat and capable of replication only within the living cells of bacteria, animals or plants
Viruses have an inner core of nucleic acid surrounded by protein coat known as an envelope.

Most viruses range in sizes from 20 – 250 nm.

Viruses are inert (nucleoprotein) filterable agents.

Viruses are obligate intracellular parasites.
• Virus particle = virion
• Protein which coats the genome = capsid
• Capsid usually symmetricad
• Capsid + genome = nucleocapsid
• May have an envelope
Virion Structure

- Lipid Envelope
- Nucleic Acid
- Protein Capsid
- Spike Projections
- Virion Associated Polymerase
Virion Structure

- Varies in size, shape and symmetry
- Highly impo. for classification
- 3 types of capsid symmetry:
  - Cubic (icosahedral)
  - Helical
  - Complex
- 5 basic types of virus structure:

Adapted from Schaechter et al., Mechanisms of Microbial Disease
Virion Structure

**ICOSAHEDRAL SYMMETRY**

5-FOLD  3-FOLD  2-FOLD

**CAPSOMER**
= PENTON (pentamer)

**CAPSOMER**
= PENTON

**CAPSOMER**
= HEXON

Adenovirus

12 PENTONS

240 HEXONS
Naked viruses (Non Enveloped)

• Stable in hostile environment
• Released by lysis of host cells
• Examples:
  – Adeno-associated Virus (AAV)
  – Adenovirus B19
How are viruses named?

Based on:

- The disease they cause
  - Poliovirus, rabies virus
- The type of disease
  - Murine leukemia virus
- Geographic locations
  - Sendai virus, Coxsackie virus
- Their discoverers
  - Epstein-Barr virus
- How they were originally thought to be contracted
  - Dengue virus ("evil spirit"), Influenza virus (the "influence" of bad air)
- Combinations of the above
  - Rous Sarcoma virus
• The Baltimore classification system Based on:
  – Genetic contents
  – Replication strategies of viruses
• Seven classes:
  1. dsDNA viruses
  2. ssDNA viruses
  3. dsRNA viruses
  4. (+) sense ssRNA viruses (codes directly for protein)
  5. (−) sense ssRNA viruses
  6. RNA reverse transcribing viruses
  7. DNA reverse transcribing viruses
Virion Replication

- Distinguishing characteristics of viruses
- Obligate intracellular parasites
- Extreme genetic simplicity
- Contain DNA or RNA
- Replication involves disassembly and reassembly
- Replicate by "one-step growth"
1. Virus attachment and entry
2. Uncoating of virion
3. Migration of genome nucleic acid to nucleus
4. Transcription
5. Genome replication
6. Translation of virus mRNAs
7. Virion assembly
8. Release of new virus particles
Pathogenicity

- Cell destruction
- Virus-induced changes to gene expression
- Immunopathogenic disease
Generation of Novel Influenza A Viruses

Human H2N2

Avian H3N8

Genetic Reassortment

Point mutation of HA and NA genes

ANTIGENIC SHIFT

Human H3N2

ANTIGENIC DRIFT
Transmission of Viruses

• Respiratory transmission
  – Influenza A virus
• Faecal-oral transmission
  – Enterovirus
• Blood-borne transmission
  – Hepatitis B virus
• Sexual Transmission
  – HIV
• Animal or insect vectors
  – Rabies virus
Virus Tissue Tropism

• Targeting of the virus to specific tissue and cell types

• Receptor Recognition
  – CD4+ cells infected by HIV
  – CD155 acts as the receptor for poliovirus
Acute Viral Infection

Amount of virus vs. Time

Symptoms

Virus
Viruses and Human Tumours

- Epstein Barr Virus
  - Burkitt’s Lymphoma

- Human papillomavirus
  - Benign warts
  - Cervical Carcinoma

- Human T-cell Leukaemia Virus (HTLV-1)
  - Leukaemia

- Hepatitis C virus
  - Liver carcinoma
A bacteriophage is any one of a number of viruses that infect bacteria. They inject genetic material, which they carry enclosed in an outer protein capsid.
Sub-viral agents

• Satellites
  – Contain nucleic acid
  – Depend on co-infection with a helper virus

• Viroids
  – Unencapsidated, small circular ssRNA molecules that replicate autonomously

• Prions
  – No nucleic acid
  – Infectious protein
Isolation of virus

- **Egg inoculation Pox virus, Influenza**
  1. Cell culture
  2. **Primary cells - Monkey Kidney**
  3. **Semi-continuous cells - Human embryonic kidney and skin fibroblasts**
- **Continuous cells - HeLa, Vero, Hep2, LLC-MK2, MDCK**
Lab diagnosis of viruses

A- Microscopic examination:

B- Serological tests:

- Detection of Immunoglobulins Ig G, Ig M, Ig A
- Primary (1 degree) and secondary (2 degree) antibody responses toward a viral pathogen
- Enzyme-Linked Immuno-Sorbant Assays (ELISAs)

C- Molecular tests:

- Polymerase Chain Reaction
- Advantages of PCR
Treatment and Prevention of Virus Infections

• Antivirals

  – Antiviral Targets:
    • Attachment/Entry
    • Nucleic acid replication
    • Virus protein processing
    • Virus maturation

• Vaccines and immunisation
Problems with Antivirals and vaccination

- Identification of virus-specific target.
- Generation of resistant variants.