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.

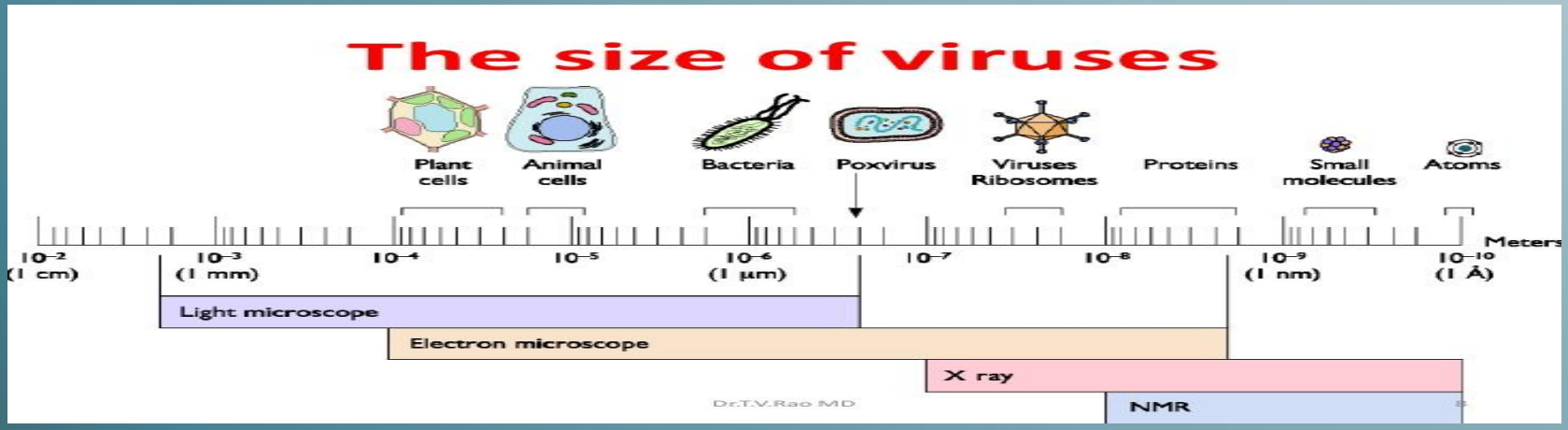
- Acute Viral Infection
- Viruses and Human Tumours
- Bacteriophage
- Sub-viral agents
- Isolation of virus
- Diagnosis
- Treatment and Prevention of Virus Infections

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

Viral Properties

- 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

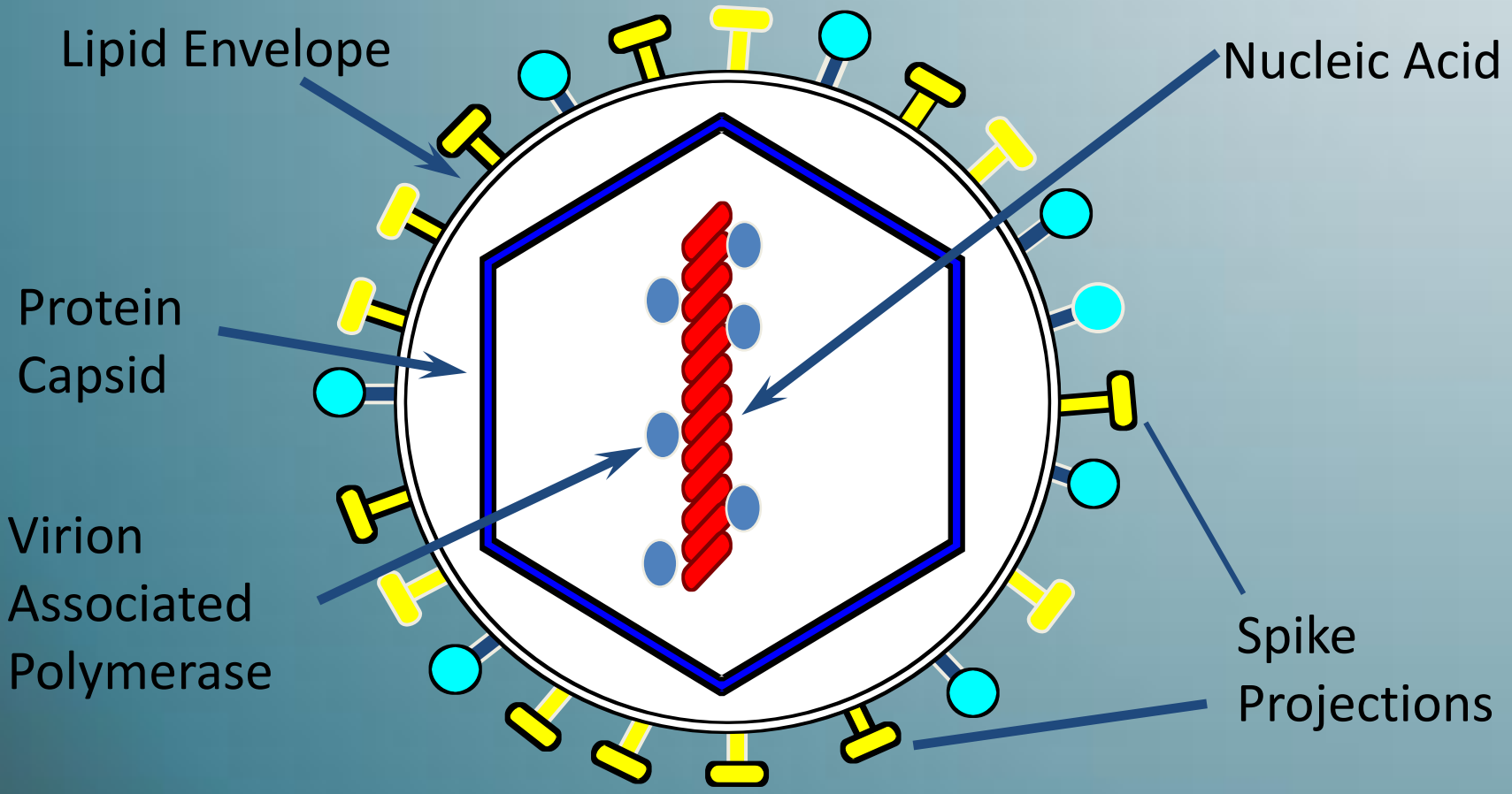


Viral structure

some terminology

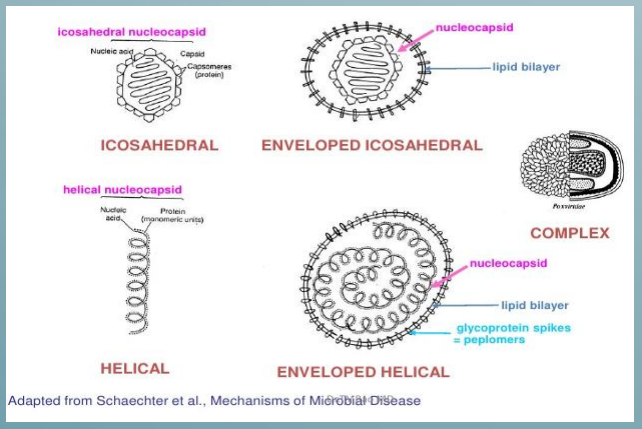
- Virus particle = virion
- Protein which coats the genome = capsid
- Capsid usually symmetricad
- Capsid + genome = nucleocapsid
- May have an envelope

Virion Structure



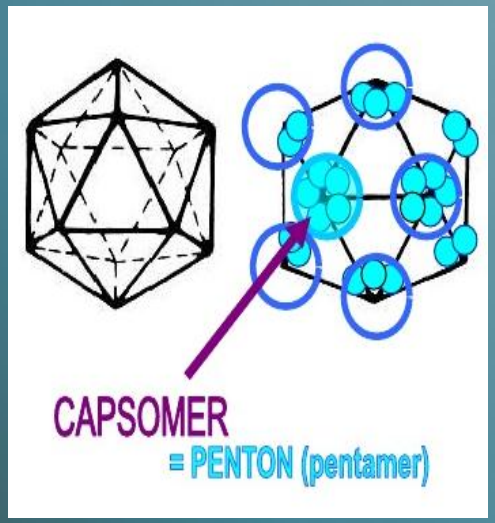
Virion Structure

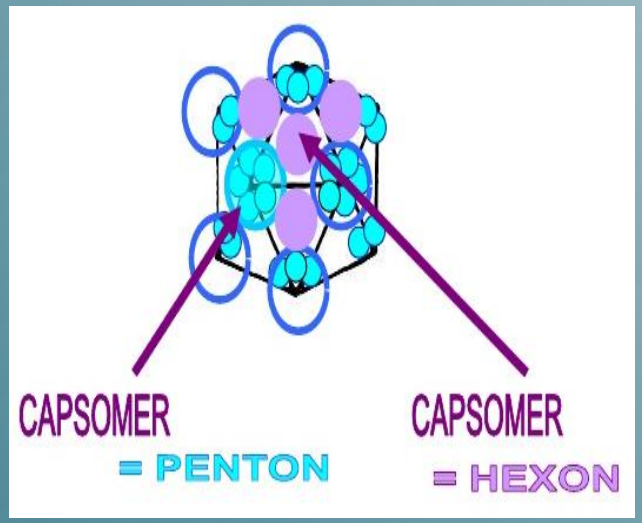
- Varies in size, shape and symmetry
- Highly impo. for classification
- 3 types of capsid symmetry:
  - Cubic (icosahedral)
  - Helical
  - Complex
- 5 basic types of virus structure:

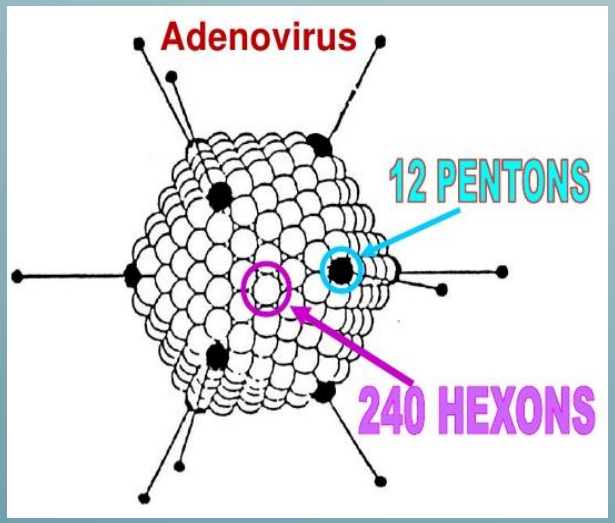


Adapted from Schaechter et al., Mechanisms of Microbial Disease

Virion Structure







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 discovers
  - 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

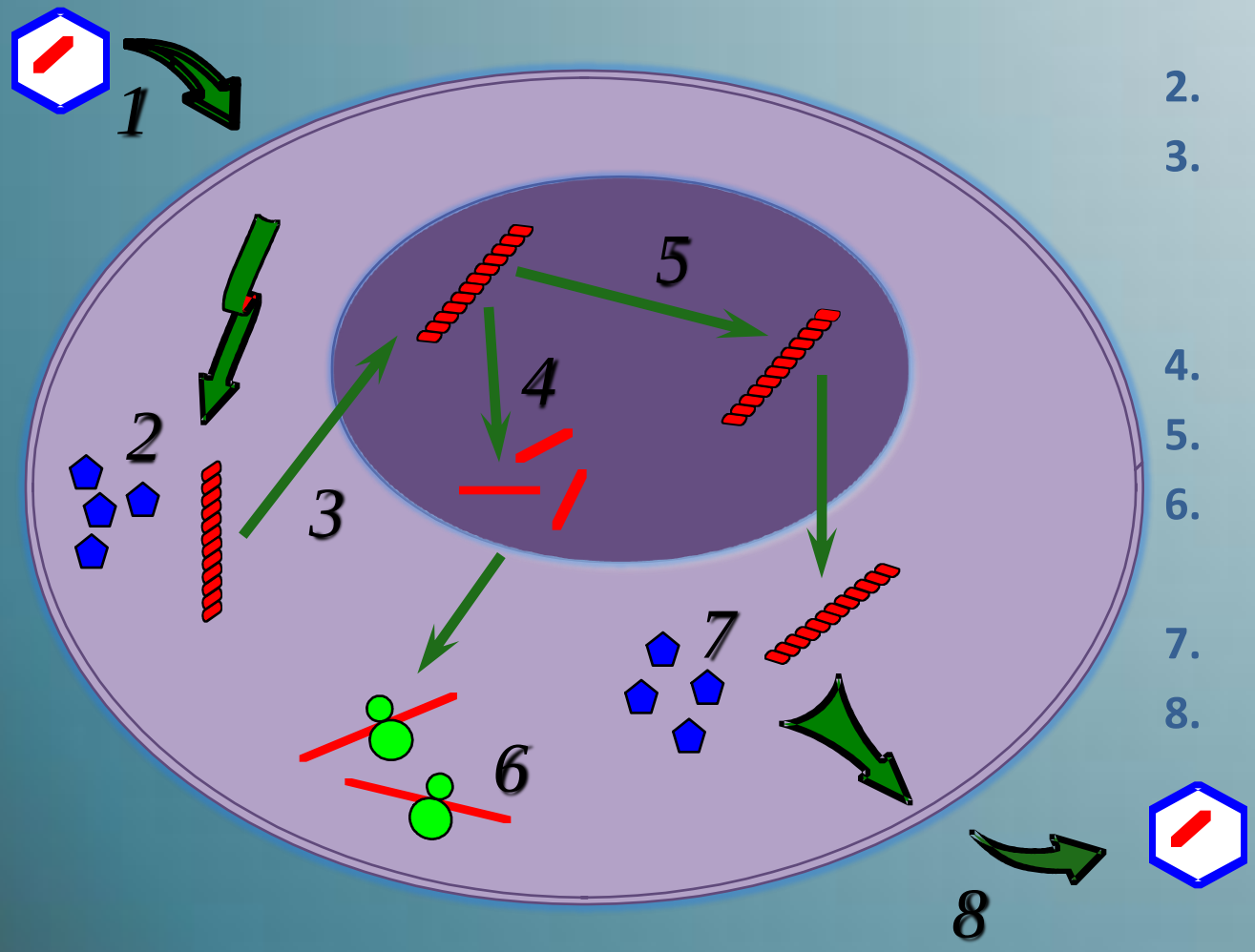
Viral classification

- 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”

Virus Replication

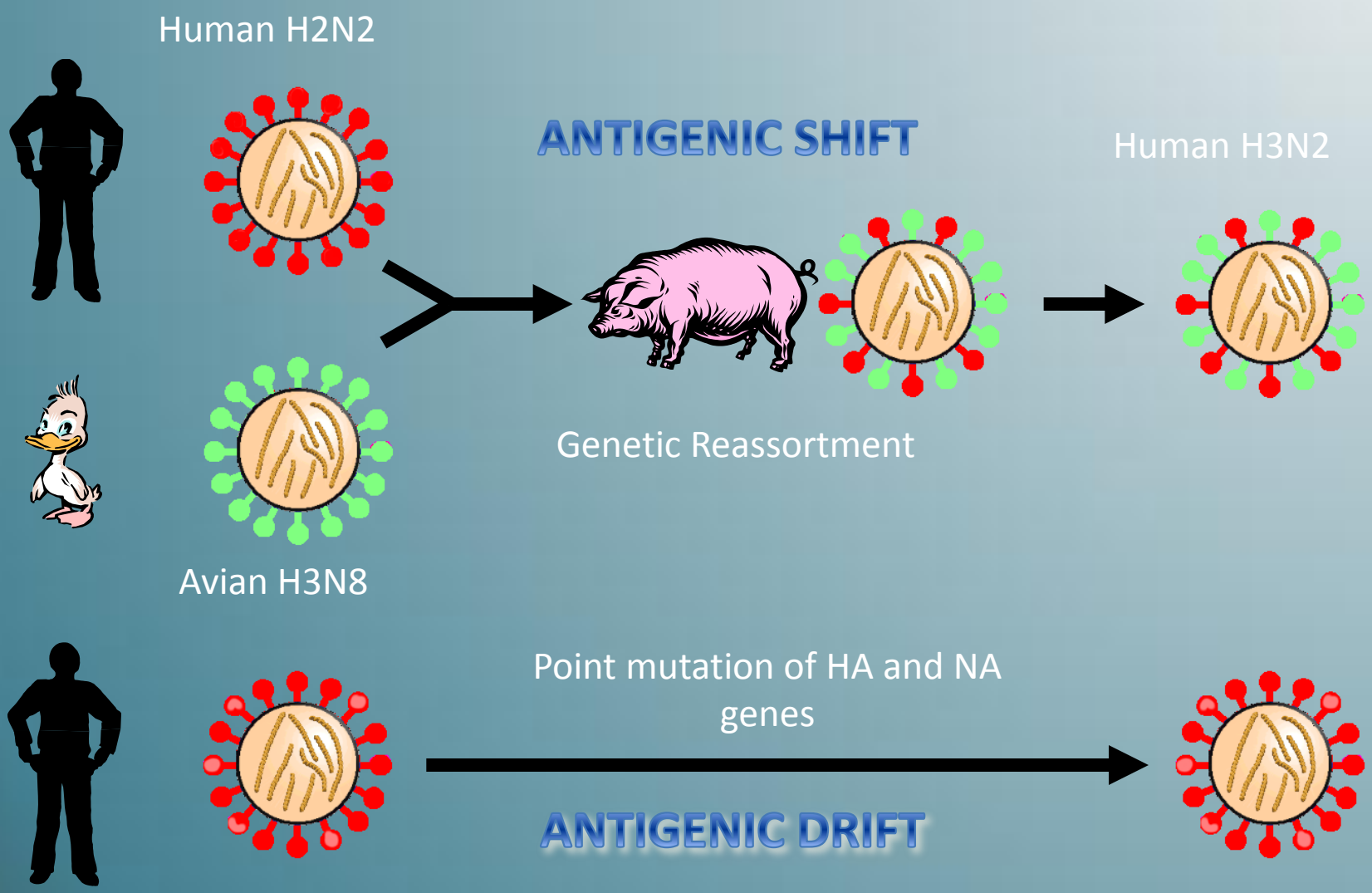


1. Virus attachment and entry
2. Uncoating of virion
3. Migration of genome nucleic acid to nucleus
4. Transcription
5. Genome replication
6. Translation of virus mRNAs
7. Virion assembly
8. Release of new virus particles

Pathogenicity

- Cell destruction
- Virus-induced changes to gene expression
- Immunopathogenic disease

Generation of Novel Influenza A Viruses



Transmission of Viruses

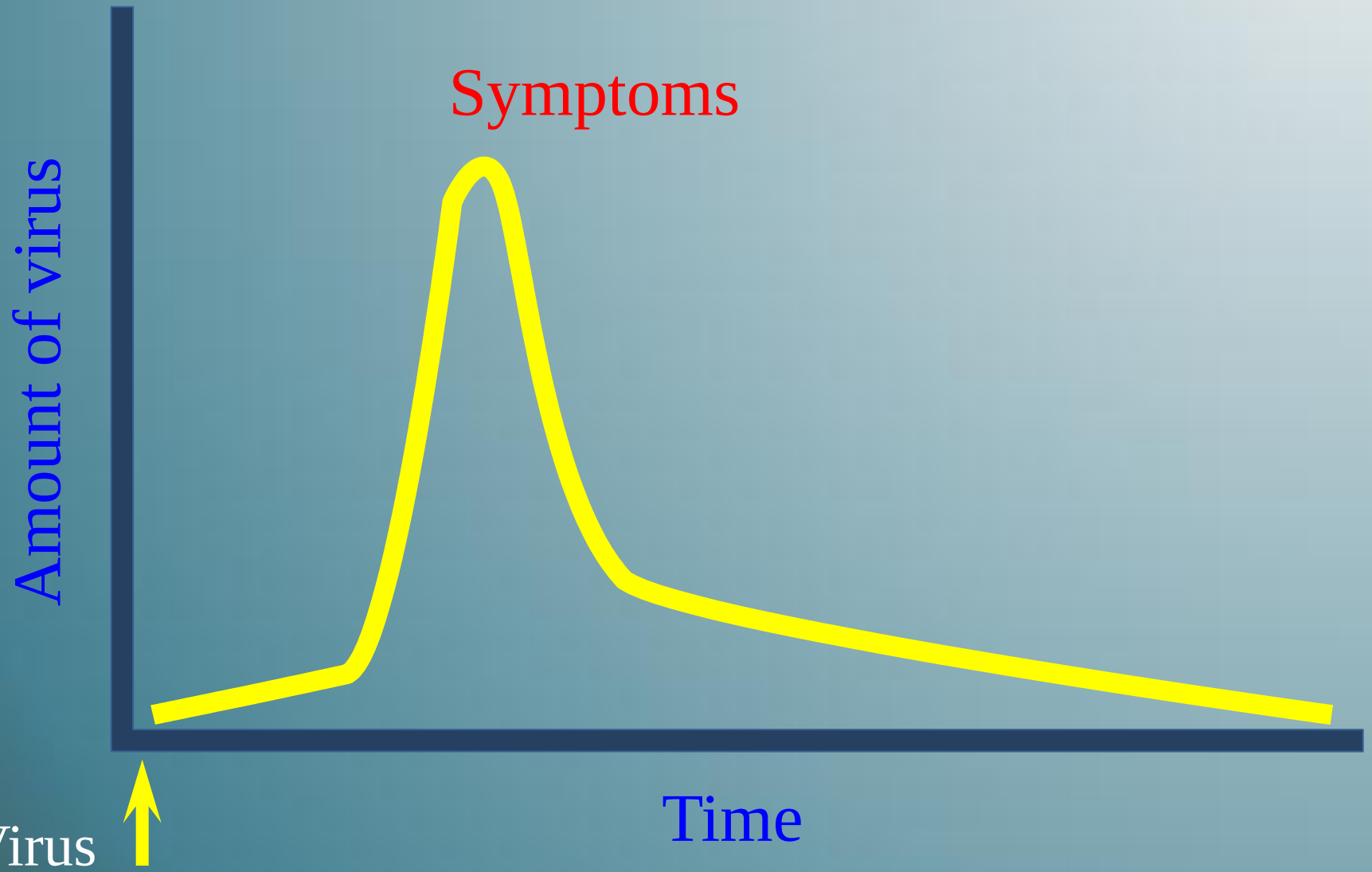
- Respiratory transmission
  - Influenza A virus
- Faecal-oral transmission
  - Enterovirus
- Blood-borne transmission
  - Hepatitis B virus
- Sexual Transmission
  - HIV
- Animal or insect vectors
  - Rabies virus

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

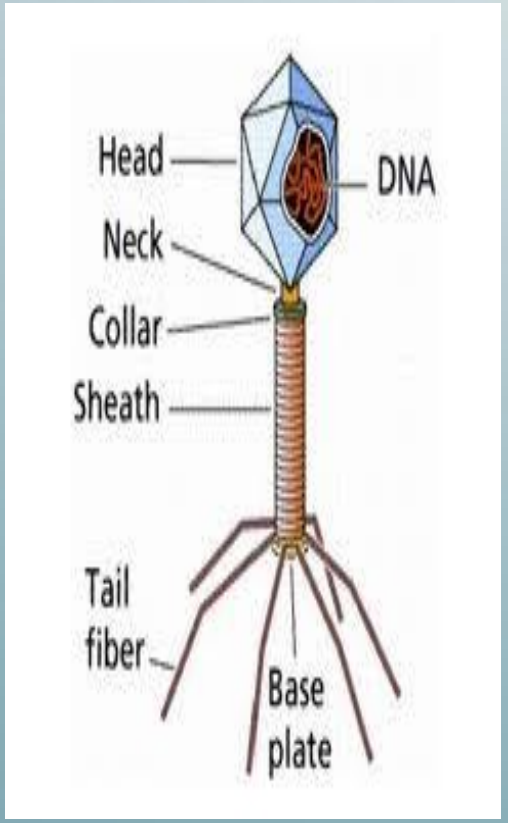


Viruses and Human Tumours

- 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

Bacteriophage

- A bacteriophage is any one of a number of viruses that infect bacteria
- Inject genetic material, which they carry enclosed in an outer protein capsid

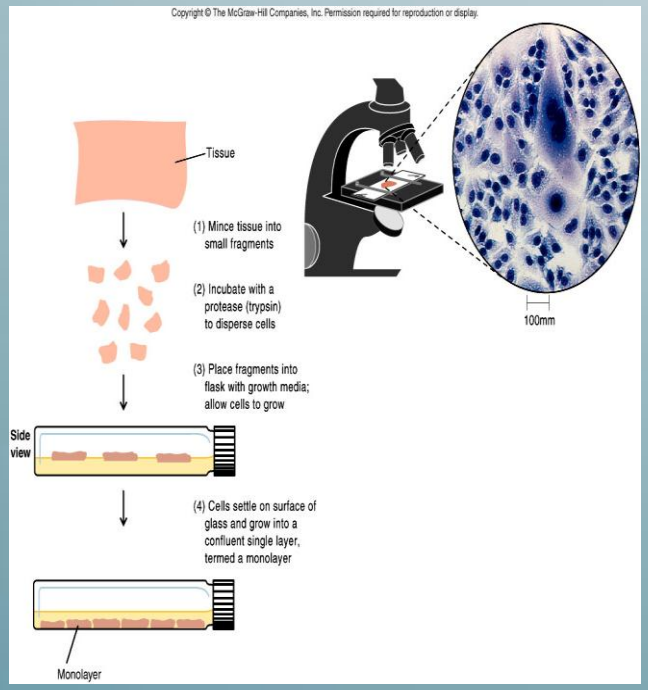


Sub-viral agents

- 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 Immunologlublins 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.