1. **Viral size and organization**
   - **Size**
     - 20-250nm
     - 0.000000002m-0.000000025m
   - **Virion structure**
     - Capsid
     - Core
   - **Acellular obligate intracellular parasites**
     - Lack organelles, metabolic activities, and reproduction
     - Replicated by live host cells

2. **Size comparison**

3. **Viral sizes table**

4. **Host specificity**
   - **Type of host organism is specific**
     - Specific host required for infection
   - **Examples of host specificity**
     - Animal, plant, bacteria
     - Mammalian, Human
   - **Host Tropism**
     - Highly Specific relationship between tissue or cell type and virus ligand
       - HIV - leukocytes, CD4 receptor
       - Rabies – neurons, Acetylcholine receptor
       - Herpes viruses – Nerve growth factor receptor

5. **Viral diversity photos**

6. **Viral external structures**
   - **Envelope**
     - Host membrane – outside of the capsid
     - identity and immune proteins
   - **Capsid**
     - Repeated protein coat
     - Naked – without envelope
   - **Spike**
     - **Ligand**
       - Protein attachment structures for host receptors
       - Host membrane receptors, proteins, or glycopalyx are attachment sites
     - **Enzyme ligand**
       - Metabolizes external host barriers

7. **Viral structure image**

8. **Rubella**  
    **SARS**

9. **Animal viral spikes**  
    **Bacterial viral spikes**

10. **Viral Core**
    - Everything interior to the capsid
• Single RNA or DNA chromosome
  – Ranges from 4 to 200 genes
  – RNA viruses subject to rapid mutation changes
• Core enzymes – RNA viruses
  – Nucleic acid polymerase enzymes
    • attached to the chromosome to initiate replication of new chromosomes

11 Viral core enzymes

12 Viral classification or naming
• Historical
  – Pox, influenza, measles, herpes
• Mode or source of transmission
  – Arbo = forest > insect transmitted
    • West Nile Virus
    • Dengue Fever Virus
• Clinical properties
  – HIV, SARS, encephalitis, hepatitis
• Anatomical or Physical properties
  – Chromosome type - DNA or RNA
  – Size and appearance
    • picorna (polio), corona (SARS)

13 Arbovirus Transmission mode

14 Arboviruses

15 Arbovirus disease map

16 Medically important DNA viruses
• Pox
  – Small pox (variola)
  – Cowpox (vaccinia)
  – Monkeypox
• Herpes
  – Cytomegalovirus (CMV)
  – Epstein-Barr
  – Varicella (chickenpox)
  – HSV1,2
• See DNA virus Table

17 Medically important DNA viruses

18 Child with Smallpox photo

19 Hepatitis B particles HepB Pathology

20 Herpes Simplex 1 virus HSV1 lesion

21 Medically important RNA viruses
• Picorna – Polio, HepA, Rhino
• Paramyxo – Rubeola, Mumps, RSV
• Toga - Rubella - Adult or German measles
• Flavi – Hep C
• Retro – HIV, HTLV
• Rhabdo
• See RNA viruses Table 1 and 2

Medically important RNA viruses table 1
Child with Polio paralysis photo
1930-40’s Polio epidemic
Medically important RNA viruses 2

Viral replication events overview
• Attachment and Entry
  – Uncoating of capsid from enveloped viruses
• Replication
  – Chromosome
  – Capsid
• Assembly and Release
  – Inside host cell
  – On membrane

Viral replication model image

Viral Attachment and Entry
• Three modes
• Adsorption – naked viruses
  – Capsid or spike proteins attach to host membrane
  – Viral plasmid admitted into cell
  – Capsid remains external
• Fusion - enveloped
  – Envelope spikes attach to receptors and fuses with host membrane
  – Capsid admitted into cell
• Receptor-mediated endocytosis - enveloped
  – Envelope spikes attach to host membrane receptors
  – Endocytosis response
  – Entire enveloped virus admitted into cell

Viral Entry modes image

Naked virus Entry
Enveloped virus Entry
HIV receptor attachment image
Endocytosis entry into host photo

Influenza spikes
• Two step entry
• Neuraminidase
  – Enzyme ligand
  – digests host glycocalyx
• Hemagglutinin
– Attachment ligand
– Growth hormone receptors

35. Hemagglutination
Used to ID viruses with hemagglutinin

36. Viral Plasmid Replication
• Plasmid is uncoated from capsid
• Viral plasmid copies are made
  – Viral core enzymes initiate replication (RNA) OR
  – Host cell enzymes initiate replication (DNA)
• Replication occurs in the cytoplasm or nucleus

37. DNA viral chromosome
• Viral DNA chromosome is used as a template to synthesize new viral DNA chromosomes
• Viral DNA > DNA synthesis > New viral DNA chromosomes

38. RNA viral chromosome
• Viral RNA chromosome is used as a template to synthesize new viral DNA chromosomes
  – Reverse Transcriptase (RT)
• Viral DNA is then a template for new viral RNA chromosome synthesis
  – Viral DNA may be a transposon in host DNA
• Viral RNA > RT > Viral DNA chromosome > Viral RNA chromosome

39. Lysogeny
• Genetic transformation of host
  – Viral chromosome is a permanent resident of the host cell
  – Viral DNA chromosome integrated into host chromosome
    • Bacterial = Transposon
    • Eukaryotic = Provirus
    • Retroviruses
  – Viral DNA chromosome stored in cytoplasm
    • Plasmid
    • Herpes viruses

40. Cell and viral chromosomes image

41. Viral Protein Synthesis
• Viral transcription
  – Viral chromosome transcribed to mRNA
• Viral translation
  – Viral mRNA translated to a large polypeptide
• Viral protein processing
  – Viral polypeptide cleaved into separate proteins
    • Capsid
    • Spikes
    • Nucleic acid polymerases
  – Viral proteins folded and assembled together

42. Viral protein synthesis image
Viral assembly and release
- Viral assembly
  - Spikes, Capsids and Chromosomes
    - at the host outer membrane
    - in the host cytoplasm
- Viral release modes
  - Lytic (lysis = splitting or bursting)
    - Acute
  - Budding = exocytosis or secretion
    - Leads to cell death
    -Persistent, Chronic or Recurrent

Enveloped viral release

Enveloped virus budding

Viral budding photo

SARS viral particles in human lung cell photo

Viral release modes image

Bacterial viruses
- Bacterial viruses are called PHAGES
  - Specific for certain bacteria species
  - Responsible for transferring antibiotic resistance between bacteria
- Phage replication
  - Adsorption is the method of attachment to host receptors
  - Entry of viral chromosome (plasmid) only

Phage photo

Phage attachment and entry image

Phages attached to bacterial cell photo

Phage replication
- Lytic
  - Viral assembly and release cause lysis of host cell

- Lysogenic
  - Viral chromosome or plasmid is replicated and then passed on to dividing bacteria
  - Lysis may occur in any generation

Phage replication and release image

Phage lysis and lysogeny image

Phage gene recombination image