Viruses

Non-cellular organisms

Premedical - Biology
Size the smallest 20 nm and more
Non-cellular: viruses are infectious particles

plant, animal, bacterial = bacteriophages

- **virion** = nucleic acid + protein coat (capsid) and another envelope similar to membrane (enveloped viruses)

- **bacteriophage** = icosahedral head + tail, sheath, base plate, fibers
Viruses infecting a bacterial cell

(a) T2 and related phages use their tail pieces to attach to the host cell and inject their genetic material (TEM).

viral DNA injection
CAPSID CONFIGURATION IN NAKED AND ENVELOPED VIRUSES.

Capsid - protein shell
subunits - Capsomers

(a) Tobacco mosaic virus has a helical capsid with the overall shape of a rigid rod.
(b) Adenoviruses have a polyhedral capsid with a glycoprotein spike at each vertex.
(c) Influenza viruses have an outer envelope studded with glycoprotein spikes. The genome consists of eight different RNA molecules, each wrapped in a helical capsid.
(d) Bacteriophage T4, like other “T-even” phages, has a complex capsid consisting of a polyhedral head and a tail apparatus.
Capsids

Helical

Polyhedral
Tobacco mosaic virus

Papillomavirus

Electron micrograph of papillomavirus particles. (Courtesy of Linda M. Stannard, University of Cape Town)
virus classification

- host specification: plant, animal, bacteria
- DNA a RNA virus: ds DNA, ss DNA, ds RNA, pos ss RNA, neg ss RNA, rev trans diploid ss RNA, rev trans circular dsDNA
- structure: symmetry helical, complex, icosahedral, capsid, envelope, number of capsomer
ds DNA, ss DNA, ds RNA, ss RNA, rev trans diploid ss RNA, rev trans circular dsDNA
Central dogma of Biology, Molecular biology, Genetics

- DNA
- RNA
- Protein

- Replication
- Reverse transcription
- Transcription
- Translation
Retrovirus, Lentivirus, pos ssRNA-RT, encapsulated: HIV-1, HIV-2
Viruses can reproduce via a host cell

- Obligate intracellular parasites
- only a limited range of host cells – host specificity
- eukaryotic viruses are tissue specific
- Lytic cycle – virulent viruses
Lytic cycle of virus reproduction

- adsorption of the virus to the cell
- penetration of the virus or viral NA into cytoplasm
- replication, transcription and translation
- assembling of new viral particles (self-assembly)
- transfer to daughter cells: effect on the cell: death of the cell – lysis (hundreds or thousand) cytopathy effect (exocytose)
A simplified viral reproductive cycle

The reproductive cycle of an enveloped RNA virus. Shown here is a virus with a single-stranded RNA genome that functions as a template for synthesis of mRNA. Some enveloped viruses enter the host cell by fusion of the envelope with the cell's plasma membrane; others enter by endocytosis.
Lysogenic - virogenic cycle

= integration of the viral nucleic acid into the host genome as provirus (prophage)

• replication with the DNA of the host cell
• latent viruses – the cell is not damaged
• virus is transferred to daughter cells
• viruses as vectors of oncogenes
The lytic and lysogenic cycles of phage λ, a temperate phage. After entering the bacterial cell and circularizing, the λ DNA can immediately initiate the production of a large number of progeny phages (lytic cycle) or integrate into the bacterial chromosome (lysogenic cycle).
RNA viruses:

**+ssRNA:** RNA serve as genetic material, i.e. is replicated to new copies

serve as mRNA for translation, i.e. production of viral proteins

e.g. virus of hepatitis C, rhinoviruses (cold), SARS

**-ssRNA:** RNA is converted to +ssRNA by viral RNA replicase

+ssRNA serve as mRNA for translation of viral proteins

and as template for replication of viral RNA

e.g. measeles, mumps, rabies
Retroviruses - reproduction:

retroviruses: single-stranded positive-sense RNA viruses

reverse transcriptase – produces DNA from RNA template

DNA replicates to double stranded DNA which is transferred to nucleus and integrated to host DNA by integrase (provirus)

Provirus can be transferred to daughter cells – dormant virus

or can be transcribed to mRNA used for translation of viral proteins

e.g. HIV, Rous sarcoma virus (RSV)

RSV genes: pol (capsid protein), pol (RT), env (envelope), src (tyrosin kinase)

Some retroviruses can cause tumors, e.g. RSV src gene (=oncogene)
Tumor viruses - transformation of eukaryotic cells

DNA viruses – oncogenes

RNA viruses

= retroviruses
RNA viruses

- Poliomyelitis - polio
- Rhinitis – cold
- Influenza – flu
- Encephalitis
- Rubella – measles Ger.
- Parotitis - mumps
- Morbilli – measles
- Rabies
- HIV-AIDS
DNA viruses:

**Adenoviruses** - respiratory disease
  - conjunctivitis
  - gastroenteritis

**Oral herpes** - herpes simplex virus

**Infectious mononucleosis** - Epstein-Barr virus (EBV)

**Smallpox** - Variola major and minor

**Human Papilomavirus (HPV)** - warts (verrucae), cancers of cervix, vulva, vagina
Prions

- degenerative brain disease
- infectious particles
- contain proteins, NA wasn’t proved
- abnormal prion = product of mutated genes
Disease

They cause an infection in sheep called *scrapie* and cattle *bovine spongiform encephalopathy* ("mad cow" disease).
Model for how prions propagate. Prions are misfolded versions of normal brain proteins. When a prion contacts a normal “twin,” it may induce the normal protein to assume the abnormal shape.
Prion protein

- occurrence in two isoforms:
  - normal PrPC (C=cellular)
  - abnormal PrPSC (SC=scrapie)

- PrPC – prevalence of alpha helix a little beta structure
- PrPSC – prevalence of beta structure
- presence of PrPSC induces PrPC change = normal protein to abnormal - runs as chain reaction
hereditary disease

= gene mutation $\rightarrow$ abnormal protein

• **transfer** between species is rare, but might be possible with a long period of latency

• **transfer from human to human**: by growth hormone, brain electrodes
Human diseases

- **Creutzfeld-Jacob** disease: affection of the grey brain cortex, severe neurological symptoms with quickly proceeded dementia
- **kuru**: Papua-New Guinea: disability of movement coordination, paralysis, dementia – disease is spread by ritual cannibalism
Neural degeneration in a prion infection.

It is a slice from the brain of a person who died of kuru. The large fluid-filled holes are places where neurons have died.