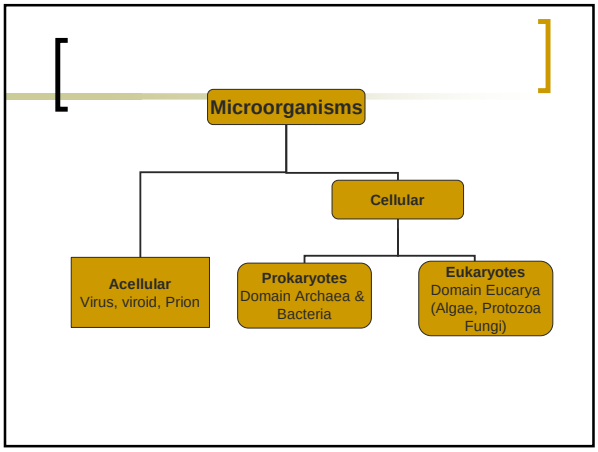
Viruses

BIO162

Page Baluch

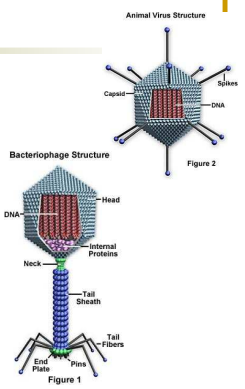


Infectious particles (20-300nm)

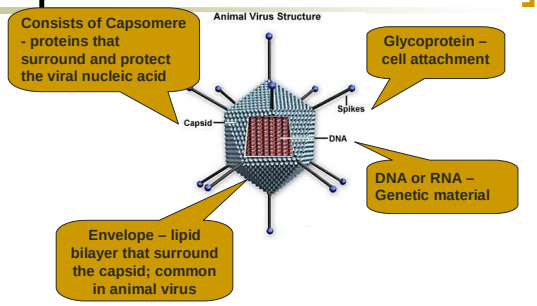
- **Virion – virus in its infective form, i.e. outside the cell**
- **Viroids - disease-causing particles that contain only nucleic acid and have no structural proteins**
- **Prions - composed primarily of a protein tightly integrated with a small nucleic acid molecule**
- **Bacteriophage – viruses that infect bacteria**

Viruses

- Acellular - Without a host cell, viruses cannot carry out their life-sustaining functions: energy production, protein and nucleic acid synthesis, replication
- contain nucleic acid, either DNA or RNA (but not both), and a protein coat
- Classified by the host range, shape, genetic materials



Virus structure



Host Range & Tropism

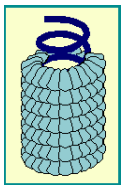
- Host range – types of organism a virus can infect
- Animals, bacteria or plants
- Plant viruses infect via a vector such as insects, worms or contaminated fomites
- Can be species specific or cross-species
- Change in host range can occur through virus mutation

Host Range & Tropism

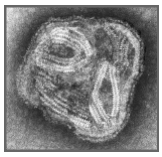
- **Tropism - The type of cell within a given individual host cell which a virus can infect**
- **Different species of viruses tend to vary both in their specific tropisms as well as in the breadth of their tropisms (i.e., they differ both in what cells they can infect and in *how many* different kinds of cells they can infect).**
- **e.g. HIV can infect T-cell, marcophage using the CD_4 receptor or other cell types using CD_4-like receptor**

Virus shape

Helical - capsomeres are arranged helically around the virus genome

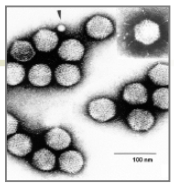


Tobacco mozaic virus

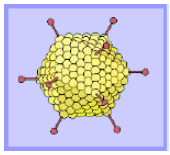


Human paramyxovirus (Enveloped)

Polyhedral- capsids form geometric shapes with flat sides (i.e., faces) and edges. e.g. an *icosahedron* which has 20 equilateral triangle faces and 12 corners



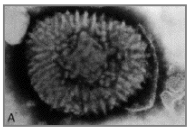
Adenovirus

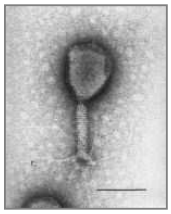


Human herpes virus (enveloped)

Complex - combinations of structures that may or may not be completely consistent between viruses of the same species

Pox virus

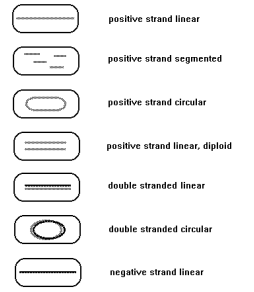




Bacteriophage T4

Genetic material

- Either DNA or RNA
- Can be single- or double-standed
- Can carry information for 4-100 proteins

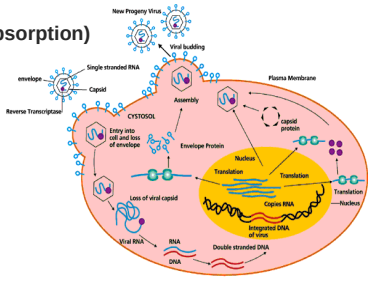


Viruses and Viral Disease of Importance for Dental professionals

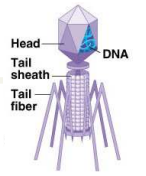
Virus	Characteristics	Disease	Transmission
Hepatitis B	d.s. DNA	Liver	Blood; sexual
Herpes simplex I	d.s. RNA	Cold sore	Kissing; contaminated fomites
HIV	d.s. RNA	AIDS	Blood; sexual
Common cold viruses	varied	Common cold	Inhalation of infected droplets; contaminated fomites

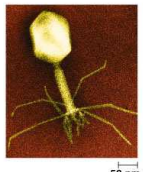
Life cycle of virus

1. **Attachment (absorption)**
2. **Penetration**
3. **Uncoating**
4. **Biosynthesis**
5. **Assembly**
6. **Release**



- The most complex capsids are found in viruses that infect bacteria, called **bacteriophages** or **phages**.
- The T-even phages that infect *Escherichia coli* have a 20-sided capsid head that encloses their DNA and protein tail piece that attaches the phage to the host and injects the phage DNA inside.





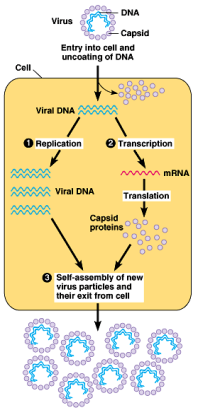
(d)Bacteriophage T4

Fig. 18.2d

Viruses can reproduce only within a host cell:

- Viruses are obligate intracellular **parasites.**
- They can **reproduce only within a host cell.**
- An isolated virus is unable to reproduce - or do anything else, except infect an appropriate host.
- Viruses lack the enzymes for metabolism or ribosomes for protein synthesis.
- An isolated virus is merely a packaged set of genes in transit from one host cell to another.
- **host range**
- Viruses identify host cells by a "**lock-and-key**" fit between proteins on the outside of virus and specific receptor molecules on the host's surface
- **Most viruses of eukaryotes attack specific tissues.**
  - Human cold viruses infect only the cells lining the upper respiratory tract.
  - The AIDS virus binds only to certain white blood cells.

- A viral infection begins when the genome of the virus enters the host cell.
- Once inside, the viral genome commandeers its host, reprogramming the cell to copy viral nucleic acid and manufacture proteins from the viral genome.
- The nucleic acid molecules and capsomeres then self-assemble into viral particles and exit the cell.

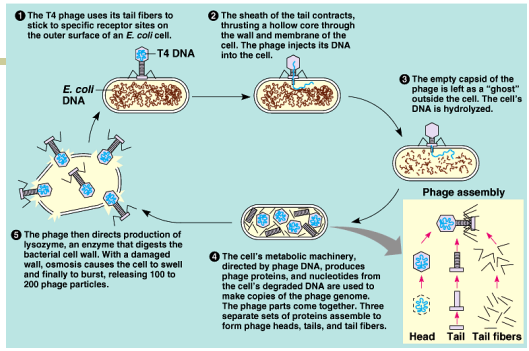


Lytic vs Lysogenic

- Bacterial cells can undergo one of two types of infections by viruses termed **lytic infections** and **lysogenic (temperate) infections**. In *E. coli,* lytic infections are caused by a group seven phages known as the T-phages, while lysogenic infections are caused by the phage lambda.
- Temperate viruses usually do not kill the host bacterial cells they infect. Their chromosome becomes integrated into a specific scection of the host chromosome. These bacteria are called **lysogenic**. The virus in this state is called **prophage**. In the prophage state all the phage genes except one are repressed. None of the usual early proteins or structural proteins are formed.
- **Virulent phages** reproduce only by a lytic cycle.

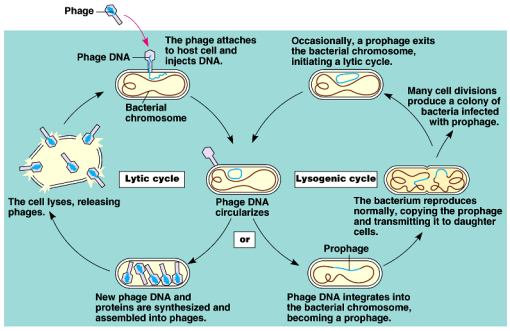
Lysogenic Cycle

- Lysogenic or temperate infection rarely results in lysis of the bacterial host cell. Lysogenic viruses, such as lambda which infects *E. coli,* have a different strategy for their replication. After penetration, the virus DNA integrates into the bacterial chromosome and it becomes replicated every time the cell duplicates its chromosomal DNA during normal cell division.



Lytic Cycle

The lambda phage which infects *E. coli* demonstrates the cycles of a temperate phage (Lysogenic Cycle).

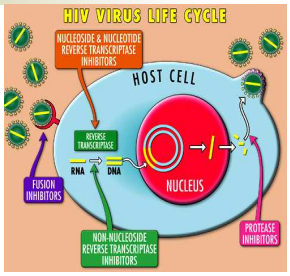


Latent Virus Infections

- **Certain viruses remain dormant once they enter the host and evade immune detection by not producing viral particles**
- **Productive cycle triggered by fever, stress, sunlight etc.**
- **e.g. Herpes simplex I (cold sores)**

Antiviral agents

- Antibiotics are NOT antiviral agents
- Targets:
  - viral-specific enzymes, protein
  - life cycle phases e.g. attachment, DNA synthesis
- Vaccinations



Viroids

- RNA molecules that infect plants
- Transmitted by vectors carrying infected seed or pollens
- ~33 species identified
- stunt growth and may kill plants
- e.g. potato spindle tuber virus

Prions

- abnormal, transmissible agents that are able to induce abnormal folding of normal cellular prion proteins in the brain → cause transmissible spongiform encephalopathies (TSEs)
- rare progressive, fatal neurodegenerative disorders
- can be infectious, inherited, or sporadic in origin
- replicate by recruiting normal proteins to their cause, "flipping" them into a rogue prion-like shape that can go on to infect other cells and animals
- e.g. scrapie, mad cow disease, Creutzfeldt-Jakob disease (CJD)
- Fungal (yeast) prion – research interest