Chapter 6 - Virology

- Topics
  - Structure
  - Classification
  - Multiplication
  - Cultivation and replication
  - Nonviral infectious agent
  - Teratogenic/Oncogenic

Viruses in Action!!

- Viruses have a host range. That is, viruses infect specific cells or tissues of specific hosts, or specific bacteria, or specific plants.

- Viral specificity refers to the specific kinds of cells a virus can infect. It is regulated by the specificities of attachment, penetration and replication of the virus

Properties of viruses

Viruses are not cells, do not have nuclei or mitochondria or ribosomes or other cellular components.
Viruses replicate or multiply. Viruses do not grow.
Viruses replicate or multiply only within living cells.
Viruses are obligate intracellular parasites.
The term virus was coined by Pasteur, and is from the Latin word for poison.
Components of viruses -

A virion is an infectious virus particle - not all virus particles are infectious
Viruses are composed of a nucleic acid, RNA or DNA - never both.
All viruses have a protein coat or shell that surrounds and protects the nucleic acid core.
Some viruses have a lipid envelope or membrane surrounding a nucleocapsid core. The source of the envelope is from the membranes of the host cell.
Some viruses package enzymes - e.g. RNA-dependent-RNA polymerase or other enzymes - some do not package enzymes
Structure

- Size and morphology
- Capsid
- Envelope
- Complex
- Nucleic acid

Capsid

- Protective outer shell that surrounds viral nucleic acid
- Capsid spikes - used for binding to cell surface proteins
- Composed of capsomer subunits - collectively protect the nucleic acid from the environment

Envelope

- Lipid and proteins - basically a modified version of our membranes
- Envelope spikes - bind to cell surface proteins
- During release of animal viruses, a part of the host membrane is taken

Nucleic acid

- Viruses contain either DNA or RNA
- Possess only the genes to invade and regulate the metabolic activity of host cells
- Ex. Hepatitis B (4 genes) and herpesviruses (100 genes)
- No viral metabolic genes, as the virus uses the host's metabolic resources
**Bacteriophages**

- **Bacteriophage**
  - Polyhedral head
  - Helical tail
  - Fibers for attachment
- Are considered either **LYTIC** or **TEMPERATE**
- Are often associated with virulence genes in bacteria
  - EX. - diphtheria toxin in *Clostridium diphtheriae* - also Bo-Tox from *C. botulinum*

**Growth curve for a bacteriophage**

![Growth curve](image)

**T-even bacteriophage** penetrate the host cell by specifically binding and injecting their DNA into the host cell

![Bacteriophage](image)

**After replication, bacteriophage release lysozyme, weaken/destroy/rupture cell and release numerous virions**

![Bacteriophage](image)
**Temperate phages** can cause disease

For example, *Corynebacterium diphtheriae* and *Clostridium botulinum* contain prophages that have genes which encode for toxins

Without these prophages, they **DO NOT** produce the toxin – without toxin, no disease

Thus, they are examples of bacteria and viruses interacting to cause medically relevant disease

**Classification**

- Structure
- Chemical composition
- Genetic makeup
- Host relationship
- Type of disease

**Baltimore Classification of Viruses**
General Steps in Viral Multiplication

- Adsorption
- Penetration
- Uncoating
- Synthesis
- Assembly
- Release

Viruses recognize specific receptors Figure 6.12 and then the virus penetrates the cell Figure 6.13

Endocytosis

Membrane Fusion
Animal Virus Replication

General Steps in Viral Multiplication
- Adsorption
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- Uncoating
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- Release

General replication scheme for an animal virus

A Magnified View of Viral Budding - ENVELOPED VIRUSES

Worst case scenario - HIV virions exiting from a T cell

What happens if it is a dsDNA virus???
Examples: Herpesvirus

A Magnified View of Viral Budding - ENVELOPED VIRUSES
Most simple - and efficient case = ss+RNA virus

Examples: Coronavirus

RETROVIRUS

Replication of RNA viruses

Insight 6.2 - Note differences between + sense, - sense and retrovirus replication

Also, be able to compare - contrast phage and animal virus replication

Cytopathic effects

• Damage to the host cell due to a viral infection – Transformation

Viral transformation of cells – cytopathic effect
Cultivation and Replication

- **In vivo** methods
  - Laboratory animals
  - Embryonic bird tissues
- **In vitro** methods
  - Cell or tissue culture

Cultivation of animal viruses –
It is possible to study viruses in animals, but due to the complexity of the animal, expense of animals and the political environment relative to the use of animals, alternatives have been developed.

Chick embryos in eggs - influenza
Persistent infection – transformation/cancer

Making the Influenza vaccine

Noncellular Infectious Agents

- Prions

Prions – Stanley Pruisner – Nobel Prize in Medicine: 1978

Prions are proteinaceous infectious agents - **Prions do not have nucleic acid**.

Prions are considered to be the causative agents of Creutzfeld Jakob disease, scrapie, bovine spongiform encephalopathy and kuru.
At least six viruses have been found to cause human cancer - Epstein-Barr virus, hepatitis B virus, hepatitis C virus, human papilloma virus (HPV-8, HPV-16), HTLV-I (adult T-cell leukemia and lymphoma), HTLV-II (hairy cell leukemia).

**Oncogenes** are normal cellular regulatory genes. When modified, these genes code for gene products that disturb the normal regulatory patterns of cells and can result in a loss of the normal properties of cell growth and division resulting in “cancer”.

**Oncogenic potential of viruses** -
Cancer is a set of diseases known to disturb the normal functioning and properties of cells.

Tumors may be malignant or benign - malignant tumors spread by metastasis.

Peyton Rous in 1911 discovered that a filterable agent could transmit a sarcoma (a type of cancer) in chickens - Rous sarcoma virus - the first retrovirus described.

**Viral oncogenes** are found usually in retroviruses.

V-oncogenes are viral homologs of the cellular oncogenes.

V-oncogenes can disturb normal regulatory properties by certain mechanisms.