



INTRODUCTION TO MEDICAL VIROLOGY

Khder Hussein Rasul

Medical Virology-Theory and MA 403

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Outline

- Historical background
- Definition of virology
- Nature of viruses
- Unconventional viruses

Objectives

- History of virus
- virology and virus
- Parts of the virus
- Tropism and host cells of viruses
- Bacteriophage and viriophage
- Viroids and prions

A brief history of virus

➤ In 1884, the French microbiologist Charles Chamberland invented the Chamberland filter (or Pasteur-Chamberland filter) with pores small enough to remove all bacteria from a solution passed through it.



➤ In 1892, the Russian biologist Dmitri Ivanovsky used this filter and described the first "filterable" infectious agent - tobacco mosaic virus (TMV) - smaller than any known bacteria.



○ Why has it called TMV?

○ Crushed leaf extracts from infected tobacco plants remained infectious even after filtration to remove bacteria.

○ Iwanowski was the first person to discriminate between viruses and other infectious agents, although he was not fully aware of the significance of this finding.

A brief history of virus

- In 1915, the English bacteriologist Frederick Twort discovered a group of viruses that infect bacteria, now called bacteriophages (or commonly 'phages').



- The first images of viruses were obtained upon the invention of electron microscopy in 1931 by Ernst Ruska and Max Knoll.
- In 1935, American biochemist and virologist Wendell Meredith Stanley examined the TMV and found it was mostly made of protein.
 - A short time later, this virus was separated into protein and RNA parts.

A brief history of virus

- In 1949, John Enders, Thomas Weller and Frederick Robbins were able to grow poliovirus *in vitro* using human tissue culture (Nobel Prize, 1954).
 - This development led to the isolation of many new viruses in tissue culture.
 - The invention of cell culture techniques enabled the growth and study of many viruses outside of their host organisms.

- In 1963, Baruch Blumberg discovered hepatitis B virus (HBV) (Nobel Prize, 1976).
 - Blumberg went on to develop the first vaccine against the HBV, considered by some to be the first vaccine against cancer because of the strong association of hepatitis B with liver cancer.

- In 1970, Howard Temin and David Baltimore independently discovered reverse transcriptase in retroviruses (Nobel Prize, 1975).

Definition of virology



- **Virology** is the scientific discipline that focuses on the study of viruses.

- **Virus** is an infectious, obligate intracellular parasite because viruses can reproduce only by using the cellular machinery of other organisms. Thus, on the one hand, viruses are considered to be living only when they multiply within host cells they infect. In this sense, viruses are parasites.

- On the other hand, viruses are not considered to be living because they are inert outside living hosts.

- Viruses are unique entities that bridge the gap between living and non-living things because they cannot carry out metabolic processes or reproduce on their own but can replicate and cause diseases when they infect a host cell.

- They are so small that most can be seen only with an electron microscope, and they are acellular (they are not cells).

Nature of viruses



- The word is from the Latin virus referring to toxin or poison.
- Viruses are the smallest infectious agents on earth ranging from 10 nm to about 400 nm in diameter.
- Viral particle contains a core made of only one type of nucleic acid, either DNA or RNA.
- This core is surrounded by a protein coat called a capsid., which is sometimes encased by a lipid membrane called an envelope.
- Many viruses encode a few structural proteins (those that make up the mature virus particle (or virion) and perhaps an enzyme that participates in the replication of the viral genome. Other viruses can encode many more proteins, most of which do not end up in the mature virus but participate in some way in viral replication.

Host cells of viruses



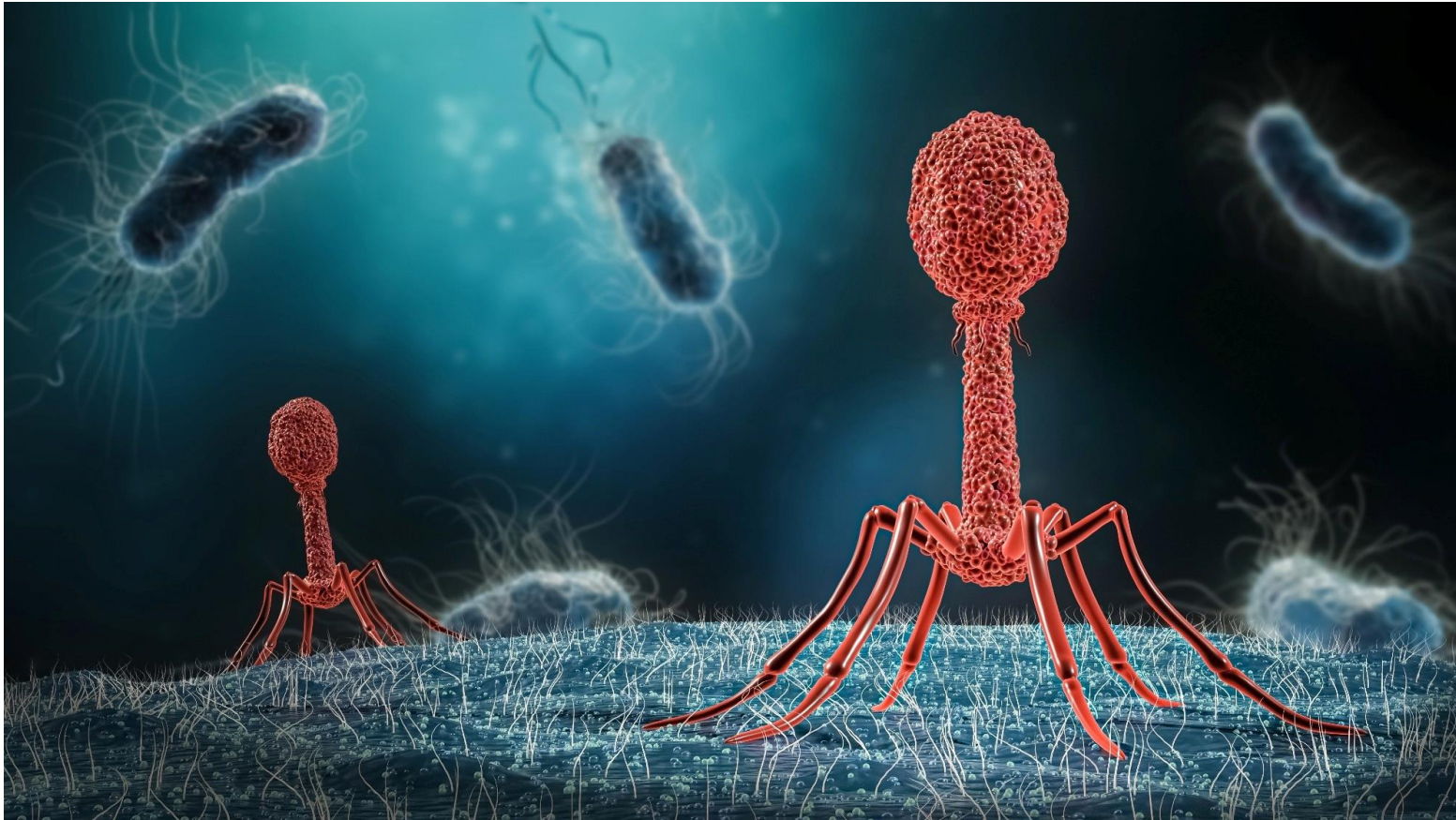
Virions (viruses) infect all cell types include

1. Animal cells
2. Plant cells
3. Cells of protists
4. Fungal cells
5. Bacteria

➤ Most viruses are restricted to infect specific types of cells of only one host species, a property known as **tropism**.

Bacteriophage

- Viruses are called bacteriophages (or phages) if they have a bacterial host.



Virophage



- Recently, viruses called virophages have been discovered that infect other viruses

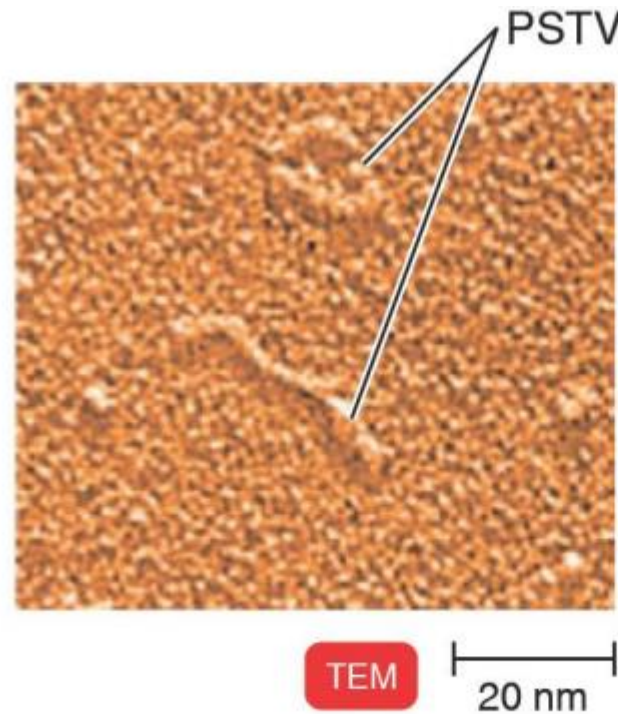


- Virophages require the co-infection of another virus (helper virus). Helper viruses are typically giant viruses. Virophages rely on the viral replication factory of the co-infecting giant virus for their own replication.

Unconventional agents

➤ There are also the 'unconventional agents' sometimes known as 'unconventional viruses'. Up to now, the main kinds that have been studied are

1. Virioids
2. Prions



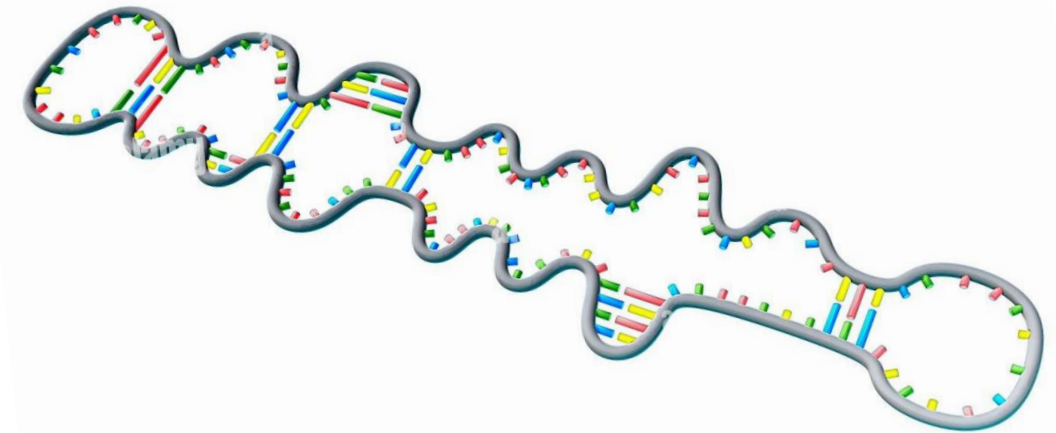
Linear and circular potato spindle tuber viroid (PSTV).



Prions isolated from the brain of infected hamster.

Viroids

- Viroids are unique infectious agents that are even simpler than viruses.
- Viroids are composed solely of a short, single-stranded, circular RNA molecule that typically ranges from a few hundred to over a thousand nucleotides in length.
- The RNAs are not packaged (they lack a protein coat (capsid)), do not appear to code for any proteins.
- So far have only been shown to be associated with plant disease. However, there are some suggestions that somewhat similar agents may possibly be involved in some human diseases.

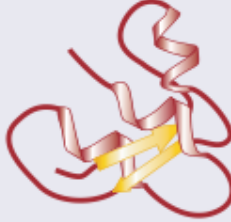



Prions

At a glance

- Prions are altered conformations of a normal cellular protein that can autocatalytically form more copies of itself.
- Prions are infectious particles associated with diseases of the central nervous system (e.g., Creutzfeldt-Jakob disease) and cause diseases in humans and animals: Mad cow disease, kuru in humans.
- Prions are resistant to nucleases but are inactivated with proteases and other agents that inactivate proteins.

PRION (Infectious PROtein)

| Normal protein | Misfolded protein |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|  |  |
| More α helix than β sheet | Mainly β sheet |

Prion diseases:

- scrapie (sheep)
- bovine spongiform encephalopathy
- sporadic Creutzfeldt-Jakob disease (humans)
- variant Creutzfeldt-Jakob disease (humans)

Question



1. TMV composed of protein and
2. Define bacteriophage
3. In 1963, Baruch Blumberg discovered
4. Viral particle contains a core made of
5. This core is surrounded by
6. Define tropism
7. What is difference between viroid and prion ?

References (in APA style)

- John Carter, Venetia Saunders - Virology Principles and Applications-Wiley (2007).
- L. R. Haaheim, J. R. Pattison, R. J. Whitley - A Practical Guide to Clinical Virology-Wiley (2002)