

INTRODUCTION TO VETERINARY VIROLOGY

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Viruses are obligatory intracellular infectious agents of sizes ranging from 20 to 300 nanometere with an absolute dependence on living cells for their replication.

DISCOVERY OF VIRUSES

The infections caused by viruses such as Rabies, Rinderpest and Smallpox have been known and feared since the dawn of history but the nature of their aetiology remained a myth. The discovery and study of viruses started sometimes in the late nineteenth century much after those of bacteria and fungi have been established.

In 1892, Dmitri Ivanovsky, a Russian scientist, reported that tobacco mosaic disease could be transmitted from a diseased plant to a healthy one using filtered leaf extract from the diseased plant as inoculums. Ivanovsky used Chamberland filter (designed in Pasteur laboratory by Charles Chamberland) to filter leaf extract from tobacco plant infected with tobacco mosaic. The filtrate was used as inoculums to infect a healthy tobacco plant. Ivanosky observed that the inoculated plant developed the disease tobacco mosaic. He then reasoned that the agent of tobacco mosaic couldn't have been a bacterium since Chamberland filter could hold back even the smallest bacterium. The agent must be smaller than bacteria to have passed through the filter.

In 1898, Martinus Beijerinck (a Dutch) unaware of the discovery by Ivanovsky also demonstrated the filterability of the agent of tobacco mosaic disease. He also showed that the disease couldn't have been due to a toxin because the filtered sap from infected plant could be used for serial transmission of the disease without loss of potency. The filterable disease-causing agent was termed '*virus*' meaning 'poisonous fluid'.

In 1898, Loeffler and Frosch showed that Foot-and-Mouth-Disease was caused by a filterable agent. In 1901, Walter Reed and his team identified Yellow Fever Virus as a filterable pathogen in humans.

General Characteristics and Properties of Viruses

1. Size: viruses are very small retaining infectivity after passing through filter with pore size small enough to hold back the smallest bacteria. Bacteria are measured in terms of micrometer (μm , 10^{-6} of a metre) whereas viruses are measured in nanometer (nm, 10^{-9} of a metre). Viruses range in size from 20nm to 300nm. The picornaviruses (e.g. Foot-and-Mouth-Disease virus) are the smallest viruses (20nm) while the poxviruses are the largest viruses (300nm). Viruses can not be seen by light microscope because of their small size. They are seen only by the aid of electron microscope. However, poxviruses can be seen by light microscope.
2. Organelles: Viruses do not possess cellular organization and do not have organelles.
3. Genome size: The genomes of viruses are smaller than those of bacteria, ranging from about 2 kilobase pairs (kbp) to 200 kbp.
4. Viruses are completely dependent on living cells, either eukaryotes or prokaryotes for replication and existence. Although some viruses possess their own enzymes such as RNA-dependent RNA polymerase or reverse transcriptase, they cannot reproduce and amplify the information in their genomes without the assistance of the cellular machinery. They do not grow in inanimate/non-living media.
5. Viruses have their genetic information in either DNA or RNA. A virus possesses only one species of nucleic acid either DNA or RNA but never both.
6. Viruses have a receptor-binding protein component for attaching to cells so that they can enter such cell and take over the machinery of the cell to their own advantage in reproducing their progeny.

7. Viruses do not multiply by binary fission but by a complex process involving protein synthesis and nucleic acid production
8. Viruses are unaffected by antibiotics
9. Viruses induce the production of interferon by infected host cell and are sensitive to the interferons.

STRUCTURE AND MORPHOLOGY OF VIRUSES

The knowledge of the structure of viruses is important in their identification and classification into groups. It also helps us to deduce many important properties of a particular virus. For instance, the processes of attachment and penetration of virus into host cell and subsequent maturation and release vary greatly among viruses and is influenced by the presence or absence of an outer lipid-containing envelope. Enveloped viruses tend to cause fusion of the host cell at some stage during their entry. Non-envelope viruses are more resistant to heat and detergents. These have consequences for control of viral infection especially disinfection of premises following an outbreak.

Basic Components of Viruses

A virus particle or virion consists of **nucleic acid (DNA or RNA)** that is covered by a protein coat called **capsid**. The combined nucleic acid and capsid is called **nucleocapsid**. The nucleocapsid can either be naked or enclosed by a membrane termed **envelope**. The capsid itself is made up of subunits called **capsomere**.

The proteins that make up the virus particle are termed **structural proteins**. The viral genome also codes for important enzymes called **non-structural proteins** required for viral replication but are not incorporated in the virion.

Viral Nucleic Acid

- This can either be RNA or DNA
- It contains the information necessary for directing the infected cells to synthesis virus-specific proteins
- It may be single stranded or double stranded
- It may be linear or circular
- It may be positive sense or negative sense (a positive sense nucleic acid possesses the same polarity as the mRNA and so can be translated directly into protein without first being transcribed)
- It may be a single piece or segmented
- It is haploid except in retroviruses in which it is diploid

The Capsid

- It is made up of proteins arranged in multiple almost identical units called capsomere
- It offers protection for the nucleic acid against adverse conditions
- It facilitates attachment and entry of the virus into host cell
- It possesses antigens used for virus identification in serological tests
- It determines the symmetry of the virus

The Envelope

- Present only in some viruses
- It is made up of lipids
- It is derived from the plasma membrane of the host cell during the release of the virus from the cell by budding
- In enveloped viruses, capsomeres take the form of projections called spikes or peplomers protruding out through the lipid bilayer of the envelope

- The spikes are glycoprotein in nature
- There may be a stabilizing protein membrane beneath the envelope lipid bilayer. This is referred to as the membrane/matrix protein
- In some viral infections, the envelope is acquired from the endoplasmic reticulum, the Golgi apparatus or the nuclear membrane
- Enveloped viruses are usually susceptible to detergent and are rendered non-infectious following damage to the envelope

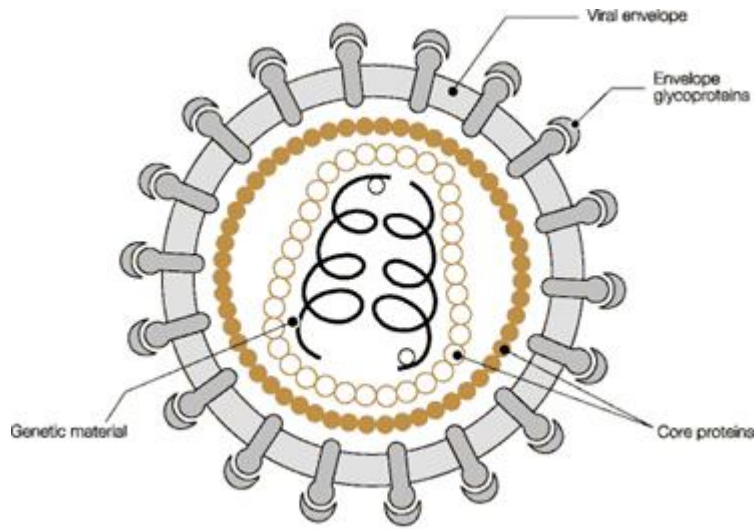


Fig 1 - Structure of a Virus (From: Encyclopedia of Molecular Biology, Blackwell Science Ltd, 1994)