# VIRUS

**"Viruses are infectious agents that replicate inside the body of a host."**

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## What is a Virus?

Viruses are non-cellular, microscopic infectious agents that can only replicate inside a host cell. From a biological perspective, viruses cannot be classified either a living organism or non-living. A virus can be an infectious agent which only replicates within a host organism. This is due to the fact that they possess certain defining characteristic features of living organisms and non-living entities.

In a nutshell, a virus is a non-cellular, infectious entity made up of genetic material and protein that can invade and reproduce only within the living cells of bacteria, plants and animals.

For instance, a virus cannot replicate itself outside the host cell. This is because viruses lack the required cellular machinery. Therefore, it enters and attaches itself to a specific host cell, injects its genetic material, reproduces by using the host genetic material and finally the host cell splits open, releasing the new viruses.

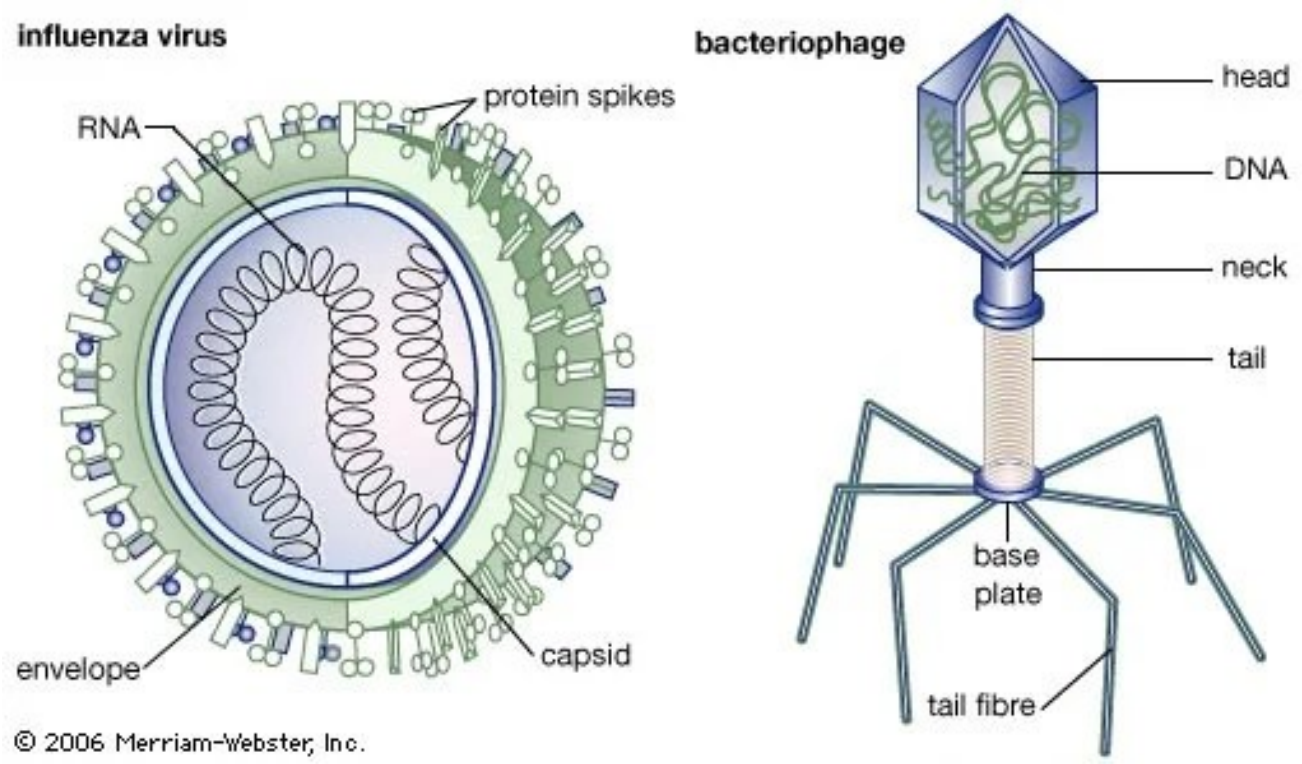
Viruses can also be crystallized, which no other living organisms can do. It is these factors that lead to viruses being classified in the grey area – between the living and non-living.

## Structure and Function of Viruses

Viruses are tiny and smaller in its size, ranging between 30-50 nm. Viruses do not contain cells and usually lack a cell wall but are surrounded by a protective protein coating called the capsid. It can be seen as a genetic element and is characterized by the combined evolution of the virus and the host. They contain either RNA or DNA as the genetic material.

Viruses mainly depend on a host to deliver the complex metabolic machinery of prokaryotic or **eukaryotic cells** for propagation. The main task of the virus is to carry its DNA or RNA genome to the host cell, which then can be transcribed by the host cell. The viral genome structure is

packed in a capsulated symmetric protein. The protein associated with nucleic acid (also known as nucleoprotein) produces the nucleocapsid with the genome.




These microbes belong to the family viridae and genus virus. Viruses could not be placed in any of the kingdoms because they are practically neither living nor dead. The term virus was coined by the Dutch microbiologist, Martinus Willem Beijerinck in the year 1897.
It is derived from Latin, which means poison or venomous substance.

**bacteriophage** , or **phage**, Any of a group of usually complex viruses that infect bacteria. Discovered in the early 20th century, bacteriophages were used to treat human bacterial diseases such as bubonic plague and cholera but were not successful; they were abandoned with the advent of antibiotics in the 1940s. The rise of drug-resistant bacteria in the 1990s focused renewed attention on the therapeutic potential of bacteriophages. Thousands of varieties exist, each of which may infect only one or a few types of bacteria. The core of a bacteriophage's genetic material may be either DNA or RNA. On infecting a host cell, bacteriophages known as lytic or virulent phages release replicated viral particles by lysing (bursting) the host cell. Other types, known as lysogenic or temperate, integrate their nucleic acid into the host's chromosome to be replicated during cell division. During this time they are not virulent. The viral genome may later become active, initiating production of viral particles and destruction of the host cell. A.D. Hershey and Martha Chase used a bacteriophage in a

famous 1952 experiment that supported the theory that DNA is the genetic material. Because bacteriophage genomes are small and because large quantities can be prepared in the laboratory, they are a favourite research tool of molecular biologists. Studies of phages have helped illuminate genetic recombination, nucleic acid replication, and protein synthesis.
Once a susceptible cell is infected, a virus can start the cell machinery to generate more virus. Viruses are composed of a core of DNA or RNA surrounded by a protein coat. They are very small and their size ranges from 20 nanometers to 250 nanometers. Therefore, they can only be seen with an electron microscope. Many viruses have either DNA or RNA as the genetic element and the nucleic acid with single or double strands. The whole infectious virus, called as virion has nucleic acid and an outer shell of **proteins**. The simplest virus includes DNA or RNA for encoding four proteins and the most complex encodes 100-200 proteins.

## Properties of Viruses

1. They are non-cellular organisms, which is enclosed in a protective envelope.
2. The presence of spikes helps in attaching the viruses to the host cell.
3. These viruses do not grow, neither respire nor metabolize, but they reproduce.
4. They are surrounded by a protein coat – capsid and have a nucleic acid core comprising DNA or RNA.
5. They are considered both as living and non-living things. These viruses are inactive when they are present outside of host cells, but become active within host cells. These viruses cause several infections and reproduce within the host cell by using the enzymes and raw materials.

## Classification of Viruses

Viruses can be classified primarily on their phenotypic characteristics, core content, chemical composition, capsid structure, size, shape, modes of replication and other viral genome structures.
The Baltimore classification is the most commonly used for studying the system of virus classification. This system was developed by an American biologist David Baltimore in the 1970s, for which he was awarded the Nobel Prize.
The below virus information describes the classification of viruses based on their different criteria.

## Classification Based On the Presence of Nucleic Acid

**DNA virus**

The virus, having DNA as its genetic material. There are two different types of DNA virus

Single-stranded (ss) DNA virus: e.g. Picornaviruses, Parvovirus, etc.

Double-stranded (ds) DNA virus: e.g. Adenovirus, Herpes virus, etc.

**RNA virus**

The virus, having RNA as its genetic material. There are two different types of RNA virus

Double-stranded (ds) RNA virus: e.g. Reovirus, etc.

Single-stranded (ss) RNA virus.

It is further classified into two Positive sense RNA (+RNA) and negative sense RNA (-RNA). Poliovirus, Hepatitis A, Rabies virus, Influenza virus are examples of single-stranded RNA virus.

## Classification Based On the Structure or Symmetry

Viruses come in different shapes, from basic helical and icosahedral shapes to more intricate ones. The classification based on different shapes and symmetry of viruses are as follows:

1. Complex virus. E.g. Poxvirus
2. Radial symmetry virus. E.g. Bacteriophage
3. Cubical or icosahedral symmetry shaped virus. E.g. Reovirus, Picornavirus
4. Rod or Spiral shaped or helical symmetry virus. E.g. Paramyxovirus, orthomyxovirus

## Classification Based On the Replication Properties and Site of Replication

Here, viruses invade into the host cell, where it replicates and assembly within the cell organelles.

1. Replication within the cytoplasm of the host cell. E.g. All RNA viruses except the Influenza virus.
2. Replication within the nucleus and the cytoplasm of the host cell. E.g. Influenza virus, Poxvirus, etc.
3. Replication within the nucleus of the host cell. All DNA viruses except Pox virus.
4. Replication of the virus through the double-stranded DNA intermediate. E.g. All DNA viruses, Retrovirus and some tumour causing RNA virus.

5. Replication of the virus through a single-stranded RNA intermediate. E.g. All RNA viruses except Reovirus and tumour-causing RNA viruses.

## Classification Based On the Host Range

Based on the type of host, there are four different types of viruses:

**Animal viruses**

These viruses infect by invading the cells of animals, including humans. Prominent examples of animal viruses include the influenza virus, mumps virus, rabies virus, poliovirus, Herpes virus, etc.

**Plant viruses**

These viruses infect plants by invading the **plant cells.** Replication of plant viruses is obligate and does not happen without a host. Well-known examples of plant virus include the potato virus, tobacco mosaic virus (TMV), beet yellow virus, and turnip yellow virus, cauliflower mosaic virus, etc.

**Bacteriophage**

The virus which infects bacterial cells is known as bacteriophage. There are many varieties of bacteriophages, such as DNA virus, MV-11, RNA virus, λ page, etc.

**Insect virus**

The virus which infects insects is known as Insect virus, also called the viral pathogen of insects. These viruses are considered as a powerful biocontrol agent in the landscape of modern agriculture. Ascovirus virions and Entomopox virus, are best examples for insect virus.

## Classification Based On the Mode of Transmission

1. Airborne infections – Transmission of the virus through the air into the respiratory tract. E.g. Swine u, and Rhinovirus.
2. Fecal oral route – Transmission of the virus through the contaminated water or food. E.g. Hepatitis A virus, Poliovirus, Rotavirus.
3. Sexually transmitted diseases – Transmission of the virus through sexual contacts with the infected person. E.g. Retrovirus, human papillomavirus, etc.
4. Transfusion-transmitted infections- Transmission of the virus through the blood transfusion. E.g. Hepatitis B virus, Human Immunodeficiency Virus, etc.

5. Zoonoses -Transmission of the virus through the biting of infected animals, birds, and insects to human. E.g. Rabies virus, Alpha virus, Flavivirus, Ebola virus, etc.

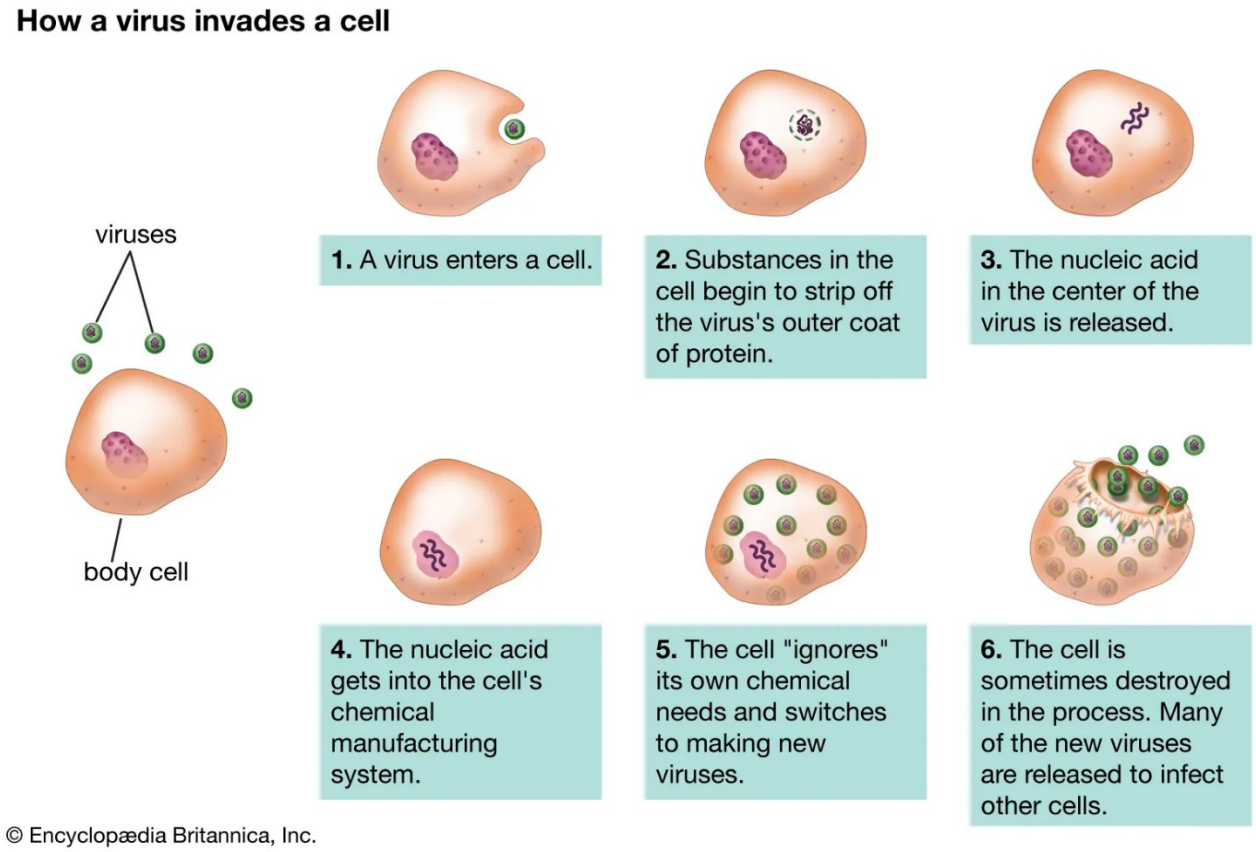
## VIRUS REPRODUCTION

Lytic infection is the method used by the majority of viruses to reproduce. A virus penetrates the host cell during lytic infection, replicates, and causes the cell to lyse or explode.

Overview of the lytic cycle:

- Attachment: Virus binds to host cell during attachment.
- Entry: Injection of genetic material into the host cell.
- Replication: The virus takes control of the host cell's metabolism, leading the organelles to produce new proteins and nucleic acids.
- Assembly: Nucleic acids and proteins are put together to form new viruses during
- assembly.

Release: Viral enzymes induce the host cell to burst, releasing viruses into the surrounding environment. These novel viruses are capable of infecting other cells



## LIST OF VIRAL DISEASES

Following is a list of virus diseases that have made a significant socioeconomic impact in the last few decades.

- AIDS (Acquired Immunodeficiency Syndrome)
- Ebola
- Influenza
- SARS (Severe Acute Respiratory Syndrome)
- Chikungunya
- Small Pox (Now eradicated)

## ECONOMIC IMPORTANCE OF VIRUS

- Viruses are used in biotechnology research because they share the properties of living and non-living species. The viruses can be both helpful and harmful. Bacteriophage can be used to preserve water since it can eliminate germs and maintain the freshness of the liquid.
- Pox, polio, mumps, jaundice, and other diseases can be controlled by injecting dead viruses into people as vaccines, which is how antidotes and vaccines are made.
- A specific virus can control some insects and animals that are hazardous to people.
- Disease management: The T2 bacteriophage virus protects from dysentery by killing dangerous bacteria, such as E-coli. Because viruses can specifically target cells and DNA, they are used in virotherapy to treat various disorders. It might play an essential role in gene therapy and cancer treatment.
- The most familiar living model utilised in laboratories is the virus. In genetics research, viruses are primarily used. It is an essential topic of discussion in genetic engineering.
- Due to the virus's combination of living and non-living traits, it is necessary to understand the evolutionary tendency and the mechanism by which living entities are created.
- Viruses are an example of an organic nanoparticle in nanotechnology. They have been utilised as a model for arranging materials on the nanoscale due to their shape, size, and structures.
- One million viruses can be found in a spoonful of seawater, aquatic ecosystems' most abundant natural component. A virus can boost the number of photosynthesis in oceans and reduce the quantity of carbon dioxide in the atmosphere by about three gigatonnes of carbon per year.