Introduction , General properties of virus , structure, classification of DNA & RNA viruses.

Introduction

A virus can be simply defined as an obligate intracellular parasite. Each viral particle, or virion, consists of a single nucleic acid, RNA or DNA, encoding the viral genome surrounded by a protein coat, and is capable of replication only within the living cells of bacteria, animals or plants. Viruses are classified into different orders and families by consideration of the type of nucleic acid present (RNA or DNA), whether the nucleic acid is single- or double-stranded, and the presence or absence of an envelope.

Scientists estimate that there are roughly 10^{31} viruses at any given moment. That's a one with 31 zeroes after it! If you were somehow able to wrangle up all 10^{31} of these viruses and line them end-to-end, your virus column would extend nearly 200 light years into space. To put it another way, there are over ten million times more viruses on Earth than there are stars in the entire universe.

Does that mean there are 10^{31} viruses just waiting to infect us? Actually, most of these viruses are found in oceans, where they attack bacteria and other microbes. It may seem odd that bacteria can get a virus, but scientists think that every kind of living organism is probably host to at least one virus!

What is a virus?

A virus is a tiny, infectious particle that can reproduce only by infecting a host cell. Viruses "commandeer" the host cell and use its resources to make more viruses, basically reprogramming it to become a virus factory. Because they can't reproduce by themselves (without a host), viruses are not considered living. Nor do viruses have cells: they're very small, much smaller than the cells of living things, and are basically just packages of nucleic acid and protein.

Still, viruses have some important features in common with cell-based life. For instance, they have nucleic acid genomes based on the same genetic code that's used in your cells (and the cells of all living creatures). Also, like cell-based life, viruses have genetic variation and can evolve. So, even though they don't meet the definition of life, viruses seem to be in a "questionable" zone.

How are viruses different from bacteria?

Even though they can both make us sick, bacteria and viruses are very different at the biological level. Bacteria are small and single-celled, but they are living organisms that do not depend on a host cell to reproduce. Because of these differences, bacterial and viral infections are treated very differently. For instance, antibiotics are only helpful against bacteria, not viruses.

Bacteria are also much bigger than viruses. The diameter of a typical virus is about 20 - 300 nanometers. This is considerably smaller than a typical *E.coli* bacterium, which has a diameter of roughly 1000 nm Tens of millions of viruses could fit on the head of a pin.

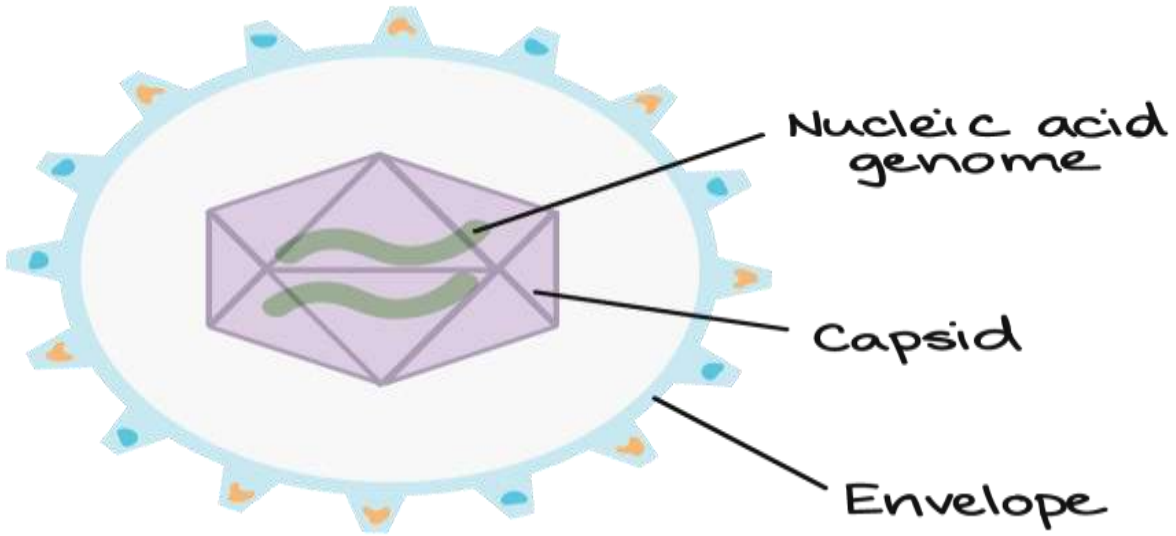
The structure of a virus

There are a lot of different viruses in the world. So, viruses vary a ton in their sizes, shapes, and life cycles. If you're curious just how much, I recommend playing around with the ViralZone website. Click on a few virus names at random, and see what bizarre shapes and features you find!

Viruses do, however, have a few key features in common. These include:

- A protective protein shell, or capsid
- A nucleic acid genome made of DNA or RNA, tucked inside of the capsid
- A layer of membrane called the envelope (some but not all viruses)

Let's take a closer look at these features.

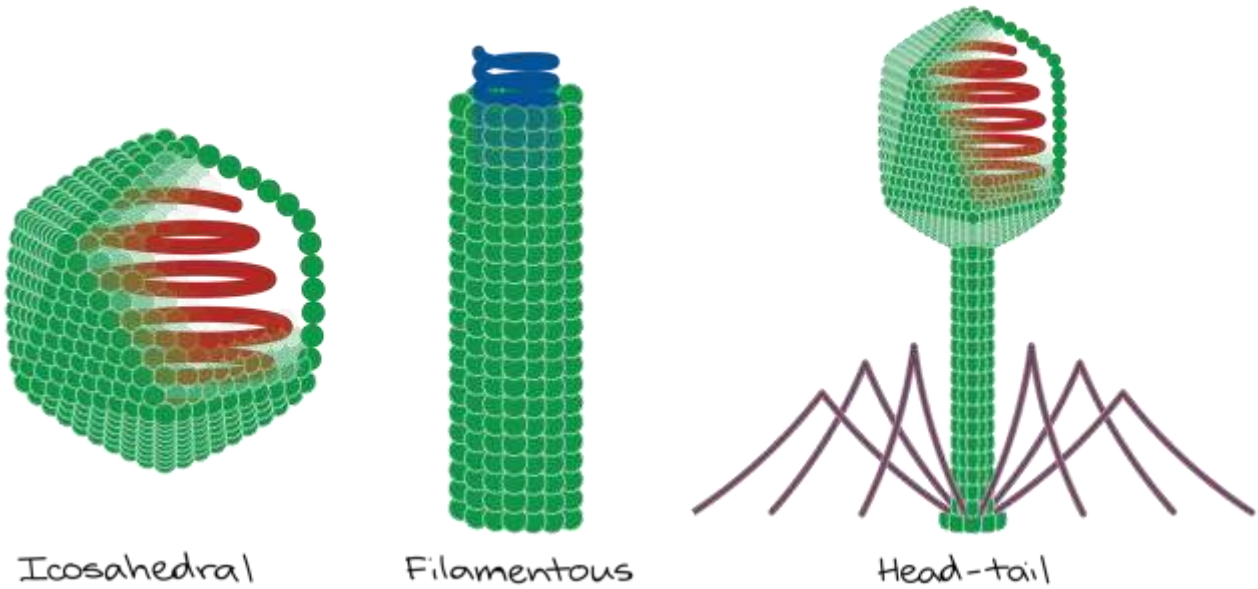


Virus capsids

The capsid, or protein shell, of a virus is made up of many protein molecules (not just one big, hollow one). The proteins join to make units called capsomers, which together make up the capsid. Capsid proteins are always encoded by the virus genome, meaning that it's the virus (not the host cell) that provides instructions for making them.

Capsids come in many forms, but they often take one of the following shapes (or a variation of these shapes):

1. Icosahedral – Icosahedral capsids have twenty faces, and are named after the twenty-sided shape called an icosahedron.
2. Filamentous – Filamentous capsids are named after their linear, thin, thread-like appearance. They may also be called rod-shaped or helical.
3. Head-tail –These capsids are kind of a hybrid between the filamentous and icosahedral shapes. They basically consist of an icosahedral head attached to a filamentous tail.

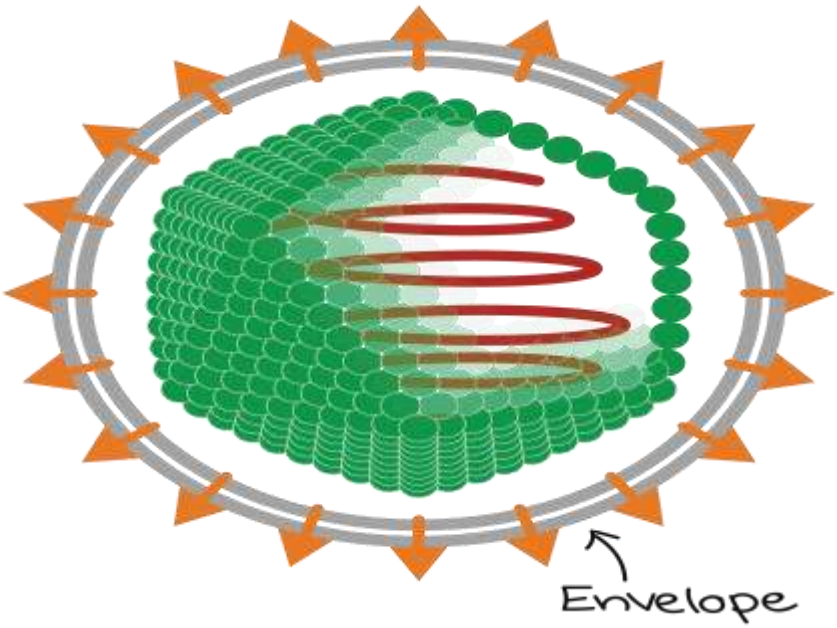


Virus envelopes

In addition to the capsid, some viruses also have an external lipid membrane known as an envelope, which surrounds the entire capsid.

Viruses with envelopes do not provide instructions for the envelope lipids. Instead, they "borrow" a patch from the host membranes on their way out of the cell.

Envelopes do, however, contain proteins that are specified by the virus, which often help viral particles bind to host cells.



Although envelopes are common, especially among animal viruses, they are not found in every virus (i.e., are not a universal virus feature).

Virus genomes

All viruses have genetic material (a genome) made of nucleic acid. You, like all other cell-based life, use DNA as your genetic material. Viruses, on the other hand, may use either RNA or DNA, both of which are types of nucleic acid.

We often think of DNA as double-stranded and RNA as single-stranded, since that's typically the case in our own cells. However, viruses can have all possible combos of strandedness and nucleic acid type (double-stranded DNA, double-stranded RNA, single-stranded DNA, or single-stranded RNA). Viral genomes also come in various shapes, sizes, and varieties, though they are generally much smaller than the genomes of cellular organisms.

Notably, DNA and RNA viruses always use the same genetic code as living cells. If they didn't, they would have no way to reprogram their host cells!

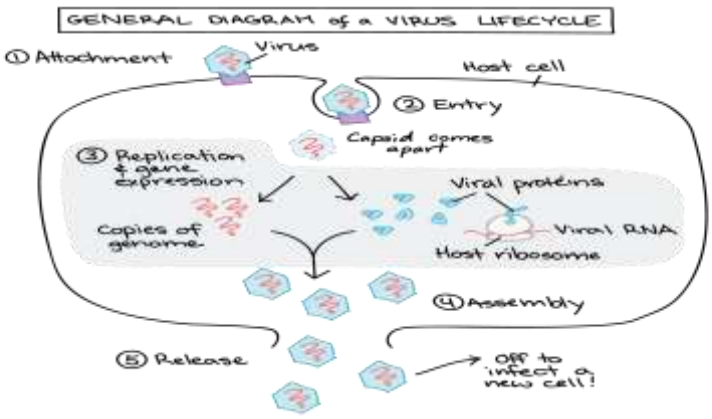
Positive Sense RNA Virus

- It is a type of virus containing a positive sense single-stranded RNA
- It is capable of operating as mRNA and can be directly translated into the protein in the host

- In the hosts, once the viral proteins are produced, it recruits RNA for the production of viral replication complexes
- The replication of virus advances through the double-stranded intermediates of RNA
- Some examples are – echovirus, poliovirus,

Negative Sense RNA Virus

- It refers to the type of single-stranded RNA virus with genetic content being the antisense strand of the viral mRNA
- It comprises a genome that is complementary to the viral mRNA
- Consequently, the genome of the virus cannot translate readily into the viral proteins. As a result, the virion must be packed with RNA-dependant RNA polymerase enzyme, which helps in the transcription of the viral RNA
- Some examples are – Ebola virus, influenza virus

The lifecycle can be divided into five broad steps (though the details of these steps will be different for each virus):

1. Attachment. The virus recognizes and binds to a host cell via a receptor molecule on the cell surface.
2. Entry. The virus or its genetic material enters the cell.
3. Genome replication and gene expression. The viral genome is copied and its genes are expressed to make viral proteins.
4. Assembly. New viral particles are assembled from the genome copies and viral proteins.
5. Release. Completed viral particles exit the cell and can infect other cells.