Virology

Introduction to viruses

Viruses are **obligate intracellular parasites**, inert in the extracellular environment, a-cellular infectious agents that require the presence of a living host cells in order to multiply (they replicate only in the living cells). Viruses are known to infect all types of cells including human, all higher plants and animals. Also, viruses infect unicellular organisms such as mycoplasmas, bacteria, algae, yeast, protozoa.

Viruses Characteristics

Viruses are simple in design, consisting of nucleic acid surrounded by a protein coat known as a **capsid**. The capsid is composed of smaller protein components referred to as **capsomers**. The (capsid + genome or nucleic acid) combination is called a **nucleocapsid**.

Viruses can also possess additional components, like membranous layer that surrounds the nucleocapsid, called an **envelope**. The envelope is actually acquired from the nuclear or plasma membrane of the infected host cell, and then modified with viral proteins called **peplomers**. Some viruses contain viral enzymes that are necessary for infection of a host cell and coded for within the viral genome. A complete virus or entire infectious unit with all the components needed for host cell infection, is referred to as a **virion**.

Virus Genome

While cells contain double-stranded DNA and RNA for their genome, viruses are including one type of nucleic acids (RNA or DNA), but not limited to this form, while there are **dsDNA** viruses, there are also viruses with single-stranded DNA (**ssDNA**), double-stranded RNA (**dsRNA**), and single-stranded RNA (**ssRNA**).

Virus Replication Cycle

Viruses incapable of reproducing by its own, they replicate only in the living cells and survives by directing the host cell machinery for the production of more viruses, which emerges from their respective host cell through lysis, viral nucleic acid

contains information necessary for programming the infected host cell to synthesize virus-specific macromolecules required for the production of viral progeny.

While the replication cycle of viruses can vary from virus to virus, there is a general pattern that can be described, consisting of many steps:

1. **Attachment** – the virion attaches to the correct host cell. Viral proteins on the capsid or phospholipid envelope interact with specific receptors on the host cellular surface.

2. **Penetration or Viral Entry** – the virus or viral nucleic acid gains entrance into the host cell. The process of attachment to a specific receptor can induce conformational changes in viral capsid proteins, or the lipid envelope, that results in the fusion of viral and cellular membranes.

3. **Uncoating** - the viral capsid is removed and degraded by viral enzymes or host enzymes releasing the viral genomic nucleic acid.

4. **Synthesis and replication** – after the viral genome has been uncoated, transcription or translation of the viral genome is initiated, genome replication and protein synthesis in which the viral proteins and nucleic acid copies are manufactured by the cells' machinery.

5. **Assembly or maturation** – after synthesis of viral genome and proteins, viruses are produced from the viral components. Viral proteins are packaged with newly replicated viral genome into new virions that are ready for release from the host cell.

6. **Virions release** – newly formed virions are released from the cell. There are two methods of viral release: lysis or budding.

a. Lysis: results in the death of an infected host cell, these types of viruses are referred to as cytolytic viruses.

b. Budding: results in the acquisition of the viral phospholipid envelope. These types of viruses do not kill the infected cell and are termed cytopathic viruses.

During the replicative cycle, numerous copies of viral nucleic acid and coat proteins are produced. The coat proteins assemble together to form the capsid, which encases and stabilizes the viral nucleic acid against the extracellular environment and facilitate the attachment and penetration by the virus upon contact with new susceptible cells. The virus infection may have little or no effect on the host cell or may result in cell damage or death.

Differences between virus and cell

Feature	**Virus**	**Cell**
Growth	Grow only within cell	Most free living
Nucleic acid content	DNA or RNA, never both	Both DNA and RNA
Cell component	Lack ribosomes and enzymes to generate energy	Contains ribosomes and enzymes for generation of energy
Enzyme content	Have very few if any enzyme	Have many enzymes

Bacteriophage

Viruses that infect bacteria are known as **bacteriophage** or **phage**. A **virulent phage** is one that lyses the host cell at the end of replication, after following the six steps of replication. This is called the **lytic cycle** of replication.

There are also **temperate phage**, viruses that have two options regarding their replication.

Option 1: is to mimic a virulent phage, following the six steps of replication and lysing the host cell at the end, referred to as the lytic cycle. But temperate phage differ from virulent phage in that they have another choice:

Option 2: where they remain within the host cell without destroying it. This process is known as **lysogeny** or the **lysogenic cycle** of replication.

Viruses and Cancer

There are many different causes of cancer (unregulated cell growth and reproduction), some known causes include exposure to certain chemicals or UV light or for hereditary reasons.

There are also certain viruses that have a known associated with the development of cancer. Such viruses are referred to as **oncoviruses**, that can cause cancer by producing proteins that bind to host proteins known as **tumor suppressor proteins**, which function to regulate cell growth and to initiate programmed cell death, if needed. If the tumor suppressor proteins are inactivated by viral proteins then cells grow out of control, leading to the development of tumors and metastasis, where the cells spread throughout the body.

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