

INTRODUCTION - VIRUS



॥ पशुधनं नित्यं सर्वलोकोपकारकम् ॥

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VIRUSES

- Viruses are **ultramicroscopic, obligate intracellular parasite/entity/particle which are not cells, are not microorganisms.**
- They possess no functional organelles and are completely dependent on their host for the machinery of energy production and synthesis of macromolecules.
- The complete virus particle known as **Virion**.
- They contain only one type of functional nucleic acid, either DNA or RNA, never both, and they differ from microorganisms in having two clearly defined phases in their life cycle.



VIRUSES

- Outside their host cell, the viruses are metabolically inert.
- Inside their host cell, the viruses are metabolically active
- This is their replicative phase in which the viral genome **exploits the machinery of the host cell** to produce progeny genome copies, viral messenger RNA, and viral proteins.
- They have no metabolic system of their own.



HISTORY

- *Ivanofsky and Beijerinck* (1892–1898) demonstrated infectious nature of the fluids (extracted from tobacco plants) that was passed through filters that retained bacteria.
- *Dimtri Ivanovski* and *Martinus Beijerinck* discovered first virus, *tobacco mosaic virus* in the 1890s.
- *Loeffler and Frosch* (1898): Foot-and-mouth disease in animals caused by filterable agent that was later on known as virus.
- *Loeffler and frosch*, working with *koch* discovered first animal virus, *foot and mouth disease virus*, in 1898.
- *Sanarelli*, discovered *Myxoma virus*, in 1898.



HISTORY

- *Reed and carroll, discovered the first virus of humans, yellow fever virus and it's mosquito transmission cycle, in 1900.*
- *M'fadyean, discovered African horse sickness virus, in 1900.*
- *Centanni, Lode and Gruber, discovered fowl plague virus, in 1901.*
- *World Health Organization (WHO) declares the world free from Smallpox (1979)*
- *World Organization for Animal Health (OIE) declares the world free from Rinderpest (2011).*



HISTORY

- *Remlinger and Riffat-Bay, discovered rabies virus, in 1903.*
- *DeSchweinitz and Dorset , discovered hog cholera virus, in 1903.*
- *Arnold theiler, made breakthrough discoveries concerning rinderpest, African horse sickness and other animal diseases in early 1900s.*
- *Ellermann and Bang, discovered Avian leukemia virus, first cancer causing virus, in 1908.*
- *Landsteiner and popper, discovered polio virus, in 1909.*
- *Rous, discovered first solid tumour virus now known as Rous sarcoma virus, in 1911.*

HISTORY

- *Felix D'Herelle and William twort, discovered Bacteriophages in 1915-1917.*
- *Laidlaw and Dunkin, discovered Canine distemper virus, in 1926.*
- *Shope, discovered Swine influenza virus, in 1931.*
- *Andrews, P. Laidlaw, Smith and Burnet, first isolated influenza virus, in 1933.*
- *Max Theiler, developed Yellow fever vaccine, in 1935.*
- *Olafson, Pritchard, Gillespie, Baker and colleagues, discovered the bovine viral diarrhoea virus in 1940s - 1950s.*
- *Sigurdsson, did studies of scrapie and meadi/visna in sheep and proposed the concept of slow infectious viral disease in 1950s.*

HISTORY

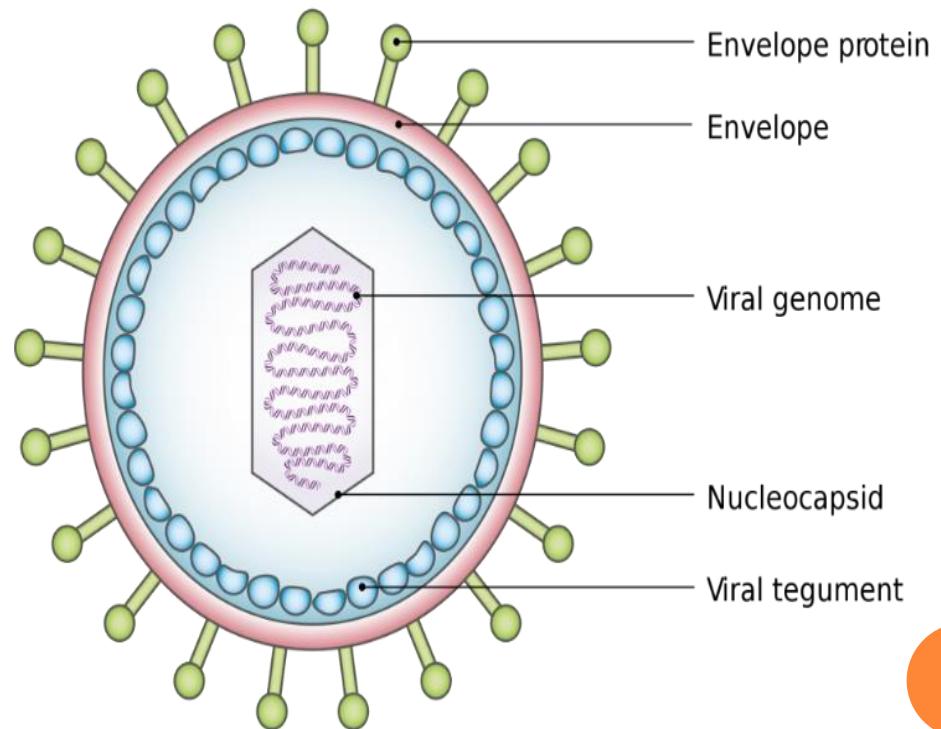
- *Salk and Sabin, developed inactivated virus and attenuated virus polio vaccines, in 1954 and 1957.*
- *Carmichael, Parrish and colleague, discovered Canine parvo virus, in 1978.*
- *Montagnier and colleagues, discovered HIV, in 1984.*
- *Many British veterinary Virologists, discovered the agent of Bovine spongiform encephalopathy, in 1986 and Stanley prusiner, who discovered the nature of prions, was awarded the Nobel Prize in medicine, in 1997.*
- *Pedersen and colleague, discovered the Feline immunodeficiency virus, in 1987.*



VIRUSES

- **Poxviruses**, the largest of the viruses of vertebrates, are 300 nm (or 0.3 μm) in their longest dimension
- **Circoviruses**, the smallest of the viruses of vertebrates, are 17-22 nm in diameter
- A protein coat that covers nucleic acid genome (DNA or RNA) of viruses known as **Capsid**, Capsid formed by morphologic units/ structural units known as **Capsomers**
- **Bluetongue viruses are composed of a subcore and two capsid layers.**
- Many viruses contain an external membrane of protein/lipid/lipoprotein coat externally capsid called an **envelope**.
- The capsid and enclosed nucleic acid constitute the **nucleocapsid**.

- The envelope is actually acquired from the nuclear or plasma membrane of the infected host cell, and then modified with viral proteins called **peplomers**.



Properties of Unicellular Microorganisms and viruses

Sl. No.	Property	Bacteria	Rickettsia	Mycoplasma	Chlamydia	Virus
1.	> 300 nm diameter*	+	+	+	+	-
2.	Growth on non-living medium	+	-	+	-	-
3.	Binary fission	+	+	+	+	-
4.	DNA and RNA	+	+	+	+	-
5.	Infectious nucleic acid	-	-	-	-	+**
6.	Functional ribosomes	+	+	+	+	-
7.	Metabolism	+	+	+	+	-
8.	Sensitivity to antibiotics	+	+	+	+	-

*Some Mycoplasma and Chlamydia are <300 nm in diameter

**Some viruses

CHEMICAL COMPOSITION OF THE VIRION

- The chemical composition of virus particles varies among virus families.
- The virus particles contain either DNA or RNA, and proteins.
- In enveloped viruses, glycoproteins are the major type of protein present on the exterior of the membrane.
- The presence of a lipid envelope makes the viruses susceptible to organic solvents.



VIRAL MORPHOLOGY

- X-ray crystallography and electron cryo-microscopy (Cryo-EM) have been used to study the virus structures.
- First, Tobacco mosaic virus (crystallized) was visualized using an electron microscope and appeared as a rod-shaped particle, confirming the particulate nature of viruses.
- The *virion*: the complete virus particle that consists of either DNA or RNA and surrounded capsid protein.
- Virus structures without the nucleic acid are referred as empty capsids or virus-like particles.
- Nucleocapsid: a capsid with its nucleic acid



VIRION SYMMETRY

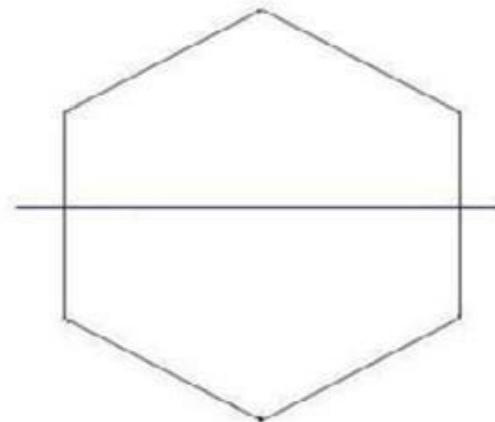
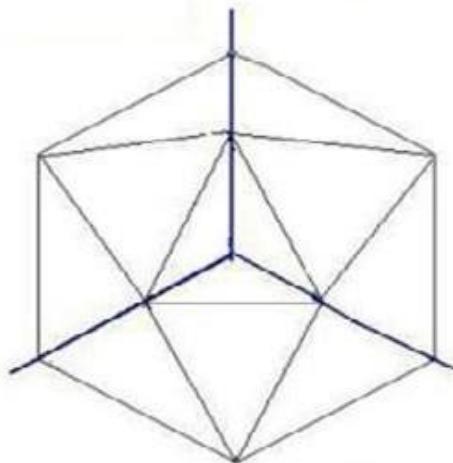
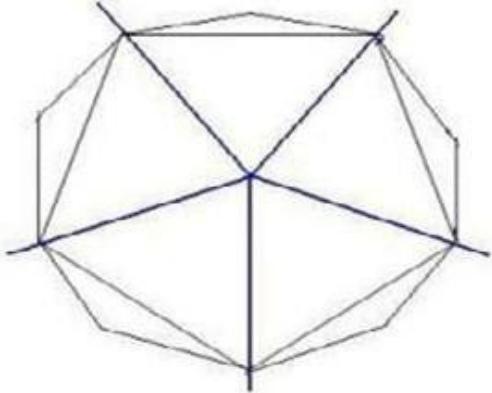
- Virions are assembled from several copies of a few kinds of protein subunit.
- The repeated occurrence of similar protein–protein interfaces leads to assembly of the subunits into symmetrical nucleocapsids.
- Viruses come in a variety of shapes and sizes that depend on the shape, size, and number of their protein subunits and the nature of the interfaces between these subunits.
- However, mainly two kinds of symmetry have been recognized in virus particles: icosahedral and helical.



ICOSAHEDRAL

- ❖ An icosahedron is a polyhedron made of 20 triangular faces with 5 each at the top and bottom and 10 at the middle.
- ❖ There are 12 vertices (corners) and 30 edges. Each triangle is symmetrical and can be inserted in any orientation whichever way it is inserted.
- ❖ The vertices have five fold symmetry. This means that rotation of the icosahedron by one fifth of a revolution presents a position which is indistinguishable from the starting orientation.
- ❖ Each of the 20 faces has a three fold axis of symmetry and each of the 30 edges has a two fold axis of symmetry. Example: Parvovirus, Adenovirus, Picornavirus, etc.

Icosahedral Symmetry



Five fold symmetry (Vertices)

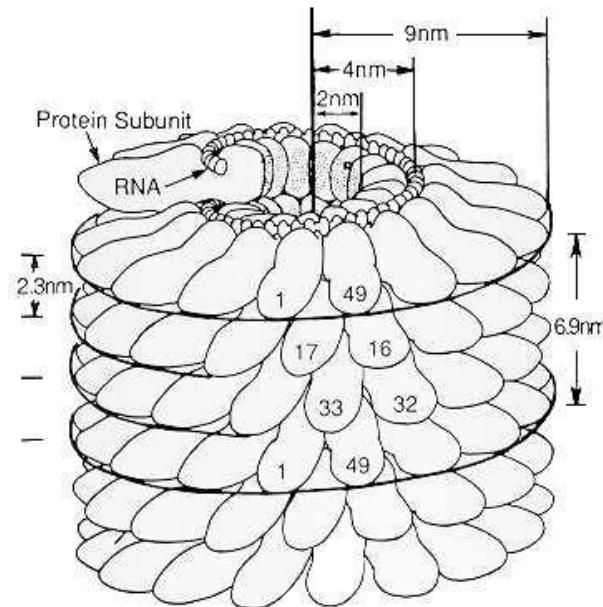
Three fold symmetry (Faces)

Two fold symmetry (Edges)



HELICAL

- In this type of symmetry the capsomeres are set in a helical manner around the genome nucleic acid. Example: Coranavirus, Flavivirus, Rhabdovirus, etc.



The Origins of Viruses

- **The Virus-First Hypothesis/ Co-evolution hypothesis**
 - ❖ Recently, several investigators proposed that viruses may have been the first replicating entities.
 - ❖ Proposes that viruses may have evolved **from complex molecules of protein and nucleic acid at the same time as cells first appeared on Earth** and would have been dependent on cellular life for billions of years.



The Origins of Viruses

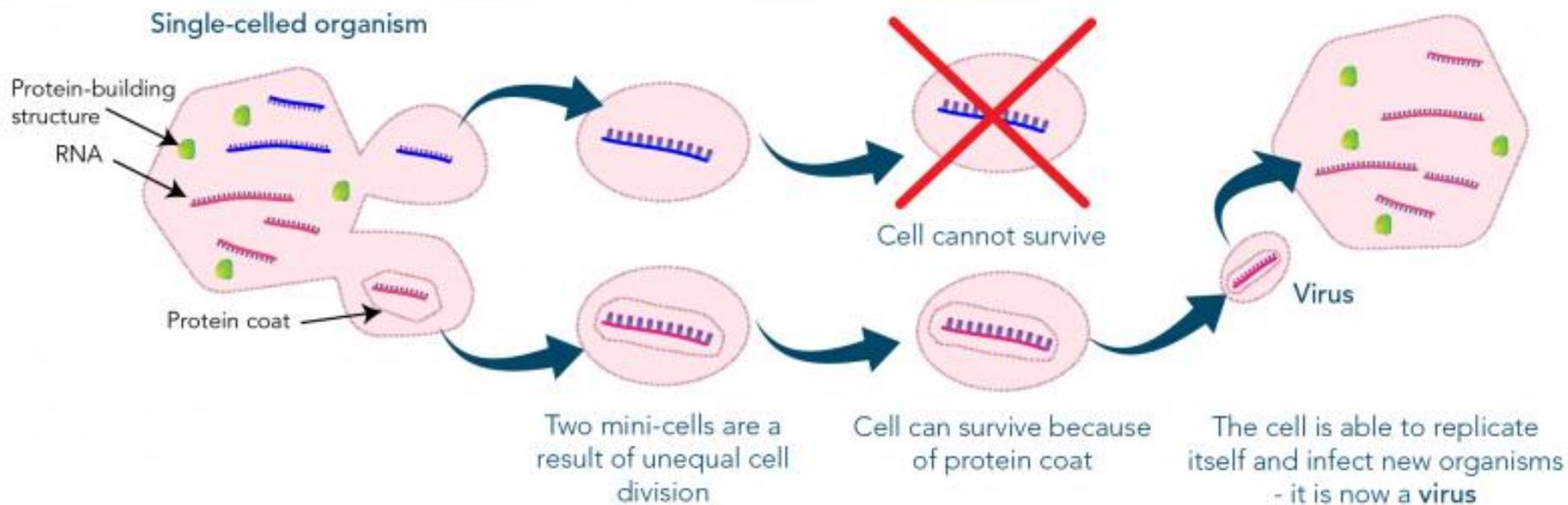
- The Progressive Hypothesis /Vagrancy hypothesis/ the escape hypothesis.
 - ❖ According to this hypothesis, viruses originated through a progressive process.
 - ❖ Mobile genetic elements, pieces of genetic material capable of moving within a genome, gained the ability to exit one cell and enter another.



The Origins of Viruses

- The Progressive Hypothesis /Vagrancy hypothesis/ the escape hypothesis.

Escape Hypothesis for the Origin of Viruses



The Origins of Viruses

- **The Regressive Hypothesis**

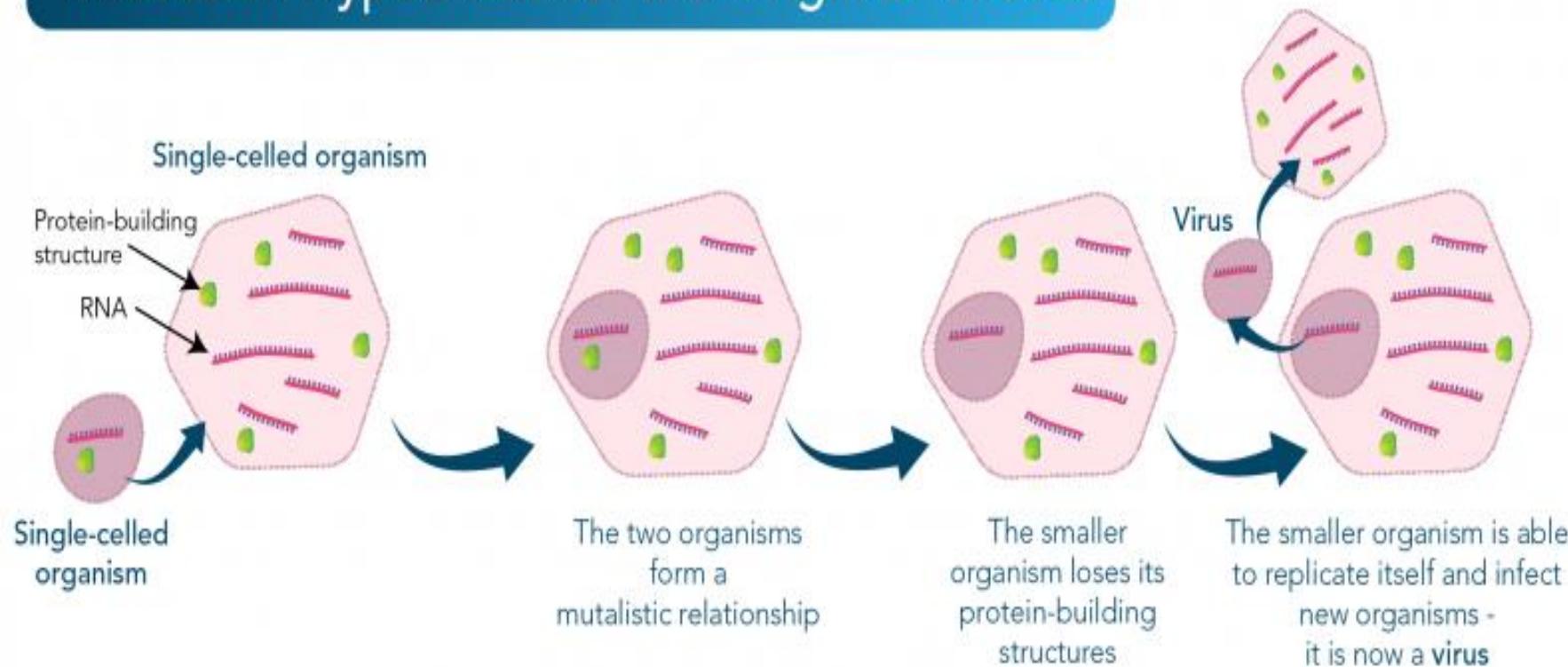
- ❖ Viruses may have originated via a **regressive, or reductive, process**.
- ❖ Microbiologists generally agree that certain bacteria that are obligate intracellular parasites, like Chlamydia and Rickettsia species, evolved from free-living ancestors.



The Origins of Viruses

○ The Regressive Hypothesis

Reduction Hypothesis for the Origin of Viruses



FURTHER READINGS

F. Murphy, E. Gibbs, M. Horzinek, M. Studdert (1999)
Veterinary Virology: 3rd ed.

- For further information
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