Introduction to Medical Virology

A Presentation

By

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OBJECTIVES

The objectives of this lecture are to

- Define virus.
- Explain the general properties of viruses.
- Define virus-related terms.
- Explain the morphology, structure and symmetry of a virus.
- Discuss the general laboratory diagnosis of a virus.

INTRODUCTION

- **Definitions:** Viruses are obligate intracellular parasites and infectious particles.

- Virology is the study of viruses. The origin of viruses is not known.

- It reproduces inside the living host cells of humans, animals, plants, bacteria, fungi and protozoa.

- The viral diseases are due to the effects of this interaction between the virus and its host.

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- The **virus** was **first discovered** by **Dmitri Ivanowsky** in **1892**.

- He recognized an infectious agent, that caused **tobacco mosaic disease** and was **smaller than bacteria**.

- **Martinus Willem Beijerinck** in **1898** called the filtered, infectious substance a "**virus**" and this discovery is considered to be the beginning of virology.

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- This **tobacco mosaic virus (TMV)** was the **first virus** to be **discovered**.
- TMV was **first seen** with an **electron microscope** in **1935**.
- Viruses are ultra microscopically small particles containing either **DNA** or **RNA genetic material**.
- **Viruses** are obligate intracellular parasites; hence, they **replicate** only **inside living cells**.

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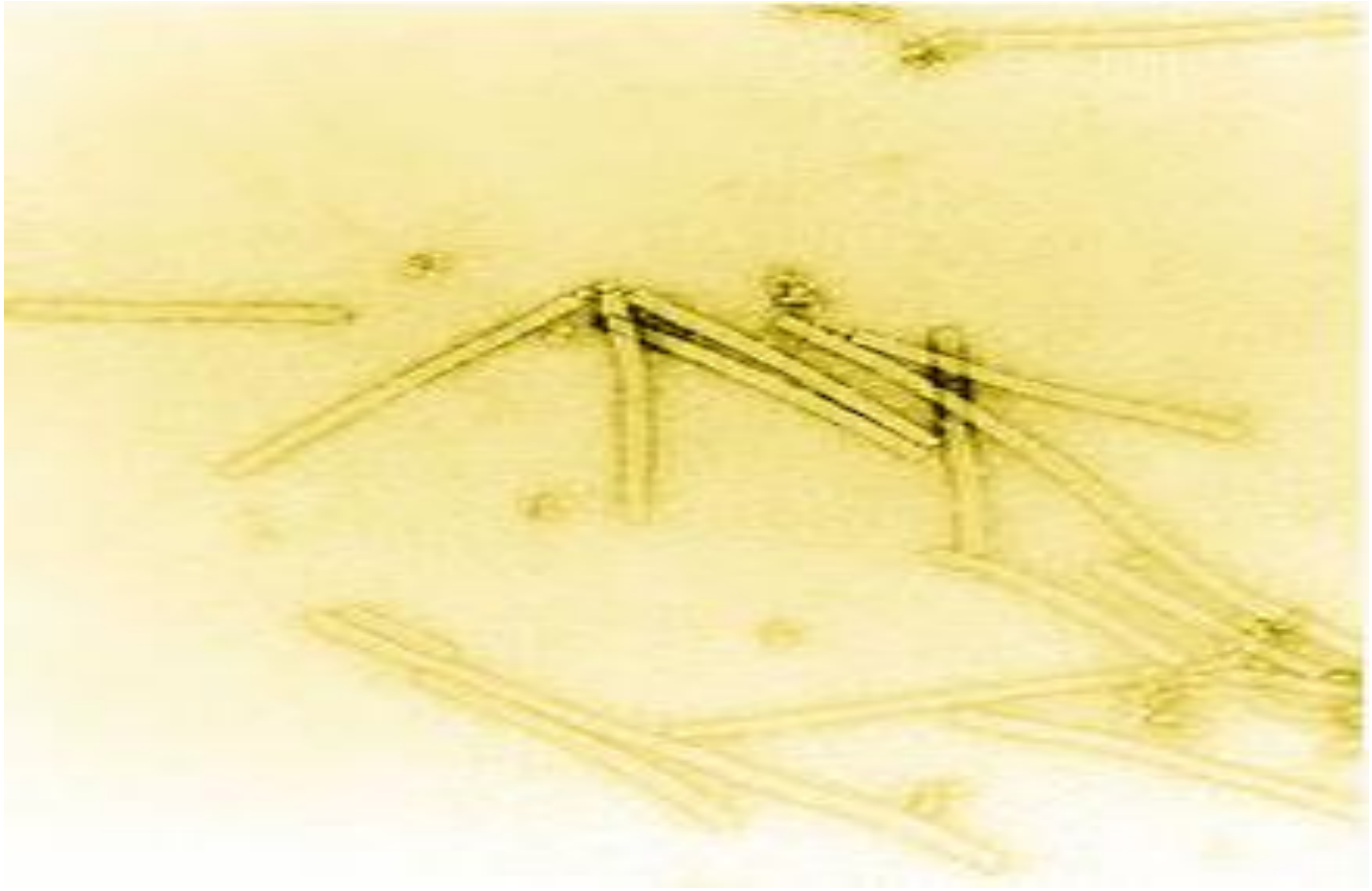
Structure of the Tobacco Mosaic Virus



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- Viruses are much smaller than bacteria; they range in size between 20-300 nanometers (nm).

- **Viruses** are too small to be **seen** under the light microscope and can only be seen under the **electron microscope**.

- Some of the **larger viruses**, such as the **Poxvirus**, can be seen under a **light microscope**, when suitably stained.

General properties of viruses

- **The General properties of viruses are;**

- Viruses do not possess cellular organization.

- They do not contain one type of nucleic acid, either **DNA** or **RNA**, but never both. Hence, viruses are mostly divided into two types. They are DNA viruses and RNA viruses.

- Most of the **viruses lack enzymes**, which are necessary for protein and nucleic acid synthesis and so **depend on host cells**.

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- They multiply by a **complex process**, not by binary fission.
- They are **unaffected** by **antibiotics**.
- Viruses **can't grow** in **chemically defined media**.
- The **modern virus classification** was developed by **David Baltimore**.

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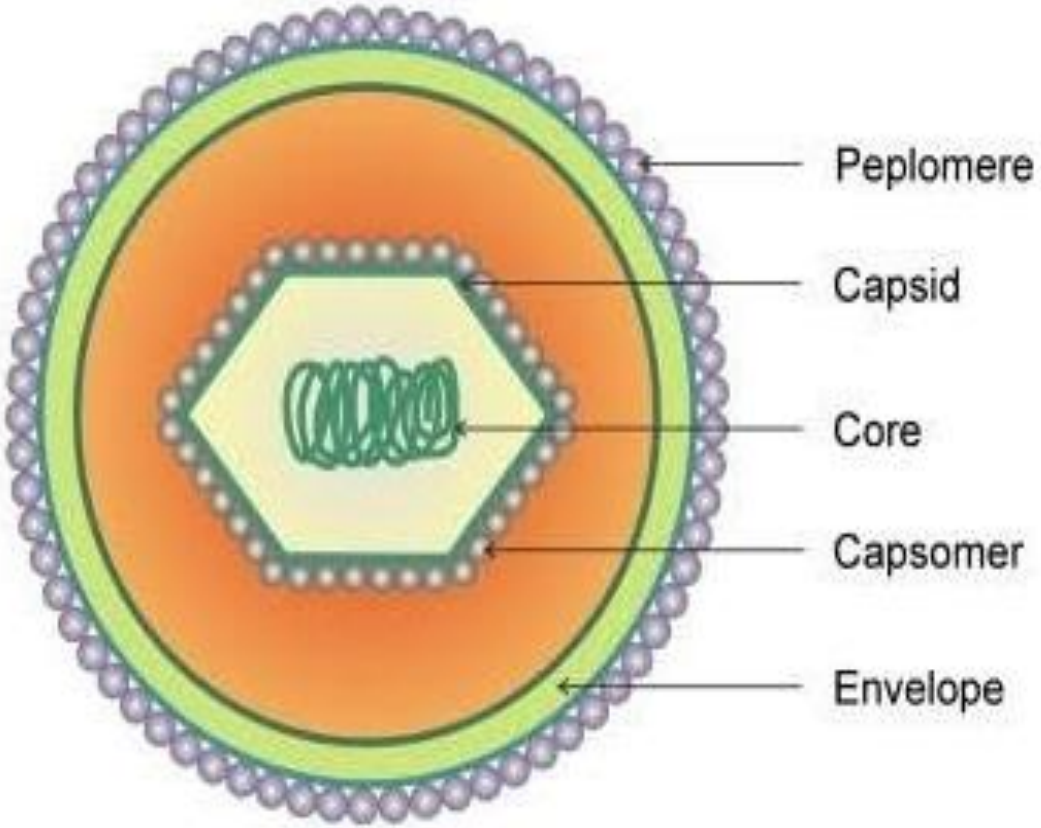
Structure of a Virus



Terms

- **Virion:** The complete virus particle.
- **Capsid:** The protein coat that surrounds nucleic acid.
- The function of the **capsid** is to **protect** the **nucleic acid** from inactivation by **nucleases** and other **toxic agents** in the **environment**.
- **Nucleocapsid:** The nucleic acid plus the capsid.

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- **Capsomeres:** The **capsid** is composed of a large number of **capsomeres**, which form the **morphological units** of a **virus**. **Capsomeres** is a structural **protein unit**.

- **Envelope:** The **envelope** is present **outside** the **nucleocapsid. It** is **made up** of a **lipid bilayer.**

Morphology of Viruses
1. Size

- Viruses vary widely in size.
- The **largest** among them is **Poxvirus**, measuring about **300 nm**.
- The **smallest virus** is **Parvovirus**, which measures about **20 nm**.
- This means that the **viruses** can only be **seen** through an **electron microscope**.

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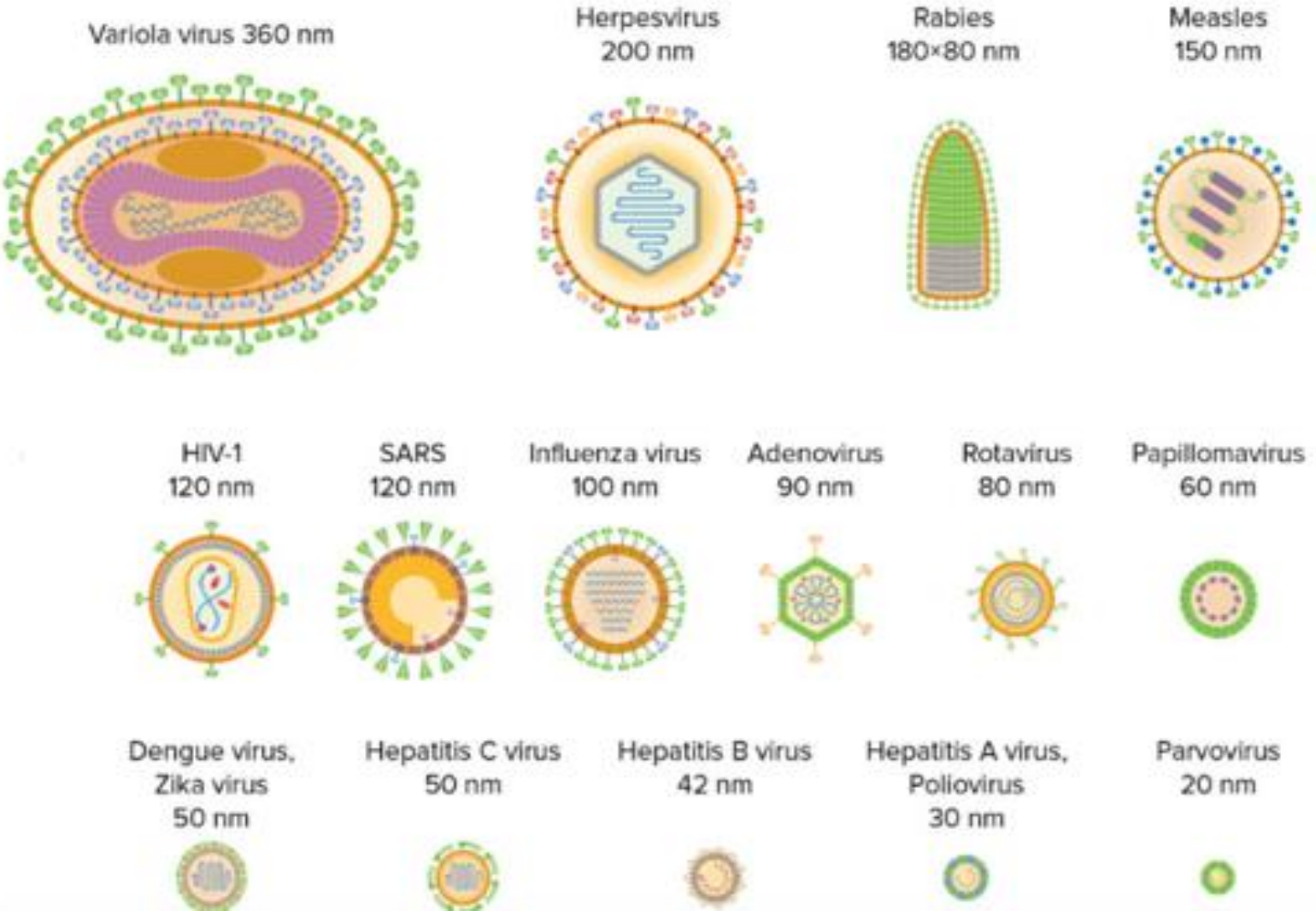
Size of medically important viruses



2. Shape

- Most animal viruses are roughly **spherical.** Some are **irregular** and **pleomorphic.**

- **Some viruses have characteristic shapes;**

  - For example, the **Rabies virus** has a **bullet shape**.
  - The Ebolavirus has a **filamentous shape.**
  - Poxviruses are **brick-shaped**.
  - The Tobacco mosaic virus is **rod-shaped.**
  - Bacteriophages (viruses that infect bacteria) have a head and tail like **sperm shape.**

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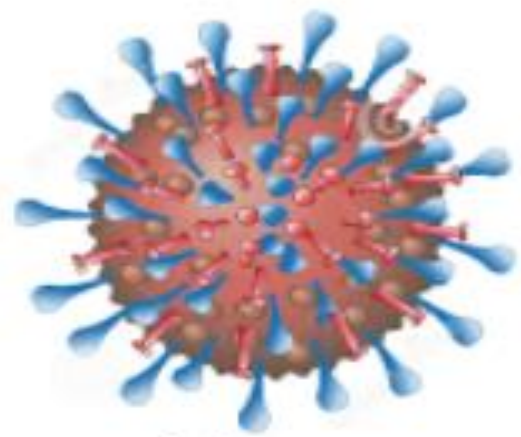
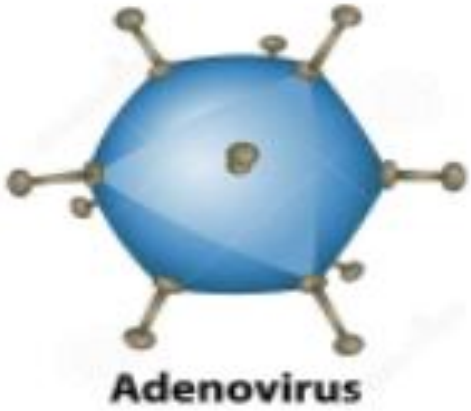
Shapes of medically important viruses





Structure and Symmetry

- **Viruses** are composed of **nucleic acids**, either DNA or RNA, and are **surrounded** by a **protein coat** called the **capsid**.

- The **capsid**, which is **surrounded** by **nucleic acid**, is called a **nucleocapsid**. Some viruses have an **envelope** and are composed of a **lipid bilayer**.

- **Three kinds** of **symmetry** are encountered in the **capsid based** on their **arrangement** of **capsomeres**.

- They are **icosahedral** (cubical), **helical** and **complex**.

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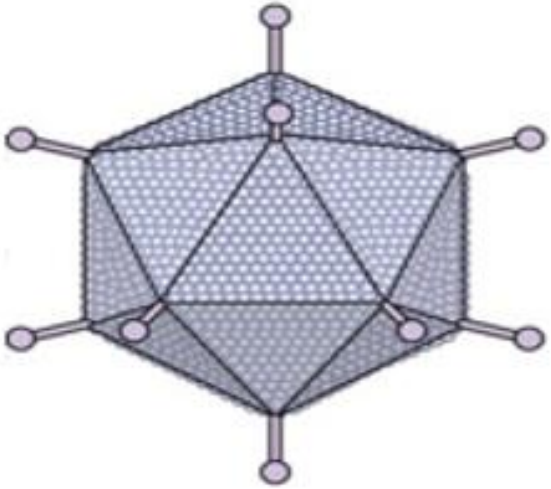
- **Icosahedral (cubical):** As cubes around the nucleic acid, this is known as an icosahedral arrangement. **E.g:** Adenovirus.

Adenovirus



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- **Helical:** Around coiled nucleic acid, which is known as a helical arrangement. **E.g:** Tobacco mosaic virus.

- Not all viruses show the typical icosahedral or helical symmetry.

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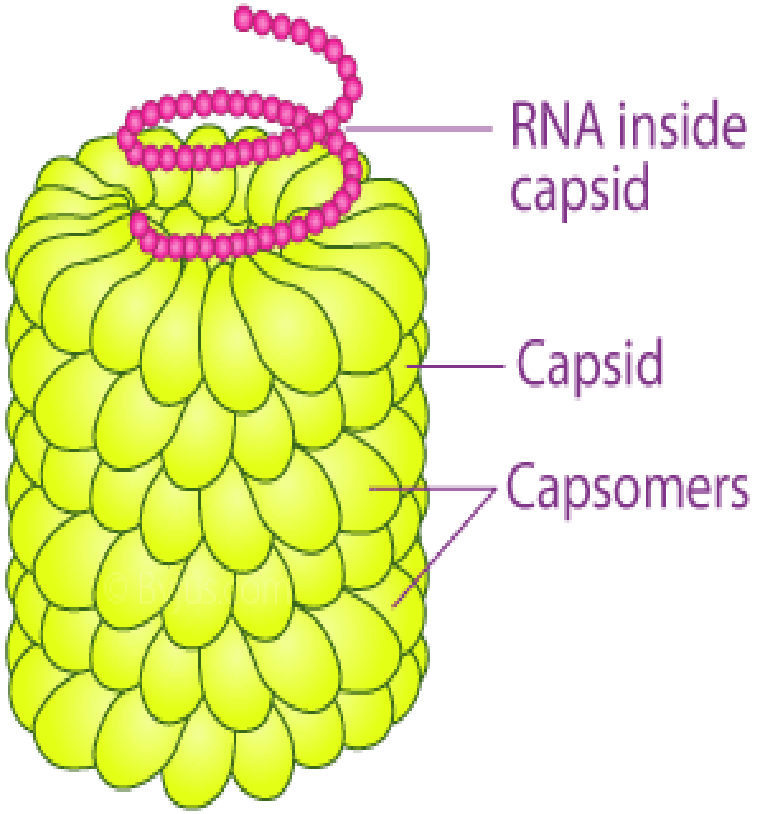
Tobacco mosaic virus



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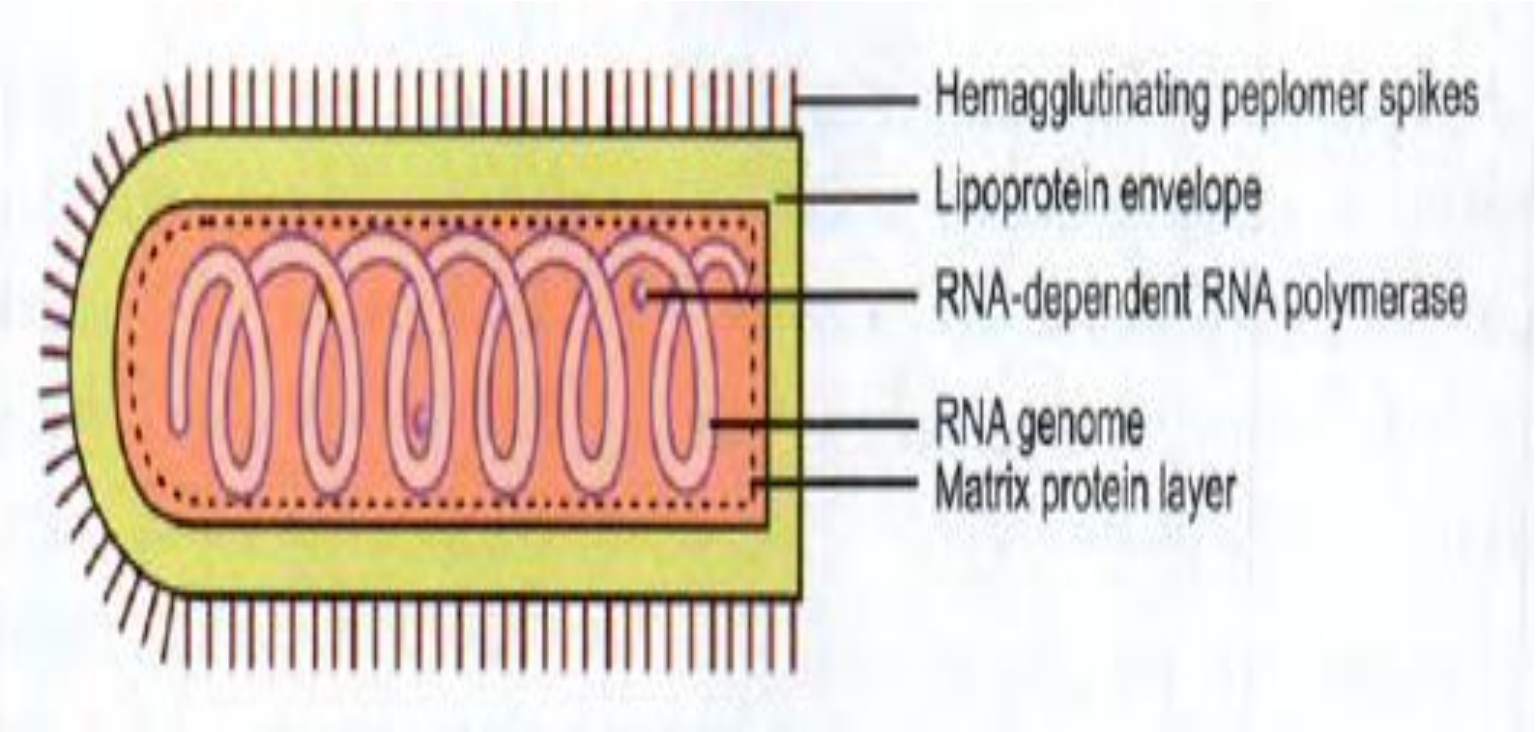
- **Complex:** Some viruses do not fit either helical or icosahedral symmetry due to the complexity of their structure. **E.g.** The **Rabies virus** is bullet-shape and exhibits **complex symmetry**.



Virus envelope

- The **virus** may be **enveloped** or **non-enveloped**. The virus **envelope** is composed of a **lipid bilayer**.
- The **envelope** is derived from the **host cell membrane** when the virus is released by **budding**.
- The **surface** of the **envelope** is covered with **spikes**.
- These **spikes** are also called **peplomers**, which are **composed** of **glycoproteins**.

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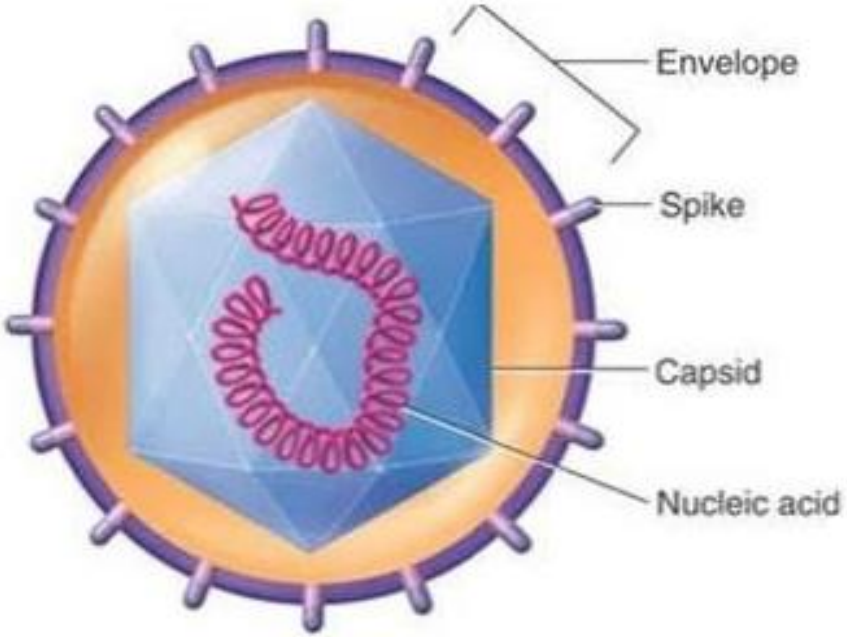
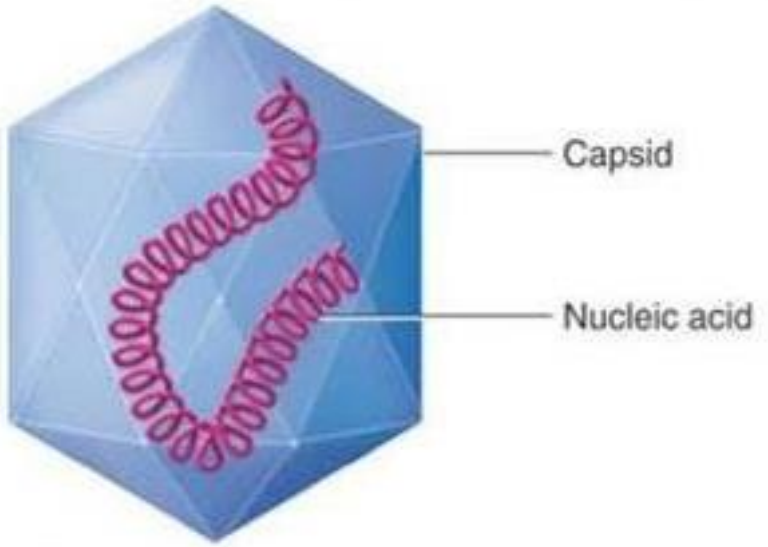
Enveloped virus



Non-enveloped virus



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- A virus may have more than one type of peplomer; for example, the **influenza virus** has **two types of peplomers**.

- They are **triangular spikes** (H) and **mushroom-shaped spikes** (N) respectively.

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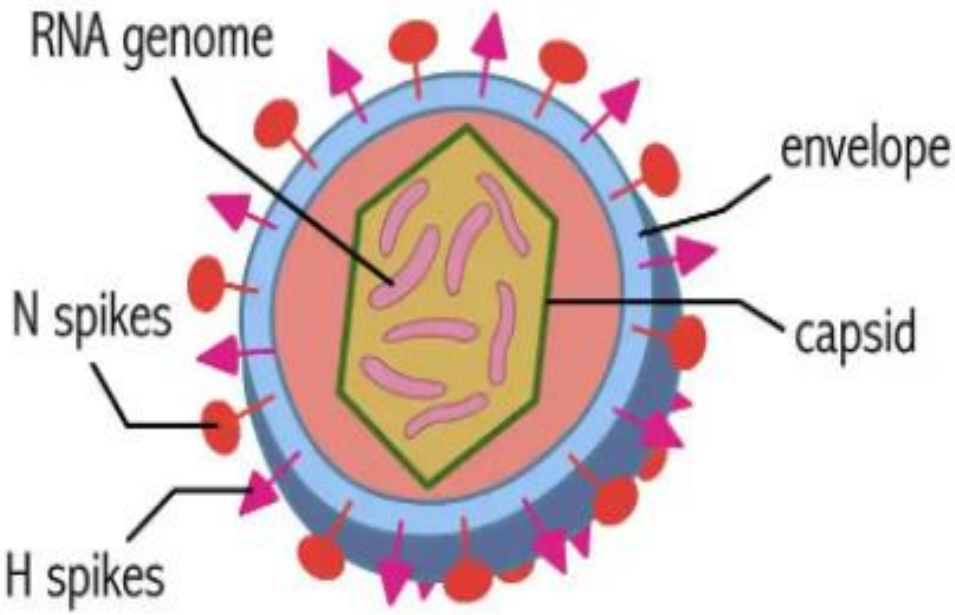
Influenza virus

(Triangular (H) and Mushroom-shaped (N) spikes)



General Laboratory diagnosis of Virus

- **Specimen:** CSF, blood and stool.

- Specimen collection in a clean container.

- **Observation** of **virus morphology** by using **electron microscopy**.

- By simple **negative staining**, the **virus particles can** be **seen directly** under the **electron microscope**.

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- **Observation** of stained **viral inclusion bodies** by using **electron microscopy**.

- The **rabies** viral **inclusion bodies** are called **Negri bodies**, which can be observed by **electron microscopy**.

- The presence of intranuclear **cowdry type A inclusion bodies** can be seen in **herpes simplex virus** (HSV) infections when they are **suitably stained** with **Giemsa stain**.

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A section of brain from a rabies patient shows Negri bodies

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Cultivation of viruses

- As viruses are obligate intracellular parasites, they cannot be grown on any inanimate culture medium.
- Three methods are employed for the cultivation of viruses.
- They are **the tissue culture method, embryonated egg inoculation** and **animal inoculation methods**.

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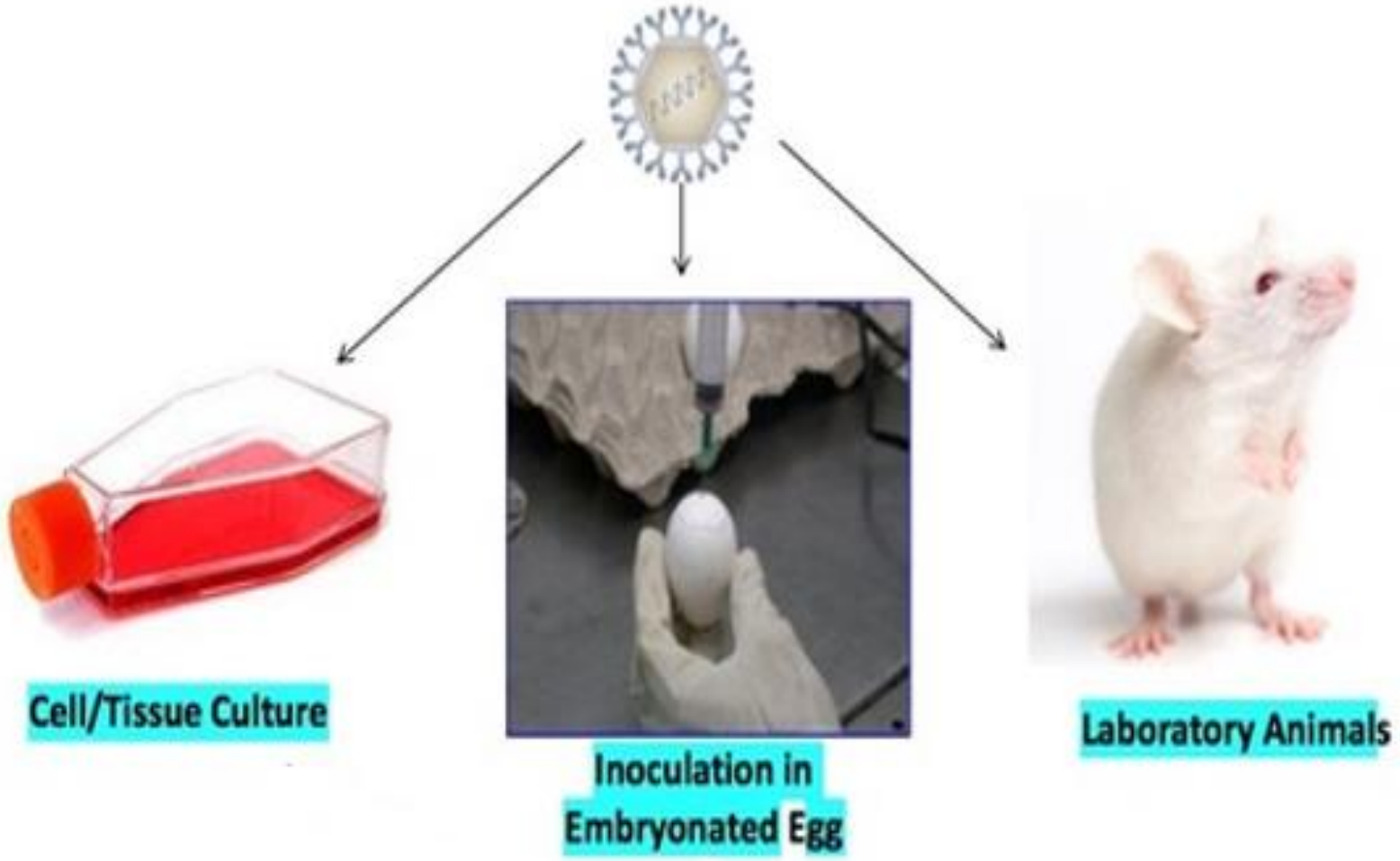
Cultivation of viruses



Serological and Molecular diagnosis

- **Serological tests** are useful for the **identification** of **virus antigens** and **antibodies**.

- Antibodies develop within a few days of infection and a rise in the titre of antibodies may be demonstrated by an **ELISA** and **complement fixation test**.

- Other serological methods are useful for the diagnosis of viral infections. They are hemagglutination, immunodiffusion, counter immune electrophoresis, immunofluorescence test and radioimmunoassay etc.

- The **molecular diagnostic PCR test** is both **sensitive** and **specific**.

LEARNING OUTCOMES

At the end of the lecture, students should be able to:

- Define virus.
- Explain the general properties of viruses.
- Define virus-related terms.
- Explain the morphology, structure and symmetry of a virus.
- Discuss the general laboratory diagnosis of a virus.

REFERENCE BOOKS

- David Greenwood *et al* (2007), Medical Microbiology (7th edition). Churchill Livingstone Elsevier.

- J. C. Pommerville (2004), Alcamo's Fundamentals of Microbiology (7th Edition). Jones and Bartlett Publishers.

- Mims *et al*, (2008) Medical Microbiology (4th Edition). Mosby Elsevier.

- Patrick. R. Murray (2009), Medical Microbiology (6th Edition), Mosby Elsevier.

Thank you