VIRAL GENETICS

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Medical Virology-Theory and MA 403

Summer Term

Third week

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Outline

- Genetic materials of viruses
- Genetic variation in viruses

Objectives

- Learn about groups of viruses according to their genetic materials
- Get knowledge about retroviruses
- Identify the importance of genetic material of viruses
- Learn about mechanisms of genetic variation in viruses

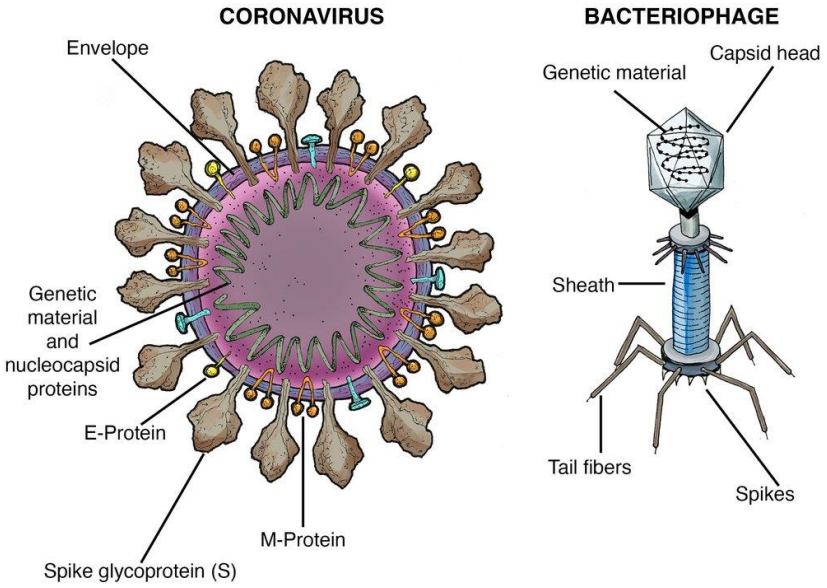
Virus and Viral structure

- **Viruses** are microscopic infectious agents that are much smaller and simpler in structure compared to living cells.

- They are not considered to be true living organisms because they cannot carry out the basic life processes on their own. Instead, viruses are parasitic entities that depend on host cells to replicate.

- The basic viral structure typically includes

1. **Genetic material**
2. **Capsid**
3. **Viruses may have Envelope**



Classes of viruses based on genetic materials

Viruses can be classified into different groups based on the type of genetic material they contain.

The primary classes of viruses based on genetic material are

1. **DNA Viruses:** These viruses have DNA as their genetic material. This DNA can be either single-stranded (ssDNA) or double-stranded (dsDNA). Examples of DNA viruses include the **herpesviruses**, **adenoviruses** and **papillomaviruses**.
2. **RNA Viruses:** RNA viruses have RNA as their genetic material. This RNA can also be single-stranded (ssRNA) or double-stranded (dsRNA).

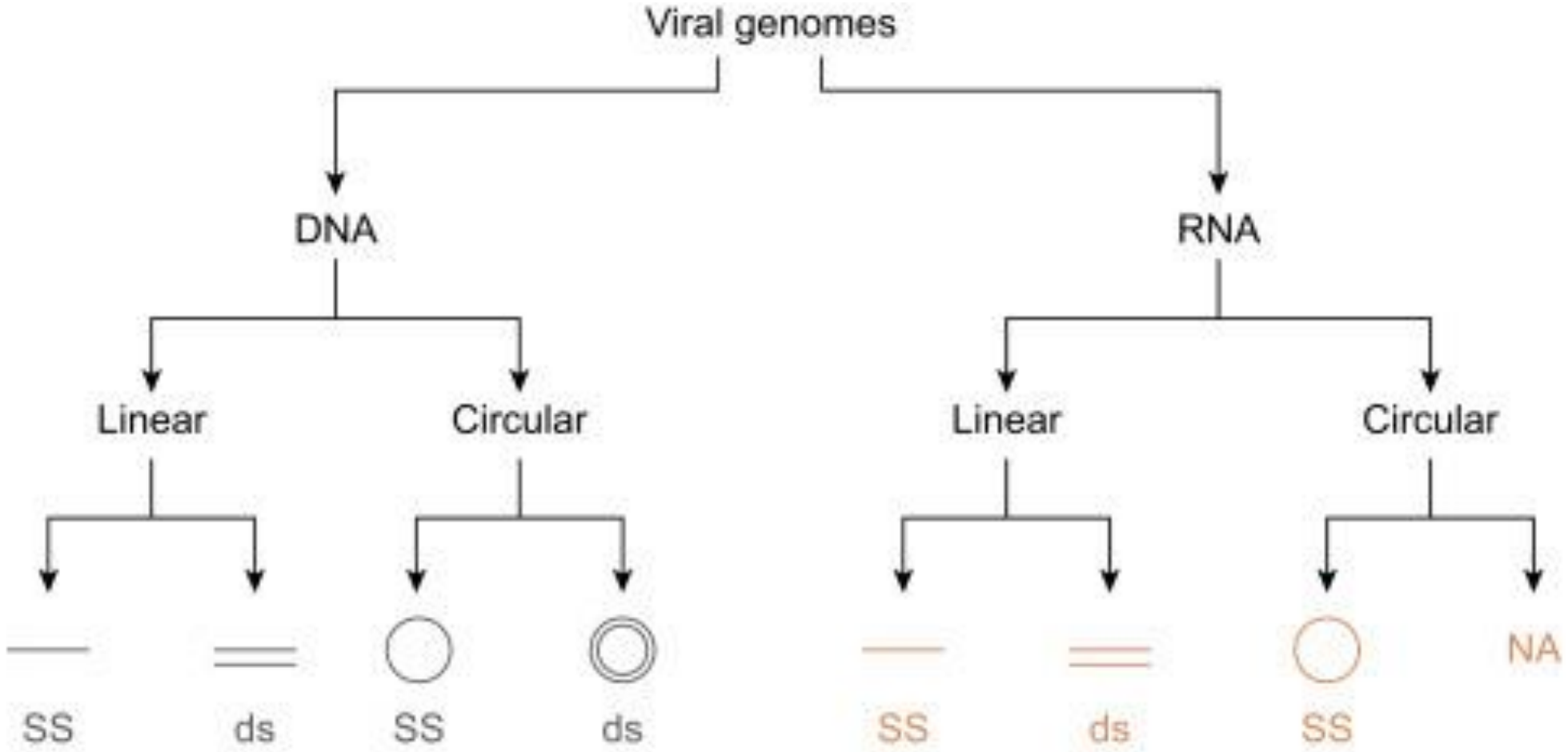
RNA viruses are further classified into several groups, including:

A. Positive-sense single-stranded RNA viruses (e.g., Flaviviruses).

B. Negative-sense single-stranded RNA viruses (e.g., Influenza virus, Ebola virus).

C. Double-stranded RNA viruses (e.g., Reoviruses).

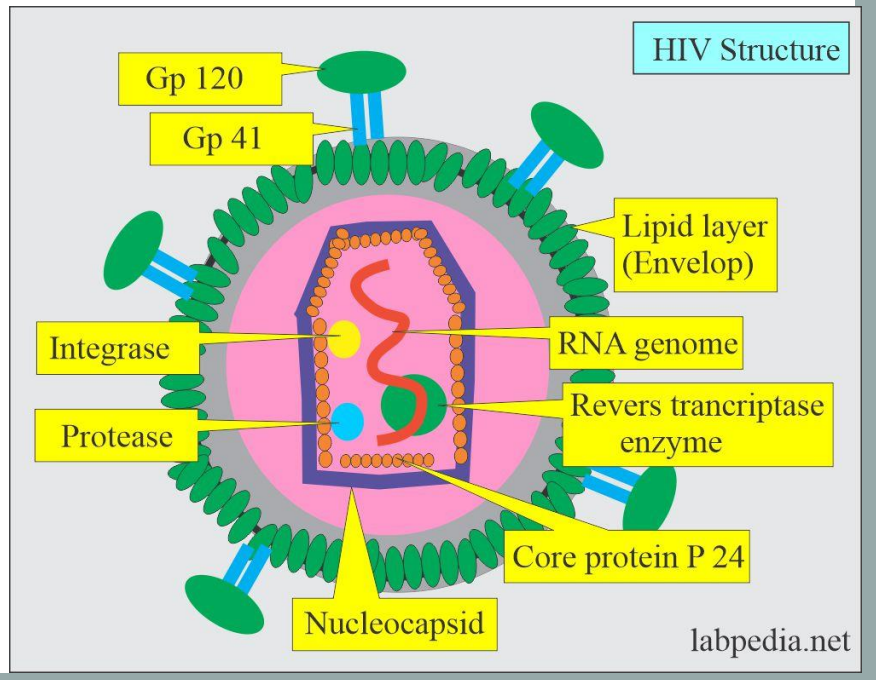
Classes of viruses based on genetic materials



Retroviruses

Retroviruses are a specific type of RNA virus that carries a unique enzyme called reverse transcriptase.

- **Reverse transcriptase** converts the viral RNA into DNA, which is then integrated into the host cell's genome.
- **Integrase** function is to integrate the viral DNA into the host cell's genome
- The function of **protease** in HIV is to cleave and process viral polyproteins, which are large precursor proteins, into their individual functional components.
- Notable examples of retroviruses include **HIV**.



Importance of genetic material of virus

- **Importance of genetic material of virus for itself**

1. **Replication:** The genetic material contains the instructions for the virus's replication. Without its genetic material, a virus cannot replicate.
2. **Viral protein synthesis:** The genetic material encodes the information required for the synthesis of viral proteins. These proteins are essential for various viral functions, such as structural components (capsid proteins), enzymes (e.g., polymerases), and proteins that interact with the host's cellular machinery.
3. **Genetic variation:** The genetic material can undergo mutations, which contribute to genetic diversity among viruses. This variation is a key driver of viral evolution and can lead to the emergence of new viral strains or variants. It plays a crucial role in the adaptability of viruses to changing environments, including the development of resistance to antiviral drugs or vaccines.

Importance of genetic material of virus

4. Host Specificity: The genetic material is responsible for determining the host range and tissue tropism of a virus. It contains information that allows the virus to recognize and bind to specific receptors on the surface of host cells. This specificity influences which species and cell types a virus can infect.

Importance of genetic material of virus

Importance of genetic material of virus for researchers, scientists or human

1. Diagnosis: The genetic material is used in the development of diagnostic tests for identifying viral infections. Techniques such as polymerase chain reaction (PCR) relies on the detection of viral genetic material to confirm the presence of a specific virus in clinical samples.

2. Vaccine Development: Understanding the genetic material of a virus is crucial for the development of vaccines. Vaccines are often based on weakened or inactivated viral genetic material. They stimulate the immune system to produce an immune response without causing disease.

Example: **The Pfizer-BioNTech COVID-19 vaccine**, is one of the vaccines developed to protect against the SARS-CoV-2 virus, which causes COVID-19. is an **mRNA vaccine**

Importance of genetic material of virus

3. Antiviral drug targets: Many antiviral drugs target specific viral proteins or processes encoded by the viral genetic material. For example, drugs may inhibit viral polymerases, proteases, or other enzymes essential for viral replication.

4. Research and understanding of disease: Viral genetic material is central to research on viral biology and pathogenesis. It helps scientists understand how viruses cause disease and provides insights into potential treatment and prevention strategies.

5. Evolutionary studies: The study of viral genetic material allows researchers to trace the evolutionary history of viruses. This information can shed light on the origins of viruses, their relationships to one another, and the factors driving their genetic diversification.

Genetic variation in viruses

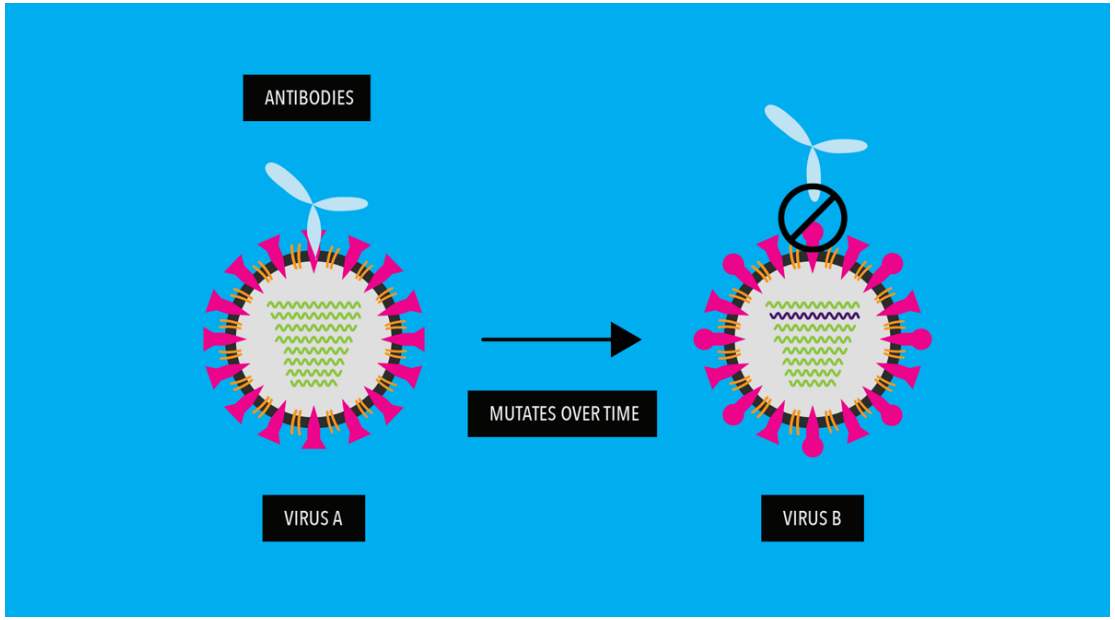
Genetic variation in viruses refers to the diverse and dynamic set of genetic changes that occur within viral populations. This variation is a fundamental aspect of viral biology and is central to their ability to **adapt** and **evolve rapidly**.

Mechanisms of genetic variation in viruses

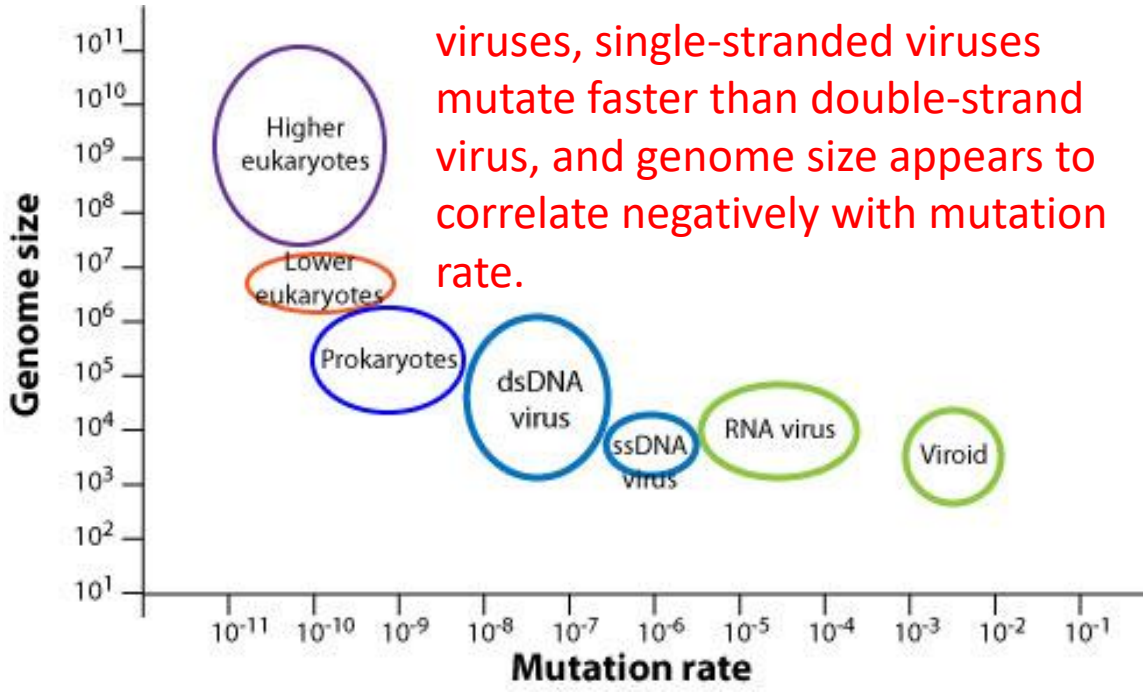
1. Mutation
2. Recombination

Mutation of viral genome

- **Definition:** Mutations are spontaneous changes in the viral genetic code during replication.
- **Types of Mutations:** Point mutations (single base changes), insertions and deletions
- **Importance:** Mutations introduce diversity into viral populations and can lead to changes in viral proteins and traits.

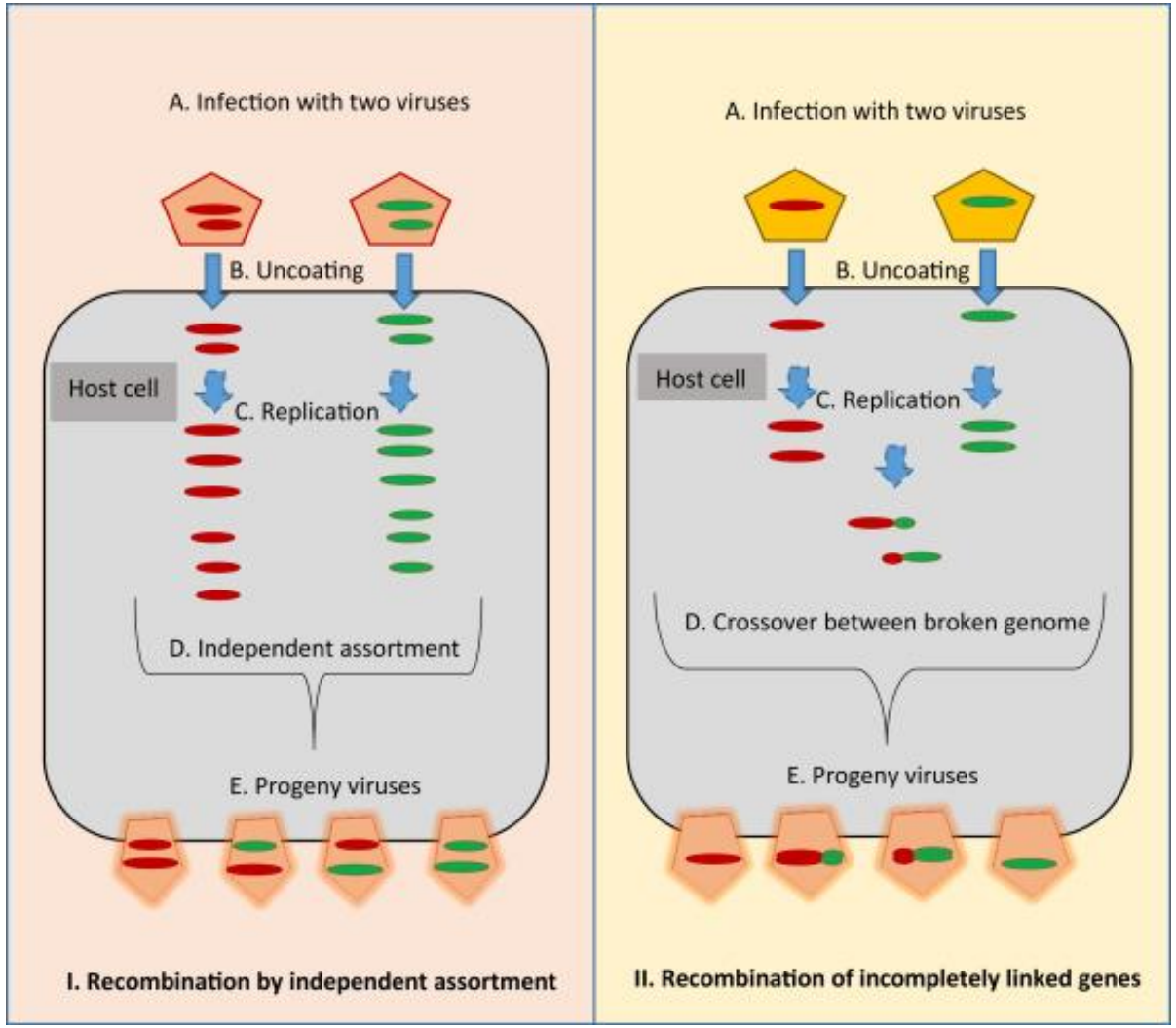


RNA viruses mutate faster than DNA viruses, single-stranded viruses mutate faster than double-strand virus, and genome size appears to correlate negatively with mutation rate.



Recombination of viral genome

- **Definition:** Recombination is the exchange of genetic material between different viral strains during co-infection of a host cell.
- **Outcome:** It generates new viral strains with genetic elements from different parental viruses.
- **Role:** Recombination accelerates genetic diversity and can lead to the emergence of novel viruses.



References (in APA style)

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- D. E. White, Frank J. Fenner - Medical Virology-Academic Press (1994)
- Sanjuán, R. and P. Domingo-Calap (2016). "Mechanisms of viral mutation." Cell Mol Life Sci **73**(23): 4433-4448.

Questions

1. Explain evolutionary study based on genetic materials of viruses
2. Define recombination of viral genome
3. What are types of mutation which happen in viral genome?
4. The function of …… in HIV is to cleave and process viral polyproteins
5. What is difference between positive and negative sense single strand RNAs?
6. Explain genetic variation of viruses
7. Mechanisms of genetic variation in viruses are ……
8. Define retroviruses