Viral Genetics

Course: Medical Virology

Code: MA 423

Summer Course

2024-2025

Objectives:

- Clarifying why understanding of viral genetics is important.
- Underline how viruses are interact!
- Figure out what the viral recombination, complementation, phenotypic mixing, and interference meaning!

Genetics of Animal Viruses

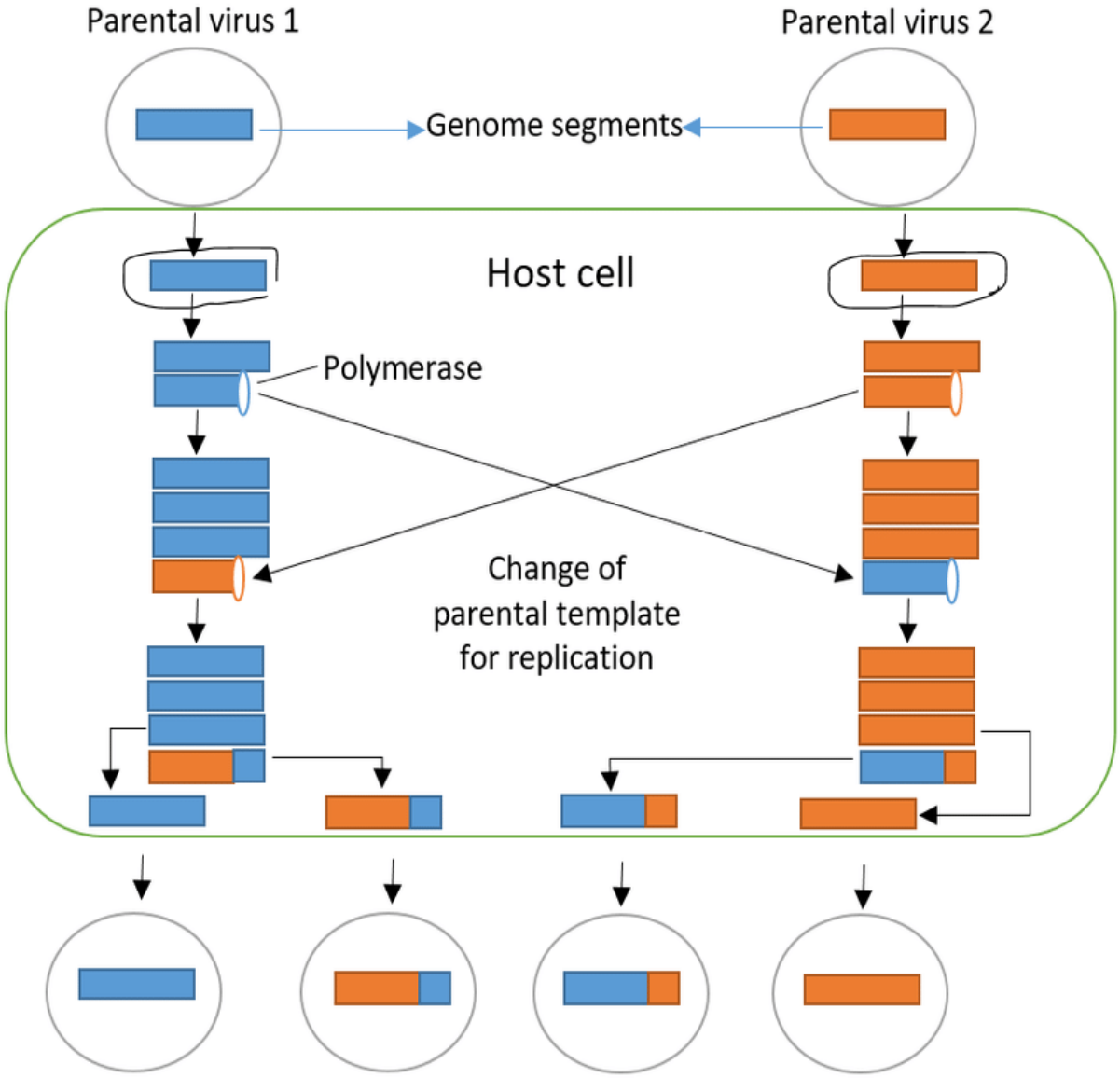
- Viruses that have stable antigens on their surfaces can be controlled by vaccination, whereas other viruses that exist as many antigenic types or change frequently are difficult to control by vaccination.
- Viral genetics may help develop more effective vaccines.
- Some types of viral infections recur repetitively or persist in the presence of antibody and may be better controlled by antiviral drugs.
- Genetic analysis will help identify virus-specific processes that may be appropriate targets for the development pf antiviral therapy.

Interactions among Viruses

- When two or more virus particles infect the same host cell at the same time, they may interact in a variety of ways.
- They must be sufficiently closely related, usually within the same viral family, for most types of interactions to occur.
- Genetic interaction results in some progeny that are heritably (genetically) different from either parent.
- Progeny produced as a consequence of non-genetic interaction are similar to the parental viruses.
- In genetic interactions the actual nucleic acid molecules interact, whereas the products of the genes are involved in non-genetic interactions.

Recombination

- Recombination results in the production of progeny virus (recombinant) that carries characters not found in either parent.
- The classic mechanism is that the nucleic acid strands break, and part of the genome of one parent is joined to part of the genome of the second parent.
- The recombinant virus is genetically stable, yielding progeny like itself upon replication.
- Viruses vary widely in the frequency with which they undergo recombination.

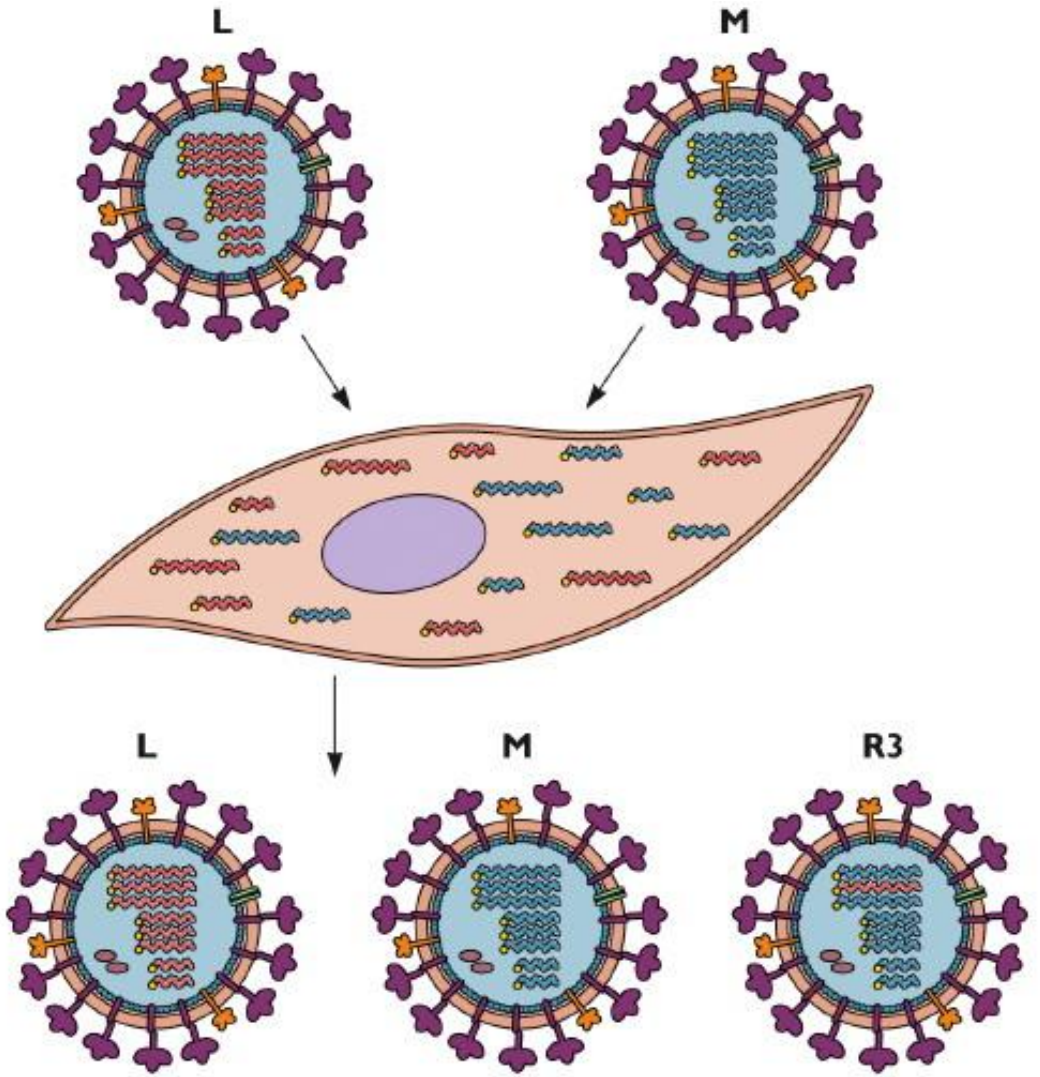


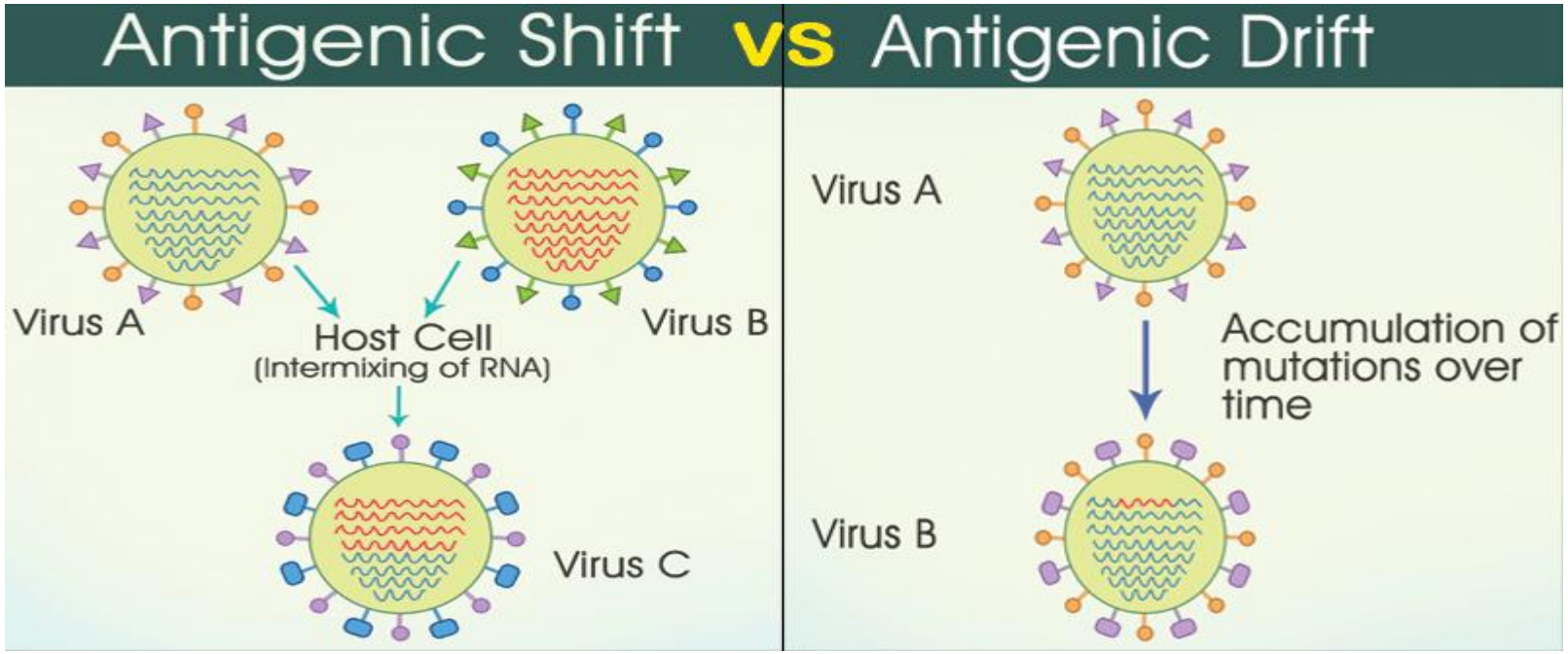
Reassortment

- **Definition:** Exchange of entire genome segments when **two segmented viruses** infect the same cell.

- Specific to viruses with segmented genomes.

Example: **Influenza virus** H1N1 and H3N2 infect the same cell, they can swap segments → leading to **antigenic shift** (new pandemic strains).





- **Antigenic shift** two or more different strains of a virus, combine to form a new subtype having a mixture of the surface antigens of the two or more original strains.

- **Antigenic drift**, random genetic mutation of an infectious agent resulting in minor changes in proteins called antigens,

Complementation

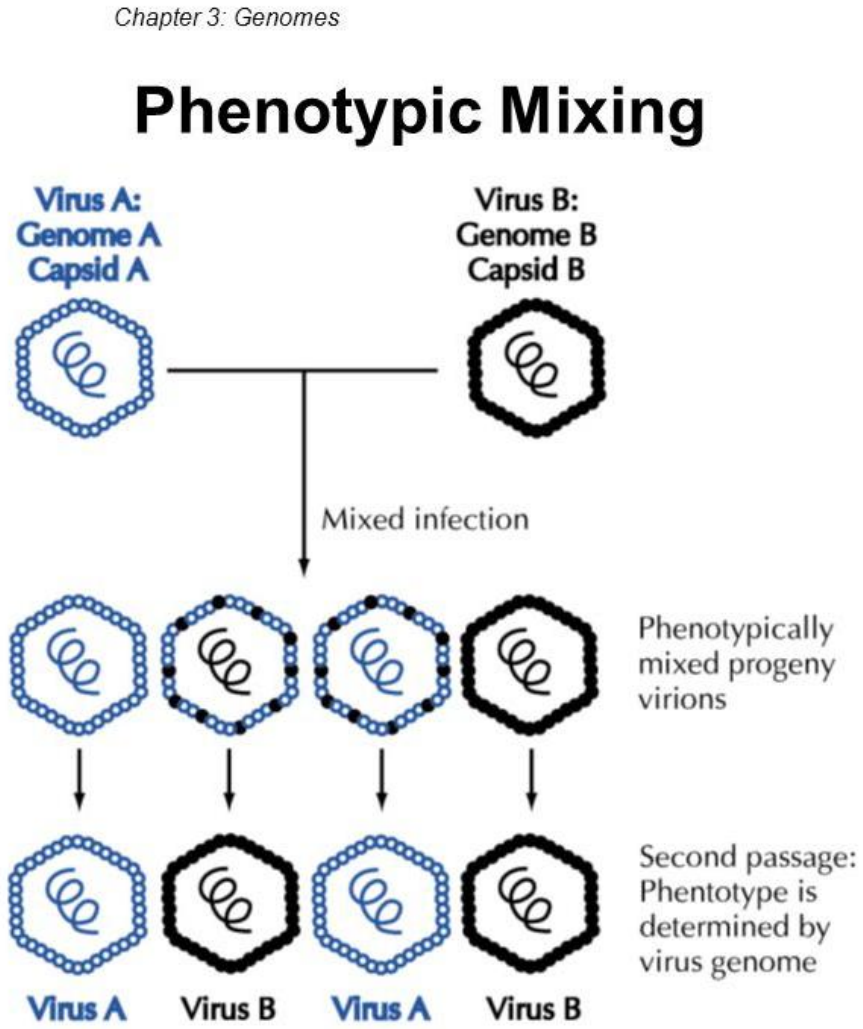
- Definition: When one virus with a defective gene is “rescued” by another virus that provides the missing function.

- The genome of the defective virus is not repaired, but it can replicate because the other virus supplies the needed protein. Example: Hepatitis D virus (HDV) requires Hepatitis B virus (HBV) to provide surface antigen (HBsAg) for packaging.

Phenotypic Mixing

- Definition: When two viruses infect the same cell, progeny viruses have a genome of one virus but the surface proteins (envelope/capsid) of another.

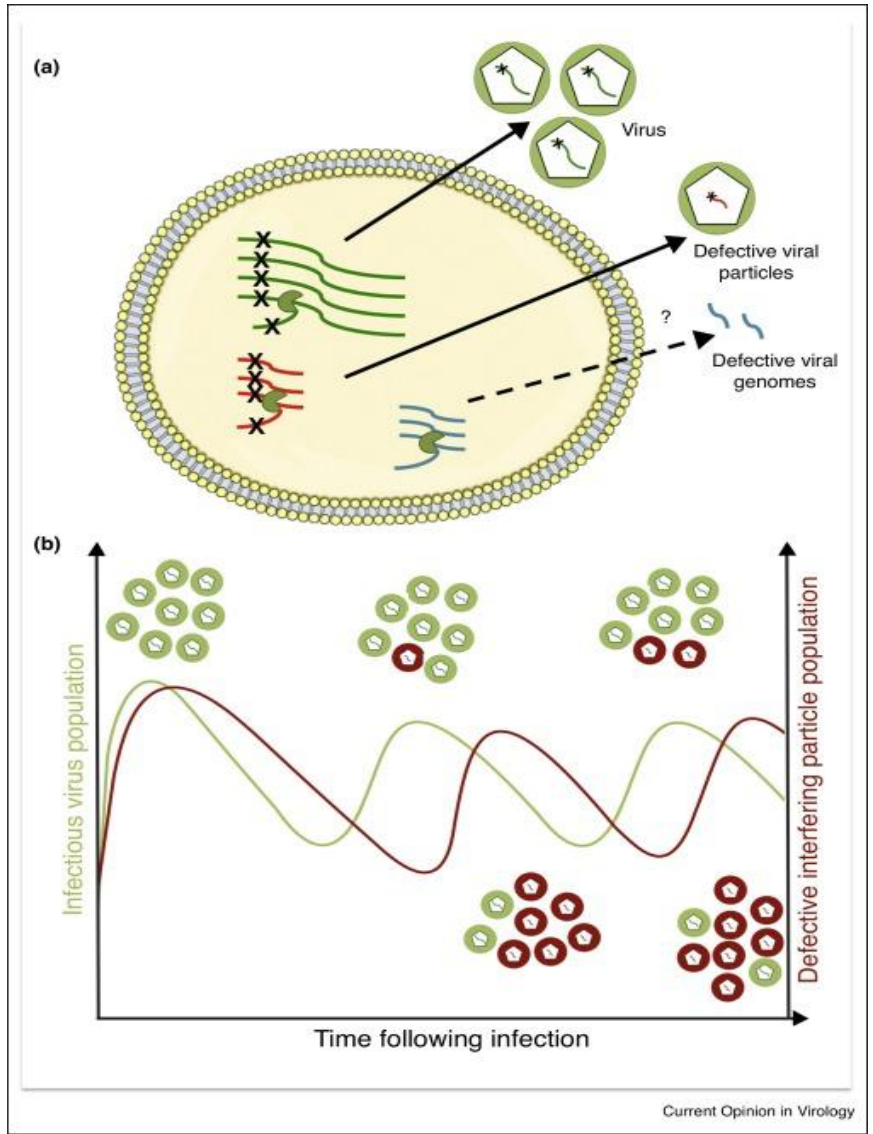
- This changes host range temporarily, but the genome remains unchanged.



Cann, A.J., 2001. *Principles of Molecular Virology (Standard Edition)*. Academic press.

Defective Viruses

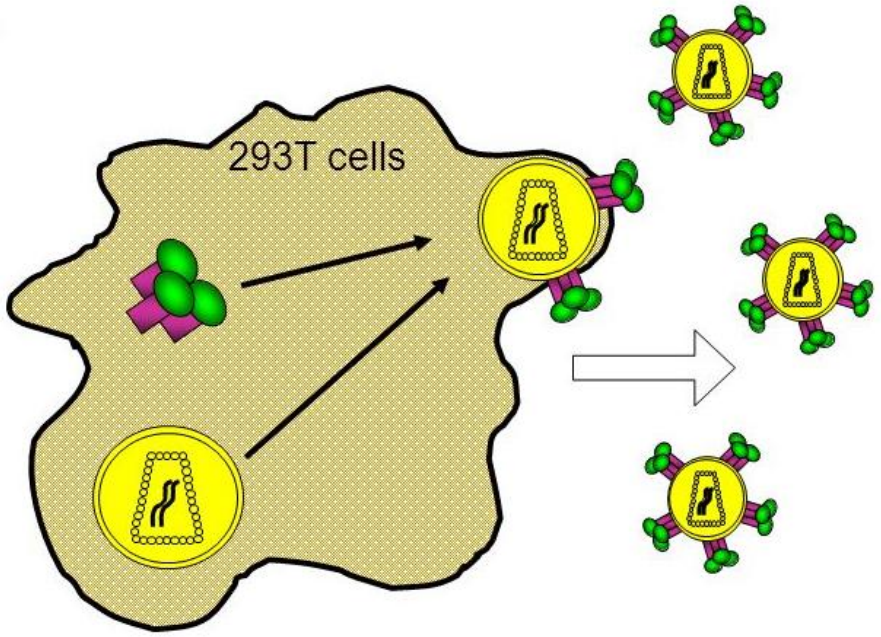
- A defective virus is one that lacks one or more functional genes required for viral replication.
- Defective viruses require helper activity from another virus for some step in replication or maturation.
- Defective interfering particles have **lost essential segments** of genome but **contain normal capsid proteins**; they require infectious homologous virus as helper for replication, and they interfere with the multiplication of that homologous virus.



Pseudovirions

- A different type of defective particle, **contain host cell DNA** rather than the viral genome, which theoretically might be able to transduce cellular nucleic acid from one cell to another.

- The transforming retroviruses are usually defective. A portion of the viral genome has been deleted and replaced with a piece of DNA of cellular origin that encodes a transforming protein and another retrovirus is required as helper in order for the transforming virus to replicate.



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References

- Skovgaard, N., 2008. Virology. Principles and Applications, John Carter, Venetia Saunders (Eds.), John Wiley & Sons, Ltd., UK (2007), xxiii+ 358 pages, soft cover, UK£ 34.95; ISBN 978-0-470-02387-7 (PB); www. wiley. com.
- Cann, A.J., 2001. *Principles of Molecular Virology (Standard Edition)*. Academic press.
- García-Murria, M.J., Expósito-Domínguez, N., Duart, G., Mingarro, I. and Martinez-Gil, L., 2019. A Bimolecular Multicellular Complementation System for the Detection of Syncytium Formation: A New Methodology for the Identification of Nipah Virus Entry Inhibitors. *Viruses*, *11*(3), p.229.