Virology for 2nd Year MD Students

(02) Virus Classification, Replication & Pathogenesis

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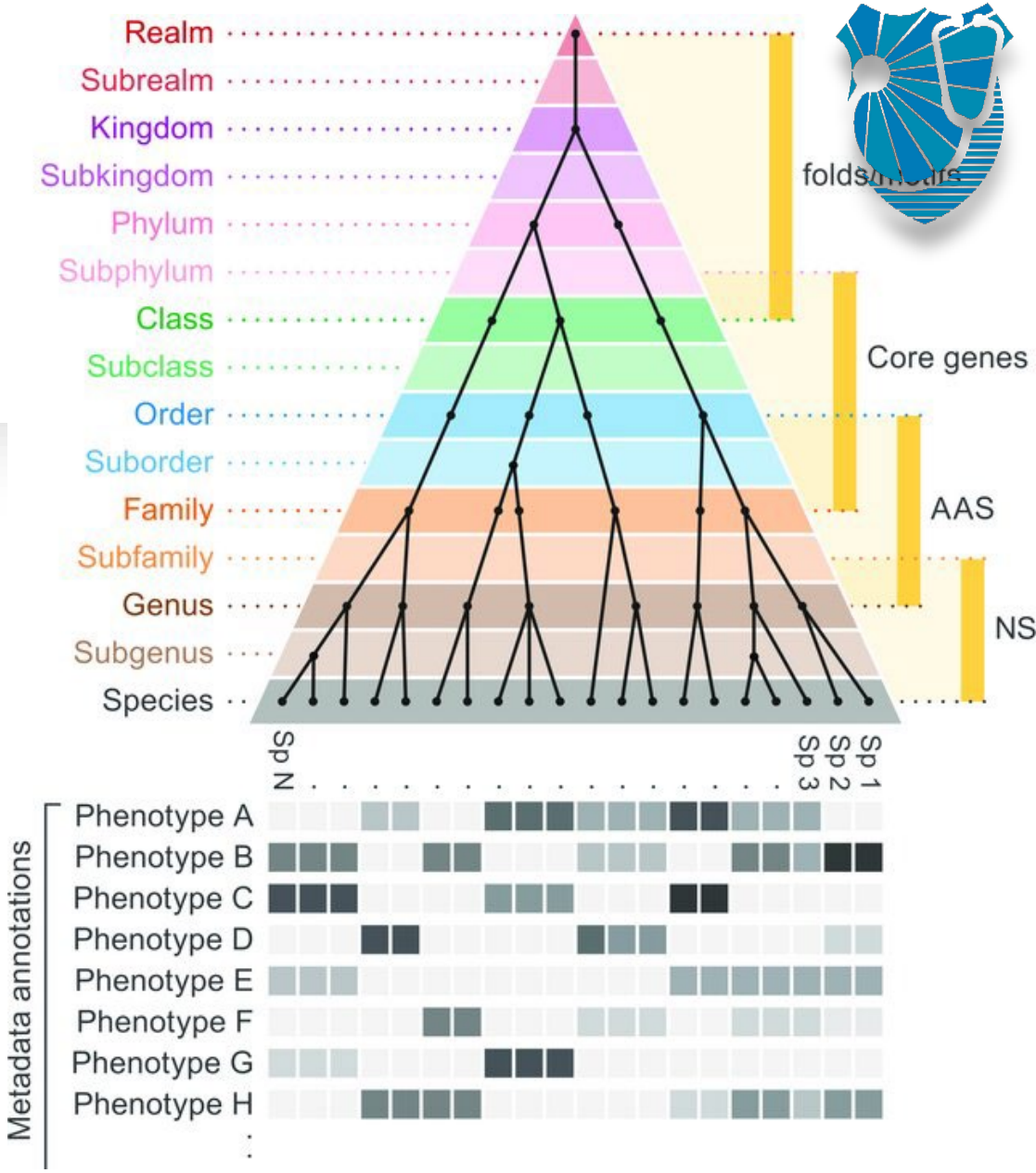
Virus Classification

- **Classification of viruses can be based on shared features:**

1. Virus family (the name ends in *viridae*). Example: Coronaviruses are classified in the family *Coronaviridae*.
2. Virus sub-family (the name ends in virinae). Example: SARS coronavirus 2 is classified in the subfamily *Orthocoronavirinae*.
3. Virus genus (the name ends in *virus*). Example: monkeypox virus is classified in the *Orthopoxvirus* genus.



Source: Simmonds P, Adriaenssens EM, Zerbini FM, Abrescia NGA, Aiewsakun P, et al. (2023) Four principles to establish a universal virus taxonomy. PLOS Biology 21(2): e3001922. https://doi.org/10.1371/journal.pbio.3001922

شرح د. محمد التميمي

Old (historical) Classification methods

1. Host preference (animal, Plant, insects, human)
2. Target organ (Respiratory, Liver, GI, etc)
3. Vector transmission (Arboviruses) عن طريق كائن حي مثل البعوض أو القراد

These old methods were problematic, why?

1. Overlaping (same virus can be in many groups)
2. Inconsistent (Not accurate) تصنيف غير منظم

Modern classification

1. Molecular biology of the genome — DNA /RNA , Single/double stranded
2. Biophysical structure — شكل الـ capsid, في envelop ولا ما في وغيرها...

Viruses

- Nucleic Acid:
  - **DNA** → Nucleus
    - ↳ Different in pathogeneses from the one in RNA Virus
    - Hepatitis B ← التهاب الكبد الوبائي (صفار) 5 أنواع: ④ → RNA, ① → DNA (B)
    - Human papiloma Virus (HPV) → cervical cancer, warts
    - Parvovirus B19
    - Herpesviridae → rash around mouth (الحمو)
    - Polyomaviruses
    - Adeno viruses
    - عنده القدرة يحول الخلية إلى Cancer
  - **RNA**
    - Influenza, RSV, Parainfluenza] Respiratory viruses
    - Hepatitis A, C, D, E
    - Enteroviruses
    - Encephalitis viruses
    - Measles, Mumps, Rubella] The most common viral infections (MMR) المطعوم الثلاثي
    - NorWalk, Rotavirus
    - Virtually all others. — أغلبيتهم
- Envelop (DNA):
  - yes
  - No
- Symmetry (yes):
  - Cubic (icosahedral)
  - Helical (cylindrical)

replication of Viruses

بيعطي نسخة شبه (طبق الأصل) 99.99%

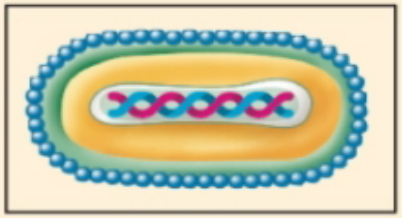
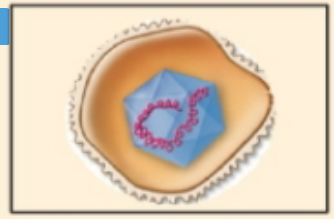
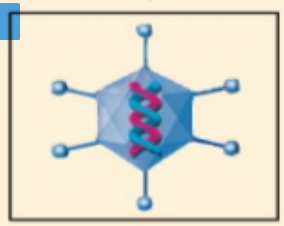
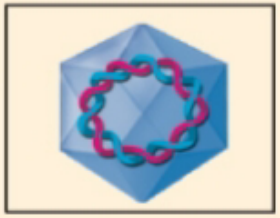
بس أكيد في exceptions

TABLE 6.2 Medically Relevant DNA Virus Groups

Double Strand → replication أسرع

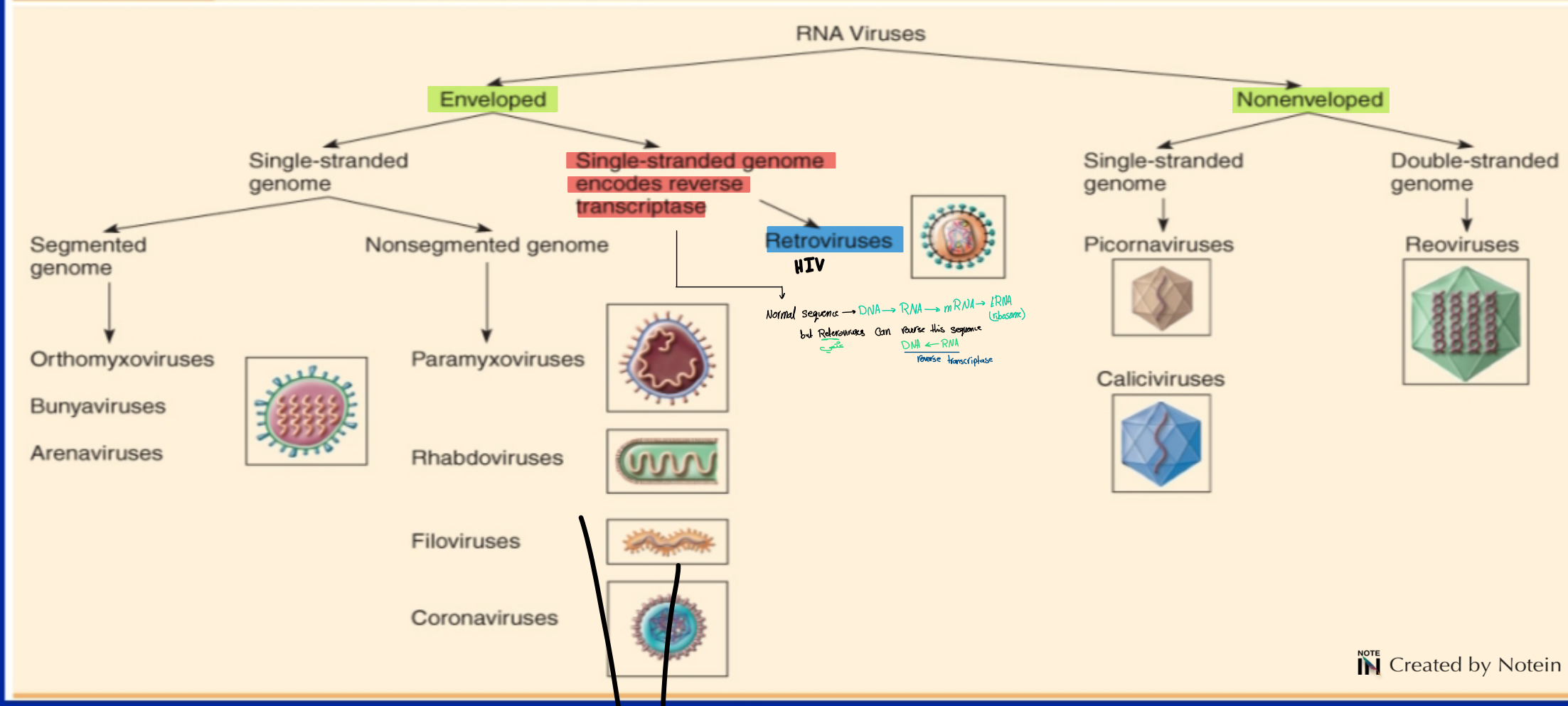
Important

DNA Viruses

- Enveloped
  - Double-stranded genome
    - Poxviruses 
    - Herpesviruses 
- Nonenveloped
  - Double-stranded genome
    - Adenoviruses (linear dsDNA) 
    - Papovaviruses (circular dsDNA) 
  - Single-stranded genome
    - Parvoviruses 

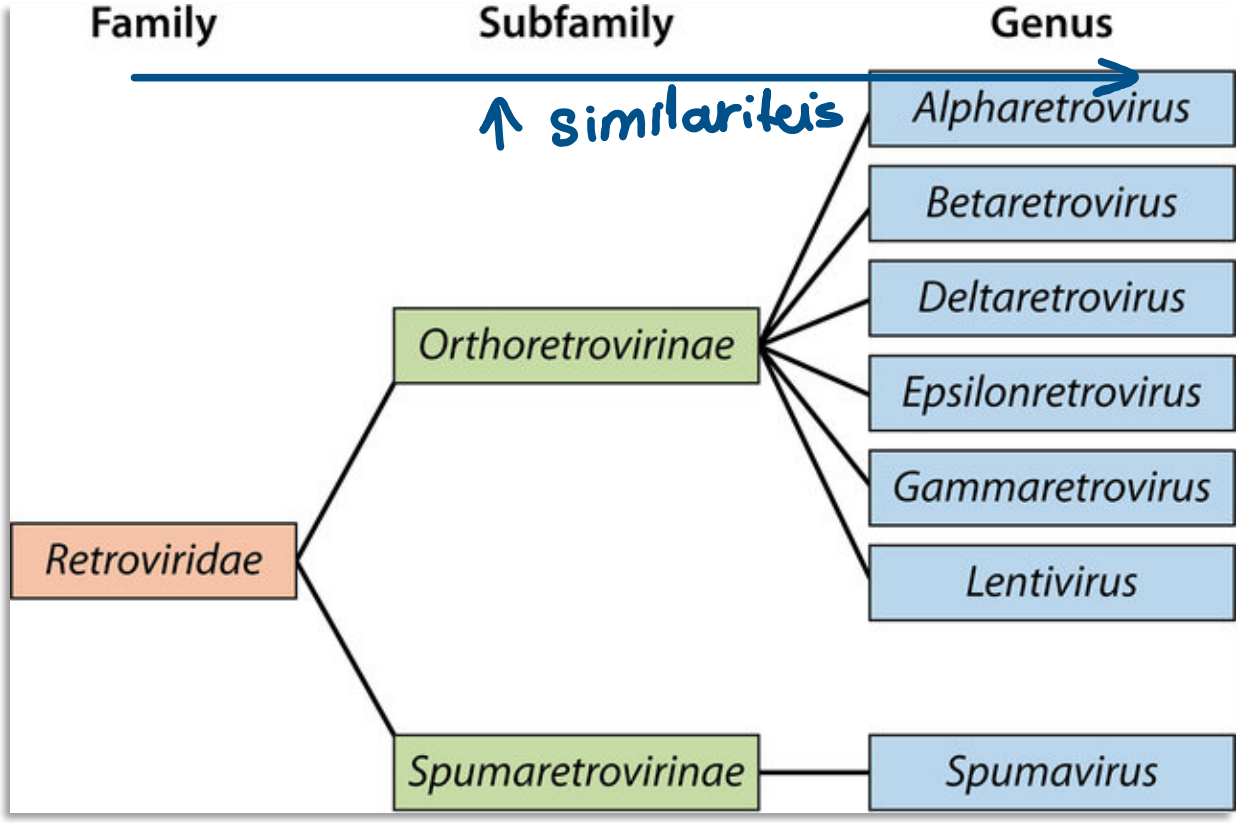
Source: Adapted from: *Poxviridae* from Buller et al., National Institute of Allergy & Infectious Disease, Department of Health & Human Services.

TABLE 6.3 Medically Relevant RNA Viruses



Virus Classification

- There are shared features among the members of the same family.
- Similarities increase among the members of the same subfamily.
- The features become very similar among the members of the same genus.



Source: Greenwood AD, Ishida Y, O'Brien SP, Roca AL, Eiden MV. 2018. Transmission, Evolution, and Endogenization: Lessons Learned from Recent Retroviral Invasions. Microbiol Mol Biol Rev 82:10.1128/mmbr.00044-17. https://doi.org/10.1128/mmbr.00044-17

Virus Replication

Attachment: The virus recognizes a cell receptor and binds it.

Penetration: The virus enters the cell.

Uncoating: The virus genome is exposed.

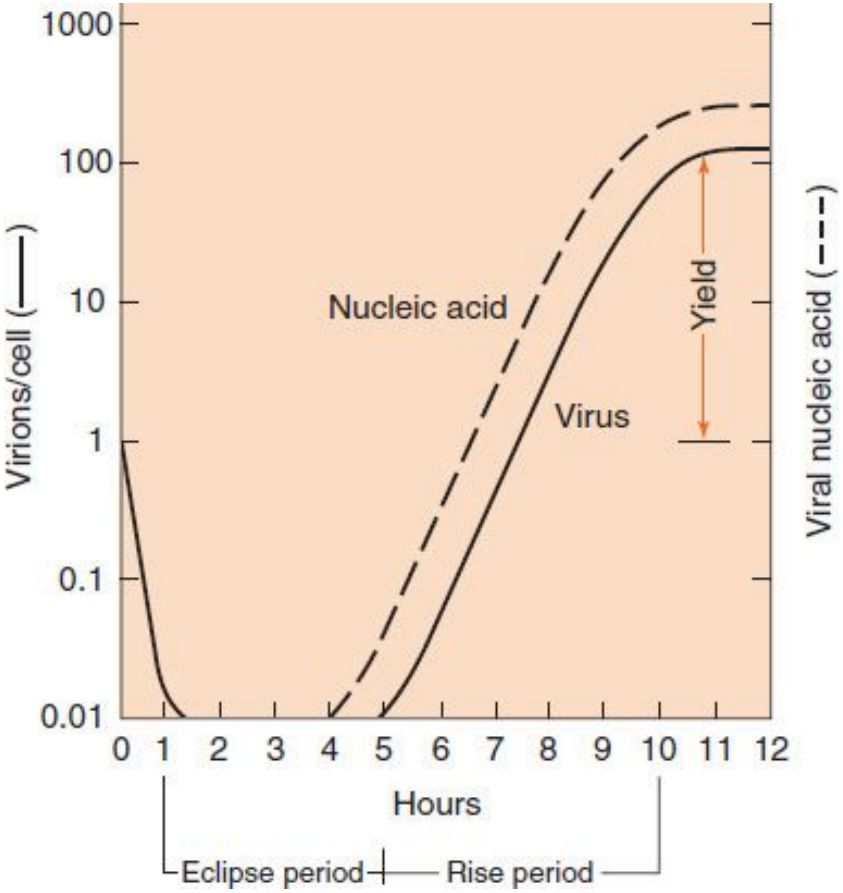
Early transcription and early translation: Production of the early mRNA and its translation into early virus proteins involved in virus replication.

Virus genome synthesis.

Late transcription and late translation: Production of the late mRNA and its translation into late virus proteins involved in virus structure.

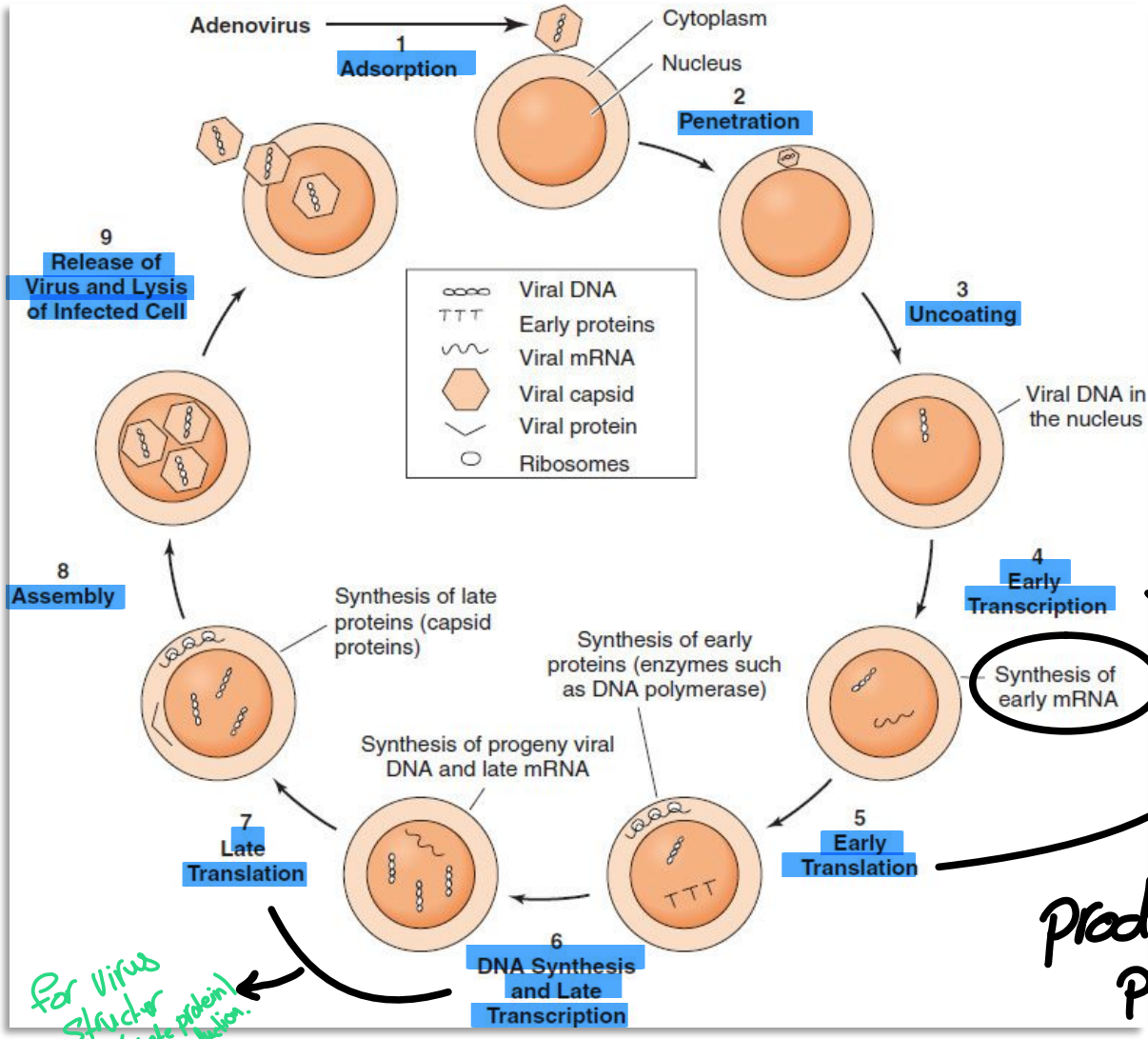
Virus assembly: The virus genome and capsid come together.

Virus release from the infected cell.



Source: Joklik WK et al. Zinsser Microbiology. 20th ed.

Virus Replication



early mRNA production & early protein production.

for replication.

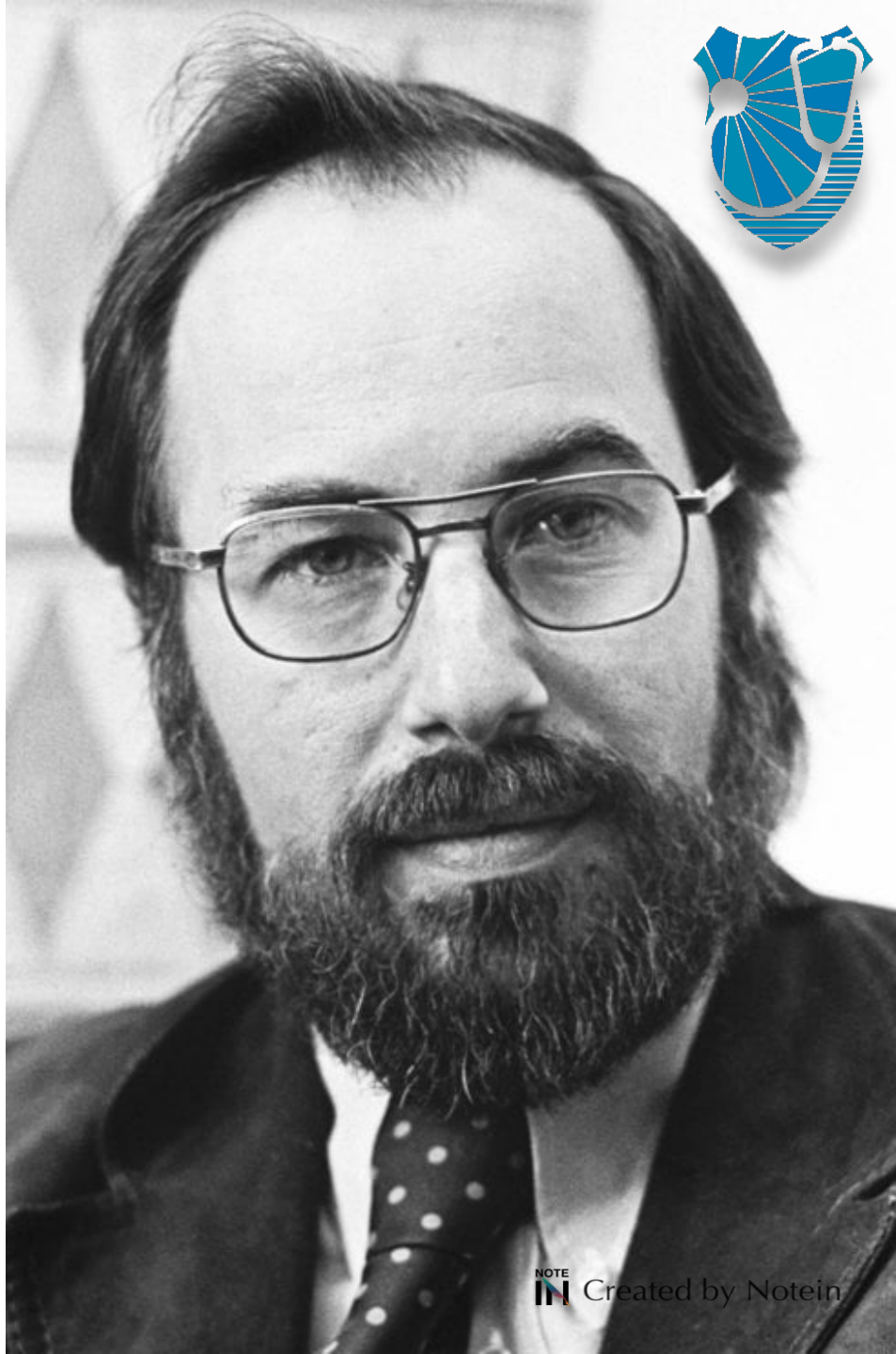
for Virus Structur (Late protein) Production.

Source: Jawetz E, Melnick JL, Adelberg EA. Review of Medical Microbiology. 16th ed. Originally published by Appleton & Lange. Copyright 1984 by McGraw-Hill.)

Baltimore Classification

- Baltimore classification of viruses depends on genome type:
- A) DNA vs. RNA
- B) double stranded vs. single stranded
- C) reverse transcription
- Note: transcription is the conversion of DNA into RNA. So, reverse transcription is the conversion of RNA into DNA.

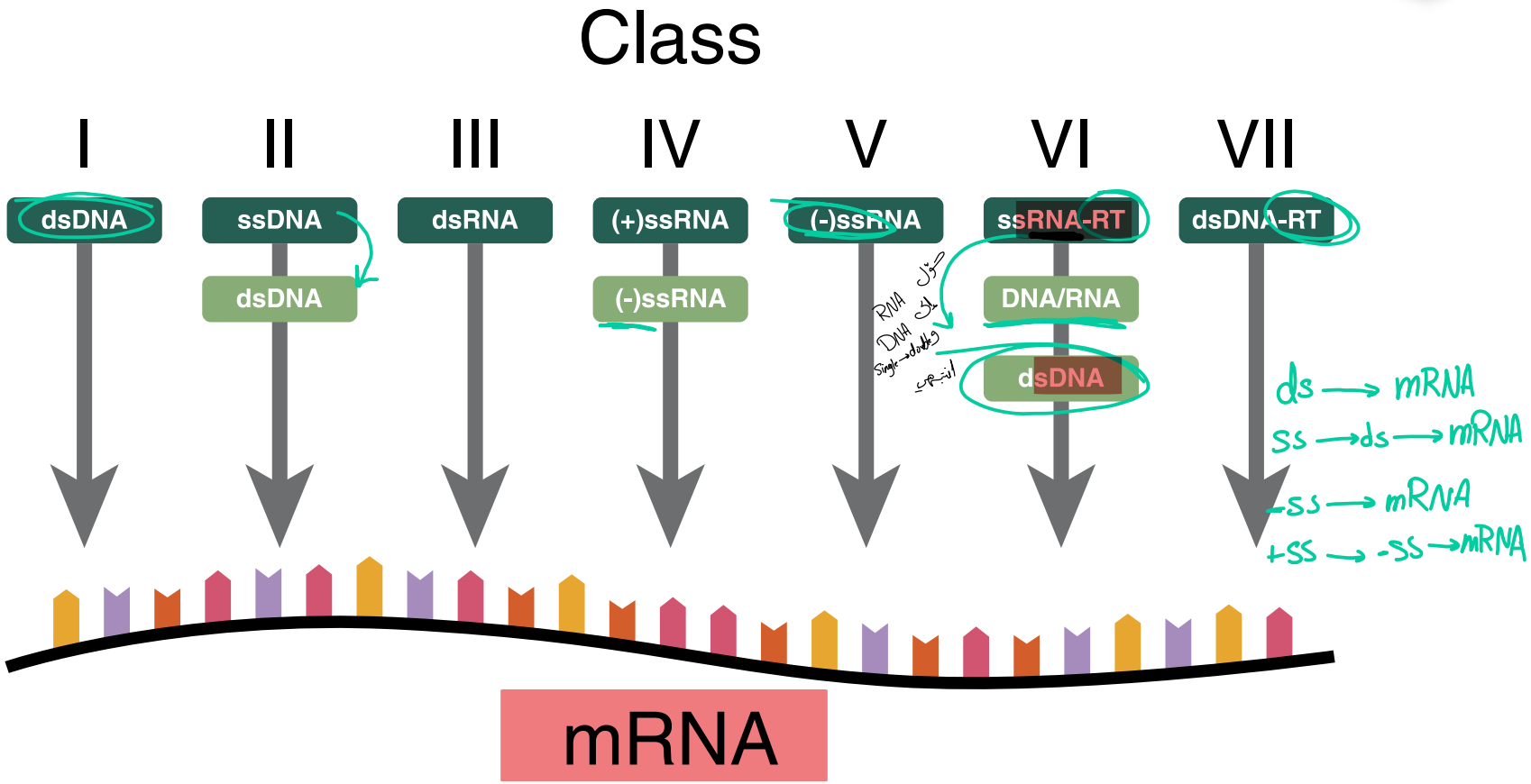
Retroviruses



Baltimore classification system

Group	Description
1 dsDNA	Double-stranded DNA
2 ssDNA	Single-stranded DNA
3 ds RNA	Double-stranded RNA
4 ssRNA+	Positive-sense single-stranded RNA
5 ssRNA-	Negative-sense single-stranded RNA
6 ssRNA reverse t.	Positive-sense single-stranded RNA with reverse transcription
7 ds DNA revers transcri.	Double-stranded DNA with reverse transcription

Baltimore classification system



Pathogenesis of virus infections

Pathogenesis of virus infections involves the processes including direct virus effect and host responses.

Pathogenic viruses cause disease. So, non-pathogenic viruses do not cause disease.

Virulent viruses cause more severe disease.

What are the possible outcomes of exposure to viruses?

1. Exposure without virus attachment and without infection.
2. Virus infection but without obvious damage: Asymptomatic infection
3. Infection with cell damage or cell transformation Symptomatic disease. Sometimes this can lead to fatality

So, the possible clinical outcomes of acute virus infection can be:

A. Acute infection with complete virus clearance.

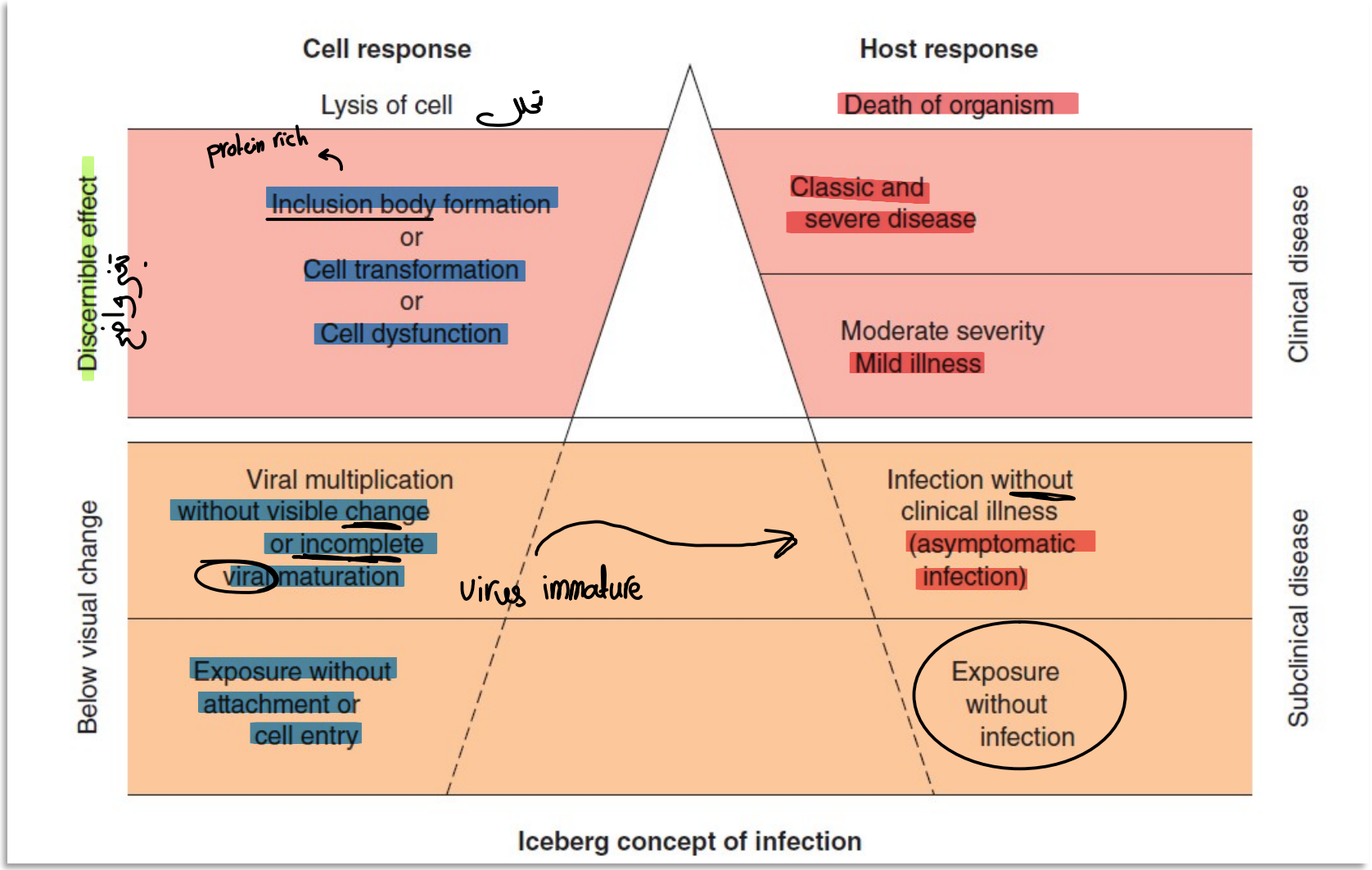
B. Acute infection followed by chronic infection.

C. Acute infection followed by silent persistence and periodic reactivation.

D. Acute infection followed by death.

لـ مثل herpesvirus
بكون متخفي بعدين بروج

What are the possible outcomes of exposure to viruses?

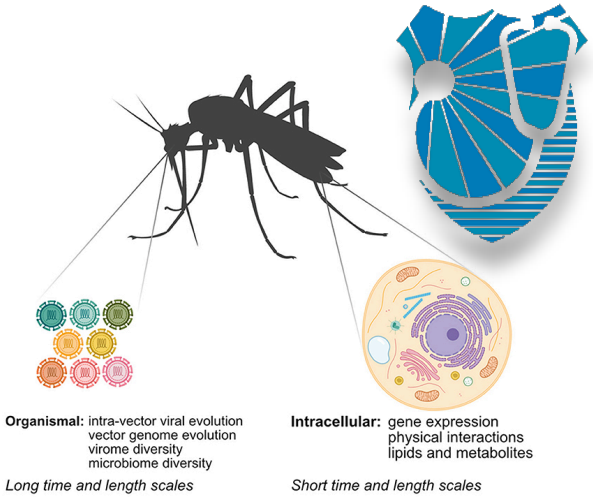


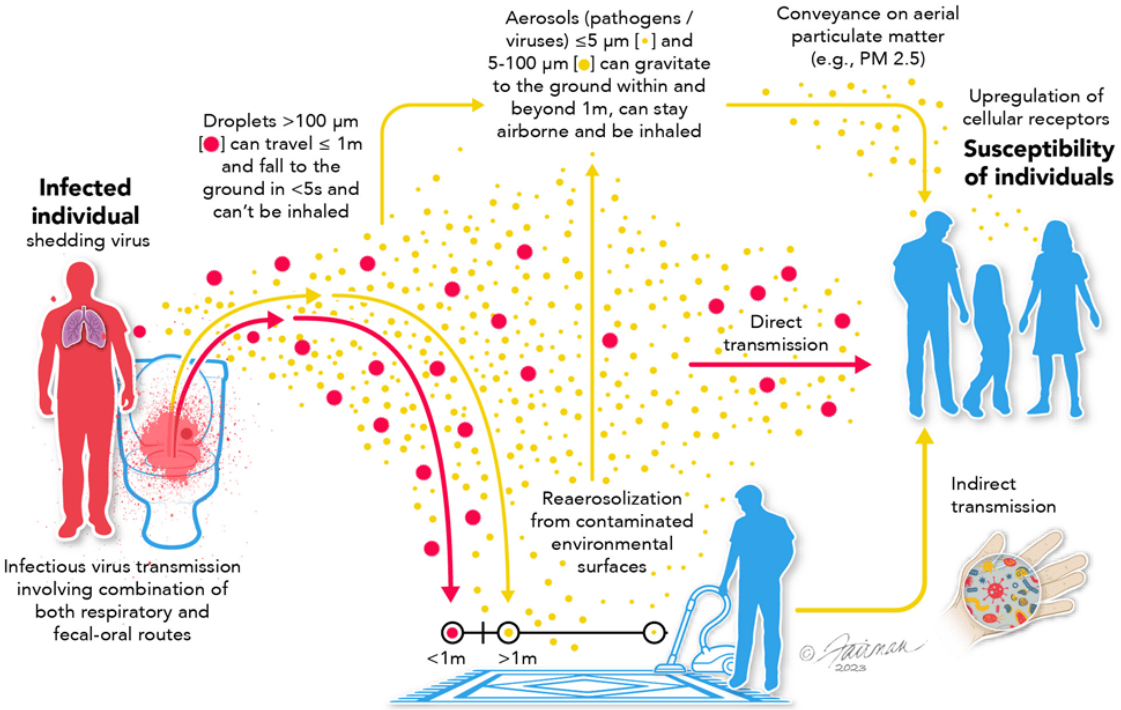
How can viruses enter the body?

A. Direct: Skin contact. Respiratory aerosols or droplets. Blood. Genital secretions. Saliva.

B. Indirect: Fomites (non-living object) or Vector (e.g. insects).

Viruses are foreign entities. Upon entry into the body, the immune system will react. The immune response to virus infection can contribute to the disease process.





Thank You…
Wishing you all the best!