



# ***Microbiology***

***Subject :***

***Lec no :25***

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وَقُلْ رَبِّ زِدْنِي عِلْمًا

# Viral life cycle



## Virology Lecture 2

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# Uncoating

تالت خطوة في  
عملية replication

هي العملية التي بطلع فيها genetic material برا ال capsid ويكون free in the cytoplasm

- Uncoating is a general term for the events which occur after penetration.
- Uncoating is one of the stages of virus replication that has been least studied and is relatively poorly understood.
- The product of uncoating depends on the structure of the virus nucleocapsid.
- The structure and chemistry of the nucleocapsid determines the subsequent steps in replication.



## BOX 6-6. Steps in Viral Replication

1. Recognition of the target cell
2. Attachment
3. Penetration
4. Uncoating
5. Macromolecular synthesis
  - a. Early mRNA and **nonstructural protein synthesis**: genes for enzymes and nucleic acid-binding proteins
  - b. **Replication of genome** 7 Strategies
  - c. Late mRNA and structural protein synthesis
  - d. Post-translational modification of protein
6. Assembly of virus
7. Budding of enveloped viruses
8. Release of virus

ملاحظة: هاد الحكي بنطبق بشكل اكبر على RNA viruses بالذات بخطوة صناعة ال early enzyme لانه ال DNA يعتمد ع الانزيمات الموجودة اصلا بالخلية وما بصنع انزيماته الخاصة

# Genome Replication and Gene Expression

- All viruses can be divided into **seven groups** - a scheme was first proposed by David Baltimore in 1971.
- Originally, **this classification included only six groups, but it has since been extended to include the** hepadnaviruses → Hepatitis B
- For **viruses with RNA genomes** in particular, **genome replication and the expression of genetic information are inextricably linked, so both are taken into account.**

# The genomes

- I: Double-stranded DNA.** Examples: Adenoviruses, Herpesviruses, Papillomaviruses, Poxiviruses, T4 bacteriophage

Some replicate in the nucleus e.g. adenoviruses using cellular proteins.

Poxviruses replicate in the cytoplasm **parvo** **DNA viruses** **الغلب ال يكونوا dsDNA ما عدا ال**

- II: Single-stranded (+)sense DNA.** Examples: phage M13, chicken anaemia virus, maize streak virus  $\rightarrow$  **parvo** **Totally dependent on the target cell to for replicated it's genome**

Replication occurs in the nucleus, involving the formation of a (-)sense strand, which serves as a template for (+)strand RNA and DNA synthesis.

- III: Double-stranded RNA.** Examples: **Reoviruses, Rotaviruses**  $\rightarrow$  **Gastroenteritis**

**Influenza**  
**Rotaviruses**

These viruses have **segmented** genomes. Each genome segment is transcribed separately to produce monocistronic mRNAs.

- IV: Single-stranded (+)sense RNA** Examples: Hepatitis A and C, Small RNA phages, common cold viruses, SARS

a) Polycistronic mRNA e.g. **Picornaviruses; Hepatitis A.** Genome RNA = mRNA. Means naked RNA is infectious, no virion particle associated polymerase. **Translation results in the formation of a**

**polyprotein product**, which is subsequently cleaved to form the mature **proteins.** **DNA  $\rightarrow$  RNA**

b) Complex **Transcription** e.g. **Togaviruses.** Two or more rounds of

translation are necessary to produce the genomic RNA.

**التر من نوع**  
**بروتين شابتين**  
**مع بعض**  $\leftarrow$  **بدهم**  
**protease** **لينفكو**



- **V: Single-stranded (-)sense RNA. Examples: Influenza viruses, Hantaviruses**

Must have a virion particle, containing RNA directed RNA polymerase.

a) **Segmented** e.g. Orthomyxoviruses. First step in replication is transcription of the (-)sense RNA genome by the virion **RNA-dependent RNA polymerase** to produce monocistronic mRNAs, which also serve as the **template** for genome replication.

b) **Non-segmented** e.g. Rhabdoviruses. Replication occurs as above and monocistronic mRNAs are produced.

- **VI: Single-stranded (+)sense RNA with DNA intermediate in life-cycle (Retroviruses). Examples: HIV, Avian leukosis virus**

Genome is (+)sense but unique among viruses in that it is **DIPLOID**, and does not serve as mRNA, but as a template for reverse transcription. \* فيها ميزة polyprotein

- **VII: Partial double-stranded (gapped) DNA with RNA intermediate (Hepadnaviruses) Example: Hepatitis B** → circular هو

This group of viruses also relies on reverse transcription, but unlike the Retroviruses, this occurs inside the virus particle on maturation.

On infection of a new cell, the first event to occur is repair of the gapped genome, followed by **transcription**. → mRNA → بروج على الرايبوسوم وبعد بروتين يعطي

لما يدخل على الخلية بصير تكميل partial ويصير complete // بعدين بصير Transcription

للتذكير بالنوع الرابع والخامس ،، من تفريغ الزميل برجس

## IF SINGLE-STRANDED RNA

إهاى ميرة لـ RNA

– is genome mRNA (+) sense or complementary to mRNA (-) sense

هسه ال ssRNA بنقسمه حسب ال replication ل

mRNA positive sense and mRNA negative sense

ال positive بقدر يروح على الرايبوزومات مباشرة و يعمل بروتين

ال negative ما بقدر يعمل فبروح بصنع complementary strand عن طريق RNA polymerase

ال complementary strand بتكون positive و بتقدر تعمل البروتين





بِسْمِ اللّٰهِ نَبِيًّا ، اسْتَوْدَعُوا دَرَاثَتَكُمْ

وَتَقَبَّلْكُمْ لِلّٰهِ وَبِالتَّوْفِيقِ لِلْجَمِيعِ .

→ HIV كيف بتصير عملية ال replication لل

① Attachment

CD4 و GP120

\* Co receptor (CCR5 - CXCR4)

\* HIV (enveloped virus)

Fusion بدخل عن طريق ال

Nucliee acid going to enter into the target cell (D cell)  
وال CD4 هو receptor

→ all virus have a one copy of viral genome

HIV : 2 copies of (+ ssRNA) بكل نيردي so 2 copies released into the cytoplasm

→ + ssRNA (Cytoplasm) → RNA يصير انتريم وبتسبك بال

ويعطي Complementary strand with DNA  
) بصير عنا في مجموعة هذا الانتريمات مثل

complementary DNA  
RNA dependante برتبط مع (+ssRNA) ويعطيني

→ RNA is going to seferate of disass-siate From the DNA (Single strand بصير)  
DNA

وال RNA يصير عليها anhor Component  
في الانتريمات من (RNAase) كسبر ال RNA

→ الانتريمات الثانية (قفل DNA) بستغل ال Polymeras وبتغليها  
double strand

Double Strand → موجودة بالنواة replication بالخاصة بالانتزاع replication بعدها تروح على النواة حتى تعمل

بالنواة بصيرلوا integration (دوج)  
(بواسطة انتزاع Integrases)  
↓

Sticky end نهايات لاصقة

\* Virus in general are occupiers of the target cell and they inforce the target cell to remain withen the S phase at the celluler machenary available all the time for the virus to replicate genome

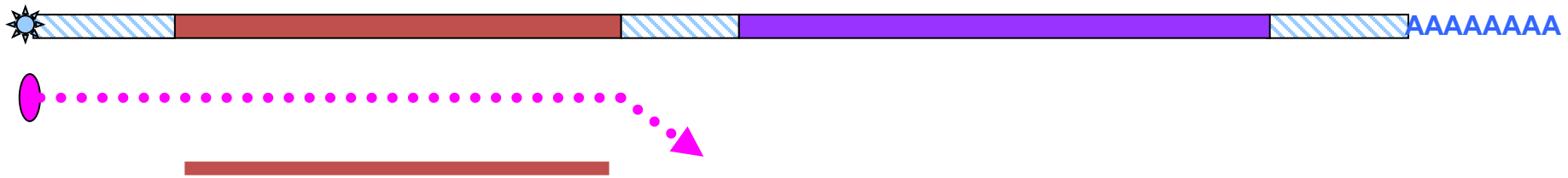
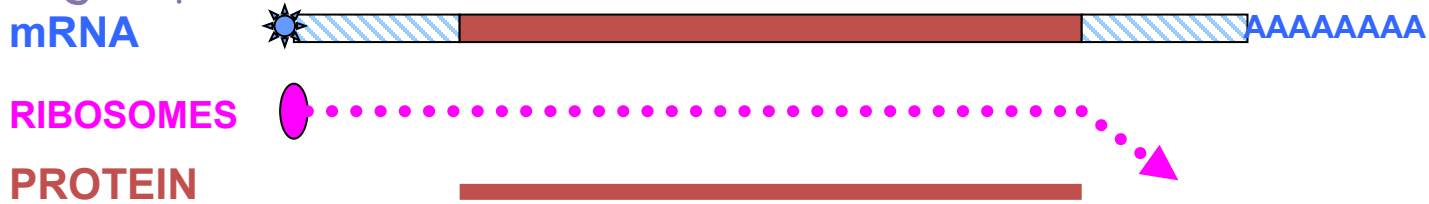
\* Transcription of the Viruse ( <sup>messenger</sup> RNA ) → بطلع من النواة للمستينوليزم  
(Poly Protein) بعدين بروج على الرايبوسوم وبعده

(معلوهم 2) ←

↓ HIV + SSRVA

# The monocistronic mRNA problem

المشكلة mRNA التي تحمل كود واحد للبروتين



- Make one monocistronic mRNA per protein
- Make a primary transcript and use alternative splicing
- Make a large protein and then cut it into smaller proteins
- Include special features in the mRNA which enable ribosomes to bind internally



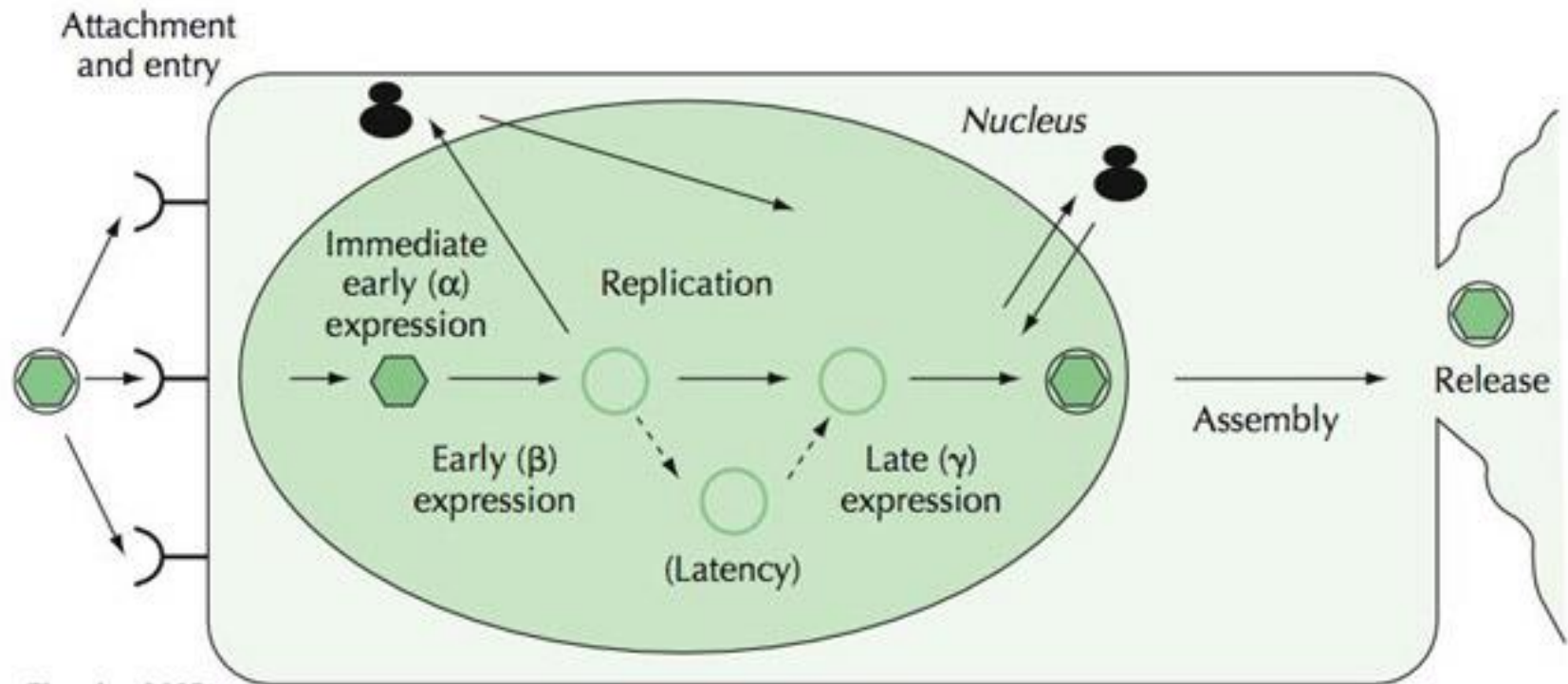
# Class I: Double-stranded DNA

Topoisomerase (عن طريق) Linear (Supercoiling) بخليط  
بعدين helicase يعمل فصل للسلسلتين

This class can be subdivided into two further groups:

- A) Replication is exclusively nuclear. The replication of these viruses is relatively dependent on cellular factors.
- B) Replication occurs in cytoplasm (*Poxviridae*). These viruses have evolved (or acquired) all the necessary factors for transcription and replication of their genomes and are therefore largely independent of the cellular machinery.

# Class I: Double-stranded DNA



double strand RNA  
(Rota Virus)

نفسه الى + و -  
Sens

+ و -  
مجاورا سلسله  
complementary



بروع على الرايبوسوم  
يصنع بروتين  
DNA ligase

DNA primase

RNA primer

DNA Polymerase (Pol $\alpha$ )

3'  
Lagging strand  
5'

Okazaki fragment

5'  
Leading strand  
3'

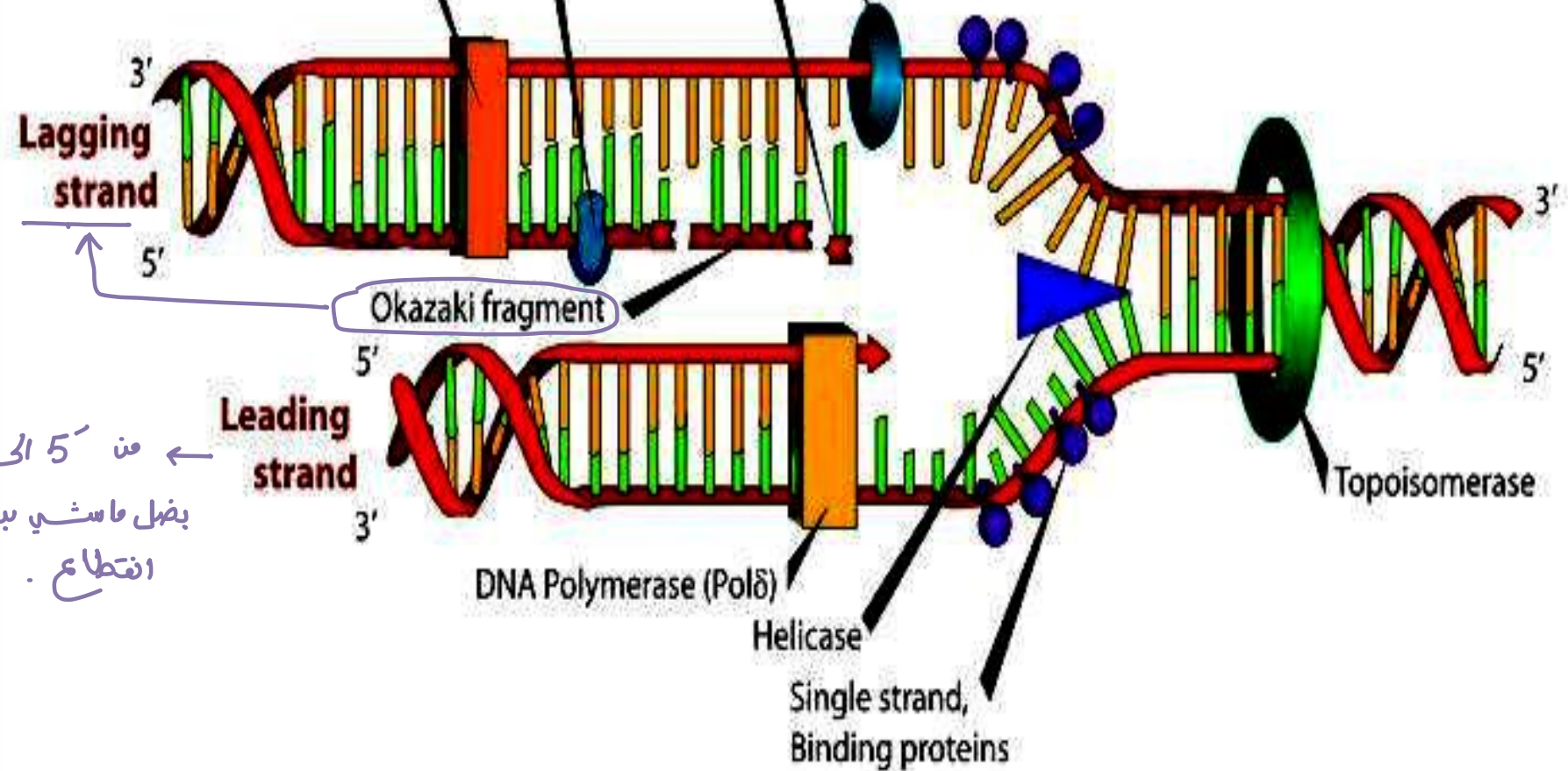
DNA Polymerase (Pol $\delta$ )

Helicase

Single strand,  
Binding proteins

Topoisomerase

من 5' الى 3'  
بفضل ماشيني بدون  
افتتاح .





- سنبلیغ حاصنا -  
ولو بعد حین  
فدحن  
بِحار عزم ان  
أردنا ♥