



Virus is an obligate intracellular parasite that contains genetic material surrounded by a protein known as capsid

viral genome < RNA DNA never both!

(RNA/DNA) + (Capsid) → nucleoprotein, we may have another thing surrounding "envelope" in this case it's enveloped virus  
↳ lipoprotein membrane

If we don't have the envelope? only genetic material + protein then it's naked virus  
RNA DNA capsid

More info:- it's size in nanometers, can't multiply by division!

\* the virus has few proteins, for sure NO mitochondria NO ribosomes, but have also few enzymes (Not all viruses have enzymes!)

Speaking about proteins of viruses, Types of Proteins / enzymes?

1) structural proteins ↓

2) non-structural proteins ↓

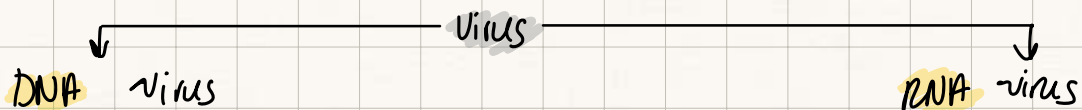
\* as attached proteins to ↓ used by a virus to attach to a cell

\* enzymes

\* capsid (the protein surrounding RNA/DNA)

envelope ال envelope ليسوي ال

\* Origin of Structural Proteins? cell membrane of the host it attacked  
→ this for the envelope protein which is non coding, why non coding?



They replicate inside the nucleus, so they should have their own enzymes

• Remember: enzymes are non structural proteins

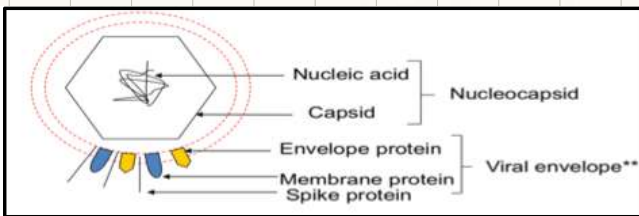
They replicate inside the cytoplasm, so they can use the host cell's enzymes

• We have exceptions, (they are IMP) ↓

- 1) Pox virus → DNA virus but replicates in cytoplasm, why? largest virus
- 2) Influenza / HIV → RNA virus but replicate in nucleus, why? شده

• IMP → there are 8 types of Herpes virus, know them! I will write them later :)

\* "Virion" : infectious unit of "mature virus" the virus which can cause an infection



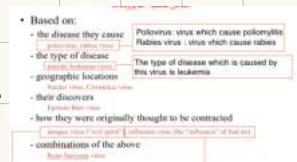
What are spike proteins?  
glycoproteins that act as ligands to recognize certain host cells  
example: HIV recognize "T cells"

• Other properties of viruses → replicate by "one step growth"

\* "Naming viruses" → largest is family, how're they classified?  
based on structure, size, nucleic acids (RNA / DNA), target cells, ...

\* 20 families (7 DNA, 13 RNA)

How are they named →



What are the 7 DNA viruses?  
they replicate → nucleus  
& make their enzymes

- 1) Poxviridae (largest one, Remember! : replicate in cytoplasm) ← eradicated via vaccine
- 2) Herpesviridae (8 types know them)
- 3) Adenoviridae
- 4) Papovaviridae
  - ↳ papillomaviridae
  - ↳ polyomaviridae
- 5) Parvoviridae (smallest)
  - ↳ totally depend on target cell
- 6) Hepadnaviridae
  - ↳ hepatitis B virus, ONLY DNA one of hepatitis viruses

\* كيف نعرف ان DNA viruses ؟ كان عندي بوكس بابا بابا من اسو حبة  
 كان فيه بارفان اسمه her شفته مرة Ad مع يوتيوب .  
 Hepadna ... Papo viriidae Pox viriidae  
 Adenoviridae herpes viriidae Parvo viriidae

Other 13 viruses → RNA viruses

\* يجب علينا يعرف عن عدوى ، لازم الفيروس يتفاعل مع ال host ، كيف ؟


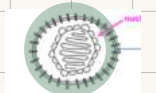
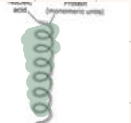
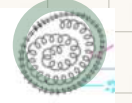

In enveloped viruses through the glycoprotein projection spikes) act as ligand to special receptors on the host cells .  
 In naked viruses , this occurs by Antine - like - projection of capsid protein act as ligand if it exist as in Adenovirus or by grooves within the capsid also act as ligand .

explained above

Aid in entry process + protect the genome +

Envelope → stored in tegumen nucle → stored in capsid  
 احنا حكيكنا انه الفايروس يحتاج اترميزات عشان يتكاثر . وهاي اترميزات ممكن يكون حاملها مع زي معظم ال RNA viruses . طيب وين بده يخزنها ؟ من هون بتيجي الوظيفة الثالثة لل structure تاغ الفايروس انه بقدر يخزن هاي اترميزات معه

These are the functions of the envelope / capsid.

- \* 5 types of the viral structure →
- 1) Icosahedral <sup>كل واده من عنده 20 faces</sup>   
↳ cubic  Adenovirus
  - 2) envelope " 
  - 3) helical <sup>equilateral triangle</sup>   
Coronavirus 
  - 4) enveloped helical 
  - 5) complex   
poxvirus 

صبة صبة بتجري ليه ، وحصا وحصا ، وانا ايه ؟ انا نزلو عن كل نوع ↓

① Helical capsid rod shaped capsomers that coil around hollow center

\* Any helical virus is made up of: RNA + envelope (NO DNA)

- California Encephalitis Virus
- Coronavirus
- Hantavirus
- Influenza Virus (Flu Virus)
- Measles Virus ( Rubeola)
- Mumps Virus
- Para influenza Virus
- Rabies Virus
- Respiratory Syncytial Virus(RSV)

↳ helical RNA enveloped viruses

لهدول حفظ و ال Pox virus باللي الـ icosahedral  
 ↳ complex

② Cubic 20 sided with 12 corners, vary in no. of capsomers, some enveloped  
 the building unit here is **promotor**, several meetings of promoters are called a capsomer  
 خزانة بيج ال helical

- DNA / RNA
- enveloped / capsid

Example :- **rota virus** ⇒ adenovirus  
 Common between kids ⇒ does gastroenteritis, ⇒ has vaccine

③ **Complex** lack normal capsid instead → has layers of lipoproteins & fibrils

"Bacteriophage"



virus that infects the bacteria, genetic material may be ssRNA, dsRNA, ssDNA, dsDNA

**Important !!**

**DNA viruses**

**Poxvirus**: large enveloped DNA virus, only virus which have complex capsid.

**Herpesviridae**: enveloped DNA virus, which have icosahedral capsid.

**Adenoviridae, papovaviridae, hepadnaviridae**: **naked DNA viruses**, which have icosahedral capsid.

**Parvoviridae**: very small naked DNA virus, which have icosahedral capsid.

**RNA viruses**

ما حكيكنا عنهم كلهم حكيكنا عن اثنين مهمين وهم

**Retroviridae**: enveloped RNA virus, which have icosahedral capsid, the most common example of these viridae is **HIV**.

**Reoviridae**: naked RNA virus, which have icosahedral capsid, the most common example of these viridae is **Rotavirus**.

All DNA viruses have double stranded DNA molecule, except parvovirus has single stranded DNA molecule.

All RNA viruses have single stranded RNA molecule, except rotavirus has double stranded RNA molecule.

**Classification of viruses**

- Nucleic acid (DNA or RNA)
- Capsid (Icosahedral, helical, complex)
- Presence of envelope (enveloped or nonenveloped)

**Replication strategy**

في اشي بتسميه (Baltimore classification of replication strategy) هه 7 strategies بالفايروسات تااعت الاقسام افي را ح يكون منهم single stranded DNA replication و في double stranded DNA replication و في single stranded RNA replication و في double stranded RNA replication و في sense negative و sense positive ل يتقسمها ل رح لتكفي عنهم الحاضرة الجاي بشكل موسع , وهاي الحاضرة حتمكي شوي عنهم



**CLASSIFICATION NUCLEIC ACID**

- RNA or DNA
- segmented or non-segmented

ال segmented يعني مقسمة لجنينات و كل جين يعطى بروتين واحد و من أشهر الامثلة : Rotavirus and influenza virus . اما ال non segmented كل المادة الوراثية قطعة واحدة . و من هون بصير في عنا اشي اسمه Non segmented virus problem يلي حتمكي عنها الحاضرة الجاي , و فكرتها انه ال non segmented viruses problem

- dsDNA (herpes, papova, adeno, pox)
- ssDNA (parvo)
- dsRNA (reo, rota)
- ssRNA (+) (picorna, toga, flavi, corona)
- ssRNA (-) (rhabdo, paramyxo, orthomyxo, bunya, filo)
- ssRNA (+/-) (arena, bunya)
- ssRNA (+RTase) (retro, lenti)

**LOSS OF ENVELOPE RESULTS IN LOSS OF INFECTIVITY**

↳ in GIT acidity

- linear or circular
- single-stranded or double-stranded

All DNA viruses have double stranded DNA molecule, except parvovirus has single stranded DNA molecule.

All RNA viruses have single stranded RNA molecule, except rotavirus has double stranded RNA molecule.

• if single-stranded RNA

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

هسة يدك تعرف انه ال single stranded RNA viruses ينقسمهم الى positive sense و negative sense ، ال + sense هو يلي بقدر يروح على ال Ribosome و يمسيره translation أما ال- sense ، هذا لازم يعمل complementary strand بعدين بمسيره translation . و يدك تعرف انه ال- sense هو complementary ل (+ sense) ، هذا الكلام رح يتوضح الحاضرة الثانية.

**Properties of naked viruses**

- Stable in hostile environment
- Not damaged by drying, acid, detergent, and heat
- Can sustain in dry environment
- Can stay dry and still retain infectivity
- Can infect the GI tract and survive the acid and bile
- Can spread easily via hands, dust, fomites, etc
- Neutralizing mucosal and systemic antibodies are needed to control the establishment of infection

**ENVELOPE**

OBTAINED BY BUDDING THROUGH A CELLULAR MEMBRANE (except poxviruses)

قلنا سابقا انه ال envelop is not coded by viral genetic material ، و انه بيجيه من مصادر خارجية ، زي شو

1. Cell membrane (common)
2. nuclear membrane (rare)
3. endoplasmic reticulum (rare)

CONTAINS AT LEAST ONE VIRALLY CODED PROTEIN attachment protein (spikes or glycoprotein)

- dsDNA (herpes, papova, adeno, pox) DNA viruses عكيا انه كل ال DNA viruses عكيا انه كل ال parvo ال ال
- ssDNA (parvo)
- dsRNA (reo, rota) ال reo هو عائلة ال reo
- ssRNA (+) (picorna, toga, flavi, corona)
- ssRNA (-) (rhabdo, paramyxo, orthomyxo, bunya, filo) Ampliviruses : RNA viruses which are (+ and -) sense at the same time
- ssRNA (+/-) (arena, bunya)
- ssRNA (+RTase) (retro, lenti) ماي ال RNA reverse transcribing viruses ال

**Satellites**

- Contain nucleic acid
- Depend on co-infection with a helper virus
- May be encapsidated (satellite virus) Single viruses بتسمى ال satellite viruses
- Mostly in plants, can be human e.g., hepatitis delta virus (delta agent) هناك فيروسات بتسمى ال delta agent
- If nucleic acid only = virusoid الغنى بتسمى ال virusoid

|  |       |            |                     |
|--|-------|------------|---------------------|
| Kuru   | Human | Kuru prion | HuPrP <sup>Sc</sup> |
| Creutzfeldt-Jakob disease (CJD)              | Human | CJD prion  | HuPrP <sup>Sc</sup> |
| Gerstmann-Sträussler-Scheiner syndrome (GSS) | Human | GSS prion  | HuPrP <sup>Sc</sup> |
| Fatal familial insomnia (FFI)                | Human | FFI prion  | HuPrP <sup>Sc</sup> |



**Viroids**

- ss RNA genome and the smallest known pathogens.
- Affects plants

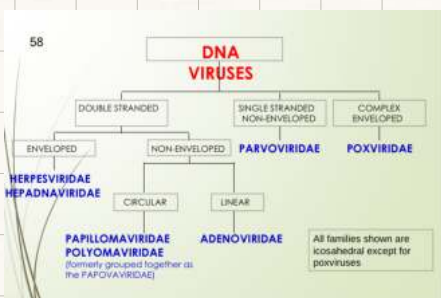
Viroids utilize cellular RNA polymerases for their replication

يس قريه ال abnormal (B) على (A) تتحول ال

• Replication cycle

**Prions**

- Infectious particles that are entirely protein. جوه مولد من قنطرة بروتين (الكتورا سكاها) ال بتسمى عنده Prions
- No nucleic acid
- Highly heat resistant ديعلاوة على جارية لدرجات مرتفعة
- Animal disease that affects nervous tissue
- Affects nervous tissue and results in Bovine spongiform encephalitis (BSE) "mad cow disease" ال BSE ال بتسمى عنده Prions
- scrapie in sheep
- kuru & Creutzfeldt-Jakob Disease (CJD) in humans



All families shown are icosahedral except for poxviruses

## exceptions

Pox virus (DNA virus) but replicates in cytoplasm (becz it's largest virus)

Influenza & HIV are RNA viruses but replicate in nucleus

\* you should know 8 types of Herpes virus

\* Hepadna virus (Hepatitis B virus) is the only dna virus of hepatitis family

\* Poxviridae → largest virus, and the only complex capsid virus

\* Parvoviridae → smallest virus (totally depend on target cells)

\* Papoviridae  
└─ Papillomaviridae  
└─ polyomaviridae

\* Rota virus → icosahedral virus that's common in kids → gastroenteritis

• enveloped virus attach to target cells by the spikes

• naked virus // by grooves "Antine-like-projection"

## \* Notes \*

• DNA viruses replicate in nucleus, so they have their own enzymes

• RNA viruses // in cytoplasm // use the host's enzymes

• DNA viruses are never helical, helical are RNA + enveloped

• when an icosahedral virus gets bigger, number of faces doesn't change only promoters and capsomers

• Icosahedral may be  $\begin{cases} \text{RNA} \\ \text{DNA} \end{cases}$  may be  $\begin{cases} \text{only capsid "naked"} \\ \text{"enveloped"} \end{cases}$

• DNA viruses (7) the enveloped ones → Poxvirus & Herpesvirus  
↳ Pox only complex other are icosahedral

• RNA viruses  
└─ Retroviruses → enveloped  $\begin{cases} \text{HIV} \\ \text{replicate nucleus} \end{cases}$  Icosahedral capsid  
└─ Reoviruses → open- and naked : Retrovirus  
└─ segmented RNA virus + double stranded

## exceptions

- All DNA viruses have double stranded except <sup>smallest</sup> parvovirus has single-strand DNA
- All RNA " " single " except rotavirus have double stranded RNA molecule  
↳ naked RNA virus

- Single stranded RNA  
SSRNA  $\left\{ \begin{array}{l} +\text{sense} \rightarrow \text{go to ribosome to translate} \\ -\text{sense} \rightarrow \text{does a complementary strand first} \end{array} \right.$

- envelope is not coded by viral genome but taken from host  $\leftarrow \begin{array}{l} \text{cell membrane} \\ \text{nuclear "} \\ \text{endoplasmic reticulum} \end{array}$

\* Note  $\rightarrow$  enveloped virus easier to destroy because it attacks using its spikes  $\&$  so when spikes are destroyed by gastric acidity for example, then it's all destroyed.

$\rightarrow$  naked viruses aren't damaged by acids, dry environment, ... so they can spread easily and infect GI tract.

\* Note:- the naked virus replicate intracellularly and since it cannot penetrate the membrane to get out (unlike the enveloped virus) so the naked accumulate in the cell until it lyse and release it with its replications

\* Naked viruses such as  $\begin{array}{ccc} \text{DNA} & \text{RNA} & \text{RNA} \\ \text{Adenovirus, B19} & \text{Hepatitis A \& " E, Coxsackie A 2, B} & \end{array}$   
they all are icosahedral and infect the GIT except B19

- Notes  $\rightarrow$  RNA reverse transcribing viruses as HIV is a positive sense SSRNA virus  
when entering host cell  $\rightarrow$  dsDNA virus by certain enzymes
- DNA reverse transcribing viruses as Hepatitis B is a DNA virus but has different replication mechanism

\* All viruses produce the sense RNA when entering a host cell in order to  
1) replicate the genome 2) make proteins for its own

Remember  $\rightarrow$  all DNA viruses ds except parvo ss

ds RNA  $\rightarrow$  reo, rota , ssRNA(+)  $\rightarrow$  picorna, corona, toga, favi

SSRNA(-)  $\rightarrow$  rhabdo, paramyxo, orthomyxo, bunya, filo

SSRNA(+R Tase)  $\rightarrow$  retro, lenta

either(-) or(+)  
 $\rightarrow$  bunya, arena viruses

• satellites have genetic material that may or may not be capsidated  
↳ cannot make infection without help from a virus

• viroids are genetic material that isn't capsid & only found in plants &  
↳ replicate by rolling circle mechanism, don't encode protein, don't depend on other virus

• prions are protein only that are infectious (no nucleic acid) & heat resistant, Animal disease nervous system "BSE"  
↳ they're found in normal humans but becuz of some reasons it's mutated to an abnormal form (Normal → cellular) (Abnormal → scrapie)  
↳ when abnormal touch a normal → abnormal, Examples: - Kuru, CJD, GSS, FFI

The prion diseases are also called → Neurodegenerative disorders, causes →

- 1) sporadic spontaneous mutation, CJD, most common 20%
- 2) Familial inherited & genetic, GSS, FFI
- 3) Transmissible rare out of them, by external source, BSE in cow → vCJD in humans, Kuru

the Prion diseases are also called → Transmissible spongiform encephalopathy (TSE)

\* PrP<sup>C</sup> → normal, transmembrane glycoprotein,  $\alpha$ -helix dominant, soluble

\* PrP<sup>Sc</sup> → abnormal,  $\beta$ -sheet, insoluble

• they don't induce immune reactions

Stopped on slide 51, file 2 → viral life cycle