GENERAL VIROLOGY 1

Virus structure & classification

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:Introduction

one of the bacterial flitor

- In 1884,(Chamberland filter) with pores smaller than bacteria → By using it ,we can filtrate a solution from any bacteria because its pores doesn't permit the bacteria to pass
- In 1892, the Russian biologist (Dimitri Ivanovski) used this filter to study what is now known to be tobacco mosaic virus.

Discovery of virus done by

- Origins of viruses:
  - Regressive theory
  - Cellular origin theory
  - Coevolution theory

These virus is a complete organism but it cant grow and replicate except inside the cell and it depend on mechinary of the cell so these result in lost organells and happen a regressive of its .consequence → These virus may come from some cells that died

These virus is an organism with all its organells

:General Characteristics

)family of virus such as :ebola(

1. Wide diversity of shapes and sizes.
2. Small size: EM, 10 - 300 nanometres (Filoviruses: length up to 1400 nm, diameters, 80 nm).
3. Filterable. → Pass from bacteria
4. Obligate intracellular parasites: using the biosynthetic machinery of the host.
5. They contain molecular machinery for viral replication.
5. Protein coat. → Have one type of nuclic acid
6. No ribosomes, mitochondria or other organelles.
7. Only one type of nucleic acid.
8. Naked **or** enveloped (lipoprotein envelope).
9. Do not grow in size.

وحدة قياس حجم الفايروس

So we cant see it by L.microscope

Virus may be part of its replication that need certain enzyme , the host cells don't have this enzyme

Means as cell membrane

Virus enter to infect the cell and out in the form of crops

VIRUS STRUCTURE

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➢ Capsid and Symmetry:

It gives the symmetry of the virus

- A complete virus particle, known as a virion, consists of nucleic acid surrounded by a protective coat of protein called a capsid.
- The capsid is made from identical protein subunits called capsomers, encoded by the viral genome.

The genome of virus doesn't contain gentic information too much → The virus exploits this point to make a subunits and these stached together around nuclic acid and make the coat

- The viral capsid proteins with viral nucleic acid is called a nucleocapsid.
- Classified as(helical, icosahedral, or complex.)

1 2 3

It is virion without envelope

الشكل النهائي للفايروس

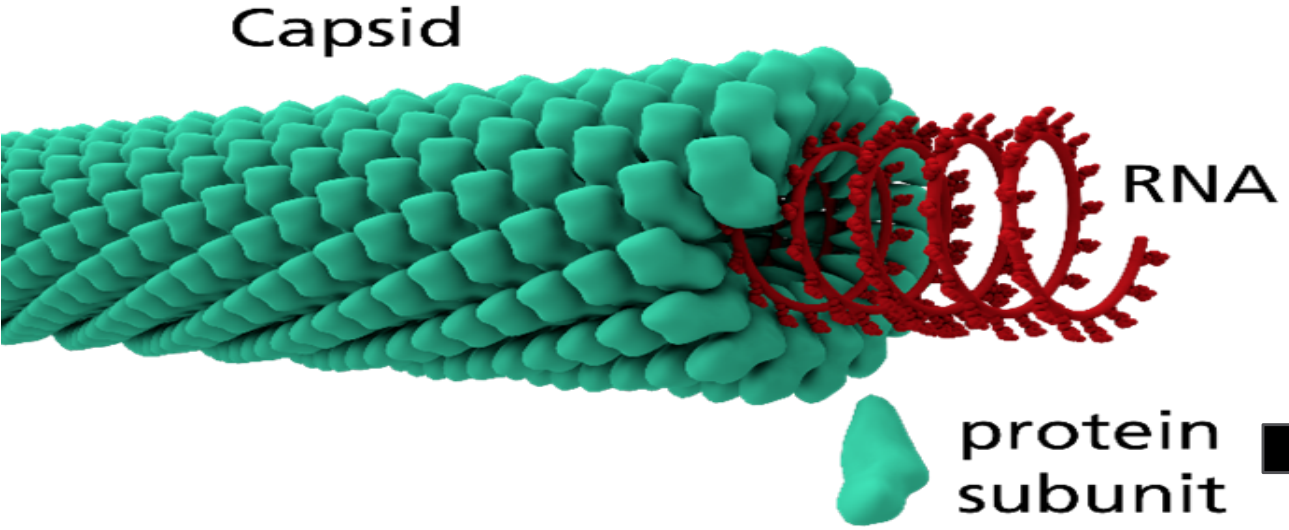
why the genome (sequence) which was between the hollow**
?tube fixed (don't fall)

- HELICAL:

the charge** → Nuclic acid (negative)
Protein (positive) ↔ This force make the interaction between the sequence

- ➢ **Rod** shaped, or **filamentous** virions, **short** and highly **rigid**, or **long** and very **flexible**. → Then stack to be envelope
- ➢ Composed of a **single type of capsomer** stacked **around a central axis** to form a **helical structure.** → Which surround arround the genome of the virus
- ➢ **Tobacco mosaic virus** is an example of a helical virus.

Short and rigid , another human viruses are long and flexible

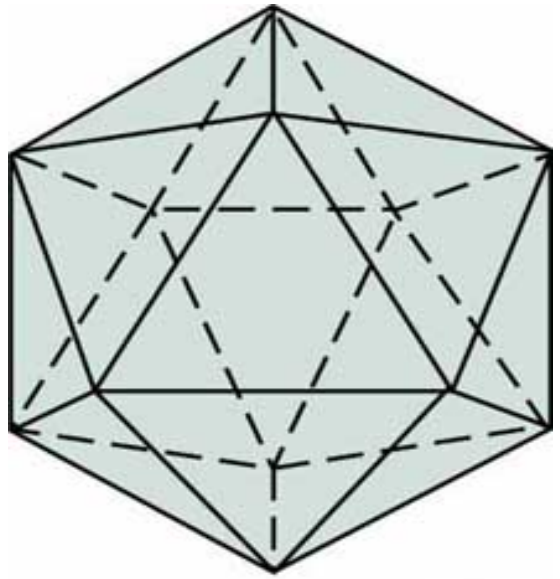


When it stacked together around nucleic acid it make a tube structure (rod shape or filament)

- ICOSAHEDRAL: الشكل المتعدد الوجوه او ذو الوجوه العشرين

- **Most animal viruses** are icosahedral. **Capsomeres** are arranged in **20 triangles** with **12** evenly spaced corners (**Vertices**). Each face is an equilateral triangle and every **vertex** of the icosahedron is formed by **five triangular** faces. Edges 30; Vertices 12; Faces 20.

التقاء الاضلع بعملوا وجه
وعند الالتقاء مع ال **abex** بعملوا ال **vertex**



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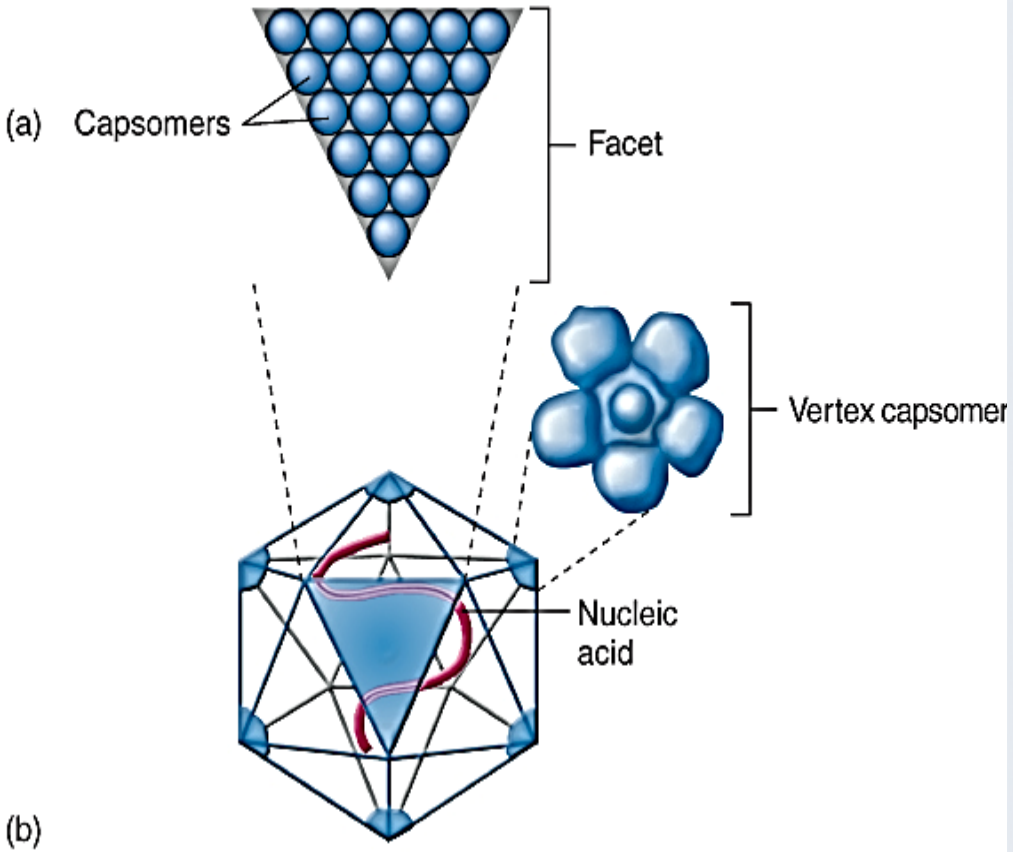
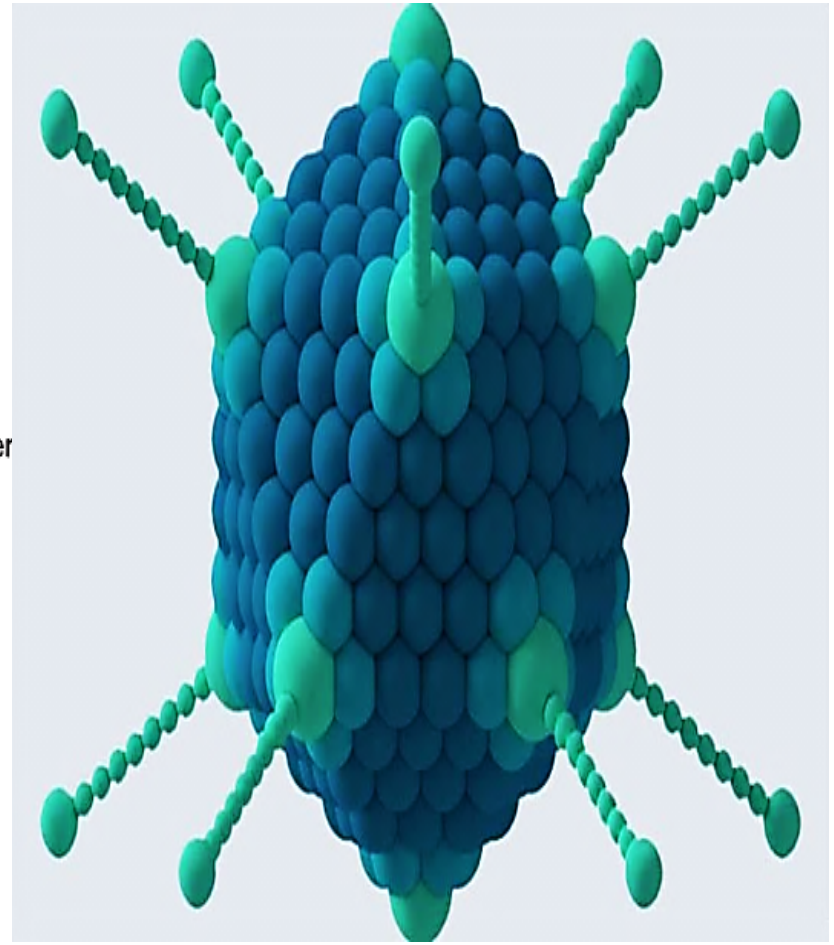
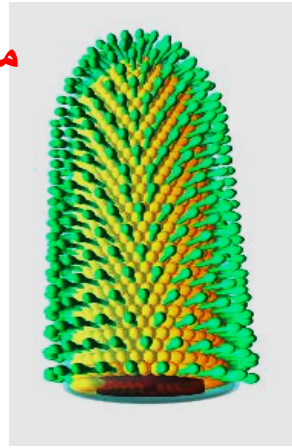

(a)
Capsomers
Facet
Vertex capsomer
Nucleic acid
(b)



- **COMPLEX:** ليس له شكل محدد

- These viruses possess a capsid which is **neither purely helical, nor purely icosahedral**, and which may possess **extra structures** such as protein tails or a complex outer wall.
- Some **bacteriophages, poxviruses**.

ممكن يكونوا على شكل رصاصة ← مثل **Rhabdo virus**



:Functions of the capsid protein

- Protect viral nucleic acid.
- Interact *specifically* with the viral nucleic acid for packaging.)charged(
- Mediate the attachment of the virus to the cell (host receptors) for entry to cell.
- Antigenic determinants. ➡ **Which recognize by body to make antibody against these antigen**
- Stimulates antibody production.
- Allow for release of nucleic acid upon entry into new cell.

When the vius enters the cell it will help in release of nucleic acid from the virus partical (uncoating)

➢ Virus Envelopes:

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1. Present in some but not all viruses
2. Composed **of viral specific glycoproteins** and **host-cell-derived lipids.**
3. The envelope contains almost **no host protein**.
4. Enveloped viruses → persistent infections. **)Always(**
5. It contains **molecules to initiate infection**, stimulus for **antibody production**, and serve as antigens; **ether sensitive.**

The material which effect on lipid :
Ether- -
alcohol- -
detergent- -
CL- -

It is sensitive to anything that effect on lipid so anything that effect on lipid may kill the envelope which means kill the virus because the virus without the envelopes cant infect the cell

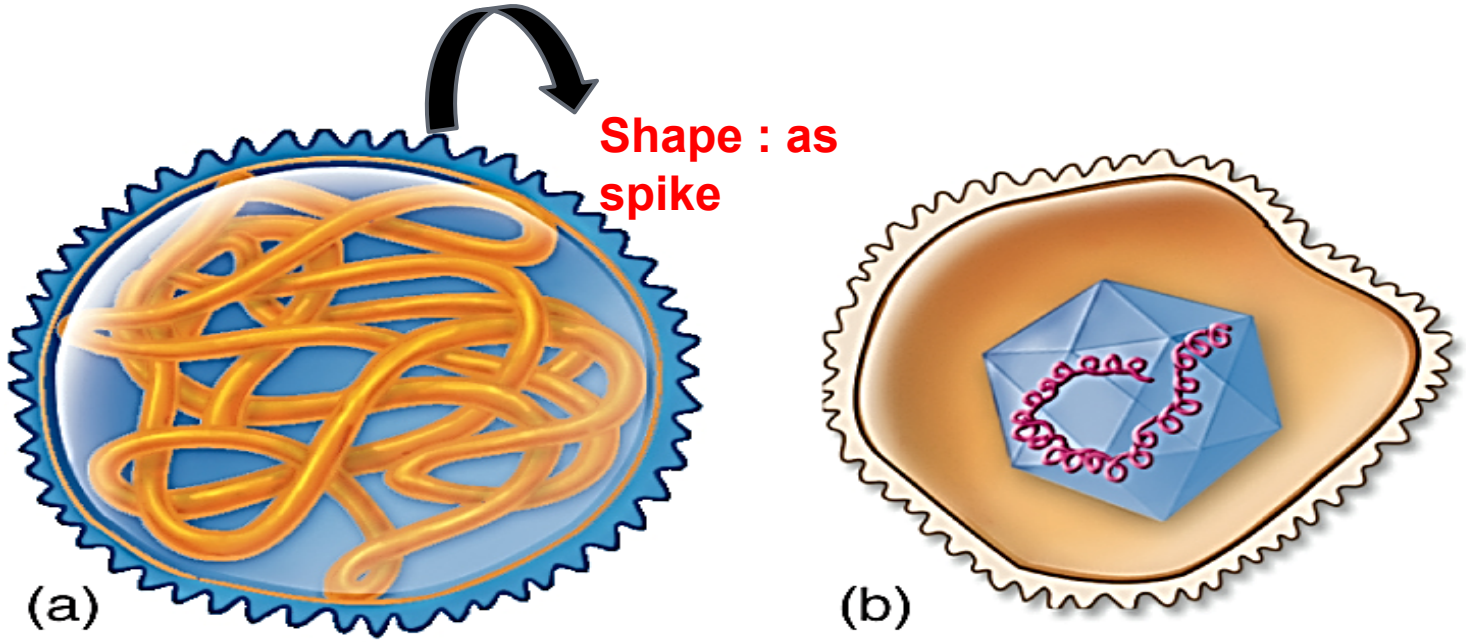
:Envelope proteins

a) Glycoproteins: Integral Membrane **Proteins** exposed on outer surface of the membrane. **host cell receptor من خلاله بتعرف على ال**

b) Matrix Proteins: are found at the inner face of the envelope. **)between envelope and capsid(**

It has many function in replication + integrity for virus partical

Shape : as spike



➢ Viral Nucleic acids:

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Parameters	Property
DNA RNA	Nucleic acid
Linear Circular Segmented	Shape
Single-stranded Double-stranded **Double-stranded with regions of single-strandedness**	Strandedness
Positive sense (+) Negative sense (−) Ambisense (+/−)	Sense

مع ال virology تنكر كل القواعد

The genome of virus complementary to the mRNA

Means that this virus when infect the cell its genome act as mRNA (dengorus)

Its genome has some parts either (+) or (-) , this sense can be in segmented

Single stranded DNA -
Double stranded RNA -
Double stranded with part of single - stranded in the same genome

ممكن نلاقي

- RNA usually smaller and more fragile than DNA viruses.
- Each 1000 bp = kilobases, for single-stranded genomes, kb is used. For double-stranded genomes, kilobase pairs (kbp) is used.
- RNA or single-stranded DNA viruses are either positive-sense or negative-sense. Positive-sense viral RNA is identical to viral mRNA and thus can be immediately translated by the host cell. Negative-sense viral RNA is complementary to mRNA and thus must be converted to positive-sense RNA by an RNA polymerase before translation.

:Atypical virus like agents

Hepatitis D cant make surface antigen ,so it should enter with hepatitis B to make a surface antigen

Defective viruses: composed of viral nucleic acid and proteins but can not replicate .without a helper virus, which provide the missing function → As delta agent = hepatitis D virus

It has deficient function / lost of function

.Pseudovirions: contain host cell DNA instead of viral DNA within the capsid

Viroids : molecules of RNA , no capsid protein or envelope. Viroids are important .pathogens of plants)virus from plant(

Prions: infectious protein molecules that do not contain DNA or RNA. They cause an infection in sheep called scrapie and cattle bovine spongiform encephalopathy ("mad .cow" disease). In humans they cause **kuru** and **Creutzfeld-Jacob disease**

الموت الضاحك , مرض يصيب آكلي لحوم البشر

The segment of genome cell may enter in the protein of the virus , so the virus look like from the outside protein coat whereas inside part of genome cellso when infect the cell ,will enter the cell by antigenic determinants,

VIRAL CLASSIFICATION:

- Viruses infect all major groups of organisms.
- Some viruses have a broader **host range**

Means : the virus may infect many kingdom

- None can cross the eukaryotic/prokaryotic boundary.

Human or animal don't infect in any virus that infect bacteria

- The oldest classification of viruses is based on the diseases they produce.

لكن هذا التصنيف جعل الفايروسات تتداخل في بعضها

Universal System of Virus Taxonomy

International Committee on Taxonomy of Viruses [ICTV]:

- **Order (-virales)**
- **Family (-viridae)**
- **Subfamily (-virinae)**
- **Genus (*-virus*)**
- **Species (*-virus*)**

مهم جدا

- **The Baltimore classification of viruses is based on the mechanism of mRNA production. This classification places viruses into <u>seven groups</u>:**

I. dsDNA viruses (e.g. Herpesviruses)

II. ssDNA viruses (+)sense DNA (e.g. Parvoviruses)

III. dsRNA viruses (e.g. Reoviruses)

IV. (+)ssRNA viruses (+)sense RNA (e.g. Picornaviruses,)

V. (-)ssRNA viruses (-)sense RNA (e.g. Orthomyxoviruses)

VI. ssRNA-RT viruses (+)sense RNA with DNA intermediate in life-cycle (e.g. Retroviruses)

VII. dsDNA-RT viruses (e.g. Hepadnaviruses)

فيها شلل الأطفال

With transcriptase character
بتعمل DNA من RNA

Double stranded with single strandedness

:Five Basic Structural Forms of Viruses in nature

- Naked Icosahedral e.g. poliovirus
- Naked helical e.g. tobacco mosaic virus
- Enveloped Icosahedral e.g. herpes virus
- Enveloped helical e.g. measles virus

DNA Viruses

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	Family	Nucleic acid	Envelope	Capsid	Example
1	Parvoviridae	SS, linear	No	Icosahedral	B19
2	Papovaviridae	DS, circular	No	Icosahedral	Papillomavirus
3	Adenoviridae	DS, linear	No	Icosahedral	Adenovirus
4	Hepadnaviridae	DS, incomplete circular	Yes	Icosahedral	Hepatitis B virus
5	Herpesviridae	DS, linear	Yes	Icosahedral	HSV, CMV
6	Poxviridae	DS, linear	Yes	Complex	Smallpox virus

are non envelope 1+2+3
are enveloped 4+5+6
all of them are icosahedral except 6 (complex)**
all of them are DS except 1 (SS)**

RNA Viruses

بعمل نزلات برد عند الأطفال

بعمل الحصبة الالمانية

	Family	Nucleic acid	Envelope	Capsid	Example
1	Picornavirus	SS linear, NS, +ve	No	Icosahedral	HAV
2	Calicivirus	SS linear, NS, +ve	No	Icosahedral	HEV
3	Reovirus	DS linear, 10S	No	Icosahedral	Rotavirus
4	Flavivirus	SS linear, NS, +ve	Yes	Icosahedral	HCV
5	Togavirus	SS linear, NS, +ve	Yes	Icosahedral	Rubella virus
6	Retrovirus	SS linear, 2S, +ve	Yes	Icosahedral	HIV
7	Orthomyxovirus	SS linear, 8S, -ve	Yes	Helical	Influenza virus
8	Paramyxovirus	SS linear, NS, -ve	Yes	Helical	Measles virus
9	Rhabdovirus	SS linear, NS, -ve	Yes	Helical	Rabies virus
10	Filovirus	SS linear, NS, -ve	Yes	Helical	Ebola virus
11	Coronavirus	SS circular, NS, +ve	Yes	Helical	Coronavirus
12	Arenavirus	SS circular, 2S, ±	Yes	Helical	LCMV
13	Bunyavirus	SS circular, 3S, -ve	Yes	Helical	Hantavirus
14	Deltavirus	SS circular, CC, -ve	Yes	Helical	HDV

All of them are SS except 3
are non envelope 1+2+3
are icosahedral 1+2+3+4+5+6

:DNA viruses

- Contain double-stranded DNA (except parvoviruses).
- Naked viruses (except herpesviruses, poxviruses, and hepadnaviruses).
- Icosahedral capsids and replicate in the nucleus (except poxviruses).

:RNA viruses

- Contain single-stranded RNA (except reoviruses).
- Enveloped (except caliciviruses, picornaviruses, and reoviruses).
- Helical capsids (except picornaviruses, reoviruses, and togaviruses,???).
- Classified positive(picornaviruses and retroviruses), negative (orthomyxoviruses and paramyxoviruses), or ambisense(arenaviruses).
- Replicate in the cytoplasm (except orthomyxoviruses and retroviruses).

Thank you!

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