University of Jordan
Faculty of Medicine

Medical Committee
The University of Jordan

Introduction to

Microbiology

Title :

Virology -1

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- Slides
- Handout
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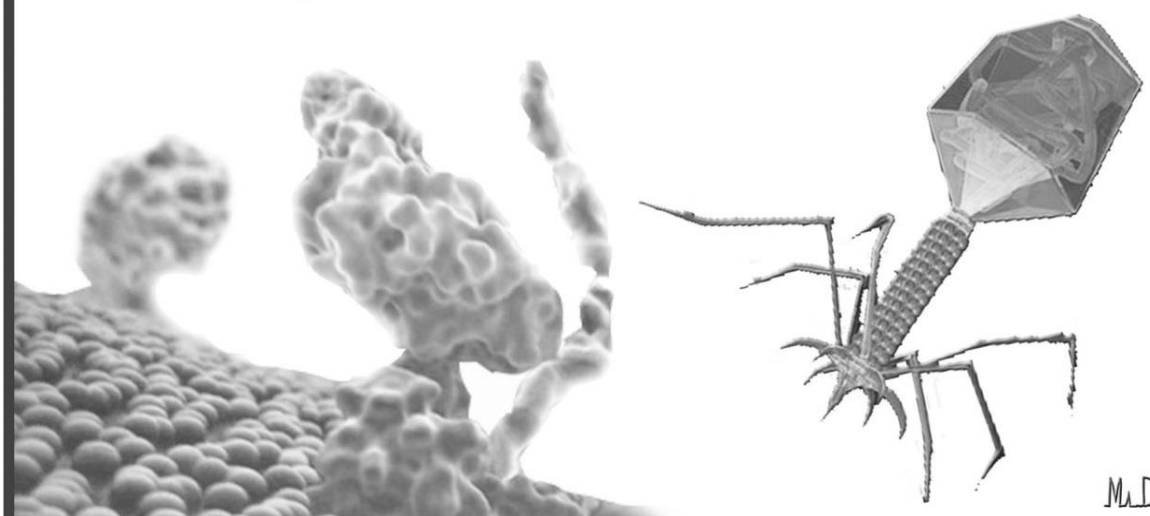

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Virology

We are going to start with general introduction about viruses, they are everywhere around us; in food; within the environment; in direct contact to …etc. .
They may cause viral infection by itself or a viral infection on a top of preexisting bacterial infection because it suppresses the immune system of the patient and make the virus entrance to the body easier.

Virus: is an obligate intracellular parasite with genetic material (either DNA **OR** RNA) surrounded by protein (envelop covers the nucleic acids called **capsid)**.

* What does an obligate intracellular mean?
That it can't live in its own it needs a living cell which can host it and provide the necessary macromolecules and enzymes for its replication.
* For its own replication and to complete the replication or virus reproduction it needs macromolecules and the enzymes of the cell because it lacks them! And without those the virus by itself is not alive!

* In the simplest form it has a protein cover which we call envelop but it is a capsid not an envelope which is a protein envelop covers the nucleic acids of the genome.

*Types of **viruses**:

naked — doesn't have an envelope

enveloped — have an envelope

*Viruses can be only observed by electron microscope never by light microscope.
The size of the virus: 20-450 nm in diameter.

Recognizing the shape, size and structure of different viruses is important to study the diseases.

* Viruses have an inner core of nucleic acid surrounded by protein known as an **envelop**.
We have nucleic acid followed by the capsid which gives the nucleocapsid.
Some viruses are naked (don't have an envelope) and others are enveloped.

Viral properties:

1. Viruses are inert filterable agent.

Inert: because they are incapable of replication or producing illness outside a living cell.
Filterable: a term given to works in laboratory because they have certain filters which can filter certain microorganism specially bacteria which is larger in size than viruses so you can get rid of bacteria in certain solutions.

2. Obligate intracellular parasite.
3. Can't make protein independent of the cell because they don't have ribosomes so they can't make their own energy.
4. Viruses genome is either DNA or RNA but never both together.
5. They have a capsid or an envelope with attached proteins .

Naked viruses don't have any envelope!
The enveloped viruses have with embedded envelope protein "glycoproteins" they attached to receptors on target cells, so they play a role in the entry process of the virus to the target cells.

This is a comparison between a virus and a normal cell:

	virus	**Normal cell**
Nucleic acid	RNA or DNA	Both together
Proteins	few	many
Membrane	Naked or enveloped	Cell membrane is essential for the stability of the cell
Ribosomes	absent	present
Mitochondria	absent	present
Enzymes	Non or few (certain viruses totally dependent on the target cell for its replication and life cycle, others are partially independent; they bring with them different enzymes and proteins and nucleic acid within the capsid which help them in the replication)	

*What is the difference between virus and virion?
virion is a mature virus .
They are similar or equivalent.

* Not all viruses must have an envelope and it's not part of replication or the development stages. Some viruses are naked and they will remain naked. So, the enveloped viruses are known viruses

and the naked viruses are known!

* Protein which encloses the genome is a capsid.
*Capsids are usually symmetrical. We are going to talk about 3 types (2 of them are symmetrical and 1 is not): **helical capsid , icosahedral capsid and complex capsid.**

* Capsid does genome, the structure of the nucleic acids or the genome or the genetic material within the capsid we called: **nucleocapsid** .

We can call the naked virus as a nucleocapsit theoretically speaking yes! But you know that this virus is named X so you called it virus X!

*many viruses have an envelope.

*Virion! Why we said mature?
because viruses at the beginning after they effect the cell and for new virus they exit the cell , the initial stages after they exit the cell they are not mature enough it is a matter of time then they mature and become totally infectious viruses = virion .

Structures:
genetic material inside.
The capsid which covers the genetic material both together we called the nucleocapsid .
Envelop within there are embedded proteins, glycoproteins …
they might be composed of one or multiple units of proteins , can be one or can be two .
Each of the two subunits work at different stages of the virus replication cycle.

Distinguish characteristic of viruses:

obligate intracellular parasite.
The nucleic acid is either DNA or RNA.
Replication goes disassembly and re- assembly.
(attaches to the receptors >> enter the cell >> nucleic acids separated from the proteins the enzymes and from the envelop "**disassembly**" >>replication " increase copy number of nucleic acids ,produce and generate more proteins & enzymes " >> **assembly** >> get an envelope from the cellular membrane "" how is this affect the hosting cell ? "" this will end the cell with death >> the native viruses keep using up the cellular machinery and resources until the cell is used up, at this stage we get new virion which exit the cell)

*<u>**How do we name viruses?**</u>

There is a general rule and some exceptions:

general rule:-

the top group is the family then come other subdivision.

we have 19 family of animals viruses families , 6 DNA families and 13 RNA viruses families .

- The family name ends with (-viridae)
- Subfamily (-virinae)
- Genus (-virus)
  Example:
  family: Herpesviridae/ Subfamily: Herpesvirinae/ Genus: Simplex virus/ it has subdivisions Herpes simplex virus-1 and Herpes simplex virus-2.

♦ Sometimes they named according to the disease they caused
for example:
-Poliovirus which causes poliomyelitis شلل الاطفال
-Rhabdovirus which causes Rabies داء الكلب
- Murine leukemia virus o murine refers to mice that the virus is contracted by it.

♦ Sometimes the viruses are named after the place, the town or the city where they were first identified, example: Coxsackie virus, Sendai virus.

♦ Sometimes they are named after the scientist who discovered them, as in case of Einstein bar virus.

♦ Sometimes they thought to be contracted like Influenza virus , in the old days Influenza used to come epidemic and kill millions of people during the year.

Viral structures*

- There are 5 basic types of viral structure , here we looking about the capsid , in fact there are 3 types of the capsid :
  1- Icosahedral 2-helical 3-complex

But for the helical and icosahedral structures, they might be enveloped or not enveloped viruses.

- The icosahedral structure has 20 triangular faces each is an equilateral triangle.
- The helical structure: this virus structure has a protein capsid which appears in coiled pattern around the DNA or the RNA .

- The complex structure: it consists of several layers of protein and lipid. Pox virus is an example of complex virus; it's one from the largest known viruses.
- The capsid and the envelope.
  CAPSID IS AMUST...all viruses have a capsid.

- Functions of the capsid:
  1- Protection of the genome.
  2- Protection of the enzymes and the proteins (especially proteins and enzymes that help in the replication).
  3 -Aids in the entry process (entry of the virus into the target cell). Both capsid and envelope have a role in the entry process .

- Envelope has proteins (called enveloped proteins), these proteins attach the target cell so they play a major role in the entry process .
- Sometimes the entry viruses don't have protein protection, instead they have sinus (cavity) which interact with the receptors on the target cell to initiate the entry process.

- Note: the building block of capsid is called **capsomere.**

- **<u>Helical Structure</u>**

- it's composed of rod shaped capsomere , they are arranged in one layer forming a hollow or a tube shape after that second layer comes then third and so on .
- The hollow has a room for the nucleic acid in the middle.

- Examples of helical capsid viruses: Influenza virus, Tobacco mosaic virus.

- **<u>Icosahedral structure</u>**

- It consists of 20 faces with 12 corners, each face is composed of small building units which make up the capsomere they are called protomeres.
- When protomeres come together at the 5 corners they make up capsomere.
- In helical structure there are no protomeres making capsomeres (just capsomere by itself).
- Capsomeres are made of 5 or 6 protomers coming together
- When it's composed of 5 protomeres coming together → called pentamer.
- When it's composed of 6 protomeres coming together → called hexamer .

- Each capsomere mainly made of one protein or several proteins. Capsid is made of one type of proteins or multiple types.

- **<u>Complex structure</u>**

- There are two examples:
  1 -**Pox virus**: it's one of the largest viruses; it has fibers on the surface and layers of lipoprotein inside.
  2 -**Bacteriophage**: it is the virus that infects bacteria. It has a combination of icosahedral (the head) and helical (the tail) structures. It has fibers to attach the bacteria cell, when it attaches

the bacterial cell, the nucleic acid within the head is injected from the helical body into the bacteria cell.

- **Classification of viruses based on :**

1) Nucleic acid: RNA or DNA
2) Capsid: helical or icosahedral or complex.
3) Presence of envelope: naked or enveloped
4) Replication strategies.

- There is another classification that based on nucleic acid which is segmented virus or not segmented. (Seen mainly by RNA viruses).

  Most times RNA is continuous and each gene of it is encoded within a segment of this continuous RNA, but in the segmented genome each segment of RNA encode for one protein or genome.

  Example of segmented viruses: Influenza virus, Rotavirus (which is responsible of gastroenteritis and it's the most common cause of severe diarrhea among newborns) .
- Linear or circular
- Double stranded (one positive and the other negative) or single stranded especially in RNA.
  Positive sense they found certain RNA can behave directly as m-RNA attached to the ribosomes and make protein.
  Negative sense is the complimentary or antisense.