



Microbiology

Lecture No:3 (virology 1)..

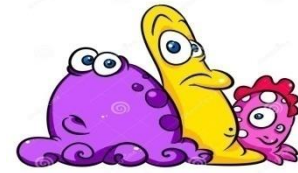
Dr Name:Hamed Alzoubi..

Done by:Alaa Taha Roto...

Sheet Slide



Virology



Let's know some information about the history of viruses:

Before 3000 years ago :

-If you look to the picture to the right, you'll see a Hieroglyphic drawing. Notice the man's dropped right foot. This is a symptom for Poliomyelitis which is caused by Poliovirus, and nowadays we have vaccines for it.



(Poliomyelitis) شلل الأطفال

-Ramses V which had smallpox caused by poxvirus.



Up till few months ago :

Ebola virus outbreak in West Africa. Ebola is a deadly virus and have killed many people . Dead bodies are left in the streets because people are afraid being infected .

So the idea is that viruses were present long time ago , and until today they have caused many diseases.

But don't worry as most viral infections are simple (mild fever) or asymptomatic , and many vaccines have been invented .

Asymptomatic means there is a virus in your body ,but you don't feel that it is present , because it causes no symptoms (silent virus).

What people think about viruses through history :

- Divinely created : the devil spirits created them .
- Outer space : space creatures created them .
- Conspiracy theory :
People thing that viruses are man made when he tries to create a treatment , he creates a pathogenic factor ☹ .

Nice info:

Conspiracy theory

It is an explanatory proposition that accuses two or more persons, a group, or an organization of having caused or covered up, through secret planning and deliberate action, an illegal or harmful event or situation .

-more speculations :

The future is opened for more speculations .

Beginning of viruses :

There was a wrong thought that viruses were simple free living creatures and the earliest creatures on earth .

But after researches, they found that viruses are intracellular parasites .They can't be alive , replicate or cause a disease without a host living cell .

So, they are not the earliest form of life .

Virology :

-It is the branch of microbiology that studies viruses (their structure, classification, nomenclature and replication) .

-It started to evolve in the late 19th century , after the discovery of the EM; because as you know viruses are too small to be seen with LM .

-Virology developed after bacteriology , because bacteria is bigger and could be seen using LM .

- late 19th century , two scientist prove that infiltrable agents cause diseases to plants and animals .

-To prove that , they extracted a fluid from tobacco plant which was infected by *tobacco mosaic virus* . They wanted to purify the fluid from the infectious agent , which they thought to be bacteria. So they filtered it using a filter that has too small pores that retain bacteria . Then , they transmitted that fluid to a healthy plant and the plant was infected.

-So there must be a thing that is smaller than bacteria and managed to pass through the pores of the filter and that's why the plant was infected .

-This thing was a virus , and that's why it was named a Virus (poisonous fluid) .

Virus studying :

Viruses can't be grown in a culture media like the ones used to culture bacteria .

In bacteria culture , we put Agar medium in a Petri dish and after hours or days ,you will notice white dots and colonies of bacteria by your eye .

So what to do to study viruses ?!

- The idea was to infect animals and plants and observe the effect , but it was an expensive way and not reproducible. Also, it is against animals' rights. (in vivo)
- In 1950s tissue culture and antibiotics were discovered. So , they cultured a certain tissue and added antibiotics to kill bacteria to prevent contamination of the tissue and let the virus grow to study it under the EM. (in vitro)

❖ Nice info :

- Antibiotics : drug against bacteria.
- Antiviral : drug against viruses .
- Anti chemotherapy: it can either be antiviral or antibiotic.

Sometimes anti chemotherapy refers to just the antibiotic one.

-Later on, the development of molecular biology (isolation , cloning and expression of viral genetics) helped a lot in the understanding of viruses .

-Virology has developed greatly to the extent that some viruses were constructed in the lab (in vitro) using chemicals, like Spanish flu virus (which killed millions of people in the 1st and 2nd world war) and Poliovirus

Structure and general features of the virus :

This is very important for identification and to know how to fight this enemy .

For example :

If you know that the virus has an envelope (lipid bilayer) it will be sensitive to alcohol, you will easily kill it by alcohol and washing your hands by detergents, and heat .

-Some viruses have spikes that help it to attach to cells and penetrate through them . So if you know the structure of these spikes , you'll prevent it from attaching to the cell and prevent infection .

-Moreover , if you know how a virus replicates , you can interfere with its replication .

General features :

- i. Extremely small , their size is measured by nm (20-300 nm in diameter) ,while bacterial size is measured by micro meter (μm) ($1\mu\text{m} = 1000 \text{ nm}$).They are infilterable.
- ii. Genome : The virus has either DNA or RNA but never ever both .
- iii. It is metabolically inert / inactive as there is no mitochondria , cytoplasm or ribosomes to build proteins . That's why it needs to invade a living cell and make it follow its orders for the virus's own replication . It kidnaps the cell and makes it a virus factory by using cell's replication mechanisms . That's why it is a parasite , hurting the cell and using its contents to cause infection .

Structure :

Imagine an orange , it has seeds , pulp and an orange sheath.

- The seeds are the genetic material.
- The pulp is the capsid.
- The orange sheath is the envelope (in some types of viruses)



Let's take a closer look to each component :

1 – The genetic material:

It can be either DNA or RNA .

Single stranded or double stranded

Segmented or single molecule .

Linear or circular .

What is common ?

For DNA → All DNA viruses are double stranded.

Always single molecule

EXCEPTION : **Parvoviruses** which has ss DNA .

Parvovirus is a dangerous virus that infects the fetal and causes abortion , or causes encephalitis (problems in the brain).

For RNA → All RNA viruses are single stranded.

{ EXCEPTION : Reoviruses (ds RNA)}

Could be single molecule or segmented

RNA Viruses that have segmented one :

Orthomyxoviruses ... like influenza virus (by the way , it is SS RNA)

Reoviruses like Rotavirus (ds RNA) , which is very common in children (2-3 years), causing diarrhea and vomiting especially in winter .

- Usually viral genome is one copy (Haploid genome) except in Retroviruses there are two copies of their RNA genome (Diploid) , like HIV virus it has two copies , and it is responsible for AIDS disease.

Two terms are used to describe RNA polarity :

Positive : the virus's RNA is similar (structure or sequence) to the mRNA of the host cell , so the cell's ribosomes will recognize it as mRNA and translate it directly .

Negative : it shows opposite symmetry to mRNA (as a mirror images of each other) , so the cell will not translate it directly (it is not infectious

directly) . The virus is really evil and is well packed up, it has a special enzyme (RNA polymerase) that copies it into positive one . The ribosomes will translate it and now it is infectious .

**NOTICE****Reo virus:**

- 1- Double stranded RNA
- 2- Segmented negative RNA

Retro virus : like HIV

- 1- SS positive RNA , yet it has enzyme (reverse transcriptase)
- 2- Has a diploid genome

Genomic size :

RNA is smaller and more fragile than DNA

Genomic size is measured in kilos .

If the virus is SS ... we use Kb (kilobase)

If it is ds ... we use kbp (kilobase pairs)

Capsid:

It is made of structural proteins that are encoded in the genetic material .

Function:

It is there to protect the genetic material which is very delicate .

It mediates attachment to the cell .

Its subunits are capsomers (spherical polypeptides) .

We have 3 types of geometry that these capsomeres could make :

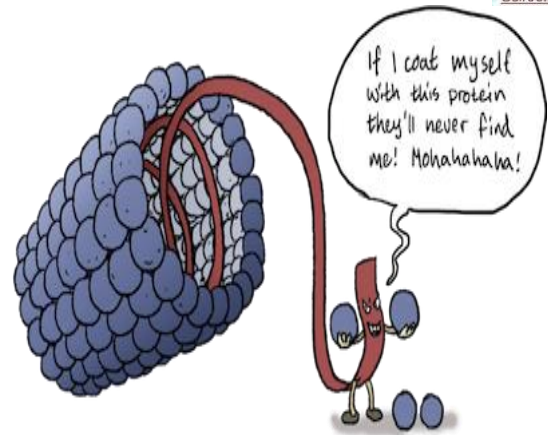
- 1- Helical (rod shaped)
- 2- Icosahedral (spherical)
- 3- Complex .

Helical symmetry :

The capsomers are arranged like the steps of spiral staircase .

In the core , the genome is hidden

It is like the shape of the spring .

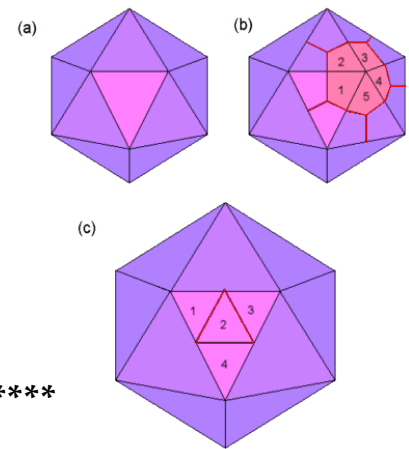


Icosahedral symmetry :

Polyhedral (many triangular faces) and it is hard to imagine as the Dr. said .

It has 20 triangular faces , if you know that the simplest icosahedral capsid needs 3 identical subunits(capsomers) to form each triangular face .

Total number = 20 faces X 3 subunits = 60 identical subunit.



Envelope :

It is a lipoprotein .(host cell lipid +viral proteins)

When the virus ends its replication and it is getting out of the cell , it takes a bunch / piece of the cellular membrane .

So , this envelope may contain **glycoproteins** , they are used :

- As spikes , for attachment of the cell . Each virus has a name for its spikes in order to differentiate between them .

Like in flu virus .. it has two types of spikes : Hemagglutinin and Neuraminidase. (I don't think the name is important)

- Channels : like M2 channels in influenza .

The protein between the capsid and the envelope is called (matrix protein).

Viruses can be divided into two categories according to the presence of the envelope :

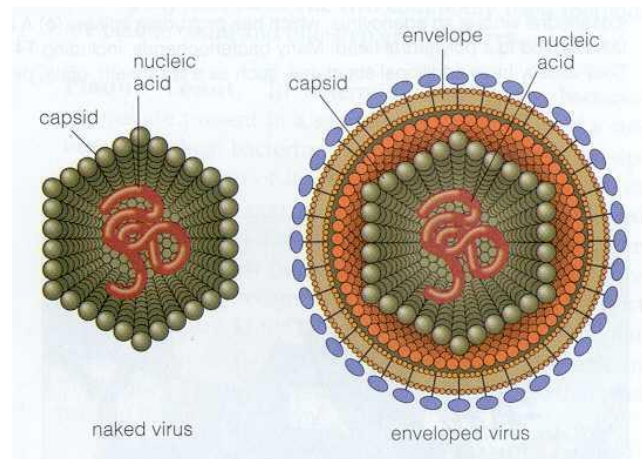
1- Enveloped :

They are surrounded by an envelope and are more sensitive to alcohol, detergents and heat.

They get out the cells by budding or cell lysis.

2- Naked (no envelope) :

These are more resistant than the enveloped , and get out of the cell by cell lysis . For example they might stay on the surfaces for a long time (24h- week) and can cause infection when touched.



-Nucleocapsid with or without envelope = Virion

The doctor said that in the slides he gave an example of enveloped virus (influenza virus) , and for more details , see the textbook.

-Proteins of the virus :

** Structural (the ones composing capsid and the ones that are associated with the genome) .

** nonstructural (transient enzymes that are translated during the replication cycle of the virus inside the living cell) . They are necessary for replication.

Classification :

According to many things :

** Genetic material (DNA ,RNA) (ss, ds) (+ve RNA , -ve RNA)
(segmented , not segmented) .

** capsid : (icosahedral , helical or complex)

** envelope : (present or not)

*** V.I.M.P :

The 3 tables in the slides are very important , please memorize them.

Notes on table 1 : (DNA)

The viruses : 4P 2H 1 A

- ✚ Polyomaviruses ,papillomaviruses , poxviruses , parvoviruses.
- ✚ Hepadnaviruses , herpesviruses.
- ✚ Adenoviruses.
- All DNA viruses' capsids are icosahedral except poxvirus , it is complex .
- All are ds except parvoviruses (ss).
- The ones that have enzymes and envelope are : PHH (pox ,herpes , hepadna)
- Hepatitis B virus is a member of hepadnaviruses.
- Polyoma and papilloma were called papova as one virus , but now they are separated to polyoma and papilloma .

Notes on table 2 : (-ve RNA)

Viruses' family :Bunya , Arena , Orthomyxo and Paramyxo , Filo (it is negative not positive as written in the book) ,Reo ,Rhabdo and Delta.

- All -ve RNA viruses have ss RNA, Except REO is ds .
- All have enzymes , in order to copy +ve RNA, Except Delta , it is unknown .
- All have envelope., Except Reoviruses.
- All have helical capsid except Delta and Reo , they have icosahedral.
- The ones with segmented RNA are : Bunya , Arena, Reo and Orthomyxovirus .
- Flu virus belongs to Orthomyxoviruses and parainfluenza virus belongs to paramyxoviruses .

- Rabid dogs are infected by Rhabies virus that belongs to rhaboviruses and causes rabies.
- Delta causes hepatitis D . We have five types of hepatitis (A,B,C,D,E).

Notes on Third table : (+ve RNA) :

The viruses families: Corona , **Picorna** ,Toga ,Hepe , Flavi ,Calici ,Retro , Astro . (قافية) ☺

- All have icosahedral capsid except corona (helical).
- All have no enzymes except Retroviruses . Retro has reverse transcriptase enzyme , which is used to make complementary DNA for the RNA present . SO it is opposite to the normal transcription . (HIV virus)
- The enveloped viruses are : Retro, Corona,Toga and flavi.
- The ss RNA of the Retroviruse is the only one that is segmented.

Nomenclature of viruses

- 1- The type of disease they cause , like herpesvirus which causes herpes simplex . الحمى
- 2- Acronyms like papovavirus (which includes polyoma and papilloma) or picornavirus (picro :small ; rna Ribonucleic acid)
- 3- Discoverers (EBV ...Epstein - Barr virus)
- 4- The isolation place (Coxsackie or Marburg)
- 5- Morphology (corona , its spikes are coronal like the crown)

Range of viral diseases :

Very wide ... From asymptomatic to death

What is the difference between tissue tropism and host specificity ?

*Tissue tropism : Affinity to the organ . For example

Rabies affects the brain

Hepatitis affects the liver

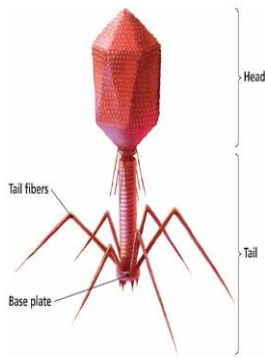
* specificity : infecting specific host ; like :plants, animals...etc .For example measles virus only affects humans.

-Many syndromes can be caused by the same virus.

- Many viruses may cause the same syndrome , like respiratory syndromes .

If someone has a sore throat , mild fever, cough and runny nose ... you may say that the virus is Rhinovirus , or influenza or parainfluenza.

So , same syndrome but different viruses .



Bacteriophage

Viruses infect bacteria and it is used in vitro in diagnosis and therapeutic issues .

Viroids

They are short ss RNA viruses , infecting plants usually (plant pathogen) .

They don't have capsids .

HDV : (Hepatitis D virus) : human pathogen

It is similar to viroid , as it is just genetic material (ss RNA), and needs the help of HBV (hepatitis B virus) in order to work. Hepatitis B virus must be present with Hepatitis D virus , but vice versa is wrong .

D requires B as a helper (co) , it needs it to be able to propagate and infect humans .That is called co-infection .

Be careful !!! ☹️

The most susceptible to get infected with HBV are doctors . When you take a blood sample from a patient , don't even think of returning the cap on the needle , through it directly in the basket .

Nowadays , there is a vaccine against HBV , but the risk is still there ;as HCV is also transmitted through blood .

Prions:

It is a proteinaceous material, but infectious !!

It is a mutation in a gene (on chromosome 20) , changing the protein from one form to another .The new form is called PrP SC (scarpie) , this new form will form aggregates and deposits in the brain (it is toxic). It will lead to CJD (creutzfeldt Jakob disease) in humans . And it will also cause encephalopathies and dementia.This cause is called sporadic (because of chromosomes) .

For Each million person, we will have one case , in Jordan for example : 7 millions ... seven cases.

Transmitted (acquired) either by:

- The cause may be iatrogenic . Doctors are responsible for that, when they do a surgery on the appendix , tonsils or the brain, they must not clean the equipments they have used , they must use new ones to avoid transporting the disease.Or through blood.
- Ingested .. like in Kuru (tribes in Africa) .

They have very bad habits in dealing with dead people, they eat them .

Men eat limbs , while children and women eat the brain (sign of appreciation (OMG !!!)) so they are infected more than men.

Or it can happen by eating infected animals.

- Inhertid.

Diagnosis :

Biopsy after dying.

EEG .. Electroencephalogram.

Treatment :

No treatment .

Symptoms are variable .

What is the difference between viroids , viruses and prions ?

- Viruses have capsid and genetic material (may have envelope) .
- Viroids have just genetic material (which is RNA), but no capsid .
- Prions are just proteins , and don't have a genetic material .

Good luck for all :D





