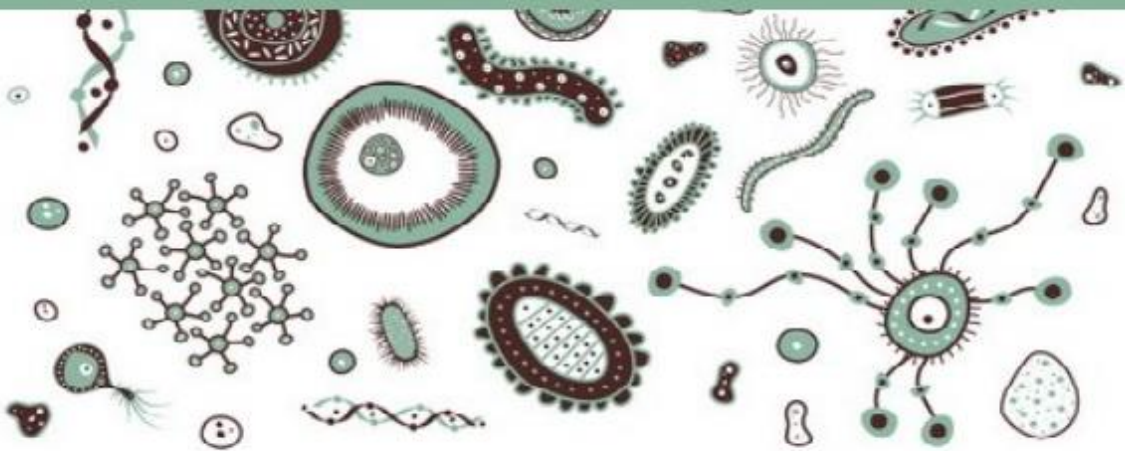




Microbiology



☒ Sheet

☐ Slides

Number : Virology-2

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Subject: Virus Classification

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Virology lecture 2

Revision:

Icosahedral capsids are characterized by having **20 sides with 12 corners**. When we say 20 sides , that means 20 equilateral triangles .These sides meet at 12 corners.

The building units of icosahedral capsids are **protomers** which represent inside the equilateral triangles and the number of protomers depends on the size of virus. If the virus is large , the number of protomers is more. If the virus is small, the number of protomers is going to be less.

In icosahedral capsids , 6 protomers (hexamer)meet inside the equilateral triangles (sides) or 5 protomers (pentamer) meet at the corners , both of them (hexamer and pentamer) are called **capsomers**.

each capsomer may compose of one type of protein or more than one type.

You have to notice that the building units in helical capsids are capsomers NOT the protomers.

Q1: Give me one example for an enveloped helical virus and enveloped icosahedral virus.

Answer:

Influenza virus is an enveloped helical virus while hepatitis B virus is an enveloped icosahedral virus.

Q2: what are the DNA viruses?

Answer:

7 viruses ; 2 H , 1 A and 4 P

H , A and P mean that the virus name begins with these letters.

(their names are mentioned in Q3 below)

Note:

All DNA viruses have an icosahedral capsids except for poxvirus which has complex capsid.



Q3: Among the DNA viruses, which of them are enveloped and which of them are naked?

Answer:

The 2 H(Herpes and Hepatitis B) are enveloped, the 1 A(Adenoviridae) is naked and papovaviridae , parvoviridae and polyomaviridae are naked while poxvirus is enveloped.

Notes:

General rule: if the virus is naked , it is most probably icosahedral .

General rule: RNA viruses can be helical or icosahedral, if the RNA virus is helical , it is enveloped. If the RNA virus is icosahedral, it is naked.

These general rules are not correct 100% , just to facilitate memorizing the classifications.

Complex viruses: they have special structures such as: poxviruses, which lack normal capsid , have layers of lipoproteins and fibrils on surface without helical or icosahedral capsids.

Another example of complex viruses is bacteriophages that have polyhedral head, helical tail and fibers for attachment. The genetic material from the head of virus is transferred to bacteria by injecting them.

(Revision is over)

Classification of viruses:

1. Nucleic Acid: DNA or RNA virus

a) The genetic material could be ***non-segmented*** (genome is continuous) or ***segmented*** (composed of segments where each segment represents one gene and code for only one protein)

- **General Rule:** All viruses are non-segmented, except for two viruses : 1. Influenza Virus: 8 segments

2. Rota Virus: 11 segments



Note: Rota virus belongs to **reoviridae family** which is RNA family .

Retroviridae is RNA family such as: HIV virus. Rota virus causes ***gastroenteritis*** specially in infants.

b) Linear or Circular:

c) Single Stranded or Double Stranded:

- **General Rule:** All DNA viruses are double stranded expect for ***Parvo Viridae family*** which has single stranded DNA.
- **General Rule:** All RNA viruses are single stranded except for ***Reo Viridae family*** (Rota virus) which is double stranded RNA.

d) Positive or Negative sense for single stranded RNA:

Positive sense : means RNA acts like mRNA and goes to ribosomes to be directly translated.

Negative sense : is not like mRNA and thus cannot undergo translation, it must be transcribed into a positive strand to give a complementary strand to mRNA and this complementary strand undergoes translation.

2.Capsid: Icosahedral, helical, complex

Example on complex: the bacteriophage has an icosahedral head and a helical body.

Pox virus has a box shaped envelope

3.Envelope: Naked or enveloped virus.

Viruses have two types of proteins (viral coded proteins):

1. Structural (spikes or glycoproteins which are embedded in the envelope and capsid) .
2. non-structural proteins (enzymes).



Envelope is acquired from the cell membrane of the host cell as a general rule. Exception for:

1.Herpes Viridae: acquire their envelope from the *nuclear membrane*.

2.Pox viruses: acquire the envelope from the *Golgi apparatus*.

Fate of the cell when an enveloped virus attacks:

At the beginning the cell is going to compensate this loss in the membrane by regenerating but once the virus replication has become at a very high rate the cell won't be able to compensate the loss and it will be lysed. Ultimately it's going to die.

The envelope contains more than one virally encoded proteins: glycoproteins (spikes).

Main role of these proteins is **attachment**.

influenza virus for example has more than one glycoproteins or spikes :**HA(influenza hemagglutinin)** and **NA(influenza neuraminidase)** . **HA:** has an important role in attachment and facilitating the entry of the virus into the target cell (adsorption step).

Note:

If the virus loses its envelope it becomes weakened because the envelope plays an important role in entry of virus into the cell.

Which is more harmful naked or enveloped viruses?

Naked; they can tolerate tough conditions such as heat, dryness, acidity, whereas enveloped viruses cannot.

Release of enveloped viruses happens one by one (one virus at a time ; the number of viruses increases with time), while naked



viruses are released by lysis of the cell, they continue replicating until the cell is exhausted so lysis happens and all viruses rush out of the cell together at the same time.

General Rule: Almost all viruses that infect the GI or gain entry through the GI and infect other locations will be naked viruses because if an enveloped virus enters the GI it will be phased with the high acidity of the stomach affecting the envelope, the virus will lose the envelope and it will do no harm after the loss.

How do these viruses enter the GI?

Through the fecal-oral route. (Fecal from feces, oral through mouth) . Contaminated fomites, food or water by feces and this feces is contaminated by the virus.

NOTE:

The naked virus can cause local infection to GI tract: gastroenteritis (stomach flu). Or infect somewhere else like in Hepatitis A: gains entry through the GI (it's a naked virus, it can survive the acidity) but it goes to the liver and causes infection there.

4.Replication Strategy:

1. dsDNA viruses
2. ssDNA viruses
3. dsRNA viruses
4. (+) sense ssRNA viruses (RNA behaves like mRNA)
5. (-) sense ssRNA viruses (RNA needs a complementary strand to be translated)



6. RNA reverse transcribing viruses: HIV is a RNA, positive single stranded virus (retroviridae) , however, it doesn't behave like viruses in class 4.
7. DNA reverse transcribing viruses: Hepatitis B is a DNA , partial double stranded virus , however, it does not behave like viruses in class 1.

Note:

The common between class 6 and class 7 is that the viruses have the reverse transcriptase enzyme.

“ ds” : double strand , “ss” : single strand .

Sub-viral Agents:

- They share some characteristics of viruses.
- Cannot be seen by the microscope.

1. Satellites

- Contains nucleic acid and could have a capsid but it cannot replicate by itself it needs the help of another virus (helper virus).

Example: Hepatitis D which is not a virus by itself lacking a structure that allows it to enter the target cell. This ability is given to Hepatitis D by the Hepatitis B virus. Hepatitis D takes a part of the surface proteins found on Hepatitis B virus, only then it can enter the cell.

- The infection could come in:
 1. **Co-infection**: Both hepatitis D and hepatitis B infect the same human cell at the same time.
 2. **Super infection**: A percentage of patients (10-15%) who become infected by Hepatitis B might never recover from it and become chronic carriers. Those patients are at a higher of getting infected by Hepatitis D because delta virus (hepatitis D) requires a certain



structure found on hepatitis B, hepatitis B is already present so if delta virus gains entry to the body ,it finds the missing structure and begins the infection.

Note: Viral infections often lead to bacterial superinfections (this is different the super infection above) which causes reduced immunity in the body.

2. Virioids:

- In common with viruses: single stranded circular RNA, capable of infecting plants only and capable of replication.
- They are unencapsidated (without capsid).

3.Prions

- They do not have genetic material, no capsid, they're only infectious proteins e.g. BSE (Bovine spongiform encephalopathy) (جنون البقر)
- can infect humans and animals.
- **Bovine spongiform encephalopathy (BSE)**, commonly known as **mad cow disease**, is a fatal neurodegenerative disease in cattle that causes a spongy degeneration in the brain and spinal cord.

- ***In Humans:***

We have prion proteins in our bodies what we call the normal proteins, once it comes in contact with abnormal infectious prion proteins from either an ***endogenous source*** (mutation in the normal protein) or exogenous sources:

1.like eating a cow's meat infected with prions.

2. Poorly cleaned surgery equipment (prions cannot be decontaminated)



3. Old rituals where people eat the brains of loved ones.

So when the normal prion proteins comes it contact with the abnormal prion, it's structure will be changed to the abnormal form, loses its function and forms aggregates.

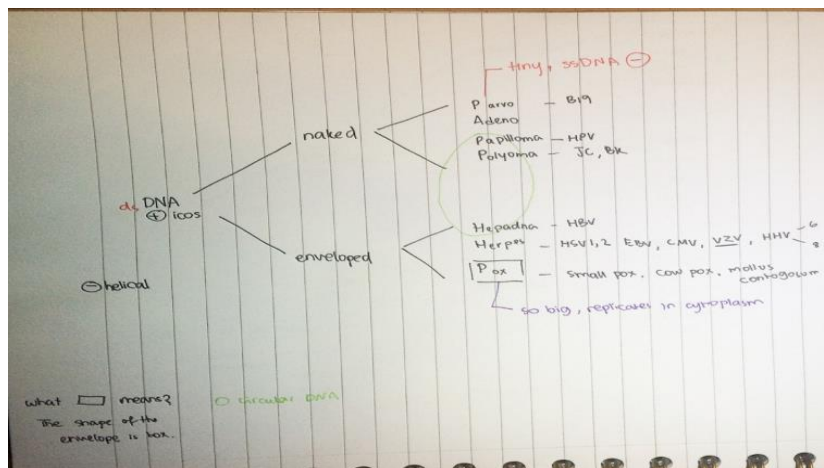
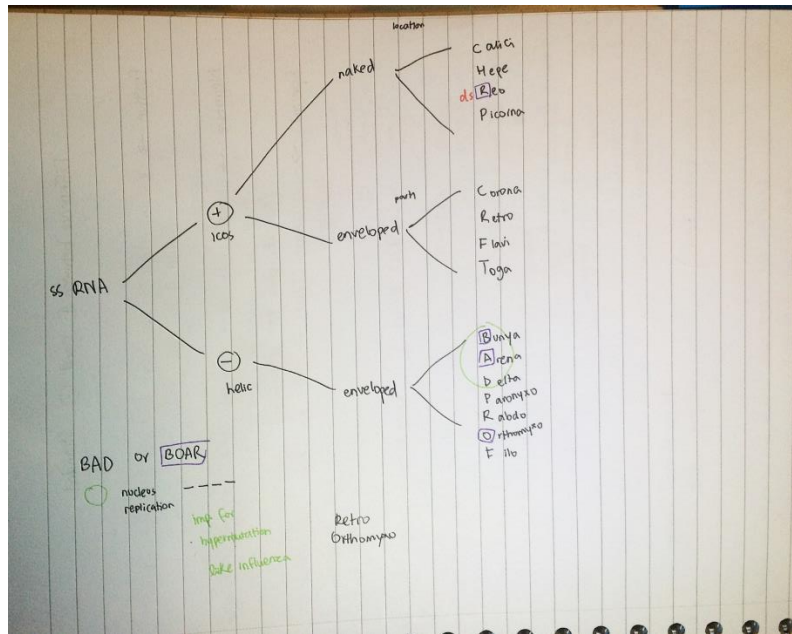
- kuru & Creutzfeld-Jakob Disease (CJD) in humans.

PrP ^c	PrP ^{Sc}
The normal protein	The abnormal protein
Transmembrane glycoprotein, binds Cu ⁺⁺	PrP ^{Sc} for scrapie; same a.a sequence of PrP ^c
Dominant alpha helix secondary structure	Dominant Beta sheets secondary structure
Monomeric and easily digested by protease.	Multimeric and resistant to proteases

Note: Retro Viridae, its genus is HIV. Reo Viridae, its genus is Rota.

General Rule: All positive single stranded RNA are icosahedral , while all negative single stranded RNA are helical.





The end