University of Mosul
Lecture No.:
College of Veterinary Medicine
Date:
Unit of Scientific Affairs
Website:

Lecture title: Viral shape structure

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Nucleocapsid is the arrangement between the viral nucleic acid genome with the capsid, this connection controlled by specific NA genetic information leading to different types of symmetry. Accordingly viruses can classified in to four symmetry structures.

1. Helical symmetry.
2. Cubical symmetry.
3. Binal symmetry.
4. complex symmetry.

1. Helical symmetry

This form can be seen in RNA viruses, that the capsomers surrounded the N.A in spiral or helical manner to give helical symmetry which may be seen naked (TMV) or enveloped in ND & Rinderpest viruses. When the tubular nucleocapsid presented in coil form and surrounded by lipoprotein envelope containing peplomers which is glycoprotein projections (also called spikes) which represent haemagglutinins and neuraminidases but in rabies virus the capsid is straight and surrounded by lipoprotein membrane to give the bullet shape.

2. Cubical symmetry

Many RNA and DNA animal viruses when studied with a method of metal shadowing from two angles by EM, in this method the virus particles have hexagonal outlines with 20 equilateral triangular faces, i.e. icosahedrons, but when these viruses studied by negative stain using phosphotungstic acid which can penetrate even through the finest contours of the viral surface. Many viruses appear to be faceted and each face forms an equilateral triangle consisting of angular arrangement of protein subunits as capsomers. There are generally 20 equilateral triangular faces.

In adeno viruses each side of the equilateral face consists of 6 capsomers linked to each other by divalent bounds. By using special equation to calculate capsomers number which are fixed in number and genetically controlled as the following:

Capsomers NO.= 10 (edge capsomers NO. - 1)^2 +2
= 10 (6 – 1)^2 +2
= 10 ×25 +2 = 252

In herpes viruses where edge capsomers NO. are 5
= 10 (5 – 1)^2 +2
= 10 ×16 +2 = 162

But in less capsomers number, other equation used.

Capsomers NO. = 30 (edge capsomers NO. - 1)^2 +2

= 30 (2 – 1)^2 +2

= 30 ×1 +2 = 32

e.g. for cubical symmetry viruses: adeno and picorna which are naked, herpes and toga which are enveloped.

3. Binal symmetry

This type of symmetry show both icosahedral (cubical) and helical symmetry, but with in the same virion like bacteriophage, when the head is cubical and the tail is helical.

4. complex symmetry

Most animal viruses show either helical or cubical symmetry but pox viruses have exceptional and their ultra structure appears to be complex. Some pox viruses are brick- shaped, while others are ovoid and the DNA is contained in nucleoid, shaped like a biconcave disc and surrounded by one or more membranes.

Negative staining shows that the virion contains a surface layer of hallow tube like fibrils which may give the particles a striated appearance.

In some species of pox viruses e.g. orf virus, the thread appears to be continuous and is arranged in a cross or figure-eight pattern across the surface of the virion giving it the characteristic ball of wool appearance.

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Classification of Animal Viruses

Animal viruses can be classified into several families according to the following characters:

A- Characters of viral nucleic acid (N.A):

1. Type of N.A if it is DNA or RNA.
2. Shape of N.A strand if it is ring or straight, single or double strand, segmented or not….
3. Molecular weight (size &diameter of N.A).
4. Replication site of N.A if it is in the cytoplasm or nucleus of infected cells.
5. Presence of transcriptase enzyme.

B- Characters of viral capsid:

1. Shape & size of capsid.
2. Symmetry of capsid with N.A (Helical, Cubical, Binal, Complex).
3. Site of capsid assembly in side the infected cells.
4. Lipid solvent sensitivity.
5. Number of capsomeres which consisting the capsid.

According to all above characters recently animal viruses classified into two major groups which are RNA group & DNA group as following:

RNA Viruses families:

1. Picornaviridae
2. Orthomyxoviridae
3. Paramyxoviridae
4. Coronaviridae
5. Reoviridae
6. Retroviridae
7. Rhabdoviridae
8. Birnaviridae
9. Bornaviridae
10. Bunyaviridae
11. Togaviridae
12. Astroviridae
13. Arteriviridae
14. Caliciviridae
15. Flaviviridae

DNA Viruses families:

1. Herpesviridae
2. Poxviridae
3. Adenoviridae
4. Parvoviridae
5. Papillomaviridae
6. Asfaviridae
7. Circoviridae

RNA Viruses

1- Picornaviridae

Pico = small in size.

General characters:

a. virions are 18-30 nm in size.
b. replicate in cytoplasm.
c. resistant to many organic solvents (ether, chloroform).
d. Non enveloped, positive-sense, single-stranded RNA viruses with icosahedral symmetry.
e. Individual members differ in their susceptibility to pH change.

Genera of Picornaviridae:

Viruses of veterinary importance in five genera of the family Picornaviridae:

1. Aphthovirus: Foot and mouth disease which have seven serotypes & more than 260 subtypes, unstable at PH values below 6.5.

2. Enterovirus:
   - Avian enterovirus cause avian encephalomyelitis, nephritis in chickens & hepatitis in ducks & turkeys.
   - Bovine enteroviruses cause respiratory &reproductive disease.
   - Swine vesicular disease virus.

3. Cardiovirus: Encephalomyocarditis in Rodents.

4. Hepatovirus: Avian encephalomyelitis-like virus.

5. Teschovirus: Porcine enterovirus (Talfan disease)

2- Orthomyxoviridae

Orthomyxo = Classical mucous

General characters:

a. Spherical or pleomorphic, enveloped viruses, nucleocapsid helical symmetry.
b. 80-120 nm in diameter .
c. Linear, negative-sense, single-stranded RNA.
d. Replication occurs in the nucleus.
e. Genome is segmented facilitating genetic reassortment.
f. Surface projections of glycoproteins from spike or peplomers which is influenza A & B viruses are of two types: a haemagglutinin (H), responsible for virus attachment and envelope fusion,

and a neuraminidase (N) capable of cleaving viral receptors & promoting both entry of virus into cells & release of virions from infected cells.

Genera of Orthomyxoviridae:

1. Influenza virus type A
   Pathogen for human and animals.

2. Influenza virus type B
   Pathogen for human.

3. Influenza virus type C
   Pathogen for human.

4. Thogoto virus
   Tick born ARBO virus.

Type A viruses are grouped into subtypes on the basis of their H & N antigens. [16] H antigens & [nine] N antigens are recognized. New subtypes of influenza A virus emerge periodically by two mechanisms; point mutation & genetic reassortment. Point mutations: give rise to antigenic drift in which variation occurs within subtype. Genetic reassortment: amore complex process producing antigenic shift, results in the development of new subtypes. The frequency of genetic reassortment in birds & pigs can lead to the emergence of virulence influenza virus subtypes which are capable of infecting humans & and initiating pandemics.

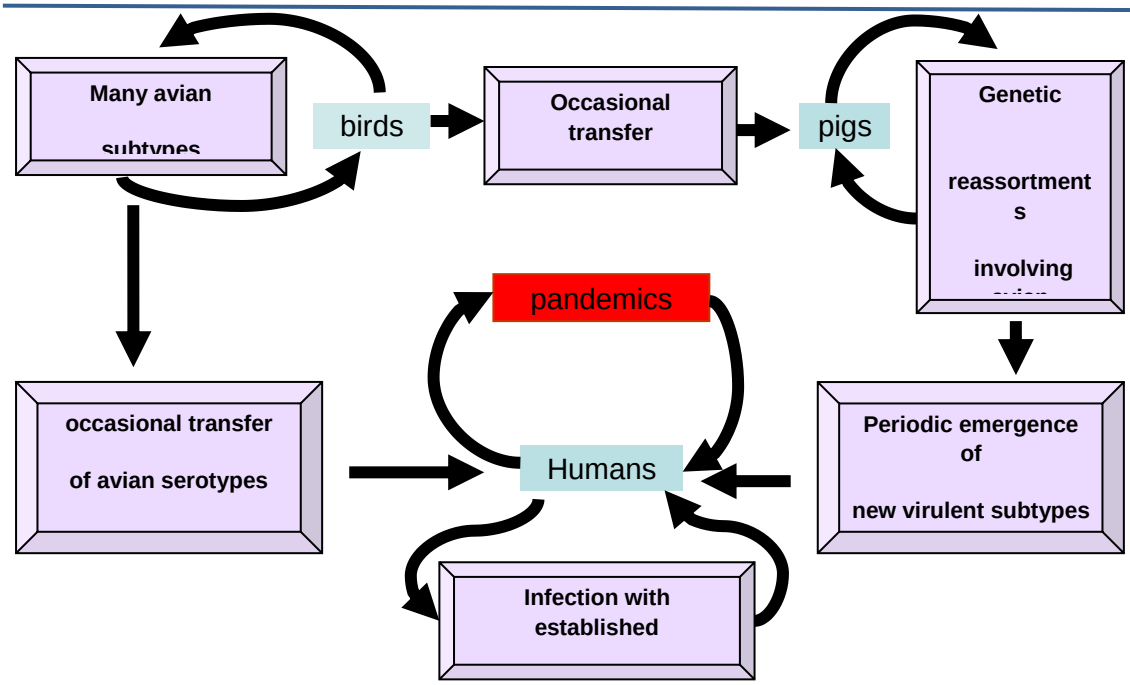

Figure 1 Flue Pandemic