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Anshul Jain

14th Edition

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CHAPTER 2

Basics of Virology

DEFINITIONS

Virion	• Extracellular infectious virus particle
Capsid	• Protein coat that protects nucleic acid.
Envelope	• Lipoprotein coat which surrounds some virus particles. Lipid is of host cell origin while protein in the form of peplomers is virus coded.
Viroids	• Subviral infectious agent which is protein free and consist of low molecular weight RNA ***(mostly double stranded, small RNA).*** It is resistant to heat and organic solvents but sensitive to nucleases.
Prion	• Proteinaceous infectious particles causing chronic neurological degenerative disease of human

Virus is obligate intracellular parasite, without cellular organization and contains only one type of nucleic acid either DNA or RNA but never both. So classified as:

	CAPSID	VIRION	NUCLEIC ACID	VIRUS FAMILY	MEMBERS
DNA VIRUS					
I.	Icosahedral	Naked	SS (-ve)	Parvoviridae	B-19 parvovirus
II.	Icosahedral	Naked	ds circular (±)	Papovaviridae	Papilloma virus, JC, BK virus, polyomavirus
III.	Icosahedral	Naked	ds (±)	Adenoviridae	Human adenovirus
IV.	Icosahedral	Enveloped	ds with ss (±) circular	Hepadnaviridae	HBV
V.	Icosahedral	Enveloped	ds (±)	Herpesviridae	VZ; HSV I, II; CMV; EBV
VI.	Complex	Complex coats	ds (±)	Poxviridae	Variola (small pox) Molluscum contagiosum
RNA VIRUS					
I.	Icosahedral or (cubical)	Naked	SS (+)	Picornaviridae	Polio, Coxsackie, Entero, Rhino, HAV
II.	Icosahedral	Naked	SS	Astroviridae	Human Astrovirus
III.	Icosahedral	Naked	SS (+)	Caliciviridae	HEV, Norwalk
IV.	Icosahedral	Naked	ds segmented (±)	Reoviridae	Rota, Reo, Orbivirus
V.	Icosahedral	Enveloped	SS (+)	Togaviridae	Rubella virus
VI.	Unknown or complex	Enveloped	SS (+)	Flaviviridae	HCV, HGV, Yellow fever, Dengue virus
VII.	Unknown or complex	Enveloped	SS (-) segmented	Arenaviridae (sandy appearance)	Lassa fever virus
VIII.	Unkonwn or complex	Enveloped	SS (+)	Coronaviridae	Corona virus
IX.	Unknown or complex	Enveloped	SS diploid (+)	Retroviridae	HIV 1, 2; HTLV I, II; slow virus group
X.	Helical	Enveloped	SS (-) segmented	Orthomyxoviridae	Influenza A, B, C
XI.	Helical		SS (-) segmented	Bunyaviridae	Hantavirus, Sandfly fever virus
XII.	Helical	Enveloped	SS	Bornaviridae	
XIII.	Helical	Enveloped	SS (-)	Rhabdoviridae	Rabies virus, Vesicular stomatitis virus
XIV.	Helical	Enveloped	SS (-)	Paramyxoviridae	Parainfluenza, RSV, Mumps, Rubeola, New castle virus
XV.	Helical	Enveloped	SS (-)	Filoviridae	Marburg virus, Ebola virus

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Mnemonic:

- Segmented Nucleic acid
  = **'PARBO virus'** = **P**icornaviruses, **A**rena, **R**eo, **B**unya, **O**rthomyxovirus
- Enveloped virus are sensitive to ether, chloroform, bile salts while non-enveloped are resistant
- All RNA virus are enveloped except **'PARC'** = **P**icorna, **A**stro, **R**eo, **C**alciviridae

- **Viruses with both DNA and RNA:** – **R**etrovirus
  – **L**entivirus
  – **H**BV
- **Complex capsid:** – **P**ox
  – **B**acteriophage
- **Shapes:**
  - *Bullet shaped :* Rabies virus
  - *Brick shaped* :– Pox virus
  - *Rod shaped :* Tobacco mosaic virus
  - *Space vehicle* : Adenovirus
- Smallest size virus : Parvovirus
- Largest size virus : Filoviridae > Pox viridae
- Virus with smallest genome: Circoviridae
- Virus with largest genome: Pandoraviruses

HEMAGGLUTINATION (HA)

- It is agglutination of erythrocytes by virus.
- It is unstable in myxovirus because *Neuraminidase (RDE- receptor destroying enzyme)* cause reversal of hemagglutination called as ***Elution.*** RDE also produced by cholera vibrios and many vertebrate cells.
- In other viruses HA is stable.
- In arbovirus, it is reversible by variation in pH and temperature.
- HA measures total quantity of virus.
- HA of *human* RBC is seen in - **R**eo, **I**nfluenza, **P**ara-influenza, **E**ntero and some cox and ECHO, **M**umps.
  Mnemonic: **RIPE Mango**
- HA also seen in measles, toga, rhino, rabies, pox, adenovirus.

POCK ASSAY

Used for quantitative infectivity assay of viruses [also done by plaque assay] since each infectious virus particle can form one pock, for example, variola, vaccinia, HSV, Pox (Monkey, Cow, Camel).

PHAGE ASSAY

- Used for titrating number of viable bacteriophage and for purification of phages.

PHAGE TYPING

- Used for typing and identification of bacteria, for example, Intraspecies typing of S. typhi (by using Vi antigen) and S. aureus; species specific bacteriophage of B. anthracis, MukerJee's phage IV for classical V. cholerae.

VIRUS MULTIPLICATION

- Critical step in viral biosynthesis is transcription of mRNA from viral nucleic acid.
- **DNA virus** synthesize nucleic acid in host cell **nucleus** except pox which synthesis all their components in host cell cytoplasm.
- **RNA virus** synthesize nucleic acid in **cytoplasm** except orthomyxo, some paramyxo and retrovirus which synthesize partly in nucleus.
- **Viral protein** is synthesized only in cytoplasm.
- Herpes and adeno assembled in nucleus while picorna and pox are assembled in cytoplasm.
- **Envelop:** Lipoprotein envelop, proteins are synthesized in cytoplasm whereas lipid is derived from cell membrane.

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ABNORMAL REPLICATIVE CYCLE

Von Magnus Phenomenon: High hemagglutinin but low infectivity due to defective assembly or incomplete virus e.g. *Influenza virus.*

Abortive Infection: Defect in the type of cell (non-permissive cell) not in the parental viruses, which lead to defective maturation or assembly.

Defective virus: Genetically defective virus which are incapable of producing infectious daughter virions without the helper activity of another virus, e.g. Rous sarcoma virus, Hepatitis D Virus, adeno-associated satellite virus (dependovirus), Measles virus from SSPE, etc.

VIRAL INTERACTION

- ***Genetic Interaction*** – occur in virus by:
  - *Mutation:* Occur during every viral infection. Most mutation are lethal.
  - *Recombination*: Occur when two different but related viruses (both active or both inactive or one active and one inactive) infect a cell simultaneously. It leads to cross reactivation/marker rescue; multiplicity reactivation and formation of pseudovirion.
- Non-Genetic Interaction
  - Phenotyping mixing: transcapsidation occurs
  - Genotyping mixing
  - *Complementation*
  - *Interference*: Infection of a cell by one virus inhibits simultaneous or subsequent infection by other virus. Most important mediator is Interferon, a soluble cellular product.
    - It is applied in controlling polio outbreaks by introducing live attenuated polio vaccine.
    - It can be produced by receptor destruction as in myxo and enterovirus or by autointerference.

INCLUSION BODIES

It is the most characteristic histological feature in virus infected cells. It is of following types:

a. Intracytoplasmic eosinophilic inclusions:
   - ***Negri bodies*** – Rabies
   - ***Guarnieri bodies*** – Variola (small pox), vaccinia
   - ***Bollinger bodies*** – Fowlpox
   - ***Henderson-Peterson bodies*** – Molluscum contagiosum

b. Intranuclear acidophilic inclusion bodies:
   - ***Cowdry type A*** – Herpes, Chicken pox, CMV, Yellow fever
   - ***Torres bodies*** – Yellow fever
   - ***Cowdry type B*** – Polio virus

c. Both Nuclear and cytoplasmic:
   - ***Warthin Finkeldey*** – Measles

d. Intranuclear basophilic inclusion bodies:
   - ***Cowdry type B*** – Adenovirus

RESPIRATORY VIRUSES

Viruses	Most frequent illness
Rhinoviruses	Common cold
Coronaviruses	Common cold
Respiratory syncytial virus	Pneumonia and bronchiolitis in young children
Parainfluenza viruses	Croup and lower respiratory tract disease in young children
Adenoviruses	Common cold and pharyngitis in children
Influenza A, B viruses	Influenza
Enteroviruses	Acute undifferentiated febrile illnesses
Herpes simplex viruses	Gingivostomatitis in children; pharyngotonsillitis in adults

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VIRUS CAUSING LATENT INFECTION

• Measles	• Hepatitis B virus	• Hepatitis C virus	• Rabies virus
• Human T-lymphotropic virus	• Herpes virus	• Kuru	• Oncogenic virus
• Scrapie	• Human immunodeficiency virus		

REACTION TO PHYSICAL AND CHEMICAL AGENTS

- Stable at low temperature. So for long-term storage, they are kept by frozen at –70°C, by lyophilization or freeze drying but poliovirus do not stand freeze drying.
- All virus are disrupted under alkaline pH. Enterovirus are very resistant to acid pH while rhinovirus are very susceptible.
- Most active antiviral disinfectants are oxidising agents such as H_2O_2, $KMnO_4$ and hypochlorides.
- Chlorination kills most viruses except hepatitis virus and polio virus.

ONCOGENIC VIRUSES		
RNA VIRUSES	**Retroviruses**	
	• Avian leukosis viruses • Murine mammary tumour viruses • Human T-cell leukemia viruses	• Murine leukosis viruses • Leukosis-sarcoma viruses of various animals
DNA VIRUSES	**I. Papovavirus**	
	• Papillomaviruses of human beings, rabbits and other animals • BK and JV viruses	• Polyomavirus • Simian virus 40
	II. Poxvirus	
	• Molluscum contagiosum • Shope fibroma	• Yaba virus
	III. Adenovirus - *Not associated with human cancer*	
	IV. Herpes virus	
	• Marek's disease virus • Epstein-Barr virus • Herpes virus (pan, papio, ateles and saimiri)	• Lucke's frog tumour virus • Herpes simplex virus types 1 and 2 • Cytomegalovirus
V. Hepatitis B and C viruses		

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