Virology Lec. 1 **Date:20-3-2024**

General Properties of Viruses

Viruses are the smallest infectious agents (ranging from about 20 nm to 300 nm in diameter) and contain only one kind of nucleic acid (RNA or DNA) as their genome. The nucleic acid is encased in a protein shell, which may be surrounded by a lipid-containing membrane. The entire infectious unit is termed a *virion* . Viruses are inert in the extracellular environment; they replicate only in living cells. The viral nucleic acid contains information necessary for programming the infected host cell to synthesize virus-specific macromolecules required for the production of viral progeny. The virus infection may have little or no effect on the host cell or may result in cell damage or death.

TERMS AND DEFINITIONS IN VIROLOGY

Schematic diagrams of viruses with icosahedral and helical symmetry are shown in Figure -1 . Indicated viral components are described below.

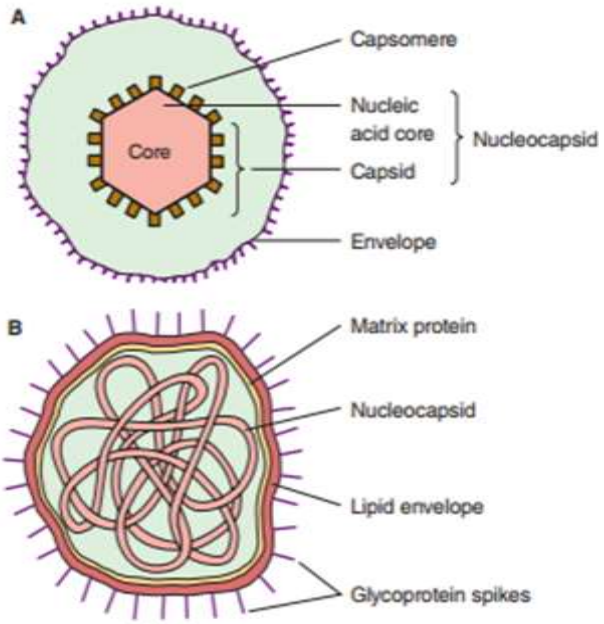

Figure-1 Schematic diagram illustrating the components of the complete virus particle (the virion). **A:** Enveloped virus with icosahedral symmetry. Not all icosahedral viruses have envelopes.
B: Virus with helical symmetry.

Capsid: The protein shell, or coat, that encloses the nucleic acid genome.
Capsomeres: Morphologic units seen in the electron microscope on the surface of icosahedral virus particles.

Capsomeres represent clusters of polypeptides, but the morphologic units do not necessarily correspond to the chemically defined structural units.
Defective virus: A virus particle that is functionally deficient in some aspect of replication.
Envelope: A lipid-containing membrane that surrounds some virus particles. It is acquired during viral maturation by a budding process through a cellular membrane. Virusencoded glycoproteins are exposed on the surface of the envelope. These projections are called **peplomers**.
Nucleocapsid: The protein–nucleic acid complex representing the packaged form of the viral genome. The term is commonly used in cases in which the nucleocapsid is a substructure of a more complex virus particle.
Structural units: The basic protein building blocks of the coat. They are usually a collection of more than one nonidentical protein subunit. The structural unit is often referred to as a **protomer**.
Subunit: A single folded viral polypeptide chain.
Virion: The complete virus particle. In some instances (eg, papillomaviruses, picornaviruses), the virion is identical with the nucleocapsid. In more complex virions (herpesviruses, orthomyxoviruses), this includes the nucleocapsid plus a surrounding envelope. This structure, the virion, serves to transfer the viral nucleic acid from one cell to another.

Prions
Prions are infectious particles composed solely of protein with no detectable nucleic acid. They are highly resistant to inactivation by heat, formaldehyde, and ultraviolet light that inactivate viruses. The prion protein is encoded by a single cellular gene. Prion diseases, called "transmissible spongiform encephalopathies," include scrapie in sheep, mad cow disease in cattle, and kuru and Creutzfeldt-Jakob disease in humans.

CLASSIFICATION OF VIRUSES

Basis of Classification

The following properties have been used as a basis for the classification of viruses.
1. Virion morphology, including size, shape, type of symmetry, presence or absence of peplomers, and presence or absence of membranes.
2. Virus genome properties, including type of nucleic acid (DNA or RNA), size of genome in kilobases (kb) or kilobase pairs (kbp), strandedness (single or double), whether linear or circular, sense (positive, negative, ambisense), segments (number, size), nucleotide sequence, G + C content, and presence of special features (repetitive elements, isomerization, 5′-terminal cap, 5′-terminal covalently linked protein, 3′-terminal poly (A) tract).
3. Genome organization and replication, including gene order, number and position of open reading frames, strategy of replication (patterns of transcription, translation), and cellular sites (accumulation of proteins, virion assembly, virion release).
4. Virus protein properties, including number, size, and functional activities of structural and nonstructural proteins, amino acid sequence, modifications (glycosylation, phosphorylation, myristylation), and special functional activities (transcriptase, reverse transcriptase, neuraminidase, fusion activities).
5. Antigenic properties.
6. Physicochemical properties of the virion, including molecular mass, buoyant density, pH stability, thermal stability, and susceptibility to physical and chemical agents, especially ether and detergents.

7. Biologic properties, including natural host range, mode of transmission, vector relationships, pathogenicity, tissue tropisms, and pathology.

Types of Symmetry of Virus Particles

A. Cubic Symmetry

All cubic symmetry observed with animal viruses is of the icosahedral pattern, the most efficient arrangement for subunits in a closed shell. The icosahedron has 20 faces.

B. Helical Symmetry

In cases of helical symmetry, protein subunits are bound in a periodic way to the viral nucleic acid, winding it into a helix. The filamentous viral nucleic acid–protein complex (nucleocapsid) is then coiled inside a lipid-containing envelope.

C. Complex Structures

Some virus particles do not exhibit simple cubic or helical symmetry but are more complicated in structure. For example, poxviruses are brick shaped, with ridges on the external surface and a core and lateral bodies inside.

CHEMICAL COMPOSITION OF VIRUSES

Protein, Nucleic Acid and Lipid Envelopes

TABLE -1 Families of Animal Viruses that Contain Members Able to Infect Humans

Nucleic Acid Core	Capsid Symmetry	Virion: Enveloped or Naked	Ether Sensitivity	Number of Capsomeres	Virus Particle Size (nm)[a]	Size of Nucleic Acid in Virion (kb/kbp)	Physical Type of Nucleic Acid[b]	Virus Family
DNA	Icosahedral	Naked	Resistant	32	18–26	5.6	ss	Parvoviridae
					30	2.0–3.9	ss circular	Anelloviridae
				72	45	5	ds circular	Polyomaviridae
				72	55	8	ds circular	Papillomaviridae
				252	70–90	26–45	ds	Adenoviridae
		Enveloped	Sensitive	180	40–48	3.2	ds circular[c]	Hepadnaviridae
				162	150–200	125–240	ds	Herpesviridae
	Complex	Complex coats	Resistant[d]		230 × 400	130–375	ds	Poxviridae
RNA	Icosahedral	Naked	Resistant	32	28–30	7.2–8.4	ss	Picornaviridae
					28–30	6.4–7.4	ss	Astroviridae
				32	27–40	7.4–8.3	ss	Caliciviridae
					27–34	7.2	ss	Hepeviridae
					35–40	4	ds segmented	Picobirnaviridae
					60–80	16–27	ds segmented	Reoviridae
		Enveloped	Sensitive	42	50–70	9.7–11.8	ss	Togaviridae
	Unknown or complex	Enveloped	Sensitive		40–60	9.5–12.5	ss	Flaviviridae
					50–300	10–14	ss segmented	Arenaviridae
					120–160	27–32	ss	Coronaviridae
					80–110	7–11[e]	ss diploid	Retroviridae
	Helical	Enveloped	Sensitive		80–120	10–13.6	ss segmented	Orthomyxoviridae
					80–120	11–21	ss segmented	Bunyaviridae
					80–125	8.5–10.5	ss	Bornaviridae
					75 × 180	13–16	ss	Rhabdoviridae
					150–300	16–20	ss	Paramyxoviridae
					80 × 1000[f]	19.1	ss	Filoviridae

aDiameter, or diameter × length.
bds, double stranded; ss, single stranded.
cThe negative-sense strand has a constant length of 3.2 kb; the other varies in length, leaving a large single-stranded gap.
dThe genus *Orthopoxvirus*, which includes the better-studied poxviruses (eg, vaccinia), is ether resistant; some of the poxviruses belonging to other genera are ether sensitive.
eSize of monomer.
fFilamentous forms vary greatly in length.

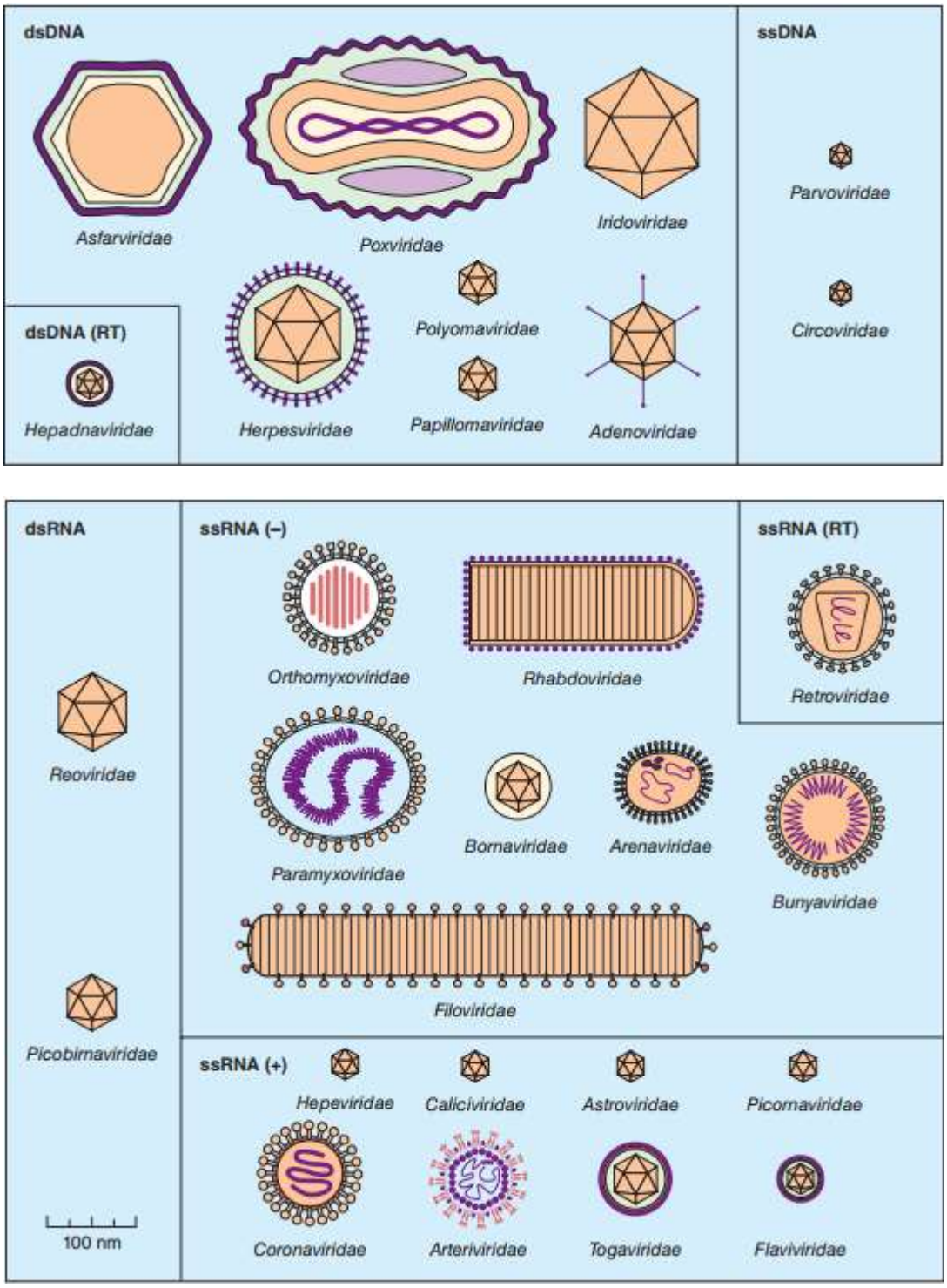

Figure -2 Shapes and relative sizes of animal viruses of families that infect vertebrates. In some diagrams, certain internal structures of the particles are represented. Only those families that include human pathogens are listed in Table -1 and described in the text.

Books:

1. Brooks G F, Carroll K C, Butel J S, Morse SA& Mietzner TA. (2013). Jawetz, Melnick, & Adelbergs, Medical Microbiology, 26th edition. Section II, PP 130-140. The McGraw-Hill Education. U.S.A.

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