Year	Investigator(s)	Event
1892	Ivanofsky	Identification of tobacco mosaic virus as filterable agent
1898	Loeffler, Frosch	Foot-and-mouth disease caused by filterable agent
1898	Sanarelli	Myxoma virus
1900	Reed	Yellow fever virus
1901	Centanni, Lode, Gruber	Fowl plague virus (avian influenza virus)
1902	Nicolle, Adil-Bey	Rinderpest virus
1902	Spruell, Theiler	Bluetongue virus
1902	Aujeszky	Pseudorabies virus
1903	Remlinger, Riffat-Bay	Rabies virus

1903	DeSchweinitz, Dorset	Hog cholera virus (classical swine fever virus)
1904	Carré, Vallée	Equine infectious anemia virus
1905	Spreull	Insect transmission of BTV
1905	Carré	1905 Carré Canine distemper virus
1908	Ellermann, Bang	Avian leukemia virus
1909	Landsteiner, Popper	Poliovirus
1911	Rous	Rous sarcoma virus—first tumor V
1915	Twort, d'Herelle	Bacterial viruses
1917	d'Herelle	Development of the plaque assay
1927	Doyle	Newcastle disease virus
1928	Verge, Christofornoni Seifried, Krembs	Feline parvovirus (feline panleukopenia virus)

1931	Woodruff, Goodpasture	Embryonated eggs for virus propagation
1935	Stanley	Tobacco mosaic virus (TMV) crystallized; protein nature of viruses confirmed
1938	Kausche, Ankuch,Ruska	First electron microscopy pictures– TMV
1939	Ellis, Delbruck	One step growth curve– bacteriophage
1946	Olafson, MacCallum,Fox	Bovine viral diarrhea virus
1948	Sanford, Earle, , Likely	Culture of isolated mammalian cells
1952	Dulbecco, Vogt	Plaque assay for first animal virus– poliovirus
1956	Madin, York	Isolation of bovine herpesvirus 1

1957	Isaacs, Lindemann	Discovery of interferon
1958	Horne, Brenner	Development of negative-stain electron microscopy
1961	Becker	First isolation of avian influenza virus from wild bird reservoir
1963	Plummer, Waterson	Equine abortion virus (herpesvirus)
1970	Temin, Baltimore	Discovery of reverse transcriptase
1978	Carmichael, Appel, Scott	Canine parvovirus 2
1979	WHO	Declares smallpox eradicated
1981	Pedersen	Feline coronavirus

1981	Baltimore	First infectious clone of an RNA virus
1983	Montagnier, Barre-Sinoussi, Gallo	Discovery of human immunodeficiency virus
1987	Pedersen	Feline immunodeficiency virus
1991	Wensvoort, Terpstra	Isolation of porcine reproductive and respiratory syndrome virus (PRRSV)
1994	Murray	Hendra virus isolated
2005	Palase, Garcia-Sastre, Tumpey, Taubenberger	Reconstruction of the 1918 pandemic influenza virus
2011	WHO	Declaration of the eradication of rinderpest
2018		**Nipah Virus outbreak reported from Kerela**

‘Virus’ (Latin, poison)

Important characteristics of viruses which can infect animals.

- Small infectious agents, ranging in size from 20 to 400 nm
- Composed of nucleic acid surrounded by a protein coat; in addition, some contain envelopes
- Contain only one type of nucleic acid, either DNA or RNA
- Unlike bacteria and fungi, viruses cannot replicate on inert media; viable host cells are required for replication
- Some viruses have an affinity for particular cell types

Viruses have some of the characteristics Living cells: such as a genome and the ability to adapt.

They lack autonomy as they cannot capture and store free energy.

Due to these limitations

Defination:

Viruses are sub-cellular, non-living, infectious entities which only become part of a living system when they have infected host cells, a form of borrowed life (van Regenmortel, 2000)

.

Recently, an icosahedral DNA virus named Sputnik has been found in association with the large mimivirus,*Acanthamoeba polyphaga mimivirus (APMV).*

Sputnik has been shown to multiply in the virus factory found in amoebae co-infected with APMV. The activities of Sputnik are deleterious to APMV and the term **virophage** has been assigned to this small 'parasitic' virus

Viroids are composed of naked RNA.

Prions are proteinaceous infectious particles which aredevoid of demonstrable nucleic acid.

VIRUS :

- Viruses are smaller than bacteria, they range in size between 20-300 nanometer(nm).
- Viruses contain only one type of nucleic acid either DNA or RNA, but never both.
- Viruses consist of nucleic acid surrounded by a protein coat. Some viruses have additional lipoprotein envelope.
- Viruses lack cellular organelles, such as mitochondria and ribosomes.

- **Viruses are obligate cellular parasites. They replicate only inside living cells.**
- **Viruses replicate through replication of their nucleic acid and synthesis of the viral protein.**
- **Viruses do not multiply in chemically defined media.**
- **Viruses do not undergo binary fission.**

Virus classification

- Virus classification is the process of naming viruses and placing them into a taxonomic system.
- Viruses are mainly classified by phenotypic characteristics such as morphology, nucleic acid type, mode of replication, host organisms and the type of disease they cause.
- Currently, two main schemes are used for the classification of viruses: the International Committee on Taxonomy of Viruses (ICTV) system and Baltimore classification system.

ICTV Classification

- The International Committee on Taxonomy of Viruses began to devise and implement rules for the naming and classification of viruses early in the 1970s

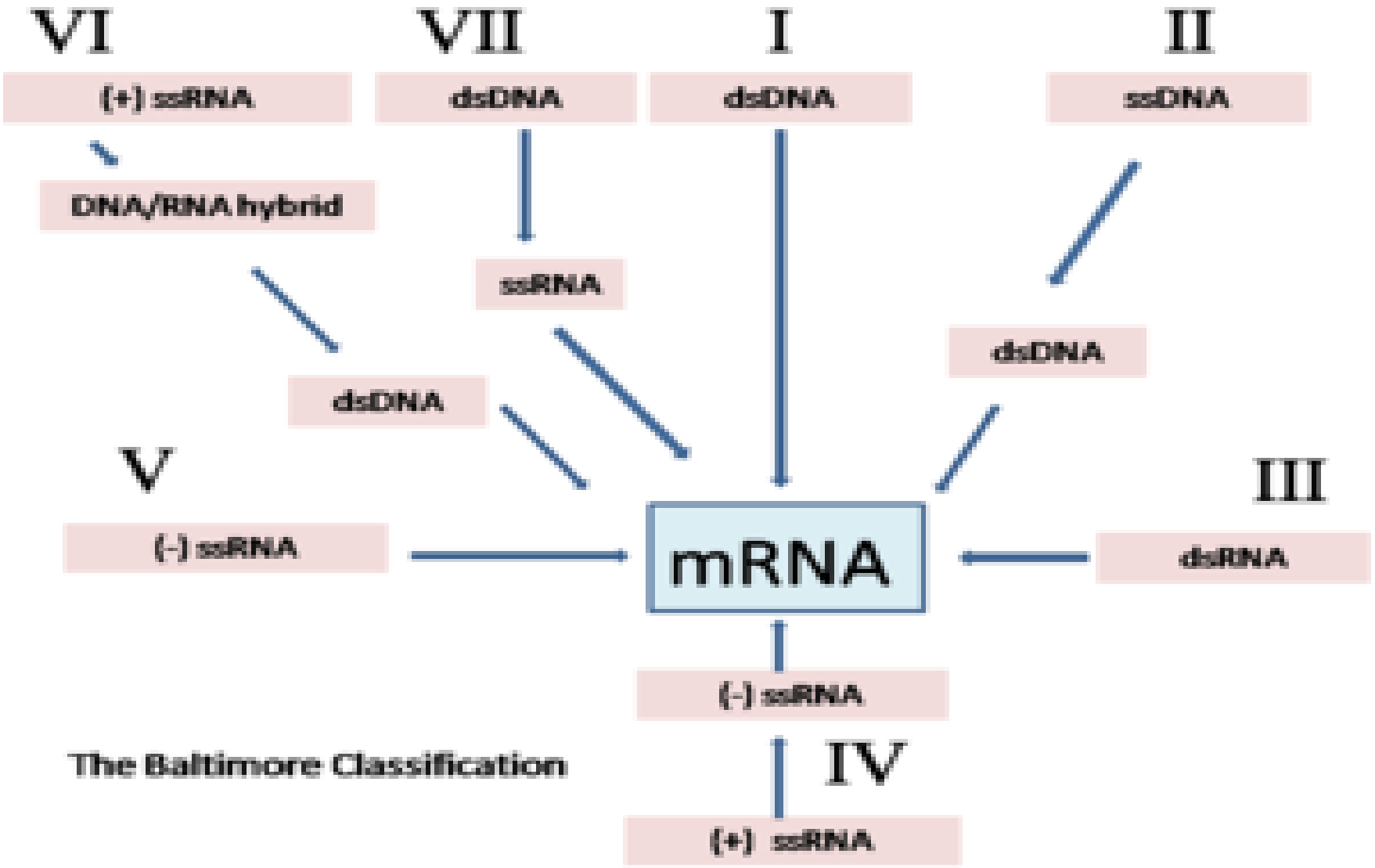
- ICTV is the only body charged by the International Union of Microbiological Societies with the task of developing, refining, and maintaining a universal virus taxonomy.

- **Viral classification starts at the level of order and continues as follows, with the taxon suffixes given in italics:**
- **Order (*-virales*)**
- **Family (*-viridae*)**
- **Subfamily (*-virinae*)**
- **Genus (*-virus*)**
- **Species**
- **Species names generally take the form of *Disease virus*.**

Baltimore Classification

- Baltimore classification (1971) is a classification system that places viruses into one of seven groups depending on a combination of their nucleic acid (DNA or RNA), strandedness (single-stranded or double-stranded), Sense, and method of transcription(m RNA synthesis).

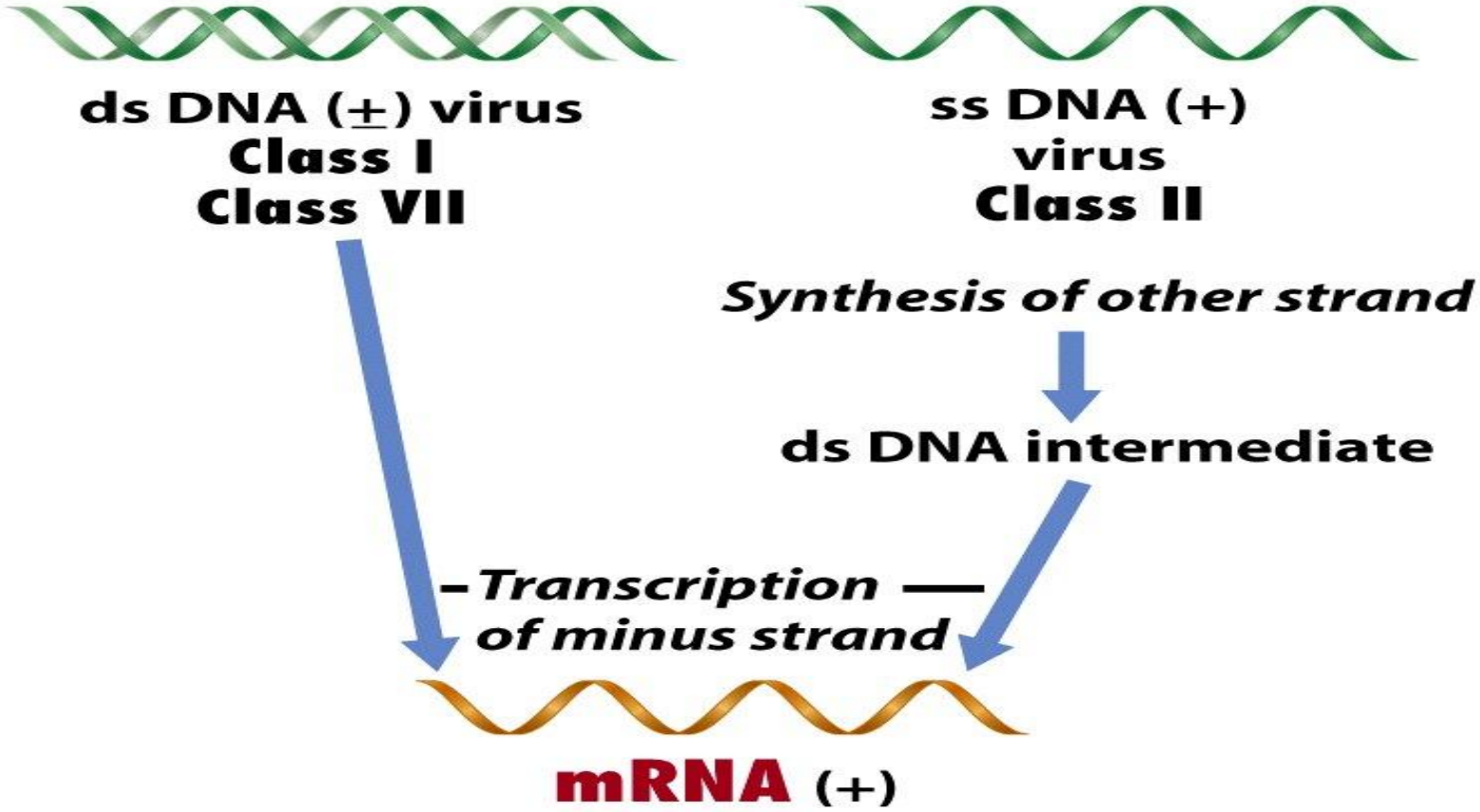
- Named after David Baltimore, a Nobel Prize-winning biologist, these groups are designated byRoman numerals.



The Baltimore Classification

- I: **dsDNAviruses** (e.g. Adenoviruses, Herpesviruses, Poxviruses)
- II: **ssDNA viruses** (+ strand or "sense") DNA (e.g. Parvoviruses)
- III: **dsRNA viruses** (e.g. Reoviruses)
- IV: **(+)ssRNA viruses** (+ strand or sense) RNA (e.g. Picornaviruses, Togaviruses)
- V: **(–)ssRNA viruses** (– strand or antisense) RNA (e.g. Orthomyxoviruses, Rhabdoviruses)
- VI: **ssRNA-RT viruses** (+ strand or sense) RNA with DNA intermediate in life-cycle (e.g. Retroviruses)
- VII: **dsDNA-RT viruses** (e.g. Hepadnaviruses)

- Before replication of viral nucleic acid occur, mRNA molecules transcribed from the virus genome encode new virus proteins.
- In some RNA viruses, the viral RNA itself is the mRNA; in others, the virus genome is a template for the formation of viral mRNA. In certain cases, essential transcriptional enzymes are contained in the virion.
- By convention, **mRNA is said to be in the plus (+) configuration**.
- **Its complement is said to be in the minus (–) configuration.** This nomenclature is also used to describe the configuration of the genome of a single-stranded virus, whether its genome contains RNA or DNA.

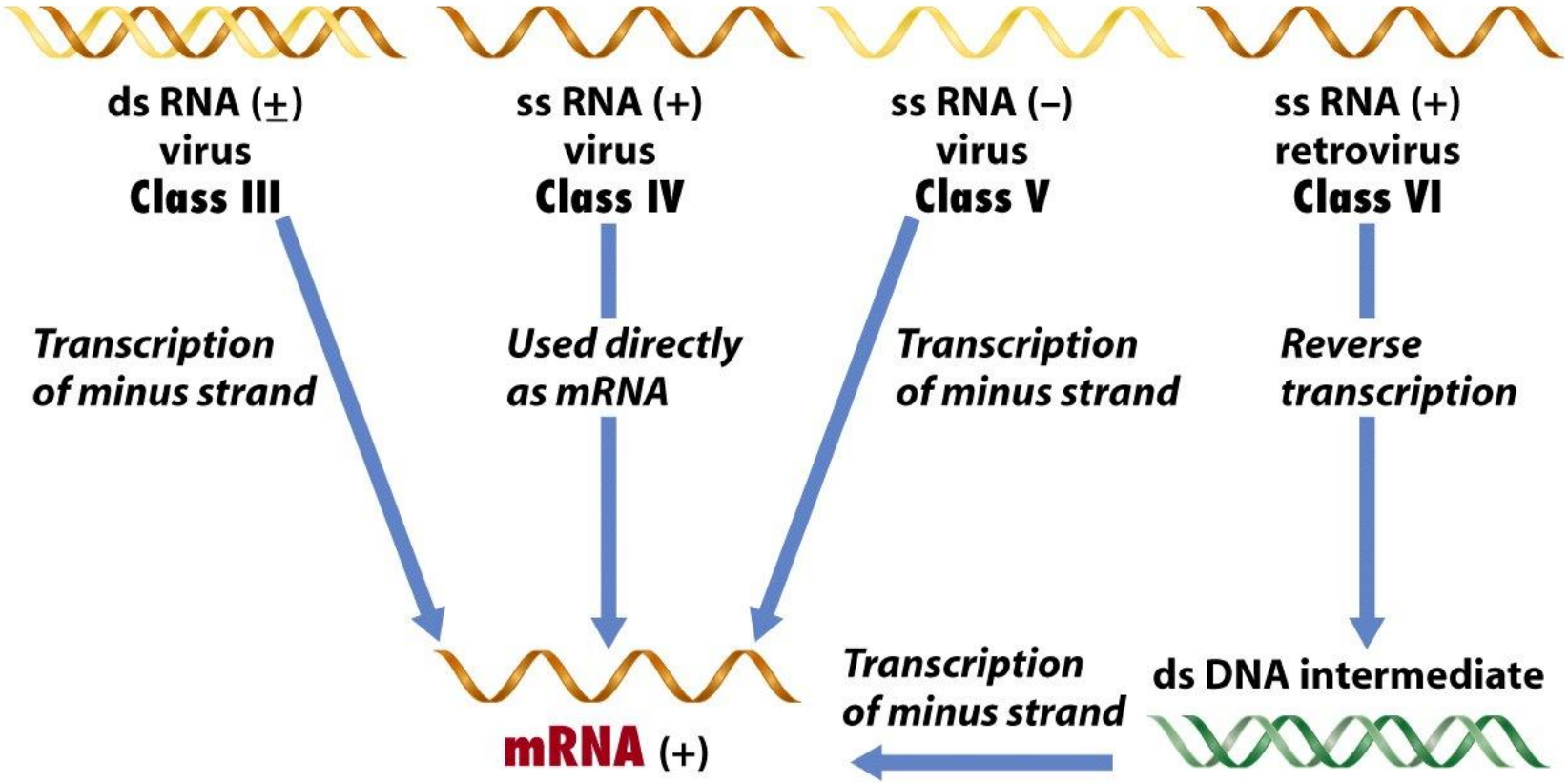


Genome replication:

- **Class I,** classical semiconservative
- **Class II,** classical semiconservative, discard (–) strand
- **Class VII,** transcription followed by reverse transcription

DNA Viruses

Figure 9-11a Brock Biology of Microorganisms 11/e



Genome replication:

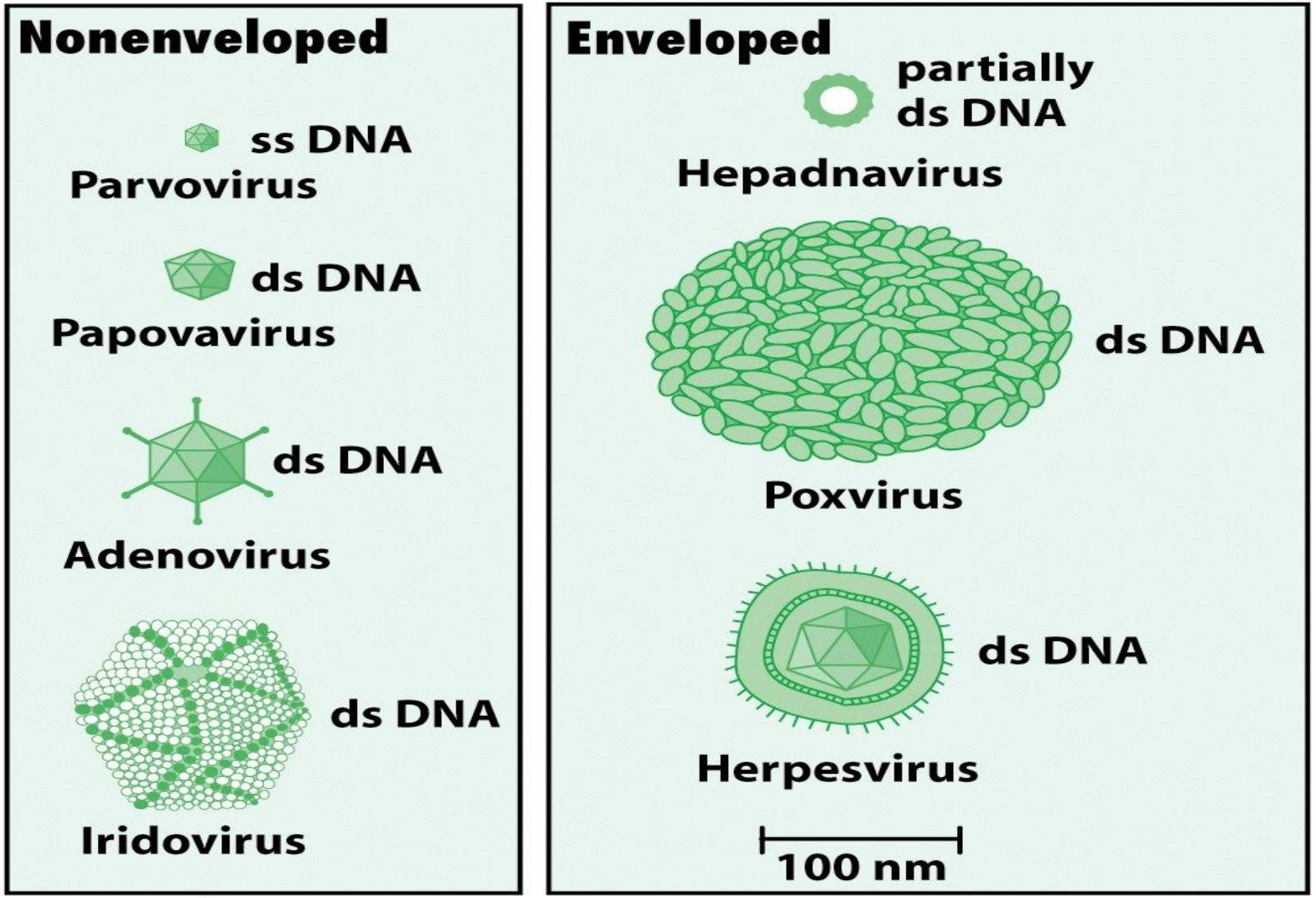
Class III, classical semiconservative replication, but of RNA not DNA
Class IV, make ss RNA (–) and transcribe from this to give ss RNA (+) genome
Class V, make ss RNA (+) and transcribe from this to give ss RNA (–) genome
Class VI, make ss RNA (+) genome by transcription off of (–) strand of ds DNA

RNA Viruses

Figure 9-11b Brock Biology of Microorganisms 11/e

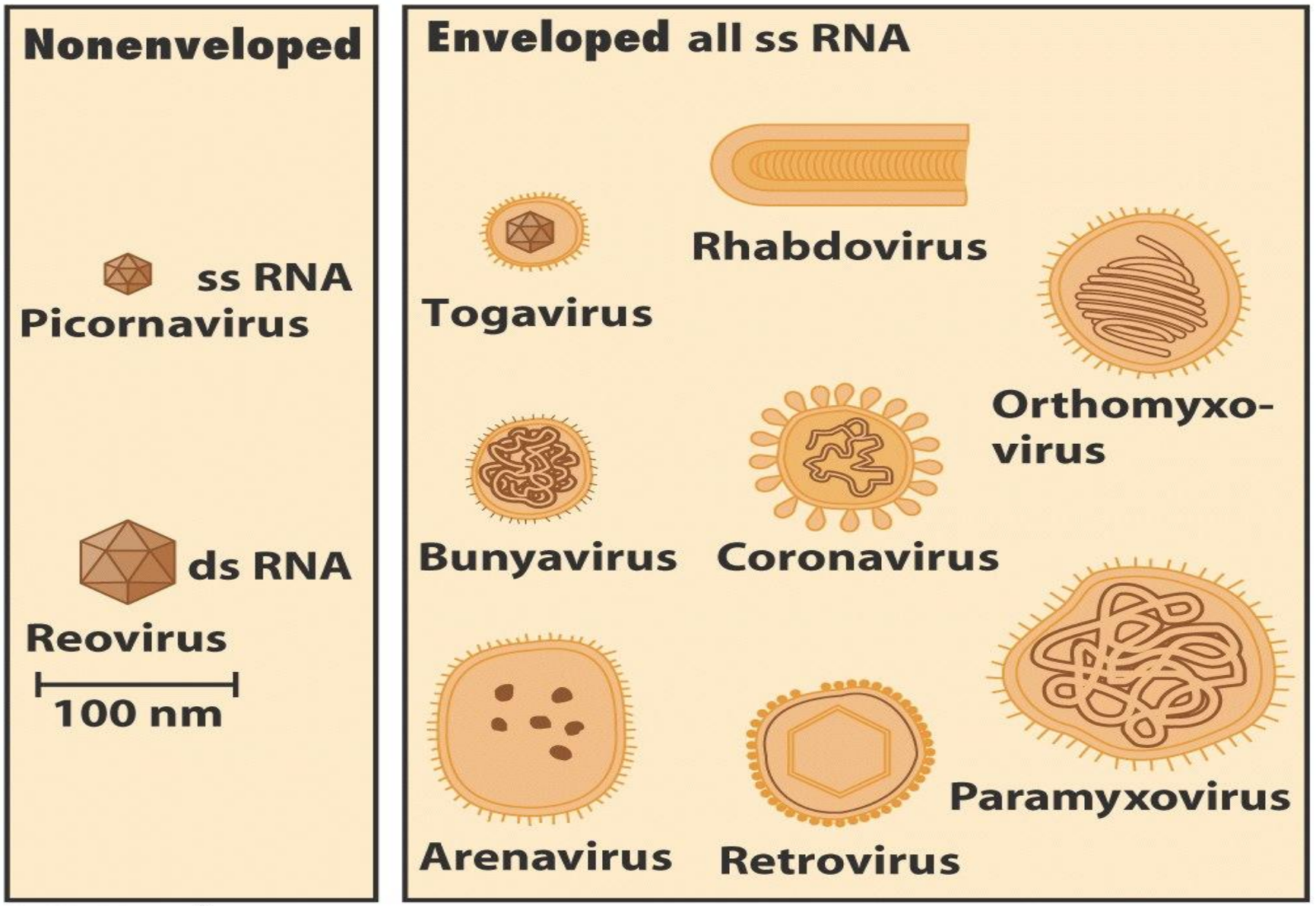
- Basically viruses are divided into 2 large groups : -

1. RNA containing viruses.
2. DNA containing viruses.



DNA viruses

Figure 9-23a Brock Biology of Microorganisms 11/e



RNA viruses

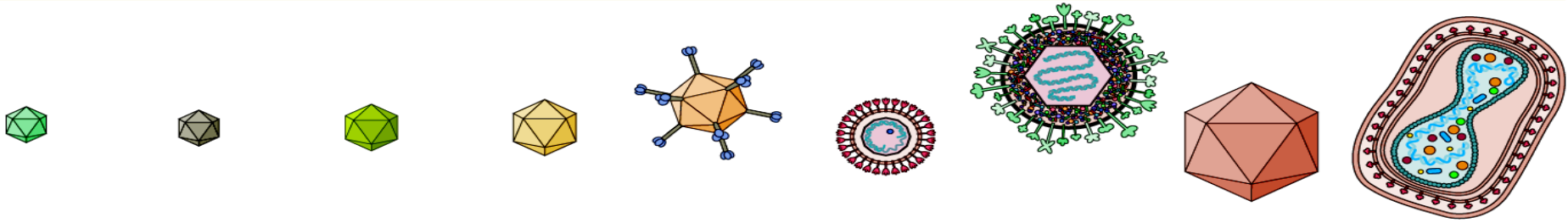
Figure 9-23b Brock Biology of Microorganisms 11/e

DNA

Icosahedral | Complex

Naked | Enveloped | Naked/ enveloped (cytoplasmic) | Enveloped (cytoplasmic)

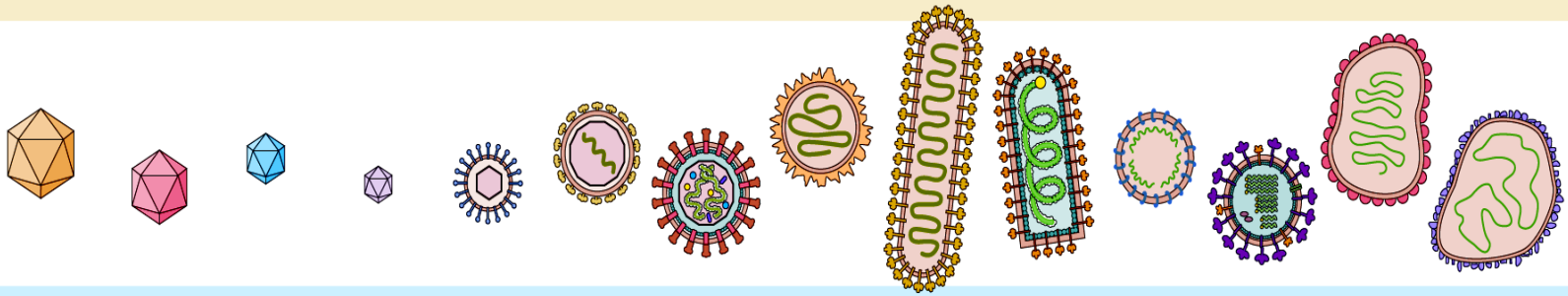
ss linear (+) or (–)	ss circular	ds circular	ds circular	ds linear	ds circle gapped	ds linear	ds linear	ds covalently joined ends
II	II	I	I	I	I	I	I	I



Parvo	Circo	Polyoma	Papilloma	Adeno	Hepadna	Herpes	Irido	Pox
(–)	(–)	(–)	(–)	(–)	(+)	(–)	(–)	(+)
18–26	12–26	40	55	70–90	42	150–200	125–300	170–200 × 300–450
5	1.8–2.3	5	7–8	36–38	3.2	120–200	150–350	130–280

Classification criteria

Nucleic acid	RNA													
Symmetry of capsid	Icosahedral							Helical						
Naked or enveloped	Naked				Enveloped			Enveloped						
Genome architecture	ds 10–18 segments	ds 2 segments	(+) ss	(+) ss	(+) ss	(+) ss	(+) ss 2 copies	(+) ss	(–) ss	(–) ss	(–) ss 3 segments	(–) ss 8 segments	(–) ss	(–) ss 2 segments
Baltimore class	III	III	IV	IV	IV	IV	VI	IV	V	V	V	V	V	V



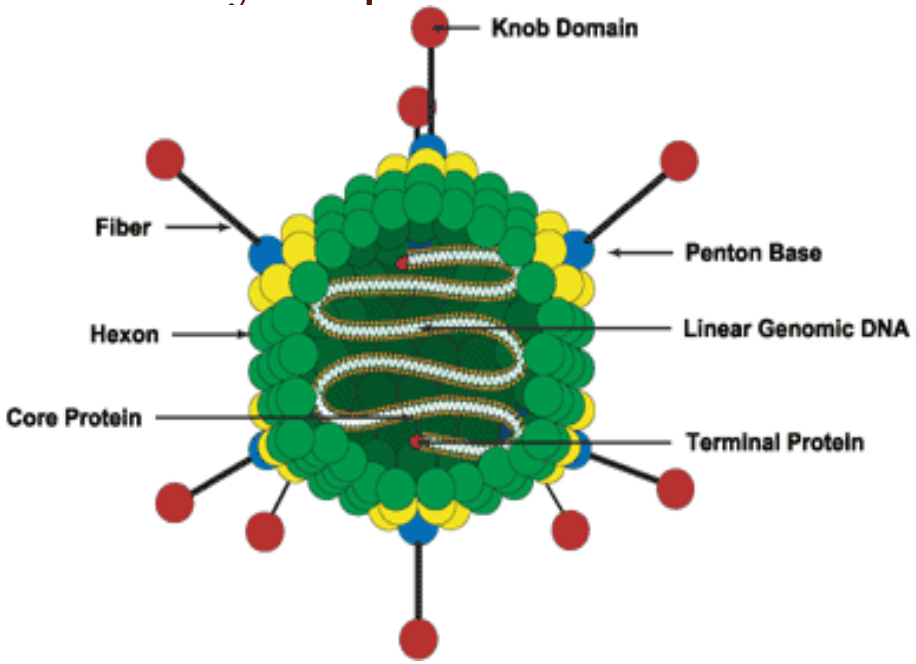
Properties

Family name	Reo	Birna	Calici	Picorna	Flavi	Toga	Retro	Corona	Filo	Rhabdo	Bunya	Ortho-myxo	Para-myxo	Arena
Virion polymerase	(+)	(+)	(–)	(–)	(–)	(–)	(+)	(–)	(+)	(+)	(+)	(+)	(+)	(+)
Virion diameter (nm)	60–80	60	35–40	28–30	40–50	60–70	80–130	80–160	80 × 790–14,000	70–85 × 130–380	90–120	90–120	150–300	50–300
Genome size (total in kb)	22–27	7	8	7.2–8.4	10	12	3.5–9	16–21	12.7	13–16	13.5–21	13.6	16–20	10–14

ADENOVIRIDAE

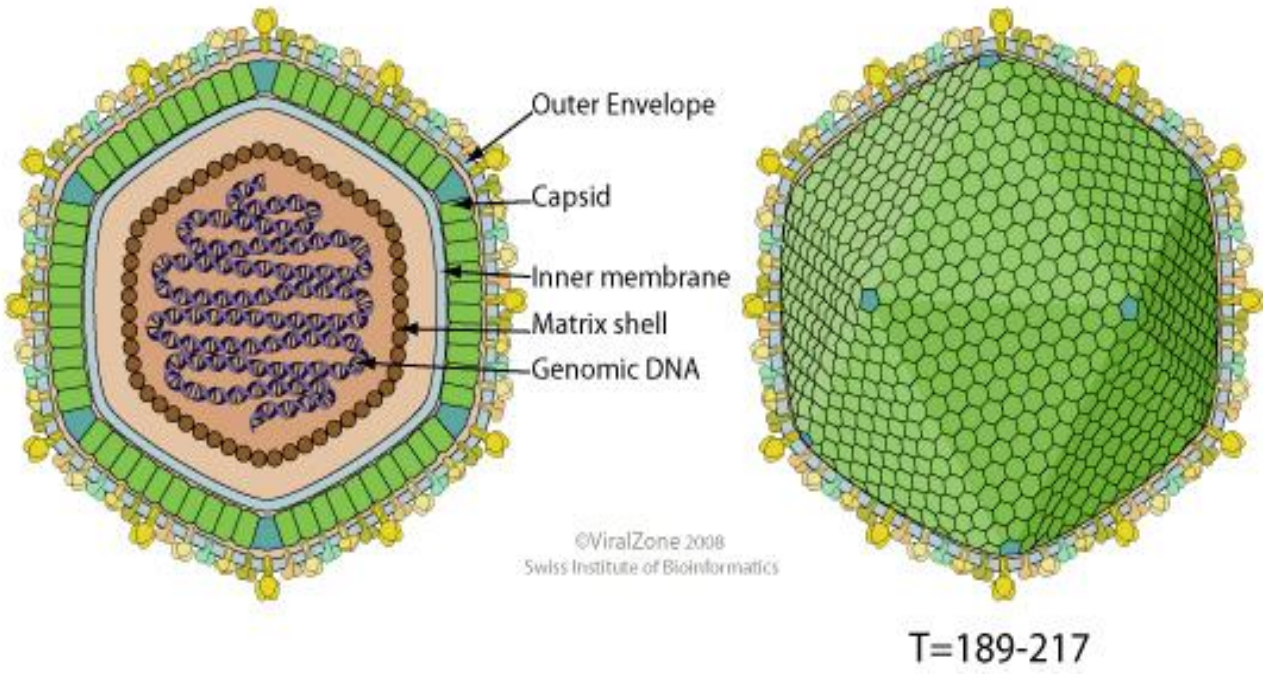
- Non enveloped, 80 nm, icosahedral with fibre protein at each vertex, ds stranded linear DNA, replication in nucleus.

- Infectious canine hepatitis
- Egg drop syndrome
- Inclusion body hepatitis – hydropericardium syndrome



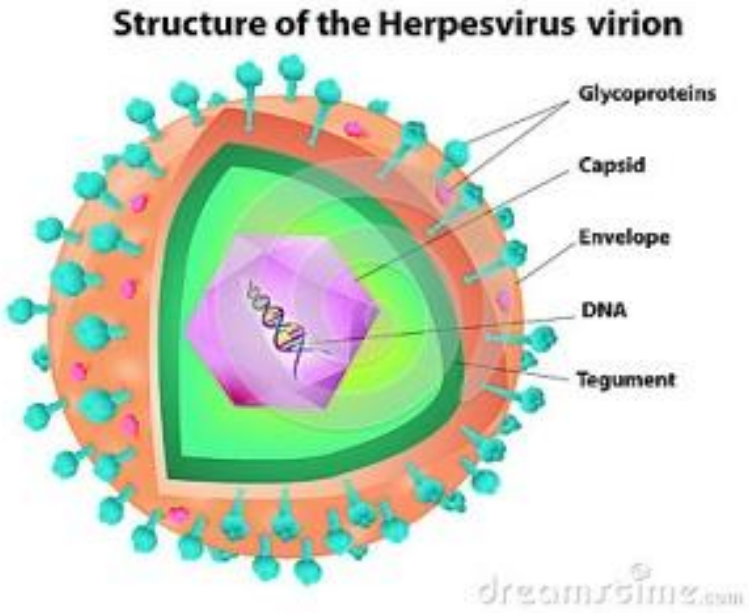
ASFARVIRIDAE

- Enveloped,200 nm icosahedral particle with 70 nm isometric core, linear ds DNA, cytoplasmic replication.
  - African swine fever virus



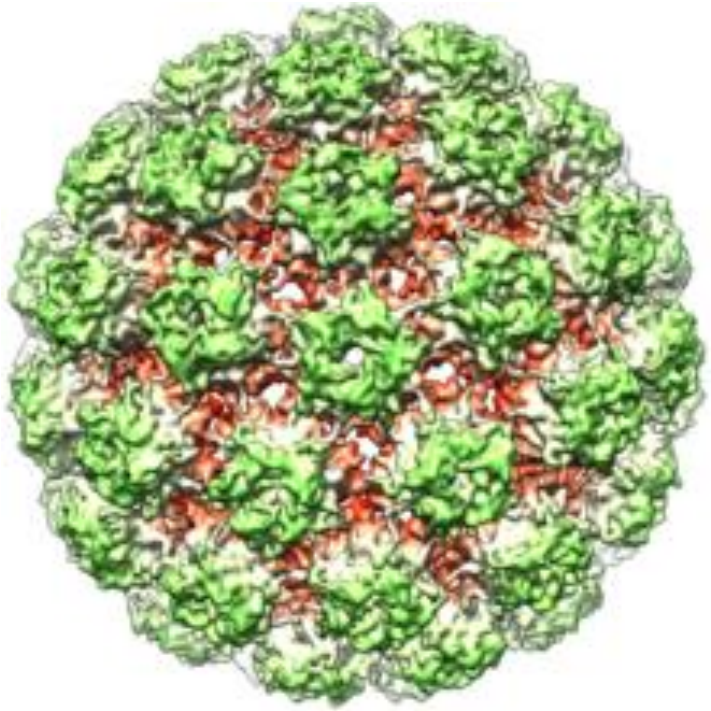
HERPESVIRIDAE

- Enveloped 200 nm particle with spikes,enclosing a tegument and an icosahedral nucleocapsid of 100 nm, Linear ds DNA, replication in nucleus. Large family, latency common, some are oncogenic.
- Three subfamilies – alphaherpesvirinae, betaherpesvirinae and gammaherpesvirinae



PAPILLOMAVIRIDAE

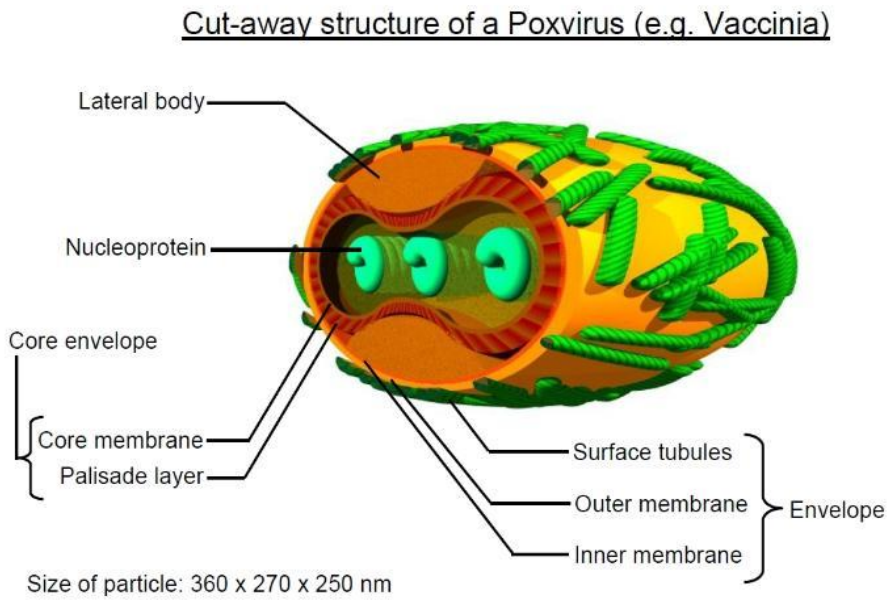
- Non enveloped, 55 nm icosahedral, covalently closed circular ds DNA genome, replication in nucleus, some are oncogenic.
- Papillomatosis



POXVIRIDAE

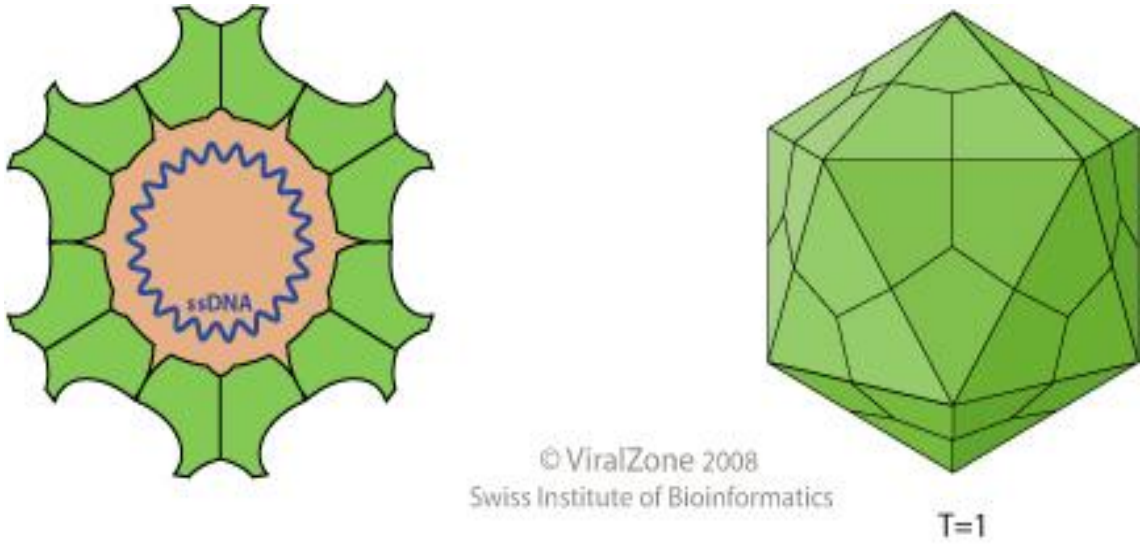
- Brick shaped or ovoid virions of 220-450 nm x 140-260 nm wide, some enveloped. Complex structure enclosing two lateral bodies and a biconcave core. Linear ds DNA genome, cytoplasmic replication.

➢ Pox viruses of cow, sheep, goat & fowl



CIRCOVIRIDAE

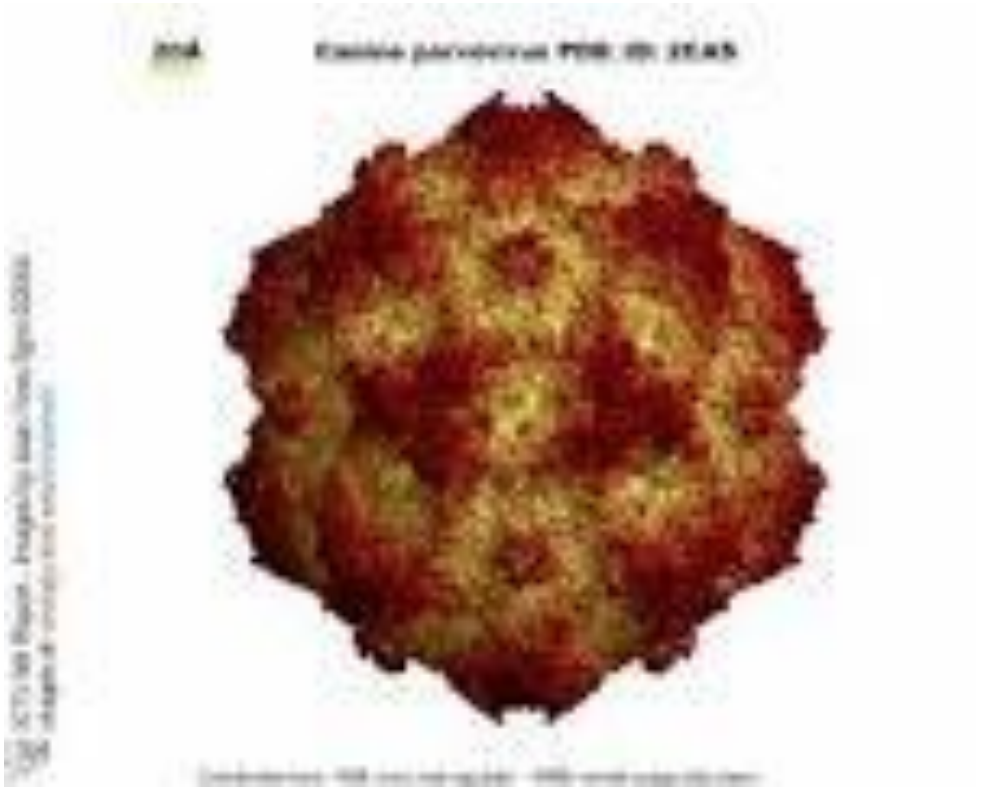
- Nonenveloped small icosahedral, circular ss DNA genome
- Chicken infectious anaemia virus



PARVOVIRIDAE

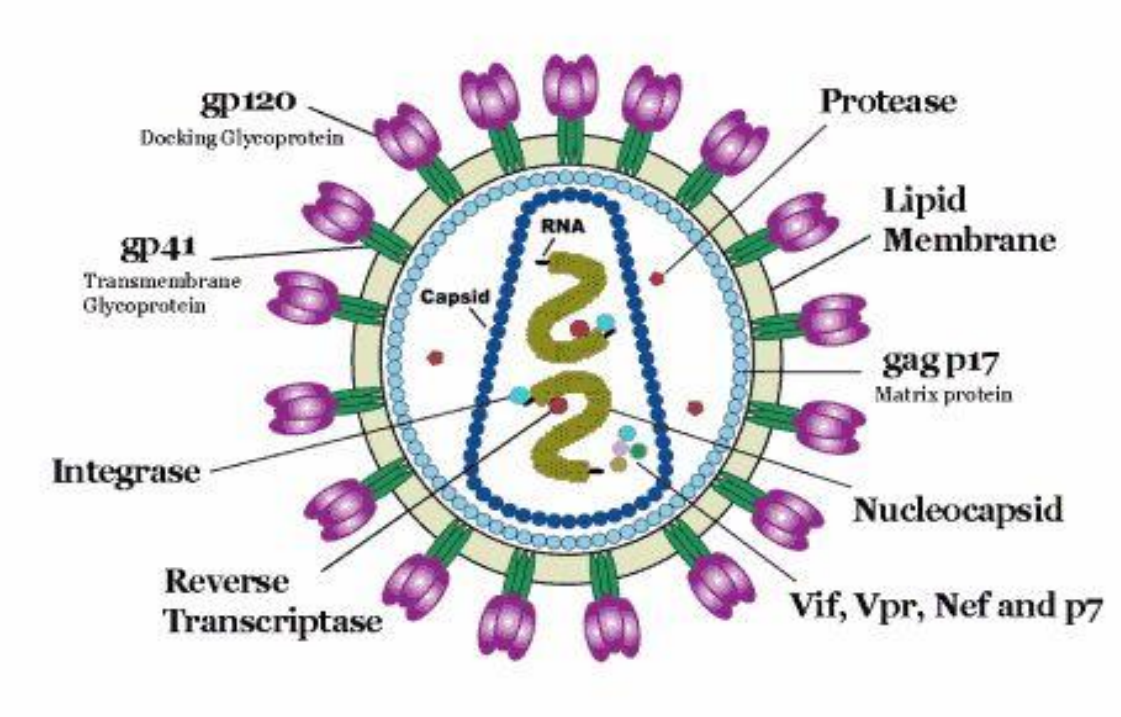
- Nonenveloped icosahedral 18-26 nm, linear ss DNA genome replication in nuceus.

- Canine parvovirus



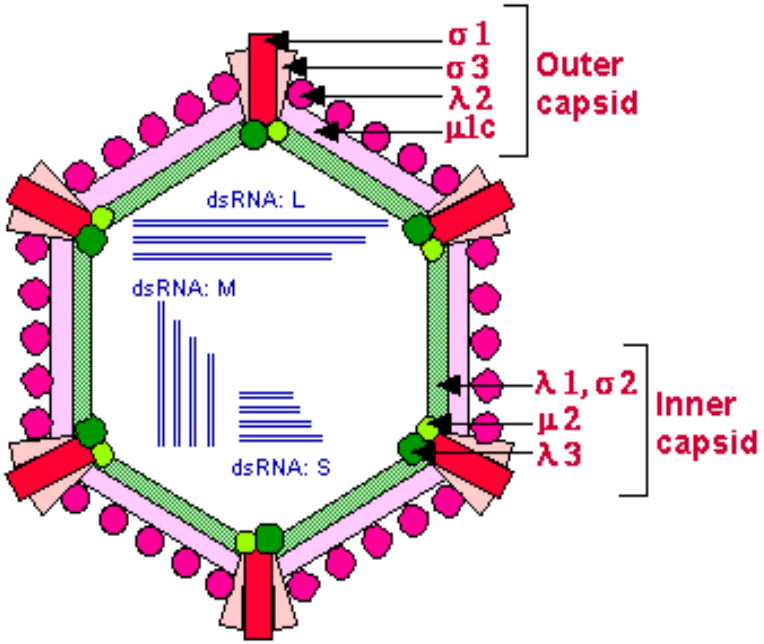
BIRNAVIRIDAE

- Nonenveloped icosahdral 60 nm particles, two segments of linear ds RNA genome, replication in cytoplasm.
- Infectious bursal disease virus



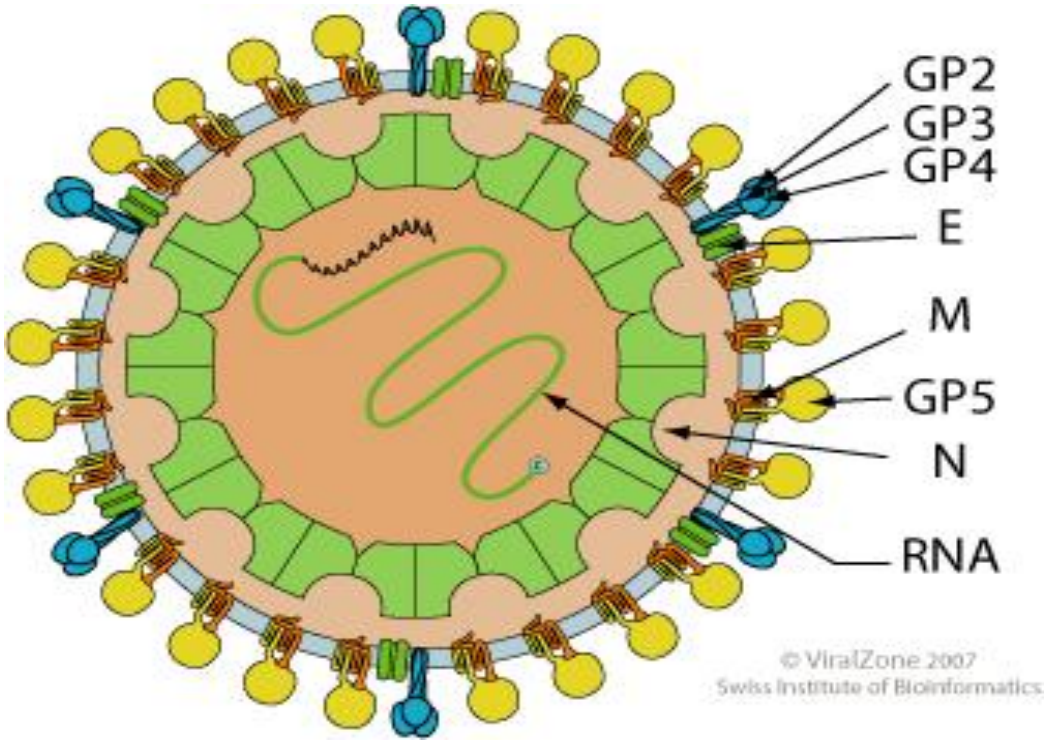
REOVIRIDAE

- Nonenveloped 60-80 nm icosahedral capsid, 10 - 12 segments of linear ds RNA , cytoplasmic replication.
- Bluetongue virus
- African horse sicknes



ARTERIVIRIDAE

- Enveloped 45-60 nmparticle containing icosahedral nucleocapsid, linear positive sense ss RNA genome, cytoplasmic replication.
- Equine arteritis virus

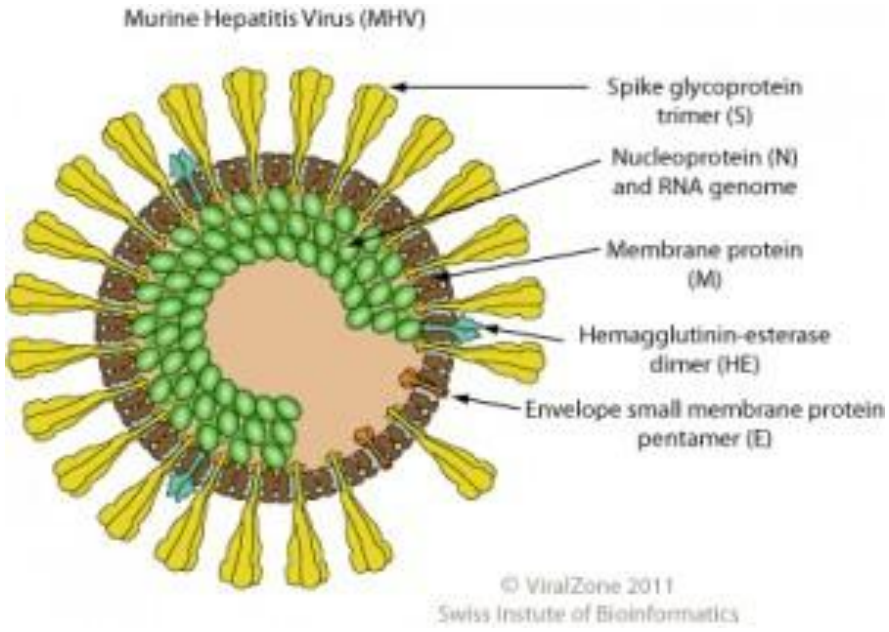


CALCIVIRIDAE

- Nonenveloped icosahedral 27-40 nm particle with calyx like (cup shaped) depressions. Linear +sense ss RNA, cytoplasmic replication.
- Vesicular exanthema virus of swine

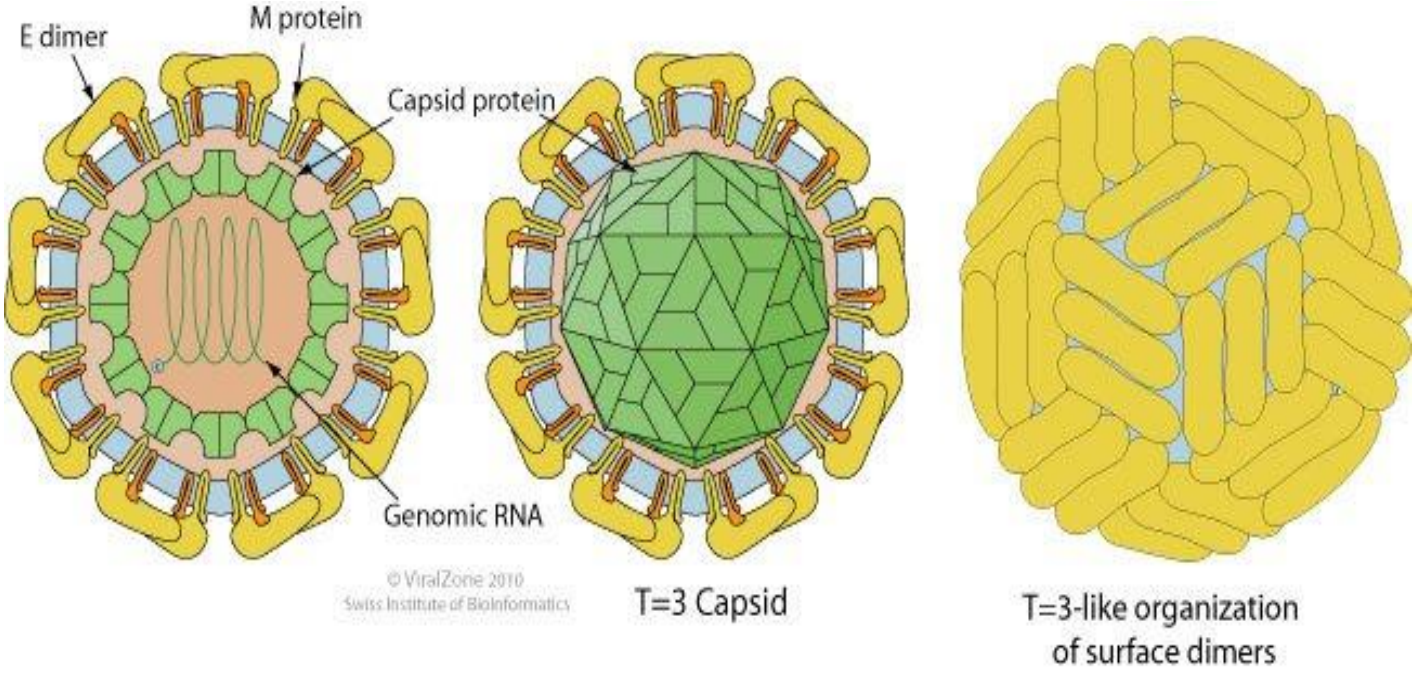
CORONAVIRIDAE

- Enveloped 120-160 nm with club shaped sparse protein spikes, helical nucleocapsid with linear +sense ss RNA genome, cytoplasmic replication.
  - Avian infectious bronchitis virus
  - Transmissable gastroenteritis virus



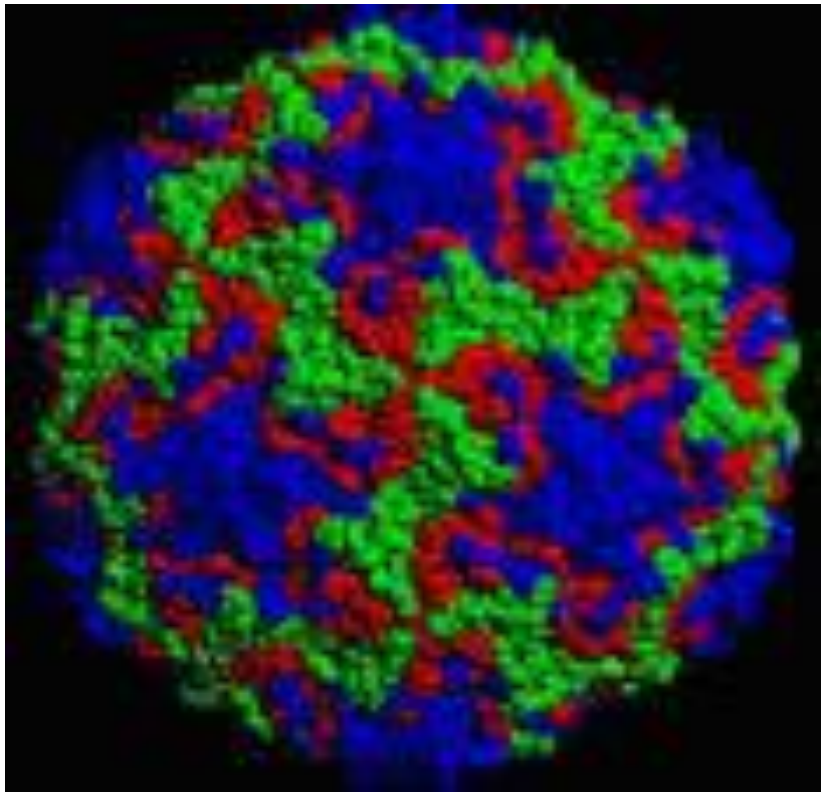
FLAVIVIRIDAE

- Enveloped 40-60 nm with icosahedral nuclecapsid of 25-30 nm linear +sense ss RNA, cytoplasmic replication.
- classical swine fever virus
- Bovine viral diarrhoea



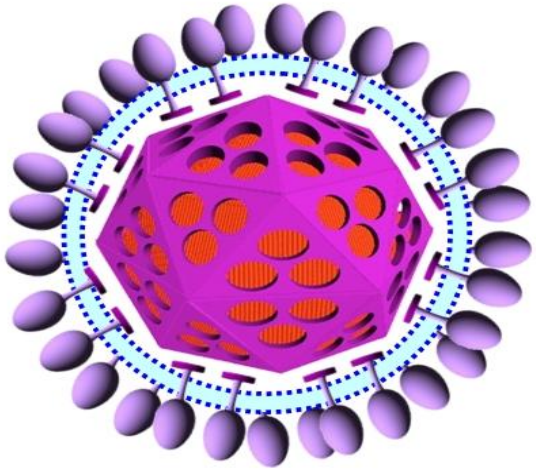
PICORNAVIRIDAE

- Nonenveloped icosahedral 30 nm, linear +sense ss RNA, cytoplasmic replication.
  - Foot-and-mouth disease
  - Duck viral hepatitis

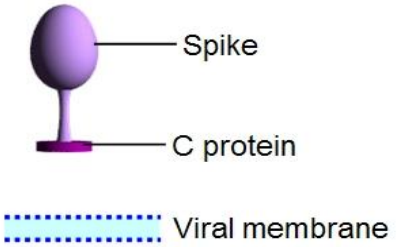


TOGAVIRIDAE

- Enveloped 70 nm particles with icosahedral nucleocapsid, linear +sense ss RNA, cytoplasmic replication.
- Equine encephalitis

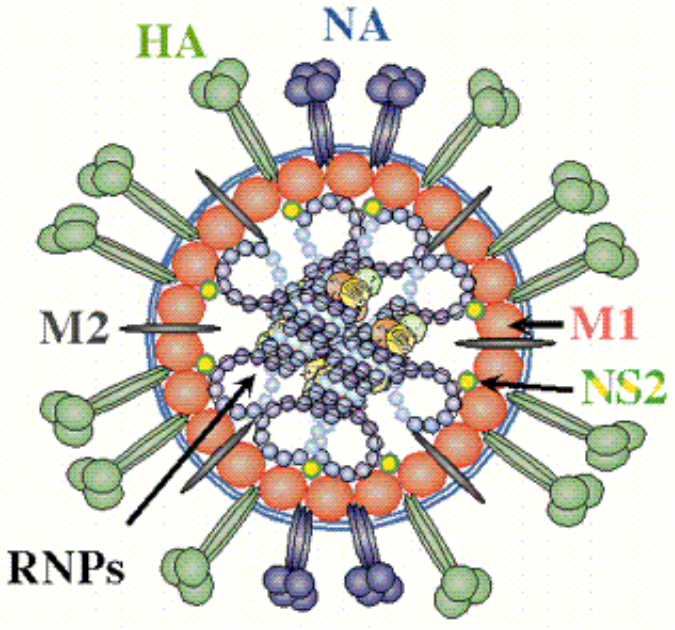


Togaviridae (e.g. *Alphavirus*, Semliki forest virus (SFV), Sindbis virus



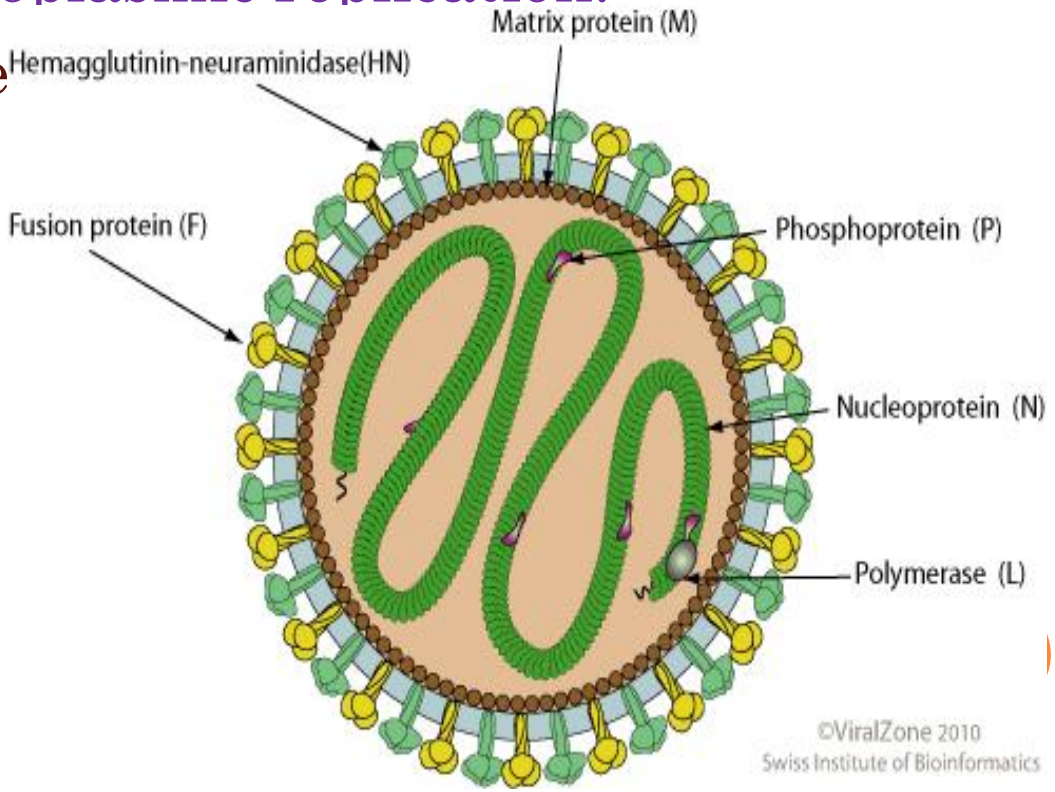
ORTHOMYXOVIRIDAE

- Enveloped pleomorphic 120 nm particles with a dense layer of protein spikes, 6-8 helical nucleocapsids , 9 nm diameter with transcriptase activity, each contains a linear, negative sense ss RNA, RNA synthesis nuclear.
- Influenza viruses of swine, equine & avian sps.



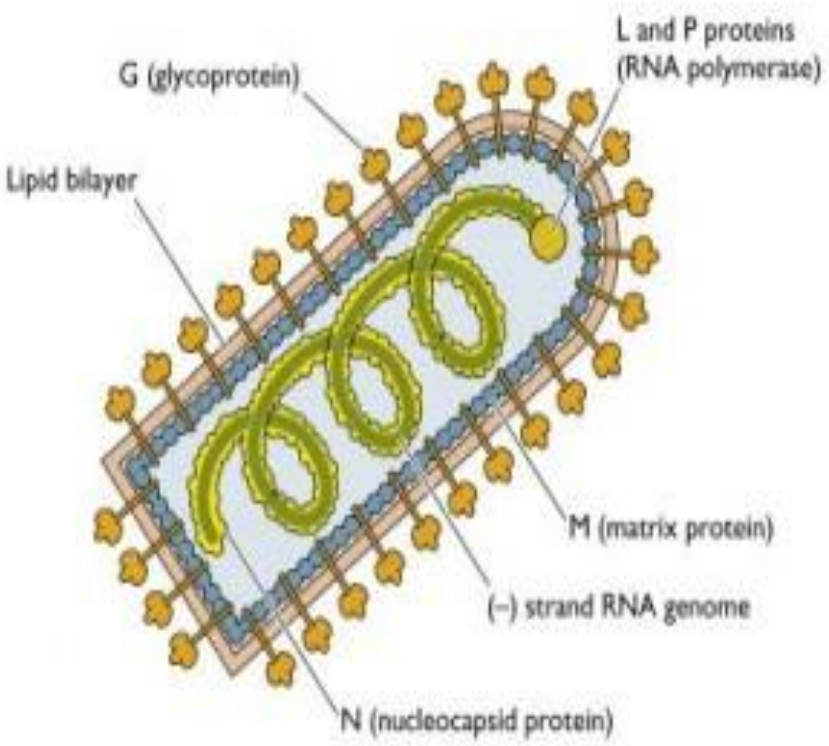
PARAMYXOVIRIDAE

- Enveloped pleomorphic particles usually 150-200 nm diameter with dense layer of protein spikes. One helical nucleocapsid 12-17 nm diameter with one molecule of linear negative sense ss RNA, cytoplasmic replication.
  - Newcastle disease
  - Rinderpest virus
  - PPR
  - Canine distemper



RHABDOVIRIDAE

- Enveloped bullet shaped particles 100-430 nm x 45-100 nm with 5-10 nm spikes, helicle necleocapsid with linear, negative sense ss RNA, cytoplasmic replication.
  - Rabies
  - Vesicular stomatitis
  - Ephimeral fever



RETROVIRIDAE

- Enveloped 80-100 nm particles with spikes, nucleocapsid is isometric or truncated cone, icosahedral symmetry contains two identical copies(diploid) of positive sense ss RNA, virions contain reverse transcriptase and integrase enzymes.
  - Avian leukosis
  - Lentiviruses

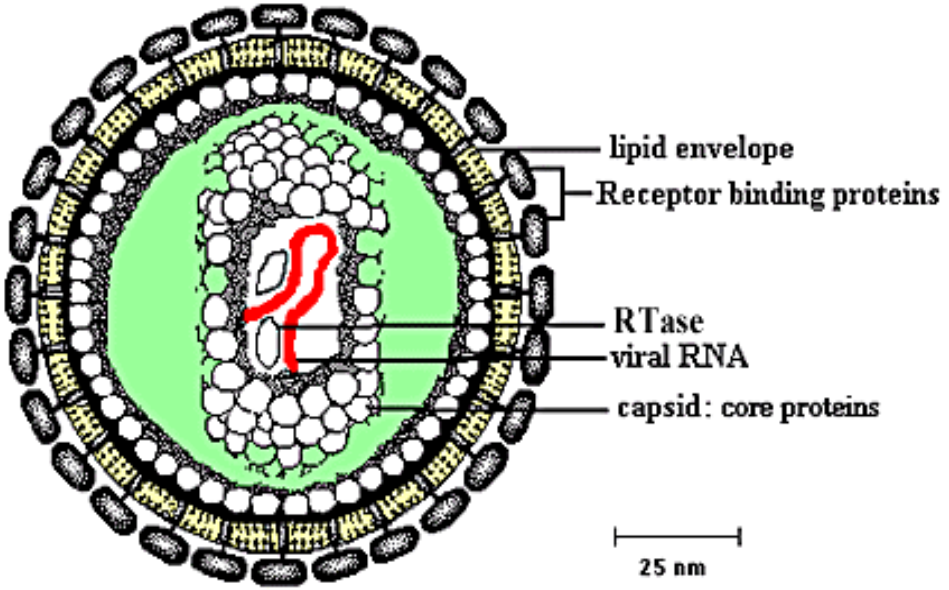


Diagram of a Retrovirus