CHAPTER 2: CLASSIFICATION OF VIRUSES

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Content

1. Naming of viruses
2. Classification of virus – ICTV, Baltimore Classification
3. Baltimore Classification – 7 classes

Lesson Outcomes

- Understands the reasons on naming viruses
- Briefly discuss the classification of viruses
- Explain the Baltimore classification
- Explain the characteristics of RNA and DNA viruses that cause human disease.

Criteria of classification

Nomenclature of Viruses

Various approaches, (do not obey the binomial nomenclature) derived from:

1. Named after the diseases

   eg. Measles virus, smallpox virus

2. Name after the places where the disease first reported

   eg. Newcastle disease virus, Ebola virus, Norwalk virus, Bunyaviridae

3. Host and signs of disease

   eg. Tobacco mosaic virus, cauliflower mosaic virus brome mosaic virus

4. Latin and Greek words

eg. Coronaviridae – “crown”

Parvoviridae – “small”

5. Virus discovers

eg. Epstein-Barr virus

6. How they were originally thought to be contracted

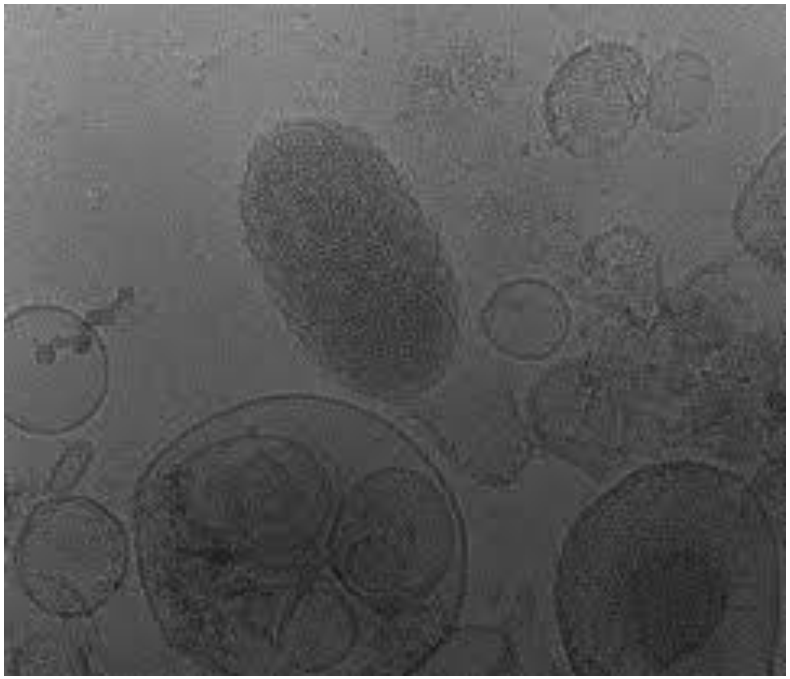
eg. dengue virus (“evil spirit”), influenza virus (the “influence” of bad air)

7. Combinations of the above

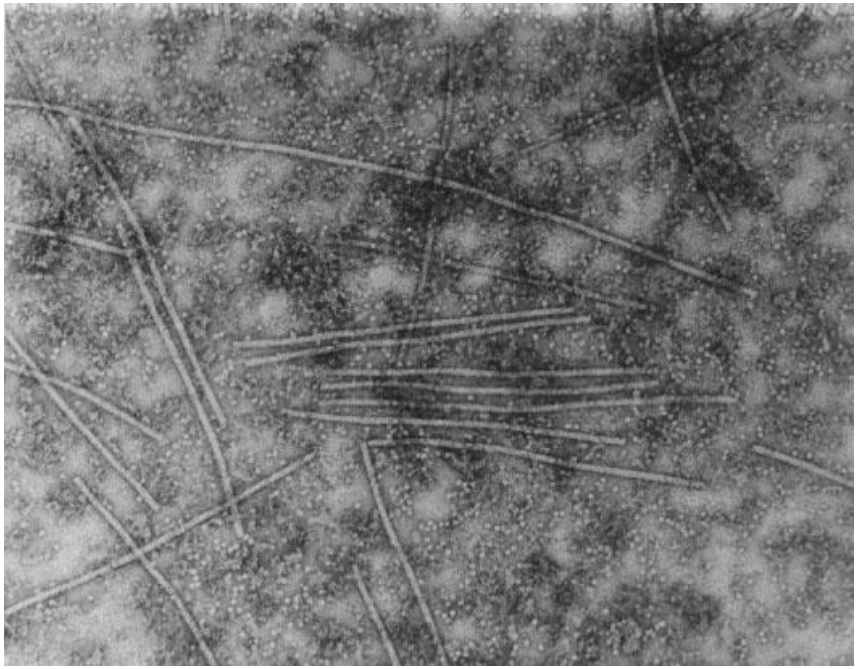
eg. Rous Sarcoma virus

Examples

Animal virus



Plant virus



Classification

Reasons beyond classification

- Classification of virus been determined by the structural and chemical composition of virus
- Are apply to all plant viruses, animal viruses and bacterial viruses
- Virus is acellular cell – cannot be categorised using taxonomic classification
- It used International Committee on Taxonomy of Viruses (ICTV) to classify the viruses

Before discovery

- *Dermotropic* – infected skin cell
- *Neurotrophic* – infected nerve cell
- *Viscerotropic* – infect organ of digestive tract
- *Pneumotropic* – infected respiratory system

After discovery

- Type and structure of their nucleic acids
- Methods of replication
- Host range
- Chemical and physical characteristics

Classification

- Viruses are not classified as members of the kingdoms
- Do not obey the biological taxonomy
- Generally based on:

1. Classical - eg. animal, plant, bacterial virus
   system - eg. naked or enveloped virus

2. Genomic - Baltimore classification

3. Serology - classification based on Diagnostic virology
   - eg. Infectious bronchitis virus (IBV) of chickens
   (a coronavirus) – 3 different types present, these types have significant antigenic differences, but perhaps very little genetic or biological difference between these viruses.

Classification of Viruses

The following criteria are used to classify viruses:

1. **Morphology – structure of capsid**
   – presence or absence of envelope
2. **Size of the virion**
3. **Type of host/host structures the virus infected**
   - Bacteriophages: infect bacterial cells
   - Plant viruses infect plant cells
   - Animal viruses are subgrouped by the tissues they attack:
   1. **Dermotrophic: if they infect the skin**
   2. **Neurotrophic: if they infect nerve tissue**
4. **Genome composition – DNA / RNA**
   – ds/ss DNA and ds/ss RNA

Classification of Viruses

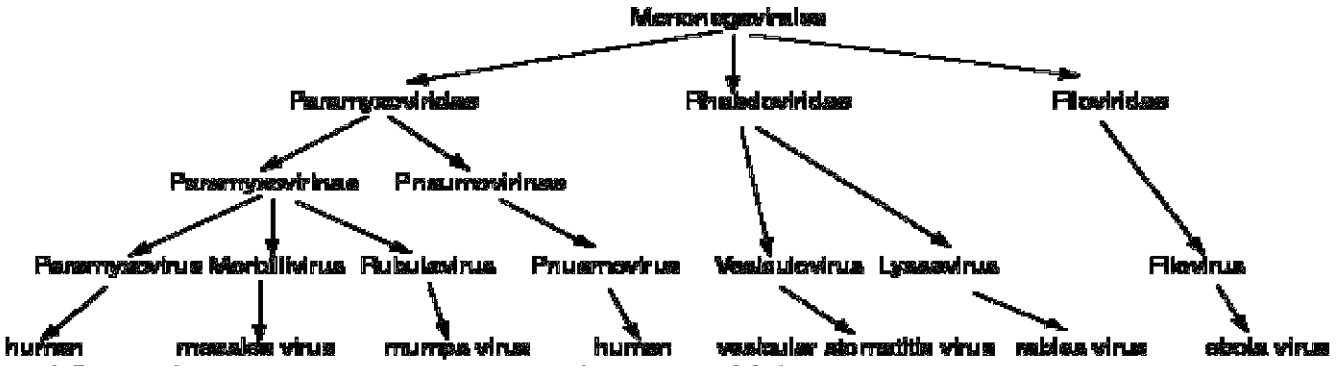
1. **Taxonomic groups – family, subfamily, genus and species**
2. **The names of virus families (family) are italicized - End in Latin suffix –*viridae***
3. **The genera (genus) end in the suffix – *virus***
4. **The species – English common name**

Table 10.1 Taxonomic groups of viruses

Taxonomic group	Suffix	Example 1	Example 2	Example 3
Family	*-viridae*	*Myoviridae*	*Paramyxoviridae*	*Coronaviridae*
Subfamily	*-virinae*	–	*Paramyxovirinae*	–
Genus	*-virus*	*T4-like viruses*	*Morbillivirus*	*Coronavirus*
Species	–	*Enterobacteria phage T4*	*Measles virus*	*Severe acute respiratory syndrome virus*

Virus taxonomy

Order	***virales***	**e.g *Mononegavirales***	
Family	***viridae***	**e.g. *Orthomyxoviridae***	***Herpesviridae***
Subfamily	***virinae***	**e.g.**	***Alphaherpesvirinae***
Genus		**e.g. influenzavirusA**	**Simplexvirus**
Species		**e.g. influenza A virus**	**human herpesvirus1**
Informally:			
Type		**e.g.**	**herpes simplex virus 1**
Strain		**e.g. influenza A/PR/8/34**	**SC16**



In biology, binomial names are used. e.g *Rattus rattus, Saccharomyces cerevisiae*
In virology, this does not happen:

***Tobacco etch potyvirus* sounds OK**
***Influenza A influenzavirus A* does not!**

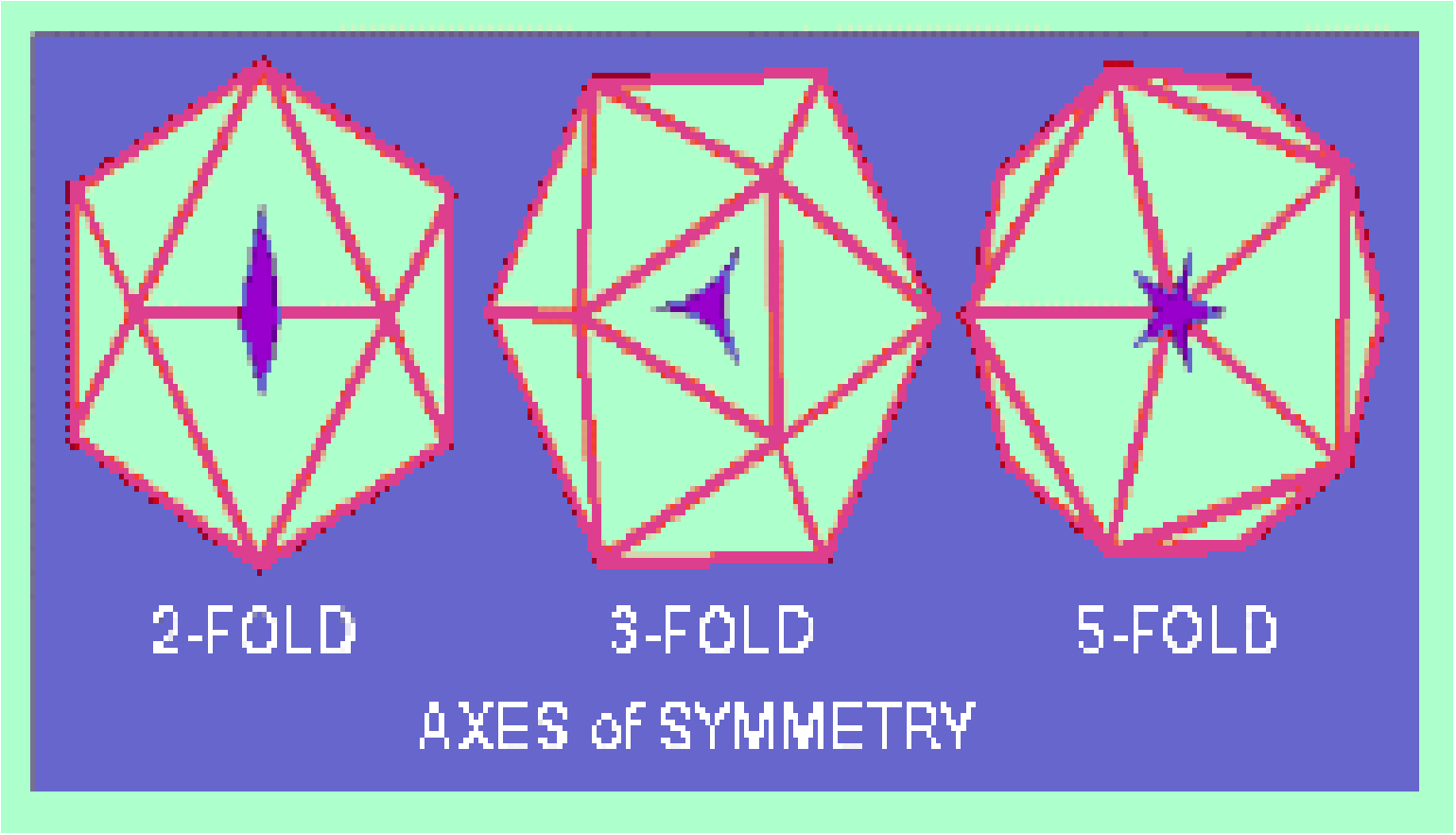
Bacteriophage have their own rules

- Viruses are divided into three groups, based on the morphology of the nucleocapsid and the arrangement of capsomeres.

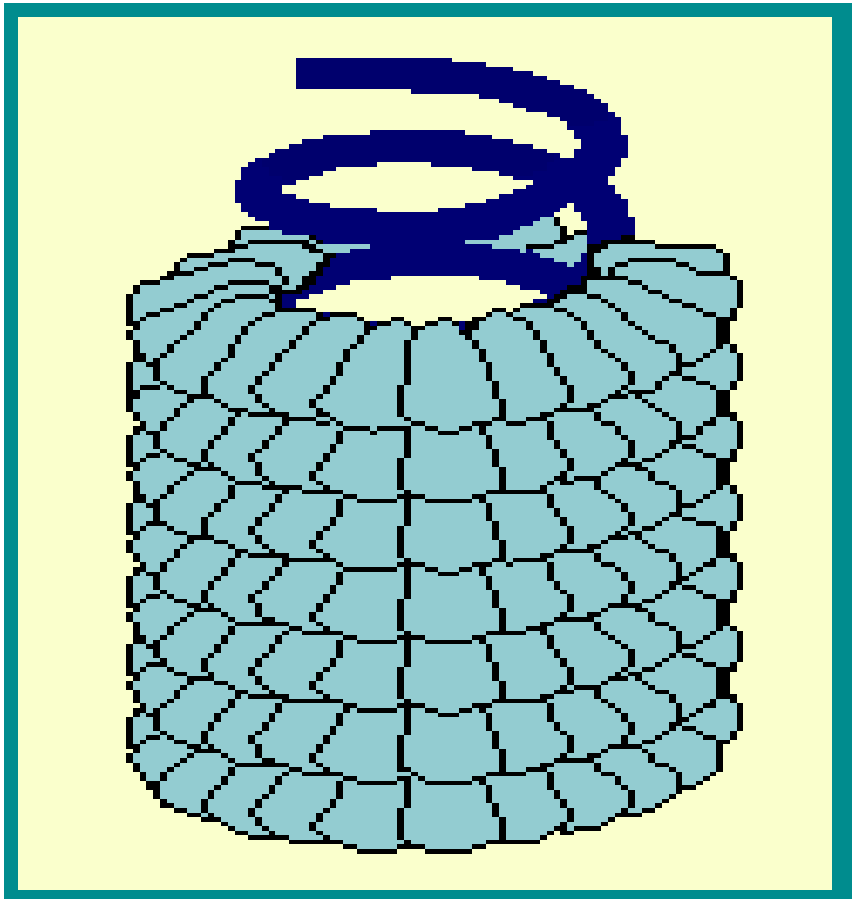
Symmetry of viruses

- Arrangement of capsomers in the virus.
- Two primary shapes of virus is rod and spherical.
- Rod shaped virus-helical symmetry
- Spherical virus-icosahedron

Cubic symmetry



Helical symmetry



Symmetry of viruses

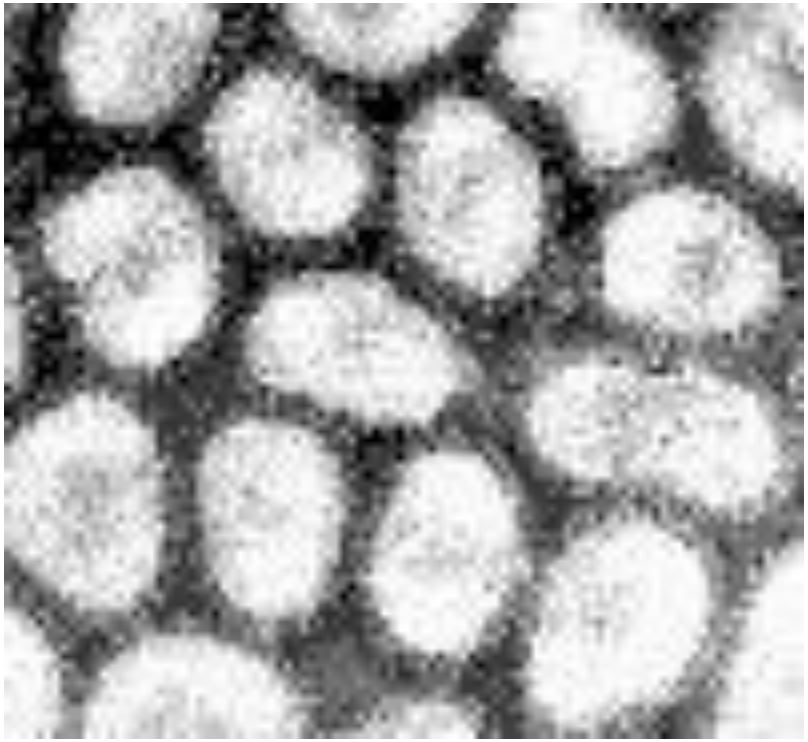
- 2- helical symmetry :

The virus particle is elongated or pleomorphic (not spherical), and the nucleic acid is spiral. Caposomeres are arranged round the nucleic acid.

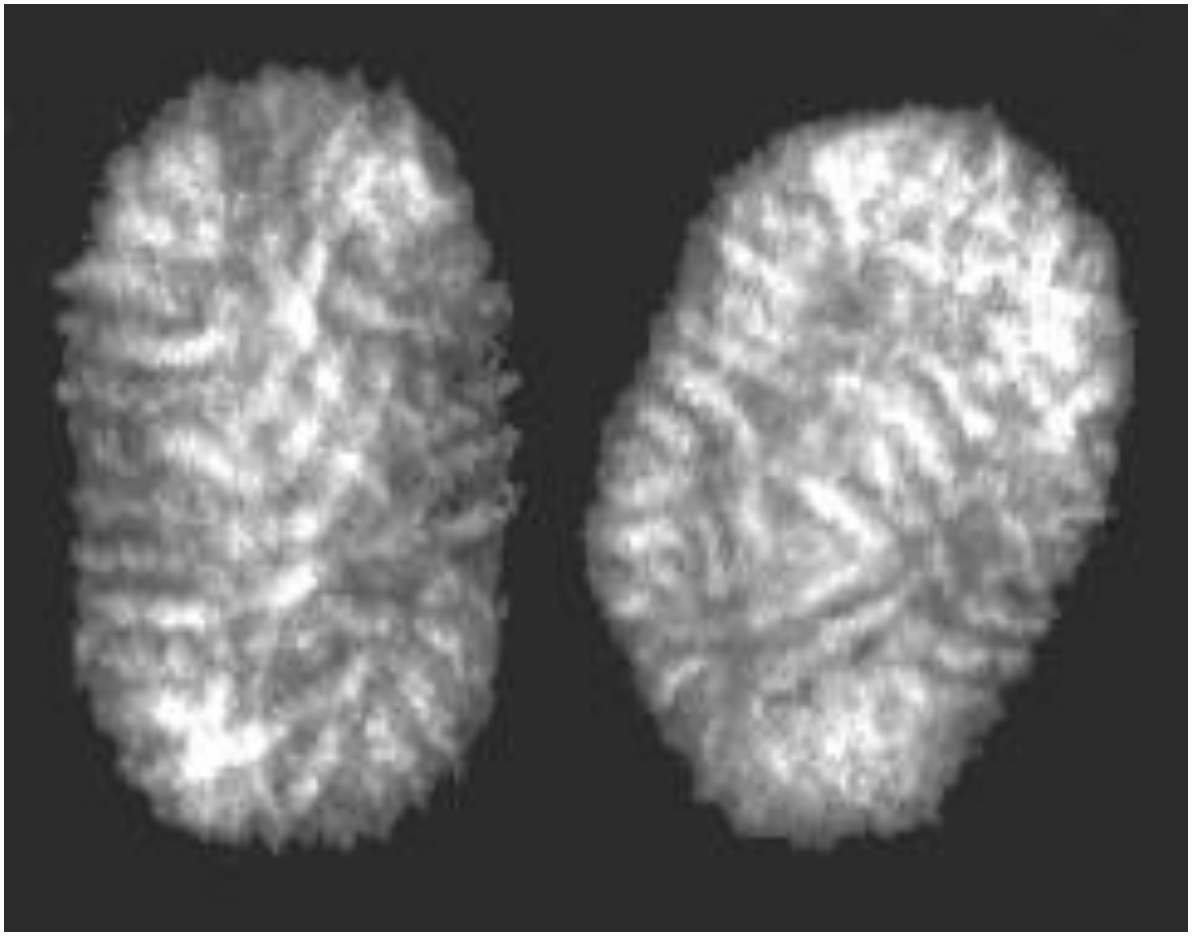
- 3- complex symmetry:

The virus particle does not confirm either cubic or helical symmetry.

Helical symmetry (influenza & rabies viruses).



Complex symmetry (Poxviruses).



Baltimore classification

Baltimore Classification of viruses

- The division of the viruses into classes based on genome type and mode of replication and transcription
- Suggested by David Baltimore – Seven Baltimore classes.
- Major groups of viruses are distinguished first by their nucleic acid content as either DNA or RNA
- RNA and DNA viruses can be single-stranded (ssRNA, ssDNA) or double-stranded (dsRNA, ssDNA)

7 class of Baltimore classification

Class	Description of genome and replication strategy	Example of bacterial virus	Example of animal virus
I	Double stranded DNA genome	Lamda,T4	Herpesvirus, poxvirus
II	Single stranded DNA genome	ØX174	Chicken anemia virus
III	Double stranded RNA genome	Ø6	Reovirus
IV	Single stranded RNA genome plus sense	MS2	Poliovirus
V	Single stranded RNA genome minus sense		Influenza virus,Rabies virus
VI	Single stranded RNA genome that replicated with DNA intermediate		Retrovirus
VII	Double stranded DNA genome that replicates with RNA intermediate		Hepatitis B virus

Class I

- Double-stranded (ds) DNA viruses are in class 1
- The production of mRNA and genome replication in such viruses occurs as it would from the host genome.

Class II

- Single-stranded(ss) DNA viruses.
- These viruses form a double stranded DNA intermediate during replication and this intermediate used for transcription.
- RNA polymerase requires double-stranded DNA as template.

Positive and Negative strand RNA viruses

- The production of mRNA and genome replication is much different with RNA viruses (Class III-VI).
- mRNA is the complementary base sequence to the template strand of DNA.
- In virology, **mRNA** is said to be ***plus***(+) configuration.
- While its **complement** is said to be the ***minus*** (-) configuration.

How does these viruses replicate?

- Cellular RNA polymerases do not catalyze formation of RNA from an RNA template but from DNA template.
- RNA viruses whether plus, negative or double stranded require a specific RNA-dependant RNA polymerase.

Class IV

- Positive-strand of RNA viruses
- Viral genome is of the plus configuration and hence serve directly as mRNA.
- The viruses required other protein, therefore mRNA encodes a *virus specific* and *RNA dependent RNA polymerase.*
- Once synthesized, this polymerase makes complementary **minus** strands of RNA and then use as template to make more **plus** strand.

Class III and Class V

- Class III (double-stranded RNA viruses)
- Class V(negative strand RNA virus)
- mRNA must be first synthesized, however cells does not have RNA polymerase.
- To circumvent ,these viruses contain enzyme in the virion,enters cell along with the genomic RNA.
- Therefore, in this case complementary plus strand is synthesized by RNA dependant RNA polymerase and used as mRNA.
- Plus strand used as template to make more negative-strand genome.

Class VI

- Single-stranded RNA genome that replicates with DNA intermediate.
- This RNA virus require reverse transcriptase to copy the information found in RNA to DNA.

Class VII

- Double-stranded DNA genome that replicates with RNA intermediate.
- Required reverse transcriptase
- Mechanism producing mRNA is similar in virus Class I

Retroviruses: are enveloped viruses that have two complete copies of (+) sense RNA. They also contain the enzyme reverse transcriptase, which uses the viral RNA to form a complementary strand of DNA, which is then replicated to form a dsDNA

***retro*, latin for "backward"**

(Class IV) in Baltimore Classification

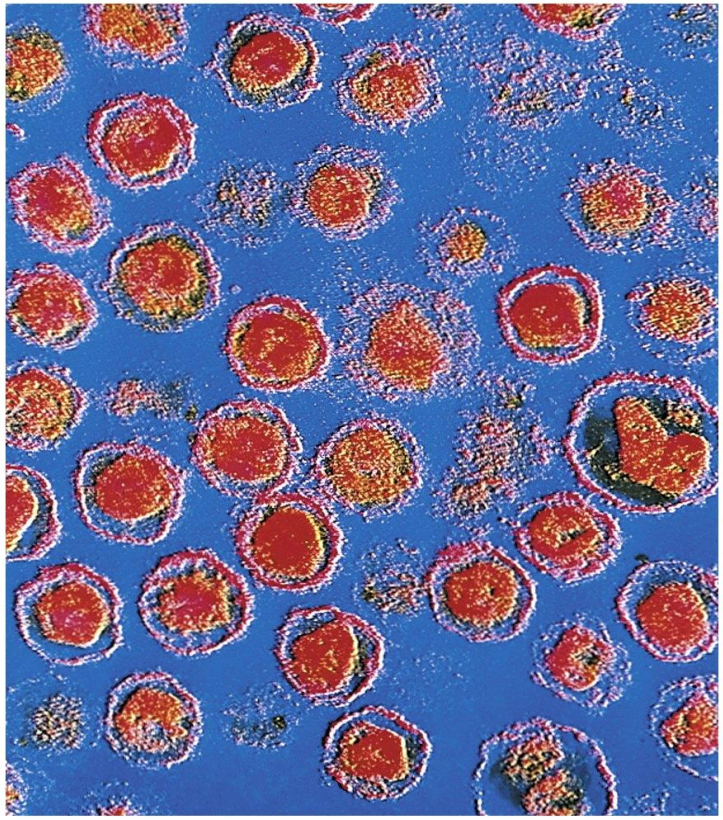


Figure 10-3b Microbiology, 6/e

Ambisense genome

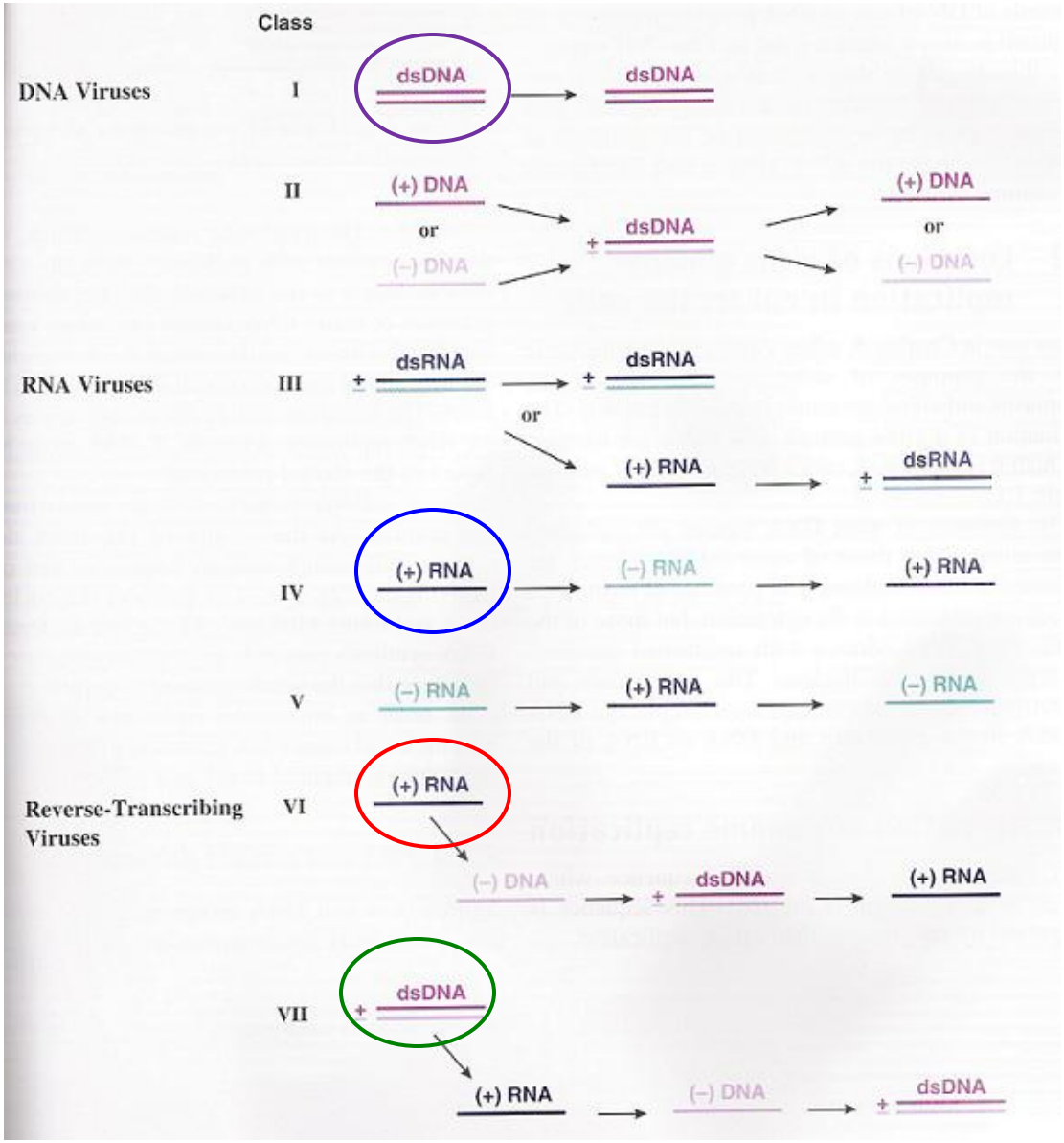
- A virus genome composed of ssDNA or ssRNA that is partly (+) sense and partly (-) sense.
- Example:

- Bunyaviridae ((-) sense RNA) and Arenavirus ((-) sense RNA)

Baltimore Classification - Advantages

1. Can classify between the (+) strand RNA viruses that do (Class VI) and do not (Class IV) undergo reverse transcription

2. Can classify between the dsDNA viruses that do (Class VII) and do not (Class I) carry out reverse transcription



General Properties of RNA Viruses

- Many ssRNA viruses contain positive (+) sense RNA, and during an infection acts like mRNA and can be translated by host's ribosomes.

- Other ssRNA viruses have negative (-) sense RNA and the RNA acts as a template during transcription to make a complementary (+) sense mRNA.

- Negative (-) sense RNA must carry a RNA polymerase within the virion.

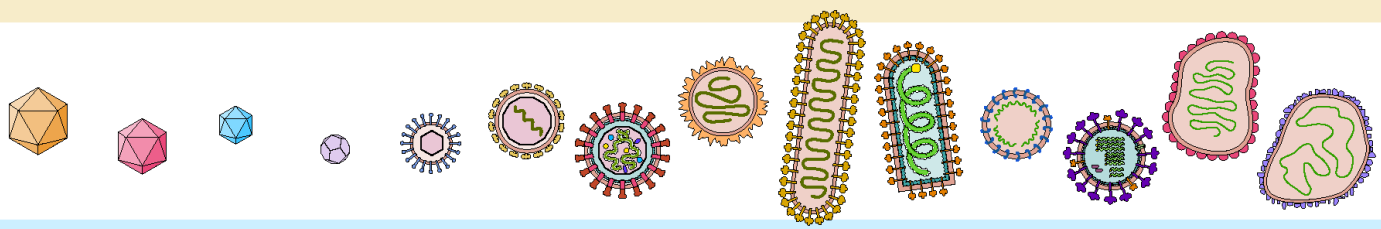
RNA dependent RNA polymerase – Class III, IV and V

- RNA viruses must either carry enzymes or have genes for those enzymes in order to copy RNA genomes after infecting a host cell

RNA VIRUSES

Classification criteria

Nucleic acid	RNA													
Symmetry of capsid	Icosahedral							Helical						
Naked or enveloped	Naked				Enveloped			Enveloped						
Genome architecture	ds 10–18 seg.	ds 2 seg.	(+) ss cont.	(+) ss cont.	(+) ss cont.	(+) ss cont.	(+) ss 2 copies	(+) ss cont.	(–) ss cont.	(–) ss cont.	(–) ss 3 seg.	(–) ss 8 seg.	(–) ss cont.	(–) ss 2 seg.
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

From Principles of Virology
Flint *et al.*, ASM Press

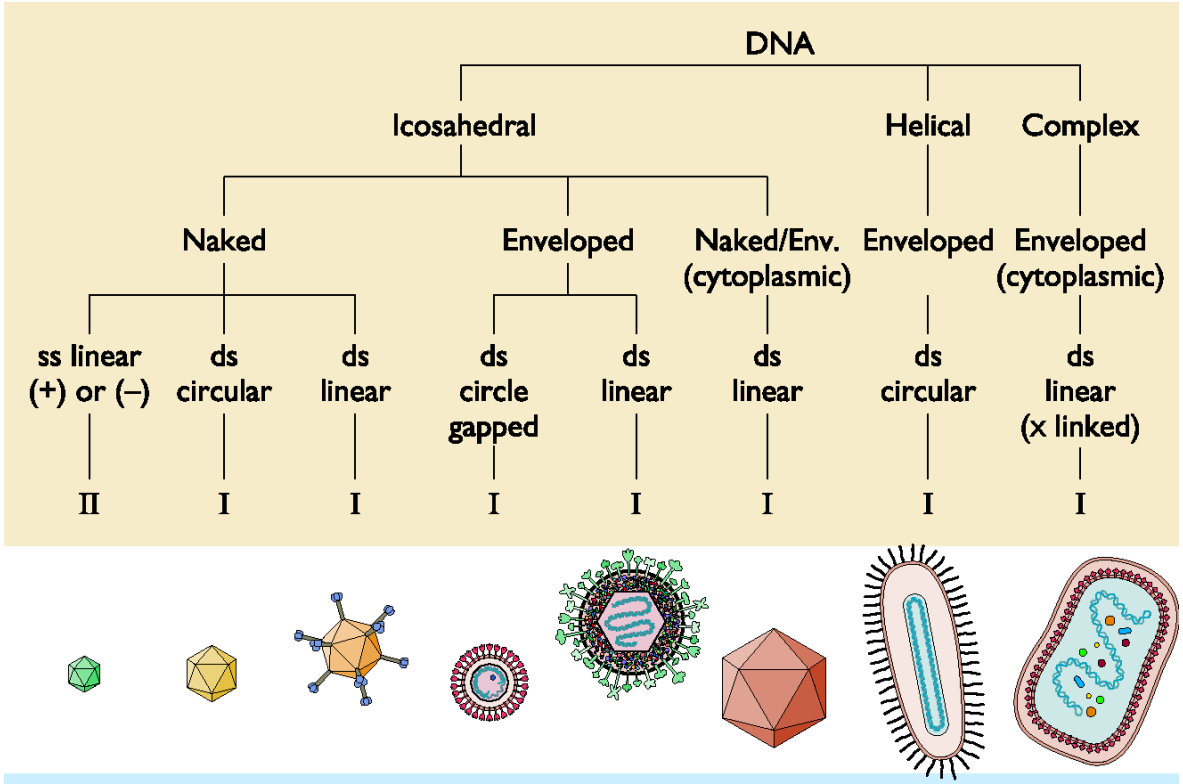
RNA viruses (+ve sense)

- Picornaviridae
- Togaviridae
- Flaviviridae
- Retroviridae

RNA viruses (-ve sense)

- Paramyxoviridae
- Rhabdoviridae
- Orthomyxoviridae
- Filoviridae
- Bunyaviridae
- Reoviridae (double-stranded)

DNA VIRUSES



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DNA viruses

Double – stranded

- Adenoviridae
- Herpesviridae
- Poxviridae
- Papovaviridae
- Hepadnaviridae

Single – stranded

- Parvoridae

Thank you