BHARATHIDASAN UNIVERSITY

Tiruchirappalli-620024

Tamil Nadu, India.

Programme: M.Sc., Biomedical Science

Course Title : Medical Virology

Course Code : BM59C19MV

Unit-I

Introduction to Virology

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Introduction to virology

Epidemiologic studies

- In developing countries, viral diseases - heavy toll in mortality and permanent disability, especially among infants and children.
- (HIV, ebola virus and hantavirus, appear regularly)
- Now that antibiotics effectively control most bacterial infections,
- Viral infections pose a relatively greater and less controlled threat to human health
- Viral infections are among the most difficult and demanding problems a physician must face.

Role in the natural selection of animal species

- Natural selection of rabbits resistant to virulent myxoma virus during several epidemics deliberately induced to control the rabbit population in Australia.
- Selective role was played by smallpox virus in humans.
- Introducing viral genetic material into animal cells by mechanisms similar to those that govern gene transfer by bacteriophages.

❑Genes from avirulent retrovirus integrated into genomes of chickens or mice produce resistance to reinfection by related, virulent retroviruses.

- The bilateral association between the virus and its host imposes specific conditions for pathogenesis.

- For example, rhinoviruses require a temperature not exceeding 34°C; this requirement restricts their growth to only those cells in the cool outer layer of the nasal mucosa, thereby preventing spread to deeper cells where temperatures are higher.

- The intracellular location of the virus often protects the virus against some of the host's immune mechanisms;
- At the same time, this location makes the virus vulnerable because of its dependence on the host cell's synthetic machinery, which may be altered by even subtle physical and chemical changes produced by the viral infection
- (inflammation, fever, circulatory alterations, and interferon)

- Viruses are difficult targets for chemotherapy because they replicate only within host cells, mainly utilizing many of the host cell's biosynthetic processes.

- The similarity of host-directed and virus-directed processes makes it difficult to find antiviral agents specific enough to exert a greater effect on viral replication in infected cells than on functions in uninfected host cells.

DISCOVERY

- Pasteur and Roux - rabies - small—but it was still a "virus" microbe.
- A virus is a submicroscopic filterable entity capable of self replication only in specific host cells.
- The "filterable virus" came to light in 1892 when Ivanowsky
- It was not until 1898 when Beijerinck repeated and confirmed.

Iwanowsky, a Russian botanist, 1892

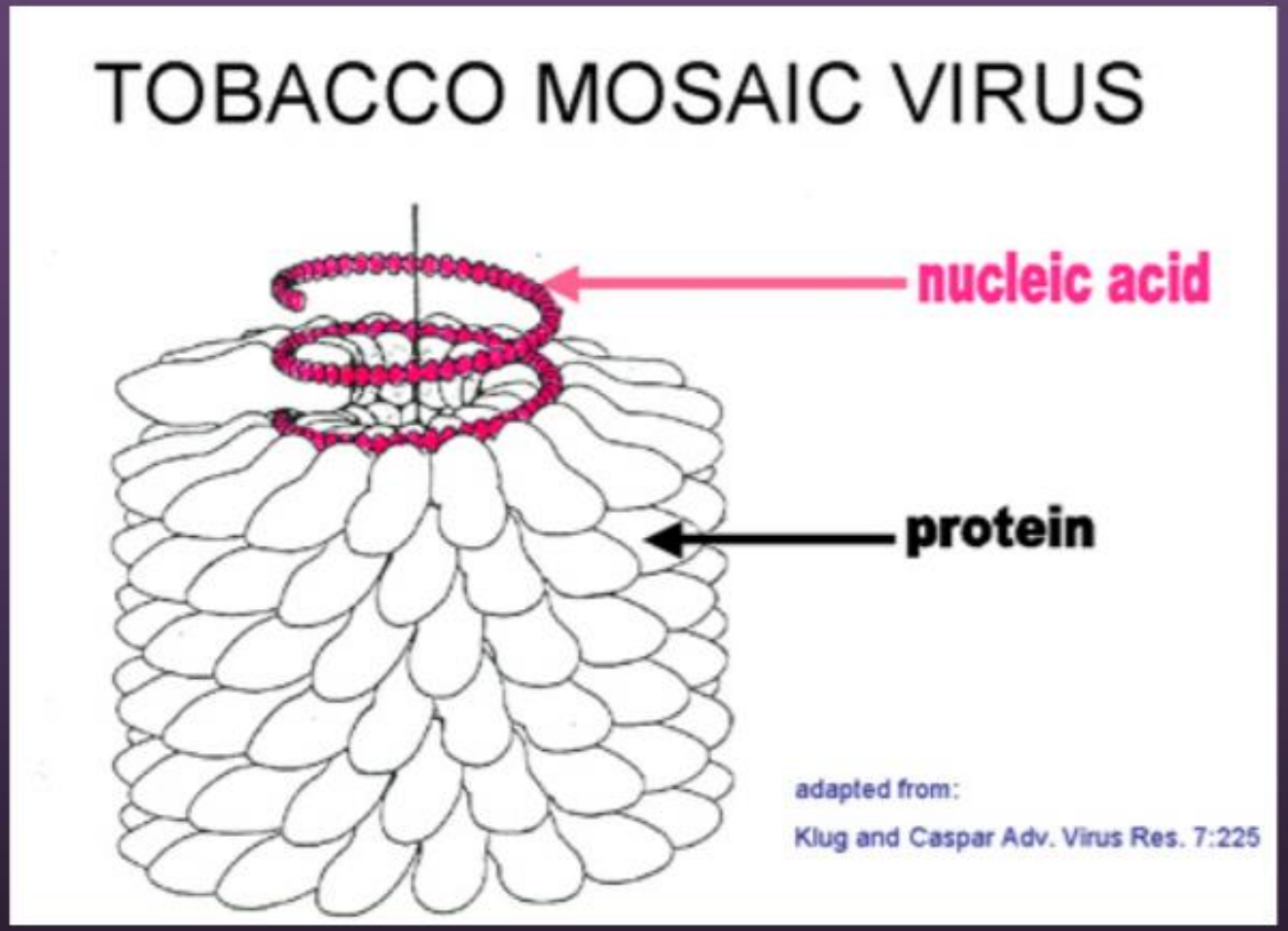
- Expressed the sap from a mosaic-infected tobacco plant and passed it under pressure through a Pasteur-Chamberland filter candle.
- The clear fluid thus obtained was sterile, free of all bacteria.
- When rubbed on the leaves of healthy tobacco plants was infectious - crude unfiltered sap.
- Concluded that he was dealing with bacteria of unusually small size;
- Electron microscope - visible for the first time.
- The intimate relationship of the virus with the living cell, was to revolutionize the whole of biology and to throw light on genetics and the structure of the gene.

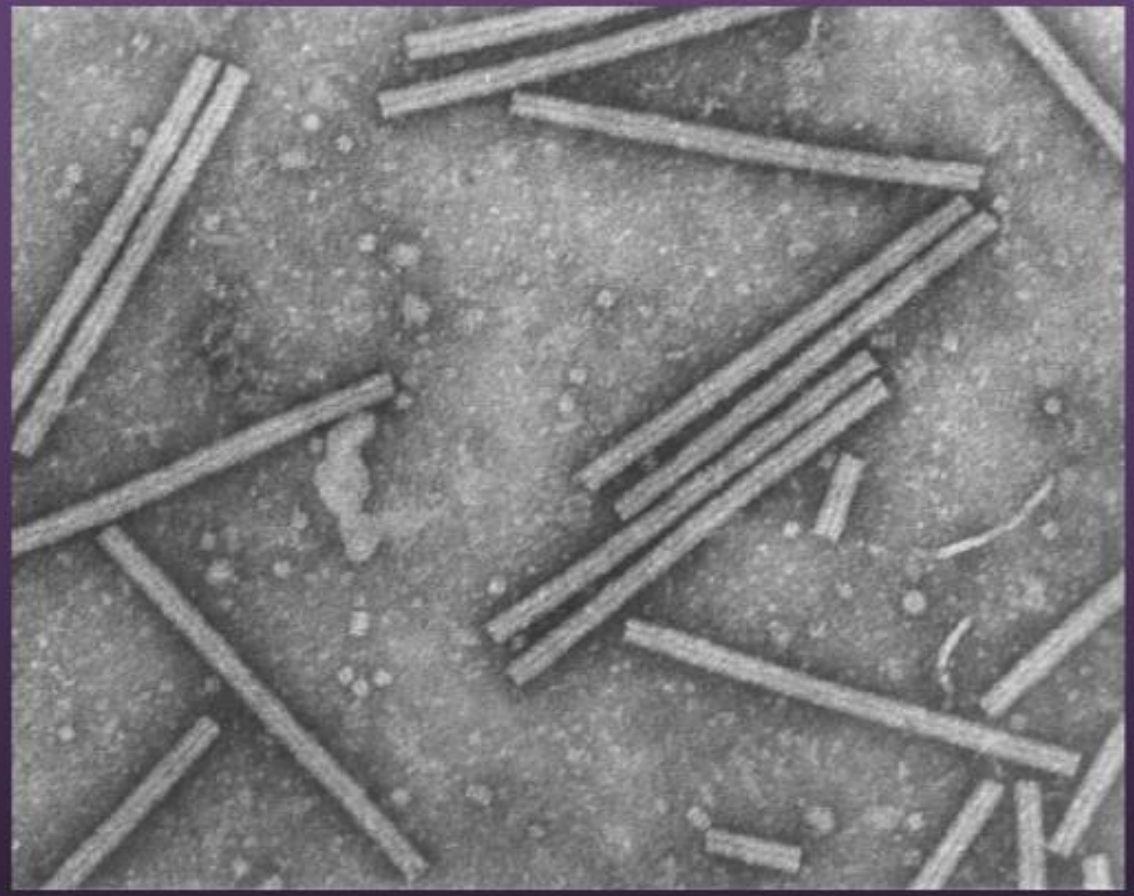
Wendell Stanley studied the tobacco mosaic virus

- He succeeded in extracting the virus in the form of pure crystals in 1935. Tobacco mosaic virus is composed of protein and ribonucleic acid, or RNA.

- 'The study of virus nucleic acid is vastly more important than any of the problems associated with the structure of the atom, for in nucleic acid structure we are dealing with life itself and with a unique approach to bettering the life of mankind on earth.'

Helical Capsid Structure





Tobacco Mosaic Virus

Viruses-Characteristics

- Have an extremely close affinity with the living cell, outside which they cannot reproduce.
- No virus has ever been cultivated in a cell-free medium.
- Their chemical constitution is simple consists of a single molecule of ribonucleic acid (RNA) or deoxyribonucleic acid (DNA) contained inside a protein coat made up of numerous identical copies of a single protein.
- The 'viroids' appear to consists of a strand of naked nucleic acid, the virus genome, without a protein coat.

- The protein coat serves two main functions:
- first, it protects the nucleic acid from extracellular environmental insults such as nucleases;
- second, it permits attachment of the virion to the membrane of the host cell, the negative charge of which would repel a naked nucleic acid.

- Virions are reproduced from their sole nucleic acid
- Viruses are unable to grow or to undergo binary fission.
- In viruses the genetic information for the synthesis of the Lipman system, the system, responsible for the production of energy with high potential, is absent.
- Viruses make use of the ribosomes of their host cells; this is defined as absolute parasitism.

- Viruses are now known to attack every kind of living organism.
- The whole animal kingdom (including, of course, man himself) and the whole plant world are susceptible to virus infection.
- Viruses are now envisaged as transmitters or vehicles of information-bearing genetic material

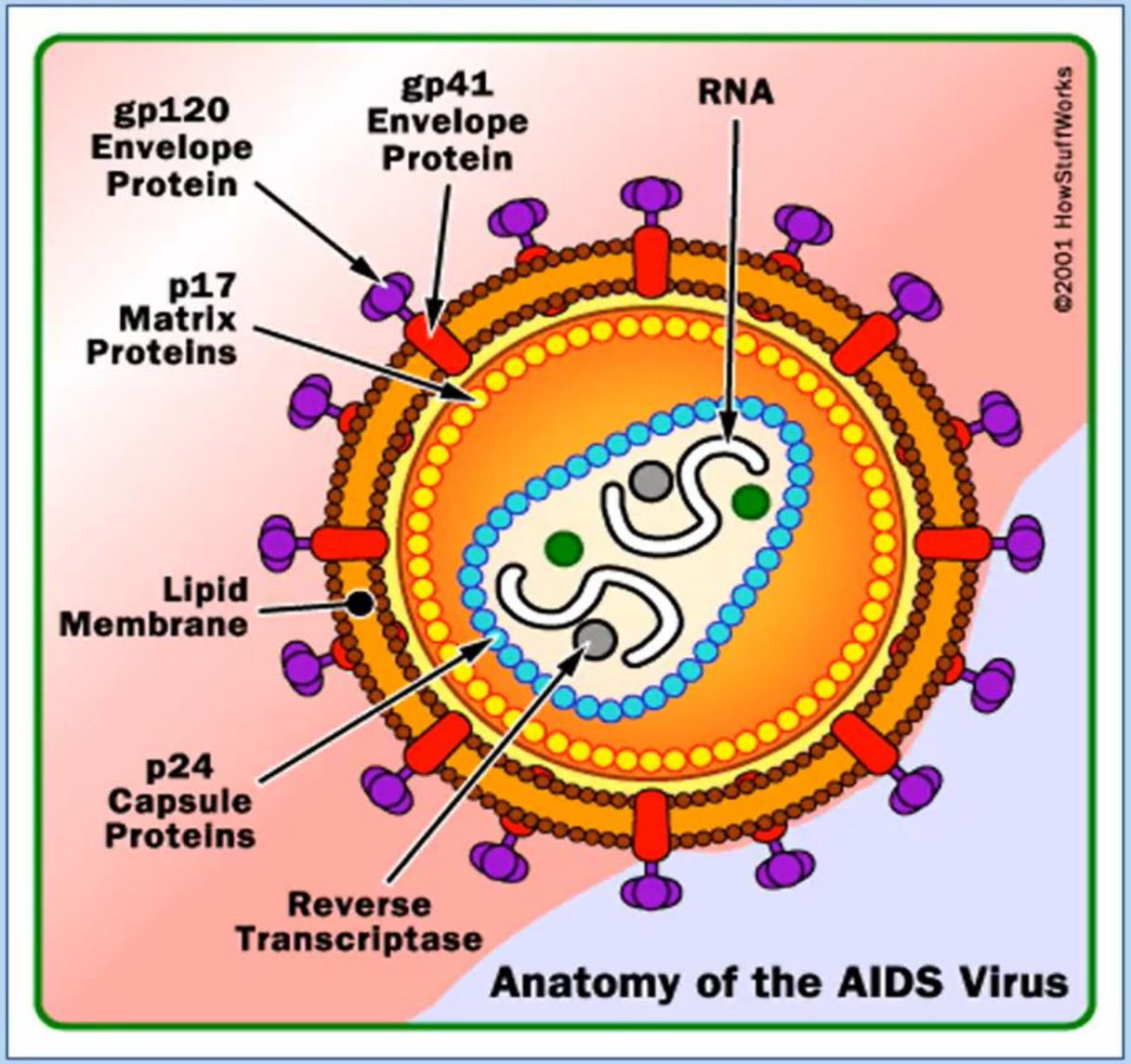
'bits of infectious heredity in search of a chromosome. '

- The main function of the virion is to deliver its DNA or RNA genome into the host cell so that the genome can be expressed (transcribed and translated) by the host cell.
- The viral genome, often with associated basic proteins, is packaged inside a symmetric protein capsid.
- The nucleic acid-associated protein, called nucleoprotein, together with the genome, forms the nucleocapsid.
- In enveloped viruses, the nucleocapsid is surrounded by a lipid bilayer derived from the modified host cell membrane and studded with an outer layer of virus envelope glycoproteins.

Viral Anatomy

Anatomical Components

- envelope
- envelope (spike) glycoproteins
- matrix proteins
- capsid
- nucleic acid
- nucleocapsid
- virus-associated enzymes



- In the case of the isometric viruses, icosahedral (twenty-sided) or near spherical, the capsomeres are arranged in a box-like form, called a capsid.

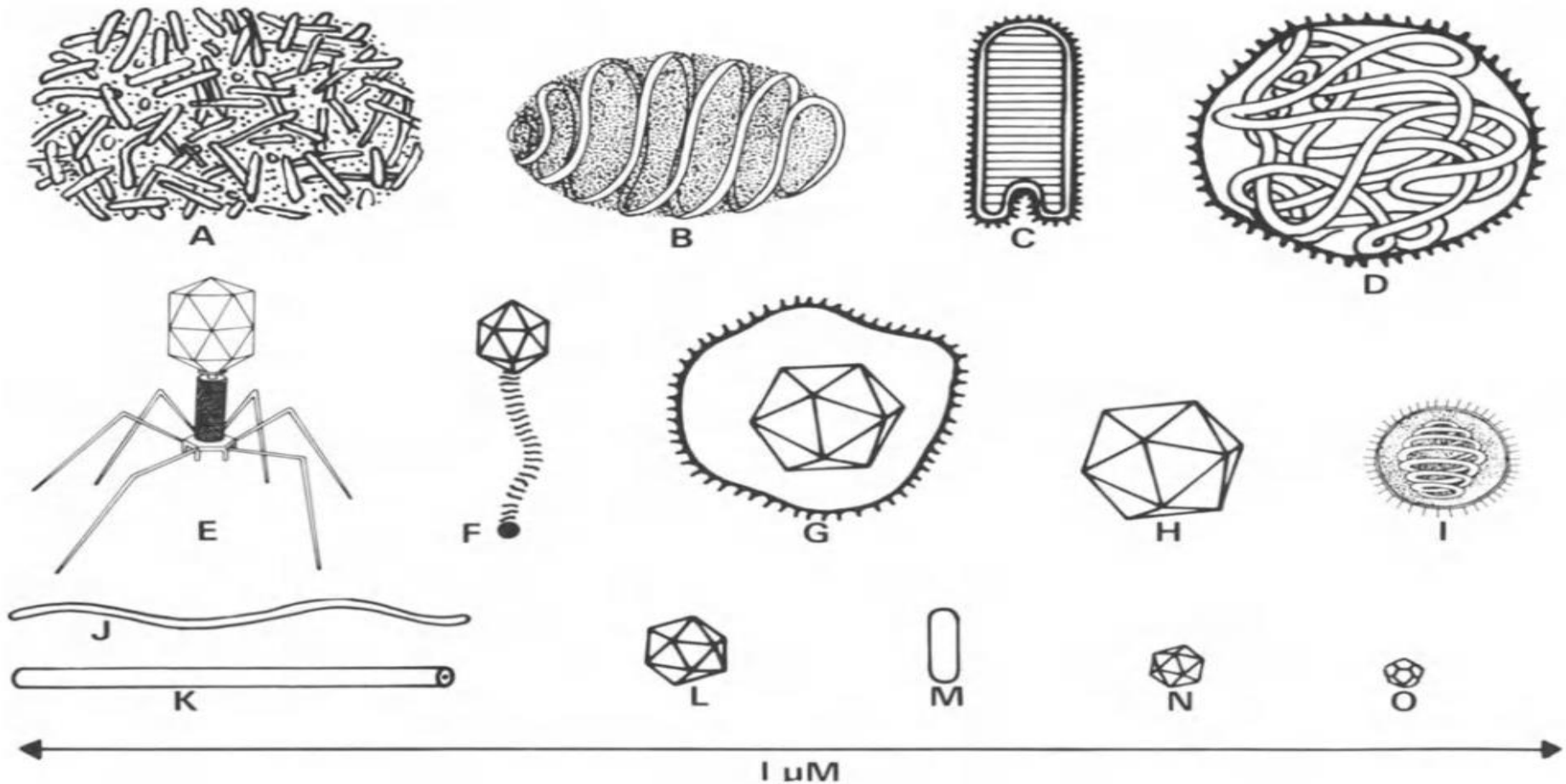
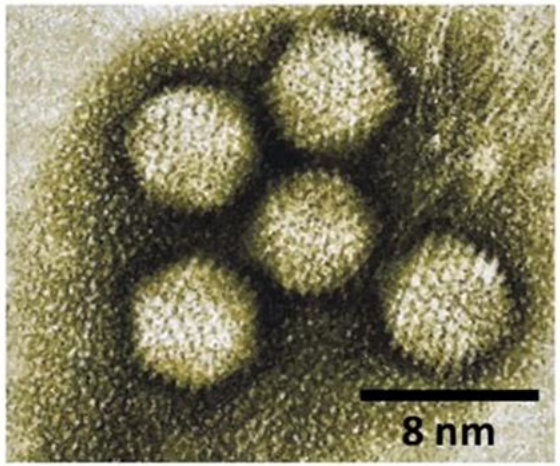


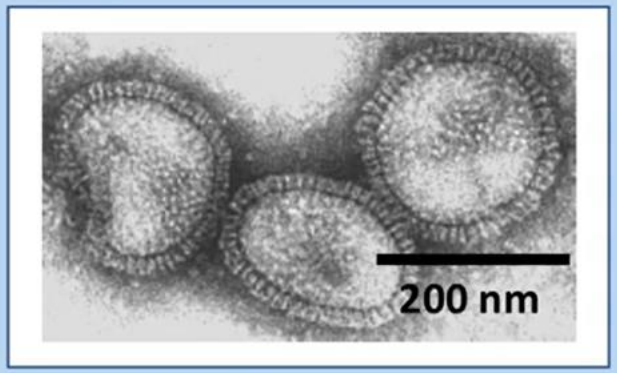
Fig. 2.4 Diagram of virus particle morphology and size range. (*Courtesy* of R.W. Horne; revised from Scientific American, 1963.)

Key: A, Poxvirus (Vaccinia); B, Poxvirus (Orf); C, Rhabdovirus; D, Paramyxovirus; E, T-even phage; F, Flexuous tailed phage; G, Herpes virus; H, Adenovirus; I, Influenza virus; J, Flexuous filamentous virus (Potato virus X); K, Rod-like virus (Tobacco mosaic virus); L, Polyomer / Papilloma virus; M, Alfalfa mosaic virus; N, Polio / Coxsackie virus; O, ϕX174 phage.

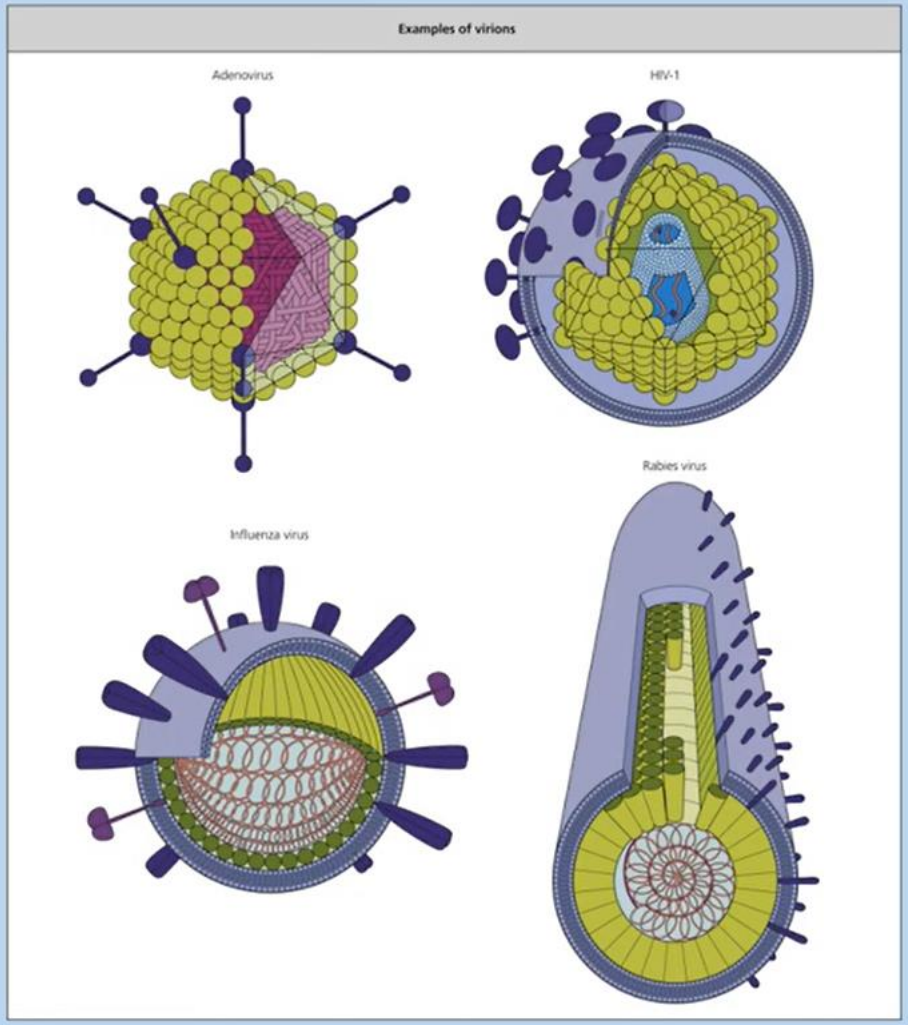
Comparative Morphologies

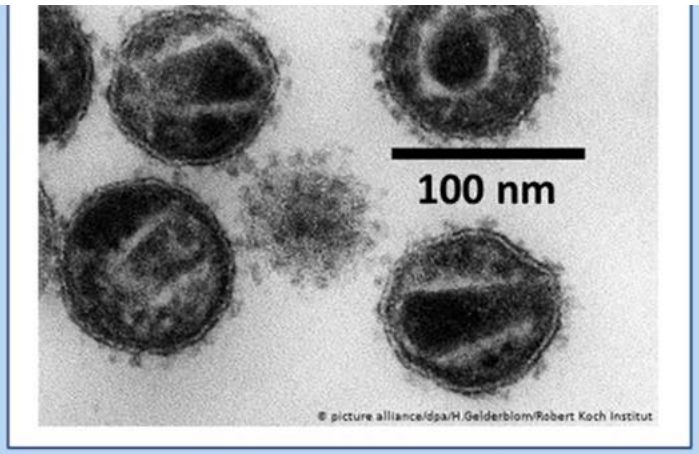


Adenovirus

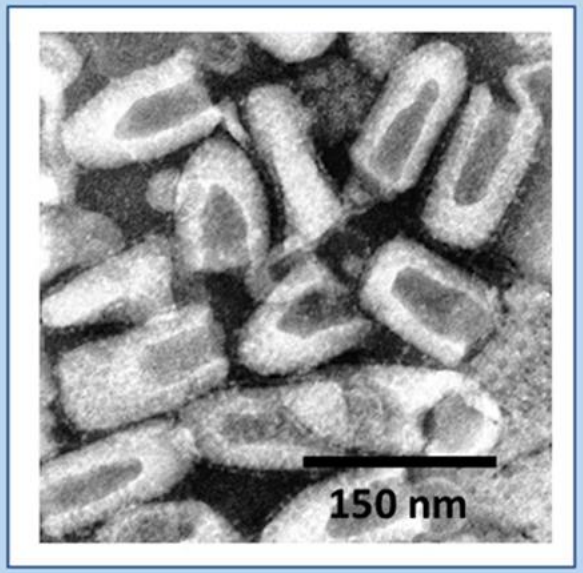


Influenza

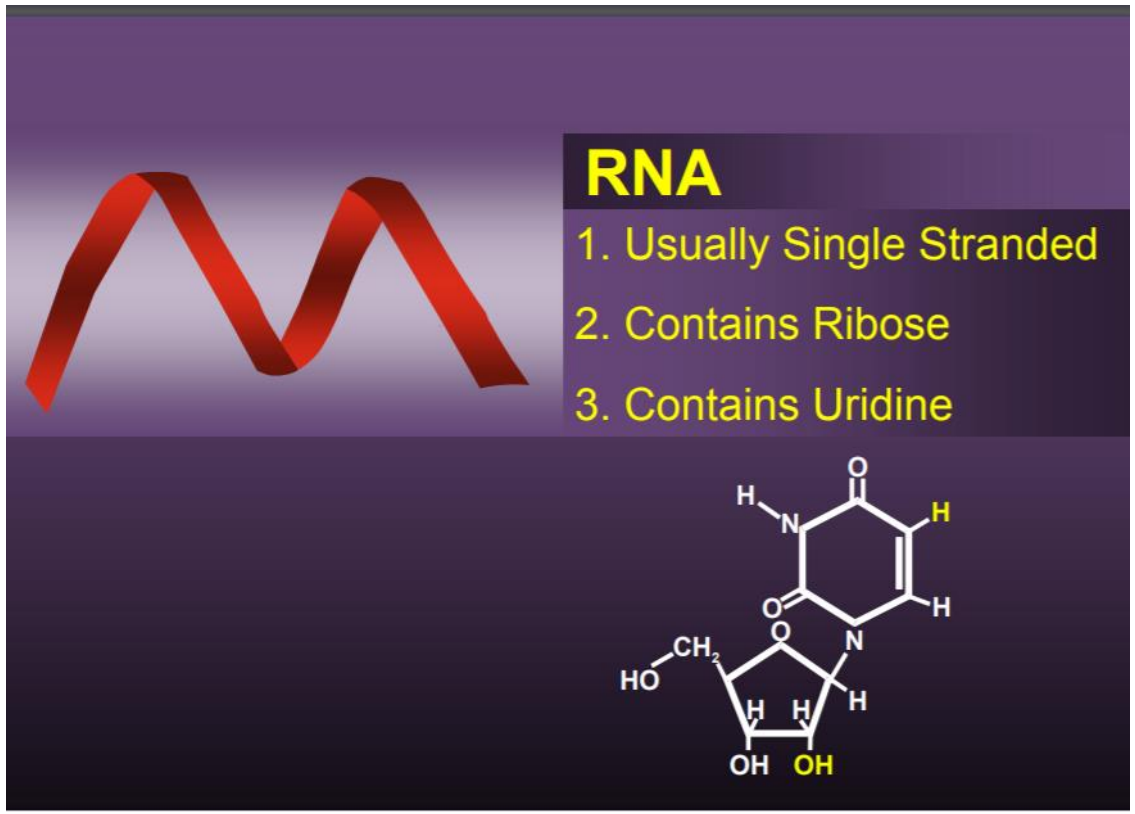


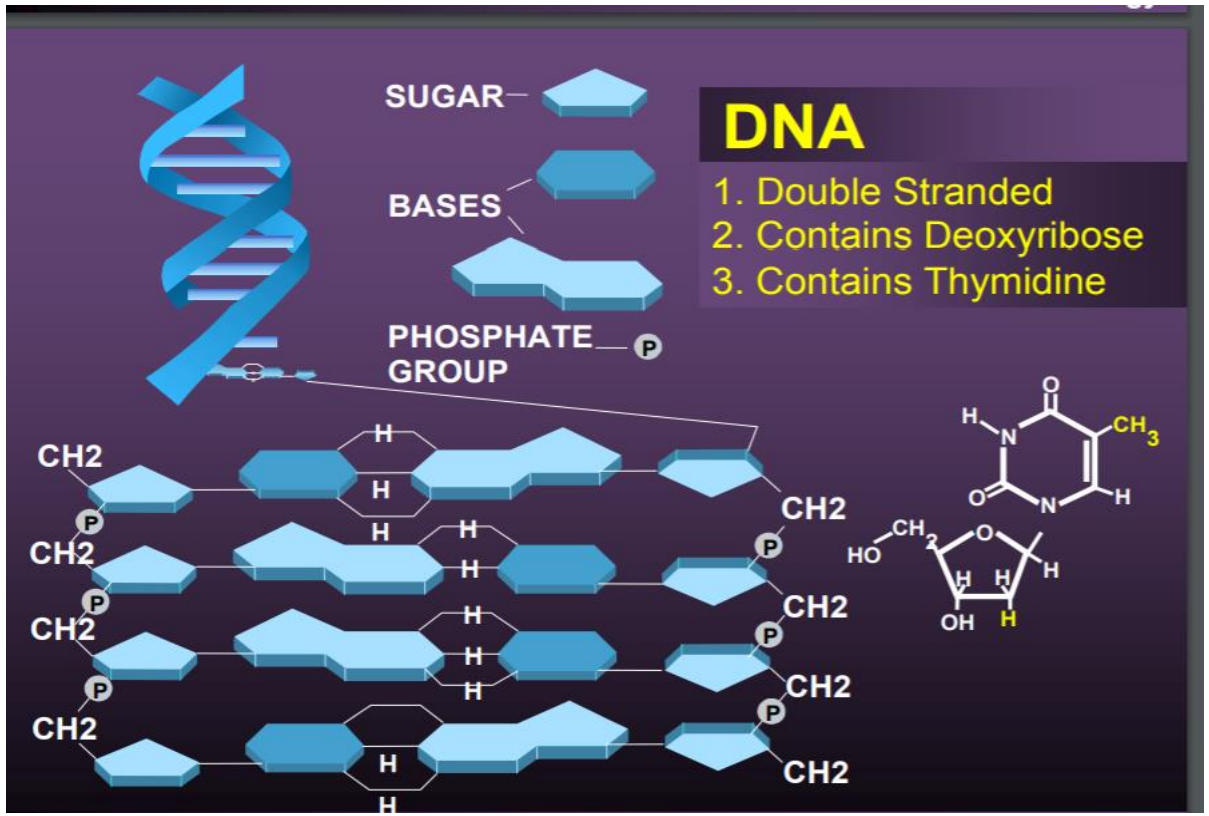


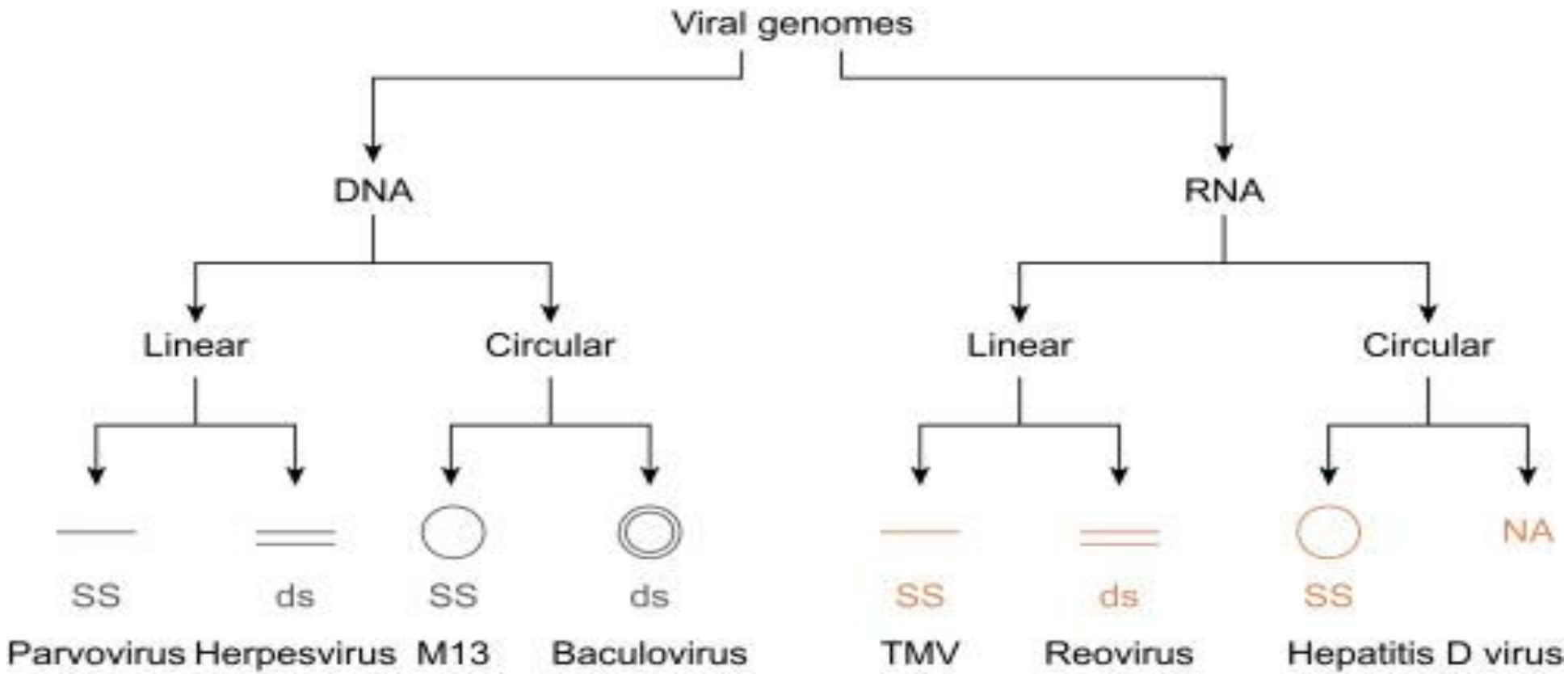
HIV



Rabies


RNA
1. Usually Single Stranded
2. Contains Ribose
3. Contains Uridine


SUGAR
BASES
PHOSPHATE GROUP
DNA
1. Double Stranded
2. Contains Deoxyribose
3. Contains Thymidine


Viral genomes
DNA
RNA
Linear
Circular
Linear
Circular
SS
ds
SS
ds
SS
ds
SS
NA
Parvovirus
Herpesvirus
M13
Baculovirus
TMV
Reovirus
Hepatitis D virus

- all DNA viruses except those belonging to Parvoviridae are double stranded and all RNA viruses except those belonging to Reoviridae are single stranded

Table 1. *Classification of human viruses.*

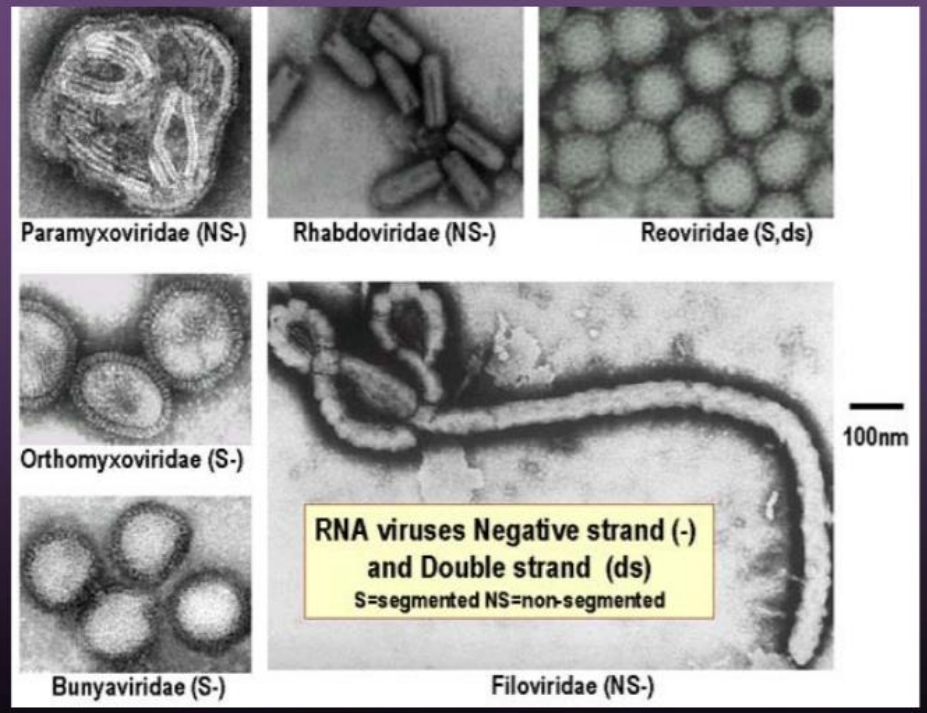
Family	Example viruses	DNA/ RNA	DS/ SS	Enveloped
Poxviridae	smallpox, cowpox, monkey pox, orf, molluscum contagiosum viruses	DNA	DS	Yes
Herpesviridae	herpes simplex viruses types 1 and 2 (HSV), varicella-zoster virus (VZV), cytomegalovirus (CMV), Epstein–Barr virus (EBV), human herpes viruses 6, 7 and 8 (HHV 6, 7 and 8)	DNA	DS	Yes
Adenoviridae	adenoviruses	DNA	DS	No
Papovaviridae	papilloma and polyoma viruses	DNA	DS	No
Hepadnaviridae	hepatitis B virus	DNA	DS	No
Parvoviridae	human parvovirus B19	DNA	SS	No
Reoviridae	rotaviruses	RNA	DS	No
Picornaviridae	enteroviruses, rhinoviruses, hepatitis A virus	+RNA	SS	No
Caliciviridae	hepatitis E virus, noroviruses	+RNA	SS	No
Coronaviridae	coronaviruses	+RNA	SS	Yes
Flaviviridae	hepatitis C virus, yellow fever virus	+RNA	SS	Yes
Togaviridae	rubella virus	+RNA	SS	Yes
Paramyxoviridae	parainfluenza viruses, respiratory syncytial virus (RSV), measles virus, mumps virus	−RNA	SS	Yes
Orthomyxoviridae	influenza A and B viruses	−RNA	SS	Yes
Rhabdoviridae	rabies virus	−RNA	SS	Yes
Filoviruses	Ebola virus	−RNA	SS	Yes
Bunyaviridae	hantavirus, Crimean–Congo haemorrhagic fever virus etc.	−RNA	SS	Yes
Arenaviridae	Lassa fever virus	−RNA	SS	Yes
Retroviridae	human immunodeficiency virus (HIV), human T-cell lymphotrophic virus (HTLV)	+RNA	SS	Yes

DNA genomes		Examples
	ss, linear	Parvoviruses
	ds, linear	Poxviruses
	ss, circular	Phage φX174
	ds, circular	Baculoviruses

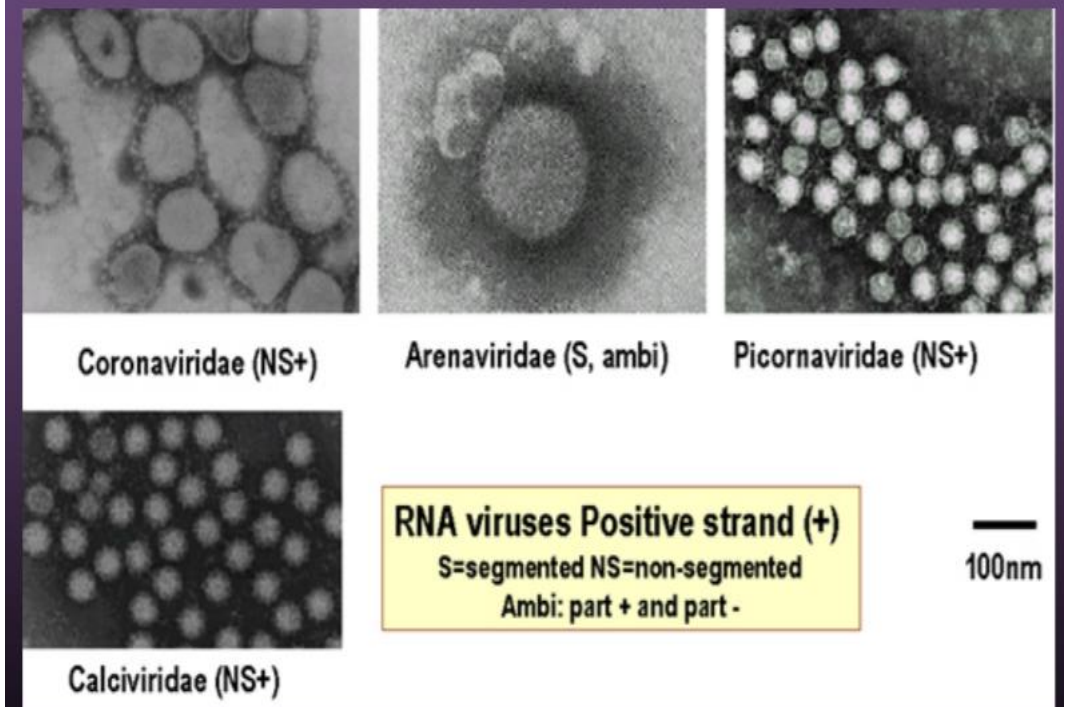
RNA genomes

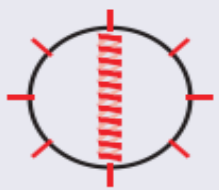
ss, linear	Tobacco mosaic virus
ds, linear	Reoviruses
ss, circular	Hepatitis delta virus

Relative Size of Negative Strand RNA Viruses



Relative Size of Positive Strand RNA Viruses



Main types of virion structure		Genomes			
		dsDNA	ssDNA	dsRNA	ssRNA
Icosahedral, naked		✓	✓	✓	✓
Icosahedral, enveloped		✓		✓	✓
Helical, naked		✓	✓		✓
Helical, enveloped					✓

REFERENCES

- Marvin, D. A., and Barbara Hohn. "Filamentous bacterial viruses." Bacteriological reviews 33.2 (1969): 172-209.
- Delbrock, M. "Bacterial viruses or bacteriophages." Biological Reviews 21.1 (1946): 30-40.
- Maruyama, Ichiro N., Hiroko I. Maruyama, and Sydney Brenner. "Lambda foo: a lambda phage vector for the expression of foreign proteins." Proceedings of the National Academy of Sciences
- Venturini, Carola, et al. "Diversity of P1 phage-like elements in multidrug resistant Escherichia coli." Scientific Reports 9.1 (2019): 18861.

THANK YOU