

# Virology: Lecture 3

## The basics of virus classification

Ausama A. Yousif  
DVM, MSc, PhD

Associate Professor of Virology and Biotechnology

# Lecture Objectives

- Overview of the approaches used in virus classification.
- Discuss the basics of each approach used in virus classification.
- Discuss other concepts related to virus classification.

# **CLASSIFICATION SCHEMES**

- **Based on virus shape and composition: The Hierarchical virus classification system.**
- **The mode of viral replication.**
- **The Universal System of Virus Taxonomy (USVT) is most widely used.**
- **Based on phylogeny [evolutionary relationships].**

# CLASSIFICATION SCHEMES

## The Hierarchical Virus Classification System

Nucleic acid genome:

DNA or RNA

ds or ss

positive or negative

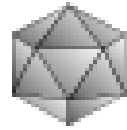
segmented or non-segmented

linear or circular

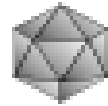
- Size and Geometry of the capsid or nucleocapsid: Helical or Icosahedral.
- Presence or absence of a lipid bilayer envelope.

# RNA

## dsRNA



**Reoviridae**  
*Orthoreovirus*  
*Orbivirus*  
*Coltivirus*  
*Rotavirus*  
*Aquareovirus*

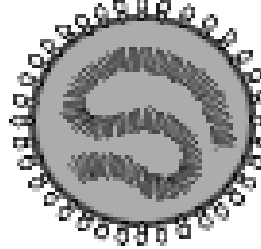


**Birnaviridae**  
*Aquabirnavirus*  
*Avibirnavirus*

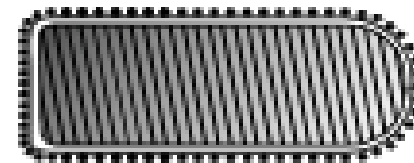
## ssRNA (-)



**Orthomyxoviridae**

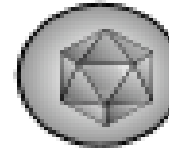


**Paramyxoviridae**



**Rhabdoviridae**

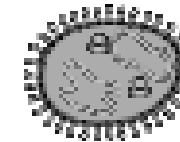
*Lyssavirus*  
*Vesiculovirus*  
*Ephemerovirus*  
*Novirhabdovirus*



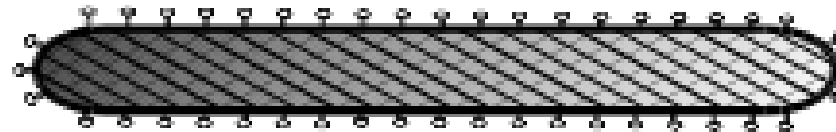
**Bornaviridae**



**Deltavirus**



**Arenaviridae**

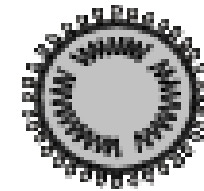


**Filoviridae**

## ssRNA (RT)



**Retroviridae**



**Bunyaviridae**

*Orthobunyavirus*  
*Hantavirus*  
*Nairovirus*  
*Phlebovirus*

## ssRNA (+)



**Caliciviridae**



HEV-like



**Nodaviridae**  
*Betanodavirus*



**Togaviridae**



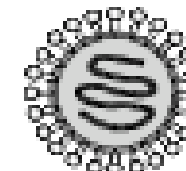
**Picornaviridae**



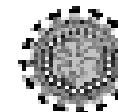
**Astroviridae**



**Flaviviridae**



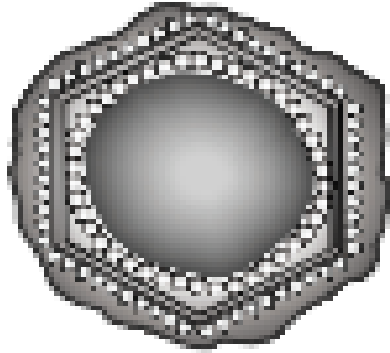
**Coronaviridae**



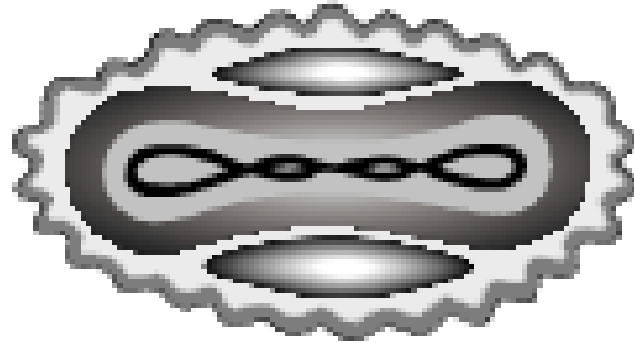
**Arteriviridae**

# DNA

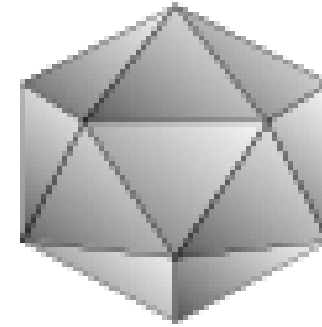
**dsDNA**



*Asfarviridae*



*Poxviridae*  
*Chordopoxvirinae*

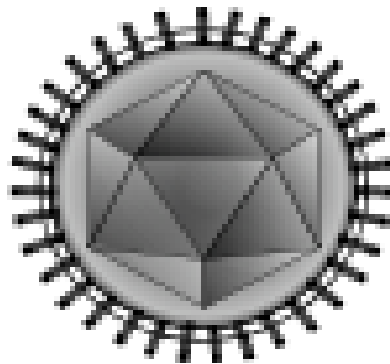


*Iridoviridae*  
*Ranavirus*  
*Lymphocystivirus*

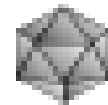
**dsDNA (RT)**



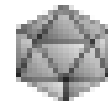
*Hepadnaviridae*



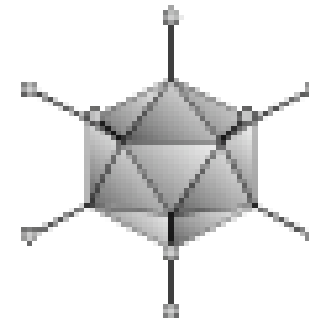
*Herpesviridae*



*Polyomaviridae*



*Papillomaviridae*



*Adenoviridae*

**ssDNA**



*Circoviridae*



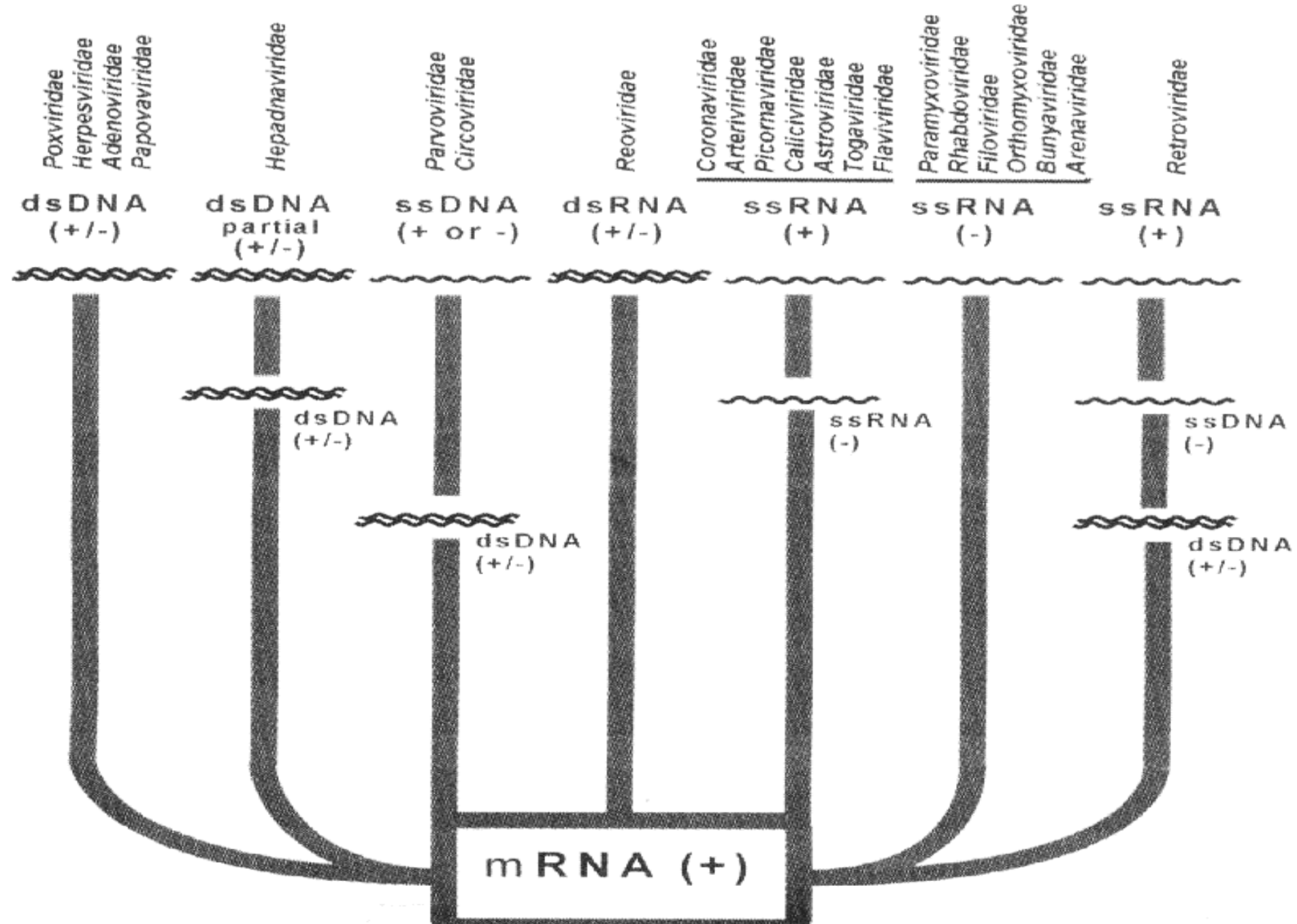
*Parvoviridae*  
*Parvovirinae*

**100 nm**

# CLASSIFICATION SCHEMES

## Mode of viral replication and mRNA synthesis

modified from the Baltimore Classification



# CLASSIFICATION SCHEMES

## The Universal System of Virus Taxonomy (USVT )

1. Most widely used.
1. Recognizes orders, families / subfamilies, genera and species.
1. Established by the International Committee on Taxonomy of Viruses (ICTV) since 1966.



# USVT

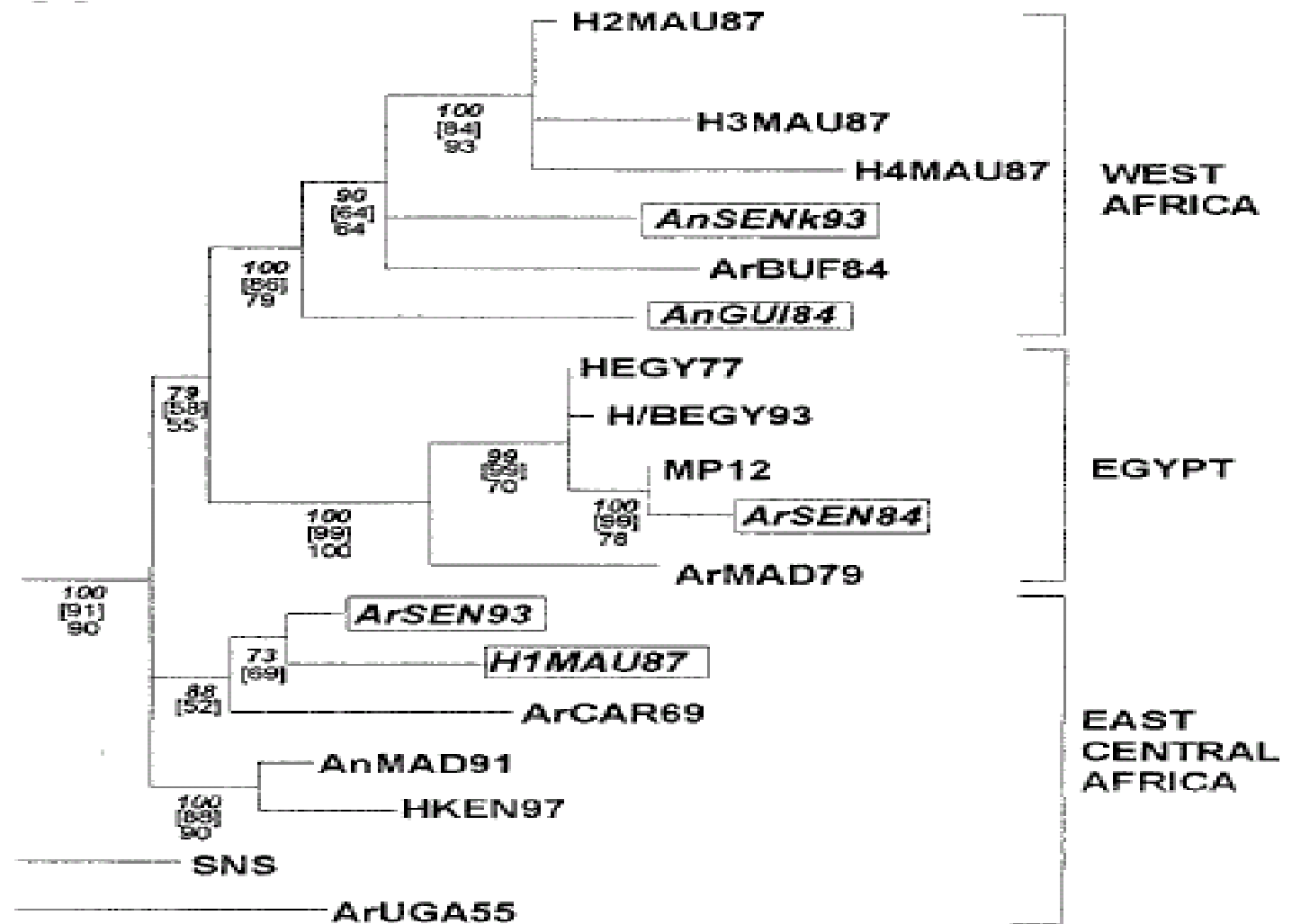
- - **Order (-virales)** being the highest currently recognized.
  - - then **Family (-viridae)**
    - - **Subfamily (-virinae)**
      - - **Genus (-virus)**
      - - **Species**

For example, the **Ebola** virus from Kikwit is classified as:

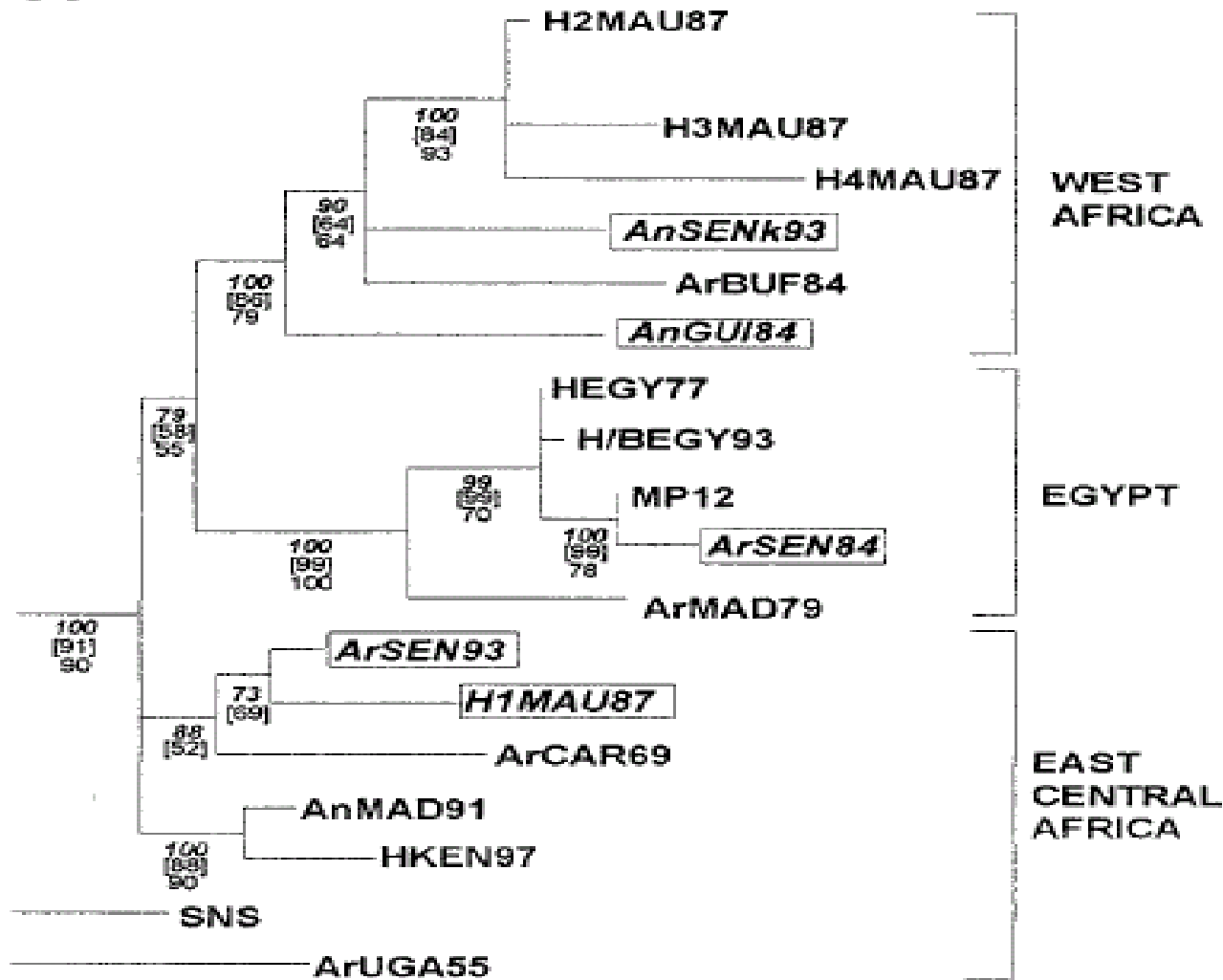
- **Order Mononegavirales** (Paramyxoviridae, Rhabdoviridae, Bornaviridae and Filoviridae)
- **Family Filoviridae**
- **Genus Filovirus**
- **Species: Ebola virus Zaire**

# CLASSIFICATION SCHEMES: Based on phylogeny

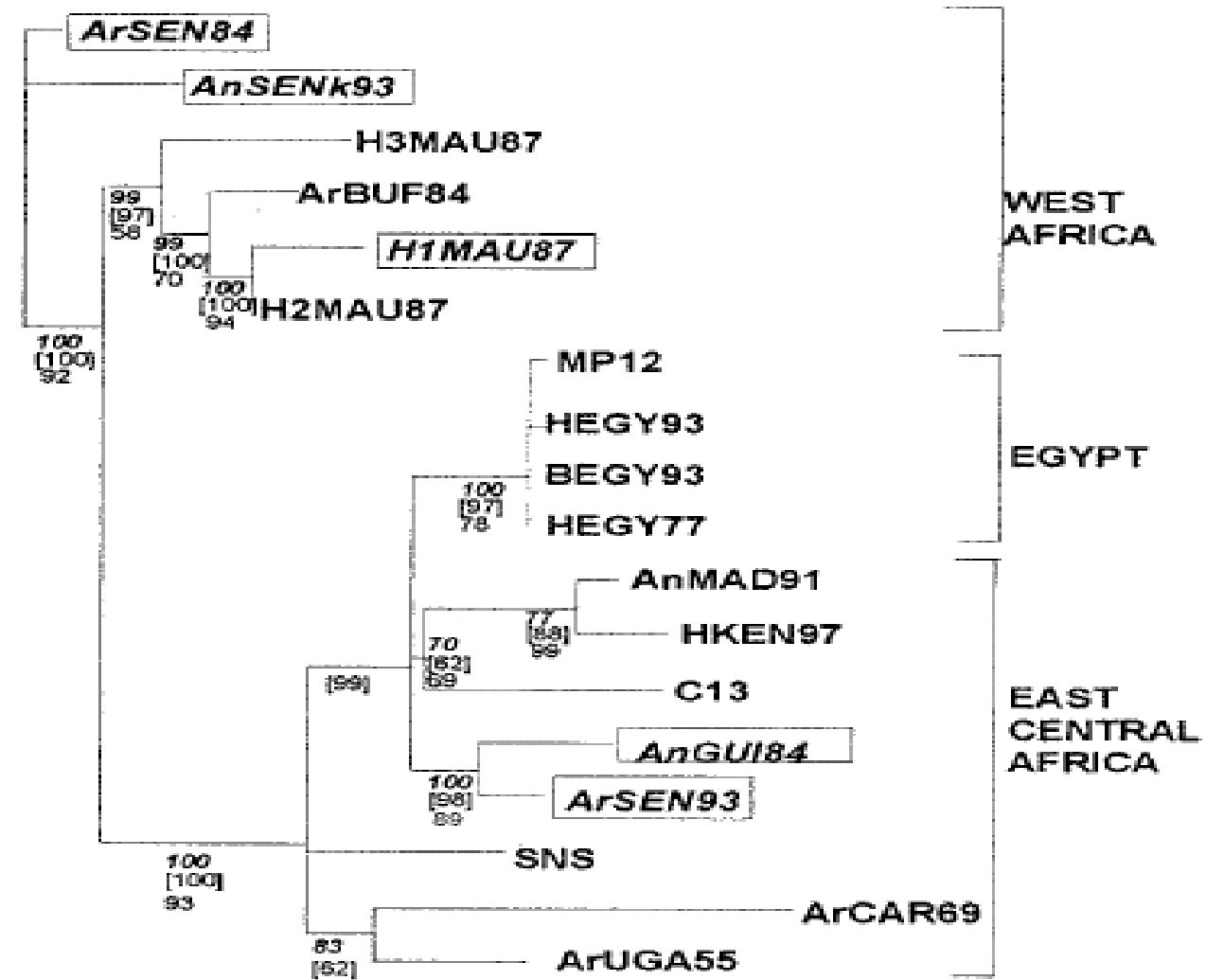
- Nucleotide sequences compared.
- Computational analysis.
- Numbers on trees indirectly represent genetic relationships.
- Can distinguish lineages.
- Genotyping.



*RVFV L segment*



*RVFV M segment*



*Genome segmentation and genotyping*

# Other Concepts Related to Virus Classification

- **Biotypes**: Some viruses have cytopathogenic and non-cytopathogenic biotypes [Flaviviridae, pestiviruses].
- **Pathotypes**: Many viruses have strains of varying virulence characteristics [Lentogenic, mesogenic, and velogenic strains of NDV].
- **Genotypes**: pathotypes and biotypes are not linked. The link to genotypes is not fully understood.
- Viruses can be grouped based on **Epidemiological criteria** (Arbo, Enteric, Respiratory, etc).

## Useful Virology web-sites

**General** “All the Virology on the www”

<http://www.virology.net/>

**Structures (X-ray crystallography and cryo-EM)**

<http://www.virology.wisc.edu/IMV/>

<http://www.uct.ac.za/depts/mmi/stannard/emimages.html>

**Universal Virus database**

<http://www.ncbi.nlm.nih.gov/ICTVdb/>

**Virus Particle Explorer (VIPER)**

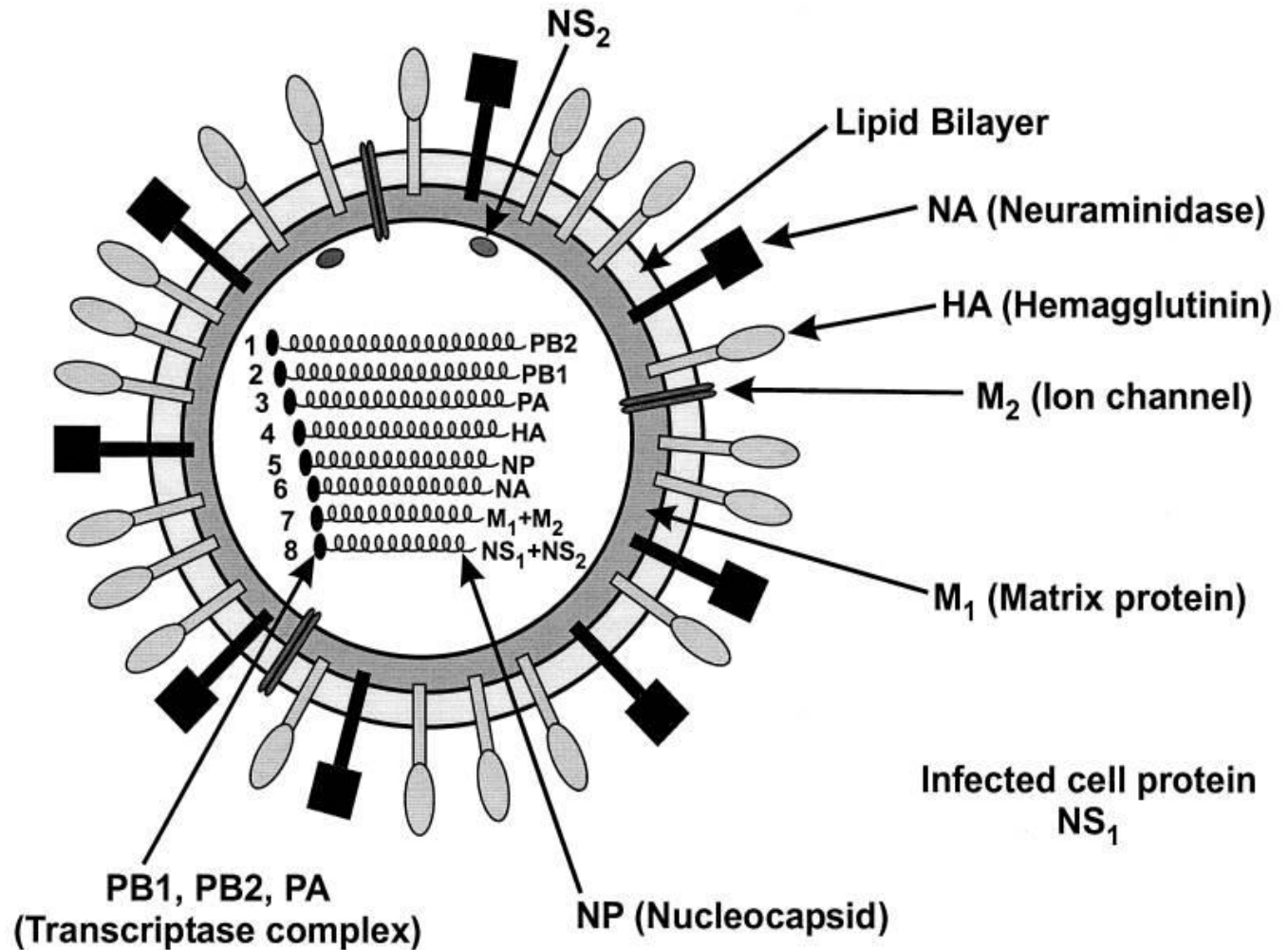
<http://mmtsb.scripps.edu/viper/>

# POP Exam

Self-learning

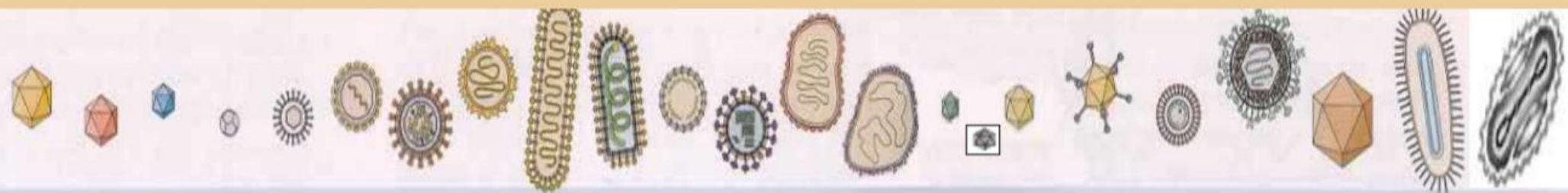
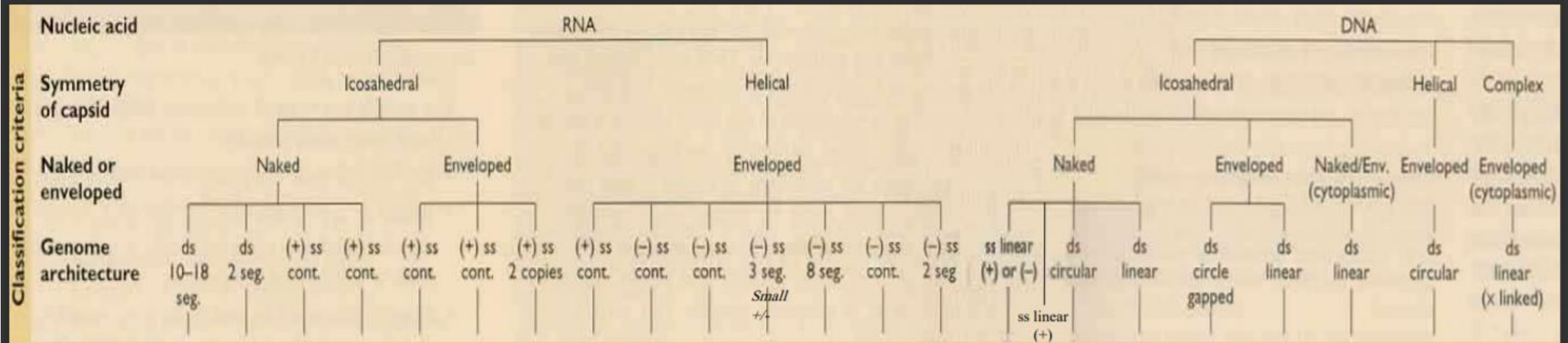
Please, try to classify this virus.

Hint: Write what you see only.



# Take-Home Exercise

Draw the general scheme for virus classification based on the USVT giving only one example for each group.



Properties	Reo	Birna	Calici	Picorna	Flavi	Toga	Retro	Corona	Filo	Rhabdo	Bunya	Orthomyxo	Paramyxo	Arena	Parvo	Papova	Adeno	Hepadna	Herpes	Irido	Baculo	Pox
Family name	Reo	Birna	Calici	Picorna	Flavi	Toga	Retro	Corona	Filo	Rhabdo	Bunya	Orthomyxo	Paramyxo	Arena	Parvo	Papova	Adeno	Hepadna	Herpes	Irido	Baculo	Pox
Virion polymerase	(+)	(+)	(-)	(-)	(-)	(-)	(+)	(-)	(+)	(+)	(+)	(+)	(+)	(+)	(-)	(-)	(-)	(+)	(-)	(-)	(-)	(+)
Virion diameter (nm)	60-80	60	35-40	28-30	40-50	60-70	80-130	80-160	80 x 790-14,000	70- 85 x 130-380	90-120	90-120	150-300	50-300	18-26	45-55	70-90	42	150-200	125-300	60 X 300	170-200 x 300-450
Genome size	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	5	5-8	36-38	3.2	120-200	150-350	100	130-280
Average in Kb or Kbp															1.7-2.3							