Viruses

Infectious agents of **small size and simple composition** that can **multiply only in living cells** of animals, plants, bacteria,…etc.

Viruses are **obligate intracellular parasites** that are metabolically inert when they are outside their hosts. They all **rely, to varying extents, on the metabolic processes of their hosts to reproduce themselves**.

The viral **diseases** we see are due to the effects of this interaction between the **virus and its host cell (and/or the host's response to this interaction).**

WHAT ARE VIRUSES?

- NUCLEIC ACID GENOME:
  - DNA OR RNA
- PROTEIN COAT
  - PROTECTION, ENTRY
- LIPID ENVELOPE IN SOME VIRUSES
- SMALL
  - (20-400nm)
- OBLIGATE INTRACELLULAR PARASITES

Virus

* Can infect all cell types:

animals, plants, bacteria, fungi,algae,protozoa

* Exists in intracellular & extracellular state

Replicative **Transmissible**

Extracellular state : VIRION

Differences between virus and bacteria

No.	Item	Bacteria	Virus
1	Cell wall	+ve	-ve
2	Organelles	+ve	-ve
3	Nuclear membrane	+ve	-ve
4	Metabolism	+ve	-ve
5	Type of nucleic acid	DNA and RNA	DNA or RNA
6	Infectious nucleic acid	-ve	+ve
7	Size	Over 300 nm	Under 300 nm
8	Sensitivity to interferon	-ve	+ve
9	Sensitivity to antibiotics	+ve	-ve
10	Replication	Binary fission	Host cell dependant

Virus

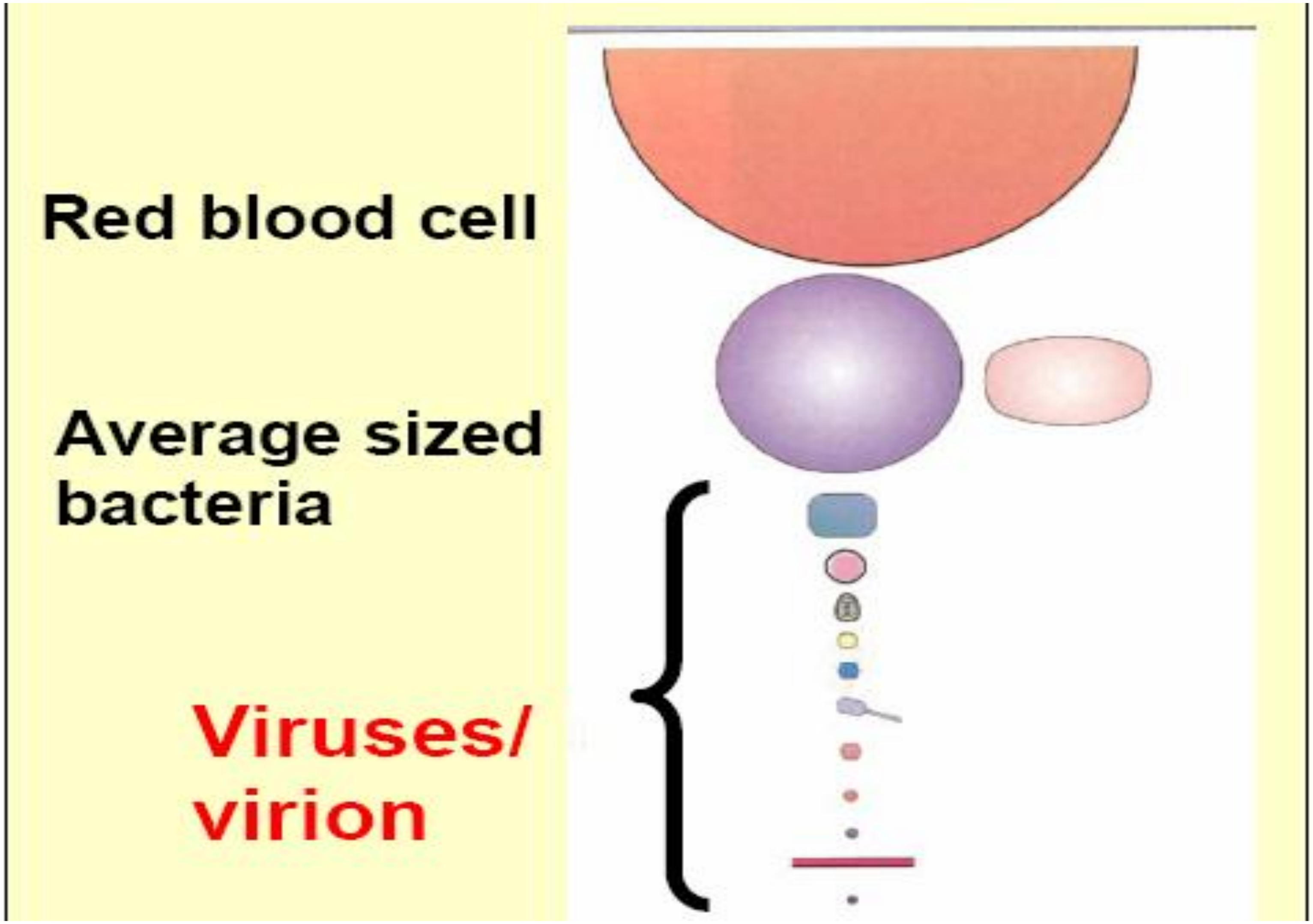
Morphology

- Structure of virion is diverse

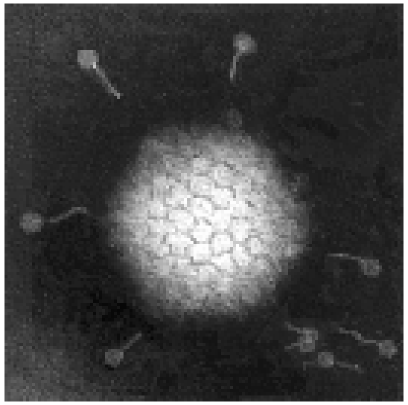
  Varies in: size, shape, chemical composition

Size 20 nm to 300 nm (Smallpox 200 nm)

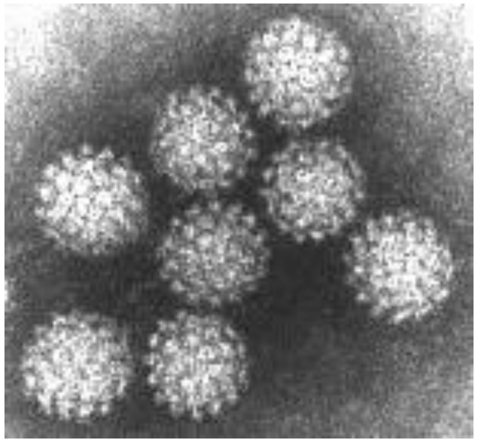
Size



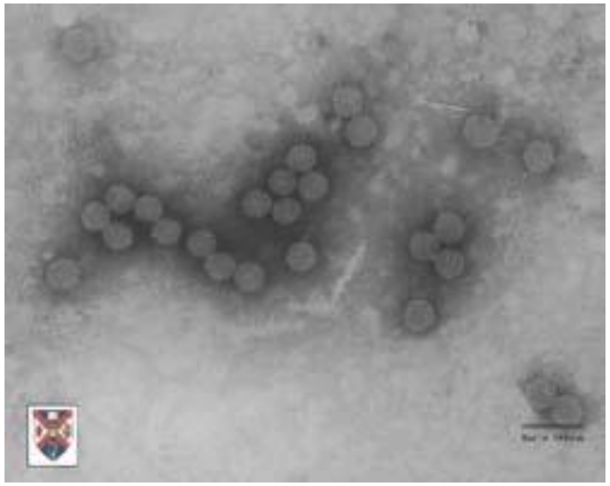
Some viral shapes



adenovirus

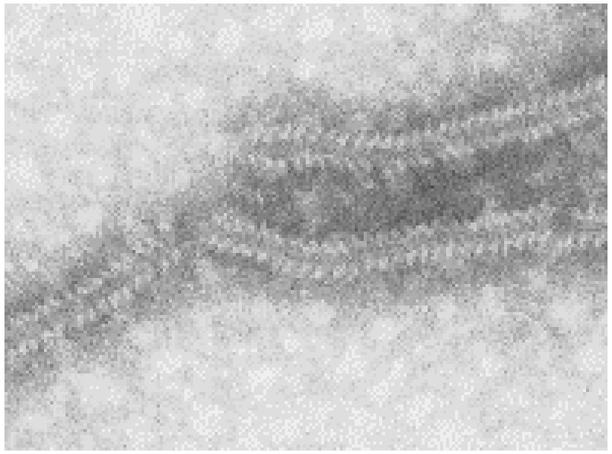


papillomavirus



parvovirus

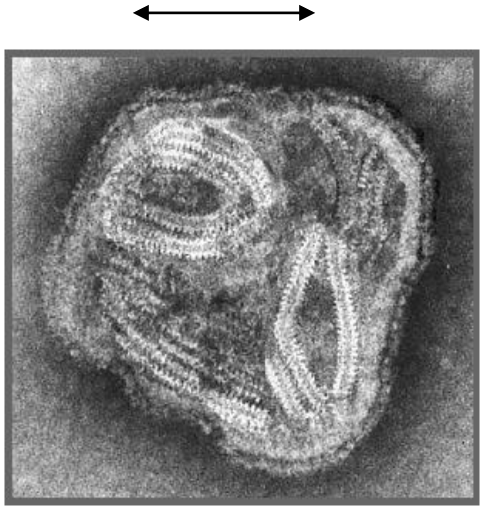
100 nm



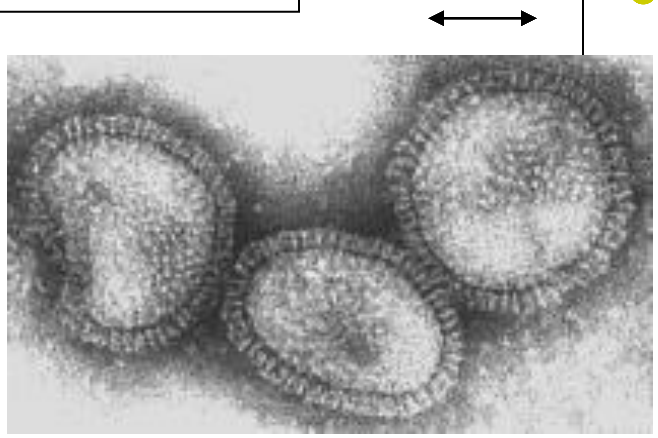
morbillivirus

Some viral shapes

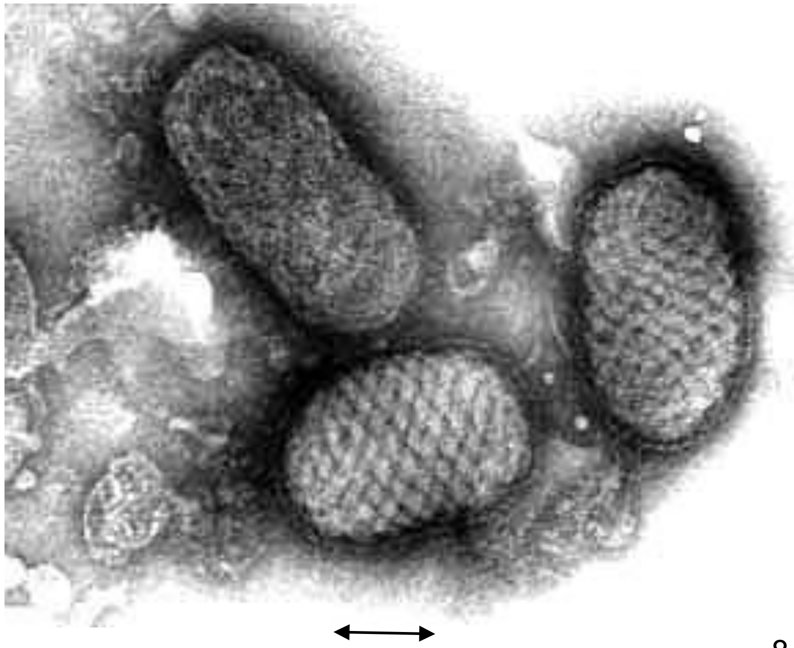
herpesvirus



parainfluenza virus



influenzavirus



poxvirus

Capsid Symmetry & Virus Architecture

- Since the approximate molecular weight of a nucleotide triplet is 1000 & the average molecular weight of a single amino acid is 150, a nucleic acid can only encode a protein that is at most 15% of its own weight.

- Therefore, virus capsids must be made up of multiple protein molecules (subunit construction)

Capsid

- Capsid is formed from protein sub-units arranged in a precise and highly repetitive pattern around NA
- Protein sub-units: **Protomers**

↓

- Associate in a specific way to form larger assemblies /structures: **Capsomers**

↓

- Capsomers make up the: **Capsid**

Nucleocapsid

Complex of NA and proteins packaged together:

NUCLEOCAPSID

Types of Symmetry

Two kinds of symmetry:

Correspond to two primary shapes

Rod:

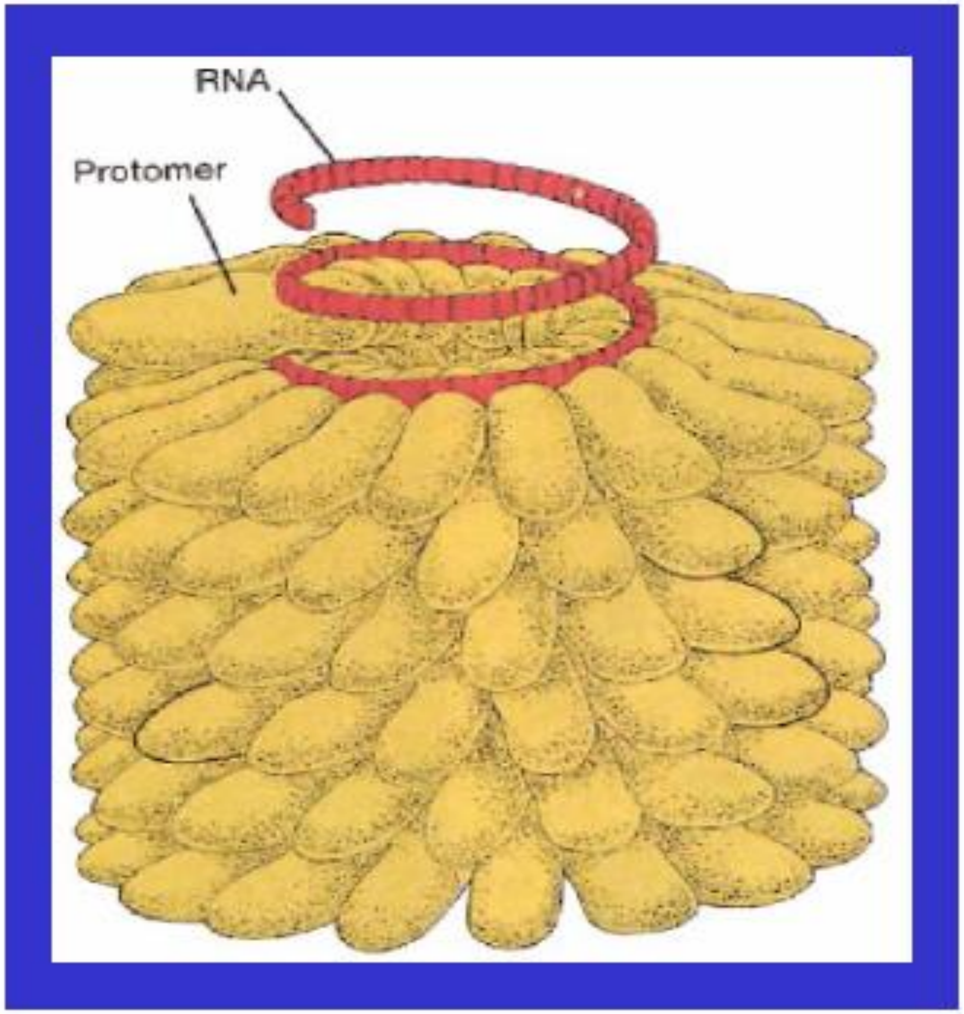
Helical symmetry

Spherical:

Icosahedral symmetry

Helical Symmetry

- Protein subunits arranged in a helix

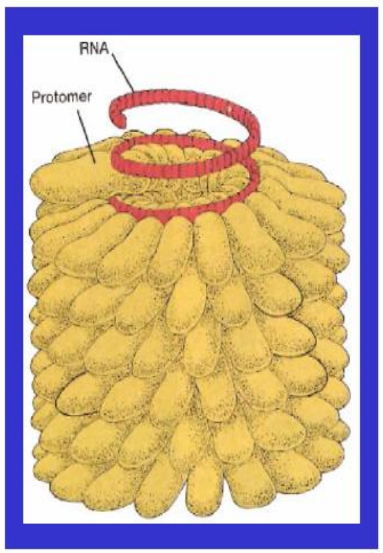


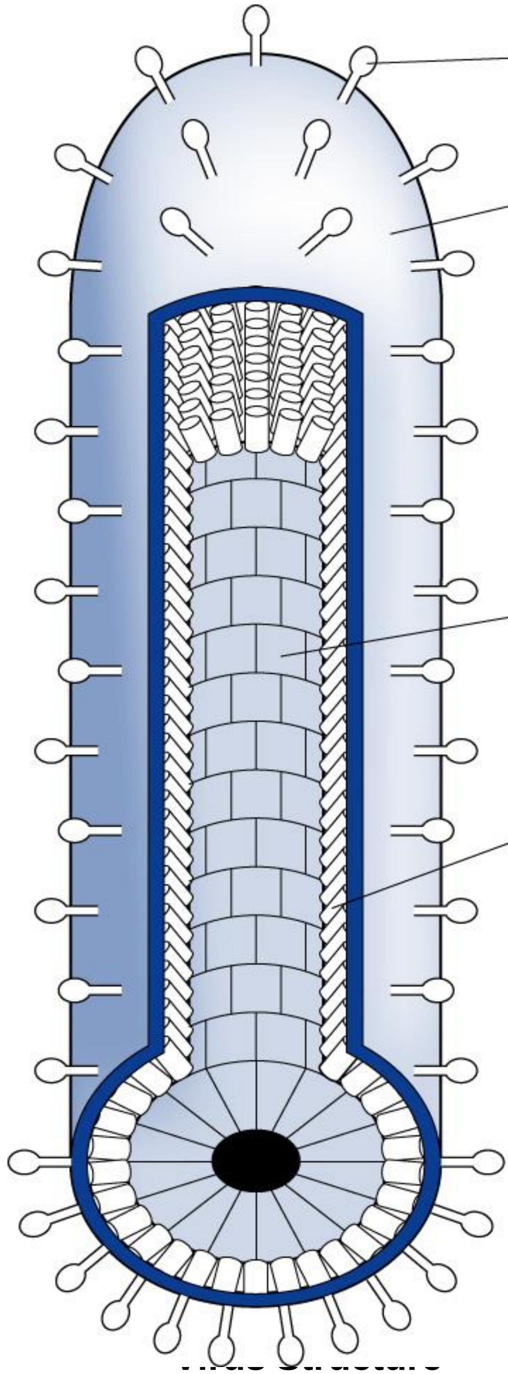
- Shaped like hollow protein cylinders

e.g. Tobacco mosaic virus (TMV)
e.g. Rabies virus

Rhabdovirus particle

Protein subunits arranged in a helix





e.g. Rabies Virus & Bovine Ephemeral Fever Virus

Helical Animal Viruses

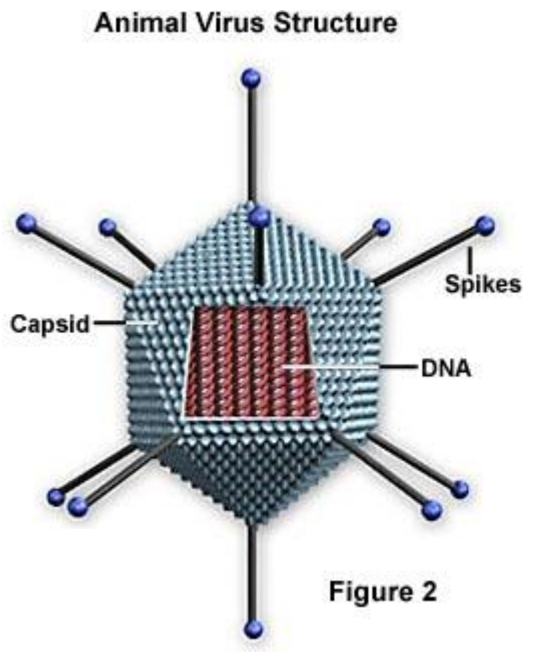
- **Helical, naked (i.e. non-enveloped) animal viruses do not exist, but the reasons are not clear**

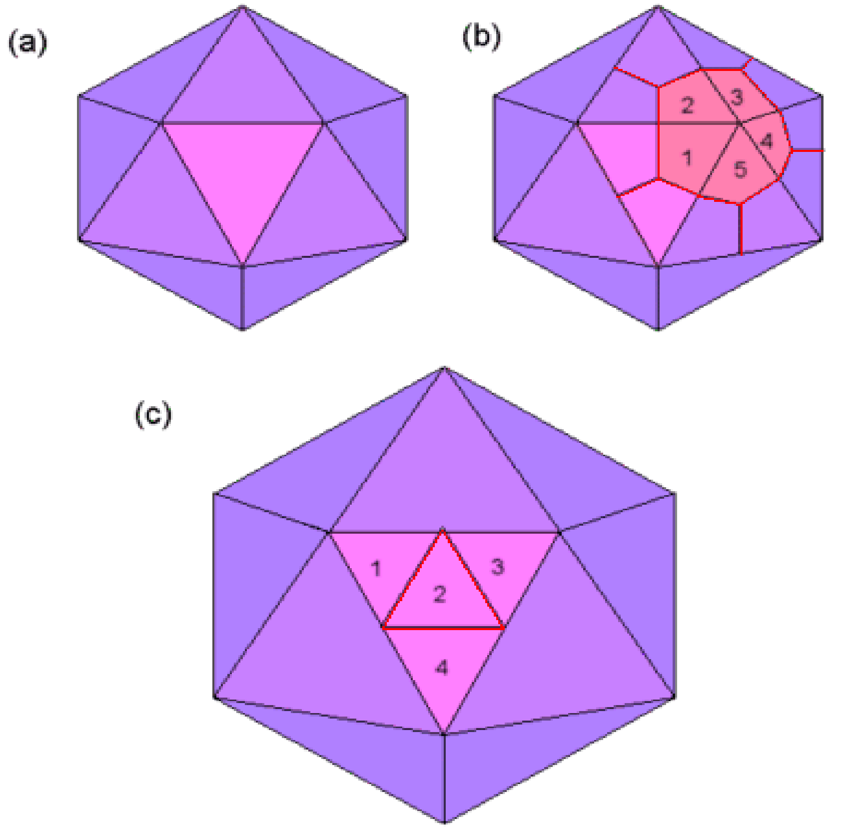
- **This category includes many of the best known human and animal pathogens**

  e.g. Avian Influenza virus, Mumps & measles viruses, Rinderpest Virus & *Rabies virus*

- **Most helical animal viruses possess single-stranded, negative-sense RNA genomes**

Icosahedral Symmetry

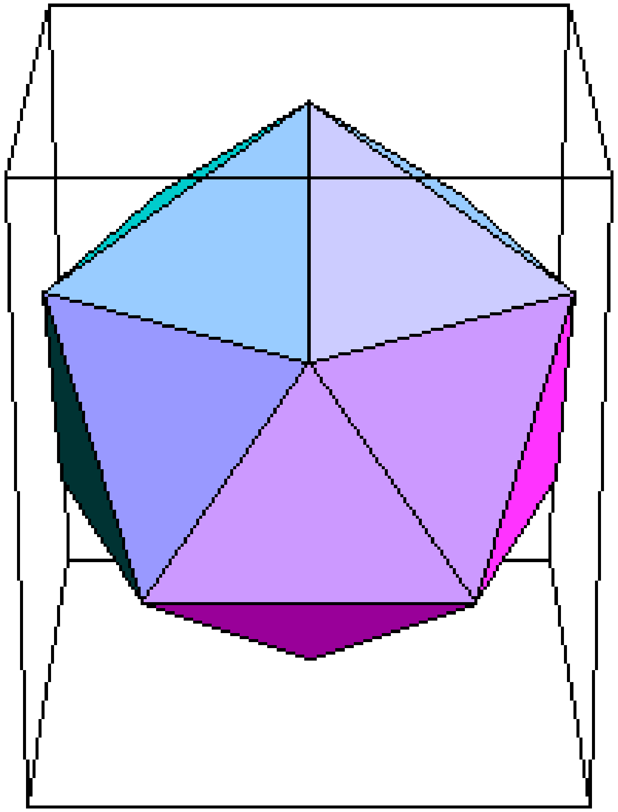




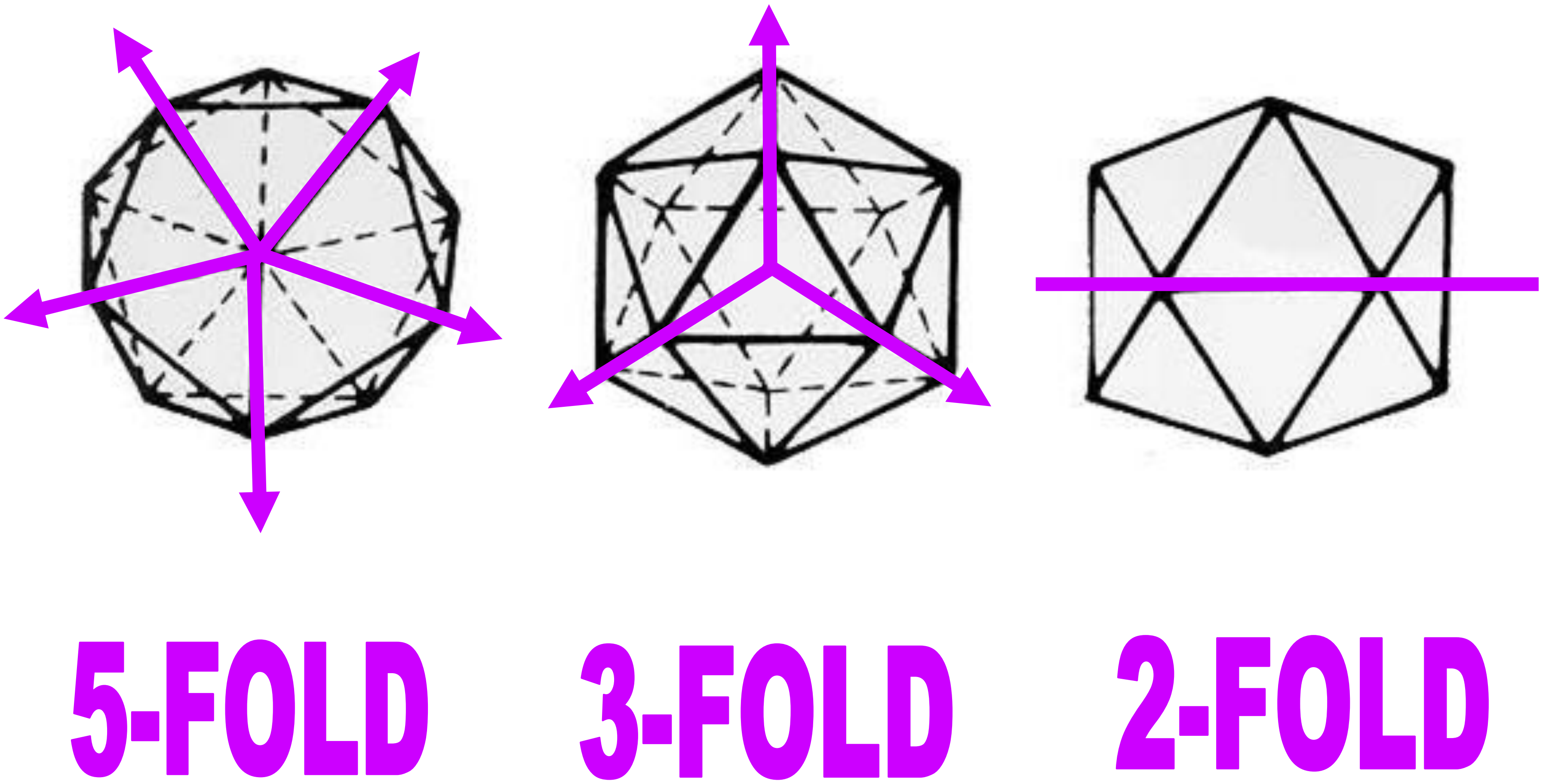
Icosahedron. (a) An icosahedron has 20 identical equilateral triangular faces. (b) In most icosahedral capsids, each triangular face is made up of three identical subunits. Hence, a capsid contains 60 subunits. The five subunits surrounding each vertex are arranged in a five-fold symmetry. (c) A large icosahedral capsid consists of more than 60 subunits. Some of triangular faces are made up of four subunits.

ICOSAHEDRAL SYMMETRY (Animated)

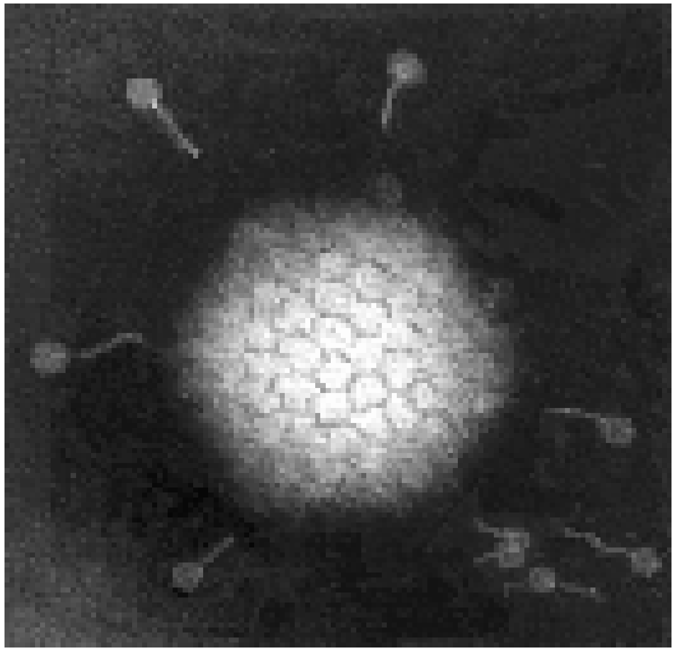
20 faces
12 vertices



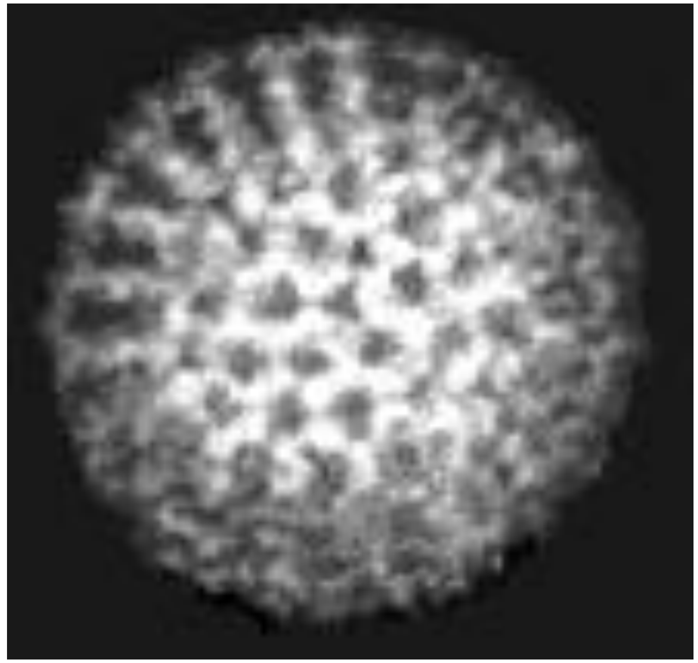
Icosahedrons



Electron micrographs



Adenovirus



Rotavirus

(courtesy of Linda Stannard, University of Cape Town, S.A.)

Complex

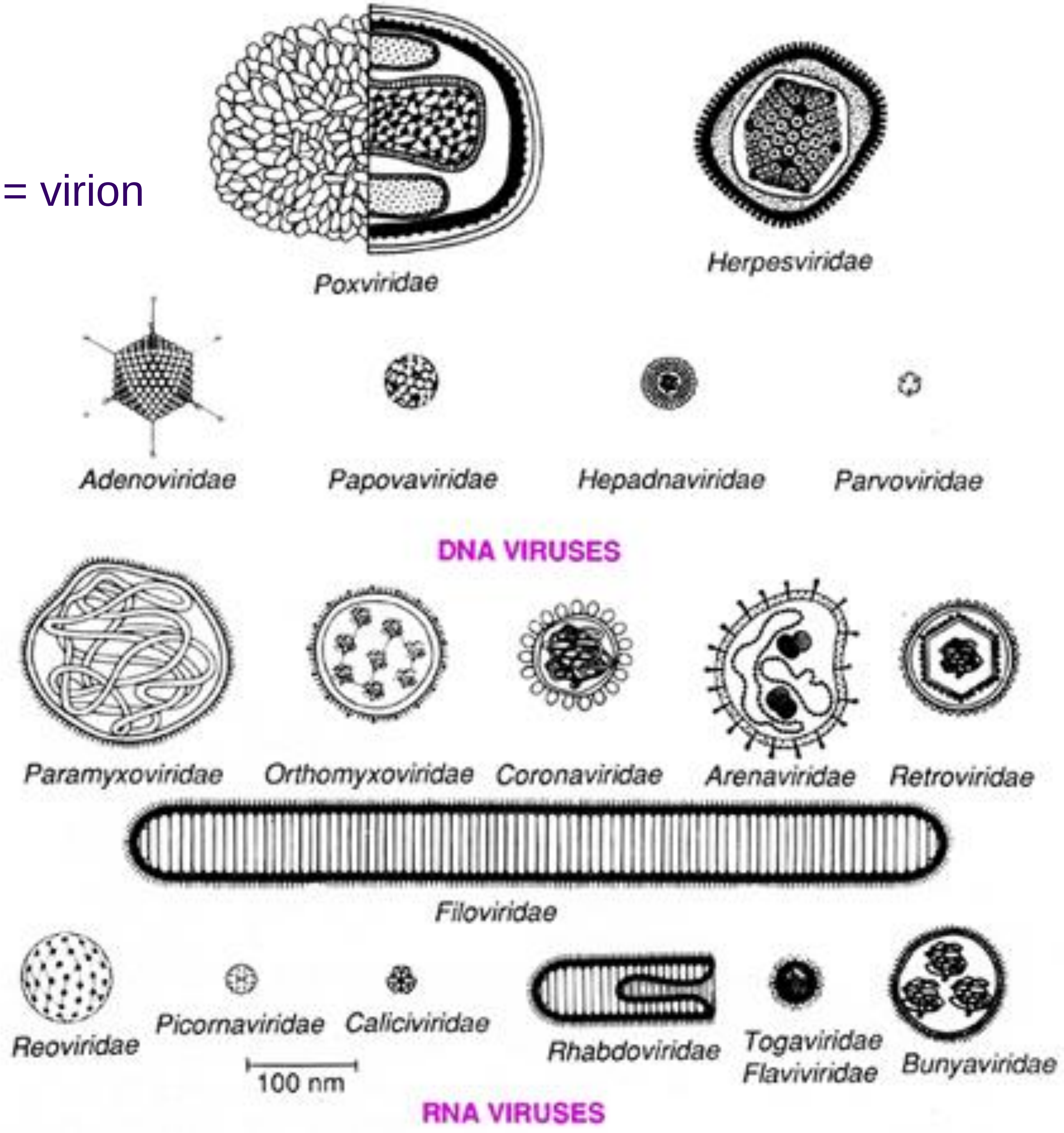
- * Neither icosahedral/helical

  e.g small pox virus

- * Can be combination of isocahedral & helical (**binal)**

  e.g bacteriophage T4 (see later)

Virus particle = virion



White, DO and Fenner, FJ. Medical Virology, 4th Ed. 1994

Viral Envelope

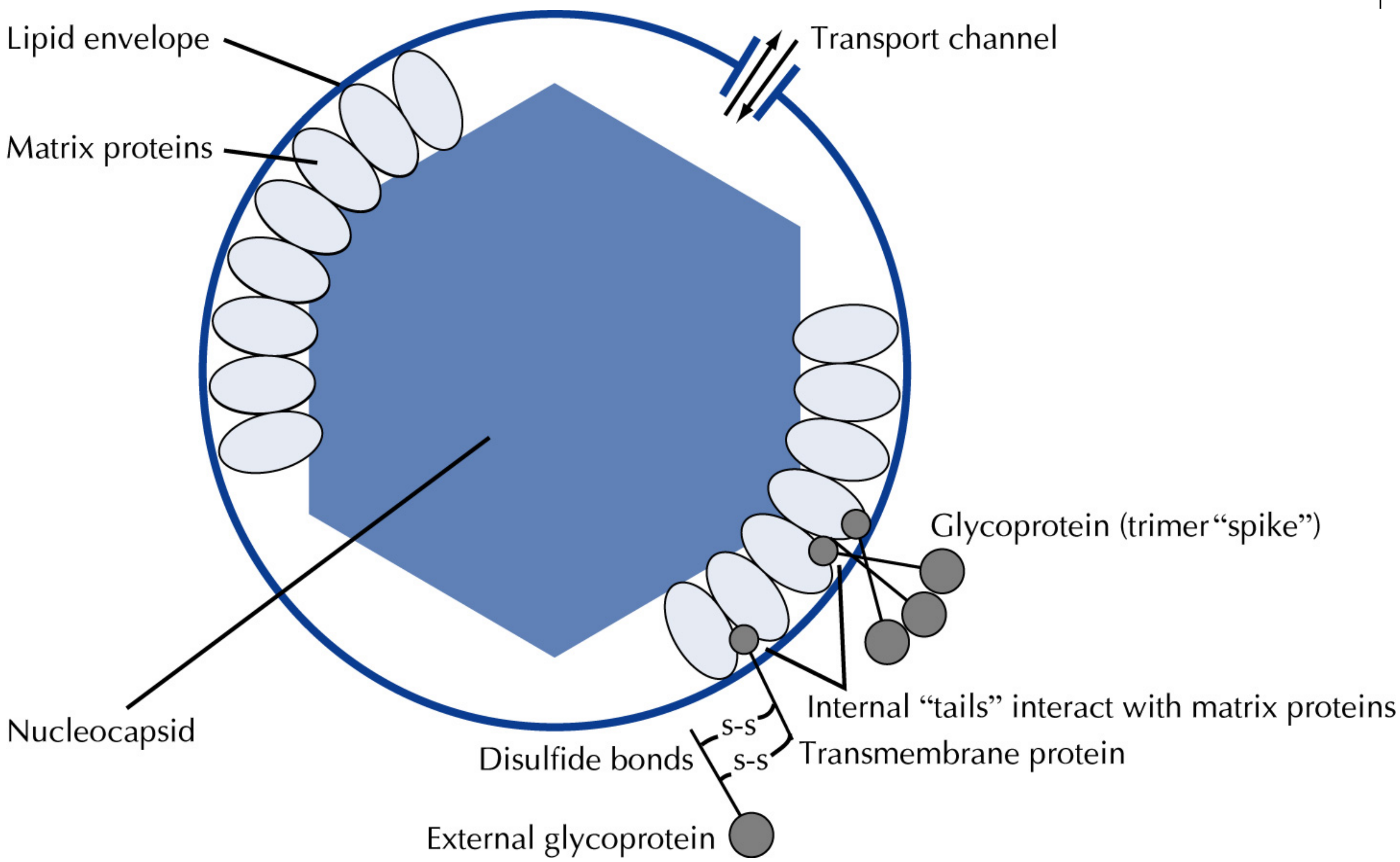
- Obtained through the cellular membrane (except poxviruses, herpesviruses, coronaviruses).
- Budding possibility of exiting cell without killing it.
- Contains at least one virally coded protein.

Enveloped Viruses:

- All living cells are covered by a membrane composed of a lipid bilayer. Viruses leaving the cell usually acquire outer coat derived from the cell membrane.

- This is achieved by extrusion (budding) of the particle through the membrane, during which process the particle becomes coated in a lipid envelope derived from the host cell membrane & with a similar composition.

Envelope and matrix proteins



Structural Components of Influenza A Viruses

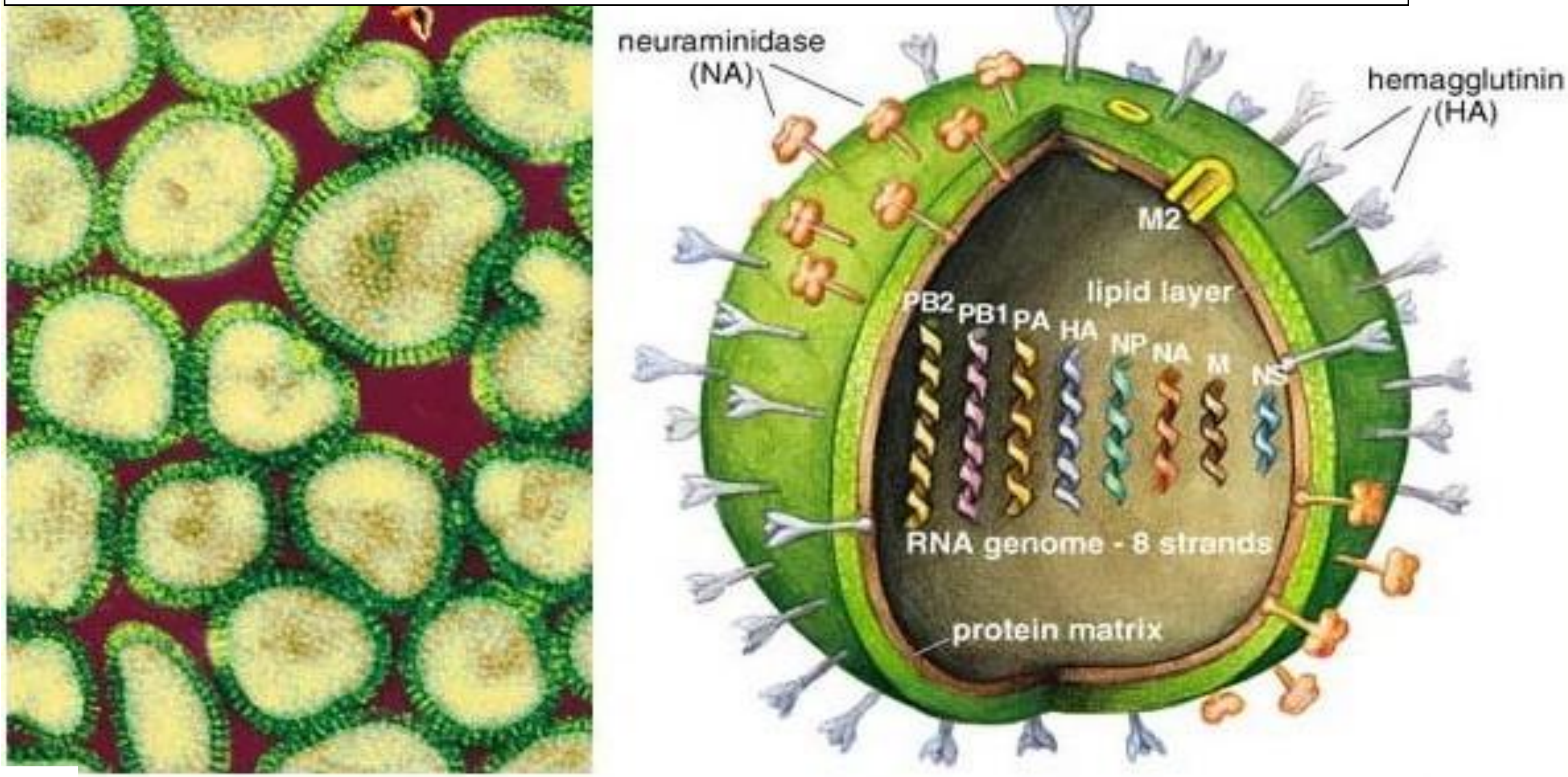


Figure 2. Type A influenza viruses—which are responsible for human pandemics—are spheroidal particles (*left*), about a tenth of a micrometer across. The virus is characterized by a relatively simple structure (*right*): an internal nucleocapsid, containing the viral genome, and a surrounding envelope consisting of an inner matrix protein, a lipid bilayer and external surface proteins.

Functions of the outer shell of virions

- Protects the fragile nucleic acid genome from physical, chemical, or enzymatic damage
- Responsible for recognition of & the first interaction with the host cell. Initially, this takes the form of binding of a specific virus-attachment protein to a cellular receptor molecule
- Plays a role in initiating infection by delivering the genome in a form that can interact with the host cell

Functions of Viral Proteins وظائف بروتينات الفيروس

I - حماية الجينوم الفيروسي Protection of Viral genome

- تجمع الغطاء الخارجي

- تميزمتخصص لتعليب الحامض النووي

- تفاعل مع الغشاء الخلوي للعائل لتكوين غلاف فيروسي

Delivery of the genome   II - نقل الجنيوم الفيروسي

- الأرتباط بالمستقبلات Receptors
- أرسال إشارات خاصة تحفز التقشر
- الإندماج مع الغشاء الخلوي للعائل
- التفاعل مع مركبات داخل الخلية

Other interactions with host   III - تفاعلات أخرى مع العائل

- التفاعل مع مناعة الجسم العائل
- التفاعل مع مركبات الخلية العائل لنقل إلى مواقع داخلية للتجمع
- انزيمات حيوية : Hemagglutination

HA —تحلل→ RBC

Hemagglutination

- انزيمات مهمه في التكاثر

RNA - dependent - DNA - polymerase (RT) Retrovirus

RNA - dependent - RNA Polymerase RNA virus

DNA - dependent - RNA Polymerase DNA virus

Transcription النسخ

Nucleic acid

DNA or RNA but NOT both

Single stranded (ss) or double stranded (ds), linear or circular

Viral genome

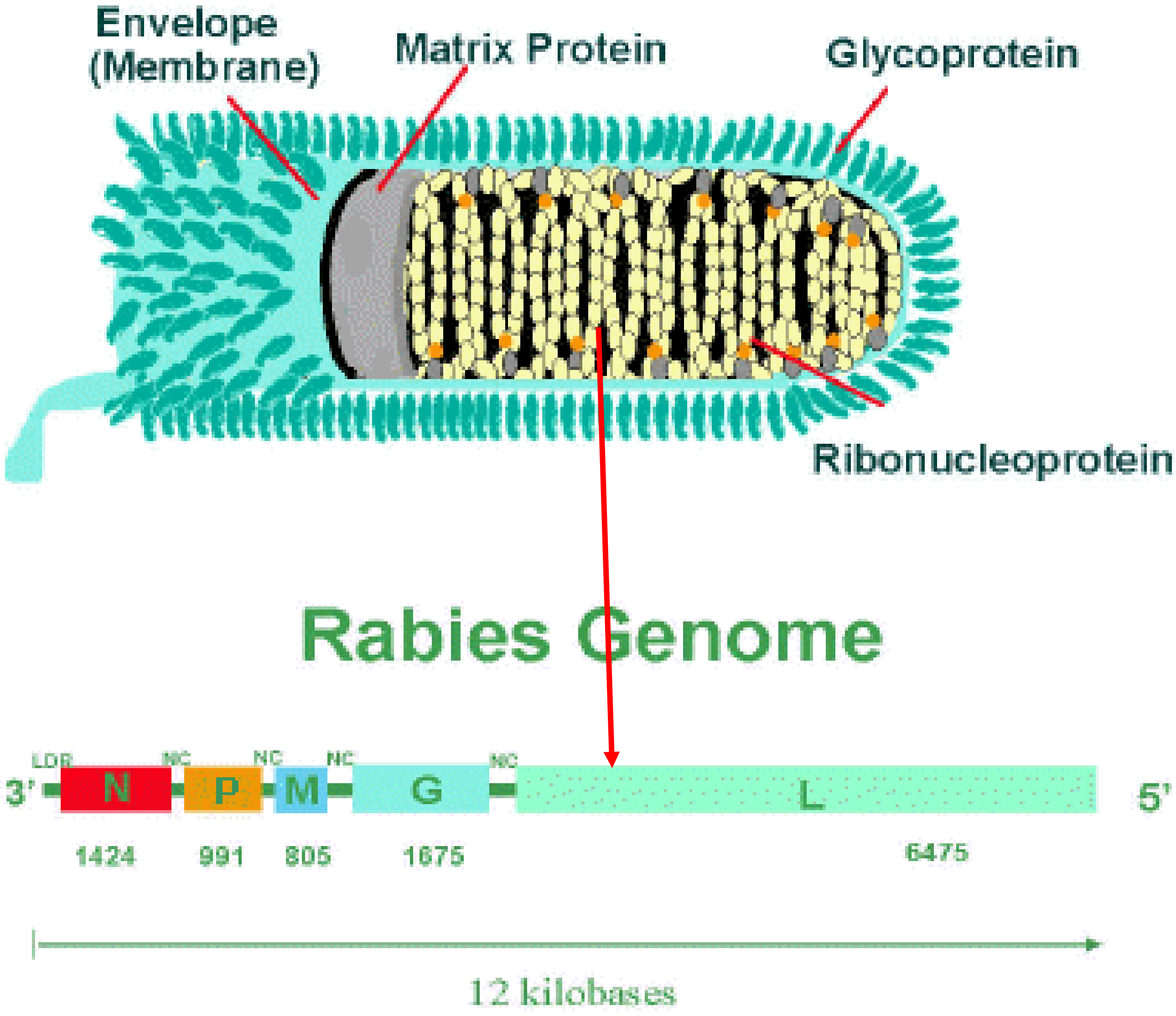
Viral genome is small

Can only code for minimum amount of information

e.g Hepatitis B virus: 4 genes

Herpesviruses: 100's genes

Compare with:


Envelope
(Membrane)
Matrix Protein
Glycoprotein
Ribonucleoprotein
Rabies Genome
LDR
NC
NC
NC
NC
3'
N
P
M
G
L
5'
1424
991
805
1675
6475
12 kilobases