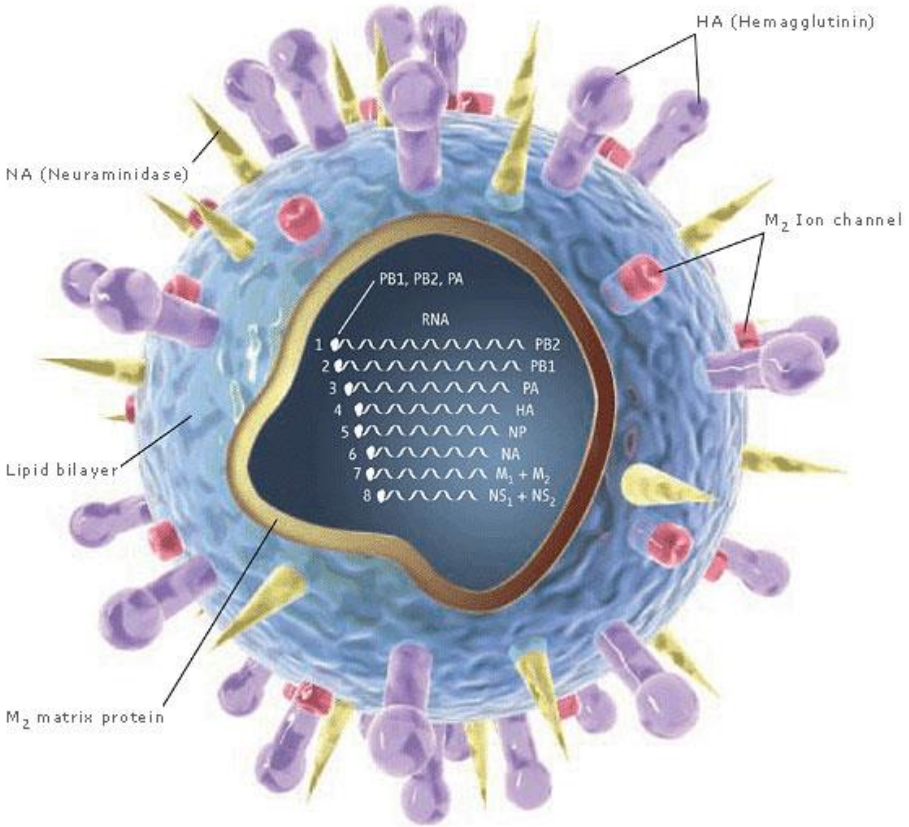
- ***MICROBIOLOGY*** → Biology of microrganisms
- ***MICROORGANISMS*** → Organisms not visible to the naked eye
- ***MEDICAL/CLINICAL MICROBIOLOGY*** → Microbiology of microorganisms responsible for some human pathologies

Medical microbiology

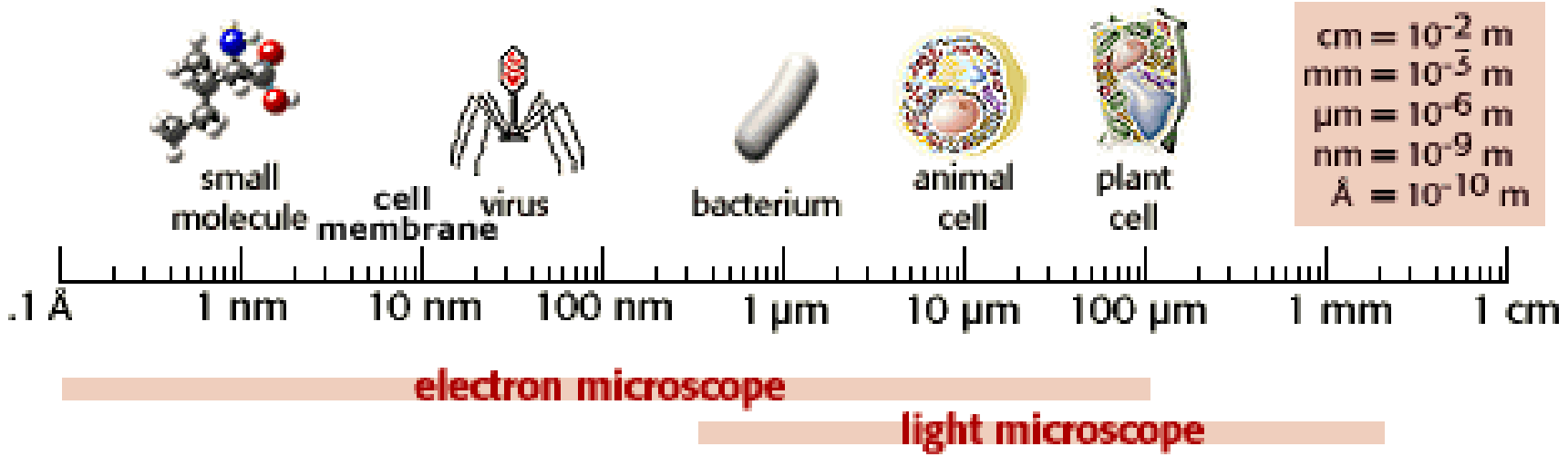
- **Virus**
- **Bacteria**
- **Fungi**
- **Protozoa**
- **Helminths and arthropods**

- *Virology*
- *Bacteriology*
- *Mycology*
- *Parasitology*

VIROLOGY



Relative sizes of cells and their components



Redifining determinants of complexity: lesson from RNA

Organism	Genome size
Protopterus aethiopicus (lung fish)	139,000,000,000
Fritillaria assyriaca	124,900,000,000
Lilium longiflorum	90,000,000,000
Necturus maculosus (salamander)	50,000,000,000
Triturus cristatus (newt)	18,600,000,000
Zea mays	5,000,000,000
Xenopus laevis (frog)	3,000,000,000
Rattus norvegicus	3,000,000,000
Mus musculus	3,000,000,000
Homo sapiens	3,000,000,000
Bos Taurus	3,000,000,000
Gallus gallus	1,200,000,000
Oryza sativa	400,000,000
Fugu rubripes (puffer fish)	400,000,000
Drosophila melanogaster	165,000,000
Caenorhabditis elegans	100,000,000
Arabidopsis thaliana	100,000,000
Toxoplasma gondii	89,000,000
Plasmodium falciparum	25,000,000
Saccharomyces cerevisiae	12,067,280
Escherichia coli	4,639,221
Mycobacterium tuberculosis	4,397,000
Bacillus subtilis	4,170,000
Synechocystis sp. strain PCC6803	3,573,470
Haemophilus influenzae	1,830,137
Mycoplasma pneumoniae	816,394
Mycoplasma genitalium	580,000
Human immunodeficiency virus type 1	**9,750**

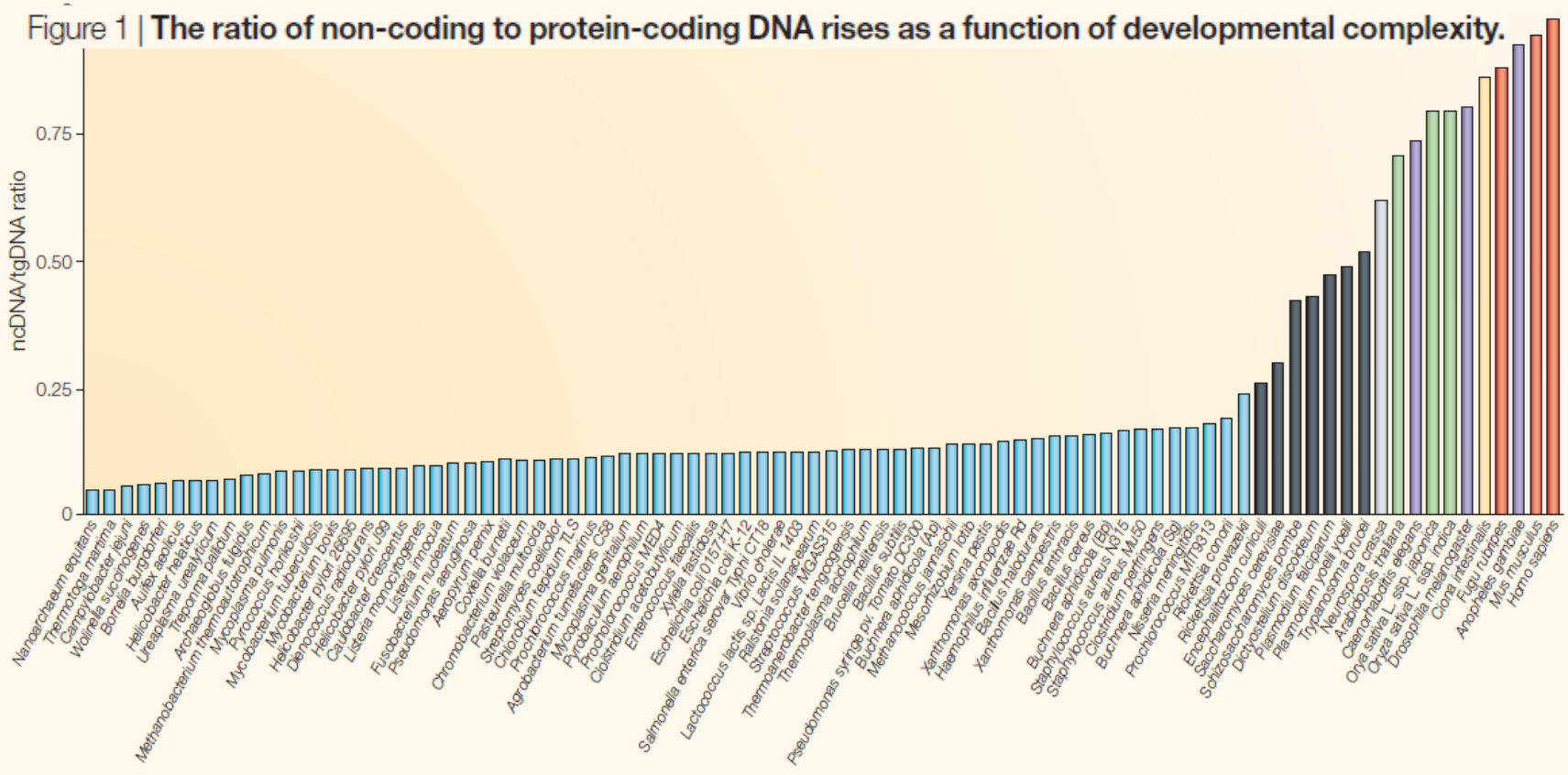
NonCodingRNA/TotalGenomicDNA

OPINION

RNA regulation: a new genetics?

John S. Mattick

Figure 1 | **The ratio of non-coding to protein-coding DNA rises as a function of developmental complexity.**



For 50 years the term 'gene' has been synonymous with regions of the genome encoding mRNAs that are translated into protein. However, recent genome-wide studies have shown that the human genome is pervasively transcribed and produces many thousands of regulatory non-protein-coding RNAs (ncRNAs), including microRNAs, small interfering RNAs, and various classes of long ncRNAs.

It is now clear that these RNAs fulfil critical roles as transcriptional and post-transcriptional regulators and as guides of chromatin-modifying complexes.

Redifining viruses: lesson from Mimivirus

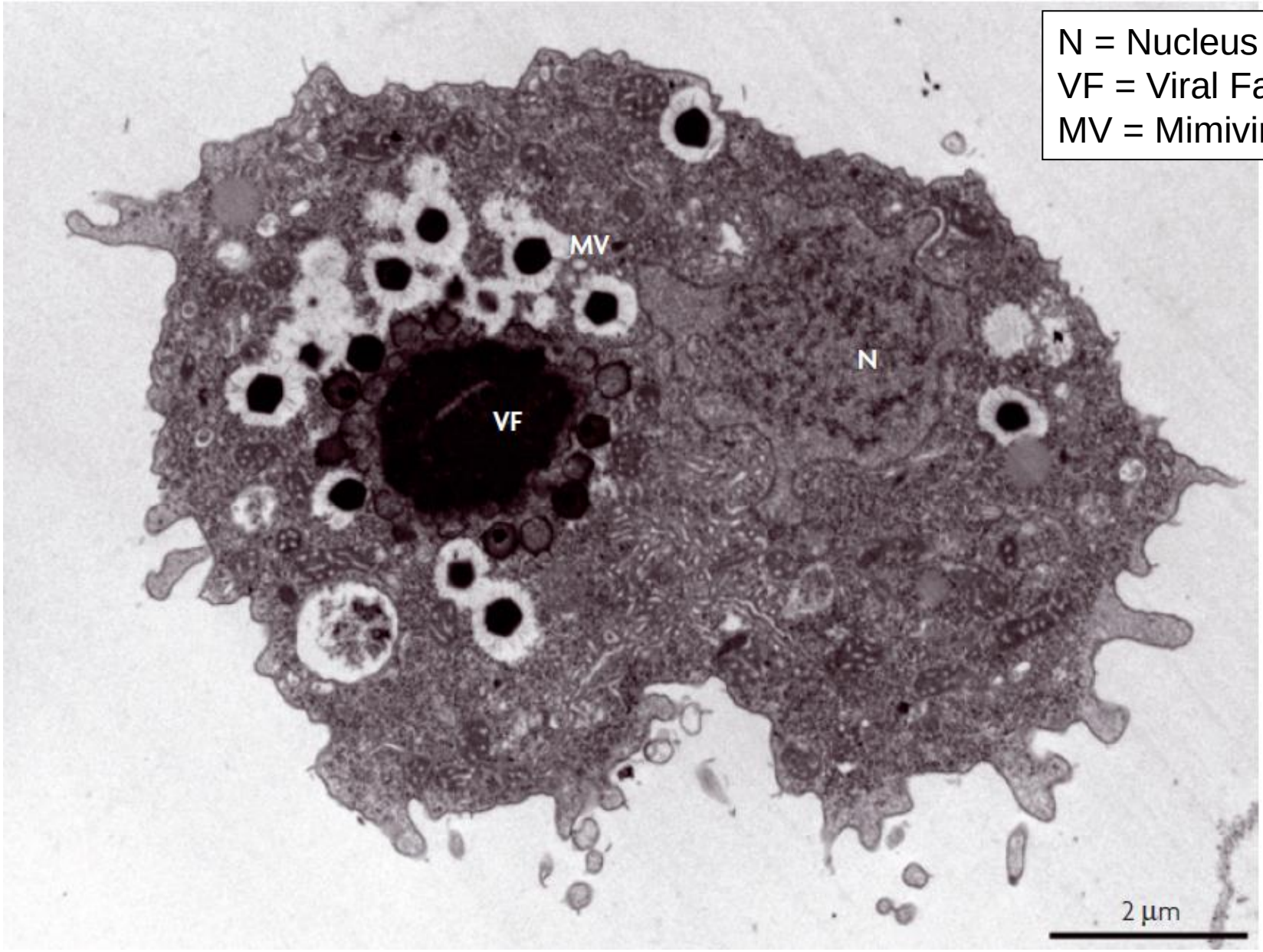
www.sciencemag.org SCIENCE VOL 299 28 MARCH 2003

A Giant Virus in Amoebae

Bernard La Scola,[1] Stéphane Audic,[2] Catherine Robert,[1]
Liang Jungang,[1] Xavier de Lamballerie,[3] Michel Drancourt,[1]
Richard Birtles,[1] Jean-Michel Claverie,[2*] Didier Raoult[1*]

Study of this microorganism within *Acanthamoeba polyphaga* (*2*) revealed a characteristic viral morphology with mature particles of 400 nm in diameter and surrounded by an icosahedral capsid. This structure is consistent with the finding that Mimivirus is not filterable through 0.2-μm pore size filters. No envelope was observed, but 80-nm fibrils attached to the capsid were visible (fig. S1). A typical virus developmental cycle, including an eclipse phase, was observed

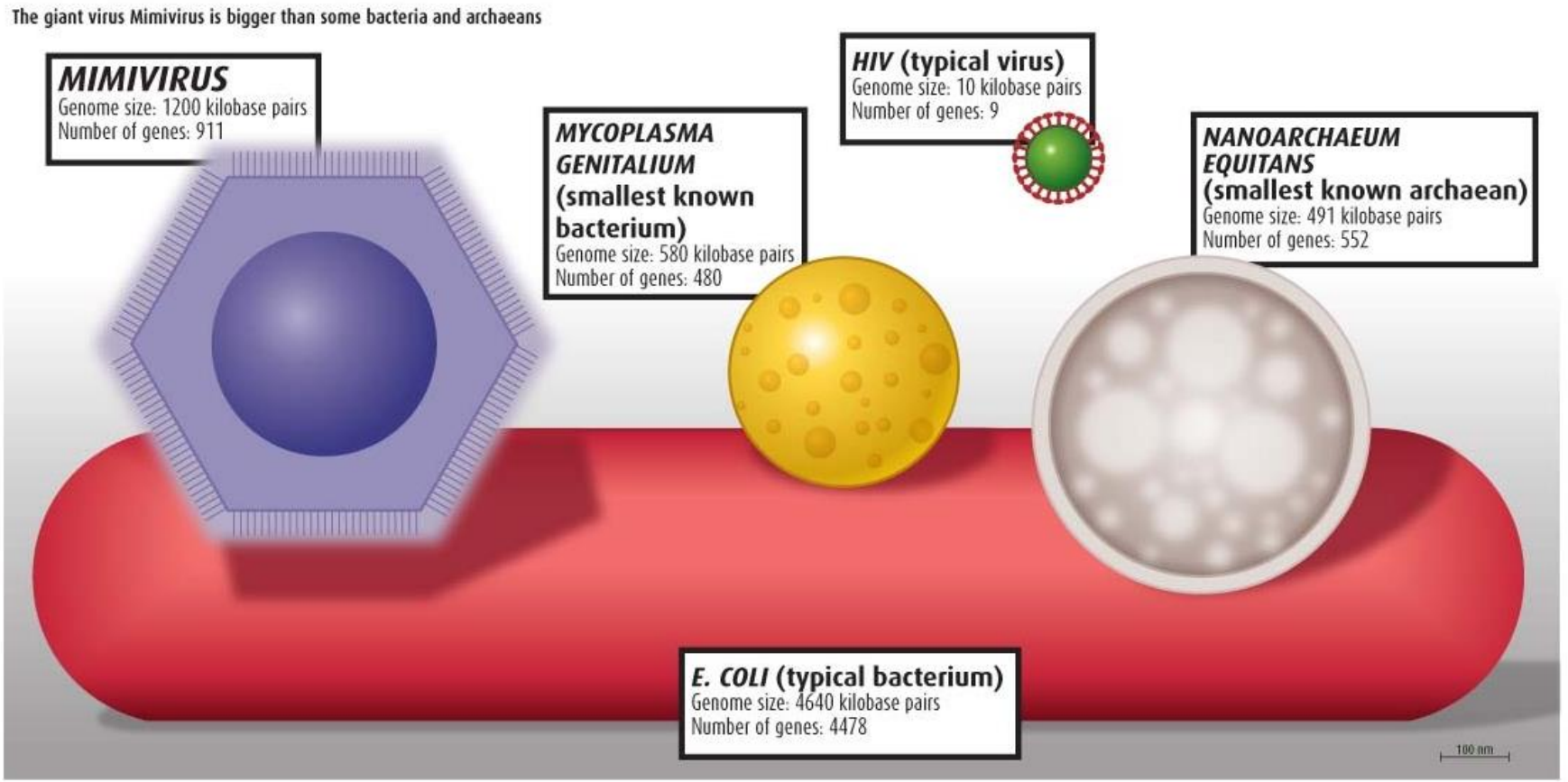
Mimivirus - NCLDV (NucleoCytoplasmic Large DNA Virus)



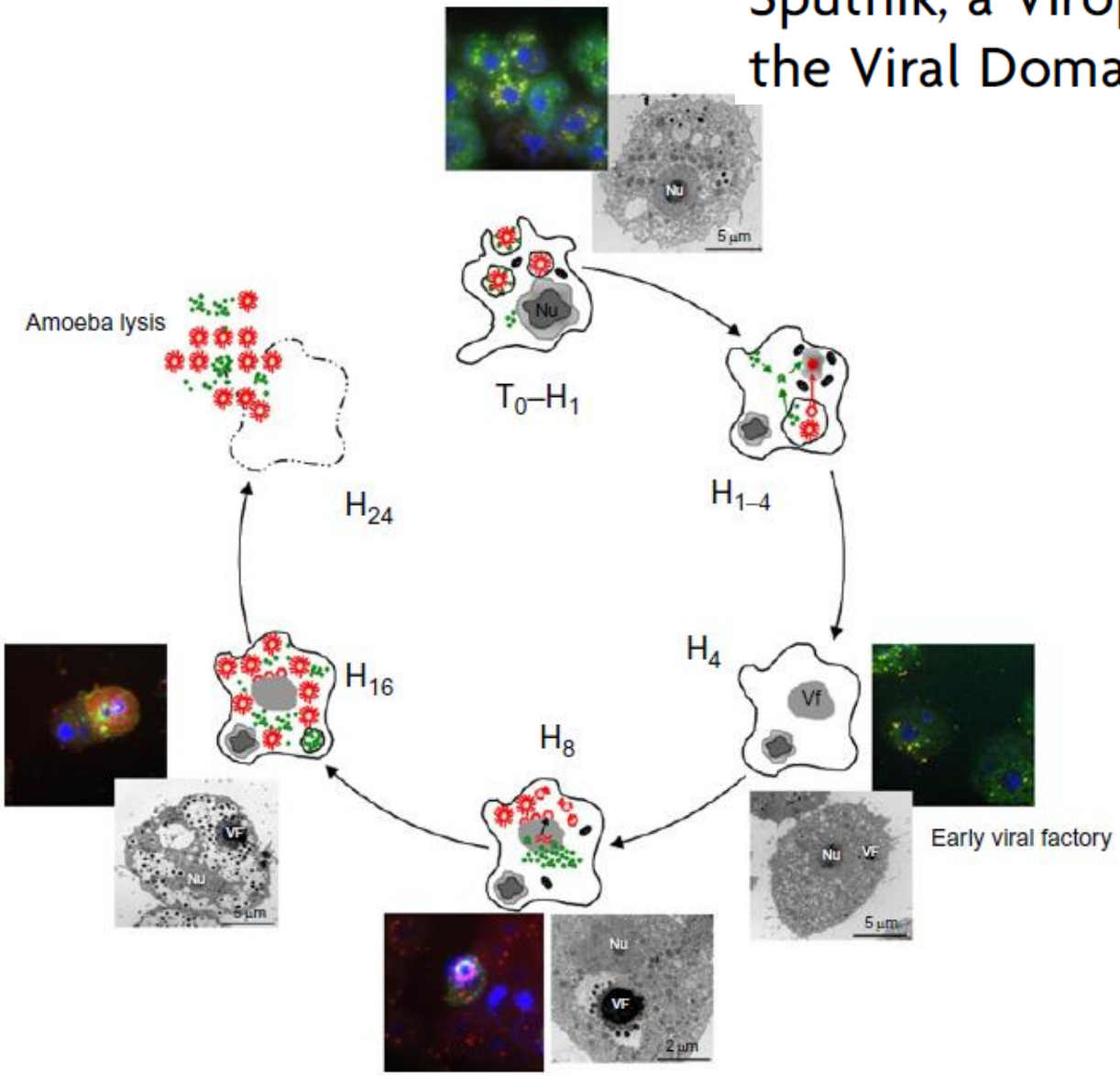
Mimivirus = Mimicking microbe
as it resembles a bacterium on Gram staining

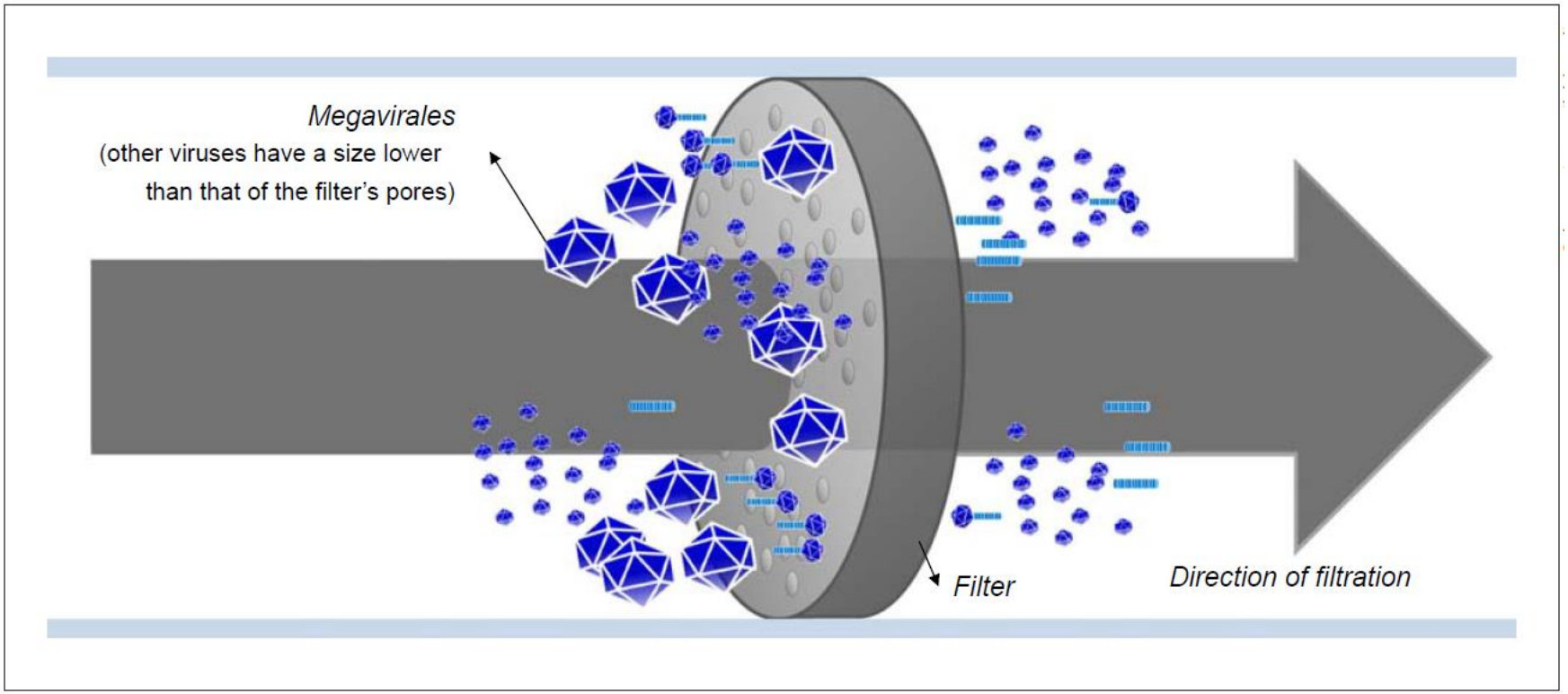
NCLDV (NucleoCytoplasmic Large DNA Virus)

NCLDV (NucleoCytoplasmic Large DNA Virus)



Sputnik, a Virophage Infecting the Viral Domain of Life




Megavirales
(other viruses have a size lower than that of the filter's pores)
Filter
Direction of filtration

General characteristics of virus

- Viruses are unique in nature.
- They are the smallest of all self-replicating organisms, historically characterized by their ability to pass through filters that retain even the smallest bacteria.
- In their most basic form, viruses consist solely of a small segment of nucleic acid encased in a simple protein shell.
- Viruses have no metabolism of their own, but rather are obliged to invade cells and parasitize subcellular machinery, subverting it to their own purposes.

VIRUS STRUCTURE

Definitions:

Virion **- physical particle of the virus**

Core **- nucleic acid and tightly associated proteins within the virion**

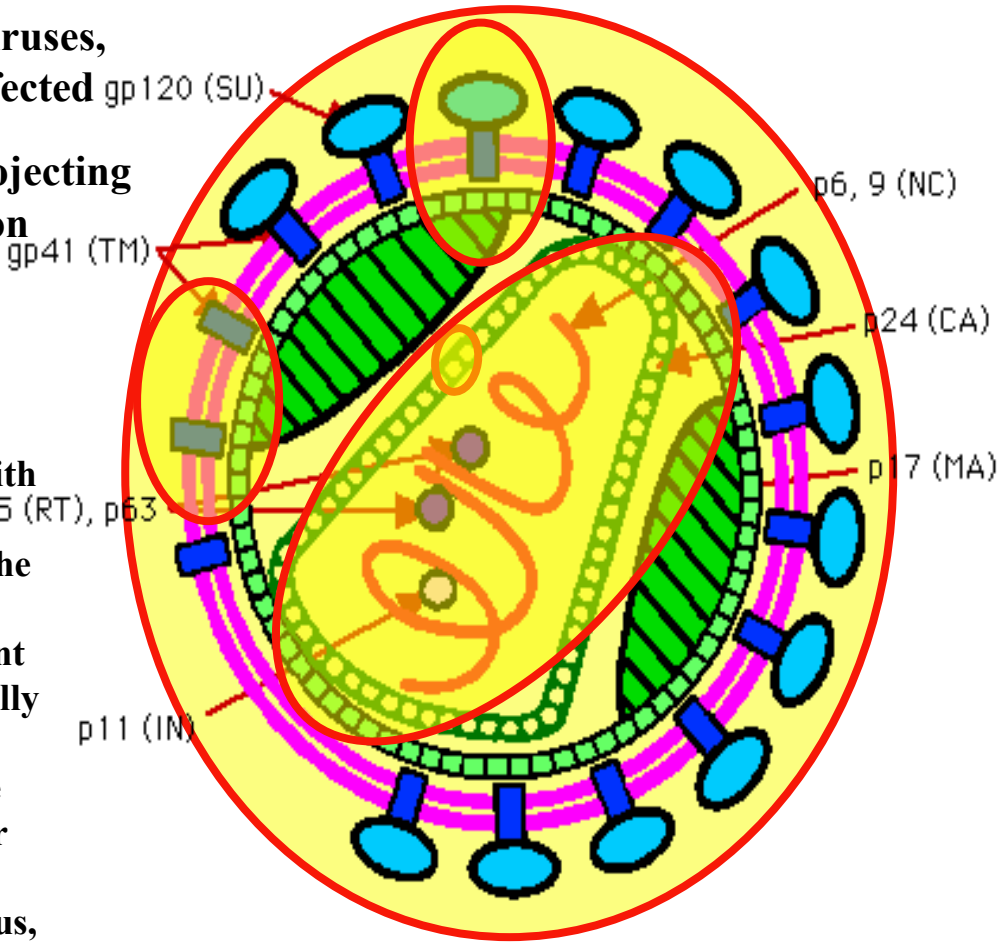
Capsid **- protein shell around NA or core**

Capsomere **- protein subunit making up the capsid**

Nucleocapsid **- core and capsid**

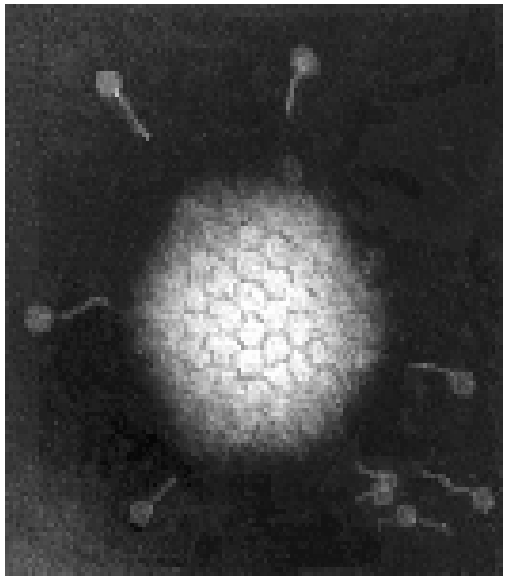
Envelope **- lipid membrane found on some viruses, often derived by budding from infected cells.**

Peplomer **- ("spike")- morphological unit projecting from the envelope or surface of a naked virion**

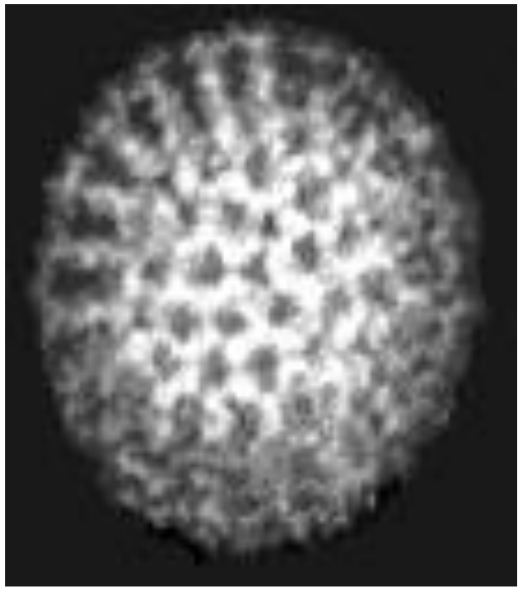


Definition Usage: Viruses outside of cells are usually metabolically inert. Virions consist of either DNA of RNA (constituting the genome) usually complexed with protein into a core, surrounded by a protein coat called the capsid, altogether called a nucleocapsid. The capsid is composed of identical subunits called capsomeres. It serves to protect and to ensure efficient delivery of the nucleic acid genome to new cells. Virally encoded peplomer spikes found protruding from the envelope or at the surface of a naked virion serve the critical function of receptor recognition necessary for binding and entry into susceptible cells. For many viruses, isolated viral nucleic acid is by itself infectious, albeit less so than when it is encapsidated.

Electronmicrographs



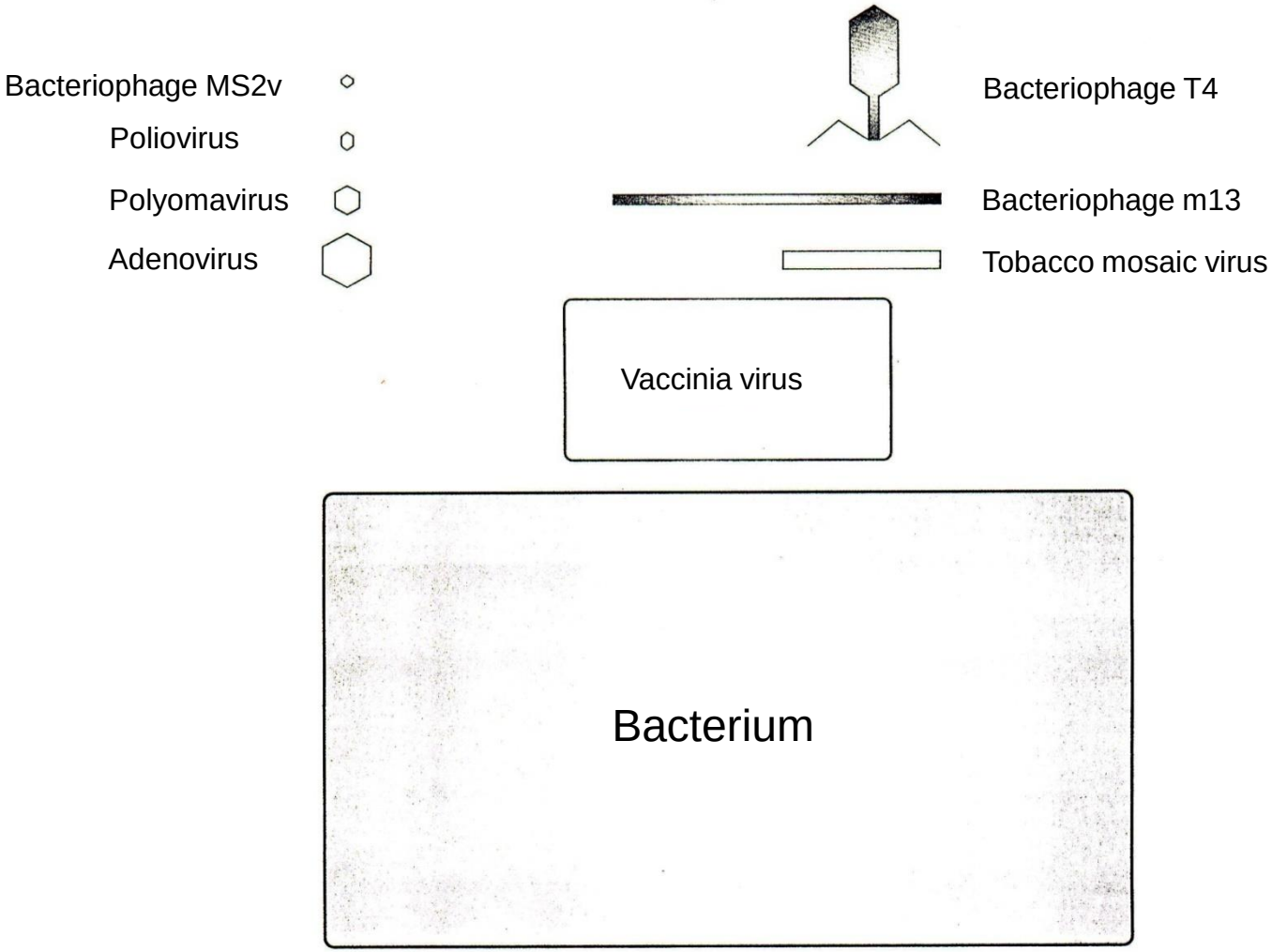
Adenovirus



Rotavirus

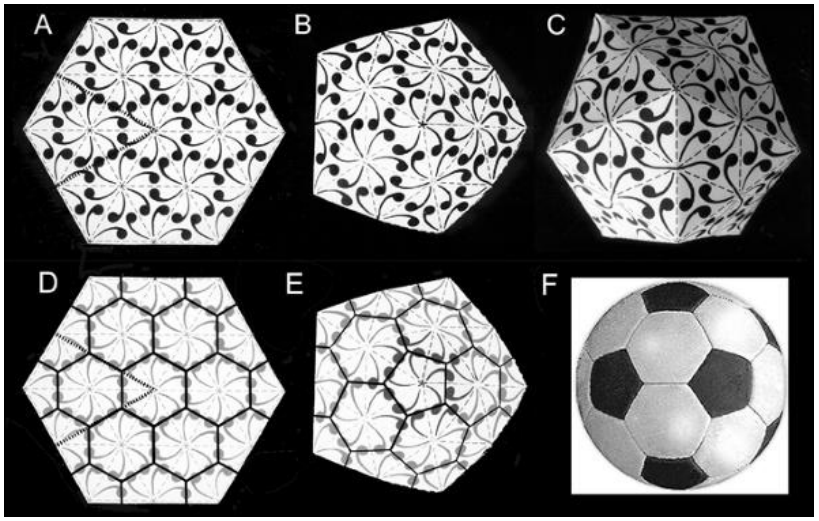
(courtesy of Linda Stannard, University of Cape Town, S.A.)

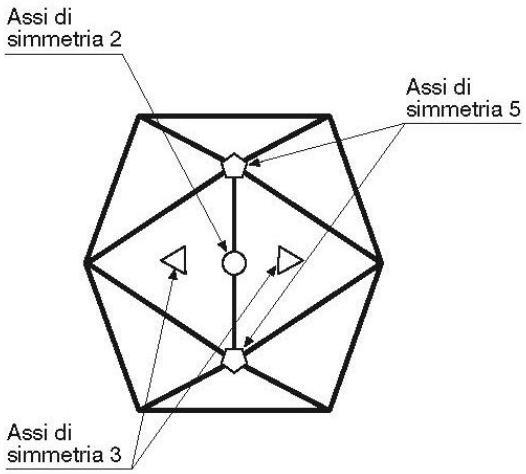
Viruses come in many shapes and sizes

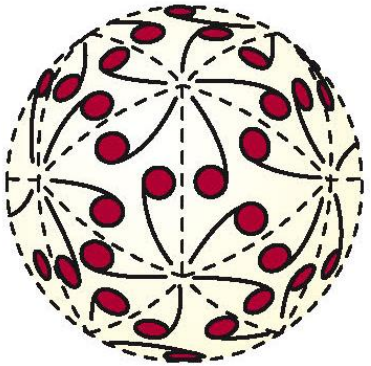


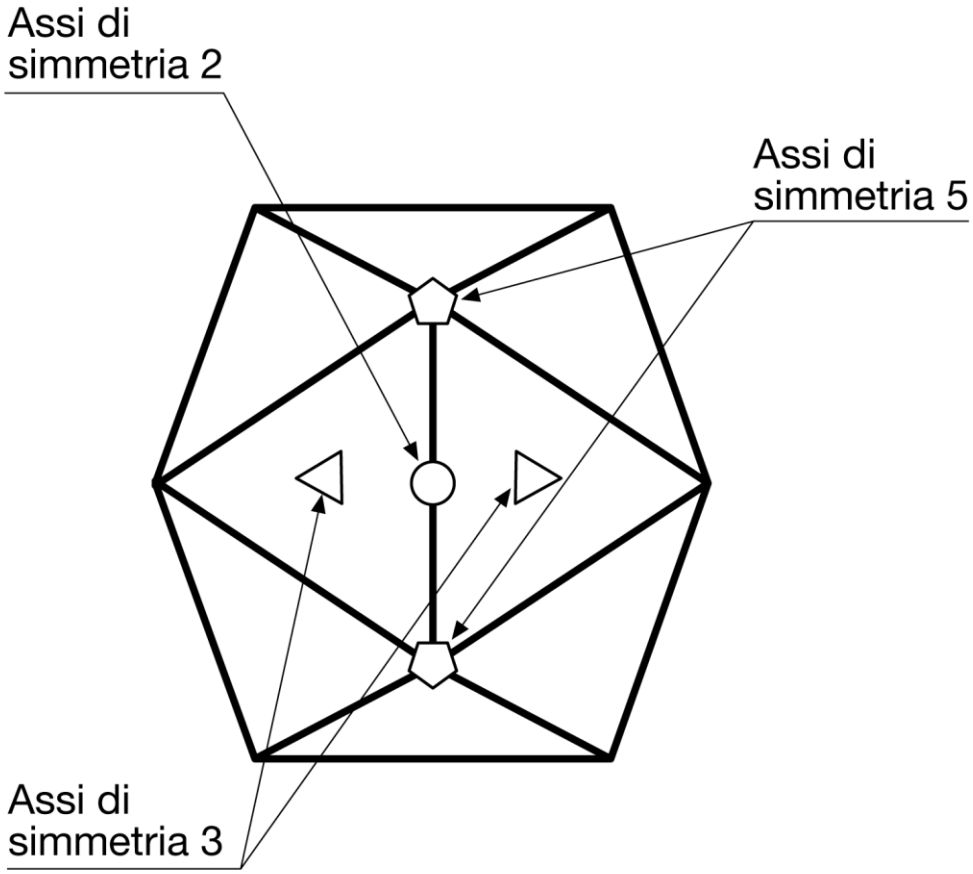
Icosahedral symmetry

- An icosahedron is composed of 20 facets, each an equilateral triangle, and 12 vertices; because of the axes of rotational symmetry is said to have 5:3:2 symmetry.
- STRUCTURE UNITS are the smallest functional equivalent building units of the capsid, thus individual proteins.
- CAPSOMERS are morphological units seen on the surface of particles and represent clusters of structure units
- For icosahedral viruses, there are two kinds of capsomers called pentamers and hexamers









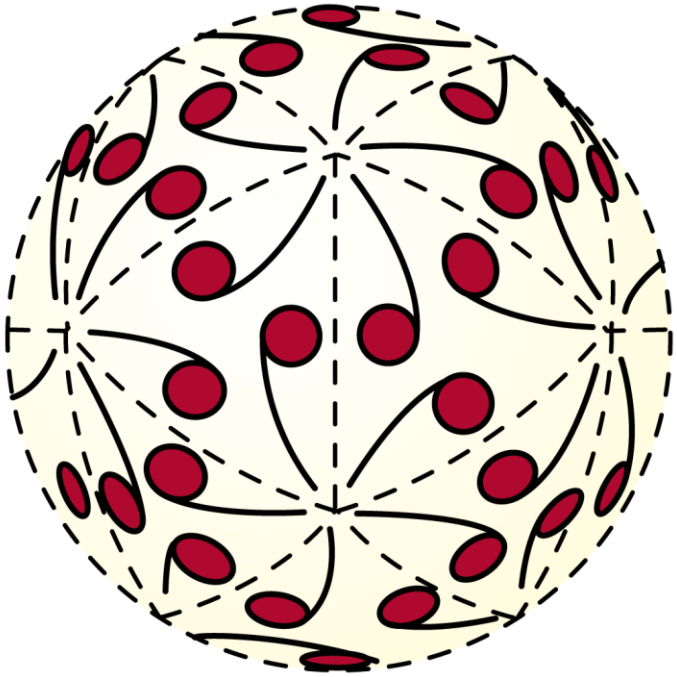


Figura 35.2 **Forme icosaedriche e relativi assi di simmetria**.

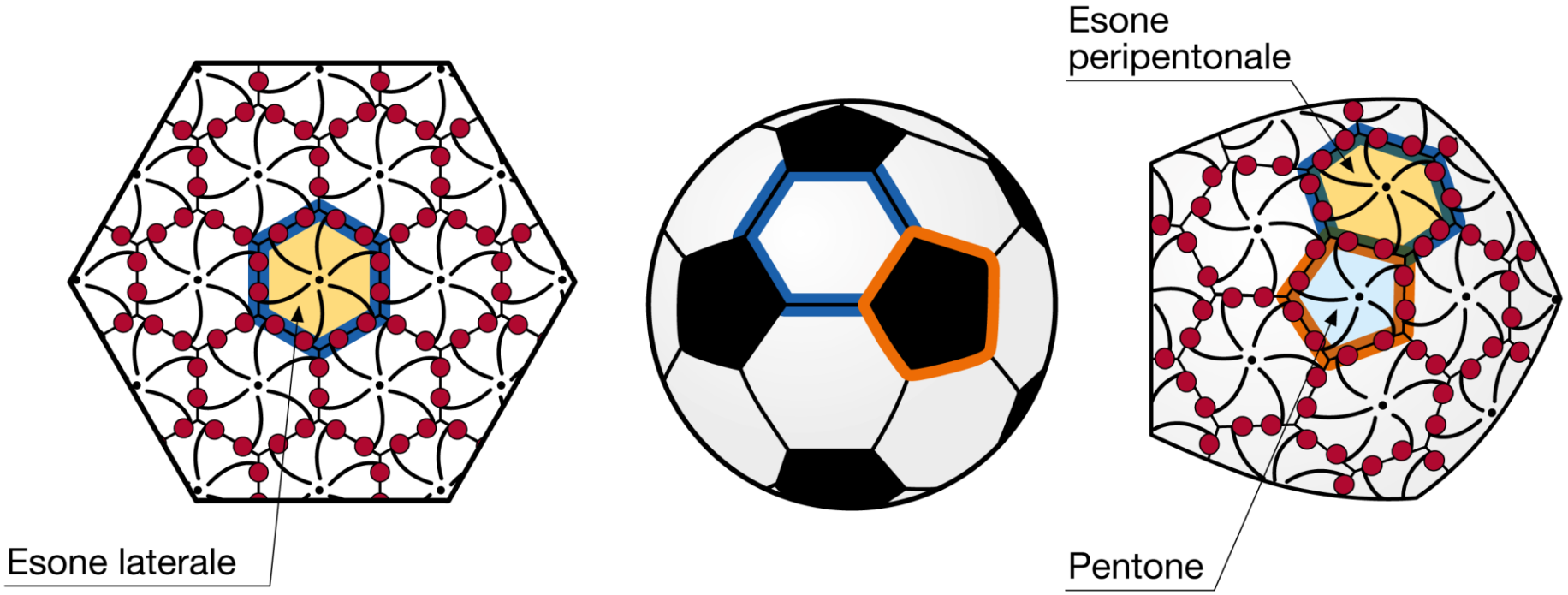


Figura 35.3 **Forme icosaedriche e relativi capsomeri.**

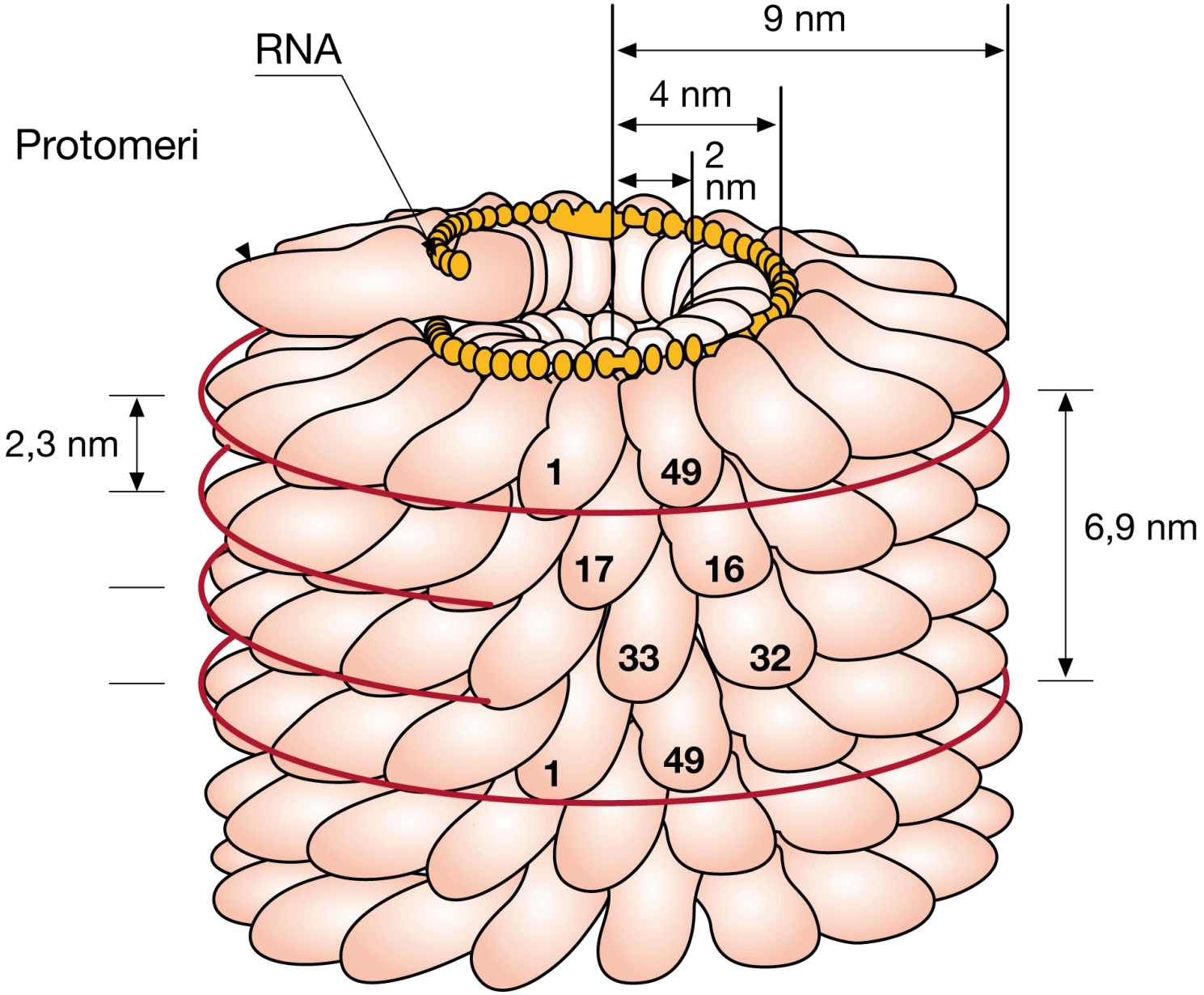


Figura 35.4 **Struttura del virus del mosaico del tabacco.**

Principles of Virus Structure

- The broadest distinction is between the so-called “enveloped” and “nonenveloped” viruses that is, those that contain or do not contain, respectively, a lipid-bilayer membrane.

- Further categorization of virus structures depends on details of their molecular organization.

- Types of viral particles:
  - Icosahedral symmetry nonenveloped
  - Icosahedral symmetry enveloped
  - Helical symmetry nonenveloped
  - Helical symmetry enveloped

Structures and Organization of Viral Genomes

- Genomes of animal viruses differ greatly in size, from as small as 3 kb to as large as 250-280 kb and the consequent differences in genetic capacity mean that viruses from different families vary widely in terms of how many of the functions necessary for virus replication they can encode for themselves

- Types of viral genome:
  - double stranded DNA(dsDNA)
  - single stranded DNA(ssDNA)
  - single stranded positive-sense (+) RNA
  - single stranded negative-sense (-) RNA
  - double stranded RNA

DNA VIRUS

- **Single strand DNA (ssDNA)**
- **Double strand DNA (dsDNA):**
  - **linear**
  - **circular**
  - **partially double strand circular**

RNA VIRUS

- **Single strand RNA (ssRNA):**
  - **Nonsegmented Genomes**
  - **Segmented**
- **Double strand RNA (dsRNA):**
  - **Segmented**

Virus Properties and Their Use in Taxonomy

- **Genome structure**
  - **Nature of the viral genome (DNA or RNA)**
  - **Strandedness**
  - **Size kb/kbb**
  - **Conformation (linear, circular)**
  - **Polarity (positive sense, negative sense, ambisense)**
  - **Number of segments**

Virus Properties and Their Use in Taxonomy

- **Replication strategy**
  - **mechanisms of transcription**
  - **mechanisms of translation**
  - **post-transcriptional modifications**
  - **protein localization**
  - **intracellular targeting and assembly of virion components**
  - **post-assembly modifications and virus release**

Virus Properties and Their Use in Taxonomy

- **Virion morphology:**
  - **size**
  - **shape**
  - **capsid symmetry**
  - **presence or absence of an envelope**
- **Virion physical properties:**
  - **genome structure**
  - **sensitivity to physical or chemical insults**
  - **specific features of viral lipids, carbohydrates, and structural nonstructural proteins**
- **Antigenic properties**
- **Biologic properties:**
  - **replication strategy**
  - **host range**
  - **mode of transmission**
  - **pathogenicity**
  - **geographic distribution**
  - **tissue tropism**
  - **histology**

ICTV Nomenclature

ORDERS (…-VIRALES)
HERPESVIRALES

FAMILIES (…-VIRIDAE)
HERPESVIRIDAE

SUBFAMILIES (…-VIRINAE)
BETAHERPESVIRINAE

GENERA (…..VIRUS)
CYTOMEGALOVIRUS

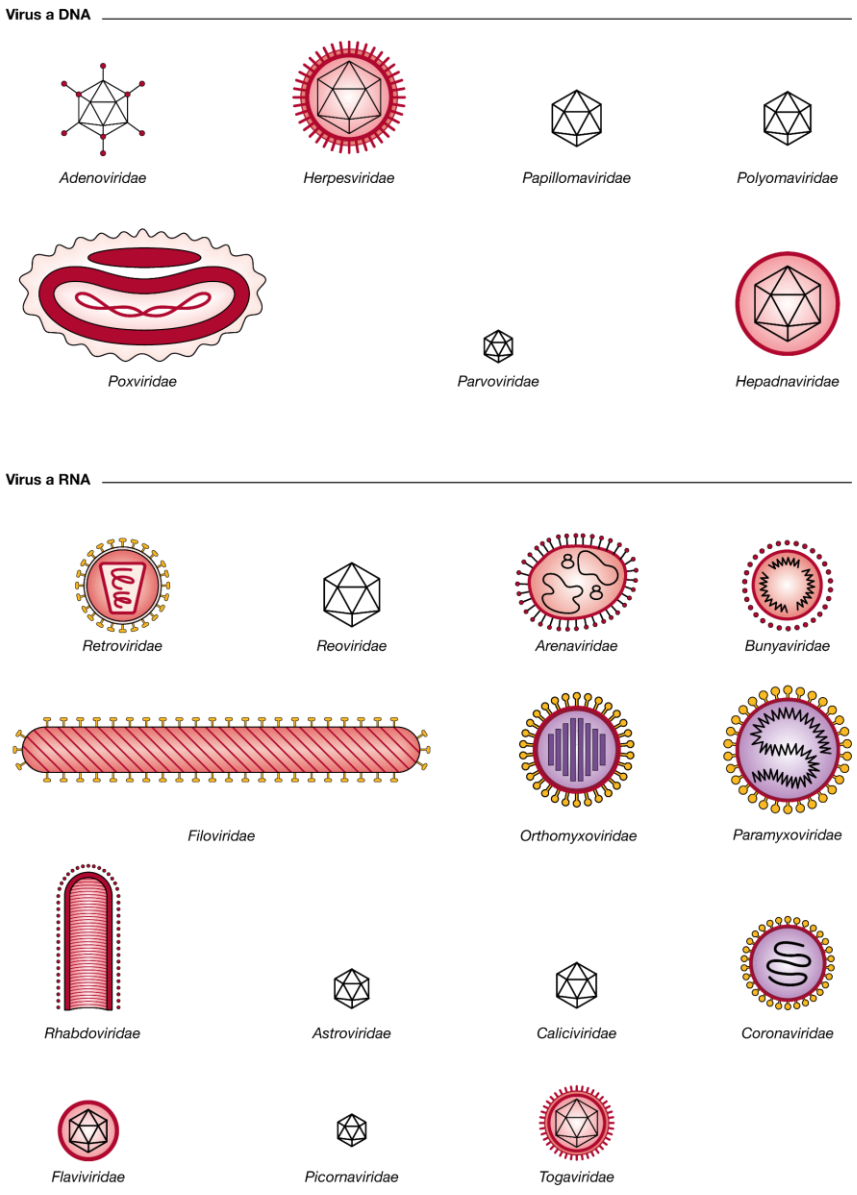


Figura 35.1 Rappresentazione schematica delle diverse famiglie di virus animali.

Tabella 35.1 Classificazione dei virus animali secondo Baltimore.

Gruppo	Nucleocapside	Pericapside	Virione	Genoma
dsDNA (I)				
Adenoviridae	Icosaedrico	No	Icosaedrico	1 lineare, 30-42 kb
Herpesviridae	Icosaedrico	Sì	Sferico con tegumento	1 lineare, 120-220 kb
Papillomaviridae	Icosaedrico	No	Icosaedrico	1 circolare, 8 kb
Polyomaviridae	Icosaedrico	No	Icosaedrico	1 circolare, 5 kb
Poxviridae	Complesso	Sì	Ovoidale	1 lineare, 130-375 kb
ssDNA (II)				
Parvoviridae	Icosaedrico	No	Icosaedrico	1 lineare, 130-375 kb
Anelloviridae	Icosaedrico	No	Icosaedrico	1 circolare, 3-4 kb
dsRNA (III)				
Reoviridae	Icosaedrico	No	Icosaedrico	10-12 lineare, 18-30 kb
ssRNA + (IV)				
Arteriviridae	Icosaedrico	Sì	Sferico	1 lineare, 13 kb
Astroviridae	Icosaedrico	No	Icosaedrico	1 lineare, 7-8 kb
Caliciviridae	Icosaedrico	No	Icosaedrico	1 lineare, 8 kb
Coronaviridae	Elicoidale	Sì	Pleiomorfo	1 lineare, 20-33 kb
Flaviviridae	Poliedrico	No	Sferico	1 lineare, 10-12 kb
Picornaviridae	Icosaedrico	No	Icosaedrico	1 lineare, 7-8 kb
Togaviridae	Icosaedrico	Sì	Sferico	1 lineare, 10-12 kb
Hepeviridae	Icosaedrico	No	Icosaedrico	
ssRNA – (V)				
Arenaviridae	Elicoidale	Sì	Sferico	2 lineare, 5-7 kb
Bornaviridae	n.d.	Sì	Sferico	1 lineare, 9 kb
Bunyaviridae	Elicoidale	Sì	Sferico	3 lineare, 10-23 kb
Filoviridae	Elicoidale	Sì	Pleiomorfo filamentoso	1 lineare, 19 kb
Orthomyxoviridae	Elicoidale	Sì	Pleiomorfo sferico	8 lineare, 12-15 kb
Paramyxoviridae	Elicoidale	Sì	Pleiomorfo sferico	1 lineare, 15-16 kb
Rhabdoviridae	Elicoidale	Sì	A proiettile	1 lineare, 11-15 kb
ssRNA RT (VI)				
Retroviridae	Sferico, troncoidale	Sì	Sferico	1 RNA dimerico, 7-11 kb
dsDNA RT (VII)				
Hepadnaviridae	Icosaedrico	Sì	Sferico	1 DNA parz. circolare, 3 kb

Abbreviazione: n.d., non determinato.