CORSO INTEGRATO MICROBIOLOGIA	CFU tot	DOCENTE	MODULO	CFU PARZIALI
COORDINATORE: G. ANTONELLI	7	G. ANTONELLI (PO)	MICROBIOLOGIA MED/07	5
		M. ARTINI (PA)	MICROBIOLOGIA MED/07	
		S. D'AMELIO (PA)	PARASSITOLOGIA VET/06	2

Obiettivi dell'insegnamento:

Conoscenza degli organismi patogeni (batteri, funghi, virus, protozoi, elminti e artropodi) per l'uomo e loro classificazione. Conoscenza delle differenze tra i vari organismi in termini di: struttura e morfologia, metabolismo, meccanismi patogenetici, riproduzione e replicazione, epidemiologia.

Conoscenza dei rapporti che si stabiliscono tra ospite e patogeni nelle infezioni umane e delle possibilità di trattamento, controllo e diagnosi delle infezioni.

Libri di testo (consigliati):

- **G. Antonelli**, M. Clementi, G. Pozzi G. M. Rossolini - Principi di Microbiologia Medica. Casa Editrice Ambrosiana (CEA) – edizione 2022
- **M. La Placa** Principi di microbiologia medica- 2014 Società Editrice Esculapio - EdiSes
- **Patrick R**. Murray, Ken S. Rosenthal, Michael A. Pfaller Microbiologia medica Editore: Edra - A cura di: P. Di Francesco Data di Pubblicazione: febbraio 2021
- G. Cancrini - Parassitologia medica illustrata. Casa editrice EDRA - edizione 2017 Casa Editrice Ambrosiana CEA

Modalità di valutazione: ESAME ORALE

Evaluation methods: …ORAL EXAM

Prof. G. ANTONELLI **- Modulo: VIROLOGIA**

Obiettivi del modulo: Comprendere come vengono classificati i virus animali, come funziona il loro apparato genetico e come interagiscono e influenzano l'ospite. I suddetti meccanismi molecolari e cellulari devono combinarsi con il concetto di patogenesi virale, epidemiologia, evoluzione e controllo.

Programma del modulo: Struttura e classificazione dei virus animali - Replicazione dei virus - Effetto del virus sulla cellula ospite - Patogenesi delle infezioni virali - Oncogenesi da virus – Meccanismi difensivi dell'ospite alle infezioni virali - Controllo delle infezioni virali - Principi di diagnosi virologica - Farmaci antiretrovirali - Sistema interferon - Vaccini antivirali. Struttura e caratteristiche morfologiche, patogenesi, controllo, epidemiologia, e diagnosi dei principali virus e infezioni virali importanti in patologia umana**.

**

Specific virus families: **Picornaviridae,** Caliciviridae, Astroviridae, Bunyaviridae, Filoviridae, **Hepeviridae** (**HEV**), **Coronaviridae (SARS), Togaviridae, Flaviridae (HCV), Rabdoviridae**, **Paramyxoviridae, Orthomyxoviridae**, Arenaviridae, Reoviridae, **Retroviridae (HIV, HTLV-1), Polyomaviridae**, **Papillomaviridae**, **Adenoviridae, Parvoviridae (B19), Herpesviridae, Hepadnaviridae (HBV),** Viroids (HDV), Prions.

- ***MICROBIOLOGY*** → Biology of microrganisms

- ***MICROORGANISMS*** → Organisms not visible to the naked eye

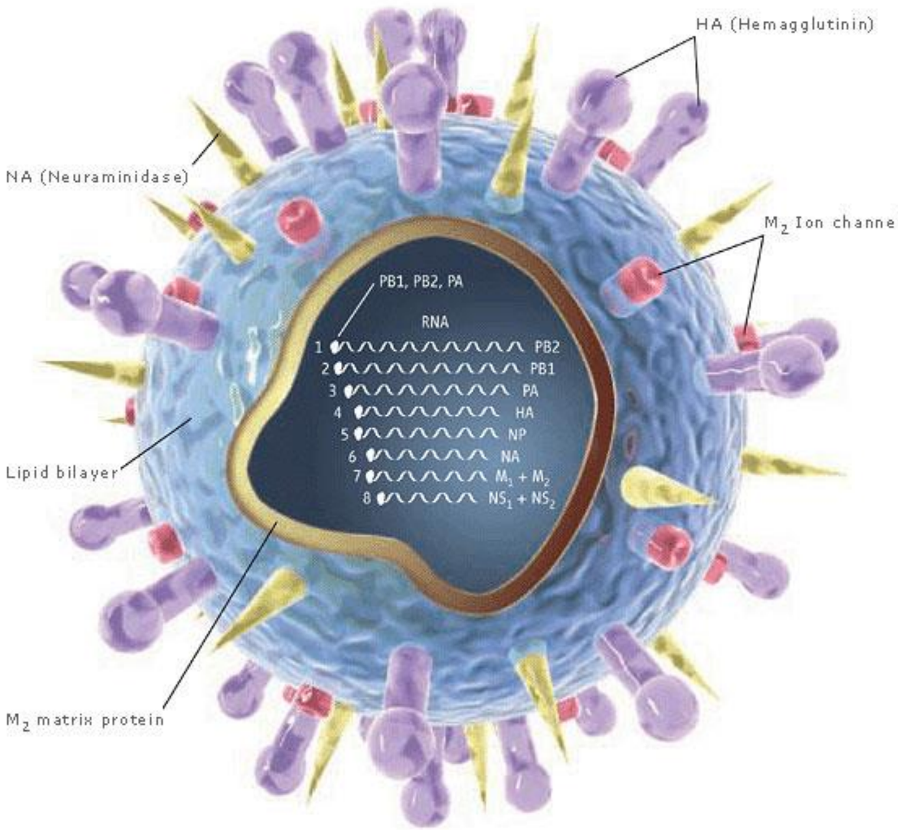
- ***MEDICAL/CLINICAL MICROBIOLOGY*** → Microbiology of microorganisms responsible for some human pathologies

Medical microbiology

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

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

VIROLOGY


HA (Hemagglutinin)
NA (Neuraminidase)
M2 Ion channel
PB1, PB2, PA
RNA
1 PB2
2 PB1
3 PA
4 HA
5 NP
6 NA
7 M1 + M2
8 NS1 + NS2
Lipid bilayer
M2 matrix protein

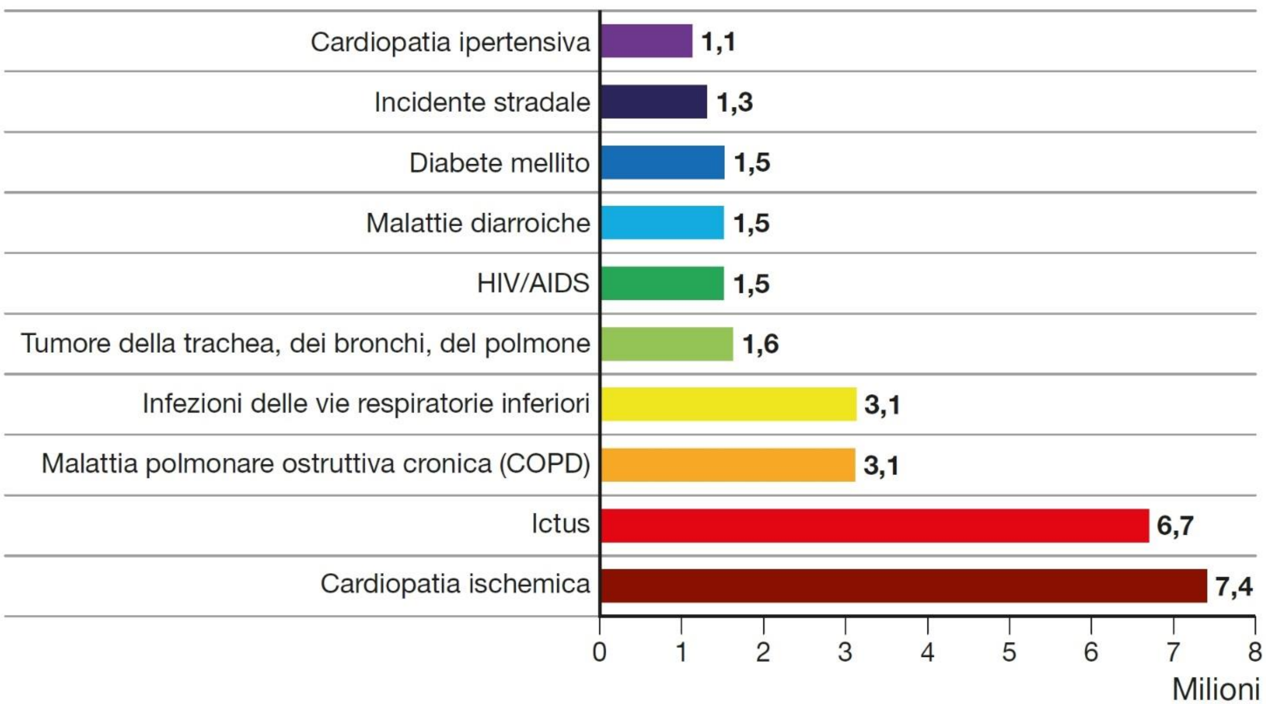


Figura 77.1 **Le 10 principali cause di morte nel mondo nel 2012 (fonte OMS, 2016).**

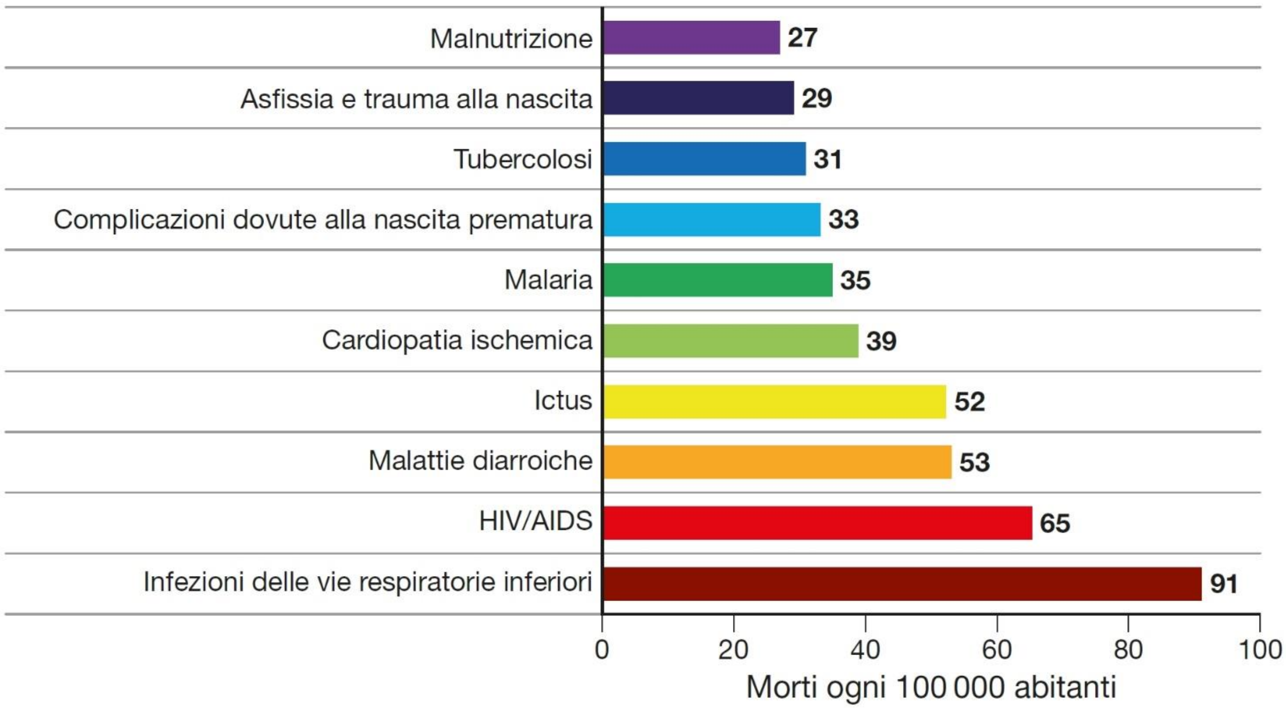
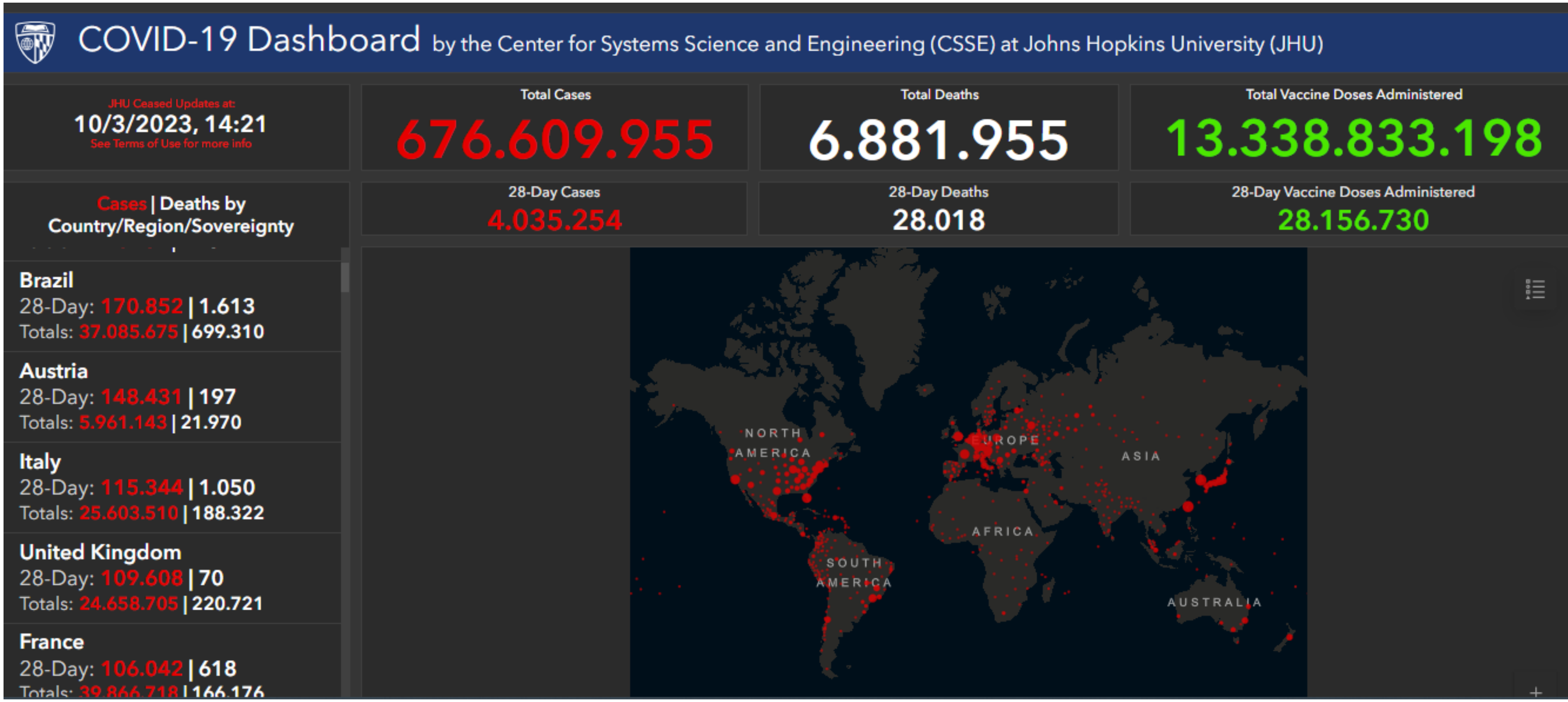


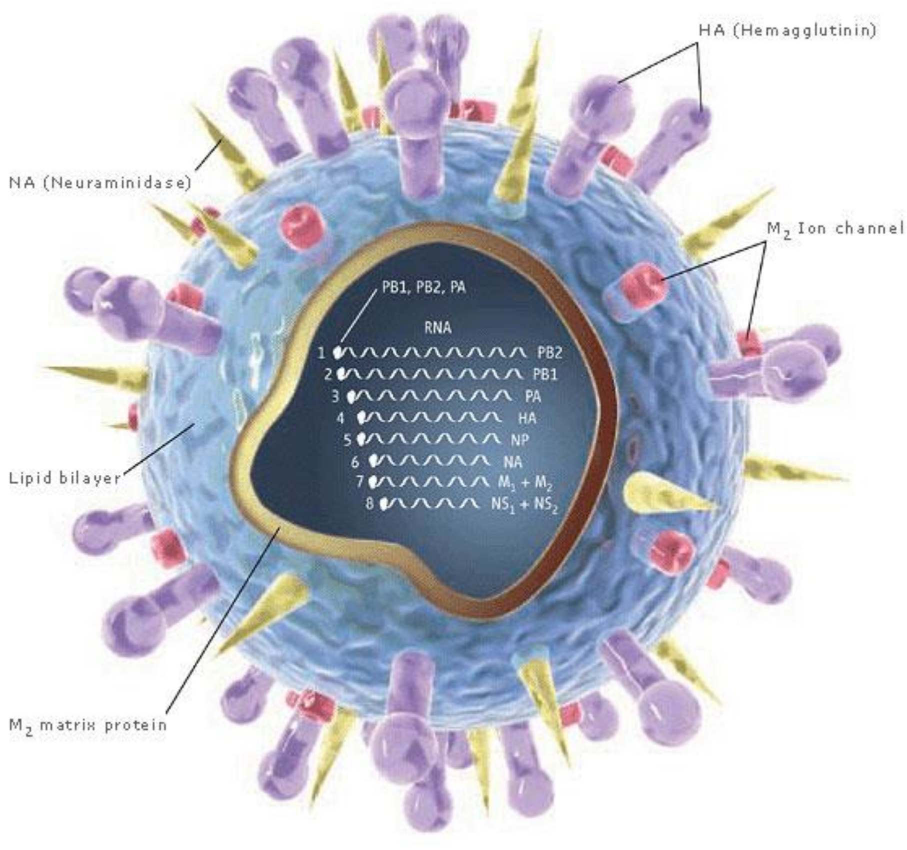
Figura 77.2 **Principali cause di morte nel 2012 nei Paesi a basso reddito (fonte OMS, 2016).**

JHU Has Stopped Collecting Data As Of

03 / 10 / 2023



VIROLOGY


HA (Hemagglutinin)
NA (Neuraminidase)
M2 Ion channel
PB1, PB2, PA
RNA
1 PB2
2 PB1
3 PA
4 HA
5 NP
6 NA
7 M1 + M2
8 NS1 + NS2
Lipid bilayer
M2 matrix protein

Redifining determinants of viral 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**

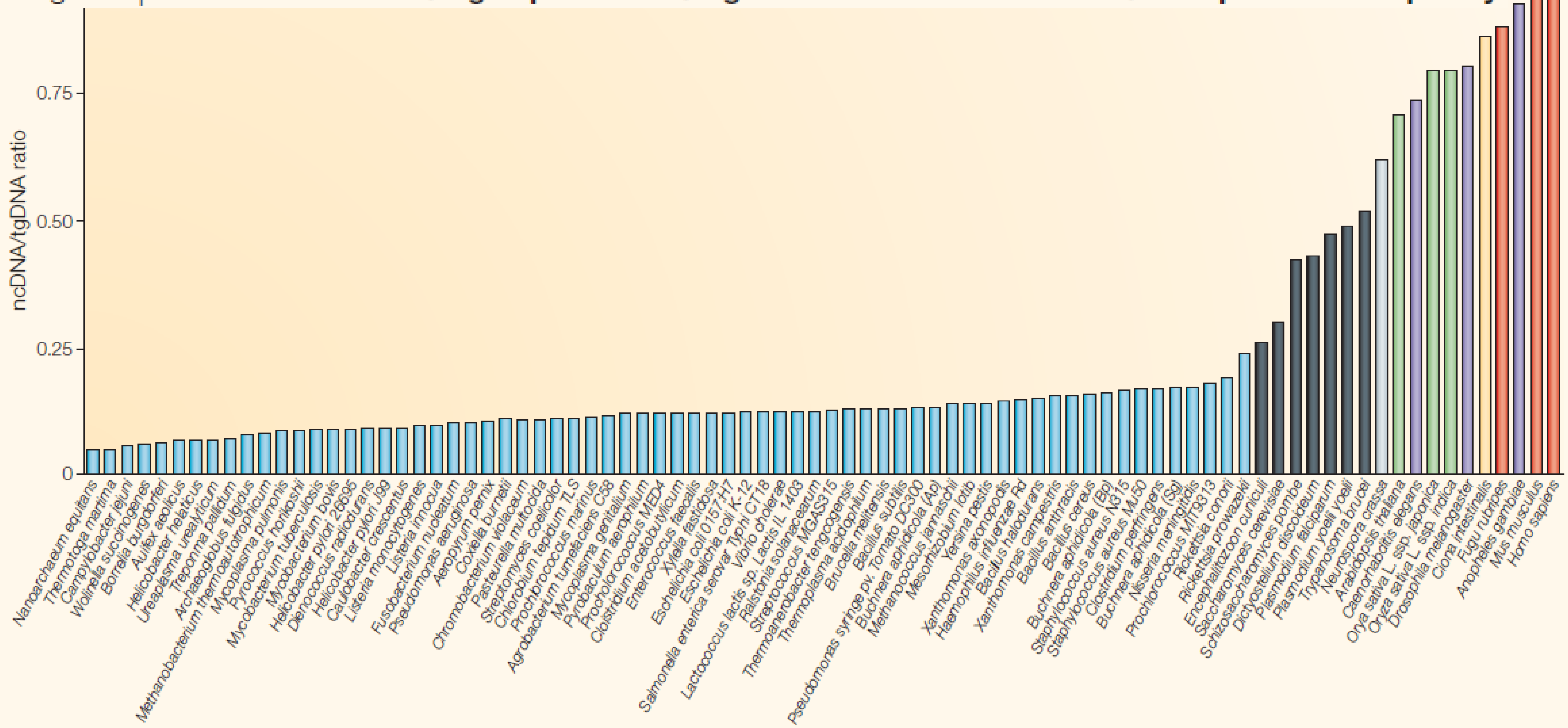
NonCodingRNA/TotalGenomicDNA

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.

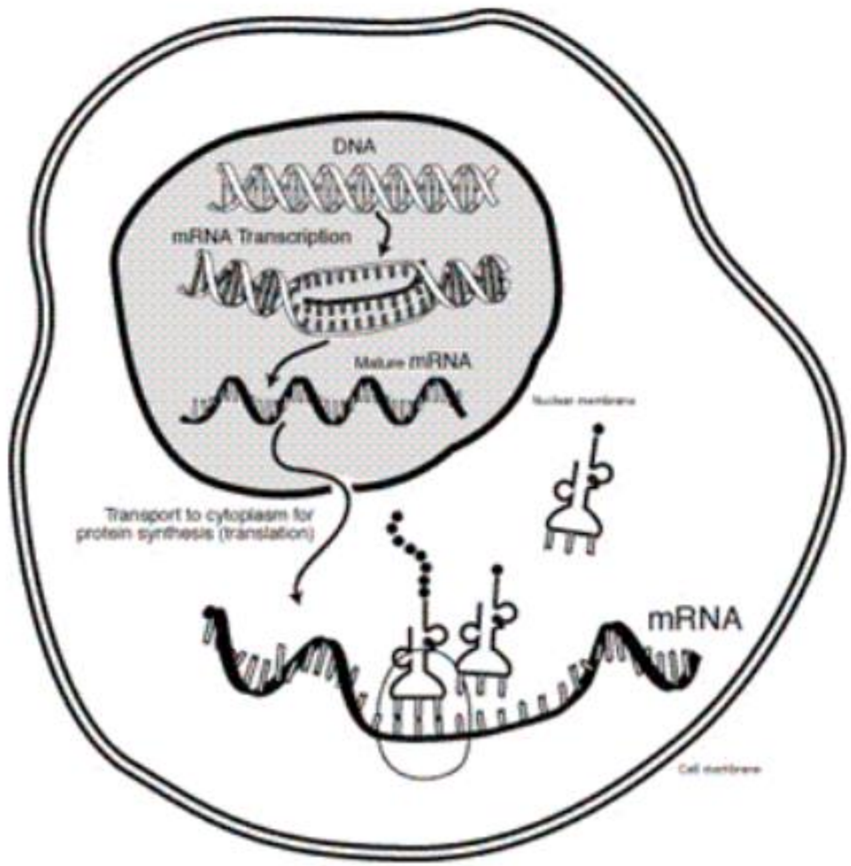


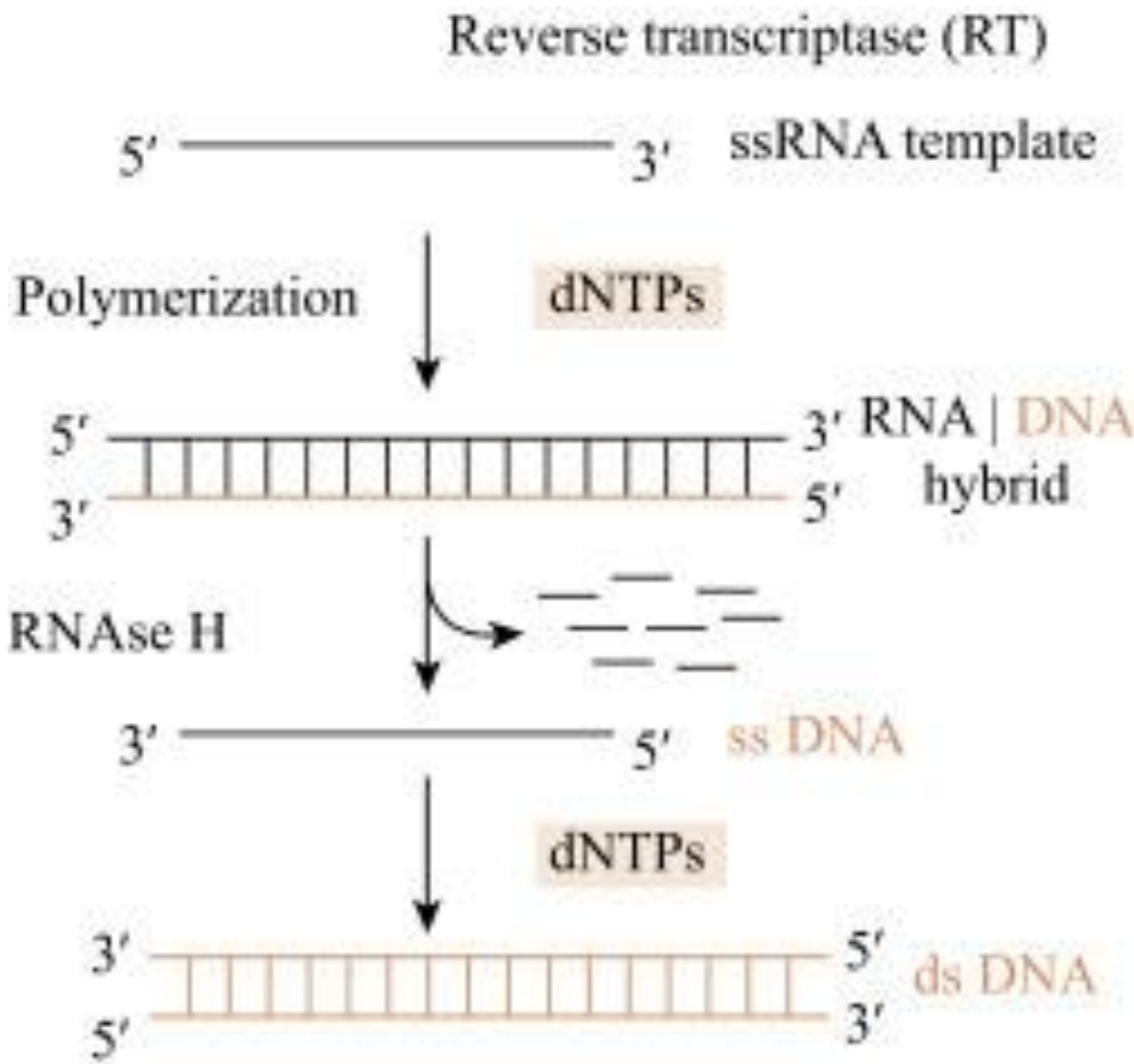
For 50 years the term 'gene' has been synonymous with regions of the genome encoding mRNAs that are translated into protein. However, recent genome-wide studies have shown that the human genome is pervasively transcribed and produces many thousands of regulatory non-protein-coding RNAs (ncRNAs), including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

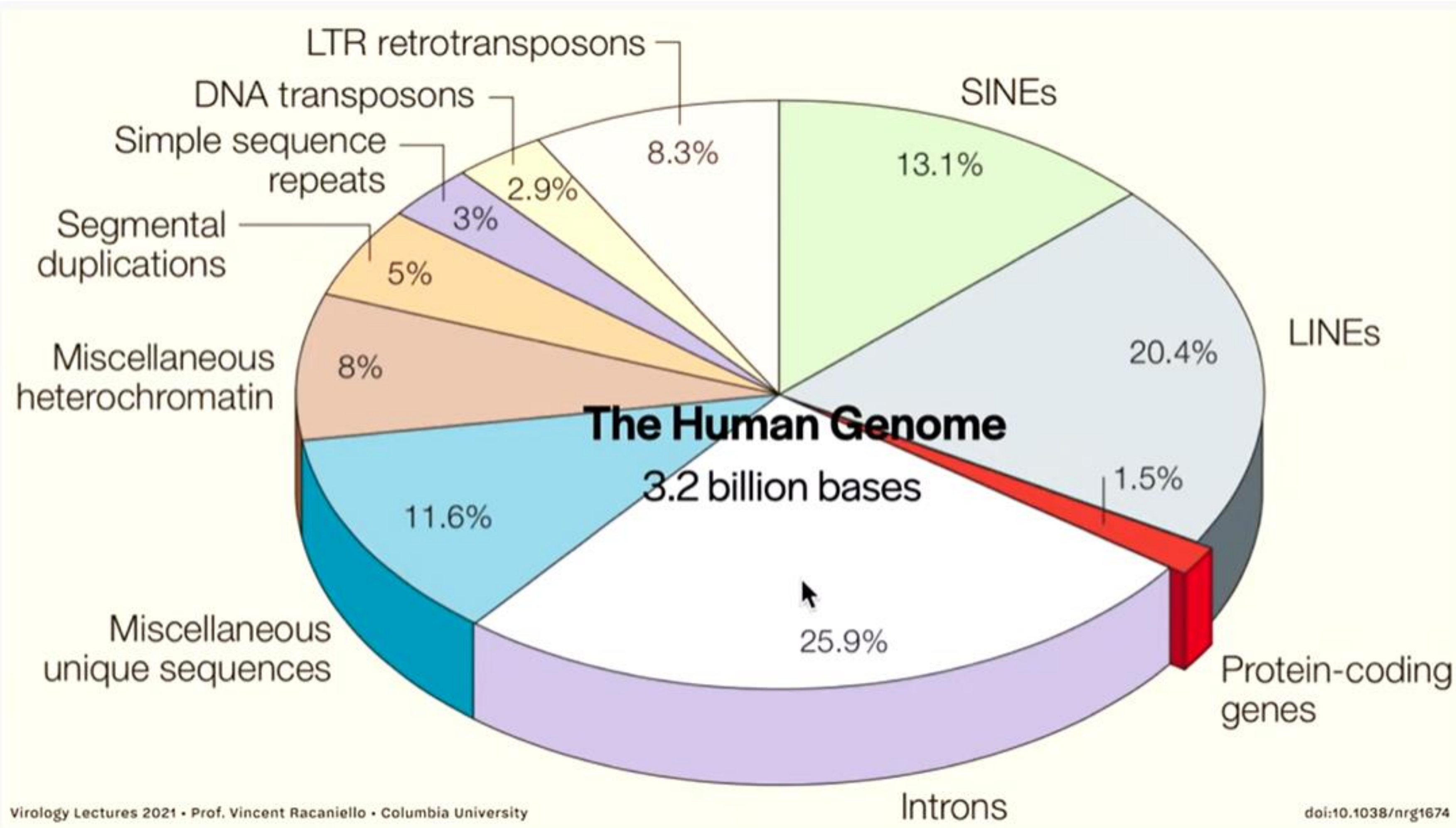
It is now clear that these RNAs fulfil critical roles as transcriptional and post-transcriptional regulators and as guides of chromatin-modifying complexes.

Redifining determinants of host-virus interaction complexity: lesson from human genome

Central Dogma of Biology: Classic View




Reverse transcriptase (RT)
5′
3′
ssRNA template
Polymerization
dNTPs
5′
3′
3′
5′
RNA | DNA
hybrid
RNAse H
3′
5′
ss DNA
dNTPs
3′
5′
5′
3′
ds DNA



LTR retrotransposons
DNA transposons
Simple sequence repeats
Segmental duplications
Miscellaneous heterochromatin
Miscellaneous unique sequences
SINEs
LINEs
Protein-coding genes
Introns
8.3%
2.9%
3%
5%
8%
11.6%
13.1%
20.4%
1.5%
25.9%
The Human Genome
3.2 billion bases
Virology Lectures 2021 • Prof. Vincent Racaniello • Columbia University
doi:10.1038/nrg1674

Liu et al., 2023, Cell *186*, 287–304
January 19, 2023 © 2022 The Author(s). Published by Elsevier Inc.
https://doi.org/10.1016/j.cell.2022.12.017

CellPress

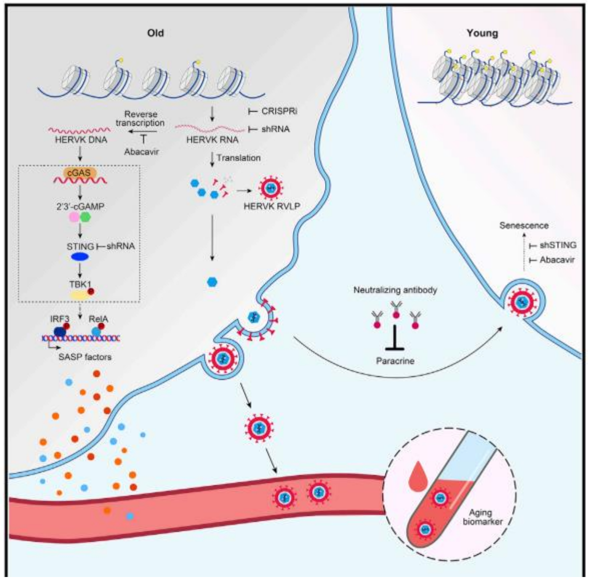
Research Highlight | Published: 20 January 2023

Cell senescence

Younger endogenous retroviruses make us older

Eytan Zlotorynski

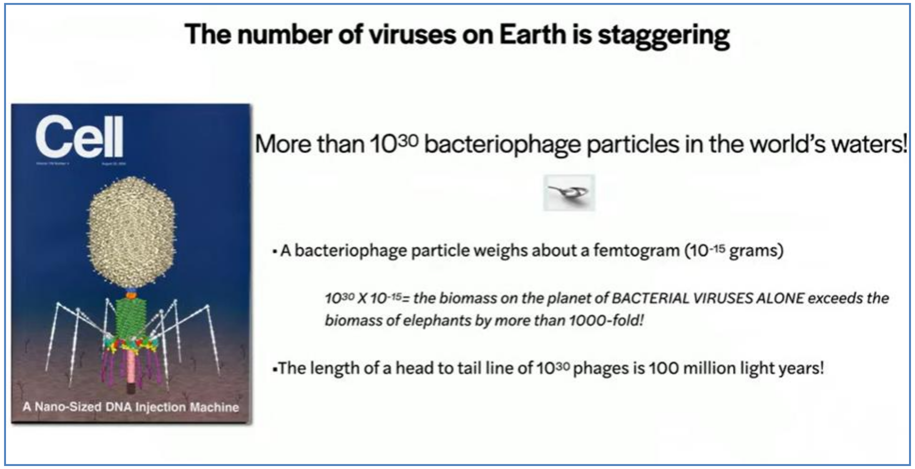
Nature Reviews Molecular Cell Biology **24**, 165 (2023) | Cite this article

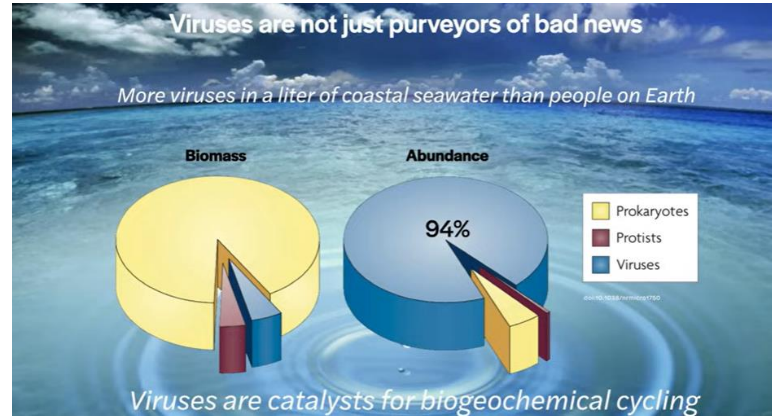


Highlights

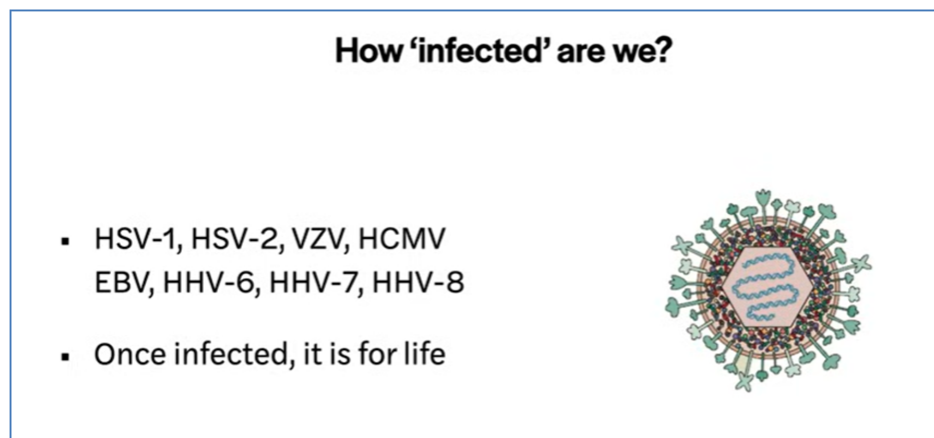
- Derepression of the endogenous retrovirus contributes to programmed aging
- Upregulation of HERVK triggers the innate immune response and cellular senescence
- Extracellular HERVK retrovirus-like particles induce senescence in young cells
- Endogenous retrovirus serves as a potential target to alleviate aging

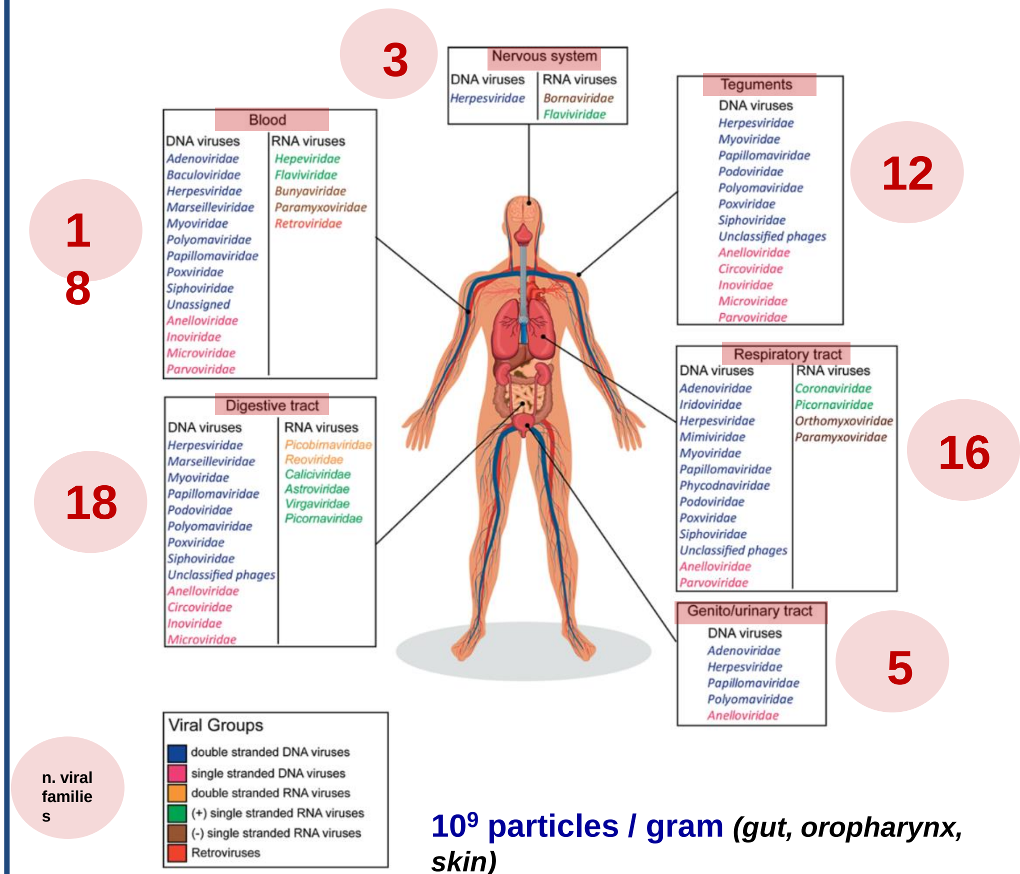
Redifining determinants of host-virus interaction complexity: lesson from virome


The number of viruses on Earth is staggering
Cell
A Nano-Sized DNA Injection Machine
More than 10^30 bacteriophage particles in the world's waters!
• A bacteriophage particle weighs about a femtogram (10^-15 grams)
10^30 X 10^-15 = the biomass on the planet of BACTERIAL VIRUSES ALONE exceeds the biomass of elephants by more than 1000-fold!
•The length of a head to tail line of 10^30 phages is 100 million light years!


Viruses are not just purveyors of bad news
More viruses in a liter of coastal seawater than people on Earth
Biomass
Abundance
94%
Prokaryotes
Protists
Viruses
Viruses are catalysts for biogeochemical cycling


There are ~10^16 HIV genomes on the planet today

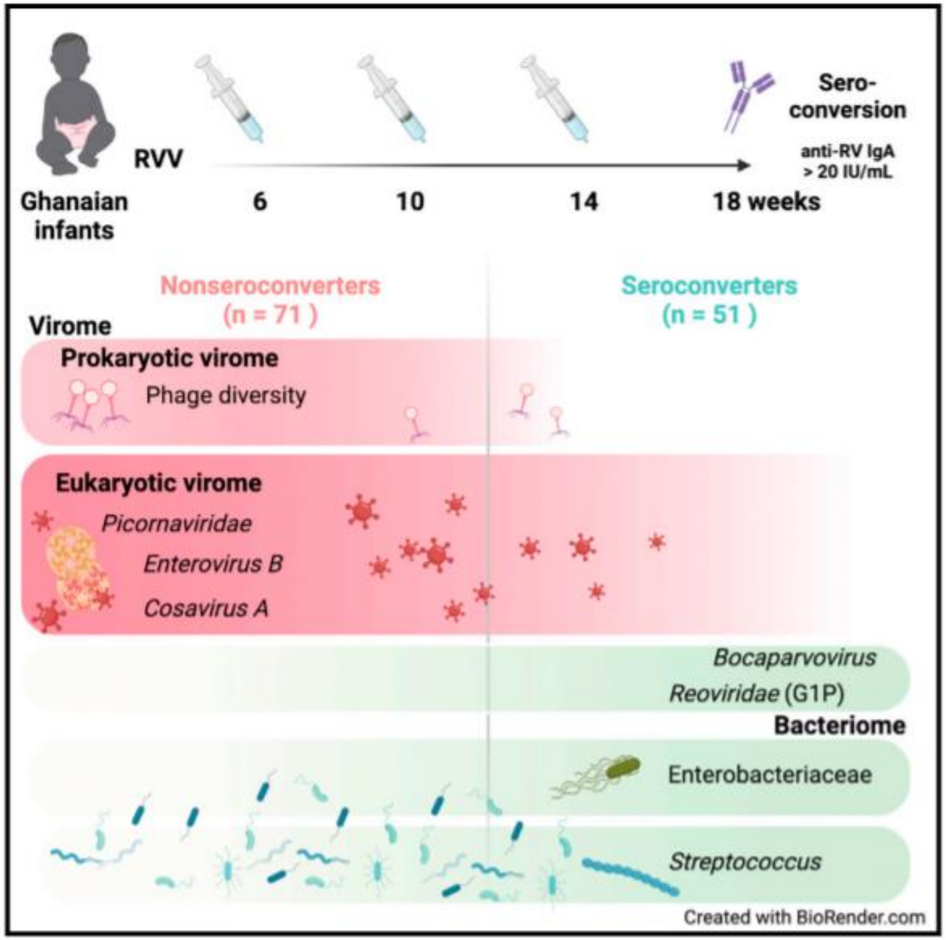

How 'infected' are we?
▪ HSV-1, HSV-2, VZV, HCMV
EBV, HHV-6, HHV-7, HHV-8
▪ Once infected, it is for life



10^9 particles / gram ***(gut, oropharynx, skin)***

10^5 - 10^7 particles / ml ***(blood, urine)***

Modified from Rascovan *et al.* Annu Rev Microbiol 2016



Clinical and Translational Report

Cell Host & Microbe

Enteric virome negatively affects seroconversion following oral rotavirus vaccination in a longitudinally sampled cohort of Ghanaian infants

Kim et al., 2022, Cell Host & Microbe *30*, 110–123
January 12, 2022
https://doi.org/10.1016/j.chom.2021.12.002

Longitudinal analysis of microbiota of Ghanaian infants receiving rotavirus vaccine

- *Streptococcus* and Enterobacteriaceae taxa positively associate with RVV seroconversion
- *Enterovirus B*, *Cosavirus A*, and phage richness negatively associate with RVV serostatus

Virome composition may affect vaccine efficacy

Clinical Microbiology and Infection 25 (2019) 133–135

Contents lists available at ScienceDirect

Clinical Microbiology and Infection

journal homepage: www.clinicalmicrobiologyandinfection.com

Editorial

Virology: a scientific discipline facing new challenges

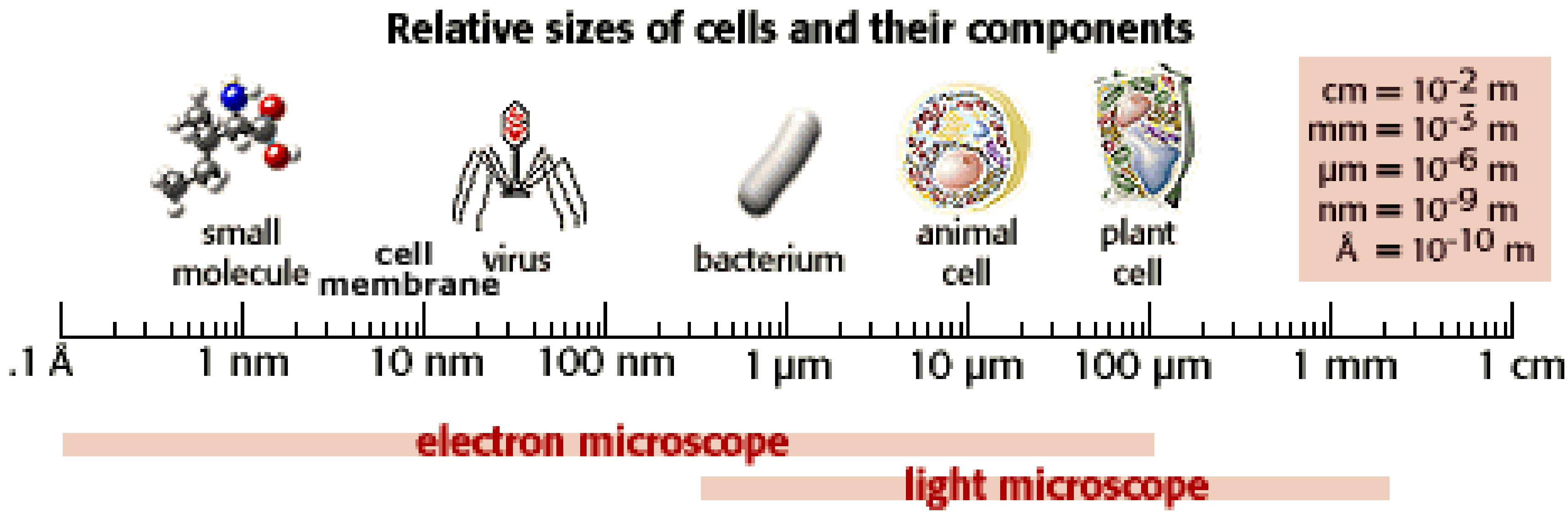
G. Antonelli*, M. Pistello

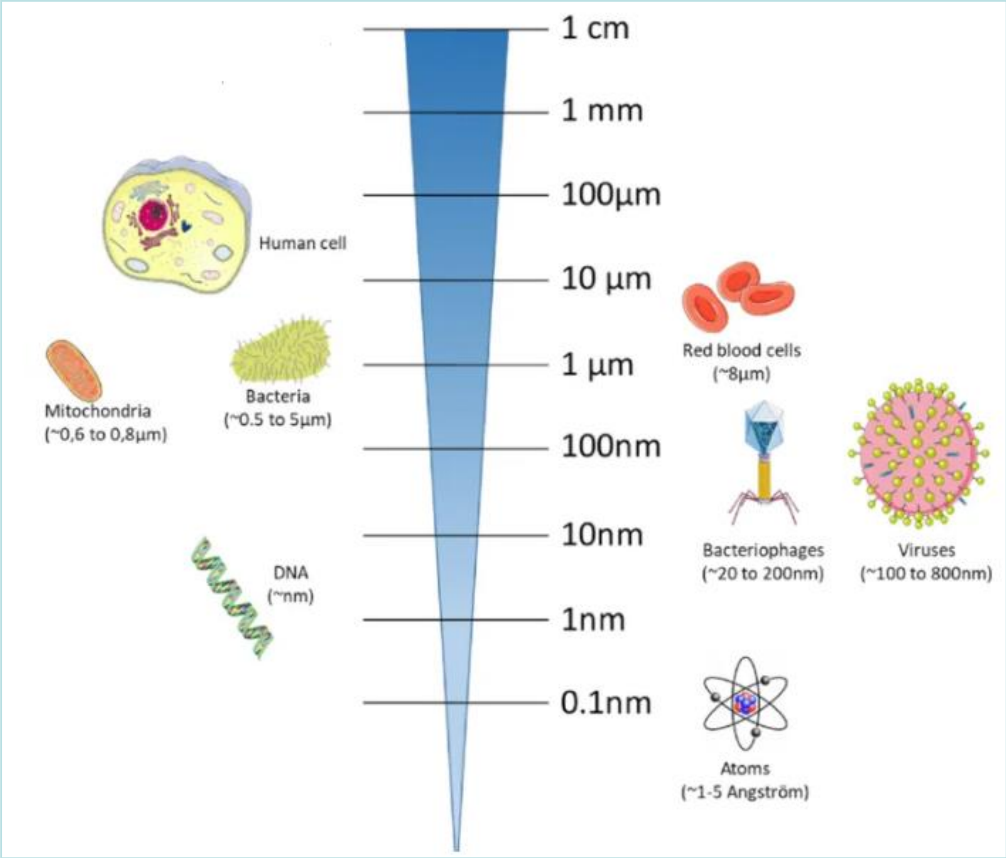
- Together with viral pathogens able to cause symptomatic chronic infections, there are viruses which constitute a stable (and little-recognized) part of our virome.

Among the many advancements and the progress we have achieved in past decades, the findings that, to our opinion, have most blurred the fundamentals of traditional virology are the following:

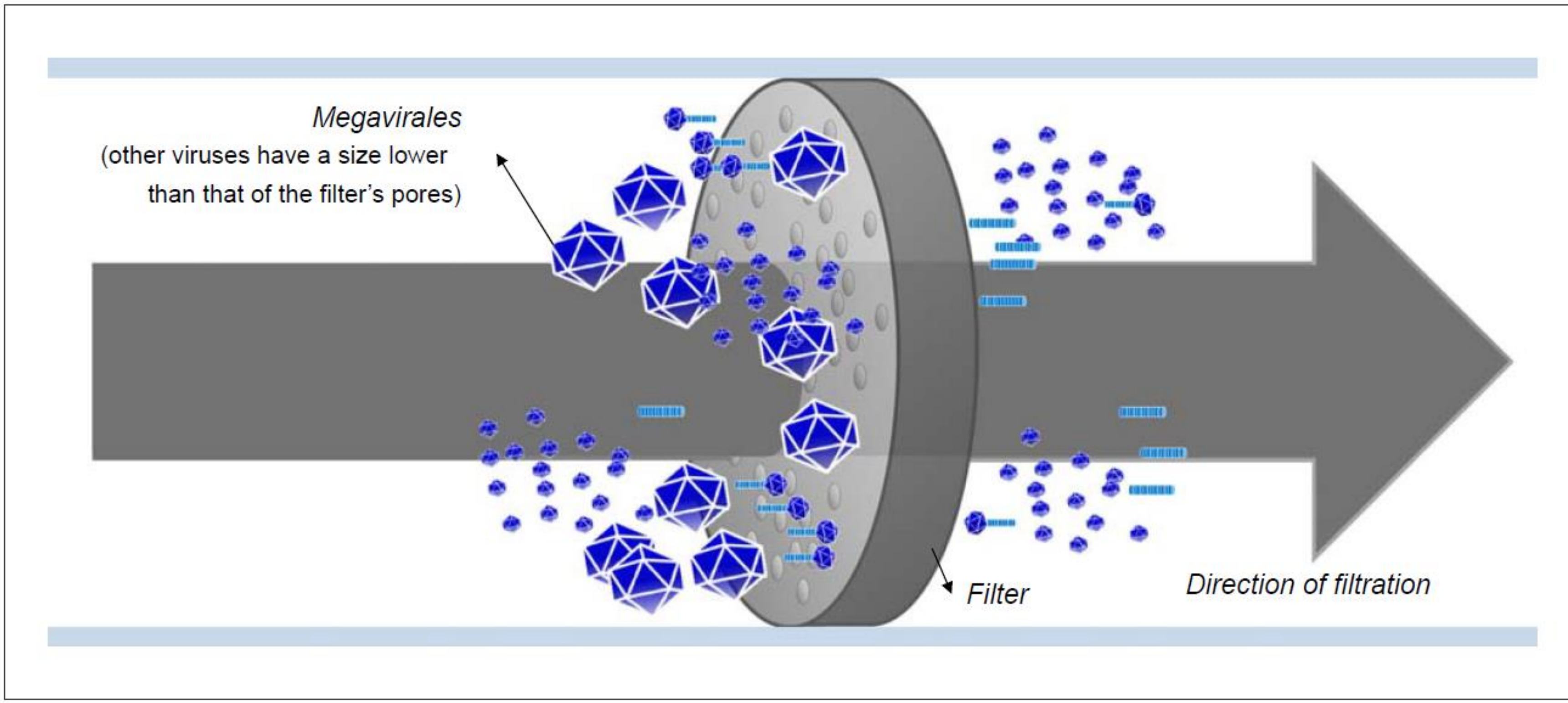
- can be considered as the set of all viruses, eukaryotic and prokaryotic, present in the human body. The virome includes viruses that infect host cells, viruses that infect the majority of other types of microorganisms harboured by the body, and virus-related genetic elements in our chromosomes [1]. Viruses, which can no longer be invariably considered pathogens, interact with the host and other members of the microbial communities (Archaea, bacteria and eukaryotes) in a variety of complex and meaningful ways. These complex interactions have just begun to be investigated but it is common opinion that they profoundly affect health status [2]. Due to the existence of commensal viruses, we should probably redefine chronic viral infections and focus our attention on the host rather than on infectious agents to dissect disease determinants. From a policy point of view, we must conclude that the integration of 'different' disciplines (virology, bacteriology, mycology, immunology, genetics, molecular biology) is essential for a more complete understanding of the role of the virome and its trans-kingdom interactions in the modulation of health and disease status.

Redifining the size of the viruses: lesson from Mimivirus


Relative sizes of cells and their components
cm = 10-2 m
mm = 10-3 m
µm = 10-6 m
nm = 10-9 m
Å = 10-10 m
small molecule
cell membrane
virus
bacterium
animal cell
plant cell
.1 Å
1 nm
10 nm
100 nm
1 µm
10 µm
100 µm
1 mm
1 cm
electron microscope
light microscope



The selection of filters for sterilization must account for the size range of the contaminants to be excluded. The most commonly used filter is composed of nitrocellulose and has a pore size of 0.22μm. The size of the bacteria ranges from 0.3 to 0.5 μm whereas the size of the viruses ranges from 20 nm to 0.36 μm. Thus a filter of 0.22μm retains all bacteria and spores but not all viruses.



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

www.sciencemag.org SCIENCE VOL 299 28 MARCH 2003

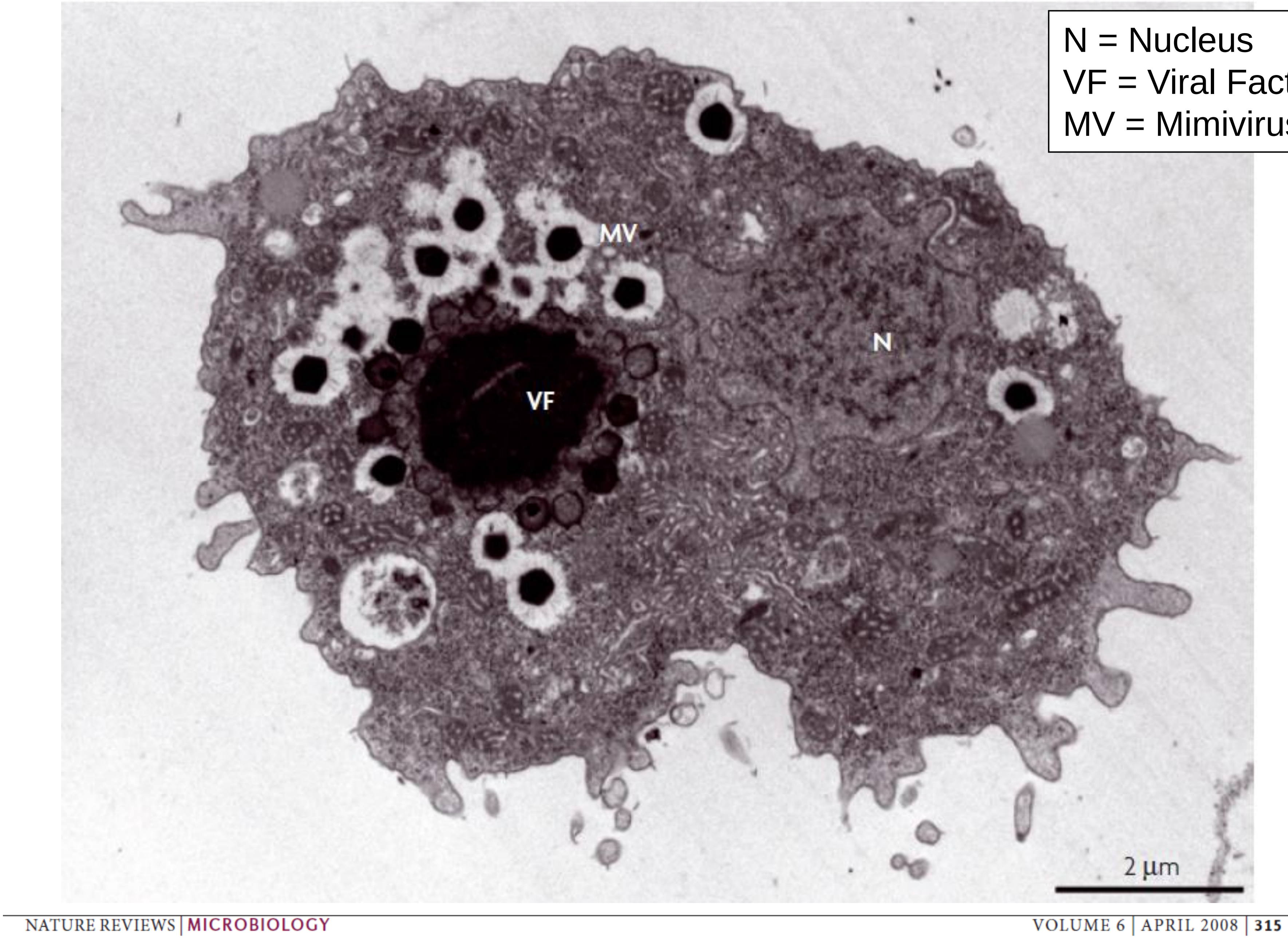
A Giant Virus in Amoebae

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]*

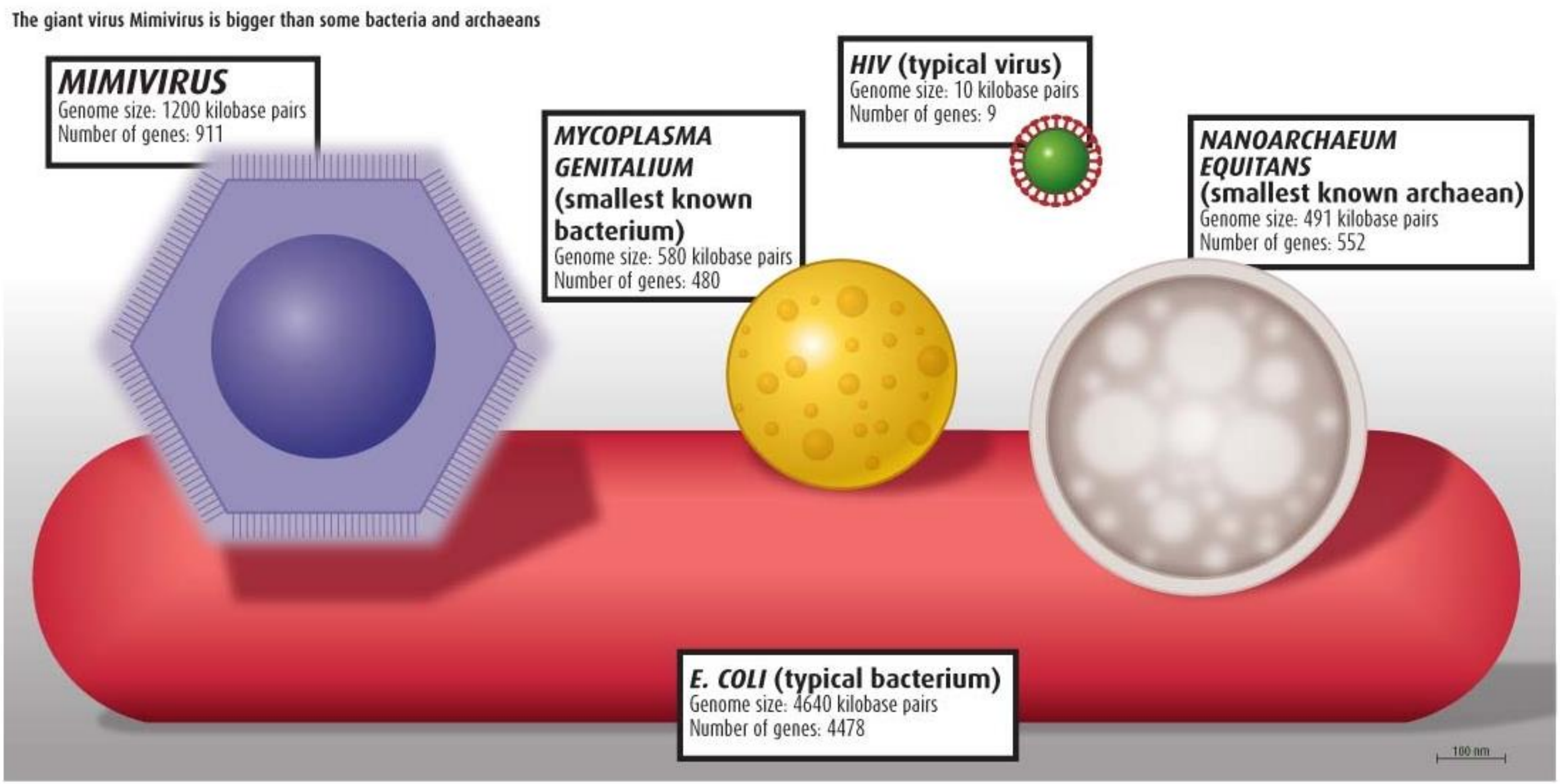
Study of this microorganism within *Acanthamoeba polyphaga* (*2*) revealed a characteristic viral morphology with mature particles of 400 nm in diameter and surrounded by an icosahedral capsid. This structure is consistent with the finding that Mimivirus is not filterable through 0.2-μm pore size filters. 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)

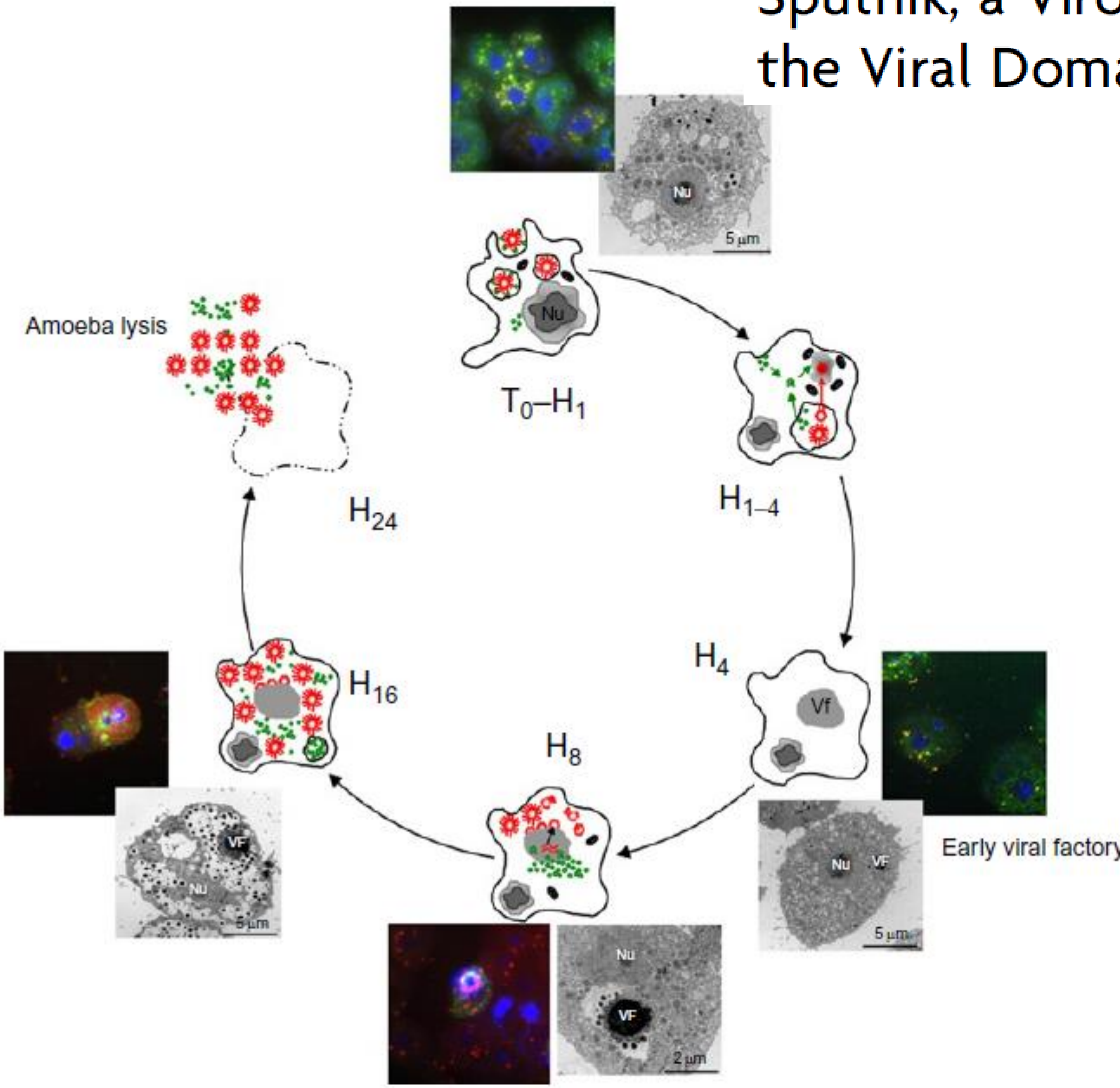
N = Nucleus
VF = Viral Factory
MV = Mimivirus



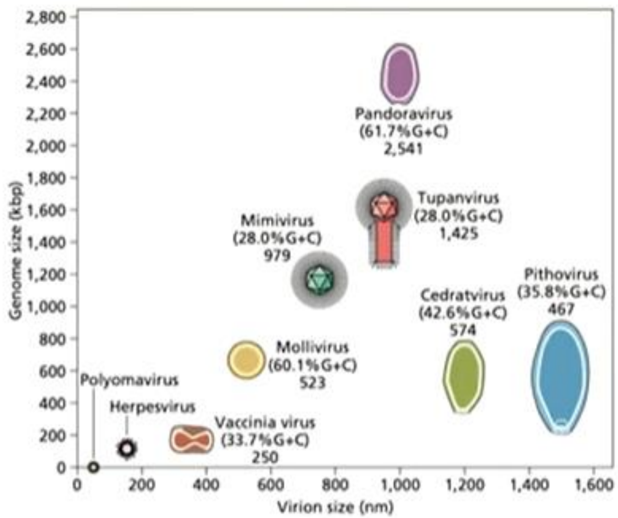
NCLDV (NucleoCytoplasmic Large DNA Virus)

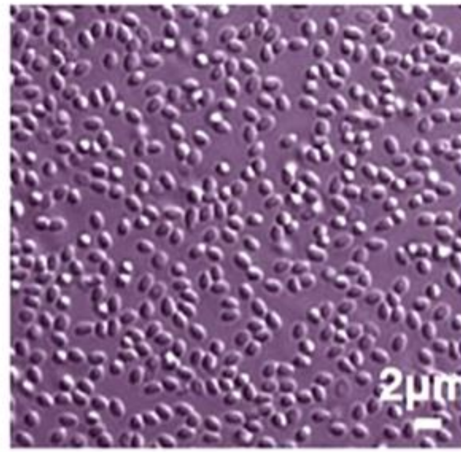


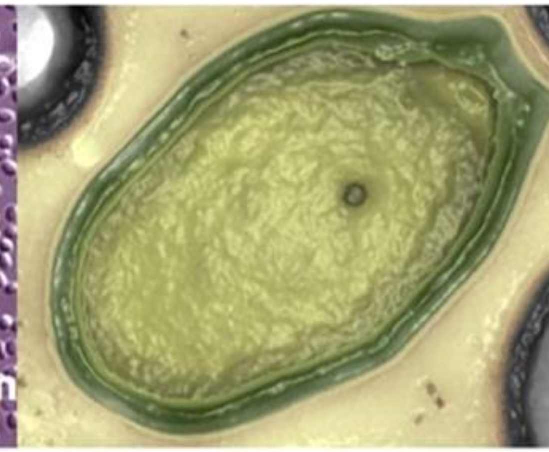
Sputnik, a Virophage Infecting the Viral Domain of Life

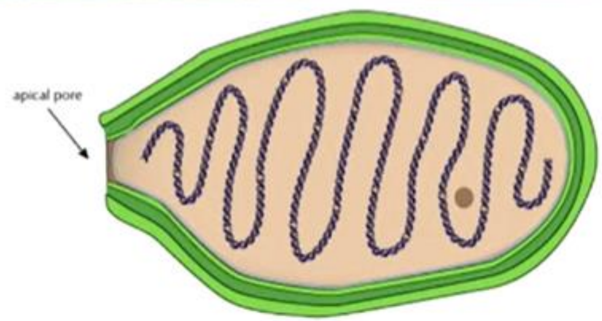


Pandoravirus





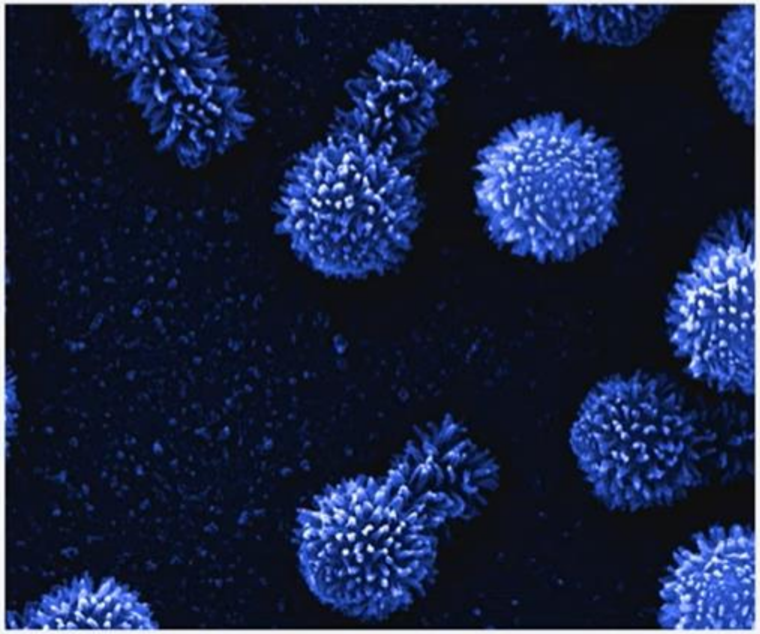




DOI: 10.1126/science.1239181

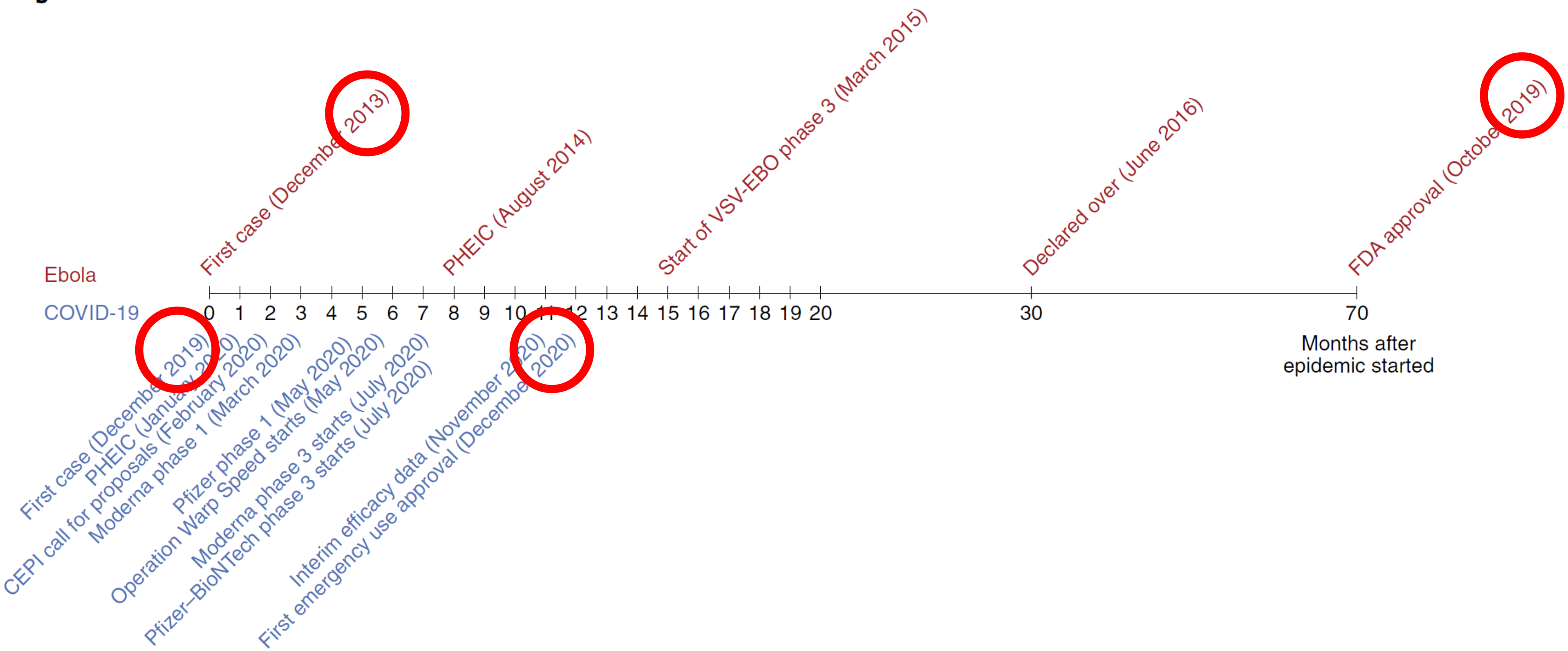
Tupanvirus - Only the ribosome is lacking

- 20 aminoacyl tRNA syntheses
- 70 tRNAs
- Multiple translation initiation and elongation proteins
- Multiple translation related genes e.g. for tRNA, mRNA maturation
- Most complete translational apparatus of the virosphere

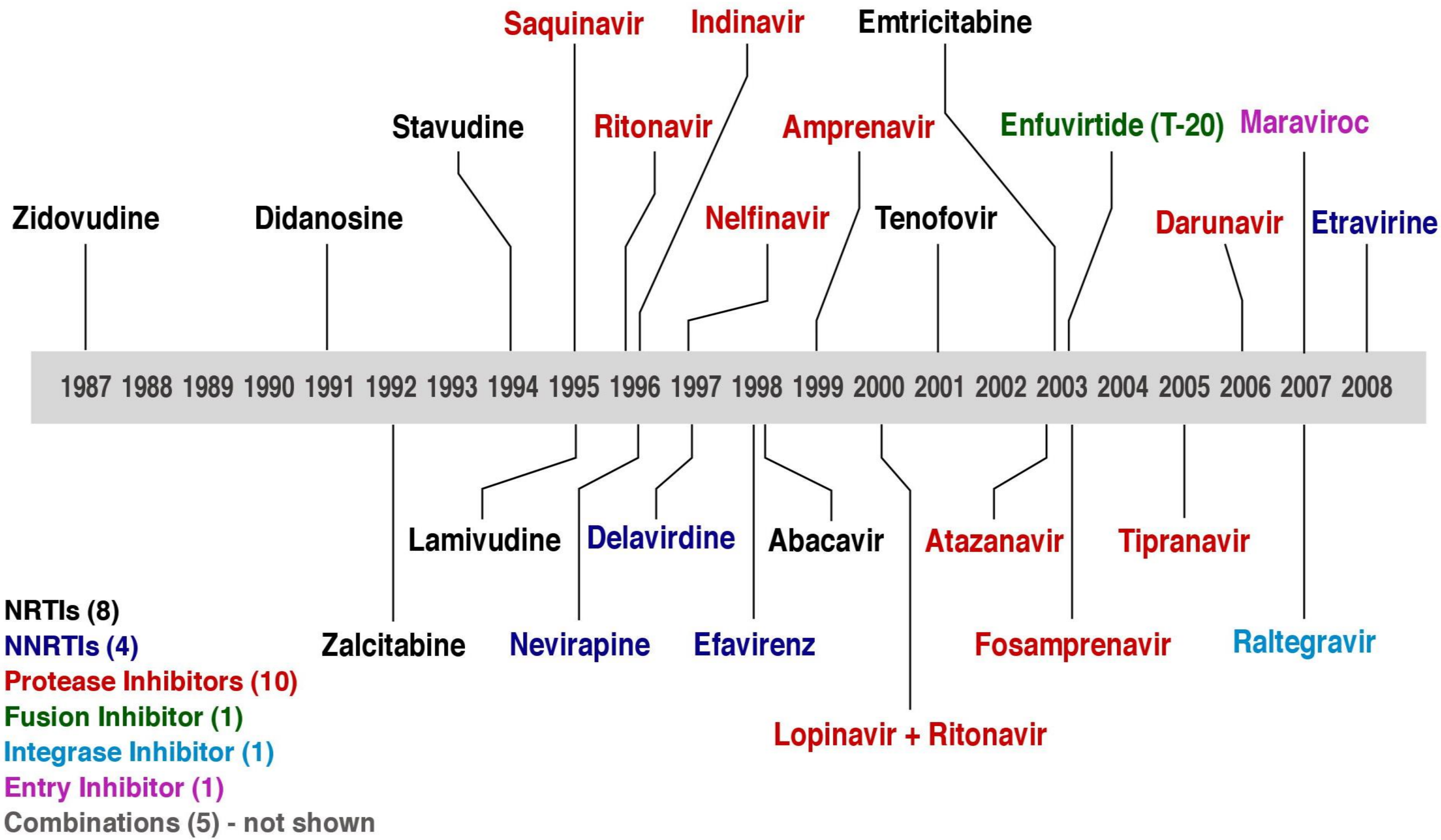


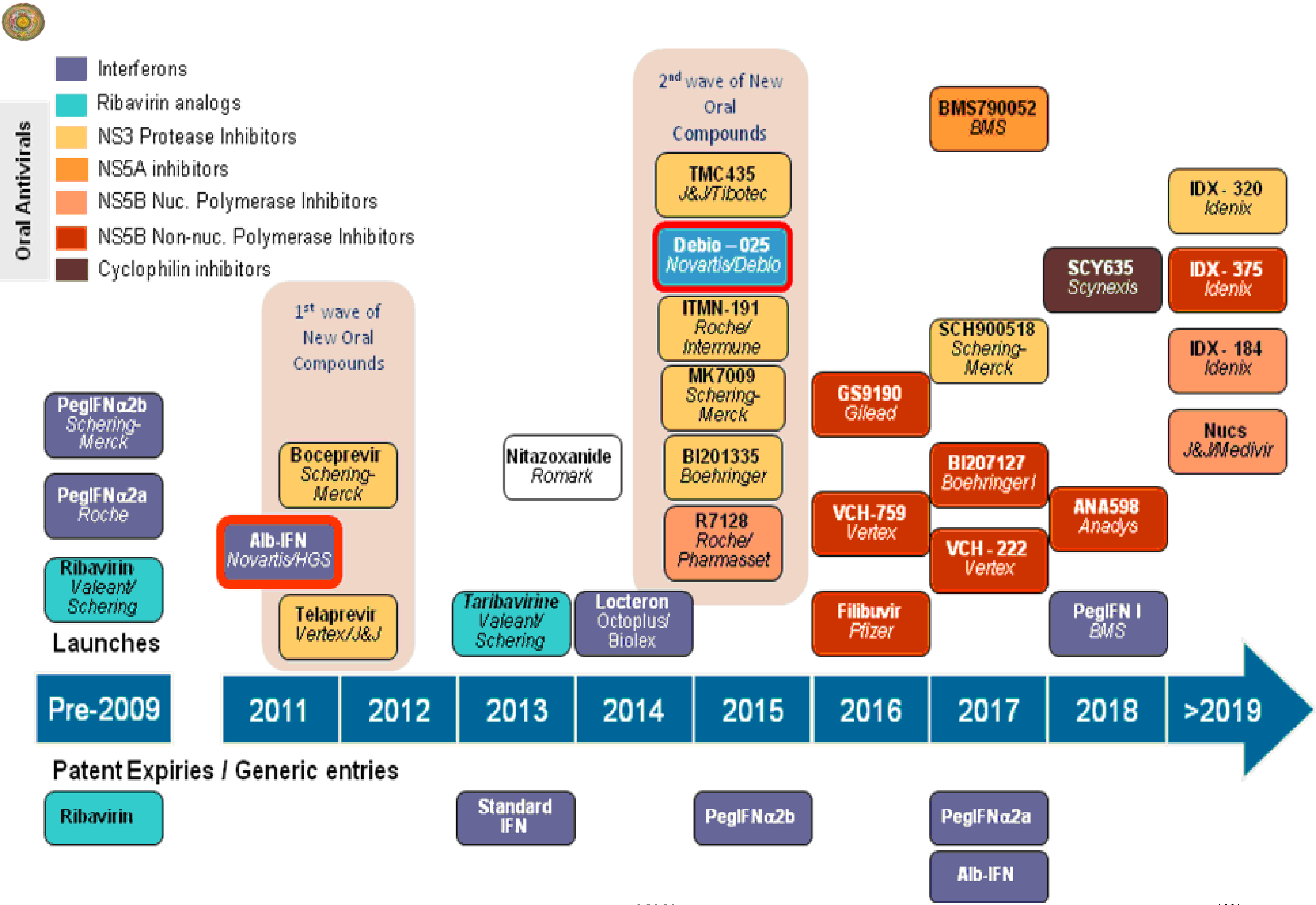
Redifining the medical intervention to fight viral diseases :
lesson from HIV, HCV and SARS-CoV-2

b

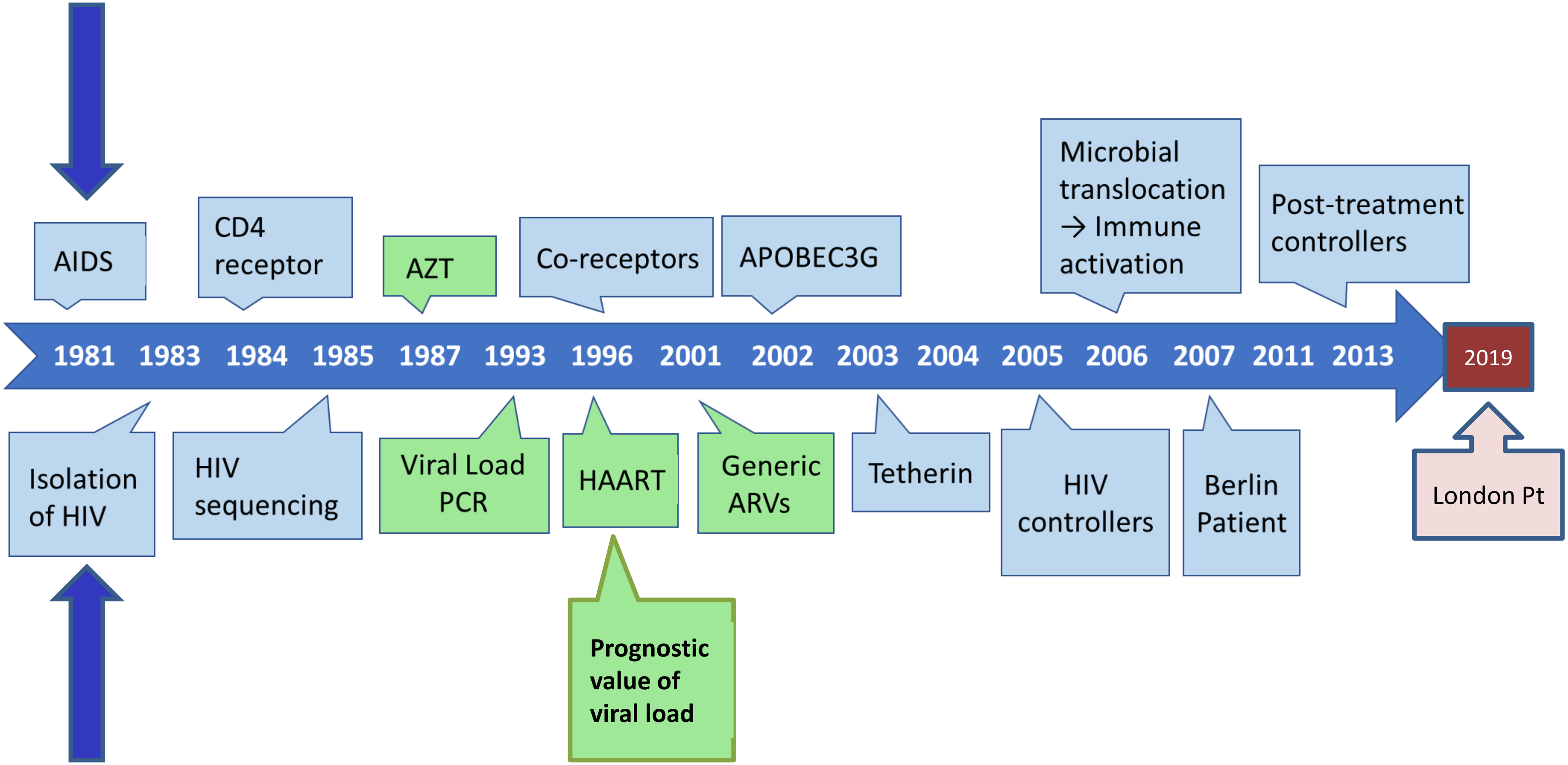

Ebola
COVID-19
First case (December 2013)
PHEIC (August 2014)
Start of VSV-EBO phase 3 (March 2015)
Declared over (June 2016)
FDA approval (October 2019)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 30 70
Months after epidemic started
First case (December 2019)
PHEIC (January 2020)
CEPI call for proposals (February 2020)
Moderna phase 1 (March 2020)
Pfizer phase 1 (May 2020)
Operation Warp Speed starts (May 2020)
Moderna phase 3 starts (July 2020)
Pfizer–BioNTech phase 3 starts (July 2020)
Interim efficacy data (November 2020)
First emergency use approval (December 2020)

30 FDA-Approved Antiretroviral Drugs




Interferons
Ribavirin analogs
NS3 Protease Inhibitors
NS5A inhibitors
NS5B Nuc. Polymerase Inhibitors
NS5B Non-nuc. Polymerase Inhibitors
Cyclophilin inhibitors
Oral Antivirals
1st wave of New Oral Compounds
2nd wave of New Oral Compounds
PegIFNα2b Schering-Merck
PegIFNα2a Roche
Ribavirin Valeant/ Schering
Launches
Alb-IFN Novartis/HGS
Boceprevir Schering-Merck
Telaprevir Vertex/J&J
Nitazoxanide Romark
Taribavirine Valeant/ Schering
Locteron Octoplus/ Biolex
TMC435 J&J/Tibotec
Debio – 025 Novartis/Debio
ITMN-191 Roche/ Intermune
MK7009 Schering-Merck
BI201335 Boehringer
R7128 Roche/ Pharmasset
GS9190 Gilead
VCH-759 Vertex
Filibuvir Pfizer
BMS790052 BMS
SCH900518 Schering-Merck
BI207127 Boehringer I
VCH - 222 Vertex
SCY635 Scynexis
ANA598 Anadys
PegIFN l BMS
IDX - 320 Idenix
IDX - 375 Idenix
IDX - 184 Idenix
Nucs J&J/Medivir
Pre-2009
2011
2012
2013
2014
2015
2016
2017
2018
>2019
Patent Expiries / Generic entries
Ribavirin
Standard IFN
PegIFNα2b
PegIFNα2a
Alb-IFN

MILESTONES IN HIV-AIDS RESEARCH
(VIROLOGICAL, DIAGNOSTIC AND PATHOGENETIC ISSUES)



HIV Cure

Timothy Ray Brown (Berlin patient) and the “London patient” shared similar medical circumstances.

They were both HIV-1-positive and receiving ART therapy.
They both eventually developed a blood cancer (acute myeloid leukemia and Hodgkin’s lymphoma, respectively), which was treated with chemotherapy and various other therapeutics.

Both ultimately required a bone marrow transplant to replenish the blood stem cells that had been destroyed during chemotherapy.

In both cases, doctors used bone marrow cells from a donor who was homozygous for a mutation in the gene encoding the HIV co-receptor CCR5 (CCR5 Δ32/Δ32), because this genotype confers resistance to HIV-1 infection. Both patients were cured of their cancer.

Both patients were also cured of their HIV infection, as evidenced by the absence of virus in their blood many months after termination of ART.

Brief Communication | Open Access | Published: 20 February 2023

In-depth virological and immunological characterization of HIV-1 cure after CCR5Δ32/Δ32 allogeneic hematopoietic stem cell transplantation

Björn-Erik Ole Jensen, Elena Knops, Leon Cords, Nadine Lübke, Maria Salgado, Kathleen Busman-Sahay, Jacob D. Estes, Laura E. P. Huyveneers, Federico Perdomo-Celis, Melanie Wittner, Cristina Gálvez, Christiane Mummert, Caroline Passaes, Johanna M. Eberhard, Carsten Münk, Ilona Hauber, Joachim Hauber, Eva Heger, Jozefien De Clercq, Linos Vandekerckhove, Silke Bergmann, Gábor A. Dunay, Florian Klein, Dieter Häussinger, ... Guido Kobbe + Show authors

Nature Medicine (2023) | Cite this article

Third person free of HIV after transplant

A 53-year-old man in Germany has become at least the third person with HIV to be declared cleared of the virus after undergoing a procedure that replaced his bone marrow cells with HIV-resistant stem cells from a donor. The man, who is being referred to as the 'Düsseldorf patient', received the treatment after being diagnosed with acute myeloid leukaemia. Stem-cell transplants are not suitable for people who don't need them to treat blood cancer because they are risky and difficult: the man called his treatment a "very rocky road".

VIROLOGY

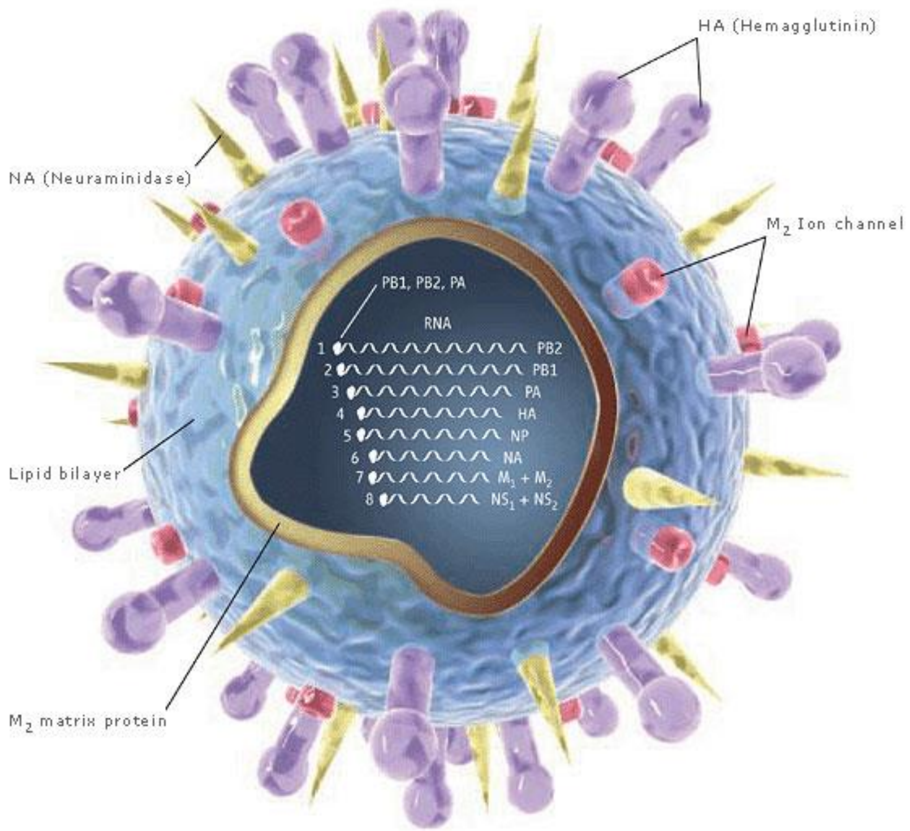
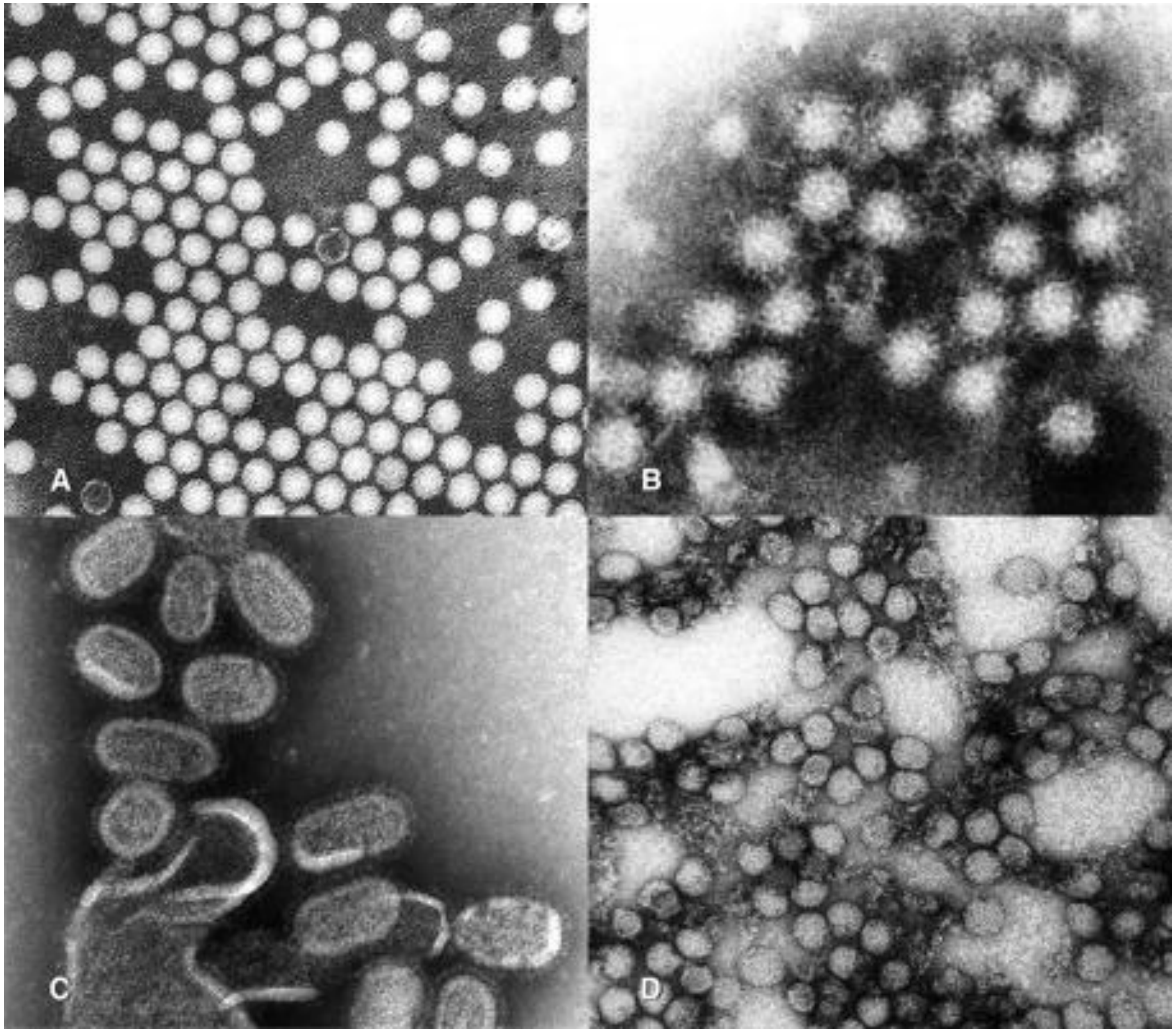


Illustration: Chris Bickel/Science. Reprinted with permission from Science Vol. 312, page 380 (21 April 2006) © 2006 by AAAS

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 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.



A
B
C
D

VIRUS STRUCTURE

Definitions:

Virion **- physical particle of the virus**

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

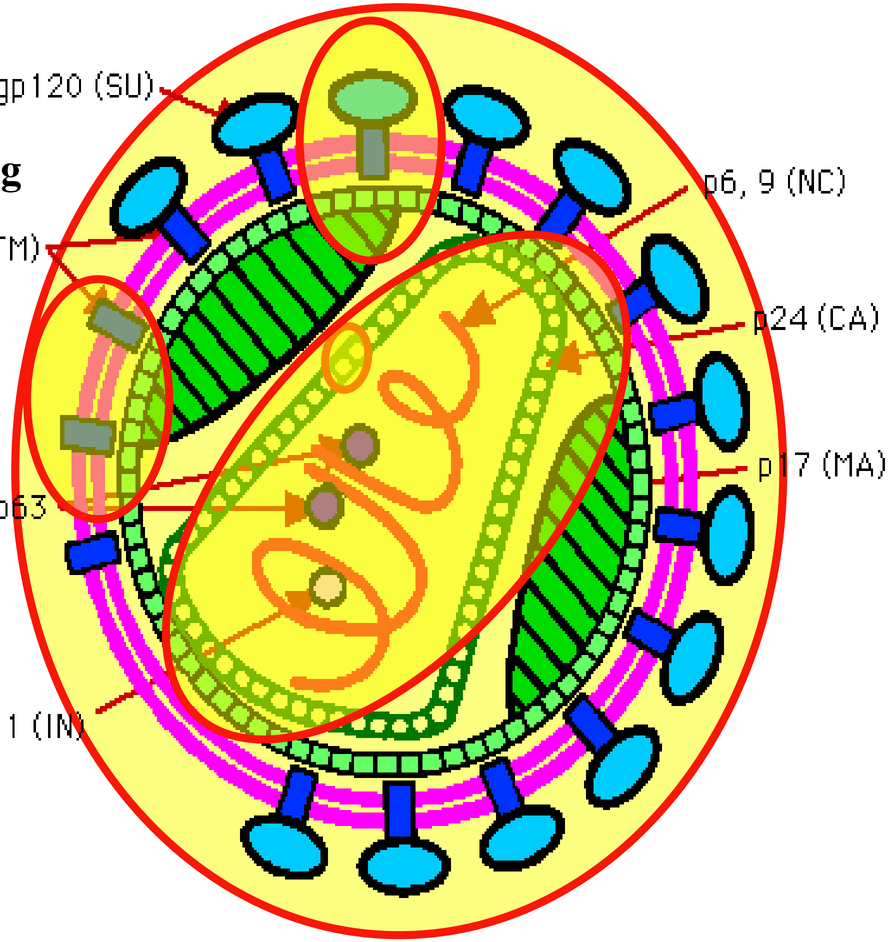
Capsid **- protein shell around NA or core**

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

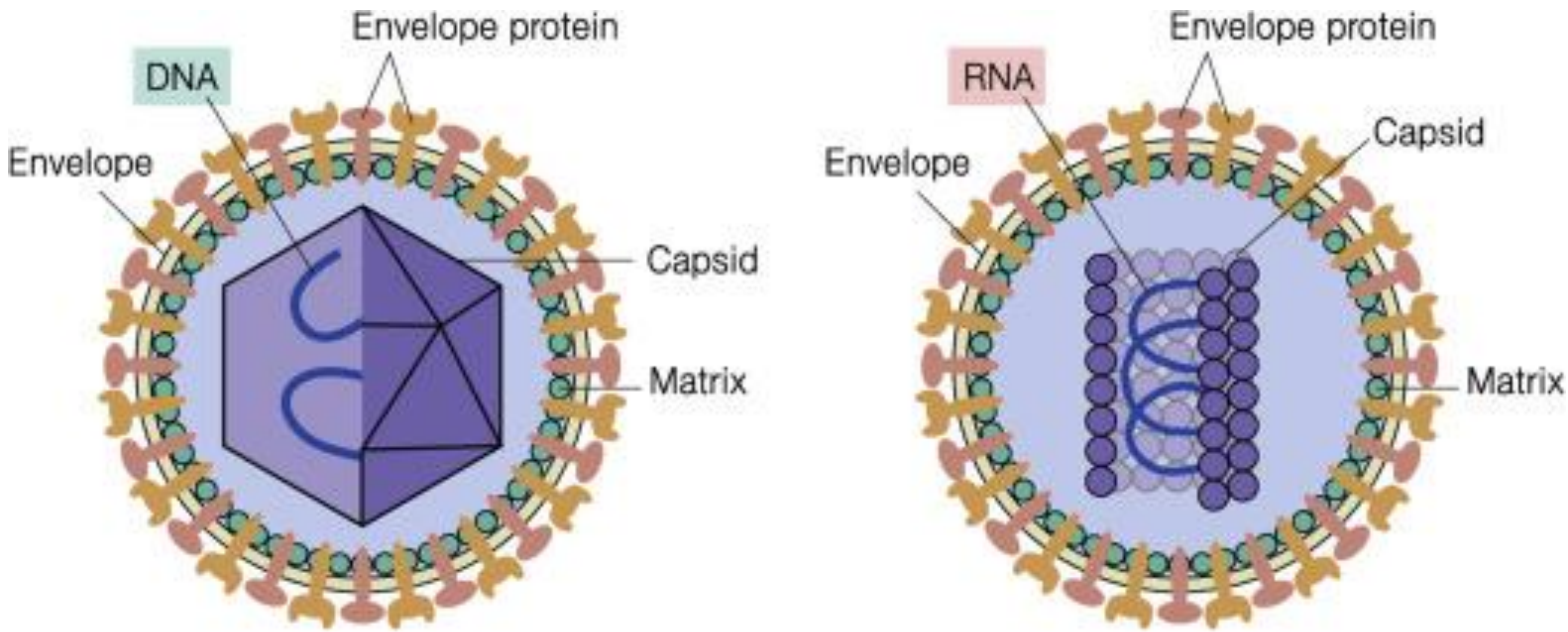
Nucleocapsid **- core and capsid**

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.**


Envelope protein
DNA
Envelope
Capsid
Matrix
Envelope protein
RNA
Capsid
Envelope
Matrix

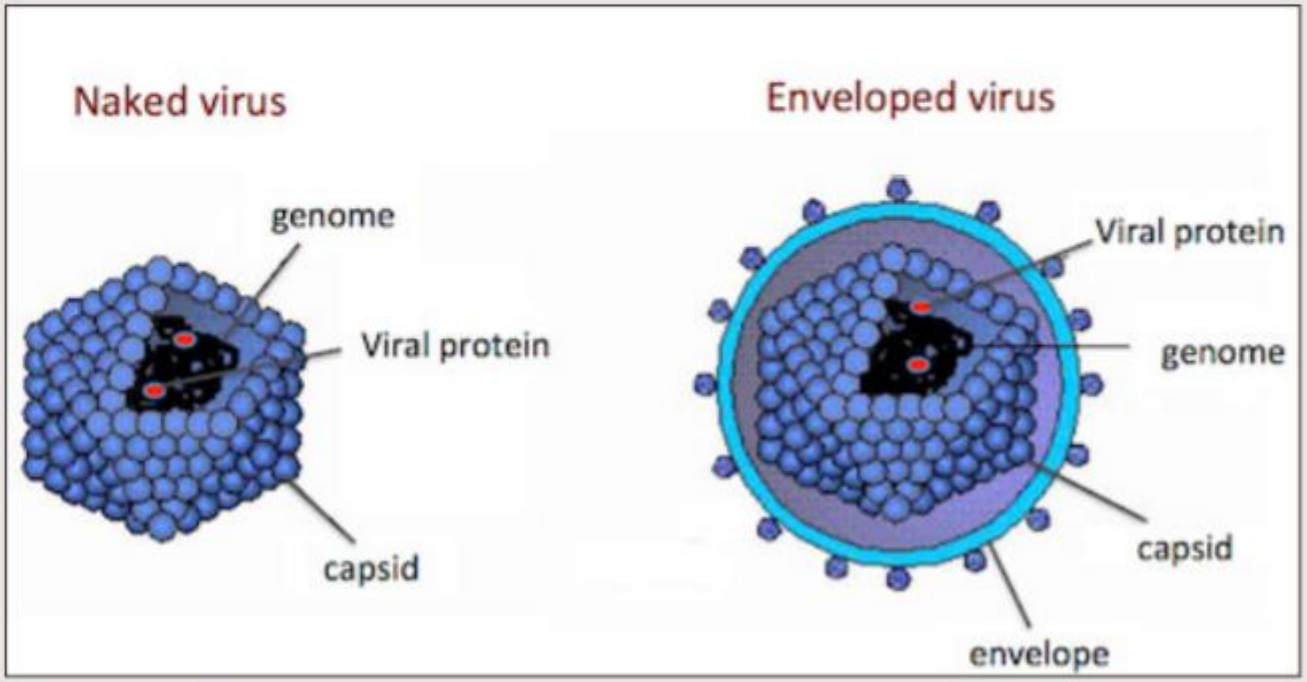
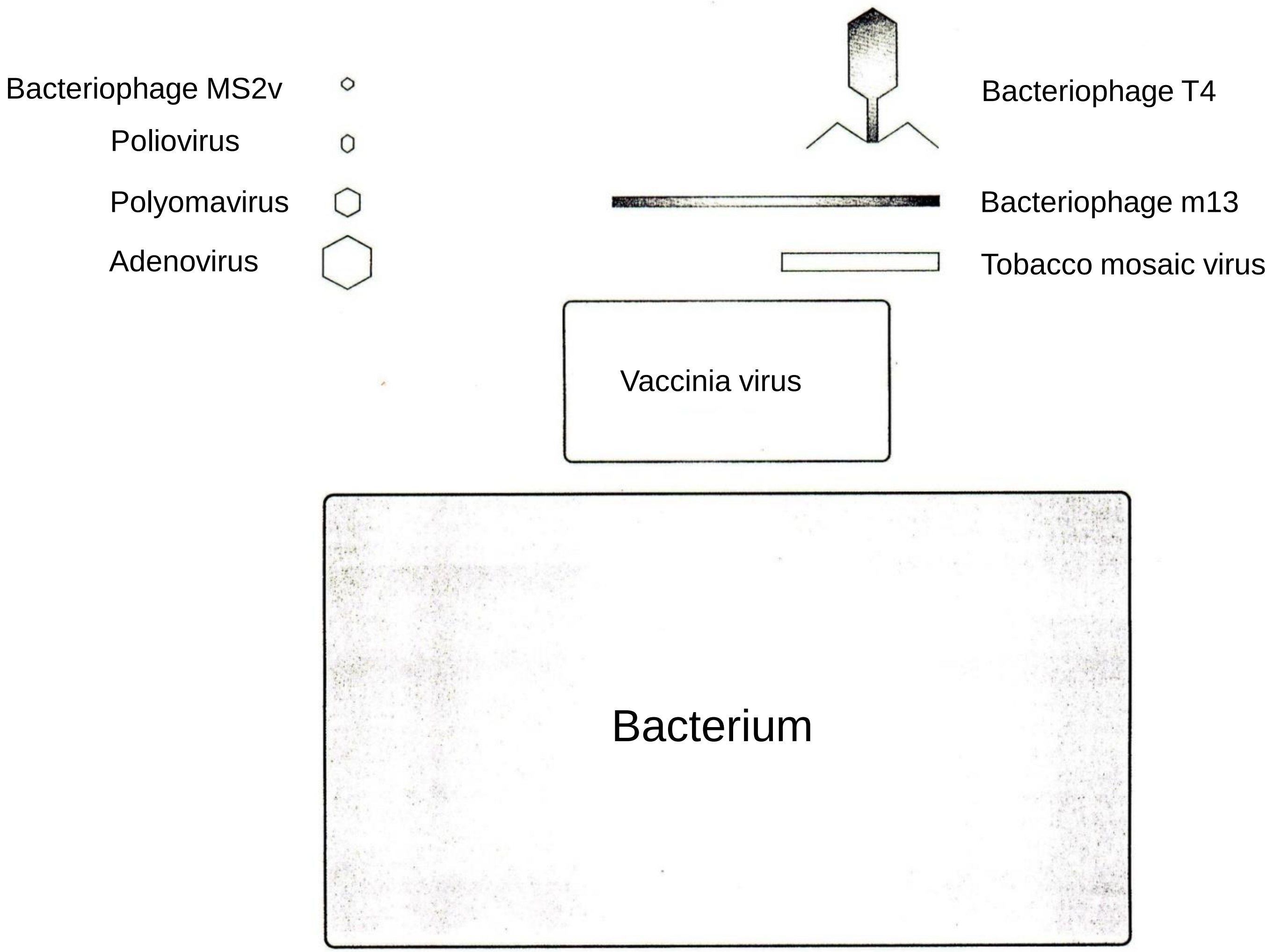
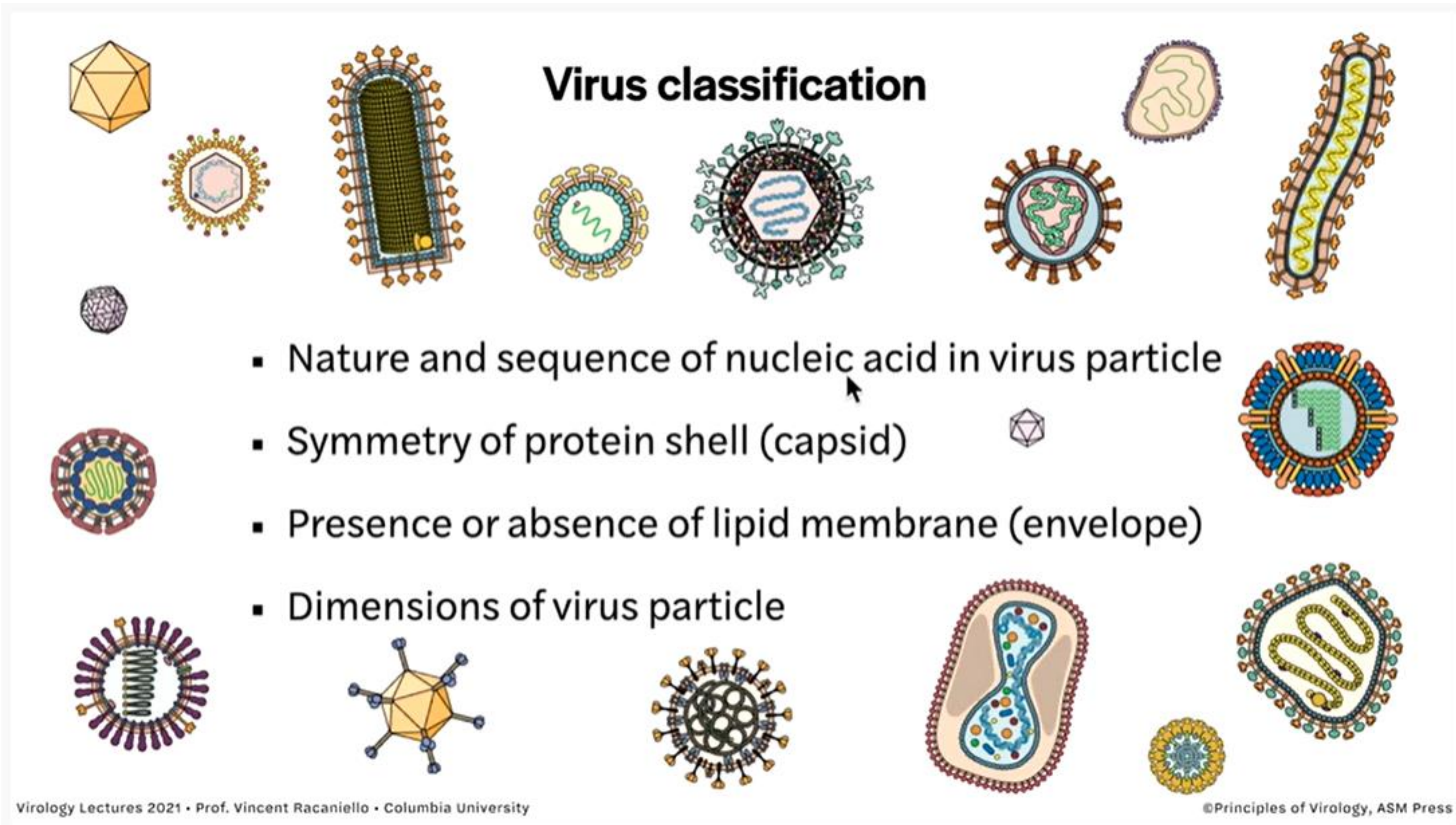


Figure 1: There are two types of viruses: Naked and Enveloped. Both have a capsid, but only the enveloped viruses have an envelope. All viruses also have a genome (RNA or DNA), and a few viral proteins that they need for replication — these are proteins that the host cells lack.

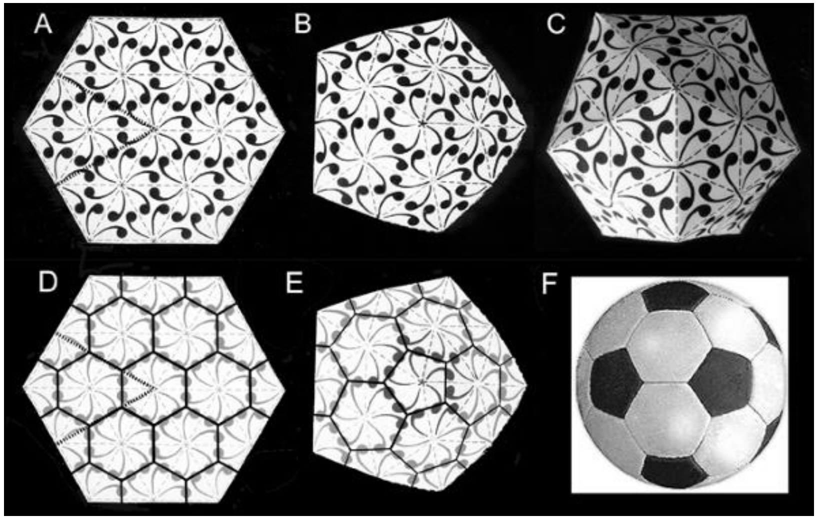
Viruses come in many shapes and sizes

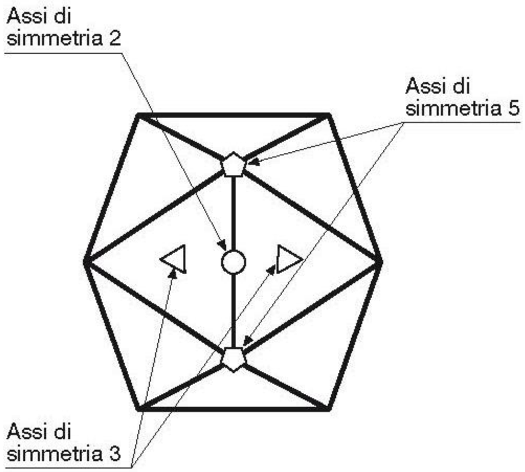


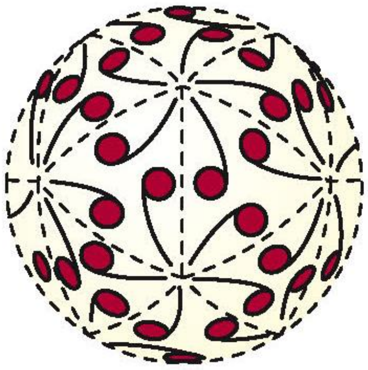

Virus classification
▪ Nature and sequence of nucleic acid in virus particle
▪ Symmetry of protein shell (capsid)
▪ Presence or absence of lipid membrane (envelope)
▪ Dimensions of virus particle
Virology Lectures 2021 • Prof. Vincent Racaniello • Columbia University
©Principles of Virology, ASM Press

Icosahedral symmetry

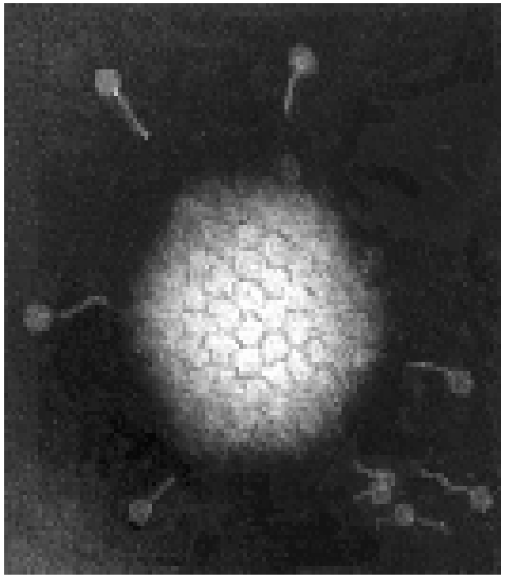
- An icosahedron is composed of 20 facets, each an equilateral triangle, and 12 vertices; because of the axes of rotational symmetry is said to have 5:3:2 symmetry.
- STRUCTURE UNITS are the smallest functional equivalent building units of the capsid, thus individual proteins.
- CAPSOMERS are morphological 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



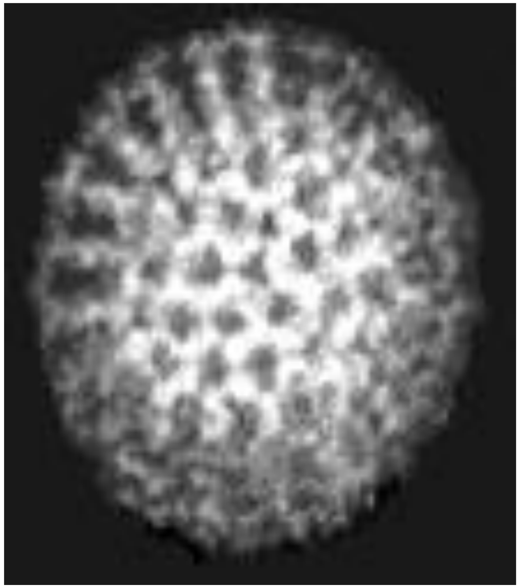




Electronmicrographs



Adenovirus



Rotavirus

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

Helical symmetry

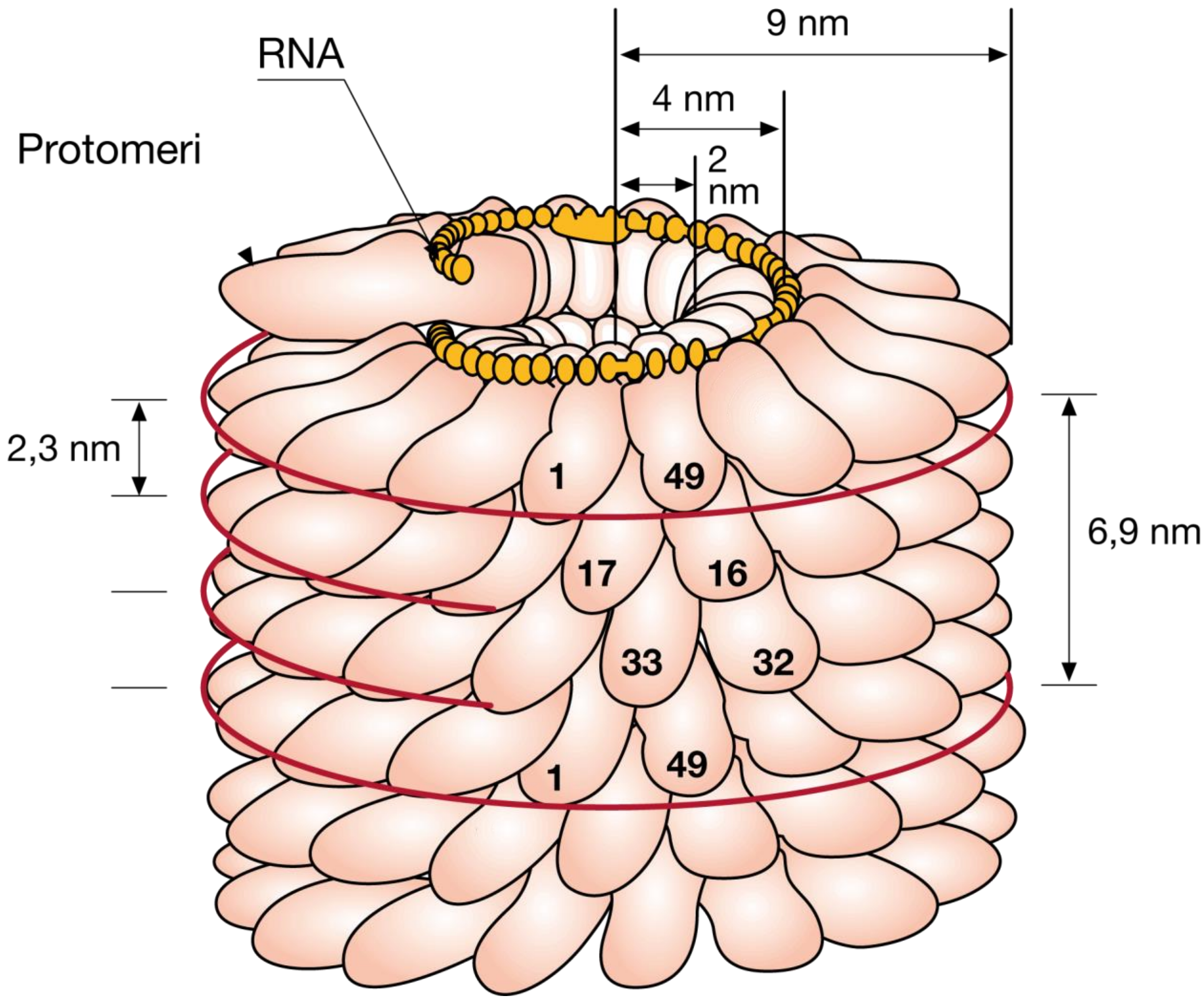


Figura 35.4 **Struttura del virus del mosaico del tabacco.**

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

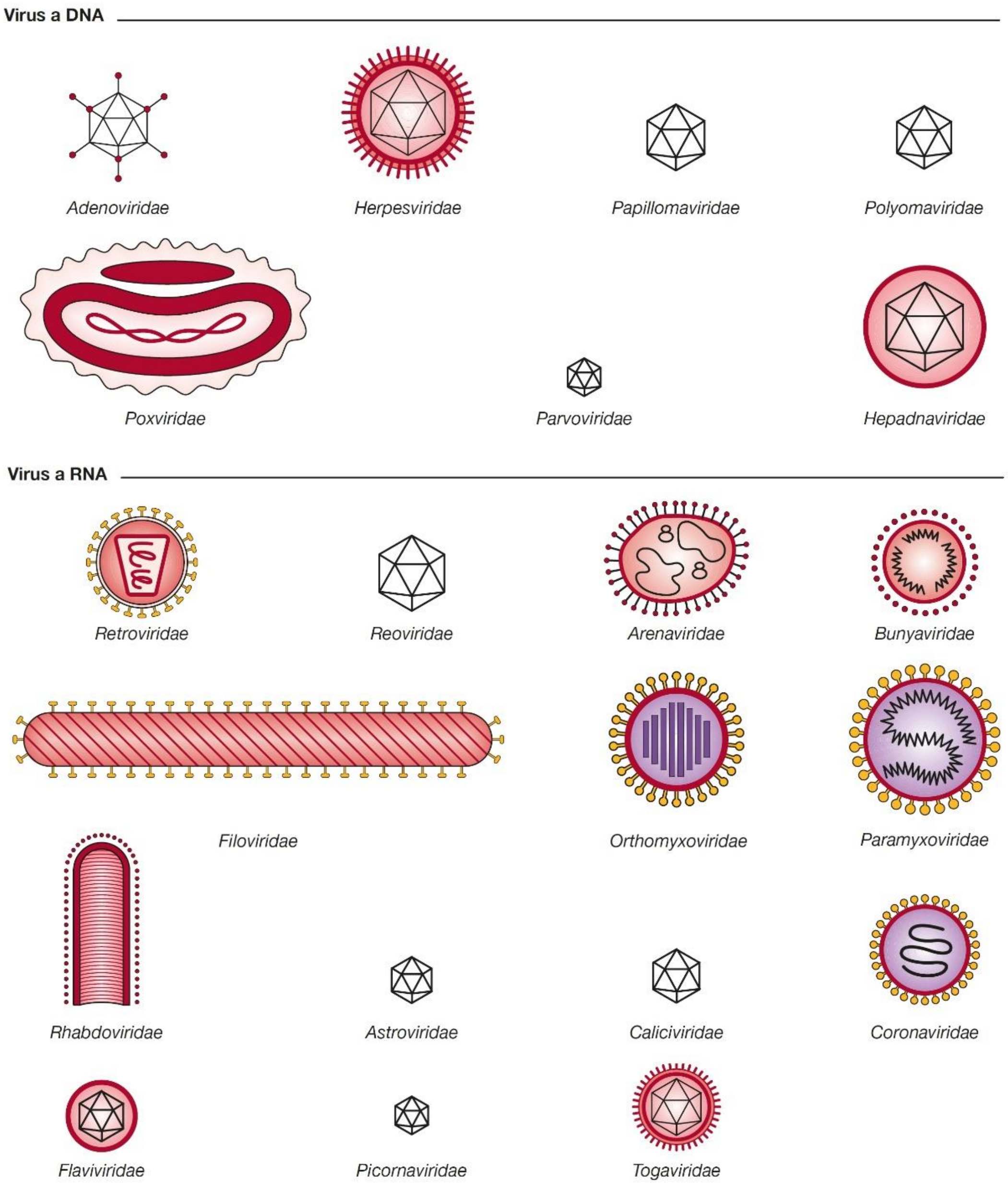


Figura 35.1 **Rappresentazione schematica delle diverse famiglie di virus animali.**

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.