Virus

dal latino → veleno

- Agenti patogeni di:
  - animali
  - vegetali
  - batteri

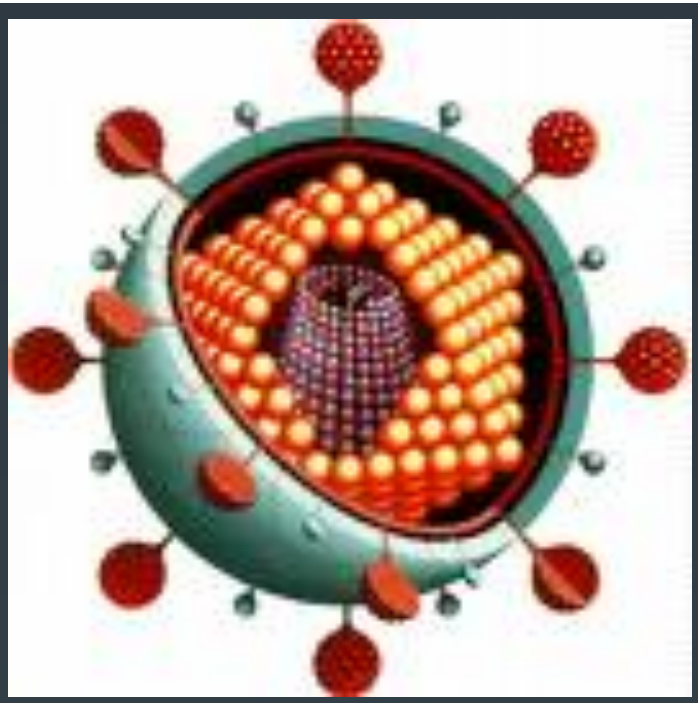
- Parassiti endocellulari obbligati

- Dimensioni molto piccole

- Incapaci di moltiplicare in assenza di cellule viventi

- Un solo tipo di acido nucleico

- Sprovvisti di enzimi metabolici



Cenni storici

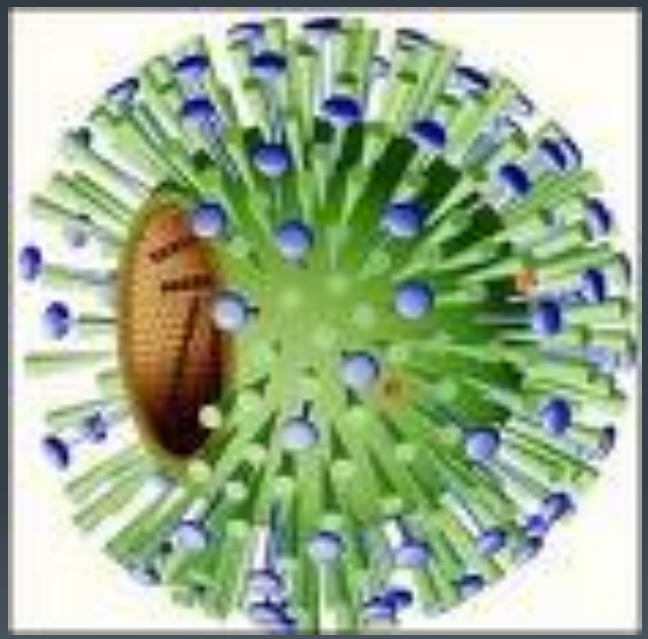
1898 L'afta è sostenuta da virus filtrabili ultramicroscopici

1892-8 Il mosaico del tabacco è sostenuto da fluido vivente contagioso

1915 Batteriofagi

1920 Colture cellulari (antibiotici)

1939 Microscopia elettronica



Origine virus

- Progenie degenerata di altri parassiti endocellulari

- Derivazione da componenti cellulari

Terminologia

Capside: guscio proteico all'interno del quale è contenuto l'acido nucleico

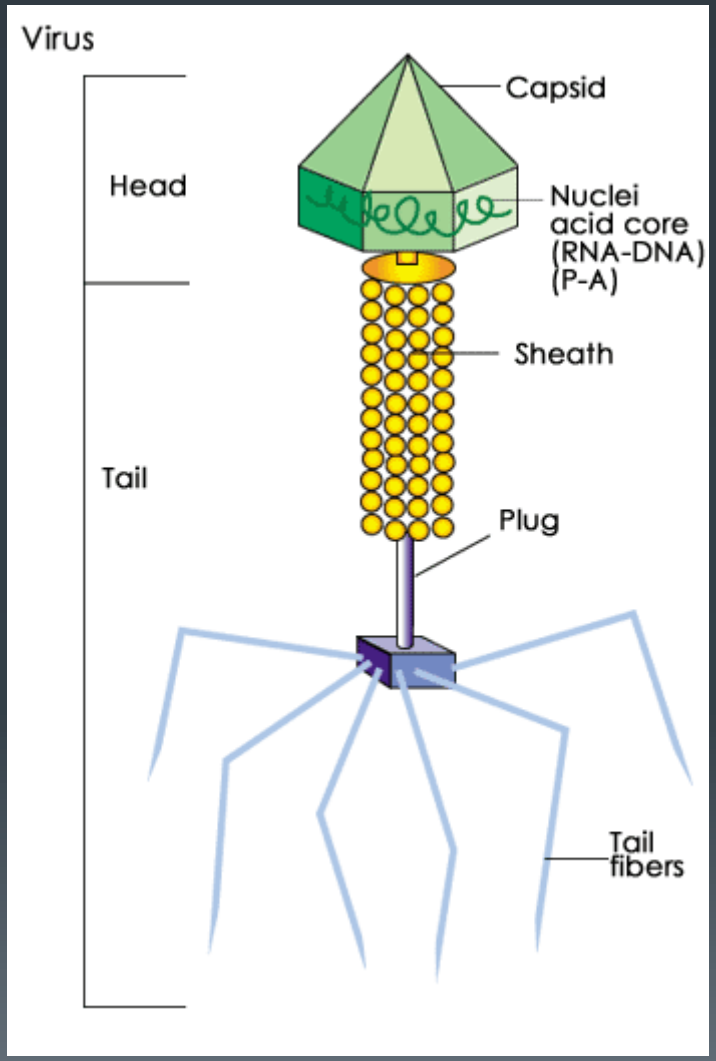
Core: acido nucleico + proteine

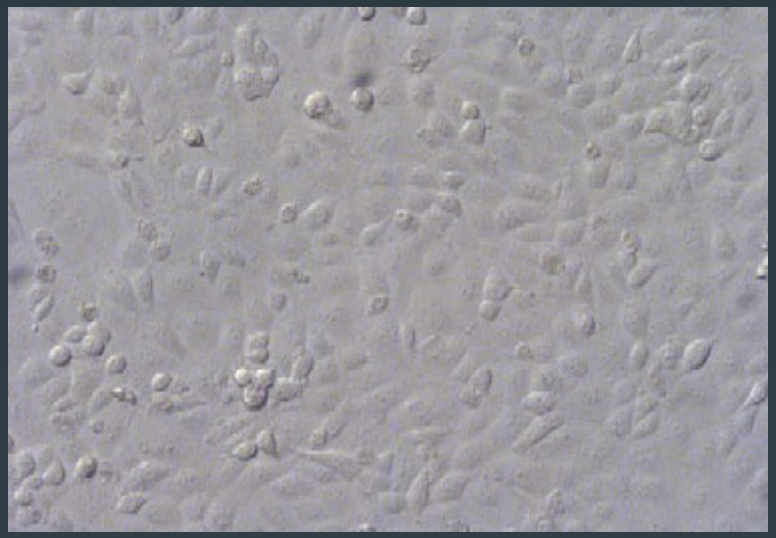
Nucleocapside: capside + acido nucleico / core

Capsomero: unità morfologica dei virus

Envelope: membrana esterna contenente lipidi presente in alcune famiglie virali

Virione: particella infettante completa





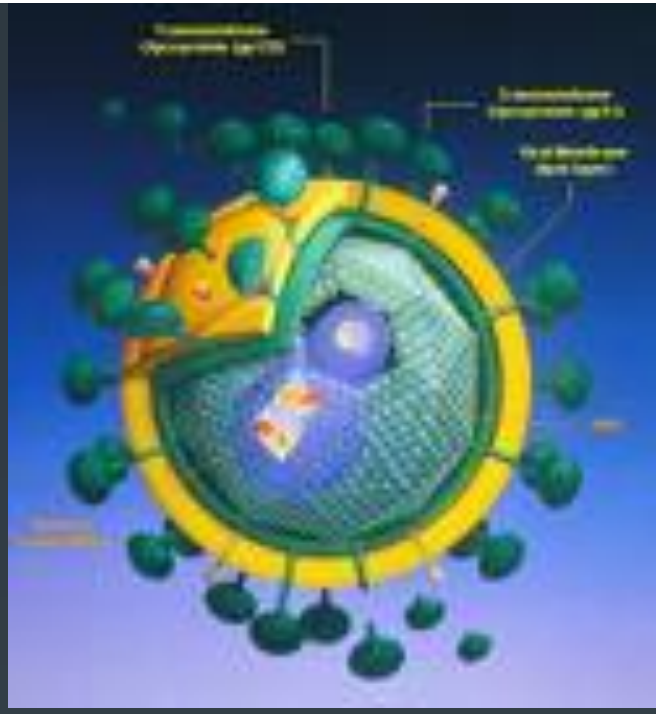
MA104

HeLa

MDBK: Madin-Darby bovine kidney

Forme di virus

- Rotondeggiante
- Proiettile
- Mattone
- Allungata



Grandezza

- Piccoli virus 18 – 20 nm
- Medi virus 80 – 180 nm
- Grossi virus 180 – 300 nm

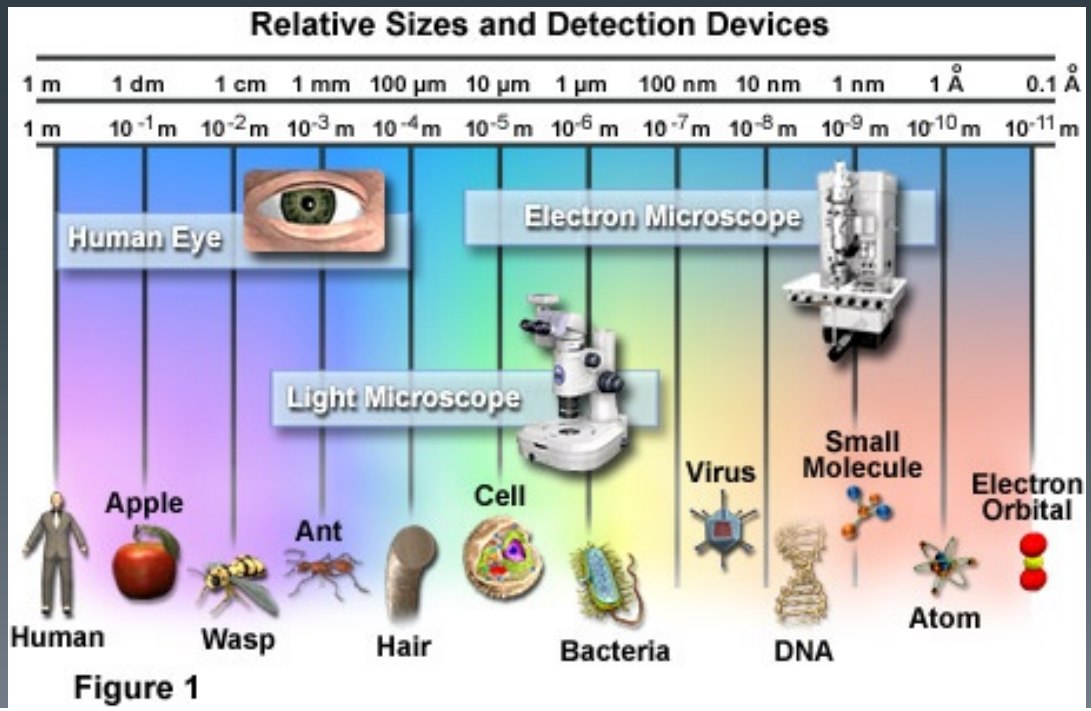
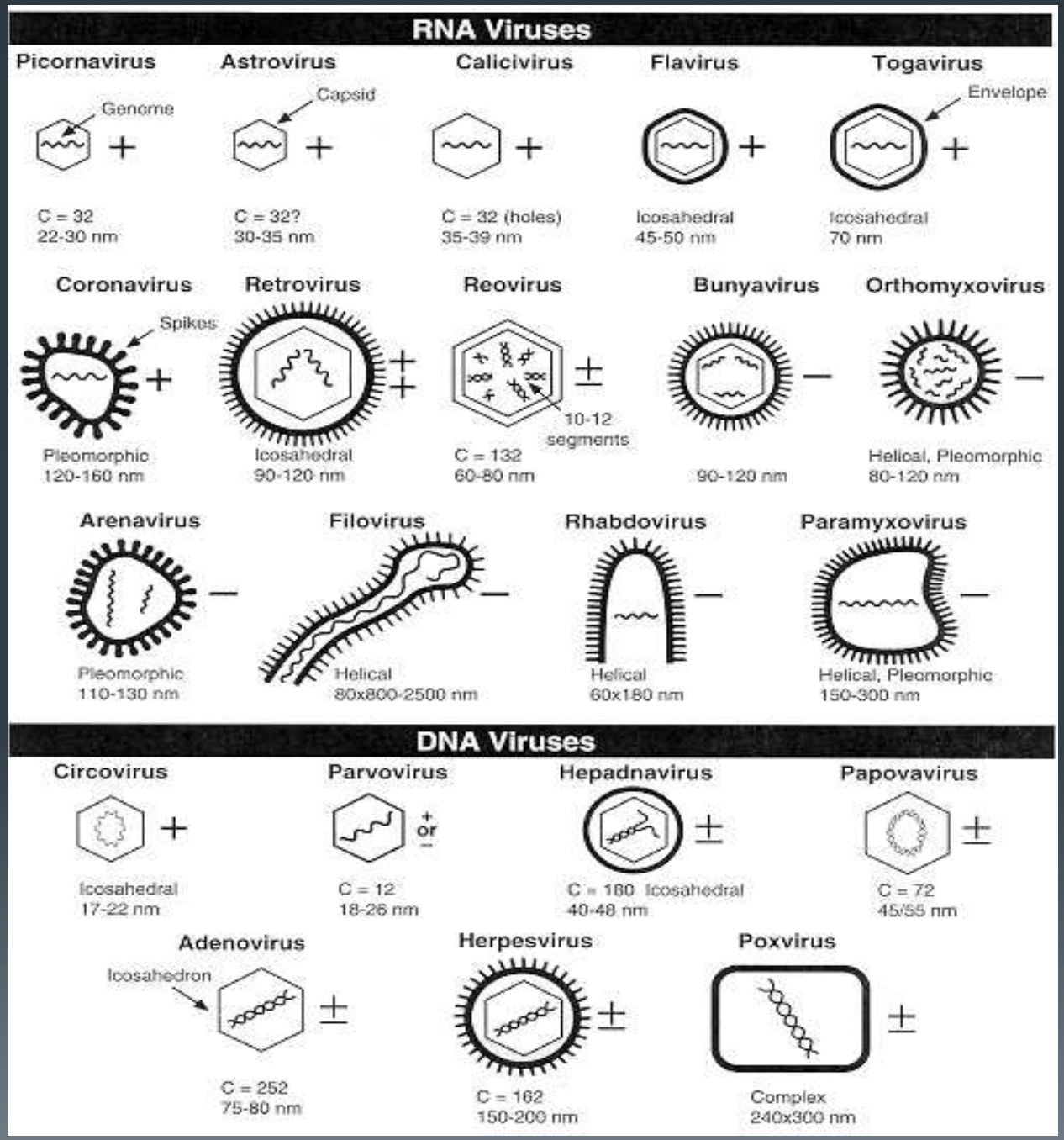


Figure 1


RNA Viruses
Picornavirus
Genome
C = 32
22-30 nm
Astrovirus
Capsid
C = 32?
30-35 nm
Calicivirus
C = 32 (holes)
35-39 nm
Flavirus
Icosahedral
45-50 nm
Togavirus
Envelope
Icosahedral
70 nm
Coronavirus
Spikes
Pleomorphic
120-160 nm
Retrovirus
Icosahedral
90-120 nm
Reovirus
10-12
segments
C = 132
60-80 nm
Bunyavirus
90-120 nm
Orthomyxovirus
Helical, Pleomorphic
80-120 nm
Arenavirus
Pleomorphic
110-130 nm
Filovirus
Helical
80x800-2500 nm
Rhabdovirus
Helical
60x180 nm
Paramyxovirus
Helical, Pleomorphic
150-300 nm
DNA Viruses
Circovirus
Icosahedral
17-22 nm
Parvovirus
or
C = 12
18-26 nm
Hepadnavirus
C = 180 Icosahedral
40-48 nm
Papovavirus
C = 72
45/55 nm
Adenovirus
Icosahedron
C = 252
75-80 nm
Herpesvirus
C = 162
150-200 nm
Poxvirus
Complex
240x300 nm

Morfologia

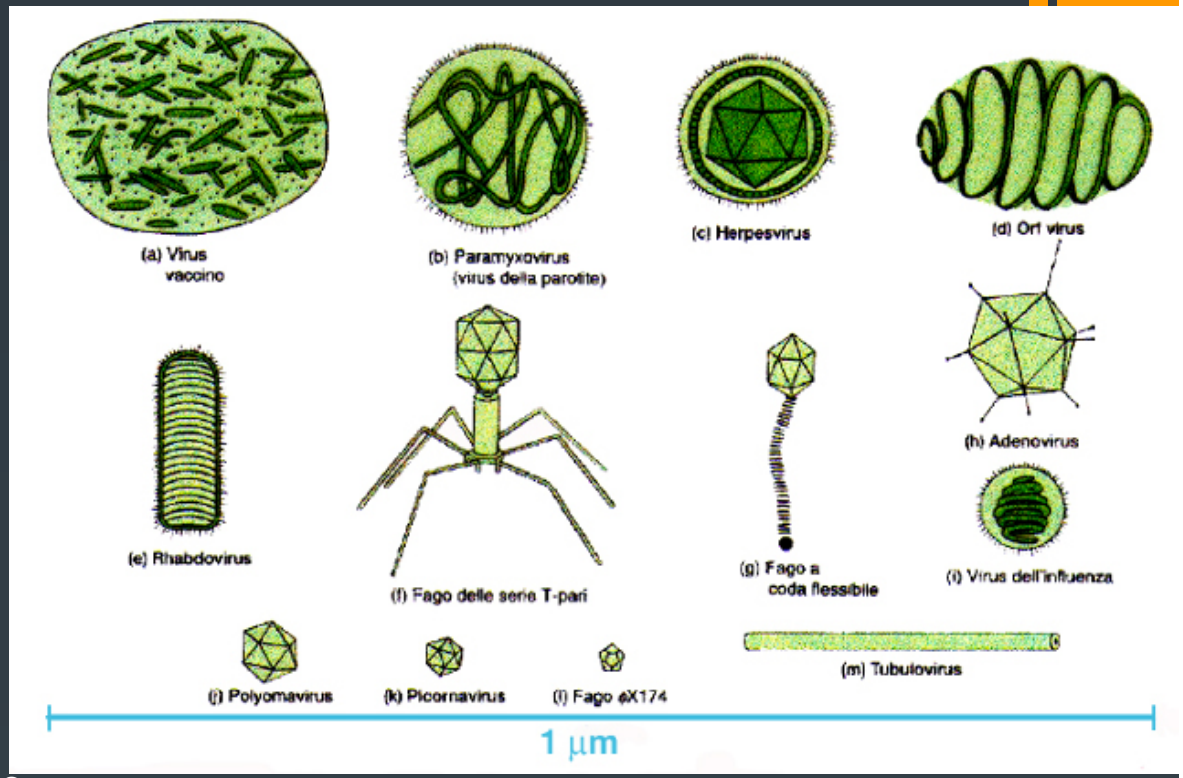
Viene studiata al M.E.

- Ombreggiatura
- Colorazione negativa
- Colorazione positiva

Diffrazione a raggi X

Altri metodi di studio

- Purificazione x filtrazione
- Purificazione x ultracentrifugazione
- SDS-PAGE
- Analisi frammenti restrizione
- Ibridazione
- Sequenza
- PCR

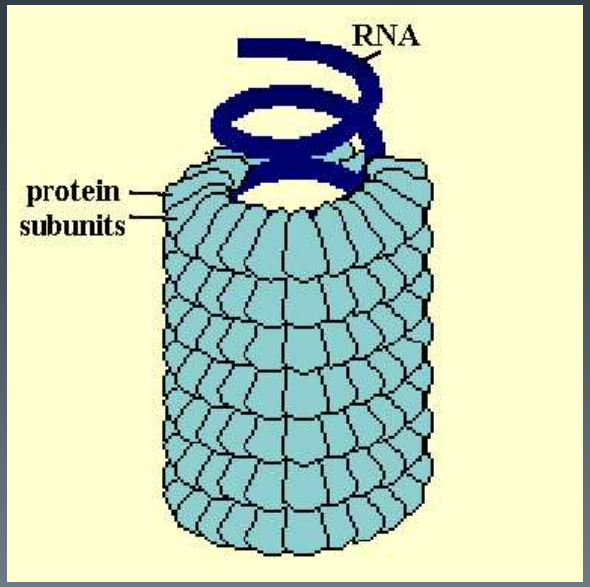


Simmetria virale

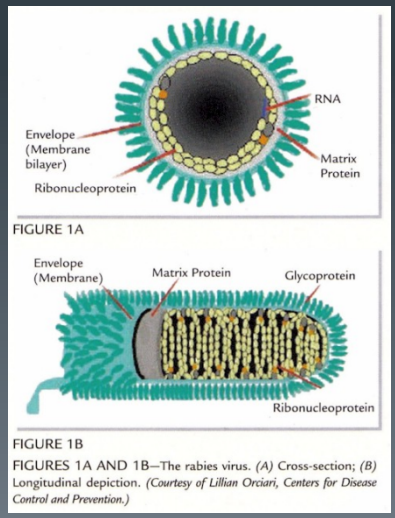
- Elicoidale
- Cubica
- Complessa

Elicoidale

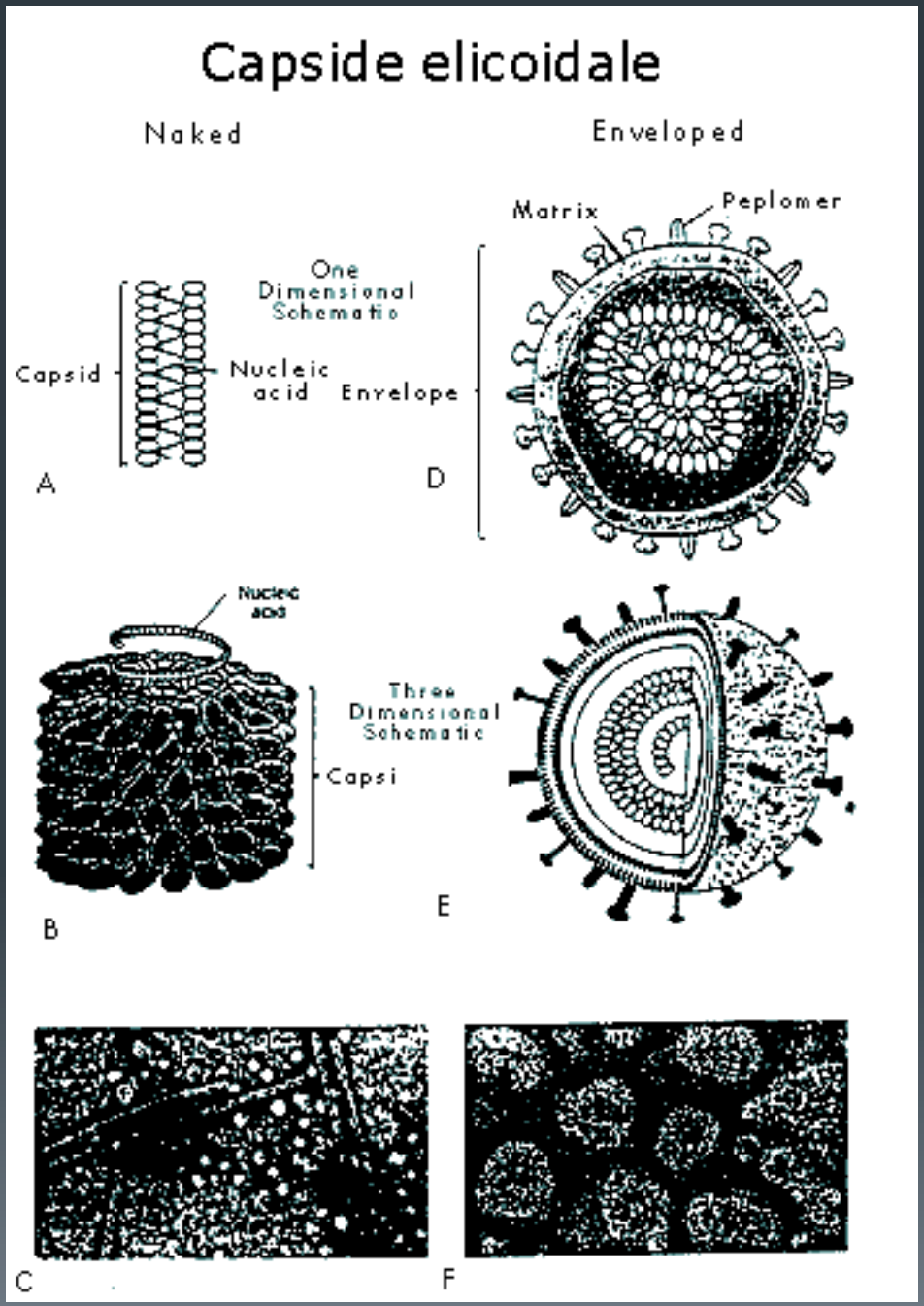
Le subunità proteiche sono legate in modo periodico a formare un nastro con andamento ad elica, all'interno è contenuto l'acido nucleico

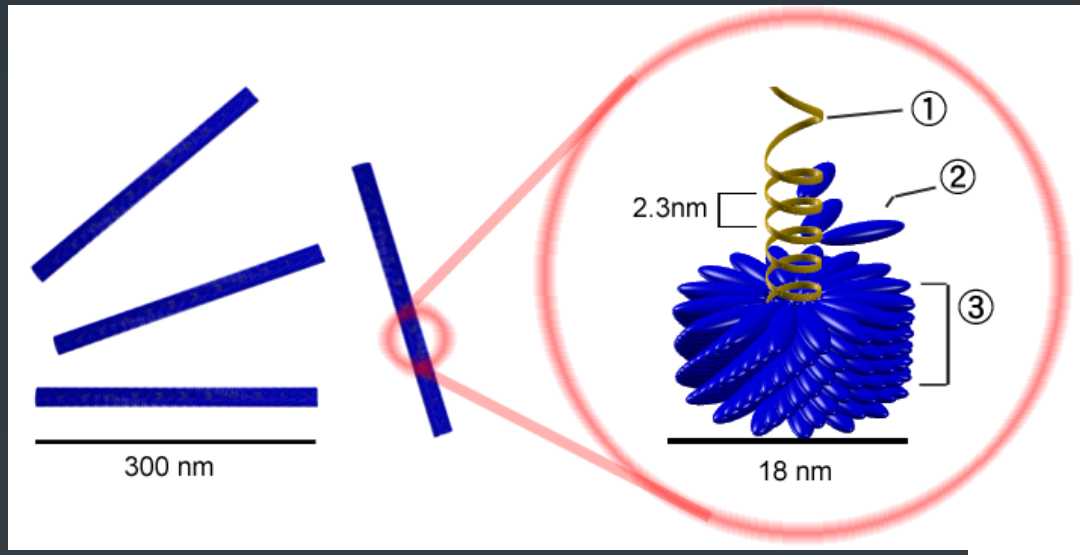


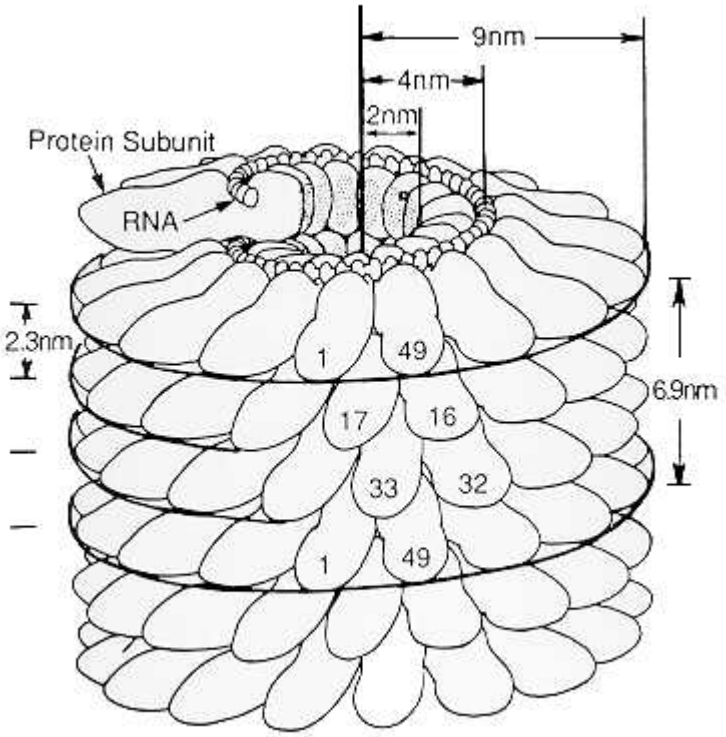
Virus animale a simmetria elicoidale RNA a gomitolo (no Rhabdoviridae) + envelope

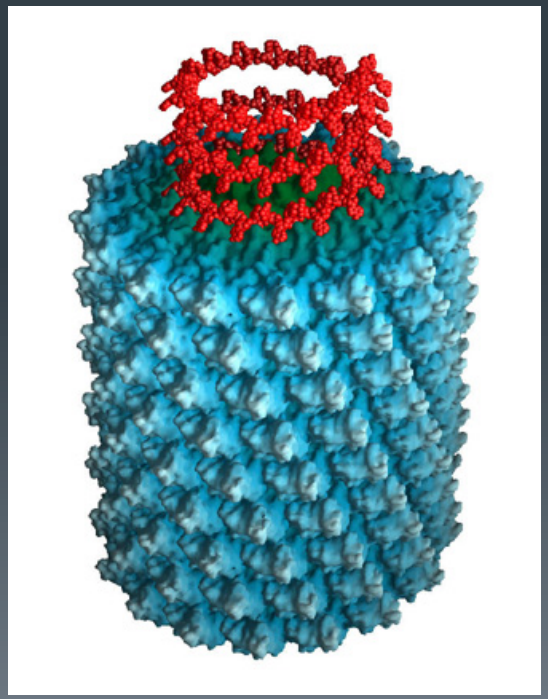


Capside elicoidale




①
②
③
2.3nm
300 nm
18 nm

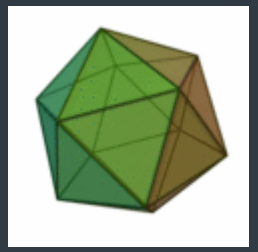

9nm
4nm
2nm
Protein Subunit
RNA
2.3nm
1
49
17
16
33
32
1
49
6.9nm



Modello di un virus a simmetria elicoidale

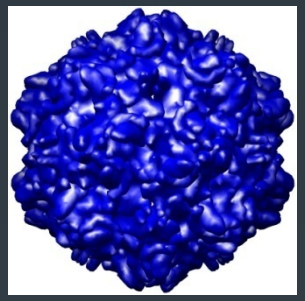
Cubica (icosaedrica)

Icosaedro → 20 facce, 12 vertici



Capsomeri costituiti da 2, 3, 4, 5, 6 subunità strutturali (monomeri)

- dimeri
- trimeri
- tetrameri
- pentameri
- esameri

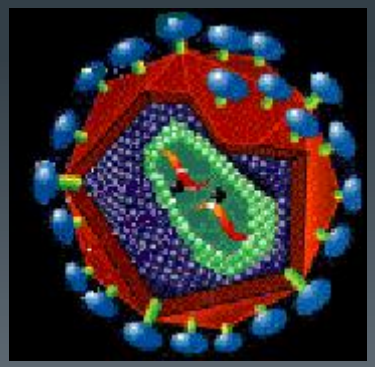


Porcine Parvovirus Capsid

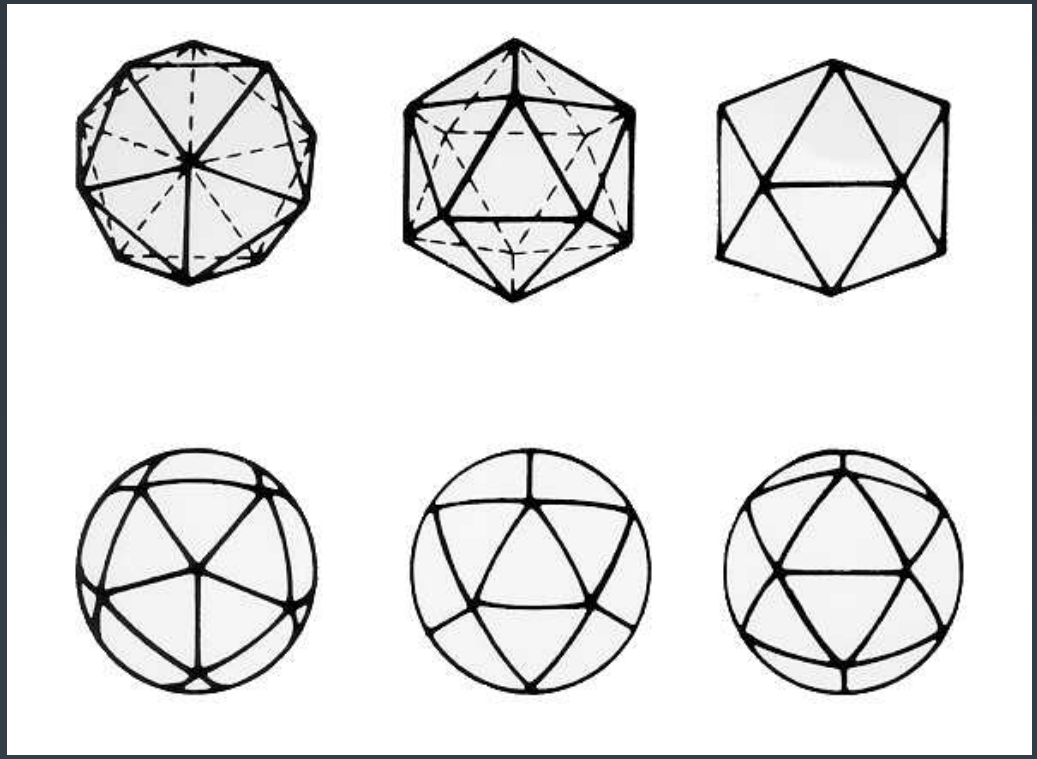
Complessa

Virus ad elevata complessità

Poxvirus
Retrovirus
Virus della peste suina africana



Retrovirus



Icosahedral models seen, left to right, on fivefold, threefold, and twofold axes of rotational symmetry

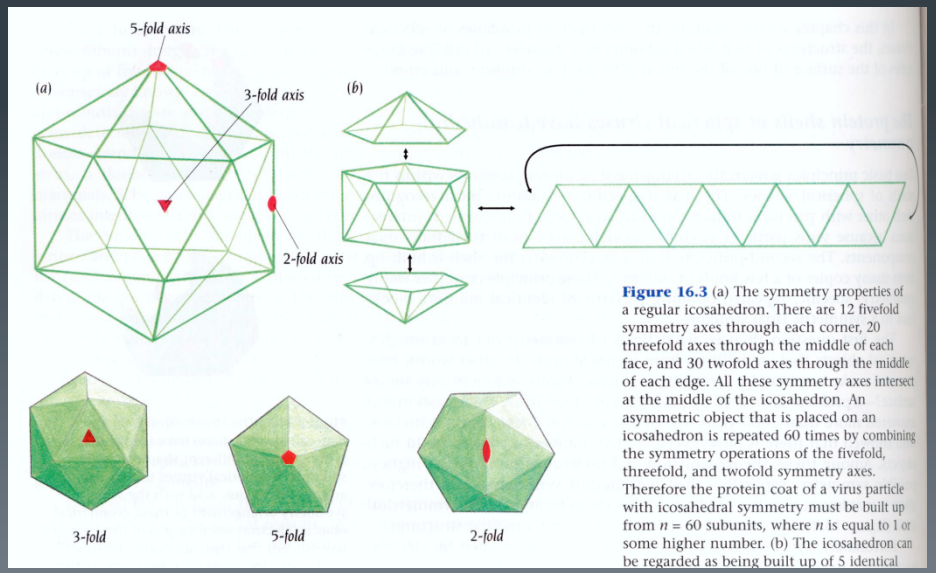
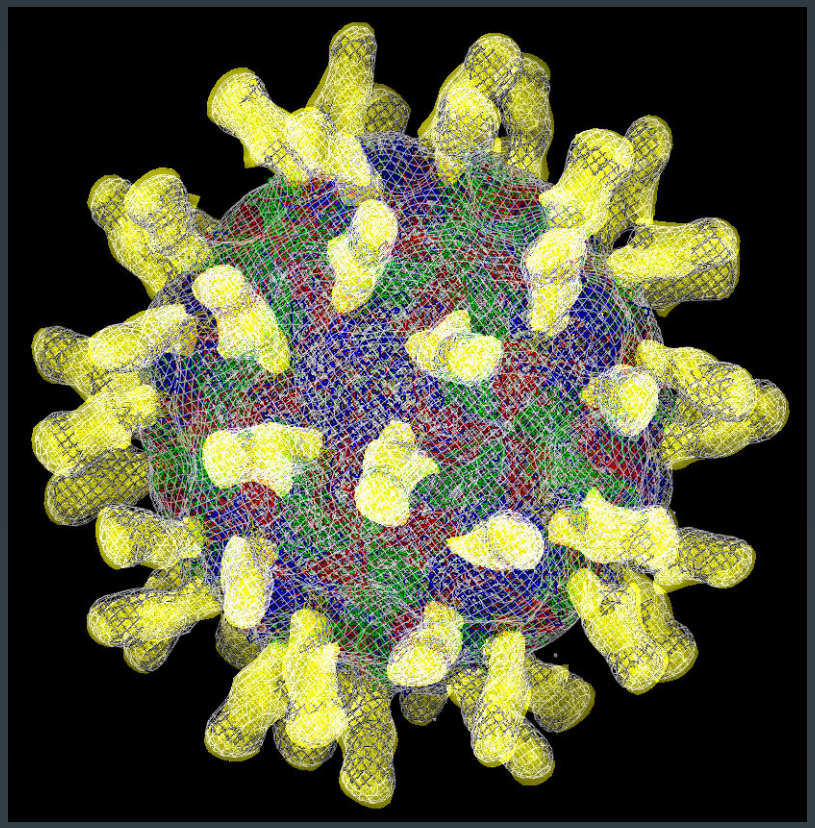
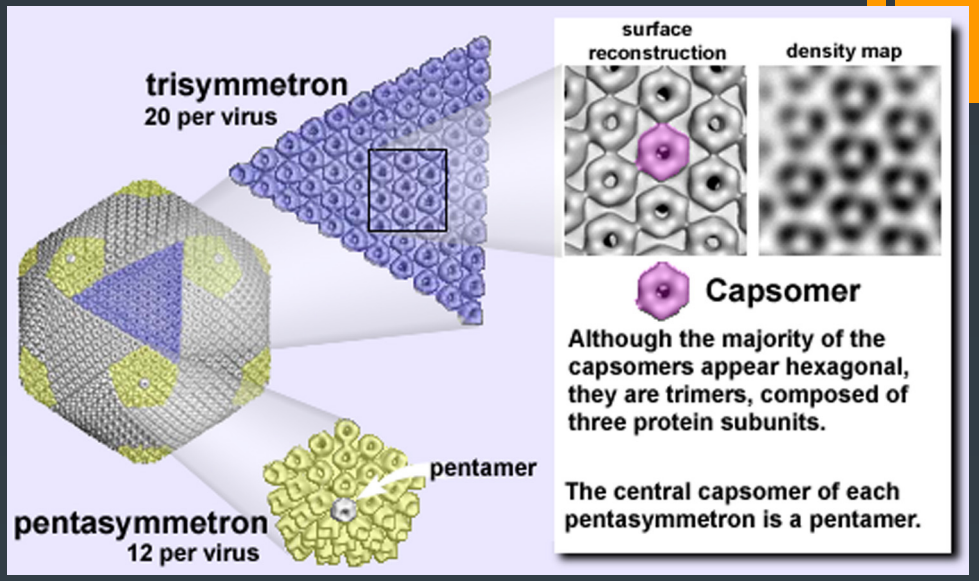
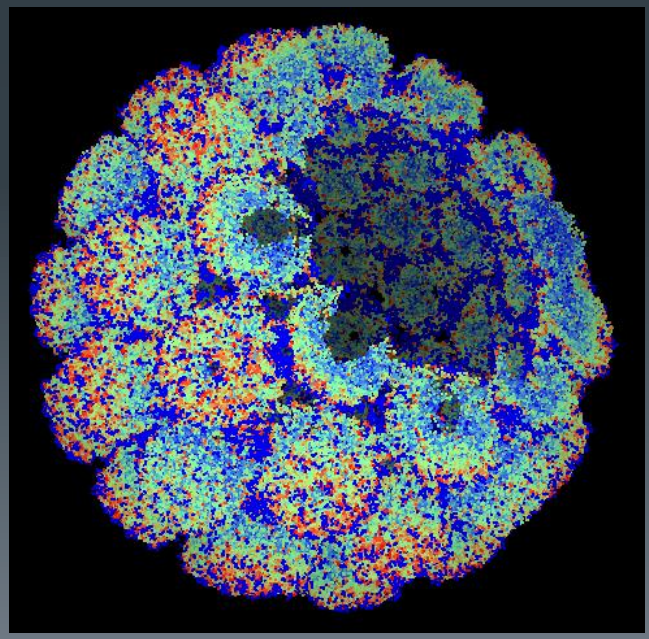


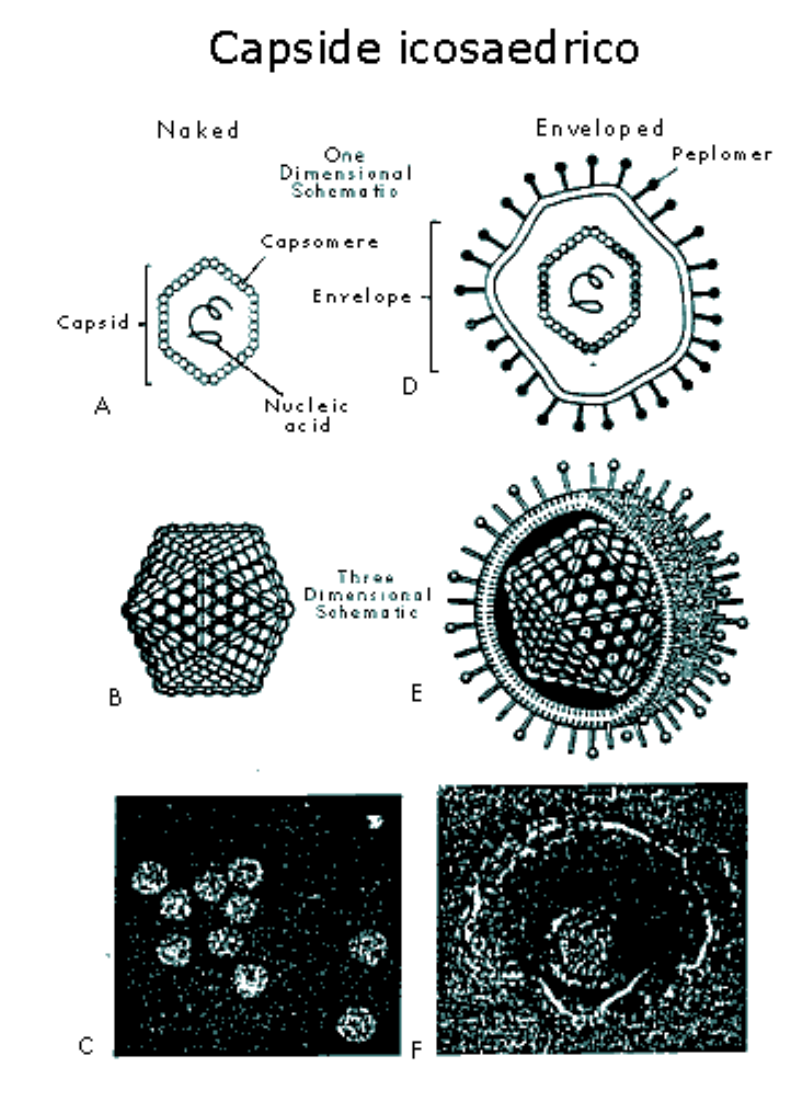
Figure 16.3 (a) The symmetry properties of a regular icosahedron. There are 12 fivefold symmetry axes through each corner, 20 threefold axes through the middle of each face, and 30 twofold axes through the middle of each edge. All these symmetry axes intersect at the middle of the icosahedron. An asymmetric object that is placed on an icosahedron is repeated 60 times by combining the symmetry operations of the fivefold, threefold, and twofold symmetry axes. Therefore the protein coat of a virus particle with icosahedral symmetry must be built up from $n = 60$ subunits, where n is equal to 1 or some higher number. (b) The icosahedron can be regarded as being built up of 5 identical

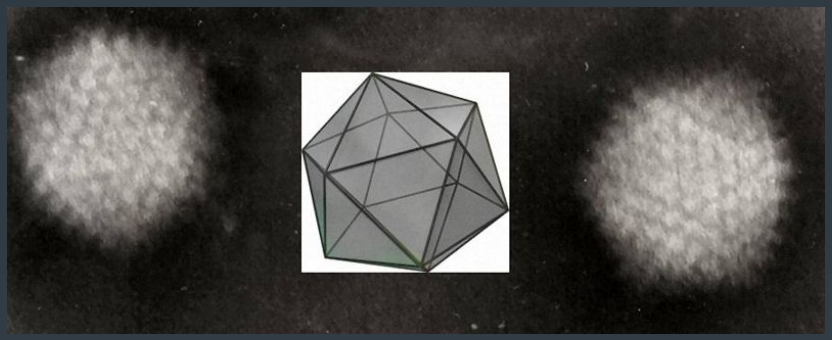



surface reconstruction
density map
trisymmetron
20 per virus
pentamer
pentasymmetron
12 per virus
Capsomer
Although the majority of the capsomers appear hexagonal, they are trimers, composed of three protein subunits.
The central capsomer of each pentasymmetron is a pentamer.

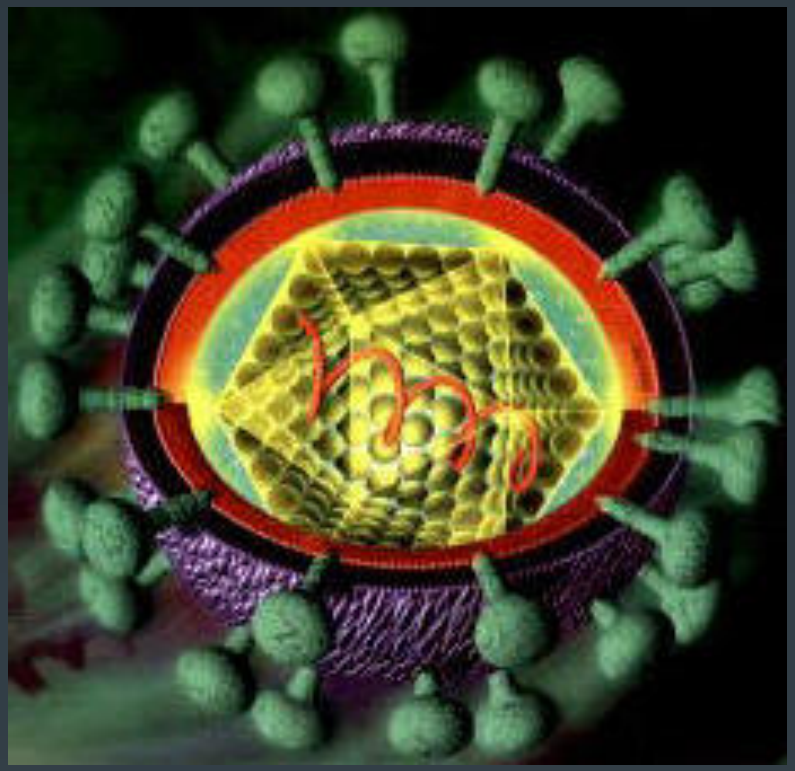


H 12





Two adenoviruses with a cartoon to show their icosahedral structure

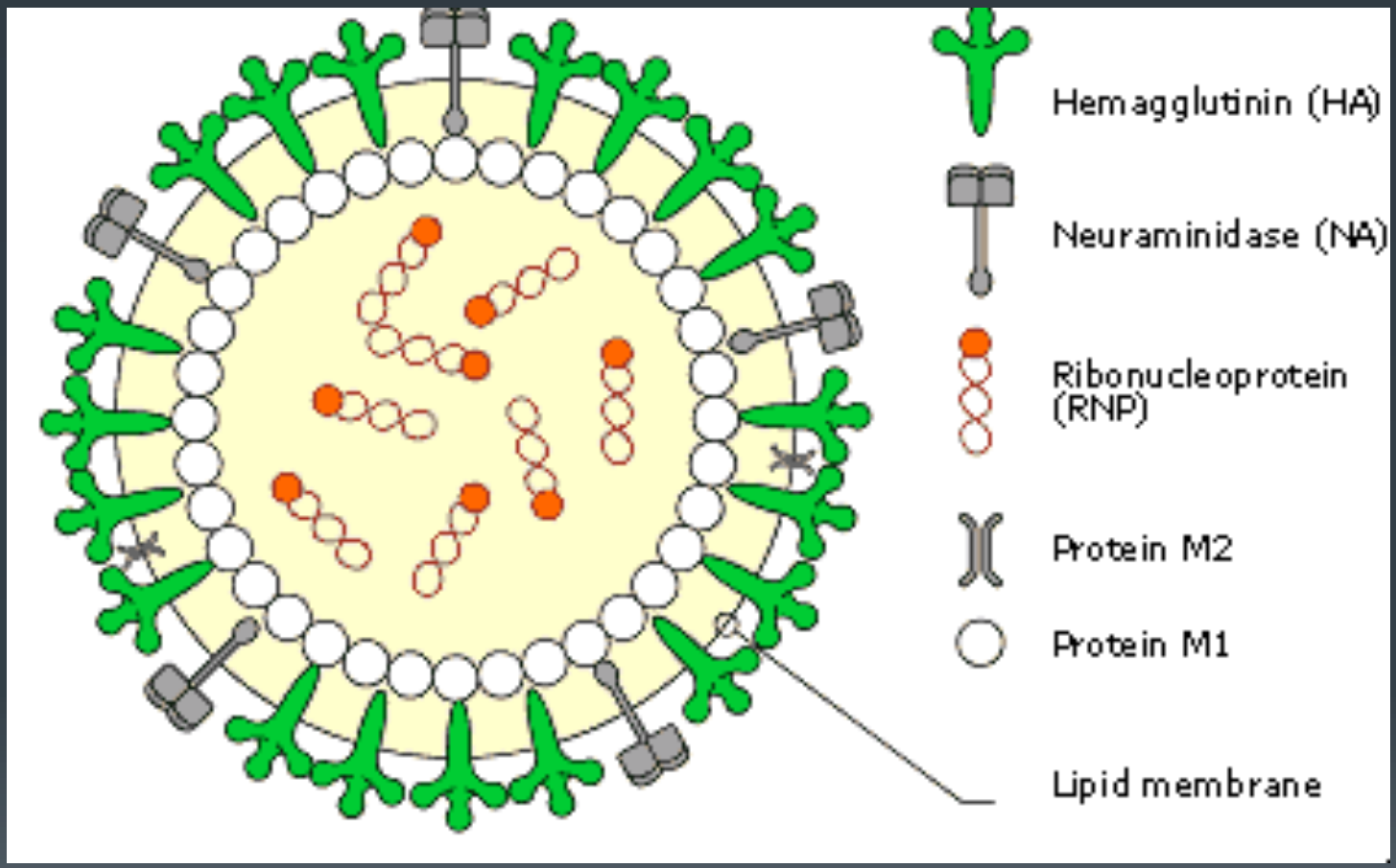


Struttura virale

Acido nucleico (+ proteine = core) circondato da struttura proteica (capside)

In alcuni casi è presente un involucro esterno generalmente lipoproteico (envelope)

Il capside è composto da un numero definito di unità morfologiche (capsomeri)


Hemagglutinin (HA)
Neuraminidase (NA)
Ribonucleoprotein (RNP)
Protein M2
Protein M1
Lipid membrane

Envelope

Peplos, involucro pericapsidico, mantello

- Rivestimento accessorio presente in alcune famiglie virali

- Natura lipo-glico-proteica

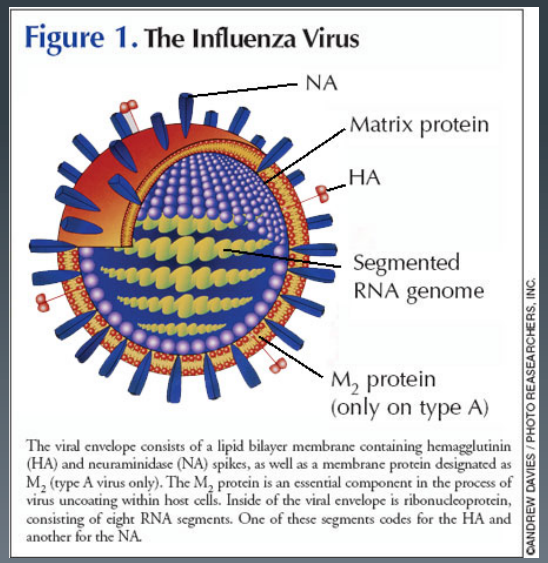
- E' di derivazione delle strutture membranali della cellula infetta

- Presenta peplomeri → glicoproteine che legano il virus alla cellula

↓

Infettività del virus
Antigenicità

- Può contenere proteina M



Acidi nucleici

Un unico tipo di acido nucleico

DNA
- Quasi sempre è a doppio filamento, dsDNA
- ssDNA → Parvoviridae, Circoviridae
- Può essere lineare o circolare
- Può essere segmentato o non-segmentato

Parvovirus $1{,}5 \cdot 10^6$

Poxvirus $200 \cdot 10^6$

RNA

- Quasi sempre è a singolo filamento, ssRNA
- dsRNA → Reoviridae, Birnaviridae
- Può essere lineare o circolare (legame debole)
- Può essere segmentato e non-segmentato
- Può essere a polarità positiva o negativa

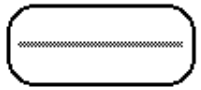
Agisce direttamente da RNAm

Deve essere convertito in RNAm da RNA polimerasi-RNA-dipendente

Picorna $2 \cdot 10^6$

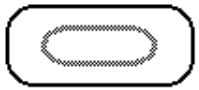
Reo $15 \cdot 10^6$

Many Possible Viral Genome Arrangements (not all shown)



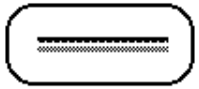
positive strand linear

positive strand segmented

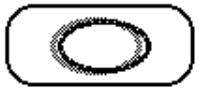


positive strand circular

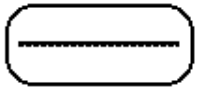
positive strand linear, diploid



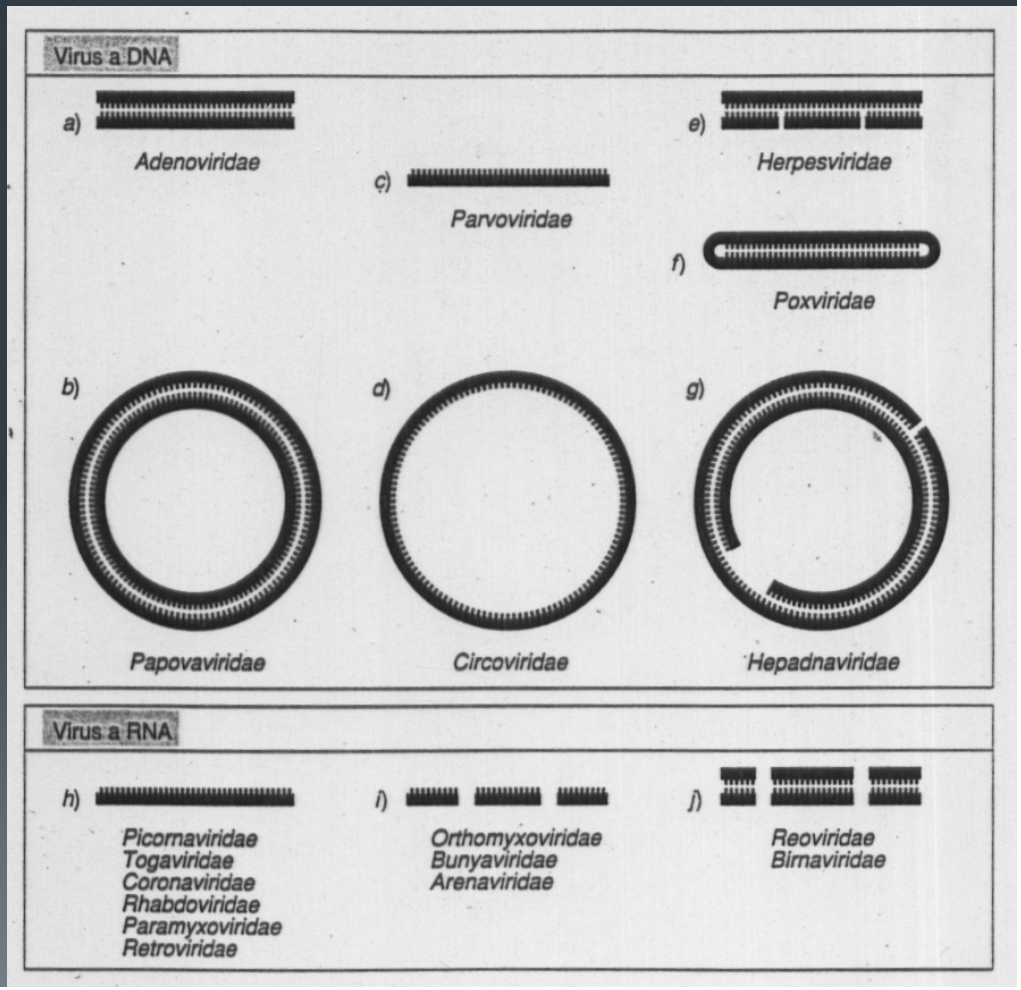
double stranded linear



double stranded circular



negative strand linear



Proteine

Strutturali
Nucleocapside, envelope

- Proteggono l'acido nucleico dalle nucleasi
- Partecipano all'aggancio del virus alla cellula
- Determinano la struttura virale
- Determinano l'antigenicità
- Possono agglutinare emazie

Non strutturali
Spesso ad attività enzimatica

RNA polimerasi-RNA dipendente
DNA polimerasi-DNA dipendente
DNA polimerasi-RNA dipendente

Lipidi

Sono di derivazione cellulare nei virus provvisti di envelope

I virus che contengono lipidi sono sensibili al trattamento con etere o cloroformio

Carboidrati

Presenti come:
Glicoproteine
Glicolipidi
Mucopolisaccaridi

- Sono codificati dal virus, ma rispecchiano quelli originari cellulari
- Sono la sede dei recettori virali
- Sono Ag → Ac neutralizzanti

Emoagglutinine HA
Neuroaminidasi NA