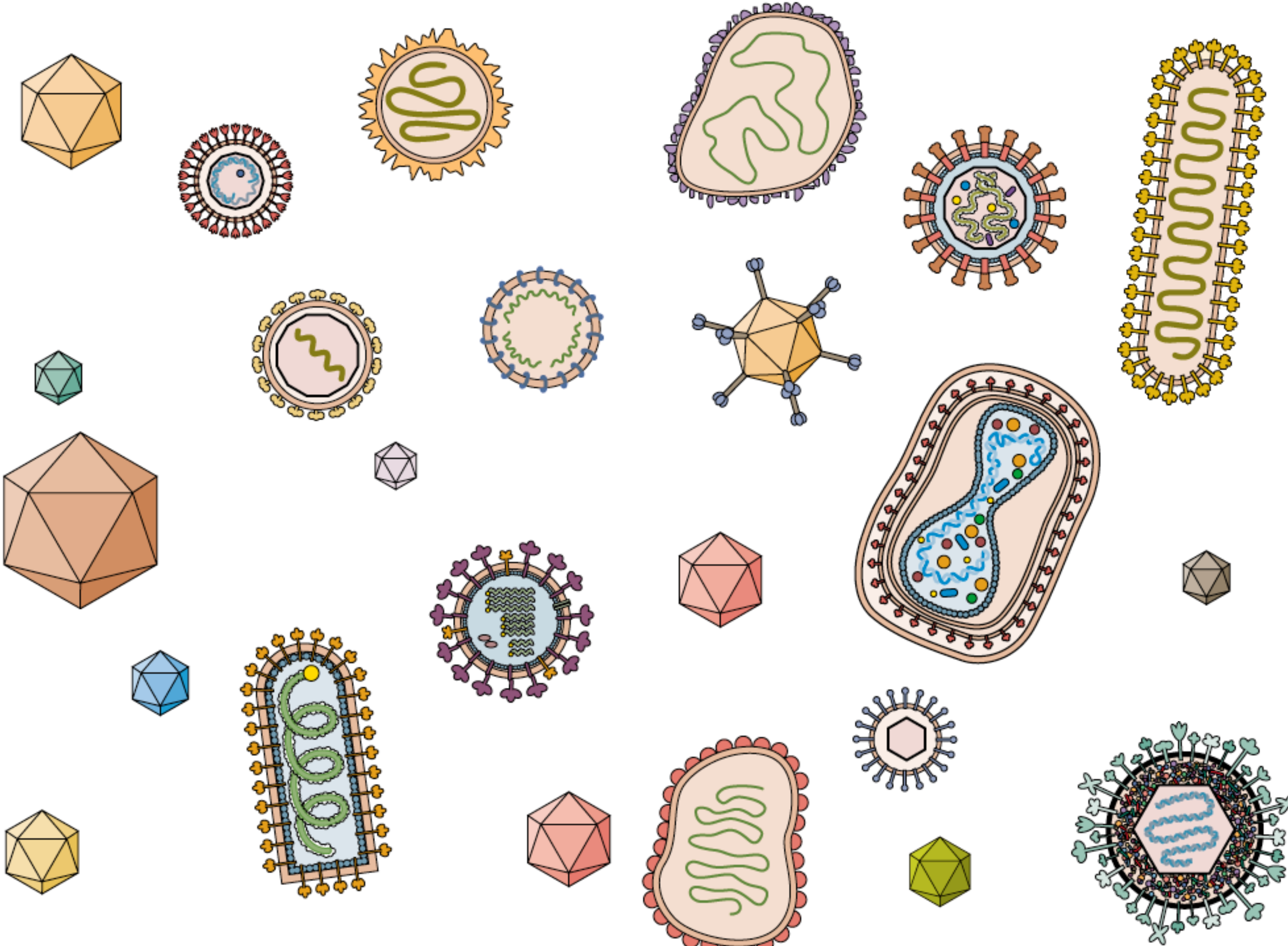
Prof. Vincent Racaniello, Ph.D.
Columbia University
vrr1@columbia.edu



What is a virus?

- Virus - coined from Latin meaning *slimy liquid* or *poison*
- A virus is a very small, infectious, obligate intracellular parasite (virion = infectious particle)
- Virus particles are **not** living
- Viruses are chemicals, and by themselves cannot reproduce
- A cellular **host** is needed for viruses to reproduce

Viruses are very small

Carbon atom

ribosome

HIV-1

TMV

poliovirus

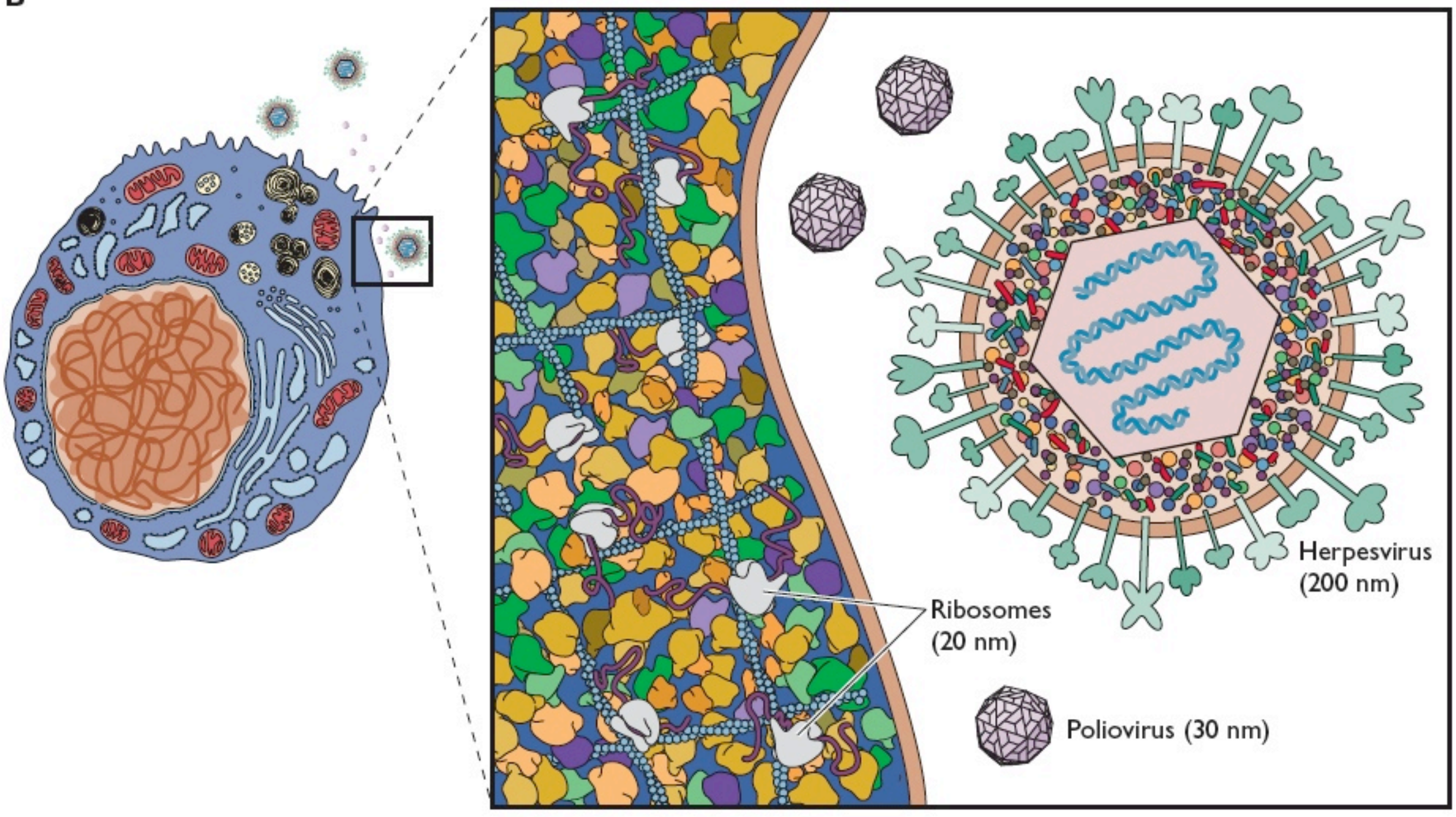
myosin actin

1,000,000x

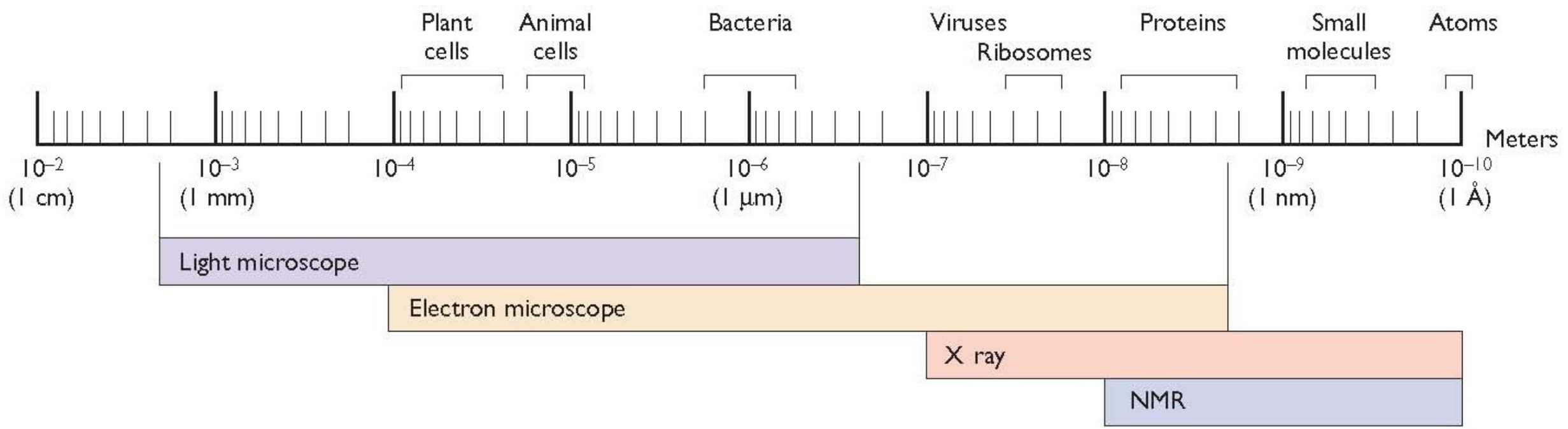
E. coli

100,000x

B



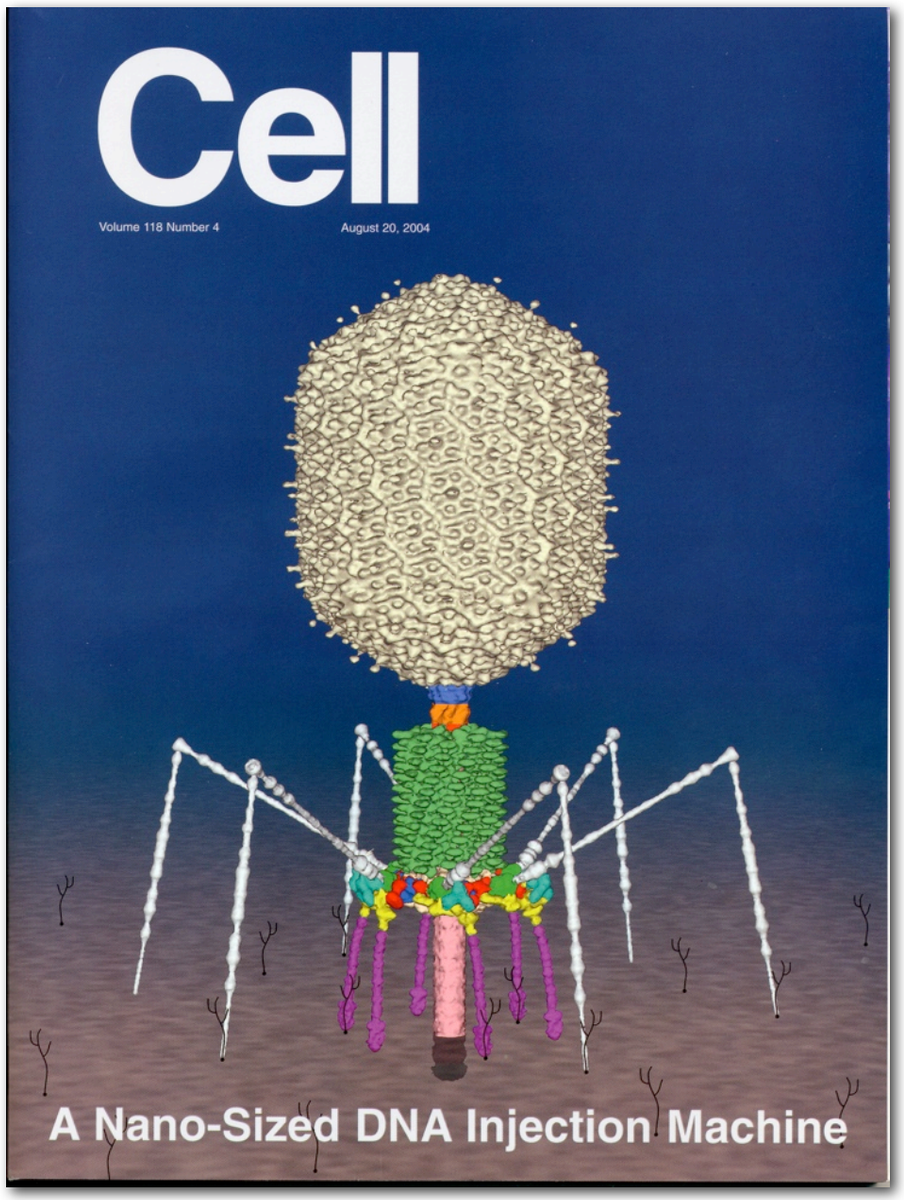
Size matters



Viruses are everywhere

- We eat and breathe billions of them regularly
  - breathe 6 liters of air per minute, eat thousands of grams of food and its allied contaminants per day, touch everything and put our fingers in our eyes and mouths
  - every milliliter of seawater has more than a million virus particles
- We carry viral genomes as part of our genetic material
- Viruses infect our pets, domestic food animals, wildlife, plants, insects

The number of viruses impinging on us is staggering



More than 10^{30} bacteriophage particles in the world's oceans!

- 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 more than 200 million light years!

- Whales are commonly infected with a virus that can caus rashes, blisters, intestinal problems, diarrhea in humans
- Infected whales excrete more than 10^{13} caliciviruses daily

There are ~10^{16} HIV viruses on the planet today

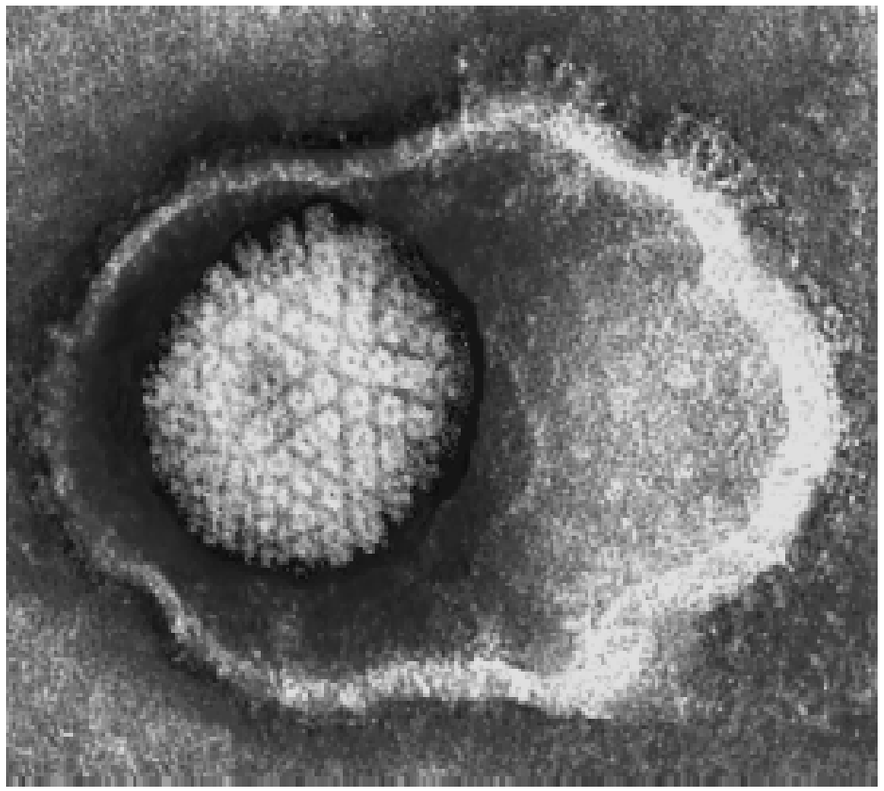
With this number, it is highly probable that
HIV viruses exist that are resistant to every one of the antiviral drugs that we have now,
or EVER WILL HAVE!

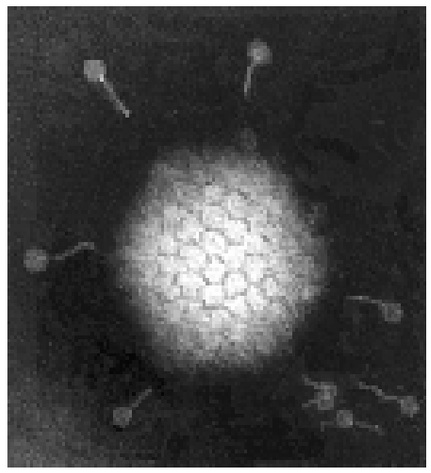
Amazingly, the vast majority of the viruses that infect us have little or no impact on our health or well being

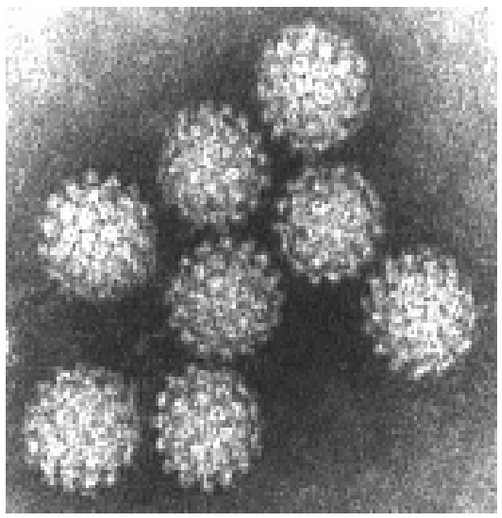
We exist because we have a *defense system* that fights infections

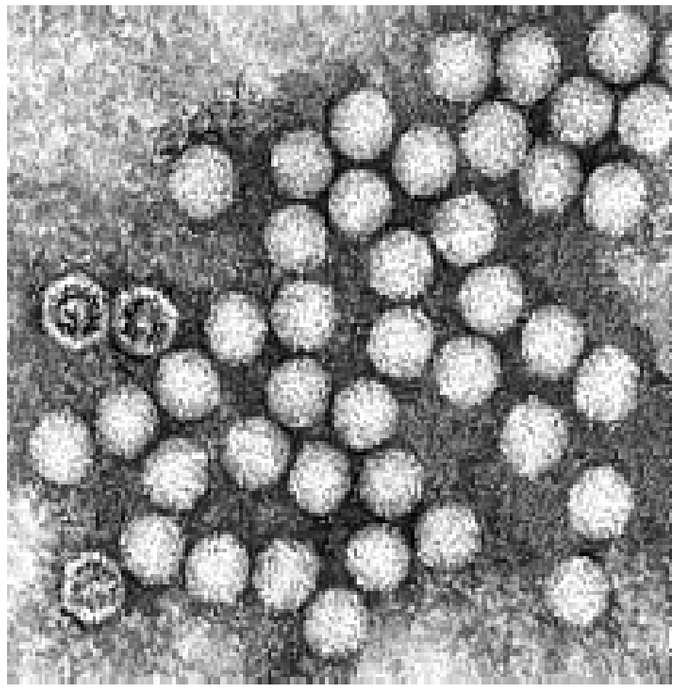
If our immune system is down (e.g. AIDS, organ transplants), even the most common viral infection can be lethal

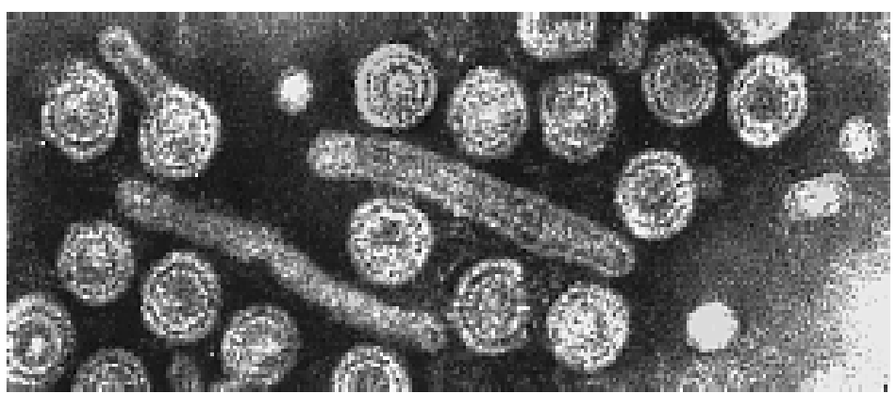
What do viruses look like?

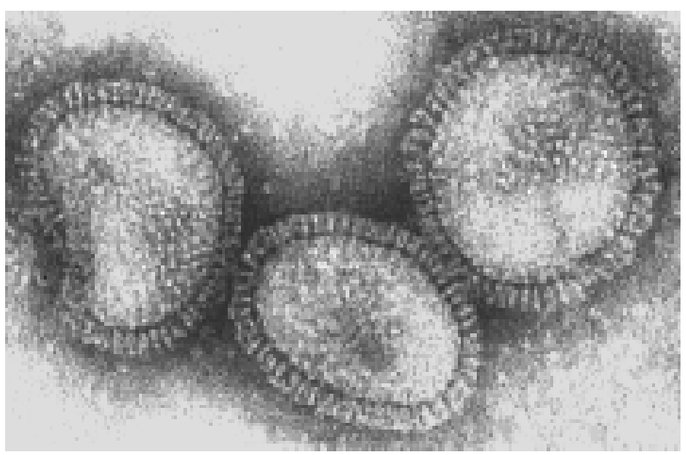


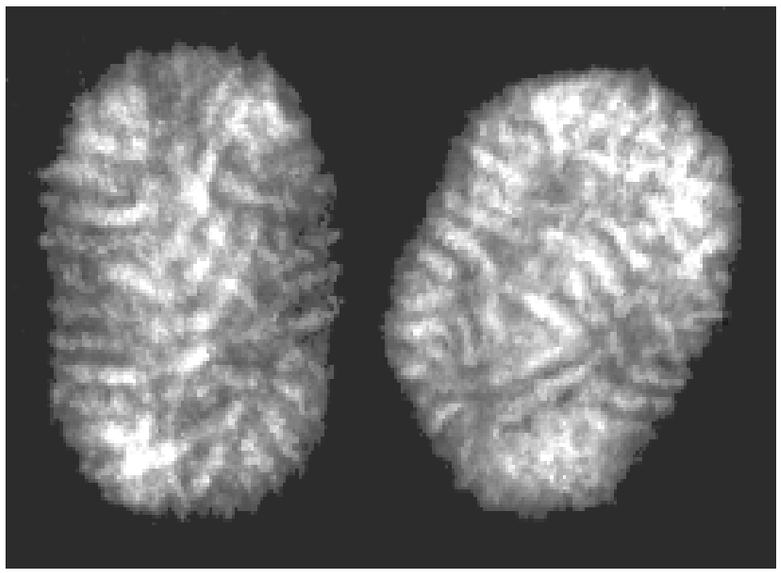












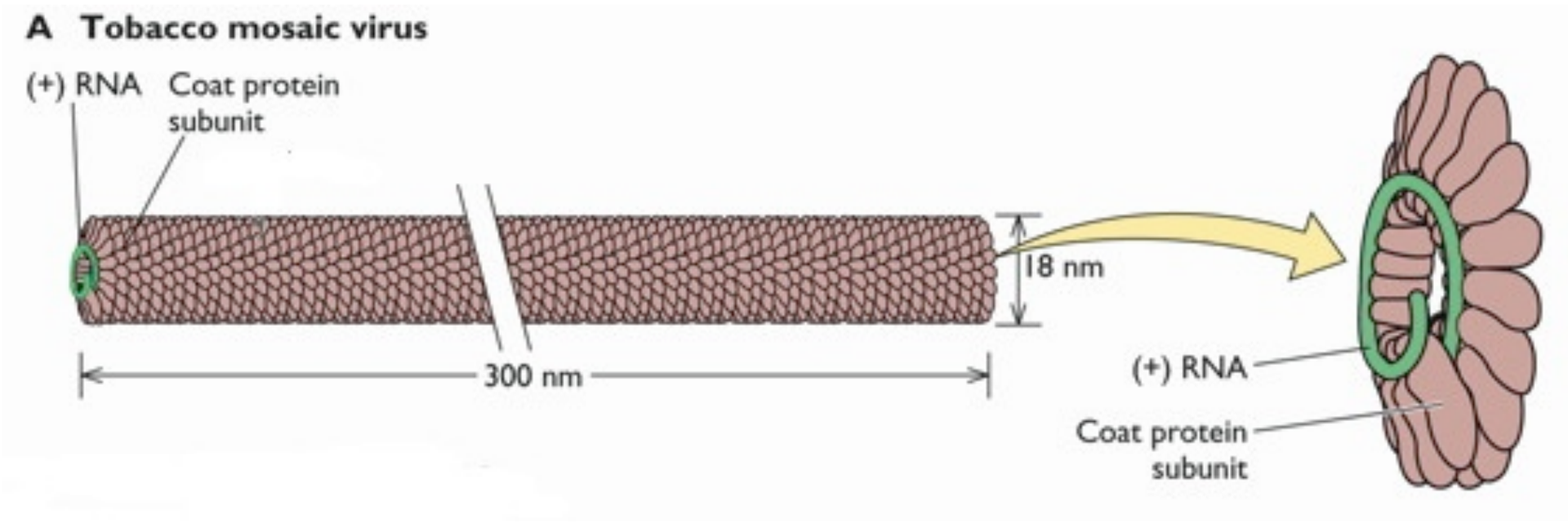
All viruses have these three attributes

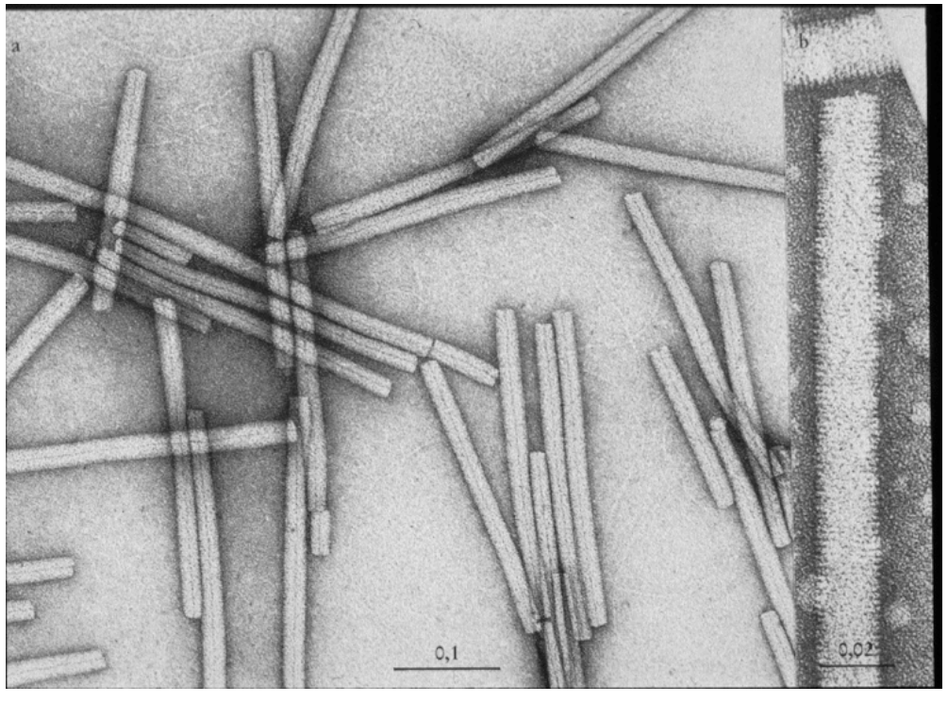
1. All have a nucleic acid genome packaged in a particle made of protein

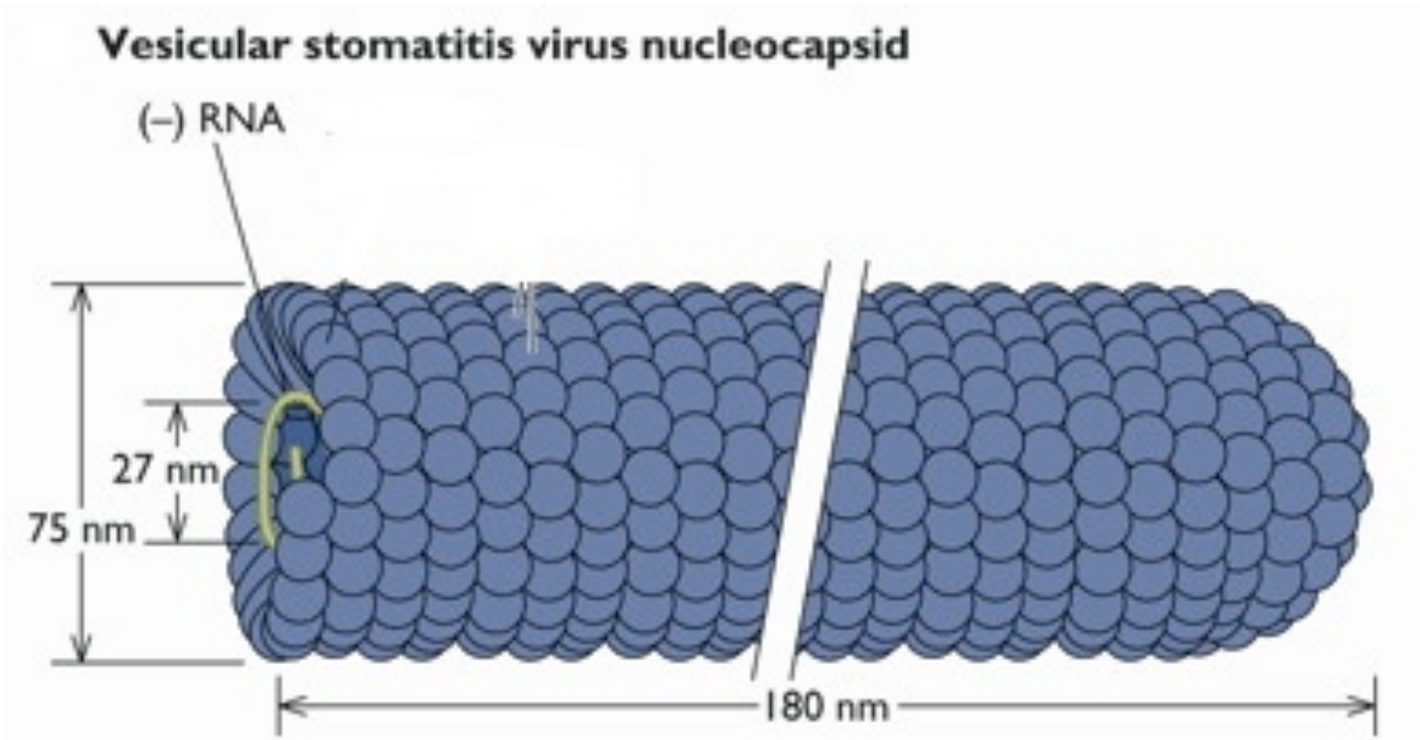
2. The viral genome contains the information to initiate and complete an *infectious cycle* within a cell

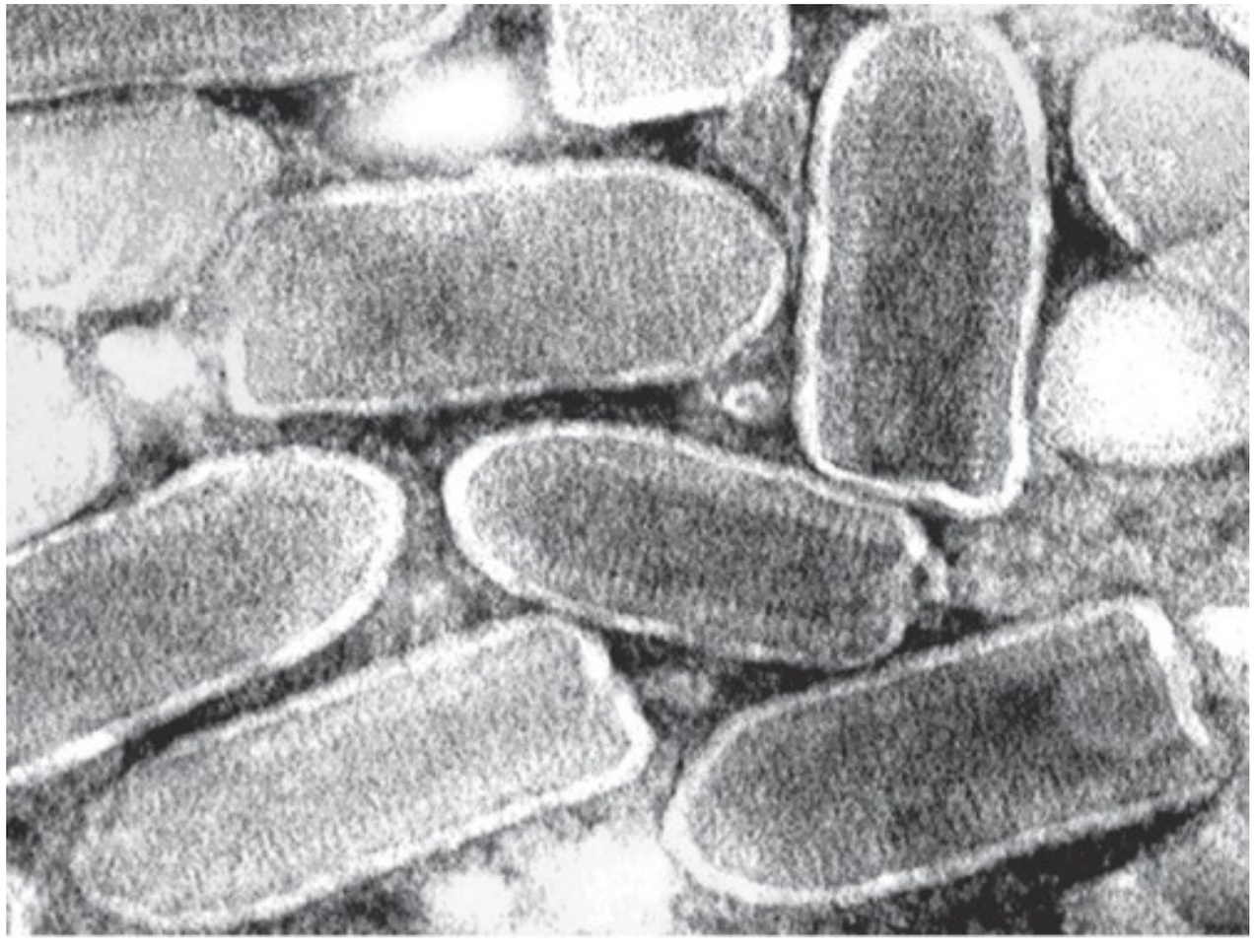
3. All viral genomes are able to establish themselves in a host population so that viral survival is ensured

How are viruses built?

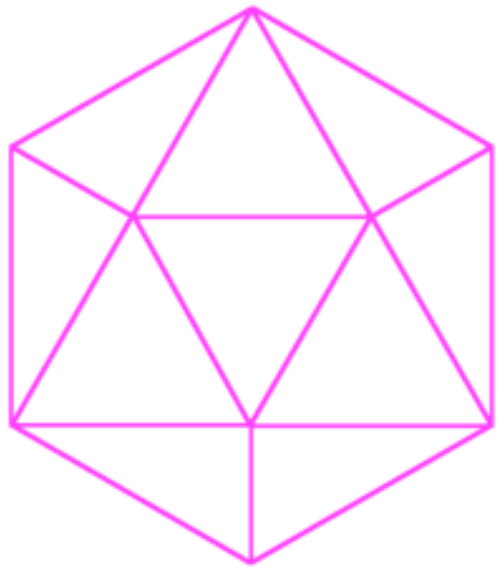




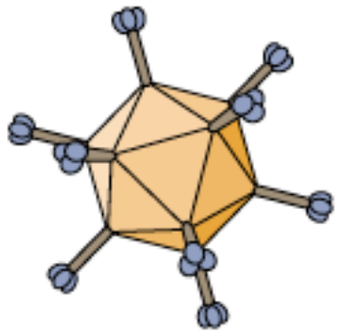

Vesicular stomatitis virus nucleocapsid
(–) RNA
27 nm
75 nm
180 nm

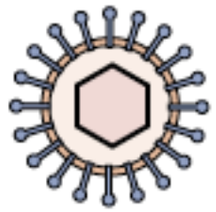


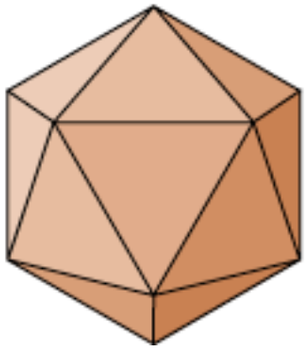
Many viruses are built like icosahedrons

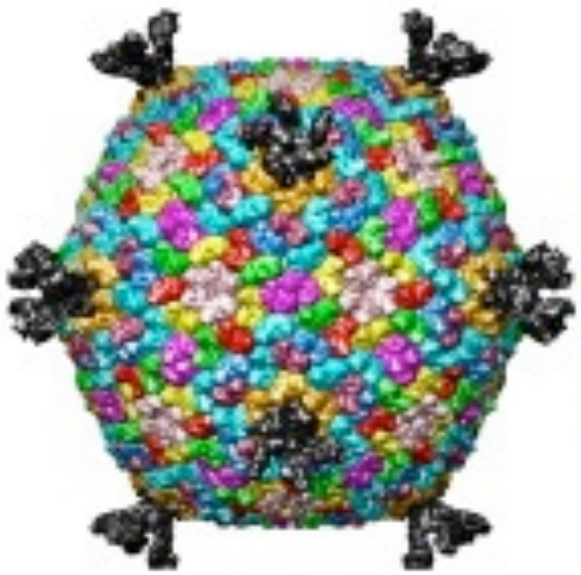


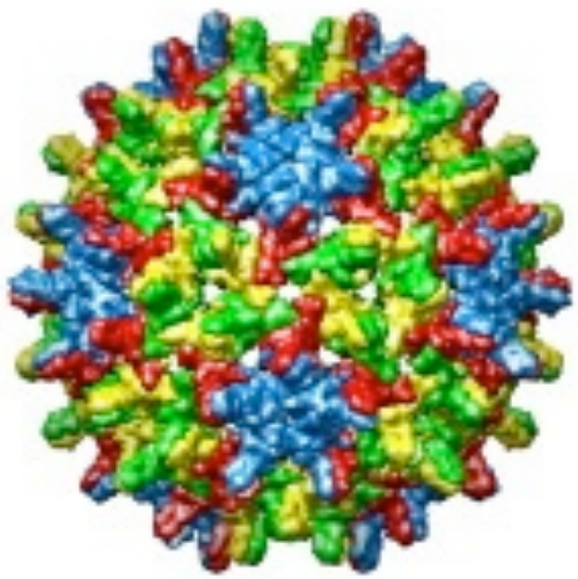
This is the best way to make a very stable shell with as little as one protein

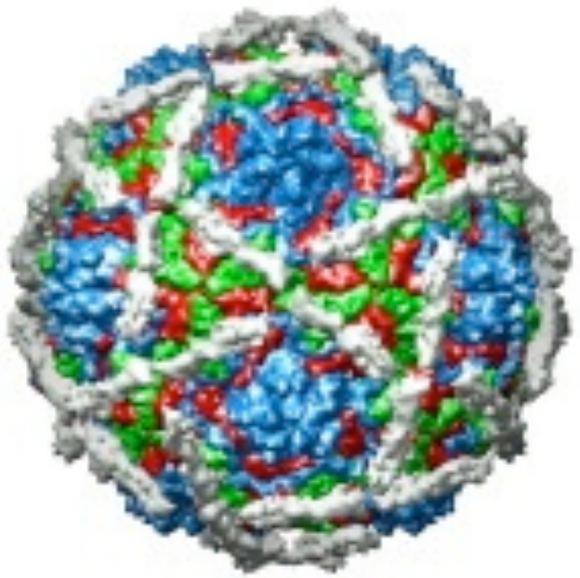


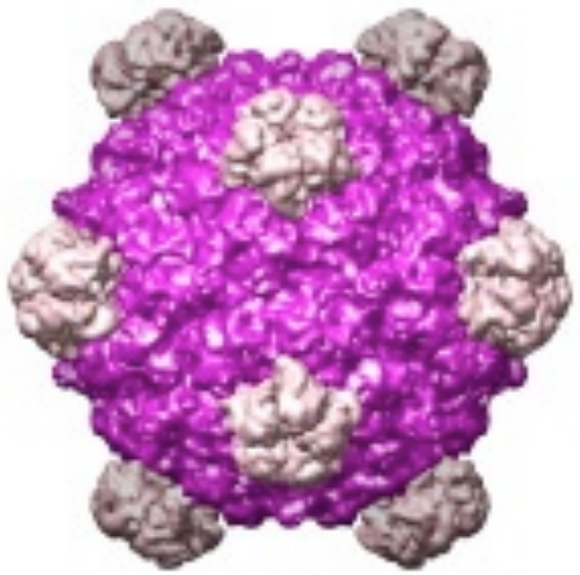


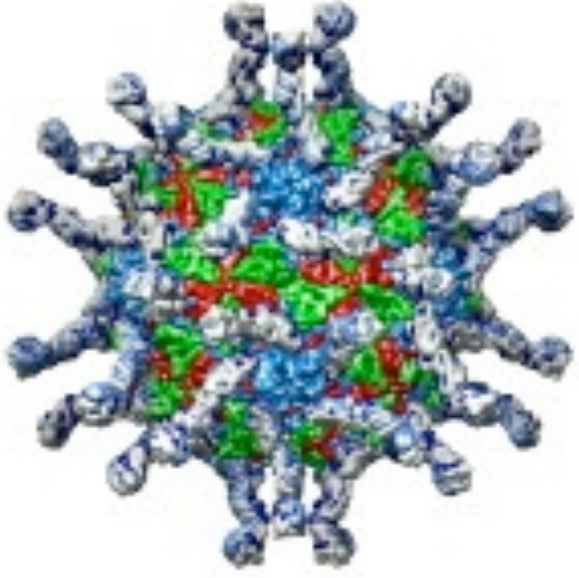


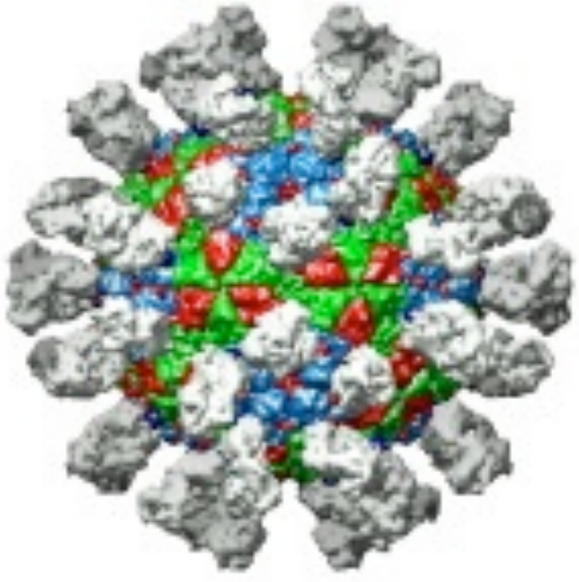


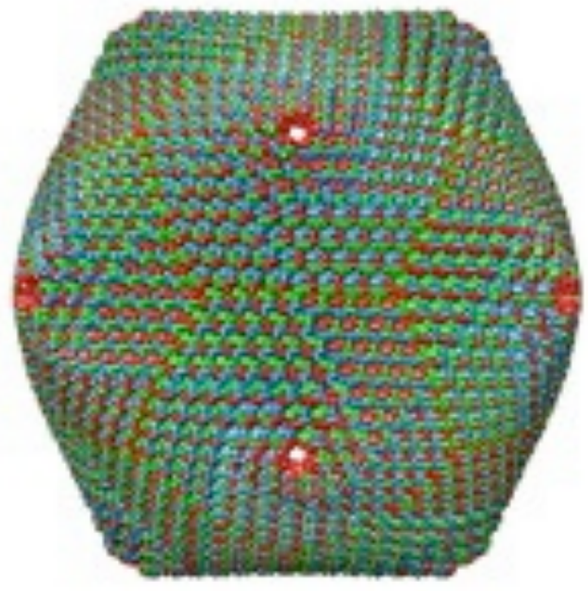




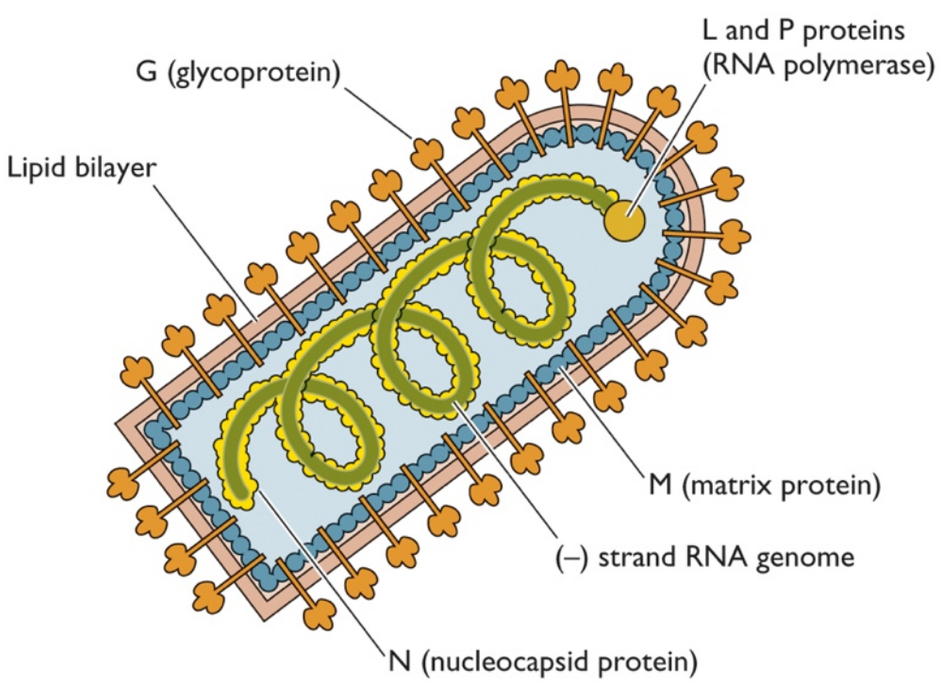


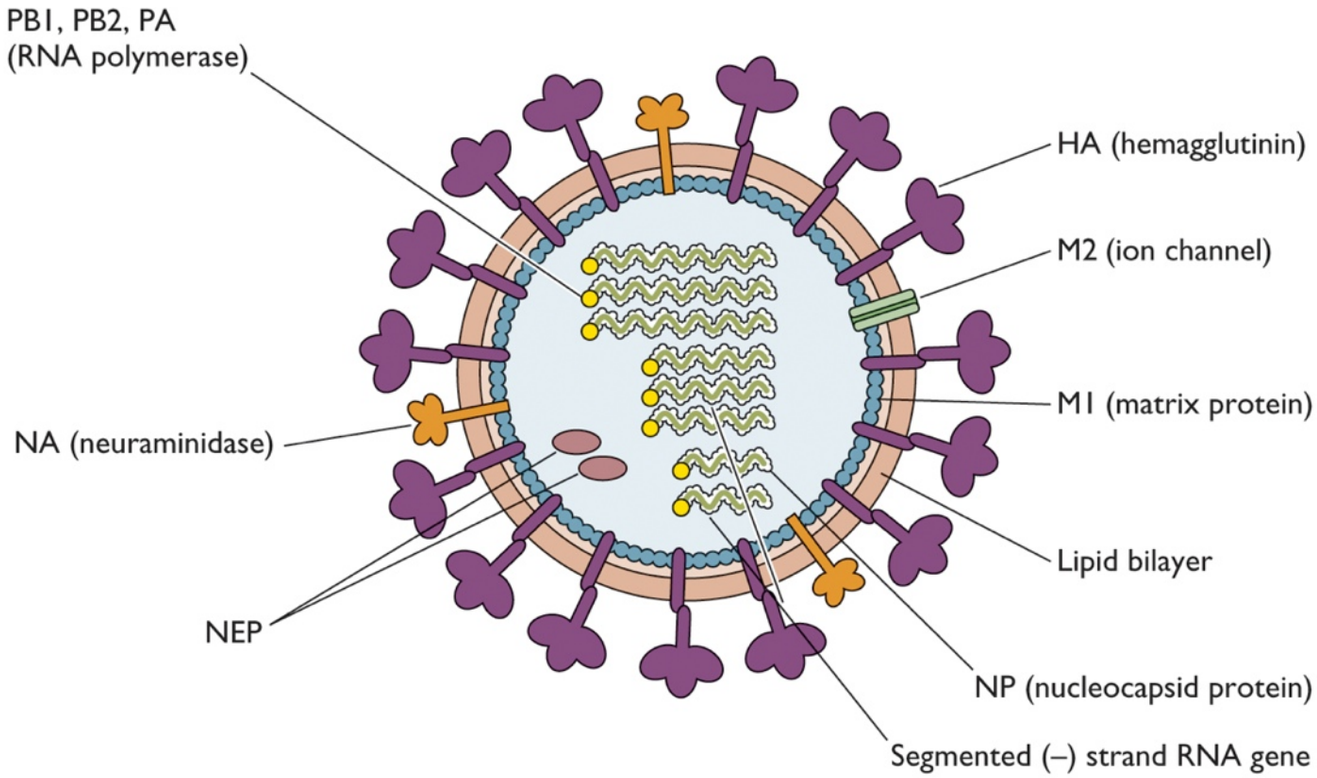


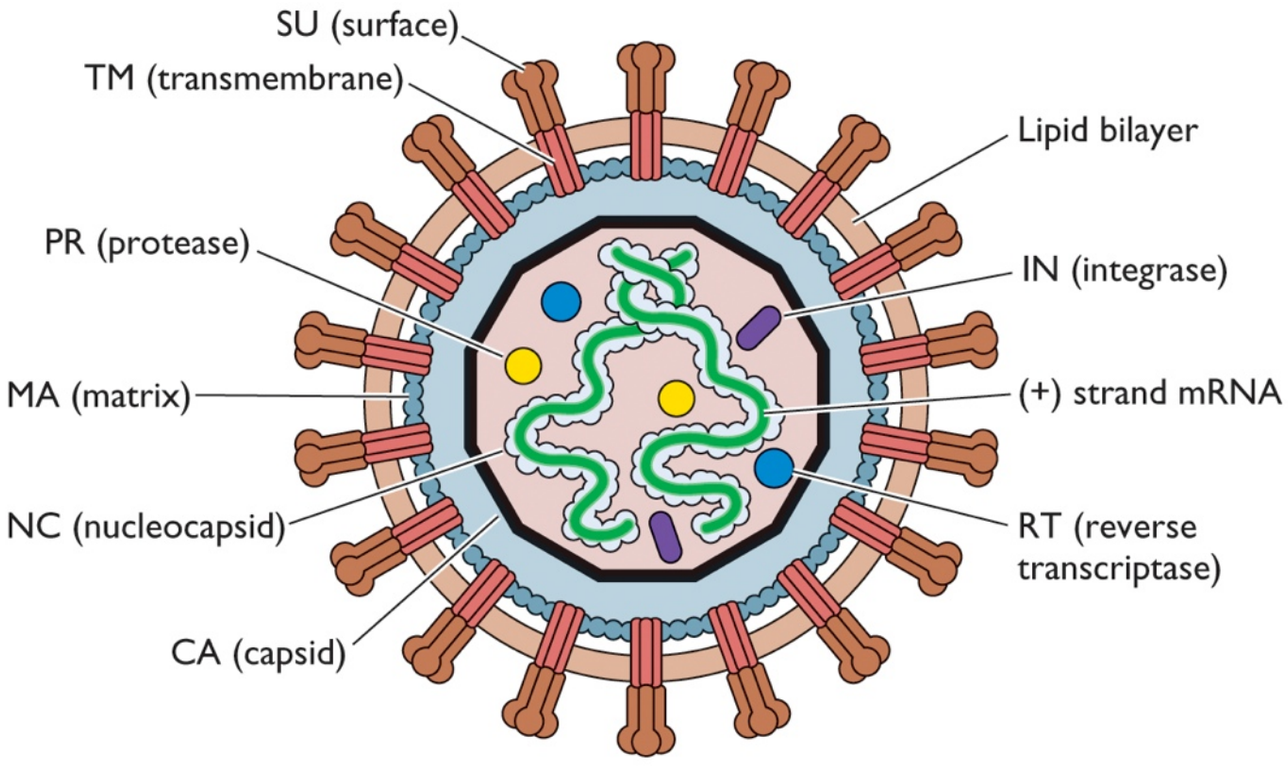




Viruses with membranes





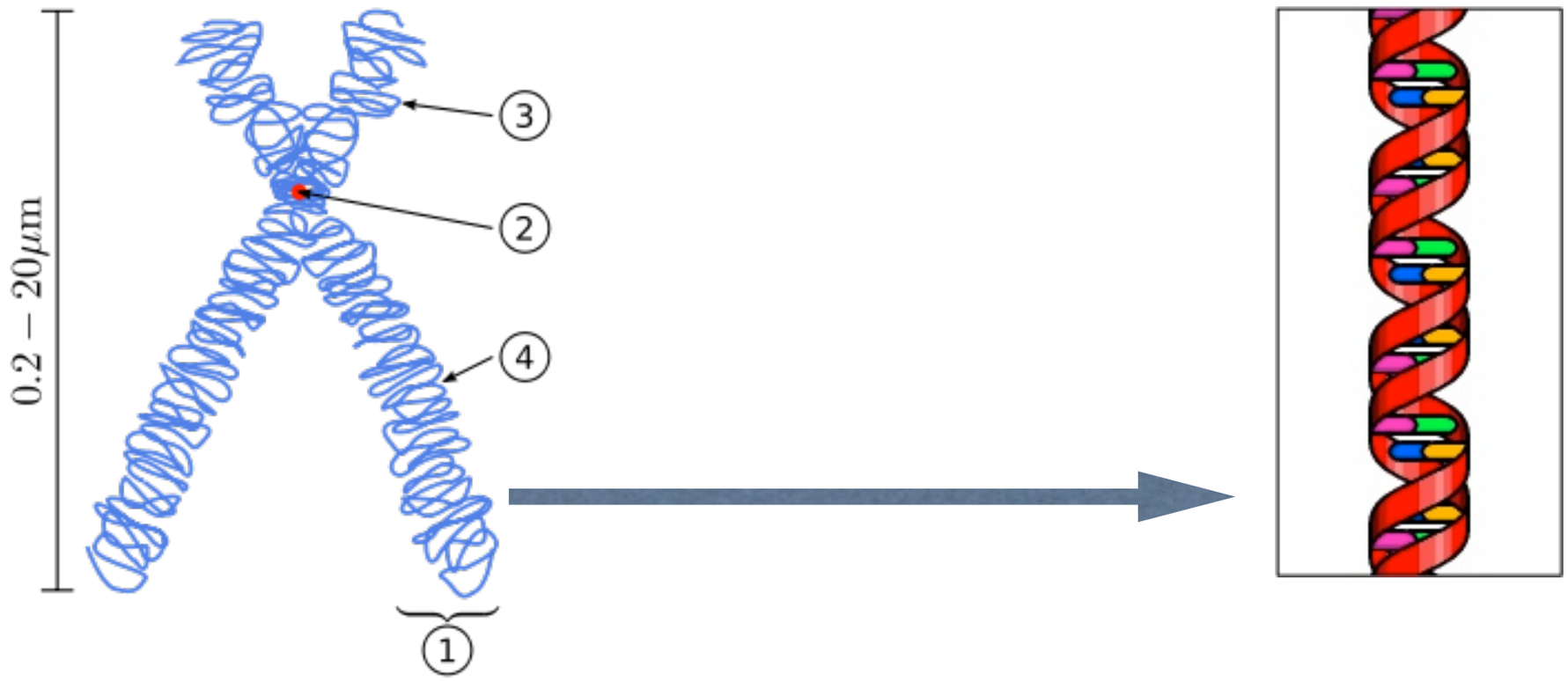


What is inside the virus particle?

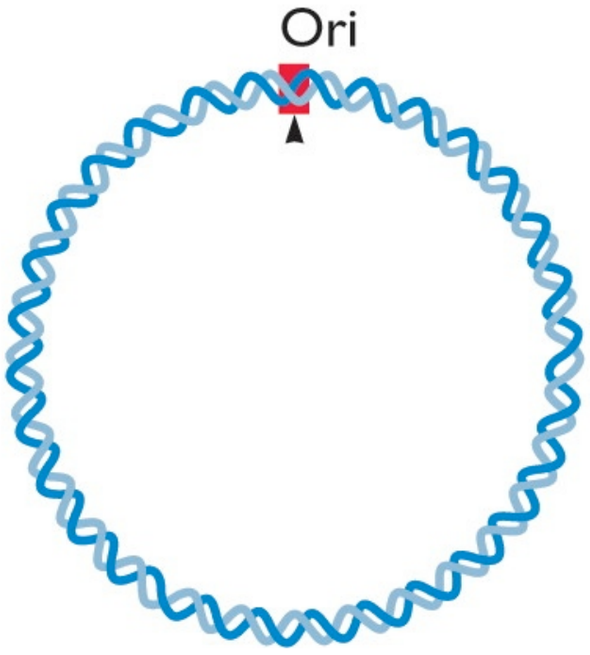
- The nucleic acid genome - directs the production of new virus particles
- The genome can be DNA or RNA

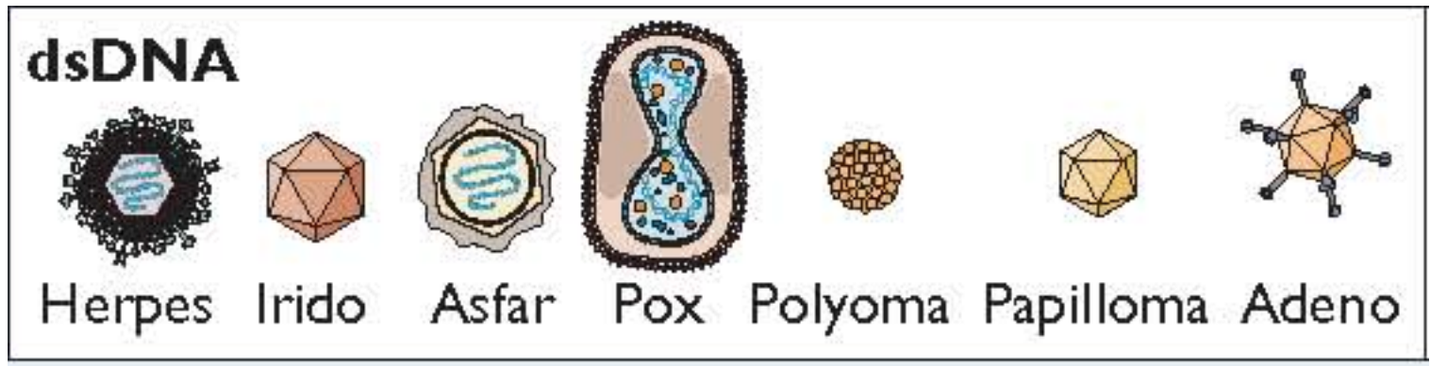
Viral genomes

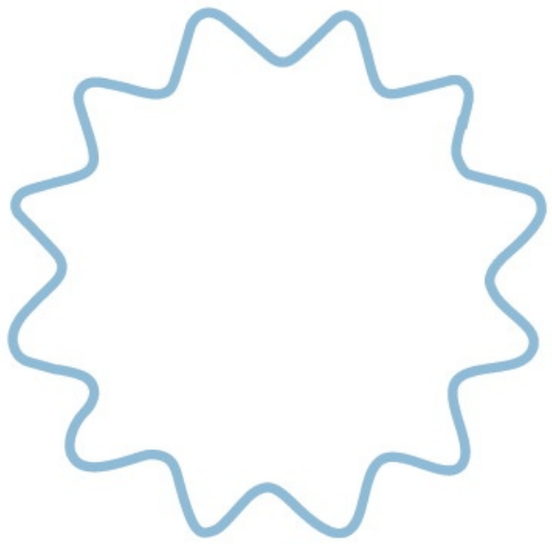
- The human genome is double-stranded DNA (dsDNA)
- Viral genomes are amazingly diverse



Viral DNA genomes





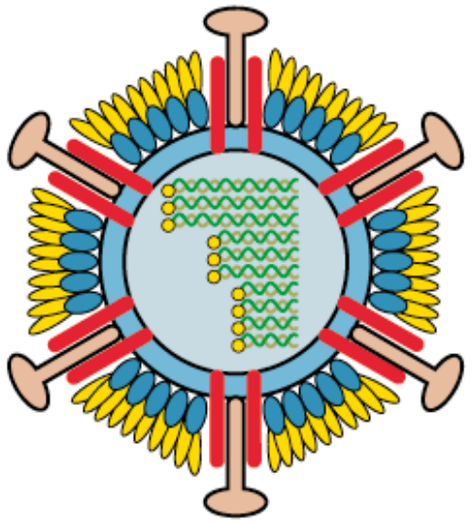


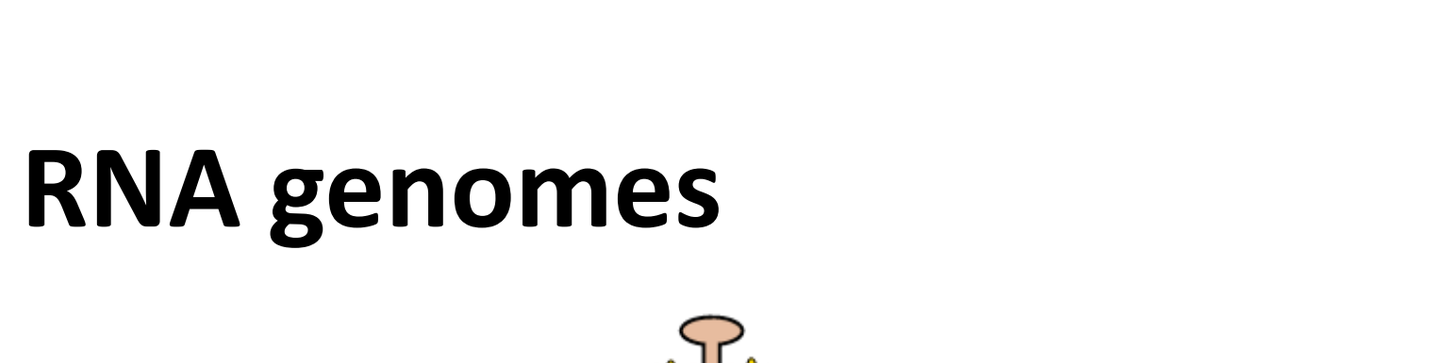
Viral RNA genomes

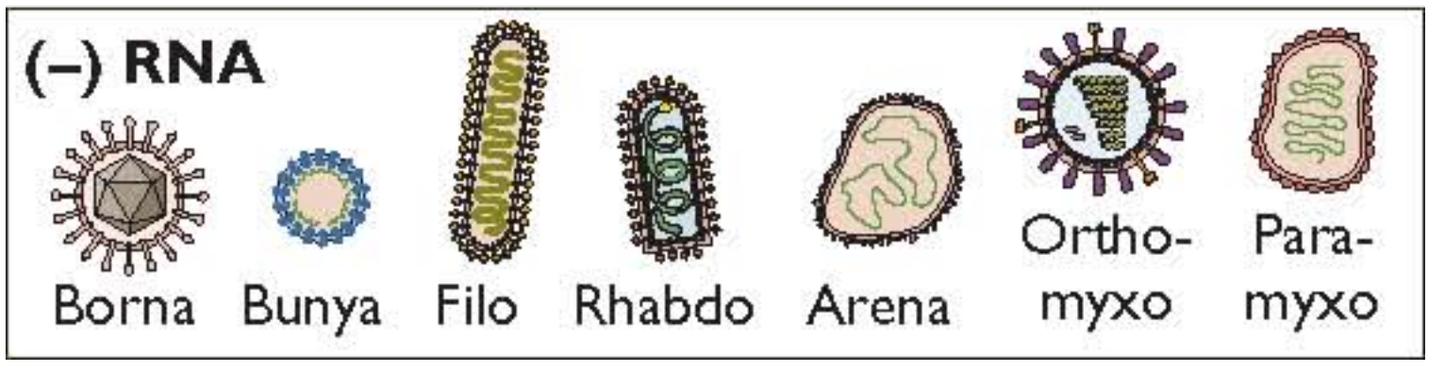
dsRNA

ss(+)RNA

ss(-)RNA





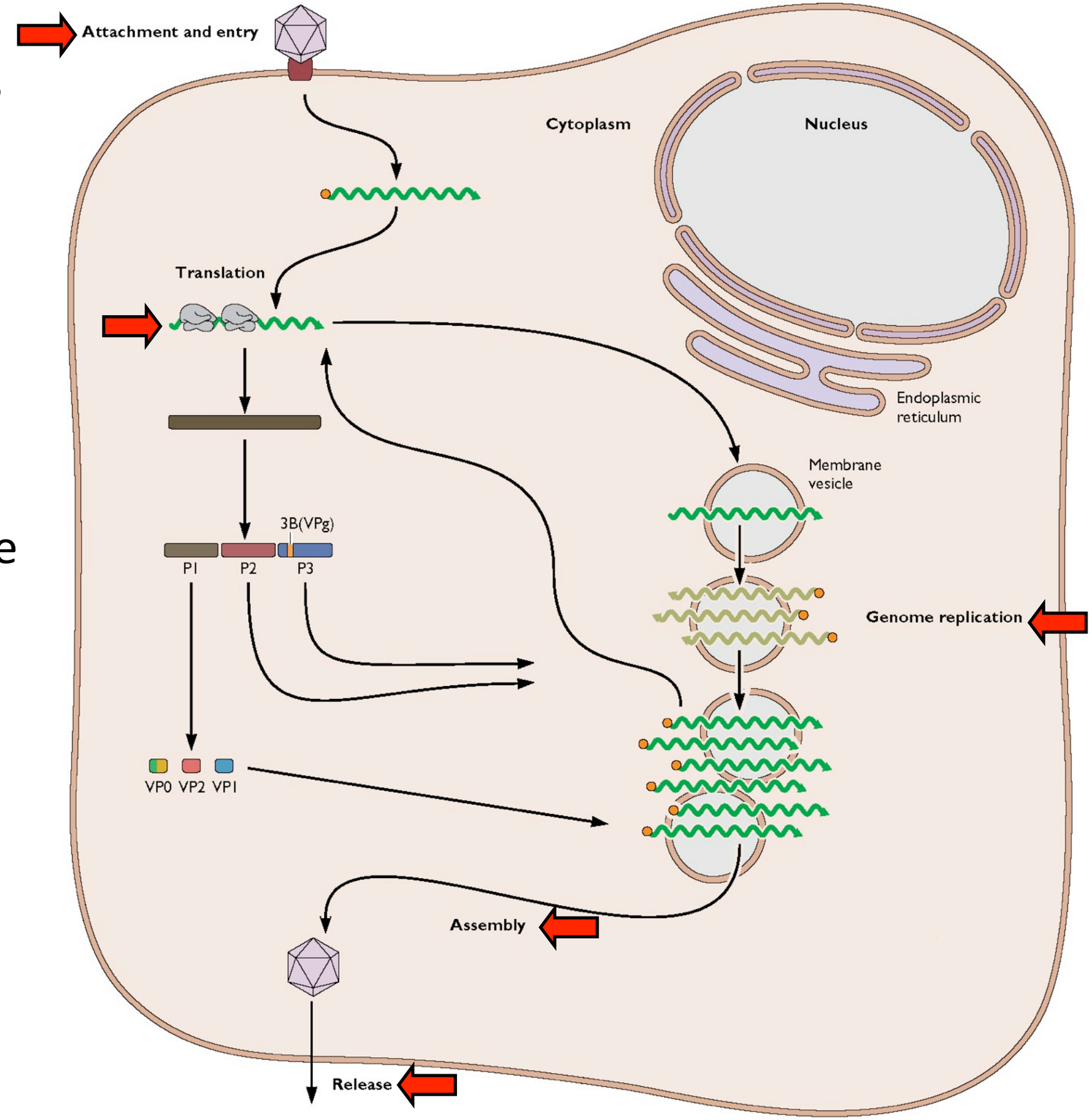


How do viruses reproduce?

- Viruses must get *inside* a cell
- The process of making more viruses, from start to finish, is called the *infectious cycle*

The Infectious Cycle

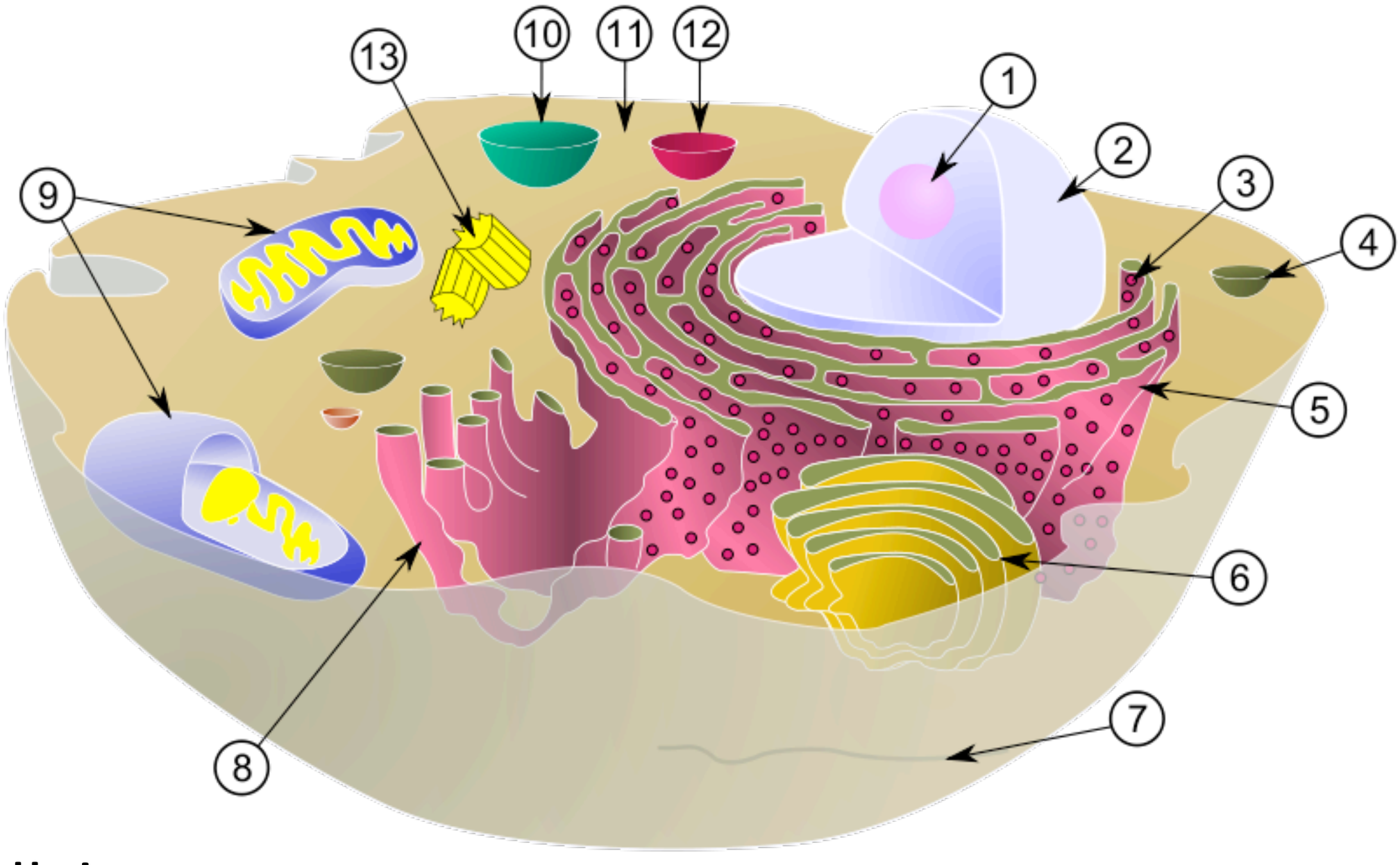
Virologists divide the infectious cycle into steps to facilitate their study, but no such artificial boundaries occur



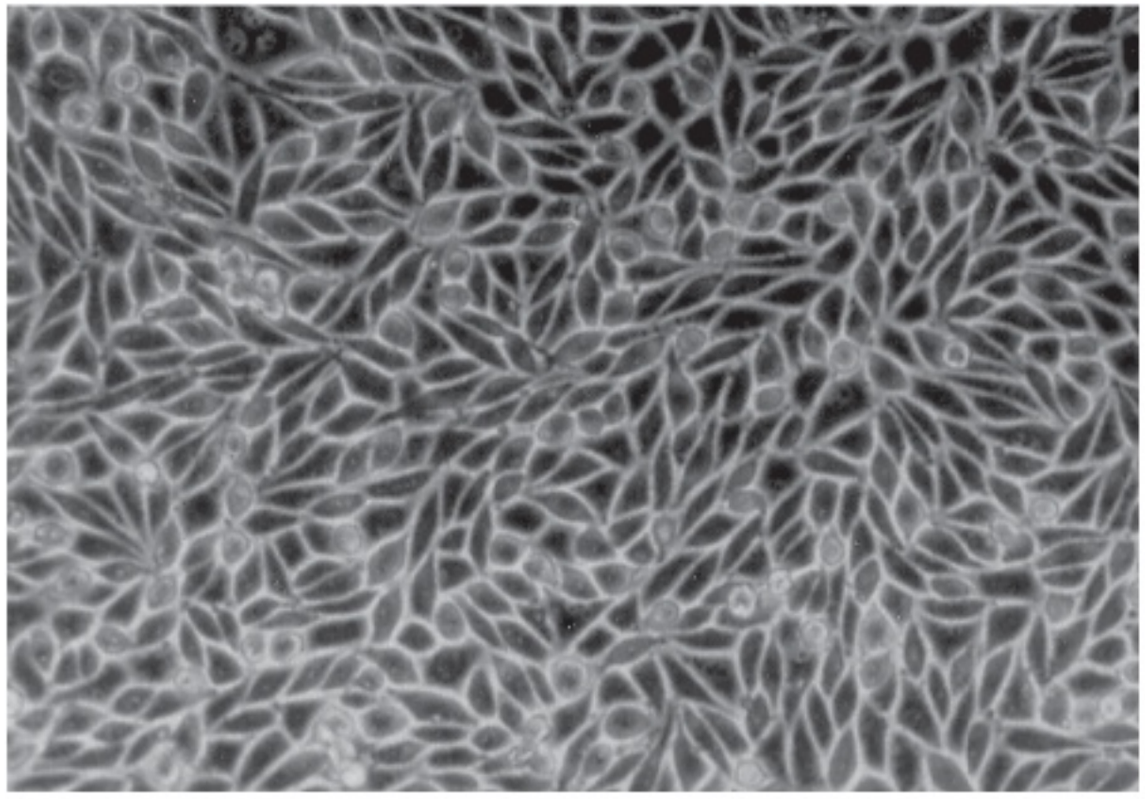
Movie of HIV replication

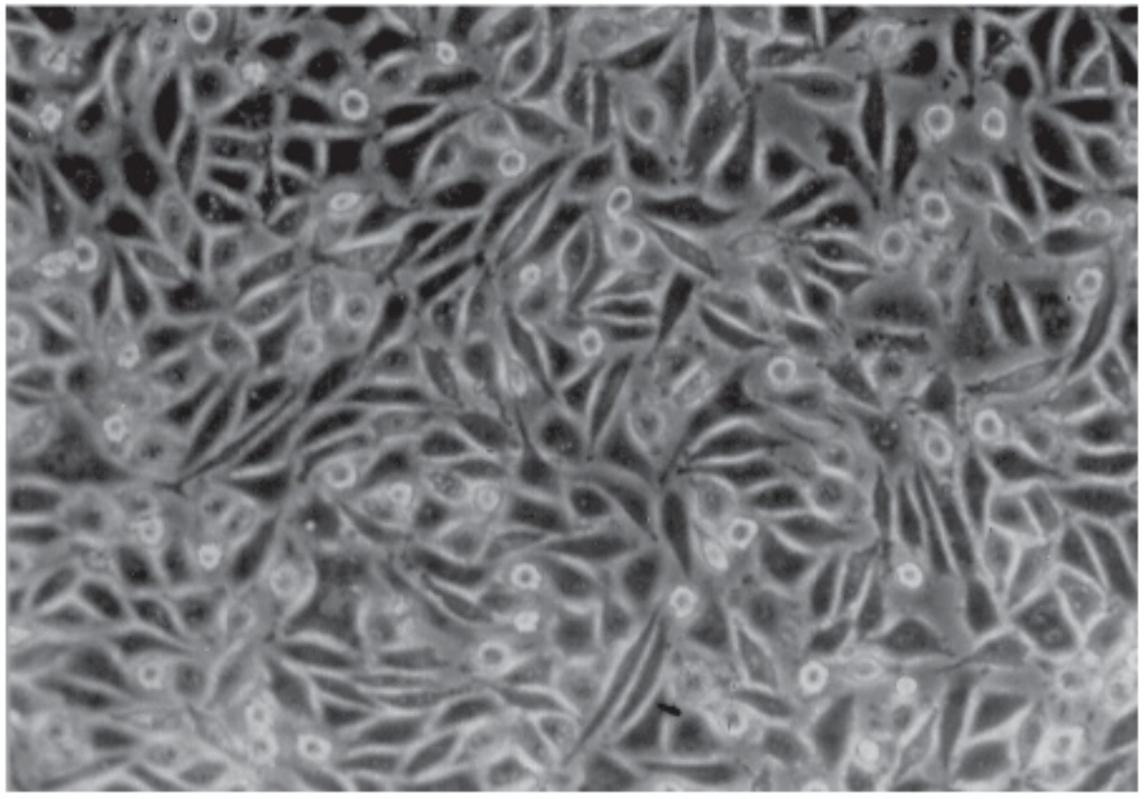
http://www.youtube.com/watch?v=RO8MP3wMvqg

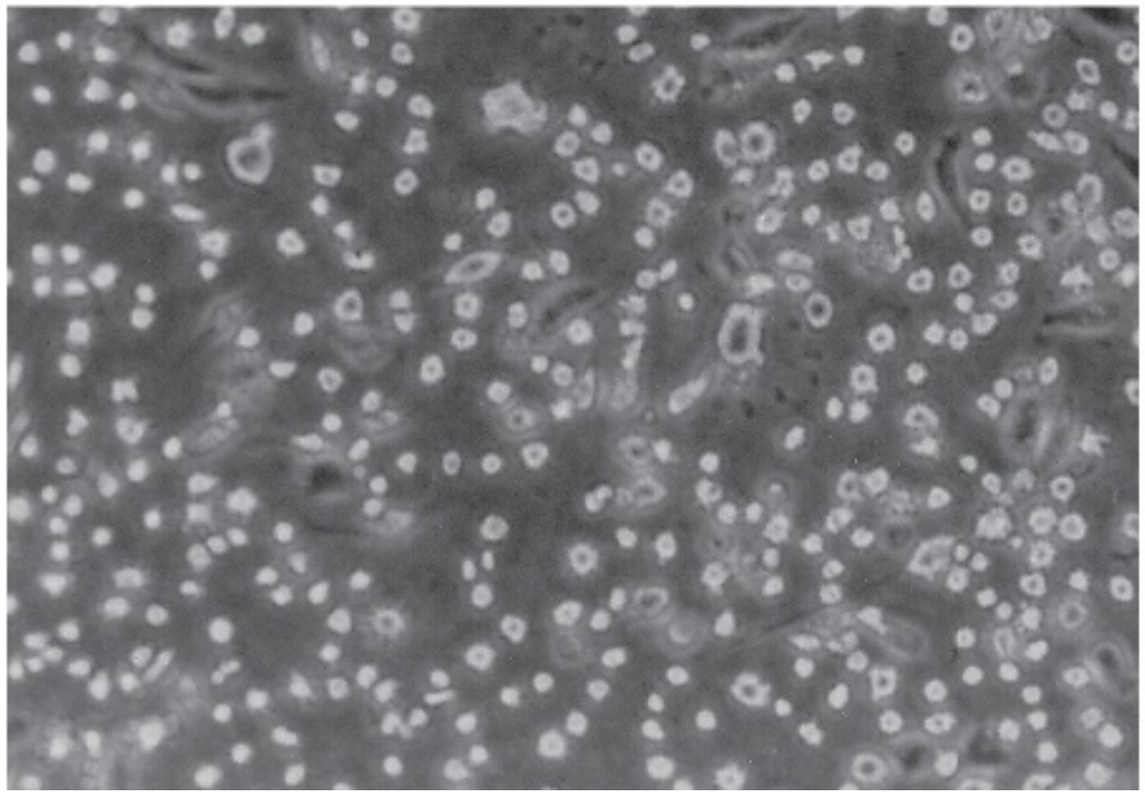
How do we study viruses?

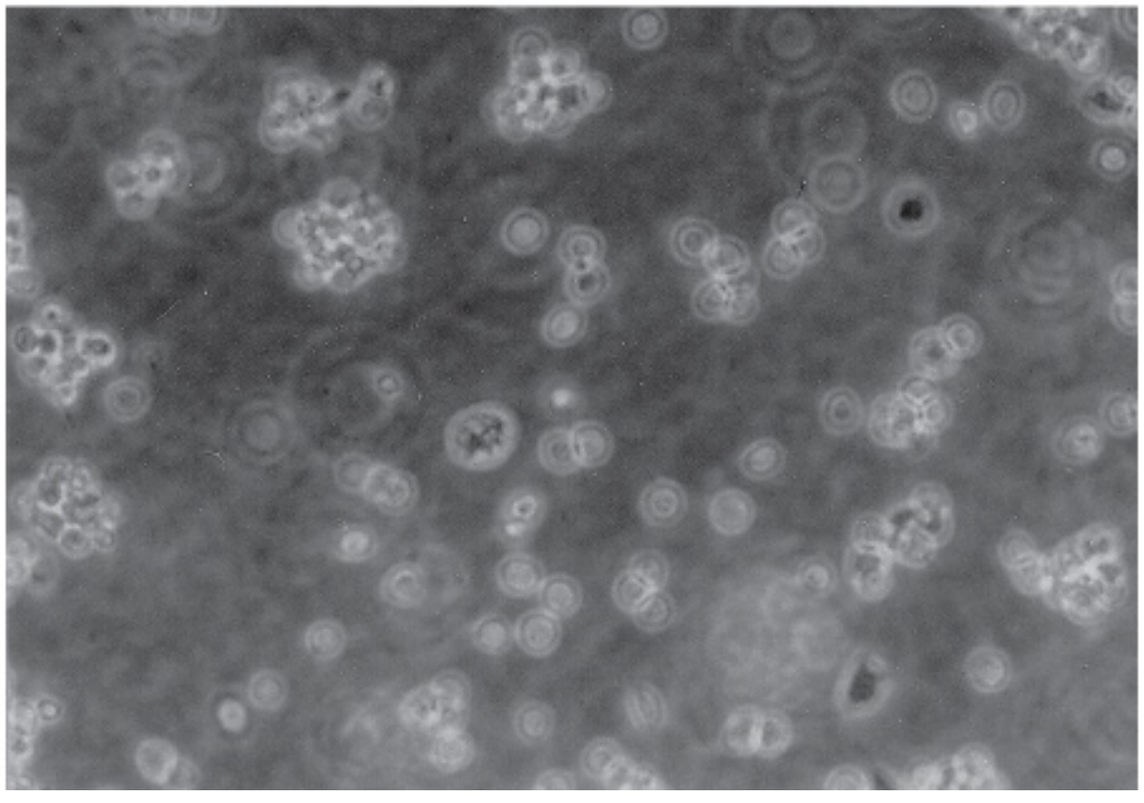


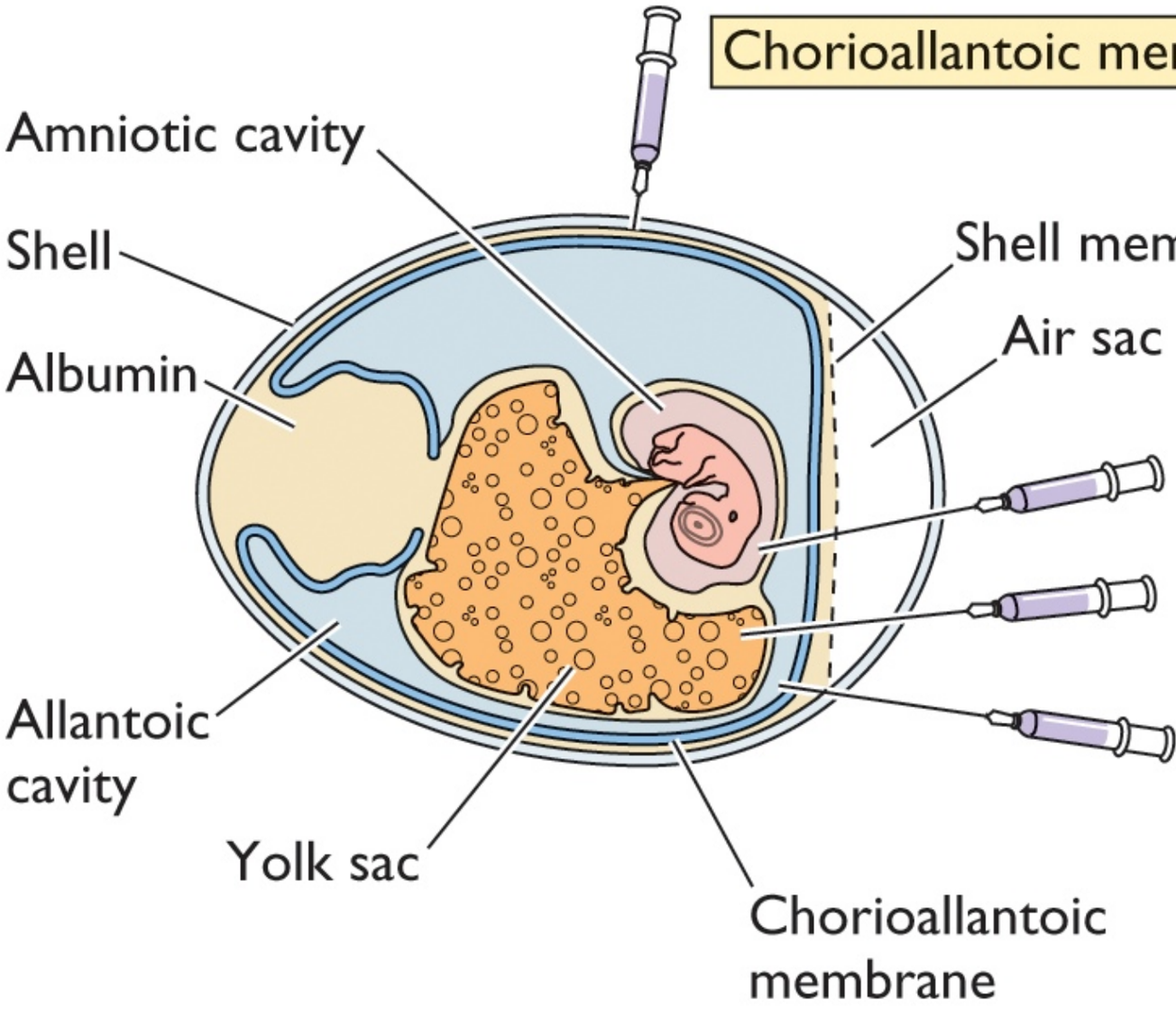
In cells!











Chorioallantoic membrane inoculation

Herpes simplex virus
Poxvirus
Rous sarcoma virus

Amniotic inoculation

Influenza virus
Mumps virus

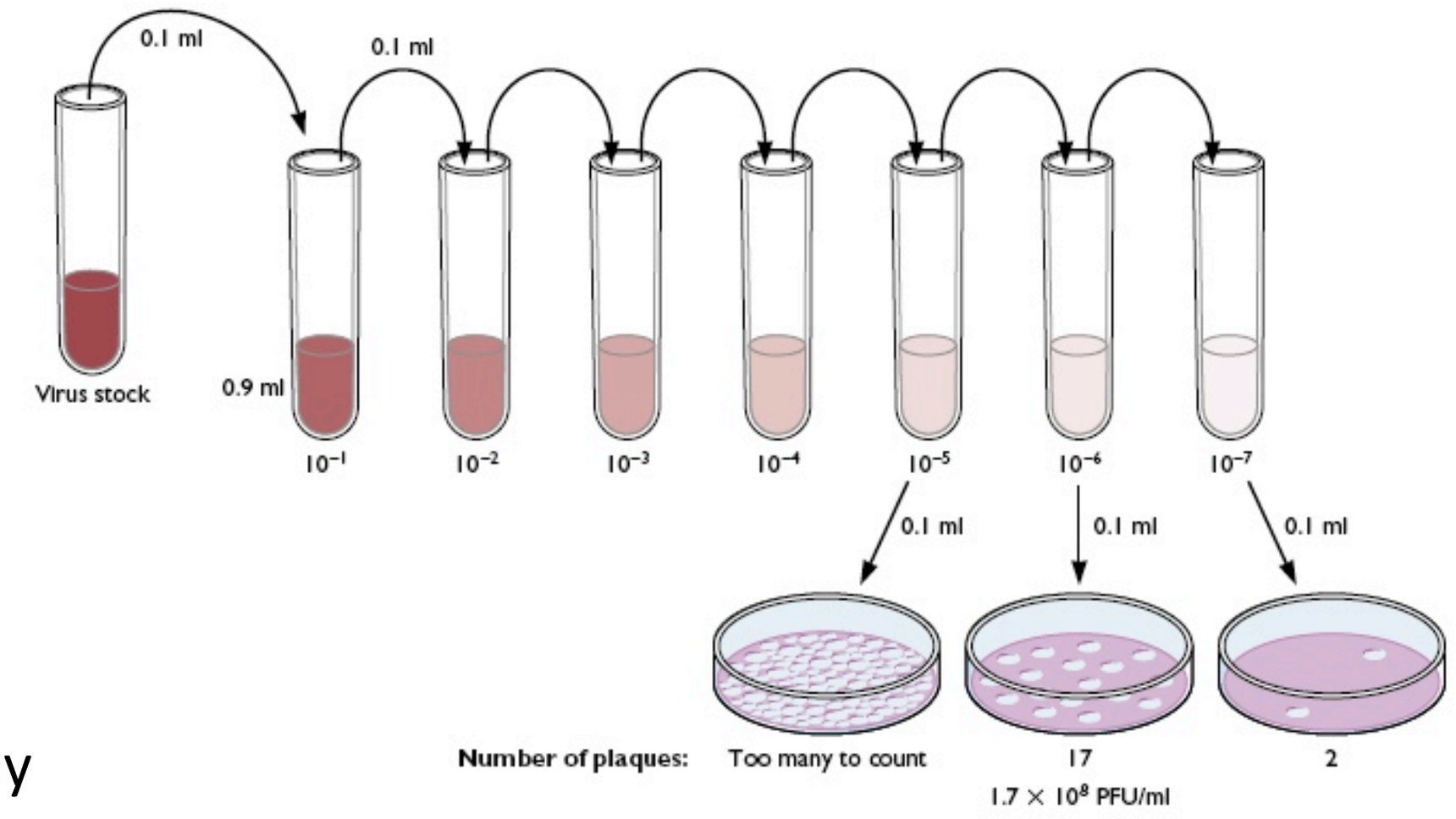
Yolk sac inoculation

Herpes simplex virus

Allantoic inoculation

Influenza virus
Mumps virus
Newcastle disease virus
Avian adenovirus

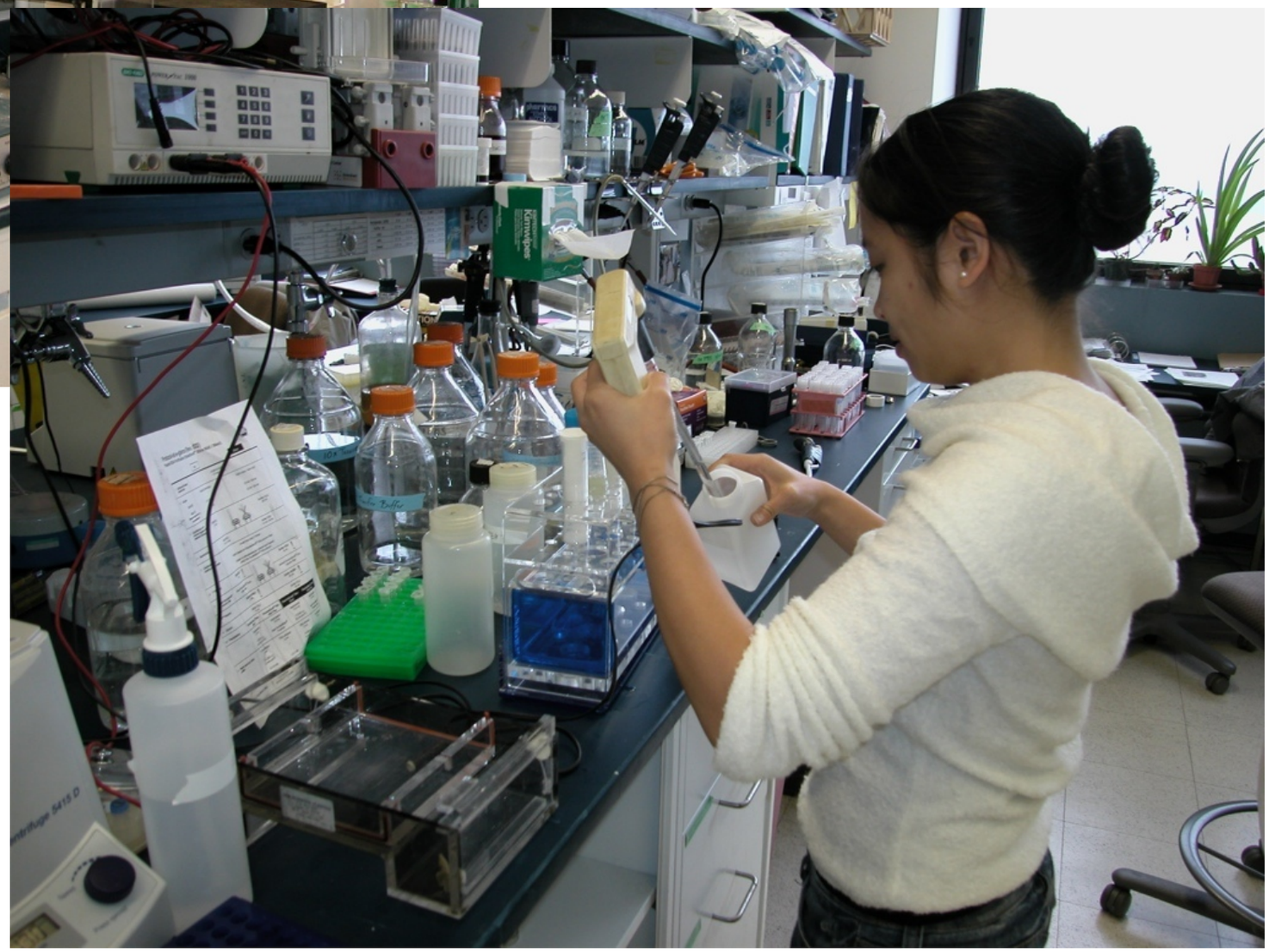
How much virus is there?



Plaque assay

Where do we work on viruses?


CHEMICALS A-B
CHEMICALS C-E
CHEMICALS F-H
CHEMICALS I-N
General Lab Supplies
Weighing Supplies

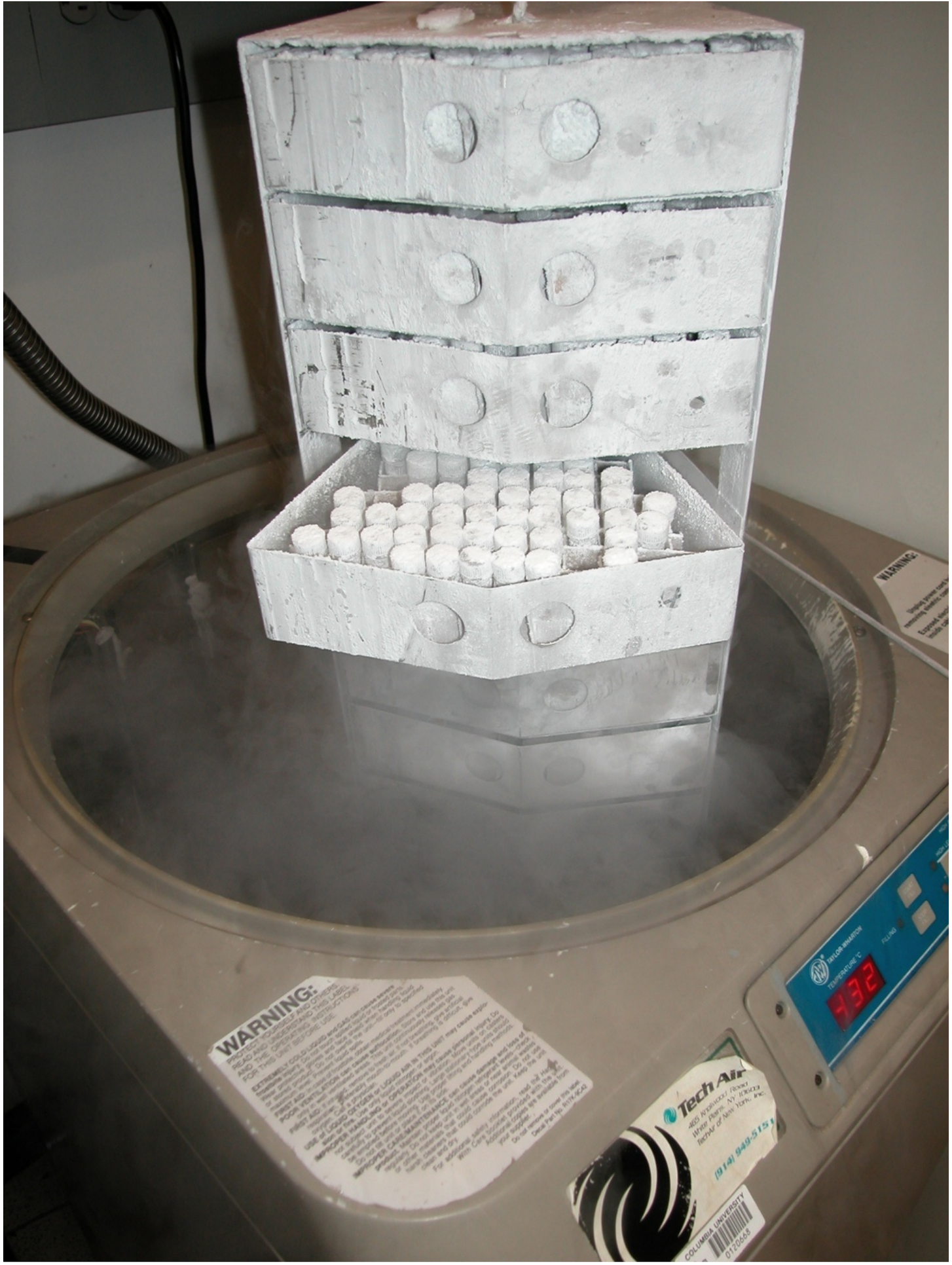

Kimwipes


SterilGARD Hood
The BAKER COMPANY, INC.
CAUTION
RADIOACTIVE MATERIAL
WORK AREA

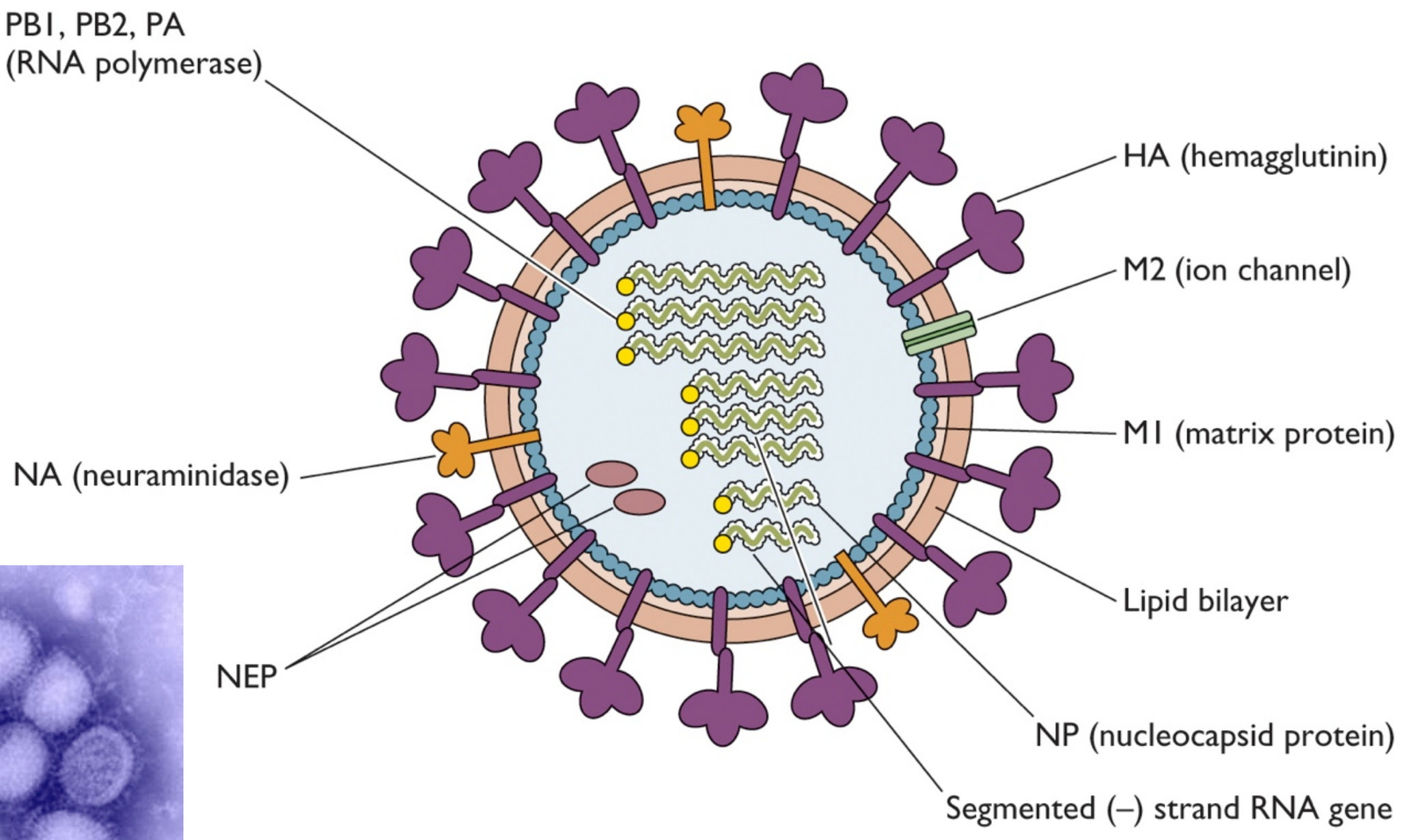
-70°C =

-94° F

-132°C =
-205° F



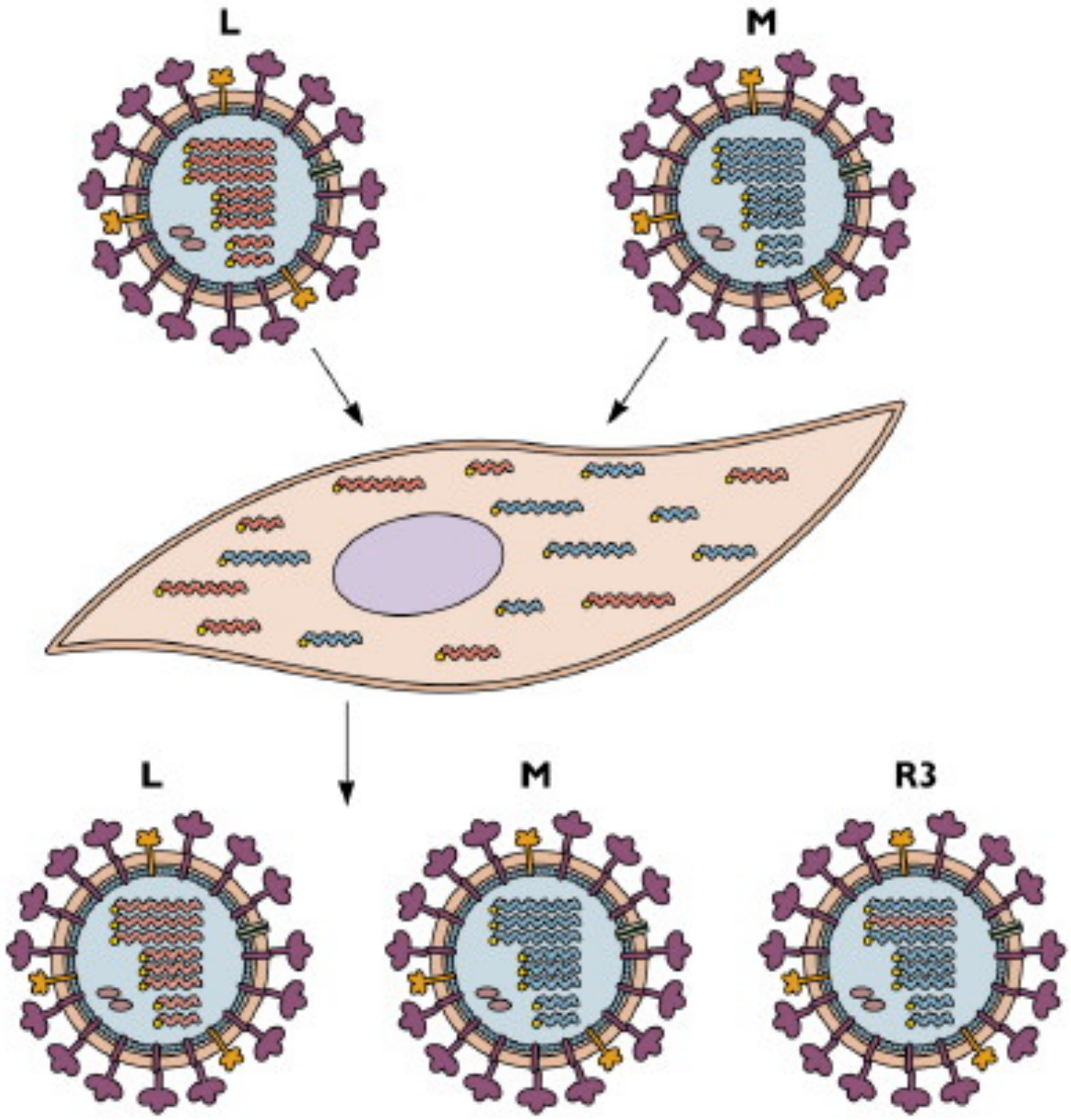
Influenza viruses



Three types: A, B, C

Influenza viruses

- Infect many animals: humans, birds, swine, horses, dogs, cats, whales, seals
- Influenza A viruses are classified by HA and NA
- Combinations of H and N are called HxNy
- x = 1-16; y = 1-9
- H1-16 can infect aquatic birds; H1, H2, H3 infect humans


L
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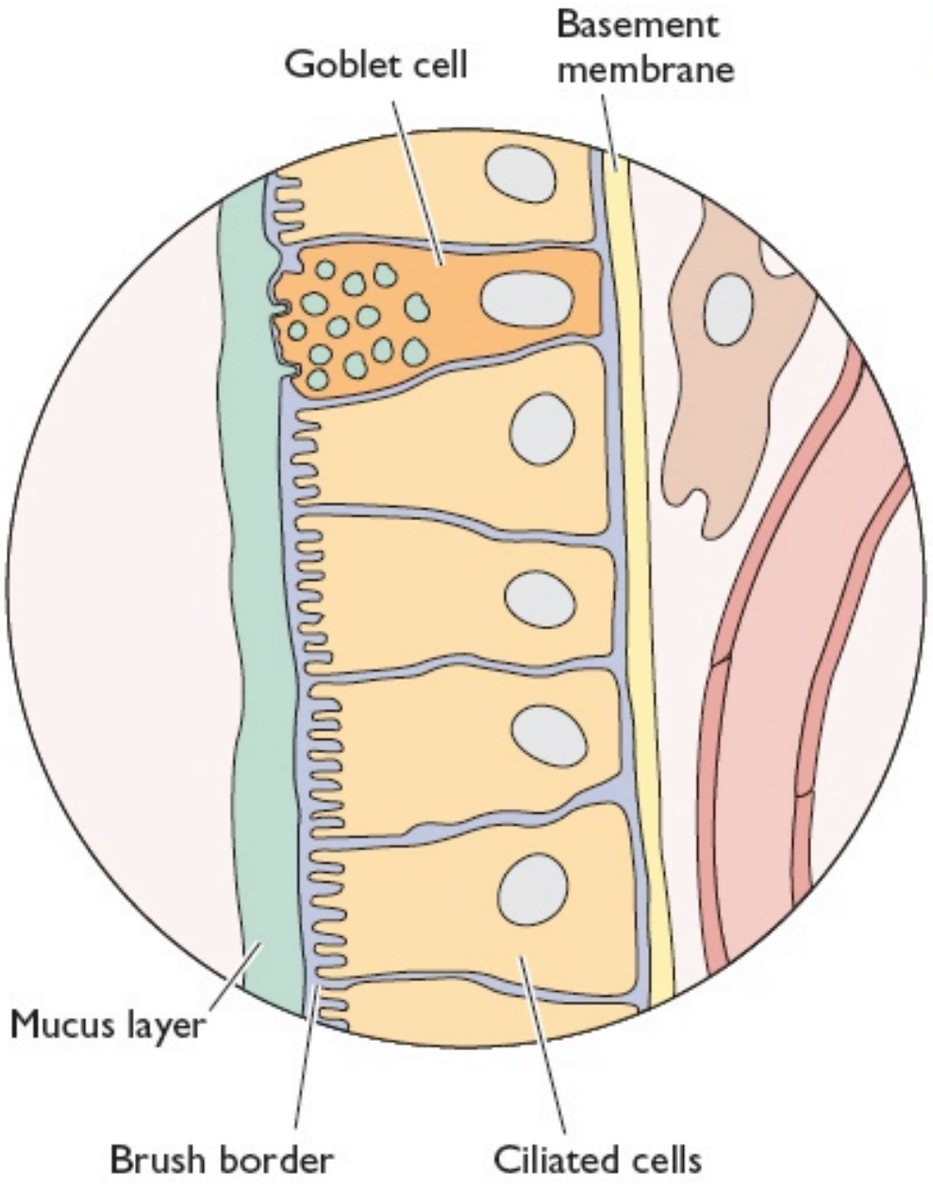
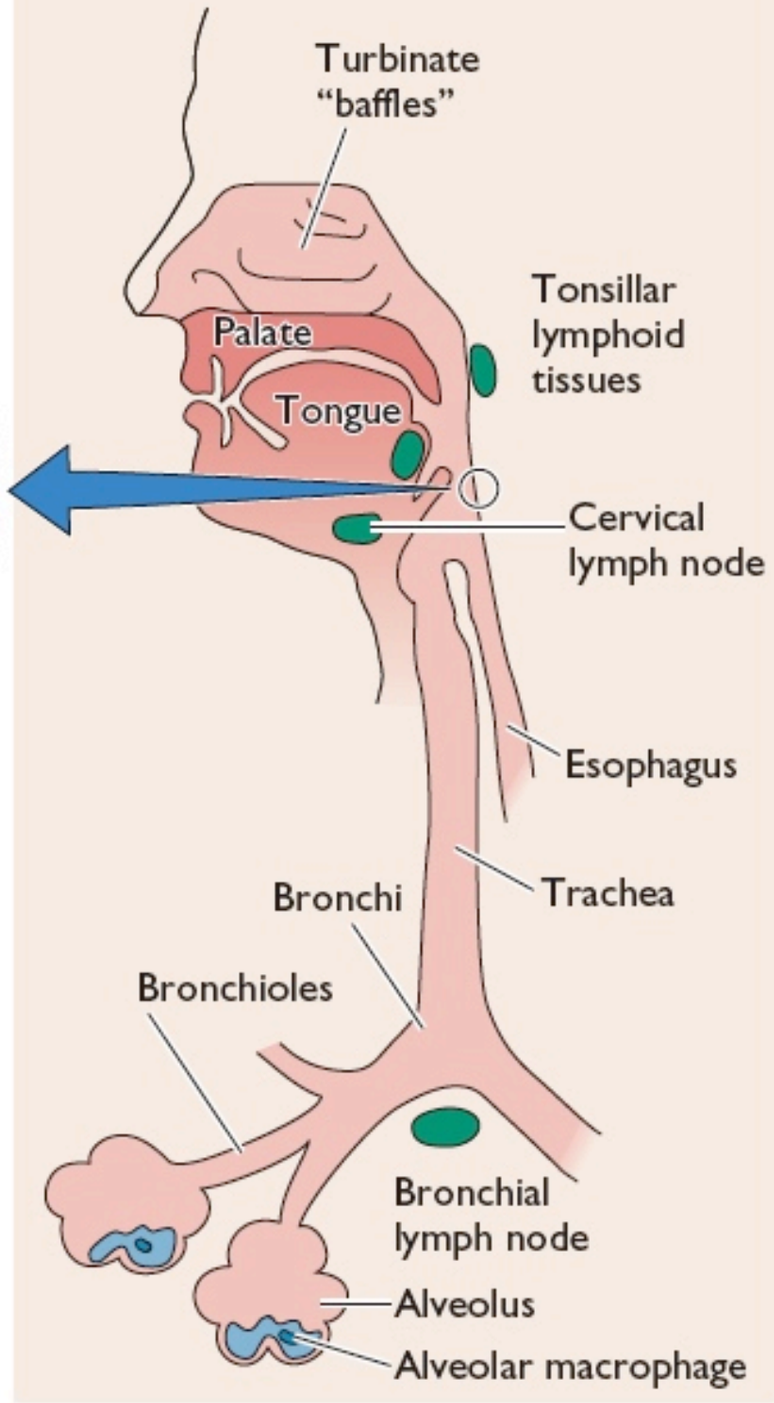


Site of replication	Clinical manifestation	Virus
	Rhinitis (common cold) Pharyngitis Laryngitis	Rhinovirus Coronavirus Parainfluenza virus Respiratory syncytial virus Influenza virus Adenovirus Herpes simplex virus Epstein-Barr virus
	Tracheitis Bronchitis Bronchiolitis Bronchopneumonia	Parainfluenza virus Respiratory syncytial virus Influenza virus Adenovirus