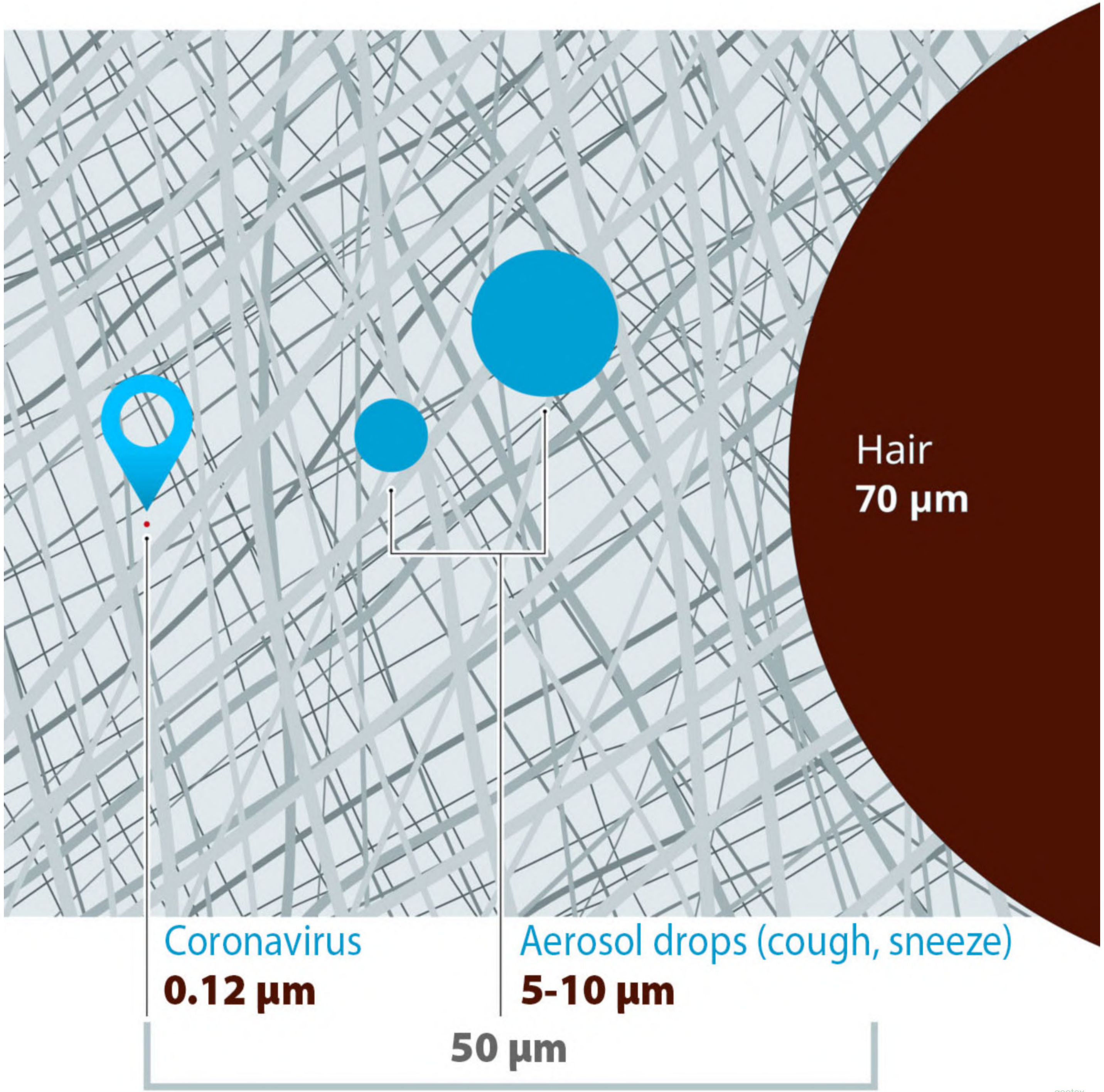
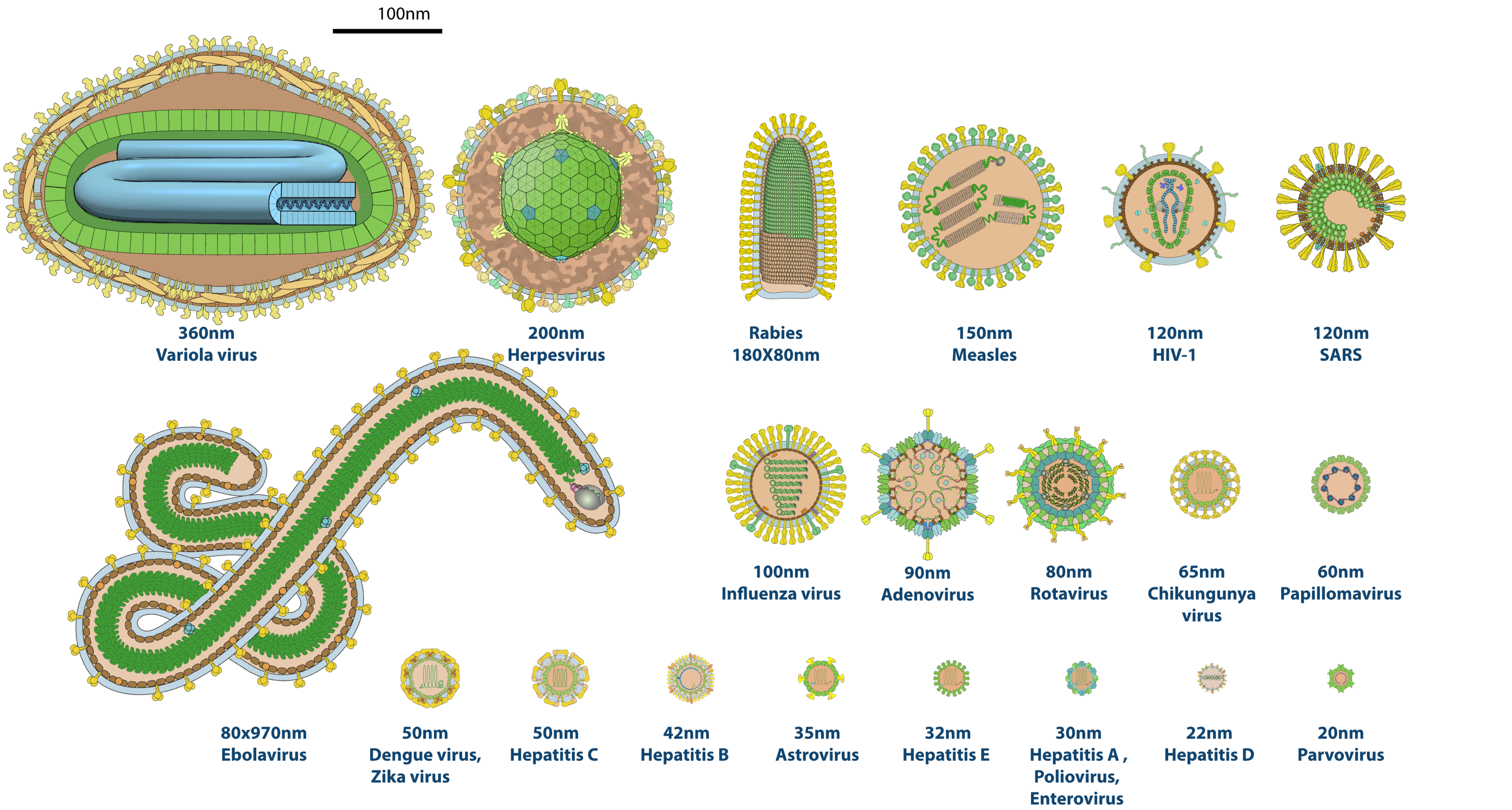
A2.3
Viruses

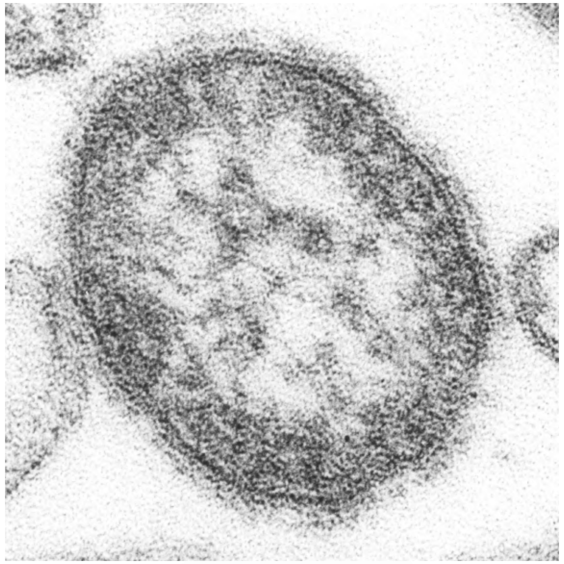
How can viruses exist with so few genes?

In what ways do viruses vary?

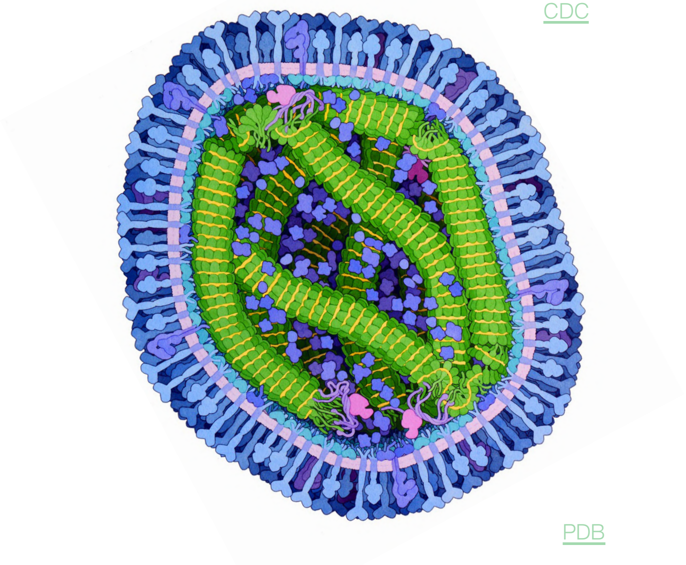

Hair
70 µm
Coronavirus
0.12 µm
Aerosol drops (cough, sneeze)
5-10 µm
50 µm



ViralZone 2024 provides higher-resolution images and advanced virus-specific resources Edouard De Castro, Chantal Hulo, Patrick Masson, Andrea Auchincloss, Alan Bridge, Philippe Le Mercier Nucleic Acids Res. 2024 Jan 5;52(D1):D817-D821.

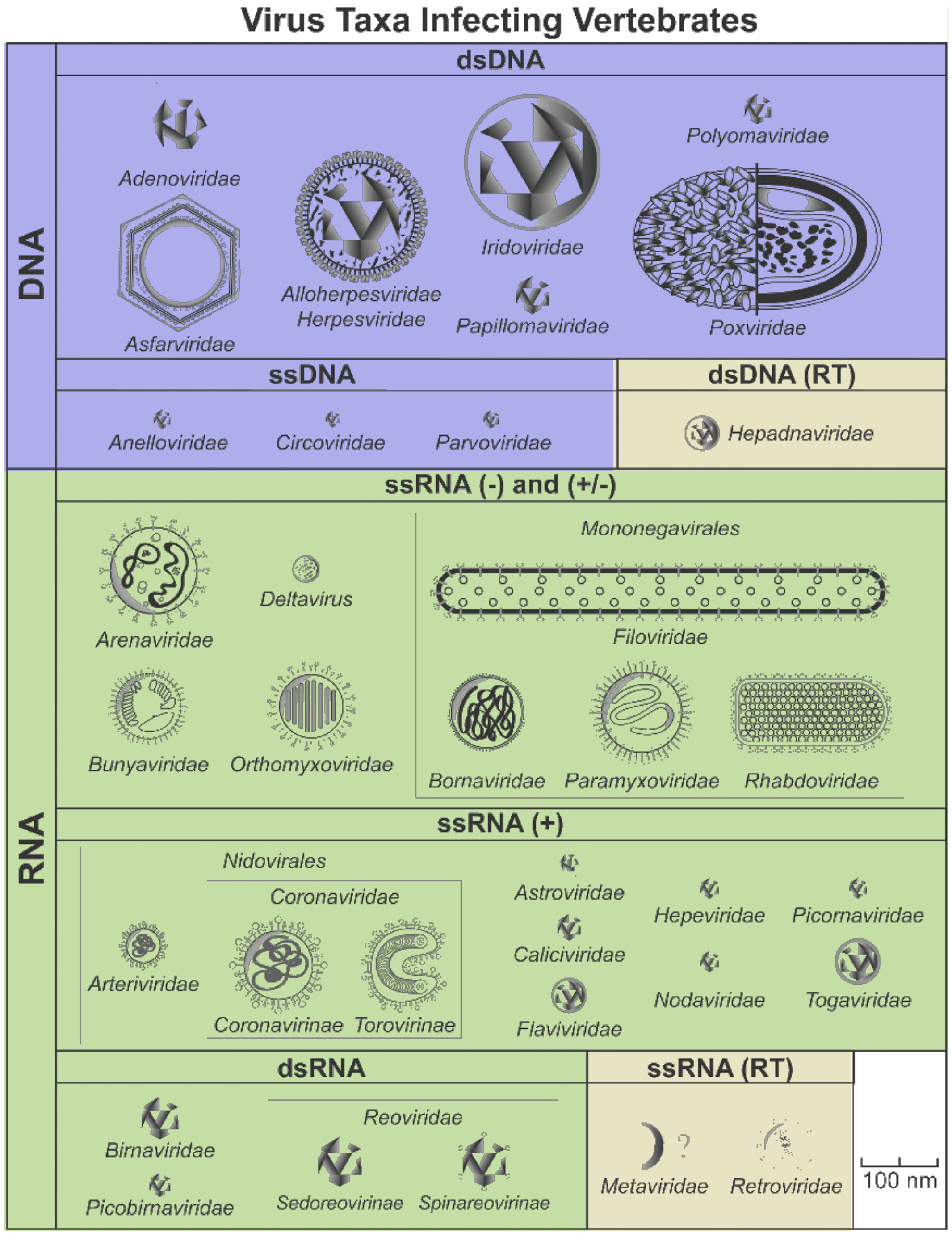


CDC



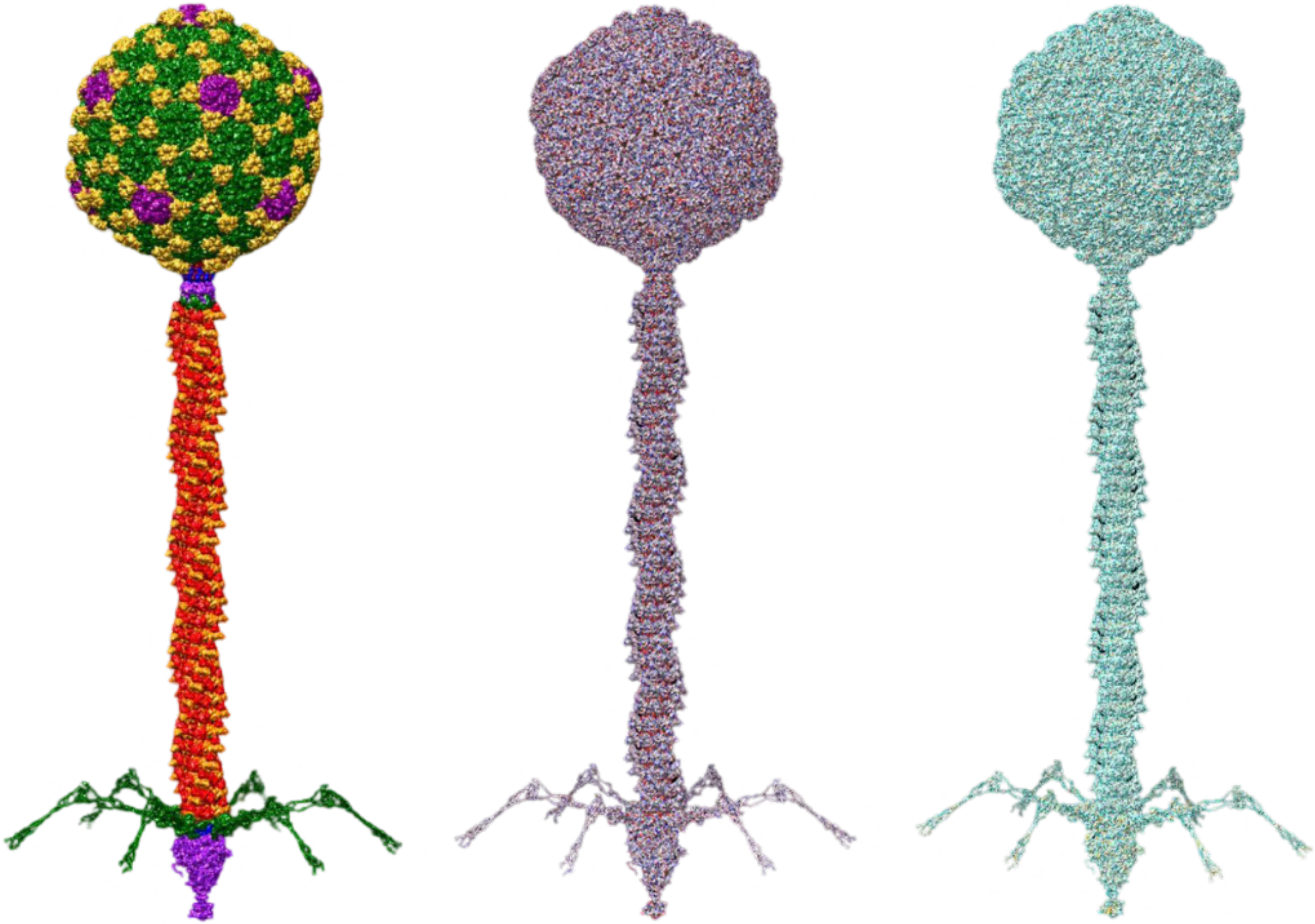
PDB

Measles virus *(Morbillivirus hominis),* is a single-stranded, negative-sense, enveloped, non-segmented RNA virus within the family of *Paramyxoviridae*.



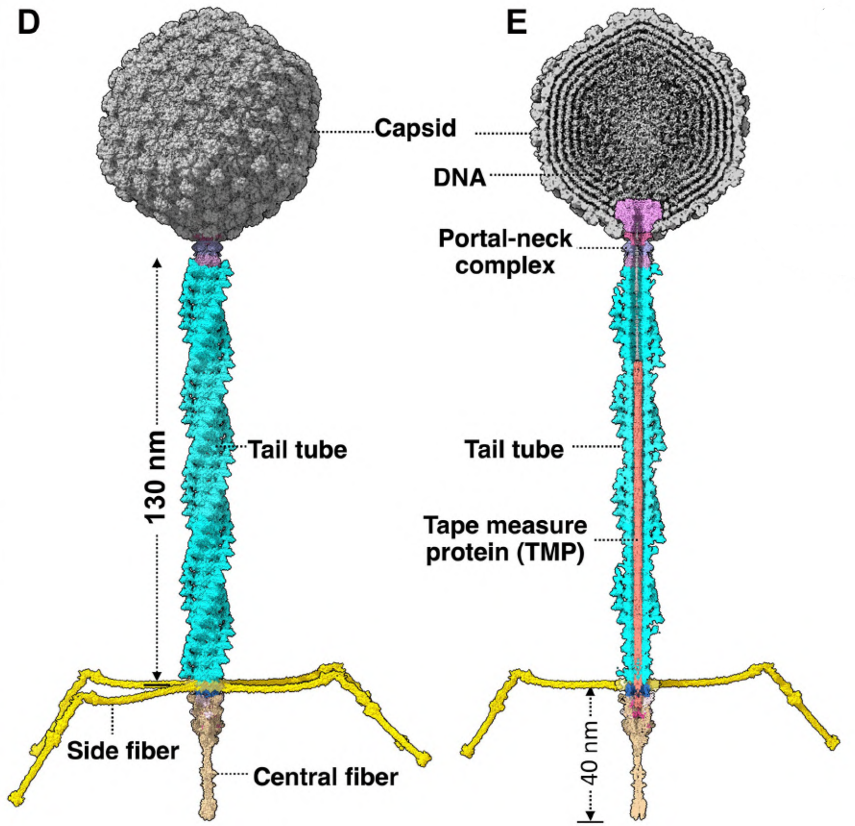
ICTV

bacteriophage lambda



Padilla-Sanchez 2026

bacteriophage lambda

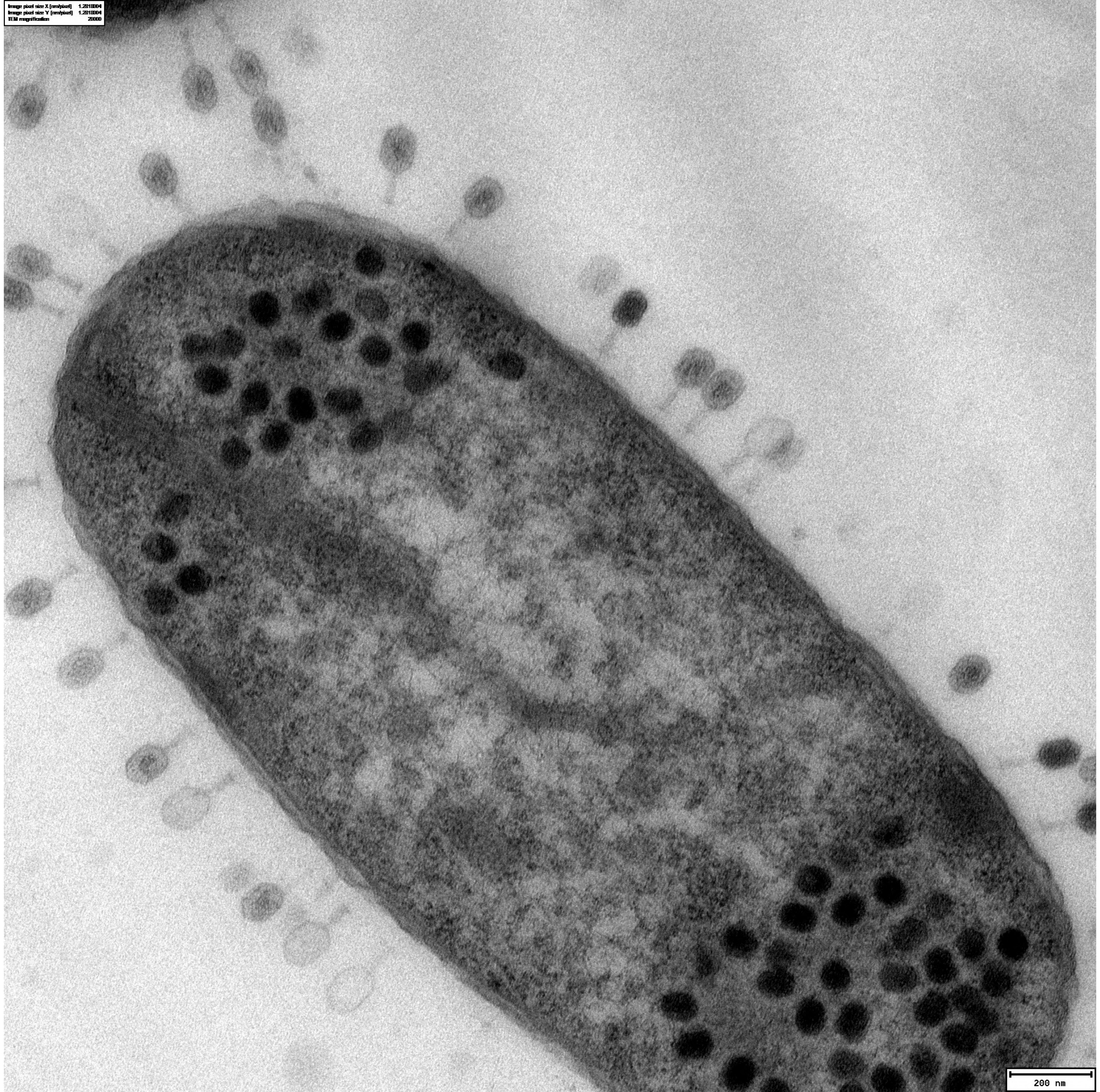


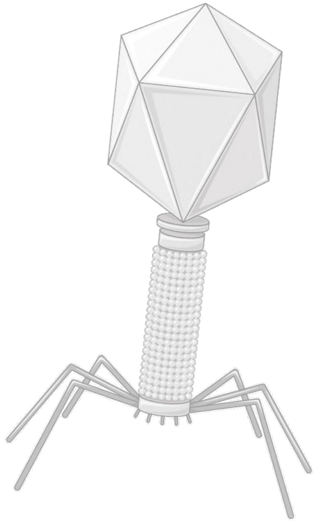
Structural basis of bacteriophage Ur-lambda infection initiation.Sci. Adv.11,eadw7914(2025).DOI:10.1126/sciadv.adw7914CC BY-NC

Some bacteriophages have contractile tails.

animation

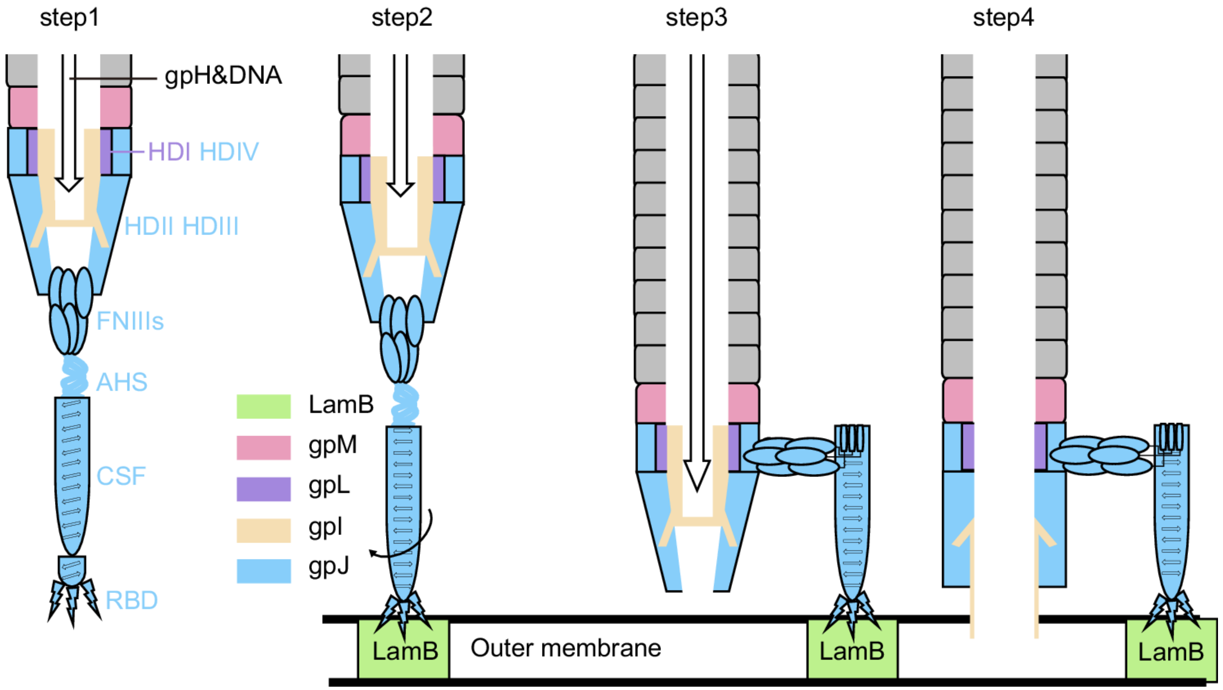
Lambda does not have a contractile tail.





sci_bastian

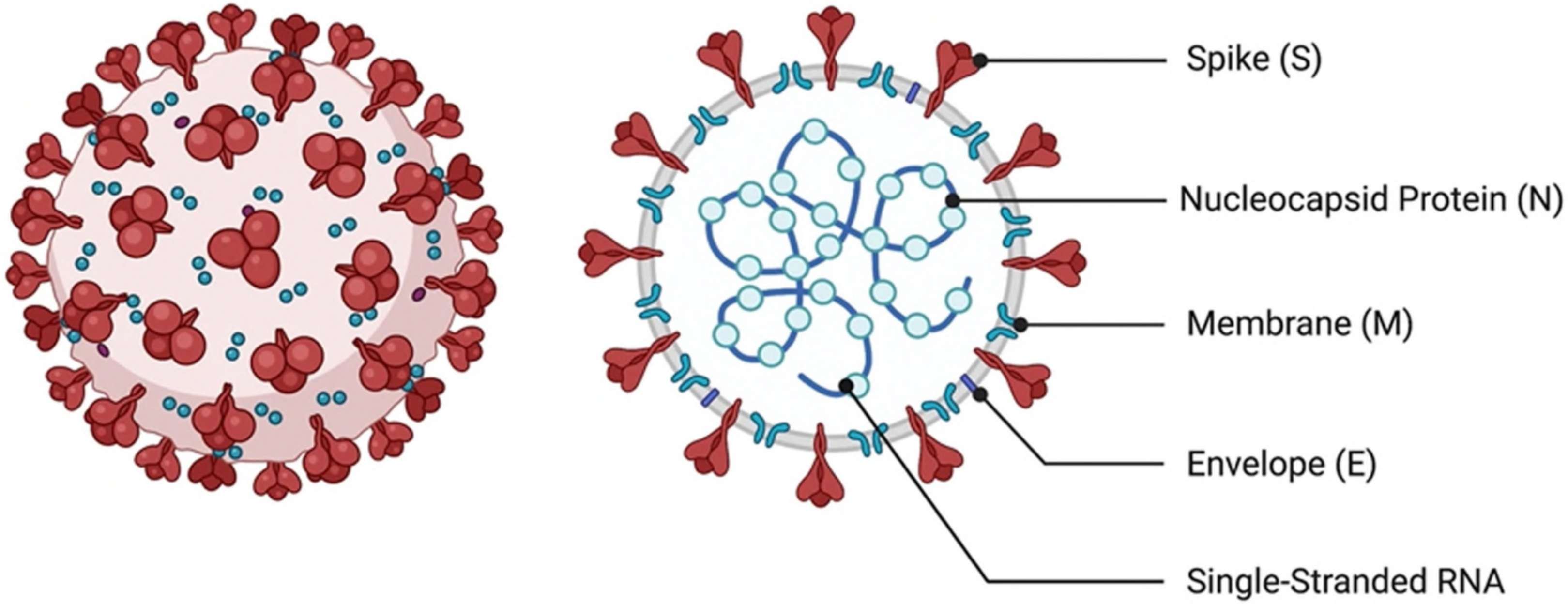
Extra detail - Tail Tube attachment of Lambda phage



Ge, X., Wang, J. Structural mechanism of bacteriophage lambda tail's interaction with the bacterial receptor. Nat Commun 15, 4185 (2024). https://doi.org/10.1038/s41467-024-48686-3

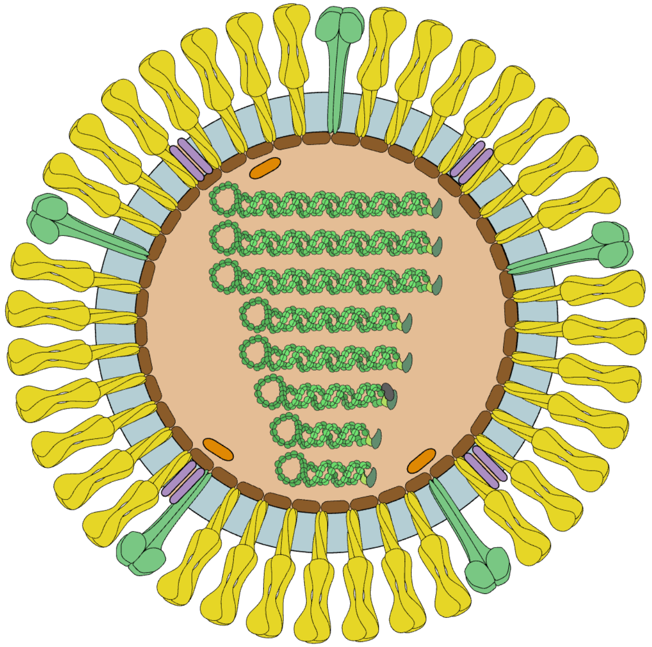
The LamB gene makes the maltoporin protein which acts as a receptor for the Lambda phage tail.

SARS CoV 2 Virus

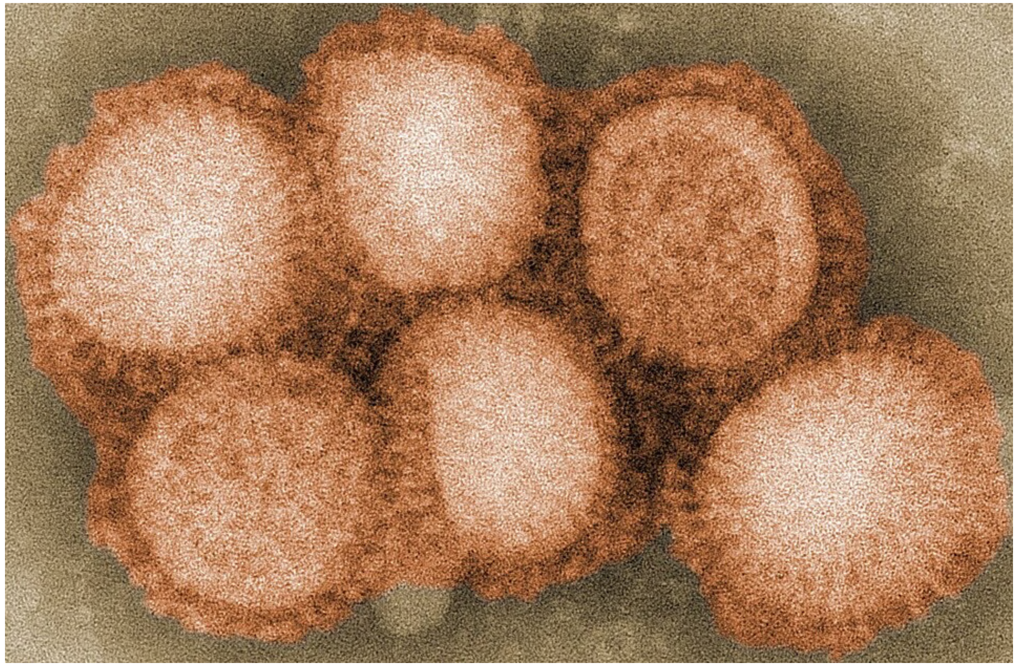


Jamison et al 2022

Influenza Virus

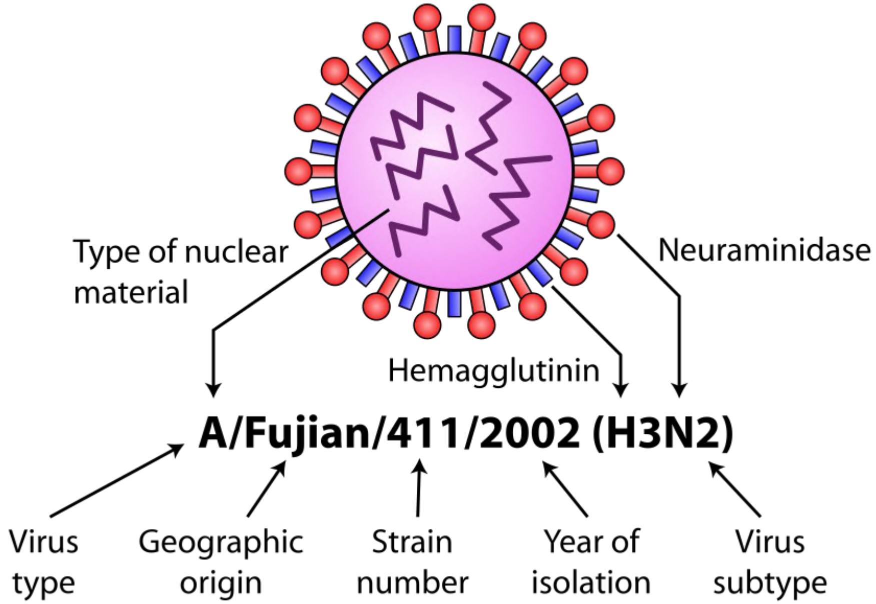


Viralzone



Wikimedia

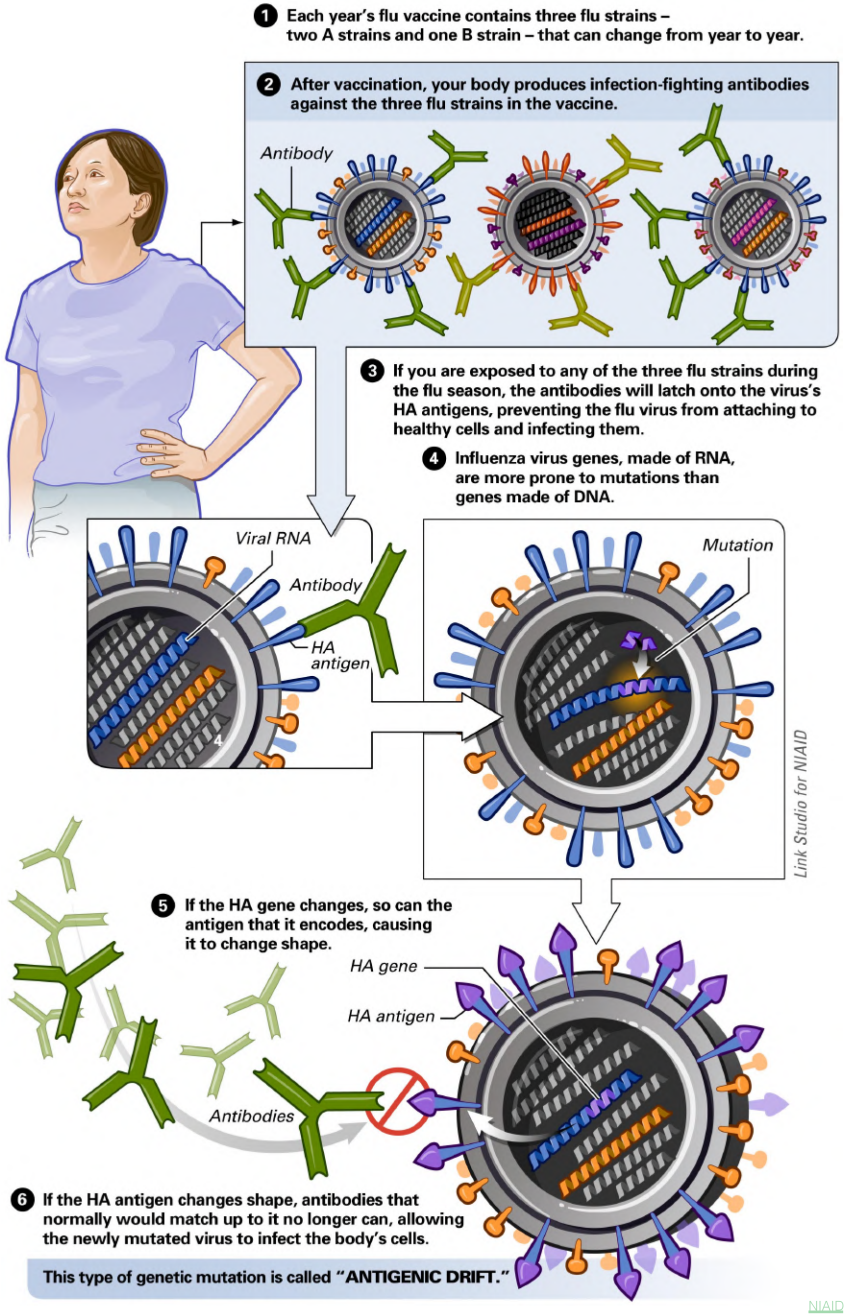
I had a little bird,
its name was Enza.
I opened the window,
and in-flu-enza.



Wikimedia

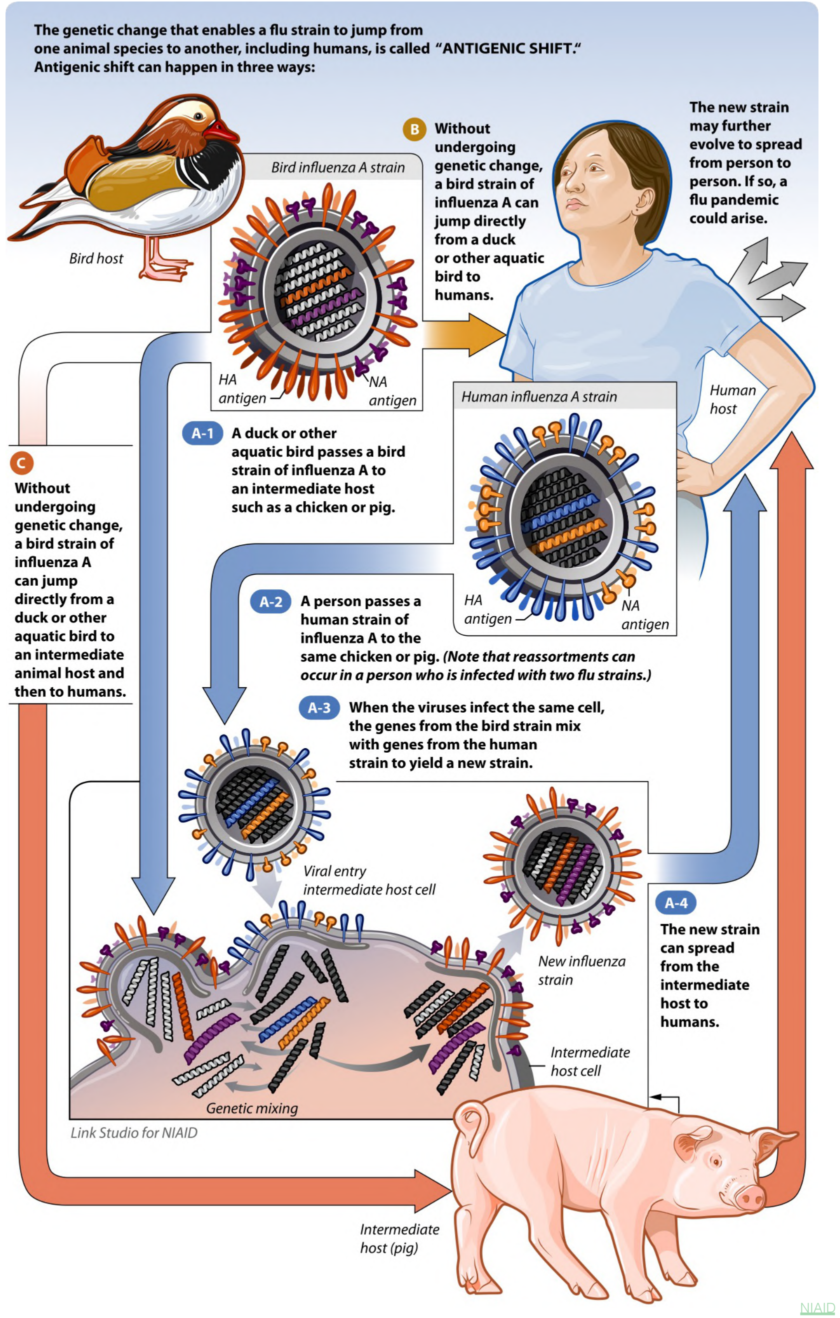
Influenza Virus

antigenic drift



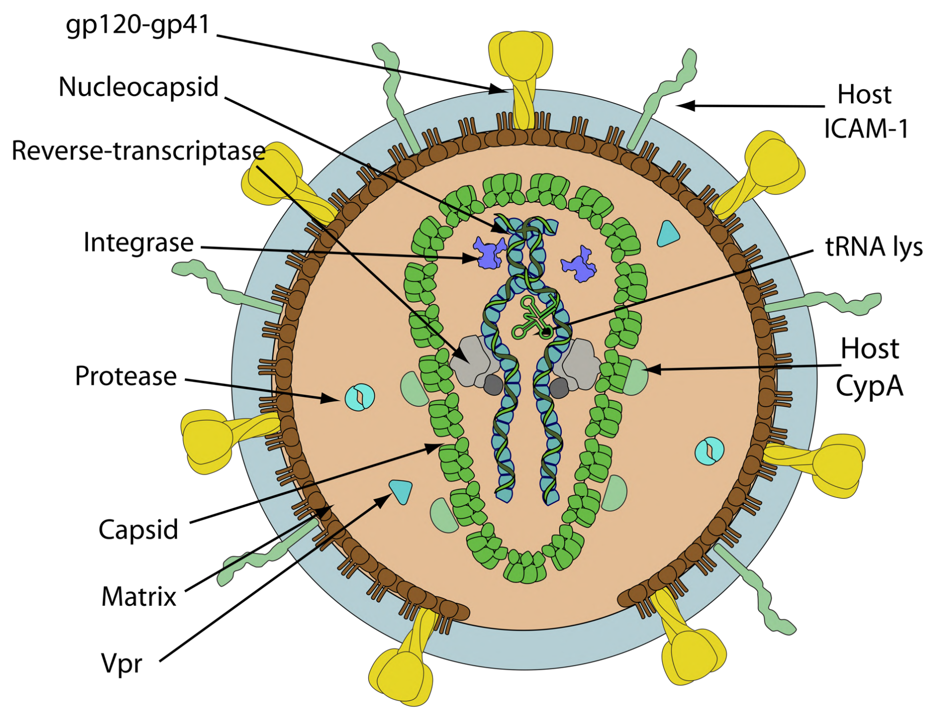
NIAID

antigenic shift



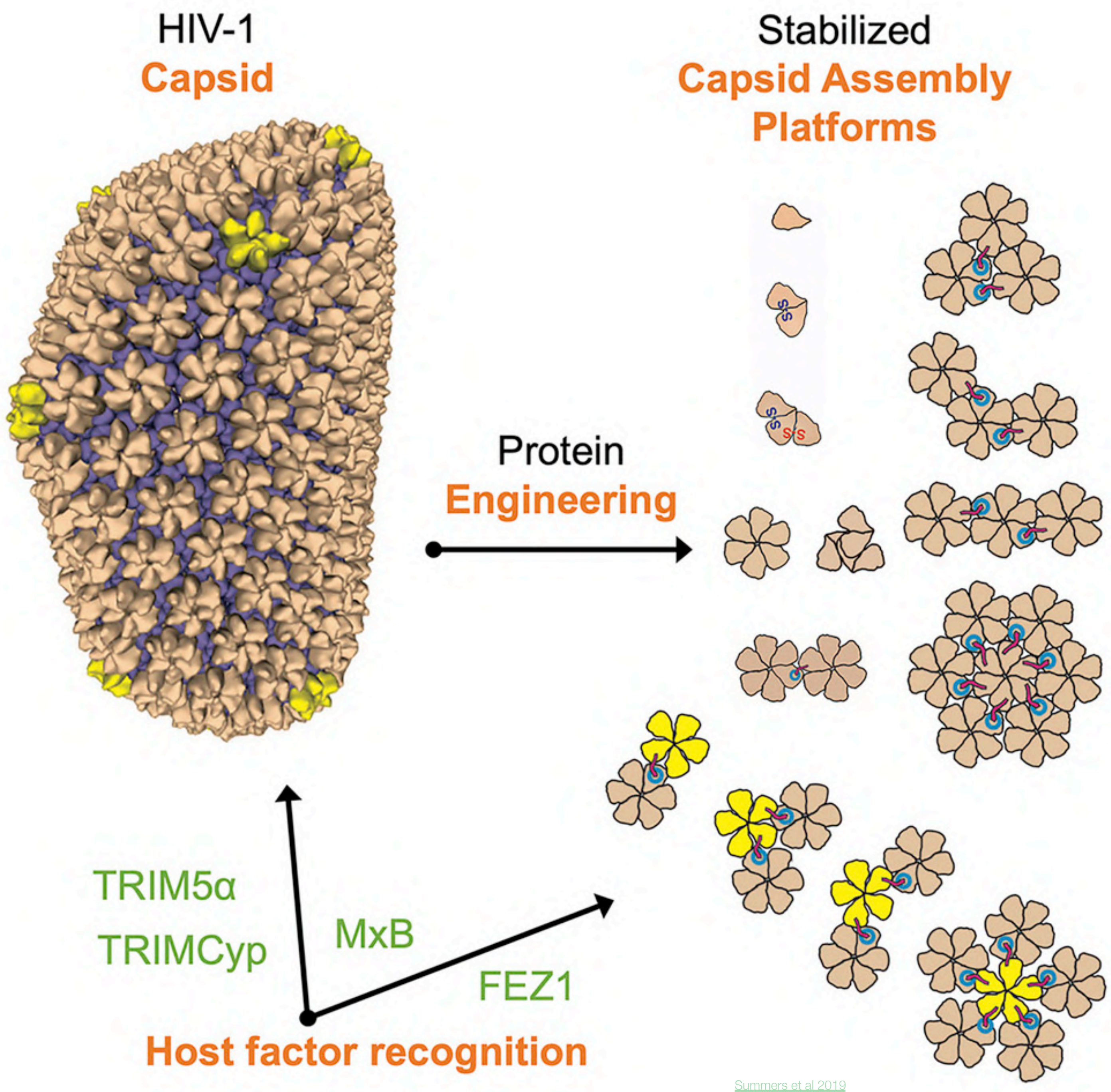
NIAID

HIV Structure



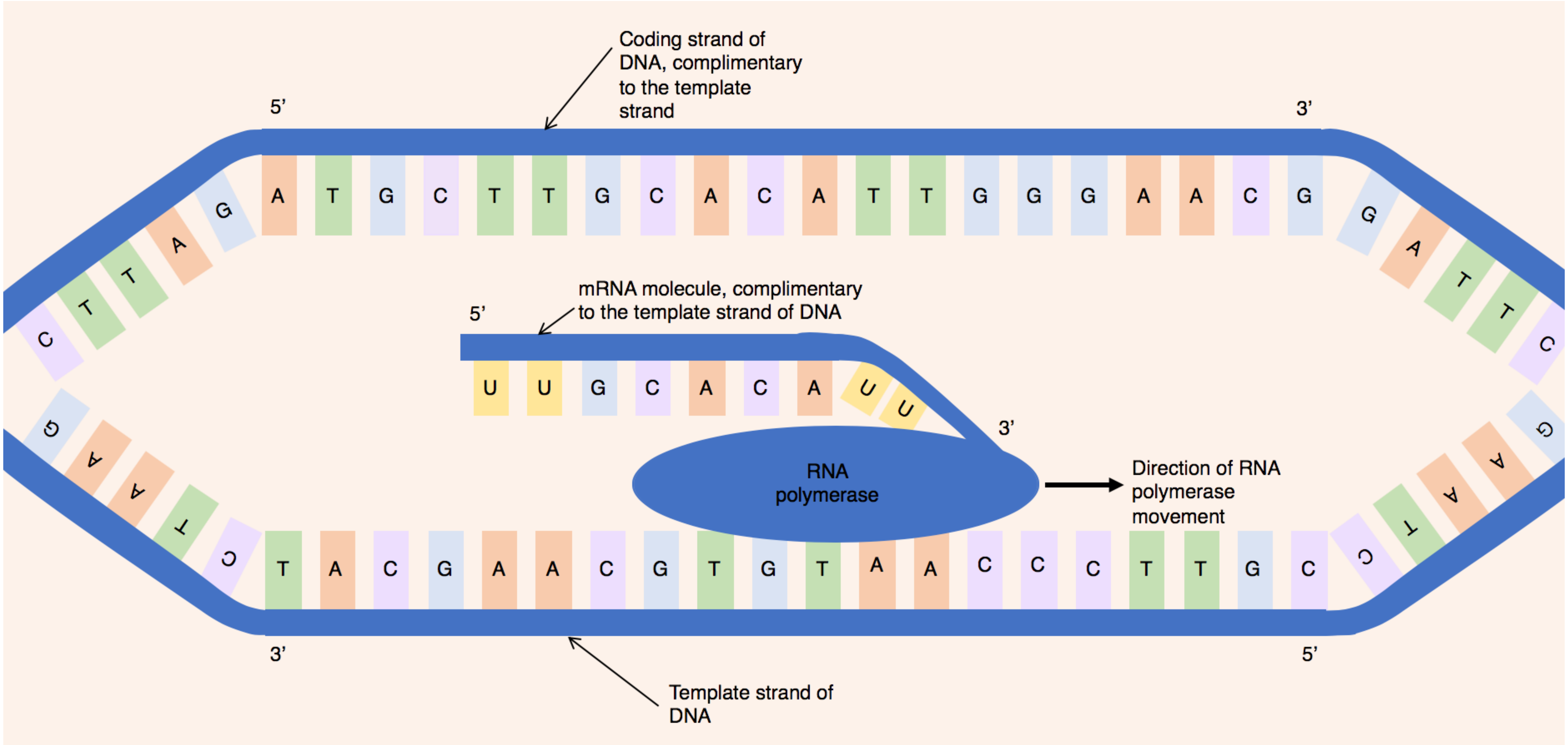
MATURE

Viralzone SIB Swiss Institute of Bioinformatics



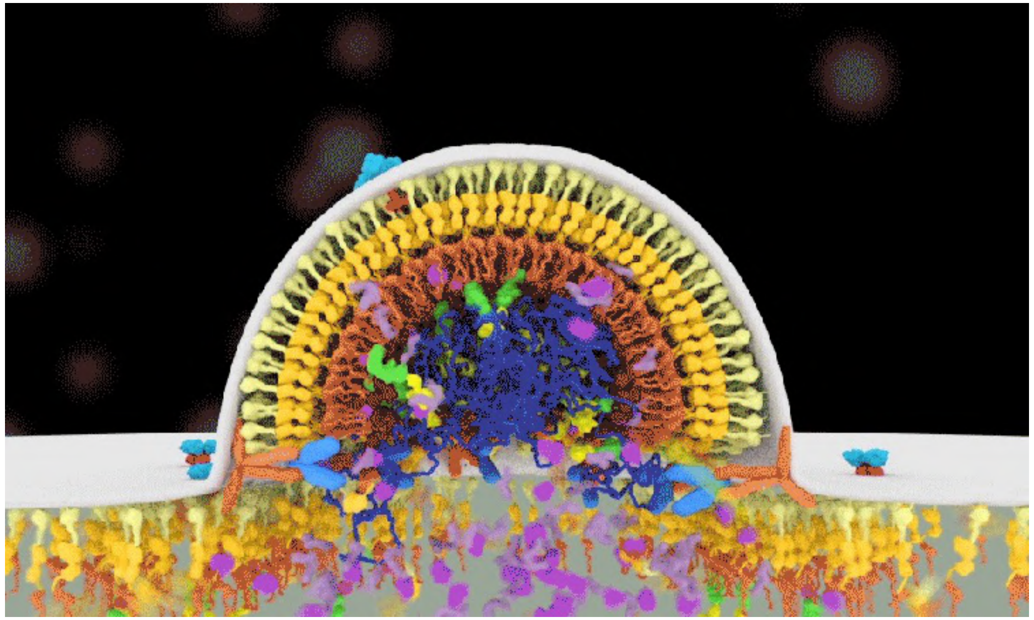
Summers et al 2019

Transcription DNA to mRNA

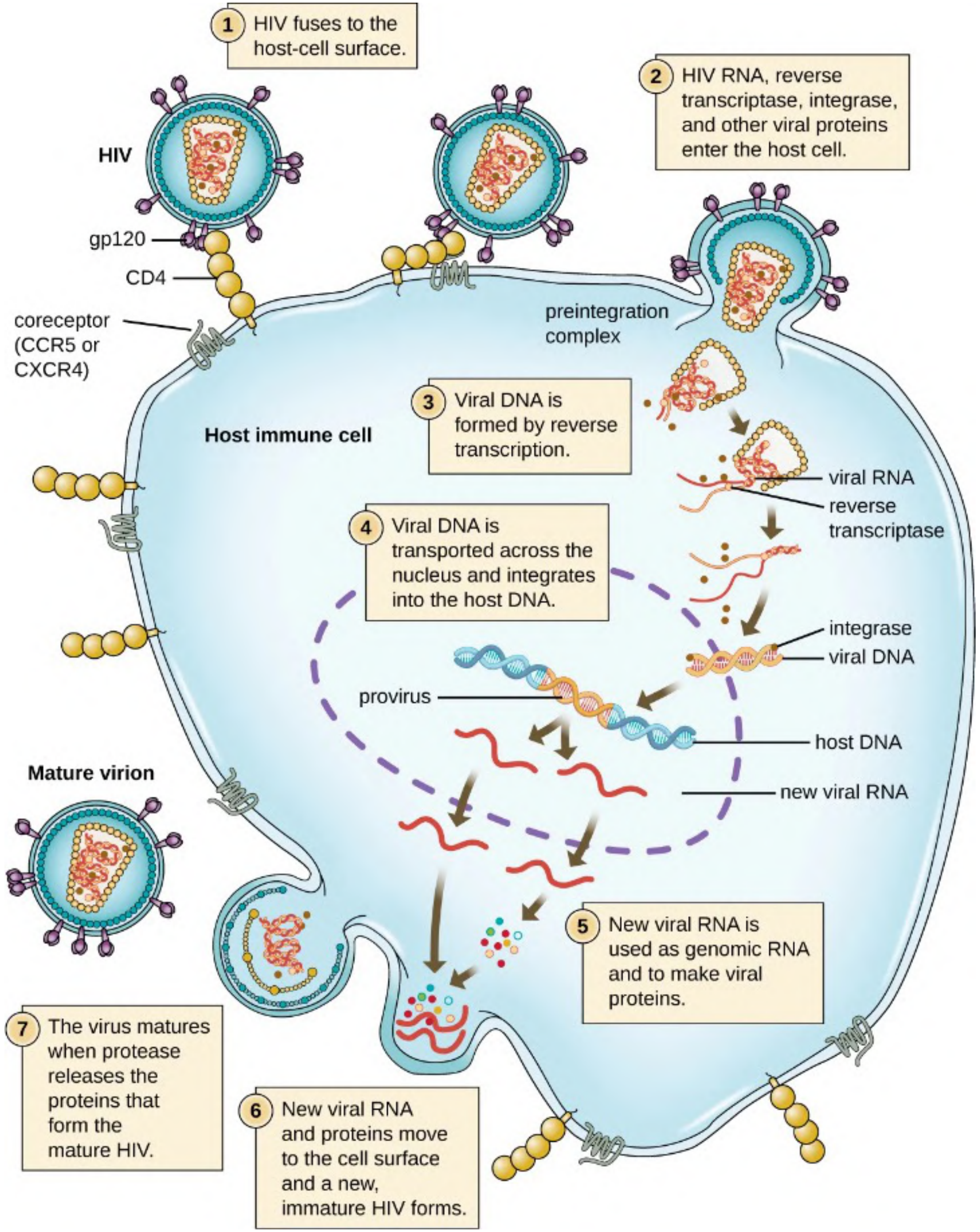


HIV Lifecycle

Budding of HIV

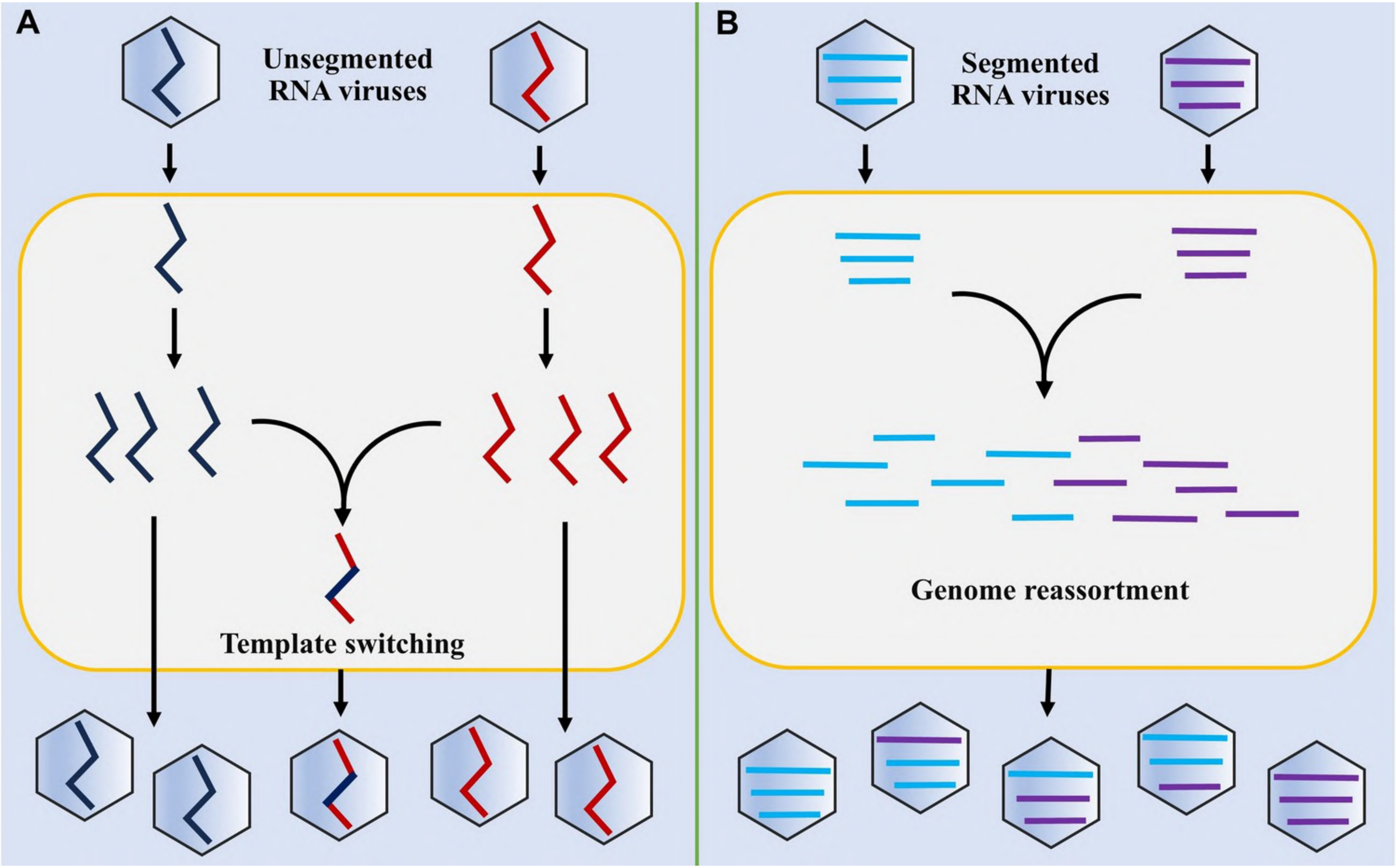


Animated and narrated by Janet Iwasa (Department of Biochemistry, University of Utah)



NIH

Rapid Evolution in Viruses



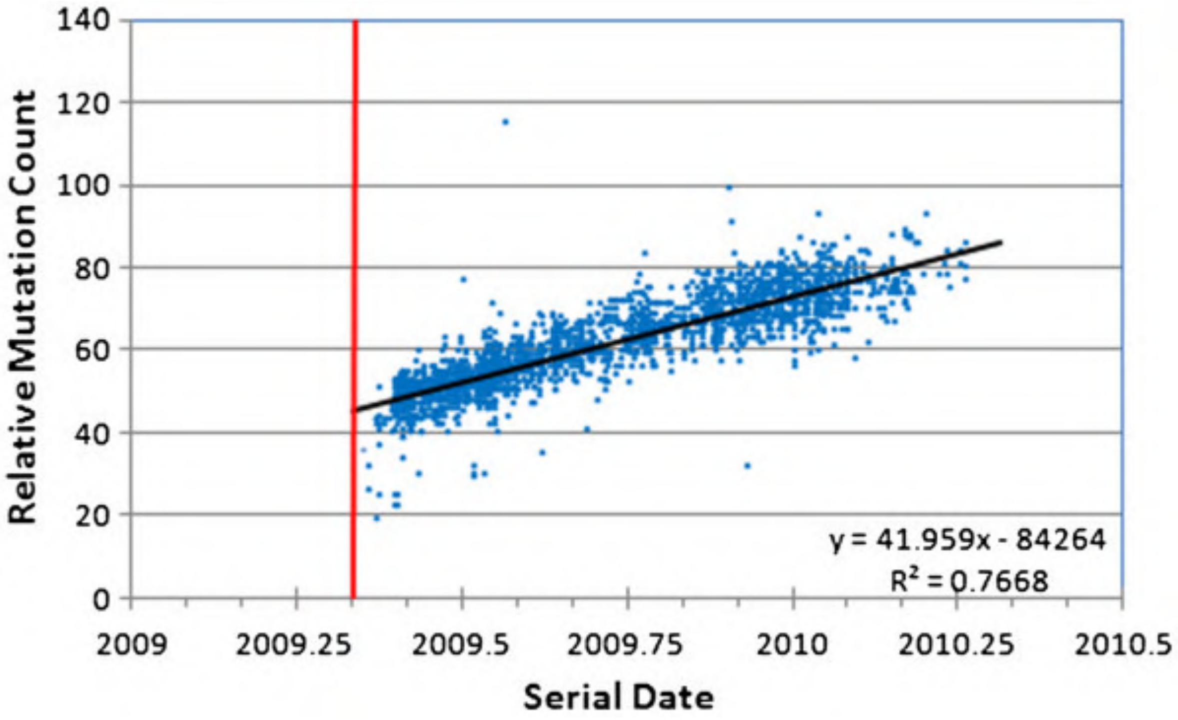
Abbasi and Alam 2025

Two viral strains of HIV in the same cell can undergo recombination of genes.

Two viral strains of influenza in the same cell can undergo reassortment of genes.

Rapid Evolution in Viruses

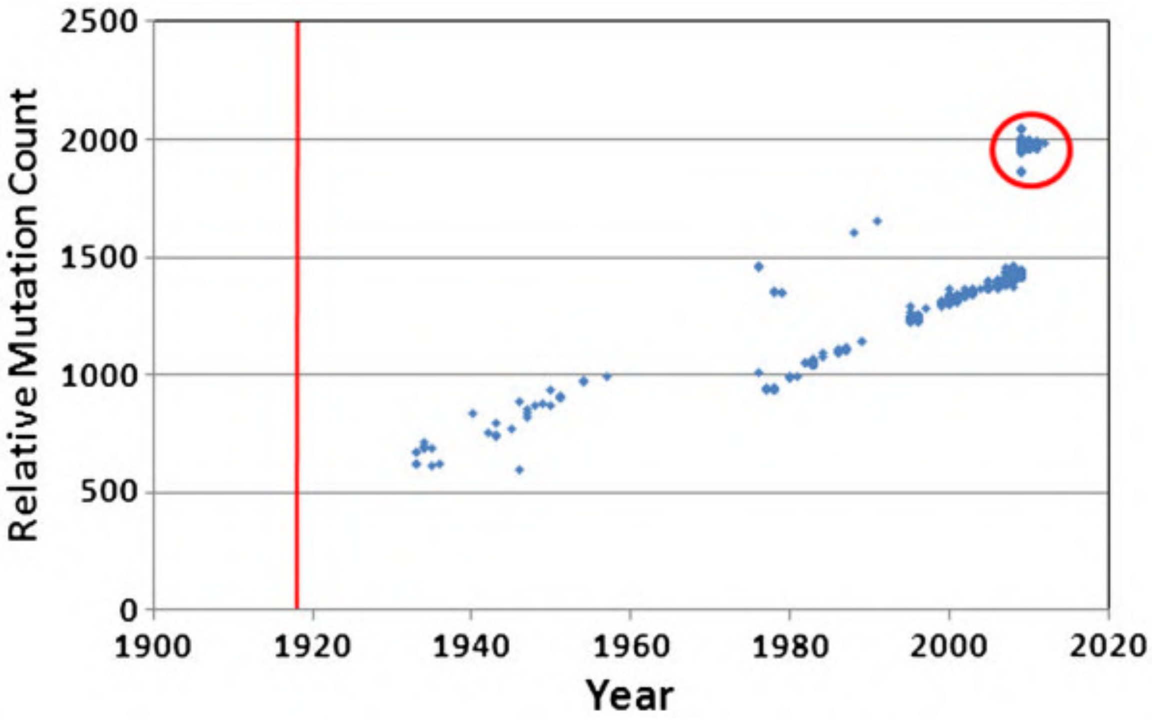
Mutation accumulation within the 2009 A/H1N1 influenza strain during the course of the 2009/2010 flu season.



The earliest sequenced genotype (California/04/2009) was used as the baseline for comparison with all subsequent genotypes (mutation counts reflect divergence from that starting sequence).
The vertical red line indicates the date the reference sequence was collected.

Carter and Sanford 2012

Mutation accumulation in H1N1 in deeper time.



The published Brevig Mission strain from 1918 was used as the baseline for comparison with all available human H1N1 genomes.
The 2009–2010 outbreak samples and additional samples from 2011–2012 are circled.

Carter and Sanford 2012

The mutations in viruses are an example of microevolution.
High error rates in viruses can override natural selection and cause a virus to go extinct.

The influenza A pandemic of 1918-20 after WW1 was the H1N1 subtype. It killed 2% of infected humans resulting in 50 million deaths.
The human form of H1N1 went extinct in 1957 then after possibly an accidential release of stored samples in 1977 it again went extinct in 2009.

Optional extension: (not required for the IB exam)

Viruses have many beneficial ecological functions:

- control microbial population size
- increase or decrease microbe species diversity
- help maintain gut health
- facilitate horizontal gene transfer which increases phenotypic variation and adaptability
- increase dissolved organic matter by bursting cells to recycle nutrients
- are eaten by protists and sponges

Many medical uses of viruses await discovery including:

- phage therapy to kill specific bacteria or
- use of oncolytic viruses that kill specific cancerous cells
- gene delivery of healthy DNA to specific cells

Agricultural uses of viruses await discovery including:

- innoculating crops with mild strains or heat killed viruses can trigger defense responses that improve drought tolerance, freezing, pest resistance and protect from harmful viral strains

James St John

A variety of *Dichanthelium lanuginosum var. thermale*, grows in geothermal areas of Yellowstone National Park, United States. When it is colonised by the fungus *Curvularia protuberata* and the fungus is in turn colonised by a particular virus, the grass is able to tolerate soil temperatures of up to 65 °C that would otherwise be lethal.