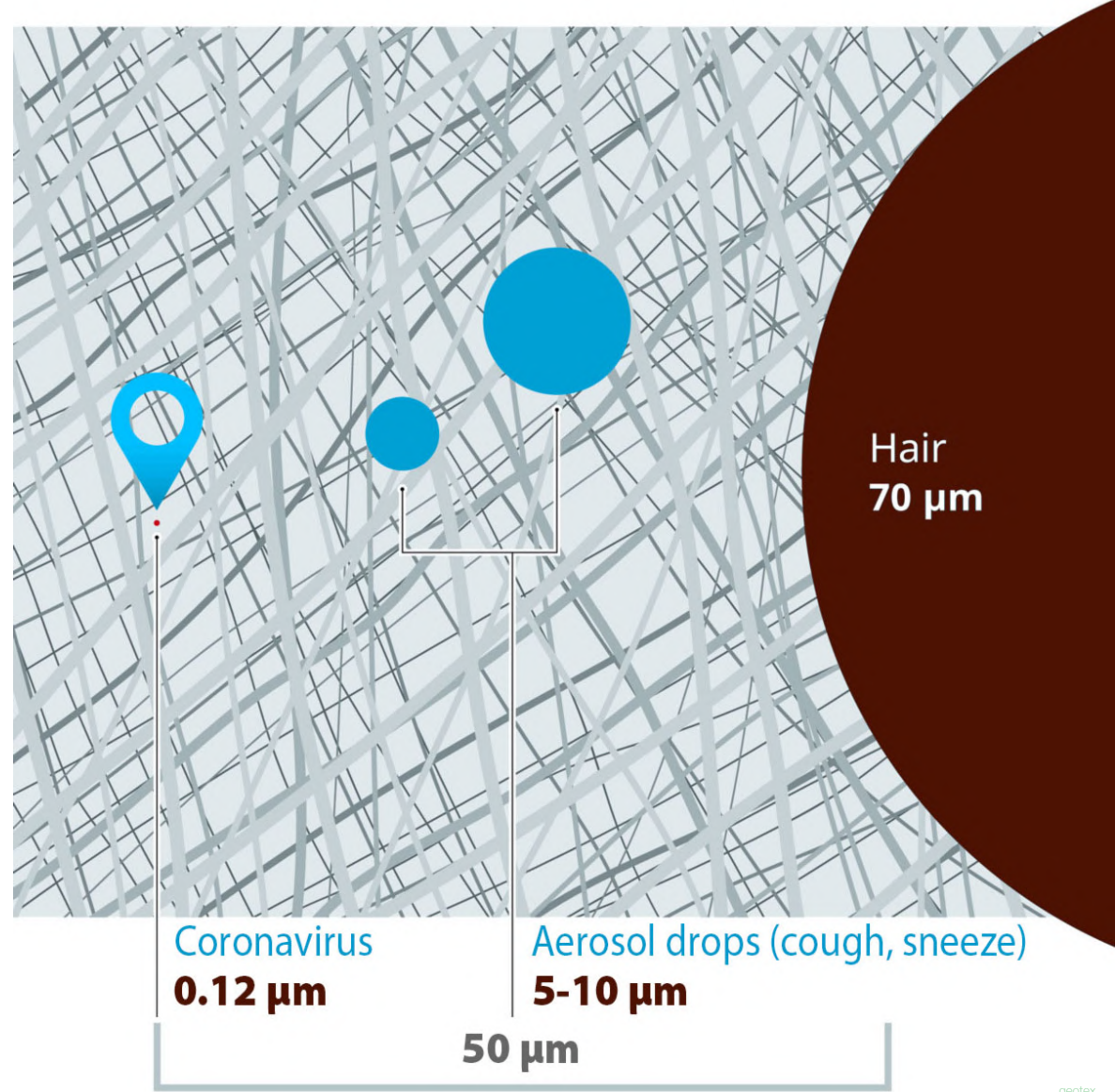


A2.3

Viruses

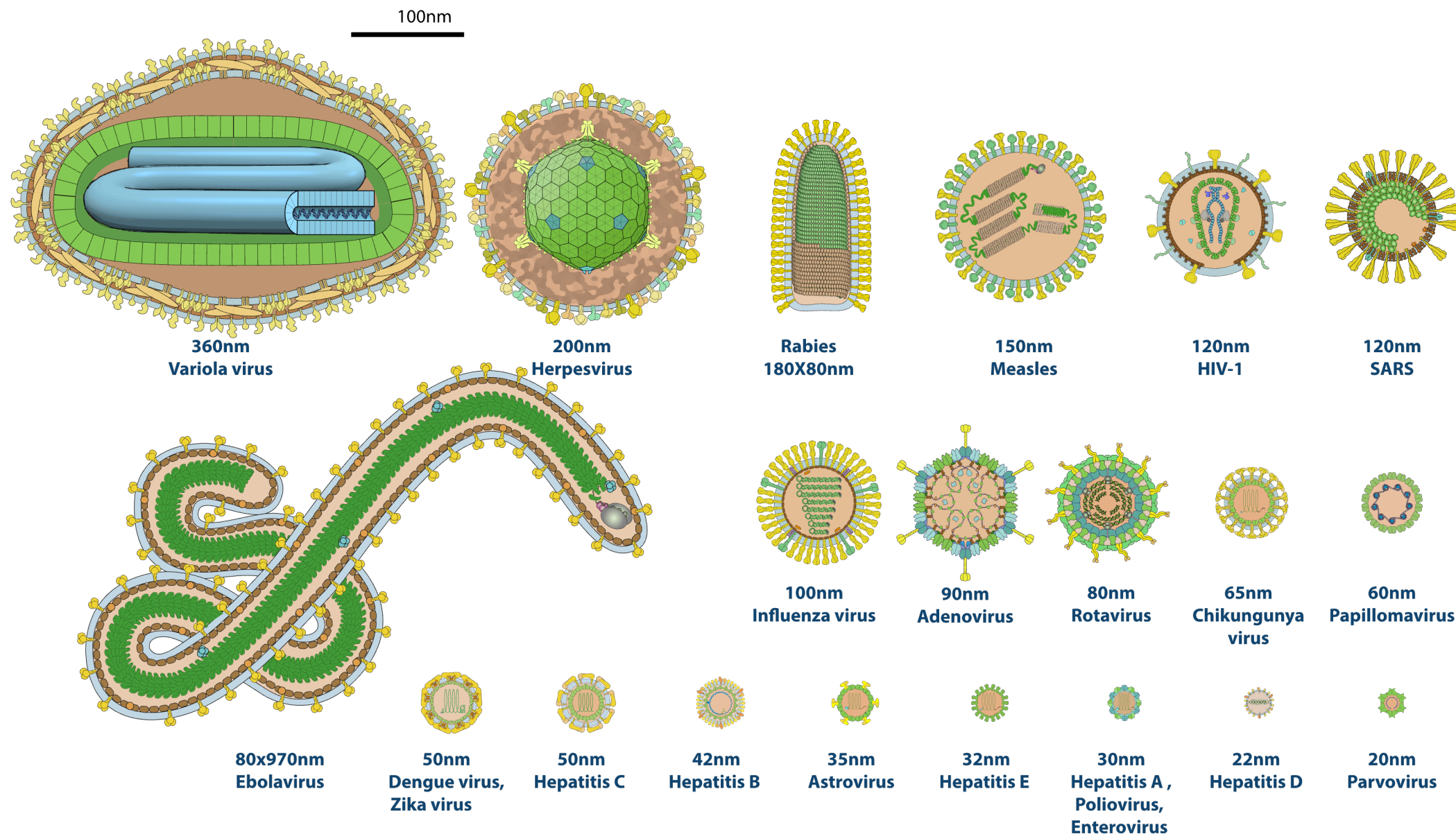
How can viruses exist with so few genes?
In what ways do viruses vary?

Structural Features Common to Viruses



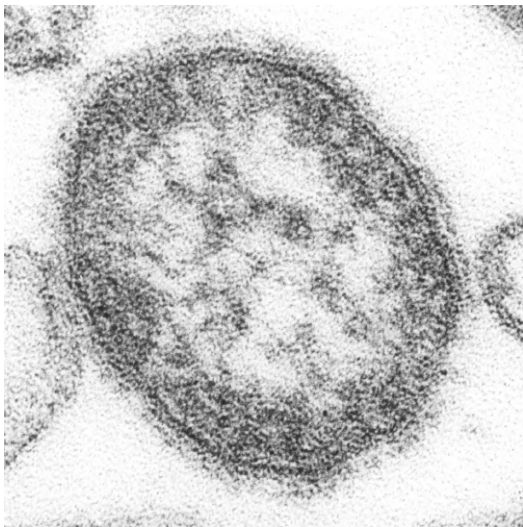
geotax

Structural Features Common to Viruses / Diversity of Structure in Viruses

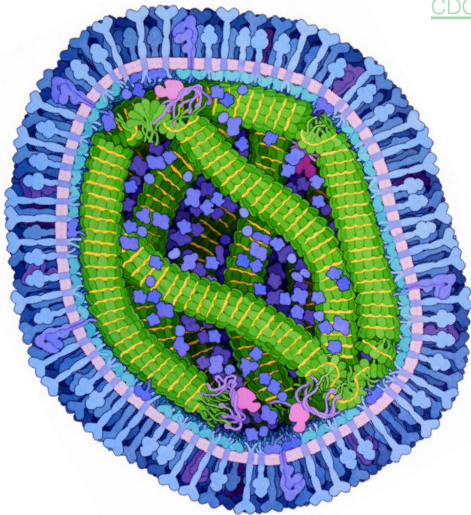


[ViralZone 2024](#) provides higher-resolution images and advanced virus-specific resources Edouard De Castro, Chantal Hulo, Patrick Masson, Andrea Auchincloss, Alan Bridge, Philippe Le Mercier Nucleic Acids Res. 2024 Jan 5;52(D1):D817-D821.

Diversity of Structure in Viruses



CDC



PDB

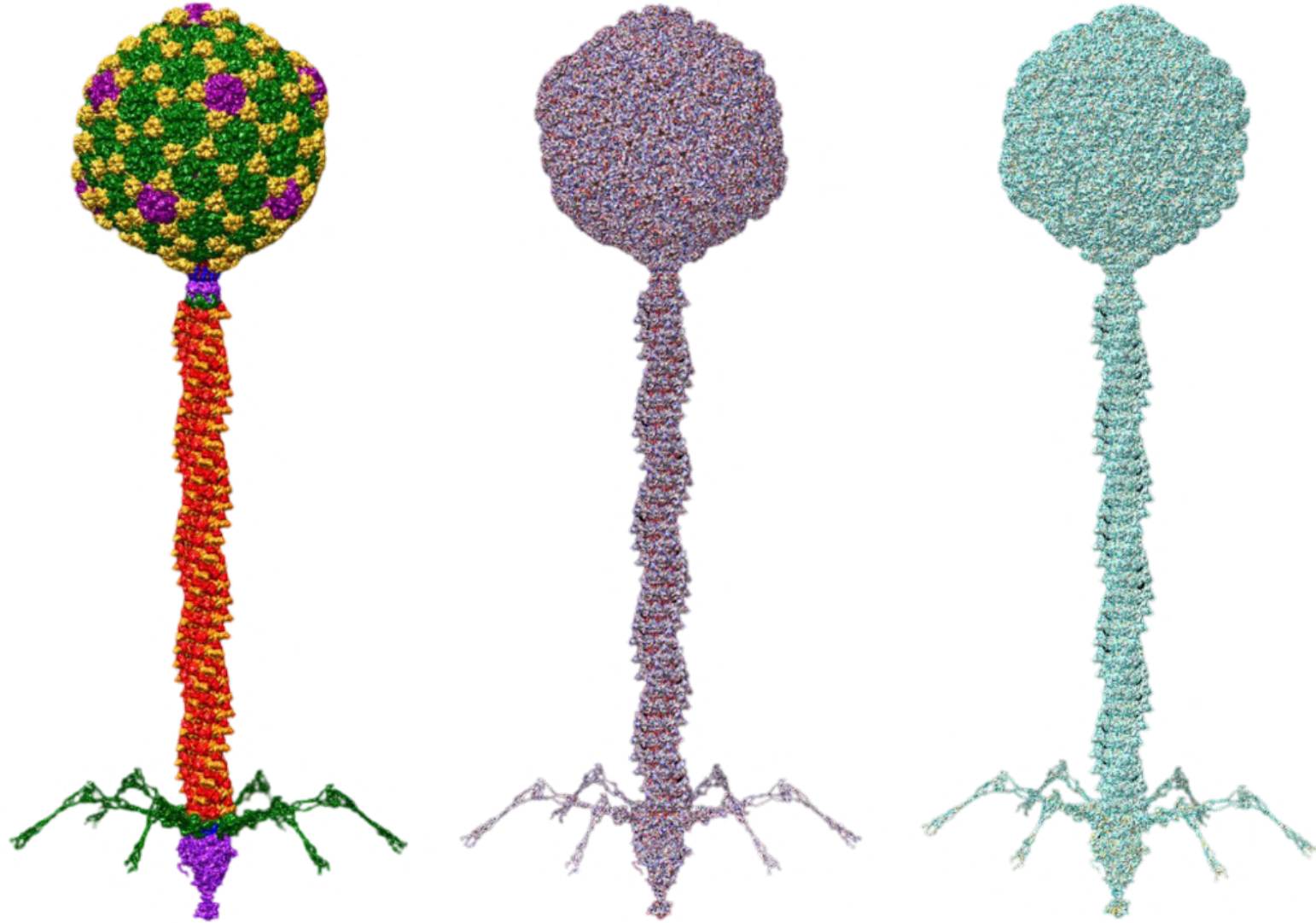
Measles virus (*Morbillivirus hominis*), is a single-stranded, negative-sense, enveloped, non-segmented RNA virus within the family of *Paramyxoviridae*.

Virus Taxa Infecting Vertebrates

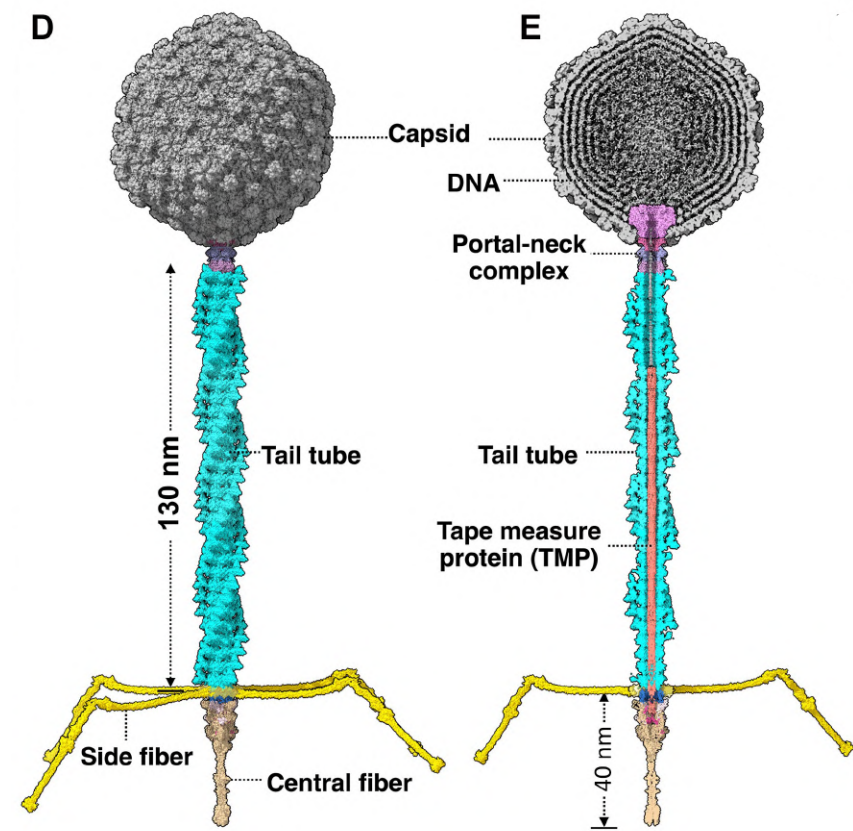
DNA	dsDNA			
	 Adenoviridae	 Alloherpesviridae Herpesviridae	 Iridoviridae	 Polyomaviridae Papillomaviridae
	 Asfarviridae	 Poxviridae		
RNA	ssDNA			dsDNA (RT)
	 Anelloviridae	 Circoviridae	 Parvoviridae	 Hepadnaviridae
	ssRNA (-) and (+/-)			
RNA	 Arenaviridae Deltavirus		 Mononegavirales Filoviridae	
	 Bunyaviridae	 Orthomyxoviridae	 Bornaviridae	 Paramyxoviridae Rhabdoviridae
	ssRNA (+)			
RNA	 Nidovirales Coronaviridae Arteriviridae		 Astroviridae Hepeviridae Picornaviridae Caliciviridae Nodaviridae Togaviridae	
	 Coronavirinae Torovirinae		 Flaviviridae	
	dsRNA			ssRNA (RT)
RNA	 Bimaviridae	 Reoviridae		 Metaviridae
	 Picobimaviridae	 Sedoreovirinae	 Spinareovirinae	 Retroviridae
				 Metaviridae Retroviridae

100 nm

Bacteriophage lambda



Bacteriophage lambda



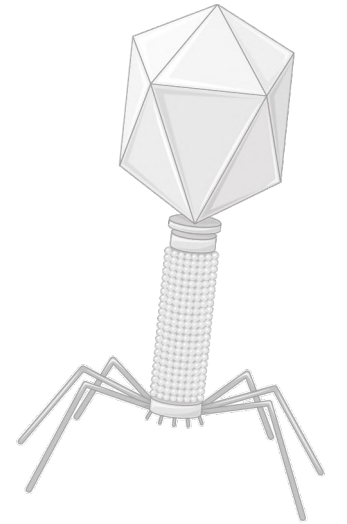
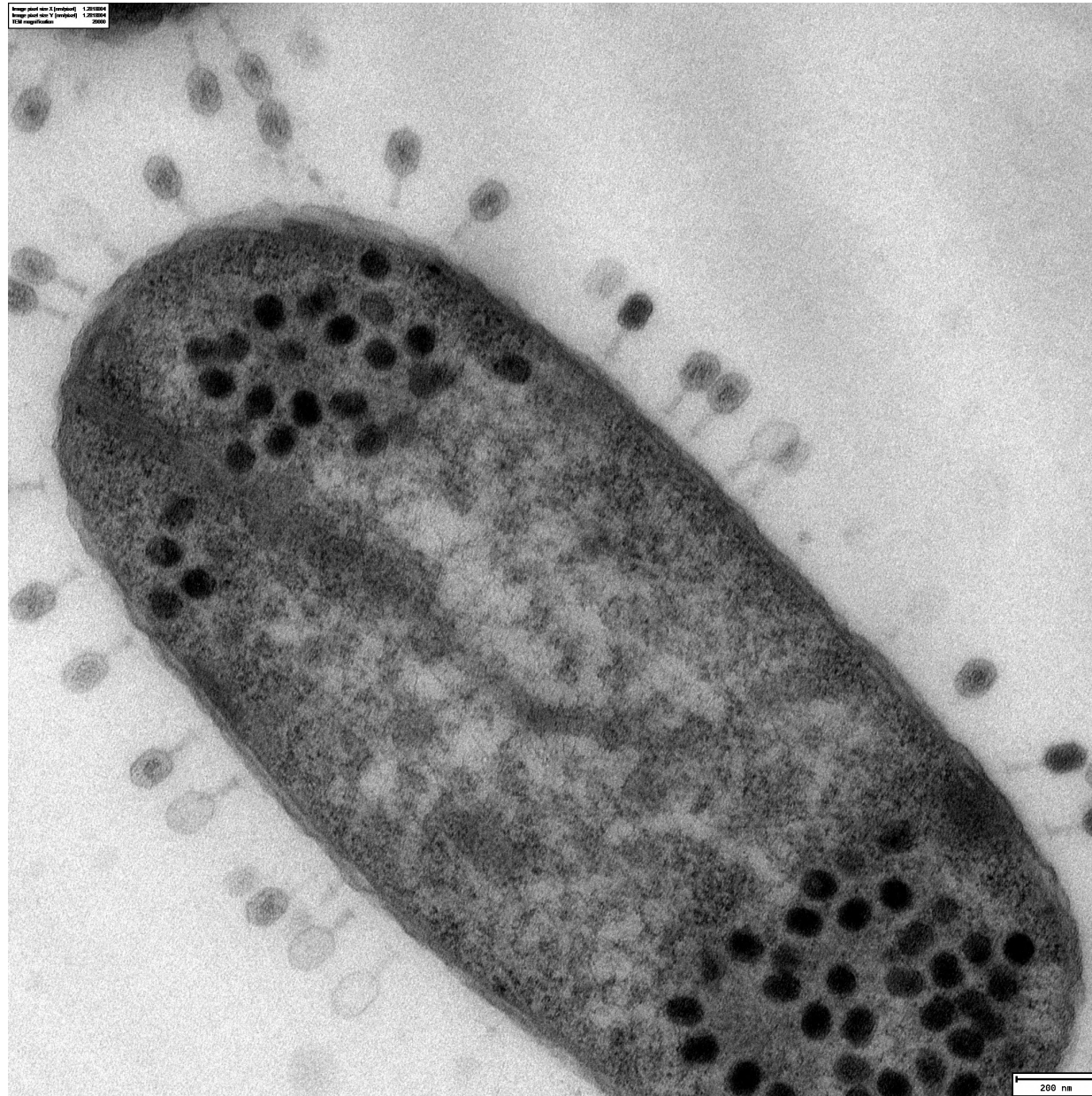
[Structural basis of bacteriophage \$\lambda\$ -lambda infection initiation Sci. Adv. 11.eadw7914\(2025\). DOI:10.1126/sciadv.adw7914CC-BY-NC](#)

Bacteriophage lambda

Some bacteriophages have contractile tails.

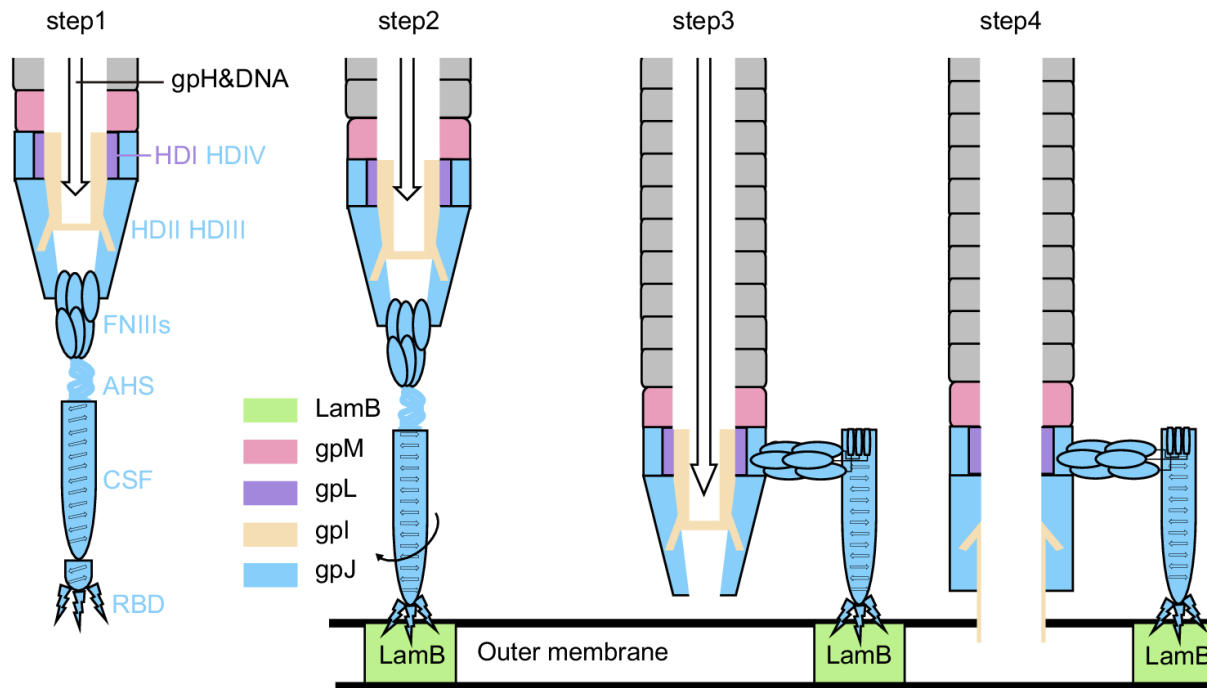
animation

Lambda does not have a contractile tail.



Bacteriophage lambda

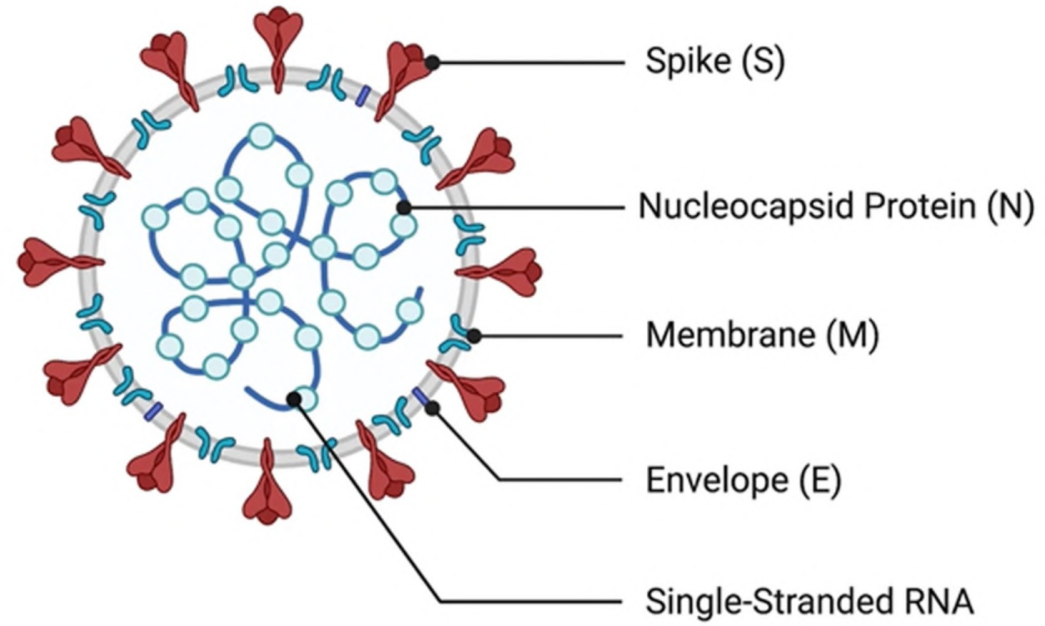
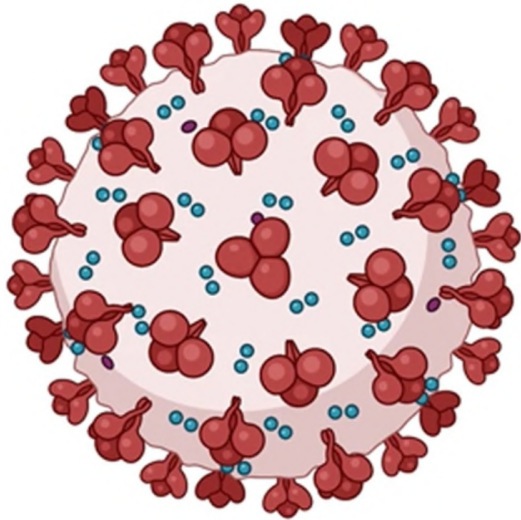
Extra detail - Tail Tube attachment of Lambda phage



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>

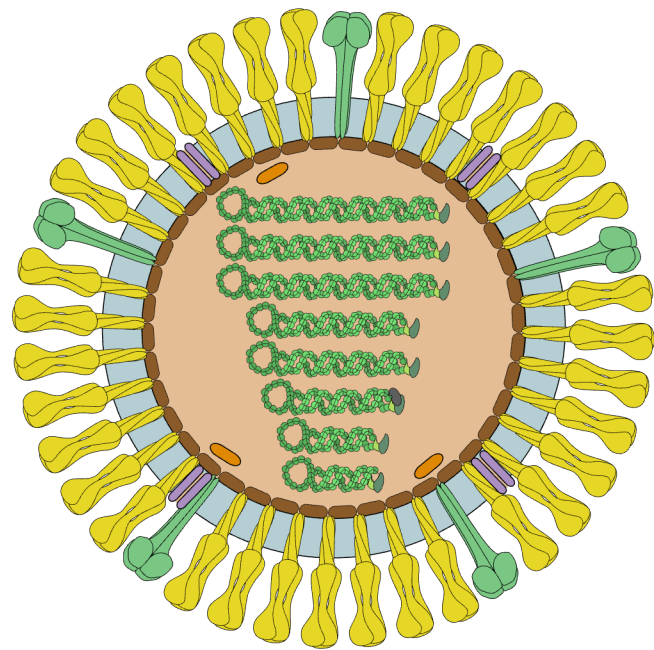
The LamB gene makes the maltoporin protein which acts as a receptor for the Lambda phage tail.

SARS-CoV-2-virus



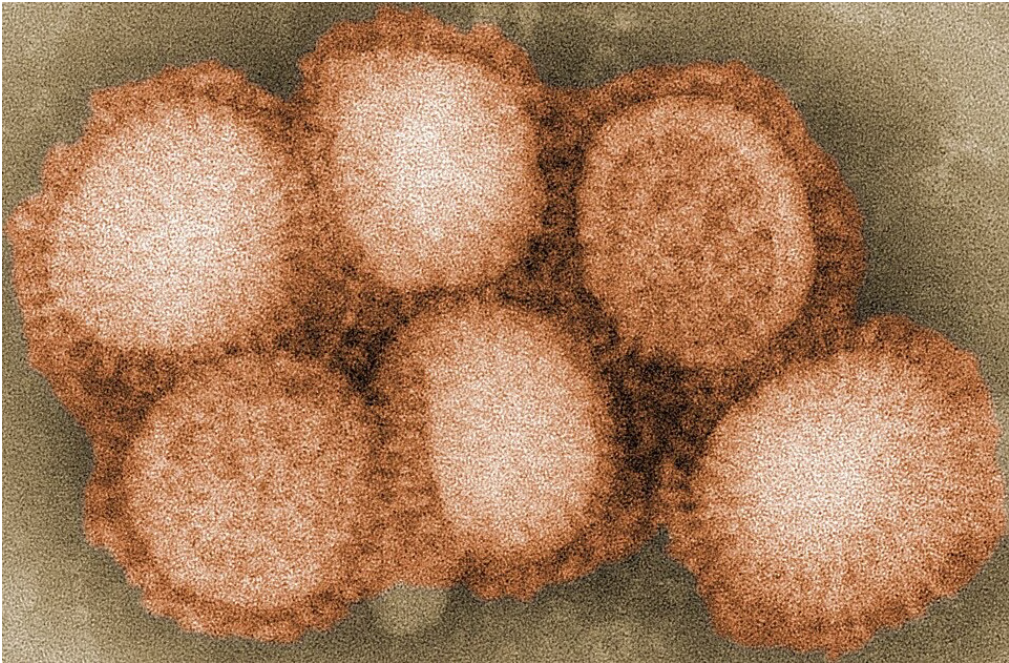
[Jamison et al 2022](#)

Influenza Virus

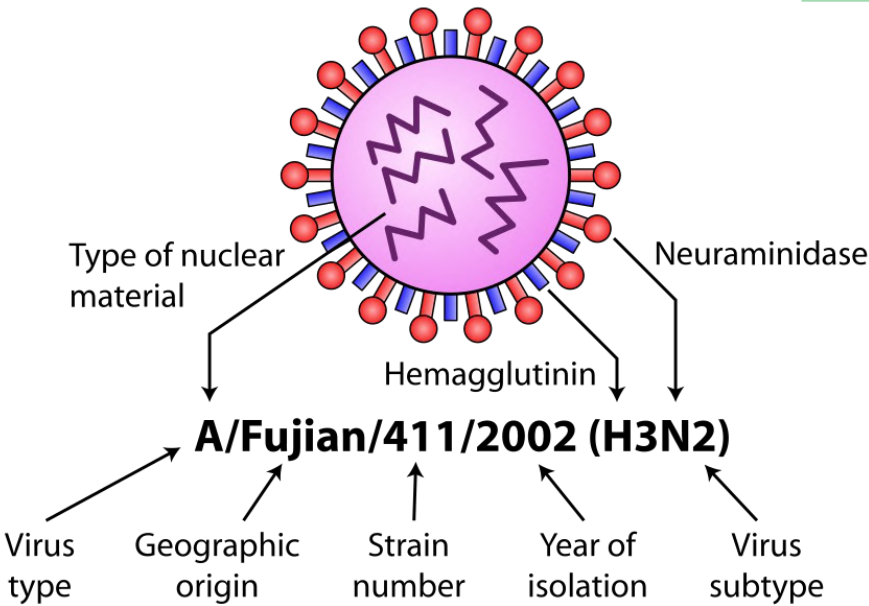


[Viralzone](#)

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



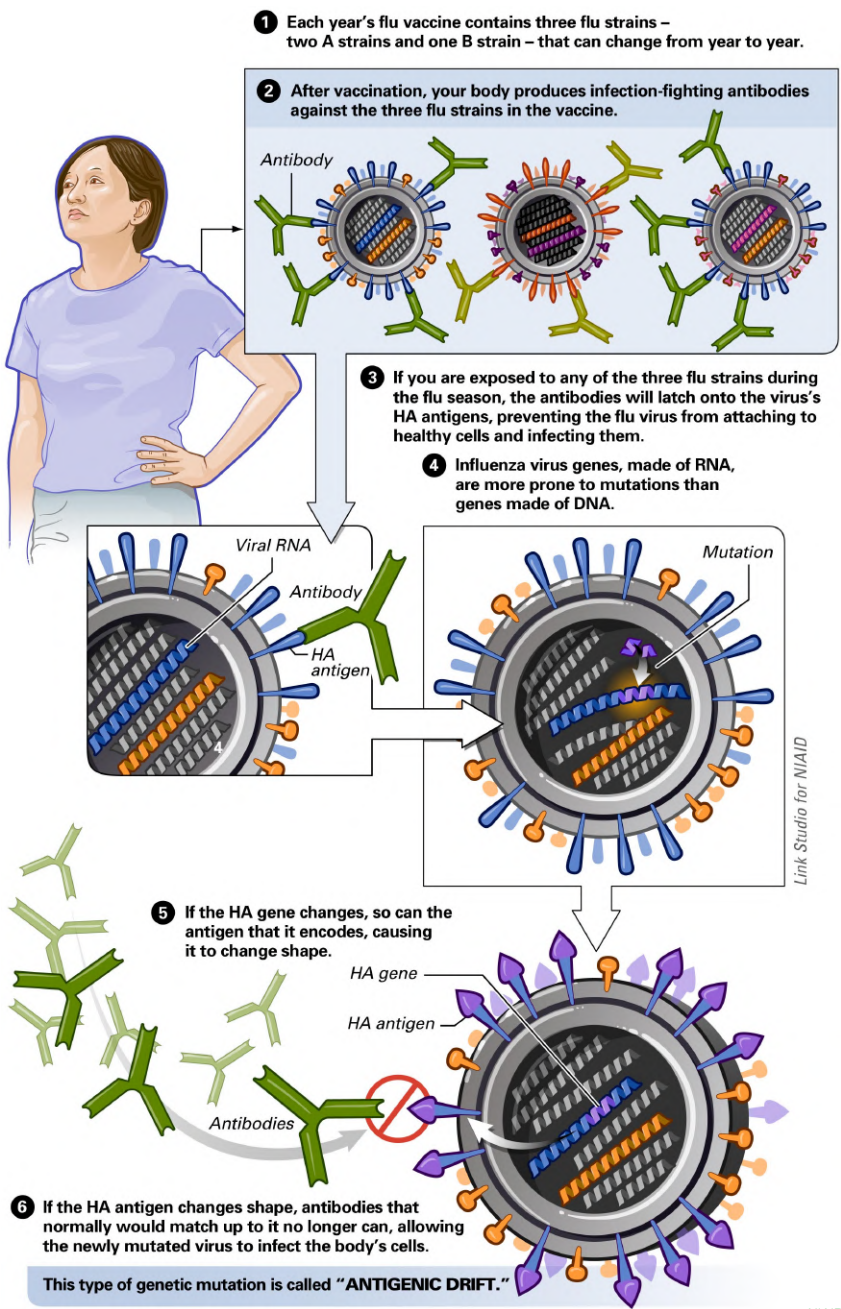
[Wikimedia](#)



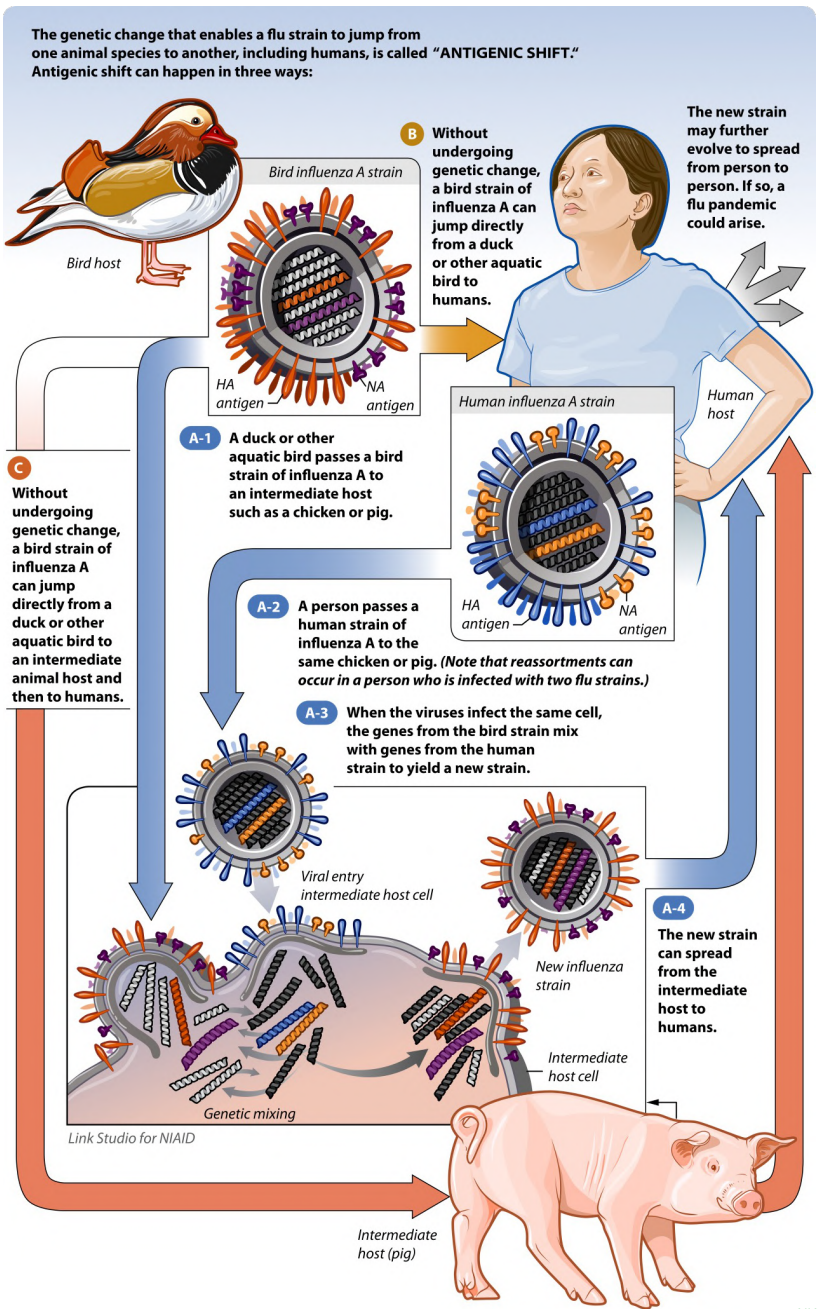
[Wikimedia](#)

Influenza Virus

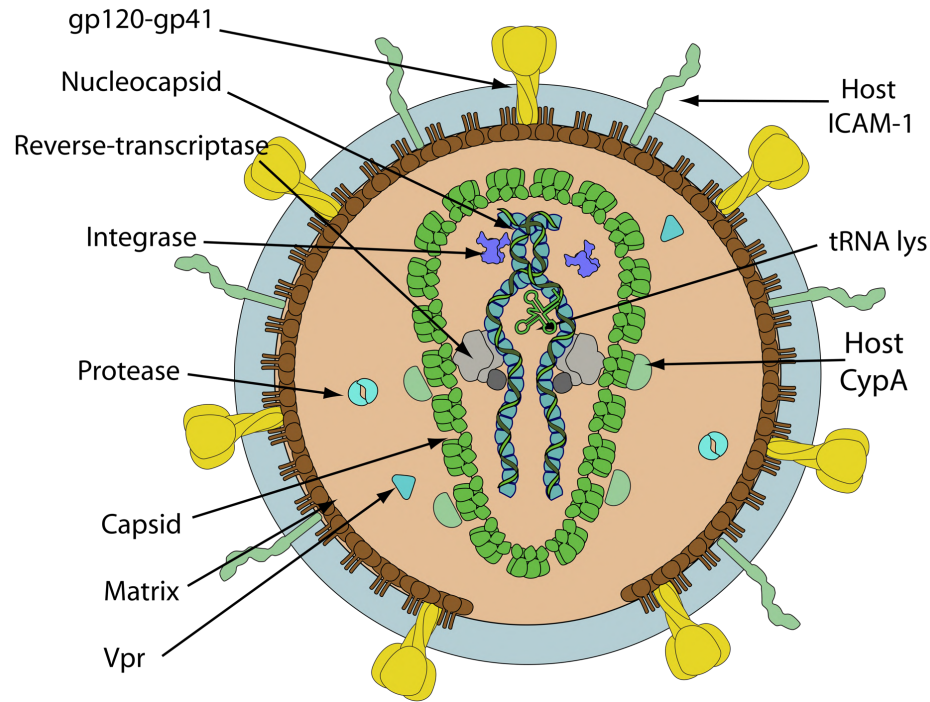
antigenic drift



antigenic shift



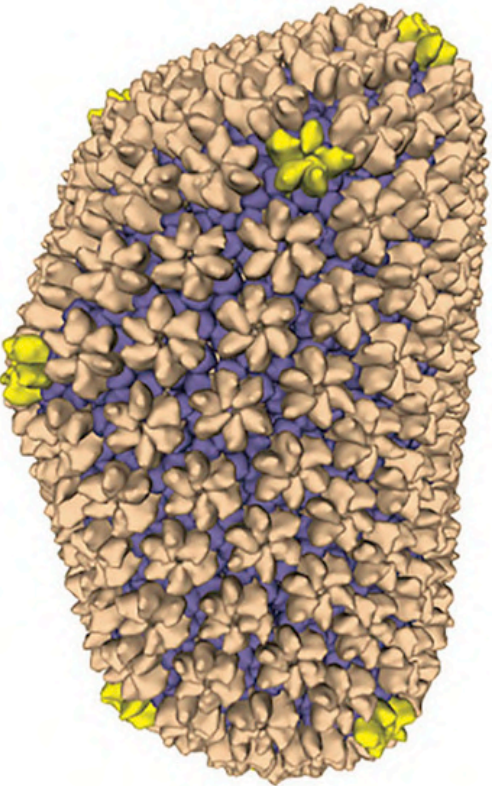
HIV Structure



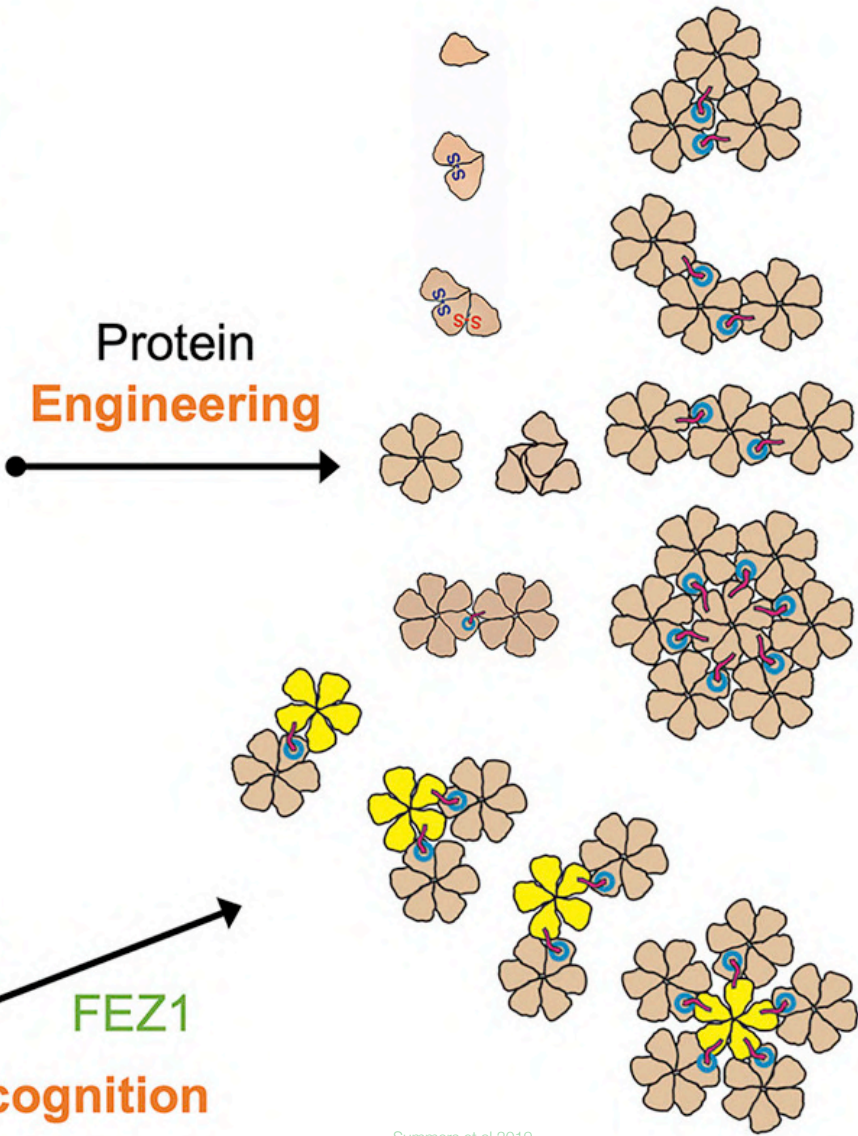
MATURE

[Viralzone SIB Swiss Institute of Bioinformatics](#)

HIV-1
Capsid

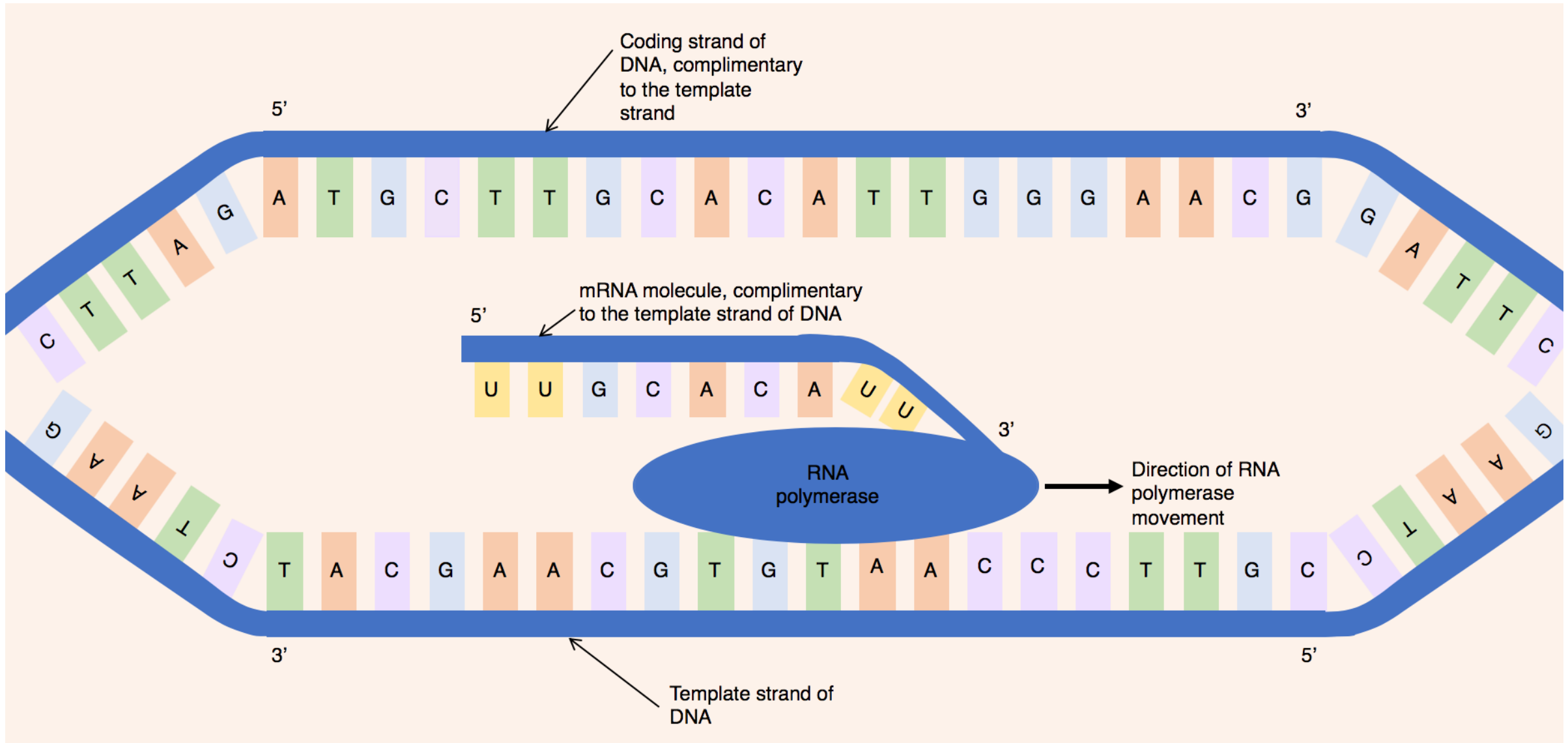


Stabilized
Capsid Assembly
Platforms



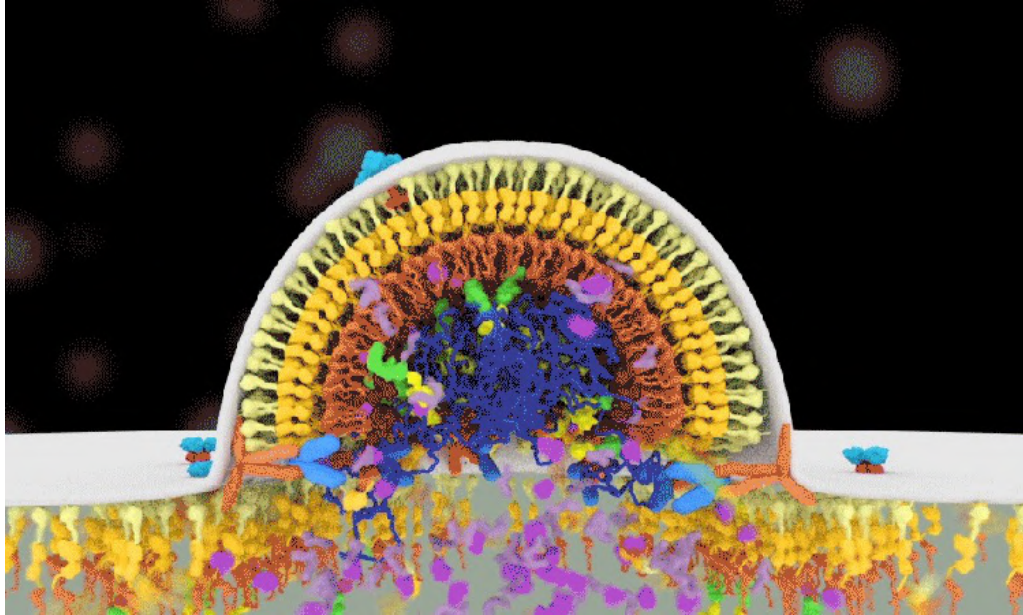
[Summers et al 2019](#)

Transcription DNA to mRNA

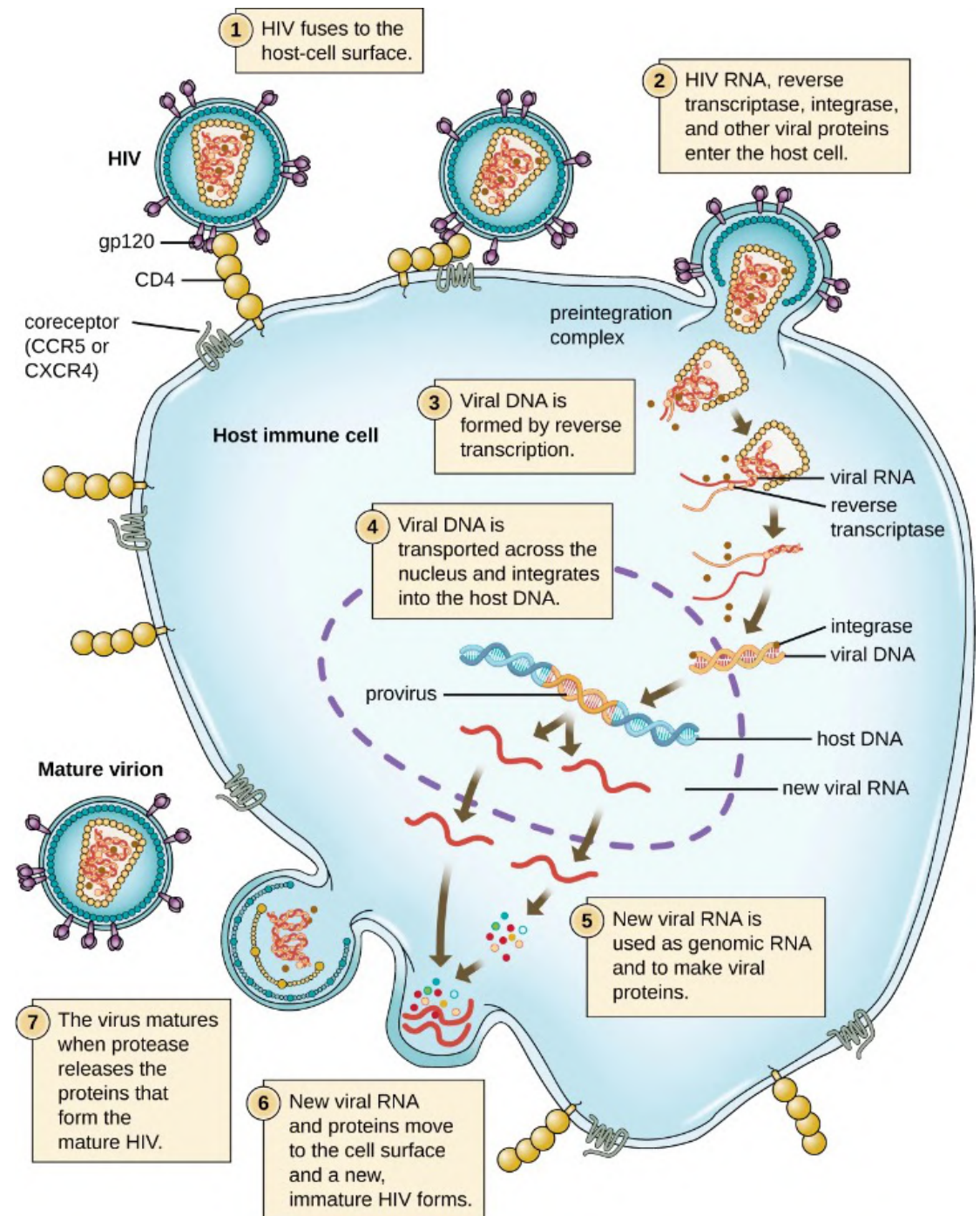


HIV Lifecycle

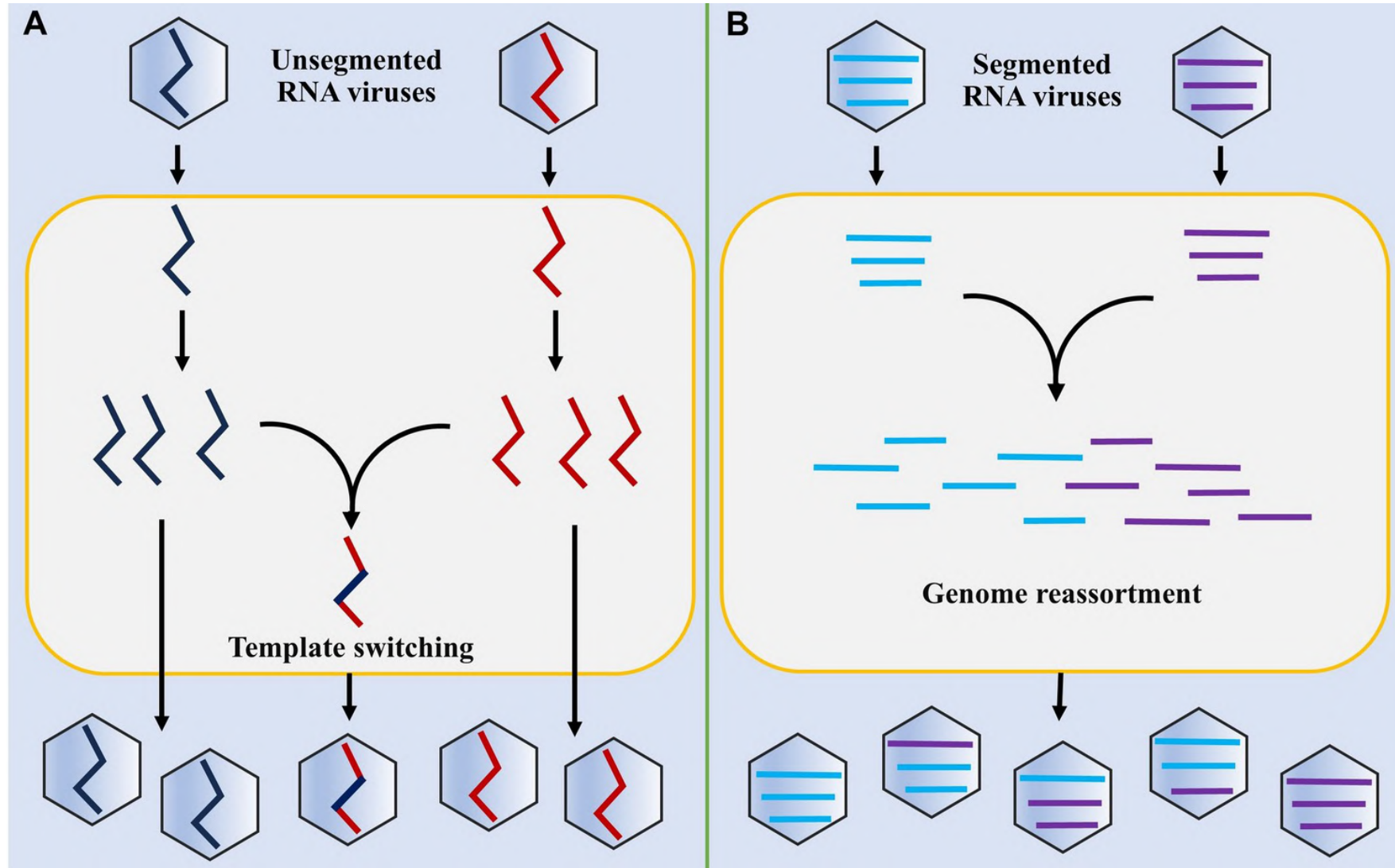
Budding of HIV



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



Rapid Evolution in Viruses



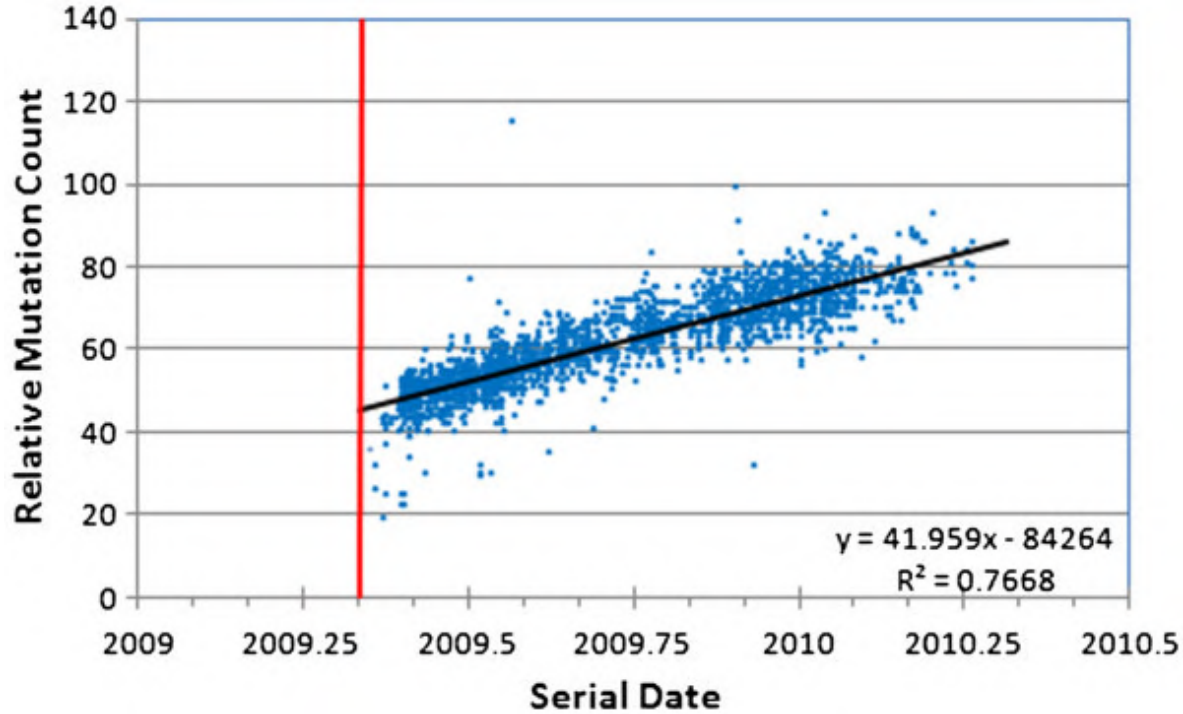
Abbasi and Alam 2025

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

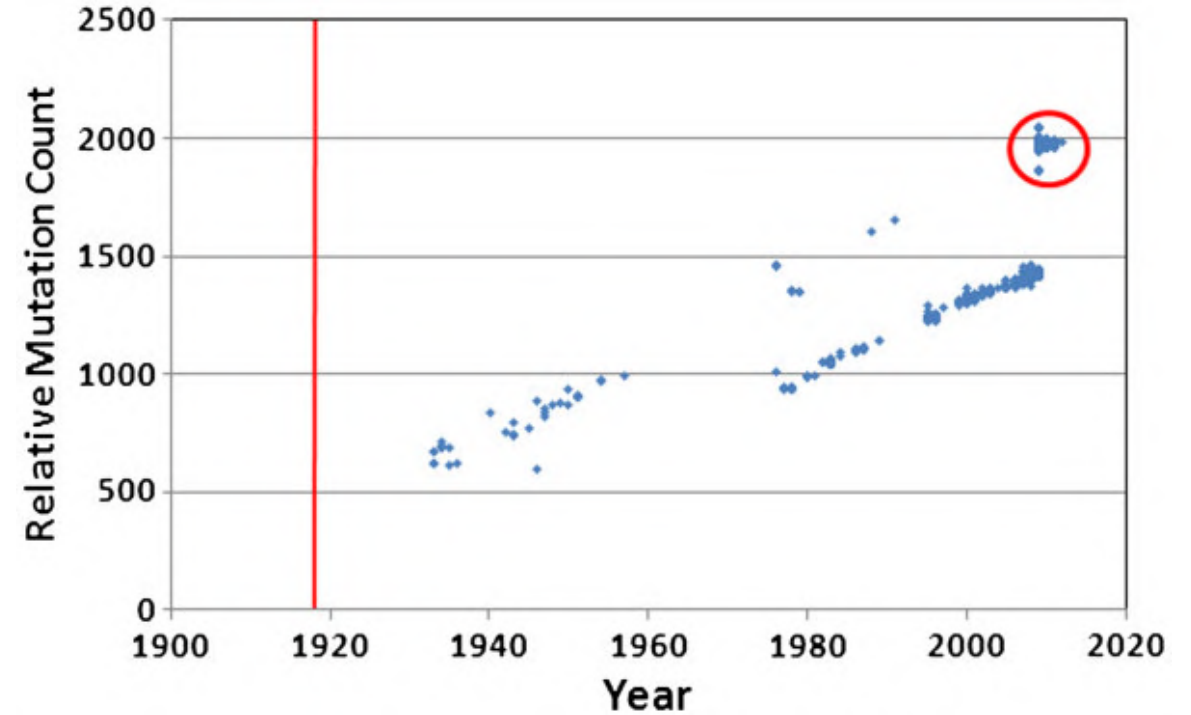
Mutation accumulation within the *human form* of the 2009 A/H1N1 influenza strain during the course of the 2009/2010 flu season.



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 the *human form* of 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](#)

Mutations in viruses are an example of microevolution.

High error rates in viruses can override natural selection and cause viral strains 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 1918 version of the human form of H1N1 went extinct in 1957 as it accumulated mutations.

After an accidental reintroduction in 1976 it again went extinct sometime in 2009.

Optional extension: (not required for the IB exam)

Viruses have many beneficial functions:

- control microbial population size
- increase or decrease microbe species diversity
- help maintain gut microbiome
- 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
- use of oncolytic viruses that kill specific cancer cells
- gene delivery of healthy DNA to specific cells

Agricultural uses of viruses await discovery including:

- inoculating 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.

In Time of Plague

Thomas Nashe

*Adieu, farewell, earth's bliss;
This world uncertain is;
Fond are life's lustful joys;
Death proves them all but toys;
None from his darts can fly;
I am sick, I must die.*

Lord, have mercy on us!

*Rich men, trust not in wealth,
Gold cannot buy you health;
Physic himself must fade.
All things to end are made,
The plague full swift goes by;
I am sick, I must die.*

Lord, have mercy on us!

*Beauty is but a flower
Which wrinkles will devour;
Brightness falls from the air;
Queens have died young and fair;
Dust hath closed Helen's eye.
I am sick, I must die.*

Lord, have mercy on us!

*Strength stoops unto the grave,
Worms feed on Hector's brave;
Swords may not fight with fate,
Earth still holds ope her gate.
"Come, come!" the bells do cry.
I am sick, I must die.*

Lord, have mercy on us.

*Wit with his wantonness
Tasteth death's bitterness;
Hell's executioner
Hath no ears for to hear
What vain art can reply.
I am sick, I must die.*

Lord, have mercy on us.

*Haste, therefore, each degree,
To welcome destiny;
Heaven is our heritage,
Earth but a player's stage;
Mount we unto the sky.
I am sick, I must die.*

Lord, have mercy on us.



[Wikipedia](#)

