



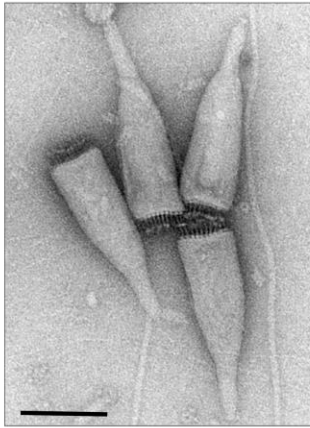
How to Package DNA: Lessons from Archaeal Viruses

David Prangishvili

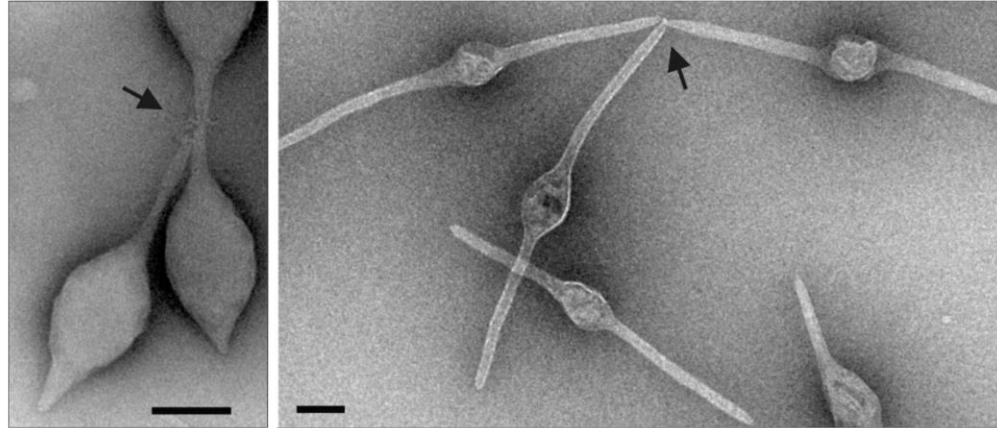
Institut Pasteur, Paris

Our collection of

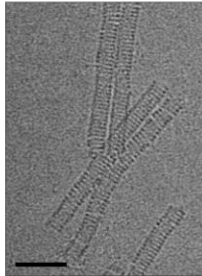
Ampullaviridae



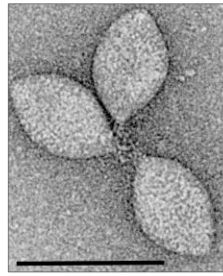
Bicaudaviridae



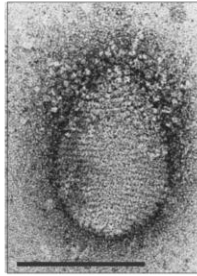
Spiraviridae



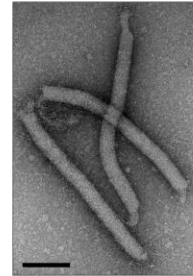
Fuselloviridae



Guttaviridae



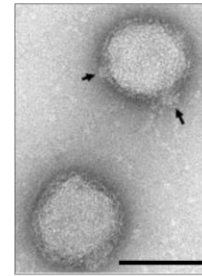
Tristromaviridae



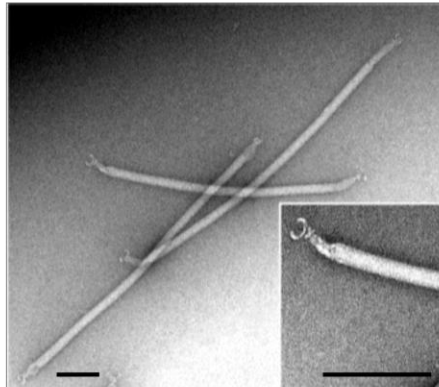
Clavaviridae



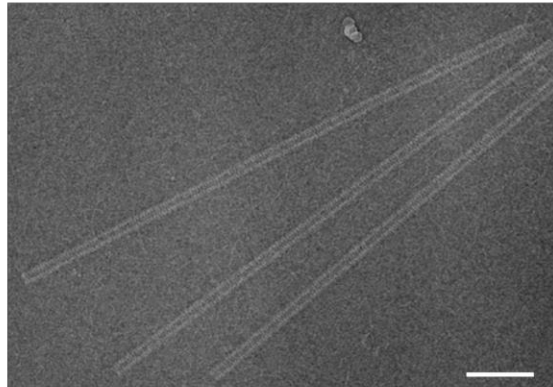
Globuloviridae



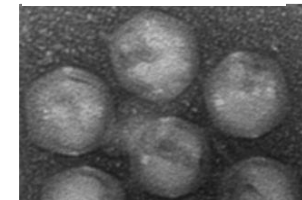
Lipothrixviridae



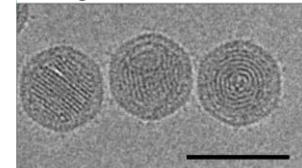
Rudiviridae



Turriviridae



Portogloboviridae

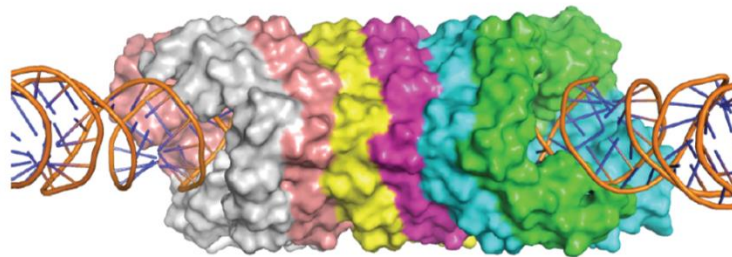
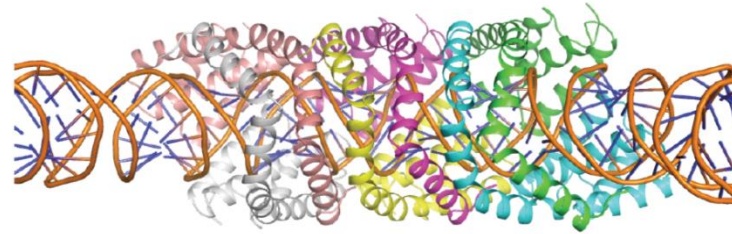
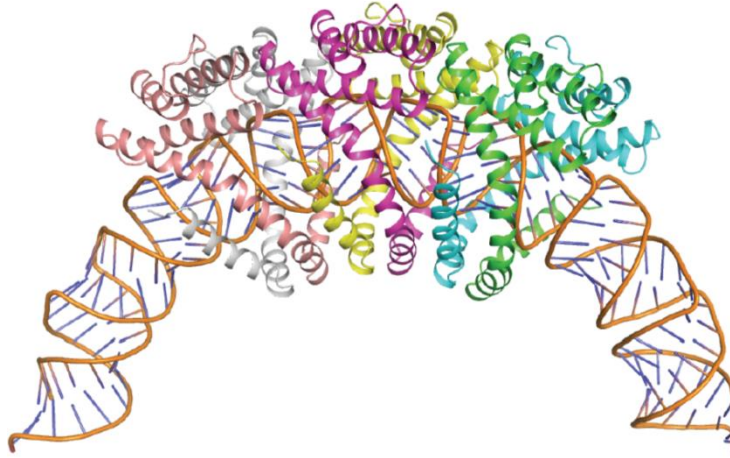
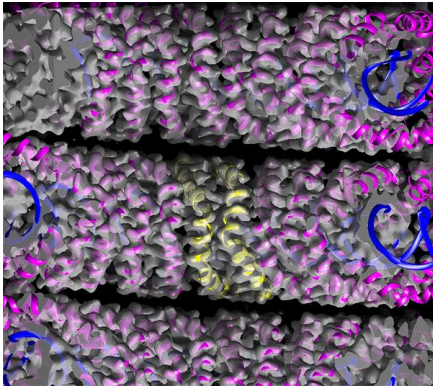
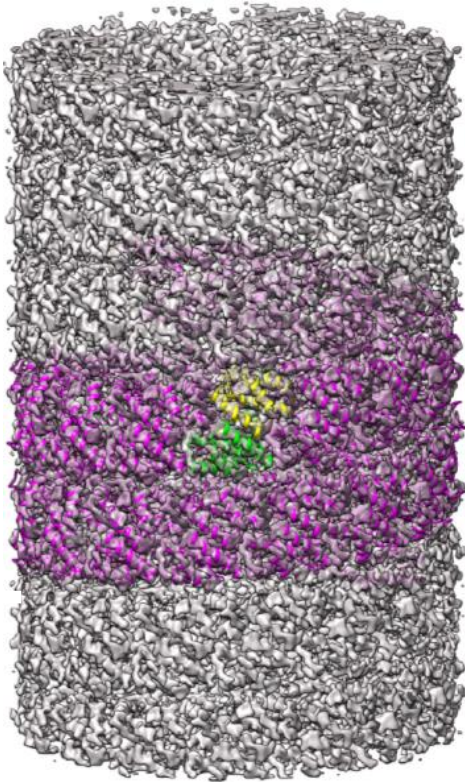


archaeal viruses

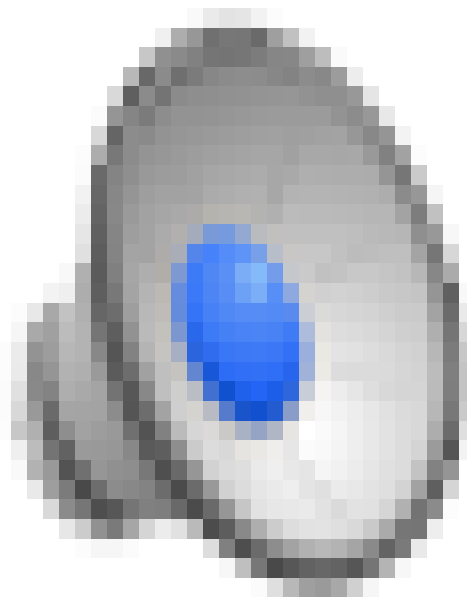
Rudiviridae: *Sulfolobus islandicus* rod-shaped virus 2, SIRV2

 linear dsDNA 35.450 bp

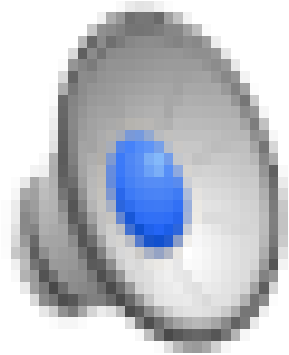
Rudiviridae: *Sulfolobus islandicus* rod-shaped virus 2, SIRV2



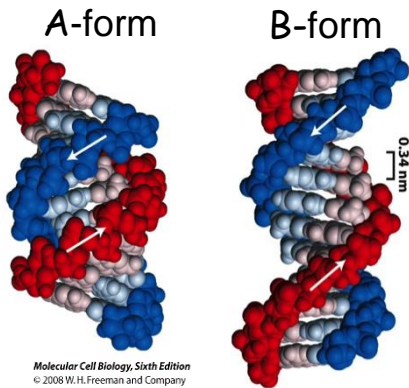
SIRV2 encapsulates A-form DNA



SIRV2 encapsulates A-form DNA



DiMaio, Yu, Rensen, Krupovic, Prangishvili, Egelman *Science* 2015



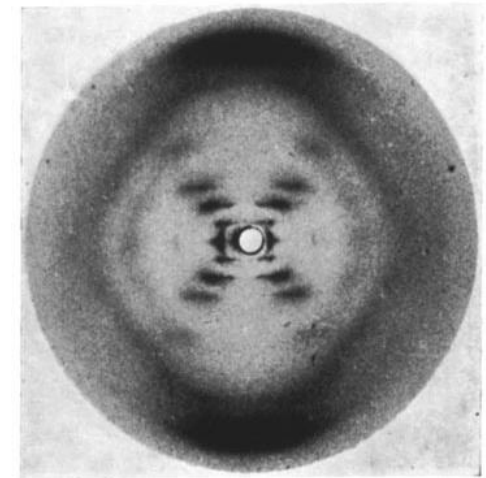
NATURE

April 25, 1953 VOL 171

Molecular Configuration in Sodium Thymonucleate

SODIUM thymonucleate fibres give two distinct types of X-ray diagram. The first corresponds to a crystalline form, structure *A*, obtained at about 75 per cent relative humidity; a study of this is described in detail elsewhere¹. At higher humidities a different structure, structure *B*, showing a lower degree of order, appears and persists over a wide range of ambient humidity. The change from *A* to *B* is reversible. The water content of structure *B* fibres which undergo this reversible change may vary from 40-50 per cent to several hundred per cent of the dry weight. Moreover, some fibres never show structure *A*, and in these structure *B* can be obtained with an even lower water content.

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King's College, London.
April 2.

* Now at Birkbeck College Research Laboratories,
Square, London, W.C.1.



Similarities between the capsid protein of SIRV2 and small, acid-soluble spore proteins, SASPs :

- The proteins are unstructured in solution, but become completely α -helical upon binding dsDNA; binding to DNA induces protein dimerization;
- The binding of proteins to DNA is saturable, and saturation occurs at an Protein/DNA weight ratio of 3:1;
- The binding of SASPs to DNA induces a transition from B-DNA to A-DNA.

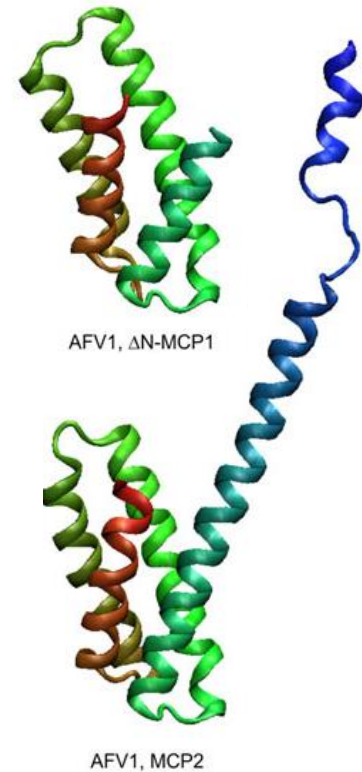
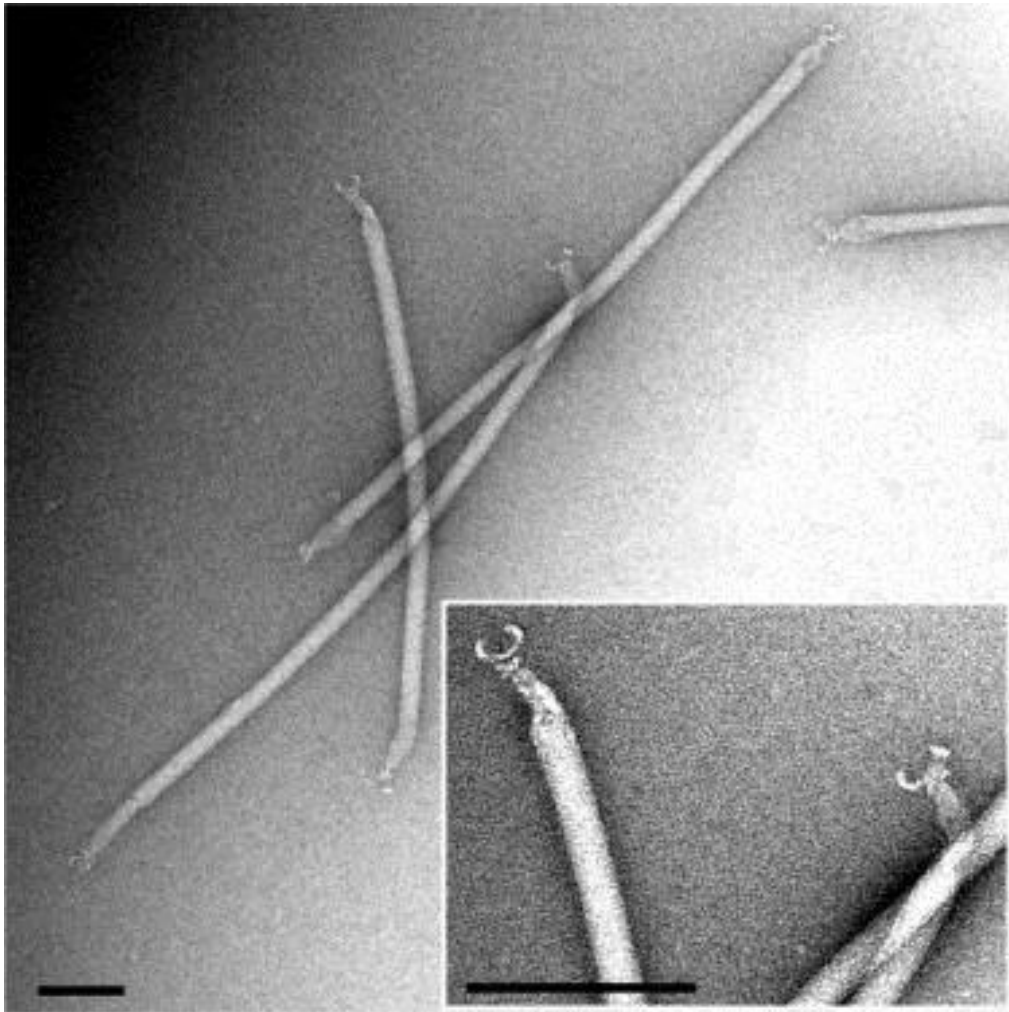
Bacterial spores and archaeal virus converged on the same solution for genome protection in hostile environments

Similarities between the capsid protein of SIRV2 and small, acid-soluble spore proteins, SASPs :

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- The binding of proteins to DNA is saturable, and saturation occurs at an Protein/DNA weight ratio of 3:1;
- The binding of SASPs to DNA induces a transition from B-DNA to A-DNA.

Adopting A-form DNA might be a widespread biological mechanism to withstand adverse conditions

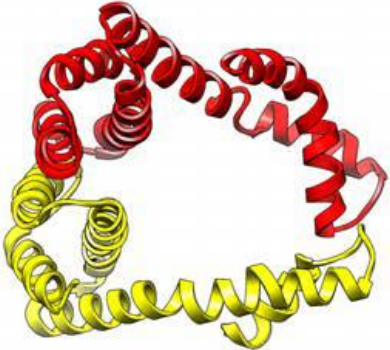
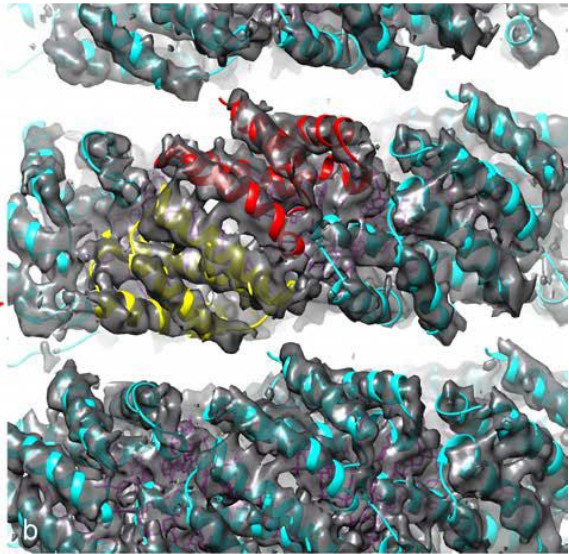
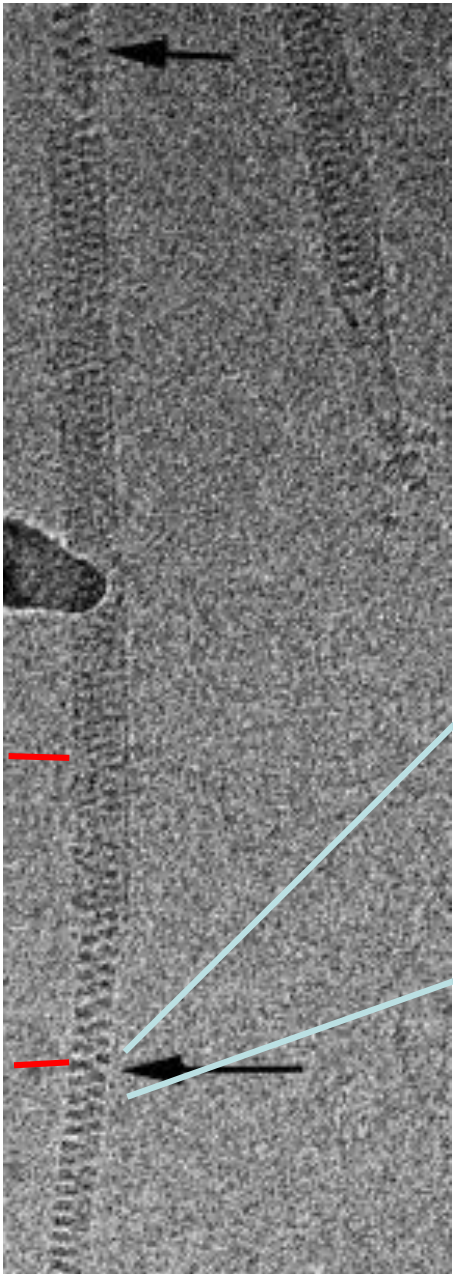
Lipothrixviridae: *Acidianus filamentous virus 1*, AFV1



linear dsDNA 35.450 bp

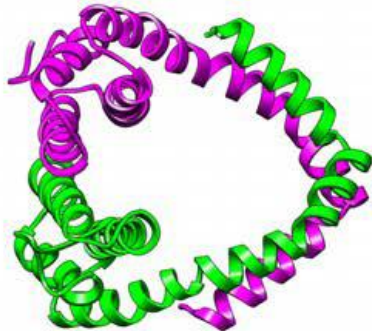
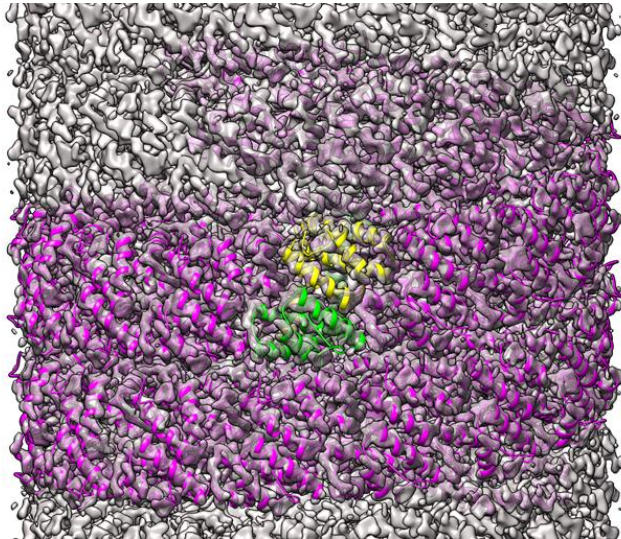
Lipothrixviridae: *Acidianus* filamentous virus 1, AFV1

Lipothrixvirus AFV1



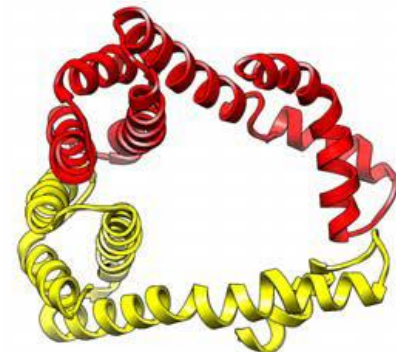
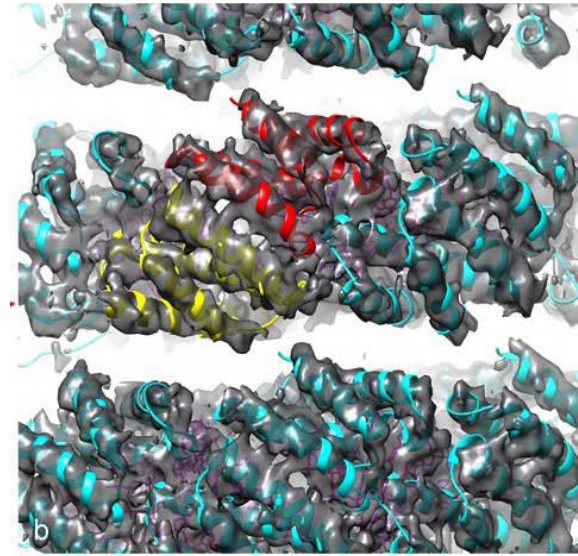
Kasson, DiMaio, Yu, Lucas, Krupovic, Schouten, Prangishvili, Egelman *Elife* 2017

Rudivirus SIRV2



DiMaio, Yu, Rensen, Krupovic,
Prangishvili, Egelman *Science* 2015

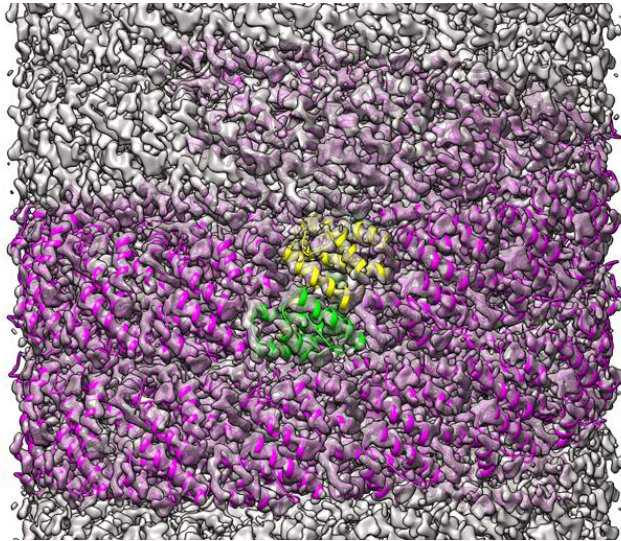
Lipothrixvirus AFV1



Kasson, DiMaio, Yu, Lucas, Krupovic, Schouten,
Prangishvili, Egelman *Elife* 2017



Rudivirus SIRV2

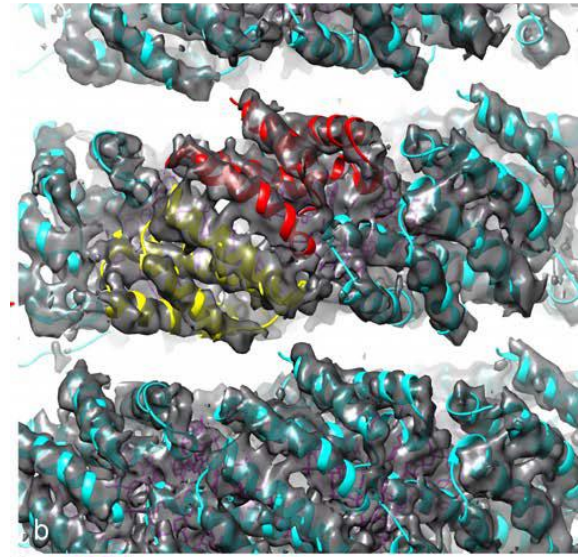


DNA radius $\approx 60 \text{ \AA}$

Twist of A-form DNA 11.2 bp/turn

DiMaio, Yu, Rensen, Krupovic,
Prangishvili, Egelman *Science* 2015

Lipothrixvirus AFV1

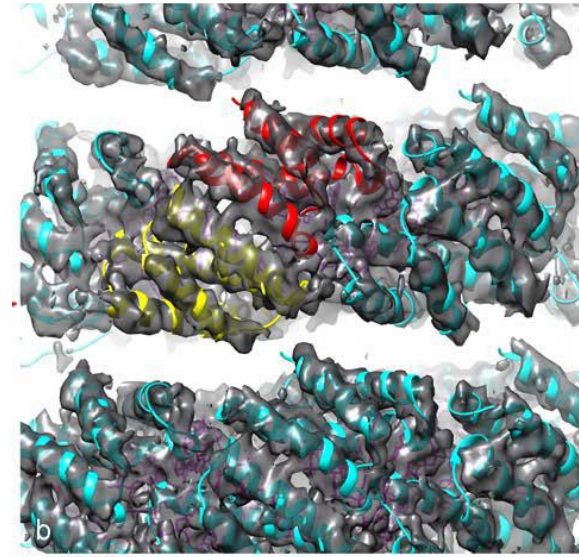
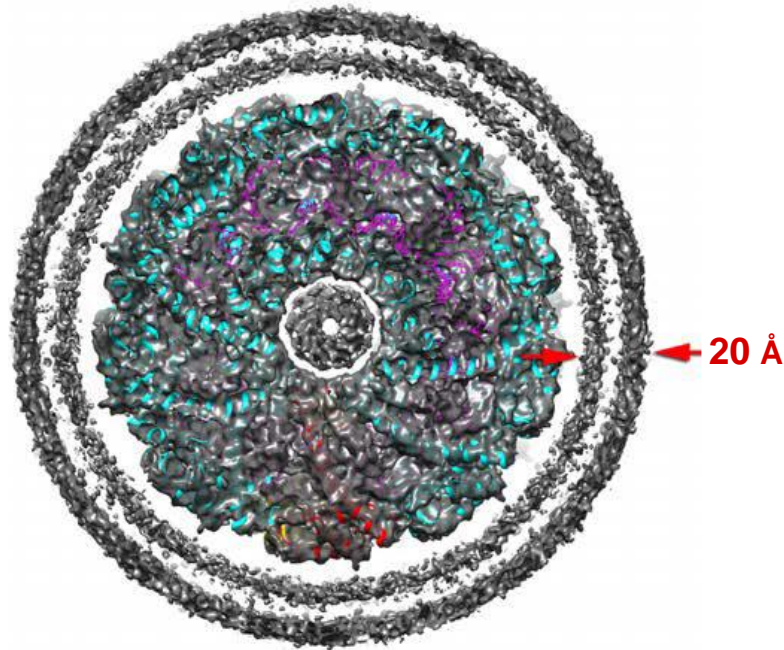


DNA radius $\approx 30 \text{ \AA}$

Twist of A-form DNA 10.8 bp/turn

Kasson, DiMaio, Yu, Lucas, Krupovic, Schouten,
Prangishvili, Egelman *Elife* 2017

Lipothrixviridae: *Acidianus filamentous virus 1*, AFV1

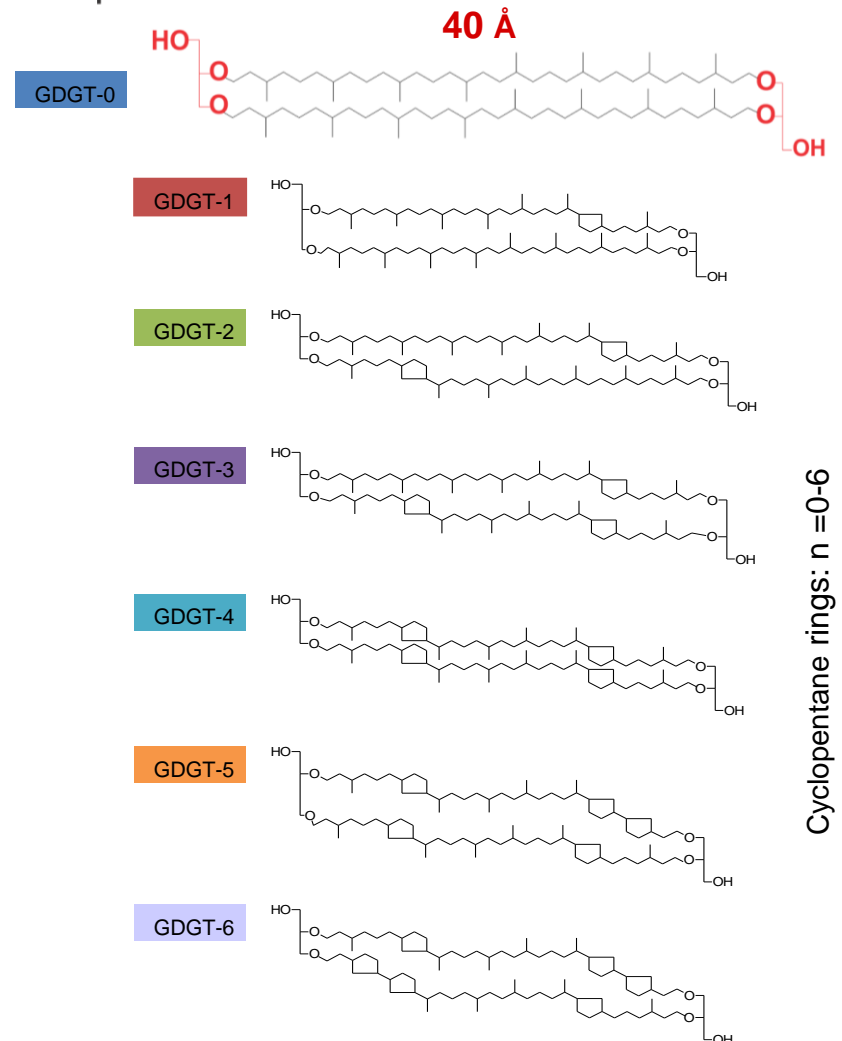
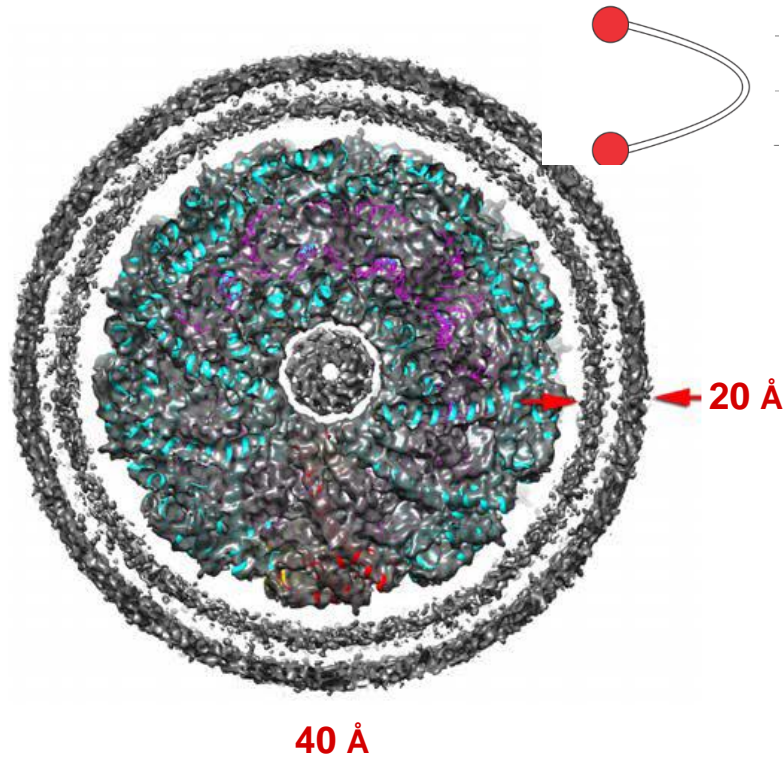


DNA radius ≈ 60 Å

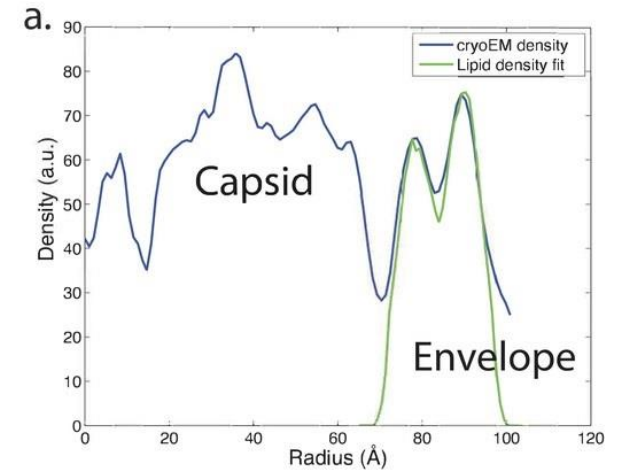
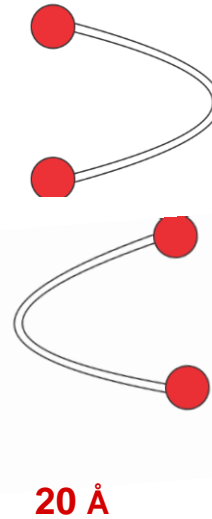
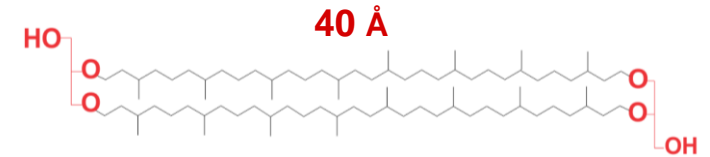
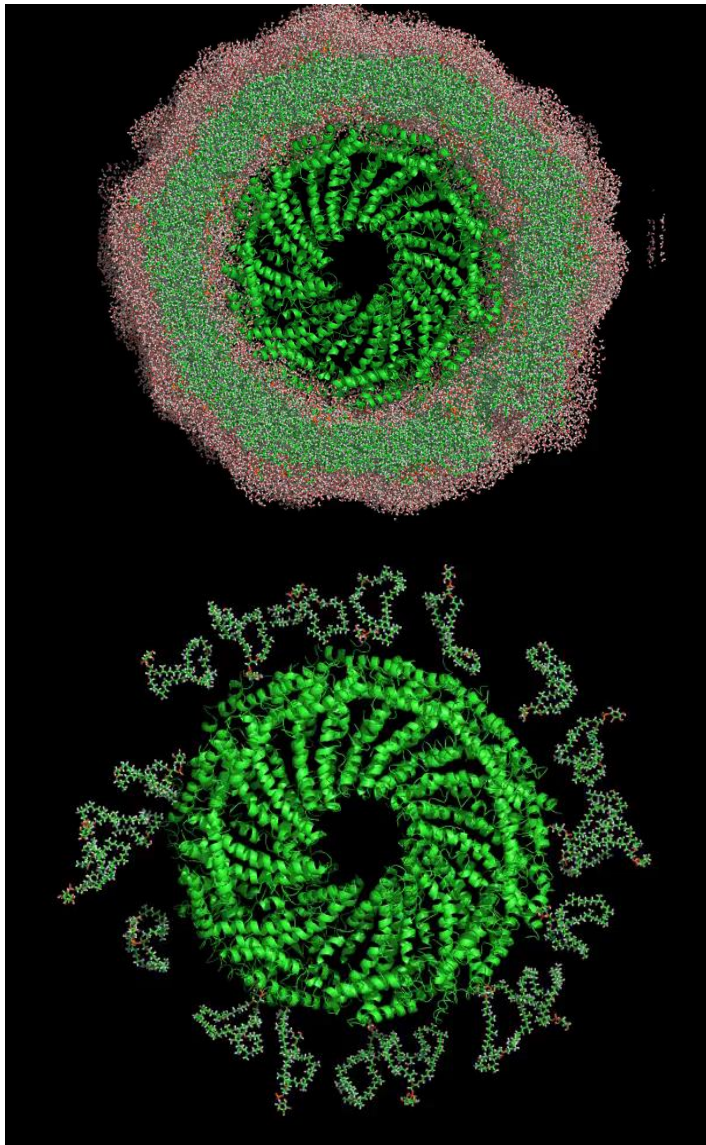
Twist of A-form DNA 11.2 bp/turn

Lipothrixviridae: *Acidianus filamentous virus 1*, AFV1

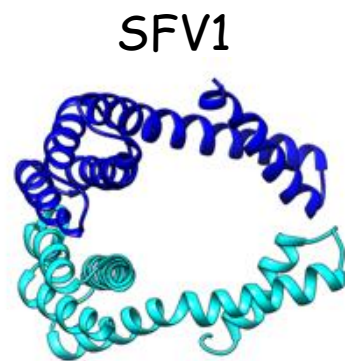
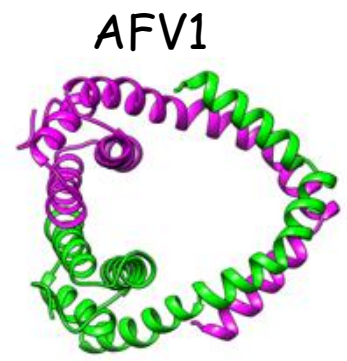
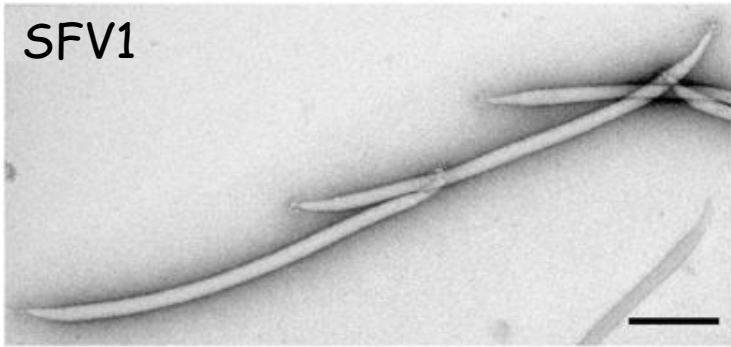
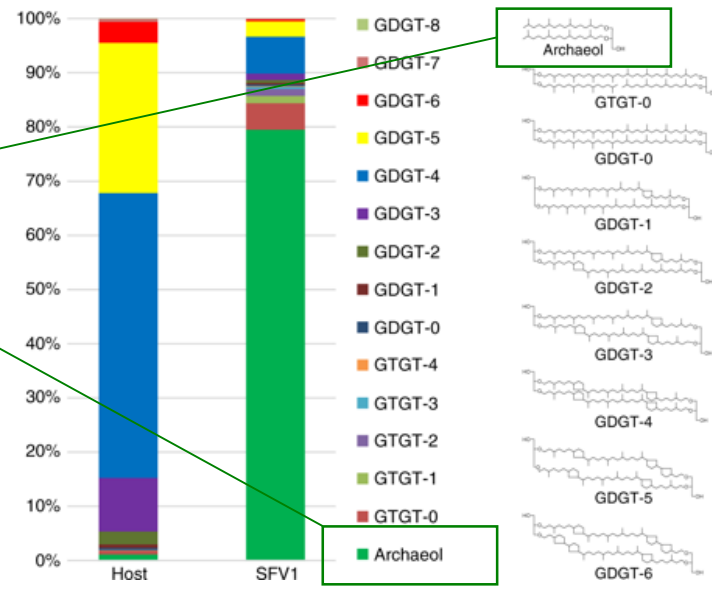
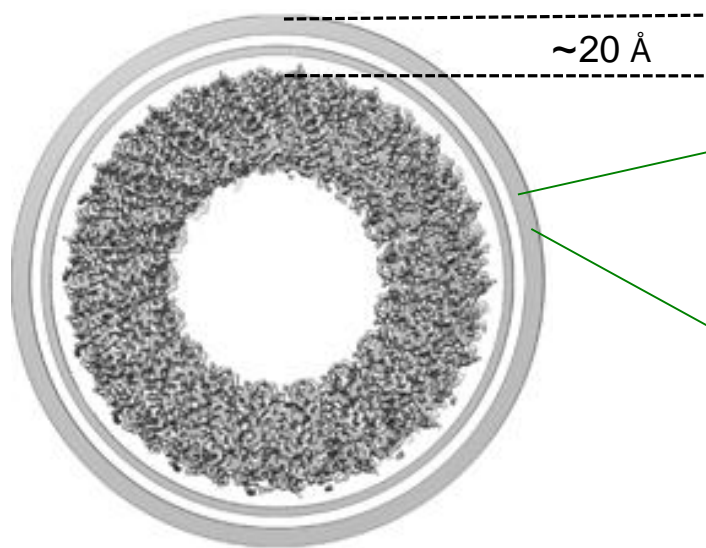
Glycerol Dibiphytanyl Glycecerol Tetraether lipids (GDGT)



Lipothrixviridae: Acidianus filamentous virus 1, AFV1

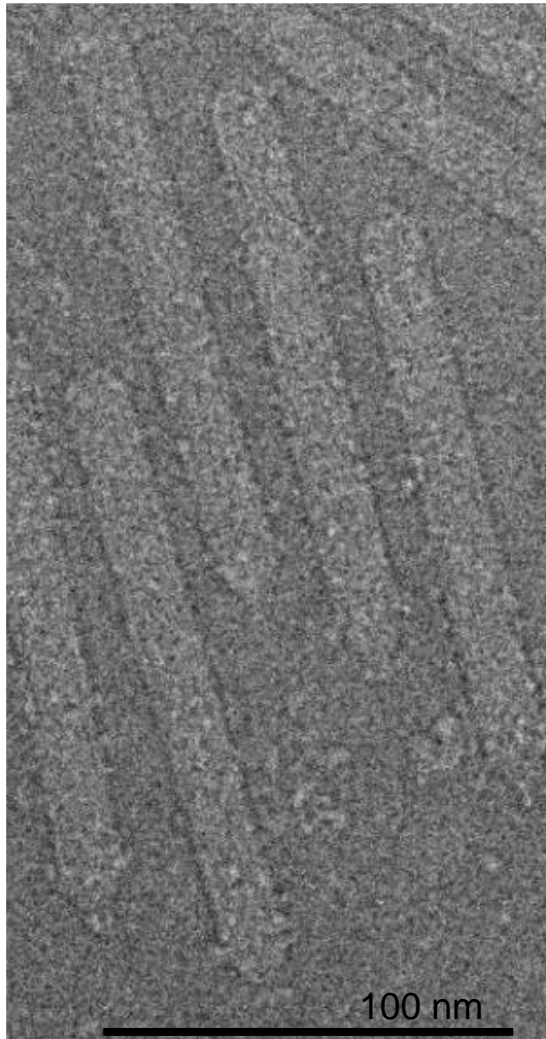


Lipothrrixviridae: *Sulfolobus filamentous virus 1*, SFV1

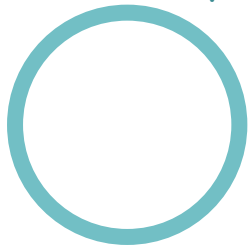


Conserved structural features can be maintained across evolution by both proteins and lipids that have diverged considerably.

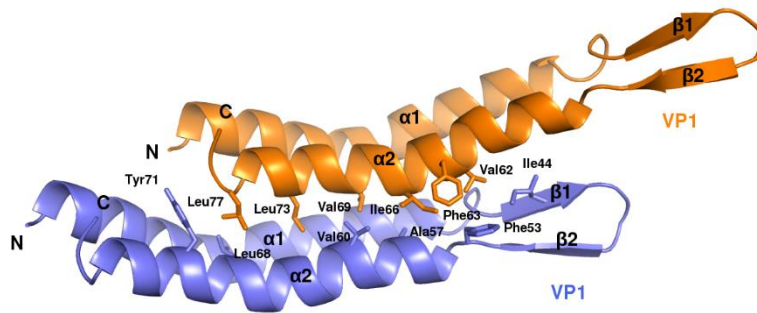
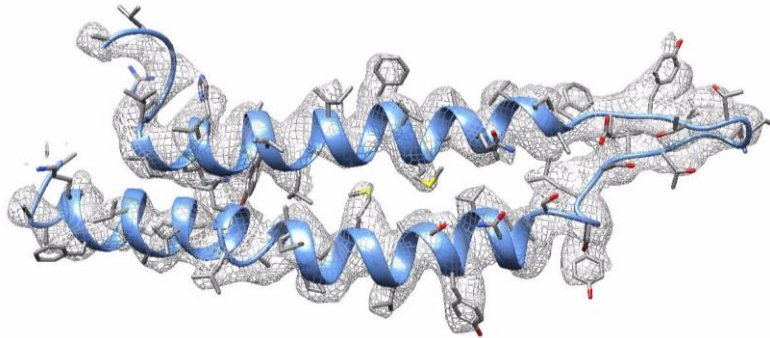
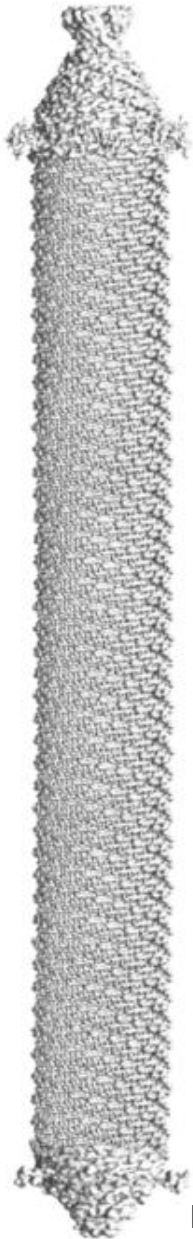
Clavaviridae: *Aeropyrum pernix* bacilliform virus 1, APBV1



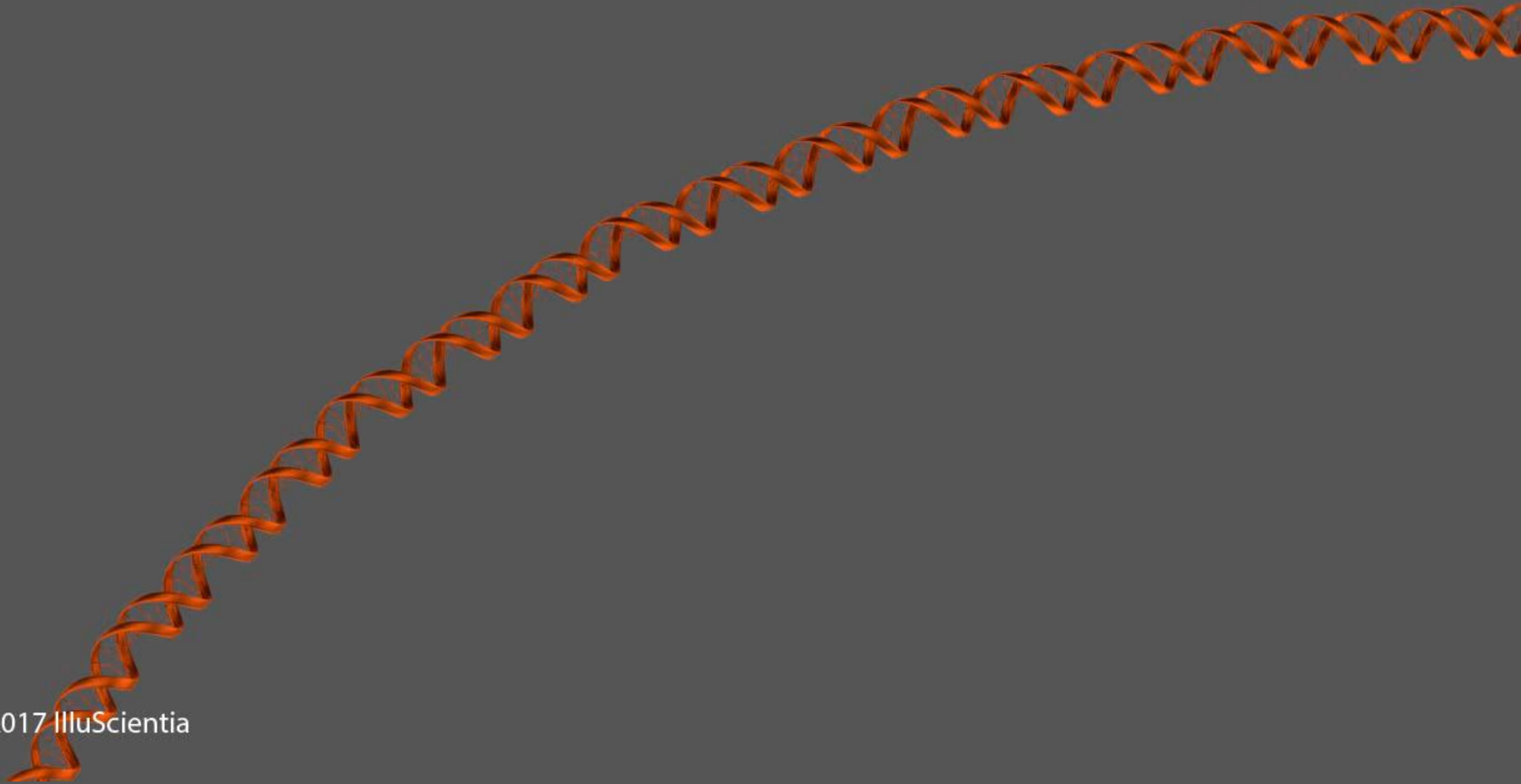
circular dsDNA
23.814 bp



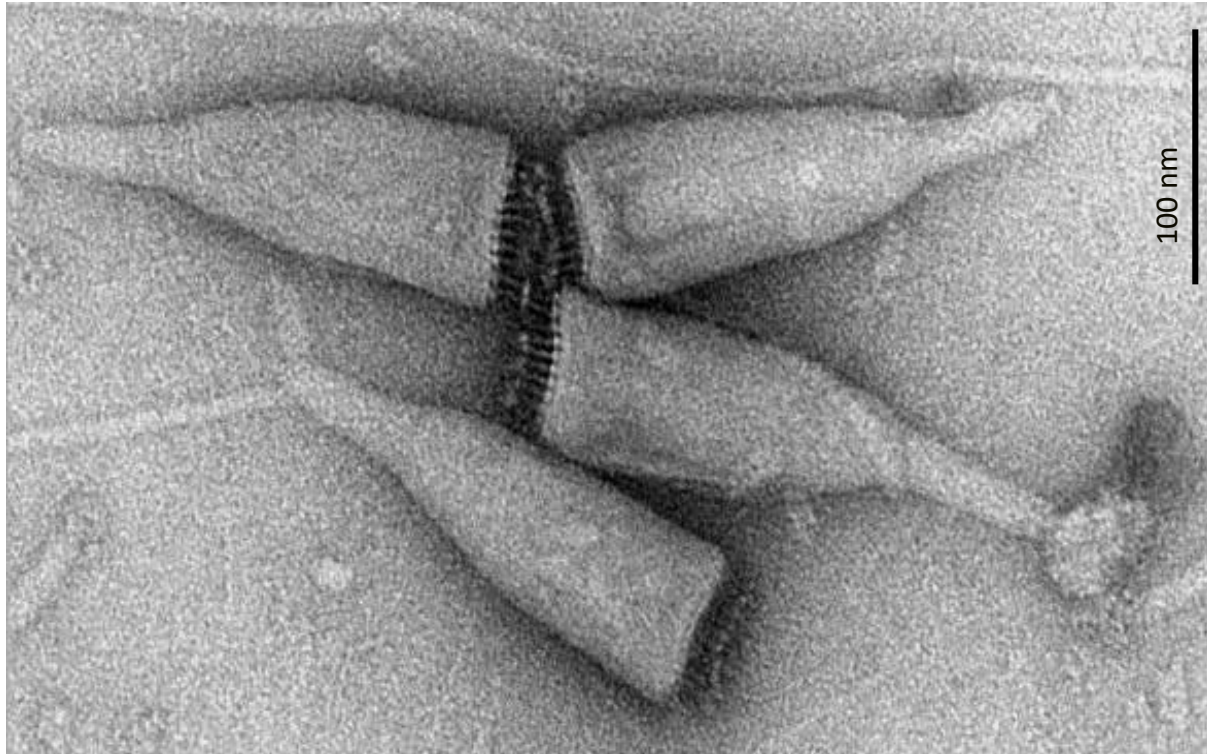
Clavaviridae: *Aeropyrum pernix* bacilliform virus 1, APBV1



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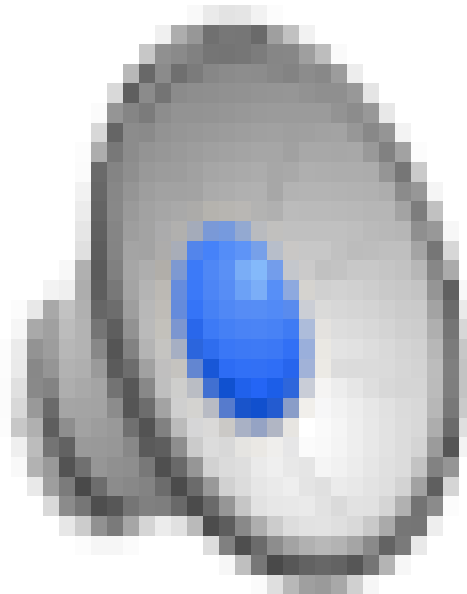


Ampullaviridae: Acidianus bottle-shaped virus, ABV

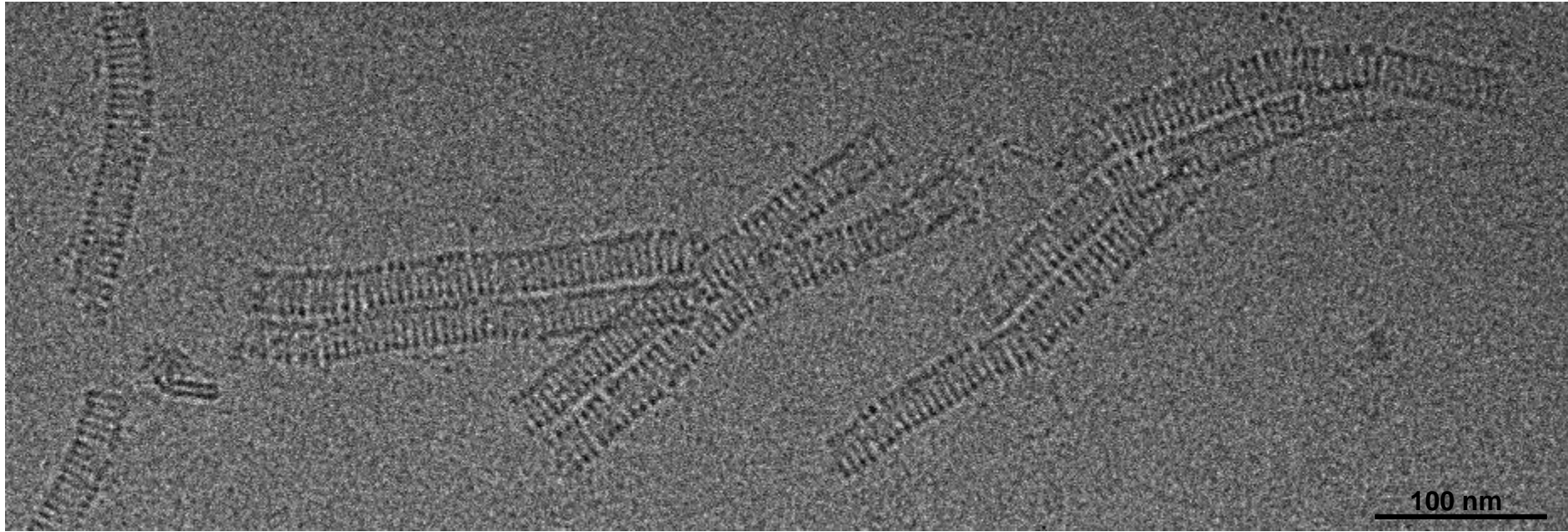


linear dsDNA 23.814 bp

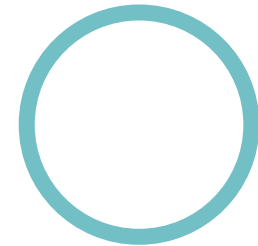
Ampullaviridae: Acidianus bottle-shaped virus, ABV



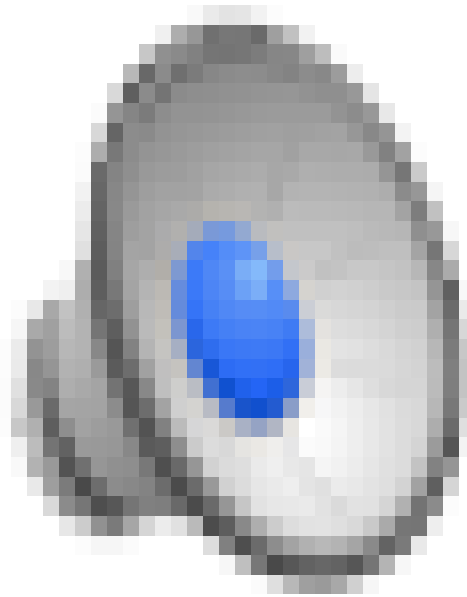
Spiraviridae: Aeropyrum pernix coil-shaped virus, ACV



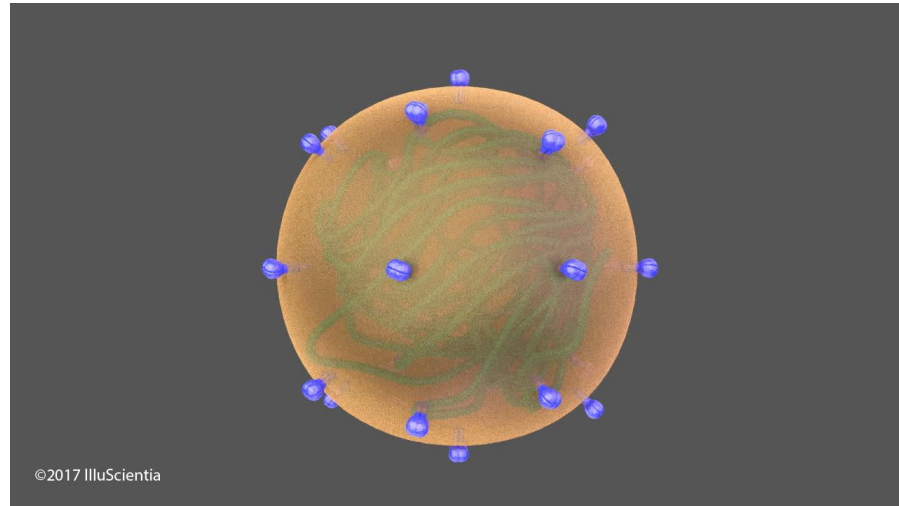
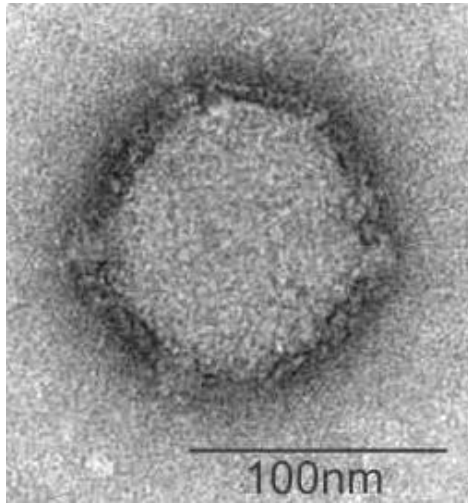
Circular ssDNA
23.814 nt



Spiraviridae: Aeropyrum pernix coil-shaped virus, ACV

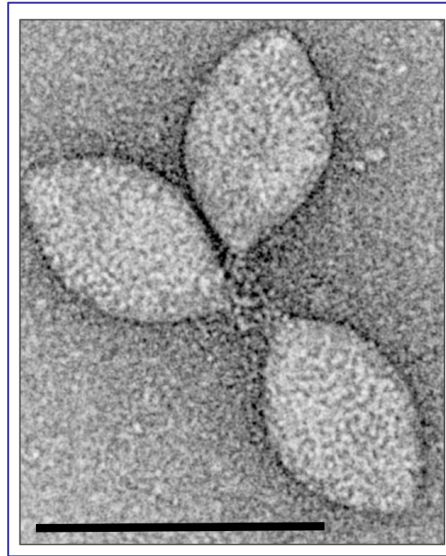


Globuloviridae: Pyrobaculum spherical virus, PSV

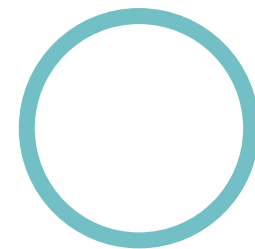


linear dsDNA 23.814 bp

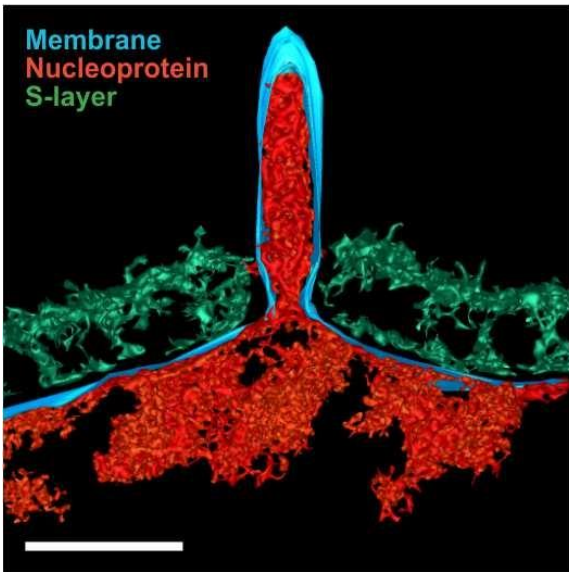
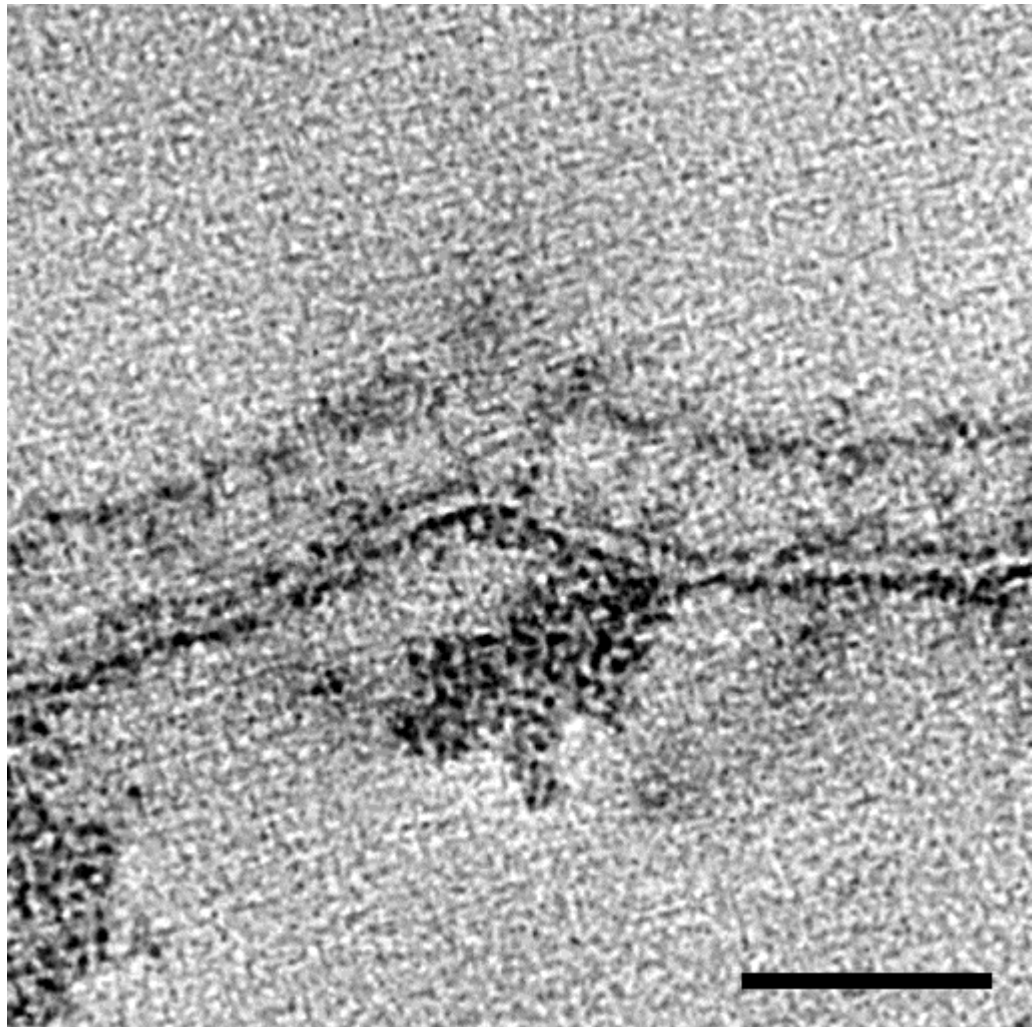
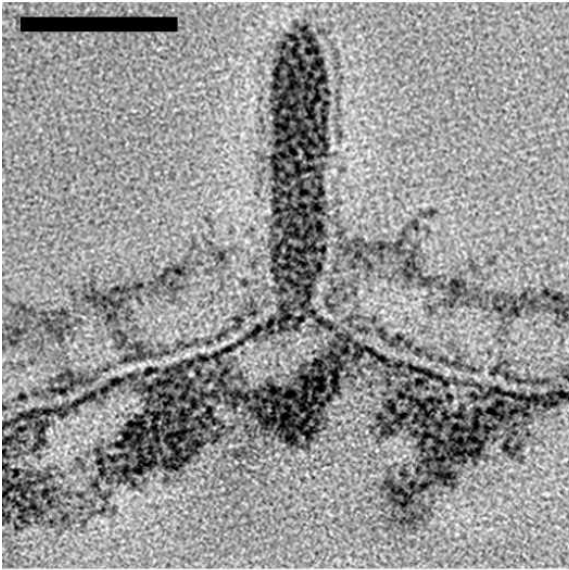
Fuselloviridae: Sulfolobus spindle-shaped virus 1, SSV1



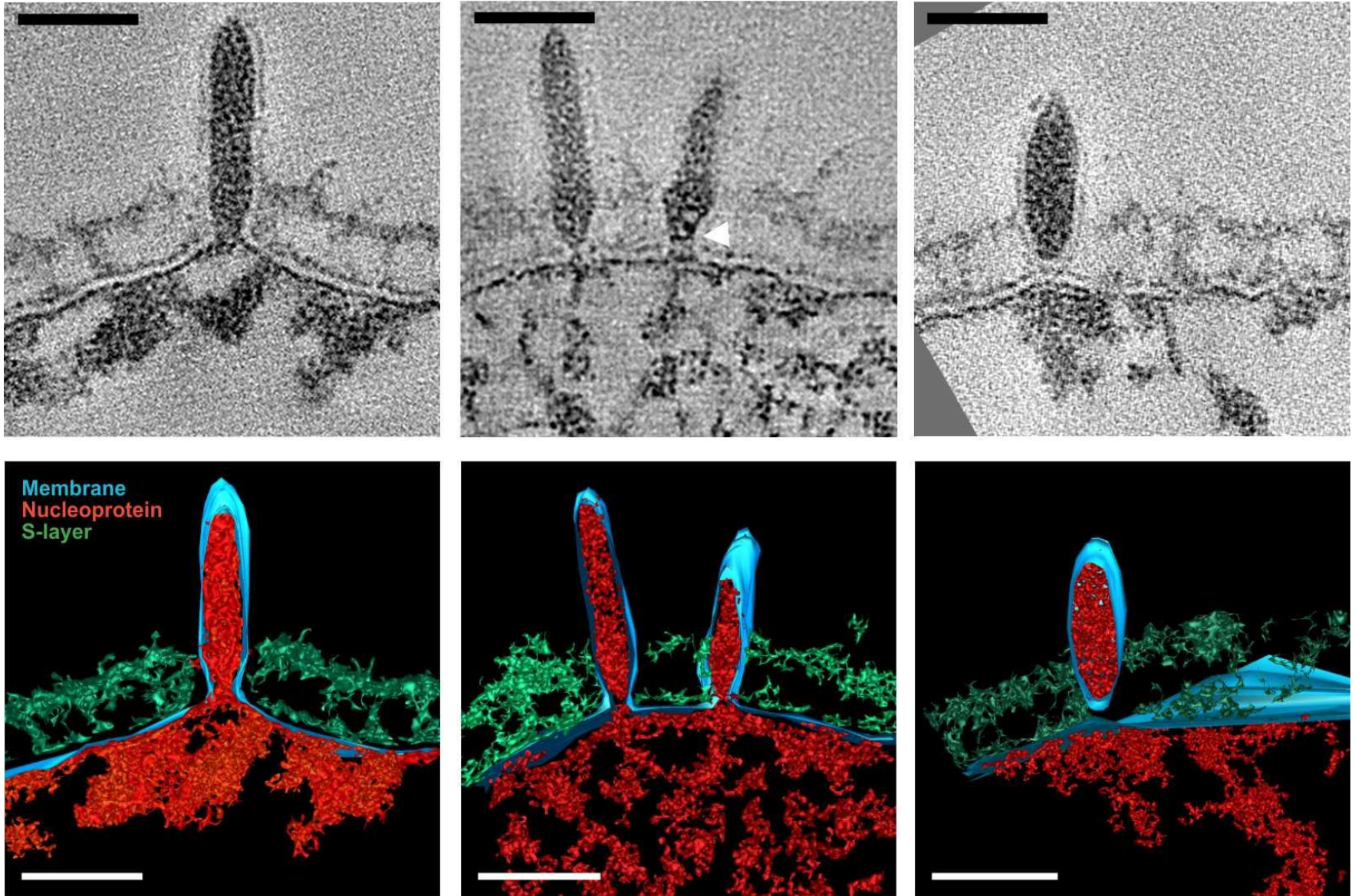
Circular dsDNA
14.814 bp



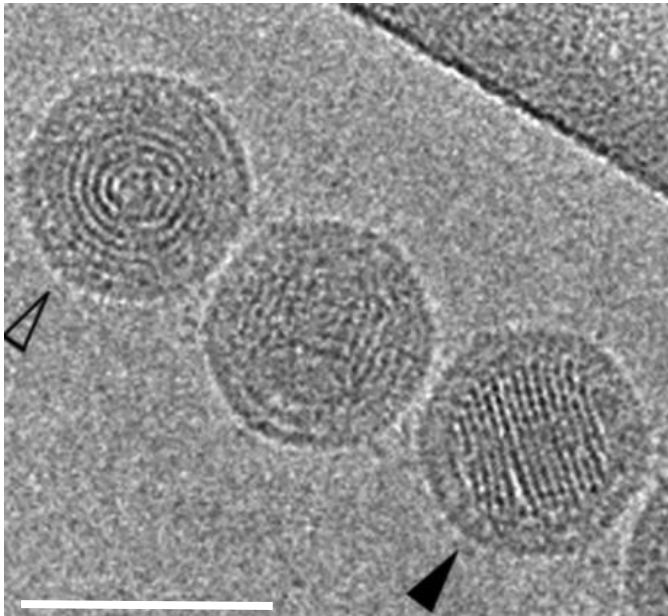
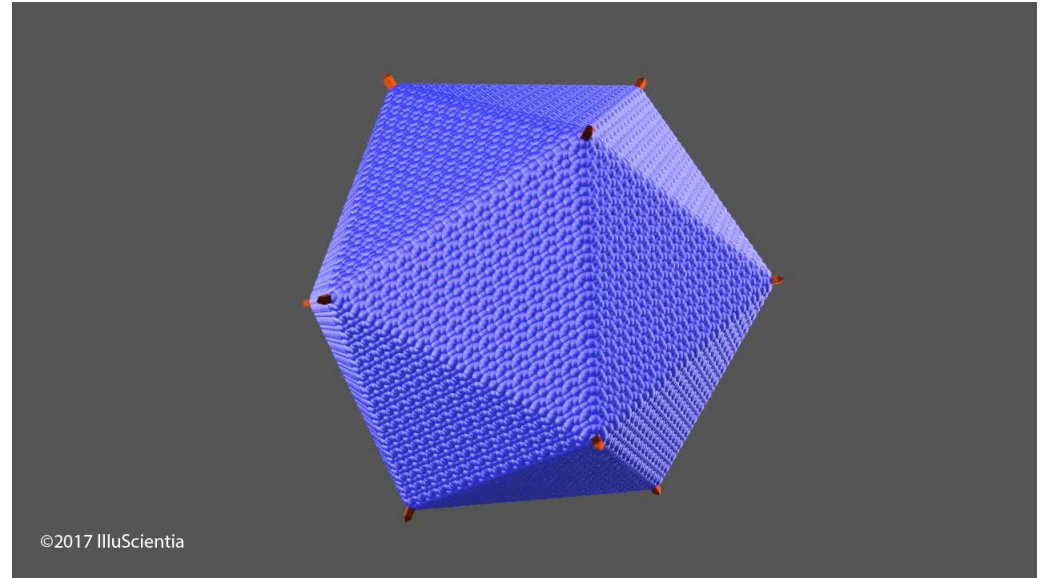
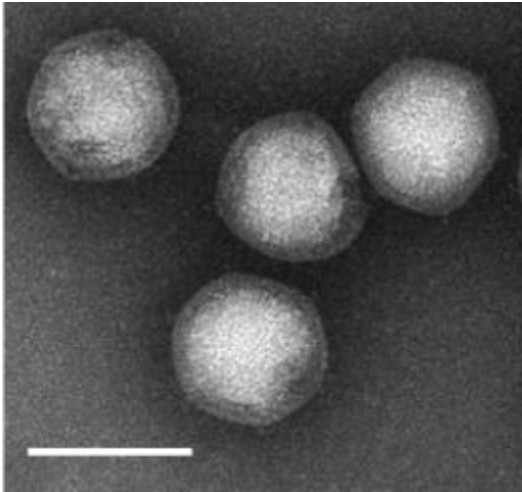
Assembly and egress of the virus SSV1 from the host cell



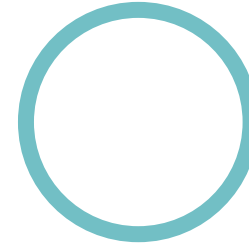
Assembly and egress of the virus SSV1 from the host cell



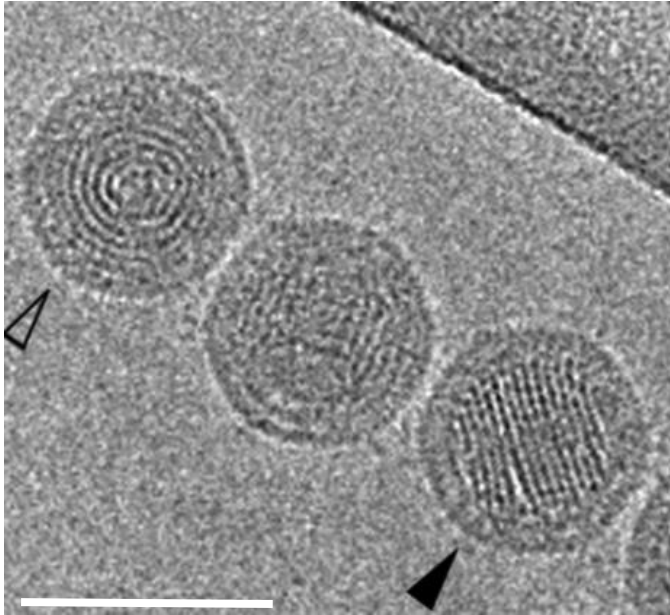
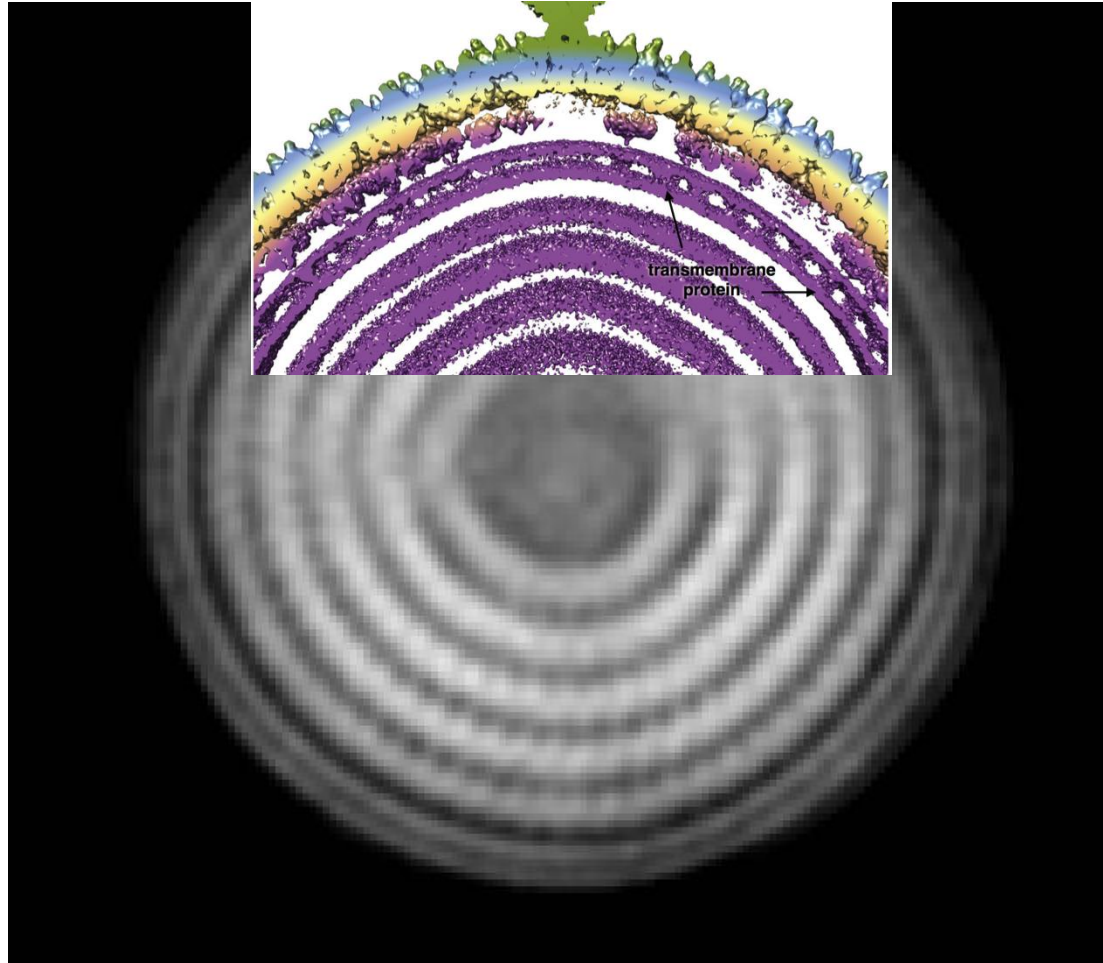
Portogloboviridae: *Aeropyrum pernix* bacilliform virus 1, APBV1



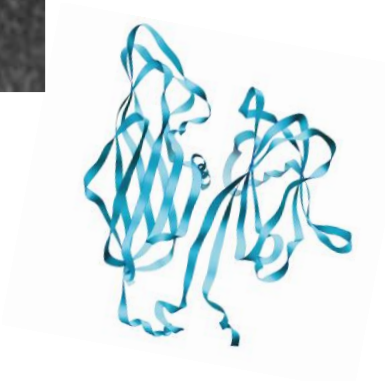
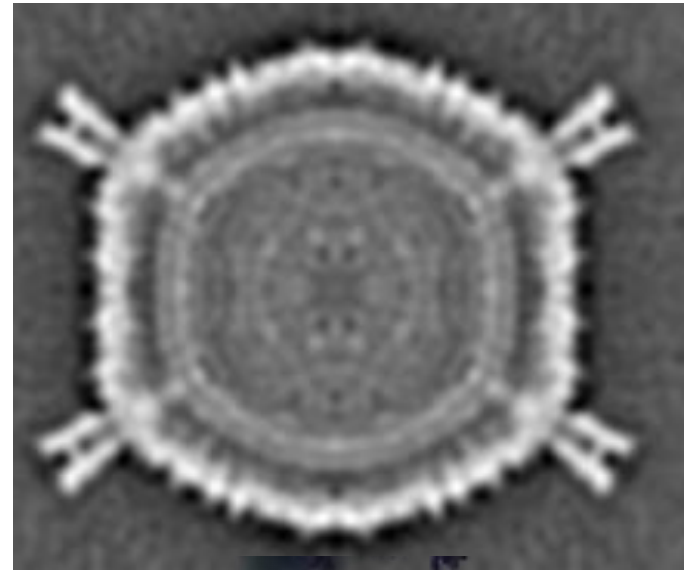
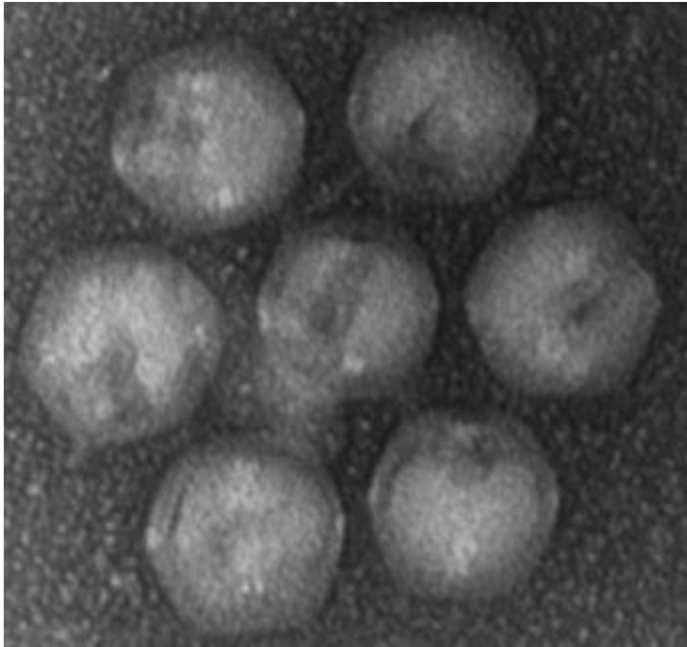
circular dsDNA
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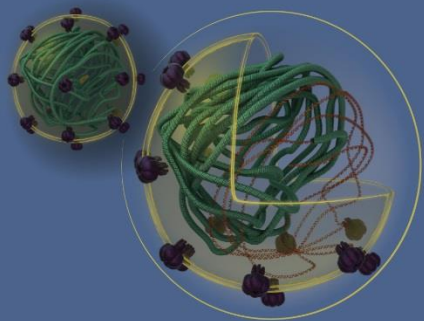
Portogloboviridae: Aeropyrum pernix bacilliform virus 1, APBV1



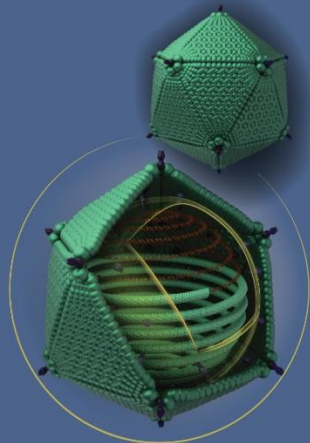
Turriviridae



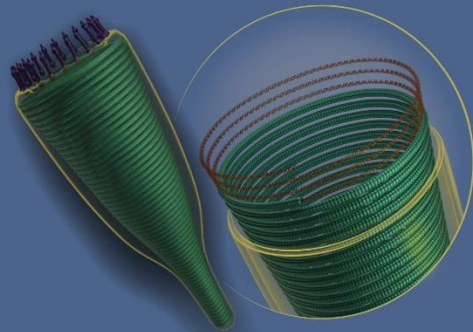
Globuloviridae



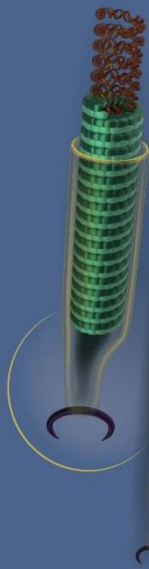
Portogloboviridae



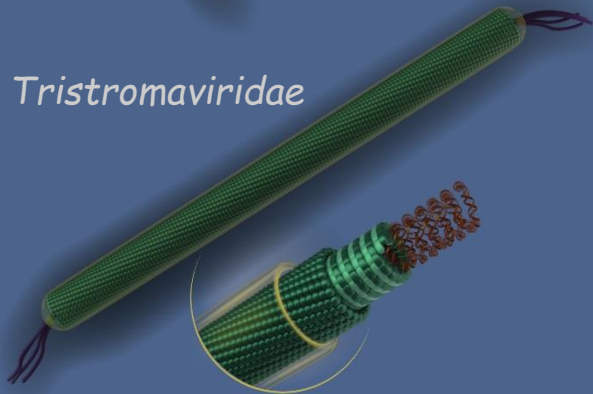
Ampullaviridae



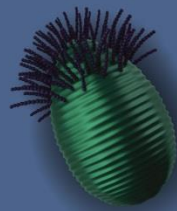
Lipothrixviridae



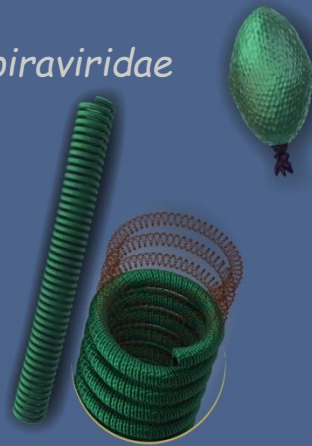
Tristromaviridae



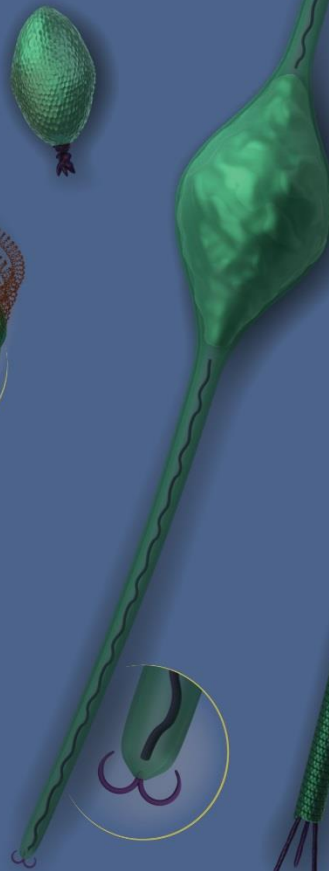
Guttaviridae



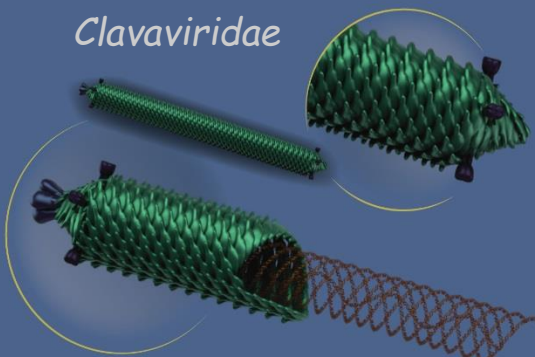
Spiraviridae



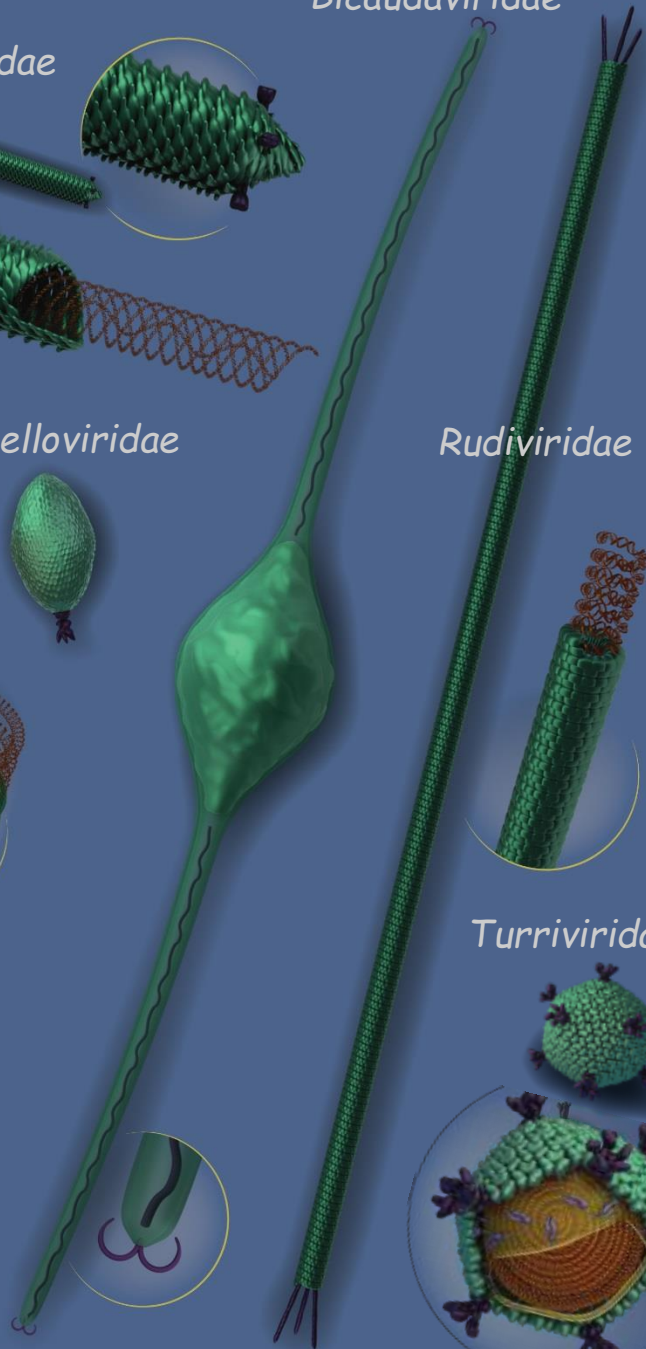
Fuselloviridae



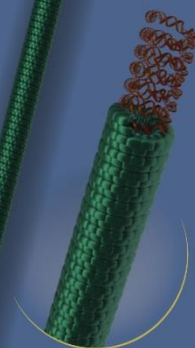
Clavaviridae



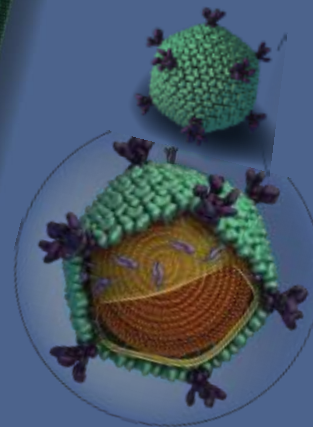
Bicaudaviridae

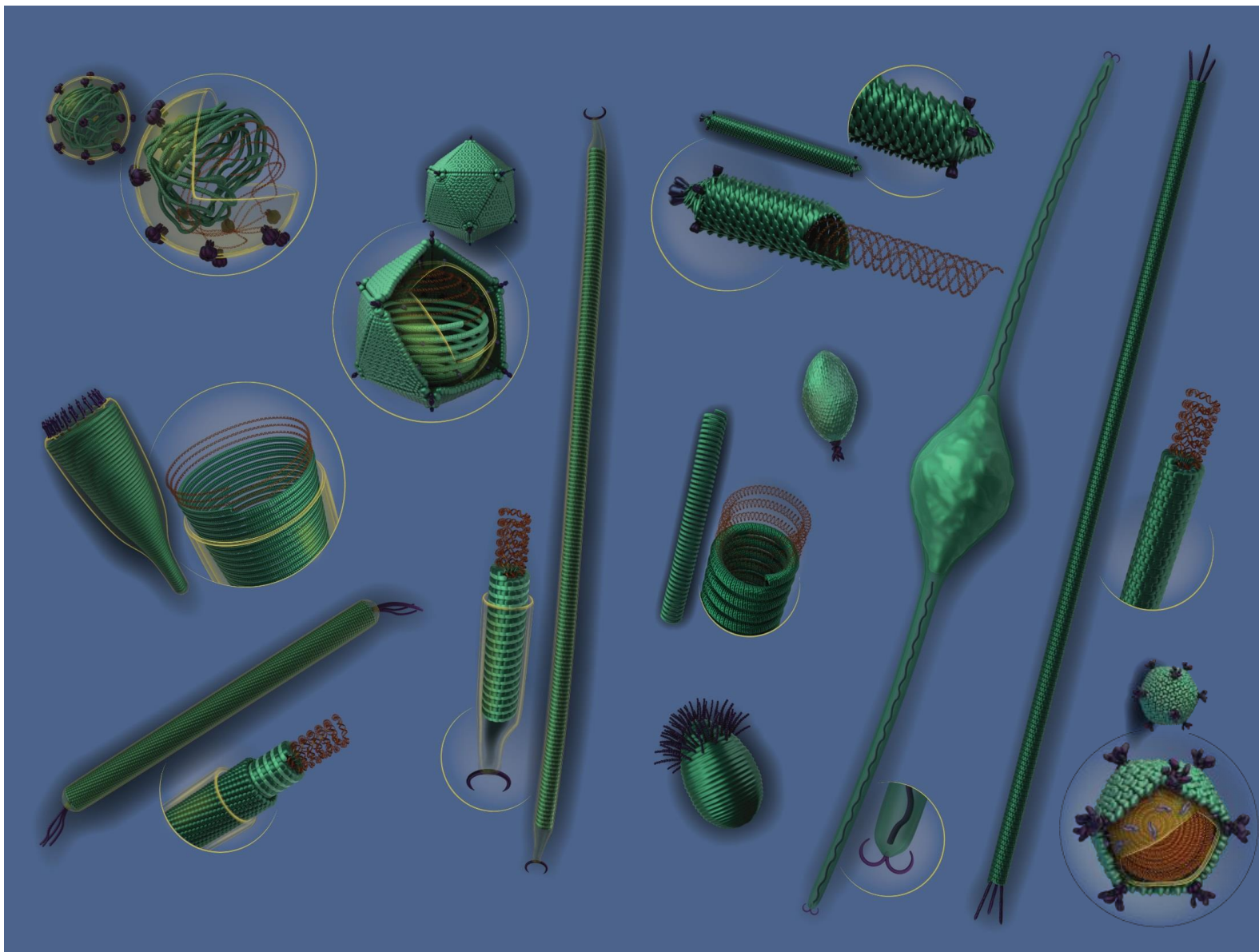


Rudiviridae

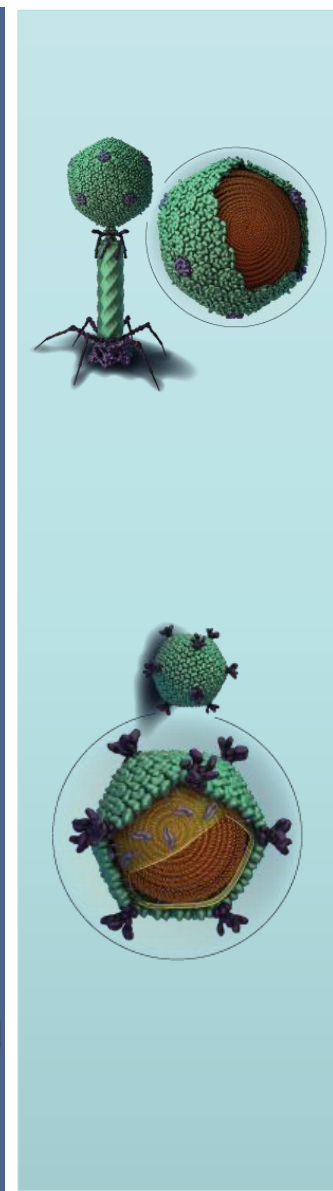


Turriviridae





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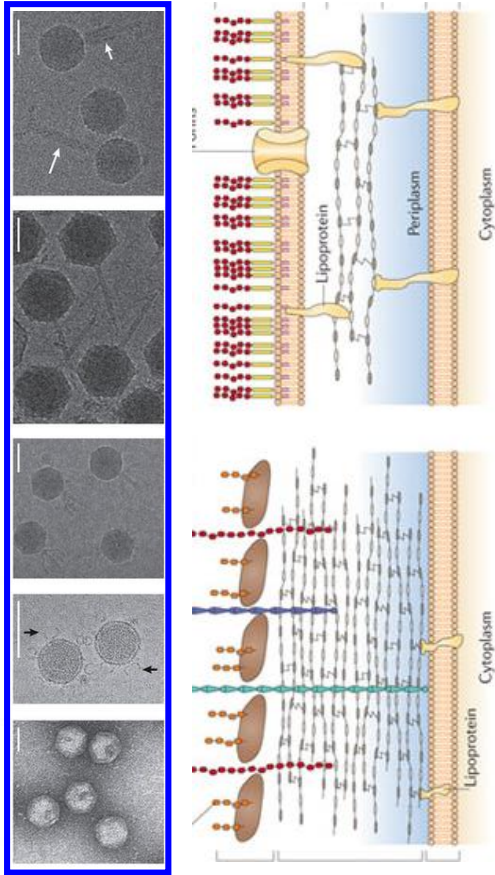


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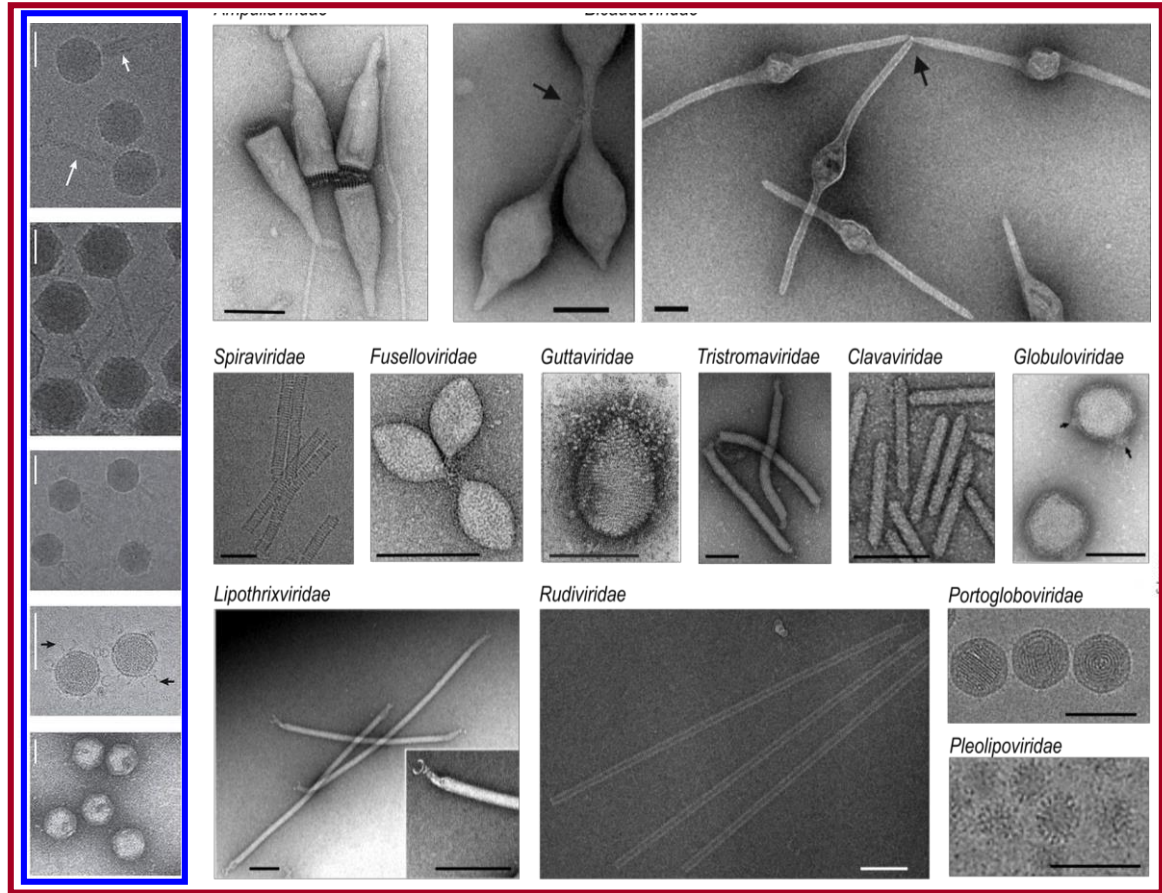
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DS-DNA VIRUSES



BACTERIA



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Distinctions between bacterial and archaeal virospheres are associated with the fundamental differences in envelope compositions of host cells